MAG 2012 FIVE PERCENT PLAN FOR PM-10 FOR THE MARICOPA COUNTY NONATTAINMENT AREA

APPENDICES

VOLUME ONE

MAY 2012

MARICOPA ASSOCIATION of GOVERNMENTS

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APPENDIX A

EXHIBIT 1:

2008 PM-10 Periodic Emissions Inventory for the Maricopa County, Arizona, Nonattainment Area. Maricopa County Air Quality Department. Revised June 2011

Maricopa County
Air Quality Department

2008 PM_{10} Periodic Emissions Inventory

for the
Maricopa County, Arizona, Nonattainment Area

REVISED
June 2011

2008 PM_{10} Periodic Emission Inventory
for the Maricopa County, Arizona Nonattainment Area

REVISED
June 2011

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1. Introduction

1.1 Overview

This 2008 periodic PM_{10} emissions inventory was developed to meet requirements set forth in Title I of the Clean Air Act Amendments of 1990 (CAAA). The CAAA require development of a baseline emission inventory and periodic revisions for areas that fail to meet the National Ambient Air Quality Standards (NAAQS). A portion of Maricopa County is classified as serious nonattainment for PM_{10}.

PM_{10} is defined as particulate matter less than or equal to ten micrometers in diameter. This inventory includes primary emissions of PM_{10} and $PM_{2.5}$ as well as three particulate matter precursors: nitrogen oxides (NO_x), sulfur dioxides (SO_x) and ammonia (NH_3). The inventory provides emission estimates from point, area, nonroad mobile, onroad mobile and biogenic sources. Note that totals shown in tables may not equal the sum of individual values due to independent rounding.

1.2 Agencies responsible for the emissions inventory

Maricopa County Air Quality Department (MCAQD) has primary responsibility for preparing and submitting the 2008 Periodic PM_{10} Emissions Inventory for Maricopa County. Point sources and the majority of area, and nonroad mobile source emission estimates were prepared by MCAQD. The Maricopa Association of Governments (MAG) prepared the emission estimates for onroad mobile, biogenic, and some area and nonroad mobile source categories. Table 1.2–1 lists those responsible for inventory preparation and quality assurance/ quality control activities, which are described in the respective chapters.

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3. Area Sources	–Matt Poppen, Eric Raisanen and Dena Konopka, MCAQD (602) 506-6790 –Cathy Arthur, MAG (602) 254-6300	–Bob Downing, MCAQD (602) 506-6790 –Cathy Arthur, MAG (602) 254-6300
4. Nonroad Mobile Sources	Matt Poppen and Bob Downing MCAQD (602) 506-6790	–Eric Raisanen and Dena Konopka MCAQD (602) 506-6790 –Cathy Arthur, MAG (602) 254-6300
5. Onroad Mobile Sources	Ieesuck Jung and Cathy Arthur MAG (602) 254-6300	Bob Downing and Dena Konopka MCAQD (602) 506-6790
6. Biogenic Sources	Feng Liu MAG (602) 254-6300	Bob Downing and Dena Konopka MCAQD (602) 506-6790

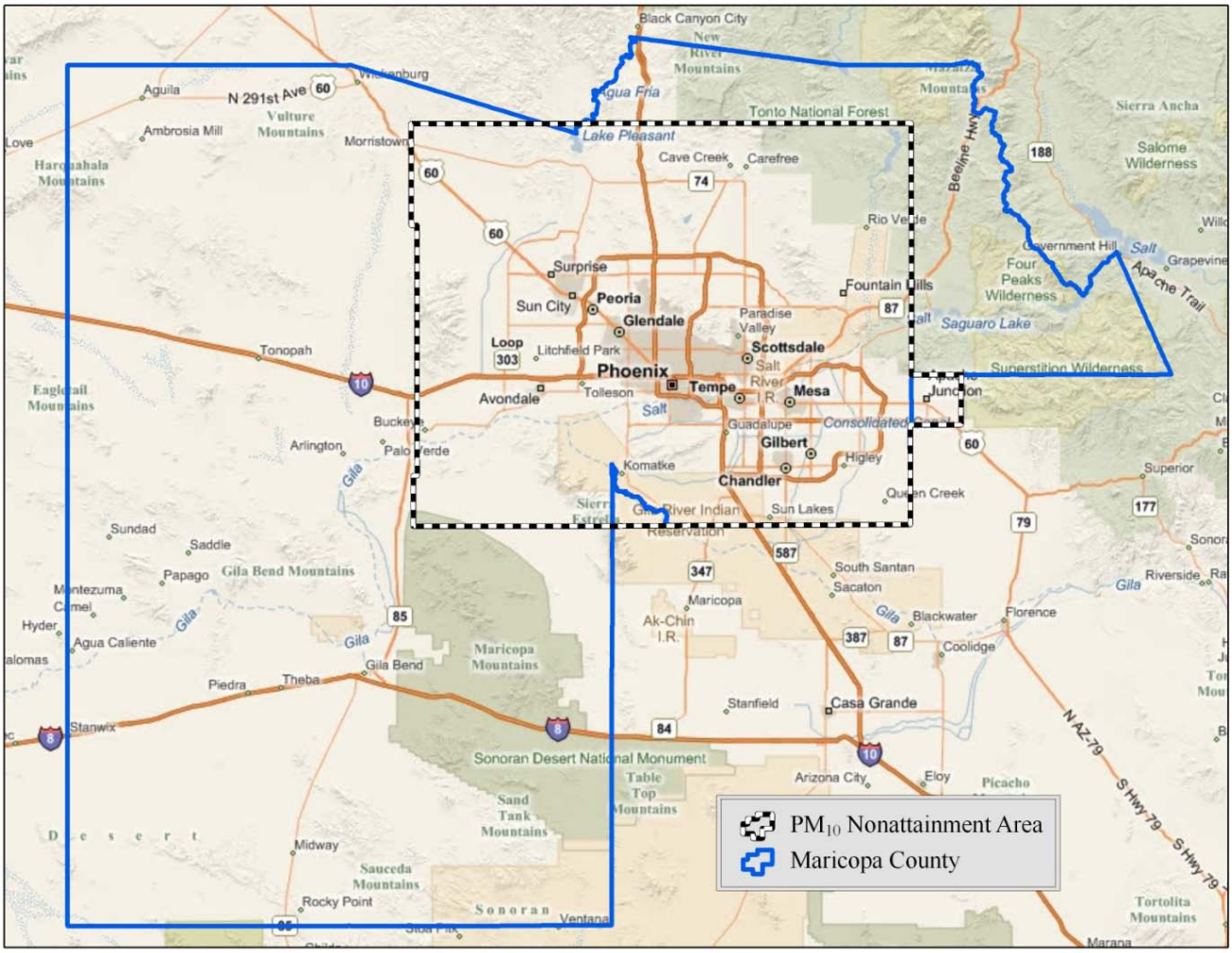
1.3 Temporal scope

Annual and typical daily emissions were estimated for the year 2008, for Maricopa County and the Maricopa County PM_{10} nonattainment area (NAA).

1.4 Geographic scope

This inventory includes emission estimates for Maricopa County and for the Maricopa County PM_{10} nonattainment area. Maricopa County encompasses approximately 9,223 square miles of land area, while the Maricopa County PM_{10} nonattainment area is approximately 2,880 square miles or approximately 31 percent of the Maricopa County land area. A map of Maricopa County and the PM_{10} nonattainment area is provided in Figure 1.4–1.

Figure 1.4–1. Map of Maricopa County and the PM_{10} nonattainment area.



1.5 Overview of local demographic and land use data

Many of the emissions estimates generated in this report were calculated using demographic and land use data provided by the Maricopa Association of Governments (MAG). These data were used to apportion and/or scale Maricopa County emissions estimates to the nonattainment area and vice versa. (For example, county-level emissions from residential natural gas usage in Maricopa County were apportioned to the nonattainment area using the ratio of total population in each area). Detailed explanations of how emission estimates were apportioned or scaled are presented in each of the following chapters, along with the data sources used.

1.5.1 Demographic profile

The demographic data provided by MAG included population, employment data, and single family/multi-family splits for calendar year 2008, for both Maricopa County and the PM_{10} nonattainment area. Table 1.5–1 provides an overview of the demographic data used in this report. As noted throughout the text, these data are frequently used to derive estimates of activity or emissions within the PM_{10} NAA from county-level calculations. It is important to note, however, that the nonattainment area includes a portion of Pinal County, AZ (Apache Junction) as shown in Figure 1.4–1. Thus in some cases (e.g., those source categories calculated based on total population), the multiplier used to derive nonattainment area estimates from County-level values may be greater than 1, and thus the resulting NAA emission totals are larger than the County-level estimates from which they are derived.

Table 1.5–1. Demographic profile of Maricopa County and the PM_{10} nonattainment area.

Demographic variable	Maricopa County	PM_{10} NAA	Percent within PM_{10} NAA
Total resident population	4,026,000	4,024,530	99.96%
Total non-resident population	253,760	272,610	107.43%
Total population:	**4,279,760**	**4,297,140**	**100.41%**
Retail employment	537,430	536,100	99.75%
Office employment	444,170	444,980	100.18%
Industrial employment	412,580	411,520	99.74%
Public employment	278,610	274,500	98.52%
Other employment	191,770	189,010	98.56%
Construction	79,680	78,980	99.12%
Work at Home	65,620	64,940	98.96%
Total employment:	**2,009,860**	**2,000,030**	**99.51%**
Single Family/Multi-Family Household Split:			
Single-Family	75%	75%	
Multi-Family	25%	25%	

Source: Maricopa Association of Governments

1.5.2 Land use data

MAG provided draft 2009 land use data (as of March 2010). The draft 2009 land use data was assumed to be representative of 2008. Table 1.5–2 presents a summary of the land use categories and acreages used to develop emissions estimates for this inventory.

Table 1.5–2. Land use categories used to apportion emissions.

Land Use Category	Acreage in Maricopa County	Acreage within PM_{10} NAA	Percentage within PM_{10} NAA
General/active open space/golf course (e.g., parks)	228,295	223,290	97.81%
Passive/restricted open space (e.g., mountain preserves)	2,373,545	302,999	12.77%
Lakes	12,525	9,510	75.93%
Agriculture	295,509	130,445	44.14%
Vacant (e.g., developable land)	2,227,981	472,831	21.22%

1.6 Emissions overview by source category

1.6.1 Point sources

The point source category includes those stationary sources that emit a significant amount of pollution into the air such as power plants, industrial processes and large manufacturing facilities. MCAQD utilizes the US EPA's Annual Emissions Reporting Requirements (AERR) Rule to define which stationary sources are listed as point sources. A detailed definition of a point source can be found in Section 2.1 of Chapter 2.

Table 1.6–1 summarizes annual and typical daily emissions from point sources in Maricopa County and the PM_{10} nonattainment area, respectively. A detailed breakdown of emissions calculations for all point sources is contained in Chapter 2.

Table 1.6–1. Summary of annual and typical daily emissions from point sources in Maricopa County.

	Annual (tons/yr)					Typical day (lbs/day)				
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	601.27	555.15	2,204.91	81.15	279.06	3,323.2	3,069.1	12,151.5	449.3	1,534.2
PM_{10} NAA	149.84	132.94	1,317.85	28.76	132.18	841.2	747.7	7,254.3	158.2	727.0

1.6.2 Area sources

Area sources are facilities or activities whose individual emissions do not qualify them as point sources. Area sources represent numerous facilities or activities that individually release small amounts of a given pollutant, but collectively they can release significant amounts of a pollutant. Emissions from stationary sources that were not identified as point sources in this report have been included in the area source inventory. Examples of area source categories include residential wood burning, commercial cooking, waste incineration and wildfires.

Tables 1.6–2 and 1.6–3 summarize annual and season-day emissions of the chief area source categories, for Maricopa County and the PM_{10} nonattainment area, respectively. A detailed breakdown of emissions calculations for each area source category is contained in Chapter 3.

Table 1.6–2. Summary of annual and typical daily emissions from area sources in Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel combustion	1,303.61	1,271.30	12,289.62	898.83	51.27	9,673.4	9,370.0	78,161.3	5,773.3	328.7
Industrial processes	11,881.57	2,953.30	362.58	129.60	1,731.34	76,667.6	19,048.2	2,816.5	1,005.8	11,077.2
Waste treatmt./disposal	230.52	204.35	77.47	58.20	1,488.07	1,613.0	1,438.8	515.3	320.0	8,131.5
Misc. area sources	29,154.21	4,012.53	126.52	32.64	13,059.05	179,712.0	27,667.0	1,676.1	446.4	71,686.1
All area sources:	**42,569.90**	**8,441.49**	**12,856.18**	**1,119.27**	**16,329.74**	**267,665.9**	**57,524.0**	**83,169.2**	**7,545.5**	**91,223.5**

Table 1.6–3. Summary of annual and typical daily emissions from area sources in the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel combustion	1,300.65	1,268.35	12,248.07	895.83	51.11	9,653.8	9,350.6	77,895.2	5,754.1	327.6
Industrial processes	10,655.39	2,771.19	360.48	129.58	1,724.27	68,764.6	17,877.6	2,802.3	1,005.7	11,034.4
Waste treatmt./disposal	120.77	95.42	50.30	56.85	1,494.12	799.8	630.5	309.9	312.6	8,164.6
Misc. area sources	12,444.36	2,143.52	115.94	29.74	7,693.04	81,929.6	18,879.4	2,318.0	622.4	42,455.4
All area sources:	**24,521.17**	**6,278.48**	**12,774.79**	**1,112.00**	**10,962.54**	**161,147.8**	**46,738.0**	**83,325.3**	**7,694.7**	**61,982.0**

1.6.3 Nonroad mobile sources

Nonroad mobile sources include off-highway vehicles and engines that move or are moved within a 12-month period. Tables 1.6–4 and 1.6–5 summarize annual and season-day emissions from nonroad mobile sources, for Maricopa County and the PM_{10} nonattainment area, respectively. A detailed breakdown of emissions calculations for each source category is contained in Chapter 4.

Table 1.6–4. Annual and typical daily emissions from nonroad mobile sources in Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Agricultural	34.27	33.24	365.55	0.14	0.67	219.7	213.1	2,343.3	0.9	4.3
Airport GSE (+APU)	27.21	26.68	586.73	26.43		148.7	145.8	3,206.1	144.4	
Commercial	117.97	112.98	1,395.23	2.40	21.12	756.2	724.2	8,943.8	15.4	135.4
Construction & mining	1,260.98	1,220.75	14,796.63	6.60	28.10	8,083.2	7,825.3	94,850.2	42.3	180.1
Industrial	101.69	98.96	2,593.13	3.22	56.23	651.8	634.4	16,622.7	20.6	360.5
Lawn and garden	182.28	168.79	798.14	3.16	19.63	1,250.1	1,156.9	5,571.5	23.1	144.6
Pleasure craft	9.25	8.54	77.74	0.85	1.73	124.5	114.9	1,046.5	11.4	23.3
Railway maintenance	1.13	1.10	9.23	0.00	0.02	7.8	7.6	63.9	0.0	0.1
Recreational equipment	45.58	41.98	63.80	0.42	2.10	389.6	358.8	545.3	3.6	18.0
Aircraft	187.91	181.42	2,625.94	317.64		1,026.8	991.3	14,349.4	1,735.8	
Locomotives	70.21	65.53	1,854.62	18.72	4.45	383.6	358.1	10,134.5	102.3	24.3
All nonroad mobile sources:	**2,038.46**	**1,959.96**	**25,166.75**	**379.58**	**134.06**	**13,042.0**	**12,530.3**	**157,677.4**	**2,099.8**	**890.6**

Table 1.6–5. Annual and typical daily emissions from all nonroad mobile sources in the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Agricultural	15.13	14.67	161.35	0.06	0.30	97.0	94.0	1,034.3	0.4	1.9
Airport GSE (+APU)	26.99	26.48	578.95	26.22		147.5	144.7	3,163.7	143.3	
Commercial	117.66	112.69	1,391.61	2.39	21.06	754.2	722.4	8,920.6	15.3	135.0
Construction & mining	1,249.88	1,210.00	14,666.42	6.55	27.85	8,012.1	7,756.4	94,015.6	42.0	178.5
Industrial	101.42	98.71	2,586.39	3.21	56.09	650.1	632.7	16,579.4	20.6	359.5
Lawn and garden	183.02	169.48	801.41	3.17	19.71	1,255.3	1,161.6	5,594.4	23.2	145.2
Pleasure craft	7.02	6.48	59.03	0.64	1.32	94.5	87.3	794.6	8.6	17.7
Railway maintenance	1.13	1.10	9.26	0.00	0.02	7.8	7.6	64.1	0.0	0.1
Recreational equipment	7.68	7.08	10.76	0.07	0.35	65.7	60.5	91.9	0.6	3.0
Aircraft	183.80	177.61	2,620.31	316.00		1,004.3	970.5	14,318.6	1,726.8	
Locomotives	34.16	31.88	907.76	9.11	2.16	186.7	174.2	4,960.4	49.8	11.8
All nonroad mobile sources:	**1,927.89**	**1,856.18**	**23,793.26**	**367.42**	**128.87**	**12,275.2**	**11,812.0**	**149,537.7**	**2,030.5**	**852.9**

1.6.4 Onroad mobile sources

Emissions from onroad mobile sources were calculated for the PM_{10} nonattainment area located primarily within Maricopa County, as well as for Maricopa County as a whole. A detailed breakout of emissions calculations for each area source category is contained in Chapter 5.

Tables 1.6–6 and 1.6–7 summarize annual and typical daily emissions from onroad mobile sources in Maricopa County and the PM_{10} nonattainment area, respectively.

Table 1.6–6. Annual and average daily emissions from all onroad mobile sources in Maricopa County.

Emission Category	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Exhaust, tire wear, and brake wear	3,295.74	2,417.89	75,033.9	314.5	1,294.1	18,009.2	13,212.4	410,021.3	1,718.2	7,072.1
Paved road fugitive dust	7,227.77	1,912.42	—	—	—	39,496.0	10,450.4	—	—	—
Unpaved road and alley fugitive dust	12,358.20	1,233.60	—	—	—	67,530.9	6,741.0	—	—	—
Totals:	**22,881.71**	**5,563.91**	**75,033.94**	**314.45**	**1,294.12**	**125,036.1**	**30,403.8**	**410,021.3**	**1,718.2**	**7,072.1**

Table 1.6–7. Annual and typical daily emissions from all onroad mobile sources in the PM_{10} NAA.

Emission Category	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Exhaust, tire wear, and brake wear	3,144.17	2,300.80	71,444.20	300.66	1,235.28	17,181.3	12,572.9	390,405.5	1,643.0	6,750.5
Paved road fugitive dust	6,694.22	1,774.76	—	—	—	36,580.5	9,698.1	—	—	—
Unpaved road and alley fugitive dust	11,710.70	1,169.00	—	—	—	63,993.1	6,387.8	—	—	—
Totals:	**21,549.09**	**5,244.56**	**71,444.20**	**300.66**	**1,235.28**	**117,754.9**	**28,658.8**	**390,405.5**	**1,643.0**	**6,750.5**

1.6.5 Biogenic sources

The biogenic source category includes emissions from all vegetation (e.g., crops, indigenous vegetation, landscaping, etc.) in Maricopa County and the PM_{10} nonattainment area. Emissions were estimated using the Model of Emissions of Gases and Aerosols from Nature (MEGAN). MEGAN is a state-of-the-art biogenic emissions model developed by the National Center for Atmospheric Research (NCAR). Some corrections and improvements were made in the latest version of MEGAN2.04. MEGAN2.04 was used to compute biogenic emissions in Maricopa County and the PM_{10} nonattainment area. Annual and daily NO_x emissions from biogenic sources are shown in Table 1.6–8 for Maricopa County and the PM_{10} nonattainment area.

Table 1.6–8. Annual and season-day NO_x emissions from biogenic sources.

Geographic area	Annual emissions (tons/yr)	Typical daily emissions (lbs/day)
Maricopa County	896.27	4,890.0
PM_{10} NAA	332.77	1,815.3

1.6.6 Summary of all source categories

Tables 1.6–9 and 1.6–10 provide summary totals of annual and typical daily emissions from all emission sources in Maricopa County and the PM_{10} nonattainment area, respectively.

Table 1.6–9. Annual and typical daily emissions from all sources in Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Section	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Point Sources	601.27	555.15	2,204.91	81.15	279.06	3,323.2	3,069.1	12,151.5	449.3	1,534.2
Area Sources:										
Fuel combustion										
Industrial natural gas	30.78	30.78	575.29	2.42	12.70	197.3	197.3	3,687.7	15.5	81.4
Industrial fuel oil	458.79	458.79	6,375.08	609.61	26.25	2,941.0	2,941.0	40,865.9	3,907.8	168.3
Comm./ind. natural gas	66.54	66.54	1,267.11	5.23	4.20	426.5	426.5	8,122.5	33.5	26.9
Comm./ind. fuel oil	224.14	224.14	3,273.40	271.27	8.13	1,436.8	1,436.8	20,983.3	1,738.9	52.1
Residential natural gas	61.75	61.75	763.81	4.88		337.5	337.5	4,173.8	26.6	
Residential wood	461.59	429.28	34.69	5.34		4,334.2	4,030.8	325.7	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
All combustion	1,303.61	1,271.30	12,289.62	898.83	51.27	9,673.4	9,370.0	78,161.3	5,773.3	328.7
Industrial Processes										
Chemical manufacturing	187.43	151.42	0.00	0.34	0.03	1,445.8	1,164.5	0.0	2.6	0.9
Food products										
Commercial cooking	988.99	917.18				5,434.0	5,039.5			
Grain handling	20.59	6.71				149.3	49.5			
Ammonia storage					1,678.43					10,759.2
Secondary metal prod.	60.56	52.16	49.73	18.65	0.04	442.7	386.2	358.8	142.7	0.0
Mineral processes (concrete batch, etc.)	192.82	95.47				1,337.7	659.3			
Mining & quarry (sand & gravel)	181.01	55.20				1,239.2	362.6			
Wood products	217.26	203.25				1,668.6	1,548.3			
Rubber/plastics mfg.	140.94	105.96				953.3	698.8			
Fabricated metal mfg.	51.48	42.62			4.50	538.1	460.6			28.9
Residential const.	1,845.79	184.58				11,832.0	1,183.2			
Commercial const.	4,320.77	432.08				27,697.2	2,769.7			
Road construction	2,695.73	269.57				17,280.3	1,728.0			
Construction – other	194.36	19.44				1,245.9	124.6			
Electric equip. mfg.	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7
ADEQ portables	59.00	29.50	282.18	88.93		492.9	246.5	2,275.7	721.7	
Unpaved road travel	566.30	271.29				3,880.4	1,847.2			
Industrial proc. NEC	144.60	107.24	10.22	21.49	16.79	953.3	726.4	69.6	137.7	94.6
All Ind. Processes	11,881.57	2,953.30	362.58	129.60	1,731.34	76,667.6	19,048.2	2,816.5	1,005.8	11,077.2
Waste Treatment/Disp.										
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	111.46	111.46	29.96			902.2	902.2	242.4		
Landfills	86.21	75.92	24.11	7.57		486.1	425.4	132.9	41.7	
POTWs					1,488.07					8,131.5
Other waste	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
All Waste Treat/Disp.	230.52	204.35	77.47	58.20	1,488.07	1,613.0	1,438.8	515.3	320.0	8,131.5
Misc. Area Sources										
Wildfires	470.39	403.43	103.79	28.46	21.76	6,271.8	5,379.0	1,383.8	379.4	290.2
Prescribed fires	0.51	0.51	0.39	0.11	0.03	169.3	169.3	131.2	36.0	10.6
Structure fires	15.04	15.04	1.95			82.2	82.2	10.7		
Vehicle fires	30.04	30.04	1.20			164.1	164.1	6.6		
Aircraft engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	2,059.00	308.85				22,932.4	3,439.9			
Harvesting	136.93	20.54				3,938.9	590.8			
Unpaved agric. roads	1,739.52	173.95				11,150.8	1,115.1			
Cotton ginning	17.90	5.11				103.8	29.7			
Fertilizer application					2,276.43					12,439.5
Livestock	455.80	50.14			9,583.89	2,490.7	274.0			52,514.5
Crematories	0.93	0.62	12.39	1.58		7.0	4.7	93.1	11.9	
Accidental releases	0.01	0.01	0.06			0.1	0.1	0.3		
Humans					1,176.93					6,431.3
Leaf blowers fugitive dust	891.36	336.41				4,870.8	1,838.3			
Offroad rec. vehicles fugitive dust	12,082.12	1,200.11				66,022.5	6,558.0			
Travel on unpaved parking lots	4,445.36	446.24				24,291.6	2,438.5			
Windblown dust	6,809.13	1,021.37				37,214.6	5,582.2			
All Misc. Area Sources	29,154.21	4,012.53	126.52	32.64	13,059.05	179,712.0	27,667.0	1,676.1	446.4	71,686.1
All Area Sources:	42,569.90	8,441.49	12,856.18	1,119.27	16,329.74	267,665.9	57,524.0	83,169.2	7,545.5	91,223.5

Table 1.6–9 (continued). Annual and typical daily emissions from all sources in Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Section	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Nonroad Sources:										
Agricultural equipment	34.27	33.24	365.55	0.14	0.67	219.7	213.1	2,343.3	0.9	4.3
Airport GSE (+APU)	27.21	26.68	586.73	26.43		148.7	145.8	3,206.1	144.4	
Commercial equipment	117.97	112.98	1,395.23	2.40	21.12	756.2	724.2	8,943.8	15.4	135.4
Construction and mining equipment	1,260.98	1,220.75	14,796.63	6.60	28.10	8,083.2	7,825.3	94,850.2	42.3	180.1
Industrial equipment	101.69	98.96	2,593.13	3.22	56.23	651.8	634.4	16,622.7	20.6	360.5
Lawn and garden equipment	182.28	168.79	798.14	3.16	19.63	1,250.1	1,156.9	5,571.5	23.1	144.6
Pleasure craft	9.25	8.54	77.74	0.85	1.73	124.5	114.9	1,046.5	11.4	23.3
Railway maintenance equipment	1.13	1.10	9.23	0.00	0.02	7.8	7.6	63.9	0.0	0.1
Recreational equipment	45.58	41.98	63.80	0.42	2.10	389.6	358.8	545.3	3.6	18.0
Aircraft	187.91	181.42	2,625.94	317.64		1,026.8	991.4	14,349.4	1,735.8	
Locomotives	70.21	65.53	1,854.62	18.72	4.45	383.6	358.1	10,134.5	102.3	24.3
All Nonroad Sources	2,038.46	1,959.96	25,166.75	379.58	134.06	13,042.0	12,530.4	157,677.4	2,099.8	890.6
Onroad Sources:										
Exhaust, tire wear, and brake wear	3,295.74	2,417.89	75,033.94	314.45	1,294.12	18,009.2	13,212.4	410,021.3	1,718.2	7,072.1
Paved road fugitive dust	7,227.77	1,912.42				39,496.0	10,450.4			
Unpaved road and alley fugitive dust	12,358.20	1,233.60				67,530.9	6,741.0			
All Mobile Sources:	22,881.71	5,563.91	75,033.94	314.45	1,294.12	125,036.1	30,403.8	410,021.3	1,718.2	7,072.1
Biogenic Sources:			896.27					4,890.0		
TOTAL, All Sources:	68,091.34	16,520.51	116,158.05	1,894.45	18,036.97	409,067.3	103,527.3	667,909.3	11,812.7	100,720.4

Table 1.6–10. Annual and typical daily emissions from all sources in the PM_{10} nonattainment area.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Section	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Point Sources	149.84	132.94	1,317.85	28.76	132.18	841.2	747.7	7,254.3	158.2	727.0
Area Sources:										
Fuel combustion										
Industrial natural gas	30.70	30.70	573.79	2.41	12.66	196.8	196.8	3,678.2	15.5	81.2
Industrial fuel oil	457.60	457.60	6,358.50	608.03	26.19	2,933.3	2,933.3	40,759.6	3,897.6	167.9
Comm./ind. natural gas	66.20	66.20	1,260.65	5.20	4.18	424.4	424.4	8,081.1	33.3	26.8
Comm./ind. fuel oil	223.00	223.00	3,256.70	269.88	8.09	1,429.5	1,429.5	20,876.3	1,730.0	51.8
Residential natural gas	61.73	61.73	763.51	4.87		337.3	337.3	4,172.2	26.6	
Residential wood	461.41	429.11	34.67	5.33		4,332.5	4,029.2	325.6	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
All combustion	1,300.65	1,268.35	12,248.07	895.83	51.11	9,653.8	9,350.6	77,895.2	5,754.1	327.6
Industrial Processes										
Chemical manufacturing	186.94	151.03	0.00	0.34	0.03	1,442.0	1,161.5	0.0	2.6	0.9
Food products										
Commercial cooking	993.04	920.94				5,456.3	5,060.1			
Grain handling	16.73	5.68				125.3	43.0			
Ammonia storage					1,674.07					10,731.2
Secondary metal prod.	60.56	52.16	49.73	18.65	0.04	442.7	386.2	358.8	142.7	0.0
Mineral processes (concrete batch, etc.)	187.73	91.92				1,302.8	635.6			
Mining & quarry (sand & gravel)	156.60	46.81				1,075.7	307.2			
Wood products	216.69	202.72				1,664.3	1,544.3			
Rubber/plastics mfg.	140.57	105.68				950.9	697.0			
Fabricated metal mfg.	51.35	42.51			4.49	536.7	459.4			28.8
Residential const.	1,692.38	169.24				10,920.3	1,092.0			
Commercial const.	4,057.29	405.73				25,897.4	2,589.7			
Road construction	2,051.78	205.18				13,156.8	1,315.7			
Construction – other	162.41	16.24				1,043.9	104.4			
Electric equip. mfg.	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7
ADEQ portable sources	59.00	29.50	282.18	88.93		492.9	246.5	2,275.7	721.7	
Unpaved road travel	472.36	217.08				3,273.9	1,500.1			
Industrial proc. NEC	136.00	99.12	8.12	21.47	14.10	906.0	681.7	55.4	137.6	79.8
All Ind. Processes	10,655.39	2,771.19	360.48	129.58	1,724.27	68,764.6	17,877.6	2,802.3	1,005.7	11,034.4
Waste Treatment/Disp.										
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	27.67	27.67	7.44			232.6	232.6	62.5		
Landfills	60.25	50.78	19.47	6.22		342.4	286.6	107.4	34.3	
POTWs					1,494.12					8,164.6
Other waste	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
All Waste Treat/Disp.	120.77	95.42	50.30	56.85	1,494.12	799.8	630.5	309.9	312.6	8,164.6
Misc. Area Sources										
Wildfires	423.56	363.27	93.46	25.62	19.60	9,412.5	8,072.7	2,076.8	569.4	435.5
Prescribed fires	0.21	0.21	0.16	0.04	0.01	104.0	104.0	80.6	22.1	6.5
Structure fires	15.10	15.10	1.96			82.5	82.5	10.7		
Vehicle fires	30.16	30.16	1.21			164.8	164.8	6.6		
Aircraft engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	834.20	125.13				9,327.3	1,399.1			
Harvesting	54.14	8.12				1,560.0	234.0			
Unpaved agric. roads	731.03	73.10				4,686.1	468.6			
Cotton ginning	4.86	1.39				26.7	7.6			
Fertilizer application					1,004.82					5,490.8
Livestock	260.95	28.70			5,486.90	1,426.0	156.9			30,065.2
Crematories	0.93	0.62	12.36	1.58		7.0	4.6	92.6	11.8	
Accidental releases	0.01	0.01	0.06			0.1	0.1	0.3		
Humans					1,181.71					6,457.5
Leaf blowers fugitive dust	894.98	337.78				4,890.6	1,845.8			
Offroad rec. vehicles fugitive dust	2,014.17	200.09				11,006.4	1,093.4			
Travel on unpaved parking lots	2,365.07	237.45				12,923.9	1,297.5			
Windblown dust	4,814.80	722.22				26,310.4	3,946.6			
All Misc. Area Sources	12,444.36	2,143.52	115.94	29.74	7,693.04	81,929.6	18,879.4	2,318.0	622.4	42,455.4
All Area Sources:	24,521.17	6,278.48	12,774.79	1,112.00	10,962.54	161,147.8	46,738.0	83,325.3	7,694.7	61,982.0

Table 1.6–10 (cont'd). Annual and typical daily emissions from all sources in the PM_{10} nonattainment area.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Section	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Nonroad Sources:										
Agricultural equipment	15.13	14.67	161.35	0.06	0.30	97.0	94.0	1,034.3	0.4	1.9
Airport GSE (+APU)	26.99	26.48	578.95	26.22		147.5	144.7	3,163.7	143.3	
Commercial equipment	117.66	112.69	1,391.61	2.39	21.06	754.2	722.4	8,920.6	15.3	135.0
Construction and mining equipment	1,249.88	1,210.00	14,666.42	6.55	27.85	8,012.1	7,756.4	94,015.6	42.0	178.5
Industrial equipment	101.42	98.71	2,586.39	3.21	56.09	650.1	632.7	16,579.4	20.6	359.5
Lawn and garden equipment	183.02	169.48	801.41	3.17	19.71	1,255.3	1,161.6	5,594.4	23.2	145.2
Pleasure craft	7.02	6.48	59.03	0.64	1.32	94.5	87.3	794.6	8.6	17.7
Railway maintenance equipment	1.13	1.10	9.26	0.00	0.02	7.8	7.6	64.1	0.0	0.1
Recreational equipment	7.68	7.08	10.76	0.07	0.35	65.7	60.5	91.9	0.6	3.0
Aircraft	183.80	177.61	2,620.31	316.00		1,004.3	970.5	14,318.6	1,726.8	
Locomotives	34.16	31.88	907.76	9.11	2.16	186.7	174.2	4,960.4	49.8	11.8
All Nonroad Sources:	1,927.89	1,856.18	23,793.26	367.42	128.87	12,275.2	11,812.0	149,537.7	2,030.5	852.9
Onroad Sources:										
Exhaust, tire wear, and brake wear	3,144.17	2,300.80	71,444.20	300.66	1,235.28	17,181.3	12,572.9	390,405.5	1,643.0	6,750.5
Paved road fugitive dust	6,694.22	1,774.76				36,580.5	9,698.1			
Unpaved road and alley fugitive dust	11,710.70	1,169.00				63,993.1	6,387.8			
All Mobile Sources:	21,549.09	5,244.56	71,444.20	300.66	1,235.28	117,754.9	28,658.8	390,405.5	1,643.0	6,750.5
Biogenic Sources:			332.77					1,815.3		
TOTAL, All Sources:	48,147.99	13,512.16	109,662.87	1,808.84	12,458.87	292,019.1	87,956.5	632,338.1	11,526.4	70,312.4

1.7 Public review process

Maricopa County Air Quality Department released a draft version of this document, its 2008 PM_{10} emission inventory, for a 30-day public review and comment period on April 26, 2010. (The department's news release announcing the availability of the draft report, and outlining the schedule for public review and comment, is contained in Appendix 1). The department held a public workshop on May 14, 2010 to discuss the draft inventory. No formal comments were received during the 30-day public comment period.

2. Point Sources

2.1 Introduction and scope

This inventory of PM_{10} and related pollutants is one of a number of emission inventories being prepared to meet US EPA reporting requirements.

In addition to preparing periodic emissions inventories for the PM_{10} nonattainment area (NAA) as a commitment under the current PM_{10} State Implementation Plan (SIP), the federal Air Emission Reporting Requirements (AERR) rule requires that state and local agencies prepare emissions estimates on a county basis, and submit data electronically to the US EPA for inclusion in the National Emission Inventory (NEI) for 2008. This inventory is being developed concurrently with similar inventories for CO and ozone precursors (VOC, NO_x, and CO), as part of Maricopa County's requirements under the respective SIPs.

In order to provide consistency among all these inventories, it was decided to standardize the definition of a "point source" by adopting the designation of point sources as outlined in the AERR:

> *We are basing the requirement for point source format reporting on whether the source is major under 40 CFR part 70 for the pollutants for which reporting is required, i.e., CO, VOC, NO_x, SO_2, $PM_{2.5}$, PM_{10}, lead and NH_3 but without regard to emissions of HAPs… [T]his approach will result in a more stable universe of reporting point sources, which in turn will facilitate elimination of overlaps and gaps in estimating point source emissions, as compared to nonpoint source emissions. Under this requirement, states will know well in advance of the start of the inventory year which sources will need to be reported.* (US EPA, 2008)

Additionally, EPA guidance requires emission inventories prepared for SIP development purposes to consider point sources with 25 miles of the nonattainment area boundary. No additional point sources met this reporting threshold.

Several tables have been constructed to provide the point source emissions and category totals. Table 2.2–1 provides an alphabetical listing of all point sources and their location. Table 2.4–1 shows the 2008 annual and typical day emissions of PM_{10}, $PM_{2.5}$, NO_x, SO_x and NH_3 for those point sources which reported emissions of one or more of these pollutants broken out by facility. Table 2.6–1 summarizes point source emissions by source category for the county and PM_{10} nonattainment area. Note that totals shown in the tables may not equal the sum of individual values due to independent rounding.

2.2 Identification of point sources

The Maricopa County Air Quality Department (MCAQD) identified point sources within Maricopa County through its electronic permit system database, EMS, and the 2008 annual emissions reports submitted to the department. A total of 25 stationary sources were identified as point sources using the definition described in Section 2.1. There are no additional point sources within the 25-mile boundary around the PM_{10} nonattainment area with permits issued by the Pinal County Air Quality Control District (PCAQCD). While the Arizona Department of Environmental Quality (ADEQ) retains permitting authority for a limited number of industrial

source categories in Maricopa County, no ADEQ-permitted facilities are considered point sources, and are addressed instead as area sources.

Table 2.2–1 contains an alphabetical listing of all point sources, including a unique business identification number, NAICS industry classification code, business name, and physical address.

Table 2.2–1. Name and location of all point sources in Maricopa County.

ID #	NAICS	Business name	Address	City	ZIP	
245	337122	AF Lorts Manufacturing Company	8120 W Harrison St	Tolleson	85353	
3313	221112	APS West Phx Power Plant	4606 W Hadley St	Phoenix	85043	
43063	221112	Dynegy Arlington Valley LLC	39027 W Elliot Rd	Arlington	85322	*
44439	221112	Gila River Power Station	1250 E Watermelon Rd	Gila Bend	85337	*
1418	326299	Goodrich Aircraft Interior Products	3414 S 5th St	Phoenix	85040	
355	336412	Honeywell-Engines Systems & Services	111 S 34th St	Phoenix	85034	
3300	92811	Luke AFB – 56th Fighter Wing	14002 W Marauder St	Glendale	85309	
62	33711	Mastercraft Cabinets Inc	305 S Brooks	Mesa	85202	
44186	221112	Mesquite Generating Station	37625 W Elliot Rd	Arlington	85322	*
43530	221112	New Harquahala Generating Co	2530 N 491st Ave	Tonopah	85354	*
20706	32614	New Wincup Holdings Inc	7980 W Buckeye Rd	Phoenix	85043	
1331	337122	Oak Canyon Manufacturing Inc	3021 N 29th Dr	Phoenix	85017	
52382	221112	Ocotillo Power Plant	1500 E University Dr	Tempe	85281	
1341	33992	Penn Racquet Sports Inc	306 S 45th Ave	Phoenix	85043	
42956	221112	Redhawk Generating Facility	11600 S 363rd Ave	Arlington	85322	*
303	332431	Rexam Beverage Can Company	211 N 51st Ave	Phoenix	85043	
3315	221112	Santan Generating Station	1005 S Val Vista Rd	Gilbert	85296	
4175	424710	SFPP LP Phoenix Terminal	49 N 53rd Ave	Phoenix	85043	
3316	221112	SRP Agua Fria Generating Station	7302 W Northern Ave	Glendale	85303	
3317	221112	SRP Kyrene Generating Station	7005 S Kyrene Rd	Tempe	85283	
552	337122	Thornwood Furniture Mfg	5125 E Madison St	Phoenix	85034	
1210	337122	Trendwood Inc (S. 15th Ave.)	2402 S 15th Ave	Phoenix	85007	
1211	337122	Trendwood Inc (E. University)	261 E University Dr	Phoenix	85004	
174	325998	W R Meadows of Az Inc	4220 S Sarival Ave	Goodyear	85338	
1382	33711	Woodcase Fine Cabinetry Inc	3255 W Osborn Rd	Phoenix	85017	

* = Facility is outside the PM_{10} nonattainment area.

2.3 Procedures for estimating emissions from point sources

Annual and typical daily emission estimates were determined from annual source emission reports, MCAQD investigation reports, permit files and logs, or telephone contacts with sources. For most of the sources, material balance methods were used for determining emissions. Emissions were estimated using the emission factors from AP–42, source tests, engineering calculations, or manufacturers' specifications.

MCAQD distributes annual emissions survey forms to nearly all facilities for which MCAQD has issued an operating permit. Facilities are required to report detailed information on stacks, control devices, operating schedules, and process-level information concerning their annual activities. (See Appendix 2 for a copy of the instructions to complete the emissions inventory.) These instructions include examples and explanations on how to complete the annual emissions reporting forms that facilities must submit to MCAQD.

After a facility has submitted an annual emissions report to MCAQD, emissions inventory staff check all reports for missing and questionable data, and check the accuracy and reasonableness of all emissions calculations with AP–42, the Factor Information and REtrieval (*webFIRE*)

software, and other EPA documentation. Control efficiencies are determined by source tests when available, or by AP–42 factors, engineering calculations, or manufacturers' specifications. MCAQD has conducted annual emissions surveys for permitted facilities since 1988, and the department's database system, EMS, contains numerous automated quality assurance/quality control checks for data input and processing.

2.3.1 Calculation of $PM_{2.5}$ emissions

For all county-permitted sources that submitted an annual emission inventory report, all process-level emissions for PM_{10}, NO_x, SO_x, and NH_3 were calculated for each facility. Actual emissions for these pollutants were calculated using reported emission factors (from AP–42 or source test results) and reflecting any control devices installed. $PM_{2.5}$ was calculated using a variety of methods, depending on the Source Classification Code (SCC) of the process reported:

1. For those SCCs and control device combinations included in EPA's *WebFIRE*, this database was used to calculate $PM_{2.5}$, using EPA-recommended emission factors and typical control efficiencies.
2. For processes with no PM_{10} controls, emission factors for $PM_{2.5}$ published by the California Air Resources Board (CARB, 2004) were used where available.
3. For all other processes (where neither of the above resources provided guidance), $PM_{2.5}$ was assumed equal to PM_{10} as a conservative estimate.

2.3.2 Application of rule effectiveness

Rule effectiveness reflects the actual ability of a regulatory program to achieve the emission reductions required by regulation. The concept of applying rule effectiveness in a SIP emission inventory has evolved from the observation that regulatory programs may be less than 100 percent effective for some source categories. Rule effectiveness ("RE") is applied to those sources affected by a regulation and for which emissions are determined by means of emission factors and control efficiency estimates.

MCAQD has estimated RE for three distinct groups of industrial processes. (See Appendix 3 for details on the methods and data used in computing RE rates):

- For manually controlled processes that are regulated under Maricopa County Rule 316 (Non-metallic Mineral Processing), the analysis showed an overall rule effectiveness of 65.44%.
- For most other processes that claimed emissions reductions through the use of a control device, RE calculations were performed separately for Title V and non-Title V sources. Overall RE values of 90.94% (for Title V processes) and 84.27% (for non-Title V) were calculated.

2.4 Detailed overview of point source emissions

Table 2.4–1 provides a summary of annual and typical daily emissions from all point sources, within and outside the PM_{10} nonattainment area. Sources for which rule effectiveness has been applied (for PM_{10} emissions) are noted. Values of "0.00" and "0.0" for annual and daily emissions denote a value below the level of significance (0.005 tons/yr and 0.05 lbs/day, respectively).

Table 2.4–1. Annual and typical daily point source emissions, by facility.

			Annual emissions (tons/yr)					Typical daily (lbs/day)				
ID #	Business name		PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
245	AF Lorts Manufacturing Company	*	2.69	2.68	0.01	0.00	0.00	20.7	20.6	0.1	0.0	0.0
3313	APS West Phx Power Plant		22.94	19.47	394.24	4.51	81.39	126.0	107.0	2,166.1	24.8	447.2
43063	Dynegy Arlington Valley LLC	†*	6.40	3.58	35.50	2.20	5.38	36.5	20.9	214.4	15.2	29.6
44439	Gila River Power Station	†	99.50	92.13	343.01	17.36	5.77	546.9	506.4	1,887.5	95.4	31.8
1418	Goodrich Aircraft Interior Products	*	0.16	0.16	0.42	0.00	0.01	1.5	1.5	3.2	0.0	0.1
355	Honeywell-Engines Systems & Srvs.		3.17	3.16	51.42	9.91	0.65	17.7	17.6	282.5	54.5	4.0
3300	Luke AFB – 56th Fighter Wing	*	0.60	0.59	7.15	0.15	0.02	3.7	3.7	43.1	1.0	0.1
62	Mastercraft Cabinets Inc		0.18	0.14	0.04	0.00	0.00	1.4	1.1	0.3	0.0	0.0
44186	Mesquite Generating Station	†	152.65	144.01	243.09	17.12	15.56	838.8	791.3	1,336.4	94.1	85.5
43530	New Harquahala Generating Co	†	116.35	116.11	86.29	6.46	93.52	639.3	638.0	474.1	35.5	513.9
20706	New Wincup Holdings Inc		0.94	0.94	12.42	0.07	0.40	5.2	5.2	68.3	0.4	2.2
1331	Oak Canyon Manufacturing Inc		0.01	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
52382	Ocotillo Power Plant		8.37	6.48	64.45	0.29	1.67	46.0	35.6	354.1	1.6	9.2
1341	Penn Racquet Sports Inc	*	1.74	1.74	3.51	0.02	0.11	13.4	13.4	27.0	0.2	0.9
42956	Redhawk Generating Facility	†	76.53	66.38	179.16	9.25	26.65	420.5	364.7	984.8	50.9	146.4
303	Rexam Beverage Can Company	*	0.33	0.33	4.39	0.03	0.14	1.8	1.8	24.1	0.1	0.8
3315	Santan Generating Station		51.88	50.33	313.85	10.59	35.55	285.1	276.5	1,724.4	58.2	195.3
4175	SFPP LP Phoenix Terminal		0.63	0.61	4.96	0.24	0.00	3.5	3.3	27.2	1.3	0.0
3316	SRP Agua Fria Generating Station		25.21	18.01	392.20	0.58	3.67	138.5	98.9	2,154.9	3.2	20.1
3317	SRP Kyrene Generating Station		26.24	25.64	60.60	2.19	8.56	144.2	140.9	333.0	12.1	47.0
552	Thornwood Furniture Mfg	*	2.66	2.42	0.10	0.00	0.00	20.5	18.6	0.8	0.0	0.0
1210	Trendwood Inc (S. 15th Ave.)		0.05	0.05	0.00	0.00	0.00	0.4	0.4	0.0	0.0	0.0
1211	Trendwood Inc (E. University)		0.01	0.01	0.00	0.00	0.00	0.1	0.0	0.0	0.0	0.0
174	W R Meadows of Az Inc		0.01	0.01	0.12	0.00	0.00	0.1	0.1	1.5	0.0	0.0
1382	Woodcase Fine Cabinetry Inc		0.23	0.18	0.00	0.00	0.00	1.8	1.4	0.0	0.0	0.0

† = Facility is outside the PM_{10} nonattainment area.
* = Facility for which rule effectiveness has been applied.

2.5 Emission reduction credits

A major source or major modification planned in a nonattainment area must obtain emissions reductions as a condition for approval. These emissions reductions, generally obtained from existing sources located in the vicinity of a proposed source must offset the emissions increase from the new source or modification. The obvious purpose of acquiring offsetting emissions decreases is to allow an area to move towards attainment of the national ambient air quality standards while still allowing some industrial growth.

In order for these emission reductions to be available in the future for offsetting, they must be: 1) explicitly included and quantified as growth in projection year inventories required in rate of progress plans or attainment demonstrations that were based on 1990 actual inventories, and 2) meet the requirements outlined in MCAQD Rule 240 (Permit Requirements for New Major Sources and Major Modification to Existing Major Sources).

Table 2.5–1 provides a list of emission reduction credits for PM_{10}, NO_x, and SO_x. Only one previously operational facility maintains emission reduction credits that are still valid for inclusion in this report and the rate of progress plan.

Table 2.5–1. Emission reduction credits.

		Emission reduction credits (tons/yr)		
ID	**Facility**	**PM_{10}**	**NO_x**	**SO_x**
1151	Freescale Semiconductor, Inc. (formerly Motorola Mesa)	1.80	8.00	0.16

2.6 Summary of point source emissions

Table 2.6–1 provides an overview of source category contributions to point source emissions for Maricopa County and the PM_{10} nonattainment area.

Table 2.6–1. Annual and typical daily point source emissions (including emission reduction credits).

	Annual (tons/yr)					Typical day (lbs/day)				
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	601.27	555.15	2,204.91	81.15	279.06	3,323.2	3,069.1	12,151.5	449.3	1,534.2
PM_{10} NAA	149.84	132.94	1,317.85	28.76	132.18	841.2	747.7	7,254.3	158.2	727.0

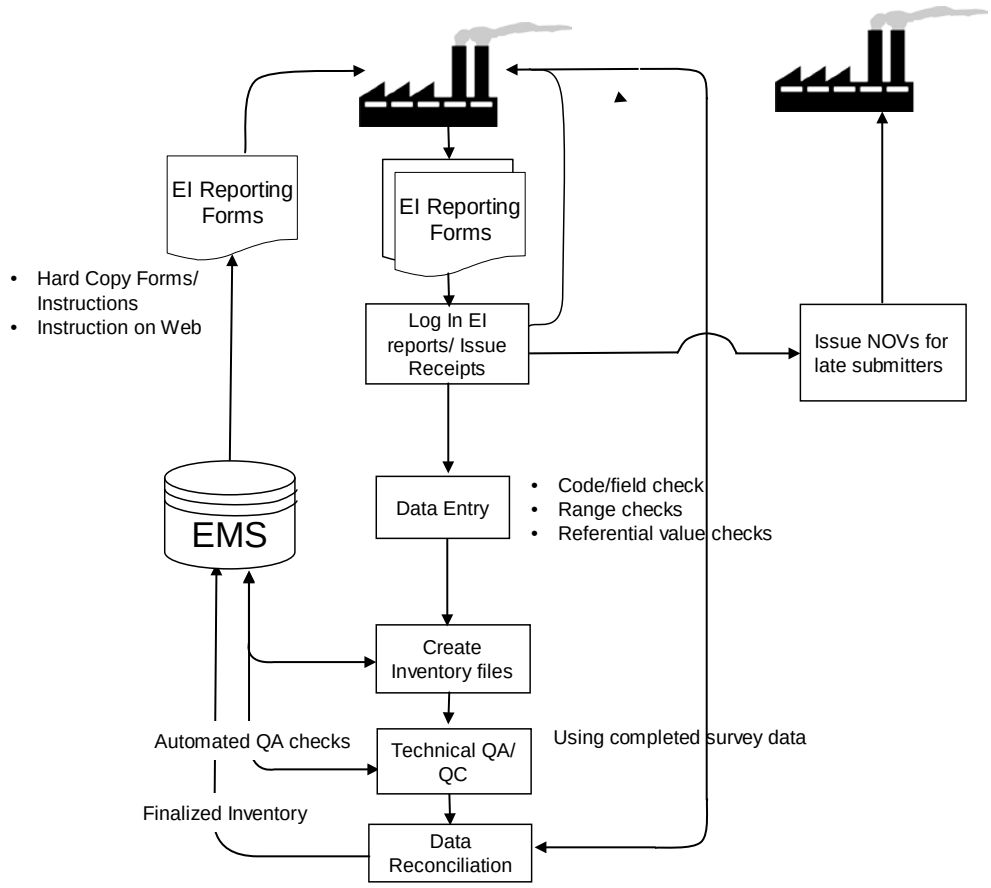
2.7 Quality assurance / quality control procedures

2.7.1 Emission survey preparation and data collection

The MCAQD's Emissions Inventory (EI) Unit annually collects point source criteria pollutant emission data from sources in the county. MCAQD annually reviews EPA guidance, documents from the Emission Inventory Improvement Program (EIIP), and other source materials to ensure that the most current emission factors and emission calculation methods are used for each year's survey. Each January, the EI Unit prepares a pre-populated hard copy of the preceding year's submissions and mails reporting forms to permitted sources, along with detailed instructions for completing the forms. (A copy of these instructions is included as Appendix 2). The EI Unit asks sources to verify and update the data. The EI Unit also holds workshops from February through April to assist businesses in completing EI forms.

The general data flow for data collection and inventory preparation is shown in Figure 2.7–1.

Figure 2.7–1. Data flow for annual point source emission inventory reporting.



2.7.2 Submission processing

Submitted EI reports are logged in as they are received, and receipts are issued for emissions fees paid. The data are input "as received" into the department's data base. During data entry, a variety of automated quality control (QC) checks are performed, including:

- pull-down menus to minimize data entry errors (e.g., city, pollutant, emission factor unit, etc.)
- mandatory data field requirement checks (e.g., a warning screen appears if a user tries to save an emission record with a missing emission factor).
- range checks (e.g., were valid SCC, Tier, SIC, and NAICS codes entered?)
- referential value checks (e.g., emission factor units, annual throughput units)
- automatic formatting of date, time, telephone number fields, etc.

Automated quality assurance (QA) checks on the report that has been entered include the following:

- Comparing reported emission factors to SCC reference lists
- Comparing reported emission factors to material name reference list

- Checking the report for calculation errors. This includes annual throughput, emission factors, unit conversion factors (e.g., BTU to therms), capture efficiency, primary / secondary control device efficiency, and any offsite recycling credits claimed.
- Checking the report for completeness of required data.

When data entry is complete, an electronic version of the original data is preserved separately to document changes made during the technical review and QA/QC process.

When errors are flagged, the businesses are contacted and correct information is obtained and input to the EMS. Outstanding reporting issues are documented. Confidential business information (CBI) is identified by a checkbox on the form, and these data elements are flagged during data entry and are not transmitted to the EPA. To prepare the inventory for submittal to the National Emissions Inventory (NEI), the EI Unit runs Microsoft Access queries on the data in the EMS to pull fields for the NEI Input format (NIF) tables.

2.7.3 Analysis of annual point source emissions data for this inventory

Two air quality planners checked inventory accuracy and reasonableness, and assured that all point sources had been identified and that the methodology applied to calculate emissions was appropriate and that the calculations were correct. Other reasonableness checks were conducted by recalculating emissions using methods other than those used to make the initial emissions calculations and then comparing results. QA was conducted by checking all emissions reports submitted to MCAQD for the year 2008 for missing and questionable data and by checking the accuracy and reasonableness of all emissions calculations made for such reports. Notes concerning follow-up calls and corrections to calculations were documented on each 2008 annual emissions report.

The QA point source coordinator reviewed and checked calculations, identified errors, and performed completeness, reasonableness and accuracy checks.

2.8 References

CARB, 2004. Speciation Profiles and Size Fractions. Available at: http://www.arb.ca.gov/ei/speciate/speciate.htm.

US EPA, 2008. Air Emissions Reporting Requirements. 73 Fed. Reg. 76539. Available at: http://www.epa.gov/ttn/chief/aerr/final_published_aerr.pdf.

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3. Area Sources

3.1 Scope and methodology

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

Table 3.1–1. List of area-source categories included in this PM_{10} inventory.

SCC Code	Category Description	Section
	Fuel combustion:	
2102006000	Industrial natural gas	3.2.1
2102004000	Industrial fuel oil	3.2.2
2103006000	Commercial/institutional natural gas	3.2.3
2103004000	Commercial/institutional fuel oil	3.2.4
2104006000	Residential natural gas	3.2.5
2104008000	Residential wood	3.2.6
2104004000	Residential fuel oil	3.2.7
	Industrial processes:	
2301010000	Chemical manufacturing	3.3.1
2302002000	Commercial cooking	3.3.2.1
2302040000	Grain handling/processing	3.3.2.2
2302080000	Ammonia cold storage	3.3.2.3
2304000000	Secondary metal production	3.3.3
2305000000	Non-metallic mineral processes	3.3.4
2325000000	Mining and quarrying	3.3.5
2307000000	Wood product manufacturing	3.3.6
2308000000	Rubber/plastics manufacturing	3.3.7
2309000000	Fabricated metal products manufacturing	3.3.8
2311010000	Residential construction	3.3.9
2311020000	Commercial construction	3.3.9
2311030000	Road construction	3.3.9
n/a	Other construction	3.3.9
2312000000	Electrical equipment manufacturing	3.3.10
n/a	State-permitted portable sources	3.3.11
n/a	Paved/unpaved road travel on industrial sites	3.3.12
2399000000	Industrial processes not elsewhere classified (NEC)	3.3.13
	Waste treatment and disposal:	
2601000000	On-site incineration	3.4.1
2610000000	Open burning	3.4.2
2620000000	Landfills	3.4.3
2630000000	Publicly owned treatment works (POTWs)	3.4.4
2650000000	Other industrial waste disposal	3.4.5
	Miscellaneous area sources:	
2810001000	Wildfires	3.5.1.1
2810014000	Prescribed fires	3.5.1.2

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

SCC Code	Category Description	Section
	Miscellaneous area sources: (continued)	
2810030000	Structure fires	3.5.1.3
2810050000	Vehicle fires	3.5.1.4
2810040000	Engine testing	3.5.1.5
2801000003	Tilling	3.5.2.1
2801000005	Harvesting	3.5.2.2
n/a	Travel on unpaved agricultural roads	3.5.2.3
2801000000	Cotton ginning	3.5.2.4
2801700000	Fertilizer application	3.5.2.5
2810060000	Livestock	3.5.3
2810060000	Health services: crematories	3.5.4
2830000000	Accidental releases	3.5.5
2810010000	Humans	3.5.6
n/a	Leaf blower fugitive dust	3.5.7
n/a	Offroad recreational vehicle fugitive dust	3.5.8
n/a	Unpaved parking lots fugitive dust	3.5.9
2730100000	Windblown dust	3.5.10

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

- Emissions estimates for some categories were developed by conducting surveys on local usage (e.g., natural gas consumption) or derived from state-wide data (e.g., fuel oil use).
- For some widespread or diverse categories (e.g., ammonia cold storage), emissions were calculated using published per-capita or per-employee emission factors.
- For source categories with some information available from annual emissions reports (e.g., wood product manufacturing), these data were combined with employment data to "scale up" reported emissions to reflect the entire source category.
- For those source categories that have detailed emissions data available from most or all of the significant sources in the category, emissions were calculated based on the detailed process-level and operational data provided by these sources.

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

3.2 Fuel combustion

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

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

	Sales by end user category (in MMCF/yr)					
Natural gas supplier	**Electric Utilities**	**Industrial**	**Commercial/ Institutional**	**Residential**	**Transport***	**Other***
Southwest Gas	17.07	1,543.27	15,643.15	14,911.67	6,487.35	n/a
City of Mesa	6.52	93.02	1,609.12	1,339.62	n/a	244.97
El Paso	227,608.92	201.90	n/a	n/a	n/a	6.07

* For emissions calculations, sales from transport and other 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 2008. Area-source industrial natural gas usage for the county is based on the reported total volume of natural gas sold to industrial sources, minus natural gas used by industrial point sources:

County area-source industrial natural gas usage	=	Total reported industrial natural gas sales	–	Industrial point source natural gas usage
	=	8,576.57 MMCF	–	516.15 MMCF
	=	8,060.42 MMCF		

Natural gas is used for both external combustions (boilers and heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source natural gas usage derived above must be divided between these two categories. This apportionment was based on the percentages of external and internal natural gas combustion reported by all industrial area sources in 2008.

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

PM_{10} emissions from external natural gas combustion	=	External industrial natural gas usage (MMCF)	×	PM_{10} emission factor for external natural gas combustion (lb/MMCF)	÷ 2,000 lbs/ton
	=	7,934.68	×	7.6	÷ 2,000
	=	30.15 tons PM_{10}/yr			

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

Type of Combustion	% of total	Natural gas use (MMCF)	Emission factors (lb/MMCF)					Annual emissions (tons/yr)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
External	98.44	7,934.68	7.6	7.6	100	0.6	3.2	30.15	30.15	396.73	2.38	12.70
Internal	1.56	125.74	10.0	10.0	2840	0.6	n/a	0.63	0.63	178.55	0.04	n/a
Total:	**100.00**	**8,060.43**						**30.78**	**30.78**	**575.29**	**2.42**	**12.70**

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

Typical daily PM_{10} emissions from industrial natural gas (lbs/day)	=	Annual PM_{10} emissions	÷ (days/week × wks/yr)	× 2,000 lbs/ton
	=	30.78 tons/yr	÷ (6 × 52)	× 2,000
	=	197.3 lbs PM_{10}/day		

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

Emissions from area-source industrial natural gas combustion	= Annual county PM_{10} emissions (tons/yr)	×	NAA:County industrial employment ratio in the PM_{10} NAA
	= 30.78	×	0.9974
	= 30.70 tons PM_{10}/yr		

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	30.78	30.78	575.29	2.42	12.70	197.3	197.3	3,687.7	15.5	81.4
PM_{10} NAA	30.70	30.70	573.79	2.41	12.66	196.8	196.8	3,678.2	15.5	81.2

3.2.2 Industrial fuel oil

Area-source emissions from industrial fuel oil combustion were calculated by a multi-step process which allocates Arizona state-level industrial fuel oil sales as reported by the U.S. Department of Energy, Energy Information Administration (US DOE, 2010a) to Maricopa County.

To derive industrial fuel oil usage in Maricopa County, reported Arizona state-level sales of high-sulfur diesel for 2008 are first subtracted from Arizona state-level total industrial fuel oil sales, as it is presumed that no high-sulfur diesel fuel is used in Maricopa County due to local air quality regulations and market conditions.

State industrial fuel oil sales other than high-sulfur diesel (in thousand gallons, or Mgal)	= Reported state total industrial fuel oil sales	–	Reported state high-sulfur diesel sales
	= 137,044 Mgal	–	224 Mgal
	= 136,820 Mgal/yr		

Arizona state industrial fuel oil sales (less high-sulfur diesel fuel) are then multiplied by the ratio of industrial employment in Maricopa County to Arizona State (0.70), as determined by data from the US Census Bureau (2010a) to estimate annual Maricopa County-level industrial fuel oil sales, as follows:

Maricopa County industrial fuel oil sales	= Arizona state industrial fuel oil sales less high-sulfur diesel	×	Maricopa County:State industrial employment ratio
	= 136,820 Mgal	×	0.7007
	= 95,869.77 Mgal/yr		

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

Maricopa County area source fuel oil sales	=	Maricopa County industrial fuel oil sales	–	Fuel oil used by industrial nonroad mobile equipment	–	Fuel oil used by industrial stationary point sources
	=	95,869.77 Mgal	–	11,596.87 Mgal	–	136.82 Mgal
	=	84,136.09 Mgal/yr				

Industrial fuel oil is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source industrial fuel oil sales derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal fuel oil combustion reported by all industrial area sources surveyed in 2008 (shown in Table 3.2–4 below).

Annual emissions for the county and the PM_{10} nonattainment area 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 PM_{10} emissions from external fuel oil combustion:

Annual PM_{10} emissions from external industrial fuel oil combustion	=	External industrial fuel oil sales (Mgal)	×	PM_{10} emission factor for external fuel oil combustion (lb/Mgal)	÷	2,000 lbs/ton
	=	65,634.56	×	2	÷	2,000
	=	65.63 tons PM_{10}/yr				

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

Combustion type	% of total	Annual sales (Mgal)	Emission factors (lb/Mgal)					Annual emissions (tons/yr)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
External	78.01	65,634.56	2.0	2.0	24	7.39	0.8	65.63	65.63	787.61	242.36	26.25
Internal	21.99	18,501.53	42.5	42.5	604	39.70	–	393.16	393.16	5,587.46	367.26	n/a
Totals:	**100.00**	**84,136.09**						**458.79**	**458.79**	**6,375.08**	**609.61**	**26.25**

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

Typical daily PM_{10} emissions from industrial fuel oil	=	Annual PM_{10} emissions (tons/yr)	÷	(days/week × wks/yr)	×	2,000 lbs/ton
	=	458.79	÷	(6 × 52)	×	2,000
	=	2,941.0 lbs PM_{10}/day				

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

PM_{10} NAA emissions from area source industrial fuel oil combustion	=	Annual county PM_{10} emissions	×	NAA:County industrial employment ratio
	=	458.79 tons/yr	×	0.9974
	=	457.60 tons PM_{10}/yr		

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	458.79	458.79	6,375.08	609.61	26.25	2,941.0	2,941.0	40,865.9	3,907.8	168.3
PM_{10} NAA	457.60	457.60	6,358.50	608.03	26.19	2,933.3	2,933.3	40,759.6	3,897.6	167.9

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 2008. Area-source commercial and institutional (C&I) natural gas usage for the county is based on the reported total volume of natural gas sold to C&I sources, minus natural gas used by C&I point sources:

County area-source C&I natural gas usage	=	Reported C&I natural gas sales	–	C&I point source natural gas usage
	=	17,503.31 MMCF	–	84.08 MMCF
	=	17,419.23 MMCF		

Natural gas is used for both external combustion (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source natural gas usage derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal natural gas combustion reported by all C&I area sources in 2008.

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

Annual PM_{10} emissions from external natural gas combustion	=	External C&I natural gas usage (MMCF)	×	PM_{10} emission factor for external natural gas combustion (lb/MMCF)	÷	2,000 lbs/ton
	=	17,130.07	×	7.6	÷	2,000
	=	65.09 tons PM_{10}/yr				

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

			Emission factors (lb/MMCF)					Annual emissions (tons/yr)				
Combustion type	**% of total**	**C&I natural gas usage (MMCF)**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
External	98.34	17,130.07	7.6	7.6	100	0.6	0.49	65.09	65.09	856.50	5.14	4.20
Internal	1.66	289.16	10.0	10.0	2840	0.6	n/a	1.45	1.45	410.61	0.09	n/a
Total:	**100.00**	**17,419.23**						**66.54**	**66.54**	**1,267.11**	**5.23**	**4.20**

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

Typical daily PM_{10} emissions from comm./inst. natural gas	=	Annual PM_{10} emissions (tons/yr)	÷ (days/week × wks/yr)	×	2,000 lbs/ton
	=	66.54	÷ (6 × 52)	×	2,000
	=	426.54 lbs/day			

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

PM_{10} NAA emissions from area-source comm./inst. natural gas combustion	=	Annual county PM_{10} emissions (tons/yr)	×	NAA:County C&I employment ratio
	=	66.54	×	0.9949
	=	66.20 tons PM_{10}/yr		

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	66.54	66.54	1,267.11	5.23	4.20	426.5	426.5	8,122.5	33.5	26.9
PM_{10} NAA	66.20	66.20	1,260.65	5.20	4.18	424.4	424.4	8,081.1	33.3	26.8

3.2.4 Commercial/institutional fuel oil

Area-source emissions from commercial and institutional (C&I) fuel oil combustion were calculated by a multi-step process of allocating Arizona state-level C&I fuel oil sales as reported by the U.S. Department of Energy, Energy Information Administration (US DOE, 2010b) to Maricopa County.

To derive commercial/institutional fuel oil usage in Maricopa County, reported Arizona state-level sales of high-sulfur diesel for 2008 are first subtracted from Arizona state-level total C&I fuel oil sales, as it is presumed that no high-sulfur diesel fuel is used in Maricopa County due to local clean air act requirements and market conditions.

State C&I fuel oil sales other than high-sulfur diesel (in thousand gallons, or Mgal)	=	Reported state total C&I fuel oil sales	–	Reported state high-sulfur diesel sales
	=	47,586 Mgal	–	367 Mgal
	=	47,219 Mgal/yr		

Arizona state commercial/institutional fuel oil sales (less high-sulfur diesel fuel) are then multiplied by the ratio of C&I employment in Maricopa County to Arizona state (0.80), as determined by data from the US Census Bureau (2010a) to estimate annual Maricopa County-level commercial/institutional fuel oil sales, as follows:

Maricopa County C&I fuel oil sales	=	Arizona state C&I fuel oil sales (less high-sulfur diesel)	×	Maricopa County:state commercial/ institutional employment ratio
	=	47,219 Mgal	×	0.7973
	=	37,647.71 Mgal/yr		

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

Annual Maricopa County commercial/institutional area-source fuel oil sales	= Maricopa County C&I fuel oil sales	–	Fuel oil used by C&I nonroad mobile equipment	–	Fuel oil used by C&I stationary point sources
	= 37,647.71 Mgal	–	7,291.00 Mgal	–	3.94 Mgal
	= 30,352.77 Mgal/yr				

Fuel oil is used for both external combustions (boilers, heaters) and internal combustion (generators), each of which have different emission factors. Thus the area-source C&I fuel oil sales derived above must be apportioned between these two categories. This apportionment was based on the percentages of external and internal fuel oil combustion reported by all commercial and institutional area sources surveyed in 2008 (shown in Table 3.2–8 below).

Annual emissions for the county were calculated by multiplying comm./inst. fuel oil sales by the respective AP-42 emission factors for external and internal combustion, as in this example for PM_{10} emissions from external fuel oil combustion:

Annual PM_{10} emissions from external fuel oil combustion	= External C&I fuel oil sales (Mgal)	×	PM_{10} emission factor for external fuel oil combustion (lb/Mgal)	÷	2,000 lbs/ton
	= 20,321.18	×	1.08	÷	2,000
	= 10.97 tons PM_{10}/yr				

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

			Emission factors (lb/Mgal)					Annual emissions (tons/yr)				
Combustion type	**% of total**	**C&I fuel oil sales (Mgal)**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
External	66.95	20,321.18	1.08	1.08	24	7.1	0.8	10.97	10.97	243.85	72.14	8.13
Internal	33.05	10,031.59	42.5	42.5	604	39.7	n/a	213.17	213.17	3,029.54	199.13	n/a
Total:	**100.00**	**30,352.78**						**224.14**	**224.14**	**3,273.40**	**271.27**	**8.13**

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

Typical daily PM_{10} emissions from C&I fuel oil combustion	= Annual PM_{10} emissions (tons/yr)	÷ (days/week × wks/yr)	×	2,000 lbs/ton
	= 224.14	÷ (6 × 52)	×	2,000
	= 1,436.8 lbs/day			

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

PM_{10} NAA emissions from area source C&I fuel oil combustion	= Annual county PM_{10} emissions (tons/yr)	×	NAA:County C&I employment ratio
	= 224.14	×	0.9949
	= 223.00 tons PM_{10}/yr		

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	224.14	224.14	3,273.40	271.27	8.13	1,436.8	1,436.8	20,983.3	1,738.9	52.1
PM_{10} NAA	223.00	223.00	3,256.70	269.88	8.09	1,429.5	1,429.5	20,876.3	1,730.0	51.8

3.2.5 Residential natural gas

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

Table 3.2–10. Residential natural gas combustion emission factors.

Emission Factors (lb/MMCF)			
PM_{10}	**$PM_{2.5}$**	**NO_x**	**SO_x**
7.6	7.6	94	0.6

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

= 16,251.29 × 7.6 ÷ 2,000

= 61.75 tons PM_{10}/yr

Typical daily emissions were calculated by dividing annual emissions by the number of days (366) that activity occurs for residential natural gas combustion, as follows:

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

= 61.75 tons/yr × 2, 000 ÷ 366

= 337.4 lbs PM_{10}/day

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

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

= 61.75 × 99.96%

= 61.73 tons PM_{10}/yr

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

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	61.75	61.75	763.81	4.88	337.5	337.5	4,173.8	26.6
PM_{10} NAA	61.73	61.73	763.51	4.87	337.3	337.3	4,172.2	26.6

3.2.6 Residential wood combustion

Area-source emissions from residential wood combustion were calculated based on the amount of wood burned in fireplaces and woodstoves in Maricopa County, as recommended by EIIP guidance (US EPA, 2001b). 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, 2010c) by the ratio of county to state households that report use of wood for heating from the US Census Bureau (2010b). The latest available data on residential wood use for household heating from the US Department of Energy is for the calendar year 2007. 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 2007 data is assumed to be representative of 2008 emissions.

Maricopa County residential wood usage (cords/yr)	= Arizona residential wood usage (cords/yr)	×	Ratio of county:state households using wood for heat
	= 651,000	×	1,457 / 44,330
	= 21,397 cords/yr		

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

County residential wood usage (tons/yr)	=	County wood usage (cords)	× avg. ft^3 wood/cord	×	Wood density (lbs/ ft^3)	÷	2,000 lbs/ton
	=	21,397	× 79	×	31.57	÷	2,000
	=	26,682 tons					

Annual emissions from residential wood combustion were calculated by multiplying the tons of wood used by the PM_{10} emission factor for residential woodstoves and fireplaces from Table 2.4 –1 of US EPA (2001b).

Annual PM_{10} emissions from residential wood combustion (tons/yr)	=	Residential wood usage (tons)	×	PM_{10} emission factor (lbs/ton)	÷	2,000 lbs/ton
	=	26,682	×	34.6	÷	2,000
	=	461.59 tons PM_{10}/yr				

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

Residential wood usage (tons/yr)	Emission factors (lbs/ton)				Annual emissions (tons/yr)			
	PM_{10}	$PM_{2.5}$*	NO_x	SO_x	PM_{10}	$PM_{2.5}$*	NO_x	SO_x
26,681.76	34.6	32.2	2.6	0.4	461.59	429.28	34.69	5.34

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

Typical daily emissions were calculated by apportioning wood burning activity based on heating degree days (i.e., the number of degrees per day that the daily average temperature is below 65°F). Data provided by Arizona Department of Commerce (ADOC, 2010) indicated that there were five months (April, plus June–September, totaling 152 days) in 2008 where no heating degree days were recorded. Assuming that no wood burning activity took place during those months, it is assumed that all residential wood burning occurred during the remaining 213 days

of the year. Thus, typical daily emissions were calculated by dividing annual emissions by the number of days residential wood burning occurred, as follows:

Typical daily PM_{10} emissions from residential wood combustion (lbs/day)	= Annual PM_{10} emissions (tons/yr)	× 2,000 lbs/ton	÷	no. days wood burning occurred
	= 461.59	× 2,000	÷ 213	
	= 4,334.2 lbs PM_{10}/day			

Annual and typical daily emissions within the PM_{10} nonattainment area (presented in Table 3.2–13) were calculated by multiplying county totals by the ratio of residential population in the nonattainment area to the residential population in the county. See Section 1.5.1 for a further discussion of the population used.

Annual emissions from residential wood combustion in the PM_{10} NAA (tons/yr)	= County annual emissions	× NAA:county residential population ratio	
	= 461.59	× 0.9996	
	= 461.41 tons PM_{10}/yr		

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

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	461.59	429.28	34.69	5.34	4,334.2	4,030.8	325.7	50.1
PM_{10} NAA	461.41	429.11	34.67	5.33	4,332.5	4,029.2	325.6	50.1

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 (US EIA, 2010) using the ratio of county to state households that report fuel oil use from the US Census Bureau (2010c):

Maricopa County residential fuel oil usage (Mgal/yr)	= Arizona residential fuel oil use (Mgal/yr)	× Ratio of county:state households reporting fuel oil use
	= 91	× 573 / 1,881
	= 27.72 Mgal/yr	

Annual and daily emissions were calculated using AP-42 emission factors (shown below in Table 3.2–14) and data on heating degree days and residential housing units described in Section 3.2.6. Annual and daily emissions are shown below in Table 3–2.14.

