2020 National Emissions Inventory Technical Support Document: Dust – Construction -Non-Residential

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21 Dust – Construction -Non-Residential

21.1 Sector Descriptions and Overview

Construction dust refers to residential and non-residential construction activity, which are functions of acreage disturbed for construction. This sector will be divided below when describing the calculation of EPA's emissions. Table 21-1 lists the nonpoint SCCs associated with this sector in the 2020 NEI. The SCC level 1 and 2 descriptions is "Industrial Processes; Construction: SIC 15 - 17" for all SCCs.

Table 21-1: SCCs in the Construction Dust sector

SCC	SCC Level Three	SCC Level Four	TSD Section
2311010000	Residential	Total	20
2311020000	Industrial/Commercial/Institutional	Total	21
2311030000	Road Construction	Total	22

This section covers non-residential (industrial/commercial/institutional) construction dust. Section 20 covers dust for residential construction activity, and Section 22 covers dust from road construction.

A list of agencies that submitted non-residential construction dust emissions is provided in Section 6.2.3.

21.2 EPA-developed estimates

The calculations for estimating the emissions from non-residential construction involve first estimating the acres disturbed from non-residential construction in each county. The value of national-level non-residential construction spending is available from the U.S. Census Bureau and is converted to acreage disturbed using a conversion factor from a report by the Midwest Research Institute (MRI). The national-level acres disturbed are distributed to counties based on the proportion of non-residential construction employment in each county. Emissions factors for PM10 and PM25 are calculated based on precipitation-evaporation values and dry silt content in each county. The total amount of acres disturbed is multiplied by these emissions factors to estimate emissions of PM from non-residential construction.

21.2.1 Activity data

The activity data for this source category is the acreage disturbed from non-residential construction, which is estimated using data from the U.S. Census Bureau's *Annual Value of Construction Put in Place in the U.S* [ref 1]. and a conversion factor from MRI's *Estimating Particulate Matter Emissions from Construction Operations, Final Report* [ref 2]. The national-level non-residential construction spending data are allocated to the county-level based on the proportion of non-residential construction employees (NAICS 2362) in each county. Employment data are taken from the U.S. Census Bureau's County Business Patterns (CBP), and gaps in employment data are filled using a process described in detail in the next section.

$$EmpFr_c = \frac{Emp_c}{Emp_{US}} \quad (1)$$

$$CS_c = EmpFr_c \times CS_{US} \quad (2)$$

Where:

$EmpFr_c$ = The fraction of non-residential construction employees in county *c*
Emp_c = The number of non-residential construction employees in county *c*
Emp_{US} = The number of non-residential construction employees in the US
CS_c = Non-residential construction spending in county *c*
CS_{US} = Non-residential construction spending in the US

Non-residential construction spending is converted to acres disturbed using a conversion factor from MRI's report. For the average acres disturbed per million dollars of non-residential construction, MRI reported a conversion factor of 2 acres/$1 million (in 1992 constant dollars). The 1992 conversion factor is adjusted to 2020 using the *Price Deflator (Fisher) Index of New Single-Family Houses under Construction* [ref 3]. In 2020 the conversion factor was 0.84 acres per million dollars spent on non-residential construction activities.

$$Apd_{2020} = \frac{2\ acres}{\$1\ million} \times \frac{PD_{1992}}{PD_{2020}} \quad (3)$$

Where:

Apd_{2020} = Acres disturbed per million dollars in 2020
PD_{1992} = Price Deflator (Fisher) Index value in 1992
PD_{2020} = Price Deflator (Fisher) Index value in 2020

County-level non-residential construction spending (from equation 2) is then multiplied by this conversion factor to estimate county-level acreage disturbed from non-residential construction activities.

$$A_c = CS_c \times Apd_{2020} \quad (4)$$

Where:

A_c = Acres disturbed from non-residential construction in county *c*
CS_c = Non-residential construction spending in county *c*
Apd_{2020} = Acres disturbed per million dollars in 2020

21.2.2 Allocation procedure

Employment data are obtained from the U.S. Census Bureau's 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 This is the case if a particular county has 2 or fewer establishments under a given North American Industrial Classification Standard (NAICS) code. In prior years, the County Business Patterns data reported the counties where data was withheld, along with dataset ranges for the withheld data (e.g., 20-99 employees). A gap-filling procedure was implemented using state-level data, which did not feature withheld data, to estimate employment counts in all counties.

