# 4.0 YUMA AREA EMISSIONS INVENTORY

In order to develop control measures for the sources of $PM_{10}$ in the Yuma Valley, ADEQ had to identify the significant sources of $PM_{10}$ in the Yuma area. This chapter describes the local data and emission estimation methods used to develop 1999 and 2016 $PM_{10}$ emission estimates for Yuma.

E. H. Pechan & Associates Inc. (Pechan), a consulting firm, was hired by ADEQ to develop the $PM_{10}$ source inventory for Yuma[1]. The starting point for the 1999 inventory preparation was Version 1.0 of EPA's National Emissions Inventory (NEI), which contains $PM_{10}$ emission estimates for Yuma County. The projection year of 2016 was selected to meet the EPA requirement that there be a maintenance plan demonstrating that the $PM_{10}$ NAAQS will still be met 10 years after the area is redesignated as an attainment area by EPA.

ADEQ staff made some revisions to the contractor's inventory. These changes are in Appendix F of the Technical Support Document.

All emission estimates discussed in this chapter are for the entire Yuma Study Area, which includes the nonattainment area, portions of Imperial County, California, and Baja California Norte, Mexico (Figure 4-1).

## 4.1 Wind-blown Dust

Wind-blown $PM_{10}$ emissions were calculated for the following land use categories: alluvial plain and channels, agricultural crop lands, agricultural unpaved roads, native desert, urban disturbed areas, and miscellaneous disturbed areas (e.g., construction areas outside the City of Yuma). Emissions for the Imperial sand dunes were also assessed. No winds exceeding 30 mph were recorded by the Yuma Valley meteorological station in 1999. Hence, 1999 emissions for sand dunes were assumed to be negligible.

For agricultural lands, it was assumed that $PM_{10}$ emissions are negligible during seasons when crops are present. Hence, emissions were only estimated during seasons when agricultural tilling occurs.

Table 4-1 provides Yuma Study Area acreage estimates for the land uses of interest (Sedlacek, 2002), as well as the emission factor types that were used to estimate $PM_{10}$ emissions. ADEQ developed acreage estimates for the various types of land use with input from stakeholders. Hence, emission estimates were developed for the entire Yuma Study Area, not just Yuma County. Fallow agricultural acreage by season was assumed to be the same in the Imperial County and Mexico portions of the Study Area. For unpaved agricultural roads, ADEQ sampled several areas throughout the Study Area from satellite imagery to derive a factor (0.0815) to estimate the portion of agricultural land that was unpaved roads versus crop land.

1 The complete inventory is presented in Appendix A of the Yuma Maintenance Plan Technical Support Document.

A specific land use category for Urban Disturbed Areas (Code 295) was created to estimate emissions within the urbanized portions of the City of Yuma. This specific category allowed for more accurate characterization of the reductions in emissions associated with the 2013 (the original out-year for the maintenance period) reduction in disturbed area acres within the City of Yuma. This same 2013 reduction in disturbed area was assumed to be representative of 2016.

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**Figure 4-1. Yuma Study Area**

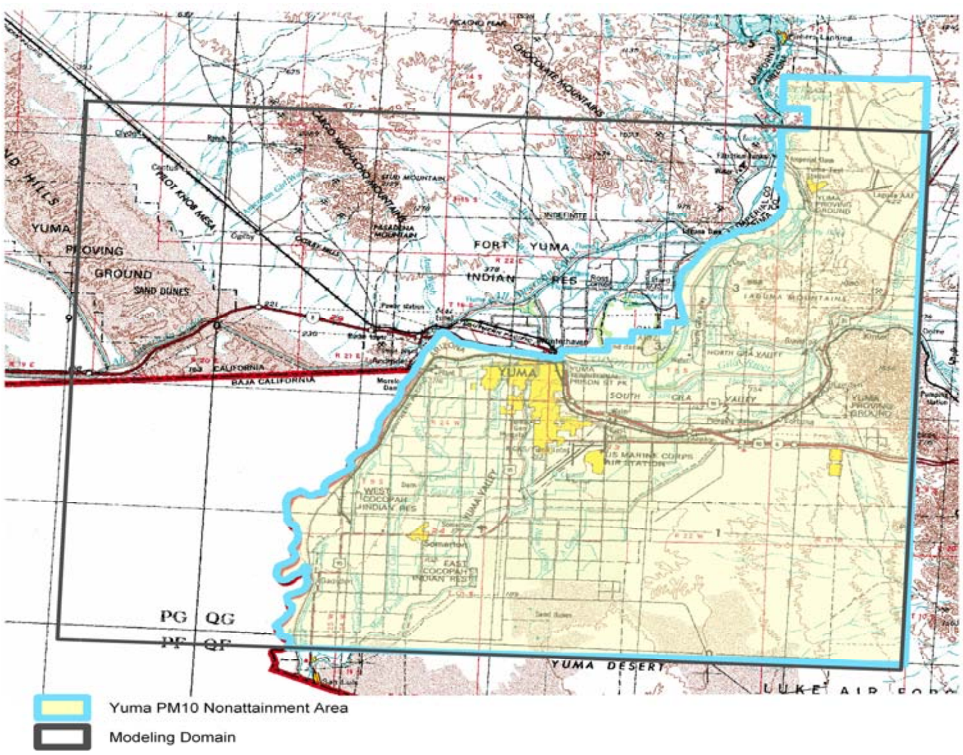


**Table 4-1. 1999 Yuma Study Area Acreage Estimates by Land Use Category and Emission Factor Type**

| Land Use Category | Land Use Code | Acres | Emission Factor Type |
|---|---|---|---|
| **Alluvial Plain and Channels** | **440** | **141,227** | **Stabilized Land** |
| **Native Desert** | **390** | **74,252** | **Native Desert** |
| **Fallow Agricultural Fields** | **260** | **18,100**[2] | **Disturbed Vacant** |
| **Unpaved Ag Roads** | **260** | **16,798** | **Disturbed Vacant** |
| **Urban Disturbed Areas** | **295** | **4,125** | **Disturbed Vacant** |
| **Miscellaneous Disturbed Areas** | **290** | **25,770** | **Disturbed Vacant** |

SOURCE: E. H. Pechan and Associates, Inc., 2004

Table 4-2 contains the 1999 emission estimates for windblown dust for the Yuma Study Area. For native and stabilized lands, emissions are calculated using the number of wind events. This method is based on the assumption that after a short period of high winds on native and stabilized lands, most of the dust capable of being entrained by the wind has already been removed (i.e., the limited reservoir theory). Table 4-2 shows that the highest $PM_{10}$ emissions in 1999 in the Yuma area occurred during the winter season with over 56,000 tons of emissions. Emissions during the fall followed at over 41,000 tons. Dust emissions during the spring of 1999 amounted to over 25,000 tons. Emissions of $PM_{10}$ were the lowest during the summer season at around 6,800 tons.

