

### 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 MCAQD’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. MCAQD 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 included in this PM<sub>10</sub> inventory.**

SCC code	Category description	Section
	<b><i>Fuel combustion:</i></b>	3.2
2102004001	Industrial distillate oil: Boilers	3.2.1
2102004002	Industrial distillate oil: Engines	3.2.1
2102006000	Industrial natural gas	3.2.2
2103004001	Commercial/institutional distillate oil: Boilers	3.2.3
2103004002	Commercial/institutional distillate oil: Engines	3.2.3
2103006000	Commercial/institutional natural gas	3.2.4
2104004000	Residential distillate oil	3.2.5
2104006000	Residential natural gas	3.2.6
2104007000	Residential liquefied petroleum gas (LPG)	3.2.7
2104011000	Residential kerosene	3.2.8
2104008100	Residential Wood Combustion (RWC): Fireplace	3.2.9
2104008210	RWC: Woodstove: fireplace inserts: Non-EPA certified	3.2.9
2104008220	RWC: Woodstove: fireplace inserts: EPA certified; non-catalytic	3.2.9
2104008230	RWC: Woodstove: fireplace inserts: EPA certified; catalytic	3.2.9
2104008310	RWC: Woodstove: freestanding: Non-EPA certified	3.2.9
2104008320	RWC: Woodstove: freestanding: EPA certified, non-catalytic	3.2.9
2104008330	RWC: Woodstove: freestanding: EPA certified, catalytic	3.2.9
2104008400	RWC: Woodstove: Pellet-fired	3.2.9
2104008610	RWC: Hydronic heater: Outdoor	3.2.9
2104008700	RWC: Outdoor wood burning device, NEC	3.2.9
2104009000	RWC: Residential firelog	3.2.9
	<b><i>Industrial Processes:</i></b>	3.3
2301000000	Chemical manufacturing	3.3.1
2302002100	Commercial cooking: Conveyorized charbroiling	3.3.2.1
2302002200	Commercial cooking: Under-fired charbroiling	3.3.2.1
2302003000	Commercial cooking: Deep fat frying	3.3.2.1
2302003100	Commercial cooking: Flat griddle frying	3.3.2.1
2302003200	Commercial cooking: Clamshell griddle frying	3.3.2.1
2302040000	Grain handling/processing	3.3.2.2
2302080002	Ammonia cold storage	3.3.2.3
2304000000	Secondary metal production	3.3.3
2305070000	Mineral processes	3.3.4
2325000000	Mining and quarrying	3.3.5

**Table 3.1-1. List of area-source categories included in this PM<sub>10</sub> inventory (continued).**

SCC code	Category description	Section
2307000000	Wood product manufacturing	3.3.6
2308000000	Rubber/plastic product manufacturing	3.3.7
2309000000	Fabricated metal products manufacturing	3.3.8
2311010000	Residential construction	3.3.9
2311020000	Commercial construction	3.3.9
2311030000	Road construction	3.3.9
2311040000	Construction, other	3.3.9
2312000000	Electrical equipment mfg.	3.3.10
2296010000	Industrial paved/unpaved road travel	3.3.11
2399000000	Industrial processes, not elsewhere classified (NEC)	3.3.12
	<b><i>Waste Treatment/Disposal:</i></b>	3.4
2601000000	On-site incineration	3.4.1
2610000500	Open burning: Land clearing debris	3.4.2
2620000000	Landfills	3.4.3
2630020000	Publicly owned treatment works	3.4.4
2650000000	Other waste	3.4.5
	<b><i>Miscellaneous Area Sources:</i></b>	3.5
n/a	Windblown dust	3.5.1
2801000000	Cotton ginning	3.5.2.1
2801000003	Tilling	3.5.2.2
2801000005	Harvesting	3.5.2.3
2801000008	Travel on unpaved agricultural roads	3.5.2.4
2801500000	Agricultural field burning (ditchbank & fence row)	3.5.2.5
n/a	Fertilizer application	3.5.2.6
n/a	Livestock	3.5.2.7
2810010000	Humans	3.5.3
2810030000	Structure fires	3.5.4
2810040000	Aircraft engine testing	3.5.5
2810050000	Vehicle fires	3.5.6
2810060100	Crematories	3.5.7
2830001000	Accidental releases	3.5.8
n/a	Wildfires	3.5.9
n/a	Prescribed fires	3.5.10
n/a	Unpaved parking lots fugitive dust	3.5.11
n/a	Leaf blowers fugitive dust	3.5.12
n/a	Offroad recreational vehicles fugitive dust	3.5.13

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) or derived from state-wide data (e.g., fuel oil use).
- For some widespread or diverse categories (e.g., ammonia cold storage), 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., wood product manufacturing), these data were combined with employment data to “scale up” reported emissions to reflect the entire source category.

- For those source categories that have detailed emissions data available from most or all of the significant sources in the category, emissions were calculated based on the detailed process-level and operational data provided by these sources.

The specific emissions estimation methodologies used for each source category (including the derivation and application of rule effectiveness) are described in greater detail in the respective sections.

### 3.2 Fuel combustion

Area-source emission estimates are provided in this section for the following categories of fuel consumption: Industrial distillate oil, industrial natural gas, commercial/institutional distillate oil, commercial/institutional natural gas, residential distillate oil, residential natural gas, residential liquefied petroleum gas, residential kerosene, and residential wood.

Data for natural gas combustion emissions estimates came from a survey of the three 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 by end-user category and supplier.**

Natural gas supplier	Sales by end user category (in MMCF/yr)					
	Electric Utilities	Industrial	Commercial/Institutional	Residential	Transport*	Other*
Southwest Gas	n/a	592.74	13,303.23	17,083.04	9,288.47	406.92
City of Mesa	n/a	91.17	1,631.61	1,030.07	175.13	n/a
El Paso	112,963.97	150.78	n/a	n/a	n/a	n/a
<b>Total:</b>	<b>112,963.97</b>	<b>834.68</b>	<b>14,934.84</b>	<b>18,113.11</b>	<b>9,463.60</b>	<b>406.92</b>

\* For emissions calculations, sales from transport and other were grouped with industrial sales.

#### 3.2.1 Industrial distillate oil

Annual emissions from industrial distillate oil combustion were derived from EPA NEI (US EPA, 2012c) calculations. Emissions come from two different sources, boilers and engines burning distillate oil.

Typical daily emissions were derived by dividing the annual emissions by six days a week for 52 weeks, as recommended by EIIP guidance (US EPA, 2001a). Annual and typical daily emissions in the PM<sub>10</sub> nonattainment area were calculated by applying the ratio of industrial employment in the nonattainment area to county-level emission calculations (99.96%). See Section 1.5.1 for a discussion of the employment data used.

**Table 3.2–2. Annual and typical daily emissions from area-source industrial distillate oil combustion for boilers.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	10.04	5.48	60.87	1.30	2.43	64.4	35.1	390.2	8.3	15.6
PM <sub>10</sub> NAA	10.04	5.48	60.85	1.30	2.43	64.4	35.1	390.0	8.3	15.6

**Table 3.2–3. Annual and typical daily emissions from area-source industrial distillate oil combustion for engines.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	129.35	121.13	1,838.26	0.00	0.00	829.2	776.5	11,783.7	0.0	0.0
PM <sub>10</sub> NAA	129.30	121.08	1,837.52	0.00	0.00	828.8	776.2	11,779.0	0.0	0.0

### 3.2.2 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 2011. Area-source industrial natural gas usage for the county is based on the reported total volume of natural gas sold to industrial sources (10,705.20 MMCF) as shown in Table 3.2–1, minus natural gas used by industrial point sources (463.95 MMCF).

Natural gas is used for both external combustions (boilers and heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source natural gas usage derived above must be divided 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 2008. A 2008 apportionment was used because 2011 data were not available for all industrial area sources at the time that these emission estimates were developed.

Annual emissions for the county were calculated by multiplying natural gas usage by the respective emission factors for external (SCC=1020060\*) and internal (SCC=2020020\*) combustion obtained from EPA’s WebFIRE database (US EPA, 2012a).

**Table 3.2–4. Natural gas usage, emission factors, and annual emissions from area-source industrial natural gas combustion, by combustion type.**

Combustion type	% of total	Natural gas use (MMCF)	Emission factors (lb/MMCF)					Annual emissions (tons/yr)				
			PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
External	98.44	10,081.49	7.6	7.6	100	0.6	3.2	38.31	38.31	504.07	3.02	16.13
Internal	1.56	159.76	10.0	10.0	2840	0.6	n/a	0.80	0.80	226.86	0.05	0.00
<b>Total:</b>	<b>100.00</b>	<b>10,241.25</b>						<b>39.11</b>	<b>39.11</b>	<b>730.94</b>	<b>3.07</b>	<b>16.13</b>

Typical daily emissions for the county were calculated by dividing annual emissions by the number of days that activity occurs throughout the year (6 days/wks × 52 wks/yr).

Annual and typical daily emissions within the PM<sub>10</sub> nonattainment area were calculated by applying the ratio of industrial employment in the nonattainment area to county-level emission calculations (99.96%). See Section 1.5.1 for a discussion of the employment data used.

**Table 3.2–5. Annual and typical daily emissions from area-source industrial natural gas combustion.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	39.11	39.11	730.94	3.07	16.13	250.7	250.7	4,685.5	19.7	103.4
PM <sub>10</sub> NAA	39.09	39.09	730.65	3.07	16.12	250.6	250.6	4,683.6	19.7	103.4

### 3.2.3 Commercial/institutional distillate oil

Annual emissions from commercial/institutional distillate oil combustion were derived from EPA NEI (US EPA, 2012c) calculations. Emissions come from two different sources, boilers and engines burning distillate oil.

Typical daily emissions were derived by dividing the annual emissions by six days a week for 52 weeks, as recommended by EIIP guidance (US EPA, 2001a). Annual and typical daily emissions in the PM<sub>10</sub> nonattainment area were calculated by applying the ratio of industrial employment in the nonattainment area to county-level emission calculations (99.96%). See Section 1.5.1 for a discussion of the employment data used.

**Table 3.2–6. Annual and typical daily emissions from area-source commercial/institutional distillate oil combustion for boilers.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	0.02	0.02	0.12	0.00	0.00	0.1	0.1	0.8	0.0	0.0
PM <sub>10</sub> NAA	0.02	0.02	0.12	0.00	0.00	0.1	0.1	0.8	0.0	0.0

**Table 3.2–7. Annual and typical daily emissions from area-source commercial/institutional distillate oil combustion for engines.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	0.26	0.26	3.72	0.00	0.00	1.7	1.7	23.8	0.0	0.0
PM <sub>10</sub> NAA	0.26	0.26	3.72	0.00	0.00	1.7	1.7	23.8	0.0	0.0

### 3.2.4 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 2011. 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 (14,934.84 MMCF) as shown in Table 3.2–1, minus natural gas used by C&I point sources (77.80 MMCF).

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 2008. A 2008 apportionment was used because 2011 data were not available for all industrial area sources at the time that these emission estimates were developed.

Annual emissions for the county were calculated by multiplying natural gas usage by the respective emission factors for external (SCC=1020060\*) and internal (SCC=2020020\*) combustion obtained from EPA’s WebFIRE database (US EPA, 2012a).

**Table 3.2–8. 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 <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
External	98.34	14,610.42	7.6	7.6	100	0.6	0.49	55.52	55.52	730.52	4.38	3.58
Internal	1.66	246.63	10.0	10.0	2840	0.6	n/a	1.23	1.23	350.21	0.07	0.00
<b>Total:</b>	<b>100.00</b>	<b>14,857.04</b>						<b>56.75</b>	<b>56.75</b>	<b>1,080.73</b>	<b>4.46</b>	<b>3.58</b>

Typical daily emissions for the county were calculated by dividing annual emissions by the number of days that activity occurs throughout the year (6 days/wk × 52 wks/yr).

Annual and typical daily emissions within the PM<sub>10</sub> nonattainment area were calculated by applying the combined ratio of retail, office, public and other employment in the nonattainment area to county-level emission calculations (99.68%). See Section 1.5.1 for a discussion of the employment data used.

**Table 3.2–9. 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 <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	56.75	56.75	1,080.73	4.46	3.58	363.8	363.8	6,927.8	28.6	22.9
PM <sub>10</sub> NAA	56.57	56.57	1,077.29	4.44	3.57	362.6	362.6	6,905.7	28.5	22.9

### 3.2.5 Residential distillate oil

Annual emissions from residential distillate oil were derived from EPA NEI (US EPA, 2012c) calculations.

Typical daily emissions were calculated by dividing annual emissions by heating degree days (i.e. the number of degrees per day that the daily average temperature is below 65°F). Data obtained from Arizona Energy Statistics (GOEP, 2013) indicated that there were six months in 2011 (May-October, totaling 183 days) where no heating degree days were recorded. Assuming that no distillate oil combustion activity took place during those months, it is assumed that all residential distillate oil combustion occurred during the remaining 182 days of the year. Thus, typical daily emissions were calculated by dividing annual emission by the number of days distillate oil combustion occurred.

Annual and typical daily emissions within the PM<sub>10</sub> nonattainment area were calculated by multiplying county totals by the ratio of total population in the nonattainment area to the total population in the county (100.64%). See Section 1.5.1 for a discussion of the population data used.

**Table 3.2–10. Annual and typical daily emissions from residential distillate oil combustion.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	0.07	0.06	0.35	0.82	0.02	0.7	0.6	3.8	9.0	0.2
PM <sub>10</sub> NAA	0.07	0.06	0.35	0.83	0.02	0.7	0.6	3.8	9.1	0.2

### 3.2.6 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 were calculated by multiplying 2011 residential natural gas sales (18,113.11 MMCF), as shown in Table 3.2–1, by emission factors for residential natural gas combustion summarized in the table below (US EPA, 1998a).

**Table 3.2–11. Residential natural gas combustion emission factors.**

Emission Factors (lb/MMCF)			
PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>
7.6	7.6	94	0.6

Typical daily emissions were calculated by dividing annual emissions by the number of days (365) that activity occurs for residential natural gas combustion.

Annual and typical daily residential natural gas emissions in the PM<sub>10</sub> nonattainment area were calculated by multiplying county-level emissions by the ratio of total resident population in the PM<sub>10</sub> nonattainment area to total resident population in the county (100.27%).

**Table 3.2–12. Annual and typical daily emissions from residential natural gas combustion.**

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>
Maricopa County	68.83	68.83	851.32	5.43	377.1	377.1	4,664.7	29.8
PM <sub>10</sub> NAA	69.02	69.02	853.61	5.45	378.2	378.2	4,677.3	29.9

### 3.2.7 Residential liquefied petroleum gas (LPG)

Annual emissions from residential liquefied petroleum gas (LPG) were derived from EPA NEI (US EPA, 2012c) calculations.

Typical daily emissions were calculated by dividing annual emissions by heating degree days (i.e. the number of degrees per day that the daily average temperature is below 65°F). Data obtained from Arizona Energy Statistics (GOEP, 2013) indicated that there were six months in 2011 (May-October, totaling 183 days) where no heating degree days were recorded. Assuming that no residential LPG combustion activity took place during those months, it is assumed that all residential LPG combustion occurred during the remaining 182 days of the year. Thus, typical daily emissions were calculated by dividing annual emission 182 days.

Annual and typical daily emissions within the PM<sub>10</sub> nonattainment area were calculated by multiplying county totals by the ratio of total population in the nonattainment area to the total population in the county (100.64%). See Section 1.5.1 for a discussion of the population used.

**Table 3.2–13. Annual and typical daily emissions from residential liquefied petroleum gas combustion.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	0.19	0.16	51.35	0.22	0.18	2.1	1.7	564.3	2.4	2.0
PM <sub>10</sub> NAA	0.19	0.16	51.68	0.22	0.18	2.1	1.7	567.9	2.4	2.0

### 3.2.8 Residential kerosene

Annual emissions from residential kerosene were derived from EPA NEI (US EPA, 2012c) calculations.

Typical daily emissions were calculated by dividing annual emissions by heating degree days (i.e. the number of degrees per day that the daily average temperature is below 65°F). Data obtained from Arizona Energy Statistics (GOEP, 2013) indicated that there were six months in 2011 (May-October, totaling 183 days) where no heating degree days were recorded. Assuming that no kerosene combustion activity took place during those months, it is assumed that all residential kerosene combustion occurred during the remaining 182 days of the year. Thus, typical daily emissions were calculated by dividing annual emission 182 days.

Annual and typical daily emissions within the PM<sub>10</sub> nonattainment area were calculated by multiplying county totals by the ratio of total population in the nonattainment area to the total population in the county (100.64%). See Section 1.5.1 for a discussion of the population data used.

**Table 3.2–14. Annual and typical daily emissions from kerosene combustion.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	0.01	0.01	0.03	0.08	0.00	0.1	0.1	0.4	0.9	0.0
PM <sub>10</sub> NAA	0.01	0.01	0.03	0.08	0.00	0.1	0.1	0.4	0.9	0.0

### 3.2.9 Residential wood combustion

Annual emissions from residential wood combustion for Maricopa County were obtained from the US Environmental Protection Agency’s Residential Wood Combustion Estimation Tool (US EPA, 2012b). County-level annual emissions by appliance type are shown below in Table 3.2–15.

**Table 3.2–15. Annual emissions by appliance type for Maricopa County from EPA’s residential wood combustion estimation tool.**

SCC	Appliance Type	Annual emissions (tons/yr)				
		PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
2104008100	Fireplace	238.59	238.59	26.29	4.04	18.20
2104008210	Woodstove: fireplace inserts; non-EPA cert.	85.07	85.07	7.78	1.11	4.73
2104008220	Woodstove: fireplace inserts; EPA cert.; non-catalytic	17.48	17.48	2.03	0.36	0.80
2104008230	Woodstove: fireplace inserts; EPA cert.; catalytic	6.06	6.06	0.59	0.12	0.27
2104008310	Woodstove: freestanding, non-EPA cert.	41.25	41.25	3.77	0.54	2.29
2104008320	Woodstove: freestanding, EPA cert.; non-catalytic	8.47	8.47	0.99	0.17	0.39
2104008330	Woodstove: freestanding, EPA cert.; catalytic	2.94	2.94	0.29	0.06	0.13
2104008400	Woodstove: pellet-fired, general	0.96	0.96	1.19	0.10	0.09
2104008610	Hydronic heater: outdoor	0.00	0.00	0.00	0.00	0.00
2104008700	Outdoor wood burning device, NEC	4.99	4.99	0.55	0.08	0.38
2104009000	Residential firelog	54.34	52.64	14.24	0.00	0.00
<b>Total</b>		<b>460.15</b>	<b>458.44</b>	<b>57.72</b>	<b>6.59</b>	<b>27.28</b>

Typical daily emissions were calculated by dividing annual emissions by heating degree days (i.e. the number of degrees per day that the daily average temperature is below 65°F). Data obtained from Arizona Energy Statistics (GOEP, 2013) indicated that there were six months in 2011 (May-October, totaling 183 days) where no heating degree days were recorded. Assuming



that no wood burning activity took place during those months, it is assumed that all residential wood burning occurred during the remaining 182 days of the year. Thus, typical daily emissions were calculated by dividing annual emission by 182 days.

