



2006 Area Source Emissions Inventory Methodology

199 – BIOLOGICAL WASTE DISPOSAL - UNSPECIFIED

I. Purpose

This document describes the Area Source Methodology used to estimate emissions of volatile organic compounds (VOC) and ammonia (NH₃) from the land application of biosolids in the San Joaquin Valley Air Basin. Biosolids are nutrient-rich organic materials resulting from the treatment of domestic sewage in a treatment facility. When treated and processed, these residuals can be (1) applied to land directly as fertilizer; (2) transported to a composting facility (for eventual application to land); (3) heat-dried (for eventual application to land as fertilizer); (4) disposed of at a landfill; or (5) incinerated. This methodology only estimates emissions from the land application of biosolids. Emissions from the composting of biosolids is reported in EIC 199-170-0260-0000, and emissions from the landfilling of biosolids is reported in EIC 120-122-0242-0000. Biosolids are not currently heat dried or incinerated within the District, and this methodology does not include emissions from biosolids that were composted prior to land application.

II. Applicability

The emission calculations from this Area Source Methodology apply to facilities 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
66712	199-995-0260-0000	Biological Wastes (Unspecified)

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 our point source inventory, so reconciliation is not necessary.

IV. Methodology Description

Biosolids are primarily organic materials produced during wastewater treatment. These materials may be (1) applied to land directly as fertilizer; (2) transported to a composting facility (for eventual application to land); (3) heat-dried (for eventual application to land as fertilizer); (4) disposed of at a landfill; or (5) incinerated. Biosolids may be processed by one of these means at the waste water treatment facility (WWTF) at which they are generated, or transported to another facility for processing.

The recycling of biosolids by land application is considered a beneficial use by the EPA since it supplies nutrients and replenishes soil organic matter. Biosolids can be applied to agricultural land, forests, rangelands, or disturbed land in need of reclamation (EPA, 2000). Biosolids can be applied to land in several different ways depending on the type of land and the consistency of the biosolids. Liquid biosolids (94 to 97% water) can be injected into the soil. More commonly, biosolids are dewatered to reduce storage and transportation costs. Dewatered biosolids (approximately 30% solids) are the consistency of damp soil and can be land applied with conventional agricultural equipment, such as manure spreaders pulled by tractors.

In California the nine regional boards of the State Water Resources Control Board (SWRCB) oversee biosolids recycling projects, however no single state agency regulates biosolids management. Currently, the best source of information on biosolids generation and movement is the Environmental Protection Agency (EPA). The EPA Region IX maintains facility-level information with amounts of biosolids produced, stored on site, land applied, composted or landfilled.

For this emissions estimate, biosolids activity data for each county in the District was obtained from the Biosolids Coordinator, Clean Water Act Compliance Office, EPA Region IX. The amount of biosolids reported as having been land applied was multiplied by an emission factor to obtain the emissions estimate.

V. Activity Data

Biosolids generation and movement data was obtained from at EPA Region IX, San Francisco, CA (Lauren Fondahl, July-August 2007). These data sets contained the following types of information:

- The amount of biosolids generated at each waste water treatment facility (WWTF; also know as Publicly Owned Treatment Works or POTWs) in the District.
- How and where each of these facilities disposed of their biosolids.
- The amount of biosolids landfilled within the district by facility and origin of the biosolids.

- The amount of biosolids composed within the district by facility and origin of the biosolids.
- The amount of biosolids land applied within the district by facility and origin of the biosolids.

Due to differences in the way facilities report their biosolid activity, some of the data was expressed on a dry metric ton (dmt) basis and some on a wet ton basis. Twenty of the facilities provided their data in both dry metric tons and wet tons. In order to combine the data sets and estimate emissions, a conversion factor of 1 dmt = 4.14 wet tons was established by regression using data from these 20 facilities (Fig. 1).

