



## 2007 Area Source Emissions Inventory Methodology 670-WASTE BURNING UNSPECIFIED

### I. Purpose

This document describes the Area Source Methodology used to estimate emissions of carbon monoxide (CO), nitrogen oxides (NO<sub>x</sub>), fine particulate matter less than 10 microns (PM<sub>10</sub>), volatile organic compounds (VOC) and sulfur oxides (SO<sub>x</sub>) from Unspecified Waste Burning within the San Joaquin Valley.

### II. Applicability

The emission calculations from this Area Source Methodology apply to sources that are identified by the following Category of Emission Source (CES) code and Reconciliation Emission Inventory Code (REIC):

**Table 1. Emission inventory codes.**

CES	REIC	Description
82131	670-995-0240-0000	Waste Burning Unspecified

**Table 2. Emission Inventory Codes (EIC) that reconcile to REIC 670-995-0240-0000 (Waste Burning Unspecified).**

EIC	Source Type
670-995-0240-9854	Waste Burning Unspecified – Fertilizer Sacks
670-995-0240-9868	Waste Burning Unspecified – Pesticide/Seed Sacks
670-995-0240-9864	Waste Burning Unspecified – Other
670-995-0240-9848	Waste Burning Unspecified – Diseased Bee Hives
670-995-0240-9846	Waste Burning Unspecified – Diseased Animals
670-995-0240-9852	Waste Burning Unspecified – Diseased Field Crops
670-995-0240-9844	Waste Burning Unspecified – Brooder Paper

### III. Point Source Reconciliation

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

#### IV. Methodology Description

This methodology estimates emissions from the burning of agricultural materials not estimated in other source categories. Examples are pesticide/seed/fertilizer sacks burned in the field where they are emptied, brooder paper, and diseased animals and crops.

All open burning, as defined in Rule 4103, requires a valid burn permit and authorization for the specific event. The District authorizes burning events based on predicted meteorological conditions and whether the emissions would cause a public nuisance, impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard. Activity data for each authorized burn events is entered into the District's *Smoke Management System* (SMS) database. Emissions are calculated by multiplying the activity data by an emission factor.

#### V. Activity Data

The activity data for this area source category is defined by:

- A. ACRES - Acres is defined as the area from which the waste was produced, in acres. For example, if the vegetation came from 40 acres of land, 40 acres should be entered into the database.
- B. FUEL LOADING - Fuel loading is a factor that defines the tonnage of burn material that is generated from an acre of a particular vegetation type.
- C. TONS - Tons of burn material is calculated by multiplying ACRES by FUEL LOADING, or can be entered directly if known.

#### VI. Emission Factors

The Air Resources Board compiled a list of emission factors by crop type based on AP-42 values, and from a study conducted by B.M. Jenkins (Gaffney, 2000). Fuel loading values from AP-42 (EPA, 1992) are also associated with each emission factor. Some of the factors and values were adjusted as needed by the District to better reflect the conditions in the San Joaquin Valley. The emission factors are presented in the table below with more detail provided in Appendix A.

Table 3. Unspecified waste burning emission factors.

EIC Code	Crop Name	Emission Factors (lbs/ton)				
		NOx	SOx	CO	VOC	PM10
670-995-0240-9854	Fertilizer Sacks	4.49	0.61	113.95	10.73	15.90
670-995-0240-9868	Pesticide/Seed Sacks	4.49	0.61	113.95	10.73	15.90
670-995-0240-9864	Other	Case by case basis				
670-995-0240-9848	Diseased Bee Hives	4.49	0.61	113.95	10.73	15.90
670-995-0240-9846	Diseased Animals	Case by case basis				
670-995-0240-9852	Diseased Field Crops	Case by case basis				
670-995-0240-9844	Brooder Paper	4.27	0.14	64.69	4.35	0.78

## VII. Emission Calculations

The Smoke Management System allows information regarding a burn to be reported in acres or individual fuel loading capacity if known. Equation A is used when the actual fuel loading is not known. Otherwise, Equation B is used. Then, the emissions from each burn are computed, summed and totaled by county and year.

