Maricopa County
Air Quality Department

2008 Periodic Emissions Inventory
for
Carbon Monoxide

for the
Maricopa County, Arizona, Maintenance Area

November 2012

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2008 Periodic Emission Inventory for Carbon Monoxide for the Maricopa County, Arizona Maintenance Area

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1. Introduction

1.1 Overview

This 2008 periodic carbon monoxide (CO) 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) and for maintenance areas. In 2005, the Phoenix metropolitan area was redesignated to attainment for CO and the area became a maintenance area.

This inventory includes emission estimates for carbon monoxide (CO) from point, area, nonroad mobile, and onroad mobile sources. Note that totals shown in all 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 Carbon Monoxide Emissions Inventory for Maricopa County. Point, area, and nonroad mobile source emission estimates were prepared by MCAQD. The Maricopa Association of Governments (MAG) prepared the emission estimates for onroad mobile and biogenic 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.

Table 1.2–1. Contact information for chapter authors and QA/QC personnel.

Chapter	Author(s)	QA/QC contact persons
2. Point Sources	Matt Poppen, MCAQD (602) 506-6790	Bob Downing and Eric Raisanen MCAQD (602) 506-6790
3. Area Sources	Matt Poppen, Eric Raisanen and Dena Konopka, MCAQD (602) 506-6790	Bob Downing, MCAQD (602) 506-6790
4. Nonroad Mobile Sources	Matt Poppen and Bob Downing MCAQD (602) 506-6790	Bob Downing and Eric Raisanen MCAQD (602) 506-6790
5. Onroad Mobile Sources	Ieesuck Jung and Cathy Arthur MAG (602) 254-6300	Bob Downing and Eric Raisanen MCAQD (602) 506-6790
6. Biogenic Sources	Feng Liu MAG (602) 254-6300	Bob Downing and Eric Raisanen MCAQD (602) 506-6790

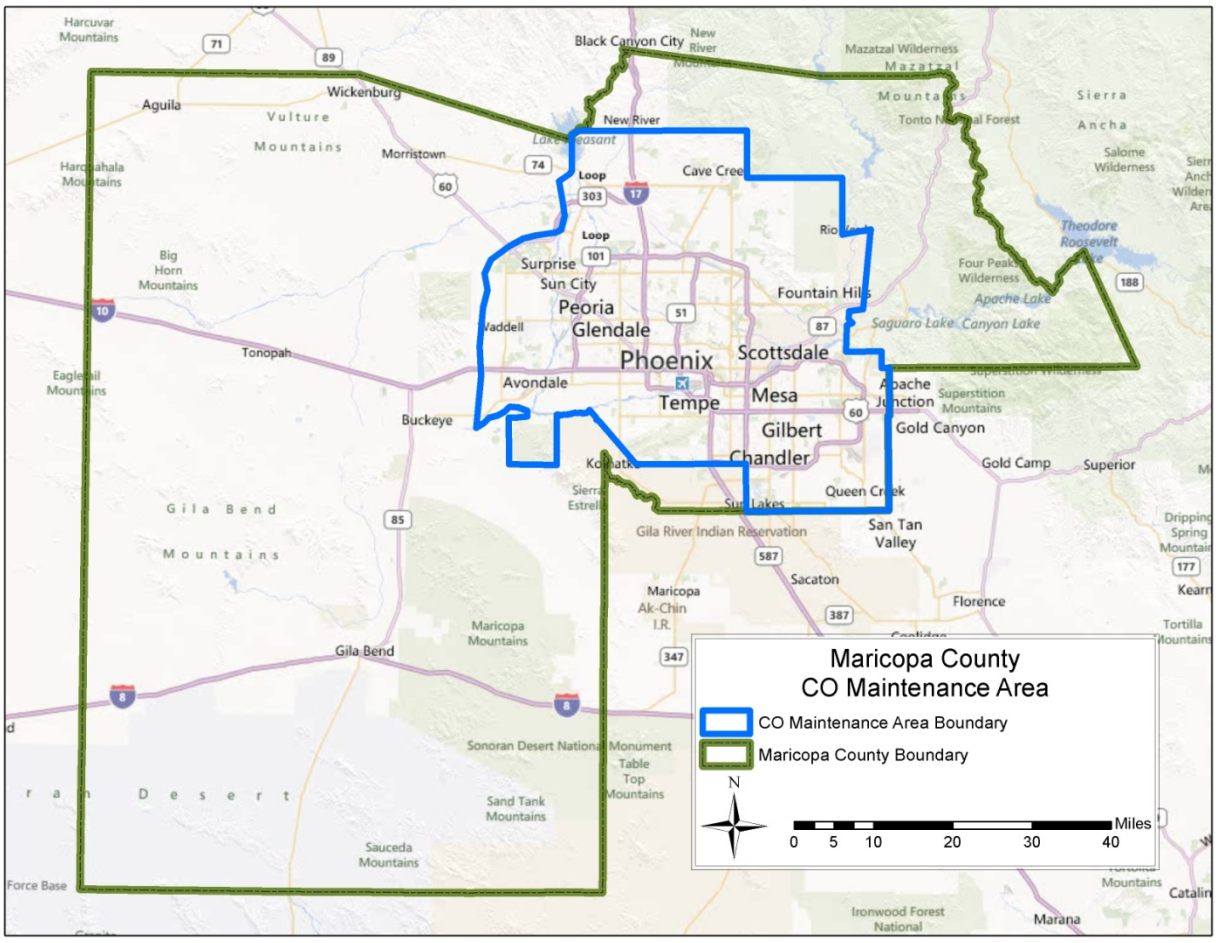
1.3 Temporal scope

Annual and CO season-day emissions were estimated for the year 2008, for Maricopa County and the Maricopa County CO maintenance area. The three-month peak CO season for Maricopa County is defined as November through January. The CO season is based on CO exceedances from 1988 through 1991 and is consistent with the CO season in the 1990 base year inventory.

1.4 Geographic scope

This inventory includes emission estimates for Maricopa County and for the Maricopa County CO maintenance area. Maricopa County encompasses approximately 9,223 square miles of land area, while the Maricopa County CO maintenance area is approximately 1,946 square miles or approximately 21 percent of the Maricopa County land area. A map of Maricopa County and the CO maintenance area is provided in Figure 1.4–1.

Figure 1.4–1. Map of Maricopa County and the CO maintenance 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 maintenance area and vice versa. (For example, county-level emissions from residential natural gas usage in Maricopa County were apportioned to the maintenance area using the ratio of occupied households 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 data

The demographic data provided by MAG included population, housing and employment data for calendar year 2008, for Maricopa County and the maintenance area. Table 1.5-1 provides an overview of the demographic data used in this report.

Table 1.5–1. Demographic profile of Maricopa County and the CO maintenance area.

Demographic variable	Maricopa County totals	Within CO Maintenance Area	Percent within CO Maintenance Area
Total resident population	4,026,000	3,899,350	96.85%
Total non-resident population	253,760	248,420	97.90%
Total population:	**4,279,760**	**4,147,770**	**96.92%**
Retail employment	537,430	526,840	98.03%
Office employment	444,170	442,770	99.68%
Industrial employment	412,580	406,050	98.42%
Public employment	278,610	267,370	95.97%
Other employment	191,770	184,210	96.06%
Construction	79,680	73,420	92.14%
Work at home	65,620	63,370	96.57%
Total employment:	**2,009,860**	**1,964,030**	**97.72%**
Single-family/multi-family household split:			
Single-family	75%	75%	
Multi-family	25%	25%	

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 acreage used to develop emission estimates for this inventory.

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

Land use category	Area within Maricopa County (acres)	Area Within CO Maintenance Area (acres)	Percent within CO Maintenance Area
General/active open space/golf course (e.g., parks)	228,295	187,787	82.26%
Passive/restricted open space (e.g., mountain preserves)	2,373,545	89,051	3.75%
Lakes	12,525	12,525	100.00%
Agriculture	295,509	84,979	28.76%
Vacant (e.g., developable land)	2,227,981	171,785	7.71%

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, petroleum product storage and transfer facilities, and large industrial 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 season-day emissions from point sources (including emission reduction credits) in Maricopa County and the CO maintenance 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 season-day point source emissions.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	738.04	3,235.7
CO Maintenance Area	371.77	1,575.4

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. Stationary sources with annual emissions lower than the point source thresholds described in Section 2.1 were included in the area source inventory. Examples of area source categories include residential wood burning, commercial cooking, waste incineration, and wildfires.

Table 1.6–2 summarizes annual and season-day emissions of the chief area source categories, for both Maricopa County and the CO maintenance area. A detailed breakdown of emissions calculations for each area source category is contained in Chapter 3.

Table 1.6–2. Summary of annual and season-day area source emissions, by source category.

	Maricopa County		CO maintenance area	
Source category	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Fuel combustion	6,900.04	79,250.4	6,725.01	77,055.5
Industrial processes	655.87	4,134.3	629.03	3,985.3
Waste treatment/disposal	730.70	17,039.4	257.60	1,657.3
Miscellaneous area sources	4,968.33	2,486.9	140.40	712.9
All area sources:	**13,254.94**	**102,911.0**	**7,752.04**	**83,411.1**

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. Table 1.6–3 summarizes annual and season-day emissions from nonroad mobile sources, for both Maricopa County and the CO maintenance area. A detailed breakdown of emissions calculations for each source category is contained in Chapter 4.

Table 1.6–3. Summary of annual and season-day emissions from nonroad mobile sources.

	Maricopa County		CO maintenance area	
Equipment category	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Agricultural	367.01	513.7	105.55	147.7
Airport ground support equipment	4,842.26	26,460.4	21,327.08	116,541.4
Commercial	37,407.59	204,928.7	36,816.55	201,690.8
Construction & mining equipment	17,097.10	90,379.7	15,753.27	83,275.9
Industrial equipment	10,294.56	64,617.8	10,131.90	63,596.8
Lawn & garden	66,712.36	100,753.6	64,657.62	97,650.4
Pleasure craft	1,627.41	5,008.5	431.81	1,328.9
Railway maintenance	19.33	120.8	18.73	117.1
Recreational equipment	7,270.41	24,593.7	412.23	1,394.5
Aircraft	17,105.50	93,472.7	16,683.40	91,166.1
Locomotives	276.93	1,513.3	119.23	651.6
All nonroad mobile sources:	**163,020.46**	**612,362.8**	**166,457.38**	**657,561.2**

1.6.4 Onroad mobile sources

Emissions from onroad mobile sources were calculated for the CO maintenance area located primarily within Maricopa County as well as for Maricopa County as a whole. A detailed break-down of emissions calculations by vehicle class and roadway type is contained in Chapter 5.

Table 1.6–4 summarizes annual and season-day emissions from onroad mobile sources for both Maricopa County and the CO maintenance area.

Table 1.6–4. Annual and season-day emissions from onroad mobile sources in Maricopa County.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	255,355.67	1,293,502.6
CO Maintenance Area	237,324.41	1,201,621.5

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 CO maintenance 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 CO maintenance area. Annual and daily CO emissions from biogenic sources are shown in Table 1.6–5 for Maricopa County and the CO maintenance area.

Table 1.6–5. Annual and season-day emissions from biogenic sources.

Geographic area	Annual CO emissions (tons/yr)	Typical daily CO emissions (lbs/day)
Maricopa County	14,452.68	21,144.7
CO Maintenance Area	3,130.39	4,646.0

2. Point Sources

2.1 Introduction and scope

This carbon monoxide (CO) inventory is one of a number of emission inventory reports being prepared to meet US EPA reporting requirements. In addition to preparing periodic emissions inventories for the CO maintenance area as a commitment under the current CO State Implementation Plan (SIP), the federal Air Emission Reporting Requirements (AERR) 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 CO inventory was developed concurrently with similar inventories for ozone precursors (VOC, NO_x and CO), and PM (including PM_{10}, $PM_{2.5}$, NO_x, SO_x, and NH_3), 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…this 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 within 25 miles of the CO maintenance area. No additional point sources met this reporting threshold.

This point source inventory includes actual CO emissions for the year 2008 and a typical day during the CO season (defined as November through January). A description and map of the maintenance area are provided in Chapter 1.

Several tables have been constructed to provide the point source emissions and category totals. Table 2.2–1 provides an alphabetical list of all point sources and their location, while Table 2.4–1 shows the 2008 annual and average CO season-day emissions broken out by facility. Note that totals shown in all tables may not equal the sum of individual values due to independent rounding.

2.2 Identification of CO point sources

The Maricopa County Air Quality Department (MCAQD) identified point sources within Maricopa County through its electronic permit system database, Environmental Management System (EMS), and the 2008 annual emissions reports submitted to the department. A total of 21 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 CO maintenance 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 Corporation	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	
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	
174	325998	W. R. Meadows Of Arizona, Inc.	4220 S Sarival Ave	Goodyear	85338	

* = Facility is outside the CO maintenance area.

2.3 Procedures for estimating emissions from point sources

Both annual and average season-day CO emissions were estimated 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 1 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. Activity data reported for the December–February winter season is presumed to be representative of the November–January CO season.

