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.

SCC Code	Category Description	Section
	Fuel combustion:	
2102006000	Industrial natural gas	3.2.1
2102004000	Industrial fuel oil	3.2.2
2103006000	Commercial/institutional natural gas	3.2.3
2103004000	Commercial/institutional fuel oil	3.2.4
2104006000	Residential natural gas	3.2.5
2104008000	Residential wood	3.2.6
2104004000	Residential fuel oil	3.2.7
	Industrial processes:	
2301010000	Chemical manufacturing	3.3.1
2302002000	Commercial cooking	3.3.2.1
2302040000	Grain handling/processing	3.3.2.2
2302080000	Ammonia cold storage	3.3.2.3
2304000000	Secondary metal production	3.3.3
2305000000	Non-metallic mineral processes	3.3.4
2325000000	Mining and quarrying	3.3.5
2307000000	Wood product manufacturing	3.3.6
2308000000	Rubber/plastics manufacturing	3.3.7
2309000000	Fabricated metal products manufacturing	3.3.8
2311010000	Residential construction	3.3.9
2311020000	Commercial construction	3.3.9
2311030000	Road construction	3.3.9
n/a	Other construction	3.3.9
2312000000	Electrical equipment manufacturing	3.3.10
n/a	State-permitted portable sources	3.3.11
n/a	Paved/unpaved road travel on industrial sites	3.3.12
2399000000	Industrial processes not elsewhere classified (NEC)	3.3.13
	Waste treatment and disposal:	
2601000000	On-site incineration	3.4.1
2610000000	Open burning	3.4.2
2620000000	Landfills	3.4.3
2630000000	Publicly owned treatment works (POTWs)	3.4.4
2650000000	Other industrial waste / disposal	3.4.5
	Miscellaneous area sources:	
2810001000	Wildfires and brush fires	3.5.1.1
n/a	Prescribed fires	3.5.1.2

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

SCC Code	Category Description	Section
	Miscellaneous area sources: (continued)	
2810030000	Structure fires	3.5.1.3
2810050000	Vehicle fires	3.5.1.4
2810040000	Engine testing	3.5.1.5
2801000003	Tilling	3.5.2.1
2801000005	Harvesting	3.5.2.2
n/a	Travel on unpaved agricultural roads	3.5.2.3
2801000000	Cotton ginning	3.5.2.4
2801700000	Fertilizer application	3.5.2.5
2805000000	Livestock	3.5.3
2850000000	Health services	3.5.4
2830000000	Accidental releases	3.5.5
2810010000	Humans	3.5.6
n/a	Leaf blower fugitive dust	3.5.7
n/a	Offroad recreational vehicle fugitive dust	3.5.8
n/a	Unpaved parking lots fugitive dust	3.5.9
2730100000	Windblown dust	3.5.10

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

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

3.2 Fuel combustion

Area-source emissions for the following seven categories of fuel consumption were calculated: Industrial natural gas, industrial fuel oil, commercial/institutional natural gas, commercial/ institutional fuel oil, residential natural gas, residential wood, and residential fuel oil. Data for emissions calculations from natural gas combustion came from a survey of the 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 data by supply company and end-user category.

Natural gas supplier	Sales by end user category (in MMCF/yr)					
	Electric Utilities	Industrial	Commercial/ Institutional	Residential	Transport*	Other*
Southwest Gas	n/a	2,459.27	13,968.02	15,364.45	5,151.97	836.01
City of Mesa	n/a	108.99	1,367.49	1,106.08	8.74	114.58
El Paso	148,506.64	185.58	n/a	n/a	n/a	n/a

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

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

3.2.1 Industrial natural gas

All natural gas suppliers in Maricopa County were surveyed to gather information on the volume of natural gas distributed, by user category, within the county in 2005. Area-source industrial natural gas usage for the county is based on the reported total volume of natural gas sold to industrial sources, minus natural gas used by industrial point sources:

County area-source industrial natural gas usage	=	Total reported industrial natural gas sales	–	Industrial point source natural gas usage
	=	8,865.13 MMCF	–	4,540.37 MMCF
	=	4,324.16 MMCF		

Natural gas is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source natural gas usage derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal natural gas combustion reported by all industrial area sources in 2005.

Annual emissions for the county and the PM_{10} nonattainment area are calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion, as in this example for PM_{10} emissions from external natural gas combustion:

Annual PM_{10} emissions from external natural gas combustion	=	External industrial natural gas usage (MMCF)	×	PM_{10} emission factor for external natural gas combustion (lb/MMCF)	÷	2,000 lb/ton
	=	4,257.47	×	7.6	÷	2,000
	=	16.18 tons PM_{10}/yr				

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

Combustion type	% of total	Natural gas usage (MMCF)	Emission factors (lb/MMCF)					Annual emissions (tons/yr)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
External	98.44	4,257.47	7.6	7.6	100	0.6	3.2	16.18	16.18	212.87	1.28	6.81
Internal	1.56	67.29	10.0	10.0	2840	0.6	n/a	0.34	0.34	95.55	0.02	n/a
Total:	**100.00**	**4,324.16**						**16.51**	**16.51**	**308.43**	**1.30**	**6.81**

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

PM_{10} typical daily emissions from industrial natural gas	=	Annual PM_{10} emissions (tons/yr)	÷ (days/week × wks/yr)	× 2,000 lbs/ton
	=	16.51	÷ (6 × 52)	× 2,000
	=	105.9 lbs PM_{10}/day		

Annual and typical daily emissions within the PM_{10} nonattainment area are calculated by applying the ratio of industrial employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

Emissions from area-source industrial natural gas combustion in the PM_{10} NAA	= Annual county PM_{10} emissions (tons/yr)	×	NAA:County Industrial employment ratio
	= 16.51	×	0.9932
	= 16.40 tons PM_{10}/yr		

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	16.51	16.51	308.43	1.30	6.81	105.9	105.9	1,977.1	8.3	43.7
PM_{10} NAA	16.40	16.40	306.33	1.29	6.77	104.7	104.7	1,955.5	8.2	43.2

3.2.2 Industrial fuel oil

Area-source emissions from industrial fuel oil combustion are calculated by a multi-step process which allocates Arizona state-level industrial fuel oil sales as reported by the U.S. Department of Energy, Energy Information Administration (US DOE, 2006a) to Maricopa County.

To derive industrial fuel oil usage in Maricopa County, reported Arizona state-level sales of high-sulfur diesel for 2005 are first subtracted from Arizona state-level total industrial fuel oil sales, as it is presumed that no high-sulfur diesel fuel is used in Maricopa County due to local air quality regulations and market conditions.

State industrial fuel oil sales other than high-sulfur diesel (in thousand gallons, or Mgal)	= Reported state total industrial fuel oil sales	–	Reported state high-sulfur diesel sales
	= 84,519 Mgal	–	431 Mgal
	= 84,088 Mgal/yr		

Arizona state industrial fuel oil sales (less high-sulfur diesel fuel) are then multiplied by the ratio of industrial employment in Maricopa County to Arizona State (0.70), as determined by data from the US Census Bureau (2006b) to estimate annual Maricopa County-level industrial fuel oil sales, as follows:

Maricopa County industrial fuel oil sales	= Arizona state industrial fuel oil sales less high-sulfur diesel	×	Maricopa County:State industrial employment ratio
	= 84,088 Mgal	×	0.70
	= 58,466.39 Mgal/yr		

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

Maricopa County area source fuel oil sales	= Maricopa County industrial fuel oil sales	–	Fuel oil used by industrial nonroad mobile equipment	–	Fuel oil used by industrial stationary point sources
	= 58,466.39 Mgal	–	9,928.15 Mgal	–	3,090.77 Mgal
	= 45,447.461 Mgal/yr				

Industrial fuel oil is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source industrial fuel oil sales derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal fuel oil combustion reported by all industrial area sources surveyed in 2005 (shown in Table 3.2–4 below).

Annual emissions for the county and the PM_{10} nonattainment area are calculated by multiplying industrial fuel oil sales by the respective AP-42 emission factors for external and internal combustion, as in this example for PM_{10} emissions from external fuel oil combustion:

Annual PM_{10} emissions from external industrial fuel oil combustion	=	External industrial fuel oil sales (Mgal)	×	PM_{10} emission factor for external fuel oil combustion (lb/Mgal)	÷	2,000 lb/ton
	=	35,453.565	×	2	÷	2,000
	=	35.45 tons PM_{10}/yr				

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

Combustion type	% of total	Annual sales (Mgal)	Emission factors (lb/Mgal)					Annual emissions (tons/yr)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
External	78.01	35,453.565	2.0	2.0	24	7.39	0.8	35.45	35.45	425.44	130.91	14.18
Internal	21.99	9,993.897	42.5	42.5	604	39.70	–	212.37	212.37	3,018.16	198.38	0.00
Totals:	**100.00**	**45,447.461**						**247.82**	**247.82**	**3,443.60**	**329.29**	**14.18**

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

PM_{10} typical daily emissions from industrial fuel oil	=	Annual PM_{10} emissions (tons/yr)	÷	(days/week × wks/yr)	×	2,000 lbs/ton
	=	247.82	÷	(6 × 52)	×	2,000
	=	1,588.6 lbs PM_{10}/day				

Annual and typical daily emissions in the PM_{10} nonattainment area are calculated by applying the ratio of industrial employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

PM_{10} NAA emissions from area source industrial fuel oil combustion	=	Annual county PM_{10} emissions	×	NAA:County industrial employment ratio
	=	247.82 tons/yr	×	0.9932
	=	246.14 tons PM_{10}/yr		

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

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Maricopa County	247.82	247.82	3,443.60	329.29	14.18	1,588.6	1,588.6	22,074.4	2,110.8	90.9
PM_{10} NAA	246.14	246.14	3,420.18	327.05	14.08	1,577.8	1,577.8	21,924.3	2,096.5	90.3

3.2.3 Commercial/institutional natural gas

All natural gas suppliers in Maricopa County were surveyed to gather information on the volume of natural gas distributed, by user category, within the county in 2005. Area-source commercial and institutional (C&I) natural gas usage for the county is based on the reported total volume of natural gas sold to C&I sources, minus natural gas used by C&I point sources:

County area-source C&I natural gas usage	=	Reported C&I natural gas sales	–	C&I point source natural gas usage
	=	16,286.09 MMCF	–	538.85 MMCF
	=	15,747.24 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 2005.

Annual emissions for the county are calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion, as in this example for PM_{10} emissions from external natural gas combustion:

Annual PM_{10} emissions from external natural gas combustion	=	External C&I natural gas usage (MMCF)	×	PM_{10} emission factor for external natural gas combustion (lb/MMCF)	÷	2,000 lb/ton
	=	15,485.18	×	7.6	÷	2,000
	=	58.84 tons PM_{10}/yr				

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

Combustion type	% of total	C&I natural gas usage (MMCF)	Emission factors (lb/MMCF)					Annual emissions (tons/yr)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
External	98.34	15,485.18	7.6	7.6	100	0.6	0.49	58.84	58.84	774.26	4.65	3.79
Internal	1.66	262.06	10.0	10.0	2840	0.6	n/a	1.31	1.31	372.13	0.08	n/a
Total:	**100.00**							**60.15**	**60.15**	**1,146.39**	**4.72**	**3.79**

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

PM_{10} typical daily emissions from C&I natural gas	=	Annual PM_{10} emissions (tons/yr)	÷ (days/week × wks/yr)	×	2,000 lbs/ton
	=	60.15	÷ (6 × 52)	×	2,000
	=	385.6 lbs/day			

Annual and typical daily emissions within the PM_{10} nonattainment area are calculated by applying the combined ratio of retail, office, public and other employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

Emissions from area-source C&I natural gas combustion in the PM_{10} NAA	= Annual county PM_{10} emissions (tons/yr)	× NAA:County C&I employment ratio	
	= 60.15	× 0.9928	
	= 59.72 tons PM_{10}/yr		

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	60.15	60.15	1,146.39	4.72	3.79	385.6	385.6	7,348.6	30.3	24.3
PM_{10} NAA	59.72	59.72	1,138.13	4.69	3.77	381.5	381.5	7,270.0	30.0	24.1

3.2.4 Commercial/institutional fuel oil

Area-source emissions from commercial and institutional (C&I) fuel oil combustion are calculated by a multi-step process of allocating Arizona state-level C&I fuel oil sales as reported by the U.S. Department of Energy, Energy Information Administration (US DOE, 2006b) to Maricopa County.

To derive commercial/institutional fuel oil usage in Maricopa County, reported Arizona state-level sales of high-sulfur diesel for 2005 are first subtracted from Arizona state-level total C&I fuel oil sales, as it is presumed that no high-sulfur diesel fuel is used in Maricopa County due to local clean air act requirements and market conditions.

State C&I fuel oil sales other than high-sulfur diesel (in thousand gallons, or Mgal)	= Reported state total C&I fuel oil sales	– Reported state high-sulfur diesel sales	
	= 20,645 Mgal	– 0 Mgal	
	= 20,645 Mgal/yr		

Arizona state commercial/institutional fuel oil sales (less high-sulfur diesel fuel) are then multiplied by the ratio of C&I employment in Maricopa County to Arizona state (0.80), as determined by data from the US Census Bureau (2006b) to estimate annual Maricopa County-level commercial/institutional fuel oil sales, as follows:

Maricopa County C&I fuel oil sales	= Arizona state C&I fuel oil sales less high-sulfur diesel	× Maricopa County:state commercial/ institutional employment ratio	
	= 20,645 Mgal	× 0.80	
	= 16,532.52 Mgal/yr		

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

Annual Maricopa County commercial/institutional area-source fuel oil sales	= Maricopa County C&I fuel oil sales	– Fuel oil used by C&I nonroad mobile equipment	– Fuel oil used by C&I stationary point sources	
	= 16,532.52 Mgal	– 6,092.013 Mgal	– 140.591 Mgal	
	= 10,299.912 Mgal/yr			

Fuel oil is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source C&I fuel oil sales derived above must be apportioned between these two categories. This apportionment was based

on the percentages of external and internal fuel oil combustion reported by all commercial and institutional area sources surveyed in 2005 (shown in Table 3.2–8 below).

Annual emissions for the county are calculated by multiplying C&I fuel oil sales by the respective AP-42 emission factors for external and internal combustion, as in this example for PM_{10} emissions from external fuel oil combustion:

Annual PM_{10} emissions from external fuel oil combustion	= External C&I fuel oil sales (Mgal)	×	PM_{10} emission factor for external fuel oil combustion (lb/Mgal)	÷	2,000 lb/ton
	= 6,895.711	×	1.08	÷	2,000
	= 3.72 tons PM_{10}/yr				

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

Combustion type	% of total	C&I fuel oil sales (Mgal)	Emission factors (lb/Mgal)					Annual emissions (tons/yr)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
External	66.95	6,895.711	1.08	1.08	24	7.1	0.8	3.72	3.72	82.75	24.48	2.76
Internal	33.05	3,404.121	42.5	42.5	604	39.7	–	72.34	72.34	1,028.04	67.57	0.00
Total:	**100.00**	**10,299.912**						**76.06**	**76.06**	**1,110.79**	**92.05**	**2.76**

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

Typical daily PM_{10} emissions from C&I fuel oil combustion	= Annual PM_{10} emissions (tons/yr)	÷	(days/week × wks/yr)	×	2,000 lbs/ton
	= 76.06	÷	(6 × 52)	×	2,000
	= 487.6 lbs/day				

Annual and typical daily emissions within the PM_{10} nonattainment area are calculated by applying the combined ratio of retail, public, office and other employment in the nonattainment area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

PM_{10} NAA emissions from area source C&I fuel oil combustion	= Annual county PM_{10} emissions (tons/yr)	×	NAA:County C&I employment ratio
	= 76.06	×	0.9928
	= 75.51 tons PM_{10}/yr		

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

Geographic area	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Maricopa County	76.06	76.06	1,110.79	92.05	2.76	487.6	487.6	7,120.5	590.1	17.7
PM_{10} NAA	75.51	75.51	1,102.80	91.39	2.74	484.1	484.1	7,069.2	585.8	17.6

3.2.5 Residential natural gas

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

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

PM_{10}	$PM_{2.5}$	NO_x	SO_x
7.6	**7.6**	**94**	**0.6**

Annual PM_{10} emissions from residential natural gas combustion = Residential natural gas annual sales (MMCF) × Residential natural gas emission factor for PM_{10} (lbs/MMCF) ÷ 2,000 lbs/ton

= 16,470.54 × 7.6 ÷ 2,000
= 62.59 tons PM_{10}/yr

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

Typical daily PM_{10} emissions from residential natural gas combustion = Annual PM_{10} emissions × 2,000 lbs/ton ÷ days/yr

= 62.59 tons/yr × 2, 000 ÷ 365
= 342.9 lbs PM_{10}/day

Annual and typical daily residential natural gas emissions in the PM_{10} nonattainment area are calculated by multiplying county-level emissions by the percentage of total residential population in the PM_{10} nonattainment area as follows:

Annual PM_{10} emissions from residential natural gas combustion in the NAA = County annual emissions × Percentage of residential population in the NAA

= 62.59 × 100.16%
= 62.69 tons PM_{10}/yr

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

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	62.59	62.59	774.12	4.94	342.9	342.9	4,241.7	27.1
PM_{10} NAA	62.69	62.69	775.35	4.95	343.5	343.5	4,248.5	27.1

3.2.6 Residential wood combustion

Area-source emissions from residential wood combustion are calculated based on the amount of wood burned in fireplaces and woodstoves in Maricopa County, as recommended by EIIP guidance (US EPA, 2001d). Residential wood combustion in the county is estimated by multiplying data on statewide residential wood combustion usage from the US Department of Energy (2006c) by the ratio of county to state households that report use of wood for heating from the US Census Bureau (2006a). The latest available data on residential wood use for household

heating from the US Department of Energy is for the calendar year 2003. Since all fireplaces in homes constructed since 1999 are required by Arizona statute to be clean-burning, it is assumed that these new homes have negligible emissions. Thus, year 2003 data is assumed to be representative of 2005 emissions.

