

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

Table 3.1–1. List of area source categories.

AMS code	Area source 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:		
2301000000	Chemical manufacturing	3.3.1
	Food and kindred products	3.3.2
2302002000	Commercial Cooking	3.3.2.1
2302050000	Bakeries	3.3.2.2
2304000000	Secondary metal production	3.3.3
2305000000	Non-metallic mineral processes	3.3.4
2308000000	Rubber/plastics manufacturing	3.3.5
2309000000	Fabricated metal products manufacturing	3.3.6
2312000000	Electrical equipment manufacturing	3.3.7
	State-permitted portable sources	3.3.8
2399000000	Industrial processes not elsewhere classified	3.3.9
Solvent use:		
2401001000	Architectural coatings	3.4.1.1
2401005000	Auto refinishing	3.4.1.2
2401008000	Traffic markings	3.4.1.3
2401015000	Factory-finished wood	3.4.1.4
2401020000	Wood furniture	3.4.1.5
2401075000	Aircraft	3.4.1.6
2401090000	Miscellaneous manufacturing	3.4.1.7
2415000000	Degreasing	3.4.2
2420000000	Dry cleaning	3.4.3
2425000000	Graphic arts	3.4.4
2440000000	Miscellaneous industrial solvent use	3.4.5
2461850000	Pesticide application: agricultural	3.4.6
2460000000	Consumer and commercial solvent use	3.4.7
2461020000	Asphalt application	3.4.8

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

AMS code	Area source description	Section
	Storage and transport:	
2501050120	Bulk plants/terminals	3.5.1
2510000000	Volatile organic liquid (VOL) storage and transport	3.5.2
2501060050	Petroleum tanker truck fuel delivery	3.5.3
2505030120	Petroleum tanker trucks in transit	3.5.4
2501060201	Service stations, breathing/emptying	3.5.5
2501060100	Vehicle refueling	3.5.6
	Summary of all storage and transport	3.5.7
	Waste treatment and disposal	3.6
2601000000	On-site incineration	3.6.1
2610000000	Open burning	3.6.2
2620000000	Landfills	3.6.3
2630000000	Publicly owned treatment works (POTWs)	3.6.4
2650000000	Other industrial waste and disposal	3.6.5
	Miscellaneous area sources:	
	Other combustion	3.7.1
2810001000	Wildfires and brush fires	3.7.1.1
2810030000	Structure fires	3.7.1.2
2810050000	Vehicle fires	3.7.1.3
2810040000	Engine testing	3.7.1.4
2850000000	Hospitals	3.7.2.1
2601020000	Crematories	3.7.2.2
2830000000	Accidental releases	3.7.3

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

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

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

3.2 Fuel combustion

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

Table 3.2–1. Natural gas sales data from Maricopa County natural gas suppliers.

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

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

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

3.2.1 Industrial natural gas

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

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

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

Annual emissions for the county are calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion (US EPA, 1998), as in this example for VOC emissions from external natural gas combustion:

$$\begin{aligned}
 \text{Annual VOC emissions from external natural gas combustion} &= \text{External industrial natural gas usage (MMCF)} \times \text{VOC emission factor for external natural gas combustion (lb/MMCF)} \div 2,000 \text{ lbs/ton} \\
 &= 1,527.09 \times 5.5 \div 2,000 \\
 &= 4.20 \text{ tons VOC/yr}
 \end{aligned}$$

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

Combustion type	% of total	Natural gas usage (MMCF)	Emission factors (lb/MMCF)			Annual emissions (tons/yr)		
			VOC	NO _x	CO	VOC	NO _x	CO
External	98.44	1,527.09	5.5	100	84	4.20	76.35	64.14
Internal	1.56	24.14	116	2840	399	1.40	34.27	4.82
Totals:	100.00	1,551.23				5.60	110.63	68.95

Season-day emissions for the county are calculated by first multiplying annual emissions by the percentage of industrial natural gas sold used during the ozone season. (Figures reported by natural gas suppliers for the June–August time period are assumed to be representative for the July–September ozone season.) Ozone season emission totals are then divided by the number of days that activity occurs during the ozone season:

$$\begin{aligned}
 \text{Ozone season-day VOC emissions from industrial natural gas} &= \text{Annual VOC emissions (tons/yr)} \times \% \text{ natural gas sold during ozone season} \div (\text{days/week} \times \text{wks/season}) \times 2,000 \text{ lbs/ton} \\
 &= 5.60 \times 23.62\% \div (6 \times 13) \times 2000 \\
 &= 33.9 \text{ lbs/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{VOC emissions from area source industrial natural gas combustion in the ozone NAA} &= \text{Annual county VOC emissions (tons/yr)} \times \text{NAA:County industrial employment ratio} \\
 &= 5.60 \times 0.9809 \\
 &= 5.49 \text{ tons VOC/yr}
 \end{aligned}$$

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

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	5.60	110.63	68.95	33.9	670.0	417.6
Ozone NAA	5.49	108.52	67.64	33.3	657.2	409.6

3.2.2 Industrial fuel oil

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

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

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

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

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

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

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

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

County-level annual emissions from this area source category were calculated by multiplying industrial fuel oil sales by the respective AP-42 emission factors for external and internal combustion, as in this example for VOC emissions from external industrial fuel oil combustion:

$$\begin{aligned}
 \text{Annual CO emissions from external industrial fuel oil combustion} &= \text{External industrial fuel oil sales (Mgal)} \times \text{CO emission factor for external fuel oil combustion (lb/Mgal)} \div 2,000 \text{ lb/ton} \\
 &= 8,003.949 \times 0.2 \div 2,000 \\
 &= 0.80 \text{ tons CO/yr}
 \end{aligned}$$

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

Combustion type	% of total	Annual fuel oil sales (Mgals)	Emission factors (lb/MMCF)			Annual emissions (tons/yr)		
			VOC	NO _x	CO	VOC	NO _x	CO
External	78.01	8,003.949	0.2	24	5	0.80	96.05	20.01
Internal	21.99	2,256.147	49.3	604	130	55.61	681.36	146.65
Totals:	100.00	10,260.097				56.41	777.40	166.66

Season-day emissions for the county are calculated by first multiplying annual emissions by 25% to estimate ozone season totals. Ozone season emission totals are then divided by the number of days that activity occurs during the ozone season as recommended by EIIP guidance (US EPA, 2001c).

$$\begin{aligned}
 \text{Ozone season-day VOC emissions from industrial fuel oil} &= \text{Annual VOC emissions (tons/yr)} \times \text{\% fuel oil sold during ozone season} \div (\text{days/week} \times \text{wks/season}) \times 2,000 \text{ lbs/ton} \\
 &= 56.41 \times 25\% \div (6 \times 13) \times 2000 \\
 &= 361.6 \text{ lbs/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Ozone NAA emissions from area} &= \text{Annual county VOC} \times \text{NAA:County industrial employment ratio} \\
 \text{source industrial fuel oil combustion} & \text{ emissions (tons/yr)} \\
 &= 56.41 \times 0.9809 \\
 &= 55.34 \text{ tons VOC/yr}
 \end{aligned}$$

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

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	56.41	777.40	166.66	361.6	4,983.4	1,068.3
Ozone NAA	55.34	762.56	163.48	354.7	4,888.2	1,047.9

3.2.3 Commercial/institutional natural gas

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

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

Natural gas is used for both external 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 C&I area sources in 2002.

Annual emissions for the county are calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion (US EPA, 1998), as in this example for VOC emissions from external natural gas combustion:

$$\begin{aligned}
 \text{Annual VOC emissions} &= \text{External C\&I natural} \times \text{VOC emission factor for} \div \text{2,000 lb/ton} \\
 \text{from external natural gas} & \text{ gas usage (MMCF)} \quad \text{external natural gas com-} \\
 \text{combustion} & \quad \quad \quad \text{bustion (lb/MMCF)} \\
 &= 14,434.79 \times 5.5 \div 2,000 \\
 &= 39.70 \text{ tons VOC/yr}
 \end{aligned}$$

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

Combustion type	% of total	C&I natural gas usage (MMCF)	Emission factors (lb/MMCF)			Annual emissions (tons/yr)		
			VOC	NO _x	CO	VOC	NO _x	CO
External	98.34	14,434.79	5.5	100	84	39.70	721.74	606.26
Internal	1.66	244.29	116	2840	399	14.17	346.89	48.74
Totals:	100.00	14,679.07				53.86	1,068.83	655.00

Season-day emissions for the county are calculated by first multiplying annual emissions by the percentage of C&I natural gas sold used during the ozone season. (Figures reported by natural gas suppliers for the June–August time period are assumed to be representative for the July–September ozone season.) Ozone season emission totals are then divided by the number of days that activity occurs during the ozone season:

$$\begin{aligned}
 \text{Ozone season-day VOC emissions from C\&I natural gas} &= \text{Annual VOC emissions (tons/yr)} \times \% \text{ natural gas sold during ozone season} \div (\text{days/week} \times \text{wks/season}) \times 2,000 \text{ lbs/ton} \\
 &= 53.86 \times 20.38\% \div (6 \times 13) \times 2000 \\
 &= 281.5 \text{ lbs/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{VOC emissions from area source C\&I natural gas combustion in the ozone NAA} &= \text{Annual county VOC emissions (tons/yr)} \times \text{NAA:County C\&I employment ratio} \\
 &= 53.86 \times 0.9829 \\
 &= 52.94 \text{ tons VOC/yr}
 \end{aligned}$$

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

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	53.86	1,068.63	655.00	281.5	5,585.3	3,423.4
Ozone NAA	52.94	1,050.35	643.80	276.7	5,489.8	3,364.9

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 US Department of Energy, Energy Information Administration (US DOE, 2002) to Maricopa County.

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

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

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

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

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

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

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

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

$$\begin{aligned}
 \text{Annual VOC emissions from external fuel oil} &= \text{External C\&I fuel oil usage (Mgal)} \times \text{VOC emission factor for external fuel oil combustion (lb/Mgal)} \div 2,000 \text{ lb/ton} \\
 &= 11,165.542 \times 0.34 \div 2,000 \\
 &= 1.90 \text{ tons VOC/yr}
 \end{aligned}$$

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

Combustion type	% of total	Annual fuel oil sales (Mgal)	Emission factors (lb/MMCF)			Annual emissions (tons/yr)		
			VOC	NO _x	CO	VOC	NO _x	CO
External	66.95	11,165.542	0.34	24	5	1.90	133.99	27.91
Internal	33.05	5,512.073	49.3	604	130	135.87	1,664.65	358.28
Totals:	100.00	16,677.614				137.77	1,798.63	386.20

Season-day emissions for the county are calculated by first multiplying annual emissions by 15% to estimate ozone season totals. Ozone season emission totals are then divided by the number of days that activity occurs during the ozone season, as recommended by EIIP guidance (US EPA, 2001c):

$$\begin{aligned}
 \text{Ozone season-day VOC emissions from C\&I fuel oil} &= \text{Annual VOC emissions (tons/yr)} \times \% \text{ fuel oil sold during ozone season} \div (\text{days/week} \times \text{wks/season}) \times 2,000 \text{ lbs/ton} \\
 &= 137.77 \times 15\% \div (6 \times 13) \times 2000 \\
 &= 529.9 \text{ lbs/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Ozone NAA emissions from area source C\&I fuel oil combustion} &= \text{Annual county VOC emissions (tons/yr)} \times \text{NAA:County commercial/institutional employment ratio} \\
 &= 137.77 \times 0.9829 \\
 &= 135.41 \text{ tons VOC/yr}
 \end{aligned}$$

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

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	137.77	1,798.63	386.20	529.9	6,917.8	1,485.4
Ozone NAA	135.41	1,767.88	379.59	520.8	6,799.5	1,460.0

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, 1998), as follows:

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

VOC	NO _x	CO
5.5	94	40

$$\begin{aligned}
 \text{Annual VOC emissions from residential natural gas combustion} &= \text{Residential natural gas annual sales (MMCF)} \times \text{Residential natural gas emission factor for VOC (lbs/MMCF)} \div 2,000 \text{ lbs/ton} \\
 &= 16,419.53 \times 5.5 \div 2,000 \\
 &= 45.15 \text{ tons VOC/yr}
 \end{aligned}$$

Ozone season-day emissions are calculated by first multiplying reported natural gas usage during the ozone season (2,390.68 MMCF) by the AP-42 emission factors for residential natural gas combustion to produce ozone season emissions. (Natural gas usage reported for the months of June–August are assumed to represent ozone season usage). Ozone season emissions are then divided by days during the ozone season that residential natural gas combustion occurs (US EPA, 2001c).

$$\begin{aligned}
 \text{Season-day VOC emissions from residential natural gas combustion} &= \text{Residential natural gas seasonal sales (MMCF)} \times \text{Residential natural gas emission factor for VOC (lbs/MMCF)} \div (\text{days/week} \times \text{weeks/season}) \\
 &= 2,390.68 \times 5.5 \div (7 \times 13) \\
 &= 144.5 \text{ lbs VOC/day}
 \end{aligned}$$

Annual and season-day residential natural gas emissions in the ozone nonattainment area are calculated by multiplying county-level emissions by the percentage of total occupied households (98.18%) in the ozone nonattainment area as follows:

$$\begin{aligned}
 \text{Annual emissions from residential natural gas combustion in the NAA} &= \text{County annual emissions} \times \text{Percentage of occupied households in the NAA} \\
 &= 45.15 \text{ tons/yr} \times 98.18\% \\
 &= 44.33 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.2–11. Annual and season-day emissions from residential natural gas combustion.

Geographic area	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	45.15	771.72	328.39	144.5	2,469.4	1,050.8
Ozone NAA	44.33	757.67	322.41	141.9	2,424.4	1,031.7

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, 2001g). Residential wood combustion in the county is estimated by multiplying data on statewide residential wood combustion usage from the US Department of Energy (US DOE, 2003) by the ratio of county to state households that report use of wood for heating from the US Census Bureau (2003c). The latest available data on residential wood use for household heating from the US Census Bureau is for the calendar year 2000. Since all fireplaces in homes constructed since 1999 are required by Arizona statute to be clean-burning, it is assumed that these new homes have negligible emissions. Thus, year 2000 data is assumed to be representative of 2002 emissions.