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 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 industrial 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. (See Appendix 2 for details on the methods and data used in computing RE rates.)

2.4 Detailed overview of point source emissions

Table 2.4–1 provides a summary of annual and CO season-day emissions from all point sources, within and outside the CO maintenance area. Sources for which rule effectiveness has been applied (for CO emissions) are noted. Values of "0.00" and "0.0" for annual and season-day 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 CO season-day point source emissions, by facility.

ID #	Business name	City	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
245	AF Lorts Manufacturing Company	Tolleson	0.0	0.06
3313	APS West Phx Power Plant	Phoenix	72.2	372.60
43063	Dynegy Arlington Valley LLC	Arlington *	41.5	97.98
44439	Gila River Power Station	Gila Bend * †	84.8	415.40
1418	Goodrich Corporation	Phoenix †	0.2	2.96
355	Honeywell-Engines Systems & Services	Phoenix	18.8	103.35
3300	Luke AFB - 56th Fighter Wing	Glendale	4.9	40.73
62	Mastercraft Cabinets Inc.	Mesa	0.0	0.68
44186	Mesquite Generating Station	Arlington * †	21.2	126.08
43530	New Harquahala Generating Co	Tonopah *	55.4	304.15
20706	New Wincup Holdings, Inc.	Phoenix	10.4	61.93
52382	Ocotillo Power Plant	Tempe	12.9	25.04
1341	Penn Racquet Sports Inc.	Phoenix	2.9	23.49
42956	Redhawk Generating Facility	Arlington *	163.4	716.74
303	Rexam Beverage Can Company	Phoenix	3.7	20.24
3315	Santan Generating Station	Gilbert	130.7	637.81
4175	SFPP LP Phoenix Terminal	Phoenix	9.6	52.73
3316	SRP Agua Fria Generating Station	Glendale	80.6	92.31
3317	SRP Kyrene Generating Station	Tempe	11.7	67.83
552	Thornwood Furniture Mfg	Phoenix	0.5	4.06
174	W. R. Meadows Of Arizona, Inc.	Goodyear	0.1	1.24

† = Facility is outside the CO maintenance area.
* = Facility for which rule effectiveness has been applied.

2.5 Emission reduction credits

A major source or major modification planned in a maintenance 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.

Table 2.5–1 provides a list of emission reduction credits for carbon monoxide. One previously operational facility maintains emission reduction credits in the Arizona Emissions Bank (http://www.azdeq.gov/environ/air/permits/eb.html) that is still valid for inclusion in this report.

Table 2.5–1. CO emission reduction credits.

ID	Facility Name	Emission Reduction Credits (tons)
1151	Freescale Semiconductor, Inc. (formerly Motorola Mesa)	12.5

2.6 Summary of point source emissions

Table 2.6–1 provides an overview of point source emissions for Maricopa County and the CO maintenance area.

Table 2.6–1. Annual and season-day point source CO emissions (including emission reduction credits).

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	738.04	3,235.7
CO Maintenance Area	371.77	1,575.4

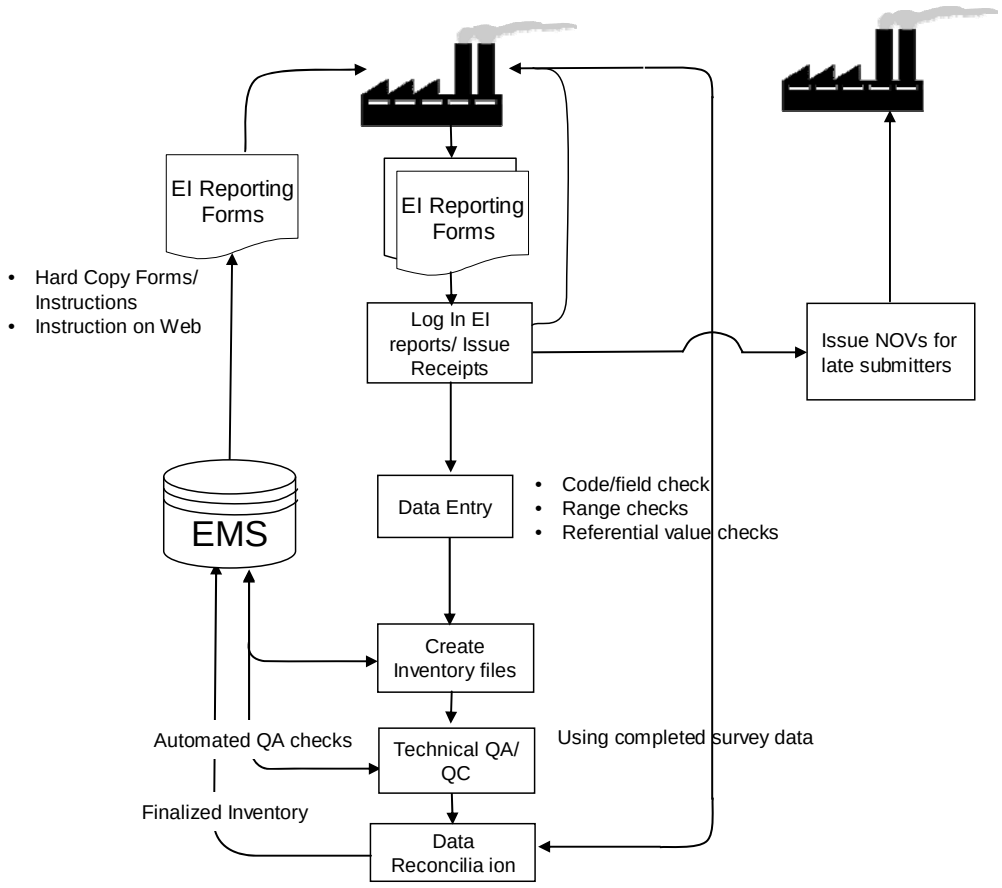
2.7 Quality assurance / quality control procedures

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 1). The EI Unit asks sources to verify and update the data. The EI Unit also holds periodic workshops from January 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, numerous 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 environmental 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 checked calculations, identified errors, and performed completeness, reasonableness and accuracy checks.

2.8 References

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

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" 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 addressed in this chapter.

Table 3.1–1. List of area source categories.

Area source description	Section
Fuel combustion:	
Industrial natural gas	3.2.1
Industrial fuel oil	3.2.2
Commercial/institutional natural gas	3.2.3
Commercial/institutional fuel oil	3.2.4
Residential natural gas	3.2.5
Residential wood	3.2.6
Residential fuel oil	3.2.7
Industrial processes:	
Secondary metal production	3.3.1
Commercial cooking	3.3.2
State-permitted portable sources	3.3.3
Industrial processes not elsewhere classified	3.3.4
Electrical equipment manufacturing	3.3.5
Waste treatment and disposal:	
On-site incineration	3.4.1
Open burning	3.4.2
Landfills	3.4.3
Other industrial waste disposal	3.4.4
Miscellaneous area sources:	
Wildfires	3.5.1.1
Prescribed Fires	3.5.1.2
Structure fires	3.5.1.3
Vehicle fires	3.5.1.4
Engine testing	3.5.1.5
Health services (crematories)	3.5.2

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., consumer solvent use), emissions were calculated using published per-capita or per-employee emission factors.
- for source categories with some information available from annual emissions reports (e.g., bakeries), these data were combined with employment data to "scale up" reported emissions to reflect the entire source category.
- for those source categories with detailed emissions data available from most or all significant sources in the category, emissions were calculated based on detailed process and operational data provided by these sources.

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

3.2 Fuel combustion

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

Table 3.2–1. Annual natural gas sales in Maricopa County, 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 these two categories were grouped with industrial sales.

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

3.2.1 Industrial natural gas

All natural gas suppliers in Maricopa County were surveyed to gather information on the volume of natural gas distributed, by user category, within the county in 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.

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 must be apportioned between these two categories. This apportionment was based

on the percentages of external and internal natural gas combustion reported by all industrial area sources in 2008.

Annual emissions for the county are calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion.

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

Combustion type	% of total	Annual natural gas usage (MMCF)	CO emission factor (lbs/MMCF)	Annual CO emissions (tons/yr)
External	98.44	7,934.68	84	333.26
Internal	1.56	125.74	399	25.09
Totals:	**100.00**	**8,060.43**		**358.34**

Season-day emissions for the county are calculated by first multiplying annual emissions by the percentage of industrial natural gas sold used during the CO season. (Figures reported by natural gas suppliers for the December–February time period are assumed to be representative for the November–January CO season.) CO season emission totals are then divided by the number of days that activity occurs during the CO season. Annual and season-day emissions within the CO maintenance area are calculated by applying the ratio of industrial employment in the maintenance area to county-level emission calculations. (See Section 1.5.1 for a discussion of the employment data used).

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

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	358.34	2,513.9
CO Maintenance Area	352.68	2,474.1

3.2.2 Industrial fuel oil

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

To derive industrial fuel oil usage in Maricopa County, reported Arizona 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.

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 (2010) to estimate annual Maricopa County industrial fuel oil sales. 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.

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 apportion-

ment 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.

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

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

Combustion type	% of total	Annual fuel oil sales (Mgals)	CO emission factor (lbs/Mgals)	Annual CO emissions (tons/yr)
External	78.01	65,634.56	5	164.09
Internal	21.99	18,501.53	130	1,202.60
Totals:	**100.00**	**84,136.09**		**1,366.69**

Season-day emissions for the county are calculated by first multiplying annual emissions by 25.07% to estimate CO season emission totals. CO season emission totals are then divided by the number of days that activity occurs during the CO season (78), as recommended by EIIP guidance (US EPA, 2001a).

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

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

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	1,366.69	8,784.8
CO Maintenance Area	1,345.09	8,646.0

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.

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

Annual emissions for the county and the CO maintenance area are calculated by multiplying natural gas usage by the respective AP-42 emission factors for external and internal combustion.

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

Combustion type	% of total	Annual natural gas usage (MMCF)	CO emission factor (lbs/MMCF)	Annual CO emissions (tons/yr)
External	98.34	17,130.07	84	719.46
Internal	1.66	289.16	399	57.69
Totals:	**100.00**	**17,419.23**		**777.15**

Season-day emissions for the county are calculated by first multiplying annual emissions by the percentage of C&I natural gas sold used during the CO season. (Figures reported by natural gas suppliers for the December–February time period are assumed to be representative for the November–January CO season.) CO season emission totals are then divided by the number of days that activity occurs during the CO season.

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

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

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	777.15	7,248.7
CO Maintenance Area	760.67	7,095.1

3.2.4 Commercial/institutional fuel oil

Area source emissions from commercial and institutional (C&I) fuel oil combustion are calculated by a multi-step process of allocating Arizona state-level C&I fuel oil sales as reported by the US 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 commercial/institutional 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. 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 (2010) to estimate Maricopa County-level C&I fuel oil sales.

To avoid double-counting, commercial/institutional 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 C&I area sources.

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

commercial/institutional area sources surveyed by MCAQD in 2008 (shown in Table 3.2–8 below).

Annual emissions for the county are calculated by multiplying C&I fuel oil sales by the respective AP-42 emission factors for external and internal combustion.

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

Combustion type	% of total	Annual fuel oil sales (Mgals)	CO emission factor (lbs/Mgals)	Annual CO emissions (tons/yr)
External	66.95	20,321.18	5	50.80
Internal	33.05	10,031.59	130	652.05
Totals:	**100.00**	**30,352.78**		**702.86**

Season-day emissions for the county are calculated by first multiplying annual emissions by 26.66% to estimate CO season emission totals. CO season emission totals are then divided by the number of days that activity occurs during the CO season (78) as recommended by EIIP guidance (US EPA, 2001a).

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

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

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	702.86	4,804.7
CO Maintenance Area	687.96	4,702.8

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 listed in AP-42 Tables 1.4-1 and 1.4-2 (US EPA, 1998).

CO season-day emissions are calculated by first multiplying reported natural gas usage during the CO season (8,172.3 MMCF) by the emission factor for CO for residential natural gas combustion (40 lbs CO/MMCF) to produce CO season emissions (natural gas usage reported for the months of December-February are assumed to represent CO season usage). CO season emissions are then divided by the number of days during the CO season that residential natural gas combustion occurs (91) (US EPA, 2001a).

Annual and season-day residential natural gas emissions in the CO maintenance area are calculated by multiplying county-level emissions by the percentage of total resident population (96.85%) in the CO maintenance area.

Table 3.2–10. Annual and season-day CO emissions from residential natural gas combustion.

Geographic area	Annual CO emissions (tons/year)	Season-day CO emissions (lbs/day)
Maricopa County	325.03	3,592.2
CO Maintenance Area	314.79	3,479.1

3.2.6 Residential wood combustion

Area-source emissions from residential wood combustion are calculated based on the amount of wood burned in fireplaces and woodstoves in Maricopa County, as recommended by EIIP guidance (US EPA, 2001b). Residential wood combustion in the county is estimated by multiplying data on statewide residential wood combustion usage (651,000 cords/yr) from the US Department of Energy (US DOE, 2010) by the ratio of county to state households that report use of wood for heating (3.2867%) from the US Census Bureau (2010a). 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.