One aspect of the windblown dust inventory deserves some further explanation: the amount of fallow agricultural fields. As the footnote below explains, this acreage has been reduced by 90% from the contractor's original estimate. What follows are some materials that support that reduction.

[2] The corrected number of fallow (vacant) agricultural acres in the Yuma Nonattainment Area is 14,000 and in the Yuma Study Area 18,100. The estimate of 181,000 acres for fallow agricultural land comes directly from the contractor's emission inventory report, reprinted in the Technical Support Document as Appendix A. On page 7 of the report, the authors state that because "vacant agricultural land varies by season, the total acreage of agricultural land was multiplied by the following percentages: fall = 35%, winter = 40%, spring = 10%, and summer = 10%. The windblown emissions from this acreage went into the air quality model.

In later discussions with the Yuma farming community, it became obvious that this estimate was several times too large. Based on Yuma area farming practices, this estimate was reduced by 90%, which yielded a "vacant (or fallow) field acreage" of 14,000 acres in the nonattainment area on an annual basis. More discussion of this subject can be found in Appendix C in the Technical Support Document.

The over estimation of windblown emissions based on the 181,000 acres contributed to the model's over estimation of measured particulates concentrations on March 31, 1999. But because it was an over estimate, and because compliance with the standards was demonstrated, it is not necessary to redo the air quality modeling.

Yuma farming has a unique cropping system that is capable of producing over 225 different crops on a year round basis. Year round crop production of the **74,000** acres in the $PM_{10}$ nonattainment area includes 40,000 acres of permanent crops. The remaining acreage is double cropped and is capable of producing as much as 60,000 harvested acres of produce and grain. The vegetable and melon growing season ranges from 60 to 90 days[1] with a rotational crop such as Sudan grass, cotton, wheat, safflower or corn being planted after vegetables and melons are harvested. The practice of double and triple cropping the fields in Yuma has an economical advantage, yielding $10,000 to $30,000 per acre, but equally important is the necessity to maintain good soil conditions in the area. With the extreme heat in Arizona, low organic matter in the soil and salts surfacing from evaporation, fallow cropland in the Yuma area is a severe detriment, not a benefit, to healthy crop production. The long growing season and the fact that all crops in the Yuma area are irrigated and not influenced by rainfall as in other rain-dependent states allows for the opportunity to double and triple crop making this practice economically competitive and accounts for a significant part of the total harvested acres reported to the Farm Service Agency office in Yuma County. The planting and harvesting dates, shown below, confirm that the estimate of ten days of being fallow per field per year is a sound one. It is this ten-day estimate, provided by the Yuma farming community in 2005, that, when compared with the contractor's estimate of from 10 to 45% being fallow depending on the season, results in the 90% reduction.

