**OPEN BURNING - RESIDENTIAL HOUSEHOLD WASTE**

***a. Source Category Description***

Open burning of residential municipal solid waste (MSW) is the purposeful burning of MSW in outdoor areas. Criteria air pollutant (CAP) and hazardous air pollutant (HAP) emission estimates for MSW burning are a function of the amount of waste burned per year.

For this source category, the following SCC was assigned:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SCC** | **SCC Level 1** | **SCC Level 2** | **SCC Level 3** | **SCC Level 4** |
| 2610030000 | Waste Disposal, Treatment, and Recovery | Open Burning | Residential | Household Waste (use 26-10-000-xxx for Yard Wastes) |

***b. Activity Data***

The amount of household MSW burned was estimated using data from EPA’s report *Advancing Sustainable Materials Management: 2013 Fact Sheet*.1,2 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 2013. According to the 2010 version of the EPA report, residential waste generation accounts for 55-65 percent of the total waste from the residential and commercial sectors.3 For the calculation of per capita household waste subject to burning, the median value of 60 percent was assumed. This information was used to calculate a daily estimate of combustible per capita household waste of 1.91 lbs/person/day, and a daily estimate of combustible plus non-combustible per capita household waste of 2.62 lbs/person/day. Burning of yard waste is included in SCC 2610000100 and SCC 2610000400; therefore, it is not part of residential MSW. Approximately 24 percent of the rural population that may open burn actually does so.4

Since open burning is generally not practiced in urban areas, only the rural and like rural population in each county was assumed to practice open burning. Like rural population is defined as the population of urbanized areas and urban clusters with population densities’ equal to or less than the maximum rural population density value for all counties. The ratio of rural and like rural to total population was obtained from 2010 U.S. Census data.5 This ratio was then multiplied by the 2014 U.S. Census Bureau estimate6 of the population in each county to obtain the county-level rural population for 2014. The county-level rural population was then multiplied by the per capita household waste subject to burning to determine the amount of rural household MSW generated in each county in 2014.

***c. Controls***

Controls for residential MSW 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 was therefore assumed that approximately 25% of the residents that may burn trash in the yard would burn waste even if a ban is in place.4 For counties that have burn bans, the assumption was applied by multiplying .25 by the number of persons estimated to practice open burning. For example, the State of Colorado implemented a state-wide ban on open burning, and this method was employed for all counties in Colorado.

***d. Emission Factors***

Emission factors are reported in Table 1 below. Emission factors for CAPs were developed by the U.S. Environmental Protection Agency (EPA) in consultation with the Eastern Regional Technical Advisory Committee and based primarily on the AP-42 report.7,8,9,10 Emission factors for HAPs are from an EPA Control Technology Center report and an EPA Office of Research and Development report.9,10 Emission factors for 17 dioxin congeners were obtained from an EPA dioxin report.11

***e. Emissions***

County-level CO, NOx, and SO2 emissions were calculated by multiplying the total amount of combustible and non-combustible residential municipal solid waste burned per year by an emission factor. County level PM, VOC, and HAP emissions were calculated by multiplying the total amount of combustible residential municipal solid waste burned per year by an emissions factor.

***f. Example Calculations***

VOC emissions in Autauga County, Alabama from open burning of residential MSW:

Population of Autauga County in 2014 = 55,395

Rural fraction of Autauga County 2010 population = 0.42

Fraction of rural population that burns MSW = 0.24

Combustible per capita MSW generated (lb/person/day) = 1.91

Number of days in a year = 365

Factor to convert from lbs to tons = 1/2000

2014 MSW burning activity in Autauga County = 55,395 \* 0.42 \* 1.91 \* 0.24 \* 365 \* 1/2000

2014 MSW activity in Autauga County = 1,946 tons

VOC emissions = MSW burned \* VOC emission factor

VOC emission factor = 7.42 lb/ton

VOC emissions from MSW burning in Autauga County = 1,946 tons \* 7.42 lbs/ton \* 1 ton/2000 lbs

VOC emissions from MSW burning in Autauga County in 2014 = 7.2 tons

CO emission in Autauga County, Alabama from open burning of MSW

Population of Autauga County in 2014 = 55,395

Rural fraction of Autauga County 2010 population = 0.42

Fraction of rural population that burns MSW = 0.24

Combustible & non-combustible per capita MSW generated (lb/person/day) = 2.62

Number of days in a year = 365

Factor to convert from lbs to tons = 1/2000

2014 MSW burning activity in Autauga County = 55,395 \* 0.42 \* 2.62 \* 0.24 \* 365 \* 1/2000

2014 MSW activity in Autauga County = 2,670 tons

CO emissions = MSW burned \* VOC emission factor

CO emission factor = 85 lb/ton

CO emissions from MSW burning in Autauga County = 1,946 tons \* 85 lbs/ton \* 1 ton/2000 lbs

