2020 National Emissions Inventory Technical Support Document: Waste Disposal – Open Burning – Yard Waste

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Office of Air Quality Planning and Standards
Air Quality Assessment Division
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36.1 Sector Descriptions and Overview

This source category covers intentional burning for waste disposal purposes of leaf and brush species in outdoor areas, and emission estimates for leaf and brush waste burning are a function of the amount of waste burned per year. Section 34 covers open burning for municipal solid waste. Section 35 covers open burning for municipal solid waste.

Table 36-1 shows, for open burning -yard waste, the nonpoint SCCs in the 2020 NEI, whether generated by EPA, or provided by SLTs. The SCC level 3 and 4 descriptions are also provided. The SCC level 1 and 2 descriptions are "Waste Disposal, Treatment, and Recovery; Open Burning" for all SCCs.

Table 36-1: Open burning SCCs in the 2017 NEI

SCC	Description	EPA	S/L/T
2610000100	All Categories; Yard Waste - Leaf Species Unspecified	X	X
2610000300	All Categories; Yard Waste - Weed Species Unspecified (incl Grass)		X
2610000400	All Categories; Yard Waste - Brush Species Unspecified	X	X

A list of agencies that submitted open burning, yard waste emissions is provided in Section 6.2.3.

36.2 EPA-developed estimates

The calculations for estimating the emissions from the burning of yard waste involve first estimating the amount of leaf and brush waste generated in each county. The amount of county-level yard waste burned is estimated by calculating the per capita amount of leaf and brush waste generated and multiplying that by the number of people likely to burn waste in each county. The number of people likely to burn waste is based on the rural population in each county. The total amount of yard waste burned is multiplied by emissions factors for criteria air pollutants (CAPs) and hazardous air pollutants (HAPs) to estimate emissions of these pollutants from yard waste burning.

36.2.1 Activity data

The activity data for this source category is the amount of leaf and brush waste generated, which is estimated using data the EPA report *Advancing Sustainable Materials Management: 2018 Fact Sheet* [ref 1]. The report presents the total mass of waste generated from the residential and commercial sectors in the United States by type of waste for the calendar year 2018.

The per capita value of yard waste subject to burning was developed based on EPA's total amount of waste generated [Table 1 in ref 1]. According to the 2010 version of the same EPA report, residential waste generation accounts for 55-65% of the total waste from the residential and commercial sectors [ref 2]; for the per capita calculation, the median value of 60% of total waste generated is assumed. This number is multiplied by the amount of yard waste generated and divided by the U.S. population in 2018 [ref 3] to determine the per capita amount of yard waste generated in the United States.

$$PC_{yw} = \frac{YW \times 0.60}{P_{y,US}} \quad (1)$$

Where:

PC_{yw} = Per capita value of yard waste in the US, in tons per person
YW = Annual yard waste generated, in million tons
$P_{y,US}$ = Population of the US for year of inventory, in million people

As open burning is generally not practiced in urbanized areas, only the rural population in each county is assumed to practice open burning. The rural and urban populations are taken from 2020 U.S. Census data [ref 4]. It is assumed that 24% of the rural population burns yard waste [ref 5].

$$PBurn_c = RPop_c \times 0.24 \quad (2)$$

Where:

$PBurn_c$ = Population likely to burn in county *c*
$RPop_c$ = Rural population in county *c* in 2020

The number of people likely to burn waste in each county (from equation 2) is then used with the value of per capita yard waste generated (from equation 1) and two assumptions to determine the amount of leaf and brush waste burned. The first assumption concerns the composition of yard waste; of the total amount of yard waste generated, yard waste composition is assumed to be 25 percent leaves, 25 percent brush, and 50 percent grass by weight [ref 6]. However, open burning of grass clippings is not typically practiced by homeowners, and as such only estimates for leaf burning and brush burning are developed.

The second assumption adjusts for variations in vegetation; the percentage of forested acres (including rural forest and urban forest) is determined using Version 2 of the Biogenic Emission Landuse Database (BELD2) within the Biogenic Emissions Inventory System (BEIS) [ref 7]. Based on this percentage, county-level yard waste values are adjusted according to the values in Table 36-2. To better account for the native vegetation that likely occurs in residential yards of farming states, agricultural land acreage is subtracted before calculating the percentage of forested acres. All municipios in Puerto Rico and counties in the U.S. Virgin Islands, Hawaii, and Alaska were assumed to have greater than 50 percent forested acres.

$$LW_c = PBurn_c \times PC_{yw} \times YWFr_t \times AF_{fa,c} \quad (3)$$

$$BW_c = PBurn_c \times PC_{yw} \times YWFr_t \times AF_{fa,c} \quad (4)$$

Where:

LW_c = Annual leaf waste burned in county *c,* in tons
BW_c = Annual brush waste burned in county *c,* in tons

$PBurn_c$ = Population likely to burn in county *c*, from equation 2
PC_{yw} = Per capita value of yard waste in the US, in tons per person, from equation 1
$YWFr_t$ = Fraction of total yard waste for waste type *t* (leaf or brush)
$AF_{fa,c}$ = Adjustment factor based on percent of forested acres in county *c*, from Table 36-2

Table 36-2: Adjustment for Percentage of Forested Acres

Percent Forested Acres per County	Adjustment for Yard Waste Generated
< 10%	0% generated
≥ 10% & < 50%	50% generated
≥ 50%	100% generated

36.2.2 Allocation procedure

National values for the amount of waste generated are distributed to the counties based on rural population, as described in Section 36.2.1.