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 (79 avg. ft^3 wood/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 (31.57 lbs/ft^3), provided by the US Forest Service (USFS, 1993).

Annual emissions from residential wood combustion are calculated by multiplying the tons of wood used by the CO emission factor for residential total woodstoves and fireplaces (252.6 lbs/ton) from EIIP Volume III, Chapter 2, Table 2.4-1 (US EPA, 2001b).

Season-day CO emissions are calculated by apportioning wood burning activity based on heating degree days (i.e., the number of degrees per day that the daily average temperature is below 65°F). Data provided by Arizona Department of Commerce (ADOC, 2010) indicated that there were a total of 885 heating degree days in Phoenix during 2008, with 625 heating degrees days reported during the CO season. Co season-day emissions were derived by applying the ratio of CO season heating degree days to annual heating degree days and are shown in Table 3.2-11.

Annual and season-day emissions within the CO maintenance area are calculated by multiplying county totals by the percentage of residential population within the CO maintenance area of 96.85%. See Section 1.5.1 for a further discussion of the housing data used.

Table 3.2–11. Annual and season-day CO emissions from residential wood combustion.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	3,369.91	52,305.0
CO Maintenance Area	3,263.75	50,657.4

3.2.7 Residential fuel oil

Emissions from residential fuel oil use were calculated using an approach similar to that used for residential wood combustion described in Section 3.2.6. County-level residential fuel oil use was derived from statewide totals (US EIA, 2010) using the ratio of county to state households that report fuel oil use from the US Census Bureau (2010b).

Annual and daily emissions were calculated using AP-42 emission factors and data on heating degree days and residential housing units described in Section 3.2.6. Annual and season-day emissions are shown in Table 3.2–12.

Table 3.2–12. Annual and season-day CO emissions from residential fuel oil combustion.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	0.07	1.1
CO Maintenance Area	0.07	1.0

3.3 Industrial processes

3.3.1 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. CO season-day emissions were calculated based on operating schedule information provided in the facilities' annual emission reports. Since all facilities considered in this section are located within the CO maintenance area, total emission values for the county and the CO maintenance area from secondary metal production are equal.

Table 3.3–1. Annual and season-day CO emissions from area-source secondary metal production.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	107.72	703.5
CO Maintenance Area	107.72	703.5

3.3.2 Commercial cooking

Emissions from commercial cooking were estimated for five types of commercial cooking equipment using EPA methodology (US EPA, 2006). The equipment types include: chain-driven charbroilers, underfired charbroilers, deep-fat fryers, flat griddles, and clamshell griddles. EPA's methodology estimates commercial cooking activity for restaurants with each type of cooking equipment (ethnic, family, fast food, seafood, and steak & barbeque) based on an average number of equipment pieces by restaurant type and average pounds of meat cooked on each type of equipment per week (steak, hamburger, poultry, pork, and seafood). The estimated 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 3.3–2.

Table 3.3–2. Number of Maricopa County restaurants, by restaurant type.

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

Using the number of restaurants for each restaurant type, along with the default emission factors and equations from US EPA (2006), emissions for each combination of equipment type, restaurant type, and meat type were calculated, and the results were summed to estimate annual emissions for each type of cooking equipment, as shown in Table 3.3–3.

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

Annual and season-day emissions for the CO maintenance area were calculated by multiplying the Maricopa County emission totals by the percentage population within the maintenance area (96.92%). (See Section 1.5.1 for a discussion of the population data used.) Table 3.3–3 summarizes the annual and season-day emissions from commercial cooking for Maricopa County and the CO maintenance area.

Table 3.3–3. Annual and season-day CO emissions from commercial cooking.

	Maricopa County		CO Maintenance Area	
Equipment type	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Chain-driven charbroilers	86.79	476.9	84.12	462.2
Underfired charbroilers	270.94	1,488.7	262.60	1,442.8
Deep fat fryers	–	0.0	0.00	0.0
Flat griddles	22.55	123.9	21.86	120.1
Clamshell griddles	–	0.0	0.00	0.0
Totals:	**380.29**	**2,089.5**	**368.58**	**2,025.1**

3.3.3 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)	CO
	6.19

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, the total emissions attributable to activity in Maricopa County were calculated as follows:

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

$$= 6.19 \times \frac{136}{136}$$

$$= 6.19 \text{ tons CO/yr}$$

Since activity was presumed to be spread equally among all "in-county" days, season-day emissions were thus calculated as follows:

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

$$= \frac{6.19 \text{ tons}}{136 \text{ days}} \times \frac{2{,}000 \text{ lbs}}{\text{ton}}$$

$$= 91.03 \text{ lbs CO /day}$$

Table 3.3–4 summarizes the annual and season-day 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 CO maintenance area; thus emission estimates for Maricopa County and the maintenance area are equal.

Table 3.3–4. CO emissions from ADEQ-permitted portable sources.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	145.42	1,212.6
CO Maintenance Area	145.42	1,212.6

3.3.4 Industrial processes, not elsewhere classified (NEC)

Annual area-source emissions from other industrial processes not elsewhere classified (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. CO season-day emissions are calculated based on operating schedule information provided by the facilities in their annual emissions report.

Table 3.3–5. Annual and season-day CO emissions from other industrial processes.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	18.59	107.3
CO Maintenance Area	3.47	22.7

3.3.5 Electrical equipment manufacturing

Annual and season-day 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.

All facilities addressed in this source category are located within the CO maintenance area; thus, emissions for the county and maintenance area are equal. Annual and season-day emissions are shown in Table 3.3–6.

Table 3.3–6. Annual and season-day CO emissions from area-source electric equipment manufacturing.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	3.85	21.3
CO Maintenance Area	3.85	21.3

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 3.5.2. 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 emissions reports. It is assumed that all incinerator emissions are accounted for, since all permitted incinerators received reports in 2008. Season-day emissions are based on operating schedules as supplied in the annual emissions reports. All surveyed facilities are located within the CO maintenance area; thus, emissions for the county and maintenance area are equal.

Table 3.4–1. Annual and season-day CO emissions from on-site incineration.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	0.69	5.7
CO Maintenance Area	0.69	5.7

3.4.2 Open burning

Emissions from controlled open burning are regulated by MCAQD Rule 314, which requires a burn permit for open burning in Maricopa County. Burn permits are issued primarily for purposes of agricultural ditch bank and fencerow burning, tumbleweed burning, land clearance, air curtain destructor burning of trees, and fire fighting training. Maricopa County's burn permit database 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 information needed to calculate emissions. Where data were missing, activity data for each permit category was grown from those permits that contained information.

Reported and estimated activity data for each open burning category are summarized in Table 3.4–2. Permits issued for firefighting training are addressed in Section 3.5.1.3, Structure fires.

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	Activity grown to total number of permits issued
Ditchbank/fencerow	Linear ft	541,336	22	32	787,398
Land clearance	Acres	564	5	12	1,354
Air curtain	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.

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

Category	CO emission factors (lbs/ton burned)	Fuel loading factors (tons/acre)
Weeds, unspecified	85	3.2
Russian Thistle (tumbleweeds)	309	0.1
Orchard Crops: Citrus	81	1.0

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

- Ditch banks and fence rows in Maricopa County average 7 feet in width and are burned twice per year (MCESD, 1999).
- A pile of tumbleweeds 15 feet in diameter and 5 feet high weighs 200 lbs (MCESD, 1993). This is equivalent to 0.1 tons/acre, the AP-42 fuel loading factor for tumbleweeds.
- 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. Activity data for the other categories were similarly converted to material burned using AP-42 fuel loading factors.

Annual emissions were then calculated by multiplying the amount of material burned by emission factors listed in AP-42 (Table 3.4–3). To account for unpermitted illegal outdoor burning, all calculated emissions estimates were increased 2.87 times based on complaints received in 2008 for open or illegal outside burning (158 complaints received; 158 complaints/55 open burn permits = 2.87). Table 3.4–4 summarizes the annual emissions for Maricopa County from each open burning category.

Table 3.4–4. Annual CO emissions from open burning in Maricopa County (tons/yr).

Category	Ton-equivalents	CO emissions (tons/yr)
Ditchbank/fencerow	809.8	98.87
Land clearance	4,331.5	528.94
Air curtain	70.0	8.14
Tumbleweeds	2.80	1.24
Total:		**637.10**

Annual emissions for the maintenance area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the CO maintenance area by the Maricopa County emission totals. (See Section 1.5.2 for a discussion of the land-use data used.) Table 3.4–5 summarizes the annual emissions for the CO maintenance area.

Table 3.4–5. Maintenance area:county ratios and annual CO emissions from open burning in the CO maintenance area.

Category	Surrogate land-use category	2009 Maint. area:county land-use ratio	CO emissions (tons/yr)
Ditchbank/fencerow	Agriculture	28.76%	28.43
Land clearance	Vacant	7.71%	152.08
Air curtain	agriculture and vacant	10.17%	2.34
Tumbleweeds	agriculture and vacant	10.17%	0.36
Total:			**183.21**

Ditch bank/fence row burning is not allowed from November to February, therefore daily emissions during the CO season are zero. For the other burning categories, it was assumed that open burning occurs 5 days per week (most burn permits are issued for weekdays but permits may be issued on weekends depending on circumstances) and open burning occurs evenly during the CO season months (November – January).

Season-day emissions for the maintenance area are calculated by multiplying the percentage of agricultural and/or vacant land use located in the maintenance area (listed in Table 3.4–5) by the County season-day emissions. Table 3.4–6 summarizes the CO season-day emissions from open burning for both Maricopa County and the CO maintenance area.

Table 3.4–6. Season-day CO emissions from open burning (lbs/day).

Category	Maricopa County (lbs/day)	CO maintenance area (lbs/day)
Ditchbank/fencerow	0.0	0.0
Land clearance	16,272.0	1,254.6
Air curtain	250.6	25.5
Tumbleweeds	38.2	3.9
Totals:	**16,560.8**	**1,284.0**

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 season-day CO emissions from landfills.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	40.05	219.9
CO Maintenance Area	20.84	114.7

3.4.4 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 3.4–8 below.

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

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

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	52.86	252.9
CO Maintenance Area	52.86	252.9

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 which encompassed nearly 750 acres. Wildfire data provided by ASLD were compared to wildfires reported in the Geospatial Multi-Agency

Coordination Group (GeoMAC) Wildland Fire Support database 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, 2008 and USGS, 2008). Two of these fires were included in the ASLD data. One fire, the Ethan fire, was not captured in the ASLD data because it occurred on tribal lands. The Ethan fire encompassed more than 6,600 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 the combined dataset 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 (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 because they appeared to be duplicates already captured in either the ASLD or DFBLS data and seven fires were excluded because they 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 sources.

Table 3.5–1. Fire data sources.

Data Source	Number of Fires	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
Totals	**96**	**7,433.49**

Fuel loading was assigned using the National Fire Danger Rating System (NFDRS) fuel model codes 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.

Land use type (by NFDRS Model Category)	No. of Fires	Total area (acres)	Fuel loading factor (tons/acre)
Agriculture*	33	744.05	4.5
California chaparral	1	0.01	19.5
Barren*	2	0.4	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
Totals	**96**	**7,433.49**	

***** "Agriculture" and "Barren" NFDRS model categories 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 by the fuel loading factor. Table 3.5–3 shows the number of wildfires and acres burned for Maricopa County and the CO maintenance area in 2008 and an estimate of material burned. No wildfires occurred during the CO season; therefore season-day emissions from wildfires were zero.

Table 3.5–3. Summary of fires, acres burned and estimate of material burned

Geographic Area	No. of Fires	Acres Burned	Material Burned Annually (tons/yr)	Material Burned in CO Season (tons/season)
Maricopa County	96	7,433	33,479	12.8
CO Maintenance Area	19	28	127	0

The CO emission factor was obtained from the Western Regional Air Partnership's (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005). The CO emission factor for wildfires and prescribed broadast burning (289 lbs CO/ton) was used.

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 CO maintenance area. Nineteen wildfires occurred within the CO maintenance area, resulting in nearly 28 acres burned.

Annual emissions from wildfires within the CO maintenance area were calculated in the same manner as Maricopa County annual emissions, except that material burned in the CO maintenance area were used rather than material burned in Maricopa County.

Annual and season-day emissions from wildfires for Maricopa County and the maintenance area are shown in Table 3.5−4.

Table 3.5–4. Annual and season-day CO emissions from wildfires

Geographic area	CO-season burn days	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	7	4,837.77	526.4
CO Maintenance Area	0	18.29	0.0

3.5.1.2 Prescribed fires

Prescribed fire 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. All six prescribed fires occurred outside the maintenance area. Because all 2008 prescribed fires were piled fuels, the total mass of material burned was derived by multiplying the number of acres burned by tons of piles per acre for each fire. Data provided by the USFS and the resulting material burned for each fire are shown below in Table 3.5–5.

Table 3.5−5. Prescribed fire activity in Maricopa County in 2008.

