

5. Onroad Mobile Sources

5.1 Introduction

Onroad mobile source emissions have been calculated for particulate matter for the 2011 Periodic Emissions Inventory (PEI) for the Maricopa County area. For the purposes of this particulate matter inventory, the following pollutants were included: PM₁₀, PM_{2.5}, nitrogen oxides (NO_x), sulfur dioxide (SO₂), and ammonia (NH₃). PM₁₀ refers to all particles less than or equal to 10 micrometers in diameter and PM_{2.5} refers to particles less than or equal to 2.5 micrometers in diameter.

Onroad mobile source emissions were estimated for the PM₁₀ nonattainment area (NAA) (approximately 3,000 square miles), as well as for Maricopa County (approximately 9,000 square miles). Emission factors were calculated using Motor Vehicle Emission Simulator (MOVES2010b), which is the latest model developed by the U.S. Environmental Protection Agency (EPA) for the purpose of estimating motor vehicle emission factors, and AP-42, which is the EPA Compilation of Air Pollutant Emission Factors. AP-42 emission factors were used to calculate fugitive dust emissions, while MOVES2010b was used to estimate exhaust, tire wear, and brake wear emissions.

The MOVES2010b modeling accounted for the oxygenated fuel and the Arizona Vehicle Inspection/Maintenance (I/M) programs applied in Maricopa County in 2011. The fuel use assumptions, including oxygen content and Reid Vapor Pressure (RVP), were derived from the 2011 fuel inspection results provided by the Arizona Department of Weights and Measures.

In order to develop the 2011 onroad mobile source emissions, the 2011 vehicle miles of travel (VMT) estimates by facility type and road type were derived from the 2011 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 2011 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, tire wear, and brake wear emissions.

Paved road fugitive dust emission estimates were derived from the AP-42 equation published by EPA in January 2011. The 2011 VMTs for freeways, high traffic arterials, and low traffic arterials were derived from the 2011 traffic assignment produced by the MAG travel demand model. Low traffic arterials carry less than 10,000 vehicles on an average weekday, while high traffic arterials carry 10,000 or more vehicles on an average weekday. These traffic assignment VMTs were normalized to 2011 HPMS VMTs and multiplied by the appropriate particulate emission factors derived from the AP-42 equation for paved roads.

Public unpaved road VMTs were derived from the MAG 2009 Unpaved Road Inventory (MAG, 2010). VMTs for private unpaved roads and alleys were derived from a study conducted by MAG in August-September 2011 (MAG, 2011). The public and private unpaved road and alley VMTs were multiplied by the appropriate AP-42 emission factors.

The main references for preparing the onroad mobile source portion of the 2011 emissions inventory were:

- Emission Inventory Requirements for Ozone State Implementation Plans (US EPA, 1991);
- Procedures for Emission Inventory Preparation Volume IV: Mobile Sources (US EPA, 1992a);
- Quality Review Guidelines for 1990 Base Year Emission Inventories (US EPA, 1992b);
- Compilation of Air Pollutant Emissions Factors, AP-42 (US EPA, 2006);
- Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity (US EPA, 2010a);
- User's Guide for the SMOKE-MOVES Integration Tool (US EPA, 2010b); and
- Motor Vehicle Emission Simulator (MOVES) - User Guide Version, MOVES2010b (US EPA, 2012a);
- Policy Guidance on the Use of MOVES2010 and Subsequent Minor Revisions for State Implementation Plan Development, Transportation Conformity, and Other Purposes (US EPA, 2012b); and
- Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity: Technical Guidance for MOVES2010, 2010a and 2010b (US EPA, 2012c).

5.2 Exhaust, tire wear, and brake wear emissions calculation

Vehicle exhaust emission factors for PM₁₀, PM_{2.5}, NO_x, SO₂, and NH₃, as well as tire wear and brake wear emission factors for PM₁₀ and PM_{2.5}, were calculated using MOVES2010b. The exhaust PM₁₀ and PM_{2.5} estimates include the components of sulfate and carbon (organic and elemental). 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 not related to fugitive dust 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 the particular scenario to be modeled by creating a Run Specification (RunSpec).

In order to calculate vehicle emissions for the calendar year 2011, MOVES2010b was executed using local input data for each month of the year and each geographical area (Maricopa County and the PM₁₀ NAA). 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 C.

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, and ramp fraction.

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 2011 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 PM₁₀ NAA. The specific MOVES tables for fuel data are presented in Appendix C.

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 Area A, with the exception of certain model years and vehicle classes. However, it is assumed that 91.6 percent of the vehicles operating within the PM₁₀ NAA and Maricopa County participate in the I/M program and the remaining 8.4 percent do not participate in the program. These percentages reflect the control measures “Tougher Enforcement of Vehicle Registration and Emissions Test Compliance” and “Expansion of Area A Boundaries,” described in the MAG Eight-Hour Ozone Redesignation Request and Maintenance Plan for the Maricopa Nonattainment Area (MAG, 2009). This percentage is directly applied to the Compliance Factor in the [IMCoverage] table. The same I/M programs were applied for Maricopa County and the PM₁₀ NAA. The specific MOVES table for I/M programs is presented in Appendix C.

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 2011 were obtained from the National Climatic Data Center (http://www7.ncdc.noaa.gov/IPS/lcd/lcd.html?page=1&state=AZ&wban=23183&_target2=Next+%3E). The same hourly average temperature and relative humidity data for each month were applied for Maricopa County and the PM₁₀ NAA. The specific MOVES table [ZoneMonthHour] for meteorological data is presented in Appendix C.

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 the population of vehicles in an area. The vehicle population in Maricopa County was obtained from the July 2011 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 2011. Then, the vehicle population data allocated to the 28 MOBILE6.2 vehicle types were assigned to the 13 MOVES source types using the match-up table (Table A.1) in the EPA’s technical guidance (EPA, 2010a). The vehicle population in the PM₁₀ NAA was estimated by applying the population ratio of the two

geographical areas to the vehicle population in Maricopa County. The specific MOVES table [SourceTypeYear] for vehicle population is presented in Appendix C.

5.2.2.5 Source type age distribution

MOVES2010b categorizes vehicles according to different vehicle classes and model years. The source type age distribution was prepared using EPA's data converter that takes the registration distribution input file created for MOBILE6.2 and converts it to the appropriate MOVES age distribution input table [SourceTypeAgeDistribution]. The same source type age distribution was applied for the PM₁₀ NAA and Maricopa County. The specific MOVES table for source type age distribution is presented in Appendix C.

5.2.2.6 Annual VMT

The 2011 daily VMTs by facility type were used to estimate onroad exhaust, tire wear, and brake wear emissions. The 2011 VMT distributions by facility type for the PM₁₀ NAA and Maricopa County were obtained from the 2011 Maricopa County Estimates of Daily Vehicle Travel by Highway Functional Classification provided by ADOT. The 2011 VMT distributions were multiplied by the 2011 HPMS VMT for the PM₁₀ NAA and Maricopa County. The resultant VMT estimates by facility type for the PM₁₀ NAA and Maricopa County are shown in Table 5.2-1.

Table 5.2-1. 2011 daily VMT by facility type (annual average daily traffic).

Facility Type		PM ₁₀ NAA (thousand miles/day)	Maricopa County (thousand miles/day)
Rural	Interstate	1,517	3,247
	Other Principal Arterial	742	1,589
	Minor Arterial	137	293
	Major Collector	608	1,301
	Minor Collector	79	168
	Local	123	264
	Urban	Interstate	10,881
Other Freeway/Expressway		19,219	19,750
Other Principal Arterial		21,425	22,017
Minor Arterial		13,735	14,115
Collector		4,670	4,799
Local		9,887	10,160
Total:		83,023	88,885

Since MOVES2010b requires annual VMTs by HPMS vehicle type as a local input, the daily VMTs by HPMS vehicle type were derived from the 2011 traffic assignment data provided by the MAG Transportation Modeling Group in May 2011 and the daily VMTs by facility type and the estimated percentages of daily vehicle travel by vehicle type and highway functional classification provided by ADOT. Then, the daily VMTs by HPMS vehicle type were multiplied by 365 days to obtain the annual VMTs by HPMS vehicle type. The specific MOVES table [HPMSvTypeYear] for annual VMT is presented in Appendix C.

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 2011 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 C.

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 C.