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

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

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

Annual emissions from residential wood combustion are calculated by multiplying the tons of wood used by the emission factor for residential total woodstoves and fireplaces from EIIP Volume III, Chapter 2, Table 2.4-1 (US EPA, 2001g):

$$\begin{aligned}
 \text{Annual VOC emissions from residential wood combustion (tons/yr)} &= \text{Residential wood usage (tons)} \times \text{VOC emission factor (lbs/ton)} \div 2,000 \text{ lbs/ton} \\
 &= 25,433.73 \times 229.0 \div 2,000 \\
 &= 2,912.16 \text{ tons VOC/yr}
 \end{aligned}$$

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

Residential wood usage (tons)	Emission factors (lb/ton)			Annual emissions (tons/yr)		
	VOC	NO _x	CO	VOC	NO _x	CO
25,433.73	229.0	2.6	252.6	2,912.16	33.06	3,212.28

Season-day emissions are calculated by apportioning wood burning activity based on heating degree days (i.e., the number of degrees per day that the daily average temperature is below 65°F). Data provided by Arizona State University (2003) indicated that there were no heating degree days reported during the 2002 ozone season (July–September). Thus ozone season-day emissions from residential wood combustion are assumed to be zero.

Annual and season-day emissions within the ozone nonattainment area (NAA) are calculated by multiplying county totals by the ratio of total occupied housing units inside the nonattainment area (1,337,099) to total residential housing units in the county (1,361,837). See Section 1.5.1 for a further discussion of the housing data used.

$$\begin{aligned}
 \text{NAA annual emissions from residential wood combustion (tons/yr)} &= \text{County annual emissions (tons/yr)} \times \text{NAA:county residential housing ratio} \\
 &= 2,912.16 \times 0.9818 \\
 &= 2,859.16 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.2–13 summarizes annual and ozone season-day emissions from residential wood combustion for both the county and the ozone nonattainment area.

Table 3.2–13. Annual and season-day emissions from residential wood combustion.

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	2,912.16	33.06	3,212.28	0.0	0.0	0.0
Ozone NAA	2,859.16	32.46	3,153.82	0.0	0.0	0.0

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 (2003b):

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

Using an AP-42 emission factors, and data on heating degree days and residential housing units described in Section 3.2.6, annual and daily emissions were calculated as shown in Table 3.2–14.

Table 3.2–14. Emission factors, annual and season-day emissions from residential fuel oil combustion.

Geographic area	Emission factors (lb/Mgal)			Annual emission (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	0.713	18.0	5.0	0.03	0.83	0.23	0.0	0.0	0.0
Ozone NAA	0.713	18.0	5.0	0.03	0.81	0.23	0.0	0.0	0.0

3.2.8 Summary of all area source fuel combustion

Table 3.2–15. Summary of annual and season-day area source fuel combustion.

Geographic area	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	3,211.00	4,560.90	4,817.71	1,351.4	20,625.8	7,445.5
Ozone NAA	3,152.71	4,480.24	4,730.96	1,327.4	20,259.1	7,314.1

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, 2001c). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2003b) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census’ County Business Patterns (CBP) for 2001 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.3–1 shows the NAICS codes and employment data used to calculate emissions from chemical manufacturing.

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

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

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

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

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

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source VOC emissions from chemical mfg.} &= \frac{6.28 \text{ tons/yr}}{744 \text{ employees}} \times 1,758 \text{ employees} \\
 &= 14.84 \text{ tons VOC/yr}
 \end{aligned}$$

Ozone season-day 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 seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned}
 \text{Season-day VOC emissions from chemical mfg.} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{14.84 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 114.2 \text{ lbs VOC/day}
 \end{aligned}$$

Annual and season-day emissions for the ozone nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. See Section 1.5.1 for a discussion of the employment data used.

$$\begin{aligned}
 \text{VOC emissions from area-source chemical mfg. in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\
 &= 14.84 \text{ tons/yr} \times 98.09\% \\
 &= 14.56 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.3–2 summarizes annual and season-day emissions from chemical manufacturing in both Maricopa County and the ozone nonattainment area.

Table 3.3–2. Annual and season-day emissions from area-source chemical manufacturing.

Geographic area	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	14.84	1.08	0.07	114.2	8.3	0.5
Ozone NAA	14.56	1.06	0.07	112.0	8.2	0.5

3.3.2 Food and kindred products

3.3.2.1 Commercial cooking

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

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

Table 3.3–3. Maricopa County restaurants by type.

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

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

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

Equipment type	Annual emissions (tons/yr)	
	VOC	CO
Chain-driven charbroilers	18.19	60.75
Underfired charbroilers	60.05	196.43
Deep fat fryers	9.38	0.00
Flat griddles	7.90	16.32
Clamshell griddles	0.32	0.00
Totals:	95.84	273.50

Commercial cooking is assumed to occur uniformly throughout the year, therefore, it was assumed that 25% of annual activity occurs during the ozone season, and that activity occurs 7 days/week.

Table 3.3–5. Season-day emissions from commercial cooking, by equipment type.

Equipment type	Season-day emissions (lbs/day)	
	VOC	CO
Chain-driven charbroilers	100.0	333.8
Underfired charbroilers	329.9	1,079.3
Deep fat fryers	51.5	0.0
Flat griddles	43.4	89.7
Clamshell griddles	1.7	0.0
Totals:	526.6	1,502.8

Annual and season-day emissions for the ozone nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage population within the nonattainment area (98.09%). (See Section 1.5.1 for a discussion of the population data used.) Table 3.3–6 summarizes the annual and season-day emissions from commercial cooking for the ozone NAA.

Table 3.3–6. Annual and season-day emissions from commercial cooking.

Equipment type	Maricopa County				Ozone nonattainment area			
	Annual emissions (tons/yr)		Season-day emissions (lbs/day)		Annual emissions (tons/yr)		Season-day emissions (lbs/day)	
	VOC	CO	VOC	CO	VOC	CO	VOC	CO
Chain-driven charbroilers	18.19	60.75	100.0	333.8	17.84	59.59	98.0	327.4
Underfired charbroilers	60.05	196.43	329.9	1,079.3	58.90	192.68	323.6	1,058.7
Deep fat fryers	9.38	0.00	51.5	0.0	9.20	0.00	50.6	0.0
Flat griddles	7.90	16.32	43.4	89.7	7.75	16.01	42.6	88.0
Clamshell griddles	0.32	0.00	1.7	0.0	0.31	0.00	1.7	0.0
Totals:	95.84	273.50	526.6	1,502.8	94.01	268.28	516.5	1,474.1

3.3.2.2 Bakeries

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

The most recent data from the Census’ County Business Patterns (CBP), for 2001 employment, were used. CBP employment data for NAICS code 31181 (bread and bakery product manufacturing) indicated 1,999 employees in this industry in Maricopa County. Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in bakeries.} &= \text{Total employment (from US Census’ County Business Patterns)} && - \text{Employment at point sources (from annual emission reports)} \\
 &= 1,999 && - 500 \\
 &= 1,499 \text{ employees}
 \end{aligned}$$

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

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

$$\begin{aligned} \text{Area-source VOC emissions from bakeries} &= \frac{15.43 \text{ tons/yr}}{783} \times 1,499 \text{ employees} \\ &= 29.54 \text{ tons VOC/yr} \end{aligned}$$

Ozone season-day emissions are calculated based on the operating schedule data reported by bakeries. From annual emission surveys, the modal values were identified for two items: days/week and seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned} \text{Season-day VOC emissions from bakeries} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= \frac{29.54 \times 25\%}{6 \times 13} \times 2,000 \\ &= 189.3 \text{ lbs VOC/day} \end{aligned}$$

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

$$\begin{aligned} \text{VOC emissions from area-source bakeries in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\ &= 29.54 \text{ tons/yr} \times 98.09\% \\ &= 28.97 \text{ tons VOC/yr} \end{aligned}$$

Table 3.3–7. Annual and season-day VOC emissions from area-source bakeries.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	29.54	189.3
Ozone NAA	28.97	185.7

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. Ozone season-day 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 ozone nonattainment area, total emission values for the county and the ozone NAA from secondary metal production are equal.

Table 3.3–8. Annual and season-day emissions from area-source secondary metal production.

Geographic area	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	54.69	0.03	0.00	309.0	0.2	0.0
Ozone NAA	54.69	0.03	0.00	309.0	0.2	0.0

3.3.4 Mineral processes

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

The most recent data from the US Census’ County Business Patterns (CBP) for 2001 employment were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Total employment in Maricopa County for NAICS code group 327, non-metallic mineral product manufacturing, for 2001 (the most recent data available) was used. In addition, some portable concrete batch operations which operate within Maricopa County for only part of the year, are issued air quality permits by the Arizona Department of Environmental Quality. All ADEQ-permitted portable sources are addressed in Section 3.3.8.

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

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

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

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source VOC emissions} &= \frac{7.61 \text{ tons/yr}}{1,068 \text{ employees}} \times 2,642 \text{ employees} \\
 &= 18.82 \text{ tons VOC/yr}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Season-day VOC emissions} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{18.82 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 144.7 \text{ lbs VOC/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{VOC emissions from area sources within the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\
 &= 18.82 \text{ tons/yr} \times 98.09\% \\
 &= 18.46 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.3–9 summarizes annual and season-day emissions from non-metallic mineral products in both Maricopa County and the ozone nonattainment area.

Table 3.3–9. Annual and season-day VOC emissions from area-source non-metallic mineral products.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	18.82	144.7
Ozone NAA	18.46	142.0

3.3.5 Rubber/plastics

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, 2001c). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2003b) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census’ County Business Patterns (CBP) for 2001 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.3–10 shows the NAICS codes and employment data used to calculate emissions from rubber and plastic manufacturing facilities.

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

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

Table 3.3–10. NAICS codes and descriptions for rubber and plastic manufacturing facilities.

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

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

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

$$\begin{aligned} \text{Area-source VOC emissions from rubber \& plastic mfg.} &= \frac{75.44 \text{ tons/yr}}{923 \text{ employees}} \times 6,344 \text{ employees} \\ &= 518.50 \text{ tons VOC/yr} \end{aligned}$$

Ozone season-day 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 seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned} \text{Season-day VOC emissions from rubber \& plastic manufacturing} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\ &= \frac{518.50 \times 25\%}{5 \times 13} \times 2,000 \\ &= 3,988.5 \text{ lbs VOC/day} \end{aligned}$$

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

$$\begin{aligned} \text{VOC emissions from rubber \& plastic mfg. in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\ &= 518.50 \text{ tons/yr} \times 98.09\% \\ &= 508.60 \text{ tons VOC/yr} \end{aligned}$$

Table 3.3–11 summarizes annual and season-day emissions from chemical manufacturing in both Maricopa County and the ozone nonattainment area.

Table 3.3–11. Annual and season-day VOC emissions from rubber and plastic manufacturing facilities.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	518.50	3,988.5
Ozone NAA	508.60	3,912.3

3.3.6 Fabricated metal products

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

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

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

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

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source VOC emissions from fabricated metal products} &= \frac{0.82 \text{ tons/yr}}{638 \text{ employees}} \times 16,157 \text{ employees} \\
 &= 20.64 \text{ tons VOC/yr}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Season-day VOC emissions from fabricated metal products} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{20.64 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 158.8 \text{ lbs VOC/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{VOC emissions from} & & = & \text{Annual Maricopa County} & \times & \text{NAA:County ratio of} \\
 \text{fabricated metal in the} & & \text{emissions} & & & \text{industrial employment} \\
 \text{ozone NAA (tons/yr)} & & & & & \\
 & & = & 20.64 \text{ tons/yr} & \times & 98.09\% \\
 & & = & 20.25 \text{ tons VOC/yr} & &
 \end{aligned}$$

Table 3.3–12 summarizes annual and season-day emissions from fabricated metal products manufacturing in both Maricopa County and the ozone nonattainment area.

Table 3.3–12. Annual and season-day VOC emissions from area-source fabricated metal products manufacturing.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	20.64	158.8
Ozone NAA	20.25	155.8

3.3.7 Electrical equipment manufacturing

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

The most recent data from the US Census’ County Business Patterns (CBP) for 2001 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.3–13 shows the NAICS codes and employment data used to calculate emissions from electric equipment manufacturing.

Table 3.3–13. NAICS codes and descriptions for electric equipment manufacturing.

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

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

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

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

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source VOC emissions from electric equipment manufacturing} &= \frac{65.21 \text{ tons/yr}}{23,516 \text{ employees}} \times 34,440 \text{ employees} \\
 &= 95.51 \text{ tons VOC/yr}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Season-day VOC emissions from electric equip. mfg.} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{95.51 \times 25\%}{7 \times 13} \times 2,000 \\
 &= 524.8 \text{ lbs VOC/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{VOC emissions from area-source electric equip. mfg. in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\
 &= 95.51 \text{ tons/yr} \times 98.09\% \\
 &= 93.68 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.3–14. Annual and season-day emissions from area-source electric equipment manufacturing.