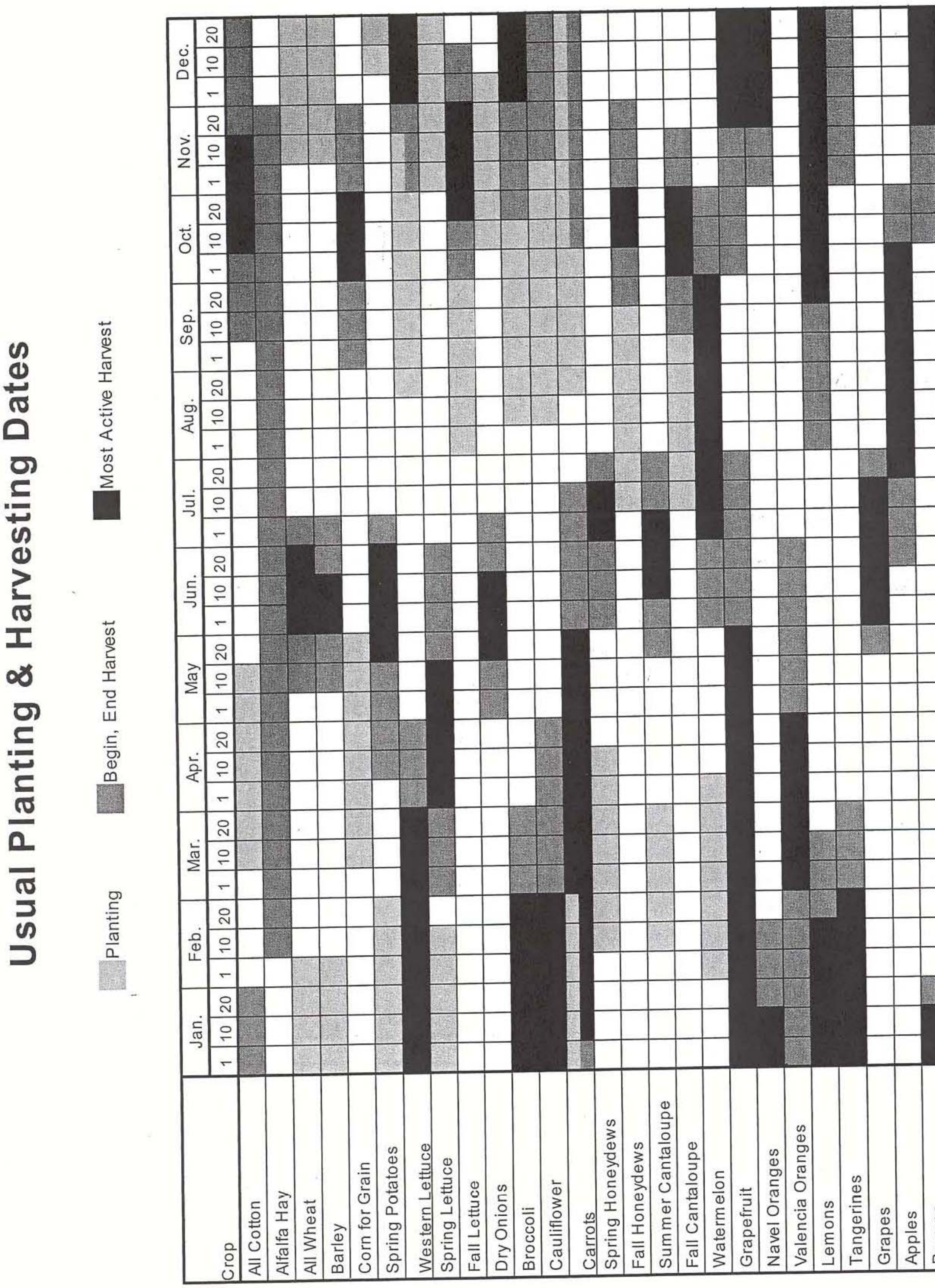

Usual Planting & Harvesting Dates
Planting
Begin, End Harvest
Most Active Harvest
Crop
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
1 10 20
All Cotton
Alfalfa Hay
All Wheat
Barley
Corn for Grain
Spring Potatoes
Western Lettuce
Spring Lettuce
Fall Lettuce
Dry Onions
Broccoli
Cauliflower
Carrots
Spring Honeydews
Fall Honeydews
Summer Cantaloupe
Fall Cantaloupe
Watermelon
Grapefruit
Navel Oranges
Valencia Oranges
Lemons
Tangerines
Grapes
Apples
Pecans

**Table 4-2. 1999 Yuma Study Area $PM_{10}$ Emission Estimates for Windblown Dust**

| | | Emissions by Season (tons) | | | | |
|---|---|---|---|---|---|---|
| Land Use Category | Acres | Fall | Winter | Spring | Summer | Total Annual ($PM_{10}$ tons) |
| **Alluvial Plain and Channels** | **141,227** | **463** | **926** | **771** | **356** | **2,517** |
| **Native Desert** | **74,252** | **191** | **191** | **0** | **0** | **382** |
| **Fallow Agricultural Fields** | **18,100** | **2,346** | **3,363** | **693** | **181** | **6,584** |
| **Unpaved Agricultural Roads** | **16,798** | **6,228** | **7,810** | **6,442** | **1,680** | **22,160** |
| **Urban Disturbed Areas** | **4,125** | **1,529** | **1,918** | **1,582** | **413** | **5,442** |
| **Miscellaneous Disturbed Areas** | **25,770** | **9,554** | **11,981** | **9,883** | **2,578** | **33,996** |
| | Totals | 20,311 | 26,189 | 19,371 | 5,208 | 71,081 |

SOURCE: E. H. Pechan and Associates, Inc., 2004

Emission estimates for 2016 are provided in Table 4-3. It was assumed that the winds in 2016 would be similar to those observed in 1999. The only significant change in the activity data (acreage estimates) between 1999 and 2016 was the reduction of urban disturbed acreage; hence, the emission estimates for the entire Study Area are very similar. A small amount of agricultural land is lost to urban development in 2016.

**Table 4-3. 2016 Yuma Study Area $PM_{10}$ Emission Estimates for Windblown Dust**

| | | **Emissions by Season (tons)** | | | | |
|---|---|---|---|---|---|---|
| **Land Use Category** | **Acres** | **Fall** | **Winter** | **Spring** | **Summer** | **Total Annual ($PM_{10}$ tons)** |
| **Alluvial Plain and Channels** | **141,227** | **463** | **926** | **771** | **356** | **2,517** |
| **Native Desert** | **74,252** | **191** | **191** | **0** | **0** | **382** |
| **Fallow Agricultural Fields** | **17,905** | **2,323** | **3,330** | **687** | **179** | **6,519** |
| **Unpaved Agricultural Roads** | **16,633** | **6,167** | **7,733** | **6,379** | **1,664** | **21,942** |
| **Urban Disturbed Areas** | **2,290** | **849** | **1,065** | **878** | **229** | **3,021** |
| **Miscellaneous Disturbed Areas** | **25,770** | **9,554** | **11,981** | **9,883** | **2,578** | **33,996** |
| Totals | | 19,547 | 25,226 | 18,598 | 5,006 | 68,377 |

In developing emissions for the unpaved roads in the Yuma area, unpaved road emissions were broken out into two subcategories: emissions from unpaved public roads and emissions from agricultural roads. The emissions for unpaved public roads is assumed to be 15% of the total (i.e. 15% of the unpaved road travel occurs on unpaved public roads), while the remaining 85% of emissions occur from agricultural roads (Ramos, 2003).

Vehicle miles traveled (VMT) data and the mean vehicle speed were obtained from the $PM_{10}$ emissions analysis conducted as part of the Yuma Metropolitan Planning Organization (YMPO) Model and Air Quality Conformity Analysis project. The report indicates that the 1999 unpaved road daily VMT, calculated using TransCAD GIS-based modeling software, is 98,864 miles (Lima & Associates, 2000). The projected daily unpaved road VMT for 2016 is 64,240 miles. This value was estimated by calculating the annual growth rate between 2013 and 2025 unpaved road VMT projections (Lima & Associates, 2002). This annual growth rate of 6.1 percent per year was then used to estimate three additional years of growth from 2013.

EPA's MOBILE6.1 model was used to obtain the reentrained road dust, brake wear, and tire wear portions of the paved road emission factors (EPA, 1995) in the Yuma Study Area. The paved road reentrained dust emissions came from EPA's AP-42 equation, which included the subtraction of the constant for the 1980s exhaust portion. These emission factors are shown in Table 4-4, along with the tire wear emission factor. This value does not change by road type or year. MOBILE6.1, another EPA model, was used to calculate 1999 and 2016 exhaust emission factors (EPA, 2002). The MOBILE6.1 exhaust emission factors account for Tier 2 emission standards and 2007 heavy duty emission standards that are not incorporated in PART5. These exhaust emission factors are shown in Table 4-4.