Maricopa County residential wood usage (cords/yr)	=	Arizona residential wood usage (cords/yr)	×	Ratio of county:state households using wood for heat
	=	304,000	×	1,449 / 41,213
	=	10,701 cords/yr		

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

County residential wood usage (tons/yr)	=	County wood usage (cords)	×	avg. ft^3 wood/cord	×	Wood density (lbs/ ft^3)	÷	2,000 lbs/ton
	=	10,701	×	79	×	31.57	÷	2,000
	=	13,344.06 tons						

Annual emissions from residential wood combustion are calculated by multiplying the tons of wood used by the PM_{10} emission factor for residential woodstoves and fireplaces from US EPA (2001d), Table 2.4-1:

Annual PM_{10} emissions from residential wood combustion (tons/yr)	=	Residential wood usage (tons)	×	PM_{10} emission factor (lbs/ton)	÷ 2,000 lbs/ton
	=	13,344.06	×	34.6	÷ 2,000
	=	230.85 tons PM_{10}/yr			

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

Residential wood usage (tons/yr)	Emission factors (lbs/ton)				Annual emissions (tons/yr)			
	PM_{10}	$PM_{2.5}$*	NO_x	SO_x	PM_{10}	$PM_{2.5}$*	NO_x	SO_x
13,344.06	34.6	32.2	2.6	0.4	230.85	214.69	17.35	2.67

*$PM_{2.5}$ is assumed to be 93% of PM_{10} (Houck and Tiegs, 1998).

Typical daily emissions are calculated by apportioning wood burning activity based on heating degree days (i.e., the number of degrees per day that the daily average temperature is below 65°F). Data provided by Arizona Department of Commerce (ADOC, 2006) indicated that there were seven months (April–October, totaling 214 days) in 2005 where no heating degree days were recorded. Assuming that no wood burning activity took place during those months, that leaves 151 days were residential wood burning can be assumed to occur. Thus, typical daily emissions are calculated by dividing annual emissions by the number of days residential wood burning occurred, as follows:

Typical daily PM_{10} emissions from residential wood combustion (lbs/day)	= Annual PM_{10} emissions	× 2,000 lbs/ton	÷ number of days wood burning occurred	
	= 230.85	× 2,000	÷ 151	
	= 3,057.6 lbs PM_{10}/day			

Annual and typical daily emissions within the PM_{10} nonattainment area (NAA) are calculated by multiplying county totals by the ratio of residential population in the nonattainment area to the

residential population in the county. See Section 1.5.1 for a further discussion of the population used.

NAA annual emissions from residential wood combustion (tons/yr)	=	County annual emissions (tons/yr)	×	NAA:county residential population ratio
	=	230.85	×	1.0016
	=	231.22 tons PM_{10}/yr		

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

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	230.85	214.69	17.35	2.67	3,057.6	2,843.6	229.8	35.3
PM_{10} NAA	231.22	215.04	17.38	2.67	3,062.5	2,848.2	230.1	35.4

3.2.7 Residential fuel oil

Emissions from residential fuel oil use were calculated using an approach similar to that used for residential wood combustion described in Section 3.2.6. County-level residential fuel oil use was derived from statewide totals using the ratio of county to state households that report fuel oil use from the US Census Bureau (2006a):

Maricopa County residential fuel oil usage (Mgal/yr)	=	Arizona residential fuel oil use (Mgal/yr)	×	Ratio of county:state households reporting fuel oil use
	=	340	×	490 / 1,813
	=	91.89 Mgal/yr		

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

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

	Emission factors (lb/Mgal)				Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	0.4	0.4	18	7.1	0.01	0.01	0.66	0.26	0.2	0.2	8.7	3.4
PM_{10} NAA	0.4	0.4	18	7.1	0.01	0.01	0.66	0.26	0.2	0.2	8.7	3.4

3.2.8 Summary of all area-source fuel combustion

Tables 3.2–15 and 3.2–16 provide a summary of annual and typical daily emissions from all fuel combustion, for Maricopa County and the PM_{10} nonattainment area, respectively.

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

Fuel combustion type	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Industrial natural gas	16.51	16.51	308.43	1.30	6.81	105.9	105.9	1,977.1	8.3	43.7
Industrial fuel oil	247.82	247.82	3,443.60	329.29	14.18	1,588.6	1,588.6	22,074.4	2,110.8	90.9
Comm./inst. natural gas	60.15	60.15	1,146.39	4.72	3.79	385.6	385.6	7,348.6	30.3	24.3
Comm./inst. fuel oil	76.06	76.06	1,110.79	92.05	2.76	487.6	487.6	7,120.5	590.1	17.7
Residential natural gas	62.59	62.59	774.12	4.94		342.9	342.9	4,241.7	27.1	
Residential wood	230.85	214.69	17.35	2.67		3,057.6	2,843.6	229.8	35.3	
Residential fuel oil	0.01	0.01	0.66	0.26		0.2	0.2	8.7	3.4	
Total:	**694.01**	**677.85**	**6,801.33**	**435.23**	**27.55**	**5,968.4**	**5,754.4**	**43,000.7**	**2,805.4**	**176.6**

Table 3.2–16. Annual and typical daily emissions from all area-source fuel combustion for the PM_{10} NAA.

Fuel combustion type	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Industrial natural gas	16.40	16.40	306.33	1.29	6.77	104.7	104.7	1,955.5	8.2	43.2
Industrial fuel oil	246.14	246.14	3,420.18	327.05	14.08	1,577.8	1,577.8	21,924.3	2,096.5	90.3
Comm./inst. natural gas	59.72	59.72	1,138.13	4.69	3.77	381.5	381.5	7,270.0	30.0	24.1
Comm./inst. fuel oil	75.51	75.51	1,102.80	91.39	2.74	484.1	484.1	7,069.2	585.8	17.6
Residential natural gas	62.69	62.69	775.35	4.95		343.5	343.5	4,248.5	27.1	
Residential wood	231.22	215.04	17.38	2.67		3,062.5	2,848.2	230.1	35.4	
Residential fuel oil	0.01	0.01	0.66	0.26		0.2	0.2	8.7	3.4	
Total:	**691.70**	**675.51**	**6,760.83**	**432.30**	**27.36**	**5,954.3**	**5,739.9**	**42,706.4**	**2,786.5**	**175.1**

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 (2006b) 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 2004 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3–3.1 shows the NAICS codes and employment data used to calculate emissions from chemical manufacturing.

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

NAICS Code	Description	US Census employment data	Value used
32532	Pesticide & Other Agricultural Chemical mfg.	0–19	10
32552	Adhesive mfg.	100–249	175
32591	Printing Ink mfg.	250–499	375
324122	Asphalt Shingle & Coating Materials mfg.	20–99	60
325188	All Other Basic Inorganic Chemical mfg.	100–249	175
325412	Pharmaceutical Preparation mfg.	500–999	750
325510	Paint & Coating mfg.	20–99	60
325611	Soap & Other Detergent mfg.	20–99	60
325991	Custom Compounding of Purchased Resins	100–249	175
325998	All Other Miscellaneous Chemical Product & Preparation mfg.	20–99	60
424690	Other Chemical & Allied Products Merchant Wholesalers	968	968
Total:			**2,868**

Since there were no point sources in this category, area-source employment estimate is used to "scale up" emissions reported from those facilities surveyed in 2005 as follows:

$$\text{Area-source } PM_{10} \text{ emissions from chemical mfg.} = \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment}$$

$$= \frac{34.26 \text{ tons of } PM_{10}/\text{yr}}{1{,}280 \text{ employees}} \times 2{,}868 \text{ employees}$$

$$= 76.77 \text{ tons } PM_{10}/\text{yr}$$

PM_{10} typical daily emissions are calculated based on the operating schedule data reported by chemical manufacturing facilities. From annual emission surveys, the modal values were identified for two items: days/week and annual activity. This data was used to calculate typical daily emissions as follows:

$$\text{Typical daily } PM_{10} \text{ emissions from chemical mfg.} = \frac{\text{Annual emissions (tons/yr)}}{\text{Days/week} \times \text{Weeks/year}} \times \frac{2{,}000 \text{ lbs}}{\text{ton}}$$

$$= \frac{76.77}{5 \times 52} \times 2{,}000$$

$$= 590.5 \text{ lbs } PM_{10}/\text{day}$$

Annual and typical daily emissions for the PM_{10} 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.)

$$PM_{10} \text{ emissions from area-source chemical mfg. in the } PM_{10} \text{ NAA (tons/yr)} = \text{Annual Maricopa County emissions} \times \text{NAA:county ratio of industrial employment}$$

$$= 76.77 \text{ tons/yr} \times .9932$$

$$= 76.25 \text{ tons } PM_{10}/\text{yr}$$

Table 3.3–2 summarizes annual and typical daily emissions from chemical manufacturing in both Maricopa County and the PM_{10} nonattainment area.

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NHx**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NHx**
Maricopa County	76.77	38.85	0.39	0.21	0.34	590.5	298.9	3.0	1.6	2.6
PM_{10} NAA	76.25	38.59	0.38	0.21	0.34	586.5	296.8	3.0	1.6	2.6

3.3.2 Food and kindred products

3.3.2.1 Commercial cooking

Emissions from commercial cooking were estimated for five source categories based on equipment type. These equipment types include: chain-driven (conveyorized) charbroilers (SCC 2302002100), under-fired charbroilers (2302002200), flat griddles (2302003100), clamshell griddles (2302003200), and deep-fat fryers (2302003000). Emission inventory methods outlined in EPA guidance (US EPA, 2006) for these source categories include emissions from all meat types (hamburger, steak, fish, pork, and chicken) and five restaurant types (ethnic, fast food, family, seafood, and steak & barbeque).

Data obtained from MCAQD's eating and drinking establishments permit database indicated that 10,238 restaurants operated in Maricopa County in 2005. The percent of restaurants in Maricopa County for the five restaurant types was obtained from a commercial business database (Harris InfoSource, 2003). The percent of restaurants for each restaurant type was multiplied by the total number of restaurants operated in Maricopa County in 2005 to derive the number of restaurants for each restaurant type as shown in Table 3.3–3.

Table 3.3–3. Maricopa County restaurants by type.

Restaurant category	**Percentage**	**# of restaurants**
Ethnic food	14.47	1,481
Fast food	15.35	1,571
Family	3.64	372
Seafood	0.61	62
Steak & barbecue	1.15	118
Unrelated restaurant types e.g., lunchroom, bars,…	64.79	6,633
All restaurants	100.00	10,238

Using the number of restaurants for each restaurant type, along with the default emission factors and equations from EPA (2006), emissions for each combination of equipment type, restaurant type, and meat type were calculated, and the results were summed to estimate annual emissions for each type of cooking equipment, as shown in Table 3.3–4.

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

	Annual emissions (tons/yr)	
Equipment type	**PM_{10}**	**$PM_{2.5}$**
Chain-driven charbroilers	155.64	150.88
Underfired charbroilers	1,071.56	1,035.86
Deep fat fryers	0.00	0.00
Flat griddles	282.14	214.43
Clamshell griddles	18.64	15.79
Totals:	**1,527.98**	**1,416.96**

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

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

	Typical daily emissions (lbs/day)	
Equipment type	**PM_{10}**	**$PM_{2.5}$**
Chain-driven charbroilers	855.2	829.0
Underfired charbroilers	5,887.7	5,691.5
Deep fat fryers	0.0	0.0
Flat griddles	1,550.2	1,178.2
Clamshell griddles	102.4	86.5
Totals:	**8,395.5**	**7,785.5**

Annual and typical daily emissions for the PM_{10} nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage population within the nonattainment area of 100.78%. (See Section 1.5.1 for a discussion of the population data used.) Table 3.3–6 summarizes the annual and typical daily emissions from commercial cooking for Maricopa County and the PM_{10} NAA.

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

	Maricopa County				PM_{10} nonattainment area			
	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)		Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Equipment type	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Chain-driven charbroilers	155.64	150.88	855.2	829.0	156.86	152.05	861.9	835.5
Underfired charbroilers	1,071.56	1,035.86	5,887.7	5,691.5	1,079.92	1,043.94	5,933.6	5,735.9
Deep fat fryers	0.00	0.00	0.0	0.0	0.00	0.0	0.0	0.0
Flat griddles	282.14	214.43	1,550.2	1,178.2	284.34	216.10	1,562.3	1,187.4
Clamshell griddles	18.64	15.79	102.4	86.8	18.79	15.91	103.2	87.4
Totals:	**1,527.98**	**1,416.96**	**8,395.5**	**7,785.5**	**1,539.90**	**1,428.01**	**8,461.0**	**7,846.2**

3.3.2.2 Grain handling/processing

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

Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on either a 5- or 6-day week. As all facilities addressed in this source category are located within the PM_{10} nonattainment area, emission totals for both areas are equal. Annual and typical daily emissions are shown in Table 3.3–7.

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

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	12.64	2.68	94.7	20.5
PM_{10} NAA	12.64	2.68	94.7	20.5

3.3.2.3 Ammonia cold storage

Area-source emissions from ammonia cold storage are estimates of ammonia emissions from food and kindred products industrial sources that use ammonia for refrigeration of food products. Emission calculations are based on the number of employees in the food and kindred products industry classification (NAICS codes 311, 312) as reported by the 2004 County Business Patterns (US Census Bureau, 2006b). Annual emissions are calculated by multiplying employment numbers by the emission factor for ammonia cold storage as listed in Table 6-5 of "Development and Selection of Ammonia Emission Factors" (Battye et al., 1994) as follows:

Annual NH_3 emissions from ammonia cold storage (tons/yr)	= Number of employees in relevant industries (from CBP)	× NH_3 emission factor (lb/employee-yr)	÷ 2,000 lbs/ton
	= 8,213	× 413	÷ 2,000
	= 1,695.98 tons NH_3/yr		

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

Typical daily NH_3 emissions (lbs/day)	= Annual emissions (tons/yr)	× 2,000 lbs/ton	÷ (weeks/year × days/week)
	= 1,695.98	× 2,000	÷ (52 × 6)
	= 10.871.7 lbs NH_3/day		

Annual and typical daily emissions for the PM_{10} nonattainment area are calculated by multiplying Maricopa County emissions by the ratio of County industrial employment that occurs in the PM_{10} nonattainment area. (See Section 1.5.1 for a discussion of employment data).

Annual NH_3 emissions from ammonia cold storage in the PM_{10} NAA (tons/yr)	= Annual county emissions (tons/yr)	× NAA:County Industrial employment ratio
	= 1,695.98	× 0.9932
	= 1,684.45 tons NH_3/yr	

Table 3.3–8. Annual and typical daily NH_3 emissions from ammonia cold storage.

Geographic area	Annual emissions (tons/yr)	Typical daily emissions (lbs/day)
Maricopa County	1,695.98	10,871.7
PM_{10} NAA	1,684.45	10,797.8

3.3.3 Secondary metal production

Annual emissions from secondary metal production facilities were derived from annual emission reports from permitted sources. As this category consists primarily of foundries, it was assumed that there were no significant unpermitted sources within Maricopa County. Since all facilities considered in this section are located within the PM_{10} nonattainment area, total emission values for the county and the PM_{10} NAA from area-source secondary metal production are equal.

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	10.95	9.27	4.53	0.05	1.34	79.0	66.3	25.0	0.4	10.3
PM_{10} NAA	10.95	9.27	4.53	0.05	1.34	79.0	66.3	25.0	0.4	10.3

3.3.4 Non-metallic mineral processes

The primary contributors to this source category include concrete batch plants, ceramic clay and tile manufacturing, brick manufacturing, and gypsum mining. Emissions from this source were derived from annual emission reports from permitted facilities. Since all permitted facilities in this category were surveyed in 2005, it was assumed that there were no significant unpermitted sources within Maricopa County. Note that larger operations are treated as point sources, and addressed in Chapter 2. Some portable concrete batch operations which operate within Maricopa County for only part of the year are issued air quality permits by the Arizona Department of Environmental Quality (ADEQ). All state-permitted portable sources are addressed in Section 3.3.11.

Typical daily emissions are calculated based on the operating schedule data reported by surveyed facilities. Annual and typical daily emissions for the PM_{10} 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_{10} nonattainment area as a conservative estimate.

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

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

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	431.60	222.71	3,030.4	1,517.2
PM_{10} NAA	430.89	222.17	3,024.9	1,513.0

3.3.5 Mining and quarrying

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

Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on either a 5- or 6-day week. Emissions within the PM_{10} 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_{10} nonattainment area as a conservative estimate. Annual and daily emissions are shown in Table 3.3–11.

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

Geographic Area	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Maricopa County	62.97	17.38	409.1	112.1
PM_{10} NAA	54.77	15.52	347.6	98.2

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 (2006b) 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 2004 employment were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.3–12 shows the NAICS codes and employment data used to calculate emissions from wood product manufacturing.