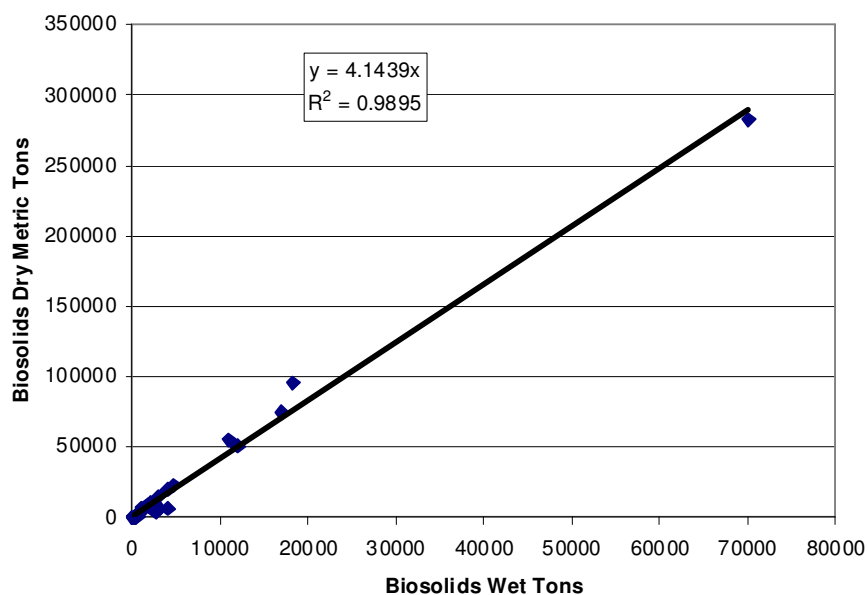


Fig. 1. Relationship between biosolids dry weight (dry metric tons) and wet weight (wet tons) derived from 20 facilities that reported process rates in both units to EPA Region IX (2006).

The data sets from EPA were input into a database, and the biosolids inventory for each county in the District was calculated. The net total inventory for each county was considered the amount produced by their WWTFs plus the amount imported from other counties for processing (composting, land application or landfilling) less the amount exported to other counties. (Table 2).

Table 2. SJVUAPCD county level biosolids inventory for 2006.

County	Biosolids (dry metric tons)			
	Produced	Imported	Exported	Net Total
Fresno	17,338	0	17,238	100
Kern	7,254	239,929	0	247,183
Kings	1,590	49	0	1,639
Madera	590	0	460	130
Merced	2,591	20,843	0	23,434
San Joaquin	7,975	2,137	6,769	3,343
Stanislaus	8,096	0	3,509	4,587
Tulare	9,001	0	3,271	5,730
District Total	54,435	31,047	31,247	286,146

The biosolids within each county that was land applied, composted, landfilled or stored in lagoons at WWTF is presented in Table 3.

Table 3. Use of biosolids within the SJVUAPCS in 2006.

County	Biosolids (dry metric tons)				
	Net Total	Land Applied	Composted	Landfilled	Stored at WWTF
Fresno	100	0	0	0	100
Kern	247,183	105,988	139,876	0	430
Kings	1,639	0	0	49	1,590
Madera	130	0	0	0	130
Merced	23,434	8,092	13,260	0	700
San Joaquin	3,343	476	0	2,137	0
Stanislaus	4,587	4,000	600	0	300
Tulare	5,730	0	0	0	5,730
District Total	280,482	118,556	153,736	2,186	8,980

*Note that the sum of the disposal routes does not equal the net total estimated inventory due to operator reporting error.

VI. Emission factors

Emission factors for the land application of biosolids were obtained from source tests conducted by the South Coast Air Quality Management District (1996) at a sludge composting facility. VOC (as total gaseous non-methane organic compounds) were measured per SCAQMD Method 25.1, and ammonia (primary and secondary amines) was measured using the Ninhydrin method. Measurements were taken from windrows of mixed biosolids and manure after 2, 20 and 50 days (before and after pile turning) using an EPA emission isolation flux chamber. The total facility VOC and NH₃ emissions are summarized in Table 4.

Table 4. Total facility emissions bases on average of 2, 20, and 50-day sludge compost piles.

Pollutant	Emissions per ton of compost mix	Emissions per 1000 ft ² of compost surface area	Emissions per hour - ton of compost mix
NH ₃	3.28 lb/ton mix	0.175 lb/hr-1000 ft ²	2.73E-03 lb/hr-ton
VOC (TGNMOC)	1.70 lb/ton mix	0.090 lb/hr-1000 ft ²	1.42E-03 lb/hr-ton

VII. Emissions Calculations

A. Assumptions

- 1 dry metric ton of biosolids = 4.14 wet tons of biosolids.
- VOC emission factor = 1.70 lb VOC per wet ton of biosolids land applied.
- NH₃ emission factor = 3.28 lb NH₃ per wet ton of biosolids land applied.

