4. Nonroad Mobile Sources

4.1 Introduction

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

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

Emission calculations for all nonroad mobile sources except aircraft, airport ground support equipment and locomotives are derived from EPA's NONROAD2005 model (Core version 2005a, Feb. 2006). Aircraft and airport ground support equipment emission calculations were derived from individual surveys of county airports. Locomotive emission calculations were derived from surveys of the 3 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 NONROAD2005 model. Monthly temperature and fuel data were provided by the Arizona State Weights and Measures Department. The following table lists the local county inputs used:

Table 4.1–1. NONROAD2005 model county temperature and fuel-related inputs.

Month	Max (°F)	Min (°F)	Average (°F)	Fuel RVP (psi)	Diesel Sulfur (ppm)	Gasoline Sulfur (ppm)
January	81	41	57.8	9	354	39
February	72	46	59.2	9	318	43
March	88	46	63.9	9	303	29
April	96	53	72.3	8	301	39
May	109	60	82.7	7	299	43
June	114	71	90.4	7	286	84
July	116	79	97.3	6	260	45
August	113	72	92.2	7	287	40
September	108	70	89.6	7	314	37
October	101	58	78.3	8	339	30
November	90	40	66.3	9	364	34
December	78	35	56.8	9	389	30

Note: All other required temperature and fuel-related inputs not listed assumed NONROAD2005 default values.

The US EPA recommends adjusting default NONROAD2005 model values (such as equipment population, activity levels of equipment, growth factors, etc.) where local data is available, as the default values in the model are derived from national averages. The NONROAD2005 model defaults were adjusted in the following manner:

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

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

Temporal allocations (used to calculate ozone season-day emissions) for nonroad equipment categories modeled in the NONROAD2005 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
Logging	0.1666667	0.0833334
Pleasure craft	0.0600000	0.3500000
Railway maintenance	0.1800000	0.0500000
Recreational	0.1111111	0.2222222

4.2 Agricultural equipment

Annual emissions from agricultural equipment in Maricopa County were calculated using EPA's NONROAD2005 model, as discussed above. Ozone nonattainment area annual emissions were calculated based on EIIP guidance (US EPA, 2002) which recommends using the ratio of agricultural land inside the nonattainment area (223,627 acres) to agricultural land inside the county (465,833 acres). See Section 1.5.2 for a discussion of land-use data used.

Ozone nonattainment area emissions from agricultural equipment	= County VOC emissions	×	Agricultural land-use allocation factor
	= 53.31 tons	×	64.37%
	= 34.32 tons VOC /yr		

County season-day emissions were calculated by multiplying ozone season emissions (generated by the NONROAD2005 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 ozone season (US EPA, 1999), as follows:

Maricopa County VOC season-day emissions (lbs/day)	= Ozone season VOC emissions (tons/season)	× 2,000 (lb/ton)	×	daily activity allocation factor for agricultural equipment expressed as (week/day)	÷ 13 (weeks/season)
	= 17.67	× 2,000	×	0.166667	÷ 13
	= 453.1 lbs/day				

Ozone nonattainment area season-day emissions were calculated by multiplying County season-day emissions by the agricultural land-use allocation factor:

Ozone nonattainment area season-day emissions	= Maricopa County VOC season-day emissions	×	Agricultural land-use allocation factor
	= 453.1 lbs/day	×	64.37%
	= 291.7 lbs/day		

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

	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
Geographic area	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Maricopa County	53.31	386.34	417.85	453.1	3,226.3	3,707.9
Ozone NAA	34.32	248.69	268.97	291.7	2,076.8	2,386.8

4.3 Airport ground support equipment

Annual emissions from airport ground support equipment (GSE) were calculated based on the MAG Airport Emission Model. Activity data on aircraft operations was obtained through the Federal Aviation Administration website for eight towered airports in Maricopa County. Since all eight towered airports are in the ozone nonattainment area, NAA emission estimates are equal to Maricopa County totals.

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

	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
Geographic area	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Maricopa County	137.28	467.82	5,944.39	752.2	2,563.4	32,572.0
Ozone NAA	137.28	467.82	5,944.39	752.2	2,563.4	32,572.0

4.4 Commercial equipment

Annual emissions from commercial equipment in Maricopa County were calculated using EPA's NONROAD2005 model, as described in Section 4.1. Annual emissions for the ozone nonattainment area for this category were derived by applying the ratio of industrial employment in the nonattainment 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 ozone season emissions (generated by the NONROAD2005 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 ozone season (US EPA, 1999). Ozone nonattainment area season-day emissions were calculated based on industrial employment ratios as described above.