Geographic area	Annual emissions (tons/yr)		Season-day emissions (lbs/day)	
	VOC	NO _x	VOC	NO _x
Maricopa County	95.51	16.28	524.8	89.4
Ozone NAA	93.68	15.97	514.7	87.7

3.3.8 State-permitted portable sources

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

Data provided:

Source information:	Onyx Construction – Kevin’s Spread, ID S7710		
Permit type:	Portable crushing/screening plant		
Operating schedule:	Operated in Mohave County 6/10/02 to 7/28/02, Maricopa County from 7/30/02 to 10/22/02, and La Paz County from 10/24/02 to 12/31/02.		
Total annual emissions:	VOC	NO_x	CO
(tons/yr)	<u>2.744</u>	<u>54.260</u>	<u>12.140</u>

Using this information, calculations were made to determine:

Total operating days in 2002: 203 = 21 (June) + 30 (July) + ... + 31 (Dec.)
 Total operating days in Maricopa County: 85 = 2 (July) + 31 (Aug.) + ... + 22 (Oct.)
 Any operating days in Maricopa County during ozone season? (July–September): yes

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

$$\begin{aligned}
 \text{Annual NO}_x \text{ emissions in Maricopa County (tons/yr)} &= \text{Total annual emissions (tons/yr)} \times \frac{\text{operating days in Maricopa County}}{\text{total operating days in 2002}} \\
 &= 54.260 \times \frac{85}{203} \\
 &= 22.72 \text{ tons NO}_x/\text{yr}
 \end{aligned}$$

If the facility had any operations in Maricopa County during the July–September ozone season, season-day emissions (in lbs/day) were calculated as follows:

$$\begin{aligned}
 \text{Season-day emissions (lbs/day)} &= \frac{\text{total emissions attributable to activity in Maricopa County}}{\text{number of operating days in Maricopa County}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{22.72 \text{ tons}}{85 \text{ days}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= 534.6 \text{ lbs NO}_x/\text{day}
 \end{aligned}$$

Table 3.3–15 summarizes the annual and season-day emissions for all ADEQ-permitted portable sources that operated within Maricopa County at some point during 2002. Since no precise locational data was available, all emissions are conservatively assumed to have originated with the ozone nonattainment area.

Table 3.3–15. Emissions from ADEQ-permitted portable sources, by permit type.

Permit type	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Asphalt batch	42.62	68.87	25.34	264.0	471.5	173.8
Concrete batch	1.09	31.81	7.25	6.7	199.0	45.4
Crushing/screening	18.80	466.40	105.56	131.1	3,121.5	705.2
Other	5.11	5.35	0.28	29.3	29.3	1.5
Totals:	67.61	572.42	138.43	431.0	3,821.3	925.9

3.3.9 Industrial processes, not elsewhere classified

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. Ozone season-day emissions are calculated based on operating schedule information provided by the facilities in their annual emissions report.

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

Table 3.3–16. Annual and season-day emissions from other industrial processes NEC.

Geographic area	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	14.91	0.05	0.98	114.7	0.4	7.5
Ozone NAA	14.91	0.05	0.98	114.7	0.4	7.5

3.3.10 Summary of all area source industrial processes

Table 3.3–17. Summary of annual and season-day emissions from area-source industrial processes.

Geographic area	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	930.91	589.86	412.98	6,501.7	3,919.7	2,436.7
Ozone NAA	915.46	589.52	407.74	6,393.8	3,917.8	2,407.8

3.4 Solvent use

3.4.1 Surface coating

3.4.1.1 Architectural coatings

The alternative calculation method outlined in EIIP guidance (US EPA, 1995a) was used to calculate VOC emissions from architectural surface coating. First, a national average usage factor (expressed in gals/person-year) was derived by dividing the 2002 national architectural coating usage from the US Census Bureau (2003b) by the United States population in 2002 (US Census Bureau, 2002).

$$\begin{aligned}
 \text{National per-capita usage (gal/person)} &= \frac{\text{National architectural coating paint usage (gals)}}{2002 \text{ US population}} \\
 &= \frac{717,230,000}{288,368,698} \\
 &= 2.4872 \text{ gals/person}
 \end{aligned}$$

Multiplying the national per capita usage by the maximum allowable emission limit for coatings in Maricopa County (Rule 335) results in an annual per-capita value of VOC emissions for architectural coating for Maricopa County.

$$\begin{aligned}
 \text{VOC emissions (lb/person-yr)} &= \text{National per capita usage (gal/person-yr)} \times \text{Maricopa County emission limit for architectural coating (Rule 335) (lb/gal)} \\
 &= 2.4872 \times 2.1 \\
 &= 5.2231 \text{ lb/person}
 \end{aligned}$$

Annual VOC emissions for architectural coating for both Maricopa County and the ozone nonattainment area were then calculated by multiplying the county per-capita emission factor by the population in the area. (See Section 1.5.2 for a discussion of the population data used.)

To calculate season-day emissions, default assumptions from EIIP (US EPA, 1995a) were used. Table 3.4–1 presents the annual and season-day VOC emissions from architectural coatings for Maricopa County and the ozone nonattainment area.

Table 3.4–1. Annual and season-day VOC emissions from architectural coating.

Geographic area	Population	Annual emissions (tons/yr)	% annual activity in ozone season	Activity level (days/wk)	Season-day emissions (lbs/day)
Maricopa County	3,549,693	9,270.23	33%	7	67,234.6
Ozone NAA	3,481,807	9,092.94	33%	7	65,948.8

3.4.1.2 Auto refinishing

VOC emissions from automobile refinishing for both Maricopa County and the ozone nonattainment area were calculated using an emission factor of 1.9 lbs VOC/person-yr (US EPA, 1991). To avoid double counting, VOC emissions from facilities treated as point sources were then subtracted out from this total, as shown below. Season-day emissions were calculated assuming that activity occurs evenly throughout the year, 5 days/wk (US EPA, 2001c).

$$\begin{aligned}
 \text{Annual VOC emissions from automobile refinishing (tons/yr)} &= \text{Population} \times \text{EPA emission factor (lbs/person)} \div 2,000 \text{ (lbs/ton)} - \text{Annual emissions from point sources (tons/yr)}^1 \\
 &= 3,549,693 \times 1.9 \div 2,000 - 32.7 \\
 &= 3,339.51 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.4-2. Annual and season-day emissions from automobile refinishing.

Geographic area	Population	Annual emissions (tons/yr)	% annual activity in ozone season	Activity level (days/wk)	Season-day emissions (lbs/day)
Maricopa County	3,549,693	3,339.51	25%	5	25,688.5
Ozone NAA	3,481,807	3,275.05	25%	5	25,192.4

1. This figure reflects the total emissions reported from these facilities before the application of rule effectiveness where appropriate, and thus may be lower than the emission totals from point sources presented in Chapter 2.

3.4.1.3 Traffic markings

VOC emissions from traffic markings were calculated following an alternative calculation method outlined in EIIP guidance (US EPA, 1997). First, an average usage factor (in gals/person-yr) was derived to calculate VOC emissions from traffic markings. The national per capita usage amount was calculated by dividing the 2002 national traffic paint usage (US Census Bureau, 2003b) by the US population in 2002 (US Census Bureau, 2002).

$$\begin{aligned}
 \text{Annual per-capita usage (gals/person)} &= \text{National traffic paint usage (gals/yr)} \div \text{US population} \\
 &= 39,397,000 \div 288,368,698 \\
 &= 0.1366 \text{ gal/person}
 \end{aligned}$$

Multiplying the national per-capita usage by the maximum allowable emission limit for traffic coatings in Maricopa County (prescribed by County Rule 335) produces annual per-capita emission rate for VOC emissions from traffic markings for Maricopa County:

$$\begin{aligned}
 \text{VOC emissions for traffic markings (lb/person-yr)} &= \text{National per-capita usage (gal/person)} \times \text{Maricopa County emission limit for traffic coatings (prescribed by County Rule 335, in lb/gal)} \\
 &= 0.1366 \times 2.1 \\
 &= 0.2869 \text{ lb VOC/person}
 \end{aligned}$$

Total VOC emissions for traffic coating for both Maricopa County and the ozone nonattainment area are then calculated by multiplying the county per-capita emission factor by the population in the area. To calculate typical daily emissions during the ozone season, recommended EPA values were used, assuming 33 percent of annual activity occurred during the ozone season, and a typical activity level of 5 days/wk (US EPA, 1997).

Table 3.4-3. Annual and season-day VOC emissions from traffic markings.

Geographic area	Population	Annual emissions (tons/yr)	% annual activity in ozone season	Activity level (days/wk)	Season-day emissions (lbs/day)
Maricopa County	3,549,693	509.21	33%	5	5,170.4
Ozone NAA	3,481,807	499.47	33%	5	5,071.5

3.4.1.4 Factory-finished wood

Emissions from factory-finished wood coating were calculated by the “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001c). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US

Census Bureau (2003b) to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent data from the US Census' County Business Patterns (CBP) for 2001 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.4-4 shows the NAICS codes and employment data used to calculate emissions from factory-finished wood surface coating.

Table 3.4-4. NAICS codes and descriptions for factory-finished wood surface coating.

NAICS Code	Description	US Census employment data	Value used
337212	Custom architectural woodwork & millwork mfg.	436	436
337215	Showcase, partition, shelving & locker manufacturing	610	610
337920	Blind & shade manufacturing	202	202
321911	Wood window & door manufacturing	1,303	1,303
321918	Other millwork	538	538
Total:			3,089

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

$$\begin{aligned}
 \text{Total area-source employment in factory-finished wood} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 3,089 - 782 \\
 &= 2,307 \text{ employees}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source VOC emissions from factory-finished wood} &= \frac{63.63 \text{ tons/yr}}{662 \text{ employees}} \times 2,307 \text{ employees} \\
 &= 221.74 \text{ tons VOC/yr}
 \end{aligned}$$

Ozone season-day emissions are calculated based on the operating schedule data reported by factory-finished wood surface coating facilities. From annual emission surveys, the modal values were identified for two items: days/week and seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned}
 \text{Season-day VOC emissions from factory-finished wood} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{221.74 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 1,705.7 \text{ lbs VOC/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{VOC emissions from area-source factory finished wood coating in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\
 &= 221.74 \text{ tons/yr} \times 98.09\% \\
 &= 217.50 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.4–5 summarizes annual and season-day emissions from factory-finished wood surface coating in both Maricopa County and the ozone nonattainment area.

Table 3.4-5. Annual and season-day VOC emissions from area-source factory-finished wood surface coating.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	221.74	1,705.7
Ozone NAA	217.50	1,673.1

3.4.1.5 Wood furniture

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

The most recent data from the US Census’ County Business Patterns (CBP) for 2001 employment were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.4–6 shows the NAICS codes and employment data used to calculate emissions from wood furniture surface coating.

Table 3.4-6. NAICS codes and descriptions for wood furniture surface coating.

NAICS Code	Description	US Census employment data	Value used
337110	Wood kitchen cabinet & countertop manufacturing	1703	1,703
337121	Upholstered household furniture manufacturing	281	281
337122	Non-upholstered wood household furniture manufacturing	3,160	3,160
337127	Institutional furniture manufacturing	100–249	175
337129	Wood television, radio & sewing machine cabinet mfg.	20–99	60
337211	Wood office furniture manufacturing	100–249	175
811420	Re-upholstery & furniture repair	407	407
Total:			5,961

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

$$\begin{aligned}
 \text{Total area-source employment} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 \text{in wood furniture manufacturing} &= 5,961 - 2,567 \\
 &= 3,394 \text{ employees}
 \end{aligned}$$

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

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

$$\begin{aligned}
 \text{Area-source VOC emissions from wood furniture coating} &= \frac{150.36 \text{ tons/yr}}{1,063 \text{ employees}} \times 3,394 \text{ employees} \\
 &= 480.09 \text{ tons VOC/yr}
 \end{aligned}$$

Ozone season-day emissions are calculated based on the operating schedule data reported by wood furniture surface coating facilities. From annual emission surveys, the modal values were identified for two items: days/week and seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned}
 \text{Season-day VOC emissions from wood furniture coating} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{480.09 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 3,693.0 \text{ lbs VOC/day}
 \end{aligned}$$

Annual and season-day emissions for the ozone nonattainment area (NAA) were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

$$\begin{aligned}
 \text{VOC emissions from area-source wood furniture coating in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\
 &= 480.09 \text{ tons/yr} \times 98.09\% \\
 &= 470.92 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.4–7 summarizes annual and season-day emissions from wood furniture surface coating in both Maricopa County and the ozone nonattainment area.

Table 3.4–7. Annual and season-day VOC emissions from area-source wood furniture surface coating.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	480.09	3,693.0
Ozone NAA	470.92	3,622.5

3.4.1.6 Aircraft surface coating

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

The most recent data from the US Census’ County Business Patterns (CBP) for 2001 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.4–8 shows the NAICS codes and employment data used to calculate emissions from aircraft surface coating.

Table 3.4–8. NAICS codes and descriptions for aircraft surface coating.

NAICS Code	Description	US Census employment data	Value used
336411	Aircraft manufacturing	2,500–4,999	3,750
336412	Aircraft engine, and engine parts	5,000–9,999	7,500
336413	Other aircraft part & auxiliary equipment manufacturing	1,000–2,499	1,750
Total:			13,000

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

$$\begin{aligned}
 \text{Total area-source employment in aircraft coating} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 13,000 - 4,438 \\
 &= 8,562 \text{ employees}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source VOC emissions from aircraft coating} &= \frac{12.95 \text{ tons/yr}}{1,303 \text{ employees}} \times 8,562 \text{ employees} \\
 &= 85.09 \text{ tons VOC/yr}
 \end{aligned}$$

Ozone season-day emissions are calculated based on the operating schedule data reported by aircraft surface coating facilities. From annual emission surveys, the modal values were identified for two items: days/week and seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned}
 \text{Season-day VOC emissions from aircraft coating} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{85.09 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 654.5 \text{ lbs VOC/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{VOC emissions from area-source aircraft coating in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\
 &= 85.09 \text{ tons/yr} \times 98.09\% \\
 &= 83.47 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.4–9 summarizes annual and season-day emissions from aircraft surface coating in both Maricopa County and the ozone nonattainment area.