Annual and typical daily emissions within the PM<sub>10</sub> nonattainment area were calculated by multiplying county totals by the ratio of total population in the nonattainment area to total population in the county (100.64%). See Section 1.5.1 for a discussion of the population data used.

**Table 3.2–16. Annual and typical daily emissions from residential wood combustion.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	460.15	458.44	57.72	6.59	27.28	5,056.6	5,037.9	634.3	72.4	299.8
PM <sub>10</sub> NAA	463.10	461.38	58.09	6.63	27.45	5,089.0	5,070.1	638.4	72.8	301.7

### 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 (2012) 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 2010 employment were used. (Where employment estimates were provided as a range of values, the midpoint was used.) Table 3.3–1 shows the NAICS codes and employment data used to calculate emissions from chemical manufacturing.

**Table 3.3–1. County-level employment estimates for chemical manufacturing, by NAICS code.**

NAICS code	NAICS description (and employment range)	Estimated employment
325	Chemical manufacturing	4,605
42469	Other chemical & allied products merchant wholesalers	1,484
424910	Farm supplies merchant wholesalers	904
33312	Construction machinery manufacturing (250–499)	375
<b>Total:</b>		<b>7,368</b>

Since there were no point sources in this category, an area-source employment estimate was used to “scale up” emissions reported from those facilities surveyed in 2011. Typical daily emissions were calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Emission estimates for the PM<sub>10</sub> nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment in the nonattainment area. Table 3.3–2 summarizes annual and typical daily emissions from chemical manufacturing in both Maricopa County and the PM<sub>10</sub> 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 <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	121.46	73.32	1,172.4	732.7
PM <sub>10</sub> NAA	121.41	73.30	1,171.9	732.4

### 3.3.2 Food and kindred products

#### 3.3.2.1 Commercial cooking

Emissions from commercial cooking were estimated for five types of commercial cooking equipment using per capita emissions factors developed by EPA for the 2008 National Emissions Inventory (NEI) (Pechan, 2012). The per capita emission factors for each equipment type are contained in Table 3.3–3. EPA created the emission factors by taking 2002 emissions in the NEI and dividing by the 2002 population to develop per capita emission factors. The equipment types include: chain-driven charbroilers, under-fired charbroilers, deep-fat fryers, flat griddles, and clamshell griddles.

**Table 3.3–3. Emission factors for commercial cooking equipment, by equipment type.**

Equipment type	Emission Factor (lb/person)	
	PM <sub>10</sub>	PM <sub>2.5</sub>
Chain-driven charbroilers	0.049795905	0.049790839
Under-fired charbroilers	0.352760432	0.352725746
Deep-fat fryers	0.000000000	0.000000000
Flat griddle fryers	0.103110693	0.103045357
Clamshell griddles	0.006994144	0.006991186

Annual commercial cooking emissions for Maricopa County were estimated by multiplying the MAG-estimated county population (4,129,646) by the per capita emission factors for each type of cooking equipment. See Section 1.5.1 for a discussion of the population data used. Commercial cooking is assumed to occur uniformly throughout the year. Thus, typical daily emissions were estimated by dividing annual emissions by 365 days/year. The results are shown in Table 3.3–4 below.

**Table 3.3–4. Annual and typical daily emissions from commercial cooking equipment in Maricopa County.**

Equipment type	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Chain-driven charbroilers	102.82	102.81	563.4	563.3
Underfired charbroilers	728.39	728.32	3,991.2	3,990.8
Flat griddles	212.91	212.77	1,166.6	1,165.9
Clamshell griddles	14.44	14.44	79.1	79.1
<b>Total:</b>	<b>1,058.55</b>	<b>1,058.33</b>	<b>5,800.3</b>	<b>5,799.1</b>

Annual and typical daily emissions for the PM<sub>10</sub> nonattainment area were calculated by multiplying the county totals by the ratio of total population in the nonattainment area to the total population in the county (100.64%). See Section 1.5.1 for a discussion of the population data used. Table 3.3–5 summarizes the annual and typical daily emissions from commercial cooking in the PM<sub>10</sub> nonattainment area.

**Table 3.3–5. Annual and typical daily emissions from commercial cooking equipment in the PM<sub>10</sub> NAA.**

Equipment type	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Chain-driven charbroilers	103.48	103.47	567.0	566.9
Underfired charbroilers	733.05	732.98	4,016.7	4,016.3
Flat griddles	214.27	214.13	1,174.1	1,173.3
Clamshell griddles	14.53	14.53	79.6	79.6
<b>Total:</b>	<b>1,065.33</b>	<b>1,065.1</b>	<b>5,837.4</b>	<b>5,836.2</b>

### 3.3.2.2 Grain handling/processing

Emissions from grain handling and processing operations 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 (2012) to estimate an annual per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent employment estimates (for the year 2010) from the US Census Bureau’s County Business Patterns (CBP) were used. Table 3.3–6 shows the NAICS codes and employment estimates used to calculate emissions from grain handling and processing operations.

**Table 3.3–6. County-level employment estimates for grain handling and processing operations, by NAICS code.**

NAICS code	NAICS description	Estimated employment
115111	Cotton ginning	60
311119	Other animal food manufacturing	48
424510	Grain and field bean merchant wholesalers	10
<b>Total:</b>		<b>118</b>

Table 3.3–7 summarizes annual and typical daily emissions from grain handling and processing operations in both Maricopa County and the PM<sub>10</sub> nonattainment area.

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

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	70.09	19.10	443.1	122.3
PM <sub>10</sub> NAA	70.06	19.10	443.0	122.2

### 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, 312) as reported by the 2010 County Business Patterns (US Census Bureau, 2012). Annual emissions were 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).

Typical daily emissions were calculated by dividing annual emissions by the number of days per year that activity occurred.

Annual and typical daily emissions for the PM<sub>10</sub> nonattainment area were calculated by multiplying Maricopa County emissions by the ratio of industrial employment in the County to the PM<sub>10</sub> nonattainment area. See Section 1.5.1 for a discussion of employment data used.

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

<b>Geographic area</b>	<b>Annual NH<sub>3</sub> (tons/yr)</b>	<b>Typical daily NH<sub>3</sub> (lbs/day)</b>
Maricopa County	1,911.36	12,252.3
PM <sub>10</sub> NAA	1,910.60	12,247.4

### 3.3.3 Secondary metal production

Annual emissions from secondary metal production facilities were derived from annual emissions 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 PM<sub>10</sub> nonattainment area, total emission values for the county and the PM<sub>10</sub> nonattainment area are equal. Annual and typical daily emissions are shown in Table 3.3–9.

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

<b>Geographic area</b>	<b>Annual emissions (tons/yr)</b>					<b>Typical daily emissions (lbs/day)</b>				
	<b>PM<sub>10</sub></b>	<b>PM<sub>2.5</sub></b>	<b>NO<sub>x</sub></b>	<b>SO<sub>x</sub></b>	<b>NH<sub>3</sub></b>	<b>PM<sub>10</sub></b>	<b>PM<sub>2.5</sub></b>	<b>NO<sub>x</sub></b>	<b>SO<sub>x</sub></b>	<b>NH<sub>3</sub></b>
Maricopa County	42.27	34.37	15.02	8.03	0.25	308.9	256.3	106.9	89.3	2.3
PM <sub>10</sub> NAA	42.27	34.37	15.02	8.03	0.25	308.9	256.3	106.9	89.3	2.3

### 3.3.4 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 derived from annual emissions reports from permitted facilities. Since all permitted facilities in this category were surveyed in 2011, it was assumed that there were no significant unpermitted sources within Maricopa County. 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). Emissions from these state-permitted portable sources are addressed in Section 3.3.12, “Industrial processes not elsewhere classified”.

Typical daily emissions were calculated based on the operating schedule data reported by surveyed facilities. Annual and typical daily emissions for the PM<sub>10</sub> nonattainment area were derived based on the location data of the individual facilities. County-permitted portable sources with no location data were assumed to operate within the PM<sub>10</sub> nonattainment area as a conservative estimate.

Table 3.3–10 summarizes annual and typical daily emissions from mineral processing activities in both Maricopa County and the PM<sub>10</sub> nonattainment area.

**Table 3.3–10. Annual and typical daily emissions from area-source mineral processes.**

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	149.32	75.94	1,065.9	542.0
PM <sub>10</sub> NAA	133.99	69.39	953.9	493.9

### 3.3.5 Mining and quarrying

Annual emissions from area-source mining and quarrying (sand and gravel) operations were derived from annual emissions reports submitted by permitted sources. It was assumed that there were no significant unpermitted sources within Maricopa County. Those 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). Emissions from these state-permitted portable sources are addressed in Section 3.3.12, “Industrial processes not elsewhere classified”.

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 PM<sub>10</sub> nonattainment area were identified using information on the location of each permitted facility. County-permitted portable sources with no location data were assumed to operate within the PM<sub>10</sub> nonattainment area as a conservative estimate. Annual and typical 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.**

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	106.28	33.49	712.7	220.5
PM <sub>10</sub> NAA	86.58	27.95	564.9	179.0

### 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 (2012) 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 2010 employment were used. Table 3.3–12 shows the NAICS codes and employment data used to calculate emissions from wood product manufacturing.

**Table 3.3–12. County-level employment estimates for wood product manufacturing, by NAICS code.**

NAICS code	NAICS description	Estimated employment
321	Wood products manufacturing	3,937
337	Furniture and related products manufacturing	4,427
<b>Total:</b>		<b>8,364</b>

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.

Typical daily emissions were calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM<sub>10</sub> 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.

Table 3.3–13 summarizes annual and typical daily emissions from wood products manufacturing in both Maricopa County and the PM<sub>10</sub> nonattainment area.

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

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	59.64	52.76	442.4	385.7
PM <sub>10</sub> NAA	59.61	52.73	442.2	385.6

### 3.3.7 Rubber/plastics product 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 (2010) 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 2010 employment were used. Where CBP employment estimates were presented as a range, the midpoint values were 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. County-level employment estimates for rubber and plastic product manufacturing, by NAICS code.**

NAICS code	NAICS description (and employment range)	Estimated employment
325211	Plastics material and resin manufacturing (0–19)	10
325991	Custom compounding of purchased resins (100–249)	175
326140	Polystyrene foam product manufacturing	164
326199	All other plastics product manufacturing	3,027
326212	Tire retreading	135
326299	All other rubber product manufacturing	92
332313	Plate work manufacturing	151
336413	Other aircraft parts and aux. equipment manufacturing	2,086
337920	Blind and shade manufacturing (250–499)	375
339115	Ophthalmic goods manufacturing	97
423830	Industrial machinery & equip. merchant wholesalers	2,634
423930	Recyclable material merchant wholesalers	1,268
441310	Automotive parts and accessories stores	3,392
441320	Tire dealers	2,095
<b>Total</b>		<b>15,701</b>

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.

Daily emissions are calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM<sub>10</sub>

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.

Table 3.3–15 summarizes annual and typical daily emissions from rubber/plastic products manufacturing in both Maricopa County and the PM<sub>10</sub> nonattainment area.

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

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	218.58	164.33	1,478.5	1,083.8
PM <sub>10</sub> NAA	218.49	164.26	1,478.0	1,083.3

### 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 (2012) 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 2010 employment were used. CBP employment data for NAICS code 332 (fabricated metal products manufacturing) indicated that there were 13,735 employees in this industry in Maricopa County. Since there were no point sources in this category, an area-source employment estimate of 13,735 was used to “scale up” emissions reported from those facilities surveyed in 2011.

Typical daily emissions are calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM<sub>10</sub> 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.

Table 3.3–16 summarizes annual and typical daily emissions from fabricated metal products manufacturing in both Maricopa County and the PM<sub>10</sub> nonattainment area.

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

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	25.87	22.97	181.2	160.4
PM <sub>10</sub> NAA	25.86	22.96	181.2	160.3

### 3.3.9 Construction

Maricopa County’s air quality permits database was used to identify all dust control permits issued during 2011. A total of 2,265 permits were issued, comprising a total of 26,273 acres (Table 3.3–17). Data requested on each dust control permit application includes the project type and acreage. It was assumed there is no unpermitted earthmoving activity.

**Table 3.3–17. Maricopa County dust control permits issued in 2011, by project type.**

<b>Project type</b>	<b>Total Acres</b>
Residential (single-family)	4,891.3
Residential (multi-family)	1,630.4
Commercial	6,902.4
Road construction	3,718.0
Trenching	740.1
Demolition	6,690.9
Weed control	86.8
Site preparation / land development	1,594.0
Temporary storage yard	19.0
<b>Total:</b>	<b>26,273.0</b>

The Western Regional Air Partnership's (WRAP) *Fugitive Dust Handbook* (WRAP, 2006a) provides different emission factors for residential (single-family houses and apartment buildings), nonresidential, road, and general construction. MCAQD used the WRAP-suggested emission factors except for the following activities:

- The WRAP *Fugitive Dust Handbook* recommended using 0.42 ton PM<sub>10</sub>/acre-month for road construction to account for the large amount of dirt moved during the construction of roadways. However, both the South Coast Air Quality Management District (SCAQMD) and the Clark County Department of Air Quality and Environmental Management have estimated that a certain percentage of their road construction projects do not involve large-scale earth-moving activities, and thus have developed average emission factors for road construction projects (0.1895 ton PM<sub>10</sub>/acre-month and 0.265 ton PM<sub>10</sub>/acre-month, respectively). Since Maricopa County and Clark County have similar population growth rates, climatic conditions, and PM<sub>10</sub> sources, MCAQD used the Clark County road construction emission factor of 0.265 tons/acre-month to estimate emissions from road construction projects (Clark County, 2001).
- Specific emission factors were not available in the WRAP *Fugitive Dust Handbook* for trenching, demolition, weed control, and temporary storage yard activities; thus, the general construction emission factor of 0.11 tons PM<sub>10</sub>/acre-month was used to estimate emissions from these activities.

Information was not readily available regarding the breakout of residential construction activity between single-family and multi-family residential construction; thus, acreage for residential construction was allocated based on single-family and multi-family household percentages. See Section 1.5.1 for single-family and multi-family household percentages used.

Estimates for the duration of house and apartment construction were obtained from EIIP guidance (US EPA, 2002). Estimates for the duration of nonresidential construction and road construction were obtained from the WRAP *Fugitive Dust Handbook* (WRAP, 2006a). No estimates for the duration of trenching, demolition, weed control, site prep/land development, and temporary storage yard activities were available; thus, MCAQD assumed the following:

- 1-month duration for trenching, demolition, and weed control.
- 8-month duration for site prep/land development activities (weighted average of residential and commercial duration) because the duration depends on the project type and size.
- 12-month duration for temporary storage yard activities because these activities are frequently associated with road construction.



The average duration of construction activity and emission factors for each project type are shown below in Table 3.3–18.

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

<b>Project Type</b>	<b>Average Duration (months)</b>	<b>Emission factor (tons PM<sub>10</sub>/acre-month)</b>
Residential: single-family	6	0.032
Residential: multi-family	12	0.11
Commercial	11	0.19
Road construction	12	0.265
Trenching	1	0.11
Demolition	1	0.11
Weed control	1	0.11
Site prep / land development	8	0.11
Temporary storage yard	12	0.11

County-wide annual uncontrolled PM<sub>10</sub> emissions for each construction category were then calculated as follows:

$$\text{Annual uncontrolled PM}_{10} \text{ emissions} = \text{total acres/yr} \times \text{no. months} \times \text{emission factor}$$

As in prior years, a control efficiency of 90% was applied to the uncontrolled emissions calculations. This factor is in line with values applied in a number of earlier state implementation plan documents for Maricopa and Clark Counties, including:

- Revised MAG 1999 Serious Area Particulate Plan for PM<sub>10</sub> (Appendices volume two, page V-9, and vol. four), Feb. 2000.
- Revised MAG 1999 Serious Area Particulate Plan for PM<sub>10</sub>, (Appendix C, Exhibit 3: Evaluation for Compliance with 24-Hour PM<sub>10</sub> Standard for West Chandler and Gilbert Microscale Sites, Arizona Department of Environmental Quality, June 1999, pp. 3-5 and 3-9), Feb. 2000.
- “Evaluation of Fugitive Dust Control in the Maricopa Co. PM<sub>10</sub> Nonattainment Area”, report by ENSR in: Final Plan for Attainment of the 24-hour PM<sub>10</sub> Standard, ADEQ, May 1997, Appendix B.
- Clark Co. PM<sub>10</sub> State Implementation Plan, June 2001, pg. L-5. (An 87% emission reduction percentage is assumed for watering at construction activities.)
- the MAG 2012 Five Percent Plan for PM<sub>10</sub> for the Maricopa County Nonattainment Area (MAG, 2012).

A 2010 rule effectiveness study by Maricopa County (contained in Appendix B) indicated a 94.0% compliance rate with Maricopa County Rule 310 on dust control at construction sites. Thus, an overall control effectiveness of 84.6% (= 90% × 94.0%) was applied. Controlled PM<sub>10</sub> emissions were calculated as follows:

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

PM<sub>2.5</sub> emissions were estimated to comprise 10% of PM<sub>10</sub> emissions (WRAP, 2006a). Table 3.3–19 summarizes the calculations for each dust control permit category.

