

3. Area Sources

3.1 Scope and methodology

This chapter considers all stationary sources which are too small or too numerous to be treated as point sources. EPA guidance documents, including “Introduction to Area Source Inventory Development” (US EPA, 2001a) as well as permit and emissions data in the MCESD’s Environmental Management System (EMS) database, and previous SIP inventories, were evaluated to develop the list of area-source categories for inclusion. Some source categories were deemed “insignificant” because there are no large production facilities and/or very few small sources, and therefore emissions were not quantified. MCESD prepared the area-source emission estimates for all area sources and provided quality assurance checks on all data. Table 3.1–1 contains a list of all area-source categories, with Source Classification Codes (SCCs), addressed in this chapter.

Table 3.1–1. List of area-source categories.

SCC Code	Category Description	Section
<i>Fuel combustion:</i>		
2102006000	Industrial natural gas	3.2.1
2102004000	Industrial fuel oil	3.2.2
2103006000	Commercial/institutional natural gas	3.2.3
2103004000	Commercial/institutional fuel oil	3.2.4
2104006000	Residential natural gas	3.2.5
2104008000	Residential wood	3.2.6
2104004000	Residential fuel oil	3.2.7
<i>Industrial processes:</i>		
2301010000	Chemical manufacturing	3.3.1
2302002000	Commercial cooking	3.3.2.1
2302040000	Grain handling/processing	3.3.2.2
2302080000	Ammonia cold storage	3.3.2.3
2304000000	Secondary metal production	3.3.3
2305000000	Non-metallic mineral processes	3.3.4
2325000000	Mining and quarrying	3.3.5
2307000000	Wood product manufacturing	3.3.6
2308000000	Rubber/plastics manufacturing	3.3.7
2309000000	Fabricated metal products manufacturing	3.3.8
2311000000	Construction	3.3.9
2312000000	Electrical equipment manufacturing	3.3.10
n/a	State-permitted portable sources	3.3.11
n/a	Paved/unpaved road travel on industrial sites	3.3.12
2399000000	Industrial processes not elsewhere classified	3.3.13
<i>Waste treatment and disposal:</i>		
2601000000	On-site incineration	3.4.1
2610000000	Open burning	3.4.2
2620000000	Landfills	3.4.3
2630000000	Publicly owned treatment works (POTWs)	3.4.4
2650000000	Other industrial waste and disposal	3.4.5
<i>Miscellaneous area sources:</i>		
2810001000	Wildfires and brush fires	3.5.1.1
2810030000	Structure fires	3.5.1.2
2810050000	Vehicle fires	3.5.1.3
2810040000	Engine testing	3.5.1.4
2801000003	Tilling	3.5.2.1

Table 3.1–1. List of area-source categories (continued).

SCC Code	Category Description	Section
<i>Miscellaneous area sources:</i>		
2801000005	Harvesting	3.5.2.2
2801000000	Cotton ginning	3.5.2.3
2801700000	Fertilizer application	3.5.2.4
2805000000	Livestock	3.5.3
2850000000	Health services	3.5.4
2830000000	Accidental releases	3.5.5
2810010000	Humans	3.5.6
2730100000	Windblown dust	3.5.7

For nearly all categories, emissions were calculated in one of the following ways:

- emissions estimates for some categories were developed by conducting surveys on local usage (e.g., natural gas consumption, pesticide usage) or derived from state-wide data (e.g., fuel oil use).
- for some widespread or diverse categories (e.g., consumer solvent use), emissions were calculated using published per-capita or per-employee emission factors.
- for source categories with some information available from annual emissions reports (e.g., bakeries), these data were combined with employment data to “scale up” reported emissions to reflect the entire source category.
- for those source categories with detailed emissions data available from most or all significant sources in the category, emissions were calculated based on detailed process and operational data provided by these sources.
- The specific emissions estimation methodologies used for each source category (including any application of rule effectiveness) are described in greater detail in the respective sections.

3.2 Fuel combustion

Area-source emissions for the following seven categories of fuel consumption were calculated: Industrial natural gas, industrial fuel oil, commercial/institutional natural gas, commercial/institutional fuel oil, residential natural gas, residential wood, and residential fuel oil. Data for emissions calculations from natural gas combustion came from a survey of the four natural gas suppliers in Maricopa County. Table 3.2–1 summarizes the natural gas sales data received from Maricopa County natural gas suppliers.

Table 3.2–1. Maricopa County natural gas sales data by supply company and end-user category.

Natural gas supplier	Sales by end user category (in MMCF/yr)					
	Electric Utilities	Industrial	Commercial/ Institutional	Residential	Transport*	Other*
Southwest Gas	n/a	3,092.760	13,774.986	14,842.508	3,802.155	1,977.644
City of Mesa	80.169	386.692	1,486.877	1,112.936	59.924	n/a
El Paso	58,334.169	161.429	n/a	n/a	n/a	n/a
Black Mountain	n/a	n/a	142.561	464.084	n/a	n/a

* For emissions calculations, sales from these two categories were grouped with industrial sales.

Area-source emissions for wood and fuel oil combustion were calculated from Arizona state-level sales and consumption data as described in the following subsections. Area-source emissions from coal and liquid petroleum gas were not calculated, as emissions from these categories were determined to be insignificant.

3.2.1 Industrial natural gas

All natural gas suppliers in Maricopa County were surveyed to gather information on the volume of natural gas distributed, by user category, within the county in 2002. Area-source industrial natural gas usage for the county is based on the reported total volume of natural gas sold to industrial sources, minus natural gas used by industrial point sources:

$$\begin{aligned}
 \text{County area-source industrial natural gas usage} &= \text{Total reported industrial natural gas sales} - \text{Industrial point source natural gas usage} \\
 &= 9,480.60 \text{ MMCF} - 7,929.38 \text{ MMCF} \\
 &= 1,551.23 \text{ MMCF}
 \end{aligned}$$

Natural gas is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source natural gas usage derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal natural gas combustion reported by all industrial area sources in 2002.

Annual emissions for the county and the PM₁₀ nonattainment area are calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion, as in this example for PM₁₀ emissions from external natural gas combustion:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from external natural gas combustion} &= \text{External industrial natural gas usage (MMCF)} \times \text{PM}_{10} \text{ emission factor for external natural gas combustion (lb/MMCF)} \div 2,000 \text{ lb/ton} \\
 &= 1,527.09 \times 7.6 \div 2,000 \\
 &= 5.80 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–2. Emission factors and annual emissions from area-source industrial natural gas combustion, by combustion type.

Combustion type	% of total	Natural gas usage (MMCF)	Emission factors (lb/MMCF)					Annual emissions (tons/yr)				
			PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
External	98.44	1,527.09	7.6	7.6	100	0.6	3.2	5.80	5.80	76.35	0.46	2.44
Internal	1.56	24.14	10.0	10.0	2840	0.6	n/a	0.12	0.12	34.27	0.01	
Total:	100.00	1,551.23						5.92	5.92	110.63	0.47	2.44

Typical daily emissions for the county are calculated by dividing annual emissions by the number of days that activity occurs throughout the year:

$$\begin{aligned}
 \text{PM}_{10} \text{ typical daily emissions from industrial natural gas} &= \text{Annual PM}_{10} \text{ emissions (tons/yr)} \div (\text{days/week} \times \text{wks/yr}) \times 2,000 \text{ lbs/ton} \\
 &= 5.92 \div (6 \times 52) \times 2,000 \\
 &= 38.0 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions within the PM₁₀ nonattainment area are calculated by applying the ratio of industrial employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

$$\begin{aligned}
 \text{Emissions from area-source industrial natural gas combustion in the PM}_{10} \text{ NAA} &= \text{Annual county PM}_{10} \text{ emissions (tons/yr)} \times \text{NAA:County Industrial employment ratio} \\
 &= 5.92 \times 0.9891 \\
 &= 5.86 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–3. Annual and typical daily emissions from area-source industrial natural gas combustion.

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	5.92	5.92	110.63	0.47	2.44	38.0	38.0	709.2	3.0	15.7
PM ₁₀ NAA	5.86	5.86	109.42	0.46	2.42	37.6	37.6	701.4	3.0	15.5

3.2.2 Industrial fuel oil

Area-source emissions from industrial fuel oil combustion are calculated by a multi-step process which allocates Arizona state-level industrial fuel oil sales as reported by the U.S. Department of Energy, Energy Information Administration (US DOE, 2002b) to Maricopa County.

To derive industrial fuel oil usage in Maricopa County, reported Arizona state-level sales of high-sulfur diesel for 2002 are first subtracted from Arizona state-level total industrial fuel oil sales, as it is presumed that no high-sulfur diesel fuel is used in Maricopa County due to local air quality regulations and market conditions.

$$\begin{aligned}
 \text{State industrial fuel oil sales other than high-sulfur diesel (in thousand gallons, or Mgal)} &= \text{Reported state total industrial fuel oil sales} - \text{Reported state high-sulfur diesel sales} \\
 &= 61,748 \text{ Mgal} - 34,076 \text{ Mgal} \\
 &= 27,672 \text{ Mgal/yr}
 \end{aligned}$$

Arizona state industrial fuel oil sales (less high-sulfur diesel fuel) are then multiplied by the ratio of industrial employment in Maricopa County to Arizona state (0.71), as determined by data from the US Census Bureau (2003b) to estimate annual Maricopa County-level industrial fuel oil sales, as follows:

$$\begin{aligned}
 \text{Maricopa County industrial fuel oil sales} &= \text{Arizona state industrial fuel oil sales less high-sulfur diesel} \times \text{Maricopa County:state industrial employment ratio} \\
 &= 27,672 \text{ Mgal} \times 0.71 \\
 &= 19,647.12 \text{ Mgal/yr}
 \end{aligned}$$

To avoid double-counting, industrial fuel oil use attributable to stationary point sources (addressed in Chapter 2) and nonroad mobile sources (addressed in Chapter 4) are subtracted from County industrial fuel oil sales to estimate county fuel oil usage by area sources:

$$\begin{aligned}
 \text{Maricopa County area source fuel oil sales} &= \text{Maricopa County industrial fuel oil sales} - \text{Fuel oil used by industrial nonroad mobile equipment} - \text{Fuel oil used by industrial stationary point sources} \\
 &= 19,647.12 \text{ Mgal} - 7,365.927 \text{ Mgal} - 2,021.10 \text{ Mgal} \\
 &= 10,260.097 \text{ Mgal/yr}
 \end{aligned}$$

Industrial fuel oil is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source industrial fuel oil sales derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal fuel oil combustion reported by all industrial area sources surveyed by MCESD in 2002 (shown in Table 3.2–4 below).

Annual emissions for the county and the PM₁₀ nonattainment area are calculated by multiplying industrial fuel oil sales by the respective AP-42 emission factors for external and internal combustion, as in this example for PM₁₀ emissions from external fuel oil combustion:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from external industrial fuel oil combustion} &= \text{External industrial fuel oil sales (Mgal)} \times \text{PM}_{10} \text{ emission factor for external fuel oil combustion (lb/Mgal)} \div 2,000 \text{ lb/ton} \\
 &= 8,003.949 \times 2 \div 2,000 \\
 &= 8.00 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–4. Emission factors and annual emissions from area-source industrial fuel oil combustion, by combustion type.

Combustion type	% of total	Annual sales (Mgal)	Emission factors (lb/Mgal)					Annual emissions (tons/yr)				
			PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
External	78.01	8,003.949	2	2	24	7.39	0.8	8.00	8.00	96.05	29.55	3.20
Internal	21.99	2,256.147	42.5	42.5	604	39.7	–	47.94	47.94	681.36	44.78	0.00
Totals:	100.00	10,260.097						55.95	55.95	777.40	74.34	3.20

Typical daily emissions for the county are calculated by dividing annual emissions by the number of days activity that occurs throughout the year, as recommended by EIIP guidance (US EPA, 2001a):

$$\begin{aligned}
 \text{PM}_{10} \text{ typical daily emissions from industrial fuel oil} &= \text{Annual PM}_{10} \text{ emissions (tons/yr)} \div (\text{days/week} \times \text{wks/yr}) \times 2,000 \text{ lbs/ton} \\
 &= 55.95 \div (6 \times 52) \times 2,000 \\
 &= 358.6 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions in the PM₁₀ nonattainment area are calculated by applying the ratio of industrial employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

$$\begin{aligned}
 \text{PM}_{10} \text{ NAA emissions from area source industrial fuel oil combustion} &= \text{Annual county PM}_{10} \text{ emissions} \times \text{NAA:County industrial employment ratio} \\
 &= 55.95 \text{ tons/yr} \times 0.9891 \\
 &= 55.34 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–5. Annual and typical daily emissions from area-source industrial fuel oil combustion.

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	55.95	55.95	777.40	74.34	3.20	358.6	358.6	4,983.4	476.5	20.5
PM ₁₀ NAA	55.34	55.34	768.93	73.53	3.17	354.7	354.7	4,929.0	471.3	20.3

3.2.3 Commercial/institutional natural gas

All natural gas suppliers in Maricopa County were surveyed to gather information on the volume of natural gas distributed, by user category, within the county in 2002. Area-source commercial and institutional (C&I) natural gas usage for the county is based on the reported total volume of natural gas sold to C&I sources, minus natural gas used by C&I point sources:

$$\begin{aligned}
 \text{County area-source C\&I natural gas usage} &= \text{Reported C\&I natural gas sales} - \text{C\&I point source natural gas usage} \\
 &= 15,404.42 \text{ MMCF} - 725.35 \text{ MMCF} \\
 &= 14,679.07 \text{ MMCF}
 \end{aligned}$$

Natural gas is used for both external combustion (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source natural gas usage derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal natural gas combustion reported by all C&I area sources in 2002.

Annual emissions for the county are calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion, as in this example for PM₁₀ emissions from external natural gas combustion:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from external natural gas combustion} &= \text{External C\&I natural gas usage (MMCF)} \times \text{PM}_{10} \text{ emission factor for external natural gas combustion (lb/MMCF)} \div 2,000 \text{ lb/ton} \\
 &= 14,434.79 \times 7.6 \div 2,000 \\
 &= 54.85 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–6. Emission factors and annual emissions from area-source commercial/institutional natural gas combustion, by combustion type.

Combustion type	% of total	C&I natural gas usage (MMCF)	Emission factors (lb/MMCF)					Annual emissions (tons/yr)				
			PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
External	98.34	14,434.79	7.6	7.6	100	0.6	0.49	54.85	54.85	721.74	4.33	3.54
Internal	1.66	244.29	10	10	2840	0.6	n/a	1.22	1.22	346.89	0.07	
Total:	100.00	14,679.07						56.07	56.07	1,068.63	4.40	3.54

Typical daily emissions for the county are calculated by dividing annual emissions by the number of days that activity occurs throughout the year:

$$\begin{aligned}
 \text{PM}_{10} \text{ typical daily emissions from C\&I natural gas} &= \text{Annual PM}_{10} \text{ emissions (tons/yr)} \div (\text{days/week} \times \text{wks/yr}) \times 2,000 \text{ lbs/ton} \\
 &= 56.07 \div (6 \times 52) \times 2,000 \\
 &= 359.4 \text{ lbs/day}
 \end{aligned}$$

Annual and typical daily emissions within the PM₁₀ nonattainment area are calculated by applying the combined ratio of retail, office, public and other employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

$$\begin{aligned}
\text{Emissions from area-source C\&I natural gas combustion in the PM}_{10}\text{ NAA} &= \text{Annual county PM}_{10}\text{ emissions (tons/yr)} \times \text{NAA:County C\&I employment ratio} \\
&= 56.07 \times 0.9893 \\
&= 55.47 \text{ tons PM}_{10}\text{/yr}
\end{aligned}$$

Table 3.2-7. Annual and typical daily emissions from area-source commercial/institutional natural gas combustion.

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	56.07	56.07	1,068.63	4.40	3.54	359.4	359.4	6,850.2	28.2	22.7
PM ₁₀ NAA	55.47	55.47	1,057.19	4.36	3.50	355.6	355.6	6,776.9	27.9	22.4

3.2.4 Commercial/institutional fuel oil

Area-source emissions from commercial and institutional (C&I) fuel oil combustion are calculated by a multi-step process of allocating Arizona state-level C&I fuel oil sales as reported by the U.S. Department of Energy, Energy Information Administration (US DOE, 2002a) to Maricopa County.

To derive commercial/institutional fuel oil usage in Maricopa County, reported Arizona state-level sales of high-sulfur diesel for 2002 are first subtracted from Arizona state-level total C&I fuel oil sales, as it is presumed that no high-sulfur diesel fuel is used in Maricopa County due to local clean air act requirements and market conditions.

$$\begin{aligned}
\text{State C\&I fuel oil sales other than high-sulfur diesel (in thousand gallons, or Mgal)} &= \text{Reported state total C\&I fuel oil sales} - \text{Reported state high-sulfur diesel sales} \\
&= 30,077 \text{ Mgal} - 71 \text{ Mgal} \\
&= 30,006 \text{ Mgal/yr}
\end{aligned}$$

Arizona state commercial/institutional fuel oil sales (less high-sulfur diesel fuel) are then multiplied by the ratio of C&I employment in Maricopa County to Arizona state (0.71), as determined by data from the US Census Bureau (2003b) to estimate annual Maricopa County-level commercial/institutional fuel oil sales, as follows:

$$\begin{aligned}
\text{Maricopa County C\&I fuel oil sales} &= \text{Arizona state C\&I fuel oil sales less high-sulfur diesel} \times \text{Maricopa County:state commercial/institutional employment ratio} \\
&= 30,006 \text{ Mgal} \times 0.71 \\
&= 21,304.26 \text{ Mgal/yr}
\end{aligned}$$

To avoid double-counting, C&I fuel oil use attributable to stationary point sources (addressed in Chapter 2) and nonroad mobile sources (addressed in Chapter 4) are subtracted from County C&I fuel oil sales to estimate county fuel oil usage used by area sources:

$$\begin{aligned}
\text{Annual Maricopa County commercial/institutional area-source fuel oil sales} &= \text{Maricopa County C\&I fuel oil sales} - \text{Fuel oil used by C\&I nonroad mobile equipment} - \text{Fuel oil used by C\&I stationary point sources} \\
&= 21,304.26 \text{ Mgal} - 4,435.974 \text{ Mgal} - 190.672 \text{ Mgal} \\
&= 16,677.614 \text{ Mgal/yr}
\end{aligned}$$

Fuel oil is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source C&I fuel oil sales derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal fuel oil combustion reported by all commercial and institutional area sources surveyed by MCESD in 2002 (shown in Table 3.2–8 below).

