San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

2006 Area Source Emissions Inventory Methodology
199 – COMPOSTING WASTE DISPOSAL

I. Purpose

This document describes the Area Source Methodology used to estimate emissions of volatile organic compounds (VOC), ammonia (NH_3), and fine particulate matter less than 10 microns (PM_{10}) from composting facilities in the San Joaquin Valley Air Basin. This methodology only includes emissions from facilities that are subject to the regulations of the Department of Resources, Recycling & Recovery (CalRecycle) pertaining to solid waste transfer, processing or disposal; or collect a tipping fee for composting. Emissions from the composting, drying, or land application of organic wastes generated on farms and used to fertilize farm crops are not included in this methodology. Per guidance from the California Air Resources Board (CARB), these emissions should be included in EIC 530-918-XXXX-XXXX (Agricultural Fertilizer), which is updated by the California Department of Pesticide Regulation. Emissions from the application of biosolids and other organic materials to land solely for disposal are included in EIC 199-995-0260-0000 (Biological Waste Disposal, Unspecified). Backyard composting and unintentional composting are not included in this estimate since we could not find reliable process rates or emission factors for these activities.

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
89490	199-170-0260-0000	Composting Waste Disposal

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 at this time, so reconciliation is not necessary.

IV. Methodology Description

Composting is the decomposition of organic waste by aerobic and anaerobic bacteria and other microorganisms into a nutrient-rich humus-like material. Composting occurs naturally when organic material and microorganisms are incubated under favorable conditions of moisture, temperature and oxygen. Storing organic matter for sufficient time may unintentionally cause it to decompose. Composting may be done to reduce bulk, pathogens, or odors; or divert organic waste from landfills to meet state Assembly Bill (AB) 939[1] waste diversion requirements. A benefit of composting is that the final product can be used to replace fertilizer and enrich the soil.

Compostable organic waste feedstock can come from many sources including the following:

- Biosolids - organic material resulting from the treatment of sewage sludge, or wastewater.
- Animal waste (manure) - non-human animal excretions and waste, including, but not limited to, dried solids and urine from cows or swine.
- Poultry litter - poultry excretions and waste, including, but not limited to, dried solids and urine from chickens, turkeys, geese, or ducks.
- Green waste - leaves, grass clippings, plants, tree prunings, branches, large trees and stumps arising from domestic, agricultural, commercial or municipal activities.
- Pomace - the solid remains of grapes, olives, or other fruit after pressing for juice or oil. It contains the skins, pulp, seeds, and stems of the fruit
- Food waste - any food scraps collected from the food service industry, grocery stores, or residential food scrap collection. Foodwaste also includes foodwaste that is chipped and ground.

[1]Assembly Bill 939, known as the Integrated Waste Management Act, was passed In 1989 because of an increase in the waste stream and a decrease in landfill capacity. AB 939 mandated a reduction of waste being disposed. Jurisdictions were required to meet diversion (recycling) goals of 25% by 1995 and 50% by the year 2000. Proposed legislation (AB 479) would increase the diversion goal to 75% by 2020.

These feedstocks can be composted individually, or mixed. The process where biosolids and/or animal manure and/or poultry litter are mixed with bulking agents (such as green waste) to produce compost is called co-composting.

Commercial composting typically takes place either in windrows or in aerated static piles (ASP). Windrows are naturally ventilated and are usually turned mechanically. Compost windrows can be 3 to 7 feet high, 8 to 20 feet wide, and 50 to 500 feet long. ASPs are large piles that can be 8 to 16 feet high and may cover 2,500 to 25,000 ft^2. They are normally formed over an air distribution system that provides air by either suction or pressure. There are also some hybrid technologies that use a cover on a windrow and may also have a forced air ventilation system. It may take from 45 to 90 days to compost organic waste. The first half of the decomposition cycle can be designated as the active phase of composting and the last half as the curing phase. In addition to the windrows/ASPs, composting facilities also have material stockpiles that store feedstock and product (Card and Schmidt, 2008). Most VOC and NH_3 emissions are generated from the active phase of the composting process and from stockpiles. PM_{10} emissions are primarily from the transfer of materials during receiving and processing.

This area source methodology is a bottom up estimate of VOC, NH_3, and PM_{10} emissions from the composting of organic wastes at facilities within the District. For this estimate, composting facility operators were surveyed to determine the amounts of manure, biosolids, poultry litter, green waste, food waste, pomace or other organic waste received and composted in 2006. These process rates were multiplied by emission factors to estimate VOC, NH_3, and PM_{10} emissions for each facility. Emissions for each county were then calculated as the sum of the emissions of all facilities operating within that county.