B. Sample Calculations

Emissions for Kern County

Step 1. Convert the biosolids process rate from dry metric tons to wet tons:

$$\text{Biosolids}_{\text{wet tons/year}} = \text{Biosolids}_{\text{dry metric tons/year}} * 4.14_{\text{wet tons/dry metric ton}}$$

Example: Given that Kern County land applied 105,988 dry metric tons of biosolids in 2006:

$$\text{Biosolids}_{\text{wet tons/year}} = 105,988_{\text{dry metric tons/year}} * 4.14 = 438,790_{\text{wet tons per year}}$$

Step 2. Multiply the wet tons of biosolids that were land applied by the appropriate emission factor:

$$\text{Emissions}_{\text{lb/year}} = \text{Biosolids}_{\text{wet tons/year}} * \text{Emission Factor}_{\text{lb/wet ton}}$$

Example: Given that Kern County land applied 438,790 wet tons of biosolids in 2006:

$$\text{VOC Emissions}_{\text{lb/year}} = 438,790_{\text{wet tons/year}} * 1.70_{\text{lb VOC/wet ton}}$$

$$\text{VOC Emissions}_{\text{lb/year}} = 745,983$$

Step 3. Convert emissions from pounds per year to tons per year:

$$\text{Emissions}_{\text{tons/year}} = \text{Emissions}_{\text{lbs/year}} / 2,000_{\text{lbs/ton}}$$

Example: Given that Kern County VOC emissions were 745,983 pounds in 2006:

$$\text{VOC Emissions}_{\text{tons/year}} = 745,983_{\text{lbs VOC/year}} / 2,000_{\text{lbs/ton}}$$

$$\text{VOC Emissions}_{\text{tons/year}} = 373.0$$

VIII. Temporal Variation

Although it is expected that land applications of biosolids occur seasonally and emissions have some relationship to ambient temperature, no studies could be found documenting temporal variations. For this reason, we conservatively assume that emissions are uniform.

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

Uniform monthly activity:

Table 5. Monthly activity.

Month (2006)	Activity Level (% of annual)
January	8.3%
February	8.3%
March	8.3%
April	8.3%
May	8.3%
June	8.4%
July	8.4%
August	8.4%
September	8.4%
October	8.3%
November	8.3%
December	8.3%
Total	100.0%

IX. Spatial Variation

For this methodology, emissions were calculated at the county level. More precise location data could be provided by reporting each facility through our point source inventory. In this way, emissions data would be transmitted with the facility's geocode.

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.

The land application of biosolids are subject to District Rule 4565 (Biosolids, Animal Manure, and Poultry Litter Operations) and may be obtained from the Air Quality Analysis Section of the District's Planning Department.

XII. 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 the disposal of unspecified biological wastes (REIC 199-995-0260-0000) is presented in Table 7.

Table 6. CARB organic gas speciation profile for REIC 199-995-0260-0000.

Profile Description	ARB Organic Gas Profile#	Fractions	
		ROG	VOC
Animal Waste Decomposition	203	0.08	0.08

XIII. Assessment Of Methodology

Currently, biosolids land application operations are not permitted by the District and are treated as area sources. Due to the adoption of District Rule 4565 (Biosolids, Animal Manure, and Poultry Litter Operations), these facilities are in the process of being permitted. Once under District permit, their emissions will be reported through the point source inventory.

XIV. Emissions

Following is the 2006 area source emissions inventory for REIC 199-995-0260-0000 estimated by this methodology. Emissions are reported for each county in the District.

Table 8. Area source emissions for REIC 199-995-0260-0000 (2006).

County	Emissions (tons/year)						
	NO _x	CO	SO _x	VOC ⁽¹⁾	PM ₁₀	PM _{2.5} ⁽²⁾	NH ₃
Fresno	--	--	--	0.0	--	--	0.0
Kern	--	--	--	373.0	--	--	719.6
Kings	--	--	--	0.0	--	--	0.0
Madera	--	--	--	0.0	--	--	0.0
Merced	--	--	--	28.5	--	--	54.9
San Joaquin	--	--	--	1.7	--	--	3.2
Stanislaus	--	--	--	14.1	--	--	27.2
Tulare	--	--	--	0.0	--	--	0.0
TOTAL	--	--	--	416.3	--	--	804.9

- (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 2006 point source emissions inventory for REIC 199-995-0260-0000 as reported to the District by our permit holders. Emissions are reported for each county in the District.

