Final Report

AREA AND MOBILE SOURCE EMISSIONS INVENTORY TECHNICAL SUPPORT PROJECT

1990-2010 EMISSION INVENTORY TRENDS AND PROJECTIONS

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1.0 INTRODUCTION

1.1 BACKGROUND

The Area and Mobile Emissions Inventory Section of the Technical Analysis Division of the Texas Natural Resource Conservation Commission (TNRCC) is responsible for the development of emission inventories for area, mobile, and biogenic source categories. Among these responsibilities is the compilation of the most accurate emission inventory using up-to-date methodologies and current activity data. In order to assist in these efforts, the TNRCC initiated projects with ENVIRON and its subcontractors for

(a) developing improved 1999 base year county-level area, nonroad mobile, and biogenic source emission inventories with annual and ozone season day emissions of volatile organic compound (VOCs), nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter (both PM_{10} and $PM_{2.5}$); and

(b) developing 1990-2010 annual and ozone season day emissions trends and projections for all area, on-road mobile, and nonroad sources for the same set of six pollutants for every county in Texas.

The development of the trends and projections data will allow the TNRCC the ability to identify emissions changes over time by species, source category, geographic region, and season. The development of both the 1999 inventory and the emissions trends data sets are documented in this report.

1.2 PURPOSE/OBJECTIVES

The 1999 statewide emission inventory project was conducted in stages, the first of which was to make an assessment of the current emission inventory for the state of Texas and to develop a prioritized list of source categories for which to devote resources for the emission inventory improvements. The emission inventory prioritization stage, which was completed during April 2001, identified the area and nonroad mobile source categories for which revised 1999 emissions would be prepared (ENVIRON, 2001). The area source categories identified for inventory improvements were:

- Residential natural gas combustion
- Commercial/institutional natural gas combustion
- Oil and gas production
- Architectural coatings
- Automobile refinishing
- Traffic markings
- Industrial surface coating
- Graphic arts

- Asphalt (emulsified and cutback)
- Agricultural pesticide application
- Consumer and commercial products
- Gasoline service stations – tank trucks in transit, tank truck unloading (Stage I), vehicle refueling (Stage II), spillage, and tank breathing losses
- Open burning – residential municipal solid waste, residential yard waste, commercial land clearing debris
- Agricultural field burning
- Wildfires
- Managed burning – slash and prescribed

The nonroad source categories identified for inventory improvements were:

- Airport ground service equipment
- Pleasure craft (recreational marine)
- Aircraft
- Locomotive
- Construction
- Commercial marine

Based on this prioritized list, an Inventory Preparation Plan (IPP) was developed in order to discuss and document the procedures to be used in compiling the inventory. The IPP prepared in June (ENVIRON, 2001) included a discussion of the methodologies for collecting activity data and calculating emissions for those source categories selected from the prioritized list for emission inventory improvements. The purpose of the IPP was to document the source categories, pollutants, activity data, emission factors, calculation methodologies, and data sources for preparing the 1999 emissions inventory for the selected area and nonroad source categories, and for biogenic emission sources. The IPP also identified the geographic region that was given priority for preparing the inventory. In addition, the IPP identified areas for cleaning up the existing 1999 NEI to reflect actual sources of emissions and current emissions inventory procedures for Texas. The statewide area, nonroad, and biogenic source emission inventory was prepared using the most current methodologies, activity data, and emission factors for the selected source categories. In several instances, methodology revisions were made after the initial IPP with the identification of more appropriate data sources and estimation methodologies. This report describes in detail the actual methodologies used for each emission source category considered, and gives examples of the calculations.

The final stage of the 1999 inventory improvement project was the compilation a 1999 statewide emission inventory, incorporating revised and updated estimates for the selected source categories. The completed statewide inventory also includes estimates for the remaining source categories from the EPA's 1999 National Emission Inventory (NEI) for the state of Texas. The project team also contacted TNRCC staff and local agencies responsible for the development of emission inventories for non-attainment and near non-attainment areas in order to incorporate the results of their emission inventory efforts into the final 1999

statewide inventory. However, most of these efforts are still on-going. The 1999 statewide inventory compiled during the study represents a complete emission inventory developed using a consistent set of methodologies for each source category. As any inventories developed for non-attainment and near non-attainment areas are to be finalized in the NIF format, the TNRCC will have the option of updating the statewide inventory with these estimates with a minimum of effort.

In general, the starting point for creating the emission trends and projections inventories was the 1999 inventory prepared under Work Order 34744-01. For years prior to 1999 emissions were back-cast using growth and control factors appropriate to each source category. Actual data were used in place of growth/control indicator surrogates where available, and the impact of regulatory changes was taken into account. Spurious trends resulting from historical changes in emissions estimation methods were reviewed and care was taken to avoid introducing such effects. Emissions were projected for years after 1999 using growth/activity surrogates. Adjustments were made to future year emissions estimates to account for the implementation of new regulations according to the regulatory agenda currently in force.

An important issue examined by ENVIRON pertains to the consistency between the products of this work and previously developed emission inventories. In the Trends and Projections Work Order, TNRCC initially stated that this work should be consistent with previous estimates (i.e., SIP, Periodic, and ROP emissions inventories) by incorporating these other inventories for all available years, or adjusting the emissions estimates to match the previous estimates. It also called for development of scaling factors to correct all other years for inconsistencies in methodology and data. However, the scope and application of a trends inventory are different from those of a SIP-level inventory. The purpose of an emissions trends analysis is to bring to light the effects of existing or approved future controls upon a region's emissions inventory with the passage of time. As such, the relative differences in emissions among the calendar years is of more significance than the absolute emissions themselves. Furthermore, the multi-year scope of this type of effort generally does not include establishing episodic emissions with the accuracy normally necessary for photochemical modeling applications such as used in attainment demonstrations. As a result, a trends inventory generally incorporates less detailed data (e.g., HPMS-based rather than link-based VMT), broader time scales (e.g., seasonal/annual average rather than episodic hourly), and different modeling tools (e.g., draft MOBILE6 rather than approved MOBILE5b) than a SIP-level inventory. Although these differences will result in differences in emission estimates between the two types of inventories, both estimates are valid for their respective applications. It was thus agreed with TNRCC that it was more important to have a consistent set of methodologies over the 1990-2010 period across all regions in order to be able to assess trends and projections; the requirement to include or develop adjustment factors to match SIP or ROP inventories was removed.

1.3 SUMMARY EMISSIONS INVENTORIES

Tables 1.3-1 and 1.3-2 show the revised 1999 emission inventory by major source category for area sources and nonroad sources, respectively.

Table 1.3-1. Revised 1999 emissions for area sources.

	Annual Emissions, Tons Per Year						Ozone Season Emissions, Tons Per Day					
Source Category	**VOC**	**NOX**	**CO**	**SO2**	**PM10**	**PM25**	**VOC**	**NOX**	**CO**	**SO2**	**PM10**	**PM25**
Fuel Combustion Industrial	47	6,219	1,420	4,148	325	135	0.10	19.53	4.25	13.55	0.85	0.33
Fuel Combustion Other	24,211	19,279	68,641	2,289	9,284	9,213	1.78	34.22	22.51	3.99	2.63	2.51
Petroleum & Related Industries	364,129	241,521	141,280	160	2,325	2,325	997.56	661.81	387.16	0.44	6.41	6.41
Other Industrial Processes	638			34	3,714	812	1.75			0.09	10.12	2.09
Solvent Utilization	227,241						947.11					
Storage & Transport	73,497						190.33					
Waste Disposal & Recycling	30,581	689	82,079	306	9,783	9,516	82.21	1.89	224.87	0.58	26.84	25.78
Miscellaneous	40,370	7,886	564,658		841,186	200,520	32.96	15.46	467.56		2,191.90	456.84
Total	760,716	275,594	858,079	6,937	866,617	222,522	2,253	733	1,106	19	2,239	494

Table 1.3-2. Revised 1999 emissions for nonroad sources.

	Annual Emissions, Tons Per Year						Ozone Season Emissions, Tons Per Day					
Source Category	**VOC**	**NOX**	**CO**	**SO2**	**PM10**	**PM25**	**VOC**	**NOX**	**CO**	**SO2**	**PM10**	**PM25**
Agricultural Equipment	5,449	43,957	25,657	8,179	2,248	2,068	25.05	204.37	120.01	37.95	10.46	9.62
Airport Ground Support Equipment	3,392	3,824	93,472	781	320	294	9.21	10.13	263.06	2.11	0.87	0.80
Commercial Equipment	14,192	12,194	304,757	2,289	1,050	967	38.55	32.29	858.01	6.17	2.85	2.62
Construction and Mining Equipment	11,504	51,524	86,430	12,646	4,819	4,434	38.85	174.85	296.12	42.70	16.44	15.12
Industrial Equipment	7,418	41,012	188,047	8,396	2,280	2,106	20.14	113.87	525.35	23.08	6.34	5.85
Lawn and Garden Equipment (Com)	32,696	7,241	393,029	1,519	1,458	1,341	135.91	32.99	1805.06	7.03	5.96	5.48
Lawn and Garden Equipment (Res)	16,372	935	211,205	191	247	227	69.48	4.12	982.61	0.88	1.02	0.94
Logging Equipment	11,429	2,078	33,615	494	849	781	30.54	5.71	90.11	1.34	2.28	2.10
Pleasure Craft	59,156	5,707	144,499	1,747	1,975	1,817	239.41	26.94	693.41	8.35	9.44	8.68
Railroad Equipment	75	311	691	102	34	31	0.21	0.85	1.93	0.28	0.09	0.09
Recreational Equipment	5,134	511	50,929	115	97	89	19.23	2.03	210.85	0.47	0.40	0.37
Commercial Marine	829	23,649	3,478	9,607	1,489	1,370	2.27	64.79	9.53	26.32	4.08	3.75
Locomotive	8,482	208,294	20,626	15,523	5,119	4,709	23.24	570.67	56.51	42.53	14.02	12.90
Aircraft	4,597	7,766	36,718	419	5,971	4,211	12.96	21.46	104.37	1.16	16.43	11.61
Total	180,725	409,002	1,593,153	62,009	27,956	24,446	665	1,265	6,017	200	91	80

Table 1.3-3 shows a comparison of the nonroad emissions estimates in the 1999 NEI (Version 1) and the revised 1999 nonroad emissions estimated using the methodologies discussed in Section 3 of this report. As discussed in Section 3, we have substantially revised the method for estimating emissions for the nonroad categories of commercial marine, airport ground support, railway (primarily locomotive), construction and mining, pleasure craft, and aircraft. Emissions for 1999 for other nonroad categories used the default EPA estimates available in the current public release (dated June 2000) of the NONROAD model. The 1999 NEI Version 1 estimates for source categories estimated with the NONROAD model are based on a December 2000 nonpublic release of the model.

Table 1.3-3. Comparison of 1999 nonroad source category emissions between 1999 NEI and revised estimates developed for TNRCC.

	This Work			NEI			% Difference		
Source Category	**VOC**	**NOx**	**CO**	**VOC**	**NOx**	**CO**	**VOC**	**NOx**	**CO**
Agricultural Equipment	5,449	43,957	25,657	6,779	55,948	32,025	-20	-21	-20
Airport Ground Support Equipment	3,392	3,824	93,472	252	1,206	2,061	1,246	217	4,435
Commercial Equipment	14,192	12,194	304,757	14,217	12,573	331,636	0	-3	-8
Construction and Mining Equipment	11,504	51,524	86,430	17,881	95,286	114,191	-36	-46	-24
Industrial Equipment	7,418	41,012	188,047	7,313	41,890	194,682	1	-2	-3
Lawn and Garden Equipment (All)	49,068	8,176	604,234	59,482	11,263	807,042	-18	-27	-25
Logging Equipment	11,429	2,078	33,615	11,700	2,029	34,229	-2	2	-2
Pleasure Craft	59,156	5,707	144,499	28,256	1,817	62,946	109	214	130
Railroad Equipment (including Locomotive)	8,556	208,605	21,318	2,633	156,557	8,081	225	33	164
Recreational Equipment	5,134	511	50,929	3,969	550	50,738	29	-7	0
Commercial Marine	829	23,649	3,478	7,162	218,231	34,876	-88	-89	-90
Aircraft	4,597	7,766	36,718	9,690	10,132	62,041	-53	-23	-41
Totals	180,725	409,002	1,593,153	169,334	607,482	1,734,548	7	-33	-8

The most striking change in the emission estimates in tons per year is with the commercial marine sector, where NOx, VOC, and CO are all reduced by about 90 percent. This category is changed from the most important nonroad category to fifth in terms of NOx emissions.

Emissions for airport ground support equipment show the largest relative change between the NEI and the revised estimates. Most of the emissions in this category are from the Dallas and Houston areas, for which the estimates were updated in the two areas' SIPs.

Emissions from railroad equipment, predominately from locomotive with a small fraction of maintenance equipment, were increased relative to the NEI emissions. The anlaysis reported here shows that the DOE-EIA fraction of national activity in Texas has risen from 13 percent to 18 percent based on fuel sales, which explains the increase in NOx emissions from the NEI to this work. Emission factors were derived from a 1997 EPA document, so it is possible that VOC and CO estimates have changed in the meantime.

Construction and mining emissions estimates are roughly 50 percent lower for NOx and somewhat closer for VOC and CO in this work compared with the NEI estimates. The revised estimates are for diesel construction equipment above 25 hp based on the Houston survey work, but the smaller gasoline and diesel equipment (most responsible for VOC and CO emissions) have not been modified. However, differences in NONROAD versions may also account for some of the changes.

The revised pleasure craft emission estimates are based on current Texas registration data, which are almost twice the default Texas pleasure craft populations in the June 2000 NONROAD model (and also likely used in the NEI work), with a proportionally higher inboard population. The inboard vessels typically use 4-stroke engines, which have higher NOx and CO emission rates than the 2-stroke engines used in outboard/personal watercraft engines.

Other nonroad categories were derived using the default NONROAD input files provided in the June 2000 release of the NONROAD model. In most cases, the estimates are similar to the 1999 NEI with the exception of Agricultural and Lawn and Garden, where emissions in this study here were 20 to 25 percent higher. These differences may be attributable to differences in versions of the NONROAD model. Also, VOC emissions are proportionally higher than the NEI compared with NOx and CO in the analyses reported here, likely because summer temperatures and gasoline volatility result in higher nonroad evaporative emissions.

Figures 1.3-1 through 1.3-6 show the statewide annual emissions trends for the period 1990-2010 for all six pollutants. As described in Sections 5 and 6, emissions for area and nonroad source categories, respectively, are backcast or forecast from the 1999 base year emissions. For on-road mobile sources, detailed modeling per year was performed (described in detail in Section 7). Discussion of the trends and projections in these figures may be found in Section 8. Section 8 also contains tabular results of the emission inventories for every five years from 1990 through 2010, including Tier 1 and Tier 2 emissions for area sources and further detail for on-road mobile sources.

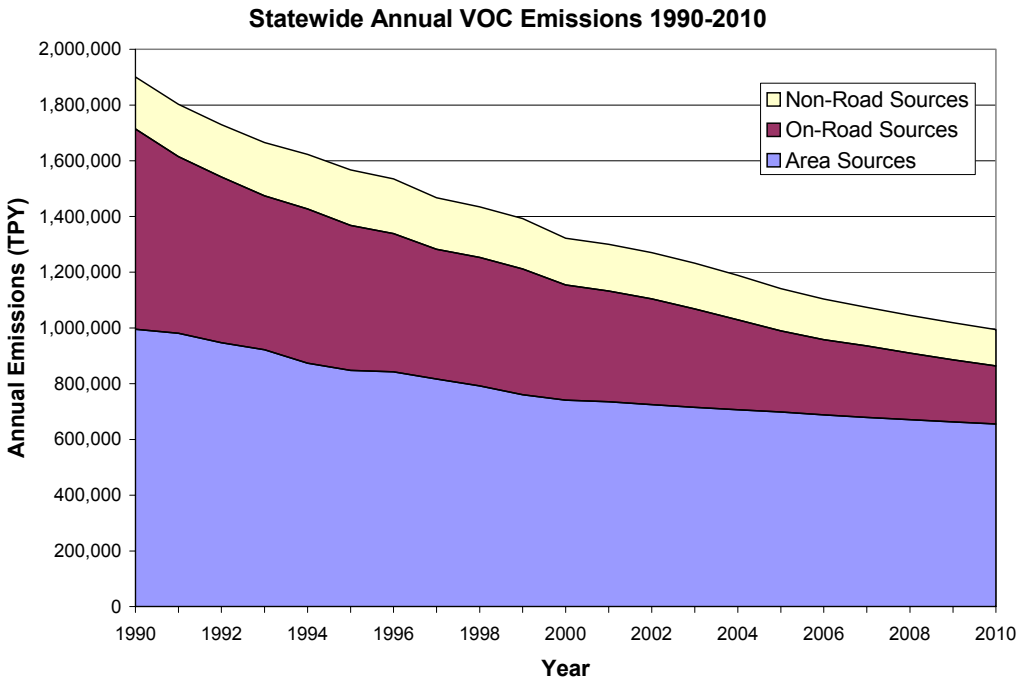


Figure 1.3-1. Statewide annual VOC emissions 1990-2010.

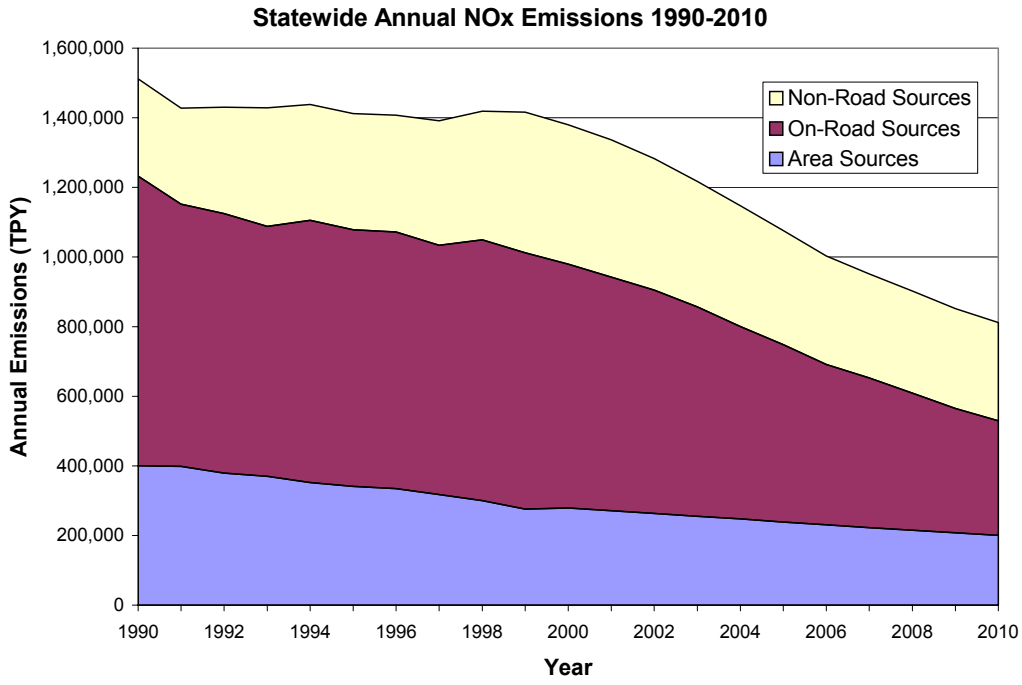


Figure 1.3-2. Statewide annual NOx emissions 1990-2010.

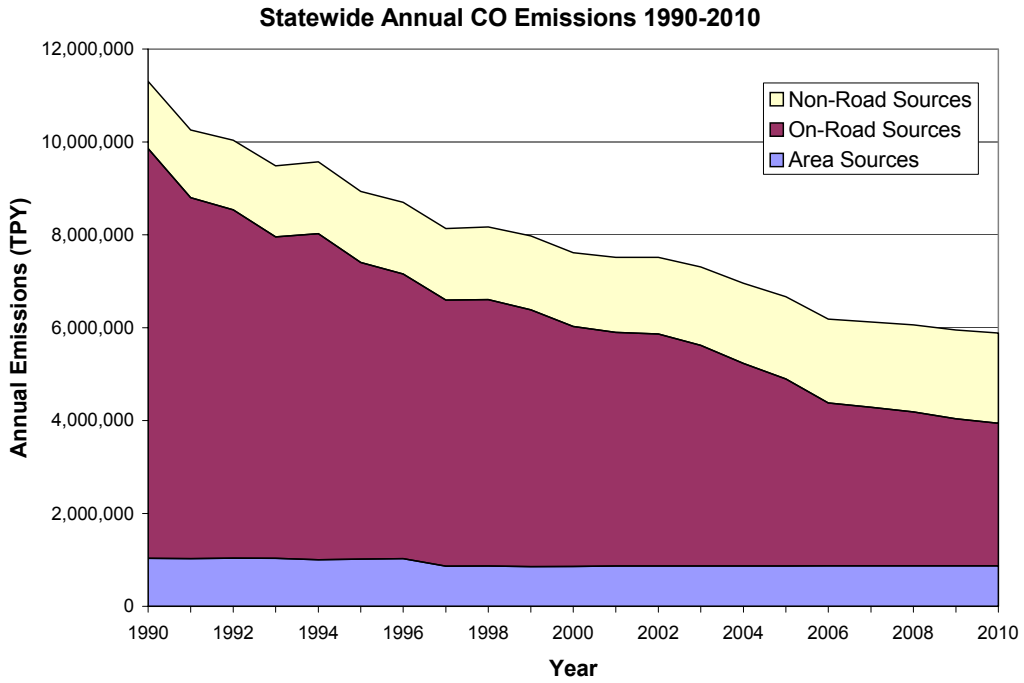


Figure 1.3-3. Statewide annual CO emissions 1990-2010.

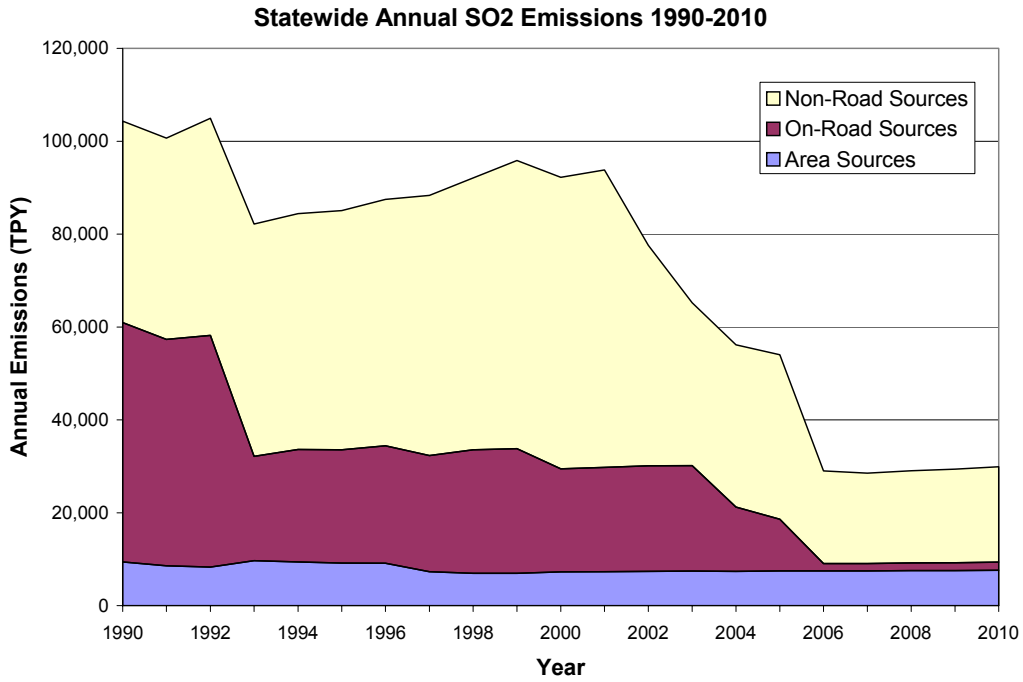


Figure 1.3-4. Statewide annual SO2 emissions 1990-2010.

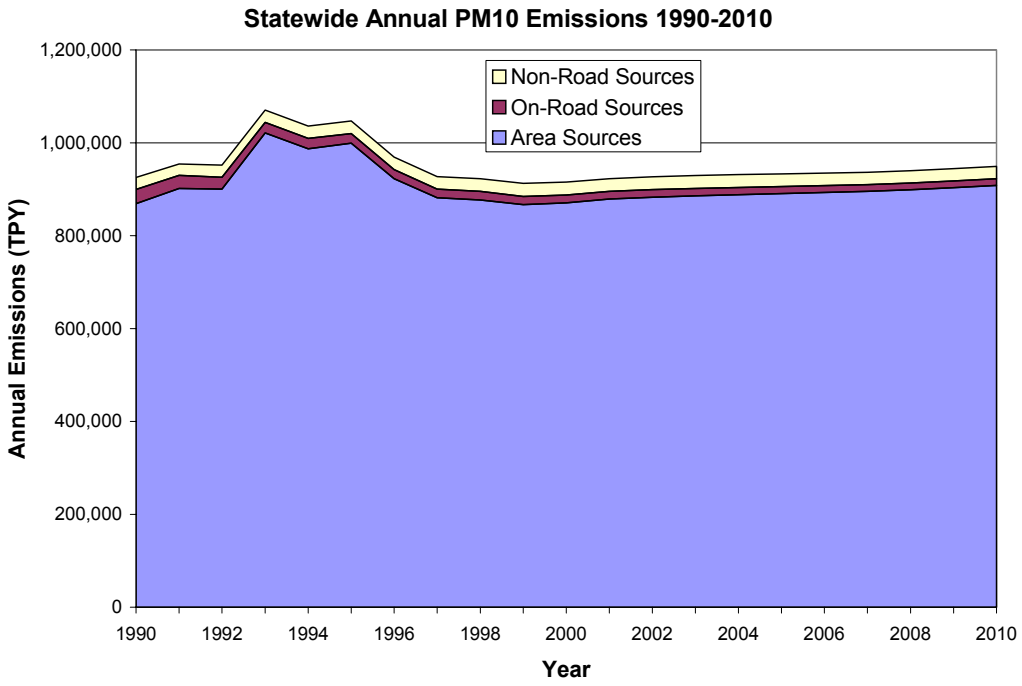


Figure 1.3-5. Statewide annual PM10 emissions 1990-2010.

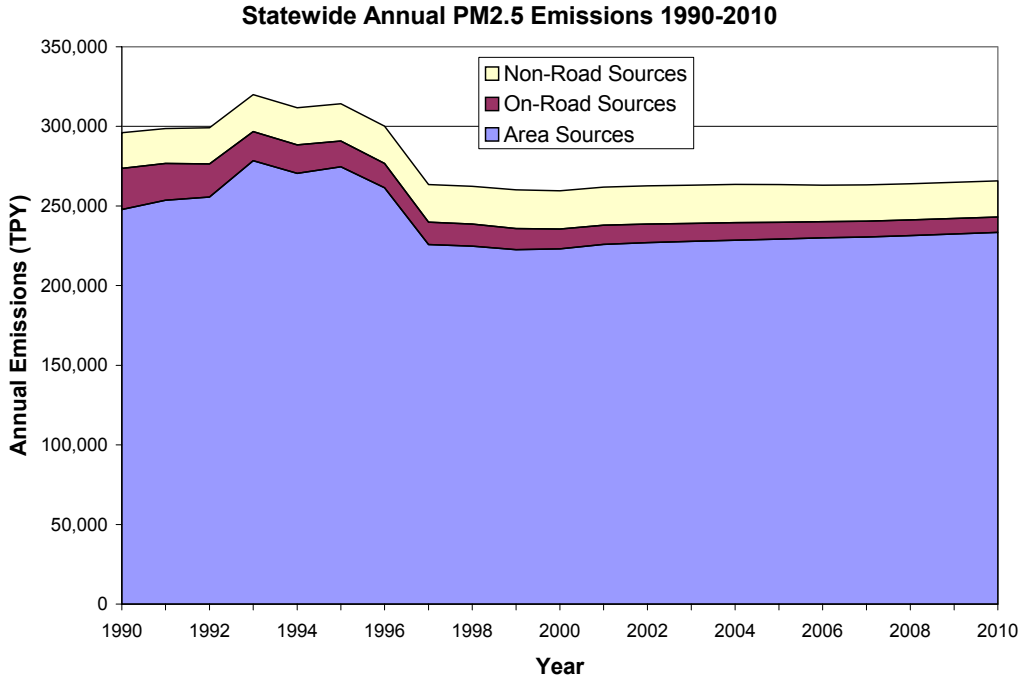


Figure 1.3-6. Statewide annual PM2.5 emissions 1990-2010.

1.4 EMISSION INVENTORY FORMAT/ELECTRONIC DATA FILES

The electronic emissions inventory files for 1999 annual and ozone season day area, nonroad, and biogenic sources have been supplied to TNRCC in Version 2 of the NEI Input Format. The inventories were compiled into the Access data base shells available from EPA to allow for conversion of the inventory to text format. The NEI Input Format requirements and Access data base shells for area/nonroad and biogenic sources are available from the following EPA website: http://www.epa.gov/ttn/chief/ nif/index.html#ver2. Computer programs developed by EPA as well as additional electronic quality assurance (QA) checks developed by ENVIRON and Pechan were applied to the Access data base tables to ensure that the tables comply with the data field specifications (i.e., character type and length), data code specifications (e.g., checks on validity of county Federal Information Processing Standards [FIPS] codes, and consistent use of pollutant codes and other coding conventions), and referential integrity requirements of Version 2 of the NEI Input Format. Additional QA checks were conducted on the data as described in Section 9 of this report.

1.5 REPORT ORGANIZATION

The remainder of this report is organized as follows:

- Sections 2 and 3 provide complete details of the 1999 emissions estimates for all area and nonroad sources, respectively, listed above for which revised 1999 emissions were prepared. The text corresponding to each source category within area and nonroad sources includes a description of the source category, methodology, emission factors and activity data, sample calculations, and a discussion of uncertainties and recommended future research. Section 2 also includes a discussion of activities performed for the 1999 NEI cleanup. Section 3 includes a discussion of how the NONROAD model was run for estimating county-level emissions for all sources for the revised 1999 inventory, and also a discussion of proposed survey procedures for developing improved estimates of residential and commercial lawn and garden equipment emissions.

- Section 4 provides a description of the revised 1999 biogenics emission inventory for Texas counties. The emissions were estimated using the GLOBEIS model that ENVIRON has developed for TNRCC under a separate contract.

- Sections 5 and 6 describe the methodologies for estimating all area and nonroad source category emissions, respectively, for the period 1990-2010. In general, these emissions estimates were based on 1999 emissions, and activity growth indicators were identified for back casting emissions from 1999 to 1990 and forecasting from 1999 to 2010. Alternative activity growth indicators evaluated are discussed, and all data sources are clearly identified. Federal, State, and local control programs are discussed, as well as how they were implemented in the analysis.

- Section 7 describes the methodologies for estimating on-road emissions for the 1990-2010 period. The emissions estimates are from the EPA draft MOBILE6 model and EPA's current regulatory PART5 model. Detailed documentation is provided for all MOBILE6 and PART5 model inputs.

- Section 8 provides tabular and graphical displays of the 1990-2010 emissions trends and projections for area, on-road, and nonroad sources. Numerous graphs show the trends by source category, geographical area, and pollutant.

- Section 9 provides a discussion of quality assurance/quality control checks performed routinely as part of emissions calculations and reporting.

- A complete list of references is provided in Section 10.

2.0 1999 AREA SOURCES METHODOLOGY

2.1 INTRODUCTION

This section of the report documents the pollutants, activity data, emission factors, calculation methodologies, and data sources used to prepare the 1999 statewide area source emissions inventory for Texas. The document also provides sample calculations of emissions for each area source category, and discusses uncertainties and future research needs for each category.

The 1999 inventory for Texas was prepared by revising the statewide inventory for Texas contained in Version 1.5 of the U.S. Environmental Protection Agency's (EPA's) 1999 National Emissions Inventory (NEI). The 1999 NEI includes emissions for all seven of the criteria air pollutant precursors. During the emission inventory prioritization stage, the NEI was reviewed to identify area source categories of ozone precursor emissions for updating emissions (ENVIRON, 2001a; TNRCC, 2001). Table 2.1-1 shows the final list of area source categories for which new 1999 emissions were prepared and incorporated into the NEI. For the priority area source categories shown in Table 2.1-1, new 1999 annual and ozone season day (OSD) emissions were prepared for volatile organic compound (VOCs), nitrogen oxides (NO_x), and carbon monoxide (CO). For El Paso County, average winter day CO emissions were also estimated and included in the inventory. Annual and average day emissions of sulfur dioxide (SO_2) and particulate matter (PM_{10} and $PM_{2.5}$) were also estimated and included in the inventory if emitted by a priority category. Area source categories in the 1999 NEI but not on the prioritization list were left in the 1999 inventory for Texas. As a result, the 1999 inventory also includes ammonia emissions from the 1999 NEI.

The 1999 NEI (Version 1.5) contains emissions data for area source categories developed using EPA default methods. These default methods were applied in the absence of data supplied by state and local agencies in an effort to prepare a complete NEI. The default methods either grow emissions from a dated inventory, or estimate emissions using national activity data and allocate emissions to states and counties using surrogate activity data. The limitations of these methods is that they may estimate emissions for source categories that do not occur in a county or, in the case of area sources, emissions may now be inventoried as point rather than area sources. The last section of the Inventory Preparation Plan (IPP) for the 1999 inventory identified several area source categories in the 1999 NEI for inventory "clean-up" to reflect actual sources of emissions and current emissions inventory procedures for Texas (ENVIRON, 2001b). Section 2.19 of this report documents the area source categories and methods for the inventory clean-up effort.

The statewide inventory was prepared using the most current methodologies, activity data, and emission factors available within the time and resource constraints for completing the work. Methodologies used for estimating the area source activity levels and calculating emissions came primarily from the following sources: *Emission Inventory Improvement Program (EIIP) Volume III, Procedures for the Preparation of Emission Inventories for Carbon Monoxide and*

Precursors of Ozone Volume I (EPA, 1991)*, AP-42, Contractor Special Studies and TNRCC Special Studies*. Emphasis was placed on using activity data obtained from state and local agencies in Texas or activity data from other entities that was specific to Texas.

The electronic area source emissions inventory files were compiled in Version 2 of the NEI Input Format. The inventories were compiled into the Access data base shell available from EPA to allow for easy conversion of the inventory to text format. The NEI Input Format requirements and Access data base shell for area sources is available from the following EPA website: http://www.epa.gov/ttn/chief/ nif/index.html#ver2. The EPA's quality assurance (QA) program was run on the final set of files to ensure compliance with data field specifications (i.e., character type and length), data code specifications (e.g., checks on validity of county Federal Information Processing Standards (FIPS) codes, and consistent use of pollutant codes and other coding conventions), and referential integrity requirements of Version 2 of the NEI Input Format. Additional QA checks were conducted on the data as identified during development of the area source inventories.

Table 2.1-1. Area source categories for which 1999 emissions were prepared.

FUEL COMBUSTION OTHER; External Combustion (Heating & Cooking)
Residential Natural Gas Combustion
Commercial/Institutional Natural Gas Combustion
PETROLEUM & RELATED INDUSTRIES; Oil & Gas Production
Crude Oil and Natural Gas Condensate Storage
Fugitive Emissions & Natural Gas Treatment
SOLVENT UTILIZATION
Architectural and Industrial Maintenance Coatings
Automobile Refinishing
Traffic Markings
Industrial Surface Coating
Graphic Arts
Asphalt (Cutback and Emulsified)
Agricultural Pesticide Application
Consumer and Commercial Products (Household; Automotive Aftermarket; Coating and Related; Adhesives and Sealants; Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)-Regulated; and Miscellaneous)
STORAGE & TRANSPORT; Petroleum & Petroleum Product Storage
Gasoline Service Stations (Vehicle Refueling and Spillage; Tank Truck Breathing Losses, Tank Truck Unloading, and Tank Trucks in Transit)
WASTE DISPOSAL & RECYCLING
Open Burning (Residential Municipal Solid Waste (MSW), Residential Yard Waste, and Land Clearing Debris)
MISCELLANEOUS
Agricultural Field Burning
Wildfires
Managed Burning (Prescribed and Slash)

2.2 RESIDENTIAL NATURAL GAS COMBUSTION

Description of Source Category

This source category covers air emissions from natural gas combustion in the residential sectors for space heating, water heating, or cooking. The residential sector is composed of all kinds of housing units. Natural gas emissions include carbon monoxide (CO), nitrogen oxides (NO_x), volatile organic compounds (VOCs), sulfur dioxide (SO_2), particulate matter less than 10 microns (PM_{10}), and particulate matter less than 2.5 microns ($PM_{2.5}$). Emissions for residential natural gas combustion are reported under source classification code (SCC) 2104006000.

Methodology

The annual, ozone season day (OSD), and CO season day emissions for residential natural gas combustion were estimated using the alternative to the EIIP preferred method. The EIIP preferred method is to obtain annual and seasonal activity data from local natural gas distributors. However, due to the time and resource constraints associated with preparing the 1999 emissions inventory for this category, the EIIP alternative method was applied (EIIP, 1999). This alternative EIIP method relies on residential natural gas consumption data from the state's energy office.

Emission Factors and Activity Data

The county-level consumption of natural gas used by residential homes in Texas in 1999 was obtained from the Railroad Commission of Texas (RCOT, 2000). The ozone and CO season adjustment factors (SAFs) were calculated from statewide monthly residential natural gas use in 1999, which was obtained from the U.S. Department of Energy (DOE), Energy Information Administration (EIA) (DOE, 2001).

The cubic feet of natural gas used in a county were multiplied by emission factors from Tables 1.4-1 and 1.4-2 of AP-42 and converted to tons per year (TPY) by dividing the product by 2000. The AP-42 emission factors are: VOC = 5.5 pounds per million cubic feet ($lb/10^6\ ft^3$); NO_x = 94 $lb/10^6\ ft^3$, CO = 40 $lb/10^6\ ft^3$, SO_2 = 0.6 $lb/10^6\ ft^3$, and PM_{10} and $PM_{2.5}$ = 7.6 $lb/10^6\ ft^3$ (EPA, 1998).

Ozone season day emissions were obtain by multiplying the annual emissions by an SAF of 0.45 and dividing by 365 days per year (i.e., emissions activity occurs 7 days per week and 52.143 weeks per year (EPA, 1991)). CO season day emissions were obtained by multiplying annual emissions by an SAF of 1.96 and dividing by 365 days per year (i.e., emissions activity occurs 7 days per week for 52.143 weeks per year (EPA, 1991)).

The ozone SAF of 0.45 was calculated using monthly statewide residential natural gas deliveries data provided by the DOE (DOE, 2001). A monthly fraction for each month for the state was obtained by dividing the total state use for a month by the total annual state use. The monthly fractions for June, July, and August were added together to obtain the SAF and divided by the average period activity of 0.25 for those three months (EIIP, 1999). The CO SAF of 1.96 was calculated by using the same method for December, January, and February.

No federal, state, or local rules applied to residential natural gas consumption sources in Texas in 1999. Therefore, control efficiency (CE) and rule penetration (RP) were assumed to be 0%, and rule effectiveness (RE) was set at 100%.

Sample Calculation

The statewide ozone season adjustment factor
Total 1999 residential gas consumption in state $=210{,}656*10^6$ ft^3
June 1999 residential gas consumption in state $= 8{,}563*10^6$ ft^3
July 1999 residential gas consumption in state $= 7{,}665*10^6$ ft^3
August residential gas consumption in state $= 7{,}565*10^6$ ft^3

$(8{,}565*10^6\ ft^3)/(210{,}656*10^6\ ft^3) + (7{,}665*10^6\ ft^3)/(210{,}656*10^6\ ft^3) + (7{,}565*10^6\ ft^3)/(210{,}656*10^6\ ft^3) = 0.1129$
$(0.1129)/(0.25) = 0.45$ ozone SAF

VOC calculation for Anderson County (annual and ozone season)
Total 1999 county residential gas consumption $= 241{,}445*10^3$ ft^3
$(241{,}445*10^3\ ft^3) * (5.5\ lb\ VOC/10^6\ ft^3) *(1/10^3\ ft^3)/(2000\ lb/ton) = 0.6640$ ton VOC per year
(0.6640 ton VOC per year) * (0 .45) / [(52.143 weeks/year) * (7 days/week)] = 0.0008 ton VOC per ozone season day

CO calculation for El Paso County (CO Season)
Total 1999 county residential gas consumption $= 7{,}963{,}110*10^3$ ft^3
$(7{,}963{,}110*10^3\ ft^3) * (40\ lb/10^6\ ft^3) * (1/10^3\ ft^3) / (2000\ lb/ton) = 159.2622$ ton CO per year
(159.2622 ton CO per year) * (1.96) / [(52.143 weeks/year) * (7 days/week)] = 0.8552 ton CO per CO season day

Uncertainties/Future Research

County level natural gas consumption by the residential sector was obtained from the Railroad Commission of Texas. Future work on this category should investigate how the Railroad Commission of Texas collects the county level data. If the data are collected by surveying all local natural gas distributors in Texas, then the requirements of the preferred EIIP

methodology would be fulfilled and not further work would be recommended for this category. If the Railroad Commission of Texas uses a sampling approach to collect data to estimate county-level consumption statewide, then surveys of natural gas distributors would be recommended. In addition, the estimates could be improved by surveying local natural gas distributors to determine actual consumption during the summer months (and winter months for El Paso) would improve the OSD and CO season day emission estimates.

2.3 COMMERCIAL/INSTITUTIONAL NATURAL GAS COMBUSTION

Introduction

This source category covers air emissions from natural gas combustion in the commercial sector, including small boilers, furnaces, and heating units. The commercial/institutional sector consists of wholesale and retail businesses and social, educational, health, and government institutions. For natural gas combustion, the commercial/institutional sector also includes agriculture, forestry, and fishing. Natural gas emissions include CO, NO_x, VOC, SO_2, PM_{10}, and $PM_{2.5}$. Emissions for commercial/institutional natural gas combustion are reported under SCC 2103006000.

Methodology

The annual, OSD, and CO season day emissions for commercial/institutional natural gas combustion were estimated using the EIIP alternative to the preferred method. The EIIP preferred method is to obtain annual and seasonal activity data from local natural gas distributors. However, due to the time and resource constraints associated with preparing the 1999 emissions inventory for this category, the EIIP alternative method was applied (EIIP, 1999).

Emission Factors and Activity Data

The statewide consumption of natural gas used in commercial/institutional establishments in Texas was obtained from the U.S. DOE, EIA (DOE, 2001). The commercial natural gas usage for each county was calculated by multiplying statewide gas usage by the ratio of county commercial sector (SIC codes 50-97) employment to state commercial sector employment (DOC, 2001). To avoid assigning consumption to counties without commercial natural gas usage, small commercial and industrial natural gas consumption data, available from the Railroad Commission of Texas (RCOT, 2000) was consulted. Those counties showing no consumption in the small commercial and industrial sectors were assigned zero commercial consumption.

Emissions, in TPY, were calculated by multiplying county usage, in million cubic feet, by the

emission factors from Tables 1.4-1 and 1.4-2 of AP-42 and dividing by 2000. The AP-42 emission factors are: VOC = 5.5 lb/10^6 ft^3; NO_X = 100 lbs/10^6 ft^3, CO = 84 lbs/10^6 ft^3, SO_2 = 0.6 lb/10^6 ft^3, and PM_{10} and $PM_{2.5}$ = 7.6 lb/10^6 ft^3 (EPA, 1998).

Ozone season day emissions were obtain by multiplying annual emissions by an SAF of 0.76 and dividing by 312.858 days per year (i.e., emissions activity occurs 6 days per week for 52.143 weeks per year (EPA, 1991)). CO season day emissions were obtain by multiplying annual emissions by an SAF of 1.44 and dividing by 312.858 days per year.

The ozone SAF of 0.76 was calculated using statewide monthly natural gas delivery data obtained from the DOE (DOE, 2001). The monthly fractions of annual gas consumption for June, July, and August were added together to obtain the SAF and divided by the average period activity of 0.25 for those three months (EIIP, 1999). The CO SAF of 1.44 was obtained using the same method for December, January, and February.

No federal, state, or local rules applied to commercial natural gas consumption sources in Texas in 1999. Therefore, CE and RP were assumed to be 0%, and RE was set at 100%.

Sample Calculation

The statewide ozone season adjustment factor
Total 1999 commercial gas consumption in state =171,715*10^6 ft^3
June 1999 commercial gas consumption in state = 9,739*10^6 ft^3
July 1999 commercial gas consumption in state = 11,721*10^6 ft^3
August 1999 commercial gas consumption in state = 9,366*10^6 ft^3

(9,739*10^6 ft^3)/(17,175*10^6 ft^3) + (11,721*10^6 ft^3)/(17,175*10^6 ft^3) +(9,366*10^6 ft^3) /(17,175*10^6 ft^3) = 0.19
(0.19)/(0.25) = 0.76 ozone season adjustment factor

VOC calculation for Anderson County (ozone season)
Commercial employees in county = 6,901
Commercial employees in state = 5,374,129
Fraction of employment = (6,901 employees)/(5,374,129 employees) = 0.001284
Total 1999 state commercial natural gas consumption = 172,000*10^6 ft^3
County commercial natural gas consumption = (0.001284)*(172,000*10^6 ft^3) = 220.87*10^6 ft^3
(220.87*10^6 ft^3) * (5.5 lbs VOC /10^6 ft^3)/(2000 lbs/ton) = 0.6074 ton VOC per year
(0.6074 ton VOC per year) * (0.76) / [(52.143 weeks/year) * (6 days/week)] = 0.0015 ton VOC per ozone season day

CO calculation for El Paso County (CO Season)
Total 1999 county commercial gas consumption = 47.98*10^6 ft^3
47.98*10^6 ft^3) * (84 lbs VOC/10^6 ft^3) / (2000 lb/ton) = 2.015 ton CO per year

(2.015 ton CO per year) * (1.44) / [(52.143 weeks/year) * (6 days/week)] = 0.0093 ton CO per CO season day.

Uncertainties/Future Research

The county commercial employment may not be an accurate indicator of commercial natural gas usage; therefore, the consumption allocated to counties is uncertain. Also, there may be additional counties with commercial employment, but no commercial gas consumption, because the RCOT data groups small commercial and small industrial consumption into a single category.

Future work on this category should investigate the feasibility for conducting a survey of natural gas distributors to determine actual annual and seasonal consumption by the institutional/commercial sector by county.

Future work should also investigate the potential for double counting of emissions in the point source inventory. The point source SCCs for commercial/institutional natural gas combustion in boilers and internal combustion engines appear in the 1999 point source inventory for Texas. A preliminary review of the plant names with the point source SCCs for institutional/commercial natural gas combustion indicated that some of the plants are in the institutional/commercial sector (e.g., wholesale and retail businesses; health institutions; social and educational institutions; and Federal, state and local government institutions (e.g., military installations, prisons, office buildings)). If these plants occur in counties for which area source emissions are estimated, then the area source emissions should be adjusted to eliminate double counting. However, the majority of the plants are probably industrial rather than institutional/commercial facilities. For example, many of the plants produce or process natural gas, which are industrial facilities. A detailed evaluation of the point source inventory by county to identify major facilities would eliminate the potential of double counting as an area source and ensure proper categorization.

2.4 OIL AND GAS PRODUCTION

Description of Source Category

Emissions considered in this category come from crude oil and natural gas production in each county in 1999. The production information was obtained from the Oil & Gas Division of the RCOT. In addition to areas previously sampled for production variables, four new production areas were added. They represent gas production dominated by hydrogen sulfide (H_2S) contamination in the Freestone production region, areas dominated by high pressure gas in the Panola production region, the salt dome production areas close to Houston, and the Giddings production area. After completing the sample it was decided that each area was unique enough to separate the emission estimates by the production field boundaries. Counties were

identified for each area, and where differences existed in the production patterns, each county was calculated with those differences. Counties not surveyed were estimated using a surrogate for average emissions/average production parameters. Oil and gas emissions are combined and reported under SCC 2310000000.

Methodology

The EIIP has not published a guidance document for the oil and gas production sector. However, the EIIP discussion of uncertainty for determination of emissions suggests that the more local data that is used the higher the quality of the emissions estimates. AP-42 does provide guidance on estimating emissions for specific activities related to oil and gas production. These include fugitive emissions from leaking components, combustion emissions from compressors and heaters, process loss emissions from glycol dehydration, and storage and transfer emissions from crude oil and condensate.

To prepare the 1999 inventory for Texas, a comprehensive survey was conducted for emission parameters in 72 counties. This survey concentrated on four production areas. Emission estimates were prepared based on this survey data. For the counties that were not surveyed, average emission parameters were used based on the data collected from the counties surveyed. Emissions were estimated with AP-42 factors for each production activity, the surveyed or estimated emission parameters for each activity, and the oil and gas production rates for each county.

Emission Factors and Activity Data

Although oil and gas emissions are reported under one SCC 2310000000, this category has six separate subcategories. Each subcategory has an individual emission factor, therefore, each category is discussed separately. Oil and gas production occurs 24 hours per day, 7 days per week. The OSD emissions were calculated using an ozone SAF of 1.0. For all of the subcategories, CE and RP were set at 0%, and RE was set at 100%.

For natural gas and crude oil production, there are fugitive emissions from leaking components in gaseous and light liquid service, combustion emissions from heaters, combustion emissions from compressors used to transfer the natural gas into production lines, and the VOC emissions from the dehydration of natural gas.

Surveys were completed to estimate the following:

1. Average number of components in gas and liquid service;
2. Quantify the horsepower of compressors versus gas produced;
3. BTU rating of heaters and use of heaters;
4. Gas composition;

5. Glycol dehydration emissions loss (average for VOC);
6. Average optional equipment on site (glycol dehydrators, heaters); and
7. Tank size at well site.

Heater use includes the combined emissions from gas dehydration and in line heating. Survey results included a file search for operating wells in the production areas of interest.

Crude Oil & Condensate Tankage

The crude oil and natural gas condensate is stored in a tank at the production site before it is transported off site to a processing plant. A survey was conducted and it was ascertained that the median size storage tank was approximately 12,600 gallons. Each well was assumed to utilize one tank for the purpose of emission calculation. The production in each county was divided by the number of wells to determine turnovers. The number of wells was multiplied by the emissions per tank to obtain the tons of VOC emissions for crude oil and condensate. The emissions per tank was estimated by using the EPA Tanks 4.0 program (EPA, 2001).

Fugitive Emissions

Fugitive emissions were based on the emission factors presented in Table 2.4-1 (EPA, 1995a). Well sites were surveyed and components were counted. An average component count per well site was developed for each production field. This component count included valves in gas service, valves in liquid service, flanges in gas service, flanges in liquid service, open ended lines in gas service and open ended lines in liquid service. The average number of components per well site was multiplied times the appropriate emission factor using Table 2.4-1 of fugitive factors. The number of well sites times the component emissions is the emission estimate basis. The category of open ended lines is not present for all producing regions. There is a pattern of capping lines in most production areas. The total emissions for components in gas service was adjusted to eliminate non-VOC emissions (primarily methane). Based on a survey, there is 75% methane or non VOC gas in the produced gas. For those components in gas service, emissions were adjusted by multiplying total emissions times 1.75 or 25%.

Fugitive emissions for oil wells are calculated by counting the number of components in liquid service. This includes pump seals, valves, flanges, and open ended lines. Based on vapor pressure, crude oil is considered a light liquid. The emission factors for light liquid are multiplied by the appropriate valve and fitting counts for oil wells. For those wells producing both oil and gas, the well was treated as an oil well. The equipment for gas collection (primarily metering) was part of the averages for equipment in gas service.

Table 2.4-1. Emission factors for estimating fugitive emissions.

Component	Service	Emission Factor (kg/hr/component)	Component	Service	Emission Factor (kg/hr/component)
Valves	Gas	0.0045	Pump	Gas	0.0024
	HV Oil	8.4E-06	Seals	HV Oil	NA
	LT Oil	0.0025		LT Oil	0.013
	H20/Oil	9.8E-05		H20/Oil	2.4E-05
Others	Gas	0.0088	Connectors	Gas	0.0002
	HV Oil	3.2E-05		HV Oil	7.5E-06
	LT Oil	0.0075		LT Oil	0.00021
	H20/Oil	0.014		H20/Oil	0.00011
Flanges	Gas	0.00039	Open Lines	Gas	0.002
	HV Oil	3.9E-07		HV Oil	0.00014
	LT Oil	0.00011		LT Oil	0.0014
	H20/Oil	2.9E-06		H20/Oil	0.00025

Compressor Emissions

Compressor emissions were calculated based on survey data for NO_x and CO. AP-42 emission factors were used for VOC, PM_{10}, $PM_{2.5}$, and SO_2 (EPA, 2001). Emission factors used are 5 gm/hp-hr for NO_x, 3 gm/hp-hr for CO, and 0.43 gm/hp-hr for VOC, 0.0095 lb/mm BTU for PM_{10} and $PM_{2.5}$, and 0.000588 lb/mmbtu for SO_2. Based on survey data the average hp/mmscf-day gas production is 205. Total natural gas production for each county is converted to mmscf/day to determine operating horsepower. Natural gas production in mmcf/year divided by 365 days/year is multiplied by 205 hp/mmcf to yield daily operating horsepower. The operating horsepower times 8,760 hours per year times the emission factor for each pollutant divided by 454 gm/lb and divided by 2000 lb/ton yields TPY per pollutant. For emission factors in lb/mmbtu a typical gas consumption per hp-hr was obtained from engine manufacturing data. This value is 7,000 BTU/hp-hr.

Heater Emissions

Heater emissions were based on the emission factors in AP-42 (EPA, 1995b) and the size of combustion sources for a typical well site. Heater sizes were determined by survey. The median size heater was 0.5 mm BTU/hr for the Glycol Dehydration and the median size heater for in-line production was 0.5 mm BTU/hr. Emissions are calculated based on 100 lb/mmcf for NO_x, 84 lb/mmcf for CO and 5.5 lb/mmcf for VOC, 7.6 lb/mmcf for PM_{10} and $PM_{2.5}$, and 0.6 lb/mmcf for SO_2. The number of well sites was taken from Railroad Commission information for 1999 (RCOT, 2001). Operating hours per heater were taken as 8,760 hrs/yr (continuous production). Based on well site surveys, 47 out of 63 well sites have in-line

heaters. Wells not equipped with heaters add chemical antifreezes (alcohols). Based on site surveys, 15 out of 63 well sites have glycol dehydrators. Wells not using dehydrators are tied to a common header and routed to a centralized compressor station which does have dehydration. This production pattern was used as an adjustment to the calculated emissions. The adjustment is 47/63 times the emission factor times annual hours times number of well sites equals in-line production heater emissions. The adjustment is 15/63 times the emission factor times annual hours times number of well sites equals glycol heater emissions.

Dehydrator Emissions

Dehydrator emission(s) factors were estimated using data from TNRCC files for operating dehydrators in the areas surveyed and the characteristics of natural gas produced. For the sample of wells studied, the amount of VOC lost in dehydration per mmscf of gas processed was 1.2163 pounds.

Sample Calculations

Condensate Tankage

The following were the input parameters for the crude oil Tanks 4.0 calculations: Vertical fixed roof, shell height 15 ft, diameter 10 ft, liquid height 15 ft, average liquid height 8 ft, volume 12,600 gallons, turnovers per year (varies by county), shell color/shade gray/light, shell condition good, roof color/shade gray/light, roof condition good, roof height 1 ft, roof radius 11 ft, mixture/component (gasoline was used as a surrogate for condensate). For the example county of Colorado there is 400,211 barrels of condensate from 301 wells. The turnover factor for the tanks program was calculated by dividing tank capacity for one well into barrels of production. Total VOC emissions from Tanks 4.0 = 1.0813 TPY per tank. Emissions are attributed to one tank per well site. There are 301 tanks times 1.0813 tons/yr/well site equals 325.49 TPY of VOC for Colorado County.

Crude Oil Tankage

The following were the input parameters for the crude oil Tanks 4.0 calculations: Vertical fixed roof, shell height 15 ft, diameter 10 ft, liquid height 15 ft, average liquid height 8 ft, volume 12,600 gallons, turnovers per year (varies by county), shell color/shade gray/light, shell condition good, roof color/shade gray/light, roof condition good, roof height 1 ft, roof radius 11 ft, mixture/component crude oil. For the example county of Colorado there is 400,510 barrels of oil from 64 wells. Total VOC emissions from Tanks 4.0 = 0.7058 TPY per tank. Emissions are attributed to one tank per well site. There are 64 tanks times 0.7058 TPY per well site equals 45.17 TPY of VOC for Colorado County.

Fugitive Emissions

For the example county (Colorado) there are 301 well sites. This number of well sites times the emissions per component is the emission estimate basis. Gaseous emissions were adjusted for percent VOC (1-0.75 methane). The number of components are as follows 21 valves, 49 fittings in gaseous service; 91 flanges, and 5 valves in liquid service. The calculation is (21 valves times 0.0045 kg/hr times 301 well sites times 25% VOC) plus (49 fittings times 0.00039 kg/hr times 301 well sites times 25% VOC) plus (5 valves times 0.0025 kg/hr times 301 well sites) plus (9 fittings times 0.00011 kg/hr times 301 well sites) times 1,000 gm/kg times 8,760 hrs/yr divided by 454 gm/lb divided by 2000 lbs/ton equals 121.65 tons per year for Colorado County gas well fugitive emissions.

Compressor Emissions

An example calculation is as follows: Colorado County production 44,456.275 mmscf/year times 205 hp/mmscf times 8,760 hrs/yr times 5 gm/hp-hr divided by 454 gm/lb divided by 2000 lb/ton divided by 365 days/yr equals 1,204.43 TPY NO_x.

Heater Emissions

For Colorado county 0.5 mm BTU/hr times 47/63 well site times 8,760 hrs/yr times 100 lb/mmcf times 301 well sites plus 0.5 mm BTU/hr times 15/63 well sites times 100 lb/mmcf times 8,760 hrs/yr times 301 well sites divided by 2000 lb/ton divided by 1000 BTU/mcf equals 64.87 T/Y NO_x. The well site data is (RCOT, 2001).

Dehydrator Emissions

Emissions were estimated for each county based on total mmscf of gas produced times 1.2163 pounds per mmscf divided by 2000 lbs/ton to yield ton per year VOC emissions. For Colorado County, 44456.275 mmscf times 1.2163 lbs VOC/mmscf divided by 2000 lbs/ton equals 27.04 TPY VOC.

Uncertainties/Future Research

The study for oil and gas emissions has been limited to 74 counties. There are 254 counties in Texas. As noted in this study there are individual differences in production patterns for each field. Because of these differences, the four surveyed areas emission estimates were independently calculated to reflect those differences in production and emissions. It is expected that studies of West Texas oil and gas production would also include unique patterns. Future studies should include these counties not currently surveyed.

2.5 ARCHITECTURAL AND INDUSTRIAL MAINTENANCE (AIM) COATINGS

Description of Source Category

Architectural surface coatings are used primarily by homeowners and painting contractors to coat the interior and exterior of houses and buildings and on the surfaces of other structures such as pavements, curbs, and signs. In TNRCC's 1996 base year inventory for 16 nonattainment areas, architectural coatings emissions are reported under SCC 2401001000. To take advantage of new and emerging information on emissions from this category, a more highly-resolved source classification scheme was used in developing the 1999 inventory as shown in Table 2.5-1. The EIIP document for this source category still contains some old SCCs for this category pertaining to emissions of specific chemical constituents.

New SCCs based on the primary AIM product categories are shown in Table 2.5-1. This source classification scheme incorporates a reasonable level of disaggregation based on information from recent survey work conducted in California (CARB, 1999). Also included in the overall AIM category is the industrial maintenance subcategory. Previously, emissions from this category were estimated by TNRCC as part of the industrial surface coatings category. Traffic coatings are often included as part of AIM emission inventories (e.g., CARB, 1999), however for the 1999 TNRCC inventory, this category is handled separately (see Section 2.7).

Table 2.5-1. Source classification codes for AIM coatings.

SCC[1]	Category Description
2401001000	Overall AIM Category
2401001001	Flat Paints
2401001005	Nonflat Paints - Low and Medium Gloss
2401001006	Nonflat Paints - High Gloss
2401001010	Primers, Sealers, and Undercoaters
2401001011	Quick Dry - Primers, Sealers, and Undercoaters
2401001015	Stains - Semitransparent
2401001020	Quick Dry - Enamels
2401001025	Lacquers - Clear
2401001050	All Other Architectural Categories
2401001060	Thinning and Clean-Up of Solvent-Based Architectural Coatings
2401100000	Industrial Maintenance Coatings
2401100001	Thinning and Clean-Up of Solvent-Based Industrial Maintenance Coatings
2401008000[2]	Traffic Coatings

[1] Codes in italics are the previous area source codes; all others are new codes. For the 1999 inventory, the overall AIM category SCC 2401001000 is not used. Emissions are reported at the subcategory level.
[2] Traffic Coatings are also described separately under its own section of this report.

Methodology

EPA is in the process of releasing new (1999) emission estimates for several solvent source categories, including AIM coatings (Tooly et al, 2001). These estimates are based on a top-down approach of national consumption data to state and local areas based on population or employment. Discussions with EPA indicate that the new solvent emissions data are not likely to be released until about September of 2001 (Tooly, 2001). There may be significant issues relative to these yet to be released estimates. For AIM coatings, EPA assumed a VOC content for AIM coatings of 4.2 lbs/gallon (about 500 grams/liter). This value is typical of a solvent-based coating, while by 1999, sales of water-based coatings have made up much of this category based on both the EIIP (EPA, 1995) and data from the 1998 California survey (CARB, 1999). For comparison, EIIP emission factors of 0.74 lbs VOC/gal for water-based paints and 3.87 lbs VOC/gal for solvent-based paints are given as defaults (EPA, 1995).

The EIIP provides methods for estimating per capita usage factors (gal/capita) by using data supplied by the U.S. Bureau of Census (BOC) on the amount of paint and allied products manufactured nationally. Based on 1993 data, usage factors of 0.59 and 1.82 gal/capita for solvent and water-based paints, respectively, were obtained (EPA, 1995). The EIIP does not provide information on the amount of thinning and clean-up solvent used during solvent-based painting operations.

CARB developed emission factors based on 1990 survey data of 0.44 and 2.87 lbs VOC/gal for water and solvent-based coatings, respectively (CARB, 1998). These emission factors also incorporate industrial maintenance coatings. However, for comparison to the EIIP, based on 1990 population data, usage factors of 0.62 and 1.92 gal/capita for solvent and water-based paints, respectively, can be derived from the California survey data. CARB uses a thinning and cleanup solvent usage factor of 1 pint/gal of solvent-based paint.

As described in the EIIP document, a survey of AIM coating manufacturers is the preferred method for developing emission estimates. However, a survey of this type would take a minimum of 6 to12 months to complete in addition to significant resources. The team developed the 1999 emission estimates based on a variant of the alternative method listed in the EIIP, which involves using population-based emission factors derived from national AIM product shipments. The method incorporates information from recent CARB survey efforts and is described in detail below.

Emission Factors and Activity Data

For the 1999 inventory, an improved variant of the alternative method in the EIIP document was used to estimate emissions. First, the national total usage for water-based (530,155,000 gallons) and solvent-based (145,584,000 gallons) architectural coatings were calculated as described in the EIIP document (EPA, 1995). These total usage values were derived from the 1999 U.S. DOC *Paint and Allied Products* (DOC, 2000). In a similar manner, the total usage

value (47,465,000 gallons) for industrial maintenance coatings was also derived. The value for industrial maintenance coatings was determined by using values listed under the heading of "Industrial new construction and maintenance paints."

In place of the emission factors listed in the EIIP, information compiled by CARB from their 1998 survey (of 1996 sales data) was utilized to develop emission factors for Texas (CARB, 1999). As one of five states that had an AIM coating rule in effect by 1995, the coatings used in Texas during the late 1990's are likely to be more comparable to those used in California than to those used in the nation as a whole. Although regional VOC limits may vary, custom formulations for specific regions may exist, but typically do not. Formulations more often meet one standard and are distributed nationally except in regions where compliance is limited by a lower VOC limit.

Table 2.5-2 provides a comparison of emission limits between those commonly in place in California and those in Texas in 1999 (the TX rule does not cover the entire state, however the major population centers are included). The AIM products listed in Table 2.5-2 are the top three categories in terms of emissions identified by CARB (CARB, 2000). The limits in the national rule went into effect in September of 1999, and hence, may not have affected 1999 emissions appreciably.

Table 2.5-2. Comparison of VOC limits between Texas and California in 1999.

Product Category	VOC Content Limit (grams/liter)	
	Texas[1]	California[2]
Flat Paints	260	250
Nonflat Paints	260	250
Industrial Maintenance Coatings:		420
Exterior Alkyd Paints	480	
Epoxy Paints	540	
Urethane Coatings	540	

[1] Source: EPA, 1995; the listed coatings under industrial maintenance are three of the resin types used in this AIM category.
[2] Source: CARB, 2000; common limit in effect in various California air districts.

The water-based (WB) and solvent-based (SB) paint usage described above was mapped to the appropriate AIM category shown in Table 2.5-2, based on data provided in CARB's survey report (CARB, 1999). For each product category, CARB provides information on the sales-weighted fraction that is solvent- versus water-based. For example, for flat paints nearly all of the paint is water-based, while, for industrial maintenance coatings, nearly all is solvent-based.

Due to the distinction between the architectural coatings and industrial maintenance coatings, the first task during the emission factor development was to separate the industrial

maintenance coating information in the CARB survey from the other categories. Additionally, information relating to traffic coatings, another emissions subcategory, was removed (as stated above traffic coatings are estimated separately from the rest of the AIM category; see Section 2.7). By doing this, possible skewing of the survey data was avoided. Since there were some architectural coating categories for which data were suppressed or missing, the following manipulations (in order) were performed:

- When the total sales quantity for an AIM category was protected or not submitted in the CARB report, it was set to 0 (10 AIM subcategories had total sales data protected and 2 subcategories had no data submitted; however these totaled less than 0.1% of the total emissions; CARB, 1999);

- When there was neither a quantity for solvent-based sales nor water-based sales, 50% of the total sales for that category were allocated to each (additional research needs to be performed to better characterize these sales data); and

- When a value for the sales weighted average VOC content was missing in a CARB category, the weighted average of the VOC contents for the appropriate classification (water-based or solvent-based) was used instead.

Following those adjustments to the data, the percentage of total sales allocation could be derived for each category using the equation:

$$fraction of\ total\ (WB\ or\ SB)\ AIM\ coating\ sales = \frac{category\ sales\ quantity\ (WB\ or\ SB)}{sum\ of\ sales\ quantities\ (WB\ or\ SB)}$$

For industrial maintenance coatings, the derivation is simpler because it only represents one CARB category, and the national usage data are not segregated by base (carrier) type. The sales allocation was derived using the following formula:

$$fraction of\ total\ IM\ coating\ sales = \frac{sales\ quantity\ (WB\ or\ SB)}{sum\ of\ WB\ and\ SB\ sales\ quantity}$$

Once the fraction of sales were obtained, emission factors (pounds/capita or employee) for each category were derived by first multiplying the fraction of sales for each SCC by the appropriate national gallons of coating usage: architectural WB, architectural SB, or industrial maintenance. The resulting SCC usage estimate was converted from gallons to pounds of VOC by multiplying it by the sales-weighted VOC content from the CARB survey (CARB, 1999). These values were converted to emission factors by dividing each by the national population for 1999 (architectural coatings). For industrial maintenance coatings, the emission factor was created via dividing by the number of 1999 national manufacturing employees (BOC, 2001).

Further adjustments were made to three emission factors based on differences in TX and CA state and local regulations. For categories, such as industrial maintenance coatings, where the common California limit was significantly lower than what was in effect in Texas in 1999, the emission factor was adjusted upward by a ratio of the TX to CA VOC content limits. Adjustments made are shown in Table 2.5-3. The CARB survey data did show that the sales-weighted average VOC content for industrial maintenance coatings was much lower than the limit (300 g/L compared to 420 g/L). However, by adjusting the emission factor upward, potentially higher emissions in Texas based on a wider variety of available products (i.e., with a higher average VOC content) are taken into account.

Table 2.5-3. Emission factor adjustment ratios.

Description	Adjustment Ratio (g/L)
All Flat and Nonflat Paints	260/250
Industrial Maintenance	520/420*
Stains – Semitransparent	780/350**

*520 g/L is the average of limits shown in Table 2.5-2.
**780 g/L is the average of the interior, 840 g/L, and exterior, 720 g/L, stain limits

The emission factors derived for the 1999 Texas EI are shown in Table 2.5-4. Emission factors for thinning and clean-up solvents for both the architectural and industrial maintenance categories were created by using the CARB value of 1 pint per gallon of solvent-based coating consumed. The assumed VOC content for thinning/clean-up solvents is 6.28 lbs per gallon (*Condensed Chemical Dictionary;* Torres, 2001a).

Table 2.5-4. Emission factors for AIM coatings.

SCC	Category Description	Emission Factor Value	Emission Factor Units
2401001001	Flat Paints	0.312	lb/capita-yr
2401001005	Nonflat Paints - Low and Medium Gloss	0.353	lb/capita-yr
2401001006	Nonflat Paints - High Gloss	0.117	lb/capita-yr
2401001010	Primers, Sealers, and Undercoaters	0.251	lb/capita-yr
2401001011	Quick Dry - Primers, Sealers, and Undercoaters	0.198	lb/capita-yr
2401001015	Stains - Semitransparent	0.386	lb/capita-yr
2401001020	Quick Dry - Enamels	0.142	lb/capita-yr
2401001025	Lacquers - Clear	0.115	lb/capita-yr
2401001050	All Other Architectural Categories	0.767	lb/capita-yr

SCC	Category Description	Emission Factor Value	Emission Factor Units
2401001060	Thinning and Clean-Up of Solvent-Based Architectural Coatings	0.419	lb/capita-yr
2401100000	Industrial Maintenance Coatings	8.80	lb/employee-yr
2401100001	Thinning and Clean-Up of Solvent-Based Industrial Maintenance Coatings	2.04	lb/employee-yr

The application of the usage factors to the Texas counties required county populations (architectural coatings) and county manufacturing employees (industrial maintenance coatings). The county population data were taken from the Texas Comptrollers Office. Manufacturing employment for each Texas county was estimated from BOC County Business Patterns data (Funderburk, 2001). For manufacturing data, NAICS codes 31-33 (designated 31----), information was withheld for some counties. For the 47 counties that had manufacturing establishment information (i.e., number of facilities) but had withheld employment information, the number of employees was estimated as follows:

- The sum of all of the manufacturing employees for all counties that did not have withheld information was calculated;
- For each county, the number of manufacturing employees was initially estimated by taking the midpoint of the range of employees for each establishment category, multiplying by the number of businesses in that category, and then summing the values obtained. For example: a county with one 1-4 employee establishment and one 5-9 employee establishment would be estimated as having 9.5 manufacturing employees;
- All of the estimated number of manufacturing employees for the counties that had information suppressed was summed ("suppressed information" refers to data that are not included in the source because of a small number of establishments, e.g., less than 3 establishments in a county);
- For counties with suppressed information, the employment factor (fraction) was found by dividing each estimate by the sum of the estimates;
- The difference between the total number of manufacturing employees for Texas at the state level (unsuppressed) (BOC, 2001) and the sum of employees from the first step was found, resulting in the total manufacturing employees that weren't accounted for; and

- For each of the counties with suppressed information, the employment factor was multiplied by the total number of unaccounted employees, producing the number of employees.

For the 21 counties that had no manufacturing information (employees or facilities), the number of employees was assumed to be zero. County-level emission estimates were developed for each SCC by multiplying the emission factor and activity data (i.e., county populations or employment totals) described above.

The industrial maintenance category has point source emissions associated with it. These point source emissions were backed out of the total county emisions using uncontrolled point source emissions supplied by TNRCC (Torres, 2001b). These uncontrolled point source emissions contained TNRCC-estimated county-level emissions for both industrial maintenance and miscellaneous industrial surface coatings categories. Emissions for each subcategory were estimated using fractions derived by TNRCC: 0.4995 for industrial maintenance; 0.5005 for miscellaneous industrial surface coating (Torres, 2001b). Uncontrolled point source emissions must be used since it is these emissions that are associated with the amount of coatings actually used by point sources (i.e., otherwise, the area source fraction would be overestimated).

For each county, the industrial maintenance coating emissions and the industrial maintenance thinning/clean-up emissions had to be combined to represent the emissions that would be included in the point source emissions. The point source emissions were then subtracted from this county total. Negative results where zeroed out (i.e., there were no resulting area source emissions for those counties). The resulting emissions were allocated back to the industrial maintenance coating and the industrial maintenance thinning/cleanup categories, based on the fraction of the original total industrial maintenance emissions (industrial maintenance coating + industrial maintenance thinner coating). The industrial maintenance coatings represented 81.2% of the total, while thinning/cleanup was 18.8% of the emissions.

Quarterly shipments data from the Bureau of Census were used to develop seasonal allocation factors (SAFs; DOC, 2000). While shipments don't necessarily equate to usage and emissions, this information does provide an indication of the industries' response to seasonal demand for their products. The months of June, July, and August were used as the ozone season for all Texas counties. Shipments under the heading, "Architectural Coatings," were used to derive an SAF (1.096) that applies to all of the categories (except the industrial maintenance coatings and industrial maintenance thinner coatings categories). For industrial maintenance and the related thinners, an SAF (1.072) was derived by using values from the "Special-purpose Coatings" heading.

Since architectural coatings are assumed to be used 7 days a week, the activity rate (AR) is 365 days/yr. Five days of activity per week are assumed for industrial maintenance coatings and industrial maintenance thinners, leading to an AR of 260.7 days/yr.

For the purposes of 1999 emission estimates, the effects of the state rule were taken into account during the development of the emission factors described above. Other than VOC content limits in the TX rule, there are no other known controls in use. Hence, control parameters (CE, RE, and RP) were not applied to the emission estimates.

Sample Calculations

The following equation was used to calculate county-level annual area source VOC emissions:

$$E_{ia} = [(POP_{ia} \times EF \times 1/2000) - E_{ps}] \times [1-(CE \times RP \times RE)]$$

where:

E_{ia} = annual emissions for the inventory area (e.g., Harris County), tons/year;
POP_{ia} = population within the inventory area (e.g., Harris County);
EF = industry-specific emission factor (e.g., wood furniture), lb/employee-yr;
1/2000 = conversion factor, ton/lb;
E_{ps} = annual uncontrolled emissions of point sources in the inventory area, tons/yr;
CE = control effectiveness (fraction) of applicable rules, unitless;
RP = rule penetration (fraction) of applicable rules, unitless; and
RE = rule effectiveness (fraction) of applicable rules, unitless.

For Harris County, annual area source emissions for flat paints (2401001001) were estimated as follows:

$$E_{ia} = \{[(3158309 \text{ people})(0.312 \text{ lb/person})(\text{ton}/2000 \text{ lbs})] - 0.0 \text{ tons/yr}\}\{1 - [(0.00)(0.00)(1.00)]\}$$

$$E_{ia} = 492.7 \text{ tons/yr}$$

To estimate ozone season daily emissions, the following equation was used:

$$E_{osd} = (E_{ia} \times SAF)/AR$$

where:

E_{osd} = ozone season day emissions, tons/day;
E_{ia} = annual area source emissions, tons/yr;
SAF = seasonal adjustment factor, unitless; and
AR = activity rate, days/yr.

Following from the example given above, the ozone season day emissions for flat architectural coating emissions in Harris County would be estimated as follows:

$$E_{osd} = [(492.7 \text{ tons/yr})(1.096)]/(365 \text{ days/yr})$$

$$E_{osd} = 1.48 \text{ tons/day}$$

Uncertainties/Future Research

The two primary sources of uncertainty are: 1) use of national DOC paint shipments data allocated to TX counties by population and manufacturing employment data; and 2) use of VOC contents and proportions of AIM products sold in CA to represent TX AIM products. To reduce these sources of uncertainty, a survey of AIM coating manufacturers on the amount and VOC content of coatings shipped to TX is needed. Based on CARB's experience in conducting these surveys and the AIM coating manufacturers experience in responding to them, a survey conducted for TX should be feasible. Completion of such a survey is expected to take up to one year.

2.6 AUTOMOBILE REFINISHING

Description of Source Category

Automobile refinishing is the repainting of automobiles, light trucks, and other vehicles. It does not include surface coating during manufacturing. Emissions are from the use of surface preparation and clean-up solvents, primers, and various types of topcoats. Emissions for this category have historically been reported under SCC 2401005000. For the 1999 inventory, a more highly-resolved source classification scheme was employed, as shown in Table 2.6-1. This break-out of emissions will allow for further refinement of VOC speciation in the future, as well as additional information for control strategy analysis.

Table 2.6-1. SCCs used for auto refinishing emissions.

SCC	Category Description
2401005500	Surface Preparation Solvents
2401005600	Primers
2401005700	Top Coats
2401005800	Clean-up Solvents

Methodology

The EIIP draft chapter for this category (EPA, 2000) lists a preferred method that involves assessment of emissions based on shop-level employment obtained from a business database vendor (e.g., Dun & Bradstreet). The largest shops (>$624,000/yr sales) are then surveyed. Given, the time constraints of this project, a survey of the largest shops was not possible. The first alternative method is the same as the preferred method except that a survey is not performed. In this case, facility-specific sales or employment data are used to scale national emission estimates from surface preparation/clean-up and coatings. The national emission estimates in the EIIP draft document were derived from 1997 population data, 1998 data on solvent usage from Connecticut, and 1999 data on coatings usage from Texas (Smith and Dunn, 1999).

There are several problems with the methods included in the draft EIIP section. One of the most obvious is that the national emission estimate of 79,429 tons per year (tpy) is made up of 50% emissions from coatings and the other 50% from clean-up and surface preparation solvents. Earlier in the document, it is stated that solvent emissions (surface preparation and clean-up) make up about 10% of the emissions. We believe that this latter estimate is closer to reality. The problems with the national estimate are probably due to multiple issues, including the use of activity data from two separate survey efforts (i.e., TX and CT) and the use of the entire SIC 7532 employment figures (instead of just the sub-categories where painting occurs).

The EIIP also changed the sizes of the shops to be broken out into separate size bins from those described by Smith and Dunn (1999). The reason for the changes in methodology in the EIIP is unknown, however the "very large" size shop would only employ about 6 employees using the relationship of annual sales to employee number mentioned in the Smith and Dunn paper.

Emission Factors and Activity Data

Due to the problems noted with the draft EIIP document, we used information provided by Smith and Dunn for developing the 1999 inventory. We noted some concerns with the actual method used by Smith and Dunn for estimating emissions. Primarily this involved the estimates that would be assigned to the largest (mega) auto refinishers. The highest annual VOC emissions would be less the 1.8 tons per year using this method. Environ Team members have direct experience with an auto refinisher in the Houston area that emits much higher levels (annual emission estimates not available, however permitted emissions are >10 tpy). Also, staff in the South Coast and Bay Area air districts in California related that there are auto refinishing shops in those districts that emit on the order of 4 to 6 tpy. A few are even permitted to emit up to 10 to 12 tpy (Schultz, 2001; Pirveysian, 2001).

The Smith and Dunn method is based on an assumption that the largest category has an annual sales range of $1.0 to $2.5 million per year (Smith and Dunn, 1999). Using the relationship provided by Smith and Dunn to estimate the number of employees per shop

($100,000/employee), this shop size is equivalent to 10 to 25 employees. Dun & Bradstreet listed about 108 facilities in TX with greater than 25 employees (after subtracting out certain SIC sub-classes, like auto interior repair) (D&B, 2000).

There are also problems involving the use of annual sales data as reported by data vendors (e.g., Dun & Bradstreet or American Business Information) to assign shop sizes. These sources often report revenue by a corporate entity and not an individual shop. Hence, facility employment data were used to supplement the process of assigning shop sizes.

In developing the 1999 survey, we added two more size categories to those described by Smith and Dunn to account for the potentially larger shops. These assignments were based on the Dun & Bradstreet revenue size classifications of $1.0MM to $2.4MM and $2.5MM to $4.9MM, respectively (D&B, 2000). Emission levels were derived by extrapolation of the weekly emission rates given by Smith and Dunn. The revenue size classes of Smith and Dunn were adjusted slightly to be consistent with those reported by Dun & Bradstreet. Table 2.6-2 provides the emission factors used in inventory development.

A database was purchased from Dun & Bradstreet for all of the larger facilities (> or = 10 employees) located in Texas in 1999 (D&B, 2000). Industry subcategories that were not associated with vehicle refinishing were not included in the database. The 8-digit SIC codes that were included in the inventory are as follows: 7532-0000; 7532-0200; 7532-0202; 7532-0203; 7532-0300; 7532-0301; 7532-0400; 7532-0401; 7532-0402; 7532-0404; 7532-9901; 7532-9902. The purchased information included annual revenue size class and geographic coordinates for each facility, as well as facility name and phone number.

For the smaller facilities (<10 employees), we used a 1999 Dun & Bradstreet database that included employment and revenue class, but none of the other facility-level information (D&B, 2000). For the larger facilities, several QA measures were taken after an initial review of the data. There were 487 of these larger facilities in Texas. Of these, 19 appeared to be miss-coded in their industrial classification (e.g., car washes, auto glass shops, etc.) or were record duplicates. These facilities were excluded from the emission estimates. In addition, the following rules were established for certain business types:

- Emissions were assigned by revenue size class as shown in Table 2.6-2. For facilities with unknown revenue, the most common size class was used based on the number of employees (e.g., for facilities with 10 to 24 employees, emissions for the $1.0 MM to $2.4 MM size class were used). In the Dun & Bradstreet data base listing of small facilities, the largest size class assigned was the “very large” size class due to the number of employees being so small (e.g., based on the current knowledge of auto refinishing emissions, shops with less than 10 employees would not likely generate revenues in excess of $2.5MM) (D&B, 2000);

- For facilities designated as headquarters, emissions were assigned assuming that painting still occurs at that location; emission factors for the $1.0 MM to $2.4MM size class were used for all headquarters locations with revenue estimates at these levels or higher (lower revenue facilities were assigned to the appropriate size category). These assumptions were edited based on information gathered in a survey of these shops, whenever information was obtained;

- For body shops aligned with a car dealership, emissions were assigned as for the $1.0 to $2.4 MM size category (revenue and employee estimates seem to be based on the overall dealership). This is the most common revenue category for the D&B auto body shops; and

- For businesses involved in selling trailers, mobile homes, etc., emissions were assigned as for the $0.2MM to $0.4MM size group. The assumption here is that painting occurs, but only at the level of a relatively small auto body shop.

As mentioned above, a telephone survey of 33 facilities designated as headquarters facilities was conducted to verify information in the Dun & Bradstreet database (D&B, 2000). Primarily, this survey was performed to verify that: 1) painting actually occurred at the facility; and 2) that the facility size information was for the facility and not for the overall company. Contacts were successfully made with 26 of these facilities, and for all of these, it was determined whether painting took place on site (22 of the 26 indicated that painting did occur). For the facilities that indicated that painting did not occur on site, these records were not included in the emission estimates. For the facilities that could not be contacted (either due to refusal, change in phone number, etc.), the records were left in the inventory estimates and assigned to the appropriate size class based on the Dun & Bradstreet data.

Table 2.6-2. Emission factors used for estimating auto refinishing coating emissions.

	Facility Size Classes					
	Very Small	**Small**	**Medium**	**Large**	**Very Large**	**Mega**
Annual Revenue ($)	**<200k**	**200k - 400k**	**400k - 600k**	**600k - 1000k**	**$1.0 to 2.4 MM**	**$2.5 to 4.9 MM**
No. of employees ($100k/employee)	**1**	**2 - 3**	**4 - 6**	**7 - 9**	**10 - 24**	**> 24**
Types of Coatings (SCC Assignment)			**VOC lbs/yr**			
PreCoat Primer (2401005600)	60	130	175	305	648	1411
Primer (2401005600)	115	255	310	755	1604	3492
Sealer (2401005600)	65	145	290	315	669	1457
Base Coat (2401005700)	125	290	485	735	1562	3399
Clear Coat (2401005700)	145	300	425	815	1732	3769
Other Products (2401005700)	100	240	340	605	1286	2798
Totals	**610**	**1360**	**2025**	**3530**	**7501**	**16326**

Notes:
Extrapolation based on a ratio of the mid-points of D&B employment categories (e.g., for the Next Largest category shops, the ratio was 17/8). Facility sizes were adjusted from the Smith & Dunn estimates to match up with D&B employee size categories and sales revenue classes.
The small number of facilities with reported revenues > the Mega size class above were assigned to the Mega size class.
Due to the way in which D&B revenue data are reported, very few facilities were assigned into the medium size facility class. The only exception were for 2 facilities contacted during the telephone survey who reported between 4 and 6 employees.

None of the companies contacted would give out revenue estimates. For the nine facilities that reported employee numbers, the sizes reported were all lower than the Dun & Bradstreet assignment. For example, a typical response was in the range of 3 to 6 employees instead of the Dun & Bradstreet assignment of 10 to 24. For these facilities, the emission factors for the appropriate size range were used to estimate emissions.

Since the information provided by Smith and Dunn only includes paints, emissions for surface preparation and clean-up solvents were added. These emissions were estimated based on paint usage and the breakdown of emissions provided in the draft EIIP (i.e., 2 percent of the total emissions for surface cleaning, and 8 percent for clean-up). Also, based on the draft EIIP, it was assumed that 90 percent of the total emissions were from coatings (EPA, 2000). Emissions were assigned based on the SCCs shown in Table 2.6-1.

The results showed that most of the facilities (over 4,000 out of about 4,600) fell within the two smallest size classes and emitted less than a ton of VOC per year. There were 178 facilities that fell in the "very large" class (annual emissions = 4.2 TPY). In the "mega" class, there were 8 facilities emitting about 9.1 TPY. Due to the way in which Dun & Bradstreet revenue data are reported, very few facilities fell within the "medium" size class. The only 2 exceptions were facilities that reported between 4 and 6 employees during the telephone survey described above.

Seasonal adjustment of emissions may be important for this category, since activity may be higher during summer (drier) months. Painting contacts have indicated that winter months are much slower than summer months, potentially due to higher humidity conditions which are not conducive to high-quality painting (Smith-Hardison, 2001). The EIIP draft states that seasonal activity may be associated with seasons with higher traffic accidents. If higher traffic accidents occur during periods of poor weather (i.e, winter), this assumption would be in contrast with the information relayed by painting contacts. For the 1999 inventory, we derived an SAF of 1.072 from quarterly shipments of special purpose coatings from the U.S. DOC (DOC, 2000).

The activity rate (AR) of 250 days/yr is based on an operating schedule of 5 days per week during 50 weeks of the year (Smith-Hardison, 2001). The 5 days per week estimate is consistent with the draft EIIP, existing TNRCC methods, and other state inventories (e.g., CARB). Some shops may operate six days per week (e.g., half a day on Saturday). Both the SAF and AR are variables that would benefit from further survey work (in addition to the emission estimates themselves).

No control parameters (CE, RE, RP) were used in developing the 1999 emission estimates. The emission factors employed were representative of 1999 operations. Hence, the effects of the state and federal rules are assumed to be incorporated in the 1999 emission estimates.

Sample Calculations

The following equation was used to calculate county-level annual area source VOC emissions for each county:

$$E_{ia} = 3[(FAC_{ias} \times EF_s \times 1/2000) - E_{pss}] \times [1-(CE \times RP \times RE)]$$

where:

E_{ia} = annual emissions for the inventory area (e.g., Harris County), TPY;
FAC_{ias} = number of facilities by size class within the inventory area (e.g., number of facilities in Harris County with revenue between $500k and $900k);
EF_f = facility size-specific emission factor (e.g., primers), lb/facility-yr;
1/2000 = conversion factor, ton/lb;
E_{pss} = annual uncontrolled emissions of point sources in the inventory area for the facility size class of interest, TPY;
CE = control effectiveness (fraction) of applicable rules, unitless;
RP = rule penetration (fraction) of applicable rules, unitless; and
RE = rule effectiveness (fraction) of applicable rules, unitless.

Hence for Harris County, annual area source emissions for primer coatings (2401005600) were estimated as follows:

$$\begin{aligned} E_{ia} = {} & \{[(532 \text{ v. small facilities})(240 \text{ lb/facility-yr})(\text{ton}/2000 \text{ lbs})] - 0 \text{ tons/yr}\}\{1 - [(0.00)(0.00)(1.00)]\} \\ & + \\ & \{[(143 \text{ small facilities})(530 \text{ lb/facility-yr})(\text{ton}/2000 \text{ lbs})] - 0 \text{ TPY}\}\{1 - [(0.00)(0.00)(1.00)]\} + \\ & \{[(49 \text{ large facilities})(1375 \text{ lb/facility-yr})(\text{ton}/2000 \text{ lbs})] - 0 \text{ TPY}\}\{1 - [(0.00)(0.00)(1.00)]\} + \\ & \{[(31 \text{ v. large facilities})(2922 \text{ lb/facility-yr})(\text{ton}/2000 \text{ lbs})] - 0 \text{ TPY}\}\{1 - [(0.00)(0.00)(1.00)]\} + \\ & \{[(2 \text{ mega facilities})(6359 \text{ lb/facility-yr})(\text{ton}/2000 \text{ lbs})] - 0 \text{ TPY}\}\{1 - [(0.00)(0.00)(1.00)]\} \end{aligned}$$

$$E_{ia} = 85.8 \text{ TPY}$$

To estimate ozone season day emissions, the following equation was used:

$$E_{osd} = (E_{ia} \times SAF)/AR$$

where:

E_{osd} = ozone season day emissions, tons/day;
E_{ia} = annual area source emissions, TPY;
SAF = seasonal adjustment factor, unitless; and
AR = activity rate, days/yr.

Following from the example given above, the ozone season day emissions for primer coating emissions in Harris County would be estimated as follows:

$$E_{osd} = [(85.8 \text{ TPY})(1.072)]/(250 \text{ days/yr})$$

$$E_{osd} = 0.368 \text{ tons/day}$$

Uncertainties/Future Research

The primary source of uncertainty in the 1999 inventory is the extrapolation of paint product usage for a typical facility into revenue-based emission factors for a wide range of facility sizes. Additional uncertainty exists in the information used to derive the activity data (numbers of facilities in various size classes). This includes business database information (Dun & Bradstreet) on facility revenue and number of employees.

The Environ Team recommends that a survey of auto refinishing businesses be performed to better characterize paint and solvent usage, VOC content of the various products, seasonal activity, and weekly activity. While this survey could be carried out as a telephone survey or mail-out survey, the best approach would be a set of focused surveys conducted by TNRCC at representative facilities (e.g., by various size classes) and including paint supply representatives.

2.7 TRAFFIC MARKINGS

Introduction

This category is a source of VOC emissions resulting from the evaporation of organic solvents during and shortly after the application of traffic paints used to mark pavement. Examples of these markings include the dividing lines to denote traffic lanes, and lines to mark parking spaces and crosswalks. Materials used for traffic markings include solvent-based paints, water-based paints, thermoplastics, preformed tapes, field-reacted materials, and permanent markers (EIIP, 1997). Emissions from thermoplastics, field-related materials, and permanent markers are excluded because they are negligible (EIIP, 1997). Emissions from this category are reported under SCC 2401008000. Preformed tapes are applied with adhesive primer. Emissions from traffic marking adhesives are included in the “Consumer and Commercial Solvents” area source category.

Because of differing emission factors and activity data, the 1999 inventory methodology is divided into the following three subcategories for the purpose of estimating emissions: state and federal highways, city and county roads, and private roads and parking lots.

Methodology

The EIIP preferred emissions estimation method for this category is to conduct a survey of traffic marking use by State, county, and city highway and road maintenance departments. A contact at the Texas Department of Transportation (TXDOT) indicated that nearly all road painting jobs were completed by private contractors (Bassett, 2001); therefore, a survey of contractors would be needed. This type of survey could not be completed within the time constraints for this project.

The ENVIRON team reviewed the three alternative emission estimation methods described in the EIIP Traffic Markings document:

- Alternative Method 1: The total state traffic paint consumption is estimated by taking a proportion of the national consumption (from Manufacturing Census data) based on highway spending data from the Federal Highway Administration (FHWA). The state traffic paint consumption is allocated to the counties based on county lane miles or state population. County emissions are calculated by multiplying county paint usage by an emission factor based on VOC contents provided by the National Paint and Coatings Association (NPCA).

- Alternative Method 2: County emissions are calculated using total lane miles of roads in each county and the lane miles emission factor.

- Alternative Method 3: County emissions are calculated using per capita usage and the national average per gallon emission factor.

To estimate traffic and zone marking paint consumption for 1999, a variant of the first alternative method was chosen for the 1999 inventory because paint consumption for state and federal highways was available from the TXDOT, and could be used to estimate consumption for city and county roads and private roads and parking lots. The second alternative was used to allocate state activity to counties to estimate emissions for application of traffic marking paints to state and federal highways and city and county roads. The third alternative was used to allocate state activity to counties to estimate emissions for application of traffic marking paints for private roads and parking lots. The use of these alternative methodologies was driven by the state and county activity data that could be obtained within the time and resource constraints of this project.

Emission Factors and Activity Data

State and Federal Highways

The annual average of the amount of traffic paint purchased by the Texas Department of Transportation (TXDOT) in 1996-2000 was calculated to estimate the amount of paint applied in 1999. This approach was suggested by a TXDOT contact who noted that more paint is

purchased than applied in some years, with the excess inventory used to cover a portion of the following year's demand (Smart, 2001). The TXDOT confirmed that the paint it purchases is applied to both state and federal highways (Smart, 2001).

The state-level data was allocated to counties based on 1999 state highway lane miles provided by the Texas Department of Transportation (TXDOT, 2001). The VOC contents of traffic paints used were obtained from the TXDOT (Smart, 2001). Various types of paint with differing VOC content was used by the TXDOT during this period. Thus, a weighted emission factor was calculated to reflect the assumption that some paint purchased in previous years was used in 1999 (see Sample Calculations). Emissions were then calculated by multiplying county paint usage by the calculated emission factor of 1.631 pounds per gallon. A contact at the TXDOT indicated that road painting is uniform throughout the year, so an ozone SAF of 1 was used (Sigler, 2001).

For emission estimates for state and federal highways, the CE and RP are assumed to be 0% since the emission factor accounts for the VOC content of the paints applied in 1999, and the TXDOT requires contractors to use the paints it purchases that meet state-specified formulation standards. The RE is assumed to be 100%.

City and County Roads

The amount of traffic paints used on city and county roads in 1999 was estimated based on information that 65 percent of all marking paint purchased is used by state highway departments and 25 percent is used by cities and counties (SRI, 1990). County and city road lane miles data were used to allocate State-level paint use to the county level. To compute 1999 county emissions for this subcategory, the estimated county volume of paints was multiplied by the Federal limit for traffic markings (1.3 pounds of VOC per gallon). A contact at the TXDOT indicated that road painting is uniform throughout the year, so an ozone SAF of 1 was used (Sigler, 2001).

For emission estimates for city and county roads, the CE and RP are assumed to be 0% since the emission factor is based on the Federal limit for traffic markings. The RE is assumed to be 100%.

Private Roads and Parking Lots

The amount of traffic paints used on city and county roads in 1999 was estimated based on information that 65 percent of all marking paint purchased is used by State highway departments and 10 percent is used for private roads and parking lots (SRI, 1990). Traffic paint use for private roads and parking lots was allocated to counties based on population data (TCPA, 2001). To calculate the 1999 county emissions for this subcategory, the estimated county volume of paints was multiplied by the Federal limit for zone markings (3.8 pounds of VOC per gallon). Zone markings, which are markings used for private roads and parking lots, are covered by the Federal regulation limiting VOC content in architectural coatings (63

FR 48848, 1998). A contact at the TXDOT indicated that road painting is uniform throughout the year, so an ozone SAF of 1 were used.

For emission estimates for private roads and parking lots, the CE and RP are assumed to be 0% since the emission factor is based on the Federal limit for zone markings. The RE is assumed to be 100%.

Sample Calculations

State Paint Consumption

	Paint Purchased by TXDOT (thousand gallons)				
Formulation	**1996**	**1997**	**1998**	**1999**	**2000**
1 (3.3 lb VOC/gallon)	818	1,195	0	0	0
2 (0.79 lb VOC/gallon)	0	0	935	0	0
3 (0.79 lb VOC /gallon)	0	0	0	1,085	774
Total	**818**	**1,195**	**935**	**1,085**	**774**

1999 Average Consumption:

(818 + 1,195 + 935 + 1,085 + 774) / 5 = 961.4 thousand gallons

Weighted consumption:

Formulation 1 = (818*0.25) + (1,195*0.5) + (0*0.75) + (0*1) + (0*0.75) = 802
Formulation 2 = (0*0.25) + (0*0.5) + (935*0.75) + (0*1) + (0*0.75) = 701.25
Formulation 3 = (0*0.25) + (0*0.5) + (0*0.75) + (1,085*1) + (774*0.75) = 1,665.5

Normalized to 1999 average total:

Formulation 1 = (802) * (961.4 / 3,168.75) = 243.33 thousand gallons
Formulation 2 = (701.25) * (961.4 / 3,168.75) = 212.76
Formulation 2 = (1,665.5) * (961.4 / 3,168.75) = 505.31

State Emissions

VOC Calculation for Anderson County

State highway lane miles in Anderson county in 1999 = 958.61 miles
Total state highway lane miles = 187,151.64 miles

Proportion of state lane miles in Anderson county = (958.61)/(187,151.64) = 0.005122
Form. 1 = (0.00512) * (243,330 gallons) * (3.3 lbs/gallon) / (2000 lbs/gallon) = 2.056 TPY
Form. 2 = (0.00512) * (212,760 gallons) * (0.79 lbs/gallon) / (2000 lbs/gallon) = 0.430 TPY
Form. 3 = (0.00512) * (505,310 gallons) * (0.79 lbs/gallon) / (2000 lbs/gallon) = 1.022 TPY
Total emissions from State traffic markings in Anderson County =
2.056 + 0.430 + 1.022 = 3.508 TPY

City and County Consumption

(0.961 million gallons / 0.65) * (0.25) = 0.369 million gallons

Private Consumption

(0.961 million gallons / 0.65) * (0.10) = 0.148 million gallons

Uncertainties/Future Research

Traffic paint usage by cities and counties and on private roads and parking lots is quite uncertain. A survey of road painting contractors is recommended to obtain a more accurate estimate of traffic paint consumption, the spatial allocation of that consumption, and the VOC content of paints used on city and county roads, and private parking lots. Almost all state traffic painting is performed by contractors; therefore, a survey of contractors would also provide information about state usage, such as the specific types and amounts of paint used in a particular year.

2.8 INDUSTRIAL SURFACE COATINGS

Description of Source Category

Area source emissions associated with industrial surface coating operations include emissions from product finishes for original equipment manufacturers and other special purpose coatings not included in the point source inventory. Original equipment product finishes include solvent-based, water-based, and solventless coatings. Special purpose coatings are generally solvent-based. Both solvent-based and water-based coatings can be applied by spray, brush, or roller (EPA, 1998). This category has both a point source and an area source component. The overall industrial surface coatings category is broken out into the following subcategories:

- Factory finished wood (SCC 2401015000);
- Wood furniture (SCC 2401020000);
- Metal furniture and fixtures (SCC 2401025000);
- Paper, foil and film (SCC 2401030000);
- Metal containers (SCC 2401040000);

- Sheet, strip and coil (SCC 2401045000);
- Machinery and equipment (SCC 2401055000);
- Large appliances (SCC 2401060000);
- Electronic and other electrical (SCC 2401065000);
- Motor vehicles (SCC 2401070000);
- Aircraft (SCC 2401075000);
- Marine (SCC 2401080000);
- Railroad (SCC 2401085000); and
- Miscellaneous manufacturing (SCC 2401090000).

Methodology

The preferred EIIP method calls for development of SIC code-specific and area-specific emission factors by scaling up point source emission estimates based on SIC-specific point source employment and total SIC county employment estimates. In order to use the preferred method, good estimates of point source employment are needed. Implicit assumptions are that emissions per employee for area sources are the same as for point sources and that emissions from SICs for which there are no point sources are insignificant (EPA, 1997). Given that good point source employment data were not available, the preferred method was not selected. The two alternative methods use default per employee and per capita emission factors based on somewhat dated information. The team chose to use the results of recent TNRCC efforts in developing top-down emission estimates. The methods for developing emission factors and activity data are described below.

Emission Factors and Activity Data

Information provided by TNRCC on 1999 coatings and associated products usage, VOC contents, CE, RE, and RP were used to develop the 1999 inventory (Torres, 2001a-n). The TNRCC information on the amount of coatings used by each industry sector and VOC content was used in the development of national SCC-specific emission factors. This information included VOC content data from the National Paint and Coatings Association (NPCA), as well as national shipments of coatings from the U.S. Department of Commerce (DOC, 2000). When combined with national Bureau of Census employment data for each industry sector (based on North American Industry Classification System (NAICS) codes), the emission factors took the form of pounds of VOC per employee. Table 2.8-1 provides the NAICS codes and emission factors used during inventory development. Some of the NAICS codes were provided in the EIIP document for industrial surface coating (EPA, 1997; Table 8.5-2). The NAICS Manual was used to assign codes that were not given in Table 8.5-2 of the EIIP document (OMB, 1997).

The 1999 NEI (Version 1.5) contains emissions for Other Special Purpose Coatings (SCC 2401200000). Following a review of the underlying DOC shipments data, it was determined that most of the Special Purpose Coatings have been accounted for in the industrial surface

coatings category or in the industrial maintenance category. Therefore, this SCC and its emissions were removed from the 1999 NEI (Version 1.5) to avoid double counting of emissions. Recommendations are provided in the "Uncertainty/Future Research" section below concerning this category.

County-level employment data for Texas in 1999 were obtained from the BOC (Funderburk, 2001). County-level employment was multiplied by the emission factors in Table 2.8-1 to obtain total SCC emissions.

For counties that had manufacturing establishment information but had withheld employment information (suppressed data), the number of employees was estimated as follows:

- The sum of all of the manufacturing employees for all counties that did not have withheld information was calculated;
- For each county, the number of manufacturing employees was initially estimated by taking the midpoint of the range of employees for each establishment category, multiplying by the number of businesses in that category, and then summing the values obtained. For example: a county with one 1-4 employee establishment and one 5-9 employee establishment would be estimated as having 9.5 manufacturing employees;
- All of the estimated number of manufacturing employees for the counties that had information suppressed was summed [suppressed information refers to data that are not reported due to confidentiality issues; this occurs at the county level when there are very few establishments (e.g., <3) for a given industry];
- For counties with suppressed information, the employment factor (fraction) was found by dividing each estimate by the sum of the estimates;
- The difference between the total number of manufacturing employees for Texas at the state level (unsuppressed) (BOC, 2001) and the sum of employees from the first step was found, resulting in the total manufacturing employees that weren't accounted for; and
- For each of the counties with suppressed information, the employment factor was multiplied by the total number of unaccounted employees, producing the number of employees.

For counties that had no manufacturing information (employees or facilities), the number of employees was assumed to be zero.

Table 2.8-1. VOC emission factors by industry sector.

Source Category (SCC)	NAICS Codes	Emission Factor (lb/employee-yr)
Factory finished wood (2401015000)	32192; 33711; 321113; 321211; 321212; 321213; 321214; 321219; 321911; 321912; 321918; 321991; 321992; 321999;337215	30.33
Wood furniture (2401020000)	337122; 337129; 337211; 337212; 337215	1349
Metal furniture and fixtures (2401025000)	337121; 337124; 337214; 337127; 339111	577.2
Paper, foil and film (2401030000)	3222; 326111; 326112; 326113	152.1
Metal containers (2401040000)	332431; 332439	5017
Sheet, strip and coil (2401045000)	332812	3101
Machinery and equipment (2401055000)	333; 332997; 332991; 33271	55.83
Large appliances (2401060000)	333414; 335211; 335212; 335221; 335222; 335224; 335228	323.1
Electronic and other electrical (2401065000)	331319; 331422; 331491; 335921; 335929; 335311	49.88
Motor vehicles (2401070000)	336111; 336112; 33612; 336211; 336992	737.6
Aircraft (2401075000)	336411; 336413	183.2
Marine (2401080000)	336611; 336612	289.6
Railroad (2401085000)	33651	1190
Miscellaneous manufacturing (2401090000)	all 31-33, except those listed above	18.39

Uncontrolled point source emissions were obtained from TNRCC so that these emissions could be backed-out of the total (Torres, 2001o). In counties where the total uncontrolled point source emissions were equal to or exceeded the total estimated emissions for that county, the county area source emissions were set to zero. Uncontrolled point source emissions need to be used for the correction, since the starting point for the emission estimate is total VOC

emissions per employee (based on total coating product usage for each industry). If controlled point source emissions were used, the area source component would be overestimated.

For miscellaneous industrial surface coating categories, the same methods developed previously by TNRCC to account for point sources were used. All point source industrial coating emissions that could not be associated with one of the industrial surface coatings area source categories were grouped together at the county-level. Since there was not enough information to determine whether they were associated with manufacturing or industrial maintenance, TNRCC calculated a fraction based on the emission factors of each to allocate the point source emissions between the two categories. The result was roughly a 50:50 split (0.4995 industrial maintenance to 0.5005 miscellaneous manufacturing; Torres, 2001i). These county-level uncontrolled point source emissions were subtracted from the total calculated for the miscellaneous industrial surface coating subcategory.

The effects of Texas nonattainment area rules were accounted for by using the estimates of CE and RP provided by TNRCC (Torres, 2001a-n). In order to be consistent with the RE estimates used for the other VOC area source categories, an RE of 100% was used. The Paint and Allied Products Report upon which the activity data are based indicates slight differences in activity by calendar quarter (DOC, 2000). This information was used to calculate an ozone SAF of 1.015. The EIIP indicates that activity generally occurs 5 days/week for 52.143 weeks/year, which yields 260.7 operating days per year.

Sample Calculations

The following equation was used to calculate county-level annual area source VOC emissions for each county:

$$E_{ia} = [(EMP_{ia} \times EF \times 1/2000) - E_{ps}] \times [1-(CE \times RP \times RE)]$$

where:

E_{ia}	=	annual emissions for the inventory area (e.g., Harris County), TPY;
EMP_{ia}	=	number of industry-specific employees within the inventory area (e.g., wood furniture manufacturing employees in Harris County);
EF	=	industry-specific emission factor (e.g., wood furniture), lb/employee-yr;
1/2000	=	conversion factor, ton/lb;
E_{ps}	=	annual uncontrolled emissions of point sources in the inventory area, TPY;
CE	=	control effectiveness (fraction) of applicable rules, unitless;
RP	=	rule penetration (fraction) of applicable rules, unitless; and
RE	=	rule effectiveness (fraction) of applicable rules, unitless.

Hence for Harris County, annual area source emissions for wood furniture coatings (2401020000) were estimated as follows:

$$E_{ia} = \{[(969 \text{ employees})(1{,}349.3 \text{ lb/employee-yr})(\text{ton}/2000 \text{ lbs})] - 39.9 \text{ TPY}\}\{1 - [(0.20)(0.75)(1.00)]\}$$

$$E_{ia} = 522.7 \text{ TPY}$$

To estimate ozone season day emissions, the following equation was used:

$$E_{osd} = (E_{ia} \times SAF)/AR$$

where:

E_{osd}	=	ozone season day emissions, tons/day;
E_{ia}	=	annual area source emissions, TPY;
SAF	=	seasonal adjustment factor, unitless; and
AR	=	activity rate, days/yr.

Following from the example given above, the ozone season day emissions for wood furniture coating emissions in Harris County would be estimated as follows:

$$E_{osd} = [(522.7 \text{ TPY})(1.015)]/(260.7 \text{ days/yr})$$

$$E_{osd} = 2.035 \text{ tons/day}$$

Uncertainties/Future Research

Sources of uncertainty include the national activity data and methods used to allocate paint and allied product shipments to Texas counties. The DOC does not provide data on the amount of coatings that are exported or imported to estimate the "apparent consumption" in the U.S. Hence, shipments are assumed to equal consumption during the quarter in which they are shipped. There are some minor coatings categories (e.g., 3255107YWV, "Special purpose coatings, not specified by kind"), where it is not clear if these shipments were included in the national activity data used for the 1999 inventory for Texas. Additional research should be conducted to determine where to allocate this activity (e.g., miscellaneous industrial surface coatings, industrial maintenance coatings). Hence, a review of some of the data referenced by Torres (2001a-n) is needed. Emissions in the NEI (Version 1.5) inventory under Special Purpose Coatings (2401200000) can be excluded from the inventory, as the bulk of these have been included in either industrial surface coating or industrial maintenance coatings categories.

The VOC content of coatings is based on 1991 data from NPCA (Torres, 2001a-n). This information may be outdated. Additional research should be conducted to verify that there was little in the way of product reformulation during the 1990's.

Another source of uncertainty requiring additional research is the emissions data used to back out point sources. For several industrial surface coating subcategories, point source emissions occurred within counties for which there were no activity data (i.e., employment). This could be a result of miss-allocating the point source SCCs to a given area source category, miss-allocation of the point source location, or an artifact of the employment data. A review of the point source data should be performed to verify their proper allocation. Table 2.8-2 provides a summary of these data.

Conflicting information was provided by TNRCC concerning the emission control parameters to apply to this source category. Most importantly, TNRCC's Area and Mobile Source Emission Inventory Section lists seven industrial surface coating SCCs with CE, RP, and RE values (Torres, 1999). These values, which were incorporated into the 1999 emissions inventory, were compiled from a December 13, 1995 document entitled "Revisions to the State Implementation Plan for the Control of Ozone Air Pollution, Post-1996 Rate-of-Progress SIP for Beaumont/Port Arthur and Houston/Galveston Ozone Nonattainment Areas." TNRCC staff also provided a separate set of emission control parameters covering industrial surface coating categories. This list includes four additional surface coating categories--Paper Products; Fabrics; Autos and Light-Duty Trucks; and Large Appliances. A reconciliation of the discrepancies between these two sets of parameters could not be performed in time for this analysis. However, the four additional surface categories are listed in TNRCC's surface coating regulation (TNRCC, 2000). Additional efforts should be made to identify whether the control parameters incorporated into the 1999 inventory are comprehensive and up-to-date.

Table 2.8-2. Counties with point source emissions but no employment data.

Source Category	County	Annual Uncontrolled Point Source Emissions (tons)
Aircraft	Taylor	33.9
Electronic and Electrical	Grayson	175.0
	Hunt	20.5
	Liberty	9.54
	Travis	354.4
Marine	Jones	3.02
Metal Containers	Bowie	21.0
Metal Furniture & Fixtures	Kaufman	42.6
Motor Vehicles	Angelina	5130
	Coryell	34.8
	Gregg	11.4
	Harrison	73.3
	Nacognoches	250

Source Category	County	Annual Uncontrolled Point Source Emissions (tons)
Sheet, Strip and Coil	Grimes	35.7
	Morris	88.9

2.9 GRAPHIC ARTS

Introduction

The printing industry includes the printing of newspapers, books, magazines, fabrics, and other materials. The graphic arts industry can be divided by technology into six different printing segments: rotogravure, flexographic, offset lithographic, letterpress, screen, and plateless (xerographic, electrostatic, magnetic, thermal, in-jet, etc.). The technology (i.e., the type of press equipment) dictates the type of inks and coatings that can be used and defines to a large extent the emissions and the control techniques that are applicable (EIIP, 1996). Emissions for Graphic Arts are reported under the source classification code (SCC) 2425000000.

Methodology

An emission factor of 1.3 lbs VOC per person was used to calculate VOC emissions from minor source graphic arts facilities (EIIP, 1996). This factor was derived for facilities with emissions that are less than 10 tpy, and is independent of the number of facilities with emissions greater than 100 tpy in the inventory area. County populations came from the Texas Comptroller of Public Accounts (TCPA, 2001). The ozone seasonal adjustment factor is 1 and the activity days per week are 5 (EIIP, 1996). Since the factor is for only small sources (including office and home printers), it was determined that printing occurs in all counties.

TNRCC staff provided emission control information for this source category. As indicated by TNRCC staff, the only graphic arts area source emissions affected by the three printing processes regulated by TNRCC are those associated with offset lithographic printing (the other two processes, flexographic and rotogravure printing, are assumed only to affect point sources). In addition, the only area sources affected by the offset lithographic printing regulations are located in El Paso county (Mack, 2001). For El Paso County, it was necessary to estimate RP representing the proportion of total graphic arts emissions from offset lithographic printing. Based on information from the EIIP document for Graphic Arts, which indicated that approximately 35 percent of national total printing ink solvents are used in offset lithography, a 35 percent RP was assumed along with the 66 percent control efficiency estimate provided by TNRCC (EIIP, 1996 and Mack, 2001).

Sample Calculations

VOC calculation for Anderson County
Anderson County 1999 Population = 52,090
(52,090 people) * (1.3 lb VOC/person) / (2000 lb/ton) = 33.8585 tons VOC per year
(33.8585 tpy VOC) *(1) / [(5 days/week) * (52.143 weeks/year)] = 0.1299 tons VOC per ozone season day

Uncertainties/Future Research

It is understood that the TNRCC has an existing contract to further estimate emissions for the graphic arts category by other methodology. Ideas for future research should be developed after comparison with the estimates of our study and the estimates of the other study. The results of the other study were not available at this time.

2.10 ASPHALT (CUTBACK AND EMULSIFIED)

Description of Source Category

Cutback asphalt and emulsified asphalt are two of the types of asphalt that are used for road paving and repair. Cutback asphalt emissions are reported under SCC 2461021000. Emulsified asphalt emissions are reported under SCC 2461022000.

Cutback asphalt is a type of liquefied road surface that is prepared by blending or cutting back asphalt cement with various kinds of petroleum distillates. It is used as pavement sealant, tack coat, and a bonding agent between layers of paving material. Cutback asphalt is divided into several grades (e.g., Rapid Cure, Medium Cure, and Slow Cure). The different grades have a range of distillate from 5% to 40%. The emissions were calculated based on the amount purchased of these grades and the solvent content of the respective grades.

Emulsified asphalt is used in the same applications as cutback asphalt. However, instead of blending asphalt cement with petroleum distillates as in cutback asphalt, emulsified asphalt uses a blend of water with an emulsifier, which is generically referred to as soap.

Methodology

For asphalt paving, the preferred EIIP methodology is to conduct a comprehensive survey of all state and local department of transportation agencies to obtain activity data on asphalt use. Alternative methods allow abbreviated surveys of state and local department of transportation agencies with assumptions from AP-42 for emission factors. The last alternative is the per capita emission factor approach with emissions based solely on population of each county. The preferred estimation methodology was used with a comprehensive survey of all state use of asphalt. Local DOT use was estimated as a percentage of state DOT use. Solvent loss was

based on the solvent content of each grade of asphalt. Solvent retention (unevaporated solvent) was based on TXDOT guidance. Allocation of emissions was based on lane miles of highway for each county.

Emission Factor and Activity Data

For 1999, emissions from cutback and emulsified asphalt used for road paving and repair were computed from asphalt data obtained from the Texas Department of Transportation (TXDOT, 2001). The TXDOT provided asphalt use data for state-maintained roads. The TXDOT estimates that 60 percent of total Texas cutback and emulsified asphalt is used on state-maintained roads, and 40 percent is used on city and county roads. As suggested by the asphalt paving EIIP document, potential spatial allocation surrogates for total asphalt paving activity are VMT, paved lane miles, total lane miles, highway spending, and population (EIIP, 2001). The TXDOT data only cover state-maintained roads. The estimates of county and city use were based on state-maintained asphalt data and their percentage of use estimate. Estimated emissions were allocated to counties based on TXDOT's city and county road lane miles data.

Texas has a regulation that limits the use of conventional cutback asphalt by any state, municipal, or county agency in Nueces county and in the BPA, DFW, EP, and HGA nonattainment areas (TNRCC, 1999). This regulation also restricts the VOC content of emulsified asphalt in these areas. With the exception of Nueces county, these same areas prohibit the application of cutback asphalt between April 16 and September 15 of any year (TNRCC, 1999). Certain counties were required to be in compliance with these regulations by December 1992, while others were required to be in compliance by April 16, 1993. TXDOT keeps use records for the nonattainment counties. This information was used to allocate cutback emissions to the nonattainment counties. All attainment counties were allocated emissions based on lane miles. All counties were allocated emissions of emulsified asphalt based on lane miles.

For cutback and emulsified asphalt emission estimates, CE and RP were set to 0%, and RE was set to 100% for all counties. For the counties where the state regulation prohibits the use of cutback asphalt during the summer months, OSD emissions were set to zero, and, therefore are not included in the 1999 emissions inventory for the counties.

Sample Calculations

The percent solvent per grade times pounds purchased per grade was summed to yield 18,907.2593 tons for total of all grades of cutback asphalt for the attainment counties. The different grades have a range of distillate from 5% to 40%. The emissions were calculated based on the amount purchased of these grades and the solvent content of the respective grades. For Anderson County, emissions from the use of cutback asphalt were estimated as follows: 18,907.2593 tons solvent statewide times 3,155.09 county lane miles divided by

510,878 state lane miles equals 116.7676 TPY. OSD emissions were calculated as follows: 0.66 times annual emissions 116.7676 TPY divided by 13 weeks divided by 7 days per week equals 0.8469 tons per day. For nonattainment area counties, there is county-specific data for cutback asphalt. Emulsified asphalt is distributed per the above example for all counties.

Uncertainties/Future Research

Asphalt emissions were calculated for emulsion and cutback use on a statewide basis. TXDOT estimates that 60% of use is on state roads. This information was factored into the estimates for total use. It is recommended that this estimate be independently verified through future studies.

2.11 AGRICULTURAL PESTICIDE APPLICATION

Introduction

Pesticides are substances used to control nuisance weeds (herbicides), insects (insecticides), fungi (fungicides), and rodents (rodenticides). Pesticides can be broken down into three chemical categories: synthetics, nonsynthetics (petroleum products), and inorganics. Formulations of pesticides are made through the combination of the pest-killing material referred to as the active ingredient, and various solvents (which act as carriers for the pest-killing material) referred to as the inert ingredient. Both types of ingredients contain VOCs that can potentially be emitted to the air either during application or as a result of evaporation. There are two sources of pesticide use, the agricultural pesticide application and non-agricultural (home) use. This source will cover only agricultural pesticide application. Non-agricultural (home) pesticide application is covered under consumer/commercial solvent use (SCC 2460800000). Application rates for a particular pesticide may vary from crop to crop and region to region. Pesticide application emissions will be reported under SCC 2461800000.

Methodology

The preferred method in the EIIP for estimating emissions from agricultural application of pesticides uses the vapor pressure of the active ingredient to determine the appropriate emission factor, the amount of pesticide applied to an area, and the percent of the active ingredient in the pesticide applied. This requires an extensive amount of survey data. Default values for pounds of pesticide applied per acre per year, fraction active ingredient in the pesticide, and pounds VOC per pound of active ingredient (as used in an example calculation in the EIIP) was used to calculate an emission factor of 3.5 lb VOC per harvested acre. An estimate of harvested acres of crops by county in 1999 was used as a surrogate for determining the number of acres to which pesticides were applied in 1999. There was neither time nor budget to obtain the survey data needed to apply the preferred EIIP method.

Emission Factor and Activity Data

An emission factor of 3.5 pounds per harvested acre was used to calculate VOC emissions from agricultural pesticide application. This factor was derived from assumptions that 41% of pesticide is active ingredient, there are 2.45 pounds VOC per pound of active ingredient and 3.5 pounds of pesticide are applied per year per acre (EIIP, 1997). The factor was applied to each county's calculated 1999 harvested acreage. Harvested acreage for 1999 is not available; therefore, the 1999 acreage was estimated using 1997 data available from the Census of Agriculture (USDA, 2001). Harvested acreage census data for some counties was withheld; therefore, size range data was used to estimate acreage for those counties. The midpoint of each size range was multiplied by the number of farms in that range. The sum of these size ranges was used as a first estimate. The state total was then compared to the total obtained by summing all counties without withheld data, and the number of withheld acres was determined. The first estimates were then scaled to equal the amount of withheld data. Once the 1997 harvested acreage was obtained, a growth factor, calculated by dividing the 1999 total state harvested acres by the 1997 total state harvested acres, was used to estimate 1999 harvested acres for each county. CE and RP were assumed to be 0%, and RE was set at 100%.

The OSD emissions were calculated using an SAF of 1.3 and with an activity days per week of 6 for 52.143 weeks per year (EPA, 1991).

Sample Calculation

VOC calculation for Anderson County for Agricultural Pesticide Emissions
Calculated harvested Acres for 1999 = 47,299.4 acres

(3.5 lb pesticide/acre)(.41 act. ing./lb pesticide)(2.45 lb VOC/lb act. ing.) = 3.5 lb VOC acre
(47,299.4 acres)(3.5 lb VOC/acre) / (2000lb/ton) = 82.7739 ton VOC per year
(82.7739 TPY)(1.3) / [(6 days/week) * (52.143 weeks/year)] = 0.3439 ton per VOC ozone season day

Uncertainties/Future Research

The VOC emitted from agricultural pesticide applications are from the inert ingredients (i.e., solvent carriers) and the volatile organic constituents of the active ingredients. These VOC are emitted during application and evaporate over time. There are several methods for estimating VOC emissions from agricultural application, depending of the data available and the information sought. To improve on the method, information needs to be gathered to calculate emissions, based on the pesticide applied, the formulation of the pesticide and the total amount applied.