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), local estimates of average speed were developed by post-processing the output from the 2011 traffic assignment data provided by the MAG Transportation Modeling Group in May 2011. To develop the average speed distribution, VHTs in sixteen speed bins were accumulated separately for each hour of the day, source type, and road type in Maricopa County. Then, the average speed distribution was calculated by normalizing VHTs in sixteen speed bins for each hour of the day, source type, and road type. The same methodology was applied to develop the speed estimates for the PM₁₀ NAA. The specific MOVES table [AvgSpeedDistribution] for the average speed distribution is presented in Appendix C.

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 2011 traffic assignment data provided by the MAG Transportation Modeling Group in May 2011. The specific MOVES table [RoadType] for ramp fractions is presented in Appendix C.

5.2.3 MOVES2010b outputs

MOVES2010b was executed with the RunSpec files described in Appendix C to obtain exhaust, tire wear, and brake wear emissions for PM₁₀, PM_{2.5}, NO_x, SO₂, and NH₃. These values were obtained for the following twelve vehicle classes: light duty gasoline vehicles (LDGV), light

duty gasoline trucks 1 & 2 (LDGT1), light duty gasoline trucks 3 and 4 (LDGT2), heavy duty gasoline vehicles 2B thru 8B and gasoline buses (HDGV), motorcycles (MC), light duty diesel vehicles (LDDV), light duty diesel trucks 1 thru 4 (LDDT), heavy duty diesel vehicles class 2B (2BHDDV), heavy duty diesel vehicles class 3, 4, and 5 (LHDDV), heavy duty diesel vehicles class 6 and 7 (MHDDV), heavy duty diesel vehicles class 8A and 8B (HHDDV), and heavy duty diesel buses (BUSES); by the following thirteen facility types: rural interstate, rural principal arterial, rural minor arterial, rural major collector, rural minor collector, rural local, urban interstate, urban freeway/expressway, urban principal arterial, urban minor arterial, urban collector, urban local, and off-network, which was newly added in MOVES2010b; by weekdays and weekend days; by month.

5.2.4 MOVES2010b emission estimates

MOVES2010b was used to generate onroad emissions by vehicle class, facility type, weekdays/weekend days, and month. The annual emissions were calculated by aggregating monthly onroad emissions derived by adding monthly weekday emissions, which is the product of daily weekday emissions estimated by MOVES2010b and the number of weekdays for a given month, and monthly weekend emissions, which is the product of daily weekend emissions estimated by MOVES2010b and the number of weekend days for a given month. The typical daily emissions were calculated by dividing the annual emissions by 365 days.

Tables 5.2–2 and 5.2–3 show the calculated annual and typical daily PM₁₀, PM_{2.5}, NO_x, SO₂, and NH₃ emissions by facility type and vehicle class in the PM₁₀ NAA and Maricopa County, respectively. Emission estimates for PM₁₀ and PM_{2.5} in these tables represent exhaust, tire wear, and brake wear emissions.

Table 5.2–2. Annual and typical daily onroad mobile source emissions by facility type and vehicle class in the PM₁₀ NAA.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
			PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Rural Interstate	LDGV	2201001110	3.58	2.12	90.59	0.92	6.92	19.6	11.6	496.4	5.0	37.9
	LDGT1	2201020110	4.60	2.93	197.03	1.15	7.05	25.2	16.1	1,079.6	6.3	38.6
	LDGT2	2201040110	2.37	1.51	101.50	0.59	3.63	13.0	8.3	556.2	3.3	19.9
	HDGV	2201070110	0.96	0.50	60.31	0.27	1.21	5.3	2.8	330.5	1.5	6.6
	MC	2201080110	0.18	0.15	3.49	0.02	0.21	1.0	0.8	19.1	0.1	1.1
	LDDV	2230001110	0.07	0.06	0.69	0.00	0.01	0.4	0.3	3.8	0.0	0.0
	LDDT	2230060110	0.74	0.69	11.54	0.01	0.09	4.1	3.8	63.2	0.1	0.5
	2BHDDV	2230071110	0.31	0.29	5.11	0.00	0.04	1.7	1.6	28.0	0.0	0.2
	LHDDV	2230072110	1.81	1.68	27.18	0.02	0.21	9.9	9.2	148.9	0.1	1.2
	MHDDV	2230073110	7.38	6.45	137.31	0.12	0.58	40.4	35.4	752.4	0.7	3.2
HHDDV	2230074110	23.18	20.76	472.88	0.42	1.48	127.0	113.8	2,591.1	2.3	8.1	
BUSES	2230075110	1.04	0.94	19.60	0.01	0.05	5.7	5.1	107.4	0.1	0.3	
Rural Principal Arterial	LDGV	2201001130	2.87	1.28	58.07	0.62	4.21	15.7	7.0	318.2	3.4	23.1
	LDGT1	2201020130	1.83	0.86	63.25	0.38	2.15	10.0	4.7	346.6	2.1	11.8
	LDGT2	2201040130	0.94	0.44	32.58	0.20	1.11	5.2	2.4	178.5	1.1	6.1
	HDGV	2201070130	0.31	0.13	14.08	0.07	0.33	1.7	0.7	77.1	0.4	1.8
	MC	2201080130	0.20	0.17	5.10	0.03	0.27	1.1	0.9	27.9	0.2	1.5
	LDDV	2230001130	0.04	0.03	0.52	0.00	0.00	0.2	0.2	2.9	0.0	0.0
	LDDT	2230060130	0.27	0.24	4.36	0.00	0.03	1.5	1.3	23.9	0.0	0.2
	2BHDDV	2230071130	0.11	0.10	1.94	0.00	0.01	0.6	0.6	10.6	0.0	0.1
	LHDDV	2230072130	0.65	0.59	10.25	0.01	0.06	3.6	3.2	56.1	0.0	0.4
	MHDDV	2230073130	1.42	1.20	23.01	0.02	0.10	7.8	6.6	126.1	0.1	0.6
HHDDV	2230074130	4.00	3.47	67.77	0.06	0.21	21.9	19.0	371.3	0.3	1.2	
BUSES	2230075130	0.35	0.31	5.77	0.00	0.01	1.9	1.7	31.6	0.0	0.1	
Rural Minor Arterial	LDGV	2201001150	2.79	1.25	56.43	0.60	4.09	15.3	6.8	309.2	3.3	22.4
	LDGT1	2201020150	1.77	0.83	61.46	0.37	2.09	9.7	4.6	336.8	2.0	11.4
	LDGT2	2201040150	0.91	0.43	31.66	0.19	1.08	5.0	2.4	173.5	1.1	5.9
	HDGV	2201070150	0.30	0.13	13.68	0.07	0.32	1.6	0.7	74.9	0.4	1.8
	MC	2201080150	0.20	0.16	4.95	0.03	0.27	1.1	0.9	27.1	0.2	1.5
	LDDV	2230001150	0.04	0.03	0.51	0.00	0.00	0.2	0.2	2.8	0.0	0.0
	LDDT	2230060150	0.26	0.23	4.24	0.00	0.03	1.4	1.3	23.2	0.0	0.1
	2BHDDV	2230071150	0.11	0.10	1.88	0.00	0.01	0.6	0.5	10.3	0.0	0.1
	LHDDV	2230072150	0.64	0.58	9.96	0.01	0.06	3.5	3.2	54.6	0.0	0.3
	MHDDV	2230073150	1.38	1.17	22.36	0.02	0.10	7.6	6.4	122.5	0.1	0.6
HHDDV	2230074150	3.88	3.37	65.85	0.06	0.20	21.3	18.5	360.8	0.3	1.1	
BUSES	2230075150	0.34	0.30	5.60	0.00	0.01	1.9	1.6	30.7	0.0	0.1	
Rural Major Collector	LDGV	2201001170	0.52	0.23	10.52	0.11	0.76	2.9	1.3	57.6	0.6	4.2
	LDGT1	2201020170	0.33	0.16	11.46	0.07	0.39	1.8	0.9	62.8	0.4	2.1
	LDGT2	2201040170	0.17	0.08	5.90	0.04	0.20	0.9	0.4	32.3	0.2	1.1
	HDGV	2201070170	0.06	0.02	2.55	0.01	0.06	0.3	0.1	14.0	0.1	0.3
	MC	2201080170	0.04	0.03	0.92	0.01	0.05	0.2	0.2	5.1	0.0	0.3
	LDDV	2230001170	0.01	0.01	0.09	0.00	0.00	0.0	0.0	0.5	0.0	0.0
	LDDT	2230060170	0.05	0.04	0.79	0.00	0.01	0.3	0.2	4.3	0.0	0.0
	2BHDDV	2230071170	0.02	0.02	0.35	0.00	0.00	0.1	0.1	1.9	0.0	0.0
	LHDDV	2230072170	0.12	0.11	1.86	0.00	0.01	0.6	0.6	10.2	0.0	0.1
	MHDDV	2230073170	0.26	0.22	4.17	0.00	0.02	1.4	1.2	22.8	0.0	0.1
HHDDV	2230074170	0.72	0.63	12.27	0.01	0.04	4.0	3.4	67.3	0.1	0.2	
BUSES	2230075170	0.06	0.06	1.04	0.00	0.00	0.3	0.3	5.7	0.0	0.0	

