2020 National Emissions Inventory Technical Support Document: Waste Disposal – Composting

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There are five sections in this documentation that discuss nonpoint inventory Waste Disposal. This section discusses Composting, the second section (34) discusses Open Burning – Land Clearing Debris, the third section (35) discusses Open Burning – Residential Household Waste, the fourth section (36) discusses Open Burning – Yard Waste, and the fifth section (37) discusses Publicly-Owned Treatment Works (POTWs). The reason these sources are broken up within this EIS sector is because the EPA methodologies for estimating the emissions are different.

33.1 Sector Descriptions and Overview

Greenwaste composting includes the diversion of yard waste, food waste, and other biogenic waste from landfills to composting facilities. Estimates of emissions of volatile organic compounds (VOC), ammonia (NH3), and three hazardous air pollutants (HAPs), acetaldehyde; methanol; and naphthalene, from greenwaste composting are based on the amount of food and yard waste composted. Composting of biogenic waste is currently not included in emissions estimates for this category as activity data on this waste type is not available.

Note that this source category does not include the composting of biosolids from wastewater treatment plants or manure management facilities. There are separate SCCs for biosolids (2680001000) and for a mixture of greenwaste and biosolids (2680002000). EPA is not currently estimating emissions for these SCCs. If S/L/Ts report any emissions for the mixture SCC, emissions from the greenwaste portion of that mixture may be duplicative of some or all of the EPA emissions estimates described here. Note also that this source category estimates emissions from composting facilities but does not estimate emissions from backyard composting.

Table 33-1 shows, for composting, the SCCs covered by the EPA estimates and by the State/Local and Tribal agencies that submitted data. The SCC level 3 and 4 SCC descriptions are also provided. The SCC level 1 and leading level 2 descriptions is "Waste Disposal, Treatment, and Recovery; Composting:" for all SCCs.

Table 33-1: Composting SCCs in the 2020 NEI

SCC	Description	EPA	S/L/T
2680001000	100% Biosolids (e.g., sewage sludge, manure, mixtures of these matls); All Processes		X
2680002000	Mixed Waste (e.g., a 50:50 mixture of biosolids and green wastes); All Processes		X
2680003000	100% Green Waste (e.g., residential or municipal yard wastes); All Processes	X	X

A list of agencies that submitted composting emissions is provided in Section 6.2.3.

33.2 EPA-developed emissions

The calculations for estimating the emissions from greenwaste composting involve first estimating the amount of food and yard waste composted in each county. The amount of state-level food waste composted is available from the EPA report *Food Waste Management in the United States, 2014* [ref 1]. The amount of state-level yard waste composted is estimated by calculating the per-capita amount of

yard waste composted using national data from the EPA report *Advancing Sustainable Materials Management: 2015 Fact Sheet* [ref 2] and multiplying that by the state population. The state-level yard and food waste are summed together and distributed to the counties based on the proportion of employment at solid waste landfills. The total amount of greenwaste composted is multiplied by emissions factors for VOC and NH3 to estimate emissions of these pollutants from greenwaste composting.

33.2.1 Activity Data

The activity data for this source category is the amount of food and yard waste composted, which is estimated using data from two EPA reports: the national-level amount of yard waste composted comes from *Advancing Sustainable Materials Management: 2015 Fact Sheet* and the state-level amount of food waste composted comes from *Food Waste Management in the United States, 2014* [ref 1, ref 2]. Table 33-2 shows the total national-level amount of yard waste generated and recovered for composting.

Table 33-2: Annual Waste (million tons) generated and recovered in the US in 2015

Material	Waste Generated	Waste Recovered
Yard trimmings	34.72	21.29

The values from Table 33-2 are used with the U.S. population in 2020 of 336 million people [ref 3] to determine per-capita values of food and yard waste recovered for composting.

$$PC_{yard,US} = \frac{W_{yard,US}}{P_{US}} \quad (1)$$

Where:

$PC_{yard,US}$ = Per-capita yard waste recovered for composting in the US, in tons per person per year
$W_{yard,US}$ = Total annual yard waste recovered in the US, in tons/year
P_{US} = US population

This calculation results in per-capita values of approximately 0.066 tons per person per year of yard waste recovered for composting. Please note that EPA data on composting does not include backyard composting.