Beginning in 2018, the Census Bureau stopped reporting dataset ranges for counties with withheld data. As such, the prior gap-filling methods required updating. For all post-2017 inventories, year-specific employment data from the County Business Patterns dataset is used to determine the total amount of withheld data in each state. The 2017 version of the County Business Patterns is then used to determine the counties for which

withheld data exist and the data ranges for those counties, and it is to these counties that the difference between the state-level total employment and county-level total employment are allocated.

To gap-fill withheld state-level employment data:

1. The 2017 version of CBP is used to determine the states for which data is withheld and the employment size range in those states.
2. State-level data for states with known employment in the NAICS code are summed to the national level.
3. The total sum of state-level known employment from step b is subtracted from the national total reported employment for the NAICS code in the national-level CBP to determine the employment total for the withheld states.
4. Each of the withheld states is assigned the midpoint of the range code reported for that state. Table 21-2 lists the range codes and midpoints.
5. The midpoints for the states with withheld data are summed to the national level.
6. An adjustment factor is created by dividing the number of withheld employees (calculated in step 3 of this section) by the sum of the midpoints (step 5).
7. For the states with withheld employment data, the midpoint of the range for that state (step 4) is multiplied by the adjustment factor (step 6) to calculate the adjusted state-level employment for the NAICS code.

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

1. The 2017 version of CBP is used to determine the counties for which data is withheld and the employment size range in those counties.
2. County-level data for counties with known employment are summed by state.
3. 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).
4. Each of the withheld counties is assigned the midpoint of the range code (Table 21-2).
5. The midpoints for the counties with withheld data are summed to the state level.
6. An adjustment factor is created by dividing the number of withheld employees (step 3) by the sum of the midpoints (step 3).
7. For counties with withheld employment data, the midpoints (step 4) are multiplied by the adjustment factor (step 6) to calculate the adjusted county-level employment.

Note that step 6 adjusts all counties within each state with withheld employment data by the same state-based proportion. It is unlikely that actual employment corresponds exactly with this smoothed adjustment method, but this method is the best option given the availability of the data.

Table 21-2: Ranges and midpoints for data withheld from State and County Business Patterns

Range Letter	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

Range Letter	Ranges	Midpoint
J	10,000-24,999	17,500
K	25,000-49,999	37,500
L	50,000-99,999	75,000
M	100,000+	

An example of this gap-filling method is provided for NAICS 2362 in Table 21-3. The values in the table and subsequent steps are for demonstration purposes and are not representative of any specific NEI year or county.

Table 21-3: Example CBP for NAICS 2361

FIPS county	NAICS	empflag	emp
001	2362	A	withheld
003	2362	B	withheld
005	2362		177
007	2362		11
009	2362	A	withheld
011	2362	H	withheld
012	2362	A	withheld
013	2362		7,945
015	2362		47
017	2362		79
019	2362		2,220
021	2362		112
023	2362	A	withheld
025	2362		171
027	2362		359

1. The total of employees not including withheld counties is 11,121.
2. The state-level *CBP* reports 13,952 employees for NAICS 2362. The difference is 2,831.
3. County 001 is given a midpoint of 10 (since range code A is 0-19) and County 011 is given a midpoint of 3,750.
4. State total for these all withheld counties is 3,850.
5. 2,831/3,850 = 0.74.
6. The adjusted employment for county 001 is 10 × 0.74 = 7.35. County 011 has an adjusted employment of 3,750 × 0.74 = 2,757.47.

The county-level employment data are used to allocate the national-level non-residential construction spending data to the county-level (see equations 1 and 2).

21.2.3 Emission factors

Due to regional variances in soil moisture and silt content, emissions factors for PM10 and PM25 are calculated for each county. The initial PM10 emissions factor from non-residential construction is 0.19 tons/acre-month [ref 5]. The duration of construction activity for non-residential construction is assumed to be 11 months.