36.2.3 Emission factors

Emissions factors for open burning of yard are provided in the "Wagon Wheel Emission Factor Compendium" on the 2020 NEI Supporting Data and Summaries site. The emissions factors for CAPs are from AP-42 [ref 8], the emissions inventory improvement program [ref 9], and an ERTAC workgroup [ref 10]. For burning of leaves, emissions factors for PM25 are calculated by multiplying the PM10 emissions factor by a ratio of 0.7709. Emission factors for NH3 were derived from the 2002 NEI crop residue emission estimates using the ratio of NH3/NOx for pasture grass from Pouliot et al. (2017) [ref 11] and the NOx emission factor from AP-42. Emissions factors for HAPs are from an EPA Control Technology Center report [ref 12] and can be found online under EIS Augmentation Datasets in the zipped data set "HAPAugmentation_Nonpoint."

36.2.4 Controls

Controls for residential yard waste burning are generally in the form of a ban on open burning of waste in a given municipality or county. However, literature suggests that burn bans are not 100% effective. It is therefore assumed that approximately 25% of the residents that may burn yard waste would burn do so even if a ban is in place. For counties that have burn bans, the assumption is applied by multiplying 0.25 by the annual waste burned. Currently no counties are assumed to have burn bans in place.

$$If\ county\ c\ has\ a\ burn\ ban \\ Then\ LW_c = LW_c \times 0.25 \quad (5)$$

$$If\ county\ c\ has\ a\ burn\ ban \\ Then\ BW_c = BW_c \times 0.25 \quad (6)$$

Where:

LW_c = Annual leaf waste burned in county *c,* in tons
BW_c = Annual brush waste burned in county *c,* in tons

36.2.5 Emissions

The annual amount of leaf and brush waste burned in each county is multiplied by the emissions factors provided in the "Wagon Wheel Emission Factor Compendium" on the 2020 NEI Supporting Data and Summaries site to estimate emissions. Emissions for leaves and residential brush are calculated separately since emission factors vary by yard waste type.

$$E_{p,c} = LW_c \times EF_p \quad (7)$$

$$E_{p,c} = BW_c \times EF_p \quad (8)$$

Where:

$E_{p,c}$ = Annual emissions of pollutant *p* in county *c*
LW_c = Annual leaf waste burned in county *c,* in tons
BW_c = Annual brush waste burned in county *c,* in tons
EF_p = Emission factor for pollutant *p,* in lbs. of pollution per ton of waste burned

36.2.6 Example calculations

Table 36-3 lists sample calculations to determine the CO emissions from open burning of yard waste. The values in these equations are demonstrating program logic and are not representative of any specific NEI year or county.

Table 36-3: Sample calculations for CO emissions from open burning

Eq. #	Equation	Values	Result
1	$PC_{yw} = \frac{YW \times 0.60}{P_{y,US}}$	$\frac{34.5\ million\ tons \times 0.60}{318.85\ million\ people}$	0.065 tons yard waste per person per year
2	$PBurn_c = RPop_c \times 0.24$	$22{,}921\ people \times 0.24$	5,501 people likely to burn
3	$LW_c = PBurn_c \times PC_{yw} \times YWFr_t \times AF_{fa,c}$	$5{,}501\ people \times 0.065\ tons \times 0.25 \times 1$	89.39 tons of leaf waste burned
4	$BW_c = PBurn_c \times PC_{yw} \times YWFr_t \times AF_{fa,c}$	$5{,}501\ people \times 0.065\ tons \times 0.25 \times 1$	89.39 tons of brush waste burned
5	$If\ county\ c\ has\ a\ burn\ ban$ $Then\ LW_c = LW_c \times 0.25$	N/A	does not have a burn ban
6	$If\ county\ c\ has\ a\ burn\ ban$ $Then\ BW_c = BW_c \times 0.25$	N/A	does not have a burn ban
7	$E_{p,c} = LW_c \times EF_p$	$89.39\ tons\ of\ leaf\ waste \times 112\ lbs.per\ ton$	5.01 tons CO emissions from burning of leaf waste

Eq. #	Equation	Values	Result
8	$E_{p,c} = BW_c \times EF_p$	$89.39\ tons\ of\ brush\ waste \times 140\ lbs.per\ ton$	6.26 tons CO emissions from burning of brush waste

36.2.7 Improvements/Changes in the 2020 NEI

For the 2020 NEI, ammonia emissions factors were developed for leaf waste and brush waste so that ammonia emissions are estimated for these sources. The ammonia emissions factors are developed by applying the ratio of NH3 to NOx emissions from pasture grass, using emissions data from Table 1 in Pouliot et al. (2011) [ref 11], to the NOx emissions factors used for these sources, from AP-42 [ref 8].

36.2.8 Puerto Rico and U.S. Virgin Islands

Emissions from Puerto Rico are calculated using the same method described above. For the U.S. Virgin Islands, emissions are calculated using 2010 population data, since 2020 Census Data does not exist for the U.S. Virgin Islands.

36.2.9 References

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