Annual emissions for the county are calculated by multiplying C&I fuel oil sales by the respective AP-42 emission factors for external and internal combustion, as in this example for PM₁₀ emissions from external fuel oil combustion:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from external fuel oil combustion} &= \text{External C\&I fuel oil sales (Mgal)} \times \text{PM}_{10} \text{ emission factor for external fuel oil combustion (lb/Mgal)} \div 2,000 \text{ lb/ton} \\
 &= 11,165.542 \times 1.08 \div 2,000 \\
 &= 6.03 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–8. Emission factors and annual emissions from area-source commercial/institutional fuel oil combustion, by combustion type.

Combustion type	% of total	C&I fuel oil sales (Mgal)	Emission factors (lb/Mgal)					Annual emissions (tons/yr)				
			PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
External	66.95	11,165.542	1.08	1.08	24	7.1	0.8	6.03	6.03	133.99	39.64	4.47
Internal	33.05	5,512.072	42.5	42.5	604	39.7	–	117.13	117.13	1,664.65	109.41	0.00
Total:	100.00	16,677.614						123.16	123.16	1,798.63	149.05	4.47

Typical daily emissions for the county are calculated by dividing annual emissions by the number of days activity occurs throughout the year, as recommended by EIIP guidance (US EPA, 2001a):

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from C\&I fuel oil combustion} &= \text{Annual PM}_{10} \text{ emissions (tons/yr)} \div (\text{days/week} \times \text{wks/yr}) \times 2,000 \text{ lbs/ton} \\
 &= 123.16 \div (6 \times 52) \times 2,000 \\
 &= 789.5 \text{ lbs/day}
 \end{aligned}$$

Annual and typical daily emissions within the PM₁₀ nonattainment area are calculated by applying the combined ratio of retail, public, office and other employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

$$\begin{aligned}
 \text{PM}_{10} \text{ NAA emissions from area source C\&I fuel oil combustion} &= \text{Annual county PM}_{10} \text{ emissions (tons/yr)} \times \text{NAA:County C\&I employment ratio} \\
 &= 123.16 \times 0.9892 \\
 &= 121.60 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–9. Annual and typical daily emissions from area-source commercial/institutional fuel oil combustion.

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	123.16	123.16	1,798.63	149.05	4.47	789.5	789.5	11,529.7	955.5	28.6
PM ₁₀ NAA	121.84	121.84	1,779.39	147.46	4.42	781.0	781.0	11,406.3	945.2	28.3

3.2.5 Residential natural gas

All natural gas suppliers in Maricopa County were surveyed to gather information on the volume of natural gas sold, by user category, within the county. Annual emissions from residential natural gas combustion emissions were calculated by multiplying residential natural gas sales by emission factors for residential natural gas combustion summarized in the table below (US EPA, 1998a), as follows:

Table 3.2–10. Residential natural gas combustion emission factors (in lb/MMCF).

PM ₁₀	PM _{2.5}	NO _x	SO _x
7.6	7.6	94	0.6

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from residential natural gas combustion} &= \text{Residential natural gas annual sales (MMCF)} \times \text{Residential natural gas emission factor for PM}_{10} \text{ (lbs/MMCF)} \div 2,000 \text{ lbs/ton} \\
 &= 16,419.53 \times 7.6 \div 2,000 \\
 &= 62.39 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions are calculated by dividing annual emissions by the number of days (365) that activity occurs for residential natural gas combustion, as follows:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from residential natural gas combustion} &= \text{Annual PM}_{10} \text{ emissions} \times 2,000 \text{ lbs/ton} \div \text{days/yr} \\
 &= 62.39 \text{ tons/yr} \times 2,000 \div 365 \\
 &= 341.9 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily residential natural gas emissions in the PM₁₀ nonattainment area are calculated by multiplying county-level emissions by the percentage of total occupied households (99.18%) in the PM₁₀ nonattainment area as follows:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from residential natural gas combustion in the NAA} &= \text{County annual emissions} \times \text{Percentage of occupied households in the NAA} \\
 &= 62.39 \times 99.18\% \\
 &= 61.88 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–11. Annual and typical daily emissions from residential natural gas combustion.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	62.39	62.39	771.72	4.93	341.9	341.9	4,228.6	27.0
PM ₁₀ NAA	61.88	61.88	765.39	4.89	339.1	339.1	4,193.9	26.8

3.2.6 Residential wood combustion

Area-source emissions from residential wood combustion are calculated based on the amount of wood burned in fireplaces and woodstoves in Maricopa County, as recommended by EIIP guidance (US EPA, 2001d). Residential wood combustion in the county is estimated by multiplying data on statewide residential wood combustion usage from the US Department of Energy (2003) by the ratio of county to state households that report use of wood for heating from the US

Census Bureau (2003a). The latest available data on residential wood use for household heating from the US Census Bureau is for the calendar year 2000. Since all fireplaces in homes constructed since 1999 are required by Arizona statute to be clean-burning, it is assumed that these new homes have negligible emissions. Thus, year 2000 data is assumed to be representative of 2002 emissions.

$$\begin{aligned}
 \text{Maricopa County residential wood usage (cords/yr)} &= \text{Arizona residential wood usage (cords/yr)} \times \text{Ratio of county:state households using wood for heat} \\
 &= 491,000 \times 1,655 / 39,842 \\
 &= 20,396 \text{ cords/yr}
 \end{aligned}$$

To calculate emissions, the amount of wood used is converted to tons by multiplying cords by the number of cubic feet of wood in a cord and by the density of the wood used (US EPA, 2001d). Wood density is determined by weighted average of types of wood used for residential combustion in Maricopa County, provided by the US Forest Service (USFS, 1993).

$$\begin{aligned}
 \text{County residential wood usage (tons/yr)} &= \text{County wood usage (cords)} \times \text{avg. ft}^3 \text{ wood/cord} \times \text{Wood density (lbs/ft}^3) \div 2,000 \text{ lbs/ton} \\
 &= 20,396 \times 79 \times 31.57 \div 2,000 \\
 &= 25,433.73 \text{ tons}
 \end{aligned}$$

Annual emissions from residential wood combustion are calculated by multiplying the tons of wood used by the PM₁₀ emission factor for residential woodstoves and fireplaces from US EPA (2001d), Table 2.4-1:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from residential wood combustion (tons/yr)} &= \text{Residential wood usage (tons)} \times \text{PM}_{10} \text{ emission factor (lbs/ton)} \div 2,000 \text{ lbs/ton} \\
 &= 25,433.73 \times 34.6 \div 2,000 \\
 &= 440.00 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–12. Annual wood usage, emission factors, and annual emissions from residential wood combustion.

Residential wood usage (tons/yr)	Emission factors (lbs/ton)				Annual emissions (tons/yr)			
	PM ₁₀	PM _{2.5} *	NO _x	SO _x	PM ₁₀	PM _{2.5} *	NO _x	SO _x
25,433.73	34.6	32.2	2.6	0.4	440.00	409.20	33.06	5.09

*PM_{2.5} is assumed to be 93% of PM₁₀ (Houck and Tiegs, 1998).

Typical daily emissions are calculated by apportioning wood burning activity based on heating degree days (i.e., the number of degrees per day that the daily average temperature is below 65°F). Data provided by Arizona State University (2003) indicated that there were six months (April–September, totaling 184 days) in 2002 where no heating degree days were recorded. Assuming that no wood burning activity took place during those months, that leaves 181 days were residential wood burning can be assumed to occur. Thus, typical daily emissions are calculated by dividing annual emissions by the number of days residential wood burning occurred, as follows:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from residential wood combustion (lbs/day)} &= \text{Annual PM}_{10} \text{ emissions} \times 2,000 \text{ lbs/ton} \div \text{number of days wood burning occurred} \\
 &= 440.00 \times 2,000 \div 181 \\
 &= 4,861.9 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions within the PM₁₀ nonattainment area (NAA) are calculated by multiplying county totals by the ratio of total occupied housing units in the nonattainment area (1,350,717) to the total residential housing units in the county (1,361,837). See Section 1.5.1 for a further discussion of the housing data used.

$$\begin{aligned}
 \text{NAA annual emissions from residential wood combustion (tons/yr)} &= \text{County annual emissions (tons/yr)} \times \text{NAA:county residential housing ratio} \\
 &= 440.00 \times 0.9918 \\
 &= 436.40 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.2–13. Annual and typical daily emissions from residential wood combustion.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	440.00	409.20	33.06	5.09	4,861.9	4,521.6	365.3	56.2
PM ₁₀ NAA	436.40	405.85	32.79	5.05	4,822.0	4,484.5	362.4	55.7

3.2.7 Residential fuel oil

Emissions from residential fuel oil use were calculated using an approach similar to that used for residential wood combustion described in Section 3.2.6. County-level residential fuel oil use was derived from statewide totals using the ratio of county to state households that report fuel oil use from the US Census Bureau (2003a):

$$\begin{aligned}
 \text{Maricopa County residential fuel oil usage (Mgal/yr)} &= \text{Arizona residential fuel oil use (Mgal/yr)} \times \text{Ratio of county:state households reporting fuel oil use} \\
 &= 340 \times 490 / 1,813 \\
 &= 91.89 \text{ Mgal/yr}
 \end{aligned}$$

Using an AP-42 emission factors, and data on heating degree days and residential housing units described in Section 3.2.6, annual and daily emissions were calculated as shown in Table 3-2.14.

Table 3.2–14. Annual and typical daily emissions from residential fuel oil combustion.

Geographic area	Emission factors (lb/Mgal)				Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	0.4	0.4	18	7.1	0.02	0.02	0.83	0.33	0.2	0.2	9.1	3.6
PM ₁₀ NAA	0.4	0.4	18	7.1	0.02	0.02	0.82	0.32	0.2	0.2	9.1	3.6

3.2.8 Summary of all area-source fuel combustion

Tables 3.2–15 and 3.2–16 provide a summary of annual and typical daily emissions from all fuel combustion, for Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.2–15. Annual and typical daily emissions from all area-source fuel combustion for Maricopa County.

Fuel combustion type	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Ind. natural gas	5.92	5.92	110.63	0.47	2.44	38.0	38.0	709.2	3.0	15.7
Ind. fuel oil	55.95	55.95	777.40	74.34	3.20	358.6	358.6	4,983.4	476.5	20.5
C&I natural gas	56.07	56.07	1,068.63	4.40	3.54	359.4	359.4	6,850.2	28.2	22.7
C&I fuel oil	123.16	123.16	1,798.63	149.05	4.47	789.5	789.5	11,529.7	955.5	28.6
Res. natural gas	62.39	62.39	771.72	4.93		341.9	341.9	4,228.6	27.0	
Res. wood	440.00	409.20	33.06	5.09		4,861.9	4,521.6	365.3	56.2	
Res. fuel oil	0.02	0.02	0.83	0.33		0.2	0.2	9.1	3.6	
Total:	743.52	712.72	4,560.90	238.60	13.65	6,749.6	6,409.2	28,675.4	1,550.0	87.5

Table 3.2–16. Annual and typical daily emissions from all area-source fuel combustion for the PM₁₀ NAA.

Fuel combustion type	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Ind. natural gas	5.86	5.86	109.42	0.46	2.42	37.6	37.6	701.4	3.0	15.5
Ind. fuel oil	55.34	55.34	768.93	73.53	3.17	354.7	354.7	4,929.0	471.3	20.3
C&I natural gas	55.47	55.47	1,057.19	4.36	3.50	355.6	355.6	6,776.9	27.9	22.4
C&I fuel oil	121.84	121.84	1,779.39	147.46	4.42	781.0	781.0	11,406.3	945.2	28.3
Res. natural gas	61.88	61.88	765.39	4.89		339.1	339.1	4,193.9	26.8	
Res. wood	436.40	405.85	32.79	5.05		4,822.0	4,484.5	362.4	55.7	
Res. fuel oil	0.02	0.02	0.82	0.32		0.2	0.2	9.1	3.6	
Total:	736.81	706.26	4,513.93	236.06	13.50	6,690.3	6,352.7	28,379.0	1,533.5	86.5

3.3 Industrial processes

3.3.1 Chemical manufacturing

Emissions from area-source chemical manufacturing were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2003b) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census Bureau’s County Business Patterns (CBP) for 2001 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3-3.1 shows the NAICS codes and employment data used to calculate emissions from chemical manufacturing.

Table 3.3–1. NAICS codes and descriptions for chemical manufacturing.

NAICS Code	Description	US Census employment data	Value used
32551	Paint & coating manufacturing	100–249	175
32591	Printing ink manufacturing	20–99	60
422910	Farm supplies, wholesale	298	298
325991	Custom compounding of purchased resin	100–249	175
325998	All other misc. chemical product & prep. manufacturing	316	316
325188	All other basic inorganic chemical manufacturing	100–249	175
325412	Pharmaceutical manufacturing.	500–999	750
Total:			1,949

Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in chemical mfg.} &= \text{Total employment (from US Census' County Business Patterns)} && - \text{Employment at point sources (from annual emission reports)} \\
 &= 1,949 && - 191 \\
 &= 1,758 \text{ employees}
 \end{aligned}$$

This area-source employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2002 as follows:

$$\begin{aligned}
 \text{Area-source PM}_{10} \text{ emissions from chemical mfg.} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 &= \frac{12.07 \text{ tons of PM}_{10}/\text{yr}}{744 \text{ employees}} \times 1,758 \text{ employees} \\
 &= 28.52 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

PM₁₀ typical daily emissions are calculated based on the operating schedule data reported by chemical manufacturing facilities. From annual emission surveys, the modal values were identified for two items: days/week and annual activity. This data was used to calculate typical daily emissions as follows:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from chemical mfg.} &= \frac{\text{Annual emissions (tons/yr)}}{\text{Days/week} \times \text{Weeks/year}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{28.52}{5 \times 52} \times 2,000 \\
 &= 219.4 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
 \text{PM}_{10} \text{ emissions from area-source chemical mfg. in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:county ratio of industrial employment} \\
 &= 28.52 \text{ tons/yr} \times .9891 \\
 &= 28.21 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.3–2 summarizes annual and typical daily emissions from chemical manufacturing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–2. Annual and typical daily emissions from area-source chemical manufacturing.

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	28.53	17.72	1.08	0.25	0.61	219.4	136.3	8.3	1.9	4.7
PM ₁₀ NAA	28.22	17.53	1.07	0.25	0.61	217.1	134.8	8.2	1.9	4.7

3.3.2 Food and kindred products

3.3.2.1 Commercial cooking

Emissions from commercial cooking were estimated for five source categories based on equipment type. These equipment types include: chain-driven (conveyorized) charbroilers (SCC 2302002100), under-fired charbroilers (2302002200), flat griddles (2302003100), clamshell griddles (2302003200), and deep-fat fryers (2302003000). Emission inventory methods outlined in EPA guidance (US EPA, 2004) for these source categories include emissions from all meat types (hamburger, steak, fish, pork, and chicken) and five restaurant types (ethnic, fast food, family, seafood, and steak & barbeque).

Data obtained from MCESD’s eating and drinking establishments permit database indicated that 9,038 restaurants operated in Maricopa County in 2002. The percent of restaurants in Maricopa County for the five restaurant types was obtained from a commercial business database (Harris InfoSource, 2003). The percent of restaurants for each restaurant type was multiplied by the total number of restaurants operated in Maricopa County in 2002 to derive the number of restaurants for each restaurant type as shown in Table 3.3–3.

Table 3.3–3. Maricopa County restaurants by type.

Restaurant category	Percentage	# of restaurants
Ethnic food	14.47	1,308
Fast food	15.35	329
Family	3.64	1,387
Seafood	0.61	55
Steak & barbeque	1.15	104
Unrelated restaurant types e.g., lunchroom, bars,...	64.79	5,856
All restaurants	100.00	9,038

Using the number of restaurants for each restaurant type, along with the default emission factors and equations from EPA (2004), emissions for each combination of equipment type, restaurant type, and meat type were calculated, and the results were summed to estimate annual emissions for each type of cooking equipment, as shown in Table 3.3–4.

Table 3.3–4. Annual emissions from commercial cooking equipment, by equipment type.

Equipment type	Annual emissions (tons/yr)	
	PM ₁₀	PM _{2.5}
Chain-driven charbroilers	72.71	70.49
Underfired charbroilers	500.61	483.94
Deep fat fryers	0.00	0.00
Flat griddles	131.81	100.18
Clamshell griddles	8.71	7.38
Totals:	713.85	661.98

Commercial cooking is assumed to occur uniformly throughout the year, therefore, it was assumed that the annual activity was 7 days/week.

Table 3.3-5. Typical daily emissions from commercial cooking equipment, by equipment type.

Equipment type	Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}
Chain-driven charbroilers	399.5	387.3
Underfired charbroilers	2,750.6	2,659.0
Deep fat fryers	0.0	0.0
Flat griddles	724.2	550.4
Clamshell griddles	47.9	40.5
Totals:	3,922.2	3,637.2

Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage population within the nonattainment area of 99.14%. (See Section 1.5.1 for a discussion of the population data used.) Table 3.3-6 summarizes the annual and typical daily emissions from commercial cooking for Maricopa County and the PM₁₀ NAA.

Table 3.3-6. Annual and typical daily emissions from commercial cooking equipment.