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

	Emission factors (lb/Mgal)				Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	0.4	0.4	18	7.1	0.01	0.01	0.25	0.10	0.1	0.1	2.3	0.9
PM_{10} NAA	0.4	0.4	18	7.1	0.01	0.01	0.25	0.10	0.1	0.1	2.3	0.9

3.2.8 Summary of all area-source fuel combustion

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

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Fuel combustion type	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Industrial natural gas	30.78	30.78	575.29	2.42	12.70	197.3	197.3	3,687.7	15.5	81.4
Industrial fuel oil	458.79	458.79	6,375.08	609.61	26.25	2,941.0	2,941.0	40,865.9	3,907.8	168.3
Comm./inst. natural gas	66.54	66.54	1,267.11	5.23	4.20	426.5	426.5	8,122.5	33.5	26.9
Comm./inst. fuel oil	224.14	224.14	3,273.40	271.27	8.13	1,436.8	1,436.8	20,983.3	1,738.9	52.1
Residential natural gas	61.75	61.75	763.81	4.88		337.5	337.5	4,173.8	26.6	
Residential wood	461.59	429.28	34.69	5.34		4,334.2	4,030.8	325.7	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
Total:	1,303.61	1,271.30	12,289.62	898.83	51.27	9,673.4	9,370.0	78,161.3	5,773.3	328.7

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Fuel combustion type	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Industrial natural gas	30.70	30.70	573.79	2.41	12.66	196.8	196.8	3,678.2	15.5	81.2
Industrial fuel oil	457.60	457.60	6,358.50	608.03	26.19	2,933.3	2,933.3	40,759.6	3,897.6	167.9
Comm./inst. natural gas	66.20	66.20	1,260.65	5.20	4.18	424.4	424.4	8,081.1	33.3	26.8
Comm./inst. fuel oil	223.00	223.00	3,256.70	269.88	8.09	1,429.5	1,429.5	20,876.3	1,730.0	51.8
Residential natural gas	61.73	61.73	763.51	4.87		337.3	337.3	4,172.2	26.6	
Residential wood	461.41	429.11	34.67	5.33		4,332.5	4,029.2	325.6	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
Total:	1,300.65	1,268.35	12,248.07	895.83	51.11	9,653.8	9,350.6	77,895.2	5,754.1	327.6

3.3 Industrial processes

3.3.1 Chemical manufacturing

Emissions from area-source chemical manufacturing were calculated by the "scaling up" method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2010a) 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 2007 employment were used. 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
325	Chemical Manufacturing	3,930
42469	Other Chemical and Allied Products Merchant Wholesalers	1,093
424910	Farm Supplies Merchant Wholesalers	229
33312	Construction Machinery Manufacturing	212
Total:		**5,464**

There were no point sources in this category. Area-source employment estimate were used to "scale up" emissions reported from those facilities surveyed in 2008 as follows:

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

$$= \frac{35.71 \text{ tons of } PM_{10}/\text{yr}}{1{,}041 \text{ employees}} \times 5{,}464 \text{ employees}$$

$$= 187.43 \text{ tons } PM_{10}/\text{yr}$$

Typical daily emissions were calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM_{10} nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

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

$$= 187.43 \times 0.9974$$

$$= 186.94 \text{ tons } PM_{10}/\text{yr}$$

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

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NHx**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NHx**
Maricopa County	187.43	151.42	0.00	0.34	0.03	1,445.8	1,164.5	0.0	2.6	0.9
PM_{10} NAA	186.94	151.03	0.00	0.34	0.03	1,442.0	1,161.5	0.0	2.6	0.9

3.3.2 Food and kindred products

3.3.2.1 Commercial cooking

Emissions from commercial cooking were estimated for five types of commercial cooking equipment using EPA methodology (US EPA, 2006a). The equipment types include: chain-driven charbroilers, under-fired charbroilers, deep-fat fryers, flat griddles, and clamshell griddles. EPA's methodology estimates commercial cooking activity rates for restaurants with each type of cooking equipment (ethnic, family, fast food, seafood, and steak & barbeque) based on an average number of equipment pieces in each restaurant type, and also the and average quantity of meat cooked on each type of equipment per week (steak, hamburger, poultry, pork, and seafood). The estimates number of restaurants in Maricopa County for the five restaurant types was obtained from a commercial database (www.selectoryonline.com) and is shown in Table 3.3–3.

Table 3.3–3. Number of Maricopa County restaurants, by restaurant type.

Restaurant Type	No. of restaurants
Ethnic food	907
Fast food	1,068
Family	253
Seafood	37
Steak and barbecue	75
All restaurants:	**2,340**

Using EPA's emissions estimation methodology (US EPA, 2006a), commercial cooking activity data were estimated by first multiplying the county number of restaurants that use commercial cooking equipment in each category (ethnic, fast food, family, seafood, and steak and barbeque) by the percentage of restaurants with each type of cooking equipment (Table 3.3–4).

Number of ethnic food restaurants with under-fired charbroilers	=	Number of ethnic food restaurants in Maricopa County	×	% ethnic food restaurants with underfired charbroilers
	=	907	×	47.5%
	=	431		

Table 3.3–4. Percentages of restaurants with each type of cooking equipment.

Restaurant Type	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Ethnic	3.5%	47.5%	81.9%	62.7%	4.0%
Family	10.1%	60.9%	91.4%	82.9%	1.4%
Fast Food	18.6%	30.8%	96.8%	51.9%	14.7%
Seafood	0.0%	52.6%	100.0%	36.8%	10.5%
Steak and Barbeque	6.9%	55.2%	82.8%	89.7%	0.0%

The resulting product was then multiplied by the average number of equipment pieces by restaurant type (shown in Table 3.3–5) to derive an estimate of the total number of each cooking equipment type in Maricopa County restaurants (Table 3.3–6).

Table 3.3–5. Average number of equipment pieces per restaurant, by type.

Restaurant Type	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Ethnic	1.62	1.54	1.63	1.88	1.80
Family	1.71	1.29	2.34	2.03	—
Fast Food	1.07	1.58	3.10	1.43	2.09
Seafood	—	1.10	2.47	1.11	1.50
Steak and Barbeque	—	1.63	2.42	1.35	—

Number of underfired charbroilers at ethnic food restaurants	=	number of ethnic food restaurants with underfired charbroilers	×	average number of underfired char-broilers per ethnic food restaurant
	=	431	×	1.54
	=	664		

Table 3.3–6. Total pieces of cooking equipment, by restaurant type.

Restaurant Type	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Ethnic	51.43	663.47	1,210.82	1,069.14	65.30
Family	43.70	198.76	541.11	425.77	—
Fast Food	212.55	519.73	3204.85	792.64	328.12
Seafood	—	21.41	91.39	15.11	5.83
Steak and Barbeque	—	67.48	150.28	90.82	—
Totals:	**307.68**	**1,470.85**	**5,198.45**	**2,393.47**	**399.25**

The total number of each type of cooking equipment is then multiplied by average pounds of meat cooked on each type of equipment per week (Table 3.3–7) to derive the total estimate of the amount of meat cooked in Maricopa County each week (Table 3.3–8).

Table 3.3–7. Meat cooked weekly per restaurant (in pounds), by equipment type.

Type of Meat	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Steak	236	180	181	166	94
Hamburger	798	270	274	362	1314
Poultry, with Skin	147	144	365	88	113
Poultry, Skinless	266	179	208	111	108
Pork	57.6	148	58.6	112	118
Seafood	119	143	159	92.1	632
Other	0	41.5	274	57.5	0

Total steak cooked on all under-fired charbroilers (tons/wk)	=	Steak cooked on each under-fired charbroiler (lbs/wk)	× Total number of under-fired charbroilers at all restaurants	÷ 2,000 lbs/ton
	=	180 lbs/ week	× 1,470.85	÷ 2,000
	=	132.38 tons/week		

Table 3.3–8. Total meat cooked weekly (in tons), by equipment type.

Type of Meat	Chain-driven Charbroilers	Underfired Charbroilers	Deep Fat Fryers	Flat Griddles	Clamshell Griddles
Steak	36.31	132.38	470.46	198.66	18.76
Hamburger	122.76	198.56	712.19	433.22	262.31
Poultry, with Skin	22.61	105.90	948.72	105.31	22.56
Poultry, Skinless	40.92	131.64	540.64	132.84	21.56
Pork	8.86	108.84	152.31	134.03	23.56
Seafood	18.31	105.17	413.28	110.22	126.16
Other	0.00	30.52	712.19	68.81	0.00
Totals:	**249.77**	**813.01**	**3,949.78**	**1,183.09**	**474.91**

The total amount of meat cooked in Maricopa County restaurants weekly (Table 3.3–8) was then multiplied by the appropriate emission factor from Table 3.3–9 (US EPA, 2006a). The results were then summed to estimate annual emissions for each type of cooking equipment, shown in Table 3.3–10. Commercial cooking is assumed to occur uniformly throughout both the week (i.e., 7 days/week) and year.

Table 3.3–9. PM_{10} and $PM_{2.5}$ emission factors for commercial cooking equipment, by device type.

	Emission Factor (lb/ton)	
Equipment type	**PM_{10}**	**$PM_{2.5}$**
Chain-driven charbroilers	15.996058	15.506208
Underfired charbroilers	32.666124	31.577929
Deep fat fryers	0.00	0.00
Flat griddle fryers	5.922517	4.501113
Clamshell griddles	1.006137	0.852257

Table 3.3–10. Annual and daily emissions from commercial cooking equipment in Maricopa County.

	Annual Emissions (tons/yr)		Typical Daily Emissions (lbs/day)	
Equipment type	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Chain-driven charbroilers	103.88	100.70	570.8	553.3
Underfired charbroilers	690.51	667.51	3,794.0	3,667.6
Deep fat fryers	0.00	0.00	0.0	0.0
Flat griddles	182.18	138.46	1,001.0	760.7
Clamshell griddles	12.42	10.52	68.3	57.8
Totals:	**988.99**	**917.18**	**5,434.0**	**5,039.5**

Annual and typical daily emissions for the PM_{10} nonattainment area were calculated by multiplying the county totals by the ratio of total population in the nonattainment area to the total population in the county (100.41%) (See Section 1.5.1 for a discussion of the population data used.) Table 3.3–11 summarizes the annual and typical daily emissions from commercial cooking for the PM_{10} NAA.

Table 3.3–11. Annual and daily PM emissions from commercial cooking equipment in the PM_{10} NAA.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Equipment type	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Chain-driven charbroilers	104.31	101.11	573.1	555.6
Underfired charbroilers	693.34	670.24	3,809.6	3,682.6
Deep fat fryers	0.00	0.00	-	-
Flat griddles	182.93	139.02	1,005.1	763.9
Clamshell griddles	12.47	10.57	68.5	58.1
Totals:	**993.04**	**920.94**	**5,456.3**	**5,060.1**

3.3.2.2 Grain handling/processing

Annual emissions from area-source grain handling and processing operations were derived from annual emission reports submitted by permitted sources. It was assumed that there were no significant unpermitted sources within Maricopa County.

Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on either a 5- or 6-day week. Annual and typical daily emissions for the PM_{10} nonattainment area were derived based on the location data of the individual facilities. Annual and typical daily emissions for both the County and the PM_{10} NAA are shown in Table 3.3–12.

Table 3.3–12. Annual and typical daily emissions from area-source grain handling and processing.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	20.59	6.71	149.3	49.5
PM_{10} NAA	16.73	5.68	125.3	43.0

3.3.2.3 Ammonia cold storage

Area-source emissions from ammonia cold storage are estimates of ammonia emissions from food and kindred products industrial sources that use ammonia for refrigeration of food products. Emission calculations are based on the number of employees in the food and kindred products industry classification (NAICS codes 311, 312) as reported by the 2007 County Business Patterns (US Census Bureau, 2010a). Annual emissions were calculated by multiplying employment numbers by the emission factor for ammonia cold storage as listed in Table 6-5 of "Development and Selection of Ammonia Emission Factors" (Battye et al., 1994) as follows:

Annual NH_3 emissions from ammonia cold storage (tons/yr)	= Number of employees in relevant industries (from CBP)	× NH_3 emission factor (lb/employee-yr)	÷ 2,000 lbs/ton
	= 8,128	× 413	÷ 2,000
	= 1,678.43 tons NH_3/yr		

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

Typical daily NH_3 emissions (lbs/day)	= Annual emissions (tons/yr)	× 2,000 lbs/ton	÷ (weeks/year × days/week)
	= 1,678.43	× 2,000	÷ (52 × 6)
	= 10,759.2 lbs NH_3/day		

Annual and typical daily emissions for the PM_{10} nonattainment area (shown in Table 3.3–13 below) were calculated by multiplying Maricopa County emissions by the ratio of County industrial employment that occurs in the PM_{10} nonattainment area. (See Section 1.5.1 for a more detailed discussion of the employment data used).

Annual NH_3 emissions from ammonia cold storage in the PM_{10} NAA (tons/yr)	= Annual county emissions (tons/yr)	× NAA:County industrial employment ratio
	= 1,678.43	× 0.9974
	= 1,674.07 tons NH_3/yr	

Table 3.3–13. Annual and typical daily ammonia emissions from ammonia cold storage.

Geographic area	Annual emissions (tons/yr)	Typical daily emissions (lbs/day)
Maricopa County	1,678.43	10,759.2
PM_{10} NAA	1,674.07	10,731.2

3.3.3 Secondary metal production

Annual emissions from secondary metal production facilities were derived from annual emission reports from permitted sources. As this category consists primarily of foundries, it was assumed that there were no significant unpermitted sources within Maricopa County. Since all facilities considered in this section are located within the PM_{10} nonattainment area, total emission values for the county and the PM_{10} NAA from area-source secondary metal production are equal. Annual and daily emissions are shown in Table 3.3–14.

Table 3.3–14. Annual and typical daily emissions from secondary metal production.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	60.56	52.16	49.73	18.65	0.04	442.7	386.2	358.8	142.7	0.0
PM_{10} NAA	60.56	52.16	49.73	18.65	0.04	442.7	386.2	358.8	142.7	0.0

3.3.4 Non-metallic mineral processes

The primary contributors to this source category include concrete batch plants, ceramic clay and tile manufacturing, brick manufacturing, and gypsum mining. Emissions from this source were derived from annual emission reports from permitted facilities. Since all permitted facilities in this category were surveyed in 2008, it was assumed that there were no significant unpermitted sources within Maricopa County. Some portable concrete batch operations which operate within Maricopa County for only part of the year are issued air quality permits by the Arizona Department of Environmental Quality (ADEQ). All state-permitted portable sources are addressed in Section 3.3.11.

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

Table 3.3–15 summarizes annual and typical daily emissions from non-metallic mineral processing activities in both Maricopa County and the PM_{10} nonattainment area.

Table 3.3–15. Annual and typical daily emissions from area-source non-metallic mineral products.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	192.82	95.47	1,337.7	659.3
PM_{10} NAA	187.73	91.92	1,302.8	635.6

3.3.5 Mining and quarrying

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

Typical daily emissions were calculated based on reported activity data (days per week) for each individual process, and then summed. Nearly all processes reported operating on either a 5- or 6-day week. Emissions within the PM_{10} nonattainment area were identified using information on the location of each permitted facility. County-permitted portable sources with no location data were assumed to operate within the PM_{10} nonattainment area as a conservative estimate. Annual and daily emissions are shown in Table 3.3–16.

Table 3.3–16. Annual and typical daily emissions from area-source mining and quarrying operations.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	181.01	55.20	1,239.2	362.6
PM_{10} NAA	156.60	46.81	1,075.7	307.2

3.3.6 Wood product manufacturing

Emissions from wood product manufacturing were calculated by the "scaling up" method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2010a) to estimate an annual per-employee emission factor that is then used to estimate emissions from all sources in an industry category.

The most recent employment estimates (for the year 2007) from the US Census Bureau's County Business Patterns (CBP) were used. Table 3.3–17 shows the NAICS codes and employment estimates used to calculate emissions from wood product manufacturing.

Table 3.3–17. County-level employment estimates for wood product manufacturing, by NAICS code.

NAICS Code	NAICS Code Description	2007 employment estimate
321---	Wood products manufacturing	6,917
337---	Furniture and related products manufacturing	7,153
Total:		**14,070**

Since some larger facilities in this category are considered point sources, they have been included in the point source calculations presented earlier in Chapter 2. To avoid double-counting, employment at point sources was subtracted from total employment as follows:

Total area-source employment in wood products	= Total County employment for the sector	– Employment reported from facilities reported as point sources
	= 14,070	– 930
	= 13,140 employees	

Annual emissions for the entire wood product manufacturing sector were calculated by "scaling up" detailed area-source emissions reported from those facilities surveyed in 2008 as follows:

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

$$\text{Area-source } PM_{10} \text{ emissions from wood products} = \frac{102.99 \text{ tons } PM_{10}/\text{yr}}{6{,}229 \text{ employees}} \times 13{,}140 \text{ employees}$$

$$= 217.26 \text{ tons } PM_{10}/\text{yr}$$

Typical daily emissions were calculated in the same method, using surveyed daily emissions estimates from the subset of surveyed area sources. From these County totals, emissions estimates for the PM_{10} nonattainment area were calculated by multiplying the County totals by the percentage of industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

PM_{10} emissions from area-source wood product manufacturing in the PM_{10} NAA (tons/yr)	= Total County emissions	×	NAA:county ratio for industrial employment
	= 217.26 tons/yr	×	0.9974
	= 216.69 tons PM_{10}/yr		

Table 3.3–18 summarizes annual and typical daily emissions from wood products manufacturing in both Maricopa County and the PM_{10} nonattainment area.

Table 3.3–18. Annual and typical daily emissions from area-source wood product manufacturing.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	217.26	203.25	1,668.6	1,548.3
PM_{10} NAA	216.69	202.72	1,664.3	1,544.3

3.3.7 Rubber/plastics manufacturing

Emissions from area-source rubber and plastic manufacturing facilities were calculated by the "scaling up" method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from the US Census Bureau (2010a) 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 2007 employment were used. Where CBP employment estimates were presented as a range, the midpoint values were chosen for these calculations. Table 3.3–19 lists 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:

Total area-source employment in rubber & plastic product manufacturing	= Total employment (from US Census' County Business Patterns)	–	Employment at point sources (from annual emission reports)
	= 11,380	–	896
	= 10,484 employees		

This area-source employment estimate is used to "scale up" emissions reported from those facilities surveyed in 2008 as follows:

Total area-source PM_{10} emissions from rubber/plastic product mfg.	= $\frac{\text{Emissions from surveyed area sources}}{\text{Employment at surveyed area sources}}$	×	Area-source employment
	= $\frac{30.37 \text{ tons } PM_{10}/\text{yr}}{2{,}256 \text{ employees}}$	×	10,484 employees
	= 140.94 tons PM_{10}/yr		

Table 3.3–19. County-level employment estimates for rubber and plastic manufacturing, by NAICS code.

NAICS Code	NAICS Code Description	2007 employment estimate
32614	Polystyrene Foam Product Manufacturing	351
32619	Other Plastics Product Manufacturing	4,178
32622	Rubber & Plastics Hoses & Belting Manufacturing	60
33992	Sporting & Athletic Goods Manufacturing	1,750
42461	Plastics Materials & Basic Forms & Shapes Merchant Wholesalers	368
325211	Plastics Material & Resin Manufacturing	10
325520	Adhesive Manufacturing	123
325991	Custom Compounding of Purchased Resins	194
326113	Unlaminated Plastics Film & Sheet (except Packaging) Mfg.	60
326122	Plastics Pipe & Pipe Fitting Manufacturing	144
326140	Polystyrene Foam Product Manufacturing	351
326160	Plastics Bottle Manufacturing	175
326199	All Other Plastics Product Manufacturing	175
326212	Tire Retreading	42
326299	All Other Rubber Product Manufacturing	71
327991	Cut Stone & Stone Product Manufacturing	583
332913	Plumbing Fixture Fitting & Trim Manufacturing	10
336612	Boat Building	53
337920	Blind & Shade Manufacturing	286
339113	Surgical Appliance & Supplies Manufacturing	88
339115	Ophthalmic Goods Manufacturing	60
441320	Tire Dealers	2,248

Typical daily emissions were calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM_{10} nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

PM_{10} emissions from area-source plastic/rubber in the PM_{10} NAA (tons/yr)	= Annual Maricopa County emissions	×	NAA:county ratio of industrial employment
	= 140.94 tons PM_{10}/yr	×	0.9974
	= 140.57 tons PM_{10}/yr		

Table 3.3–20 summarizes annual and typical daily emissions from rubber/plastic products manufacturing in both Maricopa County and the PM_{10} nonattainment area.

Table 3.3–20. Annual and typical daily emissions from area-source rubber/plastic product manufacturing.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	140.94	105.96	953.3	698.8
PM_{10} NAA	140.57	105.68	950.9	697.0

3.3.8 Fabricated metal products manufacturing

Emissions from fabricated metal products manufacturing were calculated by the "scaling up" method as described in EPA emission inventory guidance (US EPA, 2001a). This method combines detailed emissions data from a subset of sources, and county-level employment data from

the US Census Bureau (2010a) 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 2007 employment were used. CBP employment data for NAICS code 332* (fabricated metal products manufacturing) indicated that there were 16,138 employees in this industry in Maricopa County. Some facilities in this category are considered point sources, and have been addressed in Chapter 2. To avoid double-counting, employment at point sources is subtracted from total employment as follows:

Total area-source employment in fab. metal products	= Total employment (from US Census' County Business Patterns)	–	Employment at point sources (from annual emission reports)
	= 16,138	–	4,000
	= 12,138 employees		

Annual emissions were calculated by "scaling up" area-source emissions reported from those facilities surveyed in 2007 as follows:

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

$$\text{Area-source } PM_{10} \text{ emissions from fab. metal products} = \frac{18.07 \text{ tons of } PM_{10}/\text{yr}}{4{,}261 \text{ employees}} \times 12{,}138 \text{ employees}$$

$$= 51.48 \text{ tons } PM_{10}/\text{yr}$$

Typical daily emissions were calculated in the same method as annual emissions, only using surveyed daily emissions instead of annual totals. Annual and typical daily emissions for the PM_{10} nonattainment area were calculated by multiplying the Maricopa County emission totals by the percentage of industrial employment within the nonattainment area. (See Section 1.5.1 for a discussion of the employment data used.)

PM_{10} emissions from area-source fabricated metal production in the PM_{10} NAA (tons/yr)	= Annual Maricopa County emissions (tons/yr)	×	NAA:County ratio of industrial employment
	= 51.48 tons/yr	×	0.9974
	= 51.35 tons PM_{10}/yr		

Table 3.3–21 summarizes annual and typical daily emissions from fabricated metal products manufacturing in both Maricopa County and the PM_{10} nonattainment area.

Table 3.3–21. Annual and typical daily emissions from area-source fabricated metal product manufacturing.

	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**NH_x**	**PM_{10}**	**$PM_{2.5}$**	**NH_x**
Maricopa County	51.48	42.62	4.50	538.1	460.6	28.9
PM_{10} NAA	51.35	42.51	4.49	536.7	459.4	28.8

3.3.9 Construction

Maricopa County's air quality permits database was used to identify all dust control permits issued during 2008. A total of 4,622 permits were issued, comprising a total of 42,130 acres (Table 3.3–22). Data requested on each dust control permit application includes the project type and acreage. It was assumed there is no unpermitted earthmoving activity.

Table 3.3–22. Maricopa County dust control permits issued in 2008, by type.

Total Acreage, by Project Type	Reported Acres
Residential (single- and multi-family)	20,437.0
Commercial	10,850.0
Road construction	4,449.0
Trenching	3,396.1
Demolition	1,970.6
Weed control	687.0
Site prep / land development	218.9
Temp. storage yard	122.4
Totals:	**42,130.9**

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

- The WRAP Fugitive Dust Handbook recommended using 0.42 ton PM_{10}/acre-month for road construction to account for the large amount of dirt moved during the construction of roadways. However, both the South Coast Air Quality Management District (SCAQMD) and the Clark County Department of Air Quality and Environmental Management have estimated that a certain percentage of their road construction projects do not involve large-scale earthmoving activities, and thus have developed average emission factors for road construction projects (0.1895 ton PM_{10}/acre-month and 0.265 ton PM_{10}/acre-month, respectively). Since Maricopa County and Clark County have similar population growth rates, climatic conditions, and PM_{10} sources, MCAQD used the Clark County road construction emission factor of 0.265 tons/acre-month to estimate emissions from road construction projects (Clark County, 2001).

- Specific emission factors were not available in the WRAP Fugitive Dust Handbook for trenching, demolition, weed control, and temporary storage yard activities; thus, the general construction emission factor of 0.11 tons PM_{10}/acre-month was used to estimate emissions from these activities.

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

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

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

The average duration of construction activity and emission factors for each project type are shown below in Table 3.3–23.

Table 3.3–23. Average project duration and emission factor, by project type.

Project Type	Average Duration (months)	Emission factor (tons PM_{10}/acre-month)
Residential: single-family	6	0.032
Residential: multi-family	12	0.11
Commercial	11	0.19
Road construction	12	0.265
Trenching	1	0.11
Demolition	1	0.11
Weed control	1	0.11
Site prep / land development	8	0.11
Temp. storage yard	12	0.11

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

Annual uncontrolled PM_{10} emissions	= total acres/yr	× no. months	× emission factor
Example:			
Annual uncontrolled PM_{10} emissions from single-family residential construction	= 15,327.8 acres/yr	× 6 months	× 0.032 tons PM_{10}/acre-month
	= 2,942.93 tons PM_{10}/yr		

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

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

A recent rule effectiveness study by Maricopa County (contained in Appendix 3) indicated an 89.94% compliance rate with Maricopa County Rule 310 on dust control at construction sites.

Thus, an overall control effectiveness of 80.9% (= 90% × 89.94%) was applied. Controlled PM_{10} emissions were calculated as follows:

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

Example:
Annual controlled PM_{10} emissions from single-family residential construction = 2,942.93 tons/yr × [1 – (90% control × 89.94% rule effectiveness)]
= 560.75 tons PM_{10}/yr

$PM_{2.5}$ emissions were estimated to comprise 10% of PM_{10} emissions (WRAP, 2006a). Table 3.3–24 summarizes the calculations for each dust control permit category.

Table 3.3–24. Annual emissions from construction in Maricopa County, by project type.

Project Type	Total acre-months	Emission factor (tons/acre-month)	Uncontrolled PM_{10}	Controlled PM_{10}	Controlled $PM_{2.5}$
Residential: single-family	91,966.5	0.032	2,942.93	560.75	56.07
Residential: multi-unit	61,311.0	0.11	6,744.21	1,285.04	128.50
Commercial	119,349.7	0.19	22,676.44	4,320.77	432.08
Road construction	53,388.0	0.265	14,147.82	2,695.73	269.57
Trenching	3,396.1	0.11	373.57	71.18	7.12
Demolition	1,970.6	0.11	216.76	41.30	4.13
Weed control	687.0	0.11	75.56	14.40	1.44
Site prep/land development	1,750.9	0.11	192.60	36.70	3.67
Temporary storage yard	1,468.7	0.11	161.55	30.78	3.08
Totals:			**47,531.45**	**9,056.64**	**905.66**

Dust control permit site location data were used to determine construction activity that occurred in the Maricopa County PM_{10} nonattainment area. The same average duration of construction activity and emission factors used to estimate Maricopa County emissions (see Table 3.3–18) were applied to construction activity in the Maricopa County PM_{10} nonattainment area. Table 3.3–25 summarizes Maricopa County PM_{10} nonattainment area construction activity and calculations for each project type.

Table 3.3–25. Annual emissions from construction within the Maricopa County portion of the PM_{10} nonattainment area, by project type.

Project Type	Total Acres	Total acre-months	EF (tons/ acre-month)	Uncontrolled PM_{10}	Controlled PM_{10}	Controlled $PM_{2.5}$
Residential: single-family	13,989.0	83,934.0	0.032	2,685.89	511.77	51.18
Residential: multi-unit	4,663.0	55,956.0	0.11	6,155.16	1,172.80	117.28
Commercial	10,125.2	111,376.9	0.19	21,161.61	4,032.13	403.21
Road construction	3,383.9	40,606.8	0.265	10,760.80	2,050.36	205.04
Trenching	1,938.2	1,938.2	0.11	213.20	40.62	4.06
Demolition	1,949.0	1,949.0	0.11	214.39	40.85	4.08
Weed control	638.5	638.5	0.11	70.23	13.38	1.34
Site prep/land development	218.9	1,750.9	0.11	192.60	36.70	3.67
Temporary storage yard	122.4	1,468.7	0.11	161.55	30.78	3.08
Totals:	**37,027.9**			**41,615.42**	**7,929.40**	**792.94**

In addition, the Pinal County Air Quality Department (PCAQD) provided construction emission estimates for the Pinal County portion of the PM_{10} nonattainment. PCAQD estimated that approximately 0.8 percent of the Pinal County construction activity occurred in the Pinal County portion of the PM_{10} nonattainment area, thus, annual and typical daily emission for the Pinal

County portion of the PM_{10} nonattainment area was calculated by multiplying the Pinal County emission totals by 0.8 percent. The PCAQD estimates (presented in Table 3.3–26 below) incorporated the same assumptions concerning relevant input variables such as the average duration of construction activity, emission factors, control efficiency, and rule effectiveness as Maricopa County's estimates.

Table 3.3–26. Annual emissions from construction in the Pinal County portion of the PM_{10} NAA, by project type.

Project Type	PM_{10}	$PM_{2.5}$
Residential: single-family	7.65	0.77
Residential: multi-family	0.16	0.02
Commercial	25.16	2.52
Road construction	1.42	0.14
Trenching	0.08	0.00
Totals:	**34.47**	**3.45**

To calculate average daily emissions from construction activity, It was assumed that construction activity typically occurs 6 days per week and remains relatively even throughout the year. Thus, typical daily emissions were calculated by dividing annual emissions for each category were divided by 312 (= 6 days/wk × 52 wks/yr) to derive the daily emissions estimates shown in Table 3.3–27.

Table 3.3–27. Annual and typical daily emissions from construction in Maricopa County and the PM_{10} NAA.

	Maricopa County				PM_{10} NAA			
	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)		Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Construction Type	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Residential	1,845.79	184.58	11,832.0	1,183.2	1,692.38	169.24	10,920.3	1,092.0
Commercial	4,320.77	432.08	27,697.2	2,769.7	4,057.29	405.73	25,897.4	2,589.7
Road construction	2,695.73	269.57	17,280.3	1,728.0	2,051.78	205.18	13,156.8	1,315.7
All other*	194.36	19.44	1,245.9	124.6	162.41	16.24	1,043.9	104.4
Total:	**9,056.64**	**905.66**	**58,055.4**	**5,805.5**	**7,963.87**	**796.39**	**51,018.4**	**5,101.8**

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

3.3.10 Electrical equipment manufacturing

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

As all facilities addressed in this source category are located within the PM_{10} nonattainment area, emission totals for both areas are equal. Annual and typical daily emissions are shown in Table 3.3–28.

Table 3.3–28. Annual and typical daily emissions from area-source electric equipment manufacturing.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Maricopa County	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7
PM_{10} NAA	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7

3.3.11 State-permitted portable sources

The Arizona Department of Environmental Quality (ADEQ) retains the authority to permit certain categories of sources within Maricopa County, including portable sources. MCAQD requested information from ADEQ for all ADEQ-permitted sources that reported any activity in Maricopa County during 2008. Annual total emissions for most pollutants were provided, along with information on the facility type, and information on the location of the site(s) during the year. Permits were classified into four major types: asphalt batch, concrete batch, crushing/ screening, and other (including soil remediation, generators, etc.). From this information, emissions that occurred within Maricopa County were estimated as in the following example.

Data provided:

Source information:	McNeil Brothers - Erie Strayer Portable Plant
Permit type:	Concrete batch plant
Operating schedule:	Operated from 1/1-5/15 in Mesa at SR202 and McKellips (SE Corner); operated from 10/16-12/31 in Goodyear at Northside I-10 east of Estrella.

Total annual emissions: (tons/yr)	PM_{10}	$PM_{2.5}$ *	NO_x	SO_x
	0.923	0.461	8.429	2.306

* PM2.5 was assumed to be 50% of reported PM10 for crushing/screening operations.

Using this information, calculations were made to determine:

Total operating days in 2008: 136 = 31 (Jan.) + 29 (Feb.) + …16 (Oct.) + 30 (Nov.) + 31 (Dec.)
Total operating days in Maricopa County: 136 = 31 (Jan.) + 29 (Feb.) + …16 (Oct.) + 30 (Nov.) + 31 (Dec.)

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

$$\text{Annual } PM_{10} \text{ emissions in Maricopa County} = \text{Total annual emissions (tons/yr)} \times \frac{\text{operating days in Maricopa County}}{\text{total operating days in 2008}}$$

$$= 0.923 \times \frac{136}{136}$$

$$= 0.923 \text{ tons } PM_{10}/\text{yr}$$

Typical daily emissions were then calculated as follows:

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

$$= \frac{0.923 \text{ tons}}{136 \text{ days}} \times \frac{2{,}000 \text{ lbs}}{\text{ton}}$$

$$= 13.6 \text{ lbs } PM_{10}/\text{day}$$

Table 3.3–29 summarizes the annual and typical daily emissions for all ADEQ-permitted portable sources that operated within Maricopa County at some point during 2008. Since precise location data was not available for all permits, all emissions are conservatively assumed to have originated within the PM_{10} nonattainment area; thus emission estimates for Maricopa County and the PM_{10} nonattainment area are equal.

Table 3.3–29. Annual and typical daily emissions from ADEQ-permitted portable sources.

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	PM_{10}	$PM_{2.5}$	NO_x	SO_x
Total:	59.00	29.50	282.18	88.93	492.9	246.5	2,275.7	721.7

3.3.12 Paved/unpaved road travel on industrial sites

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

$PM_{2.5}$ emissions were calculated from PM_{10} using a ratio derived from California Air Resources Board's (CARB) $PM_{2.5}$ Fraction Table (CARB, 2006).

Typical daily emissions were calculated using operating schedule information for each reported process (normally a 5 or 6-day week), which were then summed to provide total daily emissions for the county. Emissions totals for the PM_{10} nonattainment area were determined from the site locations of each facility. Results for each geographic area are shown in Table 3.3–30.

Table 3.3–30. Annual and typical daily emissions from paved and unpaved road travel at industrial facilities.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Maricopa County	566.30	271.29	3,880.4	1,847.2
PM_{10} NAA	472.36	217.08	3,273.9	1,500.1

3.3.13 Industrial processes not elsewhere classified (NEC)

Annual area-source emissions from other industrial processes NEC were derived from annual emissions reports from permitted facilities. Other industrial processes include a wide array of industrial activities that are often specific to the permitted facility that reported the process. For this reason, it is assumed there are no significant emissions from other industrial processes, other than those reported by permitted facilities on their annual emissions reports. Typical daily emissions were calculated based on operating schedule information provided by individual facilities through MCAQD's annual emissions reporting program. Emissions estimates for the PM_{10} nonattainment area were derived using data on the location of the facilities that report other industrial processes. Emissions totals are presented in Table 3.3–31.

Table 3.3–31. Annual and typical daily emissions from other industrial processes not elsewhere classified.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Geographic area	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Maricopa County	144.60	107.24	10.22	21.49	16.79	953.3	726.4	69.6	137.7	94.6
PM_{10} NAA	136.00	99.12	8.12	21.47	14.10	906.0	681.7	55.4	137.6	79.8

3.3.14 Summary of all area-source industrial processes

Tables 3.3–32 and 3.3–33 provide a summary of annual and typical daily emissions from all industrial sources, for Maricopa County and the PM_{10} nonattainment area, respectively.

Table 3.3–32. Annual and daily emissions from all area-source industrial processes in Maricopa County.

	Annual emissions (tons/yr)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Chemical manufacturing	187.43	151.42	0.00	0.34	0.03
Commercial cooking	988.99	917.18			
Grain handling/processing	20.59	6.71			
Ammonia cold storage					1,678.43
Secondary metal production	60.56	52.16	49.73	18.65	.004
Non-metallic mineral processes	195.81	97.28			
Mining and quarrying	210.39	59.56			
Wood product manufacturing.	217.26	203.25			
Rubber/plastic product manufacturing	140.94	105.96			
Fabricated metal product manufacturing	51.48	42.62			
Residential construction	2,451.72	245.17			
Commercial construction	5,739.18	573.92			
Road construction	3,580.67	358.07			
Other construction	258.18	25,82			
Electrical equipment manufacturing	13.94	9.64	20.45	0.18	31.55
ADEQ-permitted portable sources	59.00	29.50	282.18	88.93	
Road travel at industrial sites	566.30	271.29			
Industrial processes NEC	144.60	107.24	10.22	21.49	16.79
All industrial processes:	**11,881.57**	**2,953.30**	**362.58**	**129.60**	**1,731.34**

	Typical daily emissions (lbs/day)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Chemical manufacturing	1,445.8	1,164.5	0.0	2.6	0.6
Commercial cooking	5,434.0	5,039.5			
Grain handling/processing	149.3	49.5			
Ammonia cold storage					10,759.2
Secondary metal production	442.7	386.2	358.8	142.7	0.0
Non-metallic mineral processes	1,357.4	671.7			
Mining and quarrying	1,442.1	390.8			
Wood product manufacturing.	1,668.6	1,548.3			
Rubber/plastic product manufacturing	953.3	698.8			
Fabricated metal product manufacturing	538.1	460.6			28.9
Residential construction	15,716.1	1,571.6			
Commercial construction	36,789.6	3,679.0			
Road construction	22,953.0	2,295.3			
Other construction	1,654.9	165.5			
Electrical equipment manufacturing	76.9	53.2	112.4	1.1	193.7
ADEQ-permitted portable sources	492.9	246.5	2,275.7	721.7	
Road travel at industrial sites	3,880.4	1,847.2			
Industrial processes NEC	953.3	726.4	69.6	137.7	94.6
All industrial processes:	**76,667.6**	**19,048.2**	**2,816.5**	**1,005.8**	**11,077.2**

Table 3.3–33. Annual and typical daily emissions from all area-source industrial processes in the PM_{10} NAA.

	Annual emissions (tons/yr)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Chemical manufacturing	186.94	151.03	0.00	0.34	0.03
Commercial cooking	993.04	920.94			
Grain handling/processing	16.73	5.68			
Ammonia cold storage					1,674.1
Secondary metal production	60.56	52.16	49.73	18.65	0.04
Non-metallic mineral processes	187.73	91.92			
Mining and quarrying	156.60	46.81			
Wood product manufacturing.	216.69	202.72			
Rubber/plastic product manufacturing	140.57	105.68			
Fabricated metal product manufacturing	51.35	42.51			4.49
Residential construction	1,692.38	169.24			
Commercial construction	4,057.29	405.73			
Road construction	2,051.78	205.18			
Other construction	162.41	16.24			
Electrical equipment manufacturing	13.94	9.64	20.45	0.18	31.55
ADEQ-permitted portable sources	59.00	29.50	282.18	88.93	
Road travel at industrial sites	472.36	217.08			
Industrial processes NEC	136.00	99.12	8.12	21.47	14.10
All industrial processes:	**10,655.39**	**2,771.19**	**360.48**	**129.58**	**1,724.27**

	Typical daily emissions (lbs/day)				
Source category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Chemical manufacturing	1,442.0	1,161.5	0.0	2.6	0.9
Commercial cooking	5,456.3	5,060.1			
Grain handling/processing	125.3	43.0			
Ammonia cold storage					10,731.2
Secondary metal production	442.7	386.2	358.8	142.7	0.0
Non-metallic mineral processes	1,302.8	635.6			
Mining and quarrying	1,075.7	307.2			
Wood product manufacturing.	1,664.3	1,544.3			
Rubber/plastic product manufacturing	950.9	697.0			
Fabricated metal product manufacturing	536.7	459.4			28.8
Residential construction	10,920.3	1,092.0			
Commercial construction	25,897.4	2,589.7			
Road construction	13,156.8	1,315.7			
Other construction	1,043.9	104.4			
Electrical equipment manufacturing	76.9	53.2	112.4	1.1	193.7
ADEQ-permitted portable sources	492.9	246.5	2,275.7	721.7	
Road travel at industrial sites	3,273.9	1,500.1			
Industrial processes NEC	906.0	681.7	55.4	137.6	79.8
All industrial processes:	**68,764.6**	**17,877.6**	**2,802.3**	**1,005.7**	**11,034.4**

3.4 Waste treatment and disposal

3.4.1 On-site incineration

This section includes emissions from on-site industrial incinerators, primarily burn-off ovens used to reclaim electric wire or other materials. Emissions from human and animal crematories are addressed in Section 3.5.4. There were no incinerators at residential (e.g., apartment complexes) or commercial/institutional facilities (e.g., hospitals, service establishments) in operation during 2008.

Emissions from on-site incineration were determined from annual emission inventory reports. It is assumed that all incinerator emissions are accounted for, since all permitted incinerators received surveys in 2008. All surveyed facilities are located within the PM_{10} nonattainment area, thus total emissions for the county and NAA are equal.

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

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	0.06	0.04	5.01	0.01	0.7	0.4	38.9	0.1
PM_{10} NAA	0.06	0.04	5.01	0.01	0.7	0.4	38.9	0.1

3.4.2 Open burning

Emissions from controlled open burning are regulated by Maricopa County Air Pollution Control Regulations Rule 314 (Open Outdoor Fires), which requires a burn permit for open burning in Maricopa County. Burn permits are issued primarily for purposes of agricultural ditch bank and fence row burning, tumbleweed burning, land clearance, air curtain destructor burning of trees, and fire fighting training. Maricopa County's burn permit data base was used to identify all burn permits issued during 2008. A total of 55 permits were issued during the year; however, not all permit applications contained the requested information that is needed to calculate emissions. Where data were missing, activity data for each permit category was grown from those permits that contained the necessary 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:

$$\text{Total ditch-bank/fencerows} = 541{,}336 \text{ linear ft (reported)} \times \frac{32 \text{ burn permits issued}}{22 \text{ permits with data}} = 787{,}398 \text{ linear ft}$$

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

Table 3.4–2. Summary of 2008 Maricopa County burn permit activity.

Category	**Unit of measure**	**Total reported activity**	**Number of permits with activity data**	**Total permits issued**	**Estimated total annual activity level**
Ditchbank/fencerow	Linear ft	541,336	22	32	787,398
Land clearance	Acres	564	5	12	1,354
Air curtain	Tons of Material Burned	70*	0	7	70
Tumbleweeds	Piles	14	2	4	28

* Assumed that air curtain destructors burn 10 tons/day of brush/trees/vegetation.

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

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

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

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

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

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

$$\text{Material burned from ditchbanks and fence rows} = \frac{787{,}398 \text{ ft length}}{43{,}560 \text{ ft}^2/\text{acre}} \times 7 \text{ ft width} \times 3.2 \text{ tons/acre} \times 2 \text{ times/yr}$$

$$= 809.81 \text{ tons/yr}$$

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

Annual emissions were then calculated by multiplying the amount of material burned by AP-42 emission factors (listed in Table 3.4–3) for each open burning category. To account for unpermitted illegal outdoor burning, all calculated emissions estimates were multiplied by a factor of 2.87, based on complaints received in 2008 reporting suspected open or illegal outside burning in the County (158 complaints were received in 2008; thus 158 complaints/55 open burn permits = 2.87).

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

$$= 809.81 \text{ tons} \times 15 \text{ lbs/ton} \times 1 \text{ ton} / 2{,}000 \text{ lbs}$$

$$= 6.07 \text{ tons/yr}$$

$$\text{Total annual } PM_{10} \text{ emissions including unpermitted burning} = \text{Calculated emissions from permit data} \times \text{unpermitted burning adjustment factor}$$

$$= 6.07 \text{ tons/yr} \times 2.87$$

$$= 17.43 \text{ tons } PM_{10}/\text{yr}$$

Table 3.4–4 summarizes the 2008 emissions in Maricopa County from each category of open burning activity.

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

		Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
Category	**Ton-equivalents**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**
Ditchbank/fencerow	809.8	17.45	17.45	4.65	179.0	179.0	47.7
Land clearance	4,331.5	93.32	93.32	24.89	717.9	717.9	191.4
Air curtain	70.0	0.60	0.60	0.40	4.6	4.6	3.1
Tumbleweeds	2.8	0.09	0.09	0.02	0.7	0.7	0.1
Totals:		**111.46**	**111.46**	**29.96**	**902.2**	**902.2**	**242.4**

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

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

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

$$\text{Typical daily } PM_{10} \text{ emissions from ditchbank/ fence row burning} = \frac{17.45 \text{ tons/yr} \times 2000 \text{ lbs/ton}}{5 \text{ days/wk} \times 39 \text{ wks/yr}}$$

$$= 179.0 \text{ lbs } PM_{10}\text{/day}$$

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

Annual and daily emissions for the nonattainment area were calculated by multiplying the percentage of agricultural and/or vacant land use within the PM_{10} nonattainment area by the County wide emissions estimates, results are shown in Table 3.4–5. (See Section 1.5.1 for a discussion of the land use data used.) Table 3.4–6 summarizes the annual emissions for the PM_{10} nonattainment area.

Table 3.4–5. Surrogate land use classes and NAA:County activity ratios for burn permit categories.

Category	**Surrogate land use categories**	**2008 NAA:county land use ratio**
Ditchbank/fencerow	Agriculture	44.14 %
Land clearance	Vacant	21.22 %
Air curtain	Agriculture and vacant	23.91 %
Tumbleweeds	Agriculture and vacant	23.91 %

Table 3.4–6. Annual and typical daily emissions from open burning in the PM_{10} NAA.

	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**
Ditchbank/fencerow	7.70	7.70	2.05	79.0	79.0	21.1
Land clearance	19.81	19.81	5.28	152.4	152.4	40.6
Air curtain	0.14	0.14	0.10	1.1	1.1	0.7
Tumbleweeds	0.02	0.02	0.00	0.2	0.2	0.0
Totals:	**27.67**	**27.67**	**7.44**	**232.6**	**232.6**	**62.5**

3.4.3 Landfills

Emissions from municipal solid waste (MSW) landfills come from uncontrolled landfill gas emissions as well as from cover operations and combustion from control measures, such as a flare. Total emissions were calculated from annual emissions inventory reports from all landfills located within the county; results are shown in Table 3.4–7 below. No landfills were considered point sources; thus all MSW landfills are reported here as an area-source activity.

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

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	86.21	75.92	24.11	7.57	486.1	425.4	132.9	41.7
PM_{10} NAA	60.25	50.78	19.47	6.22	342.4	286.6	107.4	34.3

3.4.4 Publicly owned treatment works (POTWs)

Emissions from publicly owned treatment works (POTWs) were calculated by multiplying per-capita emission factors (Battye et al., 1994) by population estimates and per-capita wastewater usage estimates of 100 gallons per day per person (Tchobanoglous, 1979), as shown in Table 3.4–8. Typical daily emissions were calculated by dividing annual emissions by 366 days, as activity is assumed to occur uniformly throughout the year.

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

Geographic area	2008 Population	NH_3 emission factor (lbs/10^6 gals treated)	Annual NH_3 emissions (tons/yr)	Typical daily NH_3 emissions (lbs/day)
Maricopa County	4,279,760	19.0	1,488.07	8,131.5
PM_{10} NAA	4,297,140	19.0	1,494.12	8,164.6

3.4.5 Other industrial waste disposal

Annual area-source emissions from other industrial waste disposal were derived from annual emissions reports from permitted facilities. Other industrial waste disposal processes include a wide array of industrial activities that are often specific to the permitted facility that reported the process. For this reason, it is assumed there are no significant emissions from this category, other than those reported by permitted facilities on their annual emissions reports. Typical daily emissions were calculated based on operating schedule information provided by the facilities in their annual emissions report. Emission estimates are shown in Table 3.4–9 below.

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

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

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	32.78	16.93	18.39	50.62	224.1	110.9	101.0	278.1
PM_{10} NAA	32.78	16.93	18.39	50.62	224.1	110.9	101.0	278.1

3.4.6 Summary of all area-source waste disposal

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

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	111.46	111.46	29.96			902.2	902.2	242.4		
Landfills	86.21	75.92	24.11	7.57		486.1	425.4	132.9	41.7	
POTWs					1,488.07					8,131.5
Other	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
Total:	**230.52**	**204.35**	**77.47**	**58.20**	**1,488.07**	**1,613.0**	**1,438.8**	**515.3**	**320.0**	**8,131.5**

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	27.67	27.67	7.44			232.62	232.62	62.46		
Landfills	60.25	50.78	19.47	6.22		342.4	286.6	107.4	34.3	
POTWs					1,494.12					8,164.6
Other	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
Total:	**120.77**	**95.42**	**50.30**	**56.85**	**1,494.12**	**799.8**	**630.5**	**309.9**	**312.6**	**8,164.6**

3.5 Miscellaneous area sources

3.5.1 Other combustion

3.5.1.1 Wildfires

Data on wildfires in 2008 within Maricopa County were obtained from the Arizona State Land Department (ASLD) Forestry Division (ASLD, 2009); the Arizona Department of Fire, Building, and Life Safety (DFBLS, 2009); and the Federal Fire Occurrence website (FFOW, 2009).

The ASLD Forestry Division provides for the prevention and suppression of wildfires on state and private lands located outside of incorporated municipalities. The wildfire data provided by ASLD includes wildfires that occur outside of local fire districts and municipalities on State, private, and U.S. Bureau of Land Management (BLM) land in 2008. The ASLD reported 25 wildfires in 2008 in Maricopa County, encompassing a total of nearly 750 acres. Wildfire data provided by ASLD were compared to that data reported in the Geospatial Multi-Agency Coordination Group (GeoMAC) Wildland Fire Support database[1] and 2008 Incident Status Summary reports (ICS-209) to identify wildfires that may have occurred outside of ASLD jurisdiction. GeoMAC and ICS-209 reports only include large wildfires, generally fires greater than 100 acres. Three Maricopa County wildfires were reported in GeoMAC and on ICS-209 reports in 2008 (USDA, 2008a; USGS, 2008). Two of these fires were included in the ASLD data, one

[1] The GeoMAC, is an internet-based mapping application designed for fire managers to access online maps of current fire locations and perimeters in the conterminous 48 States and Alaska. Historical fire data is also housed in the GeoMac database http://www.geomac.gov/.

fire, the Ethan fire, was not captured in the ASLD data because it occurred on tribal lands. The Ethan fire encompassed 6,660 acres.

The DFBLS coordinates reporting to the National Fire Incident Reporting System (NFIRS) for Arizona fire departments. NFIRS is a national reporting system used by fire departments to report fires and other incidents to which they respond and to maintain records of these incidents in a uniform manner. Twenty-one of thirty-six fire departments in Maricopa County reported over 10,000 fires to NFIRS in 2008. This included ten "forest, woods or wildland fires". The ten "forest, woods or wildland fires" were analyzed for inclusion in the wildfire emission estimates. First, the DFBLS fires were culled for duplicates by comparing the incident dates and locations with wildfires reported by ASLD. One DFBLS fire was excluded from combined data-set because it may have been a duplicate already captured in the ASLD data. Because only four of the ten DFBLS fires included acreage, an average number of acres burned per fire (= 1.05 acres) were determined from the fires with reported acreage. This average number of acres burned was then applied to the fires with no reported acreage.

The Federal Fire Occurrence Website is an official government website that provides users with the ability to query, research and download wildland fire occurrence data. The data available through this website contains over 548,000 fire records collected by Federal land management agencies for fires that occurred from 1980 through 2008 in the United States. The 2008 data for Maricopa County included eighty-one fires. The federal wildland fire occurrence data were culled for duplicates by comparing the incident names, dates and locations with wildfires reported by ASLD and DFBLS. Thirteen fires were excluded from the combined dataset as they appeared to be duplicates already captured in either the ASLD or DFBLS data and seven fires contained no acreage data. The final 2008 dataset listed 96 fires encompassing over 7,400 acres. Table 3.5–1 summarizes fire data obtained from each data source.

Table 3.5–1. Sources and input data used to estimate emissions from fires in Maricopa County.

Data Source	Number of Fires in 2008	Total Acreage
Arizona State Land Department (ASLD)	25	747.25
Arizona Department of Fire, Building, and Life Safety (DFBLS)	9	9.45
Federal Fire Occurrence website (FFOW)	61	16.79
ICS-209	1	6,660.00
Total:	**96**	**7,433.49**

Estimates for fuel loading rates were assigned using fuel model codes from the National Fire Danger Rating System (NFDRS) and a table of fuel loading values for NFDRS fuel model categories (WGA/WRAP, 2005). The department used the NFDRS Fuel Model map in ArcGIS to identify NFDRS fuel types for fires with latitude and longitude data.

Table 3.5–2. NFDRS fuel model categories and fuel loading factors for 2008 Maricopa County wildfires.

NFDRS Model Category	2008 Fires	Total Acreage	Fuel Loading Factor (tons/acre)
Agriculture*	33	744.05	4.5
California chaparral	1	0.01	19.5
Barren*	2	0.40	0.5
Pine-grass savanna	1	0.01	4.7
Intermediate brush	17	2.87	15.0
Sagebrush grass	42	6,686.15	4.5
Total	**96**	**7,433.49**	**—**

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

Estimates of the material burned were derived by multiplying the number of acres burned for each category by the applicable fuel loading factor. Table 3.5–3 shows the number of wildfires and acres burned within both Maricopa County and the PM_{10} nonattainment area during 2008, as well as estimates of total material burned.

Table 3.5–3. Summary of data on fire occurrence, total acres burned, and total material burned in 2008.

Geographic Area	No. of Fires	Total Acres Burned	Material Burned (tons)
Maricopa County	96	7,433	33,479
PM_{10} NAA	55	6,699	30,147

The prescribed-fire emission factors listed in Table 3.5–4 were obtained from the Western Regional Air Partnership's (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005).

Table 3.5–4. Summary of emission factors for prescribed fire.

	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
WRAP Emission Factors for Wildfires and Prescribed Broadcast Burning (lbs/ton)	28.1	24.1	6.2	1.7	1.3

Source: WGA/WRAP, 2005

Annual emissions from wildfires for each geographic area were calculated as follows:

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

$$= \frac{33{,}479 \text{ tons of material burned} \times 28.1 \text{ lbs } PM_{10}\text{/ton}}{2{,}000 \text{ lbs/ton}}$$

$$= 470.38 \text{ tons } PM_{10}\text{/yr}$$

The majority of fire data included fire locations in latitude and longitude. For those fires without longitude and latitude, the fire location address was used to determine latitude and longitude. This latitude and longitude data was used to determine the number of acres burned inside of the nonattainment areas. Fifty-five wildfires occurred within the PM_{10} nonattainment area, resulting in nearly 6,700 acres burned. The largest fire within the PM_{10} nonattainment area was the Ethan fire which occurred in July 2008 and resulted in more than 6,600 acres burned.

Annual emissions from wildfires within the nonattainment area were calculated in the same method as Maricopa County annual emissions.

Table 3.5–5. Annual emissions from wildfires in Maricopa County and the PM_{10} NAA.

	Annual emissions (tons/yr)				
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	470.39	403.43	103.79	28.46	21.76
PM_{10} NAA	423.56	363.27	93.46	25.62	19.60

Average daily emissions were estimated by dividing annual emissions by the number of burn days in 2008. There were 150 burn days in Maricopa County and 90 burn days in the PM_{10} nonattainment area in 2008; thus:

$$\text{Average daily } PM_{10} \text{ emissions from wildfires in Maricopa County} = \frac{470.39 \text{ tons } PM_{10}/\text{yr} \times 2{,}000 \text{ lbs/ton}}{150 \text{ days/yr}}$$

$$= 6{,}271.8 \text{ lbs } PM_{10}/\text{day}$$

Table 3.5–6. Average daily emissions from wildfires in Maricopa County and the PM_{10} NAA.

	Number of	Average daily emissions (lbs/day)				
Geographic Area	**Burn Days**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	150	6,271.8	5,379.0	1,383.8	379.4	290.2
PM_{10} NAA	90	9,412.5	8,072.7	2,076.8	569.4	435.5

3.5.1.2 Prescribed fires

Prescribed fires data were obtained from the U. S. Forest Service (USFS, 2009). The USFS reported that six prescribed fires occurred in Maricopa County in 2008. Twenty-nine acres of piled fuels were burned. Four of six prescribed fires occurred inside the PM_{10} nonattainment area. Because all 2008 prescribed fires were piled fuels, material burned was derived by multiplying the number of acres burned by tons of piles per acre for each fire. The data provided by the USFS, the resulting material burned for each fire, and whether the fire occurred within the nonattainment area are shown below in Table 3.5–7.

Table 3.5–7. Summary of data used to estimate emissions from prescribed fires.

Burn Date	**Burn Number**	**Burn Location**	**Acres Treated**	**Tons of Piles/ Acre**	**Material Burned (tons)**	**Within NAA?**
01/13/2008	TNF0106	T6N,R7E,S28	3	1	3	Yes
03/13/2008	TNF0106P	T6N,R7E,S28	3	3	9	Yes
04/04/2008	TNF0302	T3N,R7E,S34	2	5	10	Yes
04/09/2008	TNF0302	T3N,R8E,S28	5	5	25	No
09/25/2008	TNF0302	T3N,R8E,S31	10	5	50	No
11/06/2008	TNF0302	T2N,R7E,S18	6	5	30	Yes
			29	**24**	**127**	

Prescribed fire emission factors for "piled fuels" were obtained from the Western Regional Air Partnership's (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005). The emission factors are listed below in Table 3.5–8.

Table 3.5–8. Emission factors for prescribed fires.

	Emission factors (lbs/ton burned)				
Type of fire	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Prescribed fire (piled fuels)	8.0	8.0	6.2	1.7	0.5

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

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

$$= \frac{127 \text{ tons/acres} \times 8.0 \text{ lbs/ton}}{2{,}000 \text{ lbs/ton}}$$

$$= 0.508 \text{ tons } PM_{10}\text{/yr}$$

It was assumed that each prescribed fire lasted one day. Thus, daily emissions from prescribed fires were determined by dividing the annual emissions (converted to lbs/yr) by the number of burn days. Because six prescribed fires occurred in Maricopa County in 2008, it was assumed that there were 6 burn days in 2008.

$$\text{Typical daily } PM_{10} \text{ emissions} = \frac{\text{annual } PM_{10} \text{ emissions (lbs) from prescribed fires}}{\text{Number of burn days}}$$

$$= \frac{1{,}016 \text{ lbs } PM_{10}}{6 \text{ burn days}}$$

$$= 169.3 \text{ lbs } PM_{10}\text{/day}$$

Since the prescribed fire data provided by USFS (2009) included burn location, GIS was used to determine the fires that burned inside the nonattainment area. Fifty-two of the one-hundred twenty-seven acres burned were within the nonattainment area. Thus, annual emissions from prescribed fires for the nonattainment area were determined using the formula shown above with the material burned within the nonattainment area. Results are shown in Table 3.5–9 below.

Table 3.5–9. Annual and typical daily emission from prescribed fire in Maricopa County and the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emission (lbs/day)				
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Maricopa County	0.51	0.51	0.39	0.11	0.03	169.3	169.3	131.2	36.0	10.6
PM_{10} NAA	0.21	0.21	0.16	0.04	0.01	104.0	104.0	80.6	22.1	6.5

3.5.1.3 Structure fires

2008 structure fire data were from the Arizona Department of Fire, Building, and Life Safety (DFBLS; DFBLS, 2009). The DFBLS coordinates reporting to the National Fire Incident Reporting System (NFIRS) for Arizona fire departments. The NFIRS is a national reporting system used by fire departments to report fires and other incidents to which they respond and to maintain records of these incidents in a uniform manner. Twenty-one of thirty-six fire departments in Maricopa County reported over 10,000 fires to NFIRS in 2008. This included nearly 2,150 reported structure fires. Because the DFBLS data only included data reported by twenty-one of thirty-six fire departments in Maricopa County, the number of structure fires reported were scaled up to the entire inventory area based on population. The most recent population estimates for Maricopa County were used to scale up the number of structure fires (ADC, 2008). Seven open burn permits were issued in 2008 for fire training; these were included in the total number of estimated structure fires for 2008. It was estimated that 2,422 structure fires occurred in Maricopa County in 2008.

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 the estimated percentage of structural loss and content loss (US EPA, 2001c). The amount (tons) of material burned was estimated as follows:

Material burned in structure fires (tons/yr) = 2,422 fires/yr × 1.15 tons/fire

= 2,785 tons material burned/yr

Table 3.5–10. Material burned, emission and fuel loading factors for structure fires.

Estimated number of structure fires	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)				
			PM_{10}	$PM_{2.5}$*	NO_x	SO_x	NH_3
2,422	1.15	2,785	10.8	10.8	1.4	n/a	n/a

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

Annual emissions were then calculated by multiplying the amount of material burned by the emission factors listed in Table 3.5–10 (from US EPA, 2001c), as follows:

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

= 2,785 tons × 10.8 lbs/ton × (1 ton/2,000 lbs)

= 15.04 tons PM_{10}/yr

Annual emissions for the PM_{10} nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the PM_{10} non-attainment area (100.41%), as shown in the example below. See Section 1.5.2 for a discussion of the population data used.

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

= 15.04 tons/yr × 100.41%

= 15.10 tons PM_{10}/yr

Typical daily emissions for both Maricopa County and the PM_{10} nonattainment area were calculated by dividing annual emissions by 366, as activity is assumed to take place 7 days a week. Typical daily emissions for Maricopa County were derived using the following formula:

$$\text{Typical daily } PM_{10} \text{ emissions from structure fires} = \frac{\text{annual } PM_{10} \text{ emissions (lbs)}}{366 \text{ days/yr}}$$

$$= \frac{30{,}080 \text{ lbs}}{366}$$

$$= 82.2 \text{ lbs/day}$$

Table 3.5–11. Annual and typical daily emissions from structure fires in Maricopa County and the NAA.

Geographic area	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
	PM_{10}	$PM_{2.5}$	NO_x	PM_{10}	$PM_{2.5}$	NO_x
Maricopa County	15.04	15.04	1.95	82.2	82.2	10.7
PM_{10} NAA	15.10	15.10	1.96	82.5	82.5	10.7

3.5.1.4 Vehicle fires

2008 vehicle fire data were from the Arizona Department of Fire, Building, and Life Safety (DFBLS) (DFBLS, 2009). The DFBLS coordinates reporting to the National Fire Incident Reporting System (NFIRS) for Arizona fire department. NFIRS is a national reporting system used by fire departments to report fires and other incidents to which they respond and to maintain records of these incidents in a uniform manner. Twenty-one of thirty-six fire departments in Maricopa County reported over 10,000 fires to NFIRS in 2008. This included over 2,100 reported vehicle fires. Because the DFBLS data only included data reported by twenty-one of thirty-six fire departments in Maricopa County, the number of vehicle fires reported were scaled up to the entire inventory area based on population. The most recent population estimates for Maricopa County were used to scale up the number of vehicle fires (ADC, 2008). It was estimated that 2,403 vehicle fires occurred in Maricopa County in 2008.

Annual emissions from vehicle fires were calculated by first multiplying the number of vehicle fires by a fuel loading factor of per vehicle fire to estimate the annual amount of material burned in vehicle fires (US EPA, 2000). The amount of annual material burned in vehicle fires is then multiplied by emission factors for open burning of automobile components from AP-42 as listed in table 3.5–12 (US EPA, 1992).

Annual PM_{10} emissions from vehicle fires	= annual number of vehicle fires	× fuel loading factor	× emission factor	× unit conversion factor
	= 2,403	× 0.25 tons/vehicle	× 100 lbs/ton	× (1 ton / 2,000 lbs)
	= 30.04 tons PM_{10}/yr			

Table 3.5–12. Estimated material burned, fuel loading factors, and emission factors for vehicle fires.

Vehicle fires reported	Fuel loading factor (tons/fire)	Material burned (tons)	Emission factors (lbs/ton)				
			PM_{10}	$PM_{2.5}$*	NO_x	SO_x	NH_3
2,403	0.25	600.75	100	100	4	n/a	n/a

* All PM10 is assumed to be PM2.5.

Annual emissions for the PM_{10} nonattainment area were derived by multiplying Maricopa County annual emissions by the percentage of total residential population within the PM_{10} non-attainment area (100.41%). See Section 1.5.1 for a discussion of the population data used.

Annual PM_{10} emissions from vehicle fires in the PM_{10} NAA	= annual PM_{10} emissions for Maricopa County	× percentage of total residential population within the PM_{10} NAA
	= 30.04 tons/yr	× 100.41%
	= 30.16 tons/yr	

It is assumed that vehicle fires occur evenly throughout the year. Thus, typical daily emissions were derived by dividing the Maricopa County and nonattainment area annual emissions by 366 days/year. The results are shown in Table 3.5–13 below.

Table 3.5–13. Annual and typical daily emissions from vehicle fires.

	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
Geographic area	PM_{10}	$PM_{2.5}$	NO_x	PM_{10}	$PM_{2.5}$	NO_x
Maricopa County	30.04	30.04	1.20	164.1	164.1	6.6
PM_{10} NAA	30.16	30.16	1.21	164.8	164.8	6.6

3.5.1.5 Engine testing

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

Since all facilities considered in this section are located within the PM_{10} nonattainment area, total emission values for the county and the PM_{10} NAA are equal. Results are shown in Table 3.5–14.

Table 3.5–14. Annual and typical daily emissions from engine testing.

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	0.18	0.17	6.74	2.49	1.3	1.2	50.5	19.0
PM_{10} NAA	0.18	0.17	6.74	2.49	1.3	1.2	50.5	19.0

3.5.2 Agricultural activities

3.5.2.1 Tilling

Tillage emissions were estimated using the tillage emission factor equation and Maricopa County specific soil silt content for agricultural land (URS and ERG, 2001). The majority of planted acres were obtained from the 2008 Arizona Agricultural Statistics Bulletin (AASS, 2009). Planted acres for potatoes and sorghum for grain were obtained from the USDA National Agricultural Statistics Service for 2008 (USDA, 2008b) and vegetables and citrus acreage were obtained from the 2007 Census of Agriculture (USDA, 2007a). Crop-specific annual land preparation operations data were obtained from the Technical Support Document for Quantification of Agricultural Best Management Practices (URS and ERG, 2001). The agricultural tillage emission factor was calculated as follows:

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

where:

EF = Agricultural emission tillage factor (lbs PM_{10}/acre-pass)
k = Particle size multiplier (value of 0.15 for PM_{10})
s = Silt content of soil (%) = 35.2% (URS and ERG, 2001)

Thus: $EF = 0.15 \times 4.8 \times (35.2)^{0.6}$

$= 6.10$ lbs PM_{10}/acre-pass

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

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

where:

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

For example, annual PM_{10} emissions from cotton tilling were calculated using:

EF = 6.10 lbs PM_{10}/acre-pass
AP_{cotton} = 8.8 tillage passes for a cotton crop
AP_{cotton} = 19,300 acres cotton

Thus:

$$Tillage_{cotton} = 6.10 \times 8.8 \times 19{,}300$$
$$= 1{,}036{,}024 \text{ lbs/yr}$$
$$= 518.01 \text{ tons/yr}$$

Table 3.5–15 lists crop types and acreage; typical number of land preparation operations and acre-passes; and annual uncontrolled PM_{10} emissions from agricultural tillage for Maricopa County.

Table 3.5–15. 2008 crop acreage, activity, and annual uncontrolled PM_{10} emissions in Maricopa County.

Crop	Acres Planted	No. of land preparation operations/yr	Acre-passes	Annual uncontrolled PM_{10} emissions (tons/yr)
Cotton	19,300	8.8	169,978	518.43
Corn	11,500	7.3	84,180	256.75
Wheat	30,500	3.1	93,488	285.14
Barley	10,100	2.1	20,856	63.61
Alfalfa (stand establishment)[1]	21,875	5.1	110,469	336.93
Potatoes	1,400	10.6	14,805	45.16
Sorghum for grain	16,500	3.1	50,575	154.25
Vegetables[2]	16,072	14.0	224,888	685.91
Citrus[3]	425	5.0	2,124	6.48
Totals:	**127,672**			**2,352.66**

1. Alfalfa is a multi-year crop and alfalfa stand establishment is assumed to occur once every 4 years to approximately 25% of the total alfalfa acreage (URS and ERG, 2001).
2. Including melons, not including potatoes.
3. 15 to 20% of citrus orchard acreage is non-bearing in a given year (URS and ERG, 2001); therefore, tillage is assumed to occur in 20% of the reported harvested acreage.

In November 2007, the agricultural PM_{10} general permit (Arizona Administrative Code R18-2-610 and R18-2-611) was expanded to apply to commercial farming practices within the Maricopa County portion of Area A. Previously this rule only applied to the Maricopa County PM_{10} NAA. The agricultural PM_{10} general permit revisions also resulted in the requirement for commercial farmers to implement six agricultural best management practices (BMP) (up from 3 BMPs) to control PM_{10} emissions generated from tillage and harvest, non-cropland, and cropland. Because no data is available on the additional BMPs being implemented, MCAQD used the net control efficiencies from the implementation of agricultural BMPs developed by

URS and ERG (2001) in the *Technical Support Document for Quantification of Agricultural BMPs*. URS and ERG quantified three BMPs for tillage: 1) combining tractor operations, 2) limited activity during high-wind events, and 3) multi-year crops. URS and ERG (2001) derived net control efficiencies by multiplying mid-point BMP control efficiency by a compliance factor and a relevancy factor for applicable crops. MCAQD has used the same mid-point BMP control efficiency and relevancy factor with a revised compliance factor of 55% (from 80%). The revised compliance factor was derived based on latest EPA rule effectiveness guidance (US EPA, 2005) which eliminates use of the 80% default rule effectiveness value. (Rule effectiveness calculations for agricultural activities are included as Appendix 3). To estimate controlled tillage emissions from agricultural operations taking place within the Maricopa County portion of Area A, the mid-point net control efficiency for each BMP were applied to 63.09% (the percent of agricultural land in the Maricopa County portion of Area A) of the uncontrolled annual emissions (MAG, 2009) as follows:

Controlled annual $\text{tillage}_{\text{Crop}}$ emissions	=	Annual uncontrolled PM_{10} emissions	×	(100% – mid-point net control $\text{efficiency}_{\text{crop}}$)	×	% agricultural land in the Area A
Controlled annual $\text{tillage}_{\text{Cotton}}$ emissions	=	518.01 tons PM_{10}/yr	×	(100% – 22.8%)	×	63.09%
	=	252.30 tons PM_{10}/yr				

The uncontrolled portion of tillage emissions from agricultural operations taking place outside Area A but within Maricopa County were estimated by multiplying the uncontrolled annual PM_{10} emissions by the percentage of agricultural land located within Maricopa County but outside of Area A (100% – 63.09%) as follows:

Uncontrolled annual $\text{tillage}_{\text{Crop}}$ emissions	=	Uncontrolled annual PM_{10} emissions	×	36.91%
	=	518.01 tons PM_{10}/yr	×	36.91%
	=	191.20 tons PM_{10}/yr		

Controlled and uncontrolled emissions were then summed to estimate total annual PM_{10} emissions from agricultural tillage in Maricopa County. Annual $PM_{2.5}$ emissions from agricultural tillage were calculated by multiplying the annual PM_{10} emissions by a conversion factor of 0.15 (WRAP, 2006b). Annual PM_{10} and $PM_{2.5}$ emissions from agricultural tillage in Maricopa County and Area A are shown in Table 3.5–16.

Table 3.5–16. Annual emissions from agricultural tillage in Maricopa County and Area A (tons/yr).

Crop	Net control efficiency (%)	Area A (controlled)		Outside Area A (uncontrolled)	Maricopa Co. (Area A + outside Area A)	
		PM_{10}	$PM_{2.5}$	PM_{10}	PM_{10}	$PM_{2.5}$
Cotton	22.8%	252.36	37.85	191.35	443.72	66.56
Corn	22.8%	124.98	18.75	94.77	219.75	32.96
Wheat	22.8%	138.80	20.82	105.24	244.04	36.61
Barley	22.8%	30.96	4.64	23.48	54.44	8.17
Alfalfa (stand establishment)	13.8%	183.23	27.49	124.36	307.60	46.14
Potatoes	16.8%	21.98	3.30	16.67	38.65	5.80
Sorghum for grain	22.8%	75.09	11.26	56.94	132.02	19.80
Vegetables	16.8%	359.82	53.97	253.17	612.99	91.95
Citrus	16.8%	3.40	0.51	2.39	5.79	0.87
Totals:		**1,190.63**	**178.59**	**868.37**	**2,059.00**	**308.85**

*Includes melons, excludes potatoes.

Annual PM_{10} emissions from agricultural tillage in the PM_{10} NAA were calculated in the same manner as the annual PM_{10} emissions for the Maricopa County portion of Area A; the only difference being the percent of agricultural land located within the Maricopa County PM_{10} NAA is 44.14% (rather than 63.09% for Area A). Results are shown in Table 3.5–17.

Table 3.5–17. Annual emissions from agricultural tillage in the PM_{10} NAA (tons/yr).

Crop	Net Control Efficiency (%)	Fraction of Ag Land in PM_{10} NAA	PM_{10} NAA annual emissions	
			PM_{10}	$PM_{2.5}$
Cotton	22.8%	44.14%	176.56	26.48
Corn	22.8%	44.14%	87.44	13.12
Wheat	22.8%	44.14%	97.11	14.57
Barley	22.8%	44.14%	21.66	3.25
Alfalfa (stand establishment)	13.8%	44.14%	128.20	19.23
Potatoes	16.8%	44.14%	16.57	2.49
Sorghum for grain	22.8%	44.14%	52.53	7.88
Vegetables	16.8%	44.14%	251.75	37.76
Citrus	16.8%	44.14%	2.38	0.36
Totals:			**834.20**	**125.13**

Typical daily emissions for Maricopa County, Area A, and the PM_{10} NAA were calculated by dividing the annual emissions by estimated days per year of tillage operation by crop. The number of days of tillage operations was estimated using the calendar of tillage operations by crop in the Technical Support Document for Quantification of Agricultural BMPs (URS and ERG, 2001) and assuming tillage activities occur 7 days per week during the months of tillage operations. Results are shown in Table 3.5–18. The calendar of tillage operations did not include months of tillage operations for citrus, thus, a conservative estimate of three (3) months per year was assumed.

Table 3.5–18. Controlled typical daily emissions from tillage (in lbs/day).

Crop	Tillage operations[1] (months/yr)	Tillage operations (days/yr)	Maricopa County		Area A		PM_{10} NAA	
			PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Cotton	12	364	2,438.0	365.7	1,386.6	208.0	970.1	145.5
Corn	5	152	2,897.8	434.7	1,648.1	247.2	1,153.1	173.0
Wheat	8	243	2,011.3	301.7	1,143.9	171.6	800.3	120.1
Barley	8	243	448.7	67.3	255.2	38.3	178.6	26.8
Alfalfa (stand establishment)	3	91	6,760.3	1,014.1	4,027.1	604.1	2,817.5	422.6
Potatoes	6	182	424.7	63.7	241.6	36.2	182.1	27.3
Sorghum for grain	8	243	1,088.1	163.2	618.9	92.8	433.0	64.9
Vegetables	6	182	6,736.2	1,010.4	3,954.1	593.1	2,766.4	415.0
Citrus	3	91	127.2	19.1	37.3	5.6	26.1	3.9
Totals:			**22,932.4**	**3,439.9**	**13,312.8**	**1,996.9**	**9,327.3**	**1,399.1**

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

3.5.2.2 Harvesting

Harvest emissions were estimated using crop-specific emission factors (CARB, 2003). The majority of harvest acres were obtained from the 2008 Arizona Agricultural Statistics Bulletin (AASS, 2009). Harvest acres for potatoes were obtained from the USDA National Agricultural Statistics Service for 2008 (USDA, 2008b) and vegetables and citrus were obtained from the 2007 Census of Agriculture (USDA, 2007a). Table 3.5–19 lists the crop types, acres harvested and associated PM_{10} emission factors used to calculate emissions from agricultural harvesting.

Table 3.5–19. Maricopa County harvested acres and emission factors.

Crop	PM_{10} emission factor (lb/acre-yr)	2008 Acreage
Cotton	3.4	18,800
Wheat	5.8	30,100
Barley	5.8	9,900
Alfalfa Hay	0.0	83,000
Other Hay	1.68	4,500
Corn	1.68	700
Sorghum for Grain**	5.8	2,200
Potatoes	2.7	1,400
Vegetables*	0.08	16,072
Citrus	0.08	2,124
Total		**168,796**

*Includes melons, exclude potatoes.
** Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

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

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

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

Example:
EF_{Cotton} = 3.4 lbs PM_{10}/acre for cotton

A_{Cotton} = 18,800 acres of cotton

Uncontrolled annual Harvest$_{Cotton}$ Emissions = 3.4 lbs PM_{10}/acre ×18,800 acres × 1 ton/2,000 lbs
= 31.96 tons PM_{10}/yr

In November 2007, the agricultural PM_{10} general permit program (Arizona Administrative Code R18-2-610 and 611) was expanded to apply to commercial farming practices within the Maricopa County portion of Area A. (Previously this requirement had only applied to the Maricopa County PM_{10} NAA.) The agricultural PM_{10} general permit revisions also resulted in the requirement for commercial farmers to implement six agricultural best management practices (BMP) (up from 3 BMPs) to control PM_{10} emissions generated from tillage and harvest, non-cropland, and cropland. Because no data is available on the additional BMPs being implemented, MCAQD used the net control efficiencies from the implementation of agricultural BMPs developed by URS and ERG (2001) in the *Technical Support Document for Quantification of Agricultural BMPs*. URS and ERG quantified two BMPs for harvesting: 1) combining tractor operations, and 2) reduced harvest activity. URS and ERG (2001) derived net control efficiencies by multiplying mid-point BMP control efficiency by a compliance factor and a relevancy factor for applicable crops. MCAQD has used the same mid-point BMP control efficiency and relevancy factor with a revised compliance factor of 55% (from 80%). The revised compliance factor was derived based on latest EPA rule effectiveness guidance (US EPA, 2005) which eliminates use of the 80% default rule effectiveness value. (Rule effectiveness calculations for agricultural activities are included as Appendix 3). To estimate controlled harvest emissions from agricultural operations taking place within the Maricopa County portion of Area A, the mid-point net control efficiency for each BMP were applied to 63.09% of the uncontrolled annual emissions (the percent of agricultural land in the Maricopa County portion of Area A) (MAG, 2009) as follows:

Controlled annual harvest$_{Crop}$ emissions	=	annual uncontrolled PM_{10} emissions	× (100% – mid-point net control efficiency$_{crop}$)	×	% agricultural land in the Maricopa Co. portion of Area A
Controlled annual harvest$_{Cotton}$ emissions from within the Maricopa Co. portion of Area A	=	31.96 tons PM_{10}/yr	×(100% – 25.6%)	×	63.09%
	=	15.01 tons PM_{10}/yr			

The uncontrolled portion of harvest emissions from agricultural operations outside the Maricopa County portion of Area A but within Maricopa County were estimated by multiplying the uncontrolled annual PM_{10} emissions by the percent of agricultural land located within Maricopa County but outside of the Area A (100% – 63.09%) as follows:

Uncontrolled annual Harvest$_{Cotton}$ emission from outside the Maricopa Co. portion of Area A	=	Uncontrolled PM_{10} emissions	×	36.91%
	=	31.96 tons PM_{10}/yr	×	36.91%
	=	11.80 tons PM_{10}/yr		

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

Total annual $harvest_{Cotton}$ emissions for Maricopa County	=	Uncontrolled annual $harvest_{Cotton}$ emissions from outside Area A	+	Controlled annual $harvest_{Cotton}$ emissions from within the Maricopa Co. portion of Area A
	=	11.80	+	15.01
	=	26.81 tons PM_{10}/yr		

Annual $PM_{2.5}$ emissions from agricultural harvesting were calculated by multiplying the annual PM_{10} emissions by a conversion factor of 0.15 (WRAP, 2006c). Annual PM_{10} and $PM_{2.5}$ emissions from harvesting in Maricopa Co. and Area A are shown in Table 3.5–20.