2.12 CONSUMER AND COMMERCIAL PRODUCTS

Introduction

Consumer and commercial products include household products, toiletries, aerosol products, rubbing compounds, windshield washing fluids, polishes and waxes, nonindustrial adhesives, space deodorants, moth control products, and laundry detergents and treatments. Volatile organic compounds in these products may act either as the carriers for the active product ingredients or as the active ingredients themselves. The VOCs may be released to the atmosphere through immediate evaporation of an aerosol spray, evaporation after application, or direct release in the gaseous phase. The overall consumer and commercial products category is broken out into the subcategories shown in Table 2.12-1.

Methodology

The preferred method for estimating emissions in the EIIP document is to use per capita emission factors derived from national consumer and commercial products sales or shipments data (EPA, 1996). As described below, TNRCC developed a different set of per capita emission factors based on more recent (1997) survey data from CARB (TNRCC, 1999). These data are felt to better represent 1999 Texas emissions than those in the EIIP document, which are based on a 1990 EPA survey.

Emission Factors and Activity Data

TNRCC prepared per capita emission factors for the consumer and commercial products category as shown in Table 2.12-1 (TNRCC, 1999). These emission factors were derived from a 1997 CARB survey.

Table 2.12-1. Emission factors for consumer and commercial products.

Source Category (SCC)	Emission Factor (lb/person-yr)
Overall Consumer and Commercial Products (2460000000)	6.73
Personal care products (2460100000)	1.66
Household products (2460200000)	1.10
Automotive aftermarket products (2460400000)	0.71
Coatings and related products (2460500000)	1.87
Adhesives and sealants (2460600000)	0.28
FIFRA-Regulated products (2460800000)	0.51
Miscellaneous products (2460900000)	0.60

The per capita emission factors above were used with 1999 county population data from the Texas Comptrollers Office. The EIIP document states that there should not be significant variation in seasonal or weekly use (EPA, 1996). The only potentially significant adjustment factor would be for pesticide application (2460800000). The EIIP document for pesticides (EPA, 2001) indicates that data need to be collected in order to develop an SAF for this category (e.g., survey of commercial pesticide companies). Due to the lack of available data, no seasonal variation was assumed for pesticides or any other subcategory.

The activity rate for all subcategories, except pesticides, is 365 days per year. The activity rate selected for pesticides is 260.7 days/yr. The EIIP (EPA, 2001) indicates that commercial and municipal pesticide application occurs 5 or 6 days per week, while residential application occurs 7 days per week. The selected AR assumes that the majority of emissions are associated with commercial and municipal application and that the most common operating schedule is 5 days per week.

The emission factors in Table 2.12-1, incorporate the effects of regulatory programs that were in effect in 1999, including 30 TAC Section 115.612 and the Federal Rule. Therefore, control parameters CE and RP were set to 0%, and RE was set to 100%.

Sample Calculations

The following equation was used to calculate county-level annual area source VOC emissions:

$$E_{ia} = [(POP_{ia} \times EF \times 1/2000) - E_{ps}] \times [1-(CE \times RP \times RE)]$$

where:

E_{ia}	=	annual emissions for the inventory area (e.g., Harris County), TPY;
POP_{ia}	=	population within the inventory area (e.g., Harris County);
EF	=	product-specific emission factor (e.g., pesticides), lb/person-yr;
1/2000	=	conversion factor, ton/lb;
E_{ps}	=	annual uncontrolled emissions of point sources in the inventory area, TPY;
CE	=	control effectiveness (fraction) of applicable rules, unitless;
RP	=	rule penetration (fraction) of applicable rules, unitless; and
RE	=	rule effectiveness (fraction) of applicable rules, unitless.

For all consumer/commercial products subcategories, there are no point source emissions. For Harris County, annual area source emissions for nonagricultural pesticides (2460800000) were estimated as follows:

$$E_{ia} = \{[(3158309 \text{ people})(0.51 \text{ lb/person})(\text{ton}/2000 \text{ lbs})] - 0.0 \text{ TPY}\}\{1 - [(0.00)(0.00)(1.00)]\}$$

$$E_{ia} = 805.4 \text{ TPY}$$

To estimate ozone season daily emissions, the following equation was used:

$$E_{osd} = (E_{ia} \text{ x } SAF)/AR$$

where:

E_{osd}	=	ozone season day emissions, tons/day;
E_{ia}	=	annual area source emissions, TPY;
SAF	=	seasonal adjustment factor, unitless; and
AR	=	activity rate, days/yr.

Following from the example given above, the ozone season day emissions for nonagricultural pesticide usage emissions in Harris County would be estimated as follows:

$$E_{osd} = [(805.4 \text{ TPY})(1.000)]/(260.7 \text{ days/yr})$$

$$E_{osd} = 3.09 \text{ tons/day}$$

Uncertainties/Future Research

The largest source of uncertainty is in the use of California survey data to develop emission factors for Texas. While a survey of consumer and commercial products in Texas is something that could be performed to reduce the uncertainty, the value in performing such a survey is questionable. Most consumer and commercial product manufacturers ship their products nationally. Hence, the formulations (i.e., VOC content) of products are not likely to be substantially different. The question then remains of whether the California population consumes these products in substantially different quantities than the Texas population. Without some indication of whether this is an issue, there does not seem to be significant value in performing a survey for Texas. The team recommends that TNRCC remain aware of the continuing survey efforts of CARB for use in future inventory efforts.

2.13 GASOLINE SERVICE STATIONS

Description of Source Category

Motor gasoline is produced by domestic petroleum refineries or in some cases imported to the United States, and then transported through a distribution network to customers. The Gasoline Distribution category is divided into appropriate subcategories due to different emission factors necessary to calculate VOC emissions.

Tank Truck Unloading

Tank truck unloading refers to the transfer of fuel from the tank truck to the service station tank. VOC emissions are caused by displacement of gasoline vapors from storage tanks during the transfer of gasoline from tank trucks to storage tanks at the service station. Controls for this source category are referred to as Stage I controls. The TNRCC provided L_L factors for each county for the winter and summer months that took into account the gasoline Reid vapor pressure (RVP), true vapor pressure, molecular weight, and temperature of the gasoline (EPA, 1995; TNRCC, 2001a). The TNRCC also provided Control Efficiency (CE), Rule Penetration (RP), and Rule Effectiveness (RE) factors to be used in ozone nonattainment counties (TNRCC, 2001b). Tank truck unloading emissions are reported under SCC 2501060053.

Vehicle Refueling

VOC emissions from refueling result from the displacement of gasoline vapors from the vehicle fuel tank by dispensed gasoline. Controls for this source category are referred to as Stage II controls. The MOBILE6 model was used to calculate the emission factors and details of these calculations are given below. The CE, RP, and RE values were factored into the generation of the emission factors in ozone nonattainment counties. Vehicle refueling emissions are reported under SCC 2501060100.

Tank Breathing Losses

Tank breathing losses produce VOC from evaporation of gasoline in storage tanks and from the vapor in lines going to the pumps during transfer of gasoline. The vapor emissions are displaced from the tank when the tank temperature rises. Tank breathing loss emissions are reported under SCC 2501060201.

Tank Trucks in Transit

The emissions from this category are from evaporation of gasoline vapor (1) from loaded tank trucks during transportation of gasoline from the bulk plant/terminal to the service station or other dispensing outlet, and (2) from empty tank trucks returning from service stations to bulk plant/terminals. The TNRCC provided CE, RP, and RE factors to be used in ozone nonattainment counties (Mack, 2001). Tank trucks in transit emissions are reported under SCC 2505030120.

Spillage

Other losses are caused by spillage of gasoline during prefill and postfill nozzle drip, spitback, and overflow from the filler pipe of the vehicle's fuel tank during filling. The MOBILE6 model was used to calculate the emission factors. Spillage emissions are reported under SCC 2501060103.

Methodology

The preferred method in the EIIP for activity information is to collect data through a survey of fuel distributors and retailers to determine the gasoline consumption. The time and resource constraints associated with preparing this inventory precluded conducting a survey of the many distributers and retailers in Texas to obtain state-level and county-level activity data for each of the 254 Counties. Alternative Method 2 in the EIIP was used to calculate gasoline consumption in each county except that data from the Texas Comptroller of Public Accounts was used in place of data from *Highway Statistics*. There was neither time or budget to obtain the survey data needed to use the preferred method.

Emission Factors and Activity Data

The activity level needed to calculate emissions is 10^3 gallons of gasoline throughput (throughput was based on consumption). Gasoline consumption in Texas in 1999 was apportioned to each county based on the sales at service stations in each county to the State sum of County sales at service stations in Texas. The gasoline sales data came from the U.S. Bureau of the Census (BOC, 1999). Total gasoline consumption in the state and gasoline consumption by month came from the Texas Comptroller of Public Accounts' web site (TCPA, 2001).

For tank truck unloading, vehicle refueling, and spillage, the gasoline consumption in Texas for each month was apportioned to each county by month, based on the sales at service stations in each county to the State sum of County sales at service stations in Texas. The winter consumption for a county was calculated by adding the consumption during January, February, March, October, November, and December. The summer consumption for a county was calculated by adding the consumption during April, May, June, July, August, and September.

For tank breathing losses and tank trucks in transit, the gasoline consumption in the State, total for the year, was apportioned to each County by total for the year, based on the sales at service stations in each County to the total sales at service stations in the State.

The ozone season (June, July, August) gasoline consumption for each county was derived by taking the state gasoline consumption in June, July, and August and apportioning to each county based on the sales at service stations in each county to the State sum of County sales at service stations in the state.

The annual VOC emissions for tank breathing losses and tank trucks in transit were calculated by applying emission factors to the number of gallons of gasoline consumption for 1999 and corrected to tons/year. A gasoline transportation adjustment factor of 1.25 was applied to the tank trucks in transit calculation (EIIP, 1997). The ozone nonattainment counties for tank trucks in transit were corrected to controlled area emissions by multiplying emissions by [1-((CE)(RP)(RE))] (this equals 0.19250).

Where:

CE = 95%
RP = 100%
RE = 85%

As stated earlier these numbers were supplied by the TNRCC.

The emission factors used are as follows:

Tank Breathing Losses	1.0 lb/1,000 gal. (EIIP, 1997)
Tank Trucks in Transit	0.06 lb/ 1,000 gal. (EIIP, 1997)

The annual VOC emissions from tank truck unloading were calculated by applying the TNRCC supplied L_L factor for winter and summer for each county to the winter and summer gasoline consumption calculated for each county and corrected to ton/yr. The sum of the winter and summer emissions for a county was the total VOC emissions for the year for that county. The ozone nonattainment counties were corrected to controlled area emissions by multiplying emissions by [1-((CE)(RP)(RE))] (this equals 0.13564).

Where:

CE = 98%
RP = 98%
RE = 90%

As stated earlier these numbers were supplied by the TNRCC.

The annual VOC emissions from vehicle refueling and spillage were calculated by applying the MOBILE6 emission factor for winter and summer for each county to the winter and summer gasoline consumption calculated for each county and corrected to tons/year. The sum of the winter and summer emissions for a county was the total VOC emissions for the year for that county.

Methodology for Vehicle Refueling and Spillage

The following discusses the approach to estimating fleet-average g/gal refueling emission factors (separately for displacement and spillage) for each county in Texas for each calendar year (1990-2010) and season (winter and summer). In an effort to simplify the refueling emissions modeling process, the primary factors affecting refueling emissions were examined. Since refueling emission factors are most strongly influenced by ambient temperature, RVP, and refueling vapor controls, the state was partitioned into regions, in each of which are counties with similar seasonal temperatures, RVPs, and controls. These regions were determined by overlapping the regions TNRCC staff has determined to have similar climate (see temperature discussion elsewhere for details) with a demarcation scheme which delineates

counties with similar historic and future RVPs and Stage II vapor control status. Figure 2.13-1 indicates the result of overlapping the temperature and RVP/control regions.

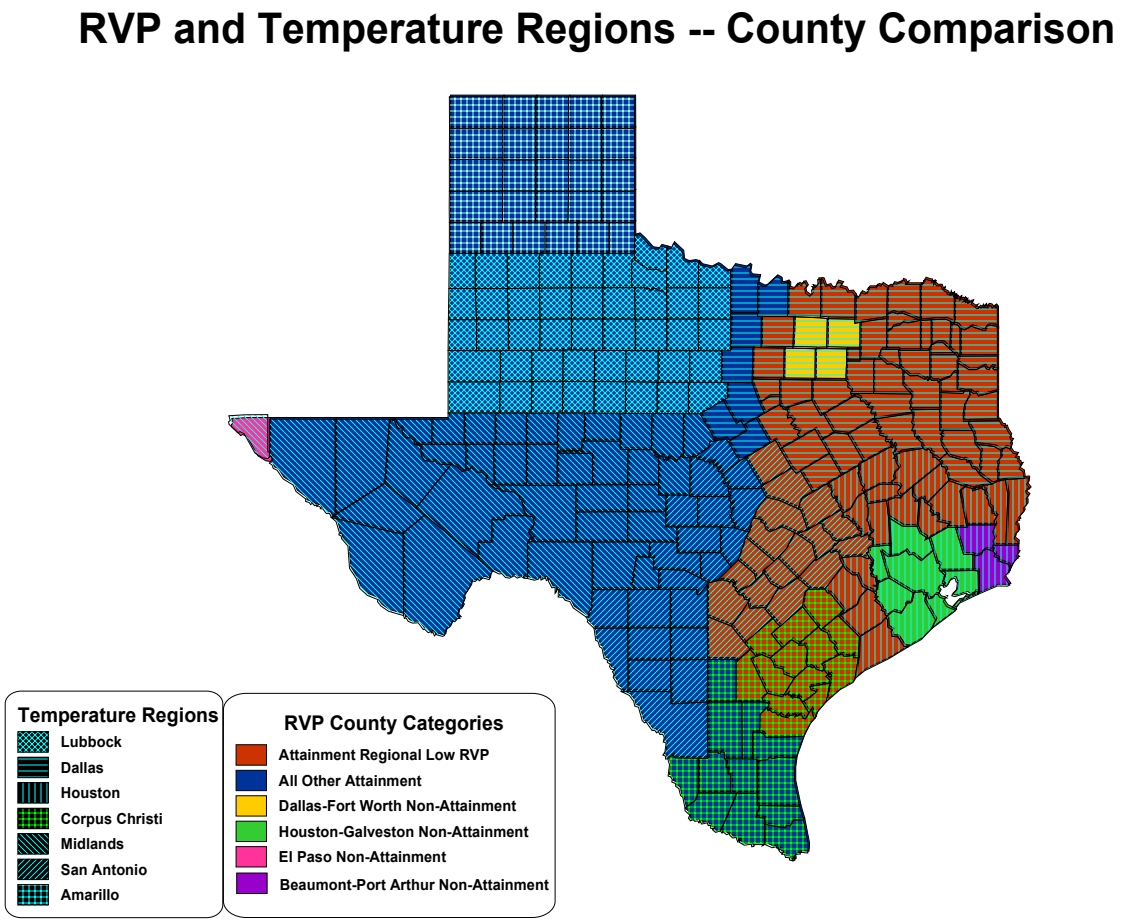


Figure 2.13-1. County groups within which the same temperature and RVP can be assumed.

According to the temperature and RVP overlapping areas illustrated above, the following 14 combinations of categories arose:

Temperature Region	RVP County Category
Amarillo	All Other Attainment
Lubbock	All Other Attainment
Midlands	All Other Attainment
Midlands	El Paso Non-Attainment
Corpus Christi	All Other Attainment
Corpus Christi	Attainment Regional Low RVP
San Antonio	All Other Attainment
San Antonio	Attainment Regional Low RVP
Houston	Attainment Regional Low RVP
Houston	Houston-Galveston Non-Attainment
Houston	Beaumont-Port Arthur Non-Attainment
Dallas	All Other Attainment
Dallas	Attainment Regional Low RVP
Dallas	Dallas-Fort Worth Non-Attainment

To further simplify the 14 above combinations, the actual temperature and RVP values were consulted (see applicable sections). The results allowed further groupings, which included:

- Lumping Amarillo and Lubbock all other attainment combinations because temperatures within the Lubbock and Amarillo regions are significantly close to each other
- Lumping Corpus Christi and San Antonio all other attainment combinations because temperatures within the Corpus Christi and San Antonio regions are significantly close to each other
- Lumping Corpus Christi and San Antonio regional low RVP combinations because temperatures within the Corpus Christi and San Antonio regions are significantly close to each other
- Lumping Midlands and Dallas all other attainment combinations because temperatures within the Midlands and Dallas regions are significantly close to each other
- Lumping Houston and Dallas regional low RVP combinations because temperatures within the Houston and Dallas regions are significantly close to each other
- Lumping Houston and Dallas Houston-Galveston non-attainment and Dallas-Fort Worth non-attainment combinations because RVP values within the HGA and DFW non-attainment areas are significantly close to each other

Therefore, the 14 initial combinations of temperature and RVP regions were reduced to 8 final combinations. For each final combination listed below, a representative county was chosen. A detailed listed of counties within each refueling category is provided in Appendix 2-A.

Refueling Category		Representative County
Temperature Region	**RVP County Category**	
Amarillo & Lubbock	All Other Attainment	Floyd
Midlands & Dallas	All Other Attainment	Brown
Midlands	El Paso Non-Attainment	El Paso
Corpus Christi & San Antonio	All Other Attainment	De Witt
Corpus Christi & San Antonio	Attainment Regional Low RVP	Webb
Houston & Dallas	Attainment Regional Low RVP	Angelina
Houston	Beaumont-Port Arthur Non-Attainment	Orange
Dallas & Houston	Dallas-Fort Worth & Houston-Galveston Non-Attainment	Dallas

The counties representing each of the eight final refueling categories are illustrated in Figure 2.13-2.

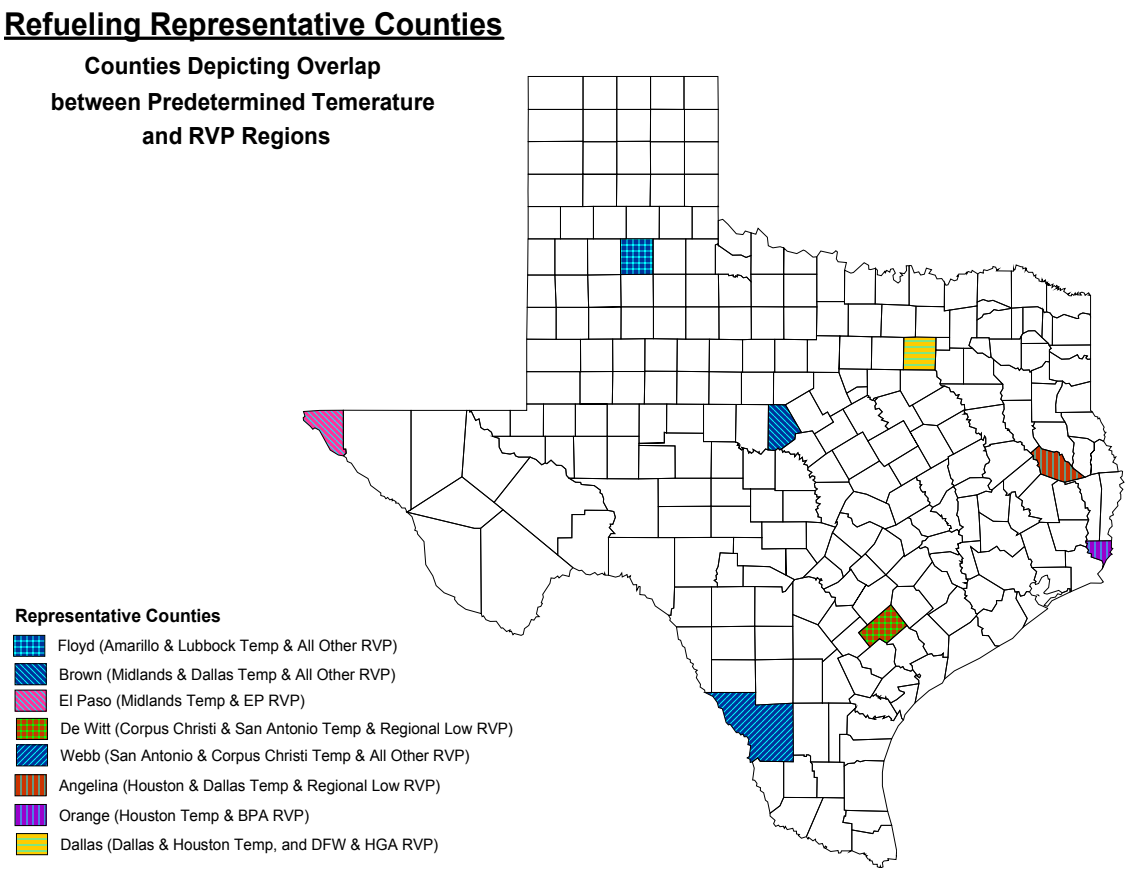


Figure 2.13-2. Counties chosen to represent each final refueling category (shown above) in draft MOBILE6 modeling.

A summary of the representative counties associated temperatures and RVP history is shown in Table 2.13-1.

Table 2.13-1. Summary of temperature and RVP values assumed for each refueling category/representative county.

Representative County	Temperature					
	Summer			Winter		
	June	July	Aug	Dec	Jan	Feb
Floyd	74.85	80.25	81.28	41.55	42.68	49.73
Brown	79.68	81.98	84.63	48.45	50.13	56.28
El Paso	79.75	81.05	82.95	47.50	50.35	56.40
De Witt	83.36	83.71	86.11	56.98	59.33	65.32
Webb	83.36	83.71	86.11	56.98	59.33	65.32
Angelina	80.28	82.78	86.10	51.50	52.83	58.43
Orange	80.97	82.67	85.90	53.60	55.77	60.70
Dallas	80.28	82.78	86.10	51.50	52.83	58.43

Representative County	RVP			
	Historic Summer	Future Summer	Historic Winter	Future Winter
Floyd	9	8.7	11.9	11.5
Brown	9	8.7	11.9	11.5
El Paso	6.5 - 7.8	7	10.4 - 12.3	11.5
De Witt	9	8.7	11.9	11.5
Webb	9	7.8	11.9	11.5
Angelina	9	7.8	11.9	11.5
Orange	9.0 (1990-91); 7.8 (1992-99)	7.8	11.5 - 12.7	11.5
Dallas	7.0 - 8.2	6.8	11.3 - 12.3	11.5

Stage II refueling control occurs at the pump. It consists of a means (usually a vacuum source) to capture vapor displaced as liquid fuel is pumped into the tank. Stage II control was implemented in Texas starting in late 1992 and all affected stations must be in compliance by late 1994. The affected counties include Brazoria, Fort Bend, Galveston, Harris, Liberty, Montgomery, Waller, Hardin, Jefferson, Orange, El Paso, Collin, Dallas, Denton, and Tarrant.

Aside from the parameters already listed, on-board refueling vapor recovery (ORVR) systems also have a significant effect on the emission factors. For light duty vehicles, this technology was phased in at 40, 80, and 100% starting with model year 1998 and completed with the 2000 models. For light duty trucks (<6000 lbs), the phase-in would be during the 2001-2003 model years, using the same percentages. For light duty trucks greater than 6000 lbs, the model years affected are 2004 through 2006, following the same percentages. These controls affect both displacement and spillage emissions and are included within the MOBILE6 model, the main tool used in this analysis.

Emission Factors and Activity Data for Vehicle Refueling and Spillage

The following is a detailed list of the steps taken to obtain spillage and displacement emission factors:

1. Run MOBILE6 with refueling 'on', evaporative emissions expanded, and all gasoline vehicle classes expanded to obtain both descriptive and data base outputs. The data base outputs were set to include the total (displacement plus spillage) emission factor (EF) (g/mi), fuel economy (mi/gal), daily VMT per vehicle (mi), and registration distribution fraction for each model year within each vehicle class.

2. Convert the g/mi emission factors to a g/gal basis by multiplying the former by the corresponding fuel economy.

3. Estimate the travel fraction (TF) for each model year within a vehicle class as the product of that model year's per vehicle VMT and registration distribution fraction divided by the sum of all such products within the vehicle class.

4. Separate out the spillage and displacement portions. Spillage is 0.31 g/gal for all vehicles without ORVR, 0.155 g/gal for those with ORVR. Phase-in fractions are used to determine the spillage EF for model years which experience phase-in. The displacement EFs are calculated as the total which MOBILE6 outputs minus the spillage.

5. Combine the model year-specific g/gal EFs within each vehicle class. The fraction of the (vehicle class') total fuel consumed attributed to each model year served as the weighting factor. These fractions were estimated by dividing each model year's TF by the corresponding fuel economy, summing the results, and then dividing each model year's result by the sum.

6. Combine the vehicle class-specific g/gal EFs. The fraction of total fuel consumed attributed to each vehicle class served as the weighting factor. These fractions were estimated by dividing the vehicle class' VMT mix fraction by the corresponding average fuel economy, summing these dividends across all vehicle classes, and then dividing the individual vehicle class' dividend by the sum. The average fuel economy for each vehicle class was estimated as the total mileage traveled (sum of TFs=1) divided by the total fuel consumed (model year-specific TF divided by corresponding fuel economy and then dividends summed across all model years.) VMT mix fractions for each of the gasoline vehicle classes were obtained by converting mixes from TTI MOBILE5 input files to MOBILE6 using EPA-recommended algorithms and using these in the MOBILE6 modeling. Thus, the VMT mixes used were "local".

Appendix 2-B contains the final refueling emission factors.

For tank breathing losses, vehicle refueling, and spillage CE and RP were assumed to be 0%, and RE was set at 100%.

The ozone season emissions for each county for tank breathing losses and tank trucks in transit were calculated by using the appropriate emission factor and multiplying by the gasoline consumption for each county during the ozone season and dividing by 92 days and corrected to tons/day. The ozone nonattainment counties for the category of tank trucks in transit were corrected to controlled area emissions by multiplying emissions by 0.19250.

The ozone season emissions for each county for vehicle refueling and spillage were calculated by applying the MOBILE6 county-level summer emission factor and multiplying by the gasoline consumption for each county during the ozone season and dividing by 92 days and corrected to tons/day.

The ozone season emissions for each county for tank truck unloading were calculated by using the county summer L_L factor and multiplying by the gasoline consumption for each county during the ozone season and dividing by 92 days and corrected to tons/day. The ozone nonattainment Counties were corrected to controlled area emissions by multiplying emissions by 0.13564.

Sample Calculation

<u>Calculation for Anderson County Tank Truck Unloading</u>

Gas station sales in county = $33,429,000
Gas station sales in state = $15,376,471,000
Total Gasoline consumed in state = 10,349.3 * 10^6 gal/yr
Gasoline consumed in state winter = 5,122.7 * 10^6 gal
Gasoline consumed in state summer = 5,226.6 * 10^6 gal
Gasoline consumed in state ozone season = 2,657.6 * 10^6 gal

L_L factor winter = 11.47836 lb VOC/10^3 gal
L_L factor summer = 8.83515 lb VOC/10^3 gal

($33,429,000)/($15,376,471,000) * (5,122.7 * 10^6 gal) * (1000/10^3) = 11,136.934 * 10^3 gal winter
($33,429,000)/($15,376,471,000) * (5,226.6 * 10^6 gal) * (1000/10^3) = 11,362.816 * 10^3 gal summer
($33,429,000)/($15,376,471,000) * (2,657.6 * 10^6 gal) * (1000/10^3) / (92 days) = 62.801 * 10^3 gal ozone season day

[(11,136.934 * 10^3 gal winter) * (11.47836 lb/10^3 gal) / (2000 lb/ton)] + [(11,362.816 * 10^3 gal summer) * (8.83515 lb/10^3 gal) / (2000 lb/ton)] = 114.1131 tons VOC per year

(62.801 * 10^3 gal ozone season day) * (8.83515 lb/10^3 gal) / (2000 lb/ton) = 0.2774 tons VOC per ozone season day

<u>Corrected to controlled area emission calculations for Brazoria County Tank Truck Unloading</u>

Uncontrolled annual emissions = 599.6638 ton VOC per year
Uncontrolled ozone season daily emissions = 1.3639 ton VOC per ozone season day

(599.6638 ton/yr VOC uncontrolled) * (0.13564) = 81.3384 ton VOC per year controlled
(1.3639 ton/day VOC uncontrolled) * (0.13564) = 0.1850 ton VOC per ozone season day

<u>Calculation for Anderson County Vehicle Refueling</u>

Emission factor winter = 8.74595 lb VOC/10^3 gal
Emission factor summer = 9.48717 lb VOC/10^3 gal

[(11,136.934 * 10^3 gal winter) * (8.74595 lb/10^3 gal) / (2000 lb/ton)] + [(11,362.816 * 10^3 gal summer) * (9.48717 lb/10^3 gal) / (2000 lb/ton)] = 102.6020 tons VOC per year

(62.801 * 10^3 gal ozone season day) * (9.48717 lb/10^3 gal) / (2000 lb/ton) =0.2979 tons VOC per ozone season day

<u>Calculation for Anderson County Tank Breathing Losses</u>

($33,429,000/$15,376,471,000) * (10,349.3 *10^6 gal) * (1000/10^3) = 22,499.750 *10^3 gal per year
(22,499.750 * 10^3 gal/yr) * (1 lb VOC/10^3 gal) / (2000 lb/ton) = 11.2499 ton per year

(62.801 * 10^3 gal/ oz season day) * (1 lb VOC/10^3 gal) / (2000 lb/ton) = 0.0314 ton per ozone season day

Calculation for Anderson County Tank Trucks in Transit

(22,499.750 * 10^3 gal/yr) * (0.06 lb VOC/10^3 gal) * (1.25) / (2000 lb/ton) = 0.8437 tons VOC per year

(62.801 * 10^3 gal/ozone season day) * (0.06 lb VOC /10^3 gal) * (1.25) / (2000 lb/ton) = 0.0024 tons VOC per ozone season day

Calculation for Anderson County Spillage

Emission factor winter = 0.67476 lb VOC/10^3 gal
Emission factor summer = 0.67308 lb VOC/10^3 gal

[(11,136.934 * 10^3 gal winter) * (0.67476 lb/10^3 gal) / (2000 lb/ton)] + [(11,362.816 * 10^3 gal summer) * (0.67308 lb/10^3 gal) / (2000 lb/ton)] = 7.5814 tons VOC per year

(62.801 * 10^3 gal ozone season day) * (0.67308 lb/10^3 gal) / (2000 lb/ton) =0.0211 tons VOC per ozone season day

Uncertainties/Future Research

To arrive at gasoline consumption in a county, convenience store gas station sales were used. The problem with using gas station sales is that gas station sales include other items sold beside gasoline. Studies need to be made which separate gasoline from other sales data or which use an other surrogate to determine gasoline consumption by county. For example the wholesale distribution data from gasoline terminals may provide a better more regional consumption pattern.

2.14 OPEN BURNING

Description of Source Category

As described in the EIIP, "open burning is the purposeful burning of materials in outdoor areas such as forests and yards" (EPA, 2001). For the 1999 NEI (Version 1.5), EPA prepared county-level emission estimates for the following open burning categories:

SCC	SCC Name
2610030000	Residential municipal solid waste (MSW) burning
2610000100	Residential leaf burning
2610000400	Residential brush burning
2610000500	Land clearing debris burning

Residential municipal solid waste (MSW) refers to refuse produced by households (e.g., paper, metals, glass, leather, textiles, and food wastes). Since the state promulgated an outdoor burning regulation (30 TAC, Chapter 111.219), the following materials are prohibited from being burned: electrical insulation, treated lumber, plastics, non-wood construction/demolition materials, heavy oils, asphaltic materials, potentially explosive materials, chemical wastes, and items containing natural or synthetic rubber (TNRCC, 1996). Residential yard waste refers to materials such as leaves, trimmings from trees and shrubs, and grass. Land clearing debris refers to the clearing of land for new construction and the burning of organic material (i.e., trees, shrubs and other vegetation). The SCCs for residential brush burning and land clearing debris burning are new SCCs. Previous years' estimates for open burning were reported under SCC 2610000000 (total for all open burning categories), SCC 2610010000 (industrial open burning), and SCC 2610020000 (commercial/institutional open burning). In the 1999 NEI (Version 1.5), these SCCs were removed and the 1999 emissions were reported on the SCCs listed above to avoid double-counting of emissions.

In September of 1996, the Texas adopted Administrative Code (TAC) Rule 111.201, which specifies general prohibition of outdoor burning, as provided by the rule, "no person may cause suffer, allow, or permit any outdoor burning within the State of Texas." However, there are exceptions made for disposal in TAC 111.209. The exceptions include provisions for domestic waste and land clearing debris. Burning of domestic waste is allowed "when collection of domestic waste is not provided or authorized by the local governmental entity having jurisdiction, and when the waste is generated only from that property" (TAC, 1996). Burning of land clearing debris can occur "when no practical alternative to burning exists and when the materials are generated only from that property." Additionally, burning must be "outside the corporate limits of a city or town except where the incorporated city or town has enacted ordinances which permit burning" (TAC, 1996).

Methodology

As described in the EIIP document, the preferred method for estimating emissions for the open burning categories is to collect specific, local information on the amount of materials (i.e. fuel) in each category that was open burned (EPA, 2001). For instance, the preferred approach for calculating emissions for the open burning of MSW is "to collect estimates of open burning of MSW, in weight units" (EPA, 2001). The time and resources required to conduct a survey necessary to follow the preferred method were not available. Instead, a limited telephone survey was conducted of Texas NAA county officials. These survey results, described in "Summary of Research on Open Burning of Residential Municipal Solid Waste (MSW), Yard Waste, and Land Clearing Debris for Texas," allowed for the improvement of the alternative EIIP methods for estimating open burning emissions (Pechan, 2001). These methods are detailed below.

Emission Factors and Activity Data

Emission Factors

The EIIP provides emission factors to apply to each of the categories once the tons of fuel burned have been obtained (EPA, 2001). These factors are shown below in Table 2.14-1 with the original source listed as well. The residential MSW VOC emission factor (8.556 lb/ton) has the acetone emissions removed (1.88 lb/ton), as described in the EIIP document to produce the value reported in Table 2.14-1 (6.676 lb/ton). Although the majority of these factors are in units of (pounds of emission) per (ton of waste subject to burning), the MSW factors for both VOC and particulate emissions are based on the tons of waste that actually burned (including non-combustibles and combustibles that did not burn). For those three emission estimates, the total mass of waste subject to burning was adjusted by 50% to account for the amount of waste that actually burned (for a non-recycler's waste as described by EPA, 1997).

Table 2.14-1. Criteria pollutant emission factors for open burning (lb/ton).

SCC	Description	VOC	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	Source
2610030000	Residential MSW	6.676[1]	6	85	1	38[1]	34.8[1]	EPA, 1995 & 1997
2610000100	Yard waste - leaves	28	NA	112	NA	38	38	EPA, 1995
2610000400	Yard waste - brush	19	NA	140	NA	17	17	EPA, 1995
2610000500	Land clearing debris	11.6	NA	169	NA	17	17	Ward, 1989

[1]EPA, 1997: these factors are in lb/ton of MSW actually burned; residential MSW VOC has acetone removed.
NA = Not available

The emission factors for land clearing debris are averages of the factors from the two types of material burned as listed in the EIIP from *Mitigation of Prescribed Fire Atmospheric Pollution Through Increased Utilization of Hardwoods, Piled Residues, and Long-Needled Conifers* (Ward, 1989). Additionally, particulate emissions were considered equal for categories in which two unique values were not given.

Activity Data

Residential MSW Burning

In the EIIP, the first alternative method for estimating MSW burning emissions assumes that the amount of open burned waste can be estimated from the total amount of waste generated (EPA, 2001). Previous uses of this method have relied solely on the EPA's *Characterization of Municipal Solid Waste* to produce a per capita waste generation factor that can then be applied to the population of interest. An example of this approach can be viewed in the EIIP (EPA, 2001).

As a result of contacts made during the survey, the ENVIRON team received a characterization of 1999 Texas landfill waste from the TNRCC Waste Planning Team, as well as totals for the recycling of waste, the export of waste, and the incineration of waste (WPT, 2001). By utilizing this information, along with the EPA's *Characterization of Municipal Solid Waste in the United States 1999 Update* (EPA, 2000), a Texas per capita waste generation factor of 3.24 lbs/person/day was produced (Pechan, 2001).

The Texas per capita waste generation factor was applied to each county population and multiplied by 365 days per year to generate total pounds of MSW generated in a year. A value of 28% was applied to each total pounds of MSW generated value to represent the amount of waste that was subject to burning. The 28% is the median value of the estimated percentages of municipal waste generated that is burned for rural populations from *Emissions Characteristics of Burn Barrels* (TRRC, 1994). Since this was the only value available, it was applied to the entire county population (urban and rural), realizing that the CE, RE, and RP values would account for the fact that most urban populations do not open burn MSW.

Once the total waste subject to burning in each county was calculated, the emission factors were applied. As mentioned previously, the total waste subject to burning had to be adjusted by 50% for both VOC and particulate emissions to account for the waste that actually burned (EPA, 1997). The result is emission estimates for both urban and rural populations within each county. This improves upon the procedure used in the EPA's 1999 NEI, which assumed that no open burning occurred in urban areas or in counties with urban populations greater than 80%. Survey results allowed for this improvement.

The Texas open burning rule specifies that open burning generally cannot take place inside the corporate limits of a city or town (TAC, 1996). Survey results also indicated that there were differences in the RP and RE values for rural and urban areas (Pechan, 2001). When available, county-specific RP and RE values generated from the survey were used. The average values of the respondents (rural or urban) were used when specific information was not available. Overall RP and RE values were produced for each county by weighting the urban and rural RP and RE values by the percentage of the county that was urban or rural as reported in the 1990 Bureau of the Census data.

Seasonal allocation was assumed to be uniform, as data could not be identified to decisively prove that open burning was not practiced equally throughout the year. Control efficiency is assumed to be 100%, since there is a general ban on open burning in Texas. Finally, an activity rate of 365.001 days per year was assumed because no evidence was found to suggest that the open burning of residential MSW does not occur evenly throughout the week.

Residential Yard Waste Burning

Similar to the EIIP's first alternative method for residential MSW burning, the third alternative method for the estimation of residential yard waste burning emissions is based on a local yard waste generation rate (EPA, 2001). A Texas-specific yard waste generation factor could not be prepared because enough information to calculate one was not identified (e.g.,

although estimates on the amount of yard waste sent to landfills was available, these estimates are only a fraction of the total yard waste generated). Therefore, the last available reported value of 0.57 lb yard waste/person/day was used (EPA, 1999).

The generation factor was then applied to the 1999 county populations to determine the total amount of yard waste generated per county. After deriving the total weight of generation, a further adjustment was made for variations in vegetation within counties. The percentage of forested acres, without agricultural land acreage, was obtained from Version 2 of the Biogenic Emissions Landcover Database (BELD2) within EPA's Biogenic Emission Inventory System (BEIS). The following ranges were then used to adjust the amount of yard waste that is assumed to be generated per county:

Percent forested acres per county	Adjustment for yard waste generated
< 10%	Zero out
>=10%, and <50%	Multiply by 50%
>=50%	Assume 100%

Since yard waste burning is separated into two SCCs for the burning of leaves and brush respectively, the “ballpark” composition of 50% grass, 25% brush, and 25% leaves was used for SCC allocation (EPA, 1996). Possible grass burning emissions are not reported because it is assumed that grass is not burned.

To calculate the amount of waste that was subject to burning, the 28% value used for MSW was also employed for the yard waste calculation. By applying the emission factors to the amount of yard waste burned, the annual emissions were calculated.

Seasonal allocation was assumed to be uniform, as data could not be identified to show that open burning was not practiced equally throughout the year. Control efficiency is assumed to be 100%, since there is a general ban on open burning in Texas. The same weighted RE and RP values from the open burning of MSW were used for the open burning of yard waste. Finally, an activity rate of 365.001 days per year was assumed because no evidence was found to suggest that the open burning of residential yard waste does not occur evenly throughout the week.

Land Clearing Debris Burning

The EIIP’s first alternative approach to estimating land clearing emissions begins by estimating the amount of land cleared in the inventory area and then applying the amount of debris generated for a typical acre of cleared land (fuel loading factor) (EPA, 2001). The EIIP also specifies that “in the absence of reliable estimates, assume that all of the debris in an area that is cleared is burned.”

To estimate the acres cleared, three distinct types of land clearing were analyzed: residential construction, nonresidential construction, and road construction. Due to dissimilarities in the available data, different procedures were followed to estimate total acres disturbed for each type of land clearing.

For residential construction, state-level data from the TCPA provided 1999 housing starts totals for single-family units and multi-family units (TCPA, 2001). F.W. Dodge data provided county-level numbers of apartment units, one-family units, and two-family units (TNRCC, 2001). From the Dodge data, the percentage of apartment units and two family units out of the total number of multi-family units was calculated for 1999. These percentages were applied to the TCPA multi-family starts information to derive the total apartment and two-family housing starts in the state. The total number of state acres disturbed were estimated from these housing unit figures using the conversion factors shown in Table 2.14-2. Because the number of units is not equivalent to the number of buildings for two-family and apartment buildings, a second set of conversion factors were applied for these building types. For two-family buildings, the number of buildings were computed by dividing the number of housing units by two. For apartment buildings, the number of housing units were divided by 13.8, which represents the number of housing units per building in Texas for residential structures of 3 or more units in 1999. This factor was computed from 1999 Texas housing units data reported by the Bureau of the Census (BOC, 2001. U.S. Department of Commerce, Bureau of the Census, "New Residential Construction, Building Permits, C40 Residential Housing Units by State," downloaded from http://www.census.gov/const/www/C40/table2.html, Washington, DC. 2001). The F.W. Dodge county-level housing starts data for 1999 were then used to allocate the state acreage disturbed estimates to each county. The resulting acreage estimates were used to calculate residential construction land clearing emissions.

Table 2.14-2. Residential construction building to acres conversion factors.

Type of Building	Acres Disturbed per Building
Single-family	1/4
Two-family	1/3
Apartment	1/2

The county-level dollar value of different categories of nonresidential construction was provided by the F.W. Dodge data (TNRCC, 2001). By summing the different categories of nonresidential construction within each county, the total funds spent on nonresidential construction for that county were calculated. Acres disturbed were derived using the conversion value of 2 acres/$\$10^6$ in 1992 dollars from the Price and Cost Indices for Construction. The 1992 dollars value was used because it is also the basis for the F.W. Dodge information.

To estimate land clearing due to road construction in 1999, the ENVIRON team contacted the Texas Department of Transportation, which provided Texas lane miles of both new location and added-capacity road construction (TXDOT, 2001). The information provided was at a county and functional class level. Miles to acres conversion factors used in the 1999 NEI were mapped to the appropriate Texas functional class categories as shown in Table 2.14-3. By applying the conversion factors to the associated miles of road construction in each county, acres disturbed were calculated.

Table 2.14-3. Road construction miles to acres conversion factors.

Texas DOT Road Classifications	FHWA Road Classifications	Conversion Factor
1 - Interstate; 2 – Other urban freeway or expressway	Interstate, urban and rural; other arterial, urban	15.2 acres/mile
3 - Rural Principal Arterial; urban connecting links of rural arterials; other urban principal arterials; 4 – Minor arterial road or street	Other arterial, rural	12.7 acres/mile
5 – Rural major collector or Urban collector street	Collectors, urban	9.8 acres/mile
6 – Rural minor collectors; 7 – Local road or street	Collectors, rural	7.9 acres/mile

To calculate the emissions for the open burning of land clearing debris, a fuel loading factor (tons/acre) was applied to convert the total acres disturbed (residential + nonresidential + road) in a given county to tons of fuel. The fuel loading at any given location varies depending on the predominant vegetation in the area being cleared. Ideally, one would account for where within the county the land clearing is actually occurring, and what type of vegetation is being cleared. In the absence of these data, the BELD2 database in BEIS was used to determine the number of acres of hardwoods, softwoods, and grasses in each county. The average loading factors described in the EIIP are shown below in Table 2.14-4 (Ward, 1989). Slash hardwood and slash softwood were adjusted by a factor of 1.5 to account for the mass of tree that is below the soil surface that would also be subject to burning once the land is cleared. Those average loading factors were weighted according to the percent contribution of each type of vegetation class to the total land area for each county to calculate county-specific fuel loading factors.

Table 2.14-4. Average fuel loading factors.

Fuel type	Fuel loading (tons/acre)[1]
Hardwood	99
Softwood	57[2]
Grass	4.5

[1]Original values for hardwood and softwood slash were adjusted by a factor of 1.5 to account for the mass of tree that is below the soil surface.
[2]This value represents the average of a loading factor value reported for long-needle pine slash (21 tons/acre) and mixed conifer slash (54 tons/acre), multiplied by 1.5.

By applying the fuel loading factors to the total acres disturbed, the total amount of land clearing debris (fuel) generated was calculated. As a result of the telephone survey that the ENVIRON team conducted, it was assumed that, for only 58% of all acres cleared, open burning was used to dispose of the debris (Pechan, 2001). The value of 0.58 was applied to the fuel generation to calculate the amount of fuel that was subject to burning. Additionally, it was assumed that all debris subject to burning did burn. Emissions were then calculated by multiplying the amount of fuel actually burned by the appropriate emission factor.

Seasonal allocation of the open burning of land clearing debris was assumed to be uniform. As a result of the stipulation within the TAC code that allows for the burning of land clearing debris, "when no practical alternative to burning exists and when the materials are generated only from that property," the values for CE, RP, and RE will be dependent on a case-by-case interpretation and implementation of the statewide rule, as well as local ordinances (TAC, 1996). Enough information was not obtained to allow for this distinction. Therefore, the default values for CE, RP, and RE of 0, 0, and 100%, respectively, were used for the open burning of land clearing debris. Finally, an activity rate of 365.001 days per year was assumed because no evidence was found to suggest that the open burning of land clearing debris does not occur evenly throughout the week.

Sample Calculations

Residential MSW

The following equation was used to calculate county-level annual area source emissions for criteria pollutants from the open burning of residential MSW:

$$E_{ia} = POP_{ia} \cdot WGF \cdot \frac{365.001\ days}{year} \cdot F_{SB} \cdot \left(F_{AB}\right) \cdot \frac{1\ ton}{2000\ lb} \cdot EF_p \cdot \frac{1\ ton}{2000\ lb} \cdot \left[1 - \left(CE \cdot RP \cdot RE\right)\right]$$

where:

E_{ia}	=	annual emissions for the inventory area, TPY;
POP_{ia}	=	population in the inventory area;
WGF	=	waste generation factor, 3.24 lbs per person per day for yard waste;
F_{SB}	=	fraction of fuel (waste) subject to burning, 0.28;
F_{AB}	=	fraction of fuel (waste) subject to burning that actually burned, only required for VOC, PM_{10}, and $PM_{2.5}$ (all 0.50);
EF_p	=	criteria pollutant emission factor, lbs per ton of fuel (waste);
CE	=	control efficiency (fraction) of applicable rules, 1;
RP	=	rule penetration (fraction) of applicable rules, weighted by urban and rural populations;
RE	=	rule effectiveness (fraction) of applicable rules, weighted by urban and rural populations.

For Anderson County, annual area source VOC emissions for open burning of residential MSW (2610030000) were estimated as follows:

$$E_{ia} = \left(52{,}090\ people\right) \cdot \left(\frac{3.24\ lbs\ MSW}{person \cdot day}\right) \cdot \left(\frac{365.001\ days}{year}\right) \cdot (0.28) \cdot (0.50) \cdot \left(\frac{1\ ton}{2000\ lb}\right)$$
$$\cdot \left(\frac{6.676\ lbs\ VOC}{ton\ MSW}\right) \cdot \left(\frac{1\ ton}{2000\ lb}\right) \cdot \left[1 - \left(1 \cdot 0.95005 \cdot 0.85513\right)\right]$$
$$E_{ia} = 2.70\ \frac{tons\ VOC}{year}$$

<u>Residential Yard Waste</u>

The following equation was used to calculate county-level annual area source emissions for criteria pollutants from the open burning of residential yard waste:

$$E_{ia} = POP_{ia} \cdot WGF \cdot \frac{365.001\ days}{year} \cdot AF \cdot YW_C \cdot F_{SB} \cdot \frac{1\ ton}{2000\ lb} \cdot EF_p \cdot \frac{1\ ton}{2000\ lb} \cdot \left[1 - \left(CE \cdot RP \cdot RE\right)\right]$$

where:

E_{ia}	=	annual emissions for the inventory area, TPY;
POP_{ia}	=	population in the inventory area;

WGF	=	waste generation factor, 0.57 lbs per person per day for MSW;
AF	=	adjustment factor for yard waste generation based on the percentage of forested acres.
YW_C	=	component's percentage of total yard waste, brush = 0.25, leaves = 0.25;
F_{SB}	=	fraction of fuel (waste) subject to burning, 0.28;
EF_p	=	criteria pollutant emission factor, lbs per ton of fuel (waste);
CE	=	control efficiency (fraction) of applicable rules, 1;
RP	=	rule penetration (fraction) of applicable rules, weighted by urban and rural populations;
RE	=	rule effectiveness (fraction) of applicable rules, weighted by urban and rural populations.

For Anderson County, annual area source VOC emissions for open burning of residential yard waste leaves (2610000100) were estimated as follows:

$$E_{ia} = \left(52{,}090\ people\right) \cdot \left(\frac{0.57\ lbs\ yard\ waste}{person \cdot day}\right) \cdot \left(\frac{365.001\ days}{year}\right) \cdot (1) \cdot (0.25) \cdot (0.28) \cdot \left(\frac{1\ ton}{2000\ lb}\right)$$
$$\cdot \left(\frac{28\ lbs\ VOC}{ton\ yard\ waste\ leaves}\right) \cdot \left(\frac{1\ ton}{2000\ lb}\right) \cdot \left[1 - \left(1 \cdot 0.95005 \cdot 0.85513\right)\right]$$
$$E_{ia} = 0.996\ \frac{tons\ VOC}{year}$$

<u>Land Clearing Debris</u>

The following equation was used to calculate county-level annual area source emissions for criteria pollutants:

$$E_{ia} = Acres_{ia} \cdot LF_{ia} \cdot FB_{ia} \cdot EF_p \cdot \frac{1\ ton}{2000\ lb} \cdot \left[1 - \left(CE \cdot RP \cdot RE\right)\right]$$

where:

E_{ia}	=	annual emissions for the inventory area, TPY;
$Acres_{ia}$	=	total acres (residential + nonresidential + road) disturbed by land clearing in the inventory area;
LF_{ia}	=	weighted fuel loading factor for the inventory area, tons of fuel per acre;
FB_{ia}	=	fraction of fuel (land clearing debris) that is burned in the inventory area;
EF_p	=	criteria pollutant emission factor, lbs per ton of fuel;
CE	=	control efficiency (fraction) of applicable rules;
RP	=	rule penetration (fraction) of applicable rules;
RE	=	rule effectiveness (fraction) of applicable rules.

For Anderson County, annual area source VOC emissions for open burning of land clearing debris (2610000500) were estimated as follows:

$$E_{ia} = \left(65.012\ acres\right) \cdot \left(44.833 \frac{tons\ of\ fuel}{acre}\right) \cdot (0.58) \cdot \left(11.6 \frac{lbs\ VOC}{ton\ of\ fuel}\right) \cdot \frac{1\ ton}{2000\ lb} \cdot \left[1 - \left(0 \cdot 0 \cdot 1\right)\right]$$

$$E_{ia} = 9.805 \frac{tons\ VOC}{year}$$

Seasonal Allocation

The following equation was used to calculate both OSD and CO season day emissions:

$$E_d = \frac{E_{ia} \cdot SAF}{AR}$$

where:

E_d	=	daily emissions in the inventory area, tons per day;
E_{ia}	=	emissions for the inventory year, TPY;
SAF	=	seasonal adjustment factor, since no seasonal change was assumed (this value is 1 for both OSD and CO season day);
AR	=	activity rate or days of operation per year, 365 days per year.

For Anderson County, OSD VOC emissions for open burning of land clearing debris (2610000500) were estimated as follows:

$$E_d = \frac{\left(9.805 \frac{tons\ VOC}{year}\right) \cdot 1}{\left(365.001 \frac{days}{year}\right)}$$

$$E_d = 0.027 \frac{tons\ VOC}{day}$$

Uncertainties/Future Research

The work on these open burning categories significantly improved on the EPA default estimates by using state- and county-specific activity data. However, uncertainties associated with the estimates for each of the categories are still prevalent. Using the national yard waste per capita generation factor for Texas emission estimations also presents one source of error.

Additionally, information on the amount of residential MSW that is actually burned in rural counties was limited. The only reference available cited the amount as 28% of total MSW generated. In addition, no information was available on the amount of yard waste that is actually burned; consequently, the 28% assumption applied to MSW was also applied to yard waste. TNRCC staff believe that the amount of MSW and yard waste that is burned in rural counties is much higher than 28% of the total waste generated. Therefore, future research should focus on conducting survey work for rural counties to obtain a more realistic estimate of the amount of residential MSW and yard waste that is actually burned in Texas. Due to the time constraints for preparing the 1999 area source inventory, the telephone survey of city and county officials focused on the 16 nonattainment area counties to improve estimates of RE and RP for residential MSW and yard waste burning. Future work should include rural counties to obtain RE and RP values relevant to rural counties.

For open burning of land clearing debris, the factors applied to convert construction measurements to acres disturbed present one source of the uncertainty. Having accurate measurements of the amount of acres disturbed for each construction activity that took place for the year of interest is desirable. Estimations from local sources of the type and tons of fuel (debris) burned, as opposed to estimates derived from the BELD2 database, would also improve emission estimates. Also, information should be collected to determine the amount of trench burning that takes place in counties for each of the land clearing debris sectors, and the appropriate emission factors to use to estimate emissions from trench burning. If trench burning produces lower emissions than open burning and is used to dispose of a significant portion of land clearing debris that is burned, then emissions would be overestimated for counties where trench burning is applied. However, information on emission factors for trench burning will need to be obtained to determine if there is a significant difference in emissions from open versus trench burning.

A broader, more detailed survey of the entire state of Texas is recommended to collect the data needed to reduce these uncertainties. The information obtained from such a survey could allow the implementation of the preferred method for estimating emissions, as described in the EIIP. It could also assist in characterizing trench burning, county burn bans, and local interpretation of the “allowance” for the open burning of land clearing debris. Such a survey would also provide more data points, allowing for the improvement of the values that were generated from the limited telephone survey that the ENVIRON team administered. As a result of the ENVIRON team’s survey of county and city officials in the 16 nonattainment area counties, the team has obtained information for improving the design of the questions to ask to obtain data for these categories. This information should be consulted if future survey work is conducted for these open burning categories.

2.15 AGRICULTURAL FIELD BURNING

Description of Source Category

This source category covers agricultural burning practices used to clear and/or prepare land for planting. Operations included under this category are stubble burning, burning of standing field crops as part of harvesting (e.g., sugarcane), and burning of agricultural crop residues. The burning of sugarcane residue is allowed in Texas because there is no feasible alternative. On the other hand, other agricultural waste can be managed in a number of ways. Emissions for this category include CO, NO_x, VOC, PM_{10}, $PM_{2.5}$, and NH_3. Emissions for this category are reported under SCC 2801500000.

Methodology

The preferred methodology for estimating emissions for this category would be to collect activity data by county on the number of acres burned, the type of fuel, fuel loading factors, and the time and duration of each fire. This activity information would then be used with emission factors to estimate annual and seasonal emissions for 1999. However, time and resource constraints precluded collection of the local activity data needed to estimate 1999 emissions using the preferred methodology.

The University of Texas (UT) prepared a 1996/1997 county-level, annual and seasonal emissions inventory using the preferred methodology of collecting local activity data. The 1999 inventory is based on the 1996/1997 inventory prepared by the UT. The UT inventory calculated emissions by county and by month. The emissions for June, July, and August in the UT inventory were summed and divided by 92 to calculate 1996/19977 OSD emissions. These emissions were grown to 1999 based on changes in harvested acreage data as described later in this section. The UT inventory did not contain any emissions for El Paso County during the winter months; therefore, CO winter season day emissions were not estimated for El Paso County. CE and RP were set to 0% and RE was set to 100%.

The following highlights the UT's emissions inventory methods and describes the methods applied to develop 1999 emissions activity data for each prescribed burning subcategory.

<u>Sugarcane</u>

The Rio Grande Valley Sugar Growers' Association maintains records of sugarcane areas burned, as well as the estimated fuel loading available to each burn. The sugarcane cropland data are reported by each of four regions. Unfortunately, these records are in hard copy format and are purged two years after each harvest (CEER, 2000). In the UT's Forest, Grassland, and Agricultural Burning Inventory study, these regional data were allocated to counties based on 1996 harvested sugarcane acreage, which is reported by the National Agricultural Statistics Service (NASS) (USDA, 2001a). By comparing the acres of residue

burned data from the Growers' Association to the NASS harvested acreage data, it was determined that 64 percent of residues from harvested sugarcane acreage were burned in Texas in 1997. Based on this finding, the UT inventory study estimated the number of acres burned in each county by multiplying harvested sugarcane acreage by 64 percent.

The NASS harvested sugarcane acreage data were compiled for 1996 and 1999. These data were used, along with harvested acreage data for the other crops described below, in developing harvested acreage-based growth factors that were applied to the UT inventory to estimate 1999 agricultural field burning emissions.

Other Crops

There are a number of crop waste management techniques available for other agricultural crops, including tilling back into the soil, transporting to a compost or landfill, use as a supplemental feed, or field burning. Burning of crop residues is believed to be the least frequent disposal method for non-sugarcane crops (CEER, 2000). Because Texas does not maintain any records on burning of these crops, the UT Inventory Study estimated the fraction of residue burned based on survey data collected from the Agricultural Extension Service and county sheriffs. The data requested from the Agricultural Extension Service agents and county sheriffs included the number of fires and acres burned monthly during a typical year for each crop type. After review of the collected data, a list of reported crop types was compiled, and the following three crop types were identified as predominant:

- Corn;
- Hay/Grasses; and
- Wheat.

Texas burning activity was estimated for these crops by extrapolating from the survey data. The UT Inventory Study compiled county-level 1996 harvested acreage data from the NASS for wheat and corn, and county-level harvested acreage data from the Texas Agricultural Statistics Service for hay (CEER, 2000). Next, two fractions were computed: (1) the fraction of harvested acreage burned for each crop based only on counties that reported burning; and (2) the fraction of harvested acreage burned for each crop assuming that all counties not reporting acres burned had no burning activity. Because the actual fraction burned is likely somewhere between these two values, a weighted average, based on the fraction of counties reporting burning, was calculated and used as the best estimate.

The 1999 burning activity for non-sugarcane crops was estimated by compiling 1999 year harvested acreage data for the three predominant non-sugarcane agricultural field burning crops. For wheat and corn, county-level harvested acreage data were compiled from the NASS (USDA, 2001a). The year of harvested hay acreage data incorporated into the UT inventory was unclear. Based on the corn, wheat, and sugarcane data, however, the hay data were also assumed to represent 1996 year acreage. Investigations into TASS harvested acreage data for hay indicated that historical time-series data are not available. Therefore,

Census of Agriculture acreage data were compiled for this effort (USDA, 2001b). County-level harvested hay acreage data are available from this source for 1992 and 1997. The 1996 year county-level hay harvested acreage data were estimated by interpolating between the 1992 and 1997 values. To estimate the county-level 1999 hay acreage, harvested hay acreage data for the state of Texas were compiled for 1997 and 1999. A growth factor was developed from the 1997-1999 state-level change in harvested hay acreage and then applied to each of the county's 1997 acreage values to estimate county-level 1999 year acreage.

Next, the county-level 1999 acreage data for corn, hay, wheat, and sugarcane were multiplied by percentages representing the percentage of harvested acreage burned. These percentages, which were obtained from the UT study, differed regionally for corn, hay, and wheat. For sugarcane, a value of 64 percent was applied to the acreage data for each county in Texas. Finally, the total 1999 year acreage burned was calculated by summing the individual acreage burned estimates for corn, hay, wheat, and sugarcane. Growth factors were then developed at the county-level based on the ratio of 1999 to 1996 acreage burned. These growth factors were multiplied by the UT inventory's county emissions to estimate agricultural field burning emissions for the year 1999.

Uncertainties/Future Research

The main uncertainty with the 1999 agricultural burning inventory is that it is based on a 1996/1997 inventory. Future work should compile the 1999 activity data (preferably by county) needed to prepare an inventory. Although 1999 activity data were collected for the major crop types (i.e., sugarcane, wheat, corn, and hay) to prepare emissions trends for this category, time and resource constraints precluded collecting the activity data for all of the crop types included in the UT inventory.

2.16 WILDFIRES

Description of Source Category

The wildfires category contains emissions from unplanned burning of wild vegetation (e.g., fires started by lightning). Wildfire emissions include CO, NO_x, VOC, PM_{10}, $PM_{2.5}$, and ammonia (NH_3). Wildfires can produce very large, short-term emissions. The emissions for this category are reported under SCC 2810001000.

Methodology

The preferred methodology for estimating emissions for this category would be to collect activity data by county on the number of acres burned by wildfires, the type of fuel, fuel loading factors, and the time and duration of each fire. This activity information would then

be used with emission factors to estimate annual and seasonal emissions for 1999. However, collection of the activity data from the various county, state, and federal land management agencies requires extensive time and resources which were not available for preparing the 1999 area source inventory for Texas.

The UT developed estimates of wildfire emissions for 1996 and 1997 (CEER, 2000). Because of the large number of agencies that manage land affected by wildfires in Texas, and the lack of a centralized system for reporting wildfire activity, UT employed a number of agency-specific methods to develop wildfire activity estimates for 1996 and 1997. Given the random nature of the level of wildfire activity, the 1997 inventory prepared by UT was used for the 1999 inventory. The UT inventory calculated emissions by county and by month. The emissions for June, July, and August in 1997 were summed and divided by 92 to calculate OSD emissions. For CO winter season day emissions for El Paso County, the 1996 emissions for December were summed with the 1997 emissions for January and February and divided by 90 days.

There are no air pollution control requirements affecting this source category. Thus, CE and RP were set to 0% and RE was set to 100%.

Uncertainties/Future Research

The main uncertainty with the 1999 wildfire inventory is that it is based on a 1997 inventory. Future work should compile the 1999 activity data (preferably by county) needed to prepare an inventory. TNRCC provided the ENVIRON team with the number of acres burned on state lands by county supplied by the Texas Forest Service. However, information on the number of acres burned by county for the various Federal agencies and private lands was not readily available within the time frame for completing the 1999 inventory. State-level wildfire acres burned data for Texas is available for lands managed by the U.S. Forest Service, U.S. Fish and Wildlife Service, National Park Service, and Bureau of Land Management. Regional activity data is available from the Bureau of Indian Affairs. However, further work would need to be conducted to determine if county-level data can be obtained from the Federal agencies, or to develop a reliable method for allocating state activity to counties. In addition, activity for private lands would need to be collected for 1999. Fuel loading factors and emission factors can be taken from the UT inventory (CEER, 2000) unless more recent factors can be identified for Texas.

2.17 MANAGED BURNING, SLASH

Description of Source Category

This source category covers emissions associated with planned non-agricultural fires of wild biomass residues resulting from timber harvesting practices. Emissions include CO, NO_x,

VOC, PM_{10}, $PM_{2.5}$, and NH_3. Emissions for this category are reported under SCC 2810005000.

Methodology

The preferred methodology for estimating emissions for this category would be to collect activity data by county on the number of acres burned, the type of fuel, fuel loading factors, and the time and duration of each fire. This activity information would then be used with emission factors to estimate annual and seasonal emissions for 1999. However, time and resource constraints precluded collection of the local activity data needed to estimate 1999 emissions using the preferred methodology.

The UT prepared a 1997 county-level, annual emissions inventory for slash burning of logging debris using the preferred methodology for collecting local activity data. The 1999 inventory is based on the 1997 inventory prepared by the UT. Information on activity during the summer months for this category was not available; therefore, OSD emissions were not calculated based on EPA guidance (EPA, 1991). The UT inventory did not contain any emissions for El Paso County; therefore, CO winter season day emissions were not estimated for El Paso County. CE and RP were set to 0% and RE was set to 100%.

The UT slash burning category represents residue from logging operations in the East Texas Piney Woods region. Because the UT study found that no documentation of burning activity practices exists outside of individual company records, several steps were taken in that study to estimate the level of this activity (CEER, 2000). Two companies that dominate logging operations in Texas (Temple-Inland and Champion International) were contacted to determine the amount of logging slash burning. Champion International estimated that only 0.5 percent of acres harvested were burned by the company, and that this number is typical of most large logging companies (Carroll, 1999). Smaller companies are believed to burn a higher percentage (CEER, 2000). Temple-Inland estimated that their company burns approximately 70 percent of the harvested acreage to be replanted. In the UT study, State harvested acreage data were estimated based on tree planting acreage data from the Harvest Trends Report, and an assumption that all the land planted by the forest industry had previously been harvested. The Temple-Inland 70 percent assumption was then applied to the 1996 and 1997 State tree planting acreage to estimate the number of acres of logging residue burned in 1996 and 1997. The State totals were allocated to each of the 43 counties in the Piney Woods region based on the fraction of total State industrial timberland in each county, which was determined from 1992 forested acreage data compiled by the U.S. Forest Service (USFS, 1999).

To develop 1999 emissions for this category, a combination of state and sub-state data were used. First, state-level forest industry tree planting acreage data were compiled for 1997 and 1999. Next, a 1997-1999 state-level growth factor was computed from these data. To regionalize the state growth factor, Logging sector (SIC code 241) growth factors were compiled for Texas from EGAS Version 4.0. These constant dollar output-based growth

factors are available for four regions in Texas (each Texas county is included in one of these four regions). A state-level growth factor was calculated for each year after summing the regional Logging sector output data from the REMI models that underlie EGAS. Next, ratios of each year's regional Logging sector growth factors to the state growth factor were calculated. These ratios were then used to adjust the state forest industry acreage-based growth factor to account for regional variations in logging activity. These composite growth factors were then applied to the 1997 UT inventory to estimate 1999 emissions..

2.18 MANAGED BURNING, PRESCRIBED

Description of Source Category

This category includes non-agricultural controlled forest/understory, grassland, and rangeland management fires, but excludes slash burning (CEER, 2000). Emissions include CO, NO_x, VOC, PM_{10}, $PM_{2.5}$, and NH_3. Emissions from this category are reported under SCC 2810015000.

Methodology

The preferred methodology for estimating emissions for this category would be to collect activity data by county on the number of acres burned, the type of fuel, fuel loading factors, and the time and duration of each fire. This activity information would then be used with emission factors to estimate annual and seasonal emissions for 1999. However, collection of the activity data from the various county, state, and federal land management agencies requires extensive time and resources which were not available for preparing the 1999 area source inventory for Texas.

The UT developed a 1997 inventory for prescribed burning of wildland, and a combined 1996/97 inventory for prescribed burning of rangeland (CEER, 2000). The UT methodology followed the preferred method for collecting county and state activity data.

The 1999 inventory is based on the 1996/97 inventory prepared by the UT. The UT inventory calculated emissions by county and by month. The emissions for June, July, and August were summed and divided by 92 to calculate OSD emissions. For El Paso County, the UT inventory contains emissions for only prescribed range burning during January, February, and December. For CO winter season day emissions for El Paso County, the 1996/97 emissions for these three months were summed and divided by 90 days. CE and RP were set to 0% and RE was set to 100%.

The following highlights the UT's emissions inventory methods and describes the methods applied to estimate 1999 emissions for each prescribed burning subcategory.

Prescribed Wildland

Activity data for the prescribed wildland subcategory is further divided into publicly managed and privately managed lands. For publicly managed lands, the UT study utilized 1996 and 1997 data compiled by the National Applied Resource Sciences Center (NARSC) from information from the National Interagency Fire Center (NIFC). In 1996 and 1997, only the U.S. Fish and Wildlife Service and the National Park Service reported fire data to the NIFC. Because data from the U.S. Forest Service was not available from the NARSC, UT contacted each U.S. Forest Service district office to obtain monthly totals. The 1996 and 1997 acres burned on state parks was obtained from the Texas Parks and Wildlife Department through prescribed burning surveys sent to each Wildlife Management Area. The Texas Forest Service acreage burned data reported for the non-industrial private and the forest industry ownership categories were used in the UT study to estimate prescribed burning activity on private lands (TFS, 2001). These data, however, are only available on a State basis. To allocate these data to counties, the UT utilized U.S. Forest Service county-level 1992 forested acreage data for industrial and non-industrial private landowners (USFS, 1999).

For the prescribed wildland burning, the ENVIRON team was unable to develop 1999 activity data for public lands burned because time did not allow for contacting and compiling data from each U.S. Forest Service district office and Wildlife Management Area for 1999. Therefore, the public land prescribed wildland emission estimates from the UT study were held constant for 1999. However, 1999 private land acreage burned data was estimated by applying the growth rates for the state-level non-industrial private/forest industry prescribed burning activity to the UT county inventory.

Prescribed Range

Prescribed burning is often used to manage rangeland, but records of this activity are virtually nonexistent (CEER, 2000). In the UT study, each of the 250 Agricultural Extension Service agents was surveyed to obtain estimates of the number of acres burned during a "typical year." Identical surveys were sent to county sheriffs, but these surveys had a low response rate, and were often returned blank. The results of the surveys were compiled and regional values were calculated that represented the fraction of total rangeland acreage that was burned in a "typical" year. These regional fractions were then applied to county rangeland acreage data from the *Census of Agriculture* to estimate the county-level acres burned (USDA, 2001b). This general approach is the same as that used to estimate acres burned data for the agricultural field burning "other crops" subcategory. Although not explicitly noted in the UT study, the acreage data used to develop the 1996/97 inventory was 1997 data (from the *Census of Agriculture*, which is not published for 1996).

The UT inventory for 1996/97 was held constant for the 1999 inventory because projections of rangeland acreage are not available. This is consistent with the no growth assumption incorporated into EGAS 4.0 for prescribed burning (Pechan, 2001).

Uncertainties/Future Research

The main uncertainty with the 1999 prescribed burning inventory is that it is based on a 1996/97 inventory. Future work should compile the 1999 activity data (preferably by county) needed to prepare an inventory. For prescribed burning of wildlands, state-level acres burned data for Texas is available for lands managed by the U.S. Fish and Wildlife Service, National Park Service, Bureau of Indian Affairs, and Bureau of Land Management. Regional activity data is available from the U.S. Forest Service. However, further work would need to be conducted to determine if county-level data can be obtained from the Federal agencies, or to develop a reliable method for allocating state activity to counties. In addition, activity for private lands would need to be collected for 1999. Fuel loading factors and emission factors can be taken from the UT inventory (CEER, 2000) unless more recent factors can be identified for Texas.

2.19 CLEAN-UP OF THE 1999 NATIONAL EMISSIONS INVENTORY (Version 1.5)

Introduction and Scope

The 1999 NEI (Version 1.5) contains emissions data for area source categories developed using EPA default methods. These default methods were applied in the absence of data supplied by state and local agencies in an effort to prepare a complete NEI. The default methods are based on growing emissions from a dated inventory or preparing emissions using national activity data and allocating emissions to states and counties using surrogate activity data. The limitations of these methods is that they may estimate emissions for source categories that do not occur in a county or, in the case of area sources, emissions may now be inventoried as point rather than area sources.

Methodology and Approach

Through discussions with TNRCC, the area source categories discussed in this section were identified for review to determine if their emissions should be reported on other SCCs or removed from the 1999 inventory.

<u>Solvent Utilization/Degreasing</u>

TNRCC reports degreasing emissions under SCC 2415300000. Degreasing emissions in the 1999 NEI (Version 1.5), which were grown from the 1996 NEI base year inventory, are reported under this one SCC for the 16 nonattainment area counties for which TNRCC submitted a 1996 inventory to EPA. However, for the remaining counties in Texas, degreasing emissions are reported on 20 different SCCs for a given county. The 20 different SCCs are associated with different manufacturing sectors and solvent types. The emissions for these SCCs are most likely grown from a 1990 solvent degreasing inventory prepared by EPA.

In the Inventory Preparation Plan (IPP) prepared for the 1999 area source inventory, the approach was to revise the 1999 NEI to report solvent degreasing emissions under SCC 2415300000 to make the reporting of emissions for solvent degreasing consistent statewide. However, this was not completed because of time constraints associated with determining how to aggregate RE, RP, and CE values reported for several SCCs to reflect the sum of the emissions that would be reported on the one SCC.

Given that the emissions for this category are grown from a 1996 or prior year inventory, it is recommended that the emissions for this category be revised using 1999 activity data. If the emissions are revised, research should be conducted to determine if reporting emissions on more than one SCC will be useful for evaluating the effects of future controls, preparing emissions trends, and supporting air quality modeling. For example, if different speciation profiles for air quality modeling area assigned to different solvent degreasing SCCs, then the emissions should be prepared to reflect the SCC level that will facilitate assignment of speciation profiles. In addition, any emissions included in the point source inventory for this category should be subtracted from area source estimates if applicable for a given county.

Solvent Utilization/Dry Cleaning

TNRCC reports dry cleaning emissions under SCC 2420000000. Dry cleaning emissions in the 1999 NEI (Version 1.5) are reported under this one SCC for the 16 nonattainment area counties for which TNRCC submitted a 1996 inventory to EPA. However, for the remaining counties in Texas, dry cleaning emissions are reported on three different SCCs (i.e., Commercial/Industrial Cleaners/Perchloroethylene and Special Naphthas, and Coin-operated Cleaners/Perchloroethylene). The emissions for these SCCs are most likely grown from a 1990 inventory prepared by EPA. In the IPP prepared for the 1999 area source inventory, the approach was to revise the 1999 NEI to report solvent degreasing emissions under SCC 2420000000 in order to make the reporting of emissions for solvent degreasing consistent statewide. However, this was not completed because of time constraints associated with determining how to aggregate RE, RP, and CE values reported for several SCCs to reflect the sum of the emissions that would be reported on the one SCC. The previous discussion on future work on the solvent degreasing category also applies to future work on the dry cleaning area source category.

Solvent Utilization/Consumer Products

Consumer product emissions in the 1999 NEI (Version 1.5) are reported under SCC 2465000000 (All Products/Processes/ Total: All Solvent Types) for the 16 nonattainment area counties for which TNRCC submitted a 1996 inventory to EPA. For the remaining counties in Texas, consumer product emissions are reported for the following SCCs:

Consumer/Personal Care Products (SCC 2465100000);
Consumer/Household Products (SCC 2465200000);
Consumer/Automotive Aftermarket Products (SCC 2465400000); and
Consumer/Adhesives and Sealants (SCC 2465600000).

These five SCCs were removed from the 1999 inventory and replaced with emissions for the eight SCCs identified in section 2.12 for this report. In addition, the 1999 NEI reports VOC emissions for commercial/pesticide application under SCC 2461800000. The emissions for this SCC were replaced with the emission estimates prepared for agricultural pesticide application as discussed in section 2.11.

Residential Wood Combustion

TNRCC reports residential wood combustion emissions under SCC 2104008000. The emissions for this SCC include emissions from both fireplaces and wood stoves. Version 1.5 of the 1999 NEI now incorporates a new set of residential wood emission estimates including CO, NO_X, PM_{10}, $PM_{2.5}$, SO_2, and VOC supplied by EPA in August 2001. The new estimates are reported under seven SCCs (three SCCs for fireplaces and four SCCs for woodstoves). The SCCs and more details on the new 1999 emissions prepared by EPA are discussed in section 5.5 of this report. Use of EPA's new emission estimates for this category replace those in the previous NEI which, for 16 nonattainment area counties in Texas, were grown from 1996 estimates, and, for the remaining counties, were grown from a 1990 base year inventory.

Commercial/Institutional Residual Oil Consumption

The 1999 NEI (Version 1.5) reports emissions for this category under SCC 2103005000. According to the DOE/EIA, residual oil was not consumed by the commercial sector in Texas in 1999. Therefore, the SCC and associated emissions data for this source category were removed from the NEI.

Residential Coal Combustion

The 1999 NEI (Version 1.5) reports four nonattainment area counties with emissions for this source category under SCC 2104001000. The origin of the emission estimates for the 4 counties is unknown. Residential coal consumption in Texas is extremely low. According to the DOE/EIA, total residential coal consumption statewide was 3,000 tons in 1999. This category was removed from the NEI because emissions were extremely low when the state-level activity was allocated to counties.

Waste Disposal, Treatment, and Recovery/Treatment, Storage, and Disposal Facilities

TNRCC does not estimate emissions for this source category (SCC 2640000000). The emissions in the 1999 NEI (Version 1.5) are most likely grown from a dated inventory. This SCC was removed from the inventory.

Storage and Transport/Petroleum and Petroleum Product Storage/All Storage Types: Breathing Loss

The 1999 NEI (Version 1.5) reports four nonattainment area counties with emissions for this source category under SCC 2501000000. The origin of the emission estimates for the four counties is unknown. Emissions associated with breathing losses are accounted for under other SCCs. Therefore, this SCC was removed from the inventory.

Industrial Area Source Emissions

Several area source industrial sector SCCs were identified in the 1999 NEI with emissions that may be double counted in the point source inventory. The ENVIRON team compared point and area source emissions by county and determined that some of the area source emissions should be removed from the 1999 inventory to avoid double counting of point source emissions. For this analysis, the ENVIRON team used Texas' 1999 point source data base as the source of point source data. The team identified the point sources that correspond to the area sources and compared emissions at the county level. The following identifies the area source categories and the decisions made on whether to remove area source emissions from the 1999 inventory.

- Industrial Distillate Oil Combustion (SCC 2102004000). A total of 219 counties contained point and area source emissions for the category. The area source inventory did not contain any controls for this source category. Point source emissions were identified as emission units with SCCs starting with 102005xx and 202001xx. Time and resource constraints precluded retrieving the CE and RE values from the point source data base to back calculate uncontrolled emissions for comparison to uncontrolled area source emissions. Therefore, area source emissions for this category were removed only from the counties where the actual point source emissions were equal to or exceeded the area source emissions. The area source emissions were removed from 22 counties.

- Industrial Residual Oil Combustion (SCC 2102005000). All 254 counties in Texas contained area source emissions for this category in the 1999 NEI. The area source inventory did not contain any controls for this source category; the RE is 100% and the RP is 0% for all counties. Only two counties (FIPS 157 and 355) contained point source emissions and all of the point source emissions are uncontrolled. For these two counties, the area source emissions were removed from the 1999 inventory to avoid double counting of emissions in the point source inventory. Texas's 1999 point source inventory was searched for facilities with SCCs starting with 102004xx and 202005xx. However, the point source SCC 10200401 was the only point source SCC present in both counties.

- Industrial Natural Gas Combustion (SCC 2102006000). All except one county in Texas contained area source emissions for this category in the 1999 NEI. The area source inventory did not contain any controls for this source category. Point source emissions were identified as emission units with SCCs starting with 102006xx and 202002xx. Time and resource constraints precluded retrieving the CE and RE values from the point source data base to back calculate uncontrolled emissions for comparison to uncontrolled area source emissions. Therefore, area source emissions for this category were removed only from the counties where the actual point source emissions were equal to or exceeded the area source emissions. The area source emissions were removed from 185 counties.

- Solvent Utilization/Industrial Adhesives Application (SCC 2440020000). Point and area source VOC emissions for this category occurred in seven counties in the 1999 NEI. The FIPS codes for the counties are 027, 037, 061, 097, 143, 183, and 203. The area source emissions in each county have a CE of 63%, RE of 80%, and RP of 0%. The point source emissions in these counties are uncontrolled. SCCs starting with 402007xx were used to identify point sources. Uncontrolled area and point source emissions were summed by county and compared. For all counties, total point source emissions were less than the area source emissions. Uncontrolled area and point source VOC emissions for all seven counties combined are 765 and 117 TPY, respectively. It is unknown if the area source emissions represent total emissions for the category or represent the area source contribution for the category. Because of this uncertainty, the area source emissions in the 1999 NEI were not changed for Texas' 1999 inventory.

- Solvent Utilization/Rubber and Plastics Manufacture (SCC 2430000000). Point and area source emissions for this category occurred in 37 counties in the 1999 NEI (Version 1.5). The area source SCC accounts for emissions associated with facilities with SIC code 30. Therefore, point source emissions were identified as those occurring at facilities with SIC code 30. The area source emissions in each county have a CE of 87%, RE of 89%, and RP of 0%. Uncontrolled area and uncontrolled point source emissions were summed for each county and compared. The area source emissions were removed from the 1999 inventory if the uncontrolled point source emissions equaled or exceeded the uncontrolled area source emissions. Area source emissions were removed from the 1999 inventory for 16 of the 37 counties with both point and area source emissions.

Wildfires, Prescribed Burning, and Agricultural Field Burning

As discussed in the IPP for the 1999 area source inventory, TNRCC has sponsored development of emission inventories for these area source categories. After consultation with

TNRCC, it was decided to use the emission inventories as the basis for preparing revisions to the emissions for the 1999 NEI. The methodologies applied to prepare 1999 emissions for the categories are discussed in sections 2.15 through 2.18 of this report.

3.0 1999 NONROAD SOURCES METHODOLOGY

3.1 INTRODUCTION

This section describes in detail all approaches and methodologies for generating revised 1999 emissions for nonroad source categories. In brief, the work that was performed is as follows:

- Airport ground support equipment (GSE): An attempt was made to obtain detailed GSE population and activity data for every piece of GSE equipment at 28 airports in Texas. No useful GSE survey data were received in the time frame needed. Instead, GSE populations were estimated on the basis of detailed data on landing and take-off cycles by air carrier and aircraft type at each airport, and used in the NONROAD model to estimate GSE emissions.

- Recreational marine equipment: NONROAD default equipment population files were replaced with Texas state-level registration data obtained from the Texas Parks and Wildlife Department and allocated to the county-level with water surface area from the NONROAD default allocation input files.

- Aircraft: The Texas Transportation Institute recently completed estimation of 1999 aircraft emissions by airport using Federal Aviation Administration models and procedures. The data were obtained from TTI and incorporated into the 1999 emissions data base.

- Locomotive: Emissions were derived from published emission factors and statewide fuel consumption allocated to Texas counties using an estimate of relative activity of freight transfers (ton-mile) within each county. An attempt was made to obtain detailed locomotive activity information with Burlington-Northern Sante Fe and Union Pacific providing such detail, but other railroads could not prepare similar data within the time frame of this review.

- Construction and mining equipment: For diesel equipment greater than 25 horsepower, equipment populations by county and hours of use were derived from the Houston area construction and mining survey. The Houston survey data produced for the latest SIP were gathered for 10 categories, each reflecting a unique equipment ownership category. The Houston data were extrapolated to other Texas counties using surrogates that indicate the amount of construction activity occurring in a given county.

- Commercial marine vessels: Commercial marine vessel emission were derived from Texas-specific activity estimates in terms of number of vessels, annual activity, and average power for ocean-going, tugs, ferries, dredges, and commercial fishing. Houston SIP estimates were provided for 1997 and 2007 and interpolated for 1999 Houston nonattainment area estimates.

The 1999 NEI NONROAD categories were estimated by taking the 1996 NEI and scaling it up to 1999. For the 1996 NEI, the April 1999 version of NONROAD was run for each county. The 1996 county-level NEI was scaled up to 1999 using the ratio of *national-level* emissions estimates by source category from a December 2000 internal EPA version of NONROAD.

In this study, the current public version of the NONROAD model (June 2000) was run for all counties in Texas for 1999, using county-specific temperature and fuel inputs. The 1999 estimates were derived by running the model separately for summer and winter, so that seasonal temperature and fuel inputs could be used.

The default populations in the June 2000 NONROAD model are based on 1996 and 1998 proprietary data from Power Systems Research (PSR). The default growth factors in the model were developed from the PSR data, and are high, especially for construction equipment. Alternative growth factors were used to estimate the 1999 equipment populations from the 1996 or 1998 PSR base population data. EGAS3.0 growth factors were used for recreational, industrial, lawn and garden, agricultural, commercial, and logging equipment. F. W. Dodge construction valuation data were used as the basis for growth factors for construction equipment, and data from the Association of American Railroads were used to develop growth factors for railroad equipment.

The remainder of this section provides the detailed methodologies and example calculations, as well as a discussion of uncertainties and future research recommended for each source category. Summaries of the 1999 nonroad emissions estimates are provided in Section 1 of this report.

3.2 AIRPORT GROUND SUPPORT EQUIPMENT

Description of Source Category

Airport ground support equipment (GSE) includes a broad set of equipment types used to service aircraft. While most GSE are not highway-certified, there are GSE trucks that are highway-capable but are presumably driven either partly or entirely off street networks and so should be included in the nonroad emissions inventory. The current NONROAD model has only one SCC for all airport GSE – 22xx008005 (xx indicates fuel type). GSE surveys in Texas and other states have identified the following GSE types:

- A/C Tug, Narrow Body
- A/C Tug, Wide Body
- Air Conditioner
- Air Start Unit
- Baggage Tug
- Belt Loader
- Bobtail
- Cargo Loader

- Cargo Tractor
- Cart
- Forklift
- Fuel Truck
- Generator
- Ground Power Unit
- Hydrant Truck
- Lav Cart
- Lav Truck
- Lift
- Maintenance Truck
- Other Truck
- Service Truck
- Water Truck
- Sweeper
- Passenger Stand

EPA's NONROAD model has a crude estimate of GSE populations. The NONROAD model estimates county-level GSE populations by taking an estimate of the national total allocating that total to the county level. The model's national population data come from Power Systems Research (PSR), based on proprietary marketing research data and methods, and are suspect. To allocate the national level GSE population data to the county level, the current draft version of NONROAD uses the number of people employed in air transportation by county, based on US Census Bureau's County Business Pattern data (SIC 4500). However, this indicator may include employees that are not directly connected to aircraft operations, such as airline reservation staff and ticket agents. Using this factor may lead to an overestimation of aircraft ground support equipment population and activity in a county, especially in counties that either have airports with one or more airline "hubs" or that do not have a commercial airport but have branch ticket offices for various airlines. State and local air quality agencies are encouraged to substitute local data for the national default allocation estimates where the national default estimates may not adequately reflect local conditions.

Detailed GSE surveys for Dallas and Houston airports (as well as many other cities) have been performed by the Air Transport Association (ATA); the survey population and activity data were used by ATA and their contractor to estimate GSE emissions for the Dallas and Houston SIPs.

Methodology

Preferred Approach – GSE Surveys

The approach discussed in the Inventory Preparation Plan (IPP) was to obtain the detailed GSE survey data for the Dallas and Houston airports, and possibly for some smaller airports in Texas, and then to use the survey data to develop estimates of GSE populations by equipment type for different aircraft types, and also to revise NONROAD GSE activity inputs. The GSE population and activity survey data would then be input to the NONROAD model to derive revised emissions estimates.

TNRCC staff wanted to extend the work proposed in the IPP to obtain GSE survey data for all major airports in Texas. The request was made for detailed information for each piece of GSE equipment as shown in Table 3.2-1. TNRCC sent out letters requesting such data to the 28 airports with commercial air carriers listed in Table 3-2.2.

Table 3.2-1. Information requested from airports for each piece of GSE equipment.

SCC	Fuel Type	Rated Power (Hp)	Activity (Hours/year)	Load (% of Full Load)	Model Year
Each Category Listed Above in Table 3.2-1	Diesel, Gasoline, LPG, and CNG. (Electric equipment for completeness)	Power of engine	Engine hours or miles for trucks (shorter time periods can be scaled to a year)	May be estimated from fuel use (gallons/hour)	NOT REQUIRED but useful for determining fleet turnover.

Table 3.2-2. Texas airports to which GSE population and activity data surveys were sent.

Airport Code	City	Airport Name
ABI	Abilene	Abilene Regional
ACT	Waco	Waco Regional
ADS	Dallas	Addison
AFW	Fort Worth	Fort Worth Alliance
AMA	Amarillo	Amarillo International
AUS	Austin	Austin-Bergstrom International
BPT	Beaumont/Port Arthur	Southeast Texas Regional
BRO	Brownsville	Brownsville/South Padre Island International
CLL	College Station	Easterwood Field
CRP	Corpus Christi	Corpus Christi International
DAL	Dallas	Dallas Love Field
DFW	Dallas-Fort Worth	Dallas/Fort Worth International
EFD	Houston	Ellington Field
ELP	El Paso	El Paso International
FTW	Fort Worth	Fort Worth Meacham International
GGG	Longview	Gregg County

Airport Code	City	Airport Name
HOU	Houston	William P. Hobby
HRL	Harlingen	Valley International
IAH	Houston	George Bush Intercontinental Arpt/Houston
LBB	LUBBOCK	Lubbock International
LRD	Laredo	Laredo International
MAF	Midland	Midland International
MFE	Mc Allen	Mc Allen Miller International
RBD	Dallas	Redbird
SAT	San Antonio	San Antonio International
SGR	Houston	Sugar Land Muni/Hull Field
SPS	Wichita Falls	Sheppard AFB/Wichita Falls Muni
TYR	Tyler	Tyler Pounds Field

Despite repeated contacts, no useful GSE survey data were received from airports, and the detailed data provided to TNRCC for the Dallas SIP could not be found.

Alternative Approach – Estimating GSE Populations from LTOs

ENVIRON proposed, and TNRCC accepted, an alternative approach for estimating GSE emissions, given the lack of any useful GSE survey data. The basic approach is to estimate GSE equipment populations based on the number of landing and take-off (LTO) cycles at each airport. The Bureau of Transportation Statistics (BTS) of the U.S. Department of Transportation compiles detailed records on LTO activity by airport, carrier, and aircraft type. An electronic file of the detailed LTO data for 1999 was obtained. The spreadsheets contain LTO cycles by airport, airline, and specific aircraft type (manufacturer/model).

The Federal Aviation Agency's (FAA) Emissions and Dispersion Modeling System (EDMS) can also be used to estimate GSE operations based on the number of LTO cycles by aircraft type. With an operation time per LTO cycle given in minutes, the calculation for emissions generated per LTO cycle is the product of the emission factor and operation time. For annual emissions this result is multiplied by the number of yearly LTO cycles for the specific aircraft to which the equipment is assigned. As stated in the DFW SIP (Appendix W) the EPA, TNRCC, FAA and ATA recognize that EDMS default assumptions, which include total activity per LTO, types and numbers of GSE assigned to an LTO, activities for each GSE and fuel type, will significantly underestimate emissions from GSE.

ENVIRON's alternative approach is to use a set of equations developed for EPA for estimating GSE equipment populations using engine-type-specific LTOs. These equations were developed from a regression analysis of detailed GSE survey data from 35 airlines at ten U.S. airports (EPA, 1999). In this analysis, scatterplots and regression statistics of airline- and airport-specific GSE populations by annual airline- and airport-specific LTO cycles revealed distinct differences in the GSE inventories of airlines along three major

classifications: major airlines other than Southwest, Southwest Airlines which uses only Boeing 737 aircraft, and regional/commuter airlines. Statistical relationships were developed for the three airline groups to estimate GSE populations based on annual LTOs for wide-body jets, narrow-body jets, and commuter aircraft; these regressions are shown in Table 3.2-3.

Table 3.2-3. EPA regressions for estimating GSE populations from LTOs.

Airline Classification	Regression Equation (GSE Population =)	Correlation Coefficient
Major Airlines (other than Southwest)	$0.0266\ (LTO_{wb}) + 0.0054\ (LTO_{nb})$	0.79
Southwest Airlines	0.0022 (LTO)	0.83
Regional Airlines	0.0008 (LTO)	0.75

In order to estimate GSE emissions by county, the following steps were followed:

1. For each airport in Texas, using the detailed LTO data available from BTS by airline, carrier, and specific aircraft type (manufacturer/model), assign each of the specific aircraft types to one of the three aircraft classifications (wide-body jet, narrow-body jet, and commuter/propeller. In previous work that ENVIRON has performed for EPA, we developed a cross-reference list that maps each specific aircraft type to one of these three aircraft classifications. This must be done separately for domestic and international LTOs, as they come in separate files from BTS and have different aircraft codes.

2. Apply the regressions in Table 3.2-3 to estimate GSE populations for the three major air carrier classifications for each airport.

3. For those counties with more than one airport, aggregate the GSE populations across airports within the county.

4. Develop revised GSE population input files for the NONROAD model and run the model to estimate GSE emissions with the new population files.

<u>Example Calculation</u>

Example calculations are shown here for the Harlingen airport (airport code HRL) in Cameron County. Table 3.2-4 shows the 1999 scheduled, unscheduled, and total LTOs at Harlingen by carrier for each specific aircraft manufacturer/model. The last column in the table classifies each aircraft as either wide-body (W), narrow-body (N), commuter/propeller (C), or Southwest (S, carrier code WN).

Table 3.2-4. 1999 LTO data by aircraft type for the Harlingen airport.

Carrier	Aircraft	Aircraft Name	Scheduled Departures	Nonscheduled departures	Total LTOs	Aircraft Class
5X	622	Boeing 757-200	-	84	84	N
5X	710	Boeing 727-100	-	31	31	N
5X	715	Boeing 727-200	-	140	140	N
AA	603	Fokker 100	1	-	1	N
CO	616	Boeing 737-500/600	1	-	1	N
ER	416	Cessna 208	254	-	254	C
FX	110	Beech 18	4	-	4	C
FX	416	Cessna 208	97	-	97	C
FX	710	Boeing 727-100	14	-	14	N
FX	715	Boeing 727-200	247	-	247	N
MQ	442	ATR-72	1,396	-	1,396	C
MQ	456	Saab-Fairchild 340/B	13	-	13	C
MQ	675	Embraer-145	2	-	2	C
RU	441	ATR-42	1,435	-	1,435	C
RU	461	EMB-120 Brasilia	1	-	1	C
SY	715	Boeing 727-200	18	-	18	N
SYQ	715	Boeing 727-200	-	9	9	N
SYQ	730	Douglas DC-10-10	-	17	17	W
WN	616	Boeing 737-500/600	241	-	241	S
WN	619	Boeing 737-300/700	2,507	1	2,508	S
WN	620	Boeing 737-100/200	1,332	-	1,332	S

The total 1999 LTOs by aircraft classification for this airport are: 4081 LTOs for Southwest planes, 17 wide-body aircraft LTOs, 551 narrow-body aircraft LTOs, and 3202 LTOs for commuter/propeller planes. Using the regression equations in Table 3.2-3, the estimated GSE populations for the Harlingen airport are then calculated as:

Major Airlines (not Southwest): GSE population = 0.0226 (17) + 0.0054 (551) = 3.4

Southwest Airlines: GSE population = 0.0022 (4081) = 9.0

Commuter: GSE population = 0.0008 (3202) = 2.6

The total estimated GSE population is the sum of these three estimates, or 14.9.

Use of Dallas and Houston SIP estimates

As stated above, detailed GSE surveys data for Dallas and Houston airports were used to estimate GSE emissions for the Dallas and Houston SIPs. For both nonattainment areas, GSE populations and emissions by airport were provided. The original plan was to use the GSE

populations for the DFW and HGA area airports. However, GSE emissions estimated with NONROAD for these airports using the populations in the SIPs resulted in emissions estimates significantly lower than the GSE emissions estimates in the SIPs. This is likely because the ATA SIP estimates used different activity data and possibly different emission factors by GSE equipment type. The decision was therefore made to use the GSE emissions estimates from the SIP for the DFW and HGA area airports. As the SIP estimates were for the 1996 calendar year, the emissions estimates were grown from 1996 to 1999 using the LTO growth rate.

Uncertainties/Future Research

ENVIRON recommends that TNRCC continue to work with Texas airport authorities to obtain detailed survey data on both population and activity for ground support equipment. Even with detailed survey data from only a subset of the 28 airports to which surveys were sent, scaling factors can still be developed for small, medium, and large airports with which to improve the current GSE estimates. In addition, further discussions should be held with ATA and their contractor in an effort to obtain the details of their reported emissions calculations.
The current NONROAD model has only one SCC for all GSE equipment types (this SCC is further subdivided by fuel type). With more refined information on activity patterns by GSE equipment type, GSE estimates could be improved by incorporating into the NONROAD model new SCCs for each of the GSE equipment types listed.

3.3 RECREATIONAL MARINE

Description of Source Category

Recreational marine equipment, or pleasure craft, includes outboard, inboard, personal water craft (PWC), and sailboat auxiliary types with 2-stroke and 4-stroke gasoline, and diesel engines. Such equipment is subject to EPA regulations for gasoline and diesel equipment, though the emission standards are not expected to produce different emission rates from 4-stroke gasoline engines but will likely affect the relative proportion of 2- and 4-stroke engine sales.

In the current EPA NONROAD model, national recreational marine populations by equipment type are estimated using data from Power Systems Research (PSR), a private marketing research company. The NONROAD model allocates the national total populations by equipment type to all counties in the U.S. based on water surface area in each county. County-level human population is not used as the allocation surrogate because recreational marine equipment may be registered and housed in one county (where the owner lives), but used primarily in a different county.

Methodology

To improve the 1999 recreational marine emission inventory, recreational marine equipment registration statistics as of April 30, 2001 were purchased (for a nominal fee) from the Texas Parks and Wildlife Department. The data summarize, for each county, the registered equipment population by propulsion type (outboard, inboard, in/out, other and sail), and separately by fuel type (gasoline, diesel and other). Because the data provided were not delineated in the level of detail that the NONROAD model uses, the state total populations by engine propulsion type were disaggregated into fuel type/horse power groups using the NONROAD national distribution of vessel type populations into these groups.

Although the registration data are available by county, the county-level populations were not used, as they are a poor indicator of recreational marine activity. The statewide recreational marine equipment populations were thus used to generate revised NONROAD model state population files for Texas recreational marine equipment, and state-to-county allocation was done using the NONROAD default approach (using water surface area as the allocation indicator). The model was then exercised to estimate 1999 recreational marine emissions using these revised files.

Uncertainties/Future Research

The county-level recreational marine equipment populations are determined from county-level registration data. However, as stated above, the equipment may be used in a different county from where it is registered or housed. An allocation method should be derived to account for differences between where vessels are housed and where they are operated.

3.4 AIRCRAFT

Description of Source Category

The aircraft source category includes emissions from three types of aircraft activity: commercial aircraft (SCC 2275020000), general aviation (SCC 2275050000), and military aircraft (SCC 2275001000). The 1999 aircraft emissions for each county in Texas were estimated by the Texas Transportation Institute under contract to TNRCC (TTI, 2000). The TTI analysis includes 1999 annual and summer daily emissions of CO, HC, NO_X and SO_X for air carriers/commercial aircraft, military aircraft, and general aviation. For this work, TTI 1999 emissions were extracted from data files provided by TTI, with some additional calculations as described below.

Methodology – Emission Factors and Activity Data

The emissions estimates for commercial aircraft for the 27 commercial service airports in Texas were developed using the Emissions Dispersion and Modeling System (EDMS) available from the Federal Aviation Administration (FAA). The EDMS model requires detailed inputs on aircraft operations by aircraft and engine type, which TTI obtained from the Bureau of Transportation Statistics (BTS). The EDMS model provides emission estimates for CO, HC, NO_X, and SO_X. A typical summer day air carrier factor was developed by reviewing commercial service operations data for several years at all of the towered airports in Texas and was used to estimate average summer day emissions.

TTI estimated general aviation emissions for airports with at least 10 based aircraft. Exhaust emissions were estimated using EPA AP-42 fleet average emission factors. Evaporative emissions related to fuel venting, pre-flight safety checks, and refueling were estimated using FAA methodologies (FAA, 1997). The general aviation operations data were obtained from the 1999 forecast in FAA's TAF report. The average summer day factor was developed by reviewing general aviation operations data for the three-year period 1996-1998 at all of the towered airports in Texas.

Operations data for military aircraft at public-use airports in Texas were obtained from the 1999 FAA Terminal Area Forecast (TAF). Generalized emission factors of CO, HC, NO_X, and SO_X were developed from the FAA aircraft emissions database and were used to calculate the 1999 emission inventories for military aircraft.

The summer daily emission inventories for general aviation were developed using the annual emission inventories and the average summer day factor. An average summer day factor for military aircraft was not provided in the TTI report; it was therefore assumed that there is no seasonal variation for military operations.

The 1999 emission inventory from TTI includes CO, HC, NO_X, and SO_X emissions. To estimate PM_{10} and PM2.5 emissions, ratios of the annual and summer daily emissions for PM10 and PM2.5 to the emissions for NO_X were calculated separately for commercial aircraft, general aviation, and military aircraft from EPA's current 1999 NEI. These ratios were applied to the NO_X emissions by aircraft type to estimate PM10 and PM2.5 emissions.

Uncertainties/Future Research

PM_{10} and PM2.5 emissions estimates are uncertain, especially for military aircraft. As stated above, PM emissions are not in the TTI report (and are not estimated by EDMS), and so the NEI 1999 NO_X to PM ratios were used. The NEI 1999 PM/NO_X ratios for military aircraft are much higher than for commercial and general aviation, and result in extremely high PM emissions for military aircraft. There is no detail in the 1999 NEI on military emissions by fuel type, or any other detail that would allow further checking. PM emissions in general, and military aircraft PM emissions in particular, should be further investigated and improved estimates made.

Aircraft emissions estimates for military aircraft at military bases are not included in the 1999 inventory. The TTI report lists ten military bases in Texas with significant flight operations. TTI has initiated contacts with all of these bases, and has been able to obtain only limited information on some bases. In addition, the emissions estimates for military aircraft at public-use airports are much more uncertain that the general and commercial aviation emissions estimates, as activity data are rarely available and only two aircraft types were used to characterize all military operations. EPA/EIIP are currently considering work to develop improved estimates (nationwide) for air emissions from the military aircraft source category; critical to the effort would be cooperation and data input from military air base authorities.

3.5 LOCOMOTIVE

Description of Source Category

The locomotive source category includes engine exhaust emissions associated with freight and passenger line-haul and switching locomotive activity. This source category is likely to be the most significant nonroad category for NOx and SO_2 and a significant category for PM emissions. The category is difficult to estimate equipment activity because the information is not publicly available. ENVIRON made multiple contacts with all Class 1 and Regional railroads, and a subset of Local and Switching and Terminus Railroads, operating within the state and received activity information for the two largest carriers, Union Pacific (UP) and Burlington Northern Santa Fe (BNSF), but was unable to complete the census of activity for all railroads and had no method to estimate the fraction of all railroad activity represented by UP and BNSF.

Methodology

This section outlines the methodology for estimating locomotive emissions for each Texas county for the 1999 base year from data publicly available. Emissions from locomotive activity in Texas for the base year 1999 were derived from published emission factors and fuel consumption data relevant to the industry. In general, the activity (fuel consumed) of locomotives was derived from generally accepted national fuel consumption estimates allocated to the state of Texas through publicly-available relative state fuel consumption estimates. These state fuel consumption estimates were then allocated to Texas counties through the use of an estimate of relative activity of freight transfers (ton-mile) within each county. The locomotive emissions in each county were then estimated by applying the EPA averaged emission factors.

Emission Factors and Activity Data

The EPA's Office of Transportation and Air Quality (OTAQ) has published HC, CO, NOx and PM emission factors for locomotives (EPA, 1997). These emission factors were available

separately for line-haul and switch locomotive duty cycles, and were also reported as fleet-averaged emission factors. The fleet-average emission factors were weighted based on national line-haul and switch engine fuel consumption data gathered by the Association of American Railroads (AAR), and were the emission factors applied in estimating emissions in this work; these are shown in the Table 3.5-1.

All PM emissions were assumed to fall into the PM10 particle size fraction and 92percent in the PM2.5 particle size fraction. This is consistent with the method applied in the National Emission Inventory to estimate particulate emissions from locomotives.

Sulfur dioxide emissions were estimated based on the percentage of sulfur present in distillate fuel consumed by locomotives. Federal Rule (40 CFR Parts 85, 89 and 92 Emission Standards for Locomotives and Locomotive Engines; Final Rule) allows from 0.2 to 0.4 percent by weight of sulfur in distillate fuel. The railroad industry uses both high and low sulfur diesel[1], however specific information on the quantities of each fuel were not available. A sulfur content of 0.33 percent by weight was therefore applied, consistent with the NONROAD model default.

Table 3.5-1. Locomotive emission factors.

	HC (g/gal.)	CO (g/gal.)	NOx (g/gal.)	PM (g/gal.)	SO2 (g/gal.)
Line-haul	10	26.6	270	6.7	
Switch	21	38.1	362	9.2	
Fleet Average	10.7	27.4	276.7	6.8	20.62 (0.33% sulfur fuel)

Activity data was available on the national fuel consumed by locomotives from the Association of American Railroads (AAR,2000), and a state level from the Energy Information Administration (EIA, 2000). The AAR data was based on fuel consumption information provided by railroad companies. The EIA data was based on surveys of fuel sales provided by fuel distributors. Table 3.5-2 presents the national fuel sales and national locomotive fuel consumption data for the years 1990 through 1999.

Table 3.5-2. National locomotive fuel consumption data for the years 1990 through 1999.

	Energy Information Administration (EIA) National Fuel Sales to Railroad Companies (Mgal)	Association of American Railroads (AAR) National Locomotive Fuel Consumption (Mgal)	AAR National Fuel Consumption relative to EIA National Fuel Sales
1990	3,105	3134	1.01
1991	2,879	2926	1.02
1992	3,173	3023	0.95
1993	3,000	3113	1.04

[1] http://www.epa.gov/otaq/regs/nonroad/locomotv/frm/loco1.txt

	Energy Information Administration (EIA) National Fuel Sales to Railroad Companies (Mgal)	Association of American Railroads (AAR) National Locomotive Fuel Consumption (Mgal)	AAR National Fuel Consumption relative to EIA National Fuel Sales
1994	3,141	3356	1.07
1995	3,429	3504	1.02
1996	3,447	3601	1.04
1997	3,278	3602	1.10
1998	3,180	3618	1.14
1999	3,239	3749	1.16

The EIA national fuel sales to railroad companies have been consistently less than the AAR locomotive national fuel consumption. Based on conversations with EIA[2] and AAR staff, the EIA data is most likely to underestimate national locomotive fuel consumption, and that the AAR data is the more reliable source for this information. Furthermore, EPA applied the AAR data in their locomotive rulemaking. The EIA is currently investigating the matter, however have advised that they are not expecting to reveal any findings in the near future.

Given that the EIA underestimates national locomotive fuel consumption, it was considered likely that the EIA also underestimates locomotive fuel consumption on a State level. Therefore, to adjust the national fuel consumption data from the AAR to reflect state locomotive fuel consumption the following equation was used:

$$F(\text{Corrected})_{\text{Texas}} = \frac{F(\text{AAR})_{\text{National}} \times F(\text{EIA})_{\text{Texas}}}{F(\text{EIA})_{\text{National}}}$$

$F(\text{Corrected})_{\text{Texas}}$ = Texas State Locomotive Fuel Consumption, corrected (gal)
$F(\text{AAR})_{\text{National}}$ = National Locomotive Fuel Consumption, reported by AAR (gal)
$F(\text{EIA})_{\text{Texas}}$ = Texas State Locomotive Fuel Consumption, reported by EIA (gal)
$F(\text{EIA})_{\text{National}}$ = National Locomotive Fuel Consumption, reported by EIA (gal)

The correction resulted in an adjustment of the EIA state fuel sales data by a national average adjustment factor of 1.16 for the year 1999. The adjustment factor may vary from state to state, however, for the purposes of estimating the locomotive state fuel consumption this factor was considered reasonable for estimating Texas activity.

The state locomotive fuel consumption estimate was then distributed to individual Texas counties using the US Department of Transportation's National Transportation Atlas (NTA) data[3] (DOT, 2001). The NTA provided a rail freight density rating along each rail route, as illustrated in Figure 3.5-1. DOT conversion software was used to convert the NTA data into

[2] Pers comm. June 25 2001 Daniel Walzer, Energy Information Administration.

[3] http://www.bts.gov/gis/ntatlas/natlas.html

ArcInfo compatible files. The rail freight density was then associated with spatial features in the GIS data to estimate relative county activity within Texas.

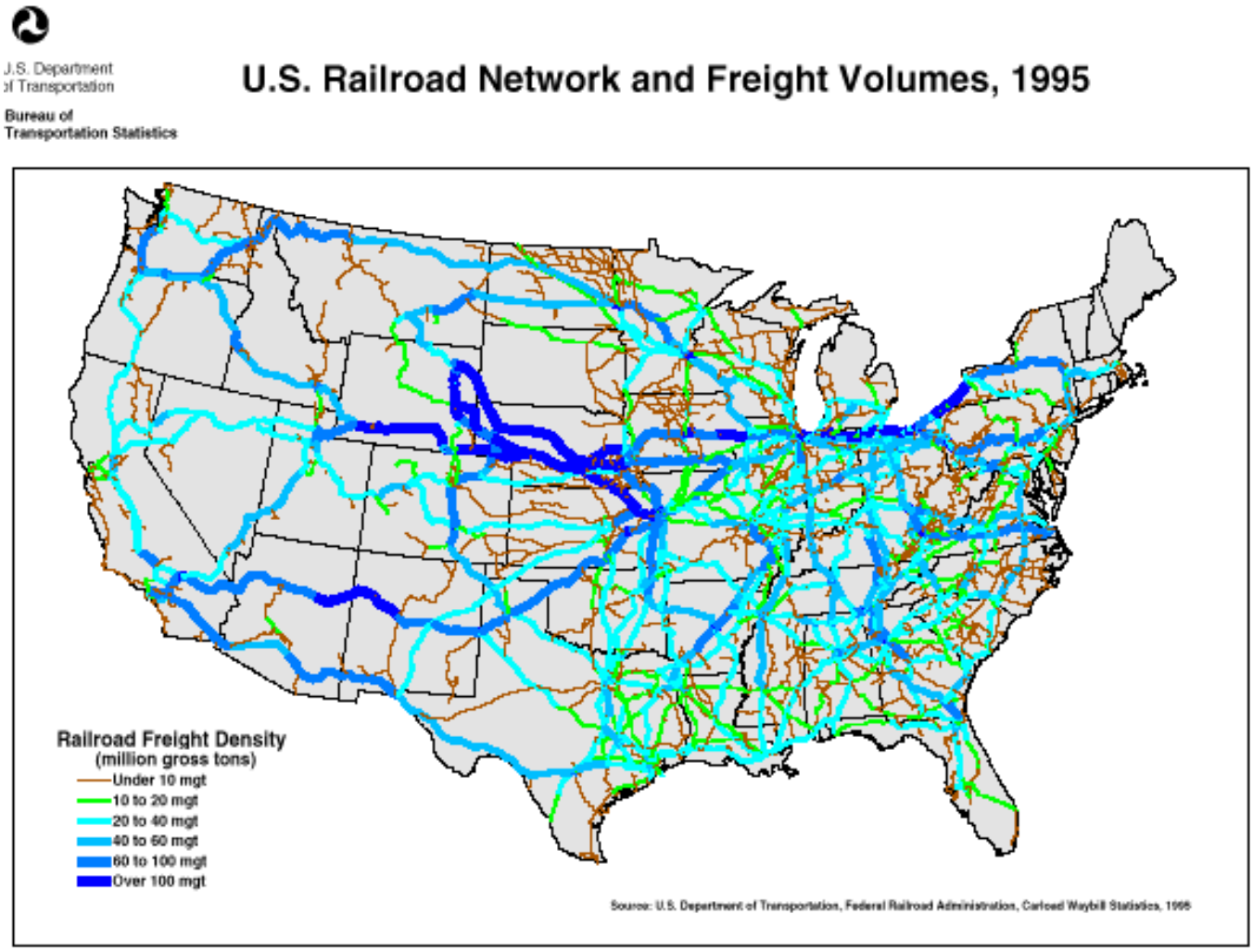


Figure 3.5-1: US DOT Bureau of Transportation Statistics' National Transportation Atlas

The NTA data classified rail lines according to the freight density system shown in Table 3.5-3. The NTA data was interrogated to derive a surrogate for rail activity in each county, based on the sum of the length of each rail line segment in the county, weighted by the median freight density for each segment of rail line.

Table 3.5-3. National Transportation Atlas rail line freight density classification system.

NTA Rail Line Freight Density Classification Indicator	Corresponding Freight Density Range (M Gross Ton-Miles/Mi)	Median Freight Density Applied in Estimating County Allocation of Emissions (M Gross Ton-Miles/Mi)
0	Unknown, abandoned or dummy	0
1	0.1 – 4.9	2.5
2	5.0 – 9.9	5.0
3	10.0 – 19.9	15.0
4	20.0 – 39.9	30.0
5	40.0 – 59.9	50.0
6	60.0 – 99.9	80.0
7	100.0 and greater	100

Sample Calculation

The following series of equations were used to calculate county-level annual locomotive emissions:

1. To estimate Texas locomotive fuel consumption

$$F(\text{Corrected})_{\text{Texas}} = \frac{F(\text{AAR})_{\text{National}} \times F(\text{EIA})_{\text{Texas}}}{F(\text{EIA})_{\text{National}}}$$

$F(\text{Corrected})_{\text{Texas}}$ = Texas State Locomotive Fuel Consumption, corrected (gal)
$F(\text{AAR})_{\text{National}}$ = National Locomotive Fuel Consumption, reported by AAR (gal)
$F(\text{EIA})_{\text{Texas}}$ = Texas State Locomotive Fuel Consumption, reported by EIA (gal)
$F(\text{EIA})_{\text{National}}$ = National Locomotive Fuel Consumption, reported by EIA (gal)

2. To estimate Texas state total emissions

$$E_{\text{Texas}} = F(\text{Corrected})_{\text{Texas}} \times EF$$

EF = Emission Factor, locomotive fleet averaged, pollutant specific (g/gal)
E_{Texas} = Texas State locomotive emissions (tons/year)

3. To allocate Texas state emission estimates to the county-level

$$E_{\text{County}} = E_{\text{Texas}} \times \frac{3_1^N \; D(N) \times L(N)_{\text{County}}}{3_{\text{All Texas Counties}} \; [\, 3_1^N \; D(N) \times L(N)_{\text{County}}]}$$

E_{County} = County locomotive emissions (tons/year)
N = Rail line Freight Density Classification reference number, 1-7
D(N) = Median Rail Freight Density for length of rail line (M Gross ton-miles/mile)
$L(N)_{\text{County}}$ = Length of rail line with Freight Density Classification N in each county (length)

Hence for Harris county, annual locomotive NOx emissions were estimated as follows:

1. To estimate Texas locomotive fuel consumption

$$F(\text{Corrected})_{\text{Texas}} = \frac{3{,}749 \times 591}{3{,}239}$$

$F(\text{Corrected})_{\text{Texas}}$ = 684 (Million gallons/year)
$F(\text{AAR})_{\text{National}}$ = 3,749 (Million gallons/year)
$F(\text{EIA})_{\text{Texas}}$ = 591 (Million gallons/year)
$F(\text{EIA})_{\text{National}}$ = 3,239 (Million gallons/year)

2. To estimate Texas state total emissions

$E_{\text{Texas}} = 684 \times 276.7$

E_{Texas} = 189 (Thousand Tonnes/year) = 208,294 (tons/year)
EF = 276.7 NOX (g/gal)

3. To allocate Texas state emission estimates to the county-level

$$E_{\text{Harris}} = 189{,}357.8 \times \frac{292.188}{7{,}050.535}$$

E_{Harris} = 7,847 (tonnes/year)
N = 1-7
D(N) = See Table 3.5-4
$L(N)_{\text{Harris}}$ = See Table 3.5-4

Table 3.5-4. National Transportation Atlas rail line freight density sample data.

N	D(N)	$L(N)_{\text{Harris}}$	$\Sigma_{\text{All Texas Counties}}$ L(N)
1	2.5	1.6987	18.9744
2	5	0.3408	6.65814
3	15	0.0000	8.95354
4	30	0.5200	13.9076
5	50	0.8740	19.4411
6	80	1.6703	14.2601
7	100	0.9341	206.8207
		Σ_1^N D(N) x $L(N)_{\text{County}}$	$\Sigma_{\text{All Texas Counties}}$ [Σ_1^N D(N) x $L(N)_{\text{County}}$]
		292.1885	7050.5346

Uncertainties/Future Research

The EIA national fuel sales estimates to railroad companies underestimate national locomotive fuel consumption. This finding has been confirmed by the EIA, who are currently investigating the matter. Given that the EIA underestimates national locomotive fuel consumption, it was assumed for this work that the EIA Texas state fuel sales to railroad companies is underestimated by the same proportion as the EIA national fuel sales data. It is possible that the degree of underestimation may vary from the national value due to state-specific influences. Future emission estimates should investigate if any specific influences in Texas affect the accuracy of the fuel sales data collected by the EIA.

A number of inherent uncertainties arose in applying the NTA data to allocate emissions to county level. The first of these is a result of applying the median rail freight density within each density range. The NTA data also contained freight density classification indicators that were greater than seven, the maximum rail freight density. However, no information was available on what the rail freight density range was for these indicators, so an estimate was assumed for this indicator range.

The accuracy of the state estimates and the state to county emissions allocation can be tested at a later date using alternative county rail activity data. Such data are available from Reebie Associates, in the form of a Freight Movements database. The database contains rail freight ton-miles traveled in each Texas county, which can be applied to allocate rail activity down to the county level or used with fuel consumption estimates to estimate state totals. The Reebie Associates Freight Movements database is based on weigh bill data collected by the Surface Transportation Board, and a freight route model which determines the distance the freight has been transported based on the origin and destination point of the commodity being freighted. At the request of TNRCC, ENVIRON has purchased and is providing TNRCC an independent proprietary estimate (Reebie, 2001) of rail activity within Texas. This then provides freight ton-miles for each county. It should be recognized that the Surface Transportation Board collects weigh bill data based on samples of roughly 10 percent of rail freight movements, and therefore there are likely to be uncertainties in this data also. Also, freight movements do not provide an estimate of switching locomotive activity. The Reebie database was not available in the time required for analysis, and so should be reviewed in a future effort.

ENVIRON made multiple contacts in an attempt to gather information directly from all Class I freight and passenger railroad companies operating in Texas; namely Union Pacific, BNSF, Kansas City Southern, Texas Mexican and Amtrak. ENVIRON also made multiple contacts with the aim of obtaining activity data from all Regional Railroads, and from a subset of the remaining railroad companies, but it became clear that only the Class I and Regional railroads kept any useful activity records.

Table 3.5-5. Railroads operating within Texas.

Railroad	Operating Miles and Contact Information
Class I Railroads	
Burlington Northern and Sante Fe	4,667 miles; Lyle Stanley (785) 435-2291
Union Pacific	6,238 miles; Deb Stephans (402) 271-2235
Kansas City Southern	381 miles; Michael Haverty (816) 983-1303
AMTRAK	0 miles; (202) 906-3000/3872
Regional Railroads	
South Orient	380 miles; Roy Willims (915) 643-6476
Texas Mexican	544 miles; Manuek Zulaica (956) 728-6700
Local Railroads	
Angeline & Neches	15 miles; David Perkins (409) 634-4403
Blacklands	64 miles; Wayne Defebaugh (903) 739-0738
Border Pacific	32 miles; Sam Vale (956) 487-5606
Georgetown	30 miles; (806) 828-4841 or (806) 762-3689
Grainbelt	12 miles; not available
Gulf, Colorado, & San Saba	68 miles; Richard McClure (847) 382-0523
Kiamichi	13 miles; Mitch Becker (580) 326-8357
Panhandle Northern	31 miles; Gary Earnshaw (806) 273-3513
Pecos Valley Southern	34 miles; Guy Weatherman (915) 445-2487
Point Comfort & Northern	16 miles; David Besio (972) 487-8180
Rockdale, Sandow, & Southern	10 miles; Kathryn Johnston (512)446-3478
Sabine River & Northern	40 miles; Jerry Wisener (806) 828-4841
Texas & New Mexico	34 miles; Curtis Goodin (806)637-8323
Texas & Northern	8 miles; Randy Pirkey (903) 656-6855
Texas North Western	43 miles; Ken Rankin (806) 935-7474
Texas Northeastern	117 miles; Kent Snead (512) 863-2538
Texas Rock Crusher	6 miles; Steve Coffman (915) 643-5105
Timber Rock	16 miles; Pat Lacaze (337) 463-2702
West Texas & Lubbock	104 miles; Rich Thull (806) 785-8668
Western	1 mile; not available

Railroad	Operating Miles and Contact Information
Switching and Terminus Railroads	
Alamo Gulf Coast	10 miles; Ray Tucker (210) 208-4097
Brownsville & Rio Grande International	41 miles; Larry Cantu (956) 831-7731
CMC	5 miles; Mark Sjolander (409) 258-4030
Corpus Christi	23 miles; not available
Dallas, Garland & Northeastern	187 miles; Dave Eyerman (972) 487-8180
Fort Worth & Western	276 miles; Jim Martin (817) 763-8297
Galveston	43 miles; Ron Surovik (409) 762-5227
Longhorn	162 miles; not available
Moscow, Camden, & San Augustine	7 miles; Robert Moore (409) 398-4640
Orange	1 mile; not available
Port Terminal	37 miles; L.J. Jenkins Jr. (713) 393-6504
Rio Valley Switching	78 miles; Greg Cundiff (618) 632-4400
South Plains Lamesa	5 miles; Larry Wisener (806) 828-4841
South Plains Switching	15 miles; Larry Wisener (806) 828-4841
Southern Switching	19 miles; Larry Carrizales (915) 677-3601
Southwestern	76 miles; Ron Lindsey (806) 435-2322
Texas City Terminal	5 miles; J.B. Mathis (409) 945-4461
Texas South-Eastern	12 miles; Gray Smith (936) 829-5613
Texas, Gonzales, & Northern	12 miles; Stanley Bias (830) 672-9259
Texas, Gonzales, & Northern	12 miles; Stanley Bias (830) 672-9259
Wichita, Tillman, & Jackson	20 miles; Richard Bertel (817) 737-7288

Union Pacific (2001) and BNSF (2001) provided fuel consumption estimates; those are shown in Table 3.5-6 in comparison with the estimates from this work. The combined total fuel consumption of these two railroad companies accounted for 44 percent of the total fuel consumed in Texas by locomotives in 1999 as estimated in this work. ENVIRON could not determine an acceptable method to scale to extrapolate the remaining fuel consumption, therefore this data was not used. Because the fraction of fuel consumption (44%) reported by BNSF and Union Pacific was considerably lower than the fraction of railroad miles (79%) operated by the two largest carriers, there is considerable uncertainty in the overall state estimate and the geographic allocation.