Table 3.4–9. Annual and season-day VOC emissions from area-source aircraft surface coating.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	85.09	654.5
Ozone NAA	83.47	642.0

3.4.1.7 Miscellaneous manufacturing

Area-source VOC emissions from miscellaneous surface coating were estimated by a “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001c). This method combines detailed emissions and employment data from Maricopa County permitted facilities to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category, as follows:

$$\begin{aligned}
 \text{Average misc. coat. emission factor (lbs/employee)} &= \frac{\text{Annual reported VOC emissions from misc. coating (lbs/yr)}}{\text{Number of employees in area-source businesses that reported misc. coating activity in 2002}} \\
 &= \frac{580,947.3 \text{ lbs}}{34,945 \text{ employees}} \\
 &= 16.625 \text{ lbs/employee}
 \end{aligned}$$

The typical “scale-up” methodology was revised slightly for this source category for a number of reasons. First, miscellaneous surface coating activity occurs at some level across a wide spectrum of industries, both industrial and commercial/institutional. Additionally, annual emissions reports may be inconsistent in how activities are reported, and it is uncertain if all relevant activities are categorized as “miscellaneous surface coating” vs. some other category (e.g., manufacturing). Estimating total emissions from miscellaneous surface coating based on county employment by NAICS code (for which employment data are often presented only as a broad range), or all industrial employment (including industries which have little or no miscellaneous surface coating activities) would therefore be misleading and lead to an over-estimate of area-source emissions from this source category.

Instead, the list of SIC codes used by businesses that reported miscellaneous surface coating activities was conservatively assumed to represent the “universe” of businesses that could possibly have significant miscellaneous surface coating activity. As some facilities are considered point sources (which are addressed in Chapter 2), to avoid double-counting, employment at point sources is subtracted from total employment within these SIC categories as follows:

$$\begin{aligned}
 \text{Total area-source employ-} &= \text{Total employment in all businesses} & - & \text{Employment at point sources} \\
 \text{men in industries with} & \text{in SIC codes that reported} & & \text{in these SIC codes} \\
 \text{misc. coating activity} & \text{misc. coating activity in 2002} & & \text{(from annual emission reports)} \\
 & = 132,155 & & - 47,087 \\
 & = 85,068 \text{ employees} & &
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Total area-source} &= \text{per-employee emission factor} & \times & \text{Total area-source employment} \\
 \text{emissions from misc.} & & & \text{in relevant SIC categories} \\
 \text{coating operations} & = 16,625 \text{ lbs/employee} & \times & 85,068 \text{ employees} \\
 & = 1,414,223.0 \text{ lbs/yr} \\
 & = 707.11 \text{ tons VOC/yr}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Season-day VOC} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} & \times & \frac{2,000 \text{ lbs}}{\text{ton}} \\
 \text{emissions from area-} & & & \\
 \text{source misc. coating} & = \frac{707.11 \times 25\%}{5 \times 13} & \times & 2,000 \\
 & = 5,439.3 \text{ lbs VOC/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{VOC emissions from} &= \text{Annual Maricopa County} & \times & \text{NAA:County ratio of} \\
 \text{area-source degreasing} & \text{emissions} & & \text{industrial employment} \\
 \text{in the ozone NAA (tons/yr)} & = 707.11 \text{ tons/yr} & \times & 98.09\% \\
 & = 693.61 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.4–10 summarizes annual and season-day emissions from area-source miscellaneous surface coating in both Maricopa County and the ozone nonattainment area.

Table 3.4–10. Annual and season-day VOC emissions from miscellaneous surface coating.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	707.11	5,439.3
Ozone NAA	693.61	5,335.4

3.4.1.8 Summary of all area source surface coating

Table 3.4–11. Summary of annual and season-day VOC emissions from area-source surface coating.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	14,612.98	109,586.1
Ozone NAA	14,332.92	107,485.8

3.4.2 Degreasing

Area-source VOC emissions from degreasing were estimated by a “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001c). This method combines detailed emissions and employment data from Maricopa County permitted facilities to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category, as follows:

$$\begin{aligned} \text{Average degreasing} &= \text{Annual reported VOC emissions} \div \text{Number of employees in area-source} \\ \text{emission factor} & \quad \text{from degreasing (lbs/yr)} \quad \quad \quad \text{businesses that reported degreasing} \\ \text{(lbs/employee)} & \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \text{activity in 2002} \\ & = 64,782 \text{ lbs} \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \div 11,677 \text{ employees} \\ & = 5.548 \text{ lbs/employee} \end{aligned}$$

The typical “scale-up” methodology was revised slightly for this source category for a number of reasons. First, degreasing activity occurs at some level across a wide spectrum of industries, both industrial and commercial/ institutional. Additionally, annual emissions reports may be inconsistent in how activities are reported, and it is uncertain if all relevant activities are categorized as “degreasing” vs. some other category (e.g., manufacturing). Estimating total emissions from degreasing based on county employment by NAICS code (for which employment data are often presented only as a broad range), or all industrial employment (including industries which have little or no degreasing activities) would therefore be misleading and lead to an over-estimate of area-source emissions from this source category.

Instead, the list of SIC codes used by businesses that reported degreasing activities was conservatively assumed to represent the “universe” of businesses that could possibly have significant degreasing activity. As some facilities are considered point sources (which are addressed in Chapter 2), to avoid double-counting, employment at point sources is subtracted from total employment within these SIC categories as follows:

$$\begin{aligned}
\text{Total area-source employ-} &= \text{Total employment in all businesses} & - & \text{Employment at point sources} \\
\text{men in industries with} & \text{in SIC codes that reported} & & \text{in these SIC codes} \\
\text{degreasing activity} & \text{degreasing activity in 2002} & & \text{(from annual emission reports)} \\
& = 144,821 & & - 56,764 \\
& = 88,057 \text{ employees}
\end{aligned}$$

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

$$\begin{aligned}
\text{Total area-source} &= \text{per-employee emission factor} & \times & \text{Total area-source employment} \\
\text{emissions from de-} & & & \text{in relevant SIC categories} \\
\text{greasing operations} & = 5.548 \text{ lbs/employee} & \times & 88,057 \text{ employees} \\
& = 488,540 \text{ lbs/yr} \\
& = 244.26 \text{ tons VOC/yr}
\end{aligned}$$

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

$$\begin{aligned}
\text{Season-day VOC} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} & \times & 2,000 \text{ lbs} \\
\text{emissions from area-} & & & \text{ton} \\
\text{source degreasing} & = \frac{244.26 \times 25\%}{5 \times 13} & \times & 2,000 \\
& = 1,878.9 \text{ lbs VOC/day}
\end{aligned}$$

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

$$\begin{aligned}
\text{VOC emissions from} &= \text{Annual Maricopa County} & \times & \text{NAA:County ratio of} \\
\text{area-source degreasing} & \text{emissions} & & \text{industrial employment} \\
\text{in the ozone NAA (tons/yr)} & = 244.26 \text{ tons/yr} & \times & 98.09\% \\
& = 239.60 \text{ tons VOC/yr}
\end{aligned}$$

Table 3.4–12 summarizes annual and season-day emissions from area-source degreasing in both Maricopa County and the ozone nonattainment area.

Table 3.4–12. Annual and season-day VOC emissions from area-source degreasing.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	244.26	1,878.9
Ozone NAA	239.60	1,843.1

3.4.3 Dry cleaning

Dry cleaning facilities are identified as one of two types: those that use perchloroethylene and those that use a petroleum solvent (140 or Stoddard solvent) or other VOC-based solvent. Perchloroethylene is a synthetic solvent that is not considered photochemically reactive and therefore is not included in this inventory. Annual VOC emissions from this category were estimated using annual emission reports, as all permitted dry cleaners are surveyed annually. (It is assumed there are no unpermitted dry cleaning facilities operating within the county.)

A total of 19 dry cleaning establishments reported using VOC-based cleaning solvents. Dry cleaning activity is not constant throughout the year. The 2002 emission reports contained seasonal percentages for each process as well as data on typical operating schedules. Seasonal activity data collected for the period June–August was assumed not to be significantly different from the ozone season, July–September. The modes (i.e., most frequently occurring) of these values were used to calculate ozone season-day emissions from VOC-containing dry cleaning solvents. Assuming on average 20% of annual throughput occurred during the ozone season, and a 5-day work week, ozone season-day emissions were calculated as:

$$\begin{aligned}
 \text{Ozone season-day VOC emissions from dry cleaning} &= \text{Annual emissions} \times \% \text{ ozone-season throughput} \div (\text{days/week} \times \text{weeks/season}) \\
 &= 52,784 \text{ lbs/yr} \times 20\% \div (5 \times 13) \\
 &= 162.7 \text{ lbs VOC/day}
 \end{aligned}$$

Since all dry cleaning establishments are located within the ozone nonattainment area, the county and nonattainment area emission totals are the same. Table 3.4–13 summarizes the materials used, emission factors, and annual and season-day VOC emissions from dry cleaning.

Table 3.4–13. Annual and season-day VOC emissions from dry cleaning.

Material	Amount used (gal/yr)	Emission factor (lbs/gal)	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Petroleum solvents	7,626	6.5	24.78	152.5
DF-2000	515	6.42	1.65	10.2
Totals:			26.44	162.7

3.4.4 Graphic arts

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

The most recent data from the US Census’ County Business Patterns (CBP) for 2001 employment, were used. Where CBP employment estimates were presented as a range, the midpoint values was chosen for these calculations. Table 3.4–14 shows the NAICS codes and employment data used to calculate emissions from graphic arts.

Table 3.4-14. NAICS codes and descriptions for graphic arts

NAICS Code	Description	US Census employment data	Value used
323*	Printing & related support activities	6,511	6,511
5111*	Newspaper, periodical, book & database publishers	5,875	5,875
Total:			12,386

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

$$\begin{aligned}
 \text{Total area-source employment in graphic arts} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 12,386 - 1,703 \\
 &= 10,683 \text{ employees}
 \end{aligned}$$

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

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

$$\begin{aligned}
 \text{Area-source VOC emissions from graphic arts} &= \frac{171.55 \text{ tons/yr}}{3,979 \text{ employees}} \times 10,683 \text{ employees} \\
 &= 460.58 \text{ tons VOC/yr}
 \end{aligned}$$

Ozone season-day emissions are calculated based on the operating schedule data reported by graphic arts facilities. From annual emission surveys, the modal values were identified for two items: days/week and seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned}
 \text{Season-day VOC emissions from graphic arts} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{460.58 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 3,542.9 \text{ lbs VOC/day}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{VOC emissions from area-source graphic arts in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\
 &= 460.58 \text{ tons/yr} \times 98.09\% \\
 &= 451.78 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.4–15 summarizes annual and season-day emissions from graphic arts in both Maricopa County and the ozone nonattainment area.

Table 3.4–15. Annual and season-day VOC emissions from area-source graphic arts.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	460.58	3,542.9
Ozone NAA	451.78	3,475.2

3.4.5 *Miscellaneous industrial solvent use*

Area-source VOC emissions from miscellaneous industrial solvent use were estimated by a “scaling up” method as described in EPA emission inventory guidance (US EPA, 2001c). This method combines detailed emissions and employment data from Maricopa County permitted facilities to develop a per-employee emission factor that is then used to estimate emissions from all sources in an industry category, as follows:

$$\begin{aligned}
 \text{Average solvent use} &= \text{Annual reported VOC emissions} \div \text{Number of employees in area-source} \\
 \text{emission factor} & \quad \text{from solvent use (lbs/yr)} \quad \quad \quad \text{businesses that reported solvent use} \\
 \text{(lbs/employee)} & \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \text{activity in 2002} \\
 & = 15,789.6 \text{ lbs} \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \quad \div 3,502 \text{ employees} \\
 & = 4.509 \text{ lbs/employee}
 \end{aligned}$$

The typical “scale-up” methodology was revised slightly for this source category for a number of reasons. First, miscellaneous industrial solvent use occurs at some level across a wide spectrum of industries. Additionally, annual emissions reports may be inconsistent in how activities are reported, and it is uncertain if all relevant activities are categorized as “miscellaneous industrial solvent use” vs. some other category (e.g., manufacturing). Estimating total emissions from miscellaneous industrial solvent use based on county employment by NAICS code (for which employment data are often presented only as a broad range), or all industrial employment (including industries which have little or no solvent use activities) would therefore be misleading and lead to an overestimate of area-source emissions from this source category.

Instead, the list of SIC codes used by businesses that reported miscellaneous industrial solvent use activities was conservatively assumed to represent the “universe” of businesses that could possibly have significant miscellaneous industrial solvent use activity. As some facilities are considered point sources (which are addressed in Chapter 2), to avoid double-counting, employment at point sources is subtracted from total employment within these SIC categories as follows:

$$\begin{aligned}
 \text{Total area-source employ-} &= \text{Total employment in all businesses} & - & \text{Employment at point sources} \\
 \text{men in industries with} & \quad \text{in SIC codes that reported} & & \text{in these SIC codes} \\
 \text{misc. solvent use} & \quad \text{misc. solvent use in 2002} & & \text{(from annual emission reports)} \\
 & = 44,731 & & - 17,753 \\
 & = 26,978 \text{ employees}
 \end{aligned}$$

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

$$\begin{aligned}
\text{Total area-source emissions from misc. solvent use (tons/yr)} &= \text{per-employee emission factor} \times \text{Total area-source employment in relevant SIC categories} \\
&= 4.509 \text{ lbs/employee} \times 26,978 \text{ employees} \\
&= 121,636.6 \text{ lbs/yr} \\
&= 60.82 \text{ tons VOC/yr}
\end{aligned}$$

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

$$\begin{aligned}
\text{Season-day VOC emissions from area-source misc. solvent use (lbs/day)} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
&= \frac{60.82 \times 25\%}{5 \times 13} \times 2,000 \\
&= 467.8 \text{ lbs VOC/day}
\end{aligned}$$

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

$$\begin{aligned}
\text{VOC emissions from area source misc. solvent use in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of industrial employment} \\
&= 60.82 \text{ tons/yr} \times 98.09\% \\
&= 59.66 \text{ tons VOC/yr}
\end{aligned}$$

Table 3.4–16 summarizes annual and season-day emissions from area-source miscellaneous industrial solvent use in both Maricopa County and the ozone nonattainment area.