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

NAICS Code	Description	US Census employment data	Value used
321---	Wood products manufacturing	7430	7430
337---	Furniture and related products manufacturing	7342	7342
Total:			**14,772**

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

Total area-source employment in wood products = Total employment (from US Census' County Business Patterns) – Employment at point sources (from annual emission reports)

= 14,772 – 4,216

= 10,556 employees

Annual emissions are calculated by "scaling up" area-source emissions reported from those facilities surveyed in 2005 as follows:

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

$$\text{Area-source } PM_{10} \text{ emissions from wood products} = \frac{51.792 \text{ tons of } PM_{10}/\text{yr}}{2{,}564 \text{ employees}} \times 10{,}556 \text{ employees}$$

$$= 213.23 \text{ tons } PM_{10}/\text{yr}$$

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_{10} 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.)

PM_{10} emissions from area-source wood products in the PM_{10} NAA (tons/yr)	= Annual Maricopa County emissions	×	NAA:county ratio of industrial employment
	= 213.23 tons/yr	×	.9932
	= 211.78 tons PM_{10}/yr		

Table 3.3–13 summarizes annual and typical daily emissions from wood products manufacturing in both Maricopa County and the PM_{10} nonattainment area.

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

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	213.23	149.95	1,657.9	1,170.0
PM_{10} NAA	211.78	148.93	1,646.6	1,162.0

3.3.7 Rubber/plastics manufacturing

Emissions from area-source rubber and plastic manufacturing facilities were calculated by the "scaling up" method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2006b) 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 2004 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. NAICS codes and descriptions for rubber and plastic manufacturing facilities.

NAICS Code	Description	US Census employment data	Value used
322130	Paperboard Mills	0 – 19	10
323116	Manifold Business Forms Printing		375
325991	Custom Compounding of Purchased Resins	100 – 249	175
326122	Plastics Pipe & Pipe Fitting Mfg.	250 – 499	375
32613	Laminated Plastics Plate, Sheet (except Packaging), & Shape Mfg.	0 – 19	10
32614	Polystyrene Foam Product Mfg.		316
326160	Plastics Bottle Mfg.		161
32619	Other Plastics Product Mfg.		4,117
326212	Tire Retreading	20 – 99	60
32622	Rubber & Plastics Hoses & Belting Mfg.	20 – 99	60
326299	All Other Rubber Product Mfg.	100 – 249	175
327991	Cut Stone & Stone Product Mfg.		411
333415	HVAC Equipment Mfg.	500 – 999	750
336612	Boat Building	0 – 19	10
33992	Sporting & Athletic Goods Mfg.		1,212
423930	Recyclable Material Merchant Wholesalers		503
Total:			**8,720**

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

Total area-source employment in rubber & plastic product manufacturing = Total employment (from US Census' County Business Patterns) – Employment at point sources (from annual emission reports)

= 8,720 – 2,536

= 6,184 employees

This area-source employment estimate is used to "scale up" emissions reported from those facilities surveyed in 2005 as follows:

$$\text{Total area-source } PM_{10} \text{ emissions from rubber/plastic product mfg.} = \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment}$$

$$= \frac{66.09 \text{ tons of } PM_{10}/\text{yr}}{1{,}119 \text{ employees}} \times 6{,}184 \text{ employees}$$

$$= 365.26 \text{ tons } PM_{10}/\text{yr}$$

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

$$\text{Typical daily } PM_{10} \text{ emissions from rubber \& plastic manufacturing} = \frac{\text{Annual emissions (tons/yr)}}{\text{Days/week} \times \text{Weeks/year}} \times \frac{2{,}000 \text{ lbs}}{\text{ton}}$$

$$= \frac{365.26}{5 \times 52} \times 2{,}000$$

$$= 2{,}809.7 \text{ lbs } PM_{10}/\text{day}$$

Annual and typical daily emissions for the PM_{10} 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.)

PM_{10} emissions from area-source plastic/rubber in the PM_{10} NAA (tons/yr) = Annual Maricopa County emissions × NAA:county ratio of industrial employment

= 365.26 tons PM_{10}/yr × 0.9932

= 362.77 tons PM_{10}/yr

Table 3.3–15 summarizes annual and typical daily emissions from rubber/plastic products manufacturing in both Maricopa County and the PM_{10} nonattainment area.

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

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	365.26	236.52	2,809.7	1,819.4
PM_{10} NAA	362.77	234.91	2,790.6	1,807.0

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 (2006b) 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 2004 employment were used. CBP employment data for NAICS code 332* (fabricated metal products manufacturing) indicated that there were 13,400 employees in this industry in Maricopa County. Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

Total area-source employment in fab. metal products	= Total employment (from US Census' County Business Patterns)	–	Employment at point sources (from annual emission reports)
	= 13,400	–	691
	= 12,709 employees		

Annual emissions are calculated by "scaling up" area-source emissions reported from those facilities surveyed in 2005 as follows:

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

$$\text{Area-source } PM_{10} \text{ emissions from fab. metal products} = \frac{12.519 \text{ tons of } PM_{10}/\text{yr}}{1{,}145 \text{ employees}} \times 12{,}709 \text{ employees}$$

$$= 138.96 \text{ tons } PM_{10}/\text{yr}$$

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_{10} 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.)

PM_{10} emissions from area-source fab. metal prod. in the PM_{10} NAA (tons/yr)	= Annual Maricopa County emissions	×	NAA:County ratio of industrial employment
	= 138.96 tons/yr	×	0.9932
	= 138.01 tons PM_{10}/yr		

Table 3.3–16 summarizes annual and typical daily emissions from fabricated metal products manufacturing in both Maricopa County and the PM_{10} nonattainment area.

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

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	138.96	119.88	1,579.3	1,404.1
PM_{10} NAA	138.01	119.06	1,568.6	1,394.5

3.3.9 Construction

Maricopa County's air quality permits database was used to identify all dust control permits issued during 2005. A total of 5,257 permits were issued, comprising a total of 68,664 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. 2005 Maricopa County dust control permits issued, by type.

Dust Control Permit Project Type	Reported Acres
Residential	47,324.4
Commercial	10,163.0
Road construction	4,247.5
Trenching	470.3
Demolition	584.3
Weed control	177.7
Site prep / land development	5,607.0
Temp. storage yard	89.3
Totals:	**68,663.5**

The Western Regional Air Partnership (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_{10}/acre-month for road construction to account for the large amount of dirt moved during the construction of roadways. However, the South Coast Air Quality Management District (SCAQMD) and the Clark County Department of Air Quality and Environmental Management estimated a percentage of their road construction projects did not involved large-scale earthmoving activities and therefore they used an average emission factor for road construction (.1895 ton PM_{10}/acre-month and 0.265 ton PM_{10}/acre-month, respectively). Because Maricopa County and Clark County have similar population growth, climatic, and PM_{10} 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_{10}/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.

Project Type	Average Duration (months)	Emission factor (tons PM_{10}/ acre-month)
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
Temp. storage yard	12	0.11

County-wide annual uncontrolled PM_{10} emissions for each construction category were then calculated as follows:

Annual uncontrolled PM_{10} emissions	= total acres/yr	× no. months	× emission factor (tons of PM_{10}/acre-month)
Example:			
Annual uncontrolled PM_{10} emissions from single-family residential construction	= 35,493.3 acres/yr	× 6 months	× 0.032 tons PM_{10}/acre-month
	= 6,814.72 tons PM_{10}/yr		

A control efficiency of 90% was applied to the uncontrolled emissions calculations. A recent rule effectiveness study by Maricopa County (contained in Appendix 2.2) indicates a 51% compliance rate with Maricopa County Rule 310 on dust control at construction sites. Thus, an overall control effectiveness of 44.1% (= 90% × 49%) was applied. Controlled PM_{10} emissions were calculated as follows:

Annual controlled PM_{10} emissions = Uncontrolled PM_{10} emissions (tons/yr) × [1 – (control efficiency × rule effectiveness)]

Example:

Annual controlled PM_{10} emissions from single-family residential construction = 6,814.72 tons × [1 – (90% control × 51% rule effectiveness)]

= 3,686.76 tons PM_{10}/yr

$PM_{2.5}$ emissions were calculated as 10% of PM_{10} emissions (WRAP, 2006a). Table 3.3–19 summarizes the calculations for each construction category.

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

Project Type	Total acre-months	Emission factor (tons/acre-month)	Uncontrolled PM_{10}	Controlled PM_{10}	Controlled $PM_{2.5}$
Residential: single-family	212,960.0	0.032	6,814.72	3,686.76	368.68
Residential: multi-unit	141,973.3	0.11	15,617.07	8,448.83	844.88
Commercial	111,793.1	0.19	21,240.69	11,491.21	1,149.12
Road construction	50,970.2	0.265	13,507.11	7,307.35	730.73
Trenching	470.3	0.11	51.73	27.99	2.80
Demolition	584.3	0.11	64.27	34.77	3.48
Weed control	177.7	0.11	19.55	10.58	1.06
Site prep/land development	44,855.8	0.11	4,934.13	2,669.37	266.94
Temporary storage yard	1,071.5	0.11	117.86	63.76	6.38
Totals:			**62,367.14**	**33,740.62**	**3,374.06**

Dust control permit site location data was used to determine construction activity that occurred in the Maricopa County PM_{10} 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_{10} nonattainment area. Table 3.3–20 summarizes Maricopa County PM_{10} nonattainment area construction activity and calculations for each project type.

Table 3.3–20. Annual emissions from construction (tons/yr) for the Maricopa County portion of PM_{10} NAA.

Project Type	Total Acres	Total acre-months	EF (tons/ acre-month)	Uncontrolled PM_{10}	Controlled PM_{10}	Controlled $PM_{2.5}$
Residential: single-family	32,631.6	195,789.5	0.032	6,265.26	3,389.51	338.95
Residential: multi-unit	10,877.2	130,526.3	0.11	14,357.90	7,767.62	776.76
Commercial	9,740.3	107,143.0	0.19	20,357.16	11,013.23	1,101.32
Road construction	4,199.2	50,390.8	0.265	13,353.55	7,224.27	722.43
Trenching	450.5	450.5	0.11	49.56	26.81	2.68
Demolition	580.6	580.6	0.11	63.86	34.55	3.46
Weed control	177.7	177.7	0.11	19.55	10.58	1.06
Site prep/land development	4,905.6	39,244.6	0.11	4,316.90	2,335.44	233.54
Temporary storage yard	89.3	1,071.48	0.11	117.86	63.76	6.38
Totals:	**63,652.0**			**58,901.61**	**31,865.77**	**3,186.58**

The Pinal County Air Quality Department (PCAQD) provided construction emission estimates for the Pinal County portion of the PM_{10} nonattainment. PCAQD estimated that 1.3 percent of the Pinal County construction activity occurred in the Pinal County portion of the PM_{10} nonattainment area, thus, annual and typical daily emission for the Pinal County portion of the PM_{10} nonattainment area was calculated by multiplying the Pinal County emission totals by 1.3 percent. PCAQD estimates incorporated the same average duration of construction activity, emission factors, control efficiency, and rule effectiveness as Maricopa County's estimates.

Table 3.3–21. Annual emissions from construction (tons/yr) for the Pinal County portion of the PM_{10} NAA.

Project Type	PM_{10}	$PM_{2.5}$
Residential: single-family	22.29	2.23
Residential: multi-family	152.56	15.26
Commercial	72.32	7.23
Road construction	12.15	1.21
Trenching	0.02	0.00
Demolition	0.00	0.00
Weed control	0.00	0.00
Site prep/land development	0.00	0.00
Temporary storage yard	4.72	0.47
Totals:	**264.08**	**26.41**

It was assumed that construction activity occurs 6 days per week and evenly throughout the year. Thus, typical daily emissions were calculated by dividing annual emissions by 312 (6 days/wk × 52 wks/yr).

Table 3.3–22. Annual and typical daily emissions from construction.

	Maricopa County				PM_{10} NAA			
	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)		Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Construction Type	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Residential	12,135.60	1,213.56	77,792.3	7,779.2	11,331.99	1,133.20	72,641.0	7,264.1
Commercial	11,491.21	1,149.12	73,661.6	7,366.2	11,085.55	1,108.55	71,061.2	7,106.1
Road construction	7,307.35	730.73	46,842.0	4,684.2	7,236.42	723.64	46,387.3	4,638.7
Construction - other*	2,806.46	280.65	17,990.2	1,799.0	2,475.89	247.59	15,871.1	1,587.1
Total	**33,740.62**	**3,374.06**	**216,286.0**	**21,628.6**	**32,129.85**	**3,212.98**	**205,960.6**	**20,596.1**

*Includes: trenching, demolition, weed control, site prep/land development, and temp. storage yd.

3.3.10 Electrical equipment manufacturing

Emissions from electric equipment manufacturing were derived from annual emission reports submitted by permitted sources. It was assumed that there were no significant unpermitted sources within Maricopa County. Note that larger operations are treated as point sources, and addressed in Chapter 2.

Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on either a 5- or 6-day week. As all facilities addressed in this source category are located within the PM_{10} 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.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	5.24	3.25	0.01	4.59	0.96	40.3	25.0	0.1	35.3	7.4
PM_{10} NAA	5.24	3.25	0.01	4.59	0.96	40.3	25.0	0.1	35.3	7.4

3.3.11 State-permitted portable sources

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

Data provided:

Source information: D.G.Huskin Construction 1000677

Permit type: Portable crushing/screening plant

Operating schedule: Operated from 5/31-6/29 Gila Bend SR 85 (Maricopa Co.); 6/30-8/30 Buckeye SR 85 (Maricopa Co.) 9/1-10/24 Cordes Jct I-17 (Yavapai Co.), 10/25-11/09 Williams SR 64 (Coconino Co.) and 11/10-12/31 Parker SR 95 (La Paz Co.)

Total annual emissions (tons/yr):

PM_{10}	$PM_{2.5}$ [1]	NO_x	SO_x
1.415	0.708	10.067	4.062

1. $PM_{2.5}$ was assumed to be 50% of reported PM_{10} for crushing/screening operations.

Using this information, calculations were made to determine:

Total operating days in 2005: 216 = 1 (May) + 30 (June) + … + 31 (Dec.)

Total operating days in Maricopa County: 92 = 1 (May) + 30 (June) + … + 30 (Aug.)

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

$$\text{Annual } PM_{10} \text{ emissions in Maricopa County} = \text{Total annual emissions (tons/yr)} \times \frac{\text{operating days in Maricopa County}}{\text{total operating days in 2002}}$$

$$= 1.415 \times \frac{92}{216}$$

$$= 0.61 \text{ tons } PM_{10}/\text{yr}$$

Typical daily emissions were then calculated as follows:

$$\text{Typical daily emissions (lbs/day)} = \frac{\text{total emissions attributable to activity in Maricopa County}}{\text{number of operating days in Maricopa County}} \times \frac{2{,}000 \text{ lbs}}{\text{ton}}$$

$$= \frac{0.61 \text{ tons}}{92 \text{ days}} \times \frac{2{,}000 \text{ lbs}}{\text{ton}}$$

$$= 13.2 \text{ lbs } PM_{10}/\text{day}$$

Table 3.3–24 summarizes the annual and typical daily emissions for all ADEQ-permitted portable sources that operated within Maricopa County at some point during 2005. Since no precise location data was not available for all permits, all emissions are conservatively assumed to have originated within the PM_{10} nonattainment area, therefore emissions in Maricopa County and the PM_{10} nonattainment area are equal.

Table 3.3–24. Emissions from ADEQ-permitted portable sources.

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM_{10}	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Total:	101.70	42.18	554.60	142.20	844.2	389.8	5,377.5	1,431.7

3.3.12 Paved/unpaved road travel on industrial sites

This section addresses emissions from travel on paved and unpaved roads within the boundaries of a permitted facility. Emissions from motor vehicle travel on public and private roads is addressed in Chapter 5, Mobile Sources, and road travel emissions from facilities considered point sources are addressed in Chapter 2, Point Sources. PM_{10} emissions from this source category were derived from annual emission reports from permitted sources, using AP-42 equations based on vehicle size and average speed (US EPA, 1997; 1998b). It is assumed that there are no unpermitted sources with significant emissions from on-site road travel.

$PM_{2.5}$ emissions were calculated from PM_{10} using a ratio derived from California Air Resources Board's (CARB) PM2.5 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_{10} nonattainment area were determined from the site locations of each facility.

Table 3.3–25. Annual and typical daily emissions from paved and unpaved road travel at industrial facilities.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	170.49	65.45	1,138.8	436.2
PM_{10} NAA	167.78	64.48	1,118.8	429.0

3.3.13 Industrial processes not elsewhere classified (NEC)

Annual area-source emissions from other industrial processes NEC were derived from annual emissions reports from permitted facilities. Other industrial processes include a wide array of industrial activities that are often specific to the permitted facility that reported the process. For this reason, it is assumed there are no significant emissions from other industrial processes, other than those reported by permitted facilities on their annual emissions reports. Typical daily emissions are calculated based on operating schedule information provided by the facilities in their annual emissions report. Emissions for the PM_{10} nonattainment area are based on the location of the facilities that report other industrial processes.

Table 3.3–26. Annual and typical daily emissions from other industrial processes not elsewhere classified.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	24.31	13.87	4.58	0.01	0.80	202.0	97.3	26.7	<0.1	4.6
PM_{10} NAA	24.29	13.86	4.08	0.01	0.80	201.9	97.2	22.9	<0.1	4.6

3.3.14 Summary of all area-source industrial processes

Tables 3.3–27 and 3.3–28 provide a summary of annual and typical daily emissions from all industrial sources, for Maricopa County and the PM_{10} nonattainment area, respectively.