Table 5.2–2 (continued). Annual and typical daily onroad mobile source emissions by facility type and vehicle class in the PM₁₀ NAA.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
			PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Rural Minor Collector	LDGV	2201001190	0.12	0.05	2.43	0.03	0.18	0.7	0.3	13.3	0.1	1.0
	LDGT1	2201020190	0.08	0.04	2.65	0.02	0.09	0.4	0.2	14.5	0.1	0.5
	LDGT2	2201040190	0.04	0.02	1.37	0.01	0.05	0.2	0.1	7.5	0.0	0.3
	HDGV	2201070190	0.01	0.01	0.59	0.00	0.01	0.1	0.0	3.2	0.0	0.1
	MC	2201080190	0.01	0.01	0.21	0.00	0.01	0.0	0.0	1.2	0.0	0.1
	LDDV	2230001190	0.00	0.00	0.02	0.00	0.00	0.0	0.0	0.1	0.0	0.0
	LDDT	2230060190	0.01	0.01	0.18	0.00	0.00	0.1	0.1	1.0	0.0	0.0
	2BHDDV	2230071190	0.00	0.00	0.08	0.00	0.00	0.0	0.0	0.4	0.0	0.0
	LHDDV	2230072190	0.03	0.02	0.43	0.00	0.00	0.2	0.1	2.4	0.0	0.0
	MHDDV	2230073190	0.06	0.05	0.96	0.00	0.00	0.3	0.3	5.3	0.0	0.0
	HHDDV	2230074190	0.17	0.15	2.84	0.00	0.01	0.9	0.8	15.6	0.0	0.0
	BUSES	2230075190	0.01	0.01	0.24	0.00	0.00	0.1	0.1	1.3	0.0	0.0
Rural Local	LDGV	2201001210	1.26	0.56	25.44	0.27	1.84	6.9	3.1	139.4	1.5	10.1
	LDGT1	2201020210	0.80	0.38	27.71	0.17	0.94	4.4	2.1	151.8	0.9	5.2
	LDGT2	2201040210	0.41	0.19	14.27	0.09	0.48	2.3	1.1	78.2	0.5	2.7
	HDGV	2201070210	0.13	0.06	6.17	0.03	0.14	0.7	0.3	33.8	0.2	0.8
	MC	2201080210	0.09	0.07	2.23	0.01	0.12	0.5	0.4	12.2	0.1	0.7
	LDDV	2230001210	0.02	0.01	0.23	0.00	0.00	0.1	0.1	1.3	0.0	0.0
	LDDT	2230060210	0.12	0.11	1.91	0.00	0.01	0.6	0.6	10.5	0.0	0.1
	2BHDDV	2230071210	0.05	0.04	0.85	0.00	0.01	0.3	0.2	4.7	0.0	0.0
	LHDDV	2230072210	0.29	0.26	4.49	0.00	0.03	1.6	1.4	24.6	0.0	0.2
	MHDDV	2230073210	0.62	0.53	10.08	0.01	0.05	3.4	2.9	55.2	0.0	0.2
	HHDDV	2230074210	1.75	1.52	29.69	0.03	0.09	9.6	8.3	162.7	0.1	0.5
	BUSES	2230075210	0.15	0.13	2.53	0.00	0.01	0.8	0.7	13.8	0.0	0.0
Urban Interstate	LDGV	2201001230	55.76	31.89	1,119.58	11.63	82.53	305.5	174.8	6,134.7	63.7	452.2
	LDGT1	2201020230	49.50	29.94	1,598.64	9.71	56.18	271.2	164.0	8,759.7	53.2	307.9
	LDGT2	2201040230	25.50	15.42	823.54	5.00	28.94	139.7	84.5	4,512.5	27.4	158.6
	HDGV	2201070230	11.26	5.58	593.00	2.71	10.42	61.7	30.6	3,249.3	14.8	57.1
	MC	2201080230	4.69	4.12	73.22	0.48	4.24	25.7	22.6	401.2	2.6	23.2
	LDDV	2230001230	1.05	0.94	8.79	0.01	0.07	5.8	5.1	48.2	0.1	0.4
	LDDT	2230060230	6.78	6.20	102.73	0.08	0.70	37.1	34.0	562.9	0.4	3.9
	2BHDDV	2230071230	2.86	2.61	45.55	0.04	0.32	15.7	14.3	249.6	0.2	1.7
	LHDDV	2230072230	16.48	15.11	241.98	0.18	1.63	90.3	82.8	1,325.9	1.0	9.0
	MHDDV	2230073230	76.32	65.35	1,312.96	1.18	5.25	418.2	358.1	7,194.3	6.5	28.8
	HHDDV	2230074230	209.89	183.55	3,738.11	3.35	11.22	1,150.1	1,005.8	20,482.8	18.3	61.5
	BUSES	2230075230	15.98	14.24	271.96	0.16	0.61	87.5	78.0	1,490.2	0.9	3.3
Urban Freeway And Expressway	LDGV	2201001250	58.50	33.46	1,174.64	12.20	86.59	320.6	183.3	6,436.4	66.9	474.5
	LDGT1	2201020250	51.94	31.41	1,677.26	10.19	58.95	284.6	172.1	9,190.5	55.8	323.0
	LDGT2	2201040250	26.76	16.18	864.04	5.25	30.37	146.6	88.7	4,734.5	28.8	166.4
	HDGV	2201070250	11.81	5.86	622.16	2.84	10.93	64.7	32.1	3,409.1	15.6	59.9
	MC	2201080250	4.92	4.32	76.82	0.50	4.45	26.9	23.7	420.9	2.7	24.4
	LDDV	2230001250	1.10	0.98	9.22	0.01	0.07	6.0	5.4	50.5	0.1	0.4
	LDDT	2230060250	7.11	6.50	107.79	0.08	0.74	39.0	35.6	590.6	0.5	4.0
	2BHDDV	2230071250	3.01	2.74	47.79	0.04	0.33	16.5	15.0	261.9	0.2	1.8
	LHDDV	2230072250	17.29	15.85	253.88	0.19	1.71	94.7	86.8	1,391.1	1.0	9.4
	MHDDV	2230073250	80.08	68.57	1,377.53	1.24	5.51	438.8	375.7	7,548.1	6.8	30.2
	HHDDV	2230074250	220.21	192.58	3,921.96	3.51	11.77	1,206.6	1,055.2	21,490.2	19.3	64.5
	BUSES	2230075250	16.76	14.94	285.34	0.17	0.64	91.8	81.9	1,563.5	0.9	3.5