Table 3.4–16. Annual and season-day VOC emissions from area source miscellaneous industrial solvent use.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	60.82	467.8
Ozone NAA	59.66	458.9

3.4.6 Pesticide application: agricultural

Pesticides are substances used to control nuisance weeds (herbicides), insects (insecticides), fungi (fungicides), and rodents (rodenticides). Formulations of pesticides are made through the combination of the pest-killing material referred to as the active ingredient, and various solvents (which act as carriers for the pest-killing material) referred to as the inert ingredient. Both types of ingredients contain VOCs that can potentially be emitted to the air either during application or as a result of evaporation. Application rates for a particular pesticide may vary from crop to crop. Application of pesticides can be from the ground or from the air.

The Arizona Agricultural Statistics Service (AASS) provided MCESD with data on agricultural pesticide usage for 2002. The data included the active ingredient, the amount of active ingredient, and the date and number of acres applied (AASS, 2003) as shown in Appendix 3.1. VOC emissions from the active ingredients were calculated using the preferred method outlined in EIIP guidance (US EPA, 2001f). VOC emissions from the inert ingredients were calculated using an EPA default for inert ingredient components (US EPA, 2001f). The EPA methods only apply to ground applications. Currently, EPA has no recommended method for calculating VOC emissions from aerial application of pesticides. According to EIIP guidance, a major factor in losses by aerial application is drift, and neither equations nor experimental data are currently available to permit predictions of these losses or the development of emission factors (US EPA, 2001f). AASS did not provide data on the method of application (air vs. ground application), thus, the amount of active ingredient (AI) applied by ground in 2002 was estimated for each active ingredient using 1999 data on ground and aerial application (MCESD, 2002), as in this example for Diazinon, the active ingredient contained in the pesticide Diazinon AG500:

$$\begin{aligned}
 \text{Amount of Diazinon applied by ground (lbs/yr)} &= \text{Total Diazinon applied in 2002 (lbs)} \times \frac{\text{1999 AI applied by ground (lbs)}}{\text{1999 Total AI applied (lbs)}} \\
 &= 369.73 \text{ lbs} \times \frac{880,113 \text{ lbs}}{4,345,836 \text{ lbs}} \\
 &= 74.87 \text{ lbs}
 \end{aligned}$$

The emission factors for the active ingredients were determined based on the vapor pressure of the active ingredient (US EPA, 2001, Table 9.4-4). Vapor pressure of the active ingredient was obtained from multiple sources including: EIIP guidance (US EPA 2001f), the Crop Protection Handbook (Meister Pro, 2003) and from the Arizona Department of Environmental Quality (Yu, 2004). Because data was not available regarding surface application vs. soil incorporation, the more conservative of the two emission factors (surface application) was used. Annual VOC emissions from the active ingredient of the pesticide applied were calculated as in this example for Diazinon:

$$\begin{aligned}
 \text{Annual VOC emissions from AI Diazinon (lbs/yr)} &= \text{Total Diazinon applied by ground (lbs/yr)} \times \text{AI Diazinon emission factor from AP-42, Table 9.4-4 (lbs VOC/lb AI)} \\
 &= 74.87 \text{ lbs} \times 0.35 \text{ lbs VOC/lb of AI Diazinon} \\
 &= 26.20 \text{ lbs VOC/yr}
 \end{aligned}$$

Annual VOC emissions from the inert ingredient components of pesticides are calculated as in this example for Diazinon:

$$\begin{aligned}
 \text{Annual VOC emissions from inert ingredient component for Diazinon AG500 (lbs/yr)} &= \text{Lbs. Diazinon applied by ground} \times \text{EPA VOC default factor for inert ingredients components} \\
 &= 74.87 \text{ lbs} \times 1.45 \\
 &= 108.56 \text{ lbs VOC/yr}
 \end{aligned}$$

Total VOC emissions for each pesticide applied was then calculated by summing the VOC emissions from the active ingredient and the inert ingredient as in this example for the pesticide Diazinon AG500:

$$\begin{aligned}
 \text{Total annual VOC emissions from Diazinon AG 500 (lbs/yr)} &= \text{Annual VOC emissions from AI of Diazinon (lbs/yr)} + \text{Annual VOC emissions from inert ingredients} \\
 &= 26.2 \text{ lbs} + 108.6 \text{ lbs} \\
 &= 134.8 \text{ lbs VOC/yr}
 \end{aligned}$$

This procedure was followed for each pesticide that was used in 2002. Totaling these calculated emissions resulted in 377.00 tons of VOC emissions from agricultural pesticide usage in 2002. Ozone season-day emissions were calculated by dividing ozone season emissions (July–September; 546,027 lbs) by an application schedule of 6 days a week for the 13 weeks of the ozone season, as follows:

$$\begin{aligned}
 \text{Ozone season-day VOC emissions from agricultural pesticides (lbs/day)} &= \text{Ozone season emissions from pesticides (lbs)} \div (6 \text{ days/week} \times 13 \text{ weeks/season}) \\
 &= 546,027 \text{ lbs} \div 78 \\
 &= 7,000.3 \text{ lbs of VOC/day}
 \end{aligned}$$

Annual and ozone season-day emissions for the ozone nonattainment area were derived by multiplying the county annual and ozone season-day emissions by the percentage of agricultural land located in the ozone NAA (44.53%; see Section 1.5.2 for a discussion of land-use data used).

Table 3.4–17. Annual and season-day VOC emissions from agricultural pesticide application.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	377.00	7,000.3
Ozone NAA	167.88	3,117.3

3.4.7 Consumer and commercial solvent use

Consumer and commercial products emissions include all emissions from seven product categories: personal care products, household products, automotive aftermarket products, adhesives and sealants, FIFRA-regulated products, coatings and related products, and miscellaneous products.

Annual area source VOC emissions from consumer and commercial products are calculated by multiplying per-capita emission factors from EIIP guidance (US EPA, 1996) by the population estimates for Maricopa County (3,549,693) and the ozone nonattainment area (3,481,807) (see Section 1.5.1 for a discussion of population data). Ozone season-day emissions for the county and the ozone NAA are calculated by dividing annual emissions 365 days as activity is assumed to occur uniformly throughout the year according to EIIP guidance (US EPA, 2001c).

Table 3.4–18. Annual and season-day VOC emissions from consumer and commercial products.

Product category	Emission factor (lbs/person)	Maricopa County		Ozone NAA	
		Annual (tons/yr)	Season day (lbs/day)	Annual (tons/yr)	Season day (lbs/day)
Personal care	2.32	4,117.64	22,562.4	4,038.90	22,130.9
Household	0.79	1,402.13	7,682.9	1,375.31	7,536.0
Automotive aftermarket	1.36	2,413.79	13,226.3	2,367.63	12,973.3
Adhesives/sealants	0.57	1,011.66	5,543.4	992.31	5,437.3
FIFRA-Regulated	1.78	3,159.23	17,310.8	3,098.81	16,979.8
Coatings and related	0.95	1,686.10	9,238.9	1,653.86	9,062.2
Miscellaneous	0.07	124.24	680.8	121.86	667.7
Totals:	7.84	13,914.80	76,245.5	13,648.68	74,787.3

3.4.8 Asphalt application

Asphalt is applied to pave, seal, and repair surfaces such as roads, parking lots, drives, walkways, roofs, and airport runways. Area-source emissions from asphalt application are calculated by first allocating 2002 state-level asphalt usage data (Asphalt Institute, 2004) to Maricopa County and the ozone nonattainment area by the use of two surrogates: vehicle miles traveled (VMT) and population. Table 3.4–19 lists 2002 vehicle miles traveled (VMT) and population for Arizona state, Maricopa County and the ozone NAA. (See Chapters 1 and 5, respectively, for a discussion of population and VMT data used).

Table 3.4–19. Vehicle miles traveled (VMT) and population data.

Geographic area	VMT	Total residential population
Arizona	142,275,000 ⁽¹⁾	5,472,750
Maricopa County	73,579,000	3,296,250
Ozone NAA	67,524,300	3,232,387

1. from ADOT, 2004.

Maricopa County asphalt usage is allocated from state-level usage for three categories of asphalt application: roofing, cutback and emulsified. Population was used to allocate state-wide roofing asphalt usage to county-levels, while VMT was used to allocate cutback and emulsified asphalt to county levels (US EPA, 2001a); as in this example for cutback asphalt:

$$\begin{aligned}
 \text{2002 county cutback asphalt usage (tons/yr)} &= \text{2002 Arizona cutback asphalt usage (tons/yr)} \times \text{2002 county:state VMT ratio} \\
 &= 14,192 \times (73,579,000 \div 142,275,000) \\
 &= 7,340 \text{ tons/yr}
 \end{aligned}$$

Table 3.4–20 details state and county asphalt usage by type and they county:state allocation factor used.

Table 3.4–20. Annual asphalt usage, by type.

Asphalt type	2002 Arizona asphalt usage (tons/yr)	County:state allocation factor (surrogate measure)	County asphalt usage (tons/yr)
Cutback	14,192	51.72% (VMT)	7,339.54
Emulsified	47,079	51.72% (VMT)	24,347.40
Roofing	6,519	60.23% (population)	3,926.41

County annual VOC emissions from cutback asphalt are calculated by multiplying annual usage of cutback asphalt by an emission factor derived based on the percent volume of VOCs in the diluent. The diluent content of cutback asphalt typically ranges between 25 to 45 percent VOC by volume. The midpoint of 35 percent was used for Maricopa County as actual diluent percentages were not available, and because all cutback asphalt used in the county was assumed to be “medium cure”, as “rapid cure” blends are prohibited by county rule. An emission factor of 0.20 pounds of VOC per pound of cutback asphalt was used, based on the 35 percent VOC (by volume) content of the diluent (US EPA, 2001a), to derive annual emissions as follows:

$$\begin{aligned}
 \text{Annual VOC emissions from cutback asphalt in Maricopa County (tons/yr)} &= \text{Maricopa County cutback asphalt usage (tons/yr)} \times \text{Emission factor (ton/ton)} \\
 &= 7,339.54 \times 0.20 \\
 &= 1,467.91 \text{ tons VOC/yr}
 \end{aligned}$$

Emissions from emulsified asphalt were calculated similarly, using a VOC emission factor of 0.0263 ton/ton. Emissions from roofing asphalt were calculated by multiplying the amount of asphalt melted in roofing kettles during hot-applied methods by an emission factor for asphalt roofing kettles (US EPA, 2000a). It was conservatively assumed that all roofing asphalt used in Maricopa County is melted through hot-applied methods. Thus, annual emissions are calculated as follows:

$$\begin{aligned}
 \text{Annual VOC emissions from roofing asphalt in Maricopa County (tons/yr)} &= \text{Maricopa County roofing asphalt usage (tons/yr)} \times \text{emission factor (lbs/ton)} \div \text{unit conversion factor (lbs/ton)} \\
 &= 3,926.41 \times 6.2 \div 2,000 \\
 &= 12.17 \text{ tons VOC/yr}
 \end{aligned}$$

For all three types of asphalt application, it was assumed that asphalt application occurs equally throughout the calendar year, with cutback and emulsified application occurring 7 days a week and roofing asphalt application occurring 5 days a week. Therefore, ozone season-day VOC emissions for the county are calculated by dividing county annual emissions by the number of days activity occurs during the year, as in this example for cutback asphalt:

$$\begin{aligned}
 \text{Season-day VOC emissions from cutback asphalt (lbs/day)} &= \text{Annual emissions (tons/yr)} \times \text{unit conversion factor (lbs/ton)} \div \text{activity schedule (days/yr)} \\
 &= 1,467.91 \times 2,000 \div 365 \\
 &= 8,043.3 \text{ lbs VOC/day}
 \end{aligned}$$

Annual and season-day emissions for the ozone nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage of VMT within the nonattainment area (for cutback and emulsified asphalt) and by the percentage of population within the nonattainment area (for roofing asphalt) as in this example for annual VOC emissions from cutback asphalt in the ozone nonattainment area:

$$\begin{aligned}
 \text{Annual VOC emissions from cutback asphalt in the NAA (tons/yr)} &= \text{Maricopa County cutback asphalt usage (tons/yr)} \times \text{Ratio of NAA:County VMT} \\
 &= 1,467.91 \times 0.9177 \\
 &= 1,347.12 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.4–21. Annual and season-day VOC emissions from asphalt application.

Asphalt type	Maricopa County		Ozone nonattainment area	
	Annual emissions (tons/yr)	Season-day emissions (lbs/day)	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Cutback	1,467.91	8,043.3	1,347.12	7,381.5
Emulsified	640.34	3,508.7	587.64	3,220.0
Roofing	12.17	93.6	11.94	91.8
Totals:	2,120.42	11,645.7	1,946.70	10,693.2

3.4.9 Summary of all area source solvent use

Table 3.4–22. Summary of annual and season-day VOC emissions from all area-source solvent use.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	31,817.28	210,530.0
Ozone NAA	30,873.65	202,023.5

3.5 Storage and transport

3.5.1 Bulk plants/terminals

Emissions from this source category were calculated by summing reported VOC emissions from bulk terminals and plants emissions inventory reports. It is assumed that there are no unpermitted bulk terminals or plants in Maricopa County. To avoid double-counting, emissions from bulk terminals and bulk plants treated as point sources (totaling 210.58 tons)¹ were subtracted from total emissions to derive total annual emissions from area-source bulk terminals and bulk plants of 40.15 tons/yr. Since all bulk terminals and bulk plants considered in this section are located within the ozone nonattainment area, total emission values for the county and the ozone NAA are equal.

Ozone season-day emissions are then calculated based on operational data provided in the annual emissions inventory as follows:

$$\begin{aligned}
 \text{Ozone season-day emissions (lbs/day)} &= \frac{\text{Area source annual emissions (tons/yr)} \times (\text{summer \%})}{\text{Days of operation/week} \times \text{weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{40.15 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 308.9 \text{ lbs/day}
 \end{aligned}$$

Table 3.5–1. Annual and season-day VOC emissions from area-source bulk terminals and bulk plants.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	40.15	308.9
Ozone NAA	40.15	308.9

¹ This figure reflects the total emissions reported from these facilities *before* the application of rule effectiveness where appropriate, and thus may be lower than the emission totals from point sources presented in Chapter 2.