### Equation A:

$$\text{Emission (tons)} = \text{Acreage Burned} \times \frac{\text{Tons Fuel}}{\text{Acre}} \times \frac{\text{Pounds of Emissions}}{\text{Ton of Fuel}} \times \frac{1 \text{ Ton}}{2,000 \text{ Pounds}}$$

### Equation B:

$$\text{Emission (tons)} = \text{Tons Fuel Burned} \times \frac{\text{Pounds of Emissions}}{\text{Ton of Fuel}} \times \frac{1 \text{ Ton}}{2,000 \text{ Pounds}}$$

### Example PM10 Emissions, Burn #1:

Given that 20 acres of brooder paper was burned with a fuel loading of 0.030 tons per acre and an emission factor of 0.78 pounds per ton.

$$\text{Emission (tons)} = \text{Acreage Burned} \times \frac{\text{Tons Fuel}}{\text{Acre}} \times \frac{\text{Pounds of Emissions}}{\text{Ton of Fuel}} \times \frac{1 \text{ Ton}}{2,000 \text{ Pounds}}$$

$$\text{PM10 Emission (tons)} = 20 \text{ Acreage Burned} \times \frac{0.030 \text{ Tons Fuel}}{\text{Acre}} \times \frac{0.78 \text{ Pounds of Emissions}}{\text{Ton of Fuel}} \times \frac{1 \text{ Ton}}{2,000 \text{ Pounds}}$$

$$\text{PM10 Emission} = 0.0002 \text{ tons}$$

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### Example PM10 Emissions, Burn #2:

Given that 2.8 tons of fertilizer sacks was burned with an emission factor of 15.9 pounds per ton.

$$\text{Emission (tons)} = \text{Tons Fuel Burned} \times \frac{\text{Pounds of Emissions}}{\text{Ton of Fuel}} \times \frac{1 \text{ Ton}}{2,000 \text{ Pounds}}$$

$$\text{PM10 Emission (tons)} = 2.8 \text{ Tons Fuel Burned} \times \frac{15.9 \text{ Pounds of Emissions}}{\text{Ton of Fuel}} \times \frac{1 \text{ Ton}}{2,000 \text{ Pounds}}$$

$$\text{PM10 Emission} = 0.02 \text{ tons}$$

## VIII. Temporal Variation

### A. Daily

ARB Code 24. 24 hours per day - uniform activity during the day

### B. Weekly

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

### C. Monthly

Monthly temporal variation for unspecified waste burning was extracted from the District's *Smoke Management System* and is presented in Appendix B.

## IX. Spatial Variation

Burn locations are defined by street address in the *Smoke Management System*. The street addresses are converted to Latitude and Longitudes, and UTM's.

## X. Growth Factor

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

## XI. Control Level

Control levels are developed by either the District's Planning Department or CARB for each EIC. Control levels are used to estimate emissions reductions in future years due to implementation of District rules. These control levels take into account the effect of control technology, compliance and exemptions at full implementation of the rules.

Unspecified waste burning in the San Joaquin Valley is subject to District Rule 4103 (Open Burning). Control measures specified in Rule 4103 are reflected in the reduction in amount of material burned. Control levels associated with this emissions category may be obtained from the Air Quality Analysis Section of the District's Planning Department.

## XII. ARB 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 profile for unspecified waste burning is presented in Table 4.

**Table 4. CARB chemical speciation profile for agricultural burning.**

Profile Description	ARB Organic Gas Profile#	Fractions	
		ROG	VOC
Species unknown - all category composite	600	0.6986	0.6986

CARB has also 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<sub>10</sub>) or particulate matter with a diameter less than or equal to 2.5 microns (PM<sub>2.5</sub>) given any one of the three values. For each speciation profile, the fraction of PM that is PM<sub>10</sub> and PM<sub>2.5</sub> is given. The particulate matter profile codes can also be used to lookup associated toxics. CARB's speciation profile for unspecified waste burning is presented in Table 5.