Table 5.2–2 (continued). Annual and typical daily onroad mobile source emissions by facility type and vehicle class in the PM₁₀ NAA.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
			PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Urban Principal Arterial	LDGV	2201001270	166.80	65.87	2,454.76	27.42	167.28	914.0	361.0	13,450.7	150.2	916.6
	LDGT1	2201020270	101.39	41.31	2,262.60	15.03	73.19	555.6	226.4	12,397.8	82.3	401.1
	LDGT2	2201040270	52.23	21.28	1,165.58	7.74	37.71	286.2	116.6	6,386.7	42.4	206.6
	HDGV	2201070270	18.93	6.81	524.90	2.90	11.51	103.7	37.3	2,876.1	15.9	63.0
	MC	2201080270	6.24	5.05	120.69	0.94	6.59	34.2	27.7	661.3	5.2	36.1
	LDDV	2230001270	1.80	1.38	24.82	0.03	0.13	9.8	7.5	136.0	0.2	0.7
	LDDT	2230060270	12.04	10.44	202.55	0.13	0.90	66.0	57.2	1,109.8	0.7	4.9
	2BHDDV	2230071270	5.13	4.43	90.04	0.06	0.40	28.1	24.3	493.4	0.3	2.2
	LHDDV	2230072270	29.28	25.53	476.80	0.29	2.09	160.4	139.9	2,612.6	1.6	11.4
	MHDDV	2230073270	77.96	61.97	1,113.72	0.97	3.89	427.2	339.6	6,102.5	5.3	21.3
	HHDDV	2230074270	218.00	180.86	2,979.96	2.65	7.75	1,194.5	991.0	16,328.6	14.5	42.5
BUSES	2230075270	17.07	14.27	228.85	0.13	0.46	93.5	78.2	1,254.0	0.7	2.5	
Urban Minor Arterial	LDGV	2201001290	84.78	33.48	1,247.74	13.94	85.03	464.6	183.5	6,836.9	76.4	465.9
	LDGT1	2201020290	51.54	21.00	1,150.07	7.64	37.20	282.4	115.1	6,301.7	41.8	203.9
	LDGT2	2201040290	26.55	10.82	592.46	3.93	19.17	145.5	59.3	3,246.4	21.6	105.0
	HDGV	2201070290	9.62	3.46	266.80	1.47	5.85	52.7	19.0	1,461.9	8.1	32.0
	MC	2201080290	3.17	2.57	61.35	0.48	3.35	17.4	14.1	336.1	2.6	18.3
	LDDV	2230001290	0.91	0.70	12.62	0.02	0.07	5.0	3.8	69.1	0.1	0.4
	LDDT	2230060290	6.12	5.31	102.95	0.06	0.46	33.5	29.1	564.1	0.4	2.5
	2BHDDV	2230071290	2.61	2.25	45.77	0.03	0.21	14.3	12.3	250.8	0.2	1.1
	LHDDV	2230072290	14.88	12.97	242.36	0.15	1.06	81.5	71.1	1,328.0	0.8	5.8
	MHDDV	2230073290	39.63	31.50	566.10	0.49	1.98	217.1	172.6	3,101.9	2.7	10.8
	HHDDV	2230074290	110.81	91.93	1,514.70	1.35	3.94	607.2	503.7	8,299.7	7.4	21.6
BUSES	2230075290	8.68	7.25	116.32	0.07	0.24	47.5	39.7	637.4	0.4	1.3	
Urban Collector	LDGV	2201001310	16.56	6.54	243.68	2.72	16.61	90.7	35.8	1,335.2	14.9	91.0
	LDGT1	2201020310	10.06	4.10	224.60	1.49	7.27	55.1	22.5	1,230.7	8.2	39.8
	LDGT2	2201040310	5.18	2.11	115.70	0.77	3.74	28.4	11.6	634.0	4.2	20.5
	HDGV	2201070310	1.88	0.68	52.10	0.29	1.14	10.3	3.7	285.5	1.6	6.3
	MC	2201080310	0.62	0.50	11.98	0.09	0.65	3.4	2.7	65.6	0.5	3.6
	LDDV	2230001310	0.18	0.14	2.46	0.00	0.01	1.0	0.7	13.5	0.0	0.1
	LDDT	2230060310	1.20	1.04	20.11	0.01	0.09	6.5	5.7	110.2	0.1	0.5
	2BHDDV	2230071310	0.51	0.44	8.94	0.01	0.04	2.8	2.4	49.0	0.0	0.2
	LHDDV	2230072310	2.91	2.53	47.33	0.03	0.21	15.9	13.9	259.3	0.2	1.1
	MHDDV	2230073310	7.74	6.15	110.55	0.10	0.39	42.4	33.7	605.8	0.5	2.1
	HHDDV	2230074310	21.64	17.95	295.81	0.26	0.77	118.6	98.4	1,620.9	1.4	4.2
BUSES	2230075310	1.69	1.42	22.72	0.01	0.05	9.3	7.8	124.5	0.1	0.3	
Urban Local	LDGV	2201001330	79.92	31.56	1,176.23	13.14	80.15	437.9	173.0	6,445.1	72.0	439.2
	LDGT1	2201020330	48.58	19.80	1,084.16	7.20	35.07	266.2	108.5	5,940.6	39.5	192.2
	LDGT2	2201040330	25.03	10.20	558.51	3.71	18.07	137.1	55.9	3,060.3	20.3	99.0
	HDGV	2201070330	9.07	3.26	251.51	1.39	5.51	49.7	17.9	1,378.1	7.6	30.2
	MC	2201080330	2.99	2.42	57.83	0.45	3.16	16.4	13.3	316.9	2.5	17.3
	LDDV	2230001330	0.86	0.66	11.89	0.02	0.06	4.7	3.6	65.2	0.1	0.4
	LDDT	2230060330	5.77	5.00	97.05	0.06	0.43	31.6	27.4	531.8	0.3	2.4
	2BHDDV	2230071330	2.46	2.12	43.15	0.03	0.19	13.5	11.6	236.4	0.1	1.1
	LHDDV	2230072330	14.03	12.23	228.47	0.14	1.00	76.9	67.0	1,251.9	0.8	5.5
	MHDDV	2230073330	37.36	29.69	533.65	0.46	1.87	204.7	162.7	2,924.1	2.5	10.2
	HHDDV	2230074330	104.46	86.66	1,427.90	1.27	3.72	572.4	474.9	7,824.1	6.9	20.4
BUSES	2230075330	8.18	6.84	109.66	0.06	0.22	44.8	37.5	600.9	0.3	1.2	

Table 5.2–2 (continued). Annual and typical daily onroad mobile source emissions by facility type and vehicle class in the PM₁₀ NAA.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
			PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Off-Network	LDGV	2201001000	62.75	57.78	4,385.52	4.26	0.00	343.8	316.6	24,030.2	23.3	0.0
	LDGT1	2201020000	17.88	16.46	1,456.07	0.93	0.00	97.9	90.2	7,978.5	5.1	0.0
	LDGT2	2201040000	9.21	8.48	750.10	0.48	0.00	50.5	46.5	4,110.1	2.6	0.0
	HDGV	2201070000	2.41	2.22	215.13	0.13	0.00	13.2	12.1	1,178.8	0.7	0.0
	MC	2201080000	0.08	0.07	2.41	0.02	0.00	0.4	0.4	13.2	0.1	0.0
	LDDV	2230001000	10.02	9.72	27.39	0.01	0.00	54.9	53.3	150.1	0.0	0.0
	LDDT	2230060000	1.15	1.11	26.36	0.01	0.00	6.3	6.1	144.4	0.0	0.0
	2BHDDV	2230071000	0.43	0.41	11.56	0.00	0.00	2.3	2.3	63.3	0.0	0.0
	LHDDV	2230072000	2.63	2.55	61.80	0.01	0.00	14.4	14.0	338.6	0.1	0.0
	MHDDV	2230073000	1.57	1.52	143.06	0.03	0.00	8.6	8.3	783.9	0.1	0.0
	HHDDV	2230074000	23.95	23.23	2,653.09	0.37	0.00	131.2	127.3	14,537.5	2.0	0.0
	BUSES	2230075000	0.20	0.19	4.41	0.00	0.00	1.1	1.1	24.2	0.0	0.0