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

	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
Geographic area	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Maricopa County	2,339.70	1,449.72	54,941.52	17,907.0	8,553.8	410,503.5
Ozone NAA	2,331.28	1,444.50	54,743.73	17,842.5	8,523.0	409,025.7

4.5 Construction and mining equipment

Annual emissions from construction and mining equipment in Maricopa County were calculated using EPA's NONROAD2005 model as described in Section 4.1. Annual emissions for the ozone nonattainment area for this category were derived by applying the ratio of population in the nonattainment area to Maricopa County-level totals as a conservative estimate, as the EIIP-recommended allocation factor of total dollar value of construction was unavailable (US EPA, 2002). See Section 1.5.1 for a discussion of the population data used.

County season-day emissions were calculated by multiplying Maricopa County ozone season emissions (generated by the NONROAD2005 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 ozone season (US EPA, 1999). Ozone nonattainment area season-day emissions were calculated based on population ratios as described above.

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

	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
Geographic area	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Maricopa County	2,690.85	16,016.62	23,667.21	18,840.1	108,785.6	177,261.9
Ozone NAA	2,720.45	16,192.81	23,927.55	19,047.3	109,982.3	179,211.8

4.6 Industrial equipment

Annual emissions from industrial equipment in Maricopa County were calculated using EPA's NONROAD2005 model, as described in Section 4.1. Annual emissions for the ozone nonattainment area for this category were derived by applying the ratio of industrial employment in the

nonattainment area to Maricopa County-level totals as a conservative estimate, as the number of employees in manufacturing recommended by EIIP guidance (US EPA, 2002) was 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 ozone season emissions (generated by the NONROAD2005 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 ozone season (US EPA, 1999). Ozone nonattainment area season-day emissions were calculated based on industrial employment ratios as described above.

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

	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
Geographic area	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Maricopa County	772.17	3,316.67	13,597.40	5,035.6	21,109.0	90,844.8
Ozone NAA	769.39	3,304.73	13,548.45	5,017.5	21,033.0	90,517.8

4.7 Lawn and garden equipment

Annual emissions from lawn and garden equipment in Maricopa County were calculated using EPA's NONROAD2005 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 ozone nonattainment area for this category were derived by applying the ratio of population in the nonattainment 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 ozone season emissions (generated by the NONROAD2005 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 ozone season (US EPA, 1999). Ozone nonattainment area season-day emissions were calculated based on population as described above.

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

	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
Geographic area	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Maricopa County	6,586.38	843.10	101,879.34	74,053.0	6,409.9	1,085,431.7
Ozone NAA	6,658.83	852.37	103,000.01	74,867.6	6,480.4	1,097,371.4

4.8 Pleasure craft

Annual emissions from pleasure craft equipment in Maricopa County were calculated using EPA's NONROAD2005 model, as described in Section 4.1. Annual emissions for the ozone nonattainment area for this category were derived by applying the ratio of water surface area in the nonattainment area to Maricopa County-level totals, as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.2 for a discussion of the land-use data used.

County season-day emissions were calculated by multiplying Maricopa County ozone season emissions (generated by the NONROAD2005 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 ozone season (US EPA, 1999). Ozone nonattainment area season-day emissions were calculated based on water surface area as described above.

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

	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
Geographic area	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Maricopa County	809.50	70.58	1,748.83	17,294.9	1,347.2	40,149.6
Ozone NAA	809.50	70.58	1,748.83	17,294.9	1,347.2	40,149.6

4.9 Railway maintenance equipment

Annual emissions from railway maintenance equipment in Maricopa County were calculated using EPA's NONROAD2005 model, as described in Section 4.1. Annual emissions for the ozone nonattainment area for this category were derived by applying the ratio of population in the nonattainment area to Maricopa County-level totals, as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.1 for a discussion of the population data used.

County season-day emissions were calculated by multiplying Maricopa County ozone season emissions (generated by the NONROAD2005 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 ozone season (US EPA, 1999). Ozone nonattainment area season-day emissions were calculated based on the population ratio as described above.