Table 3.5-6. State total fuel consumption estimates (gallons of fuel).

State Total Estimate	Line-Haul	Switching	Totals
This work	-	-	684, 343,511
Union Pacific (2001)	173,042,220	4,077,780	177,120,000
BNSF (2001)	116,489,000	7,506,590	123,995,590

The data provided by the Union Pacific and BNSF has been forwarded to TNRCC. It should also be noted that it has become evident that railroad companies do not keep records of actual fuel consumed on a county level. The data provided by the railroad companies is an estimate of fuel consumption, based on freight ton-miles multiplied by average fuel consumption per freight ton-mile.

3.6 CONSTRUCTION AND MINING EQUIPMENT

Description of Source Category

This section describes the update to the emission estimates for construction equipment for each Texas county for the 1999 base year. The construction source category includes emissions from engines associated with nonroad vehicles and equipment used for construction, mining, and maintenance activities, such as residential housing, roads and highways, industrial construction or landfill, mining, and material handling. Examples of types of construction equipment include Pavers, Rollers, Scrapers, Concrete Saws, Off-highway Trucks and Rough Terrain Forklifts.

Methodology

Diesel construction and mining equipment population and usage estimates were estimated for all diesel equipment greater than 25 horsepower (under Source Category Codes [SCC] 2270002***) for all Texas counties. These estimates are based on construction and mining survey work from the Houston-Galveston Area Diesel Construction Emissions Project (ERG, 2000). The Houston survey data were gathered for the following ten categories, each reflecting a unique equipment ownership category:

- Rental
- State/Municipal Owners
- State/Municipal Contractors
- Residential Contractors
- Commercial Building Contractors
- Highway Contractors
- Industrial Construction and Maintenance

- Mining and Aggregate (Standard Industrial Codes (SIC) 10, 12, 14 and 3273 or North American Industry Classification System (NAICS) codes 212 and 3273)
- Landfill
- Marine Ports

Emission Factors and Activity Data

The emission factors used to generate the emission estimates come directly from the most recent (June 2000) release of the NONROAD emissions model. This model included the EPA's best estimates of base and future year emission factors estimates. Adaptation of the emissions for Texas-specific rules was made to estimates derived from the NONROAD model.

The Houston-area equipment population survey data were extrapolated to other Texas counties using surrogates, which were expected to indicate the amount of construction activity occurring in a given county. Table 3.6-1 indicates the surrogates used for each equipment use/ownership category. See Appendix 3-A for the matrix of relevant Dodge (F.W. Dodge, 1999) construction groupings referred to in Table 3.6-1 and the Houston survey results.

Table 3.6-1. Surrogates for extrapolating the Houston survey equipment populations to other Texas counties**.**

Construction Equipment Use/Ownership Category	Surrogate Description	Source of Surrogate Data
Rental Companies	Permit $ for all Dodge construction groupings FW Dodge	
State/Municipal Owners	Human Population	US Census Bureau
State/Municipal Contractors	Permit $ for relevant Dodge construction groupings	FW Dodge
Residential Contractors	Permit $ for relevant Dodge construction groupings	FW Dodge
Commercial Building Contractors	Permit $ for relevant Dodge construction groupings	FW Dodge
Highway Contractors	Permit $ for relevant Dodge construction groupings	FW Dodge
Industrial Construction and Maintenance	Permit $ for relevant Dodge construction groupings	FW Dodge
Mining and Aggregate	Mining and Aggregate Employee numbers	County Business Patterns, US Census Bureau[1]
Landfill	Landfill Tonnage	TNRCC [2]
Ports	Port Tonnage	Waterborne Commerce of United States, US Army

Construction Equipment Use/Ownership Category	Surrogate Description	Source of Surrogate Data
		Corps of Engineers[3]

ENVIRON also applied the revised construction equipment hours of use, based on the findings of the Houston Galveston Area Diesel Construction Emissions Project survey work. Revised hours of operation for all types of construction equipment except Cranes (SCC 2270002045) and Crushing/Processing Equipment (SCC 2270002054) were used. Table 3.6-2 lists the NONROAD model default and revised construction equipment hours of use.

Table 3.6-2. NONROAD model default and revised construction equipment annual hours.

SCC	Source	NONROAD Default	Revised
2270002003	Pavers	821	672
2270002015	Rollers	754	719
2270002018	Scrapers	914	556
2270002021	Paving Equipment	622	344
2270002024	Surfacing Equipment	561	575
2270002027	Signal Boards	535	532
2270002030	Trenchers	593	603
2270002033	Drill Rig	466	513
2270002036	Excavator	859	777
2270002039	Concrete Saws	580	510
2270002045	Cranes	806	806
2270002048	Motor Graders	821	732
2270002051	Off-Highway Trucks	1641	1257
2270002054	Crushing and Processing*	955	0
2270002057	Rough Terrain Forklifts	662	1033
2270002060	Rubber Tire Loaders	761	872
2270002063	Tractor/Dozer	899	469
2270002066	Backhoes	1135	781
2270002069	Crawler Tractor	936	829
2270002072	Skid Steer Loader	818	845
2270002075	Off-Highway Tractor	855	853
2270002081	Other Construction Equip.	606	511

* Assigned either to surfacing or other construction equipment

Sample Calculation

The following equation was used to extrapolate the 8-county Houston equipment population survey data to other Texas counties using the surrogate data for each construction equipment use/ownership category:

$$Pop_{county} = Pop_{Houston} * [AS_{county}/AS_{Houston}]$$

Pop_{county} - County equipment population

$Pop_{Houston}$ - 8-County Houston-area equipment population
AS_{county} - Construction activity surrogate data for county
$AS_{Houston}$ - Construction activity surrogate data for Houston

Hence equipment populations were extrapolated from Houston to any county for residential construction activity for Pavers, Rollers and Excavators for example as follows:

The activity surrogate data from F.W. Dodge for residential construction permit dollars are summed for Houston and a sample county respectively.

FW Dodge Permit $	**$AS_{Houston}$**	**AS_{County}**
Single Housing	$2,994,430,514	$246,536,866
Two Family Housing	9,705,604	$0
Apartments	$401,718,524	$8,984,612
Total Residential Construction	**$3,405,854,641**	**$255,521,478**

The ratio of the sample county and Harris residential construction permit dollars was applied to Houston equipment populations, to arrive at revised sample county equipment populations.

Equipment Type	**$Pop_{Houston}$**	**AS_{County} / $AS_{Houston}$**	**Pop_{county}**
Pavers (SCC 227002003)	29	$255,521,478 / $3,405,854,640	2
Rollers (SCC 227002015	210	$255,521,478 / $3,405,854,640	16
Excavators (SCC 2270002036)	264	$255,521,478 / $3,405,854,640	20

Uncertainties/Future Research

There are many uncertainties in relating Houston-area survey and activity surrogate information to the entire State of Texas. Construction population surveys and methods for this area may be unrepresentative of the entire state given the diversity of construction and mining practices around Texas.

One of the uncertainties in applying the F.W. Dodge permit dollars is that F.W. Dodge valuation by calendar year is determined from when the permit is issued; the full construction valuation is assigned to the year that the permit was issued, and the 1999 dollar estimates were much higher than in other years and in F.W. Dodge forecasts. However, because large projects, which may span multiple years, are included only in the year in which the project began, this may produce a bias for the state totals or some counties where particularly large projects were begun in 1999. On the other hand, if large construction projects were begun in 1998 and continued in 1999, this can result in a bias in the other direction. In addition, permit valuation may be different than the actual project valuation due to project overruns, tax policy, or other reasons; this is not accounted for in the Dodge data.

Most coal and mineral mining in Texas is done in open pits or by liquid extraction (e.g., sulfur and uranium). Large pits, such as those at ALCOA-Rockdale (lignite) or the Georgetown Pit (limestone aggregates) or the coal mining in the East Texas area, are not in the emissions inventory when we consider all the trucks, excavators, and support equipment. There was no clear way to accurately extrapolate these sources from the Houston-Galveston surveys because Houston does not have any mines, other than for small quantities of molten sulfur and washed sand. Some of these larger mines use other types of construction equipment than is used in Houston, such as mining trucks, which can exceed 200-ton loads (>2,000 BHP).

Aggregate facilities were assumed to have one front-end loader each. There are State Comptroller of Public Accounts databases, and telephone directories can be used as well, to find these outlets for finished aggregates (concrete, hot-mix asphalt, asphaltic concrete). Other aggregate facilities called "Mini" mills may need to be added to the estimates in this work because they are sometimes exempted or not recorded in the point source database. The estimate of one front-end loader or a very large one should also be revisited. The aggregate-processing category is important because there are so many in Texas, especially in high-growth areas surrounding Dallas and Austin.

By far the largest source of uncertainty in the previous Houston-Galveston Heavy-Duty Diesel Construction Equipment Inventory survey was the rental market. The trend in equipment ownership is towards more and more equipment leasing. There are several improvements that can be made to the method to extrapolate rental equipment owners, such as obtaining tax data for the rental market, but such approaches were beyond the scope of this work.

3.7 COMMERCIAL MARINE

Description of Source Category

Commercial marine vessels comprise all vessels not included in the recreational marine vessel population. For the purposes of this work, they are considered to be ocean-going vessels (OGV), tow or push boats (for barge traffic), tugs (for assisting OGV), ferries, dredges, and commercial fishing vessels. Based on data from the Texas Parks and Wildlife Department, charter sport-fishing (labeled either 'livery' or 'com-fish'), light commercial (labeled 'com-other'), and municipally-owned vessels (such as those owned by police, fire, or parks departments labeled 'political') were assumed to be included in the recreational marine vessel population available from the Texas boat registration population.

Methodology

Commercial marine emissions were estimated following the procedures outlined in EPA (1992) and derived from BAH (1991). Essentially, the emissions were estimated using the equation shown below for OGV, tug, push boat, and ferry activity. Commercial fishing vessel

emissions were estimated from BAH (1991) using fish catch tonnage as a method to convert from 1990 emission levels. The Houston-Galveston Area Vessel Emissions Inventory (HGAVEI, Starcrest, 2000) determined the emissions associated with dredge activity for 1997 in Houston and were converted to state totals for Texas in 1999 using dredge tonnage as the activity indicator.

Emissions = Population * Power * Load Factor * Activity * Emission Factor

where:

Population = Vessel Population or Ship Calls
Power = Average Power (hp)
Load Factor = Load Factor (fraction of available power)
Activity = Activity (hrs)
Emission Factor (g/hp-hr)

Emission Factors and Activity Data

EPA has detailed the emission factors for the shipboard generator and propulsion engines in several documents (BAH, 1991). These emission factors and estimates represent the official guidance for emission inventory preparation and are provided here as a reference (EPA, 1992). However, the data on which these EPA (1992) emission factors were derived was not referenced, and a number of studies determining emission rates have been completed since the time of the guidance. EPA reviewed the base emission factor estimates during the determination of the impact of recent federal rulemakings (EPA, 1999, 1999), but at this time they are not official guidance. The revised EPA emission factors were used for this work; these are described in Appendix D of Starcrest (2000) and are shown in Table 3.7-1.

Table 3.7-1. Baseline emission factors for engines on ocean-going vessels.

Engine Category	HC [g/kW-hr]	NOx [g/kW-hr]	CO [g/kW-hr]	PM [g/kW-hr]
Generator Engines (5-30 l/cylinder)	0.134	13.36	2.48	0.32
# 3 Medium Speed Propulsion Engines (> 300 rpm) (> 30 l/cylinder)	0.5	12	1.6	1.24*
# 3 Slow Speed Propulsion Engines (< 200 rpm) (> 30 l/cylinder)	0.5	17	1.6	1.16*
Steam Generators	0.07	0.30	2.80	2.49*

* Using 3% sulfur fuel for propulsion engines

For harbor craft (all vessels except OGV) the emission factors used in this work were those shown in Table 3.7-2 based on the average power of the vessels.

Table 3.7-2. Emission factors for harbor craft.

Power Range [kW]	HC [g/kW-hr]	NOx [g/kW-hr]	CO [g/kW-hr]	PM [g/kW-hr]
75-1,000	0.27	10	1.5	0.3

Activity data for OGV emissions were available from the HGAVEI for 1997 for the ports included within the Houston-Galveston nonattainment area, and these data were used directly for these ports in the Houston area (including Houston, Texas City, Galveston, and Freeport). Also, EPA (1999) supplied activity information for 1996 at the Port of Corpus Christi, which was used in estimating emissions at this port in this work.

In order to estimate the activity of OGV, vessel trips (inbound and outbound), characteristic (power and speed), and time in hotelling mode for other Texas ports (Beaumont, Port Arthur, Matagorda, and Brownsville), a surrogate method was employed to convert data from detailed port data from EPA (1999) to other Texas ports. Total vessel calls for each port were estimated by using the ratio of the vessel calls from the US Army Corps of Engineers annual Waterborne Commerce Database (USACE, 1999) multiplied by the actual vessel calls available from the EPA (1999) data derived from more accurate Marine Exchange or Port Authority 1996 data for Corpus Christi or Tampa. The USACE vessel trips for these and other ports for 1996 are shown in Table 3.7-3 with 1999 values used to scale 1996 results for the 1999 base year estimates.

Table 3.7-3. 1996 OGV vessel calls to Texas ports (USACE, 1999).

PORT NAME	BC	CS	GC	OT	PA	RF	RO	TA	VC	Grand Total
Corpus Christi, TX	605	10	40	4,218	0	0	0	2,186	0	**7,059**
Port Arthur, TX	244	18	96	77	8	2	12	934	-	1,390
Matagorda Ship Channel, TX	282	3	47	8	-	-	-	192	-	532
Victoria, TX*	-	-	-	-	-	-	-	-	-	-
Brownsville, TX	278	69	57	34	5	-	14	299	5	761
Beaumont, TX	39	3	6	193	-	-	-	1,223	-	**1,465**
Tampa, Fl	1,964	65	470	49	197	487	132	1,255	5	**4,624**

* The Port of Victoria was found to service only tug traffic.

Table 3.7-4. 1999 OGV vessel calls to Texas ports (USACE, 1999).

PORT_NAME	BC	CS	GC	OT	PA	RF	RO	TA	VC	Grand Total
Corpus Christi, TX	722	12	48	5,037	-	-	-	2,036	-	7,855
Port Arthur, TX	452	34	177	159	14	3	23	326	-	1,188
Matagorda Ship Channel, TX	327	3	54	12	-	-	-	298	-	694
Victoria, TX	-	-	-	-	-	-	-	-	-	-
Brownsville, TX	133	33	27	12	2	-	7	202	2	418
Beaumont, TX	45	3	8	225	-	-	-	2,211	-	2,492

BC = Bulk Cargo Carrier
CS = Container Ship
GC = General Cargo
OT = Other, Unknown, or Undefined
PA = Passenger, Cruise and Excursion
RF = Reefer
RO = RORO and Ferry
TA = Tanker
VC = Vehicle Carrier

In studies performed for EPA, the vessel characteristics, such as power level and cruise speed, were determined either from Lloyds data of each ship or from power correlations based on design and speed of each vessel. This type of data was not available for this study for Beaumont, Port Arthur, Matagorda, and Brownsville, so the vessel characteristics were determined from ports considered to be most like these four OGV Texas ports, which, based on typical vessel types and drafts, were Corpus Christi for Beaumont and Tampa for Port Arthur, Matagorda, and Brownsville. The reason for using Tampa as the representative port for some of Texas' ports was that, overall, smaller and lower power ships visit these ports and vessels visiting Tampa are smaller than those visiting Corpus Christi. Associating these Texas ports with data from Corpus Christi or the Houston area ports would likely overestimate the average vessel power and therefore the emissions.

The load factor for the port calls was estimated for four modes of operation; cruise (full speed), reduced speed zone (RSZ), maneuvering (EPA assumed 4 knots), and hotelling (while docked). These modes associate load with vessel speed through the use of the equation below, where full cruise power is assumed to be 80 percent of full engine power and 10 percent hotelling load from the assumption provided by BAH (1991). Maneuvering and RSZ loads were calculated based on the average vessel speed by vessel type using the equation below.

$$D = B \times (\text{vessel speed})^3 + A$$

where:

D = power demand, horsepower
B = multiplier based on the vessel's top speed and maximum power output (assumed to be about 70% of full load)
A = constant representing the minimum load required to run the engine plus any auxiliary load (such as a shaft generator typically about 10% of full engine load)

The activity in hours for the transit modes (cruise, RSZ and maneuvering) was determined from vessel speeds (determined from the detailed vessel data, conversations from port authorities or harbor pilots, and 4 knots assumed for maneuvering) and port geography, such as 25 miles out from the breakwater for cruise or the distance from port to the breakwater for RSZ.

For other types of vessels, including tugs, push boats, and ferries, annual activity (number and hours) and average vessel power and load were used to calculate emissions. The number of towboat and tugboat transits was obtained from Volume 5 of the Navigation Data Center (NDC) Publications and U.S. Waterway Data CD provided by the U.S. Army Corps of Engineers (USACE). Volume 5 includes data for the year 1999. This resource provides detailed data on the movements of vessels at ports and harbors and on waterways of the U.S., including the number of trips made by towboats and tugboats. Mileage for each transit was estimated by scaling the distances from maps showing the various ports, harbors, and waterways as shown in Table 3.7-5. The only ferry running outside of the Houston-Galveston area was the Port Aransas ferry, for which vessel power and yearly transits were chronicled from discussions with the TxDOT District Public Information Officers.

Table 3.7-5. Activity data for tug and push boats in Texas. (Starcrest provided estimates from HGAVEI of average power 1,059 hp, load 69%, and speed 5 miles/hr).

		Domestic		Foreign	
Geographic Region	**Mileage**	**Up or Inbound**	**Down or Outbound**	**Up or Inbound**	**Down or Outbound**
Sabine River to Galveston	88	10,790	10,729	0	0
Galveston to Corpus Christi	200	6,593	6,794	0	0
Corpus Christi to Mexican Border	130	539	584	0	0
Sabine Neches Waterway	19	12,668	9,686	30	22
Orange (Sabine River)	3	556	541	4	3
Beaumont (Neches River)	16	5,230	5,141	10	6
Port Arthur	6	2,344	2,363	16	13
Sabine Pass Harbor	3	596	434	0	0
Cedar Bayou	25	379	308	0	0
Houston Ship Channel	52	30,426	30,417	40	48
Dickinson Bayou	13	189	189	0	0
Texas City	6	4,360	4,179	0	1
Galveston Channel	3	1,957	2,339	16	17
Chocolate Bayou	2	939	915	0	0
San Bernard River	15	284	274	0	0
Freeport Harbor	5	6,463	6,324	4	3
Colorado River and FD Channels	62	82	0	0	
Matagorda Ship Channel	1	655	664	0	0
Channel to Victoria	32	1,442	1,218	0	0
Corpus Christi	27	6,962	6,928	10	11
Corpus Christi Ship Channel	9	6,999	6,926	10	11
Tributary Arroyo Colorado	35	127	118	0	0
Brazos Island Harbor		350	333	12	14
Brownsville	16	313	331	11	14

Geographic Region	Mileage	Domestic		Foreign	
		Up or Inbound	Down or Outbound	Up or Inbound	Down or Outbound
Anahuac Channel	30	108	108	0	0
Channel to Aransas Pass	6	11	14	0	0
Double Bayou	22	104	108	0	0
Harbor Island		33	37	0	0
Port Isabel	3	23	17	0	0

Dredging activity for 1999 was obtained from Volume 5 of the NDC Publications and U.S. Waterway Data CD provided by the USACE. The USACE tracks dredging activity by contracts awarded during each fiscal year (1 September through 31 August) and are shown in Table 3.7-6. As a result, many dredging contracts awarded in 1998 continued in 1999, and some contracts awarded during the year 2000 began in 1999. Therefore, dredging data were compiled for each of the three fiscal periods of 1998, 1999, and 2000.

Table 3.7-6. 1999 Dredging activity for Texas.

Location	Estimated Cubic Yards
BIH Brownsville Entrance Ch	700,000
Barbours Terminal	1,000,000
Bayport, flare to turning basin	2,017,000
CCSC Corpus Christi Ent. Ch.	900,000
CCSC Inner Basin to BCN 82	2,500,000
Cedar Bayou Channel	573,000
Channel to Victoria 2B	1,000,000
Chocolate Bayou	1,400,000
Freeport Entrance Channel	1,000,000
GIWW, CC Bay to Mud Flats	1,700,000
GIWW, Ch to Palacios	1,900,000
GIWW, Col	3,730,000
GIWW, Freeport to Brazos Crossing	1,995,400
GIWW, HI	1,100,000
GIWW, Port O'Conner to S.A Bay	847,000
GIWW, Turnstake to Live Oak	1,500,000
HGNC Jetty and Entrance Channel	7,500,000
HSC Greens to Sims Bayou	1,200,000
MSC, Matagorda Entrance Ch.	500,000
Port Mansfield, Entrance Ch.	300,000
SNWW, Neches River, Lower R	1,200,000
SNWW, Port Arthur TB to Jnct.	1,500,000
SNWW, Sabine Pass Ch.	1,600,000
Total	37,662,400

For commercial fishing vessel activity, it was difficult to find exact data on vessel operation so the base year estimates were scaled from BAH (1991) estimates for the Houston-Galveston area. Here, fishing vessel registrations (Fisheries of the United States, 1990) were compared to annual landings and dollar revenue, obtained from local, state and federal regulatory agencies, such as the National Marine Fisheries Service (NMFS). Some assumptions regarding throttle setting, brake horsepower, hours of use, and resulting emissions were then made so that one could apply emission factors to the dollar revenue statistics. BAH admitted that their method could misrepresent the emissions from fishing vessels. However, emissions were less than 5 percent of the total commercial marine vessel inventory, so any discrepancy was considered to be minor. The NMFS fishing landings for 1999 and 1990 were used to scale the 1990 emission estimates to 1999 and are shown in Table 3.7-7.

Table 3.7-7. 1999 Fishing catch/landings.

Port	Millions Pounds
Brownsville - Port Isabel	22.2
Palacios	12.8
Galveston	18.0
Port Arthur	8.9
Freeport	5.9
Aransas Pass	3.2
Rockport	3.2
Seabrook	3.8
Houston	7.5
Port Lavaca	7.5
Total Identified	78.0
All others	14.9
1999 Totals	92.9
1990 Totals (BAH, 1991)	107.0

Sample Calculation

Emission estimates for the detailed ports (Corpus Christi and Tampa) are derived from data provided by EPA (1999), which include vessel power by vessel type, size, and propulsion engine type. For example, the average vessel power for Bulk Carriers of greater than 90,000 dead weight tons with 2-stroke slow speed engines visiting Corpus Christi in 1996 was 19,693 hp.

The load factor at cruise was 80% of that power at a cruise speed of 14.51 knots for Bulk Carriers, while the reduce speed zone (RSZ) speed was approximately 10 knots. The load for the RSZ was then calculated below.

$$\text{RSZ load} = 0.7 * (10/15)^3 + 0.1 = 0.33 \text{ or } 33\% \text{ of full power}$$

For Corpus Christi in 1996, 36 vessel calls occurred for Bulk Carriers of this size. With a time in the RSZ of 6.6 hours multiplied by the emission factors above, yields an estimate of yearly emissions as shown below.

RSZ NOx emissions = 36 * 19,693 * 0.33 * 6.6 * 12.98 = 20,042, 271 grams/year
(Actual 19,535,478 without rounding errors)

For all Bulk Carriers summed, the reduced speed emissions in Corpus Christi was 90.5 tons/year with an average RSZ time of 5.28 hours for all types of Bulk Carriers. For the Port of Beaumont, considered to be like the Port of Corpus Christi, 39 trips were recorded for Beaumont in 1996 (and 45 trips in 1999) compared with 605 in Corpus Christi in 1996 by the Corps of Engineers. Also, the RSZ was estimated to be 56.5 miles and the average speed of 7 knots (producing an average load factor of 0.17 from the equation above) produced an estimate of 16.14 hours in the RSZ mode per vessel call. Therefore, the 1996 and 1999 emissions for Beaumont are calculated by multiplying a series of ratios with the Corpus Christi estimates.

Beaumont RSZ Mode NOx Emissions:

1996 Beaumont NOx Emissions = 90.5 * (0.17/0.33) * (16.14/5.28) * (39/605)
= 9.3 tons (without rounding errors)

1999 Beaumont RSZ NOx Emissions = 9.3 * (45/39) = 10.7 tons/year

In this manner emissions from all types of ocean-going vessels are estimated and summed for the ports. The harbor vessels are calculated separately using the same type of equations summing average vessel power and load with annual hours of operation multiplied by the emission factors detailed above. Dredging and fishing emission estimates were determined by the ratio of the activity surrogate (tons of dredged material or landings) multiplied by the base emission estimates for dredging (Starcrest, 2000) or fishing vessels (BAH, 1991).

Uncertainties/Future Research

For ocean-going vessels (OGV), the gulf ports where vessel characteristics were have been well chronicled (Houston, Corpus Christi, and Tampa) are considerably larger in terms of tonnage as well as available vessel draft than the other four ports for Texas. So the vessel power for these smaller ports may be overestimated compare to the vessel calling on these ports. Also, for OGV, the emissions were estimated 25 miles out from the pilot pickup and included in these estimates. This approach excluded much of the vessel traffic along the coast that may or may not call on a Texas port.

Dredging contracts fluctuate from year to year and some multi-year projects may not be carried through the estimates. These estimates only used the 1999 contracted tonnage which was less than the 1998 or 2000 totals, so these estimates may be low.

Fishing vessels are the least understood estimates as the number and activity of the vessels are not well characterized. Some vessel may work significantly off-shore as to not be included in a nonattainment area. Also, average power, load, and annual hours were not well understood at the time of the original emissions estimates (BAH, 1991).

Another method for estimating emissions from diesel-powered marine vessels was prepared for the State of Washington using through the Tennessee Valley Authority (TVA) Barge Costing Model (Corbett, 2001). This work appeared to estimate total marine diesel fuel use by state or locality for any type of marine vessel propulsion or shipboard engine and is reported to increase the activity estimates over previous methods (Corbett and Fischbeck, 2000) including this work. While this approach would affect all diesel marine emission estimates, it would have the greatest effect on the push boat and tug activity estimates.

3.8. LAWN AND GARDEN SURVEY APPROACH

Introduction

Lawn and garden (L&G) estimates made by the draft NONROAD model estimate emissions from lawn and garden equipment by using a national estimate allocated to a specific region and day of week in a 'top-down' approach. The lawn and garden equipment is split between the commercial and the residential owner/operators because of differences in the types of equipment and typical usage for these two owner/operators types. National estimates are made of equipment population, a typical distribution of the power of equipment, average annual activity, and typical load during operation. The regional allocation for residential owners is performed with a rough allocation approximation using the relative number of single and double (duplex) family housing units from 1990 Census by county adjusted by 1997 county human population estimates from U. S. Census. The regional allocation for commercial owners was performed with a rough allocation approximation using the relative number of employees in landscape and horticultural services from the Census County Business Patterns (CBP) found in the Standard Industrial Code (SIC) 078, which has been replaced by the North American Industry Classification System (NAICS) - 561730 for Landscaping Services.

This NONROAD default method of producing regional lawn and garden activity and emission estimates ignores many regional aspects of such activity. In a report prepared by ENVIRON for the EIIP (ENVIRON, 1997), a survey approach was recommended to determine lawn and garden activity for a given region. The survey work and emissions estimates need to be done separately for residential and commercial use because of the different types of owner/operators.

The types of equipment covered by the lawn and garden category are shown in Table 3.8-1. Some equipment types will primarily or exclusively be associated with commercial owner/operators.

Table 3.8-1. Types of lawn and garden equipment

Lawn mowers
Rotary Tillers
Chain Saws
Trimmers/Edgers/Brush Cutter
Leafblowers/Vacuums
Snowblowers* (included for completeness)
Rear Engine Riding Mowers
Front Mowers
Shredders
Lawn & Garden Tractors
Chippers/Stump Grinders
Commercial Turf Equipment such as aerators, dethatchers, hydroseeders, riding reel mowers, sod cutters, turf utility vehicles, and various golf course equipment.
Other Lawn & Garden Equipment such as augers, sickle bar mowers, and wood splitters.

Residential Survey Approach

For residential lawn and garden emissions estimates, telephone surveys of single-family and duplex residences are best for determining the equipment types owned and activity patterns (e.g, weekly hours of use), though mailed surveys may also succeed. A proposed survey questionnaire for residential lawn and garden equipment is provided at the end of this section; this survey form could be mailed, or could be used as the form for a telephone survey.

The overall scope (number and type) of owner/operators must be identified. One possible method is to use Census data which distinguishes housing into the following seven groups:

- 1 unit - detached,
- 1 unit - attached (to neighboring structure on at least one side),
- 2-4 units,
- 4-49 units,
- 50 or more units,
- mobile home or trailer, and
- condominium or cooperative.

While single unit homeowners are expected to be the prime owner/operators of residential lawn and garden equipment, mobile home or duplex owners (2-4 units) may also tend the grounds and should also be included. The responses for each specific type of category, such as single-unit, mobile home, 2-4 units as suggested here, need to be kept separate because the equipment use may be different for each type.

Once the scope of residences has been identified, a complete list of residences (or a randomly selected subset of the complete list) must be prepared to phone and ask the questions in the questionnaire form. Each residence responding to the survey would be used to determine the average equipment owned per residence, and summed for all residences as shown in the equation below.

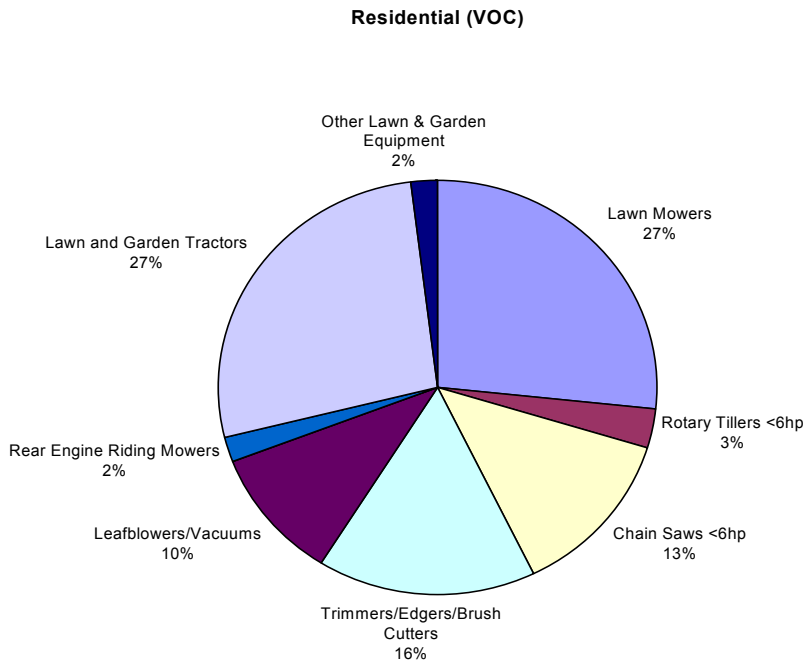
$$\text{Total Equipment} = 3\ (\text{Survey Result})_I * (\#\ \text{of Residences})_I$$

Survey Result - Equipment per residence by equipment type
I - type of residences (e.g. single-unit, mobile home, or 2-4 unit residence)

Also, an important part of the survey is to determine if the annual usage and fuel use is similar to the default estimates provided with the NONROAD model. The temporal (mainly use by month and time of day) equipment operation is needed to determine if the emissions have an effect on ambient air quality.

One concern in surveys is the potential for bias between the survey responses and those contacted but not responding. It is important to determine whether those not responding own or use equipment differently than those responding to the survey. The methods used to test this hypothesis are either persistent contacts or financial incentive. If those not responding are shown to have a bias in equipment use per residence, then the fraction of those not responding to initial queries should be treated as a separate type of residence, so single-unit respondents would be treated separately from single-unit non-respondents.

Figure 3.8-1 shows the relative contributions to state total annual VOC and CO emissions from lawn and garden equipment for residential use. It clearly shows that equipment related specifically to the maintenance of lawns are significant contributors. Because lawn maintenance is responsible for a large fraction of the activity for lawn and garden equipment, it would also be useful to determine if the residences maintain a lawn. This is especially important for arid regional areas (such as El Paso) where water for lawn less available and more expensive, but residences in even relatively wet areas (such as Houston) may elect not to plant a lawn. Even residences that do not have lawns should be surveyed because blowers, trimmers, or other equipment may be used.



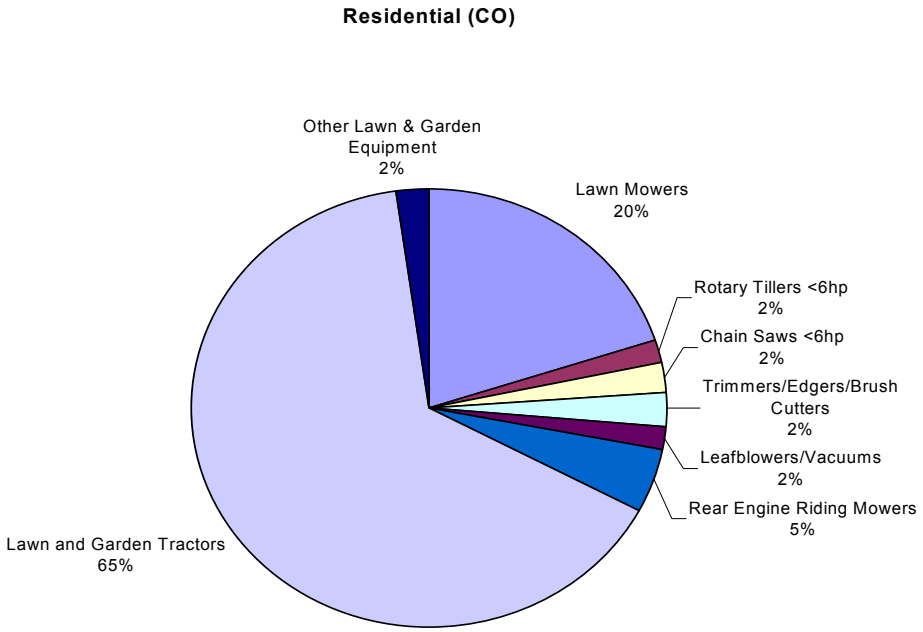


Figure 3.8-1. Relative VOC and CO emissions contributions from different types of residential lawn and garden equipment.

It may also be useful to determine if the residences that do not own equipment hire professional landscaping services for the primary care of the grounds to check if the such companies are included in the commercial survey below.

Commercial Survey Approach

For commercial lawn and garden equipment, a survey of equipment users should be conducted, with steps in the process similar to the residential survey above. An proposed questionnaire form for commercial lawn and garden equipment usage is provided at the end of this section. ENVIRON (1997) describes the methods used to identify the scope of potential commercial owner/operators. Commercial lawn and garden equipment owner/operators include the following:

- landscape and horticultural service providers (SIC - 078), or landscaping services (NAICS - 561730)
- establishments that have their own equipment and staff, such as golf courses with NAICS - 71391 and municipally-owned equipment for parks and other maintenance,
- equipment rental companies, and
- general building maintenance providers.

For landscaping services, these companies offer landscaping for new and continuing maintenance of residential or business grounds. There are several methods to determine the number and size of the companies that offer these services. One approach is to obtain lists of companies available (for a fee) from Dun and Bradstreet; these have been found to be very complete lists of businesses operating in a given area. Other choices detailed by the EIIP (1997) report include:

- Yellow Pages
- Government agency files (e.g., labor or tax departments)
- The Professional Lawn Care Association of America (PLCAA)
- National Business Lists (a firm that specializes in compiling lists of firms)
- Nationwide Directory of Businesses (from American Business Directories)
- Commercially available lists of businesses

In addition to these, local chambers of commerce may retain lists of member businesses. Licensing records might also serve as a source of information for smaller operations.

For establishments that own their own equipment, it may be difficult to determine a complete listing. However, EIIP lists private and public golf courses, publicly-owned equipment for park and other maintenance as well as road medians, cemeteries, universities, military bases, utility companies, and other large institutions. Golf courses are particularly important to cover because of the large number and special types of equipment used only at golf courses. Another possibility would be to contact equipment sales or repair businesses in an area to try

to identify types of establishments with a sizeable equipment fleet which have not been mentioned in the EIIP list above.

The number and size of equipment rental companies can be determined from sources such as Dun and Bradstreet or other data sources (the EIIP recommends consulting the local Yellow Pages). These companies lease equipment of all types, including lawn and garden equipment, especially the types which are used infrequently and only by operators. Examples of such equipment include shredders or wood splitters, which may be found only at rental locations.

General building maintenance may include equipment owned or contracted through grounds maintenance companies. To the extent that building grounds maintenance is not included in the surveys above, these could be covered under a specific survey. Building management companies can be targeted for this survey.

The survey would be conducted similarly to the residential surveys, either through telephone, mail, or in person contact, with the form that follows. One significant difference is that the commercial lawn and garden survey must determine the size of the facility through an estimate of the number of employees, revenue, or through another size categorization (such as the number of golf courses at each site or people covered by a municipality). This is shown at the bottom of the commercial survey form.

The surveys should specifically determine the annual usage and fuel use because the default estimates provided with the NONROAD model are high rates of usage, which should be confirmed with local surveys. The temporal (mainly use by month and time of day) equipment operation is needed to determine if the emissions have an affect on the ambient air quality. These questions are also on the sample commercial form.

ENVIRON

Residential Lawn and Garden Equipment Use Questionnaire

Name: _____
Contact:_____ (Contact information will be kept confidential)
Address:_____
Phone #:_____
Fax #:_____

Does your household have a lawn? **Y** or **N**

Does your household own any of the lawn and garden equipment listed below? **Y** or **N**

Does your household hire a landscaping service to maintain the grounds? **Y** or **N**

Lawn Mowers
Rotary Tillers
Chain Saws
Trimmers/Edgers/Brush Cutter
Leafblowers/Vacuums
Rear Engine Riding Mowers
Shredders
Lawn & Garden Tractors
Chippers/Stump Grinders
Other Lawn & Garden Eqp. (examples; augers, sickle bar mowers, and wood splitters)

Equipment Profile

For each and every piece of construction equipment type owned (NOT LEASED), please enter the required information. If possible, enter the information listed under "optional".

Essential Information					**Optional Information**	
Equipment Type	**Engine Rated HP (make and model, if HP is unknown)**	**Gasoline (G) or Diesel(D) (Electric or Unpowered)**	**Estimated or Measures Hours of Use (hrs/wk)**	**Estimated of Measured Weeks of Use (wks/yr)**	**Equipment Model Year**	**Typical Engine Fuel Use in Gallons ****
**Front Mower*	*51 hp Deere 1620*	*D*	*10 hours/wk*	*30 wks/yr*	*1998*	*36 Gal. for 30 Hrs.*

* example

** please indicate the gallons by one of the following: hourly, daily, weekly, monthly or annually.

- **Number of days per week (or typical day of week):**_____
- **Time of day for equipment operation:**_____ (example; 5-8 pm)

ENVIRON

Private Company Equipment Use Questionnaire
(company identities will be kept confidential)

Company Name: _____
Contact:_____
Address:_____
Phone #:_____
Fax #:_____

Does your company own any lawn and garden equipment shown below? **Y** or **N**

Lawn Mowers
Rotary Tillers
Chain Saws
Trimmers/Edgers/Brush Cutter
Leafblowers/Vacuums
Snowblowers* (included for completeness)
Rear Engine Riding Mowers
Front Mowers
Shredders
Lawn & Garden Tractors
Chippers/Stump Grinders
Commercial Turf Equipment
(examples; aerators, dethatchers, hydroseeders, riding reel mowers, sod cutters, turf utility vehicles, and various golf course equipment)
Other Lawn & Garden Eqp.
(examples; augers, sickle bar mowers, and wood splitters)

Equipment Profile

For each and every piece of construction equipment type owned (NOT LEASED), please enter the required information. If possible, enter the information listed under "optional."

Essential Information					**Optional Information**	
Equipment Type	**Engine Rated HP (make and model, if HP is unknown)**	**Gasoline (G) or Diesel(D)**	**Estimated or Measures Hours of Use (hrs/wk)**	**Estimated or Measured Weeks of Use (wks/yr)**	**Equipment Model Year**	**Typical Engine Fuel use in Gallons ****
**Front Mower*	*51 hp Deere 1620*	*D*	*10 hours/wk*	*30 wks/yr*	*1998*	*36 Gal. for 30 Hrs.*

* example
** please indicate the gallons by one of the following: hourly, daily, weekly, monthly or annually.

- **Total number of employees:**_____
- **Total annual revenue from landscaping services:**_____
- **Number of working days per week (Saturday or Sunday?):**_____
- **Time of day for equipment operation:**_____(example; 9am – 5pm)

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4.0 BIOGENIC SOURCES

INTRODUCTION AND SCOPE

The improved 1999 statewide emission inventory developed under this Work Order will ultimately be utilized in air quality modeling and planning efforts, and therefore it is important that all components of the inventory (area, mobile, non-road mobile, biogenic and point sources) are the most accurate and up-to-date as possible. While biogenic emission sources are an important component of the inventory, the existing 1999 NEI database includes biogenic emissions developed through use of the PC-BEIS model. In support of TNRCC's current regional scale air quality modeling efforts, ENVIRON has recently developed an updated statewide county level biogenic emission inventory using the latest version of the GLOBEIS model (Yarwood et al, 2001). As part of this project, the ENVIRON team has reviewed this biogenic inventory and completed the necessary steps required to generate ozone season day biogenic emission estimates.

METHODOLOGY AND APPROACH

The biogenic emission inventory has been developed using the most modern and scientifically advanced tool currently available, which is GLOBEIS. The TNRCC sponsored the development of GLOBEIS through several projects performed by ENVIRON, the University of Texas at Austin and the National Center for Atmospheric Research (NCAR). The GLOBEIS model is publicly available at http://www.globeis.com along with a User's Guide and the report describing the model development. The key advantages of GLOBEIS are: updated (1999) emission factors; Texas specific land use data based on local surveys; ability to use solar radiation data from GOES satellite imagery; built in QA and reporting functions.

ENVIRON recently completed an updated county level biogenic emission inventory for the State of Texas based on the latest version of the GLOBEIS model and updated Texas-specific vegetation data. For this project, a county level ozone season day biogenic emission inventory for 1999 for the State of Texas was developed. The specific temperature and solar radiation data for each county required for use in the GLOBEIS model, corresponding to a typical ozone season day, are based on observations for the August/September 1999 period. The new biogenic emissions are based on:

Version 2.2 of the GloBEIS biogenic emissions model (Yarwood et al., 1999b and 1999c; Guenther et al., 1999a and 1999b).

The latest landuse/landcover (LULC) data for biogenic emissions developed by the TNRCC (Yarwood et al., 1999b; Wiedinmyer et al., 1999).

Weather conditions typical of August/September 1999.

GloBEIS2 Model Options

Emissions were calculated using Version 2.2 of the GloBEIS biogenic emissions model (Yarwood et al., 1999b and 1999c;). GloBEIS2 includes options for calculating emissions using either the BEIS2 methodology or the updated BEIS99 methodology (Guenther et al., 1999a and 1999b). The BEIS99 option was used here because it represents improved science over BEIS2. GloBEIS also includes an option to adjust the BEIS99 emissions for seasonal variations in biomass density. The seasonal adjustment was not used because the TNRCC would like to further review the methodology before using it in emission inventories.

Temperature and Cloud Cover Data

Representative temperature and cloud cover data for an ozone season day were developed as part of a TNRCC project to improve the 1999 emission inventory for all counties in Texas. The objective was to characterize typical conditions on a high ozone day in 1999, not to characterize any one particular day.

Surface temperatures were characterized by averaging over two periods (August 13-22, and September 13-20, 1999) when high ozone levels were observed in many parts of Eastern Texas. These periods are also the basis of photochemical modeling currently being developed for several ozone “near nonattainment areas” so the county level biogenic emissions developed here are generally representative of biogenic emissions being used in the 1999 ozone modeling. Hourly surface temperature observations archived by the National Climatic Data Center (NCDC) were analyzed to develop an average temperature profile for each county. Table 4-1 presents the daily maximum, minimum and average temperatures for each county used in the development of the biogenic inventory. These temperature data are further described in the report on the preparation of the biogenic emission inventories for ozone modeling (Yarwood et al., 2001).

Table 4-1. Average daily temperatures (K) for Texas counties during summer 1999 (in Kelvin).

County	Min	Max	Avg
Anderson	294.30	308.10	301.04
Andrews	293.30	305.10	299.35
Angelina	293.10	307.80	300.10
Aransas	296.30	306.00	300.73
Archer	294.10	307.30	300.72
Armstrong	290.50	302.30	296.17
Atascosa	295.00	308.00	301.51
Austin	294.50	308.50	301.09
Bailey	290.50	302.30	296.30
Bandera	294.60	308.30	301.69
Bastrop	293.90	308.90	301.28
Baylor	293.90	306.70	300.33
Bee	295.00	307.30	300.91
Bell	295.50	309.00	302.22
Bexar	295.10	308.30	301.78
Blanco	295.20	308.70	302.08
Borden	292.90	305.10	299.16
Bosque	295.70	308.50	302.10
Bowie	292.60	306.30	299.38
Brazoria	296.50	307.20	301.25
Brazos	294.10	309.10	301.29
Brewster	295.60	307.40	301.61
Briscoe	291.20	303.00	296.99
Brooks	296.40	307.50	301.44
Brown	294.90	307.90	301.55
Burleson	294.20	309.10	301.39
Burnet	295.70	308.80	302.35
Caldwell	293.80	308.70	301.18
Calhoun	295.70	306.50	300.68
Callahan	294.80	307.10	301.03
Cameron	296.30	306.20	300.81
Camp	293.60	306.80	300.17
Carson	289.90	301.90	295.59
Cass	292.90	306.50	299.70
Castro	290.00	301.70	295.70
Chambers	296.10	307.40	301.10
Cherokee	293.70	307.90	300.62
Childress	292.40	304.40	298.39
Clay	294.10	307.40	300.72
Cochran	291.10	303.10	297.11
Coke	293.90	306.90	300.62
Coleman	294.50	307.50	301.20
Collin	295.70	307.40	301.43
Collingsworth	291.60	303.80	297.59
Colorado	294.40	308.30	300.97
Comal	295.00	308.60	301.84
Comanche	295.30	308.00	301.72
Concho	293.80	307.70	301.08
Cooke	294.70	307.10	300.83
Coryell	295.50	308.70	302.19
Cottle	292.80	304.90	298.83

County	Min	Max	Avg
Crane	294.30	306.30	300.53
Crockett	294.30	307.70	301.31
Crosby	292.10	304.20	298.18
Culberson	294.00	305.60	300.08
Dallam	288.30	299.20	293.42
Dallas	296.60	307.80	302.10
Dawson	292.70	304.80	298.88
Deaf Smith	289.40	300.80	294.86
Delta	294.10	306.80	300.38
Denton	295.60	307.70	301.58
DeWitt	294.20	308.00	300.85
Dickens	292.50	304.60	298.61
Dimmit	295.80	308.30	302.07
Donley	290.90	302.90	296.74
Duval	295.80	307.80	301.41
Eastland	295.10	307.60	301.43
Ector	293.90	305.70	299.99
Edwards	294.50	308.20	301.66
El Paso	293.50	304.60	299.38
Ellis	296.10	308.10	302.01
Erath	295.60	308.00	301.83
Falls	295.00	309.00	301.91
Fannin	294.30	306.80	300.45
Fayette	294.00	308.70	301.09
Fisher	293.70	306.00	299.95
Floyd	291.60	303.50	297.58
Foard	293.20	305.70	299.49
Fort Bend	295.70	307.80	301.21
Franklin	293.80	306.80	300.23
Freestone	294.80	308.40	301.45
Frio	295.20	308.20	301.75
Gaines	292.60	304.50	298.65
Galveston	296.70	307.00	301.23
Garza	292.60	304.80	298.78
Gillespie	294.50	308.30	301.70
Glasscock	293.80	306.30	300.26
Goliad	294.70	307.40	300.79
Gonzales	294.00	308.30	301.01
Gray	290.30	302.50	296.13
Grayson	294.60	306.90	300.69
Gregg	293.70	307.10	300.34
Grimes	294.10	308.90	301.12
Guadalupe	294.50	308.50	301.46
Hale	290.80	302.70	296.71
Hall	291.80	303.60	297.65
Hamilton	295.50	308.40	302.02
Hansford	289.20	301.10	294.81
Hardeman	292.90	305.40	299.17
Hardin	294.80	307.70	300.64
Harris	295.40	308.20	301.26
Harrison	293.40	306.90	300.12
Hartley	288.60	299.60	293.77
Haskell	294.00	306.30	300.20

County	Min	Max	Avg
Hays	294.70	308.80	301.77
Hemphill	290.30	303.00	296.35
Henderson	295.00	308.00	301.34
Hidalgo	296.90	307.70	301.74
Hill	295.80	308.50	302.08
Hockley	291.10	303.10	297.16
Hood	295.90	308.10	301.93
Hopkins	294.30	306.90	300.55
Houston	293.70	308.30	300.70
Howard	293.50	305.70	299.77
Hudspeth	293.90	305.30	299.88
Hunt	295.10	307.20	301.08
Hutchinson	289.50	301.50	295.17
Irion	293.90	307.30	300.92
Jack	295.00	307.60	301.25
Jackson	294.60	307.60	300.66
Jasper	294.00	307.70	300.32
Jeff Davis	294.60	306.20	300.62
Jefferson	295.70	307.30	300.82
Jim Hogg	296.40	307.90	301.68
Jim Wells	295.60	307.30	301.04
Johnson	296.10	308.20	302.07
Jones	294.20	306.40	300.39
Karnes	294.70	307.90	301.14
Kaufman	295.90	307.70	301.68
Kendall	295.00	308.50	301.88
Kenedy	296.60	306.50	301.03
Kent	293.00	305.10	299.13
Kerr	294.20	308.20	301.51
Kimble	293.30	307.80	301.00
King	293.10	305.30	299.27
Kinney	295.70	308.60	302.33
Kleberg	296.30	306.50	300.92
Knox	293.60	306.00	299.84
La Salle	295.50	308.00	301.73
Lamar	293.60	306.50	300.00
Lamb	290.50	302.40	296.41
Lampasas	295.40	308.60	302.12
Lavaca	294.10	308.20	300.80
Lee	294.20	309.00	301.42
Leon	294.30	308.70	301.24
Liberty	295.00	308.00	300.87
Limestone	295.00	308.80	301.75
Lipscomb	289.80	302.50	295.83
Live Oak	295.10	307.50	301.13
Llano	295.00	308.50	301.95
Loving	293.60	305.40	299.75
Lubbock	291.30	303.40	297.38
Lynn	292.00	304.10	298.18
Madison	294.10	308.80	301.13
Marion	293.20	306.70	299.97
Martin	293.40	305.40	299.56
Mason	294.00	308.10	301.38

County	Min	Max	Avg
Matagorda	296.00	306.90	300.95
Maverick	296.10	308.60	302.38
McCulloch	294.20	307.90	301.33
McLennan	295.40	308.80	302.09
McMullen	295.30	307.80	301.43
Medina	294.80	308.20	301.73
Menard	293.40	307.80	301.03
Midland	294.00	306.00	300.13
Milam	294.80	309.10	301.78
Mills	295.10	308.20	301.83
Mitchell	293.60	306.10	300.04
Montague	294.50	307.30	300.86
Montgomery	294.40	308.60	301.00
Moore	289.00	300.40	294.32
Morris	293.30	306.60	299.93
Motley	292.10	304.00	298.08
Nacogdoches	293.20	307.70	300.20
Navarro	295.50	308.30	301.80
Newton	294.10	307.40	300.23
Nolan	293.90	306.50	300.35
Nueces	296.00	306.20	300.77
Oldham	289.00	300.10	294.24
Orange	295.40	307.30	300.65
Orchiltree	289.40	301.70	295.21
Palo Pinto	295.30	307.70	301.51
Panola	293.40	307.10	300.18
Parker	295.80	307.90	301.75
Parmer	289.90	301.50	295.52
Pecos	294.90	306.90	301.09
Polk	293.70	308.10	300.46
Potter	289.30	300.70	294.62
Presidio	295.10	306.60	301.08
Rains	294.90	307.30	301.03
Randall	289.70	301.30	295.20
Reagan	294.10	306.90	300.76
Real	294.30	308.20	301.60
Red River	293.10	306.40	299.65
Reeves	294.10	305.90	300.24
Refugio	295.50	306.60	300.70
Roberts	289.80	302.10	295.65
Robertson	294.50	309.00	301.57
Rockwall	296.00	307.50	301.66
Runnels	294.10	307.20	300.88
Rusk	293.60	307.40	300.35
Sabine	293.30	307.40	300.00
San Augustine	293.20	307.60	300.06
San Jacinto	294.10	308.30	300.69
San Patricio	295.60	306.50	300.76
San Saba	294.90	308.30	301.80
Schleicher	293.70	307.80	301.12
Scurry	293.30	305.50	299.55
Shackelford	294.60	306.90	300.80
Shelby	293.20	307.40	300.09

County	Min	Max	Avg
Sherman	288.70	300.10	294.05
Smith	294.20	307.50	300.73
Somervell	295.80	308.20	301.99
Starr	296.90	308.10	301.95
Stephens	295.00	307.40	301.20
Sterling	293.80	306.70	300.49
Stonewall	293.50	305.70	299.68
Sutton	294.00	307.90	301.31
Swisher	290.40	302.10	296.10
Tarrant	296.00	307.90	301.90
Taylor	294.40	306.70	300.67
Terrell	295.30	307.60	301.64
Terry	291.90	303.90	297.96
Throckmorton	294.40	306.90	300.66
Titus	293.50	306.70	300.02
Tom Green	293.70	307.50	300.92
Travis	296.30	309.10	302.69
Trinity	293.50	308.20	300.51
Tyler	293.80	307.80	300.32
Upshur	293.70	307.00	300.33
Upton	294.30	306.60	300.65
Uvalde	295.00	308.40	301.90
Val Verde	295.60	308.50	302.20
Van Zandt	294.90	307.50	301.13
Victoria	294.40	307.50	300.58
Walker	294.00	308.60	300.93
Waller	294.60	308.60	301.14
Ward	294.10	306.00	300.25
Washington	294.20	308.90	301.21
Webb	296.10	308.20	301.97
Wharton	295.10	307.80	300.95
Wheeler	290.90	303.40	296.93
Wichita	293.60	307.10	300.36
Wilbarger	293.30	306.30	299.81
Willacy	296.60	306.40	301.05
Williamson	295.60	309.10	302.34
Wilson	294.80	308.10	301.37
Winkler	293.70	305.60	299.83
Wise	295.30	307.60	301.42
Wood	294.30	307.20	300.70
Yoakum	291.80	303.80	297.88
Young	294.70	307.40	301.03
Zapata	296.60	308.10	301.96
Zavala	295.50	308.40	302.04

Cloud cover was characterized from Geostationary Operational Environmental Satellite (GOES) data analyzed and archived by the University of Maryland (UMD). UMD provided average cloud cover fraction for the months of June, July, August and September 1999 on a half-degree grid covering the continental US. These data are shown for Texas in Figure 4-1. The cloud cover fraction over Texas in 1999 varied from month to month according to the passage of stormy and clear weather systems. Overall, a cloud cover fraction of two tenths appears representative for summer conditions in Texas, and so this was used as the basis for calculating the biogenic emissions. The UMD satellite data were also used in the preparation of the biogenic emission inventories for ozone modeling as described further in (Yarwood et al., 2001).

RESULTS

Table 4-2 presents a summary of the county level biogenic NO_x and VOC emissions in tons/day (tpd). Figure 4-2 portrays the county-level VOC emissions for 1999. These emission totals are for a typical summer day condition. Biogenic emission inventories for ozone modeling will require a re-calculation for the specific temperatures that actually occurred on the days being modeled (i.e., the biogenic emissions will be day specific) using the same model and LULC data.

Table 4-2. 1999 biogenic emissions (tons/day) for a typical summer day.

County	VOC (tpd)	NOx (tpd)
Anderson	231.1480	0.6037
Andrews	19.3427	3.3833
Angelina	199.6931	0.2684
Aransas	24.1730	0.3992
Archer	10.7822	5.7398
Armstrong	3.3427	7.2624
Atascosa	40.0005	3.3720
Austin	74.0277	4.6519
Bailey	5.5553	14.4530
Bandera	63.5820	0.3101
Bastrop	123.8891	2.1763
Baylor	5.1601	5.6588
Bee	46.5847	6.9447
Bell	62.5940	8.7363
Bexar	60.1065	4.9931
Blanco	79.3796	0.3156
Borden	6.2555	3.5530
Bosque	59.8434	0.4980
Bowie	140.5566	1.2023
Brazoria	71.9006	0.9318
Brazos	118.6545	4.6483
Brewster	14.3433	3.4045
Briscoe	4.2745	6.3315
Brooks	27.0947	1.4098
Brown	80.5752	2.0606
Burleson	147.0727	3.2978
Burnet	75.7626	0.3109

County	VOC (tpd)	NOx (tpd)
Caldwell	80.9532	4.9308
Calhoun	4.4608	4.6865
Callahan	39.8340	4.4171
Cameron	4.8215	13.4204
Camp	115.1080	0.2800
Carson	2.0387	11.3488
Cass	204.7745	0.2832
Castro	1.3096	16.6407
Chambers	44.3217	0.2958
Cherokee	203.9791	0.3195
Childress	8.1831	5.2920
Clay	26.9175	1.9641
Cochran	7.1559	13.8247
Coke	13.6468	2.9339
Coleman	83.8099	2.2542
Collin	18.7480	7.9983
Collingsworth	5.6727	5.5484
Colorado	107.0656	3.6247
Comal	56.5272	1.5415
Comanche	44.4172	3.7474
Concho	72.0164	2.4860
Cooke	72.4829	2.6861
Coryell	83.4081	2.7287
Cottle	10.2174	5.3942
Crane	31.8288	1.3505
Crockett	18.5706	1.2166
Crosby	3.9909	10.0153
Culberson	9.8408	3.0714
Dallam	3.4252	8.9238
Dallas	35.3334	2.9346
Dawson	3.4024	17.9318
Deaf Smith	0.9156	13.4813
Delta	59.7323	3.3215
Denton	41.1997	5.0225
DeWitt	69.4689	3.1877
Dickens	7.2227	6.5332
Dimmit	40.1762	1.5039
Donley	6.8387	4.0959
Duval	40.5731	11.5945
Eastland	44.7577	4.2256
Ector	9.8651	2.1182
Edwards	75.5652	0.3132
Ellis	45.1174	8.5104
El Paso	6.9852	4.7174
Erath	53.7033	0.5185
Falls	54.4344	12.6554
Fannin	83.1882	4.7803
Fayette	62.9383	3.7650
Fisher	5.6203	8.4958
Floyd	2.0717	14.1153
Foard	7.4374	6.6049
Fort Bend	68.5356	7.5078
Franklin	123.0893	0.6313

County	VOC (tpd)	NOx (tpd)
Freestone	223.6569	0.3229
Frio	28.0648	4.3390
Gaines	8.8884	11.3479
Galveston	24.6293	0.2246
Garza	7.6287	4.2136
Gillespie	66.2829	0.3091
Glasscock	8.0407	3.9833
Goliad	67.1798	1.3091
Gonzales	87.5090	1.0167
Gray	4.6956	7.2296
Grayson	84.8165	5.8701
Gregg	152.4939	0.4391
Grimes	99.5359	1.0285
Guadalupe	83.6011	7.5204
Hale	1.5056	15.9772
Hall	5.3958	6.0771
Hamilton	61.8031	0.3838
Hansford	1.9519	9.5780
Hardeman	6.7009	7.8763
Hardin	232.2714	0.3030
Harris	85.6114	1.0854
Harrison	215.1322	0.3285
Hartley	7.4611	7.0706
Haskell	4.3172	10.1940
Hays	49.4151	3.2907
Hemphill	10.0908	2.7923
Henderson	183.1291	0.4184
Hidalgo	9.8587	20.7573
Hill	63.0486	11.6201
Hockley	2.1009	14.1605
Hood	44.4290	0.2941
Hopkins	107.2661	0.7541
Houston	189.6129	1.2335
Howard	8.5424	9.2653
Hudspeth	8.2497	3.4120
Hunt	56.7815	4.7869
Hutchinson	5.8972	4.5364
Irion	16.1281	1.2404
Jack	202.2986	0.5554
Jackson	40.8668	13.0752
Jasper	203.2716	0.2895
Jeff Davis	38.8274	2.8257
Jefferson	35.4961	0.4560
Jim Hogg	36.6078	0.9004
Jim Wells	19.4324	16.1678
Johnson	93.7706	4.0572
Jones	5.4281	11.9323
Karnes	28.1690	6.0472
Kaufman	85.6343	4.0727
Kendall	70.9157	0.3128
Kenedy	22.8274	0.4144
Kent	10.2126	2.6937
Kerr	61.5964	0.3065

County	VOC (tpd)	NOx (tpd)
Kimble	72.2483	0.2980
King	8.3918	2.1615
Kinney	54.3280	1.0703
Kleberg	15.9896	3.3800
Knox	3.5237	10.4272
Lamar	117.8317	2.1486
Lamb	4.1508	14.5279
Lampasas	92.5582	0.4719
La Salle	38.3731	2.1653
Lavaca	76.5731	2.9380
Lee	110.2774	1.2504
Leon	228.2055	0.3879
Liberty	195.7655	0.7005
Limestone	180.6427	3.8669
Lipscomb	9.7248	3.9938
Live Oak	31.4183	4.2257
Llano	109.4559	0.3055
Loving	6.7397	2.2645
Lubbock	2.2412	12.7801
Lynn	5.5397	14.3551
McCulloch	64.2402	1.1660
McLennan	35.3024	10.6185
McMullen	48.0393	1.7154
Madison	109.8914	0.5390
Marion	213.6409	0.2622
Martin	4.5874	13.6557
Mason	80.0373	0.3039
Matagorda	24.7901	5.5495
Maverick	49.5785	1.2094
Medina	39.2558	6.8127
Menard	90.2808	0.2994
Midland	6.0811	4.7750
Milam	93.4904	8.2347
Mills	95.7168	0.3133
Mitchell	7.4421	7.6754
Montague	89.1500	1.1549
Montgomery	213.9938	0.3469
Moore	2.2446	9.6107
Morris	161.1117	0.3288
Motley	7.6610	3.3268
Nacogdoches	194.9694	0.2809
Navarro	183.9074	5.3756
Newton	210.2412	0.2929
Nolan	17.4344	4.5577
Nueces	8.8441	16.2583
Ochiltree	1.7598	9.8415
Oldham	4.1631	3.1600
Orange	145.0642	0.3672
Palo Pinto	87.3320	0.2945
Panola	195.2737	0.3060
Parker	81.8250	0.4278
Parmer	0.8086	16.1354
Pecos	13.0980	2.5188

County	VOC (tpd)	NOx (tpd)
Polk	224.0671	0.2897
Potter	4.2810	2.4358
Presidio	9.0513	3.4345
Rains	140.5809	0.4767
Randall	1.7899	9.5191
Reagan	11.2244	3.2454
Real	67.3320	0.3080
Red River	146.9095	1.0780
Reeves	7.7834	3.8396
Refugio	34.9145	6.2205
Roberts	6.8109	2.8136
Robertson	132.5208	2.8553
Rockwall	14.0575	7.6098
Runnels	32.3868	10.1308
Rusk	191.1841	0.3057
Sabine	198.6300	0.2415
San Augustine	169.0659	0.2536
San Jacinto	230.0011	0.2791
San Patricio	25.1542	15.5193
San Saba	71.4331	0.3102
Schleicher	37.9265	0.8322
Scurry	5.2717	6.2174
Shackelford	8.3958	2.4703
Shelby	173.2222	0.2730
Sherman	1.1590	18.5520
Smith	176.0661	0.4402
Somervell	65.3474	0.3074
Starr	44.0028	5.9040
Stephens	84.4818	0.5535
Sterling	14.0392	1.4756
Stonewall	8.9148	3.5153
Sutton	54.8403	0.7037
Swisher	2.6903	13.4693
Tarrant	43.3704	2.0099
Taylor	12.4474	8.3034
Terrell	11.8619	2.0180
Terry	4.3292	13.9164
Throckmorton	6.2760	4.0134
Titus	121.1728	0.4050
Tom Green	16.6802	5.1834
Travis	71.6363	4.7800
Trinity	215.2918	0.2922
Tyler	206.7514	0.2929
Upshur	172.3757	0.4890
Upton	8.6800	2.7871
Uvalde	50.1724	2.8945
Val Verde	32.5861	1.5860
Van Zandt	134.6056	0.5665
Victoria	31.6302	6.8667
Walker	198.2213	1.5031
Waller	93.3653	1.0844
Ward	11.5581	2.2229
Washington	62.0027	1.9229

County	VOC (tpd)	NOx (tpd)
Webb	48.0085	1.2802
Wharton	29.4283	15.9076
Wheeler	7.4728	5.7790
Wichita	4.6914	6.8903
Wilbarger	6.0183	8.1736
Willacy	6.6073	14.6577
Williamson	68.1958	9.7522
Wilson	62.7537	6.5214
Winkler	27.3109	1.4362
Wise	96.8701	1.5870
Wood	203.9709	0.3605
Yoakum	11.9569	10.6902
Young	117.9418	4.4407
Zapata	40.0188	2.0559
Zavala	48.8869	3.0752
Texas Total	**16028.3910**	**1142.4634**

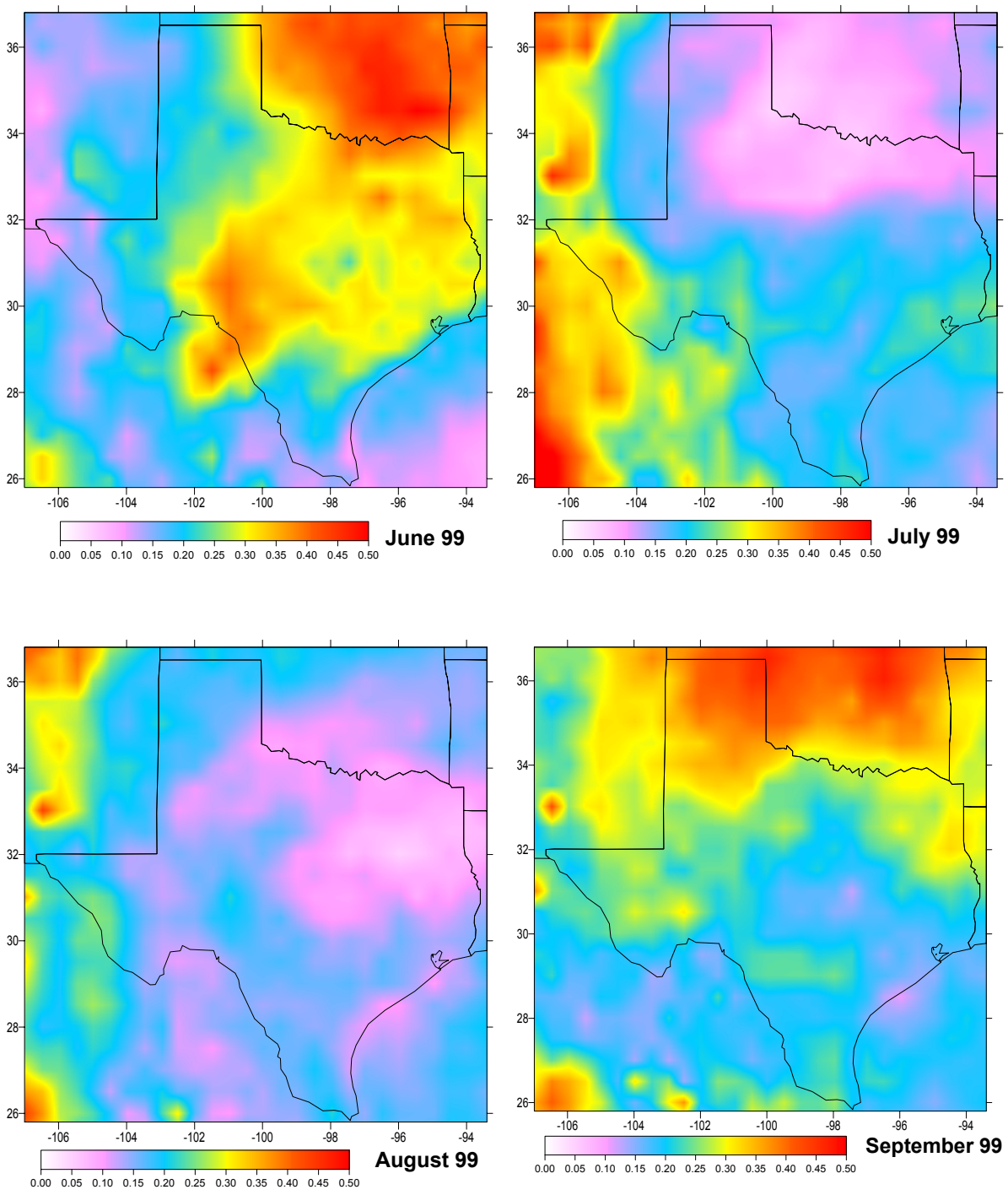


Figure 4-1. Cloud fraction plot for summer 1999.

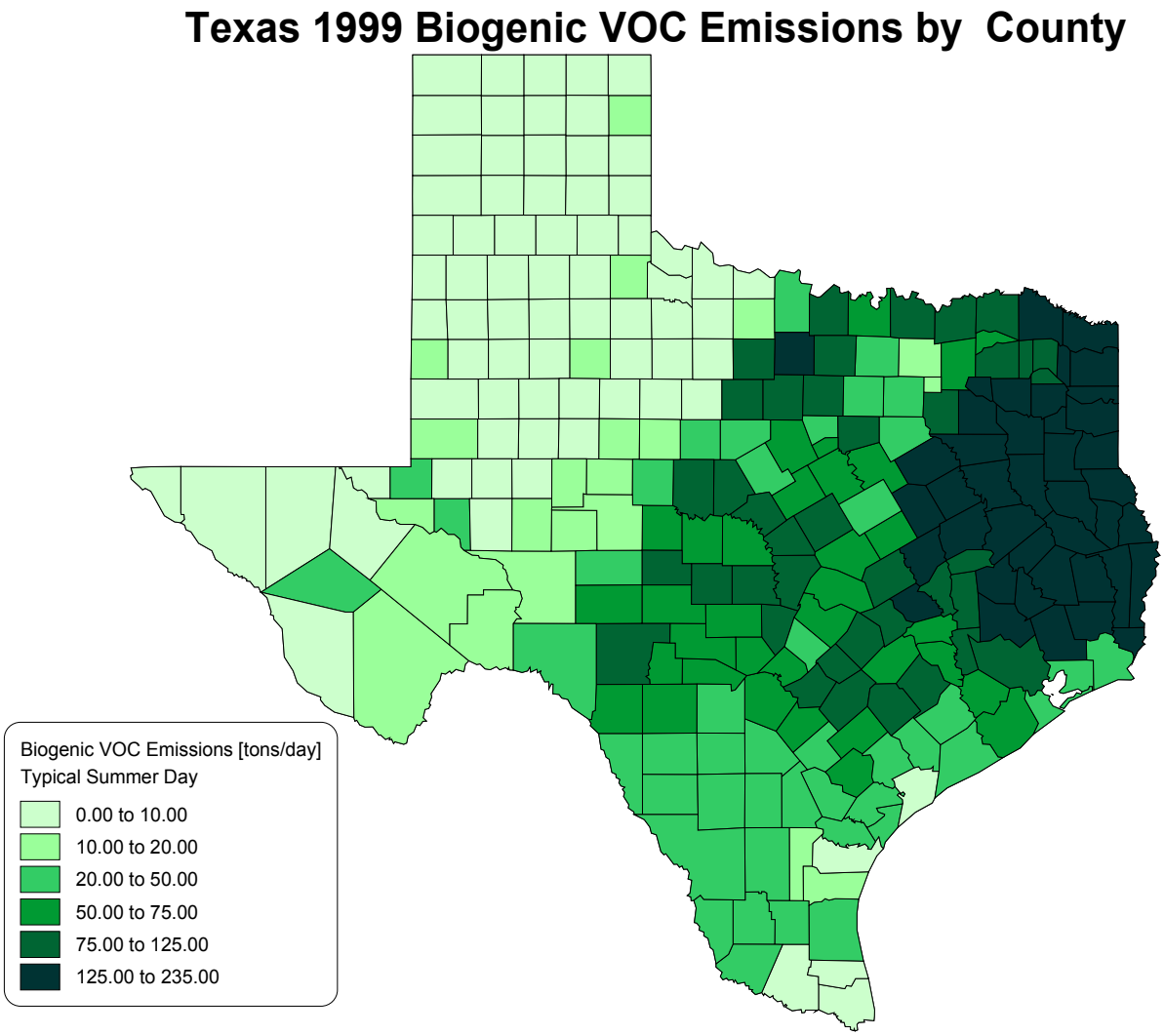


Figure 4-2. County-level VOC emissions for 1999.

5.0 1990 - 2010 AREA SOURCES METHODOLOGY

5.1 INTRODUCTION

The purpose of this section is to describe the methodologies used to develop area source emission trends data for 1990-2010. Section 2 of this report describes the methodologies utilized in estimating 1999 emissions for area source categories. To ensure consistency, for most area source categories the 1999 inventory was the starting point for identifying the data sources and methodologies for estimating emission trends data.

This section first provides an overview of the two types of approaches used in this effort: the *general* approach and the *detailed* approach. Because of the time required in implementing the detailed approach, this procedure is reserved for the area source categories whose emission estimates were improved under a separate work order of this contract (see Section 2 for a list of these categories) and any additional source categories that emitted at least 5 percent of total area source VOC or NO_x emissions as identified from the EPA's 1999 National Emissions Inventory (NEI) (Version 1.5). The general approach was followed for all other area source categories.

The following subsection provides an overview of the two general methods for developing 1990-2010 emission trends data. This subsection includes a discussion of the general equations used in calculating emission trends. The final 18 subsections present discussions of the emission trends methodologies employed for each of the source categories for which the detailed emission trends approach was used.

5.2 OVERVIEW

Changes in emissions activity levels are generally measured using one of two approaches, which are termed the *detailed* and *general* approaches for the purpose of this discussion. The *detailed* approach utilizes emissions activity data that have been identified as directly related to the level of uncontrolled emissions for a particular process. For example, Stage II emissions from vehicle refueling at gasoline service stations have been related to the amount of gasoline pumped from these stations. The EIIP preferred emission estimation approach for Stage II emissions is to multiply an emission factor (grams per gallon of dispensed gasoline) by highway vehicle gasoline sales (EIIP, 2001a). The *general* approach uses a surrogate indicator, such as employment or economic output, to estimate trends in emissions activity. For this effort, the Economic Growth Analysis System, Version 4.0 (EGAS 4.0) was the source of surrogate emission growth indicators for the general emission trends approach.

Although the detailed approach is preferred, project time constraints precluded its use for all area source categories. The following subsections first describe the general approach and then provide an overview of the detailed approach.

General Approach

Because of time and resource constraints, the ENVIRON team relied on the use of EGAS 4.0 and related data for estimating trends in the level of emission activity for many area source categories. EGAS 4.0 is an EPA-approved source of 1996-2020 growth factors for projecting emission activity levels (Pechan, 2001a). It is important to note that EGAS 4.0 is built using data sources that are not specified at the county-level. For most SCCs included in EGAS 4.0, surrogate indicators are based on 3-digit Standard Industrial Classification (SIC) code economic output data produced by models developed by Regional Economic Models Inc. (REMI). For Texas, the EGAS 4.0 REMI models have been defined into 4 regions:

- Houston-Galveston-Brazoria Nonattainment Area;
- Beaumont-Port Arthur Nonattainment Area;
- El Paso Nonattainment Area; and
- Rest-of-Texas.

The counties that comprise each of these regions are identified in Table A-1 of the EGAS 4.0 User's Guide (Pechan, 2001b). EGAS 4.0 also employs surrogate indicator data from other information sources. One key data source for fuel combustion sources is the U.S. Department of Energy (DOE), Energy Information Administration (EIA)'s *Annual Energy Outlook 1999* (DOE, 1998). This data source develops fuel production and consumption projections for oil and gas supply regions and census divisions, respectively. These areas represent multi-state regions (e.g., the West South Central region includes Texas as well as Arkansas, Louisiana, and Oklahoma). The EGAS 4.0-based data, therefore, do not reflect county-specific trends that deviate from the regional trends predicted by the EGAS 4.0 data. For additional cost, TNRCC can purchase county-level projections data from REMI, Economy.com, or other regional economic forecasting firm. The team evaluated alternative sources of emissions growth surrogate data for TNRCC in July and determined that project time constraints precluded use of an alternative surrogate indicator source (ENVIRON, 2001).

With the exception of the source categories described in sections 5.3 through 5.20, the ENVIRON team used EGAS 4.0 growth factors to reflect 1996-2010 emissions activity level changes. In EGAS 4.0, for example, the Stage II gasoline service station source classification code (SCC) is assigned total gasoline and oil expenditures data as the surrogate emissions activity indicator (Pechan, 2001a). In developing EGAS 4.0, researchers identified that this indicator has historically correlated with total gasoline demand at the national level. Because of the level of effort required to identify the existence of such correlations and the lack of readily available long-term data for conducting these analyses, EGAS 4.0 developers conducted correlation analyses for less than 30 emissions activities. For all of the other more than 9,000 SCCs included in EGAS 4.0, a surrogate indicator was assigned based on judgment. Without conducting detailed analyses, however, it is not possible to be certain that these indicators are correlated with their assigned emissions activities.

For 1990-1995 emissions activity level changes, the team utilized the same data sources that underlie EGAS 4.0 whenever these sources are available for these years. The economic

output data are available for 1990-1995 from the REMI models that underlie EGAS 4.0. However, DOE/EIA's *Annual Energy Outlook* publications do not report historical energy consumption/production data. To reflect historical emissions activity levels for these source categories, energy data from the DOE/EIA's *State Energy Data Report 1999* were utilized (DOE, 2001). This DOE/EIA publication provides data that characterize state-level changes in fuel combustion-related emissions activities.

Detailed Approach

The detailed emissions estimation approach is to compile the same 1990-2010 emissions activity data that were used in developing the 1999 baseline emission estimates. The detailed emission trends approach was used for all area source categories that (1) emit at least 5 percent of total statewide VOC or NO_x area source emissions as reported in the 1999 NEI (Version 1.5), and/or (2) had their 1999 emissions estimates improved as discussed in Section 2 of this report. In cases where the detailed emissions activity-based approach was utilized, sections 5.3 through 5.20 describe the specific data sources and methods that were used in estimating emission trends throughout the 1990-2010 period.

Emission Trends Calculations

With some minor exceptions, both emission trends approaches use a similar equation to develop post-1999 year emission trends estimates:

$$E_{ix} = [(E_{i1999} \text{ x } GF_x)] \text{ x } [1-(CE_x \text{ x } RP_x \text{ x } RE_x)] \qquad (5.2.1)$$

where:

E_{ix} = emissions for county I for post-1999 trends year x, tons/year or tons/day;
E_{i1999} = emissions for county I for year 1999, tons/year or tons/day;
GF_x = emissions activity growth factor for trends year x relative to 1999 (1999 = 1.0);
CE_x = control effectiveness (fraction) of applicable rules for trends year x, unitless;
RP_x = rule penetration (fraction) of applicable rules for trends year x, unitless; and
RE_x = rule effectiveness (fraction) of applicable rules for trends year x, unitless.

The Equation 5.2-1 term that reflects the level of emission reduction from an applicable control program ($[1-(CE_x \text{ x } RP_x \text{ x } RE_x)]$), can be ignored when there are no controls affecting a given source category's emissions. In most cases, the major distinguishing characteristic of the general approach is that it utilizes emissions activity growth factors (GF_x) from EGAS 4.0, while the detailed approach uses emissions activity growth factors that are based on the same or similar activity data to that used in estimating 1999 emissions (e.g., residential natural gas consumption data for the residential natural gas combustion category).

The 1999 emission estimates were generally developed before the emission trends estimates. Because the emission trends estimates were developed concurrently with the 1999 emission estimates for a few detailed approach source categories, these source categories did not utilize the above growth and control factor-based equation. These source categories include:

- Architectural and industrial maintenance coatings;
- Traffic markings;
- Asphalt (emulsified and cutback); and
- Gasoline distribution–vehicle refueling (Stage I) and spillage.

Unless otherwise noted in their respective individual source category methodology section, the emission trends calculations for these source categories were performed using the same procedures as identified in Section 2 of this report.

Because some source categories had the effects of control programs incorporated into their 1999 emission factors, it was necessary in these cases to estimate pre-1999 emissions by implementing one of two adjustments to the 1999 emission estimates. As indicated in Equation 5.2-2, this first adjustment, which was used for all years before control program implementation, effectively removes the emission reduction term that is incorporated into the 1999 emission estimates. For counties and source categories that are not affected by control programs, this adjustment is not necessary for calculating pre-1999 year emissions.

$$E_{ix} = [(E_{i1999} \text{ x } GF_x)] / [1-(CE_{1999} \text{ x } RP_{1999} \text{ x } RE_{1999})] \qquad (5.2.2)$$

where:

E_{ix} = emissions for county I for pre-1999 trends year x, tons/year or tons/day;
CE_{1999} = control effectiveness (fraction) of applicable rules in year 1999, unitless;
RP_{1999} = rule penetration (fraction) of applicable rules in year 1999, unitless; and
RE_{1999} = rule effectiveness (fraction) of applicable rules in year 1999, unitless.

The second adjustment, which was used for source categories with pre-1999 year CE, RP, and/or RE values that differ from their values in year 1999, represents the ratio of the pre-1999 year level of emission control to the year 1999 level of emission control (see Equation 5.2-3). This second adjustment is used to reflect the emission reduction associated with the pre-1999 year implementation of the emission control program.

$$E_{ix} = [(E_{i1999} \text{ x } GF_x)] \text{ x } [\ [1-(CE_x \text{ x } RP_x \text{ x } RE_x)]/ [1-(CE_{1999} \text{ x } RP_{1999} \text{ x } RE_{1999})]] \qquad (5.2.3)$$

where:

E_{ix} = emissions for county I for pre-1999 trends year x, tons/year or tons/day;
CE_x = control effectiveness (fraction) of applicable rules in pre-1999 year x, unitless;
RP_x = rule penetration (fraction) of applicable rules in pre-1999 year x, unitless; and
RE_x = rule effectiveness (fraction) of applicable rules in pre-1999 year x, unitless.

5.3 RESIDENTIAL NATURAL GAS COMBUSTION

1999 Baseline Emissions

To calculate 1999 emissions for this SCC, county-level residential natural gas consumption estimates were multiplied by an emission factor. The 1999 inventory relied on 1999 Railroad Commission of Texas (RCOT) county-level residential natural gas consumption data (RCOT, 2000). Section 2.2 provides additional information on the 1999 baseline emissions, including sample emission calculations.

Emission Trends Estimates

In developing the 1990-2010 emission trends for this category, the ENVIRON team considered the use of the residential natural gas consumption estimates developed by RCOT, but determined that the RCOT data could not be compiled in time for use in this effort because the data are reported at the city level, are not in electronic format, and are not readily available for all the years required.

Changes in 1990-1999 state-level emissions activity for this category were estimated based on state-level residential natural gas consumption estimates reported by the Department of Energy's Energy Information Administration (DOE/EIA) (DOE, 2001). County-level emissions activity was based on these state-level data and the estimated number of 1990-2000 housing units using utility gas. The use of these housing units data is consistent with the Emission Inventory Improvement Program (EIIP)'s *Area Source Method Abstract* that identifies the number of housing units using utility gas as one of the acceptable sets of data for allocating state consumption to local areas (EIIP, 1999). The EIIP spatial allocation method that is based on local and state totals of annual heating degree days and housing units heating with natural gas was not used in this study because time constraints precluded the compilation of annual heating degrees data by county.

For 1990-1999, each county's proportion of total state housing units using utility gas was calculated. These county proportions were developed by first estimating the county-level number of housing units using utility gas based on the 1990 percentage of housing units in each county using utility gas and the total number of housing units in each county, which are reported for 1990 and 2000 by the Bureau of the Census (BOC, 2001a and 2001b). The 1991-1999 proportions of total state housing units using utility gas in each county were estimated through interpolation. The team then developed ratios of the county proportions for each trends year in relation to the 1999 county proportion. These ratios represent the change (relative to a base year of 1999) in the county's proportion of state number of housing units using gas. These ratios were then applied to the state-level growth factors that were developed from the EIA projections for the purpose of reflecting relative county trends in residential natural gas consumption.

Post-1999 emissions activity trends were based on DOE/EIA projected West South Central region residential natural gas consumption growth rates (DOE, 2000) and the change in each county's proportion of state number of housing units using gas. The projected county number of housing units using gas was estimated through 2010 using the Texas Comptroller of Public Account (TCPA)'s estimated number of state housing starts for 2000-2010, F.W. Dodge county-level 2000-2005 housing unit projections data supplied by TNRCC, and the 1990 percentage of housing units in each county using utility gas (TCPA, 2001; TNRCC, 2001; and BOC, 2001a). The lack of F.W. Dodge data beyond 2005 results in the projected state trend being used to estimate each county's 2006-2010 trend.

A TNRCC regulation that sets NO_x emission limits for natural gas-fired water heaters, boilers, and process heaters will affect this category statewide beginning in 2002 (TNRCC, 2000). Staff from TNRCC provided control efficiency estimates for the water heater component of this regulation—for 2002-2004, CE is estimated at 53 percent, after 2004, CE is estimated at 88 percent (Mack, 2001). TNRCC also provided an estimate of the annual water heater turnover rate (10 percent), which is based on the average lifetime of a water heater (10 years) as reported by the Gas Appliance Manufacturers Association. This annual turnover rate, along with information on the effective date of the regulation, and the projected percentage of total residential natural gas consumption from water heaters, was used in developing RP estimates for each year. The projected percentage of national residential natural gas consumption from water heaters was compiled for 2002-2010 from the Department of Energy's *Annual Energy Outlook 2001* (DOE, 2000). In 2002, approximately 31 percent of total residential gas consumption is estimated from water heaters; this percentage is estimated at approximately 28 percent in 2010. Based on this percentage and the projected annual turnover rate, RP is estimated at approximately 28 percent for the year 2010. Rule effectiveness was assumed at 100 percent.

5.4 COMMERCIAL/INSTITUTIONAL NATURAL GAS COMBUSTION

1999 Baseline Emissions

To estimate 1999 emissions for this SCC in this study, county-level commercial/institutional natural gas consumption levels were multiplied by an emission factor. The statewide consumption of natural gas used in commercial/institutional establishments in Texas was obtained from DOE/EIA (DOE, 2000). The commercial natural gas usage for each county was estimated by multiplying statewide gas usage by the ratio of county commercial sector (SIC codes 50-97) employment to state commercial sector employment (DOC, 2001). To avoid assigning consumption to counties without commercial natural gas usage, RCOT commercial and industrial natural gas consumption data were consulted (RCOT, 2000). Those counties showing no consumption in the small commercial/industrial sector were assigned zero commercial consumption. Section 2.3 provides examples of calculations used in developing the 1999 baseline emission estimates for this category.

Emission Trends Estimates

Changes in 1990-1999 state-level activity for this category were estimated using state-level commercial natural gas consumption estimates reported by the DOE/EIA (DOE, 2000). As suggested by the EIIP *Area Source Method Abstract* for this category, state-level consumption estimates can be allocated to the county-level based on changes in the ratio of county commercial sector (SIC codes 50-97) employment to state commercial sector employment (EIIP, 1999). To develop county-level activity data for this category, the team specifically calculated commercial sector employment ratios for each county for the years 1990 and 1999 and estimated these ratios for the intervening years through interpolation. These ratios were then applied to the state-level consumption estimates to estimate county-level commercial sector natural gas consumption. To ensure that commercial/institutional gas consumption is not estimated for areas without such gas service, counties without 1999 commercial/industrial natural gas consumption as reported by RCOT, were allocated zero emissions activity for this category. Post-1999 changes in activity were based on DOE/EIA projected West South Central region commercial natural gas consumption growth rates and the relative growth in commercial sector employment in each of the four Texas regions as forecast by the REMI models incorporated into EGAS Version 4.0 (DOE, 2000 and Pechan, 2001).

The state rule that sets NO_x emission limits for natural gas-fired water heaters, boilers, and process heaters, will affect emissions from this category starting in 2002 (TNRCC, 2000). TNRCC staff were contacted to obtain emission control parameter assumptions for this category. Because TNRCC has not yet analyzed the emission reductions associated with this regulation, it was not possible to model control parameters that reflect its impact on this source category. TNRCC should recalculate the post-2001 emission trends estimates for this category when this information becomes available.

5.5 RESIDENTIAL WOOD COMBUSTION

Description of Source Category

This category is used to characterize wood burning emissions from residential woodstoves and fireplaces. Version 1.5 of the 1999 National Emissions Inventory (NEI) incorporates a new set of residential wood emission estimates including CO, NO_X, PM_{10}, $PM_{2.5}$, SO_2, and VOC. The new estimates are reported under the following SCCs:

SCC	Description
2104008001	Residential Wood - Fireplaces
2104008002	Residential Wood - Fireplaces, Inserts; non-EPA certified
2104008003	Residential Wood - Fireplaces, Inserts; non-catalytic, EPA certified
2104008004	Residential Wood - Fireplaces, Inserts; catalytic, EPA certified
2104008010	Residential Wood - Woodstoves, General
2104008030	Residential Wood - Catalytic woodstoves, General
2104008050	Residential Wood - Non-catalytic woodstoves, General

1999 Baseline Emissions

Based on draft documentation for the 1999 NEI emission estimates for this category, emissions are based on a set of very detailed methodologies that require a minimum of sixteen calculations per SCC (ERG, 2000). Because the methodology documentation has not been finalized, it is not possible to fully document the NEI methodologies at this time. Readers should consult the final residential wood emission methodology documentation when it becomes available.

Emission Trends Estimates

Because of the time constraints associated with this project, it was not possible to replicate the detailed methods used to develop the 1999 NEI emission estimates for the emission trends for this category. The preferred EIIP methodology is to conduct a survey of residential wood combustion activity (EIIP, 2001). Time constraints also precluded this approach for this effort. The alternative EIIP method for estimating residential wood activity is based on DOE state-level residential wood consumption data and U.S. Bureau of the Census county-level data on the number of households that use wood as a primary fuel (DOE, 2001; and BOC, 2001a and 2001b). This method was used to develop the trends estimates for this source category.

Because the DOE data represent total residential wood combustion, the same state-level growth rate was applied to each of the residential wood subcategories. Changes in county activity relative to state activity were estimated using trends in each county's proportion of total state housing units that use wood as a primary fuel. The 1990 year county proportions were computed directly from Census data (BOC, 2001a). The 2000 year county proportions were developed by estimating the county-level number of housing units using wood in year 2000 based on the 1990 percentage of housing units in each county using wood as a primary fuel (the 2000 percentages were not yet available) and the year 2000 total number of housing units in each county. The 1991-1999 proportions of total state housing units using wood as a primary fuel in each county were estimated through interpolation. The team then developed ratios of the county proportions for each trends year in relation to the 1999 county proportion. These ratios represent the change (relative to a base year of 1999) in the county's proportion of state number of housing units using wood. These ratios were then applied to the state-level growth factors that were developed from the EIA projections for the purpose of reflecting relative county trends in residential wood consumption.

Post-1999 changes in activity were based on DOE projected West South Central region residential renewable energy (wood) consumption growth rates (DOE, 2000) and, for estimating relative county wood consumption growth, the projected county number of housing units burning wood. The county number of housing units burning wood was estimated by multiplying total housing unit projections by the 1990 percentage of each county's total housing units burning wood. The post-1999 total housing units data were based on the TCPA number of state-level housing unit starts in each year apportioned to counties based on the ratio of county to state housing starts as projected by F.W. Dodge data supplied by TNRCC

(TCPA, 2001 and TNRCC, 2001). Because the Dodge data is only available through 2005, the 2005 county ratios are applied to the TCPA state housing starts data for 2006-2010. The housing units burning wood data were used to estimate the relative wood consumption growth rate in each county versus the state growth rate (the state growth rate is assumed to equal the growth rate for the West South Central region).

A new source performance standard (NSPS) was promulgated in 1988 that controls PM emissions from wood heaters (i.e., both wood stoves and fireplaces with inserts). This regulation utilizes a two-tiered control approach with the first phase standards (for wood heaters sold after July 1990) associated with an estimated 35 percent PM CE and the second phase standards (for wood heaters sold after July 1992) with an associated 50 percent PM CE. A turnover rate of 4 percent per year (representing a wood heater lifetime of 25 years) was used to calculate the percentage of Phase I, Phase II, and conventional wood heaters in each year. To simplify the emission trends calculations, a 50 percent CE was used to model the NSPS in this study for each year. The annual RP value for each year was calculated from the product of the CE and RP values for each year (the RP values were computed from the percentage of Phase I and Phase II wood heaters in each year based on the 4 percent annual turnover rate). Because the NSPS requires manufacturer certifications, an RE of 100 percent was assumed in each year. Based on the approach, the 1990 values for CE, RP, and RE are 50 percent, 1.2 percent, and 100 percent, respectively, while the 2010 values are 50 percent, 79.4 percent, and 100 percent, respectively. Because the annual RP and ozone season RP values are very similar for each year, the annual RP values were applied to both the annual and ozone season emissions in estimating the emission trends for this category. These control parameters were applied to all of the residential wood combustion subcategories except the following two SCCs, which represent uncontrolled residential wood combustion equipment: 2104008001-Fireplaces and 2014008002-Fireplaces: Inserts; non-EPA certified.

5.6 OIL AND GAS PRODUCTION

1999 Baseline Emissions

Oil and gas emissions are combined under one SCC Code 2310000000, but this category has six separate subcategories. Each subcategory has an individual emission factor. For natural gas and crude oil production there are fugitive emissions from leaking components in gaseous and light liquid service, combustion emissions from heaters, combustion emissions from compressors used to transfer the natural gas into production lines, and the VOC emissions from the dehydration of natural gas. Surveys were conducted to obtain activity data for estimating these emissions. Surveys were completed to estimate the following:

- Average number of components in gas and liquid service;
- Quantify the horsepower of compressors versus gas produced;
- BTU rating of heaters and use of heaters;
- Gas composition;
- Glycol dehydration emission loss (average for VOC);

- Average optional equipment on site (glycol dehydrators, heaters) ; and
- Tank size at well site

Emission Trends Methodology

It is not possible to identify historical values for most of the activity data parameters used in developing the 1999 emission estimates. Information is not available on the estimated number of components in liquid and gas service in previous years, for example. Therefore, RCOT county-level crude oil and natural gas production estimates were used as the emissions activity indicators for all oil and gas production emission processes included in this SCC (RCOT, 2001). To simplify the calculations, the 1999 emission total estimates for this category were multiplied by weighted composite growth factors computed from the individual oil production and natural gas production estimates. Each county's oil production-based and natural gas production-based growth factors were weighted by the number of gas wells and the number of oil wells in each county as determined in estimating 1999 emissions.

Post-2000 emissions activity for this category was first based on state-level projections of oil and natural gas production reported by the TCPA (TCPA, 2001b). EGAS Version 4.0 data was used to regionalize the state oil and natural gas production forecast. Specifically, the TCPA forecast data was adjusted based on the relative growth rates in oil and natural gas production sector output in each of four Texas regions as projected by EGAS Version 4.0 (Pechan, 2001). As with the historical data, each county's individual oil production-based and natural gas production-based factors were weighted by the year 1999 percentage of total wells in each county that were natural gas or oil wells.

There is a state regulation that affects VOC emissions from natural gas processing operations in the Beaumont/Port Arthur (BPA), Dallas/Fort Worth (DFW), El Paso (EP), and Houston/Galveston (HGA) nonattainment areas (TNRCC, 1997). Discussions with TNRCC staff indicate that these regulations only affect point sources, therefore, no emission reductions have been estimated from this regulation for this area source category (Mack, 2001).

5.7 ARCHITECTURAL AND INDUSTRIAL MAINTENANCE (AIM) COATINGS

1999 Baseline Emissions

Architectural coatings emissions are reported in the existing TNRCC inventory under SCC 2401001000. As identified in Section 2.5, a more highly-resolved source classification scheme was used in this effort. As described in the EIIP document for architectural coatings, a survey of AIM coating manufacturers is the preferred method for developing emission estimates for this source category (EIIP, 2001). Because of time constraints, the survey approach was not selected for use in developing 1999 emission estimates. The EIIP document for architectural coatings identifies an alternative procedure for estimating emissions from this source category, which relies on the following two initial steps:

1) Determine per capita usage factors by dividing the amount of solvent- and water-based paint and allied products manufactured nationally by the U.S. population for that year, both of which are available from the U.S. Bureau of the Census; and

2) Determine the VOC emission factors for solvent- and water-based coatings based on the weighted average VOC emissions at maximum thinning. The EIIP document presents solvent- and water-based coating emission factors calculated from the weighted averages identified in a survey conducted in 1990--0.74 lbs VOC/gal for water-based paints and 3.87 lbs VOC/gal for solvent-based paints (EPA, 1993).

For the 1999 inventory, the ENVIRON team used an improved variant of this alternative EIIP emissions estimation method. First, as described in the EIIP document, the per capita usage factors for water- and solvent-based coatings were derived from the 1999 U.S. Bureau of the Census' *Paint and Allied Products* publication (BOC, 1999). Next, information compiled by the California Air Resources Board (CARB) from their 1998 survey (of 1996 sales data) was used to develop VOC emission factors for Texas. The ENVIRON team mapped the water- and solvent-based paint usage to the appropriate AIM product category based on data provided in CARB's survey report (CARB, 1999). For each product category, CARB provides information on the fraction that is solvent- versus water-based. For flat paints, for example, nearly all of the paint is water-based, while, for industrial maintenance coatings, nearly all is solvent-based. Sales-weighted average VOC contents for each product category from the 1996 California sales data were used to develop emission factors (i.e., lbs VOC/gallon coating). For AIM categories such as industrial maintenance coatings, where the common California limit was significantly lower than what was in effect in Texas in 1999, the emission factor was adjusted upward by the ratio of the California to Texas VOC content limits.

The application of the usage factors to the Texas counties required county population data (architectural coatings) and county manufacturing employment data (industrial maintenance coatings). The county population data were taken from the TCPA (TCPA, 2001). Manufacturing employment for each Texas county was estimated from the Bureau of the Census' *County Business Patterns* (Funderburk, 2001). County-level emission estimates were developed for each SCC by multiplying the emission factor by the activity data (i.e., county populations or employment totals) described above. Because the industrial maintenance category has point source emissions associated with it, these point source emissions were backed out of the total county emissions using uncontrolled point source emissions data supplied by TNRCC (Torres, 2001). For the purpose of estimating 1999 emissions, the effects of the state/federal coatings regulations were taken into account during the development of the emission factors described above.

Emission Trends Methodology

For the 1990 inventory, the team first computed the 1990 per capita usage values from 1990 Bureau of the Census' paint manufacturing and population data. These per capita usage values were then multiplied by TCPA county-level population data to estimate total AIM coatings use

in 1990 (TCPA, 2001). Next, the ratio of total AIM coatings use in 1999 to total AIM coatings use in 1990 was applied to each of the 1999 individual product category's use values to estimate each product category's 1990 use. To estimate a composite VOC content for each product category in 1990, overall 1999 water-based and solvent-based emission factors were first computed. Next, the 1990 emission factors identified in the EIIP document (0.74 lbs VOC/gal for water-based paints and 3.87 lbs VOC/gal for solvent-based paints), were divided by their respective 1999 emission factors to develop 1990/1999 ratios. These ratios were multiplied by the 1999 product category-level emission factors computed for the 1999 inventory from the 1996 CARB sales data to estimate product category-level emission factors for 1990.

Total AIM coatings use for 1991-1998 was estimated by computing per capita water-based and solvent-based coating use values from 1991-1998 Bureau of the Census data and multiplying these values by TCPA county population data. The resulting use values were multiplied by the fraction of sales represented by each product category based on the CARB data to estimate 1991-1998 AIM coating use by product category. The VOC content of each product category in 1991-1995 was estimated by interpolating between the water-based and solvent-based paint VOC contents for 1990 and 1996 and multiplying the interpolated values by the percentage of solvent-based versus water-based coatings for each product category from the 1996 CARB sales data. Although the CARB sales data actually represents year 1996, these data were directly used to estimate 1999 emission factors. Therefore, the 1996-1999 emission factors were held constant.

Post-1999 emissions were estimated based on projected per capita usage factors. The architectural coatings per capita factors were computed by dividing the projected growth in national water- and solvent-based architectural coating shipments from the Freedonia Group by national population projections from the REMI model incorporated in EGAS 4.0 (Freedonia, 1998 and Pechan, 2001). The Freedonia Group projects national water-based and solvent-based architectural coating shipments through 2007; the time-trend in these shipments was extended through 2010 to estimate shipments in 2008-2010. The TCPA's county population projections were multiplied by the projected per capita usage factors to estimate the amount of water- and solvent-based paints applied in each county throughout the forecast period. An analogous approach was used to develop per capita industrial maintenance coating usage factors, which were then multiplied by projected manufacturing employment data from the REMI model incorporated in EGAS 4.0. Because there are no regulations that would reduce the VOC content of post-1999 paints, the post-1999 VOC content of each product category was held constant at its estimated 1999 value.

It should be noted that, because of a lack of available data, it was not possible to determine if/to what extent AIM coatings used in certain nonattainment areas during the 1990s had lower VOC content than the rest of Texas. Such a distinction could have resulted from the nonattainment area-specific state regulation, which was later superceded in September 1999 by the Federal AIM coatings rule (63 FR 48848, 1998). However, the assumption that AIM coatings have the same VOC content in attainment areas as well as nonattainment areas is consistent with the 1999 emissions inventory.

5.8 AUTOMOBILE REFINISHING

1999 Baseline Emissions

The emissions for this category have historically been reported under SCC 2401005000. For the 1999 inventory, a more highly-resolved source classification scheme was employed, as shown in Table 2.6-1. The EIIP draft chapter for this category (EIIP, 2000) lists a preferred method that estimates emissions based on shop-level employment obtained from a business database vendor (e.g., Dun & Bradstreet). The largest identified shops are then surveyed under this methodology. For the 1999 inventory, the survey approach was eliminated from consideration due to project time constraints. As noted in Section 2.6, there are several problems with the alternative methods included in the draft EIIP section. Due to these problems, the 1999 inventory methodology was based on information provided by Smith and Dunn (Smith and Dunn, 1999). The 1999 emissions activity data for this category were county-level 1999 Dun & Bradstreet (D&B) employment data for automobile top and body repair and paint shops (SIC code 7532) (D&B, 2000). 1999 emissions were estimated from the employment data and weekly VOC emissions estimates by shop size category and coating type. Section 2.6 provides additional details on the 1999 emissions methodology.

Emission Trends Estimates

The D&B employment data source is not available back to 1990, therefore, *County Business Patterns* SIC code 7532 employment data were used to estimate historical trends in automobile refinishing activity (BOC, 2001). *County Business Patterns* employment data were compiled for 1990 and 1999 for each county in the state; the 1991-1998 county employment data were estimated through interpolation. It was necessary to estimate 1990 and 1999 year withheld data for a number of counties in the state. For the counties that had SIC code 7532 establishment information but had withheld employment information, the number of employees was estimated as follows:

- The sum of all of the SIC code 7532 employees for all counties that did not have withheld information was calculated;
- For each county, the number of SIC code 7532 employees was initially estimated by taking the midpoint of the range of employees for each establishment category, multiplying by the number of businesses in that category, and then summing the values obtained. For example: a county with one 1-4 employee establishment and one 5-9 employee establishment would be estimated as having 9.5 SIC code 7532 employees;
- All of the estimated number of SIC code 7532 employees for the counties that had information suppressed was summed;
- For counties with suppressed information, the employment factor (fraction) was found by dividing each estimate by the sum of the estimates;

- The difference between the total number of SIC code 7532 employees for Texas at the state level (unsuppressed) (BOC, 2001) and the sum of employees from the first step was found, resulting in the total SIC code 7532 employees that weren't accounted for; and

- For each of the counties with suppressed information, the employment factor was multiplied by the total number of unaccounted employees, producing the number of employees.

Post-1999 trends in emissions activity were estimated using employment projections for SIC codes 752-754 from the REMI model that is incorporated into EGAS 4.0 (Pechan, 2001). Each county in the state was assigned a set of growth factors based on one of the four regional employment projections available from the REMI model.

A national automobile refinishing regulation sets VOC content limits for seven categories of automobile refinish coatings (63 FR 48806, 1998). These VOC limits, which went into effect in January 1999, and are met through product reformulation, reduce VOC emissions by 33 percent (EPA, 1998). There is also a state regulation affecting this source category in the Beaumont/Port Arthur, Dallas/Fort Worth, El Paso, and Houston/Galveston nonattainment areas (TNRCC, 2000). According to TNRCC staff, this regulation has a control efficiency of 40 percent and rule penetration and rule effectiveness of 100 percent; in addition, the weekly 1999 VOC emission estimates by shop size incorporate the effects of the state/federal regulations (Smith, 2001). TNRCC staff also suggest that it is reasonable to assume that the 40 percent emission reduction that is required in specific Texas nonattainment areas also applies to the rest of the state (Smith, 2001). Rule penetration values were estimated for pre-1999 years based on the implementation dates for the state regulation. No additional post-1999 reductions are anticipated from the state or federal automobile refinishing regulations. Because the state regulation was first implemented in Dallas and Tarrant on December 3, 1993 (affecting only primer and primer surfacers), while it was implemented for the additional automobile coating processes and the remaining nonattainment areas on July 31, 1994, separate rule penetration values were calculated for 1994 for Dallas and Tarrant for the primer SCC versus the other three automobile refinishing SCCs (the extremely small RP for 1993 was ignored). In 1994 in Dallas and Tarrant counties, a 100 percent RP is assumed for the primer SCC, while the three remaining automobile refinishing SCCs have an assigned 41.7 percent annual RP (5 months/12 months) and a 33.3 percent ozone season day RP (1 month/3 months). For all SCCs, the rest-of-state 1994 annual RP is also 41.7 percent (5 months/12 months) and the ozone season RP is 33.3 percent. In 1995 and later years, the annual RP and ozone season RP are both set to 100 percent throughout the state. An RE of 100 percent is assumed in all years.

5.9 TRAFFIC MARKINGS

1999 Baseline Emissions

The ENVIRON team reviewed the three alternative emission estimation methods described in the EIIP Traffic Markings document and selected a variant of one of the alternative methods as the methodology for the 1999 inventory (ENVIRON, 2001). The 1999 inventory methodology is divided into three subcategories for the purpose of estimating emissions: state and federal highways, city and county roads, and private roads and parking lots. Because of the similarities in methodology, the following subsection highlights both the 1999 inventory methodology and describes the approach used for developing emission trends data.

Emission Trends Estimates

State and Federal Highways

The annual average of the amount of traffic paint purchased by the Texas Department of Transportation (TXDOT) in 1996-2000 was calculated to estimate the amount of paint applied in 1999. This approach was suggested by a TXDOT contact who noted that more paint is purchased than applied in some years, with the excess inventory used to cover a portion of the following year's demand (Smart, 2001). As suggested by the EIIP document for this category, state-level emissions data were allocated to counties based on state highway maintenance expenditures (EIIP, 1997). The 1999 emission factor is based on the TXDOT's traffic paint specifications for 1996-2000 and traffic paint volumes for each year (TXDOT, 1998). Specifically, a weighted average emission factor was computed from each paint specification based on weighting the paint volumes in each year (3 years previous to calculation year is weighted 0.25, 2 years previous is weighted 0.5, 1 year previous is weighted 0.75, the calculation year is weighted by a factor of 1, and the year following the calculation year is weighted 0.75). For example, assume these 3 paint formulation were purchased in the following amounts (in thousands of gallons) between 1996 and 2000:

Formulation	1996	1997	1998	1999	2000
1 (2 lb VOC/gallon)	10	5	5	3	3
2 (1 lb VOC/gallon)	2	2	5	10	10
3 (.8 lb VOC /gallon)	1	2	2	5	5

The following calculations are performed for each formulation of paint:

Formulation 1 = (10*0.25) + (5*0.5) + (5*0.75) + (3*1) + (3*0.75) = 14.0.
Formulation 2 = (2*0.25) + (2*0.5) + (5*0.75) + (10*1) + (10*0.75) = 22.75.
Formulation 3 = (1*0.25) + (2*0.5) + (2*0.75) + (5*1) + (5*0.75) = 11.5.

To estimate the amount of each paint formulation applied in 1999, these paint formulation volumes provide the weights that would be applied to the estimated total amount of paint applied in 1999 (the estimated total paint applied is based on the annual average of the total paint purchased between 1996 and 2000). The estimated amount of each paint formulation applied in 1999 is then multiplied by the VOC content of the formulation to compute 1999 emissions. Sample emission calculations using actual 1999 data are provided in Section 2.7.

To estimate emissions for other historical years, TXDOT paint volume data were obtained back though 1987 and annual five year average paint volumes were computed (e.g., 1990 traffic paint use was estimated based on 1987-1991 paints purchased). The TXDOT provided traffic paint specifications for 1987-2000. State-level emissions were computed by multiplying each paint formulation's VOC content by the estimated amount of that paint formulation applied in each year. County emissions were estimated by apportioning the state emissions based on state-maintained lane miles by county. Future year total state-level year paint use was held constant at the 2000 year value based on data indicating relatively constant use between 1998 and 2000. However, the post-2001 paint formulation percentages reflect data for the years available within the five year period, resulting in continued reductions in total state traffic marking emissions for 2001. Post-2001 emission estimates remain constant because the paint formulations purchased in the preceding years are all at the lowest VOC content limit.

City and County Roads

The amount of traffic paints used on city and county roads in 1999 was estimated based on information that 65 percent of all marking paint purchased is used by state highway departments and 25 percent is used by cities and counties (SRI, 1990). Traffic markings are covered by the federal regulation limiting VOC content in architectural coatings (63 FR 48848, 1998). The national rule results in an estimated 20 percent VOC reduction when fully effective. To compute 1999 state emissions for this subcategory, the estimated county volume of paints was multiplied by the federal limit for traffic markings (1.3 pounds of VOC per gallon). County and city road lane miles data were used as the indicator for allocating state emissions to the counties.

To estimate the amount of traffic paints used on city and county roads in Texas for all other years over the analysis period, the ENVIRON team first estimated the total traffic marking paint used based on the TXDOT paint use data for each year and the estimate that 65 percent of all marking paint purchased is used by state highway departments. Next, the estimated total volume of marking paint was multiplied by 25 percent, which represents the estimated percentage of total traffic paints used by cities and counties. To reflect pre-regulation conditions, 1990-1998 emissions were estimated using an emission factor that is 20 percent higher than the federal limit for traffic markings. City and county road lane miles data were used to allocate state-level emissions data to counties. 1990 city and county road lane miles data were compiled by county and 1991-1998 county and road lane miles were estimated by interpolating between each county's 1990 and 1999 proportion of total Texas city/county road lane miles. Post-1999 emissions were estimated assuming no growth in the volume of city/count traffic markings applied and the federal traffic markings limit.

Private Roads and Parking Lots

Zone markings, which are markings used for private roads and parking lots, are covered by the federal regulation limiting VOC content in architectural coatings (63 FR 48848, 1998). To calculate the 1999 emissions for this subcategory, the estimated state volume of paints was multiplied by the federal limit for zone markings (3.8 pounds of VOC per gallon). The amount of paint used by this subcategory was estimated for each year based on the TXDOT data and information that 10 percent of traffic paints are used by private developers (SRI, 1990). To reflect pre-regulation conditions, pre-1999 emissions were estimated using an emission factor that is 20 percent higher than the federal limit for zone markings. Traffic paint emissions for private roads and parking lots were allocated to counties based on population data. Post-1999 emissions were estimated assuming no change in the volume of traffic markings applied to private roads and parking lots and the federal zone markings limit.

5.10 INDUSTRIAL SURFACE COATING

1999 Baseline Emissions

For each of the 14 industrial surface coating subcategories, Texas 1999 industrial surface coating emissions were estimated by multiplying national industrial surface coating emission estimates by allocation factors. The ENVIRON team first multiplied the ratio of the state of Texas number of employees in each applicable industrial surface coating subcategory-related North American Industrial Classification System (NAICS) code to the national number of employees in that NAICS code (DOC, 2001). Estimated state emissions were then allocated to counties based on the estimated number of employees in the 6-digit NAICS codes that directly related to the industrial surface coating subcategories. For counties that had manufacturing establishment information but had withheld employment information, the number of employees was estimated as described in Section 2.8.

Table 5.10-1 presents the 14 industrial surface coating subcategories with their associated spatial allocation indicators. The NAICS-based indicators were used to allocate the 1999 national emission estimates. As described later in this section, the Standard Industrial Classification (SIC) code-based indicators were used to allocate 1990 national emission estimates. Area source industrial surface coating emissions were estimated in the 1999 inventory by subtracting 1999 point source emissions from estimated 1999 total emissions. Because point source emissions are not available throughout the analysis period, changes in area source emission activity were estimated for this category based on changes in total emission activity.

A TNRCC regulation requires VOC emission limits/control equipment for industrial surface coating operations in the BPA, DFW, EP, and HGA nonattainment areas (TNRCC, 2000). Section 2.8 presents the CE, RP, and RE estimates that were applied to the counties in these nonattainment areas for 1999.

The following subsections identify how emissions were estimated for the other years over the analysis period. The proposed methods and data sources are similar to those used in developing the 1999 estimates. Industrial surface coating emissions are discussed first, followed by thinning and cleanup solvents.

Table 5.10-1. Spatial allocation indicators for industrial surface coating subcategories.

	Allocation Indicator	
Coating Subcategory	**SIC Code(s)**	**NAICS Code(s)**
2401015000 - Factory Finished Wood: Coating	2426 2429 243 244 245 2493 2499	321113 321211 321212 321213 321214 321219 321911 321912 321918 32192 321991 321992 321999 33711 337215
2401020000 - Wood Furniture: Coating	2511 2512 2517 2521 2541	337122 337129 337211 337212 337215
2401025000 - Metal Furniture: Coating	2514 2515 2519 2522 253 2542 2599	337121 337124 337127 337214 339111
2401030000 - Paper, Foil, and Film: Coating	2671 2672 2673 3081 3082	3222 326111 326112 326113
2401040000 - Metal Cans: Coating	341	332431 332439
2401045000 - Sheet, Strip, and Coil: Coating	3479	332812
2401055000 - Machinery and Equipment: Coating	35	33271 332991 332997 333

Coating Subcategory	Allocation Indicator	
	SIC Code(s)	NAICS Code(s)
2401060000 - Appliances: Coating	363	333414 335211 335212 335221 335222 335224 335228
2401065000 - Electronic and Other Electrical: Coating	3357 3612	331319 331422 331491 335311 335921 335929
2401070000 - Motor Vehicles: Coating	371	336111 336112 33612 336211 336992
2401075000 - Aircraft: Coating	3721	336411 336413
2401080000 - Marine: Coating	373	336611 336612
2401085000 - Railroad: Coating	374	33651
2401090000 - Miscellaneous Manufacturing: Coating	All of 20-39, except those listed above	All of 31-33, except those listed above

Note: SCC 2401100000 (Industrial Maintenance), which was included under TNRCC's Industrial Surface Coating methodology, is included in this analysis as part of the Architectural and Industrial Maintenance Coating (see Section 5.7).

Emission Trends Estimates

Surface Coating Emissions

As identified in the description of the TNRCC general industrial surface coating methodology, the average VOC per gallon of paint and coatings for 1991 is assumed to remain constant through 1999 (Torres, 1999). This assumption was based on the exemptions presented in the state's surface coating processes regulation (TNRCC 30 TAC §115.42). For this study, the 1991 average VOC per gallon for each coating subcategory was also used to represent the 1990 emission factor for each year. The 1990-1999 total volume of paint shipments in each of the 14 industrial surface coating subcategories was compiled from a Bureau of Census publication (BOC, 2000). To estimate 1990-1999 national industrial surface coating emissions, each subcategory's VOC content (e.g., in pounds per gallon) was multiplied by the 1990-1999 volume of paint shipments for that subcategory. County emissions for 1990 were estimated using the same allocation factor methodology described for 1999, however, 1990 allocation factors were based on 1990 SIC code employment data. The 1991-1998 allocation factors were computed by interpolating between each county's 1990 and 1999 allocation

factors. Because the 1999 inventory removes point source emissions, pre-1999 emissions were estimated by multiplying the 1999 county emissions, after removing these point source emissions, by that county's ratio of pre-1999 total emissions to 1999 total emissions. Based on information provided by TNRCC staff, a lower RE was assumed in pre-1999 years than the 100 percent assumed for 1999 (CE and RP were kept constant, however). For most surface coating categories, RE values of 80 percent and 85 percent were assumed for 1990-1995 and 1996-1998, respectively. Exceptions include sheet, strip, and coil; miscellaneous manufacturing; and metal furniture (70 percent RE in 1990-1995 and 75 percent for 1996-1998); and metal containers (96 percent RE for 1990-1995 and 99 percent for 1996-1998).

Post-1999 paint volumes were projected using EGAS growth factors for the industrial sector that most closely approximates the SIC code(s) used to allocate national emissions to counties. Table 5.10-2 displays the EGAS growth factors applied to the 1999 county emissions. These EGAS growth factors are based on constant dollar output projections from the REMI models for four Texas regions. By applying these growth factors to 1999 emission levels, the 1999 emission factors and control parameters are assumed to stay constant throughout the forecast period.

Table 5.10-2. Growth indicators for industrial surface coating subcategories.

Coating Subcategory	EGAS 4.0 Growth Indicator SIC Code(s)	Spatial Allocation Indicator SIC Code(s)
2401015000 - Factory Finished Wood: Coating	24	2426 2429 243 244 245 2493 2499
2401020000 - Wood Furniture: Coating	25	2511 2512 2517 2521 2541
2401025000 - Metal Furniture: Coating	25	2514 2515 2519 2522 253 2542 2599
2401030000 - Paper, Foil, and Film: Coating	267	2671 2672 2673 3081 3082
2401040000 - Metal Cans: Coating	341	341
2401045000 - Sheet, Strip, and Coil: Coating	347	3479
2401055000 - Machinery and Equipment: Coating	356	35
2401060000 - Appliances	363	363

Coating Subcategory	EGAS 4.0 Growth Indicator SIC Code(s)	Spatial Allocation Indicator SIC Code(s)
2401065000 - Electronic and Other Electrical: Coating	36	3357 3612
2401070000 - Motor Vehicles: Coating	371	371
2401075000 - Aircraft: Coating	372, 376	3721
2401080000 - Marine: Coating	373	373
2401085000 - Railroad: Coating	374	374
2401090000 - Miscellaneous Manufacturing: Coating	20-39	All of 20-39, except those listed above

Note: SCC 2401100000 (Industrial Maintenance), which was included under TNRCC's Industrial Surface Coating methodology, is included in this analysis as part of the Architectural and Industrial Maintenance Coating (see Section 5.7).

Thinning and Cleanup Solvent Emissions

Previous work on this category by TNRCC referred to these operations as "cleanup and maintenance" solvent use (Torres, 1999). To avoid confusion with the industrial maintenance category, these operations are referred to here as "thinning and cleanup." To estimate pre-1999 national emissions activity for thinning and cleanup solvents, the ENVIRON team compiled the national amount of allied and paint products industry solvents used for thinning and cleanup. These data, which were used to develop the 1999 emission estimates, are reported annually by the Bureau of the Census (BOC, 2000). Other parameters used by TNRCC in calculating 1999 industrial surface coating thinning and cleanup emissions (the percentage of total industrial surface coatings consumed by each of the industrial subcategories) are based on 1991 NPCA survey data, and, in lieu of data for other years, were used throughout the trends analysis period (SRI, 1992). Pre-1999 Texas county emissions were estimated from the national emission estimates using the same allocation factor methodology described for 1999, however, 1990 allocation factors were based on 1990 employment data, and 1991-1998 allocation factors were computed by interpolating between the 1990 and 1999 allocation factors. Thinning and cleanup solvents use for post-1999 years was estimated as a percentage of the projected paint use estimates that were derived from multiplying 1999 paint use by EGAS Version 4.0 growth factors. The 1999 emission factors and control parameters were kept constant throughout the forecast period.

5.11 GRAPHIC ARTS

1999 Baseline Emissions

1999 graphic arts emissions were estimated using a per capita emission factor and TCPA county population data (TCPA, 2001). It is important to note that this approach estimates total graphic arts emissions; 1999 area source graphic arts emissions were estimated by subtracting out point source emissions reported in TNRCC's point source inventory.

Emission Trends Estimates

Because point source emissions are not available throughout the analysis period, estimated changes in emission activity levels for this category are based on TCPA county population trends (TCPA, 2001).

Texas statutes control emissions from several graphic arts processes in nonattainment areas (TNRCC, 1994 and TNRCC, 1999). TNRCC staff provided emission control information for this source category. As indicated by TNRCC staff, the only graphic arts area source emissions affected by the three printing processes regulated by TNRCC are those associated with offset lithographic printing (the other two processes, flexographic and rotogravure printing, are assumed only to affect point sources). In addition, the only area sources affected by the offset lithographic printing regulations are located in El Paso county (Mack, 2001). It was necessary to estimate the RP representing the proportion of total El Paso area source graphic arts emissions from offset lithographic printing. Based on information from the EIIP document for Graphic Arts, which indicates that approximately 35 percent of national total printing ink solvents are used in offset lithography, a 35 percent RP is assumed for 1996 and later years along with the 66 percent control efficiency estimate provided by TNRCC (EIIP, 1996 and Mack, 2001). The TNRCC offset lithographic printing regulation is also modeled using an RE of 100 percent.