Table 5.2-3. Annual and typical daily onroad mobile source emissions by facility type and vehicle class in Maricopa County.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
			PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Rural Interstate	LDGV	2201001110	6.00	3.62	166.74	1.67	12.70	32.9	19.9	913.7	9.1	69.6
	LDGT1	2201020110	9.98	6.55	475.25	2.73	16.91	54.7	35.9	2,604.1	15.0	92.6
	LDGT2	2201040110	5.14	3.38	244.83	1.41	8.71	28.2	18.5	1,341.5	7.7	47.7
	HDGV	2201070110	1.85	1.02	118.92	0.55	2.64	10.1	5.6	651.6	3.0	14.5
	MC	2201080110	0.35	0.31	7.49	0.05	0.45	1.9	1.7	41.0	0.3	2.5
	LDDV	2230001110	0.12	0.11	1.25	0.00	0.01	0.7	0.6	6.8	0.0	0.1
	LDDT	2230060110	1.69	1.58	27.11	0.02	0.22	9.3	8.7	148.5	0.1	1.2
	2BHDDV	2230071110	0.71	0.66	12.00	0.01	0.10	3.9	3.6	65.8	0.1	0.5
	LHDDV	2230072110	4.12	3.85	63.90	0.05	0.51	22.6	21.1	350.2	0.3	2.8
	MHDDV	2230073110	14.34	12.67	281.49	0.26	1.16	78.6	69.4	1,542.4	1.4	6.3
Rural Principal Arterial	HHDDV	2230074110	52.08	47.14	1,129.87	1.01	3.49	285.4	258.3	6,191.1	5.5	19.1
	BUSES	2230075110	1.76	1.59	34.23	0.02	0.08	9.6	8.7	187.5	0.1	0.4
	LDGV	2201001130	5.55	2.49	113.61	1.21	8.26	30.4	13.6	622.5	6.6	45.2
	LDGT1	2201020130	4.18	1.99	149.19	0.90	5.09	22.9	10.9	817.5	4.9	27.9
	LDGT2	2201040130	2.15	1.02	76.86	0.46	2.62	11.8	5.6	421.1	2.5	14.4
	HDGV	2201070130	0.68	0.29	31.89	0.16	0.76	3.7	1.6	174.7	0.9	4.2
	MC	2201080130	0.43	0.36	10.98	0.07	0.59	2.4	2.0	60.2	0.4	3.2
	LDDV	2230001130	0.07	0.06	1.02	0.00	0.01	0.4	0.3	5.6	0.0	0.0
	LDDT	2230060130	0.62	0.56	10.05	0.01	0.07	3.4	3.1	55.0	0.0	0.4
	2BHDDV	2230071130	0.26	0.24	4.46	0.00	0.03	1.4	1.3	24.5	0.0	0.2
Rural Minor Arterial	LHDDV	2230072130	1.51	1.37	23.59	0.02	0.15	8.3	7.5	129.3	0.1	0.8
	MHDDV	2230073130	3.10	2.63	51.42	0.05	0.23	17.0	14.4	281.7	0.2	1.3
	HHDDV	2230074130	8.92	7.79	159.49	0.14	0.51	48.9	42.7	873.9	0.8	2.8
	BUSES	2230075130	0.75	0.66	12.48	0.01	0.03	4.1	3.6	68.4	0.0	0.2
	LDGV	2201001150	5.39	2.42	110.40	1.17	8.02	29.5	13.2	604.9	6.4	44.0
	LDGT1	2201020150	4.06	1.93	144.97	0.87	4.94	22.3	10.6	794.4	4.8	27.1
	LDGT2	2201040150	2.09	0.99	74.68	0.45	2.55	11.5	5.5	409.2	2.5	13.9
	HDGV	2201070150	0.66	0.28	30.98	0.15	0.74	3.6	1.5	169.8	0.8	4.1
	MC	2201080150	0.42	0.35	10.67	0.07	0.57	2.3	1.9	58.5	0.4	3.1
	LDDV	2230001150	0.07	0.06	0.99	0.00	0.01	0.4	0.3	5.4	0.0	0.0
Rural Major Collector	LDDT	2230060150	0.60	0.55	9.76	0.01	0.06	3.3	3.0	53.5	0.0	0.4
	2BHDDV	2230071150	0.26	0.23	4.34	0.00	0.03	1.4	1.3	23.8	0.0	0.2
	LHDDV	2230072150	1.47	1.34	22.92	0.02	0.15	8.1	7.3	125.6	0.1	0.8
	MHDDV	2230073150	3.02	2.56	49.96	0.04	0.23	16.5	14.0	273.8	0.2	1.2
	HHDDV	2230074150	8.67	7.57	154.98	0.14	0.49	47.5	41.5	849.2	0.8	2.7
	BUSES	2230075150	0.73	0.64	12.13	0.01	0.03	4.0	3.5	66.5	0.0	0.2
	LDGV	2201001170	1.01	0.45	20.58	0.22	1.50	5.5	2.5	112.7	1.2	8.2
	LDGT1	2201020170	0.76	0.36	27.02	0.16	0.92	4.1	2.0	148.1	0.9	5.0
	LDGT2	2201040170	0.39	0.19	13.92	0.08	0.47	2.1	1.0	76.3	0.5	2.6
	HDGV	2201070170	0.12	0.05	5.78	0.03	0.14	0.7	0.3	31.6	0.2	0.8
MC	2201080170	0.08	0.07	1.99	0.01	0.11	0.4	0.4	10.9	0.1	0.6	
LDDV	2230001170	0.01	0.01	0.18	0.00	0.00	0.1	0.1	1.0	0.0	0.0	
LDDT	2230060170	0.11	0.10	1.82	0.00	0.01	0.6	0.6	10.0	0.0	0.1	
2BHDDV	2230071170	0.05	0.04	0.81	0.00	0.01	0.3	0.2	4.4	0.0	0.0	
LHDDV	2230072170	0.27	0.25	4.27	0.00	0.03	1.5	1.4	23.4	0.0	0.2	
MHDDV	2230073170	0.56	0.48	9.31	0.01	0.04	3.1	2.6	51.0	0.0	0.2	
HHDDV	2230074170	1.62	1.41	28.89	0.03	0.09	8.9	7.7	158.3	0.1	0.5	
BUSES	2230075170	0.14	0.12	2.26	0.00	0.01	0.7	0.7	12.4	0.0	0.0	

Table 5.2–3 (continued). Annual and typical daily onroad mobile source emissions by facility type and vehicle class in Maricopa County.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
			PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Rural Minor Collector	LDGV	2201001190	0.23	0.10	4.76	0.05	0.35	1.3	0.6	26.1	0.3	1.9
	LDGT1	2201020190	0.18	0.08	6.26	0.04	0.21	1.0	0.5	34.3	0.2	1.2
	LDGT2	2201040190	0.09	0.04	3.22	0.02	0.11	0.5	0.2	17.7	0.1	0.6
	HDGV	2201070190	0.03	0.01	1.34	0.01	0.03	0.2	0.1	7.3	0.0	0.2
	MC	2201080190	0.02	0.02	0.46	0.00	0.02	0.1	0.1	2.5	0.0	0.1
	LDDV	2230001190	0.00	0.00	0.04	0.00	0.00	0.0	0.0	0.2	0.0	0.0
	LDDT	2230060190	0.03	0.02	0.42	0.00	0.00	0.1	0.1	2.3	0.0	0.0
	2BHDDV	2230071190	0.01	0.01	0.19	0.00	0.00	0.1	0.1	1.0	0.0	0.0
	LHDDV	2230072190	0.06	0.06	0.99	0.00	0.01	0.3	0.3	5.4	0.0	0.0
	MHDDV	2230073190	0.13	0.11	2.16	0.00	0.01	0.7	0.6	11.8	0.0	0.1
	HHDDV	2230074190	0.37	0.33	6.69	0.01	0.02	2.0	1.8	36.6	0.0	0.1
	BUSES	2230075190	0.03	0.03	0.52	0.00	0.00	0.2	0.2	2.9	0.0	0.0
Rural Local	LDGV	2201001210	2.43	1.09	49.77	0.53	3.62	13.3	6.0	272.7	2.9	19.8
	LDGT1	2201020210	1.83	0.87	65.35	0.39	2.23	10.0	4.8	358.1	2.2	12.2
	LDGT2	2201040210	0.94	0.45	33.67	0.20	1.15	5.2	2.5	184.5	1.1	6.3
	HDGV	2201070210	0.30	0.13	13.97	0.07	0.33	1.6	0.7	76.5	0.4	1.8
	MC	2201080210	0.19	0.16	4.81	0.03	0.26	1.0	0.9	26.3	0.2	1.4
	LDDV	2230001210	0.03	0.03	0.45	0.00	0.00	0.2	0.1	2.4	0.0	0.0
	LDDT	2230060210	0.27	0.25	4.40	0.00	0.03	1.5	1.3	24.1	0.0	0.2
	2BHDDV	2230071210	0.12	0.10	1.96	0.00	0.01	0.6	0.6	10.7	0.0	0.1
	LHDDV	2230072210	0.66	0.60	10.33	0.01	0.07	3.6	3.3	56.6	0.0	0.4
	MHDDV	2230073210	1.36	1.15	22.52	0.02	0.10	7.4	6.3	123.4	0.1	0.6
	HHDDV	2230074210	3.91	3.41	69.87	0.06	0.22	21.4	18.7	382.8	0.3	1.2
	BUSES	2230075210	0.33	0.29	5.47	0.00	0.01	1.8	1.6	30.0	0.0	0.1
Urban Interstate	LDGV	2201001230	57.00	32.71	1,147.02	11.90	84.51	312.4	179.3	6,285.0	65.2	463.1
	LDGT1	2201020230	50.87	30.86	1,645.13	9.99	57.81	278.7	169.1	9,014.4	54.7	316.7
	LDGT2	2201040230	26.21	15.90	847.49	5.14	29.78	143.6	87.1	4,643.8	28.2	163.2
	HDGV	2201070230	11.62	5.77	613.34	2.80	10.74	63.7	31.6	3,360.8	15.3	58.9
	MC	2201080230	4.84	4.25	75.30	0.49	4.36	26.5	23.3	412.6	2.7	23.9
	LDDV	2230001230	1.08	0.96	8.99	0.01	0.07	5.9	5.3	49.3	0.1	0.4
	LDDT	2230060230	6.97	6.37	105.63	0.08	0.72	38.2	34.9	578.8	0.4	4.0
	2BHDDV	2230071230	2.94	2.68	46.83	0.04	0.33	16.1	14.7	256.6	0.2	1.8
	LHDDV	2230072230	16.94	15.53	248.83	0.19	1.68	92.8	85.1	1,363.4	1.0	9.2
	MHDDV	2230073230	79.11	67.75	1,361.53	1.23	5.44	433.5	371.2	7,460.4	6.7	29.8
	HHDDV	2230074230	217.75	190.46	3,879.33	3.48	11.64	1,193.2	1,043.6	21,256.6	19.0	63.8
	BUSES	2230075230	16.55	14.75	281.59	0.17	0.63	90.7	80.8	1,542.9	0.9	3.5
Urban Freeway And Expressway	LDGV	2201001250	59.81	34.32	1,203.43	12.48	88.67	327.7	188.1	6,594.1	68.4	485.9
	LDGT1	2201020250	53.37	32.38	1,726.04	10.48	60.65	292.5	177.4	9,457.7	57.4	332.3
	LDGT2	2201040250	27.49	16.68	889.17	5.40	31.24	150.7	91.4	4,872.2	29.6	171.2
	HDGV	2201070250	12.19	6.05	643.51	2.93	11.27	66.8	33.2	3,526.1	16.1	61.8
	MC	2201080250	5.07	4.46	79.00	0.52	4.57	27.8	24.4	432.9	2.8	25.1
	LDDV	2230001250	1.13	1.01	9.43	0.01	0.07	6.2	5.5	51.7	0.1	0.4
	LDDT	2230060250	7.31	6.69	110.83	0.09	0.76	40.1	36.6	607.3	0.5	4.2
	2BHDDV	2230071250	3.09	2.82	49.13	0.04	0.34	16.9	15.4	269.2	0.2	1.9
	LHDDV	2230072250	17.77	16.30	261.06	0.20	1.76	97.4	89.3	1,430.5	1.1	9.7
	MHDDV	2230073250	83.00	71.08	1,428.49	1.29	5.71	454.8	389.5	7,827.3	7.0	31.3
	HHDDV	2230074250	228.46	199.83	4,070.12	3.65	12.21	1,251.8	1,095.0	22,302.0	20.0	66.9
	BUSES	2230075250	17.36	15.48	295.43	0.18	0.66	95.1	84.8	1,618.8	1.0	3.6