Equipment type	Maricopa County				PM ₁₀ nonattainment area			
	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)		Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Chain-driven charbroilers	72.71	70.49	399.5	387.3	72.09	69.88	396.1	384.0
Underfired charbroilers	500.61	483.94	2,750.6	2,659.0	496.31	479.77	2,727.0	2,636.1
Deep fat fryers	0.00	0.00	0.0	0.0	0.00	0.0	0.0	0.0
Flat griddles	131.81	100.18	724.2	550.4	130.68	99.31	718.0	545.7
Clamshell griddles	8.71	7.38	47.9	40.5	8.63	7.31	47.4	40.2
Totals:	713.85	661.98	3,922.2	3,637.2	707.71	656.28	3,888.5	3,605.9

3.3.2.2 Grain handling/processing

Annual emissions from area-source grain handling and processing operations were derived from annual emission reports submitted by permitted sources. It was assumed that there were no significant unpermitted sources within Maricopa County. Note that larger operations are treated as point sources, and addressed in Chapter 2.

Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on either a 5- or 6-day week. As all facilities addressed in this source category are located within the PM₁₀ nonattainment area, emission totals for both areas are equal. Annual and typical daily emissions are shown in Table 3.3-7.

Table 3.3-7. Annual and typical daily emissions from area-source grain handling and processing.

Category	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	7.01	1.80	53.1	13.5
PM ₁₀ NAA	7.01	1.80	53.1	13.5

3.3.2.3 Ammonia cold storage

Area-source emissions from ammonia cold storage are estimates of ammonia emissions from food and kindred products industrial sources that use ammonia for refrigeration of food products. Emission calculations are based on the number of employees in the food and kindred products industry classification (NAICS codes 311, 3121) as reported by the 2001 County Business Patterns (US Census Bureau, 2003b). Annual emissions are calculated by multiplying employment numbers by the emission factor for ammonia cold storage as listed in Table 6-5 of “Development and Selection of Ammonia Emission Factors” (Battye et al., 1994) as follows:

$$\begin{aligned}
 \text{Annual NH}_3 \text{ emissions from ammonia cold storage (tons/yr)} &= \text{Number of employees in relevant industries (from CBP)} \times \text{NH}_3 \text{ emission factor (lb/employee-yr)} \div 2,000 \text{ lbs/ton} \\
 &= 8,033 \times 413 \div 2,000 \\
 &= 1,658.81 \text{ tons NH}_3/\text{yr}
 \end{aligned}$$

Typical daily emissions are calculated by dividing annual emissions by the number of days per year that activity occurred, as follows:

$$\begin{aligned}
 \text{Typical daily NH}_3 \text{ emissions (lbs/day)} &= \text{Annual emissions (tons/yr)} \times 2,000 \text{ lbs/ton} \div (\text{weeks/year} \times \text{days/week}) \\
 &= 1,685.81 \times 2,000 \div (52 \times 6) \\
 &= 10,633.4 \text{ lbs NH}_3/\text{day}
 \end{aligned}$$

Annual and typical daily emissions for the PM₁₀ nonattainment area are calculated by multiplying Maricopa County emissions by the ratio of County industrial employment that occurs in the PM₁₀ nonattainment area. (See Section 1.5.1 for a discussion of employment data).

$$\begin{aligned}
 \text{Annual NH}_3 \text{ emissions from ammonia cold storage in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual county emissions (tons/yr)} \times \text{NAA:County Industrial employment ratio} \\
 &= 1,658.81 \times 0.9891 \\
 &= 1,640.73 \text{ tons NH}_3/\text{yr}
 \end{aligned}$$

Table 3.3–8. Annual and typical daily NH₃ emissions from ammonia cold storage.

Geographic area	Annual emissions (tons/yr)	Typical daily emissions (lbs/day)
Maricopa County	1,658.81	10,633.4
PM ₁₀ NAA	1,640.73	10,517.5

3.3.3 Secondary metal production

Annual emissions from secondary metal production facilities were derived from annual emission reports from permitted sources. As this category consists primarily of foundries, it was assumed that there were no significant unpermitted sources within Maricopa County. Since all facilities considered in this section are located within the PM₁₀ nonattainment area, total emission values for the county and the PM₁₀ NAA from area-source secondary metal production are equal.

Table 3.3–9. Annual and typical daily emissions from secondary metal production.

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	6.72	3.68	0.03	0.03	2.68	52.1	28.7	0.2	0.3	15.6
PM ₁₀ NAA	6.72	3.68	0.03	0.03	2.68	52.1	28.7	0.2	0.3	15.6

3.3.4 Non-metallic mineral processes

The primary contributors to this source category include concrete batch plants, ceramic clay and tile manufacturing, brick manufacturing, and gypsum mining. Emissions from this source category were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2003b) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census Bureau’s County Business Patterns (CBP) for 2001 employment were used. Total employment in Maricopa County for NAICS code group 327, non-metallic mineral product manufacturing, for 2001 (the most recent data available) was used. In addition, some portable concrete batch operations which operate within Maricopa County for only part of the year, are issued air quality permits by the Arizona Department of Environmental Quality (ADEQ). All state-permitted portable sources are addressed in Section 3.3.11.

Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in non-metallic mineral products} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 4,054 - 1,412 \\
 &= 2,642 \text{ employees}
 \end{aligned}$$

This area-source employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2002 as follows:

$$\text{Total area-source emissions} = \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment}$$

$$\begin{aligned}
 \text{Area-source PM}_{10} \text{ emissions} &= \frac{35.21 \text{ tons of PM}_{10}/\text{yr}}{1,068 \text{ employees}} \times 2,642 \text{ employees} \\
 &= 87.11 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions are calculated based on the operating schedule data reported by surveyed facilities. From annual emission surveys, the modal values were identified for two items: days/week and annual activity. This data was used to calculate typical daily emissions as follows:

$$\begin{aligned}
\text{Typical daily PM}_{10} \text{ emissions} &= \frac{\text{annual emissions (tons/yr)}}{\text{days/week} \times \text{weeks/year}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
&= \frac{87.11}{5 \times 52} \times 2,000 \\
&= 670.1 \text{ lbs PM}_{10}/\text{day}
\end{aligned}$$

Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
\text{PM}_{10} \text{ emissions from area sources within the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:county ratio of industrial employment} \\
&= 87.11 \text{ tons/yr} \times .9891 \\
&= 86.16 \text{ tons PM}_{10}/\text{yr}
\end{aligned}$$

Table 3.3–10 summarizes annual and typical daily emissions from non-metallic mineral processing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–10. Annual and typical daily emissions from area-source non-metallic mineral products.

Category	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	87.11	31.61	670.1	243.2
PM ₁₀ NAA	86.16	31.27	662.8	240.5

3.3.5 Mining and quarrying

Annual emissions from area-source mining and quarrying (sand and gravel) operations were derived from annual emission reports submitted by permitted sources. It was assumed that there were no significant unpermitted sources within Maricopa County. Note that larger mining and quarrying operations are treated as point sources, and addressed in Chapter 2. Some portable mining and quarrying operations which operate within Maricopa County for only part of the year, are issued air quality permits by the Arizona Department of Environmental Quality (ADEQ). All state-permitted portable sources are addressed in Section 3.3.11.

Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on either a 5- or 6-day week. Emissions within the PM₁₀ nonattainment area were identified using information on the location of each permitted facility. Annual and daily emissions are shown in Table 3.3–11.

Table 3.3–11. Annual and typical daily emissions from area-source mining and quarrying operations.

Category	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	28.43	11.09	177.1	68.3
PM ₁₀ NAA	22.92	9.20	138.9	55.1

3.3.6 Wood product manufacturing

Emissions from wood product manufacturing were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2003b) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census Bureau’s County Business Patterns (CBP) for 2001 employment were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.3–12 shows the NAICS codes and employment data used to calculate emissions from wood product manufacturing.

Table 3.3–12. NAICS codes and descriptions for wood product manufacturing.

NAICS Code	Description	US Census employment data	Value used
321---	Wood products manufacturing	6,720	6,720
337110	Wood kitchen cabinet & countertop manufacturing	1,703	1,703
337121	Upholstered household furniture manufacturing	281	281
337122	Non-upholstered wood household furniture manufacturing	3,160	3,160
337127	Institutional furniture manufacturing	100–249	175
337129	Wood television, radio and sewing machine cabinet mfg.	20–99	60
337211	Wood office furniture manufacturing	20–99	60
337212	Custom architectural woodwork & millwork mfg.	436	436
337215	Showcase, partition, shelving & locker manufacturing	610	610
337920	Blind & shade manufacturing	202	202
Total:			13,407

Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in wood products} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 13,407 - 1,097 \\
 &= 12,310 \text{ employees}
 \end{aligned}$$

This area-source employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2002 as follows:

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source PM}_{10} \text{ emissions from wood products} &= \frac{13.56 \text{ tons of PM}_{10}/\text{yr}}{1,150 \text{ employees}} \times 12,310 \text{ employees} \\
 &= 145.14 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions are calculated based on the operating schedule data reported by wood products facilities. From annual emission surveys, the modal values were identified for two items: days/week and annual activity. This data was used to calculate typical daily emissions as follows:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from wood products} &= \frac{\text{Annual emissions (tons/yr)}}{\text{Days/week} \times \text{Weeks/year}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{145.14}{5 \times 52} \times 2,000 \\
 &= 1,116.5 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage of industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
 \text{PM}_{10} \text{ emissions from area-source wood products in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:county ratio of industrial employment} \\
 &= 145.14 \text{ tons/yr} \times .9891 \\
 &= 143.56 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.3–13 summarizes annual and typical daily emissions from wood products manufacturing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–13. Annual and typical daily emissions from area-source wood products manufacturing.

Category	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	145.14	89.36	1,116.5	687.4
PM ₁₀ NAA	143.56	88.38	1,104.3	679.9

3.3.7 Rubber/plastics manufacturing

Emissions from area-source rubber and plastic manufacturing facilities were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2003b) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category. The most recent data from the US Census Bureau’s County Business Patterns (CBP) for 2001 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.3–14 shows the NAICS codes and employment data used to calculate emissions from rubber and plastic manufacturing facilities.

Table 3.3–14. NAICS codes and descriptions for rubber and plastic manufacturing facilities.

NAICS Code	Description	US Census employment data	Value used
32613	Laminated plastics plate, sheet & shape mfg	20–99	60
32614	Polystyrene foam product mfg	250–499	375
32622	Rubber & plastics hoses & belting mfg	100–249	175
33992	Sporting & athletic goods mfg	1,293	1,293
325991	Custom compounding of purchased resin	100–249	175
326122	Plastics pipe & pipe fitting mfg	100–249	175
326160	Plastics bottle mfg	250–499	375
326191	Plastics plumbing fixture mfg	250–499	375
326199	All other plastics product mfg	4,282	4,282
326212	Tire retreading	20–99	60
326299	All other rubber product mfg	250–499	375
327991	Cut stone & stone product mfg	111	111
336612	Boat building	250–499	375
Total:			8,206

Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in rubber \& plastic product manufacturing} &= \text{Total employment (from US Census' County Business Patterns)} && - \text{Employment at point sources (from annual emission reports)} \\
 &= 8,206 && - 1,862 \\
 &= 6,344 \text{ employees}
 \end{aligned}$$

This area-source employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2002 as follows:

$$\begin{aligned}
 \text{Total area-source PM}_{10} \text{ emissions from rubber/plastic product mfg.} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 &= \frac{3.706 \text{ tons of PM}_{10}/\text{yr}}{923 \text{ employees}} \times 6,344 \text{ employees} \\
 &= 25.47 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions are calculated based on the operating schedule data reported by rubber/plastics products manufacturing facilities. From annual emission surveys, the modal values were identified for two items: days/week and annual activity. This data was used to calculate typical daily emissions as follows:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from rubber \& plastic manufacturing} &= \frac{\text{Annual emissions (tons/yr)}}{\text{Days/week} \times \text{Weeks/year}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{25.47}{5 \times 52} \times 2,000 \\
 &= 195.9 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
 \text{PM}_{10} \text{ emissions from area-source in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:county ratio of industrial employment} \\
 &= 25.47 \text{ tons/yr} \times .9891 \\
 &= 25.19 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.3–15 summarizes annual and typical daily emissions from rubber/plastic products manufacturing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–15. Annual and typical daily emissions from area-source rubber/plastic products manufacturing.

Category	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	25.47	23.41	195.9	180.1
PM ₁₀ NAA	25.19	23.16	193.7	178.1

3.3.8 Fabricated metal products manufacturing

Emissions from fabricated metal products manufacturing were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2003b) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census Bureau’s County Business Patterns (CBP) for 2001 employment were used. CBP employment data for NAICS code 332* (fabricated metal products manufacturing) indicated that there were 16,232 employees in this industry in Maricopa County. Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in fab. metal products} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 16,232 - 75 \\
 &= 16,157 \text{ employees}
 \end{aligned}$$

This area-source employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2002 as follows:

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source PM}_{10} \text{ emissions from fab. metal products} &= \frac{0.025 \text{ tons of PM}_{10}/\text{yr}}{638 \text{ employees}} \times 16,157 \text{ employees} \\
 &= 0.63 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions are calculated based on the operating schedule data reported by fabricated metal products facilities. From annual emission surveys, the modal values were identified for two items: days/week and annual activity. This data was used to calculate typical daily emissions as follows:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from fab. metal products} &= \frac{\text{Annual emissions (tons/yr)}}{\text{Days/week} \times \text{Weeks/year}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{0.63}{5 \times 52} \times 2,000 \\
 &= 4.8 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
 \text{PM}_{10} \text{ emissions from area-source fab. metal prod. in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\
 &= 0.63 \text{ tons/yr} \times 0.9891 \\
 &= 0.62 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.3–16 summarizes annual and typical daily emissions from fabricated metal products manufacturing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–16. Annual and typical daily emissions from area-source fabricated metal product manufacturing.

Category	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	0.63	0.44	4.8	3.4
PM ₁₀ NAA	0.62	0.44	4.8	3.4

3.3.9 Construction

Maricopa County’s air quality permits database was used to identify all earthmoving permits issued during 2002. A total of 3,506 permits were issued, comprising a total of 51,803 acres (Table 3.3–17). Data requested on each earthmoving permit application includes the activity type and acreage. Where the activity type was unknown, this acreage was apportioned to residential and commercial construction, the two largest categories, as shown below.

Table 3.3–17. 2002 Maricopa County earthmoving permits issued, by type.

Earthmoving Permit Category	Reported Acres	“All other” category apportionment	Revised Acres
Residential	29,431.9	+ 13,073.9	42,505.8
Commercial	4,457.8	+1,980.2	6,438.0
Road construction	2,129.1		2,129.1
Trenching	649.5		649.5
Weed control	80.4		80.4
All other categories / unknown	15,054.1		
Totals:	51,802.8		51,802.8

The latest EPA guidance (US EPA, 2002) provides different emission factors of single-family vs. multi-unit residential construction activity. As no information was available about the breakout of residential construction activity between these two categories, the following assumptions were made:

- all permits less than 1 acre were assumed to be single-family construction.
- the remainder of residential permits were assumed to be split equally between single- and multi-unit housing.

The average duration of construction activity and emission factors were applied to each of these categories as shown below in Table 3.3–18. Estimates of project duration for residential construction are from EIIP guidance (US EPA, 2002); estimates for commercial, road construction, and trenching/weed control are from MRI (1996):

Table 3.3–18. Average project duration and emission factor, by permit type.

Permit Category	Total Acres	Average Duration (months)	Total acre-months	Emission factor (tons PM₁₀/acre-month)
Residential: single-family	22,117.1	6	132,702.9	0.032
Residential: multi-family	20,388.7	12	244,663.9	0.11
Commercial	6,438.0	12	77,256.0	0.11
Road construction	2,129.1	12	25,549.1	0.11
Trenching	649.5	1	649.5	0.11
Weed control	80.4	1	80.4	0.11
Totals:	51,802.8			

county-wide annual uncontrolled PM₁₀ emissions for each construction category were then calculated as follows:

$$\text{Annual uncontrolled PM}_{10} \text{ emissions} = \text{total acres/yr} \times \text{no. months} \times \text{emission factor (tons of PM}_{10}\text{/acre-month)}$$

Example:

$$\begin{aligned} \text{Annual uncontrolled PM}_{10} \text{ emissions from single-family residential construction} &= 22,117.1 \text{ acres/yr} \times 6 \text{ months} \times 0.032 \text{ tons PM}_{10}\text{/acre-month} \\ &= 4,246.50 \text{ tons PM}_{10}\text{/yr} \end{aligned}$$

A control efficiency of 70% was applied to the uncontrolled emissions calculations. A recent rule effectiveness study by Maricopa County (MCESD, 2003) indicates a 80% compliance rate with County Rule 310 on dust control. Thus, an overall control effectiveness of 56% (= 70% × 80%) was applied, consistent with the approach used by ADEQ to estimate construction activity emissions for the Salt River PM₁₀ State Implementation Plan Revision (ADEQ, 2004).

Controlled PM₁₀ emissions were calculated as follows:

$$\text{Annual controlled PM}_{10} \text{ emissions} = \text{Uncontrolled PM}_{10} \text{ emissions (tons/yr)} \times [1 - (\text{control efficiency} \times \text{rule effectiveness})]$$

Example:

$$\begin{aligned} \text{Annual controlled PM}_{10} \text{ emissions from single-family residential construction} &= 4,246.5 \text{ tons} \times [1 - (70\% \text{ control} \times 80\% \text{ rule effectiveness})] \\ &= 1,868.5 \text{ tons PM}_{10}\text{/yr} \end{aligned}$$

PM_{2.5} emissions were calculated as 20% of PM₁₀ emissions (US EPA, 2002). Table 3.3–19 summarizes the calculations for each construction category.

Table 3.3–19. Annual emissions from construction (tons/yr).

Category	Total acre-months	Emission factor (tons/acre-month)	Uncontrolled PM ₁₀	Controlled PM ₁₀	Controlled PM _{2.5}
Residential: single-family	132,702.9	0.032	4,246.5	1,868.5	373.7
Residential: multi-unit	244,663.9	0.11	26,913.0	11,841.7	2,368.3
Commercial	77,256.0	0.11	8,498.2	3,739.2	747.8
Road construction	25,549.1	0.11	2,810.4	1,236.6	247.3
Trenching	649.5	0.11	71.4	31.4	6.3
Weed control	80.4	0.11	8.8	3.9	0.8
Totals:			42,548.4	18,721.3	3,744.3

It was assumed that construction activity occurs 5 days per week and evenly throughout the year. Thus, County typical daily emissions were calculated by dividing Maricopa County annual emissions by 260 (5 days/wk × 52 wks/yr).