**Table 5. CARB chemical speciation profile for agricultural burning.**

Profile Description	ARB Organic Gas Profile#	Fractions	
		PM <sub>10</sub>	PM <sub>2.5</sub>
Waste Burning	462	0.9825	0.9316

### XIII. Assessment Of Methodology

Emissions calculations are based on amount of material burned. This method is deemed to be an accurate method for calculating emissions for this area source category, provided that the characterization of amount of burn material is true and accurate.

### XIV. Emissions

The 2007 area source emissions inventory for unspecified waste burning is presented in Appendix C..

### XV. Revision History

2007. Process rates were updated.

2006 The methodology was reformatted to the new District standard. Process rates were updated.

2005. This is a new District methodology.

### XVI. Update Schedule

In an effort to provide inventory information to ARB and other District programs and maximize limited resources, the District has developed an update cycle based on emissions within the source category as shown in Table 7.

**Table 6. Area source update frequency criteria.**

Total Emissions (Tons/Day)	Update Cycle (Years)
<1	4
>1 and <= 2.5	3
>2.5 and <=5	2
>5	1

Even though emissions for this source category are less than one ton per day, this area source estimate will be updated every year since the data is readily available in our compliance database.

## **XVII. References**

1. Environmental Protection Agency. 1995. AP-42 Chapter 2, Section 2.5.2.3: Open burning, agricultural waste.
2. Gaffney, P. 2000. California Air Resources Board [pgaffney@arb.ca.gov](mailto:pgaffney@arb.ca.gov) (916) 322-7303 <http://www.arb.ca.gov/ei/see/mngdburnemissionfactors.pdf>.
3. Jenkins, B., Atmospheric Pollutant Emission Factors from Open Burning of Agricultural and Forest Biomass by Wind Tunnel Simulation, April 1996, UC Davis.
4. Hardy, C.C.; Conard, S.G.; Regelbrugge, J.C.; Teesdale, D.R. 1996. Smoke emissions from prescribed burning of southern California chaparral. Res. Pap. PNW-RP-486. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 37 p.
5. Peterson, J. and Ward, D. 1989. An inventory of particulate matter and air toxic emissions from prescribed fires in the United States for 1989, final report. USDA Forest Service, Pacific Northwest Research Station, Fire and Environmental Research Applications, Seattle, WA.

## **XVIII. Appendices**

Appendix A. Unspecified Waste Burning Emission Factors

Appendix B. Monthly Temporal Data

Appendix C. Emissions

## Appendix A.

Table 7. Unspecified waste burning emission factors.

Material Type (SMS Code)	Emissions (lb/ton)						Fuel Loading (tons/acre)	Source of Data
	PM <sub>10</sub>	PM <sub>2.5</sub>	NOx	SO <sub>2</sub>	VOC	CO		
Brooder paper (703)	0.78	0.74	4.27	0.14	4.35	64.69	0.030	PM & loading from UCDA/Asbaugh, NOx, etc from Jenkins pine; using raisin tray
Diseased bee hives (701)	15.90	15.18	4.49	0.61	10.73	113.95	2.175	Average of Alfalfa, Barley, Corn, Oats, Rice, Dafflower, Sorghum, and Wheat (as of 9/12/00, Patrick Gaffney's letter)
Pesticide/seed sacks (258)	15.90	15.18	4.49	0.61	10.73	113.95	2.175	Average of Alfalfa, Barley, Corn, Oats, Rice, Dafflower, Sorghum, and Wheat (as of 9/12/00, Patrick Gaffney's letter)
Fertilizer sacks (257)	15.90	15.18	4.49	0.61	10.73	113.95	2.175	Average of Alfalfa, Barley, Corn, Oats, Rice, Dafflower, Sorghum, and Wheat (as of 9/12/00, Patrick Gaffney's letter)



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Appendix B.