V. Activity Data

A list of composting facilities operating within the District was queried from the Department of Resources Recycling and Recovery's (CalRecycle) Solid Waste Information System (SWIS) database. Each facility was surveyed to determine the type and quantity of material composted in 2006. For facilities that did not respond to the survey, throughputs were estimated using data provided by the CalRecycle and EPA Region IX (for biosolids). A list of facilities included in this emissions inventory is provided in Appendix A. A summary of organic wastes composted by type and county is presented in the following table:

Table 2. Organic waste composting process rates by waste type in the SJVAPCD (2006).

County	Organic Waste Composted (tons)						
	Green Waste	Biosolids	Manure	Poultry Litter	Grape Pomace	Food Waste	Other Organic Waste
Fresno	30,303	0	0	0	1,425	0	0
Kern	415,066	457,657	29,308	0	0	308,151	34,779
Kings	125,978	0	0	0	0	2,696	0
Madera	0	0	0	0	0	0	0
Merced	69,343	68,528	8,800	137,549	0	1,500	13,837
San Joaquin	94,591	0	58,561	0	3,000	28,870	0
Stanislaus	265,629	1,246	0	0	0	0	11,727
Tulare	97,894	0	0	0	0	0	0
TOTAL	1,098,804	527,431	96,669	137,549	4,425	341,217	60,343

VI. Emission Factors

A. Volatile Organic Compounds and Ammonia

The District conducted a review of composting source test data (Clements, Norman and Chan, 2010) and developed default volatile organic compound and ammonia emission factors as summarized in the table below:

Table 3. Summary of composting volatile organic compound and ammonia emission factors.

Type of Waste	Emission Factor (lb /wet ton)	
	VOC	NH_3
Biosolids, manure, poultry litter	1.78	2.93
Green waste, food waste, pomace	9.75[1]	1.50

[1]Includes stockpile emissions of 1.06 lbs VOC per wet ton per day for 3.80 days, plus windrow emissions of 5.71 lbs VOC per wet ton.

B. Particulate Matter

The District is not aware of any generally accepted particulate matter emission factors for composting. Therefore, the District will use the AP-42 crushed stone emission factor (AP-42, Table 11.19.2-2) as a conservative estimate. For uncontrolled emissions, the EF is:

EF (uncontrolled) = 0.0011 lb-PM_{10}/ton

If water sprays are used for dust control, a control efficiency of 70% is assumed. In this case, the EF is:

EF (controlled) = 0.0011 lb-PM_{10}/ton × (1-0.70) = 0.00033 lb-PM_{10}/ton

To estimate particulate matter emissions, the appropriate emission factor is multiplied by an assumed number of drop points for each of the composting processes as follows:

Material receiving, storage, and mixing. For organic feedstock material receiving, transfer to storage, and mixing there will be a total of 5 drop points assumed consisting of the following: (a) 1-drop point from the receiving of the material; (b) 2-drop points from the transfer of the material from the receiving area to the storage pile; (c) 2 drop points consisting of the repeated lifting and dropping of the materials with a front-end loader during feedstock mixing.

Open windrow active and curing phase composting. For the forming of the windrow composting piles there will be a total of 2 drop points assumed consisting of the transfer of the mixed compost materials from the mixing pile to the windrow pile. PM_{10} emissions during the turning of the active phase windrows and forming of the curing phase windrows are assumed to be negligible due to the high moisture content of materials handled (moisture content is typically 40% to 65%).

Compost screening. Compost screening operations are currently subject to District permit and their emissions reported through the point source inventory. PM_{10} emissions from compost screening will not be included in the area source inventory to avoid double counting.

Finished compost storage and loadout operation. For the loading of the finished compost into trucks there will be a total of 2 drop points assumed consisting of the transfer of the finished compost materials from the storage piles to the truck.

Total facility PM_{10} emissions per ton of organic material composted are summarized in the following table:

Table 4. Summary of composting operation particulate matter emissions

Operation	Drop Points (No.)	Emissions(lbs PM_{10}/wet ton)	
		Uncontrolled	Controlled[1]
Material receiving, storage, and mixing	5	0.0055	0.00165
Open windrow active and curing phase composting	2	0.0022	0.00066
Finished compost storage and loadout operation	2	0.0022	0.00066
Facility total	9	0.0099	0.00297

[1]Assumes water sprays are used with a 70% control efficiency.