The per-capita yard waste values from equation 1 are multiplied by the population of each state to estimate the state-level amount of yard waste recovered for composting.

$$W_{yard,s} = PC_{yard,US} \times P_s \quad (2)$$

Where:

$W_{yard,s}$ = Annual yard waste recovered for composting in state *s*, in tons
$PC_{yard,US}$ = Per-capita yard waste recovered for composting in the US, in tons per person per year

P_s = Population of state *s*

EPA reports the amount of food waste composted at the state level in the report *Food Waste Management in the United States, 2015* [Table 3 in ref 1]. These values are shown in Table 33-3. EPA collected these data from state environmental websites and contacts with state agencies. The data year for each state is listed and represents the latest data available. The data were not altered from the original reference for use in this methodology.

Table 33-3: State-level food waste composting (tons)

State	Food Composted	Data Year	State	Food Composted	Data Year
California	715,119	2012	Nevada	35,869	2014
Colorado	29,130	2013	New Hampshire	110	2012
Connecticut	4,644	2013	New Jersey	28,634	2012
Delaware	17,626	2013	New York	44,405	2013
Florida	158,711	2014	North Carolina	38,014	2014
Georgia	8,021	2014	Ohio	81,450	2014
Hawaii	39,287	2014	Oregon	50,143	2013
Indiana	13,525	2013	Pennsylvania	56,851	2013
Iowa	4,334	2010	Rhode Island	150	2014
Kansas	1,127	2010	South Carolina	4,277	2014
Maine	1,658	2010	Tennessee	1,500	2013
Maryland	69,643	2014	Texas	188	2012
Massachusetts	2,753	2014	Vermont	14,738	2013
Michigan	8,700	2013	Virginia	2,454	2014
Minnesota	46,751	2013	Washington	65,221	2013
Mississippi	242	2013	Wisconsin	8,677	2013
Missouri	16,000	2014	**Total**	**1,569,952**	

The state-level amount of total greenwaste composted is the sum of the state-level food and yard waste composted.

$$W_{GW,s} = W_{yard,s} + W_{food,s} \quad (3)$$

Where:

$W_{GW,s}$ = Annual total greenwaste recovered for composting in state *s*, in tons
$W_{yard,s}$ = Annual yard waste recovered for composting in state *s*, in tons
$W_{food,s}$ = Annual food waste recovered for composting in state *s*, in tons, from Table 33-3

The process used to distribute the state-level amount of greenwaste composted to the counties is discussed in next section.

33.2.2 Allocation Procedure

Comprehensive data on the county locations of composting facilities is not available. As a result, the analysis assumes that greenwaste composting facilities are co-located with solid waste landfills.

State-level food greenwaste composting activity (from equation 3) is allocated to the county-level using employment at solid waste landfills (NAICS code 562212). Specifically, state-level estimates of greenwaste collected for composting are multiplied by the ratio of county- to state- level number of employees at landfills.

$$EmpFrac_c = \frac{Emp_c}{Emp_s} \quad (4)$$

Where:

$EmpFrac_c$ = The fraction of landfill employees in county *c*
Emp_c = The number of landfill employees in county *c*
Emp_s = The number of landfill employees in state *s*

Employment data are from the U.S. Census Bureau's 2016 County Business Patterns (CBP) [ref 4]. Due to concerns with releasing confidential business information, the CBP does not release exact numbers for a given NAICS code if the data can be traced to an individual business. Instead, a series of range codes is used. Many counties and some smaller states have only one solid waste landfill, leading to withheld data in the county and/or state business pattern data. To estimate employment in counties and states with withheld data, the following procedure is used for NAICS code 562212.

To gap-fill withheld state-level employment data:

a. State-level data for states with known employment in NAICS 562212 are summed to the national level.
b. The total sum of state-level known employment from step a is subtracted from the national total reported employment for NAICS 562212 in the national-level CBP to determine the employment total for the withheld states.
c. Each of the withheld states is assigned the midpoint of the range code reported for that state. Table 33-4 lists the range codes and midpoints.
d. The midpoints for the states with withheld data are summed to the national level.
e. An adjustment factor is created by dividing the number of withheld employees (calculated in step b of this section) by the sum of the midpoints (step d).
f. For the states with withheld employment data, the midpoint of the range for that state (step c) is multiplied by the adjustment factor (step e) to calculate the adjusted state-level employment for landfills.