Table 3.5–20. Annual emissions from harvesting in Maricopa County and Area A (in tons/yr).

Crop	Net control efficiency	Maricopa Co. Uncontrolled	Area A (controlled)		Outside Area A (uncontrolled)	Maricopa Co. (Area A + outside Area A)	
	(%)	PM_{10}	PM_{10}	$PM_{2.5}$	PM_{10}	PM_{10}	$PM_{2.5}$
Cotton	25.5%	31.96	15.02	2.25	11.80	26.81	4.02
Wheat	23.5%	87.29	42.15	6.32	32.22	74.37	11.16
Barley	23.5%	28.71	13.86	2.08	10.60	24.46	3.67
Alfalfa Hay	27.6%	0.00	0.00	0.00	0.00	0.00	0.00
Other Hay	27.6%	3.78	1.73	0.26	1.40	3.12	0.47
Corn	23.5%	0.59	0.28	0.04	0.22	0.50	0.08
Sorghum for Grain**	23.5%	6.38	3.08	0.46	2.35	5.44	0.82
Potatoes	23.5%	1.89	0.91	0.14	0.70	1.61	0.24
Vegetables*	23.5%	0.64	0.31	0.05	0.24	0.55	0.08
Citrus	23.5%	0.08	0.04	0.01	0.03	0.07	0.01
Total		161.33	77.39	11.61	59.54	136.93	20.54

*Includes melons, excludes potatoes.
** Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

Annual PM_{10} emissions from agricultural harvesting in the PM_{10} NAA were calculated in the same manner as the annual PM_{10} emissions for the Maricopa County portion of Area A. The only difference being the percent of agricultural land located within the Maricopa County PM_{10} NAA is 44.14% (rather than 63.09% for Area A). Results are shown in Table 3.5–21.

Table 3.5–21. Annual emissions from harvesting in the PM_{10} NAA (tons/yr).

Crop	Net control efficiency	Fraction of Ag land in	PM_{10} NAA (controlled)	
	(%)	PM_{10} NAA	PM_{10}	$PM_{2.5}$
Cotton	25.5%	44.1%	10.51	1.58
Wheat	23.5%	44.1%	29.49	4.42
Barley	23.5%	44.1%	9.70	1.45
Alfalfa Hay	27.6%	44.1%	0.00	0.00
Other Hay	27.6%	44.1%	1.21	0.18
Corn	23.5%	44.1%	0.20	0.03
Sorghum for Grain**	23.5%	44.1%	2.16	0.32
Potatoes	23.5%	44.1%	0.64	0.10
Vegetables*	23.5%	44.1%	0.22	0.03
Citrus	23.5%	44.1%	0.03	0.00
Total			54.14	8.12

*Includes melons, excludes potatoes.
** Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

Typical daily emissions for Maricopa County, Area A, and the PM_{10} NAA were calculated by dividing the annual emissions by the number of harvest days per year and multiplying the result by 2000 lbs/ton (URS and ERG, 2001). Because acres harvested were not reported for individual vegetables and citrus fruit, an average number of harvest days per year were used for vegetables and citrus (116 and 188 harvest days per year, respectively). Results are shown in Table 3.5–22.

Table 3.5–22. Typical daily emissions from harvesting, by crop (in lbs/day).

Crop	Harvest days/yr	Maricopa County		Area A		PM_{10} NAA	
		PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Cotton	143	375.0	56.2	210.0	31.5	146.9	22.0
Wheat	60	2,479.0	371.8	1,405.1	210.8	983.0	147.5
Barley	60	815.3	122.3	462.2	69.3	323.3	48.5
Alfalfa Hay	294	0.0	0.0	0.0	0.0	0.0	0.0
Other Hay	294	21.2	3.2	11.7	1.8	8.2	1.2
Corn	91	11.0	1.7	6.2	0.9	4.4	0.7
Sorghum for Grain**	60	181.2	27.2	102.7	15.4	71.8	10.8
Potatoes	70	46.0	6.9	26.1	3.9	18.2	2.7
Vegetables*	116	9.4	1.4	5.3	0.8	3.7	0.6
Citrus	188	0.8	0.1	0.4	0.1	0.3	0.0
Total		3,938.9	590.8	2,229.9	334.5	1,560.0	234.0

*Includes melons, excludes potatoes.
** Assumed same emission factor, control efficiency, and number of harvest days per year as wheat and barley.

3.5.2.3 Travel on unpaved agricultural roads

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

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

where:

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

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

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

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

Daily uncontrolled PM_{10} = unpaved road EF × VMT/1000 acres × 2008 harvested acres

emissions from ag roads = 1.444 lbs/VMT ×49.5 VMT/1000 acres × 168,796 acres
= 12,065 lbs/day

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

Two BMPs were quantified for unpaved road travel: 1) access restriction and 2) reduced vehicle speed. A 2001 study (URS and ERG, 2001) estimated net control efficiencies by multiplying a midpoint BMP control efficiency by a compliance factor and a relevancy factor for applicable crops. MCAQD has used the same mid-point BMP control efficiency and relevancy factor with a revised compliance factor of 55% (from 80%). The revised compliance factor was derived based on latest EPA rule effectiveness guidance (US EPA, 2005) which eliminates use of the 80% default rule effectiveness value. (Rule effectiveness calculations for agricultural activities are included as Appendix 3).

To estimate controlled daily emissions from travel on unpaved agricultural roads within Area A, the mid-point net control efficiency for each BMP (0.4% and 11.6 %, respectively) were applied to 63.09 % (the percent of agricultural land in Area A) of the uncontrolled daily PM_{10} emissions as follows:

Controlled daily unpaved ag road emissions within Area A	= Daily uncontrolled PM_{10} emissions	×	(100%-mid-point net control efficiency)	×	% agricultural land in Area A
	= 12,065 lbs/day	×	(100% – 12.0%)	×	63.09%
	= 6,698.4 lbs/day				

The uncontrolled portion of unpaved agricultural road daily emissions outside the Maricopa County portion of Area A but within Maricopa County were estimated by multiplying uncontrolled daily PM_{10} emissions by the percent of agricultural land located within Maricopa County but outside of Area A (100% – 63.09%) as follows:

Uncontrolled daily unpaved ag road emissions from outside of Area A	= Uncontrolled PM_{10} emissions × (100% - 63.09%)
	= 12,065 lbs/day × 36.91%
	= 4,453 lbs/day

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

Total daily unpaved ag road emissions for Maricopa County	= Uncontrolled daily unpaved ag road emissions from outside Area A	+	Controlled daily unpaved ag road emissions from within Area A
	= 4,453	+	6,698

= 11,151 lbs PM_{10}/day

Daily PM_{10} emissions from unpaved agricultural roads in the PM_{10} NAA were calculated in the same manner as the daily PM_{10} emissions for the Maricopa County portion of Area A. The only difference being the percent of agricultural land located within the Maricopa County PM_{10} NAA is 44.14% (rather than 63.09% for Area A). Results are shown in Table 3.5–21.

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

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

Annual and daily PM_{10} and $PM_{2.5}$ emissions from unpaved agricultural roads are shown in Table 3.5–23.

Table 3.5–23. Annual and typical daily emissions from travel on unpaved agricultural roads.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Maricopa County (Area A + outside Area A)	1,739.52	173.95	11,150.8	1,115.1
Area A (controlled)	1,044.92	104.49	6,698.2	669.8
PM_{10} NAA (controlled)	731.03	73.10	4,686.1	468.6

3.5.2.4 Cotton ginning

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

Table 3.5–24 summarizes annual and typical daily emissions from cotton gins in both Maricopa County and the PM_{10} nonattainment area.

Table 3.5–24. Annual and typical daily emissions from area-source cotton ginning.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	17.90	5.11	103.8	29.7
PM_{10} NAA	4.86	1.39	26.7	7.6

3.5.2.5 Fertilizer application

Annual NH_3 emissions from synthetic nitrogen fertilizers for 2008 were obtained from the US EPA 2008 National Emissions Inventory (US EPA, 2010).

In 2005, MCAQD used the CMU Ammonia Model v.3.6 to calculate NH_3 emissions from synthetic nitrogen fertilizers (MCAQD, 2007). The CMU Ammonia Model used semiannual sales data for 2002 from the Association of American Plant Food Control Officials and crop calendar information from National Agricultural Statistics Service (NASS) to estimate monthly

fertilizer application rates for each county. The activity data in the CMU Ammonia Model v.3.6 has not been updated and therefore, MCAQD was unable to use the model to calculated 2008 NH_3 emissions. EPA, however, obtained county-level fertilizer consumption data for 2002 and 2007 from the Fertilizer Institute's Commercial Fertilizer 2002 and 2007 reports and calculated the percent change in county-level fertilizer quantities applied between 2002 and 2007. EPA used the percent change in applied fertilizer quantity to grow the fertilizer activity files provided with the CMU Ammonia Model v.3.6. EPA then ran the CMU Ammonia Model with the updated county-level fertilizer quantities to calculate NH_3 emissions. Typical daily NH_3 emissions were derived by dividing annual emissions by 366 days/year. Annual and typical daily emissions for the PM_{10} nonattainment area were derived by multiplying the county annual and typical daily emissions by the percentage of agricultural land located in the PM_{10} NAA (44.1%). See Section 1.5.2 for a discussion of the land use data used. Annual and typical daily NH_3 emissions from fertilizer application are shown in Table 3.5–25.

Table 3.5–25. Annnual and typical daily NH_3 emissions from fertilizer application.

	Maricopa County		PM_{10} NAA	
Fertilizer Category	**Annual Emissions (tons/year)**	**Daily NH_3 Emissions (lbs/day)**	**Annual NH_3 Emissions (tons/year)**	**Daily NH_3 Emissions (lbs/day)**
Anhydrous ammonia	70.64	386.0	31.18	170.4
Aqueous ammonia	3.75	20.5	1.65	9.0
Ammonium nitrate	0.00	0.0	0.00	0.0
Ammonium sulfate	74.40	406.5	32.84	179.5
Ammonium thiosulfate	0.00	0.0	0.00	0.0
N-P-K (multi-grade nutrient fertilizers)	0.00	0.0	0.00	0.0
Calcium ammonium nitrate	0.00	0.0	0.00	0.0
Nitrogen solutions	1,397.66	7637.5	616.93	3371.2
Urea	496.42	2712.7	219.12	1197.4
Diammonium phosphate	2.66	14.6	1.18	6.4
Monoammonium phosphate	71.77	392.2	31.68	173.1
Liquid ammonium polyphosphate	38.94	212.8	17.19	93.9
Potassium nitrate	0.95	5.2	0.42	2.3
Miscellaneous	119.24	651.6	52.63	287.6
Total	2,276.43	12,439.5	1,004.82	5,490.8

3.5.3 Livestock

PM_{10} and $PM_{2.5}$ emissions estimates were derived using Maricopa County cattle inventory estimates for 2008 from Arizona Agricultural Statistics Bulletin (AASS, 2009) and emission factor for PM_{10} for dairy cattle, and feedlot cattle from the California Air Resources Board (CARB, 2004). $PM_{2.5}$ was presumed to be 11% of PM_{10} per WRAP Fugitive Dust Handbook (WRAP, 2006d).

The number of "cattle on feed" was not available from the Arizona Agricultural Statistics Bulletin (AASS, 2009) for 2005 through 2008; therefore, 2004 numbers were used. Beef cows were excluded from the inventory as information provided by Arizona Agricultural Statistics staff (Koong, 2004) indicated that the majority of beef cows that are not on feed are grazed on range and pastures. Cattle on feed, milk cows, and other cattle (heifers, steers, bulls, and calves on dairies and ranches) were included in the PM_{10} and $PM_{2.5}$ emission estimates for livestock.

The 2008 Maricopa County cattle inventory and applicable PM emission factors are contained in Table 3.5–26.

Table 3.5–26. Maricopa County cattle populations and PM emission factors.

Animal type	No. of Head	PM_{10} Emission Factor (lb/1000 head/day)	$PM_{2.5}$:PM_{10} Ratio
Cattle on feed	5,000	28.9	0.11
Milk cows	100,000	6.7	0.11
Other cattle	58,000	28.9	0.11
Total:	**170,000**		

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

Typical daily emissions (lbs/day) from dairy cattle = milk cow inventory (1,000 head) × emission factor (lbs PM_{10}/1,000 head/day)
= 100 × 6.7
= 670.0 lbs PM_{10}/day

It was assumed that livestock emissions occur evenly throughout the year. Annual PM_{10} and $PM_{2.5}$ emissions were derived by multiplying typical daily emissions by 366 days/year.

NH_3 emissions from livestock in Maricopa County were estimated by growing the 2005 NH_3 emissions by the percentage change in Maricopa County cattle and calve numbers from 2002 to 2008 (AASS, 2003; AASS, 2009)[2]. The cattle and calf populations declined 8.11% from 2002 to 2008; as shown in Table 3.5–27 below. The estimated 2005 and 2008 NH_3 emissions from livestock emissions are shown in Table 3.5–28.

Table 3.5–27. Maricopa County cattle inventory for 2002 and 2008.

	Maricopa Co.		Percentage
	2002	**2008**	**Change**
All cattle & calves	185,000	170,000	-8.1%

Table 3.5–28. Annual and typical daily NH_3 emissions from livestock in Maricopa County.

	Annual emissions (tons/year)	Typical daily emissions (lbs/day)
2005 Emissions	10,429.53	57,148.1
% Change in cattle and calves, 2002 to 2008	–8.11%	-8.11%
2008 Emissions	**9,583.89**	**52,514.5**

MCAQD determined through GIS analysis of confined animal feeding operation (CAFO) locations and animal numbers in Maricopa County that 57.3% of CAFO animals are located within the nonattainment area. Therefore, annual and typical daily emissions for the nonattainment area were calculated by multiplying the Maricopa County emission totals by 57.3%.

Table 3.5–29 summarizes the annual and typical daily emissions from livestock for Maricopa County and the PM_{10} nonattainment area.

[2] The 2005 NH_3 emissions were calculated using the CMU Ammonia Model (CMU, 2004). The activity levels in the CMU model are based on the 2002 Census of Agriculture; therefore, emissions were grown using the percentage change in cattle and calve numbers from 2002 to 2008.

Table 3.5–29. Annual and typical daily emissions from livestock.

	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NH_3**
Maricopa County	455.80	50.14	9,583.89	2,490.7	274.0	52,514.5
PM_{10} NAA	260.95	28.70	5,486.90	1,426.0	156.9	30,065.2

3.5.4 Health services: crematories

Emissions from human and animal crematories were calculated from annual emissions inventory reports from all crematories located within the county. Typical daily emissions were calculated based on the operating schedule data reported by surveyed facilities. Annual and typical daily emissions for the PM_{10} nonattainment area were derived based on the location data of the individual facilities.

Table 3.5–30 summarizes annual and typical daily emissions from crematories in both Maricopa County and the PM_{10} nonattainment area.

Table 3.5–30. Annual and typical daily emissions from crematories.

	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Maricopa County	0.93	0.62	12.39	1.58	7.0	4.7	93.1	11.9
PM_{10} NAA	0.93	0.62	12.36	1.58	7.0	4.6	92.6	11.8

3.5.5 Accidental releases

As part of its air quality permit compliance program, MCAQD keeps an “upset log”, for each calendar year that records excess emissions and accidental releases at permitted facilities. Annual emissions inventory reports also provide for recording of accidental releases. Data from these two sources documented the release of 0.01 tons of PM_{10} and 0.06 tons of NO_x for the year 2008. To be conservative, $PM_{2.5}$ amounts are assumed to be equal to PM_{10} amounts. (No accidental releases of SO_x or NH_3 were reported).

Typical daily emissions were calculated by summing reported releases and dividing the total by 366 days. Emissions in the PM_{10} nonattainment area were calculated based on locations of facilities that reported releases. The resulting estimates are shown in Table 3-5–31 below.

Table 3.5–31. Annual and typical daily emissions from accidental releases.

	Annual emissions (tons/yr)			Typical daily emissions (lbs/day)		
Geographic area	**PM_{10}**	**$PM_{2.5}$***	**NO_x**	**PM_{10}**	**$PM_{2.5}$***	**NO_x**
Maricopa County	0.01	0.01	0.06	0.1	0.1	0.3
PM_{10} NAA	0.01	0.01	0.06	0.1	0.1	0.3

* As a conservative estimate, all PM10 emissions are assumed to be PM2.5.

3.5.6 Humans

A literature review by Battye et al. (1994) recommended using a per-capita emission factor developed for the National Acid Precipitation Assessment Program (NAPAP) inventory in 1985. This factor was applied to MAG population estimates for the county and PM_{10} nonattainment

areas (see section 1.5 for population information). Daily emissions were calculated by dividing annual values by 366. The resulting estimates are shown in Table 3-5–32.

Table 3.5–32. Annual and typical daily NH_3 emissions from human activity.

Geographic Area	Population	Emission factor (lbs/ person-yr)	Annual NH_3 emissions (tons/yr)	Typical daily NH_3 emissions (lbs/day)
Maricopa County	4,279,760	0.55	1,176.93	6,431.3
PM_{10} NAA	4,297,140	0.55	1,181.71	6,457.5

3.5.7 Leaf blower fugitive dust

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

EPA's 2008NONROAD model was used to estimate the number of gasoline-powered leaf blowers in Maricopa County (n = 109,787), along with the average activity figures for those leaf blowers. Total leaf blower population estimates were derived from CARB (2000), which estimated that 60% of all leaf blowers sold are electric. Thus assuming the remaining 40% are gasoline-powered, the total population was estimated as:

Total leaf blower population = Gas-powered leaf blower population ÷ 40%

= 109,787 ÷ 0.4

= 274,468 units

The remaining 164,681 units [= 274,468 – 109,787] are thus assumed to be electric-powered. Fitz et al. (2005) developed emission factors for PM_{10} and $PM_{2.5}$ fugitive dust emissions from leaf blowers. For this report, the most conservative (highest) emission factors were chosen to estimate emissions. Given these two data sources, Table 3.5–33 lists the equipment population numbers, activity estimates and emission factors for leaf blowers in Maricopa County.

Table 3.5–33. Leaf blower equipment populations, activity levels and emission factors for Maricopa County.

Leaf blower description	Population	Annual activity (hrs/yr)	PM_{10} emission factors (mg/m^2)	$PM_{2.5}$ Emission factors (mg/m^2)
Commercial 2-stroke gasoline	3,345	626	70	30
Commercial 4-stroke gasoline	1,639	626	70	30
Residential 2-stroke gasoline	99,624	10	70	30
Residential 4-stroke gasoline	5,179	10	70	30
Electric	164,681	10	130	40
Total:	**274,468**	n/a	n/a	n/a

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

Annual PM_{10} emissions from electric leaf blowers	=	population	× activity (hrs/yr)	×	emission factor (mg/m^2)	×	area covered (m^2/hr)
	=	164,681	× 10 hrs/yr	×	130 mg/m^2	×	1600 m^2/hr
	=	342,536,480,000 mg/yr					
	=	377.24 tons PM_{10}/yr					

The activity hours associated with leaf blowers can occur at any time during the year in Maricopa County due to the temperate climate, with no substantial seasonal variation. Therefore, typical daily emissions were estimated by dividing annual totals by 366 days per year. Emissions for the PM_{10} nonattainment area are allocated based on the ratio of population in the County to the nonattainment area (see Section 1.5 for information on population). Table 3.5–34 lists annual and daily fugitive emissions from leaf blowers for Maricopa County and the PM_{10} nonattainment area.

Table 3.5–34. Annual and typical daily emissions from leaf blower fugitive dust.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	891.36	336.41	4,870.8	1,838.3
PM_{10} NAA	894.98	337.78	4,890.6	1,845.8

3.5.8 Offroad recreation vehicles fugitive dust

The EPA NONROAD2008 model estimates exhaust emissions for offroad recreational vehicles. These emissions are included in the nonroad emissions category of the 2008 particulate emissions inventory. Particulate emissions are also generated by recreational vehicles traveling on unpaved surfaces. For the 2008 periodic inventory, these emissions were estimated by MAG using mileage and activity data for offroad recreational vehicles in Maricopa County from the NONROAD2008 model. The methodology and assumptions for calculating fugitive dust emissions from offroad recreational vehicles traveling are described in this section.

The EPA NONROAD2008 model provides annual mileage and number of vehicles by county for all-terrain vehicles (ATVs), offroad motorcycles (ORMs), and specialty vehicles/carts (SVCs). The NONROAD2008 default values for annual mileage and number of vehicles by type for Maricopa County in 2008 are shown in Table 3.5–35.

To be consistent with the 2005 Periodic Emissions Inventory for PM_{10} (MCAQD, 2007), it was assumed that 75 percent of the annual travel by offroad recreational vehicles occurs on unpaved surfaces inside Maricopa County, with the remaining 25 percent occurring on paved surfaces within Maricopa County and paved and unpaved surfaces outside of Maricopa County. The product of the mileage, number of vehicles, and 75 percent produces the annual vehicle miles traveled (VMT) on unpaved surfaces, shown in Table 3.5–35. Dividing annual VMT totals by 366 produces a daily estimated offroad recreational vehicle travel on unpaved surfaces in Maricopa County in 2008.

Table 3.5–35. 2008 offroad recreational vehicle travel on unpaved surfaces in Maricopa County.

Vehicle Type	Annual Mileage	Number of Vehicles	2008 Annual VMT	2008 Daily VMT
ATV	1,608	30,424	36,691,344	100,250
ORM	1,600	7,359	8,830,800	24,128
SVC (Non-Diesel)	65	1,718	83,753	229
SVC (Diesel)	435	150	48,938	134

The VMTs above were multiplied by emission factors for unpaved industrial roads from AP-42 (US EPA, 2006b), assuming a silt content of 11.9 percent and an average vehicle weight of one-half of a ton. The resultant PM_{10} emission factor for ATVs and SVCs is 0.594 pounds per vehicle mile traveled. This emission factor was reduced by 50 percent for ORMs (i.e., 0.297 pounds per mile) to account for two wheels generating dust instead of four. Applying the AP-42 equation results in a $PM_{2.5}$ emission factor for ATVs and SVCs of 0.059 pounds per mile, while the comparable $PM_{2.5}$ emission factor for ORMs is 0.0295 pounds per mile.

The AP-42 emission rates were multiplied by the annual and daily VMTs in Table 3.5–36 to obtain uncontrolled fugitive dust emissions in pounds per day and tons per year. The results for Maricopa County are shown in Table 3.5–37.

The emissions for the PM_{10} nonattainment area were derived by applying geographic information systems (GIS) to MAG 2009 land use data[1] to obtain the acreage of passive open space in the PM_{10} nonattainment area and Maricopa County. Passive open space includes open desert, mountains and washes. The detailed calculations for deriving the PM_{10} nonattainment area emissions are shown below:

Passive Open Space in the PM_{10} nonattainment area (NAA) = 262,662 acres

Passive Open Space in Maricopa County = 1,476,922 acres

Ratio of Passive Open Space in PM_{10} NAA vs. Maricopa County = 17.8%

PM_{10} NAA Emissions = 0.178 × Maricopa County Emissions

Application of the ratio above to Maricopa County emissions produces the uncontrolled annual and typical daily PM_{10} NAA emissions shown in Table 3.5–36. The PM_{10} and $PM_{2.5}$ emissions for all offroad recreational vehicle types (i.e., ATVs, ORMs and SVCs) are summed in this table. These uncontrolled emissions do not include the 2008 emission reductions attributed to the committed measures in the MAG 2007 Five Percent Plan.

Table 3.5–36. 2008 uncontrolled emissions from offroad recreational vehicles.

	Annual emissions (tons/yr)		Typical Daily Emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	12,248.11	1,216.56	66,929.6	6,647.9
PM_{10} NAA	2,180.16	216.55	11,913.5	1,183.3

Two committed measures that reduce emissions from offroad recreational vehicles were quantified in the MAG 2007 Five Percent Plan for PM_{10} (MAG, 2007). The benefit taken in 2008 for these measures in the Five Percent Plan is shown in Table 3.5–37.

1. Draft, as of March 24, 2010.

Table 3.5–37. Benefits of measures that reduce offroad recreational vehicle emissions.

Committed Measures in Five Percent Plan	2008 PM_{10} Emission Reductions tons/yr	lbs/day
1. Reduce offroad vehicle use in areas with high offroad vehicle activity (Measure 19)	140.3	766.5
2. Ban ATV use on high pollution days (Measure 23)	25.7	140.6
Total 2008 PM_{10} emission reductions for offroad recreational vehicles	**166.0**	**907.0**

The emission benefits in Table 3.5–37 were subtracted from the uncontrolled PM_{10} emissions in Table 3.5–36. The 2008 PM_{10} emission reduction of 166.0 tons per year represents 7.6% of the uncontrolled emissions in the PM_{10} NAA of 2,180.16 tons per year. This percent reduction was applied to the uncontrolled $PM_{2.5}$ emissions in the PM_{10} NAA; then the absolute reduction in $PM_{2.5}$ emissions due to the control measures was applied to the uncontrolled $PM_{2.5}$ emissions in Maricopa County. The annual and daily controlled emission estimates are shown in Table 3.5–38 below.

Table 3.5–38. 2008 controlled emissions from offroad recreational vehicles.

	Annual Emissions (tons/yr)		Typical Daily Emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	12,082.12	1,200.11	66,022.5	6,558.0
PM_{10} NAA	2,014.17	200.09	11,006.4	1,093.4

3.5.9 Unpaved parking lots fugitive dust

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

The vehicle miles traveled on unpaved parking lots in the PM_{10} nonattainment area (NAA) were derived using assumptions from the Phase I windblown dust modeling for the Western Regional Air Partnership (ENVIRON, 2004). This study estimated that eight percent of the vacant land in core urban areas is disturbed and thirty percent of the land under development is disturbed. For the 2008 periodic emissions inventory, the core urban area is defined as the carbon monoxide maintenance area. In addition, the thirty percent of disturbed land under development has been reduced by two-thirds (i.e., from thirty percent to ten percent) to mirror a 67 percent decline in total permitted construction acreage in the PM_{10} NAA between 2005 and 2008. GIS was applied to 2009 MAG land use data[2] to estimate that there are 171,785 acres of vacant land in the core urbanized area and 64,519 acres of land under development in the PM_{10} NAA. Multiplying the vacant disturbed percentages by these land areas produces:

171,785 acres × 0.08 = 13,743 acres of vacant disturbed land in the urbanized core

64,519 acres × 0.10 = 6,452 acres of vacant disturbed land under development

Summing the vacant disturbed acres in the urbanized core and areas under development produces a total of 20,195 acres of vacant disturbed land in the PM_{10} NAA. In estimating fugitive dust emissions from unpaved parking lots, the MAG Serious Area PM_{10} Plan assumed that 24 percent

2. *Ibid*.

of the disturbed vacant non-agricultural land is devoted to unpaved parking areas (MAG, 2000). Applying this percentage to the acres of vacant disturbed land results in 4,847 acres of unpaved parking lots in the PM_{10} NAA.

The MAG Serious Area PM_{10} Plan also assumed that the average size of an unpaved parking lot is 625 square meters (i.e., 0.154 acres), an average of ten vehicles travel on each lot per day, and each vehicle travels an average distance of 0.031 miles on a lot. Multiplying 10 vehicles per day times 0.031 miles per vehicle and dividing by 0.154 acres produces 2.0 vehicle miles of travel (VMT) per acre per day. Multiplying 2.0 by 4,847 acres yields 9,694 VMT per day on unpaved parking lots in the PM_{10} NAA.

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

These AP-42 emission factors were applied to the unpaved parking lot VMT of 9,694 to obtain uncontrolled emissions in pounds per day. The pounds per day were converted to tons per year, assuming 366 days in 2008. The results for the PM_{10} NAA are shown in Table 3.5–40.

To estimate emissions for Maricopa County, GIS was applied to 2009 MAG land use data[3] to obtain 2,227,981 acres of vacant land in Maricopa County. Removing the vacant land in the Maricopa County portion of the PM_{10} NAA (i.e., 466,553 acres) results in 1,761,428 vacant acres located inside Maricopa County, but outside the PM_{10} NAA.

Assuming one percent of the vacant land outside the PM_{10} NAA is disturbed (Clark County, 2006) and 24 percent of the disturbed vacant land is unpaved parking areas (MAG, 2000), results in 4,227 acres of unpaved parking areas inside Maricopa County, but outside the PM_{10} NAA. Multiplying by 2.0 VMT per acre per day results in 8,454 VMT per day. Applying the AP-42 emission rates produces the unpaved parking lot emissions inside Maricopa County, but outside the PM_{10} NAA of 11,539.7 pounds per day of PM_{10} and 1,158.2 pounds per day of $PM_{2.5}$.

The final step in estimating Maricopa County emissions requires removing the Pinal County portion of the PM_{10} NAA. The unpaved parking lot emissions in the Pinal County portion of the PM_{10} NAA are assumed to be proportional to the acres of vacant land. These were derived using GIS and 2009 MAG land use data[4], with the results shown below:

Vacant land in the Pinal County portion of the PM_{10} NAA = 6,278 acres

Vacant land in the PM_{10} NAA = 472,831 acres

Ratio = 6,278/472,831 = 1.3%; Pinal County portion = 1.3% × PM_{10} NAA emissions

Pinal County portion of PM_{10} emissions = 1.3% × 13,232.3 = 172.0 pounds per day

Pinal County portion of $PM_{2.5}$ emissions = 1.3% × 1,158.2 = 17.3 pounds/day

Adding the emissions inside and outside the PM_{10} NAA and subtracting the Pinal County portion produces total Maricopa County emissions attributable to vehicles traveling on unpaved parking

3. *Ibid*.

4. *Ibid*.

lots in pounds per day. Pounds per day were multiplied by 366 [= no. days in 2008] to derive annual totals. The resultant 2008 uncontrolled emissions for Maricopa County are shown in Table 3.5–39. Uncontrolled emissions do not include the 2008 emission reductions attributed to the committed measure in the MAG 2007 Five Percent Plan.

Table 3.5–39. 2008 uncontrolled emissions from vehicles traveling on unpaved parking lots.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	4,501.80	451.83	24,600.0	2,469.0
PM_{10} NAA	2,421.51	243.04	13,232.3	1,328.1

One committed measure that reduces emissions from unpaved parking lots was quantified in the MAG 2007 Five Percent Plan for PM_{10} (MAG, 2007). The benefit taken in 2008 for this measure in the Five Percent Plan is shown in Table 3.5–40.

Table 3.5–40. Benefits of measure that reduces unpaved parking lot emissions.

	2008 PM_{10} emission reduction	
Committed Measure in Five Percent Plan	**tons/yr**	**lbs/day**
1. Pave or stabilize existing unpaved parking lots (Measure 25)	56.4	308.4

The emission benefit in Table 3.5–40 was subtracted from the uncontrolled PM_{10} emissions in Table 3.5–39. The 2008 PM_{10} emission reduction of 56.4 tons per year represents 2.3% of the uncontrolled emissions in the PM_{10} NAA of 2,421.51 tons per year. This percent reduction was applied to the uncontrolled $PM_{2.5}$ emissions in the PM_{10} NAA; then the absolute reduction in $PM_{2.5}$ emissions due to the control measure was applied to the uncontrolled $PM_{2.5}$ emissions in Maricopa County. The annual and daily controlled emission estimates are shown in Table 3.5–41 below.

Table 3.5–41. Annual and typical daily controlled emissions from unpaved parking lots.

	Annual emissions (tons/yr)		Typical daily emissions (lbs/day)	
Geographic area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Maricopa County	4,445.36	446.24	24,291.6	2,438.5
PM_{10} NAA	2,365.07	237.45	12,923.9	1,297.5

3.5.10 Windblown dust

Windblown dust emissions were calculated using a combination of local meteorology conditions, land use and vertical flux emission rates. A full description of the methodology can be found in Appendix 4. Tables 3.5–42 and 3.5–43 summarize annual and typical daily emissions from windblown dust by major land use category for Maricopa County and the PM_{10} nonattainment area.

Table 3.5–42. Annual and typical daily emissions from fugitive windblown dust for Maricopa County.

	Annual Emissions (tons/yr)		Avg. Daily Emissions (lb/day)	
Land Use Category	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Active open space	215.94	32.39	1,180.0	177.0
Agriculture – active	61.69	9.25	337.1	50.6
Agriculture – inactive	345.86	51.88	1,890.1	283.5
Auto test tracks	49.23	7.38	269.0	40.4
Developing	394.98	59.25	2,158.4	323.8
Landfill	6.33	0.95	34.6	5.2
Mining	25.37	3.81	138.7	20.8
Passive open space / wash	2,755.11	413.27	15,058.1	2,258.7
Sand & gravel	108.47	16.27	592.7	88.9
Vacant	2,846.15	426.92	15,555.8	2,333.4
Total	**6,809.13**	**1,021.37**	**37,214.6**	**5,582.2**

Table 3.5–43. Annual and typical daily emissions from fugitive windblown dust for the PM_{10} NAA.

	Annual Emissions (tons/yr)		Avg. Daily Emissions (lb/day)	
Land Use Category	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Active open space	213.93	32.09	1,169.0	175.4
Agriculture – active	57.82	8.67	315.9	47.4
Agriculture – inactive	296.42	44.46	1,619.8	243.0
Auto test tracks	42.93	6.44	234.6	35.2
Developing	391.00	58.65	2,136.6	320.5
Landfill	6.33	0.95	34.6	5.2
Mining	23.75	3.56	129.8	19.5
Passive open space / wash	1,822.61	273.39	9,959.6	1,493.9
Sand & gravel	107.82	16.17	589.2	88.4
Vacant	1,852.19	277.83	10,121.2	1,518.2
Total	**4,814.80**	**722.22**	**26,310.4**	**3,946.6**

3.5.11 Summary of all miscellaneous area sources

Tables 3.5–44 and 3.5–45 provide a summary of annual and typical daily emissions from all miscellaneous area sources, for Maricopa County and the PM_{10} nonattainment area, respectively.

Table 3.5–44. Annual and typical daily emissions from all miscellaneous area sources for Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Source Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Wildfires	470.39	403.43	103.79	28.46	21.76	6,271.8	5,379.0	1,383.8	379.4	290.2
Prescribed fires	0.51	0.51	0.39	0.11	0.03	169.3	169.3	131.2	36.0	10.6
Structure fires	15.04	15.04	1.95			82.2	82.2	10.7		
Vehicle fires	30.04	30.04	1.20			164.1	164.1	6.6		
Engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	2,059.00	308.85				22,932.4	3,439.9			
Harvesting	136.93	20.54				3,938.9	590.8			
Unpaved ag roads	1,739.52	173.95				11,150.8	1,115.1			
Cotton ginning	17.90	5.11				103.8	29.7			
Fertilizer					2,276.43					12,439.5
Livestock	455.80	50.14			9,583.89	2,490.7	274.0			52,514.5
Crematories	0.93	0.62	12.39	1.58		7.0	4.7	93.1	11.9	
Accidental releases	0.01	0.01	0.06			0.1	0.1	0.3		
Humans					1,176.93					6,431.3
Leaf blowers dust	891.36	336.41				4,870.8	1,838.3			
Offroad rec. veh. dust	12,082.12	1,200.11				66,022.5	6,558.0			
Unpaved parking lots	4,445.36	446.24				24,291.6	2,438.5			
Windblown dust	6,809.13	1,021.37				37,214.6	5,582.2			
Total:	**29,154.21**	**4,012.53**	**126.52**	**32.64**	**13,059.05**	**179,712.0**	**27,667.0**	**1,676.1**	**446.4**	**71,686.1**

Table 3.5–45. Annual and typical daily emissions from all miscellaneous area sources for the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Source Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Wildfires	423.56	363.27	93.46	25.62	19.60	9,412.5	8,072.7	2,076.8	569.4	435.5
Prescribed fires	0.21	0.21	0.16	0.04	0.01	104.0	104.0	80.6	22.1	6.5
Structure fires	15.10	15.10	1.96			82.5	82.5	10.7		
Vehicle fires	30.16	30.16	1.21			164.81	164.81	6.59		
Engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	834.20	125.13				9,327.3	1,399.1			
Harvesting	54.14	8.12				1,560.0	234.0			
Unpaved ag roads	731.03	73.10				4,686.1	468.6			
Cotton ginning	4.86	1.39				26.7	7.6			
Fertilizer					1,004.82					5,490.8
Livestock	260.95	28.70			5,486.90	1,426.0	156.9			30,065.2
Crematories	0.93	0.62	12.36	1.58		7.0	4.6	92.6	11.8	
Accidental releases	0.01	0.01	0.06			0.1	0.1	0.3		
Humans					1,181.71					6,457.5
Leaf blowers dust	894.98	337.78				4,890.6	1,845.8			
Offroad rec. veh. dust	2,014.17	200.09				11,006.4	1,093.4			
Unpaved parking lots	2,365.07	237.45				12,923.9	1,297.5			
Windblown dust	4,814.80	722.22				26,310.4	3,946.6			
Total:	**12,444.36**	**2,143.52**	**115.94**	**29.74**	**7,693.04**	**81,929.6**	**18,879.4**	**2,318.0**	**622.4**	**61,982.0**

3.6 Summary of all area sources

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

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Source Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel Combustion										
Industrial natural gas	30.78	30.78	575.29	2.42	12.70	197.3	197.3	3,687.7	15.5	81.4
Industrial fuel oil	458.79	458.79	6,375.08	609.61	26.25	2,941.0	2,941.0	40,865.9	3,907.8	168.3
Comm./inst. natural gas	66.54	66.54	1,267.11	5.23	4.20	426.5	426.5	8,122.5	33.5	26.9
Comm./inst. fuel oil	224.14	224.14	3,273.40	271.27	8.13	1,436.8	1,436.8	20,983.3	1,738.9	52.1
Residential natural gas	61.75	61.75	763.81	4.88		337.5	337.5	4,173.8	26.6	
Residential wood	461.59	429.28	34.69	5.34		4,334.2	4,030.8	325.7	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
All fuel combustion	**1,303.61**	**1,271.30**	**12,289.62**	**898.83**	**51.27**	**9,673.4**	**9,370.0**	**78,161.3**	**5,773.3**	**328.7**
Industrial Processes										
Chemical manufacturing	187.43	151.42	0.00	0.34	0.03	1,445.8	1,164.5	0.0	2.6	0.6
Commercial cooking	988.99	917.18				5,434.0	5,039.5			
Grain processing	20.59	6.71				149.3	49.5			
Cold storage					1,678.43					10.759.2
Secondary metal prod.	60.56	52.16	49.73	18.65	.004	442.7	386.2	358.8	142.7	0.0
Mineral processes	192.82	95.47				1,337.7	659.3			
Mining & quarrying	181.01	55.20				1,239.2	362.6			
Wood product mfg.	217.26	203.25				1,668.6	1,548.3			
Rubber/plastic mfg.	140.94	105.96				953.3	698.8			
Fabricated metal mfg.	51.48	42.62			4.50	538.1	460.6			28.9
Residential construction	1,845.79	184.58				11,832.0	1,183.2			
Commercial construction	4,320.77	432.08				27,697.2	2,769.7			
Road construction	2,695.73	269.57				17,280.3	1,728.0			
Other construction	194.36	19.44				1,245.9	124.6			
Electrical equip mfg.	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7
ADEQ-permitted portable sources	59.00	29.50	282.18	88.93		492.9	246.5	2.275.7	721.7	
Road travel at industrial sites	566.30	271.29				3,880.4	1,847.2			
Industrial processes NEC	144.60	107.24	10.22	21.49	16.79	953.3	726.4	69.6	137.7	94.6
All Industrial Processes	**11,881.57**	**2,953.30**	**362.58**	**129.60**	**1,731.34**	**76,667.6**	**19,048.2**	**2,816.5**	**1,005.8**	**11,077.2**
Waste Treatment/disposal										
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	111.46	111.46	29.96			902.2	902.2	242.4		
Landfills	86.21	75.92	24.11	7.57		486.1	425.4	132.9	41.7	
POTWs					1,484.01					8,131.5
Other waste	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
All Waste Treatment/ Disposal	**230.52**	**204.35**	**77.47**	**58.20**	**1,484.01**	**1,613.0**	**1,438.8**	**515.3**	**320.0**	**8,131.5**

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Misc. Area Sources										
Wildfires fires	470.39	403.43	103.79	28.46	21.76	6,271.8	5,379.0	1,383.8	379.4	290.2
Prescribed fires	0.51	0.51	0.39	0.11	0.03	169.3	169.3	131.2	36.0	10.6
Structure fires	15.04	15.04	1.95			82.2	82.2	10.7		
Vehicle fires	30.04	30.04	1.20			164.1	164.1	6.6		
Engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	2,059.00	308.85				22,932.4	3,439.9			
Harvesting	136.93	20.54				3,938.9	590.8			
Unpaved ag roads	1,739.52	173.95				11,150.8	1,115.1			
Cotton ginning	17.90	5.11				103.8	29.7			
Fertilizer application					2,276.43					12,439.5
Livestock	455.80	50.14			9,583.89	2,490.7	274.0			52,514.5
Crematories	0.93	0.62	12.39	1.58		7.0	4.7	93.1	11.9	
Accidental releases	0.01	0.01	0.06			0.1	0.1	0.3		
Humans					1,176.93					6,431.3
Leaf blowers dust	891.36	336.41				4,870.8	1,838.3			
Offroad rec. veh. dust	12,082.12	1,200.11				66,022.5	6,558.0			
Unpaved parking lots	4,445.36	446.24				24,291.6	2,438.5			
Windblown dust	6,809.13	1,021.37				37,214.6	5,582.2			
All Misc. Sources	**29,154.21**	**4,012.53**	**126.52**	**32.64**	**13,059.05**	**179,712.0**	**27,667.0**	**1,676.1**	**446.4**	**71,686.1**
TOTAL, ALL AREA SOURCES	**42,569.90**	**8,441.49**	**12,856.18**	**1,119.27**	**16,329.74**	**267,665.9**	**57,524.0**	**83,169.2**	**7,545.5**	**91,223.5**

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel Combustion										
Industrial natural gas	30.70	30.70	573.79	2.41	12.66	196.8	196.8	3,678.2	15.5	81.2
Industrial fuel oil	457.60	457.60	6,358.50	608.03	26.19	2,933.3	2,933.3	40,759.6	3,897.6	167.9
Comm./inst. natural gas	66.20	66.20	1,260.65	5.20	4.18	424.4	424.4	8,081.1	33.3	26.8
Comm./inst. fuel oil	223.00	223.00	3,256.70	269.88	8.09	1,429.5	1,429.5	20,876.3	1,730.0	51.8
Residential natural gas	61.73	61.73	763.51	4.87		337.3	337.3	4,172.2	26.6	
Residential wood	461.41	429.11	34.67	5.33		4,332.5	4,029.2	325.6	50.1	
Residential fuel oil	0.01	0.01	0.25	0.10		0.1	0.1	2.3	0.9	
All fuel combustion	**1,300.65**	**1,268.35**	**12,248.07**	**895.83**	**51.11**	**9,653.8**	**9,350.6**	**77,895.2**	**5,754.1**	**327.6**
Industrial Processes										
Chemical manufacturing	186.94	151.03	0.00	0.34	0.03	1,442.0	1161.5	0.0	2.6	0.9
Commercial cooking	993.04	920.94				5,456.3	5,060.1			
Grain processing	16.73	5.68				125.3	43.0			
Cold storage					1,674.1					10,731.2
Secondary metal prod.	60.56	52.16	49.73	18.65	0.04	442.7	386.2	358.8	142.7	0.0
Mineral processes	187.73	91.92				1,302.8	635.6			
Mining & quarrying	156.60	46.81				1,075.7	307.2			
Wood product mfg.	216.69	202.72				1,664.3	1,544.3			
Rubber/plastic mfg.	140.57	105.68				950.9	697.0			
Fabricated metal mfg.	51.35	42.51			4.49	536.7	459.4			28.8
Residential construction	1,692.38	169.24				10,920.3	1,092.0			
Commercial construction	4,057.29	405.73				25,897.4	2,589.7			
Road construction	2,051.78	205.18				13,156.8	1,315.7			
Other construction	162.41	16.24				1,043.9	104.4			
Electrical equip mfg	13.94	9.64	20.45	0.18	31.55	76.9	53.2	112.4	1.1	193.7
ADEQ-permitted portable sources	59.00	29.50	282.18	88.93		492.9	246.5	2,275.7	721.7	
Road travel at industrial sites	472.36	217.08				3,273.9	1,500.1			
Industrial processes NEC	136.00	99.12	8.12	21.47	14.10	906.0	681.7	55.4	137.6	79.8
All Industrial Processes	**10,655.39**	**2,771.19**	**360.48**	**129.58**	**1,724.27**	**68,764.6**	**17,877.6**	**2,802.3**	**1,005.7**	**11,034.4**

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

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Fuel Combustion										
Waste Treatment/disposal										
On-site incineration	0.06	0.04	5.01	0.01		0.7	0.4	38.9	0.1	
Open burning	27.67	27.67	7.44			232.6	232.6	62.5		
Landfills	60.25	50.78	19.47	6.22		342.4	286.6	107.4	34.3	
POTWs					1,494.12					8,164.6
Other waste	32.78	16.93	18.39	50.62		224.1	110.9	101.0	278.1	
All Waste Treatment/ Disposal	**120.77**	**95.42**	**50.30**	**56.85**	**1,494.12**	**799.8**	**630.5**	**309.9**	**312.6**	**8,164.6**
Misc. Area Sources										
Wildfires	423.56	363.27	93.46	25.62	19.60	9,412.5	8,072.7	2,076.8	569.4	435.5
Prescribed fires	0.21	0.21	0.16	0.04	0.01	104.0	104.0	80.6	22.1	6.5
Structure fires	15.10	15.10	1.96			82.5	82.5	10.7		
Vehicle fires	30.16	30.16	1.21			164.81	164.81	6.59		
Engine testing	0.18	0.17	6.74	2.49		1.3	1.2	50.5	19.0	
Tilling	834.20	125.13				9,327.3	1,399.1			
Harvesting	54.14	8.12				1,560.0	234.0			
Unpaved ag roads	731.03	73.10				4,686.1	468.6			
Cotton ginning	4.86	1.39				26.7	7.6			
Fertilizer application					1,004.82					5,490.8
Livestock	260.95	28.70			5,486.90	1,426.0	156.9			30,065.2
Crematories	0.93	0.62	12.36	1.58		7.0	4.6	92.6	11.8	
Accidental releases	0.01	0.01	0.06			0.1	0.1	0.3		
Humans					1,181.71					6,457.5
Leaf blowers dust	894.98	337.78				4,890.6	1,845.8			
Offroad rec. veh. dust	2,014.17	200.09				11,006.4	1,093.4			
Unpaved parking lots	2,365.07	237.45				12,923.9	1,297.5			
Windblown dust	4,814.80	722.22				26,310.4	3,946.6			
All Misc. Sources	**12,444.36**	**2,143.52**	**115.94**	**29.74**	**7,693.04**	**81,929.6**	**18,879.4**	**2,318.0**	**622.4**	**42,455.4**
TOTAL, ALL AREA SOURCES:	**24,521.17**	**6,278.48**	**12,774.79**	**1,112.00**	**10,962.54**	**161,147.8**	**46,738.0**	**83,325.3**	**7,694.7**	**61,982.0**

3.7 Quality assurance/quality control procedures

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

Area source categories were selected for inclusion in the inventory based on the latest Emission Inventory Improvement Program (EIIP) guidance available. EPA's guidance for area source categories included in the draft 2002 National Emission Inventory (NEI) was also evaluated, as area source emissions from this inventory will be submitted to EPA for the 2008 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 those from the US Census Bureau) was used when no local, state or regional data was available. In addition, the most recent EIIP guidance for area sources was consulted for direction in determining the most relevant data source for use in emissions calculations.

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

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

The draft version of the area source chapter was sent to the Arizona Department of Environmental Quality, the Arizona Department of Transportation, and the Maricopa Association of Governments for a quality assurance review. These agencies provided comments which were addressed and incorporated into the final area source chapter. 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 2008 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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WRAP 2006c. Fugitive Dust Handbook. Chapter 6.0 Unpaved Roads, September 2006. Internet address: http://wrapair.org/forums/dejf/fdh/index.html.

WRAP 2006d. Fugitive Dust Handbook. Chapter 13.0 Livestock Husbandry, September 2006. Internet address: http://wrapair.org/forums/dejf/fdh/index.html.

4. Nonroad Mobile Sources

4.1 Introduction

Nonroad mobile sources are defined as those that move or are moved within a 12-month period and are not licensed or certified as highway vehicles. Nonroad mobile sources are vehicles and engines that fall under the following categories:

- Agricultural equipment, such as tractors, combines and balers;
- Airport ground support equipment, such as baggage tugs and terminal tractors;
- Commercial equipment, such as generators and pumps;
- Industrial equipment, such as forklifts and sweepers;
- Construction and mining equipment, such as graders, back hoes and trenchers;
- Lawn and garden equipment, such as leaf blowers and lawn mowers;
- Logging equipment (not present in Maricopa County);
- Pleasure craft, such as power boats and personal watercraft;
- Railway maintenance equipment, such as rail straighteners;
- Recreational equipment, such as all-terrain vehicles and off-road motorcycles;
- Underground mining and oil field equipment (not present in Maricopa County);
- Aircraft, such as jet and piston engines; and
- Locomotives, such as switching and line haul trains.

Emission calculations for most nonroad mobile source categories except aircraft, airport ground support equipment (GSE) and locomotives were derived using EPA's NONROAD model, ver. 2008.1.0 (Core version 2008, April 2009). Aircraft and airport GSE emission estimates were made using the Federal Aviation Administration's EDMS (Emissions Dispersion Modeling System) model, ver. 5.1.1. Locomotive emission calculations were derived from surveys of the three railroad companies that have operations in the county (Burlington Northern Santa Fe, Union Pacific and Amtrak).

County specific temperature and fuel-related inputs are required for the operation of the NON-ROAD model. Monthly temperature and fuel data were provided by the Arizona Department of Weights and Measures. The following table lists the local county inputs used:

Table 4.1–1. NONROAD model county temperature- and fuel-related inputs.

Month	Temperatures (°F) Max.	Min.	Average	Fuel RVP (psi)	Diesel Sulfur (ppm)	Gasoline Sulfur (ppm)	Ethanol (EtOH) Blend EtOH (Vol %)	Market Share (%)	Total Oxygen (wt%)
January	64	45	54.90	8.8	6	35	9.47	100	3.49
February	69	48	58.45	8.4	6	23	9.24	100	3.42
March	79	54	66.84	8.4	7	49	9.18	100	3.41
April	87	61	74.23	7.8	7	23	5.57	100	2.06
May	91	66	78.74	6.8*	6 *	27*	0.00*	0*	0.00*
June	107	80	93.40	6.6	6	25	0.00	0	0.00
July	106	84	95.16	7.0	4	19	0.00	0	0.00
August	104	82	93.16	6.8	6	29	0.00	0	0.00
September	101	79	90.07	6.5	6	35	0.00	0	0.00
October	91	65	78.13	7.9	7 †	25	6.79	100	2.52
November	81	56	68.67	8.4	7 †	15	8.78	100	3.27
December	65	46	56.03	8.3†	7	28†	8.17†	100†	3.03†

* Since measurements were not available, the average of June, July, August and September data was used.
† Since measurements were not available, the average of October, November, January, February, March and April data was used.

EPA recommends adjusting default NONROAD model values (such as equipment population, activity levels of equipment, growth factors, etc.) where local data is available, as the default values in the model are derived from national averages. The NONROAD model defaults were adjusted in the following manner:

- Equipment population numbers and activity levels for commercial lawn and garden equipment were adjusted based on 2003 survey results of the commercial lawn and garden industry performed by ENVIRON as part of an inventory developed to study the impact of visibility impairing pollutants (ENVIRON et al., 2003). Survey results show that for most categories of lawn and garden equipment, the equipment populations for Maricopa County are significantly lower than EPA default values, while the average annual hours of operation for most equipment types are slightly higher than EPA's values. Using these new local data results is a considerable decrease in emissions from this category, compared with earlier results using EPA default data.

The NONROAD model does not calculate emission values for NH_3. Ammonia emission calculations for the NONROAD model were derived by using a multiplier of NO_x emissions developed by ENVIRON (2003).

Spatial allocation factors were developed (based on EPA guidance documents) to apportion nonroad emissions to the PM_{10} nonattainment area. The approaches used are described in each section of this chapter.

Temporal allocations (used to calculate PM_{10} average-day emissions) for nonroad equipment categories modeled in the NONROAD model come from EPA recommendations on weekday and weekend day activity levels for each nonroad equipment category (US EPA, 1999). Table 4.1–2 lists the weighted activity level allocation fractions for each equipment class for weekdays and weekend days. For this report, the most conservative (highest) allocation fraction in each nonroad equipment class was used to calculate average-day emissions.

Table 4.1–2. Default weekday and weekend day activity allocation fractions.

Equipment category	Weekday	Weekend day
Agricultural	0.1666667	0.0833334
Airport ground support	0.1428571	0.1428571
Commercial	0.1666667	0.0833334
Construction and mining	0.1666667	0.0833334
Industrial	0.1666667	0.0833334
Lawn and garden (residential)	0.1111111	0.2222222
Lawn and garden (commercial)	0.1600000	0.1000000
Logging	0.1666667	0.0833334
Pleasure craft	0.0600000	0.3500000
Railway maintenance	0.1800000	0.0500000
Recreational	0.1111111	0.2222222

4.2 Agricultural equipment

Annual emissions from agricultural equipment in Maricopa County were calculated using EPA's NONROAD model as discussed above. County-wide results are shown in Table 4.2–1.

Table 4.2–1. Annual emissions (tons/yr) from agricultural equipment in Maricopa County.

PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
34.27	33.24	365.55	0.14	0.67

Annual emissions for the PM_{10} nonattainment area were calculated based on EIIP guidance (US EPA, 2002) which recommends using the ratio of agricultural land inside the nonattainment area to agricultural land inside the county. See Section 1.5.2 for a discussion of land use data used.

PM_{10} NAA emissions from agricultural equipment	=	Total County PM_{10} emissions from agricultural equipment	×	Agricultural land use allocation factor
	=	34.27 tons	×	44.14%
	=	15.13 tons PM_{10} /yr		

Table 4.2–2. Annual emissions (tons/yr) from agricultural equipment in the PM_{10} NAA.

PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
15.13	14.67	161.35	0.06	0.30

County average-day emissions were calculated by multiplying annual emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for agricultural equipment listed in Table 4.1–2, and dividing the product by the number of weeks (52) in the year (US EPA, 1999), as follows:

Average County PM_{10} daily emissions (lbs/day)	=	Annual PM_{10} emissions (tons/yr)	×	daily activity allocation factor for agricultural equipment (week/day)	×	2000 (lbs/ton)	÷	52 (wks/yr)
	=	34.27	×	0.166667	×	2000	÷	52
	=	219.7 lbs/day						

Table 4.2–3. Typical daily emissions (lbs/day) from agricultural equipment in Maricopa County.

PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
219.7	213.1	2,343.3	0.9	4.3

PM_{10} nonattainment area average-day emissions were calculated by multiplying County average-day emissions by the agricultural land use allocation factor:

PM_{10} NAA average-day emissions	=	Maricopa County PM_{10} average-day emissions	×	Agricultural land use allocation factor
	=	219.7 lbs/day	×	44.14%
	=	100.4 lbs/day		

Table 4.2–4. Typical daily emissions (lbs/day) from agricultural equipment in the PM_{10} nonattainment area.

PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
97.0	94.0	1,034.3	0.4	1.9

4.3 Airport ground support equipment and auxiliary power units

Annual emissions from airport ground support equipment (GSE) and auxiliary power units (APUs) at most airports in the county were estimated using the Emissions Dispersion Modeling System (EDMS, v. 5.1.1) from the U.S. Federal Aviation Administration (FAA). The model can estimate emissions from affiliated ground support equipment (GSE) and auxiliary power units (APUs), by using either default equipment profiles, or user-specified data on equipment populations and activity patterns. In most cases, activity data on 2008 aircraft operations and GSE / APU usage was obtained from individual airport surveys issued by MAG and/or MCAQD. Where survey responses were incomplete or information was otherwise unavailable, activity data was estimated using commercially available data, and EDMS default assumptions where appropriate. Further details concerning the modeling input data and results are presented in Section 4.11 of this report.

For Luke Air Force Base (AFB), emissions estimates for ground support equipment were obtained from a recent base-wide mobile source emissions inventory for calendar year 2008 that had recently been completed for the US Air Force (Weston, 2010). Using data on the frequency and intensity of usage for each type of equipment, annual emissions were calculated as in the following example for a light cart equipped with a diesel engine:

$$E_{pol} = ELHP \times OT \times LF \times EF / CF$$

where:

E_{pol} = Annual emissions of a particular pollutant (lb/yr)	
ELHP = Maximum horsepower rating of engine (hp)	e.g. 10.7 hp
OT = Operating time (hr/yr)	e.g. 52,560 hr/yr
LF = Typical load factor that the engine operates (% of max)	e.g. 51%
EF = Emission factor (g/hp-hr)	e.g. 7.8 g/hp-hr
CF = Conversion factor to convert grams to pounds	(453.59 g/lb)

Thus, total annual NO_x emissions all similar pieces of this type of GSE was calculated as:

$$E_{NOx} = 10.7\ (hp) \times 52{,}560\ (hrs/yr) \times 51\% \times 7.8\ (g/hp\text{-}hr) / 453.59\ (g/lb)$$
$$= 4{,}932\ (lb/yr) / 2{,}000\ (lb/ton)$$
$$= 2.47\ tpy$$

GSE emissions from the Luke AFB study were added to the EDMS-estimated emissions from the other airports in the County. (The Luke study assumed APU usage, and thus emissions, to be negligible.) A simplifying assumption was made for all airports; i.e., that activity is spread fairly evenly throughout the week and year; thus daily emissions were estimated by dividing annual totals by 366 (= days/yr in 2008). Tables 4.3–1 and 4.3–2 below present the totals for all airport GSE and APU usage within both Maricopa County and the PM_{10} nonattainment area, on an annual and typical daily basis, respectively.

Table 4.3–1. Annual emissions (tons/yr) from all airport ground support equipment (GSE) and auxiliary power units (APUs).

	Maricopa County					PM_{10} nonattainment area				
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
GSE	14.92	14.39	497.97	13.62	*	14.72	14.21	490.28	13.42	*
APUs	12.29	12.29	88.76	12.82	*	12.27	12.27	88.68	12.80	*
Total:	**27.21**	**26.68**	**586.73**	**26.43**		**26.99**	**26.48**	**578.95**	**26.22**	

* At present, EDMS does not include calculation of ammonia emissions from aircraft operations.

Table 4.3–2. Typical daily emissions (lb) from airport GSE and APU usage.

	Maricopa County					PM_{10} nonattainment area				
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
GSE	81.5	78.7	2,721.1	74.4	*	80.4	77.7	2,679.1	73.3	*
APUs	67.1	67.1	485.0	70.0	*	67.1	67.1	484.6	70.0	*
Total:	**148.7**	**145.8**	**3,206.1**	**144.4**		**147.5**	**144.7**	**3,163.7**	**143.3**	

* At present, EDMS does not include calculation of ammonia emissions from aircraft operations.

4.4 Commercial equipment

Annual emissions from commercial equipment in Maricopa County were calculated using EPA's NONROAD model, as described in Section 4.1. Annual emissions for the PM_{10} nonattainment area for this category were derived by applying the ratio of industrial employment in the non-attainment area to Maricopa County-level totals, as data on the number of wholesale establishments recommended by EIIP guidance (US EPA, 2002) was not available. See Section 1.5.1 for a discussion of the industrial employment data used.

Table 4.4–1. Annual emissions (tons/yr) from commercial equipment usage.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
117.97	112.98	1,395.23	2.40	21.12	117.66	112.69	1,391.61	2.39	21.06

County average-day emissions were calculated by multiplying Maricopa County annual emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for commercial equipment (0.1666667) listed in Table 4.1–2, and dividing the product by the number of weeks (52) in the year (US EPA, 1999). PM_{10} nonattainment area average-day emissions were calculated based on industrial employment ratios as described above.

Table 4.4–2. Typical daily emissions (lbs/day) from commercial equipment usage.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
756.2	724.2	8,943.8	15.4	135.4	754.2	722.4	8,920.6	15.3	135.0

4.5 Construction and mining equipment

Annual emissions from construction and mining equipment in Maricopa County were calculated using EPA's NONROAD model as described in Section 4.1. Annual emissions for the PM_{10} nonattainment area for this category were derived by applying the ratio of construction employment in the nonattainment area to Maricopa County-level totals as a conservative estimate, as the EIIP-recommended allocation factor of total dollar value of construction was unavailable (US EPA, 2002). See Section 1.5.1 for a discussion of the employment data used.

Table 4.5–1. Annual emissions (tons/yr) from construction and mining equipment usage.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
1,260.98	1,220.75	14,796.63	6.60	28.10	1,249.88	1,210.00	14,666.42	6.55	27.85

County average-day emissions were calculated by multiplying Maricopa County annual emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for construction/mining equipment (0.1666667) listed in Table 4.1–2, and dividing the product by the number of weeks (52) in the year (US EPA, 1999). PM_{10} nonattainment area average-day emissions were calculated based on population ratios as described above.

Table 4.5–2. Typical daily emissions (lbs/day) from construction and mining equipment usage.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
8,083.2	7,825.3	94.850.2	42.3	180.1	8,012.1	7,756.4	94,015.6	42.0	178.5

4.6 Industrial equipment

Annual emissions from industrial equipment in Maricopa County were calculated using EPA's NONROAD model, as described in Section 4.1. Annual emissions for the PM_{10} nonattainment area for this category were derived by applying the ratio of industrial employment in the nonattainment area to Maricopa County-level totals as a conservative estimate, as the number of employees in manufacturing recommended by EIIP guidance (US EPA, 2002) was unavailable. See Section 1.5.1 for a discussion of the industrial employment data used.

Table 4.6–1. Annual emissions (tons/yr) from industrial equipment usage.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
101.69	98.96	2,593.13	3.22	56.23	101.42	98.71	2,586.39	3.21	56.09

County average-day emissions were calculated by multiplying Maricopa County annual emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for industrial equipment (0.1666667) listed in Table 4.1–2, and dividing the product by the number of weeks (52) in the year (US EPA, 1999). PM_{10} nonattainment area average-day emissions were calculated based on industrial employment ratios as described above.

Table 4.6–2. Typical daily emissions (lbs/day) from industrial equipment usage.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
651.8	634.4	16,622.7	20.6	360.5	650.1	632.7	16,579.4	20.6	359.5

4.7 Lawn and garden equipment

Annual emissions from lawn and garden equipment in Maricopa County were calculated using EPA's NONROAD model, as described in Section 4.1. These results reflect revised equipment population and usage estimates from survey work done in early 2003 for the Arizona Department of Environmental Quality (discussed in further detail in Section 4.1). Annual emissions for the PM_{10} nonattainment area for this category were derived by applying the ratio of population in the nonattainment area to Maricopa County-level totals (since data on housing units was unavailable, it was not possible to implement the EIIP-recommended calculation approach (US EPA, 2002). See Section 1.5.1 for a discussion of the population data used.

Table 4.7–1. Annual emissions (tons/yr) from lawn and garden equipment.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
182.28	168.79	798.14	3.16	19.63	183.02	169.48	801.41	3.17	19.71

County average-day emissions were calculated by multiplying Maricopa County annual emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for lawn and garden equipment (0.1600000 for the commercial segment, 0.2222222 for residential) listed in Table 4.1–2, and dividing the product by 52 (the number of weeks in a year; US EPA, 1999). PM_{10} nonattainment area average-day emissions were calculated by applying a population-based ratio as described in Section 4.7 above.

Table 4.7–2. Typical daily emissions (lbs/day) from lawn and garden equipment.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
1,250.1	1,156.9	5,571.5	23.1	144.6	1,255.3	1,161.6	5,594.4	23.2	145.2

4.8 Pleasure craft

Annual emissions from pleasure craft equipment in Maricopa County were calculated using EPA's NONROAD model, as described in Section 4.1. Annual emissions for the PM_{10} nonattainment area for this category were derived by applying the ratio of water surface area in the nonattainment area to Maricopa County-level totals, as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.2 for a discussion of the land use data used.

Table 4.8–1. Annual emissions (tons/yr) from pleasure craft equipment.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
9.25	8.54	77.74	0.85	1.73	7.02	6.48	59.03	0.64	1.32

County average-day emissions were calculated by multiplying Maricopa County annual emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for pleasure craft (0.3500000) listed in Table 4.1–2, and dividing the product by the number of weeks (52) in the year (US EPA, 1999). PM_{10} nonattainment area average-day emissions were calculated based on water surface area as described above.

Table 4.8–2. Typical daily emissions (lbs/day) from pleasure craft equipment.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
124.5	114.9	1,046.5	11.4	23.3	94.5	87.3	794.6	8.6	17.7

4.9 Railway maintenance equipment

Annual emissions from railway maintenance equipment in Maricopa County were calculated using EPA's NONROAD model, as described in Section 4.1. Annual emissions for the PM_{10} nonattainment area for this category were derived by applying the ratio of population in the nonattainment area to Maricopa County-level totals, as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.1 for a discussion of the population data used.

Table 4.9–1. Annual emissions (tons/yr) from railway maintenance equipment.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
1.13	1.09	9.23	0.00	0.02	1.13	1.10	9.26	0.00	0.02

County average-day emissions were calculated by multiplying Maricopa County annual emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for railway maintenance equipment (0.1800000) listed in Table 4.1–2, and dividing the product by the number of weeks (52) in the year (US EPA, 1999). PM_{10} nonattainment area average-day emissions were calculated based on the population ratio as described above.

Table 4.9–2. Typical daily emissions (lbs/day) from railway maintenance equipment.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
7.8	7.6	63.9	0.0	0.1	7.8	7.6	64.1	0.0	0.1

4.10 Recreational equipment

Annual emissions from recreational equipment in Maricopa County were calculated using EPA's NONROAD model, as described in Section 4.1. Annual emissions for the PM_{10} nonattainment area for this category were derived by applying the ratio of passive open space and vacant land use in the nonattainment area to Maricopa County-level totals as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.2 for a discussion of the land use data used.

Table 4.10–1. Annual emissions (tons/yr) from recreational equipment.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
45.58	41.98	63.80	0.42	2.10	7.68	7.08	10.76	0.07	0.35

County average-day emissions were calculated by multiplying Maricopa County annual emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for recreational equipment (0.2222222) listed in Table 4.1–2, and dividing the product by the number of weeks (52) in the year (US EPA, 1999). PM_{10} nonattainment area average-day emissions were calculated based on land use as described above.

Table 4.10–2. Typical daily emissions (lbs/day) from recreational equipment.

Maricopa County					PM_{10} nonattainment area				
PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
389.6	358.8	545.3	3.6	18.0	65.7	60.5	91.9	0.6	3.0

4.11 Aircraft

Emissions from aircraft operations at the largest civilian airports in Maricopa County were estimated using the Federal Aviation Administration's Emissions and Dispersion Model (EDMS, v. 5.1.1). The EDMS model combines specified aircraft type and activity levels with default emission factors in order to estimate annual emissions inventories for a specific airport. The model calculates emissions of sulfur oxides (SOx), oxides of nitrogen (NOx), carbon monoxide (CO), and volatile organic compounds (VOC), and, for a small subset of aircraft and engine types), PM_{10} and $PM_{2.5}$ as well. The model also estimates emissions from affiliated ground support equipment (GSE) and auxiliary power units (APUs); these emissions are reported separately and are summarized in Section 4.3.

MCAQD surveyed all medium and large airports in Maricopa County to gather data on aircraft type and activity level of aircraft operations. Specifically, the number of landing and takeoff cycles (LTO's) or touch and go operations (TGOs), along with information on the types of aircraft that comprise the airport's typical fleet mix, and other operational data, such as typical usage patterns of ground support equipment (GSE) and auxiliary power units (APUs), average taxi/idle times, etc. Where survey responses were unavailable or incomplete, aircraft activity data from publicly accessible databases, such as the FAA's Air Traffic Activity System (ATADS) and Enhanced Traffic Management System Counts (ETMSC), were used.

All emission estimates in this section have been developed using the EDMS model, with the exception of Luke Air Force Base (AFB), whose emissions calculations have been prepared as part of a base-wide 2008 mobile source emissions inventory that has recently been completed (Weston, 2010). Luke AFB's emissions reported as 'aircraft activity' actually comprise three distinct, though related, types of activity: (1) the operation of aircraft stationed at the base, (2) a much smaller level of "transient" aircraft traffic within Luke's airspace, and (3) emissions produced during on-wing engine testing – considered a "mobile source" emission category. As with all other airports included in this inventory, emissions from ground support equipment (GSE) at Luke AFB are addressed in Section 4.3, Airport ground support equipment and auxiliary power units.

In addition to the LTOs (and occasional TGO activity) reported by other airports in the area, Luke reported two additional, types of aircraft operations: aircraft low fly bys (LFB), and aircraft low fly patterns (LFP). Each of these types of operations can be characterized by a distinctive combination of the times in mode (TIM); (e.g., approach, taxi in/out, takeoff and climb out.)

Luke AFB's emissions are not based on the number of LTOs, but rather the aggregate annual operational time in modes (TIMs) for all aircraft of similar type. For the F-16, an LTO cycle includes five modes of operation: idle (taxi in/out), intermediate, approach, military and afterburner. The F-16 emissions were estimated using the annual TIMs provided by Luke AFB and emission factors from military guidance documents.

Table 4.11–1 lists the data sources for each airport's activity level, as well as fleet mix. The total number of aircraft operations in 2008 is also listed. For all airports other than Luke AFB, aircraft emissions were estimated for four aircraft categories:

- Air carriers (abbreviated "AC"): Larger commercial aircraft with at least 60 seats or 18,000 lbs payload capacity, used for scheduled service to transport passengers and/or freight;

- Air taxis ("AT"): Smaller commercial turbine- or piston-powered aircraft with less than 60 seats or 18,000 lbs payload capacity;
- General aviation ("GA"): Aircraft used on an unscheduled basis for recreational flying, personal transportation, and other activities, including business travel; and
- Military ("ML"): Aircraft used to support military operations.

Table 4.11–1. Annual airport operations (by aircraft category), and related data sources.

Airport	Airport Code	Operations Data Source[1]	Fleet Mix Data Source[2]	Aircraft Type	2008 Operations
Buckeye Municipal	BXK	airnav.com	Generic GA profile	GA	26,535
Chandler Municipal	CHD	FAA/ATADS	FAA/ETMSC	AT	2,882
				GA	233,713
				ML	247
Falcon Field	FFZ	FAA/ATADS	FAA/ETMSC	AC	6
				AT	3,813
				GA	313,448
				ML	2,152
Gila Bend Municipal	E63	airnav.com	Generic GA profile	GA	1,768
Glendale Municipal	GEU	FAA/ATADS, Survey response	FAA/ETMSC	AT	1,873
				GA	134,282
				ML	57
Luke Air Force Base	LUF	[Emission totals provided by Luke AFB are based on times-in-mode.]			
Phoenix Deer Valley	DVT	Survey response	Survey response, FAA/ETMSC	AC	284
				AT	6,217
				GA	370,003 *
				ML	130
Phoenix Goodyear	GYR	Survey response	Survey response, FAA/ETMSC	AC	140
				AT	1962
				GA	169,177 *
				ML	6,747
Phoenix-Mesa Gateway (formerly Williams Gateway)	IWA	FAA/ATADS, Survey response	FAA/ETMSC	AC	3,876
				AT	5,937
				GA	211,674
				ML	5,939
Phoenix Sky Harbor	PHX	Survey response	Survey response, FAA/ETMSC	AC	391,518
				AT	77,354
				GA	30,868
				ML	2,759
Pleasant Valley	P48	airnav.com	Generic GA profile	GA	23,535
Scottsdale	SDL	FAA/ATADS	FAA/ETMSC	AT	11,232
				GA	179,619
				ML	560
Sky Ranch at Carefree	18AZ	Survey response	Generic GA profile	GA	1,515
Stellar Airpark	P19	airnav.com	Generic GA profile	GA	19,528
Wickenburg Municipal	E25	Survey responses	Generic GA profile	GA	6,000

1. FAA/ATADS: Federal Aviation Administration's Air Traffic Activity Data System (database); http://aspm.faa.gov.
2. FAA/ETMSC: Federal Aviation Administration's Enhanced Traffic Management System Counts (database); http://aspm.faa.gov.

* includes touch-and-go (TGO) operations levels reported by the airport.

The following section describes how activity and emissions were estimated for a representative airport, Chandler Municipal (CHD). The FAA's Air Traffic Activity System (ATADS, http://www.aspm.faa.gov) provided data on 2008 activity by aircraft type; these results are contained in Table 4.11–1. While ATADS reported a total of 233,713 general aviation operations at this airport in 2008, further information on the aircraft types comprising this activity was

needed. The FAA's Enhanced Traffic Management System Counts (ETMSC) database was used to "grow" available aircraft-specific operational data as described below.

The ETMSC database on general aviation activity at CHD in 2008 comprises 152 different aircraft types, totaling 3,589 operations, (See Table 4.11–2). To simplify modeling input requirements, this aircraft-specific activity data was ranked in order of decreasing frequency and activity data for the most frequently reported aircraft was then grown to represent all general aviation ("GA") activity, as shown in Table 4.11–2 below.

Table 4.11–2. Example showing how most common aircraft-specific activity was grown for EDMS modeling.

Rank	Aircraft Type	ETMSC-reported operations	% of total reported operations	Cumulative Percent	"Grown" operations for EDMS modeling
1	BE20 - Beech 200 Super King	240	6.7%		21,919
2	BE58 - Beech 58	233	6.5%		21,280
3	PA28 - Piper Cherokee	233	6.5%		21,280
4	C525 - Cessna CitationJet/CJ1	232	6.5%		21,189
5	C182 - Cessna Skylane 182	203	5.7%	31.8%	18,540
6	C172 - Cessna Skyhawk 172/Cutlass	194	5.4%		17,718
7	TBM7 - Socata TBM-7	166	4.6%		15,161
8	R22 - Robinson R-22 Mariner	138	3.8%		12,604
9	BE9L - Beech King Air 90	106	3.0%		9,681
10	BE36 - Beech Bonanza 36	97	2.7%	51.3%	8,859
11	BE55 - Beech Baron 55	90	2.5%		8,220
12	BE35 - Beech Bonanza 35	87	2.4%		7,946
13	C210 - Cessna 210 Centurion	75	2.1%		6,850
14	PA32 - Piper Cherokee Six	73	2.0%		6,667
15	P28R - Cherokee Arrow/Turbo	71	2.0%	62.4%	6,484
16	P46T - Piper Malibu Meridian	67	1.9%		6,119
17	SR22 - Cirrus SR 22	67	1.9%		6,119
18	BE30 - Raytheon 300 Super King Air	65	1.8%		5,936
19	MO20 - Mooney M-20	62	1.7%		5,662
20	C560 - Cessna Citation V/Ultra/Encore	60	1.7%	71.3%	5,480
⋮	⋮	⋮	⋮	⋮	
152	XL2 - Liberty XL-2	1	< 0.1%	100.0%	(n/a)
	Totals:	**3,589**			**233,713**

This approach of ranking reported activity, and then growing the most frequently occurring subset of aircraft typically resulted in a set comprised of 10 to 30 aircraft types being modeled for each airport/aircraft class combination, representing 60 to 100% of all reported activity. Since the EDMS model includes estimates of PM_{10} emissions only for a relatively small number of aircraft/engine types, all model output files were reviewed for missing data. For those aircraft/engine combinations for which the EDMS model indicated zero PM_{10} emissions, the default EPA emission factors listed in Table 4.11–3 (US EPA, 2003) were incorporated into the EDMS output data files, and total PM emissions recalculated.

Table 4.11–3. EPA's default PM_{10} emission factors for aircraft, by activity type.