VII. Emissions Calculations

C. Assumptions

1. Emissons of VOC and NH_3 are uncontrolled, and PM_{10} is controlled.

D. Sample Calculations

VOC Emissions from composting in Kern County

Step 1. Multiply the annual throughput of each type of waste composted by the emission factor for that waste type:

$$CE_{(waste,voc)} = CM_{(waste)} \times EF_{(waste,voc)} \times \frac{1\ ton}{2{,}000\ lbs}$$

where: $CE_{(waste,voc)}$ = *VOC emissions from composting a specific waste type*
$CM_{(waste)}$ = *tons of waste received in 2006*
$EF_{(waste,voc)}$ = *VOC emission factor for the appropriate waste type*

Example:

Given that 415,066 tons of greenwaste; 29,308 tons of animal manure; 457,657 tons of biosolids; and 308,151 tons of food waste were composted in Kern County in 2006.

$$CE_{(greenwaste,voc)} = 415{,}066\ tons\ greenwaste \times \frac{9.79\ lb\ VOC}{ton\ greenwaste} \times \frac{1\ ton}{2{,}000\ lb} = 2{,}031.75\ tons\ VOC$$

$$CE_{(manure,voc)} = 29{,}308\ tons\ manure \times \frac{1.78\ lb\ VOC}{ton\ manure} \times \frac{1\ ton}{2{,}000\ lb} = 26.08\ tons\ VOC$$

$$CE_{(biosolids,voc)} = 457{,}657\ tons\ biosolids \times \frac{1.78\ lb\ VOC}{ton\ manure} \times \frac{1\ ton}{2{,}000\ lb} = 407.31\ tons\ VOC$$

$$CE_{(foodwaste,voc)} = 308{,}151\ tons\ foodwaste \times \frac{9.79\ lb\ VOC}{ton\ foodwaste} \times \frac{1\ ton}{2{,}000\ lb} = 1{,}508.40\ tons\ VOC$$

Step 2. Sum the VOC emissions from the composting of each waste type:

$$CE_{(compost,voc)} = CE_{(greenwaste,voc)} + CE_{(manure,voc)} + CE_{(biosolids,voc)} + CE_{(food\ waste,voc)}$$

where: $CE_{(compost,voc)}$ = total VOC emissions from composting
$CE_{(greenwaste,voc)}$ = VOC emissions from composting greenwaste
$CE_{(manure,voc)}$ = VOC emissions from composting manure
$CE_{(biosolids,voc)}$ = VOC emissions from composting biosolids
$CE_{(foodwaste,voc)}$ = VOC emissions from composting food waste

Example:

$$CE_{(compost,voc)} = 2{,}031.75 \text{ tons VOC} + 26.08 \text{ tons VOC} + 407.31 \text{ tons VOC} + 1{,}508.40 \text{ tons VOC}$$

$$CE_{(compost,voc)} = 3{,}973.55 \text{ tons VOC}$$

VIII. Temporal Variation

Information on the temporal distribution of emissions from composting facilities is not currently available. It is likely that emissions have some dependence on ambient temperature, and that green waste processing experiences seasonal fluxes. Since these factors have not been quantified, we will conservatively assume uniform temporal emissions.

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: 8.333% per month.

IX. Spatial Variation

For this methodology, emissions were calculated to the county level. The SWIS database contains geo-referenced location data for all composting facilities within the District. Emissions within each county may be mapped to grid cells containing composting facilities, and apportioned as the number of facilities within the grid cell divided by the total number of facilities within the county.

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 this emissions category may be obtained from the District's Strategies and Incentives Department.

XI. Control Level

Control levels are developed by either the District's Strategies and Incentives 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.

Composting facilities may be subject to District Rule 4565 (Disposal of Biosolids, Animal Manure, and Poultry Litter). Control levels associated with this emissions category may be obtained from the District's Strategies and Incentives 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 composting is presented in the following table:

Table 5. CARB organic gas speciation profile for composting.

Profile Description	ARB Organic Gas Profile#	Fractions	
		ROG	VOC
Animal waste decomposition	203	0.08	0.08

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 composting is presented in the following table

Table 6. CARB particulate matter speciation profile for composting.