Date of burn	Burn number	Burn location	Acres Burned	Tons of piles/acre	Material Burned (tons)
01/13/2008	TNF0106	T6N,R7E,S28	3	1	3
03/13/2008	TNF0106P	T6N,R7E,S28	3	3	9
04/04/2008	TNF0302	T3N,R7E,S34	2	5	10
04/09/2008	TNF0302	T3N,R8E,S28	5	5	25
09/25/2008	TNF0302	T3N,R8E,S31	10	5	50
11/06/2008	TNF0302	T2N,R7E,S18	6	5	30
Totals:			**29**	**24**	**127**

The prescribed fire CO emission factor (74.3 lbs CO per ton burned) was obtained from the Western Regional Air Partnership's (WRAP) 2002 Fire Emission Inventory (WGA/WRAP, 2005).

Annual emissions from prescribed fires in Maricopa County were calculated by multiplying the material burned (tons/acre) by the emission factor (lbs CO/ton) and dividing the result by 2,000 lbs/ton.

Two prescribed fires occurred during the CO season. The fires occurred on January 13, 2008 and November 6, 2008, and resulted in 33 tons of material burned. It was assumed the prescribed fires lasted one day each. CO-season day emissions are determined by multiplying the tons material burned by the emission factor (lbs CO/ton) and then dividing the resulting emissions by the number of burn days. In this case, there were only two burn days.

Because all the 2008 prescribed fires burned outside of the maintenance area, the annual and season-day emissions for the maintenance area are zero.

Table 3.5−6. Annual and season-day CO emissions from prescribed fires.

Geographic Area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	4.72	1,226.0
CO Maintenance area	0.00	0.0

3.5.1.3 Structure fires

2008 structure fire data were from the Arizona Department of Fire, Building, and Life Safety (DFBLS). 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 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 (ADOC, 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 the county during 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 percentage structural loss and content loss (US EPA, 2001c). Annual emissions were then calculated by multiplying the amount of material burned by a 60 lbs of CO per ton of material burned emission factor (from US EPA, 2001c) and dividing the resultant amount by 2,000 lbs/ton.

Annual emissions for the CO maintenance were derived by multiplying Maricopa County annual emissions by the percentage of total population within the maintenance area (96.92%). See Section 1.5.1 for a discussion of the population data used.

It was assumed that structure fires occur 7 days a week; however, structure fires vary seasonally and may increase during cold weather. Because local season-specific data were not available from the NFIRS data, seasonal occurrences of residential and non-residential structure fires reported by the Federal Emergency Management Agency (FEMA) were used to derive a seasonal adjustment factor for the CO season (US EPA, 2001c). FEMA reported that 29.6% of residential structure fires and 24.5% of non-residential structural fires occurred during November, December, and January 1994. Thus, an average occurrence of 27.05% [(29.6% + 24.5%) ÷ 2] was used as a seasonal adjustment factor to estimate CO season-day emissions.

CO season-day emissions for Maricopa County were derived by multiplying the annual emissions by the 27.5% seasonal adjustment factor and then dividing the result by 91 (7 days/wk × 13 weeks/season).

Table 3.5−7. Annual and season-day CO emissions from structure fires.

Geographic area	Annual CO emissions (tons/yr)	Season day CO emissions (lbs/day)
Maricopa County	83.56	496.8
CO Maintenance area	80.98	481.4

3.5.1.4 Vehicle fires

2008 vehicle fire data were from the Arizona Department of Fire, Building, and Life Safety (DFBLS). 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 (ADOC, 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 0.25 tons 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 was then multiplied by the emission factor for open burning of automobile components (125 lbs of CO/ton of material burned) from AP-42 as listed in table 3.7–12 (US EPA, 1992). The resultant amount was divided by 2,000 lbs/ton to obtain annual emissions in tons per year.

Annual emissions for the CO maintenance area were derived by multiplying Maricopa County annual emissions by the percentage of total population within the CO maintenance area (96.92%). See Section 1.5.1 for a discussion of the population data used. It is assumed that vehicle fires occur evenly throughout the year. Thus, CO season day emissions were derived by dividing the Maricopa County and maintenance area annual emissions by 366 days/year. The results are shown in Table 3.5−8 below.

Table 3.5−8. Annual and season-day CO emissions from vehicle fires.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	37.55	205.2
CO Maintenance area	36.39	198.8

3.5.1.5 Engine testing

Annual emissions from engine testing facilities were derived from annual emission reports from permitted sources that were not considered point sources in this inventory. It was assumed that there were no significant unpermitted sources within Maricopa County. Season-day emissions were calculated based on operating schedule information provided in the facilities' annual emission reports. Since all facilities considered in this section are located within the CO maintenance area, total emission values for the county and the CO maintenance are equal. Results are shown in Table 3.5–9.

Table 3.5–9. Annual and season-day CO emissions from engine testing.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	4.06	27.5
CO Maintenance Area	4.06	27.5

3.5.2 Health services: crematories

Emissions from human and animal crematories were calculated from annual emissions inventory reports from all crematories located within the county. It is assumed that there are no unpermitted crematories in Maricopa County. CO season-day emissions were calculated based on operating schedule information provided in the facilities annual emission reports. Location information provided in those annual emission reports indicated whether the facility was inside or outside the CO maintenance area.

Table 3.5–10. Annual and season-day CO emissions from crematories.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	0.68	5.2
CO Maintenance Area	0.68	5.1

3.6 Summary of area source emissions

Table 3.6–1 summarizes the total annual and CO season-day emissions from all area sources addressed in this chapter for both Maricopa County and the CO maintenance area.

Table 3.6–1. Summary of annual and season-day area source CO emissions, by source category.

	Maricopa County		CO maintenance area	
Source category	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Fuel combustion:				
Industrial natural gas	358.34	2,513.9	352.68	2,474.1
Industrial fuel oil	1,366.69	8,784.8	1,345.09	8,646.0
Commercial/institutional natural gas	777.15	7,248.7	760.67	7,095.1
Commercial/institutional fuel oil	702.86	4,804.7	687.96	4,702.8
Residential natural gas	325.03	3,592.2	314.79	3,479.1
Residential wood	3,369.91	52,305.0	3,263.75	50,657.4
Residential fuel oil	0.07	1.1	0.07	1.0
Total, all fuel combustion:	**6,900.04**	**79,250.4**	**6,725.01**	**77,055.5**
Industrial processes:				
Commercial cooking	380.29	2,089.5	368.58	2,025.1
Secondary metal production	107.72	703.5	107.72	703.5
State-permitted portable sources	145.42	1,212.6	145.42	1,212.6
Industrial process NEC	18.59	107.3	3.47	22.7
Electric equipment mfg	3.85	21.3	3.85	21.3
Total, all industrial processes:	**655.87**	**4,134.3**	**629.03**	**3,985.3**
Waste treatment/disposal:				
On-site incineration	0.69	5.7	0.69	5.7
Open burning	637.10	16,560.8	183.21	1,284.0
Landfills	40.05	219.9	20.84	114.7
Other industrial waste disposal	52.86	252.9	52.86	252.9
Total, all waste treatment	730.70	17,039.4	257.60	1,657.3
Miscellaneous Area Sources:				
Wildfires	4,837.77	526.4	18.29	0.0
Prescribed fires	4.72	1,226.0	0.00	0.0
Structure fires	83.56	496.8	80.98	481.4
Vehicle fires	37.55	205.2	36.39	198.8
Engine testing	4.06	27.5	4.06	27.5
Crematories	0.68	5.2	0.68	5.1
Total, all miscellaneous sources:	**4,968.33**	**2,486.9**	**140.40**	**712.9**
Total, all area sources:	**13,254.94**	**102,911.0**	**7,752.04**	**83,411.1**

3.7 Quality assurance / quality control procedures

Quality assurance and quality control (QA/QC) activities for the area source emissions inventory were driven by the goal of creating a comprehensive, accurate, representative and comparable inventory of area source emissions for Maricopa County and the CO maintenance 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 prior National Emission Inventories (NEIs) was also evaluated. 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 (e.g., emissions from industrial coal combustion, or oil and natural gas production facilities). Prior Maricopa County periodic inventories for ozone and carbon monoxide, as well as and other similar emission inventories from other locales were also consulted, to cross-check the completeness of the list of area source categories identified for inclusion in the present inventory.

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

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

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

The draft version of the area source chapter was sent to the Arizona Department of Environmental Quality, the Arizona Department of Transportation, and the Maricopa Association of Governments for a quality assurance review. These agencies provided comments which were addressed and incorporated into the final area source chapter. 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.

3.8 References

ADOC, 2008. Arizona Department of Commerce, July 1, 2008 Population Estimates for Arizona's Counties, Incorporated Places and Balance of County, Population Statistics Unit, Research Administration, Arizona Department of Commerce, December 12, 2008. Internet address: http://www.azcommerce.com/doclib/econinfo/FILES/2008AZestimates.pdf

ADOC, 2010. Arizona Department of Commerce, Heating Degree Days: Phoenix. Internet address: http://www.azcommerce.com/doclib/ENERGY/Degreedays.pdf.

ALSD, 2009. Glen Buettner [glenbuettner@azstatefire.org], Forestry Division, Arizona State Land Department, Re: 2008 wildland fire data for Maricopa County, e-mail message, April 20, 2009.

DFBLS, 2009. Frank Fisher [frank.fisher@dfbls.az.gov], Arizona Department of Fire, Building, and Life Safety (DFBLS), Re: data request – 2008 fire data for Maricopa County, e-mail message, May 4, 2009.

FFOW, 2009. Federal Fire Occurrence website, http://wildfire.cr.usgs.gov/firehistory/data.html, federal wildland fire occurrence data downloaded on Aug. 18, 2009.

MCAQD, 2006. Personal communications with George Mills, Dust Compliance Division, MCAQD, and Dena Konopka, MCAQD, November 2006.

MCESD, 1993. 1990 Base year Ozone Emission Inventory for Maricopa County, Arizona, Nonattainment Area, Draft Submittal, Maricopa County Environmental Quality & Community Services Agency, March 1993.

MCESD, 1999. 1999 Periodic Ozone Emissions Inventory for the Maricopa County, Arizona Nonattainment Area, Maricopa County Environmental Services Department, Rev. Aug. 2002.

US Census Bureau, 2010. 2007 County Business Patterns (NAICS). Internet address: http://censtats.census.gov/cgi-bin/cbpnaic/cbpsect.pl

US Census Bureau, 2010a. Selected Housing Characteristics: 2008, 2008 American Community Survey 1-Year Estimates, House Heating Fuel for Maricopa County and Arizona State. Internet address: http://factfinder.census.gov [Accessed 2/10/2010]

US Census Bureau, 2010b. 2008 American Community Survey, Table B25117. Tenure by House Heating Fuel – Universe: Occupied Housing Units. 1-Year Estimates, Fuel oil, kerosene, etc. for Maricopa County and Arizona State [Owner occupied and renter occupied]. Internet address: http://factfinder.census.gov [Accessed 2/10/2010]

USDA, 2008. U.S. Department of Agriculture, Forest Service, Fire and Aviation Management Web Application (FAMWEB), Previous Years ICS-209s. Internet address: https://fam.nwcg.gov/fam-web/

US DOE, 2010. US Department of Energy, Energy Information Administration. State Energy Data 2007: Consumption, Table 8–Residential Sector Energy Consumption Estimates, 1960–2007, Arizona. Internet address: http://www.eia.doe.gov/emeu/states/sep_use/notes/use_print2007.pdf

US DOE, 2010a. US Department of Energy, Energy Information Administration. Adjusted Sales for Industrial Use: Distillate Fuel Oil, Residual Fuel Oil, and Kerosene, 2008 (Table 21).
US DOE, 2010b. US Department of Energy, Energy Information Administration. Adjusted Sales for Commercial Use: Distillate Fuel Oil, Residual Fuel Oil, and Kerosene, 2008 (Table 20).
US EIA, 2010. U.S. Energy Information Administration, Arizona Total Distillate Sales/Deliveries to Residential Consumers. Internet address: http://tonto.eia.doe.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=KD0VRSSAZ1&f=A
US EPA, 1992. Compilation of Air Pollution Emission Factors (AP-42). Volume I: Stationary Point and Area Sources. Fifth ed. Chapter 2: Solid Waste Disposal, 2.5 Open Burning. US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC.
US EPA, 1998. Compilation of Air Pollution Emission Factors (AP-42). Fifth Ed. Vol. I: Stationary Point and Area Sources. Section 1.4: Natural Gas Combustion. US Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC. Internet address: http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s04.pdf
US EPA, 2000. Area Source Category Method Abstract: Vehicle Fires. Emission Inventory Improvement Program (EIIP), May 2000. Internet address: http://www.epa.gov/ttn/chief/eiip/techreport/volume03/vehclf13.pdf
US EPA, 2001a. Introduction To Area Source Emission Inventory Development. Emission Inventory Improvement Program (EIIP) Vol. III, Chap. 1. Prepared by Eastern Research Group, Revised Final, Jan. 2001. Internet address: http://www.epa.gov/ttn/chief/eiip/techreport/volume03/iii01_apr2001.pdf
US EPA, 2001b. Residential Wood Combustion. Emission Inventory Improvement Program (EIIP) Vol. III, Chap. 2. Revised Final, Jan. 2001. Prepared by Eastern Research Group, Inc. for the Area Source Committee, EIIP. Internet address: http://www.epa.gov/ttn/chief/eiip/techreport/volume03/iii02_apr2001.pdf.
US EPA, 2001c. Structure Fires. Emission Inventory Improvement Program (EIIP) Vol. III, Chap. 18. Revised Final, Jan. 2001. Prepared by Eastern Research Group, Inc. for the Area Source Committee, EIIP. Internet address: http://www.epa.gov/ttn/chief/eiip/techreport/volume03/iii18_apr2001.pdf.
US EPA 2006, Documentation for the Final 2002 Nonpoint Sector (Feb 06 version) National Emission Inventory for Criteria and Hazardous Air Pollutants. Prepared by E.H. Pechan & Associates, Inc. for Emission Factor and Inventory Group. Internet address: ftp://ftp.epa.gov/EmisInventory/2002finalnei/documentation/nonpoint/2002nei_final_nonpoint_documentation0206version.pdf
USGS, 2008. United States Geological Survey, GeoMAC (Geospatial Multi-agency Coordination) Wildland Fire Support database. Internet address: http://www.geomac.gov/
USFS, 1993. Cliff Dills, US Forest Service, Payson Ranger Station, Payson AZ, pers. comm.
USFS, 2009. July 28, 2009, E-mail communication with Ronald Sherron, US Forest Service.
WGA/WRAP, 2005. 2002 Fire Emission Inventory for the WRAP Region – Phase II. Project No. 178-6. Western Governors Association/Western Regional Air Partnership. July 22, 2005. Tables 5 and 6. Internet address: http://www.wrapair.org/forums/fejf/documents/WRAP_2002_PhII_EI_Report_20050722.pdf.