5.12 ASPHALT (EMULSIFIED AND CUTBACK)

1999 Baseline Emissions

Cutback asphalt and emulsified asphalt are two of the types of asphalt that are used for road paving and repair. Cutback asphalt is divided into several grades (e.g., MC30 and RC250) and 1999 cutback asphalt emissions were calculated based on the amount of these grades purchased. Emulsified asphalt emissions for 1999 were estimated by applying an emission factor to the total volume of 1999 emulsified asphalt purchased. Because of the similarities in methodology, the following subsection highlights both the 1999 inventory methodology and describes the approach used for developing emission trends data.

Emission Trends Estimates

TXDOT provided state-level cutback asphalt use by grade for the years 1992-2000. Emissions were estimated throughout this period by multiplying the state-level grade-specific data by solvent content information for each grade. Solvent loss was based on the solvent content of each grade of asphalt. Solvent retention (unevaporated solvent) was based on TXDOT guidance. Because only total cutback asphalt use data were available for 1990 and 1991, state emissions for these years were calculated by multiplying the 1992 cutback asphalt emission estimate by the ratio of 1990 (or 1991) total use to 1992 total use. For example, 1990 year cutback emissions were estimated by dividing total cutback use in 1990 by total cutback use in 1992 and multiplying this ratio by the 1992 cutback emission estimate.

TXDOT also provided 1991-2000 cutback asphalt use data for the 16 nonattainment area counties (all but three counties actually only had data from 1993-2000). To estimate cutback emission estimates from these data, the per gallon cutback emission factor was computed for each year by dividing state-level emissions in each year by the asphalt use for that year. These per gallon emission factors were then multiplied by each county's cutback asphalt use data to develop emission estimates for the nonattainment counties. To estimate cutback asphalt use in the nonattainment counties for the years where nonattainment county data were not available, the first available county-level emission estimate was multiplied by the ratio of total state cutback asphalt use in the missing year to the total state cutback use in the first available year with county-level data. After subtracting the total cutback emissions estimates for the nonattainment counties from the total state cutback emissions, the remainder was allocated to attainment counties based on total lane miles. The TXDOT provided the ENVIRON team with county lane miles data for 1990 and 1999. County lane miles for other years were estimated by interpolating between the 1990 and 1999 values (year 1999 county proportions were used to reflect year 2000 proportions).

County-level emulsified asphalt emission trend estimates were developed using state-level emulsified use data from the TXDOT for 1991-2000, the assumption that the TXDOT data represents 60 percent of total emulsified asphalt use, an emission factor of 0.22 lbs per gallon of emulsified asphalt, and county allocation factors based on total lane miles. Because 1990 emulsified asphalt use data were not available, 1990 state-level emulsified emissions were computed by multiplying the 1991 state emission estimate by the ratio of 1990 state-level total non-cutback asphalt use to 1991 state-level total non-cutback asphalt use. County allocation factors (from lane miles data) were used to allocate state emulsified use data to nonattainment counties because, unlike cutback asphalt, individual estimates of emulsified asphalt use data were not available for these counties.

To project cutback and emulsified asphalt emissions activity, separate forecasts were computed for: (1) total asphalt consumption; and (2) the proportion of total asphalt demand from (a) cutback asphalt and from (b) emulsified asphalt. Total asphalt use was forecast first. Because projections of total lane miles, paved lane miles, and highway spending are not available for the forecast period, the other two surrogate asphalt use indicators cited in the asphalt EIIP document (population and VMT) were reviewed for potential use in this analysis (EIIP, 2001). To identify which surrogate to select, the team compared the state growth rates in asphalt use, population, and VMT over the 1990-2000 period. Because of the volatility in the asphalt use data, the team calculated state growth factors for 1990 and 2000 based on a two-year average (e.g., 1990 was estimated as the average of the 1989 and 1990 asphalt use). On this basis, asphalt use increased approximately 24 percent between 1990 and 2000, while population increased 18 percent and VMT increased 32 percent. Because the state asphalt growth over the 1990-2000 period approximated the average of the population and VMT growth rates, the ENVIRON team projected total asphalt use based on the average of each county's growth rates for these two variables.

The proportion of total paving asphalt demand met by cutback asphalt was forecast next. Based on a review of the historical data, there was a dramatic decline in the percentage of

cutback use between 1992 and 1994 (about 20 percent per year). In the last six years, the reduction has been at a much slower rate (averaging about 6 percent per year). Based on this information, and forecasts from The Freedonia Group, Inc. for continued national declines in the percentage of total asphalt demand met by cutback asphalt, the ENVIRON team forecasts that this percentage will continue to decline at the 6 percent annual average observed over the last six years (Freedonia, 2000). This results in cutback asphalt accounting for approximately 1 percent of total asphalt demand in the year 2010, versus a 2.6 percent figure for the year 2000. Therefore, the average of each county's population and VMT growth rates was adjusted downward to reflect the projected decline in the percentage of total paving asphalt demand supplied by cutback asphalt.

The final projections value that is required is the proportion of total asphalt demand from emulsified asphalt. A review of the proportions from the during the 1990s did not indicate any clear trend. Therefore, emulsified asphalt use was projected based on the rate of projected total paving asphalt demand, which is based on the average of each county's population and VMT growth rates.

The state has a regulation that limits the use of conventional cutback asphalt by any state, municipal, or county agency in Nueces county and in the BPA, DFW, EP, and HGA nonattainment areas (TNRCC, 1999). This regulation also restricts the VOC content of emulsified asphalt in these areas. With the exception of Nueces county, these same areas prohibit the application of cutback asphalt between April 16 and September 15 of any year (TNRCC, 1999). Certain counties were required to be in compliance with these regulations by December 1992, while others were required to be in compliance by April 16, 1993. In keeping with TNRCC's restrictions on the use of cutback asphalt between April 16 and September 15, ozone season day cutback emissions were zeroed out for all ozone nonattainment area counties for 1993-2010. The cutback asphalt annual emission estimation methods reflect the impact of these regulations through reductions in the amount and proportions of the various grades of cutback asphalt used; no information was available to reflect potential reductions associated with VOC content limits for emulsified asphalt.

5.13 AGRICULTURAL PESTICIDE APPLICATION

1999 Baseline Emissions

Agricultural pesticide application emissions for year 1999 were estimated using an emission factor based on total harvested crop acreage. Section 2.11 provides additional details on the emissions estimation methodology for this category, including sample emission calculations.

Emission Trends Estimates

County-level total acres harvested data are available from the *Census of Agriculture* for 1987, 1992, and 1997 (USDA, 2001a). These *Census of Agriculture* data were used to develop a

1990-1997 county-level harvested acreage data series. The 1990-1997 county-level total harvested acreage data were estimated by interpolating between the 1987, 1992, and 1997 *Census of Agriculture* total harvested acreage data. For a number of counties in the state, it was necessary to estimate harvested acreage data that were withheld from publication in the *Census of Agriculture*. For the counties that had number of farms data, but did not report their associated harvested acreage information, acreage data were estimated as follows:

- The sum of all of the harvested acreage data for all counties that did not have withheld information was calculated;
- For each county, the harvested acreage was initially estimated by taking the midpoint of the range of harvested acreage for each acreage range category, multiplying by the number of farms in that category, and then summing the values obtained. For example: a county with one farm with 1 to 9 harvested acres and one farm with 10 to 19 harvested acres would be estimated as having 19.5 total acres harvested (5 acres plus 14.5 acres);
- All of the estimated harvested acreage data for the counties that had information suppressed were summed;
- For counties with suppressed information, the harvested acreage factor (fraction) was found by dividing each estimate by the sum of the estimates;
- The difference between the total state harvested acreage (unsuppressed) and the sum of the harvested acreage from the first step was found, resulting in the total harvested acreage that was not accounted for; and
- For each of the counties with suppressed information, the harvested acreage factor was multiplied by the total unaccounted harvested acreage, producing the estimated harvested acreage by county.

1998-2000 total harvested acreage data were estimated by applying the state-level growth rates in total harvested acreage for 1997-2000 to each county's 1997 total harvested acreage.

National crop acreage projections from the U.S. Department of Agriculture were used to develop post-2000 harvested acreage estimates (USDA, 2001b). The available crop-specific National projections were weighted based on the relative contribution of each available crop to the 1997 total Texas harvested crop acreage. Composite growth factors were computed for each post-2000 year using these crop weights and the National crop projections. These growth factors were then applied to the 2000 county-level harvested acreage estimates.

There are no known federal, state, or local control programs that affect emissions from this source category over the analysis period.

5.14 CONSUMER AND COMMERCIAL PRODUCTS

1999 Baseline Emissions

For consumer and commercial products, 1999 emissions were calculated by multiplying per capita emission factors by county population data. These emission factors incorporate the effects of regulatory programs that were in effect in 1999. Additional details on the 1999 consumer and commercial product emission estimation procedures are provided in Section 2.12.

Emission Trends Estimates

To estimate 1990-2010 trends in consumer product consumption, the per capita emission factors that were used to develop 1999 emissions were first multiplied by TCPA county-level population data (TCPA, 2001). The 1999 year per capita emission factors are based on 1997 consumer product survey data compiled by the California Air Resources Board (CARB). These emission factors were selected for use instead of EPA's EIIP emission factors because the EIIP factors are based on 1990 survey data (TNRCC, 1999).

Both national and state regulations control VOC emissions from consumer products (63 FR 48819, 1998 and TNRCC, 1995). The EPA estimates a 20 percent reduction in VOC emissions from the national regulation (CE, RP, and RE factors were not identified). Because of the similarity between the state VOC content limits and the national VOC content limits, no additional emission reductions were attributed to the state consumer products rule.

Although the national consumer product regulation became effective in 1998, national manufacturers were reformulating products for many years before this due to state regulations such as those implemented in California as early as 1989. As indicated by the TNRCC consumer product emission factor document, most consumer products are reformulated to comply with the most stringent state regulations and are marketed nationally (TNRCC, 1999). One of the goals of the national regulation was to encourage consistency across the country.

By comparing the EIIP 1990 composite consumer/commercial product emission factor (7.84 pounds per person per year) to the CARB 1997 composite emission factor (6.73 pounds per person per year), a 14 percent reduction in consumer/commercial products is estimated to have occurred between 1990 and 1997. Although the CARB survey data represents 1997 conditions, these data were used in developing the 1999 year emission factors. To reflect the 14 percent reduction estimated from the EIIP/CARB emission factors, it was assumed that the 1999 emission factors reflect a CE of 20 percent and a RP of 70 percent (0.14/0.20 = 0.70). For the purposes of the emission trends effort, the 1997 and 1998 RP values were held constant at 70 percent to reflect the fact that the CARB survey data are based on 1997 information. Because the national regulation requires that VOC content limits be achieved by December 10, 1999, a RP of 100 percent was assumed for year 2000.

Given the existence of earlier state regulations and the national marketing of these products, it is reasonable to assume that some pre-1997 emission reductions should be attributed to this source category. In lieu of better information, the following RP assumptions were used to adjust the trends emission estimates for RP in each year relative to the 70 percent RP value implicitly incorporated into the 1999 emission factor:

Year	Rule Penetration Factor (%)
1990	0
1991	10
1992	20
1993	30
1994	40
1995	50
1996	60
1997-1999	70
2000	100

Because CE and RE were assumed to be constant throughout the analysis period, the above RP values provide the total estimated percentage change in emission reductions relative to 1999 control levels.

5.15 GASOLINE DISTRIBUTION

1999 Baseline Emissions

This source category includes area source emissions from the gasoline distribution system. Stage I and Stage II emissions (occurring during the transfer of gasoline from tank trucks to storage tanks at service stations, and subsequent transfer to the vehicle gasoline tank, respectively) are covered, as well as emissions from delivery trucks in transit, gasoline station storage tanks, and spillage. Separate emissions estimation methodologies were used to develop emissions from the individual processes that comprise this source category.

Gasoline throughput was the activity data used in calculating 1999 emissions from each gasoline distribution SCC (throughput was based on consumption). Monthly state-level gasoline consumption data were obtained from the Texas Comptroller of Public Accounts (TCPA, 2001). For tank truck unloading, vehicle refueling, and spillage, the gasoline consumption in Texas was apportioned by winter versus summer season. The winter consumption was calculated by adding the consumption during January, February, March, October, November, and December. The summer consumption was calculated by adding the consumption during April, May, June, July, August, and September. State gasoline

consumption was apportioned to each county based on the proportion of 1997 year sales at service stations in each county, which was computed from Bureau of Census data (BOC, 1999).

The annual VOC emissions from *vehicle refueling* and *spillage* were calculated by applying the MOBILE6 emission factor for winter and summer for each county to the winter and summer gasoline consumption calculated for each county. The sum of the winter and summer emissions for a county was the total VOC emissions for the year for that county. The MOBILE6 emission factors incorporate the effects of emission control programs.

The annual VOC emissions from *tank truck unloading* were calculated by applying the TNRCC supplied L_L factor for winter and summer for each county to the winter and summer gasoline consumption calculated for each county. The sum of the winter and summer emissions for a county was the total VOC emissions for the year for that county. These emissions were controlled in nonattainment areas using CE, RP, and RE values supplied by TNRCC.

The annual VOC emissions for *tank breathing losses* and *tank trucks in transit* were calculated by applying emission factors to the number of gallons of gasoline consumption for 1999. A gasoline transportation adjustment factor of 1.25 was applied to the tank trucks in transit calculation (EIIP, 2001). The ozone nonattainment county emissions for tank trucks in transit were modeled using CE, RP, and RE values supplied by TNRCC.

Emission Trends Estimates

State gasoline consumption data were obtained for 1990 through 2000 from the TCPA (TCPA, 2001). County-level *Census of Retail Trade* gasoline service station data were compiled for 1987, 1992, and 1997. For counties that had gasoline service station establishment information but had withheld sales information, sales data were estimated as follows:

- The sum of all of the gasoline service station sales for all counties that did not have withheld information was calculated;
- For each county, gasoline service station sales were initially estimated by taking the midpoint of the range of sales for each sales category, multiplying by the number of businesses in that category, and then summing the values obtained;
- All of the estimated gasoline service station sales for the counties that had information suppressed was summed;
- For counties with suppressed information, the sales factor (fraction) was found by dividing each estimate by the sum of the estimates;

- The difference between the total gasoline service station sales at the state level (unsuppressed) and the sum of the gasoline service station sales from the first step was found, resulting in the total gasoline service station sales that weren't accounted for; and

- For each of the counties with suppressed information, the sales factor was multiplied by the total amount of unaccounted gasoline service station sales, producing the estimated gasoline service station sales for each county with withheld data.

A complete 1990-1997 gasoline service station data series was then developed through interpolation. To estimate county-level gasoline sales, the proportion of gasoline service station sales in each county to the state total was computed for each year and these proportions were applied to the 1990-1997 state gasoline sales data from the TCPA. Because the 1997 proportions are the latest year available, these proportions were also used to allocate state gasoline consumption data to counties for the years 1998-2000 (the last year of state gasoline sales data available from the TCPA).

Although gasoline sales data are preferred, the EIIP gasoline distribution document discusses the use of vehicle miles traveled (VMT) data as a substitute for gasoline sales activity data (EIIP, 2001). Because gasoline sales projections are not available, post-2000 year growth in gasoline sales was estimated by applying growth rates developed from county-level VMT projections produced by the Texas Transportation Institute (TTI) to the 2000 year gasoline sales data.

Finally, growth factors were computed from the estimated 1990-2010 gasoline consumption data. These growth factors were computed for a base year of 1999 (i.e., 1999 = 1.0). The following describes how these factors were applied in estimating emissions from each gasoline distribution SCC.

Vehicle Refueling (Stage I) and Spillage

The EPA's MOBILE6 model was run to develop 1990-2010 summer and winter Stage II vehicle refueling (Stage II) emission factors and summer and winter spillage emission factors on a per gallon basis. This software uses local data (e.g., temperature, fuel volatility) to generate VOC emission factors. Details of the calculations performed to split the MOBILE6 refueling output into refueling vapor displacement and spillage have been provided in Section 2. The 1990-2010 gasoline sales-based growth factors, computed using the methods described above, were then multiplied by the 1999 summer and winter gasoline consumption estimates used in computing 1999 emissions from these subcategories. The product of these calculations was estimated summer and winter gasoline throughput by county for 1990-2010. Vehicle refueling and spillage emissions were calculated for each year by multiplying the summer and winter MOBILE6 emission factors by the estimated gasoline throughput by county in each year. The MOBILE6 emission factors incorporate the effects of vehicle refueling controls, so no further adjustments were necessary.

Tank Truck Unloading (Stage I)

Changes in tank truck unloading emissions activity were estimated by applying the gasoline sales-based growth factors to 1999 emissions. A TNRCC rule controls VOC emissions from Stage I gasoline service stations in specific ozone attainment and nonattainment area counties in the state (TNRCC, 1999a). TNRCC estimates that the current tank truck unloading (Stage I) CE, RP, and RE are 98 percent, 98 percent, and 90 percent, respectively. These estimates apply to 1999 and all future years for the 16 nonattainment area counties. It was necessary to adjust these estimates for the level of control in each pre-1999 year. The 1996-1998 RE for this regulation is estimated at 85 percent; pre-1996 RE is assumed to be 80 percent. For 1990-1995, the Stage I CE is estimated at 95 percent (CE was increased in nonattainment counties in 1996 when the Stage I control requirements were strengthened). For 1990-1994, RP is estimated at 95 percent for the earlier Stage I requirements (although the compliance date for the strengthened Stage I requirements was tied to the Stage II compliance schedule, which was a phased schedule with dates between 5/15/93 and 12/22/98, the vast majority of gas stations had an 11/15/94 compliance date, therefore the full RP of 98 percent was assumed starting in January 1995). Twelve of the sixteen counties had Stage I requirements in place by 1990. For Brazoria and Galveston Counties, the Stage I compliance date was July 31, 1992; for Jefferson and Orange Counties, the compliance date was January 31, 1994. For the 95 "covered" attainment area counties, the Stage I compliance date is April 30, 2000. Because of different exemption levels, TNRCC estimates an overall reduction of only 30 percent for these attainment area counties. Based on the 98 percent CE and 90 percent RE estimates, an RP of 34 percent was assumed for these counties. For counties with compliance dates in the middle of a year, the RP estimates for these years reflect the portion of the year (and for the covered attainment areas in year 2000, the portion of the ozone season) when compliance was required.

Tank Breathing Losses

Tank breathing loss emissions for 1990-2010 were calculated by applying gasoline sales-based growth factors, computed using the methods described above, to the 1999 emission estimates for this subcategory. No other adjustments were necessary because there are no known controls that affect tank breathing loss emissions.

Tank Trucks in Transit

Changes in tank truck in transit emissions activity were estimated by applying the gasoline sales-based growth factors to 1999 emissions. Because of leak-tightness test requirements (TNRCC, 1993 and TNRCC, 1999b), it was necessary to adjust these initial estimates for the level of control in each year. TNRCC staff identified the counties impacted by the leak-tightness regulation and provided CE, RE, and RP estimates for each year (Mack, 2001). For gasoline transit trucks in the 16 nonattainment area counties, the 1999 CE, RP, and RE estimates provided by TNRCC are 95, 100, and 85 percent, respectively. For 1990-1999, RE was estimated at 80 percent. Four of the sixteen nonattainment counties had gasoline transit truck leak testing requirements in place by 1990. In May of 1991, TNRCC adopted a rule

change which added testing requirements to Brazoria, Galveston, Jefferson, and Orange Counties, with a compliance date of July 31, 1992. The remaining eight nonattainment area counties had to comply with the gasoline tank truck regulations by January 21, 1994. For the 95 "covered" attainment areas, the compliance date for the truck testing requirements was April 30, 2000. For counties with compliance dates in the middle of a year, the RP estimates for these years reflect the portion of the year (and for the covered attainment areas in year 2000, the portion of the ozone season) when compliance was required.

5.16 OPEN BURNING

1999 Baseline Emissions

Because of the similarities in methodology, the following subsection highlights both the 1999 inventory methodology and describes the approach used for developing emission trends data. Additional details on the 1999 emissions estimation methodology are provided in Section 2.14.

Emission Trends Estimates

For the 1999 NEI, EPA prepared county-level emission estimates for the following open burning categories:

SCC	SCC Name
2610030000	Residential municipal solid waste (MSW) burning
2610000100	Residential leaf burning
2610000400	Residential brush burning
2610000500	Land clearing debris burning

Residential municipal solid waste (MSW) refers to nonhazardous refuse produced by households (e.g., paper, metals, glass, leather, textiles, and food wastes). Since the state promulgated an outdoor burning regulation (30 TAC, Chapter 111.219), the following materials are prohibited from being burned: electrical insulation, treated lumber, plastics, non-wood construction/demolition materials, heavy oils, asphaltic materials, potentially explosive materials, chemical wastes, and items containing natural or synthetic rubber (TNRCC, 1996). Residential yard waste refers to materials such as leaves, trimmings from trees and shrubs, and grass. Land clearing debris refers to the clearing of land for new construction and the burning of organic material (i.e., trees, shrubs and other vegetation). The SCCs for residential brush burning and land clearing debris burning are new SCCs. Previous years' estimates for open burning were reported under SCC 2610000000 (total for all open burning categories). In the 1999 NEI, this SCC was removed and the 1999 emissions were reported on the SCCs listed above to avoid double-counting of emissions.

SCC 2610030000 (Residential Municipal Solid Waste Burning) - an estimated 1999 state per capita waste generation factor (3.24 pounds/person/day), the estimated 1999 rural population in each county (based on 1990 rural/urban percentage applied to 1999 county populations), and the estimated percentage of total waste that is subject to burning (28 percent) was used to estimate this source category's 1999 emissions activity. For the emission trends effort, the ENVIRON team investigated the availability of data characterizing pre-1999 per capita waste generation factors. Unfortunately, detailed data on state waste disposal has only recently been compiled. Therefore, the ENVIRON team solely used TCPA county population data to represent 1990-2010 trends in this emissions activity (TCPA, 2001a).

The state of Texas has a regulation prohibiting open burning by households, however, certain exceptions apply–see 30 TAC, Chapter 111 for these allowances (TNRCC, 1996). To estimate RP values, the team contacted county and city officials for 1997 and 1999 estimates of the portion of the residential population in their jurisdictions that were subject to the statewide open burning rule. The underlying assumption is that county officials responses are applicable to rural populations and city officials responses are applicable to urban populations. The RP rates for 1999 were applied to all future years and for the previous two complete years that the state ban has been in existence (the ban was promulgated on September 16, 1996). This latter assumption is supported by the 1997 RP estimates provided by Texas county and city officials. These values were identical or virtually identical to the 1999 values.

To estimate RE values, the team contacted county and city officials to determine the portion of the residential population that complied with the statewide open burning rule in 1997 and 1999. The same assumption of rural/urban applicability was used. For 6 of the 11 county agencies that were contacted, lower RE values were applied for 1997 than 1999 (no municipal agencies estimated a different RE value for 1997 versus 1999). For counties that were not surveyed and counties for which a percentage value could not be obtained, the average of the 1997 county agency RE estimates were assumed to represent these counties' 1997 RE. Similarly, for cities that were not surveyed and cities for which a percentage value could not be obtained, the average of the 1997 city agency RE estimates were assumed to represent these cities' 1997 RE. The 1998 RE values were computed by interpolating between the 1997 and 1999 values. Years following 1999 year were assumed to have the same RE values as 1999.

To develop composite control parameters that are applicable to the county emissions, the team weighted the county RP and RE values by the 1990 percentage of county population considered rural, and the city RP and RE values by the 1990 percentage of county population considered urban, as provided by the 1990 Census.

The only growth factor needed for the open burning of MSW calculations was population (POP). A population growth factor was derived for each county by dividing that year's population by the 1999 population.

To calculate the emissions for each year, the uncontrolled 1999 emissions were calculated by dividing the 1999 controlled emissions (E_{1999}) by the (1 - CE · RE · RP) factor, followed by

application of the appropriate growth factor and the composite CE, RE, RP values. Control efficiency is assumed to be 100 percent because of the general ban on open burning. The overall equation is as follows:

$$E_{year} = \frac{E_{1999}}{\left(1 - CE_{1999} \cdot RE_{1999} \cdot RP_{1999}\right)} \cdot \frac{POP_{year}}{POP_{1999}} \cdot \left(1 - CE_{year} \cdot RE_{year} \cdot RP_{year}\right)$$

The $(1 - CE_{year} \cdot RE_{year} \cdot RP_{year})$ factor was not applied to years previous to 1997 because the open burning rule was promulgated in late 1996 (CE = 0), so, the overall factor is assumed to be 1 for those years. For all years following 1999, the 1999 values of CE, RE, and RP are assumed to apply.

SCCs 2610000100 and 2610000400 (Residential Yard Waste Burning-Leaves and Brush) - the following data/assumptions were used in estimating 1999 emissions for these two categories: the 1997 national per capita waste generation value (0.57 pounds per person per day), the estimated 1999 rural population in each county (based on 1990 rural/urban percentage applied to 1999 county populations), as well as assumptions as to the percentage of yard waste that is leaves and brush, and the percentage of total yard waste generated that is burned. One other data source mentioned is the Biogenic Emissions Landcover Database (Version 2) that is within Version 3.1 of EPA's Biogenic Emission Inventory System (BEIS). This data base reports the number of acres of various types of vegetation by county, which is used to calculate the percentage of total county acres that are forested. These county percentages are used to determine an adjustment factor for the amount of yard waste that is generated.

The ENVIRON team investigated the availability of Texas yard waste generation data, but was unable to identify sufficient data to estimate a state-specific waste generation factor. However, data were identified for estimating a 1990 national yard waste generation factor. Based on EPA's estimated 35 million tons of national yard waste generated in 1990 and Bureau of the Census national population estimate of 249,464,000 in 1990, a 1990 yard waste generation factor of 0.77 pounds per person per day is estimated (EPA, 1997 and BOC, 2001). Because the 1997 waste generation factor was used to represent 1999, the 1997 and 1998 waste generation factor was held constant at the value used for 1999, while the 1991-1996 factors were estimated by interpolating between the 1990 and 1997 factors. No information was identified on future yard waste generation factors, nor were values located for any non-1999 years for the other parameters used in developing the 1999 emission activity estimates (e.g., percentage of waste generated that is burned). Therefore, trends in the TCPA county population data, and for historical years, trends in the yard waste generation factors, generated the trends in this emissions activity (TCPA, 2001a).

To calculate emissions trends for this category, it was necessary to develop growth factors for both population (derived previously) and yard waste generation (YWG). A yard waste generation growth factor was computed for each year by dividing that year's per capita yard waste generation factor by the 1999 factor.

To calculate the emissions for each year, the uncontrolled 1999 emissions were calculated by dividing 1999 controlled emissions by the (1 - CE · RE · RP) factor. This was followed by application of the appropriate growth factors and CE, RE, RP values for the trends year of interest. The equation is as follows:

$$E_{year} = \frac{E_{1999}}{\left(1 - CE_{1999} \cdot RE_{1999} \cdot RP_{1999}\right)} \cdot \frac{YWG_{year}}{YWG_{1999}} \cdot \frac{POP_{year}}{POP_{1999}} \cdot \left(1 - CE_{year} \cdot RE_{year} \cdot RP_{year}\right)$$

As discussed for the residential municipal solid waste source category above, the ENVIRON team contacted city and county agency staff to assist in developing RP and RE assumptions for the state open burning ban. The same RP and RE values described for the residential municipal solid waste category were applied to the residential yard waste source category.

SCC 2610000500 (Land Clearing Debris) - there are three components to this source category. The approaches used in estimating emissions activity trends for these components are described below along with a discussion of how total land clearing debris emission trends were estimated.

Residential Construction

Investigations into the availability of Texas housing information identified state-specific data sources relevant to estimating residential construction activity. The TCPA publishes state-level single-family and multi-family housing starts data for 1990-2010 (TCPA, 2001b). Because the TCPA housing starts data do not differentiate multi-family units into two-family versus apartment units, a second data source was used for this purpose. This F.W. Dodge data source, which was supplied by TNRCC, contains county-level 1993-2005 housing starts data, including data for apartment units and two-family units (TNRCC, 2001). The emissions activity for this source category (total acres disturbed) was estimated by applying the following conversion factors to the number of units for each housing type:

- Single-family - 1/4 acre per building and 1 single-family unit per building;
- Two-family - 1/3 acre per building and 2 two-family units per building; and
- Apartment - 1/2 acre per building and year-specific factors to convert the number of apartment units to number of buildings.

The number of apartment units per building was calculated for each available year from 1990-2000 data representing the number of housing units per building for new residential structures in Texas of 3 or more units. These factors were computed from Texas housing units data reported by the Bureau of the Census (BOC, 2001. U.S. Department of Commerce, Bureau of the Census, "New Residential Construction, Building Permits, C40 Residential Housing Units by State," downloaded from http://www.census.gov/const/www/C40/table2.html, Washington, DC. 2001). The year 2000 conversion factor was applied to the apartment units data for each post-2000 year. The F.W. Dodge data were then used to allocate the state

acreage data to individual counties. Because pre-1993 and post-2005 data were not available, the 1993 county proportions were applied to the pre-1993 state totals, and the 2005 county proportions were applied to the post-2005 state totals. The residential construction growth factors for each county and year combination were calculated by dividing the total acres disturbed by the total acres disturbed in the county in year 1999.

Heavy Construction

The TCPA publishes total square footage of nonresidential construction activity in Texas for 1990-2010 (TCPA, 2001b). The TNRCC provided the team with 1993-2005 F.W. Dodge data on the value of nonresidential building construction in 1992 dollars (TNRCC, 2001). These county-level data are reported by type of nonresidential building (e.g., commercial warehouses). As described in Section 2.14, 1999 emissions estimates were computed by directly converting the Dodge nonresidential building construction values to acres disturbed using a value of 2 acres/$\$10^6$ (BOC, 2000).

For the emission trends effort, the ENVIRON team used the TCPA nonresidential square footage data to represent state-level trends in nonresidential land clearing emissions. The F.W. Dodge data source was used to allocate the official state data to individual counties. Because pre-1993 and post-2005 data are not available, the 1993 county proportions was applied to the pre-1993 state values, and the 2005 county proportions were applied to the post-2005 state values. The allocation to counties was accomplished by first dividing each county's total value of nonresidential building constructions by the total value for the year of interest. By multiplying that year's known total nonresidential square footage data by the allocation value for a county, an estimate of the nonresidential square footage in the county was derived. Dividing the nonresidential square footage in a given county for the year of interest by the nonresidential square footage in the county for 1999 produced the growth factor for nonresidential construction.

Road Construction

The TXDOT provided county-level data on the total lane miles of road construction (new and added capacity) in 1999 (Olsen, 2001a). This includes all road construction that occurred in the county, including federal, state, and local. To estimate the number of acres disturbed, the seven road categories for which TXDOT provides county-level data were matched to the road categories used in EPA's road construction open burning emissions methodology as follows:

Texas DOT Road Classifications	FHWA Road Classifications	Conversion Factor
1 - Interstate; 2 – Other urban freeway or expressway	Interstate, urban and rural; other arterial, urban	15.2 acres/mile
3 - Rural Principal Arterial; urban connecting links of rural arterials; other urban principal arterials; 4 – Minor arterial road or street	Other arterial, rural	12.7 acres/mile
5 – Rural major collector or Urban collector street	Collectors, urban	9.8 acres/mile
6 – Rural minor collectors; 7 – Local road or street	Collectors, rural	7.9 acres/mile

The TXDOT also provided county-level total lane miles of new construction data for 1990 (Olsen, 2001b). Since lane miles of construction data were obtained for only 1990 and 1999, the acres disturbed for the intervening years had to be estimated and allocated appropriately. To derive county allocation (CA) factors, the acres disturbed data for intervening years was estimated by interpolating the 1990 and 1999 data derived from the TXDOT. Each county's interpolated value for a year was divided by the total of interpolated values for that year. The allocation was further refined by making use of the FHWA's 1990-1999 capital outlay (CO) data for Texas highways (FHWA, 1999). The overall estimation of county-level acres disturbed (AD) for the years 1991-1998, based on total acres disturbed (TAD) for 1990 and 1999, was calculated using the following equation:

$$AD_{year} = CA \cdot \left(TAD_{1990} + \left(TAD_{1999} - TAD_{1990} \right) \cdot \left(\frac{CO_{year} - CO_{1990}}{CO_{1999} - CO_{1990}} \right) \right)$$

To forecast activity level changes beyond 1999, the ENVIRON team reviewed the availability of TCPA projections for this category. Because the TCPA projects total nonbuilding construction, which includes sewer, utilities, and other non-road related construction activities, the team used county-level forecasts of the value of 1999-2005 street construction in 1992 dollars (denoted FWD below) from the F.W. Dodge data supplied by TNRCC (TNRCC, 2001). County-level acres disturbed were calculated through 2005 using the following equation:

$$AD_{year} = AD_{1999} \cdot \frac{FWD_{year}}{FWD_{1999}}$$

The acres disturbed were assumed to be constant at the 2005 level for years after 2005.

Finally, road construction activity growth factors were computed by dividing the acres disturbed in a county for a given year by the acres disturbed in 1999.

A significant limitation of the approach is that county-level road construction activity is very volatile. For example, there are many counties with road construction activity in 1999 that do not have activity in 1990. Road construction lane miles data from TXDOT could not be obtained for every year because of project time constraints. TNRCC should consider revisiting this category when time and resources allow a more detailed analysis.

Estimation of Total Land Clearing Emissions

Based on information gathered from Texas county and city officials, an estimated 58 percent of total 1999 land clearing acres is assumed to be open burned (Pechan, 2001). No information is available for determining whether this percentage would be different for other years, therefore, the 58 percent figure is applicable to each year's level of land clearing activity. Because no change was assumed in this percentage throughout the analysis period, it was not necessary to incorporate this assumption into the growth factors developed for land clearing activity.

A Texas statute prohibits most forms of open burning throughout the state, although there is an exception for land clearing operations "when no practical alternative to burning exists and when the materials are generated only from that property." (TNRCC, 1996). The open-ended nature of the statement, "when no practical alternative to burning exists," leaves room for county-specific interpretations. The values for RP and RE for the open burning of land clearing debris are dependent on a case-by-case interpretation and implementation of the statewide rule. No level of control was assumed in the 1999 inventory, and no change was made to this assumption throughout the analysis period.

Total county-level emissions activity (acres disturbed) was calculated by using the growth factors derived by the methods presented in the previous sections applied to the 1999 acres disturbed values as follows:

$$\begin{aligned} AD_{year} = & \left(residential\ AD_{1999} \cdot residential\ GF_{year}\right) + \\ & \left(nonresidential\ AD_{1999} \cdot nonresidential\ GF_{year}\right) + \\ & \left(road\ AD_{1999} \cdot road\ GF_{year}\right) \end{aligned}$$

Composite county-level growth factors were obtained by dividing the total acres disturbed by the county's 1999 year total acres disturbed.

$$GF_{year} = \frac{AD_{year}}{AD_{1999}}$$

Land clearing debris emissions were calculated for each trends years by multiplying each county/year composite growth factor by 1999 emissions.

5.17 AGRICULTURAL FIELD BURNING

1999 Baseline Emissions

This source category covers agricultural burning practices used to clear and/or prepare land for planting. Because the same methodology was used for estimating 1999 baseline emissions and emissions in each trends year, the following subsection describes the approach used for developing emissions throughout the analysis period.

Emission Trends Estimates

The University of Texas (UT) prepared a 1996/1997 county-level, annual and seasonal emissions inventory using the preferred methodology of collecting local activity data. The following highlights the UT's emissions inventory methods and describes the methods applied to develop 1999 emissions activity data for each prescribed burning subcategory (sugarcane and other crops).

Sugarcane

The Rio Grande Valley Sugar Growers' Association maintains records of sugarcane areas burned, as well as the estimated fuel loading available to each burn. The sugarcane cropland data are reported by each of four regions. Unfortunately, these records are in hard copy format and are purged two years after each harvest (CEER, 2000). In UT's 1996/1997 Forest, Grassland, and Agricultural Burning Inventory study, these regional data were allocated to counties based on harvested sugarcane acreage, which is reported by the National Agricultural Statistics Service (NASS) (USDA, 2001a). By comparing the acres of residue burned data from the Growers' Association to the NASS harvested acreage data, it was determined that 64 percent of residues from harvested acreage were burned in Texas in 1997. Based on this finding, the UT inventory study estimated the number of acres burned in each county by multiplying sugarcane harvested acreage by 64 percent.

For the purpose of estimating emissions in other years, NASS harvested sugarcane acreage data were compiled for 1990-2000 (USDA, 2001a). To project harvested sugarcane acreage through 2010, growth factors based on 2000-2010 national sugarcane harvested acreage data

were applied to each county's 2000 year harvested sugarcane acreage. National sugarcane harvested acreage data were obtained from the U.S. Department of Agriculture (USDA, 2001b). These data were used, along with harvested acreage data for the other crops described below, in developing harvested acreage-based growth factors that were applied to the UT agricultural field burning emissions inventory.

Other Crops

There are a number of crop waste management techniques available for other agricultural crops, including tilling back into the soil, transporting to a compost or landfill, use as a supplemental feed, or field burning. Burning of crop residues is believed to be the least frequent disposal method for non-sugarcane crops (CEER, 2000). Because Texas does not maintain any records on burning of these crops, the UT inventory study estimated the fraction of residue burned based on survey data collected from the Agricultural Extension Service (AEXS) and county sheriffs. The data requested from the AEXS agents and county sheriffs included the number of fires and acres burned monthly during a typical year for each crop type. After review of the collected data, a list of reported crop types was compiled, and the following three crop types were identified as predominant:

- Corn;
- Hay/Grasses; and
- Wheat.

Texas burning activity was estimated for these crops by extrapolating from the survey data. The UT inventory study compiled harvested acreage data from the NASS for wheat and corn and harvested acreage data from the Texas Agricultural Statistics Service (TASS) for hay (CEER, 2000). Next, two fractions were computed: (1) the fraction of harvested acreage burned for each crop based only on counties that reported burning; and (2) the fraction of harvested acreage burned for each crop assuming that all counties not reporting acres burned had no burning activity. Because the actual fraction burned is likely somewhere between these two values, a weighted average, based on the fraction of counties reporting burning, was calculated and used as the best estimate.

The 1990-2010 burning activity for non-sugarcane crops was estimated by first compiling 1990-2010 year harvested acreage data for the three predominant non-sugarcane agricultural field burning crops. For wheat and corn, 1990-2000 county-level harvested acreage data were compiled from the NASS (USDA, 2001a). County-level wheat and corn harvested acreage data were forecast through 2010 by applying growth factors based on national harvested acreage projections for these crops (USDA, 2001b).

By comparing the NASS acreage data compiled for this effort with the data compiled for the UT inventory, it was determined that the UT corn, wheat, and sugarcane acreage data represented 1996 year harvested acreage. The year of harvested hay acreage data incorporated into the UT inventory was unclear. Based on the corn, wheat, and sugarcane data, however,

the hay data were also assumed to represent 1996 year acreage. Investigations into TASS harvested acreage data for hay indicated that historical time-series data are not available.

Therefore, *Census of Agriculture* acreage data were compiled for this effort (USDA, 2001c). County-level harvested hay acreage data are available from this source for 1987, 1992, and 1997. Intervening years over the 1990-1997 period were estimated through interpolation. To estimate county-level 1998-2000 year acreage, growth factors were developed for 1997-2000 from the state-level change in harvested hay acreage and then applied to each of the county's 1997 acreage values. Because, forecasts of hay acreage are not available, post-2000 acreage is kept constant at 2000 year values. The fact that projections of hay acreage data are not available is not anticipated to have a large effect on the emission trends for this category because corn and wheat account for the majority of emissions from burning of non-sugarcane crops (e.g., approximately 85 percent of NO_X emissions in the UT inventory study).

Next, the county-level acreage data for corn, hay, wheat, and sugarcane for each year were multiplied by percentages representing the proportion of harvested acreage burned. These percentages, which were obtained from the UT study, differ regionally for corn, hay, and wheat. For sugarcane, a 64 percent acreage burned assumption was applied to the acreage data for each county in Texas. The total 1990-2010 year acreage burned estimates were then calculated by summing the individual acreage burned estimates for corn, hay, wheat, and sugarcane. Next, growth factors were developed at the county-level based on the ratio of estimated acreage burned in each trends year to the 1996 acreage burned (i.e., the year of the emissions activity data used in the UT study). Finally, these growth factors were multiplied by the UT inventory's county emissions to estimate agricultural field burning emissions throughout the 1990-2010 period.

5.18 WILDFIRES

1999 Baseline Emissions

The UT developed estimates of wildfire emissions for 1996 and 1997 (CEER, 2000). Collection of the activity data from the various county, state, and federal land management agencies requires extensive time and resources which were not available for preparing the 1999 area source inventory for Texas. Given the random nature of the level of wildfire activity, the 1997 inventory prepared by UT was used for the 1999 inventory.

Emission Trends Estimates

Given the time constraints of this project, it was not possible to replicate the UT's methods in developing emission trends estimates. No alternative wildfire emission methodologies were identified that could be accomplished in the time-frame available for this study. Therefore, the UT inventories were incorporated to represent 1996 and 1997 emissions, while pre-1996 emissions were kept constant at 1996 values and post-1997 emissions were kept constant at

1997 values. (It is important to note that this category is a relatively small contributor to the emissions inventory estimated in the UT study.) There are no air pollution control requirements affecting this source category.

5.19 MANAGED BURNING, SLASH

1999 Baseline Emissions

The UT prepared a 1996 and 1997 county-level, annual emissions inventory for slash burning of logging debris using the preferred methodology of collecting local activity data. The 1999 baseline emissions were developed from the 1997 inventory prepared by the UT. Because the same methodology was used for estimating 1999 baseline emissions and emissions in each trends year, the following subsection describes the approach used for developing emissions throughout the analysis period.

Emission Trends Estimates

This category covers the burning of residue from logging operations in the East Texas Piney Woods region. Because the UT inventory study found that no documentation of burning activity practices exists outside of individual company records, several steps were taken in that study to estimate the level of this activity (CEER, 2000).

Two companies that dominate logging operations in Texas (Temple-Inland and Champion International) were contacted to determine the amount of logging slash burning. Temple-Inland estimated that their company burns approximately 70 percent of the harvested acreage to be replanted. In the UT study, state harvested acreage data were estimated based on tree planting acreage data from the Harvest Trends Report (Xu, 1998), and an assumption that all the land planted by the forest industry had previously been harvested. The Temple-Inland 70 percent assumption was then applied to the 1996 and 1997 state tree planting acreage to estimate the number of acres of logging residue burned in 1996 and 1997. The state totals were allocated to each of the 43 counties in the Piney Woods region based on the fraction of total state industrial timberland in each county, which was determined from 1992 forested acreage data compiled by the U.S. Forest Service (USFS, 1999).

To develop emission trends data for this source category, a combination of state and sub-state data were used. First, state-level forest industry tree planting acreage data for 1992-1999 were compiled. Because the 1996 and 1997 UT inventory emissions were used to represent county emissions in those years, separate pre-1996 and post-1997 growth factors were developed from the state forest industry acreage data. For pre-1996 years, growth factors were based on tree planting acreage relative to 1996 levels, for post-1997 years, growth factors were based on acreage relative to 1997 levels. Because pre-1992 data are not available from the Harvest Trends Report, the state-level forest industry tree planting acreage for 1990 and 1991 was held constant at the 1992 value. To regionalize the state acreage-based growth

factors, Logging sector (SIC code 241) growth factors were compiled for Texas from EGAS Version 4.0. These constant dollar output-based growth factors are available for four regions in Texas (each Texas county is included in one of these four regions). A state-level growth factor was calculated for each year after summing the regional Logging sector data from the REMI models that underlie EGAS. Next, ratios of each year's regional Logging sector growth factors to the state growth factor were calculated. These ratios were then used to adjust the state forest industry acreage-based growth factor to account for regional variations in logging activity. These composite growth factors were then applied to the 1996 (for pre-1996 years) or 1997 (for post-1997 years) UT inventory to estimate 1990-1999 emissions trends.

Post-1999 emissions activity changes were estimated based on the trends in EGAS 4.0 Logging sector-based growth factors. Because there were no changes made to the UT's 70 percent acres burned assumption over the study period, the emission trends for this category are solely based on the changes in state/sub-state tree planting/logging sector activity.

5.20 MANAGED BURNING, PRESCRIBED

1999 Baseline Emissions

The general approach for developing 1999 emissions for this category was to apply growth factors representing changes in emissions activity levels to a 1996/1997 UT inventory (CEER, 2000). The UT inventory separated this activity into two subcategories: prescribed wildland and prescribed range (with prescribed range emissions far outweighing prescribed wildland emissions). Because the same methodology was used for estimating 1999 baseline emissions and emissions in each trends year, the following subsection describes the approach used for developing emissions throughout the analysis period.

Emission Trends Estimates

The following highlights the UT's emissions inventory methods and describes the approach used in developing emission trends data for each prescribed burning subcategory.

Prescribed Wildland

Emissions activity data for the prescribed wildland subcategory are further divided into publicly managed and privately managed lands. For publicly managed lands, the UT study utilized 1996 and 1997 data compiled by the National Applied Resource Sciences Center (NARSC) from information from the National Interagency Fire Center (NIFC). In 1996 and 1997, only the Fish and Wildlife Service (FWS) and the National Park Service (NPS) reported fires to the NIFC. Because data from the U.S. Forest Service was not available from the NARSC, UT contacted each National Forest district office to obtain monthly totals. The 1996 and 1997 acres burned on state parks was obtained from the Texas Parks and Wildlife

Department through prescribed burning surveys sent to each Wildlife Management Area (WMA). The Texas Forest Service (TFS) acreage burned data reported for the non-industrial private and the forest industry ownership categories were used in the UT study to estimate prescribed burning activity on private lands (TFS, 2001). These data, however, are only available on a state basis. To allocate these data to counties, the UT utilized U.S. Forest Service county level 1992 forested acreage data for industrial and non-industrial private landowners (USFS, 1999).

For the Prescribed Wildland burning emission trends effort, the ENVIRON team was unable to develop data characterizing trends in public land acreage burned because time did not allow contacting and compiling data from each National Forest district office and WMA for each historical year. Therefore, the public land Prescribed Wildland 1996 emission estimates from the UT study were held constant for each pre-1996 year, while the 1997 emission estimates were held constant after 1997. However, trends in private land acreage burned data were estimated by applying growth rates for the state-level non-industrial private/forest industry prescribed burning activity to the UT county inventory. The state level non-industrial private/forest industry data are available for 1992-1999. Because pre-1992 data are not available for this activity, the 1990 and 1991 values were held constant at the 1992 values. Emissions for 1993-1995 were estimated by developing growth factors from the ratio of state-level non-industrial private/forest industry prescribed burning acreage in each year to the 1996 year acreage. An analogous procedure was used to develop 1998 and 1999 emission estimates from the 1997 UT inventory. Post-1999 values were held constant at 1999 levels because the 1992-1999 data do not indicate any trend in private prescribed wildland burning activity.

Prescribed Range

Prescribed burning is often used to manage rangeland, but records of this activity are virtually nonexistent (CEER, 2000). In the UT study, each of the 250 Agricultural Extension Service (AEXS) agents was surveyed to obtain estimates of the number of acres burned during a "typical year." Identical surveys were sent to county sheriffs, but these surveys had a low response rate, and were often returned blank. The results of the surveys were compiled and regional values were calculated that represented the fraction of total rangeland acreage that was burned in a "typical" year. These regional fractions were then applied to county rangeland acreage data from the *Census of Agriculture* to estimate the county-level acres burned.

To develop emissions trends activity data for Prescribed Range burning, the ENVIRON team used the "typical" year regional fractions of total rangeland acreage that are burned and historical total rangeland data from the *Census of Agriculture* (USDA, 2001). Because county rangeland acreage data are available from the *Census of Agriculture* for 1987, 1992, and 1997, interim years in the 1990-1997 period were estimated through interpolation. Although not explicitly noted in the UT study, the acreage data used to develop the 1996/97 inventory was 1997 data (from the *Census of Agriculture*, which is not published for 1996). Post-1997 rangeland acreage data are not available. Post-1997 year emissions were held constant at the 1997 value because extrapolating from three years of data was not considered appropriate.

This is consistent with the no growth assumption incorporated into EGAS 4.0 for prescribed burning (Pechan, 2001). To estimate 1990-1997 emissions, growth factors were developed from the 1990-1997 county rangeland data and then applied to the UT emissions inventory. The state's outdoor burning statute contains provisions allowing prescribed burning under certain circumstances (TNRCC, 1996). No changes were made to the UT-derived regional fractions of total acreage burned over the study period. The Prescribed Range emission estimates were then added to the Prescribed Wildland emissions to develop total emissions for this category.

6.0 1990 - 2010 NONROAD SOURCE METHODOLOGIES

6.1 INTRODUCTION

This section describes the methodologies and procedures used to develop county-level 1990-2010 emissions estimates for all nonroad sources. Both annual emissions estimates and summer ozone season estimates have been prepared. In general, the analysis approach followed these steps:

a. Estimate 1999 emissions, and use these emissions as the base year from which all other years are forecast (2000-2010) or back cast (1990-1998). Section 3 of this report describes in detail the emissions methodologies for all nonroad sources for the 1999 base year estimates.

b. For traditional nonroad sources (i.e., those source categories included in the EPA NONROAD emissions model), the NONROAD model was run for years 1990-2010 using county-specific temperatures and fuel parameters, separately for summer and winter. Section 7 of this report provides a discussion of these fuel and temperature model inputs, which are the same as used in the estimation of on-road mobile source emissions. The model was run with all growth factors set to zero, as growth was applied outside the model. These zero-growth runs therefore provide the emissions effects for temperature and fuel inputs, and also the effects of future year Federal nonroad emissions control programs (discussed in Section 6.3), and so includes what is often referred to as the control effectiveness for fuel and Federal rules.

c. Alternative activity growth factors for nonroad sources were evaluated, to be used in back casting 1999 emissions annually to 1990, and forecasting 1999 emissions annually to 2010. NONROAD model default growth factors were compared to alternative growth indicators, and in most cases alternative growth indicators were used. These growth factors, described in Section 6.2, were discussed with and approved by TNRCC.

d. The effects of Federal, State, and local nonroad emissions control programs were evaluated, and a method was developed for incorporating these emissions reductions into the analysis. These control programs are discussed in Section 6.3

e. In a data base application, the growth factors and effects of control programs not already included in the NONROAD model were applied to derive 1990-2010 emissions estimates by county/year/season.

6.2 NONROAD ACTIVITY TREND/PROJECTION INDICATORS

Emission Inventory Improvement Program (EIIP) guidance states that growth indicators should closely approximate the change in emission source activity. In the case of nonroad emissions, this is engine usage. Three criteria are listed in EIIP for choosing an appropriate growth indicator:

- consistency with the activity indicator used to estimate base year emissions,
- consistency with the activity which generates emissions, and
- geographic consistency – local versus state versus regional and national data.

Table 6.2-1 shows the growth indicators for nonroad source as recommended by EIIP.

Table 6.2-1. EIIP recommended growth indicator and data source (EIIP, 1999).

Source Category	Growth Indicator	Information Services
Aircraft	Landings and takeoffs (LTO)	Local or FAA data
Aircraft Ground Support Equipment (GSE)	Landings and takeoffs	Local or FAA data
Railroads	Fuel consumption or ton-miles	AAR or local carriers
Commercial Marine Vessels	Cargo tonnage	US Army Corps
Recreational Marine	Equipment population or human population	Local MPO, NONROAD model
Recreational vehicles	Equipment population or human population	Local MPO, NONROAD model
Construction equipment	Equipment population, construction GSP, earnings, employment	Local MPO, NONROAD model
Industrial equipment	Equipment population, industrial GSP, earnings, employment	Local MPO, NONROAD model
Lawn and garden equipment	Equipment population, single-unit housing or human population	Local MPO, NONROAD model, Census
Agricultural equipment	Equipment population, agricultural land-use, agricultural GSP, earnings, employment	Local MPO, NONROAD model, Census
Commercial equipment	Equipment population, commercial GSP, earnings, employment	Local MPO, NONROAD model

For this work, activity surrogate estimates need to be made to forecast from 1999 to 2010 and to backcast from 1999 to 1990. For the most part, the activity indicators used to develop nonroad emissions trends and projection rely on historic trends analysis projected using a

linear fit to the historic trend for forecasting. The activity indicators evaluated and selected for each nonroad source category are described below.

Aircraft and Aircraft Ground Support Equipment

The 1999 NEI divides aircraft emissions into three source categories. These categories, their SCC's, and the SICs used in developing EPA's emissions trends inventories are provided in Table 6.2-2; the table also includes this information for GSE. The SIC indicators "Transportation by Air" and "Federal, military" correspond to Bureau of Economic Analysis (BEA) gross state product (GSP) data by state and by industry. For the years before 1999, BEA GSP data can be obtained from the BEA web site (http://www.bea.doc.gov/bea/regional/data.htm). EPA's 1996 emissions trends procedures document has emissions projections as well as trends and provides the Texas state-wide growth factors for these industries out to 2010 (for intermittent years, not all years).

Table 6.2-2. SCC-SIC crosswalk for aircraft and airport GSE.

SCC	Non-road Segment	SIC	SIC Name
2275	Aircraft (except military and commercial)	45	Transportation by Air
2275001	Military Aircraft	992	Federal, military
2275002	Commercial Aircraft	-	Landing-Takeoff Operations
22**008	Airport Service Equipment (GSE)	45	Transportation by Air

For the latest EPA trends and projection inventories, Federal Aviation Administration (FAA) recorded and forecast LTOs from 1990 to 2010 were used as the growth surrogates for commercial aircraft; these data are available at http://www.apo.data.faa.gov/faatafall.HTM. The LTO data by airport were grouped together for each county to derive the county-specific growth factors.

The SIC indicator "Transportation by Air" is the sum of the gross state product originating in this industry. This factor has three components: compensation of employees, indirect business tax and non-tax liability, and property-type income. We do not agree with the use of this as a growth indicator for airport GSE emissions (as is done in the NONROAD model), and instead use the county-specific commercial aircraft LTO data from FAA LTOs as the indicator for airport GSE as well as for commercial aircraft, as the majority of GSE emissions are associated with commercial aircraft. Figure 6.2-1 shows these trends and projection factors. Missing years are interpolated from available years.

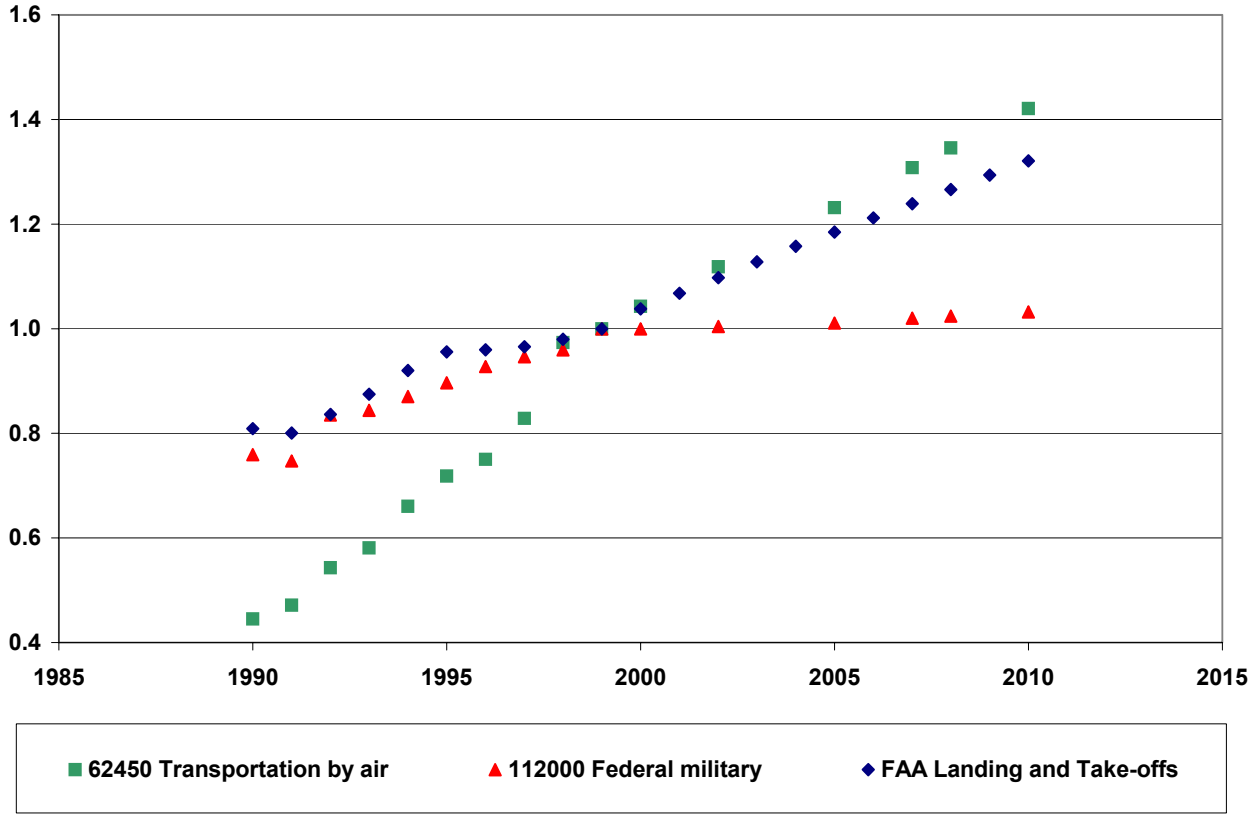


Figure 6.2-1. Alternative activity indicators for aircraft and GSE emissions.

Locomotive

Locomotive emission activity trends were calculated from national fuel consumption data. For the years 1990 through 1999 base year, Texas state locomotive fuel consumption was derived using national fuel consumption data reported by the Association of American Railroads (AAR, 2000) and apportioned to Texas using the ratio of Texas state to national fuel consumption estimates from the Energy Information Administration (EIA, 2000).

For the years 2000 through 2010, EIA has forecasted national locomotive ton-miles freight transfers in their National Energy Modeling System. The freight forecasts were converted to national fuel consumption forecasts using the 1999 AAR-derived fuel consumption estimates divided by the 1999 EIA-derived freight transfer estimates. The ratio of EIA Texas state to national fuel consumption in 1999 was applied the historic trend in national fuel consumption just described. The resulting past and forecasted fuel consumption estimates are shown in Figure 6.2-2.

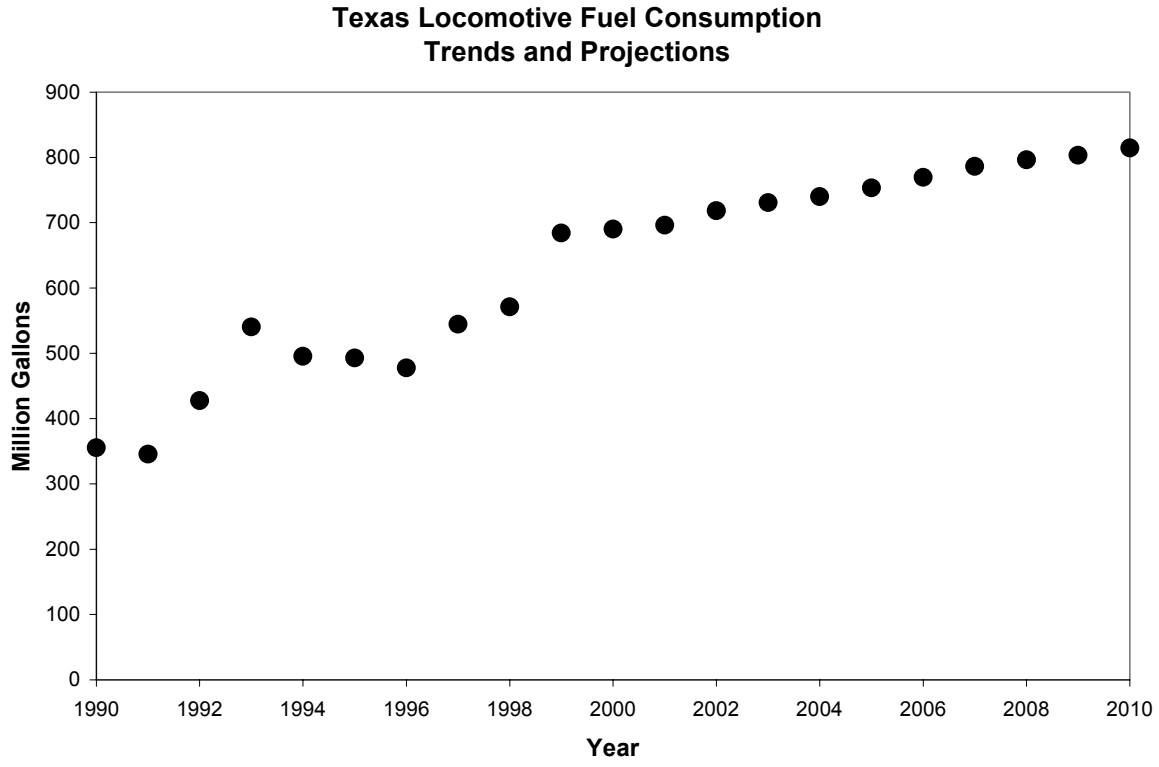


Figure 6.2-2. Texas locomotive fuel consumption trend and projections.

Commercial Marine

Emissions from commercial marine vessels are dominated by vessels involved in freight movement, including ocean-going vessels, tug, and push boat vessel activity. The trend in cargo tonnage was therefore expected to be a reasonable indicator of overall vessel activity. Ten-year historic trends (1990-1999) in cargo tonnage (incoming + outgoing) within each port and along the Texas coast, especially along the Intercoastal Waterway, are available from the US Army Corps of Engineers (USACE, 1999). Cargo tonnage summed for the state for each of the ten years was used to develop a long-term linear trend for projecting overall activity levels to 2010. The actual yearly tonnages were used for backcasting from 1999 to 1990. The USACE data for Texas are shown in Figure 6.2-3.

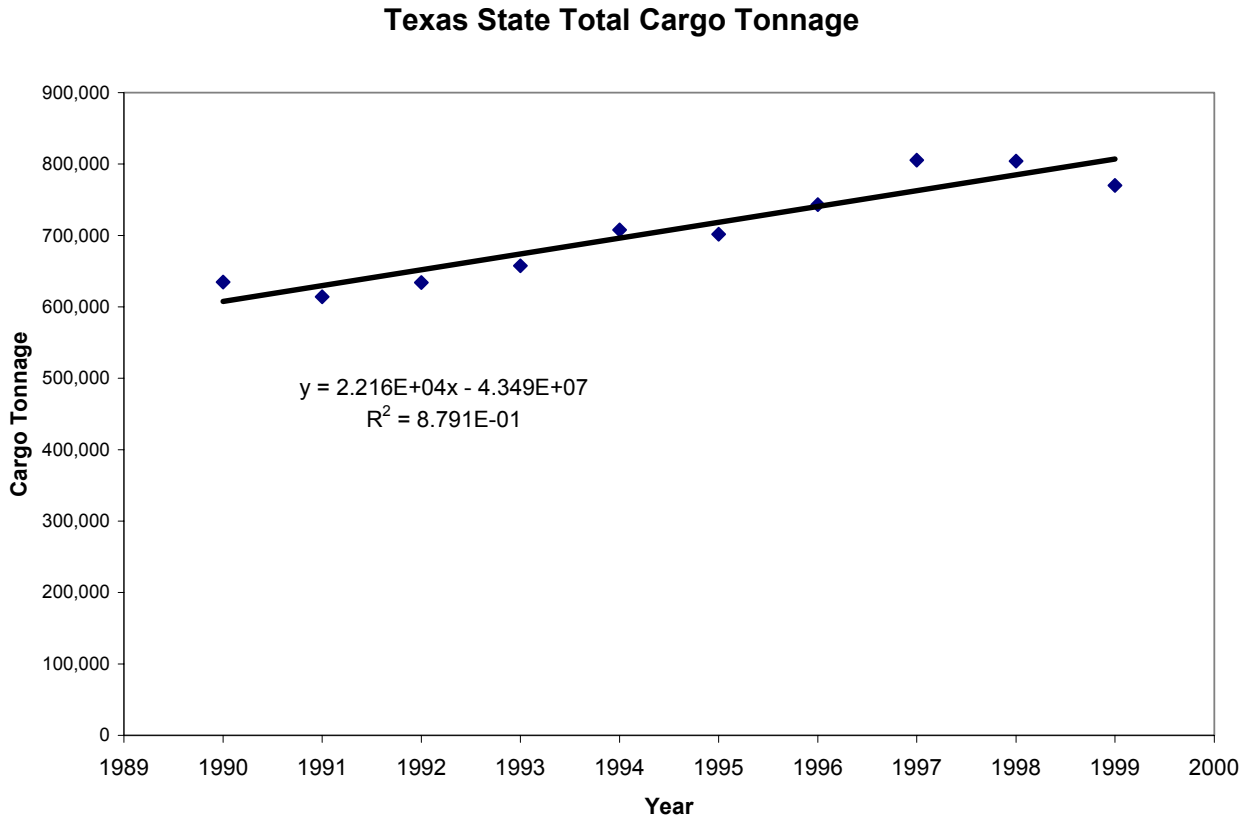


Figure 6.2-3. Marine port cargo tonnage trend.

Recreational Marine

Three sources of information were investigated for projecting recreational marine boat populations: historic trends in Texas statewide boat registrations (obtained from Texas Parks and Wildlife Department), Texas human population forecasts (from the Texas Comptroller's Office), and estimates and forecasts purchases from The Freedonia Group. We also contacted the National Marine Manufacturers Association, but they have historical trends only and no forecasts.

Texas historic trends in boat registration from 1990 to 2000 show a 0.2 percent growth rate per year. Human population trends from 1990 to 2000 show a 1.7 percent growth rate, and projection from 2000 - 2010 are for 1.9 percent per year growth rate. Freedonia estimates of boat demand (in inflation adjusted dollars) rose at a 12 percent per year rate for 1990 through 2000 and is forecast to rise at 8 percent per year through 2010. ENVIRON and TNRCC agreed to use the Texas boat registration rate of 0.2 percent per year for the trends and projections.

Recreational Vehicles

Recreational vehicles will rely on the human population indicators from the Texas Comptroller office according to the EIIP protocols.

Construction

Construction equipment activity estimates are more difficult in that the activity information used for the 1999 base year inventory (F.W. Dodge permit $ of construction) forecasts an unreasonable decline in activity continuing from 1999 through 2010, as shown in Figure 6.2-4. Therefore, several other information sources were investigated: EGAS-3 and EGAS-4, Census (2001) historic trends of construction employees, and Bureau of Economic Analysis (BEA, 2001) historic trends for gross state product (GSP). The EGAS models are forecasting programs made available by EPA for use to forecast activity trends including nonroad equipment categories. The Census estimates of employees are historic trends available from 1993 through 1999 for Texas; data before 1993 are unavailable because the data was gathered using a method not compatible with the current methods. The BEA estimates are historic trends available from 1986 through 1999 for Texas.

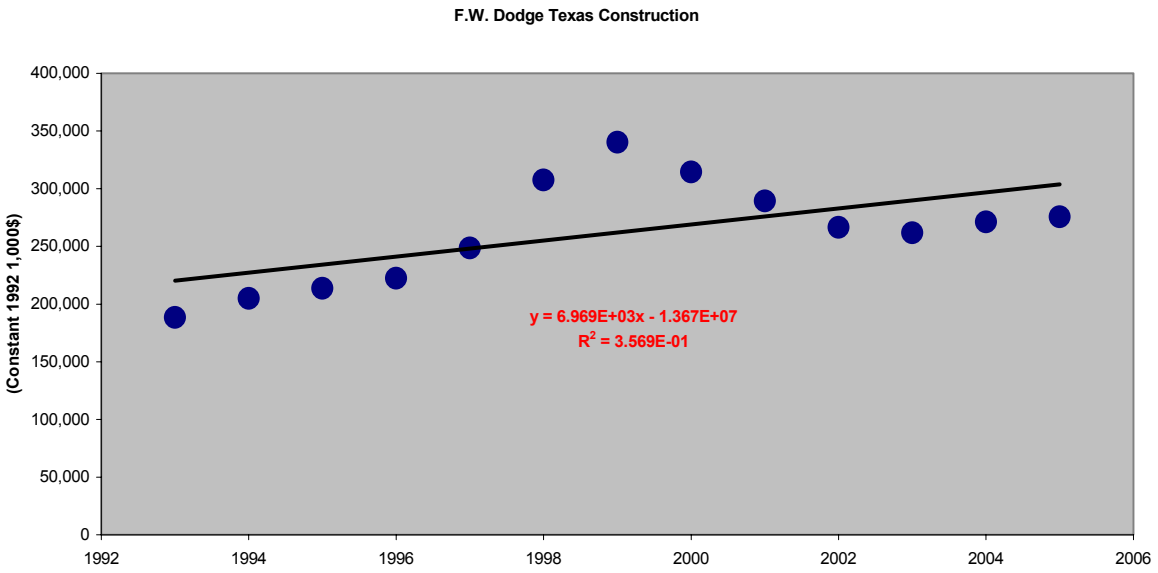


Figure 6.2-4. F.W. Dodge construction dollar trend and forecast.

The most recent EGAS-4 estimates are identical to the NONROAD model national defaults; these are derived from an historic trend estimate of equipment population based on the proprietary Powers Systems Research (PSR) database. The EGAS-3 numbers are dated (1995 or earlier), and the historic trend underestimates (17 percent increase from 1993 through 1999) the historic Dodge trend (80 percent increase), the Census (2001) County Business Patterns

construction employees (31 percent for SIC 15 and 16; or 44 percent with SIC – 15, 16, and 17), or the BEA construction GSP (36 percent).

The Census' Standard Industrial Code (SIC) system follows different industry types with SIC-15 indicative of general construction contractors, SIC-16 heavy construction contractors (highway and municipal work), and SIC-17 specialty subcontractors (such as plumbers, electricians, and carpenters). The historic trend data are shown in Figures 6.2-5 and 6.2-6. The Census changed the SIC system to a slightly different method starting in 1998; therefore, before and after 1998 may be directly comparable. Also, the historic trend information was only valid for 1993 through 1999, a shorter period than the BEA construction GSP and during a period of extraordinary growth in activity.

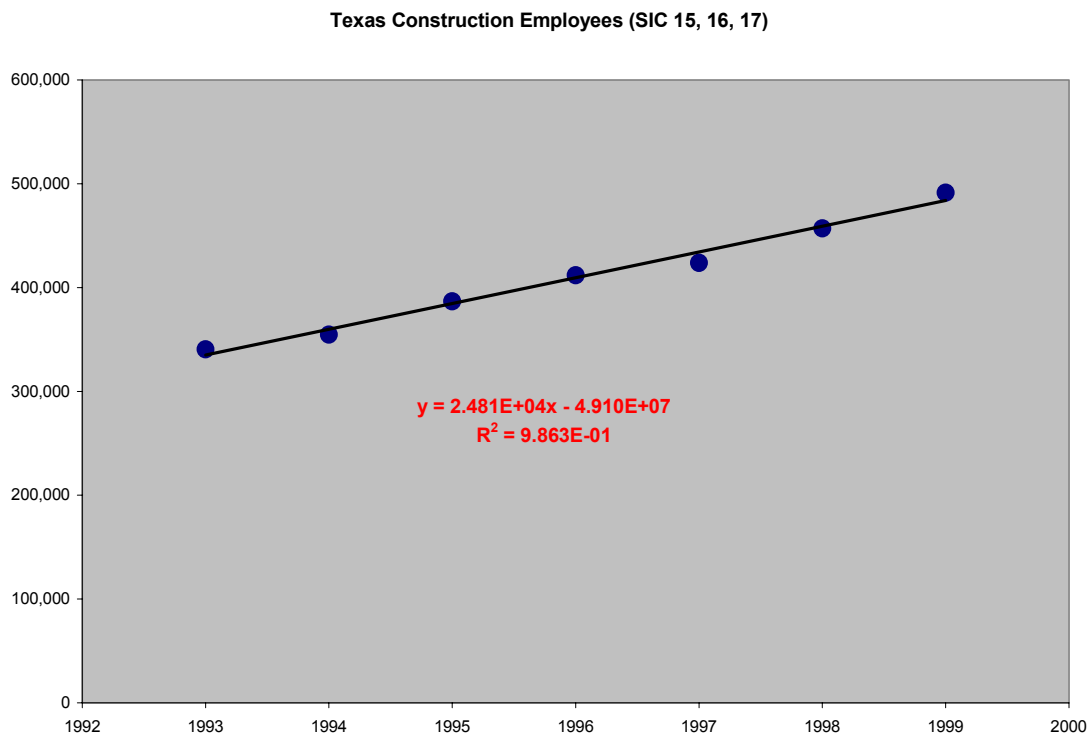


Figure 6.2-5. Construction employees trend.

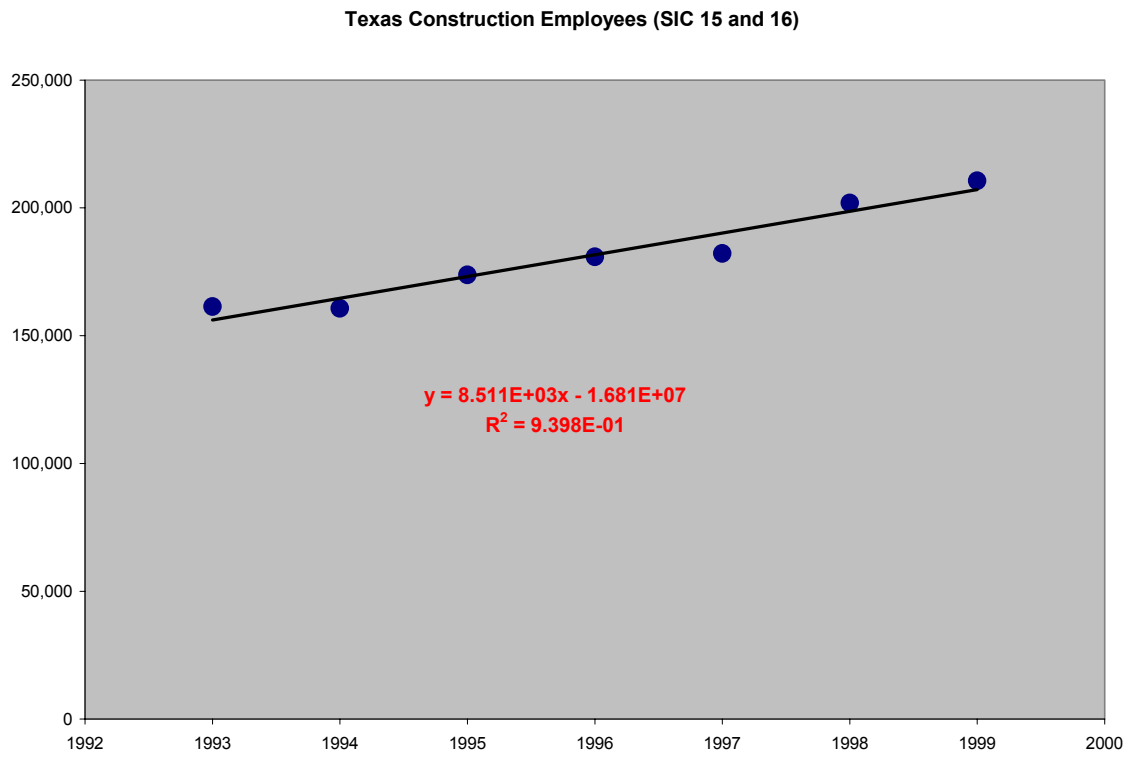


Figure 6.2-6. General contractors and highway construction employees trend.

Therefore, because F.W. Dodge, EGAS-3 and EGAS-4, and Census forecasts are all suspect for Texas construction activity, the historic Texas BEA construction GSP trend is used for the forecasts of Texas construction activity. As shown in Figure 6.2-7, the trend includes a much longer trend including business cycles compared with the much shorter trend available for employees. A comparison of the results of all the methods attempted is shown in Table 6.2-3. A linear fit was used for determining the trend line because in most cases it provided the best fit.

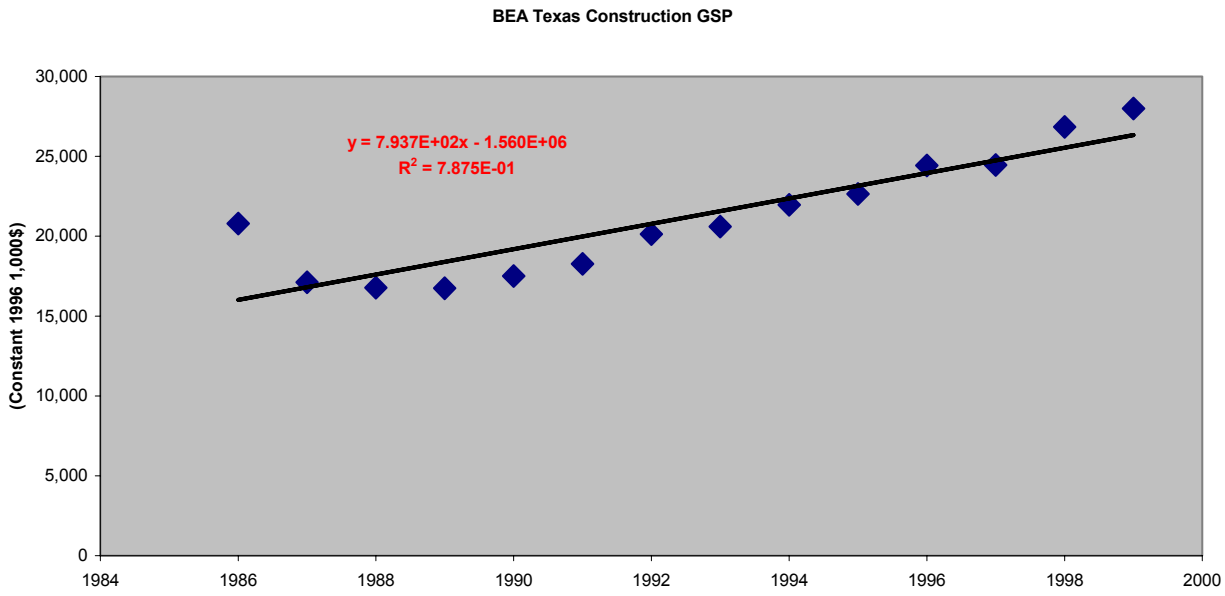


Figure 6.2-7. Texas construction gross state product (GSP).

Table 6.2-3. Construction surrogate trends for alternative indicators.

Data Source	Growth Indicator	2010/1999 Indicator	1990/1999 Indicator
BEA (2001)	Construction GSP (1986-1999 Trend)	1.262	0.625
Census (2001) County Business Patterns	Construction Employees (SIC 15,16, 17) (1993-1999 trend)	1.563	0.553
Census (2001) County Business Patterns	Construction Employees (SIC 15,16) (1993-1999 trend)	1.411	0.603
F.W. Dodge	Permit Dollars (1993 through forecast years to 2005)	0.999	0.583
F.W. Dodge	Permit Dollars (1993-1999 trend)	1.758	0.298

Industrial and Commercial

Industrial and commercial equipment categories comprise ubiquitous equipment types such as forklifts, sweepers, generators, pumps, compressors, and other generic types. The geographic allocation indicators for this equipment in the default NONROAD files are the number of employees in manufacturing (for industrial equipment like forklifts and sweepers) and wholesale establishments (for commercial equipment like generators, pumps, compressors). It is difficult to argue that these two business types are indicative of all uses of this kind of equipment. Because industrial and commercial activity is not well suited to these default surrogates, gross state product (GSP), which reflects overall business activity, was used as the growth indicator for these categories.

Lawn and Garden

There is no accepted source for equipment population estimates for this category. This category includes two distinct types of owners, commercial and residential. The NONROAD default geographic allocation uses single and double unit residences as the indicator for residential equipment, and employees in landscaping and horticultural services for commercial equipment.

The 2000 Census is not yet available for Texas to provide the number of single and double unit residences from 1990 to 2000. An estimate of the number of households in Texas was taken from the Census (2001) for 2000 and 1990 to provide an estimate of the trend of the number of households and is shown in Table 6.2-4.

The number of employees in landscaping services (Census County Business Patterns, 2001) is shown in Table 6.2-4 and indicates a greater than 5 percent per year increase in the number of employees during the historic period available, 1993-1999, and with the linear projection to increase at 4 percent per year rate through 2010. These data also reflect a change of method of analysis between 1997 and 1998, when a new industrial classification system was introduced, lowering the overall number of employees in this sector for 1998 from 1997.

Because the data on households and landscaping employees have not been demonstrated to produce better equipment activity estimates, human population trends and projections from the Texas Comptroller are used to estimate the trend in lawn and garden equipment. The commercial users dominate overall lawn and garden equipment activity, and with the extraordinary growth in the number of employees in this sector the future year projection would be extraordinarily high.

Table 6.2-4. Lawn and garden equipment surrogate estimates.

Source Category	Growth Indicator	2010/1999 Indicator	1990/1999 Indicator
Lawn and garden equipment	Human population	1.235 (Comptroller)	0.860 (Comptroller)
Lawn and garden (residential)	Households	1.157	0.871
Lawn and garden (commercial)	Landscaping employees	1.532	0.622

Agricultural

ENVIRON investigated a number of surrogates for agricultural equipment activity and recommends tillable acreage (NASS, 2001). Acreage is considered to be the most representative of overall equipment activity, and also was used to provide the geographic allocation of the equipment activity.

Other indicators investigated were equipment population counts (NASS, 2001) and agricultural GSP (BEA, 2001). As shown in Table 6.2-5. The equipment counts for the five agricultural equipment types available show similar overall estimates to the tillable acreage, but do not necessarily reflect actual activity. For instance, the average power of the equipment or the annual usage may be higher though the equipment counts are lower. Also, the number of combines in Texas was inexplicably and significantly lower in 1997 as opposed to 1987, which affected the overall sum of all of the equipment types available. Other agricultural equipment not listed here was not available, potentially also biasing the results. Farm GSP shows a dramatic rise in activity not reflected in the either the tillable acreage or the equipment counts, so while farms may have become more economically productive, there is no indication that the equipment activity shows a similar increase in activity.

Table 6.2-5. Agricultural equipment counts and other surrogate methods.

Equipment Type	1997	1992	1987
Wheel tractor	286,975	275,951	288,018
Grain and bean combines	11,934	17,107	21,260
Cotton pickers and strippers	14,036	13,839	16,811
Mower conditioners	51,880	49,528	47,054
Pickup balers	37,864	41,222	41,208
Sum total of 5 equipment types	402,689	397,647	414,351
Tillable acreage	131,308,286	130,886,608	130,502,792
Farm GSP (BEA, 2001)	$6,609 (million 1996 $)	$6,089 (million 1996 $)	4,661 (million 1996 $)

Summary of Results

Given the description and review of the available indicators of equipment activity, ENVIRON recommended to TNRCC, and TNRCC approved, the following activity growth indicators by category as shown in Table 6.2-6. The table includes a summary of the indicator value for converting activity from the 1999 base year to 1990 or 2010. Because the F.W. Dodge data were intended to reflect actual construction activity back to 1993 (Dodge indicator values show extraordinary and unrealistic growth in construction activity during the 1990s), these are shown for comparison, but ENVIRON recommended the BEA construction GSP indicator for backcasts as well as forecasts.

Table 6.2-6. ENVIRON recommended growth indicator and data source.

Source Category	Growth Indicator	2010/1999 Indicator	1990/1999 Indicator
Aircraft	Landings and takeoffs (LTO) (FAA, 2001)	1.321	0.809
Airport Ground Support Equipment (GSE)	LTO (FAA, 2001)	1.321	0.809
Railroads	Fuel consumption (EIA, 2001)	1.190	0.836
Commercial Marine Vessels	Cargo tonnage (USACE, 1999)	1.366	0.824
Recreational Marine	Equipment population (TxPWD, 2000)	1.097	0.976
Recreational vehicles	Human population (TX Comptroller)	1.235	0.860
Construction equipment	Construction GSP (BEA, 2001)	1.262	0.625
Industrial equipment	GSP (BEA, 2001)	1.284 linear fit (r2 = 0.942) 1.507 log fit (r2 = 0.970)	0.658
Lawn and garden equipment	Human population (TX Comptroller)	1.235	0.860
Agricultural equipment	Agricultural land-use (NASS, 2001)	1.007	0.995
Commercial equipment	GSP (BEA, 2001)	1.284	0.658

The 2010/1999 and 1999/1990 growth indicators in Table 6.2-6 are the overall averages based on the regressions of the indicator data. The actual data values for all indicators are shown in Table 6.2-7. Figure 6.2-8 shows the historical values and the projections for each indicator. The projections are based on the linear regressions for available historical data.

Table 6.2-7. Nonroad trend and projection indicator values. Red indicates projection, interpolation, or some other estimates; while BLACK are actual referenced numbers.

Year	Aircraft & GSE (LTO)	Recreational Vehicles (Human Population)	Construction (Const. GSP)	Industrial (GSP)	Lawn & Garden (Human Pop.)	Agricultural (Acreage)	Commercial (GSP)	Logging and Wood GSP)	Rec. Marine (Registration)	Rail (Fuel Use)	Comm. Marine (Cargo Tonnage)
1990	1,789,003	16,986,510	17,513	439,548	16,986,510	130,617,937	439,548	1,752	604,192	356	634,687
1991	1,770,187	17,044,605	18,275	447,200	17,044,605	130,656,318	447,200	1,724	600,371	346	614,239
1992	1,849,168	17,348,540	20,142	461,434	17,348,540	130,886,608	461,434	1,731	592,237	428	634,106
1993	1,934,355	17,661,971	20,613	480,045	17,661,971	130,928,776	480,045	1,759	591,879	540	657,436
1994	2,035,218	18,009,031	21,962	504,252	18,009,031	130,970,944	504,252	2,004	602,375	495	707,878
1995	2,113,175	18,347,571	22,648	527,685	18,347,571	131,013,111	527,685	2,192	615,527	493	701,755
1996	2,121,789	18,694,226	24,433	553,180	18,694,226	131,055,279	553,180	2,283	611,374	478	743,298
1997	2,135,375	19,032,991	24,475	597,889	19,032,991	131,308,286	597,889	2,036	605,184	545	805,605
1998	2,166,873	19,385,693	26,846	636,179	19,385,693	131,139,615	636,179	2,308	615,067	571	804,182
1999	2,211,219	19,759,617	28,005	668,462	19,759,617	131,181,783	668,462	2,313	618,986	684	770,019
2000	2,295,338	20,124,384	27,400	650,000	20,124,384	131,223,950	650,000	2,200	615,512	690	830,000
2001	2,361,361	20,496,669	28,194	670,830	20,496,669	131,266,118	670,830	2,227	641,232	696	852,160
2002	2,427,396	20,861,040	28,987	691,660	20,861,040	131,308,286	691,660	2,254	645,464	718	874,320
2003	2,493,430	21,233,150	29,781	712,490	21,233,150	131,350,454	712,490	2,281	649,696	731	896,480
2004	2,559,467	21,612,703	30,575	733,320	21,612,703	131,392,622	733,320	2,309	653,928	740	918,640
2005	2,619,603	22,391,587	31,369	754,150	22,391,587	131,434,789	754,150	2,336	658,160	753	940,800
2006	2,679,740	22,800,747	32,162	774,980	22,800,747	131,476,957	774,980	2,363	662,392	769	962,960
2007	2,739,885	23,214,757	32,956	795,810	23,214,757	131,519,125	795,810	2,390	666,624	786	985,120
2008	2,800,025	23,624,150	33,750	816,640	23,624,150	131,561,293	816,640	2,417	670,856	796	1,007,280
2009	2,860,179	24,020,659	34,543	837,470	24,020,659	131,603,461	837,470	2,444	675,088	803	1,029,440
2010	2,920,456	24,402,429	35,337	858,300	24,402,429	131,645,628	858,300	2,471	679,320	815	1,051,600

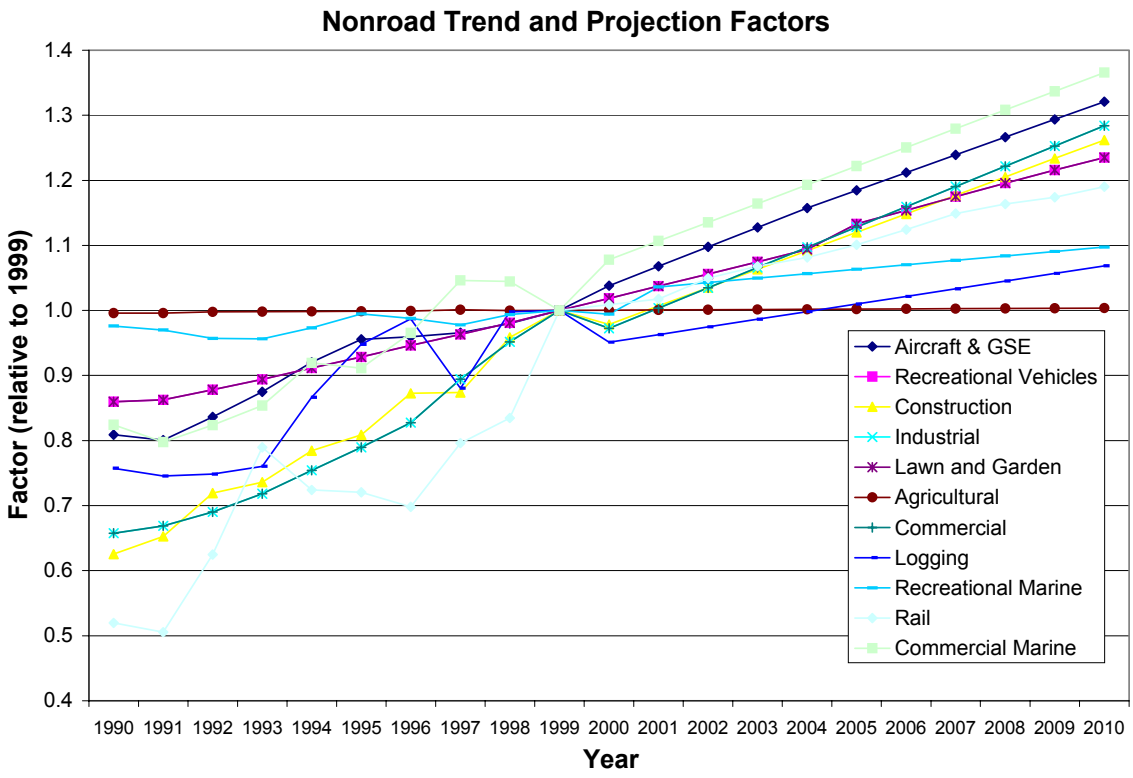


Figure 6.2-8. Summary trends and projections for nonroad source categories.

6.3 EMISSION REDUCTIONS FROM FEDERAL, STATE, AND LOCAL CONTROLS

Future year emissions in nonroad mobile sources will be reduced as a result of many Federal, State, and local control programs. This subsection describes these programs and how they were implemented in the estimation of 1990-2010 emissions.

Federal Rulemakings

Traditional Nonroad Equipment

Federal controls for traditional nonroad engines are already incorporated into the current version of the NONROAD model (in the technology and emission factor input files). Federal controls for non-road spark-ignition engines in NONROAD model are:

- Emission standards for new nonroad spark-ignition engines at or below 19 kilowatts. ("Small Engine Rule, Phase I"),

- Phase 2 emission standards for new nonroad spark-ignition engines at or below 19 kilowatts ("Small Engine Rule Phase II"),
- Emission standards for new gasoline spark-ignition marine engines ("Marine Rule"), and
- Emission standards for hand-held small spark-ignition engines (classes iii, iv, and v).

Federal controls for non-road compression ignition engines in the NONROAD model are:

- Tier 1 emission standards for new nonroad compression-ignition engines at or above 37 kilowatts (50 HP), and
- Tier 1 and Tier 2 emission standards for new nonroad compression-ignition engines below 50 hp, and Tier 2 and Tier 3 standards for engines of 50 hp and greater.

Commercial Marine

For the commercial marine sector, EPA has promulgated emission standards for domestic ships with engines smaller than 30 liters per cylinder that incorporate the international standards and have lower emission standards starting with new engines in 2004. The international standards, if implemented, are considered 'Tier 1' emission controls. The proposed regulations were developed under aegis of the International Maritime Organization (IMO). However, these emission regulations have not been ratified, and at this time it is difficult to predict if the regulations will be in practice for new ships built after 2000. Regardless of international implementation, EPA is assuming that all vessels and particularly US flagged vessels will comply with the international regulations as proposed, and this has been assumed in the future year emissions for commercial marine vessels in this work.

We have revisited the emission factors for the base year emissions from the Starcrest (2000) work, and left the emission estimates the same as in the previous work. However, for harbor vessels (tug/ferry/dredging/fishing) a NOx emissions factor of 10 g/kW-hr was used, which is the applicable emission factor for marine engines between 75 kW and 1,000 kW. This base emission estimate affected the predicted emission reduction associated with the rulemakings.

For the international emission standards, which are based on the rated speed of the engines, no emission reduction is expected in this work for the ocean-going vessels or for the harbor vessels. The applicable EPA emission standards for these engines are shown in Table 6.3-1.

Table 6.3-1. EPA Primary Exhaust Emission Standards (g/kW-hr).

Subcategory Liters/cylinder	Tier	Model Year*	THC + NOx g/kW-hr	CO G/kW-hr	PM g/kW-hr
Power $ 37 kW And disp. <0.9	Tier 2	2005	7.5	5.0	0.40
0.9 # disp. < 1.2	Tier 2	2004	7.2	5.0	0.30
1.2 # disp. < 2.5	Tier 2	2004	7.2	5.0	0.20
2.5 # disp. < 5.0	Tier 2	2007	7.2	5.0	0.20
5.0 # disp. < 15	Tier 2	2007	7.8	5.0	0.27
15 # disp. < 20 Power <3300 kW	Tier 2	2007	8.7	5.0	0.50
15 # disp. < 20 Power >3300 kW	Tier 2	2007	9.8	5.0	0.50
20 # disp. < 25	Tier 2	2007	9.8	5.0	0.50
25 # disp. < 30	Tier 2	2007	11.0	5.0	0.50

For the harbor vessels, an equal amount of emissions was assumed to be derived from engines above and below 2.5 liters per cylinder (they have different implementation dates). The resulting emissions reductions applied are shown in Table 6.3-2; the average emission reduction was applied to the future year emission estimates.

Table 6.3-2. NOx emission reductions (%) for harbor craft relative to 1999 emission rates.

Year	>2.5 liters per cylinder	< 2.5 l/cylinder	Average
2000	0.0	0.0	**0.0**
2001	0.0	0.0	**0.0**
2002	0.0	0.0	**0.0**
2003	0.0	0.0	**0.0**
2004	0.0	-0.9	**-0.5**
2005	0.0	-2.6	**-1.3**
2006	0.0	-4.3	**-2.2**
2007	-0.9	-6.1	**-3.5**
2008	-2.6	-7.7	**-5.2**
2009	-4.3	-9.4	**-6.9**
2010	-6.1	-11.1	**-8.6**

Locomotive

Locomotive standards were promulgated by EPA in 1997. There are three sets of emission standards, which include provisions for retrofit of current locomotives to provide greater

emission reductions earlier. The future year standards for new locomotives are phased in with three steps to allow retooling of the manufacturing process. These emission standards have been incorporated into this study's locomotive emissions calculations by applying emission reductions relative to the 1999 base year emissions; the emission reduction factors are provided in Table 6.3-3.

Table 6.3-3. Emission reduction factors for locomotives relative to 1999 emission rates.

Year	HC	CO	NO_X	PM	SO2	NH3
1998	1.000	1.000	1.000	1.000	1.000	1.000
1999	1.000	1.000	1.000	1.000	1.000	1.000
2000	1.000	1.000	0.990	1.000	1.000	1.000
2001	1.000	1.000	0.958	1.000	1.000	1.000
2002	1.000	1.000	0.901	1.000	1.000	1.000
2003	1.000	1.000	0.847	1.000	1.000	1.000
2004	1.000	1.000	0.790	1.000	1.000	1.000
2005	0.972	1.000	0.725	0.971	1.000	1.000
2006	0.944	1.000	0.674	0.941	1.000	1.000
2007	0.916	1.000	0.641	0.912	1.000	1.000
2008	0.897	1.000	0.621	0.882	1.000	1.000
2009	0.879	1.000	0.605	0.868	1.000	1.000
2010	0.860	1.000	0.592	0.838	1.000	1.000

Fuel Regulations

Federal fuel regulations included in controls for on-road mobile sources also affect the nonroad sector. These regulations are:

- Federal RVP regulations;
- Federal reformulated gasoline (RFG), used in the Dallas-Ft. Worth and Houston-Galveston nonattainment areas since January 1995;
- Low sulfur gasoline regulated along with on-road Tier 2 vehicle emission standards; and
- Low sulfur diesel required beginning in 2006 as part of the 2007 on-road heavy-duty vehicle emission standards.

These fuel regulations have been incorporated into the trend and projection emissions calculations by specifying RVP levels, gasoline and diesel sulfur levels, and presence/absence of RFG in the county/year-specific inputs to the NONROAD model. A detailed discussion of these fuel inputs may be found in Section 7.3 of this report. Sulfur content for nonroad diesel fuel has been modified by the Texas Cleaner Diesel Fuel, as described below.

Texas State and Local Rulemakings

In addition to the Federal control programs listed above, there are a number of Texas State and local regulations that have been enacted to further reduce emissions from on-road and off-road mobile sources statewide and in specific regions of the state. The state and local rulemakings, the emissions reductions expected, and how the rules were implemented in the 1990-2010 emissions estimates are described below.

Cleaner Diesel Fuel

This rule (TAC Rule 114.312) specifies diesel fuel sulfur content, aromatic hydrocarbon content, and cetane number beginning May 2002. Specifically, cetane number must be at least 48, aromatic HC must be no more than 10 percent, and sulfur content must be no more than 500 ppm (as compared to 3300 ppm for Federal nonroad diesel). Sulfur levels are further tightened to 15 ppm beginning June 2006. The rule requires that low emission diesel fuel be used year-round in all diesel fueled compression-ignition engines in nonroad equipment operating within 110 affected counties in central and eastern Texas. Following the approach in Houston-Galveston SIP (ERG, 2000), we assume that the effect of the rule is a 7 percent reduction in NO_X emissions and an 83 percent reduction in SO_2 emissions for all nonroad CI sources (except aircraft and commercial marine ocean-going vessels) in the affected counties.

Regional Low RVP Gasoline

The Regional Low RVP Gasoline program requires that gasoline with a maximum RVP of 7.8 psi be used in 95 central and eastern Texas counties during the summer ozone season beginning in May 2000. This rule is implemented in the nonroad emissions estimates by specifying the RVP levels in the affected counties and years in the NONROAD input files (scenario definition); RVP levels by county are discussed in further detail in Section 7.3.

Accelerated Purchase of Diesel Equipment

At the time this study was being performed, an accelerated purchase of diesel equipment program had been adopted in the Dallas and Houston SIPs. It required construction and mining, industrial, and commercial nonroad equipment powered by most compression-ignition engines 50 hp and larger to be certified to meet or exceed EPA Tier 2 and Tier 3 standards in accordance with an accelerated time frame, beginning at the end of 2004. The rule applied in the four-county Dallas nonattainment area and in the eight-county Houston nonattainment area. The emissions effects of this rule were implemented for this work by substituting an alternative technology file (TECH_AT.DAT) for the affected counties and years.

After this work was completed, this rule was replaced by the Texas Emissions Reduction Plan (TERP). The TERP rule provides money for emissions reductions from on-road and nonroad diesel engines. The TERP will provide funding for diesel equipment owners to reduce emissions from their diesel equipment with a variety of control options.

Adoption of California Large Spark-Ignition Standards

This statewide rule adopts the California large SI standards, which are stricter than EPA's current standards. The rule applies to most SI engines of 25 hp or greater, beginning in early 2004. The rule was implemented in this analysis by using alternative technology and emission factor input files for NONROAD.

Operational Restrictions for Lawn and Garden Equipment

A rule in the Houston SIP restricts the use lawn and garden service equipment so that it is not operated between the hours of 6:00 a.m. and noon, between the months of April and October. This rule, effective April 2005, applies to commercial lawn and garden service equipment, handheld or non-handheld, powered by spark-ignition engines of 25 hp and below.

This lawn and garden rules does not reduce emissions. Rather, it shifts the timing of the emissions in order to reduce the impact of morning NO_X emissions on afternoon peak ozone. Because this project is estimating ozone season daily emissions, no adjustments were made for this operational restrictions.

Airport Ground Support Equipment

For the Dallas and Houston nonattainment area SIPs, agreements were made with airport authorities to reduce ground support equipment (GSE) NO_X emissions by 90 percent, or to come up with equivalent alternative emissions reductions at the airports. The agreements to meet the emission reduction requirements for GSE have a mixture of some agreed-to GSE reductions and non-GSE reductions to offset any shortfall in the actual GSE reductions. Since it is not yet clear exactly where the offsetting emissions reductions will come from, we assumed (with TNRCC agreement) 90 percent NO_X emissions reductions for GSE in DFW and HGA beginning in 2005 for Dallas-Ft. Worth and 2007 for the Houston area.

7.0 ON-ROAD MOBILE SOURCE EMISSIONS TRENDS ESTIMATION

7.1 INTRODUCTION

This section describes in detail the tools, data, and approach used to obtain county-level on-road mobile source emissions for each calendar year from 1990 to 2010, both annual total and ozone season average daily. The pollutants examined included VOC, CO, NOx, SO2, PM10, and PM2.5. Particulate matter emissions were separated into exhaust and tire/brake wear portions. Emissions were estimated for each of 56 vehicle type/facility class combinations within each county. These combinations arise from the eight major vehicle classes supported by MOBILE models:

- light-duty gasoline vehicles (LDGV)
- light-duty gasoline trucks in two weight classes (LDGT1, LDGT2)
- heavy-duty gasoline vehicles (HDGV)
- light-duty diesel vehicles (LDDV)
- light-duty diesel trucks (LDDT)
- heavy-duty diesel vehicles (HDDV)
- motorcycles (MC)

and cover standard HPMS facility types (interstates, freeways, principal arterials, minor arterials, major collectors, minor collectors, and locals).

Emissions were estimated as products of emission factors (expressed in grams/mile) and associated vehicle miles traveled (VMT). US EPA's emission factor models were used to obtain the required emission factors. In particular, the current draft MOBILE6 model was utilized for VOC, CO and NOx emission factors. For PM and SO2, the current PART5 model was the main tool. Presented below are separate discussions of these two components of the emission inventory development process.

7.2 VEHICLE MILES TRAVELED

Vehicle miles traveled data were provided to ENVIRON by the Texas Transportation Institute (TTI). Annual average daily travel (AADT) values for the seven HPMS facility classes were given for each county for calendar years 1990 through 2010. TTI also provided seasonal adjustment factors to allow summer daily travel values to be obtained from the annual average; these are shown in Appendix 7-A. These adjustment factors are distinct for each county but not between years. The VMT mix, or the fraction of the total fleet mileage attributable to each of the eight vehicle classes by county and by year, was also provided by TTI.

The total annual VMT used in the preparation of annual emissions was computed as the AADT for the county and calendar year multiplied by the number of days in that year. For

the ozone season daily VMT, the AADT was multiplied by the summer seasonal adjustment factor for the particular county. To further apportion the VMT for each facility class to each of the eight vehicle classes, the fleet mix for the county was used. Note that since only one VMT mix was provided for each county for each year, the same mix was used for all seven facility classes within that county.

7.3 EMISSION FACTORS

Draft MOBILE6

In accordance with TNRCC's decision, the current draft MOBILE6 model was used for generating VOC, CO and NOx emission factors. Although not officially released in final draft, the use of MOBILE6 is appropriate for this work. Its major advantages over MOBILE5 include the incorporation of the latest regulations and vehicle test data, more flexibility to aid in the modeling process, and significantly revised exhaust and evaporative emission rates. However, it should be noted that the final release of MOBILE6 may result in slightly different emissions, depending on what kinds of issues were identified under the draft version. This work is in progress at EPA, and the release date for the final model has not yet been set.

To comply with MOBILE6 input structure and requirements, the 254 Texas counties were grouped into one of two categories: with or without inspection and maintenance (I/M) and anti-tampering programs (ATP). To correctly model the ATPs, it was necessary to complete three different executions of the model for each county with ATP (more details on modeling ATPs are given below). Within each county, each calendar year was modeled in one 'run' thus allowing efficient input of data that do not vary among the scenarios. Finally, within each 'run', a particular combination of county, calendar year, facility class and season was modeled as a 'scenario'. The remainder of this subsection provides information regarding the development of required input parameters and the post-processing of MOBILE6 outputs to generate emissions.

<u>Minimum and Maximum Temperatures</u>

MOBILE6 requires, at the least, maximum and minimum daily temperatures which are used to correct emission factors for temperature effects as well as to compute diurnal evaporative emission contributions. For this work, TTI provided minimum and maximum daily temperatures for each season for each county. Accompanying documentation stated that the temperatures were developed by dividing the state into seven climatologically similar regions and using National Climatological Data Center (NCDC) data from a weather station located centrally within each region. See Appendix 7-B for more details. Figure 7.3-1 shows these regions. The same set of temperatures was used for all calendar years.

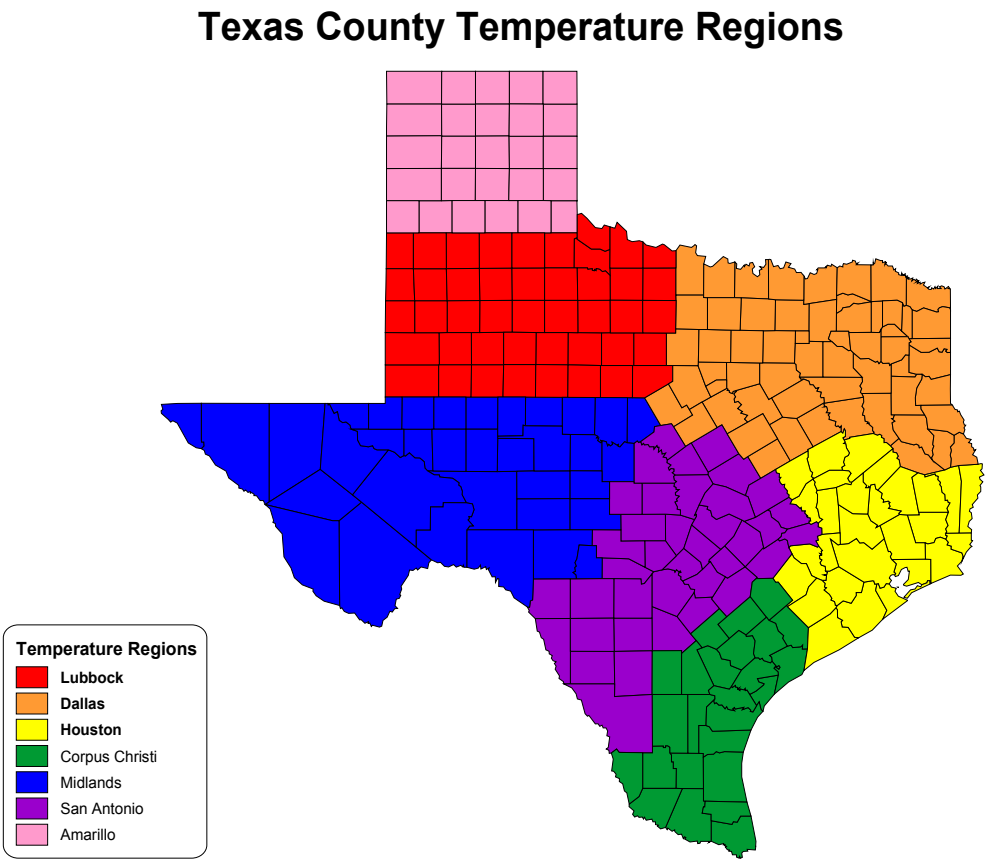


Figure 7.3-1. Climatologically similar regions used to assign temperatures in draft MOBILE6 modeling.

Absolute Humidity

Absolute humidity is an optional input in MOBILE6. It is used to estimate the amount of automotive air conditioning usage. Since humidity can vary widely in the state of Texas with respect to geography as well as season, local data were used in place of the default value of 75 grains/lb air. 1999 ambient temperature and relative humidity data were obtained from the NCDC web site at http://www.ncdc.noaa.gov/ol/climate/online/ccd/avgrh.html. Using the relative humidity and ambient temperature, the absolute humidity was obtained with the aid of a psychrometric chart. Where possible, data from two or more weather stations were averaged to obtain representative values for each of the temperature regions discussed above. Morning and afternoon values were also averaged to produce daily average humidity. The resulting absolute humidity values for each county and season are shown in Appendix 7-C.

Registration Distributions

The registration distribution is the set of fractions indicating the relative populations of age bins within a vehicle class. Though MOBILE6 contains default distributions, local data were used. These were obtained from MOBILE5 input files composed by TTI for 1999 East Texas emissions inventory work. According to TTI, the distributions were based on Texas registration data compiled by TxDOT. The distributions were made suitable for MOBILE6 (which supports more vehicle classes) using Energy Research Group's (ERG) Route56 conversion software. Route56 follows the algorithm prescribed by EPA (in Chapter 5 of the draft MOBILE6 user's guide) to convert MOBILE5 registration distributions to MOBILE6. For each county, the same distributions were used for all calendar years.

Speed by Facility Class

In MOBILE5, a single average speed (or eight total, one for each vehicle class) is specified; it does not correspond to a specific road type within the model. In MOBILE6, the four available road types reflect a unique driving cycle, and there are different speed correction factors for each; thus, the road type must be specified for each speed to be modeled. This section presents the premises and methodologies used to accomplish speed modeling in MOBILE6.

TTI provided typical 24-hour speeds for each of 14 county type/facility class combinations, shown in Appendix 7-D. In order for MOBILE6 to generate emission factors that could be directly applied to the VMT data provided, the speeds were modeled separately (as scenarios), thus preserving the same 14 categories. As a consequence, two types of data were required: (1) the distribution of speeds among 14 speed bins, which together represent the single speed being modeled, and (2) a corresponding distribution of VMT among the four roadway types, matching the modeled speed to the correct road type.

Data files were prepared according to the methodology presented in the MOBILE6 Draft User's Guide (Chapter 5, Section 3.4). Basically, each modeled speed was converted into a distribution of speed bins. In order to carry out the methodology contained in the MOBILE6 manual, the following premises were adopted:

- Since the given speeds are "typical 24-hour" speeds, the same distribution was used for all hours. (Speed distributions in MOBILE6 are required by hour.)

- Ramps leading onto freeways and interstates were identified as being excluded from the speed values provided by TTI. However, the ramp VMT was lumped with the VMT for interstates. To correctly account for this, freeway, interstate highways and ramps should be modeled separately. Both the freeway and interstate speeds would be applied as-is from TTI. Ramps would be assigned the default speed. To correct the VMT, 8/92th of the TTI freeway VMT would be subtracted from the TTI interstate VMT before applying the emission factors. (The draft MOBILE6 manual allocated 8% of freeway VMT to be attributable to ramps). However, TNRCC agreed with

ENVIRON's recommendation to model ramps as part of the interstate highways without any further adjustments for the following reasons. This approach assumes a less aggressive acceleration cycle while having a higher speed; these phenomena may have a net canceling effect.

- Speeds can only be specified in MOBILE6 if the associated road type is a freeway or arterial/collector. TTI data included two facility types which did not neatly fit under a MOBILE6 category: interstate highways and locals. Interstate highways were assigned to the freeway category. The assignment for locals requires more consideration since it involves a trade-off between having the correct cycle or the correct speed. For local roads, the EPA MOBILE staff suggested two alternatives (from using the 'local' category) to allow the user control over the speed:

  (1) Model local roads as both local and as arterial/collector. A ratio would then be derived from the results; these ratios are then applied to the local case on a specific link basis. If the situation is such that there are link data containing an assortment of speeds for local roads, then this approach has the effect of distributing the arterial/collector-based speed corrections in proportion to the speed distribution. Since a distribution of speeds for local roads was not included in the data available, this approach is irrelevant and unnecessary. If this approach is applied, the result is basically the average of the local and arterial/collector cycles with the latter's speed correction.

  (2) Model local roads as arterial/collector. The impact of following this alternative can be arrived at through the following. The default average speed for local roads is 12.9 mph; the TTI data show speeds of approximately 20 mph for both urban and rural local roadways. According to EPA's report on Facility-Specific Speed Correction Factors (http://www.epa.gov/otaq/models/mobile6/m6spd002.pdf - Figures 2a-2c), within this speed range, nitrogen oxides and carbon monoxide emissions do not vary significantly, and the local and arterial/collector cycles produce relatively similar results. For hydrocarbons however, there are considerable differences between the two cycles as well as large variances within the speed range. (Note that the speed effects referenced in the above statements are based upon the arterial/collector test results, since the EPA does not have any speed effect data for local roadways).

Given these findings and in the interest of making the processing stream uniform, local roads were assigned the arterial/collector designation and modeled using the speeds TTI provided.

To correctly model a particular county area type/facility class, two files corresponding to that scenario were specified. These two files contain the distribution among the various speed bins and the distribution among four facility classes, respectively. These files were constructed as follows:

Speed VMT: Fourteen data files were constructed, one corresponding to each county area type/facility class combination. Each file has 16 columns and 48 rows. The first column represents the freeway or arterial/collector flag value. Each roadway type flag has 24 hours listed in column two. (Note that the first hour corresponds to 6:00 a.m.) Since each file must have both roadway flags embedded in the file, this leads to the 48 rows (two flags with 24 hours each). The following 14 columns designate the 14 speed bins (2.5, 5.0, 10.0, 15.0, 20.0, 25.0, 30.0, 35.0, 40.0, 45.0, 50.0, 55.0, 60.0, and 65.0+ mph) that describe the distribution of VMT by average speed. These speed bins are used as a baseline to determine if interpolation of VMT fractions is required (i.e. if the average speed matches a bin value, the VMT distribution is simply 1.0 for that bin). VMT fractions were determined via the harmonic mean equation provided in the MOBILE6 manual.

VMT by Facility: Fourteen data files were constructed, one corresponding to each county area type/facility class combination. Each file has 5 columns and 672 rows. The first column signifies one of 28 vehicle classes, listed in the order provided in Appendix B, Table 3 of the MOBILE6 manual. For each vehicle class, 24 sets of values represent the hours of the day (i.e. 672 rows). For each vehicle class and hour, four values represent the VMT distribution on freeways, arterial/collectors, local roads and freeway ramps, respectively. Since each TTI facility class was matched to only one MOBILE6 category, a file corresponding to a particular TTI facility class would show only a value of 1.0 under the column for the appropriate MOBILE6 road type. As discussed above, interstates were designated under freeways and local roads were designated under arterial/collectors; therefore, values for interstates were listed under the column for freeways and values for local roadways were listed under the arterial/collector column.

Fuel Parameters

Important fuel characteristics which impact emission factor calculations within MOBILE6 are the Reid Vapor Pressure (RVP), oxygenate content, reformulation (RFG), and sulfur content.

RVP affects evaporative VOC emissions and to a lesser extent, exhaust VOC. In this modeling work, appropriate RVP values were compiled for each county for every calendar year and season. In general, counties were grouped into specific non-attainment areas, attainment areas without RVP controls, and attainment areas with RVP controls. Counties within each group share the same RVPs. In an agreement with TNRCC, NIPER fuel survey data were used in non-attainment areas for historic years (i.e., before 2000), and adopted regulatory documents were consulted for future year RVP values. In the attainment areas, the regulated maximum RVP limits were used for both historic and future year RVPs. Table 7.3-1 and Table 7.3-2 summarize the final RVP values used in the MOBILE6 modeling as well as the informational sources used to determine the values. Figure 7.3-2 depicts the county groups, and Appendix 7-E contains the RVP data for each county, year, and season.

Table 7.3-1. RVP values used in MOBILE6 modeling for Attainment areas.

Season	Time Frame	RVP	Resource
			Regional Low RVP Counties
Summer	Historic	9.0	40 CFR Chapter I, Part 80 Section 27
Summer	Future	7.8	TX Administrative Code (30 TAC 114.301 and 114.309), TNRCC web page (http://www.tnrcc.state.tx.us/air/ms/fuelprograms.html), and EPA web page (http://www.epa.gov/otaq/regs/fuels/rfg/b00004.pdf)
Winter	Historic	11.9	Not specified in regulations, therefore, value is an average of NIPER RVP values for Amarillo
Winter	Future	11.5	TNRCC RFG web page (http://www.tnrcc.state.tx.us/air/ms/rfg.html)
			All Other Attainment Counties
Summer	Historic	9.0	40 CFR Chapter I, Part 80 Section 27
Summer	Future	8.7	TNRCC RFG web page (http://www.tnrcc.state.tx.us/air/ms/rfg.html), and EPA web page (http://www.epa.gov/otaq/regs/fuels/rfg/b00004.pdf)
Winter	Historic	11.9	Average of NIPER RVP values for Amarillo
Winter	Future	11.5	TNRCC RFG web page (http://www.tnrcc.state.tx.us/air/ms/rfg.html)

Table 7.3-2. RVP values used in MOBILE6 modeling for nonattainment areas.

Season	Time Frame	RVP	Resource
			Dallas-Fort Worth
Summer	Historic	7.0-8.0	NIPER Data
Summer	Future	6.8	EPA Phase II RFG web page (http://www.epa.gov/otaq/regs/rfg/r99025). [TNRCC
Winter	Historic	11.3-12.3	NIPER Data
Winter	Future	11.5	TNRCC RFG web page (http://www.tnrcc.state.tx.us/air/ms/rfg.html)
			Houston-Galveston
Summer	Historic	6.9-8.3	NIPER Data
Summer	Future	6.8	EPA Phase II RFG web page (http://www.epa.gov/otaq/regs/fuels/rfg/r99025).
Winter	Historic	11.5-12.7	NIPER Data
Winter	Future	11.5	TNRCC RFG web page (http://tnrcc.state.tx.us/air/ms/rfg.html)

Season	Time Frame	RVP	Resource
			El Paso
Summer	Historic	6.5-7.8	NIPER Data
Summer	Future	7.0	TX Administrative Code (30 TAC 115.252-259), and TNRCC web page
Winter	Historic	10.4-12.3	NIPER Data
Winter	Future	11.6	Information previously supplied by TNRCC
			Beaumont-Port Arthur
Summer	Historic	9.0 (1990-1991) 7.8	1990-1994: 40 CFR Chapter I, Part 80 Section 27; 1992-1999: as per email correspondence with TNRCC
Summer	Future	7.8	As per email correspondence with TNRCC
Winter	Historic	11.5-12.7	Houston-Galveston NIPER data
Winter	Future	11.5	TNRCC RFG web page (http://.tnrcc.state.tx.us/air/ms/rfg,html)

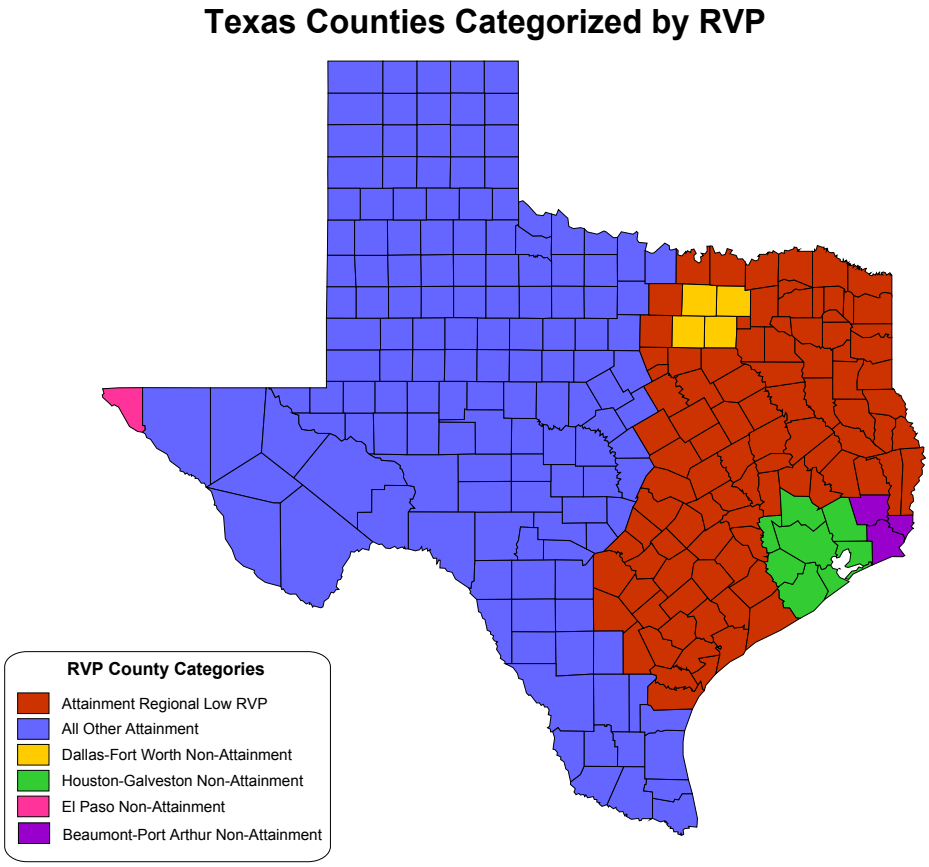


Figure 7.3-2. RVP Regions within which counties have similar historic and future RVPs.