Table 3.3–27. Annual and typical daily emissions from all area-source industrial processes in Maricopa County.

	Annual emissions (tons/yr)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Chemical manufacturing	76.77	38.85	0.39	0.21	0.34
Commercial cooking	1,527.98	1,416.96			
Grain handling/processing	12.64	2.68			
Ammonia cold storage					1,695.98
Secondary metal production	10.95	9.27	4.53	0.05	1.34
Non-metallic mineral processes	431.60	222.71			
Mining and quarrying	62.97	17.38			
Wood product manufacturing.	213.23	149.95			
Rubber/plastic product manufacturing	365.26	236.52			
Fabricated metal product manufacturing	138.96	119.88			
Residential construction	12,135.60	1,213.56			
Commercial construction	11,491.21	1,149.12			
Road construction	7,307.35	730.73			
Other construction	2,806.46	280.65			
Electrical equipment manufacturing	5.24	3.25	0.01	4.59	0.96
ADEQ-permitted portable sources	101.70	42.18	554.60	142.20	
Road travel at industrial sites	170.49	65.45			
Industrial processes NEC	24.31	13.87	4.58	0.01	0.80
All industrial processes:	**36,882.71**	**5,713.02**	**564.11**	**147.06**	**1,699.43**

	Typical daily emissions (lbs/day)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Chemical manufacturing	590.5	298.9	3.0	1.6	2.6
Commercial cooking	8,395.5	7,785.5			
Grain handling/processing	94.7	20.5			
Ammonia cold storage					10,871.7
Secondary metal production	79.0	66.3	25.0	0.4	10.3
Non-metallic mineral processes	3,030.4	1,517.2			
Mining and quarrying	409.1	112.1			
Wood product manufacturing.	1,657.9	1,170.0			
Rubber/plastic product manufacturing	2,809.7	1,819.4			
Fabricated metal product manufacturing	1,579.3	1,404.1			
Residential construction	77,792.3	7,779.2			
Commercial construction	73,661.6	7,366.2			
Road construction	46,842.0	4,684.2			
Other construction	17,990.2	1,799.0			
Electrical equipment manufacturing	40.3	25.0	0.1	35.3	7.4
ADEQ-permitted portable sources	844.2	389.8	5,377.5	1,431.7	
Road travel at industrial sites	1,138.8	436.2			
Industrial processes NEC	202.0	97.3	26.7	<0.1	4.6
All industrial processes:	**237,157.6**	**36,770.8**	**5,432.2**	**1,469.1**	**10,896.2**

Table 3.3–28. Annual and typical daily emissions from all area-source industrial processes in the PM_{10} NAA.

	Annual emissions (tons/yr)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Chemical manufacturing	76.25	38.59	0.38	0.21	0.34
Commercial cooking	1,539.90	1,428.01			
Grain handling/processing	12.64	2.68			
Ammonia cold storage					1,684.45
Secondary metal production	10.95	9.27	4.53	0.05	1.34
Non-metallic mineral processes	430.89	222.17			
Mining and quarrying	54.77	15.52			
Wood product manufacturing.	211.78	148.93			
Rubber/plastic product manufacturing	362.77	234.91			
Fabricated metal product manufacturing	138.01	119.06			
Residential construction	11,331.99	1,133.20			
Commercial construction	11,085.55	1,108.55			
Road construction	7,236.42	723.64			
Other construction	2,475.89	247.59			
Electrical equipment manufacturing	5.24	3.25	0.01	4.59	0.96
ADEQ-permitted portable sources	101.70	42.18	554.60	142.20	
Road travel at industrial sites	167.78	64.48			
Industrial processes NEC	24.29	13.86	4.08	0.01	0.80
All industrial processes:	**35,266.82**	**5,555.90**	**563.60**	**147.05**	**1,687.89**

	Typical daily emissions (lbs/day)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Chemical manufacturing	586.5	296.8	3.0	1.6	2.6
Commercial cooking	8,461.0	7,846.2			
Grain handling/processing	94.7	20.5			
Ammonia cold storage					10,797.8
Secondary metal production	79.0	66.3	25.0	0.4	10.3
Non-metallic mineral processes	3,024.9	1,513.0			
Mining and quarrying	347.6	98.2			
Wood product manufacturing.	1,646.6	1,162.0			
Rubber/plastic product manufacturing	2,790.6	1,807.0			
Fabricated metal product manufacturing	1,568.6	1,394.5			
Residential construction	72,641.0	7,264.1			
Commercial construction	71,061.2	7,106.1			
Road construction	46,387.3	4,638.7			
Other construction	15,871.1	1,587.1			
Electrical equipment manufacturing	40.3	25.0	0.1	35.3	7.4
ADEQ-permitted portable sources	844.2	389.8	5,377.5	1,431.7	
Road travel at industrial sites	1,118.8	429.0			
Industrial processes NEC	201.9	97.2	22.9	<0.1	4.6
All industrial processes:	**226,765.3**	**35,741.7**	**5,428.5**	**1,469.1**	**10,822.7**

3.4 Waste treatment and disposal

3.4.1 On-site incineration

This section includes emissions from on-site industrial incinerators, primarily burn-off ovens used to reclaim electric wire or other materials. Emissions from human and animal crematories are addressed in Section 3.5.4. There were no incinerators at residential (e.g., apartment complexes) or commercial/institutional facilities (e.g., hospitals, service establishments) in operation during 2005.

Emissions from on-site incineration were determined from annual emission inventory reports. It is assumed that all incinerator emissions are accounted for, since all permitted incinerators received surveys in 2005. All surveyed facilities are located within the PM_{10} 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.

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	0.15	0.10	2.54	0.03	1.6	1.1	19.9	0.3
PM_{10} NAA	0.15	0.10	2.54	0.03	1.6	1.1	19.9	0.3

3.4.2 Open burning

Emissions from controlled open burning are regulated by Maricopa County Air Pollution Control Regulations Rule 314 (Open Outdoor Fires), which requires a burn permit for open burning in Maricopa County. Burn permits are issued primarily for purposes of agricultural ditch bank and fence row burning, tumbleweed burning, land clearance, air curtain destructor burning of trees, and fire fighting training. Maricopa County's burn permit data base was used to identify all burn permits issued during 2005. A total of 73 permits were issued during the year; however, not all permit applications contained the information needed to calculate emissions. Where data were missing, activity data for each permit category was grown from those permits that contained information, as follows:

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

Example:

$$\text{Total ditch-bank/fencerows} = 1{,}504{,}852 \text{ linear ft (reported)} \times \frac{50 \text{ burn permits issued}}{29 \text{ permits with data}} = 2{,}594{,}572 \text{ linear ft}$$

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

Table 3.4–2. 2005 Maricopa County burn permit activity data.

Category	**Unit of measure**	**Total reported activity**	**Number of permits with activity data**	**Total permits issued**	**Activity grown to total number of permits issued**
Ditchbank/fencerow	Linear ft	1,504,852	29	50	2,594,572
Land clearance	Acres	5	1	7	35
Land clearance	Piles	37	2	7	130
Air curtain	Material Burned	70	7	7	70
Tumbleweeds	Piles	20	3	4	27

The above activity data were converted to tons material burned using fuel loading factors from AP-42, Table 2.5-5 (US EPA, 1992). The emission and loading factors used are shown in Table 3.4–3. As a conservative estimate, all particulate matter is presumed to be PM_{10} (and $PM_{2.5}$).

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

	Emission factors (lb/ton burned)					
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**Fuel loading factor**
Weeds, unspecified	15	15	4	n/a	n/a	3.2 tons/acre
Russian Thistle (tumbleweeds)	22	22	4	n/a	n/a	0.1 tons/acre
Orchard Crops: Citrus	6	6	4	n/a	n/a	1.0 tons/acre

The following assumptions were made based on previous Maricopa County emission inventory and information from MCAQD's open burn program staff:

- Ditch banks and fence rows in Maricopa County average 7 feet in width and are burned twice per year (MCESD, 1999).
- A pile of tumbleweeds 15 feet in diameter and 5 feet high weighs 200 lbs (MCESD, 1993). This is equivalent to the AP-42 fuel loading factor for tumbleweeds – 0.1 tons/acre.
- Air curtain destructors burn between 7–10 tons of material per day. (MCAQD, 2006).

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

Material burned from ditchbanks and fence rows $= \frac{2{,}594{,}572 \text{ ft length}}{43{,}560 \text{ ft}^2 / \text{acre}} \times 7 \text{ ft width} \times 3.2 \text{ tons/acre} \times 2 \text{ times/yr}$

$= 2{,}668$ tons material burned/yr

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

Annual emissions were then calculated by multiplying the amount of material burned by AP-42 emission factors (listed in Table 3.4–3) for each open burning category. To account for unpermitted illegal outdoor burning, all calculated emissions estimates were increased 2.31 times based on complaints received in 2006 for open or illegal outside burning (169 complaints received; 169 complaints/73 open burn permits = 2.31).

Annual PM_{10} emissions from ditchbank and fence row burning = Total material burned × emission factor × unit conversion factor

= 2,668 tons × 15 lbs/ton × 1 ton / 2,000 lbs
= 20.01 tons/yr

Total annual PM_{10} emissions including unpermitted burning = Calculated emissions from permit data + unpermitted burning adjustment factor

= 20.02 tons/yr × 2.32
= 46.44 tons PM_{10}/yr

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

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

		Annual emissions (tons/yr)		
Category	**Ton-equivalents**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**
Ditchbank/fencerow	2,668.4	46.43	46.43	12.38
Land clearance	526.4	9.61	9.61	2.44
Air curtain	70.0	0.49	0.49	0.32
Tumbleweeds	2.67	0.07	0.07	0.01
Totals:		**56.15**	**56.15**	**15.16**

Annual emissions for the nonattainment area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the PM_{10} nonattainment area by the Maricopa County emission totals. (See Section 1.5.1 for a discussion of the land-use data used.) Table 3.4–5 summarizes the annual emissions for the PM_{10} nonattainment area.

Table 3.4–5. Surrogate land-use classes, ratios, and annual emissions from open burning in the PM_{10} NAA.

	Surrogate land	**2004 NAA:county**	**Emissions (tons/yr)**		
Category	**use categories**	**land-use ratio**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**
Ditchbank/fencerow	Agriculture	48.01 %	22.29	22.29	5.94
Land clearance	Vacant	19.82 %	1.82	1.82	048
Air curtain	Agriculture and vacant	25.06 %	0.12	0.12	0.08
Tumbleweeds	Agriculture and vacant	25.06 %	0.02	0.02	0.00
Totals:			**24.24**	**24.24**	**6.51**

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

PM_{10} typical daily emissions for Maricopa County are derived as follows:

$$\text{Typical daily } PM_{10} \text{ emissions} = \frac{\text{annual } PM_{10} \text{ emissions (tons/yr)} \times 2000 \text{ lbs/ton}}{\text{(burn days/week)} \times \text{(burn weeks/year)}}$$

$$\text{Typical daily } PM_{10} \text{ emissions from ditchbank/ fence row burning} = \frac{46.43 \text{ tons/yr} \times 2000 \text{ lbs/ton}}{5 \text{ days/wk} \times 39 \text{ wks/yr}}$$

$$= 476.2 \text{ lbs } PM_{10}\text{/day}$$

Typical daily emissions for the PM_{10} nonattainment area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the nonattainment area by the Maricopa County typical daily emissions. (See Section 1.5.2 for a discussion of the land-use data used.) Table 3.4–6 summarizes the typical daily emissions from open burning for both Maricopa County and the PM_{10} nonattainment area.

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

	Maricopa County (lbs/day)			**PM_{10} nonattainment area (lbs/day)**		
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**
Ditchbank/fencerow	476.2	476.2	127.0	228.6	228.6	61.0
Land clearance	70.5	70.5	28.8	14.0	14.0	3.7
Air curtain	3.7	3.7	2.5	0.9	0.9	0.6
Tumbleweeds	0.5	0.5	0.1	0.1	0.1	0.0
Totals:	**550.9**	**550.9**	**148.4**	**243.6**	**243.6**	**65.3**

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. Five MSW landfills (Butterfield Station, City Of Chandler Landfill, Northwest Regional Landfill, Skunk Creek Landfill and Southwest Regional Municipal Solid Waste Landfill) are considered point sources and are reported in Chapter 2. All other MSW landfills are reported here as area-source landfills.

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

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	6.79	4.05	6.50	1.11	39.5	23.5	36.3	6.3
PM_{10} NAA	6.79	4.05	6.50	1.11	39.5	23.5	36.3	6.3

3.4.4 Publicly owned treatment works (POTWs)

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

Table 3.4–8. NH_3 emissions from publicly-owned treatment works (POTWs).

Geographic area	**2005 Population**	**NH_3 emission factor (lbs/10^6 gals treated)**	**Annual NH_3 emissions (tons/yr)**	**Typical daily NH_3 emissions (lbs/day)**
Maricopa County	3,780,380	19.0	1,310.85	7,182.72
PM_{10} NAA	3,809,701	19.0	1,321.01	7,238.4

3.4.5 Other industrial waste disposal

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

All facilities that reported area-source emissions from other industrial waste disposal are located inside the PM_{10} nonattainment area, therefore emissions for Maricopa County and the PM_{10} NAA are equal.

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

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	79.55	48.51	4.15	5.01	606.0	369.6	22.8	27.5
PM_{10} NAA	79.55	48.51	4.15	5.01	606.0	369.6	22.8	27.5

3.4.6 Summary of all area-source waste disposal

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

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
On-site incineration	0.15	0.10	2.54	0.03		1.6	1.1	19.9	0.3	
Open burning	56.15	56.15	15.16			550.9	550.9	148.4		
Landfills	6.79	4.05	6.50	1.11		39.5	23.5	36.3	6.3	
POTWs					1,310.85					7,182.7
Other	79.55	48.51	4.15	5.01		606.0	369.6	22.8	27.5	
Total:	**142.64**	**108.81**	**28.35**	**6.14**	**1,310.85**	**1,198.1**	**945.1**	**227.4**	**34.0**	**7,182.7**

Table 3.4–11. Annual and typical daily emissions from all area-source waste disposal for the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
On-site incineration	0.15	0.10	2.54	0.03		1.6	1.1	19.9	0.3	
Open burning	24.24	24.24	6.51			243.6	243.6	65.3		
Landfills	6.79	4.05	6.50	1.11		39.5	23.5	36.3	6.3	
POTWs					1,321.01					7,238.4
Other	79.55	48.51	4.15	5.01		606.0	369.6	22.8	27.5	
Total:	**110.74**	**76.90**	**19.70**	**6.14**	**1,321.01**	**890.8**	**637.8**	**144.4**	**34.0**	**7,238.4**

3.5 Miscellaneous area sources

3.5.1 Other combustion

3.5.1.1 Wildfires

Federal and state records of individual vegetation fire events were collected from the Arizona State Land Department WildCAD database (ASLD, 2006a), and the United States Geological Survey GeoMAC Wildland Fire Support database (USGS, 2006). Only vegetation fires with reported acreage were used to estimate emissions from wildfires. Thirty-eight fires occurred within the PM_{10} nonattainment area, resulting in nearly 22,000 acres burned. The largest fire within the PM_{10} nonattainment area was the Bart fire which occurred in May 2006 and resulted in over 14,000 acres burned.

Fire activity records in the two databases were culled for duplicates by comparing incident names and incident dates. The acreage for fires located near the Maricopa County border where reviewed by Arizona State Land Department (ASLD) staff to ensure that only acres burned within Maricopa County were included in emission estimates. ASLD staff also reviewed acreage estimates for all fires with a discrepancy greater than 500 acres between data reported by ASLD and USGS. When fuel type data was missing from state and federal records, fuel type was obtained from Incident Status Summary, Form ICS-209 (USFSa, 2006). In the event that fire event-specific fuel type were not contained in federal or state data nor in the ICS-209 forms, then National Fire Danger Rating System (NFDRS) model descriptions of "sagebrush grass" or "California chaparral" were assigned based on guidance from Arizona State Land Department (ASLD, 2006b).

NFDRS model descriptions were assigned to each fire event based on the fuel type and then corresponding fuel loadings were assigned (WGA/WRAP, 2005). Estimates of the material burned were derived by multiplying the number of acres burned by the assigned fuel loading factor.

Table 3.5–1. Assigned NFDRS Model categories, fuel loading factors, and material burned.

NFDRS Model Description	Fuel Load (tons/acre)	Data	PM_{10} NAA	Maricopa County
California Chaparral	19.5	acres burned	14,634	187,864
		material burned (tons)	285,365	3,663,350
Intermediate Brush	15	acres burned	2,788	81,446
		material burned (tons)	41,820	1,221,690
Sagebrush Grass	4.5	acres burned	4,137	34,163
		material burned (tons)	18,618	153,736
Western Grasses (annual)	0.5	acres burned	213	12,447
		material burned (tons)	106	6,224
Total acres burned			21,772	315,921
Total material burned (tons)			345,909	5,044,999

Emission factors were obtained from the Western Regional Air Partnership's (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005). Emission factors are listed below in Table 3.5–2.

Table 3.5–2. Summary of emission factors for prescribed fire (lb/ton).