4. Nonroad Mobile Sources

4.1 Introduction

Nonroad mobile sources are defined as those sources 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. Table 4.1-1 below 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 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.

NONROAD model default values were adjusted based on 2003 survey results of the commercial lawn and garden industry 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 population estimates 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 local data results in a considerable decrease in emissions from this category, compared with earlier results using EPA default data.

Spatial allocation factors were developed (based on EPA guidance documents) to apportion non-road emissions to the CO maintanence area. The approaches used are described in each section of this chapter.

Temporal allocations (used to calculate CO season-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 below 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 season-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
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. CO maintenance area annual emissions were calculated based on EIIP guidance (US EPA, 2002) which recommends using the ratio of agricultural land inside the maintenance area (84,979 acres) to agricultural land inside the county (295,509 acres). See Section 1.5.2 for a discussion of land-use data used.

County season-day emissions were calculated by multiplying CO season emissions (generated by the NONROAD2002 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 (13) in the CO season (US EPA, 1999).

CO maintenance area season-day emissions were calculated by multiplying county season-day emissions by the agricultural land-use allocation factor.

Table 4.2–1. Annual and season-day CO emissions from agricultural equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	367.01	513.7
CO Maintenance Area	105.55	147.7

4.3 Airport ground support equipment

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 GSE and 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). 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 CO season day emissions were estimated by dividing annual totals by 366 (= days/yr in 2008). Table 4.3–1 below presents the totals for all airport GSE and APU usage within both Maricopa County and the CO maintenance area, on an annual and season-day basis, respectively.

Table 4.3–1. Annual and season day CO emissions from airport ground support equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	4,842.26	26,460.4
CO Maintenance Area	4,765.55	26,041.3

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 CO maintenance area for this category were derived by applying the ratio of industrial employment in the maintenance 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.

County season-day emissions were calculated by multiplying Maricopa County CO season 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 (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on industrial employment ratios as described above.

Table 4.4–1. Annual and season day CO emissions from commercial equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	37,407.59	204,928.7
CO Maintenance Area	36,816.55	201,690.8

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 CO maintenance area for this category were derived by applying the ratio of population in the maintenance 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 population data used.

County season-day emissions were calculated by multiplying Maricopa County CO season 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 (13) in the CO season (US EPA, 1999). CO

maintenance area season-day emissions were calculated based on population ratios as described above.

Table 4.5–1. Annual and season day CO emissions from construction and mining equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	17,097.10	90,379.7
CO Maintenance Area	15,753.27	83,275.9

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 CO maintenance area for this category were derived by applying the ratio of industrial employment in the maintenance 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 not available. See Section 1.5.1 for a discussion of the industrial employment data used.

County season-day emissions were calculated by multiplying Maricopa County CO season 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 (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on industrial employment ratios as described above.

Table 4.6–1. Annual and season day CO emissions from industrial equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	10,294.56	64,617.8
CO Maintenance Area	10,131.90	63,596.8

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 new equipment population and usage estimates from survey work done in early 2003 for the Arizona Department of Environmental Quality (discussed further in Section 4.1). Annual emissions for the CO maintenance area for this category were derived by applying the ratio of population in the maintenance area to Maricopa County-level totals, since housing units was not available, as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.1 for a discussion of the population data used.

County season-day emissions were calculated by multiplying Maricopa County CO season 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 the number of weeks (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on population as described above.

Table 4.7–1. Annual and season day CO emissions from lawn and garden equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	66,712.36	100,753.6
CO Maintenance Area	64,657.62	97,650.4

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 CO maintenance area for this category were derived by applying the ratio of water surface area in the maintenance 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.

County season-day emissions were calculated by multiplying Maricopa County CO season emissions (generated by the NONROAD model) by the most conservative weekday/weekend day activity allocation factor for pleasure craft (0.350000) listed in Table 4.1–2, and dividing the product by the number of weeks (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on water surface area as described above.

Table 4.8–1. Annual and season day CO emissions from pleasure craft equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	1,627.41	5,008.5
CO Maintenance Area	431.81	1,328.9

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 CO maintenance area for this category were derived by applying the ratio of population in the maintenance 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.

County season-day emissions were calculated by multiplying Maricopa County CO season 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 (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on the population ratio as described above.

Table 4.9–1. Annual and season day CO emissions from railway maintenance equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	19.33	120.8
CO Maintenance Area	18.73	117.1

4.10 Recreational equipment

Annual emissions from recreational equipment in Maricopa County were calculated using EPA's NONROAD model (see Section 4.1). Annual emissions for the CO maintenance area were

derived by applying the ratio of passive open space, golf courses and vacant land use in the CO maintenance area to Maricopa County-level totals per EIIP guidance (US EPA, 2002). See Section 1.5.2 for a discussion of the land use data used.

County season-day emissions were calculated by multiplying Maricopa County CO season 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 (13) in the CO season (US EPA, 1999). CO maintenance area season-day emissions were calculated based on land use as described above.

Table 4.10–1. Annual and season day CO emissions from recreational equipment.

Geographic area	Annual CO emissions (tons/yr)	Season-day CO emissions (lbs/day)
Maricopa County	7,270.41	24,593.7
CO Maintenance Area	412.23	1,394.5

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 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 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, or (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 Data 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.

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'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. 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). Data from FAA's Air Traffic Activity Data 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 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. For ease in modeling computation and the assessment of emissions, all activity was assumed to occur evenly throughout the year. Thus, CO season day emissions were calculated by dividing annual totals by 366 (= days per year in 2008). Table 4.11–3 lists the total annual emissions and season-day emissions, of each airport and aircraft type, and for airports within and outside the CO maintenance area, respectively.

Table 4.11–3. Annual and season-day CO emissions, by airport and aircraft type.

Airport	Category[1]	Annual CO Emissions (tons/yr)	Typical season day CO emissions (lbs/day)
Buckeye Muni (BXK)	Aircraft: GA	351.30	1,919.7
Chandler Muni (CHD)	Aircraft: AT	13.70	74.8
	Aircraft: GA	2,146.93	11,731.8
	Aircraft: ML	1.28	7.0
	CHD total	2,161.90	11,813.7
Falcon Field (FFZ)	Aircraft: AC	0.03	0.2
	Aircraft: AT	15.25	83.3
	Aircraft: GA	2,824.89	15,436.5
	Aircraft: ML	9.28	50.7
	FFZ total	2,849.45	15,570.8
Gila Bend Muni (E63)	Aircraft: GA	23.42	128.0
Glendale Muni (GEU)	Aircraft: AT	118.76	648.9
	Aircraft: GA	1,068.47	5,838.6
	Aircraft: ML	0.65	3.6
	GEU total	1,187.88	6,491.1
Luke AFB (LUF)	Aircraft: ML	665.20	3,635.0
Phx Deer Valley (DVT)	Aircraft: AC	2.29	12.5
	Aircraft: AT	26.75	146.2
	Aircraft: GA	3,159.04	17,262.5
	Aircraft: ML	0.83	4.5
	DVT total	3,188.91	17,425.7
Phx Goodyear (GYR)	Aircraft: AC	0.81	4.4
	Aircraft: AT	8.30	45.3
	Aircraft: GA	2,428.23	13,269.0
	Aircraft: ML	36.49	199.4
	GYR total	2,473.82	13,518.1
Phx Sky Harbor (PHX)	Aircraft: AC	1,795.49	9,811.4
	Aircraft: AT	200.51	1,095.7
	Aircraft: GA	151.06	825.5
	Aircraft: ML	24.69	134.9
	PHX total	2,171.75	11,867.5
Williams Gateway (IWA)	Aircraft: AC	14.37	78.5
	Aircraft: AT	30.55	166.9
	Aircraft: GA	823.11	4,497.8
	Aircraft: ML	48.93	267.4
	IWA total	916.95	5,010.7
Pleasant Valley (P48)	Aircraft: GA	2.70	14.7
Scottsdale (SDL)	Aircraft: AT	52.75	288.3
	Aircraft: GA	702.20	3,837.1
	Aircraft: ML	3.53	19.3
	SDL total:	758.48	4,144.7
Sky Ranch / Carefree	Aircraft: GA	11.61	63.4
Stellar Airpark (P19)	Aircraft: GA	294.75	1,610.7
Wickenburg Muni (E25)	Aircraft: GA	47.39	259.0
	County totals:	17,105.50	93,472.7
Maricopa County	Aircraft: AC	1,812.99	9,907.0
	Aircraft: AT	466.56	2,549.5
	Aircraft: GA	14,035.08	76,694.4
	Aircraft: ML	790.88	4,321.8
	Aircraft, total	17,105.50	93,472.7
CO Maintenance area: (excludes Buckeye, Gila Bend and Wickenburg)	Aircraft: AC	1,812.99	9,907.0
	Aircraft: AT	466.56	2,549.5
	Aircraft: GA	13,613.0	74,387.8
	Aircraft: ML	790.88	4,321.8
	Aircraft, total	16,683.40	91,166.1

1. AC = air carrier, GA = general aviation, AT = air taxi, ML = military.

4.12 Locomotives

Annual emissions from locomotives were calculated based on diesel fuel usage 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 Class I haul operations and yard/switching operations 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)
Class I haul line	0.059
Yard/switch operations	0.061

Fuel use reported by railroads, and annual emission totals are summarized in Table 4.12–2.

Table 4.12–2. Fuel use and annual CO emissions from locomotives in Maricopa County.

Locomotive type	Diesel fuel used (gals)	Annual CO emissions (tons/yr)
BNSF Class I haul line	750,094	22.13
UP Class I haul line	7,780,284	229.52
BNSF yard/switch operations	400,000	12.20
UP yard/switch operations	378,199	11.54
Amtrak	52,416	1.55
Totals:	**9,360,993**	**276.93**

CO maintenance area emissions were calculated by multiplying Maricopa County emissions by the percentage of track miles inside the CO maintenance area, determined by GIS mapping. Results are shown in Table 4.12–3.

Table 4.12–3. Annual CO emissions (in tons/yr) from locomotives in the CO maintenance area.

Locomotive type	Track in maintenance area (%)	Annual CO emissions (tons/yr)
BNSF Class I haul line	37.95	8.40
UP Class I haul line	37.95	87.10
BNSF yard/switch operations	100.00	12.20
UP yard/switch operations	100.00	11.54
Amtrak	0.00	0.00
Totals:		**119.23**

CO season-day emissions for both the county and the CO maintenance area (shown in Table 4.12–4) were calculated by dividing annual totals by 366 days per year (= days/yr in 2008), as locomotive activity is assumed to be uniform throughout the year.

Table 4.12–4. Season-day emissions (in lbs/day) from locomotives in Maricopa County and the CO maintenance area.

Locomotive type	Maricopa County	CO maintenance area
BNSF Class I haul line	120.9	45.9
UP Class I haul line	1,254.2	476.0
BNSF yard/switch operations	66.7	66.7
UP yard/switch operations	63.0	63.0
Amtrak	8.4	0.0
Totals:	**1,513.3**	**651.6**

4.13 Summary of all nonroad mobile source emissions

Table 4.13−1 summarizes the annual and season-day emissions of carbon monoxide from nonroad mobile sources in Maricopa County and the CO maintenance area.

Table 4.13–1. Summary of annual and season-day CO emissions from nonroad mobile sources.