A review of earthmoving permit site location data indicated that 95.7 percent of the earthmoving activity occurred in the PM₁₀ nonattainment area, thus, annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by 95.7 percent.

Table 3.3–20. Annual and typical daily emissions from construction.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	18,721.29	3,744.26	144,009.9	28,802.0
PM ₁₀ NAA	17,916.27	3,583.25	137,817.5	27,563.5

3.3.10 Electrical equipment manufacturing

Emissions from electric equipment manufacturing were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2003b) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census Bureau’s County Business Patterns (CBP) for 2001 employment were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.3–21 shows the NAICS codes and employment data used to calculate emissions from electrical equipment manufacturing.

Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in electric equipment manufacturing} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 44,756 - 10,316 \\
 &= 34,440 \text{ employees}
 \end{aligned}$$

Table 3.3–21. NAICS codes and descriptions for electric equipment manufacturing.

NAICS Code	Description	CBP employment data provided	Value used
32613	Laminated plastics plate, sheet & shape mfg.	20–99	60
333315	Photographic & photocopying equipment mfg.	68	68
33421	Telephone apparatus mfg.	782	782
33422	Radio, TV broadcast & wireless communication equipment mfg.	3,471	3,471
334412	Bare printed circuit board mfg.	2,134	2,134
334413	Semiconductor & related device mfg.	18,479	18,479
334416	Electronic coil, transformer, other inductor mfg.	346	346
334418	Printed circuit assembly (electronic assembly) mfg.	2,500–4,999	3,750
334419	Other electronic component mfg.	656	656
334511	Search, detection & navigation instrument mfg.	5,000–9,999	7,500
336412	Aircraft engine & engine parts mfg.	5,000–9,999	7,500
336419	Other missile, space vehicle parts & auxiliary equipment mfg.	0–19	10
Total:			44,756

This area-source employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2002 as follows:

$$\text{Total area-source emissions} = \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment}$$

$$\begin{aligned}
 \text{Area-source PM}_{10} \text{ emissions from electric equipment manufacturing} &= \frac{0.70 \text{ tons of PM}_{10}/\text{yr}}{23,516 \text{ employees}} \times 34,440 \text{ employees} \\
 &= 1.03 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions are calculated based on the operating schedule data reported by electric equipment manufacturing facilities. From annual emission surveys, the modal values were identified for two items: days/week and annual activity. This data was used to calculate typical daily emissions as follows:

$$\begin{aligned}
 \text{Typical daily PM}_{10} \text{ emissions from electric equipment mfg.} &= \frac{\text{Annual emissions (tons/yr)}}{\text{Days/week} \times \text{Weeks/year}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{1.03}{7 \times 52} \times 2,000 \\
 &= 5.7 \text{ lbs PM}_{10}/\text{day}
 \end{aligned}$$

Annual and typical daily emissions for the PM₁₀ nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
 \text{PM}_{10} \text{ emissions from area-source in the PM}_{10} \text{ NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:county ratio of industrial employment} \\
 &= 1.03 \text{ tons/yr} \times .9891 \\
 &= 1.02 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.3–22 summarizes annual and typical daily emissions from electrical equipment manufacturing in both Maricopa County and the PM₁₀ nonattainment area.

Table 3.3–22. Annual and typical daily emissions from area-source electric equipment manufacturing.

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	1.03	0.63	16.28	0.00	6.27	5.7	3.4	89.4	0.0	34.4
PM ₁₀ NAA	1.02	0.62	16.10	0.00	6.20	5.6	3.4	88.5	0.0	34.0

3.3.11 State-permitted portable sources

The Arizona Department of Environmental Quality (ADEQ) retains the authority to permit certain categories of sources within Maricopa County, including portable sources. MCESD requested information from ADEQ for all ADEQ-permitted sources that reported any activity in Maricopa County during 2002. Annual total emissions for each pollutant were provided, along with information on the facility type, and information on the location of the site during the year. Permits were classified into four major types: asphalt batch, concrete batch, crushing/screening, and other (including soil remediation, generators, etc.). From this information, emissions that occurred within Maricopa County were estimated as in the following example.

Data provided:

Source information: Onyx Construction – Kevin’s Spread, ID S7710
 Permit type: Portable crushing/screening plant
 Operating schedule: Operated in Mohave County 6/10/02 to 7/28/02, Maricopa County from 7/30/02 to 10/22/02, and La Paz County from 10/24/02 to 12/31/02.

Total annual emissions: (tons/yr)	PM ₁₀	PM _{2.5} ¹	NO _x	SO _x
	4.8448	2.4224	54.2499	10.0424

1. PM_{2.5} was assumed to be 50% of reported PM₁₀ for crushing/screening operations.

Using this information, calculations were made to determine:

$$\begin{aligned}
 \text{Total operating days in 2002:} & 203 = 21 \text{ (June)} + 30 \text{ (July)} + \dots + 31 \text{ (Dec.)} \\
 \text{Total operating days in Maricopa County:} & 85 = 2 \text{ (July)} + 31 \text{ (Aug.)} + \dots + 22 \text{ (Oct.)}
 \end{aligned}$$

All emissions were assumed to be equally distributed among all reported days of operation. First, the total emissions attributable to activity in Maricopa County was calculated as follows:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions in Maricopa County (tons/yr)} &= \text{Total annual emissions} \times \frac{\text{operating days in Maricopa County}}{\text{total operating days in 2002}} \\
 &= 4.84 \times \frac{85}{203} \\
 &= 2.03 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions were then calculated as follows:

$$\begin{aligned} \text{Typical daily emissions (lbs/day)} &= \frac{\text{total emissions attributable to activity in Maricopa County}}{\text{number of operating days in Maricopa County}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= \frac{2.03 \text{ tons}}{85 \text{ days}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= 47.7 \text{ lbs PM}_{10}/\text{day} \end{aligned}$$

Table 3.3–23 summarizes the annual and typical daily emissions for all ADEQ-permitted portable sources that operated within Maricopa County at some point during 2002. Since no precise location data was available, all emissions are conservatively assumed to have originated within the PM₁₀ nonattainment area, therefore emissions in Maricopa County and the PM₁₀ nonattainment area are equal.

Table 3.3–23. Emissions from ADEQ-permitted portable sources, by permit type.

Permit type	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Asphalt batch	27.46	13.73	68.87	42.92	239.6	119.8	639.2	343.5
Concrete batch	10.07	5.03	31.81	7.97	56.5	28.3	199.0	50.4
Crushing/screening	72.39	36.20	466.40	105.42	564.4	282.2	4,352.1	864.4
Other	0.91	0.91	5.35	0.83	5.0	5.0	29.3	4.5
Total:	110.83	55.87	572.42	157.14	865.5	435.3	5,219.6	1,262.8

3.3.12 Paved/unpaved road travel on industrial sites

This section addresses emissions from travel on paved and unpaved roads within the boundaries of a permitted facility. Emissions from motor vehicle travel on public and private roads is addressed in Chapter 5, Mobile Sources, and road travel emissions from facilities considered point sources are addressed in Chapter 2, Point Sources. PM₁₀ emissions from this source category were derived from annual emission reports from permitted sources, using AP-42 equations based on vehicle size and average speed (US EPA, 1997; 1998b). It is assumed that there are no unpermitted sources with significant emissions from on-site road travel.

PM_{2.5} emissions were calculated from PM₁₀ using the ratio of the constant *k* for paved and unpaved industrial roads, respectively, from AP-42, as in this example for medium-duty vehicles traveling at 15 mph:

$$\begin{aligned} \text{Uncontrolled PM}_{10} \text{ emissions from unpaved road travel} &= \text{Vehicle miles traveled (mi/yr)} \times \text{AP-42 emission factor (lb PM}_{10}/\text{mi)} \\ &= 5,968 \text{ mi/yr} \times 0.86 \\ &= 5,132 \text{ lbs PM}_{10}/\text{yr} \end{aligned}$$

Dust control measures are required under County Rule 310 for all industrial haul roads in the county. The most common practice, watering, is assumed to have a 70% control efficiency for PM₁₀, calculated as:

$$\begin{aligned}
 \text{Controlled PM}_{10} \text{ emissions} &= \text{uncontrolled PM}_{10} \text{ emissions} \times 1 - (\text{control efficiency \%}) \\
 &= 5,132 \text{ lb/yr} \times 1 - 0.70 \\
 &= 1,540 \text{ lbs PM}_{10}/\text{yr}
 \end{aligned}$$

PM_{2.5} emissions were calculated using the ratio of the constant *k* in the respective AP-42 equations for paved and unpaved roads, as well as a 40% control efficiency, from EPA's PM Calculator software (US EPA, 2001c).

$$\begin{aligned}
 \text{Uncontrolled PM}_{2.5} \text{ emissions} &= \text{Uncontrolled PM}_{10} \text{ emissions} \times \text{ratio of } k \text{ for unpaved roads} \\
 &= 5,132 \text{ lbs/yr} \times 0.15333 \\
 &= 787 \text{ lbs PM}_{2.5}/\text{yr}
 \end{aligned}$$

Controlled PM_{2.5} emissions, reflecting the lesser control efficiency of watering, are then calculated as:

$$\begin{aligned}
 \text{Controlled PM}_{2.5} \text{ emissions} &= \text{uncontrolled PM}_{2.5} \text{ emissions} \times 1 - (\text{control efficiency \%}) \\
 &= 787 \text{ lb/yr} \times 1 - 0.40 \\
 &= 472 \text{ lbs PM}_{10}/\text{yr}
 \end{aligned}$$

Typical daily emissions were calculated using operating schedule information for each reported process (normally a 5- or 6-day week), which were then summed to provide total daily emissions for the county. Emissions totals for the PM₁₀ nonattainment area were determined from the site locations of each facility.

Table 3.3–24. Annual and typical daily emissions from paved and unpaved road travel at industrial facilities.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	74.58	23.36	543.0	166.1
PM ₁₀ NAA	69.11	22.11	504.1	157.3

3.3.13 Industrial processes not elsewhere classified (NEC)

Annual area-source emissions from other industrial processes NEC were derived from annual emissions reports from permitted facilities. Other industrial processes include a wide array of industrial activities that are often specific to the permitted facility that reported the process. For this reason, it is assumed there are no significant emissions from other industrial processes, other than those reported by permitted facilities on their annual emissions reports. Typical daily emissions are calculated based on operating schedule information provided by the facilities in their annual emissions report.

All facilities that reported area-source emissions from other industrial processes NEC are located inside the PM₁₀ nonattainment area, therefore emissions for Maricopa County and the PM₁₀ NAA are equal.

Table 3.3–25. Annual and typical daily emissions from other industrial processes not elsewhere classified.

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Maricopa County	23.83	18.39	0.05	0.03	4.42	183.3	141.5	0.4	0.4	34.0
PM ₁₀ NAA	23.83	18.39	0.05	0.03	4.42	183.3	141.5	0.4	0.4	34.0

3.3.14 Summary of all area-source industrial processes

Tables 3.3–26 and 3.3–27 provide a summary of annual and typical daily emissions from all industrial sources, for Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.3–26. Annual and typical daily emissions from all area-source industrial processes in Maricopa County.

Source category	Annual emissions (tons/yr)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Chemical manufacturing	28.53	17.72	1.08	0.25	0.61
Commercial cooking	713.85	661.98			
Grain handling/processing	7.01	1.80			
Ammonia cold storage					1,658.81
Secondary metal production	6.72	3.68	0.03	0.03	2.68
Non-metallic mineral processes	87.11	31.61			
Mining and quarrying	28.43	11.09			
Wood product manufacturing.	145.14	89.36			
Rubber/plastic product manufacturing	25.47	23.41			
Fabricated metal product manufacturing	0.63	0.44			
Construction	18,721.29	3,744.26			
Electrical equipment manufacturing	1.03	0.63	16.28		6.27
ADEQ-permitted portable sources	110.83	55.87	572.42	157.14	
Road travel at industrial sites	74.58	23.36			
Industrial processes NEC	23.83	18.39	0.05	0.03	4.42
All industrial processes:	19,974.43	4,683.60	589.86	157.46	1,672.79

Source category	Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Chemical manufacturing	219.4	136.3	8.3	1.9	4.7
Commercial cooking	3,922.2	3,637.2			
Grain handling/processing	53.1	13.5			
Ammonia cold storage					10,633.4
Secondary metal production	52.1	28.7	0.2	0.3	15.6
Non-metallic mineral processes	670.1	243.2			
Mining and quarrying	177.1	68.3			
Wood product manufacturing.	1,116.5	687.4			
Rubber/plastic product manufacturing	195.9	180.1			
Fabricated metal product manufacturing	4.8	3.4			
Construction	144,009.9	28,802.0			
Electrical equipment manufacturing	5.7	3.4	89.4		34.4
ADEQ-permitted portable sources	865.5	435.3	5,219.6	1,262.8	
Road travel at industrial sites	543.0	166.1			
Industrial processes NEC	183.3	141.5	0.4	0.4	34.0
All industrial processes:	152,018.5	34,546.4	5,318.0	1,265.4	10,722.2

Table 3.3–27. Annual and typical daily emissions from all area-source industrial processes in the PM₁₀ NAA.

Source category	Annual emissions (tons/yr)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Chemical manufacturing	28.22	17.53	1.07	0.25	0.61
Commercial cooking	707.71	656.28			
Grain handling/processing	7.01	1.80			
Ammonia cold storage					1,640.73
Secondary metal production	6.72	3.68	0.03	0.03	2.68
Non-metallic mineral processes	86.16	31.27			
Mining and quarrying	22.92	9.20			
Wood product manufacturing.	143.56	88.38			
Rubber/plastic product manufacturing	25.19	23.16			
Fabricated metal product manufacturing	0.62	0.44			
Construction	17,916.27	3,583.25			
Electrical equipment manufacturing	1.02	0.62	16.10		6.20
ADEQ-permitted portable sources	110.83	55.87	572.42	157.14	
Road travel at industrial sites	69.11	22.11			
Industrial processes NEC	23.83	18.39	0.05	0.03	4.42
All industrial processes:	19,149.15	4,511.99	589.67	157.45	1,654.64

Source category	Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Chemical manufacturing	217.1	134.8	8.2	1.9	4.7
Commercial cooking	3,888.5	3,605.9			
Grain handling/processing	53.1	13.5			
Ammonia cold storage					10,517.5
Secondary metal production	52.1	28.7	0.2	0.3	15.6
Non-metallic mineral processes	662.8	240.5			
Mining and quarrying	138.9	55.1			
Wood product manufacturing.	1,104.3	679.9			
Rubber/plastic product manufacturing	193.7	178.1			
Fabricated metal product manufacturing	4.8	3.4			
Construction	137,817.5	27,563.5			
Electrical equipment manufacturing	5.6	3.4	88.5		34.0
ADEQ-permitted portable sources	865.5	435.3	5,219.6	1,262.8	
Road travel at industrial sites	504.1	157.3			
Industrial processes NEC	183.3	141.5	0.4	0.4	34.0
All industrial processes:	145,691.2	33,240.8	5,316.9	1,265.4	10,605.8

3.4 Waste treatment and disposal

3.4.1 On-site incineration

This section includes emissions from on-site industrial incinerators, primarily burn-off ovens used to reclaim electric wire or other materials. Emissions from human and animal crematories are addressed in Section 3.5.4. There were no incinerators at residential (e.g., apartment complexes) or commercial/institutional facilities (e.g., hospitals, service establishments) in operation during 2002.

Emissions from on-site incineration were determined from annual emission inventory reports. Of the four incinerators under permit in 2002, two were surveyed and reported annual emissions. As all four facilities are roughly similar in terms of capacity, these survey results were doubled to estimate total annual and typical daily emissions from all four incinerators in Maricopa

County. All four facilities are located within the PM₁₀ nonattainment area, thus total emissions for the county and NAA are equal.

Table 3.4-1. Annual and typical daily emissions from on-site incineration.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	0.67	0.59	28.90	0.03	5.2	4.6	222.3	0.2
PM ₁₀ NAA	0.67	0.59	28.90	0.03	5.2	4.6	222.3	0.2

3.4.2 Open burning

Emissions from controlled open burning are regulated by MCESD Rule 314, which requires a burn permit for open burning in Maricopa County. Burn permits are issued primarily for purposes of agricultural ditch bank and fence row burning, tumbleweed burning, land clearance, air curtain destructor burning of trees, and fire fighting training. Maricopa County's burn permit data base was used to identify all burn permits issued during 2002. A total of 140 permits were issued during the year; however, not all permit applications contained the information needed to calculate emissions. Where data were missing, activity data for each permit category was grown from those permits that contained information, as follows:

$$\text{Total activity} = \sum \text{activity reported} \times \frac{\text{total number of permits issued}}{\text{number of permits with activity data}}$$

Example:

$$\text{Total ditch - bank/fencerows} = 973,885 \text{ linear ft} \times \frac{85 \text{ ditchbank/fencerow permits issued}}{29 \text{ permits with quantitative data}} = 2,854,491 \text{ linear ft}$$

Reported and estimated activity data for each open burning category are summarized in Table 3.4-2. Permits issued for fire fighting training will be addressed Section 3.5.1.2.

Table 3.4-2. 2002 Maricopa County burn permit activity data.

Category	Unit of measure	Total reported activity	Number of permits with activity data	Total permits issued	Activity grown to total number of permits issued
Ditchbank/fencerow	Linear ft	973,885	29	85	2,854,491
Land clearance	Acres	1,345	17	34	2,690
Land clearance	Piles	69	8	34	293
Air curtain	Trees	200	1	2	400
Tumbleweeds	Piles	9	3	8	24

The above activity data were converted to tons material burned using fuel loading factors from AP-42, Table 2.5-5 (US EPA, 1992). The emission and loading factors used are shown in Table 3.4-3. As a conservative estimate, all particulate matter is presumed to be PM₁₀ (and PM_{2.5}).