Activity type	PM_{10} Emission Factor (lb/LTO)
Air Carrier, Air Taxi, Military	0.60333
General Aviation	0.2367

Following EPA guidance (US EPA, 2003), $PM_{2.5}$ emissions were estimated to be 92% of PM_{10} levels. For ease in modeling computation and the assessment of emissions, all activity was assumed to occur evenly throughout the year. Thus, average daily emissions were calculated by dividing annual totals by 366 (= days per year in 2008). Tables 4.11–4 and 4.11–5 list the total annual emissions and average daily emissions of each airport and aircraft type, and for airports within and outside the PM_{10} NAA, respectively.

Table 4.11–4. Annual and average daily emissions, by airport and aircraft type, from airports within the PM_{10} NAA.

	Cate-	Annual emissions (tons/yr)				Typical daily emissions (lbs/day)			
Airport	**gory**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**
Chandler Municipal	AT	0.27	0.27	0.94	0.24	1.5	1.5	5.1	1.3
	GA	12.68	11.79	18.51	6.43	69.3	64.4	101.1	35.1
	ML	0.04	0.04	0.12	0.02	0.2	0.2	0.6	0.1
	Total	***12.99***	***12.10***	***19.56***	***6.68***	***71.0***	***66.1***	***106.9***	***36.5***
Falcon Field	AC	0.00	0.00	0.00	-	0.0	0.0	0.0	0.0
	AT	0.23	0.23	2.94	0.49	1.3	1.2	16.0	2.7
	GA	18.49	17.07	14.34	6.16	101.0	93.3	78.3	33.7
	ML	0.31	0.29	0.40	0.13	1.7	1.6	2.2	0.7
	Total	***19.03***	***17.59***	***17.67***	***6.78***	***104.0***	***96.1***	***96.6***	***37.0***
Glendale Municipal	AT	1.06	1.05	9.70	2.43	5.8	5.7	53.0	13.3
	GA	6.90	6.41	5.51	2.20	37.7	35.0	30.1	12.0
	ML	0.01	0.01	0.12	0.02	0.0	0.0	0.6	0.1
	Total	***8.17***	***7.66***	***15.51***	***4.71***	***44.6***	***41.8***	***84.8***	***25.7***
Luke Air Force Base†	ML	***62.82***	***62.82***	***382.40***	***31.81***	***343.3***	***343.3***	***2,089.6***	***173.8***
Phoenix Deer Valley	AC	0.04	0.04	0.05	0.01	0.2	0.2	0.3	0.1
	AT	0.41	0.41	3.97	0.76	2.2	2.2	21.7	4.2
	GA	10.10	9.43	62.81	14.61	55.2	51.5	343.2	79.8
	ML	0.02	0.02	0.07	0.02	0.1	0.1	0.4	0.1
	Total	***10.57***	***9.90***	***66.91***	***15.40***	***57.8***	***54.1***	***365.6***	***84.1***
Phoenix Goodyear	AC	0.02	0.01	0.36	0.05	0.1	0.1	1.9	0.3
	AT	0.19	0.19	1.61	0.28	1.1	1.0	8.8	1.5
	GA	0.66	0.66	18.86	5.25	3.6	3.6	103.0	28.7
	ML	0.96	0.89	3.66	1.07	5.2	4.8	20.0	5.8
	Total	***1.83***	***1.74***	***24.48***	***6.64***	***10.0***	***9.5***	***133.8***	***36.3***
Phoenix Sky Harbor Intl.	AC	22.38	22.38	1,751.85	185.77	122.3	122.3	9,573.0	1,015.2
	AT	4.24	4.02	116.92	17.51	23.2	22.0	638.9	95.7
	GA	3.37	3.21	12.81	2.83	18.4	17.6	70.0	15.4
	ML	0.45	0.43	23.48	2.34	2.5	2.4	128.3	12.8
		30.45	***30.05***	***1,905.06***	***208.45***	***166.4***	***164.2***	***10,410.2***	***1,139.1***
Phoenix-Mesa Gateway Airport	AC	0.16	0.15	13.25	1.72	0.9	0.8	72.4	9.4
	AT	0.63	0.62	3.02	0.64	3.4	3.4	16.5	3.5
	GA	12.99	12.04	17.41	5.48	71.0	65.8	95.2	29.9
	ML	0.58	0.55	26.56	3.14	3.2	3.0	145.1	17.1
		14.35	***13.36***	***60.24***	***10.98***	***78.4***	***73.0***	***329.2***	***60.0***
Pleasant Valley	GA	0.36	0.33	1.65	0.34	1.9	1.8	9.0	1.8
Scottsdale	AT	1.03	1.02	7.84	1.37	5.7	5.6	42.8	7.5
	GA	19.83	18.86	116.13	21.79	108.4	103.1	634.6	119.1
	ML	0.08	0.08	0.24	0.06	0.5	0.4	1.3	0.3
		20.95	***19.96***	***124.21***	***23.22***	***114.5***	***109.1***	***678.8***	***126.9***
Skyranch at Carefree	GA	***0.18***	***0.17***	***0.39***	***0.10***	***1.0***	***0.9***	***2.1***	***0.5***
Stellar Airpark	GA	***2.31***	***2.13***	***2.42***	***0.97***	***12.6***	***11.6***	***13.2***	***5.3***
PM_{10} NAA totals:		**183.80**	**177.61**	**2,620.31**	**316.00**	**1,004.3**	**970.5**	**14,318.6**	**1,726.8**

† Sum of emissions from the following categories, as reported in Weston (2010): (1) aircraft stationed at Luke AFB, (2) transient aircraft, and (3) on-wing aircraft engine testing.

Table 4.11–5. Annual and average daily emissions, by aircraft type, from airports outside the PM_{10} NAA.

Facility	Cate-gory	Annual emissions (tons/yr)				Average daily emissions (lbs/day)			
		PM_{10}	$PM_{2.5}$	NO_x	SO_x	PM_{10}	$PM_{2.5}$	NO_x	SO_x
Buckeye Municipal	GA	3.14	2.89	2.70	0.97	17.2	15.8	14.8	5.3
Gila Bend Municipal	GA	0.21	0.19	0.18	0.06	1.1	1.1	1.0	0.3
Wickenburg Municipal	GA	0.77	0.73	2.75	0.61	4.2	4.0	15.0	3.3
Maricopa County totals:		**187.91**	**181.42**	**2,625.94**	**317.64**	**1,026.8**	**991.4**	**14,349.4**	**1,735.8**

4.12 Locomotives

Annual emissions from locomotives were calculated based on diesel fuel usage data provided by Burlington Northern/Santa Fe Railway (BNSF), Union Pacific Railway (UP) and Amtrak. Railway operations from these companies fall into two categories: Class I haul lines and yard/ switching operations. Annual emissions from these two activity categories were calculated by multiplying diesel fuel usage by the emission factors listed in Table 4.12–1 (US EPA, 2009).

Table 4.12–1. Emission factors for locomotives.

Activity type	Emission factors (lbs/gal diesel)				
	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
Class I haul line	0.015	0.014	0.394	0.004	0.0001
Yard/switch operations	0.015	0.014	0.421	0.004	0.0001

The example below illustrates how emissions were calculated for each locomotive activity type. Fuel use reported by railroads, and emission totals are summarized in Table 4.12–2.

PM_{10} emissions from UP Class I haul lines = Diesel use (gals/yr) × PM_{10} emission factor (lbs/gal) ÷ 2,000 lbs/ton

= 7,780,284 gals/yr × 0.015 lbs/gal ÷ 2,000 lbs/ton

= 58.35 tons PM_{10}/yr

Table 4.12–2. Total diesel use and annual emissions from locomotives in Maricopa County.

Locomotive type	Diesel use (gals/yr)	Annual emissions (tons/yr)				
		PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
BNSF Class I haul line	750,094	5.63	5.25	147.77	1.50	0.36
UP Class I haul line	7,780,284	58.35	54.46	1,532.72	15.56	3.70
BNSF yard/switch operations	400,000	3.00	2.80	84.20	0.80	0.19
UP yard/switch operations	378,199	2.84	2.65	79.61	0.76	0.18
Amtrak	52,416	0.39	0.37	10.33	0.10	0.02
Totals:	**9,360,993**	**70.21**	**65.53**	**1,854.62**	**18.72**	**4.45**

PM_{10} nonattainment area emissions were calculated by multiplying Maricopa County emissions by the percentage of track miles within the PM_{10} nonattainment area, determined by GIS mapping. Results are shown in Table 4.12–3.

PM_{10} nonattainment area emissions from UP Class I haul lines (tons/yr) = County PM_{10} emissions (tons/yr) × Percentage of track miles within the PM_{10} nonattainment area

= 58.35 tons PM_{10}/yr × 44.27%

= 25.83 tons PM_{10}/yr

Table 4.12–3. Annual emissions (in tons/yr) from locomotives in the PM_{10} NAA.

Locomotive type	Track in nonattainment area (%)	Annual emissions (tons/yr)				
		PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
BNSF Class I haul line	44.27	2.49	2.32	65.42	0.66	0.16
UP Class I haul line	44.27	25.83	24.11	678.53	6.89	1.64
BNSF yard/switch operations	100.00	3.00	2.80	84.20	0.80	0.19
UP yard/switch operations	100.00	2.84	2.65	79.61	0.76	0.18
Amtrak	0.00	0.00	0.00	0.00	0.00	0.00
Totals:		**34.16**	**31.88**	**907.76**	**9.11**	**2.16**

PM_{10} typical daily emissions for both the county (shown in Table 4.12–4) and the PM_{10} non-attainment area (Table 4.12–5) were calculated by dividing annual totals by 366 days (since 2008 was a leap year), as locomotive activity is assumed to be uniform throughout the year.

PM_{10} typical daily emissions from haul lines = Annual PM_{10} emissions (tons) × 2000 lbs/ton ÷ 366 days

= 58.35 tons PM_{10}/yr × 2000 lbs/ton ÷ 366 days

= 318.9 lbs PM_{10}/day

Table 4.12–4. Typical daily emissions (in lbs/day) from locomotives in Maricopa County.

Locomotive type	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
BNSF Class I haul line	30.7	28.7	807.5	8.2	1.9
UP Class I haul line	318.9	297.6	8,375.5	85.0	20.2
BNSF yard/switch operations	16.4	15.3	460.1	4.4	1.0
UP yard/switch operations	15.5	14.5	435.0	4.1	1.0
Amtrak	2.1	2.0	56.4	0.6	0.1
Totals:	**383.6**	**358.1**	**10,134.5**	**102.3**	**24.3**

Table 4.12–5. Typical daily emissions (in lbs/day) from locomotives in the PM_{10} nonattainment area.

Locomotive type	PM_{10}	$PM_{2.5}$	NO_x	SO_x	NH_3
BNSF Class I haul line	13.6	12.7	357.5	3.6	0.9
UP Class I haul line	141.2	131.8	3,707.8	37.6	8.9
BNSF yard/switch operations	16.4	15.3	460.1	4.4	1.0
UP yard/switch operations	15.5	14.5	435.0	4.1	1.0
Amtrak	0.0	0.0	0.0	0.0	0.0
Totals:	**186.7**	**174.2**	**4,960.4**	**49.8**	**11.8**

4.13 Summary of all nonroad mobile source emissions

Table 4.13–1 summarizes annual and daily emissions of PM_{10}, $PM_{2.5}$, NO_x, SO_x and NH_3 from nonroad mobile sources in Maricopa County. Table 4.13–2 shows annual and typical daily emissions for these pollutants for the PM_{10} nonattainment area.

Table 4.13–1. Annual and typical daily emissions from nonroad mobile sources in Maricopa County.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Agricultural	34.27	33.24	365.55	0.14	0.67	219.7	213.1	2,343.3	0.9	4.3
Airport GSE	27.21	26.68	586.73	26.43		148.7	145.8	3,206.1	144.4	
Commercial	117.97	112.98	1,395.23	2.40	21.12	756.2	724.2	8,943.8	15.4	135.4
Construction & mining	1,260.98	1,220.75	14,796.63	6.60	28.10	8,083.2	7,825.3	94,850.2	42.3	180.1
Industrial	101.69	98.96	2,593.13	3.22	56.23	651.8	634.4	16,622.7	20.6	360.5
Lawn & garden	182.28	168.79	798.14	3.16	19.63	1,250.1	1,156.9	5,571.5	23.1	144.6
Pleasure craft	9.25	8.54	77.74	0.85	1.73	124.5	114.9	1,046.5	11.4	23.3
Railway maintenance	1.13	1.10	9.23	0.00	0.02	7.8	7.6	63.9	0.0	0.1
Recreational	45.58	41.98	63.80	0.42	2.10	389.6	358.8	545.3	3.6	18.0
Aircraft	187.91	181.41	2,625.94	317.64		1,026.8	991.3	14,349.4	1,735.8	
Locomotives	70.21	65.53	1,854.62	18.72	4.45	383.6	358.1	10,134.5	102.3	24.3
Totals:	**2,038.46**	**1,959.95**	**25,166.75**	**379.58**	**134.06**	**13,042.0**	**12,530.3**	**157,677.4**	**2,099.8**	**890.6**

Table 4.13–2. Annual and typical daily emissions from nonroad mobile sources in the PM_{10} NAA.

	Annual emissions (tons/yr)					Typical daily emissions (lbs/day)				
Category	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**	**PM_{10}**	**$PM_{2.5}$**	**NO_x**	**SO_x**	**NH_3**
Agricultural	15.13	14.67	161.35	0.06	0.30	97.0	94.0	1,034.3	0.4	1.9
Airport GSE	26.99	26.48	578.95	26.22		147.5	144.7	3,163.7	143.3	
Commercial	117.66	112.69	1,391.61	2.39	21.06	754.2	722.4	8,920.6	15.3	135.0
Construction & mining	1,249.88	1,210.00	14,666.42	6.55	27.85	8,012.1	7,756.4	94,015.6	42.0	178.5
Industrial	101.42	98.71	2,586.39	3.21	56.09	650.1	632.7	16,579.4	20.6	359.5
Lawn & garden	183.02	169.48	801.41	3.17	19.71	1,255.3	1,161.6	5,594.4	23.2	145.2
Pleasure craft	7.02	6.48	59.03	0.64	1.32	94.5	87.3	794.6	8.6	17.7
Railway maintenance	1.13	1.10	9.26	0.00	0.02	7.8	7.6	64.1	0.0	0.1
Recreational	7.68	7.08	10.76	0.07	0.35	65.7	60.5	91.9	0.6	3.0
Aircraft	183.80	177.60	2,620.31	316.00		1,004.3	970.5	14,318.6	1,726.8	
Locomotives	34.16	31.88	907.76	9.11	2.16	186.7	174.2	4,960.4	49.8	11.8
Totals:	**1,927.89**	**1,856.17**	**23,793.26**	**367.42**	**128.87**	**12,275.2**	**11,811.9**	**149,537.7**	**2,030.5**	**852.9**

4.14 Quality assurance procedures

Established procedures were used to check, and correct when necessary, the nonroad mobile sources emissions estimates. All NONROAD model input and output files, and Excel spreadsheets used to calculate the emissions, were checked by personnel not involved in developing the modeling inputs/outputs and spreadsheets being reviewed. In addition, the emissions estimates were reviewed for reasonableness by external agency staff.

4.15 References

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5. Onroad Mobile Sources

5.1 Introduction

Onroad mobile source emissions have been calculated for particulate matter for the 2008 Periodic Emissions Inventory for the Maricopa County area. For the purposes of this particulate matter inventory, the following pollutants were included: PM_{10}, $PM_{2.5}$, nitrogen oxides (NO_x), sulfur dioxides (SO_2), and ammonia (NH_3). PM_{10} refers to all particles less than or equal to 10 micrometers in diameter and $PM_{2.5}$ refers to particles less than or equal to 2.5 micrometers in diameter.

Onroad mobile source emissions were estimated for the PM_{10} nonattainment area (NAA) (approximately 3,000 sq. mi.), as well as for Maricopa County (approximately 9,000 sq. mi.). Emission factors were calculated using the Motor Vehicle Emission Simulator (MOVES2010a) model, the most recent model developed by the U.S. EPA for the purpose of estimating motor vehicle emission factors, and AP-42, which is the EPA Compilation of Air Pollutant Emission Factors. AP-42 emission factors were used to calculate fugitive dust emissions, while MOVES2010a was used to estimate emissions from exhaust, tire wear, and brake wear.

The MOVES2010a modeling accounted for the oxygenated fuel and the Arizona Vehicle Inspection/Maintenance (I/M) programs applied in Maricopa County in 2008. The fuel use assumptions, including oxygen content and Reid Vapor Pressure (RVP), were derived from the 2008 fuel inspection results provided by the Arizona Department of Weights and Measures.

In order to develop the 2008 onroad mobile source emissions, the 2008 vehicle miles of travel (VMT) estimates by facility type and road type were derived from the 2008 Highway Performance Monitoring System (HPMS) data provided by the Arizona Department of Transportation (ADOT). The distribution of VMT by vehicle type is based on the July 2008 vehicle registration data for Maricopa County provided by ADOT. The VMT by vehicle type was provided as local input data for MOVES2010a to produce onroad exhaust, tire wear, and brake wear emissions.

Paved road fugitive dust emission estimates were derived from the AP-42 equation published by EPA in January 2011. The 2008 VMTs for freeways, high traffic arterials, and low traffic arterials were derived from the 2008 traffic assignment produced by the MAG travel demand model. Low traffic arterials carry less than 10,000 vehicles on an average weekday, while high traffic arterials carry 10,000 or more vehicles on an average weekday. These traffic assignment VMTs were normalized to 2008 HPMS VMTs and multiplied by the appropriate particulate emission factors derived from the AP-42 equation for paved roads. The 2008 benefits of the committed measures in the MAG 2007 Five Percent Plan for the Maricopa County PM10 Nonattainment Area (MAG, 2007) were applied to estimate 2008 paved road particulate emissions for the PEI.

Unpaved road VMT was derived from the MAG 2009 Unpaved Road Inventory (MAG, 2010). Unpaved alley VMT was derived from a GIS analysis of 2009 aerial photographs conducted by MAG. The unpaved road and alley VMTs were multiplied by the appropriate AP-42 emission factors. The 2008 benefits of the committed measures in the MAG 2007 Five Percent Plan were applied to estimate 2008 unpaved road and alley particulate emissions for this inventory.

The main references for preparing the onroad mobile source portion of the 2008 emissions inventory were:

- Emission Inventory Requirements for Ozone State Implementation Plans (EPA, 1991);
- Procedures for Emission Inventory Preparation Volume IV: Mobile Sources (EPA, 1992a);
- Compilation of Air Pollutant Emissions Factors, AP-42 (EPA, 2006);
- Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity (EPA, 2010a);
- User's Guide for the SMOKE-MOVES Integration Tool (EPA, 2010b); and
- Motor Vehicle Emission Simulator (MOVES) - User Guide for MOVES2010a, (EPA, 2010c).

5.2 Exhaust, tire wear, and brake wear emissions

Vehicle exhaust emission factors for PM_{10}, $PM_{2.5}$, NO_x, SO_2, and NH_3, as well as tire wear and brake wear emission factors for PM_{10} and $PM_{2.5}$, were calculated using MOVES2010a. The exhaust PM_{10} and $PM_{2.5}$ estimates include the components of sulfate and carbon (organic and elemental). The MOVES2010a runs were executed by MAG. The contact person for the MOVES2010a emission estimates is Ieesuck Jung (602-254-6300).

5.2.1 MOVES2010a model

The emissions not related to fugitive dust were calculated using MOVES2010a, the U.S. EPA's state-of-the-art emissions modeling tool, which replaces EPA's previous mobile source emissions model, MOBILE6.2. MOVES2010a is intended for official use to estimate national, state, and county level inventories of criteria air pollutants from highway vehicles. The user of MOVES2010a is allowed to specify vehicle types, time periods, geographical areas, pollutants, vehicle operating characteristics, and road types for the particular scenario to be modeled by creating a Run Specification (RunSpec).

In order to calculate vehicle emissions for the calendar year 2008, MOVES2010a was executed using local input data for each month of the year and each geographical area (Maricopa County and the PM_{10} NAA). Each scenario was created using the County Domain/Scale and the Inventory Calculation Type. The specific MOVES2010a model RunSpec and RunSpec summaries are described in Appendix 5.

5.2.2 MOVES2010a local input data

Compared with MOBILE6.2, MOVES2010a requires a more detailed level of local data, including fuel data, I/M program, meteorological data, vehicle population, source type age distribution, annual VMT, monthly/daily/hourly VMT fractions, road type distribution, average speed distribution, and ramp fraction.

5.2.2.1 Fuel data

Regarding the fuel local input data, MOVES2010a provides two MOVES tables, which are [fuelsupply] and [fuelformulation]. The fuel data for each month were derived from the 2008 fuel inspection results in Maricopa County provided by the Arizona Department of Weights and Measures. The fuel data for Maricopa County were also applied to the PM_{10} NAA. The specific MOVES tables for fuel data are presented in Appendix 5.

5.2.2.2 I/M programs

MOVES2010a has an [IMCoverage] table for I/M programs; this table was prepared using MOBILE6.2 input. This table reflects the actual proportions of vehicles subject to the specified levels of inspection. The term "I/M vehicles" denotes vehicles which are required to undergo an emission test and/or inspection under the Vehicle Inspection/Maintenance Program. It is important to note that participation in the I/M program is required for all vehicles registered in the PM_{10} NAA, with the exception of certain model years and vehicle classes. However, it is assumed that 91.6 percent of the vehicles operating within the PM_{10} NAA and Maricopa County participate in the I/M program and the remaining 8.4 percent do not participate in the program. These percentages reflect the control measures "Tougher Enforcement of Vehicle Registration and Emissions Test Compliance" and "Expansion of Area A Boundaries," described in the MAG Eight-Hour Ozone Redesignation Request and Maintenance Plan for the Maricopa Nonattainment Area (MAG, 2009). This percentage is directly applied to the Compliance Factor in the [IMCoverage] table. The same I/M programs were applied for Maricopa County and the PM_{10} NAA. The specific MOVES table for I/M programs is presented in Appendix 5.

5.2.2.3 Meteorological data

MOVES2010a requires hourly temperature and relative humidity data by specific month of the year. Meteorological data for the Phoenix Sky Harbor International Airport in 2008 were obtained from the National Climatic Data Center (http://www7.ncdc.noaa.gov/IPS/lcd/lcd.html?_page=1&state=AZ&wban=23183&_target2=Next+%3E). The same hourly average temperature and relative humidity data for each month were applied for Maricopa County and the PM_{10} NAA. The specific MOVES table [ZoneMonthHour] for meteorological data is presented in Appendix 5.

5.2.2.4 Vehicle population

In order to capture start, evaporative, and extended idle emissions, MOVES2010a introduced a new mobile source emission category called off-network emissions. In MOVES2010a, these off-network emissions are directly determined by the population of vehicles in an area. The vehicle population in Maricopa County was obtained from the July 2008 vehicle registration data provided by ADOT. The vehicle population data were allocated to the 28 MOBILE6.2 vehicle types based on MOBILE6.2 VMT fractions for 2008. Then, the vehicle population data allocated to the 28 MOBILE6.2 vehicle types were assigned to the 13 MOVES source types using the match-up table (Table A.1) in the EPA's technical guidance (EPA, 2010a). The vehicle population in the PM_{10} NAA was estimated by applying the population ratio of the two geographical areas to the vehicle population in Maricopa County. The population ratio for 2008 was derived from the MAG socioeconomic data, which is 4,005,000 people for the PM_{10} NAA and 3,988,000 people for Maricopa County. The specific MOVES table [SourceTypeYear] for vehicle population is presented in Appendix 5.

5.2.2.5 Source type age distribution

MOVES2010a categorizes vehicles according to different vehicle classes and model years. The source type age distribution was prepared using EPA's data converter that takes the registration distribution input file created for MOBILE6.2 and converts it to the appropriate MOVES age distribution input table [SourceTypeAgeDistribution]. The same source type age distribution was applied for Maricopa County and the PM_{10} NAA. The specific MOVES table for source type age distribution is presented in Appendix 5.

5.2.2.6 Annual VMT

The 2008 daily VMTs by facility type were used to estimate onroad exhaust, tire wear, and brake wear emissions. The 2008 VMT distributions by facility type for the PM10 NAA and Maricopa County were obtained from the 2008 Maricopa County Estimates of Daily Vehicle Travel by Highway Functional Classification provided by ADOT. The 2008 VMT distributions were multiplied by the 2008 HPMS VMT for the PM10 NAA and Maricopa County. The resultant VMT estimates by facility type for the PM10 NAA and Maricopa County are shown in Table 5.2–1.

Table 5.2–1. 2008 daily VMT by facility type (annual average daily traffic).

	Facility Type	PM_{10} NAA (thousand miles/day)	Maricopa County (thousand miles/day)
Rural	Interstate	2,581	3,223
	Other Principal Arterial	1,035	1,293
	Minor Arterial	529	661
	Major Collector	1,347	1,682
	Minor Collector	164	205
	Local	630	787
Urban	Interstate	10,606	10,939
	Other Freeway/Expressway	19,158	19,760
	Other Principal Arterial	21,961	22,651
	Minor Arterial	14,476	14,930
	Collector	4,717	4,865
	Local	9,949	10,261
Totals:		**87,153**	**91,257**

Since MOVES2010a requires annual VMTs by HPMS vehicle type as a local input, the daily VMTs by HPMS vehicle type were derived from the 2008 traffic assignment data provided by the MAG Transportation Modeling Group in March 2011 and the daily VMTs by facility type and the estimated percentages of daily vehicle travel by vehicle type and highway functional classification provided by ADOT. Then, the daily VMTs by HPMS vehicle type were multiplied by 366 days to obtain the annual VMTs by HPMS vehicle type. The specific MOVES table [HPMSvTypeYear] for annual VMT is presented in Appendix 5.

5.2.2.7 Road type distribution

MOVES2010a requires the distribution of VMTs by road type as a local input. The road type VMT distribution by HPMS vehicle type was derived from the 2008 traffic assignment data and the daily VMTs by HPMS vehicle type mentioned in the previous section. As suggested in EPA's technical guidance (EPA, 2010a), the same road type distribution by HPMS vehicle type was used for all MOVES source types within an HPMS vehicle class. The specific MOVES table [RoadTypeDistribution] for road type distribution is presented in Appendix 5.

5.2.2.8 VMT fraction

Since VMT varies by month, day of week, and hour, MOVES2010a requires month/day/hour VMT fractions as a local input in order to derive hourly VMT for each weekday/weekend and month from the annual VMT. The month/day/hour VMT fractions were developed from data recorded by continuous traffic counters on freeways (ADOT Freeway Management System) and arterials (Phoenix Automatic Traffic Recorders) during the year 2007. The specific MOVES tables [MonthVMTFraction], [DayVMTFraction], and [HourVMTFraction] for VMT fractions are presented in Appendix 5.

5.2.2.9 Average speed distribution

In MOVES2010a, vehicle power, speed, and acceleration have a significant effect on vehicle emissions for all pollutants. MOVES2010a estimates those emission effects by assigning activity to operating mode distributions, which are determined by the distribution of vehicle hours traveled (VHT) by average speed. As recommended in EPA's technical guidance (EPA, 2010a), local estimates of average speed were developed by post-processing the output from the 2008 traffic assignment data provided by the MAG Transportation Modeling Group in March 2011. To develop the average speed distribution, VHTs in sixteen speed bins were accumulated separately for each hour of the day, source type, and road type in Maricopa County. Then, the average speed distribution was calculated by normalizing VHTs in sixteen speed bins for each hour of the day, source type, and road type. The same methodology was applied to develop the speed estimates for the PM_{10} NAA. The specific MOVES table [AvgSpeedDistribution] for the average speed distribution is presented in Appendix 5.

5.2.2.10Ramp fraction

MOVES2010a requires the ramp fraction, which represents the percent of VHT on ramps, on both rural restricted roads (road type 2) and urban restricted roads (road type 4). The fraction of VHT on ramps was derived by dividing the total VHTs on ramps by the total VHTs for each restricted road type. Those VHTs were obtained from the 2008 traffic assignment data provided by the MAG Transportation Modeling Group in March 2011. The specific MOVES table [RoadType] for ramp fractions is presented in Appendix 5.

5.2.3 MOVES2010a outputs

MOVES2010a was executed with the RunSpec files described in Appendix 5 to obtain exhaust, tire wear, and brake wear emissions for PM_{10}, $PM_{2.5}$, NO_x, SO_2, and NH_3. These values were obtained for the following twelve vehicle classes: light duty gasoline vehicles (LDGV), light duty gasoline trucks 1 & 2 (LDGT1), light duty gasoline trucks 3 and 4 (LDGT2), heavy duty gasoline vehicles 2B thru 8B and gasoline buses (HDGV), motorcycles (MC), light duty diesel vehicles (LDDV), light duty diesel trucks 1 thru 4 (LDDT), heavy duty diesel vehicles class 2B (2BHDDV), heavy duty diesel vehicles class 3, 4, and 5 (LHDDV), heavy duty diesel vehicles class 6 and 7 (MHDDV), heavy duty diesel vehicles class 8A and 8B (HHDDV), and heavy duty diesel buses (BUSES); by the following thirteen facility types: rural interstate, rural principal arterial, rural minor arterial, rural major collector, rural minor collector, rural local, urban interstate, urban freeway/expressway, urban principal arterial, urban minor arterial, urban collector, urban local, and off-network, which was newly added in MOVES2010a; by weekdays and weekend days; by month.

5.2.4 MOVES2010a emission estimates

MOVES2010a was used to generate onroad emissions by vehicle class, facility type, weekdays/ weekend days, and month. The annual emissions were calculated by aggregating monthly on-road emissions derived by adding monthly weekday emissions, which is the product of daily weekday emissions estimated by MOVES2010a and the number of weekdays for a given month, and monthly weekend emissions, which is the product of daily weekend emissions estimated by MOVES2010a and the number of weekend days for a given month. The average daily emissions were calculated by dividing the annual emissions by 366 days.

Tables 5.2–2 and 5.2–3 show the calculated annual and average daily PM_{10}, $PM_{2.5}$, NO_x, SO_2, and NH_3 emissions by facility type and vehicle class in the PM_{10} NAA and Maricopa County, respectively. Emission estimates for PM_{10} and $PM_{2.5}$ in these tables represent exhaust, tire wear, and brake wear emissions.

Table 5.2–2. Annual and average daily onroad mobile source emissions by facility type and vehicle class in the PM_{10} NAA.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Rural Interstate	LDGV	2201001110	4.03	2.36	113.80	1.39	8.47	**PM_{10}**	**$PM_{2.5}$**	621.8	7.6	46.3
	LDGT1	2201020110	9.97	6.47	416.37	3.27	15.05	54.5	35.3	2,275.3	17.9	82.2
	LDGT2	2201040110	5.13	3.33	214.49	1.68	7.75	28.1	18.2	1,172.1	9.2	42.4
	HDGV	2201070110	2.16	1.30	116.05	0.71	2.44	11.8	7.1	634.1	3.9	13.4
	MC	2201080110	0.27	0.24	6.28	0.05	0.34	1.5	1.3	34.3	0.3	1.9
	LDDV	2230001110	0.05	0.05	0.73	0.00	0.01	0.3	0.2	4.0	0.0	0.0
	LDDT	2230060110	1.69	1.58	26.36	0.02	0.19	9.2	8.6	144.0	0.1	1.0
	2BHDDV	2230071110	0.71	0.66	11.70	0.01	0.08	3.9	3.6	63.9	0.1	0.5
	LHDDV	2230072110	4.12	3.85	62.48	0.05	0.44	22.5	21.1	341.4	0.3	2.4
	MHDDV	2230073110	14.60	13.06	299.34	0.24	0.99	79.8	71.4	1,635.7	1.3	5.4
	HHDDV	2230074110	46.97	42.91	1,072.87	0.84	2.54	256.7	234.5	5,862.7	4.6	13.9
	BUSES	2230075110	2.08	1.90	43.45	0.02	0.08	11.3	10.4	237.4	0.1	0.5
Rural Principal Arterial	LDGV	2201001130	4.47	2.00	99.90	1.25	6.86	24.4	10.9	545.9	6.9	37.5
	LDGT1	2201020130	6.17	3.02	206.39	1.67	6.98	33.7	16.5	1,127.8	9.1	38.2
	LDGT2	2201040130	3.18	1.55	106.32	0.86	3.60	17.4	8.5	581.0	4.7	19.7
	HDGV	2201070130	1.03	0.52	40.56	0.27	0.99	5.6	2.9	221.6	1.5	5.4
	MC	2201080130	0.43	0.36	11.30	0.09	0.56	2.3	2.0	61.8	0.5	3.1
	LDDV	2230001130	0.04	0.03	0.76	0.00	0.00	0.2	0.2	4.2	0.0	0.0
	LDDT	2230060130	0.94	0.85	15.35	0.01	0.09	5.1	4.7	83.9	0.1	0.5
	2BHDDV	2230071130	0.40	0.36	6.84	0.01	0.04	2.2	2.0	37.4	0.0	0.2
	LHDDV	2230072130	2.29	2.09	36.25	0.03	0.20	12.5	11.4	198.1	0.1	1.1
	MHDDV	2230073130	3.51	3.04	62.16	0.05	0.21	19.2	16.6	339.7	0.3	1.2
	HHDDV	2230074130	10.16	9.00	188.59	0.15	0.44	55.5	49.2	1,030.6	0.8	2.4
	BUSES	2230075130	0.86	0.76	15.40	0.01	0.03	4.7	4.2	84.1	0.0	0.2

Table 5.2–2. Annual and average daily onroad mobile source emissions by facility type and vehicle class in the PM_{10} NAA (continued).

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Rural Minor Arterial	LDGV	2201001150	4.34	1.94	97.07	1.22	6.66	23.7	10.6	530.4	6.7	36.4
	LDGT1	2201020150	5.99	2.93	200.55	1.62	6.79	32.7	16.0	1,095.9	8.9	37.1
	LDGT2	2201040150	3.09	1.51	103.31	0.83	3.50	16.9	8.3	564.6	4.6	19.1
	HDGV	2201070150	1.00	0.51	39.41	0.26	0.96	5.5	2.8	215.4	1.4	5.2
	MC	2201080150	0.42	0.35	10.98	0.09	0.55	2.3	1.9	60.0	0.5	3.0
	LDDV	2230001150	0.04	0.03	0.74	0.00	0.00	0.2	0.2	4.1	0.0	0.0
	LDDT	2230060150	0.91	0.83	14.92	0.01	0.08	5.0	4.5	81.5	0.1	0.5
	2BHDDV	2230071150	0.39	0.35	6.64	0.00	0.04	2.1	1.9	36.3	0.0	0.2
	LHDDV	2230072150	2.23	2.03	35.23	0.03	0.20	12.2	11.1	192.5	0.1	1.1
	MHDDV	2230073150	3.41	2.96	60.40	0.05	0.21	18.7	16.2	330.1	0.3	1.1
	HHDDV	2230074150	9.87	8.75	183.26	0.14	0.43	54.0	47.8	1,001.4	0.8	2.3
	BUSES	2230075150	0.83	0.74	14.96	0.01	0.03	4.6	4.1	81.8	0.0	0.2
Rural Major Collector	LDGV	2201001170	0.81	0.36	18.09	0.23	1.24	4.4	2.0	98.9	1.2	6.8
	LDGT1	2201020170	1.12	0.55	37.38	0.30	1.27	6.1	3.0	204.3	1.6	6.9
	LDGT2	2201040170	0.58	0.28	19.26	0.16	0.65	3.1	1.5	105.2	0.8	3.6
	HDGV	2201070170	0.19	0.09	7.35	0.05	0.18	1.0	0.5	40.1	0.3	1.0
	MC	2201080170	0.08	0.06	2.05	0.02	0.10	0.4	0.4	11.2	0.1	0.6
	LDDV	2230001170	0.01	0.01	0.14	0.00	0.00	0.0	0.0	0.8	0.0	0.0
	LDDT	2230060170	0.17	0.15	2.78	0.00	0.02	0.9	0.8	15.2	0.0	0.1
	2BHDDV	2230071170	0.07	0.07	1.24	0.00	0.01	0.4	0.4	6.8	0.0	0.0
	LHDDV	2230072170	0.42	0.38	6.57	0.00	0.04	2.3	2.1	35.9	0.0	0.2
	MHDDV	2230073170	0.64	0.55	11.26	0.01	0.04	3.5	3.0	61.5	0.0	0.2
	HHDDV	2230074170	1.84	1.63	34.16	0.03	0.08	10.1	8.9	186.7	0.1	0.4
	BUSES	2230075170	0.16	0.14	2.79	0.00	0.01	0.9	0.8	15.2	0.0	0.0
Rural Minor Collector	LDGV	2201001190	0.19	0.08	4.19	0.05	0.29	1.0	0.5	22.9	0.3	1.6
	LDGT1	2201020190	0.26	0.13	8.65	0.07	0.29	1.4	0.7	47.3	0.4	1.6
	LDGT2	2201040190	0.13	0.07	4.46	0.04	0.15	0.7	0.4	24.4	0.2	0.8
	HDGV	2201070190	0.04	0.02	1.70	0.01	0.04	0.2	0.1	9.3	0.1	0.2
	MC	2201080190	0.02	0.02	0.47	0.00	0.02	0.1	0.1	2.6	0.0	0.1
	LDDV	2230001190	0.00	0.00	0.03	0.00	0.00	0.0	0.0	0.2	0.0	0.0
	LDDT	2230060190	0.04	0.04	0.64	0.00	0.00	0.2	0.2	3.5	0.0	0.0
	2BHDDV	2230071190	0.02	0.02	0.29	0.00	0.00	0.1	0.1	1.6	0.0	0.0
	LHDDV	2230072190	0.10	0.09	1.52	0.00	0.01	0.5	0.5	8.3	0.0	0.0
	MHDDV	2230073190	0.15	0.13	2.61	0.00	0.01	0.8	0.7	14.2	0.0	0.0
	HHDDV	2230074190	0.43	0.38	7.91	0.01	0.02	2.3	2.1	43.2	0.0	0.1
	BUSES	2230075190	0.04	0.03	0.65	0.00	0.00	0.2	0.2	3.5	0.0	0.0
Rural Local	LDGV	2201001210	1.96	0.88	43.76	0.55	3.00	10.7	4.8	239.1	3.0	16.4
	LDGT1	2201020210	2.70	1.32	90.41	0.73	3.06	14.8	7.2	494.0	4.0	16.7
	LDGT2	2201040210	1.39	0.68	46.57	0.38	1.58	7.6	3.7	254.5	2.1	8.6
	HDGV	2201070210	0.45	0.23	17.77	0.12	0.43	2.5	1.3	97.1	0.7	2.4
	MC	2201080210	0.19	0.16	4.95	0.04	0.25	1.0	0.9	27.0	0.2	1.4
	LDDV	2230001210	0.02	0.01	0.33	0.00	0.00	0.1	0.1	1.8	0.0	0.0
	LDDT	2230060210	0.41	0.37	6.73	0.00	0.04	2.2	2.0	36.7	0.0	0.2
	2BHDDV	2230071210	0.17	0.16	3.00	0.00	0.02	1.0	0.9	16.4	0.0	0.1
	LHDDV	2230072210	1.00	0.92	15.88	0.01	0.09	5.5	5.0	86.8	0.1	0.5
	MHDDV	2230073210	1.54	1.33	27.23	0.02	0.09	8.4	7.3	148.8	0.1	0.5
	HHDDV	2230074210	4.45	3.94	82.61	0.06	0.19	24.3	21.6	451.4	0.4	1.1
	BUSES	2230075210	0.38	0.33	6.74	0.00	0.01	2.1	1.8	36.9	0.0	0.1

Table 5.2–2. Annual and average daily onroad mobile source emissions by facility type and vehicle class in the PM_{10} NAA (continued).

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Urban Interstate	LDGV	2201001230	34.07	19.77	826.32	10.12	59.49	186.2	108.0	4,515.4	55.3	325.1
	LDGT1	2201020230	61.65	38.52	2,159.31	17.31	76.76	336.9	210.5	11,799.5	94.6	419.4
	LDGT2	2201040230	31.76	19.84	1,112.37	8.92	39.54	173.6	108.4	6,078.5	48.7	216.1
	HDGV	2201070230	13.64	7.78	662.41	4.08	12.90	74.5	42.5	3,619.7	22.3	70.5
	MC	2201080230	4.11	3.60	78.03	0.65	4.24	22.4	19.6	426.4	3.5	23.2
	LDDV	2230001230	0.43	0.38	5.36	0.01	0.04	2.4	2.1	29.3	0.0	0.2
	LDDT	2230060230	9.50	8.78	145.30	0.12	0.92	51.9	48.0	794.0	0.6	5.1
	2BHDDV	2230071230	4.02	3.70	64.53	0.05	0.41	21.9	20.2	352.6	0.3	2.3
	LHDDV	2230072230	23.20	21.48	344.36	0.27	2.17	126.8	117.4	1,881.8	1.5	11.8
	MHDDV	2230073230	84.59	74.53	1,618.55	1.29	5.20	462.2	407.3	8,844.5	7.1	28.4
	HHDDV	2230074230	238.30	214.02	4,871.28	3.82	11.30	1,302.2	1,169.5	26,619.0	20.9	61.7
	BUSES	2230075230	18.04	16.38	348.55	0.19	0.65	98.6	89.5	1,904.6	1.0	3.5
Urban Freeway And Expressway	LDGV	2201001250	35.75	20.74	866.95	10.62	62.41	195.3	113.3	4,737.5	58.0	341.0
	LDGT1	2201020250	64.69	40.41	2,265.51	18.16	80.53	353.5	220.8	12,379.8	99.2	440.1
	LDGT2	2201040250	33.32	20.82	1,167.08	9.35	41.49	182.1	113.8	6,377.5	51.1	226.7
	HDGV	2201070250	14.31	8.16	694.98	4.28	13.53	78.2	44.6	3,797.7	23.4	74.0
	MC	2201080250	4.31	3.77	81.87	0.68	4.45	23.6	20.6	447.4	3.7	24.3
	LDDV	2230001250	0.45	0.40	5.63	0.01	0.04	2.5	2.2	30.7	0.0	0.2
	LDDT	2230060250	9.97	9.21	152.44	0.12	0.97	54.5	50.3	833.0	0.7	5.3
	2BHDDV	2230071250	4.21	3.88	67.70	0.05	0.43	23.0	21.2	370.0	0.3	2.4
	LHDDV	2230072250	24.34	22.53	361.30	0.28	2.27	133.0	123.1	1,974.3	1.5	12.4
	MHDDV	2230073250	88.75	78.19	1,698.15	1.36	5.45	485.0	427.3	9,279.5	7.4	29.8
	HHDDV	2230074250	250.02	224.55	5,110.85	4.00	11.85	1,366.2	1,227.0	27,928.1	21.9	64.8
	BUSES	2230075250	18.92	17.19	365.69	0.20	0.68	103.4	93.9	1,998.3	1.1	3.7
Urban Principal Arterial	LDGV	2201001270	112.79	45.15	1,898.68	24.98	123.71	616.3	246.7	10,375.3	136.5	676.0
	LDGT1	2201020270	150.63	61.39	3,540.67	31.15	114.87	823.1	335.5	19,347.9	170.2	627.7
	LDGT2	2201040270	77.59	31.63	1,823.98	16.05	59.17	424.0	172.8	9,967.1	87.7	323.4
	HDGV	2201070270	26.09	10.35	725.63	5.36	16.59	142.6	56.5	3,965.2	29.3	90.7
	MC	2201080270	6.29	5.08	130.89	1.31	6.61	34.4	27.8	715.2	7.1	36.1
	LDDV	2230001270	0.86	0.64	16.10	0.02	0.07	4.7	3.5	88.0	0.1	0.4
	LDDT	2230060270	20.07	17.65	336.50	0.22	1.35	109.7	96.4	1,838.8	1.2	7.4
	2BHDDV	2230071270	8.56	7.50	149.81	0.10	0.60	46.8	41.0	818.7	0.5	3.3
	LHDDV	2230072270	49.11	43.37	797.14	0.49	3.16	268.3	237.0	4,356.0	2.7	17.3
	MHDDV	2230073270	93.47	77.13	1,474.01	1.15	3.96	510.8	421.5	8,054.7	6.3	21.6
	HHDDV	2230074270	268.61	229.65	4,055.08	3.18	7.98	1,467.8	1,254.9	22,158.9	17.4	43.6
	BUSES	2230075270	20.39	17.43	301.38	0.16	0.50	111.4	95.2	1,646.9	0.9	2.7
Urban Minor Arterial	LDGV	2201001290	57.33	22.95	965.09	12.70	62.88	313.3	125.4	5,273.7	69.4	343.6
	LDGT1	2201020290	76.56	31.20	1,799.71	15.83	58.39	418.4	170.5	9,834.5	86.5	319.1
	LDGT2	2201040290	39.44	16.08	927.12	8.16	30.08	215.5	87.8	5,066.2	44.6	164.4
	HDGV	2201070290	13.26	5.26	368.83	2.72	8.43	72.5	28.7	2,015.5	14.9	46.1
	MC	2201080290	3.20	2.58	66.53	0.66	3.36	17.5	14.1	363.6	3.6	18.3
	LDDV	2230001290	0.44	0.33	8.18	0.01	0.04	2.4	1.8	44.7	0.1	0.2
	LDDT	2230060290	10.20	8.97	171.04	0.11	0.68	55.7	49.0	934.6	0.6	3.7
	2BHDDV	2230071290	4.35	3.81	76.15	0.05	0.31	23.8	20.8	416.1	0.3	1.7
	LHDDV	2230072290	24.96	22.05	405.18	0.25	1.61	136.4	120.5	2,214.1	1.4	8.8
	MHDDV	2230073290	47.51	39.20	749.23	0.58	2.01	259.6	214.2	4,094.2	3.2	11.0
	HHDDV	2230074290	136.53	116.73	2,061.18	1.62	4.06	746.1	637.9	11,263.3	8.8	22.2
	BUSES	2230075290	10.37	8.86	153.19	0.08	0.25	56.6	48.4	837.1	0.5	1.4

Table 5.2–2. Annual and average daily onroad mobile source emissions by facility type and vehicle class in the PM_{10} NAA (continued).

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Urban Collector	LDGV	2201001310	11.20	4.48	188.48	2.48	12.28	61.2	24.5	1,029.9	13.6	67.1
	LDGT1	2201020310	14.95	6.09	351.47	3.09	11.40	81.7	33.3	1,920.6	16.9	62.3
	LDGT2	2201040310	7.70	3.14	181.06	1.59	5.87	42.1	17.2	989.4	8.7	32.1
	HDGV	2201070310	2.59	1.03	72.03	0.53	1.65	14.2	5.6	393.6	2.9	9.0
	MC	2201080310	0.62	0.50	12.99	0.13	0.66	3.4	2.8	71.0	0.7	3.6
	LDDV	2230001310	0.09	0.06	1.60	0.00	0.01	0.5	0.3	8.7	0.0	0.0
	LDDT	2230060310	1.99	1.75	33.40	0.02	0.13	10.9	9.6	182.5	0.1	0.7
	2BHDDV	2230071310	0.85	0.74	14.87	0.01	0.06	4.6	4.1	81.3	0.1	0.3
	LHDDV	2230072310	4.87	4.31	79.13	0.05	0.31	26.6	23.5	432.4	0.3	1.7
	MHDDV	2230073310	9.28	7.66	146.32	0.11	0.39	50.7	41.8	799.6	0.6	2.1
	HHDDV	2230074310	26.66	22.80	402.53	0.32	0.79	145.7	124.6	2,199.6	1.7	4.3
	BUSES	2230075310	2.02	1.73	29.92	0.02	0.05	11.1	9.5	163.5	0.1	0.3
Urban Local	LDGV	2201001330	54.04	21.63	909.78	11.97	59.28	295.3	118.2	4,971.5	65.4	323.9
	LDGT1	2201020330	72.17	29.42	1,696.57	14.93	55.04	394.4	160.7	9,270.9	81.6	300.8
	LDGT2	2201040330	37.18	15.15	873.99	7.69	28.35	203.2	82.8	4,775.9	42.0	154.9
	HDGV	2201070330	12.50	4.96	347.69	2.57	7.95	68.3	27.1	1,900.0	14.0	43.4
	MC	2201080330	3.01	2.44	62.72	0.63	3.17	16.5	13.3	342.7	3.4	17.3
	LDDV	2230001330	0.41	0.31	7.71	0.01	0.03	2.2	1.7	42.1	0.1	0.2
	LDDT	2230060330	9.62	8.46	161.24	0.10	0.65	52.5	46.2	881.1	0.6	3.5
	2BHDDV	2230071330	4.10	3.59	71.79	0.05	0.29	22.4	19.6	392.3	0.3	1.6
	LHDDV	2230072330	23.53	20.78	381.96	0.24	1.51	128.6	113.6	2,087.2	1.3	8.3
	MHDDV	2230073330	44.79	36.96	706.29	0.55	1.90	244.7	202.0	3,859.5	3.0	10.4
	HHDDV	2230074330	128.71	110.04	1,943.05	1.52	3.82	703.3	601.3	10,617.8	8.3	20.9
	BUSES	2230075330	9.77	8.35	144.41	0.08	0.24	53.4	45.6	789.1	0.4	1.3
Off-Network	LDGV	2201001000	69.77	64.25	4,540.27	6.29	0.00	381.3	351.1	24,810.2	34.4	0.0
	LDGT1	2201020000	20.34	18.73	1,572.71	1.46	0.00	111.2	102.4	8,594.0	8.0	0.0
	LDGT2	2201040000	10.48	9.65	810.18	0.75	0.00	57.3	52.7	4,427.2	4.1	0.0
	HDGV	2201070000	3.97	3.66	251.38	0.22	0.00	21.7	20.0	1,373.7	1.2	0.0
	MC	2201080000	0.08	0.07	2.31	0.02	0.00	0.4	0.4	12.6	0.1	0.0
	LDDV	2230001000	6.41	6.22	18.94	0.01	0.00	35.0	34.0	103.5	0.0	0.0
	LDDT	2230060000	1.48	1.44	28.27	0.01	0.00	8.1	7.9	154.5	0.0	0.0
	2BHDDV	2230071000	0.53	0.51	12.31	0.00	0.00	2.9	2.8	67.3	0.0	0.0
	LHDDV	2230072000	3.33	3.23	66.71	0.02	0.00	18.2	17.6	364.5	0.1	0.0
	MHDDV	2230073000	2.24	2.18	147.44	0.03	0.00	12.3	11.9	805.7	0.2	0.0
	HHDDV	2230074000	31.74	30.79	2,629.48	0.44	0.00	173.4	168.2	14,368.7	2.4	0.0
	BUSES	2230075000	0.24	0.24	4.00	0.01	0.00	1.3	1.3	21.9	0.0	0.0

Table 5.2–3. Annual and average daily onroad mobile source emissions by facility type and vehicle class in Maricopa County.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Rural Interstate	LDGV	2201001110	4.06	2.41	122.38	1.47	9.05	22.2	13.2	668.8	8.0	49.5
	LDGT1	2201020110	12.43	8.28	561.77	4.35	20.14	67.9	45.2	3,069.8	23.8	110.1
	LDGT2	2201040110	6.40	4.26	289.40	2.24	10.38	35.0	23.3	1,581.4	12.2	56.7
	HDGV	2201070110	2.48	1.56	135.09	0.84	3.05	13.6	8.6	738.2	4.6	16.7
	MC	2201080110	0.33	0.29	7.83	0.06	0.44	1.8	1.6	42.8	0.3	2.4
	LDDV	2230001110	0.05	0.05	0.77	0.00	0.01	0.3	0.3	4.2	0.0	0.0
	LDDT	2230060110	2.17	2.03	34.87	0.03	0.25	11.8	11.1	190.6	0.2	1.4
	2BHDDV	2230071110	0.91	0.86	15.47	0.01	0.11	5.0	4.7	84.5	0.1	0.6
	LHDDV	2230072110	5.28	4.96	82.73	0.07	0.59	28.9	27.1	452.1	0.4	3.2
	MHDDV	2230073110	16.74	15.10	362.98	0.29	1.15	91.5	82.5	1,983.5	1.6	6.3
	HHDDV	2230074110	62.15	57.25	1,498.95	1.17	3.49	339.6	312.8	8,191.0	6.4	19.1
	BUSES	2230075110	2.07	1.90	44.50	0.02	0.08	11.3	10.4	243.1	0.1	0.5
Rural Principal Arterial	LDGV	2201001130	4.94	2.22	111.37	1.40	7.66	27.0	12.1	608.6	7.6	41.9
	LDGT1	2201020130	7.96	3.93	270.70	2.18	9.19	43.5	21.5	1,479.2	11.9	50.2
	LDGT2	2201040130	4.10	2.02	139.45	1.12	4.73	22.4	11.1	762.0	6.1	25.9
	HDGV	2201070130	1.33	0.68	52.65	0.35	1.29	7.3	3.7	287.7	1.9	7.1
	MC	2201080130	0.54	0.45	14.17	0.12	0.71	2.9	2.4	77.4	0.6	3.9
	LDDV	2230001130	0.04	0.04	0.85	0.00	0.00	0.2	0.2	4.6	0.0	0.0
	LDDT	2230060130	1.22	1.11	19.83	0.01	0.11	6.6	6.1	108.4	0.1	0.6
	2BHDDV	2230071130	0.52	0.47	8.83	0.01	0.05	2.8	2.6	48.3	0.0	0.3
	LHDDV	2230072130	2.97	2.71	46.80	0.03	0.27	16.2	14.8	255.7	0.2	1.5
	MHDDV	2230073130	4.71	4.10	85.77	0.07	0.29	25.7	22.4	468.7	0.4	1.6
	HHDDV	2230074130	14.61	13.03	286.25	0.22	0.68	79.8	71.2	1,564.2	1.2	3.7
	BUSES	2230075130	1.09	0.97	19.60	0.01	0.04	5.9	5.3	107.1	0.1	0.2
Rural Minor Arterial	LDGV	2201001150	4.80	2.16	108.22	1.36	7.45	26.2	11.8	591.4	7.4	40.7
	LDGT1	2201020150	7.74	3.82	263.05	2.12	8.93	42.3	20.9	1,437.4	11.6	48.8
	LDGT2	2201040150	3.99	1.97	135.51	1.09	4.60	21.8	10.8	740.5	6.0	25.1
	HDGV	2201070150	1.29	0.66	51.17	0.34	1.26	7.0	3.6	279.6	1.9	6.9
	MC	2201080150	0.52	0.43	13.77	0.11	0.69	2.8	2.4	75.2	0.6	3.8
	LDDV	2230001150	0.04	0.03	0.82	0.00	0.00	0.2	0.2	4.5	0.0	0.0
	LDDT	2230060150	1.18	1.08	19.27	0.01	0.11	6.5	5.9	105.3	0.1	0.6
	2BHDDV	2230071150	0.50	0.46	8.58	0.01	0.05	2.7	2.5	46.9	0.0	0.3
	LHDDV	2230072150	2.89	2.64	45.48	0.03	0.26	15.8	14.4	248.5	0.2	1.4
	MHDDV	2230073150	4.57	3.98	83.34	0.07	0.28	25.0	21.7	455.4	0.4	1.5
	HHDDV	2230074150	14.20	12.66	278.16	0.22	0.66	77.6	69.2	1,520.0	1.2	3.6
	BUSES	2230075150	1.06	0.94	19.04	0.01	0.04	5.8	5.1	104.1	0.1	0.2
Rural Major Collector	LDGV	2201001170	0.89	0.40	20.17	0.25	1.39	4.9	2.2	110.2	1.4	7.6
	LDGT1	2201020170	1.44	0.71	49.03	0.40	1.66	7.9	3.9	267.9	2.2	9.1
	LDGT2	2201040170	0.74	0.37	25.26	0.20	0.86	4.1	2.0	138.0	1.1	4.7
	HDGV	2201070170	0.24	0.12	9.54	0.06	0.23	1.3	0.7	52.1	0.3	1.3
	MC	2201080170	0.10	0.08	2.57	0.02	0.13	0.5	0.4	14.0	0.1	0.7
	LDDV	2230001170	0.01	0.01	0.15	0.00	0.00	0.0	0.0	0.8	0.0	0.0
	LDDT	2230060170	0.22	0.20	3.59	0.00	0.02	1.2	1.1	19.6	0.0	0.1
	2BHDDV	2230071170	0.09	0.08	1.60	0.00	0.01	0.5	0.5	8.7	0.0	0.1
	LHDDV	2230072170	0.54	0.49	8.48	0.01	0.05	2.9	2.7	46.3	0.0	0.3
	MHDDV	2230073170	0.85	0.74	15.53	0.01	0.05	4.7	4.1	84.9	0.1	0.3
	HHDDV	2230074170	2.65	2.36	51.84	0.04	0.12	14.5	12.9	283.3	0.2	0.7
	BUSES	2230075170	0.20	0.18	3.55	0.00	0.01	1.1	1.0	19.4	0.0	0.0

Table 5.2–3. Annual and average daily onroad mobile source emissions by facility type and vehicle class in Maricopa County (continued).

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Rural Minor Collector	LDGV	2201001190	0.21	0.09	4.67	0.06	0.32	1.1	0.5	25.5	0.3	1.8
	LDGT1	2201020190	0.33	0.16	11.35	0.09	0.39	1.8	0.9	62.0	0.5	2.1
	LDGT2	2201040190	0.17	0.08	5.85	0.05	0.20	0.9	0.5	32.0	0.3	1.1
	HDGV	2201070190	0.06	0.03	2.21	0.01	0.05	0.3	0.2	12.1	0.1	0.3
	MC	2201080190	0.02	0.02	0.59	0.00	0.03	0.1	0.1	3.2	0.0	0.2
	LDDV	2230001190	0.00	0.00	0.04	0.00	0.00	0.0	0.0	0.2	0.0	0.0
	LDDT	2230060190	0.05	0.05	0.83	0.00	0.00	0.3	0.3	4.5	0.0	0.0
	2BHDDV	2230071190	0.02	0.02	0.37	0.00	0.00	0.1	0.1	2.0	0.0	0.0
	LHDDV	2230072190	0.12	0.11	1.96	0.00	0.01	0.7	0.6	10.7	0.0	0.1
	MHDDV	2230073190	0.20	0.17	3.60	0.00	0.01	1.1	0.9	19.7	0.0	0.1
	HHDDV	2230074190	0.61	0.55	12.00	0.01	0.03	3.3	3.0	65.6	0.1	0.2
	BUSES	2230075190	0.05	0.04	0.82	0.00	0.00	0.2	0.2	4.5	0.0	0.0
Rural Local	LDGV	2201001210	2.16	0.97	48.79	0.61	3.36	11.8	5.3	266.6	3.3	18.3
	LDGT1	2201020210	3.49	1.72	118.58	0.96	4.02	19.1	9.4	648.0	5.2	22.0
	LDGT2	2201040210	1.80	0.89	61.09	0.49	2.07	9.8	4.8	333.8	2.7	11.3
	HDGV	2201070210	0.58	0.30	23.07	0.15	0.57	3.2	1.6	126.0	0.8	3.1
	MC	2201080210	0.23	0.20	6.21	0.05	0.31	1.3	1.1	33.9	0.3	1.7
	LDDV	2230001210	0.02	0.02	0.37	0.00	0.00	0.1	0.1	2.0	0.0	0.0
	LDDT	2230060210	0.53	0.49	8.69	0.01	0.05	2.9	2.7	47.5	0.0	0.3
	2BHDDV	2230071210	0.23	0.21	3.87	0.00	0.02	1.2	1.1	21.1	0.0	0.1
	LHDDV	2230072210	1.30	1.19	20.50	0.01	0.12	7.1	6.5	112.0	0.1	0.6
	MHDDV	2230073210	2.06	1.79	37.57	0.03	0.13	11.3	9.8	205.3	0.2	0.7
	HHDDV	2230074210	6.40	5.71	125.39	0.10	0.30	35.0	31.2	685.2	0.5	1.6
	BUSES	2230075210	0.48	0.42	8.59	0.00	0.02	2.6	2.3	46.9	0.0	0.1
Urban Interstate	LDGV	2201001230	35.00	20.31	849.09	10.40	61.12	191.2	111.0	4,639.9	56.8	334.0
	LDGT1	2201020230	63.55	39.72	2,226.82	17.85	79.15	347.3	217.0	12,168.4	97.5	432.5
	LDGT2	2201040230	32.74	20.46	1,147.15	9.19	40.77	178.9	111.8	6,268.6	50.2	222.8
	HDGV	2201070230	14.10	8.04	686.11	4.22	13.33	77.1	43.9	3,749.2	23.1	72.8
	MC	2201080230	4.24	3.71	80.48	0.67	4.37	23.2	20.3	439.8	3.7	23.9
	LDDV	2230001230	0.44	0.39	5.51	0.01	0.04	2.4	2.1	30.1	0.0	0.2
	LDDT	2230060230	9.80	9.05	149.81	0.12	0.95	53.5	49.5	818.7	0.7	5.2
	2BHDDV	2230071230	4.14	3.82	66.53	0.05	0.43	22.6	20.8	363.6	0.3	2.3
	LHDDV	2230072230	23.92	22.14	355.07	0.28	2.24	130.7	121.0	1,940.3	1.5	12.2
	MHDDV	2230073230	87.96	77.50	1,683.69	1.35	5.40	480.7	423.5	9,200.5	7.4	29.5
	HHDDV	2230074230	248.09	222.83	5,074.27	3.98	11.77	1,355.7	1,217.7	27,728.2	21.7	64.3
	BUSES	2230075230	18.74	17.02	362.14	0.20	0.67	102.4	93.0	1,978.9	1.1	3.7
Urban Freeway And Express way	LDGV	2201001250	36.72	21.31	890.85	10.91	64.12	200.6	116.4	4,868.1	59.6	350.4
	LDGT1	2201020250	66.67	41.67	2,336.34	18.72	83.04	364.3	227.7	12,766.9	102.3	453.8
	LDGT2	2201040250	34.35	21.47	1,203.57	9.65	42.78	187.7	117.3	6,576.9	52.7	233.8
	HDGV	2201070250	14.79	8.43	719.85	4.43	13.99	80.8	46.1	3,933.6	24.2	76.4
	MC	2201080250	4.45	3.89	84.44	0.70	4.59	24.3	21.3	461.4	3.8	25.1
	LDDV	2230001250	0.46	0.41	5.78	0.01	0.04	2.5	2.2	31.6	0.0	0.2
	LDDT	2230060250	10.28	9.50	157.18	0.13	1.00	56.2	51.9	858.9	0.7	5.5
	2BHDDV	2230071250	4.34	4.00	69.81	0.06	0.45	23.7	21.9	381.5	0.3	2.4
	LHDDV	2230072250	25.10	23.23	372.53	0.29	2.35	137.1	126.9	2,035.7	1.6	12.8
	MHDDV	2230073250	92.29	81.32	1,766.50	1.41	5.67	504.3	444.3	9,653.0	7.7	31.0
	HHDDV	2230074250	260.29	233.79	5,323.82	4.17	12.35	1,422.3	1,277.6	29,091.9	22.8	67.5
	BUSES	2230075250	19.66	17.86	379.95	0.21	0.70	107.5	97.6	2,076.2	1.1	3.8

Table 5.2–3. Annual and average daily onroad mobile source emissions by facility type and vehicle class in Maricopa County (continued).

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Urban Principal Arterial	LDGV	2201001270	116.26	46.54	1,955.75	25.74	127.42	635.3	254.3	10,687.2	140.7	696.3
	LDGT1	2201020270	155.34	63.31	3,649.06	32.11	118.39	848.9	345.9	19,940.2	175.5	646.9
	LDGT2	2201040270	80.03	32.61	1,879.82	16.54	60.99	437.3	178.2	10,272.2	90.4	333.3
	HDGV	2201070270	26.96	10.68	750.02	5.54	17.12	147.3	58.4	4,098.5	30.3	93.6
	MC	2201080270	6.49	5.24	134.88	1.35	6.81	35.4	28.7	737.1	7.4	37.2
	LDDV	2230001270	0.88	0.66	16.58	0.02	0.07	4.8	3.6	90.6	0.1	0.4
	LDDT	2230060270	20.69	18.19	346.70	0.22	1.39	113.0	99.4	1,894.5	1.2	7.6
	2BHDDV	2230071270	8.82	7.73	154.36	0.10	0.62	48.2	42.2	843.5	0.5	3.4
	LHDDV	2230072270	50.62	44.71	821.30	0.51	3.26	276.6	244.3	4,488.0	2.8	17.8
	MHDDV	2230073270	97.03	80.06	1,530.08	1.19	4.11	530.2	437.5	8,361.1	6.5	22.5
	HHDDV	2230074270	278.56	238.17	4,204.75	3.30	8.27	1,522.2	1,301.5	22,976.8	18.0	45.2
	BUSES	2230075270	21.19	18.11	313.11	0.17	0.51	115.8	99.0	1,711.0	0.9	2.8
Urban Minor Arterial	LDGV	2201001290	59.09	23.65	994.10	13.08	64.77	322.9	129.3	5,432.2	71.5	353.9
	LDGT1	2201020290	78.96	32.18	1,854.80	16.32	60.18	431.5	175.8	10,135.5	89.2	328.8
	LDGT2	2201040290	40.68	16.58	955.50	8.41	31.00	222.3	90.6	5,221.3	46.0	169.4
	HDGV	2201070290	13.70	5.43	381.23	2.82	8.70	74.9	29.7	2,083.2	15.4	47.6
	MC	2201080290	3.30	2.67	68.56	0.68	3.46	18.0	14.6	374.6	3.7	18.9
	LDDV	2230001290	0.45	0.34	8.43	0.01	0.04	2.5	1.8	46.1	0.1	0.2
	LDDT	2230060290	10.51	9.25	176.23	0.11	0.71	57.5	50.5	963.0	0.6	3.9
	2BHDDV	2230071290	4.48	3.93	78.46	0.05	0.32	24.5	21.5	428.7	0.3	1.7
	LHDDV	2230072290	25.73	22.72	417.46	0.26	1.65	140.6	124.2	2,281.2	1.4	9.0
	MHDDV	2230073290	49.32	40.70	777.73	0.61	2.09	269.5	222.4	4,249.9	3.3	11.4
	HHDDV	2230074290	141.59	121.06	2,137.26	1.68	4.20	773.7	661.5	11,679.0	9.2	23.0
	BUSES	2230075290	10.77	9.20	159.15	0.09	0.26	58.9	50.3	869.7	0.5	1.4
Urban Collector	LDGV	2201001310	11.54	4.62	194.14	2.56	12.65	63.1	25.2	1,060.9	14.0	69.1
	LDGT1	2201020310	15.42	6.28	362.23	3.19	11.75	84.3	34.3	1,979.4	17.4	64.2
	LDGT2	2201040310	7.94	3.24	186.60	1.64	6.05	43.4	17.7	1,019.7	9.0	33.1
	HDGV	2201070310	2.68	1.06	74.45	0.55	1.70	14.6	5.8	406.8	3.0	9.3
	MC	2201080310	0.64	0.52	13.39	0.13	0.68	3.5	2.8	73.2	0.7	3.7
	LDDV	2230001310	0.09	0.07	1.65	0.00	0.01	0.5	0.4	9.0	0.0	0.0
	LDDT	2230060310	2.05	1.81	34.42	0.02	0.14	11.2	9.9	188.1	0.1	0.8
	2BHDDV	2230071310	0.88	0.77	15.32	0.01	0.06	4.8	4.2	83.7	0.1	0.3
	LHDDV	2230072310	5.02	4.44	81.53	0.05	0.32	27.5	24.2	445.5	0.3	1.8
	MHDDV	2230073310	9.63	7.95	151.89	0.12	0.41	52.6	43.4	830.0	0.6	2.2
	HHDDV	2230074310	27.65	23.64	417.39	0.33	0.82	151.1	129.2	2,280.8	1.8	4.5
	BUSES	2230075310	2.10	1.80	31.08	0.02	0.05	11.5	9.8	169.8	0.1	0.3
Urban Local	LDGV	2201001330	55.71	22.30	937.13	12.33	61.05	304.4	121.8	5,120.9	67.4	333.6
	LDGT1	2201020330	74.44	30.33	1,748.50	15.39	56.73	406.8	165.8	9,554.7	84.1	310.0
	LDGT2	2201040330	38.35	15.63	900.74	7.93	29.22	209.5	85.4	4,922.1	43.3	159.7
	HDGV	2201070330	12.92	5.12	359.38	2.65	8.20	70.6	28.0	1,963.8	14.5	44.8
	MC	2201080330	3.11	2.51	64.63	0.65	3.26	17.0	13.7	353.2	3.5	17.8
	LDDV	2230001330	0.42	0.32	7.95	0.01	0.03	2.3	1.7	43.4	0.1	0.2
	LDDT	2230060330	9.91	8.72	166.13	0.11	0.66	54.2	47.6	907.8	0.6	3.6
	2BHDDV	2230071330	4.23	3.70	73.96	0.05	0.30	23.1	20.2	404.2	0.3	1.6
	LHDDV	2230072330	24.25	21.42	393.54	0.24	1.56	132.5	117.1	2,150.5	1.3	8.5
	MHDDV	2230073330	46.49	38.36	733.16	0.57	1.97	254.1	209.6	4,006.3	3.1	10.8
	HHDDV	2230074330	133.47	114.12	2,014.77	1.58	3.96	729.4	623.6	11,009.7	8.6	21.7
	BUSES	2230075330	10.15	8.68	150.03	0.08	0.25	55.5	47.4	819.8	0.4	1.3

Table 5.2–3. Annual and average daily onroad mobile source emissions by facility type and vehicle class in Maricopa County (continued).

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
			PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Off-Network	LDGV	2201001000	69.48	63.97	4,520.99	6.27	0.00	379.6	349.6	24,704.9	34.3	0.0
	LDGT1	2201020000	20.26	18.65	1,566.03	1.46	0.00	110.7	101.9	8,557.5	8.0	0.0
	LDGT2	2201040000	10.44	9.61	806.74	0.75	0.00	57.0	52.5	4,408.4	4.1	0.0
	HDGV	2201070000	3.96	3.64	250.31	0.22	0.00	21.6	19.9	1,367.8	1.2	0.0
	MC	2201080000	0.08	0.07	2.30	0.02	0.00	0.4	0.4	12.6	0.1	0.0
	LDDV	2230001000	6.38	6.19	18.86	0.01	0.00	34.9	33.8	103.1	0.0	0.0
	LDDT	2230060000	1.48	1.43	28.15	0.01	0.00	8.1	7.8	153.8	0.0	0.0
	2BHDDV	2230071000	0.53	0.51	12.26	0.00	0.00	2.9	2.8	67.0	0.0	0.0
	LHDDV	2230072000	3.31	3.22	66.42	0.02	0.00	18.1	17.6	363.0	0.1	0.0
	MHDDV	2230073000	2.34	2.27	155.73	0.03	0.00	12.8	12.4	851.0	0.2	0.0
	HHDDV	2230074000	33.61	32.61	2,787.80	0.46	0.00	183.7	178.2	15,233.9	2.5	0.0
	BUSES	2230075000	0.24	0.24	3.99	0.01	0.00	1.3	1.3	21.8	0.0	0.0

5.3 Fugitive dust emissions

While exhaust, tire wear, and brake wear emissions were calculated using the EPA MOVES-2010a model, fugitive dust emissions from paved and unpaved roads were calculated using the equations found in sections 13.2.1 and 13.2.2 of the EPA Compilation of Air Pollutant Emission Factors, AP-42 (EPA, 2006). The new AP-42 equation published by EPA in January 2011 has been applied to estimate the PM_{10} and $PM_{2.5}$ emissions from paved roads. The contact person for the fugitive dust emission estimates is Cathy Arthur (602-254-6300).

5.3.1 Paved road fugitive dust emissions

In the AP-42 equation, paved road emissions are a function of silt loading values and the average weight of vehicles traveling on paved road surfaces. Paved roads have been classified as freeways, high-traffic arterials, and low-traffic arterials to reflect different silt loading assumptions. An arterial carrying a traffic volume of less than 10,000 vehicles per average weekday is classified as low-traffic; all other roads that are not freeways are classified as high-traffic arterials. The silt loading levels, in grams per square meter, are 0.02 for freeways, 0.067 for high-traffic arterials, and 0.23 for low-traffic arterials. The silt loadings were derived from paved road samples collected in Maricopa County by an EPA contractor (US EPA, 1993). The average vehicle weights were derived from July 1, 2010 vehicle registrations for Maricopa County provided by the Arizona Department of Transportation. The fugitive dust emission factors for paved roads were derived by applying the following AP-42 equation:

$$E = k \times sL^{0.91} \times W^{1.02} \times (1 - P/4N)$$

where: E = annual average particulate emission factor (g/mile),
k = particle size multiplier for particle size range (1.0 g/mile for PM_{10} and 0.25 g/mile for $PM_{2.5}$),
sL = road surface silt loading (0.02 g/m^2 for freeways, 0.067 g/m^2 for high-traffic arterials, and 0.23 g/m^2 for low-traffic arterials),
W = average weight of the vehicles traveling on the roads (3.53 tons on freeways and 2.65 tons on arterials),

P = annual number of "wet" days with at least 0.254 mm (0.01 in) of precipitation (39 days[3] in 2008), and
N = annual number of days (366 days in 2008).

The annual average PM_{10} and $PM_{2.5}$ emission factors for paved roads derived from the AP-42 equation are presented in Table 5.3–1.

The 2008 VMTs by silt loading category were used to estimate paved road fugitive dust emissions. Daily VMTs by silt loading category for the PM_{10} NAA and Maricopa County are shown in Table 5.3–2. The VMTs were derived by applying geographic information systems (GIS) to a 2008 traffic assignment output by the MAG travel demand model, TransCAD. The 2008 weekday traffic volumes output by TransCAD were normalized to 2008 HPMS VMTs for the PM_{10} NAA and Maricopa County to produce the VMTs by silt loading category shown in Table 5.3–2.

Table 5.3–1. 2008 fugitive dust emission factors for paved roads.

	Emission factors (g/mile)	
Silt Loading Category	**PM_{10}**	**$PM_{2.5}$**
Freeways	0.10	0.03
High Traffic Arterials	0.22	0.06
Low Traffic Arterials	0.69	0.17

Table 5.3–2. 2008 VMT by silt loading category for paved roads.

	Daily VMT	
Silt Loading Category	**PM_{10} NAA**	**Maricopa County**
Freeways	30,835,329	32,526,693
High Traffic Arterials	42,498,543	43,586,568
Low Traffic Arterials	13,819,127	15,143,740
Totals:	**87,153,000**	**91,257,000**

Applying the emission factors in Table 5.3–1 to the VMTs in Table 5.3–2 and converting to pounds per day produces the 2008 uncontrolled particulate emissions from paved roads for the PM_{10} NAA and Maricopa County, shown in Table 5.3–3. These uncontrolled emissions do not include the 2008 emission reductions attributed to the committed measures in the MAG 2007 Five Percent Plan.

Table 5.3–3. 2008 uncontrolled fugitive dust emissions from paved roads.

	PM_{10} NAA(lbs/day)		Maricopa County (lbs/day)	
Silt Loading Category	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Freeways	6,798.0	2,039.4	7,170.8	2,151.3
High Traffic Arterials	20,612.3	5,621.5	21,140.0	5,765.5
Low Traffic Arterials	21,021.3	5,179.2	23,036.3	5,675.6
Totals:	**48,431.6**	**12,840.1**	**51,347.1**	**13,592.4**

The MAG 2007 Five Percent Plan contains a number of committed measures that reduce paved road fugitive dust emissions in the PM_{10} NAA. Five committed measures that reduce paved road particulate emissions were quantified in the MAG 2007 Five Percent Plan. Table 5.3–4 shows the emission reductions attributed to these committed measures based on their implementation

[3] Precipitation data for 2008 were obtained from National Oceanic and Atmospheric Administration (NOAA) in the form of local climatological data at Phoenix Sky Harbor Airport.

status in 2008. In addition, Table 5.3–4 includes emission reduction credit for 97 PM_{10}-certified street sweepers purchased by December 31, 2007 with FY 2001–2006 MAG Congestion Mitigation and Air Quality Improvement (CMAQ) funds. Reductions for the sweepers that were purchased with FY 2001–2006 CMAQ funds were also applied to base case uncontrolled paved road emissions in the MAG 2007 Five Percent Plan.

The emission benefits in Table 5.3–4 were subtracted from the uncontrolled PM_{10} emissions in Table 5.3–3. The total 2008 PM_{10} emission reduction of 11,851.1 pounds per day in the PM_{10} NAA represents 24.5 percent of the uncontrolled PM_{10} emissions of 48,431.6 pounds per day. This percent reduction was applied to the uncontrolled $PM_{2.5}$ emissions in the PM_{10} NAA; then the absolute reduction in $PM_{2.5}$ emissions due to the control measures was applied to the uncontrolled $PM_{2.5}$ emissions in Maricopa County. The controlled emissions in tons per year and pounds per day are shown in Table 5.3–5.

Table 5.3–4. 2008 benefits of measures that reduce paved road fugitive dust in the PM10 NAA[4].