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

	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
Geographic area	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Maricopa County	2.32	9.27	28.38	16.8	63.9	221.4
Ozone NAA	2.35	9.37	28.69	17.0	64.6	223.8

4.10 Recreational equipment

Annual emissions from recreational equipment in Maricopa County were calculated using EPA's NONROAD2005 model, as described in Section 4.1. Annual emissions for the ozone nonattainment area for this category were derived by applying the ratio of passive open space, golf courses and vacant land use in the nonattainment area to Maricopa County-level totals as recommended by EIIP guidance (US EPA, 2002). See Section 1.5.2 for a discussion of the land use data used.

County season-day emissions were calculated by multiplying Maricopa County ozone season emissions (generated by the NONROAD2005 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 ozone season (US EPA, 1999). Ozone nonattainment area season-day emissions were calculated based on land use as described above.

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

	Annual emissions (tons/yr)			Season-day emission (lbs/day)		
Geographic area	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Maricopa County	1,416.44	59.99	10,675.34	16,532.4	535.5	135,733.8
Ozone NAA	911.28	38.59	6,868.11	10,636.3	344.5	87,326.0

4.11 Aircraft

A survey of 17 airports in Maricopa County was conducted to collect data on the total number of landing and take-off operations (LTO's) as well as fleet mix to determine the types of aircraft used and idle times to calculate annual emissions. Of these airports, three locations (Gila Bend Municipal Airport, Gila Bend Air Force Auxiliary Field and Wickenburg Municipal Airport) are outside of the nonattainment area.

For airports that provided complete survey data, the FAA's latest airport Emissions and Dispersion Modeling Software (EDMS 4.5) was used to calculate emissions. Parameters required to apply this model include annual LTO figures, fleet mix of types of aircraft in each activity category, and average taxi-in and taxi-out times.

For those airports that provided only partial data, the EDMS model could not be used to calculate emissions for that specific airport. Instead, emission factors from similar airports that provided complete information was used. Examples of missing data were detailed fleet mix data or unknown idle times. For airports that did not respond to the survey, LTO figures, taxi-in/taxi-out times and aircraft types were derived from online databases that provide detailed aeronautical information on airports at http://www.transtats.bts.gov, http:// www.apo.data.faa.gov and http://www.airnav.com.

The following provides an example of how aircraft emissions were calculated using the FAA's EDMS modeling software for Skyranch at Carefree, a small, general-aviation only airport that has an ordinance mandate that the airport can only accept aircraft that weigh 12,500 lbs or less. Since the EDMS model requires an exact LTO value for each airframe considered in the model, and since the survey did not require respondents to supply exact LTO counts for each individual airframe, an averaging method was used. EDMS was run to produce a composite emission factor for an airport based on the most common type of aircraft using that facility and then that composite emission factor was applied to the actual reported activity for the airport. For Skyranch, a composite profile was created by selecting within EDMS 12 aircraft types likely to utilize the airport, based on data provided by the airport survey and follow-up correspondence. These 12 aircraft types are: Cessna 150, Comanche, Robin R 2160, Socata Tampico, Cessna 172 Skyhawk, Piper PA-28, Robin R 3000, Socata Tobago, Cherokee six, Robin DR 400, Rockwell Commander, and Spencer S-12 Air Car.

The EDMS model was run with the above 12 aircraft types and for ease of calculation, each aircraft was allocated 1000 LTO/year. It was then necessary to divide the lbs/LTO result by the 12 representative aircraft used to derive an emission factor for an "average" aircraft LTO. Table 4.11–1 summarizes the activity level for each aircraft category for each airport surveyed as well as the emission factor for each pollutant.

Table 4.11–1. 2005 airport activity data, emission calculation methods, and emission factors.