Profile Description	CARB PM Profile#	Fractions	
		PM_{10}	$PM_{2.5}$
Landfill Dust	421	0.4893	0.0734

XIII. Assessment Of Methodology

This area source methodology is a bottom up estimate of VOC and NH_3 emissions from the composting of organic wastes at facilities within the District. For this

estimate, composting facility operators were surveyed to determine the amounts of manure, biosolids, poultry litter, green waste, food waste, pomace or other organic waste received and composted. Additional process rate data was obtained from CalRecycle and EPA Region IX (for biosolids) for some facilities that did not respond to our survey.

The accuracy of this emissions estimate depends upon two important elements:

1. Accurate reporting of process rate data – tons of feedstock composted per year.

2. Use of appropriate emission factors – pounds of pollutant emitted per ton of feedstock composted.

The District is in the process of issuing permits to existing composting facilities. Once under permit, these facilities will report their emissions annually through the point source inventory. This will improve our ability to collect accurate process rate data in the future.

A more significant source of error may be in the application of the emission factors. The limited source test data that is available shows that the emission factors for different operators composting similar feedstocks can be very different. This is presumably due to differences in windrow size, feedstock characteristics (ie., carbon to nitrogen ratio), moisture content, temperature, and operating characteristics. In addition, there may be seasonal variability likely due to temperature, moisture and feedstock properties. The use of site specific source test data, rather than generic emission factors, would improve this emissions estimate.

XIV. Emissions

Following is the 2006 area source emissions inventory for REIC 199-170-0260-0000 estimated by this methodology. Emissions are reported for each county in the District.

Table 7. Area source emissions for REIC 199-170-0260-0000 (2006).

County	Criteria Emissions (tons/year)					Toxic Emissions (lbs/year)
	NOx	CO	SOx	VOC[(1)]	PM_{10}	NH_3
Fresno	0.00	0.00	0.00	154.67	0.05	47,592
Kern	0.00	0.00	0.00	3,959.08	1.80	2,511,633
Kings	0.00	0.00	0.00	627.29	0.19	193,011
Madera	0.00	0.00	0.00	0.00	0.00	0
Merced	0.00	0.00	0.00	529.29	0.42	733,604
San Joaquin	0.00	0.00	0.00	535.19	0.23	320,220
Stanislaus	0.00	0.00	0.00	1,436.79	0.44	445,399
Tulare	0.00	0.00	0.00	477.23	0.15	146,841
TOTAL	0.00	0.00	0.00	7,719.54	3.28	4,398,300

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

Following is the 2006 point source emissions inventory for REIC 199-170-0260-0000 as reported to the District by our permit holders. Emissions are reported for each county in the District.

Table 8. Point source emissions for REIC 199-170-0260-0000 (2006).

County	Criteria Emissions (tons/year)					Toxic Emissions (lbs/year)
	NOx	CO	SOx	VOC[(1)]	PM_{10}	NH_3
Fresno	0.00	0.00	0.00	0.00	0.00	0
Kern	0.00	0.00	0.00	0.00	0.00	0
Kings	0.00	0.00	0.00	0.00	0.00	0
Madera	0.00	0.00	0.00	0.00	0.00	0
Merced	0.00	0.00	0.00	0.00	0.00	0
San Joaquin	0.00	0.00	0.00	0.00	0.00	0
Stanislaus	0.00	0.00	0.00	0.00	0.00	0
Tulare	0.00	0.00	0.00	0.00	0.00	0
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.

Following is the 2006 total unreconciled (point source plus area source) emissions inventory for REIC 199-170-0260-0000. Emissions are reported for each county in the District.

Table 9. Total emissions for REIC 199-170-0260-0000 (2006).

County	Criteria Emissions (tons/year)					Toxic Emissions (lbs/year)
	NOx	CO	SOx	VOC[(1)]	PM_{10}	NH_3
Fresno	0.00	0.00	0.00	154.67	0.05	47,592
Kern	0.00	0.00	0.00	3,959.08	1.80	2,511,633
Kings	0.00	0.00	0.00	627.29	0.19	193,011
Madera	0.00	0.00	0.00	0.00	0.00	0
Merced	0.00	0.00	0.00	529.29	0.42	733,604
San Joaquin	0.00	0.00	0.00	535.19	0.23	320,220
Stanislaus	0.00	0.00	0.00	1,436.79	0.44	445,399
Tulare	0.00	0.00	0.00	477.23	0.15	146,841
TOTAL	0.00	0.00	0.00	7,719.54	3.28	4,398,300

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

Following is the net change in total unreconciled emissions between this update (2006 inventory year) and the previous year (2005 inventory year) for REIC 199-170-0260-0000. The change in emissions are reported for each county in the District.