Wildfire Emission Factors	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Prescribed fire (Non-Piled)	28.1	24.1	6.2	1.7	1.3

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

$$\text{Annual } PM_{10} \text{ emissions from wildfires in Maricopa County} = \frac{\text{material burned} \times \text{emission factor (lbs/ton)}}{2{,}000 \text{ lbs/ton}}$$

$$= \frac{5{,}044{,}999 \text{ tons of material burned} \times 28.1 \text{ lbs } PM_{10}/\text{ton}}{2{,}000 \text{ lbs/ton}}$$

$$= 70{,}882.24 \text{ tons } PM_{10}/\text{yr}$$

Fire activity records included fire locations in latitude and longitude. This data was used to determine the number of acres burned inside of the nonattainment area. Estimates of the material burned were derived by multiplying the number of acres burned within the nonattainment area by the assigned fuel loading factor. Annual emissions from wildfires within the nonattainment area were then calculated by multiplying the material burned by the appropriate emission factor.

$$\text{Annual } PM_{10} \text{ emissions from wildfires within the } PM_{10} \text{ NAA} = \frac{\text{material burned within the } PM_{10} \text{ NAA} \times \text{emission factor (lbs/ton)}}{2{,}000 \text{ lbs/ton}}$$

$$= \frac{345{,}909 \text{ tons of material burned} \times 28.1 \text{ lbs } PM_{10}/\text{ton}}{2{,}000 \text{ lbs/ton}}$$

$$= 4{,}860.0 \text{ tons } PM_{10}/\text{yr}$$

Table 3.5–3. Annual emissions from wildfires (tons/yr).

Geographic Area	Material Burned (tons)	Annual emissions (tons/yr)				
		PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Maricopa County	5,044,999	70,882.24	60,792.24	15,639.50	4,288.25	3,279.25
PM_{10} NAA	345,909	4,860.02	4,168.20	1,072.32	294.02	224.84

Average daily emissions were estimated by dividing annual emissions by the number of burn days in 2005.

$$\text{Average daily } PM_{10} \text{ emissions from wildfires in Maricopa County} = \frac{70{,}882.24 \text{ tons } PM_{10}/\text{yr} \times 2{,}000 \text{ lbs/ton}}{298 \text{ days/yr}}$$

$$= 475{,}719.7 \text{ lbs } PM_{10}/\text{day}$$

Table 3.5–4. Average daily emissions from wildfires (lbs/day).

Geographic Area	Number of Burn Days	Avg daily emissions (lbs/day)				
		PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Maricopa County	298	475,719.7	408,001.6	104,963.1	28,780.2	22,008.4
PM_{10} NAA		32,617.6	27,974.5	7,196.8	1,973.3	1,509.0

3.5.1.2 Prescribed fires

Prescribed fires data were obtained from the United States Forest Service (USFS, 2006b). The United States Forest Service reported that one prescribed fire occurred in Maricopa County in 2005. Three acres of piled fuels were burned in the Tonto National Forest on October 21, 2005. The burn occurred outside of the PM_{10} nonattainment area.

Prescribed fire emission factors were obtained from the Western Regional Air Partnership's (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005). The United States Forest Service estimated the fuel loading. Both are listed in Table 3.5–5. Estimates of the material burned in are derived by multiplying the number of acres burned by the appropriate fuel loading factor.

Table 3.5–5. Emission and fuel loading factors for prescribed fires.

Type of fire	Number of acres burned	Fuel loading factor (tons/acre)	Emission factors (lbs/ton burned)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Prescribed fire (piled Fuels)	3	5.0	8.0	8.0	6.2	1.7	.05

Annual emissions from prescribed fires in Maricopa County were calculated as follows.

$$\text{Annual } PM_{10} \text{ emissions from prescribed fires in Maricopa County} = \frac{\text{acres burned} \times \text{fuel loading factor} \times \text{emission factor (lbs/ton)}}{2{,}000 \text{ lbs/ton}}$$

$$= \frac{3 \text{ acres burned} \times 5.0 \text{ tons/acre} \times 8.0 \text{ lbs/ton}}{2{,}000 \text{ lbs/ton}}$$

$$= 0.06 \text{ tons } PM_{10}/\text{yr}$$

Because the prescribed fire occurred in the Tonto National Forest, which is located outside of the nonattainment area, emissions from prescribed fires within the nonattainment area were determined to be zero. It was assumed that the prescribed fire lasted one day. Thus, daily

emissions from prescribed fires (lbs./day) are equal to annual emissions (tons/day) divided by 2000 lbs/ton.

Table 3.5–6. Annual and typical daily emissions from prescribed fires.

	Annual emissions (tons/yr)					Typical daily emission (lbs/day)				
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	0.06	0.06	0.05	0.01	0.00	120.0	120.0	93.0	25.5	7.5
PM_{10} NAA	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0

3.5.1.3 Structure fires

2005 structure fire data were obtained by surveying fire departments in Maricopa County and by querying Maricopa County's burn permit data base. Approximately 50 percent of the fire departments surveyed responded to the survey. Because actual fire data was only collected for a portion of the fire departments in Maricopa County, the number of structure fires reported were scaled up to the entire inventory area based on population. The most recent population estimates for Maricopa County were used to scale up the number of structure fires (DES, 2006). Five open burn permits were issued in 2005 for fire training; these were included in the total number of estimated structure fires for 2005. It was estimated that 3,628 structure fires occurred in Maricopa County in 2005.

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

Material burned in structure fires (tons/yr) = 3,628 fires × 1.15 tons/fire

= 4,171.77 tons material burned/yr

Table 3.5–7. Estimated material burned, emission and fuel loading factors for structure fires.

Structure fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)				
			PM_{10}	**$PM_{2.5}$***	**NO_x**	**SO_x**	**NH_3**
3,628	1.15	4,171.77	10.8	10.8	1.4	n/a	n/a

* All PM_{10} is assumed to be $PM_{2.5}$.

Annual emissions were then calculated by multiplying the amount of material burned by the emission factors listed in Table 3.5–7 (from US EPA, 2001e), as follows:

Annual PM_{10} emissions from structure fires Maricopa County = Quantity of material burned × emission factor × unit conversion factor

= 4,171.77 tons × 10.8 lbs/ton × (1 ton/2,000 lbs.)

= 22.53 tons PM_{10}/yr

Annual emissions for the PM_{10} nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the PM_{10} nonattainment area (100.16%), as shown in the example below. See Section 1.5.2 for a discussion of the population data used.

Annual PM_{10} emissions within the PM_{10} NAA = annual PM_{10} emissions for Maricopa County × percentage residential population within the NAA

= 22.53 tons/yr × 100.16%

= 22.56 tons PM_{10}/yr

Typical daily emissions for both Maricopa County and the PM_{10} nonattainment area are calculated by dividing annual emissions by 364, as activity is assumed to take place 7 days a week. Typical daily emissions for Maricopa County were derived using the following formula:

Typical daily PM_{10} emissions from structure fires = $\frac{\text{annual } PM_{10} \text{ emissions (lbs)}}{\text{7 days/wk} \times \text{52 weeks/yr}}$

= $\frac{45{,}060 \text{ lbs}}{364}$

= 123.8 lbs/day

Table 3.5–8. Annual and typical daily emissions from structure fires.

	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**
Maricopa County	22.53	22.53	2.92	123.8	123.8	16.0
PM_{10} NAA	22.56	22.56	2.92	124.0	124.0	16.1

3.5.1.4 Vehicle fires

2005 vehicle fire data were obtained by surveying fire departments in Maricopa County. Approximately 50 percent of the fire departments surveyed responded to the survey. Because actual fire data was only collected for a portion of the fire departments in Maricopa County, the number of vehicle fires reported were scaled up to the entire inventory area based on population. The most recent population estimates for Maricopa County were used to scale up the number of vehicle fires (DES, 2006). It was estimated that 2,113 vehicle fires occurred in Maricopa County in 2005.

Annual emissions from vehicle fires are calculated by first multiplying the number of vehicle fires by a fuel loading factor of per vehicle fire to estimate the annual amount of material burned in vehicle fires (US EPA, 2000). The amount of annual material burned in vehicle fires is then multiplied by emission factors for open burning of automobile components from AP-42 as listed in table 3.5–9 (US EPA, 1992).

Annual PM_{10} emissions from vehicle fires = annual number of vehicle fires × fuel loading factor × emission factor × unit conversion factor

= 2,113 × 0.25 tons/vehicle × 100 lbs/ton × (1 ton / 2,000 lbs)

= 26.41 tons PM_{10}/yr

Table 3.5–9. Estimated material burned, fuel loading factors, and emission factors for vehicle fires.

Vehicle fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)				
			PM_{10}	**$PM_{2.5}$***	**NO_x**	**SO_x**	**NH_3**
2,113	0.25	528.25	100	100	4	n/a	n/a

* All PM_{10} is assumed to be $PM_{2.5}$.

Annual emissions for the PM_{10} nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the PM_{10} nonattainment area (100.16%). See Section 1.5.1 for a discussion of the population data used.

Annual PM_{10} emissions from vehicle fires in the PM_{10} NAA	= annual PM_{10} emissions for Maricopa County	×	percentage of total residential population within the PM_{10} NAA
	= 26.41 tons/yr	×	100.16%
	= 26.45 tons/yr		

It is assumed that vehicle fires occur evenly throughout the year. Thus, typical daily emissions were derived by dividing the Maricopa County and nonattainment area annual emissions by 365 days/year. The results are shown in Table 3.5–10 below.

Table 3.5–10. Annual and typical daily emissions from vehicle fires.

	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**
Maricopa County	26.41	26.41	1.06	144.7	144.7	5.8
PM_{10} NAA	26.45	26.45	1.06	145.0	145.0	5.8

3.5.1.5 Engine testing

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

Since all facilities considered in this section are located within the PM_{10} nonattainment area, total emission values for the county and the PM_{10} NAA are equal. Results are shown in Table 3.5–11.

Table 3.5–11. Annual and typical daily emissions from engine testing.

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	0.15	0.12	4.61	1.89	1.1	0.9	35.4	14.5
PM_{10} NAA	0.15	0.12	4.61	1.89	1.1	0.9	35.4	14.5

3.5.2 Agricultural Activities

3.5.2.1 Tilling

Tillage emissions were estimated using the tillage emission factor equation and Maricopa County specific soil silt content for agricultural land (URS and ERG, 2001). The number of planted or harvested acres by crop were obtained from the Arizona Agricultural Statistics Service (AASS, 2006). 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_{10} / acre-pass)
k = Particle size multiplier (value of 0.15 for PM_{10})
s = Silt content of soil (percent) = 35.2% (URS and ERG, 2001)

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

Annual PM_{10} emissions from agricultural tillage were calculated for each crop category using the following equation (URS and ERG, 2001; Pollack *et al.*, 2003):

$$Tillage_{Crop} = EF \times AP_{Crop} \times A_{Crop} \times ton / 2{,}000\ lb$$

where:
$Tillage_{Crop}$ = Tillage emissions for each crop type (lbs PM_{10}),
EF = Tillage emission factor (lbs PM_{10}/acre-pass),
AP_{Crop} = Number of tillage passes per crop (passes), and
A_{Crop} = Total number of tilled acres for each crop type (acres)

Example:
EF = 6.10 lbs PM_{10}/acre-pass
AP_{Cpttpm} 8.9 tillage passes for a cotton crop
A_{Cotton} 42,000 acres of cotton

$Tillage_{Cotton}$ = 6.10 lbs PM_{10} / acre-pass × 8.9 passes × 42,000 acres × ton/ 2,000 lb
= 1,140.09 tons PM_{10} / year

Table 3.5–12 lists crop types and acreage; typical number of land preparation operations and acre-passes; and annual uncontrolled PM_{10} emissions from agricultural tillage for Maricopa County.

Table 3.5–12. 2002 Maricopa County agricultural crop acreage, activity, and uncontrolled annual PM_{10} emissions.

Crop	Reported Acres	Annual land preparation operations	Acre-passes	Annual uncontrolled PM_{10} emissions (tons/yr)
Cotton	42,000	8.9	373,800	1,140.09
Corn	15,100	7.3	109,475	333.90
Wheat	18,200	3.1	55,510	169.31
Barley	12,500	2.1	25,625	78.16
Alfalfa (stand establishment)	21,750 (1)	5.1	109,838	335.00
Cantaloupe (fall)	6,400	16.1	102,880	313.78
Cantaloupe (spring)	8,900	15.0	133,634	407.58
Watermelon	3,400	13.7	46,410	141.55
Honeydew (fall)	700	16.1	11,253	34.32
Honeydew (summer)	1,500	12.5	18,750	57.19
Dry onion	700	11.1	7,757	23.66
Carrots	2,000	12.1	24,241	73.93
Broccoli	2,600	13.2	34,190	104.28
Grapefruit	220 (2)	5.0	1,100	3.36
Navel Oranges and miscellaneous	540 (2)	5.0	2,700	8.24
Valencia Oranges	360 (2)	5.0	1,800	5.49
Lemon	300 (2)	5.0	1,500	4.58
Tangerine	440 (2)	5.0	2,200	6.71
Total acreage:	**137,610**			**3,241.12**

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

In the Maricopa County PM_{10} nonattainment area, the agricultural PM_{10} general permit (Arizona Administrative Code [AAC], R18-2-610 and 611) requires that commercial farmers implement at least three agricultural best management practice (BMP) to control PM_{10} emissions generated from tillage and harvest, non-cropland, and cropland.

Net control efficiencies from implementation of agricultural BMPs were developed by URS and ERG (2001) in the Technical Support Document for Quantification of Agricultural BMPs. Three BMPs were quantified for tillage: 1) combining tractor operations, 2) limited activity during high-wind events, and 3) multi-year crops. URS/ERG derived net control efficiencies by multiplying a 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 59%, which was derived using latest EPA rule effectiveness guidance (US EPA, 2005) that supercedes the 80% "default" rule effectiveness (RE) value. (RE calculations for agricultural activities are included as Appendix 3.1). To estimate controlled tillage emissions from agricultural operations within the PM_{10} NAA, the mid-point net control efficiency for each BMP were applied to 48.01% (the percent of agricultural land in the PM_{10} NAA) of the uncontrolled annual PM_{10} emissions as follows:

Controlled annual $tillage_{Crop}$ emissions = Annual uncontrolled PM_{10} emissions × (100% – mid-point net control $efficiency_{crop}$) × % agricultural land in the PM_{10} NAA

Controlled annual $tillage_{Cotton}$ emissions = 1,140.09 tons PM_{10}/yr × (100% – 24.3%) × 48.01%

= 413.94 tons PM_{10}/yr

The uncontrolled portion of tillage emissions from agricultural operations taking place outside the PM_{10} NAA but within Maricopa County were estimated by multiplying the uncontrolled annual PM_{10} emissions by the percent of agricultural land located within Maricopa County by outside of the PM_{10} NAA (100% – 48.01%) as follows:

$$\begin{aligned} \text{Uncontrolled annual tillage}_{\text{Crop}}\text{ emissions} &= \text{Uncontrolled annual } PM_{10}\text{ emissions} \times 51.99\% \\ &= 1{,}140.09 \text{ tons } PM_{10}/\text{yr} \times 51.99\% \\ &= 592.73 \text{ tons } PM_{10}/\text{yr} \end{aligned}$$

Controlled and uncontrolled emissions were then summed to estimate total annual PM_{10} emissions from agricultural tillage in Maricopa County. Results are shown in Table 3.5–13.

Table 3.5–13. Annual controlled PM_{10} emissions from agricultural tillage in Maricopa County.

		Annual PM_{10} emissions (tons/yr)		
Crop	**Net control efficiency**	**Controlled PM_{10} Emissions (within the PM_{10} NAA)**	**Uncontrolled PM_{10} emissions (outside the PM_{10} NAA)**	**Total PM_{10} (controlled + uncontrolled)**
Cotton	0.244	413.94	592.73	1006.67
Corn	0.244	121.23	173.59	294.82
Wheat	0.244	61.47	88.02	149.49
Barley	0.244	28.38	40.63	69.01
Alfalfa (stand establishment)	0.147	137.15	174.17	311.32
Cantaloupe (fall)	0.18	123.56	163.14	286.70
Cantaloupe (spring)	0.18	160.50	211.90	372.40
Watermelon	0.18	55.74	73.59	129.33
Honeydew (fall)	0.18	13.51	17.84	31.36
Honeydew (summer)	0.18	22.52	29.73	52.25
Dry onion	0.18	9.32	12.30	21.62
Carrots	0.18	29.11	38.44	67.55
Broccoli	0.18	41.06	54.21	95.28
Grapefruit	0.18	1.32	1.74	3.07
Navel oranges and miscellaneous	0.18	3.24	4.28	7.52
Valencia oranges	0.18	2.16	2.85	5.02
Lemon	0.18	1.80	2.38	4.18
Tangerine	0.18	2.64	3.49	6.13
Total		**1,228.67**	**1,685.06**	**2,913.73**

Annual $PM_{2.5}$ emissions from agricultural tillage were calculated by multiplying the total annual PM_{10} emissions by a conversion factor of 0.15 (WRAP, 2006b). Table 3.5–14 summarizes the 2005 PM_{10} and $PM_{2.5}$ emissions for Maricopa County and the PM_{10} NAA from agricultural tillage after the implementation of agricultural BMPs.

Table 3.5–14. Annual controlled PM_{10} and $PM_{2.5}$ emissions from agricultural tillage.