Table 9. Point source emissions for REIC 199-995-0260-0000 (2006).

County	Emissions (tons/year)						
	NOx	CO	SOx	VOC ⁽¹⁾	PM ₁₀	PM _{2.5} ⁽²⁾	NH ₃
Fresno	--	--	--	0.0	--	--	0.0
Kern	--	--	--	0.0	--	--	0.0
Kings	--	--	--	0.0	--	--	0.0
Madera	--	--	--	0.0	--	--	0.0
Merced	--	--	--	0.0	--	--	0.0
San Joaquin	--	--	--	0.0	--	--	0.0
Stanislaus	--	--	--	0.0	--	--	0.0
Tulare	--	--	--	0.0	--	--	0.0
TOTAL	--	--	--	0.0	--	--	0.0

- (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 PM2.5 emissions. PM2.5 emissions can be estimated using the speciation profiles found in Section XII.

Following is the 2006 total unreconciled (point source plus area source) emissions inventory for REIC 199-995-0260-0000. Emissions are reported for each county in the District.

Table 10. Total emissions for REIC 199-995-0260-0000 (2006).

County	Emissions (tons/year)						
	NOx	CO	SOx	VOC ⁽¹⁾	PM ₁₀	PM _{2.5} ⁽²⁾	NH ₃
Fresno	--	--	--	0.0	--	--	0.0
Kern	--	--	--	373.0	--	--	719.6
Kings	--	--	--	0.0	--	--	0.0
Madera	--	--	--	0.0	--	--	0.0
Merced	--	--	--	28.5	--	--	54.9
San Joaquin	--	--	--	1.7	--	--	3.2
Stanislaus	--	--	--	14.1	--	--	27.2
Tulare	--	--	--	0.0	--	--	0.0
TOTAL	--	--	--	416.3	--	--	804.9

- (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 PM2.5 emissions. PM2.5 emissions can be estimated using the speciation profiles found in Section XII.

Following is the net change in total unreconciled emissions between this update (2006 inventory year) and the previous update (1996 inventory year) for REIC 199-995-0260-0000. The change in emissions are reported for each county in the District.

Table 11. Net emissions change for REIC 199-995-0260-0000 (2006).

County	Emissions (tons/year)						
	NOx	CO	SOx	VOC ⁽¹⁾	PM ₁₀	PM _{2.5} ⁽²⁾	NH ₃
Fresno	--	--	--	-11.9	--	--	0.0
Kern	--	--	--	373.0	--	--	719.6
Kings	--	--	--	-25.4	--	--	0.0
Madera	--	--	--	0.0	--	--	0.0
Merced	--	--	--	28.5	--	--	54.9
San Joaquin	--	--	--	1.7	--	--	3.2
Stanislaus	--	--	--	14.1	--	--	27.2
Tulare	--	--	--	0.0	--	--	0.0
TOTAL	--	--	--	379.0	--	--	804.9

(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 PM2.5 emissions. PM2.5 emissions can be estimated using the speciation profiles found in Section XII.

XV. Revision History

2007. This is a new District methodology.

XVI. Update Schedule

In an effort to provide needed information to CARB and other District departments and to maximize the limited resource available, the following criteria are used by the District to determine the appropriate update cycle for each area source methodology.

Table 12. District area source update frequency criteria.

Emissions Category (tons/day)	Update Cycle (years)
<1	4
>1 and <= 2.5	3
>2.5 and <=5	2
>5	1

Based upon these criteria, this area source category will be updated every three years.

XVII. References

1. Sonoma Technology inc. (2003). Emission inventory methodology - Biosolids management and imported livestock waste. Methods Document STI-903340-2429g-MD. Prepared for the San Joaquin Valley Unified Air Pollution Control District on November 18, 2003.
2. South Coast Air Quality Management District. (1996). Characterization of ammonia, total amine, organic sulfur compound, and total non-methane organic compound (TGNMOC) emissions from composting operations, Source Test Report 95-0032/96-0003, conducted at EKO Systems, South Coast Air Quality Management District. January 1996.
3. United States Environmental Protection Agency. (2000). Biosolids technology fact sheet: Land application of biosolids. EPA Document 832-F-00-064. September 2000.