Table 5.2–3 (continued). Annual and typical daily onroad mobile source emissions by facility type and vehicle class in Maricopa County.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
			PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Urban Principal Arterial	LDGV	2201001270	171.20	67.62	2,518.28	28.14	171.62	938.1	370.5	13,798.8	154.2	940.4
	LDGT1	2201020270	104.13	42.44	2,323.35	15.43	75.17	570.6	232.5	12,730.7	84.6	411.9
	LDGT2	2201040270	53.64	21.86	1,196.87	7.95	38.72	293.9	119.8	6,558.2	43.6	212.2
	HDGV	2201070270	19.50	7.01	541.20	2.99	11.84	106.9	38.4	2,965.5	16.4	64.9
	MC	2201080270	6.41	5.19	123.95	0.97	6.76	35.1	28.4	679.2	5.3	37.0
	LDDV	2230001270	1.84	1.41	25.46	0.03	0.14	10.1	7.7	139.5	0.2	0.8
	LDDT	2230060270	12.36	10.72	207.85	0.13	0.92	67.7	58.8	1,138.9	0.7	5.1
	2BHDDV	2230071270	5.27	4.54	92.40	0.06	0.42	28.9	24.9	506.3	0.3	2.3
	LHDDV	2230072270	30.06	26.21	489.28	0.30	2.14	164.7	143.6	2,681.0	1.6	11.7
	MHDDV	2230073270	80.61	64.08	1,151.68	1.00	4.03	441.7	351.1	6,310.6	5.5	22.1
HHDDV	2230074270	225.10	186.79	3,077.56	2.73	8.01	1,233.4	1,023.5	16,863.4	15.0	43.9	
BUSES	2230075270	17.66	14.76	236.81	0.14	0.48	96.8	80.9	1,297.6	0.7	2.6	
Urban Minor Arterial	LDGV	2201001290	87.02	34.37	1,280.03	14.30	87.24	476.8	188.3	7,013.9	78.4	478.0
	LDGT1	2201020290	52.93	21.57	1,180.95	7.84	38.21	290.0	118.2	6,470.9	43.0	209.4
	LDGT2	2201040290	27.27	11.11	608.37	4.04	19.68	149.4	60.9	3,333.5	22.1	107.9
	HDGV	2201070290	9.91	3.56	275.09	1.52	6.02	54.3	19.5	1,507.3	8.3	33.0
	MC	2201080290	3.26	2.64	63.00	0.49	3.44	17.9	14.4	345.2	2.7	18.8
	LDDV	2230001290	0.94	0.72	12.94	0.02	0.07	5.1	3.9	70.9	0.1	0.4
	LDDT	2230060290	6.28	5.45	105.65	0.07	0.47	34.4	29.9	578.9	0.4	2.6
	2BHDDV	2230071290	2.68	2.31	46.97	0.03	0.21	14.7	12.7	257.4	0.2	1.2
	LHDDV	2230072290	15.28	13.32	248.70	0.15	1.09	83.7	73.0	1,362.7	0.8	6.0
	MHDDV	2230073290	40.97	32.57	585.39	0.51	2.05	224.5	178.5	3,207.6	2.8	11.2
HHDDV	2230074290	114.42	94.94	1,564.31	1.39	4.07	626.9	520.2	8,571.6	7.6	22.3	
BUSES	2230075290	8.98	7.50	120.37	0.07	0.24	49.2	41.1	659.6	0.4	1.3	
Urban Collector	LDGV	2201001310	16.99	6.71	249.98	2.79	17.04	93.1	36.8	1,369.8	15.3	93.4
	LDGT1	2201020310	10.34	4.21	230.63	1.53	7.46	56.6	23.1	1,263.7	8.4	40.9
	LDGT2	2201040310	5.32	2.17	118.81	0.79	3.84	29.2	11.9	651.0	4.3	21.1
	HDGV	2201070310	1.94	0.70	53.72	0.30	1.18	10.6	3.8	294.4	1.6	6.4
	MC	2201080310	0.64	0.52	12.30	0.10	0.67	3.5	2.8	67.4	0.5	3.7
	LDDV	2230001310	0.18	0.14	2.53	0.00	0.01	1.0	0.8	13.8	0.0	0.1
	LDDT	2230060310	1.23	1.06	20.63	0.01	0.09	6.7	5.8	113.1	0.1	0.5
	2BHDDV	2230071310	0.52	0.45	9.17	0.01	0.04	2.9	2.5	50.3	0.0	0.2
	LHDDV	2230072310	2.98	2.60	48.57	0.03	0.21	16.4	14.3	266.1	0.2	1.2
	MHDDV	2230073310	8.00	6.36	114.32	0.10	0.40	43.8	34.9	626.4	0.5	2.2
HHDDV	2230074310	22.34	18.54	305.50	0.27	0.79	122.4	101.6	1,674.0	1.5	4.4	
BUSES	2230075310	1.75	1.47	23.51	0.01	0.05	9.6	8.0	128.8	0.1	0.3	
Urban Local	LDGV	2201001330	82.03	32.40	1,206.67	13.48	82.24	449.5	177.5	6,611.9	73.9	450.6
	LDGT1	2201020330	49.89	20.33	1,113.27	7.39	36.02	273.4	111.4	6,100.1	40.5	197.4
	LDGT2	2201040330	25.70	10.48	573.50	3.81	18.56	140.8	57.4	3,142.5	20.9	101.7
	HDGV	2201070330	9.34	3.36	259.32	1.43	5.67	51.2	18.4	1,420.9	7.8	31.1
	MC	2201080330	3.07	2.49	59.39	0.46	3.24	16.8	13.6	325.4	2.5	17.8
	LDDV	2230001330	0.88	0.68	12.20	0.02	0.07	4.8	3.7	66.8	0.1	0.4
	LDDT	2230060330	5.92	5.14	99.59	0.06	0.44	32.5	28.2	545.7	0.3	2.4
	2BHDDV	2230071330	2.52	2.18	44.27	0.03	0.20	13.8	11.9	242.6	0.2	1.1
	LHDDV	2230072330	14.41	12.56	234.45	0.14	1.03	78.9	68.8	1,284.6	0.8	5.6
	MHDDV	2230073330	38.62	30.70	551.84	0.48	1.93	211.6	168.2	3,023.8	2.6	10.6
HHDDV	2230074330	107.86	89.50	1,474.66	1.31	3.84	591.0	490.4	8,080.3	7.2	21.0	
BUSES	2230075330	8.46	7.07	113.47	0.07	0.23	46.4	38.8	621.8	0.4	1.3	

Table 5.2–3 (continued). Annual and typical daily onroad mobile source emissions by facility type and vehicle class in Maricopa County.