Daily VMT estimates were obtained from the $PM_{10}$ emissions analysis prepared by Lima & Associates for the Arizona Department of Transportation (ADOT) and the YMPO (Lima & Associates, 2000). VMT for each roadway type was estimated using TransCAD GIS based modeling software. Lima & Associates projected 2013 and 2025 daily VMT on paved roads (Lima & Associates, 2002). Daily VMT estimates were not available for 2016 for this analysis. Therefore, the average annual growth rate was calculated for each road type from 2013 to 2025. Three years of growth at this annual growth rate were then applied to the 2013 VMT by road type to estimate 2016 average daily VMT on paved roads. The 1999, 2013, and 2025 VMT, as well as the calculated annual growth rates between 2013 and 2025, and the estimated 2016 VMT are all shown in Table 4-5.

## Table 4-4. 1999 and 2016 $PM_{10}$ Paved Road Emission Factors by Road Type

| Roadway Type | Speed (mph) | Silt Loading ($g/m^2$) | AP-42 Equation, 1999 & 2016 (includes Reentrained Dust, Brake Wear, Tire Wear, and Exhaust) | PART5 1999 and 2016 Paved Road Reen-trained Dust plus Brake Wear Emission Factor (g/mi) | PART5 1999 and 2016 Tire Wear Emission Factor (g/mi) | 1999 MOBILE6.1 $PM_{10}$ Exhaust Emission Factor (g/mi) | 2016 MOBILE6.1 $PM_{10}$ Exhaust Emission Factor (g/mi) | 1999 Total Paved Road $PM_{10}$ Emission Factor (includes Reentrained Dust, Tire Wear, Brake Wear, and Exhaust) | 2016 Total Paved Road $PM_{10}$ Emission Factor (includes Reentrained Dust, Tire Wear, Brake Wear, and Exhaust) |
|---|---|---|---|---|---|---|---|---|---|
| Interstate | 55 | 0.04 | 0.57 | 0.37 | 0.009 | 0.064 | 0.011 | 0.443 | 0.390 |
| Principal Arterials | 42 | 0.3 | 2.13 | 1.92 | 0.009 | 0.064 | 0.011 | 1.993 | 1.940 |
| Minor Arterials | 40 | 0.3 | 2.13 | 1.92 | 0.009 | 0.064 | 0.011 | 1.993 | 1.940 |
| Rural Major Collectors | 45 | 0.7 | 3.69 | 3.49 | 0.009 | 0.064 | 0.011 | 3.563 | 3.510 |
| Rural Minor Collectors | 46 | 0.7 | 3.69 | 3.49 | 0.009 | 0.064 | 0.011 | 3.563 | 3.510 |
| Urban Collectors | 35 | 0.24 | 1.84 | 1.64 | 0.009 | 0.064 | 0.011 | 1.713 | 1.660 |
| Local Roads | 35 | 0.85 | 4.19 | 3.98 | 0.009 | 0.065 | 0.011 | 4.054 | 4.000 |
| Interstate Ramps | 35 | 0.04 | 0.57 | 0.37 | 0.009 | 0.064 | 0.011 | 0.443 | 0.390 |
| Local | 20 | 0.85 | 4.19 | 3.98 | 0.009 | 0.065 | 0.011 | 4.054 | 4.000 |

NOTES: Emission factors are in grams per mile.

SOURCE: E. H. Pechan and Associates, Inc., 2004

As with unpaved roads, the paved road reentrained dust emission factors were corrected for the effects of precipitation. Only the fugitive dust portion of the emission factor was adjusted for precipitation effects. No adjustments were applied to the brake wear, tire wear, or exhaust portions of the emission factors.

**Table 4-5. 1999 and 2016 Daily VMT by Road Type**

| Road Type | 1999 Daily VMT (miles per day) | 2013 Daily VMT (miles per day) | 2025 Daily VMT (miles per day) | Average Annual Growth Rate from 2013 to 2025 | Estimated 2016 Daily VMT (miles per day) |
|---|---|---|---|---|---|
| **Interstate** | **541,163** | **866,379** | **986,872** | **1.09%** | **895,048** |
| **Principal Arterials** | **860,715** | **1,564,166** | **1,768,187** | **1.03%** | **1,612,851** |
| **Minor Arterials** | **672,408** | **1,137,824** | **1,443,793** | **2.00%** | **1,207,626** |
| **Rural Major Collectors** | **91,129** | **198,520** | **289,087** | **3.18%** | **218,077** |
| **Rural Minor Collectors** | **448,640** | **870,923** | **1,028,207** | **1.39%** | **907,831** |
| **Urban Collectors** | **139,709** | **232,904** | **271,676** | **1.29%** | **242,045** |
| **Local Roads** | **4,841** | **17,387** | **21,204** | **1.67%** | **18,271** |
| **Interstate Ramps** | **50,581** | **84,437** | **94,825** | **0.97%** | **86,922** |
| **Local Paved** | **889,680** | **1,361,490** | **1,678,386** | **1.76%** | **1,434,610** |
| Total | 3,698,866 | 6,334,030 | 7,582,237 | | 6,623,281 |

SOURCES: The 1999 Daily VMT estimates are from Lima & Associates, 2000. The 2013 and 2025 Daily VMT estimates are from Lima & Associates, 2002.

### 4.1.1 Road Construction Emissions

Construction emissions are estimated using two basic construction parameters, the acres of land disturbed by the construction activity and the duration of the activity. Data on the actual acres disturbed by road construction are generally not available, so a surrogate is used. The 1999 NEI emission estimation methods for road construction use the following miles to acres conversions by roadway type:

Interstate, urban and rural; Other arterial, urban – 15.2 acres/mile
Other arterial, rural – 12.7 acres/mile
Collectors, urban – 9.8 acres/mile
Collectors, rural – 7.9 acres/mile

The projected number of miles of highway constructed in 1999 and 2013 were provided by local officials. Activity in 2016 is assumed to be equivalent to the 2013 projected activity (see Table 4-6). The type of roadways constructed was not available; therefore, 9.8 acres/mile was assumed for all roads.