NIPER data were provided by TNRCC staff and the following are a few notes regarding their use. The data span the historic years (1990-1999) except 1993, for which ENVIRON has NIPER data in-house. However, the level of detail of the in-house data was insufficient, and the average of the 1992 and 1994 data were used. Also, data generally existed for non-attainment areas only, with the exception of Amarillo. As a result Amarillo's data were used whenever an attainment county's RVP cannot be determined from regulations; i.e., wintertime RVP in historic years.

El Paso is the only county with an oxygenated fuel program. The program has been in effect since October 1, 1992 and requires an oxygenate content of at least 2.7%. The fuel is required in the winter months (October through March) only. Information obtained from TNRCC in previous work suggests the use of mostly alcohol as the oxygenate. The fuel was modeled beginning with the winter scenarios in 1993.

Reformulated gasoline was required in the Houston-Galveston area beginning in 1995. At the start of 1995, the Dallas-Fort Worth area also opted into the program. Counties included in each region are shown in Table 7.3-3.

Table 7.3-3. Texas counties with RFG.

Area	Counties in Each Area
Dallas-Fort Worth	Collin, Dallas, Denton, Tarrant
Houston-Galveston Area	Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller

Modeling RFG in MOBILE6 requires specification of two parameters. The first is a flag indicating the type of fuel as RFG (flag=2). If RFG is indicated, a second flag indicating volatility requirement region must accompany the first. In this case, this second flag was chosen to represent the southern region.

The final fuel specification to enter into these computations is the fuel sulfur content. In regards to this parameter, default MOBILE6 values were used in all scenarios. These values are different for conventional gasoline and RFG. Table 7.3-4 shows sulfur content for both types and the applicable years. Diesel fuel sulfur contents were also defaults.

Table 7.3-4. Fuel sulfur contents assumed in draft MOBILE6.

Fuel Type	Sulfur (ppm)	Applicable Model Years
Conventional Fuel	300	pre-2004
	120	2004
	90	2005
	30	2006+
Reformulated Gasoline	300	pre-2000
	150	2000-2003
	120	2004
	90	2005
	30	2006

Anti-tampering Programs (ATP)

The majority of the effort to model the effects of anti-tampering programs involved ascertaining which counties were involved and when. After much investigation, the following program history was compiled.

The origin of the anti-tampering program in Texas was in Harris County. In July 1984 the county required visual inspections of emissions components as well as a tailpipe lead test. This program, called the Parameter Program, was expanded to include El Paso in 1986. In 1987, the ATP was expanded to include Dallas and Tarrant Counties. Denton, Collin, Rockwall, Ellis, Parker, Johnson, and Wise counties were added into the program on April 1, 1990 but in July 1993, all but Collin, Denton and Harris counties were removed. In 1994, the Texas Legislature passed a legislative bill requiring a centralized testing program with I/M 240 emissions testing, and as a result the Department of Public Safety (DPS) ceased all testing at the end of 1994. In January of 1995, the TNRCC began the new testing program but it was stopped in February due to public complaints. The following year, the Legislature passed a bill requiring a decentralized program to replace the abandoned program. Until this new program was developed, DPS was required to resume the previous testing program for Collin, Dallas, Denton, El Paso, Harris, and Tarrant counties, and it did so in July 1995. On October 1, 1996, the new Texas Motorist Choice Program (TMCP) began in Dallas and Tarrant counties. In 1997, Harris and El Paso were included in the TMCP. Recent legislation will expand the TMC program to include various counties around the DFW and HGA non-attainment areas.

Combining the information above with program specifications received from TNRCC, the ATPs were modeled as follows. Table 7.3-5 summarizes the start dates and locations of ATPs as modeled in this work. Note that the numerous changes in program coverage in the early 1990s were not exactly followed because these short-term changes have little effect upon the entire trends and projections analysis and no information was available regarding the program parameters for these lesser counties. In brief, two sets of ATPs were identified, those that were in place before the TMCP and those which are part of the TMCP. Within each of these sets, there are two separate programs designed to cover different model year ranges. Pre-TMCP ATP1 covered pre-1980 model years and pre-TMCP ATP2 covered 1980 and later model years. The two programs also differ in the types of inspections required. (Entirely separate model runs were required to correctly model each ATP. A run without ATP was also needed for each county. More details are given below) TMCP ATP1 and ATP2 differ from their predecessors by including HDGVs, having the model year split occur later (1983/1984), and excluding vehicles outside the 2-24 years old range.

Table 7.3-5. Summary of start years for Anti-tampering programs modeled.

County	pre-TMCP	TMCP
El Paso	1986	1997
Dallas, Tarrant	1987	1996
Collin, Denton		2002
Ellis, Johnson, Kaufman, Parker, Rockwall		2003
Harris	1984	1997
Brazoria, Fort Bend, Galveston, Montgomery		2003
Chambers, Liberty, Waller		2004

Other program parameters used (e.g., compliance rate, inspection frequency) are from TNRCC sources and are shown in Appendix 7-F.

Inspection and Maintenance Programs (I/M)

The history of the emissions testing programs closely parallels that of the anti-tampering programs. For this modeling effort, the start dates for the emissions testing portion were 1987, 1990, and 1997 for El Paso, Dallas/Tarrant, and Harris counties, respectively. All counties operating under the TMCP were presumed to have emissions testing so that their start dates are as shown in Table 7.3-5. However, the test types changed for several of the counties due to recent legislation, and these were also accounted for as discussed below.

MOBILE6 can model the effects of all the I/M test types in MOBILE5 plus OBD-based I/M. Test types utilized in Texas include 2-speed idle (TSI), acceleration simulation mode (ASM), and on-board diagnostics-based (OBD). In all the I/M counties, a combination of two test types are present in the future years, each applicable to different model year sets, as required by the new regulations. In these instances, two I/M programs were used within MOBILE6 in order to accurately capture the benefits of the physical programs. Furthermore, the model requires the specification of an evaporative I/M program if the benefits of a gas cap check are to be included. Since the gas cap check is part of the inspection, evaporative I/M programs paralleling the exhaust tests were indeed used in the modeling. One final note is in regards to the ASM test used in several counties. It was assumed that the test was an ASM2525 with phase-in cut-points. Table 7.3-6 shows the test types that are applicable for various years and counties.

Table 7.3-6. Summary of applicable test types used in I/M counties.

County	Test Type	Applicable Cal. Yrs.	Applicable Model Yrs.
El Paso	TSI	1987-2001	all
	TSI	2002+	pre-1996
	OBD	2002+	1996+
Dallas, Tarrant	TSI	1990-2001	all
	ASM	2002+	pre-1996
	OBD	2002+	1996+
Collin, Denton	ASM	2002+	pre-1996
	OBD	2002+	1996+
Ellis, Johnson, Kaufman, Parker, Rockwall	ASM	2003+	pre-1996
	OBD	2003+	1996+
Harris	TSI	1997-2001	all
	ASM	2002+	pre-1996
	OBD	2002+	1996+
Brazoria, Fort Bend, Galveston, Montgomery	ASM	2003+	pre-1996
	OBD	2003+	1996+
Chambers, Liberty, Waller	ASM	2004+	pre-1996
	OBD	2004+	1996+

All other I/M program specifications (e.g., effectiveness, stringency) used were in accordance with information from TNRCC; these are shown in Appendix 7-F.

A fault in the current draft version of MOBILE6 is worth mentioning. Presently, a conventional (i.e., non-OBD) I/M cannot be prescribed for model years newer than 1995.

Neither can an OBD-based I/M be applied to model years older than 1996. This presented a problem for El Paso for the years 1999-2001 where 1996-1998 model years were not modeled with any I/M though they should be under a TSI test. It was confirmed with EPA that this problem will be fixed in the final version, yet to be released.

Speed Limit Reductions

Recently, the state of Texas adopted measures to reduce particular speed limits in the DFW and HGA areas as part of SIP revisions. In particular, all speed limits in the Houston-Galveston area (Harris, Brazoria, Fort Bend, Galveston, Montgomery, Chambers, Liberty and Waller counties) which are 60 mph or above will be reduced to 55 mph. This is reflected in the current modeling by setting the interstate highway and urban freeway speeds to 55 mph for both urban and rural counties. For Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall and Tarrant counties, 65 mph speed limits are to be reduced to 60 mph while 70 mph limits are decreased to 65 mph. These changes were accounted for by reducing the TTI-provided urban interstate highway speed from 65 mph to 60 mph and the rural interstate speed from 67 mph to 62 mph. The DFW speed reductions were modeled beginning January 2002 while the HGA changes start in summer 2002. These modifications were made after the speed-related inputs were prepared as detailed above.

Other Controls

Aside from those controls already discussed above, the emissions from on-road vehicles will also benefit from Tier 2 vehicle technology and gasoline sulfur rule phase-in, the 2004 heavy-duty rule (including the Consent Decree), and the 2007 heavy-duty standards and accompanying cleaner diesel fuel. These effects are accounted for intrinsically by the draft MOBILE6 model and warranted no further adjustments.

Once the emission factors were obtained from the draft MOBILE6 model, two significant post processing steps were employed. For counties with ATPs, emission factors from the scenarios with ATP were summed and then the no-ATP emission factors were subtracted from that result. This correctly accounts for the emission reductions effected by these programs. To obtain annual average emission factors, the summer and winter runs were combined using the TTI seasonal VMT adjustment factors as weighting factors.

PART5

PART5 modeling was performed similarly to the MOBILE modeling. Scenarios were defined for combinations of county, calendar year, facility class and particulate size cutoff. However, PART5 results are pseudo annual averages since none of the seasonal parameters (temperature, RVP,…) affect the calculations. The direct results from the model are not exactly yearly averages because the registration is not ‘aged’. Thus, the average of two consecutive years’ results were used to approximate that fleet turnover.

Registration Distributions

These distributions were the same ones used in the draft MOBILE6 application, except that no modifications were necessary since MOBILE5 and PART5 registration distributions are compatible.

Fuel Parameters

Fuel programs are easily (and simplistically) modeled in PART5. Oxyfuel and RFG are indicated via flags. The start dates and geographical applicability for these programs are as discussed above.

I/M Programs

Inspection and maintenance programs are modeled in a similar manner to the fuel controls. A single flag indicates the presence of a basic I/M program. No facilities exist for more detailed program specifications. The start dates and geographical applicability for these programs are as discussed above.

Other Controls

Low Emission Diesel (LED) affects both PM (sulfates) and SO2 emissions. These effects were accounted for by modifying the model's hard-coded diesel fuel sulfur contents to reflect the 15 ppm sulfur content beginning in 2006.

The Tier 2 low sulfur gasoline also affects the sulfate and SO2 emissions, but for gasoline vehicles. The fuel, mandated as part of the Tier 2 rule, will be phased in from 2004 to 2006 with sulfur contents of 120 ppm, 90 ppm and 30 ppm respectively. These effects were also implemented by modifying the source code (subroutine EFCALX).

The 2007 heavy-duty diesel PM standards were also included in this analysis. The adjustments for these new standards were applied via the by-model-year output from PART5. The emission factors for 2007 and newer model years were reset to 0.02 g/mi in the case of PM10. For PM2.5, a factor of 0.92 was used according to the PART5 size cutoff fraction for PM2.5. Although these emission factors are the new vehicle standards, they are compatible within PART5 since the model does not contain deterioration effects. Only the 2BHHDV weight class was affected, according to the standard's applicability. The first-time PM standard for heavy-duty gasoline vehicles was not accounted for since EPA did not claim any PM credits for this vehicle class in the Regulatory Impact Analysis (RIA).

Whenever necessary, by-model-year adjustments were completed first. Then the model years were combined within a vehicle class, using travel fractions from the model output. Next, the heavy-duty diesel classes were combined using the model VMT mix fractions for these classes.

Final post-processing of these emission factors generally involved obtaining the average of two consecutive years to represent the first's annual average emission factor. The exceptions came for years in which there was a midyear (e.g., May 1st) advent of a control program. In this case, weighting factors were assigned to the with- and without-control emission factors in proportion to the length of the year applicable to each control status. Note that the same resulting emission factor was used for both annual and ozone season emission calculations.

8.0 1990-2010 EMISSIONS TRENDS AND PROJECTIONS

8.1 INTRODUCTION

This section provides tabular and graphical summaries of 1990-2010 emissions trends and projections for all area, nonroad, and on-road mobile sources. For all area and nonroad sources, the 1990-2010 trends and projections were based on 1999 emissions, described earlier in Sections 2 and 3, respectively. Activity growth surrogates for area and nonroad sources used to back cast 1999 emissions annually to 1990 and to forecast 1999 emissions annually to 2010 have been described in Sections 5 and 6, respectively. Detailed procedures for estimating 1990-2010 county-level on-road emissions estimates have been provided in Section 7.

Subsections 8.2, 8.3, and 8.4 discuss salient points about the estimated emissions trends and projections for area, nonroad, and on-road mobile sources, respectively. Following these subsections, tables are provided that show statewide emissions every five years by season (annual and summer ozone season) and pollutant. For area sources and nonroad sources, these 5-year emissions summaries are provided by source categories. For on-road mobile source, these emissions are provided for each of the eight on-road vehicle classes.

Following the discussion and summary tables, there are a large number of graphs showing emissions trends and projections. All of these graphs for area sources are provided first, followed by the same set of graphs for nonroad sources, followed by the same set of graphs for on-road mobile sources. Within each of area, nonroad, and on-road sources, the graphs are in order as follows. First there is a set of eight graphs for each pollutant in the order of VOC, NO_X, CO, PM10, PM2.5, and SO2. These eight graphs are

- Statewide Annual Emission Trends by Source Category (or vehicle class)
- Statewide Annual Emission Trends by Source Category (or vehicle class) - Ratios Relative to 1999
- Annual Emission Trends by Area
- Annual Emission Trends by Area - Ratios Relative to 1999
- Statewide Summer Emission Trends by Source Category (or vehicle class)
- Statewide Summer Emission Trends by Source Category (or vehicle class) - Ratios Relative to 1999
- Summer Ozone Season Emission Trends by Area
- Summer Ozone Season Emission Trends by Area - Ratios Relative to 1999

In addition, six plots compare the trends in statewide annual and summer ozone season daily emissions VOC, NOx, CO, PM10, PM2.5 and SO2 (in that order). The final plot in each set shows statewide emissions trends relative to the 1999 level for each pollutant (to compare relative trends across pollutants).

The areas for which emissions trends are shown are the ozone nonattainment areas (NA) and near-nonattainment areas (NNA). These areas, and the counties located within each, are listed in Table 8.1-1.

Table 8.1-1. Counties in ozone nonattainment and near-nonattainment areas.

	Counties
Ozone Nonattainment Areas	
Dallas-Fort Worth	Collin, Dallas, Denton, and Tarrant
Houston-Galveston	Brazoria, Chambers, Fort Bend, Galveston, Harris
El Paso	El Paso
Beaumont-Port Arthur	Hardin, Jefferson, and Orange
Ozone Near-Nonattainment Areas	
Tyler-Longview	Gregg, Harrison, Rusk, Smith, Upshur
Corpus Christi	Nueces and San Patricio
San Antonio	Bexar, Comal, Guadalupe, Wilson
Austin	Bastrop, Caldwell, Hays, Travis, Williamson
Victoria	Calhoun, Victoria

8.2 AREA SOURCES EMISSIONS TRENDS AND PROJECTIONS

This subsection summarizes the 1990-2010 area source emission trends by pollutant, source category, and geographic area. In most instances, the annual emission trends are very similar to the Ozone Season Daily (OSD) emission trends. Exceptions are identified in the following paragraphs, which describe the major 1990-2010 area source emissions trends.

Statewide annual and OSD VOC emissions are estimated to decline throughout the analysis period. The main contributor to this decline is the Oil and Gas Production source category, which is projected to decline from more than 580,000 tpy in 1990 to less than 250,000 tpy in 2010. Because no controls are assumed to affect this area source category, the reduction is solely attributable to the historical and forecasted decline in oil and gas production activity in Texas. The Service Stations: Stage II source category is projected to have the second largest VOC emission reduction over the analysis period. Significant emission reductions are estimated for this category due to the effect of on board vapor recovery systems. Nonattainment area (NA) counties increase their percentage of total state VOC emissions over the 1990-2010 period. One major explanation for this result is that oil and gas production emissions contribute a greater portion of total VOC emissions in the near nonattainment area (NNA) and attainment area counties (more than two-thirds) than the NA counties (nearly one-tenth). There are no substantial differences in the estimated OSD emission trends versus the estimated annual emission trends.

Statewide annual and OSD NO_X emissions are estimated to decline throughout the analysis period. As with VOC emissions, the majority of this decline is attributable to the Oil and Gas

Production sector. Annual Oil and Gas Production NO_X emissions are projected to decline from approximately 350,000 tpy in 1990 to less than 163,000 tpy in 2010. This decline is solely attributable to the historical/forecast reduction in oil and gas production activity in the state. Other major source categories with projected NO_x emission reductions include Residential Fuel Combustion, Other and Open Burning. For the Residential Fuel Combustion, Other category, emission reductions are forecast based on implementation of the state's water heater NO_X regulations. For the Open Burning category, a dramatic reduction occurred between 1996 and 1997 due to implementation of the state's open burning regulation. However, small emission increases are projected in this category through the remainder of the trends period due to forecast increases in emissions activity. NA counties increase their percentage of total state emissions over the 1990-2010 period. One major explanation for this result is that oil and gas production emissions contribute a greater portion of total NO_X emissions in the NNA and attainment area counties (greater than 90 percent) than the NA counties (less than 50 percent). There are no major differences between the estimated OSD emission trends and the estimated annual emission trends.

Annual statewide CO emissions decline significantly between 1996 and 1997, but then hold relatively constant through 2010. There are three source categories that account for the bulk of the reductions between 1996 and 1997. Emission reductions from the Open Burning sector result from implementation of the state's open burning ban in 1997. In addition, the Residential Wood and Oil and Gas Production sectors are significant CO contributors that experienced declines between 1996 and 1997. The Residential Wood and Oil and Gas Production categories declined due to reductions in each sector's activity. NA and NNA counties constitute a fairly steady percentage of total state annual emissions over the 1990-2010 period. However, these counties make up a much larger percentage of total state OSD CO emissions in 2010 than 1990. The explanation for this occurrence is that a greater proportion of total OSD CO emissions come from the Oil and Gas Production sector for the attainment counties versus the NA and NNA counties. Similarly, there is a noticeable decline in post-1997 statewide OSD CO emissions while annual CO emissions are relatively constant after 1997. The reason for this discrepancy is that the Oil and Gas Production sector, which declines throughout the analysis period, contributes a larger proportion of total OSD CO emissions than total annual CO emissions.

Particulate matter emissions, which are dominated by the Miscellaneous category, experienced a significant reduction between 1996 and 1997, but are projected to undergo a small increase thereafter. The only significant emission control programs affecting PM sources are the open burning ban and the wood heater New Source Performance Standard (NSPS). The open burning ban resulted in most of the emission reductions that occurred between 1996 and 1997. Over the 1990-2010 period, NA and NNA counties experience a small increase in their contribution to total state PM2.5 and PM10 emissions. This results from higher emission activity growth rates in the NA and NNA areas. With the exception of the Residential Wood source category, where significant reductions are associated with annual, but not OSD emission estimates (because this activity does not occur in the ozone season), there are no major differences in the OSD emission trends versus annual emission trends. It is important to note that the major PM2.5 and PM10 source categories are forecasted using the general

projections approach that relies on EGAS 4.0 growth factors (see Section 5 for discussion of this approach). A more detailed analysis would be appropriate before drawing firm conclusions as to future PM2.5 and PM10 emission trends.

Sulfur dioxide (SO2) annual and OSD emissions declined dramatically between 1996 and 1997, continued to decline slightly through 1999, then experience a small projected increase through 2010. The only area source control program affecting SO2 sources is the open burning ban which contributed the majority of the SO2 emission reductions that occurred between 1996 and 1997. Other source categories with significant changes over the analysis period include Oil and Gas Production, Commercial/Institutional Fuel Combustion, Oil, and Residential Fuel Combustion, Other. All three of these categories' emission reductions are due to solely to declines in emissions activity. NA and NNA counties constitute less than half of the state's annual and OSD SO2 emissions throughout the trends analysis period. There are no major differences in the OSD SO2 emission trends versus the annual SO2 emission trends.

8.3 NONROAD SOURCES EMISSIONS TRENDS AND PROJECTIONS

Overall emissions in nonroad VOC and NOx are expected to decrease in the future, while PM remains relatively flat, and CO emissions, increase primarily according to growth in activity. SO_2 emissions are affected primarily by the diesel fuel sulfur regulations and are expected to decrease because the highway diesel fuel is mandated in the nonroad sector for many counties within Texas. The VOC and NOx decreases are due to emission regulations for small gasoline engines for VOC and for large diesel engines for NOx. The diesel engine design changes are expected to just offset the growth in activity for PM emissions. CO emission increase because emission regulations are not expected to affect the CO emission factors.

VOC emissions are dominated by gasoline engines found in a variety of nonroad categories except for aircraft, locomotive, and commercial marine categories. The VOC emissions for Texas peaked in 1996 are expected to be further reduced through 2010 as engines meeting lower emission standards are produced and fleet turnover occurs. Nearly all gasoline engines are covered by emission regulations intended to reduce VOC emissions specifically (Federal regulations for <25 hp engines, and State regulations for >25 hp engines, with some exceptions for recreational, agricultural, and construction applications). These regulations began with the 1996 model year and were to be phased-in through the 2007 model year with fleet turnover expected to result in emission reductions for years after 2007. Gasoline volatility regulations beginning with the year 2000 were predicted to have a demonstrable effect on the evaporative emissions from nonroad engines resulting in an abrupt decrease in that one year, especially for recreational marine emissions.

NOx emissions are dominated by locomotive engines and diesel engines associated with a variety of nonroad categories. Texas nonroad NOx emissions were to have peaked in 1999 and are expected to fall through 2010 as new engine emission standards are phased in and fleet turnover occurs. Locomotive emission regulations targeted at reducing NOx emissions were to have begun with the 2000 model year and three separate standards are to be phased in

through the 2005 model year with fleet turnover accounting for additional NOx emission reductions past 2005. For other diesel engines (except commercial marine), emission regulations began with the 1996 model with additional emission regulations phased in through the 2013 model year. This effect is best demonstrated with agricultural equipment, which has little predicted activity growth. The Texas large (>25 hp) spark-ignition engine rule has the greatest effect on the commercial and industrial categories, where these type of engines are primarily found, offsetting the activity growth in these categories. Because of the commitment in the Dallas-Ft. Worth and Houston-Galveston area SIPs, a large proportional reduction in airport ground support equipment NOx emissions is expected. Commercial marine emissions rates are relatively unchanged due to emission regulations, and aircraft engines are unaffected by any emission regulations, so emissions increase for these two categories.

Carbon monoxide emissions generally grow because emission regulations are not expected to have much effect on this pollutant. The trends in carbon monoxide emissions generally follows the activity trends.

Overall particulate emission trends reflect little change as emission regulations for diesel engines just offset activity growth. The increase in particulate emissions from the aircraft and commercial marine categories, where no PM emission regulations are expected, is offset by reductions in general purpose diesel engines reflected primarily but not exclusively in the agricultural and construction and mining categories. Locomotive Tier 2 regulations beginning with the 2005 model year are expected to keep locomotive particulate emissions relatively stable through 2010.

Sulfur dioxide emissions would have been expected to increase according to activity growth had Texas not mandated that highway diesel fuel be used in nonroad engines for many of the Texas counties. Thus SO2 emissions decrease with the 2003 requirement that highway diesel fuel be used in many nonroad categories, and the 2006 Federal regulations.

In general, the emission trends for all geographical areas reflect the trends in the nonroad categories, which are primarily found in each area. For instance, in the Corpus Christi and Beaumont-Port Arthur area, where commercial marine represents a disproportionally larger share of the PM and NOx emissions and for which little change in emission rates is expected, less emission reduction is expected.

8.4 ON-ROAD MOBILE SOURCES EMISSIONS TRENDS AND PROJECTIONS

VOC emissions arise almost entirely from gasoline vehicles as shown in the plots depicting emissions of this pollutant by vehicle class. This is to be expected since the only significant diesel class is the HDDVs and these emit practically no evaporative VOC and relatively little in the exhaust. NA and NNA counties contribute roughly half the state's VOC emissions in both summer and annual cases. Motorcycles are the only class with increasing emissions in the future years, probably due to increasing VMT coupled with little control requirements, but these are an insignificant portion of the fleet total. The summer and annual daily average

emissions trend lines cross at around 1993-1994, with the summer case showing lower emissions for the later years. This is mostly indicative of the lower RVP fuel used during the summer months for NA and NNA counties.

NO_X emissions are clearly dominated by heavy-duty diesel trucks (HDDVs). The HDDV emissions do not begin to significantly decline until about 1999. This reflects the 20 percent lower NO_X standard beginning with the 1998 model year (model years 1991-1997 have the same NO_X standards). Other factors that contribute to this decline include the 2004 and 2007 heavy-duty emissions regulations, and diesel fuel sulfur reductions. NA and NNA counties constitute roughly half the state's NO_X emissions in both summer and annual cases. Again, all vehicle classes show emission declines except for motorcycles. The presence of RFG in the Dallas-Ft. Worth and Houston-Galveston areas seem to ensure that emission reductions (relative to 1999) for these counties are greater than that observed in other areas. Only the Beaumont-Port Arthur (BPA) area approaches the reduction rates of DFW and HGA. Surprisingly, on a ton per day basis, summer NO_X emissions are lower than the annual emissions in all years. In an attempt to understand this result, tests were performed to determine the draft MOBILE6 sensitivity to RVP, temperature, and absolute humidity inputs. The investigation revealed that the parameters responsible for this counter-intuitive result are temperature and absolute humidity; these results issue should be further pursued with EPA.

Carbon monoxide emissions are dominated by gasoline vehicles, particularly the light-duty cars and trucks. Heavy-duty gasoline vehicles also contribute a significant amount, especially in historic years. Relative to their 1999 emissions, all vehicle classes except motorcycles show a decreasing trend out to 2010. NA and NNA counties constitute roughly half the state's CO emissions in both summer and annual cases. Another significant observation is that the attainment counties actually show lower future year emissions relative to 1999 than NA and NNA counties. This is in spite of the controls placed upon the NA counties and is probably the result of greater VMT growth in the NA and NNA (Bexar, Travis) counties. Taken on a per day basis, the annual CO emissions are higher than the summer season as expected since the annual values include winter temperatures. The intersection of the two in 1990 and the fact that the difference between the two trends increases over time are mainly a result of the temperature correction factors being larger for newer vehicles.

Particulate matter emissions are shown for the sum of exhaust, brake wear, and tire wear (though the emissions for these three sources are separated in the every-five-years emissions tables). For both PM2.5 and PM10, HDDVs dominate in the early years, but their emissions decline dramatically so that by 2000 they only contribute half the total emissions. This trend is mainly driven by the continually tightening standards for these diesel trucks. These PM standards decreased from 0.60 in 1990, to 0.25 for 1991-1993 model years, to 0.10 for 1994-2006 model years, and finally to 0.01 g/bhp-hr for 2007 and later model years. Interestingly, light-duty gasoline vehicles and trucks show an increasing trend in PM emissions since their standard has remained at 0.08 g/mi since 1994, and VMT is increasing. There is not much difference between the seasonal and annual emissions (on a per day basis) since the same annual average emission factors were used in both calculations. NA and NNA counties' contributions to the state total are approximately 50 percent in the early years but eventually

become greater than the attainment counties portion. This is due to a higher average VMT growth rate in the NA and NNA areas. All areas show future emissions that are less than the 1999 levels, but DFW, HGA, and the Austin NNA already show an increasing trend by 2010. This is a concern given the new PM2.5 ambient standard.

Sulfur dioxide (SO2) emissions are directly correlated with the fuel sulfur content. The heavy-duty diesel vehicle class has the largest contribution in 1990-1991 but then quickly declines, due to the diesel sulfur content limit being lowered from 2500 to 500 ppm in 1993. A second sharp drop for this vehicle class occurs in 2006 when the sulfur content will be lowered again to 15 ppm. For gasoline vehicles, the first sign of significant reductions in SO2 should occur in 2000, when Phase II RFG is implemented in the DFW and HGA counties. The reduction seen in 2004 comes as a result of the phase-in of Tier 2 low sulfur gasoline. The gasoline trends can be seen more clearly as they pertain to specific areas by examining the relative emissions by area plot. Again, the NA and NNA counties together contribute roughly one half of the entire state's SO2 emissions inventory.

An important note to bear in mind is that the estimated on-road mobile source emissions are not the same as those in the State Implementation Plans (SIP) or Rate of Progress (ROP) emissions inventories. There are two primary reasons for this: First, the current SIP and ROP inventories were developed using MOBILE5 with adjustments made to approximate some MOBILE6 effects. Second, link-specific speeds and VMT were used in the SIP and ROP inventories, and MOBILE5 and MOBILE6 emission factors are extremely sensitive to speeds. Because of the highly non-linear nature of the speed corrections, the average of MOBILE emission factors across different speeds will not be the same as the average of the speed-specific emission factors. However, the relative trends between link-based emission inventories and non-link-based emission inventories should be quite similar, and it is the trends in emissions that are the focus of this analysis.

VOC Emissions Trends Summary Table

	1990		1995		2000		2005		2010	
	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)
AREA SOURCE CATEGORIES										
Fuel Comb. Industrial										
Oil	45	-	31	0.0	38	-	42	-	44	-
Gas	1	-	1	-	2	-	2	-	2	-
Other	6	0.0	8	0.0	8	0.0	9	0.0	9	0.0
Fuel Comb. Other										
Commercial/Institutional Oil	26	0.0	18	0.0	15	0.0	14	0.0	13	0.0
Commercial/Institutional Gas	473	1.1	577	1.4	490	1.2	583	1.4	617	1.5
Misc. Fuel Comb. (Except Residential)	20	0.0	11	0.0	8	0.0	8	0.0	9	0.0
Residential Wood	34,282	-	35,928	-	22,461	-	30,109	-	30,854	-
Residential Other	680	0.8	620	0.7	527	0.6	588	0.7	598	0.7
Petroleum & Related Industries										
Oil & Gas Production	583,694	1,599.1	458,488	1,256.1	367,086	1,005.7	300,263	822.6	243,097	666.0
Other Industrial Processes										
Agriculture, Food, & Kindred Products	606	1.7	599	1.6	658	1.8	721	2.0	778	2.1
Solvent Utilization										
Degreasing	7,147	63.0	9,188	80.4	10,311	89.8	12,438	107.7	14,562	125.8
Graphic Arts	11,041	42.3	11,926	45.8	12,970	49.7	14,428	55.3	15,723	60.3
Dry Cleaning	7,834	28.2	10,455	37.6	12,002	43.2	13,182	47.5	14,285	51.4
Surface Coating	60,479	218.7	60,816	226.7	63,002	240.8	72,804	283.3	80,403	316.8
Other Industrial	565	2.1	583	2.1	651	2.4	802	2.9	885	3.3
Nonindustrial	134,775	588.3	119,546	475.2	111,937	447.4	116,814	449.4	119,990	443.0
Storage & Transport										
Petroleum & Petroleum Product Transport	223	0.6	217	0.6	176	0.4	149	0.4	161	0.4
Service Stations: Stage I	32,753	82.6	31,588	75.7	31,170	69.6	31,556	75.4	34,087	81.4
Service Stations: Stage II	42,092	116.0	29,198	81.0	30,808	83.2	22,730	60.9	13,208	35.5
Service Stations: Breathing & Emptying	4,266	11.9	4,484	12.5	5,280	14.7	5,757	16.1	6,247	17.4
Waste Disposal & Recycling										
Open Burning	10,631	29.1	12,612	34.6	6,883	18.9	6,994	19.2	7,702	21.1
POTW	132	0.2	129	0.2	135	0.2	150	0.2	166	0.3
Landfills	7,785	21.3	7,466	20.5	7,761	21.3	8,605	23.6	9,490	26.0
Other	17,408	45.7	16,849	44.7	17,754	47.2	19,723	52.4	21,777	57.9
Miscellaneous										
Other Combustion	37,270	27.8	36,004	23.7	39,353	25.2	40,082	24.8	41,252	24.8
Catastrophic/Accidental Releases	1,075	3.0	1,180	3.3	1,256	3.5	1,311	3.6	1,368	3.8
Total	**995,311**	**2,883.6**	**848,521**	**2,424.5**	**742,740**	**2,167.0**	**699,862**	**2,049.5**	**657,328**	**1,939.5**

VOC Emissions Trends Summary Table (concluded)

NON-ROAD MOBILE SOURCES										
Agricultural Equipment	8,356	38.5	6,931	31.9	5,084	23.3	3,772	17.3	2,727	12.4
Aircraft	3,717	10.5	4,390	12.4	4,782	13.4	5,443	15.3	6,068	17.1
Airport Ground Support Equipment	4,146	11.3	4,584	12.4	3,442	9.3	3,087	8.4	1,659	4.6
Commercial Equipment	14,787	39.9	17,370	46.8	13,205	35.5	11,284	30.6	8,868	23.9
Commercial Marine	683	1.9	755	2.1	896	2.4	1,012	2.8	1,132	3.1
Construction and Mining Equipment	9,578	32.1	12,180	40.8	10,626	35.8	8,129	27.4	5,952	20.0
Industrial Equipment	6,844	18.6	7,710	20.9	7,060	19.1	6,078	16.7	4,968	13.6
Lawn and Garden Equipment (Com)	39,987	167.8	42,750	179.2	32,423	133.9	24,661	103.4	16,670	69.3
Lawn and Garden Equipment (Res)	17,297	73.5	18,433	78.3	15,505	65.4	12,478	52.8	9,143	38.2
Locomotives	4,407	12.1	6,110	16.7	8,579	23.4	9,076	24.9	8,682	23.8
Logging Equipment	11,234	30.1	14,078	37.7	10,821	28.8	8,325	22.6	4,907	13.1
Railroad Equipment	55	0.1	71	0.2	70	0.2	50	0.1	37	0.1
Recreational Equipment	4,810	18.1	5,107	19.2	4,989	18.6	5,290	19.7	5,708	21.2
Recreational Marine	61,023	248.6	59,088	239.1	50,028	196.0	53,098	208.3	54,428	213.1
Total	**186,924**	**703.0**	**199,559**	**737.7**	**167,511**	**605.1**	**151,784**	**550.2**	**130,947**	**473.5**
ON-ROAD VEHICLES										
Light-Duty Gas Vehicles	406,914	1,149.5	295,816	792.6	239,687	615.8	170,211	430.1	120,458	305.0
Light-Duty Gas Trucks 1	191,535	541.9	141,395	384.4	124,270	287.9	119,366	192.3	105,786	141.6
Light-Duty Gas Trucks 2	24,692	68.4	18,239	49.1	16,624	37.1	15,717	25.4	13,849	18.2
Heavy-Duty Gas Vehicles	65,349	191.6	45,999	135.2	42,258	96.7	39,057	64.4	32,271	44.2
Light-Duty Diesel Vehicles	799	2.3	423	1.2	303	0.7	264	0.7	239	0.2
Light-Duty Diesel Trucks	879	2.5	638	1.8	469	0.9	404	1.1	283	0.6
Heavy-Duty Diesel Vehicles	27,913	76.8	17,064	46.8	14,868	36.1	13,840	26.5	12,366	20.4
Motorcycles	771	2.3	683	2.1	650	2.0	697	2.1	691	2.2
Total	**718,852**	**2,035.3**	**520,256**	**1,413.3**	**439,128**	**1,077.1**	**359,557**	**742.6**	**285,943**	**532.5**
TOTAL, ALL SOURCES	**1,901,086**	**5,622.0**	**1,568,337**	**4,575.5**	**1,349,379**	**3,849.1**	**1,211,203**	**3,342.3**	**1,074,218**	**2,945.5**

NOx Emissions Trends Summary Table

	1990		1995		2000		2005		2010	
	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)
AREA SOURCE CATEGORIES										
Fuel Comb. Industrial										
Oil	6,685	21.2	4,963	15.7	5,927	18.8	6,423	20.3	6,813	21.6
Gas	69	0.2	74	0.2	84	0.2	89	0.2	93	0.2
Other	304	0.9	391	1.1	429	1.2	458	1.3	489	1.4
Fuel Comb. Other										
Commercial/Institutional Oil	1,551	3.2	1,046	2.1	855	1.7	796	1.6	789	1.6
Commercial/Institutional Gas	8,599	20.9	10,499	25.5	8,908	27.3	10,605	25.8	11,221	27.3
Misc. Fuel Comb. (Except Residential)	393	0.7	212	0.4	156	0.3	167	0.3	179	0.3
Residential Wood	1,128	-	1,184	-	741	-	992	-	1,017	-
Residential Other	11,774	15.4	10,671	13.6	9,061	11.5	9,235	11.7	8,191	10.4
Petroleum & Related Industries										
Oil & Gas Production	351,100	962.1	292,862	802.5	244,141	669.0	201,461	552.0	162,946	446.5
Waste Disposal & Recycling										
Open Burning	11,054	30.3	11,945	32.7	703	1.9	789	2.2	870	2.4
Miscellaneous										
Other Combustion	7,730	16.9	7,235	13.6	7,593	12.2	7,709	12.1	7,921	12.3
Total	**400,387**	**1,071.7**	**341,083**	**907.5**	**278,600**	**738.5**	**238,723**	**627.6**	**200,529**	**524.0**
NON-ROAD MOBILE SOURCES										
Agricultural Equipment	54,532	253.3	50,165	232.9	42,412	196.6	33,604	156.3	25,297	117.7
Aircraft	6,281	17.4	7,420	20.5	8,081	22.3	9,198	25.4	10,254	28.3
Airport Ground Support Equipment	4,164	11.1	4,253	11.3	3,849	10.2	987	2.6	352	0.9
Commercial Equipment	7,554	20.1	9,148	24.4	11,875	31.4	11,475	30.4	10,550	28.0
Commercial Marine	19,493	53.4	21,552	59.0	25,561	69.8	27,733	76.0	29,869	81.8
Construction and Mining Equipment	39,579	134.1	46,709	158.0	48,766	165.0	40,996	139.2	31,439	106.9
Industrial Equipment	29,554	82.0	33,928	94.1	39,328	108.9	34,448	96.5	25,679	71.7
Lawn and Garden Equipment (Com)	5,575	25.5	6,050	27.7	7,237	32.9	5,969	27.2	5,276	24.0
Lawn and Garden Equipment (Res)	527	2.3	569	2.5	1,050	4.6	1,183	5.3	1,048	4.6
Locomotives	108,221	296.5	150,047	411.1	208,587	569.9	158,509	434.3	139,929	383.4
Logging Equipment	2,256	6.2	2,452	6.6	1,856	5.1	1,421	3.9	937	2.6
Railroad Equipment	197	0.5	248	0.7	306	0.8	258	0.7	206	0.6
Recreational Equipment	374	1.5	406	1.6	522	2.1	483	1.9	471	1.9
Recreational Marine	5,570	26.3	5,674	26.8	5,690	26.8	5,934	28.0	6,170	29.1
Total	**283,877**	**930.2**	**338,623**	**1,077.3**	**405,120**	**1,246.4**	**332,195**	**1,027.7**	**287,477**	**881.6**
ON-ROAD VEHICLES										
Light-Duty Gas Vehicles	276,779	651.0	212,280	513.8	174,129	430.3	129,445	324.8	82,413	206.4
Light-Duty Gas Trucks 1	107,936	250.1	85,315	200.9	77,073	186.0	64,452	155.3	44,732	106.8
Light-Duty Gas Trucks 2	16,369	37.9	13,541	32.1	13,768	33.4	12,802	30.8	7,718	18.2
Heavy-Duty Gas Vehicles	73,991	197.5	71,028	193.2	70,844	195.2	65,492	180.3	40,812	113.3
Light-Duty Diesel Vehicles	2,471	7.0	1,191	3.4	637	1.8	658	1.9	223	0.6
Light-Duty Diesel Trucks	1,634	4.6	1,084	3.1	647	1.8	826	2.3	451	1.3
Heavy-Duty Diesel Vehicles	352,743	981.8	352,103	989.2	363,174	1,006.6	235,780	651.2	152,078	413.3
Motorcycles	243	0.5	289	0.6	336	0.7	363	0.8	394	0.9
Total	**832,166**	**2,130.5**	**736,830**	**1,936.3**	**700,607**	**1,855.8**	**509,817**	**1,347.4**	**328,820**	**860.9**
TOTAL, ALL SOURCES	**1,516,430**	**4,132.4**	**1,416,535**	**3,921.0**	**1,384,327**	**3,840.7**	**1,080,735**	**3,002.7**	**816,826**	**2,266.5**

CO Emissions Trends Summary Table

	1990		1995		2000		2005		2010	
	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)
Area Source Categories										
Fuel Comb. Industrial										
Oil	1,584	4.8	1,072	3.2	1,327	4.0	1,448	4.3	1,541	4.6
Gas	17	0.0	19	0.0	21	0.1	22	0.1	23	0.1
Other	76	0.2	98	0.3	107	0.3	114	0.3	122	0.4
Fuel Comb. Other										
Commercial/Institutional Oil	388	0.7	262	0.5	214	0.4	199	0.4	197	0.4
Commercial/Institutional Gas	7,223	17.5	8,820	21.4	7,483	18.2	8,908	21.6	9,425	22.9
Misc. Fuel Comb. (Except Residential)	79	0.1	43	0.1	31	0.1	34	0.1	36	0.1
Residential Wood	84,686	-	88,938	-	55,720	-	74,513	-	76,357	-
Residential Other	4,629	5.7	4,335	5.4	3,716	4.6	4,177	5.2	4,263	5.3
Petroleum & Related Industries										
Oil & Gas Production	203,919	558.8	170,304	466.7	143,338	392.8	118,284	324.1	95,674	262.2
Waste Disposal & Recycling										
Open Burning	204,838	561.2	241,183	660.8	103,577	283.8	105,613	289.4	116,319	318.7
Miscellaneous										
Other Combustion	528,973	436.3	516,941	396.0	565,345	424.6	580,800	418.5	597,640	416.3
Total	**1,036,413**	**1,585.5**	**1,032,013**	**1,554.3**	**894,113**	**1,128.8**	**880,879**	**1,064.0**	**901,598**	**1,030.7**
NON-ROAD MOBILE SOURCES										
Agricultural Equipment	28,754	134.4	27,526	128.7	25,335	118.2	23,975	112.1	23,184	108.5
Aircraft	29,690	84.4	35,070	99.7	38,197	108.3	43,474	123.6	48,467	137.8
Airport Ground Support Equipment	89,381	251.8	92,447	260.3	97,083	272.5	110,735	311.3	122,445	344.4
Commercial Equipment	233,221	655.5	258,044	725.1	294,490	826.4	342,797	962.7	395,548	1,111.3
Commercial Marine	2,867	7.9	3,170	8.7	3,760	10.3	4,250	11.6	4,750	13.0
Construction and Mining Equipment	64,571	220.3	79,835	272.3	82,719	282.6	86,273	294.0	93,186	315.5
Industrial Equipment	141,502	396.1	157,824	441.2	183,273	510.6	221,288	614.2	252,018	698.8
Lawn and Garden Equipment (Com)	412,184	1,883.0	408,794	1,863.0	399,176	1,827.8	444,222	2,046.2	480,103	2,215.3
Lawn and Garden Equipment (Res)	205,828	954.4	209,699	971.7	211,117	979.9	226,120	1,054.1	249,717	1,166.0
Locomotives	10,717	29.4	14,858	40.7	20,864	57.0	22,390	60.5	22,832	57.8
Logging Equipment	36,511	97.9	45,690	122.5	31,912	85.3	30,848	83.0	29,246	78.4
Railroad Equipment	397	1.1	547	1.5	678	1.9	673	1.9	708	2.0
Recreational Equipment	47,665	197.2	49,657	205.4	51,915	214.3	58,944	243.3	64,365	265.8
Recreational Marine	142,672	684.7	143,732	689.7	144,046	689.4	153,022	734.4	157,029	753.6
Total	**1,445,959**	**5,597.9**	**1,526,891**	**5,830.4**	**1,584,564**	**5,984.4**	**1,769,012**	**6,652.8**	**1,943,600**	**7,268.1**
ON-ROAD VEHICLES										
Light-Duty Gas Vehicles	5,006,087	13,929.1	3,535,566	8,966.0	2,874,107	7,033.8	2,377,012	5,432.8	1,863,448	4,001.5
Light-Duty Gas Trucks 1	2,456,525	6,587.9	1,856,072	4,646.3	1,520,689	3,616.0	1,153,443	2,521.3	898,514	1,830.5
Light-Duty Gas Trucks 2	348,730	894.7	268,979	666.9	228,923	556.1	167,946	368.6	135,975	272.4
Heavy-Duty Gas Vehicles	885,563	2,595.3	641,621	1,878.3	474,865	1,368.8	268,549	753.7	135,958	336.4
Light-Duty Diesel Vehicles	1,764	5.0	918	2.6	546	1.5	681	1.9	492	1.4
Light-Duty Diesel Trucks	1,474	4.2	1,100	3.1	534	1.5	698	2.0	513	1.4
Heavy-Duty Diesel Vehicles	121,148	336.3	81,035	222.9	63,727	175.8	53,200	148.1	32,899	89.7
Motorcycles	3,582	11.0	3,393	10.6	3,950	12.3	4,145	12.9	4,495	14.0
Total	**8,824,872**	**24,363.5**	**6,388,685**	**16,396.8**	**5,167,341**	**12,765.8**	**4,025,673**	**9,241.1**	**3,072,293**	**6,547.4**
TOTAL, ALL SOURCES	#########	**31,547.0**	**8,947,589**	**23,781.5**	**7,646,018**	**19,879.0**	**6,675,564**	**16,957.9**	**5,917,490**	**14,846.18**

PM Emissions Trends Summary Table

	1990		1995		2000		2005		2010	
	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)
AREA SOURCE CATEGORIES										
Fuel Comb. Industrial										
PM10, Oil	309	-	253	-	292	-	314	-	332	-
PM10, Gas	31	-	33	-	37	-	39	-	41	-
PM10, Other	7	0.0	9	0.0	10	0.0	11	0.2	11	0.2
PM2.5, Oil	115	0.3	94	0.2	108	0.2	117	0.3	123	0.3
PM2.5, Gas	26	0.1	28	0.1	32	0.1	34	0.1	35	0.1
Fuel Comb. Other										
PM10, Commercial/Institutional Coal	66	0.2	66	0.2	71	0.2	75	0.2	81	0.2
PM10, Commercial/Institutional Oil	44	0.1	29	0.0	24	0.0	22	0.0	22	0.0
PM10, Commercial/Institutional Gas	654	1.6	798	1.9	677	1.6	806	2.0	853	2.1
PM10, Residential Wood	12,738	-	12,707	-	7,497	-	9,408	-	9,007	-
PM10, Residential Other	861	1.0	823	1.0	713	1.0	799	1.0	813	1.0
PM2.5, Commercial/Institutional Coal	29	0.1	29	0.1	31	0.1	33	0.1	35	0.0
PM2.5, Commercial/Institutional Oil	16	0.0	11	0.0	9	0.0	8	0.0	8	0.0
PM2.5, Commercial/Institutional Gas	654	1.6	798	1.9	677	1.6	806	2.0	853	1.0
PM2.5, Residential Wood	12,738	-	12,707	-	7,497	-	9,408	-	9,007	-
PM2.5, Residential Other	841	1.0	806	1.0	697	0.8	786	1.0	803	1.0
Petroleum & Related Industries										
PM10, Oil & Gas Production	3,361	9.3	2,801	7.7	2,358	6.5	1,946	5.4	1,574	4.3
PM2.5, Oil & Gas Production	3,361	9.3	2,801	7.7	2,358	6.5	1,946	5.4	1,574	4.3
Other Industrial Processes										
PM10, Agriculture, Food, & Kindred Products	2,460	6.6	2,627	7.1	2,673	7.2	2,849	7.7	3,120	8.4
PM10, Miscellaneous Industrial Processes	798	2.2	970	2.7	1,124	3.1	1,398	3.9	1,624	4.5
PM2.5, Agriculture, Food, & Kindred Products	65	0.1	70	0.1	71	0.1	76	0.1	83	0.2
PM2.5, Miscellaneous Industrial Processes	553	1.5	672	1.8	779	2.1	968	2.6	1,126	3.0
Waste Disposal & Recycling										
PM10, Incineration	195	0.6	237	0.7	272	0.8	317	0.9	354	1.0
PM10, Open Burning	41,025	112.4	46,089	126.3	11,708	32.1	12,070	33.1	13,296	36.4
PM2.5, Incineration	134	0.1	162	0.2	186	0.2	217	0.2	242	0.3
PM2.5, Open Burning	38,077	104.3	42,904	117.5	11,520	31.6	11,860	32.5	13,064	35.8
Miscellaneous										
PM10, Agriculture & Forestry	453,110	1,242.4	548,004	1,502.6	445,277	1,220.7	432,541	1,185.5	424,595	1,163.3
PM10, Other Combustion	52,224	42.6	50,873	37.4	55,839	40.2	57,589	39.9	59,449	40.1
PM10, Fugitive Dust	301,177	820.9	334,282	910.6	344,057	937.1	372,667	1,015.0	395,963	1,078.4
PM2.5, Agriculture & Forestry	65	236.6	70	286.2	71	231.3	76	223.2	83	217.4
PM2.5, Other Combustion	45,030	38.5	43,785	33.6	47,975	35.7	49,420	35.4	51,001	35.6
PM2.5, Fugitive Dust	60,234	164.0	66,855	181.9	68,811	187.2	74,532	202.8	79,192	215.4
PM10 Total	**869,059**	**2,239.9**	**1,000,601**	**2,598.3**	**872,629**	**2,250.4**	**892,851**	**2,294.5**	**911,136**	**2,340.0**
PM2.5 Total	**248,159**	**557.5**	**276,082**	**632.4**	**225,124**	**497.6**	**231,629**	**505.5**	**236,472**	**515.5**

PM Emissions Trends Summary Table (continued).

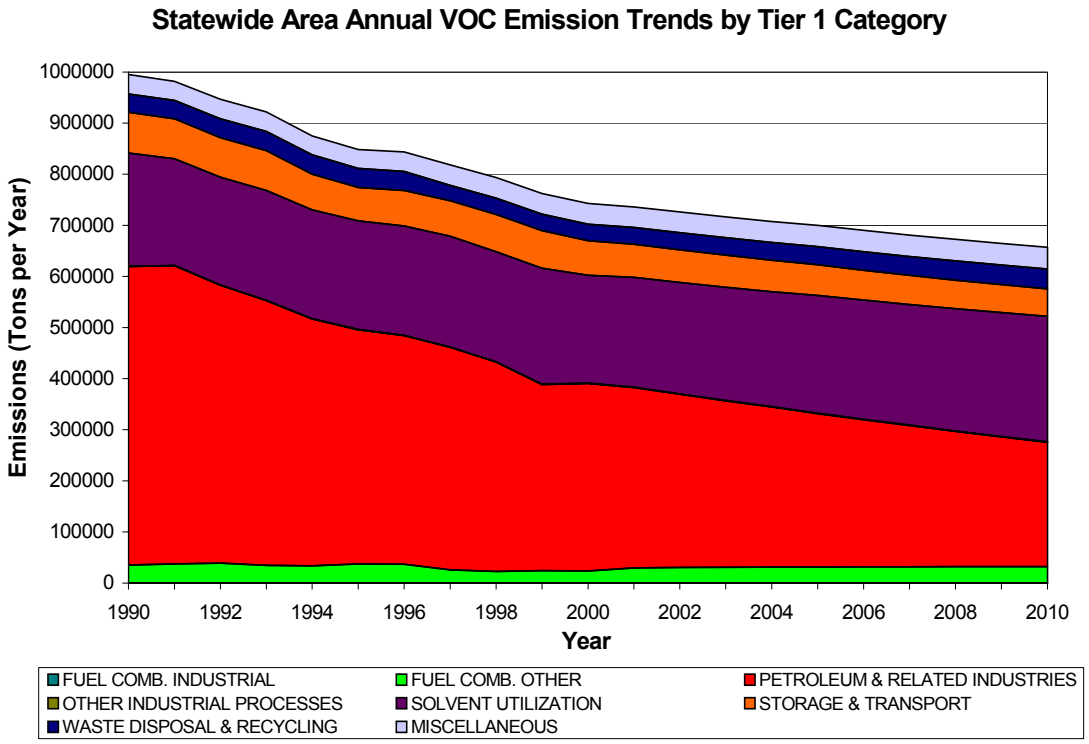
ON-ROAD VEHICLES										
Light-Duty Gas Vehicles										
PM10, exhaust	1,900	5.4	1,642	4.6	1,732	4.9	1,868	5.3	1,960	5.5
PM10, brake	1,339	3.8	1,519	4.3	1,792	5.0	1,955	5.5	2,124	6.0
PM10, tire	824	2.3	935	2.6	1,103	3.1	1,203	3.4	1,307	3.7
PM2.5, exhaust	1,735	4.9	1,568	4.4	1,671	4.7	1,739	4.9	1,888	5.3
PM2.5, brake	515	1.5	584	1.6	689	1.9	752	2.1	817	2.3
PM2.5, tire	206	0.6	234	0.7	276	0.8	301	0.8	327	0.9
Light-Duty Gas Trucks 1										
PM10, exhaust	1,032	2.9	872	2.5	912	2.6	951	2.7	1,022	2.9
PM10, brake	525	1.5	594	1.7	700	2.0	761	2.1	823	2.3
PM10, tire	323	0.9	365	1.0	431	1.2	468	1.3	507	1.4
PM2.5, exhaust	916	2.6	817	2.3	875	2.5	916	2.6	972	2.7
PM2.5, brake	202	0.6	228	0.6	269	0.8	293	0.8	317	0.9
PM2.5, tire	81	0.2	91	0.3	108	0.3	117	0.3	127	0.4
Light-Duty Gas Trucks 2										
PM10, exhaust	335	0.9	234	0.7	207	0.6	183	0.5	191	0.5
PM10, brake	101	0.3	114	0.3	134	0.4	147	0.4	159	0.4
PM10, tire	62	0.2	70	0.2	83	0.2	90	0.3	98	0.3
PM2.5, exhaust	271	0.8	201	0.6	189	0.5	174	0.5	187	0.5
PM2.5, brake	39	0.1	44	0.1	52	0.1	56	0.2	61	0.2
PM2.5, tire	16	0.0	18	0.0	21	0.1	23	0.1	24	0.1
Heavy-Duty Gas Vehicles										
PM10, exhaust	1,817	5.1	1,312	3.7	1,142	3.2	956	2.7	766	2.2
PM10, brake	129	0.4	144	0.4	167	0.5	182	0.5	196	0.6
PM10, tire	119	0.3	133	0.4	155	0.4	168	0.5	181	0.5
PM2.5, exhaust	1,284	3.6	961	2.7	861	2.4	744	2.1	626	1.8
PM2.5, brake	50	0.1	55	0.2	64	0.2	70	0.2	75	0.2
PM2.5, tire	30	0.1	33	0.1	39	0.1	42	0.1	45	0.1
Light-Duty Diesel Vehicles										
PM10, exhaust	458	1.3	170	0.5	61	0.2	50	0.1	48	0.1
PM10, brake	17	0.0	8	0.0	4	0.0	5	0.0	7	0.0
PM10, tire	10	0.0	5	0.0	3	0.0	3	0.0	4	0.0
PM2.5, exhaust	421	1.2	156	0.4	56	0.2	46	0.1	44	0.1
PM2.5, brake	6	0.0	3	0.0	2	0.0	2	0.0	3	0.0
PM2.5, tire	3	0.0	1	0.0	1	0.0	1	0.0	1	0.0
Light-Duty Diesel Trucks										
PM10, exhaust	214	0.6	141	0.4	76	0.2	86	0.2	101	0.3
PM10, brake	7	0.0	5	0.0	5	0.0	8	0.0	13	0.0
PM10, tire	4	0.0	3	0.0	3	0.0	5	0.0	8	0.0
PM2.5, exhaust	197	0.6	128	0.4	69	0.2	79	0.2	93	0.3
PM2.5, brake	3	0.0	2	0.0	2	0.0	3	0.0	5	0.0
PM2.5, tire	1	0.0	1	0.0	1	0.0	1	0.0	2	0.0

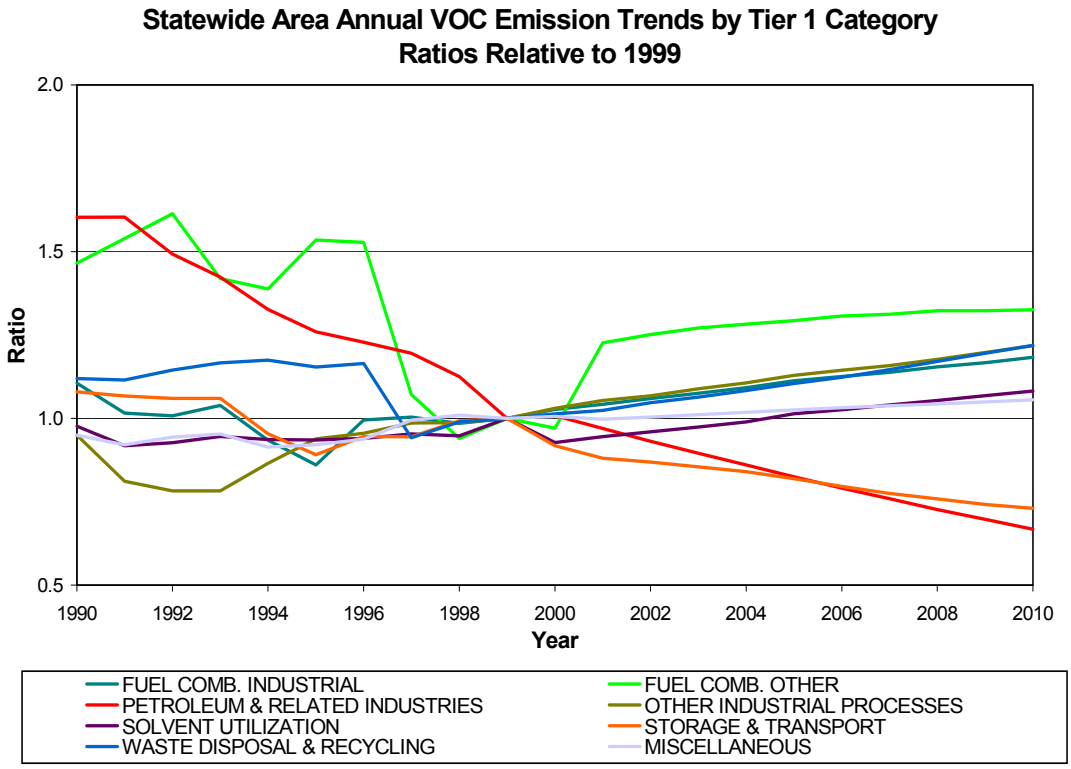
PM Emissions Trends Summary Table (concluded).

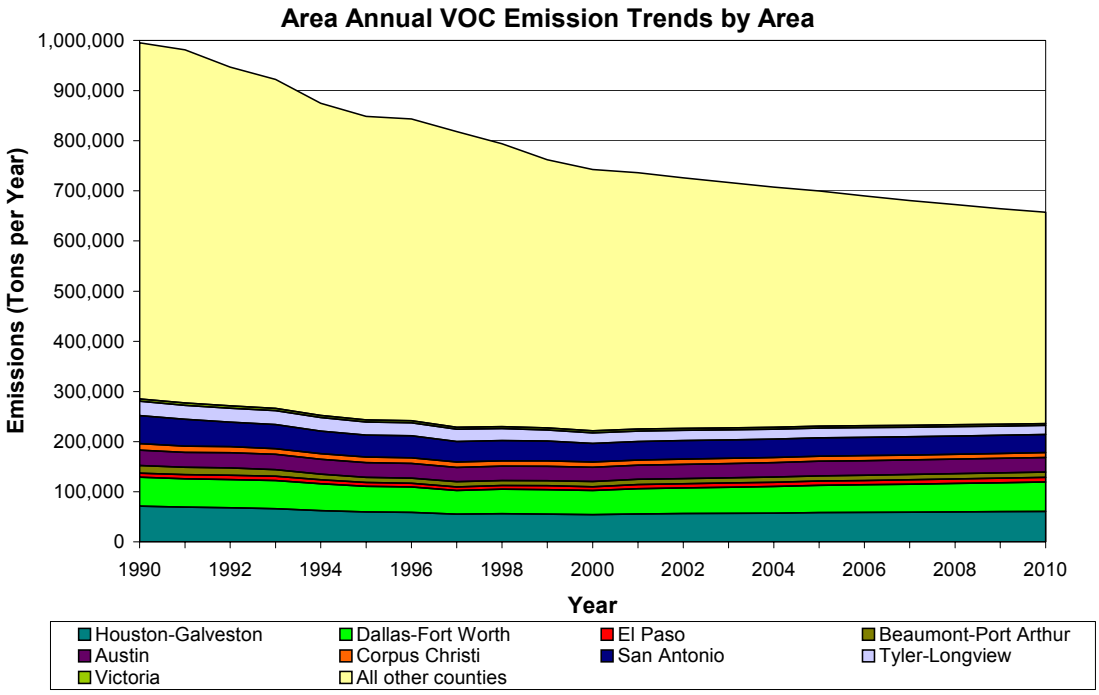
Heavy-Duty Diesel Vehicles										
PM10, exhaust	21,428	60.4	12,017	33.9	7,725	21.7	5,459	15.4	4,179	11.8
PM10, brake	184	0.5	205	0.6	237	0.7	259	0.7	280	0.8
PM10, tire	355	1.0	372	1.0	415	1.2	458	1.3	497	1.4
PM2.5, exhaust	19,713	55.6	10,946	30.8	7,059	19.8	4,979	14.0	3,795	10.7
PM2.5, brake	71	0.2	79	0.2	91	0.3	100	0.3	108	0.3
PM2.5, tire	89	0.3	93	0.3	104	0.3	115	0.3	124	0.3
Motorcycles										
PM10, exhaust	4	0.0	4	0.0	5	0.0	5	0.0	6	0.0
PM10, brake	2	0.0	3	0.0	3	0.0	3	0.0	4	0.0
PM10, tire	1	0.0	1	0.0	1	0.0	1	0.0	1	0.0
PM2.5, exhaust	2	0.0	3	0.0	3	0.0	4	0.0	4	0.0
PM2.5, brake	1	0.0	1	0.0	1	0.0	1	0.0	1	0.0
PM2.5, tire	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Light-Duty Gas Vehicles										
PM10 total	4,063	11.5	4,096	11.5	4,628	13.0	5,027	14.2	5,391	15.2
PM2.5 total	2,456	6.9	2,386	6.7	2,636	7.4	2,792	7.9	3,032	8.5
Light-Duty Gas Trucks 1										
PM10 total	1,880	5.3	1,831	5.2	2,043	5.7	2,181	6.1	2,352	6.6
PM2.5 total	1,198	3.4	1,137	3.2	1,252	3.5	1,325	3.7	1,415	4.0
Light-Duty Gas Trucks 2										
PM10 total	499	1.4	418	1.2	424	1.2	419	1.2	448	1.3
PM2.5 total	326	0.9	262	0.7	262	0.7	253	0.7	273	0.8
Heavy-Duty Gas Vehicles										
PM10 total	2,065	5.8	1,588	4.5	1,464	4.1	1,305	3.7	1,143	3.2
PM2.5 total	1,363	3.8	1,049	3.0	964	2.7	856	2.4	747	2.1
Light-Duty Diesel Vehicles										
PM10 total	485	1.4	183	0.5	68	0.2	59	0.2	59	0.2
PM2.5 total	430	1.2	160	0.5	58	0.2	49	0.1	48	0.1
Light-Duty Diesel Trucks										
PM10 total	226	0.6	149	0.4	83	0.2	100	0.3	121	0.3
PM2.5 total	201	0.6	131	0.4	72	0.2	84	0.2	99	0.3
Heavy-Duty Diesel Vehicles										
PM10 total	21,967	61.9	12,594	35.5	8,377	23.5	6,177	17.4	4,956	14.0
PM2.5 total	19,873	56.0	11,118	31.3	7,254	20.4	5,193	14.6	4,027	11.3
Motorcycles										
PM10 total	7	0.0	7	0.0	9	0.0	9	0.0	10	0.0
PM2.5 total	4	0.0	4	0.0	5	0.0	5	0.0	6	0.0
Total PM10	**31,192**	**87.9**	**20,867**	**58.8**	**17,095**	**48.0**	**15,278**	**43.0**	**14,481**	**40.8**
Total PM2.5	**25,850**	**72.9**	**16,247**	**45.8**	**12,503**	**35.1**	**10,558**	**29.7**	**9,646**	**27.2**
TOTAL, ALL SOURCES PM10	**925,823**	**2,415.3**	**1,048,177**	**2,745.8**	**917,279**	**2,387.2**	**935,515**	**2,424.4**	**952,167**	**2,463.8**
TOTAL, ALL SOURCES PM2.5	**296,507**	**708.1**	**315,686**	**756.5**	**261,655**	**610.7**	**265,877**	**611.0**	**268,868**	**614.4**

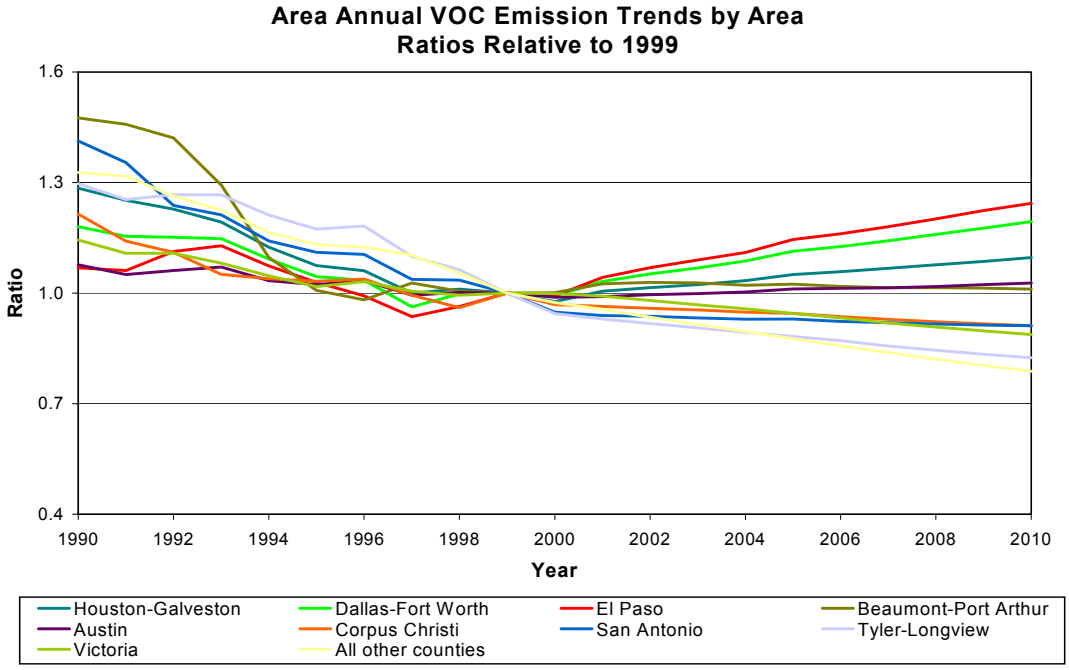
SO2 Emissions Trends Summary Table

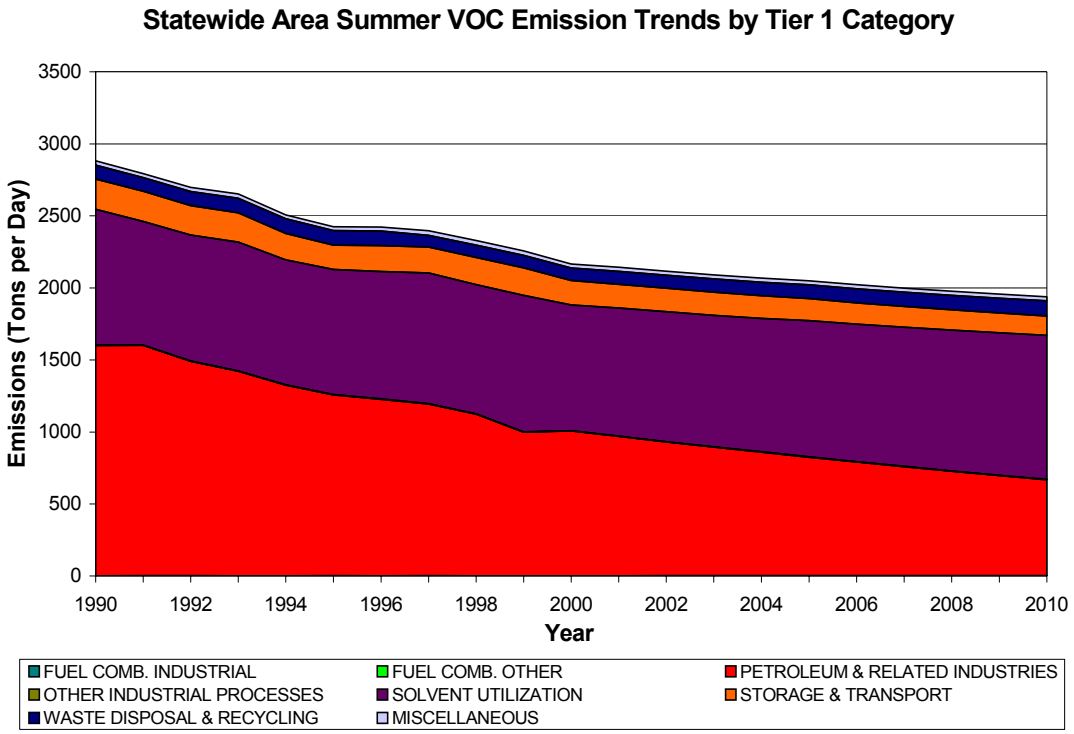
	1990		1995		2000		2005		2010	
	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)	Annual (tpy)	O3 Season (tpd)
AREA SOURCE CATEGORIES										
Fuel Comb. Industrial										
Oil	3,972	12.9	4,228	13.9	4,486	14.7	4,729	15.5	4,954	16.2
Gas	7	0.0	7	0.0	8	0.0	8	0.0	9	0.0
Fuel Comb. Other										
Commercial/Institutional Coal	639	1.7	639	1.7	682	1.9	729	2.0	778	2.1
Commercial/Institutional Oil	1,033	3.3	696	2.2	569	1.8	530	1.7	525	1.7
Commercial/Institutional Gas	52	0.1	63	0.2	53	0.1	64	0.2	67	0.2
Residential Wood	171	-	179	-	112	-	150	-	154	-
Residential Other	1,313	0.3	964	0.3	853	0.2	726	0.2	596	0.2
Petroleum & Related Industries										
Oil & Gas Production	231	0.6	193	0.5	162	0.4	134	0.4	108	0.3
Other Industrial Processes										
Miscellaneous Industrial Processes	25	0.1	31	0.1	35	0.1	44	0.1	51	0.1
Waste Disposal & Recycling										
Incineration	141	0.2	171	0.2	196	0.3	227	0.3	252	0.3
Open Burning	1,842	5.0	1,991	5.5	117	0.3	131	0.4	145	0.4
Total	**9,425**	**24.4**	**9,161**	**24.5**	**7,275**	**19.8**	**7,472**	**20.7**	**7,640**	**21.5**
NON-ROAD MOBILE SOURCES										
Agricultural Equipment	8,093	37.6	8,131	37.7	8,219	38.0	5,807	26.9	41	0.2
Aircraft	339	0.9	401	1.1	436	1.2	497	1.4	554	1.5
Airport Ground Support Equipment	649	1.8	768	2.1	806	2.2	156	0.4	15	0.0
Commercial Equipment	1,455	3.9	1,747	4.7	2,283	6.1	944	2.6	46	0.1
Commercial Marine	7,919	21.7	8,755	24.0	10,384	28.4	11,738	32.2	13,120	35.9
Construction and Mining Equipment	7,845	26.5	10,133	34.2	12,429	41.9	4,148	14.0	81	0.3
Industrial Equipment	5,227	14.4	6,296	17.3	8,336	22.8	3,390	9.3	309	0.8
Lawn and Garden Equipment (Com)	1,335	6.2	1,442	6.7	1,550	7.2	381	1.8	39	0.2
Lawn and Garden Equipment (Res)	177	0.8	191	0.9	190	0.9	57	0.3	20	0.1
Locomotives	8,065	22.1	11,182	30.6	15,702	42.9	7,442	20.4	6,238	17.1
Logging Equipment	402	1.1	502	1.4	462	1.3	75	0.2	4	0.0
Railroad Equipment	54	0.1	74	0.2	103	0.3	37	0.1	1	0.0
Recreational Equipment	100	0.4	108	0.4	117	0.5	50	0.2	8	0.0
Recreational Marine	1,705	8.1	1,737	8.3	1,742	8.3	683	3.3	72	0.3
Total	**43,364**	**145.6**	**51,468**	**169.7**	**62,761**	**201.9**	**35,405**	**113.0**	**20,545**	**56.7**
ON-ROAD VEHICLES										
Light-Duty Gas Vehicles	8,982	25.3	9,382	26.5	7,919	22.2	1,805	5.1	817	2.3
Light-Duty Gas Trucks 1	4,581	12.9	4,872	13.7	4,111	11.5	908	2.6	382	1.1
Light-Duty Gas Trucks 2	855	2.4	928	2.6	788	2.2	175	0.5	74	0.2
Heavy-Duty Gas Vehicles	2,123	6.0	2,195	6.2	1,898	5.3	387	1.1	180	0.5
Light-Duty Diesel Vehicles	719	2.0	65	0.2	35	0.1	42	0.1	2	0.0
Light-Duty Diesel Trucks	374	1.1	56	0.2	47	0.1	80	0.2	4	0.0
Heavy-Duty Diesel Vehicles	33,896	95.6	6,916	19.5	7,371	20.7	7,743	21.8	248	0.7
Motorcycles	6	0.0	7	0.0	6	0.0	1	0.0	1	0.0
Total	**51,536**	**145.3**	**24,422**	**68.8**	**22,176**	**62.2**	**11,141**	**31.4**	**1,707**	**4.8**
TOTAL, ALL SOURCES	**104,325**	**315.4**	**85,051**	**263.1**	**92,212**	**283.9**	**54,018**	**165.0**	**29,892**	**83.0**

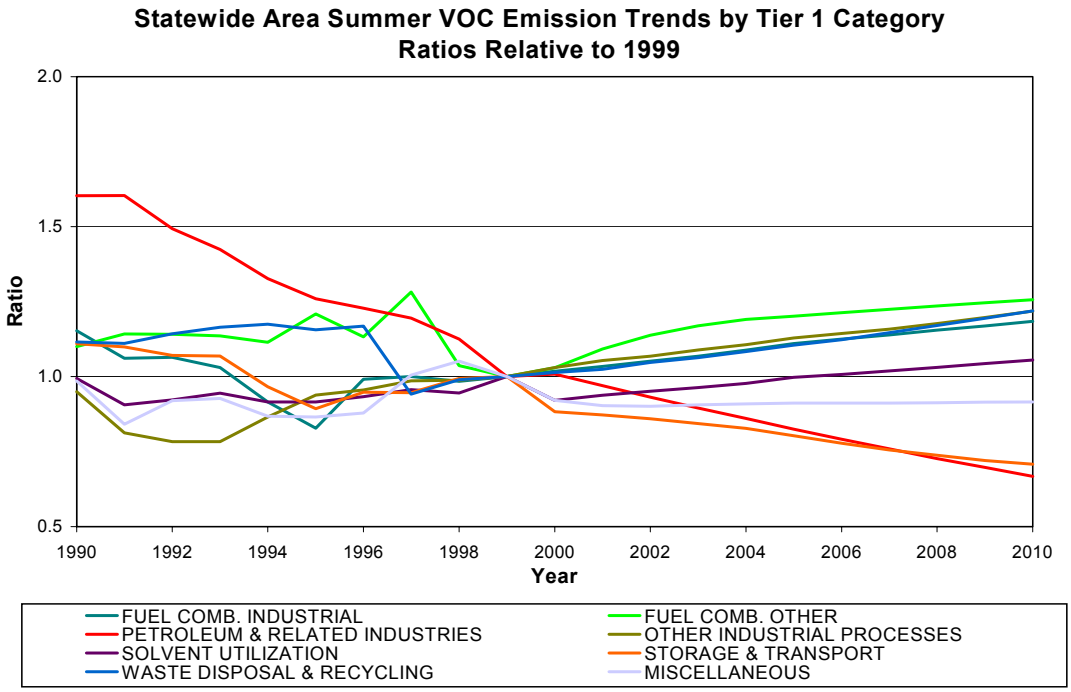

Statewide Area Annual VOC Emission Trends by Tier 1 Category
Emissions (Tons per Year)
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
SOLVENT UTILIZATION
STORAGE & TRANSPORT
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

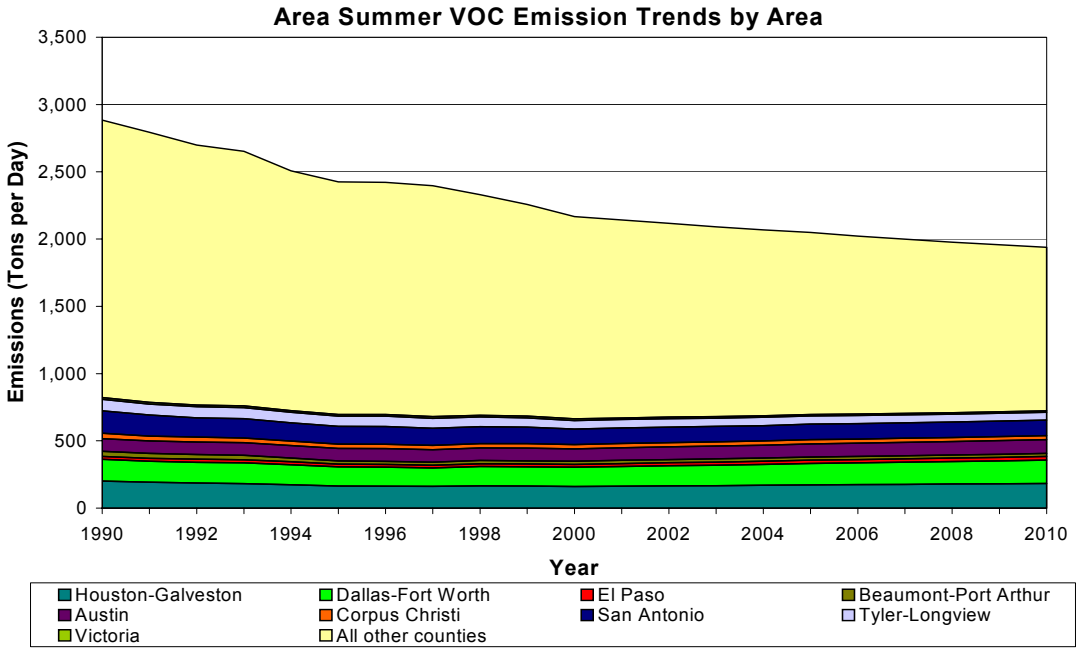

Statewide Area Annual VOC Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
SOLVENT UTILIZATION
STORAGE & TRANSPORT
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

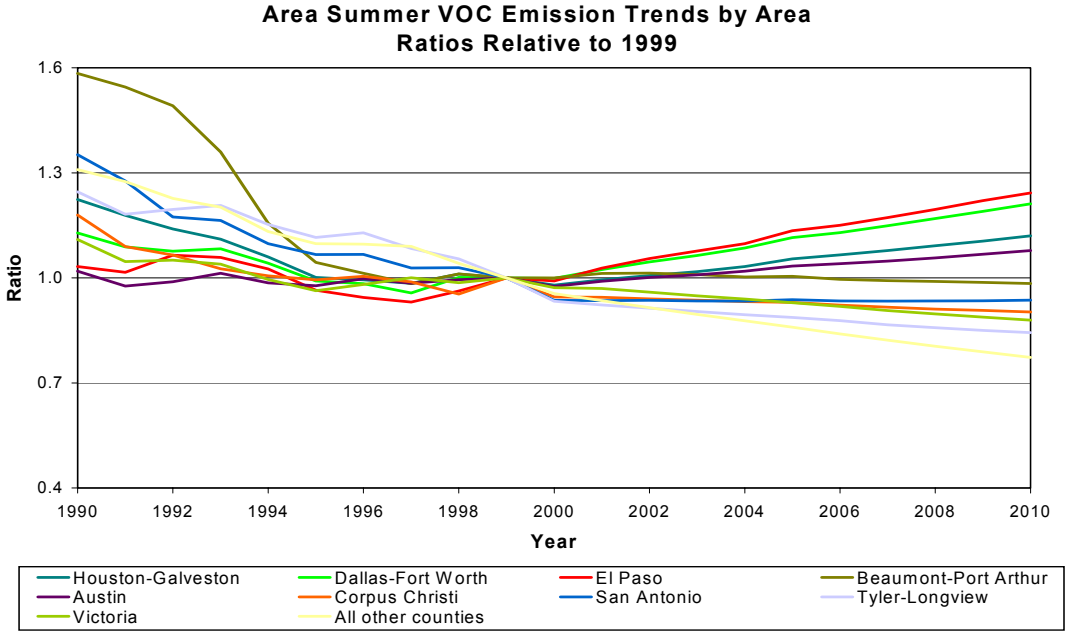

Area Annual VOC Emission Trends by Area
Emissions (Tons per Year)
1,000,000
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

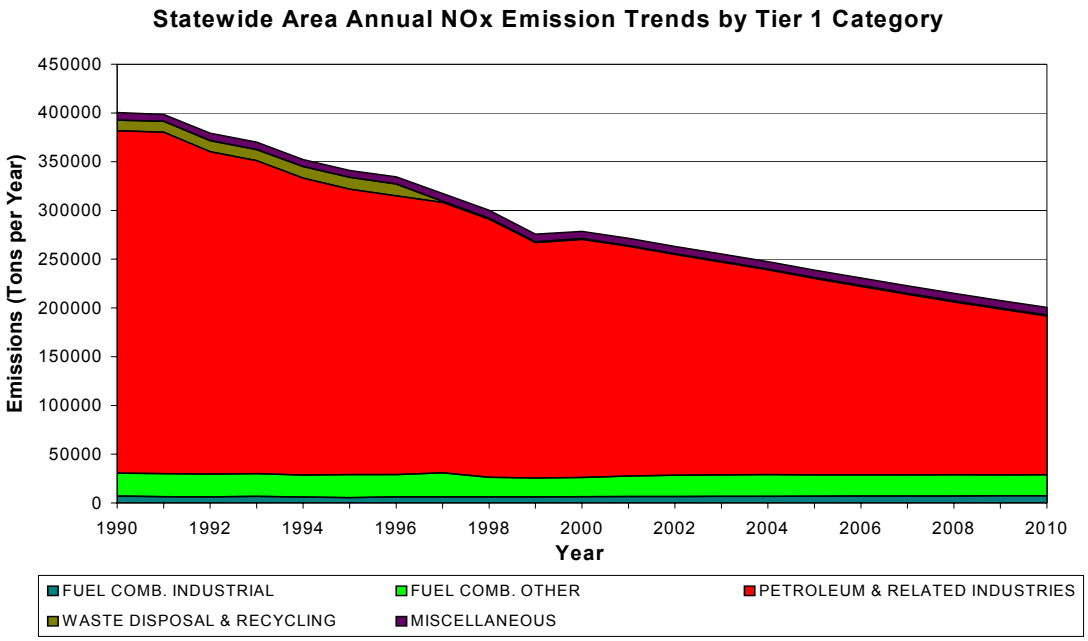

Area Annual VOC Emission Trends by Area
Ratios Relative to 1999
Ratio
1.6
1.3
1.0
0.7
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

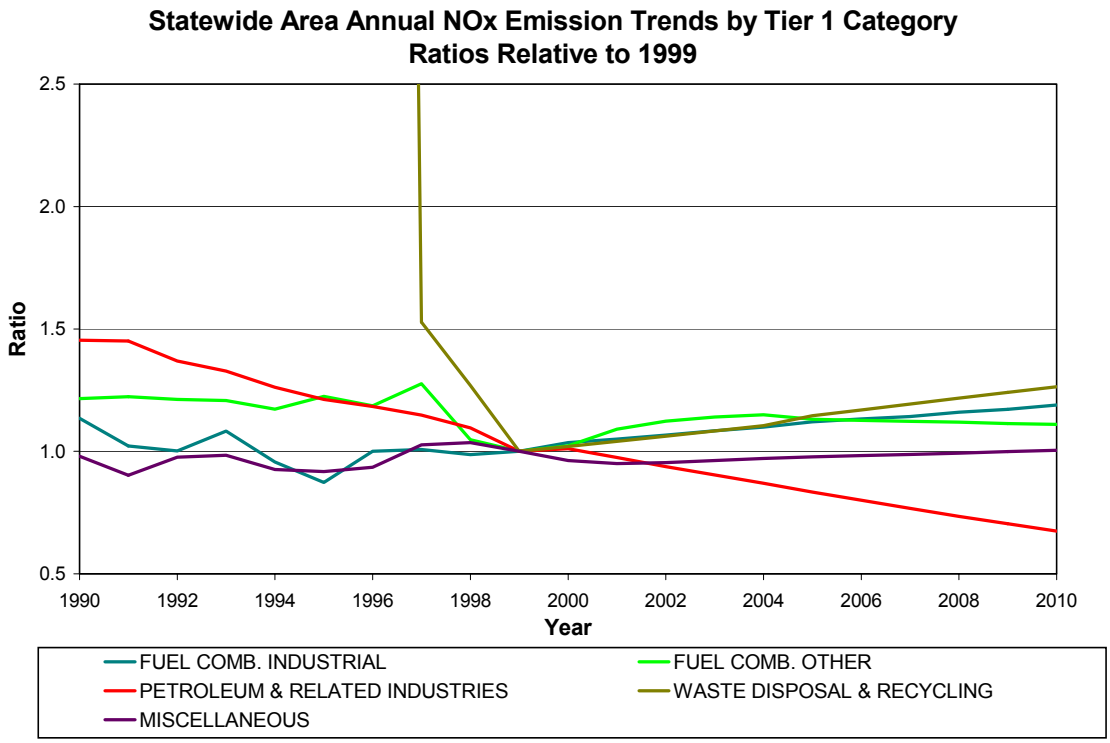

Statewide Area Summer VOC Emission Trends by Tier 1 Category
Emissions (Tons per Day)
3500
3000
2500
2000
1500
1000
500
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
SOLVENT UTILIZATION
STORAGE & TRANSPORT
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

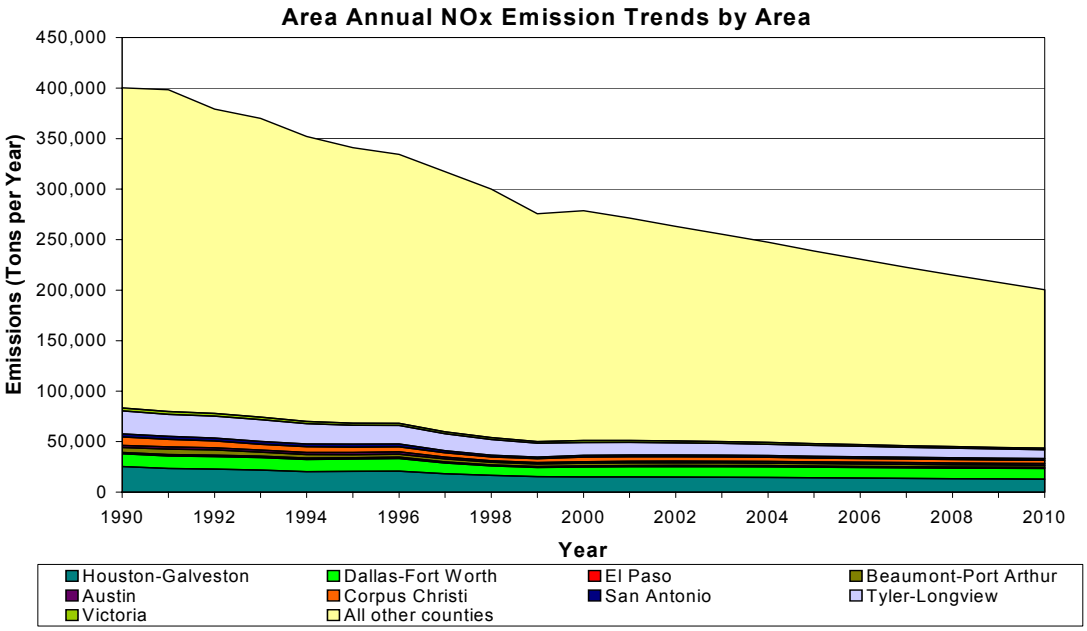

Statewide Area Summer VOC Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
SOLVENT UTILIZATION
STORAGE & TRANSPORT
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

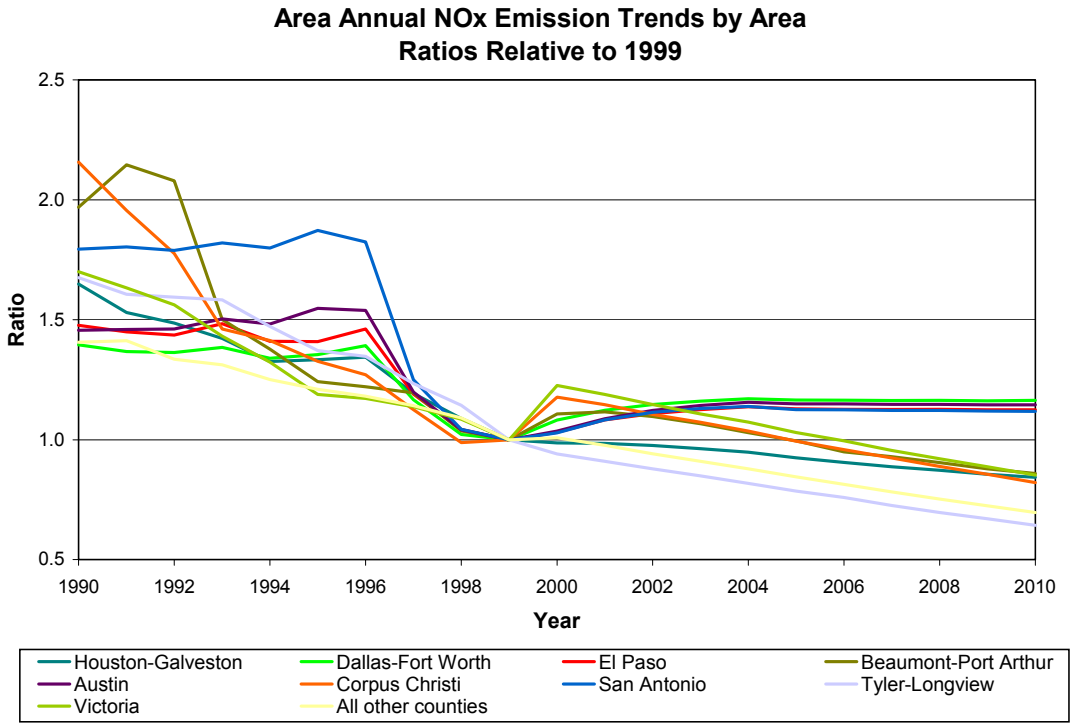

Area Summer VOC Emission Trends by Area
Emissions (Tons per Day)
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

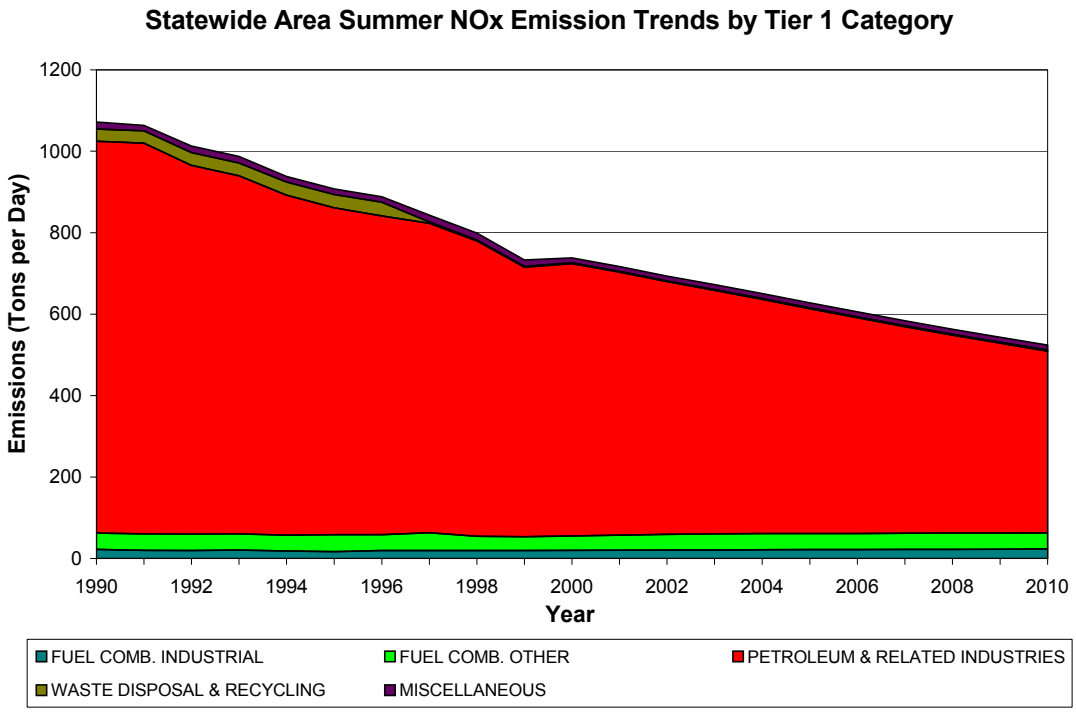

Area Summer VOC Emission Trends by Area
Ratios Relative to 1999
Ratio
1.6
1.3
1.0
0.7
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

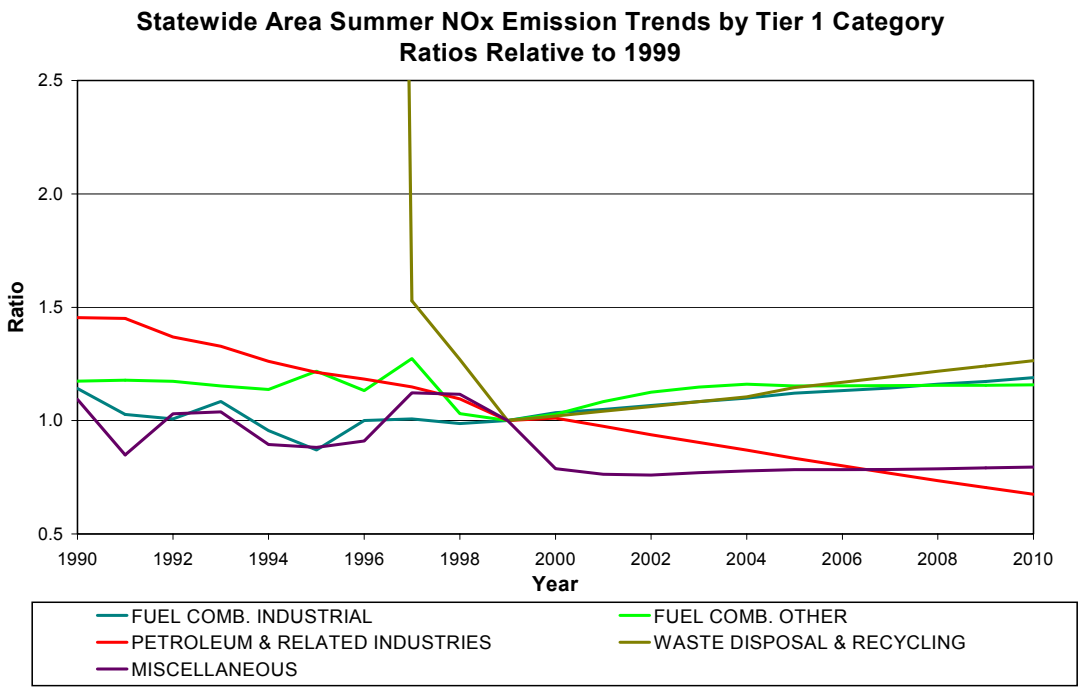

Statewide Area Annual NOx Emission Trends by Tier 1 Category
Emissions (Tons per Year)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

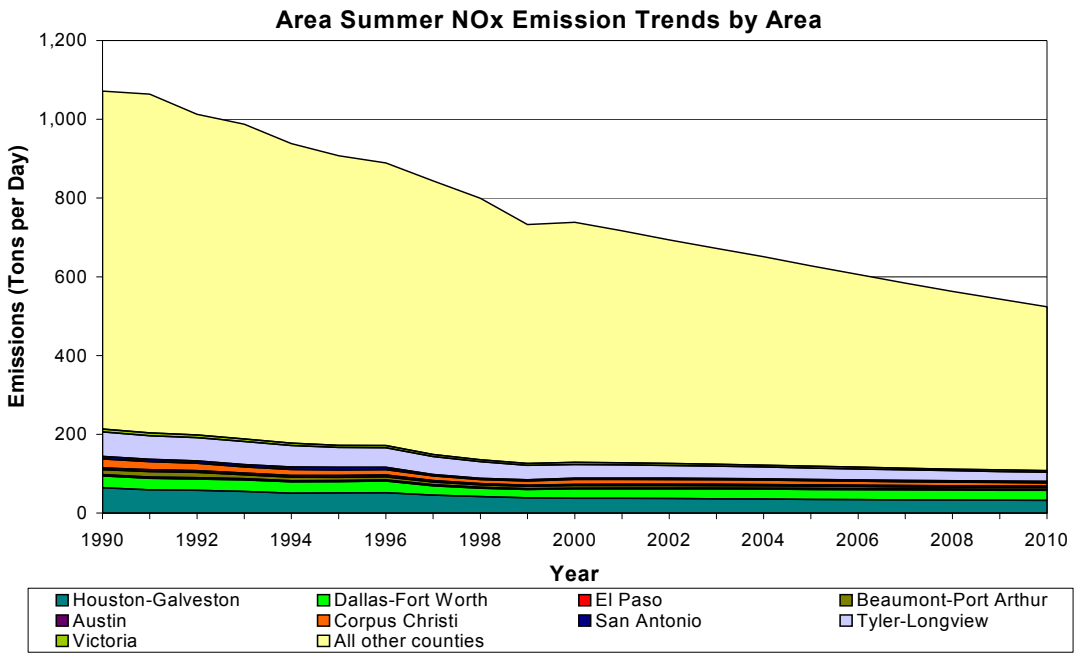

Statewide Area Annual NOx Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

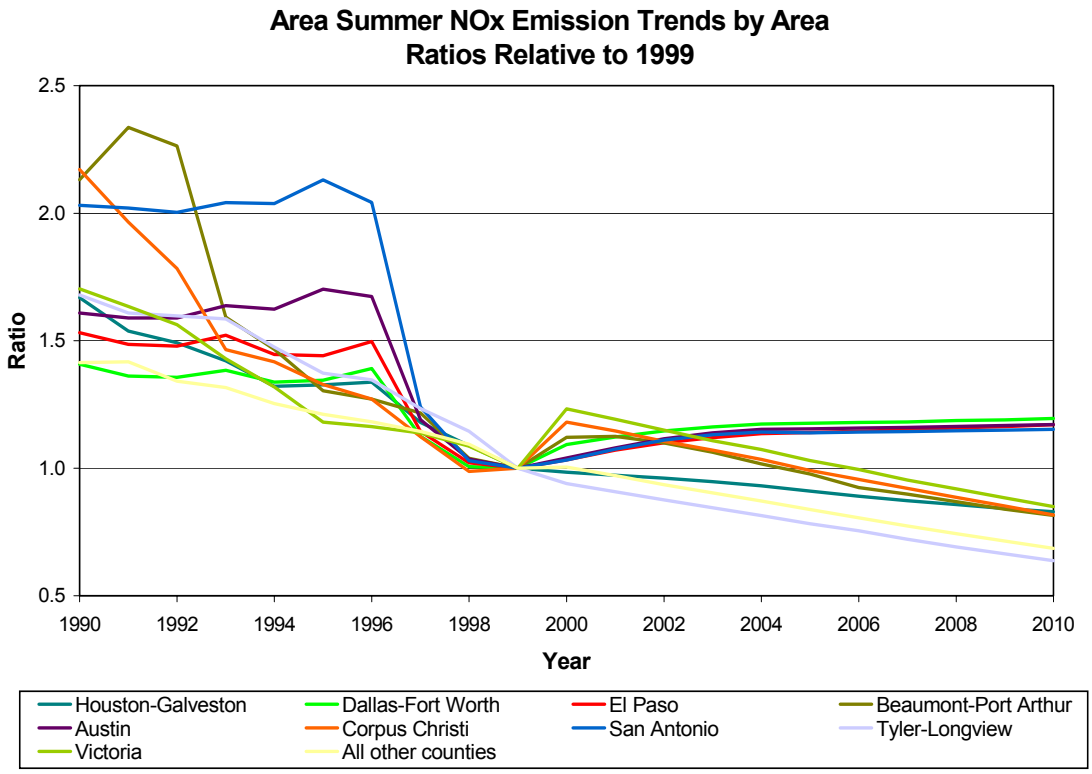

Area Annual NOx Emission Trends by Area
Emissions (Tons per Year)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

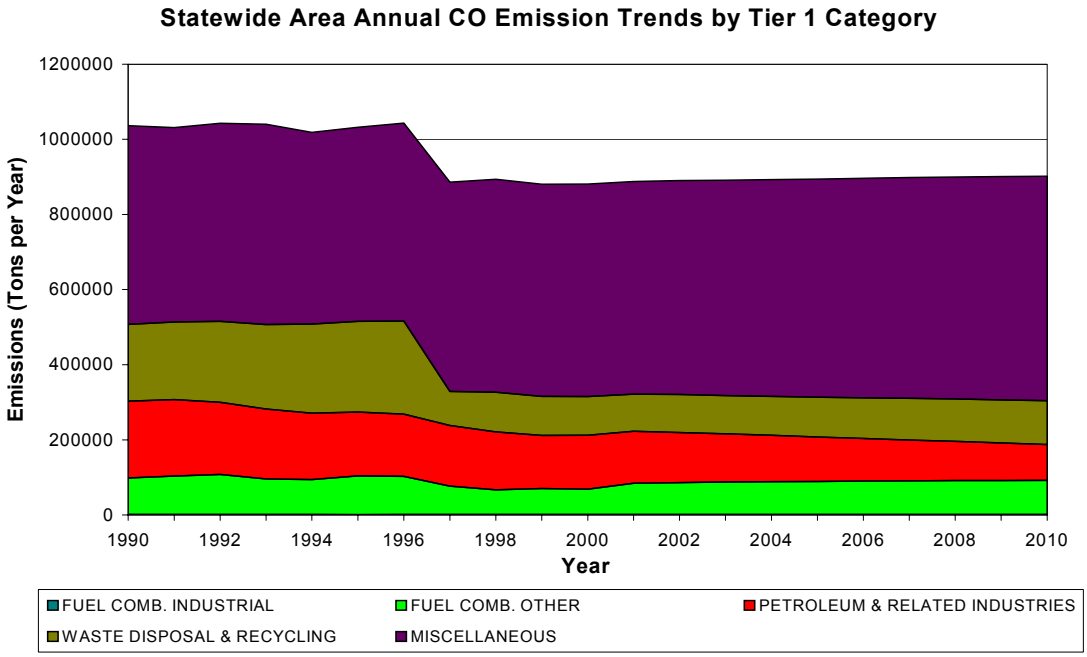

Area Annual NOx Emission Trends by Area
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

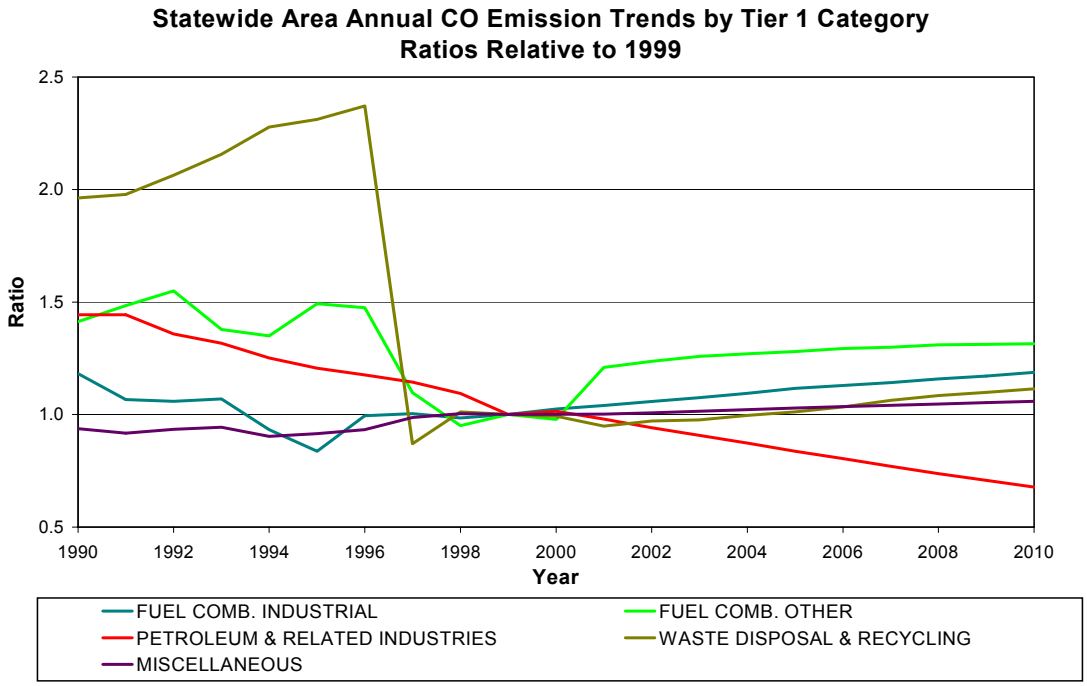

Statewide Area Summer NOx Emission Trends by Tier 1 Category
Emissions (Tons per Day)
1200
1000
800
600
400
200
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

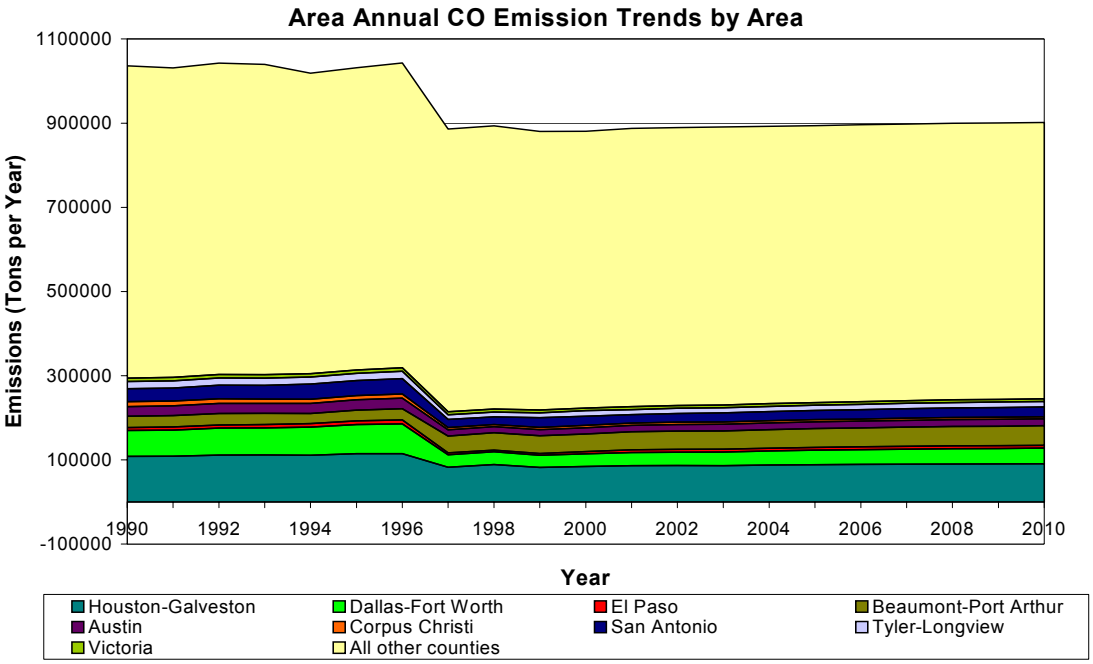

Statewide Area Summer NOx Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

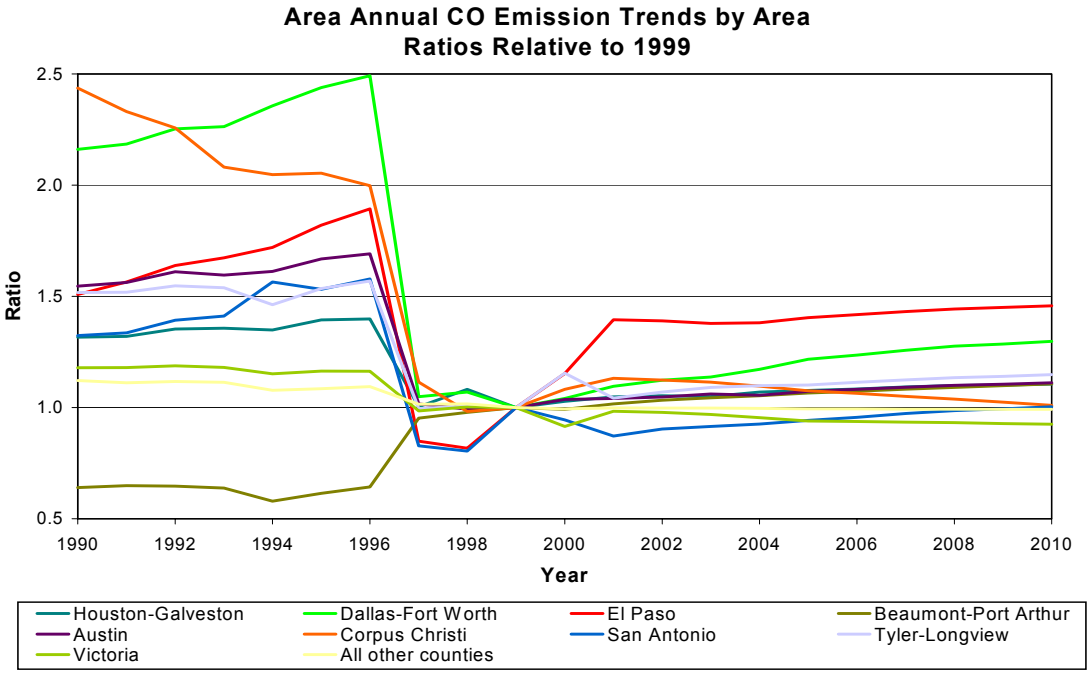

Area Summer NOx Emission Trends by Area
Emissions (Tons per Day)
1,200
1,000
800
600
400
200
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

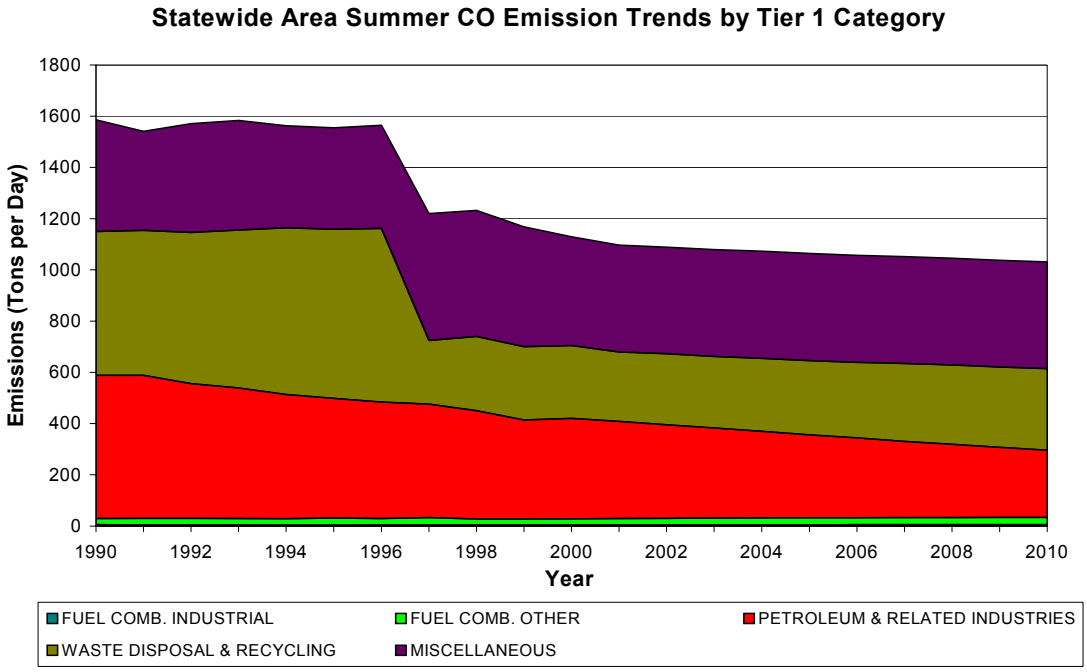

Area Summer NOx Emission Trends by Area
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

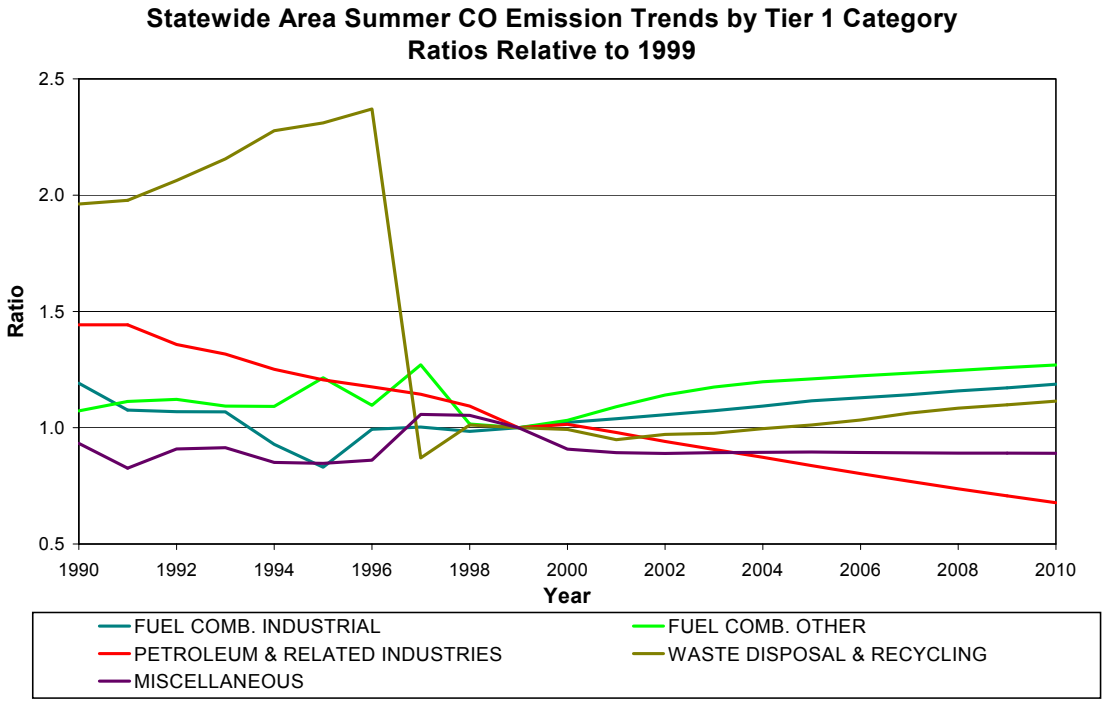

Statewide Area Annual CO Emission Trends by Tier 1 Category
Emissions (Tons per Year)
1200000
1000000
800000
600000
400000
200000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

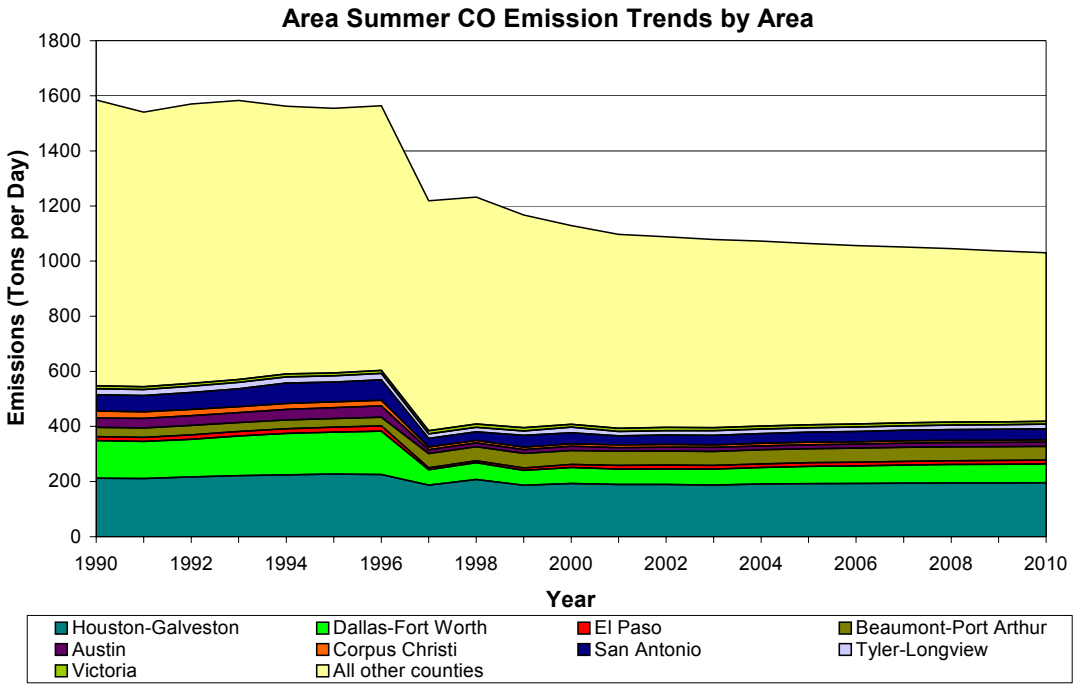

Statewide Area Annual CO Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

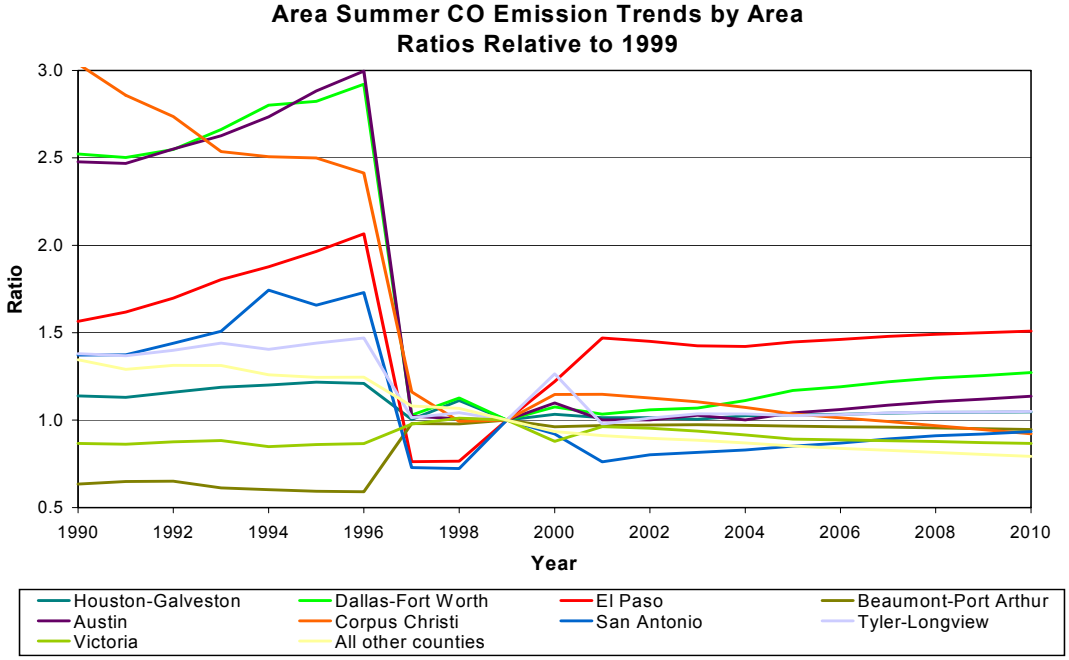

Area Annual CO Emission Trends by Area
Emissions (Tons per Year)
1100000
900000
700000
500000
300000
100000
-100000
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