Table 10. Net emissions change for REIC 199-170-0260-0000 (2006).

County	Criteria Emissions (tons/year)					Toxic Emissions (lbs/year)
	NOx	CO	SOx	VOC[(1)]	PM_{10}	NH_3
Fresno	0.00	0.00	0.00	154.67	0.05	47,592
Kern	0.00	0.00	0.00	3,959.08	1.80	2,511,633
Kings	0.00	0.00	0.00	627.29	0.19	193,011
Madera	0.00	0.00	0.00	0.00	0.00	0
Merced	0.00	0.00	0.00	529.29	0.42	733,604
San Joaquin	0.00	0.00	0.00	535.19	0.23	320,220
Stanislaus	0.00	0.00	0.00	1,436.79	0.44	445,399
Tulare	0.00	0.00	0.00	477.23	0.15	146,841
TOTAL	0.00	0.00	0.00	7,719.54	3.28	4,398,300

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

XV. Revision History

2006. 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 the following table:

Table 11. 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

Since this area source category has emissions of more than five tons per day, it will be updated every year.

XVII. References

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3. California Integrated Waste Management Board. 2003. Technical summary report: Best management practices for greenwaste composting operations - Air emissions tests vs. feedstock controls & aeration techniques. 80 pages
4. California Integrated Waste Management Board. 2007. Emissions testing of volatile organic compounds from greenwaste composting at the Modesto compost facility in the San Joaquin Valley. 82 pages.
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14. South Coast Air Quality Management District. 2001a. Ammonia and volatile organic compound (VOC) emissions from a greenwaste composting operation. Source Test Report 01-171, conducted at Inland Empire Composting, Colton, CA. 30 pages.
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16. South Coast Air Quality Management District. 2002a. Technology Assessment for proposed Rule 1133: Emission reductions from composting and related operations. Staff Report Attachment A. 76 pages.
17. South Coast Air Quality Management District. 2002b. Ammonia, methane, volatile organic compound (VOC) emissions from a non-curbside greenwaste chipping and grinding facility. Source Test Report 02-186, conducted at Intravia Rock & Sand Inc., Upland, CA 4 pages.
18. Wallace, Z, How to Interpret Compost Analysis, 2005, available at http://www.wallacez.freeserve.ca.uk/analysis.

XVIII. Appendix

Appendix A. SJVAPCD Composting Facilities.

Appendix A. SJVAPCD Composting Facilities.

Table 12. Composting facilities located within the San Joaquin Valley Unified Air Pollution Control District.

County	SWIS ID	Facility Name
Fresno	10-AA-0182	E&J Gallo Compost Facility
Kern	15-AA-0287	Liberty Composting Inc (formerly San Joaquin Composting)
	15-AA-0307	Community Recycling Lamont Compost Facility
	15-AA-0311	Mt Vernon Composting & Recycling Facility
	15-AA-0374	Grimmway Farms Composting - Arvin Yard
	15-AA-0381	South Kern Industrial Center Compost Facility
Kings	16-AA-0016	Kings Waste & Recycling Authority
	16-AA-0022	Kochergen Farms Composting
	16-AA-0026	Westlake Farms Co-Composting
Merced	24-AA-0029	Billy Wright Composting Facility
	24-AA-0011	El Nido Composting Facility-Synagro West
	24-AA-0020	Highway 59 Compost Facility
	24-AA-0018	Kopro Manure Storage Facility
	24-AA-0023	Rainbow Farms/Valley Fresh Foods Inc
	24-AA-0031	Nakashima Farms Composting #1
	24-AA-0032	Nakashima Farms Composting #2
San Joaquin	39-AA-0020	Forward Landfill
	39-AA-0024	Tracy Material Recovery & T.S.
	39-AA-0026	Scotts Regional Composting Facility
	39-AA-0037	Delicato Vineyards
Stanislaus	50-AA-0016	Gilton Resource Recovery Composting Facility
	50-AA-0018	City of Modesto, Compost Facility
	50-AA-0020	Grover Environmental Products/Vernalis
	50-AA-0021	City of Turlock Regional Water Quality Control Facility
Tulare	54-AA-0026	Tulare County Compost and Biomass
	54-AA-0028	Wood Industries Company