**Table 4-6. 1999 and 2016 Miles of Roadway Constructed and $PM_{10}$ Emissions**

| Location | 1999 Miles of Roadway Constructed | 1999 Emissions (tons) | 2016 Miles of Roadway Constructed | 2016 Emissions (tons) |
|---|---|---|---|---|
| **Somerton** | **2.52** | **1,383** | **0** | **0** |
| **City of Yuma** | **7.2** | **3,951** | **11.1** | **6,092** |
| **Yuma Co.** | **1.9** | **384** | **3.6** | **2,634** |
| **ADOT** | **0.7** | **1,043** | **4.8** | **1,976** |
| Total | | 6,761 | | 10,702 |

SOURCE: E. H. Pechan and Associates, Inc., 2004

Emissions were calculated using the total acres disturbed, the $PM_{10}$ emission factor of 0.42 tons/acre/month, and the activity duration, estimated to be 12 months. Adjustments were made to the $PM_{10}$ emissions to account for conditions in Yuma including correction parameters for soil moisture level and silt content (MRI, 1999).

Soil moisture levels were estimated using precipitation-evaporation values from Thornthwaite's PE Index. The PE value for Yuma County is 6. A silt content value of 40 percent was used. This value was used to calculate 1999 NEI emissions for Yuma County and was determined by comparing the U.S. Department of Agriculture surface soil map with the county map. See Appendix F for a revision to these road construction estimates.

### 4.1.2 General Building Construction Emissions

This emissions category includes $PM_{10}$ emissions from residential building (housing) construction and commercial building construction. Housing construction $PM_{10}$ emissions were calculated using an emission factor of 0.032 tons $PM_{10}$/acre/month, number of housing units constructed, a units-to-acres conversion factor, and the duration of construction activity. The duration of construction activity is assumed to be 6 months (MRI, 1999).

Apartment construction emissions were computed separately using an emission factor that is more representative of emissions from apartment building construction (0.11 tons $PM_{10}$/acre/month). A 12-month duration is assumed for apartment construction. The same emission factor and duration were used for warehouse construction.

The total acres disturbed by construction are estimated by applying conversion factors to the housing start data for each category as follows:

Single family - 1/4 acre/building
Two families - 1/3 acre/building
Apartment - ½ acre/building or 1/20 acre/unit

These conversion factors were used unless they were larger than 1999 average lot sizes reported by local officials. Average lot size was used for all Yuma County buildings and City of Yuma single family houses and duplexes. The warehouse average lot size of 7 acres provided by the City of Yuma seemed excessively large, and there were no acres per building conversion factors available for warehouses. Therefore, the average warehouse lot size provided by Yuma County was also used for the 8 warehouses constructed in the City of Yuma.

The number of single-family, two-family, and apartment buildings and warehouses constructed in 1999 and 2013 projections were provided by Somerton, Yuma, and Yuma County officials. The data provided by Somerton combined single-family and two-family data; therefore, all units were assumed to be single-family buildings. The number of single family houses, duplexes, and warehouses constructed in 1999 and 2013 projections and the acre/unit used for each is shown in Table 4-7. Activity in the 2016 projection year is assumed to be the same as projected for 2013. The 1999 and 2016 emission estimates in tons per year (tpy) for building construction are given in Table 4-8.

**Table 4-7. 1999 and 2013 Housing Starts and Acres/Unit Conversions**

| | | 1999 | | 2013 | |
|---|---|---|---|---|---|
| | Unit Type | No. of Units | Acres/Unit | No. of Units | Acres/Unit |
| **Yuma Co.** | **single family** | **370** | **0.25** | **370** | **0.25** |
| | **warehouses** | **8** | **1.30** | **8** | **1.30** |
| **City of Yuma** | **single family** | **251** | **0.184** | **1533** | **0.184** |
| | **Duplex** | **2** | **0.184** | **6** | **0.184** |
| | **apartment** | **44** | **0.05** | **111** | **0.05** |
| | **warehouses** | **8** | **1.30** | **7** | **1.30** |
| **Somerton** | **single family** | **393** | **0.25** | **393** | **0.25** |
| | **apartment** | **84** | **0.05** | **84** | **0.05** |

SOURCE: E. H. Pechan and Associates, Inc., 2004

**Table 4-8. 1999 and 2016 $PM_{10}$ Emission Estimates for Building Construction**

| Area | Unit Type | 1999 Emissions (tons) | 2016 Emissions (tons) |
|---|---|---|---|
| **Yuma Co.** | **single family** | **11.1** | **11.1** |
| | **warehouses** | **14.8** | **14.8** |
| **City of Yuma** | **single family** | **5.51** | **33.8** |
| | **duplex** | **0.04** | **0.13** |
| | **apartment** | **1.82** | **9.16** |
| | **warehouses** | **14.8** | **13.0** |
| **Somerton** | **single family** | **3.24** | **3.24** |
| | **apartment** | **2.48** | **2.48** |
| Totals | | 53.8 | 87.7 |

SOURCE: E. H. Pechan and Associates, Inc., 2004; See Appendix F for revised estimates.

## 4.2 Aircraft Emissions

The basic method for estimating emissions for this category involves determining aircraft fleet make-up and level of activity and this is matched with the appropriate emission factors by aircraft type to estimate daily or annual emissions. Aircraft emission estimates focus on emissions that occur close enough to the ground to affect ground-level concentrations. Aircraft operations within this layer are defined as landing and takeoff (LTO) cycle. The five specific operating modes in an LTO are:

Approach
Taxi/idle-in
Taxi/idle-out
Takeoff
Climb-out

The following $PM_{10}$ emission factors were used for calculating emissions (EPA, 1992):

Air Taxi: 0.60333 pounds/LTO
Military Aircraft: 0.60333 pounds/LTO

Air taxi refers to small aircraft used for scheduled service carrying passengers and/or freight.

LTO information was provided by the U.S. Border Patrol, the Marine Corps Air Station, the Yuma Proving Ground, and Yuma International Airport, shown in Table IV-21. The number of flights per day is expected to decrease at Yuma International Airport between 1999 and 2013 due to a decrease in the number of passengers to the Yuma market and the subsequent increased fares to Yuma. The 2013 estimates provided by the sources above are assumed to be representative of 2016 activity.