**Table 3.3–19. Annual emissions from construction in Maricopa County, by project type.**

Project Type	Total acre-months	Emission factor (tons/acre-month)	Annual Emissions (tons/yr)		
			Uncontrolled PM <sub>10</sub>	Controlled PM <sub>10</sub>	Controlled PM <sub>2.5</sub>
Residential: single-family	29,348.0	0.032	939.13	144.63	14.46
Residential: multi-unit	19,565.3	0.11	2,152.18	331.44	33.14
Commercial	75,926.7	0.19	14,426.08	2,221.62	222.16
Road construction	44,616.5	0.265	11,823.37	1,820.80	182.08
Trenching	740.1	0.11	81.41	12.54	1.25
Demolition	6,690.9	0.11	736.00	113.34	11.33
Weed control	86.8	0.11	9.55	1.47	0.15
Site prep/land development	12,752.0	0.11	1,402.72	216.02	21.60
Temporary storage yard	227.5	0.11	25.03	3.85	0.39
<b>Total:</b>			<b>31,595.48</b>	<b>4,865.70</b>	<b>486.57</b>

Dust control permit site location data were used to determine construction activity that occurred in the Maricopa County PM<sub>10</sub> nonattainment area. The same average duration of construction activity and emission factors used to estimate Maricopa County emissions (see Table 3.3–18) were applied to construction activity in the Maricopa County PM<sub>10</sub> nonattainment area. Table 3.3–20 summarizes Maricopa County PM<sub>10</sub> nonattainment area construction activity and emissions for each project type.

**Table 3.3–20. Annual emissions from construction within the Maricopa County portion of the PM<sub>10</sub> nonattainment area, by project type.**

Project Type	Total acre-months	Emission factor (tons/acre-month)	Annual Emissions (tons/yr)		
			Uncontrolled PM <sub>10</sub>	Controlled PM <sub>10</sub>	Controlled PM <sub>2.5</sub>
Residential: single-family	29,333.4	0.032	938.67	144.55	14.46
Residential: multi-unit	19,555.6	0.11	2,151.11	331.27	33.13
Commercial	44,684.0	0.19	8,489.96	1,307.45	130.75
Road construction	39,689.5	0.265	10,517.73	1,619.73	161.97
Trenching	668.4	0.11	73.52	11.32	1.13
Demolition	3,488.8	0.11	383.76	59.10	5.91
Weed control	86.8	0.11	9.55	1.47	0.15
Site prep/land development	9,898.3	0.11	1,088.82	167.68	16.77
Temporary storage yard	220.0	0.11	24.20	3.73	0.37
<b>Total:</b>			<b>23,677.31</b>	<b>3,646.31</b>	<b>364.63</b>

In addition, the Pinal County Air Quality Department (PCAQD) provided construction emission estimates for the Pinal County portion of the PM<sub>10</sub> nonattainment area. The PCAQD estimates (presented in Table 3.3–21 below) incorporated the same assumptions concerning relevant input variables such as the average duration of construction activity, emission factors and control efficiency. PCAQD assumed an 83% rule effectiveness.

**Table 3.3–21. Annual emissions from construction in the Pinal Co. portion of the PM<sub>10</sub> NAA, by project type.**

Project Type	Annual Emissions (tons/yr)	
	PM <sub>10</sub>	PM <sub>2.5</sub>
Residential: single-family	1.24	0.12
Residential: multi-family	0.00	0.00
Commercial	35.64	3.56
Road construction	0.00	0.00
Trenching	0.02	0.00
Temporary storage yard	0.33	0.03
<b>Total:</b>	<b>37.23</b>	<b>3.72</b>

To calculate typical daily emissions from construction activity, it was assumed that construction activity typically occurs 6 days per week and remains relatively even throughout the year. Thus, typical daily emissions were calculated by dividing annual emissions for each category by 312 (= 6 days/wk × 52 wks/yr). Table 3.3–22 provides a summary of construction emissions for Maricopa County and the PM<sub>10</sub> nonattainment area.

**Table 3.3–22. Annual and typical daily emissions from construction in Maricopa County and the PM<sub>10</sub> NAA.**

Construction Type	Maricopa County				PM <sub>10</sub> NAA			
	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)		Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Residential	476.06	47.61	3,051.7	305.2	477.1	47.71	3,058.1	305.8
Commercial	2,221.62	222.16	14,241.1	1,424.1	1,343.1	134.31	8,609.6	861.0
Road construction	1,820.8	182.08	11,671.8	1,167.2	1,619.7	161.97	10,382.9	1,038.3
All other*	347.22	34.72	2,225.8	222.6	243.6	24.36	1,561.8	156.2
<b>Total:</b>	<b>4,865.70</b>	<b>486.57</b>	<b>31,190.4</b>	<b>3,119.0</b>	<b>3,683.54</b>	<b>368.35</b>	<b>23,612.4</b>	<b>2,361.2</b>

\*Includes: trenching, demolition, weed control, site prep/land development, and temporary storage yard.

### 3.3.10 Electrical equipment manufacturing

Annual and typical daily emissions from electric equipment manufacturing were derived from annual emissions reports submitted by permitted sources. It was assumed that there were no significant unpermitted sources within Maricopa County and all electrical equipment manufacturing permitted sources are reported here as area-sources.

As all facilities addressed in this source category are located within the PM<sub>10</sub> nonattainment area, emission totals for both areas are equal. Annual and typical daily emissions are shown in Table 3.3–23.

**Table 3.3–23. Annual and typical daily emissions from area-source electric equipment manufacturing.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	7.66	5.00	23.47	0.28	9.63	42.7	28.0	129.0	1.6	52.9
PM <sub>10</sub> NAA	7.66	5.00	23.47	0.28	9.63	42.7	28.0	129.0	1.6	52.9

### 3.3.11 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. PM<sub>10</sub> emissions from this source category were derived from annual emissions 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<sub>2.5</sub> emissions were calculated from PM<sub>10</sub> using a ratio derived from California Air Resources Board's (CARB) PM<sub>2.5</sub> Fraction Table (CARB, 2006).

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 PM<sub>10</sub> 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 <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	356.35	101.68	2,486.7	718.7
PM <sub>10</sub> NAA	262.12	79.73	1,874.6	575.7

### 3.3.12 Industrial processes not elsewhere classified (NEC)

Annual area-source emissions from other industrial processes not elsewhere classified (NEC) were derived primarily 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 were calculated based on operating schedule information provided by individual facilities through MCAQD’s annual emissions reporting program. Emissions estimates for the PM<sub>10</sub> nonattainment area were derived using data on the location of the facilities that report other industrial processes.

In addition, emissions from ADEQ-permitted sources are included in this category due to a lack of specificity regarding the nature of the reported emissions. As a conservative estimate, all of these emissions are assumed to occur within the PM<sub>10</sub> nonattainment area. Estimates of total emissions from this source category are presented in Table 3.3–25.

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

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	158.29	80.67	224.92	40.48	9.98	903.6	465.4	1,236.4	222.0	55.3
PM <sub>10</sub> NAA	102.65	45.41	222.86	40.48	6.77	597.8	271.6	1,222.5	221.9	37.6

## 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 3.5.7. There were no incinerators at residential (e.g., apartment complexes) or commercial/institutional facilities (e.g., hospitals, service establishments) in operation during 2011.

Emissions from on-site incineration were determined from annual emission inventory reports. It was assumed that all incinerator emissions are accounted for, since all permitted incinerators received surveys in 2011. All surveyed facilities are located within the PM<sub>10</sub> 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 <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>
Maricopa County	0.62	0.41	3.31	1.05	4.1	2.7	21.4	6.8
PM <sub>10</sub> NAA	0.62	0.41	3.31	1.05	4.1	2.7	21.4	6.8

### 3.4.2 Open burning: Land clearing debris

Emissions from controlled open burning are regulated by Maricopa County Air Pollution Control Regulations Rule 314 (Open Outdoor Fires and Indoor Fireplaces at Commercial and Institutional Establishments), 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, and fire fighting training. Maricopa County’s burn permit database was used to identify all burn permits issued during 2011. A total of 57 permits were issued during the year. The quantity and reported activity for the open burn permits (except for firefighting burn permits) are shown in Table 3.4–2.

**Table 3.4–2. Maricopa County burn permit activity in 2011.**

Category	Number of permits	Unit of measure	Total reported activity
Annual ditchbank & fencerow	41	Linear Feet	1,967,795
Land clearance	4	Acres	14
Fire hazard	1	Acres	2

Emissions from land clearance and fire hazard open burning are addressed in this section whereas ditchbank and fencerow burning are addressed in Section 3.5.2.5.

The above activity data for land clearance and fire hazard were converted to tons of material burned using fuel loading factor for “weeds, unspecified” from AP-42, Table 2.5–5 (US EPA, 1992). The emission and loading factors used are shown in Table 3.4–3.

**Table 3.4–3. Emission and fuel loading factors for land clearance and fire hazard open burning.**

Category	Emission factors (lbs/ton burned)					Fuel loading factor (tons/acre)
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	
Weeds, unspecified	15	15	4	N/A	N/A	3.2

Activity data were multiplied by the 3.2 tons/acre fuel loading factor to derive the amount of material burned.

Annual emissions were then calculated by multiplying the amount of material burned by the emission factors for “weeds, unspecified” (shown in Table 3.4–3). Based on an analysis of complaints received in 2011 reporting suspected open or illegal outside burning, emissions estimates were multiplied by a factor of 2.87 to account for unpermitted illegal outdoor burning.

It was assumed that land clearance and fire hazard open burning occur 5 days per week (most burn permits are issued for weekdays but permits may be issued on weekends depending on circumstances) and year-round. Thus, typical daily emissions for Maricopa County were derived by dividing annual emissions (lbs/yr) by 260 days (5 days/wk × 52 wks/yr).

Table 3.4–4 summarizes 2011 annual and typical daily emissions for Maricopa County from land clearance and fire hazard open burning activity.

**Table 3.4-4. Annual and typical daily emissions from land clearance and fire hazard open burning in Maricopa County.**

Category	Ton-equivalents	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
		PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>
Land clearance	45.25	0.97	0.97	0.26	7.5	7.5	2.0
Fire hazard	6.4	0.14	0.14	0.04	1.1	1.1	0.3
<b>Total:</b>	<b>51.65</b>	<b>1.11</b>	<b>1.11</b>	<b>0.30</b>	<b>8.6</b>	<b>8.6</b>	<b>2.3</b>

Annual and typical daily emissions for the nonattainment area were calculated by multiplying the percentage of vacant land use within the PM<sub>10</sub> nonattainment area (19.67%) by the Maricopa County emissions estimates. See Section 1.5.1 for a discussion of the land use data used. Table 3.4-5 summarizes annual and typical daily emissions for the PM<sub>10</sub> nonattainment area.

**Table 3.4-5. Annual and typical daily emissions from land clearance and fire hazard open burning in the PM<sub>10</sub> NAA.**

Category	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>
Land clearance	0.19	0.19	0.05	1.5	1.5	0.4
Fire hazard	0.03	0.03	0.01	0.2	0.2	0.1
<b>Total:</b>	<b>0.22</b>	<b>0.22</b>	<b>0.06</b>	<b>1.7</b>	<b>1.7</b>	<b>0.4</b>

### 3.4.3 Landfills

Emissions from municipal solid waste (MSW) landfills come from uncontrolled landfill gas emissions as well as from cover operations and combustion from control measures, such as a flare. Total emissions were calculated from annual emissions inventory reports from all landfills located within the county; results are shown in Table 3.4-6 below. Northwest Regional Landfill was considered a point source; all other MSW landfills are reported here as an area-source activity.

**Table 3.4-6. Annual and typical daily emissions from landfills.**

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>
Maricopa County	76.05	40.73	30.40	7.17	421.1	225.5	167.1	39.4
PM <sub>10</sub> NAA	56.90	29.06	23.84	2.38	314.8	160.8	131.0	13.1

### 3.4.4 Publicly owned treatment works

Annual emissions from publicly owned treatment works (POTWs) within Maricopa County were obtained from the US Environmental Protection Agency's 2011 National Emission Inventory (US EPA, 2012c). US EPA estimated 14.92 tons of ammonia was emitted from POTWs in Maricopa County in 2011. There were no point sources in this category that needed to be subtracted.

Typical daily emissions were calculated by dividing annual emissions by 365 days, as activity is assumed to occur uniformly throughout the year.

Annual and typical daily emissions for the PM<sub>10</sub> nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage of total population in the nonattainment area to the total population in the county (100.64%). See Section 1.5.1 for a discussion of the population data used.

**Table 3.4–7. Annual and typical daily NH<sub>3</sub> emissions from publicly-owned treatment works.**

<b>Geographic area</b>	<b>Annual NH<sub>3</sub> emissions (tons/yr)</b>	<b>Typical daily NH<sub>3</sub> emissions (lbs/day)</b>
Maricopa County	14.92	81.7
PM <sub>10</sub> NAA	15.01	82.3

### 3.4.5 Other waste

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 were calculated based on operating schedule information provided by the facilities in their annual emissions report. Annual and typical daily emissions for the PM<sub>10</sub> nonattainment area were derived based on the location data of the individual facilities. Emission estimates are shown in Table 3.4–8 below.

**Table 3.4–8. Annual and typical daily emissions from other industrial waste disposal.**

<b>Geographic area</b>	<b>Annual emissions (tons/yr)</b>				<b>Typical daily emissions (lbs/day)</b>			
	<b>PM<sub>10</sub></b>	<b>PM<sub>2.5</sub></b>	<b>NO<sub>x</sub></b>	<b>SO<sub>x</sub></b>	<b>PM<sub>10</sub></b>	<b>PM<sub>2.5</sub></b>	<b>NO<sub>x</sub></b>	<b>SO<sub>x</sub></b>
Maricopa County	26.71	14.44	22.19	63.53	169.6	85.6	121.9	349.0
PM <sub>10</sub> NAA	25.58	13.64	21.59	56.39	163.4	81.2	118.6	309.8

## 3.5 Miscellaneous area sources

### 3.5.1 Windblown dust

Estimates of PM<sub>10</sub> and PM<sub>2.5</sub> emissions from windblown dust are developed using the supply-limited windblown dust emission scheme described in Appendix 4 of the *2008 PM<sub>10</sub> Periodic Emissions Inventory for the Maricopa County, Arizona, Nonattainment Area* (MCAQD, 2011), referred to hereafter as the 2008 methodology. Updates to the 2008 methodology include the use of 2010 land use data, 2010 rule effectiveness rates, 2011 meteorological data, and 2011 PM<sub>10</sub> concentration monitoring data.

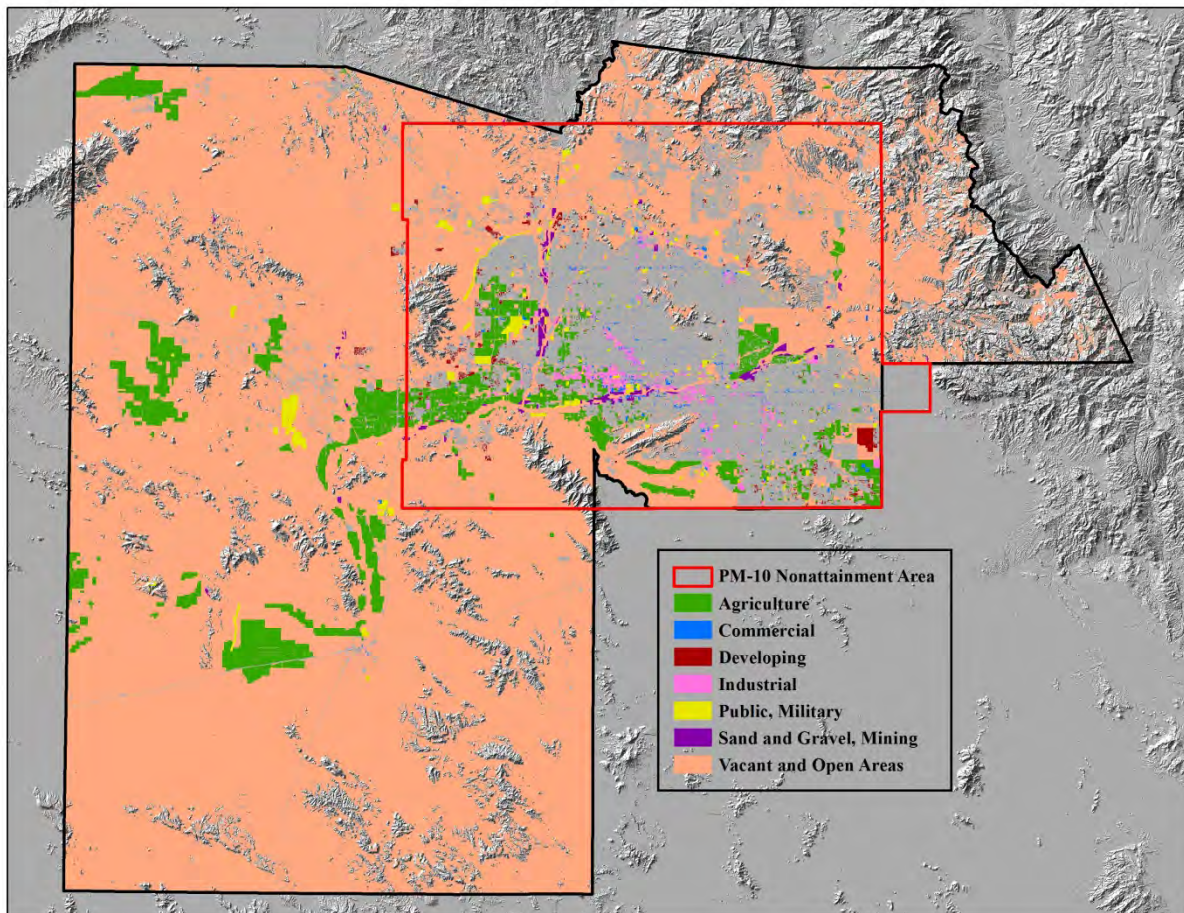
The land use categories that are capable of producing windblown dust in Maricopa County and the PM<sub>10</sub> nonattainment area were defined in the 2008 methodology. Three additional categories (commercial, industrial, and public/military) have been identified as sources of windblown dust based upon work performed in the *MAG 2012 Five Percent Plan for PM<sub>10</sub> for the Maricopa County Nonattainment Area* (MAG, 2012). Since portions of these new land use categories contain areas that are incapable of creating windblown dust emissions (e.g., permanent structures, paved parking lots), only a percentage of the total area covered by these land use categories is assumed to be capable of producing windblown dust. The average percentage of area within the new land use categories that are capable of producing windblown dust (26% for commercial, 24% for industrial, and 35% for public/military) is quantified through examination of aerial photography of these land uses within the PM<sub>10</sub> nonattainment area.

Table 3.5–1 contains the amount of acreage in each land use category capable of producing windblown dust within Maricopa County and the nonattainment area. Figure 3.5–1 displays the location of land use categories that are capable of producing windblown dust within Maricopa County and the nonattainment area.