3.5.2 Volatile organic liquid (VOL) storage and transport

Emissions from this source category were calculated by summing reported VOC emissions from volatile organic liquid storage/transfer emissions inventory reports. (It is assumed that there are no significant unpermitted volatile organic liquid storage/transfer facilities in Maricopa County.) To avoid double counting, emissions from those facilities treated as point sources (totaling 0.20 tons) are addressed in Chapter 2. Since all facilities considered in this section are located within the ozone nonattainment area, total emission values for the county and the ozone NAA are equal.

Ozone season-day emissions are calculated based on the operating schedule data reported by volatile organic liquid storage / transfer facilities. From annual emission surveys, the modal values were identified for two items: days/week and seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned}
 \text{Season-day VOC emissions} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times 2,000 \frac{\text{lbs}}{\text{ton}} \\
 &= \frac{25.42 \times 25\%}{7 \times 13} \times 2,000 \\
 &= 139.7 \text{ lbs VOC/day}
 \end{aligned}$$

Table 3.5-2. Annual and season-day VOC emissions from area-source organic liquid storage/transfer.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	25.42	139.7
Ozone NAA	25.42	139.7

3.5.3 Petroleum tanker truck fuel delivery

Following EPA methodologies (US EPA, 2001b), annual VOC emissions from tanker truck fuel delivery to outlets are calculated by multiplying gasoline sales (1,468,658,402 gallons (ADOT, 2003)) by emission factors found in AP-42 Table 5.2-7 (US EPA, 1995b) for each filling technology. Based on 2002 emissions survey data, 98.5% of gasoline is delivered using balanced submerged filling with the remaining 1.5% delivered by submerged filling. Annual emissions in the ozone nonattainment area are allocated by multiplying annual county emissions by the percentage of retail gasoline outlets located in the nonattainment area (96.39%).

$$\begin{aligned}
 \text{VOC emissions from balanced submerged filling} &= \text{Gas sales (Mgals)} \times \% \text{ delivered by fill technology} \times \text{emission factor (lbs/Mgals)} \\
 &= 1,468,658.402 \times 98.5\% \times 0.3 \\
 &= 433,988.6 \text{ lbs} \\
 &= 216.99 \text{ tons VOC/yr}
 \end{aligned}$$

$$\begin{aligned}
 \text{VOC emissions from submerged filling} &= \text{Gas sales (Mgals)} \times \% \text{ delivered by fill technology} \times \text{emission factor (lbs/Mgals)} \\
 &= 1,468,658.402 \times 1.5\% \times 7.3 \\
 &= 160,818.1 \text{ lbs} \\
 &= 80.41 \text{ tons VOC/yr}
 \end{aligned}$$

Ozone season-day emissions are calculated by multiplying ozone-season gasoline sales (July–September) by the emission factors listed above, then dividing by the product of the number of weeks in the ozone season (13) and the number of days a week (6) deliveries occur during the

ozone season. Season-day emissions in the ozone nonattainment area are allocated based on the percentage of retail gasoline outlets located in the nonattainment area (96.39%).

$$\begin{aligned} \text{Season-day VOC emissions from balanced submerged fill} &= \text{Total seasonal gas sales (Mgals)} \times \% \text{ fill tech.} \times \text{emission factor (lbs/MGals)} \div (\text{days/week} \times \text{wks/season}) \\ &= 360,957.386 \times 98.5\% \times 0.3 \div (6 \times 13) \\ &= 1,367.5 \text{ lbs VOC/day} \end{aligned}$$

Table 3.5-3. Annual and season-day VOC emissions from tanker truck fuel delivery.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	297.40	1,874.2
Ozone NAA	286.67	1,806.5

3.5.4 Petroleum tanker trucks in transit

Gasoline trucks in transit VOC emissions are dependent on the number of times gasoline is distributed inside the inventory area. Gasoline distribution may occur once (from bulk terminals to retail outlets) or twice (distribution to bulk plants, then retail outlets). Annual VOC emissions from gasoline trucks in transit are calculated by the following formula (US EPA, 2001b):

$$\text{TTE} = \frac{(\text{TGD} \times \text{LEF} \times \text{GTA}) + (\text{TGD} \times \text{UEF} \times \text{GTA})}{2,000}$$

where:

- TTE = Total gasoline emissions from tank trucks in transit (tons/yr)
- TGD = Total gasoline distributed in area (Mgals)
- LEF = Loaded tank truck in-transit emission factor (lbs/Mgals) (AP-42, Table 5.2-5)
- UEF = Unloaded tank truck in-transit emission factor (lbs/Mgals) (AP-42, Table 5.2-5)
- GTA = Gasoline transportation adjustment factor (1.25; US EPA historical default)

Substituting Maricopa County values in the above equation yields:

$$\begin{aligned} &= \frac{(1,468,658.402 \text{ Mgals/yr} \times 0.005 \text{ lbs/Mgals} \times 1.25) + (1,468,658.402 \text{ Mgals/yr} \times 0.055 \text{ lbs/Mgals} \times 1.25)}{2,000} \\ &= 55.07 \text{ tons VOC/yr} \end{aligned}$$

Ozone season-day VOC emissions are calculated using the same formula as above by using only the gasoline distributed during the ozone season (July–September) (360,957,386 gallons (ADOT, 2003)), and dividing the resultant total by the product of the number of weeks (13) in the ozone season and the number of days (6) gasoline distribution occurs each week.

VOC emissions from gasoline trucks in transit in the ozone nonattainment area are allocated by the percentage (96.39%) of County retail gasoline outlets located in the ozone nonattainment area (US EPA, 2001b).

Table 3.5-4. Annual and season-day VOC emissions from gasoline trucks in transit.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	55.07	347.1
Ozone NAA	53.09	334.5

3.5.5 Service stations, breathing/emptying

Following EPA methodologies (US EPA, 2001b), annual VOC emissions from storage tank breathing and emptying are calculated by multiplying annual gasoline throughput (1,468,658,402 gallons (ADOT, 2003)) by the emission factor for underground tank breathing and emptying (1.0 lb/Mgal) found in AP-42 Table 5.2-7 (US EPA, 1995b).

$$\begin{aligned} \text{Annual emissions from breathing and emptying losses (tons/yr)} &= \frac{\text{gasoline throughput (Mgal)} \times \text{emission factor (lb/Mgal)}}{2,000} \\ &= \frac{1,468,658.402 \text{ Mgal} \times 1.0 \text{ lb/Mgal}}{2,000} \\ &= 734.33 \text{ tons/yr} \end{aligned}$$

Ozone season-day VOC emissions are calculated using the same formula as above, using only the gasoline distributed during the ozone season (July–September) (360,957,386 gallons (ADOT, 2003)) and dividing by the product of the number of weeks (13) in the ozone season and the number of days per week (7) gasoline storage occurs.

VOC emissions from breathing and emptying losses in the ozone nonattainment area are allocated by the percentage (96.39%) of retail gasoline outlets operating in the ozone nonattainment area (US EPA, 2001b).

Table 3.5–5. Annual and season-day VOC emissions from gasoline marketing breathing and emptying losses.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	734.33	3,966.6
Ozone NAA	707.82	3,823.4

3.5.6 Vehicle refueling

Following EPA guidance (US EPA, 2001b), annual VOC emissions from vehicle refueling are calculated by multiplying the annual gasoline throughput (1,468,658,402 gallons (ADOT, 2003)) by a vehicle refueling factor estimated from the MOBILE6 model (MAG, 2004) as follows:

$$\begin{aligned} \text{Annual VOC emissions from vehicle refueling (tons/yr)} &= \text{Annual gasoline throughput (gals)} \times \text{MOBILE6 vehicle refueling factor (g/gal)} \div \text{unit conversion factor} \\ &= 1,468,658,402 \text{ gals} \times 0.64 \text{ g/gal} \div \frac{908,000 \text{ grams}}{\text{ton}} \\ &= 1,035.18 \text{ tons VOC/yr} \end{aligned}$$

Ozone season-day emissions were calculated using the same formula as above with ozone season specific data. First, ozone season emissions were estimated using the gasoline distributed during the ozone season (July–September) (360,957,386 gallons (ADOT, 2003)) and the ozone season vehicle refueling factor (0.68 g/gal). Then, ozone season emissions were divided by 91, the product of the number of weeks (13) in the ozone season and the number of days (7) vehicle refueling occurs each week.

Annual and season-day emissions for the ozone nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage (96.39%) of retail gasoline outlets operating in the ozone nonattainment area (US EPA, 2001b).

Table 3.5–6. Annual and season-day VOC emissions from vehicle refueling.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	1,035.18	5,941.1
Ozone NAA	997.81	5,726.6

3.5.7 Summary of all area source storage and transport

Table 3.5–7. Summary of annual and season-day VOC emissions from area-source storage and transport.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	2,187.56	12,577.5
Ozone NAA	2,110.96	12,139.6

3.6 Waste treatment and disposal

3.6.1 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 3.7.2.2. There were no incinerators at residential (e.g., apartment complexes) or commercial/institutional facilities (e.g., hospitals, service establishments) in operation during 2002.

Emissions from on-site incineration were determined from annual emission inventory reports. Of the four incinerators under permit in 2002, two were surveyed and reported annual emissions. As all four facilities are roughly similar in terms of capacity, these survey results were doubled to estimate total annual and season-day emissions from all four incinerators in Maricopa County. All four facilities are located within the ozone nonattainment area, thus total emissions for the county and NAA are equal.

Table 3.6–1. Annual and season-day emissions from on-site incineration.

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO_x	CO	VOC	NO_x	CO
County	1.02	28.90	0.59	7.8	222.3	4.5
Ozone NAA	1.02	28.90	0.59	7.8	222.3	4.5

3.6.2 Open burning

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

calculate emissions. Where data were missing, activity data for each permit category was grown from those permits that contained information, as follows:

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

Example:

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

Reported and estimated activity data for each open burning category are summarized in Table 3.6–2. Permits issued for fire fighting training will be addressed in Section 3.7.1.2, Structure fires.

Table 3.6–2. 2002 burn permit activity data used to estimate the amount of material burned.

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

The above activity data were converted to tons material burned using fuel loading factors from AP-42, Table 2.5-5 (US EPA, 1992). The emission and loading factors used are shown in Table 3.6–3.

Table 3.6–3. Emission and fuel loading factors for open burning.

Category	Emission factors (lb/ton burned)			Fuel loading factor
	VOC	NO _x	CO	
Weeds, unspecified	9	4	85	3.2 tons/acre
Russian Thistle (tumbleweeds)	1.5	4	309	0.1 tons/acre
Orchard Crops: Citrus	9	4	81	1.0 tons/acre

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

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

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

Material burned
for ditch bank and fence row burning = $\frac{2,854,491 \text{ ft length}}{43,560 \text{ ft}^2 / \text{acre}} \times 7 \text{ ft width} \times 3.2 \text{ tons/acre} \times 2 \text{ times/yr}$
= 2,936 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 emission factors listed in AP-42 (Table 3.6–3.) for each open burning category. To account for unpermitted illegal outdoor burning, the county’s Air Quality Complaint data base was examined, which indicated 65 illegal outdoor open burning complaints (mostly residential) and 6 issued Notices of Violation. All calculated emissions estimates were thus increased by 10 percent, as a conservative estimate.

Annual CO emissions from ditchbank and fence row burning = Total material burned × emission factor × unit conversion factor
= 2,936 tons × 85 lbs/ton × 1 ton / 2,000 lbs
= 124.78 tons CO/yr

Total annual CO emissions including unpermitted burning = Calculated emissions from permit data + unpermitted burning adjustment factor
= 124.78 tons/yr + (10% x 124.78)
= 137.25 tons CO/yr

Table 3.6–4 summarizes the annual emissions for Maricopa County from each open burning category.

Table 3.6–4. Annual emissions from open burning.

Category	Ton-equivalents	Annual emissions (tons/yr)		
		VOC	NO _x	CO
Ditchbank/fencerow	2,935.7	14.53	6.46	137.25
Land clearance	9,545.5	47.26	21.00	446.25
Air curtain	100.0	0.50	0.22	4.46
Tumbleweeds	2.4	0.00	0.01	0.41
Totals:		62.28	27.68	588.36

Annual emissions for the nonattainment area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the ozone nonattainment area by the Maricopa County emission totals. (See Section 1.5.2 for a discussion of the land-use data used.) Table 3.6–5 summarizes the annual emissions for the ozone nonattainment area.

Table 3.6–5. Surrogate land-use classes, ratios, and annual emissions from open burning in the ozone NAA.

Category	Surrogate land-use categories	2000 NAA:County land-use ratio	Annual emissions (tons/yr)		
			VOC	NO _x	CO
Ditchbank/fencerow	agriculture	44.53%	6.47	2.88	61.12
Land clearance	vacant	15.62%	7.38	3.28	69.70
Air curtain	agriculture and vacant	19.53%	0.10	0.04	0.87
Tumbleweeds	agriculture and vacant	19.53%	0.00	0.00	0.08
Totals:			13.95	6.20	131.77

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) and open burning occurs evenly during the ozone season months (July–September). A seasonal adjustment factor was derived as follows:

$$\text{Seasonal adjustment factor} = \frac{\text{\# of permits issued July–Sept. for the category}}{\text{total \# of permits issued in 2002 for the category}}$$

Example:

$$\begin{aligned} \text{Seasonal adjustment factor for ditchbank/fencerow burning} &= \frac{13 \text{ permits issued during July–Sept. for ditchbank/fencerow burning}}{85 \text{ total permits issued in 2002 for ditchbank/fencerow burning}} \\ &= 15.29\% \end{aligned}$$

Ozone season-day emissions for Maricopa County are derived using the following formula:

$$\text{Ozone season-day CO emissions (lbs/day)} = \frac{(\text{annual CO emissions lbs}) \times (\text{seasonal adjustment factor})}{(\text{\# of burn days/week}) \times (\text{\# of season weeks/yr})}$$

$$\begin{aligned} \text{Season-day CO emissions from ditchbank/fencerow burning} &= 274,500 \text{ lbs} \times 0.1529 \\ &= 5 \text{ days/wk} \times 13 \text{ wks/yr} \\ &= 645.9 \text{ lbs CO/day} \end{aligned}$$

Ozone season-day emissions for the nonattainment area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the nonattainment area (listed in Table 3.6–5) by the total County season-day emissions. Table 3.6–6 summarizes ozone season-day emissions from open burning for both Maricopa County and the ozone nonattainment area.