	Annual CO emissions (tons/yr)		Season-day CO emissions	
Equipment category	Maricopa County	CO maintenance area	Maricopa County	CO mainten-ance area
Agricultural	367.01	513.7	105.55	147.7
Airport GSE (+APU)	4,842.26	26,460.4	4,765.55	26,041.3
Commercial equipment	37,407.59	204,928.7	36,816.55	201,690.8
Construction & mining equipment	17,097.10	90,379.7	15,753.27	83,275.9
Industrial equipment	10,294.56	64,617.8	10,131.90	63,596.8
Lawn & garden equipment	66,712.36	100,753.6	64,657.62	97,650.4
Pleasure craft	1,627.41	5,008.5	431.81	1,328.9
Railway maintenance	19.33	120.8	18.73	117.1
Recreational equipment	7,270.41	24,593.7	412.23	1,394.5
Aircraft	17,105.50	93,472.7	16,683.40	91,166.1
Locomotives	276.93	1,513.3	119.23	651.6
Totals:	**163,020.46**	**612,362.8**	**149,895.85**	**567,061.0**

4.14 Quality assurance procedures

Established procedures were used to check, and correct when necessary, the off-road mobile sources emissions estimates. All NONROAD model input and output files, and Excel spreadsheets used to calculate the emissions, were checked by personnel who were not involved in the development of the modeling inputs/outputs and spreadsheets. In addition, the emissions estimates were reviewed for reasonableness by external agency staff.

4.15 References

ENVIRON *et al.*, 2003. Maricopa County 2002 Comprehensive Emission Inventory for the Cap and Trade Oversight Committee, Final Rep. prepared for Arizona Dept. of Environmental Quality, October 9, 2003.

US EPA, 2009. Emission Factors for Locomotives. Office of Transportation and Air Quality. Rep. EPA420-F-09-025, April 2009. Internet address http://www.epa.gov/otaq/regs/nonroad/locomotv/420f09025.pdf

US EPA, 2002. Geographic Allocation of State Level Nonroad Engine Population Data to the County Level. EPA Office of Transportation and Air Quality, Rep. EPA420-P-02-009, July. Internet address: http://www.epa.gov/otaq/ models/nonrdmdl/p02009.pdf.

US EPA, 1999. Weekday and Weekend Day Temporal Allocation of Activity in the NONROAD Model. EPA Office of Transportation and Air Quality, Rep. EPA420-P-99-033, March. Internet address: http://www.epa.gov/otaq/ models/nonrdmdl/p99033.pdf.

Weston Solutions Inc., 2010. 2008 Mobile source Air Emissions Inventory for Luke Air force Base. Rept. Prepared for Air Education and Training Command (AETC), US Air Force, Randolph AFB, TX. June 2010.

5. Onroad Mobile Sources

5.1 Introduction

Onroad mobile source emissions for carbon monoxide (CO) have been calculated for the CO maintenance area and Maricopa County for the 2008 Periodic Emissions Inventory (PEI).

Motor Vehicle Emission Simulator (MOVES2010b) is the latest model developed by the U.S. Environmental Protection Agency (EPA) for the purpose of estimating onroad and off-network motor vehicle emission factors.

The MOVES2010b 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 traveled (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 MOVES2010b to produce onroad exhaust emissions.

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);
- Quality Review Guidelines for 1990 Base Year Emission Inventories (EPA, 1992b);
- User's Guide for the SMOKE-MOVES Integration Tool (EPA, 2010a);
- Motor Vehicle Emission Simulator (MOVES) - User Guide Version, MOVES2010b (EPA, 2012a);
- Policy Guidance on the Use of MOVES2010 and Subsequent Minor Revisions for State Implementation Plan Development, Transportation Conformity, and Other Purposes (EPA, 2012b); and
- Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a and 2010b (EPA, 2012c).

5.2 Exhaust emissions

Vehicle exhaust emission factors for CO were calculated using MOVES2010b. The MOVES2010b runs were executed by MAG. The contact person for the MOVES2010b emission estimates is Ieesuck Jung (602-254-6300).

5.2.1 MOVES2010b model

The emissions were calculated using MOVES2010b. MOVES2010b is EPA's state-of-the-art emissions modeling tool, which replaces EPA's previous mobile source emissions model, MOBILE6.2. MOVES2010b is intended for official use to estimate national, state, and county

level inventories of criteria air pollutants from highway vehicles. The user of MOVES2010b is allowed to specify vehicle types, time periods, geographical areas, pollutants, vehicle operating characteristics, and road types for a particular scenario to be modeled by creating a Run Specification (RunSpec).

In order to calculate vehicle emissions for the calendar year 2008, MOVES2010b was executed using local input data for each month of the year and each geographical area (the CO maintenance area and Maricopa County). Each scenario was created using the County Domain/Scale and the Inventory Calculation Type. The specific MOVES2010b model RunSpec and RunSpec summaries are described in Appendix 3.

5.2.2 MOVES2010b local input data

Compared with MOBILE6.2, MOVES2010b 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, ramp fraction, and Alternative Vehicle and Fuel Technologies (AVFT) strategy.

5.2.2.1 Fuel data

Regarding the fuel local input data, MOVES2010b 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 CO maintenance area. The specific MOVES tables for fuel data are presented in Appendix 3.

5.2.2.2 I/M programs

MOVES2010b 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 CO maintenance area, with the exception of certain model years and vehicle classes. However, it is assumed that 91.6 percent of the vehicles operating within the CO maintenance area 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 the CO maintenance area and Maricopa County. The specific MOVES table for I/M programs is presented in Appendix 3.

5.2.2.3 Meteorological data

MOVES2010b 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 the CO maintenance area and Maricopa County. The specific MOVES table [ZoneMonthHour] for meteorological data is presented in Appendix 3.

5.2.2.4 Vehicle population

In order to capture start, evaporative, and extended idle emissions, MOVES2010b introduced a new mobile source emission category called off-network emissions. In MOVES2010b, these off-network emissions are directly determined by 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 EPA's technical guidance (EPA, 2010a). The vehicle population in the CO maintenance area 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 3,688,000 people for the CO maintenance area and 3,988,000 people for Maricopa County. The specific MOVES table [SourceTypeYear] for vehicle population is presented in Appendix 3.

5.2.2.5 Source type age distribution

MOVES2010b categorizes vehicles according to 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 the CO maintenance area and Maricopa County. The specific MOVES table for source type age distribution is presented in Appendix 3.

5.2.2.6 Annual VMT

The 2008 daily VMTs by facility type were used to estimate onroad exhaust emissions. The 2008 VMT distributions by facility type for the CO maintenance area 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 CO maintenance area and Maricopa County. The resultant VMT estimates by facility type for the CO maintenance area and Maricopa County are shown in Table 5.2-1.

Since MOVES2010b 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 January 2012 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 3.

Table 5.2–1. 2008 daily VMT by facility type (annual average daily traffic).

	Facility Type	CO Maintenance Area (thousand miles/day)	Maricopa County (thousand miles/day)
Rural	Interstate	2,040	3,223
	Other Principal Arterial	819	1,293
	Minor Arterial	418	661
	Major Collector	1,065	1,682
	Minor Collector	130	205
	Local	498	787
Urban	Interstate	10,467	10,939
	Other Freeway/Expressway	18,907	19,760
	Other Principal Arterial	21,673	22,651
	Minor Arterial	14,285	14,930
	Collector	4,655	4,865
	Local	9,818	10,261
Totals:		**84,775**	**91,257**

5.2.2.7 Road type distribution

MOVES2010b 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 3.

5.2.2.8 VMT fraction

Since VMT varies by month, day of week, and hour, MOVES2010b 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 3.

5.2.2.9 Average speed distribution

In MOVES2010b, vehicle power, speed, and acceleration have a significant effect on vehicle emissions for all pollutants. MOVES2010b 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), estimates of local average speeds were developed by post-processing the output from the 2008 traffic assignment data provided by the MAG transportation modeling group in January 2012. 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 CO maintenance area. The specific MOVES table [AvgSpeedDistribution] for the average speed distribution is presented in Appendix 3.

5.2.2.10 Ramp fraction

MOVES2010b 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 January 2012. The specific MOVES table [RoadType] for ramp fractions is presented in Appendix 3.

5.2.2.11 AVFT strategy

MOVES2010b allows users to modify the fuel engine fraction using different fuels and technologies in each model year in order to reflect the local situation. The fleet information for transit buses for model years 1997 through 2010 was provided by Valley Metro and used to prepare the AVFT input file. Since the fleet data are available only for specific model years, MOVES2010b default values were obtained from the [fuelEngFraction] table in the MOVES default database and used for the rest of the model years. The specific MOVES table [AVFT] for AVFT strategy is presented in Appendix 3.

5.2.3 MOVES2010b outputs

MOVES2010b was executed with the RunSpec files described in Appendix 3 to obtain exhaust emissions for CO. These values were obtained for the following categories by month:

- 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 classes 3, 4, and 5 (LHDDV), heavy duty diesel vehicles classes 6 and 7 (MHDDV), heavy duty diesel vehicles classes 8A and 8B (HHDDV), and heavy duty diesel buses (BUSES)
- 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 MOVES2010b
- Days: weekdays and weekend days

5.2.4 MOVES2010b emission estimates

MOVES2010b was used to generate onroad emissions by vehicle class, facility type, weekdays /weekend days, and month. By specifying the output time aggregate level as month, MOVES2010b produces monthly emissions including weekday and weekend emissions for a given month. The annual emissions were calculated by aggregating monthly onroad emissions derived by MOVES2010b. The CO season-day emissions were calculated by dividing the three-month peak CO season emissions from November through January by 92 days.

Table 5.2-2 shows the calculated annual and season-day CO emissions by facility type and vehicle class in the CO maintenance area and Maricopa County.

Table 5.2–2. Annual and CO season-day onroad mobile source emissions by facility type and vehicle class in the CO maintenance area and Maricopa County.

Facility Type	Vehicle Class	SCC	Annual CO emissions (tons/year)		Season-day CO emissions (lbs/day)	
			CO Maintenance Area	Maricopa County	CO Maintenance Area	Maricopa County
Rural Interstate	LDGV	2201001110	1,315.28	2,145.56	5,249.8	8,541.7
	LDGT1	2201020110	1,026.34	1,716.57	4,191.5	6,991.0
	LDGT2	2201040110	528.72	884.29	2,159.3	3,601.4
	HDGV	2201070110	410.53	540.14	1,970.5	2,543.7
	MC	2201080110	46.53	63.10	236.8	321.1
	LDDV	2230001110	0.35	0.52	1.5	2.3
	LDDT	2230060110	7.61	11.09	32.7	47.5
	2BHDDV	2230071110	3.33	4.85	14.3	20.7
	LHDDV	2230072110	18.21	26.48	78.5	113.7
	MHDDV	2230073110	64.39	84.06	351.2	458.6
	HHDDV	2230074110	162.43	260.03	886.0	1,418.6
	BUSES	2230075110	3.67	6.41	20.0	34.9
Rural Principal Arterial	LDGV	2201001130	682.58	1,062.08	2,788.2	4,329.5
	LDGT1	2201020130	562.67	876.46	2,345.7	3,643.6
	LDGT2	2201040130	289.86	451.51	1,208.4	1,877.0
	HDGV	2201070130	139.18	214.84	646.3	995.6
	MC	2201080130	32.65	46.22	166.2	235.2
	LDDV	2230001130	0.25	0.38	1.1	1.7
	LDDT	2230060130	5.68	8.45	24.9	36.8
	2BHDDV	2230071130	2.48	3.70	10.8	16.1
	LHDDV	2230072130	13.60	20.20	59.6	88.2
	MHDDV	2230073130	16.94	26.68	92.5	145.6
	HHDDV	2230074130	38.90	64.41	212.3	351.5
	BUSES	2230075130	3.01	5.30	16.5	28.9
Rural Minor Arterial	LDGV	2201001150	663.29	1,032.06	2,709.3	4,207.1
	LDGT1	2201020150	546.76	851.69	2,279.4	3,540.7
	LDGT2	2201040150	281.67	438.75	1,174.3	1,824.0
	HDGV	2201070150	135.25	208.77	628.1	967.4
	MC	2201080150	31.73	44.92	161.5	228.6
	LDDV	2230001150	0.24	0.37	1.1	1.6
	LDDT	2230060150	5.52	8.21	24.2	35.8
	2BHDDV	2230071150	2.41	3.59	10.5	15.6
	LHDDV	2230072150	13.21	19.63	57.9	85.7
	MHDDV	2230073150	16.46	25.93	89.8	141.5
	HHDDV	2230074150	37.80	62.59	206.3	341.5
	BUSES	2230075150	2.93	5.15	16.0	28.1
Rural Major Collector	LDGV	2201001170	123.63	192.36	505.0	784.1
	LDGT1	2201020170	101.91	158.74	424.9	659.9
	LDGT2	2201040170	52.50	81.78	218.9	340.0
	HDGV	2201070170	25.21	38.91	117.1	180.3
	MC	2201080170	5.91	8.37	30.1	42.6
	LDDV	2230001170	0.04	0.07	0.2	0.3
	LDDT	2230060170	1.03	1.53	4.5	6.7
	2BHDDV	2230071170	0.45	0.67	2.0	2.9
	LHDDV	2230072170	2.46	3.66	10.8	16.0
	MHDDV	2230073170	3.07	4.83	16.7	26.4
	HHDDV	2230074170	7.04	11.67	38.4	63.7
	BUSES	2230075170	0.55	0.96	3.0	5.2

Table 5.2–2. Annual and CO season-day onroad mobile source emissions by facility type and vehicle class in the CO maintenance area and Maricopa County (continued).