Table 3.4-3. Emission and fuel loading factors for open burning.

Category	Emission factors (lb/ton burned)					Fuel loading factor
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	
Weeds, unspecified	15	15	4	n/a	n/a	3.2 tons/acre
Russian Thistle (tumbleweeds)	22	22	4	n/a	n/a	0.1 tons/acre
Orchard Crops: Citrus	6	6	4	n/a	n/a	1.0 tons/acre

The following assumptions were made based on previous MCESD emission inventory work:

- Ditch banks and fence rows in Maricopa County average 7 feet in width and are burned twice per year (MCESD, 1999).
- A pile of tumbleweeds 15 feet in diameter and 5 feet high weighs 200 lbs (MCESD, 1993). This is equivalent to the AP-42 fuel loading factor for tumbleweeds – 0.1 tons/acre.
- The estimated weight of a mature, partially dried citrus tree, including trunk, limbs and bulk of root is 500 lbs per tree (MCESD, 1993).

To calculate the annual amount of material burned on ditch banks and fence rows in Maricopa County, MCESD estimated the area burned and then applied AP-42 fuel loading factor. The tons of material burned in ditch banks and fence rows in Maricopa County were estimated as follows:

$$\begin{aligned} \text{Material burned from ditchbanks and fence rows} &= \frac{2,854,491 \text{ ft length}}{43,560 \text{ ft}^2 / \text{acre}} \times 7 \text{ ft width} \times 3.2 \text{ tons/acre} \times 2 \text{ times/yr} \\ &= 2,936 \text{ tons material burned/yr} \end{aligned}$$

Activity data for the other categories were similarly converted to material burned using AP-42 fuel loading factors.

Annual emissions were then calculated by multiplying the amount of material burned by AP-42 emission factors (listed in Table 3.4–3) for each open burning category. To account for unpermitted illegal outdoor burning, the county’s Air Quality Complaint data base was examined, which indicated 65 illegal outdoor open burning complaints (mostly residential) and 6 issued Notices of Violation. All calculated emissions estimates were thus increased by 10 percent, as a conservative estimate.

$$\begin{aligned} \text{Annual PM}_{10} \text{ emissions from ditchbank and fence row burning} &= \text{Total material burned} \times \text{emission factor} \times \text{unit conversion factor} \\ &= 2,936 \text{ tons} \times 15 \text{ lbs/ton} \times 1 \text{ ton} / 2,000 \text{ lbs} \\ &= 22.02 \text{ tons/yr} \end{aligned}$$

$$\begin{aligned} \text{Total annual PM}_{10} \text{ emissions including unpermitted burning} &= \text{Calculated emissions from permit data} + \text{unpermitted burning adjustment factor} \\ &= 22.02 \text{ tons/yr} + (10\% \times 22.02) \\ &= 24.22 \text{ tons PM}_{10}\text{/yr} \end{aligned}$$

Table 3.4–4 summarizes the annual emissions for Maricopa County from each open burning category.

Table 3.4–4. Annual emissions from open burning in Maricopa County.

Category	Ton-equivalents	Annual emissions (tons/yr)		
		PM ₁₀	PM _{2.5}	NO _x
Ditchbank/fencerow	2,935.7	24.22	24.22	6.46
Land clearance	9,545.5	78.75	78.75	21.00
Air curtain	100.0	0.33	0.33	0.22
Tumbleweeds	2.4	0.03	0.03	0.01
Totals:		103.33	103.33	27.68

Annual emissions for the nonattainment area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the PM₁₀ nonattainment area by the Maricopa County emission totals. (See Section 1.5.1 for a discussion of the land-use data used.) Table 3.4–5 summarizes the annual emissions for the PM₁₀ nonattainment area.

Table 3.4–5. Surrogate land-use classes, ratios, and annual emissions from open burning in the PM₁₀ NAA.

Category	Surrogate land use categories	2000 NAA:county land-use ratio	Emissions (tons/yr)		
			PM ₁₀	PM _{2.5}	NO _x
Ditchbank/fencerow	Agriculture	53.43 %	12.95	12.95	3.45
Land clearance	Vacant	28.25 %	22.25	22.25	5.93
Air curtain	Agriculture and vacant	31.66 %	0.10	0.10	0.07
Tumbleweeds	Agriculture and vacant	31.66 %	0.01	0.01	0.00
Totals:			35.31	35.31	9.46

It was assumed that open burning occurs 5 days per week (most burn permits are issued for weekdays but permits may be issued on weekends depending on circumstances). Open burning occurs year-round with the exception of ditch bank and fence row burning, which is not allowed during the CO season (November through February).

PM₁₀ typical daily emissions for Maricopa County are derived as follows:

$$\text{Typical daily PM}_{10} \text{ emissions} = \frac{\text{annual PM}_{10} \text{ emissions (lbs)}}{(\text{burn days/week}) \times (\text{burn weeks/year})}$$

$$\begin{aligned} \text{Typical daily PM}_{10} \text{ emissions from ditchbank/ fence row burning} &= \frac{48,440 \text{ lbs}}{5 \text{ days/wk} \times 35 \text{ wks/yr}} \\ &= 276.8 \text{ lbs PM}_{10}/\text{day} \end{aligned}$$

Typical daily emissions for the PM₁₀ nonattainment area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the nonattainment area by the Maricopa County typical daily emissions. (See Section 1.5.2 for a discussion of the land-use data used.) Table 3.4–6 summarizes the typical daily emissions from open burning for both Maricopa County and the PM₁₀ nonattainment area.

Table 3.4–6. Typical daily emissions from open burning.

Category	Maricopa County			PM ₁₀ nonattainment area		
	PM ₁₀	PM _{2.5}	NO _x	PM ₁₀	PM _{2.5}	NO _x
Ditchbank/fencerow	276.8	276.8	73.8	148.0	148.0	39.5
Land clearance	605.8	605.8	161.5	171.1	171.1	45.6
Air curtain	2.5	2.5	1.7	0.8	0.8	0.5
Tumbleweeds	0.2	0.2	0.0	0.1	0.1	0.0
Totals:	885.3	885.3	237.1	320.0	320.0	85.6

3.4.3 Landfills

Emissions from municipal solid waste (MSW) landfills come from uncontrolled landfill gas emissions as well as from combustion from control measures, such as a flare. Total emissions were calculated from annual emissions inventory reports from all landfills located within the county. Two MSW landfills (Butterfield Station and Allied Waste Industries Southwest

Regional Facility) are considered point sources and are reported in Chapter 2 . All other MSW landfills are reported here as area-source landfills.

Since all of the landfills considered in this section are located within the PM₁₀ nonattainment area, total emission values for the county and the NAA are equal. Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on a 7 day week. Annual and daily emissions are shown in Table 3.4–7.

Table 3.4-7. Annual and typical daily emissions from landfills.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	4.53	3.30	10.44	2.33	24.9	18.1	57.4	12.8
PM ₁₀ NAA	4.53	3.30	10.44	2.33	24.9	18.1	57.4	12.8

3.4.4 Publicly owned treatment works (POTWs)

Emissions from publicly owned treatment works (POTWs) were calculated by multiplying per-capita emission factors (Battye et al., 1994) by population estimates and per-capita wastewater usage estimates of 100 gallons per day per person (Tchobanoglous, 1979), as shown in Table 3.4–8. Typical daily emissions were calculated dividing annual emission by 365 day as activity is assumed to occur uniformly throughout the year.

Table 3.4-8. NH₃ emissions from publicly-owned treatment works (POTWs).

Geographic area	2002 Population	NH ₃ emission factor (lbs/10 ⁶ gals treated)	Annual NH ₃ emissions	Typical daily NH ₃ emissions
			(tons/yr)	(lbs/day)
Maricopa County	3,549,693	19.0	1,230.86	6,744.4
PM ₁₀ NAA	3,519,288	19.0	1,220.31	6,686.6

3.4.5 Other industrial waste disposal

Annual area-source emissions from other industrial waste disposal were derived from annual emissions reports from permitted facilities. Other industrial waste disposal processes include a wide array of industrial activities that are often specific to the permitted facility that reported the process. For this reason, it is assumed there are no significant emissions from this category, other than those reported by permitted facilities on their annual emissions reports. Typical daily emissions are calculated based on operating schedule information provided by the facilities in their annual emissions report.

All facilities that reported area-source emissions from other industrial waste disposal are located inside the PM₁₀ nonattainment area, therefore emissions for Maricopa County and the PM₁₀ NAA are equal.

Table 3.4-9. Annual and typical daily emissions from other industrial waste disposal.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	3.05	2.53	0.33	0.31	23.5	19.5	2.6	2.4
PM ₁₀ NAA	3.05	2.53	0.33	0.31	23.5	19.5	2.6	2.4

3.4.6 Summary of all area-source waste disposal

Tables 3.4–10 and 3.4–11 provide a summary of annual and typical daily emissions from all waste disposal, for Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.4–10. Annual and typical daily emissions from all area-source waste disposal for Maricopa County.

Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
On-site incineration	0.67	0.59	28.90	0.03		5.2	4.6	222.3	0.2	
Open burning	103.33	103.33	27.68			885.3	885.3	237.1		
Landfills	4.53	3.30	10.44	2.33		24.9	18.1	57.4	12.8	
POTWs					1,230.86					6,744.4
Other	3.05	2.53	0.33	0.31		23.5	19.5	2.6	2.4	
Total:	111.58	109.76	67.36	2.67	1,230.86	938.8	927.5	519.3	15.4	6,744.4

Table 3.4–11. Annual and typical daily emissions from all area-source waste disposal for the PM₁₀ NAA.

Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
On-site incineration	0.67	0.59	28.90	0.03		5.2	4.6	222.3	0.2	
Open burning	35.31	35.31	9.46			320.0	320.0	85.6		
Landfills	4.53	3.30	10.44	2.33		24.9	18.1	57.4	12.8	
POTWs					1,220.31					6,686.6
Other	3.05	2.53	0.33	0.31		23.5	19.5	2.6	2.4	
Total:	43.56	41.74	49.13	2.67	1,220.31	373.6	362.2	367.9	15.4	6,686.6

3.5 Miscellaneous area sources

3.5.1 Other combustion

3.5.1.1 Wildfires and brush fires

The Arizona Department of Environmental Quality, in cooperation with the United States Forest Service, reported that one wildfire burned 1000 acres in the Tonto National Forest on July 16–18, 2002. The wildfire occurred within Maricopa County but outside of the nonattainment area. ADEQ also reported that negligible prescribed fires occurred in Maricopa County in 2002.

In addition, 2002 survey results from Maricopa County fire departments, the Bureau of Land Management, and the Arizona State Land Department were used to calculate emissions from brush fires. In some cases, the survey results included limited information on the average size of fires. Thus, when acreage data was incomplete or unclear, each reported brush fire was assumed to be equal to 0.1 acres. Survey results are included in Appendix 3.1. It was estimated that 7,054 brush fires occurred in Maricopa County in 2002 and burned approximately 1,656.5 acres.

Wildfire emission factors and fuel loading factors were obtained from the Western Regional Air Partnership's (WRAP) 1996 Fire Emission Inventory (WGA/WRAP, 2002), while brush fire emission factor and fuel loading factors were obtained from AP-42 (US EPA, 1992). Both are listed in Table 3.5–1. Estimates of the material burned in are derived by multiplying the number of acres burned by the appropriate fuel loading factor. For wildfires, a “combustive efficiency” factor of 90% is included in the calculation to reflect the fact that not all available material (fuel) is consumed in a wildfire (WGA/WRAP, 2002).

Table 3.5–1. Emission and fuel loading factors for wildfires and brush fires.

Type of fire	Fires reported	Number of acres burned	Fuel loading factor (tons/acre)	Emission factors (lbs/ton burned)				
				PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Wildfire (Calif. chaparral)	1	1,000	19.5	28.1	24.1	6.2	1.7	1.3
Brush fire (weeds)	7,054	1,656.5	3.2	15	15	4	n/a	n/a

Annual emissions from wildfires in Maricopa County were calculated as follows.

$$\begin{aligned}
 \text{Annual CO emissions from wildfires in Maricopa County} &= \frac{\text{acres burned} \times \text{fuel loading factor} \times \text{combustive efficiency} \times \text{emission factor (lbs/ton)}}{2,000 \text{ lbs/ton}} \\
 &= \frac{1,000 \text{ acres burned} \times 19.5 \text{ tons/acre} \times 90\% \times 289 \text{ lbs/ton}}{2,000 \text{ lbs/ton}} \\
 &= 2,535.98 \text{ tons CO/yr}
 \end{aligned}$$

Because the 1,000-acre wildfire occurred in the Tonto National Forest, which is located outside of the nonattainment area, emissions from wildfires within the nonattainment area were determined to be zero. However, annual emissions from brush fires for the nonattainment area were calculated by multiplying the Maricopa County annual emissions by the percentage of vacant land located in the PM₁₀ nonattainment area (28.25%). See Section 1.5.2 for a discussion of the land-use data used.

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from brush fires within the PM}_{10} \text{ NAA} &= \text{Annual PM}_{10} \text{ emissions from brush fires, County total} \times \text{Percentage of vacant land within the NAA} \\
 &= 39.75 \text{ tons/yr} \times 28.25\% \\
 &= 11.23 \text{ tons PM}_{10}/\text{yr}
 \end{aligned}$$

Table 3.5–2. Annual emissions from wildfires and brush fires (tons/yr).

Type of fire	Maricopa County					PM ₁₀ nonattainment area				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Wildfires	246.58	211.48	54.41	14.92	11.41	0.00	0.00	0.00	0.00	0.00
Brush fires	39.75	39.75	10.60	–	–	11.23	11.23	2.99	–	–
Totals:	286.33	251.23	65.01	14.92	11.41	11.23	11.23	2.99	0.00	0.00

Since the 1,000-acre wildfire lasted three days, annual emissions from this category were divided by 3 to derive a “worst-case” daily emissions value. It was assumed that brush fires occur evenly throughout the year. Thus, daily emissions from brush fires were derived by dividing the annual emissions for Maricopa County and the nonattainment area by a 365 days/yr, as follows:

$$\begin{aligned}
 \text{Season-day CO emissions from wildfires in Maricopa County} &= \frac{2,535.98 \text{ tons/yr} \times 2,000 \text{ lbs/ton}}{3 \text{ days/yr}} \\
 &= 1,690,650 \text{ lbs CO/day}
 \end{aligned}$$

Table 3.5–3. Typical daily emissions from wildfires and brush fires (lbs/day).

Type of fire	Maricopa County					PM ₁₀ nonattainment area				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Wildfires	164,385.0	140,985.0	36,270.0	9,945.0	7,605.0	0.0	0.0	0.0	0.0	0.0
Brush fires	217.8	217.8	58.1	–	–	61.5	61.5	16.4	–	–
Totals:	164,602.8	141,202.8	36,328.1	9,945.0	7,605.0	61.5	61.5	16.4	0.0	0.0

3.5.1.2 Structure fires

2002 structure fire data were obtained by surveying fire departments in Maricopa County and by querying Maricopa County's burn permit data base. The fire departments surveyed reported 3,597 structure fires in Maricopa County in 2002. The list of fire departments surveyed and survey results are contained in Appendix 3.1. Eleven open burn permits were issued in 2002 for fire training; these were included in the total number of estimated structure fires for 2002. It was estimated that 3,608 structure fires occurred in Maricopa County in 2002.

Estimates of the material burned in a structure fire were determined by multiplying the number of structure fires by a fuel loading factor of 1.15 tons of material per fire, which factors in percent structural loss and content loss (US EPA, 2001e). Tons of material burned were estimated as follows:

$$\begin{aligned} \text{Material burned in} &= 3,608 \text{ fires} \quad \times 1.15 \text{ tons/fire} \\ \text{structure fires (tons/yr)} &= 4,149.2 \text{ tons material burned/yr} \end{aligned}$$

Table 3.5–4. Estimated material burned, emission and fuel loading factors for structure fires.

Structure fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)				
			PM ₁₀	PM _{2.5} *	NO _x	SO _x	NH ₃
3,608	1.15	4,149.20	10.8	10.8	1.4	n/a	n/a

* All PM₁₀ is assumed to be PM_{2.5}.

Annual emissions were then calculated by multiplying the amount of material burned by the emission factors listed in Table 3.5–4 (from US EPA, 2001e), as follows:

$$\begin{aligned} \text{Annual PM}_{10} \text{ emissions} &= \text{Quantity of material burned} \times \text{emission factor} \times \text{unit conversion factor} \\ \text{from structure fires} & \\ \text{Maricopa County} & \\ &= 4,149.20 \text{ tons} \times 10.8 \text{ lbs/ton} \times (1 \text{ ton}/2,000 \text{ lbs.}) \\ &= 22.41 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Annual emissions for the PM₁₀ nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the PM₁₀ nonattainment area (99.14%), as shown in the example below. See Section 1.5.2 for a discussion of the population data used.

$$\begin{aligned} \text{Annual PM}_{10} \text{ emissions} &= \text{annual PM}_{10} \text{ emissions} \times \text{percentage residential} \\ \text{within the PM}_{10} \text{ NAA} & \quad \text{for Maricopa County} \quad \text{population within the NAA} \\ &= 22.41 \text{ tons/yr} \quad \times 99.14\% \\ &= 22.22 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Typical daily emissions for both Maricopa County and the PM₁₀ nonattainment area are calculated by dividing annual emissions by 364, as activity is assumed to take place 7 days a week. Typical daily emissions for Maricopa County were derived using the following formula:

$$\begin{aligned}
\text{Typical daily PM}_{10} \text{ emissions from structure fires} &= \frac{\text{annual PM}_{10} \text{ emissions (lbs)}}{7 \text{ days/wk} \times 52 \text{ weeks/yr}} \\
&= \frac{44,820 \text{ lbs}}{364} \\
&= 123.1 \text{ lbs/day}
\end{aligned}$$

Table 3.5-5. Annual and typical daily emissions from structure fires.