**Table 3.5–1. Maricopa County and PM<sub>10</sub> NAA acreage totals within each land use category capable of producing windblown dust.**

Land use category	Maricopa County acreage	PM <sub>10</sub> NAA acreage
Agriculture	276,589	117,432
Commercial	16,783	15,797
Developing	16,626	15,450
Industrial	28,582	28,432
Public/Military	40,808	28,571
Sand & Gravel/Mining	14,223	12,729
Vacant and Open Areas	3,884,396	808,916

**Figure 3.5–1. Location of land use categories within Maricopa County capable of producing windblown dust.**



The 2008 methodology established a five-minute average threshold friction velocity of 12 mph (based upon a matched-pairs comparison of wind speed and concentration data) as the minimum wind speed for the initiation of windblown dust from both the stable and disturbed portions of each land use category. Additionally, the 2008 methodology developed vertical flux emission factors for the stable and disturbed portions of each land use category by five-minute average wind speed bins. The vertical flux emission factors are primarily based upon wind tunnel testing



performed in southern Arizona with additional input from, and consideration of, wind tunnel tests in the areas around Barstow, California and Las Vegas, Nevada.

As per the 2008 methodology, the amounts of stable and disturbed land in each land use category are determined through the use of rule effectiveness rates. The 2010 rule effectiveness rates, developed for use in the MAG 2012 Five Percent Plan (ibid.), have been carried forward to represent 2011 conditions. Table 3.5–2 contains the PM<sub>10</sub> vertical flux emission factors for the stable and disturbed portions of each land use category, by wind speed bin.

**Table 3.5–2. Vertical flux PM<sub>10</sub> emission factors for the stable and disturbed portions of each land use category, by wind speed bin.**

Land use category	Percent of total land use category	PM <sub>10</sub> emission factor (tons/acre-5-minute) by wind speed bin (mph)				
		12–15	15–20	20–25	25–30	30–35
Active Agriculture (crop activity present)	NA	NA – Calculated under different methodology				
Inactive Agriculture – Stable	85%	1.10×10 <sup>-5</sup>	2.93×10 <sup>-5</sup>	7.68×10 <sup>-5</sup>	1.64×10 <sup>-4</sup>	3.10×10 <sup>-4</sup>
Inactive Agriculture – Disturbed	15%	5.44×10 <sup>-5</sup>	1.69×10 <sup>-4</sup>	5.14×10 <sup>-4</sup>	1.24×10 <sup>-3</sup>	2.57×10 <sup>-3</sup>
Commercial – Stable	96%	1.10×10 <sup>-5</sup>	2.93×10 <sup>-5</sup>	7.68×10 <sup>-5</sup>	1.64×10 <sup>-4</sup>	3.10×10 <sup>-4</sup>
Commercial – Disturbed	4%	5.44×10 <sup>-5</sup>	1.69×10 <sup>-4</sup>	5.14×10 <sup>-4</sup>	1.24×10 <sup>-3</sup>	2.57×10 <sup>-3</sup>
Developing – Stable	94%	1.10×10 <sup>-5</sup>	2.93×10 <sup>-5</sup>	7.68×10 <sup>-5</sup>	1.64×10 <sup>-4</sup>	3.10×10 <sup>-4</sup>
Developing – Disturbed	6%	5.44×10 <sup>-5</sup>	1.69×10 <sup>-4</sup>	5.14×10 <sup>-4</sup>	1.24×10 <sup>-3</sup>	2.57×10 <sup>-3</sup>
Industrial – Stable	96%	1.10×10 <sup>-5</sup>	2.93×10 <sup>-5</sup>	7.68×10 <sup>-5</sup>	1.64×10 <sup>-4</sup>	3.10×10 <sup>-4</sup>
Industrial – Disturbed	4%	5.44×10 <sup>-5</sup>	1.69×10 <sup>-4</sup>	5.14×10 <sup>-4</sup>	1.24×10 <sup>-3</sup>	2.57×10 <sup>-3</sup>
Public/Military – Stable	96%	1.10×10 <sup>-5</sup>	2.93×10 <sup>-5</sup>	7.68×10 <sup>-5</sup>	1.64×10 <sup>-4</sup>	3.10×10 <sup>-4</sup>
Public/Military – Disturbed	4%	5.44×10 <sup>-5</sup>	1.69×10 <sup>-4</sup>	5.14×10 <sup>-4</sup>	1.24×10 <sup>-3</sup>	2.57×10 <sup>-3</sup>
Sand & Gravel/Mining – Stable	73%	1.10×10 <sup>-5</sup>	2.93×10 <sup>-5</sup>	7.68×10 <sup>-5</sup>	1.64×10 <sup>-4</sup>	3.10×10 <sup>-4</sup>
Sand & Gravel/Mining – Disturbed	27%	5.44×10 <sup>-5</sup>	1.69×10 <sup>-4</sup>	5.14×10 <sup>-4</sup>	1.24×10 <sup>-3</sup>	2.57×10 <sup>-3</sup>
Vacant and Open Areas – Stable	96%	1.10×10 <sup>-5</sup>	2.93×10 <sup>-5</sup>	7.68×10 <sup>-5</sup>	1.64×10 <sup>-4</sup>	3.10×10 <sup>-4</sup>
Vacant and Open Areas – Disturbed	4%	5.44×10 <sup>-5</sup>	1.69×10 <sup>-4</sup>	5.14×10 <sup>-4</sup>	1.24×10 <sup>-3</sup>	2.57×10 <sup>-3</sup>

2011 calendar year wind speed data from 32 meteorological stations are gathered to produce counts of five-minute average wind speeds, and then grouped into wind speed bins. Where necessary, wind speed data are adjusted to account for differences in heights between anemometers, grown to account for missing values, and interpolated from hourly averages to produce five-minute averages through linear regression. Table 3.5–3 lists the resulting counts of five-minute average wind speeds (by bin) for all meteorological stations in 2011.

**Table 3.5–3. Calendar year 2011 counts of hourly average wind speeds and actual/interpolated five-minute average wind speeds, by meteorological station and wind speed bin.**

Meteorological Station	Count of hourly average wind speeds >12 mph	Count of hourly average wind speeds >15 mph	Count of hourly average wind speeds >18 mph	Count of five-minute average wind speeds by wind speed bin*				
				12–15 mph	15–20 mph	20–25 mph	25–30 mph	30–35 mph
ADEQ Super Site	23	3	0	723	217	4	0	0
AZMET Aguila	742	254	86	6,222	3,032	482	83	8
AZMET Buckeye	392	135	44	3,545	1,698	256	42	4
AZMET Desert Ridge	229	69	12	2,298	957	130	11	1
AZMET Harquahala	686	334	140	5,794	3,929	635	135	12
AZMET Maricopa	415	134	56	3,721	1,686	254	54	5
AZMET Mesa	63	13	1	1,029	329	23	0	0
AZMET Paloma	487	205	68	4,272	2,483	389	65	6
AZMET Phoenix Encanto	71	6	0	1,090	251	10	0	0
AZMET Phoenix Greenway	90	10	5	1,235	296	18	4	1
AZMET Queen Creek	398	136	49	3,591	1,709	258	47	4
MCAQD Blue Point	204	48	8	2,360	713	118	15	0
MCAQD Buckeye	319	113	35	2,870	1,426	252	12	1
MCAQD Cave Creek	204	47	9	2,533	941	95	2	0
MCAQD Central Phoenix	169	28	4	2,048	626	38	3	0
MCAQD Durango Complex	156	42	12	1,941	657	88	1	0
MCAQD Dysart	221	62	11	2,530	996	110	2	0
MCAQD Falcon Field	163	55	12	2,100	798	139	31	7
MCAQD Fountain Hills	38	8	1	576	156	18	2	0
MCAQD Glendale	244	70	11	2,661	1,009	118	19	1
MCAQD Greenwood	49	9	0	851	210	10	1	0
MCAQD Higley	119	22	8	1,332	452	83	10	0
MCAQD Mesa	179	50	6	1,602	659	53	6	0
MCAQD Pinnacle Peak	208	27	0	2,708	624	15	0	0
MCAQD South Phoenix	47	7	1	516	173	12	2	0
MCAQD South Scottsdale	65	9	0	931	243	16	0	0
MCAQD Tempe	11	1	0	186	31	1	0	0
MCAQD West 43 <sup>rd</sup> Avenue	259	75	17	2,625	1,141	119	7	1
MCAQD West Chandler	143	46	12	1,482	626	92	9	5
MCAQD West Phoenix	92	18	1	1,147	375	12	0	0
MCAQD Zuni Hills	697	266	85	5,397	3,085	497	91	8
PCAQCD Apache Junction	419	141	32	3,752	1,765	267	30	3

\*Shaded cells denote interpolated values.

Per the 2008 methodology, GIS is used to assign the five-minute average wind speed counts in Table 3.5–3 to individual parcels within the land use categories listed in Table 3.5–1. Pre-standardized emissions<sup>1</sup> are then calculated for those windblown dust-producing parcels using the emission factors in Table 3.5–2, with the exception of parcels in the active agricultural land use category (i.e., fields growing crops, neither fallow or abandoned). Windblown dust from the active agricultural land use category is calculated using a U.S. Department of Agriculture (USDA) soil erodibility formula (in US EPA, 1974) as explained in the 2008 methodology. Calendar year 2011 harvested acres by crop type (cf. Section 3.5.2) serves as a surrogate for determining the amount of acreage in the active agricultural land use category within Maricopa County. The USDA formula is applied to each crop type acreage to generate annual 2011

<sup>1</sup> Pre-standardized emissions are windblown dust emissions that have not been adjusted to scale with observed ratios of PM<sub>10</sub> monitoring concentrations under high wind conditions. See the 2008 methodology for an expanded explanation of pre-standardized emissions.

windblown dust emissions. Per the 2008 methodology, a control factor is then applied to the USDA-generated emissions to account for the benefits of the State of Arizona Agricultural Best Management Practices (BMP) program.

To account for the dust-mitigating effects of precipitation, pre-standardized emissions have been reduced by 8.49% (31 days of precipitation in 2011 in Maricopa County) per the 2008 methodology. 2011 annual pre-standardized PM<sub>10</sub> windblown dust emissions from all applicable land use categories are listed in Table 3.5–4 for Maricopa County and the PM<sub>10</sub> nonattainment area.

**Table 3.5–4. Pre-standardized PM<sub>10</sub> emissions from windblown dust in Maricopa County and the PM<sub>10</sub> NAA in 2011.**

Land use category	Annual PM <sub>10</sub> emissions (tons/yr)	
	Maricopa County	PM <sub>10</sub> NAA
Active Agriculture	3,244.67	1,393.91
Inactive Agriculture	17,252.86	3,735.75
Commercial	288.03	245.48
Developing	1,916.75	1,759.87
Industrial	318.83	312.03
Public/Military	1,379.71	790.77
Sand & Gravel/Mining	2,469.54	2,034.94
Vacant and Open Areas	628,821.95	73,591.03
<b>Total:</b>	<b>655,692.33</b>	<b>83,863.79</b>

Pre-standardized windblown dust emission estimates are the product of maximum windblown dust emission rates. These pre-standardized emissions are based upon wind tunnel-produced vertical flux emission factors that do not incorporate many of the supply limitations to windblown dust production that exist in Maricopa County, and thus over-estimate windblown dust emissions. As per the 2008 methodology, correction for this bias in the pre-standardized emissions is accomplished through a sensitivity analysis that utilizes the percentage of 2011 monitored PM<sub>10</sub> concentrations under high wind conditions to scale pre-standardized emissions. Table 3.5–5 shows the percentages of 2011 PM<sub>10</sub> concentrations associated with five-minute average wind speeds greater than or equal to 12 mph at the 11 monitors in Maricopa County that simultaneously record five-minute average wind speed and PM<sub>10</sub> concentration.

**Table 3.5–5. Percentages of 2011 PM<sub>10</sub> concentrations associated with five-minute average wind speeds greater than or equal to 12 mph at 11 Maricopa County monitors.**

Monitoring Station	Sum of 5-min PM <sub>10</sub> concentrations when 5-min winds ≥ 12mph (µg/m <sup>3</sup> )	Sum of all 5-min PM <sub>10</sub> concentrations (µg/m <sup>3</sup> )	Percent PM <sub>10</sub> concentrations associated with 5-min winds ≥ 12 mph
Buckeye	559,048	4,741,856	11.79%
Central Phoenix	405,430	4,037,151	10.04%
Durango Complex	519,556	4,926,122	10.55%
Dysart	314,003	3,001,412	10.46%
Glendale	372,872	3,389,605	11.00%
Greenwood	284,082	4,142,587	6.86%
Higley	438,988	3,824,581	11.48%
South Phoenix	321,578	4,720,122	6.81%
West 43 <sup>rd</sup> Avenue	643,082	5,181,888	12.41%
West Chandler	729,467	3,287,402	22.19%
Zuni Hills	558,431	2,756,840	20.26%
<b>All Monitors</b>	<b>5,146,537</b>	<b>44,009,566</b>	<b>11.69%</b>

Table 3.5–5 shows that as a weighted average of the monitoring stations, about 12% of PM<sub>10</sub> concentrations are associated with five-minute average wind speeds greater than or equal to 12 mph. As such, pre-standardized emission estimates are scaled to represent 12% of the total annual 2011 emissions inventory for PM<sub>10</sub> for Maricopa County and the nonattainment area. Annual 2011 PM<sub>10</sub> emissions from sources other than windblown dust total 56,397.20 tons for Maricopa County and 35,101.46 tons for the PM<sub>10</sub> nonattainment area. After applying this scaling technique, PM<sub>10</sub> emissions from windblown dust for Maricopa County and the nonattainment area are thus standardized to 7,690.53 and 4,786.56 tons, respectively.<sup>2</sup>

Standardized estimates of annual and daily PM<sub>10</sub> and PM<sub>2.5</sub> emissions for Maricopa County and the PM<sub>10</sub> nonattainment area are shown in Tables 3.5–6 and 3.5–7. Typical daily emissions are obtained by dividing annual emissions by 365, the number of days in calendar year 2011. As per WRAP guidance, PM<sub>2.5</sub> emissions are assumed to be 15% of PM<sub>10</sub> emissions (WGA, 2006).

**Table 3.5–6. Standardized, 2011 annual and typical daily PM<sub>10</sub> and PM<sub>2.5</sub> emissions from windblown dust in Maricopa County, by land use category.**

Land use category	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Active Agriculture	88.96	13.34	487.4	73.1
Inactive Agriculture	281.86	42.28	1,544.5	231.7
Commercial	14.23	2.13	78.0	11.7
Developing	101.24	15.19	554.8	83.2
Industrial	17.84	2.68	97.8	14.7
Public/Military	48.12	7.22	263.7	39.6
Sand & Gravel/Mining	118.35	17.75	648.5	97.3
Vacant and Open Areas	7,019.92	1,052.99	38,465.3	5,769.8
<b>Total:</b>	<b>7,690.52</b>	<b>1,153.58</b>	<b>42,140.0</b>	<b>6,321.1</b>

**Table 3.5–7. Standardized, 2011 annual and typical daily PM<sub>10</sub> and PM<sub>2.5</sub> emissions from windblown dust in the PM<sub>10</sub> NAA, by land use category.**

Land use category	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Active Agriculture	79.56	11.93	435.9	65.4
Inactive Agriculture	213.22	31.98	1,168.3	175.2
Commercial	14.01	2.10	76.8	11.5
Developing	100.45	15.07	550.4	82.6
Industrial	17.81	2.67	97.6	14.6
Public/Military	45.13	6.77	247.3	37.1
Sand & Gravel/Mining	116.15	17.42	636.4	95.5
Vacant and Open Areas	4,200.24	630.04	23,015.0	3,452.3
<b>Total:</b>	<b>4,786.57</b>	<b>717.98</b>	<b>26,227.7</b>	<b>3,934.2</b>

### 3.5.2 Agricultural activities

#### 3.5.2.1 Cotton ginning

Annual emissions from cotton ginning were derived from annual emissions reports from all permitted cotton gins in the county. Typical daily emissions were calculated based on the operating schedule data reported by surveyed facilities. Annual and typical daily emissions for the PM<sub>10</sub> nonattainment area were derived based on the location data of the individual facilities.

<sup>2</sup> (56,397.20 tons ÷ (1 – 12%)) – 56,397.20 = 7,690.53 tons; (35,101.46 ÷ (1 – 12%)) – 35,101.46 = 4,786.56 tons.

Table 3.5–8 summarizes annual and typical daily emissions from cotton gins in both Maricopa County and the PM<sub>10</sub> nonattainment area.

**Table 3.5–8. Annual and typical daily emissions from area-source cotton ginning.**

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	45.02	12.86	263.8	75.4
PM <sub>10</sub> NAA	9.68	2.77	53.2	15.2

### 3.5.2.2 Tilling

Tilling emissions were estimated using the tillage emission factor equation and Maricopa County specific soil silt content for agricultural land (URS and ERG, 2001). Planted acres for upland cotton, wheat, and alfalfa were obtained from the 2011 Arizona Agricultural Statistics Bulletin (AASS, 2012). Planted acres for pima cotton, corn, other hay, potatoes, sorghum for grain, vegetables, and citrus were estimated by multiplying the 2011 statewide harvested acres for each crop by the 2007 Maricopa County percentage (USDA, 2012) as described in Section 3.5.2.3 of this report. 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 PM<sub>10</sub>/acre-pass)

$k$  = Particle size multiplier (value of 0.21 for PM<sub>10</sub>) [US EPA, 2012c]

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

$$\begin{aligned} \text{Thus: } EF &= 0.21 \times 4.8 \times (35.2)^{0.6} \\ &= 8.54 \text{ lbs PM}_{10}\text{/acre-pass} \end{aligned}$$

Annual PM<sub>10</sub> emissions from agricultural tillage were calculated for each crop category using the following equation (URS and ERG, 2001):

$$Tillage_{Crop} = EF \times AP_{Crop} \times A_{Crop}$$

where:

$Tillage_{Crop}$  = Annual PM<sub>10</sub> emissions from tilling each crop type (lbs)

$EF$  = Tillage emission factor (lbs PM<sub>10</sub>/acre-pass)

$AP_{Crop}$  = Number of tillage passes per crop (passes)

$A_{Crop}$  = Total number of tilled acres for each crop type (acres)

Table 3.5–9 lists crop types and acreage; typical number of land preparation operations and acre-passes; and annual uncontrolled PM<sub>10</sub> emissions from agricultural tillage for Maricopa County.