Airport name	Activity category	2005 LTOs	Lbs/LTO		
			VOC	NO_x	CO
Arizona Army National Guard [2]	ML	1,080	2.899	2.251	3.458
Buckeye Municipal Airport [2]	GA	21,457	2.008	1.412	8.567
Chandler Municipal Airport [4]	AT	1,370	2.137	2.036	14.437
	GA	116,158	2.008	1.412	8.567
	ML	28	9.841	4.243	27.098
Falcon Field [2]	AC	24	1.275	26.34	6.208
	AT	4,098	2.137	2.036	14.437
	GA	128,835	0.617	1.214	4.564
	ML	2,136	9.841	4.243	27.098
Gila Bend Air Force Auxiliary Field [1,2]	ML	31,003	0.465	4.174	4.82
Gila Bend Municipal Airport [1,3]	GA	6,935	0.617	1.214	4.564
Glendale Municipal Airport [4]	AT	935	2.137	2.036	14.437
	GA	65,438	0.617	1.214	4.564
	ML	62	9.841	4.243	27.098
Luke Air Force Base [2]	ML	59,500	6.424	14.327	26.727
Phoenix Deer Valley Airport [4]	AT	2,293	2.137	2.036	14.437
	GA	186,231	0.617	1.214	4.564
	ML	30	9.841	4.243	27.098
Phoenix Goodyear Airport [4]	AC	172	1.275	26.34	6.208
	AT	1,893	2.137	2.036	14.437
	GA	46,440	0.617	1.214	4.564
	ML	2,005	9.841	4.243	27.098
Phoenix Sky Harbor Int'l. [4]	AC	204,856	5.431	16.889	23.897
	AT	48,118	2.174	5.494	14.862
	GA	20,670	2.008	1.412	8.567
	ML	1,447	27.986	35.936	59.645
Pleasant Valley Airport [2]	GA	14,096	0.045	0.354	0.724
Scottsdale Airport [2]	AT	5,903	2.137	2.036	14.437
	GA	100,164	2.008	1.412	8.567
	ML	155	9.841	4.243	27.098
Skyranch at Carefree [2]	GA	2,248	0.278	0.046	18.171
Stellar Airpark [2]	GA	19,528	0.617	1.214	4.564
Wickenburg Municipal Airport[1]	AT	485	2.137	2.036	14.437
	GA	23,059	0.617	1.214	4.564
	ML	728	9.841	4.243	27.098
Williams Gateway Airport [4]	AC	450	1.275	26.34	6.208
	AT	3,874	2.137	2.036	14.437
	GA	128,310	0.617	1.214	4.564
	ML	5,689	40.954	19.82	75.111

1. Airport is outside the nonattainment area.
2. Data reported from source.
3. No data reported from source. Data derived from http://www.airnav.com
4. No data reported from source. Data derived from http://www.apo.data.faa.gov/main/atads.asp

For example, the model run with the 12 aircraft types resulted in total NO_x emissions of 0.277 tons (assuming each of the 12 aircraft types had 1000 LTOs each during the period).

Composite NO_x emission factor (lb/LTO) $= \Sigma$ modeled NO_x emissions (tons/yr) × 1 yr / 12,000 LTOs × 2,000 lb/ton

$= 0.046$ lb NO_x /LTO

This composite emission factor was then multiplied by the actual number of LTOs at the airport to derive an annual NO_x emissions total:

NO_x emissions (lb/ yr) = 2,248 LTO/yr × 0.046 lb NO_x /LTO
= 103.4 lb NO_x /yr

Table 4.11–2 lists the total annual emissions and ozone season-day emissions, for each airport and aircraft type. For all airports, activity is presumed to occur evenly over a 7-day week. To develop seasonal allocation factors, Phoenix Sky Harbor International Airport's distribution of LTO's for air carrier activity was used. Seasonal activity for the ozone season (July–September) is thus calculated as (17,578 + 17,784 + 16,882 ÷ 204,856 = 25%).

Table 4.11–2. Annual and ozone season-day emissions by airport and aircraft type.