Table 8. Monthly unspecified waste burning activity (2007).

EIC Category	Activity Level by Month (% of annual)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
670-995-0240-9854	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	50.0%	0.0%
670-995-0240-9868	0.4%	6.6%	2.1%	7.2%	3.5%	1.5%	0.2%	13.0%	8.9%	42.7%	13.6%	0.4%
670-995-0240-9864	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
670-995-0240-9848	16.2%	15.5%	21.9%	13.8%	2.2%	0.0%	1.7%	0.0%	4.1%	1.8%	10.5%	12.3%
670-995-0240-9846	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%
670-995-0240-9852	47.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	52.2%
670-995-0240-9844	0.0%	23.1%	23.1%	0.0%	7.7%	0.0%	23.1%	0.0%	0.0%	15.4%	0.0%	7.7%

## Appendix C.

Table 9. Total emissions for unspecified waste burning (2007).

County	Process Rate (Tons)	Emissions (tons/year)				
		NOx	SOx	CO	PM <sub>10</sub>	VOC <sup>(1)</sup>
<b>670-995-0240-9854 - Fertilizer Sack)</b>						
Fresno	2.00	0.00	0.00	0.11	0.02	0.01
Kern	0.00	0.00	0.00	0.00	0.00	0.00
Kings	0.00	0.00	0.00	0.00	0.00	0.00
Madera	0.00	0.00	0.00	0.00	0.00	0.00
Merced	0.00	0.00	0.00	0.00	0.00	0.00
San Joaquin	0.00	0.00	0.00	0.00	0.00	0.00
Stanislaus	0.00	0.00	0.00	0.00	0.00	0.00
Tulare	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>2.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.11</b>	<b>0.02</b>	<b>0.01</b>
<b>670-995-0240-9868 - Pesticide/Seed Sacks</b>						
Fresno	154.55	0.35	0.05	8.81	1.23	0.83
Kern	8.70	0.02	0.00	0.50	0.07	0.05
Kings	0.00	0.00	0.00	0.00	0.00	0.00
Madera	2.18	0.00	0.00	0.12	0.02	0.01
Merced	0.00	0.00	0.00	0.00	0.00	0.00
San Joaquin	0.00	0.00	0.00	0.00	0.00	0.00
Stanislaus	0.00	0.00	0.00	0.00	0.00	0.00
Tulare	6.53	0.01	0.00	0.37	0.05	0.04
<b>Total</b>	<b>171.96</b>	<b>0.38</b>	<b>0.05</b>	<b>9.80</b>	<b>1.37</b>	<b>0.93</b>
<b>670-995-0240-9864 - Other</b>						
Fresno	0.00	0.00	0.00	0.00	0.00	0.00
Kern	0.00	0.00	0.00	0.00	0.00	0.00
Kings	0.00	0.00	0.00	0.00	0.00	0.00
Madera	0.00	0.00	0.00	0.00	0.00	0.00
Merced	0.00	0.00	0.00	0.00	0.00	0.00
San Joaquin	0.00	0.00	0.00	0.00	0.00	0.00
Stanislaus	0.00	0.00	0.00	0.00	0.00	0.00
Tulare	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>	<b>0.00</b>