	PM_{10} emission reduction	
Committed Measures in the MAG 2007 Five Percent Plan	**Annual (tons/year)**	**Average daily (lbs/day)[5]**
1. Public education and outreach program (Measure 1)[6]	7.7	42.2
2. Reduce trackout onto paved roads (Measures 14/15/17)	579.9	3,169.0
3. Sweep streets with PM_{10}-certified sweepers (Measure 24)	166.9	911.9
4. Pave or stabilize existing unpaved shoulders (Measure 28)	233.3	1,274.6
5. Additional $5M in FY07 MAG TIP for paving roads/shoulders (Measure 43)[7]	8.2	44.8
97 PM_{10}-certified sweepers purchased with FY 2001–2006 CMAQ funds:	1,172.8	6,408.6
Total 2008 PM_{10} emission reductions for paved roads:	**2,168.8**	**11,851.1**

Table 5.3–5. Annual controlled fugitive dust emissions from paved roads.

	Annual emissions (tons/year)		Average daily emissions (lbs/day)	
Geographic Area	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
PM_{10} NAA	6,694.2	1,774.8	36,580.5	9,698.1
Maricopa County	7,227.8	1,912.4	39,496.0	10,450.4

5.3.2 Unpaved road fugitive dust emissions

AP-42 emission factors were applied to unpaved road and alley VMTs to estimate fugitive dust emissions (US EPA, 2006). The unpaved road and alley particulate emission factors were derived from the following AP-42 equation for publicly accessible unpaved roads, assuming a silt content of 11.9%, a soil moisture content of 0.5%, and an average speed of 25 miles per hour on unpaved roads and 10 miles per hour on unpaved alleys:

[4] The 2008 benefits of the committed measures in the Five Percent Plan have been reduced by 61 percent to reflect the new AP-42 equation for paved road dust released by EPA in January 2011.
[5] 366 days were used to convert tons per year to pounds per day in 2008.
[6] Measure benefit reflects a 0.1% reduction in 2008 uncontrolled paved road emissions in the MAG 2007 Five Percent Plan.
[7] Measure benefit includes only the projects that paved unpaved shoulders in 2008.

$$E = \left[\frac{k\left(\frac{s}{12}\right)^{1}\left(\frac{S}{30}\right)^{0.5}}{\left(\frac{M}{0.5}\right)^{0.2}} - C \right]\left(1 - \frac{P}{N}\right)$$

where: E = annual average particulate emission factor extrapolated for natural mitigation (lb/mile),

k = particle size multiplier for particle size range (1.8 lb/mile for PM_{10} and 0.18 lb/mile for $PM_{2.5}$),

s = surface material silt content (11.9%),

S = mean vehicle speed (25 mph for unpaved roads and 10 mph for unpaved alleys),

M = surface material moisture content (0.5%),

C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear (0.00047 lb/mile for PM_{10} and 0.00036 lb/mile for $PM_{2.5}$),

P = annual number of "wet" days with at least 0.254 mm (0.01 in) of precipitation (39 days in 2008), and

N = annual number of days (366 days in 2008).

The unpaved road emission factors resulting from the above equation are 1.4554 pounds per mile for PM_{10} and 0.1453 pounds per mile for $PM_{2.5}$. The unpaved alley emission factors are 0.9203 pounds per mile for PM_{10} and 0.0918 pounds per mile for $PM_{2.5}$.

The 2008 daily VMTs on unpaved roads and alleys in the PM_{10} NAA and Maricopa County are shown in Table 5.3–6. The 2008 VMT for unpaved roads in the PM_{10} NAA was derived from the MAG 2009 Unpaved Road Inventory (MAG, 2010). The 2008 VMT for unpaved alleys was derived by multiplying a MAG GIS-derived estimate of 650 miles of dirt alleys by an annual average daily traffic estimate of 9.1 vehicles per day.

The 2008 Maricopa County VMT was obtained by applying a ratio of 1.047 to the PM_{10} NAA VMT in Table 5.3–6. This ratio represents 2008 VMT on all roads in Maricopa County to 2008 VMT on all roads in the PM_{10} NAA, as derived in Table 5.3–7. The VMTs in Table 5.3–7 represent 2008 HPMS data submitted to the Federal Highway Administration by ADOT in August 2009.

Table 5.3–6. 2008 VMT on unpaved roads in the PM10 NAA and Maricopa County.

	2008 Annual Average Daily VMT	
Geographic Area	**Unpaved Roads**	**Unpaved Alleys**
PM_{10} NAA	47,984	5,915
Maricopa County	50,239	6,193

Table 5.3–7. 2008 VMT on all roads in the PM10 NAA and Maricopa County.

Geographic Area	2008 Annual Average Daily VMT (in thousands)	Ratio to 2008 Annual Average Daily VMT in the PM_{10} NAA
PM_{10} NAA	87,153	1.000
Maricopa County	91,257	1.047

Multiplying the unpaved road emission factors by the VMTs in Table 5.3–6 results in the uncontrolled emissions shown in Table 5.3–8. These uncontrolled emissions do not include the 2008 emission reductions attributed to the committed measures in the MAG 2007 Five Percent Plan for PM_{10}.

Table 5.3–8. Daily uncontrolled unpaved road and alley fugitive dust emissions.

	PM_{10} (lbs/day)		$PM_{2.5}$ (lbs/day)	
Geographic Area	Unpaved Roads	Unpaved Alleys	Unpaved Roads	Unpaved Alleys
PM_{10} NAA	69,835.9	5,443.6	6,972.1	543.0
Maricopa County	73,117.8	5,699.4	7,299.7	568.5

The MAG 2007 Five Percent Plan contains a number of committed measures that reduce unpaved road and alley fugitive dust emissions in the PM_{10} NAA (MAG, 2007). Four committed measures that reduce unpaved road and alley PM_{10} emissions were quantified in the MAG 2007 Five Percent Plan. The 2008 emission reductions attributed to these measures are shown in Table 5.3–9.

Table 5.3–9. 2008 benefits of measures that reduce unpaved road and alley fugitive dust in the PM10 NAA.

	PM_{10} emission reductions	
Committed Measures in the MAG 2007 Five Percent Plan	Annual (tons/year)	Average daily (lbs/day)[8]
1. Public education and outreach program (Measure 1)[9]	17.5	95.6
2. Pave or stabilize existing public dirt roads and alleys (Measure 26)	1,488.0	8,131.2
3. Limit speeds to 15 mph on high-traffic dirt roads (Measure 27)	390.4	2,133.4
4. Additional $5M in FY07 MAG TIP for paving roads/shoulders (Measure 43)[10]	169.5	926.2
Total 2008 PM_{10} emission reductions for unpaved roads:	**2,065.4**	**11,286.4**

The reductions in Table 5.3–9 were subtracted from the uncontrolled PM_{10} emissions in Table 5.3–8. The total 2008 PM_{10} emission reduction of 11,286.4 pounds per day represents 15.0 percent of the total uncontrolled unpaved road and alley PM_{10} emissions of 75,279.5 pounds per day in the PM_{10} NAA. This percent reduction was applied to the uncontrolled $PM_{2.5}$ emissions in the PM_{10} NAA; then the absolute reduction in $PM_{2.5}$ emissions due to the control measures was applied to the uncontrolled $PM_{2.5}$ emissions in Maricopa County. The controlled emissions in tons per year and pounds per day are shown in Table 5.3–10.

Table 5.3–10. Annual and average daily controlled fugitive dust emissions from unpaved roads.

	Annual emissions (tons/year)		Average daily emissions (lbs/day)	
Area	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
PM_{10} NAA	11,710.70	1,169.00	63,993.1	6,387.8
Maricopa County	12,358.20	1,233.60	67,530.9	6,741.0

[8] 366 days were used to convert tons per year to pounds per day in 2008.
[9] Measure benefit reflects a 0.1% reduction in 2008 uncontrolled paved road emissions in the MAG 2007 Five Percent Plan.
[10] Measure benefit includes only the projects that paved unpaved roads in 2008.

5.4 Summary of particulate emissions from onroad mobile sources

Table 5.4–1 summarizes the annual emissions and the average daily emissions for PM_{10}, $PM_{2.5}$, NO_x, SO_2, and NH_3 from all onroad mobile sources in Maricopa County in 2008. Similar data for the PM_{10} NAA are presented in Table 5.4–2.

Table 5.4–1. Annual and average daily emissions from all onroad mobile sources in Maricopa County.

Emission Category	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Exhaust, tire wear, and brake wear	3,295.74	2,417.89	75,033.94	314.45	1,294.12	18,009.2	13,212.4	410,021.3	1,718.2	7,072.1
Paved road fugitive dust	7,227.77	1,912.42	—	—	—	39,496.0	10,450.4	—	—	—
Unpaved road and alley fugitive dust	12,358.20	1,233.60	—	—	—	67,530.9	6,741.0	—	—	—
Totals:	**22,881.71**	**5,563.91**	**75,033.94**	**314.45**	**1,294.12**	**125,036.1**	**30,403.8**	**410,021.3**	**1,718.2**	**7,072.1**

Table 5.4–2. Annual and average daily emissions from all onroad mobile sources in the PM10 NAA.

Emission Category	Annual emissions (tons/year)					Average daily emissions (lbs/day)				
	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3	PM_{10}	$PM_{2.5}$	NO_x	SO_2	NH_3
Exhaust, tire wear, and brake wear	3,144.17	2,300.80	71,444.20	300.66	1,235.28	17,181.3	12,572.9	390,405.5	1,643.0	6,750.5
Paved road fugitive dust	6,694.22	1,774.76	—	—	—	36,580.5	9,698.1	—	—	—
Unpaved road and alley fugitive dust	11,710.70	1,169.00	—	—	—	63,993.1	6,387.8	—	—	—
Totals:	**21,549.09**	**5,244.56**	**71,444.20**	**300.66**	**1,235.28**	**117,754.9**	**28,658.8**	**390,405.5**	**1,643.0**	**6,750.5**

5.5 Quality assurance process

5.5.1 VMT estimates

Normal quality assurance procedures, including automated and manual consistency checks, were conducted by MAG in developing the 2008 TransCAD traffic assignment network used to generate the VMT data. The VMT estimates using the MAG travel demand model have been validated against approximately 2,200 traffic counts collected in 2006–2008.

5.5.2 Emission estimates

The quality assurance process performed on the MOVES2010a analyses included accuracy, completeness, and reasonableness checks. For accuracy and completeness, all calculations were checked by an independent reviewer. Any errors found were corrected and the changes were then rechecked by the reviewer.

5.5.3 Draft particulate matter emissions inventory

The draft onroad mobile source portion of the 2008 periodic PM_{10} emissions inventory was reviewed using published EPA quality review guidelines for base year emission inventories (EPA, 1992b). The procedure review (Levels I, II, and III) included checks for completeness, consistency, and the correct use of appropriate procedures.

5.6 References

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6. Biogenic Sources

6.1 Introduction

Biogenic emissions have been estimated for the 2008 Periodic Emissions Inventory for particulate matter in Maricopa County (9,223 square miles) and the PM_{10} Nonattainment Area (NAA) (2,887 square miles). The Model of Emissions of Gases and Aerosols from Nature (MEGAN) has been used to estimate the biogenic emissions. MEGAN is a state-of-the-art biogenic emissions model developed by the National Center for Atmospheric Research (NCAR). Some important corrections and improvements were made in the latest version of MEGAN2.04 (Guenther, 2007) compared to previous versions (Guenther, 2006, 2006a and 2006b). MEGAN2.04 was applied to compute biogenic emissions in Maricopa County and the PM_{10} NAA. Among the chemical species included in MEGAN, only nitric oxide (NO) is attributable to particulate matter formation. Therefore, only NO_x emissions are included in the inventory. The MEGAN runs were executed by the Maricopa Association of Governments. The contact person for the MEGAN emission estimates is Feng Liu (602-254-6300).

6.2 Modeling domain

As a numerical model, the MEGAN inputs and outputs are given in user-defined two-dimensional grid cells. To develop biogenic emissions for the 2008 Periodic Emission Inventory for particulate matter, the 4-km and 12-km modeling domains developed for the MAG eight-hour ozone plans for the Maricopa Nonattainment Area (MAG, 2007 and 2009), were employed for the PM_{10} NAA and Maricopa County, respectively. The definitions of these two domains in the Universal Transverse Mercator (UTM) coordinate system are presented in Table 6.2–1. Since MEGAN estimates biogenic emissions for entire modeling domains rather than specific areas, additional input files, masking areas covered by the PM_{10} NAA and Maricopa County, were developed by applying Geographic Information Systems (GIS) to calculate emissions for those two target areas. In order to represent the target area, the masking file assigns 1.0 for the grid cells fully covered by the target area, a fractional value for grid cells partially covered by the target area, and 0.0 for grid cells outside the target area. As shown in Figure 6.3–1, biogenic emissions for the PM_{10} NAA and Maricopa County were extracted from MEGAN runs for the masked grid cells in the 4-km and 12-km modeling domains, respectively.

Table 6.2–1. Two modeling domains defined in the UTM coordinate system.

Grid Horizontal Resolution	Grid Size	Domain Range (km)	Target Area
4-km	50 × 29	(297,3652) to (497,3768)	PM_{10} NAA
12-km	111 × 84	(275, 3188) to (1,057,4196)	Maricopa County

6.3 Input data

To calculate biogenic emissions using MEGAN, the following gridded input files for land cover and meteorological data were prepared:

1. EFMAP_LAI file: This file provides emission factors (EF) for 20 MEGAN species including NO, and monthly average leaf index (LAI) for 12 months for each grid cell.

2. PFTF file: This input file gives percentage of four plant function types (PFT) including broadleaf trees (BT), needle leaf trees (NT), grass and crops (HB) and shrubs (SB) for each model domain grid location.

3. METCRO2D file: This file contains meteorological parameters including temperature, short wave radiation, wind speed, humidity and soil moisture for each grid.

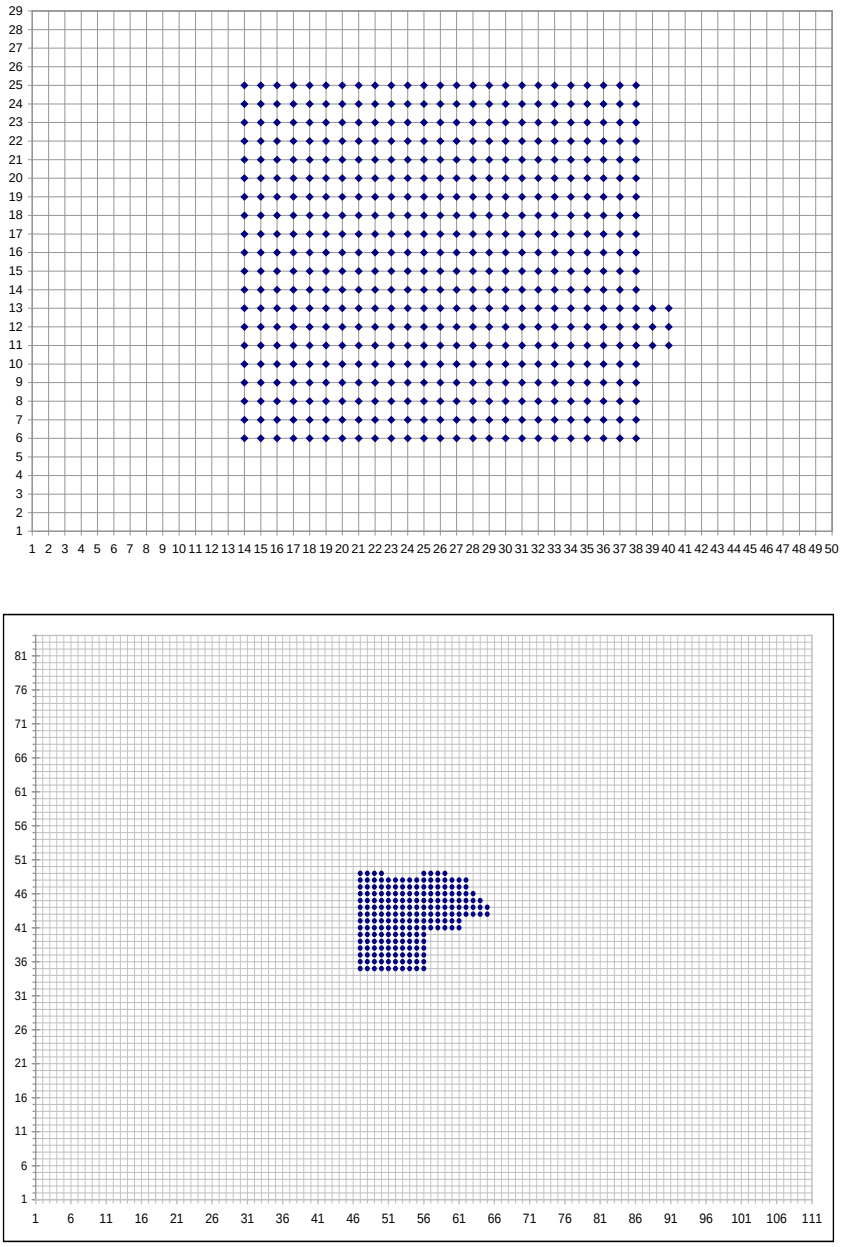

Figure 6.3–1. Mask of the PM_{10} NAA in the 4-km modeling domain (top) and mask of Maricopa County in the 12-km modeling domain (bottom).

6.3.1 Land cover data

The land cover data, including the monthly LAI, PFT, and EF, are provided by the EFMAP_LAI and PFTF files. These input data were derived from the MEGAN land cover database available

at a base resolution of 30 seconds latitude by 30 seconds longitude (~1×km^2) in ArcGIS format (http://acd.ucar.edu/~guenther/MEGAN/MEGAN.htm). For the MEGAN runs, however, the default land cover data during the summer season (June to August) were replaced by local datasets, which were developed by a field study conducted by Dr. Guenther in June 2006 (ENVIRON, 2006). The substitution was made because the default database systematically underestimated the LAIs in Maricopa County.

6.3.2 Weather data

The weather data used by MEGAN are temperature, downward short wave radiation, wind speed, humidity and soil moisture. The Measurement and Instrumentation Data Center (MIDC) collects irradiance and meteorological data from nation-wide stations, one of which is located in northern Phoenix (33.83° N, 112.17° W, denoted by red star in Figure 6.3–2), and is operated by the Phoenix Federal Correction Institution (PFCI). The archived hourly temperature, wind speed, humidity and radiation data from this site are available to the public. Monthly mean diurnal cycles of the weather parameters were calculated based on hourly data for the year 2008, and a netCDF file representing 24-hour data for each month was prepared for MEGAN inputs.

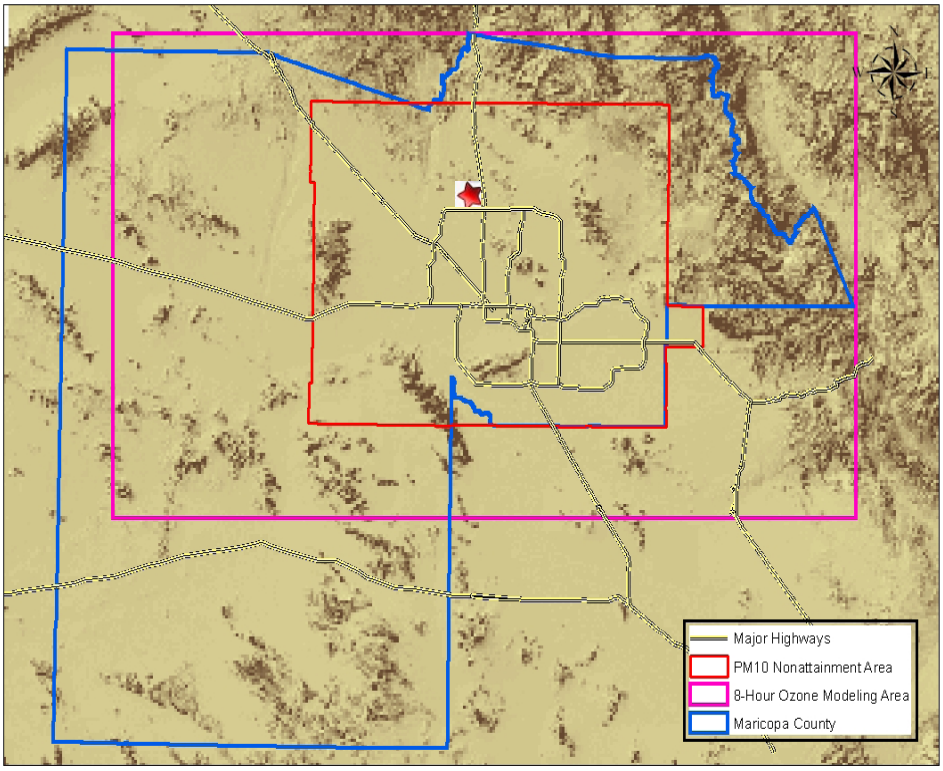

Figure 6.3–2. Boundaries of the PM_{10} NAA (red line), the 4-km eight-hour ozone modeling domain (pink line), Maricopa County (blue line), and the meteorological observation site (red star).

Biogenic NO is mainly emitted from wetted soil. The emission rate is dependent not only upon temperature and downward short wave radiation but also on soil moisture. Due to dry conditions year round in Maricopa County, the NO flux from the surface is very low compared to other states with higher precipitation. Only moisture delivery by Arizona monsoons leads to precipitation during the summer. This precipitation, in turn, increases soil moisture and humidity. According to weather records at the Phoenix Sky Harbor International Airport, the precipitation

in the Phoenix area was 0.0 and 2.15 inches in June and July 2008, respectively. Therefore, maximum monthly NO emissions occurred in July 2008. In general, however, NO emissions in the Maricopa County area are temperature and radiation dominated during the year. Figure 6.3–3 shows annual mean diurnal cycles of temperature and radiation. The peak temperature around 4:00–5:00 pm lags three hours behind the peak radiation. The delay is due to the fact that heating of the air occurs not from the sun's rays, but from heating of the earth and infrared radiation leaving the ground in the form of heat. As a result, maximum hourly emission rates take place in the afternoon because the emission rates are positively related to both temperature and short wave radiation (Guenther, 2006).

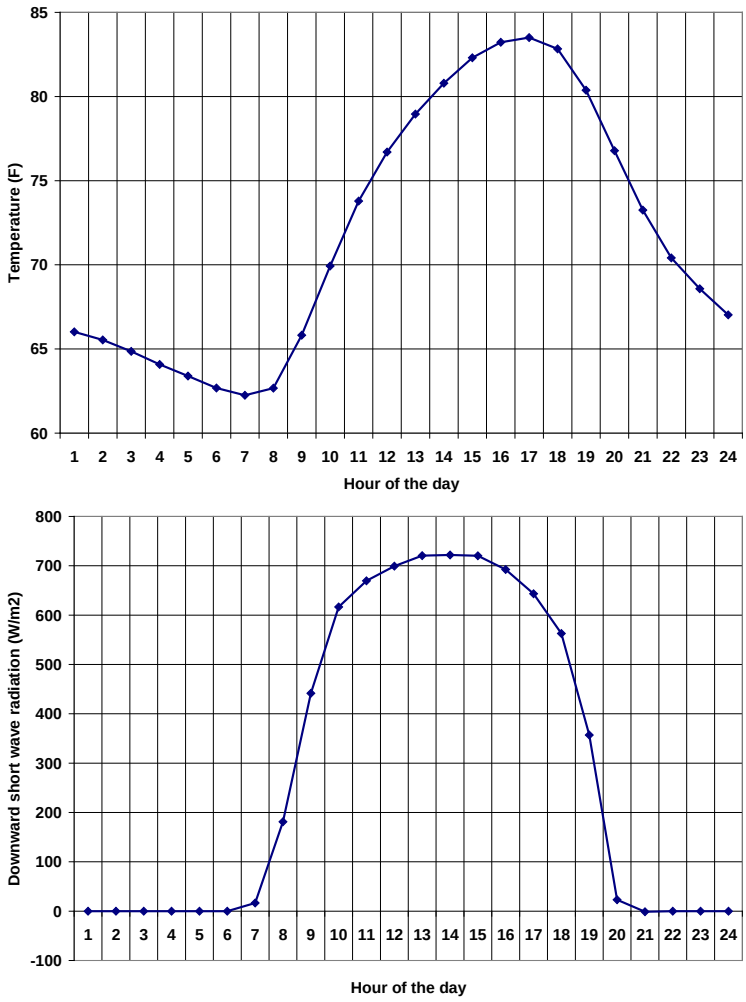

Figure 6.3–3. Annual mean diurnal cycles of measured temperature (top panel) and downward short wave radiation (bottom panel) in 2008.

6.4 Emissions estimation

MEGAN runs for the two modeling domains provide hourly emission outputs for the year 2008. Daily mean emissions for each month in 2008 were derived by using the hourly outputs for each month. In addition, monthly total emissions were obtained by multiplying the daily mean emissions for each month by the number of days in the month. The daily mean emissions for the 12 months of 2008 are shown in Table 6.4–1.

Table 6.4–1. Daily mean biogenic emissions of NO_x in the PM_{10} NAA and Maricopa County, by month.

	PM_{10} NAA		Maricopa County	
Month	**kg/day**	**lbs/day**	**kg/day**	**lbs/day**
January	127.2	280.4	355.2	783.1
February	168.0	370.4	480.9	1,060.2
March	413.3	911.2	1,131.0	2,493.4
April	601.7	1,326.5	1,658.8	3,657.0
May	721.0	1,589.5	1,923.1	4,239.7
June	1,818.8	4,009.8	4,729.4	10,426.5
July	1,878.7	4,141.8	4,930.0	10,868.8
August	1,702.0	3,752.3	4,485.1	9,888.0
September	1,331.9	2,936.3	3,784.7	8,343.8
October	651.1	1,435.4	1,839.9	4,056.3
November	328.5	724.2	910.8	2,008.0
December	138.6	305.6	388.0	855.4

Monthly mean emissions for Maricopa County and the PM_{10} NAA are illustrated in Figure 6.4–1. Monthly emission values are presented in Table 6.4–2. It can be seen that the monthly NO_x emissions reached the highest values in July. This is because biogenic emissions of nitric oxide (NO) are mainly from wetted soil. Thus, the NO emission rate depends not only on temperature and radiation, but also on soil moisture, which is related to precipitation. As discussed in Section 6.3, there were 2.15 inches of precipitation in July, but no precipitation in June, 2008. There is also one more day in July than June; therefore, the total NO_x monthly emissions in July are higher than in June.

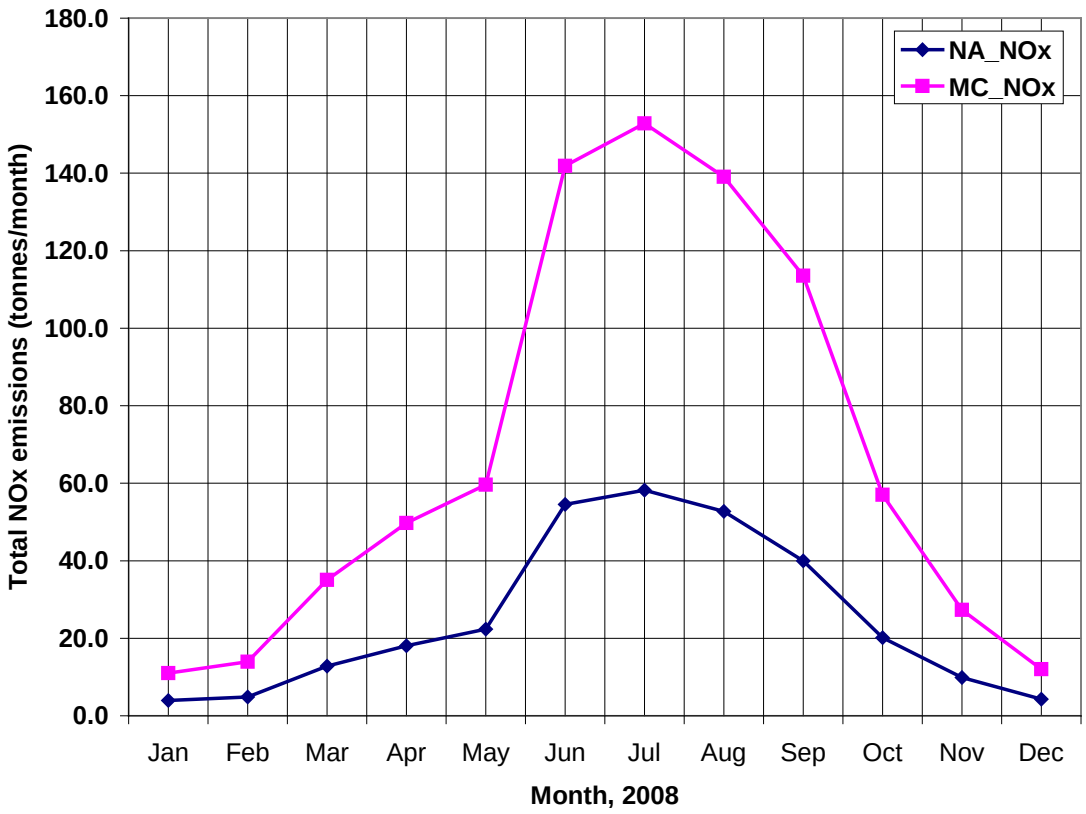

Figure 6.4–1. Monthly emissions of NO_x in Maricopa County (pink solid line, abbreviated as "MC") and the PM_{10} NAA (blue solid line, abbreviated as "NA").

Table 6.4–2. Monthly biogenic emissions of NO_x in the PM_{10} NAA and Maricopa County.

	PM_{10} NAA		Maricopa County	
Month	**Metric tons/mo**	**Tons/mo**	**Metric tons/mo**	**Tons/mo**
January	3.94	4.35	11.01	12.14
February	4.87	5.37	13.95	15.37
March	12.81	14.12	35.06	38.65
April	18.05	19.90	49.76	54.85
May	22.35	24.64	59.62	65.72
June	54.56	60.15	141.88	156.40
July	58.24	64.20	152.83	168.46
August	52.76	58.16	139.04	153.27
September	39.96	44.05	113.54	125.16
October	20.18	22.26	57.04	62.87
November	9.86	10.86	27.32	30.12
December	4.30	4.74	12.03	13.26
Totals:	**301.88**	**332.77**	**813.08**	**896.27**

6.5 Summary of biogenic source emissions

Daily mean and annual total biogenic NO_x emissions for Maricopa County and the PM_{10} NAA in 2008 are summarized in Table 6.5–1. Due to the incorporation of land cover data that are more characteristic of plants located in the desert southwest, as well as improvements to the MEGAN model, the 2008 data shown in Table 6.5–1 represent a substantial improvement over previous biogenic emission estimates for Maricopa County and the PM_{10} NAA.

Table 6.5–1. Daily mean and annual total NO_x emissions from biogenic sources.

	Daily mean		Annual total	
Geographic Area	**kg/day**	**lbs/day**	**Metric tons/yr**	**Tons/yr**
Maricopa County	2,218.1	4,890.0	813.08	896.27
PM_{10} NAA	823.4	1,815.3	301.88	332.77

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Maricopa County Air Quality Department

NEWS RELEASE

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April 26, 2010

Contact: Holly Ward: 602-506-6713/desk * 602-526-7307/cell

FOR IMMEDIATE RELEASE

Emissions Inventory Public Review Draft Released

Document details sources of air pollution emissions within Maricopa County; public workshop to be held May 14

The Maricopa County Air Quality Department announced today the release of its draft 2008 Periodic Emissions Inventory for PM_{10} for the Maricopa County PM_{10} Nonattainment Area. The document is now available for an informal 30-day public review period. The PM_{10} emissions inventory includes emissions estimates for PM_{10} and $PM_{2.5}$ as well as three particulate matter precursors: nitrogen oxides (NO_x), sulfur oxides (SO_x) and ammonia (NH_3).

The inventory provides emission estimates from point, area, nonroad mobile, onroad mobile and biogenic sources. The report is divided into six chapters, as follows:

Chapter 1: Introduction
Chapter 2: (Stationary) point sources (large manufacturing facilities, power plants)
Chapter 3: Area (non-point) sources (widespread, similar sources, such as fuel combustion, fires, etc.)
Chapter 4: Nonroad mobile sources (aircraft, locomotives, lawn movers, tractors, etc.)
Chapter 5: Onroad mobile sources (cars, trucks, other vehicles)
Chapter 6: Biogenic sources (crops, indigenous vegetation, landscaping, etc.)

The latter two chapters were prepared by the Maricopa Association of Governments (MAG).

The document is available in electronic format (PDF files) on the department's website at:
http://www.maricopa.gov/aq/divisions/planning_analysis/emissions_inventory/Default.aspx

The Air Quality Department will hold a public workshop to discuss the draft 2008 Periodic Emissions Inventory for PM_{10}. The workshop will be held at 9 AM at the department's offices at 1001 N. Central Ave., Suite 560, on Friday, May 14, 2010.

(continued on next page)

The department is also accepting written comments on the draft inventory through Wednesday, May 26, 2010, 5:00 PM. Comments may be submitted to:

Maricopa County Air Quality Department
Emissions Inventory Unit
1001 N. Central Avenue, Suite 595
Phoenix, AZ 85004
E-mail: EmisInv@mail.maricopa.gov

Questions may be addressed to Bob Downing at bdowning@mail.maricopa.gov.

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About Maricopa County Air Quality Department

The Maricopa County Air Quality Department is a regulatory agency whose goal is to ensure federal clean air standards are achieved and maintained for the residents and visitors of Maricopa County. The department is governed by the Maricopa County Board of Supervisors and follows air quality standards set forth by the federal Clean Air Act.

Maricopa County
Air Quality Department

INSTRUCTIONS

FOR REPORTING 2008

ANNUAL AIR POLLUTION EMISSIONS

January 2009

Emissions Inventory Unit
1001 North Central Avenue, Suite 595
Phoenix, Arizona 85004
(602) 506-6790
(602) 506-6179 (Fax)

Copies of this document, related forms
and other reference materials are available online at our web site:
http://www.maricopa.gov/aq/divisions/planning_analysis/emissions_inventory/Default.aspx

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WHAT'S NEW FOR 2008?

Reporting forms:

- Some **preprinted information** on your report may be different from last year's version. Please review the enclosed forms carefully, and verify all preprinted information.

- Many of our reporting forms **have changed** in past years. If you use your own forms, or a computerized reproduction of our forms, the forms used ***MUST*** conform to the current information requirements and **FORMAT** as supplied on our preprinted forms. "Homemade" reporting forms that vary significantly from the preprinted forms sent to you will ***not*** be accepted.

- **Please VERIFY that your reporting forms match the preprinted forms.**

Miscellaneous:

- **If this is the first emissions inventory for your permit and your business did not operate in 2008, you must still submit a completed Business Form and a signed Data Certification Form stating that there were no operations at your facility during 2008.**

- In accordance with Maricopa County Air Pollution Control Rule 280 (Fees), the 2008 annual emission fee for Title V sources only is $38.25/ton. **NOTE:** Only Title V sources (those whose air quality permit numbers have a **"V"** prefix) are subject to this annual emissions fee.

I. INTRODUCTION

An annual emissions inventory is a document submitted by a business that: (1) lists all processes emitting reportable air pollutants and (2) provides details about each of those processes. Submitting the emissions inventory report is ***required*** as a condition of your Maricopa County Air Quality Permit. A separate emissions report is required for each business location with its own air quality permit.

Follow these steps to complete your 2008 Maricopa County emissions inventory:

STEP 1: Determine which forms are needed for your business. There are eight different forms available, but not all are required for every type of business. For most permitted sources, the packet you received from us contains the necessary preprinted forms based on your site's most recent emissions inventory.

1. **Business Form**: Contains general contact information about the permitted site. This form is required for all businesses.
2. **Stack Form**: Only required if your business location annually emits over 10 tons of a single pollutant (CO, VOC, NO_x, PM_{10}, or SO_x). A "stack" is defined as a stack, pipe, vent or opening through which a significant percentage of emissions (from one or more processes) are released into the atmosphere. See the "Stack Form Instructions" on page 9 for specific requirements.
3. **Control Device Form**: Required only if there is one or more emission control devices used at the business location.
4. **General Process Form** and
5. **Evaporative Process Form**: } Either or both will be required for all businesses.
6. **Off-Site Recycling/Disposal Form**: Required if you want to claim off-site recycling or disposal.
7. **Emission Factor Calculations**: Required as attachment for each process for which you calculated your own emission factors.
8. **Data Certification Form or Data Certification/Fee Calculation Form**: Only sources with a **Title V** (permit number would start with **"V"**) permit are required to pay a fee for their emissions and need to use the Data Certification/Fee Calculation Form. All other sources use the Data Certification Form.

STEP 2: Complete the applicable forms. Verify all preprinted information, and make corrections where necessary. When making corrections, strike out the preprinted data and write in corrections beside it. Please make all changes readily noticeable. Detailed information on how to complete the most common forms is included in this document. The packet you received also contains information about other resources (workshops, one-on-one assistance, etc.) available to help you in completing the necessary forms.

STEP 3: Make a copy of your completed emissions inventory report. Make sure to KEEP COPIES of all forms submitted and copies of all records and calculations used in completing the forms. Air pollution control regulations require that you keep all documentation for at least FIVE YEARS at the location where pollution is being emitted.

STEP 4: Make sure the Data Certification Form (or Data Certification/Fee Calculation Form for Title V sources) is ***signed*** by a company representative. ***Include your air quality permit number on all correspondence and applicable checks submitted with your report.*** Return the ***original***, signed copy of your annual emission report, with payment for any applicable emission fees to:

MCAQD One Stop Shop
Emissions Inventory Intake
501 N. 44th St. Suite 200
Phoenix AZ 85008-6538

II. REPORTING REQUIREMENTS

POLLUTANTS TO BE REPORTED:
Your emissions inventory must include your business's emissions of the following air pollutants:

CO	=	Carbon monoxide
NO_x	=	Nitrogen oxides
PM_{10}	=	Particulate matter less than 10 microns
SO_x	=	Sulfur oxides
VOC	=	Volatile organic compounds *
HAP&NON	=	Hazardous Air Pollutant (HAP) that is also NOT a volatile organic compound (VOC)**
NH_x	=	Ammonia and ammonium compounds
Pb	=	Lead

* A ***volatile organic compound (VOC)*** is defined as any compound of carbon that participates in atmospheric photochemical reactions. This definition ***excludes***: carbon monoxide, carbon dioxide, acetone, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, as well as certain other organic compounds. (See Maricopa County Air Pollution Control Rule 100, Sections 200.69 and 200.110 for a full definition.)

EPA has re-designated the chemical **t-butyl acetate (CAS Number 540-88-5)** as a VOC for record-keeping requirements and emissions reporting, but not for emission limitations or content requirements. County Rule 100, Section 200.69b states:

"The following compound(s) are VOC for purposes of all recordkeeping, emissions reporting, photochemical dispersion modeling and inventory requirements which apply to VOC and shall be uniquely identified in emission reports, but are not VOC for purposes of VOC emissions limitations or VOC content requirements: t-butyl acetate (540-88-5)."

Therefore, if your facility uses t-butyl acetate, it is necessary to report t-butyl acetate as a separate material on the evaporative process form, not as part of a grouped material (e.g., solvents, thinners, activators, etc.). T-butyl acetate will continue to be identified as a VOC on your emission report and count towards any applicable emission fees.

** ***HAP&NON:*** Usage of certain materials that are: (1) a Hazardous Air Pollutant (HAP) **and** (2) **not** also a VOC (that is, not also an ozone precursor) should also be reported if:
(a) your site is subject to a Federal MACT (Maximum Achievable Control Technology) standard ***or***
(b) your air quality permit contains specific quantitative limits for HAP emissions.

The most common materials categorized as "HAP&NON" include:

- methylene chloride (dichloromethane)
- perchloroethylene
- 111-trichloroethane (111-TCA or methyl chloroform)
- hydrochloric acid
- hydrofluoric acid

NOTE: HAPs that are also considered volatile organic compounds are reported as VOC.

EMISSION CALCULATION METHOD HIERARCHY:

When preparing emission information for your report, the most accurate method for calculating **actual** emissions must be used. The hierarchy listed below outlines the preferred methods for calculating emission estimates (taken from County Rule 280, Section 305.1).

(1) Whenever available, emissions estimates should be calculated from continuous emissions monitors certified under 40 CFR Part 75, Subpart C, or data quality assured pursuant to Appendix F of 40 CFR, Part 60.

(2) When sufficient data obtained using the methods described in paragraph 1 is not available, emissions estimates should be calculated from source performance tests conducted pursuant to Rule 270 in Maricopa County's Air Pollution Control Rules and Regulations.

(3) When sufficient data obtained using the methods described in paragraphs 1 or 2 is not available, emissions estimates should be calculated from material balance using engineering knowledge of the process.

(4) When sufficient data obtained using the methods described in paragraphs 1 through 3 is not available, emissions estimates shall be calculated using emissions factors from EPA Publication No. AP-42 "Compilation of Air Pollutant Emission Factors," Volume I: Stationary Point and Area Sources.

(5) When sufficient data obtained using the methods described in paragraphs 1 through 4 is not available, emissions estimates should be calculated by equivalent methods supported by back-up documentation that will substantiate the chosen method.

III. CONFIDENTIALITY OF DATA SUBMITTED

Information submitted in your annual emissions reports must be made available to the public unless it meets certain criteria of Arizona State Statutes and Maricopa County Rules. Applicable excerpts concerning confidentiality of data are reproduced below.

ARS § 49-487 D. ...the following information shall be available to the public:…

2. The chemical constituents, concentrations and amounts of any emission of any air contaminant. ...

MARICOPA COUNTY AIR POLLUTION CONTROL RULES AND REGULATIONS, Rule 100:

§ **200.107 TRADE SECRETS -** Information to which all of the following apply:

a. A person has taken reasonable measures to protect from disclosure and the person intends to continue to take such measures.

b. The information is not, and has not been, reasonably obtainable without the person's consent by other persons, other than governmental bodies, by use of legitimate means, other than discovery based on a showing of special need in a judicial or quasi-judicial proceeding.

c. No statute, including ARS §49-487, specifically requires disclosure of the information to the public.

d. The person has satisfactorily shown that disclosure of the information is likely to cause substantial harm to the business's competitive position.

§ **402 CONFIDENTIALITY OF INFORMATION:**

402.2 Any records, reports or information obtained from any person under these rules shall be available to the public ... unless a person:

a. Precisely identifies the information in the permit(s), records, or reports which is considered confidential.

b. Provides sufficient supporting information to allow the Control Officer to evaluate whether such information satisfies the requirements related to trade secrets as defined in Section 200.107 of this rule.

For emissions inventory information to be deemed confidential, the following steps must be followed:

- Specific data which you request be held confidential must be identified by marking an "X" in the corresponding gray confidentiality box(es) on the relevant report forms.
- Provide a written explanation which gives factual information satisfactorily describing why releasing this information could cause substantial harm to the business's competitive position.
- Use the gray-shaded boxes on the reporting forms to indicate which data are to be held confidential. Do NOT stamp "Confidential", highlight data, or otherwise mark the page.
  No data can be held confidential without proper justification.

IV. HELPFUL HINTS AND INFORMATION

Be sure to verify all preprinted information on forms. If any information is incorrect or blank, please provide correct information. Making a change on the Business Form will **NOT** transfer the permit ownership or location. You must contact the Department's One Stop Shop at (602) 506-6464 to accomplish this.

WHAT IS A PROCESS? A ***process*** is a business activity at your location that emits one or more of the pollutants listed on page 3, and has only ***one*** material type as input and ***one*** operating schedule. For each applicable process at your business, you must assign a unique Process ID number to differentiate each process.

PROCESSES AND MATERIALS THAT DO ***NOT*** HAVE TO BE REPORTED:

- Welding.
- Acetone usage.
- Fuel use for forklifts or other vehicles. (NOTE: Fuel use in ***non-vehicle*** engines ***is*** reportable.)
- Soil remediation activities. (Note: Other periodic reporting requirements may exist; consult your permit.)
- Storage emissions from fuels or organic chemicals in any tank with a capacity of 250 gallons or less.
- Storage emissions of diesel and Jet A fuel in underground tanks of any size.
- Storage emissions of diesel and Jet A fuel in aboveground tanks, with throughput < 4,000,000 gal/yr.
- Routine pesticide usage, housekeeping cleaners, and routine maintenance painting at your facility.

Please group all similar equipment and materials together before applying the following limitations:

- Internal combustion engines (e.g., emergency generators) or external combustion equipment (e.g., boilers and heaters) that operated less than 100 hrs. and burned less than 200 gals. diesel or gas, or less than 100,000 cubic feet of natural gas.
- Materials with usage of less than 15 gallons or 100 pounds per year.

GROUPING MATERIALS AND/OR EQUIPMENT UNDER ONE PROCESS ID:
You can group together under one process ID:

- All internal combustion engines ***less than 600 hp*** if they burn the same fuel and have similar operating schedules.
- All external combustion equipment (boilers, heaters) with a capacity of ***less than 10,000,000 Btu*** per hour if they burn the same fuel and have similar operating schedules.
- All similar evaporative materials with similar emission factors that have similar operating schedules and process descriptions. For example, group low-VOC red paint, green paint and white paint together as one material: "Paint: Low-VOC." Do ***not*** group dissimilar materials together, such as thinners and paints. Attach documentation (see example, p. 20) showing how the grouped emission factor was determined.
- All underground tanks with the same fuel and same type of vapor recovery system.

ASSIGNING IDENTIFICATION NUMBERS (IDs):
Unique IDs are required for the following report elements: Stacks, Control Devices and Processes. For processes, that means a process ID number may be used only once on each General Process form and for each material reported on the Evaporative Process Forms.

These numbers are usually assigned by the person who prepares the original report. If you are adding a new item to a preprinted report, assign a number not already in use. Once an ID number is assigned, continue using the same number for that item each year. If that item is no longer reportable, mark it with 'DELETE' and return the preprinted form with a brief explanation. Do not use that ID number again.

INDUSTRY-SPECIFIC INSTRUCTIONS: Additional help sheets, detailed examples, and special instructions are available for a number of specific processes or industries listed below. To get copies of any of these documents, please visit our web site at:
http://www.maricopa.gov/aq/divisions/planning_analysis/emissions_inventory/Default.aspx
or call (602) 506-6790.

- Bakeries
- Concrete Batch Plants
- Fuel Storage and Handling
- Incinerators and Crematories
- Lg. Aboveground Storage Tanks
- Natural Gas Boilers/Heaters
- Polyester Resin
- Printing Plants
- Roofing Asphalt
- Sand and Gravel Plants
- Using EPA's TANKS 4.09d Program
- Vehicle Refinishing
- Vehicle Travel on Unpaved Roads
- Woodworking

COMMONLY USED CONVERSION FACTORS:

1 gram/liter	=	0.00834 lbs/gal	1 foot	=	0.0001894 mile
1 liter	=	0.2642 gallon (US)	1 square foot	=	0.000022957 acre
1 therm	=	0.0000952 MMCF	1 pound	=	0.0005 ton

NOTE: MM = 1,000,000 Example: MMCF = 1,000,000 cubic feet
M = 1,000 Example: MGAL = 1,000 gallons

ADDITIONAL RESOURCES AND ASSISTANCE:
The Maricopa County Emissions Inventory web site at:
http://www.maricopa.gov/aq/divisions/planning_analysis/emissions_inventory/Default.aspx
contains additional reference materials, such as:

- blank copies of most emissions reporting forms.
- an updated list of emission factors for a large number of industrial processes, including SCC codes.
- a list of Tier Codes for industrial processes.
- detailed help sheets for a number of specific industries or processes.

To receive any of the above materials by fax or mail, or for additional information or assistance in how to calculate and report your emissions, please call us at (602) 506-6790.

V. INSTRUCTIONS AND EXAMPLES FOR COMPLETING EMISSIONS REPORTING FORMS

Business Form Instructions

Verify all preprinted information, and make corrections where necessary. When making corrections, strike out the preprinted data and write in corrections beside it. Please make all changes readily noticeable.

NOTE: Indicating a change in ownership or business location on the Business Form will ***not*** serve to transfer the permit ownership or location. You must contact the MCAQD One Stop Shop at (602) 506-6464 to accomplish this.

Data fields:

6 Number of employees: This should be the annual average number of full-time equivalent (FTE) employee positions ***at this business location***.

9 NAICS Code: This 5- or 6-digit North American Industrial Classification System (NAICS) code has been introduced to replace the 4-digit Standard Industrial Classification (SIC) codes. Please list the primary and secondary NAICS codes for your business, if known. (Consult our website, at: http://www.maricopa.gov/aq/divisions/planning_analysis/emissions_inventory/Default.aspx, for a link to a full list of NAICS codes.)

10 Preparer of the Inventory (primary contact for technical questions concerning this report): This should be the person who knows the most about the data in the report. If this person has an e-mail address used for business purposes, please provide it.

Stack Form Instructions

A "stack" is defined as a **stationary** stack, pipe, vent or opening through which a significant percentage of emissions (from one or more processes) are released into the atmosphere (with or without a control device).

NOTE: Stack information is required only if your business location annually emits over 10 tons of any one individual pollutant. If so, you must complete a Stack Form for:

- each stack connected to a control device.
- any stack that discharges annually more than 5 tons of combined pollutant emissions (such as a paint booth exhaust).

EXAMPLE Stack Form Information:

1	**2**	**3**	**4**	**5a OR 5b**		**6a OR 6b & 6c**			**7**
Stack ID	Stack Type Code*	Stack Height**	Exit Gas Temperature	Velocity feet/sec	Flow Rate acfm	Diameter inside inch	Length / Width inside inch		Stack Name/Description. Include lat/long coordinates of stack (in decimal degrees)
1	***W***	***30*** ft	***90*** ^{o}F		***20,000***	***36***			***paint booth Lat: N33.5276 Long: W112.2626***
2	***V***	***14*** ft	***200*** ^{o}F		***19,186***	***40***			***thermal oxidizer, Bldg. 2 Lat:N33.5259 Long:W112.2611***

* Stack Type Codes: **V** = Vertical unobstructed; **D** = Downward unobstructed; **W** = Obstructed vertical (e.g. weather cap); **H** = Horizontal unobstructed; **G** = Gooseneck

** Stack height is calculated relative to the surrounding terrain. For instance, the stack height of a 10-foot stack on top of a 20-foot tall building is 30 feet.

Data fields:

1 Stack ID: (See "Assigning Identification Numbers" on page 6.) A number (up to three digits, numeric only) which identifies a specific stack. It is suggested you start with 1, then 2, etc.

4 Exit Gas Temperature: Should represent average operating conditions, in degrees Fahrenheit. ***DO NOT*** report "ambient".

5a Exit Gas Velocity: ***OR*** 5b Gas Flow Rate:
Provide ***EITHER*** the exit velocity (in feet per second) ***OR*** the flow rate of gas (in actual cubic feet per minute) exiting the stack during normal operations. Preprinted information provides both.

6a Inside Stack Diameter: For round stacks, provide Inside Stack ***Diameter*** in inches.
OR
6b & 6c Inside Stack Length and Width: For square or rectangular stacks, provide inside ***Length and inside Width*** in inches.

7 Stack Name/Description and Lat/Long Coordinates: Provide a brief text description of the stack along with the latitude and longitude coordinates of the stack (in decimal degrees).

Control Device Form Instructions

EXAMPLE Control Device Form Information

1	2	3	4	5	6
Control ID	Installation/ Reconstruction* Date	Size or Rated Capacity**	Control Type Code	Control Device Name/Description	Stack ID
1	***05/09/98***	***25,000.0*** cfm	***021***	***Thermal oxidizer***	***2***
4	***03/10/97***	cfm	***153***	***Watering with water trucks***	

Data fields:

1 Control ID: (See "Assigning Identification Numbers" on page 6.) A unique number (up to three digits) that you assign to identify a specific control device.

2 Installation/Reconstruction Date: The completion date (given in *mm/dd/yy* format) of installation or the most recent reconstruction of the identified control device. This is not a date on which routine repair or maintenance was done. "Reconstruction" means any component of the control device was replaced and the cost (fixed capital) of the new component(s) was more than half of what it would have cost to purchase or construct a new control device.

3 Size or Rated Capacity: Report the air or water flow rate in ***cubic feet per minute***. Some devices (e.g., water trucks for dust control) will not include a value in this field.

4 Control Type Code: A 3-digit code designating the type of control device. A complete list of all EPA control device codes can be found on the Web at: http://www.maricopa.gov/aq/divisions/planning_analysis/emissions inventory/Default.aspx or call (602) 506-6790 for assistance.

6 Stack ID: Not all businesses require a Stack ID. This is required if the Stack Form is used for your site (see page 9) ***and*** the control device is vented through that identified stack. This is the ID number shown in column 1 of the Stack Form. The Stack ID can be entered on this form after the Stack Form has been filled out.

General Process Form Instructions

The General Process Form is used to record data on all emissions-producing processes except evaporative processes. A "***general process***" is normally characterized by the burning or handling of a material. One form reports all the pollutants for one process. For example, several pollutants are produced by burning fuel, and PM_{10} is emitted by processing rock products, processing materials such as wood or cotton, and driving on unpaved areas.

Data fields: (See sample forms on pages 13 and 14.)

1 Process ID: A number (up to three digits) that is preprinted or you assign. (See "Assigning Identification Numbers" on page 6.) This Process ID number can not be used for any other process at this location.

2 Process Type/Description: Brief details on the type of activity that is occurring.

3 Stack ID(s): The stack ID number(s) shown in column 1 of the Stack Form that identify the stack(s) which vent pollution created by this process. Not all businesses are required to report stacks. This is only required if the Stack Form is required for your site (see page 9) ***and*** the process has a stack.

4 Process Tier Code and
5 SCC Code:
If these codes are not preprinted on your form, please consult the section "Other Resources" on our web site, or call (602) 506-6790.

6 Seasonal Throughput Percent: Enter the percent of total annual operating time that occurred per season, rounded to the nearest percent. For example, "Dec-Feb 30% " means 30% of total annual activity occurred in January, February and December 2008. The total for all four seasons must equal 100%.

7 Normal Operating Schedule and
8 Typical Hours of Operation:
These reflect the normal daily, weekly, and annual operating parameters of ***this process*** during 2008.

9 Emissions Based on: Provide the ***name*** of the material used, fuel used, product produced, or whatever was measured for the purpose of calculating emissions, such as "natural gas", "hours of operation," "vehicle miles traveled," or "acres."

10 Used, Produced or Existing: Indicate whether calculated emissions are based on a material type or fuel *used* (an input, such as "paint" or "natural gas"), or an *output* (such as "sawdust produced" or "finished product"). Use "Existing" if the parameter reported on line 9 is not directly used or produced in the process (such as "vehicle miles traveled" or "acres").

11 Annual Amount: The annual amount (a number) of material that was used, fuel combusted, product produced, hours of operation, vehicle miles traveled, or acres.

12 Fuel Sulfur Content (in percent): For processes that involve the combustion of oil or diesel fuels, report the sulfur content of the fuel as a decimal value. Example: 0.05 % (= 500 ppm)

13 Unit of Measure: Units of the material used, fuel used or product produced shown on line 9. For example: gallons, pounds, tons, therms, acres, vehicle miles traveled, units produced.

14 Unit Conversion Factor: You must provide this if you use an emission factor with an emission factor unit (see item 17 below) that is ***not*** the same as the unit of measure (from line 13). This is the standard number you would multiply your amount (line 11) by to convert it to the units of the emission factor. See page 7 for a list of commonly used conversion factors.

General Process Form Instructions (continued)

15 Pollutant: See page 3 for a list of pollutants that need to be reported.

16 Emission Factor (EF): The number to be multiplied by the annual amount (line 11) to determine how much of the pollutant was emitted. If you calculate your own emission factor or change the preprinted emission factor, you must provide details of your calculations in an attachment.

17 Emission Factor (EF) Units: Enter the appropriate Emission Factor Units in pounds (lb) per unit; e.g., lb/ton, lb/MMCF, lb/gal.

18 Controlled Emission Factor (EF)? YES or NO: Indicate "YES" if: 1) you have your own emission factor from testing **and** included the control device efficiency within the factor, or 2) the emission factor used is clearly identified as a controlled emission factor. A "YES" response requires the use of Formula A (see #25 below). Indicate "NO" if: 1) there is no emission control device, or 2) the emission factor represents emission rates **before** controls. A "NO" response requires the use of Formula B (see #25 below).

19 Calculation Method: Enter the number code (listed at the bottom of the General Process Form) which best describes the method you used to obtain this emission factor. Code 5, "AP-42/FIRE Method or Emission Factor" means that the factor comes from EPA documents or software. ***NOTE:*** If you have continuous emissions monitors (CEM) data or conducted a source test that was required and approved by the County for a specific process or piece of equipment, you ***must*** use the emission data from the CEM or the test results. Report "1" in this column for CEM data or "4" for performance test data.

20 through 24: Leave blank if there is no control device.

20 Capture % Efficiency: The percent of the pollutant that is captured and sent to the primary control device in this process. Be sure to list capture efficiency separately for ***each*** pollutant affected.

21 Primary Control Device ID: If this pollutant is being controlled in this process, enter the Control Device ID number which represents the first control device affecting the pollutant.

22 Secondary Control Device ID: If this pollutant is being controlled sequentially by 2 devices, enter the Control Device ID number which represents the second control device; otherwise leave this field blank.

23 Control Device(s) % Efficiency: Enter the total control efficiency of the control device(s). Be sure to list control device efficiency separately for ***each*** pollutant affected. If you report control device efficiency, you must ***also*** show capture efficiency in column 20.

24 Efficiency Reference Code: Enter the code (1 through 6) that best describes how you determined the ***control device efficiency***. A list of possible codes is included at the bottom of the form.

25 Estimated Actual Emissions (in pounds/year): You may round the calculated emissions values to the nearest pound. Calculate as follows:

A. *Emissions with no controls* or *controls are reflected in the emission factor:*
Column 25 = line 11 × line 14 × column 16

B. *Emissions after control:*
Column 25 = line 11 × line 14 × column 16 × (1 – [column 20 × column 23])

Use the decimal equivalent for columns 20 and 23. Example: 96.123% = 0.96123

General Process Form 2008

EXAMPLE: Internal Combustion

Permit number(s) V99999

Place an X in any gray cell to mark data requested to be held confidential. See page 5 for requirements for information to be deemed confidential.

1- Process ID 80

2- Process Type/Description: 3 ENGINES FOR CRUSHING (EACH LESS THAN 600 HP)

3- Stack ID(s) *(only if required on Stack Form)* _____ _____ _____ _____ _____

4- Process TIER Code: 020599 FUEL COMB. INDUSTRIAL: INTERNAL COMBUSTION

5- SCC Code 20200102 *(8 digit number)* IND:DIESEL-RECIPROCATING

6- Seasonal Throughput Percent: Dec-Feb 25 % Mar-May 25 % Jun-Aug 25 % Sep-Nov 25 %

7- Normal Operating Schedule: Hours/Day 8 Days/Week 5 Hours/Year 2080 Weeks/Year 52

8- Typical Hours of Operation: *(military time)* Start 0700 End 1530

9- Emissions based on *(name of material or other parameter, e.g. "rock", "diesel", "vehicle miles traveled")* DIESEL

10- [X] Used (input) or [ ] Produced (output) or [ ] Existing (e.g. VMT, acres)

11- Annual Amount: *(a number)* 16,250 12- Fuel Sulfur Content (in percent) 0.05 %

13- Unit of Measure: *(for example: tons, gallons, million cu ft, acres, units produced, etc.)* GALLONS

14- Unit Conversion Factor *(if needed to convert Unit of Measure to correlate with emission factor units)* 0.001

	Emission Factor (EF) Information					Control Device Information					
	15	16	17	18	19	20	21	22	23	24	25
Pollutant	Emission Factor (EF) (number)		Emission Factor Unit (lb per)	Controlled EF? Yes or No	Calculation Method Code*	Capture % Efficiency	Primary Control Device ID	Secondary Control Device ID	Control Device(s) % Efficiency	Efficiency Reference Code**	Estimated Actual Emissions
CO	130		M GALS	N	5						2,113 lbs
NOx	604		M GALS	N	5						9,815 lbs
PM-10	42.5		M GALS	N	5						691 lbs
SOx	39.7		M GALS	N	5						645 lbs
VOC	49.3		M GALS	N	5						801 lbs

*** Calculation Method Codes:**

1 = Continuous Emissions Monitoring Measurements
2 = Best Guess / Engineering Judgment
3 = Material Balance
4 = Source Test Measurements (Stack Test)
5 = AP-42 / FIRE Method or Emission Factor
6 = State or Local Agency Emission Factor
7 = Manufacturer Specifications
8 = Site-Specific Emission Factor
9 = Vendor Emission Factor
10 = Trade Group Emission Factor

**** Control Efficiency Reference Codes:**

1 = Tested efficiency / EPA reference method
2 = Tested efficiency / other source test method
3 = Design value from manufacturer
4 = Best guess / engineering estimate
5 = Calculated based on material balance
6 = Estimated, based on a published value

General Process Form **2008**

EXAMPLE: Unpaved Road Travel

Permit number(s) V99999

Place an X in any gray cell to mark data requested to be held confidential. See page 5 for requirements for information to be deemed confidential.

1- Process ID 28

☐ **2-** Process Type/Description: UNPAVED ROAD TRAVEL: HEAVY-DUTY TRUCKS @ 15 MPH

3- Stack ID(s) *(only if required on Stack Form)* _____ _____ _____ _____ _____

4- Process TIER Code: 140799 MISCELLANEOUS: FUGITIVE DUST

5- SCC Code 30502504 *(8 digit number)* SAND/GRAVEL: HAULING

6- Seasonal Throughput Percent: Dec-Feb 25 % Mar-May 25 % Jun-Aug 25 % Sep-Nov 25 %

7- Normal Operating Schedule: Hours/Day 8 Days/Week 5 Hours/Year 2080 Weeks/Year 52

8- Typical Hours of Operation: *(military time)* Start 0700 End 1530

☐ **9-** Emissions based on *(name of material or other parameter, e.g. "rock", "diesel", "vehicle miles traveled")* VEHICLE MILES TRAVELED (VMT)

10- ☐ Used (input) or ☐ Produced (output) or ☒ Existing (e.g. VMT, acres)

☐ **11-** Annual Amount: *(a number)* 7,500 12- Fuel Sulfur Content (in percent) _____%

13- Unit of Measure: *(for example: tons, gallons, million cu ft, acres, units produced, etc.)* VMT

14- Unit Conversion Factor *(if needed to convert Unit of Measure to correlate with emission factor units)* _____

Emission Factor (EF) Information					Control Device Information					
15	16	17	18	19	20	21	22	23	24	25
Pollutant	Emission Factor (EF) (number)	Emission Factor Unit (lb per)	Controlled EF? Yes or No	Calculation Method Code*	Capture % Efficiency	Primary Control Device ID	Secondary Control Device ID	Control Device(s) % Efficiency	Efficiency Reference Code**	Estimated Actual Emissions
PM-10	3.2	VMT	N	6	100	4		70	6	7200 lbs
										lbs
										lbs
										lbs
										lbs
										lbs

NOTE: Emissions in col. 25 are calculated as follows: (line 11 × col. 16) × (1 – [col. 20 × col. 23])

*** Calculation Method Codes:**
- **1** = Continuous Emissions Monitoring Measurements
- **2** = Best Guess / Engineering Judgment
- **3** = Material Balance
- **4** = Source Test Measurements (Stack Test)
- **5** = AP-42 / FIRE Method or Emission Factor
- **6** = State or Local Agency Emission Factor
- **7** = Manufacturer Specifications
- **8** = Site-Specific Emission Factor
- **9** = Vendor Emission Factor
- **10** = Trade Group Emission Factor

**** Control Efficiency Reference Codes**
- **1** = Tested efficiency / EPA reference method
- **2** = Tested efficiency / other source test method
- **3** = Design value from manufacturer
- **4** = Best guess / engineering estimate
- **5** = Calculated based on material balance
- **6** = Estimated, based on a published value

Evaporative Process Form Instructions

The Evaporative Process Form is used to report all emissions produced by evaporation. Examples include: cleaning with solvents, painting and other coatings, printing, using resin, evaporation of fuels from storage tanks, ammonia use, etc. All other processes should be shown on the General Process Form.

One Evaporative Process Form may be used to report numerous materials, with each material given a separate process ID number, as long as the information on lines 1–5 apply to all items on that form. Use a separate form for each group of materials that has a different Process Type/Description (shown on line 1), different Tier Code (line 2) or different operating schedule (lines 3, 4, or 5).

Data fields: (See sample forms on pages 17 and 18.)

1 Process Type/Description: Brief details of the activity in which the listed materials were used.

2 Process Tier Code: If this 6-digit code is not preprinted on your form, please refer to the Tier Code list at: http://www.maricopa.gov/aq/divisions/planning_analysis/emissions_inventory/Default.aspx or call (602) 506-6790.

3 Seasonal Throughput Percent: Enter the percent of total annual operating time that occurred per season (rounded to the nearest percent). For example, "Dec-Feb 30% " means 30% of the total annual activity occurred during January, February and December 2008. The total for all four seasons must equal 100%.

4 Normal Operating Schedule and
5 Typical Hours of Operation:
These represent the usual number of hours, time of day and weeks per year when ***this process*** occurred during the calendar year.

6 Process ID: A number (up to three digits) that represents this specific material (process). Each process on one form must have the same tier code and operating schedule as that shown in the top portion of the form. This Process ID number can ***not*** be used for any other process at this business location. See page 6 of these instructions for more explanation of ID numbers and for exclusions and guidance on grouping materials.

7 Stack ID(s): The stack ID number(s) shown in column 1 of the Stack Form that identify the stack(s) which vent pollution created by this process. Not all businesses are required to report stacks. This is only required if the Stack Form is required for your site (see page 9) ***and*** the process has a stack.

8 Material Type: Provide the name of the material used in this process. Give the chemical name for pure chemicals or a name that reflects its use (paint, ink, etc.), rather than just a brand name or code number. Examples of materials include: paint, thinner, degreasing solvent (plus its common name), ink, fountain solution, ammonia, alcohol, ETO (ethylene oxide), gasoline (in a storage tank).

9 Annual Material Usage/Input: Amount of this material used during the year. In most cases, the amount purchased is suitable. Write in "lbs" or "gal" (pounds or gallons).

10 Pollutant: The only pollutants reported on this form are VOC, HAP&NON and NH_X (see definitions on page 3). When one process (or material) has more than one of these pollutants, list each pollutant on a separate line, using the same process ID number.

Evaporative Process Form (continued)

11 Emission Factor (EF): An emission factor is a number used to calculate the pounds of pollutant emitted based on the quantity of material used in a process. Emission factors can be obtained from your supplier (usually provided on a Material Safety Data Sheet or environmental data sheet), and must correspond with the material units reported in column 9. If the material unit is "gal," then the emission factor must be in pounds of pollutant per gallon. If the material unit is "lb," then the emission factor must be in pounds of pollutant per pound of material.

Verify (and correct, where necessary) all preprinted emission factors, as the composition of materials used may have changed since your last report. A "lb/gal" emission factor is almost always less than 8 and never greater than 14. A "lb/lb" emission factor is never larger than 1.0.

12 Pounds of pollutant sent off-site: Required only if you wish to take credit for reduced emissions because waste of this material is sent off-site for recycling or disposal. Only waste generated during the report year may be claimed. The Off-Site Recycling/Disposal Form ***must*** be completed if you wish to claim a credit. The number of pounds reported in column 12 ***must*** equal the number of pounds reported on the Off-Site Recycling/Disposal Form(s) for the same Process ID number.

13 and 14: Leave these fields blank if there is no control device present.

13 Capture % Efficiency: The percent of the pollutant from this process that is captured and sent to the control device.

14 Control ID: If this pollutant is being controlled in this process, enter the Control Device ID number from column 1 of the Control Device Form.

Control % Efficiency: Enter the percent of this pollutant that is controlled by this control device.

Code: Select the Control Efficiency Reference Code from the list at the bottom of the form.

15 Estimated Emissions (lbs/yr): Estimated pounds of the pollutant emitted during the year, after off-site recycling/disposal and controls if applicable. **Credit will not be given for off-site recycling/disposal unless it is shown on the Off-Site Recycling/Disposal Form.** Round to the nearest pound. If the answer is 0, give a decimal answer to the first significant digit. Column 15 is calculated as follows:

Emissions without off-site recycling/disposal or controls:
Column 15 = column 9 × column 11

Emissions with off-site recycling/disposal:
Column 15 = (column 9 × column 11) – column 12

*Emissions with off-site recycling/disposal **and** controls:*
Column 15 = ([column 9 × column 11] – column 12) × (1 – [column 13 × column 14])

Use the decimal equivalent for columns 13 and 14. Example: 96.123% = 0.96123

EXAMPLE: Coating and Painting

Evaporative Process Form 2008

Permit number(s) V99999

Place an X in any gray cell to mark data requested to be held confidential. See page 5 for requirements for information to be deemed confidential.

1- Process Type/Description: *Coating metal parts*

2- Process TIER Code: *080415* **SOLVENT USE: SURFACE COATING - MISC METAL PARTS**

3- Seasonal Throughput Percent: Dec-Feb *25* % Mar-May *25* % Jun-Aug *25* % Sep-Nov *25* %

4- Normal Operating Schedule: Hours/Day *8* Days/Week *5* Hours/Year *2080* Weeks/Year *52*

5- Typical Hours of Operation *(military time)* Start *0800* End *1700*

6	7	8	9		10	11		12	13	14			15
Process ID	Stack ID(s)	Material Type	Annual Usage Input	lb or gal	VOC, HAP&NON or NHx	Emission Factor	EF Units (lbs per)	Pounds of pollutant* sent off site	Capture Efficiency %	Control ID	Control Efficiency %	Control Efficiency Code**	Estimated Emissions (lbs/yr)
800	1	Lacquer 6455-06	95	gl	VOC	4.7	gal		%		%		447
801	1	lacq thinner	120	gl	VOC	7.1	gal		%		%		852
802	1	Paint red 4039-03	940	gl	VOC	4.2	gal		%		%		3,948
803	1	paint thinner	707	gl	VOC	7.0	gal		%		%		4,949
804	1	powder paint 8730-11	20,200	lb	VOC	0.001	lb		%		%		20
									%		%		

Note: Do NOT change preprinted Process ID numbers. See page 6 of these instructions for information on how to delete materials that are no longer used, or to assign Process ID numbers for new materials.

* If you have off-site recycling/disposal of any of the materials listed above, you must complete an Off-site Recycling/Disposal Form to receive credit for reduced emissions.

NOTE: Emissions in col. 15 are calculated as follows: **([col. 9 × col. 11] – col. 12) × (1 – [col. 13 × col. 14])**

**** Control Efficiency Reference Codes**

1 = Tested efficiency / EPA reference method
2 = Tested efficiency / other source test method
3 = Design value from manufacturer
4 = Best guess / engineering estimate
5 = Calculated based on material balance
6 = Estimated, based on a published value.

EXAMPLE: Cleaning solvent (with recycling)

***Evaporative Process Form* 2008** Permit number(s) V99999

Place an X in any gray cell to mark data requested to be held confidential. See page 5 for requirements for information to be deemed confidential.

1- Process Type/Description: CLEANING METAL PARTS

2- Process TIER Code: 080103 SOLVENT USE: DEGREASING - COLD CLEANING

3- Seasonal Throughput Percent: Dec-Feb 25 % Mar-May 25 % Jun-Aug 25 % Sep-Nov 25 %

4- Normal Operating Schedule: Hours/Day 8 Days/Week 5 Hours/Year 2080 Weeks/Year 52

5- Typical Hours of Operation *(military time)* Start 1300 End 1700

6	7	8	9		10	11		12	13	14			15
Process ID	Stack ID(s)	Material Type	Annual Usage Input	lb or gal	VOC, HAP&NON or NHx	Emission Factor	EF Units (lbs per)	Pounds of pollutant* sent off site	Capture Efficiency %	Control ID	Control Efficiency %	Control Efficiency Code**	Estimated Emissions (lbs/yr)
3	2	SANITIZER	716	lb	VOC	1.0	lb		95 %	1	80 %	3	172
6		GUN CLEANER	180	gl	VOC	7.2	gl	569	%		%		727
7		XYZ STRIPPER	1300	gl	VOC	3.3	gl	1,884	%		%		2,406
8		CLEANING SOLVENTS	358	gl	VOC	6.4	gl	1,006	%		%		1,285
9		MEGASOLVE	2258	gl	VOC	6.8	gl	6,741	%		%		8,613
									%		%		

Note: Do NOT change preprinted Process ID numbers. See page 6 of these instructions for information on how to delete materials that are no longer used, or to assign Process ID numbers for new materials.

* If you have off-site recycling/disposal of any of the materials listed above, you must complete an Off-site Recycling/Disposal Form to receive credit for reduced emissions.

NOTE: This example shows the case where 2,400 of the original 4,096 gallons of materials #6 through 9 were captured for off-site recycling, and the pollutant content of the waste material was estimated to be 75% of the original. The pounds of pollutant sent off-site shown in column 12 is calculated on the example Off-Site Recycling/Disposal Form on the next page.

EXAMPLE

Off-Site Recycling/Disposal Form 2008

Permit number(s) ***V99999***

NOTE: If you need blank copies of this form, call the Emissions Inventory Unit at (602) 506-6790 or consult our web page at http://www.maricopa.gov/aq/divisions/planning_analysis/emissions_inventory/Default.aspx

Provide one off-site recycling/disposal form for each waste stream at your business location. A waste stream is the waste from one or more processes mixed together to make one waste product before it is taken off site for recycling, disposal or combustion.

1) Assign a unique two-digit ID number to identify the waste stream that will be described below. ***01***
(Start with ID# 01 for first waste stream. Make copies of a blank Off-Site Recycling/Disposal form and use 02 for second, etc.)

2) What was the quantity of this waste stream in 2008? 2,400 *Check one:* ☐ pounds ☒ gallons
Indicate whether this quantity is reported in pounds or gallons. Keep waste disposal company manifests as proof that this amount of waste was taken off-site.

3) What was the **average** pollutant content of the waste stream? NOTE: Report in the same units (pounds or gallons) as used in line 2.

VOC ***4.25*** lbs/unit HAP&NON _____ lbs/ unit NHx _____ lbs/ unit

NOTE: Waste normally has less pollutant content than the new product. Some of the pollutant evaporates during the use of the product, and there is usually dirt, water or other contaminants in the waste stream. The estimated pollutant content of the waste is usually between 50% and 95% of the new product. This example estimates an average VOC content (on line 3) to be 75% of the original VOC content of 5.67 lbs/gal., to account for evaporation and contaminants. See page 20 to calculate a weighted average.

4) Calculate the **total** annual pollutant content of the waste in this waste stream.
(volume of waste, from Line 2) × (pollutant content, from Line 3) = Total pollutants in waste stream, in lbs/yr.

VOC ***10,200*** lbs/yr HAP&NON _____ lbs/yr NHx _____ lbs/yr

5) List the process ID numbers of the processes contributing to this waste stream. Also estimate the pounds of pollutant that each process contributed to this waste stream.

NOTE: In this example, the amount each process material contributed to total pollutants in the waste stream (Line 4) is based on the percentage, by weight, of each material that contributed to the waste stream (e.g., Process ID #6 contributed 5.6%, therefore 5.6% × 10,200 lbs/yr = 569 lbs. See example on page 20).

NOTE: Column totals in the table below must equal the total for each pollutant type reported on line 4. The quantities you report below for each pollutant and process must also be reported in column 12 on the Evaporative Process Form.

Process ID	Annual VOC (lbs)	Annual HAP&NON (lbs)	Annual NHx (lbs)
6 Contributed about	***569*** lbs	lbs	lbs
7 Contributed about	***1,884*** lbs	lbs	lbs
8 Contributed about	***1,006*** lbs	lbs	lbs
9 Contributed about	***6,741*** lbs	lbs	lbs

EXAMPLE: Documentation of Emission Factor Calculations

Identify the process ID number(s) and pollutant(s). Show calculations made to obtain the emission factors used for the process(es). Include references to data sources used, including the document name, date published, page numbers, etc.

Emission Factor Calculation

Process ID ***201*** Permit number ***V99999***

Emission factors derived from source test performed 12/2/00 by XYZ Engineering Company (copy of summary tables also attached).

Outlet (after controls):

CO = 0.43 lb/hr × 1 hr/60 min × 1 min/77.9 cu. ft × 1,000,000 cu. ft/MMCF
= 92.0 lb/MMCF

NOx = 0.09 lb/hr × 1 hr/60 min × 1 min/77.9 cu. ft × 1,000,000 cu. ft/MMCF
= 19.3 lb/MMCF

Weighted average sample calculation

NOTE: The example below shows how the weighted average of the materials going into the waste stream is calculated. A weighted-average emission factor has been calculated by listing usage amounts and emission factors for each material, summing each column, and then dividing the total emissions by the total gallons used.

In this example: 23,231 lbs ÷ 4,096 gal = 5.67 lb/gal average VOC content. This emission factor is then used to calculate the average pollutant content in the Off-site Recycling / Disposal Form example.