**Table 3.5–9. 2008 crop acreage, activity, and annual uncontrolled PM<sub>10</sub> emissions in Maricopa County.**

<b>Crop</b>	<b>Acres Planted</b>	<b>No. of land preparation operations/yr</b>	<b>Acre-passes</b>	<b>Annual uncontrolled PM<sub>10</sub> emissions (tons/yr)</b>
Cotton	48,900	8.8	430,671	1,838.66
Corn	8,611	7.3	63,033	269.10
Wheat	10,700	3.1	32,797	140.02
Barley	15,000	2.1	30,975	132.24
Alfalfa (stand establishment) <sup>1</sup>	21,192	5.1	107,017	456.89
Potatoes	1,241	10.6	13,124	56.03
Sorghum for grain	8,477	3.1	25,983	110.93
Vegetables <sup>2</sup>	12,881	14.0	180,238	769.49
Citrus <sup>3</sup>	314	5.0	1,570	6.70
<b>Total:</b>				<b>3,780.06</b>

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. Includes melons, excludes potatoes.

3. 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 November 2007, the agricultural PM<sub>10</sub> general permit (Arizona Administrative Code R18-2-610 and R18-2-611) was expanded to apply to commercial farming practices within the Maricopa County portion of Area A. The agricultural PM<sub>10</sub> general permit revisions also resulted in the requirement for commercial farmers to implement six agricultural best management practices (BMP) (up from 3 BMPs) to control PM<sub>10</sub> emissions generated from tillage and harvest, non-cropland, and cropland. Because no data is available on the additional BMPs being implemented, MCAQD used the net control efficiencies from the implementation of agricultural BMPs developed by URS and ERG (2001) in the *Technical Support Document for Quantification of Agricultural BMPs*.

URS and ERG quantified three BMPs for tillage: 1) combining tractor operations, 2) limited activity during high-wind events, and 3) multi-year crops. URS and ERG (2001) derived net control efficiencies by multiplying mid-point BMP control efficiency by a compliance factor and a relevancy factor for applicable crops. MCAQD has used the same mid-point BMP control efficiency and relevancy factor with a revised compliance factor of 55% (from 80%). The revised compliance factor was derived in 2008 (MCAQD, 2011) based on latest EPA rule effectiveness guidance which eliminates use of the 80% default rule effectiveness value (US EPA, 2005). MCAQD used the 2008 compliance factor (55%) for 2011 because there had been no changes in the Agricultural BMP program as of 2011.

To estimate controlled tillage emissions from agricultural operations taking place within the Maricopa County portion of Area A, the mid-point net control efficiency for each BMP (see Table 3.5–10) was applied to 58.24% (the percent of agricultural land in the Maricopa County portion of Area A) (M. Poppen, MAG, pers. commun., Nov. 20, 2012) of the uncontrolled annual emissions as follows:

$$\begin{aligned} \text{Controlled annual tillage}_{\text{Crop}} \text{ emissions} &= \text{Annual uncontrolled PM}_{10} \text{ emissions} \times (100\% - \text{mid-point net control efficiency}_{\text{crop}}) \times \% \text{ agricultural land in the Area A} \\ \text{Controlled annual tillage}_{\text{Cotton}} \text{ emissions} &= 1,838.66 \text{ tons PM}_{10}/\text{yr} \times (100\% - 22.8\%) \times 58.24\% \\ &= 826 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

The uncontrolled portion of tillage emissions from agricultural operations taking place outside Area A but within Maricopa County were estimated by multiplying the uncontrolled annual PM<sub>10</sub> emissions by the percentage of agricultural land located within Maricopa County but outside of Area A (100% – 58.24%).

The total controlled and uncontrolled annual emissions were then summed to estimate total annual PM<sub>10</sub> emissions from agricultural tilling in Maricopa County.

Annual PM<sub>2.5</sub> emissions from agricultural tilling were calculated by multiplying the annual PM<sub>10</sub> emissions by a conversion factor of 0.15 (WRAP, 2006b). Annual PM<sub>10</sub> and PM<sub>2.5</sub> emissions from agricultural tilling in Maricopa County and Area A are shown in Table 3.5–10.

**Table 3.5–10. Annual emissions from agricultural tilling in Maricopa County and Area A.**

Crop	Net control efficiency (%)	Annual emissions (tons/yr)				
		Within Area A (controlled)		Outside Area A (uncontrolled)	Total, Maricopa Co.	
		PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Cotton	22.8%	826.29	123.94	1,070.92	1,594.02	239.10
Corn	22.8%	120.93	18.14	156.74	233.30	34.99
Wheat	22.8%	62.92	9.44	81.56	121.39	18.21
Barley	22.8%	59.43	8.91	77.02	114.65	17.20
Alfalfa (stand establishment)	13.8%	229.39	34.41	266.11	420.16	63.02
Potatoes	16.8%	25.18	3.78	32.63	48.58	7.29
Sorghum for grain	22.8%	49.85	7.48	64.61	96.17	14.43
Vegetables	16.8%	372.67	55.90	448.19	693.97	104.10
Citrus	16.8%	3.25	0.49	3.90	6.04	0.91
<b>Total:</b>		<b>1,749.91</b>	<b>262.49</b>	<b>2,201.69</b>	<b>3,328.28</b>	<b>499.24</b>

Annual PM<sub>10</sub> emissions from agricultural tilling in the PM<sub>10</sub> nonattainment were calculated in the same manner as the annual PM<sub>10</sub> emissions for the Maricopa County portion of Area A; the only difference being the percent of agricultural land located within the Maricopa County PM<sub>10</sub> nonattainment area is 42.96% (rather than 58.24% for Area A). Results are shown in Table 3.5–11.

**Table 3.5–11. Annual emissions from agricultural tillage in the PM<sub>10</sub> NAA.**

Crop	Annual emissions (tons/yr)	
	PM <sub>10</sub> NAA	
	PM <sub>10</sub>	PM <sub>2.5</sub>
Cotton	609.41	91.41
Corn	89.19	13.38
Wheat	46.41	6.96
Barley	43.83	6.57
Alfalfa (stand establishment)	169.18	25.38
Potatoes	20.01	3.00
Sorghum for grain	36.77	5.52
Vegetables	274.85	41.23
Citrus	2.39	0.36
<b>Total:</b>	<b>1,292.04</b>	<b>193.81</b>

Typical daily emissions for Maricopa County, Area A, and the PM<sub>10</sub> nonattainment area were calculated by dividing the annual emissions by 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. Typical daily emissions from tilling in Maricopa County, Area A, and the PM<sub>10</sub> NAA.**

Crop	Tillage operations <sup>1</sup> (months/yr)	Tillage operations (days/yr)	Typical daily emissions (lbs/day)					
			Maricopa County		Area A		PM <sub>10</sub> NAA	
			PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Cotton	12	364	8,758.4	1,313.8	4,540.0	681.0	3,348.4	502.3
Corn	5	152	3,076.5	461.5	1,594.7	239.2	1,176.2	176.4
Wheat	8	243	1,000.5	150.1	518.6	77.8	382.5	57.4
Barley	8	243	944.9	141.7	489.8	73.5	361.2	54.2
Alfalfa <sup>2</sup>	3	91	9,234.4	1,385.2	5,041.5	756.2	3,718.2	557.7
Potatoes	6	182	533.8	80.1	276.7	41.5	219.9	33.0
Sorghum for grain	8	243	792.6	118.9	410.9	61.6	303.0	45.5
Vegetables	6	182	7,626.0	1,143.9	4,095.3	614.3	3,020.3	453.1
Citrus	3	91	132.9	19.9	71.3	10.7	52.6	7.9
Total:			32,099.9	4,815.0	17,038.9	2,555.8	12,582.4	1,887.4

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

<sup>2</sup> Stand establishment.

### 3.5.2.3 Harvesting

Harvesting emissions were estimated using crop-specific emission factors (CARB, 2003). Harvested acres for upland cotton, durum wheat, and alfalfa were obtained from the 2011 Arizona Agricultural Statistics Bulletin (AASS, 2012). Harvested acres for barley were obtained from the 2010 Arizona Agricultural Statistics Bulletin (AASS, 2011). Harvested acres for all other crops were estimated by multiplying the 2011 statewide harvested acres for each crop by the 2007 Maricopa County percentage (USDA, 2012). For example, in 2011, 6,000 acres of sorghum for grain were harvested in Arizona. In 2007, 14.3% of sorghum for grain was harvested in Maricopa County. Thus, 857 acres were estimated to have been harvested in Maricopa County in 2011 (6,000 acres × 14.3%). Table 3.5–13 lists the crop types, acres harvested and associated PM<sub>10</sub> emission factors used to calculate emissions from agricultural harvesting.



**Table 3.5–13. Maricopa County harvested acres, PM<sub>10</sub> emission factors, and uncontrolled PM<sub>10</sub> emissions**

<b>Crop</b>	<b>PM<sub>10</sub> emission factor (lb/acre-yr)</b>	<b>2011 Acreage</b>	<b>Annual emissions (tons/yr)</b>
			<b>Maricopa County (uncontrolled) PM<sub>10</sub></b>
Upland Cotton	3.4	47,500	80.75
Pima Cotton	3.4	900	1.53
Wheat	5.8	10,700	31.03
Barley	5.8	15,000	43.50
Alfalfa Hay	0.0	80,000	0.00
Other Hay	1.68	4,766	4.00
Corn for grain	1.68	606	0.51
Corn for silage	0.17	8,005	0.68
Sorghum <sup>1</sup>	5.8	8,477	24.58
Potatoes	2.7	1,241	1.68
Vegetables <sup>2</sup>	0.08	12,881	0.52
Citrus	0.08	1,570	0.06
<b>Total</b>		<b>191,647</b>	<b>188.84</b>

<sup>1</sup> Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

<sup>2</sup> Includes melons, excludes potatoes.

Uncontrolled annual PM<sub>10</sub> emissions from agricultural harvesting were calculated by multiplying the crop specific emission factor by the number of harvested acres for each crop type.

In November 2007, the agricultural PM<sub>10</sub> general permit program (Arizona Administrative Code R18-2-610 and 611) was expanded to apply to commercial farming practices within the Maricopa County portion of Area A. The agricultural PM<sub>10</sub> general permit revisions also resulted in the requirement for commercial farmers to implement six agricultural best management practices (BMP) (up from 3 BMPs) to control PM<sub>10</sub> emissions generated from tillage and harvest, non-cropland, and cropland. Because no data is available on the additional BMPs being implemented, MCAQD used the net control efficiencies from the implementation of agricultural BMPs developed by URS and ERG (2001) in the *Technical Support Document for Quantification of Agricultural BMPs*.

URS and ERG quantified two BMPs for harvesting: 1) combining tractor operations, and 2) reduced harvest activity. URS and ERG (2001) derived net control efficiencies by multiplying mid-point BMP control efficiency by a compliance factor and a relevancy factor for applicable crops. MCAQD used the same mid-point BMP control efficiency and relevancy factor with a revised compliance factor of 55% (from 80%). The revised compliance factor was derived in 2008 (MCAQD, 2011) based on EPA rule effectiveness guidance which eliminates use of the 80% default rule effectiveness value (US EPA, 2005). MCAQD used the 2008 compliance factor (55%) for 2011 because there had been no changes in the Agricultural BMP program as of 2011.

To estimate controlled harvesting emissions from agricultural operations taking place within the Maricopa County portion of Area A, the mid-point net control efficiency for each BMP (43% and 50%, respectively) were applied to 58.24% (the percent of agricultural land in the Maricopa County portion of Area A) (M. Poppen, MAG, pers. commun., Nov. 20, 2012) of the uncontrolled annual emissions as follows:

$$\text{Controlled annual harvest}_{\text{Crop}} \text{ emissions} = \text{annual uncontrolled PM}_{10} \text{ emissions} \times (100\% - \text{mid-point net control efficiency}_{\text{crop}}) \times \% \text{ agricultural land in the Maricopa Co. portion of Area A}$$

$$\begin{aligned} \text{Controlled annual Harvest}_{\text{Upland cotton}} \text{ emissions from within the Maricopa Co. portion of Area A} &= 80.75 \text{ tons PM}_{10}/\text{yr} \times (100\% - 25.5\%) \times 58.24\% \\ &= 35.03 \text{ tons PM}_{10}/\text{yr} \end{aligned}$$

The uncontrolled portion of harvest emissions from agricultural operations outside the Maricopa County portion of Area A but within Maricopa County were estimated by multiplying the uncontrolled annual PM<sub>10</sub> emissions by the percent of agricultural land located within Maricopa County but outside of the Area A (100% – 58.24%).

The total controlled and uncontrolled annual emissions were then summed to estimate total annual PM<sub>10</sub> emissions from agricultural harvesting in Maricopa County

Annual PM<sub>2.5</sub> emissions from agricultural harvesting were calculated by multiplying the annual PM<sub>10</sub> emissions by a conversion factor of 0.15 (WRAP, 2006c). Annual PM<sub>10</sub> and PM<sub>2.5</sub> emissions from harvesting in Maricopa Co. and Area A are shown in Table 3.5–14.

**Table 3.5–14. Annual emissions from harvesting in Maricopa County and Area A.**

Crop	Net control efficiency (%)	Annual emissions (tons/yr)					
		Maricopa Co. (uncontrolled)	Area A (controlled)		Outside Area A (uncontrolled)	Maricopa Co. (Area A + outside Area A)	
		PM <sub>10</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Upland Cotton	25.5%	80.75	35.03	5.25	33.72	68.74	10.31
Pima Cotton	25.5%	1.53	0.66	0.10	0.64	1.30	0.20
Wheat	23.5%	31.03	13.83	2.08	12.96	26.79	4.02
Barley	23.5%	43.50	19.39	2.91	18.16	37.56	5.63
Alfalfa Hay	27.6%	0.00	0.00	0.00	0.00	0.00	0.00
Other Hay	27.6%	4.00	1.69	0.25	1.67	3.36	0.50
Corn for grain	23.5%	0.51	0.23	0.03	0.21	0.44	0.07
Corn for silage	23.5%	0.68	0.30	0.05	0.28	0.59	0.09
Sorghum <sup>1</sup>	23.5%	24.58	10.96	1.64	10.26	21.22	3.18
Potatoes	23.5%	1.68	0.75	0.11	0.70	1.45	0.22
Vegetables <sup>2</sup>	23.5%	0.52	0.23	0.03	0.22	0.44	0.07
Citrus	23.5%	0.06	0.03	0.00	0.03	0.05	0.01
<b>Total</b>		<b>188.84</b>	<b>83.10</b>	<b>12.46</b>	<b>78.85</b>	<b>161.95</b>	<b>24.29</b>

<sup>1</sup> Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

<sup>2</sup> Includes melons, excludes potatoes.

Annual PM<sub>10</sub> emissions from agricultural harvesting in the PM<sub>10</sub> NAA were calculated in the same manner as the annual PM<sub>10</sub> emissions for the Maricopa County portion of Area A. The only difference being the percent of agricultural land located within the Maricopa County PM<sub>10</sub> NAA is 42.96% (rather than 58.24% for Area A). Results are shown in Table 3.5–15.

**Table 3.5–15. Annual emissions from harvesting in the PM<sub>10</sub> NAA**

Crop	Annual emissions (tons/yr)	
	PM <sub>10</sub> NAA	
	PM <sub>10</sub>	PM <sub>2.5</sub>
Upland Cotton	25.83	3.88
Pima Cotton	0.49	0.07
Wheat	10.20	1.53
Barley	14.30	2.15
Alfalfa Hay	0.00	0.00
Other Hay	1.25	0.19
Corn for grain	0.17	0.03
Corn for silage	0.22	0.03
Sorghum <sup>1</sup>	8.08	1.21
Potatoes	0.55	0.08
Vegetables <sup>2</sup>	0.17	0.03
Citrus	0.02	0.00
Total	61.29	9.19

<sup>1</sup> Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

<sup>2</sup> Includes melons, excludes potatoes.

Typical daily emissions for Maricopa County, Area A, and the PM<sub>10</sub> nonattainment area were calculated by dividing the annual emissions by the number of harvest days per year and multiplying the result by 2000 lbs/ton (URS and ERG, 2001). Because acres harvested were not reported for individual vegetables and citrus fruit, an average number of harvest days per year were used for vegetables and citrus (116 and 188 harvest days per year, respectively). Results are shown in Table 3.5–16.

**Table 3.5–16. Typical daily emissions from harvesting in Maricopa County, Area A, and the PM<sub>10</sub> NAA.**

Crop	Harvest days/yr	Typical daily emissions (lbs/day)					
		Maricopa County		Area A		PM <sub>10</sub> NAA	
		PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Upland Cotton	143	961.4	144.2	489.9	73.5	361.3	54.2
Pima Cotton	143	18.2	2.7	9.3	1.4	6.8	1.0
Wheat	60	893.0	133.9	461.1	69.2	340.1	51.0
Barley	60	1,251.9	187.8	646.4	97.0	476.8	71.5
Alfalfa Hay	294	0.0	0.0	0.0	0.0	0.0	0.0
Other Hay	294	22.9	3.4	11.5	1.7	8.5	1.3
Corn for grain	91	9.7	1.4	5.0	0.7	3.7	0.6
Corn for silage	91	12.9	1.9	6.7	1.0	4.9	0.7
Sorghum <sup>1</sup>	60	707.5	106.1	365.3	54.8	269.5	40.4
Potatoes	70	41.3	6.2	21.3	3.2	15.7	2.4
Vegetables <sup>2</sup>	116	7.6	1.1	3.9	0.6	2.9	0.4
Citrus	188	0.6	0.1	0.3	0.0	0.2	0.0
Total		3,927.0	589.0	2,020.7	303.1	1,490.4	223.6

<sup>1</sup> Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

<sup>2</sup> Includes melons, excludes potatoes.