Table 3.6–6. Season-day emissions (lbs/day) from open burning.

Category	Maricopa County			Ozone nonattainment area		
	VOC	NO _x	CO	VOC	NO _x	CO
Ditchbank/fencerow	68.4	30.4	645.9	30.5	13.5	287.6
Land clearance	256.5	114.0	2,423.1	40.0	17.9	378.5
Air curtain	7.6	3.4	68.5	1.5	0.7	13.4
Tumbleweeds	0.0	0.0	1.6	0.0	0.0	0.3
Totals:	332.6	147.8	3,139.1	72.0	32.0	679.8

3.6.3 Landfills

Emissions from municipal solid waste (MSW) landfills come from uncontrolled landfill gas emissions as well as from combustion from control measures, such as a flare. Total emissions were calculated from annual emissions inventory reports from all landfills located within the county. Two MSW landfills (Butterfield Station and Allied Waste Industries Southwest Regional Facility) are considered point sources and are reported in Chapter 2. All other MSW landfills are reported here as area source landfills.

Since there are no area source landfills located outside the ozone nonattainment area, total emission values for the county and the ozone nonattainment area are equal. Season-day emissions were calculated based on reported activity data (days per week) for each individual

process, and then summed. Nearly all processes reported operating on a 7-day week. Annual and daily emissions are shown in Table 3.6–7.

Table 3.6–7. Annual and season-day emissions from landfills.

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	10.31	10.44	27.35	56.7	57.4	150.3
Ozone NAA	10.31	10.44	27.35	56.7	57.4	150.3

3.6.4 Publicly owned treatment works (POTWs)

Emissions from publicly owned treatment works (POTWs) were calculated by multiplying per-capita emission factors from EPA guidance (US EPA, 2001i) by population estimates and per-capita wastewater usage estimates of 100 gallons per day per person (Tchobanoglous, 1979). Ozone season-day emissions were calculated by multiplying annual emissions by a 35% season adjustment factor and then dividing by 91 days per season (7 days/wk × 13 wks/season; US EPA, 2001c).

Table 3.6–8. Annual and season-day VOC emissions from publicly-owned treatment works (POTWs).

Geographic area	Population	VOC emission factor (lbs/10 ⁶ gals treated)	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	3,549,693	8.9	576.56	4,435.1
Ozone NAA	3,481,807	8.9	565.53	4,350.3

3.6.5 Remediation of leaking underground storage tanks

Leaking underground storage tanks (LUST) are typically not considered a quantifiable source of air emissions until excavation and remediation efforts begin. The majority of air emissions from LUST site remediations occur during initial site action, which is typically tank removal. Emissions from soil occur as the tank is being removed and when soil is deposited on the ground before treatment/disposal occurs (US EPA, 2001d).

A default emission rate of 28 lbs/day per remediation event was used to estimate VOC emissions from LUST remediations (US EPA, 2001d). Data obtained from the Arizona Department of Environmental Quality Leaking Underground Storage Tank Section indicated that 57 confirmed LUST releases occurred in Maricopa County in 2002 (ADEQ, 2004). Data were not available on the number or date of remediations that occurred in 2002; therefore, it was conservatively assumed that all 57 LUST releases were remediated in 2002 during the ozone season. It was also assumed that an initial site action (tank and soil removal) for an average LUST remediation lasts five days. Thus, annual emissions attributable to remediations in Maricopa County were calculated as follows:

$$\begin{aligned}
 &\text{Annual VOC emissions} \\
 &\text{from LUST remediations} = \frac{28 \text{ lbs VOC}}{\text{day}} \times 57 \text{ remediations} \times \frac{5 \text{ days}}{\text{remediation}} \times \frac{1 \text{ ton}}{2,000 \text{ lbs}} \\
 &= 3.99 \text{ tons/yr}
 \end{aligned}$$

Ozone season-day emissions were calculated by dividing annual values by 65 (5 days/wk × 13 wks/ozone season). Annual and season-day emissions for the ozone nonattainment area were calculated by multiplying the Maricopa County totals by the percentage of retail gasoline outlets located in the ozone NAA (96.39%).

Table 3.6–9. Annual and season-day VOC emissions from remediation of leaking underground storage tanks.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	3.99	122.8
Ozone NAA	3.85	118.3

3.6.6 Other industrial waste disposal

Annual area-source emissions from other waste disposal were derived from annual emissions reports from permitted facilities. 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 emission reports. Ozone season-day 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 waste disposal are located inside the ozone nonattainment area; therefore emissions for Maricopa County and the ozone NAA are equal.

Table 3.6–10. Annual and season-day emissions from other waste disposal.

Geographic area	Annual emissions (tons/yr)		Season-day emissions (lbs/day)	
	VOC	NO_x	VOC	NO_x
Maricopa County	1.54	0.33	11.8	2.6
Ozone NAA	1.54	0.33	11.8	2.6

3.6.7 Summary of all area-source waste treatment and disposal

Table 3.6–11. Summary of annual and season-day emissions from area-source waste treatment and disposal.

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO_x	CO	VOC	NO_x	CO
County	655.70	67.36	616.30	4,966.7	430.0	3,293.9
Ozone NAA	596.19	45.87	159.71	4,616.9	314.2	834.6

3.7 Miscellaneous area sources

3.7.1 Other combustion

3.7.1.1 Wildfires and brush fires

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

In addition, 2002 survey results from Maricopa County fire departments, the Bureau of Land Management, and the Arizona State Land Department were used to calculate emissions from brush fires. In some cases, the survey results included limited information on the average size of fires. Thus, when acreage data was incomplete or unclear, each reported brush fire was assumed to be equal to 0.1 acres. Survey results are included in Appendix 3.2. It was estimated that 7,054 brush fires occurred in Maricopa County in 2002 and burned approximately 1,656.5 acres.

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

Table 3.7–1. Emission factors and fuel loading factors for wildfires.

Type of fire	Fires reported	Number of acres burned	Fuel loading factor (tons/acre)	Emission factors (lbs/ton burned)		
				VOC	NO _x	CO
Wildfire (Calif. chaparral)	1	1,000	19.5	13.6	6.2	289
Brush fire (weeds)	7,054	1,656.5	3.2	9*	4	85

*non-methane TOC; assumed NMOC=VOC

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

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

Because the 1,000-acre wildfire occurred in the Tonto National Forest, which is located outside of the nonattainment area, emissions from wildfires within the nonattainment area were determined to be zero. However, annual emissions from brush fires for the nonattainment area were calculated by multiplying the Maricopa County annual emissions by the percentage of vacant land located in the ozone nonattainment area (15.62%). See Section 1.5.2 for a discussion of the land-use data used.

$$\begin{aligned}
 \text{Annual CO emissions from brush fires within the ozone NAA} &= \text{Annual CO emissions from brush fires, County total} \times \text{Percentage of vacant land within the NAA} \\
 &= 225.28 \text{ tons/yr} \times 15.62\% \\
 &= 35.19 \text{ tons CO/yr}
 \end{aligned}$$

Table 3.7–2. Annual emissions from wildfires and brush fires (tons/yr).

Type of fire	Maricopa County			Ozone nonattainment area		
	VOC	NO _x	CO	VOC	NO _x	CO
Wildfires	119.34	54.41	2,535.98	0.00	0.00	0.00
Brush fires	23.85	10.60	225.28	3.73	1.66	35.19
Totals:	143.19	65.01	2,761.25	3.73	1.66	35.19

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

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

Table 3.7–3. Season-day emissions from wildfires and brush fires (lbs/day).

Type of fire	Maricopa County			Ozone nonattainment area		
	VOC	NO _x	CO	VOC	NO _x	CO
Wildfires	79,560.0	36,270.0	1,690,650.0	0.0	0.0	0.0
Brush fires	130.7	58.1	1,234.4	20.4	9.1	192.8
Totals:	79,690.7	36,328.1	1,691,884.4	20.4	9.1	192.8

3.7.1.2 Structure fires

2002 structure fire data were obtained by surveying fire departments in Maricopa County and by querying Maricopa County’s burn permit data base. The fire departments surveyed reported 3,597 structure fires in Maricopa County in 2002. The list of fire departments surveyed and survey results are contained in Appendix 3.2. Eleven open burn permits were issued in 2002 for fire training; these were included in the total number of estimated structure fires for 2002. It was estimated that 3,608 structure fires occurred in Maricopa County in 2002.

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

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

Table 3.7–4. Estimated material burned, emission factors and fuel loading factors for structure fires.

Structure fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)		
			VOC	NO _x	CO
3,608	1.15	4,149.20	11	1.4	60

Annual emissions were then calculated by multiplying the amount of material burned by the emission factors listed in Table 3.7–4 (US EPA, 2001h), as follows:

$$\begin{aligned}
 \text{Annual CO emissions from structure fires Maricopa County} &= \text{Quantity of material burned} \times \text{emission factor} \times \text{unit conversion factor} \\
 &= 4,149.20 \text{ tons} \times 60 \text{ lbs/ton} \times (1 \text{ ton}/2,000 \text{ lbs.}) \\
 &= 124.48 \text{ tons CO/yr}
 \end{aligned}$$

Annual emissions for the ozone nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the ozone nonattainment area (98.06%), as shown in the example below. See Section 1.5.1 for a discussion of the population data used.

$$\begin{aligned}
 \text{Annual CO emissions from structure fires within the ozone NAA} &= \text{annual CO emissions for Maricopa County} \times \text{percentage of residential population within the NAA} \\
 &= 124.48 \text{ tons/yr} \times 98.06\% \\
 &= 122.07 \text{ tons CO/yr}
 \end{aligned}$$

It was assumed that structure fires occur 7 days a week; however, structure fires vary seasonally and may increase during cold weather. Because local season-specific data were not available from the fire department surveys, seasonal occurrences of residential and non-residential structure fires reported by the Federal Emergency Management Agency (FEMA) were used to derive a seasonal adjustment factor for the ozone season (US EPA, 2001h). FEMA reported that 20.9% of residential structure fires and 23.7% of non-residential structural fires occurred during July, August, and September 1994. Thus, an average occurrence of 22.3% $[(20.9\% + 23.7\%) \div 2]$ was used as a seasonal adjustment factor to estimate ozone season-day emissions.

Ozone season-day emission for Maricopa County were derived using the following formula:

$$\begin{aligned}
 \text{Season-day CO emissions from structure fires} &= \frac{\text{annual CO emissions (lbs)} \times \text{seasonal adjustment factor}}{7 \text{ days/wk} \times 13 \text{ weeks/season}} \\
 &= \frac{248,960 \times 22.3\%}{91} \\
 &= 610.1 \text{ lbs CO/day}
 \end{aligned}$$

Table 3.7–5. Annual and season-day emissions from structure fires.

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	22.82	2.90	124.48	111.9	14.2	610.1
Ozone NAA	22.38	2.85	122.06	109.7	14.0	598.2

3.7.1.3 Vehicle fires

2002 vehicle fire data were obtained by surveying fire departments in Maricopa County. The fire departments surveyed reported 5,316 vehicle fires (4 boat fires were included in vehicle fires) in Maricopa County in 2002. The list of fire departments surveyed and survey results are presented in Appendix 3.2.

Annual emissions from vehicle fires are calculated by first multiplying the number of vehicle fires by a fuel loading factor of per vehicle fire to estimate the annual amount of material burned in vehicle fires. The amount of annual material burned in vehicle fires is then multiplied by emission factors for open burning of automobile components as listed in AP-42 Table 2.5-1 (US EPA, 2000b).

$$\begin{aligned}
 \text{Annual CO emissions from vehicle fires} &= \text{annual number of vehicle fires} \times \text{fuel loading factor} \times \text{emission factor} \times \text{unit conversion factor} \\
 &= 5,316 \quad \times 0.25 \text{ tons/vehicle} \quad \times 125 \text{ lbs/ton} \quad \times (1 \text{ ton} / 2,000 \text{ lbs}) \\
 &= 83.06 \text{ tons CO/yr}
 \end{aligned}$$

Table 3.7-6. Estimated material burned, fuel loading factors, and emission factors for vehicle fires.

Vehicle fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)		
			VOC*	NO _x	CO
5,316	0.25	1,329	32	32	125

*non-methane TOC; assumed NMOC=VOC

Annual emissions for the ozone nonattainment area were derived by multiplying the Maricopa County annual emissions by the percentage of total residential population within the ozone nonattainment area (98.06%). See Section 1.5.1 for a discussion of the population data used.

$$\begin{aligned}
 \text{Annual CO emissions from vehicle fires in the ozone NAA} &= \text{annual CO emissions for Maricopa County} \times \text{percentage of total residential population within the ozone NAA} \\
 &= 83.06 \text{ tons/yr} \quad \times 98.06\% \\
 &= 81.45 \text{ tons CO/yr}
 \end{aligned}$$

It was assumed that vehicle fires occur evenly throughout the year. Thus, ozone season-day emissions were derived by dividing the Maricopa County and nonattainment area annual emissions by 365 days/year. Results are shown in Table 3.7-7.

Table 3.7-7. Annual and season-day emissions from vehicle fires.

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	21.26	2.66	83.06	116.5	14.6	455.1
Ozone NAA	20.85	2.61	81.45	114.3	14.3	446.3

3.7.1.4 Engine testing

Annual emissions from engine testing facilities were derived from annual emission reports from permitted sources that were not considered point sources in this inventory. It was assumed that there were no significant unpermitted sources within Maricopa County. Season-day 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 ozone nonattainment area, total emission values for the county and the NAA are equal.