	Maricopa County (tons/yr)		PM_{10} NAA (tons/yr)	
Crop	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Cotton	1,006.67	151.00	413.94	62.09
Corn	294.82	44.22	121.23	18.18
Wheat	149.49	22.42	61.47	9.22
Barley	69.01	10.35	28.38	4.26
Alfalfa (stand establishment)	311.32	46.70	137.15	20.57
Cantaloupe (fall)	286.70	43.00	123.56	18.53
Cantaloupe (spring)	372.40	55.86	160.50	24.07
Watermelon	129.33	19.40	55.74	8.36
Honeydew (fall)	31.36	4.70	13.51	2.03
Honeydew (summer)	52.25	7.84	22.52	3.38
Dry onion	21.62	3.24	9.32	1.40
Carrots	67.55	10.13	29.11	4.37
Broccoli	95.28	14.29	41.06	6.16
Grapefruit	3.07	0.46	1.32	0.20
Navel oranges and miscellaneous	7.52	1.13	3.24	0.49
Valencia oranges	5.02	0.75	2.16	0.32
Lemon	4.18	0.63	1.80	0.27
Tangerine	6.13	0.92	2.64	0.40
Total	**2,913.73**	**437.06**	**1,228.67**	**184.30**

Typical daily emissions for Maricopa County and the PM_{10} NAA were calculated by dividing the annual PM_{10} 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 3.5–15. 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 3.5–15. Controlled typical daily emissions from tillage in Maricopa County.

	Tillage operations [(1)]	Tillage operations	Daily emissions (lbs/day)	
Crop	**(months/yr)**	**(days/yr)**	**PM_{10}**	**$PM_{2.5}$**
Cotton	12	364	5,531.2	829.7
Corn	5	152	3,887.8	583.2
Wheat	8	243	1,232.1	184.8
Barley	8	243	568.8	85.3
Alfalfa (stand establishment)	3	91	6,842.2	1,026.3
Cantaloupe (fall)	6	182	3,150.5	472.6
Cantaloupe (spring)	6	182	4,092.3	613.8
Watermelon	6	182	1,421.2	213.2
Honeydew (fall)	6	182	344.6	51.7
Honeydew (summer)	6	182	574.2	86.1
Dry onion	6	182	237.5	35.6
Carrots	7	243	742.3	111.4
Broccoli	6	182	1,047.0	157.1
Grapefruit	3	91	67.4	10.1
Navel Oranges and misc.	3	91	165.4	24.8
Valencia Oranges	3	91	110.2	16.5
Lemon	3	91	91.9	13.8
Tangerine	3	91	134.7	20.2
Total			**30,241.4**	**4,536.2**

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

Typical daily emissions for the PM_{10} nonattainment area were calculated by dividing the annual PM_{10} emissions for the PM_{10} NAA by an estimated day per year of tillage operation by crop. Results are shown in Table 3.5–16.

Table 3.5–16. Controlled annual and typical daily emissions from tillage within the PM_{10} NAA.

	Typical daily emissions (lbs/day)	
Crop	**PM_{10}**	**$PM_{2.5}$**
Cotton	2,274.4	341.2
Corn	1,598.6	239.8
Wheat	506.6	76.0
Barley	233.9	35.1
Alfalfa (stand establishment)	3,014.3	452.2
Cantaloupe (fall)	1,357.8	203.7
Cantaloupe (spring)	1,763.7	264.6
Watermelon	612.5	91.9
Honeydew (fall)	148.5	22.3
Honeydew (summer)	247.5	37.1
Dry onion	102.4	15.4
Carrots	240.0	36.0
Broccoli	451.2	67.7
Grapefruit	29.0	4.4
Navel Oranges and miscellaneous	71.3	10.7
Valencia Oranges	47.5	7.1
Lemon	39.6	5.9
Tangerine	58.1	8.7
Total	**12,797.0**	**1,919.6**

3.5.2.2 Harvesting

Harvest emissions were estimated using crop-specific emission factors (CARB, 2003). The number of harvested acres by crop was obtained from the 2005 Arizona Agricultural Statistics Bulletin (AASS, 2006). Table 3.5–17 lists the crop types and associated PM_{10} emission factors used to calculate emissions from agricultural harvesting.

Annual PM_{10} emissions from agricultural harvesting were calculated using the following equation:

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

where:
$harvest_{Crop}$ = harvest emissions for each crop type (tons PM_{10}/yr)
EF_{Crop} = harvest emission factor (lbs PM_{10}/acre)
A_{Crop} = total number of reported acres for each crop type per year

Example:
EF_{Cotton} = 3.4 lbs PM_{10}/acre for cotton
A_{Cotton} = 41,900 acres of cotton

Uncontrolled annual $Harvest_{Cotton}$ Emissions = 3.4 lbs PM_{10}/acre × 41,900 acres × 1 ton/2,000 lbs = 71.23 tons PM_{10}/yr

Table 3.5–17. Maricopa County harvested acres and emission factors.

Crop	PM_{10} emission factor (lb/acre-yr)	2005 Acreage	Uncontrolled Annual PM_{10} Emissions (tons/yr)
Cotton	3.4	41,900	71.23
Wheat	5.8	17,500	50.75
Barley	5.8	12,300	35.67
Alfalfa Hay	0.0	80,000	0.00
Other Hay	1.68	7,000	5.88
Corn	1.68	900	0.76
Broccoli	0.08	2,600	0.10
Dry Onions	1.68	700	0.59
Carrots	0.17	2,000	0.17
Summer Honeydews	0.08	1,500	0.06
Fall Honeydews	0.08	700	0.03
Spring Cantaloupe	0.08	8,900	0.36
Fall Cantaloupe	0.08	6,400	0.26
Watermelon	0.08	3,400	0.14
Grapefruit	0.08	1,100	0.04
Lemons	0.08	1,500	0.06
Valencia oranges	0.08	1,800	0.07
Navel, sweet, and miscellaneous	0.08	2,700	0.11
Tangerines	0.08	2,200	0.09
Total		**195,100**	**166.36**

In the Maricopa County PM_{10} nonattainment area, the agricultural PM_{10} general permit (Arizona Administrative Code [AAC], R18-2-610 and 611) requires that commercial farmers implement at least three agricultural best management practice (BMP) to control PM_{10} emissions generated from tillage and harvest, non-cropland, and cropland. Net control efficiencies from the

implementation of agricultural BMPs were developed by URS and ERG (2001) in the *Technical Support Document for Quantification of Agricultural BMPs*. Two BMPs were quantified for harvesting: 1) combining tractor operations, and 2) reduced harvest activity. URS and ERG (2001) derived net control efficiencies by multiplying a 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 compiance factor of 59% (from 80%). The revised compliance factor was derived using latest EPA rule effectiveness guidance (US EPA, 2005) which eliminates use of the 80% default rule effectiveness value (rule effectiveness calculations for agricultural activities are included as Appendix 3.1). To estimate controlled harvest emissions from agricultural operations taking place within the PM_{10} NAA, the mid-point net control efficiency for each BMP were applied to 48.01% of the uncontrolled annual emissions (the percent of agricultural land in the PM_{10} NAA) as follows:

Controlled annual harvest$_{Crop}$ emissions	=	annual uncontrolled PM_{10} emissions	×	(100% – mid-point net control efficiency$_{crop}$)	×	% agricultural land in PM_{10} NAA
Controlled annual harvest$_{Cotton}$ emissions from within the PM_{10} NAA	= 71.23 tons PM_{10}/yr = 24.88 tons PM_{10}/yr		×	(100% – 27.2%)	×	48.01%

The uncontrolled portion of harvest emissions from agricultural operations outside the PM_{10} NAA but within Maricopa County were estimated by multiplying the uncontrolled annual PM_{10} emissions by the percent of agricultural land located within Maricopa County but outside of the PM_{10} NAA (100% – 48.01%) as follows:

Uncontrolled annual Harvest$_{Cotton}$ emission from outside the PM_{10} NAA	=	Uncontrolled PM_{10} emissions	×	51.99%
	=	71.23 tons PM_{10}/yr	×	51.99%
	=	37.03 tons PM_{10}/yr		

The total controlled and uncontrolled annual emissions were then summed to estimate total annual PM_{10} emissions from agricultural harvesting in Maricopa County as follows:

Total annual harvest$_{Cotton}$ emissions for Maricopa County	=	Uncontrolled annual harvest$_{Cotton}$ emissions from outside the PM_{10} NAA	+	Controlled annual harvest$_{Cotton}$ emissions from within the PM_{10}NAA
	=	37.03	+	24.88
	=	61.91 tons PM_{10}/yr		

Annual $PM_{2.5}$ emissions from agricultural harvesting were calculated by multiplying the annual PM_{10} emissions by a conversion factor of 0.15 (WRAP, 2006c).

Typical daily emissions for Maricopa County and the PM_{10} NAA were calculated by dividing the controlled annual emissions by the number of harvest days per year (URS and ERG, 2001), as shown in Table 3.5–19.

Table 3.5–18. Annual emissions from harvesting (tons/yr).

Crop	Uncontrolled PM_{10} (tons/yr)	Net control efficiency (%)	PM_{10} NAA (controlled)	Outside NAA (uncontrolled)	Maricopa County (controlled + uncontrolled)		PM_{10} NAA (controlled)
			PM_{10}	PM_{10}	PM_{10}	$PM_{2.5}$	$PM_{2.5}$
Cotton	71.23	27.2%	24.88	37.04	61.91	9.29	3.73
Wheat	50.75	25.0%	18.26	26.39	44.65	6.70	2.74
Barley	35.67	25.0%	12.84	18.55	31.38	4.71	1.93
Alfalfa Hay	0.00	29.5%	0.00	0.00	0.00	0.00	0.00
Other Hay	5.88	29.5%	1.99	3.06	5.05	0.76	0.30
Corn	0.76	25.0%	0.27	0.39	0.67	0.10	0.04
Broccoli	0.10	25.0%	0.04	0.05	0.09	0.01	0.01
Dry Onions	0.59	25.0%	0.21	0.31	0.52	0.08	0.03
Carrots	0.17	25.0%	0.06	0.09	0.15	0.02	0.01
Summer Honeydews	0.06	25.0%	0.02	0.03	0.05	0.01	0.00
Fall Honeydews	0.03	25.0%	0.01	0.01	0.02	0.00	0.00
Spring Cantaloupe	0.36	25.0%	0.13	0.19	0.31	0.05	0.02
Fall Cantaloupe	0.26	25.0%	0.09	0.13	0.23	0.03	0.01
Watermelon	0.14	25.0%	0.05	0.07	0.12	0.02	0.01
Grapefruit	0.04	25.0%	0.02	0.02	0.04	0.01	0.00
Lemons	0.06	25.0%	0.02	0.03	0.05	0.01	0.00
Valencia oranges	0.07	25.0%	0.03	0.04	0.06	0.01	0.00
Navel, sweet, and misc.	0.11	25.0%	0.04	0.06	0.10	0.01	0.01
Tangerines	0.09	25.0%	0.03	0.05	0.08	0.01	0.00
Total	**166.36**		**58.99**	**86.50**	**145.48**	**21.82**	**8.85**

Table 3.5–19. Typical daily emissions from harvesting (lbs/day).

Crop	Harvest days/yr	Maricopa County		PM_{10} nonattainment area	
		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Cotton	143	865.9	129.9	348.0	52.19
Wheat	60	1488.4	223.3	608.8	91.32
Barley	60	1046.1	156.9	427.9	64.19
Alfalfa Hay	294	0.0	0.0	0.0	0.00
Other Hay	294	34.3	5.2	13.5	2.03
Corn	91	14.6	2.2	6.0	0.90
Broccoli	161	1.1	0.2	0.5	0.07
Dry Onions	70	14.8	2.2	6.0	0.91
Carrots	273	1.1	0.2	0.4	0.07
Summer Honeydews	61	1.7	0.3	0.7	0.11
Fall Honeydews	71	0.7	0.1	0.3	0.04
Spring Cantaloupe	72	8.7	1.3	3.6	0.53
Fall Cantaloupe	71	6.3	1.0	2.6	0.39
Watermelon	152	1.6	0.2	0.6	0.10
Grapefruit	304	0.3	0.0	0.1	0.02
Lemons	232	0.5	0.1	0.2	0.03
Valencia oranges	151	0.8	0.1	0.3	0.05
Navel, sweet, and misc.	102	1.9	0.3	0.8	0.11
Tangerines	151	1.0	0.2	0.4	0.06
Total		**3,489.9**	**523.5**	**1,420.8**	**213.1**

3.5.2.3 Travel on unpaved agricultural roads

Resuspended PM_{10} emissions from travel on unpaved agricultural roads were estimated using an unpaved road emission factor derived from AP-42 13.2.2 (US EPA, 2006b). The unpaved road emission factor equation is shown below:

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

where:

s	=	surface material silt content	=	11.90% (MAG, 2000)
W	=	mean vehicle weight (tons)	=	2.80 (URS and ERG, 2001)
k	=	1.5 (PM_{10} constant) (US EPA, 2006b)		
a	=	0.9 (PM_{10} constant) (US EPA, 2006b)		
b	=	0.45 (PM_{10} constant) (US EPA, 2006b)		

Unpaved road emission factor (lb/VMT) $= 1.5\,(11.9/12)^{0.9}(2.8/3)^{0.45}$
$= 1.444$ lb/VMT

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). URS and ERG (2001) estimated average daily vehicle miles traveled per 1,000 acres to be 49.5 VMT.

Daily emissions from travel on unpaved agricultural roads were then estimated as follows:

Daily uncontrolled PM_{10} emissions from ag roads = unpaved road EF × VMT/1000 acres × 2005 harvested acres
= 1.444 lbs/VMT × 49.5 VMT/1000 acres × 195,100 acres
= 13,944.8 lbs/day

Net control efficiencies from implementation of agricultural BMPs were developed by URS and ERG (2001) in the Technical Support Document for Quantification of Agricultural BMPs. Two BMPs were quantified for unpaved road travel: 1) access restriction and 2) reduced vehicle speed. URS and ERG (2001) derived net control efficiencies by multiplying a mid-point BMP control efficieincy 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 59% (from 80%). The revised compliance factor was derived using latest EPA rule effectiveness guidance (US EPA, 2005) which eliminates use of the 80% default rule effectiveness value (rule effectiveness calculations for agricultural activities are included as Appendix 3.1). To estimated controlled emissions from travel on unpaved agricultural roads within the PM_{10} NAA, the mid-point net control efficiency for each BMP (12.4 % and 0.4%, respectively) were applied to 48.01 % (the percent of agricultural land in the PM_{10} NAA) of the uncontrolled daily PM_{10} emissions as follows:

Controlled daily unpaved ag road emissions within the NAA	= Daily uncontrolled PM_{10} emissions	× (100%-mid-point net control efficiency)	× % agricultural land in the PM_{10} NAA
	= 13,944.8 lbs/day	× (100% – 12.8%)	× 48.01%
	= 5,838.0 lbs/day		

The uncontrolled portion of unpaved agricultural road emissions outside the PM_{10} NAA but within Maricopa County were estimated by multiplying uncontrolled daily PM_{10} emissions by the percent of agricultural land located within Maricopa County but outside of the PM_{10} NAA (100% – 48.01%) as follows:

Uncontrolled daily unpaved ag. road emissions from outside of the PM_{10} NAA = Uncontrolled PM_{10} emissions × 51.99%

= 13,944.8 lbs/day × 51.99%

= 7,249.90 lbs/day

Total controlled and uncontrolled daily emissions were then summed to estimate total daily PM_{10} emissions from travel on unpaved agricultural roads in Maricopa County as follows:

Total daily unpaved ag road emissions for Maricopa County	= Uncontrolled daily unpaved ag road emissions from outside the PM_{10} NAA	+	Controlled daily unpaved ag road emissions from within the PM_{10} NAA
	= 7,249.90	+	5,838.0
	= 13,087.9 lbs PM_{10}/day		

Daily $PM_{2.5}$ emission from travel on unpaved agricultural unpaved roads were calculated by multiplying the daily PM_{10} emissions by a conversion factor of 0.10 (WRAP, 2006d).

Annual emissions for Maricopa County and the PM_{10} NAA were calculated by multiplying the daily emissions by the 312 (6 days per week × 52 weeks per year).

Table 3.5–20. Annual and typical daily emissions from travel on unpaved agricultural roads.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Maricopa County (controlled + uncontrolled)	2,041.71	204.17	13,087.9	1,308.8
PM_{10} NAA (controlled)	910.64	91.06	5,837.4	583.7

3.5.2.4 Cotton ginning

Annual emissions from cotton ginning were derived from annual emission reports from permitted sources. There is only one small cotton gin operating in the County that is not addressed as a point source in Chapter 2.

Data from CARB's $PM_{2.5}$ Fraction Table (CARB, 2006) were used to calculate $PM_{2.5}$ emissions, assumed to be 28.6% of PM_{10} emissions. Since all cotton gins considered in this section are located within the PM_{10} nonattainment area, total emission values for the county and the PM_{10} NAA from cotton ginning are equal. Results are shown in Table 3.5–21.

Table 3.5–21. Annual and typical daily emissions from area-source cotton ginning.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	0.09	0.02	0.7	0.2
PM_{10} NAA	0.09	0.02	0.7	0.2

3.5.2.5 Fertilizer application

Annual NH_3 emissions from synthetic nitrogen fertilizers were calculated using the CMU Ammonia Model (CMU, 2004). The CMU Ammonia Model uses semiannual sales data for 2002 from the Association of American Plant Food Control Officials, which are available at the county-level. This information was combined with information from National Agricultural Statistics Service (NASS) crop calendars to estimate monthly fertilizer application rates for each county. County-wide results are shown in Table 3.5–22. Typical daily NH_3 emissions were derived by dividing annual emissions by 365 days/year.

Annual and typical daily emissions for the PM_{10} nonattainment area were derived by multiplying the county annual and typical daily emissions by the percentage of agricultural land located in the PM_{10} NAA (48.01%). See Section 1.5.2 for a discussion of the land-use data used.