These same steps are then followed to fill in withheld data in the county-level business patterns.

g. County-level data for counties with known employment are summed by state.
h. County-level known employment is subtracted from the state total reported in state-level CBP (or, if the state-level data are withheld, from the state total estimated using the procedure discussed above).

i. Each of the withheld counties is assigned the midpoint of the range code (Table 33-4).
j. The midpoints for the counties with withheld data are summed to the state level.
k. An adjustment factor is created by dividing the number of withheld employees (step h) by the sum of the midpoints (step j).
l. For counties with withheld employment data, the midpoints (step i) are multiplied by the adjustment factor (step k) to calculate the adjusted county-level employment for landfills.

Table 33-4: Ranges and midpoints for data withheld from state and county business patterns

Employment Code	Ranges	Midpoint
A	0-19	10
B	20-99	60
C	100-249	175
E	250-499	375
F	500-999	750
G	1,000-2,499	1,750
H	2,500-4,999	3,750
I	5,000-9,999	7,500
J	10,000-24,999	17,500
K	25,000-49,999	37,500
L	50,000-99,999	75,000
M	100,000+	

For example, take the 2016 CBP data for NAICS 562212 (Landfills) in Arizona provided in Table 33-5.

Table 33-5: 2016 County Business Pattern for NAICS 562212 in Arizona

State FIPS	County FIPS	County Name	NAICS	Employment Code	Employment
04	001	Apache	562212	B	withheld
04	007	Gila	562212	A	withheld
04	012	La Paz	562212	A	withheld
04	013	Maricopa	562212		296
04	015	Mohave	562212	B	withheld
04	017	Navajo	562212	B	withheld
04	021	Pinal	562212		40
04	023	Santa Cruz	562212		withheld
04	025	Yavapai	562212	A	withheld
04	027	Yuma	562212	B	withheld

Note: Counties in Arizona that do not have employment in solid waste landfills are excluded from this table.

1. The total number of known county-level employees in Arizona is 336.

2. The state-level CBP reports 522 employees for NAICS 562212 in Arizona. This means there are 186 employees total for the 8 counties for which data are withheld.

3. The counties with withheld data are assigned midpoints according to their employment code in Table 33-4. For example, Apache County is given a midpoint of 60 employees (since range code B is 20-99) and Gila County is given a midpoint of 10 employees.

4. The state total of the midpoints for all withheld counties is 270 employees.

5. The adjustment factor is 186/272 = 0.6889.

6. The adjusted employment for Apache County is 60 × 0.6889 = 41. Gila County has an adjusted employment of 10 × 0.6889 = 7 employees.

Once county- and state-level employment have been estimated, the ratio of county to state employees (from equation 4) is calculated and multiplied by the state-level greenwaste recovered for composting (from equation 3) to calculate the amount of waste composted in each county.

$$W_{GW,c} = EmpFrac_c \times W_{GW,s} \quad (5)$$

Where:

$W_{GW,c}$ = Annual total greenwaste composted in county *c*, in tons
$W_{GW,s}$ = Annual total greenwaste recovered for composting in state *s*, in tons
$EmpFrac_c$ = The fraction of landfill employees in county *c*

33.2.3 Emissions Factors

Emissions factors for greenwaste composting (SCC=2680003000) are provided in the "Wagon Wheel Emission Factor Compendium" on the 2020 NEI Supporting Data and Summaries site. The emissions factors for VOC and ammonia (NH3) are taken from the California Air Resources Board Emissions Inventory Methodology for Composting Facilities [ref 5] and are unaltered from the original reference. The emissions factors for the HAPs (acetaldehyde, methanol, and naphthalene) are taken from Kumar et al [ref 6].

33.2.4 Controls

There are no controls assumed for this category.