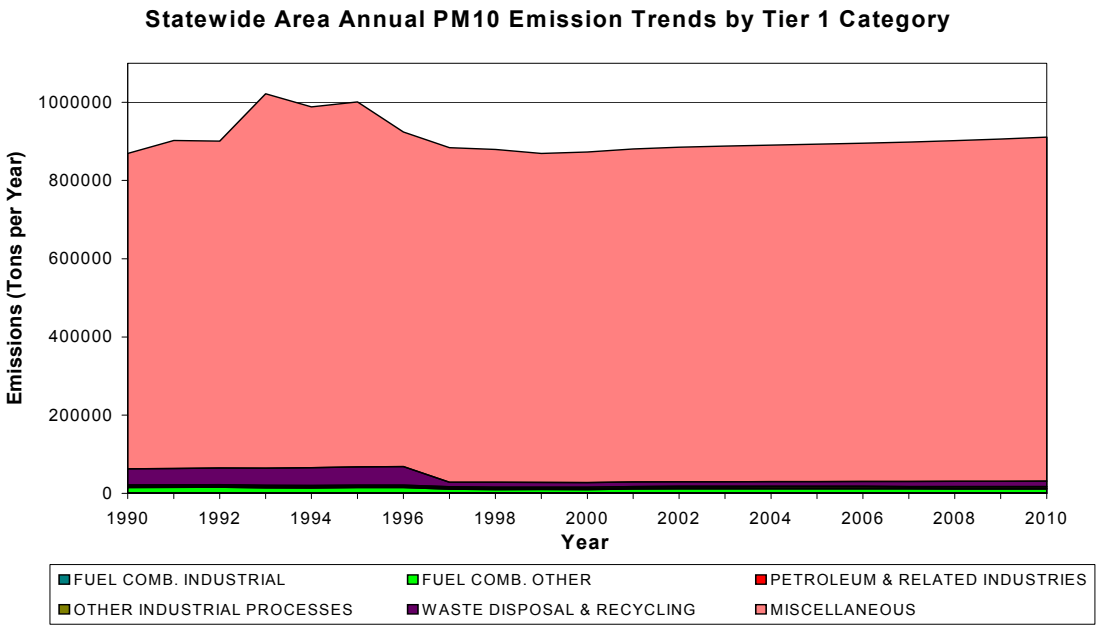

Area Annual CO Emission Trends by Area
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

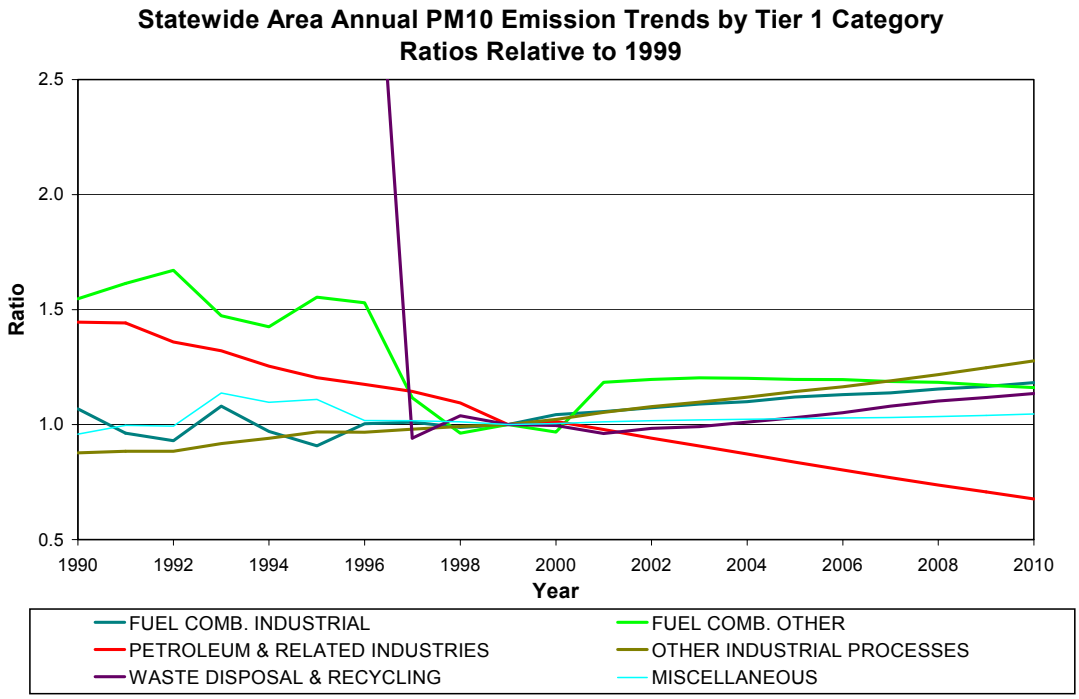

Statewide Area Summer CO Emission Trends by Tier 1 Category
Emissions (Tons per Day)
1800
1600
1400
1200
1000
800
600
400
200
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

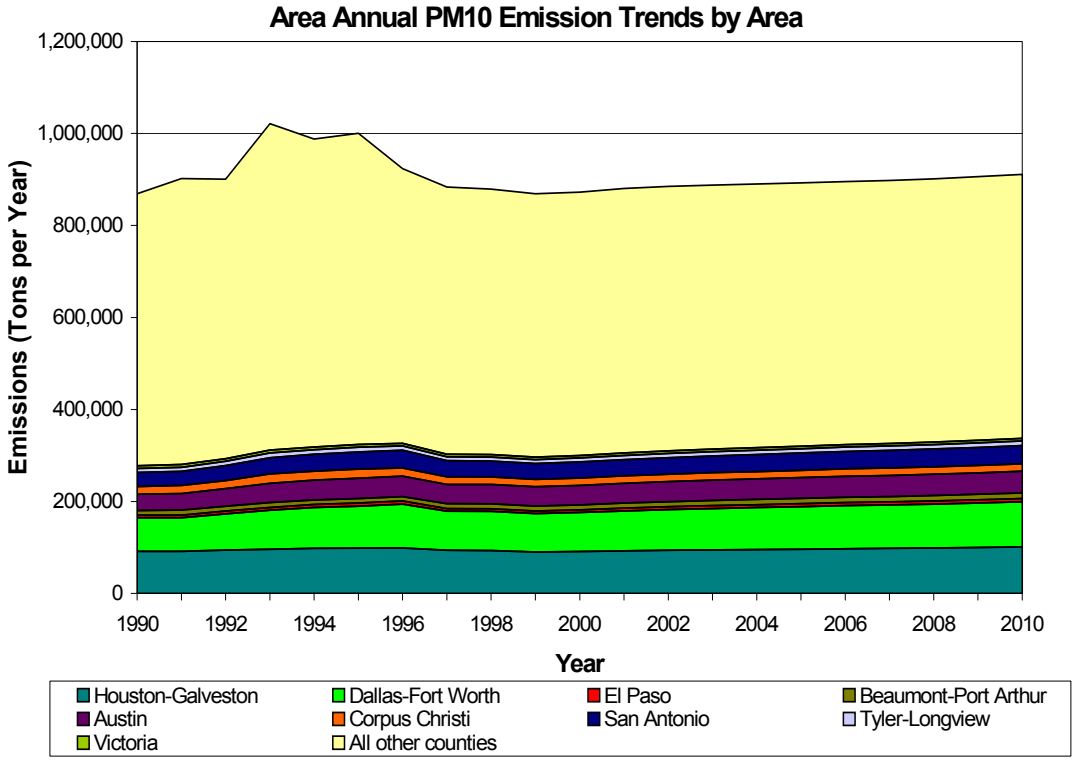

Statewide Area Summer CO Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

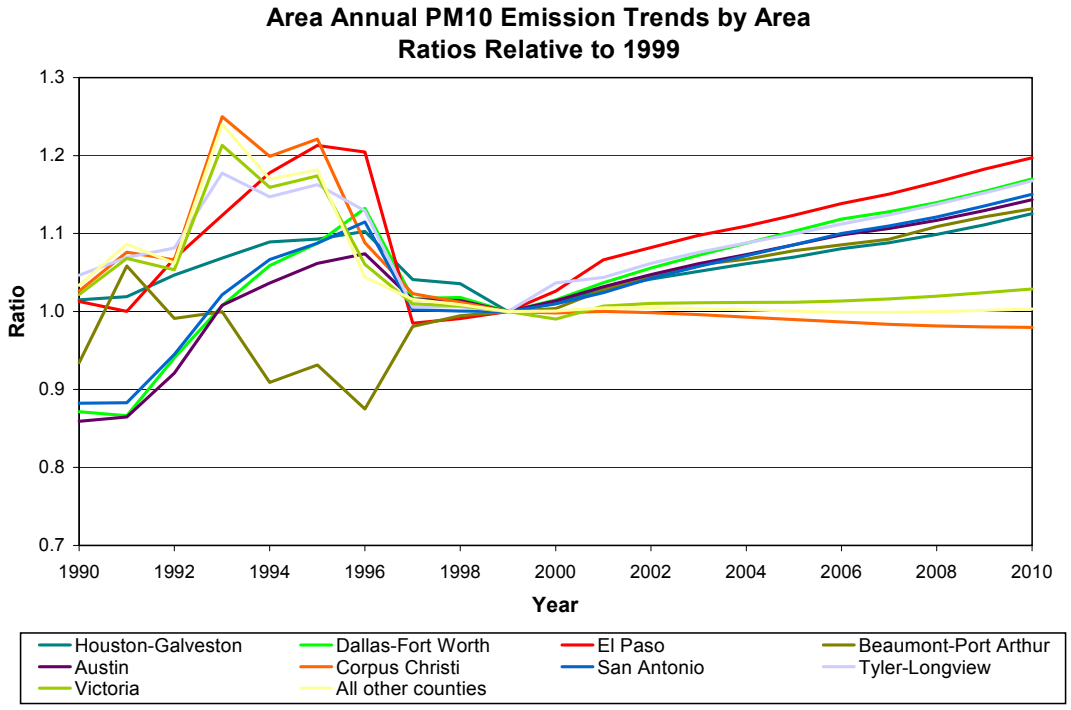

Area Summer CO Emission Trends by Area
Emissions (Tons per Day)
1800
1600
1400
1200
1000
800
600
400
200
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

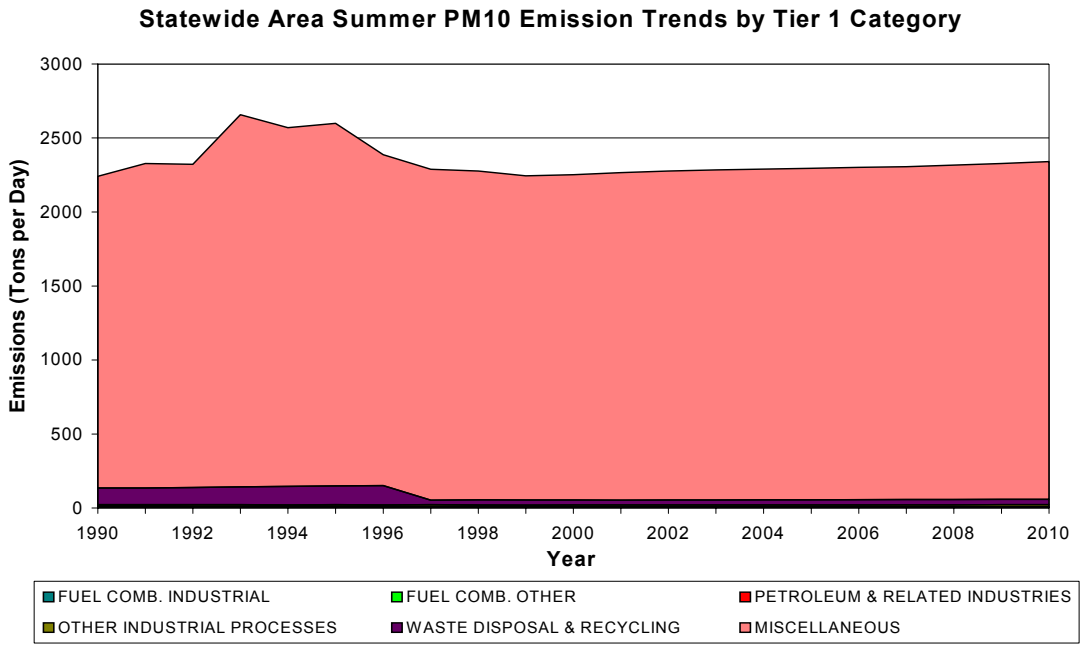

Area Summer CO Emission Trends by Area
Ratios Relative to 1999
Ratio
3.0
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

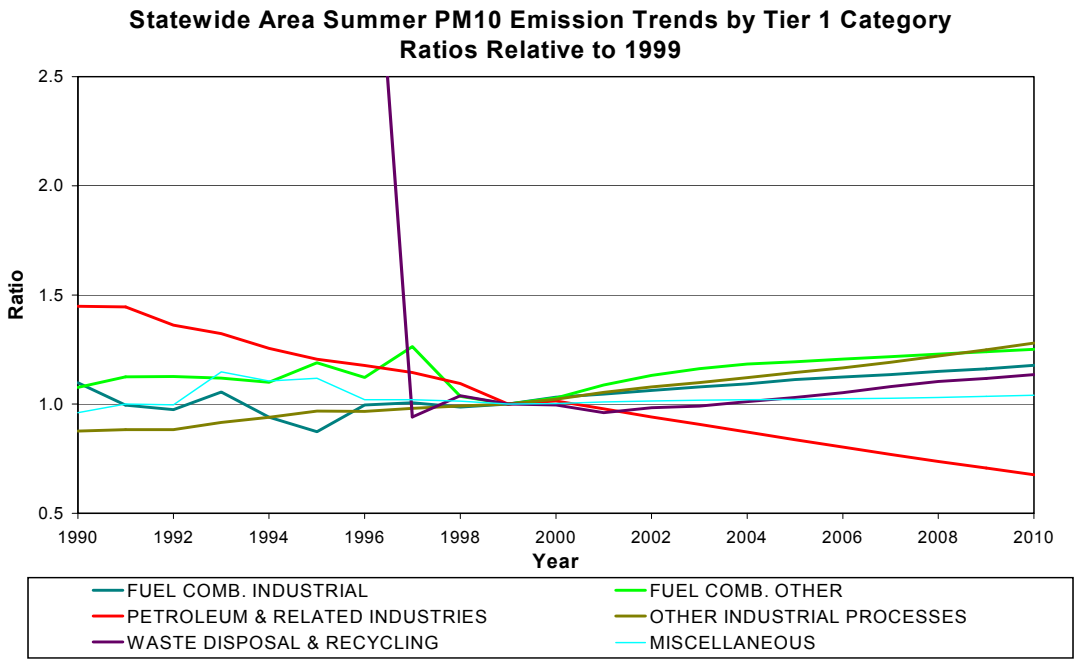

Statewide Area Annual PM10 Emission Trends by Tier 1 Category
Emissions (Tons per Year)
1000000
800000
600000
400000
200000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

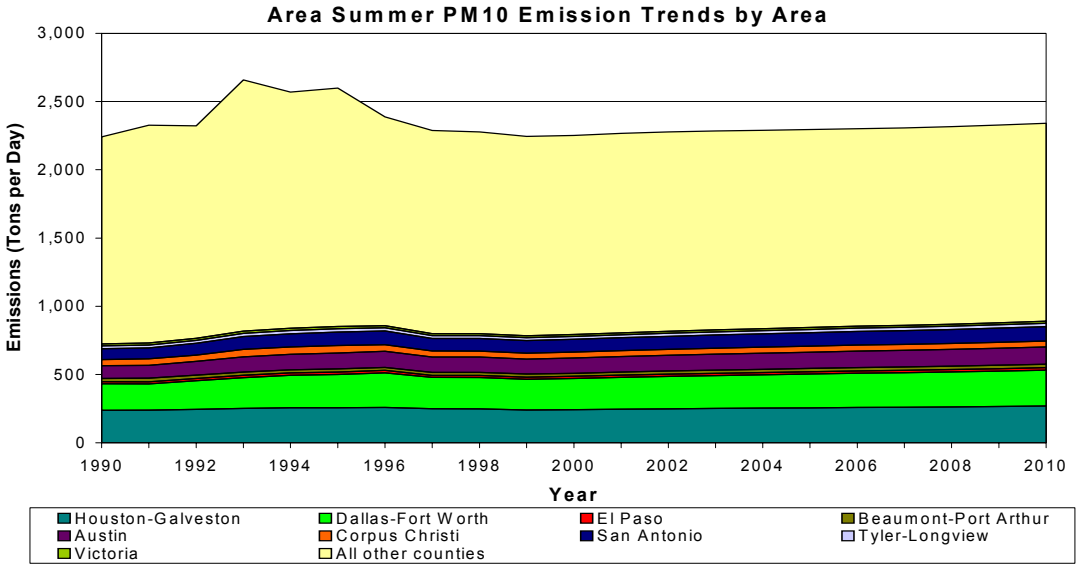

Statewide Area Annual PM10 Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

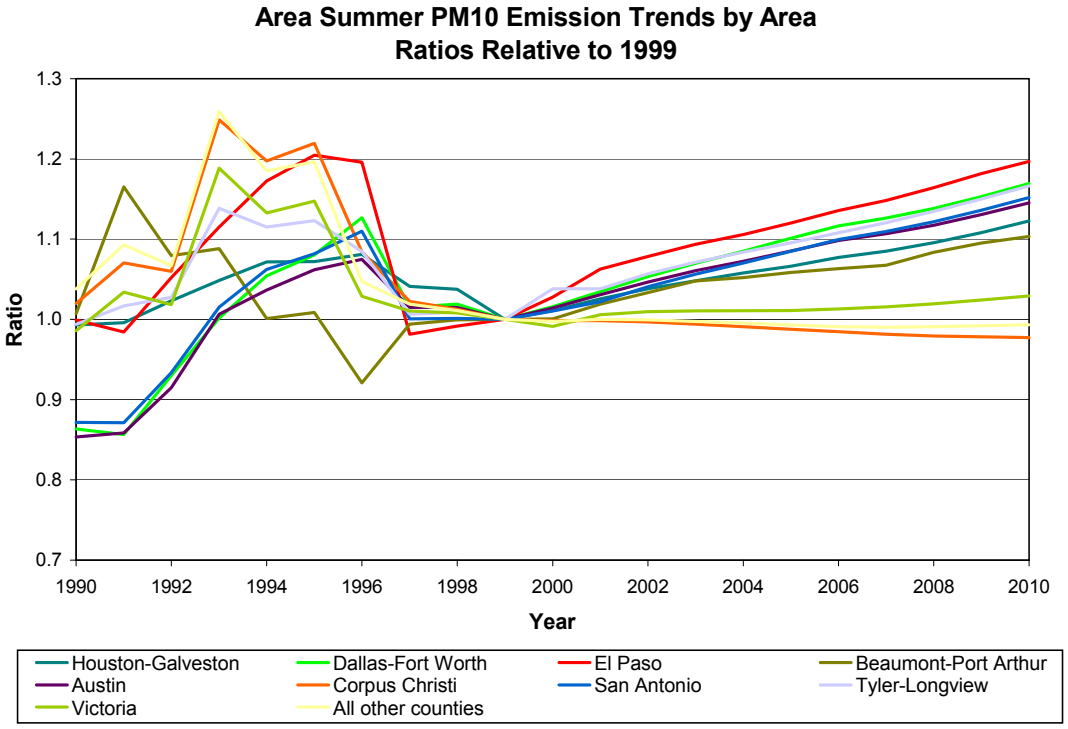

Area Annual PM10 Emission Trends by Area
Emissions (Tons per Year)
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

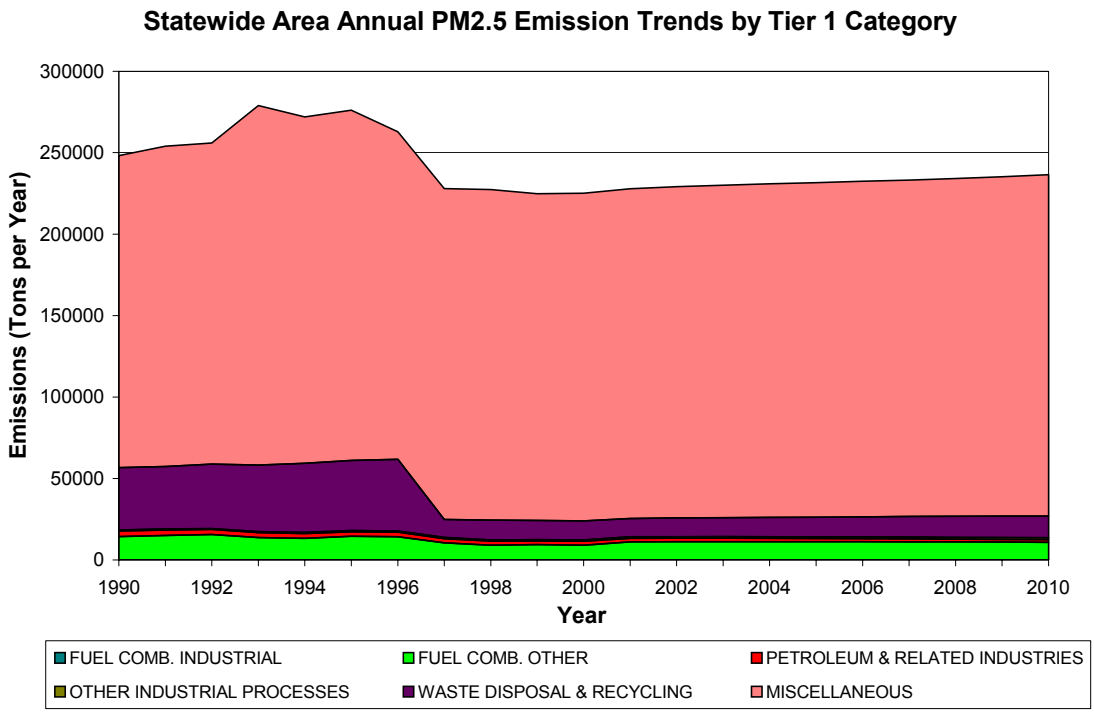

Area Annual PM10 Emission Trends by Area
Ratios Relative to 1999
Ratio
1.3
1.2
1.1
1.0
0.9
0.8
0.7
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

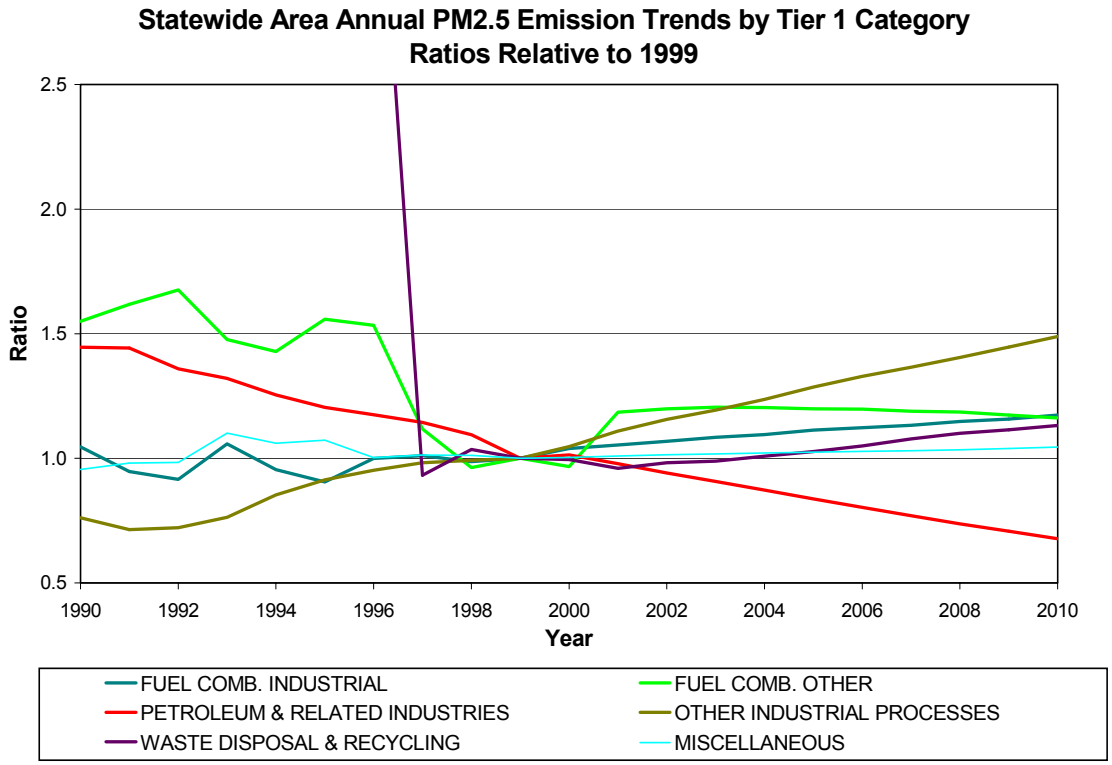

Statewide Area Summer PM10 Emission Trends by Tier 1 Category
Emissions (Tons per Day)
3000
2500
2000
1500
1000
500
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

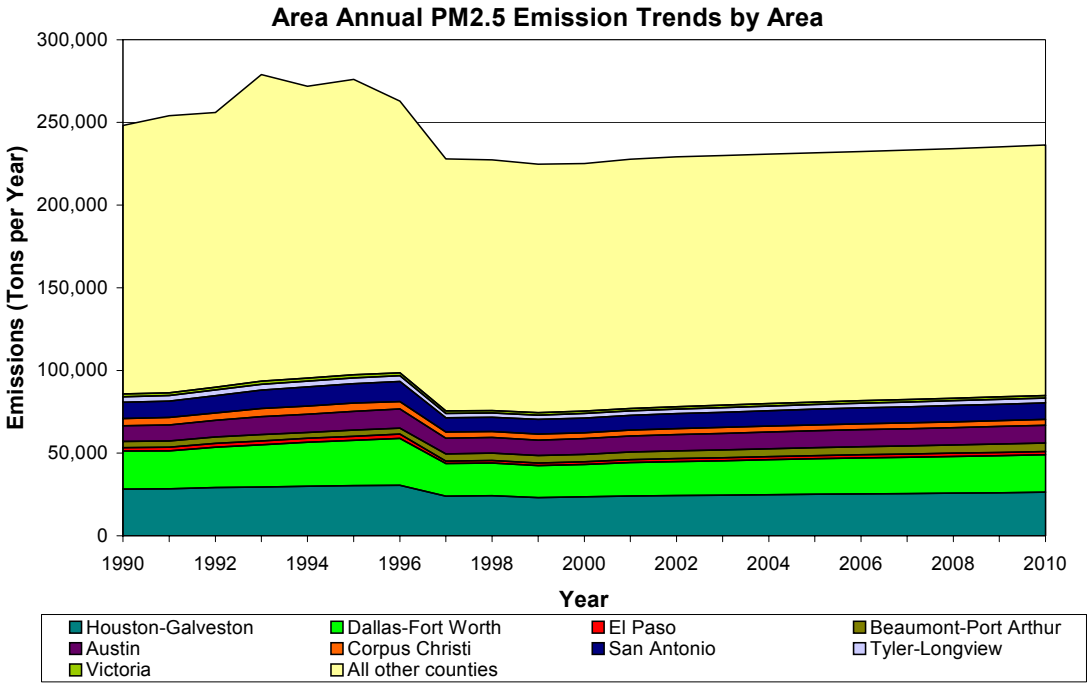

Statewide Area Summer PM10 Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

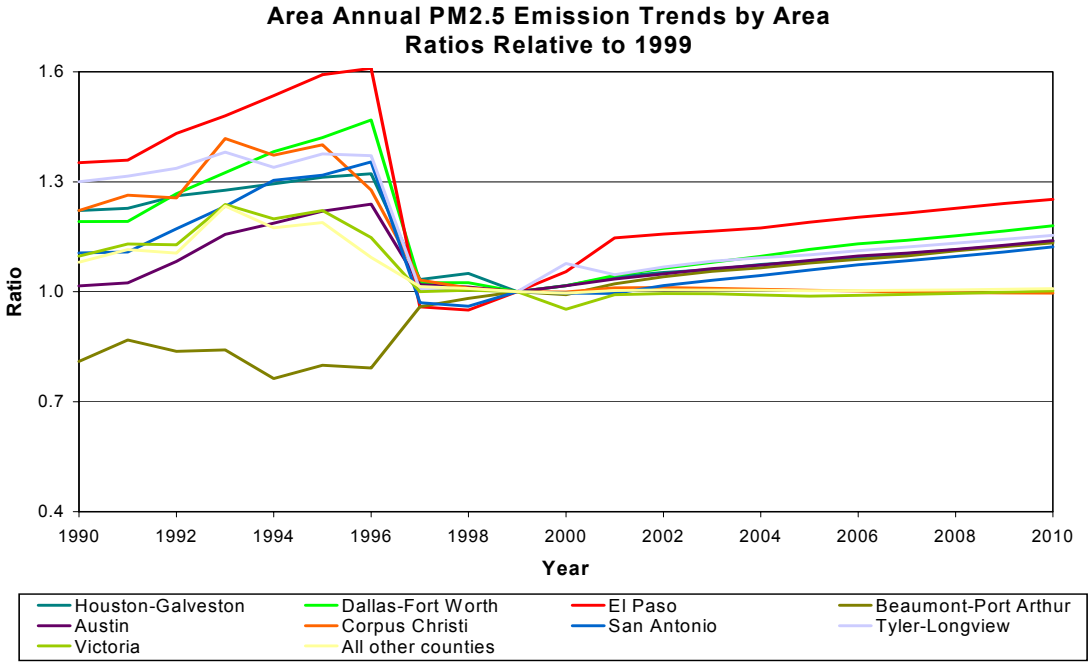

Area Summer PM10 Emission Trends by Area
Emissions (Tons per Day)
3,000
2,500
2,000
1,500
1,000
500
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

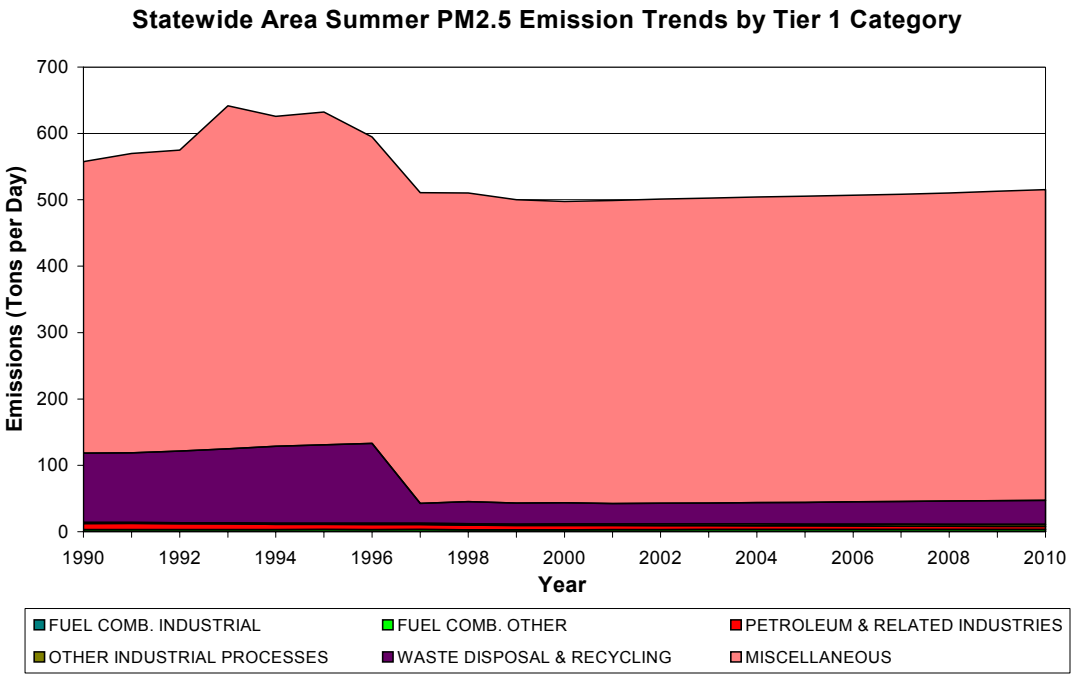

Area Summer PM10 Emission Trends by Area
Ratios Relative to 1999
Ratio
1.3
1.2
1.1
1.0
0.9
0.8
0.7
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

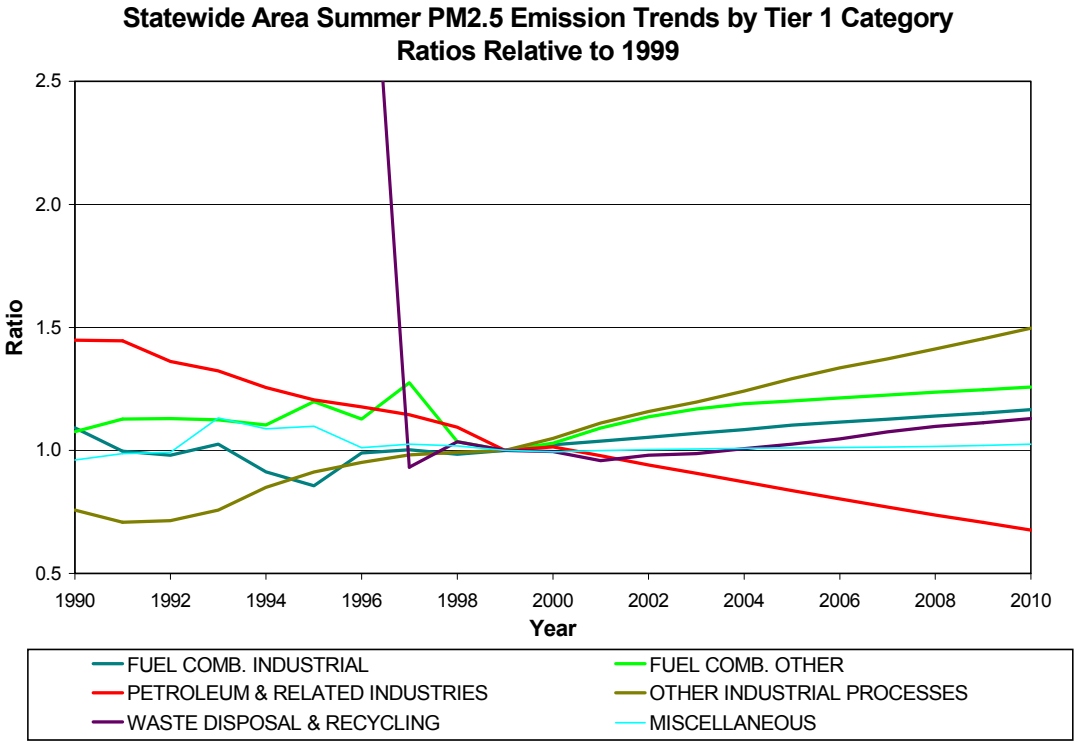

Statewide Area Annual PM2.5 Emission Trends by Tier 1 Category
Emissions (Tons per Year)
300000
250000
200000
150000
100000
50000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

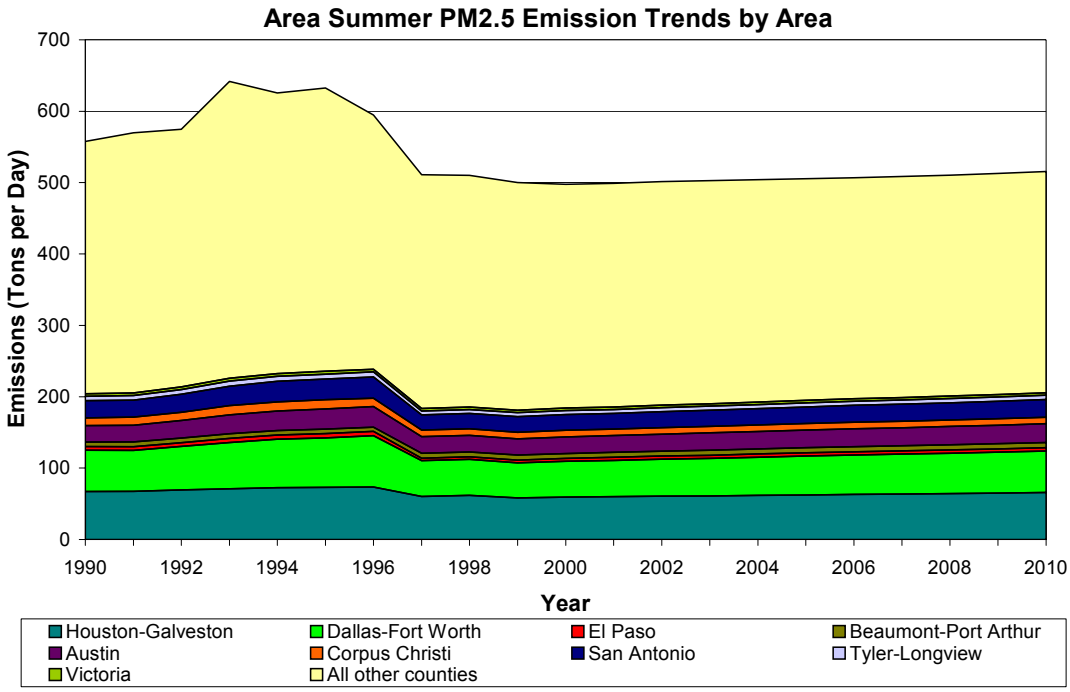

Statewide Area Annual PM2.5 Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

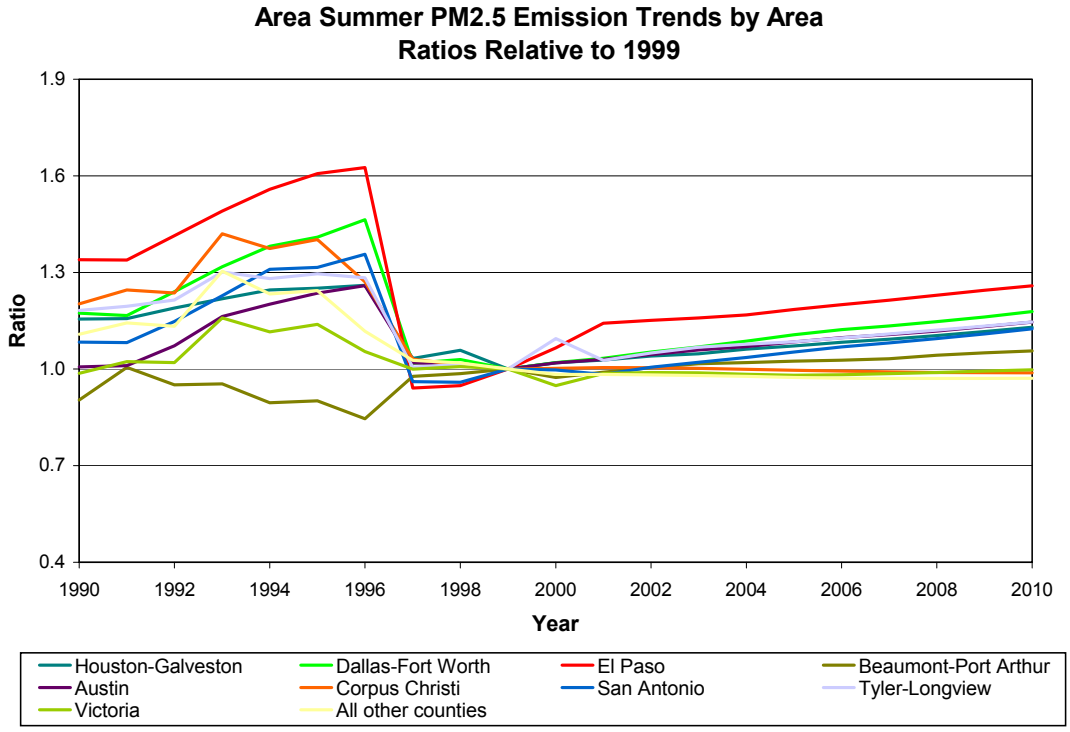

Area Annual PM2.5 Emission Trends by Area
Emissions (Tons per Year)
300,000
250,000
200,000
150,000
100,000
50,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

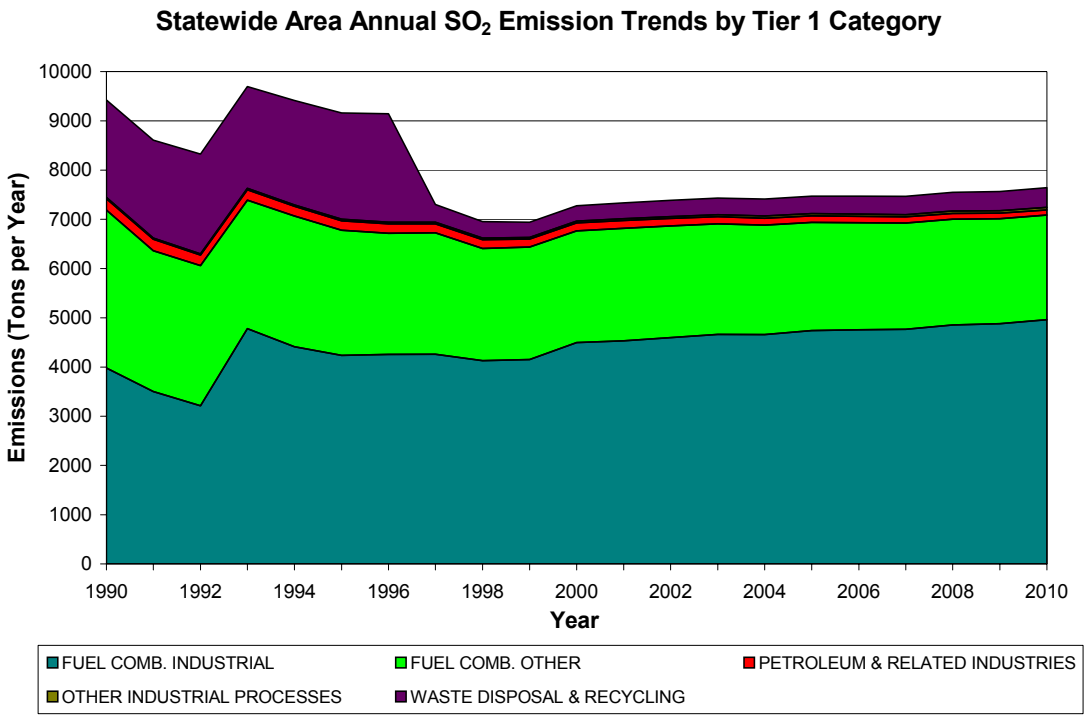

Area Annual PM2.5 Emission Trends by Area
Ratios Relative to 1999
Ratio
1.6
1.3
1.0
0.7
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

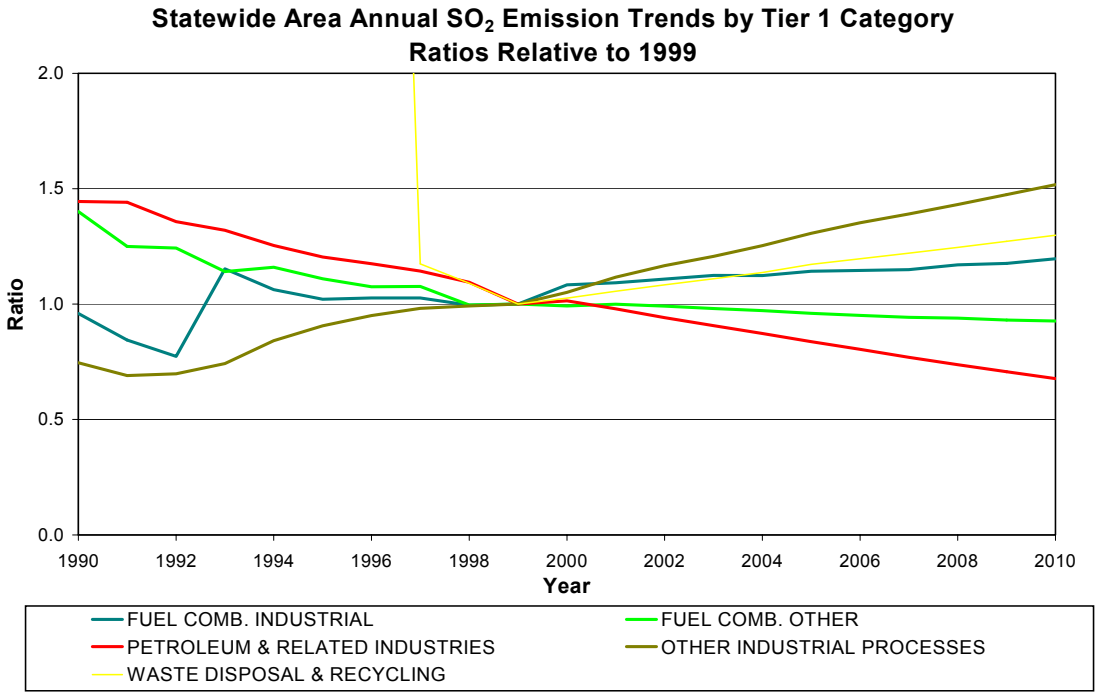

Statewide Area Summer PM2.5 Emission Trends by Tier 1 Category
Emissions (Tons per Day)
700
600
500
400
300
200
100
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

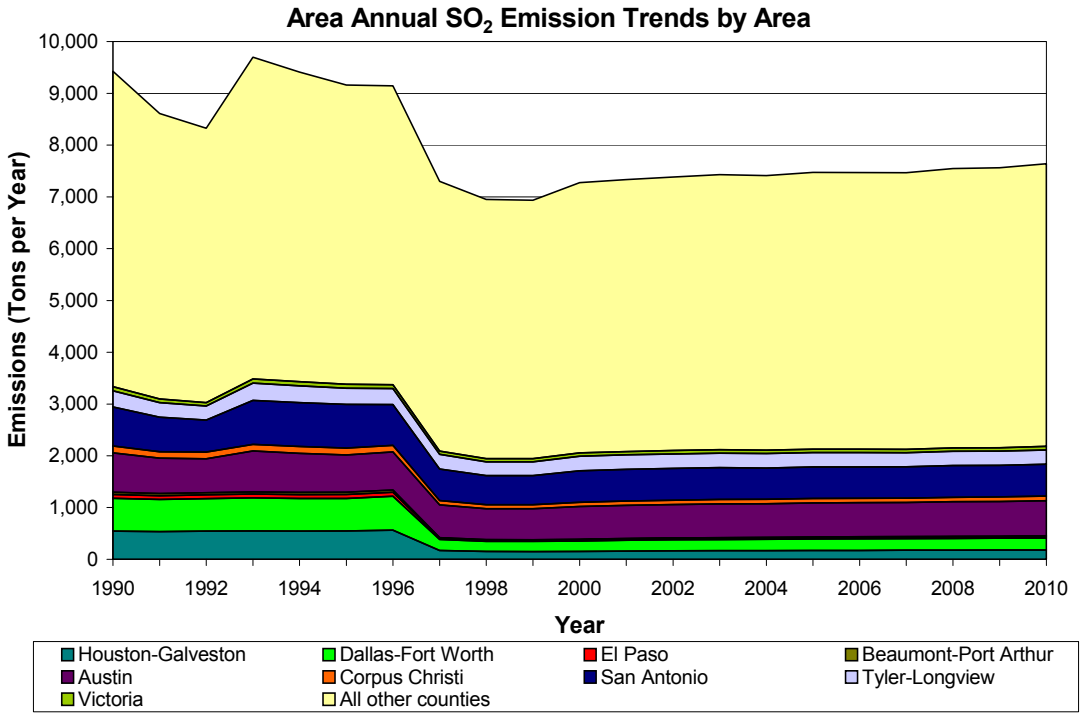

Statewide Area Summer PM2.5 Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING
MISCELLANEOUS

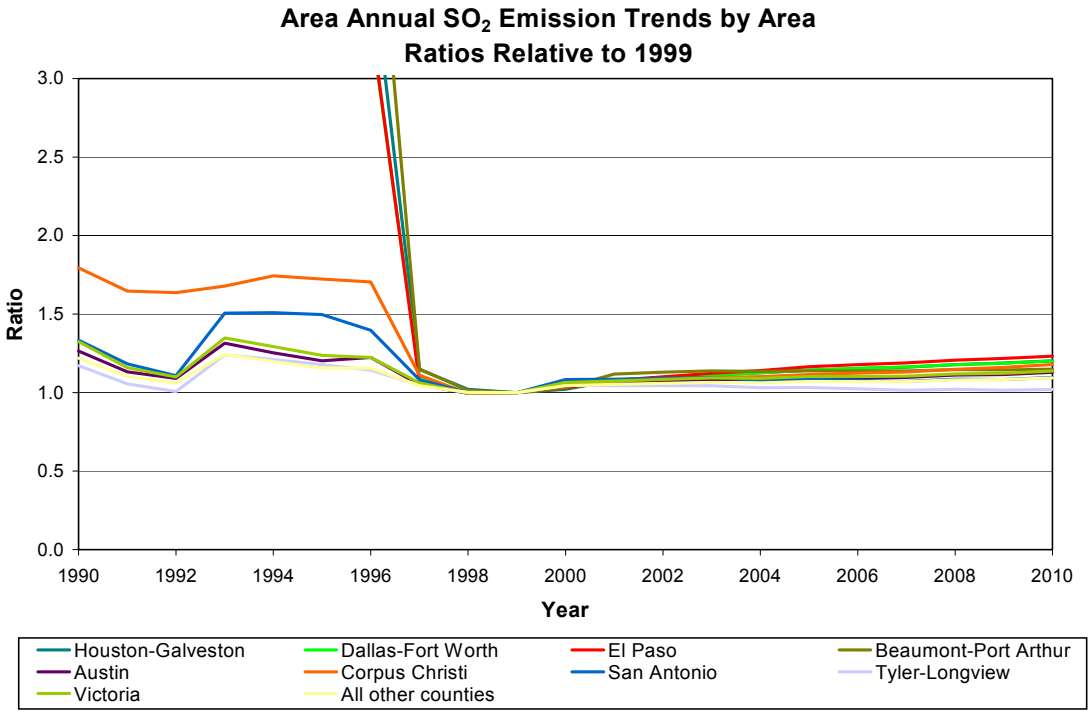

Area Summer PM2.5 Emission Trends by Area
Emissions (Tons per Day)
700
600
500
400
300
200
100
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

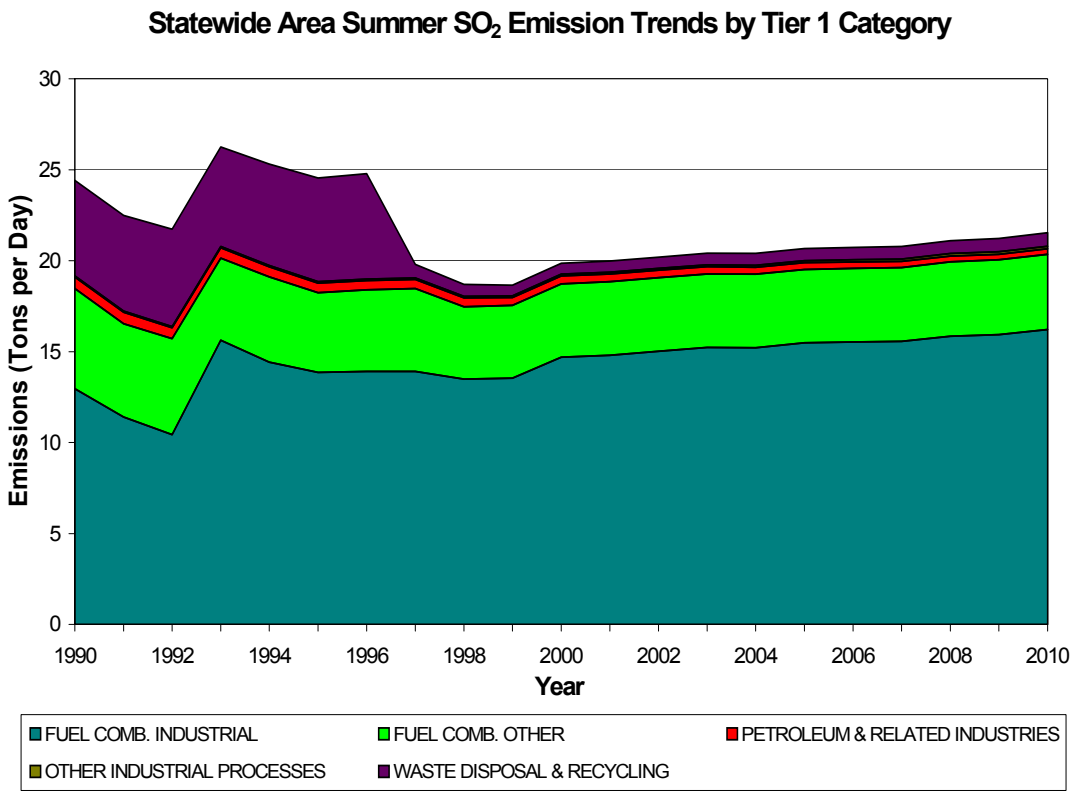

Area Summer PM2.5 Emission Trends by Area
Ratios Relative to 1999
Ratio
1.9
1.6
1.3
1.0
0.7
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

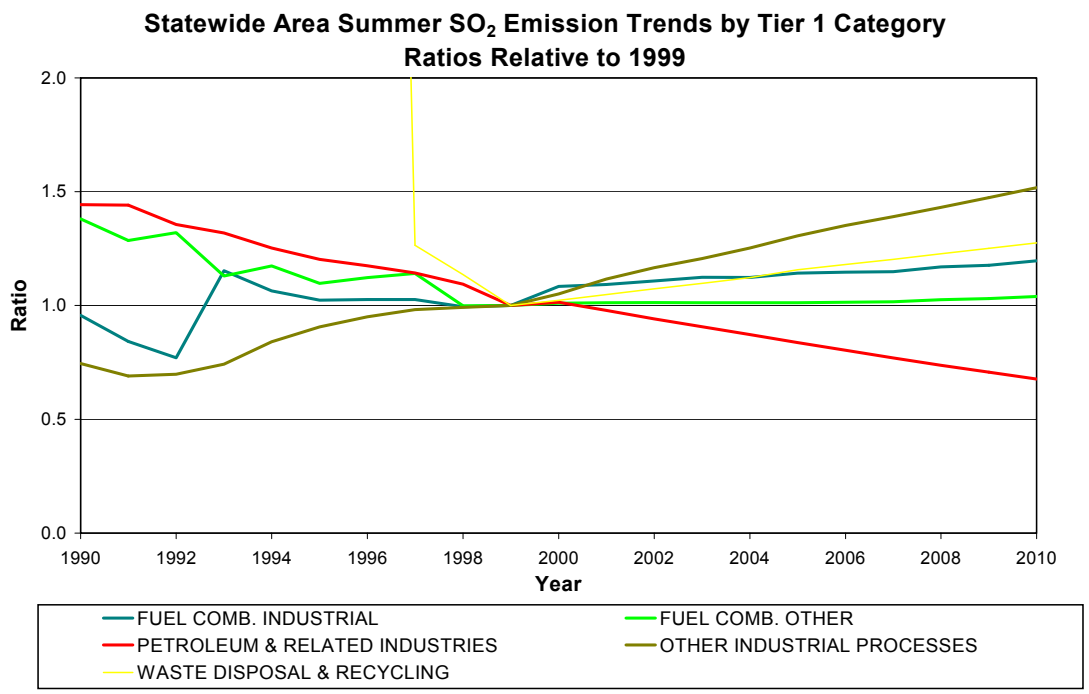

Statewide Area Annual SO_2 Emission Trends by Tier 1 Category
Emissions (Tons per Year)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING

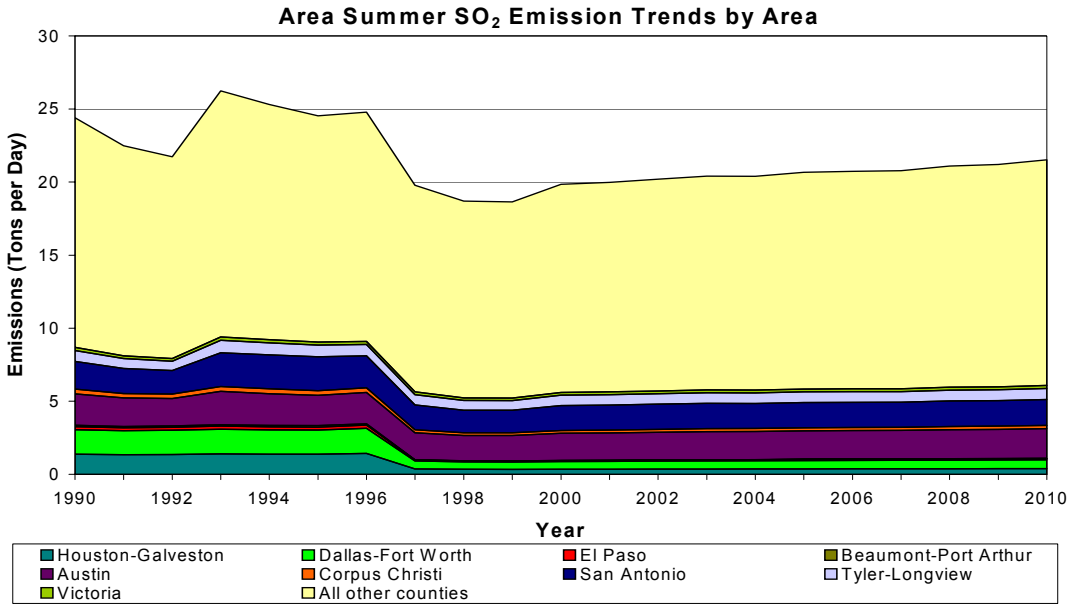

Statewide Area Annual SO_2 Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING

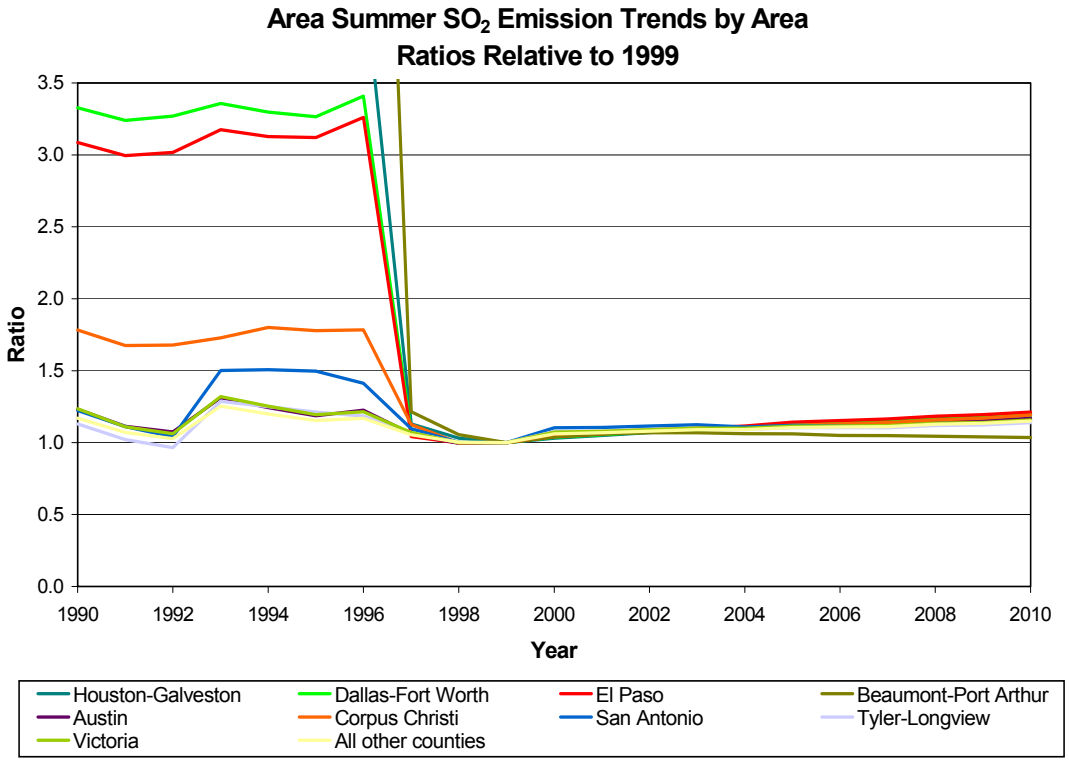

Area Annual SO_2 Emission Trends by Area
Emissions (Tons per Year)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

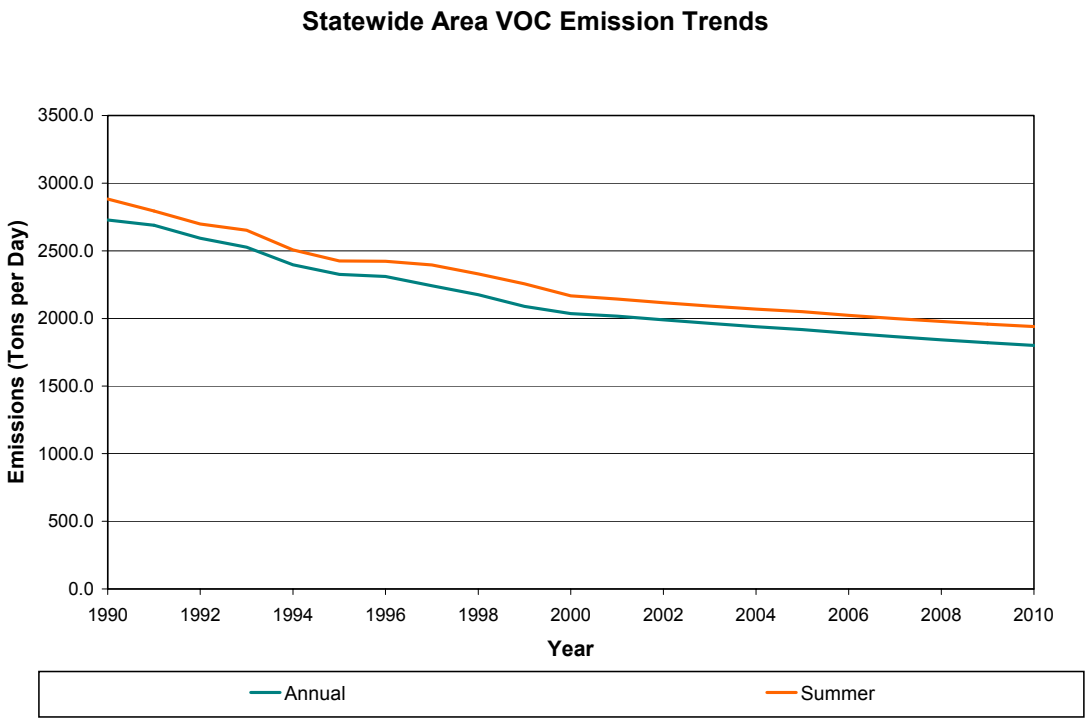

Area Annual SO_2 Emission Trends by Area
Ratios Relative to 1999
Ratio
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

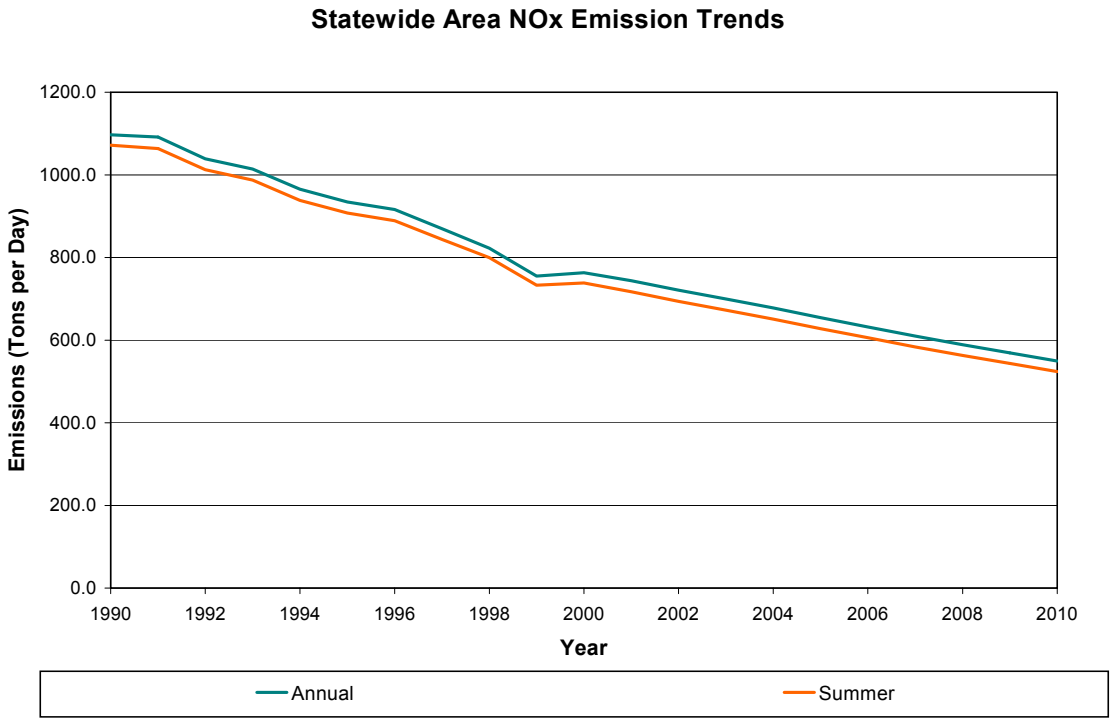

Statewide Area Summer SO_2 Emission Trends by Tier 1 Category
Emissions (Tons per Day)
30
25
20
15
10
5
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING


Statewide Area Summer SO_2 Emission Trends by Tier 1 Category
Ratios Relative to 1999
Ratio
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
FUEL COMB. INDUSTRIAL
FUEL COMB. OTHER
PETROLEUM & RELATED INDUSTRIES
OTHER INDUSTRIAL PROCESSES
WASTE DISPOSAL & RECYCLING

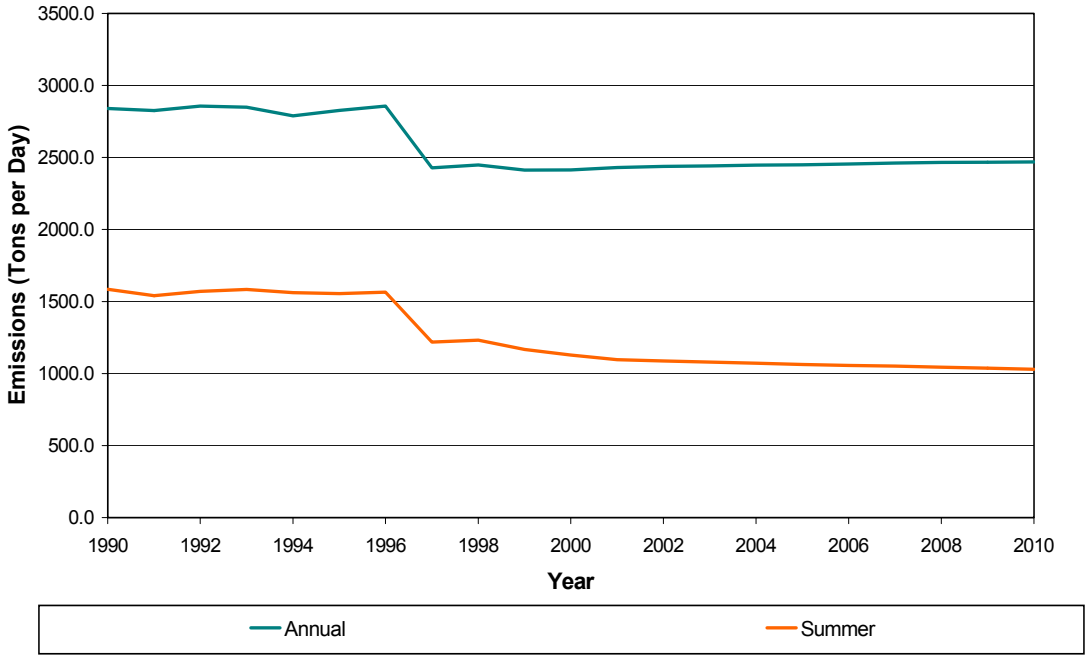

Area Summer SO2 Emission Trends by Area
Emissions (Tons per Day)
30
25
20
15
10
5
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


Area Summer SO2 Emission Trends by Area
Ratios Relative to 1999
Ratio
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

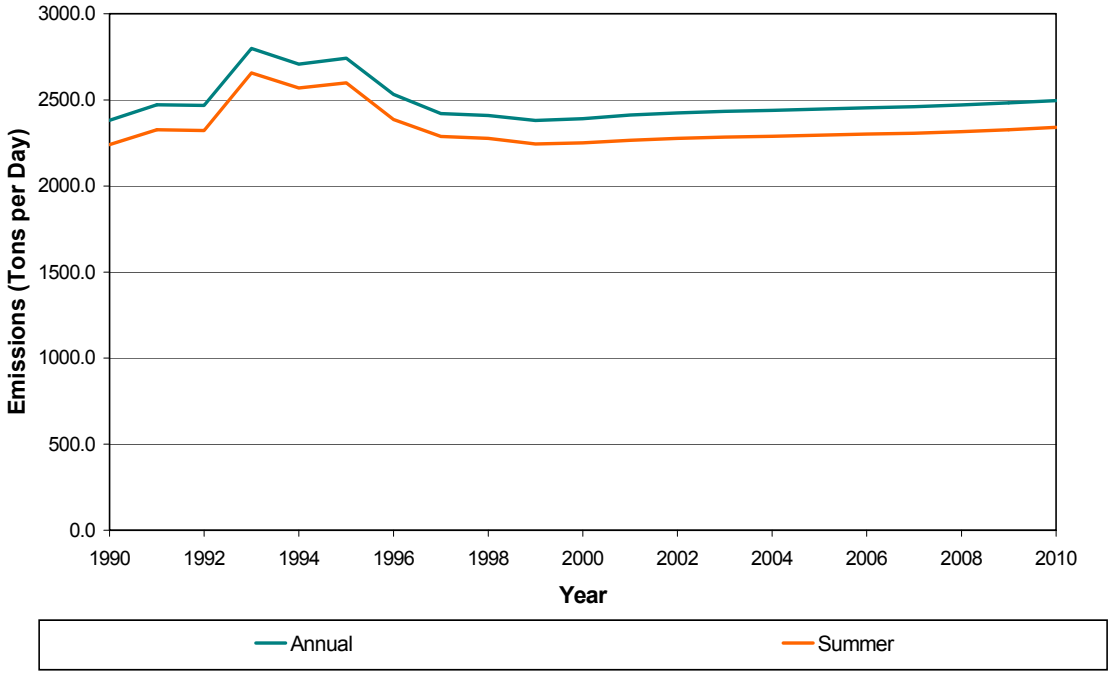

Statewide Area VOC Emission Trends
Emissions (Tons per Day)
3500.0
3000.0
2500.0
2000.0
1500.0
1000.0
500.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide Area NOx Emission Trends
Emissions (Tons per Day)
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer

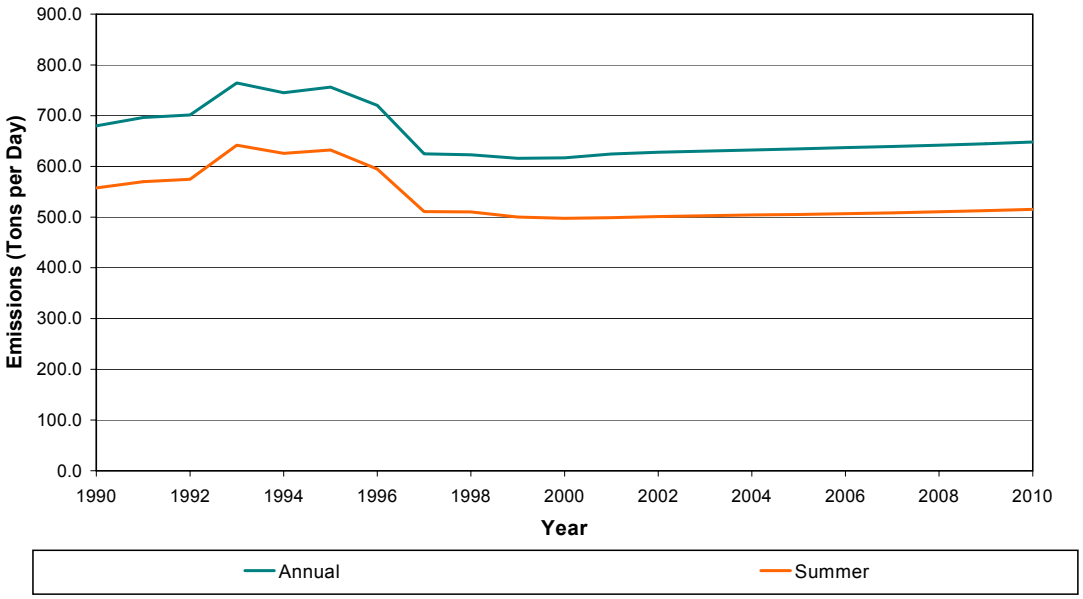
Statewide Area CO Emission Trends



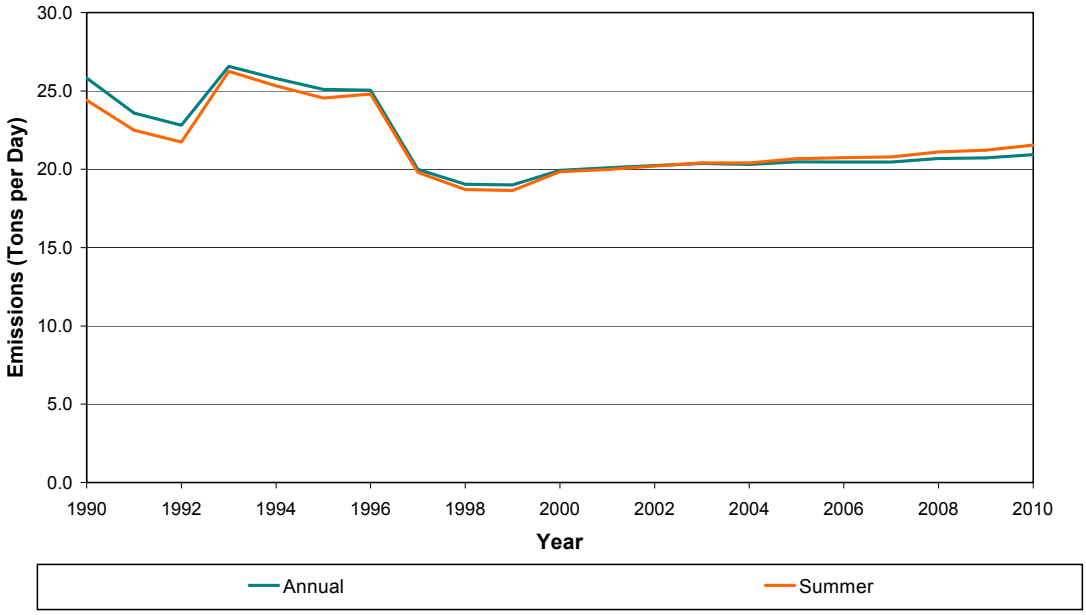
Statewide Area PM10 Emission Trends

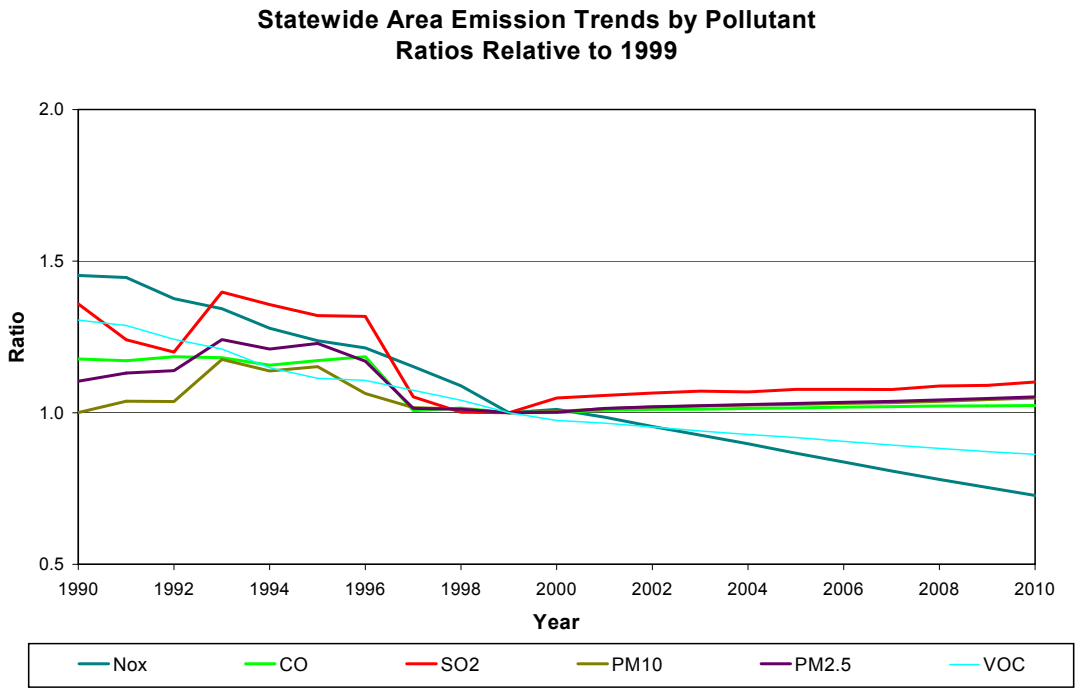


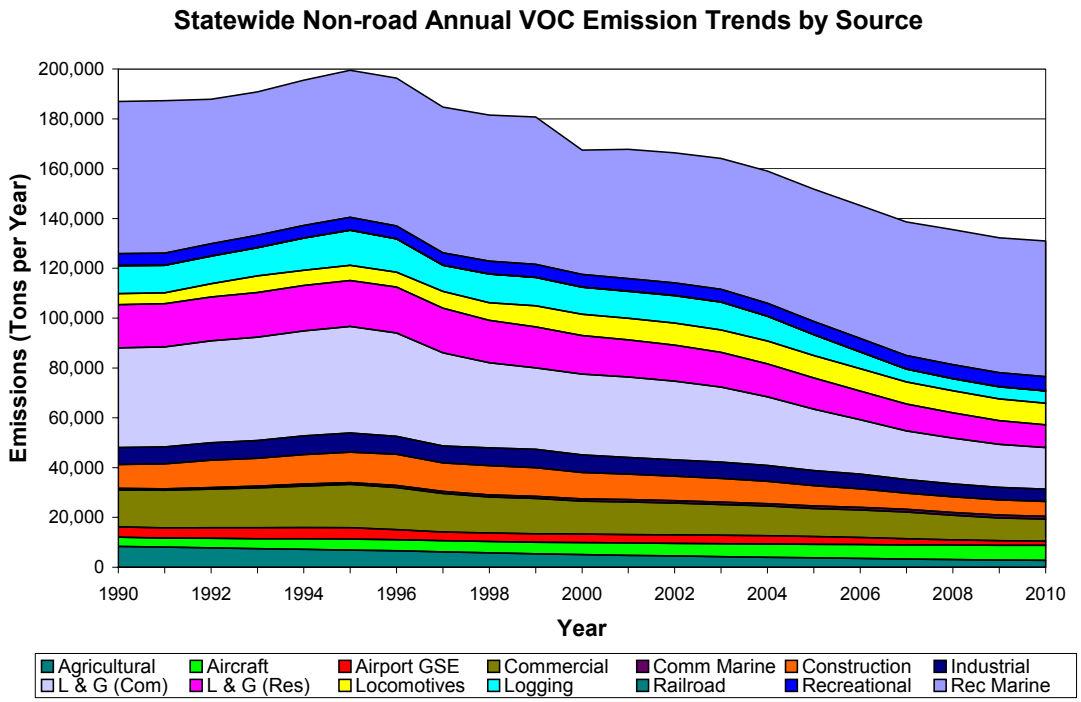
Statewide Area PM2.5 Emission Trends

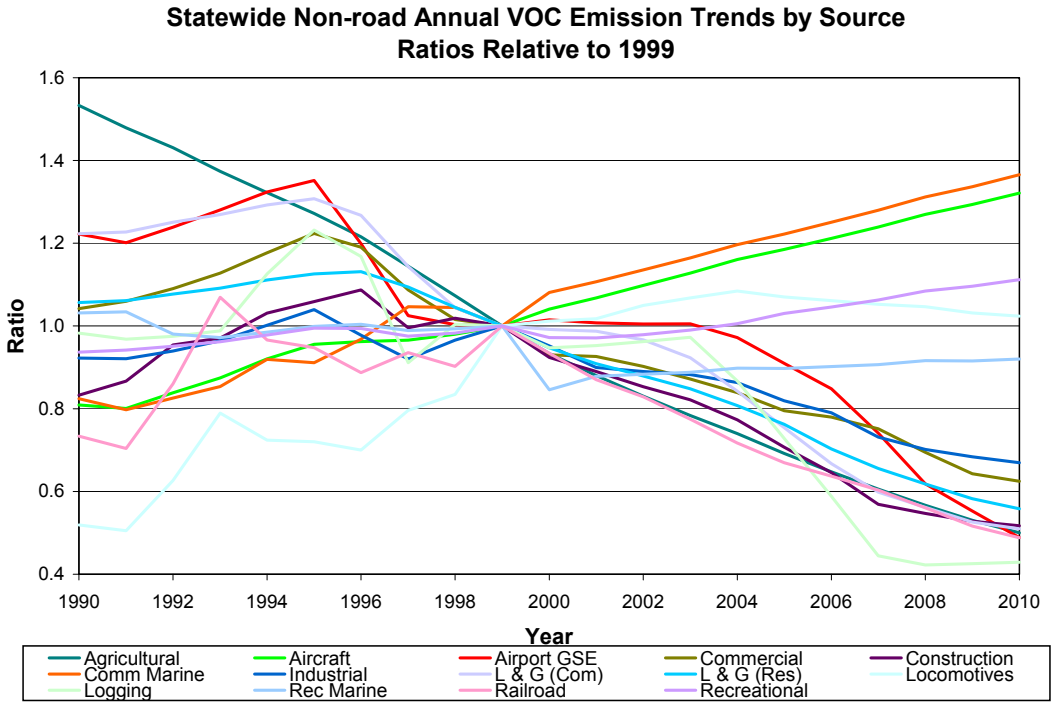


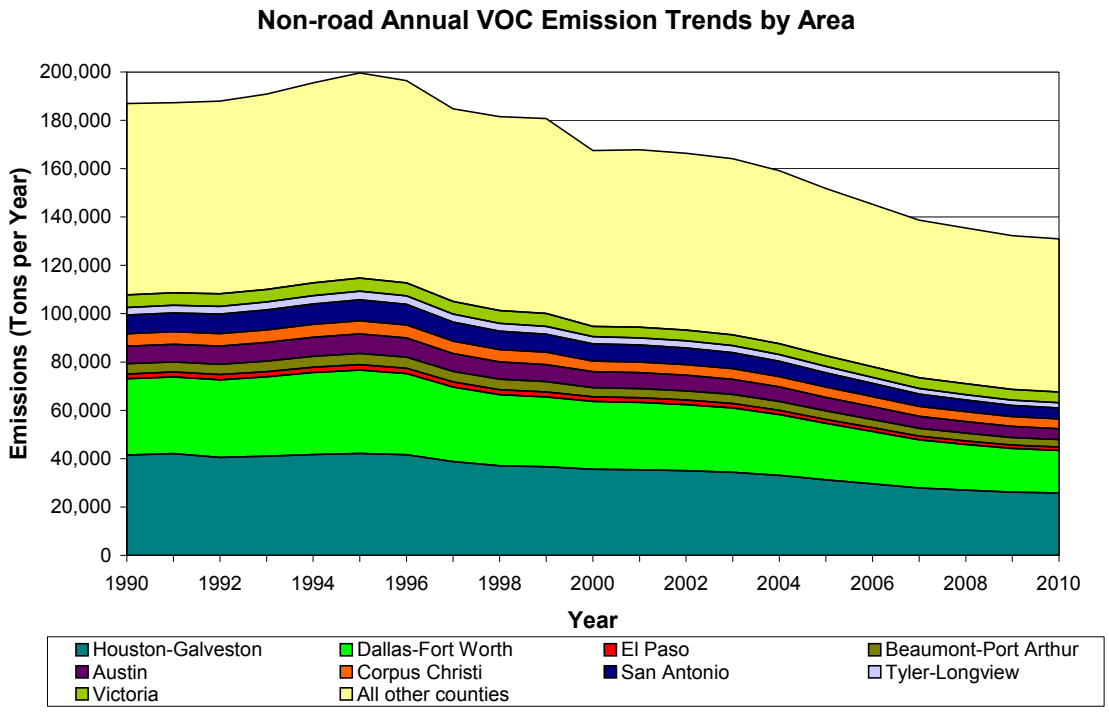
Statewide Area SO_2 Emission Trends

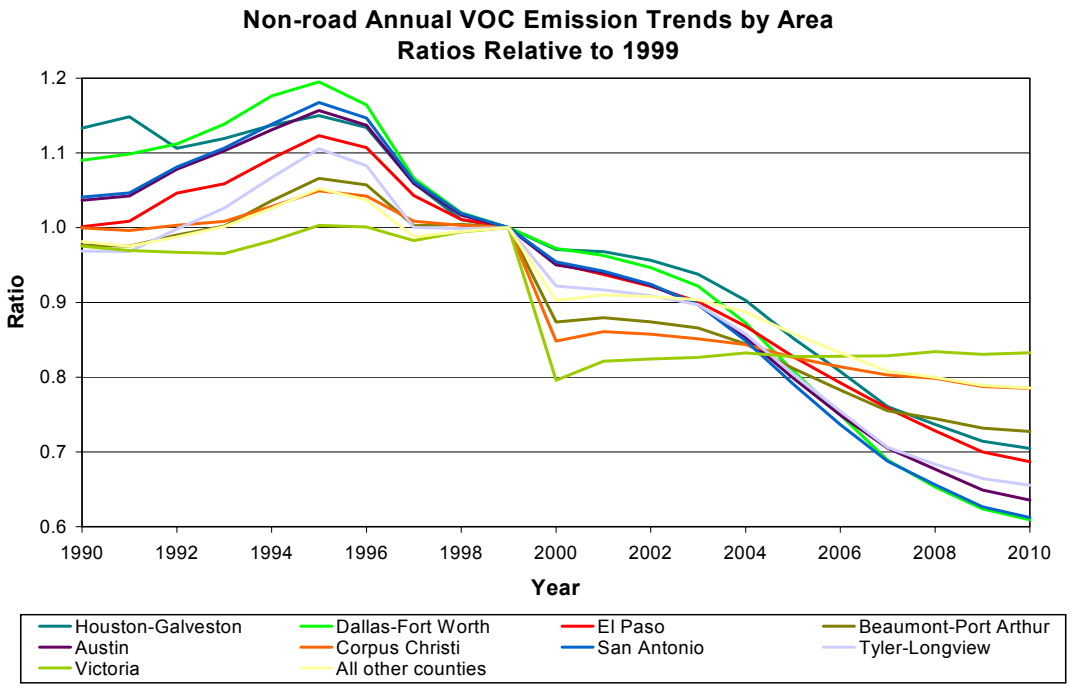


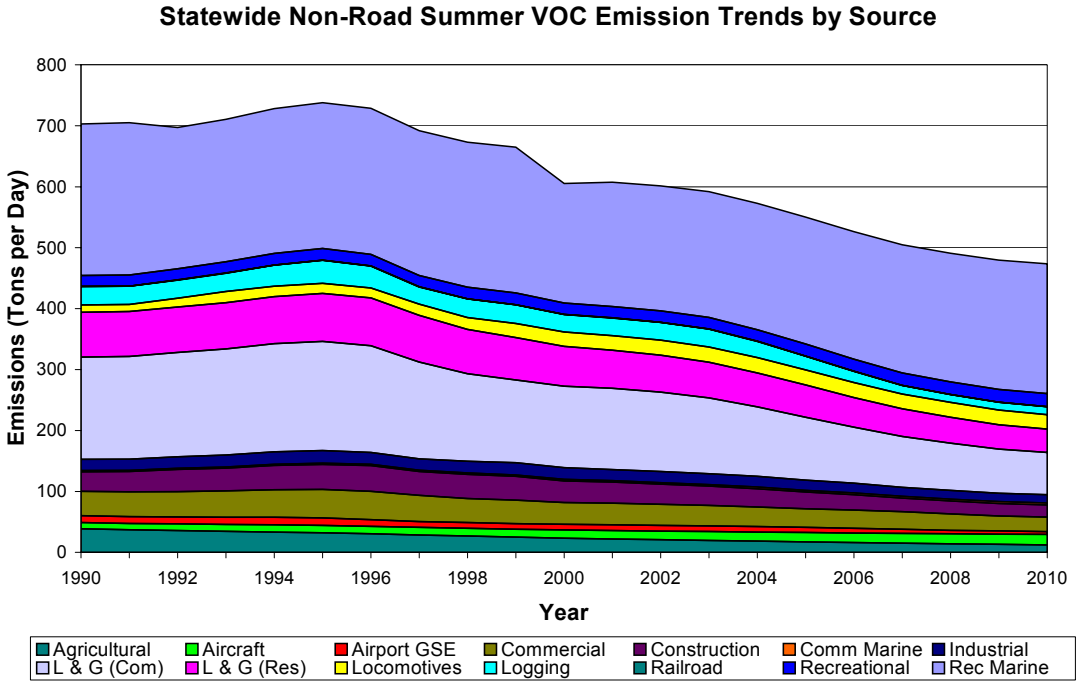

Statewide Area Emission Trends by Pollutant
Ratios Relative to 1999
2.0
1.5
1.0
0.5
Ratio
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Nox
CO
SO2
PM10
PM2.5
VOC

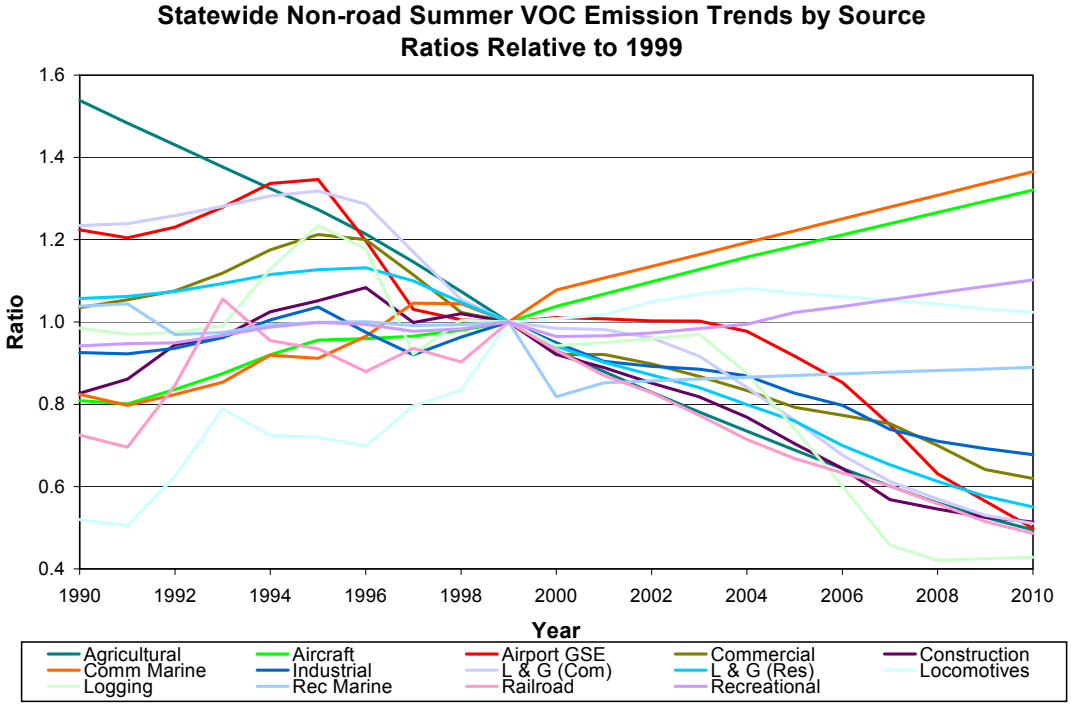

Statewide Non-road Annual VOC Emission Trends by Source
Emissions (Tons per Year)
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Comm Marine
Construction
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Railroad
Recreational
Rec Marine

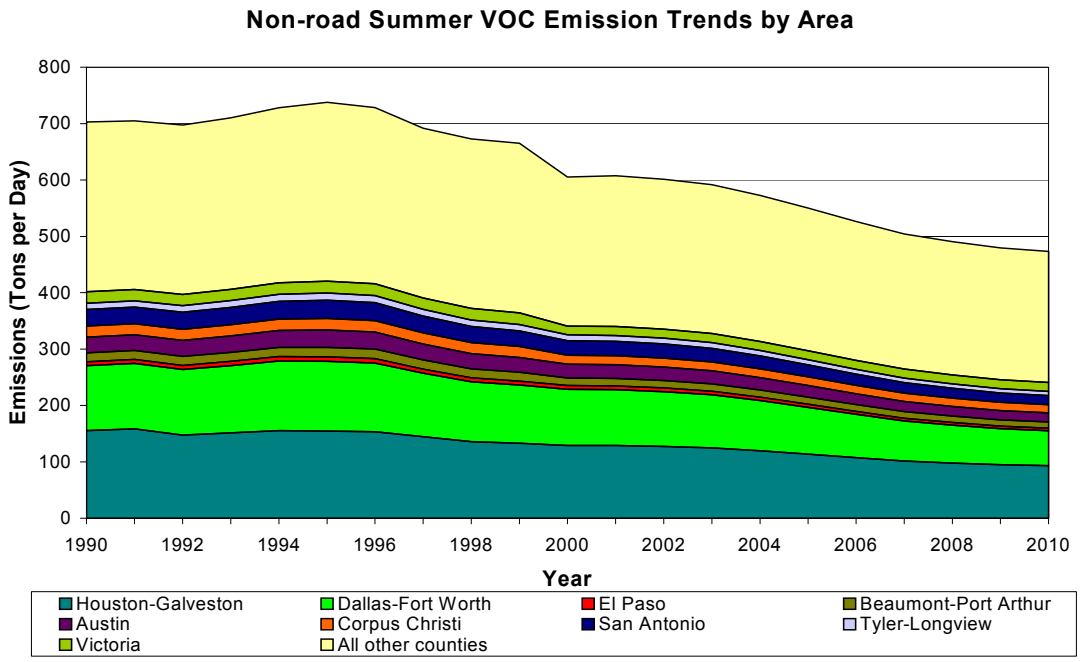

Statewide Non-road Annual VOC Emission Trends by Source
Ratios Relative to 1999
Ratio
1.6
1.4
1.2
1.0
0.8
0.6
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

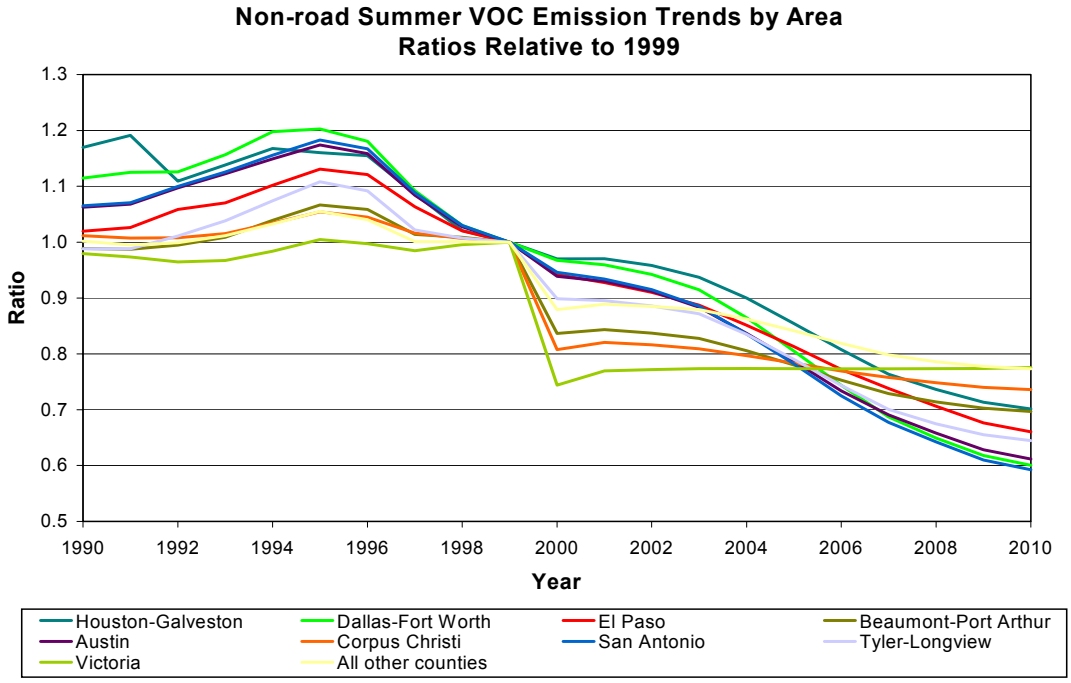

Non-road Annual VOC Emission Trends by Area
Emissions (Tons per Year)
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

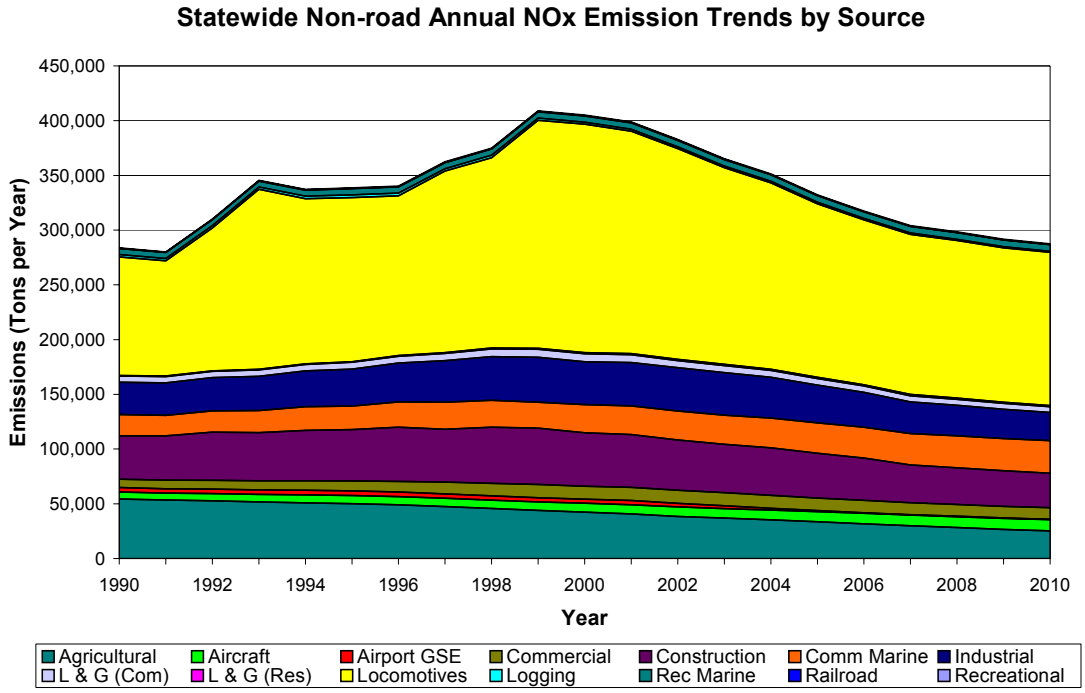

Non-road Annual VOC Emission Trends by Area
Ratios Relative to 1999
Ratio
1.2
1.1
1.0
0.9
0.8
0.7
0.6
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

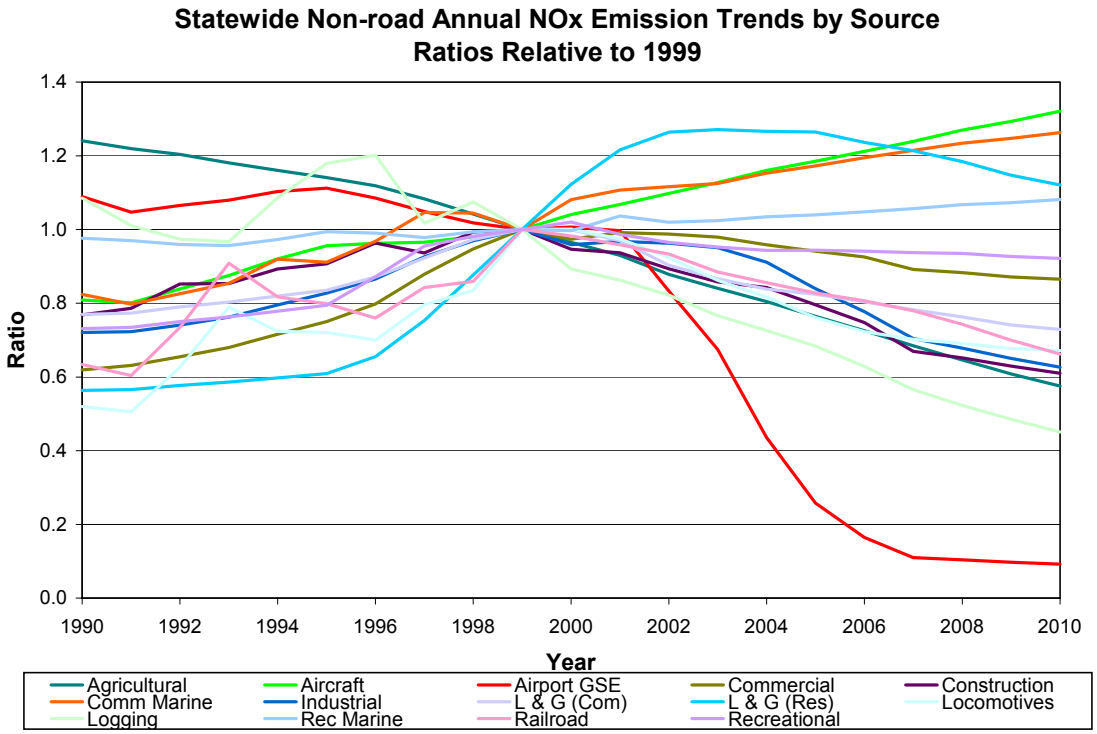

Statewide Non-Road Summer VOC Emission Trends by Source
Emissions (Tons per Day)
800
700
600
500
400
300
200
100
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Railroad
Recreational
Rec Marine

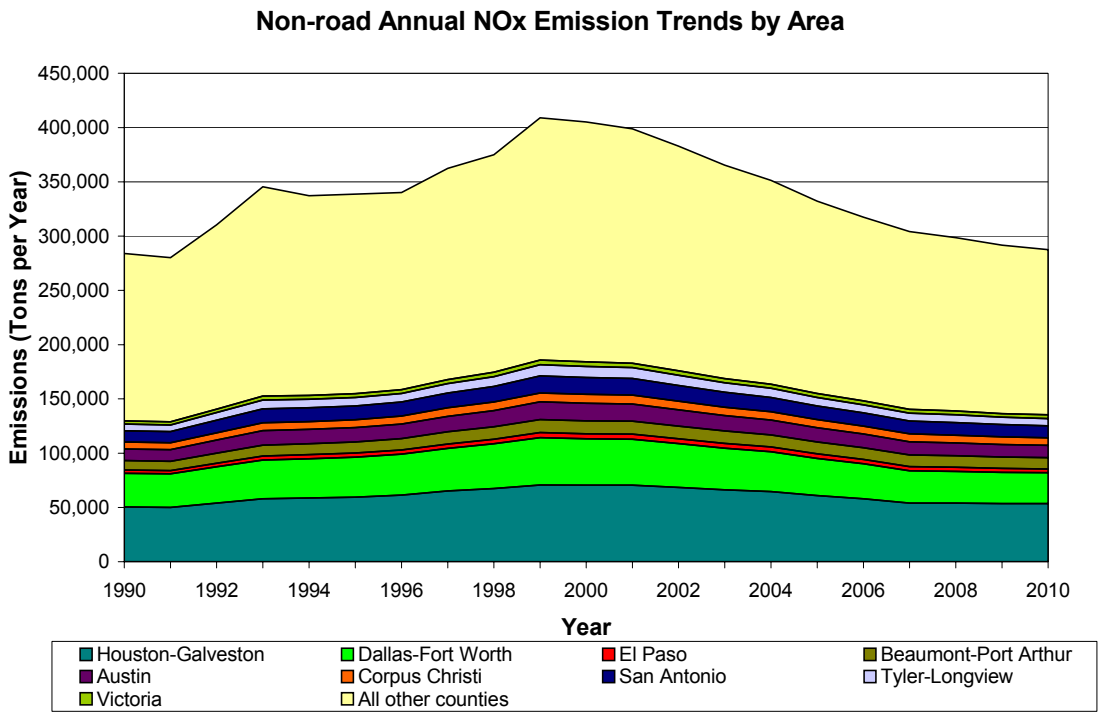

Statewide Non-road Summer VOC Emission Trends by Source
Ratios Relative to 1999
Ratio
1.6
1.4
1.2
1.0
0.8
0.6
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

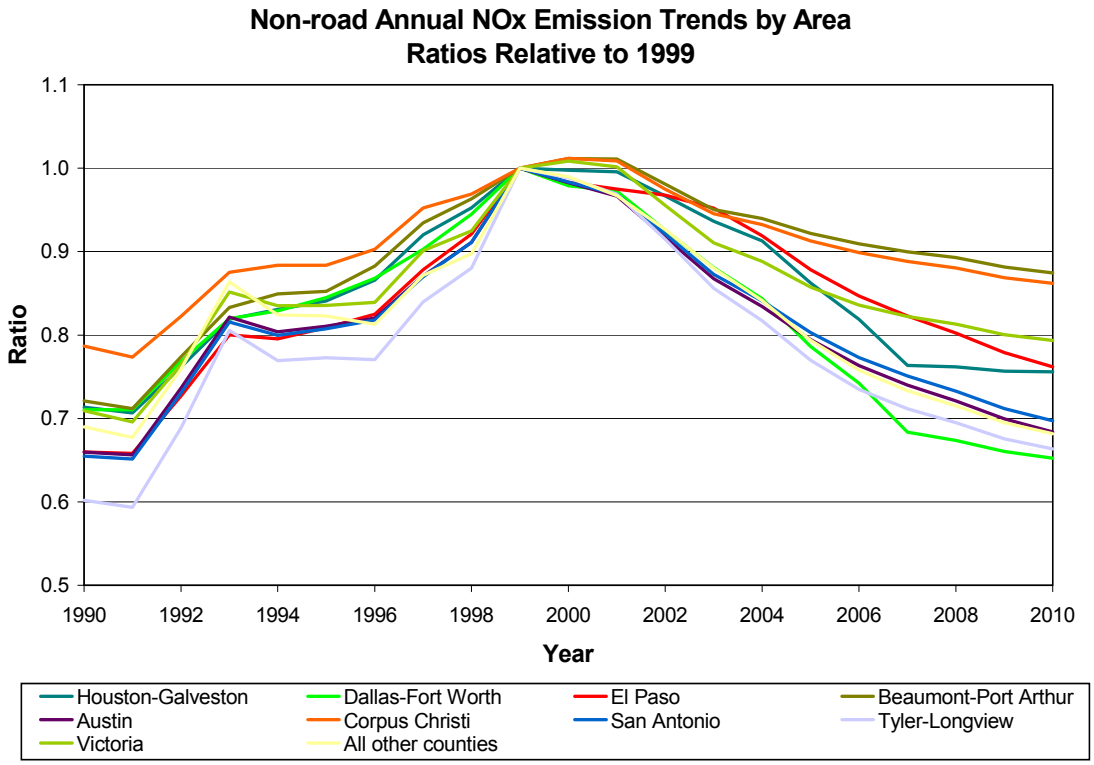

Non-road Summer VOC Emission Trends by Area
Emissions (Tons per Day)
800
700
600
500
400
300
200
100
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

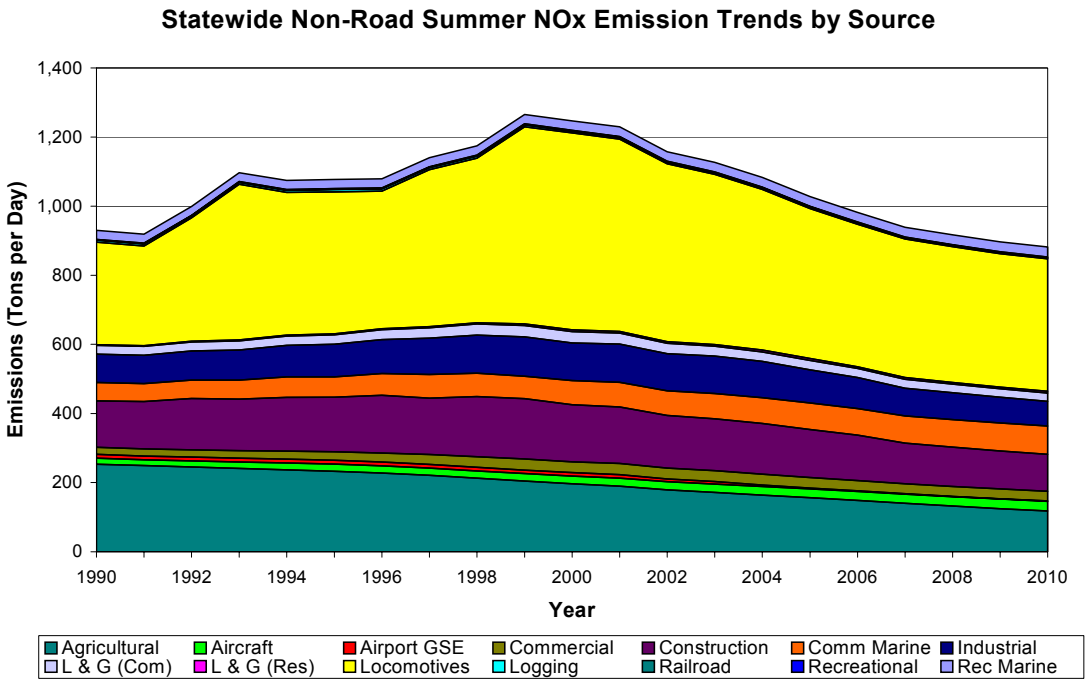

Non-road Summer VOC Emission Trends by Area
Ratios Relative to 1999
Ratio
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

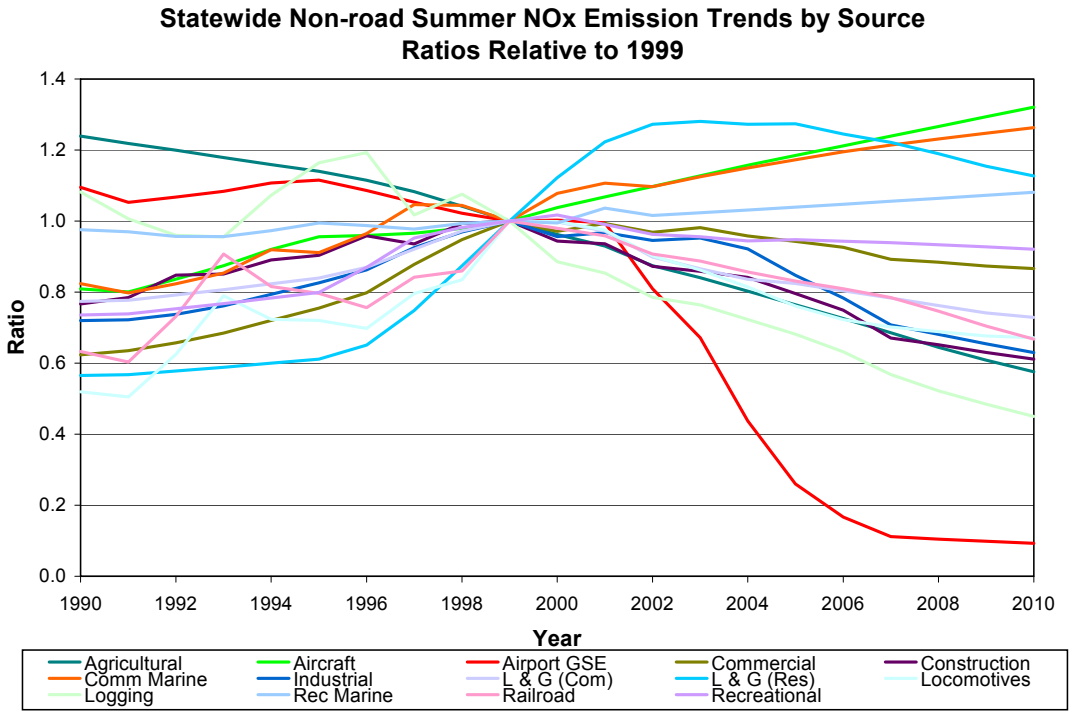

Statewide Non-road Annual NOx Emission Trends by Source
Emissions (Tons per Year)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

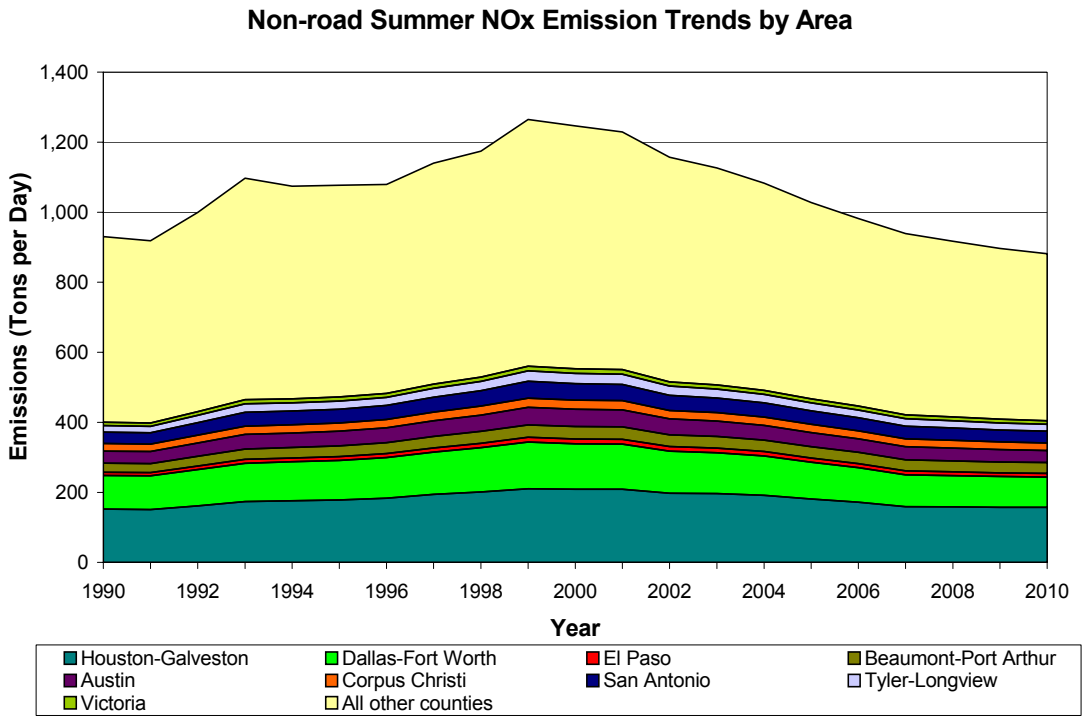

Statewide Non-road Annual NOx Emission Trends by Source
Ratios Relative to 1999
Ratio
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

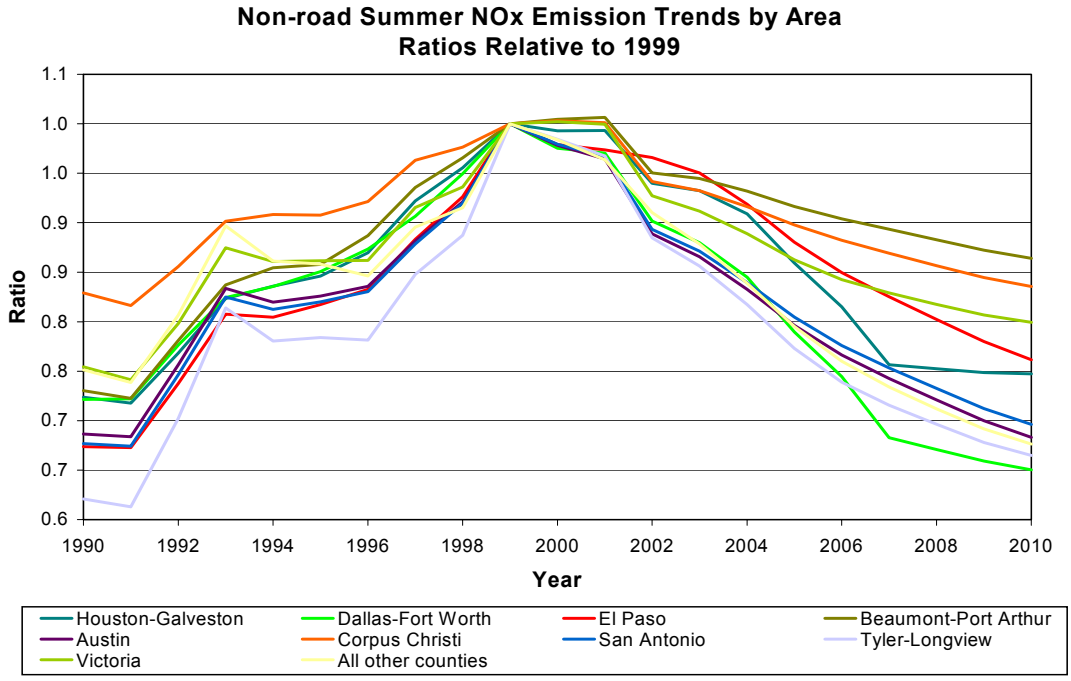

Non-road Annual NOx Emission Trends by Area
Emissions (Tons per Year)
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

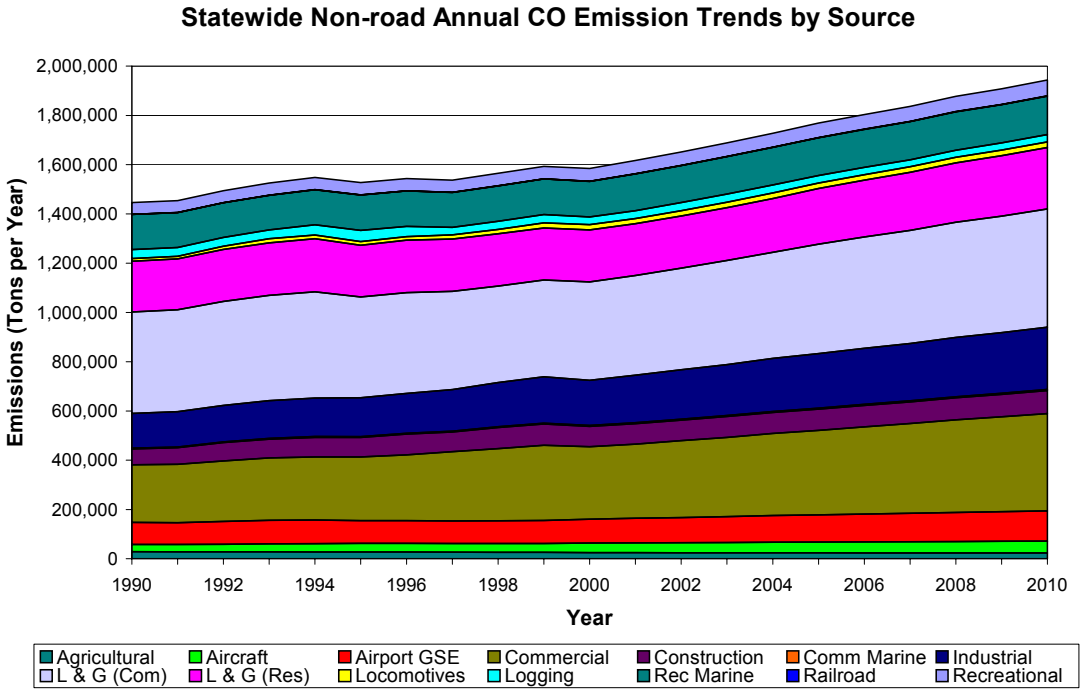

Non-road Annual NOx Emission Trends by Area
Ratios Relative to 1999
Ratio
1.1
1.0
0.9
0.8
0.7
0.6
0.5
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

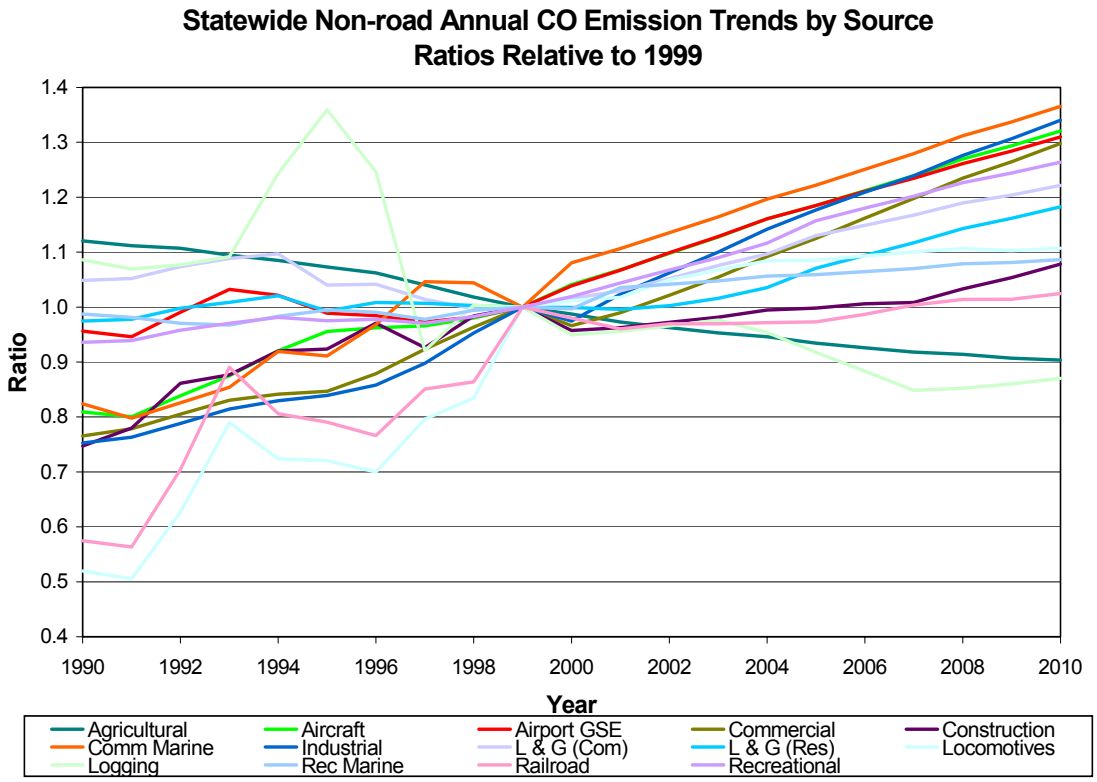

Statewide Non-Road Summer NOx Emission Trends by Source
Emissions (Tons per Day)
1,400
1,200
1,000
800
600
400
200
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Railroad
Recreational
Rec Marine