To account for the soil moisture level, the PM10 emissions are weighted using the 30-year average precipitation-evaporation (PE) values from Thornthwaite's PE Index. Average precipitation evaporation values for each state are estimated based on PE values for specific climatic divisions within a state [ref 5]. The average PE value for the

test sites from which the PM10 emissions factor was developed is 24. Equation 5 adjusts the county-level emissions factor based on this PE value.

To account for the silt content, the PM10 emissions are weighted using average silt content for each county. EPA uses the National Cooperative Soil Survey Microsoft Access Soil Characterization Database to develop county-level, average silt content values for surface soil [ref 6]. The U.S. Department of Agriculture and the National Cooperative Soil Survey define silt content of surface soil as the percentage of particles (mass basis) of diameter smaller than 50 micrometers (µm) found in the surface soil. Note that this definition is different than the U.S. Environmental Protection Agency's definition that includes all particles (mass basis) of diameter smaller than 75 micrometers. This database contains the most commonly-requested data from the National Cooperative Soil Survey Laboratories including data from the Kellogg Soil Survey Laboratory and cooperating universities. The average silt content for the test sites from which the PM10 emissions factor was developed is 9%. Equation 5 adjusts the county-level emissions factor based on this silt content value.

$$EF_{PM10,c} = ef_{PM10} \times \frac{24}{PE_s} \times \frac{S_c}{9\%} \quad (5)$$

Where:

$EF_{PM10,c}$ = PM_{10} emission factor corrected for soil moisture and silt content in state *s* and county *c,* in tons/acre-month

ef_{PM10} = Initial PM_{10} emissions factor for non-residential construction, 0.19 tons/acre-month

PE_s = Precipitation-evaporation value for state *s*

S_c = Percent dry silt content in soil for county *c*

Once PM_{10} adjustments have been made, $PM_{2.5}$ emissions are set to 10% of PM_{10}.[ref 7]

$$EF_{PM25,c} = 0.10 \times EF_{PM10,c} \quad (6)$$

Where:

$EF_{PM10,c}$ = PM_{10} emission factor corrected for soil moisture and silt content in state *s* and county *c,* in tons/acre-month

$EF_{PM25,c}$ = $PM_{2.5}$ emission factor corrected for soil moisture and silt content in county *c,* in tons/acre-month

Primary PM emissions are equal to filterable emissions as there are no condensible emissions from dust from non-residential construction. The resulting emission factors therefore vary by county and the composite minimum, median, and maximum emission factors for these sources are provided in the "Wagon Wheel Emission Factor Compendium" on the 2020 NEI Supporting Data and Summaries site.

21.2.4 Controls

There are no controls assumed for this category.

21.2.5 Emissions

The total annual PM emissions from non-residential construction in each county are calculated by multiplying the acres disturbed by the emissions factors calculated in equations 5 and 6 and by the duration of construction activity.

$$E_{p,c} = A_c \times EF_{p,c} \times M \quad (7)$$

Where:

$E_{p,c}$ = Annual emissions of pollutant *p* in county *c*
A_c = Acres disturbed from non-residential construction in county *c*
$EF_{PM10,c}$ = PM_{10} emission factor corrected for soil moisture and silt content in state *s* and county *c,* in tons/acre-month
$EF_{PM25,c}$ = $PM_{2.5}$ emission factor corrected for soil moisture and silt content in county *c,* in tons/acre-month
M = Duration of construction activity in months, assumed to be 11 months

21.2.6 Sample calculations

Table 21-4 lists sample calculations to determine the dust emissions from non-residential construction. The values in these equations are demonstrating program logic and are not representative of any specific NEI year or county.