**Table 4-9. 1999 and 2016 LTO Data and Emission Estimates for Yuma Airports**

| Airport | 1999 Daily LTOs | 1999 Emissions (tons) | 2016 Daily LTOs | 2016 Emissions (tons) |
|---|---|---|---|---|
| **U.S. Border Patrol** | **2** | **0.22** | **6** | **0.66** |
| **Marine Corp Air Station** | **60** | **6.60** | **69** | **7.60** |
| **Yuma Proving Ground** | **54** | **5.95** | **54** | **5.95** |
| **Yuma Intl. Airport** | **25** | **2.75** | **20** | **2.20** |
| Total | | 15.5 | | 16.4 |

SOURCE: E. H. Pechan and Associates, Inc., 2004

### 4.2.1 Unpaved Airstrips

$PM_{10}$ emissions from unpaved airstrips were estimated using the same equation as was used for unpaved roads. The soil silt content and moisture content were assumed to be 3 percent and 1 percent, respectively. An average speed of 40 mph was used, and the length of one LTO was assumed to be 1 mile. The number of flights per week for the two unpaved airstrips in the Yuma nonattainment area, shown in Table 4-10, was provided by local officials. The number of LTOs estimated by these officials for 2013 is assumed to be representative of activity in 2016.

**Table 4-10. 1999 and 2016 LTO Data and Emissions for Unpaved Airstrips**

| | 1999 | | | 2016 | | |
|---|---|---|---|---|---|---|
| Airstrip | Flights per Week | Average Annual LTOs | Emission (lbs) | Flights per Week | Average Annual LTOs | Emission (lbs) |
| **Somerton** | **7-10** | **442** | **202** | **15** | **780** | **356** |
| **Pierce Aviation** | **70-80** | **3,900** | **1,781** | **70-80** | **3,900** | **1,781** |
| Total | | 4,342 | 1,982 | | 4,680 | 2,137 |

SOURCE: E. H. Pechan and Associates, Inc., 2004

## 4.3 Stationary Sources

1999 $PM_{10}$ emissions for 5 categories of stationary sources, shown in Table 4-11, were provided by ADEQ. Emissions for 2016 were calculated by applying growth factors to the 1999 emissions. The growth factors were based on industry sector constant dollar output projections from Regional Economics Model, Inc. (REMI) economic models incorporated into Version 4.0

of the Economic Growth Analysis System (EGAS) (Pechan, 2001). Table 4-12 shows the 1999 and 2016 REMI data for each sector. The growth factors, the ratio of 2016 output to 1999 output, are also shown in Table 4-12. The growth factor for manufacturing stationary sources was calculated by summing the REMI data for REMI sectors 1 (lumber and wood products), 3 (stone, clay, and glass products), 16 (paper and allied products), and 18 (chemical and allied products).

**Table 4-11. 1999 and 2016 $PM_{10}$ Stationary Source Emissions**

| Sector | 1999 Emissions (tons) | 2016 Emissions (tons) |
|---|---|---|
| **Support activities for agriculture** | **10** | **14** |
| **Utilities** | **50** | **73** |
| **Manufacturing** | **6** | **11** |
| **National Security** | **1** | **1** |
| **Rock Products** | **10** | **20** |
| Total | 77 | 119 |

SOURCE: E. H. Pechan and Associates, Inc., 2004

**Table 4-12. 1999 and 2016 REMI Data and Growth Factors**

| Sector | REMI Sector | 1999 REMI Data | 2016 REMI Data | 2016 Growth Factor |
|---|---|---|---|---|
| **Support activities for agriculture** | **49** | **0.656** | **0.893** | **1.361** |
| **Utilities** | **30** | **1.883** | **2.740** | **1.455** |
| **Manufacturing** | **1,3,16, and 18** | **3.839** | **10.267** | **1.877** |
| **National Security** | **52** | **4.608** | **4.800** | **1.042** |
| **Rock Products** | **3** | **1.631** | **3.291** | **2.018** |

SOURCE: E. H. Pechan and Associates, Inc., 2004

## 4.4 Railroad Locomotives

The 1999 NEI estimates that railroad locomotives contribute 17 tpy of $PM_{10}$ in the Yuma Nonattainment Area. Estimation methods are described in the Trends Procedures Document (EPA, 2001a). Future year activity changes affecting emission estimates are based on earnings projections for Railroad Transportation.

In January 1997, EPA proposed draft locomotive emission standards to control emissions of oxides of nitrogen, volatile organic compounds, carbon monoxide, PM, and smoke from newly manufactured and remanufactured diesel-powered locomotives and locomotive engines. In December 1997, EPA promulgated the locomotive emission standards (EPA, 1997). The locomotive standards are to be implemented in three phases, depending on the manufacture date. Tier 0 applies to the remanufacturing of locomotives and locomotive engines manufactured from 1973 through 2001. Tier I applies to the original manufacture and remanufacturing of locomotives and locomotive engines manufactured from 2002 through 2004. Tier II applies to the original manufacture and remanufacturing of locomotives and locomotive engines manufactured in 2005 and later. When fully phased-in by 2040, EPA estimates that the rule will achieve a 46 percent reduction in PM emissions. Emission estimates for 1999 and 2016 are shown in Table 4-13 below.

## 4.5 Summary of Stationary and Area Source Emissions for the Yuma Area

Table 4-13 summarizes the 1999 and 2016 $PM_{10}$ emissions by source category developed by Pechan and Associates, Inc. for the Yuma area. These source categories are listed in the same order that they appear in this chapter. The emission estimates summarized in Table 4-13 are for the entireYuma Study Area. In total, 2016 emissions are expected to be at the same level that they were in 1999. The largest $PM_{10}$ emission reductions between 1999 and 2016 come from paving unpaved roads, and through reducing the acreage that is susceptible to windblown dust. These $PM_{10}$ emission reductions are offset by increased $PM_{10}$ emissions resulting from increased travel on paved roads and more road construction occurring in 2016 than in 1999. Agriculture-related $PM_{10}$ emissions are expected to remain steady during the study period.