Facility Type	Vehicle Class	SCC	Annual CO emissions (tons/year)		Season-day CO emissions (lbs/day)	
			CO Maintenance Area	Maricopa County	CO Maintenance Area	Maricopa County
Rural Minor Collector	LDGV	2201001190	28.62	44.53	116.9	181.5
	LDGT1	2201020190	23.59	36.75	98.4	152.8
	LDGT2	2201040190	12.15	18.93	50.7	78.7
	HDGV	2201070190	5.84	9.01	27.1	41.7
	MC	2201080190	1.37	1.94	7.0	9.9
	LDDV	2230001190	0.01	0.02	0.0	0.1
	LDDT	2230060190	0.24	0.35	1.0	1.5
	2BHDDV	2230071190	0.10	0.16	0.5	0.7
	LHDDV	2230072190	0.57	0.85	2.5	3.7
	MHDDV	2230073190	0.71	1.12	3.9	6.1
	HHDDV	2230074190	1.63	2.70	8.9	14.7
	BUSES	2230075190	0.13	0.22	0.7	1.2
Rural Local	LDGV	2201001210	299.00	465.24	1,221.4	1,896.5
	LDGT1	2201020210	246.48	383.93	1,027.6	1,596.1
	LDGT2	2201040210	126.97	197.78	529.3	822.2
	HDGV	2201070210	60.97	94.11	283.1	436.1
	MC	2201080210	14.30	20.25	72.8	103.0
	LDDV	2230001210	0.11	0.17	0.5	0.7
	LDDT	2230060210	2.49	3.70	10.9	16.1
	2BHDDV	2230071210	1.09	1.62	4.7	7.0
	LHDDV	2230072210	5.96	8.85	26.1	38.6
	MHDDV	2230073210	7.42	11.69	40.5	63.8
	HHDDV	2230074210	17.04	28.21	93.0	154.0
	BUSES	2230075210	1.32	2.32	7.2	12.7
Urban Interstate	LDGV	2201001230	10,581.17	11,055.84	42,347.7	44,246.7
	LDGT1	2201020230	7,657.75	8,003.28	31,375.3	32,790.3
	LDGT2	2201040230	3,944.90	4,122.90	16,163.0	16,892.0
	HDGV	2201070230	3,124.96	3,260.99	15,041.9	15,695.1
	MC	2201080230	339.16	354.16	1,726.2	1,802.6
	LDDV	2230001230	2.69	2.81	11.7	12.2
	LDDT	2230060230	58.55	61.12	253.0	264.0
	2BHDDV	2230071230	25.58	26.70	110.3	115.1
	LHDDV	2230072230	140.47	146.62	608.2	634.8
	MHDDV	2230073230	436.75	455.92	2,382.4	2,486.9
	HHDDV	2230074230	990.85	1,036.24	5,404.9	5,652.5
	BUSES	2230075230	36.86	38.59	201.0	210.5
Urban Freeway And Expressway	LDGV	2201001250	11,101.55	11,599.57	44,430.4	46,422.8
	LDGT1	2201020250	8,034.36	8,396.88	32,918.3	34,402.9
	LDGT2	2201040250	4,138.91	4,325.66	16,957.9	17,722.7
	HDGV	2201070250	3,278.65	3,421.37	15,781.8	16,467.0
	MC	2201080250	355.84	371.58	1,811.1	1,891.2
	LDDV	2230001250	2.82	2.95	12.2	12.8
	LDDT	2230060250	61.43	64.13	265.4	277.0
	2BHDDV	2230071250	26.83	28.01	115.7	120.8
	LHDDV	2230072250	147.38	153.83	638.1	666.0
	MHDDV	2230073250	458.23	478.34	2,499.5	2,609.2
	HHDDV	2230074250	1,039.58	1,087.20	5,670.8	5,930.5
	BUSES	2230075250	38.67	40.49	210.9	220.9

Table 5.2–2. Annual and CO season-day onroad mobile source emissions by facility type and vehicle class in the CO maintenance area and Maricopa County (continued).

Facility Type	Vehicle Class	SCC	Annual CO emissions (tons/year)		Season-day CO emissions (lbs/day)	
			CO Maintenance Area	Maricopa County	CO Maintenance Area	Maricopa County
Urban Principal Arterial	LDGV	2201001270	17,742.84	18,539.93	73,323.3	76,615.7
	LDGT1	2201020270	12,966.07	13,548.16	54,751.7	57,207.8
	LDGT2	2201040270	6,679.49	6,979.35	28,205.4	29,470.7
	HDGV	2201070270	3,594.78	3,756.21	16,948.1	17,708.9
	MC	2201080270	546.45	571.05	2,781.0	2,906.2
	LDDV	2230001270	6.86	7.17	30.6	31.9
	LDDT	2230060270	150.86	157.58	669.7	699.5
	2BHDDV	2230071270	65.87	68.80	291.9	304.8
	LHDDV	2230072270	362.20	378.33	1,611.1	1,682.7
	MHDDV	2230073270	463.74	484.61	2,530.6	2,644.5
	HHDDV	2230074270	965.51	1,008.84	5,268.8	5,505.2
	BUSES	2230075270	61.82	64.60	337.4	352.5
Urban Minor Arterial	LDGV	2201001290	9,018.61	9,423.76	37,270.0	38,943.4
	LDGT1	2201020290	6,590.60	6,886.47	27,830.0	29,078.5
	LDGT2	2201040290	3,395.16	3,547.57	14,336.7	14,979.8
	HDGV	2201070290	1,827.21	1,909.26	8,614.6	9,001.4
	MC	2201080290	277.76	290.26	1,413.6	1,477.2
	LDDV	2230001290	3.49	3.64	15.5	16.2
	LDDT	2230060290	76.68	80.10	340.4	355.6
	2BHDDV	2230071290	33.48	34.97	148.3	154.9
	LHDDV	2230072290	184.11	192.30	818.9	855.3
	MHDDV	2230073290	235.72	246.32	1,286.3	1,344.2
	HHDDV	2230074290	490.77	512.79	2,678.1	2,798.3
	BUSES	2230075290	31.43	32.83	171.5	179.2
Urban Collector	LDGV	2201001310	1,761.28	1,840.40	7,278.6	7,605.4
	LDGT1	2201020310	1,287.10	1,344.88	5,435.0	5,678.8
	LDGT2	2201040310	663.05	692.82	2,799.9	2,925.5
	HDGV	2201070310	356.84	372.87	1,682.4	1,757.9
	MC	2201080310	54.24	56.69	276.1	288.5
	LDDV	2230001310	0.68	0.71	3.0	3.2
	LDDT	2230060310	14.98	15.64	66.5	69.4
	2BHDDV	2230071310	6.54	6.83	29.0	30.3
	LHDDV	2230072310	35.95	37.56	159.9	167.0
	MHDDV	2230073310	46.03	48.11	251.2	262.5
	HHDDV	2230074310	95.84	100.14	523.0	546.5
	BUSES	2230075310	6.14	6.41	33.5	35.0
Urban Local	LDGV	2201001330	8,501.75	8,883.68	35,134.1	36,711.5
	LDGT1	2201020330	6,212.89	6,491.80	26,235.1	27,412.0
	LDGT2	2201040330	3,200.58	3,344.26	13,515.0	14,121.3
	HDGV	2201070330	1,722.49	1,799.84	8,120.9	8,485.5
	MC	2201080330	261.84	273.63	1,332.5	1,392.5
	LDDV	2230001330	3.29	3.43	14.6	15.3
	LDDT	2230060330	72.29	75.51	320.9	335.2
	2BHDDV	2230071330	31.56	32.97	139.8	146.1
	LHDDV	2230072330	173.56	181.28	772.0	806.3
	MHDDV	2230073330	222.21	232.21	1,212.6	1,267.1
	HHDDV	2230074330	462.64	483.40	2,524.6	2,637.9
	BUSES	2230075330	29.62	30.95	161.7	168.9

Table 5.2–2. Annual and CO season-day onroad mobile source emissions by facility type and vehicle class in the CO maintenance area and Maricopa County (continued).

Facility Type	Vehicle Class	SCC	Annual CO emissions (tons/year)		Season-day CO emissions (lbs/day)	
			CO Maintenance Area	Maricopa County	CO Maintenance Area	Maricopa County
Off-Network	LDGV	2201001000	44,232.59	47,830.69	316,294.2	342,022.9
	LDGT1	2201020000	20,331.12	21,984.95	121,473.5	131,354.9
	LDGT2	2201040000	10,473.60	11,325.57	62,577.3	67,667.6
	HDGV	2201070000	5,302.43	5,733.76	29,934.9	32,370.0
	MC	2201080000	68.78	74.37	748.5	809.4
	LDDV	2230001000	12.03	13.01	71.6	77.5
	LDDT	2230060000	16.20	17.52	95.7	103.5
	2BHDDV	2230071000	6.96	7.52	41.2	44.5
	LHDDV	2230072000	37.59	40.65	222.4	240.5
	MHDDV	2230073000	216.62	233.95	1,201.1	1,297.2
	HHDDV	2230074000	1,231.54	1,326.20	6,745.5	7,264.1
	BUSES	2230075000	81.74	88.39	453.2	490.0

5.3 Summary of CO emissions from onroad mobile sources

Table 5.3-1 summarizes the annual and season-day emissions for CO from all onroad mobile sources in the CO maintenance area and Maricopa County in 2008.

Table 5.3–1. Annual and CO season-day emissions from all onroad mobile sources in the CO maintenance area and Maricopa County.

Emission Category	Annual CO emissions (tons/year)	Season-day CO emissions (lbs/day)
Maricopa County	255,355.67	1,293,502.6
CO maintenance area	237,324.41	1,201,621.5

5.4 Quality assurance process

5.4.1 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.

5.4.2 Emission estimates

The quality assurance process performed on the MOVES2010b 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 corrections were then rechecked by the reviewer.

5.4.3 Draft CO emissions inventory

The draft onroad mobile source portion of the 2008 periodic CO 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.

5.5 References

MAG, 2009. MAG Eight-Hour Ozone Redesignation Request and Maintenance Plan for the Maricopa Nonattainment Area, February 2009.

US EPA, 1991. Emission Inventory Requirements for Ozone State Implementation Plans, EPA-450/4-91-010, March 1991.

US EPA, 1992a. Procedures for Emission Inventory Preparation Volume IV: Mobile Sources, EPA-450/4-81-026d (Revised), 1992.

US EPA, 1992b. Quality Review Guidelines for 1990 Base Year Emission Inventories, EPA-454/R-92-007, July 1992.

US EPA, 2010a. User's Guide for the SMOKE-MOVES Integration Tool, EPA Contract EP-D-07-102 (WA 3-03), July 2010.

US EPA, 2012a. Motor Vehicle Emission Simulator (MOVES) - User Guide Version, MOVES2010b, EPA-420-B-12-001, March 2012.

US EPA, 2012b. Policy Guidance on the Use of MOVES2010 and Subsequent Minor Revisions for State Implementation Plan Development, Transportation Conformity, and Other Purposes, EPA-420-B-12-010, April 2012.

US EPA, 2012c. Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a and 2010b, EPA-420-B-12-028, April 2012.

6. Biogenic Sources

6.1 Introduction

Biogenic emissions have been estimated for the 2008 Periodic Emissions Inventory for carbon monoxide (CO) in Maricopa County (9,223 square miles) and the CO maintenance area (MA) (1,814 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 and Feng Liu, 2009) compared to previous versions (Guenther, 2006, 2006a and 2006b). MEGAN2.04 was applied to compute biogenic emissions in Maricopa County and the CO MA. Estimated emissions for CO are included in this biogenic emissions 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 two dimensional grid cells. To develop biogenic emissions for the 2008 Periodic Emission Inventory for CO, 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 to develop biogenic CO emissions for the CO MA and Maricopa County, respectively. The definition of the domains in the Universal Transverse Mercator (UTM) coordinate system is presented in Table 6.2–1. Since MEGAN estimates biogenic emissions for an entire modeling domain, masking areas covered by the CO MA and Maricopa County, were developed by applying Geographic Information Systems (GIS) to those two target areas. For 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 CO MA and Maricopa County were extracted from MEGAN outputs 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 by 29	(297,3652) to (497,3768)	CO Maintenance Area
12-km	111 by 84	(-275,3188) to (1057,4196)	Maricopa County

6.3 Input data

To calculate biogenic emissions using MEGAN, the following gridded land-cover and meteorological input files were prepared:

1) EFMAP_LAI file: This file provides emission factors (EF) for 20 MEGAN species including NOx, CO and VOC, and monthly average leaf index (LAI) for 12 months for each grid cell.