Table 21-4: Sample calculations for non-residential construction

Eq. #	Equation	Values	Result
1	$EmpFr_c = \frac{Emp_c}{Emp_{US}}$	$\frac{120\ nonres\ construction\ employees}{582{,}574\ nonres\ construction\ employees}$	0.000206 fraction of non-residential construction employees
2	$CS_c = EmpFrac_c \times CS_{US}$	$0.000206\ fraction\ of\ employees\ in\ Grand\ Traverse \times \$\ 347{,}666\ million\ in\ nonres\ construction\ spending\ in\ the\ US$	$71.61 million in non-residential construction spending
3	$Apd_y = \frac{2\ acres}{\$1\ million} \times \frac{PD_{1992}}{PD_y}$	$\frac{2\ acres\ disturbed}{\$1\ million} \times \frac{57\ in\ 1992}{113\ in\ 2020}$	1.009 acres disturbed per million dollars spent on non-residential construction spending
4	$A_c = CS_c \times Apd_y$	$\$\ 71.61\ million \times 1.009 \frac{acres\ disturbed}{million\ \$}$	72.25 acres disturbed from non-residential construction

Eq. #	Equation	Values	Result
5	$EF_{PM10,c} = ef_{PM10} \times \frac{24}{PE_s} \times \frac{S_c}{9\%}$	$0.19\ tons\ per\ acre\ month \times \frac{24}{103.6} \times \frac{21.95\%}{9\%}$	0.1073 tons PM10 per acre-month of non-residential construction
6	$EF_{PM25,c} = 0.10 \times EF_{PM10,c}$	$0.10 \times 0.1073\ tons\ per\ acre\ month$	0.0107 tons PM25 per acre month on non-residential construction
7	$E_{p,c} = A_c \times EF_{p,c} \times M$	$72.25\ acres \times 0.1073 \frac{tons}{acre - month} \times 11\ months$	85.3 tons PM10 emissions from non-residential construction
		$72.25\ acres \times 0.0107 \frac{tons}{acre - month} \times 11\ months$	8.5 tons PM25 emissions from non-residential construction

21.2.7 Improvements/Changes in the 2020 NEI

For prior inventory years, the U.S. Census Bureau denoted counties for which County Business Patterns (CBP) data was withheld and reported an employment size range. A gap-filling procedure was implemented using state-level data, which was used to estimate the number of employees not reported in the county-level dataset. An average value for number of employmees for each employment size range was used to allocate the difference to the counties with withheld data. Beginning in reference year 2018, data are still only published for a county and NAICS code if there are three or more establishments. However, the CBP data no longer includes an employment size range for counties in which data is withheld for a NAICS code. For the 2020 NEI, the gap-filling method was updated. 2020 employment data from the CBP dataset is used to determine the total amount of withheld data in each state. The 2017 version of the CBP is then used to determine the counties for which data is withheld and the employment size range in those counties. The difference between the state-level total employment and the county-level total employment is allocated to the counties identified using 2017 CBP. Except for activity data updates, the CBP gap-filling method update is the only significant change made to the methodology for this source used in the 2020 NEI.

21.2.8 Puerto Rico and Virgin Islands

Since insufficient data exists to calculate emissions for the counties in Puerto Rico and the US Virgin Islands, emissions are based on two proxy counties in Florida: 12011, Broward County for Puerto Rico and 12087, Monroe County for the US Virgin Islands. The total emissions in tons for these two Florida counties are divided

by their respective populations creating a tons per capita emission factor. For each Puerto Rico and US Virgin Island counties, the tons per capita emission factor is multiplied by the county population (from the same year as the inventory's activity data) which serve as the activity data. In these cases, the throughput (activity data) unit and the emissions denominator unit are "EACH".

21.3 References

1. U.S. Census Bureau, 2020. Value of Construction Put in Place.
2. Midwest Research Institute. 1999. *Estimating Particulate Matter Emissions from Construction Operations, Final Report,* prepared for the Emission Factor and Inventory Group, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency. Table 5-2.
3. U.S. Census Bureau. 2020. *Price Deflator (Fisher) Index of New Single-Family Houses Under Construction*
4. U.S. Census Bureau, County Business Patterns. 2020. CBP Tables.
5. Midwest Research Institute. 1996. Improvement of Specific Emission Factors (BACM Project No. 1). Prepared for South Coast Air Quality Management District.
6. U.S. Department of Agriculture, National Cooperative Soil Survey, NCSS Microsoft Access Soil Characterization Database.
7. Midwest Research Institute. 2006. Background Document for Revisions to Find Fraction Ratios Used for AP-42 Fugitive Dust Emissions Factors. Prepared for Wester Governors 'Association.

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