Table 3.7-8. Annual and season-day emissions from engine testing.

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	1.50	4.26	3.67	17.8	87.9	95.9
Ozone NAA	1.50	4.26	3.67	17.8	87.9	95.9

3.7.2 Health services

3.7.2.1 Hospitals

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

The most recent data from the US Census' County Business Patterns (CBP) for 2001 employment, were used. CBP employment data for NAICS code 662110 (general medical and surgical hospitals) indicated 34,799 employees in this industry in Maricopa County. Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

$$\begin{aligned}
 \text{Total area-source employment in hospitals} &= \text{Total employment (from US Census' County Business Patterns)} - \text{Employment at point sources (from annual emission reports)} \\
 &= 34,799 - 5,326 \\
 &= 29,473 \text{ employees}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source VOC emissions from hospitals} &= \frac{14.55 \text{ tons/yr}}{21,637 \text{ employees}} \times 29,473 \text{ employees} \\
 &= 19.82 \text{ tons VOC/yr}
 \end{aligned}$$

Ozone season-day emissions are calculated based on the operating schedule data reported by hospital facilities. From annual emission surveys, the modal values were identified for two items: days/week and seasonal activity as a percentage of annual activity. This data was used to calculate typical season-day emissions as follows:

$$\begin{aligned}
 \text{Season-day VOC emissions from hospital} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{19.82 \times 25\%}{7 \times 13} \times 2,000 \\
 &= 108.9 \text{ lbs VOC/day}
 \end{aligned}$$

Annual and season-day emissions for the ozone nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage of population within the nonattainment area. (See Section 1.5.1 for a discussion of the population data used.)

$$\begin{aligned}
 \text{VOC emissions from area-source hospitals in the ozone NAA (tons/yr)} &= \text{Annual Maricopa County emissions} \times \text{NAA:County ratio of population} \\
 &= 19.82 \text{ tons/yr} \times 98.06\% \\
 &= 19.44 \text{ tons VOC/yr}
 \end{aligned}$$

Table 3.7–9 summarizes annual and season-day emissions from hospitals in both Maricopa County and the ozone nonattainment area.

Table 3.7–9. Annual and season-day VOC emissions from hospitals.

Geographic area	Annual emissions (tons/yr)	Season-day emissions (lbs/day)
Maricopa County	19.82	108.9
Ozone NAA	19.44	106.8

3.7.2.2 Crematories

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

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

$$\begin{aligned}
 \text{Total area-source emissions} &= \frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}} \times \text{Total area-source employment} \\
 \text{Area-source NO}_x \text{ emissions from crematories} &= \frac{3.13 \text{ tons/yr}}{110} \times 683 \text{ employees} \\
 &= 19.46 \text{ tons NO}_x\text{/yr}
 \end{aligned}$$

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

$$\begin{aligned}
 \text{Season-day NO}_x \text{ emissions from crematories} &= \frac{\text{Annual emissions (tons/yr)} \times \text{season \%}}{\text{Days/week} \times \text{Weeks/season}} \times \frac{2,000 \text{ lbs}}{\text{ton}} \\
 &= \frac{19.46 \times 25\%}{5 \times 13} \times 2,000 \\
 &= 149.7 \text{ lbs NO}_x/\text{day}
 \end{aligned}$$

As all facilities addressed in this source category are located within the ozone nonattainment area, emission totals for both areas are equal. Annual and daily emissions are shown in Table 3.7–10.

Table 3.7–10. Annual and season-day emissions from crematories.

Geographic area	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
County	0.35	19.46	1.06	2.7	149.7	8.2
Ozone NAA	0.35	19.46	1.06	2.7	149.7	8.2

3.7.3 Accidental releases

As part of its air quality permit compliance program, MCESD keeps an “upset log”, for each calendar year that records excess emissions and accidental releases at permitted facilities. Annual emissions inventory reports also provide for recording of accidental releases. Data from these two sources documented the release of 0.51 tons of VOC, 1.08 tons of NO_x, and 3.47 tons of CO for the year 2002.

Season-day emissions are calculated based on the whether the reported release occurred during the ozone season. If emissions occurred during the ozone season, those emissions were summed and divided by the number of days in the ozone season to produce season-day emissions. Emissions within the ozone nonattainment area are calculated based on locations of facilities that reported releases. Results are shown in Table 3.7–11.

Table 3.7–11. Annual and season-day emissions from accidental releases.

Geographic area	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	0.51	1.08	3.47	0.3	0.0	0.0
Ozone NAA	0.51	0.00	0.00	0.3	0.0	0.0

3.7.4 Summary of all miscellaneous area sources

Table 3.7–12. Summary of annual and season-day emissions from miscellaneous area sources.

Geographic area	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
Maricopa County	209.46	95.36	2,976.99	80,048.8	36,594.5	1,693,053.6
Ozone NAA	68.76	30.82	243.43	372.0	274.9	1,341.4

3.8 Summary of all area sources

Tables 3.8–1 and 3.8–2 summarize the total annual and average daily emissions from all area sources addressed in this chapter, for both Maricopa County and the ozone NAA, respectively.

Table 3.8–1. Summary of annual and season-day emissions from all area sources in Maricopa County.

Category	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
<i>Fuel Combustion:</i>						
Industrial natural gas	5.60	110.63	68.95	33.9	670.0	417.6
Industrial fuel oil	56.41	777.40	166.66	361.6	4,983.4	1,068.3
Commercial/institutional natural gas	53.86	1,068.63	655.00	281.5	5,585.3	3,423.4
Commercial/institutional fuel oil	137.77	1,798.63	386.20	529.9	6,917.8	1,485.4
Residential natural gas	45.15	771.72	328.39	144.5	2,469.4	1,050.8
Residential wood	2,912.16	33.06	3,212.28	0.0	0.0	0.0
Residential fuel oil	0.03	0.83	0.23	0.0	0.0	0.0
Total, all fuel combustion:	3,211.00	4,560.90	4,817.71	1,351.4	20,625.8	7,445.5
<i>Industrial Processes:</i>						
Chemical manufacturing	14.84	1.08	0.07	114.2	8.3	0.5
Commercial cooking	95.84		273.50	526.6		1,502.8
Bakeries	29.54			189.3		
Secondary metal production	54.69	0.03	0.00	309.0	0.2	0.0
Mineral Process	18.82			144.7		
Rubber/plastic product mfg.	518.50			3,988.5		
Fabricated metal product mfg.	20.64			158.8		
Electrical equipment mfg.	95.51	16.28		524.8	89.4	
State-permitted portable sources	67.61	572.42	138.43	431.0	3,821.3	925.9
Industrial processes, NEC	14.91	0.05	0.98	114.7	0.4	7.5
Total, all industrial processes:	930.91	589.86	412.98	6,501.7	3,919.7	2,436.7
<i>Solvent Use:</i>						
<i>Surface Coating:</i>						
–Architectural coatings	9,270.23			67,234.6		
–Auto refinishing	3,339.51			25,688.5		
–Traffic markings	509.21			5,170.4		
–Flatwood	221.74			1,705.7		
–Wood furniture	480.09			3,693.0		
–Aircraft	85.09			654.5		
–Misc. surface coating	707.11			5,439.3		
Total, all surface coating:	14,612.98			109,586.1		

Table 3.8–1. Summary of annual and season-day emissions from all area sources in Maricopa County (continued).

Category	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
<i>Solvent Use: (continued)</i>						
Degreasing	244.26			1,878.9		
Dry cleaning	26.44			162.7		
Graphics arts	460.58			3,542.9		
Misc. industrial solvent use	60.82			467.8		
Agricultural pesticides	377.00			7,000.3		
Consumer/ commercial solvent use	13,914.80			76,245.5		
Asphalt application	2,120.42			11,645.7		
Total, all solvent use:	31,817.28			210,530.0		
<i>Storage/Transport:</i>						
Bulk plants and terminals	40.15			308.9		
VOL storage/transport	25.42			139.7		
Fuel delivery	297.40			1,874.2		
Trucks in transit	55.07			347.1		
Station losses	734.33			3,966.6		
Vehicle refueling	1,035.18			5,941.1		
Total, all storage/transport:	2,187.56			12,577.5		
<i>Waste Treatment/Disposal:</i>						
On-site incineration	1.02	28.90	0.59	7.8	222.3	4.5
Open burning	62.28	27.68	588.36	332.6	147.8	3,139.1
Landfills	10.31	10.44	27.35	56.7	57.4	150.3
Publicly owned treatment works	576.56			4,435.1		
Leaking underground storage tanks	3.99			122.8		
Other waste treatment/disposal	1.54	0.33		11.8	2.6	
All waste treatment/disposal:	655.70	67.36	616.30	4,966.7	430.0	3,293.9
<i>Miscellaneous Area Sources:</i>						
Wildfires and brush fires	143.19	65.01	2,761.25	79,690.7	36,328.1	1,691,884.4
Structure fires	22.82	2.90	124.48	111.8	14.2	610.1
Vehicle fires	21.26	2.66	83.06	116.5	14.6	455.1
Engine testing	1.50	4.26	3.67	17.8	87.9	95.9
Hospitals	19.82			108.9		
Crematories	0.35	19.46	1.06	2.7	149.7	8.2
Accidental releases	0.51	1.08	3.47	0.3	0.0	0.0
Total, all miscellaneous sources:	209.46	95.36	2,976.99	80,048.8	36,594.5	1,693,053.6
Total, all area sources:	39,011.90	5,313.47	8,823.98	315,976.1	61,570.0	1,706,229.7

Table 3.8–2. Summary of annual and season-day emissions from all area sources within the ozone NAA.

Category	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
<i>Fuel Combustion:</i>						
Industrial natural gas	5.49	108.52	67.64	33.3	657.2	409.6
Industrial fuel oil	55.34	762.56	163.48	354.7	4,888.2	1,047.9
Commercial/institutional natural gas	52.94	1,050.35	643.80	276.7	5,489.8	3,364.9
Commercial/institutional fuel oil	135.41	1,767.88	379.59	520.8	6,799.5	1,460.0
Residential natural gas	44.33	757.67	322.41	141.9	2,424.4	1,031.7
Residential wood	2,859.16	32.46	3,153.82	0.0	0.0	0.0
Residential fuel oil	0.03	0.81	0.23	0.0	0.0	0.0
Total, all fuel combustion:	3,152.71	4,480.24	4,730.96	1,327.4	20,259.1	7,314.1
<i>Industrial Processes:</i>						
Chemical manufacturing	14.56	1.06	0.07	112.0	8.2	0.5
Commercial cooking	94.01		268.28	516.5		1,474.1
Bakeries	28.97			185.7		
Secondary metal production	54.69	0.03	0.00	309.0	0.2	0.0
Mineral Process	18.46			142.0		
Rubber/plastic product mfg.	508.60			3,912.3		
Fabricated metal product mfg.	20.25			155.8		
Electrical equipment mfg.	93.68	15.97		514.7	87.7	
State-permitted portable sources	67.61	572.42	138.43	431.0	3,821.3	925.9
Industrial processes, NEC	14.91	0.05	0.98	114.7	0.4	7.5
Total, all industrial processes:	915.75	589.52	407.76	6,393.8	3,917.8	2,408.0
<i>Solvent Use:</i>						
<i>Surface Coating:</i>						
–Architectural coatings	9,092.94			65,948.8		
–Auto refinishing	3,275.02			25,192.4		
–Traffic markings	499.47			5,071.5		
–Flatwood	217.50			1,673.1		
–Wood furniture	470.92			3,622.5		
–Aircraft	83.47			642.0		
–Misc. surface coating	693.61			5,335.4		
Total, all surface coating:	14,332.92			107,485.8		
Degreasing	239.60			1,843.1		
Dry cleaning	26.44			162.7		
Graphics arts	451.78			3,475.2		
Misc. industrial solvent use	59.66			458.9		
Agricultural pesticides	167.88			3,117.3		
Consumer/ commercial solvent use	13,648.68			74,787.3		
Asphalt application	1,946.70			10,693.2		
Total, all solvent use:	30,873.65			202,023.5		
<i>Storage/Transport:</i>						
Bulk plants and terminals	40.15			308.9		
VOL storage/transport	25.42			139.7		
Fuel delivery	286.67			1,806.5		
Trucks in transit	53.09			334.5		
Station losses	707.82			3,823.4		
Vehicle refueling	997.81			5,726.6		
Total, all storage/transport:	2,110.96			12,139.6		

Table 3.8–2. Summary of annual and season-day emissions from all area sources within the ozone NAA (continued).

Category	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
	VOC	NO _x	CO	VOC	NO _x	CO
<i>Waste Treatment/Disposal:</i>						
On-site incineration	1.02	28.90	0.59	7.8	222.3	4.5
Open burning	13.95	6.20	131.77	72.0	32.0	679.8
Landfills	10.31	10.44	27.35	56.7	57.4	150.3
Publicly owned treatment works	565.53			4,350.3		
Leaking underground storage tanks	3.85			118.3		
Other waste treatment/disposal	1.54	0.33		11.8	2.6	
All waste treatment/disposal:	596.19	45.87	159.71	4,616.9	314.2	834.6
<i>Miscellaneous Area Sources:</i>						
Wildfires and brush fires	3.73	1.66	35.19	20.4	9.1	192.8
Structure fires	22.38	2.85	122.06	109.7	14.0	598.2
Vehicle fires	20.85	2.61	81.45	114.3	14.3	446.3
Engine testing	1.50	4.26	3.67	17.8	87.9	95.9
Hospitals	19.44			106.8		
Crematories	0.35	19.46	1.06	2.7	149.7	8.2
Accidental releases	0.51	0.00	0.00	0.3	0.0	0.0
Total, all miscellaneous sources:	68.76	30.82	243.43	372.0	274.9	1,341.4
Total, all area sources:	37,718.02	5,146.47	5,541.86	226,873.2	24,766.1	11,898.0

3.9 Quality assurance / quality control procedures

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

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

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

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

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

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

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

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