**Table 4-13. Yuma $PM_{10}$ Nonattainment Area Emissions Summary - 1999 and 2016**

| | 1999 Annual Emissions (tons) | 2016 Annual Emissions (tons) |
|---|---|---|
| **Agricultural and Prescribed Burning** | **40.7** | **34.1** |
| **Agricultural Tilling** | **3,572** | **3,572** |
| **Agricultural Cultivation and Harvesting** | **15.7** | **15.7** |
| **Windblown Dust** | **130,331** | **127,046** |
| **Unpaved Roads - Re-entrained Dust** | **10,183** | **5,537** |
| **Paved Roads** | **3,419** | **5,839** |
| **Road Construction** | **6,761** | **10,702** |
| **General Building Construction** | **53.8** | **87.7** |
| **Aircraft** | **15.5** | **16.4** |
| **Unpaved Airstrips** | **1.0** | **1.1** |
| **Stationary Sources** | **77** | **119** |
| **Railroad Locomotives** | **17** | **15** |
| Total | 154,487 | 152,985 |

See revised estimates in Appendix F.
SOURCE: E. H. Pechan and Associates, Inc., 2004

## 4.6 Mobile Source Emissions Budgets

Mobile sources are also a source of $PM_{10}$ emissions in the Yuma area. Their impact on the air quality of the Yuma area has to be assessed in the context of attaining the $PM_{10}$ NAAQS and complying with the NAAQS throughout the maintenance period. Transportation conformity regulations in 40 CFR Part 93, Subpart A require that mobile source emissions budgets be calculated for the Yuma area. To this end, the Yuma Metropolitan Planning Organization (YMPO) and its contractor, Lima and Associates, Inc., have forecasted mobile source emissions in the Yuma area for 2004, 2008, and the maintenance year of 2016. Since these forecasts were not part of the area source and point source emissions inventory developed by Pechan and Associates, Inc., they are presented here in Tables 4-14, 4-15, and 4-16, respectively.

**Table 4-14. Mobile Sources Emissions Data Used in the Calculation of the Mobile Source Emissions Budgets for the Yuma Nonattainment Area for the Year 2004**

| Facility Type | Daily VMT (miles) | Daily VHT | Modeled Speed | Speed Used | Silt Loading | Factor (kg/mi) | Total (kg/day) |
|---|---|---|---|---|---|---|---|
| Interstate | 450,868 | 8,738 | 51.60 | 55.00 | 0.040 | 0.000370 | 166.8 |
| Principal Arterials | 972,027 | 25,688 | 37.84 | 42.00 | 0.040 | 0.001920 | 1,866.3 |
| Minor Arterials | 741,717 | 22,402 | 33.11 | 40.00 | 0.070 | 0.001920 | 1,424.1 |
| Rural Major Collectors | 51,790 | 1,188 | 43.57 | 45.00 | 0.240 | 0.003490 | 180.7 |
| Rural Minor Collectors | 396,212 | 9,730 | 40.72 | 46.00 | 0.240 | 0.003490 | 1,382.8 |
| Urban Collectors | 136,550 | 5,039 | 27.10 | 35.00 | 0.240 | 0.001640 | 223.9 |
| Local Roads | 5,043 | 144 | 34.97 | 35.00 | 0.580 | 0.003980 | 20.1 |
| Interstate Ramps | 43,629 | 1,440 | 30.30 | 35.00 | 0.040 | 0.000370 | 16.1 |
| Local Paved | 1,003,951 | | | 20.00 | 0.580 | 0.003980 | 3,995.7 |
| Local Unpaved | 72,281 | | | 10.00 | 0.580 | 0.108570 | 7,847.5 |
| DAILY TOTAL | 3,874,068 | 74,369 | | | | | 17,124.0 |

*PM10 Emissions (tons/day) – 18.88
*PM10 Emissions (tons/year) – 6,891.2

SOURCE: Yuma Metropolitan Planning Organization and Lima and Associates, Inc. 2005

**Table 4-15. Mobile Sources Emissions Data Used in the Calculation of the Mobile Source Emissions Budgets for the Yuma Nonattainment Area for the Year 2008**

| Facility | Daily VMT (miles) | Daily VHT | Modeled Speed | Speed Used | Silt Loading | Factor (kg/mi) | Total (kg/day) |
|---|---|---|---|---|---|---|---|
| Interstate | 507,964 | 9,863 | 51.50 | 55.00 | 0.040 | 0.000370 | 187.9 |
| Principal Arterials | 1,089,183 | 28,830 | 37.78 | 42.00 | 0.040 | 0.001920 | 2,091.2 |
| Minor Arterials | 853,125 | 25,899 | 32.94 | 40.00 | 0.070 | 0.001920 | 1,638.0 |
| Rural Major Collectors | 73,965 | 1,758 | 42.17 | 45.00 | 0.240 | 0.003490 | 258.1 |
| Rural Minor Collectors | 468,916 | 11,871 | 39.50 | 46.00 | 0.240 | 0.003490 | 1,636.5 |
| Urban Collectors | 156,972 | 5,792 | 27.10 | 35.00 | 0.240 | 0.001640 | 257.4 |
| Local Roads | 5,176 | 149 | 34.71 | 35.00 | 0.580 | 0.003980 | 20.6 |
| Interstate Ramps | 49,491 | 1,784 | 27.74 | 35.00 | 0.040 | 0.000370 | 18.3 |
| Local Paved | 1,165,752 | | | 20.00 | 0.580 | 0.003980 | 4,640.0 |
| Local Unpaved | 76,469 | | | 10.00 | 0.580 | 0.108570 | 8,302.2 |
| Daily Totals | 4,447,013 | 85,946 | | | | | 19,050.2 |

*$PM_{10}$ Emissions (tons/day) – 21.00
*$PM_{10}$ Emissions (tons/year) – 7,664.7

SOURCE: Yuma Metropolitan Planning Organization and Lima and Associates, Inc. 2005

**Table 4-16. Mobile Sources Emissions Data Used in the Calculation of the Mobile Source Emissions Budgets for the Yuma Nonattainment Area for the Year 2016**

| Facility | Daily VMT (miles) | Daily VHT | Modeled Speed | Speed Used | Silt Loading | Factor (kg/mi) | Total (kg/day) |
|---|---|---|---|---|---|---|---|
| Interstate | 662,471 | 12,659 | 52.33 | 55.00 | 0.040 | 0.000370 | 245.1 |
| Principal Arterials | 1,466,306 | 41,539 | 35.30 | 42.00 | 0.300 | 0.001920 | 2,815.3 |
| Minor Arterials | 1,007,532 | 32,696 | 30.82 | 40.00 | 0.300 | 0.001920 | 1,934.5 |
| Rural Major Collectors | 166,904 | 3,834 | 43.53 | 45.00 | 0.700 | 0.003490 | 582.5 |
| Rural Minor Collectors | 870,323 | 23,261 | 37.42 | 46.00 | 0.700 | 0.003490 | 3,037.4 |
| Urban Collectors | 247,995 | 8,699 | 28.51 | 35.00 | 0.240 | 0.001640 | 406.7 |
| Local Roads | 8,133 | 232 | 35.06 | 35.00 | 0.850 | 0.003980 | 32.4 |
| Interstate Ramps | 63,083 | 2,206 | 28.60 | 35.00 | 0.040 | 0.000370 | 23.3 |
| Local Paved | 1,510,851 | | | 20.00 | 0.850 | 0.003980 | 6,013.2 |
| Local Unpaved | 100,856.76 | | | 10.00 | 0.850 | 0.108570 | 10,950.0 |
| Daily Totals | 6,104,454.76 | 125,126 | | | | | 26,040.4 |