CO emissions from MSW burning in Autauga County in 2014 = 113 tons

***g. Changes from 2011 Methodology***

The main change to the methodology as compared to the 2011 NEI was the use of population density to determine the number of people likely to burn waste in a county. In the previous methodology, an 80% urban no-burn threshold, based on the ratio of urban to rural *population,* indicated that a county would have zero emissions from MSW burning. In the current methodology, this no burn threshold was replaced by the use of population density to determine rural and like rural populations for each county. Additionally, the current methodology assumes that 25% of people likely to burn in counties with bans will do so, even with bans in place. A review of the background literature on CAP factors revealed that some factors represent the burning of combustible and non-combustible waste while others represent the burning of only combustible waste. That distinction is applied by this method and was not distinguished previously. The VOC emission factor was updated to 7.42 lb/ton compared to the previously used 8.56 lb/ton factor.10 Emission factors for 18 new HAPs were added to the analysis.

***h. Puerto Rico and US Virgin Islands Emissions Calculations***

2014 Census Data does not exist for the US Virgin Islands. Emissions are calculated using the same method described above using 2010 data.

***i. References***

1. U.S. Environmental Protection Agency, [*Advancing Sustainable Materials: 2013 Fact Sheet*](https://www.epa.gov/sites/production/files/2015-09/documents/2013_advncng_smm_fs.pdf), "Table 1. Generation, Recovery and Discards of Materials in MSW, 2013(in millions of tons and percent of generation of each material)," February 2014, (accessed May 2019).

2. U.S. Environmental Protection Agency, [*Advancing Sustainable Materials: 2013 Fact Sheet*](https://www.epa.gov/sites/production/files/2015-09/documents/2013_advncng_smm_fs.pdf), "Table 2. Generation, Recovery and Discards of Materials in MSW, 2013(in millions of tons and percent of generation of each product)," February 2014, (accessed May 2019).

3. U.S. Environmental Protection Agency, [*Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010—Fact Sheet*](https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/advancing-sustainable-materials-management-0)," p. 4, December 2011, (accessed May 2019).

4. Environment Canada. “Household Garbage Disposal and Burning.” Prepared by Environics Research Group. March 2001.

5. U.S. Census Bureau, Decennial Censuses, [2010 Census: Summary File 1](https://www2.census.gov/census_2010/04-Summary_File_1/).

6. U.S. Census Bureau. [*Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2014, 2014 Populations Estimates*](https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml)*,* (accessed May 2019).

7. Huntley, Roy, U.S. Environmental Protection Agency, “state\_comparison ERTAC SS\_version7\_3 Oct 20 2009 [electronic file],” November 5, 2009.

8. United States Environmental Protection Agency, Office of Air Quality Planning and Standards. *Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources, Section 2.5 Open Burning*. Research Triangle Park, NC. 1995a.

9. U.S. Environmental Protection Agency, Office of Research and Development. “Emissions of organic air toxics from open burning: a comprehensive review.” EPA-600/R-02-076. October 2002

10. U.S. Environmental Protection Agency, Control Technology Center. “Evaluation of Emissions from the Open Burning of Household Waste in Barrels.” EPA‑600/R‑97‑134a. November 1997.

11. United States Environmental Protection Agency, Office of Research and Development. *Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzeno-p-Dioxin (TCCD) and Related Compounds. Part I: Estimating Exposure to Dioxin-Like Compounds. Volume 2: Sources of Dioxin-Like Compounds in the United States*. EPA/600/P-00/001Ab. Washington D.C. March 2001.