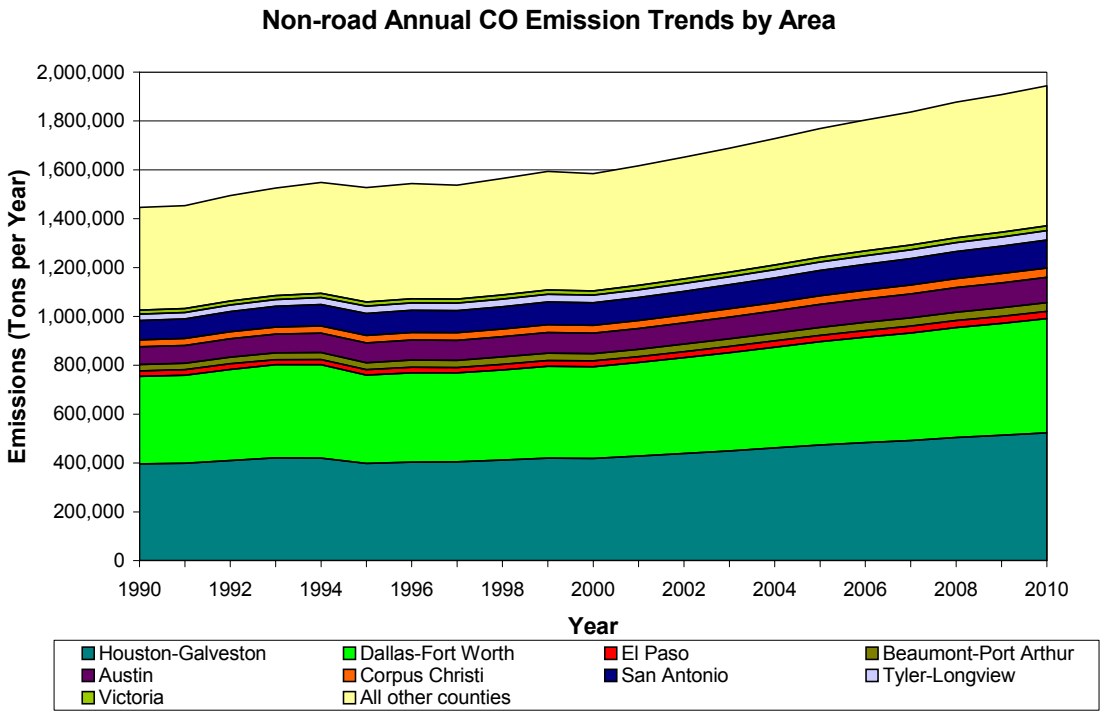

Statewide Non-road Summer NOx Emission Trends by Source
Ratios Relative to 1999
Ratio
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

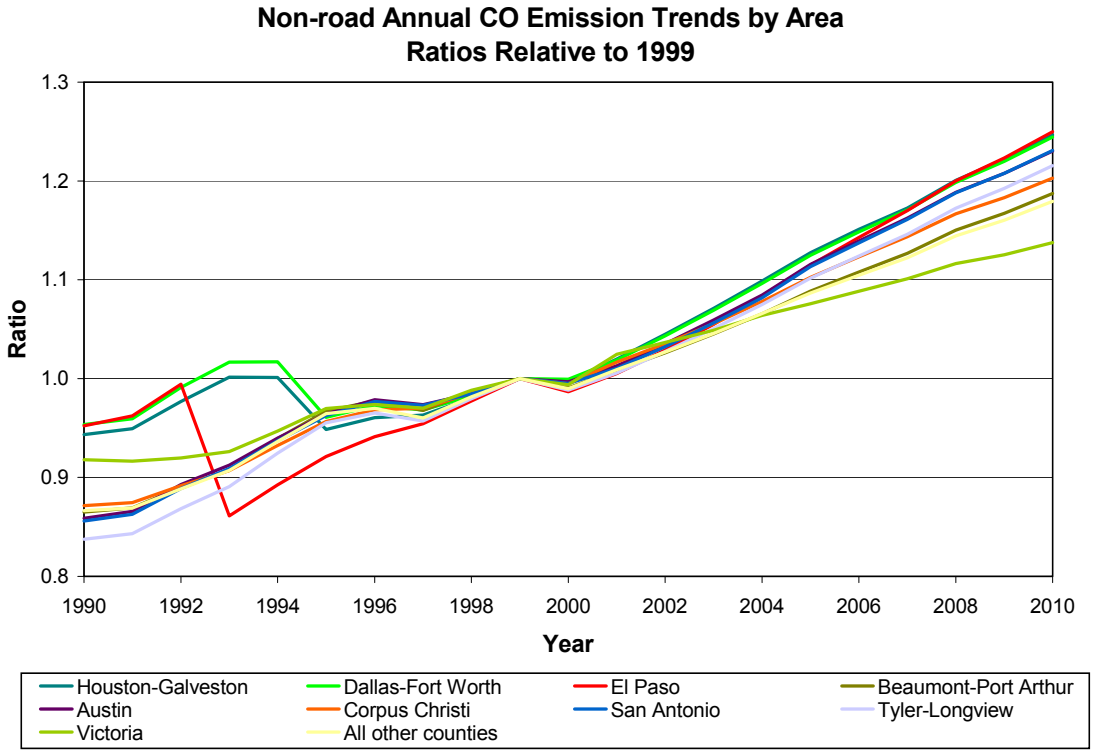

Non-road Summer NOx Emission Trends by Area
Emissions (Tons per Day)
1,400
1,200
1,000
800
600
400
200
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

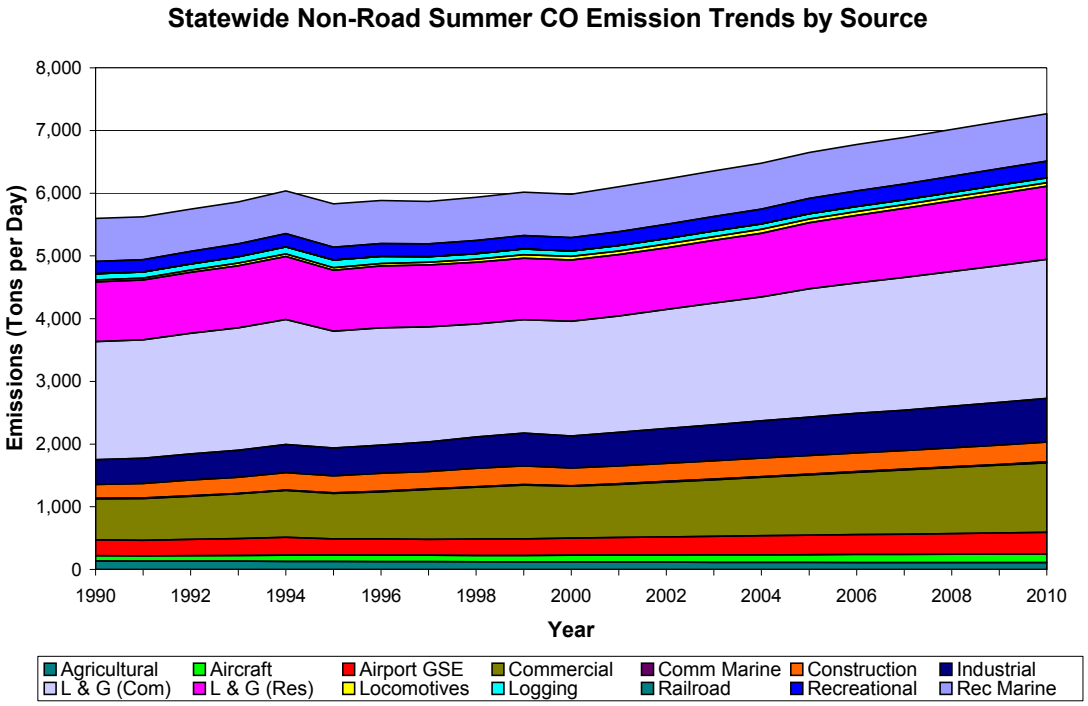

Non-road Summer NOx Emission Trends by Area
Ratios Relative to 1999
Ratio
1.1
1.0
1.0
0.9
0.9
0.8
0.8
0.7
0.7
0.6
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

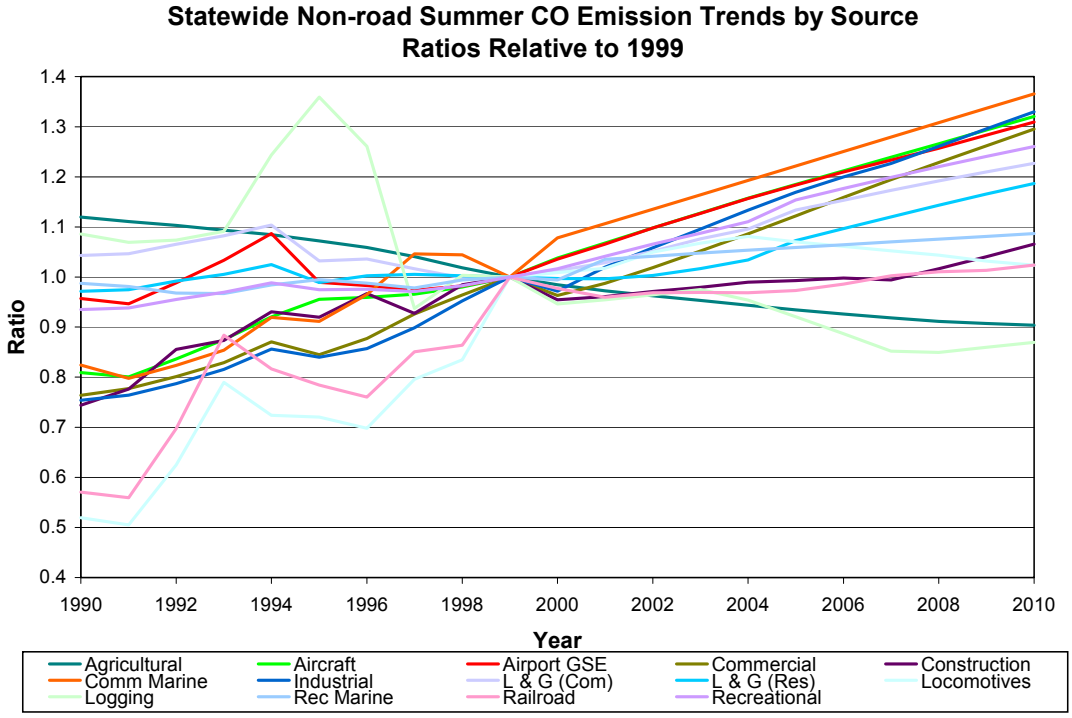

Statewide Non-road Annual CO Emission Trends by Source
Emissions (Tons per Year)
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

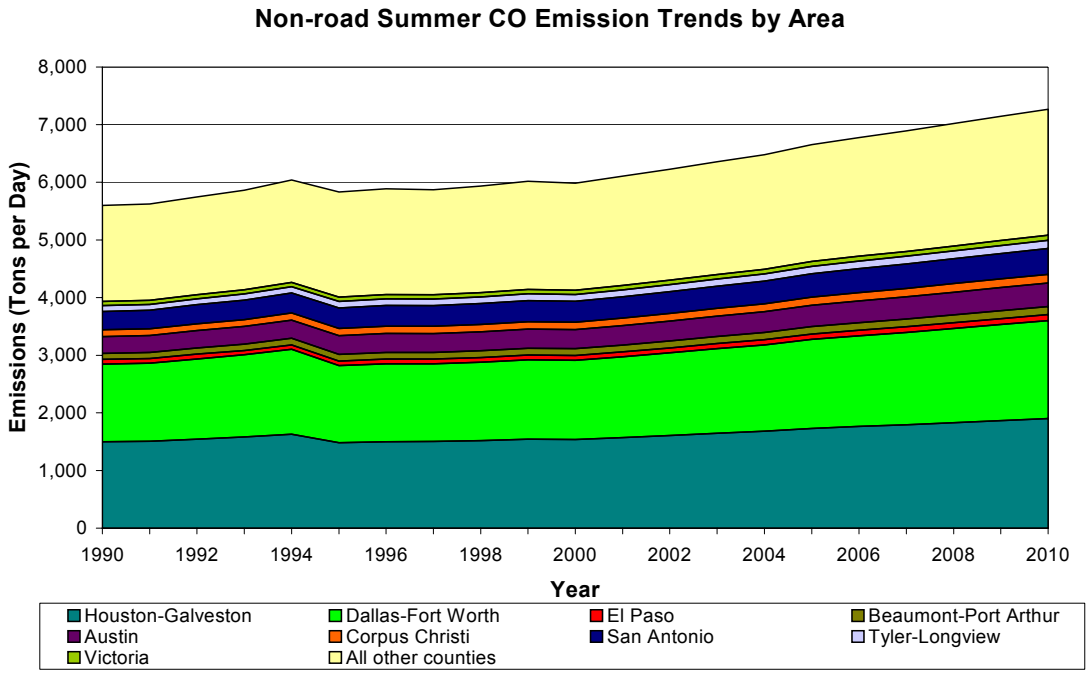

Statewide Non-road Annual CO Emission Trends by Source
Ratios Relative to 1999
Ratio
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

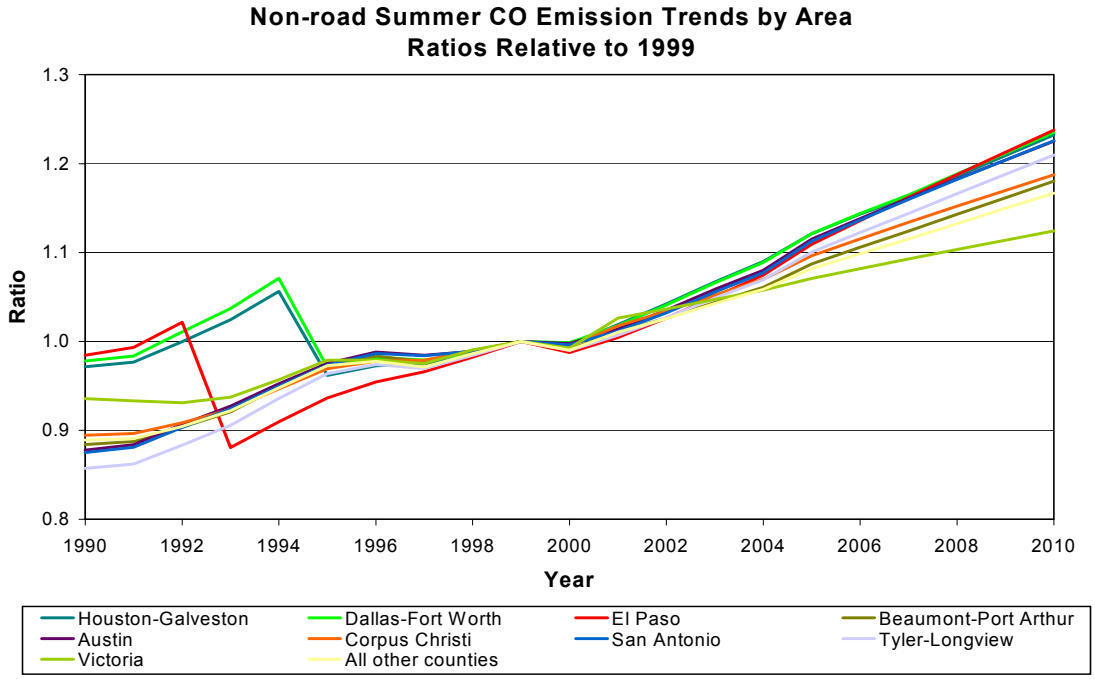

Non-road Annual CO Emission Trends by Area
Emissions (Tons per Year)
2,000,000
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

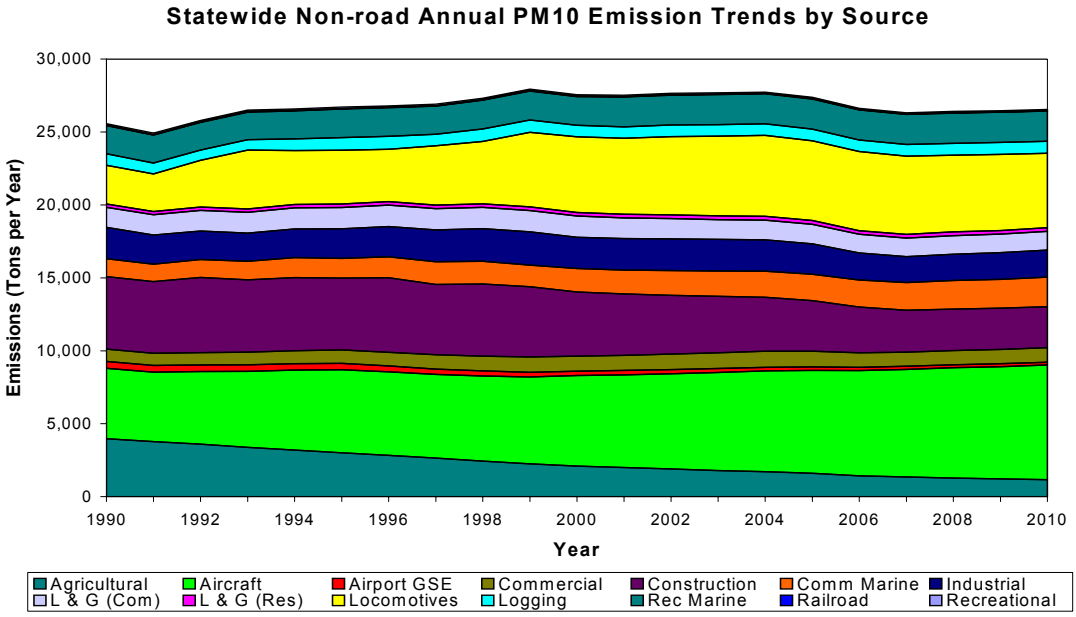

Non-road Annual CO Emission Trends by Area
Ratios Relative to 1999
Ratio
1.3
1.2
1.1
1.0
0.9
0.8
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

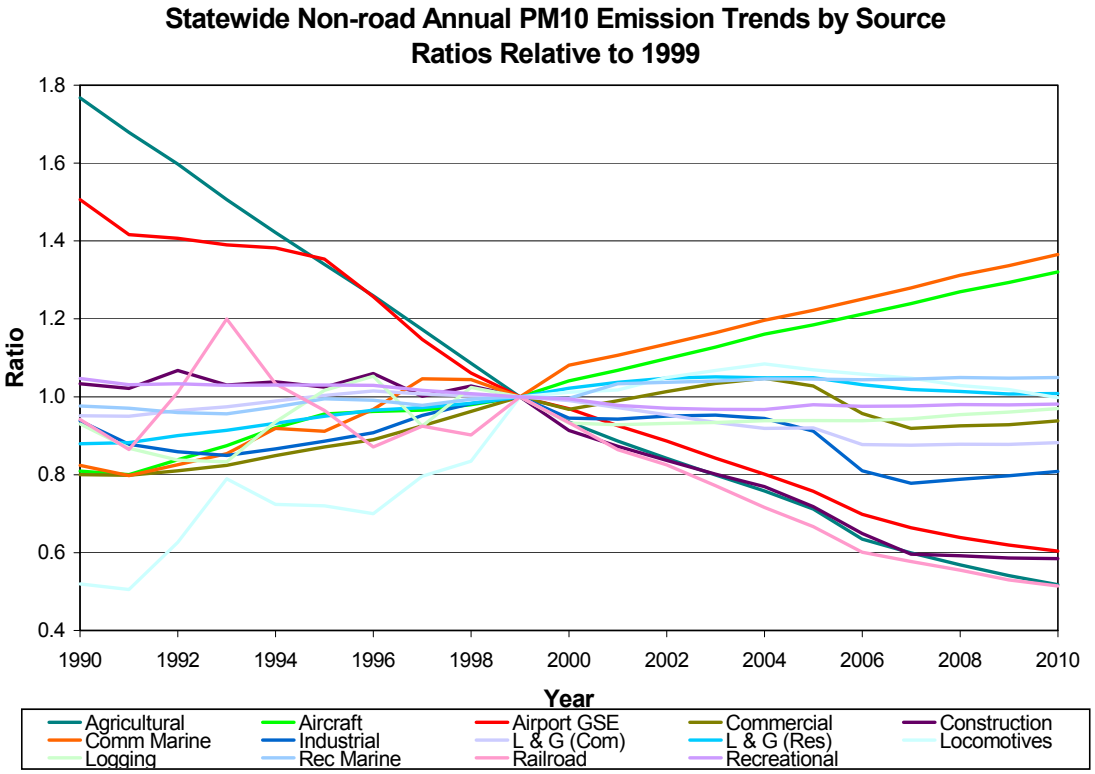

Statewide Non-Road Summer CO Emission Trends by Source
Emissions (Tons per Day)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Comm Marine
Construction
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Railroad
Recreational
Rec Marine

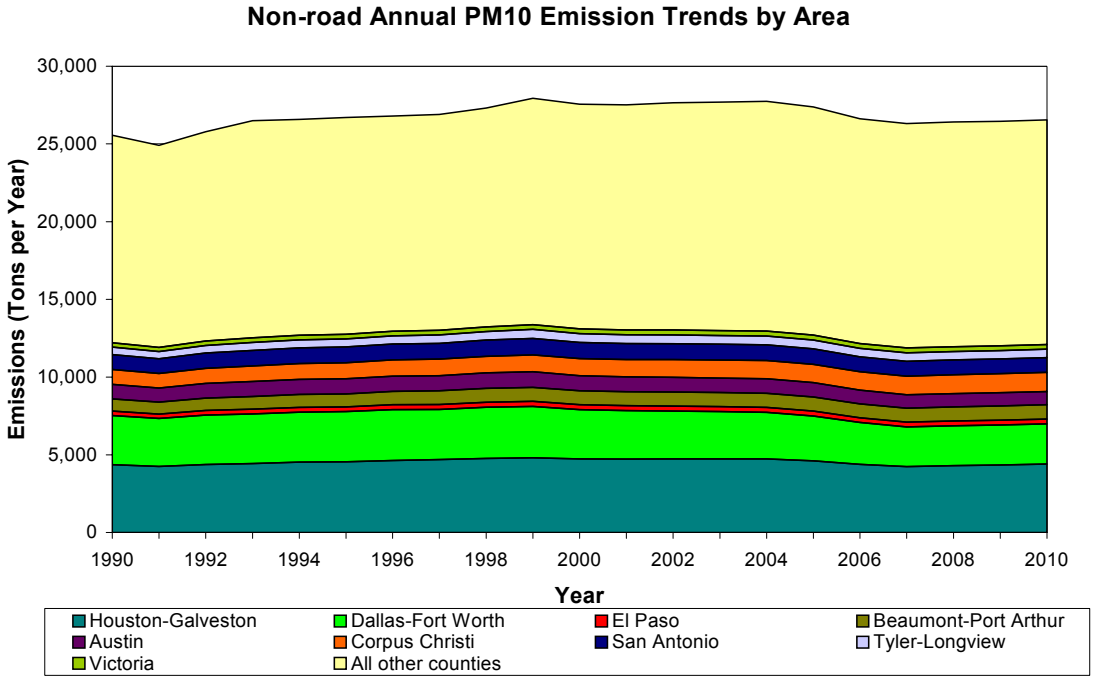

Statewide Non-road Summer CO Emission Trends by Source
Ratios Relative to 1999
Ratio
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

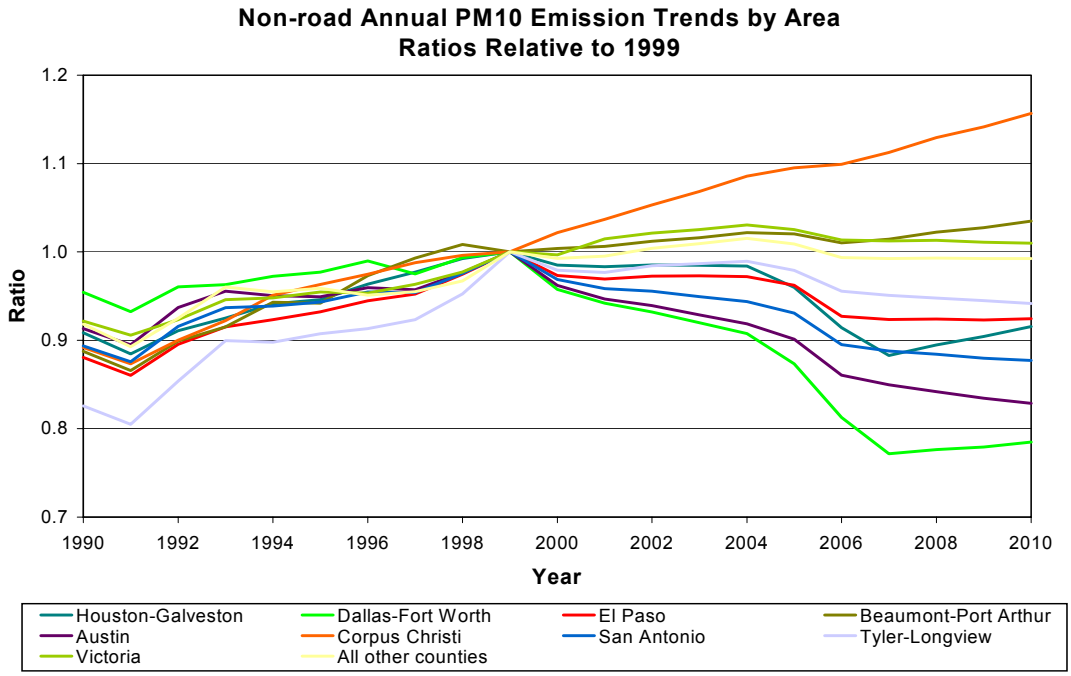

Non-road Summer CO Emission Trends by Area
Emissions (Tons per Day)
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

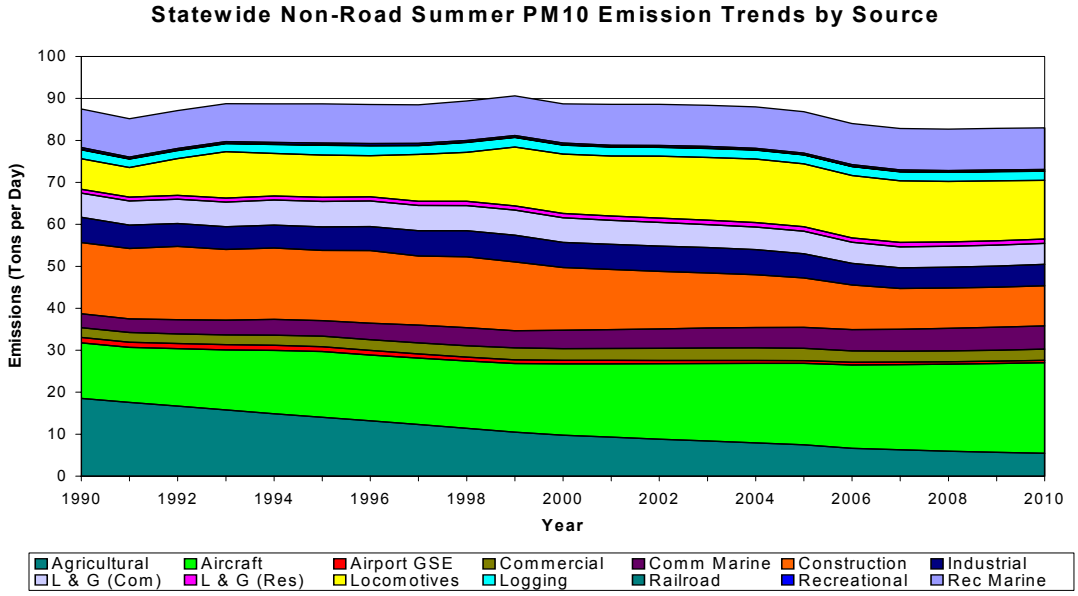

Non-road Summer CO Emission Trends by Area
Ratios Relative to 1999
Ratio
1.3
1.2
1.1
1.0
0.9
0.8
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

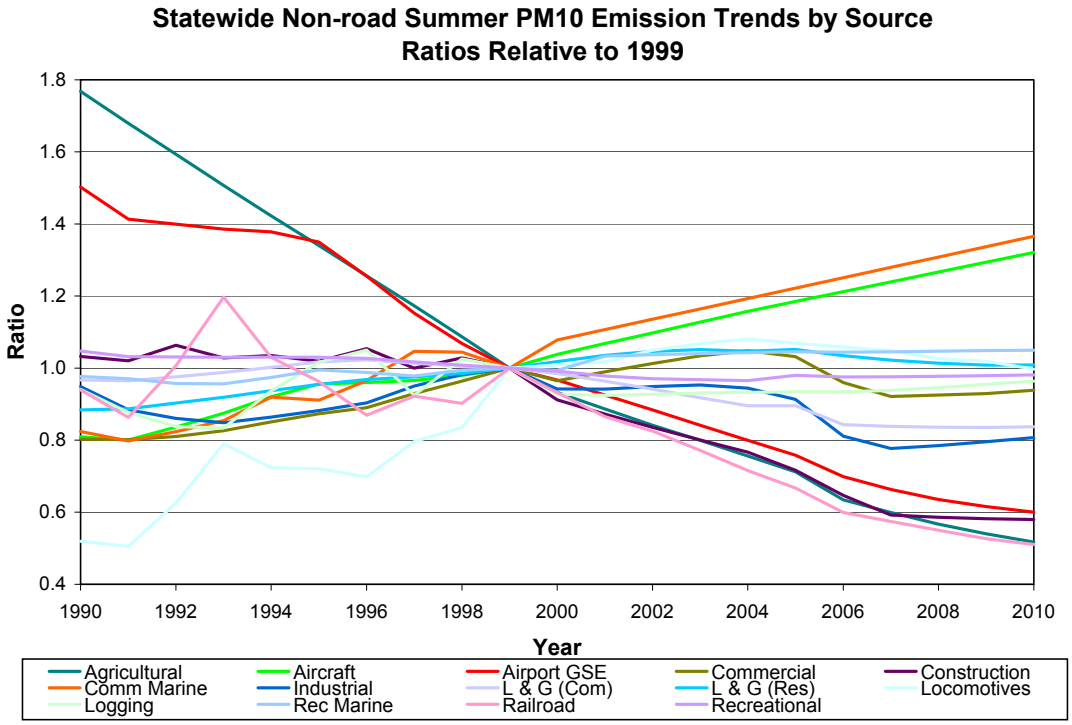

Statewide Non-road Annual PM10 Emission Trends by Source
Emissions (Tons per Year)
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

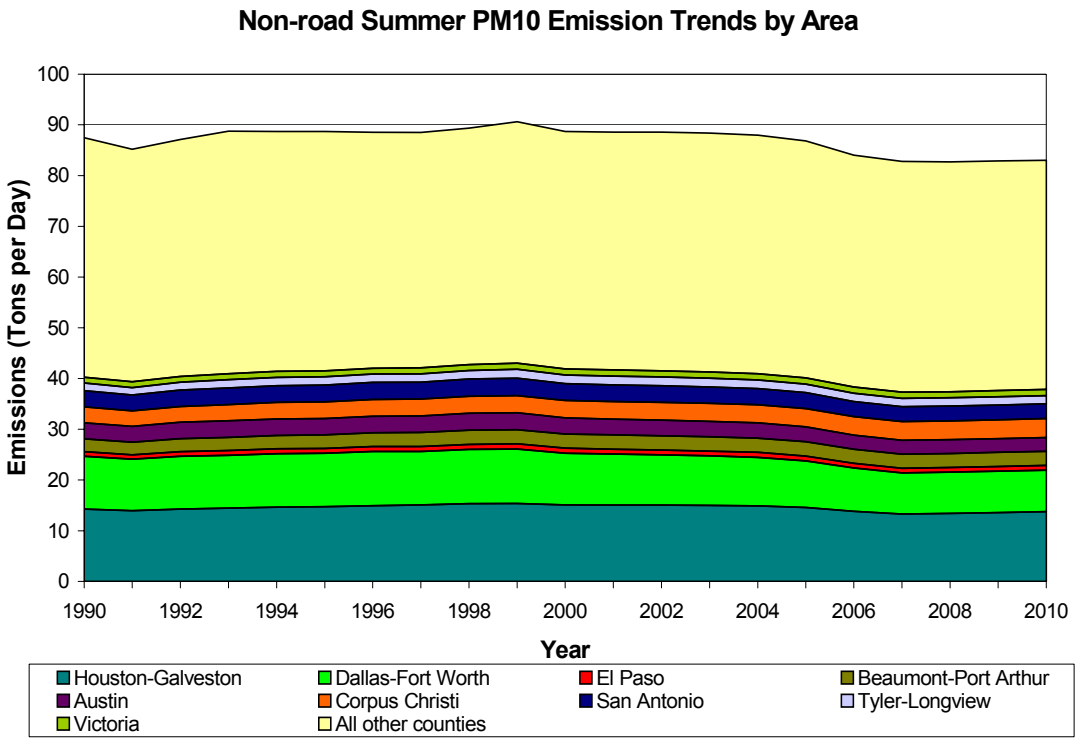

Statewide Non-road Annual PM10 Emission Trends by Source
Ratios Relative to 1999
Ratio
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

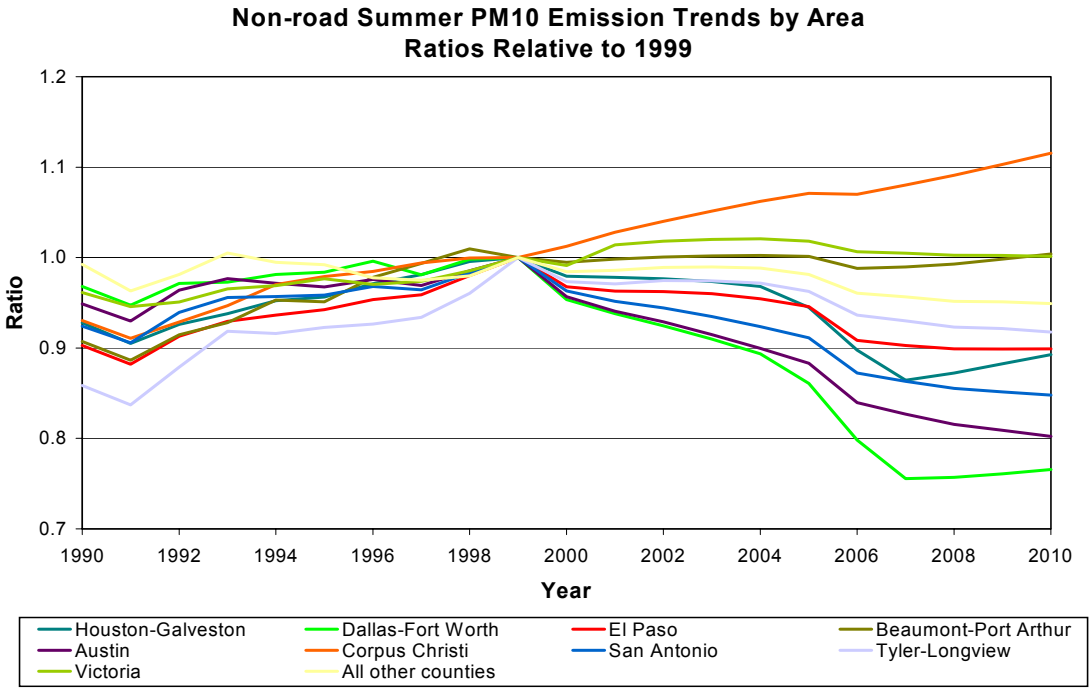

Non-road Annual PM10 Emission Trends by Area
Emissions (Tons per Year)
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

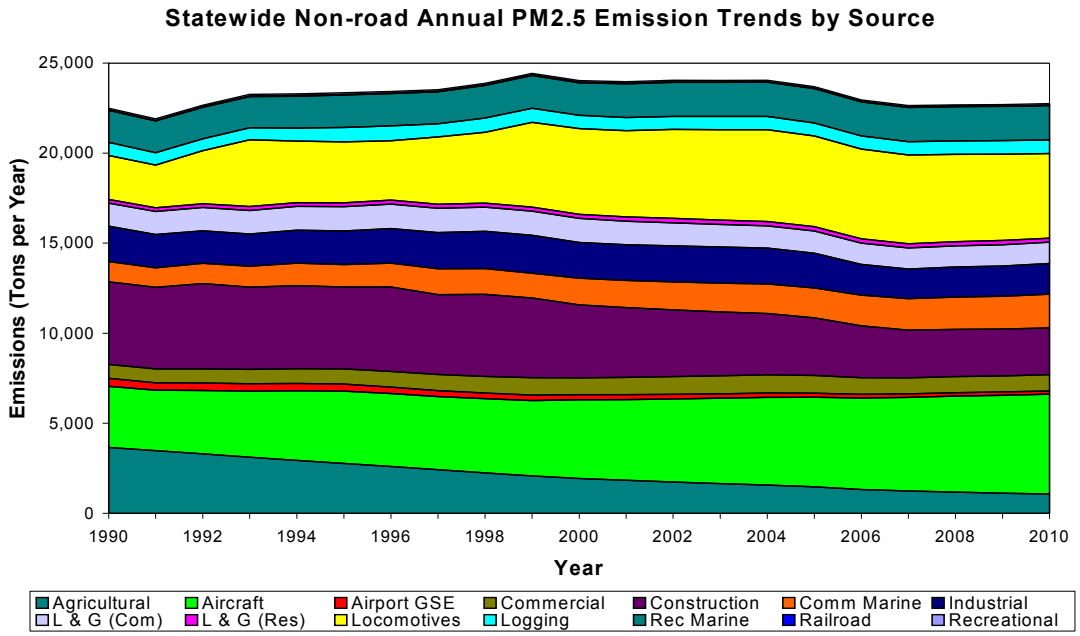

Non-road Annual PM10 Emission Trends by Area
Ratios Relative to 1999
Ratio
1.2
1.1
1.0
0.9
0.8
0.7
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

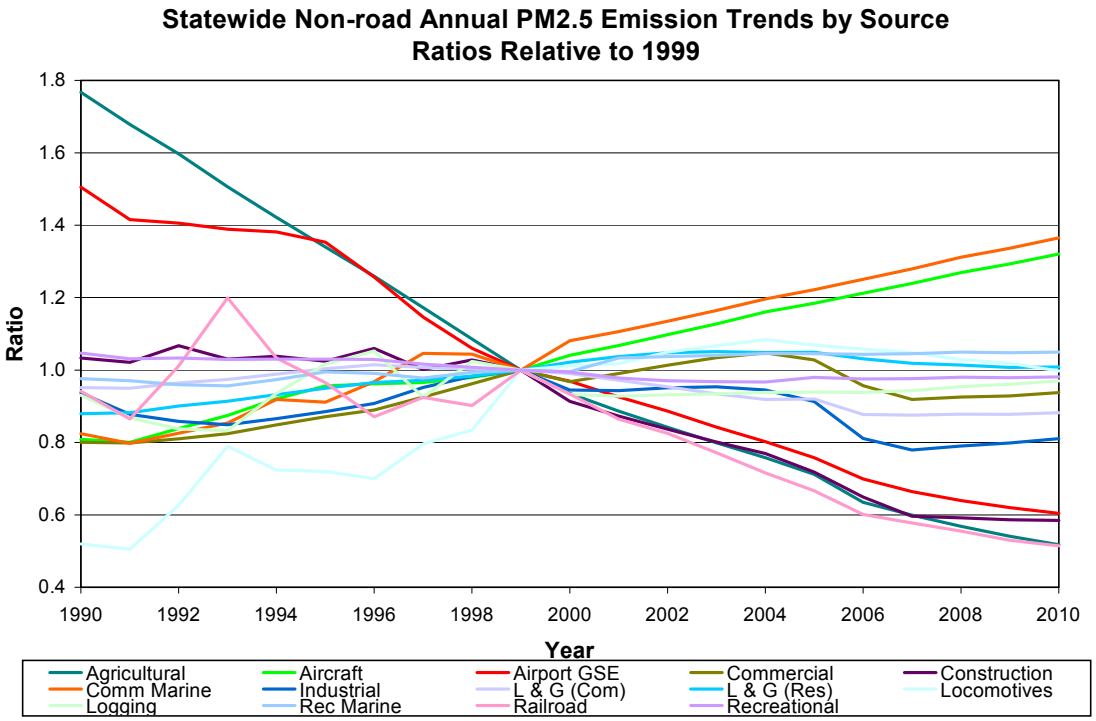

Statewide Non-Road Summer PM10 Emission Trends by Source
Emissions (Tons per Day)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Comm Marine
Construction
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Railroad
Recreational
Rec Marine

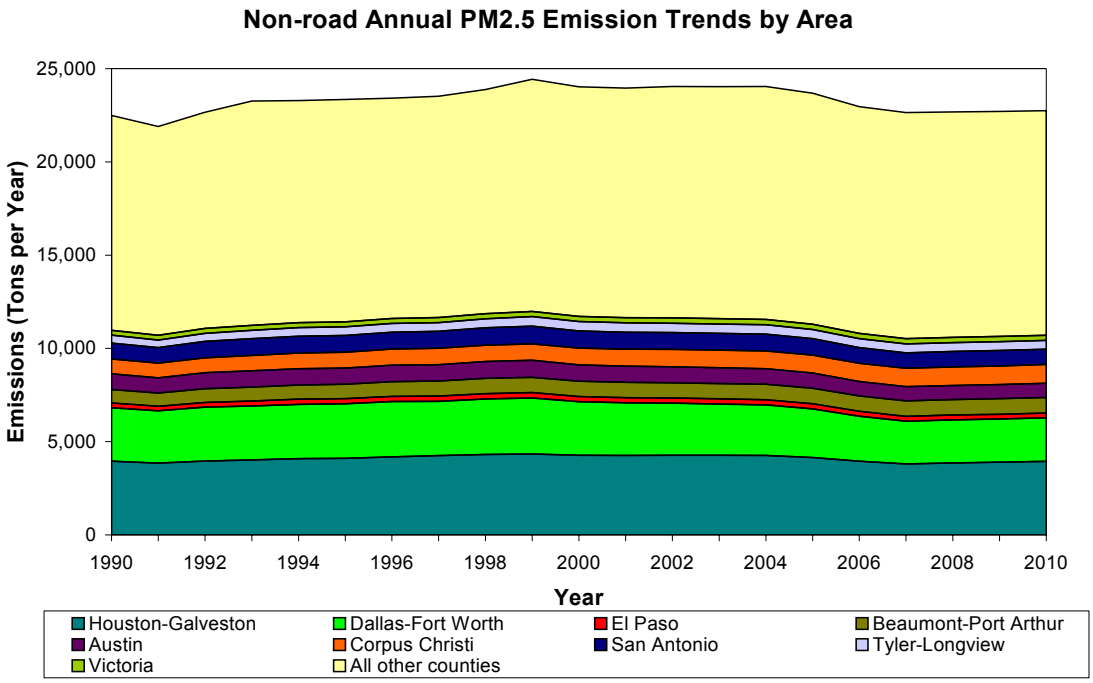

Statewide Non-road Summer PM10 Emission Trends by Source
Ratios Relative to 1999
Ratio
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

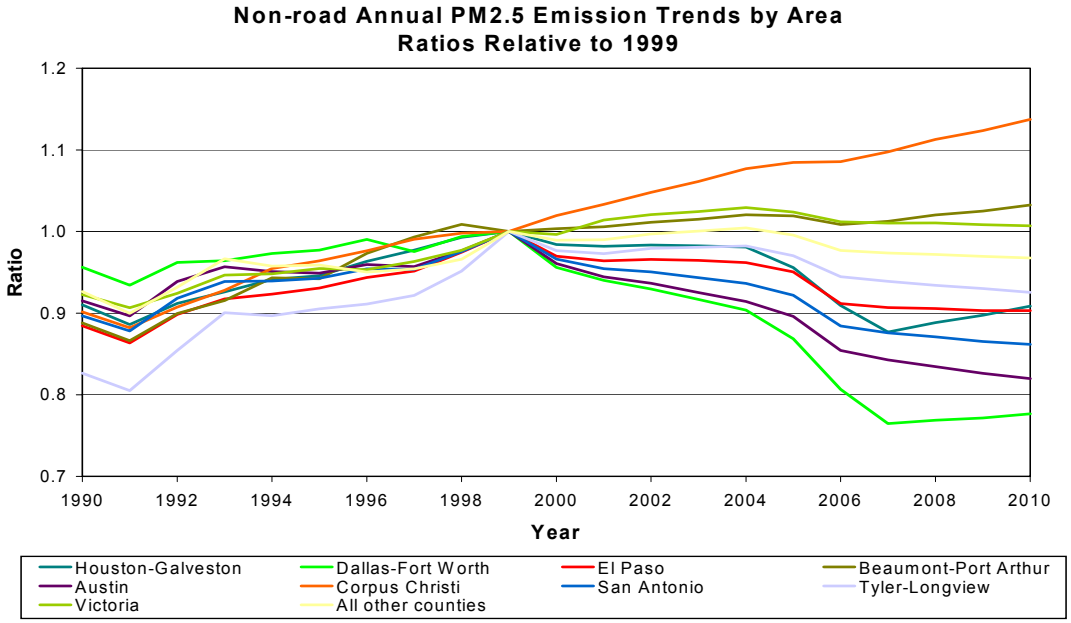

Non-road Summer PM10 Emission Trends by Area
Emissions (Tons per Day)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

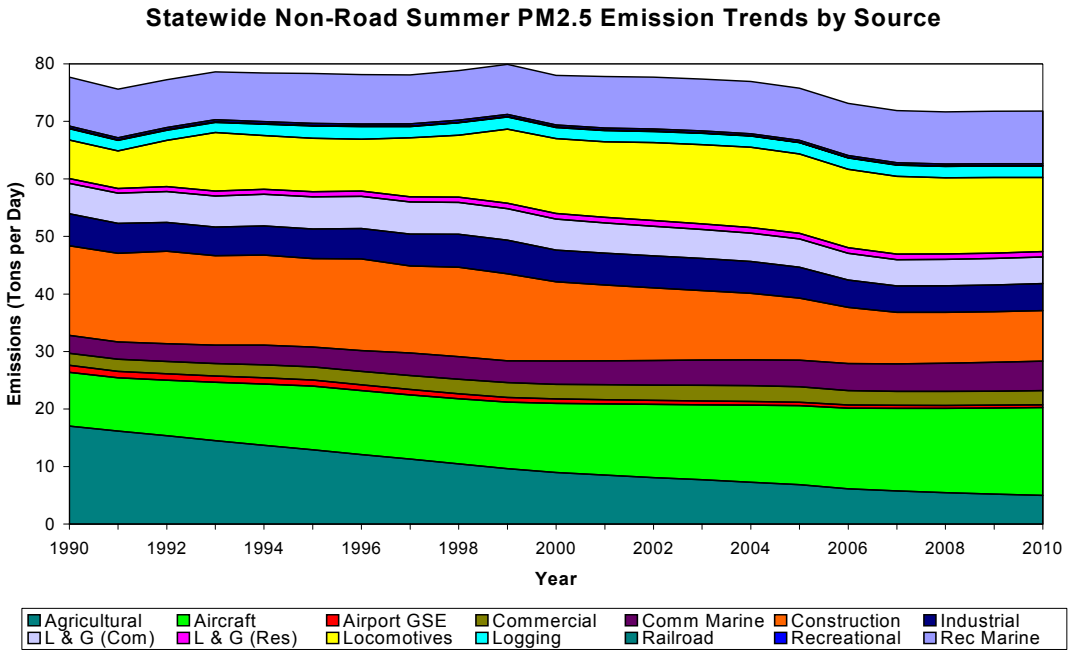

Non-road Summer PM10 Emission Trends by Area
Ratios Relative to 1999
Ratio
1.2
1.1
1.0
0.9
0.8
0.7
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

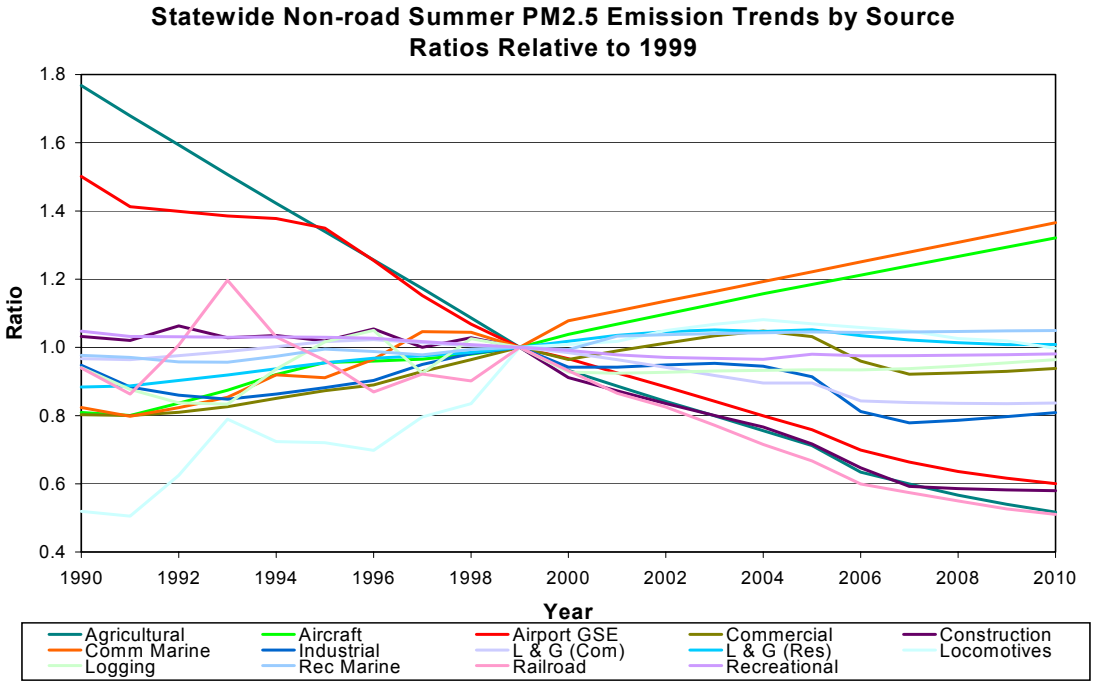

Statewide Non-road Annual PM2.5 Emission Trends by Source
Emissions (Tons per Year)
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

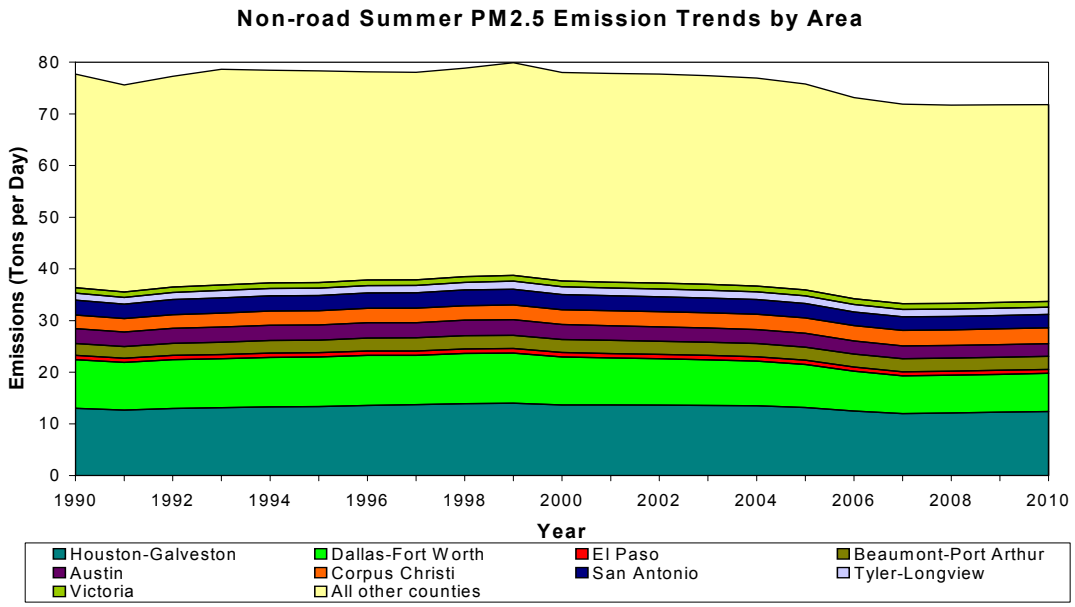

Statewide Non-road Annual PM2.5 Emission Trends by Source
Ratios Relative to 1999
Ratio
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

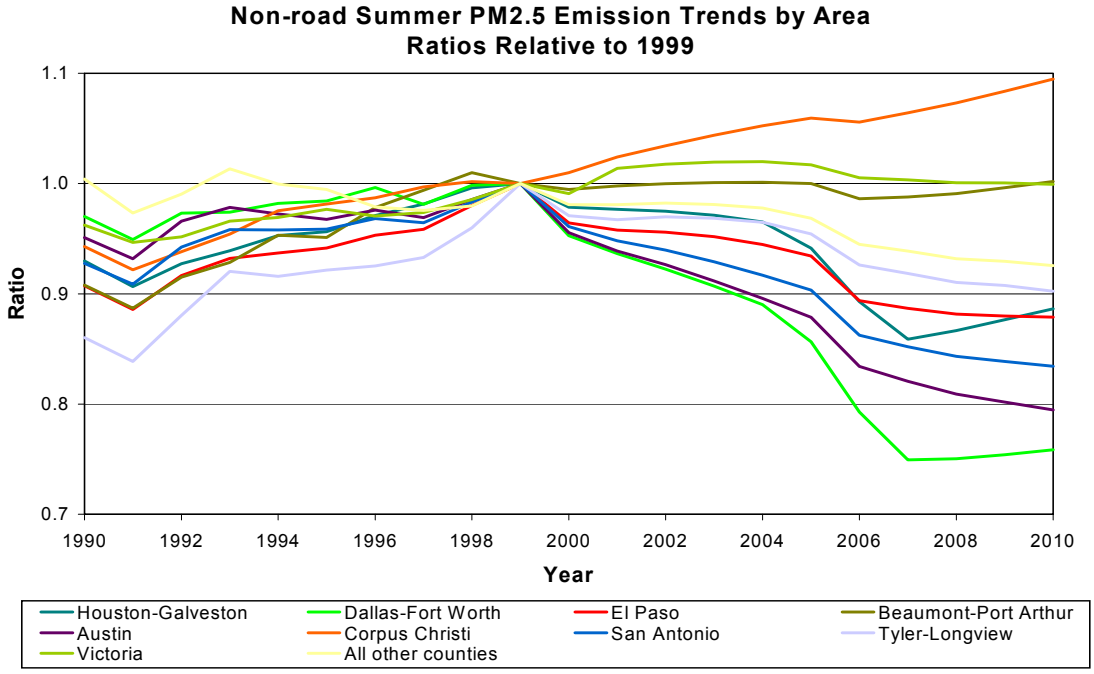

Non-road Annual PM2.5 Emission Trends by Area
Emissions (Tons per Year)
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

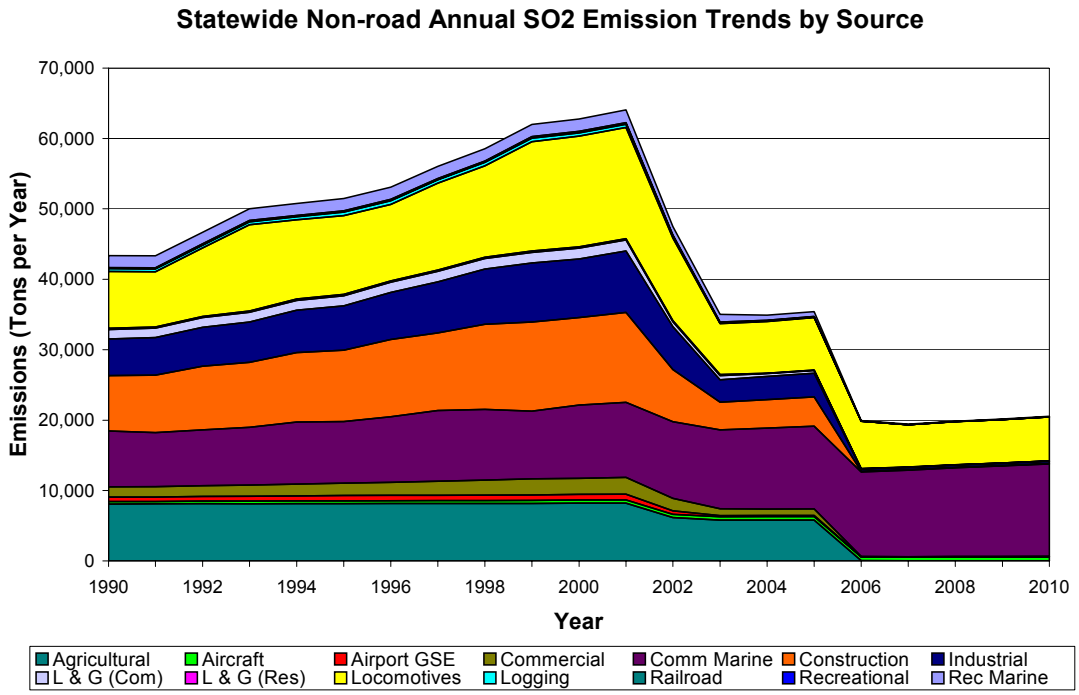

Non-road Annual PM2.5 Emission Trends by Area
Ratios Relative to 1999
Ratio
1.2
1.1
1.0
0.9
0.8
0.7
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

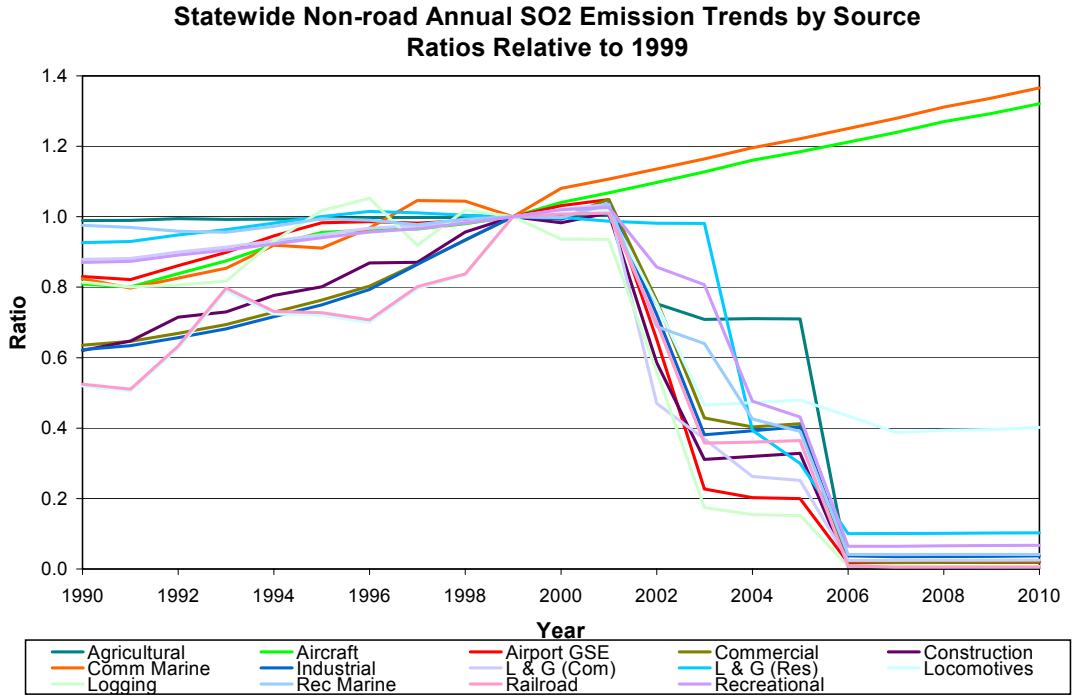

Statewide Non-Road Summer PM2.5 Emission Trends by Source
Emissions (Tons per Day)
0
10
20
30
40
50
60
70
80
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Comm Marine
Construction
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Railroad
Recreational
Rec Marine

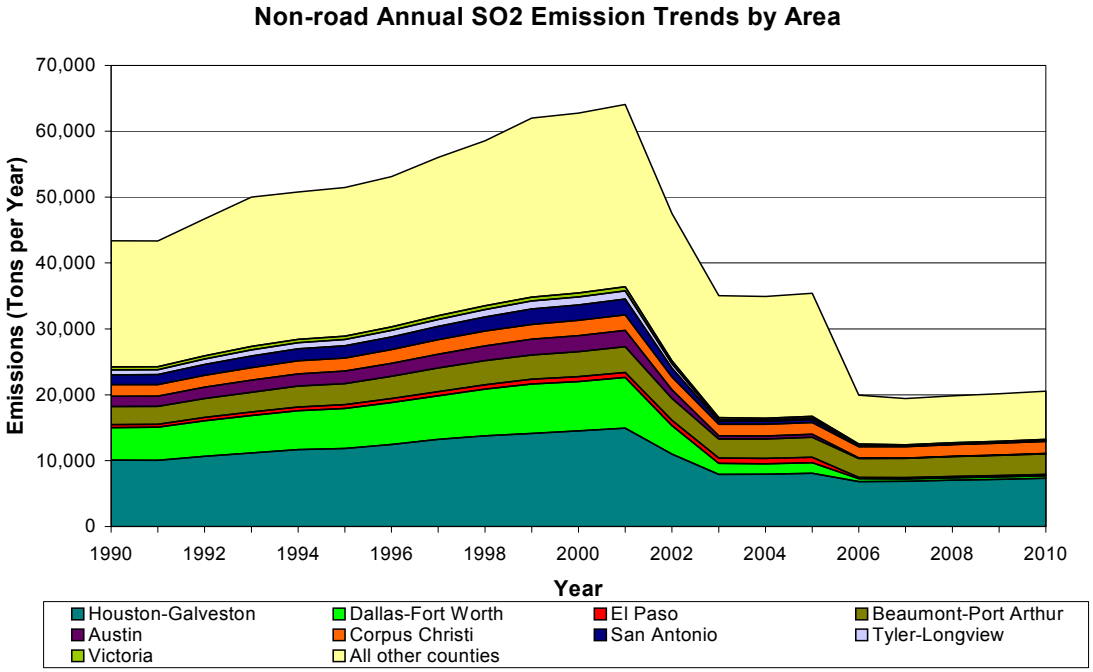

Statewide Non-road Summer PM2.5 Emission Trends by Source
Ratios Relative to 1999
Ratio
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

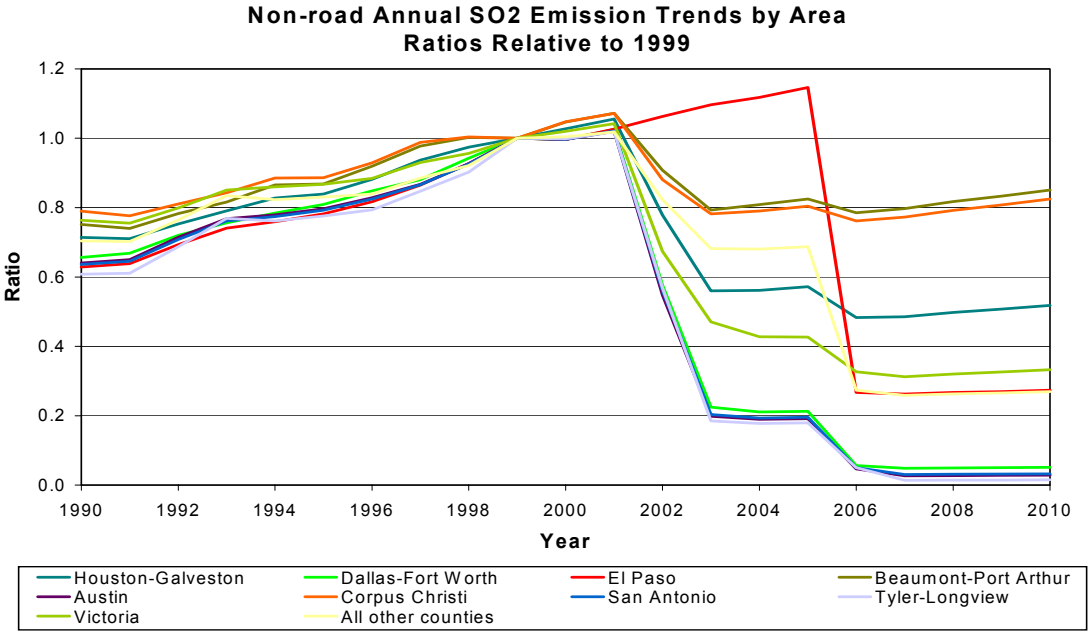

Non-road Summer PM2.5 Emission Trends by Area
Emissions (Tons per Day)
0
10
20
30
40
50
60
70
80
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

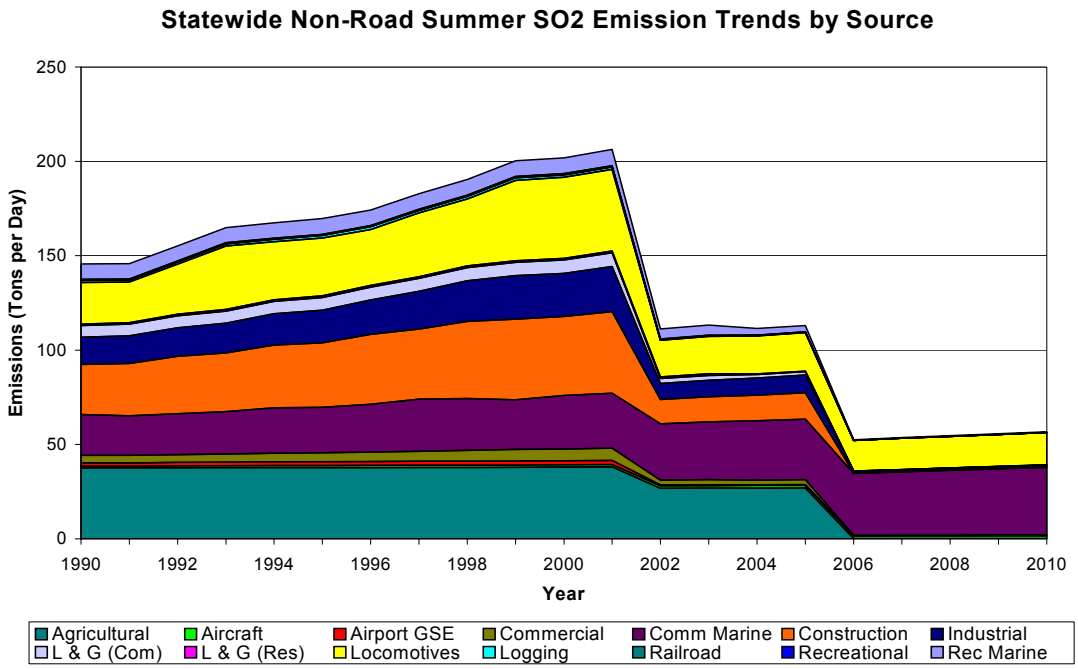

Non-road Summer PM2.5 Emission Trends by Area
Ratios Relative to 1999
Ratio
0.7
0.8
0.9
1.0
1.1
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

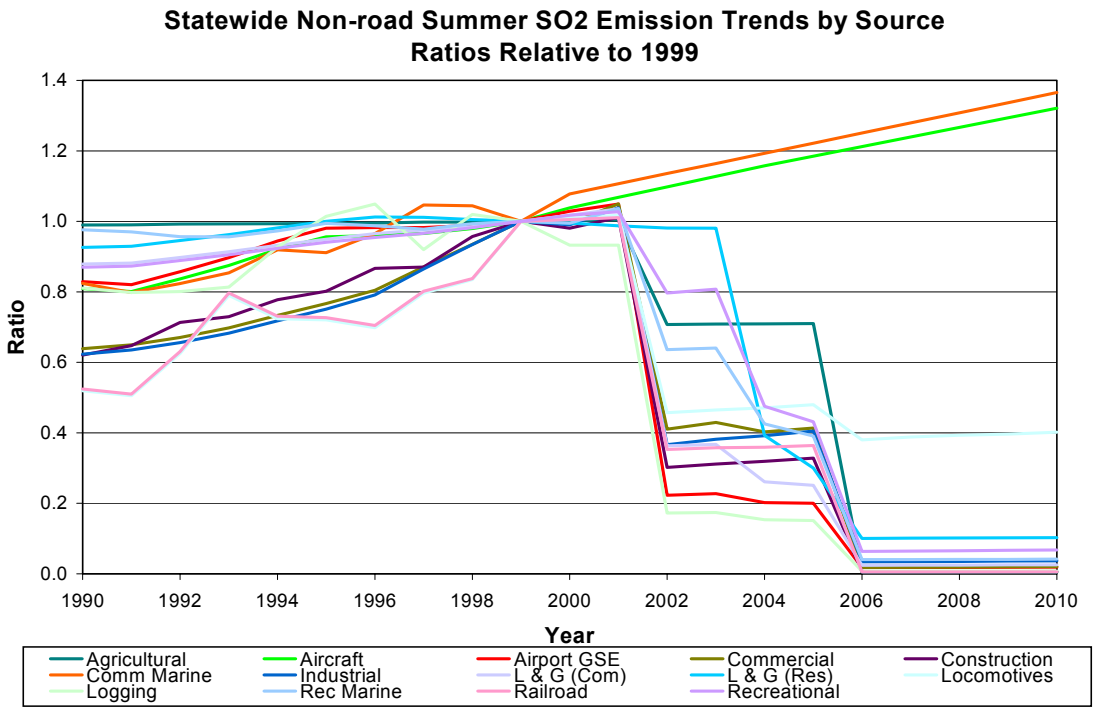

Statewide Non-road Annual SO2 Emission Trends by Source
Emissions (Tons per Year)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Comm Marine
Construction
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Railroad
Recreational
Rec Marine

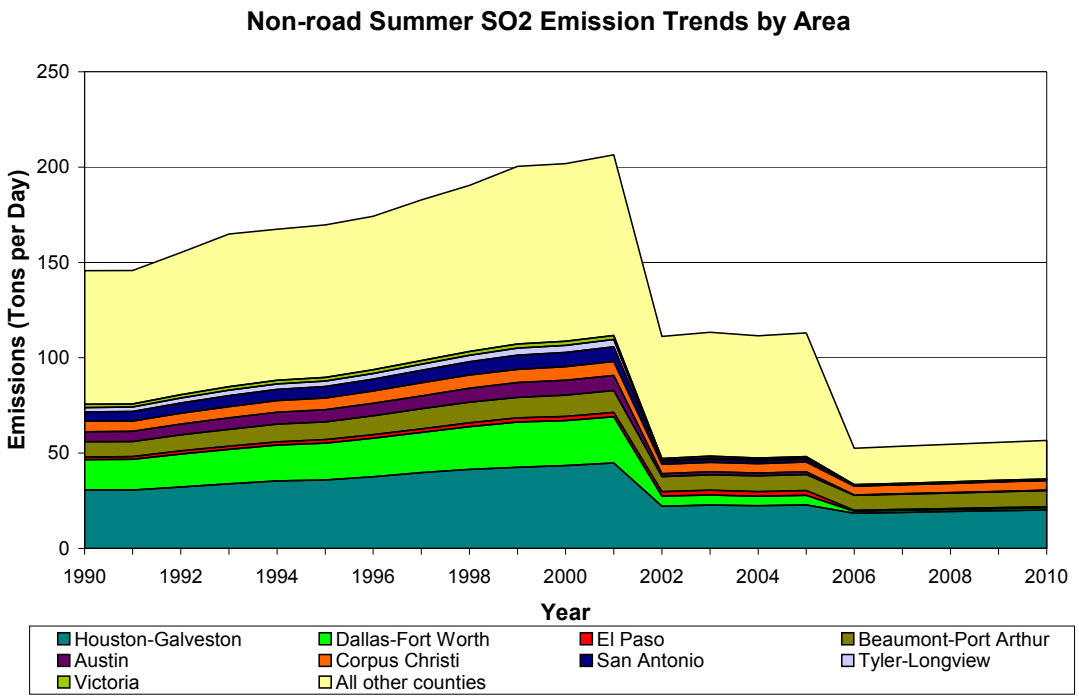

Statewide Non-road Annual SO2 Emission Trends by Source
Ratios Relative to 1999
Ratio
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

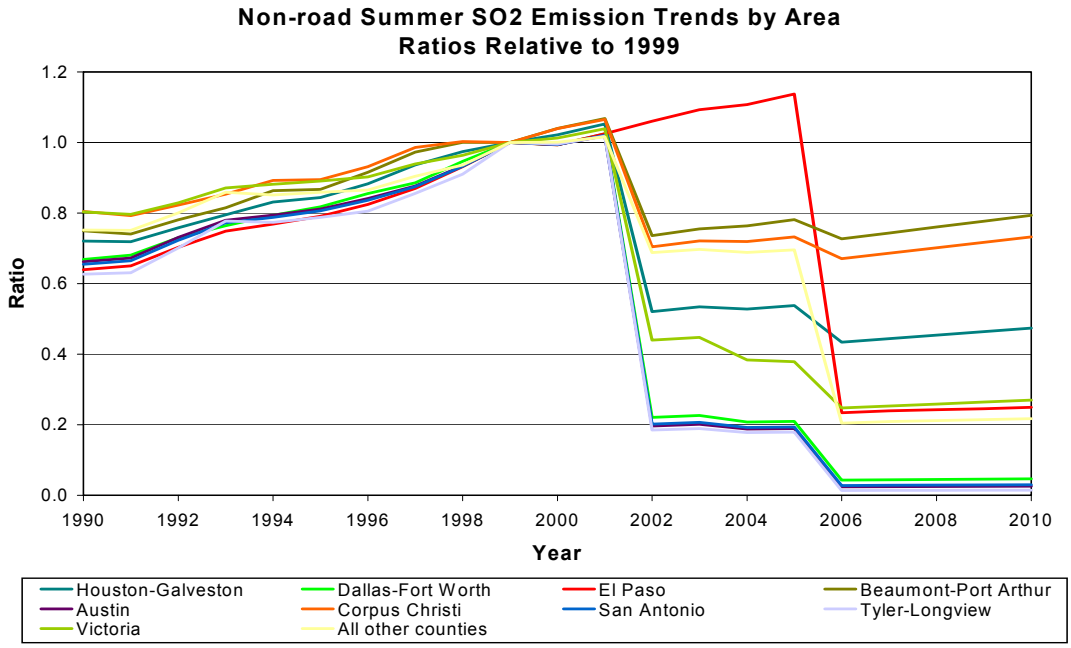

Non-road Annual SO2 Emission Trends by Area
Emissions (Tons per Year)
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

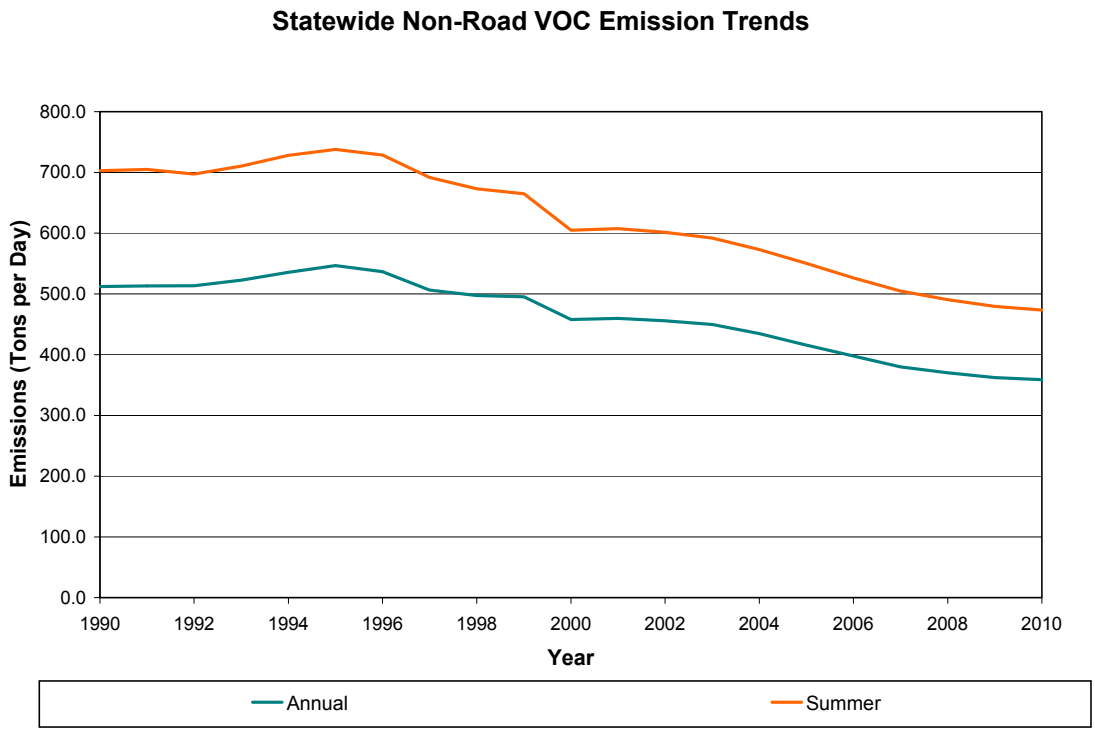

Non-road Annual SO2 Emission Trends by Area
Ratios Relative to 1999
Ratio
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

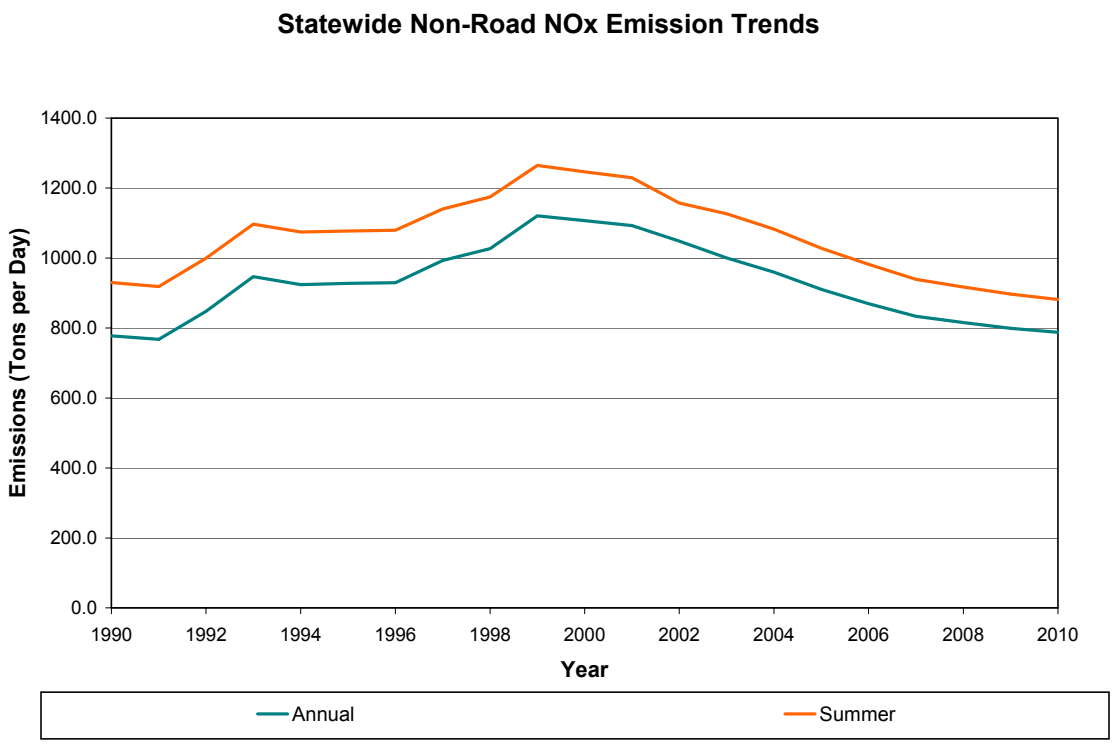

Statewide Non-Road Summer SO2 Emission Trends by Source
Emissions (Tons per Day)
250
200
150
100
50
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Comm Marine
Construction
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Railroad
Recreational
Rec Marine

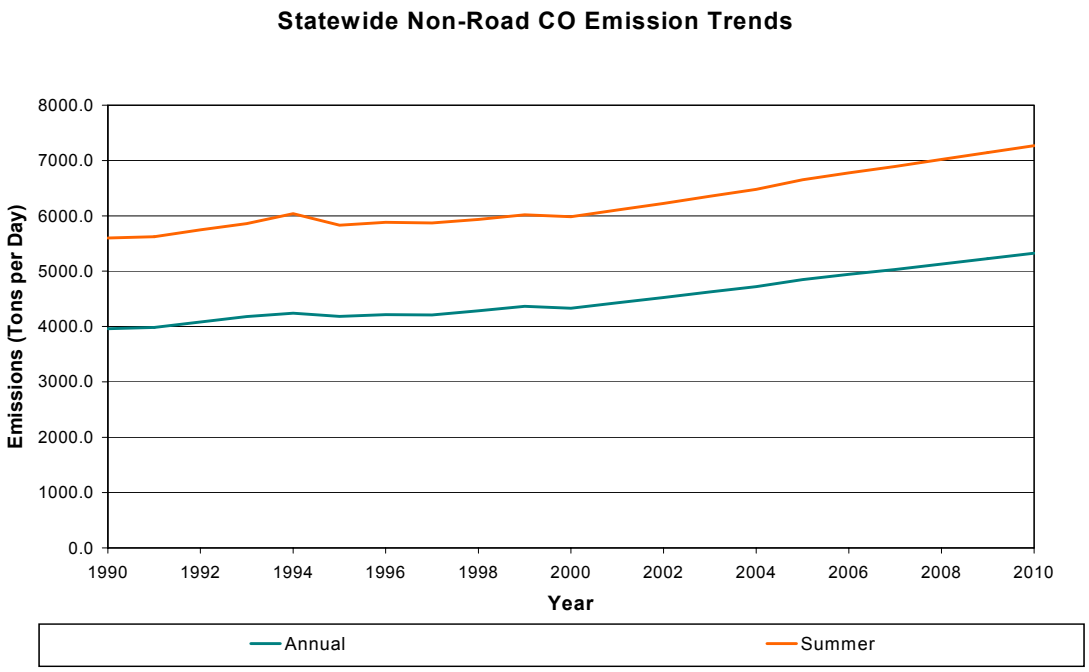

Statewide Non-road Summer SO2 Emission Trends by Source
Ratios Relative to 1999
Ratio
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Agricultural
Aircraft
Airport GSE
Commercial
Construction
Comm Marine
Industrial
L & G (Com)
L & G (Res)
Locomotives
Logging
Rec Marine
Railroad
Recreational

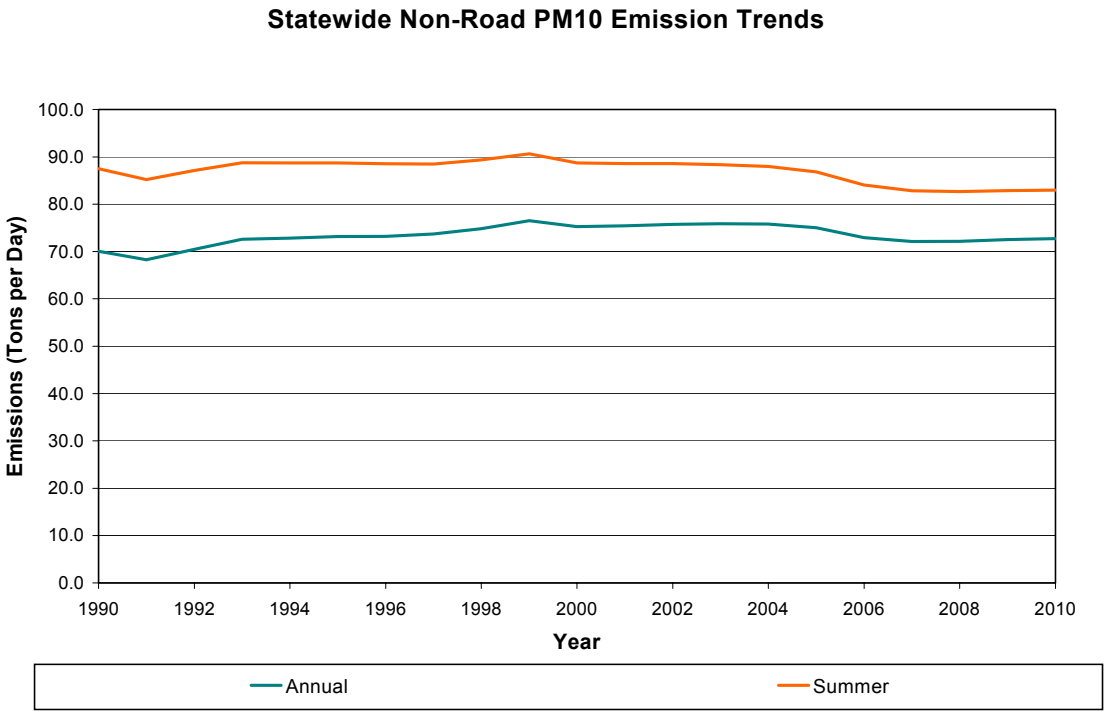

Non-road Summer SO2 Emission Trends by Area
Emissions (Tons per Day)
250
200
150
100
50
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

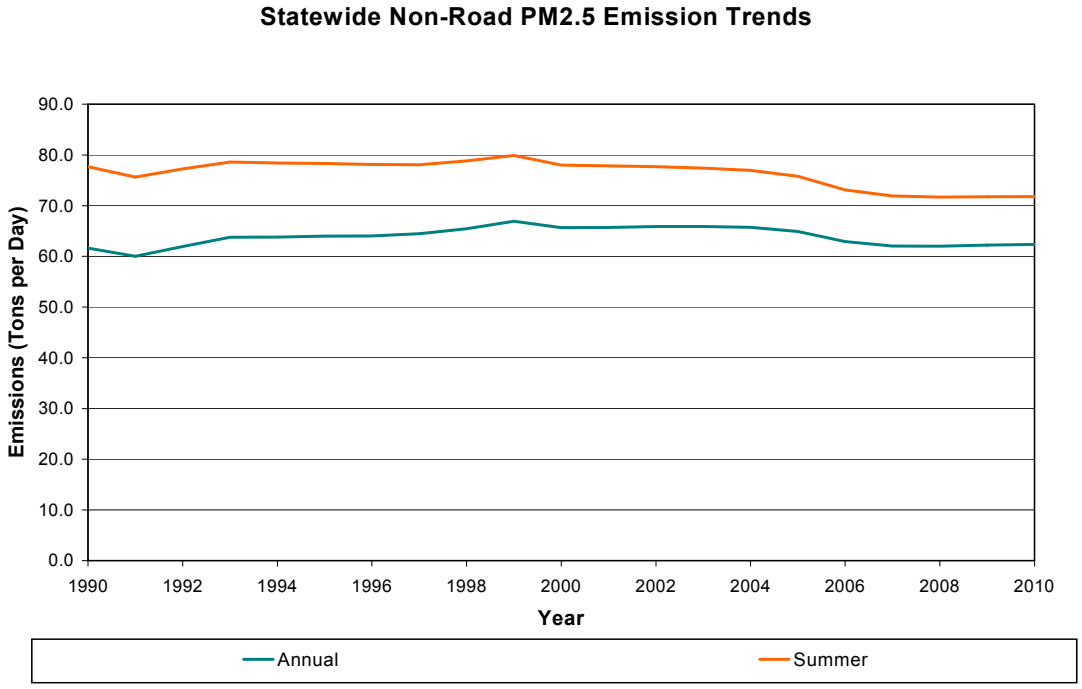

Non-road Summer SO2 Emission Trends by Area
Ratios Relative to 1999
Ratio
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


Statewide Non-Road VOC Emission Trends
Emissions (Tons per Day)
800.0
700.0
600.0
500.0
400.0
300.0
200.0
100.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide Non-Road NOx Emission Trends
Emissions (Tons per Day)
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide Non-Road CO Emission Trends
Emissions (Tons per Day)
8000.0
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide Non-Road PM10 Emission Trends
Emissions (Tons per Day)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide Non-Road PM2.5 Emission Trends
Emissions (Tons per Day)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1990
1992
1994
1996
1998
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2002
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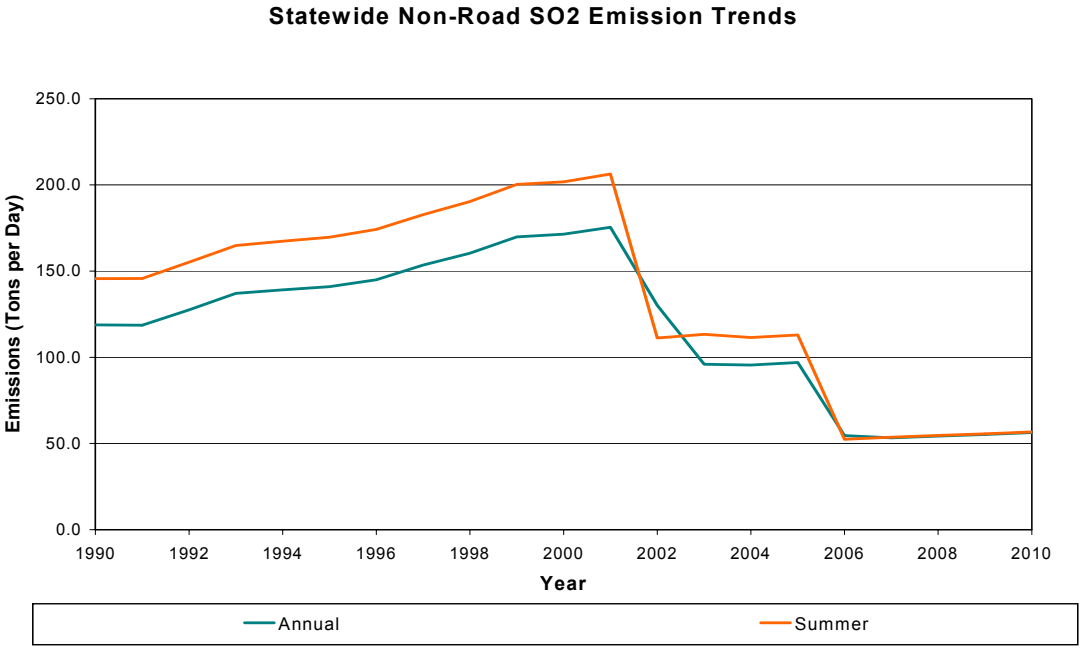
2006
2008
2010
Year
Annual
Summer


Statewide Non-Road SO2 Emission Trends
Emissions (Tons per Day)
250.0
200.0
150.0
100.0
50.0
0.0
1990
1992
1994
1996
1998
2000
2002
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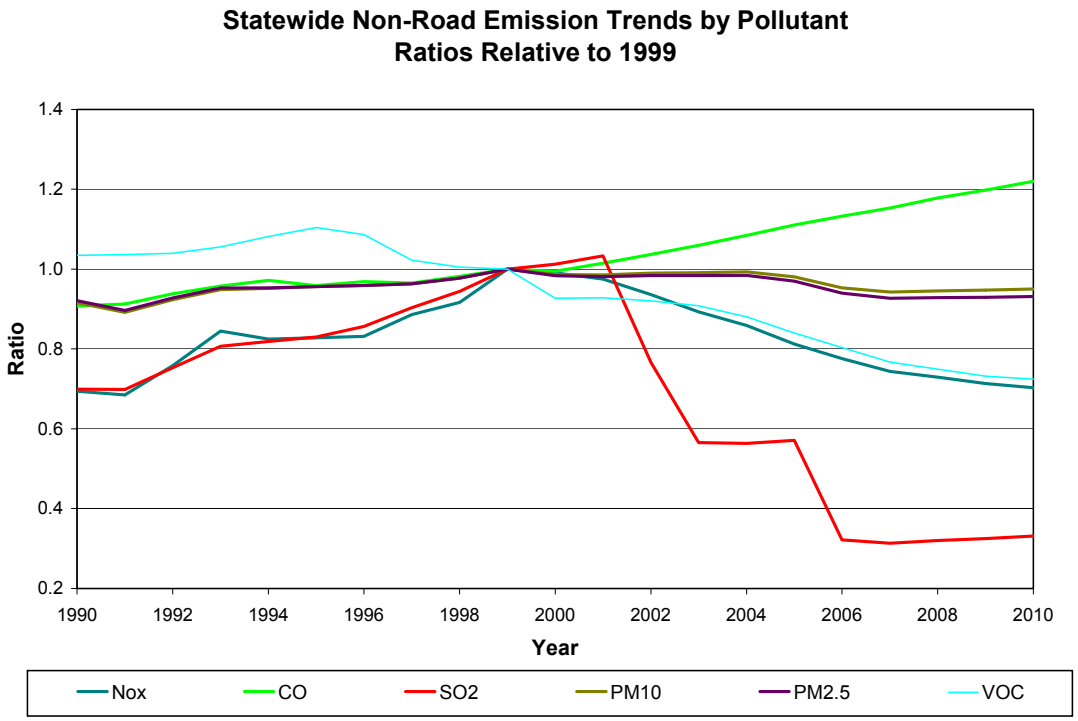
2006
2008
2010
Year
Annual
Summer


Statewide Non-Road Emission Trends by Pollutant
Ratios Relative to 1999
Ratio
1.4
1.2
1.0
0.8
0.6
0.4
0.2
1990
1992
1994
1996
1998
2000
2002
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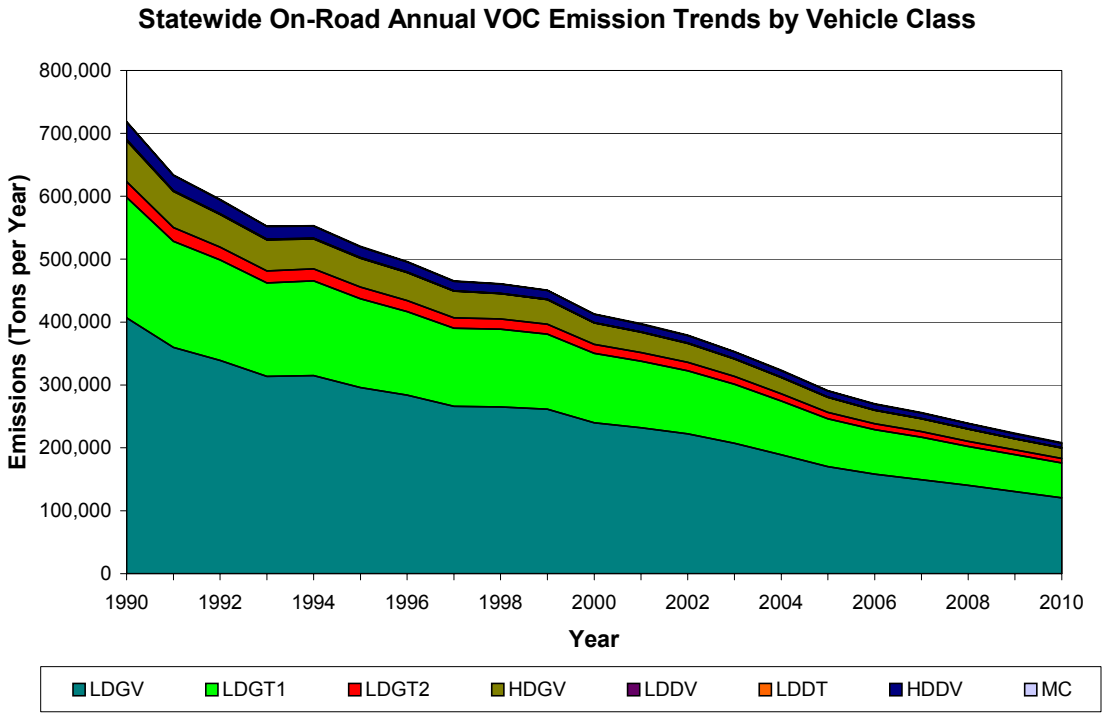
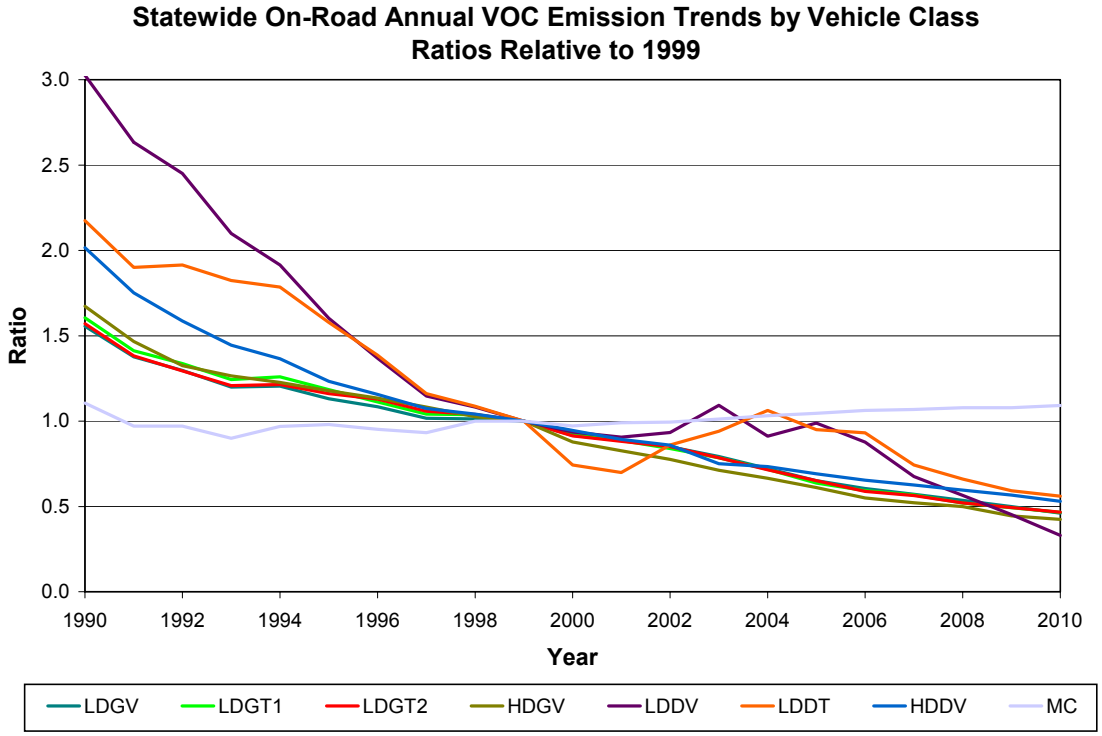
2006
2008
2010
Year
Nox
CO
SO2
PM10
PM2.5
VOC


Statewide On-Road Annual VOC Emission Trends by Vehicle Class
Emissions (Tons per Year)
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


Statewide On-Road Annual VOC Emission Trends by Vehicle Class
Ratios Relative to 1999
Ratio
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
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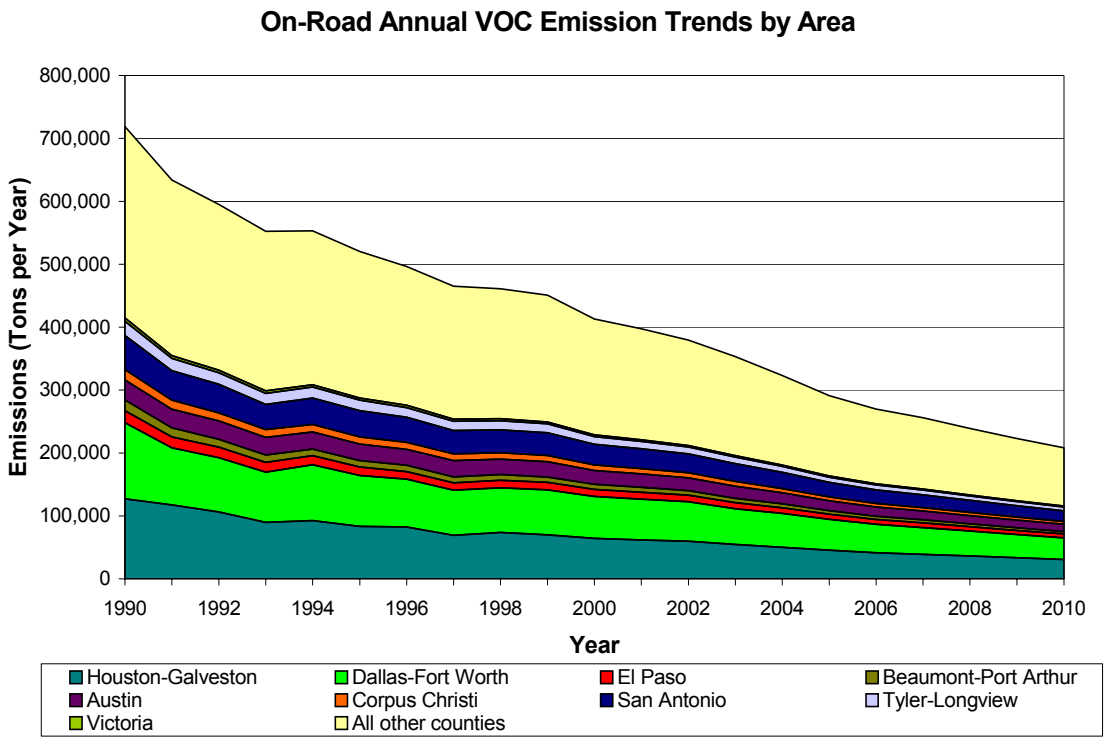
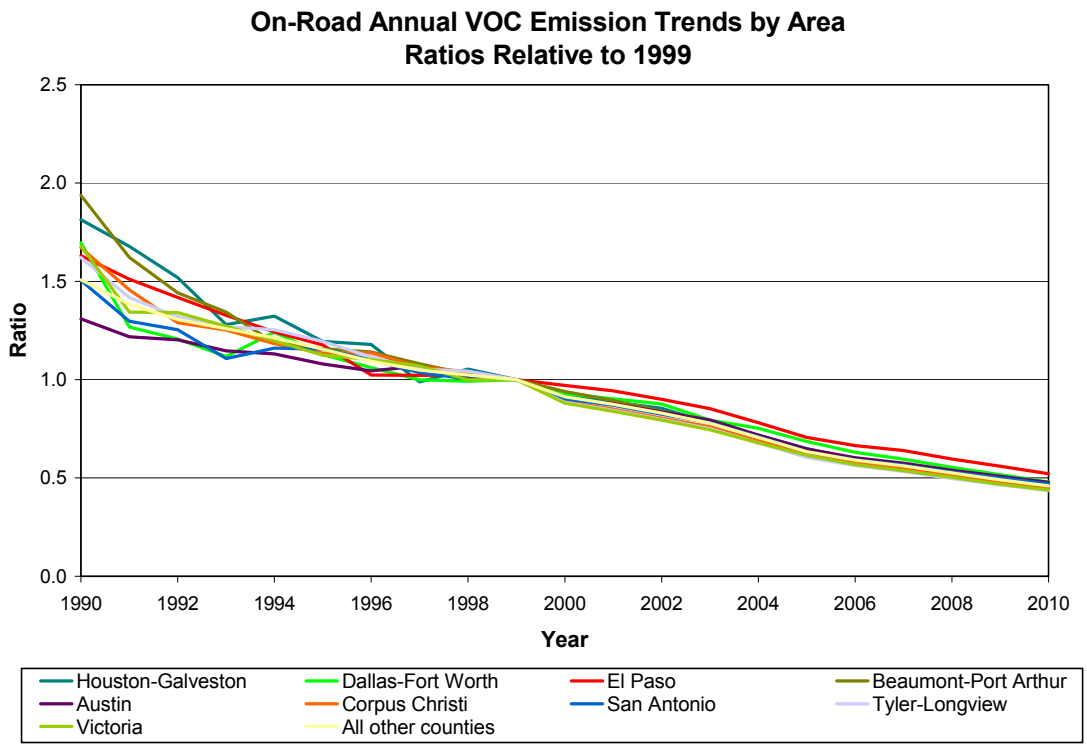
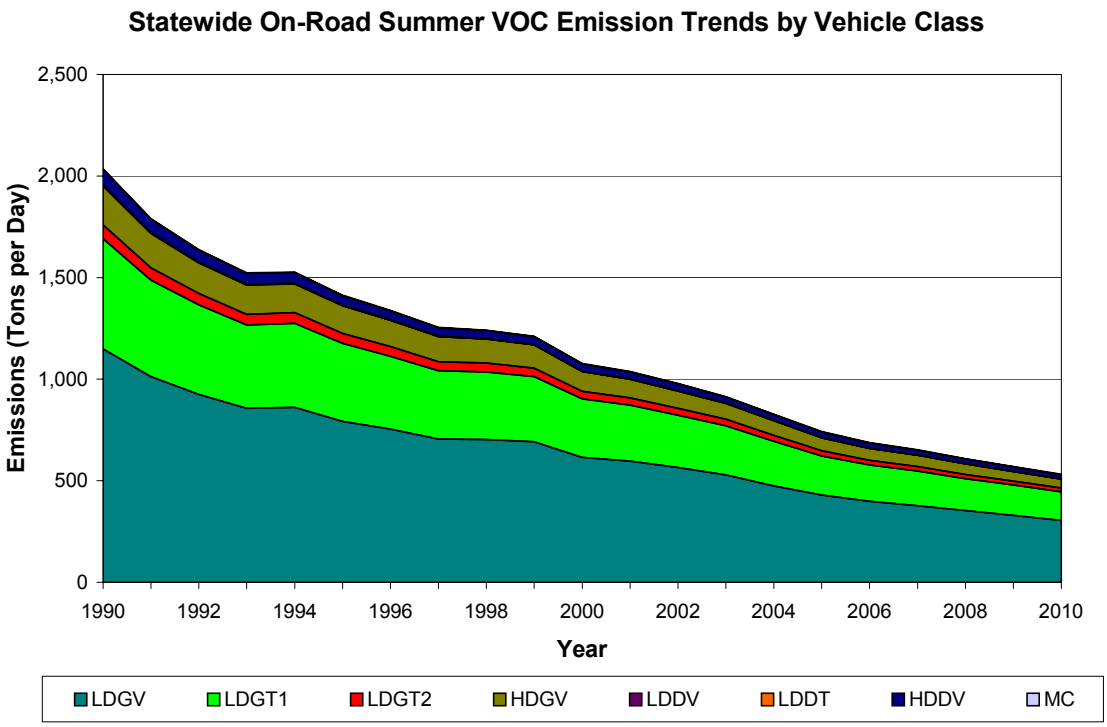
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


On-Road Annual VOC Emission Trends by Area
Emissions (Tons per Year)
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


On-Road Annual VOC Emission Trends by Area
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


Statewide On-Road Summer VOC Emission Trends by Vehicle Class
Emissions (Tons per Day)
2,500
2,000
1,500
1,000
500
0
1990
1992
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2006
2008
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Year
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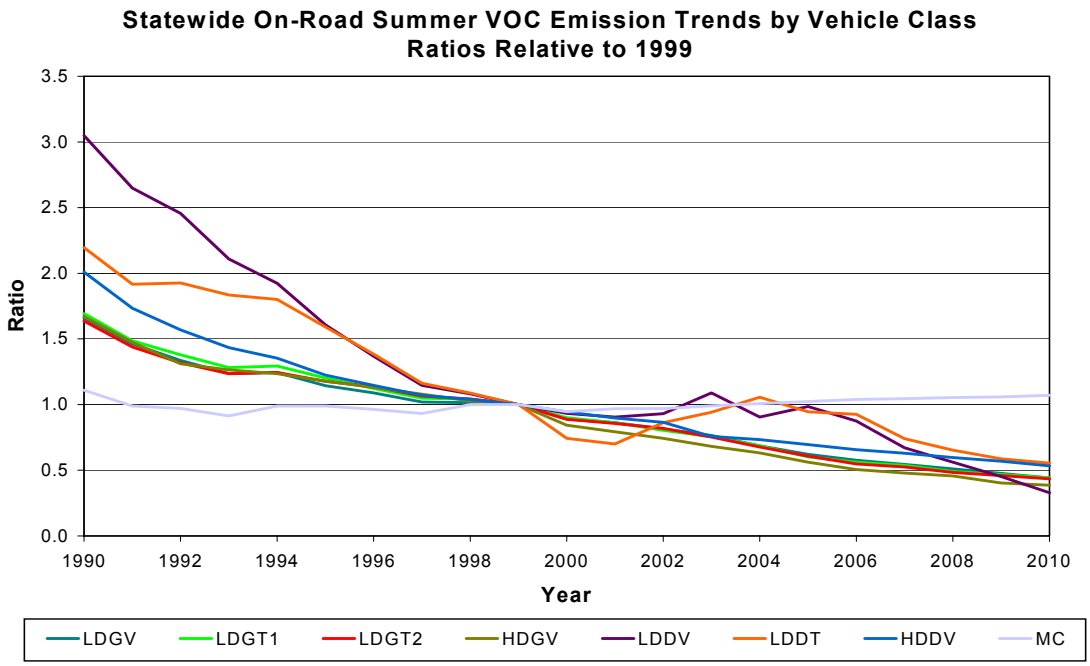
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


Statewide On-Road Summer VOC Emission Trends by Vehicle Class
Ratios Relative to 1999
Ratio
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
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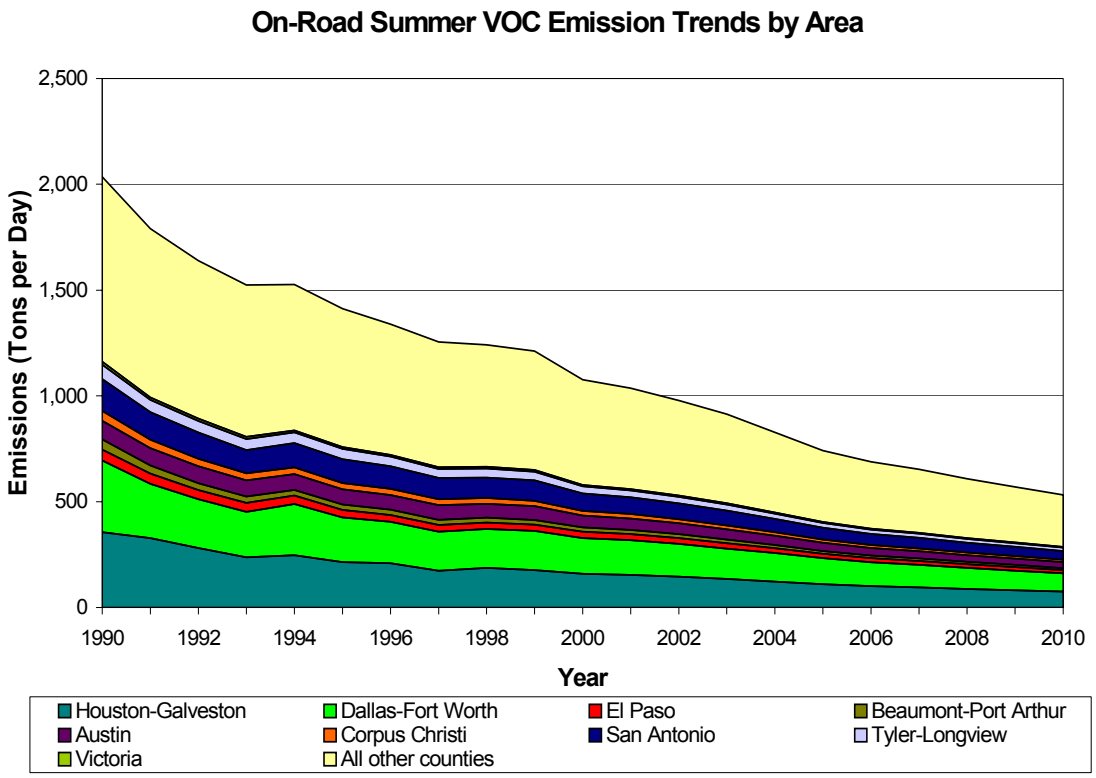
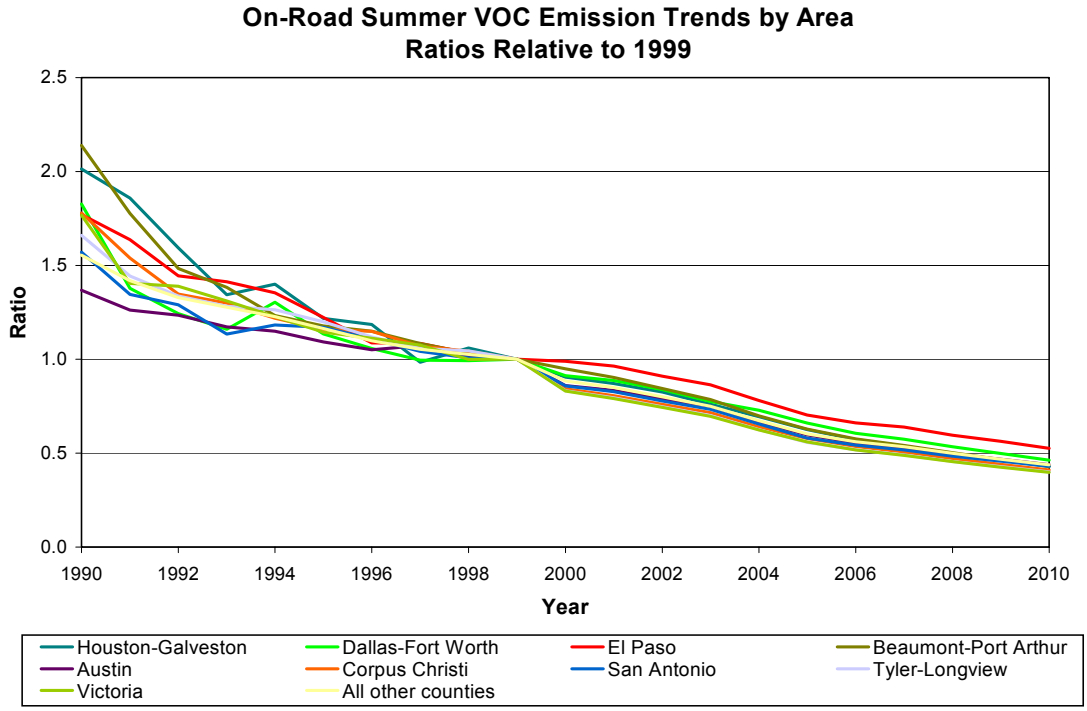
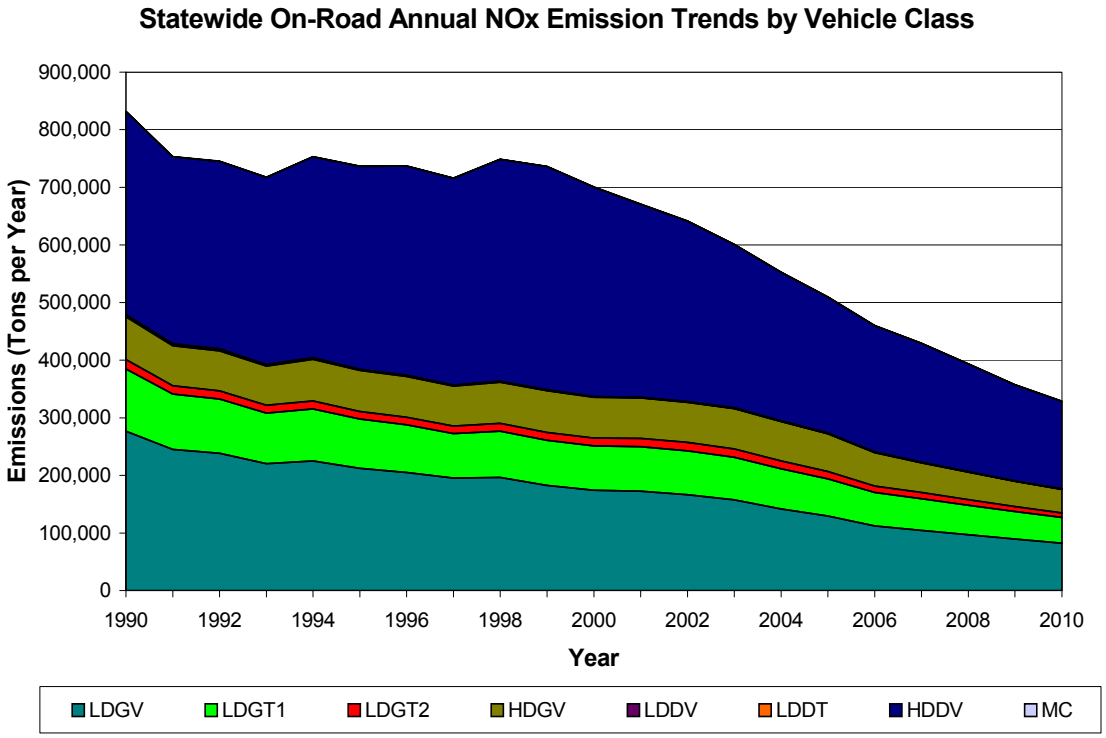
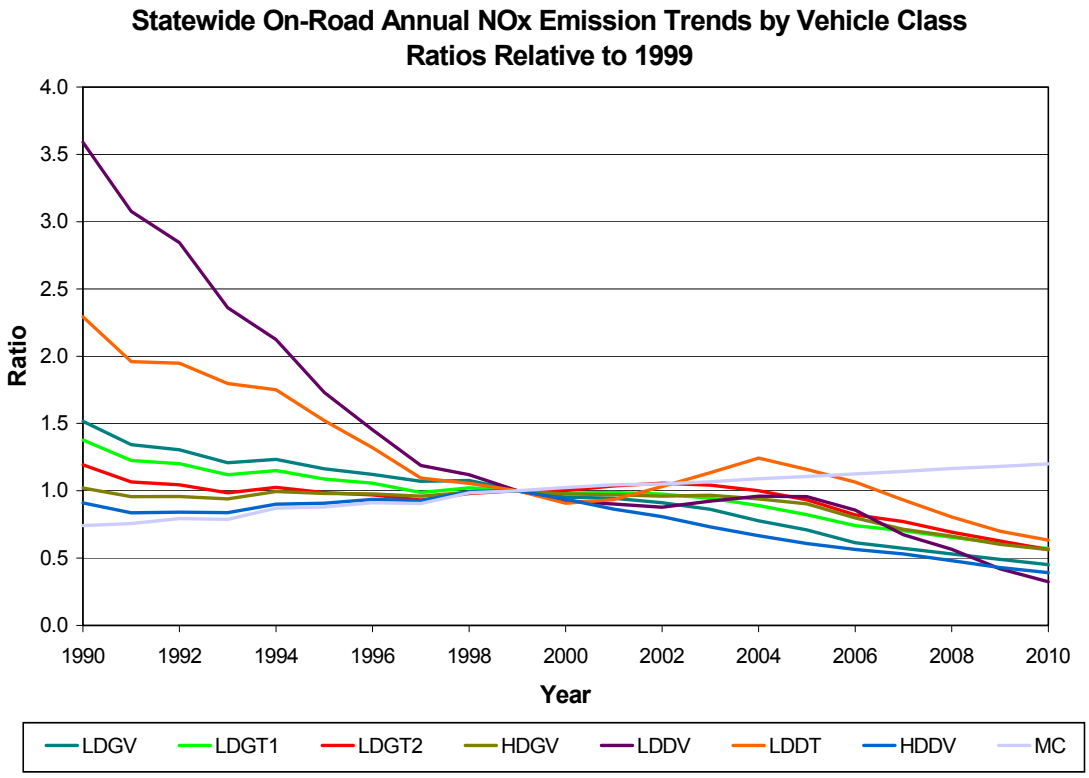
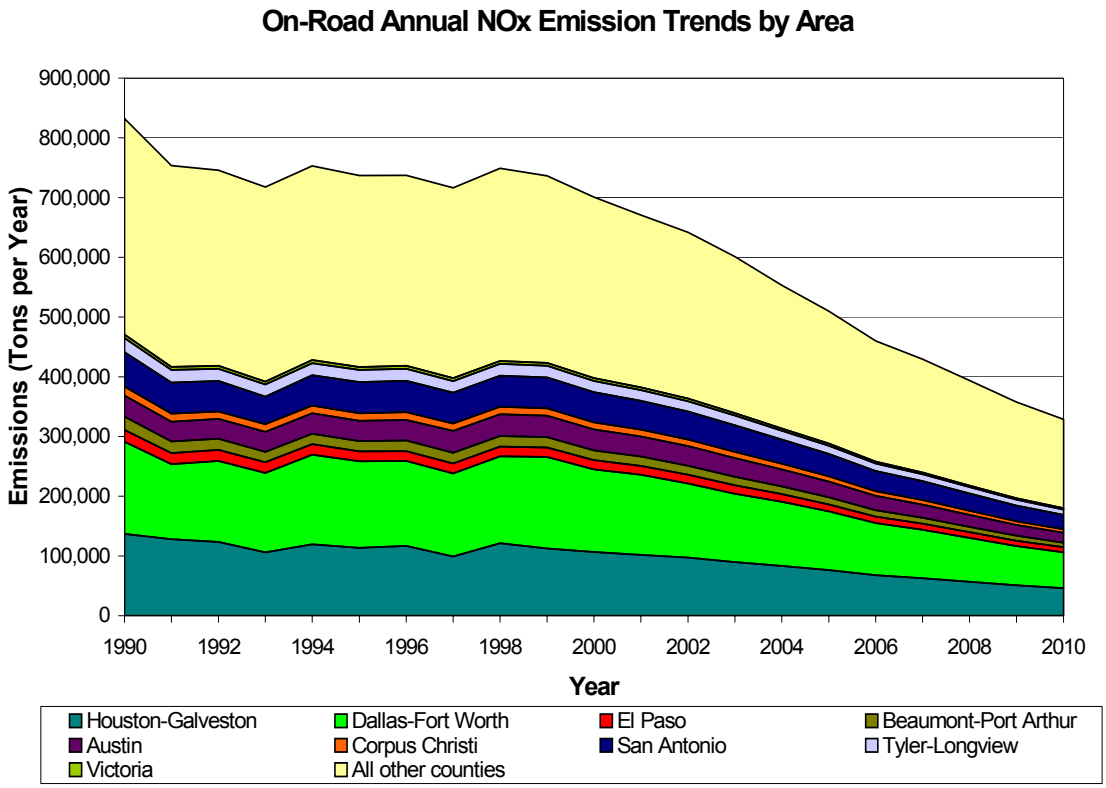
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