***$PM_{10}$ Emissions (tons/day) – 28.64**
***$PM_{10}$ Emissions (tons/year) – 10,455.2**

SOURCE: Yuma Metropolitan Planning Organization and Lima and Associates, Inc. 2005

The contractor did use the latest AP-42 emission factor equation for reentrained dust, which is given below.

The quantity of particulate emissions from resuspension of loose material on the road surface due to vehicle travel on a dry paved road may be estimated using the following empirical expression:

$$E = k\left(\frac{sL}{2}\right)^{0.65} \times \left(\frac{W}{3}\right)^{1.5} - C \qquad (1)$$

where: $E$ = particulate emission factor (having units matching the units of k),
$k$ = particle size multiplier for particle size range and units of interest (see below),
$sL$ = road surface silt loading (grams per square meter) ($g/m^2$),
$W$ = average weight (tons) of the vehicles traveling the road, and
$C$ = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear.

The "C" in the equation above for $PM_{10}$ is 0.2119 grams per mile. When this value is subtracted from emission factors from the earlier equation that incorrectly included C, the result is that the paved road emission factors go down substantially, from 3% to 67 % (see Table 4-17). The unpaved road emission factors effectively do not change. Because of their magnitude, 250 grams per mile, subtracting 0.2 from 250 does not have a significant effect on emissions.

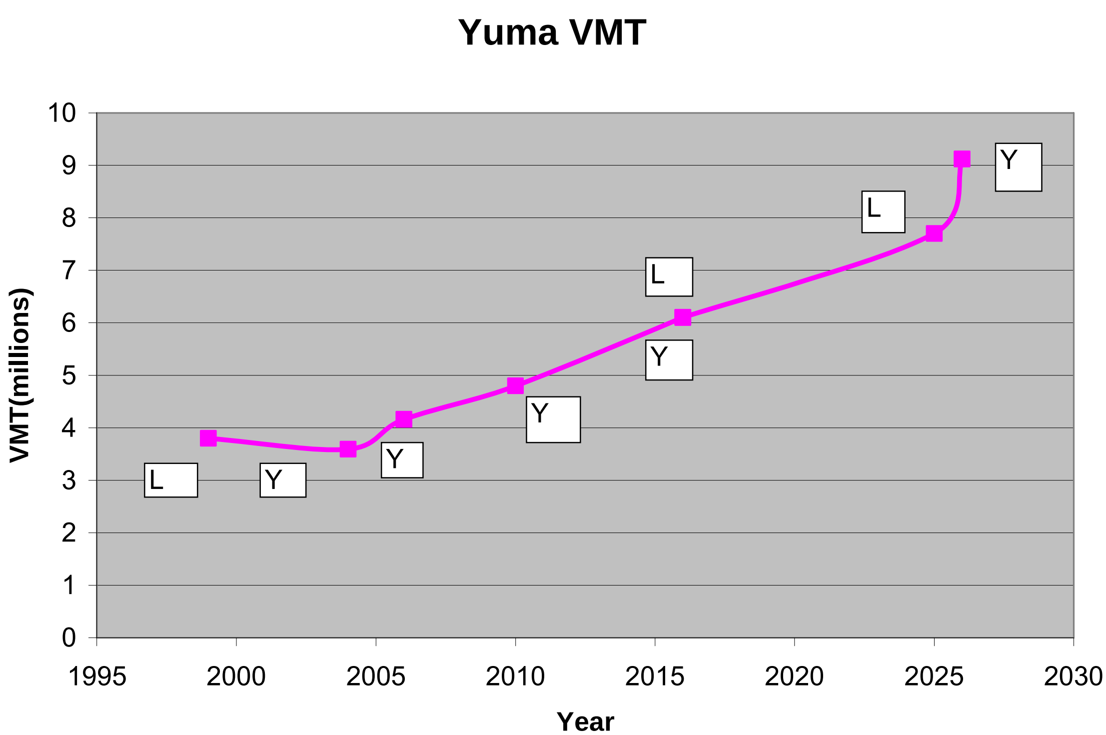
Lima used 1999 vehicle miles traveled (VMT) numbers, the latest available numbers at the time Lima completed its work. ADEQ has compared more recent VMT numbers published by the YMPO in its 2005 Conformity Analysis. As Table 4-18 and Figure 4-2 below demonstrate, the two sets of traffic modeling are similar.

**Table 4-18. Vehicle Miles Traveled in Yuma Planning Area**

| Source | Year | VMT |
|---|---|---|
| Lima 2000 - 2002 | 1999 | 3.8 |
| YMPO 2005 Conform | 2004 | 3.59 |
| YMPO 2005 Conform | 2006 | 4.16 |
| YMPO 2005 Conform | 2010 | 4.8 |
| Lima 2000 - 2002 | 2016 | 6.1 |
| YMPO 2005 Conform | 2016 | 6.1 |
| Lima 2000 - 2002 | 2025 | 7.7 |
| YMPO 2005 Conform | 2026 | 9.12 |

SOURCE: AQD Assessment Section, 2006

**Figure 4-2.**




SOURCE: AQD Assessment, 2006

Use of 2005 VMT figures does not have a significant emissions impact, and maintenance is still demonstrated.

## 4.7 Revisions to the Emissions Inventory

Discussed in Appendix F of the Technical Support Document, ADEQ staff made several revisions to the contractor's emissions inventory. Three new categories were added: lawn and garden equipment, all terrain vehicles, and offroad light commercial vehicles. Road and building construction emissions were recalculated. Unpaved road emissions changed slightly. Windblown dust from vacant agricultural fields was reduced 90%. All of these changes are documented in Appendix F and should be consulted for a better understanding of Yuma's emissions.