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County	Process Rate (Tons)	Emissions (tons/year)				
		NOx	SOx	CO	PM <sub>10</sub>	VOC <sup>(1)</sup>
<b>670-995-0240-9848 - Diseased Bee Hives</b>						
Fresno	5.18	0.01	0.00	0.29	0.04	0.03
Kern	0.00	0.00	0.00	0.00	0.00	0.00
Kings	22.70	0.05	0.01	1.29	0.18	0.12
Madera	8.35	0.02	0.00	0.48	0.07	0.05
Merced	8.53	0.02	0.00	0.49	0.07	0.05
San Joaquin	3.18	0.01	0.00	0.18	0.03	0.02
Stanislaus	9.53	0.02	0.00	0.54	0.08	0.05
Tulare	30.40	0.07	0.01	1.73	0.24	0.16
<b>Total</b>	<b>87.87</b>	<b>0.20</b>	<b>0.02</b>	<b>5.00</b>	<b>0.71</b>	<b>0.48</b>
<b>670-995-0240-9846 - Diseased Animals</b>						
Fresno	0.00	0.00	0.00	0.00	0.00	0.00
Kern	0.00	0.00	0.00	0.00	0.00	0.00
Kings	0.25	0.00	0.00	0.01	0.00	0.00
Madera	0.00	0.00	0.00	0.00	0.00	0.00
Merced	0.50	0.00	0.00	0.01	0.00	0.00
San Joaquin	0.00	0.00	0.00	0.00	0.00	0.00
Stanislaus	0.00	0.00	0.00	0.00	0.00	0.00
Tulare	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>0.75</b>	<b>0.00</b>	<b>0.00</b>	<b>0.02</b>	<b>0.00</b>	<b>0.00</b>
<b>670-995-0240-9852 Diseased Field Crops</b>						
Fresno	0.00	0.00	0.00	0.00	0.00	0.00
Kern	200.10	0.49	0.06	13.28	2.25	3.96
Kings	0.00	0.00	0.00	0.00	0.00	0.00
Madera	0.00	0.00	0.00	0.00	0.00	0.00
Merced	0.00	0.00	0.00	0.00	0.00	0.00
San Joaquin	0.00	0.00	0.00	0.00	0.00	0.00
Stanislaus	0.00	0.00	0.00	0.00	0.00	0.00
Tulare	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>200.1</b>	<b>0.49</b>	<b>0.06</b>	<b>13.28</b>	<b>2.25</b>	<b>3.96</b>
<b>670-995-0240-9844 - Brooder Paper</b>						
Fresno	0.00	0.00	0.00	0.00	0.00	0.00
Kern	0.00	0.00	0.00	0.00	0.00	0.00
Kings	0.00	0.00	0.00	0.00	0.00	0.00
Madera	0.39	0.00	0.00	0.01	0.00	0.00
Merced	0.00	0.00	0.00	0.00	0.00	0.00
San Joaquin	0.00	0.00	0.00	0.00	0.00	0.00
Stanislaus	0.00	0.00	0.00	0.00	0.00	0.00
Tulare	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>0.39</b>	<b>0.00</b>	<b>0.00</b>	<b>0.01</b>	<b>0.00</b>	<b>0.00</b>
<b>GRAND TOTAL</b>	<b>463.07</b>	<b>1.07</b>	<b>0.13</b>	<b>28.22</b>	<b>4.35</b>	<b>5.38</b>

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**Table 10. Net emissions change for waste burning (2007-2006).**

County	Emissions (tons/year)				
	NO <sub>x</sub>	SO <sub>x</sub>	CO	PM <sub>10</sub>	VOC <sup>(1)</sup>
Fresno	-0.01	0.00	0.03	0.00	0.01
Kern	0.36	0.04	10.07	1.8	3.66
Kings	-0.01	0.00	-0.35	-0.05	-0.04
Madera	0.00	0.00	0.16	0.03	0.02
Merced	0.00	0.00	0.09	0.01	0.01
San Joaquin	-0.77	-0.11	-19.71	-2.75	-1.86
Stanislaus	0.00	0.00	0.06	0.01	0.00
Tulare	0.02	0.00	0.56	0.07	0.05
<b>TOTAL</b>	<b>-0.41</b>	<b>-0.07</b>	<b>-9.09</b>	<b>-0.88</b>	<b>1.85</b>

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