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5}	NO _x	PM ₁₀	PM _{2.5}	NO _x
Maricopa County	22.41	22.41	2.90	123.1	123.1	16.0
PM ₁₀ NAA	22.21	22.21	2.88	122.0	122.0	15.8

3.5.1.3 Vehicle fires

2002 vehicle fire data were obtained by surveying fire departments in Maricopa County. The fire departments surveyed reported 5,316 vehicle fires (4 boat fires were included in vehicle fires) in Maricopa County in 2002. The list of fire departments surveyed and survey results are presented in Appendix 3.1.

Annual emissions from vehicle fires are calculated by first multiplying the number of vehicle fires by a fuel loading factor of per vehicle fire to estimate the annual amount of material burned in vehicle fires. The amount of annual material burned in vehicle fires is then multiplied by emission factors for open burning of automobile components from AP-42 as listed in table 3.5-6 (US EPA, 1992).

$$\begin{aligned}
\text{Annual PM}_{10} \text{ emissions from vehicle fires} &= \text{annual number of vehicle fires} \times \text{fuel loading factor} \times \text{emission factor} \times \text{unit conversion factor} \\
&= 5,316 \times 0.25 \text{ tons/vehicle} \times 100 \text{ lbs/ton} \times (1 \text{ ton} / 2,000 \text{ lbs}) \\
&= 66.45 \text{ tons PM}_{10}/\text{yr}
\end{aligned}$$

Table 3.5-6. Estimated material burned, fuel loading factors, and emission factors for vehicle fires.

Vehicle fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)				
			PM ₁₀	PM _{2.5} *	NO _x	SO _x	NH ₃
5,316	0.25	1,329	100	100	4	n/a	n/a

* All PM₁₀ is assumed to be PM_{2.5}.

Annual emissions for the PM₁₀ nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the PM₁₀ nonattainment area (99.14%). See Section 1.5.1 for a discussion of the population data used.

$$\begin{aligned}
\text{Annual PM}_{10} \text{ emissions from vehicle fires in the PM}_{10} \text{ NAA} &= \text{annual PM}_{10} \text{ emissions for Maricopa County} \times \text{percentage of total residential population within the PM}_{10} \text{ NAA} \\
&= 66.45 \text{ tons/yr} \times 99.14\% \\
&= 65.88 \text{ tons/yr}
\end{aligned}$$

It is assumed that vehicle fires occur evenly throughout the year. Thus, typical daily emissions were derived by dividing the Maricopa County and nonattainment area annual emissions by 365 days/year. The results are shown in Table 3.5–7 below.

Table 3.5–7. Annual and typical daily emissions from vehicle fires.

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5}	NO _x	PM ₁₀	PM _{2.5}	NO _x
Maricopa County	66.45	66.45	2.66	364.1	364.1	14.6
PM ₁₀ NAA	65.88	65.88	2.64	361.0	361.0	14.4

3.5.1.4 Engine testing

Annual emissions from engine testing facilities were derived from annual emission reports from permitted sources that were not considered point sources in this inventory. It was assumed that there were no significant unpermitted sources within Maricopa County. Typical daily emissions were calculated based on operating schedule information provided in the facilities' annual emission reports.

Since all facilities considered in this section are located within the PM₁₀ nonattainment area, total emission values for the county and the PM₁₀ NAA are equal. Results are shown in Table 3.5–8.

Table 3.5–8. Annual and typical daily emissions from engine testing.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	0.41	0.30	4.26	0.82	6.5	5.4	89.1	7.4
PM ₁₀ NAA	0.41	0.30	4.26	0.82	6.5	5.4	89.1	7.4

3.5.2 Agricultural crops

3.5.2.1 Tilling

Tillage emissions were estimated using the tillage emission factor equation and Maricopa County specific soil silt content for agricultural land (URS and ERG, 2001). The number of planted or harvested acres by crop were obtained from the Arizona Agricultural Statistics Service (AASS, 2003). Crop specific annual land preparation operations data were obtained from the Technical Support Document for Quantification of Agricultural Best Management Practices (URS and ERG, 2001). The agricultural tillage emission factor was calculated as follows:

$$EF = k (4.8) s^{0.6}$$

where:

EF = Agricultural emission tillage factor (lbs PM₁₀ / acre-pass)

k = Particle size multiplier (value of 0.15 for PM₁₀)

s = Silt content of soil (percent) = 35.2% (URS and ERG, 2001)

$$\text{Thus: } EF = 0.15 \times 4.8 \times (35.2)^{0.6} = 6.10 \text{ lbs PM}_{10} / \text{acre-pass}$$

Annual PM₁₀ emissions from agricultural tillage were calculated for each crop category using the following equation (URS and ERG, 2001; Pollack *et al.*, 2003):

$$\text{Tillage}_{\text{Crop}} = \text{EF} \times \text{AP}_{\text{Crop}} \times \text{A}_{\text{Crop}} \times \text{ton} / 2,000 \text{ lb}$$

where:

- $\text{Tillage}_{\text{Crop}}$ = Tillage emissions for each crop type (lbs PM₁₀),
 EF = Tillage emission factor (lbs PM₁₀/acre-pass),
 AP_{Crop} = Number of tillage passes per crop (passes), and
 A_{Crop} = Total number of tilled acres for each crop type (acres)

Example:

- EF = 6.10 lbs PM₁₀/acre-pass
 AP_{Crop} = 15 tillage passes for a cotton crop
 A_{Crop} = 46,300 acres of cotton

$$\begin{aligned} \text{Tillage}_{\text{Cotton}} &= 6.10 \text{ lbs PM}_{10} / \text{acre-pass} \times 15 \text{ passes} \times 46,300 \text{ acres} \times \text{ton} / 2,000 \text{ lb} \\ &= 2,118 \text{ tons PM}_{10} / \text{year} \end{aligned}$$

Table 3.5–9 lists crop types and acreage; typical number of land preparation operations and acre-passes; and annual uncontrolled PM₁₀ emissions from agricultural tillage for Maricopa County.

Table 3.5–9. 2002 Maricopa County agricultural crop acreage, activity, and uncontrolled annual PM₁₀ emissions.

Crop	Reported Acres	Annual land preparation operations	Acre-passes	Annual uncontrolled PM ₁₀ emissions (tons/yr)
Cotton	46,300	12	555,600	1,694.58
Corn	19,500	12	234,000	713.70
Durham wheat	12,100	5	60,500	184.53
Winter wheat	1,500	5	7,500	22.88
Barley	18,900	4	75,600	230.58
Alfalfa (stand establishment)	17,250 ⁽¹⁾	6	103,500	315.68
Cantaloupe (fall)	3,600	9	32,000	98.82
Cantaloupe (spring)	7,400	9	66,600	203.13
Watermelon	3,800	9	34,200	104.31
Honeydew (fall)	800	9	7,200	21.96
Honeydew (summer)	1,200	7	8,400	25.62
Dry onion	500	11	5,500	16.78
Broccoli	3,300	10	33,000	100.65
Grapefruit	120 ⁽²⁾	6	720	2.20
Navel Oranges and miscellaneous	640 ⁽²⁾	6	3,840	11.71
Valencia Oranges	320 ⁽²⁾	6	1,920	5.86
Lemon	300 ⁽²⁾	6	1,800	5.49
Tangerine	480 ⁽²⁾	6	2,880	8.78
Total acreage:	138,010			3,767.24

1. Alfalfa is a multi-year crop and alfalfa stand establishment is assumed to occur once every 4 years to approximately 25% of the total alfalfa acreage (URS and ERG, 2001).
2. 15 to 20% of citrus orchard acreage is non-bearing in a given year (URS and ERG, 2001); therefore, tillage is assumed to occur in 20% of the reported harvested acreage.

In the Maricopa County PM₁₀ nonattainment area, the agricultural PM₁₀ general permit (Arizona Administrative Code [AAC], R18-2-610 and 611) requires that commercial farmers implement at least three agricultural best management practice (BMP) to control PM₁₀ emissions generated from tillage and harvest, non-cropland, and cropland.

Net control efficiencies from implementation of agricultural BMPs were developed by URS and ERG (2001) in the Technical Support Document for Quantification of Agricultural BMPs. Three BMPs were quantified for tillage: 1) combining tractor operations, 2) limited activity during high-wind events, and 3) multi-year crops. To estimate controlled tillage emissions from agricultural operations taking place within the PM₁₀ NAA, the mid-point net control efficiency for each BMP were applied to 53.46% (the percent of agricultural land in the PM₁₀ NAA) of the uncontrolled annual PM₁₀ emissions as follows:

$$\text{Controlled annual tillage}_{\text{Crop}} \text{ emissions} = \text{Annual uncontrolled PM}_{10} \text{ emissions} \times (100\% - \text{mid-point net control efficiency}_{\text{crop}}) \times \% \text{ agricultural land in the PM}_{10} \text{ NAA}$$

$$\begin{aligned} \text{Controlled annual tillage}_{\text{Cotton}} \text{ emissions} &= 1,694.58 \text{ tons PM}_{10}/\text{yr} \times (100\% - 33.0\%) \times 53.46\% \\ &= 606.97 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

The uncontrolled portion of tillage emissions from agricultural operations taking place outside the PM₁₀ NAA but within Maricopa County were estimated by multiplying the uncontrolled annual PM₁₀ emissions by the percent of agricultural land located within Maricopa County by outside of the PM₁₀ NAA (100% – 53.46%) as follows:

$$\begin{aligned} \text{Uncontrolled annual tillage}_{\text{Crop}} \text{ emissions} &= \text{Uncontrolled annual PM}_{10} \text{ emissions} \times 46.54\% \\ &= 1,694.58 \text{ tons PM}_{10}/\text{yr} \times 46.54\% \\ &= 788.66 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Controlled and uncontrolled emissions were then summed to estimate total annual PM₁₀ emissions from agricultural tillage in Maricopa County. Results are shown in Table 3.5–10.

Table 3.5–10. Annual controlled PM₁₀ emissions from agricultural tillage in Maricopa County.

Crop	Net control efficiency ⁽¹⁾	Maricopa County Annual PM ₁₀ emissions (tons/yr)		
		Controlled PM ₁₀ Emissions (within the PM ₁₀ NAA)	Uncontrolled PM ₁₀ emissions (outside the PM ₁₀ NAA)	Total PM ₁₀ (controlled + uncontrolled)
Cotton	0.33	606.97	788.66	1,395.63
Corn	0.33	255.63	332.16	587.79
Durham wheat	0.33	66.09	85.88	151.97
Winter wheat	0.33	8.19	10.65	18.84
Barley	0.33	82.59	107.31	189.90
Alfalfa (stand establishment)	0.20	135.01	146.92	281.92
Cantaloupe (fall)	0.244	39.94	45.99	85.93
Cantaloupe (spring)	0.244	82.10	94.54	176.63
Watermelon	0.244	42.16	48.55	90.70
Honeydew (fall)	0.244	8.88	10.22	19.10
Honeydew (summer)	0.244	10.35	11.92	22.28
Dry onion	0.244	6.78	7.81	14.59
Broccoli	0.244	40.68	46.84	87.52
Grapefruit	0.244	0.89	1.02	1.91
Navel oranges and miscellaneous	0.244	4.73	5.45	10.18
Valencia oranges	0.244	2.37	2.73	5.09
Lemon	0.244	2.22	2.56	4.77
Tangerine	0.244	3.55	4.09	7.64
Total		1,399.12	1,753.27	3,152.40

1. Source: URS and ERG, 2001, p. B-7.

Annual PM_{2.5} emissions from agricultural tillage were calculated by multiplying the total annual PM₁₀ emissions by a conversion factor of 0.20 (US EPA, 2003b). Table 3.5–11 summarizes the 2002 PM₁₀ and PM_{2.5} emissions for Maricopa County and the PM₁₀ NAA from agricultural tillage after the implementation of agricultural BMPs.

Table 3.5–11. Annual controlled PM₁₀ and PM_{2.5} emissions from agricultural tillage.

Crop	Maricopa County (tons/yr)		PM ₁₀ NAA (tons/yr)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Cotton	1395.63	279.12	606.97	121.39
Corn	587.79	117.56	255.63	51.13
Durham wheat	151.97	30.39	66.09	13.22
Winter wheat	18.84	3.77	8.19	1.64
Barley	189.90	37.98	82.59	16.52
Alfalfa (stand establishment)	281.92	56.38	135.01	27.00
Cantaloupe (fall)	85.93	17.19	39.94	7.99
Cantaloupe (spring)	176.63	35.33	82.10	16.42
Watermelon	90.70	18.14	42.16	8.43
Honeydew (fall)	19.10	3.82	8.88	1.78
Honeydew (summer)	22.28	4.46	10.35	2.07
Dry onion	14.59	2.92	6.78	1.36
Broccoli	87.52	17.50	40.68	8.14
Grapefruit	1.91	0.38	0.89	0.18
Navel Oranges and miscellaneous	10.18	2.04	4.73	0.95
Valencia Oranges	5.09	1.02	2.37	0.47
Lemon	4.77	0.96	2.22	0.44
Tangerine	7.64	1.53	3.55	0.71
Total	3,152.40	630.48	1,399.12	279.82

Typical daily emissions for Maricopa County and the PM₁₀ NAA were calculated by dividing the annual PM₁₀ emissions by an estimated days per year of tillage operation by crop. The number of days of tillage operations was estimated using the calendar of tillage operations by crop in the Technical Support Document for Quantification of Agricultural BMPs (URS and ERG, 2001) and assuming tillage activities occur 7 days per week during the months of tillage operations. Results are shown in Table 3.5–12. The calendar of tillage operations did not include months of tillage operations for citrus, thus, a conservative estimate of three (3) months per year was assumed.

Table 3.5–12. Controlled typical daily emissions from tillage in Maricopa County.

Crop	Tillage operations ⁽¹⁾ (months/yr)	Tillage operations (days/yr)	Typical daily emissions (lbs/day)	
			PM ₁₀	PM _{2.5}
Cotton	12	364	7,668.3	1533.7
Corn	5	152	7,751.1	1550.2
Durham wheat	8	243	1,252.5	250.5
Winter wheat	8	243	155.3	31.1
Barley	8	243	1,565.1	313.0
Alfalfa (stand establishment)	3	91	6,196.1	1239.2
Cantaloupe (fall)	6	182	944.3	188.9
Cantaloupe (spring)	6	182	1,941.0	388.2
Watermelon	6	182	996.7	199.3
Honeydew (fall)	6	182	209.8	42.0
Honeydew (summer)	6	182	244.8	49.0
Dry onion	6	182	160.3	32.1
Broccoli	6	182	961.8	192.4
Grapefruit	3	91	42.0	8.4
Navel Oranges and miscellaneous	3	91	223.8	44.8
Valencia Oranges	3	91	111.9	22.4
Lemon	3	91	104.9	21.0
Tangerine	3	91	167.9	33.6
Total			30,697.6	6,140.0

(1) Source: URS and ERG, 2001, Table 3-2, p. 3-5.

Typical daily emissions for the PM₁₀ nonattainment area were calculated by dividing the annual PM₁₀ emissions for the PM₁₀ NAA by an estimated day per year of tillage operation by crop. Results are shown in Table 3.5–13.

Table 3.5–13. Controlled annual and typical daily emissions from tillage within the PM₁₀ NAA.

Crop	Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}
Cotton	3,335.0	667.0
Corn	3,371.0	674.2
Durham wheat	544.7	108.9
Winter wheat	67.5	13.5
Barley	680.7	136.1
Alfalfa (stand establishment)	2,967.2	593.4
Cantaloupe (fall)	438.9	87.8
Cantaloupe (spring)	902.2	180.4
Watermelon	463.3	92.7
Honeydew (fall)	97.5	19.5
Honeydew (summer)	113.8	22.8
Dry onion	74.5	14.9
Broccoli	447.0	89.4
Grapefruit	19.5	3.9
Navel Oranges and miscellaneous	104.0	20.8
Valencia Oranges	52.0	10.4
Lemon	48.8	9.8
tangerine	78.0	15.6
Total	13,805.6	2,761.1

3.5.2.2 Harvesting

Harvest emissions were estimated using crop-specific emission factors for cotton (URS and ERG, 2001) and for wheat and barley (US EPA, 1980). Emission factors are only available for these three crops grown in Maricopa County (URS and ERG, 2001). The number of harvested acres by crop was obtained from the Arizona Agricultural Statistics Report (AASS, 2003). Table 3.5–14 lists the crop types and associated PM₁₀ emission factors used to calculate emissions from agricultural harvesting.

Annual PM₁₀ emissions from agricultural harvesting were calculated for the above crop categories using the following equation:

$$\text{Uncontrolled annual harvest}_{\text{Crop}} \text{ emissions} = \text{EF} \times \text{A}_{\text{Crop}} \times \text{ton} / 2,000 \text{ lb}$$

where:

- harvest_{Crop} = harvest emissions for each crop type (tons PM₁₀/yr)
- EF = harvest emission factor (lbs PM₁₀/acre)
- A_{Crop} = total number of reported acres for each crop type per year

Example:

- EF = 1.12 lbs PM₁₀/acre for cotton
- A_{Crop} = 45,900 acres of cotton

$$\begin{aligned} \text{Uncontrolled annual Harvest}_{\text{Cotton}} \text{ Emissions} &= 1.12 \text{ lbs PM}_{10}/\text{acre} \times 45,900 \text{ acres} \times 1 \text{ ton}/2,000 \text{ lbs} \\ &= 25.70 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Table 3.5–14. Maricopa County harvested acres and emission factors.