Table 3.5–22. Annual and typical daily ammonia emissions from fertilizer application.

	Maricopa County		PM_{10} NAA	
Fertilizer Category	**Annual NH_3 Emissions (tons/year)**	**Daily NH_3 Emissions (lbs/day)**	**Annual NH_3 Emissions (tons/year)**	**Daily NH_3 Emissions (lbs/day)**
Anhydrous ammonia	70.66	387.2	33.92	185.9
Aqueous ammonia	3.75	20.5	1.80	9.9
Ammonium nitrate	0.00	0.0	0.00	0.0
Ammonium sulfate	74.41	407.7	35.72	195.7
Ammonium thiosulfate	0.00	0.0	0.00	0.0
Calcium ammonium nitrate	0.00	0.0	0.00	0.0
Nitrogen solutions	1,399.94	7670.9	672.11	3682.8
Urea	496.04	2718.0	238.15	1304.9
Diammonium phosphate	2.67	14.6	1.28	7.0
Monoammonium phosphate	71.76	393.2	34.45	188.8
Liquid ammonium polyphosphate	38.91	213.2	18.68	102.4
Potassium nitrate	0.95	5.2	0.46	2.5
Miscellaneous	119.05	652.3	57.16	313.2
Total	**2,278.14**	**12,483.0**	**1,093.74**	**5,993.1**

3.5.3 Livestock

Annual NH_3 emissions from livestock in Maricopa County were calculated using the CMU Ammonia Model (CMU, 2004). The CMU Ammonia Model developed by Carnegie Mellon University is a software application that generates ammonia emissions from many different sources for the continental United States. County-wide results are shown in Table 3.5–24. It was assumed that livestock emissions occur evenly throughout the year. Typical daily NH_3 emissions were derived by dividing annual emissions for Maricopa County by 365 days/year.

PM_{10} and $PM_{2.5}$ emissions estimates were derived using Maricopa County cattle inventory estimates for 2005 from Arizona Agricultural Statistics Bulletin (AASS, 2006) and emission factor for PM_{10} for dairy cattle, and feedlot cattle from the California Air Resources Board (CARB, 2004). $PM_{2.5}$ was presumed to be 11% of PM_{10} per WRAP Fugitive Dust Handbook (WRAP, 2006d).

The number of "cattle on feed" was not available from the Arizona Agricultural Statistics Bulletin (AASS, 2006) for 2005; therefore, 2004 numbers were used. Beef cows were excluded

from the inventory as information provided by Arizona Agricultural Statistics staff (Coon, 2004) indicated that the majority of beef cows that are not on feed are grazed on range and pastures. Cattle on feed, milk cows, and other cattle (heifers, steers, bulls, and calves) were included in the PM_{10} emission estimates for livestock. The 2005 Maricopa County cattle inventory and applicable PM emission factors are contained in Table 3.5–23.

Table 3.5–23. Maricopa County cattle inventory and PM emission factors.

		Emission factors	
Animal type	**Head**	**PM_{10} (lb/1000 head/day)**	**$PM_{2.5}/PM_{10}$ Ratio**
Cattle on feed	5,000	28.9	0.11
Milk cows	105,000	6.7	0.11
Other cattle	93,000	28.9	0.11
Total	**203,000**		

Typical daily PM_{10} emissions from livestock in Maricopa County were calculated using the following formula:

Typical daily emissions (lbs/day) from dairy cattle = milk cow inventory (1,000 head) × emission factor (lbs PM_{10}/1,000 head/day)
= 105 × 6.7
= 703.5 lbs PM_{10}/day

It was assumed that livestock emissions occur evenly throughout the year. Annual PM_{10} and $PM_{2.5}$ emissions were derived by multiplying typical daily emissions for Maricopa County and the nonattainment area by 365 days/year.

MCAQD determined through GIS analysis of confined animal feeding operation (CAFO) locations and animal numbers in Maricopa County that 80.7% of CAFO animals are located within the nonattainment area. Therefore, annual and typical daily emissions for the nonattainment area were calculated by multiplying the Maricopa County emission totals by 80.7%.

Table 3.5–24 summarizes the annual and typical daily emissions from livestock for Maricopa County and the PM_{10} nonattainment area.

Table 3.5–24. Annual and typical daily emissions from livestock.

	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
Maricopa County	645.27	70.98	10,429.53	3,535.7	388.9	57,148.1
PM_{10} NAA	520.84	57.29	8,418.39	2,853.9	313.9	46,128.1

3.5.4 Health services: crematories

Emissions from human and animal crematories were calculated from annual emissions inventory reports from all landfills located within the county. Typical daily emissions are calculated based on the operating schedule data reported by surveyed facilities. From annual emission surveys, it was determined that crematories operate on a 5-day week throughout the year. This data was used to calculate typical daily emissions as follows:

Typical daily PM_{10} emissions from crematories $= \frac{\text{Annual emissions (tons/yr)}}{\text{Days/week} \times \text{Weeks/yr}} \times \frac{2{,}000 \text{ lbs}}{\text{ton}}$

$= \frac{0.96}{5 \times 52} \times 2{,}000$

$= 7.4$ lbs PM_{10}/day

Annual and typical daily emissions for the PM_{10} nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage county permitted sources that are within the nonattainment area.

PM_{10} emissions from area-source crematories in the PM_{10} NAA (tons/yr) = Annual Maricopa County emissions × Percentage of crematories within the NAA

$= 0.96$ tons/yr × .95

$= 0.91$ tons PM_{10}/yr

Table 3.5–25 summarizes annual and typical daily emissions from crematories in both Maricopa County and the PM_{10} nonattainment area.

Table 3.5–25. Annual and typical daily emissions from crematories.

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	0.96	0.64	11.45	1.46	7.4	4.9	88.0	11.3
PM_{10} NAA	0.91	0.61	10.87	1.39	7.0	4.7	83.6	10.7

3.5.5 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. Data from these two sources documented the release of 1.03 tons of PM_{10} for the year 2005. (No accidental releases of NO_x, SO_x or NH_3 were reported). Accidental releases from point source facilities are included as part of their annual emissions totals (see chapter 2).

Typical daily emissions are calculated by summing reported releases and dividing the total by 365 days. Emissions in the PM_{10} nonattainment area are calculated based on locations of facilities that reported releases.

Table 3.5–26. Annual and typical daily emissions from accidental releases.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$***	**PM_{10}**	**$PM_{2.5}$***
Maricopa County	1.03	1.03	5.6	5.6
PM_{10} NAA	1.03	1.03	5.6	5.6

* As a conservative estimate, all PM_{10} emissions are assumed to be $PM_{2.5}$.

3.5.6 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_{10} nonattainment areas (see section 1.5 for population information). Daily emissions were calculated by dividing annual values by 365.

Table 3.5–27. Annual and typical daily NH_3 emissions from human activity.

Geographic Area	Population	Emission factor (lbs/ person-yr)	Annual NH_3 emissions (tons/yr)	Typical daily NH_3 emissions (lbs/day)
Maricopa County	3,780,380	0.55	1,039.60	5,696.5
PM_{10} NAA	3,809,701	0.55	1,047.67	5,740.6

3.5.7 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 chapter of this report (see chapter 4). Fugitive dust emission estimates are developed with the use of three main sources: EPA's NONROAD model, California Air Resources Board report to legislature on leaf blowers (CARB, 2000), and a very recent research effort done by the University of Riverside (Fitz et al., 2005).

EPA's NONROAD model was used to develop estimates of the number of gasoline powered leaf blowers in Maricopa County, along with the average activity figures for those leaf blowers. Electric leaf blower population numbers were derived from the CARB report (2000) which indicates 60% of all leaf blowers sold are electric, as in the following equation:

Population of electric Leaf blowers = (gas-powered leaf blowers ÷ 40% [= all leaf blowers]) – gas-powered leaf blowers

= (103,668 ÷ 0.4 [=259,170]) – 103,668

= 155,502 units

Fitz et al. (2005) developed emission factors for PM_{10} and $PM_{2.5}$ 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 3.5–28 lists the equipment population numbers, activity estimates and emission factors for leaf blowers in Maricopa County.

Table 3.5–28. Leaf blower equipment populations, activity levels and emission factors for Maricopa County.

Leaf blower description	Population	Activity (hrs/yr)	PM_{10} Emission factors (mg/m^2)	$PM_{2.5}$ Emission factors (mg/m^2)
Commercial 2-stroke gasoline	3,158	626	70	30
Commercial 4-stroke gasoline	1,548	626	70	30
Residential 2-stroke gasoline	94,072	10	70	30
Residential 4-stroke gasoline	4,890	10	70	30
Electric	155,502	10	130	40
Total	259,170	n/a	n/a	n/a

The CARB report (2000) estimates that approximately $1600m^2$ of surface can be cleared in one hour of leaf blower operation. Therefore, annual emission estimates are calculated by using the following formula, as in this example for electric leaf blowers:

Annual PM_{10} emissions from electric leaf blowers = Population × Activity (hrs/yr) × Emission Factor (mg/m^2) × area covered ($1600m^2$) ÷ 1000g/mg ÷ 454g/lb ÷ 2000lb/ton

= 155,502 × 10 hrs/yr × $130mg/m^2$ × $1600m^2$/hr ÷ 1000g/mg ÷ 454g/lb ÷ 2000lb/ton

= 356.22 tons PM_{10}/yr

Leaf blowers are assumed to operate seven days a week all year long. Typical daily emissions are estimated by dividing annual totals by 365 days per year. Emissions for the PM_{10} nonattainment area are allocated based on the ratio of resident population in the County to the nonattainment area (see Section 1.5 for information on population). Table 3.5–29 lists annual and daily fugitive emission from leaf blowers for Maricopa County and the PM_{10} nonattainment area.

Table 3.5–29. Annual and typical daily emissions from leaf blower fugitive dust.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Maricopa County	841.66	317.65	4,611.8	1,740.6
PM_{10} NAA	843.00	318.16	4,619.2	1,743.3

3.5.8 Offroad recreation vehicles fugitive dust

The EPA NONROAD model estimates exhaust emissions for offroad recreational vehicles. These emissions are included in the Nonroad Emissions category of the 2005 particulate inventory. Particulate emissions are also generated by recreational vehicles traveling on unpaved surfaces. For the 2005 periodic inventory, these emissions were estimated by MAG using mileage and activity data for offroad recreational vehicles in Maricopa County, from the EPA NONROAD model. The specific methodology, calculations, and assumptions for the calculation of fugitive dust emissions from offroad recreational vehicles traveling on unpaved surfaces are described below.

The EPA NONROAD model provides annual mileage and activity data for all terrain vehicles (ATV), all terrain cycles (ATC), and specialty vehicles/carts (SVC). The NONROAD activity and mileage estimates for Maricopa County in 2005 are shown in Table 3.5–30. The product of the mileage and the number of vehicles equals the annual VMT.

It was further assumed that 75% of the annual VMT is traveled on unpaved surfaces inside Maricopa County. The remaining 25% of the miles are assumed to be on paved surfaces and unpaved surfaces outside of Maricopa County. Multiplying the annual VMT by 75 percent and dividing by 365 produces the Daily VMTs on unpaved surfaces in Maricopa County as shown in Table 3.5–30.

Table 3.5–30. VMT for offroad recreational vehicles in Maricopa County.

Vehicle Type	Annual Mileage	Number of Vehicles	Annual VMT	Daily VMT inside Maricopa County
ATV	1,600	24,511	39,413,688	80,987
ATC	1,600	6,158	9,852,800	20,246
SVC	65	1,664	108,160	222

The daily VMTs were multiplied by the AP-42 emission factor for unpaved industrial roads, assuming silt content of 11.9% and a vehicle weight of one-half of a ton. The AP-42 emission factor for ATVs and ATCs is 272 grams per mile. This emission rate was reduced by 50%, to 136 grams per mile, for ATCs, to account for two wheels generating dust instead of four.

According to the November 2006 revision of AP-42, $PM_{2.5}$ emissions are 10 percent of PM_{10} emissions from unpaved roads. Therefore, the $PM_{2.5}$ emission rate for ATVs and ATCs is 27 grams per mile; and for SVCs, 14 grams per mile.

The PM_{10} and $PM_{2.5}$ emission rates were multiplied by the daily VMT by vehicle type to obtain total emissions attributable to offroad recreational vehicles traveling on unpaved surfaces in Maricopa County, as shown in Table 3.5–31.

Emissions for the PM_{10} nonattainment area were derived by applying GIS to MAG 2004 land use data to obtain the acreage of passive open space in the PM_{10} nonattainment area and in Maricopa County. Passive open space includes mountains and washes. The detailed calculations to derive the PM_{10} nonattainment area emissions are shown below:

Passive Open Space in the PM NAA:377,814 acres
Passive Open Space in Maricopa County: 1,748,816 acres
Ratio of Passive Open Space in PM NAA vs. Maricopa County: 377,814/1,748,816 = 21.6%
PM NAA Emissions: 0.216 × Maricopa County Emissions

The application of the above methodology resulted in total emissions for offroad recreational vehicles traveling on unpaved surfaces in the PM_{10} nonattainment area, as shown in Table 3.5–31.

Table 3.5–31. Annual and typical daily emissions from offroad recreational vehicles traveling on unpaved surfaces.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	9,994.00	999.00	54,764.0	5,476.0
PM_{10} NAA	2,159.00	216.00	11,830.0	1,184.0

3.5.9 Unpaved parking lots fugitive dust

Fugitive dust particulate emissions from vehicles traveling in unpaved parking areas were estimated by MAG based on the acres of disturbed land devoted to unpaved parking areas, estimated vehicle activity on unpaved parking areas, and emission rates from AP-42. The specific methodology, calculations, and assumptions for each component of the calculation are described below.

Acres of disturbed vacant land were estimated as follows: In the Phase I Windblown Dust Modeling for the Western Regional Air Partnership (ENVIRON, 2004), it was estimated that eight percent of the vacant land in core urban areas is disturbed and thirty percent of the land under development is disturbed. MAG used geographic information systems (GIS) and the 2004 MAG land use data, to estimate that there were 93,429 acres of vacant land in the core urbanized area and 60,357 acres of land under development in the PM_{10} nonattainment area. Multiplying the percentages above by these acreage estimates produces:

93,429 × 0.08 = 7,474 acres of vacant disturbed land in the urbanized core
60,357 × 0.30 = 18,107 acres of vacant disturbed land under development

Summing the urbanized core and developing acreages results in a total of 25,581 acres of vacant disturbed land in the PM_{10} nonattainment area. The 1995 microscale particulate emissions study (MAG, 1995) estimated that 24 percent of the disturbed vacant land is devoted to unpaved parking areas. Applying this assumption to the total acreage of vacant disturbed land results in a total of 6,139 acres of unpaved parking areas in the PM_{10} nonattainment area..

Vehicle activity on unpaved parking areas was estimated by assuming that each day, an average of 100 vehicles drive on each acre of unpaved parking area. One acre, if perfectly square, would have dimensions of about 212 × 212 feet. If the average vehicle travels one-half the distance from the center of the acre, each vehicle would travel an average of 106 feet or 0.02 miles per acre. Multiplying 100 vehicles per day times 0.02 miles produces 2 vehicle miles traveled (VMT) per acre per day. Multiplying 6,139 acres times 2 VMT per acre per day yields 12,278 VMT per day on unpaved parking areas in the PM_{10} nonattainment area.

Emission rates for unpaved parking areas were derived from the AP-42 equation for unpaved industrial roads, assuming 11.9 percent silt content and an average vehicle weight of three tons. The resultant PM_{10} emission rate is 609.23 grams per mile. The November 2006 revision to AP-42 indicates that the $PM_{2.5}$ emission rate is 10 percent of the PM_{10} emission rate or 60.92 grams per mile. Applying the emission rate to the VMT produces the total emissions from vehicles traveling on unpaved parking areas in the PM_{10} nonattainment area of 7,480 kg/day.

To estimate emissions for Maricopa County, GIS was applied to the 2004 MAG land use data to derive the total acres of vacant land in Maricopa County. The vacant land in Maricopa was estimated to be 1,642,255 acres. Removing the acres of vacant land in the Maricopa County portion of the PM_{10} nonattainment area (i.e., 397,080 acres) results in 1,642,255 vacant acres inside Maricopa County but outside the PM_{10} nonattainment area.

Assuming that one percent of the vacant acres outside the PM_{10} nonattainment area is disturbed (Clark County, 2006), and 24 percent of the disturbed vacant land is unpaved parking areas (MAG, 1995) results in 3,942 acres of unpaved parking areas outside the PM_{10} nonattainment area. Multiplying this by 2 VMT per acre, per day results in 7,884 VMT/day. Applying the same emission rate from AP-42 produces 4,803 kg/day of PM_{10} emissions due to unpaved parking areas located outside the PM_{10} nonattainment area.

To estimate Maricopa County emissions, the Pinal County portion needs to be removed from the PM_{10} nonattainment area emissions. The emissions in the Pinal County portion of the PM_{10} nonattainment area are assumed to be proportional to the acres of vacant land, derived using GIS and the 2004 MAG land use, as calculated below.