		Tons/yr			Lbs/day		
Facility	**Cate-gory[1]**	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Arizona Army Natl. Guard	ML	1.57	1.22	1.87	8.6	6.7	10.3
Buckeye Municipal Airport	GA	21.54	15.15	91.91	118.4	83.2	505.0
Chandler Municipal Airport	AT	1.46	1.39	9.89	8.0	7.7	54.3
	GA	116.62	82.01	497.56	640.8	450.6	2,733.9
	ML	0.14	0.06	0.38	0.8	0.3	2.1
Falcon Field	AC	0.02	0.32	0.07	0.1	1.7	0.4
	AT	4.38	4.17	29.58	24.1	22.9	162.5
	GA	39.75	78.20	294.00	218.4	429.7	1,615.4
	ML	10.51	4.53	28.94	57.7	24.9	159.0
Glendale Municipal Airport	AT	1.00	0.95	6.75	5.5	5.2	37.1
	GA	20.19	39.72	149.33	110.9	218.2	820.5
	ML	0.31	0.13	0.84	1.7	0.7	4.6
Luke Air Force Base	ML	191.11	426.23	795.13	1,050.1	2,341.9	4,368.8
Phoenix Deer Valley Airport.	AT	2.45	2.33	16.55	13.5	12.8	90.9
	GA	57.45	113.04	424.98	315.7	621.1	2,335.1
	ML	0.15	0.06	0.41	0.8	0.3	2.2
Phoenix Goodyear Airport	AC	0.11	2.27	0.53	0.6	12.4	2.9
	AT	2.02	1.93	13.66	11.1	10.6	75.1
	GA	14.33	28.19	105.98	78.7	154.9	582.3
	ML	9.87	4.25	27.17	54.2	23.4	149.3
Phoenix Sky Harbor Int'l.	AC	556.29	1,729.91	2,447.72	3,056.5	9,505.0	13,449.0
	AT	52.30	132.18	357.56	287.4	726.3	1,964.6
	GA	20.75	14.59	88.54	114.0	80.2	486.5
	ML	20.25	26.00	43.15	111.3	142.9	237.1
Pleasant Valley Airport	GA	0.32	2.49	5.10	1.7	13.7	28.0
Scottsdale Airport	AT	6.31	6.01	42.61	34.7	33.0	234.1
	GA	100.56	70.72	429.05	552.6	388.5	2,357.4
	ML	0.76	0.33	2.10	4.2	1.8	11.5
Skyranch at Carefree	GA	0.31	0.05	20.42	1.7	0.3	112.2
Stellar Airpark	GA	6.02	11.85	44.56	33.1	65.1	244.9
Williams Gateway Airport	AC	0.29	5.93	1.40	1.6	32.6	7.7
	AT	4.14	3.94	27.96	22.7	21.7	153.7
	GA	39.58	77.88	292.80	217.5	427.9	1,608.8
	ML	116.49	56.38	213.65	640.1	309.8	1,173.9
Ozone nonattainment area totals:		1,419.35	2,944.42	6,512.18	7,798.6	16,178.1	35,781.2

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

Table 4.11–2 (continued). Annual and ozone season-day emissions, by airport and aircraft type.

Airports outside the nonattainment area:							
Gila Bend AF Auxiliary Field	ML	7.21	64.70	74.72	39.6	355.5	410.5
Gila Bend Municipal Airport	GA	2.14	4.21	15.83	11.8	23.1	87.0
Wickenburg Municipal Airport	AT	0.52	0.49	3.50	2.8	2.7	19.2
	GA	7.11	14.00	52.62	39.1	76.9	289.1
	ML	3.58	1.54	9.86	19.7	8.5	54.2
Maricopa County totals:		1,439.91	3,029.37	6,668.71	7,911.6	16,644.9	36,641.3

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, 1997).

Table 4.12–1. Emission factors for locomotives.

	Emission factors (lbs/gal diesel)		
Activity type	**VOC**	**NO_x**	**CO**
Class I haul line	0.022	0.595	0.059
Yard/switch operations	0.046	0.798	0.084

The example below illustrates how emissions were calculated for each locomotive activity type. Fuel use reported by railroads, and emission totals are summarized in Table 4.12–2.

VOC emissions from UP Class I haul lines = Diesel fuel used (gals) × EPA emission factor (lbs/gal) for VOC ÷ 2,000 lbs/ton

= 7,598,448 gallons × 0.022 lbs/gal ÷ 2,000 lbs/ton

= 83.58 tons VOC/yr

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

	Diesel fuel	Annual emissions (tons/yr)		
Locomotive type	**used (gals)**	**VOC**	**NO_x**	**CO**
BNSF Class I haul line	1,089,969	11.99	324.27	32.15
UP Class I haul line	7,598,448	83.58	2,260.54	224.15
BNSF yard/switch operations	500,000	11.50	199.50	21.00
UP yard/switch operations	415,740	9.56	165.88	17.46
Amtrak	17,000	0.19	5.06	0.50
Totals:	**9,621,157**	**116.82**	**2,955.24**	**295.27**

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

Table 4.12–3. Annual emissions (in tons/yr) from locomotives in the ozone NAA.

Locomotive type	Track in nonattainment area (%)	Annual emissions (tons/yr) VOC	NO_x	CO
BNSF Class I haul line	60.65%	7.27	196.67	19.50
UP Class I haul line	60.65%	50.69	1,371.02	135.95
BNSF yard/switch operations	100.00%	11.50	199.50	21.00
UP yard/switch operations	100.00%	9.56	165.88	17.46
Amtrak	6.98%	0.01	0.35	0.04
Totals:		**79.04**	**1,933.42**	**193.95**

Ozone season-day emissions for both the county (shown in Table 4.12–4) and the ozone nonattainment area (Table 4.12–5) were calculated by dividing annual totals by 365 days per year, as locomotive activity is assumed to be uniform throughout the year.