#### 3.5.2.4 Travel on unpaved agricultural roads

Resuspended PM<sub>10</sub> emissions from travel on unpaved agricultural roads were estimated using an unpaved road emission factor derived from AP-42 13.2.2 (US EPA, 2006). The unpaved road emission factor equation is shown below:

$$\text{Unpaved road emission factor (lb/VMT)} = k (s/12)^a (W/3)^b$$

where:

$$\begin{aligned} s &= \text{surface material silt content} &&= 11.90\% \text{ (MAG, 2000)} \\ W &= \text{mean vehicle weight (tons)} &&= 2.80 \text{ (URS and ERG, 2001)} \\ k &= 1.5 \text{ (PM}_{10}\text{ constant; US EPA, 2006)} \\ a &= 0.9 \text{ (PM}_{10}\text{ constant; US EPA, 2006)} \\ b &= 0.45 \text{ (PM}_{10}\text{ constant; US EPA, 2006)} \end{aligned}$$

$$\begin{aligned} \text{Unpaved road emission factor (lb/VMT)} &= 1.5 (11.9/12)^{0.9} (2.8/3)^{0.45} \\ &= 1.444 \text{ lb/VMT} \end{aligned}$$

Emissions were estimated using farm vehicle activity data obtained from the Technical Support Document for Quantification of Agricultural Best Management Practices (URS and ERG, 2001) which estimated average daily vehicle miles traveled per 1,000 acres to be 49.5 vehicle miles traveled (VMT).

Typical daily emissions from travel on unpaved agricultural roads were derived by multiplying 2011 harvested acres (191,647 acres) by 49.5VMT per 1,000 acres and then multiplying the result by 1.444 lbs per VMT emission factor.

In November 2007, the agricultural PM<sub>10</sub> general permit (Arizona Administrative Codes R18-2-610 and 611) was expanded to apply to commercial farming practices within the Maricopa County portion of Area A. The agricultural PM<sub>10</sub> general permit revisions also resulted in the requirement for commercial farmers to implement six agricultural best management practices (BMP) (up from 3 BMPs) to control PM<sub>10</sub> emissions generated from tillage and harvest, non-cropland, and cropland. Because no data is available on the additional BMPs being implemented, MCAQD used the net control efficiencies from the implementation of agricultural BMPs developed by URS and ERG (2001) in the *Technical Support Document for Quantification of Agricultural BMPs*.

URS and ERG quantified two BMPs for unpaved road travel: 1) access restriction and 2) reduced vehicle speed. URS and ERG (2001) derived net control efficiencies by multiplying mid-point BMP control efficiency by a compliance factor and a relevancy factor for applicable crops. MCAQD used the same mid-point BMP control efficiency and relevancy factor with a revised compliance factor of 55% (from 80%). The revised compliance factor was derived in 2008 (MCAQD, 2011) based on EPA rule effectiveness guidance which eliminated the use of the 80% default rule effectiveness value (US EPA, 2005). MCAQD used the 2008 compliance factor (55%) for 2011 because there had been no changes in the Agricultural BMP program as of 2011.

To estimate controlled typical daily emissions from travel on unpaved agricultural roads within Area A, the mid-point net control efficiency for each BMP (12.0% = 0.4% + 11.6 %, respectively) was applied to 58.24% (the percent of agricultural land in Area A) (M. Poppen, MAG, pers. commun., Nov. 20, 2012) of the uncontrolled typical daily PM<sub>10</sub> emissions as follows:

$$\begin{aligned}
\text{Controlled daily unpaved ag road emissions within Area A} &= \text{Daily uncontrolled PM}_{10} \text{ emissions} \times (100\% - \text{mid-point net control efficiency}) \times \% \text{ agricultural land in Area A} \\
&= 13,698 \text{ lbs/day} \times (100\% - 12.0\%) \times 58.24\% \\
&= 7,020 \text{ lbs/day}
\end{aligned}$$

The uncontrolled portion of unpaved agricultural road typical daily emissions outside the Maricopa County portion of Area A but within Maricopa County were estimated by multiplying uncontrolled typical daily PM<sub>10</sub> emissions by the percent of agricultural land located within Maricopa County but outside of Area A (100% – 58.24%) as follows:

$$\begin{aligned}
\text{Uncontrolled daily unpaved ag road emissions from outside of Area A} &= \text{Uncontrolled PM}_{10} \text{ emissions} \times (100\% - 58.24\%) \\
&= 13,698 \text{ lbs/day} \times 41.76\% \\
&= 5,720 \text{ lbs/day}
\end{aligned}$$

Total controlled and uncontrolled typical daily emissions were then summed to estimate total typical daily PM<sub>10</sub> emissions from travel on unpaved agricultural roads in Maricopa County as follows:

$$\begin{aligned}
\text{Total daily unpaved ag road emissions for Maricopa County from outside Area A} &= \text{Uncontrolled daily unpaved ag road emissions} + \text{Controlled daily unpaved ag road emissions from within Area A} \\
&= 5,720 + 7,020 \\
&= 12,740 \text{ lbs PM}_{10}/\text{day}
\end{aligned}$$

Typical daily PM<sub>10</sub> emissions from unpaved agricultural roads in the PM<sub>10</sub> NAA were calculated in the same manner as the typical daily PM<sub>10</sub> emissions for the Maricopa County portion of Area A. The only difference being the percent of agricultural land located within the Maricopa County PM<sub>10</sub> NAA is 42.96% (rather than 58.24% for Area A). Results are shown in Table 3.5–17.

Annual emissions for Maricopa County, Area A and the PM<sub>10</sub> NAA were calculated by multiplying typical daily emission estimates (in tons) by 312 (=6 days per week × 52 weeks per year).

Annual and typical daily PM<sub>2.5</sub> emissions from travel on unpaved agricultural roads were calculated by multiplying the annual and typical daily PM<sub>10</sub> emissions by a conversion factor of 0.10 (WRAP, 2006d).

**Table 3.5–17. Annual and typical daily emissions from travel on unpaved agricultural roads.**

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County (Area A + outside Area A)	1,987.45	198.75	12,740.1	1,274.0
Area A (controlled)	1,095.19	109.52	7,020.5	702.0
PM <sub>10</sub> NAA (controlled)	807.79	80.78	5,178.1	517.8

### 3.5.2.5 Agricultural field burning

Agricultural ditch bank and fence row burning is captured in this report as agricultural field burning. Agricultural ditch bank and fence row burning is regulated by Maricopa County Air Pollution Control Regulations Rule 314 (Open Outdoor Fires and Indoor Fireplaces at Commercial and Institutional Establishments), which requires a burn permit for open burning in Maricopa County. A total of 41 permits were issued during the year for ditch bank and fence row burning. The permit data indicated 1,967,795 linear feet of ditch bank and fence rows were burned in 2011.

To calculate the amount of material burned, MCAQD assumed that ditch banks and fence rows in Maricopa County average 7 feet in width and are burned twice per year, based on previous Maricopa County emission inventory (MCESD, 1999).

MCAQD estimated 632.44 acres burned  $[(1,967,795 \text{ linear ft.} \times 7 \text{ ft.} \times 2) \div 43,560 \text{ ft/acre}]$ . Acres burned were then converted to tons of material burned using a 3.2 tons/acre fuel loading factor for open burning of “weeds, unspecified” from AP-42, Table 2.5–5 (US EPA, 1992). This resulted in an estimated 2,023.81 ton of material burned.

Annual emissions were then calculated by multiplying the amount of material burned by AP-42 emission factors, shown in Table 3.5–18 below, for open burning of “weeds, unspecified”.

**Table 3.5–18. Emission and fuel loading factors for open burning of “weeds, unspecified”.**

Category	Emission factors (lbs/ton burned)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Weeds, unspecified	15	15	4	N/A	N/A

Based on an analysis of 2011 complaints received reporting suspected open or illegal outside burning, emissions estimates were multiplied by a factor of 2.87 to account for unpermitted illegal outdoor burning.

It was assumed that ditch bank and fence row burning occurs 5 days per week and ditch bank and fence row burning is not allowed during the CO season (November through January). Therefore, typical daily emissions were calculated by dividing annual emissions (in lbs) by 195 (5 days/wk × 39 wks/yr).

Annual and typical daily emissions for the nonattainment area were calculated by multiplying the percentage of agricultural land use within the PM<sub>10</sub> nonattainment area (42.96%) by the Maricopa County emissions estimates. See Section 1.5.1 for a discussion of the land use data used.

Table 3.5–19 summarizes annual and typical daily emissions from agricultural field burning (i.e. ditch bank and fence row burning) for Maricopa County and the PM<sub>10</sub> nonattainment area.

**Table 3.5–19. Annual and typical daily emissions from agricultural field (ditch bank and fence row) burning.**

Category	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>
Maricopa County	43.56	43.56	11.62	446.8	446.8	119.1
PM <sub>10</sub> NAA	18.71	18.71	4.99	191.9	191.9	51.2

### 3.5.2.6 Fertilizer application

Annual NH<sub>3</sub> emissions from synthetic nitrogen fertilizers for Maricopa County were obtained from the US Environmental Protection Agency's 2011 National Emissions Inventory (US EPA, 2012c).

Typical daily NH<sub>3</sub> emissions were derived by dividing annual emissions by 365 days/year. Annual and typical daily emissions for the PM<sub>10</sub> nonattainment area were derived by multiplying the county annual and typical daily emissions by the percentage of agricultural land located in the PM<sub>10</sub> nonattainment (42.96%). See Section 1.5.2 for a discussion of the land use data used. Annual and typical daily NH<sub>3</sub> emissions from fertilizer application are shown in Table 3.5–20.

**Table 3.5–20. Annual and typical daily emissions from fertilizer application.**

Fertilizer Category	Maricopa County		PM <sub>10</sub> NAA	
	Annual NH <sub>3</sub> emissions (tons/year)	Typical daily NH <sub>3</sub> emissions (lbs/day)	Annual NH <sub>3</sub> emissions (tons/year)	Typical daily NH <sub>3</sub> emissions (lbs/day)
Anhydrous ammonia	19.47	106.7	8.36	45.8
Aqueous ammonia	0.12	0.7	0.05	0.3
Nitrogen solutions	573.42	3,142.0	246.33	1,349.7
Urea	393.12	2,154.1	168.87	925.3
Ammonium nitrate	1.64	9.0	0.70	3.9
Ammonium sulfate	181.74	995.8	78.07	427.8
Ammonium thiosulfate	2.57	14.1	1.10	6.0
N-P-K (multi-grade nutrient fertilizers)	5.61	30.8	2.41	13.2
Calcium ammonium nitrate	3.15	17.3	1.35	7.4
Potassium nitrate	0.83	4.6	0.36	2.0
Diammonium phosphate	–	–	–	–
Monoammonium phosphate	9.40	51.5	4.04	22.1
Liquid ammonium polyphosphate	11.22	61.5	4.82	26.4
Miscellaneous fertilizers	573.21	3,140.9	246.23	1,349.2
<b>Total:</b>	<b>1,775.51</b>	<b>9,728.8</b>	<b>762.71</b>	<b>4,179.2</b>

### 3.5.2.7 Livestock

Annual NH<sub>3</sub> emissions from livestock for Maricopa County were obtained from the US Environmental Protection Agency's 2011 National Emissions Inventory (US EPA, 2012c). EPA estimated 8,301,600 kg of NH<sub>3</sub> was emitted from livestock in Maricopa County in 2011. This was converted to tons assuming 907.18474 kg/ton. Therefore, it was estimated that 9,150.95 tons of NH<sub>3</sub> were emitted from livestock in Maricopa County in 2011.

EPA did not estimate PM from livestock; therefore, PM emissions were grown from 2008 based on the percentage change in NH<sub>3</sub> emissions from 2008 to 2011 (4.52%; see Table 3.5–21). Thus, 2011 PM emissions were estimated by applying the same 4.52% decrease to 2008 PM emissions as shown in Table 3.5–22.

**Table 3.5–21. 2008 and 2011 annual NH<sub>3</sub> emissions from livestock in Maricopa County.**

	Maricopa Co.		
	2008	2011	Percentage change
NH <sub>3</sub> emissions	9,583.89	9,150.95	–4.52 %

**Table 3.5–22. 2008 and 2011 annual PM emissions from livestock in Maricopa County.**

Year	Annual emissions (tons/yr)	
	PM <sub>10</sub>	PM <sub>2.5</sub>
2008	455.80	50.14
2011	435.21	47.87

It was assumed that livestock emissions occur evenly throughout the year. Typical daily NH<sub>3</sub> and PM emissions were derived by dividing annual emissions by 365 days/year.

Assuming the same percentage (57.3%) of confined animal feeding operations (CAFO) and animal numbers in the nonattainment area as in 2008, annual and typical daily emissions for the nonattainment area were calculated by multiplying the Maricopa County emission totals by 57.3%. Annual and typical daily emissions from livestock are shown in Table 3.5–23.

**Table 3.5–23. Annual and typical daily emissions from livestock.**

Geographic area	Annual NH <sub>3</sub> emissions (tons/yr)			Typical daily NH <sub>3</sub> emissions (lbs/day)		
	PM <sub>10</sub>	PM <sub>2.5</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NH <sub>3</sub>
Maricopa County	435.21	47.87	9,150.95	2,384.7	262.3	50,142.2
PM <sub>10</sub> NAA	249.37	27.43	5,243.49	1,366.4	150.3	28,731.5

### 3.5.3 Humans

A literature review by Battye et al. (1994) recommended 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 PM<sub>10</sub> nonattainment areas. See Section 1.5 for a discussion of the population data used. Typical daily emissions were calculated by dividing annual values by 365. The resulting estimates are shown in Table 3.5–24.

**Table 3.5–24. Annual and typical daily emissions from human activity.**

Geographic Area	Population	Emission factor (lbs/person-yr)	Annual NH <sub>3</sub> emissions (tons/yr)	Typical daily NH <sub>3</sub> emissions (lbs/day)
Maricopa County	4,129,649	0.55	1,135.65	6,222.8
PM <sub>10</sub> NAA	4,156,105	0.55	1,142.93	6,262.6

### 3.5.4 Structure fires

Structure fire emissions for Maricopa County were grown from 2008 based on county population growth from 2008 to 2011. Population data was provided by MAG and is shown in Table 3.5–25.

**Table 3.5–25. Maricopa County Population Growth 2008 to 2011.**

	2008	2011	Percentage change
Maricopa Co. Total Population	4,279,760	4,129,646	-3.51%

Table 3.5–26 shows 2008 annual emissions from structure fires for the county and annual emissions grown to 2011.



**Table 3.5–26. 2008 and 2011 annual emissions from structure fires in Maricopa County**

Year	Annual emissions (tons/yr)		
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>
2008	15.04	15.04	1.95
2011	14.51	14.51	1.88

Annual emissions for the PM<sub>10</sub> nonattainment area were derived by multiplying annual county emissions by the percentage of total residential population within the nonattainment area (100.64%). See Section 1.5.1 for a discussion of the population data used.

Typical daily emissions for both Maricopa County and the nonattainment area were derived by dividing the annual emissions (in lbs) by 365, as activity was assumed to take place 7 days a week.

**Table 3.5–27. Annual and typical daily emissions from structure fires.**

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>
Maricopa County	14.51	14.51	1.88	79.5	79.5	10.3
PM <sub>10</sub> NAA	14.61	14.61	1.89	80.0	80.0	10.4

### 3.5.5 Aircraft engine testing

Annual emissions from area-source engine testing facilities were derived from annual emissions 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 emissions reports.

Since all facilities considered in this section are located within the PM<sub>10</sub> nonattainment area, total emission values for the county and the PM<sub>10</sub> NAA are equal. Results are shown in Table 3.5–28.

**Table 3.5–28. Annual and typical daily emissions from engine testing.**

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>
Maricopa County	2.39	2.38	46.36	9.98	13.2	13.2	259.3	56.6
PM <sub>10</sub> NAA	2.39	2.38	46.36	9.98	13.2	13.2	259.3	56.6

### 3.5.6 Vehicle fires

Vehicle fire emissions for Maricopa County were grown from 2008 based on county population growth from 2008 to 2011. The population data was provided by MAG and is shown in Table 3.5–29.

**Table 3.5–29. Maricopa County population growth 2008 to 2011.**

	2008	2011	Percentage change
Maricopa Co. Total Population	4,279,760	4,129,646	–3.51%

Table 3.5–30 shows 2008 annual emissions from structure fires for the county and annual emissions grown to 2011.

**Table 3.5–30. 2008 and 2011 annual emissions from vehicle fires in Maricopa County.**

Year	Annual emissions (tons/yr)		
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>
2008	30.04	30.04	1.20
2011	28.98	28.98	1.16

Annual emissions for the PM<sub>10</sub> nonattainment area were derived by multiplying annual county emissions by the percentage of total residential population within the nonattainment area (100.64%). See Section 1.5.1 for a discussion of the population data used.

It was assumed that vehicle fires occur evenly throughout the year. Thus, typical daily emissions for both Maricopa County and the nonattainment area were derived by dividing the annual emissions (in lbs) by 365, as activity was assumed to take place 7 days a week.

**Table 3.5–31. Annual and typical daily emissions from vehicle fires.**

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>
Maricopa County	28.98	28.98	1.16	158.8	158.8	6.4
PM <sub>10</sub> NAA	29.17	29.17	1.17	159.8	159.8	6.4

### 3.5.7 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 (2012) 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 2010 employment were used. Table 3.5–32 shows the NAICS code and employment data used to calculate emissions from crematories.

**Table 3.5–32. County-level employment estimate for crematories, by NAICS code.**

NAICS code	NAICS description	Estimated employment
81222	Cemeteries and crematories	251

Since there were no point sources in this category, an area-source employment estimate was used to “scale up” emissions reported from those facilities surveyed in 2011.

Typical daily emissions were calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM<sub>10</sub> 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.

Table 3.5–33 summarizes annual and typical daily emissions from crematories in both Maricopa County and the PM<sub>10</sub> nonattainment area.

**Table 3.5–33. Annual and typical daily emissions from area-source crematories.**

Geographic area	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>
Maricopa County	3.08	2.82	11.19	1.77	23.9	21.8	88.5	13.9
PM <sub>10</sub> NAA	3.08	2.82	11.19	1.77	23.9	21.8	88.4	13.9

### 3.5.8 Accidental releases

As part of its air quality permit compliance program, MCAQD 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. For the year 2011, there were no accidental releases.

**Table 3.5–34. Annual and typical daily emissions from accidental releases.**

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
PM <sub>10</sub> NAA	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0

### 3.5.9 Wildfires

2011 Maricopa County wildfire data were obtained from the Arizona State Forestry Division (ASFD) (G. Buettner, pers. commun., December 17, 2012); the National Wildfire Coordinating Group (NWCG, 2012), and the US Fire Administration, National Fire Data Center (USFA, 2012).

