San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

2007 Area Source Emissions Inventory Methodology
670 – RANGE IMPROVEMENT

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 then 10 microns (PM_{10}), volatile organic compounds (VOC), and sulfur oxides (SO_x) from range improvement burns in the San Joaquin Valley Air Basin. 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 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
47282	670-664-0200-9876	Range Improvement

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 source category is used to measure emissions from range improvement burn operations. Range improvement is defined as the removal of unwanted vegetation through burning operations for the purpose of improving or establishing livestock grazing, watershed conditions, wildlife habitat, or similar purposes. This includes vegetation management programs (VMPs), duck clubs, wildlife reserves, and grassland burning operations.

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 total emissions generated 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 event is entered into the District's *Smoke Management System* (SMS) database. Emissions are calculated by multiplying the activity data by crop or vegetation specific emission factors.

V. Activity Data

Activity data for range improvement burning was obtained from the District's *Smoke Management System*. Activity data for each burn event includes the following:

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.

For 2007, no range improvement burns were recorded in the District's *Smoke Management System*.

VI. Emission Factors

Emission factors for range improvement operations are included in Appendix A.

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:

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

Equation B:

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

Example PM10 Emissions, Burn #1:

Given that 20 acres of chaparral was burned with a fuel loading of 23 ton per acre and an emission factor of 20.10 pounds per ton.

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

$$PM10\ Emission\,(tons) = 20\ Acreage\ Burned \times \frac{23\ Tons\ Fuel}{Acre} \times \frac{20.10\ Pounds\ of\ Emissions}{Ton\ of\ Fuel}\ x\ \frac{1\ Ton}{2{,}000\ Pounds}$$

$$PM10\ Emission = 4.62\ tons$$

Example PM10 Emissions, Burn #2:

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

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

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

$$PM10\ Emission = 0.02\ tons$$

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 range improvement burning was extracted from the District's *Smoke Management System*. Temporal variation data for range improvement is provided below and is based on burn dates entered in the database in this category.

Table 2. Range improvement burn activity (2007).

Month	Activity Level (% of annual)
January	0.0%
February	0.0%
March	0.0%
April	0.0%
May	0.0%
June	0.0%
July	0.0%
August	0.0%
September	0.0%
October	0.0%
November	0.0%
December	0.0%
Total	0.0%

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 UTMs.

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.

Range improvement 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 range improvement burning is presented in Table 3.

Table 3. CARB chemical speciation profile for agricultural burning.

Profile Description	ARB Organic Gas Profile#	Fractions	
		ROG	VOC
Forest Fires	307	0.5698	0.5698

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_{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 profile for range improvement burning is presented in Table 4.

Table 4. CARB chemical speciation profile for agricultural burning.

Profile Description	ARB Organic Gas Profile#	Fractions	
		PM_{10}	$PM_{2.5}$
Range Improvement Burning	441	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, provided that the characterization of the amount of burn material is accurate.

XIV. Emissions

For 2007, there were no range improvement burns reported in the District. Following is the 2007 total unreconciled emissions inventory for REIC 670-664-0200-9876. Emissions are reported for each county in the District.

Table 5. Total emissions for REIC 670-664-0200-9876 (2007).

County	Emissions (tons/year)					
	NOx	CO	SOx	VOC	PM_{10}	$PM_{2.5}$
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
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00

(1) The District only reports ROG to ARB. 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.

Following is the net change in total emissions between this update (2007 inventory year) and the previous update (2006 inventory year) for REIC 670-664-0200-9876. The change in emissions are reported for each county in the District.

Table 6. Net emission change REIC 670-664-0200-9876 (2007-2006).

County	Emissions (tons/year)					
	NOx	CO	SOx	VOC	PM_{10}	$PM_{2.5}$
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	-0.01	-0.12	-0.00	-0.01	-0.02	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
TOTAL	-0.01	-0.12	-0.00	-0.01	-0.02	0.00

(1) The District only reports ROG to ARB. 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

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 7. 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. 1992. AP-42 Chapter 2, Section 2.5.2.3: Open burning, agricultural waste.

2. Gaffney, P. 2000. Draft Memorandum to Bill Sandman, Colusa County Air Pollution Control District from Patrick Gaffney, Emission Inventory Branch, California Air Resources Board dated May 23, 2000.

3. 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.

4. Jenkins, B., 1996. Atmospheric pollutant emission factors from open burning of agricultural and forest biomass by wind tunnel simulations. April 1996, UC Davis. Tables 4.1.1 to 4.1.8.

Appendix A. Range Improvement Emission factors.

Table 8. Range improvement emission factors.

Vegetation Type (SMS Code)	Emissions (lb/ton)							Fuel Loading (tons/acre)	Source of Data
	PM_{10}	$PM_{2.5}$	NOx	SO_2	VOC	CO	NH_3		
Chaparral (362)	20.10	17.30	3.50	0.10	14.40	153.70	2.43	23.000	Jenkins fir & pine; Hardy, 1996, NOx & SOx avg.
Grassland (398)	15.90	15.20	4.50	0.60	10.70	114.00	1.80	3.200	Average of Alfalfa, Barley, Corn, Oats, Rice, Dafflower, Sorghum, and Wheat (as of 9/12/00, Patrick Gaffney's letter)
Pasture (607)	15.90	15.18	4.49	0.61	10.73	113.95	1.80	2.175	Average of Alfalfa, Barley, Corn, Oats, Rice, Dafflower, Sorghum, and Wheat (as of 9/12/00, Patrick Gaffney's letter)