**Table 1. Emission Factors for Open Burning of Residential MSW (2610030000)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Pollutant** | **Pollutant Code** | **Emission Factor**  **(lb/ton)** | **Emission Factor**  **Reference** |
| CO | CO | 8.50E+01 | Reference 8 |
| NOX | NOX | 6.00E+00 | Reference 8 |
| PM10-FIL | PM10-FIL | 3.80E+01 | Reference 7,10 |
| PM10-PRI | PM10-PRI | 3.80E+01 | Reference 7,10 |
| PM25-FIL | PM25-FIL | 3.48E+01 | Reference 7,10 |
| PM25-PRI | PM25-PRI | 3.48E+01 | Reference 7,10 |
| SO2 | SO2 | 1.00E+00 | Reference 8 |
| VOC | VOC | 7.42 E+00 | Reference 9 |
| 1,2,3,4,6,7,8-heptachlorodibenzo-p-dioxin | 35822469 | 7.96E-08 | Reference 11 |
| 1,2,3,4,7,8-hexachlorodibenzo-p-dioxin | 39227286 | 1.28E-08 | Reference 11 |
| 1,2,3,6,7,8-hexachlorodibenzo-p-dioxin | 57653857 | 1.94E-08 | Reference 11 |
| 1,2,3,7,8,9-hexachlorodibenzo-p-dioxin | 19408743 | 3.80E-08 | Reference 11 |
| 1,2,3,7,8-pentachlorodibenzo-p-dioxin | 40321764 | 1.62E-08 | Reference 11 |
| 1,2,4-trichlorobenzene | 120821 | 1.95E-04 | Reference 10 |
| 1,4-dichlorobenzene | 106467 | 6.65E-05 | Reference 10 |
| 2,3,7,8-tetrachlorodibenzo-p-dioxin | 1746016 | 5.40E-09 | Reference 11 |
| 2,4,6-Trichlorophenol | 88062 | 3.80E-04 | Reference 9 |
| 2-Methylnapthalene | 91576 | 1.70E-01 | Reference 9 |
| Acenaphthene | 83329 | 1.54E-03 | Reference 10 |
| Acenaphthylene | 208968 | 2.26E-02 | Reference 10 |
| Acetalaldehyde | 75070 | 8.57E-01 | Reference 10 |
| Acetophenone | 98862 | 9.00E-03 | Reference 9 |
| Acrolein | 107028 | 6.19E-02 | Reference 10 |
| Anthracene | 120127 | 3.66E-03 | Reference 10 |
| Benz[a]anthracene | 56553 | 4.48E-03 | Reference 10 |
| Benzene | 71432 | 2.48E+00 | Reference 10 |
| Benzo[a]pyrene | 50328 | 4.24E-03 | Reference 10 |
| Benzo[b]fluoranthene | 205992 | 5.26E-03 | Reference 10 |
| Benzo[g,h,i,]Perylene | 191242 | 3.95E-03 | Reference 10 |
| Benzo[k]fluoranthene | 207089 | 2.05E-03 | Reference 10 |
| Bis(2-Ethylhexyl)Phthalate | 117817 | 4.80E-02 | Reference 9 |
| Chlorobenzene | 108907 | 8.48E-04 | Reference 10 |
| Chrysene | 218019 | 5.07E-03 | Reference 10 |
| Cresol/Cresylic Acid (Mixed Isomers) | 1319773 | 8.80E-02 | Reference 9 |
| Dibenzo[a,h]anthracene | 53703 | 6.46E-04 | Reference 10 |
| Dibutyl Phthalate | 84742 | 7.00E-03 | Reference 9 |
| Ethyl Benzene | 100414 | 3.64E-01 | Reference 9 |
| Fluoranthene | 206440 | 8.14E-03 | Reference 10 |
| Fluorene | 86737 | 7.31E-03 | Reference 10 |
| Formaldehyde | 50000 | 8.87E-01 | Reference 9 |
| Hexachlorobenzene | 118741 | 4.40E-05 | Reference 10 |
| Hydrochloric Acid | 7647010 | 5.68E-01 | Reference 10 |
| Hydrogen Cyanide | 74908 | 9.36E-01 | Reference 10 |
| Indeno[1,2,3-c,d]pyrene | 193395 | 3.75E-03 | Reference 10 |
| Isophorone | 78591 | 1.90E-02 | Reference 9 |
| Methylene Chloride | 75092 | 3.40E-02 | Reference 9 |
| Naphthalene | 91203 | 3.51E-02 | Reference 10 |
| o-Cresol | 95487 | 4.90E-02 | Reference 9 |
| Octachlorodibenzo-p-dioxin | 3268879 | 9.94E-08 | Reference 11 |
| 0-xylene | 95476 | 3.30E-02 | Reference 9 |
| Pentachloronitrobenzene | 82688 | 2.00E-05 | Reference 9 |
| Pentachlorophenol | 87865 | 1.06E-04 | Reference 10 |
| Phenanthrene | 85018 | 1.46E-02 | Reference 10 |
| Phenol | 108952 | 2.80E-01 | Reference 10 |
| Polychlorinated Biphenyls | 1336363 | 5.72E-03 | Reference 10 |
| Propionaldehyde | 123386 | 2.25E-01 | Reference 9 |
| Pyrene | 129000 | 9.66E-03 | Reference 10 |
| Styrene | 100425 | 1.48E+00 | Reference 10 |
| Toluene | 108883 | 7.44E-01 | Reference 9 |
| Xylenes (Mixed Isomers) | 1330207 | 4.40E-02 | Reference 9 |