Vacant land in the Pinal County portion of the PM_{10} nonattainment area: 7,134 acres
Vacant land in the PM_{10} nonattainment area: 404,214
Ratio: 7,134/404,214 = 1.8%
Emissions attributable to the Pinal County portion: 7,480 kg/day × 0.018 = 135 kg/day

Adding the emissions inside and outside the PM_{10} nonattainment area (7,480 kg/day and 4,803 kg/day) and subtracting the emissions for the Pinal County portion (135 kg/day) produces total Maricopa County emissions attributable to vehicles traveling in unpaved parking areas of 12,148 kg/day. The results for the PM_{10} nonattainment area and Maricopa County are summarized in tons per year and lbs per day in Table 3.5–32.

Table 3.5–32. Annual and typical daily emissions from vehicles traveling in unpaved parking areas.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	4,888.00	489.00	26,781.0	2,678.0
PM_{10} NAA	3,009.00	301.00	16,490.0	1,649.0

3.5.10 Windblown dust

ENVIRON International corporation estimated windblown dust based on the computer model developed by Western Regional Air Partnership Regional Modeling Center (WRAP RMC). A full description of this modeling process is included as Appendix 3.2. Table 3.5–33 summarizes annual and typical daily emissions from windblown dust.

Table 3.5–33. Annual and typical daily emissions from fugitive windblown dust.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	44,488.84	4,448.88	243,774.4	24,377.4
PM_{10} NAA	7,380.43	738.04	40,440.7	4,044.1

3.5.11 Summary of all miscellaneous area sources

Tables 3.5–34 and 3.5–35 provide a summary of annual and typical daily emissions from all miscellaneous area sources, for Maricopa County and the PM_{10} nonattainment area, respectively.

Table 3.5–34. Annual and typical daily emissions from all miscellaneous area sources for Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Wildfires	70,882.24	60,792.24	15,639.50	4,288.25	3,279.25	475,719.7	408,001.6	104,963.1	28,780.2	22,008.4
Prescribed fires	0.06	0.06	0.05	0.01	0.00	120.0	120.0	93.0	25.5	7.5
Structure fires	22.53	22.53	2.92			123.8	123.8	16.0		
Vehicle fires	26.41	26.41	1.06			144.7	144.7	5.8		
Engine testing	0.15	0.12	4.61	1.89		1.1	0.9	35.4	14.5	
Tilling	2,913.73	437.06				30,241.4	4,536.2			
Harvesting	145.48	21.82				3,489.9	523.5			
Unpaved ag roads	2,041.71	204.17				13,087.9	1,308.8			
Cotton ginning	0.09	0.02				0.7	0.2			
Fertilizer					2,278.14					12,483.0
Livestock	645.27	70.98			10,429.53	3,535.7	388.9			57,148.1
Crematories	0.96	0.64	11.45	1.46		7.4	4.9	88.0	11.3	
Accidental releases	1.03	1.03				5.6	5.6			
Humans					1,039.60					5,696.5
Leaf blowers dust	841.66	317.65				4,611.8	1,740.6			
Offroad rec dust	9,994.00	999.00				54,764.0	5,476.0			
Unpaved parking lots	4,888.00	489.00				26,781.0	2,678.0			
Windblown dust	44,488.84	4,448.88				243,774.4	24,377.4			
Total:	**136,892.15**	**67,831.62**	**15,659.58**	**4,291.61**	**17,026.53**	**856,409.2**	**449,431.2**	**105,201.4**	**28,831.5**	**97,343.4**

Table 3.5–35. Annual and typical daily emissions from all miscellaneous area sources for the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Wildfires	4,860.02	4,168.2	1,072.32	294.02	224.84	32,617.6	27,974.5	7,196.8	1,973.3	1,509.0
Prescribed fires	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
Structure fires	22.56	22.56	2.92			124.0	124.0	16.1		
Vehicle fires	26.45	26.45	1.06			145.0	145.0	5.8		
Engine testing	0.15	0.12	4.61	1.89		1.1	0.9	35.4	14.5	
Tilling	1,228.67	184.30				12,797.0	1,919.6			
Harvesting	58.99	8.85				1,420.8	213.1			
Unpaved ag roads	910.64	91.06				5,837.4	583.7			
Cotton ginning	0.09	0.02				0.7	0.2			
Fertilizer					1,093.74					5,993.1
Livestock	520.84	57.29			8,418.39	2,853.9	313.93			46,128.1
Crematories	0.91	0.61	10.87	1.39		7.0	4.7	83.6	10.7	
Accidental releases	1.03	1.03				5.6	5.6			
Humans					1,047.67					5,740.6
Leaf blowers dust	843.00	318.16				4619.2	1743.3			
Offroad rec dust	2,159.00	216.00				11,830.0	1,184.0			
Unpaved parking lots	3,009.00	301.00				16,490.0	1,649.0			
Windblown dust	7,380.43	738.04				40,440.7	4,044.1			
Total:	**21,021.78**	**6,133.71**	**1,091.78**	**297.30**	**10,784.63**	**129,190.0**	**39,905.6**	**7,337.7**	**1,998.5**	**59,370.9**

3.6 Summary of all area sources

Tables 3.6–1 and 3.6–2 summarize the total annual and typical daily emissions from all area sources addressed in this chapter, for both Maricopa County and the PM_{10} nonattainment area, respectively.

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel Combustion										
Industrial natural gas	16.51	16.51	308.43	1.30	6.81	105.9	105.9	1,977.1	8.3	43.7
Industrial fuel oil	247.82	247.82	3,443.60	329.29	14.18	1,588.6	1,588.6	22,074.4	2,110.8	90.9
Comm./inst. natural gas	60.15	60.15	1,146.39	4.72	3.79	385.6	385.6	7,348.6	30.3	24.3
Comm./inst. fuel oil	76.06	76.06	1,110.79	92.05	2.76	487.6	487.6	7,120.5	590.1	17.7
Residential natural gas	62.59	62.59	774.12	4.94		342.9	342.9	4,241.7	27.1	
Residential wood	230.85	214.69	17.35	2.67		3,057.6	2,843.6	229.8	35.3	
Residential fuel oil	0.01	0.01	0.66	0.26		0.2	0.2	8.7	3.4	
All fuel combustion	**694.01**	**677.85**	**6,801.33**	**435.23**	**27.55**	**5,968.4**	**5,754.4**	**43,000.7**	**2,805.4**	**176.6**
Industrial Processes										
Chemical manufacturing	76.77	38.85	0.39	0.21	0.34	590.5	298.9	3.0	1.6	2.6
Commercial cooking	1,527.98	1,416.96				8,395.5	7,785.5			
Grain processing	12.64	2.68				94.7	20.5			
Cold storage					1,695.98					10,871.7
Secondary metal prod.	10.95	9.27	4.53	0.05	1.34	79.0	66.3	25.0	0.4	10.3
Mineral processes	431.60	222.71				3,030.4	1,517.2			
Mining & quarrying	62.97	17.38				409.1	112.1			
Wood product mfg.	213.23	149.95				1,657.9	1,170.0			
Rubber/plastic mfg.	365.26	236.52				2,809.7	1,819.4			
Fabricated metal mfg.	138.96	119.88				1,579.3	1,404.1			
Residential construction	12,135.60	1,213.56				77,792.3	7,779.2			
Commercial construction	11,491.21	1,149.12				73,661.6	7,366.2			
Road construction	7,307.35	730.73				46,842.0	4,684.2			
Other construction	2,806.46	280.65				17,990.2	1,799.0			
Electrical equip mfg.	5.24	3.25	0.01	4.59	0.96	40.3	25.0	0.1	35.3	7.4
ADEQ-permitted portable sources	101.70	42.18	554.60	142.20		844.2	389.8	5,377.5	1,431.7	
Road travel at industrial sites	170.49	65.45				1,138.8	436.2			
Industrial processes NEC	24.31	13.87	4.58	0.01	0.80	202.0	97.3	26.7	<0.1	4.6
All Industrial Processes	**36,882.71**	**5,713.02**	**564.11**	**147.06**	**1,699.43**	**237,157.6**	**36,770.8**	**5,432.2**	**1,469.1**	**10,896.6**
Waste Treatment/disposal										
On-site incineration	0.15	0.10	2.54	0.03		1.6	1.1	19.9	0.3	
Open burning	56.15	56.15	15.16			550.9	550.9	148.4		
Landfills	6.79	4.05	6.50	1.11		39.5	23.5	36.3	6.3	
POTWs					1,310.85					7,182.7
Other waste	79.55	48.51	4.15	5.01		606.0	369.6	22.8	27.5	
All Waste Treatment/ Disposal	**142.64**	**108.81**	**28.35**	**6.14**	**1,310.85**	**1,198.1**	**945.1**	**227.4**	**34.0**	**7,182.7**

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Misc. Area Sources										
Wildfires fires	70,882.24	60,792.24	15,639.50	4,288.25	3,279.25	475,719.7	408,001.6	104,963.1	28,780.2	22,008.4
Prescribed fires	0.06	0.06	0.05	0.01	0.00	120.0	120.0	93.0	25.5	7.5
Structure fires	22.53	22.53	2.92			123.8	123.8	16.0		
Vehicle fires	26.41	26.41	1.06			144.7	144.7	5.8		
Engine testing	0.15	0.12	4.61	1.89		1.1	0.9	35.4	14.5	
Tilling	2,913.73	437.06				30,241.4	4,536.2			
Harvesting	145.48	21.82				3,489.9	523.5			
Unpaved ag roads	2,041.71	204.17				13,087.9	1,308.8			
Cotton ginning	0.09	0.02				0.7	0.2			
Fertilizer application					2,278.14					12,483.0
Livestock	645.27	70.98			10,429.53	3,535.7	388.93			57,148.1
Crematories	0.96	0.64	11.45	1.46		7.4	4.9	88.0	11.3	
Accidental releases	1.03	1.03				5.6	5.6			
Humans					1,039.60					5,696.5
Leaf blowers dust	841.66	317.65				4611.8	1740.6			
Offroad rec dust	9,994.00	999.00				54,764.0	5,476.0			
Unpaved park. lots	4,888.00	489.00				26,781.0	2,678.0			
Windblown dust	44,488.84	4,448.88				243,774.4	24,377.4			
All Misc. Sources	**136,892.15**	**67,831.62**	**15,659.58**	**4,291.61**	**17,026.53**	**856,409.2**	**449,431.2**	**105,201.4**	**28,831.5**	**97,343.4**
TOTAL, ALL AREA SOURCES	**174,611.51**	**74,331.30**	**23,053.36**	**4,880.05**	**20,064.35**	**1,100,733.4**	**492,901.5**	**153,861.8**	**33,140.0**	**115,599.4**

Table 3.6–2. Summary of annual and typical daily emissions from all area sources in the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel Combustion										
Industrial natural gas	16.40	16.40	306.33	1.29	6.77	104.7	104.7	1,955.5	8.2	43.2
Industrial fuel oil	246.14	246.14	3,420.18	327.05	14.08	1,577.8	1,577.8	21,924.3	2,096.5	90.3
Comm./inst. natural gas	59.72	59.72	1,138.13	4.69	3.77	381.5	381.5	7,270.0	30.0	24.1
Comm./inst. fuel oil	75.51	75.51	1,102.80	91.39	2.74	484.1	484.1	7,069.2	585.8	17.6
Residential natural gas	62.69	62.69	775.35	4.95		343.5	343.5	4,248.5	27.1	
Residential wood	231.22	215.04	17.38	2.67		3,062.5	2,848.2	230.1	35.4	
Residential fuel oil	0.01	0.01	0.66	0.26		0.2	0.2	8.7	3.4	
All fuel combustion	**691.70**	**675.51**	**6,760.83**	**432.30**	**27.36**	**5,954.3**	**5,739.9**	**42,706.4**	**2,786.5**	**175.1**
Industrial Processes										
Chemical manufacturing	76.25	38.59	0.38	0.21	0.34	586.5	296.8	3.0	1.6	2.6
Commercial cooking	1,539.90	1,428.01				8,461.0	7,846.2			
Grain processing	12.64	2.68				94.7	20.5			
Cold storage					1,684.45					10,797.8
Secondary metal prod.	10.95	9.27	4.53	0.05	1.34	79.0	66.3	25.0	0.4	10.3
Mineral processes	430.89	222.17				3,024.9	1,513.0			
Mining & quarrying	54.77	15.52				347.6	98.2			
Wood product mfg.	211.78	148.93				1,646.6	1,162.0			
Rubber/plastic mfg.	362.77	234.91				2,790.6	1,807.0			
Fabricated metal mfg.	138.01	119.06				1,568.6	1,394.5			
Residential construction	11,331.99	1,133.20				72,641.0	7,264.1			
Commercial construction	11,085.55	1,108.55				71,061.2	7,106.1			
Road construction	7,236.42	723.64				46,387.3	4,638.7			
Other construction	2,475.89	247.59				15,871.1	1,587.1			
Electrical equip mfg	5.24	3.25	0.01	4.59	0.96	40.3	25.0	0.1	35.3	7.4
ADEQ-permitted portable sources	101.70	42.18	554.60	142.20		844.2	389.8	5,377.5	1,431.7	
Road travel at industrial sites	167.78	64.48				1,118.8	429.0			
Industrial processes NEC	24.29	13.86	4.08	0.01	0.80	201.9	97.2	22.9	<0.1	4.6
All Industrial Processes	**35,266.82**	**5,555.90**	**563.60**	**147.05**	**1,687.89**	**226,765.3**	**35,741.7**	**5,428.5**	**1,469.1**	**10,822.7**

Table 3.6–2. Summary of annual and typical daily emissions from all area sources in the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel Combustion										
Waste Treatment/disposal										
On-site incineration	0.15	0.10	2.54	0.03		1.6	1.1	19.9	0.3	
Open burning	24.24	24.24	6.51			243.6	243.6	65.3		
Landfills	6.79	4.05	6.50	1.11		39.5	23.5	36.3	6.3	
POTWs					1,321.01					7,238.4
Other waste	79.55	48.51	4.15	5.01		606.0	369.6	22.8	27.5	
All Waste Treatment/ Disposal	**110.74**	**76.90**	**19.70**	**6.14**	**1,321.01**	**890.8**	**637.8**	**144.4**	**34.0**	**7,238.4**
Misc. Area Sources										
Wildfires	4,860.02	4,168.2	1,072.32	294.02	224.84	32,617.6	27,974.5	7,196.8	1,973.3	1,509.0
Prescribed fires	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
Structure fires	22.56	22.56	2.92			124.0	124.0	16.1		
Vehicle fires	26.45	26.45	1.06			145.0	145.0	5.8		
Engine testing	0.15	0.12	4.61	1.89		1.1	0.9	35.4	14.5	
Tilling	1,228.67	184.30				12,797.0	1,919.6			
Harvesting	58.99	8.85				1,420.8	213.1			
Unpaved ag roads	910.64	91.06				5,837.4	583.7			
Cotton ginning	0.09	0.02				0.7	0.2			
Fertilizer application					1,093.74					5,993.1
Livestock	520.84	57.29			8,418.39	2,853.9	313.9			46,128.1
Crematories	0.91	0.61	10.87	1.39		7.0	4.7	83.6	10.7	
Accidental releases	1.03	1.03				5.6	5.6			
Humans					1,047.67					5,740.6
Leaf blowers dust	843.00	318.16				4,619.2	1,743.3			
Offroad rec dust	2,159.00	216.00				11,830.0	1,184.0			
Unpaved park. lots	3,009.00	301.00				16,490.0	1,649.0			
Windblown dust	7,380.43	738.04				40,440.7	4,044.1			
All Misc. Sources	**21,021.78**	**6,133.71**	**1,091.78**	**297.30**	**10,784.63**	**129,190.0**	**39,905.6**	**7,337.7**	**1,998.5**	**59,370.9**
TOTAL, ALL AREA SOURCES:	**57,091.05**	**12,442.02**	**8,435.92**	**882.80**	**13,820.89**	**362,800.5**	**82,025.0**	**55,616.9**	**6,288.1**	**77,607.1**

3.7 Quality assurance / quality control procedures

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

Area source categories were selected for inclusion in the inventory based on the latest Emission Inventory Improvement Program (EIIP) guidance available. EPA's guidance for area source categories included in the draft 2002 National Emission Inventory (NEI) was also evaluated, as area source emissions from this inventory will be submitted to EPA for the 2005 NEI. The list of area source categories developed based on these guidance documents was modified to fit the characteristics of Maricopa County, with some area source categories determined to be insignificant (such as industrial coal combustion and oil and gas production). The 1999 Maricopa County Periodic Ozone and Carbon Monoxide Emission Inventories and other regional emission inventories were also consulted to confirm the completeness of the area source categories chosen for inclusion.

Data for area source emission calculations were gathered from a wide universe of resources. Whenever applicable, local surveyed data (such as annual emissions report) was used as this data

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

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

Once area source emission estimates had been produced, several quality control checks were performed to substantiate the calculations. Most area source calculations were peer-reviewed by two other planners, with all area sources being reviewed by at least one other planner. Peer review ensured that all emission calculations were reasonable and could be reproduced. Sensitivity analyses and computational method checks were performed on area sources when emissions seemed to be outside the expected ranges. When errors were found, the appropriate changes were made by the author of the calculations to ensure consistency of the emissions calculations. The peer-reviewed emissions estimates were combined into a draft area source chapter. This draft chapter was read through in its entirety by the unit manager and the three air quality planners for final review, with any identified errors corrected by the author of the section.

The draft version of the area source chapter was sent to the Arizona Department of Environmental Quality, the Arizona Department of Transportation, and the Maricopa Association of Governments for a quality assurance review. These agencies provided comments which were addressed and incorporated into the final area source chapter. Further quality analysis was performed by inputting the emission estimates into EPA's "QA/QC basic format and content checker", prior to submitting the data to the 2005 NEI.

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

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