This process can also be used to find the weighted average emission factor for similar materials if you are reporting them together as a single line item on the Evaporative Process form. Refer to the explanation of "grouping" on page 6.

Process ID #	Material Type	2008 Usage	Units	VOC (lbs/unit)	VOC Emissions (= Usage × VOC content)	Percent contributed to waste stream
6	gun cleaner	180	gal	7.2	1,296 lbs.	5.6 %
7	xyz stripper	1,300	gal	3.3	4,290 lbs.	18.5 %
8	cleaning solvent	358	gal	6.4	2,291 lbs.	9.9 %
9	MEGASOLVE	2,258	gal	6.8	15,354 lbs.	66.1 %
	Totals:	**4,096**	**gal**		**23,231 lbs.**	100.0 %

Average VOC content:	***23,231 lbs. / 4,096 gals***	=	***5.67 lb/gal***

EXAMPLE (for all sources except Title V sources)

Data Certification Form 2008

Permit number ***999999***

For EACH pollutant listed, total up all emissions recorded on your General Process and Evaporative Process Forms. Enter these numbers in column 1, "Totals from Process Forms." Report any emissions from accidental releases in column 2.
Add the figures in each row across, and enter the result in column 3, "Total Emissions".

NOTE: "Accidental Releases" reported in column 2 should include all excess emissions reported to the Department under Rule 140, Section 500.

Summary of 2008 Annual Emissions:	(1) Totals from Process Forms	(2) + Accidental Releases	(3) = TOTAL 2008 Emissions
CO	2,113	0	2,113
NH_x	0	0	0
Lead	0	0	0
HAP&NON	0	0	0
VOC	24,220	0	24,220
NO_x	9,815	0	9,815
SO_x	645	0	645
PM_{10}	7,891	0	7,891

NOTE: Review specific requirements for data confidentiality on page 5. We cannot hold any data confidential without the required documentation.

TO COMPLETE YOUR EMISSIONS INVENTORY REPORT:

- Complete the Confidentiality Statement below.
- Sign and date this form below where indicated.
- Send the **original** copy of your completed forms to: Maricopa County Air Quality Department, One Stop Shop, Emissions Inventory Intake, 501 N. 44th Street, Suite 200, Phoenix, AZ 85008-6538. Keep a copy of all forms for your records.

CONFIDENTIALITY STATEMENT:

This annual emissions report contains requests to keep some data confidential. ☐ YES ☒ NO
If you check "YES", you must submit documentation and meet certain requirements before your data can be deemed confidential. See enclosed instructions for further details.

NOTE: The Data Certification form must be signed by a responsible company official.

CERTIFICATION STATEMENT:

I declare under penalty of perjury that the data (e.g. inputs, emission factors, controls, and annual emissions) presented herein represents the best available information and is true, accurate and complete to the best of my knowledge.

Signature of owner/business officer | Date of signature | Telephone number

Type or print full name of owner/business officer | Type or print full title

How to calculate an emission fee (for Title V sources only):

1. For each pollutant listed on the "Data Certification/Fee Calculation" form, total up all emissions recorded on your General Process and Evaporative Process Forms. Enter these numbers in column 1, "Totals from Process Forms."

NOTE: While most processes that generate PM_{10} should be reported on line 5 of the Data Certification/Fee Calculation form, "[f]ugitive emissions of PM_{10} from activities other than crushing, belt transfers, screening, or stacking" (County Rule 280, § 305.2d) are NOT subject to annual emission fees. The most common occurrences of these PM_{10}-producing activities that are NON-billable are listed below:

SCC codes and description of PM_{10}-producing processes that are NOT subject to emission fees

SCC	Major Category	Subcategory	Facility / Process Type	Process Description
30200814	Industrial Processes	Food and Agriculture	Feed Manufacture	Storage
30400737	Industrial Processes	Secondary Metal Production	Steel Foundries	Raw Material Silo
30500120	Industrial Processes	Mineral Products	Asphalt Roofing Manufacture	Storage Bins: Ferric Chloride
30500121	Industrial Processes	Mineral Products	Asphalt Roofing Manufacture	Storage Bins: Mineral Stabilizer
30500134	Industrial Processes	Mineral Products	Asphalt Roofing Manufacture	Blown Saturant Storage
30500135	Industrial Processes	Mineral Products	Asphalt Roofing Manufacture	Blown Coating Storage
30500141	Industrial Processes	Mineral Products	Asphalt Roofing Manufacture	Granules Storage
30500143	Industrial Processes	Mineral Products	Asphalt Roofing Manufacture	Mineral Dust Storage
30500203	Industrial Processes	Mineral Products	Asphalt Concrete	Storage Piles
30500212	Industrial Processes	Mineral Products	Asphalt Concrete	Heated Asphalt Storage Tanks
30500213	Industrial Processes	Mineral Products	Asphalt Concrete	Storage Silo
30500290	Industrial Processes	Mineral Products	Asphalt Concrete	Haul Roads: General
30500303	Industrial Processes	Mineral Products	Brick Manufacture	Storage of Raw Materials
30500608	Industrial Processes	Mineral Products	Cement Manufacturing (Dry Process)	Raw Material Piles
30500708	Industrial Processes	Mineral Products	Cement Manufacturing (Wet Process)	Raw Material Piles
30501710	Industrial Processes	Mineral Products	Mineral Wool	Storage of Oils and Binders
30502007	Industrial Processes	Mineral Products	Stone Quarrying - Processing	Open Storage
30502011	Industrial Processes	Mineral Products	Stone Quarrying - Processing	Hauling
30502504	Industrial Processes	Mineral Products	Construction Sand and Gravel	Hauling
30502507	Industrial Processes	Mineral Products	Construction Sand and Gravel	Storage Piles
30502760	Industrial Processes	Mineral Products	Industrial Sand and Gravel	Sand Handling, Transfer, & Storage
30531090	Industrial Processes	Mineral Products	Coal Mining, Cleaning, Material Handling	Haul Roads: General
30532007	Industrial Processes	Mineral Products	Stone Quarrying - Processing	Open Storage
30704002	Industrial Processes	Pulp and Paper & Wood Pdts.	Bulk Handling and Storage - Wood/Bark	Stockpiles
31100199	Industrial Processes	Building Construction	Construction: Building Contractors	Other Not Classified
31100299	Industrial Processes	Building Construction	Demolitions/Special Trade Contracts	Other Construction/Demolition
50100401	Waste Disposal	Solid Waste Disposal	Landfill Dump	Unpaved Road Traffic
50100402	Waste Disposal	Solid Waste Disposal	Landfill Dump	Fugitive Emissions
50100403	Waste Disposal	Solid Waste Disposal	Landfill Dump	Area Method
50100404	Waste Disposal	Solid Waste Disposal	Landfill Dump	Trench Method
50100405	Waste Disposal	Solid Waste Disposal	Landfill Dump	Ramp Method

2. Report any accidental releases in column 2. Add columns 1 and 2 together for each pollutant, and enter the sum in column 3. Sum lines 1 through 5 together, and enter the total on line 6.

3. Divide your facility's total billable emissions (on line 6) by 2000 to convert pounds into tons. **Round to the nearest ton.** Enter this value on line 7. Multiply this number by **$38.25**, and enter the result on line 8. This is your 2008 emission fee.

EXAMPLE (for Title V sources only)

Data Certification/Fee Calculation Form 2008

Permit number **V99999**

For EACH pollutant listed, total up all emissions recorded on your General Process and Evaporative Process Forms. Enter these numbers in column 1, "Totals from Process Forms." Report any emissions from accidental releases in column 2.
Add the figures in each row across, and enter the result in column 3, "Total Emissions".
Carefully follow the instructions on lines 6 through 8 to calculate any emission fee owed.

NOTE: "Accidental Releases" reported in column 2 should include all excess emissions reported to the Department under Rule 140, Section 500.

Summary of 2008 Annual Emissions:	(1) Totals from Process Forms	(2) + Accidental Releases	(3) = TOTAL 2008 Emissions
CO	2,113	0	2,113
NH_x	0	0	0
Lead	0	0	0
PM_{10} (non-billable; see page 22)	7,200	0	7,200

Emissions fees are based on your emissions of the following pollutants ONLY:

1	HAP&NON	0	0	0
2	VOC	24,220	0	24,220
3	NO_x	9,815	0	9,815
4	SO_x	645	0	645
5	PM_{10} (billable; see page 22)	691	0	691
6	**Add "TOTAL" column from lines 1 through 5 ONLY:**			35,371 lbs.
7	Divide the total on line 6 by 2000 (pounds per ton) to get tons, and round the number to the nearest ton. (Drop any decimal of .499 or less. Increase to the next whole number any decimal of .500 or more.) Enter the resulting WHOLE NUMBER here.			18 TONS
8	Multiply line 7 (a WHOLE number) by **$ 38.25**. This is your **2008 ANNUAL EMISSION FEE**.			$ 688.50

NOTE: Review specific requirements for data confidentiality on page 5. We cannot hold any data confidential without the required documentation.

TO COMPLETE YOUR EMISSIONS INVENTORY REPORT:

- Include a check (made payable to Maricopa County Air Quality Department) for the amount calculated on line 8 above.
- Complete the Confidentiality Statement below.
- Sign and date this form below where indicated.
- Send the **original** copy of your completed forms, along with any emission fee due to: Maricopa County Air Quality Department, One Stop Shop, Emissions Inventory Intake, 501 N. 44th Street, Suite 200, Phoenix, AZ 85008-6538. Keep a copy of all forms for your records.

CONFIDENTIALITY STATEMENT:

This annual emissions report contains requests to keep some data confidential. ☐ YES ☒ NO
If you check "YES", you must submit documentation and meet certain requirements before your data can be deemed confidential.
See enclosed instructions for further details.

NOTE: The Data Certification form must be signed by a responsible company official.

CERTIFICATION STATEMENT:

I declare under penalty of perjury that the data (e.g. inputs, emission factors, controls, and annual emissions) presented herein represents the best available information and is true, accurate and complete to the best of my knowledge.

Signature of owner/business officer | Date of signature | Telephone number

Type or print full name of owner/business officer | Type or print full title

Appendix 3. Rule Effectiveness (RE) Studies

3.1 Introduction

Rule effectiveness (RE) studies are designed to assess the success of regulatory rules at controlling their targeted emissions. It is acknowledged that facilities and source categories subject to control techniques and devices mandated by rules do not always achieve 100% compliance with those requirements. Given this reality, the US EPA recommends the use of rule effectiveness studies to improve the quality of emission estimates presented in emission inventories.

Once an RE rate has been calculated, its value is applied to relevant sources at an individual process level, thus adjusting (i.e., increasing) emission estimates to reflect a lower degree of control efficiency. The formulas below illustrate how inclusion of rule effectiveness can significantly affect the resulting emission estimates:

Emissions <u>before</u> the application of rule effectiveness:

Uncontrolled Emissions	×	[1 – (Control Efficiency)]	=	Emissions with Control
100 tons	×	**[1 – (0.90)]**	**=**	**10.0 tons**

Emissions <u>including</u> the application of rule effectiveness:

Uncontrolled Emissions	×	[1 – (Control Efficiency × RE)]	=	Emissions with Control
100 tons	×	**[1 – (0.90 × 0.83)]**	**=**	**25.3 tons**

In general, the RE rate is applied to all processes where a control device or control technique is in use. There are however some limitations to this blanket rule, as expressed in US EPA's most recent guidance:

> *…not all emission estimates involving use of a control device or technique need to be adjusted to account for RE…For example, a state or local agency may conclude that a control device that operates in conjunction with a continuous emissions monitor, or is equipped with an automatic shutdown device, may provide a sufficient level of assurance that intended emission reductions will be achieved, and therefore an adjustment for rule effectiveness is not necessary. Another example would be in instances where a direct determination of emissions, such as via a mass balance calculation, can be made.* (US EPA, 2005)

Another complication in any attempt to apply a blanket RE percentage rate occurs where control device efficiencies are extremely high. Some categories of control devices routinely operate at efficiencies of 99% or greater (e.g., baghouses, thermal oxidizers). For these activities, even small adjustments through the application of RE can cause a dramatic increase in reported emissions. As an example, a process with a control device of 99.9% efficiency may report controlled emissions of 10 tons. If an RE rate of 85% were applied to this process, the adjusted emissions would total 1,508.5 tons (an increase of nearly 15,000%). In these types of instances, the department evaluated the affected processes on a case-by-case basis to determine the appropriateness of applying an RE adjustment.

3.2 Calculating Rule Effectiveness Rates for Rules 310, 310.01, and 316

Rule effectiveness studies adjust the emissions from subject facilities and source categories to account for times of non-compliance and control device equipment failure. Of particular importance to the Maricopa County Air Quality Department (MCAQD) are those rules that control particulate matter release, since parts of the county have been designated as nonattainment areas in regard to US EPA PM_{10} standards. Consequently, the rule effectiveness studies presented here deal with the control of criteria pollutant PM_{10}.

Source-specific rule effectiveness studies were undertaken as part of this project to adjust the emissions from subject facilities and source categories to account for times of non-compliance and control device equipment failure by incorporating applicable compliance history data to ascribe a percentage rate (RE rate) at which the subject rule(s) attains the intended emissions reductions. These source-specific studies use data from inspections conducted from July 2008 through June 2009 to determine the rate of compliance of subject facilities and source categories with Rule 310 (Fugitive Dust from Dust-Generating Operations), Rule 310.01 (Fugitive Dust from Non-Traditional Sources of Fugitive Dust), and Rule 316 (Nonmetallic Mineral Processing) with final RE rates listed in Table A3–1 below. Rule effectiveness rates were calculated separately for agricultural activities (best management practices), Title V, and non-Title V permitted facilities, which are each described in detail in Section 3.3.

Table A3–1. Rule effectiveness rates, listed by rule analyzed.

Rule	Rule Effectiveness (RE) Rate
Rule 310	89.94%
Rule 310.01	95.21%
Rule 316	65.44%

The resulting RE rates shown above have been applied to relevant point and area source inventory categories and are reflected in the emission estimates presented in applicable sections of Chapters 2 and 3.

The US EPA has provided a number of guidance documents that detail the use and formulation of rule effectiveness studies (US EPA, 2005; 1994; 1992). The most recent of these documents states, “First and foremost, an agency responsible for emissions inventory preparation should attempt to obtain facility specific data from as many sources as possible, and use the collected information to make a refined source or source category RE determination” (US EPA, 2005). Given this directive, MCAQD developed a rule effectiveness study methodology that utilizes all available compliance data to produce a RE rate that best reflects the field effectiveness of the rule. By using the entire population of data for the prescribed time period, (July 2008 – June 2009) the statistical validity of the RE rate greatly improves. This approach differs from previous rule effectiveness studies conducted by the department that were based upon a small sample pool of targeted inspections (MCAQD, 2007).

The source-specific RE rates presented here are developed from statistical examination of recorded inspection data. This is the rate at which inspection staff is observing facility and source category compliance in the field. While this provides the most direct measure of rule effectiveness, it can still be an incomplete picture of overall rule effectiveness. In the case of the source-specific studies for those sources directly affected by a county air quality rule (Rules 310, 310.01, and 316) the compliance rate is used as the RE rate. These sources tend to have a focused, homogeneous set of processes. This, combined with the fact that these studies not only

contain the entire population of affected sources but are also very large sample sizes, gives confidence that inconsistencies of individual inspections are already addressed in practice. To further focus the study of these sources each unique permit was classified as "in violation" if any inspection during the allotted time period resulted in an emission based violation or as "in compliance" if no violations were issued or an administrative based violation was issued.

A total of six distinct rule effectiveness rates were calculated for use in this emissions inventory: four source-specific rule effectiveness determinations (Rule 310, Rule 310.01, Rule 316 and agricultural activities) along with two multi-rule determinations (Title V and non-Title V permitted facilities). The following three sections describe in further detail the data and methods used in the development of the Rule 310, Rule 310.01, and Rule 316 RE factors.

3.2.1 Calculating Rule Effectiveness for Sources Subject to Rule 310

Sources subject to the department Rule 310 (Fugitive Dust from Dust-Generating Operations) are most often those construction sites where the disturbance of earth is occurring. The RE rate for Rule 310 sources is developed from the observed compliance rate of permitted sites.

The compliance rate for Rule 310 sources uses inspection data of issued dust permits between July 2008 and June 2009. Only inspections that result in a finding of compliance or non-compliance (i.e., "in violation") are considered in the compliance rate. Inspections conducted solely to confirm the closing of a permit, or inspections where a compliance determination could not be made, were not included in the development of the compliance rate. Using these criteria, a total of 12,325 inspections were conducted on 5,467 issued permits, out of a possible pool of 7,918 issued permits. Dust Control Permits are only valid for 12 months, and expire on the anniversary of their issue date; for instance a permit issued on July 22, 2007 would have a July 22, 2008 expiration date. This permit would therefore only have "operated" 22 days in the inspection period on which this compliance data is based. Some issued permits also experience limited operations, perhaps only a month or two, but in most cases these permits are left open by the permit holder for the entire 12 months. Given these realities, it is not unexpected that 2,451 out of the pool of 7,918 permits received no compliance determination inspection during the 12-month period of July 2008–June 2009. Conversely, over 59% of all issued permits that received a compliance determination inspection were inspected two or more times, with some sites receiving as many as 13 inspections during the 12-month time period of this study.

Of the inspected sources listed above, individual compliance rates are determined on a permit by permit basis. Any permit that received at least one emissions-related violation during any inspection conducted between July 2008 and June 2009 received a compliance rate of 0%. Permitted sites that had no recorded emissions-related violations during the study period received a compliance rate of 100%. Of the permits with violations noted, 550 (80%) were emissions-related (track-out, visible emissions, recordkeeping, silt content, etc.), with the remaining 137 (20%) violating permits being procedural (inadequate dust control plan, late fees, etc.). The permit-specific compliance rates were summed and averaged to produce an overall grouped compliance rate of 89.94%.

3.2.2 Calculating Rule Effectiveness for Sources Subject to Rule 310.01

The majority of sources subject to Rule 310.01 (Fugitive Dust from Non-Traditional Sources of Fugitive Dust) are vacant lots. It is estimated that there are presently more than 100,000 vacant lots in Maricopa County. Rule 310.01 sources generally do not require a permit, unlike Rule 310 and Rule 316 sources. The RE rate for Rule 310.01 sources is calculated based upon vacant lot inspection compliance rates.

During the study period (July 2008 – June 2009), the department inspectors performed a total of 12,370 inspections of vacant lots in Maricopa County. The primary purpose of a Rule 310.01 inspection is to verify whether or not the vacant lot in question has a stabilized surface. If the surface is determined to be stable (through a variety of tests), the lot is deemed to be in compliance. Conversely, if the lot's surface is deemed to be unstable, then a violation of Rule 310.01 has occurred. As with Rule 310, a compliance rate is determined individually for each vacant lot, and then summed and averaged to produce a group compliance rate. The overall compliance rate for Rule 310.01 sites is 95.21%. All 592 violations noted by inspectors were emissions-related violations, as all the violations are for unstable soil conditions.

3.2.3 Calculating Rule Effectiveness for Sources Subject to Rule 316

Facilities subject to Rule 316 (Nonmetallic Mineral Processing) include those involved in the mining of sand and gravel and the production of concrete products. All such "Rule 316 sites" are required to have either a Title V or non-Title V permit issued by the department. At present, all facilities that are subject to Rule 316 have only non-Title V permits. (One class of sources that has long been an exception to this is portable sources that may operate in more than one county during the life of the permit; thus these sources are issued permits by the Arizona Department of Environmental Quality.) The RE rate for Rule 316 sites was determined in a similar fashion as for Rules 310 and 310.01; i.e., calculated on the basis of the actual observed compliance rates of permitted sites.

Inspection data for the period July 2008 through June 2009 reveal that inspections were conducted for 136 issued permits for Rule 316 facilities. All of these facilities were inspected at least once during this study period, with a compliance determination made for each facility. Overall, 525 inspections that resulted in a compliance determination were performed during the study period. As with Rules 310 and 310.01, a compliance rate is computed for each facility, and then summed and averaged for the group, resulting in an overall compliance rate of 65.44%. Of the violating permits noted, 47 (54%) were emissions-related, with the remaining 40 (46%) primarily procedural in nature.

3.3 Calculating Rule Effectiveness Rates for Agricultural Activities, Title V Facilities, and Non-Title V Facilities

The observed compliance rate in some cases, such as multi-source Title V and non-Title V facilities, can be better described as a rate at which inspection staff issue violations. Inspection staff has a range of experience and training which influences their proficiency in issuing appropriate violations. There may be instances when a rule violation goes unnoticed by staff, or

conversely a violation may be issued in error. Even when a compliance rate has a high statistical measure of accuracy, it can fail to reflect a number of programmatic measures that affect overall rule effectiveness; measures like the strength of rule language, departmental enforcement and penalty actions, inspector training programs, educational and public outreach efforts, etc. This reality is reflected in earlier US EPA guidance:

> *A percentage effectiveness rating is not enough to describe the compliance effectiveness of a rule for a source category. An SSCD [Stationary Source Compliance Division] study should attempt to link the rating to a regulatory agency's overall effort. The study should address the factors that affect the percentage effectiveness rating such as the compliance rate of the sources in a category, inspection frequency and thoroughness, the language of the rule (i.e., whether or not it has loopholes), and the reporting and recordkeeping by the regulatory agency. Evaluating these factors will provide a more complete evaluation of the effectiveness of a rule.* (US EPA, 1994)

In order to incorporate all the salient factors described above, a matrix was created to produce a final RE rate. US EPA's latest guidance (2005) provides a listing of factors that can impact rule effectiveness rates (e.g., inspector training, frequency of inspections, media outreach, enforcement policies, recordkeeping requirements, etc.), grouped into major categories such as most important factors, important factors and other factors. The department used these suggested factors as the basis for developing the RE matrices contained in Tables A3–3 through A3–5.

In brief, the compliance rate developed from inspection data accounts for 70% of the overall RE rate, while all other factors account for the remaining 30%. (An exception to these values applies in the case of agricultural activities.) Each factor is scored individually, based upon the department's success in implementing that factor. As an example, the score for the factor "Compliance History" is the compliance rate developed from the study period inspection data, while the score for "Enforcement Penalties" is based upon the department's timely response to, and settlement of, observed violations associated with the subject rule or source category. The complete matrices for each applicable rule or source category for which rule effectiveness was addressed, are contained in Tables A3–3 through A3–5.

The following sections describe in further detail the data and methods used in the development of the remaining RE factors for agricultural activities, Title V, and non-Title V permitted facilities; results are summarized in Table A3–2 below.

Table A3–2. Compliance and rule effectiveness rates, by source category analyzed.

Source Category	Compliance Rate	Rule Effectiveness (RE) Rate
Agricultural Activities	Unknown	55.33%
Title V Facilities	89.14% *	90.94%
Non-Title V Facilities	81.00% *	84.27%

** Compliance rates for both Title V and Non-Title V facilities are based upon 2008-2009 inspection data, and reflect compliance self-monitoring recordkeeping practice, in addition to violation data.*

3.3.1 Calculating Rule Effectiveness for Agricultural Activities

Agricultural activities in most parts of Maricopa County are subject to the Best Management Practices program administered by the Arizona Department of Environmental Quality (ADEQ). This program is largely a self-monitoring program, in which participants indicate which management practices were chosen to be used during various operations (e.g., harvesting, tilling). No compliance rate estimates for this program were noted during the study period. ADEQ does indicate that after a site has been visited, 100% of the sources return to compliance. Since compliance with this program is verified only on a complaint-driven basis, the weight given to compliance history was lowered, from 70% to 25%, in the matrix shown in Table A3–3, indicating an overall RE rate of 55.30% for agricultural activities.

3.3.2 Calculating Rule Effectiveness for Title V and Non-Title V Processes

For the remaining emission processes (not regulated by Rules 310, 310.01 and/or 316) that include a control device or technique that limits particulate matter or ozone formation, separate multi-rule RE rates have been calculated for permitted Title V and non-Title V facilities. Factor-based matrices have been utilized to develop RE rates for Title V and non-Title V facilities. Compliance rates for these sources are based upon two full years of data (2008 through 2009), as compliance information for these sources tends to be more detailed (as reflected in the matrix). The compliance rate for these facilities also includes data on self-monitoring recordkeeping practices in addition to inspection data. The combination of monitoring data and inspection data comprise the 'compliance rate' section of the RE calculation matrix, and still account for 70% of the overall RE rate. The combined compliance rate for Title V facilities is 89.14% and 81.00% for non-Title V facilities, resulting in RE rates of 90.94% and 84.27% for Title V and non-Title V facilities, respectively, as shown in Tables A3–4 and A3–5 below.

3.4 References

MCAQD, 2007. 2005 Periodic Emissions Inventory for PM_{10} for the Maricopa County, Arizona, Nonattainment Area.

US EPA, 1992. Guidelines for Estimating and Applying Rule Effectiveness for Ozone/CO State Implementation Plan Base Year Inventories. EPA Rep. 452/R-92-010, November 1992.

US EPA, 1994. Rule Effectiveness Guidance: Integration of Inventory, Compliance and Assessment Applications. EPA Rep. 452/R-94-001, January 1994.

US EPA, 2005. Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations. EPA Rep. 454/R-05-001, November 2005.

Table A3–3. Rule Effectiveness Matrix for Agricultural Activities

A. Most important factor (1 criterion, assigned weighting of 25% of total):

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score (= weight × value)
Compliance History	86%	100%	93%	Over 90% of facilities inspected in the source category are in compliance	25%	93%	**23.25%**
	70%	85%	78%	Over 75% of facilities inspected in the source category are in compliance			
		< 70%	35%	Over 60% of facilities inspected in the source category are in compliance			
Type of Inspection	86%	100%	93%	Inspections are thorough and detailed, and include close examination of control equipment, and a detailed records review			
	70%	85%	78%	Inspections consist of a records review, and sometimes inspection of control equipment;			
		< 70%	35%	Inspections generally consist of a records review only;	10%	35%	**3.5%**

B. Other important factors (6 criteria, each assigned weighting of 10% of total):

Compliance Certifications	86%	100%	93%	Source is subject to some type of compliance certification;			
	70%	85%	78%	Source is subject to some type of compliance certification;			
		< 70%	35%	Source is not subject to any type of compliance certification;	10%	35%	**3.5%**
Inspection Frequency/ Percentage	86%	100%	93%	Percent of facilities inspected in the sector in a given year is 25% or greater;			
	70%	85%	78%	Percent of facilities inspected in the sector in a given year is 15% or greater;			
		< 70%	35%	Percent of facilities inspected in the sector in a given year is less than 15%	10%	35%	**3.5%**
Unannounced Inspections	86%	100%	93%	Unannounced inspections are sometimes done;			
	70%	85%	78%	Unannounced inspections are done, but infrequently;			
		< 70%	35%	Unannounced inspections are never done;	10%	35%	**3.5%**
Enforcement Penalties	86%	100%	93%	Agency takes prompt enforcement action, including monetary fines, against violators;			
	70%	85%	78%	Agency usually takes enforcement action, including monetary fines, against violators;			
		< 70%	35%	Agency usually does not take enforcement action against violators;	10%	35%	**3.5%**
Compliance Assistance	86%	100%	93%	A compliance assistance program exists and is adequately staffed, and includes such things as workshops, mailings, web-based tutorials, etc.	10%	93%	**9.3%**
	70%	85%	78%	A compliance assistance program exists and is minimally staffed. The program occasionally makes workshops, mailings, web-based tutorials, etc., available.			
		< 70%	35%	A compliance assistance program does not exist			

C. Other factors (3 criteria, each assigned weighting of 5% of total):

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score (= weight × value)
Monitoring Requirements	86%	100%	93%	Monitoring requirements exist and must be reported to regulatory agency at least once a year;			
	70%	85%	78%	Monitoring requirements exist but records don't have to be filed with regulatory agency;			
		< 70%	35%	Monitoring requirements do not exist;	5%	35%	**1.75%**
Follow-up Inspections	86%	100%	93%	Follow-up inspections are done when violations are noted most (>75%) of the time;			
	70%	85%	78%	Follow-up inspections are done when violations are noted some of the time;			
		< 70%	35%	Follow-up inspections are not routinely done;	5%	35%	**1.75%**
Media Publicity	86%	100%	93%	Media publicity of enforcement actions is routinely conducted.			
	70%	85%	78%	Media publicity of enforcement actions is sometimes done.			
		< 70%	35%	Media publicity of enforcement actions is rarely done.	5%	35%	**1.75%**

Overall rule effectiveness score for agricultural activities: 55.30%

Table A3–4. Rule Effectiveness Matrix for Title V Facilities

A. Most important factors (2 criteria, each assigned weighting of 35% of total):

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score (= weight × value)
Monitoring	94%	100%	97%	Source specific monitoring used for compliance purposes, and monitoring records filed with regulatory agency at least every 4 months.			
	87%	93%	90%	Source specific monitoring used as an indicator of compliance, and monitoring records filed with regulatory agency every 6 to 9 months.	35%	90%	**31.5%**
	81%	86%	84%	Source specific monitoring used as an indicator of compliance, and monitoring records filed with regulatory agency each year.			
	70%	80%	75%	General guidance exists for source specific enhanced monitoring, and monitoring records required but aren't submitted to regulatory agency.			
		< 70%	35%	No requirements for any type of monitoring.			

Compliance History	94%	100%	97%	The facility has been in compliance for the past eight quarters.	35%	10 of 19 facilities	**17.9%**
	87%	93%	90%	The facility is believed to have been in compliance for the past eight quarters, although inspection frequency is such that this can't be positively confirmed.			
	81%	86%	84%	On schedule; the facility is meeting its compliance schedule.			
	70%	80%	75%	In Violation; facility is in violation of emissions and/or procedural requirements.		8 of 19 facilities	**12.4%**
		< 70%	35%	High Priority Violator (HPV): the facility is in significant violation of one or more applicable requirement of the CAA.		1 of 19 facilities	**0.6%**
						Sum:	**30.9%**

B. Other important factors (4 criteria, each assigned weighting of 3% of total):

Type of Inspection	94%	100%	97%	Inspections involve compliance test methods with a high degree of accuracy, such as stack testing or other types of precise emissions measurement.	3%	97%	**2.9%**
	87%	93%	90%	Inspections involve detailed review of process parameters & inspection of control equipment.			
	81%	86%	84%	Inspections involve review of process and inspection of control equipment.			
	70%	80%	75%	Inspections generally consist of only a records review.			
		< 70%	35%	Inspections most likely consist of visual inspection (e.g., opacity), or drive by.			

Operation & Maintenance	94%	100%	97%	Control equipment operators follow and sign daily O&M instructions.			
	87%	93%	90%	Control equipment operators follow daily O&M instructions.	3%	90%	**2.7%**
	81%	86%	84%	Control equipment operators follow daily or weekly O&M instructions.			
	70%	80%	75%	O&M requirements exist, but on no specific schedule.			
		< 70%	35%	No specific O&M requirements.			

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score (= weight × value)
Unannounced Inspections	94%	100%	97%	Routinely conducted.	3%	97%	**2.9%**
	87%	93%	90%	Sometimes done.			
	81%	86%	84%	Done, but infrequently.			
	70%	80%	75%	Rarely done.			
		< 70%	35%	Never done.			

Enforcement Penalties	94%	100%	97%	Agency has the authority to impose punitive measures, including monetary fines, towards violators such as in delegated Title V Operating Permit programs.	3%	97%	**2.91%**
	87%	93%	90%	Agency has the authority to impose punitive measures, including monetary fines, towards violators such as in delegated Title V Operating Permit programs.			
	81%	86%	84%	Agency has the authority to impose punitive measures, including monetary fines, towards violators such as in delegated Title V Operating Permit programs.			
	70%	80%	75%	Agency has the authority to impose punitive measures, including monetary fines, towards violators such as in delegated Title V Operating Permit programs.			
		< 70%	35%	Agency does not have sufficient authority to impose punitive measures towards violators.			

C. Other factors (9 criteria, each assigned weighting of 2% of total):

Compliance Certifications	94%	100%	97%	Source subject to Title V or other type of compliance certification.	2%	97%	**1.94%**
	87%	93%	90%	Source subject to Title V or other type of compliance certification.			
	81%	86%	84%	Source not subject to any type of compliance certification.			
	70%	80%	75%	Source not subject to any type of compliance certification.			
		< 70%	35%	Source not subject to any type of compliance certification.			

Inspection Frequency	94%	100%	97%	Source(s) are inspected once every 2 years or more frequently.	2%	97%	**1.94%**
	87%	93%	90%	Source(s) are inspected once every 3 years or more frequently.			
	81%	86%	84%	Source(s) are inspected once every 5 years or more frequently.			
	70%	80%	75%	Inspection of source(s) infrequent; > every 5 years.			
		< 70%	35%	Inspections rarely, if ever, performed.			

EPA HPV Enforcement	94%	100%	97%	Agency has sufficient resources to implement EPA's 12/22/98 HPV policy.	2%	97%	**1.94%**
	87%	93%	90%	Agency's resources allow it to implement EPA's 12/22/98 HPV policy in most instances.			
	81%	86%	84%	Agency's resources allow it to implement EPA's 12/22/98 HPV policy in most instances.			
	70%	80%	75%	Agency's resources allow it to implement EPA's 12/22/98 HPV policy more often than not.			
		< 70%	35%	Resource constraints prohibit agency from implementing EPA's 12/22/98 HPV policy in most instances.			

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score (= weight × value)
Operator Training	94%	100%	97%	Control equipment operators complete a formal training program on use of the equipment, and such program is kept up to date and has been reviewed by the regulatory agency.			
	87%	93%	90%	Control equipment operators complete formal training program, and such program is kept up to date and available for review by the regulatory agency upon request.			
	81%	86%	84%	Control equipment operators complete some amount of formal training.	2%	84%	**1.68%**
	70%	0.8	75%	Control equipment operators receive only on the job training.			
		< 70%	35%	Control equipment operators receive no specific training.			
Media Publicity	94%	100%	97%	Media publicity of enforcement actions.	2%	97%	**1.94%**
	87%	93%	90%	Media publicity of enforcement actions.			
	81%	86%	84%	Media publicity of enforcement actions.			
	70%	80%	75%	Media publicity of enforcement actions.			
		< 70%	35%	No media publicity of enforcement actions.			
Regulatory Workshops	94%	100%	97%	Regulatory workshops are available annually, and/or the implementing agency mails regulatory information packages each year.	2%	97%	**1.94%**
	87%	93%	90%	Regulatory workshops are available every 1-2 years, and/or the implementing agency mails regulatory information packages every 1-2 years.			
	81%	86%	84%	Regulatory workshops are available every 2-3 years, and/or the implementing agency mails regulatory information packages once every 2-3 years.			
	70%	80%	75%	Regulatory workshop not routinely available, but implementing agency mails regulatory information packages out about once every 2-3 years.			
		< 70%	35%	Regulatory workshops not routinely available. Implementing agency mails regulatory information packages infrequently, if ever.			
Inspector Training	94%	100%	97%	Inspectors must undergo 2 weeks of comprehensive basic training, and 1 to 2 weeks of source specific training, and such training is updated each year.			
	87%	93%	90%	Inspectors must undergo 1 to 2 weeks of basic training and 1 week of source specific training and such training is updated every 1-2 years.	2%	90%	**1.80%**
	81%	86%	84%	Inspectors must undergo 1 to 2 weeks of basic training and 3 to 5 days of source specific training, and such training is updated every 1-2 years.			
	70%	80%	75%	Inspectors must undergo 1 to 2 weeks of basic training and 1 to 3 days of source specific training, and such training is updated every 1-2 years.			
		< 70%	35%	Inspectors must undergo less than 5 days of basic training less than 3 days of source specific training, and such training is updated only every 2 years or less frequently.			

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score (= weight × value)
Testing Guidelines	94%	100%	97%	Specific guidelines and schedule for testing and test methods exist.	2%	97%	**1.94%**
	87%	93%	90%	Specific guidelines on testing and test methods exist, but no schedule for testing.			
	81%	86%	84%	Specific guidelines on testing and test methods exist, but no schedule for testing.			
	70%	80%	75%	Specific guidelines on testing and test methods, but no schedule for testing.			
		< 70%	35%	Only general guidance on testing, or no mention of testing requirements.			

Follow-up Inspections	94%	100%	97%	Follow-up inspections always or almost always conducted (90 % of the time or more).	2%	97%	**1.94%**
	87%	93%	90%	Follow-up inspections usually conducted (approximately 75% of the time).			
	81%	86%	84%	Follow-up inspections sometimes conducted (approximately 50% of the time).			
	70%	80%	75%	Follow-up inspections infrequently conducted (approximately 25% of the time).			
		< 70%	35%	Follow-up inspections rarely or never conducted (10% of the time or less)			

Overall rule effectiveness score for Title V facilities: 90.94%

Table A3–5. Rule Effectiveness Matrix for Non-Title V Facilities

A. Most important factors (2 criteria, each assigned weighting of 35% of total):

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score (= weight × value)
Monitoring	94%	100%	97%	Source specific monitoring used for compliance purposes, and monitoring records filed with regulatory agency at least every 4 months.			
	87%	93%	90%	Source specific monitoring used as an indicator of compliance, and monitoring records filed with regulatory agency every 6 to 9 months.			
	81%	86%	84%	Source specific monitoring used as an indicator of compliance, and monitoring records filed with regulatory agency each year.			
	70%	80%	75%	General guidance exists for source specific enhanced monitoring, and monitoring records required but aren't submitted to regulatory agency.	35%	75%	**26.3%**
		< 70%	35%	No requirements for any type of monitoring.			

Compliance History	94%	100%	97%	The facility has been in compliance for the past eight quarters.	35%	156 of 298 facilities	**17.8%**
	87%	93%	90%	The facility is believed to have been in compliance for the past eight quarters, although inspection frequency is such that this can't be positively confirmed.		10 of 298 facilities	**1.1%**
	81%	86%	84%	On schedule; the facility is meeting its compliance schedule.			
	70%	80%	75%	In Violation; facility is in violation of emissions and/or procedural requirements.		130 of 298 facilities	**11.5%**
		< 70%	35%	High Priority Violator (HPV): the facility is in significant violation of one or more applicable requirement of the CAA.		2 of 298 facilities	**0.1%**
						Sum:	**30.4%**

B. Other important factors (4 criteria, each assigned weighting of 3% of total):

Type of Inspection	94%	100%	97%	Inspections involve compliance test methods with a high degree of accuracy, such as stack testing or other types of precise emissions measurement.			
	87%	93%	90%	Inspections involve detailed review of process parameters & inspection of control equipment.	3%	90%	**2.7%**
	81%	86%	84%	Inspections involve review of process and inspection of control equipment.			
	70%	80%	75%	Inspections generally consist of only a records review.			
		< 70%	35%	Inspections most likely consist of visual inspection (e.g., opacity), or drive by.			

Operation & Maintenance	94%	100%	97%	Control equipment operators follow and sign daily O&M instructions.			
	87%	93%	90%	Control equipment operators follow daily O&M instructions.	3%	90%	**2.7%**
	81%	86%	84%	Control equipment operators follow daily or weekly O&M instructions.			
	70%	80%	75%	O&M requirements exist, but on no specific schedule.			
		< 70%	35%	No specific O&M requirements.			

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score (= weight × value)
Unannounced Inspections	94%	100%	97%	Routinely conducted.	3%	97%	**2.91%**
	87%	93%	90%	Sometimes done.			
	81%	86%	84%	Done, but infrequently.			
	70%	80%	75%	Rarely done.			
		< 70%	35%	Never done.			

Enforcement Penalties	94%	100%	97%	Agency has the authority to impose punitive measures, including monetary fines, towards violators such as in delegated Title V Operating Permit programs.	3%	97%	**2.91%**
	87%	93%	90%	Agency has the authority to impose punitive measures, including monetary fines, towards violators such as in delegated Title V Operating Permit programs.			
	81%	86%	84%	Agency has the authority to impose punitive measures, including monetary fines, towards violators such as in delegated Title V Operating Permit programs.			
	70%	80%	75%	Agency has the authority to impose punitive measures, including monetary fines, towards violators such as in delegated Title V Operating Permit programs.			
		< 70%	35%	Agency does not have sufficient authority to impose punitive measures towards violators.			

C. Other factors (9 criteria, each assigned weighting of 2% of total):

Compliance Certifications	94%	100%	97%	Source subject to Title V or other type of compliance certification.			
	87%	93%	90%	Source subject to Title V or other type of compliance certification.			
	81%	86%	84%	Source not subject to any type of compliance certification.			
	70%	80%	75%	Source not subject to any type of compliance certification.	2%	75%	**1.5%**
		< 70%	35%	Source not subject to any type of compliance certification.			

Inspection Frequency	94%	100%	97%	Source(s) are inspected once every 2 years or more frequently.	2%	97%	**1.94%**
	87%	93%	90%	Source(s) inspected every 3 years or more frequently.			
	81%	86%	84%	Source(s) inspected every 5 years or more frequently.			
	70%	80%	75%	Inspection of source(s) infrequent; > every 5 years.			
		< 70%	35%	Inspections rarely, if ever, performed.			

EPA HPV Enforcement	94%	100%	97%	Agency has sufficient resources to implement EPA's 12/22/98 HPV policy.	2%	97%	**1.94%**
	87%	93%	90%	Agency's resources allow it to implement EPA's 12/22/98 HPV policy in most instances.			
	81%	86%	84%	Agency's resources allow it to implement EPA's 12/22/98 HPV policy in most instances.			
	70%	80%	75%	Agency's resources allow it to implement EPA's 12/22/98 HPV policy more often than not.			
		< 70%	35%	Resource constraints prohibit agency from implementing EPA's 12/22/98 HPV policy in most instances.			

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score(= weight × value)
Operator Training	94%	100%	97%	Control equipment operators complete a formal training program on use of the equipment; the program is kept up to date and has been reviewed by the regulatory agency.			
	87%	93%	90%	Control equipment operators complete formal training program, and such program is kept up to date and available for review by the regulatory agency upon request.			
	81%	86%	84%	Control equipment operators complete some amount of formal training.			
	70%	0.8	75%	Control equipment operators receive only on the job training.	2%	75%	**1.5%**
		< 70%	35%	Control equipment operators receive no specific training.			
Media Publicity	94%	100%	97%	Media publicity of enforcement actions.	2%	97%	**1.94%**
	87%	93%	90%	Media publicity of enforcement actions.			
	81%	86%	84%	Media publicity of enforcement actions.			
	70%	80%	75%	Media publicity of enforcement actions.			
		< 70%	35%	No media publicity of enforcement actions.			
Regulatory Workshops	94%	100%	97%	Regulatory workshops are available annually, and/or the implementing agency mails regulatory information packages each year.	2%	97%	**1.94%**
	87%	93%	90%	Regulatory workshops are available every 1-2 years, and/or the implementing agency mails regulatory information packages every 1-2 years.			
	81%	86%	84%	Regulatory workshops are available every 2-3 years, and/or the implementing agency mails regulatory information packages once every 2-3 years.			
	70%	80%	75%	Regulatory workshop not routinely available, but implementing agency mails regulatory information packages out about once every 2-3 years.			
		< 70%	35%	Regulatory workshops not routinely available. The implementing agency mails regulatory information packages infrequently, if ever.			
Inspector Training	94%	100%	97%	Inspectors must undergo 2 weeks of comprehen-sive basic training, and 1 to 2 weeks of source specific training, and such training is updated each year.			
	87%	93%	90%	Inspectors must undergo 1 to 2 weeks of basic training and 1 week of source specific training and such training is updated every 1-2 years.	2%	90%	**1.80%**
	81%	86%	84%	Inspectors must undergo 1 to 2 weeks of basic training and 3 to 5 days of source specific training, and such training is updated every 1-2 years.			
	70%	80%	75%	Inspectors must undergo 1 to 2 weeks of basic training and 1 to 3 days of source specific training, and such training is updated every 1-2 years.			
		< 70%	35%	Inspectors must undergo less than 5 days of basic training less than 3 days of source specific training, and such training is updated only every 2 years or less frequently.			

Factor	Range		Midpt. value	Description	Weight	Value assigned to MCAQD	Score(= weight × value)
Testing Guidelines	94%	100%	97%	Specific guidelines and schedule for testing and test methods exist.	2%	97%	**1.94%**
	87%	93%	90%	Specific guidelines on testing and test methods exist, but no schedule for testing.			
	81%	86%	84%	Specific guidelines on testing and test methods exist, but no schedule for testing.			
	70%	80%	75%	Specific guidelines on testing and test methods, but no schedule for testing.			
		< 70%	35%	Only general guidance on testing, or no mention of testing requirements.			

Follow-up Inspections	94%	100%	97%	Follow-up inspections always or almost always conducted (90 % of the time or more).	2%	97%	**1.94%**
	87%	93%	90%	Follow-up inspections usually conducted (approximately 75% of the time).			
	81%	86%	84%	Follow-up inspections sometimes conducted (approximately 50% of the time).			
	70%	80%	75%	Follow-up inspections infrequently conducted (approximately 25% of the time).			
		< 70%	35%	Follow-up inspections rarely or never conducted (10% of the time or less)			

Overall rule effectiveness score for non-Title V facilities: 84.27%

Appendix 4. Windblown Dust Emission Estimation Methodology

Introduction

The production of windblown dust occurs through an intricate process where the force of wind initiates the movement of soil particles. As stated below,

> *This process has the distinct phases of particle entrainment, transport and deposition. It is a complex process because it is affected by many factors which include atmospheric conditions (e.g., wind, precipitation and temperature), soil properties (e.g., soil texture, composition and aggregation), land-surface characteristics (e.g., topography, moisture, aerodynamic roughness length, vegetation and non-erodible elements) and land-use practice (e.g., farming, grazing and mining). During a wind-erosion event, these factors interact with each other and, as erosion progresses, the properties of the eroded surface can be significantly modified.* (Shao, 2008a)

The development of an annual inventory of PM_{10} emissions from windblown dust focuses on quantifying the first phase of windblown dust production: particle entrainment. The phases of transport and deposition are typically explored during modeling exercises of specific windblown dust events and are not discussed here.

An assortment of dust emission schemes have been developed that attempt to quantify the entrainment of windblown dust (e.g., "Open Area Wind Erosion" chapter in *WRAP Fugitive Dust Handbook*, WGA, 2006). These schemes differ greatly depending on the geographic scale (local, regional or global) and theoretical constructs of the scheme (e.g., assessment of threshold wind speeds, the importance of soil properties and land uses, etc.). Published empirical data on windblown dust emissions varies widely as well, with dust emission rates for a given wind speed varying from 10^{-1} to 10^{5} $\mu g\ m^{-2}s^{-1}$ (Shao, 2008b). This suggests that the specific conditions and properties of subject soils greatly modify dust emission rates, and that the accuracy of a dust emission scheme is heavily dependent on the quality of the input data describing each of these controlling factors (e.g., surface roughness lengths, soil texture, moisture content, vegetation, etc.). Often, there is no reliable data available to account for a controlling factor (e.g., soil moisture or surface roughness lengths), forcing dust schemes to use surrogates or broad assumptions in an attempt to incorporate the effects of a controlling factor. Additionally, even when quality data on a relevant factor exists (e.g., soil texture), the role of that factor as it interacts with other factors is uncertain (Alfaro et al., 2004) or could change as atmospheric or soil conditions are altered throughout the year.

The inherent uncertainties involved with any windblown dust emission scheme require that the available input data for the region of interest be scrutinized to help inform the selection of an appropriate scheme. In choosing a dust emission scheme for this inventory, the focus was placed upon a theoretical model that best describes local, observed windblown dust events combined with empirical data from wind tunnel studies performed in the deserts of the southwest U.S.

Supply-Limited Windblown Dust Emission Scheme

The deserts of the southwest U.S., including Maricopa County, are characterized as supply-limited environments (Gillette and Chen, 2001; Zender and Kwon, 2005), where the potential for generating windblown dust is controlled primarily by the amount of surface material available for entrainment. In contrast, traditional dust emission schemes consider soils to be transport-

limited, where windblown dust emissions are controlled solely by the force of wind (Bagnold, 1941; Greeley and Iverson, 1985). Traditional dust emission schemes perform best in areas where contiguous desert land with little vegetation exists (e.g., Sahara Desert). The Sonoran Desert, of which Maricopa County is a part of, contains a wide variety of vegetation, which can be quite dense in some areas, severely limiting the amount of exposed soil to be entrained by wind. Since the bulk of wind erosion research is rooted in the physics of transport-limited soils, most dust emission schemes (Gillette and Passi, 1988; Shao et al., 1993; Marticorena and Bergametti, 1995; Alfaro and Gomes, 2001) do not address many of the physical realities of supply-limited soils.

A major theoretical tenet of transport-limited schemes is that little or no dust emissions occur until wind speeds reach the threshold required for saltation to occur; the process by which the dynamic bombardment of sand particles blasts and breaks down aggregated soils to then be suspended as dust emissions. However, the supply-limited soils of the desert southwest have been shown to emit substantial quantities of dust, even the majority of dust emissions, in the absence of saltation (Macpherson et al., 2008). While the southwest deserts can experience high magnitude wind events where saltation dominates dust production (e.g., haboob), the majority of windblown dust emissions occur during lower intensity, higher frequency events (e.g., synoptic scale fronts, dust devils) (Koch and Renno, 2005; Macpherson et al., 2008). These events often do not reach the threshold wind speeds required for saltation to occur, yet monitoring data consistently record elevated ambient PM_{10} concentrations at these wind speeds (see further discussion in section on Threshold Friction Velocity). This suggests that significant quantities of dust emissions are generated primarily through direct aerodynamic entrainment of available surface material, before saltation occurs. Despite concerns that direct aerodynamic entrainment is limited due to the strong interactive cohesive forces between dust particles (Iverson and White, 1982), several studies have shown the importance of direct aerodynamic entrainment in the production of windblown dust (Loosmore and Hunt, 2000; Roney and White 2004; Kjelgaard et al., 2004; Macpherson et al., 2008; Harris and Davidson 2009). Consequently, the dust scheme chosen for the supply-limited environment of Maricopa County includes the process of direct aerodynamic entrainment as a major contributor to the production of windblown dust.

Another key limitation of transport-limited schemes concerns surface disturbance of soils. Disturbance levels of soils have been shown to be a key factor in controlling the intensity of dust emissions during a wind event (Tegen and Fung, 1995; Belnap and Gilliette, 1998; Gillette and Chen, 2001; Zender and Newman, 2003; Baddock et al., 2011). However, many transport-limited schemes do not have a direct mechanism to incorporate the effects of disturbed soil on dust production. Since dust emissions in a transport-limited scheme are dependent solely on saltation, a disturbed soil is often theoretically assumed to emit at the same rate as a stable soil since the texture, or particle size distribution of the soil is uniform in both disturbed and stable conditions (Alfaro et al., 2004). A common adjustment made to account for disturbance in traditional dust schemes is to assume that disturbed soils have lower threshold friction velocities than stable soils (WGA, 2006). This effect has been shown in relation to saltation (Gillette, 1980), but does not necessarily reflect the threshold friction velocities required for dust emissions, since supply-limited soils can show dust emissions in the absence of saltation on both disturbed and stable soils (Macpherson et al., 2008).

Instead of directly addressing surface disturbance, incorporation of the surface roughness length of the soil (which can provide an approximation for the non-erodible elements of the soil) is usually assumed to be the principal limiter of dust production, beyond friction velocities, in transport-limited schemes (Marticorena et al., 1997; Alfaro et al., 2004). Surface roughness

lengths (the theoretical height at which the mean wind speed is assumed to be zero) are either calculated through direct measurement of wind speeds at varying heights or approximated through equations that estimate the roughness elements (e.g., rocks, vegetation, structures) associated with land cover or land uses. This produces wide variations in the estimation of surface roughness lengths for similar surfaces (MacKinnon et al., 2004). Surface roughness values have also been shown to change dynamically with effects from factors such as atmospheric conditions, past wind events, levels of disturbance and vegetation growth (Greeley et al., 1997). Attempts have been made recently to improve the database of available surface roughness lengths through satellite data, but incorporation of these data has not readily occurred and is largely focused on global scale dust emissions (Prigent et al., 2005). Because of the transient nature of surface roughness lengths and differing methodologies used to measure these lengths, a reliable local database does not exist that can incorporate their effects, especially when dealing with a large time period like an annual inventory (Marticorena et al., 2006).

While surface roughness lengths can eliminate rough surfaces as sources of dust production (i.e., many dust schemes assume no windblown dust emissions occur from surfaces with roughness lengths greater than 0.1 cm; Gillette, 1999) it cannot explain the difference in emissions seen between disturbed and stable soils at similar roughness lengths. In fact, the Owen Effect (Owen, 1964) demonstrates that surface roughness actually *increases* during saltation events. This positive feedback loop has the effect of simultaneously increasing friction velocities and saltation effects, which in turn increase vertical flux emissions (Gillette et al., 1998). Additionally, with supply-limited soils in particular, disturbed soils have been shown to produce orders of magnitude higher dust emissions than similar stable soils, despite having similar surface roughness lengths (Nickling and Gillies, 1989; Macpherson et al., 2008). This is because disturbance of the soil, through breaking of surface crusts and reorientation of surface grains, has the foremost effect of creating larger reservoirs of surface material available to be entrained as compared to stable soils. Since actual surface roughness lengths of subject soils are largely unknown and vary over time; and because surface roughness does not directly address the effects of disturbed soils, another variable is required to approximate disturbance levels. In this scheme, disturbance of soils is determined through use of site-specific inspection data of specific land uses gathered by Maricopa County Air Quality Department (MCAQD) personnel (further detail available in section on Threshold Friction Velocity).

In addition to the conceptual dust scheme associated with supply-limited soils, empirical wind tunnel data gathered in local supply-limited environments is utilized in the development of vertical dust fluxes. Three data sets of wind tunnel tests performed in the southwest U.S. (areas around Barstow, California; Las Vegas, Nevada and southern Arizona) present empirical data on windblown dust emission rates (Nickling and Gillies, 1989; Wacaser et al., 2006; Macpherson et al., 2008). These data confirm the initiation of dust emissions at wind speeds lower than thresholds required for saltation and that disturbed soils produce higher dust emissions than stable soils. These outcomes are expected in supply-limited environments and support the use of a dust scheme modeled around the characteristics of supply-limited environments. Specifically, the wind tunnel tests performed in southern Arizona (Nickling and Gillies, 1989) form the basis of the vertical fluxes (dust emission rates) used to quantify PM_{10} emissions from windblown dust in Maricopa County and the PM_{10} nonattainment area (see section on Vertical Emission Fluxes for further discussion).

As highlighted in the introduction, there are many factors that control the production of windblown dust beyond wind speed velocities and disturbance levels that cannot be directly accounted for in this dust scheme (e.g., soil texture, soil moisture, topography, land use, etc.).

Data for these factors can be limited, nonexistent or unreliable. It is also unknown what degree of importance each of these factors have when they combine in the processes that contribute to the production of windblown dust. In order to account for the role of these missing variables, windblown dust emissions developed here were standardized to match observed PM_{10} monitor concentrations when high winds were present. This sensitivity analysis puts the windblown dust emission estimates in context with other emissions sources and provides a reality check on dust emissions developed using only wind speed velocities and vertical flux equations. The analysis of PM_{10} concentrations under elevated wind speeds estimated that approximately 10% of annual PM_{10} emissions are linked to high wind speeds (see Standardized Windblown Dust Emissions section for more information). As such, windblown dust emissions have been limited to no more than 10% of the total annual inventory for Maricopa County and the PM_{10} nonattainment area.

Threshold Friction Velocity

An essential factor to any windblown dust scheme involves determining the threshold friction velocity (represented as u^*_t); the minimum wind speed at which windblown dust emissions are initiated at ground level. In reality, the threshold friction velocity will change based upon the individual properties of the subject soil during any given wind event. However, for the purposes of development of a windblown dust inventory, it is necessary to identify a minimum wind speed at which dust production can theoretically begin. The threshold friction velocity for this inventory was identified using the theoretical principles of aerodynamic entrainment observed on supply-limited soils (Macpherson et al., 2008) and empirical data from regional wind tunnel tests, local meteorological data, and local PM_{10} monitoring data.

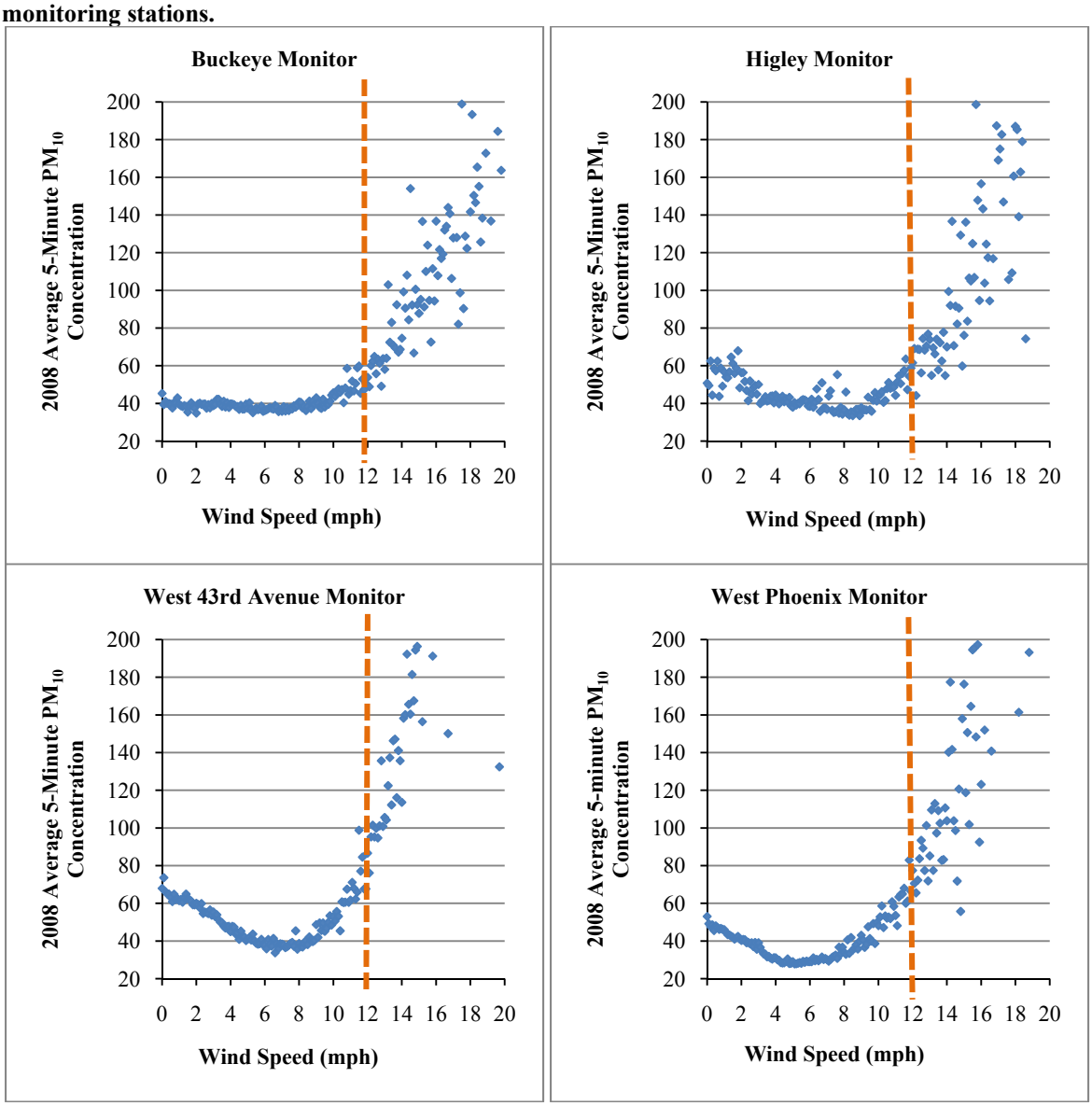
Many dust schemes set separate threshold velocities depending upon a measured or assumed set of soil properties. In the absence of, or augmentation to, local wind tunnel studies, soil texture and soil roughness lengths are common variables used to determine threshold friction velocities. In traditional transport-limited schemes, the physics of saltation dictate that loose, sandy soils will have lower threshold friction velocities than undisturbed clay- or silt-dominated soils (Gillette, 1999). However, the role of soil texture is unclear in the published literature, with recent studies finding that soil texture plays only a secondary role in dust production (Chatenet et al., 1996; Alfaro et al., 2004).

Wind tunnel studies done in the supply-limited deserts of the southwestern U.S. also show little connection between soil texture and threshold friction velocities. Wind tunnel studies in Las Vegas, Nevada (Wacaser et al., 2006) on nine different soil types (including both stable and disturbed soil conditions) found that all soil types emitted dust at the lowest available wind speed of the wind tunnel, approximately 11 mph, suggesting that soil texture plays no distinguishable role in setting threshold friction velocities. Studies in the deserts around Barstow, California found that dust emissions were initiated for three different soil textures (stable and disturbed) at ground-level wind speeds (u*) between 16 to 26 cm/s. Depending on surface roughness values, these ground-level wind speeds translate into 10-meter wind speeds of approximately 10–15 mph. Wind tunnel studies performed in southern Arizona on mostly disturbed, sandy or sandy loam soils found saltation velocities to be between 13 to 30 mph. Roney and White (2004) found that direct aerodynamic entrainment threshold friction velocities are approximately 50 to 75% less than saltation thresholds, suggesting that the dust emission thresholds for southern Arizona could be as low as 7 mph. The measured wind tunnel data, combined with the conceptual ambiguity surrounding the role of soil texture, provide limited empirical rationale to set threshold friction velocities according to soil texture alone.

Large changes in surface roughness lengths have been clearly shown to affect threshold friction velocities of soils (Marticorena et al., 1997). However, there is no reliable data available to estimate surface roughness lengths throughout Maricopa County, especially on lands where frequent human activity is expected (e.g., agriculture, construction sites, urban vacant lots) (Marticorena et al., 2006). As mentioned earlier, these values are not static and change with atmospheric and anthropogenic activities. Surfaces that are known to have uniformly high surface roughness lengths (e.g., built-out urban areas and mountain ranges) have already been eliminated from the underlying land uses that are selected as possible sources of windblown dust. The land uses that remain (e.g., open and vacant areas, agriculture, construction sites) can have varying surface roughness lengths depending on the level of human and natural activity occurring on the soils. As such, tying threshold friction velocities to assumed surface roughness lengths is not a viable option.

Examination of local PM_{10} concentration and meteorological monitoring data in Maricopa County show that when wind speeds reach approximately 12 mph (measured as a 5-minute average), average PM_{10} concentrations are consistently higher than concentrations at lower wind speeds. Also, as wind speeds exceed 12 mph, average PM_{10} concentrations uniformly increase with increasing wind speeds. These monitoring stations are surrounded by a wide variety of land uses and differing surface roughness lengths, yet they all consistently display similar relationships between wind speeds and PM_{10} concentrations. Figure A4–1 displays the annual average relationship between wind speed and PM_{10} concentrations from four distinct monitoring locations which represent a variety of land uses, soil types and geographic conditions within Maricopa County. Although not shown in Figure A4-1, the remaining four monitoring stations that collected 5-minute PM_{10} concentration data in 2008 (Central Phoenix, Durango Complex, Greenwood and South Phoenix) show similar relationships between PM_{10} concentrations and wind speeds. This data, combined with the information developed from the wind tunnel studies performed in the southwest U.S., suggest that 12 mph is a valid approximation of the threshold friction velocity required for the initiation of windblown dust in Maricopa County.

Figure A4–1. 2008 average 5-minute PM_{10} concentration by wind speed at sample Maricopa County monitoring stations.



Vertical Emission Fluxes

The rate at which windblown dust emissions are created and suspended in air is described as a vertical flux. Shao (2008a) describes three processes that contribute to the verical flux: (1) *Aerodynamic Entrainment* where dust particles are directly lifted off the surface; (2) *Saltation Bombardment* as sand grains or aggregates strike the surface and eject dust particles and (3) *Aggregate Disintegration* where dust particles attached to sand grains disintegrate under strong winds. A vertical flux rate can be developed through an equation that represents these processes, or empirically with the use of wind tunnel studies.

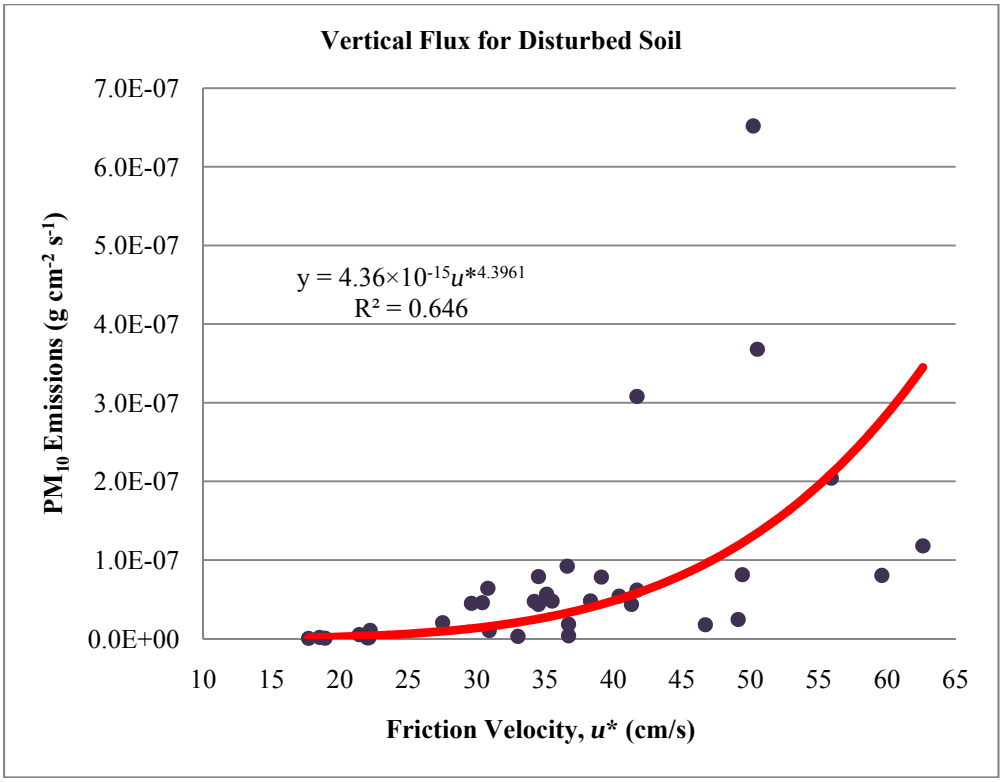
The vertical flux rate developed for this inventory uses wind tunnel studies performed in southern Arizona (Nickling and Gillies, 1989). These studies were performed under a variety of land uses (e.g., native desert, riverbeds, construction sites, agricultural land, mine tailings and dune flats) in soil textures that consisted of either sand or sandy loams. The studies were performed on thirteen sites that are described as disturbed by human activity, or having a strong

potential to be disturbed because of the surface condition of the soil. The authors of the study provide vertical flux rates grouped by land use and by percent clay content. However, these grouping are not useful for this inventory given that recent research (Alfaro et al., 2004) and other wind tunnel studies (Wacaser et al., 2006) have shown that soil texture is not of primary importance in determining vertical fluxes. Fluxes based upon land use groupings provide limited information on soil condition and ignore other essential soil characteristics. Additionally, the wind tunnel studies performed in Barstow, California and Las Vegas, Nevada (Wacaser et al., 2006; Macpherson et al., 2008) show that soil disturbance is the largest factor affecting the vertical flux rate of a soil.

For the above reasons, applicable data from the southern Arizona studies (Nickling and Gillies, 1989) were grouped together to form an overall vertical flux for disturbed soils. Data from seven of the thirteen test sites was grouped together to form the disturbed soil vertical flux. These seven sites include the land uses of construction activities, abandoned agriculture, dry river beds and scrub desert. Six sites were excluded because the land uses or soil properties do not exist in Maricopa County (mine tailings, sand dunes) or because they were conducted on active agricultural fields. Dust emissions from active agricultural fields are calculated using a formula developed by the U.S. Department of Agriculture (see Active Agriculture section). Inactive agricultural land uses that are either fallow, abandoned or some other use (e.g., dairies) are represented by the vertical fluxes developed through the southern Arizona wind tunnel tests, as these land uses do not have active crop cover.

To create the disturbed soil vertical flux, a simple scatter plot of the data (frcition velocity against PM_{10} emissions) was made of the selected southern Arizona wind tunnel data. A power relationship is then developed from the data to produce the best fitting curve of the vertical flux. The assembled data performs reasonably well (R^2 of 0.646) in developing a statistically signifigant vertical flux ($4.36 \times 10^{-15} u^{*4.3961}$ g cm^{-2} s^{-1}) for disturbed soils, given the limited number of test sites and the lack of other variables describing the soil properties. There is significant scatter in the data seen at higher friction velocities. This phenomenon has been documented in other studies, and again highlights the fact that there are many other factors besides friction velocity that determine the vertical flux rates of soils (Houser and Nickling, 2001). Despite this short coming, friction velocity remains the primary variable with which to describe the magnitude of dust emissions; largely because it is one of the easiest variables to verify with quantitative data. The vertical flux developed through the southern Arizona wind tunnel data is in the same order of magnitude, and compares well with, other fluxes measured in similar wind tunnel tests in Barstow, California and Las Vegas, Nevada (Wacaser et al., 2006; Macpherson et al., 2008). Figure A4–2 graphs the data points from the wind tunnel studies used to develop the vertical flux for disturbed soil.

Figure A4–2. Vertical flux for disturbed soil.



Since the southern Arizona wind tunnel tests provided limited information on vertical fluxes from stable soils, a stable soil vertical flux could not be developed directly from the wind tunnel data. As a surrogate, the ratio of stable to disturbed vertical fluxes found in the wind tunnel studies performed in Barstow, California (Macpherson et al., 2008) was used to develop the vertical flux for stable land uses. The Barstow area study contained multiple tests done on stable and disturbed soils at the same test sites. This allows for a direct comparison of the windblown dust emission rates between stable and disturbed soils. Data from all of the Barstow wind tunnel tests were used except for the tests done on salt-crusted soils (dry lake beds), as this type of soil is rare in Maricopa County. The results of the Barstow studies indicate that the stable soil vertical flux was found to produce emissions at a rate of about 12 to 20% of the disturbed soil vertical flux.[1]

Determination of the amount of disturbed land in each land use category is accomplished through use of rule effectiveness rates developed by MCAQD (see Appendix 3 for details on rule effectiveness), since direct measurement of soil disturbance is not feasible (i.e., soil conditions are constantly changing) in an area as large as Maricopa County. Activities on land uses subject to windblown dust are regulated by MCAQD rules that require specific activity-related control measures that stabilize the soil. Compliance and inspection records provide an estimate of how often these measures are being implemented and the frequency of observed violations of the measures. By implied extension, this is also an estimate of how often a regulated land use soil is stabilized. Examination of compliance records for the period of July 2008 through June 2009 produced rule effectiveness rates of 90% for developing land uses (Rule 310), 65% for sand and

[1] For disturbed surfaces a flux of 2.35 x $10^{-12}u^{*2.5604}$ g cm^{-2} s^{-1} was calculated using the Barstow wind tunnel data; likewise for stable surfaces, a flux of 2.96 x $10^{-12}u^{*1.9744}$ g cm^{-2} s^{-1} was calculated. The ratio of these Barstow fluxes applied to the southern Arizona disturbed soil vertical flux (at the mean of each wind speed bin) allows for calculation of a vertical flux that can represent emissions from stable southern Arizona soils.

gravel processing and mining land uses (Rule 316), and 95% for vacant land uses (Rule 310.01). For the purposes of calculating windblown dust, these rule effectiveness percentages are used as surrogates for the percentage of a land use category that is assumed to be disturbed. Thus, the Rule 310 effectiveness rate of 90% serves as a surrogate for developing land uses (i.e., 90% of the land is stable, 10% is disturbed), the Rule 316 rate of 65% serves as a surrogate for sand and gravel processing and mining activities, and the Rule 310.01 rate of 95% serves as a surrogate for all open and vacant lands, landfills, automotive test tracks and inactive agricultural land uses. The rule effectiveness rate developed for agricultural operations (55%) applies only to active agricultural land uses and is incorporated in the equation used to estimate windblown dust from active agricultural fields (see section on Active Agricultural Emissions).

In order to utilize the disturbed soil and stable soil vertical fluxes for generating PM_{10} emission estimates, PM_{10} emission factors based upon these vertical fluxes are created. Initially, the units of the fluxes were converted (from g cm^{-2} s^{-1} to tons $acre^{-1}$ 5-$minute^{-1}$) to match available meteorological data on wind speeds and comparable units of mass with other sections of this inventory. Selection of a 5-minute average for the wind speed value was chosen because it is the shortest duration of wind speed available that is constantly measured. Windblown dust production has been shown to be more closely correlated with gusts than with averaged wind speeds (Cakmur et al., 2004; Engelstaedter and Washington, 2007). However, gusts (usually 1-second maximums) are not constantly measured which does not allow for their use in calculation of emissions in an annual inventory. Thus, the 5-minute average wind speed is selected as the input wind speed in both vertical fluxes (see Wind Speed Data section for more information).

These 5-minute average wind speeds are aggregated into five 10-meter wind speed bins (12-15 mph, 15-20 mph, 20-25 mph, 25-30 mph, and 30-35 mph) in order to develop a disturbed soil and stable soil emission factor per each wind speed bin. The midpoint of each wind speed bin (13.5 mph, 17.5 mph, 22.5 mph, 27.5 mph, and 32.5 mph) is converted via the Prandtl equation[2] to a $u*$ value (surface wind speed) for use in the disturbed soil vertical flux equation, resulting in a disturbed soil emission factor for each wind speed bin. After the disturbed soil emission factors are calculated, the ratio between disturbed and stable soil emissions observed at the Barstow tests is used to develop a stable soil emission factor for each wind speed bin. Table A4–1 shows the resulting stable soil and disturbed soil emission factors for each wind speed bin (by land use category) and the ratio of stable to disturbed soil emissions observed in the Barstow area wind tunnel studies.

[2] The fluid dynamics Prandtl equation: $U = \frac{u^*}{k} ln \frac{z}{z_o}$, allows for the calculation of $u*$ at various 10-meter wind speeds by solving for $u*$: ($u^* = U \frac{k}{ln \frac{z}{z_o}}$), where U is wind speed at 10 meters, k is Von Karman's constant (0.4), z is 10 meters, and z_o is measured surface roughness value. An average value of 0.025cm (as measured during southern Arizona wind tunnel tests) was assumed for z_o Once $u*$ is calculated for each wind speed bin, that value is then inserted into the vertical flux rate to develop the emission factors seen in Table A4-1.

Table A4–1. PM_{10} emission factors for stable and disturbed land uses by wind speed bin.