The Arizona State Forestry Division (ASFD) provides for the prevention and suppression of wildfires on state trust land and private lands located outside of incorporated communities. The wildfire data provided by ASFD includes wildfires that occur outside of local fire districts and municipalities on State, private, and U.S. Bureau of Land Management (BLM) land. In 2011, the ASFD reported 5 wildfires in Maricopa County, encompassing 15.2 acres.

Wildfire data provided by ASFD were compared to 2011 Incident Status Summary reports (ICS-209) to identify wildfires that may have occurred outside of ASFD jurisdiction. ICS-209 reports only include large wildfires, generally fires greater than 100 acres. ICS-209 reports showed 2 additional Maricopa County wildfires in 2011, encompassing 2,006 acres (NWCG, 2012).

Lastly, 2011 National Fire Incident Reporting System (NFIRS) data were obtained from the US Fire Administration (USFA, 2012). NFIRS is a voluntary national reporting system used by fire departments to report fires and other incidents to which they respond and to maintain records of these incidents in a uniform manner. However, not all fire departments report to NFIRS and they may not report all of their fire incidents. The 2011 NFIRS data was culled for wildland fires greater than 1 acre that contained either latitude and longitude or township and range information. Wildfire data for Arizona included 18 fires which met these criteria; however, only 2 of these fires were located within Maricopa County, encompassing 7 acres. The NFIRS data was compared to the ASFD data to identify duplicates by comparing the incident dates and locations. One NFIRS fire was excluded from the combined dataset because it may have been a duplicate already captured in the ASFD data.

Table 3.5–35 summarizes fire data obtained from each data source.

**Table 3.5–35. Wildfire activity in Maricopa County in 2011, by data source.**

<b>Data Source</b>	<b>Number of Fires in 2011</b>	<b>Total Acreage</b>
Arizona State Forestry Division	5	15.2
US Fire Administration NFIRS	1	1.5
National Wildfire Coordinating Group ICS-209	2	2006.0
<b>Total:</b>	<b>8</b>	<b>2,022.7</b>

The National Fire Danger Rating System (NFDRS) Fuel Model map in ArcGIS was used to identify NFDRS fuel types for fires with latitude and longitude data. Fuel loading values obtained from the Western Regional Air Partnership's (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005). Table 3.5–36 shows the data categorized by NFDRS fuel model and the applicable fuel loading factor.

**Table 3.5–36. Wildfires by NFDRS fuel model category and fuel loading factor.**

<b>NFDRS Model Category</b>	<b>Number of Fires in 2011</b>	<b>Total Acres Burned</b>	<b>Fuel Loading Factor (tons/acre)</b>
Agriculture*	1	1.5	4.5
Barren*	1	0.1	0.75
Intermediate brush	4	2,019.5	15.0
Sagebrush grass	2	1.6	4.5
<b>Total</b>	<b>8</b>	<b>2,022.70</b>	

\* "Agriculture" and "barren" NFDRS model descriptions were not included in WGA/WRAP 2002 fuel loading values for NFDRS fuel model categories. Therefore, it was assumed that "Agriculture" is similar to "sagebrush grass" and "Barren" is similar to "western grasses (annual)" and fuel loadings were assigned accordingly.

Estimates of the material burned were derived by multiplying the number of acres burned for each category by the applicable fuel loading factor.

Latitude and longitude data were used to determine the number of acres burned inside of the PM<sub>10</sub> nonattainment area. Three wildfires occurred within the PM<sub>10</sub> nonattainment area, resulting in 15 acres burned. Table 3.5–37 shows the number of wildfires and acres burned within both Maricopa County and the PM<sub>10</sub> nonattainment area, as well as estimates of material burned.

**Table 3.5–37. Number of wildfires and acres/material burned in Maricopa County and the PM<sub>10</sub> NAA.**

<b>Geographic Area</b>	<b>Number of Fires in 2011</b>	<b>Total Acres Burned</b>	<b>Material Burned (tons)</b>
Maricopa County	8	2,023	30,307
PM <sub>10</sub> NAA	3	15	209

Annual emissions from wildfires for each geographic area were calculated by multiplying the material burned for each area by the emission factors shown in Table 3.5–38. The emission factors were obtained from the Western Regional Air Partnership's (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005).

**Table 3.5–38. Emission factors for wildfires & prescribed burning (lbs/ton).**

	<b>PM<sub>10</sub></b>	<b>PM<sub>2.5</sub></b>	<b>NO<sub>x</sub></b>	<b>SO<sub>x</sub></b>	<b>NH<sub>3</sub></b>
WRAP Emission factors for wildfires and prescribed broadcast burning	28.1	24.1	6.2	1.7	1.3

Source: WGA/WRAP, 2005

Annual emissions from wildfires for Maricopa County and the nonattainment area are shown in Table 3.5–39.

**Table 3.5–39. Annual emissions from wildfires in Maricopa County and the PM<sub>10</sub> NAA.**

Geographic Area	Annual emissions (tons/yr)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	425.81	365.19	93.95	25.76	19.70
PM <sub>10</sub> NAA	2.94	2.52	0.65	0.18	0.14

Typical daily emissions were estimated by dividing annual emissions by the number of burn days in 2011. There were 36 burn days in Maricopa County and 5 burn days in the PM<sub>10</sub> nonattainment area in 2011.

**Table 3.5–40. Typical daily emissions from wildfires in Maricopa County and the PM<sub>10</sub> NAA.**

Geographic Area	Number of Burn Days	Typical daily emissions (lbs/day)				
		PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	36	23,655.9	20,288.5	5,219.5	1,431.1	1,094.4
PM <sub>10</sub> NAA	5	1,176.0	1,008.6	259.5	71.1	54.4

### 3.5.10 Prescribed fires

Prescribed fire data were obtained from the Arizona Department of Environmental Quality (ADEQ) (B. Busby, pers. commun., November 8, 2012). The ADEQ reported that fourteen prescribed fires occurred in Maricopa County in 2011. Sixty-two acres of piled fuels were burned. Three of the fourteen prescribed fires occurred inside the PM<sub>10</sub> nonattainment area. Because all 2011 prescribed fires were piled fuels, material burned was derived by multiplying the number of acres burned by tons of piles per acre for each fire. Table 3.5–41 shows the data provided by the ADEQ, the amount of material burned, and whether the fire occurred within the PM<sub>10</sub> nonattainment area.

**Table 3.5–41. Prescribed fire activity in Maricopa County in 2011.**

Date	Burn Number	Burn Location	Tons Per Acre	Treated Acres	Material Burned (tons)	Within PM <sub>10</sub> NAA?
01/05/2011	TNF0301	T7N,R8E,S36	1	5	5	N
04/06/2011	TNF0301	T2N,R7E,S18	1	1	1	Y
04/13/2011	TNF0106	T6N,R7E,S33	1	1	1	Y
04/14/2011	TNF0106	T7N,R5E,S7	1	1	1	N
04/19/2011	TNF0301	T3N,R8E,S27	1	10	10	N
07/23/2011	TNF0611	T3N,R11E,S2	5	15	75	N
08/10/2011	TNF0301	T3N,R8E,S27	0.25	6	1.5	N
08/11/2011	TNF0301	T3N,R8E,S27	0.25	6	1.5	N
08/16/2011	TNF0301	T3N,R8E,S25	1	4	4	N
10/20/2011	TNF0301	T2N,R9E,S31	1	5	5	N
11/08/2011	TNF0301	T2N,R9E,S31	3	5	15	N
11/15/2011	TNF0106	T6N,R7E,S15	1	1	1	Y
11/16/2011	TNF0106	T7N,R6E,S1	1	1	1	N
12/20/2011	TNF0301	T2N,R9E,S11	0.25	1	0.25	N
<b>Total</b>				<b>62</b>	<b>122.25</b>	

Prescribed fire emission factors for “piled fuels” were obtained from the Western Regional Air Partnership’s (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005). The emission factors are shown below in Table 3.5–42.

**Table 3.5–42. Emission factors for prescribed fires.**

Type of fire	Emission factors (lbs/ton burned)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Prescribed fire (piled fuels)	8.0	8.0	6.2	1.7	0.5

Annual emissions from prescribed fires in Maricopa County were derived by multiplying material burned by the emission factor then dividing by 2000 lbs/ton.

It was assumed that each prescribed fire lasted one day. Thus, typical daily emissions from prescribed fires were determined by dividing the annual emissions (in lbs) by the number of burn days. Because fourteen prescribed fires occurred in Maricopa County in 2011, it was assumed that there were 14 burn days in 2011.

Since the prescribed fire data provided by ADEQ (2012) included burn location, GIS was used to determine the fires that burned inside the nonattainment area. Only three of the sixty-two acres burned were within the PM<sub>10</sub> nonattainment area. Thus, annual emissions from prescribed fires for the PM<sub>10</sub> nonattainment area were calculated by multiplying three acres burned by the appropriate emission factors. Results are shown in Table 3.5–43 below.

**Table 3.5–43. Annual and typical daily emission from prescribed fire in Maricopa County and the PM<sub>10</sub> NAA.**

Geographic Area	Annual emissions (tons/yr)					Typical daily emission (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Maricopa County	0.49	0.49	0.38	0.10	0.03	69.9	69.9	54.1	14.8	4.4
PM <sub>10</sub> NAA	0.01	0.01	0.01	0.00	0.00	8.0	8.0	6.2	1.7	0.5

### 3.5.11 Unpaved parking lots fugitive dust

Fugitive dust emissions from vehicles traveling on unpaved parking lots were developed by MAG based on land area devoted to unpaved parking lots, vehicle activity on unpaved parking lots, and emission rates from AP-42 (US EPA, 2006). The methodology, assumptions and calculations involved in estimating fugitive dust from vehicles traveling on unpaved parking lots are described in this section.

The vehicle miles traveled on unpaved parking lots in the PM<sub>10</sub> nonattainment area (NAA) were derived using assumptions from the Phase I windblown dust modeling for the Western Regional Air Partnership (ENVIRON, 2004). This study estimated that eight percent of the vacant land in core urban areas is disturbed and thirty percent of the land under development is disturbed. For the 2011 periodic emissions inventory, the core urban area is defined as the carbon monoxide maintenance area. GIS was applied to 2010 MAG land use data to estimate that there are 162,702 acres of vacant land in the core urbanized area and 20,148 acres of land under residential and non-residential development in the PM<sub>10</sub> NAA. Multiplying the vacant disturbed percentages by these land areas produces:

$$162,702 \text{ acres} \times 0.08 = 13,016 \text{ acres of vacant disturbed land in the urbanized core}$$

$$20,148 \text{ acres} \times 0.30 = 6,044 \text{ acres of vacant disturbed land under development in the PM}_{10} \text{ NAA}$$

Summing the vacant disturbed acres in the urbanized core and areas under development produces a total of 19,060 acres of vacant disturbed land in the PM<sub>10</sub> NAA. In estimating fugitive dust emissions from unpaved parking lots, the MAG Serious Area PM<sub>10</sub> Plan assumed that 24 percent of the disturbed vacant non-agricultural land is devoted to unpaved parking areas (MAG, 2000).

Applying this percentage to the acres of vacant disturbed land results in 4,574 acres of unpaved parking lots in the PM<sub>10</sub> NAA.

The MAG Serious Area PM<sub>10</sub> Plan also assumed that the average size of an unpaved parking lot is 625 square meters (i.e., 0.154 acres), an average of ten vehicles travel on each lot per day, and each vehicle travels an average distance of 0.031 miles on a lot. Multiplying 10 vehicles per day times 0.031 miles per vehicle and dividing by 0.154 acres produces 2.0 vehicle miles of travel (VMT) per acre per day. Multiplying 2.0 by 4,574 acres yields 9,148 VMT per day on unpaved parking lots in the PM<sub>10</sub> NAA.

The emission factors for unpaved parking lots were derived from the AP-42 equation for unpaved industrial roads (US EPA, 2006), assuming a silt content of 11.9 percent and an average vehicle weight of 3.18 tons. The resultant AP-42 emission factors are 1.365 pounds per mile for PM<sub>10</sub> and 0.137 pounds per mile for PM<sub>2.5</sub>.

These AP-42 emission factors were applied to the unpaved parking lot VMT of 9,148 to obtain emissions in pounds per day. The pounds per day were converted to tons per year, assuming 365 days in 2011. The results for the PM<sub>10</sub> NAA are shown in Table 3.5–44.

To estimate emissions for Maricopa County, GIS was applied to 2010 MAG land use data to obtain 2,045,587 acres of vacant land in Maricopa County. Removing the vacant land in the Maricopa County portion of the PM<sub>10</sub> NAA (i.e., 396,054 acres) results in 1,649,533 vacant acres located inside Maricopa County, but outside the PM<sub>10</sub> NAA.

Assuming one percent of the vacant land outside the PM<sub>10</sub> NAA is disturbed (Clark County, 2006) and 24 percent of the disturbed vacant land is unpaved parking areas (MAG, 2000), results in 3,959 acres of unpaved parking areas inside Maricopa County, but outside the PM<sub>10</sub> NAA. Multiplying by 2.0 VMT per acre per day results in 7,918 VMT per day. Applying the AP-42 emission rates produces the unpaved parking lot emissions inside Maricopa County, but outside the PM<sub>10</sub> NAA of 10,808.1 pounds per day of PM<sub>10</sub> and 1,084.8 pounds per day of PM<sub>2.5</sub>.

The final step in estimating Maricopa County emissions requires removing the Pinal County portion of the PM<sub>10</sub> NAA. The unpaved parking lot emissions in the Pinal County portion of the PM<sub>10</sub> NAA are assumed to be proportional to the acres of vacant land. These were derived using GIS and 2010 MAG land use data, with the results shown below:

Vacant land in the Pinal County portion of the PM<sub>10</sub> NAA = 6,278 acres  
Vacant land in the PM<sub>10</sub> NAA = 402,332 acres  
Ratio = 6,278/402,332 = 1.6%; Pinal County portion = 1.6% x PM<sub>10</sub> NAA emissions  
Pinal County portion of PM<sub>10</sub> emissions = 1.6% x 12,487.0 = 199.8 pounds per day  
Pinal County portion of PM<sub>2.5</sub> emissions = 1.6% x 1,253.3 = 20.1 pounds per day

Adding the emissions inside and outside the PM<sub>10</sub> NAA and subtracting the Pinal County portion produces total Maricopa County emissions attributable to vehicles traveling on unpaved parking lots in pounds per day. Pounds per day are converted to tons per year, assuming 365 days in 2011. The resultant 2011 emissions for Maricopa County are shown in Table 3.5–44.

**Table 3.5–44 Annual and typical daily emissions from vehicles traveling on unpaved parking lots.**

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	4,214.89	423.02	23,095.3	2,317.9
PM <sub>10</sub> NAA	2,278.88	228.72	12,487.0	1,253.3

### 3.5.12 Leaf blower fugitive dust

Fugitive dust emissions from leaf blowers are the result of blowing loose material from the area being cleared by the leaf blowers. Exhaust emissions from gasoline-powered leaf blowers are covered under the Nonroad Mobile Sources section of this report (Chapter 4). Fugitive dust emission estimates are developed with the use of three sources: EPA’s NONROAD model, California Air Resources Board report to legislature on leaf blowers (CARB, 2000), and a recent research effort done by the University of Riverside (Fitz et al., 2005).

EPA’s 2011NONROAD model was used to estimate the number of gasoline-powered leaf blowers in Maricopa County ( $n = 115,920$ ), along with the average activity figures for those leaf blowers. Total leaf blower population estimates were derived from CARB (2000), which estimated that 60% of all leaf blowers sold are electric. Thus assuming the remaining 40% are gasoline-powered.

Fitz et al. (2005) developed emission factors for PM<sub>10</sub> and PM<sub>2.5</sub> fugitive dust emissions from leaf blowers. For this report, the most conservative (highest) emission factors were chosen to estimate emissions. Given these two data sources, Table 3.5–45 lists the equipment population numbers, activity estimates and emission factors for leaf blowers in Maricopa County.

**Table 3.5–45. Leaf blower equipment populations, activity levels and emission factors for Maricopa County.**

Leaf blower description	Population	Annual activity (hrs/yr)	PM <sub>10</sub> emission factors (mg/m <sup>2</sup> )	PM <sub>2.5</sub> Emission factors (mg/m <sup>2</sup> )
Commercial 2-stroke gasoline	3,531	626	70	30
Commercial 4-stroke gasoline	1,731	626	70	30
Residential 2-stroke gasoline	105,190	10	70	30
Residential 4-stroke gasoline	5,468	10	70	30
Electric	173,880	10	130	40
<b>Total:</b>	<b>289,800</b>	n/a	n/a	n/a

CARB (2000) estimates that approximately 1600m<sup>2</sup> of surface can be cleared in one hour of leaf blower operation. Therefore, annual emission estimates were calculated by using the following formula, as in this example for electric leaf blowers:

$$\begin{aligned}
 \text{Annual PM}_{10} \text{ emissions from electric leaf blowers} &= \text{population} \times \text{activity (hrs/yr)} \times \text{emission factor (mg/m}^2\text{)} \times \text{area covered (m}^2\text{/hr)} \\
 &= 173,880 \times 10 \text{ hrs/yr} \times 130 \text{ mg/m}^2 \times 1600 \text{ m}^2\text{/hr} \\
 &= 361,670,400,000 \text{ mg/yr} \\
 &= 398.32 \text{ tons PM}_{10}\text{/yr}
 \end{aligned}$$

The activity hours associated with leaf blowers can occur at any time during the year in Maricopa County due to the temperate climate, with no substantial seasonal variation. Therefore, typical daily emissions were estimated by dividing annual totals by 365 days per year. Emissions for the PM<sub>10</sub> nonattainment area are allocated based on the ratio of population in the



County to the nonattainment area. See Section 1.5 for a discussion on the population data used. Table 3.5–46 lists annual and typical daily fugitive emissions from leaf blowers for Maricopa County and the PM<sub>10</sub> nonattainment area.

**Table 3.5–46. Annual and typical daily emissions from leaf blower fugitive dust.**

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	941.12	355.19	5,156.8	1,946.2
PM <sub>10</sub> NAA	947.15	357.46	5,189.9	1,958.7

### 3.5.13 Offroad recreation vehicles fugitive dust

The EPA NONROAD2008a model estimates exhaust emissions for offroad recreational vehicles. These emissions are included in the nonroad emissions category of the 2011 particulate emissions inventory. Particulate emissions are also generated by recreational vehicles traveling on unpaved surfaces. For the 2011 periodic inventory, these emissions were estimated by MAG using mileage and activity data for offroad recreational vehicles in Maricopa County from the NONROAD2008a model. The methodology and assumptions for calculating fugitive dust emissions from offroad recreational vehicles traveling are described in this section.