Facility Type	Vehicle Class	SCC	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
			PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Off-Network	LDGV	2201001000	62.94	57.95	4,398.52	4.27	0.00	344.9	317.6	24,101.5	23.4	0.0
	LDGT1	2201020000	17.89	16.47	1,457.16	0.93	0.00	98.0	90.3	7,984.4	5.1	0.0
	LDGT2	2201040000	9.22	8.49	750.66	0.48	0.00	50.5	46.5	4,113.2	2.6	0.0
	HDGV	2201070000	2.41	2.22	215.64	0.13	0.00	13.2	12.2	1,181.6	0.7	0.0
	MC	2201080000	0.08	0.07	2.40	0.02	0.00	0.4	0.4	13.2	0.1	0.0
	LDDV	2230001000	10.05	9.75	27.47	0.01	0.00	55.1	53.4	150.5	0.0	0.0
	LDDT	2230060000	1.15	1.12	26.39	0.01	0.00	6.3	6.1	144.6	0.0	0.0
	2BHDDV	2230071000	0.43	0.41	11.57	0.00	0.00	2.3	2.3	63.4	0.0	0.0
	LHDDV	2230072000	2.63	2.55	61.88	0.01	0.00	14.4	14.0	339.1	0.1	0.0
	MHDDV	2230073000	1.67	1.62	153.86	0.03	0.00	9.1	8.9	843.0	0.1	0.0
	HHDDV	2230074000	25.83	25.05	2,863.21	0.40	0.00	141.5	137.3	15,688.8	2.2	0.0
	BUSES	2230075000	0.20	0.19	4.42	0.00	0.00	1.1	1.1	24.2	0.0	0.0

5.3 Fugitive dust emissions

While exhaust, tire wear, and brake wear emissions were calculated using the EPA MOVES2010a model, fugitive dust emissions from paved and unpaved roads were calculated using the equations found in sections 13.2.1 and 13.2.2 of the EPA Compilation of Air Pollutant Emission Factors, AP-42 (US EPA, 2006). The new AP-42 equation published by EPA in January 2011 has been applied to estimate the PM₁₀ and PM_{2.5} emissions from paved roads. The contact person for the fugitive dust emission estimates is Cathy Arthur (602-254-6300).

5.3.1 Paved road fugitive dust emissions

In the AP-42 equation, paved road emissions are a function of silt loading values and the average weight of vehicles traveling on paved road surfaces. Paved roads have been classified as freeways, high-traffic arterials, and low-traffic arterials to reflect different silt loading assumptions. An arterial carrying a traffic volume of less than 10,000 vehicles per average weekday is classified as low-traffic; all other roads that are not freeways are classified as high-traffic arterials. The silt loading levels, in grams per square meter, are 0.02 for freeways, 0.067 for high-traffic arterials, and 0.23 for low-traffic arterials. The silt loadings were derived from paved road samples collected in Maricopa County by an EPA contractor (US EPA, 1993). The average vehicle weights were derived from July 1, 2011 vehicle registrations for Maricopa County provided by the Arizona Department of Transportation. The fugitive dust emission factors for paved roads were derived by applying the following AP-42 equation:

$$E = k \times sL^{0.91} \times W^{1.02} \times (1 - P/4N)$$

- where: E = annual average particulate emission factor (g/VMT),
 k = particle size multiplier for particle size range (1.0 g/ VMT for PM₁₀ and 0.25 g/ VMT for PM_{2.5}),
 sL = road surface silt loading (0.02 g/m² for freeways, 0.067 g/m² for high-traffic arterials, and 0.23 g/m² for low-traffic arterials),
 W = average weight of the vehicles traveling on the roads (3.91 tons on freeways and 2.72 tons on arterials),

P = annual number of “wet” days with at least 0.254 mm (0.01 in) of precipitation (31 days³ in 2011), and

N = annual number of days (365 days in 2011).

The annual average PM_{10} and $PM_{2.5}$ emission factors for paved roads derived from the AP-42 equation are presented in Table 5.3–1.

The 2011 vehicle miles of travel (VMT) by silt loading category were used to estimate paved road fugitive dust emissions. Daily VMTs by silt loading category for the PM_{10} NAA and Maricopa County are shown in Table 5.3–2. The VMTs were derived by applying geographic information systems (GIS) to a 2011 traffic assignment output by the MAG travel demand model, TransCAD. The 2011 weekday traffic volumes output by TransCAD were normalized to 2011 HPMS VMTs for the PM_{10} NAA and Maricopa County to produce the annual average daily VMTs by silt loading category shown in Table 5.3–2.

Table 5.3–1. 2011 fugitive dust emission factors for paved roads.

Silt Loading Category	Emission factors (g/VMT)	
	PM_{10}	$PM_{2.5}$
Freeways	0.11	0.03
High Traffic Arterials	0.23	0.06
Low Traffic Arterials	0.71	0.18

Table 5.3–2. 2011 VMT by silt loading category for paved roads.

Silt Loading Category	Daily VMT (thousand)	
	PM_{10} NAA	Maricopa County
Freeways	32,333	34,624
High Traffic Arterials	37,518	39,614
Low Traffic Arterials	13,171	14,648
Total:	83,022	88,885

Applying the emission factors in Table 5.3–1 to the VMTs in Table 5.3–2 and converting to pounds per day produces the 2011 uncontrolled particulate emissions from paved roads for the PM_{10} NAA and Maricopa County, shown in Table 5.3–3. These uncontrolled emissions do not include the 2011 emission reductions attributed to PM_{10} certified street sweepers in the MAG 2012 Five Percent Plan for PM_{10} (MAG, 2012).

Table 5.3–3. 2011 uncontrolled fugitive dust emissions from paved roads.

Silt Loading Category	PM_{10} NAA (lbs/day)		Maricopa County (lbs/day)	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Freeways	7,840.9	2,138.4	8,396.5	2,290.0
High Traffic Arterials	19,023.8	4,962.7	20,086.6	5,240.0
Low Traffic Arterials	20,616.1	5,226.6	22,928.0	5,812.7
Total:	47,480.8	12,327.7	51,411.1	13,342.7

The MAG 2012 Five Percent Plan includes emission reduction credit for 72 PM_{10} certified street sweepers purchased by December 31, 2006 with MAG Congestion Mitigation and Air Quality

³ Precipitation data for 2011 were obtained from National Oceanic and Atmospheric Administration (NOAA) in the form of local climatological data at Phoenix Sky Harbor Airport.

Improvement (CMAQ) funds that were still in service on December 31, 2009. Reductions for the sweepers purchased by December 31, 2006 were also applied to base case uncontrolled paved road emissions in the MAG 2012 Five Percent Plan. The PM₁₀ emission reduction benefit of these 72 sweepers in 2011 is 5,110.1 pounds per day.

In addition, the MAG 2012 Five Percent Plan contains contingency measures implemented in 2007–2011 that reduce paved road emissions. These measures include Arizona Department of Transportation (ADOT) contracted PM₁₀ certified street sweeping of freeways and frontage roads (1,871.62 lbs/day), 25 PM₁₀ certified street sweepers purchased with Congestion Mitigation and Air Quality Improvement (CMAQ) funds in 2007–2009 (842.85 lbs/day), projects completed by local governments in 2008–2011 that paved and stabilized unpaved shoulders (1,607.34 lbs/day), and ADOT overlays of state highways with rubberized asphalt (14.30 lbs/day). The combined benefit of these contingency measures in 2011 is 4,336.1 pounds per day.

The total reduction of 9,446.2 pounds per day was subtracted from the uncontrolled PM₁₀ emissions in Table 5.3–3. This emission reduction represents 19.9 percent of the uncontrolled PM₁₀ emissions of 47,480.8 pounds per day in the PM₁₀ NAA. This percent reduction was applied to the uncontrolled PM_{2.5} emissions in the PM₁₀ NAA and the absolute reduction in PM_{2.5} emissions was then applied to the uncontrolled PM_{2.5} emissions in Maricopa County.

The resultant controlled emissions in tons per year and pounds per day are shown in Table 5.3–4.

Table 5.3–4. 2011 controlled fugitive dust emissions from paved roads.

