

## HANDOUT 7-2

### Case Study Number 7-2 Solution

#### Estimating PM<sub>10</sub> and PM<sub>2.5</sub> Emissions from Residential Construction Activities

**Question 1:** What PM emission factors are applicable to residential construction activities?

**Answer:** PM<sub>10</sub> emission factors are those that were used in the NEI as shown in the following table (Table 7-9 of the Student Manual).

Housing Category	Emission Factor (tons/acre/month)
1-unit housing with basement	0.011 (plus 0.059 tons/cubic yard of on-site cut/fill)
1-unit housing without basement	0.032
2-unit housing	0.032
Apartments	0.11

**Question 2:** What is the basis of the activity data for residential construction activities and how is it measured?

**Answer:** The number of acres disturbed per year is the activity data for residential construction. Unlike this case study, direct estimates of the number of acres disturbed are generally not available, therefore the value for this activity is usually estimated through the use of housing start data that is available from the Bureau of the Census.

**Question 3:** What is the methodology for estimating PM<sub>10</sub> and PM<sub>2.5</sub> emissions from residential construction activities?

**Answer:** Equation 7-12 of the Student Manual shows the equation used for estimating PM<sub>10</sub> emissions from one-unit structures without basements, as well as all two-unit structures. PM<sub>2.5</sub> emissions are estimated by assuming it accounts for 20 percent of PM<sub>10</sub>.

**Question 4:** What is your estimate of the PM<sub>10</sub> and PM<sub>2.5</sub> emissions from the residential construction activities in the county within the past year without accounting for rule effectiveness, rule penetration, soil moisture, and silt content?

**Answer:** Emissions must first be estimated individually for 1-unit houses, apartments, and duplexes using the emission factors and data specific to each of these types of dwellings and the following equation (Equation 7-12 in the Student Manual).

$$\text{Emissions} = (\text{EF} * \text{B} * \text{f} * \text{m})$$

where: EF = Emission factor  
B = number of housing starts  
f = buildings-to-acres conversion factor  
m = duration of construction activity (months)

For single unit houses:

$$\text{Emissions} = 0.032 \text{ tons/acre/month} \times 251 \text{ bldg.} \times 0.184 \text{ acres/bldg.} \times 6 \text{ months} = 8.87 \text{ tons}$$

For duplexes:

$$\text{Emissions} = 0.032 \text{ tons/acre/month} \times 2 \text{ bldg.} \times 0.184 \text{ acres/bldg.} \times 6 \text{ months} = 0.07 \text{ tons}$$

For apartments:

$$\text{Emissions} = 0.11 \text{ tons/acre/month} \times 44 \text{ bldg.} \times 0.07 \text{ acres/bldg.} \times 12 \text{ months} = 4.07 \text{ tons}$$

Total PM<sub>10</sub> emissions from all residential construction are determined by adding the emissions from the single housing units, apartments, and duplexes.

$$\text{PM}_{10} \text{ Emissions} = 8.87 + 0.07 + 4.07 = 13.0 \text{ tons}$$

PM<sub>2.5</sub> emissions are calculated by multiplying the PM<sub>10</sub> emissions by 20 percent.

$$\text{PM}_{2.5} \text{ Emissions} = 0.2 \times 13.0 \text{ tons} = 2.6 \text{ tons}$$

**Question 5:** What is your estimate of the PM<sub>10</sub> and PM<sub>2.5</sub> emissions from the residential construction activities in the county within the past year accounting for control efficiency and rule penetration, but not for soil moisture and silt content?

**Answer:** Adjustments for controls efficiency and rule penetration can be made by multiplying the results for each type of housing category from above by (1 - (CE/100)(RP/100)) as shown below. Controls in PM<sub>10</sub> non-attainment areas are accounted for by applying a control efficiency of 50% for both PM<sub>10</sub> and PM<sub>2.5</sub> emissions for all PM<sub>10</sub> nonattainment areas. There is no adjustment made for attainment areas. The 50% value represents best available control methods on fugitive dust construction activities in the nonattainment counties.

For single-unit houses:

$$8.87 \text{ tons} \times (1 - (50/100)(75/100)) = 5.54 \text{ tons}$$

For duplexes:

$$0.07 \times (1 - (50/100)(75/100)) = 0.04 \text{ tons}$$

For apartments:

$$4.07 \times (1 - (50/100)(75/100)) = 2.54 \text{ tons}$$

Adding these three estimates gives the total PM<sub>10</sub> emissions from all types of construction adjusted for controls and rule penetration.

$$\text{PM}_{10} \text{ Emissions} = 5.54 + 0.04 + 2.54 = 8.1 \text{ tons}$$

Alternatively, the control and rule penetration adjustments can be applied to the aggregate PM<sub>10</sub> emissions from all types of construction as follows:

$$13 \text{ tons} \times (1 - (50/100)(1 - 75/100)) = 8.1 \text{ tons}$$

$$\text{PM}_{2.5} \text{ Emissions} = 8.1 \text{ tons} \times 0.2 = 1.6 \text{ tons}$$

**Question 6:** What is your estimate of the PM<sub>10</sub> and PM<sub>2.5</sub> emissions from the residential construction activities in the county within the past year accounting for control efficiency, rule penetration, and soil moisture?

**Answer:** Adjustments for soil moisture content are made by applying the following formula (Equation 7-13 of the Student Manual):

$$\text{Moisture Level Corrected Emissions} = \text{Base Emissions} \times (24/\text{PE})$$

Where: PE = Precipitation Evaporation value for the county

Therefore, corrected PM<sub>10</sub> emissions are equal to 8.1 tons x 24/6 = 32.4 tons

Corrected PM<sub>2.5</sub> emissions are equal to 1.6 tons x 24/6 = 6.4 tons

**Question 7:** What is your estimate of the PM<sub>10</sub> and PM<sub>2.5</sub> emissions from the residential construction activities in the county within the past year accounting for control efficiency, rule penetration, and silt content (but not soil moisture)?

**Answer:** Emissions are adjusted for the dry silt content in the soil of the area being inventoried by using the following equation (Equation 7-14 of the Student Manual).

$$\text{Silt Content Corrected Emissions} = \text{Base Emissions} \times (s/9\%)$$

Where: s = % dry silt content in soil for area being inventoried

Therefore, corrected PM<sub>10</sub> emissions are equal to 8.1 tons x 4.45 = 36 tons

Corrected PM<sub>2.5</sub> emissions are equal to 1.6 tons x 4.45 = 7.1 tons

**Question 8:** What is your estimate of the PM<sub>10</sub> and PM<sub>2.5</sub> emissions from the residential construction activities in the county within the past year accounting for control efficiency, rule penetration, soil moisture, and silt content?

**Answer:** Emissions are adjusted for both soil moisture content and silt content by applying the appropriate adjustments to the base emissions (already corrected for controls and rule penetration) as follows:

$$\text{Corrected Emissions} = \text{Base Emissions} \times 24/\text{PE} \times (\text{s}/9\%)$$

Therefore, corrected PM<sub>10</sub> emissions are equal to 8.1 tons x 24/6 x 40/9 = 144.2 tons

Corrected PM<sub>2.5</sub> emissions are equal to 1.6 tons x 24/6 x 40/9 = 28.5 tons

**Question 9:** Explain the significance of the adjustments that are made for soil moisture content and silt content.

**Answer:** These adjustments have a significant effect on the emissions since the case study area represents a relatively dry area.