2) PFTF file: This input file gives the percentage of four plant function types (PFT) including broadleaf trees (BT), needle leaf trees (NT), grass and crops (HB) and shrubs (SB) for each modeling 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.

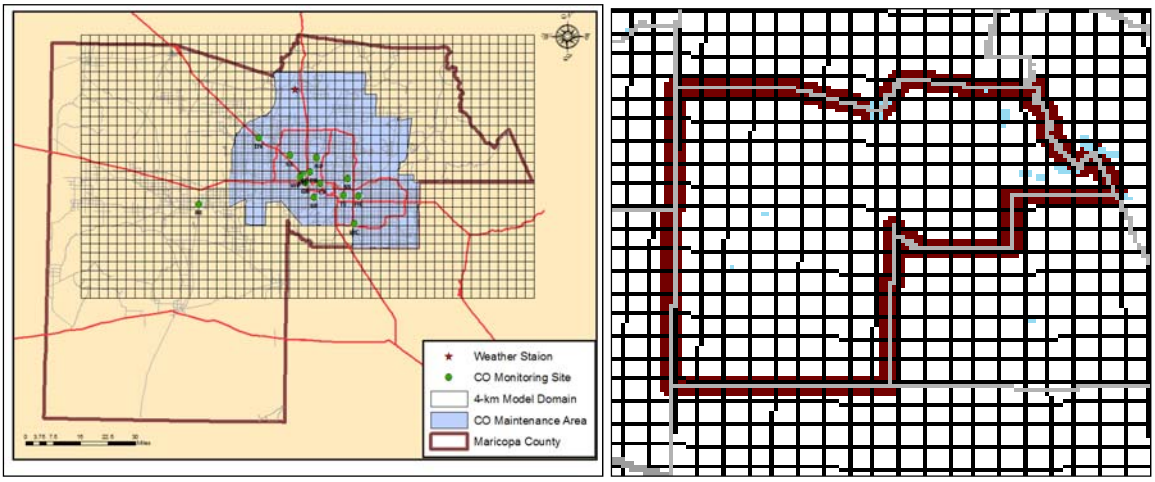


Figure 6.3–1. Masked CO maintenance area (blue area) in the 4-km domain (left) and Maricopa County in the 12-km domain (right). The red star in the left panel denotes the meteorological observation site.

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 (~ 1x1 km^2) in ArcGIS format (http://acd.ucar.edu/~guenther/MEGAN/MEGAN.htm). For the MEGAN runs, however, the default land cover data 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 include 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, see the red star in Figure 6.3–1), 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.

Biogenic emissions of CO are highly dependent on temperature and downward short wave radiation. Figure 6.3–2 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). Data analysis indicates that temperature and radiation peak values occur in June. The maximum monthly CO biogenic emission rates would be expected to occur in the same month.

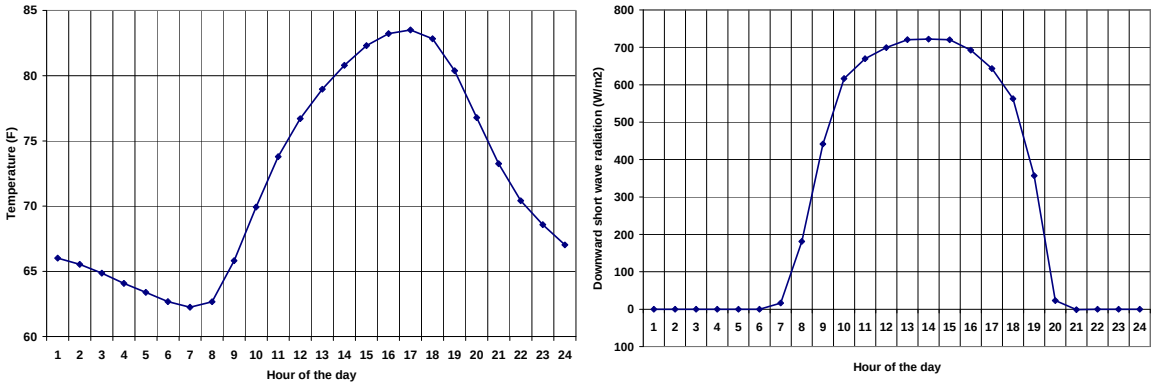


Figure 6.3–2. Annual mean diurnal cycles of measured temperature (left) and downward short wave radiation (right) in 2008.

6.4 Emission estimation

MEGAN runs for the 4-km modeling domain provide hourly biogenic emission outputs for the year 2008. Daily mean emissions for each month in 2008 are derived by using the hourly outputs for each month. The daily mean emissions for the 12 months in 2008 are shown in Table 6.4–1 for the MA and Maricopa County. Monthly total emissions were obtained by multiplying the daily mean emissions for each month by the number of days in the month. Monthly CO emissions for the MA and Maricopa County are presented in Table 6.4–2. Monthly mean emissions for the MA and Maricopa County are illustrated in Figure 6.4–1. It can be seen that the maximum monthly biogenic CO emissions took place in June, because monthly mean temperature and radiation reached the maximum in June.

Table 6.4–1. Daily mean biogenic CO emissions

	CO Maintenance Area		Maricopa County	
Month	**kg/day**	**lbs/day**	**kg/day**	**lbs/day**
Jan	1,419.3	3,129.0	6,511.4	14,355.2
Feb	1,900.4	4,189.7	9,092.3	20,045.1
Mar	4,967.9	10,952.3	23,109.3	50,947.3
Apr	7,192.1	15,855.9	33,191.0	73,173.6
May	7,744.2	17,073.0	34,216.2	75,433.8
Jun	17,801.6	39,245.8	77,086.0	169,945.6
Jul	16.420.2	36,200.3	70,985.5	156,496.3
Aug	14,891.7	32,830.5	63,556.3	140,117.7
Sep	12,355.4	27,239.0	58,326.4	128,587.7
Oct	6,675.2	14,716.3	31,130.4	68,630.8
Nov	3,408.8	7,515.1	15,432.2	34,022.2
Dec	1,494.1	3,293.9	6,829.6	15,056.7

Table 6.4–2. Monthly biogenic CO emissions in MA and Maricopa County

	CO Maintenance Area		Maricopa County	
Month	**Metric tons/month**	**Short tons/month**	**Metric tons/month**	**Short tons/month**
Jan	44.00	48.50	201.85	222.50
Feb	55.11	60.75	263.68	290.66
Mar	54.01	59.54	716.39	789.68
Apr	215.76	237.83	995.73	1,097.60
May	240.07	264.63	1,060.70	1,169.22
Jun	534.05	588.69	2,312.58	2,549.18
Jul	509.03	561.11	2,200.55	2,425.69
Aug	461.64	508.87	1,970.25	2,171.83
Sep	370.66	408.58	1,749.79	1,928.81
Oct	206.93	228.10	965.04	1,063.77
Nov	102.26	112.72	462.97	510.34
Dec	46.32	51.06	211.72	233.38

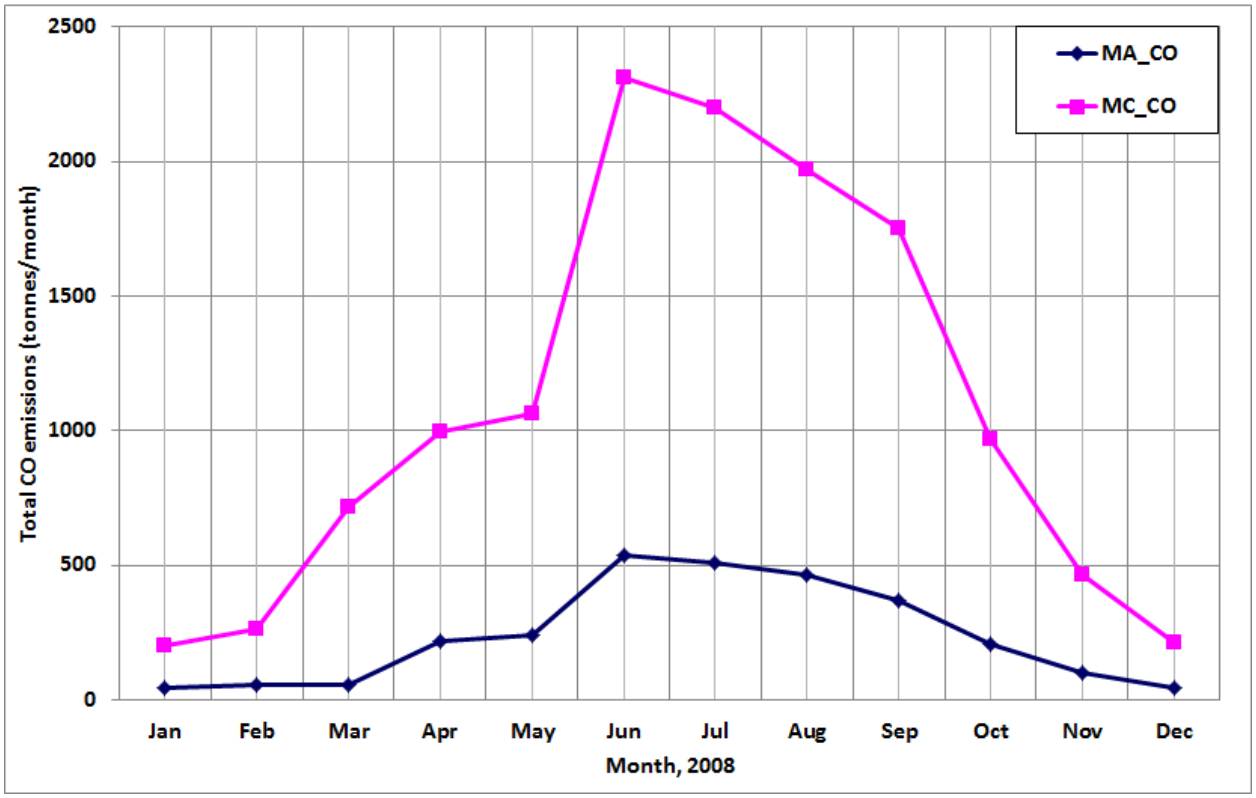


Figure 6.4–1. Monthly biogenic CO emissions in Maricopa County (pink solid line, "MC") and the CO Maintenance Area (dark blue line, "MA").

6.5 Summary of biogenic source emissions

Annual total biogenic CO emissions and daily mean biogenic CO emissions during the winter season for the MA and Maricopa County in 2008 are shown in Table 6.5–1. Due to the incorporation of land cover data that are more characteristic of plants located in the southwest desert area, as well as improvements in the MEGAN model, the 2008 biogenic CO emission estimates shown in Table 6.5–1 represent a substantial improvement over previous biogenic emission estimates for Maricopa County and the CO Maintenance Area.

Table 6.5–1. Annual total and winter season daily mean biogenic CO emissions

	Annual Total		Winter Season Daily Mean	
Area	**Tonnes*/yr**	**Tons*/yr**	**kg/day**	**lbs/day**
Maricopa County	13,111.25	14,452.68	9,591.1	21,144.7
CO Maintenance Area	2,839.84	3,130.39	2,107.4	4,646.0

** tonne denotes metric ton, and ton denotes short (or English) ton, 1 tonne = 1.10231 tons.*

6.6 References

ENVIRON International Corp., 2006. Final Report, Maricopa Association of Governments 2006 Biogenics Study.

Feng Liu, 2009: Prevention of Negative Emission Rate from MEGAN2.04, http://mailman.ucar.edu/pipermail/cdp/attachments/20110217/615f969f/attachment.pdf.

Guenther, A., T. Karl, P. Harley, C. Wiedinmyer, P. I. Palmer, and C. Geron, 2006. Estimates of global terrestrial isoprene emissions using MEGAN (Model of Emissions of Gases and Aerosols from Nature), Atmos. Chem. Phys., 6, 1-30.

Guenther, A., 2006a. User's Guide to Processing Driving Variables for Model of Emissions of Gases and Aerosols from Nature (MEGAN).

Guenther, A., 2006b. User's Guide to the Model of Emissions of Gases and Aerosols from Nature (MEGAN) Version MEGAN-VBA-2.0.

Guenther, 2007: Corrigendum to "Estimates of global terrestrial isoprene emissions using MEGAN (Model of Emissions of Gases and Aerosols from Nature)" published in Atmos. Chem. Phys., 6, 3181–3210, 2006, Atmos. Chem. Phys., 7, 4327-4327.

Maricopa Association of Governments, 2007. MAG Eight-Hour Ozone Plan for the Maricopa Nonattainment Area.

Maricopa Association of Governments, 2009. MAG Eight-Hour Ozone Redesignation Request and Maintenance Plan for the Maricopa Nonattainment Area.

Maricopa County Air Quality Department, 2010. 2008 Periodic Emission Inventory for Ozone Precursors for the Maricopa County, Arizona, Nonattainment Area, pp. 111-115.