Area	Annual emissions (tons/year)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
PM ₁₀ NAA	6,941.31	1,802.10	38,034.6	9,874.5
Maricopa County	7,658.59	1,987.33	41,964.9	10,889.5

5.3.2 Unpaved road fugitive dust emissions

AP-42 emission factors were applied to unpaved road and alley VMTs to estimate fugitive dust emissions (US EPA, 2006). The unpaved road and alley particulate emission factors were derived from the following AP-42 equation for publicly accessible unpaved roads, assuming a silt content of 11.9%, a soil moisture content of 0.5%, and an average speed of 25 miles per hour on public unpaved roads, 20 miles per hour on private unpaved roads and 10 miles per hour on unpaved alleys:

$$E = \left[\frac{k \left(\frac{s}{12} \right)^1 \left(\frac{S}{30} \right)^{0.5}}{\left(\frac{M}{0.5} \right)^{0.2}} - C \right] \left(1 - \frac{P}{N} \right)$$

where: E = annual average particulate emission factor extrapolated for natural mitigation (lb/VMT),

k = particle size multiplier for particle size range (1.8 lb/VMT for PM₁₀ and 0.18 lb/VMT for PM_{2.5}),

s = surface material silt content (11.9%),

- S = mean vehicle speed (25 mph for public unpaved roads, 20 mph for private unpaved roads and 10 mph for unpaved alleys),
- M = surface material moisture content (0.5%),
- C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear (0.00047 lb/VMT for PM_{10} and 0.00036 lb/VMT for $PM_{2.5}$),
- P = annual number of “wet” days with at least 0.254 mm (0.01 in) of precipitation (31 days in 2011), and
- N = annual number of days (365 days in 2011).

The public unpaved road emission factors resulting from the above equation are 1.4907 pounds per VMT for PM_{10} and 0.1488 pounds per VMT for $PM_{2.5}$. The private unpaved road emission factors are 1.3333 pounds per VMT for PM_{10} and 0.1331 pounds per VMT for $PM_{2.5}$. The unpaved alley emission factors are 0.9426 pounds per VMT for PM_{10} and 0.0940 pounds per VMT for $PM_{2.5}$. These unpaved road and alley emission factors are consistent with the assumptions used in the MAG 2012 Five Percent Plan (MAG, 2012). These factors were applied to the annual average daily 2011 VMT estimates shown in Table 5.3–5.

The 2011 VMT for public unpaved roads in the PM_{10} NAA was derived from the MAG 2009 Unpaved Road Inventory (MAG, 2010). The 2011 VMT for private unpaved roads in the PM_{10} NAA was derived from a study of private unpaved roads and alleys conducted by MAG in August-September 2011 (MAG, 2011). The 2011 VMT for unpaved alleys was derived by multiplying a MAG GIS-derived estimate of 650 miles of dirt alleys by an annual average daily traffic (AADT) estimate of 4 vehicles per day. The AADT for alleys was also derived from the 2011 MAG study referenced above.

The 2011 Maricopa County VMT on unpaved roads and alleys was obtained by applying a ratio of 1.071 to the PM_{10} NAA VMT in Table 5.3–6. This ratio represents 2011 VMT on all roads in Maricopa County to 2011 VMT on all roads in the PM_{10} NAA, as shown in Table 5.3–6. The VMTs in Table 5.3–6 reflect 2011 Highway Performance Monitoring System (HPMS) data submitted to the Federal Highway Administration by ADOT in 2012.

Table 5.3–5. 2011 VMT on unpaved roads in the PM_{10} NAA and Maricopa County

Area	2011 Annual Average Daily VMT		
	Unpaved Public Roads	Unpaved Private Roads	Unpaved Alleys
PM_{10} NAA	19,956	22,255	2,600
Maricopa County	21,373	23,835	2,785

Table 5.3–6. 2011 VMT on all roads in the PM_{10} NAA and Maricopa County

Area	2011 Annual Average Daily VMT (in thousands)	Ratio to 2011 Annual Average Daily VMT in the PM_{10} NAA
PM_{10} NAA	83,022	1.000
Maricopa County	88,885	1.071

Multiplying the unpaved road emission factors by the VMTs in Table 5.3–5 results in the emissions shown in Table 5.3–7. These uncontrolled emissions do not include the emission reductions attributable to contingency measures in the MAG 2012 Five Percent Plan for PM_{10} that were implemented by 2011.

Table 5.3–7. Daily uncontrolled unpaved road and alley fugitive dust emissions.

Area	PM ₁₀ (lbs/day)		PM _{2.5} (lbs/day)	
	Unpaved Roads	Unpaved Alleys	Unpaved Roads	Unpaved Alleys
PM ₁₀ NAA	59,421.0	2,450.8	5,931.6	244.4
Maricopa County	63,639.9	2,625.1	6,352.7	261.8

The MAG 2012 Five Percent Plan identifies a large number of projects that were implemented in 2008–2011 to pave, stabilize and reduce speed limits on unpaved roads and alleys in the PM₁₀ NAA (MAG, 2012). In 2011, the total PM₁₀ emission reduction credit for these projects is 15,468.8 pounds per day. This reduction was subtracted from the uncontrolled emissions in Table 5.3–8 and represents 25 percent of the total uncontrolled unpaved road and alley emissions of 61,871.8 pounds per day in the PM₁₀ NAA. This 25 percent reduction was applied to the uncontrolled PM_{2.5} emissions in the PM₁₀ NAA and the absolute reduction in PM_{2.5} emissions was then applied to the uncontrolled PM_{2.5} emissions in Maricopa County.

The resultant controlled unpaved road and alley emissions in tons per year and pounds per day are shown in Table 5.3–8.

Table 5.3–8. Annual and typical daily controlled fugitive dust emissions from unpaved roads and alleys.

Area	Annual emissions (tons/year)		Typical daily emissions (lbs/day)	
	PM ₁₀	PM _{2.5}	PM ₁₀	PM _{2.5}
PM ₁₀ NAA	8,468.55	845.34	46,403.0	4,632.0
Maricopa County	9,270.31	925.36	50,796.2	5,070.5

5.4 Summary of particulate emissions from onroad mobile sources

Table 5.4–1 summarizes the annual emissions and the typical daily emissions for PM₁₀, PM_{2.5}, NO_x, SO₂, and NH₃ from all onroad mobile sources in the PM₁₀ NAA in 2011. Similar data for Maricopa County are presented in Table 5.4–2.

Table 5.4–1. Annual and typical daily emissions from all onroad mobile sources in the PM₁₀ NAA.

Emission Category	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Exhaust, tire wear, and brake wear	2,663.31	1,869.88	56,267.92	205.82	1,108.89	14,592.8	10,246.6	308,316.8	1,127.5	6,076.6
Paved road fugitive dust	6,941.31	1,802.10	—	—	—	38,034.6	9,874.5	—	—	—
Unpaved road and alley fugitive dust	8,468.55	845.34	—	—	—	46,403.0	4,632.0	—	—	—
Total:	18,073.17	4,517.32	56,267.92	205.82	1,108.89	99,030.4	24,753.1	308,316.8	1,127.5	6,076.6

Table 5.4–2. Annual and typical daily emissions from all onroad mobile sources in Maricopa County.

Emission Category	Annual emissions (tons/year)					Typical daily emissions (lbs/day)				
	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃	PM ₁₀	PM _{2.5}	NO _x	SO ₂	NH ₃
Exhaust, tire wear, and brake wear	2,833.55	1,999.22	60,269.94	219.72	1,189.18	15,526.3	10,955.1	330,245.8	1,203.3	6,517.1
Paved road fugitive dust	7,658.59	1,987.33	—	—	—	41,964.9	10,889.5	—	—	—
Unpaved road and alley fugitive dust	9,270.31	925.36	—	—	—	50,796.2	5,070.5	—	—	—
Total:	19,762.45	4,911.91	60,269.94	219.72	1,189.18	108,287.4	26,915.1	330,245.8	1,203.3	6,517.1

5.5 Quality assurance process

5.5.1 VMT estimates

Normal quality assurance procedures, including automated and manual consistency checks, were conducted by MAG in developing the 2011 TransCAD traffic assignment network used to generate the VMT data. The VMT estimates using the MAG travel demand model have been validated by the MAG transportation modeling group.

5.5.2 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 changes were then rechecked by the reviewer.

5.5.3 Draft particulate matter emissions inventory

The draft onroad mobile source portion of the 2011 periodic PM₁₀ emissions inventory was reviewed using published EPA quality review guidelines for base year emission inventories (US EPA, 1992b). The procedure review (Levels I, II, and III) included checks for completeness, consistency, and the correct use of appropriate procedures.

5.6 References

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