The NONROAD2008a model provides annual mileage and activity data by county for all terrain vehicles (ATVs) and offroad motorcycles (ORMs). The NONROAD2008a model also provides annual operating hours and number of vehicles by county for specialty vehicles/carts (SVCs). To convert operating hours to mileage, it was assumed that SVCs travel at an average speed of 10 miles per hour. This is consistent with the speed that vehicles travel on unpaved alleys in Maricopa County (See Section 5.3.2). The annual mileage and number of vehicles by type for Maricopa County in 2011 are shown in Table 3.5–47.

To be consistent with the 2008 Periodic Emissions Inventory for PM<sub>10</sub> (MCAQD, 2011), it was assumed that 75 percent of the annual travel by offroad recreational vehicles occurs on unpaved surfaces inside Maricopa County, with the remaining 25 percent occurring on paved surfaces within Maricopa County and paved and unpaved surfaces outside of Maricopa County. The product of the mileage, number of vehicles, and 75 percent produces the annual vehicle miles of travel (VMT) on unpaved surfaces, shown in Table 3.5–47. Dividing the annual VMT by 365 results in the 2011 typical daily offroad recreational vehicle travel on unpaved surfaces in Maricopa County.

**Table 3.5–47. 2011 offroad recreational vehicle travel on unpaved surfaces in Maricopa County.**

Vehicle Type	Annual Mileage	Number of Vehicles	2011 Annual VMT	2011 Daily VMT
ATV	1,608	35,255	42,517,530	116,486
ORM	1,600	8,390	10,068,00	27,584
SVC (Non-Diesel)	650	1,755	855,563	2,344
SVC (Diesel)	4,350	161	525,263	1,439

The VMTs above were multiplied by emission factors for unpaved industrial roads from AP-42 (EPA, 2006), assuming a silt content of 11.9 percent and an average vehicle weight of one-half of a ton. The resultant PM<sub>10</sub> emission factor for ATVs and SVCs is 0.594 pounds per vehicle mile traveled. This emission factor was reduced by 50 percent for ORMVs (i.e., 0.297 pounds per mile) to account for two wheels generating dust instead of four. Applying the AP-42 equation

results in a PM<sub>2.5</sub> emission factor for ATVs and SVCs of 0.059 pounds per mile, while the comparable PM<sub>2.5</sub> emission factor for ORMs is 0.0295 pounds per mile.

The AP-42 emission rates were multiplied by the annual and daily VMTs in Table 3.5–47 to obtain Maricopa County fugitive dust emissions in pounds per day and tons per year. The results are shown in Table 3.5–48.

The emissions for the PM<sub>10</sub> nonattainment area were derived by applying geographic information systems (GIS) to MAG 2010 land use data to obtain the acreage of vacant and passive open space in the PM<sub>10</sub> nonattainment area and Maricopa County. Passive open space includes open desert, mountains, and washes. The detailed calculations for deriving the PM<sub>10</sub> nonattainment area emissions are shown below.

Vacant and Passive Open Space in the PM<sub>10</sub> nonattainment area (NAA) = 831,316 acres  
 Vacant and Passive Open Space in Maricopa County = 4,660,457 acres  
 Ratio of Vacant and Passive Open Space in PM<sub>10</sub> NAA to Maricopa County = 17.84%  
 PM<sub>10</sub> NAA Emissions = 0.1784 × Maricopa County emissions

Application of the ratio above to Maricopa County emissions produces the annual and typical daily emissions for the PM<sub>10</sub> NAA shown in Table 3.5–48. The PM<sub>10</sub> and PM<sub>2.5</sub> emissions for all offroad recreational vehicle types (i.e., ATVs, ORMs and SVCs) are summed in this table.

**Table 3.5–48. Annual and typical daily emissions from offroad recreational vehicles.**

Geographic area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM <sub>10</sub>	PM <sub>2.5</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>
Maricopa County	14,532.91	1,443.50	79,632.4	7,909.6
PM <sub>10</sub> NAA	2,592.67	257.52	14,206.4	1,411.1

### 3.6 Summary of all area sources

Tables 3.6–1 and 3.6–2 summarize annual and typical daily emissions from all area sources addressed in this chapter, for both Maricopa County and the PM<sub>10</sub> nonattainment area, respectively.

**Table 3.6–1. Annual and typical daily emissions from all area sources in Maricopa County.**

Source Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
<b>Fuel combustion:</b>										
Industrial distillate oil: Boilers	10.04	5.48	60.87	1.30	2.43	64.4	35.1	390.2	8.3	15.6
Industrial distillate oil: Engines	129.35	121.13	1,838.26	0.00	0.00	829.2	776.5	11,783.7	0.0	0.0
Industrial natural gas	39.11	39.11	730.94	3.07	16.13	250.7	250.7	4,685.5	19.7	103.4
Comm./inst. distillate oil: Boilers	0.02	0.02	0.12	0.00	0.00	0.1	0.1	0.8	0.0	0.0
Comm./inst. distillate oil: Engines	0.26	0.26	3.72	0.00	0.00	1.7	1.7	23.8	0.0	0.0
Comm./inst. natural gas	56.75	56.75	1,080.73	4.46	3.58	363.8	363.8	6,927.8	28.6	22.9
Residential distillate oil	0.07	0.06	0.35	0.82	0.02	0.7	0.6	3.8	9.0	0.2
Residential natural gas	68.83	68.83	851.32	5.43	0.00	377.1	377.1	4,664.7	29.8	0.0
Residential LPG	0.19	0.16	51.35	0.22	0.18	2.1	1.7	564.3	2.4	2.0
Residential kerosene	0.01	0.01	0.03	0.08	0.00	0.1	0.1	0.4	0.9	0.0
Residential wood combustion	460.15	458.44	57.72	6.59	27.28	5,056.6	5,037.9	634.3	72.4	299.8
<b>All Fuel Combustion</b>	<b>764.78</b>	<b>750.24</b>	<b>4,675.41</b>	<b>21.97</b>	<b>49.63</b>	<b>6,946.5</b>	<b>6,845.3</b>	<b>29,679.3</b>	<b>171.0</b>	<b>443.9</b>
<b>Industrial processes:</b>										
Chemical manufacturing	121.46	73.32				1,172.4	732.7			
Commercial cooking	1,058.55	1,058.33				5,800.3	5,799.1			
Grain handling/processing	70.09	19.10				443.1	122.3			
Ammonia cold storage					1,911.36					12,252.3
Secondary metal production	42.27	34.37	15.02	8.03	0.25	308.9	256.3	106.9	89.3	2.3
Mineral processes	149.32	75.94				1,065.9	542.0			
Mining/quarrying	106.28	33.49				712.7	220.5			
Wood product mfg.	59.64	52.76				442.4	385.7			
Rubber/plastic product mfg.	218.58	164.33				1,478.5	1,083.8			
Fabricated metals	25.87	22.97				181.2	160.4			
Residential construction	476.06	47.61				3,051.7	305.2			
Commercial construction	2,221.62	222.16				14,241.1	1,424.1			
Road construction	1,820.80	182.08				11,671.8	1,167.2			
Construction, other	347.22	34.72				2,225.8	222.6			
Electrical equipment mfg.	7.66	5.00	23.47	0.28	9.63	42.7	28.0	129.0	1.6	52.9
Industrial paved/unpaved road travel	356.35	101.68				2,486.7	718.7			
Industrial processes, NEC	158.29	80.67	224.92	40.48	9.98	903.6	465.4	1,236.4	222.0	55.3
<b>All Industrial Processes</b>	<b>7,240.06</b>	<b>2,208.53</b>	<b>263.41</b>	<b>48.80</b>	<b>1,931.23</b>	<b>46,228.9</b>	<b>13,634.0</b>	<b>1,472.3</b>	<b>312.8</b>	<b>12,362.8</b>
<b>Waste treatment/disposal:</b>										
On-site incineration	0.62	0.41	3.31	1.05		4.1	2.7	21.4	6.8	
Open burning: Land clearing debris	1.11	1.11	0.30			8.6	8.6	2.3		
Landfills	76.05	40.73	30.40	7.17		421.1	225.5	167.1	39.4	
Publicly owned treatment works					14.92					81.7
Other waste	26.71	14.44	22.19	63.53		169.6	85.6	121.9	349.0	
<b>All Waste Treatment/ Disposal</b>	<b>104.48</b>	<b>56.69</b>	<b>56.21</b>	<b>71.75</b>	<b>14.92</b>	<b>603.3</b>	<b>322.4</b>	<b>312.6</b>	<b>395.2</b>	<b>81.7</b>
<b>Misc. area sources:</b>										
Windblown dust	7,690.52	1,153.58				42,140.0	6,321.1			
Cotton ginning	45.02	12.86				263.8	75.4			
Tilling	3,328.28	499.24				32,099.9	4,815.0			
Harvesting	161.95	24.29				3,927.0	589.0			
Travel on unpaved ag roads	1,987.45	198.75				12,740.1	1,274.0			
Agricultural field burning	43.56	43.56	11.62			446.8	446.8	119.1		

**Table 3.6–1 (continued). Annual and typical daily emissions from all area sources in Maricopa County.**

Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
Fertilizer application					1,775.51					9,728.8
Livestock	435.21	47.87			9,150.95	2,384.7	262.3			50,142.2
Humans					1,135.65					6,222.8
Structure fires	14.51	14.51	1.88			79.5	79.5	10.3		
Aircraft engine testing	2.39	2.38	46.36	9.98		13.2	13.2	259.3	56.6	
Vehicle fires	28.98	28.98	1.16			158.8	158.8	6.4		
Crematories	3.08	2.82	11.19	1.77		23.9	21.8	88.5	13.9	
Accidental releases	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
Wildfires	425.81	365.19	93.95	25.76	19.70	23,655.9	20,288.5	5,219.5	1,431.1	1,094.4
Prescribed fires	0.49	0.49	0.38	0.10	0.03	69.9	69.9	54.1	14.8	4.4
Travel on unpaved parking lots	4,214.89	423.02				23,095.3	2,317.9			
Leaf blowers fugitive dust	941.12	355.19				5,156.8	1,946.2			
Offroad rec. vehicles fugitive dust	14,532.91	1,443.50				79,632.4	7,909.6			
<b>All Misc. Area Sources</b>	<b>33,856.18</b>	<b>4,616.25</b>	<b>166.54</b>	<b>37.62</b>	<b>12,081.84</b>	<b>225,888.0</b>	<b>46,589.1</b>	<b>5,757.2</b>	<b>1,516.5</b>	<b>67,192.5</b>
<b>TOTAL, ALL AREA SOURCES</b>	<b>41,965.49</b>	<b>7,631.71</b>	<b>5,161.56</b>	<b>180.14</b>	<b>14,077.61</b>	<b>279,666.7</b>	<b>67,390.7</b>	<b>37,221.4</b>	<b>2,395.6</b>	<b>80,081.0</b>

**Table 3.6–2. Annual and typical daily emissions from all area sources in the PM<sub>10</sub> NAA.**

Source Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
<b><i>Fuel combustion:</i></b>										
Industrial distillate oil: Boilers	10.04	5.48	60.85	1.30	2.43	64.4	35.1	390.0	8.3	15.6
Industrial distillate oil: Engines	129.30	121.08	1,837.52	0.00	0.00	828.8	776.2	11,779.0	0.0	0.0
Industrial natural gas	39.09	39.09	730.65	3.07	16.12	250.6	250.6	4,683.6	19.7	103.4
Comm./inst. distillate oil: Boilers	0.02	0.02	0.12	0.00	0.00	0.1	0.1	0.8	0.0	0.0
Comm./inst. distillate oil: Engines	0.26	0.26	3.72	0.00	0.00	1.7	1.7	23.8	0.0	0.0
Comm./inst. natural gas	56.57	56.57	1,077.29	4.44	3.57	362.6	362.6	6,905.7	28.5	22.9
Residential distillate oil	0.07	0.06	0.35	0.83	0.02	0.7	0.6	3.8	9.1	0.2
Residential natural gas	69.02	69.02	853.61	5.45	0.00	378.2	378.2	4,677.3	29.9	0.0
Residential LPG	0.19	0.16	51.68	0.22	0.18	2.1	1.7	567.9	2.4	2.0
Residential kerosene	0.01	0.01	0.03	0.08	0.00	0.1	0.1	0.4	0.9	0.0
Residential Wood Combustion	463.10	461.38	58.09	6.63	27.45	5,089.0	5,070.1	638.4	72.8	301.7
<b>All Fuel Combustion</b>	<b>767.66</b>	<b>753.12</b>	<b>4,673.91</b>	<b>22.02</b>	<b>49.78</b>	<b>6,978.3</b>	<b>6,877.0</b>	<b>29,670.8</b>	<b>171.6</b>	<b>445.8</b>
<b><i>Industrial processes:</i></b>										
Chemical manufacturing	121.41	73.30				1,171.9	732.4			
Commercial cooking	1,065.33	1,065.1				5,837.4	5,836.2			
Grain handling/processing	70.06	19.10				443.0	122.2			
Ammonia cold storage					1,910.60					12,247.4
Secondary metal production	42.27	34.37	15.02	8.03	0.25	308.9	256.3	106.9	89.3	2.3
Mineral processes	133.99	69.39				953.9	493.9			
Mining/quarrying	86.58	27.95				564.9	179.0			
Wood product mfg.	59.61	52.73				442.2	385.6			
Rubber/plastic product mfg.	218.49	164.26				1,478.0	1,083.3			
Fabricated metals	25.86	22.96				181.2	160.3			
Residential construction	477.07	47.71				3,058.1	305.8			
Commercial construction	1,343.10	134.31				8,609.6	861.0			
Road construction	1,619.73	161.97				10,382.9	1,038.3			
Construction, other	243.64	24.36				1,561.8	156.2			
Electrical equipment mfg.	7.66	5.00	23.47	0.28	9.63	42.7	28.0	129.0	1.6	52.9
Industrial paved/unpaved road travel	302.12	90.32				2,131.3	644.1			
Industrial processes, NEC	102.65	45.41	222.86	40.48	6.77	597.8	271.6	1,222.5	221.9	37.6
<b>All Industrial Processes</b>	<b>5,919.58</b>	<b>2,038.25</b>	<b>261.35</b>	<b>48.79</b>	<b>1,927.25</b>	<b>37,765.6</b>	<b>12,554.2</b>	<b>1,458.4</b>	<b>312.8</b>	<b>12,340.3</b>

**Table 3.6–2 (continued). Annual and typical daily emissions from all area sources in the PM<sub>10</sub> NAA.**

Source Category	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	SO <sub>x</sub>	NH <sub>3</sub>
<i>Waste treatment/disposal:</i>										
On-site incineration	0.62	0.41	3.31	1.05		4.1	2.7	21.4	6.8	
Open burning: Land clearing debris	0.22	0.22	0.06			1.7	1.7	0.4		
Landfills	56.90	29.06	23.84	2.38		314.8	160.8	131.0	13.1	
Publicly owned treatment works					15.01					82.3
Other waste	25.58	13.64	21.59	56.39		163.4	81.2	118.6	309.8	
<b>All Waste Treatment/ Disposal</b>	<b>83.32</b>	<b>43.34</b>	<b>48.80</b>	<b>59.82</b>	<b>15.01</b>	<b>484.0</b>	<b>246.4</b>	<b>271.4</b>	<b>329.7</b>	<b>82.3</b>
<i>Misc. area sources:</i>										
Windblown dust	4,786.57	717.98				26,227.7	3,934.2			
Cotton ginning	9.68	2.77				53.2	15.2			
Tilling	1,292.04	193.81				12,582.4	1,887.4			
Harvesting	61.29	9.19				1,490.4	223.6			
Travel on unpaved ag. roads	807.79	80.78				5,178.1	517.8			
Agricultural field burning	18.71	18.71	4.99			191.9	191.9	51.2		
Fertilizer application					762.71					4,179.2
Livestock	249.37	27.43			5,243.49	1,366.4	150.3			28,731.5
Humans					1,142.93					6,262.6
Structure fires	14.61	14.61	1.89			80.0	80.0	10.4		
Aircraft engine testing	2.39	2.38	46.36	9.98		13.2	13.2	259.3	56.6	
Vehicle fires	29.17	29.17	1.17			159.8	159.8	6.4		
Crematories	3.08	2.82	11.19	1.77		23.9	21.8	88.4	13.9	
Accidental releases	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
Wildfires	2.94	2.52	0.65	0.18	0.14	1,176.0	1,008.6	259.5	71.1	54.4
Prescribed fires	0.01	0.01	0.01	0.00	0.00	8.0	8.0	6.2	1.7	0.5
Travel on unpaved parking lots	2,278.88	228.72				12,487.0	1,253.3			
Leaf blowers fugitive dust	947.15	357.46				5,189.9	1,958.7			
Offroad rec. vehicles fugitive dust	2,592.67	257.52				14,206.4	1,411.1			
<b>All Misc. Area Sources</b>	<b>13,096.36</b>	<b>1,945.88</b>	<b>66.25</b>	<b>11.94</b>	<b>7,149.26</b>	<b>80,434.5</b>	<b>12,834.9</b>	<b>681.4</b>	<b>143.3</b>	<b>39,228.2</b>
<b>TOTAL, ALL AREA SOURCES</b>	<b>19,826.92</b>	<b>4,770.00</b>	<b>5,050.31</b>	<b>142.57</b>	<b>9,141.31</b>	<b>125,405.6</b>	<b>32,444.2</b>	<b>32,082.0</b>	<b>957.4</b>	<b>52,096.5</b>

### 3.7 Quality assurance/quality control procedures

Quality assurance and quality control (QA/QC) activities for the area source emissions inventory were designed to create 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 identified for inclusion in the inventory based on the latest Emission Inventory Improvement Program (EIIP) guidance available. In addition, recent EPA activities to develop county-level emissions estimates for newly created source categories (such as portable fuel containers) or redefined Source Classification Codes were also reviewed, and incorporated where relevant. Prior-year inventories for the region were also examined to identify possible additional categories for inclusion in the present inventory. 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 or non-existent (such as industrial coal combustion, oil and gas production, and snowmobile use).

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 state agencies (such as the Arizona Department of Transportation, or

Arizona Department of Weights and Measures) and regional bodies (such as the Western Regional Air Partnership, WRAP) were used. National-level data (such as those from 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. 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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