Crop	2002 Acreage	PM ₁₀ emission factor (lb/acre-yr)	Source	Uncontrolled Annual PM ₁₀ Emissions (tons/yr)
Cotton	45,900	1.12	URS and ERG, 2001	25.70
Wheat	13,600	0.002625	US EPA, 1980 (AP-42, Table 9.3.2. wheat emission factor)	0.02
Barley	17,000	0.002625	US EPA, 1980 (AP-42, Table 9.3.2. wheat emission factor)	0.02
Total	76,500			25.74

In the Maricopa County PM₁₀ nonattainment area, the agricultural PM₁₀ general permit (Arizona Administrative Code [AAC], R18-2-610 and 611) requires that commercial farmers implement at least three agricultural best management practice (BMP) to control PM₁₀ emissions generated from tillage and harvest, non-cropland, and cropland. Net control efficiencies from implementation of agricultural BMPs were developed by URS and ERG (2003) in the *Technical Support Document for Quantification of Agricultural BMPs*. Two BMPs were quantified for harvesting: 1) combining tractor operations, and 2) reduced harvest activity. To estimate controlled harvest emissions from agricultural operations taking place within the PM₁₀ NAA, the mid-point net control efficiency for each BMP were applied to 53.46% of the uncontrolled annual emissions (the percent of agricultural land in the PM₁₀ NAA) as follows:

$$\text{Controlled annual harvest}_{\text{Crop}} \text{ emissions} = \text{annual uncontrolled PM}_{10} \text{ emissions} \times (100\% - \text{mid-point net control efficiency}_{\text{crop}}) \times \% \text{ agricultural land in PM}_{10} \text{ NAA}$$

$$\begin{aligned} \text{Controlled annual harvest}_{\text{Cotton}} \text{ emissions from within the PM}_{10} \text{ NAA} &= 25.70 \text{ tons PM}_{10}/\text{yr} \times (100\% - 37\%) \times 53.46\% \\ &= 8.66 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

The uncontrolled portion of harvest emissions from agricultural operations outside the PM₁₀ NAA but within Maricopa County were estimated by multiplying the uncontrolled annual PM₁₀ emissions by the percent of agricultural land located within Maricopa County but outside of the PM₁₀ NAA (100% - 53.46%) as follows:

$$\begin{aligned} \text{Uncontrolled annual Harvest}_{\text{Cotton}} \text{ emission from outside the PM}_{10} \text{ NAA} &= \text{Uncontrolled PM}_{10} \text{ emissions} \times 46.54\% \\ &= 25.70 \text{ tons PM}_{10}/\text{yr} \times 46.54\% \\ &= 11.96 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

The total controlled and uncontrolled annual emissions were then summed to estimate total annual PM₁₀ emissions from agricultural harvesting in Maricopa County as follows:

$$\begin{aligned} \text{Total annual harvest}_{\text{Cotton}} \text{ emissions for Maricopa County} &= \text{Uncontrolled annual harvest}_{\text{Cotton}} \text{ emissions from outside the PM}_{10} \text{ NAA} + \text{Controlled annual harvest}_{\text{Cotton}} \text{ emissions from within the PM}_{10} \text{ NAA} \\ &= 8.66 + 11.96 \\ &= 20.62 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Table 3.5–15. Annual emissions from harvesting (tons/yr).

Crop	Uncontrolled PM ₁₀ (tons/yr)	Net control efficiency (%)	PM ₁₀ NAA		Maricopa County (controlled + uncontrolled)		PM ₁₀ NAA (controlled)
			(controlled) PM ₁₀	(uncontrolled) PM ₁₀	PM ₁₀	PM _{2.5}	PM _{2.5}
Cotton	25.70	37.0	8.66	11.96	20.62	4.12	1.73
Wheat	0.02	33.9	0.01	0.01	0.01	0.00	0.00
Barley	0.02	33.9	0.01	0.01	0.02	0.00	0.00
Totals:	25.74		8.67	11.98	20.65	4.12	1.73

Annual PM_{2.5} emissions from agricultural harvesting were calculated by multiplying the annual PM₁₀ emissions by a conversion factor of 0.20 (US EPA, 2003b).

Typical daily emissions for Maricopa County and the PM₁₀ NAA were calculated by dividing the controlled annual emissions by the number of harvest days per year (URS and ERG, 2001), as shown in Table 3.5–16.

Table 3.5–16. Typical daily emissions from harvesting (lbs/day).

Crop	Harvest days/yr	Maricopa County		PM ₁₀ nonattainment area	
		PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Cotton	99	416.56	83.31	174.9	35.0
Wheat	49	0.6	0.12	0.3	0.05
Barley	49	0.8	0.15	0.3	0.05
Totals:		417.90	83.58	175.4	35.1

3.5.2.3 Cotton ginning

Annual emissions from cotton ginning were derived from annual emission reports from permitted sources. Both the Maricopa County permit database and County Business Patterns from the US Census Bureau's (2003b) indicate that there are 10 cotton gins within the county; thus it was assumed that there were no unpermitted sources in this category. Total PM₁₀ emissions from gins that operated in 2002, and are not treated as point sources in this report, totaled 2.06 tons per year. Based on operating schedule information provided in the reports, typical daily PM₁₀ emissions were calculated at 13.3 lbs/day.

Data from EPA's PM calculator software (US EPA, 2001c) were used to calculate PM_{2.5} emissions, assumed to be 6.7% of PM₁₀ emissions. Since all cotton gins considered in this section are located within the PM₁₀ nonattainment area, total emission values for the county and the PM₁₀ NAA from cotton ginning are equal. Results are shown in Table 3.5-17.

Table 3.5-17. Annual and typical daily emissions from area-source cotton ginning.

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
Maricopa County	2.06	0.14	13.3	0.9
PM ₁₀ NAA	2.06	0.14	13.3	0.9

3.5.2.4 Fertilizer application

A significant source of ammonia (NH₃) emissions is fertilizer application. The Arizona Department of Agriculture provided the grade¹ and annual tonnage of fertilizer distributed in Arizona in 2002 (ADOA, 2004); data contained in Appendix 3.2). Ammonia emissions were calculated using fertilizer-specific nitrogen content and emission factors from Battye et al. (1994).

State-wide fertilizer tonnage was apportioned to Maricopa County using 2002 field crop and vegetable harvested acreage obtained from the Arizona Agricultural Statistics Service (AASS, 2003). In 2002, 696,800 acres of cotton hay, wheat, barley, corn, broccoli, honeydew, cantaloupe, and watermelon were harvested in Arizona, with 172,500 acres (24.76%) harvested within Maricopa County. ADOA (2004) reported 458,080 tons of fertilizer sold in Arizona in 2002. Maricopa County fertilizer tonnage was estimated for each "grade" of fertilizer reported as in this example for liquid fertilizer "grade" 82-0-0:

$$\begin{aligned}
 \text{Grade 82-0-0 fertilizer} &= \text{Statewide distribution of grade} \times \text{Ratio of Maricopa County:Arizona harvested acreage} \\
 \text{distributed in Maricopa} & \quad \text{82-0-0 fertilizer in 2002 (tons)} \\
 \text{County (tons)} &= 6,703.06 \text{ tons} \quad \times 24.76\% \\
 &= 1,659.41 \text{ tons}
 \end{aligned}$$

US EPA guidance (Battye et al., 1994) contains nitrogen content and ammonia emission factors for ten major categories of nitrogen fertilizers (e.g., anhydrous ammonia, ammonium nitrates, ammonium sulfates, urea, etc.). Because the fertilizer tonnage data provided by ADOA was reported by fertilizer "grade" the individual grades were assigned into one of the ten major

¹ "Grade" means the percentage of total nitrogen, available phosphate or soluble potash stated in whole numbers.

categories of nitrogen fertilizers based on their N-P-K ratios. For example, anhydrous ammonia is reported with a grade of “82-0-0” under liquid fertilizer. Fertilizer grades that did not contain nitrogen (N) were excluded. Once each grade was assigned to a fertilizer category, the total nitrogen content was estimated using the nitrogen content for each fertilizer category as in this example for anhydrous ammonia:

$$\begin{aligned} \text{Total N content of} &= \text{tons of anhydrous ammonia distributed} \times \text{N content of anhydrous ammonia} \\ \text{anhydrous ammonia (tons)} &= 1,659.41 \text{ tons} \times 82\% \\ &= 1,360.72 \text{ tons} \end{aligned}$$

Annual NH₃ emissions from fertilizer applications were then calculated as follows:

$$\begin{aligned} \text{Annual NH}_3 \text{ emissions} &= \text{Nitrogen content of} \times \text{emission factor} \times \text{unit conversion factor from} \\ \text{anhydrous ammonia} &\quad \text{anhydrous ammonia (tons)} \\ &= 1,360.72 \text{ tons} \times 24 \text{ lb of NH}_3 / \text{ton of N} \times 1 \text{ ton} / 2,000 \text{ lbs} \\ &= 16.33 \text{ tons} \end{aligned}$$

This procedure was followed for each fertilizer category. Emissions from all ten fertilizer categories were then summed to derive annual emissions from all fertilizer application. Typical daily emissions were calculated by dividing annual emissions by 365.

Annual and typical daily emissions for the PM₁₀ nonattainment area were derived by multiplying the county annual and typical daily emissions by the percentage of agricultural land located in the PM₁₀ NAA (53.46%). See Section 1.5.2 for a discussion of the land-use data used.

Table 3.5–18. Annual and typical daily ammonia emissions from fertilizer application.

Fertilizer Category	AMS code	Maricopa County		PM ₁₀ NAA	
		Annual emissions (tons/yr)	Typical daily emissions (lbs/day)	Annual emissions (tons/yr)	Typical daily emissions (lbs/day)
Anhydrous ammonia	28-01-700-001	16.33	89.5	8.73	47.8
Aqua ammonia	28-01-700-002	1.13	6.2	0.60	3.3
Nitrogen solutions	28-01-700-003	–	–	–	–
Urea	28-01-700-004	265.42	1,454.3	141.89	777.5
Ammonium nitrate	28-01-700-005	280.34	1,536.1	149.87	821.2
Ammonium sulfate	28-01-700-006	49.07	268.9	26.23	143.7
Ammonium thiosulfate	28-01-700-007	2.21	12.1	1.18	6.5
Other straight nitrogen	28-01-700-008	49.91	273.5	26.68	146.2
Ammonium phosphates	28-01-700-009	101.78	557.7	54.41	298.2
N-P-K mixture	28-01-700-010	202.76	1,111.0	108.40	594.0
Total:	28-01-700-000	968.94	5,309.3	518.00	2,838.3

3.5.3 Livestock

Estimates of Maricopa County’s inventory of cattle and calves in 2002 were obtained from published statistics (AASS, 2003). Beef cows were excluded from the inventory as information provided by Arizona Agricultural Statistics staff indicated that the majority of beef cows that are not on feed are grazed on range and pastures. Cattle on feed, milk cows, and other cattle (heifers, steers, bulls, and calves) were included in the PM₁₀ emission estimates. The emission factor for PM₁₀ from cattle feedlots was obtained from the California Air Resources Board

(CARB, 1999). PM_{2.5} was presumed to be 15% of PM₁₀ per EPA guidance (US EPA, 2003c). A composite emission factor for cattle and calves for NH₃ was obtained from Battye et al. (1994). The 2002 Maricopa County cattle inventory and applicable emission factors are contained in Table 3.5–19.

Table 3.5–19. Maricopa County cattle inventory and emission factors.

Animal type	Head	Emission factors		
		PM ₁₀ (ton/1000 head)	PM _{2.5} (ton/1000 head)	NH ₃ (lb/head)
Cattle on feed	6,000	17.2	2.58	50.50
Milk cows	119,000	17.2	2.58	50.50
Other cattle	54,000	17.2	2.58	50.50
Total	179,000			

Annual PM₁₀ emissions from feedlots and dairies in Maricopa County were calculated using the following formula:

$$\begin{aligned} \text{Annual emissions (tons/yr)} &= \text{county cattle inventory (1,000 head)} \times \text{emission factor (tons PM}_{10}/1,000 \text{ head)} \\ &= 179 \times 17.2 \\ &= 3,078.8 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Annual NH₃ emissions from feedlots and dairies in Maricopa County were calculated using the following formula:

$$\begin{aligned} \text{Annual emissions (tons/yr)} &= \text{county cattle inventory} \times \text{emission factor} \times \text{unit conversion factor} \\ &= 179,000 \times 50.50 \times 1 \text{ ton}/2,000 \text{ lbs} \\ &= 4,519.75 \text{ tons NH}_3/\text{yr} \end{aligned}$$

Annual emissions for the nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage of agricultural land-use located in the PM₁₀ nonattainment area. (See Section 1.5.2 for a discussion of the land-use data used.) It was assumed that cattle feedlot and dairy emissions occur evenly throughout the year. Typical daily emissions were derived by dividing annual emissions for Maricopa County and the nonattainment area by 365 days/year. Table 3.5–20 summarizes the annual and typical daily emissions from cattle feedlots and dairies for Maricopa County and the PM₁₀ nonattainment area.

Table 3.5–20. Annual and typical daily emissions from cattle feedlots and dairies.

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5}	NH ₃	PM ₁₀	PM _{2.5}	NH ₃
Maricopa County	3,078.80	461.82	4,519.75	16,870.1	2,530.5	24,765.8
PM ₁₀ NAA	1,645.93	246.89	2,416.26	9,018.8	1,352.8	13,239.8

3.5.4 Health services: crematories

Emissions from human and animal crematories were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2003) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the Census Bureau’s County Business Patterns (CBP), for 2001 employment, were used. CBP employment data for NAICS code 81222 (cemeteries and crematories) indicated 683 employees in this industry in Maricopa County. This employment estimate is used to “scale up” emissions reported from those facilities surveyed in 2002 as follows:

$$\text{Total area-source emissions} = \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment}$$

$$\begin{aligned} \text{Area-source PM}_{10} \text{ emissions from crematories} &= \frac{0.23 \text{ tons/yr}}{110} \times 683 \text{ employees} \\ &= 1.41 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

Typical daily emissions are calculated based on the operating schedule data reported by surveyed facilities. From annual emission surveys, it was determined that crematories operate on a 5-day week throughout the year. This data was used to calculate typical daily emissions as follows:

$$\begin{aligned} \text{Typical daily PM}_{10} \text{ emissions from crematories} &= \frac{\text{Annual emissions (tons/yr)}}{\text{Days/week} \times \text{Weeks/yr}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= \frac{1.41}{5 \times 52} \times 2,000 \\ &= 10.9 \text{ lbs PM}_{10}/\text{day} \end{aligned}$$

As all facilities addressed in this source category are located within the PM₁₀ nonattainment area, emission totals for both areas are equal. Annual and daily emissions are shown in Table 3.5–21.

Table 3.5–21. Annual and typical daily emissions from crematories.

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM ₁₀	PM _{2.5}	NO _x	SO _x	PM ₁₀	PM _{2.5}	NO _x	SO _x
Maricopa County	1.41	0.94	19.46	2.48	10.9	7.3	149.7	19.1
PM ₁₀ NAA	1.41	0.94	19.46	2.48	10.9	7.3	149.7	19.1

3.5.5 Accidental releases

As part of its air quality permit compliance program, MCESD keeps an “upset log”, for each calendar year that records excess emissions and accidental releases at permitted facilities. Annual emissions inventory reports also provide for recording of accidental releases. Data from these two sources documented the release of 0.29 tons of PM₁₀, 0.29 tons of PM_{2.5}, and 1.08 tons of NO_x for the year 2002. (No accidental releases of SO_x or NH₃ were reported).

Typical daily emissions are calculated by summing reported releases and dividing the total by 365 days. Emissions in the PM₁₀ nonattainment area are calculated based on locations of facilities that reported releases.

Table 3.5–22. Annual and typical daily emissions from accidental releases.

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM ₁₀	PM _{2.5}	NO _x	PM ₁₀	PM _{2.5}	NO _x
Maricopa County	0.29	0.29	1.08	1.6	1.6	5.9
PM ₁₀ NAA	0.29	0.29	0.00	1.6	1.6	0.0

* As a conservative estimate, all PM₁₀ emissions are assumed to be PM_{2.5}.

3.5.6 Humans

A literature review by Battye et al. (1994) recommends using a per-capita emission factor developed for the National Acid Precipitation Assessment Program (NAPAP) inventory in 1985. This factor was applied to MAG population estimates for the county and PM₁₀ nonattainment areas. Daily emissions were calculated by dividing annual values by 365.

Table 3.5–23. Annual and typical daily NH₃ emissions from human activity.

Area	Population	Emission factor (lbs/ person-yr)	Annual NH ₃ emissions (tons/yr)	Typical daily NH ₃ emissions (lbs/day)
Maricopa County	3,549,693	0.55	976.17	5,348.9
PM ₁₀ NAA	3,519,288	0.55	967.80	5,303.0

3.5.7 Windblown dust

Windblown dust emissions estimates for Maricopa County are based on the windblown dust PM₁₀ emissions estimated by MAG for the nonattainment area, as described in the Technical Support Document (TSD) for the Serious Area PM₁₀ Plan (MAG, 2000). Emissions were estimated by MAG separately for windblown dust from vacant land, fluvial channels, agricultural land, and construction. MAG estimated annual average windblown PM₁₀, calculated for hours with average wind speed greater than 15mph, for the years 1995 and 2001. MAG estimated total windblown dust PM₁₀ emissions for the PM₁₀ nonattainment area for 1995 and 2001 as follows:

Table 3.5–24. 1995 and 2001 emissions from windblown dust for the PM₁₀ nonattainment area.

Land-use categories	PM ₁₀ emissions ¹			
	1995		2001	
	tons/yr	tons/day	tons/yr	tons/day
Disturbed vacant land	1,973	5.41	1,533	4.20
Agricultural fields	8,071	22.11	5,925	16.24
Fluvial channels	1,387	3.80	1,387	3.80
Construction	1,809	4.96	2,013	5.51
Totals:	13,240	36.27	10,858	29.75

1. MAG 2000, Tables II-1 and II-2, converted to English units.

For year 2002, PM₁₀ windblown dust emissions were estimated by determining the 1995 to 2001 emissions growth rate (in fact a decrease of –3.25% per year) and then extrapolating it to 2002. Thus, total 2002 PM₁₀ windblown emissions for the nonattainment were estimated as 10,504.58 tons/yr and 28.78 tons/day. Total 2002 PM₁₀ windblown emissions were then apportioned to the different windblown categories based on 2001 percentages as follows:

$$\begin{aligned}
\text{2002 windblown emissions from} &= \text{total estimated PM}_{10} && \times && \text{2001 percentage of emissions} \\
\text{disturbed vacant land (tons/yr)} & \text{windblown emissions} && && \text{from disturbed vacant land} \\
&= 10,504.58 && \times && 14.12\% \\
&= 1,483.44 \text{ tons PM}_{10}/\text{yr}
\end{aligned}$$

Table 3.5–25. Annual and daily emissions from windblown dust within the PM₁₀ nonattainment area.