Ozone season-day emissions from haul lines = Annual VOC emissions (tons) × 2,000 lbs/ton ÷ 365 days

= 95.57 tons VOC/yr × 2,000 lbs/ton ÷ 365 days

= 523.7 lbs VOC/day

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

Locomotive type	Maricopa County VOC	NO_x	CO	Ozone nonattainment area VOC	NO_x	CO
BNSF Class I haul line	65.7	1,776.8	176.2	39.8	1,077.6	106.9
UP Class I haul line	458.0	12,386.5	1,228.2	277.8	7,512.4	744.9
BNSF yard/switch operations	63.0	1,093.2	115.1	63.0	1,093.2	115.1
UP yard/switch operations	52.4	908.9	95.7	52.4	908.9	95.7
Amtrak	1.0	27.7	2.7	0.1	1.9	0.2
Totals:	**640.1**	**16,193.1**	**1,617.9**	**433.1**	**10,594.1**	**1,062.7**

4.13 Summary of all nonroad mobile source emissions

Table 4.13–1 summarizes annual and daily emissions of VOC, NO_x, and CO from nonroad mobile sources in Maricopa County respectively. Table 4.13–2 shows annual and season-day emissions for these pollutants for the ozone nonattainment area.

Table 4.13–1. Annual and season-day emissions from nonroad mobile sources in Maricopa County.

Category	Annual emissions (tons/yr) VOC	NO_x	CO	Season-day emissions (lbs/day) VOC	NO_x	CO
Agricultural	53.31	386.34	417.85	453.1	3,226.3	3,707.9
Airport ground support	137.28	467.82	5,944.39	752.2	2,563.4	32,572.0
Commercial	2,339.70	1,449.72	54,941.52	17,907.0	8,553.8	410,503.5
Construction & mining	2,690.85	16,016.62	23,667.21	18,840.1	108,785.6	177,261.9
Industrial	772.17	3,316.67	13,597.40	5,035.6	21,109.0	90,844.8
Lawn & garden	6,586.38	843.10	101,879.34	74,053.0	6,409.9	1,085,431.7
Pleasure craft	809.50	70.58	1,748.83	17,294.9	1,347.2	40,149.6
Railway maintenance	2.32	9.27	28.38	16.8	63.9	221.4
Recreational	1,416.44	59.99	10,675.34	16,532.4	535.5	135,733.8
Aircraft	1,439.91	3,029.37	6,668.71	7,911.6	16,644.9	36,641.3
Locomotives	116.82	2,955.24	295.27	640.1	16,193.1	1,617.9
Totals:	**16,364.68**	**28,604.72**	**219,864.25**	**159,436.9**	**185,432.6**	**2,014,685.9**

Table 4.13–2. Annual and season-day emissions from nonroad mobile sources in the ozone NAA.

	Annual emissions (tons/yr)			Season-day emissions (lbs/day)		
Category	**VOC**	**NO_x**	**CO**	**VOC**	**NO_x**	**CO**
Agricultural	34.32	248.69	268.97	291.7	2,076.8	2,386.8
Airport ground support	137.28	467.82	5,944.39	752.2	2,563.4	32,572.0
Commercial	2,331.28	1,444.50	54,743.73	17,842.5	8,523.0	409,025.7
Construction & mining	2,720.45	16,192.81	23,927.55	19,047.3	109,982.3	179,211.8
Industrial	769.39	3,304.73	13,548.45	5,017.5	21,033.0	90,517.8
Lawn & garden	6,658.83	852.37	103,000.01	74,867.6	6,480.4	1,097,371.4
Pleasure craft	809.50	70.58	1,748.83	17,294.9	1,347.2	40,149.6
Railway maintenance	2.35	9.37	28.69	17.0	64.6	223.8
Recreational	911.28	38.59	6,868.11	10,636.3	344.5	87,326.0
Aircraft	1,419.35	2,944.42	6,512.18	7,798.6	16,178.1	35,781.2
Locomotives	79.04	1,933.42	193.95	433.1	10,594.1	1,062.7
Totals:	**15,873.05**	**27,507.30**	**216,784.87**	**153,998.8**	**179,187.3**	**1,975,628.9**

4.14 Quality assurance procedures

Established procedures were used to check, and correct when necessary, the nonroad mobile sources emissions estimates. All NONROAD model input and output files, and Excel spreadsheets used to calculate the emissions, were checked by personnel 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

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