33.2.5 Emissions

Emission factors are provided in the "Wagon Wheel Emission Factor Compendium" on the 2020 NEI Supporting Data and Summaries site. For VOC and NH3, the emissions are multiplied by a conversion factor to convert from pounds to tons.

$$E_{p,c} = W_{GW,c} \times EF_p \times \frac{1\ ton}{2000\ lbs.} \quad (6)$$

Where:

$E_{p,c}$ = Annual emissions of pollutant *p* in county *c*, in tons for VOC and NH3 and lbs. for HAPs

$W_{GW,c}$ = Annual total greenwaste recovered for composting in state *s*, in tons
EF_p = Emissions factor for pollutant *p*, in tons of pollutant per ton of greenwaste composted

Emissions of HAPs are estimated by applying speciation factors (available in the zip file "HAPAugmentation_Nonpoint_28jan2023", on the 2020 NEI Supplemental data FTP site) to annual VOC emissions. For HAPS, no conversion factor is needed, and the emissions are reported in tons.

$$E_{h,c} = E_{VOC,c} \times SF_h \quad (7)$$

Where:

$E_{h,c}$= Annual emissions of HAP *h* in county *c*, in tons per year
$E_{VOC,c}$ = Annual VOC emissions in county *c*, in tons
SF_h= Speciation factor for HAP *h*, in tons of HAP emissions per ton of VOC emissions

33.2.6 Sample Calculations

Table 33-6 lists sample calculations to determine the VOC emissions from composting of greenwaste in Apache County, Arizona.

Table 33-6: Sample calculations for VOC emissions from greenwaste composting in Apache County, AZ

Eq. #	Equation	Values for Apache County, AZ	Result
1	$PC_{yard,US} = \frac{W_{yard,US}}{P_{US}}$	$\frac{21.08\ million\ tons\ yard\ waste}{329\ million\ people}$	0.064 tons yard waste per person per year
2	$W_{yard,s} = PC_{yard,US} \times P_s$	$0.064\ tons\ yard\ waste\ per\ person \times 7{,}016{,}270\ people\ in\ AZ$	449,041 tons yard waste composted in AZ
3	$W_{GW,s} = W_{yard,s} + W_{food,s}$	449,041 tons yard waste + 0 tons food waste	443,520 tons green-waste composted in AZ
4	$EmpFrac_c = \frac{Emp_c}{Emp_s}$	$\frac{41\ employees\ in\ Apache\ County}{522\ employees\ in\ AZ}$	0.079 fraction of solid waste employees in Apache County, AZ
5	$W_{GW,c} = EmpFrac_c \times W_{GW,s}$	$0.079\ fraction \times 443{,}520\ tons\ greenwaste\ composted$	35,038 tons greenwaste composted in Apache County, AZ
6	$E_{p,c} = W_{GW,c} \times EF_p \times \frac{1\ ton}{2000\ lbs.}$	35,038tons greenwaste × 4.67 lbs. VOC per ton greenwaste × $\frac{1\ ton}{2000\ lbs.}$	82 tons VOC emissions from greenwaste composting in Apache County, AZ

33.2.7 Improvements/Changes in the 2020 NEI

There are no significant changes from the methodology used to calculate the 2020 NEI emissions.

33.2.8 Puerto Rico and U.S. Virgin Islands Emissions Calculations

Emissions from Puerto Rico are calculated using the same method described above. For the U.S. Virgin Islands, emissions are calculated using 2020 population data [ref 7], since 2014 Census Data does not exist for the U.S. Virgin Islands.

33.3 References

1. U.S. EPA. 2016. Food Waste Management in the United States, 2014. Office of Resource Conservation and Recovery.
2. U.S. EPA. 2018. Advancing Sustainable Materials Management: Facts and Figures Report, 2015 Facts and Figures Sheet, Table1. Generation, Recovery, and Discards of Products in MSW, 2015.
3. U.S. Census Bureau. 2020 Total Population, American Community Survey.
4. U.S. Census Bureau. 2020 County Business Patterns.
5. California Air Resources Board. 2015. ARB Emissions Inventory Methodology for Composting Facilities. Table A-4. Emission factor data taken from Draft Staff Report on Proposed Amended Rule 1133.1 (chipping and grinding activities) and Proposed Rule 1133.3 (emissions reductions from greenwaste composting operations),Table III-3.
6. Kumar, A., C.P. Alaimo, R. Horowitz, F.M. Mitloehner, M.J. Kleeman, and P.G. Green. 2011. Volatile organic compound emissions from green waste composting: Characterization and ozone formation. Atmospheric Environment, 45:1841-1848.
7. U.S. Census Bureau. 2020. County Population Totals.

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