Land Use Category	% of Land Use Category	PM_{10} Emission Factor (tons/acre-5-minute) by 10-Meter Wind Speed Bin (mph)				
		12-15	15-20	20-25	25-30	30-35
Agriculture (Active)		NA – Calculated Under Different Methodology				
Agriculture (Inactive) – Stable	95%	1.10×10^{-5}	2.93×10^{-5}	7.68×10^{-5}	1.64×10^{-4}	3.10×10^{-4}
Agriculture (Inactive) – Disturbed	5%	5.44×10^{-5}	1.69×10^{-4}	5.14×10^{-4}	1.24×10^{-3}	2.57×10^{-3}
Developing Land – Stable	90%	1.10×10^{-5}	2.93×10^{-5}	7.68×10^{-5}	1.64×10^{-4}	3.10×10^{-4}
Developing Land – Disturbed	10%	5.44×10^{-5}	1.69×10^{-4}	5.14×10^{-4}	1.24×10^{-3}	2.57×10^{-3}
Open Space, River Beds, Vacant, Landfill, Test Tracks – Stable	95%	1.10×10^{-5}	2.93×10^{-5}	7.68×10^{-5}	1.64×10^{-4}	3.10×10^{-4}
Open Space, River Beds, Vacant, Landfill, Test Tracks –Disturbed	5%	5.44×10^{-5}	1.69×10^{-4}	5.14×10^{-4}	1.24×10^{-3}	2.57×10^{-3}
Sand & Gravel, Mining – Stable	65%	1.10×10^{-5}	2.93×10^{-5}	7.68×10^{-5}	1.64×10^{-4}	3.10×10^{-4}
Sand & Gravel, Mining – Disturbed	35%	5.44×10^{-5}	1.69×10^{-4}	5.14×10^{-4}	1.24×10^{-3}	2.57×10^{-3}
Disturbed Soil Vertical Flux:		**Ratio of Barstow Stable to Disturbed Soil Emissions**				
$4.36 \times 10^{-15} u^{*4.3961}$ g cm^{-2} s^{-1}		20.16%	17.33%	14.94%	13.29%	12.06%

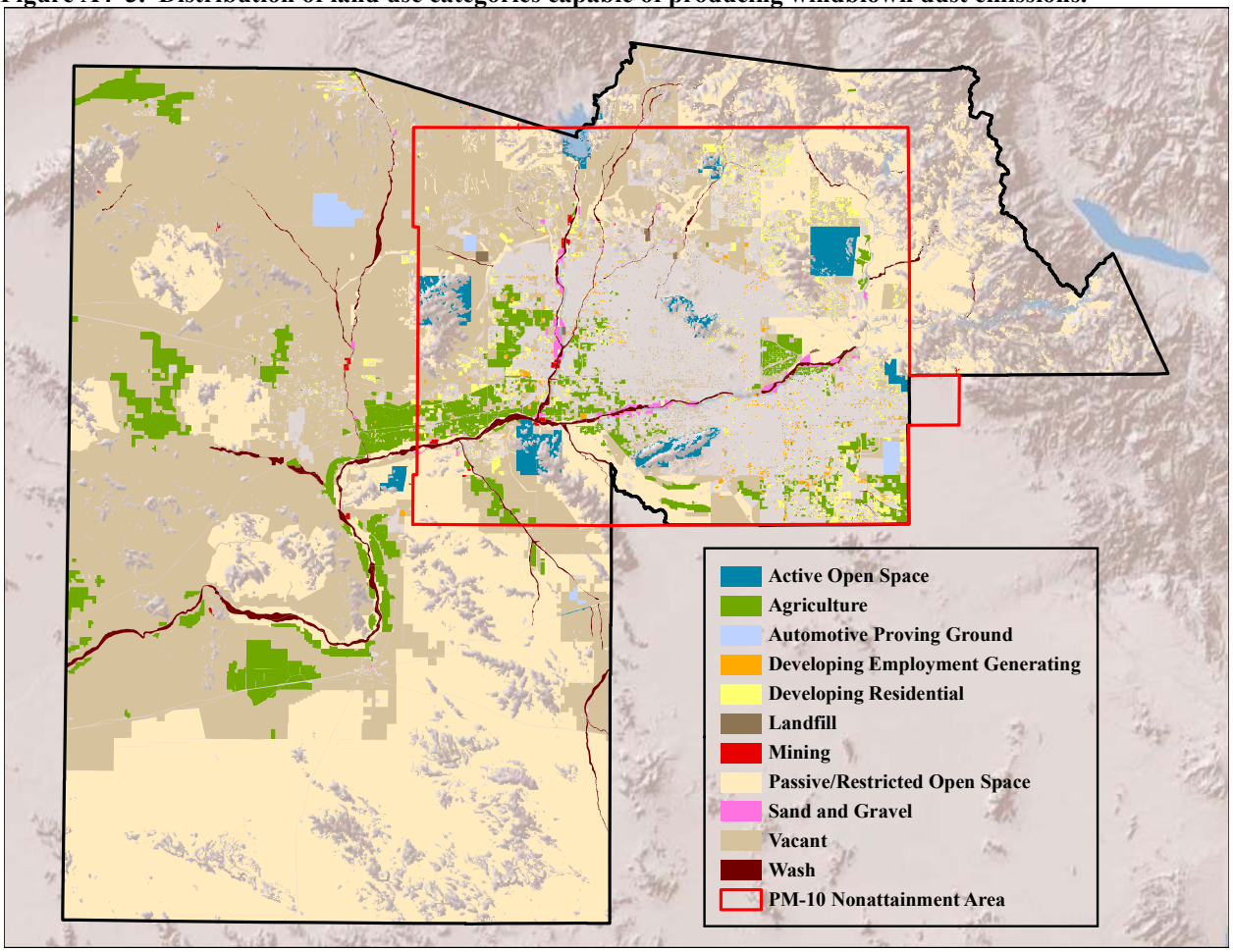
Land Use Data

The Maricopa Association of Governments (MAG) maintains GIS data on land use coverage in Maricopa County. The GIS data compiled by MAG represents land use coverage for the year 2009. A detailed explanation on how MAG assembles and maintains its GIS database is included as Attachment I of this Appendix. In addition to data provided by MAG, the Arizona Cotton Research and Protection Council (ACRPC) provided supplemental GIS information on agricultural field crops in portions of Area A in Maricopa County. Where appropriate, data from the ACRPC was used to update the agricultural land use category maintained by MAG. A total of nine individual land use categories were identified as having potential to emit windblown dust. These categories were selected due to an abundant presence of exposed soils and the possibility of periodic or frequent disturbance. Other land uses not selected may on occasion emit windblown dust, but the presence of structures or vegetated/paved surfaces associated with these land uses limits their ability to emit windblown dust on a consistent basis. Land uses on steeply sloped rocky terrain were also excluded as sources of windblown dust, as the large surface roughness lengths prohibits the production of windblown dust from this type of topography. Table A4–2 lists a description of, and the acreage associated with, the nine land use categories considered as sources of windblown dust. Figure A4–3 shows the extent and distribution of the land use categories determined to have the potential to emit windblown dust.

Table A4–2. Land use categories associated with the production of windblown dust.

MAG Land Use Category	Maricopa County Acreage	PM_{10} NAA Acreage	Description
Active Open Space	59,145	54,835	Natural desert community parks (e.g., White Tanks)
Agriculture	282,793	116,934	Active fields/orchards, dairies & inactive/abandoned
Auto Test Tracks	19,594	6,888	Unpaved automobile proving grounds
Developing	66,341	60,335	Vacant lands converting to built uses
Landfill	2,705	2,705	Community refuse disposal sites
Mining	3,329	2,004	Rock quarries/pits
Passive Open Space/Wash	1,861,493	341066	State/National parks, bombing range, dry rivers/washes
Sand & Gravel	11,112	10,350	Sand & Gravel processing facilities
Vacant	1,930,606	395,902	Developable/unprotected open spaces

Figure A4–3. Distribution of land use categories capable of producing windblown dust emissions.

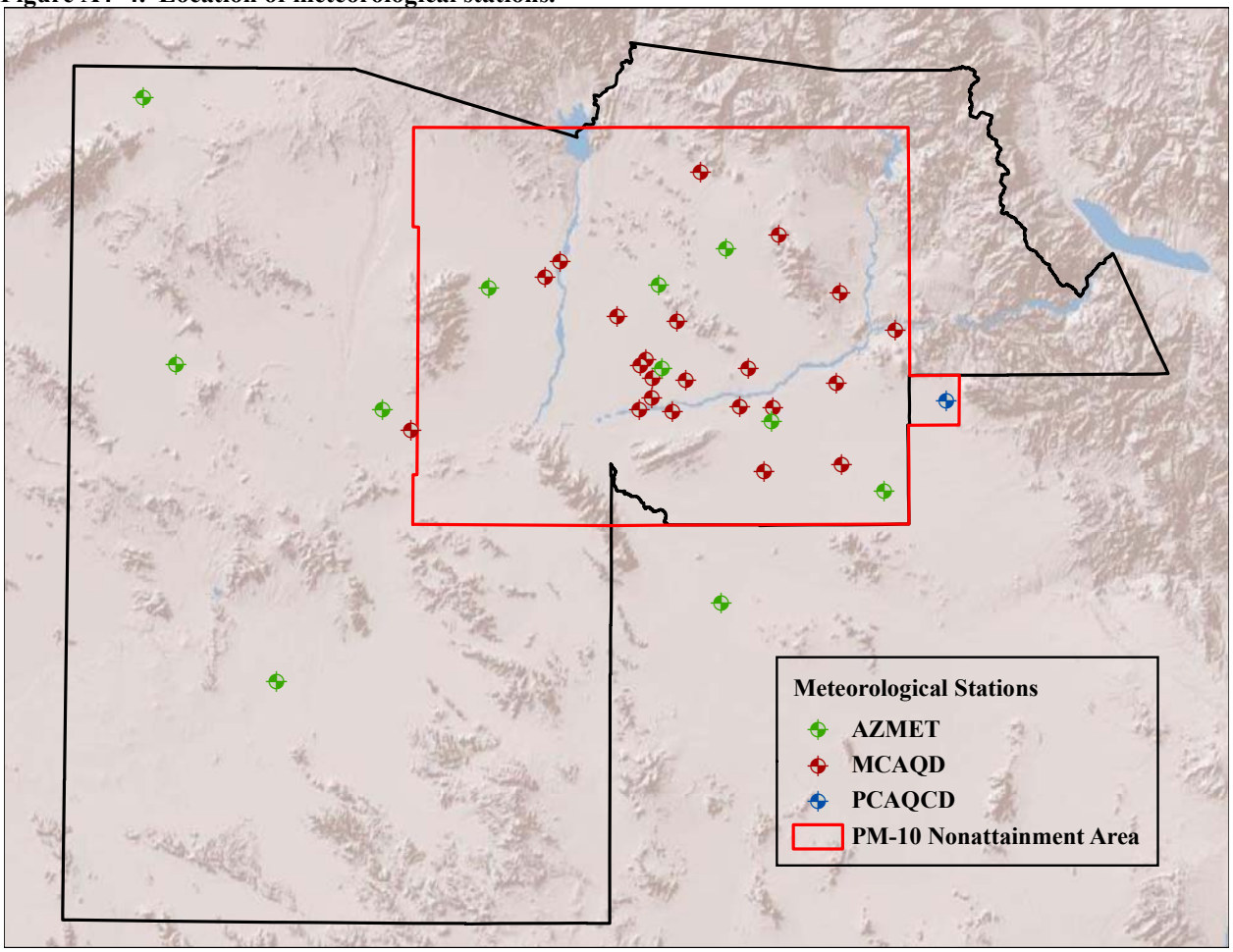


Meteorological Data

Thirty-four meteorological stations were used for source data to compile calendar year 2008 wind speed and precipitation for this inventory of windblown dust. This includes eleven stations operated by the Arizona Meteorological Network (AZMET), twenty-two stations operated by the Maricopa County Air Quality Department (MCAQD), and one station operated by the Pinal County Air Quality Control District (PCAQCD). Stations operated by the National Weather Service (NWS) in and around Maricopa County were not chosen for inclusion in this analysis due to differences in wind speed data collection methods that preclude "apples-to-apples" comparisons with data from the meteorological stations included in this work.[3] Figure A4–4 displays the location of the included meteorological stations.

[3] National Weather Service (NWS) stations report wind speeds in 2-minute averages at the time of posting, while AZMET, MCAQD and PCAQCD all report wind speed in hourly averages at the end of each hour or in 5-minute averages.

Figure A4–4. Location of meteorological stations.



Wind Speed Data

For this analysis, 5-minute average wind speeds form the basis of the wind data used in calculating windblown dust emissions. As mentioned earlier, windblown dust emissions have greater correlation with gusts than with averaged wind speeds (Cakmur et al., 2004; Engelstaedter and Washington, 2007). Data recorded as a 5-minute average provides finer time resolution (versus hourly average wind speeds) that can better capture the effects of gusts while still allowing for emission estimates to be developed. This approach also allows for any 5-minute time period over the threshold friction velocity (12 mph) to be counted and assigned into wind speed bins: 12–15 mph, 15–20 mph, 20–25 mph, 25–30 mph and 30–35 mph. Creating wind speed bins allows for the efficient calculation of emissions while still reflecting the change in magnitude of emissions as wind speeds rise. Outlined below are the steps necessary to prepare the wind speed data for inclusion in windblown dust emission calculations.

As an initial step, wind speed data from the selected meteorological stations were uniformly adjusted to speeds at 10 meters (to account for the difference in anemometer heights) through use of a standard wind profile power-law equation:

$$U_z = U_r(Z/Z_r)^p$$

where U_z is wind speed (in mph) at 10 meters, U_r is wind speed (in mph) at referenced anemometer height, Z is 10 meters, Z_r is the height (in meters) of the reference anemometer, and

p is the power-law exponent. Determination of p was made by comparing wind speeds at neighboring stations with different anemometer heights (e.g., AZMET's Buckeye station at 3 meters compared with MCAQD's Buckeye station at 10 meters) through a simple adaptation of the power-law equation:

$$p = \frac{\ln(U) - \ln(U_r)}{\ln(Z) - \ln(Z_r)}$$

The stations used in comparison were all assumed to have similar surface roughness lengths to each other as the stations were between 1–3 miles apart. Comparison of hourly average wind speeds yielded an average value for p of 0.06 for urban stations and 0.12 for rural stations (only those hours when atmospheric conditions are well mixed were used, as applying the approach described above for hours with calm winds tends to over-inflate the value of p).

In addition to correcting for height, adjustments to wind speed were performed to gap-fill missing data and interpolate 5-minute average values as necessary. All of the meteorological stations report hourly average wind speeds at the end of each hour. In addition, thirteen of the MCAQD stations also report 5-minute average wind speeds, with data completion rates of 75% or better. The data from these stations were: (1) counted and assigned to one of five wind speed bins of 12-15 mph, 15–20 mph, 20–25 mph, 25–30 mph, and 30–35 mph; and (2) "grown" to compensate for missing data, based upon the data completion rate of each station. Thus, a station that reported 124 5-minute periods assigned to a bin with a data completion rate of 90.63%, would result in a "grown" bin value of 137 (124 periods divided by 90.63%). Table A4–3 presents the recorded and grown 5-minute values by wind speed bin for the year 2008, for each of the thirteen MCAQD meteorological stations that were considered.

Table A4–3. Number of recorded and grown 5-minute average wind speeds for 2008, by wind speed bin and meteorological station.

	Recorded 5-Minute Averages						Grown 5-Minute Averages				
MCAQD Station	12-15 mph	15–20 mph	20–25 mph	25–30 mph	30–35 mph	% Data complete	12-15 mph	15–20 mph	20–25 mph	25–30 mph	30–35 mph
Buckeye	3030	1679	296	54	12	99.62%	3042	1685	297	54	12
Coyote Lakes	1846	840	77	1	0	98.71%	1870	851	78	1	0
Durango Complex	1776	618	33	10	1	96.39%	1843	641	34	10	1
Dysart	1782	784	92	6	0	78.16%	2280	1003	118	8	0
Falcon Field	2088	758	95	2	1	76.77%	2720	987	124	3	1
Greenwood	795	124	11	1	0	90.63%	877	137	12	1	0
Higley	1896	766	50	8	1	91.02%	2083	842	55	9	1
North Phoenix	376	80	8	2	0	77.59%	485	103	10	3	0
South Phoenix	696	169	9	0	1	99.19%	702	170	9	0	1
Tempe	54	5	0	0	0	86.38%	63	6	0	0	0
West Chandler	1637	515	42	3	1	99.09%	1652	520	42	3	1
West Forty-Third	2391	1042	83	13	6	98.44%	2429	1059	84	13	6
West Phoenix	892	111	8	1	0	92.47%	965	120	9	1	0

For the stations that do not record 5-minute average wind speeds[4], regression equations were developed (based upon those MCAQD stations that do report 5-minute average wind speeds) to interpolate counts of 5-minute average values. The equations were derived by regressing 5-minute average counts in each wind speed bin (dependent [y]) against a count of an hourly average wind speeds greater than a pre-determined wind speed (independent [x]). Since the

[4] AZMET and PCAQCD stations report average wind speed only on an hourly basis, and another nine MCAQD stations that measure wind speed on a 5-minute average had data completion rates less than 75% for 2008.

majority of wind speed counts exist in the lower wind speed bins (e.g., hourly average wind speeds over 25 mph were recorded only ten unique times in 2008), a count of hourly values greater than 15 mph was chosen as the independent variable (x). All of the regression equations proved to be statistically significant at the 95% confidence level. The results of the regression equations for each wind speed bin are shown in Table A4–4. The resulting 5-minute average wind speeds (by bin) for all meteorological stations in this study are shown in Table A4–5.

Table A4–4. Regression equation, *p*-value, and R^2 for interpolating 5-minute average wind speeds, by bin.

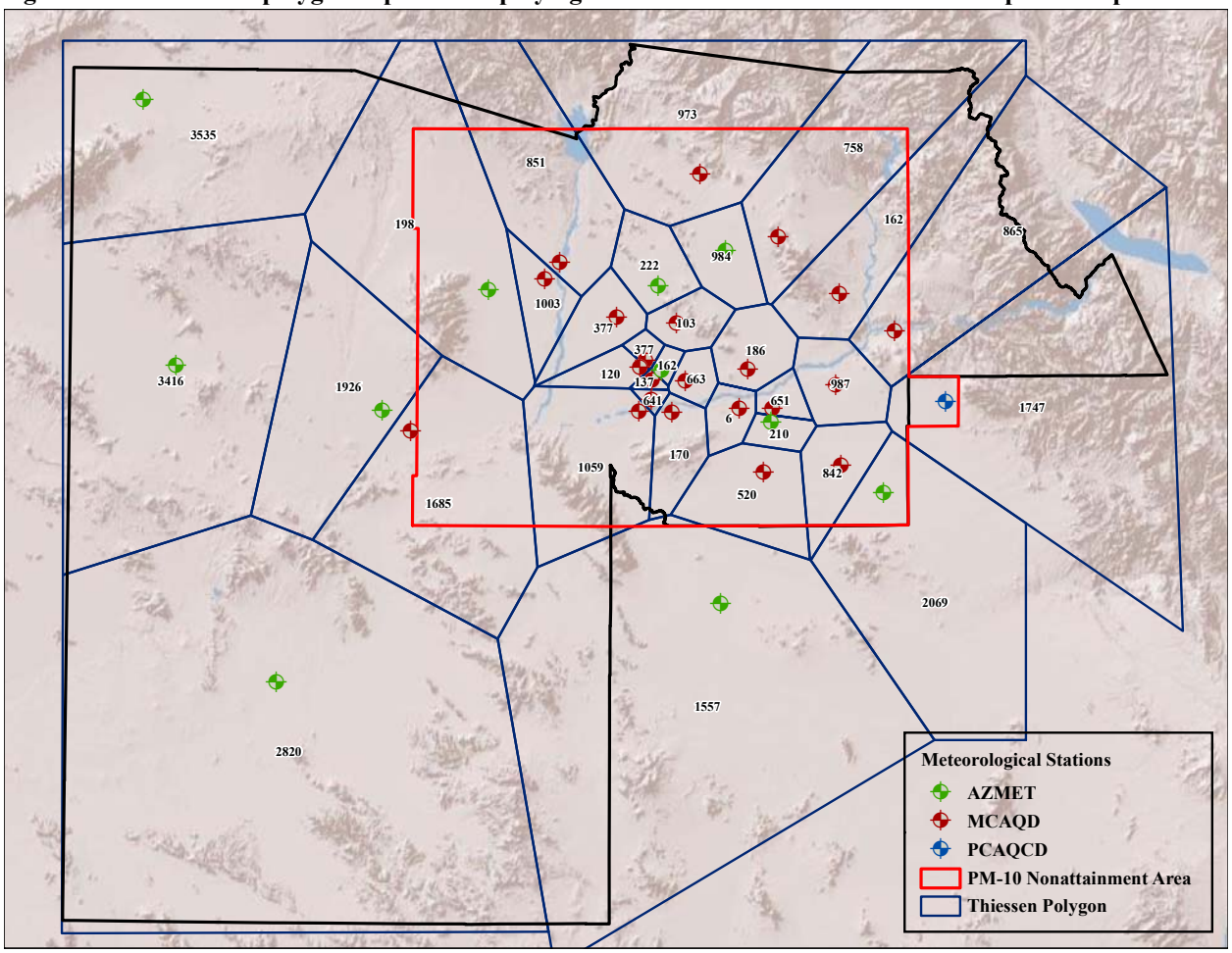
5-minute average wind speed bin	Regression equation	*p*-value (probability)	R^2
12-15 mph	$y = 827.00 + 19.80x$	0.00007056	77.55%
15–20 mph	$y = 150.05 + 11.92x$	0.00000006	93.77%
20–25 mph	$y = –8.34 + 1.39x$	0.00000021	92.09%
25–30 mph	$y = –4.20 + 0.31x$	0.00009300	76.42%
30–35 mph	$y = –0.99 + 0.07x$	0.00047000	68.57%

Table A4–5. Number of interpolated 5-minute average wind speeds, by station and wind speed bin. (Shaded cells denote interpolated values.)

Station Name	Number of hourly average values > 15 mph	Number of 5-minute average values between: 12-15 mph	15–20 mph	20–25 mph	25–30 mph	30–35 mph
AZMET Aguila	284	6450	3535	386	84	19
AZMET Buckeye	149	3777	1926	199	42	9
AZMET Desert Ridge	70	2213	984	89	18	4
AZMET Harquahala	274	6252	3416	373	81	18
AZMET Maricopa	118	3163	1557	156	32	7
AZMET Mesa	5	926	210	0	0	0
AZMET Paloma	224	5262	2820	303	65	15
AZMET Phoenix Encanto	1	847	162	0	0	0
AZMET Phoenix Greenway	6	946	222	0	0	0
AZMET Queen Creek	161	4015	2069	215	46	10
AZMET Waddell	4	906	198	0	0	0
MCAQD Blue Point	60	2015	865	75	14	3
MCAQD Buckeye	146	3042	1685	297	54	12
MCAQD Cave Creek	69	2193	973	88	17	4
MCAQD Central Phoenix	43	1678	663	51	9	2
MCAQD Coyote Lakes	54	1870	851	78	1	0
MCAQD Durango Complex	50	1843	641	34	10	1
MCAQD Dysart	64	2280	1003	118	8	0
MCAQD Falcon Field	58	2720	987	124	3	1
MCAQD Fountain Hills	1	847	162	0	0	0
MCAQD Glendale	19	1203	377	18	2	0
MCAQD Greenwood	1	877	137	12	1	0
MCAQD Higley	42	2083	842	55	9	1
MCAQD Mesa	42	1659	651	50	9	2
MCAQD North Phoenix	4	485	103	10	3	0
MCAQD Pinnacle Peak	51	1837	758	63	12	3
MCAQD South Phoenix	6	702	170	9	0	1
MCAQD South Scottsdale	3	886	186	0	0	0
MCAQD Tempe	0	63	6	0	0	0
MCAQD West Forty-Third	65	2429	1059	84	13	6
MCAQD West Chandler	23	1652	520	42	3	1
MCAQD West Indian School	19	1203	377	18	2	0
MCAQD West Phoenix	5	965	120	9	1	0
PCAQCD Apache Junction	134	3480	1747	178	37	8

Because wind speeds vary dramatically between different meteorological stations in Maricopa County (especially in the transition between rural and urban stations), it is important to represent those variations in space upon the land uses subject to windblown dust. This is accomplished by assigning the wind speed counts in Table A4–5 in GIS (spatial joining) to the land uses nearest each meteorological station through a series of Thiessen polygons[5] (Pulugurtha and James, 2006). This process allows for variations in wind speed counts to be representatively distributed in space across land uses subject to windblown dust, as opposed to "smearing" averaged wind speed counts across all of Maricopa County and the PM_{10} nonattainment area. As an example, Figure A4–5 shows the resulting Thiessen polygons for the 15-20 mph wind speed bin.

Figure A4–5. Thiessen polygon depiction displaying the number of values for the 15–20 mph wind speed bin.



Precipitation Data

During days with precipitation, windblown dust emissions are severely, if not completely, limited. Precipitation also increases overall soil moisture which acts as a control on the production of windblown dust after precipitation has ceased. To account for the role of precipitation, a simple formula used by the U.S. EPA when calculating the controlling role of precipitation on fugitive dust from unpaved roads can be adapted to windblown dust production (US EPA, 2006).

[5] A "Thiessen polygon" depicts an area whose boundaries define the region that is closest to a given point, relative to all other given points.

The adapted equation is represented as:

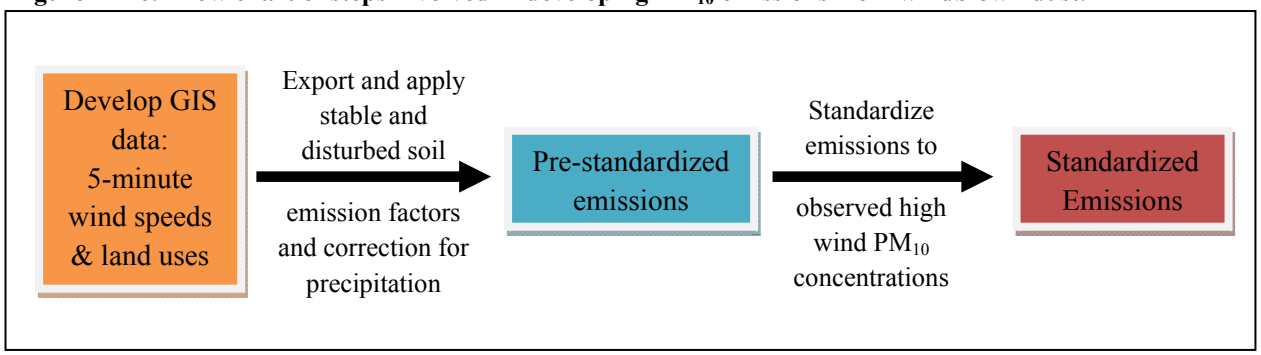
$$E = B \times (1 - P/N)$$

Where E equals emissions, B equals emissions before precipitation, P equals the annual number of "wet" days with at least 0.254 mm (0.01 in) of precipitation (39 days in 2008), and N equals the number of days in the year (366 in 2008). Using this formula equates to applying a 10.66% annual reduction in windblown dust due to precipitation.

Calculation of Windblown Dust Emissions

After developing the input data necessary to calculate windblown dust emissions (e.g., wind speed bin counts, disturbed and stable vertical flux equations, etc.), emission estimates of PM_{10} are calculated for both the PM_{10} nonattainment area and Maricopa County. These emission estimates represent the maximum potential emissions from each land use category since they are a product of only local wind speeds and emission factors developed from soils expected to emit high levels of dust. These emissions will be standardized (adjusted to match observed PM_{10} concentration under high winds) in the next section to account for a range of controlling factors (e.g., surface roughness lengths, soil moisture, vegetation, supply-limitation, etc.) where either adequate quantitative data does not exist or cannot be represented as a unique variable in an emission estimate equation (see section on Standardized Windblown Dust Emissions). Figure A4–6 contains a flow chart showing the steps involved in calculating PM_{10} emissions from windblown dust.

Figure A4–6. Flow chart of steps involved in developing PM_{10} emissions from windblown dust.



Calculation of pre-standardized emission estimates begins through the use of GIS to spatially assign the 5-minute wind speed bin counts to the underlying land use categories (as shown previously in Figure A4–5). These base data are exported from GIS as a spreadsheet, with each row of the spreadsheet representing a spatially unique land use category polygon with associated wind speed bin counts. The land use and wind speed specific emission factors for disturbed and stable soils listed in Table A4–1 are applied to each row of the spreadsheet to produce pre-standardized emissions. Since the specific geographic location of surface disturbance is unknown and varies throughout the year, each land use polygon is assumed to have the same proportion of disturbed and stable soils throughout the year as expressed by the percentages in Table A4–1 (i.e., all vacant parcels are assumed to be 95% stable and 5% disturbed). Base data and emissions from a sample vacant land use polygon are shown in Table A4–6. All pre-standardized emissions from land use categories except active agricultural fields are calculated per the methodology presented in Table A4–6.

Table A4–6. Base data and pre-standardized emissions from a sample vacant land use polygon.

	Polygon Acres	Count of 5-Minute Periods for 12 - 15 mph	Count of 5-Minute Periods for 15 - 20 mph	Count of 5-Minute Periods for 20 - 25 mph	Count of 5-Minute Periods for 25 - 30 mph	Count of 5-Minute Periods for 30 - 35 mph
Vacant Land Use Base Data	22.15	2280	1003	118	8	0
Emission Factors (tons/acre–5-min)		**12 - 15 mph**	**15 - 20 mph**	**20 - 25 mph**	**25 - 30 mph**	**30 - 35 mph**
Stable Soil Emission Factor		1.10×10^{-5}	2.93×10^{-5}	7.68×10^{-5}	1.64×10^{-4}	3.10×10^{-4}
Disturbed Soil Emission Factor		5.44×10^{-5}	1.69×10^{-4}	5.14×10^{-4}	1.24×10^{-3}	2.57×10^{-3}
Annual Emissions	**Acreage**	**12 - 15 mph Emissions (tons)**	**15- 20 mph Emissions (tons)**	**20 - 25 mph Emissions (tons)**	**25 - 30 mph Emissions (tons)**	**30 - 35 mph Emissions (tons)**
Stable Emissions (95% of acreage)[1]	21.04	0.53	0.62	0.19	0.03	0.00
Disturbed Emissions (5% of acreage)[2]	1.11	0.14	0.19	0.07	0.01	0.00
Total Emissions[3]	22.15	0.66	0.81	0.26	0.04	0.00

[1] Stable Emissions = Stable Acreage × Wind Speed Bin Count × Wind Speed Bin Emission Factor
[2] Disturbed Emissions = Disturbed Acreage × Wind Speed Bin Count × Wind Speed Bin Emission Factor
[3] Total (Pre-standardized) Emissions = Stable Emissions + Disturbed Emissions

Windblown Dust Emissions from Active Agricultural Areas

Since crop cover dramatically affects windblown dust production, windblown dust from active agricultural areas (fields or orchards with harvested or planted crops) cannot be calculated using the vertical fluxes developed for the other land use categories. Some crops, like alfalfa, maintain dense vegetative cover all year long and virtually eliminate the possibility of windblown dust from these types of fields. Thus, windblown dust from active agricultural fields is calculated using a soil erodibility formula developed by the U.S. Department of Agriculture (in US EPA, 1974):

$$E_s = a\ I\ C\ K\ L'\ V'$$

where E_s equals suspended PM in tons/acre-year, a is a constant (0.0125) representing the portion of PM as PM_{10}, I is soil erodibility, C is a climatic factor, K is surface roughness, L' is unsheltered field width and V' is vegetative cover.

The number of acres harvested in 2008 serves as a surrogate for the amount of active agricultural areas in Maricopa County. Data on the amount of acres harvested for 2008 is available through the Arizona Agricultural Statistics Bulletin and the U.S. Department of Agriculture National (USDA) Agricultural Statistics Service for 2008 (USDA, 2008; AASS, 2009). Data for the other variables in the equation is taken from the 1999 Serious Area PM-10 Plan (MAG, 2000). Table A4–7 lists the crop-specific values for each variable.

Table A4–7. Active Maricopa County agricultural acreage and default values for USDA equation variables, by crop type.

Crop	2008 Acreage	*a*	*I*	*C*	*K*	*L'*	*V'*	E_s
Cotton	18,800	0.0125	63.6	0.318	0.5	0.74	0.7	0.065
Alfalfa	83,000	0.0125	63.6	0.318	1	0.76	0	0
Other hay	4,500	0.0125	63.6	0.318	0.8	0.83	0	0
Wheat	30,100	0.0125	63.6	0.318	0.6	0.77	0	0
Barley	9,900	0.0125	63.6	0.318	0.6	0.77	0	0
Corn	700	0.0125	63.6	0.318	0.6	0.77	0.44	0.051
Potatoes	1,400	0.0125	63.6	0.318	0.8	0.70	0.6	0.085
Sorghum	2,200	0.0125	63.6	0.318	0.6	0.77	0	0
Other vegetables	16,072	0.0125	63.6	0.318	0.6	0.48	0.77	0.056
Citrus	2,124	0.0125	63.6	0.318	0.6	0.48	0.77	0.056

Application of the formula to develop annual PM_{10} emissions from active agricultural fields is achieved by multiplying crop type E_s by the number of acres in each crop type. In addition to applying the USDA formula, a control factor of 72.28% (1 – 27.72%) was applied to active agricultural emission estimates to reflect the effectiveness of the agricultural BMP program. This control factor is a combination of the rule effectiveness of the BMP program (55.33%; see Appendix 3) and the estimated control effectiveness of the BMP program (50.10%)[6], for an overall effectiveness of 27.72%. Emissions are allocated to the PM_{10} nonattainment area based upon the percentage (41.35%) of agricultural land use acres located with the nonattainment area.

Summary of Pre-standardized Windblown Dust Emission Calculations

To account for precipitation, pre-standardized emission estimates have been reduced by 10.66% (see section on Precipitation for more detail) for all land uses except active agricultural areas, as factor *C* in the USDA formula considers precipitation and the effects of soil moisture content. Annual pre-standardized PM_{10} emissions from active agricultural areas and all other land uses are listed in table A4–8 for Maricopa County and the PM_{10} nonattainment area.

Table A4–8. Annual pre-standardized PM_{10} emissions from windblown dust in Maricopa County and the PM_{10} nonattainment area.

	Annual emissions (tons/yr)	
Land use category	**Maricopa County**	**PM_{10} Nonattainment Area**
Active open space	3,191.63	2,660.86
Agriculture – active	1,739.06	719.10
Agriculture – inactive	16,711.81	3,686.87
Auto test tracks	2,192.92	534.01
Developing	5,897.93	4,863.19
Landfill	78.76	78.76
Mining	723.15	295.40
Passive open space/wash	268,122.10	22,669.38
Sand & gravel	1,511.72	1,341.04
Vacant	283,176.99	23,037.24
Totals:	**582,326.11**	**59,885.85**

[6] Derived from Table 4-2 of the Technical Support Document for Quantification of Agricultural Best Management Practices, prepared for ADEQ by URS and ERG, June 2001.

Standardized Windblown Dust Emissions

Pre-standardized windblown dust emission calculations represent maximum windblown dust emission rates from land uses that have the capability to emit windblown dust. This is largely due to the fact that the vertical fluxes used to calculate pre-standardized emissions are based upon wind tunnel tests done in areas selected *a priori* as areas suspected of generating large quantities of windblown dust (Nickling and Gillies, 1989). These are areas that are mostly free of vegetation, have low surface roughness, and have surfaces that are either disturbed or easily disturbed. Only a small percentage of the land use categories assumed to emit windblown dust have characteristics identical to the wind tunnel test sites. Many areas have much denser vegetation, higher surface roughness values, topography that shelters the wind, higher surface moisture, desert pavement crusts, etc. For those areas disturbed by anthropogenic activities, the role of active controls (e.g., applying water) is not represented in the vertical fluxes. The vertical fluxes also do not take into account the supply-limited nature of desert soils in Maricopa County, because the wind tunnel tests were only performed for a period of 10 to 30 minutes at most (ibid). During a sustained high-wind event, some soils will stop emitting before the wind speeds fall below the threshold friction velocity because the available reservoir of dust particles has been exhausted due to the supply-limitations of the soil. Because these windblown dust-limiting variables are not represented in the wind tunnel tests, they need to be accounted for outside the vertical flux equations. To account for this on an annual basis, a sensitivity analysis was performed by comparing windblown PM_{10} emission estimates against observed PM_{10} concentrations under high wind conditions.

In 2008, there were eight MCAQD PM_{10} monitors that recorded PM_{10} concentrations and associated wind speed in 5-minute averages. A simple test to see the impact of PM_{10} concentrations under high winds is to compare the measured PM_{10} mass associated with wind speeds below 12 mph (threshold friction velocity for windblown dust generation) against the mass associated with wind speeds at 12 mph or greater. While PM_{10} concentrations are not an exact surrogate for emissions since high wind PM_{10} concentrations can be the result of long distance transport from upwind sources in some cases, on an annual basis they are a rough approximation of the sources and magnitude of PM_{10} emissions in the area around the monitoring site. Table A4–9 shows the percentage of PM_{10} mass associated with wind speeds at or above 12 mph for eight MCAQD monitors with 5-minute data.

Table A4–9. Percentage of PM_{10} mass associated with wind speeds at or above 12 mph for eight MCAQD monitors in calendar year 2008.

Monitor	Sum of 5-min PM_{10} mass when 5-min winds ≥ 12mph ($\mu g/m^3$)	Sum of all 5-min PM_{10} mass ($\mu g/m^3$)	Percent PM_{10} mass associated with 5-min winds ≥ 12 mph
Buckeye	646,732	4,596,071	14.07%
Central Phoenix	96,398	2,014,492	4.79%
Durango Complex	361,223	5,023,592	7.19%
Greenwood	140,729	4,175,273	3.37%
Higley	293,153	4,468,163	6.56%
South Phoenix	204,019	4,753,036	4.29%
West Phoenix	133,834	3,698,296	3.62%
West Forty-Third	751,052	5,928,634	12.67%
All Monitors	2,627,139	34,657,557	7.58%

The analysis in Table A4–9 shows that as a weighted average, about 7.6% of annual PM_{10} emissions are associated with wind speeds greater than or equal to 12 mph. The monitors that are surrounded by land uses that are likely to produce windblown dust (e.g., Buckeye, West Forty-Third) have higher mass associated with winds ≥ 12 mph than do more urban monitors (e.g., Greenwood) where land uses have limited opportunity to produce windblown dust. A simple statistical analysis of the eight monitors produces a mean of about 7% and a standard deviation of 4%. Given that the monitors do not capture all emissions associated with high winds and that the limited numbers of monitors covering a large geographic area like Maricopa County do not represent all land use mixes, it is assumed that up to 10% (within one standard deviation of the monitor concentrations) of PM_{10} in an annual inventory of Maricopa County and the PM_{10} nonattainment area is windblown dust.

Annual PM_{10} emissions from sources other than windblown dust total 61,282.27 tons for Maricopa County and 43,333.20 tons for the PM_{10} nonattainment area. If windblown dust emissions are to represent 10% of an annual inventory, than PM_{10} emissions for the nonattainment area and Maricopa County should be standardized to 4,814.80 tons and 6,809.13 tons, respectively.[7]

Initial evaluation of the 10% standardized emission targets raises some questions. Despite the presence of significantly more acreage subject to windblown dust in the areas of Maricopa County outside the PM_{10} nonattainment area than within, the standardized emissions suggest that these areas emit at a lower rate than the PM_{10} nonattainment area. While this may seem counter-intuitive at first, given the disparity between acreages, there are theoretical reasons why these areas would emit less. It is important to point out initially that when high magnitude dust events do occur (wind speeds above saltation thresholds) the areas outside of the nonattainment area are going to be the dominant contributor of windblown dust during the event. This is because as saltation occurs, supply-limitation concerns are less important, and the potential for long-range transport increases. However, these events are rare, occurring only a handful of times in a year; while the majority of windblown dust generated on an annual basis occurs during higher frequency/lower intensity wind speeds where supply-limitations control dust production.

The following reasons therefore help to explain why the areas outside of the nonattainment area have greater supply-limitations (on an annual basis) during the more common lower magnitude/ higher frequency wind events, and thus lower dust emissions rates. First, the rates of soil disturbance are developed largely upon MCAQD inspections done only within the nonattainment area; it is very likely that areas outside the nonattainment area experience significantly fewer disturbances due to their isolation (e.g., Tonto National Forest, Goldwater Bombing Range). Second, vegetation in vacant areas outside the nonattainment area, both on the surface and just below the surface, is likely to be greater than vegetation existing on an area such as an urban vacant lot; this provides extra cohesion for the soil, limiting the reservoir of dust available to be entrained during a high wind event. Third, significantly large mountain ranges exist to the west and east of the nonattainment area, providing topographic protection from high winds and effectively funneling the winds to the valleys of the nonattainment area (Washington et al., 2006). Fourth, a recently installed temporary (March 2010 – February 2011) PM_{10} monitor located near Arlington, Arizona (approximately twelve miles west of the nonattainment border) indicated that approximately 8% of PM_{10} concentration are associated with wind speeds ≥ 12 mph. This is the only PM_{10} monitor that operated any significant distance outside the PM_{10}

[7] 43,333.20 tons ÷ 90% = 48,148.00 tons; 61,282.27 ÷ 90% = 68,091.30 tons. 10% of each represents standardized windblown dust emissions.

nonattainment area.[8] As such, PM_{10} concentrations associated with high winds in other areas of Maricopa County outside the nonattainment area are assumed to be similar to the Arlington monitor given the lack of monitoring data available. Given these observations, it is not unreasonable to assume that on an annual basis, areas outside of the nonattainment area will emit windblown dust at lower rates than areas inside the nonattainment area.

As a final note, it is critical to remember that an emissions inventory of windblown dust does not deal with the processes of transport and deposition. It seeks to quantify the amount of dust produced by the wind within a defined geographic area. Transport and deposition can consider sources of emissions hundreds or even thousands of miles away from the monitors during extreme high wind events (Prospero, 1999; VanCuren and Cahill, 2002). There are clearly sources of windblown dust immediately surrounding Maricopa County that will affect monitor concentrations during these high wind events. The purpose of air quality modeling is to combine all three stages of a dust event, particle entrainment, transport and deposition; while the purpose of this inventory is to quantify particle entrainment from sources within Maricopa County and the PM_{10} nonattainment area.

Functionally, pre-standardized emissions are scaled down to the standardized target emissions in two steps to account for the different emissions rates between Maricopa County and the nonattainment area. The first step simply takes the pre-standardized emissions of the nonattainment area and adjusts them to match the target emissions of 4,814.80 tons. This results in a uniform 91.96% reduction of the emissions in all land use categories. The second step assumes that the balance of emissions between the nonattainment area and the county standardized emission targets, 1,994.33 tons[9], originates in the "donut" area of Maricopa County outside the nonattainment area. Pre-standardized emissions from this "donut" area of the county were calculated using GIS and the methods described in previous sections; then standardized to the target of 1,994.33 tons, a 99.62% reduction of pre-standardized emissions.

Summary of Standardized Windblown Dust Emissions

Using the emission methodologies listed above, annual, standardized PM_{10} emissions for Maricopa County and the PM_{10} nonattainment area are calculated. $PM_{2.5}$ emissions are assumed to be 15% of PM_{10} emissions (WGA, 2006). Daily emissions are obtained by dividing annual emissions by the number of days in calendar year 2008 (366). Annual and daily standardized emissions for Maricopa County and the PM_{10} nonattainment area are shown in Tables A4–10 and A4–11, respectively.

[8] The Buckeye monitor is also located outside the nonattainment area, however at only a distance of 0.75 miles from the western border. In 2008 the Buckeye monitor had 14% of PM_{10} mass associated with wind speeds ≥ 12 mph, suggesting that the rural areas of Maricopa County outside of the nonattainment area may have more of their PM_{10} concentrations associated with high winds. However, when high wind PM_{10} concentrations of the Buckeye monitor are compared to the same time period of the temporary Arlington monitor (March 2010 – February 2011), the high wind percentage is reported to be approximately 7% of the PM_{10} mass, which is similar to the percentage reported by the Arlington monitor (8%).

[9] County standardized emission target of 6,809.13 tons – nonattainment area target of 4,814.80 tons = 1,994.33 tons.

Table A4–10. Standardized, annual and daily PM_{10} and $PM_{2.5}$ emissions from windblown dust in the Maricopa County, by land use category.

	Annual emissions (tons/yr)		Average daily emissions (lbs/day)	
Land use category	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Active open space	215.94	32.39	1,180.0	177.0
Agriculture – active	61.69	9.25	337.1	50.6
Agriculture – inactive	345.86	51.88	1,890.1	283.5
Auto test tracks	49.23	7.38	269.0	40.4
Developing	394.98	59.25	2,158.4	323.8
Landfill	6.33	0.95	34.6	5.2
Mining	25.37	3.81	138.7	20.8
Passive open space/wash	2,755.11	413.27	15,058.1	2,258.7
Sand & gravel	108.47	16.27	592.7	88.9
Vacant	2,846.15	426.92	15,555.8	2,333.4
Totals:	**6,809.13**	**1,021.37**	**37,214.6**	**5,582.2**

Table A4–11. Standardized, annual and daily PM_{10} and $PM_{2.5}$ emissions from windblown dust in the PM_{10} nonattainment area, by land use category.

	Annual emissions (tons/yr)		Average daily emissions (lbs/day)	
Land use category	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Active open space	213.93	32.09	1,169.0	175.4
Agriculture – active	57.82	8.67	315.9	47.4
Agriculture – inactive	296.42	44.46	1,619.8	243.0
Auto test tracks	42.93	6.44	234.6	35.2
Developing	391.00	58.65	2,136.6	320.5
Landfill	6.33	0.95	34.6	5.2
Mining	23.75	3.56	129.8	19.5
Passive open space/wash	1,822.61	273.39	9,959.6	1,493.9
Sand & gravel	107.82	16.17	589.2	88.4
Vacant	1,852.19	277.83	10,121.2	1,518.2
Totals:	**4,814.80**	**722.22**	**26,310.4**	**3,946.6**

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Attachment I

MAG 2009 GIS Existing Land Use Database Information

The following attachment exists in draft form, as the land use database is continually updated to reflect new source data and GIS methodologies. The draft as presented here was created on November 16, 2010.

Database Information

Database Name

EXISTING_LAND_USE_2009

Common Names

Existing Land Use, 2009
EXLU, 2009

Description

The Existing Land Use (EXLU) dataset was created as a joint effort of MAG and MAG member agency staff. This dataset serves as a land use inventory and is used for a variety of planning purposes including socioeconomic forecasting and air quality modeling.

This database has three components:

1. **MAG parcels:** Serves as the primary element of the land use inventory. The parcel base integrates Maricopa County Assessor's office (MCA) parcels, Arizona State Land Department (ASLD) land surface ownership and Bureau of Land Management (BLM) designated wilderness areas. Additional supplementary parcels have been created for areas not covered by the other datasets (e.g. within Tribal Lands) based on air photo interpretation and previous EXLU inventories. MCA parcels within the dataset have been modified in some cases to support data requirements for modeling efforts. In particular, groups of related or associated MCA parcels are often aggregated based on a MCA designated Economic Unit or Assessor Subdivision (MCRNUM). However, the majority of parcels retain the original geometry provided by the MCA. All parcels are assigned a detailed MAG land use code and can be related to original MCA parcels via a lookup table.

2. **Land use overlays:** Overrides the parcel base for cases in which the MCA parcels do not adequately distinguish changes in land use. Examples of this include areas encompassing public facilities and institutions, areas adjacent to water courses and major transportation corridors.

3. **Generalized EXLU:** Provides a *generalized* and *contiguous* representation of the land use inventory. Derived by integrating the MAG parcel based with the land use overlays and applying a series of GIS-based generalization procedures. The finest level of categorical detail provided is the MAG ‘Long Display Code’.

Frequency of Update

Updates are made to this dataset on an annual basis.

Format

ArcSDE geodatabase feature classes

Projection

Coordinate System = State Plane
Zone = 3176 (Arizona Central)
Horizontal Datum = NAD83 HARN
Linear units = international feet

Data Sources

1. Maricopa County Assessor Office Parcels, February 2009
2. Maricopa County Assessor's Office Subdivisions, February 2009
3. Maricopa County Assessor's Office Secured Master File, February 2009
4. Maricopa County Assessor's Office Residential Master File, February 2009
5. Maricopa County Assessor's Office Commercial Master File, February 2009
6. Arizona State Land Department Land surface management
7. Arizona State Land Department Arizona Preserve Initiative lands
8. Arizona State Land Department Wilderness areas
9. Salt River Project canals
10. Central Arizona Project canals
11. MAG aerial imagery, 2009 (procured from Aerials Express)
12. MAG Existing Land Use, 2004
13. MAG Employer Database, 2008
14. MAG Residential Completions
15. Maricopa County Elections Department Streets
16. Kammrath property databases

Reference

MAG Land Use Codes

See Appendix A.

Assessor Property Use Codes

See http://www.maricopa.gov/assessor/gis/pdf/puc.pdf.

Database Standards and Structure

Naming Conventions and Update Schedule

The naming convention for the Existing Land Use feature class is as follows:

EXISTING_LAND_USE_20xx

Where xx represents the two digit year

File Location

The final version of this dataset is in an ArcSDE geodatabase. This includes the following feature classes:

- MAG_PARCELS: the detailed MAG parcel base
- EXLU_POLYGONS: the generalized EXLU
- CANALS_ROW: land use overlay for canals and surrounding areas
- PARCEL_ADJUNCTS: used to split or override parcel geometries
- FREEWAYS_ROW: land use overlay for freeways and surrounding areas
- PARKS: land use overlay for areas of significant active open space areas
- RAIL_ROW: land use overlay for railroads and surrounding areas
- WATER_COURSES: land use overlay for significant water areas such as residential lakes and stream beds

Update Schedule

Updates will be performed on this dataset on an annual basis. New secured data are released by the Assessor's Office in September of each year. Following acquisition of this data from the Assessor's Office, an incremental update to the Existing Land Use dataset will be undertaken.

Versioning

The Existing Land Use dataset is actively maintained on the *giswork* instance of ArcSDE. Editors create child versions of the database from the QA/QC version and perform all edits against the child version. Edits are reconciled and posted to the QA/QC version from the editor's child version. Edits are checked for completeness and correctness, and are then posted to the DEFAULT version on *giswork*.

At the end of each quarter, or on an as needed basis, the Existing Land Use data are replicated to the production database, *gismag*. The replicated feature class on the *gismag*

instance is renamed with the naming convention described below. The fourth quarter iteration represents the final iteration for a calendar year.

Topological Relationships

None

Database Structure

Attributes of the generalized EXLU feature class are:

Field	Description	Format	Instance
OBJECTID	ESRI geodatabase unique identifier	ObjectID	giswork
LONG_DISPLAY_CODE	MAG generalized land use class	Text	giswork
ACRES	Area of the polygon	Double	giswork
MPA	MPA the polygon is within	Text	giswork
Shape	ESRI feature geometry	Geometry	giswork

Dependencies

1. Tabular data maintained in the form of the Parcel Information Table, Residential Information Table, and Non-Residential Information Table. These datasets provides input to the AZSMART model. These tables are a modified version of the Secured Master, Residential Master, and Commercial Master files acquired from the Maricopa County Assessor's Office. Work done to the existing land use dataset that modifies the land use also forces an update of the Parcel Information Table, Residential Information Table, and Non-Residential Information Table.
2. A feature class called MAG Parcels was constructed to serve as the basis for an Existing Land Use feature class. A MAG Parcel Number (MPN) was assigned to each feature in the dataset. In most cases the MPA is identical to the APN. In some cases, however, it was necessary to aggregate parcels together based on a shared Economic Unit (this was the case with large shopping centers and some buildings). The MPN, then, was edited to reflect this change. In these cases, the MPN was changed to reflect the Economic Unit value shared by the original parcels.

Database Creation

Summary

- Data are collected from various sources as outlined in this document.
- Assign a MAG Parcel Number (MPN) to each parcel.
- Merge parcels that fall within a single economic unit, as defined by the Maricopa County Assessor's Office. MPN is updated to reflect value of economic unit.
- Assign a property use code to the MAG Parcels by joining with the Secured Master File.
- Assign MAG land use codes based on a lookup table between property use codes and MAG land use codes.
- Locate parcels with null property uses are located and assigned a property use code and MAG land use code.
- Identify single family residential (SFR) land uses. Determine density of SFR parcels and assign a MAG land use code to these parcels.
- Identify parcels associated with airports, proving grounds, and public facilities and reviewed for assignment of correct MAG land use code.
- Compare MAG Parcels to Kammrath property databases.
- Visually inspect MAG Parcels with the aid of contextual datasets such as MAG aerial imagery, MAG employers database, and MAG residential completions database; recoding erroneous land uses.
- Construct Existing Land Use dataset for review by MAG member agencies.
- Incorporate comments from member agencies to Existing Land Use Parcels
- Construct final Existing Land Use dataset.

Ancillary Tables or Databases

MCA_MAG_LU_LOOKUP – a lookup table between Assessor property use codes and MAG land use codes.

APN_MPN_LOOKUP – a lookup table that maps MPN to APN

MAG_LU_CODES – a lookup table that provides additional information about the MAG land use codes and maps detailed land use codes to simple land use codes

Preliminary Steps

Data was collected from the Maricopa County Assessor's Office and the Arizona State Land Department. These datasets were loaded into the Enterprise geodatabase. A separate database for MAG Parcels was created. The purpose of the MAG parcel database was to aggregate parcels with shared economic units, thus aggregating multiple parcels into logical whole units. A MAG Parcel Number (MPN) was then assigned to each parcel remaining. For the majority of parcels, the MPN is the same as the APN. For parcels that were merged based on similar economic units, a new MPN was created. Following this, each parcel and property use file was checked for records with duplicate MPNs. The resulting MPN is the shared economic unit of the merged parcels or the MCR Number of the subdivision depending on if the percent ownership file is less than 100 in the Commercial Master File. The latter case was used in cases where an economic unit did not exist (i.e. condominiums) or where multiple economic units functioned as a logical whole.

Editing Steps

Initial Feature Class Construction

For each parcel and property use file, a field called FILE was added. This field was used calculate to the source of the parcels (e.g. ME for Mesa). The purpose of this was to provide a lineage back to the source file. Following this, all parcel files were merged into a single feature class, retaining the FILE, MPN, and shape fields. A new column, KEY, was added and calculated to the value of FILE + " " + MPN. The KEY field provides a unique identifier for cases in which MPN values exist in multiple files. Parcel property use tables were also merged into a single file, retaining the MPN and PROPERTY_USE fields. A similar KEY field was added to the property use table.

A PROPERTY_USE field was then added to the parcels feature class. The feature class and the property use table were then joined based on the KEY field and the PROPERTY_USE in the feature class was calculated based on the property use value in the joined table.

PROP_USE_COMMENT, REVIEW_PROP_USE, and MAG_LU fields were added to the feature class. PROP_USE_COMMENT was intended to detail problems or other information about property use codes. REVISE_PROP_USE stored changes made to the PROPERTY_USE field. Finally, MAG_LU stored the subsequent MAG land use code based on the MCA_MAG_LU lookup table.

Next, duplicate MPNs (most likely existing at the edges of merged regions) were dropped from the feature class. For parcels to be dropped, the REVISE_PROP_USE was set to -9999 and annotated using the PROP_USE_COMMENT field.

Addressing Null Property Uses

Next, null property uses were located in the feature class. Null property uses arose from one of two reasons: the parcel/MPN did not have a corresponding record in the property use table or the property use was null in the secured master file acquired from the Assessor's Office. This condition most likely arose due to the parcels and secured files being out of sync with one another, the secured files being more current than the parcels. Null values were reconciled by querying the Assessor's Office website. A script was written to scrape property uses from the Assessor's website. Most of the null values were resolved in this way, while the remainders were fixed manually.

Assigning densities to single family uses

When the 'default' MAG land use classes are assigned based on the MCA property use code, all single family residential (SFR) parcels are assigned a single class (e.g. 100). This class needs to be refined to provide additional detail about the density of the SFR parcel. Multiple definitions and approaches may be used to classify the SFR densities. The approach employed here is based on the assumption that (*a.*) MCA subdivisions provide a logical grouping of parcels within which to assess density since the subdivision boundaries likely reflect the original intents of the development and (*b.*) that SFR parcels falling outside of subdivisions may be grouped according to neighboring SFR parcels that are not separated by other land uses. This entails the following:

1. Assign each parcel to the subdivision it falls within:
    a. Obtain centroids for the parcel
    b. Perform a spatial join in which each parcel centroid is assigned to the subdivision it falls within
    c. Perform an attribute join (based on MPN) between the parcel polygons and their corresponding centroids to assign the subdivision to the parcel polygons. For parcel polygons falling outside of a centroid this value will be NULL

2. For SFR parcels falling outside a MCA subdivision, assign a pseudo subdivision based on a contiguous set of SFR parcels it falls within:
    a. Select a subset of SFR parcel polygons with NULL subdivisions
    b. Dissolve these parcels to obtain contiguous blocks: these blocks are pseudo subdivisions
    c. Assign a unique identity to each pseudo subdivision. The identity is assigned by concatenating the character 'b' with the OBJECTID of the pseudo subdivision
    d. Obtain centroids for the parcels identified in 2a.
    e. Perform a spatial join in which each centroid from 2b is assigned to the pseudo subdivision it falls within
    f. Perform an attribute join between the centroids resulting from 2e with the parcel polygons from 2b. Assign each parcel's subdivision field the values of the pseudo subdivision id of its corresponding centroid.

3. Assign a refined SFR land use based on the total number of units and the total number of SFR acres in its subdivision or pseudo subdivision.
    a. If it does not already exist, add a field called ACRES and use the Calculate Geometry tool to assign area in acres for each parcel
    b. Get a subset of SFR parcels
    c. Dissolve parcels on the subdivision field; retain the sum of ACRES field
    d. Join the parcels from 3b with the dissolved attribute table from 3c
    e. Use the following VBA code block to assign a density based SFR land use class to the parcels:

```
d = sumSubdivision Units/ sumSubdivisionAcres
if d <= 0.2 then
  lu = 110
elseif d > 0.2 and d <= 1 then
  lu = 120
elseif d > 1 and d <= 2 then
  lu = 130
elseif d > 2 and d <= 4 then
  lu = 140
elseif d > 4 and d <= 6 then
  lu = 150
elseif d > 6 then
  lu = 160
end if
```

Initial and Automated Land Use Checks

Areas in and around airports were checked. Parcels comprising the regional airports were flagged and recoded to an airport property use and MAG land use code. In most

cases, the parcel configurations closely resembled the actual airport boundaries were kept as-is. However, overlays needed to be created for Sky Harbor, Buckeye, Gila Bend, and Pleasant Valley airports whose boundaries are distinctly different from the parcel boundaries.

Proving ground areas were also examined in detail. These areas typically consist of very large parcels that end up being coded as "industrial." This tends to skew the acreage of industrial land in the county. These large parcels were sought out and recoded. Several landfills were also captured in this process.

Parcels representing large public facilities, prisons and jails, city halls, community centers, and religious institutions were also checked using aerial imagery, Google Street View, employer points, 2004 existing land use, and the values of neighboring parcels.

Kammrath property databases were also used during this process to check correctness of MAG land use code assignment. Property types addressed by this check were apartment complexes, mobile home and RV parks, and industrial parks in which the classification on warehousing versus light industrial use was not clear.

City by City Review

Having resolved a number of issues out of the gate, the next step was to perform a city by city review of the parcels. This was accomplished by the use of a tracking grid based on the PLSS to avoid duplication of effort. MAG GIS staff reviewed each city individually for assumed correctness of land use coding, to recode land uses or flag for exclusion sliver parcels. Parcels in which the land use was in question were primarily reviewed using aerial imagery, however the MAG employer database and MAG residential completions database were also used to provide supplementary information about the types of activities, and hence potential uses, taking place on individual parcels.

Overlay feature classes were also edited during this time. Since the underlying assumption in this editing process was that parcels could not be modified because they had to be tied back to an original parcel base for change tracking, overlays were used to approximate splits. For example, in many cases near water courses, property lines are not coincident with natural land use breaks. A parcel whose primary land use is agricultural may extend into the river bottom. The portion of the parcel in the river bottom is not agricultural, therefore a polygon is added to an overlay feature class representing that portion of the parcel that is in the river bottom and coded as "passive open space." Layers used for this purpose include cultural features, freeway right-of-ways, railroad right-of-ways, parks, canals, and water courses and lakes.

Rules observed during the city by city review were:

1. As a general rule, parcel geometries were not changed. Significant non-road void areas were filled to account for public lands and State Trust not otherwise present in the Assessor's data.
2. Developing residential parcels should be "parcelized" or broken into groups of parcels that look like a residential development. If this is not the case, these are recoded as vacant.
3. Developing residential and commercial parcels were generally recoded as vacant, unless it was demonstrable through review of aerial photos that the parcel in question was indeed developing.

4. Residential parcels that appeared to be connected with another already developed residential parcel were coded to match their associated parcel and flagged as "AZSMART EXCLUDE." The purpose of including this flag was so as not to change the total number of residential parcels.
5. Very small public facilities were excluded.
6. River bottoms and floodways are coded as Passive Open Space unless some other land use was evident. In most cases, this other land use would be sand and gravel operations.
7. For mobile homes or trailers sitting on large lots, as opposed to within mobile home/RV parks, the parcel was coded to match the adjacent residential parcels.
8. Parking lots and parking structures were coded to match adjacent commercial or office parcels if the parking feature was visibly associated with another parcel.

Some edits were made to the underlying parcels during this review. The Assessor's Parcels cover only those areas not occupied by State Trust or Federal public lands, including National Forests, BLM public lands, and Bureau of Reclamation sites. These were added as features to the Existing Land Use Parcels. These are identifiable by their lack of an MPN and being flagged in the comments field as being BLM, Bureau of Reclamation, Forest Service, Military or State Trust.

Once a MAG staff member had completed a review of a city, the MAG GIS Program Manager reviewed the city a second time to ensure consistency among editors and across cities.

Construction of Existing Land Use Feature Classes for Member Agency Review

Following these initial activities, the generalized existing land use for an individual city was constructed. Land use blocks were first generated using a selected subset of parcels (i.e. those parcels not flagged for exclusion). These were clipped to the MPA boundary of the individual city in question. The resulting clipped blocks were joined with a lookup table to assign generalized long display codes. The blocks were then dissolved on the long display code.

Next, land use blocks were integrated with Assessor Subdivisions. The intent in this operation was to identify subdivisions with homogenous residential land use and to remove most of the neighborhood active open space land use. These land uses were problematic because they tend to form long, continuous landscaping parcels that, in many cases, encircle a subdivision. These also include neighborhood parks of all sizes. Some parks were necessary to maintain because of their size, and the geometry of these were copied into the parks overlay.

The integration proceeded by first dividing the contiguous land use blocks into two sets: those contained within subdivisions and those falling outside of subdivisions. This was achieved by performing a union between the subdivisions and the land use blocks and then selected out the results based on the combinations of resulting values (more specifically, the FID values). Next, areas *within* subdivisions were further divided into areas within homogenous subdivisions and those falling within heterogeneous subdivisions. This classification was obtained by grouping the areas by subdivision (via the 'Summarize' tool in ArcGIS) and identifying those subdivisions that had a single long display code value. A minimum area threshold was also specified to eliminate slivers that are artifacts of the union process. Areas within homogenous subdivisions were replaced with a subdivision boundary. Areas within heterogeneous subdivisions were then independently fed into a cost allocation algorithm that assigned that land use at a given location based on the land use it was closest to (here distance was based on

impedance rather than Euclidean distance). Following this, the land use outside of subdivisions, the homogenous subdivision boundaries and the results of the cost allocation algorithms were merged into a single dataset. The resulting dataset was then fed into another cost allocation to fill in the voids for areas falling outside of subdivisions.

The final step in this process was to integrate overlays via successive erases and merges. This began by integrating all the overlays into a single feature class. The overlays were integrated in the following order:

1. Open space
2. Parks
3. Water courses
4. Canal rows
5. Railroad rows
6. Freeways
7. Cultural adjuncts

Finally, the resulting integrated overlay feature class was combined with results of the final cost allocation. This was achieved by erasing the overlay areas from the allocated feature class and then merging the results of the erase with the integrated overlay class.

Database Update

Ancillary Tables or Databases

Parcels and secured master files from the previous year are used as a point of comparison with new data collected from the Assessor's Office.

MCA_MAG_LU_LOOKUP – a lookup table between Assessor property use codes and MAG land use codes

APN_MPN_LOOKUP – a lookup table that maps MPN to APN

MAG_LU_CODES – a lookup table that provides additional information about the MAG land use codes and maps detailed land use codes to simple land use codes

Preliminary Steps

Data is collected from the Maricopa County Assessor's Office and the Arizona State Land Department. These datasets are loaded into the Enterprise geodatabase.

Preparatory Steps

A determination of the extent of changes between data vintages is made. For the Land Department data, the changes will tend to be small. The likely impact of these changes will be removal of State Trust land into private ownership or to another government entity, the end result of either case being that Assessor parcels will be created from the transfer of ownership. For the Assessor data, the change will be more substantial and will include:

1. Parcels that have been retired through splits or merges
2. Parcels that have been added due to splits from a parent parcel or transfer from State or Federal ownership

3. Parcels that have new property uses assigned to them

These changes may be identified by comparing the APNs and property use codes among the parcels in the current year with those in the previous year. This can be handled via SQL queries:

Births

```
select * from dataloader.PARCELS_2010
where APN not in (
   select APN from dataloader.PARCELS_2009
)
```

Retirements/deaths

```
select * from dataloader.PARCELS_2009
where APN not in (
   Select APN from dataloader.PARCELS_2010
)
```

Transitions/changes

```
select a.APN, a.MAG_LU as MAG_LU_2010, b.MAG_LU as MAG_LU_2009
from (
   select a.APN, b.PropertyUseCode, c.MAG_Lucode as MAG_LU
   from dataloader.PARCELS_2010 a
   inner join dataloader.SECURED_MASTER_2010 b
   on a.APN = b.APN
   inner join GISWORK.dataloader.MCA_MAG_LU_LOOKUP c
   on b.PropertyUseCode = c.Property_Use_code
) a
inner join(
   select a.APN, b.PropertyUseCode, c.MAG_Lucode as MAG_LU
   from dataloader.PARCELS_2009 a
   inner join dataloader.SECURED_MASTER_2009 b
   on a.APN = b.APN
   inner join GISWORK.dataloader.MCA_MAG_LU_LOOKUP c
   on b.PropertyUseCode = c.Property_Use_code
) b
on a.APN = b.APN
where a.MAG_LU <> b.MAG_LU
```

MAG Parcels Update Process

1. For all parcels that have not changed, (i.e. they have the same property use code and their APN exists in both years) assign the MAG_LU based on the previous year

2. For parcels that have changed (i.e. their property use codes have changed) assign MAG_LU based on the default value provided in the MCA_MAG_LU_LOOKUP.

3. Re-build MAG Parcels for the parcels that have not changed. Note: this step is only necessary if the parcel geometries have shifted, otherwise the MAG Parcels from the

previous year can be used.

4. For all deaths/retiree parcels identify any MAG Parcels that will also need to be retired. It may also be necessary to identify related parcels that may or may not also be retired (e.g. a single parcel is retired but other parcels in the Economic Unit or subdivision remain unchanged).

5. Identify parcel births that will need to be aggregated to create new Existing Land Use Parcels:

```
select a.APN, count(*) as NUM_IMPROVEMENTS from (
   select APN
   from dataloader.PARCELS_2010
   where APN not in (
      select APN from dataloader.PARCELS_2009
   )
) a
inner join dataloader.COMMERCIAL_MASTER_2010 b
on a.APN = b.APN
where LTRIM(RTRIM(b.PercentOfOwnership)) <> '100'
group by a.APN
order by count(*) desc
```

6. Re-assign single family residential densities for parcel births and surrounding areas.

Generalized Existing Land Use Update Process

Determine if the parcels have shifted across years. If the parcels have shifted, re-build the generalized land use for the entire dataset per the process discussed for the initial construction. If the parcels have not shifted, identify regions surrounding births and transitions. These neighborhoods may simply involve generating minimum bounding rectangles (MBRs) or may be more complicated using something like a Voronoi diagram. Finally, re-build the generalized EXLU for each of the identified change regions.

Reporting

Report the number of changes that will be made to the database. This might include: the number of parcel births, deaths and transitions. Also, report the number of MAG Parcels that will consequently be retired or updated. It may also be worthwhile to report the types of transitions that are occurring, as well as the dominant land uses of the births and deaths.

For example, to report the types of land use transitions occurring:

```
select cast(b.MAG_LU as int) as MAG_LU_2009, cast(a.MAG_LU as
int) as MAG_LU_2010, count(*) as Parcel_Count from (
   select a.APN, b.PropertyUseCode, c.MAG_Lucode as MAG_LU from
   dataloader.PARCELS_2010 a inner join
   dataloader.SECURED_MASTER_2010 b
```

```
   on a.APN = b.APN
   inner join GISWORK.dataloader.MCA_MAG_LU_LOOKUP c
   on b.PropertyUseCode = c.Property_Use_code
) a
inner join (
   select a.APN, b.PropertyUseCode, c.MAG_Lucode as MAG_LU from
   dataloader.PARCELS_2009 a inner join
   dataloader.SECURED_MASTER_2009 b
   on a.APN = b.APN
   inner join GISWORK.dataloader.MCA_MAG_LU_LOOKUP c
   on b.PropertyUseCode = c.Property_Use_code
) b
on a.APN = b.APN
where a.MAG_LU <> b.MAG_LU
group by a.MAG_LU, b.MAG_LU
order by count(*) desc, a.MAG_LU asc, b.MAG_LU asc
```

This will return the following:

2009 land use	2010 land use	Parcel count
910	100	6902
750	910	2567
910	710	1397
910	750	1310
900	910	1194
910	170	980
910	900	523
100	170	468
900	750	404
100	910	376
...	...	...

Review Process

Internal Review

Preliminary Steps

Perform the steps in the previous section. The resulting data should be in a versioned SDE database.

Review Steps

1. Perform QA/QC on births with “problematic” property use codes. For example most single family parcels will be fine, but parcels with a Property Use Code of 9000 will require additional review.

2. Examine problematic land use transitions. For example a transition from 910 (developing residential) to 100 (single family residential) is a reasonable transition. However, a transition, such as from 110 to 552 (public services), likely represents a problem in one of the base datasets and bears further investigation.

3. Generate acreages for all medium-level land use classes and compared against the previous existing land use acreages to determine if an error has occurred. The changes

between vintages should not be significant. Substantial changes in one land use class between vintages will be indicative of a problem in one of the underlying datasets, and will force a review of that land use class in the new data.

4. Perform point-in-polygon analysis between geocoded Kammrath data or other similar dataset and the MAG parcels. Check for parcels that contain points with incompatible uses (e.g. industrial point falling on a retail parcel) and make appropriate corrections as warranted with a secondary examination of aerial imagery for the area of interest.

Reporting

Report changes in acreages across the two years for the detailed MAG land use codes. Generate 'change maps' to highlight spatial trends in the land use transitions. Generate a semi-detailed report and dataset for the Air Quality division and Maricopa County using a course land use classification. The semi-detailed dataset contains parcel boundaries dissolved using the course classification and has overlays integrated but remaining voids are left alone and treated as 'Transportation' uses.

Member Agency Review

Preliminary Steps

The existing land use dataset is sent to members of the MAG POPTAC and GIS professionals who have been identified as key GIS contacts within the member agencies. A tracking database that includes a list of recipients and status of review material delivery and responses should be completed prior to sending any data out for review. It is also preferable to let members of the POPTAC know to expect the review materials within a certain period of time. This is best accomplished at a monthly MAG POPTAC meeting.

Review Steps

Notify members of the POPTAC that the existing land use dataset will be provided to them immediately. Members of the POPTAC will receive the low-detail dataset as a file geodatabase of their or as a paper map of their MPA, a summary table of existing land use classifications within their MPA at the low-detail level, and a lookup table of APN to MAG land use codes at the high-detail level. Data and maps will be mailed to members of the POPTAC. Members of the POPTAC will be instructed that they should provide feedback to MAG within six weeks. Feedback may be provided by individuals receiving paper maps may mark up the maps with any corrections or by individuals receiving geospatial data may provide a polygon feature class of recommended changes.

Comments received from member agencies shall be incorporated into the Existing Land Use as quickly as possible.

Reporting

Notify Members of the POPTAC that a final version of existing land use exists and that they will be provided with the dataset upon request.

Final Output

Metadata Update

Export the metadata from the current version of the Existing Land Use feature class to a local directory. This can then be imported to serve as the new feature class's metadata. Metadata fields that will then need to be updated are the citation name, publication date, and last update fields. Any additional changes to the feature class should be noted in the metadata at this time.

Export for Distribution

Export the current year's Existing Land Use feature classes from the *data* instance to I:\data\distribution\exlu. The frequency of export from ArcSDE is dependent on the frequency of replication from the *work* instance to the *data* instance.

Reporting

Report changes in acreages across the two years for the detailed MAG land use codes. Generate 'change maps' to highlight spatial trends in the land use transitions. It may also be worthwhile to generate ArcGIS server sites to deliver results and support land use queries.

Appendix A

MAG Land Use Codes

LUCODE	Land Use - Detailed	Land Use Description
110	Rural Residential	<= 1/5 du per acre (SF)
120	Estate Residential	1/5 du per acre to 1 du per acre (SF)
130	Large Lot Residential (SF)	1 du per acre to 2 du per acre (SF)
140	Medium Lot Residential (SF)	2-4 du per acre (SF)
150	Small Lot Residential (SF)	4-6 du per acre (SF)
160	Very Small Lot Residential (SF)	>6 du per acre (SF)
161	Very Small Lot Residential (SF-Mobile Homes)	Mobile home parks/RV Parks (>6 du per acre)
170	Medium Density Residential (MF)	5-10 du per acre (MF)
180	High Density Residential (MF)	10-15 du per acre (MF)
190	Very High Density Residential (MF)	15-50 DU/AC Residential (MF)
191	High Rise Residential	>50 DU/AC (MF)
210	Low Density Commercial	Movie Theatres, Skating Rinks, Amusement Facilities
220	Greenhouse Commercial	Nurseries, Greenhouses
230	Specialty Commercial	<=50,000 square feet
240	Neighborhood Commercial	50,000 to 100,000 square feet
250	Community Commercial	100,000 to 500,000 square feet
260	Regional Commercial	500,000 to 1,000,000 square feet
270	Super-Regional Commercial	>= 1,000,000 square feet
310	Storage Facilities	Storage Facilities
320	Warehouse	Warehouse/Distribution Centers
330	Light Industrial	Laboratory/Back Office
340	Heavy Industrial	Manufacturing
410	Office Low Rise	1-4 stories
420	Office Mid Rise	5-12 stories
430	Office High Rise	13 stories or more

510	Motels/Hotels	Motels/Hotels
511	Resorts	Resorts
520	Educational	Educational institutions where no detail available
521	Preschool/Daycare facilities	Preschool/Daycare facilities
522	Schools (K-12 grade)	Schools
523	Post High School Institutions	Including public and private colleges and technical training institutions
524	Arizona State University	ASU Main and Extended Campuses
525	Dormitories	Dormitories associated with educational institutions
530	Institutional	Institutions where no details are available
531	Religious Institutions	Churches/Religious Institutions
532	Medical Offices	Medical Offices
533	Hospitals/Medical Centers	Hospitals/Medical Centers
534	Nursing Homes/Assited Care Facilities	Nursing Homes/Assited Care Facilites (Group Quarter)
540	Cemeteries	Cemeteries, Mausoleums, Crematoriums
551	Public Offices	Includes city halls
552	Public Services	Includes community centers, libraries, police and fire stations, courts and other government services
553	Large Public Facilities	Includes power sub-stations, Work yards, Sewer and Water treatment plants
554	Military	Military Use
555	Prisons	Prisons and jails
560	Special Events	Includes stadiums, sports complexes, and fairgrounds
571	Landfill	Landfill
572	Sand and Gravel	Sand and Gravel
573	Automotive Proving Grounds	Automotive Proving Grounds
574	Mining	Mining

575	Solar Generating Stations	Solar generation stations not associated with other power facilities
610	Transportation	Freeways/Expressways/ Highways/ Major Roads/ Arterials/ ROWs where no detail available
611	Parking Lots	Parking Lots
612	Parking Structures	Parking Structures
613	Park and Ride lots	Park and Ride lots
614	Transit Center	Transit Center
615	Freeways/Expressways/ Highways	Freeways/Expressways/ Highways
616	Major Roads, Arterials	Major Roads, Arterials
617	Neighborhood roads	Neighborhood roads
618	Railroads	Railroads
620	Airports	Public use airports
621	Sky Harbor Airport	Sky Harbor Airport
622	Private airport	Private use airports
710	City/Regional Active Open Space	Includes city/regional parks, playgrounds/fields
711	Local/Neighborhood Active Open Space	Includes Local/Neighborhood common areas, parks, playgrounds
720	Golf courses	Golf Courses
730	Passive Open Space	Includes mountain preserves and washes
731	Restricted Open Space	Restricted Open Space (Including Firing Range)
732	Limited Use Public Facilities	Very small difficult to access parcels
733	Floodplain	Floodplain
740	Water	Reservoirs/Rivers/Lakes
741	Canal	Canal
742	Intermittant Water	Intermittant Water
743	Residential Lake	Residential Lake
750	Agriculture	General Agriculture
810	Business Park	Includes enclosed industrial, office or retail in a planned environment
820	Mixed Use	Jurisdiction defined
821	Mixed Use/Indian Community	Mixed Use/Indian Community
830	Planned Community	Planned Community

900	Vacant (existing land use database only)	Vacant
910	Developing Residential	Residential Under Construction
920	Developing Commercial	Commercial Under Construction
930	Developing Industrial	Industrial Under Construction
940	Developing Office	Office Under Construction
950	Developing Public/Other Employment	Employment Under Construction
960	Developing Transportation	Transportation Under Construction
970	Developing Open Space	Developing Open Space
980	Developing Multiple Use	Multiple Use Under Construction
999	Unknown	Unknown

Appendix 5. MOVES2010a Local Input Data and RunSpecs

In order to calculate the 2008 annual and average day onroad source emissions, MOVES2010a was executed using local input data for each month of the year and each geographical area (Maricopa County and the PM_{10} NAA).

A portion of the MOVES2010a RunSpec Summary, RunSpec, and local input data for Maricopa County are provided in this appendix as an example.