Land-use categories	2001 contribution (%)	2002 PM ₁₀ emissions		2002 PM _{2.5} emissions	
		tons/yr	lbs/day	tons/yr	lbs/day
Disturbed vacant land	14.12	1,483.44	8,128.4	328.88	1,802.1
Agricultural fields	54.57	5,732.20	31,409.3	1,270.83	6,963.4
Fluvial channels	12.77	1,341.60	7,351.2	297.43	1,629.8
Construction	18.54	1,947.35	10,670.4	431.73	2,365.6
Totals:	100.00	10,504.58	57,559.4	2,328.87	12,760.9

PM_{2.5} was estimated by applying a PM_{2.5} to PM₁₀ fraction of 0.2217 (CARB, 2003) as follows:

$$\begin{aligned}
\text{PM}_{2.5} \text{ emissions from} &= \text{2002 PM}_{10} \text{ from} && \times && \text{PM}_{2.5}:\text{PM}_{10} \text{ ratio} \\
\text{disturbed vacant land} & \text{disturbed vacant land} && && \\
\text{(tons/yr)} & && && \\
&= 1,483.44 && \times && 0.2217 \\
&= 328.88 \text{ tons PM}_{10}/\text{yr}
\end{aligned}$$

The estimates for the nonattainment area were adjusted to the county level using a combination of adjustment factors based on land-use acreage (for fluvial channels, disturbed vacant land, and agricultural fields) and population (for construction). Refer to Sections 1.5.1 and 1.5.2 for descriptions of the population and land-use data used.

$$\begin{aligned}
\text{Annual PM}_{10} \text{ emissions} &= \text{total PM}_{10} \text{ emissions from} && \div && \text{NAA:county ratio of land use} \\
\text{from disturbed vacant land} & \text{disturbed vacant land within} && && \\
\text{in Maricopa County} & \text{the PM}_{10} \text{ NAA (tons/yr)} && && \\
&= 1,483.44 && \div && 28.25\% \\
&= 5,251.11
\end{aligned}$$

Table 3.5–26. Annual and daily emissions from windblown dust in Maricopa County.

Land-use categories	Surrogate	NAA: County ratio (%)	PM ₁₀ emissions		PM _{2.5} emissions	
			tons/yr	lbs/day	tons/yr	lbs/day
Disturbed vacant land	Vacant land	28.25	5,251.50	28,775.4	1,164.26	6,379.5
Agricultural fields	Agricultural land	53.46	10,721.83	58,749.8	2,377.03	13,024.8
Fluvial channels	Total area	31.29	4,287.07	23,490.8	950.44	5,207.9
Construction	population	99.14	1,964.24	10,763.0	435.47	2,386.2
Totals:			22,224.64	121,778.9	4,927.20	26,998.4

3.5.8 Summary of all miscellaneous area sources

Tables 3.5–27 and 3.5–28 provide a summary of annual and typical daily emissions from all miscellaneous area sources, for Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.5–27. Annual and typical daily emissions from all miscellaneous area sources for Maricopa County.

Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Wildfires/brush	286.33	251.23	65.01	14.92	11.41	164,602.8	141,202.8	36,328.1	9,945.0	7,605.0
Structure fires	22.41	22.41	2.90			123.1	123.1	16.0		
Vehicle fires	66.45	66.45	2.66			364.1	364.1	14.6		
Engine testing	0.41	0.30	4.26	0.82		6.5	5.4	89.1	7.4	
Tilling	3152.40	630.48				30,697.60	6,139.50			
Harvesting	20.65	4.13				417.9	83.6			
Cotton ginning	2.06	0.14				13.3	0.9			
Fertilizer					968.94					5,309.3
Livestock	3,078.80	461.82			4,519.75	16,870.1	2,530.5			24,765.8
Crematories	1.41	0.94	19.46	2.48		10.9	7.3	149.7	19.1	
Accidental releases	0.29	0.29	1.08			1.6	1.6	5.9		
Humans					976.17					5,348.9
Windblown dust	22,224.64	4,927.20				121,778.9	26,998.4			
Total:	28,855.85	6,365.39	95.36	18.22	6,476.27	334,886.8	177,457.1	36,603.3	9,971.5	43,028.9

Table 3.5–28. Annual and typical daily emissions from all miscellaneous area sources for the PM₁₀ NAA.

Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Wildfires/brush	11.23	11.23	2.99	0.00	0.00	61.5	61.5	16.4	0.0	0.0
Structure fires	22.21	22.21	2.88			122.0	122.0	15.8		
Vehicle fires	65.88	65.88	2.64			361.0	361.0	14.4		
Engine testing	0.41	0.30	4.26	0.82		6.5	5.4	89.1	7.4	
Tilling	1,399.12	279.82				13,805.60	2,761.1			
Harvesting	8.67	1.73				175.5	35.1			
Cotton ginning	2.06	0.14				13.3	0.9			
Fertilizer					518.00					2,838.3
Livestock	1,645.93	246.89			2,416.26	9,018.8	1,352.8			13,239.8
Crematories	1.41	0.94	19.46	2.48		10.9	7.3	149.7	19.1	
Accidental releases	0.29	0.29	0.00			1.6	1.6	0.0		
Humans					967.80					5,303.0
Windblown dust	10,504.58	2,328.87				57,559.4	12,760.9			
Total:	13,661.81	2,958.31	32.22	3.30	3,902.06	81,136.1	17,469.6	285.4	26.5	21,381.1

3.6 Summary of all area sources

Tables 3.6–1 and 3.6–2 summarize the total annual and typical daily emissions from all area sources addressed in this chapter, for both Maricopa County and the PM₁₀ nonattainment area, respectively.

Table 3.6–1. Summary of annual and typical daily emissions from all area sources in Maricopa County.

Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Fuel Combustion										
Industrial natural gas	5.92	5.92	110.63	0.47	2.44	38.0	38.0	709.2	3.0	15.7
Industrial fuel oil	55.95	55.95	777.40	74.34	3.20	358.6	358.6	4,983.4	476.5	20.5
Comm./inst. nat. gas	56.07	56.07	1,068.63	4.40	3.54	359.4	359.4	6,850.2	28.2	22.7
Comm./inst. fuel oil	123.16	123.16	1,798.63	149.05	4.47	789.5	789.5	11,529.7	955.5	28.6
Residential nat. gas	62.39	62.39	771.72	4.93		341.9	341.9	4,228.6	27.0	
Residential wood	440.00	409.20	33.06	5.09		4,861.9	4,521.6	365.3	56.2	
Residential fuel oil	0.02	0.02	0.83	0.33		0.2	0.2	9.1	3.6	
All fuel combustion	743.52	712.72	4,560.90	238.60	13.65	6,749.6	6,409.2	28,675.4	1,550.0	87.5
Industrial Processes										
Chemical mfg.	28.53	17.72	1.08	0.25	0.61	219.4	136.3	8.3	1.9	4.7
Comm. cooking	713.85	661.98				3,922.2	3,637.2			
Grain processing	7.01	1.80				53.1	13.5			
Cold storage					1,658.81					10,633.4
Secondary metal production	6.72	3.68	0.03	0.03	2.68	52.1	28.7	0.2	0.3	15.6
Mineral processes	87.11	31.61				670.1	243.2			
Mining & quarrying	28.43	11.09				177.1	68.3			
Wood product mfg.	145.14	89.36				1,116.5	687.4			
Rubber/plastic product mfg.	25.47	23.41				195.9	180.1			
Fabricated metal product mfg.	0.63	0.44				4.8	3.4			
Construction	18,721.29	3,744.26				144,009.9	28,802.0			
Electrical equipment mfg.	1.03	0.63	16.28		6.27	5.7	3.4	89.4		34.4
ADEQ-permitted portable sources	110.83	55.87	572.42	157.14		865.5	435.3	5,219.6	1,262.8	
Road travel at industrial sites	74.58	23.36				543.0	166.1			
Industrial processes NEC	23.83	18.39	0.05	0.03	4.42	183.3	141.5	0.4	0.4	34.0
All Industrial Processes	19,974.43	4,683.60	589.86	157.46	1,672.79	152,018.5	34,546.4	5,318.0	1,265.4	10,722.2
Waste Treatment/Disposal										
On-site incineration	0.67	0.59	28.90	0.03		5.2	4.6	222.3	0.2	
Open burning	103.33	103.33	27.68			885.3	885.3	237.1		
Landfills	4.53	3.30	10.44	2.33		24.9	18.1	57.4	12.8	
POTWs					1,230.86					6,744.4
Other waste	3.05	2.53	0.33	0.31		23.5	19.5	2.6	2.4	
All Waste Treatment/Disposal	111.58	109.76	67.36	2.67	1,230.86	938.8	927.5	519.3	15.4	6,744.4
Misc. Area Sources										
Wildfires & brush fires	286.33	251.23	65.01	14.92	11.41	164,602.8	141,202.8	36,328.1	9,945.0	7,605.0
Structure fires	22.41	22.41	2.90			123.1	123.1	16.0		
Vehicle fires	66.45	66.45	2.66			364.1	364.1	14.6		
Engine testing	0.41	0.30	4.26	0.82		6.5	5.4	89.1	7.4	
Tilling	3,158.40	630.48				30,697.6	6,139.50			
Harvesting	20.65	4.13				417.9	83.6			
Cotton ginning	2.06	0.14				13.3	0.9			
Fertilizer application					968.94					5,309.3
Livestock	3,078.80	461.82			4,519.75	16,870.1	2,530.5			24,765.8
Crematories	1.41	0.94	19.46	2.48		10.9	7.3	149.7	19.1	
Accidental releases	0.29	0.29	1.08			1.6	1.6	5.9		
Humans					976.17					5,348.9
Windblown dust	22,224.64	4,927.20				121,778.9	26,998.4			
All Misc. Sources	28,855.85	6,365.39	95.36	18.22	6,476.27	334,886.8	177,457.1	36,603.3	9,971.5	43,028.9
TOTAL, ALL AREA SOURCES	49,685.38	11,871.47	5,313.47	416.94	9,393.56	494,593.6	219,340.2	71,116.0	12,802.3	60,582.9

Table 3.6–2. Summary of annual and typical daily emissions from all area sources in the PM₁₀ NAA.

Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO _x	NH ₃
Fuel Combustion										
Industrial natural gas	5.86	5.86	109.42	0.46	2.42	37.6	37.6	701.4	3.0	15.5
Industrial fuel oil	55.34	55.34	768.93	73.53	3.17	354.7	354.7	4,929.0	471.3	20.3
Comm./inst. nat. gas	55.47	55.47	1,057.19	4.36	3.50	355.6	355.6	6,776.9	27.9	22.4
Comm./inst. fuel oil	121.84	121.84	1,779.39	147.46	4.42	781.0	781.0	11,406.3	945.2	28.3
Residential nat. gas	61.88	61.88	765.39	4.89		339.1	339.1	4,193.9	26.8	
Residential wood	436.40	405.85	32.79	5.05		4,822.0	4,484.5	362.4	55.7	
Residential fuel oil	0.02	0.02	0.82	0.32		0.2	0.2	9.1	3.6	
All fuel combustion	736.81	706.26	4,513.93	236.06	13.50	6,690.3	6,352.7	28,379.0	1,533.0	86.5
Industrial Processes										
Chemical mfg.	28.22	17.53	1.07	0.25	0.61	217.1	134.8	8.2	1.9	4.7
Comm. Cooking	707.71	656.28				3,888.5	3,605.9			
Grain processing	7.01	1.80				53.1	13.5			
Cold storage					1,640.73					10,517.5
Secondary metal production	6.72	3.68	0.03	0.03	2.68	52.1	28.7	0.2	0.3	15.6
Mineral processes	86.16	31.27				662.8	240.5			
Mining & quarrying	22.92	9.20				138.9	55.1			
Wood product mfg.	143.56	88.38				1,104.3	679.9			
Rubber/plastic product mfg.	25.19	23.16				193.7	178.1			
Fabricated metal product mfg.	0.62	0.44				4.8	3.4			
Construction	17,916.27	3,583.25				137,817.5	27,563.5			
Electrical equipment mfg.	1.02	0.62	16.10		6.20	5.6	3.4	88.5		34.0
ADEQ-permitted portable sources	110.83	55.87	572.42	157.14		865.5	435.3	5,219.6	1,262.8	
Road travel at industrial sites	69.11	22.11				504.1	157.3			
Industrial processes NEC	23.83	18.39	0.05	0.03	4.42	183.3	141.5	0.4	0.4	34.0
All Industrial Processes	19,149.15	4,511.99	589.67	157.45	1,654.64	145,691.2	33,240.8	5,316.9	1,265.4	10,605.8
Waste Treatment/Disposal										
On-site incineration	0.67	0.59	28.90	0.03		5.2	4.6	222.3	0.2	
Open burning	35.31	35.31	9.46			320.0	320.0	85.6		
Landfills	4.53	3.30	10.44	2.33		24.9	18.1	57.4	12.8	
POTWs					1,220.31					6,686.6
Other waste	3.05	2.53	0.33	0.31		23.5	19.5	2.6	2.4	
All Waste Treatment/Disposal	43.56	41.74	49.13	2.67	1,220.31	373.5	362.2	367.9	15.4	6,686.6
Misc. Area Sources										
Wildfires & brush fires	11.23	11.23	2.99	0.00	0.00	61.5	61.5	16.4	0.0	0.0
Structure fires	22.21	22.21	2.88			122.0	122.0	15.8		
Vehicle fires	65.88	65.88	2.64			361.0	361.0	14.4		
Engine testing	0.41	0.30	4.26	0.82		6.5	5.4	89.1	7.4	
Tilling	1,399.12	279.82				13,805.6	2,761.1			
Harvesting	8.67	1.73				175.5	35.1			
Cotton ginning	2.06	0.14				13.3	0.9			
Fertilizer application					518.00					2,838.3
Livestock	1,645.93	246.89			2,416.26	9,018.8	1,352.8			13,239.8
Crematories	1.41	0.94	19.46	2.48		10.9	7.3	149.7	19.1	
Accidental releases	0.29	0.29	0.00			1.6	1.6	0.0		
Humans					967.80					5,303.0
Windblown dust	10,504.58	2,328.87				57,559.4	12,760.9			
All Misc. Sources	13,661.81	2,958.31	32.22	3.30	3,902.06	81,136.1	17,469.6	285.4	26.5	21,381.1
TOTAL, ALL AREA SOURCES:	33,591.32	8,218.30	5,184.95	399.48	6,790.51	233,890.9	57,425.4	34,349.2	2,840.8	38,760.2

3.7 Quality assurance / quality control procedures

Quality assurance and quality control (QA/QC) activities for the area source emissions inventory were driven by the goal of creating a comprehensive, accurate, representative and comparable inventory of area source emissions for Maricopa County and the nonattainment area. During each step of creating, building and reviewing the area source emissions inventory, quality checks and assurances were performed to establish confidence in the inventory structure and data.

Area source categories were selected for inclusion in the inventory based on the latest Emission Inventory Improvement Program (EIIP) guidance available. EPA's guidance for area source categories included in the draft 2002 National Emission Inventory (NEI) was also evaluated, as area source emissions from this inventory will be submitted to EPA for the 2002 NEI. The list of area source categories developed based on these guidance documents was modified to fit the characteristics of Maricopa County, with some area source categories determined to be insignificant (such as industrial coal combustion and oil and gas production). The 1999 Maricopa County Periodic Ozone and Carbon Monoxide Emission Inventories and other regional emission inventories were also consulted to confirm the completeness of the area source categories chosen for inclusion.

Data for area source emission calculations were gathered from a wide universe of resources. Whenever applicable, local surveyed data (such as annual emissions report) was used as this data best reflects activity in the county and the nonattainment area. When local data was not available, state data from Arizona State agencies (such as the Arizona Department of Transportation) and regional bodies (such as the Western Regional Air Partnership, WRAP) were used. National level data (such as the US Census Bureau) was used when no local, state or regional data was available. In addition, the most recent EIIP guidance for area sources was consulted for direction in determining the most relevant data source for use in emissions calculations.

Emissions calculations for area sources were performed by three air quality planners and one unit manager. All area source emission estimates were calculated in spreadsheets to ensure the calculations could be verified and reproduced. Whenever possible or available, the "preferred method" described in the most recent EIIP guidance documents for area sources was used to calculate emissions. Emissions were estimated using emission factors from EIIP guidance, AP-42, and local source testing. Local seasonal and activity data were used when available, with EPA and EIIP guidance used when no local seasonal or activity data existed. All calculations were evaluated to ensure that emissions from point sources were not being double-counted and to determine if rule effectiveness applied.

Once area source emission estimates had been produced, several quality control checks were performed to substantiate the calculations. Most area source calculations were peer-reviewed by two other planners, with all area sources being reviewed by at least one other planner. Peer review ensured that all emission calculations were reasonable and could be reproduced. Sensitivity analyses and computational method checks were performed on area sources when emissions seemed to be outside the expected ranges. When errors were found, the appropriate changes were made by the author of the calculations to ensure consistency of the emissions calculations. The peer-reviewed emissions estimates were combined into a draft area source

chapter. This draft chapter was read through in its entirety by the unit manager and the three air quality planners for final review, with any identified errors corrected by the author of the section.

The draft version of the area source chapter was sent to the Arizona Department of Environmental Quality, the Arizona Department of Transportation, and the Maricopa Association of Governments for a quality assurance review. These agencies provided comments which were addressed and incorporated into the final area source chapter. Further quality analysis was performed by inputting the emission estimates into EPA's "QA/QC basic format and content checker", prior to submitting the data to the 2002 NEI.

The QA/QC activities described here have produced high levels of confidence in the area source emissions estimates detailed in this chapter, and represent the best efforts of the inventory preparers.

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