MOVES2010a RunSpec Summary (Maricopa County, July 2008)

Output Database Server Name: [using default]

Output Database Name: 2008_pm10_pei_mc_07_out
Time Spans:
Aggregate By: Hour
Years:
2008

Months:
July
Days:
Weekend
Weekdays
Hours:
Begin Hour: 00:00 - 00:59
End Hour: 23:00 - 23:59

Geographic Bounds:
COUNTY geography
Selection: ARIZONA - Maricopa County

On Road Vehicle Equipment:
Diesel Fuel - Combination Long-haul Truck
Diesel Fuel - Combination Short-haul Truck
Diesel Fuel - Intercity Bus
Diesel Fuel - Light Commercial Truck
Diesel Fuel - Motor Home
Diesel Fuel - Motorcycle
Diesel Fuel - Passenger Car
Diesel Fuel - Passenger Truck
Diesel Fuel - Refuse Truck
Diesel Fuel - School Bus
Diesel Fuel - Single Unit Long-haul Truck
Diesel Fuel - Single Unit Short-haul Truck
Diesel Fuel - Transit Bus
Gasoline - Combination Long-haul Truck
Gasoline - Combination Short-haul Truck
Gasoline - Intercity Bus
Gasoline - Light Commercial Truck
Gasoline - Motor Home
Gasoline - Motorcycle
Gasoline - Passenger Car
Gasoline - Passenger Truck
Gasoline - Refuse Truck
Gasoline - School Bus
Gasoline - Single Unit Long-haul Truck
Gasoline - Single Unit Short-haul Truck
Gasoline - Transit Bus

Road Types:
Off-Network
Rural Restricted Access
Rural Unrestricted Access
Urban Restricted Access
Urban Unrestricted Access

Pollutants And Processes:
Running Exhaust Ammonia (NH3)
Start Exhaust Ammonia (NH3)
Crankcase Running Exhaust Ammonia (NH3)
Crankcase Start Exhaust Ammonia (NH3)
Crankcase Extended Idle Exhaust Ammonia (NH3)
Extended Idle Exhaust Ammonia (NH3)
Running Exhaust Oxides of Nitrogen (NOx)
Start Exhaust Oxides of Nitrogen (NOx)
Crankcase Running Exhaust Oxides of Nitrogen (NOx)
Crankcase Start Exhaust Oxides of Nitrogen (NOx)
Crankcase Extended Idle Exhaust Oxides of Nitrogen (NOx)
Extended Idle Exhaust Oxides of Nitrogen (NOx)
Running Exhaust Primary Exhaust PM10 - Total
Start Exhaust Primary Exhaust PM10 - Total
Crankcase Running Exhaust Primary Exhaust PM10 - Total
Crankcase Start Exhaust Primary Exhaust PM10 - Total
Crankcase Extended Idle Exhaust Primary Exhaust PM10 - Total
Extended Idle Exhaust Primary Exhaust PM10 - Total
Running Exhaust Primary Exhaust PM2.5 - Total
Start Exhaust Primary Exhaust PM2.5 - Total
Crankcase Running Exhaust Primary Exhaust PM2.5 - Total
Crankcase Start Exhaust Primary Exhaust PM2.5 - Total
Crankcase Extended Idle Exhaust Primary Exhaust PM2.5 - Total
Extended Idle Exhaust Primary Exhaust PM2.5 - Total
Brakewear Primary PM10 - Brakewear Particulate
Running Exhaust Primary PM10 - Elemental Carbon
Start Exhaust Primary PM10 - Elemental Carbon
Crankcase Running Exhaust Primary PM10 - Elemental Carbon
Crankcase Start Exhaust Primary PM10 - Elemental Carbon
Crankcase Extended Idle Exhaust Primary PM10 - Elemental Carbon
Extended Idle Exhaust Primary PM10 - Elemental Carbon
Running Exhaust Primary PM10 - Organic Carbon
Start Exhaust Primary PM10 - Organic Carbon
Crankcase Running Exhaust Primary PM10 - Organic Carbon
Crankcase Start Exhaust Primary PM10 - Organic Carbon
Crankcase Extended Idle Exhaust Primary PM10 - Organic Carbon
Extended Idle Exhaust Primary PM10 - Organic Carbon
Running Exhaust Primary PM10 - Sulfate Particulate
Start Exhaust Primary PM10 - Sulfate Particulate
Crankcase Running Exhaust Primary PM10 - Sulfate Particulate
Crankcase Start Exhaust Primary PM10 - Sulfate Particulate
Crankcase Extended Idle Exhaust Primary PM10 - Sulfate
Particulate
Extended Idle Exhaust Primary PM10 - Sulfate Particulate
Tirewear Primary PM10 - Tirewear Particulate
Brakewear Primary PM2.5 - Brakewear Particulate
Running Exhaust Primary PM2.5 - Elemental Carbon
Start Exhaust Primary PM2.5 - Elemental Carbon
Crankcase Running Exhaust Primary PM2.5 - Elemental Carbon
Crankcase Start Exhaust Primary PM2.5 - Elemental Carbon
Crankcase Extended Idle Exhaust Primary PM2.5 - Elemental
Carbon
Extended Idle Exhaust Primary PM2.5 - Elemental Carbon
Running Exhaust Primary PM2.5 - Organic Carbon
Start Exhaust Primary PM2.5 - Organic Carbon
Crankcase Running Exhaust Primary PM2.5 - Organic Carbon
Crankcase Start Exhaust Primary PM2.5 - Organic Carbon
Crankcase Extended Idle Exhaust Primary PM2.5 - Organic Carbon
Extended Idle Exhaust Primary PM2.5 - Organic Carbon
Running Exhaust Primary PM2.5 - Sulfate Particulate
Start Exhaust Primary PM2.5 - Sulfate Particulate
Crankcase Running Exhaust Primary PM2.5 - Sulfate Particulate
Crankcase Start Exhaust Primary PM2.5 - Sulfate Particulate
Crankcase Extended Idle Exhaust Primary PM2.5 - Sulfate
Particulate
Extended Idle Exhaust Primary PM2.5 - Sulfate Particulate
Tirewear Primary PM2.5 - Tirewear Particulate
Running Exhaust Sulfur Dioxide (SO2)
Start Exhaust Sulfur Dioxide (SO2)
Crankcase Running Exhaust Sulfur Dioxide (SO2)
Crankcase Start Exhaust Sulfur Dioxide (SO2)
Crankcase Extended Idle Exhaust Sulfur Dioxide (SO2)
Extended Idle Exhaust Sulfur Dioxide (SO2)
Running Exhaust Total Energy Consumption
Start Exhaust Total Energy Consumption
Extended Idle Exhaust Total Energy Consumption

Rate of Progress:
Rate of Progress calculations are disabled

Manage Input Data Sets:
selection: / stageii_input /

MOVES2010a RunSpec (Maricopa County, July 2008)


```
<runspec>
        <description><![CDATA[Updated 2008 PEI
- Maricopa County
- inventory mode
- both weekdays and weekend days
- output by SCC
- July 2008]]></description>
        <modelscale value="Inv"/>
        <modeldomain value="SINGLE"/>
        <geographicselections>
                <geographicselection type="COUNTY" key="4013" description="ARIZONA - Maricopa County"/>
        </geographicselections>
        <timespan>
                <year key="2008"/>
                <month id="7"/>
                <day id="2"/>
                <day id="5"/>
                <beginhour id="1"/>
                <endhour id="24"/>
                <aggregateBy key="Hour"/>
        </timespan>
        <onroadvehicleselections>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="62" sourcetypename="Combination
                    Long-haul Truck"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="61" sourcetypename="Combination
                    Short-haul Truck"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="41" sourcetypename="Intercity
                    Bus"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="32" sourcetypename="Light
                    Commercial Truck"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="54" sourcetypename="Motor Home"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="11"
                    sourcetypename="Motorcycle"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="21" sourcetypename="Passenger
                    Car"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="31" sourcetypename="Passenger
                    Truck"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="51" sourcetypename="Refuse
                    Truck"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="43" sourcetypename="School Bus"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="53" sourcetypename="Single Unit
                    Long-haul Truck"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="52" sourcetypename="Single Unit
                    Short-haul Truck"/>
                <onroadvehicleselection fueltypeid="2" fueltypedesc="Diesel Fuel" sourcetypeid="42" sourcetypename="Transit
                    Bus"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="62" sourcetypename="Combination
                    Long-haul Truck"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="61" sourcetypename="Combination
                    Short-haul Truck"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="41" sourcetypename="Intercity
                    Bus"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="32" sourcetypename="Light
                    Commercial Truck"/>
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                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="11" sourcetypename="Motorcycle"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="21" sourcetypename="Passenger
                    Car"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="31" sourcetypename="Passenger
                    Truck"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="51" sourcetypename="Refuse Truck"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="43" sourcetypename="School Bus"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="53" sourcetypename="Single Unit
                    Long-haul Truck"/>
                <onroadvehicleselection fueltypeid="1" fueltypedesc="Gasoline" sourcetypeid="52" sourcetypename="Single Unit
                    Short-haul Truck"/>
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                <roadtype roadtypeid="4" roadtypename="Urban Restricted Access"/>
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                    Exhaust"/>
                <pollutantprocessassociation pollutantkey="30" pollutantname="Ammonia (NH3)" processkey="2" processname="Start
                    Exhaust"/>
                <pollutantprocessassociation pollutantkey="30" pollutantname="Ammonia (NH3)" processkey="15"
                    processname="Crankcase Running Exhaust"/>
                <pollutantprocessassociation pollutantkey="30" pollutantname="Ammonia (NH3)" processkey="16"
                    processname="Crankcase Start Exhaust"/>
                <pollutantprocessassociation pollutantkey="30" pollutantname="Ammonia (NH3)" processkey="17"
                    processname="Crankcase Extended Idle Exhaust"/>
                <pollutantprocessassociation pollutantkey="30" pollutantname="Ammonia (NH3)" processkey="90"
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```
    processname="Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="1"
    processname="Running Exhaust"/>
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    processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="15"
    processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="16"
    processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="17"
    processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="3" pollutantname="Oxides of Nitrogen (NOx)" processkey="90"
    processname="Extended Idle Exhaust"/>
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    processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10  - Total" processkey="2"
    processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10  - Total" processkey="15"
    processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10  - Total" processkey="16"
    processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="100" pollutantname="Primary Exhaust PM10  - Total" processkey="17"
    processname="Crankcase Extended Idle Exhaust"/>
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    processname="Extended Idle Exhaust"/>
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    processname="Start Exhaust"/>
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    processname="Crankcase Running Exhaust"/>
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    processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="110" pollutantname="Primary Exhaust PM2.5 - Total" processkey="17"
    processname="Crankcase Extended Idle Exhaust"/>
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<pollutantprocessassociation pollutantkey="102" pollutantname="Primary PM10 - Elemental Carbon" processkey="1"
    processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="102" pollutantname="Primary PM10 - Elemental Carbon" processkey="2"
    processname="Start Exhaust"/>
<pollutantprocessassociation pollutantkey="102" pollutantname="Primary PM10 - Elemental Carbon" processkey="15"
    processname="Crankcase Running Exhaust"/>
<pollutantprocessassociation pollutantkey="102" pollutantname="Primary PM10 - Elemental Carbon" processkey="16"
    processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="102" pollutantname="Primary PM10 - Elemental Carbon" processkey="17"
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    processname="Running Exhaust"/>
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<pollutantprocessassociation pollutantkey="101" pollutantname="Primary PM10 - Organic Carbon" processkey="16"
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<pollutantprocessassociation pollutantkey="101" pollutantname="Primary PM10 - Organic Carbon" processkey="17"
    processname="Crankcase Extended Idle Exhaust"/>
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    processname="Extended Idle Exhaust"/>
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    processname="Running Exhaust"/>
<pollutantprocessassociation pollutantkey="105" pollutantname="Primary PM10 - Sulfate Particulate" processkey="2"
    processname="Start Exhaust"/>
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    processname="Crankcase Running Exhaust"/>
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    processkey="10" processname="Tirewear"/>
<pollutantprocessassociation pollutantkey="116" pollutantname="Primary PM2.5 - Brakewear Particulate"
    processkey="9" processname="Brakewear"/>
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    processname="Start Exhaust"/>
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    processname="Crankcase Running Exhaust"/>
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    processname="Crankcase Start Exhaust"/>
<pollutantprocessassociation pollutantkey="112" pollutantname="Primary PM2.5 - Elemental Carbon" processkey="17"
    processname="Crankcase Extended Idle Exhaust"/>
<pollutantprocessassociation pollutantkey="112" pollutantname="Primary PM2.5 - Elemental Carbon" processkey="90"
    processname="Extended Idle Exhaust"/>
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    processname="Running Exhaust"/>
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    processname="Start Exhaust"/>
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                        processname="Crankcase Start Exhaust"/>
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                        processname="Crankcase Extended Idle Exhaust"/>
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                        processname="Extended Idle Exhaust"/>
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                        processname="Running Exhaust"/>
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                        processname="Start Exhaust"/>
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                        processkey="15" processname="Crankcase Running Exhaust"/>
                    <pollutantprocessassociation pollutantkey="115" pollutantname="Primary PM2.5 - Sulfate Particulate"
                        processkey="16" processname="Crankcase Start Exhaust"/>
                    <pollutantprocessassociation pollutantkey="115" pollutantname="Primary PM2.5 - Sulfate Particulate"
                        processkey="17" processname="Crankcase Extended Idle Exhaust"/>
                    <pollutantprocessassociation pollutantkey="115" pollutantname="Primary PM2.5 - Sulfate Particulate"
                        processkey="90" processname="Extended Idle Exhaust"/>
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                        processname="Running Exhaust"/>
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                        processname="Start Exhaust"/>
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                        processname="Crankcase Running Exhaust"/>
                    <pollutantprocessassociation pollutantkey="31" pollutantname="Sulfur Dioxide (SO2)" processkey="16"
                        processname="Crankcase Start Exhaust"/>
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                        processname="Extended Idle Exhaust"/>
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                    <pollutantprocessassociation pollutantkey="91" pollutantname="Total Energy Consumption" processkey="2"
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          </databaseselections>
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classname="gov.epa.otaq.moves.master.implementation.ghg.internalcontrolstrategies.rateofprogress.RateOfProgressStrategy"><![CDATA
[
useParameters       No
]]></internalcontrolstrategy>
          </internalcontrolstrategies>
          <inputdatabase servername="" databasename="" description=""/>
          <uncertaintyparameters uncertaintymodeenabled="false" numberofrunspersimulation="0" numberofsimulations="0"/>
          <geographicoutputdetail description="COUNTY"/>
          <outputemissionsbreakdownselection>
                    <modelyear selected="false"/>
                    <fueltype selected="true"/>
                    <emissionprocess selected="false"/>
                    <onroadoffroad selected="true"/>
                    <roadtype selected="false"/>
                    <sourceusetype selected="false"/>
                    <movesvehicletype selected="false"/>
                    <onroadscc selected="true"/>
                    <offroadscc selected="false"/>
                    <estimateuncertainty selected="false" numberOfIterations="2" keepSampledData="false" keepIterations="false"/>
                    <sector selected="false"/>
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                    <hpclass selected="false"/>
          </outputemissionsbreakdownselection>
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          <outputvmtdata value="true"/>
          <outputsho value="false"/>
          <outputsh value="false"/>
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          <outputshidling value="false"/>
          <outputstarts value="false"/>
          <outputpopulation value="true"/>
          <scaleinputdatabase servername="localhost" databasename="2008_pm10_pei_mc_in" description=""/>
          <pmsize value="0"/>
          <outputfactors>
                    <timefactors selected="true" units="Hours"/>
                    <distancefactors selected="true" units="Miles"/>
                    <massfactors selected="true" units="Grams" energyunits="Joules"/>
          </outputfactors>
          <savedata>
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          <donotexecute>
          </donotexecute>

          <generatordatabase shouldsave="false" servername="" databasename="" description=""/>
                    <donotperformfinalaggregation selected="false"/>
          <lookuptableflags scenarioid="" truncateoutput="true" truncateactivity="true"/>
</runspec>
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MOVES2010a Local Input Data (Maricopa County, July 2008)

[FuelFormulation]

Fuel Formulation	Fuel Subtype	RVP	Sulfur Level	ETOH Volume	MTBE Volume	ETBE Volume	TAME Volume	Aromatic Content	Olefin Content	Benzene Content	e200	e300	volToWt PercentOxy	BioDiesel Ester	Cetane Index	PAH Content
10801	12	8.76	35.00	9.5	0	0	0	14.4	4.9	1.0	53.0	91.0	3.4933	0	0	0
10802	12	8.42	23.14	9.2	0	0	0	12.8	3.9	0.9	50.3	91.1	3.4229	0	0	0
10803	12	8.40	49.00	9.2	0	0	0	12.0	4.0	0.8	50.3	92.0	3.4075	0	0	0
10804	14	7.77	23.00	5.6	0	0	0	17.7	6.0	1.0	45.5	88.5	2.0567	0	0	0
10805	14	6.95	26.04	1.3	0	0	0	16.8	7.6	0.8	40.2	88.4	0.5086	0	0	0
10806	11	6.64	25.20	0.0	0	0	0	16.3	7.0	0.7	38.4	86.4	0.0000	0	0	0
10807	14	7.07	18.83	0.7	0	0	0	16.6	7.3	0.8	37.9	89.0	0.3367	0	0	0
10808	14	6.81	28.59	0.4	0	0	0	15.0	7.4	0.8	38.9	89.2	0.1495	0	0	0
10809	11	6.48	34.56	0.0	0	0	0	18.2	10.1	0.9	40.3	88.8	0.0000	0	0	0
10810	13	7.91	24.95	6.8	0	0	0	17.1	8.0	0.9	46.5	89.5	2.5173	0	0	0
10811	12	8.41	15.17	9.5	0	0	0	16.1	5.9	1.1	53.3	90.9	3.5425	0	0	0
10812	13	8.38	29.45	8.8	0	0	0	14.5	5.3	0.9	50.7	90.9	3.2767	0	0	0
30801	20	0	6.18	0	0	0	0	0	0	0	0	0	0	0	0	0
30802	20	0	6.27	0	0	0	0	0	0	0	0	0	0	0	0	0
30803	20	0	6.65	0	0	0	0	0	0	0	0	0	0	0	0	0
30804	20	0	6.60	0	0	0	0	0	0	0	0	0	0	0	0	0
30805	20	0	5.78	0	0	0	0	0	0	0	0	0	0	0	0	0
30806	20	0	5.60	0	0	0	0	0	0	0	0	0	0	0	0	0
30807	20	0	4.20	0	0	0	0	0	0	0	0	0	0	0	0	0
30808	20	0	6.25	0	0	0	0	0	0	0	0	0	0	0	0	0
30809	20	0	6.25	0	0	0	0	0	0	0	0	0	0	0	0	0
30810	20	0	6.49	0	0	0	0	0	0	0	0	0	0	0	0	0
30811	20	0	6.49	0	0	0	0	0	0	0	0	0	0	0	0	0
30812	20	0	6.85	0	0	0	0	0	0	0	0	0	0	0	0	0

[FuelSupply]

countyID	fuelYearID	monthGroupID	fuelFormulationID	marketShare	marketShareCV
4013	2008	1	10801	1	0.5
4013	2008	1	30801	1	0.5
4013	2008	2	10802	1	0.5
4013	2008	2	30802	1	0.5
4013	2008	3	10803	1	0.5
4013	2008	3	30803	1	0.5
4013	2008	4	10804	1	0.5
4013	2008	4	30804	1	0.5
4013	2008	5	10805	1	0.5
4013	2008	5	30805	1	0.5
4013	2008	6	10806	1	0.5
4013	2008	6	30806	1	0.5
4013	2008	7	10807	1	0.5
4013	2008	7	30807	1	0.5
4013	2008	8	10808	1	0.5
4013	2008	8	30808	1	0.5
4013	2008	9	10809	1	0.5
4013	2008	9	30809	1	0.5
4013	2008	10	10810	1	0.5
4013	2008	10	30810	1	0.5
4013	2008	11	10811	1	0.5
4013	2008	11	30811	1	0.5
4013	2008	12	10812	1	0.5
4013	2008	12	30812	1	0.5

[HPMSvTypeYear]

HPMSVtypeID	yearID	VMTGrowthFactor	HPMSBaseYearVMT	baseYearOffNetVMT
10	2008	0	645,186,775	0
20	2008	0	10,853,816,218	0
30	2008	0	18,712,863,968	0
40	2008	0	120,356,976	0
50	2008	0	1,301,102,686	0
60	2008	0	1,675,478,378	0

[SourceTypeYear]

yearID	sourceTypeID	sourceTypePopulation
2008	11	72,411
2008	21	2,056,832
2008	31	474,713
2008	32	183,510
2008	41	1,109
2008	42	680
2008	43	7,115
2008	51	832
2008	52	27,284
2008	53	1,756
2008	54	3,599
2008	61	13,958
2008	62	11,504

[ZoneMonthHour]

monthID	zoneID	HourID	temperature	relHumidity
7	40130	1	90.0	39.0
7	40130	2	89.0	41.0
7	40130	3	88.0	42.0
7	40130	4	88.0	43.0
7	40130	5	87.0	44.0
7	40130	6	86.0	46.0
7	40130	7	87.0	45.0
7	40130	8	89.0	41.0
7	40130	9	92.0	37.0
7	40130	10	94.0	34.0
7	40130	11	96.0	30.0
7	40130	12	99.0	27.0
7	40130	13	100.0	25.0
7	40130	14	102.0	23.0
7	40130	15	103.0	22.0
7	40130	16	104.0	21.0
7	40130	17	103.0	23.0
7	40130	18	103.0	23.0
7	40130	19	101.0	24.0
7	40130	20	99.0	26.0
7	40130	21	97.0	30.0
7	40130	22	95.0	32.0
7	40130	23	93.0	35.0
7	40130	24	91.0	38.0

[SourceTypeAgeDistribution]

Source TypeID	YearID	AgeID	AgeFraction
11	2008	0	0.097639
11	2008	1	0.153685
11	2008	2	0.124466
11	2008	3	0.088073
11	2008	4	0.100239
11	2008	5	0.075075
11	2008	6	0.060726
11	2008	7	0.050223
11	2008	8	0.041801
11	2008	9	0.030675
11	2008	10	0.024748
11	2008	11	0.023188
11	2008	12	0.019341
11	2008	13	0.014557
11	2008	14	0.013518
11	2008	15	0.009462
11	2008	16	0.006967
11	2008	17	0.006863
11	2008	18	0.006447
11	2008	19	0.006239
11	2008	20	0.006551
11	2008	21	0.010190
11	2008	22	0.008734
11	2008	23	0.006239
11	2008	24	0.004456
11	2008	25	0.003183
11	2008	26	0.002274
11	2008	27	0.001624
11	2008	28	0.001160
11	2008	29	0.000829
11	2008	30	0.000829
21	2008	0	0.058600
21	2008	1	0.089800
21	2008	2	0.090900
21	2008	3	0.084700
21	2008	4	0.078600
21	2008	5	0.071000
21	2008	6	0.069000
21	2008	7	0.063900
21	2008	8	0.062800
21	2008	9	0.053900
21	2008	10	0.044000
21	2008	11	0.038300
21	2008	12	0.029700
21	2008	13	0.029400
21	2008	14	0.023000
21	2008	15	0.018700
21	2008	16	0.014700
21	2008	17	0.012900
21	2008	18	0.010600
21	2008	19	0.008800
21	2008	20	0.006600
21	2008	21	0.005600
21	2008	22	0.004300

Source TypeID	YearID	AgeID	AgeFraction
21	2008	23	0.003600
21	2008	24	0.003014
21	2008	25	0.002523
21	2008	26	0.002113
21	2008	27	0.001769
21	2008	28	0.001481
21	2008	29	0.001240
21	2008	30	0.014461
31	2008	0	0.056148
31	2008	1	0.089988
31	2008	2	0.092916
31	2008	3	0.074872
31	2008	4	0.076932
31	2008	5	0.063022
31	2008	6	0.057914
31	2008	7	0.065833
31	2008	8	0.061920
31	2008	9	0.048255
31	2008	10	0.042507
31	2008	11	0.042947
31	2008	12	0.031419
31	2008	13	0.030928
31	2008	14	0.028403
31	2008	15	0.018757
31	2008	16	0.012649
31	2008	17	0.011138
31	2008	18	0.010056
31	2008	19	0.011393
31	2008	20	0.008919
31	2008	21	0.005793
31	2008	22	0.007552
31	2008	23	0.005668
31	2008	24	0.004272
31	2008	25	0.003242
31	2008	26	0.002452
31	2008	27	0.001919
31	2008	28	0.001515
31	2008	29	0.001206
31	2008	30	0.029464
32	2008	0	0.059763
32	2008	1	0.095684
32	2008	2	0.099128
32	2008	3	0.077088
32	2008	4	0.074825
32	2008	5	0.060022
32	2008	6	0.054098
32	2008	7	0.061759
32	2008	8	0.062509
32	2008	9	0.047608
32	2008	10	0.041619
32	2008	11	0.043153
32	2008	12	0.031489
32	2008	13	0.031005
32	2008	14	0.029429

Source TypeID	YearID	AgeID	AgeFraction
32	2008	15	0.019239
32	2008	16	0.011888
32	2008	17	0.010528
32	2008	18	0.009695
32	2008	19	0.011148
32	2008	20	0.008679
32	2008	21	0.005441
32	2008	22	0.007091
32	2008	23	0.005301
32	2008	24	0.004014
32	2008	25	0.003071
32	2008	26	0.002418
32	2008	27	0.001846
32	2008	28	0.001426
32	2008	29	0.001119
32	2008	30	0.027915
41	2008	0	0.054400
41	2008	1	0.127000
41	2008	2	0.137800
41	2008	3	0.114200
41	2008	4	0.062400
41	2008	5	0.042000
41	2008	6	0.031200
41	2008	7	0.041300
41	2008	8	0.057600
41	2008	9	0.053600
41	2008	10	0.030900
41	2008	11	0.029700
41	2008	12	0.030500
41	2008	13	0.029100
41	2008	14	0.054600
41	2008	15	0.014200
41	2008	16	0.008200
41	2008	17	0.007600
41	2008	18	0.014800
41	2008	19	0.023100
41	2008	20	0.017500
41	2008	21	0.004500
41	2008	22	0.003500
41	2008	23	0.002300
41	2008	24	0.001511
41	2008	25	0.000993
41	2008	26	0.000653
41	2008	27	0.000429
41	2008	28	0.000282
41	2008	29	0.000185
41	2008	30	0.003947
42	2008	0	0.054400
42	2008	1	0.127000
42	2008	2	0.137800
42	2008	3	0.114200
42	2008	4	0.062400
42	2008	5	0.042000
42	2008	6	0.031200

Source TypeID	YearID	AgeID	AgeFraction
42	2008	7	0.041300
42	2008	8	0.057600
42	2008	9	0.053600
42	2008	10	0.030900
42	2008	11	0.029700
42	2008	12	0.030500
42	2008	13	0.029100
42	2008	14	0.054600
42	2008	15	0.014200
42	2008	16	0.008200
42	2008	17	0.007600
42	2008	18	0.014800
42	2008	19	0.023100
42	2008	20	0.017500
42	2008	21	0.004500
42	2008	22	0.003500
42	2008	23	0.002300
42	2008	24	0.001511
42	2008	25	0.000993
42	2008	26	0.000653
42	2008	27	0.000429
42	2008	28	0.000282
42	2008	29	0.000185
42	2008	30	0.003947
43	2008	0	0.091684
43	2008	1	0.148636
43	2008	2	0.157944
43	2008	3	0.098690
43	2008	4	0.056752
43	2008	5	0.033430
43	2008	6	0.020118
43	2008	7	0.025423
43	2008	8	0.069363
43	2008	9	0.042739
43	2008	10	0.034531
43	2008	11	0.046342
43	2008	12	0.032930
43	2008	13	0.031173
43	2008	14	0.038212
43	2008	15	0.021940
43	2008	16	0.004822
43	2008	17	0.004813
43	2008	18	0.006470
43	2008	19	0.009141
43	2008	20	0.006922
43	2008	21	0.002448
43	2008	22	0.002714
43	2008	23	0.001715
43	2008	24	0.001077
43	2008	25	0.000681
43	2008	26	0.000430
43	2008	27	0.000290
43	2008	28	0.000183
43	2008	29	0.000115
43	2008	30	0.008269
51	2008	0	0.091611
51	2008	1	0.148519
51	2008	2	0.157820
51	2008	3	0.098612
51	2008	4	0.056707
51	2008	5	0.033404
51	2008	6	0.020103
51	2008	7	0.025403
51	2008	8	0.069309
51	2008	9	0.042705
51	2008	10	0.034504
51	2008	11	0.046306
51	2008	12	0.032904
51	2008	13	0.031602
51	2008	14	0.038601
51	2008	15	0.022601
51	2008	16	0.004899
51	2008	17	0.004900
51	2008	18	0.006499
51	2008	19	0.009099
51	2008	20	0.006797
51	2008	21	0.002400
51	2008	22	0.002700
51	2008	23	0.001700
51	2008	24	0.001070
51	2008	25	0.000674
51	2008	26	0.000424

Source TypeID	YearID	AgeID	AgeFraction
51	2008	27	0.000267
51	2008	28	0.000168
51	2008	29	0.000106
51	2008	30	0.007586
52	2008	0	0.082905
52	2008	1	0.133171
52	2008	2	0.140432
52	2008	3	0.091977
52	2008	4	0.061324
52	2008	5	0.040558
52	2008	6	0.029326
52	2008	7	0.035280
52	2008	8	0.066813
52	2008	9	0.043674
52	2008	10	0.036113
52	2008	11	0.044920
52	2008	12	0.032191
52	2008	13	0.031518
52	2008	14	0.036333
52	2008	15	0.022117
52	2008	16	0.006913
52	2008	17	0.006552
52	2008	18	0.007429
52	2008	19	0.009720
52	2008	20	0.007356
52	2008	21	0.003264
52	2008	22	0.004084
52	2008	23	0.002855
52	2008	24	0.002131
52	2008	25	0.001652
52	2008	26	0.001562
52	2008	27	0.001023
52	2008	28	0.000676
52	2008	29	0.000468
52	2008	30	0.015661
53	2008	0	0.090873
53	2008	1	0.146351
53	2008	2	0.155089
53	2008	3	0.097122
53	2008	4	0.056197
53	2008	5	0.033312
53	2008	6	0.020196
53	2008	7	0.025496
53	2008	8	0.068212
53	2008	9	0.042125
53	2008	10	0.034022
53	2008	11	0.045480
53	2008	12	0.032373
53	2008	13	0.033217
53	2008	14	0.040496
53	2008	15	0.025464
53	2008	16	0.005390
53	2008	17	0.005435
53	2008	18	0.006778
53	2008	19	0.009212
53	2008	20	0.006638
53	2008	21	0.002389
53	2008	22	0.003010
53	2008	23	0.001941
53	2008	24	0.001400
53	2008	25	0.001053
53	2008	26	0.001075
53	2008	27	0.000559
53	2008	28	0.000310
53	2008	29	0.000179
53	2008	30	0.008605
54	2008	0	0.092048
54	2008	1	0.149226
54	2008	2	0.158572
54	2008	3	0.099082
54	2008	4	0.056977
54	2008	5	0.033563
54	2008	6	0.020198
54	2008	7	0.025524
54	2008	8	0.069639
54	2008	9	0.042909
54	2008	10	0.034669
54	2008	11	0.046526
54	2008	12	0.033061
54	2008	13	0.030138
54	2008	14	0.036854
54	2008	15	0.020274

Source TypeID	YearID	AgeID	AgeFraction
54	2008	16	0.004587
54	2008	17	0.004591
54	2008	18	0.006362
54	2008	19	0.009049
54	2008	20	0.007043
54	2008	21	0.002525
54	2008	22	0.002703
54	2008	23	0.001719
54	2008	24	0.001069
54	2008	25	0.000675
54	2008	26	0.000432
54	2008	27	0.000338
54	2008	28	0.000212
54	2008	29	0.000131
54	2008	30	0.009302
61	2008	0	0.092019
61	2008	1	0.149180
61	2008	2	0.158522
61	2008	3	0.099051
61	2008	4	0.056959
61	2008	5	0.033553
61	2008	6	0.020192
61	2008	7	0.025516
61	2008	8	0.069617
61	2008	9	0.042895
61	2008	10	0.034658
61	2008	11	0.046512
61	2008	12	0.033051
61	2008	13	0.031559
61	2008	14	0.037665
61	2008	15	0.022381
61	2008	16	0.004788
61	2008	17	0.004864
61	2008	18	0.006421
61	2008	19	0.008694
61	2008	20	0.006439
61	2008	21	0.002319
61	2008	22	0.002610
61	2008	23	0.001634
61	2008	24	0.001022
61	2008	25	0.000627
61	2008	26	0.000397
61	2008	27	0.000256
61	2008	28	0.000154
61	2008	29	0.000090
61	2008	30	0.006355
62	2008	0	0.091775
62	2008	1	0.148783
62	2008	2	0.158101
62	2008	3	0.098788
62	2008	4	0.056808
62	2008	5	0.033464
62	2008	6	0.020138
62	2008	7	0.025448
62	2008	8	0.069432
62	2008	9	0.042781
62	2008	10	0.034566
62	2008	11	0.046388
62	2008	12	0.032963
62	2008	13	0.031586
62	2008	14	0.038240
62	2008	15	0.022517
62	2008	16	0.004855
62	2008	17	0.004882
62	2008	18	0.006464
62	2008	19	0.008940
62	2008	20	0.006652
62	2008	21	0.002363
62	2008	22	0.002658
62	2008	23	0.001670
62	2008	24	0.001049
62	2008	25	0.000654
62	2008	26	0.000412
62	2008	27	0.000262
62	2008	28	0.000162
62	2008	29	0.000100
62	2008	30	0.007099

[IMCoverage]

polProcess ID	State ID	County ID	yearID	sourceTypeID	fuelTypeID	IMProgramID	Beg ModelYearID	End ModelYearID	inspectFreq	Test StandardsID	useIMyn	Compliance Factor
101	4	4013	2008	21	1	103	1967	1980	1	13	Y	57.62
101	4	4013	2008	21	1	106	1981	1995	2	31	Y	64.12
101	4	4013	2008	21	1	110	1996	2004	2	51	Y	90.04
101	4	4013	2008	31	1	103	1967	1980	1	13	Y	57.62
101	4	4013	2008	31	1	106	1981	1995	2	31	Y	64.12
101	4	4013	2008	31	1	110	1996	2004	2	51	Y	90.04
101	4	4013	2008	32	1	103	1967	1980	1	13	Y	57.62
101	4	4013	2008	32	1	106	1981	1995	2	31	Y	64.12
101	4	4013	2008	32	1	110	1996	2004	2	51	Y	90.04
101	4	4013	2008	52	1	103	1967	2004	1	13	Y	87.20
102	4	4013	2008	21	1	103	1967	1980	1	13	Y	57.62
102	4	4013	2008	21	1	106	1981	1995	2	31	Y	64.12
102	4	4013	2008	21	1	110	1996	2004	2	51	Y	90.04
102	4	4013	2008	31	1	103	1967	1980	1	13	Y	57.62
102	4	4013	2008	31	1	106	1981	1995	2	31	Y	64.12
102	4	4013	2008	31	1	110	1996	2004	2	51	Y	90.04
102	4	4013	2008	32	1	103	1967	1980	1	13	Y	57.62
102	4	4013	2008	32	1	106	1981	1995	2	31	Y	64.12
102	4	4013	2008	32	1	110	1996	2004	2	51	Y	90.04
102	4	4013	2008	52	1	103	1967	2004	1	13	Y	87.20
112	4	4013	2008	21	1	108	1996	2004	2	43	Y	83.81
112	4	4013	2008	21	1	109	1981	1995	2	44	Y	64.12
112	4	4013	2008	31	1	108	1996	2004	2	43	Y	83.81
112	4	4013	2008	31	1	109	1981	1995	2	44	Y	64.12
112	4	4013	2008	32	1	108	1996	2004	2	43	Y	83.81
112	4	4013	2008	32	1	109	1981	1995	2	44	Y	64.12
112	4	4013	2008	52	1	107	1981	2004	1	41	Y	86.29
113	4	4013	2008	21	1	108	1996	2004	2	43	Y	83.81
113	4	4013	2008	21	1	109	1981	1995	2	44	Y	64.12
113	4	4013	2008	31	1	108	1996	2004	2	43	Y	83.81
113	4	4013	2008	31	1	109	1981	1995	2	44	Y	64.12
113	4	4013	2008	32	1	108	1996	2004	2	43	Y	83.81
113	4	4013	2008	32	1	109	1981	1995	2	44	Y	64.12
113	4	4013	2008	52	1	107	1981	2004	1	41	Y	86.29
201	4	4013	2008	21	1	103	1967	1980	1	13	Y	57.62
201	4	4013	2008	21	1	106	1981	1995	2	31	Y	64.12
201	4	4013	2008	21	1	110	1996	2004	2	51	Y	90.04
201	4	4013	2008	31	1	103	1967	1980	1	13	Y	57.62
201	4	4013	2008	31	1	106	1981	1995	2	31	Y	64.12
201	4	4013	2008	31	1	110	1996	2004	2	51	Y	90.04
201	4	4013	2008	32	1	103	1967	1980	1	13	Y	57.62
201	4	4013	2008	32	1	106	1981	1995	2	31	Y	64.12
201	4	4013	2008	32	1	110	1996	2004	2	51	Y	90.04
201	4	4013	2008	52	1	103	1967	2004	1	13	Y	87.20
202	4	4013	2008	21	1	103	1967	1980	1	13	Y	57.62
202	4	4013	2008	21	1	106	1981	1995	2	31	Y	64.12
202	4	4013	2008	21	1	110	1996	2004	2	51	Y	90.04
202	4	4013	2008	31	1	103	1967	1980	1	13	Y	57.62
202	4	4013	2008	31	1	106	1981	1995	2	31	Y	64.12
202	4	4013	2008	31	1	110	1996	2004	2	51	Y	90.04
202	4	4013	2008	32	1	103	1967	1980	1	13	Y	57.62
202	4	4013	2008	32	1	106	1981	1995	2	31	Y	64.12
202	4	4013	2008	32	1	110	1996	2004	2	51	Y	90.04
202	4	4013	2008	52	1	103	1967	2004	1	13	Y	87.20
301	4	4013	2008	21	1	103	1967	1980	1	13	Y	57.62
301	4	4013	2008	21	1	106	1981	1995	2	31	Y	64.12
301	4	4013	2008	21	1	110	1996	2004	2	51	Y	90.04
301	4	4013	2008	31	1	103	1967	1980	1	13	Y	57.62
301	4	4013	2008	31	1	106	1981	1995	2	31	Y	64.12
301	4	4013	2008	31	1	110	1996	2004	2	51	Y	90.04
301	4	4013	2008	32	1	103	1967	1980	1	13	Y	57.62
301	4	4013	2008	32	1	106	1981	1995	2	31	Y	64.12
301	4	4013	2008	32	1	110	1996	2004	2	51	Y	90.04
301	4	4013	2008	52	1	103	1967	2004	1	13	Y	87.20
302	4	4013	2008	21	1	103	1967	1980	1	13	Y	57.62
302	4	4013	2008	21	1	106	1981	1995	2	31	Y	64.12
302	4	4013	2008	21	1	110	1996	2004	2	51	Y	90.04
302	4	4013	2008	31	1	103	1967	1980	1	13	Y	57.62
302	4	4013	2008	31	1	106	1981	1995	2	31	Y	64.12
302	4	4013	2008	31	1	110	1996	2004	2	51	Y	90.04
302	4	4013	2008	32	1	103	1967	1980	1	13	Y	57.62
302	4	4013	2008	32	1	106	1981	1995	2	31	Y	64.12
302	4	4013	2008	32	1	110	1996	2004	2	51	Y	90.04
302	4	4013	2008	52	1	103	1967	2004	1	13	Y	87.20

[RoadType]

roadTypeID	rampFraction
2	0.042906
4	0.083904

[RoadTypeDistribution]

sourceTypeID	roadTypeID	roadTypeVMTFraction
11	1	0.00000
11	2	0.01276
11	3	0.06796
11	4	0.28067
11	5	0.63861
21	1	0.00000
21	2	0.02030
21	3	0.04908
21	4	0.28647
21	5	0.64415
31	1	0.00000
31	2	0.04043
31	3	0.05352
31	4	0.33805
31	5	0.56801
32	1	0.00000
32	2	0.04043
32	3	0.05352
32	4	0.33805
32	5	0.56801
41	1	0.00000
41	2	0.03007
41	3	0.03859
41	4	0.48841
41	5	0.44293
42	1	0.00000
42	2	0.03007
42	3	0.03859
42	4	0.48841
42	5	0.44293
43	1	0.00000
43	2	0.03007
43	3	0.03859
43	4	0.48841
43	5	0.44293
51	1	0.00000
51	2	0.04242
51	3	0.03293
51	4	0.51248
51	5	0.41217
52	1	0.00000
52	2	0.04242
52	3	0.03293
52	4	0.51248
52	5	0.41217
53	1	0.00000
53	2	0.04242
53	3	0.03293
53	4	0.51248
53	5	0.41217
54	1	0.00000
54	2	0.04242
54	3	0.03293
54	4	0.51248
54	5	0.41217
61	1	0.00000
61	2	0.07911
61	3	0.03800
61	4	0.51530
61	5	0.36759
62	1	0.00000
62	2	0.07911
62	3	0.03800
62	4	0.51530
62	5	0.36759

[MonthVMTFraction]

sourceTypeID	isLeapYear	monthID	monthVMTFraction
11	Y	7	0.07881
21	Y	7	0.07881
31	Y	7	0.07881
32	Y	7	0.07881
41	Y	7	0.07881
42	Y	7	0.07881
43	Y	7	0.07881
51	Y	7	0.07881
52	Y	7	0.07881
53	Y	7	0.07881
54	Y	7	0.07881
61	Y	7	0.07881
62	Y	7	0.07881

[DayVMTFraction]

Source TypeID	Month ID	Road TypeID	dayID	Day VMTFraction
11	7	1	5	0.78131
21	7	1	5	0.78131
31	7	1	5	0.78131
32	7	1	5	0.78131
41	7	1	5	0.78131
42	7	1	5	0.78131
43	7	1	5	0.78131
51	7	1	5	0.78131
52	7	1	5	0.78131
53	7	1	5	0.78131
54	7	1	5	0.78131
61	7	1	5	0.78131
62	7	1	5	0.78131
11	7	2	5	0.78337
21	7	2	5	0.78337
31	7	2	5	0.78337
32	7	2	5	0.78337
41	7	2	5	0.78337
42	7	2	5	0.78337
43	7	2	5	0.78337
51	7	2	5	0.78337
52	7	2	5	0.78337
53	7	2	5	0.78337
54	7	2	5	0.78337
61	7	2	5	0.78337
62	7	2	5	0.78337
11	7	3	5	0.77907
21	7	3	5	0.77907
31	7	3	5	0.77907
32	7	3	5	0.77907
41	7	3	5	0.77907
42	7	3	5	0.77907
43	7	3	5	0.77907
51	7	3	5	0.77907
52	7	3	5	0.77907
53	7	3	5	0.77907
54	7	3	5	0.77907
61	7	3	5	0.77907
62	7	3	5	0.77907
11	7	4	5	0.78337
21	7	4	5	0.78337
31	7	4	5	0.78337
32	7	4	5	0.78337
41	7	4	5	0.78337
42	7	4	5	0.78337
43	7	4	5	0.78337
51	7	4	5	0.78337
52	7	4	5	0.78337
53	7	4	5	0.78337
54	7	4	5	0.78337
61	7	4	5	0.78337
62	7	4	5	0.78337
11	7	5	5	0.77907
21	7	5	5	0.77907
31	7	5	5	0.77907
32	7	5	5	0.77907
41	7	5	5	0.77907
42	7	5	5	0.77907
43	7	5	5	0.77907
51	7	5	5	0.77907
52	7	5	5	0.77907
53	7	5	5	0.77907
54	7	5	5	0.77907
61	7	5	5	0.77907
62	7	5	5	0.77907
11	7	1	2	0.21869
21	7	1	2	0.21869
31	7	1	2	0.21869
32	7	1	2	0.21869
41	7	1	2	0.21869
42	7	1	2	0.21869
43	7	1	2	0.21869
51	7	1	2	0.21869
52	7	1	2	0.21869
53	7	1	2	0.21869
54	7	1	2	0.21869
61	7	1	2	0.21869
62	7	1	2	0.21869
11	7	2	2	0.21663
21	7	2	2	0.21663
31	7	2	2	0.21663
32	7	2	2	0.21663
41	7	2	2	0.21663
42	7	2	2	0.21663
43	7	2	2	0.21663
51	7	2	2	0.21663
52	7	2	2	0.21663
53	7	2	2	0.21663
54	7	2	2	0.21663
61	7	2	2	0.21663
62	7	2	2	0.21663
11	7	3	2	0.22093
21	7	3	2	0.22093
31	7	3	2	0.22093
32	7	3	2	0.22093
41	7	3	2	0.22093
42	7	3	2	0.22093
43	7	3	2	0.22093
51	7	3	2	0.22093
52	7	3	2	0.22093
53	7	3	2	0.22093
54	7	3	2	0.22093
61	7	3	2	0.22093
62	7	3	2	0.22093
11	7	4	2	0.21663
21	7	4	2	0.21663
31	7	4	2	0.21663
32	7	4	2	0.21663
41	7	4	2	0.21663
42	7	4	2	0.21663
43	7	4	2	0.21663
51	7	4	2	0.21663
52	7	4	2	0.21663
53	7	4	2	0.21663
54	7	4	2	0.21663
61	7	4	2	0.21663
62	7	4	2	0.21663
11	7	5	2	0.22093
21	7	5	2	0.22093
31	7	5	2	0.22093
32	7	5	2	0.22093
41	7	5	2	0.22093
42	7	5	2	0.22093
43	7	5	2	0.22093
51	7	5	2	0.22093
52	7	5	2	0.22093
53	7	5	2	0.22093
54	7	5	2	0.22093
61	7	5	2	0.22093
62	7	5	2	0.22093

[HourVMTFraction] (SourceTypeID 21: Passenger Car)

Source TypeID	Road TypeID	dayID	hourID	hourVMT Fraction
21	1	5	1	0.00773
21	1	5	2	0.00526
21	1	5	3	0.00489
21	1	5	4	0.00636
21	1	5	5	0.01666
21	1	5	6	0.03683
21	1	5	7	0.05414
21	1	5	8	0.06525
21	1	5	9	0.06070
21	1	5	10	0.05269
21	1	5	11	0.05070
21	1	5	12	0.05410
21	1	5	13	0.05696
21	1	5	14	0.05867
21	1	5	15	0.06421
21	1	5	16	0.06827
21	1	5	17	0.06945
21	1	5	18	0.06952
21	1	5	19	0.05826
21	1	5	20	0.04182
21	1	5	21	0.03361
21	1	5	22	0.02915
21	1	5	23	0.02116
21	1	5	24	0.01360
21	2	5	1	0.00935
21	2	5	2	0.00655
21	2	5	3	0.00634
21	2	5	4	0.00864
21	2	5	5	0.02363
21	2	5	6	0.04783
21	2	5	7	0.05924
21	2	5	8	0.06055
21	2	5	9	0.05818
21	2	5	10	0.05502
21	2	5	11	0.05157
21	2	5	12	0.05326
21	2	5	13	0.05552
21	2	5	14	0.05931
21	2	5	15	0.06444
21	2	5	16	0.06360
21	2	5	17	0.06052
21	2	5	18	0.05806
21	2	5	19	0.05274
21	2	5	20	0.04064
21	2	5	21	0.03340
21	2	5	22	0.03082
21	2	5	23	0.02436
21	2	5	24	0.01644
21	3	5	1	0.00608
21	3	5	2	0.00395
21	3	5	3	0.00341
21	3	5	4	0.00404
21	3	5	5	0.00958
21	3	5	6	0.02566
21	3	5	7	0.04895
21	3	5	8	0.07002
21	3	5	9	0.06326
21	3	5	10	0.05034
21	3	5	11	0.04983
21	3	5	12	0.05497
21	3	5	13	0.05843
21	3	5	14	0.05802
21	3	5	15	0.06398
21	3	5	16	0.07301
21	3	5	17	0.07853
21	3	5	18	0.08117
21	3	5	19	0.06387
21	3	5	20	0.04302
21	3	5	21	0.03383
21	3	5	22	0.02745
21	3	5	23	0.01791
21	3	5	24	0.01071
21	4	5	1	0.00935
21	4	5	2	0.00655
21	4	5	3	0.00634
21	4	5	4	0.00864
21	4	5	5	0.02363
21	4	5	6	0.04783
21	4	5	7	0.05924
21	4	5	8	0.06055
21	4	5	9	0.05818
21	4	5	10	0.05502
21	4	5	11	0.05157
21	4	5	12	0.05326
21	4	5	13	0.05552
21	4	5	14	0.05931
21	4	5	15	0.06444
21	4	5	16	0.06360
21	4	5	17	0.06052
21	4	5	18	0.05806
21	4	5	19	0.05274
21	4	5	20	0.04064
21	4	5	21	0.03340
21	4	5	22	0.03082
21	4	5	23	0.02436
21	4	5	24	0.01644
21	5	5	1	0.00608
21	5	5	2	0.00395
21	5	5	3	0.00341
21	5	5	4	0.00404
21	5	5	5	0.00958
21	5	5	6	0.02566
21	5	5	7	0.04895
21	5	5	8	0.07002
21	5	5	9	0.06326
21	5	5	10	0.05034
21	5	5	11	0.04983
21	5	5	12	0.05497
21	5	5	13	0.05843
21	5	5	14	0.05802
21	5	5	15	0.06398
21	5	5	16	0.07301
21	5	5	17	0.07853
21	5	5	18	0.08117
21	5	5	19	0.06387
21	5	5	20	0.04302
21	5	5	21	0.03383
21	5	5	22	0.02745
21	5	5	23	0.01791
21	5	5	24	0.01071
21	1	2	1	0.02131
21	1	2	2	0.01510
21	1	2	3	0.01346
21	1	2	4	0.01033
21	1	2	5	0.01242
21	1	2	6	0.01988
21	1	2	7	0.02807
21	1	2	8	0.03490
21	1	2	9	0.04138
21	1	2	10	0.04933
21	1	2	11	0.05577
21	1	2	12	0.05977
21	1	2	13	0.06401
21	1	2	14	0.06459
21	1	2	15	0.06369
21	1	2	16	0.06339
21	1	2	17	0.06375
21	1	2	18	0.06265
21	1	2	19	0.05921
21	1	2	20	0.05076
21	1	2	21	0.04447
21	1	2	22	0.04097
21	1	2	23	0.03542
21	1	2	24	0.02536
21	2	2	1	0.02131
21	2	2	2	0.01510
21	2	2	3	0.01346
21	2	2	4	0.01033
21	2	2	5	0.01242
21	2	2	6	0.01988
21	2	2	7	0.02807
21	2	2	8	0.03490
21	2	2	9	0.04138
21	2	2	10	0.04933
21	2	2	11	0.05577
21	2	2	12	0.05977
21	2	2	13	0.06401
21	2	2	14	0.06459
21	2	2	15	0.06369
21	2	2	16	0.06339
21	2	2	17	0.06375
21	2	2	18	0.06265
21	2	2	19	0.05921
21	2	2	20	0.05076
21	2	2	21	0.04447
21	2	2	22	0.04097
21	2	2	23	0.03542
21	2	2	24	0.02536
21	3	2	1	0.02131
21	3	2	2	0.01510
21	3	2	3	0.01346
21	3	2	4	0.01033
21	3	2	5	0.01242
21	3	2	6	0.01988
21	3	2	7	0.02807
21	3	2	8	0.03490
21	3	2	9	0.04138
21	3	2	10	0.04933
21	3	2	11	0.05577
21	3	2	12	0.05977
21	3	2	13	0.06401
21	3	2	14	0.06459
21	3	2	15	0.06369
21	3	2	16	0.06339
21	3	2	17	0.06375
21	3	2	18	0.06265
21	3	2	19	0.05921
21	3	2	20	0.05076
21	3	2	21	0.04447
21	3	2	22	0.04097
21	3	2	23	0.03542
21	3	2	24	0.02536
21	4	2	1	0.02131
21	4	2	2	0.01510
21	4	2	3	0.01346
21	4	2	4	0.01033
21	4	2	5	0.01242
21	4	2	6	0.01988
21	4	2	7	0.02807
21	4	2	8	0.03490
21	4	2	9	0.04138
21	4	2	10	0.04933
21	4	2	11	0.05577
21	4	2	12	0.05977
21	4	2	13	0.06401
21	4	2	14	0.06459
21	4	2	15	0.06369
21	4	2	16	0.06339
21	4	2	17	0.06375
21	4	2	18	0.06265
21	4	2	19	0.05921
21	4	2	20	0.05076
21	4	2	21	0.04447
21	4	2	22	0.04097
21	4	2	23	0.03542
21	4	2	24	0.02536
21	5	2	1	0.02131
21	5	2	2	0.01510
21	5	2	3	0.01346
21	5	2	4	0.01033
21	5	2	5	0.01242
21	5	2	6	0.01988
21	5	2	7	0.02807
21	5	2	8	0.03490
21	5	2	9	0.04138
21	5	2	10	0.04933
21	5	2	11	0.05577
21	5	2	12	0.05977
21	5	2	13	0.06401
21	5	2	14	0.06459
21	5	2	15	0.06369
21	5	2	16	0.06339
21	5	2	17	0.06375
21	5	2	18	0.06265
21	5	2	19	0.05921
21	5	2	20	0.05076
21	5	2	21	0.04447
21	5	2	22	0.04097
21	5	2	23	0.03542
21	5	2	24	0.02536

[AvgSpeedDistribution] (SourceTypeID 21: Passenger Car and RoadTypeID 2: Rural Restricted Access)

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	15	1	0.00000
21	2	15	2	0.00000
21	2	15	3	0.00000
21	2	15	4	0.00000
21	2	15	5	0.00000
21	2	15	6	0.00000
21	2	15	7	0.00360
21	2	15	8	0.00000
21	2	15	9	0.00000
21	2	15	10	0.06574
21	2	15	11	0.00073
21	2	15	12	0.01326
21	2	15	13	0.12481
21	2	15	14	0.35321
21	2	15	15	0.19430
21	2	15	16	0.24435
21	2	25	1	0.00000
21	2	25	2	0.00000
21	2	25	3	0.00000
21	2	25	4	0.00000
21	2	25	5	0.00000
21	2	25	6	0.00000
21	2	25	7	0.00360
21	2	25	8	0.00000
21	2	25	9	0.00000
21	2	25	10	0.06574
21	2	25	11	0.00073
21	2	25	12	0.01326
21	2	25	13	0.12481
21	2	25	14	0.35321
21	2	25	15	0.19430
21	2	25	16	0.24435
21	2	35	1	0.00000
21	2	35	2	0.00000
21	2	35	3	0.00000
21	2	35	4	0.00000
21	2	35	5	0.00000
21	2	35	6	0.00000
21	2	35	7	0.00360
21	2	35	8	0.00000
21	2	35	9	0.00000
21	2	35	10	0.06574
21	2	35	11	0.00073
21	2	35	12	0.01326
21	2	35	13	0.12481
21	2	35	14	0.35321
21	2	35	15	0.19430
21	2	35	16	0.24435
21	2	45	1	0.00000
21	2	45	2	0.00000
21	2	45	3	0.00000
21	2	45	4	0.00000
21	2	45	5	0.00000
21	2	45	6	0.00000
21	2	45	7	0.00360
21	2	45	8	0.00000
21	2	45	9	0.00000
21	2	45	10	0.06574
21	2	45	11	0.00073
21	2	45	12	0.01326
21	2	45	13	0.12481
21	2	45	14	0.35321
21	2	45	15	0.19430
21	2	45	16	0.24435
21	2	55	1	0.00000
21	2	55	2	0.00000
21	2	55	3	0.00000
21	2	55	4	0.00000
21	2	55	5	0.00000
21	2	55	6	0.00000
21	2	55	7	0.00360
21	2	55	8	0.00000
21	2	55	9	0.00000
21	2	55	10	0.06574
21	2	55	11	0.00073
21	2	55	12	0.01326
21	2	55	13	0.12481
21	2	55	14	0.35321
21	2	55	15	0.19430
21	2	55	16	0.24435

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	65	1	0.00000
21	2	65	2	0.00000
21	2	65	3	0.00000
21	2	65	4	0.00000
21	2	65	5	0.00000
21	2	65	6	0.00000
21	2	65	7	0.00360
21	2	65	8	0.00000
21	2	65	9	0.00000
21	2	65	10	0.06574
21	2	65	11	0.00073
21	2	65	12	0.01326
21	2	65	13	0.12481
21	2	65	14	0.35321
21	2	65	15	0.19430
21	2	65	16	0.24435
21	2	75	1	0.00000
21	2	75	2	0.00000
21	2	75	3	0.00000
21	2	75	4	0.00038
21	2	75	5	0.00000
21	2	75	6	0.00790
21	2	75	7	0.00338
21	2	75	8	0.02171
21	2	75	9	0.03200
21	2	75	10	0.15639
21	2	75	11	0.13785
21	2	75	12	0.23232
21	2	75	13	0.12192
21	2	75	14	0.06243
21	2	75	15	0.09575
21	2	75	16	0.12797
21	2	85	1	0.00000
21	2	85	2	0.00000
21	2	85	3	0.00000
21	2	85	4	0.00038
21	2	85	5	0.00000
21	2	85	6	0.00790
21	2	85	7	0.00338
21	2	85	8	0.02171
21	2	85	9	0.03200
21	2	85	10	0.15639
21	2	85	11	0.13785
21	2	85	12	0.23232
21	2	85	13	0.12192
21	2	85	14	0.06243
21	2	85	15	0.09575
21	2	85	16	0.12797
21	2	95	1	0.00000
21	2	95	2	0.00000
21	2	95	3	0.00000
21	2	95	4	0.00038
21	2	95	5	0.00000
21	2	95	6	0.00790
21	2	95	7	0.00338
21	2	95	8	0.02171
21	2	95	9	0.03200
21	2	95	10	0.15639
21	2	95	11	0.13785
21	2	95	12	0.23232
21	2	95	13	0.12192
21	2	95	14	0.06243
21	2	95	15	0.09575
21	2	95	16	0.12797
21	2	105	1	0.00000
21	2	105	2	0.00000
21	2	105	3	0.00000
21	2	105	4	0.00000
21	2	105	5	0.00000
21	2	105	6	0.00010
21	2	105	7	0.00307
21	2	105	8	0.00000
21	2	105	9	0.07782
21	2	105	10	0.20747
21	2	105	11	0.22000
21	2	105	12	0.12630
21	2	105	13	0.07248
21	2	105	14	0.09291
21	2	105	15	0.07367
21	2	105	16	0.12618

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	115	1	0.00000
21	2	115	2	0.00000
21	2	115	3	0.00000
21	2	115	4	0.00000
21	2	115	5	0.00000
21	2	115	6	0.00010
21	2	115	7	0.00307
21	2	115	8	0.00000
21	2	115	9	0.07782
21	2	115	10	0.20747
21	2	115	11	0.22000
21	2	115	12	0.12630
21	2	115	13	0.07248
21	2	115	14	0.09291
21	2	115	15	0.07367
21	2	115	16	0.12618
21	2	125	1	0.00000
21	2	125	2	0.00000
21	2	125	3	0.00000
21	2	125	4	0.00000
21	2	125	5	0.00000
21	2	125	6	0.00010
21	2	125	7	0.00307
21	2	125	8	0.00000
21	2	125	9	0.07782
21	2	125	10	0.20747
21	2	125	11	0.22000
21	2	125	12	0.12630
21	2	125	13	0.07248
21	2	125	14	0.09291
21	2	125	15	0.07367
21	2	125	16	0.12618
21	2	135	1	0.00000
21	2	135	2	0.00000
21	2	135	3	0.00000
21	2	135	4	0.00000
21	2	135	5	0.00000
21	2	135	6	0.00010
21	2	135	7	0.00307
21	2	135	8	0.00000
21	2	135	9	0.07782
21	2	135	10	0.20747
21	2	135	11	0.22000
21	2	135	12	0.12630
21	2	135	13	0.07248
21	2	135	14	0.09291
21	2	135	15	0.07367
21	2	135	16	0.12618
21	2	145	1	0.00000
21	2	145	2	0.00000
21	2	145	3	0.00000
21	2	145	4	0.00000
21	2	145	5	0.00000
21	2	145	6	0.00010
21	2	145	7	0.00307
21	2	145	8	0.00000
21	2	145	9	0.07782
21	2	145	10	0.20747
21	2	145	11	0.22000
21	2	145	12	0.12630
21	2	145	13	0.07248
21	2	145	14	0.09291
21	2	145	15	0.07367
21	2	145	16	0.12618
21	2	155	1	0.00000
21	2	155	2	0.00000
21	2	155	3	0.00000
21	2	155	4	0.00000
21	2	155	5	0.00000
21	2	155	6	0.00010
21	2	155	7	0.00307
21	2	155	8	0.00000
21	2	155	9	0.07782
21	2	155	10	0.20747
21	2	155	11	0.22000
21	2	155	12	0.12630
21	2	155	13	0.07248
21	2	155	14	0.09291
21	2	155	15	0.07367
21	2	155	16	0.12618

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	165	1	0.00000
21	2	165	2	0.00000
21	2	165	3	0.00000
21	2	165	4	0.00000
21	2	165	5	0.00000
21	2	165	6	0.00708
21	2	165	7	0.04834
21	2	165	8	0.06439
21	2	165	9	0.17359
21	2	165	10	0.34525
21	2	165	11	0.05809
21	2	165	12	0.04723
21	2	165	13	0.05493
21	2	165	14	0.07183
21	2	165	15	0.04109
21	2	165	16	0.08819
21	2	175	1	0.00000
21	2	175	2	0.00000
21	2	175	3	0.00000
21	2	175	4	0.00000
21	2	175	5	0.00000
21	2	175	6	0.00708
21	2	175	7	0.04834
21	2	175	8	0.06439
21	2	175	9	0.17359
21	2	175	10	0.34525
21	2	175	11	0.05809
21	2	175	12	0.04723
21	2	175	13	0.05493
21	2	175	14	0.07183
21	2	175	15	0.04109
21	2	175	16	0.08819
21	2	185	1	0.00000
21	2	185	2	0.00000
21	2	185	3	0.00000
21	2	185	4	0.00000
21	2	185	5	0.00000
21	2	185	6	0.00708
21	2	185	7	0.04834
21	2	185	8	0.06439
21	2	185	9	0.17359
21	2	185	10	0.34525
21	2	185	11	0.05809
21	2	185	12	0.04723
21	2	185	13	0.05493
21	2	185	14	0.07183
21	2	185	15	0.04109
21	2	185	16	0.08819
21	2	195	1	0.00000
21	2	195	2	0.00000
21	2	195	3	0.00000
21	2	195	4	0.00000
21	2	195	5	0.00000
21	2	195	6	0.00000
21	2	195	7	0.00360
21	2	195	8	0.00000
21	2	195	9	0.00000
21	2	195	10	0.06574
21	2	195	11	0.00073
21	2	195	12	0.01326
21	2	195	13	0.12481
21	2	195	14	0.35321
21	2	195	15	0.19430
21	2	195	16	0.24435
21	2	205	1	0.00000
21	2	205	2	0.00000
21	2	205	3	0.00000
21	2	205	4	0.00000
21	2	205	5	0.00000
21	2	205	6	0.00000
21	2	205	7	0.00360
21	2	205	8	0.00000
21	2	205	9	0.00000
21	2	205	10	0.06574
21	2	205	11	0.00073
21	2	205	12	0.01326
21	2	205	13	0.12481
21	2	205	14	0.35321
21	2	205	15	0.19430
21	2	205	16	0.24435
21	2	215	1	0.00000
21	2	215	2	0.00000

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	215	3	0.00000
21	2	215	4	0.00000
21	2	215	5	0.00000
21	2	215	6	0.00000
21	2	215	7	0.00360
21	2	215	8	0.00000
21	2	215	9	0.00000
21	2	215	10	0.06574
21	2	215	11	0.00073
21	2	215	12	0.01326
21	2	215	13	0.12481
21	2	215	14	0.35321
21	2	215	15	0.19430
21	2	215	16	0.24435
21	2	225	1	0.00000
21	2	225	2	0.00000
21	2	225	3	0.00000
21	2	225	4	0.00000
21	2	225	5	0.00000
21	2	225	6	0.00000
21	2	225	7	0.00360
21	2	225	8	0.00000
21	2	225	9	0.00000
21	2	225	10	0.06574
21	2	225	11	0.00073
21	2	225	12	0.01326
21	2	225	13	0.12481
21	2	225	14	0.35321
21	2	225	15	0.19430
21	2	225	16	0.24435
21	2	235	1	0.00000
21	2	235	2	0.00000
21	2	235	3	0.00000
21	2	235	4	0.00000
21	2	235	5	0.00000
21	2	235	6	0.00000
21	2	235	7	0.00360
21	2	235	8	0.00000
21	2	235	9	0.00000
21	2	235	10	0.06574
21	2	235	11	0.00073
21	2	235	12	0.01326
21	2	235	13	0.12481
21	2	235	14	0.35321
21	2	235	15	0.19430
21	2	235	16	0.24435
21	2	245	1	0.00000
21	2	245	2	0.00000
21	2	245	3	0.00000
21	2	245	4	0.00000
21	2	245	5	0.00000
21	2	245	6	0.00000
21	2	245	7	0.00360
21	2	245	8	0.00000
21	2	245	9	0.00000
21	2	245	10	0.06574
21	2	245	11	0.00073
21	2	245	12	0.01326
21	2	245	13	0.12481
21	2	245	14	0.35321
21	2	245	15	0.19430
21	2	245	16	0.24435
21	2	12	1	0.00000
21	2	12	2	0.00000
21	2	12	3	0.00000
21	2	12	4	0.00000
21	2	12	5	0.00000
21	2	12	6	0.00000
21	2	12	7	0.00360
21	2	12	8	0.00000
21	2	12	9	0.00000
21	2	12	10	0.06574
21	2	12	11	0.00073
21	2	12	12	0.01326
21	2	12	13	0.12481
21	2	12	14	0.35321
21	2	12	15	0.19430
21	2	12	16	0.24435
21	2	22	1	0.00000
21	2	22	2	0.00000
21	2	22	3	0.00000
21	2	22	4	0.00000

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	22	5	0.00000
21	2	22	6	0.00000
21	2	22	7	0.00360
21	2	22	8	0.00000
21	2	22	9	0.00000
21	2	22	10	0.06574
21	2	22	11	0.00073
21	2	22	12	0.01326
21	2	22	13	0.12481
21	2	22	14	0.35321
21	2	22	15	0.19430
21	2	22	16	0.24435
21	2	32	1	0.00000
21	2	32	2	0.00000
21	2	32	3	0.00000
21	2	32	4	0.00000
21	2	32	5	0.00000
21	2	32	6	0.00000
21	2	32	7	0.00360
21	2	32	8	0.00000
21	2	32	9	0.00000
21	2	32	10	0.06574
21	2	32	11	0.00073
21	2	32	12	0.01326
21	2	32	13	0.12481
21	2	32	14	0.35321
21	2	32	15	0.19430
21	2	32	16	0.24435
21	2	42	1	0.00000
21	2	42	2	0.00000
21	2	42	3	0.00000
21	2	42	4	0.00000
21	2	42	5	0.00000
21	2	42	6	0.00000
21	2	42	7	0.00360
21	2	42	8	0.00000
21	2	42	9	0.00000
21	2	42	10	0.06574
21	2	42	11	0.00073
21	2	42	12	0.01326
21	2	42	13	0.12481
21	2	42	14	0.35321
21	2	42	15	0.19430
21	2	42	16	0.24435
21	2	52	1	0.00000
21	2	52	2	0.00000
21	2	52	3	0.00000
21	2	52	4	0.00000
21	2	52	5	0.00000
21	2	52	6	0.00000
21	2	52	7	0.00360
21	2	52	8	0.00000
21	2	52	9	0.00000
21	2	52	10	0.06574
21	2	52	11	0.00073
21	2	52	12	0.01326
21	2	52	13	0.12481
21	2	52	14	0.35321
21	2	52	15	0.19430
21	2	52	16	0.24435
21	2	62	1	0.00000
21	2	62	2	0.00000
21	2	62	3	0.00000
21	2	62	4	0.00000
21	2	62	5	0.00000
21	2	62	6	0.00000
21	2	62	7	0.00360
21	2	62	8	0.00000
21	2	62	9	0.00000
21	2	62	10	0.06574
21	2	62	11	0.00073
21	2	62	12	0.01326
21	2	62	13	0.12481
21	2	62	14	0.35321
21	2	62	15	0.19430
21	2	62	16	0.24435
21	2	72	1	0.00000
21	2	72	2	0.00000
21	2	72	3	0.00000
21	2	72	4	0.00038
21	2	72	5	0.00000
21	2	72	6	0.00790

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	72	7	0.00338
21	2	72	8	0.02171
21	2	72	9	0.03200
21	2	72	10	0.15639
21	2	72	11	0.13785
21	2	72	12	0.23232
21	2	72	13	0.12192
21	2	72	14	0.06243
21	2	72	15	0.09575
21	2	72	16	0.12797
21	2	82	1	0.00000
21	2	82	2	0.00000
21	2	82	3	0.00000
21	2	82	4	0.00038
21	2	82	5	0.00000
21	2	82	6	0.00790
21	2	82	7	0.00338
21	2	82	8	0.02171
21	2	82	9	0.03200
21	2	82	10	0.15639
21	2	82	11	0.13785
21	2	82	12	0.23232
21	2	82	13	0.12192
21	2	82	14	0.06243
21	2	82	15	0.09575
21	2	82	16	0.12797
21	2	92	1	0.00000
21	2	92	2	0.00000
21	2	92	3	0.00000
21	2	92	4	0.00038
21	2	92	5	0.00000
21	2	92	6	0.00790
21	2	92	7	0.00338
21	2	92	8	0.02171
21	2	92	9	0.03200
21	2	92	10	0.15639
21	2	92	11	0.13785
21	2	92	12	0.23232
21	2	92	13	0.12192
21	2	92	14	0.06243
21	2	92	15	0.09575
21	2	92	16	0.12797
21	2	102	1	0.00000
21	2	102	2	0.00000
21	2	102	3	0.00000
21	2	102	4	0.00000
21	2	102	5	0.00000
21	2	102	6	0.00010
21	2	102	7	0.00307
21	2	102	8	0.00000
21	2	102	9	0.07782
21	2	102	10	0.20747
21	2	102	11	0.22000
21	2	102	12	0.12630
21	2	102	13	0.07248
21	2	102	14	0.09291
21	2	102	15	0.07367
21	2	102	16	0.12618
21	2	112	1	0.00000
21	2	112	2	0.00000
21	2	112	3	0.00000
21	2	112	4	0.00000
21	2	112	5	0.00000
21	2	112	6	0.00010
21	2	112	7	0.00307
21	2	112	8	0.00000
21	2	112	9	0.07782
21	2	112	10	0.20747
21	2	112	11	0.22000
21	2	112	12	0.12630
21	2	112	13	0.07248
21	2	112	14	0.09291
21	2	112	15	0.07367
21	2	112	16	0.12618
21	2	122	1	0.00000
21	2	122	2	0.00000
21	2	122	3	0.00000
21	2	122	4	0.00000
21	2	122	5	0.00000
21	2	122	6	0.00010
21	2	122	7	0.00307
21	2	122	8	0.00000

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	122	9	0.07782
21	2	122	10	0.20747
21	2	122	11	0.22000
21	2	122	12	0.12630
21	2	122	13	0.07248
21	2	122	14	0.09291
21	2	122	15	0.07367
21	2	122	16	0.12618
21	2	132	1	0.00000
21	2	132	2	0.00000
21	2	132	3	0.00000
21	2	132	4	0.00000
21	2	132	5	0.00000
21	2	132	6	0.00010
21	2	132	7	0.00307
21	2	132	8	0.00000
21	2	132	9	0.07782
21	2	132	10	0.20747
21	2	132	11	0.22000
21	2	132	12	0.12630
21	2	132	13	0.07248
21	2	132	14	0.09291
21	2	132	15	0.07367
21	2	132	16	0.12618
21	2	142	1	0.00000
21	2	142	2	0.00000
21	2	142	3	0.00000
21	2	142	4	0.00000
21	2	142	5	0.00000
21	2	142	6	0.00010
21	2	142	7	0.00307
21	2	142	8	0.00000
21	2	142	9	0.07782
21	2	142	10	0.20747
21	2	142	11	0.22000
21	2	142	12	0.12630
21	2	142	13	0.07248
21	2	142	14	0.09291
21	2	142	15	0.07367
21	2	142	16	0.12618
21	2	152	1	0.00000
21	2	152	2	0.00000
21	2	152	3	0.00000
21	2	152	4	0.00000
21	2	152	5	0.00000
21	2	152	6	0.00010
21	2	152	7	0.00307
21	2	152	8	0.00000
21	2	152	9	0.07782
21	2	152	10	0.20747
21	2	152	11	0.22000
21	2	152	12	0.12630
21	2	152	13	0.07248
21	2	152	14	0.09291
21	2	152	15	0.07367
21	2	152	16	0.12618
21	2	162	1	0.00000
21	2	162	2	0.00000
21	2	162	3	0.00000
21	2	162	4	0.00000
21	2	162	5	0.00000
21	2	162	6	0.00708
21	2	162	7	0.04834
21	2	162	8	0.06439
21	2	162	9	0.17359
21	2	162	10	0.34525
21	2	162	11	0.05809
21	2	162	12	0.04723
21	2	162	13	0.05493
21	2	162	14	0.07183
21	2	162	15	0.04109
21	2	162	16	0.08819
21	2	172	1	0.00000
21	2	172	2	0.00000
21	2	172	3	0.00000
21	2	172	4	0.00000
21	2	172	5	0.00000
21	2	172	6	0.00708
21	2	172	7	0.04834
21	2	172	8	0.06439
21	2	172	9	0.17359
21	2	172	10	0.34525

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	172	11	0.05809
21	2	172	12	0.04723
21	2	172	13	0.05493
21	2	172	14	0.07183
21	2	172	15	0.04109
21	2	172	16	0.08819
21	2	182	1	0.00000
21	2	182	2	0.00000
21	2	182	3	0.00000
21	2	182	4	0.00000
21	2	182	5	0.00000
21	2	182	6	0.00708
21	2	182	7	0.04834
21	2	182	8	0.06439
21	2	182	9	0.17359
21	2	182	10	0.34525
21	2	182	11	0.05809
21	2	182	12	0.04723
21	2	182	13	0.05493
21	2	182	14	0.07183
21	2	182	15	0.04109
21	2	182	16	0.08819
21	2	192	1	0.00000
21	2	192	2	0.00000
21	2	192	3	0.00000
21	2	192	4	0.00000
21	2	192	5	0.00000
21	2	192	6	0.00000
21	2	192	7	0.00360
21	2	192	8	0.00000
21	2	192	9	0.00000
21	2	192	10	0.06574
21	2	192	11	0.00073
21	2	192	12	0.01326
21	2	192	13	0.12481
21	2	192	14	0.35321
21	2	192	15	0.19430
21	2	192	16	0.24435
21	2	202	1	0.00000
21	2	202	2	0.00000
21	2	202	3	0.00000
21	2	202	4	0.00000
21	2	202	5	0.00000
21	2	202	6	0.00000
21	2	202	7	0.00360
21	2	202	8	0.00000
21	2	202	9	0.00000
21	2	202	10	0.06574
21	2	202	11	0.00073
21	2	202	12	0.01326
21	2	202	13	0.12481
21	2	202	14	0.35321
21	2	202	15	0.19430
21	2	202	16	0.24435
21	2	212	1	0.00000
21	2	212	2	0.00000
21	2	212	3	0.00000
21	2	212	4	0.00000
21	2	212	5	0.00000
21	2	212	6	0.00000
21	2	212	7	0.00360
21	2	212	8	0.00000
21	2	212	9	0.00000
21	2	212	10	0.06574
21	2	212	11	0.00073
21	2	212	12	0.01326
21	2	212	13	0.12481
21	2	212	14	0.35321
21	2	212	15	0.19430
21	2	212	16	0.24435
21	2	222	1	0.00000
21	2	222	2	0.00000
21	2	222	3	0.00000
21	2	222	4	0.00000
21	2	222	5	0.00000
21	2	222	6	0.00000
21	2	222	7	0.00360
21	2	222	8	0.00000
21	2	222	9	0.00000
21	2	222	10	0.06574
21	2	222	11	0.00073
21	2	222	12	0.01326

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	222	13	0.12481
21	2	222	14	0.35321
21	2	222	15	0.19430
21	2	222	16	0.24435
21	2	232	1	0.00000
21	2	232	2	0.00000
21	2	232	3	0.00000
21	2	232	4	0.00000
21	2	232	5	0.00000
21	2	232	6	0.00000
21	2	232	7	0.00360
21	2	232	8	0.00000

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	232	9	0.00000
21	2	232	10	0.06574
21	2	232	11	0.00073
21	2	232	12	0.01326
21	2	232	13	0.12481
21	2	232	14	0.35321
21	2	232	15	0.19430
21	2	232	16	0.24435
21	2	242	1	0.00000
21	2	242	2	0.00000
21	2	242	3	0.00000
21	2	242	4	0.00000

Source TypeID	Road TypeID	Hour DayID	avgSpeed BinID	avgSpeed Fraction
21	2	242	5	0.00000
21	2	242	6	0.00000
21	2	242	7	0.00360
21	2	242	8	0.00000
21	2	242	9	0.00000
21	2	242	10	0.06574
21	2	242	11	0.00073
21	2	242	12	0.01326
21	2	242	13	0.12481
21	2	242	14	0.35321
21	2	242	15	0.19430
21	2	242	16	0.24435