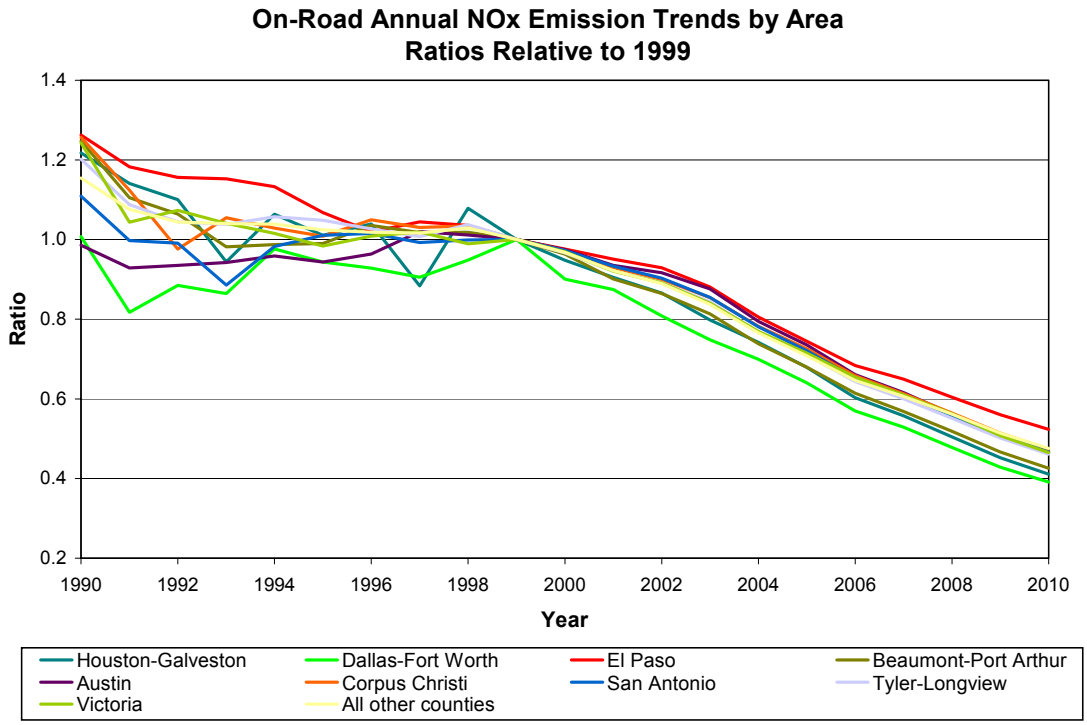

On-Road Summer VOC Emission Trends by Area
Emissions (Tons per Day)
2,500
2,000
1,500
1,000
500
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

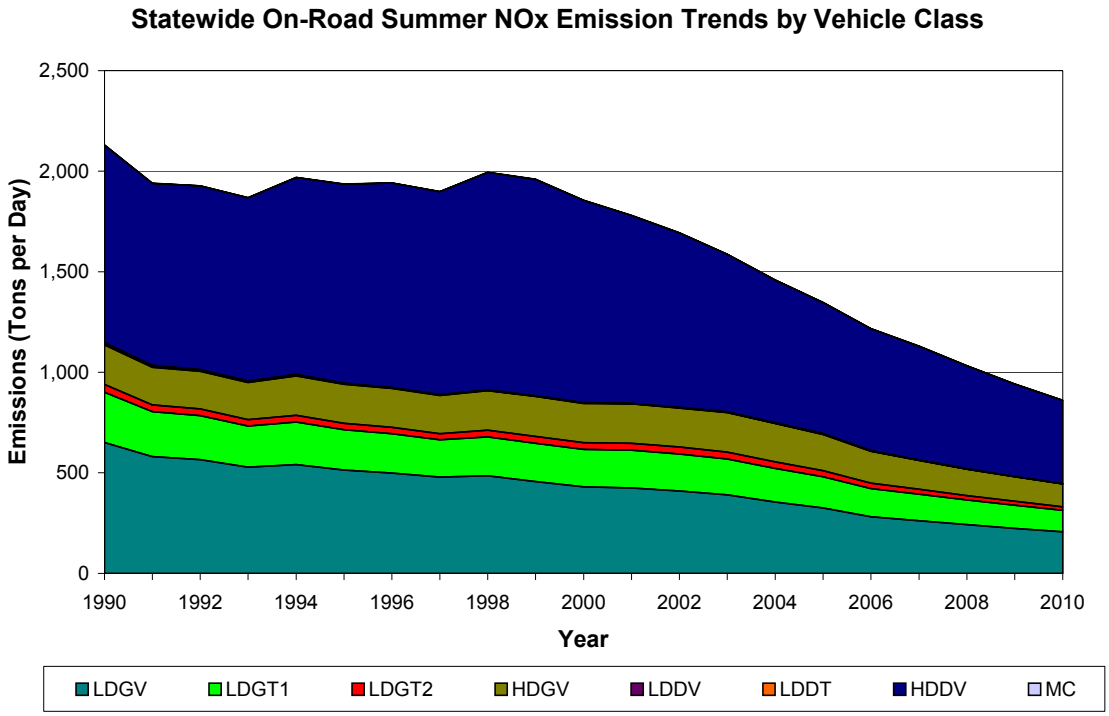

On-Road Summer VOC Emission Trends by Area
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


Statewide On-Road Annual NOx Emission Trends by Vehicle Class
Emissions (Tons per Year)
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


Statewide On-Road Annual NOx Emission Trends by Vehicle Class
Ratios Relative to 1999
Ratio
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


On-Road Annual NOx Emission Trends by Area
Emissions (Tons per Year)
900,000
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


On-Road Annual NOx Emission Trends by Area
Ratios Relative to 1999
Ratio
1.4
1.2
1.0
0.8
0.6
0.4
0.2
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


Statewide On-Road Summer NOx Emission Trends by Vehicle Class
Emissions (Tons per Day)
2,500
2,000
1,500
1,000
500
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
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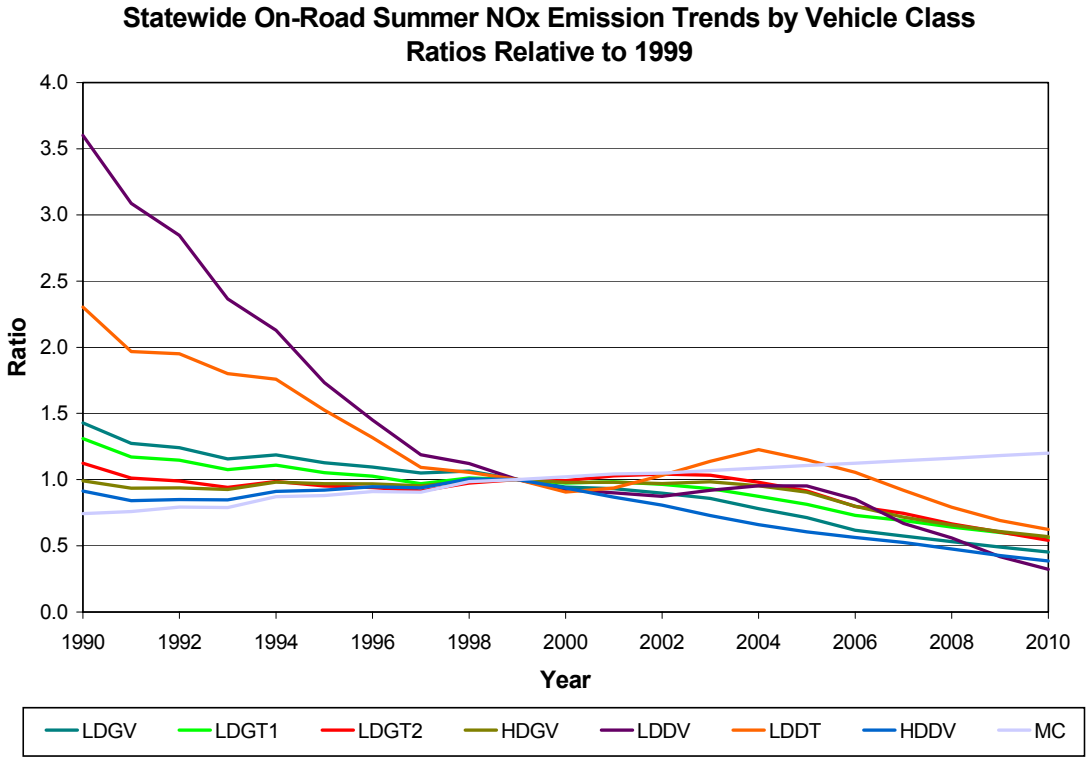
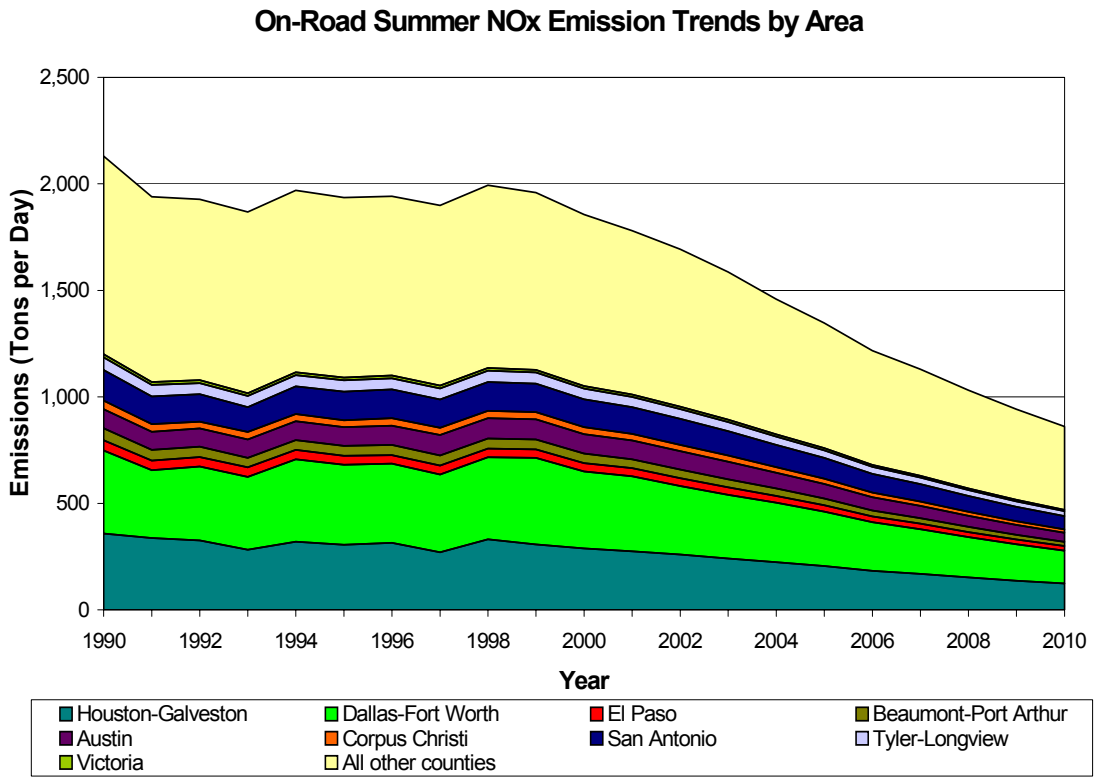
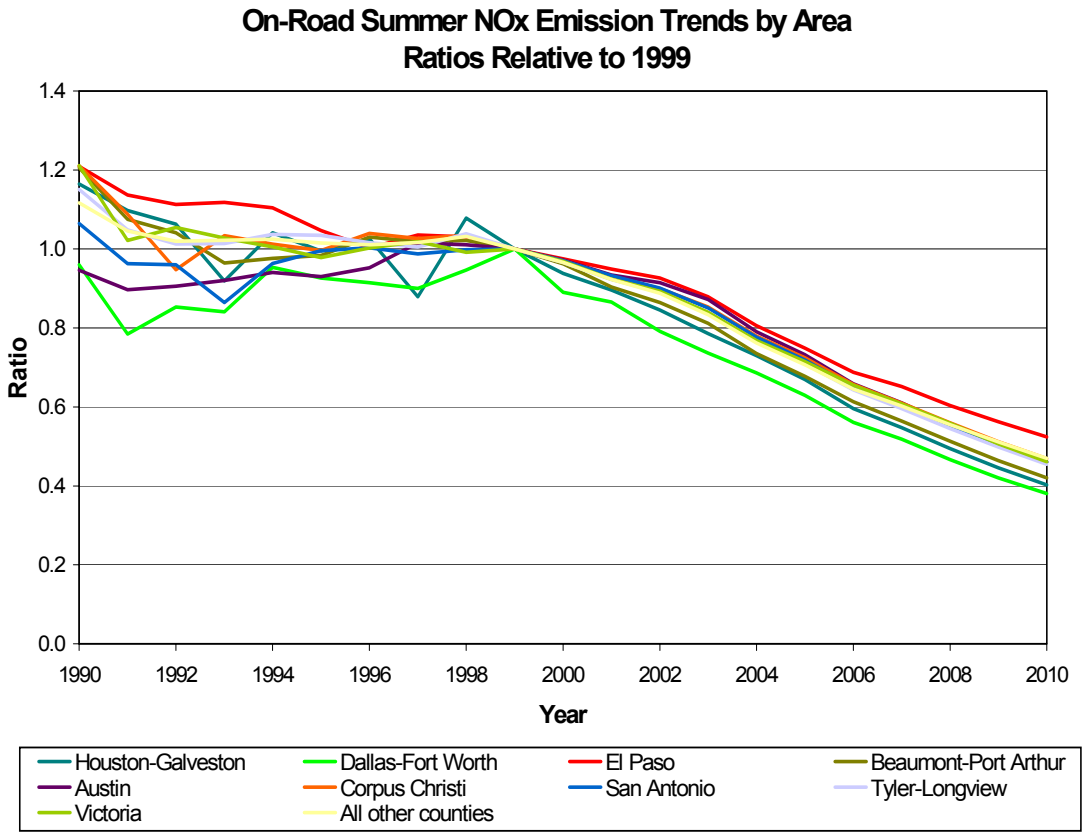
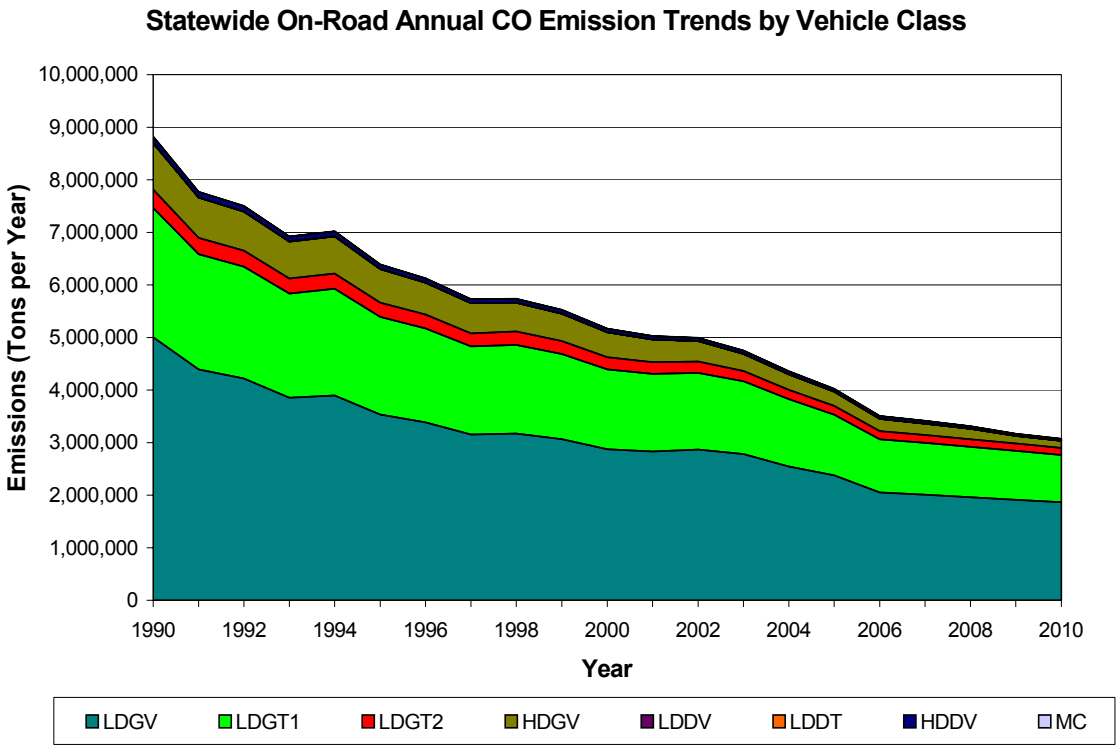
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


Statewide On-Road Summer NOx Emission Trends by Vehicle Class
Ratios Relative to 1999
Ratio
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


On-Road Summer NOx Emission Trends by Area
Emissions (Tons per Day)
2,500
2,000
1,500
1,000
500
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


On-Road Summer NOx Emission Trends by Area
Ratios Relative to 1999
Ratio
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


Statewide On-Road Annual CO Emission Trends by Vehicle Class
Emissions (Tons per Year)
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
1990
1992
1994
1996
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Year
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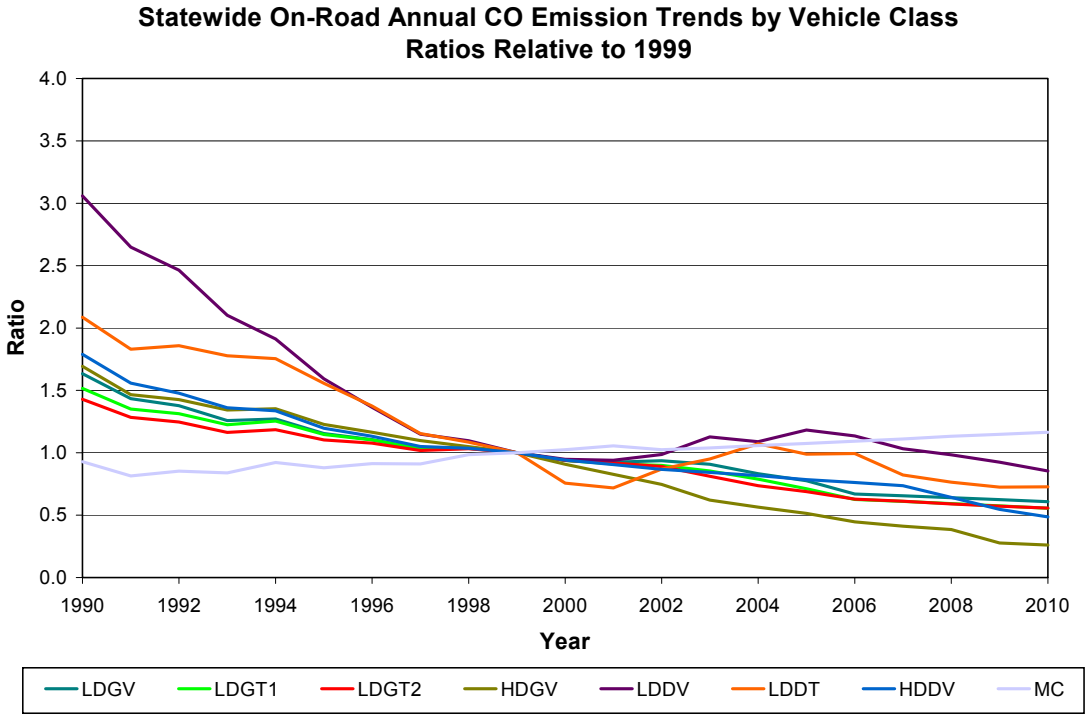
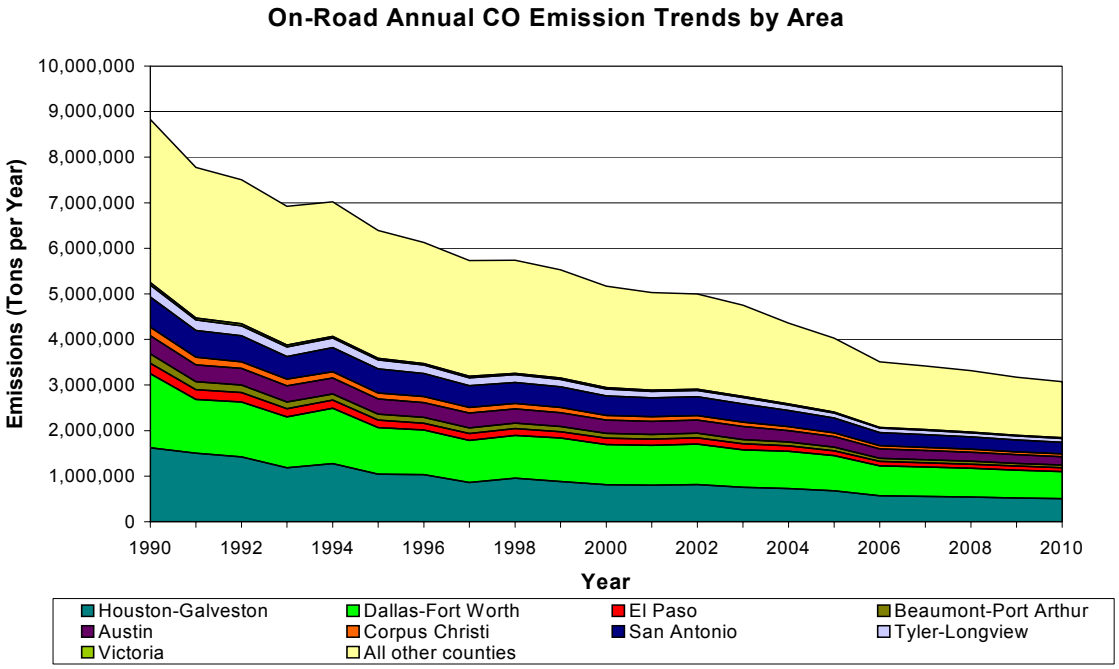
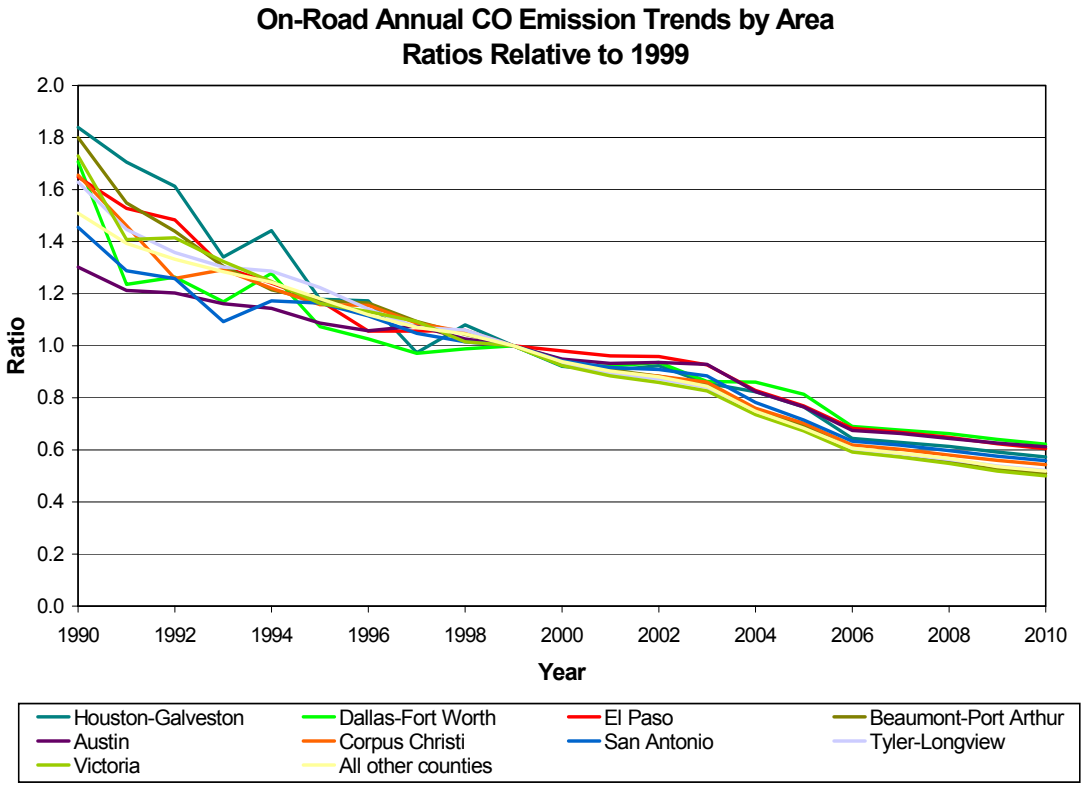
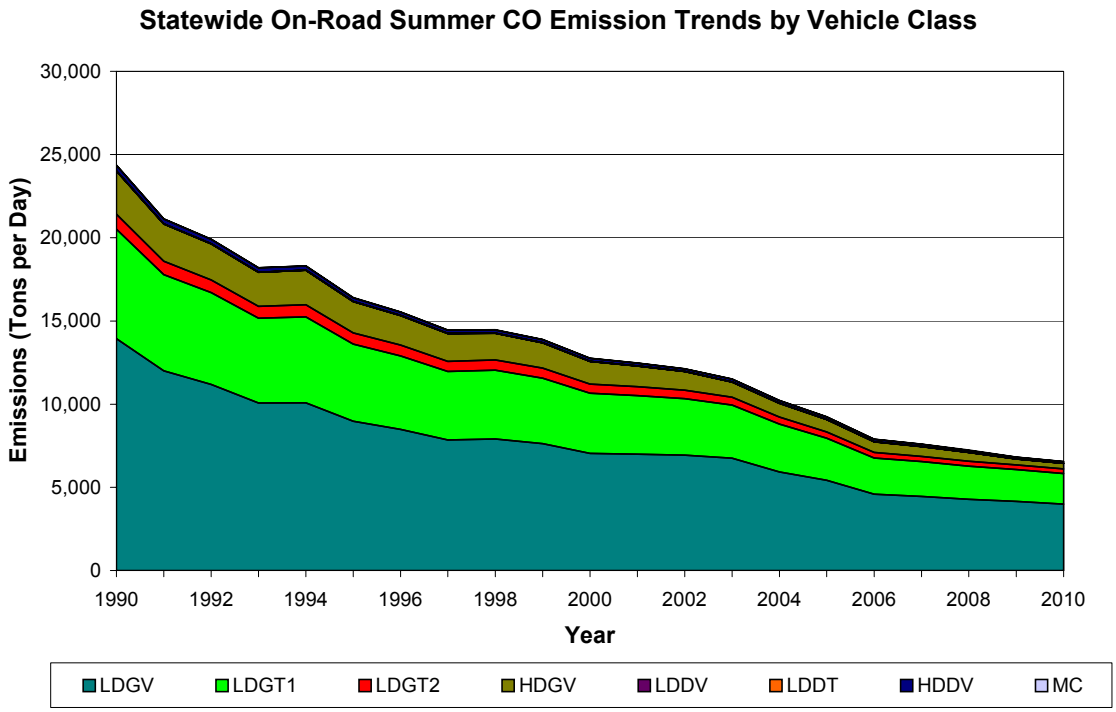
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


Statewide On-Road Annual CO Emission Trends by Vehicle Class
Ratios Relative to 1999
Ratio
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


On-Road Annual CO Emission Trends by Area
Emissions (Tons per Year)
10,000,000
9,000,000
8,000,000
7,000,000
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


On-Road Annual CO Emission Trends by Area
Ratios Relative to 1999
Ratio
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


Statewide On-Road Summer CO Emission Trends by Vehicle Class
Emissions (Tons per Day)
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
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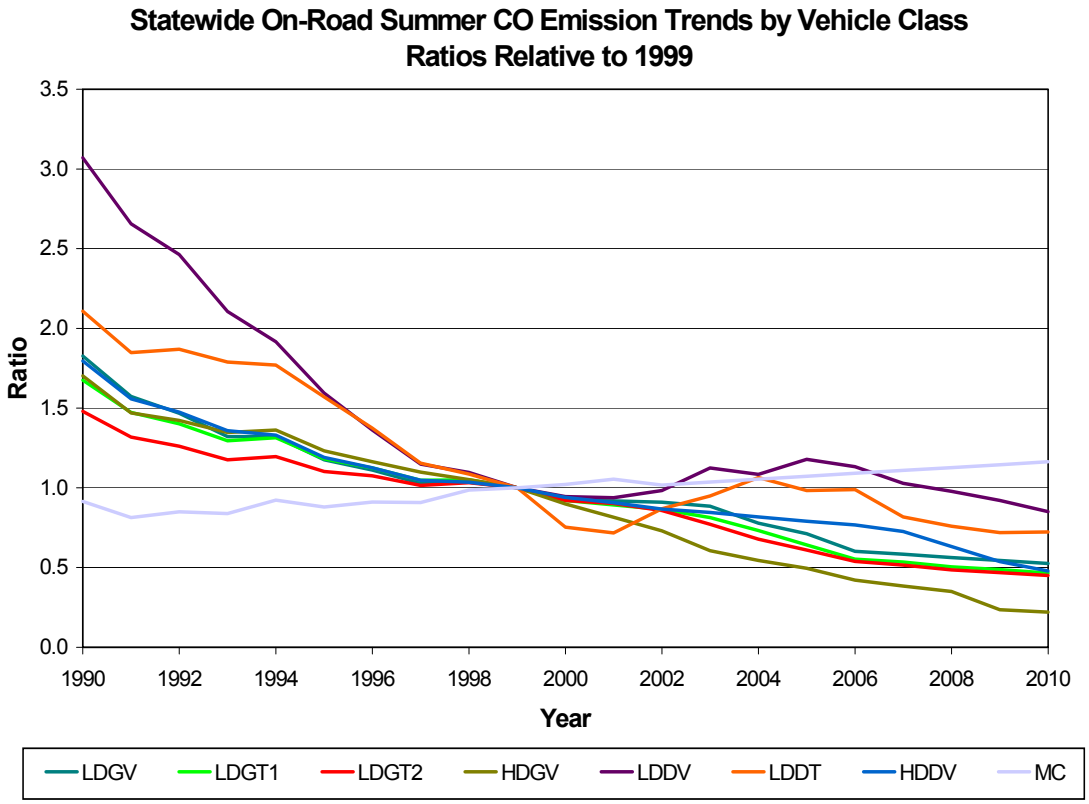
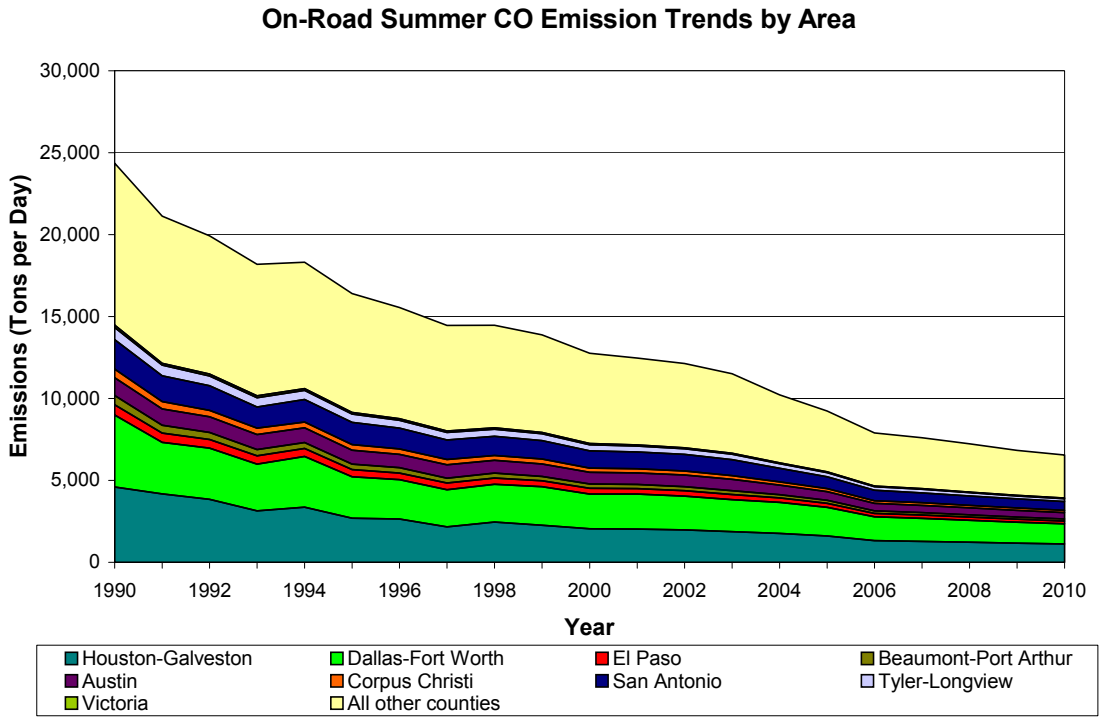
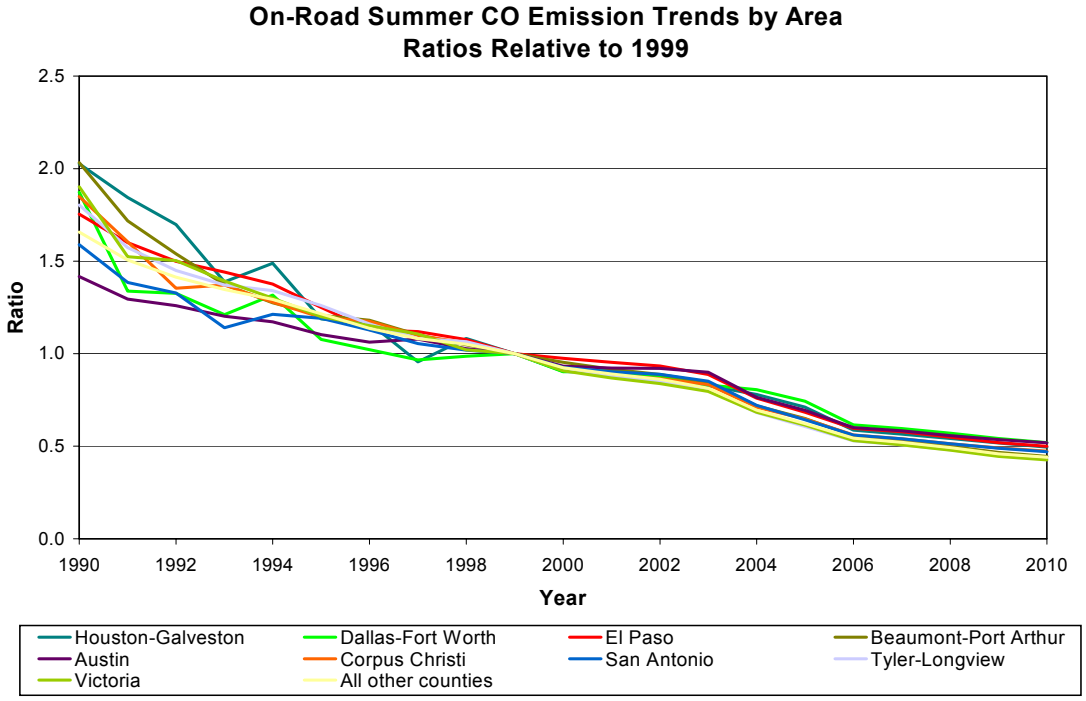
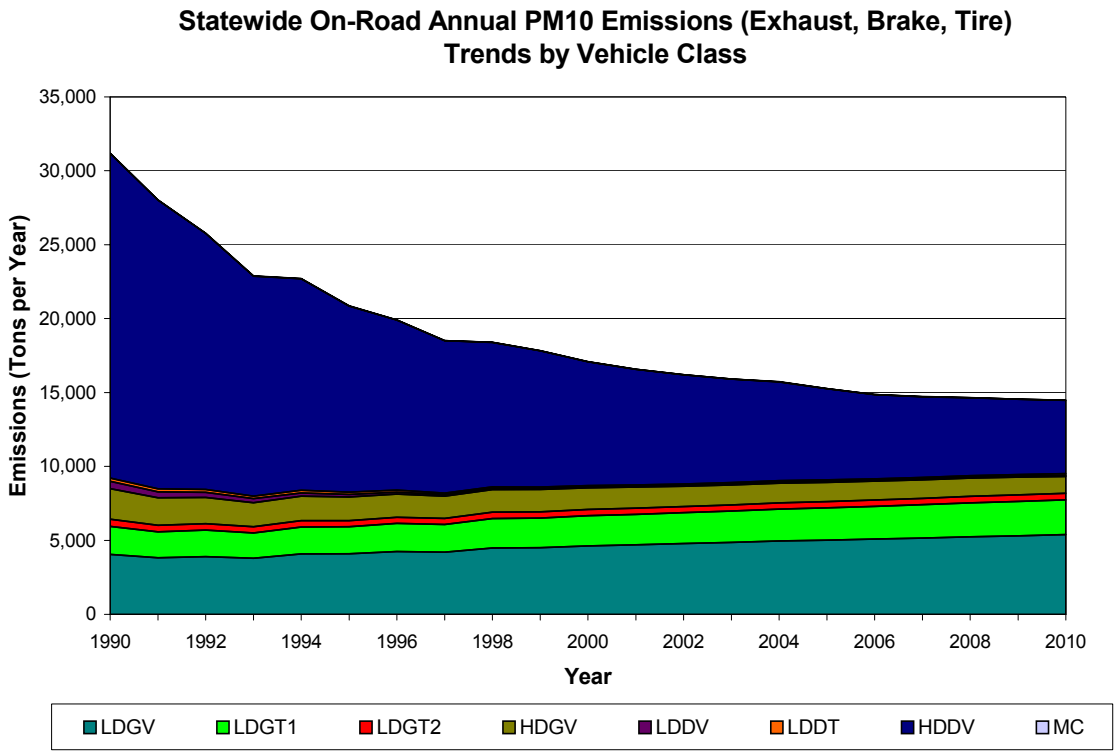
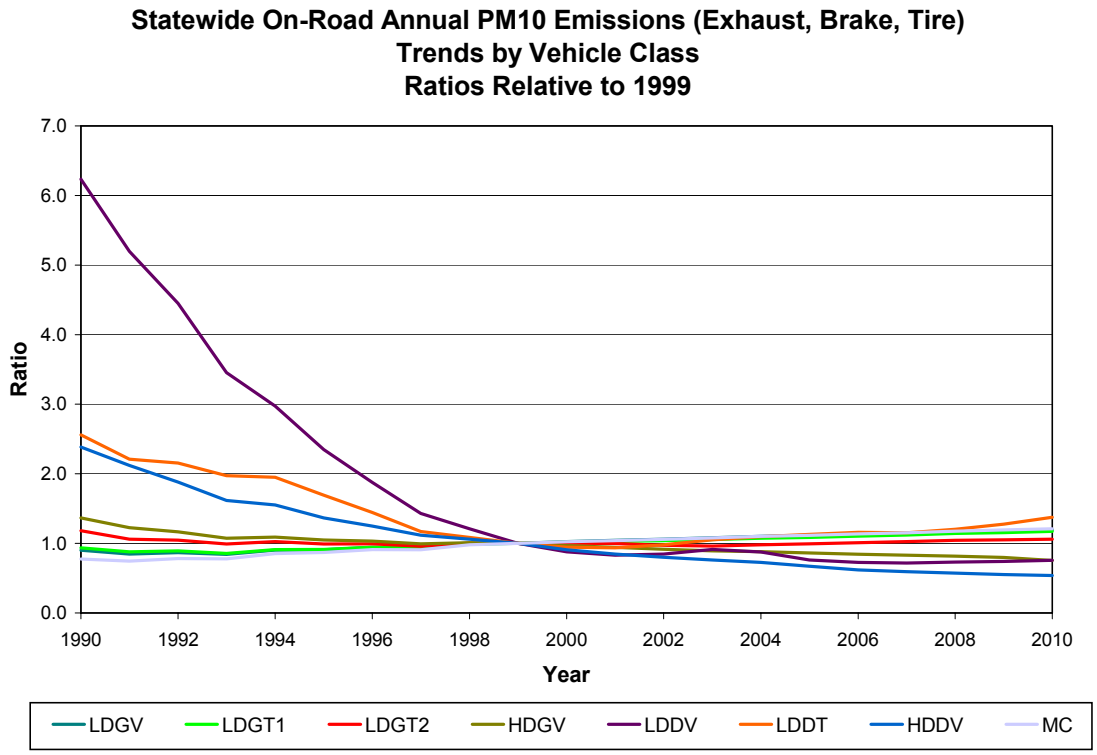
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

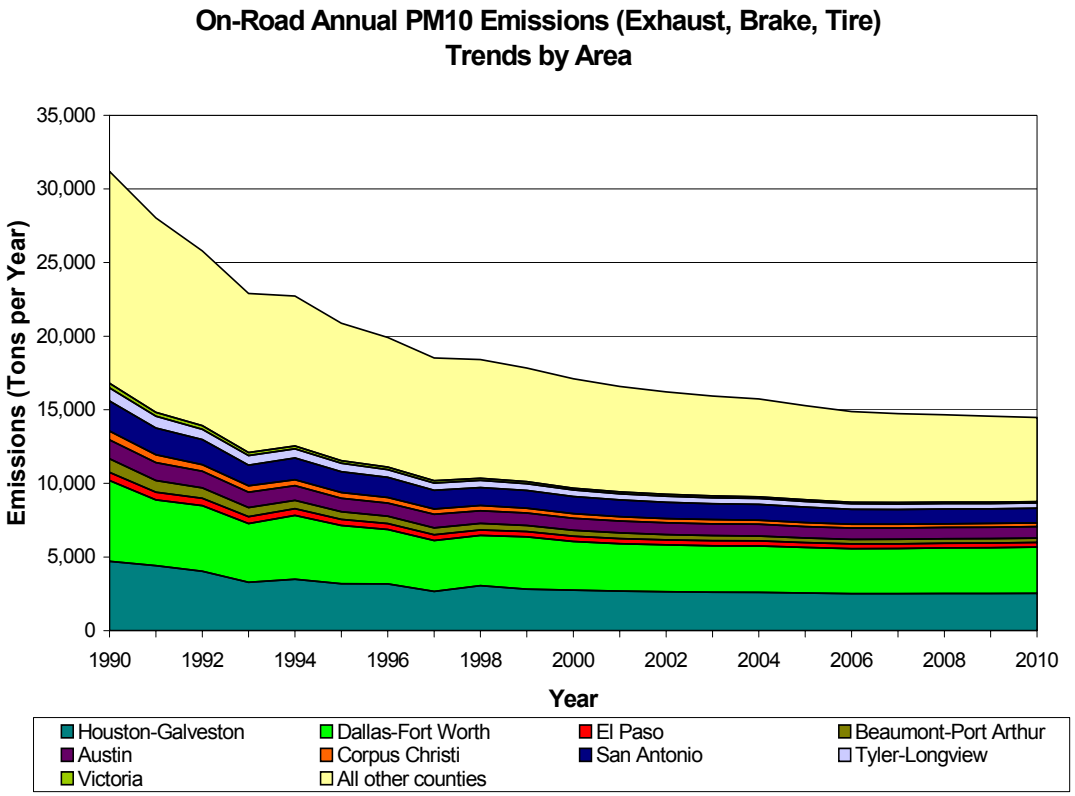

Statewide On-Road Summer CO Emission Trends by Vehicle Class
Ratios Relative to 1999
Ratio
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

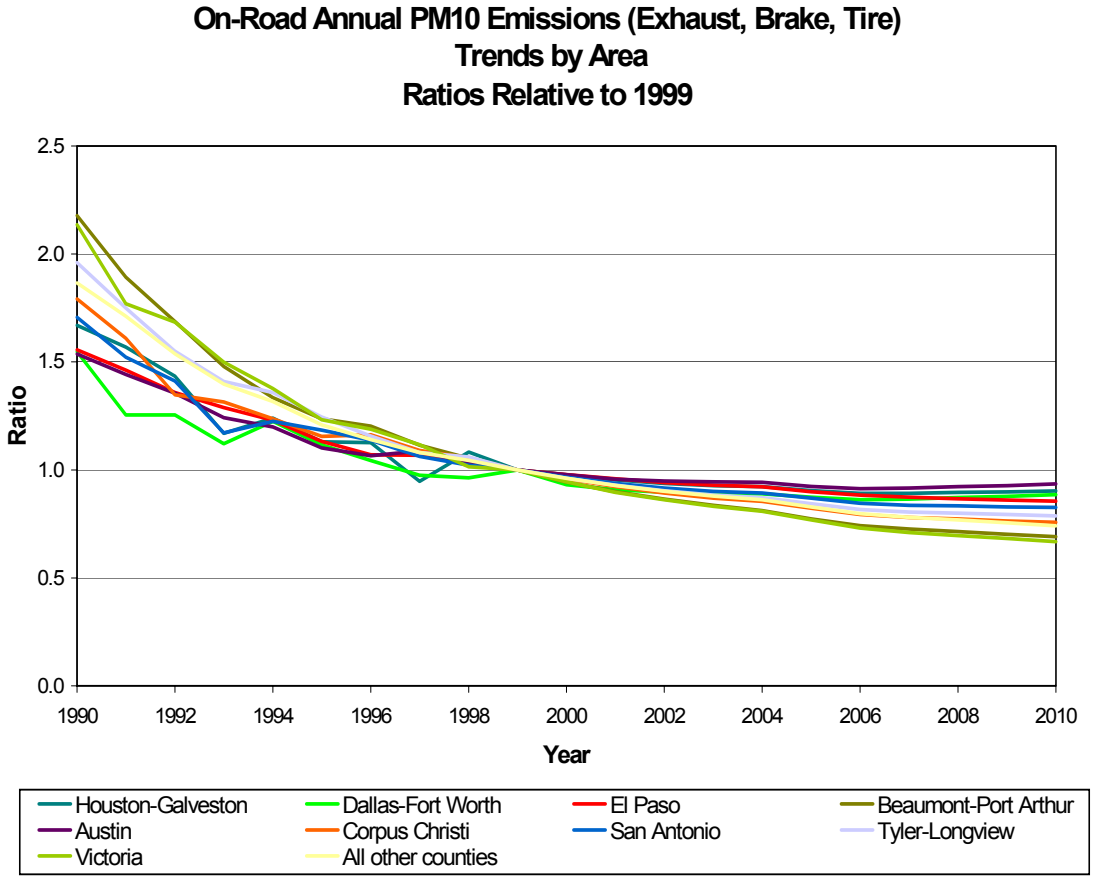

On-Road Summer CO Emission Trends by Area
Emissions (Tons per Day)
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

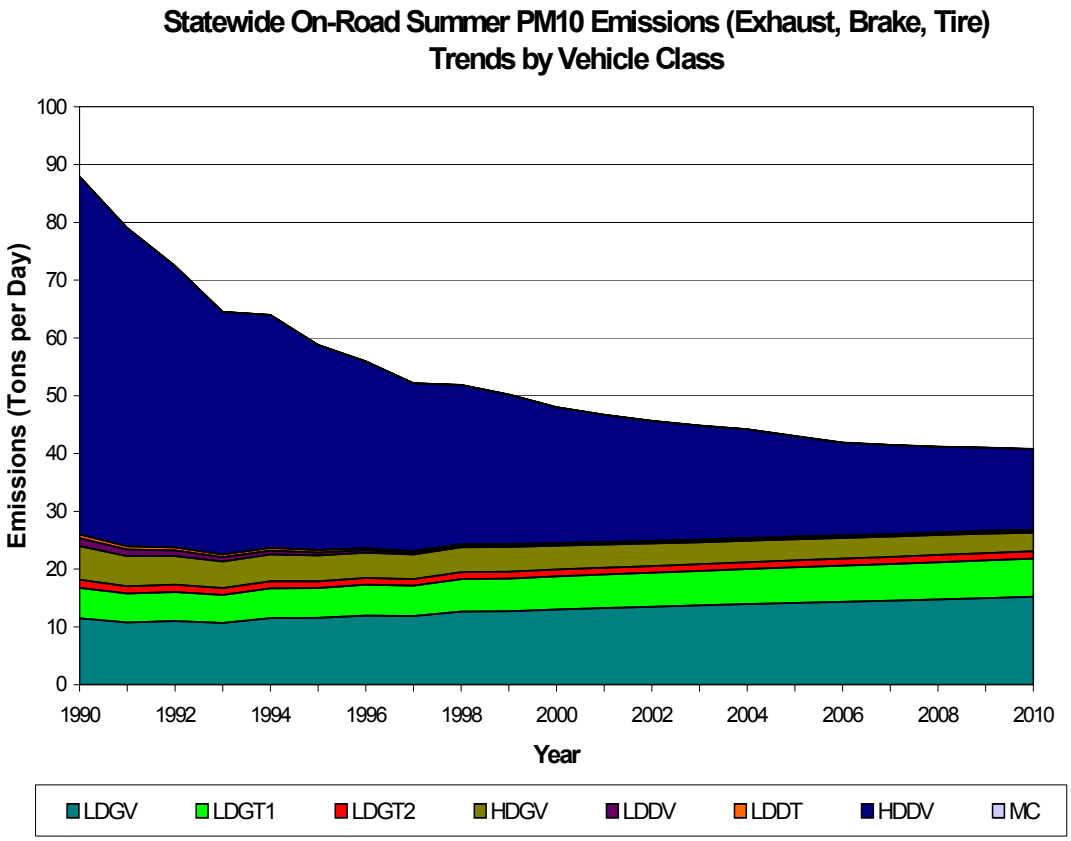

On-Road Summer CO Emission Trends by Area
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


Statewide On-Road Annual PM10 Emissions (Exhaust, Brake, Tire)
Trends by Vehicle Class
Emissions (Tons per Year)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


Statewide On-Road Annual PM10 Emissions (Exhaust, Brake, Tire)
Trends by Vehicle Class
Ratios Relative to 1999
Ratio
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


On-Road Annual PM10 Emissions (Exhaust, Brake, Tire)
Trends by Area
Emissions (Tons per Year)
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


On-Road Annual PM10 Emissions (Exhaust, Brake, Tire)
Trends by Area
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


Statewide On-Road Summer PM10 Emissions (Exhaust, Brake, Tire)
Trends by Vehicle Class
Emissions (Tons per Day)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
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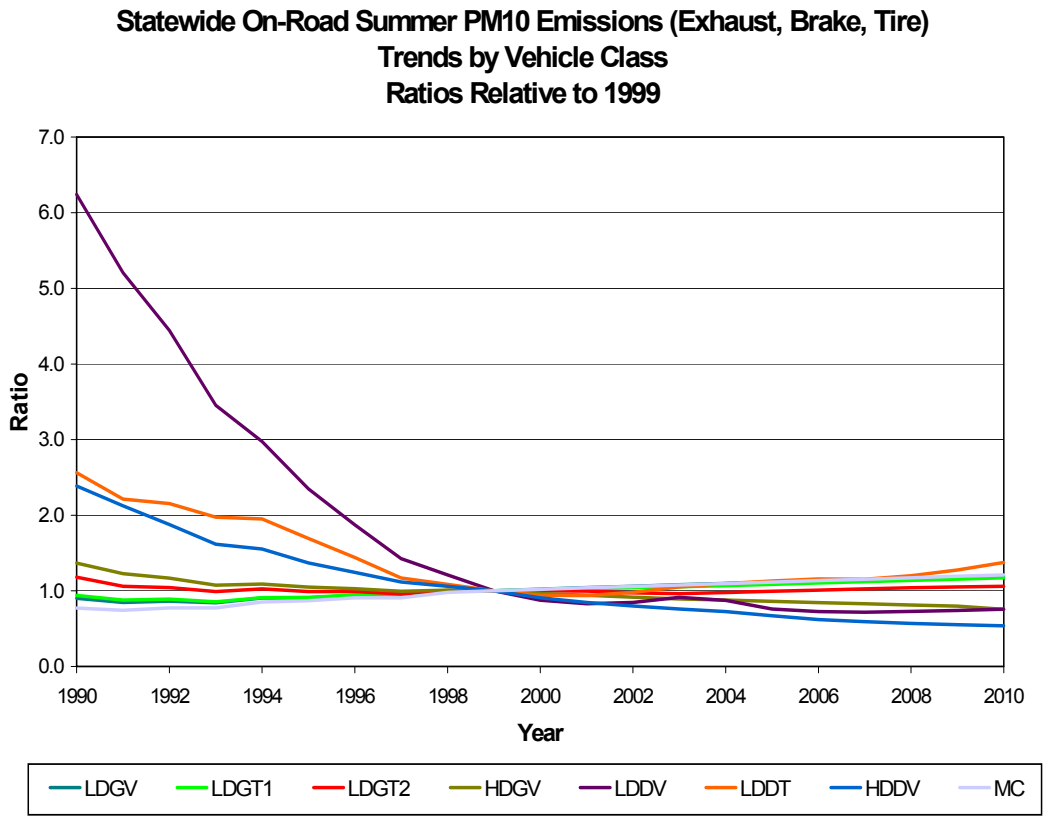
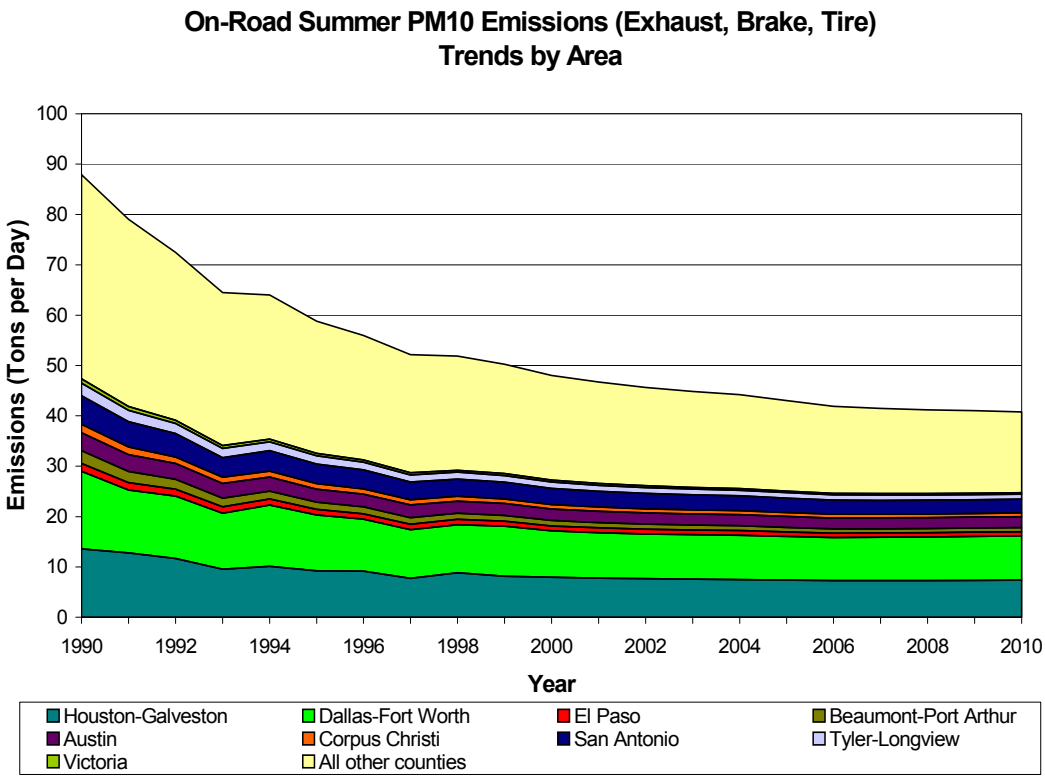
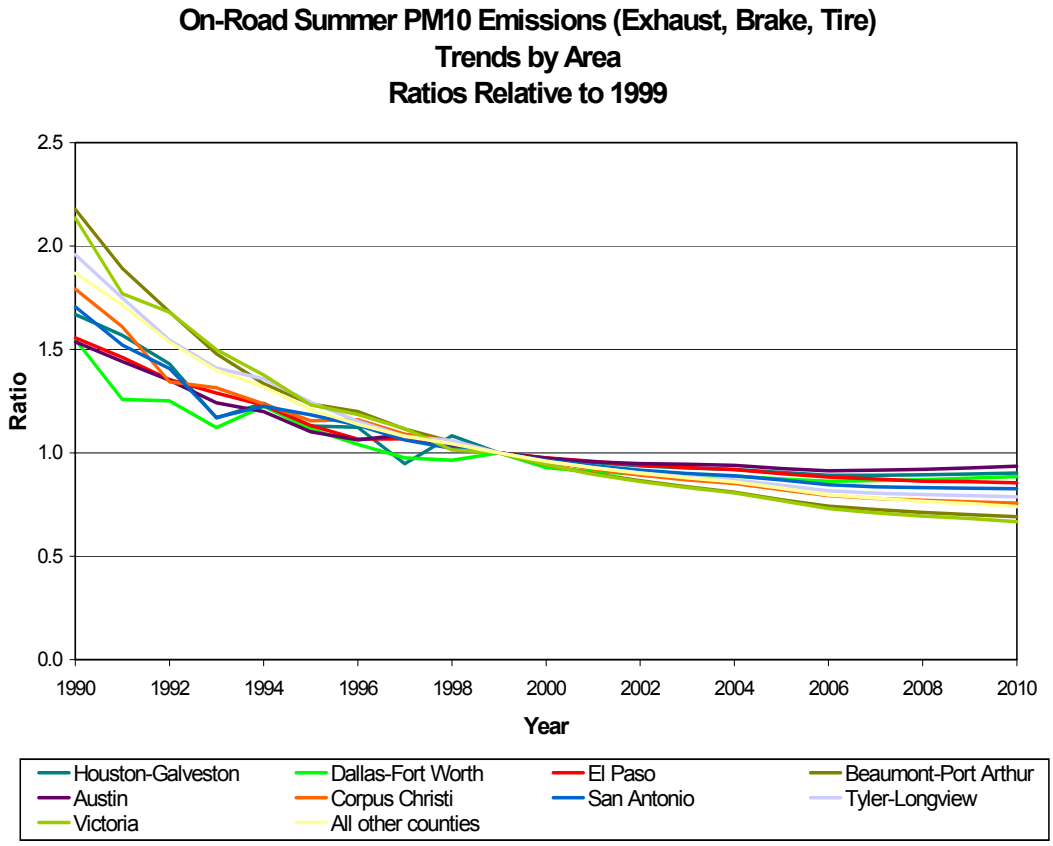
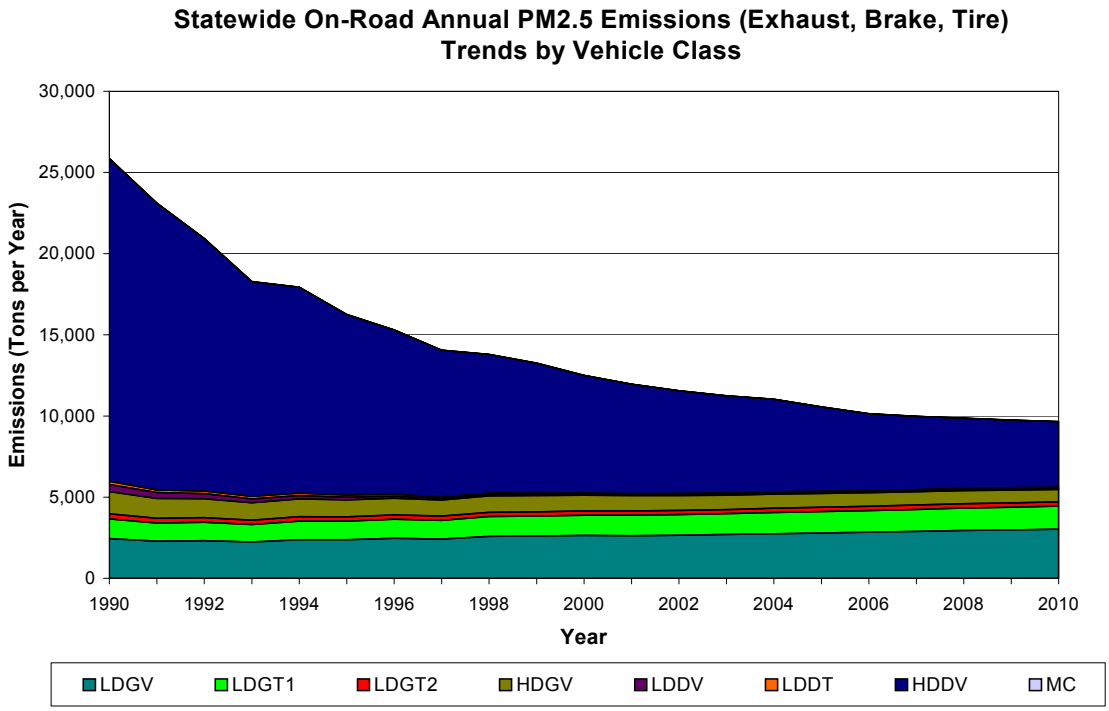
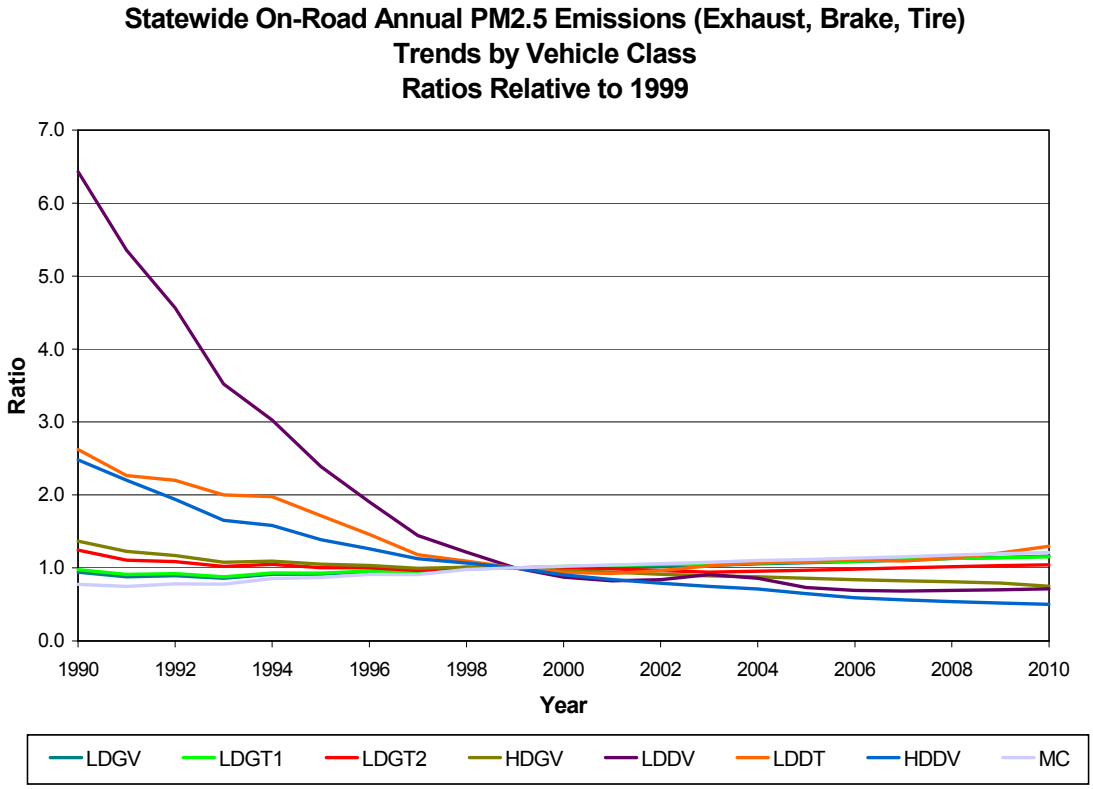
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

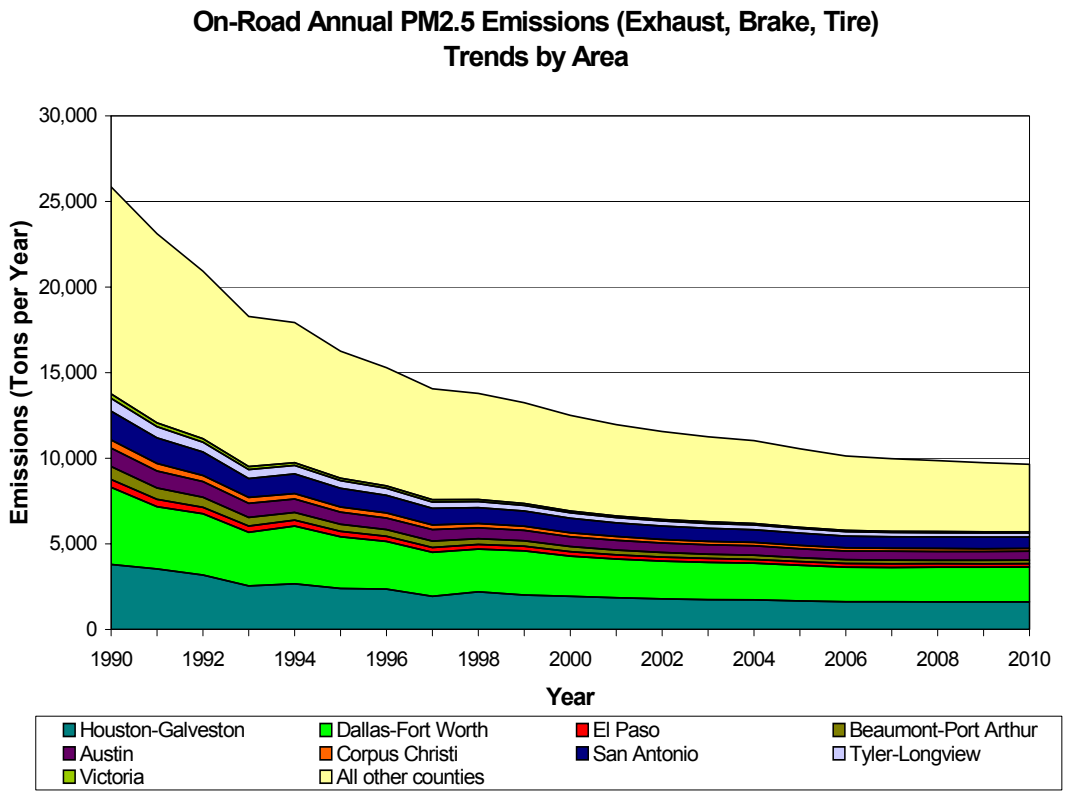

Statewide On-Road Summer PM10 Emissions (Exhaust, Brake, Tire)
Trends by Vehicle Class
Ratios Relative to 1999
Ratio
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

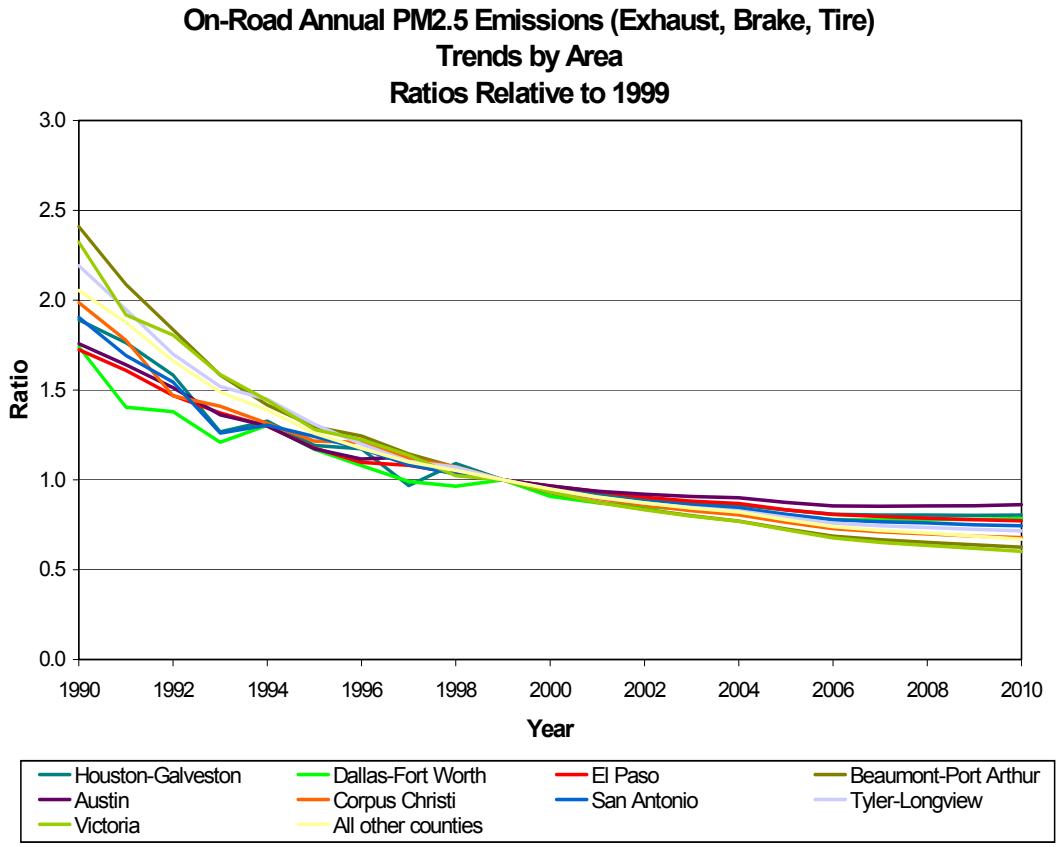

On-Road Summer PM10 Emissions (Exhaust, Brake, Tire)
Trends by Area
Emissions (Tons per Day)
100
90
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

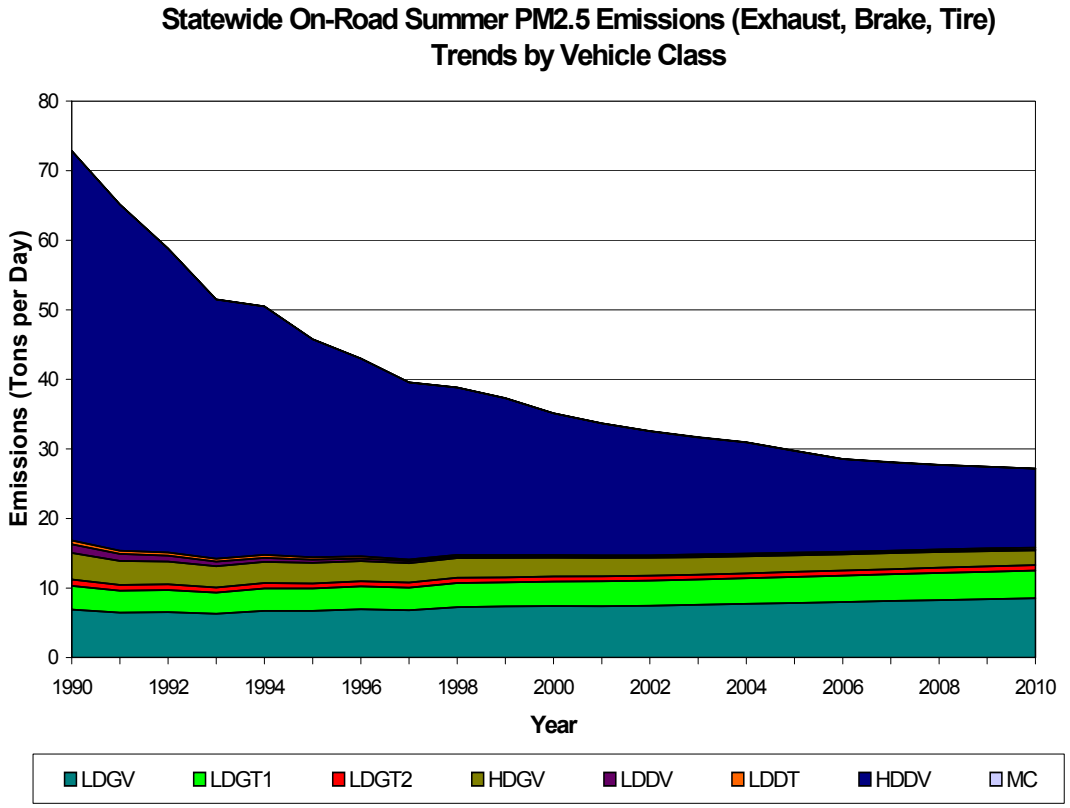

On-Road Summer PM10 Emissions (Exhaust, Brake, Tire)
Trends by Area
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

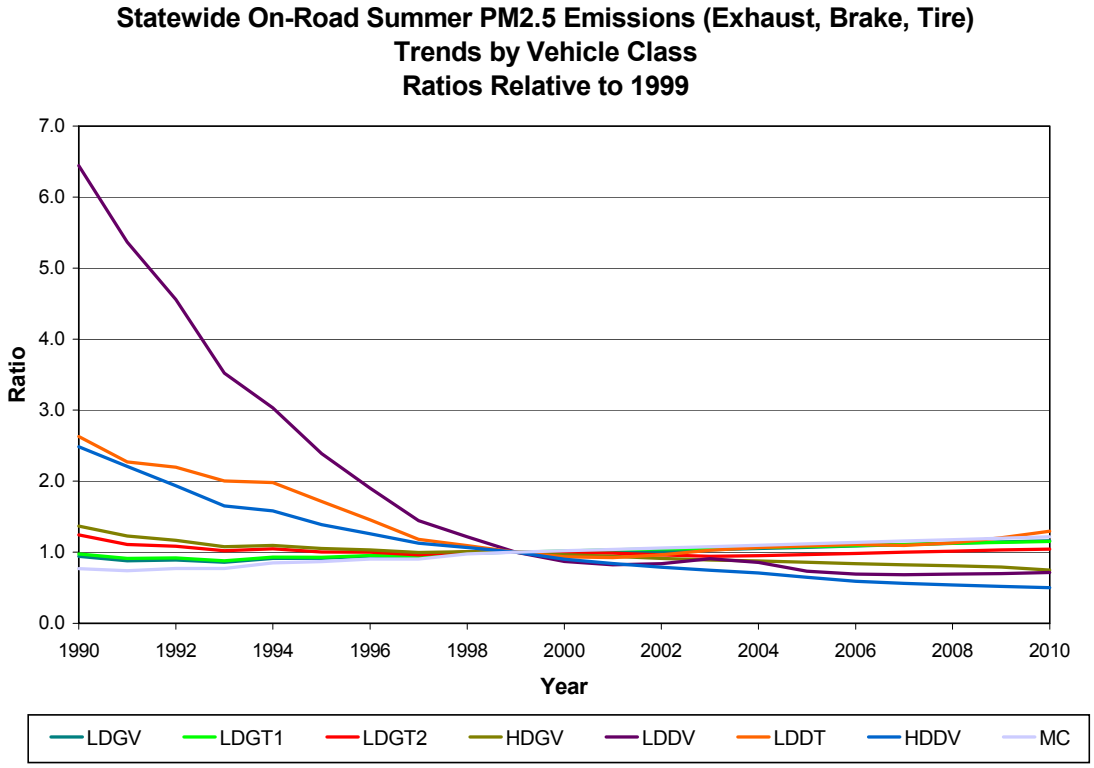

Statewide On-Road Annual PM2.5 Emissions (Exhaust, Brake, Tire)
Trends by Vehicle Class
Emissions (Tons per Year)
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

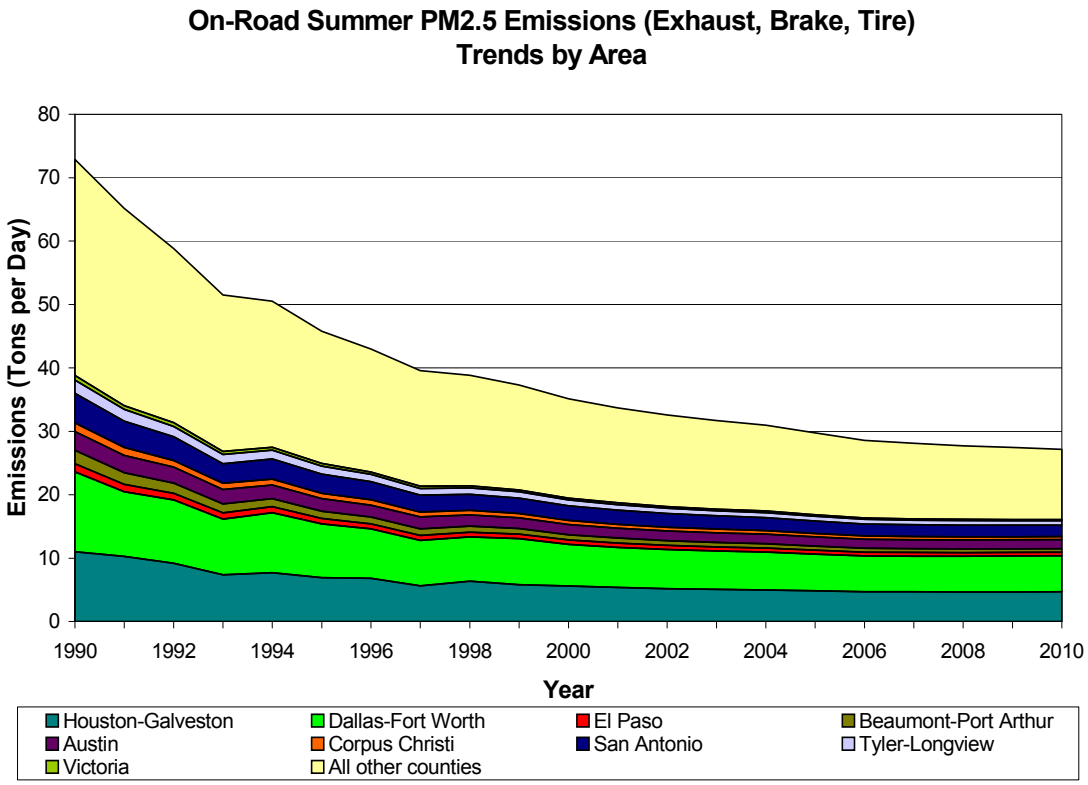

Statewide On-Road Annual PM2.5 Emissions (Exhaust, Brake, Tire)
Trends by Vehicle Class
Ratios Relative to 1999
Ratio
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

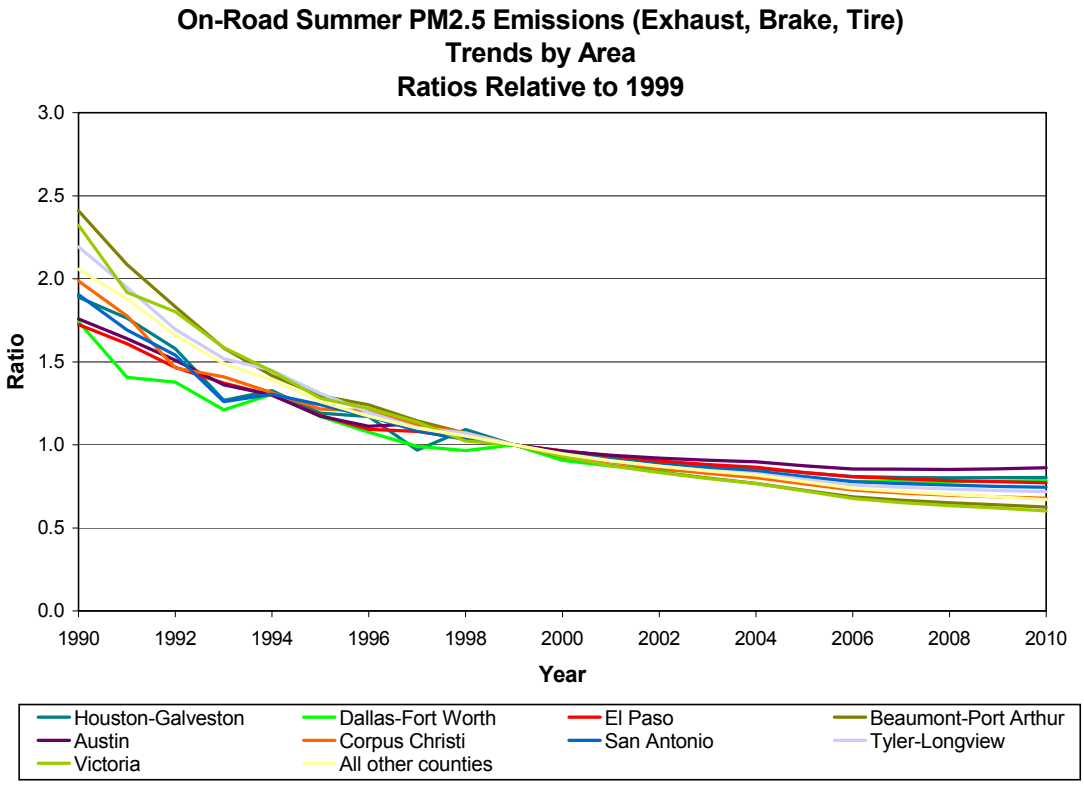

On-Road Annual PM2.5 Emissions (Exhaust, Brake, Tire)
Trends by Area
Emissions (Tons per Year)
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

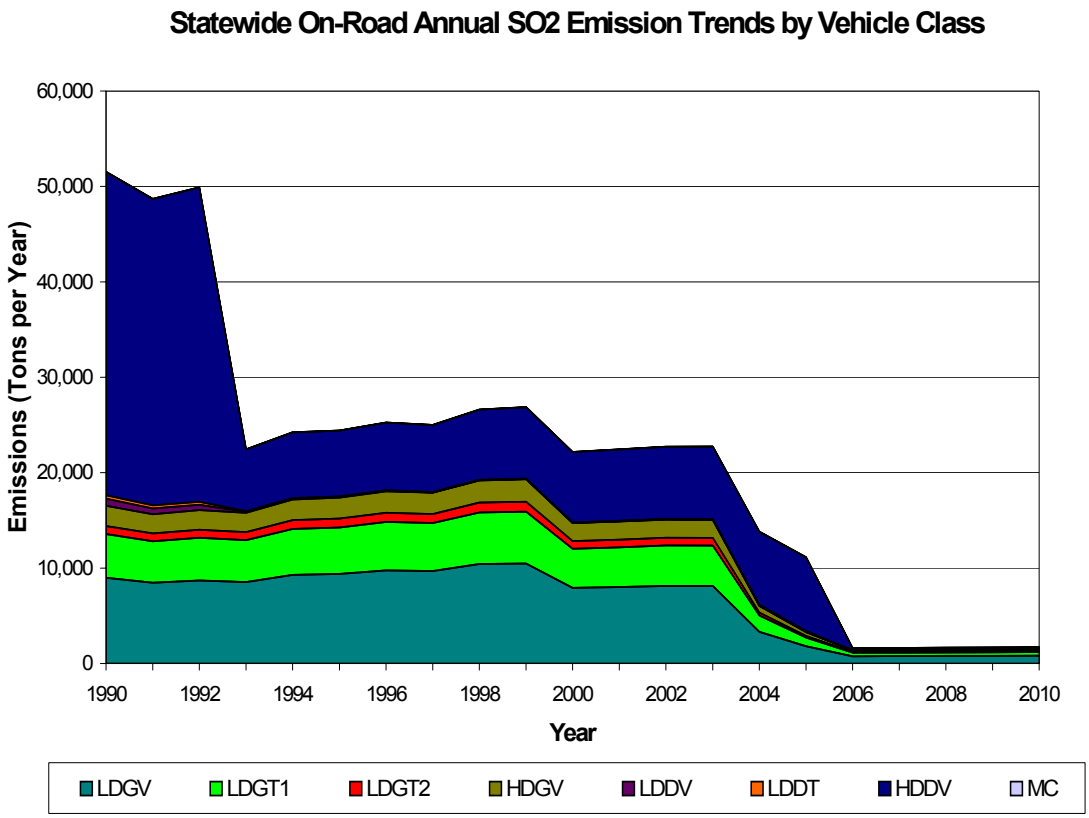

On-Road Annual PM2.5 Emissions (Exhaust, Brake, Tire)
Trends by Area
Ratios Relative to 1999
Ratio
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

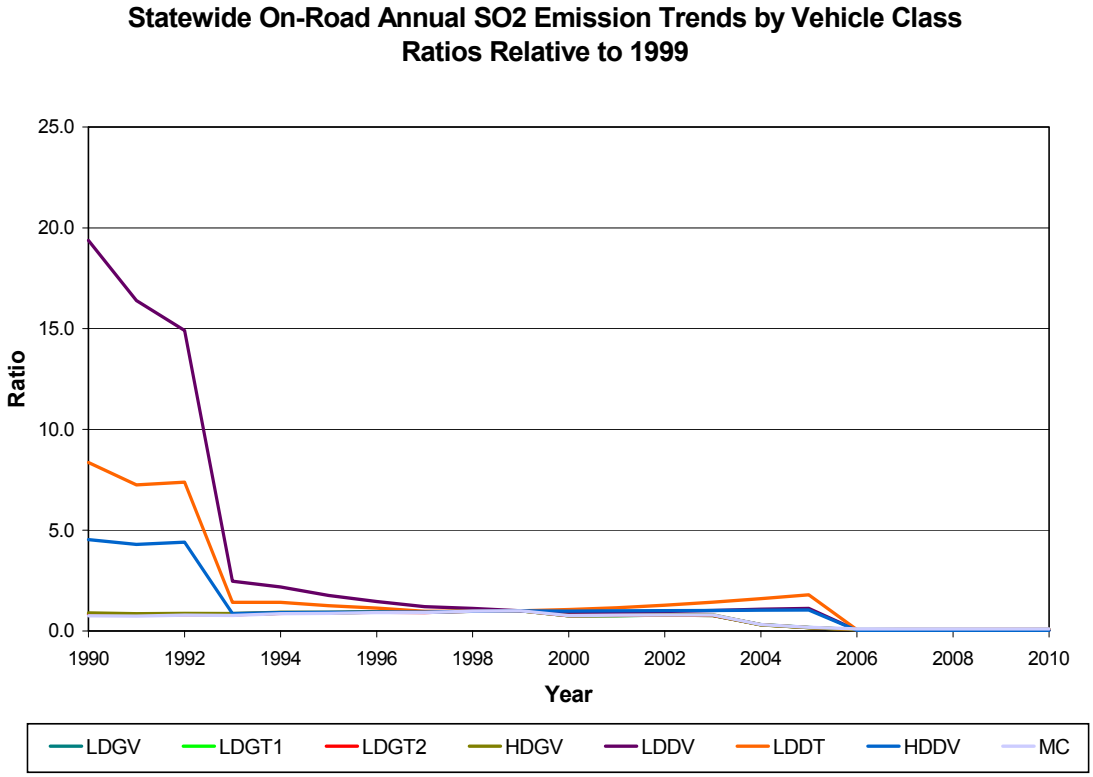

Statewide On-Road Summer PM2.5 Emissions (Exhaust, Brake, Tire)
Trends by Vehicle Class
Emissions (Tons per Day)
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

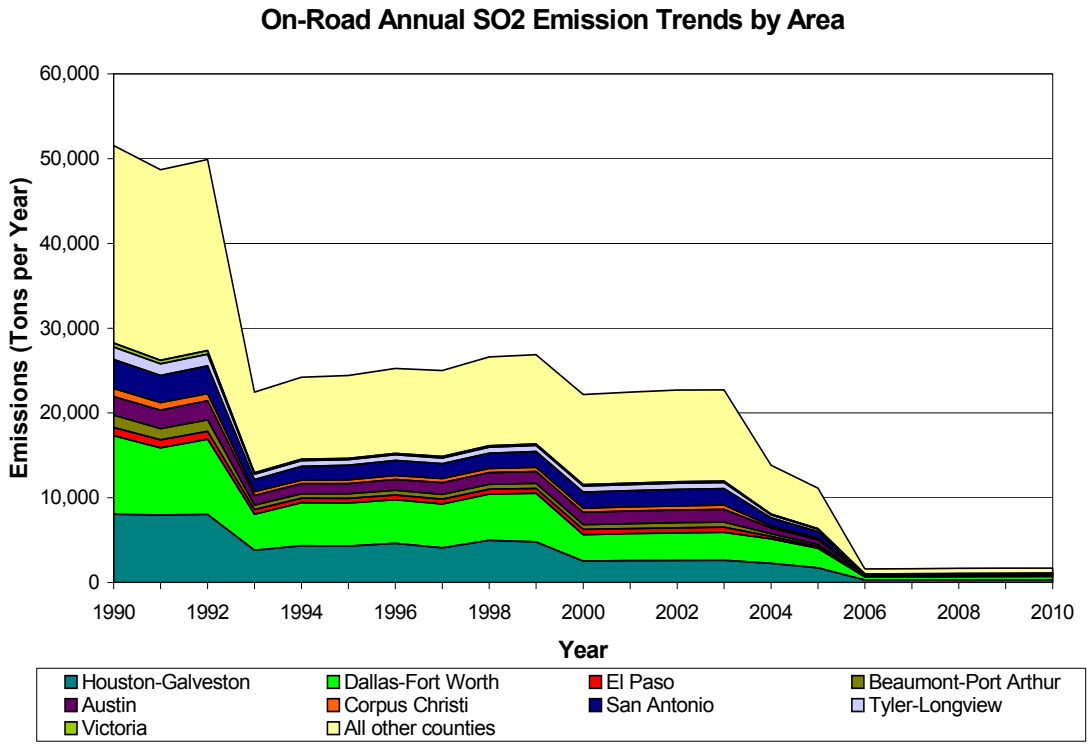

Statewide On-Road Summer PM2.5 Emissions (Exhaust, Brake, Tire)
Trends by Vehicle Class
Ratios Relative to 1999
Ratio
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

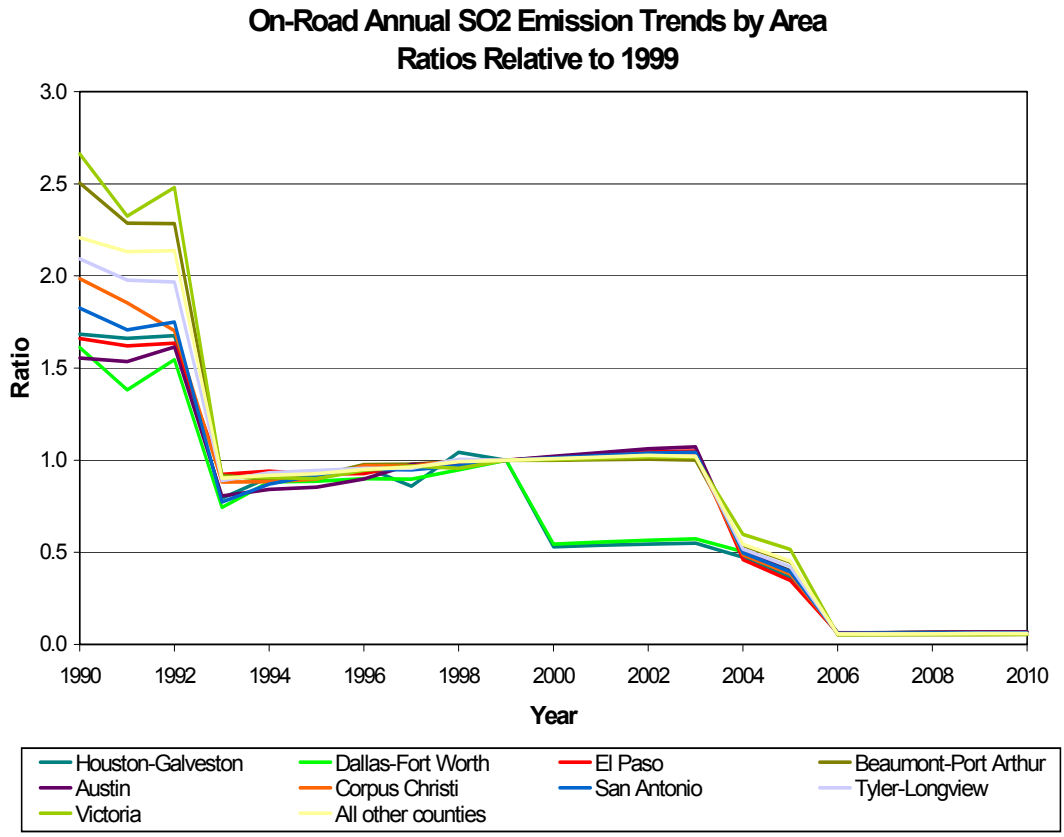

On-Road Summer PM2.5 Emissions (Exhaust, Brake, Tire)
Trends by Area
Emissions (Tons per Day)
80
70
60
50
40
30
20
10
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties


On-Road Summer PM2.5 Emissions (Exhaust, Brake, Tire)
Trends by Area
Ratios Relative to 1999
Ratio
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

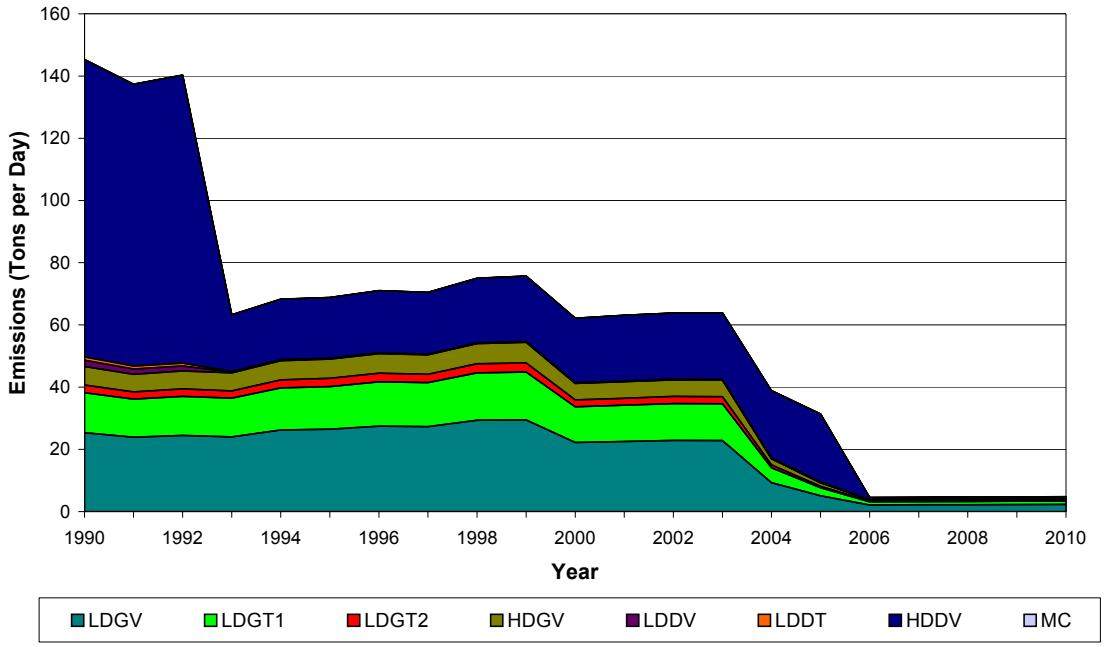

Statewide On-Road Annual SO2 Emission Trends by Vehicle Class
Emissions (Tons per Year)
60,000
50,000
40,000
30,000
20,000
10,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC


Statewide On-Road Annual SO2 Emission Trends by Vehicle Class
Ratios Relative to 1999
Ratio
25.0
20.0
15.0
10.0
5.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
LDGV
LDGT1
LDGT2
HDGV
LDDV
LDDT
HDDV
MC

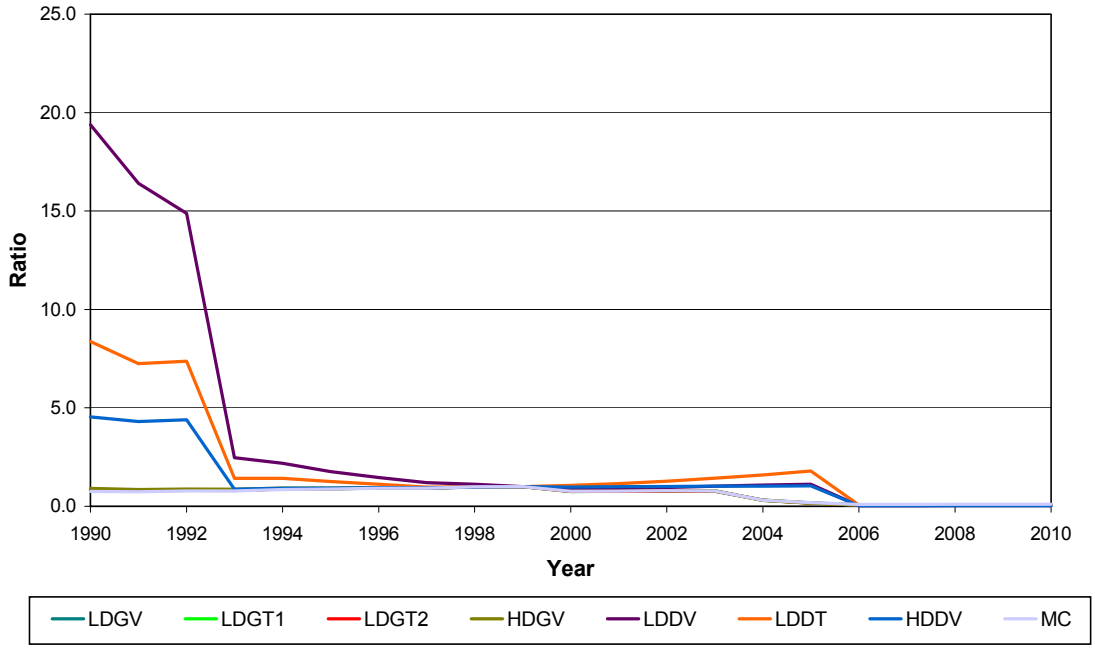

On-Road Annual SO2 Emission Trends by Area
Emissions (Tons per Year)
60,000
50,000
40,000
30,000
20,000
10,000
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

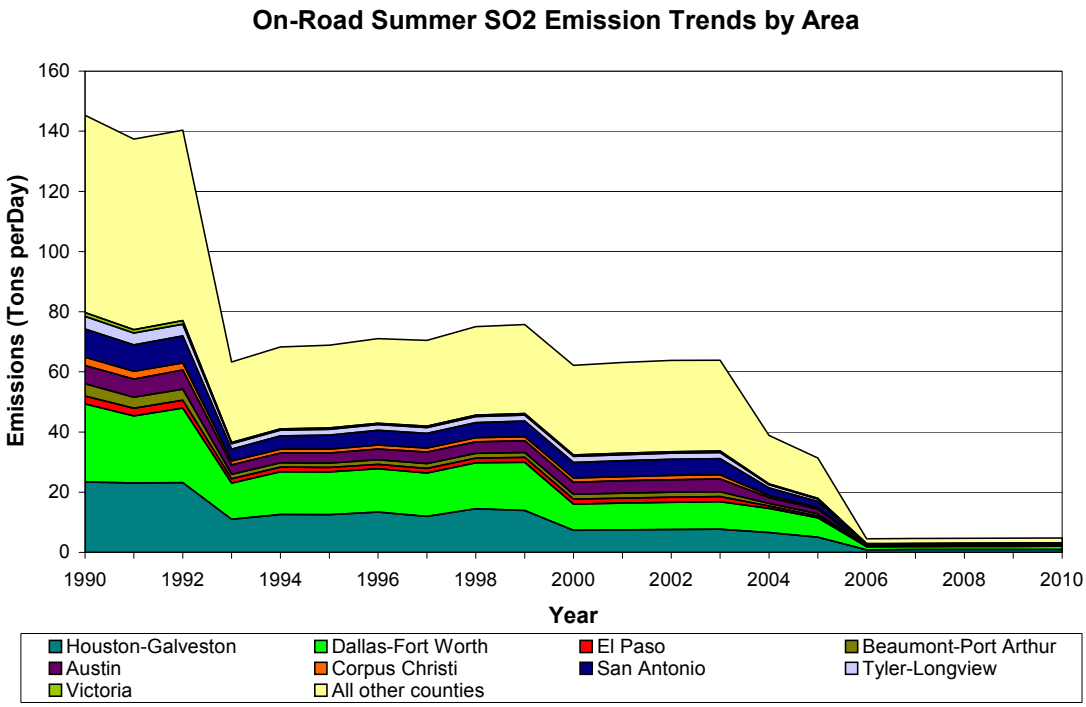

On-Road Annual SO2 Emission Trends by Area
Ratios Relative to 1999
Ratio
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

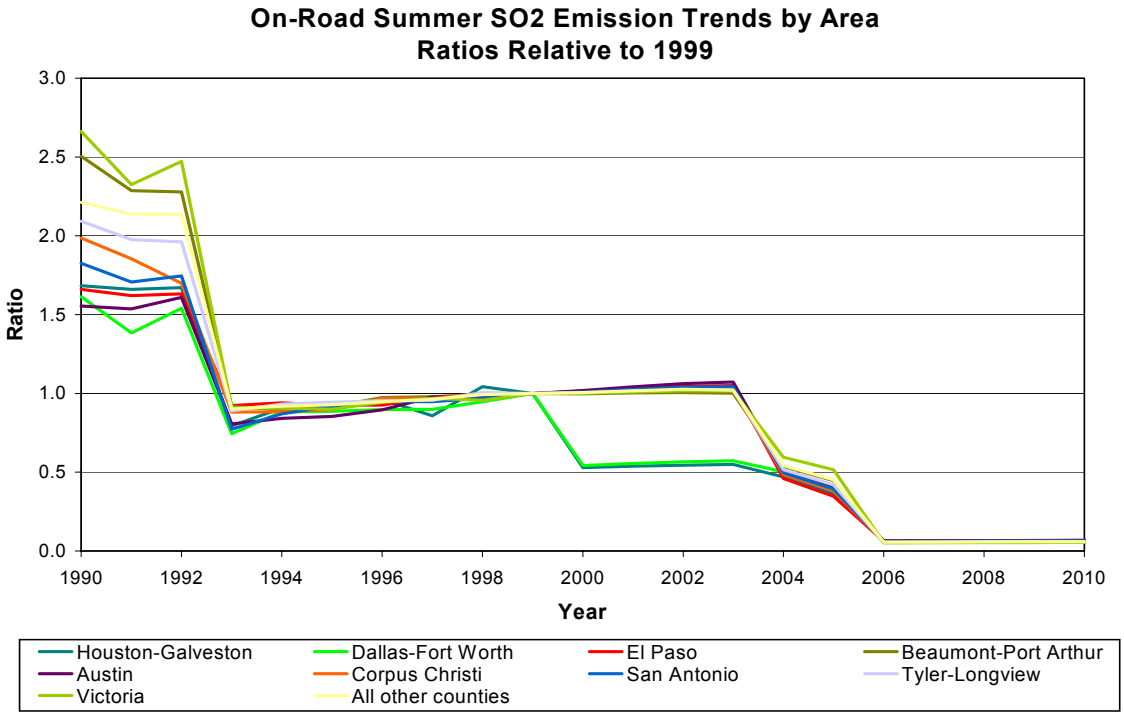
Statewide On-Road Summer SO2 Emission Trends by Vehicle Class

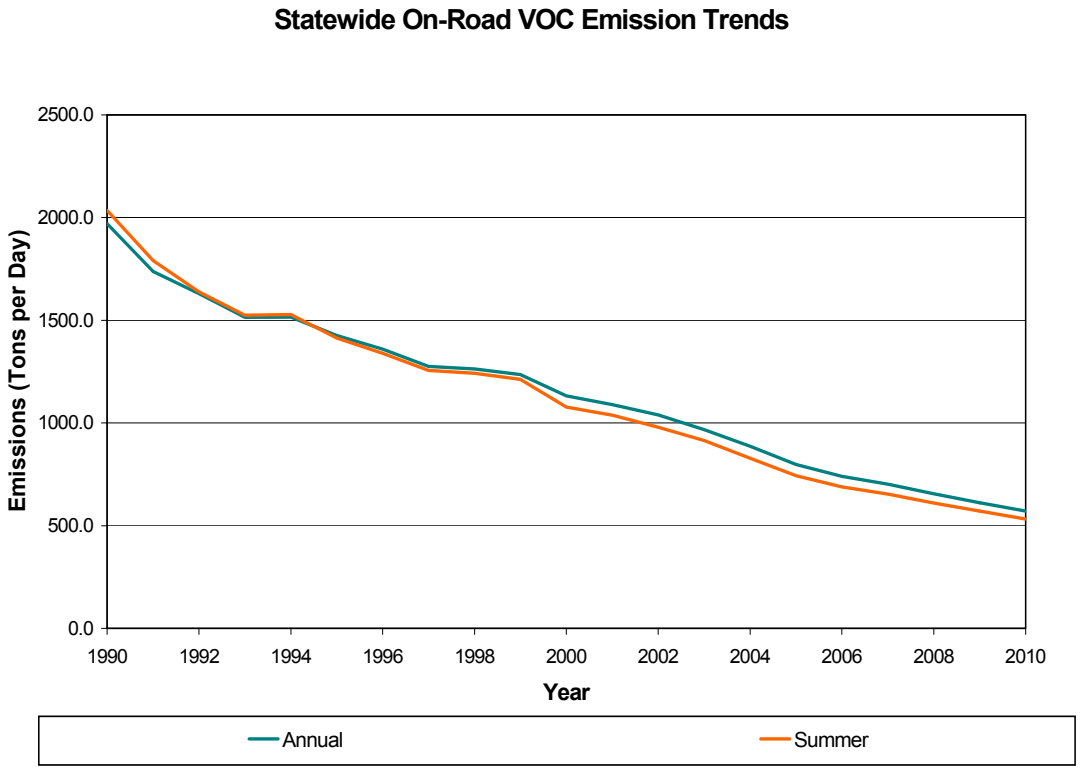


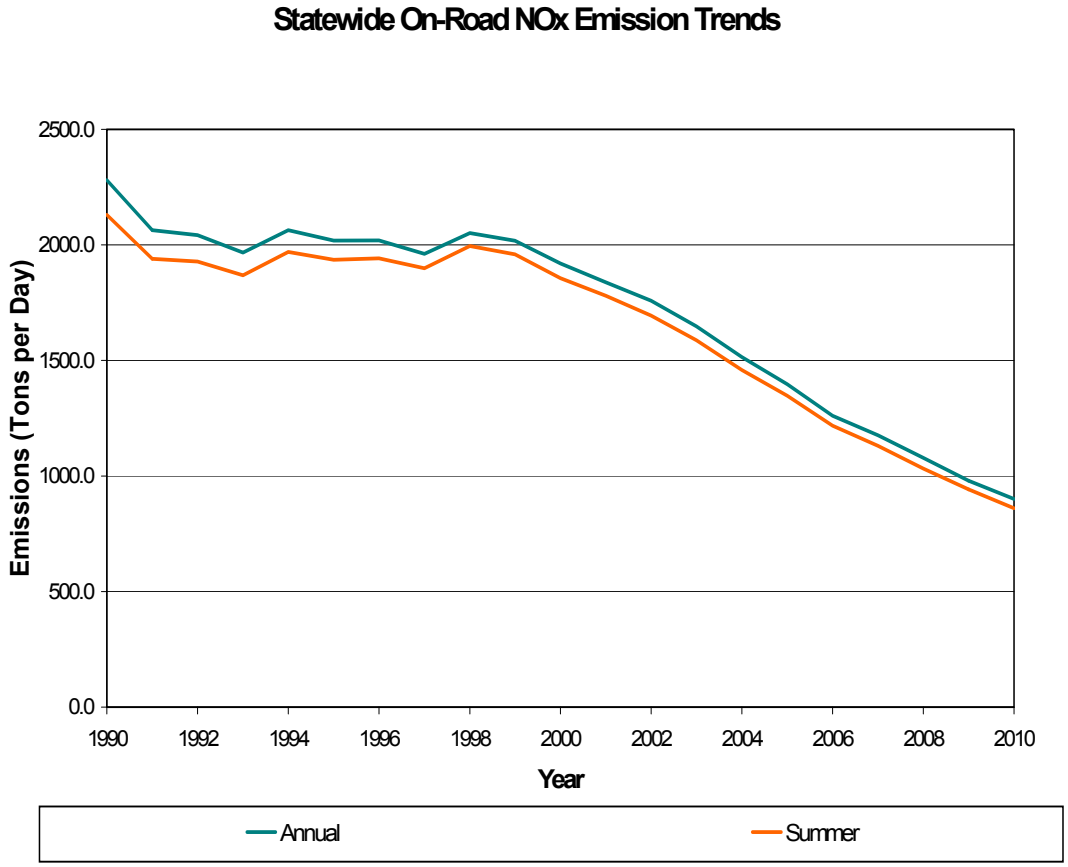
Statewide On-Road Summer SO2 Emission Trends by Vehicle Class
Ratios Relative to 1999

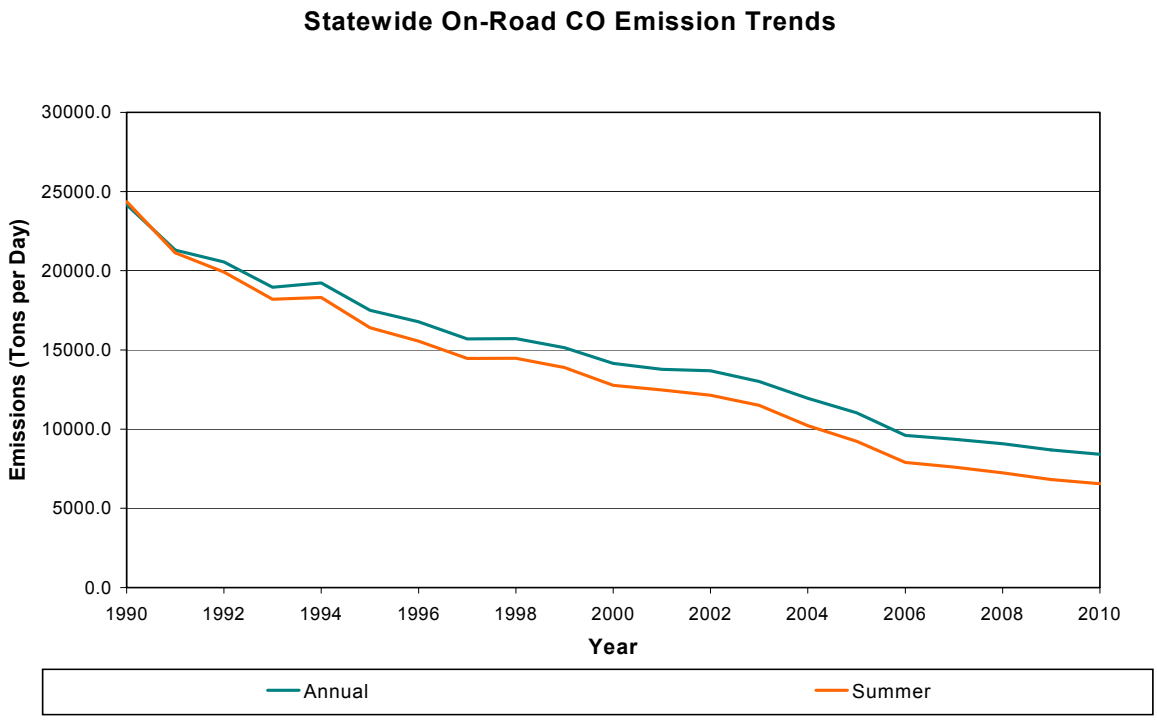


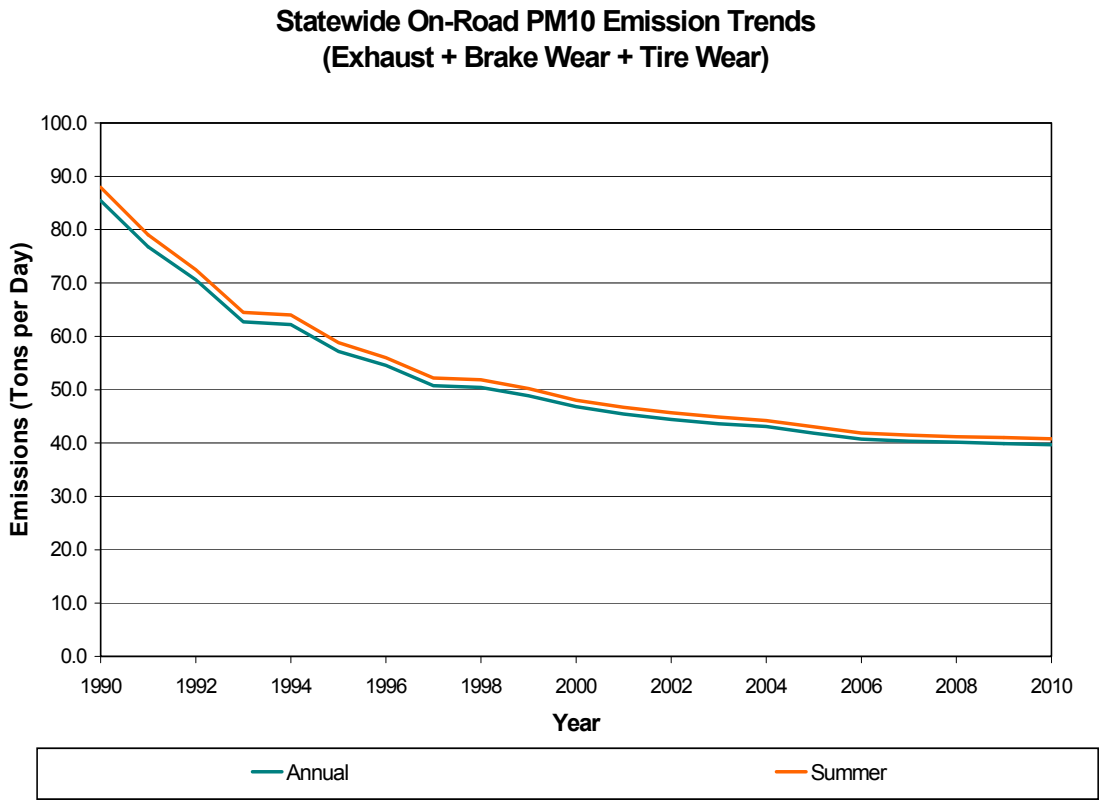

On-Road Summer SO2 Emission Trends by Area
Emissions (Tons perDay)
160
140
120
100
80
60
40
20
0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

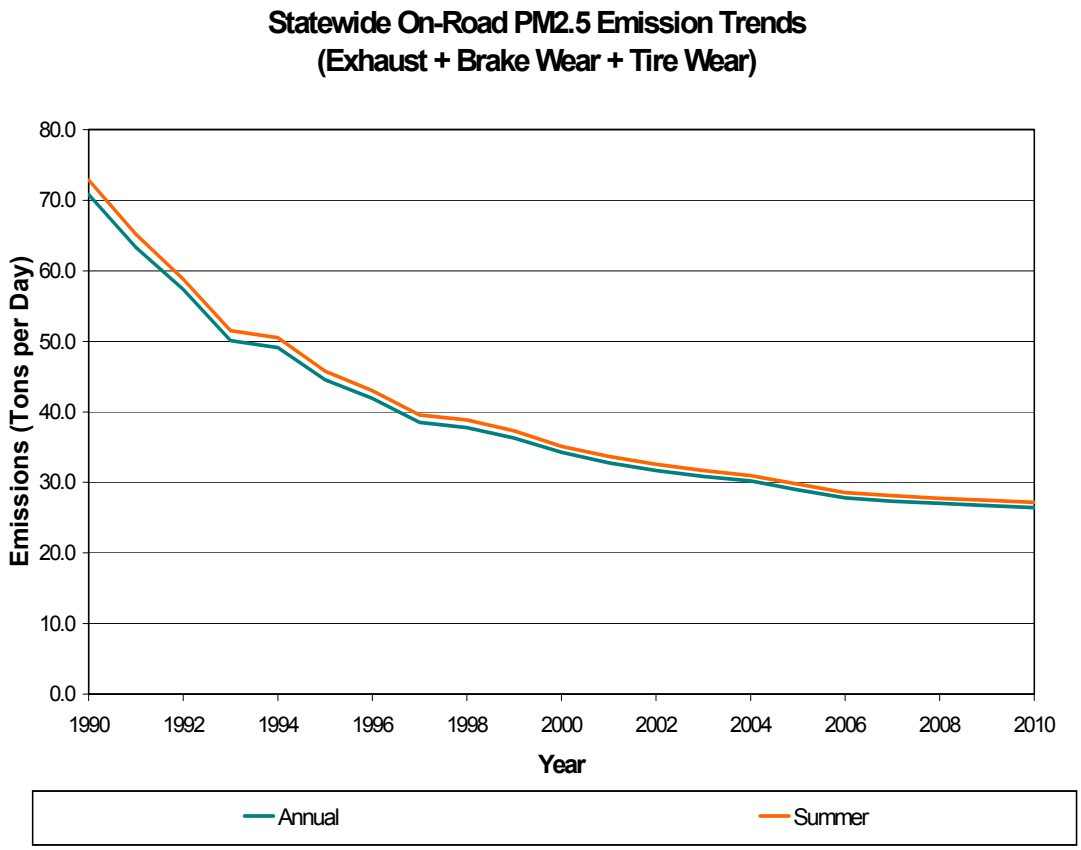

On-Road Summer SO2 Emission Trends by Area
Ratios Relative to 1999
Ratio
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Houston-Galveston
Dallas-Fort Worth
El Paso
Beaumont-Port Arthur
Austin
Corpus Christi
San Antonio
Tyler-Longview
Victoria
All other counties

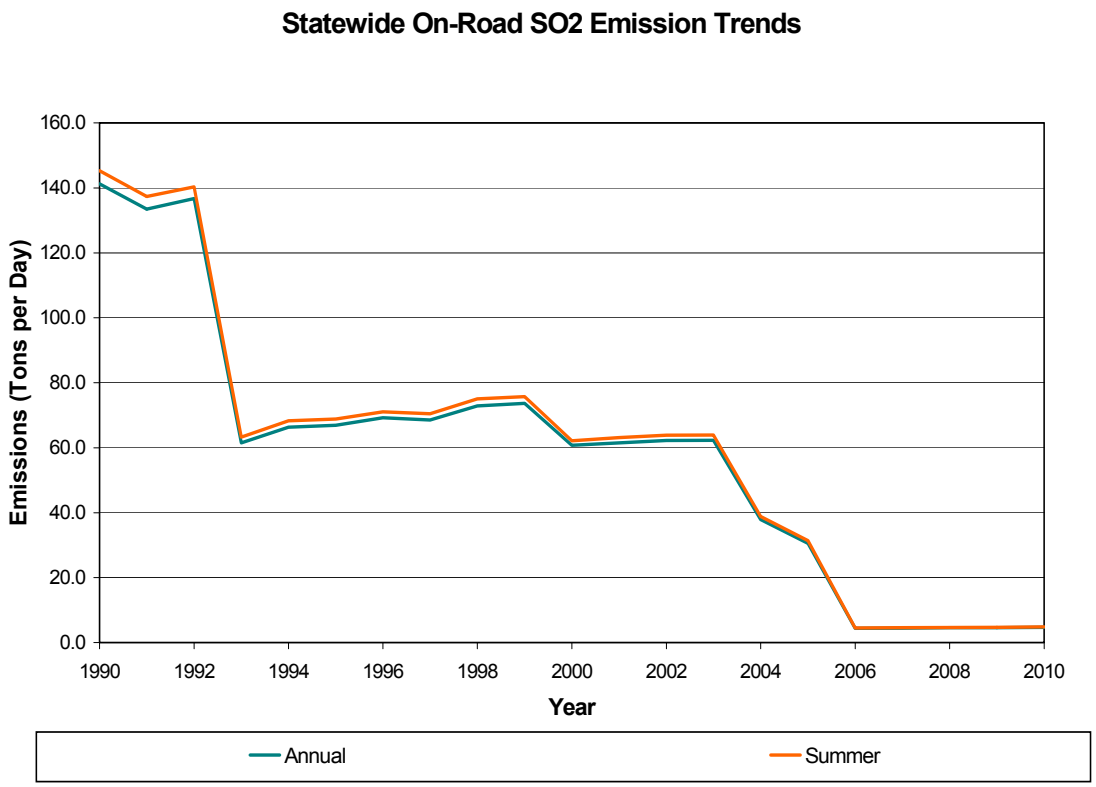

Statewide On-Road VOC Emission Trends
Emissions (Tons per Day)
2500.0
2000.0
1500.0
1000.0
500.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer

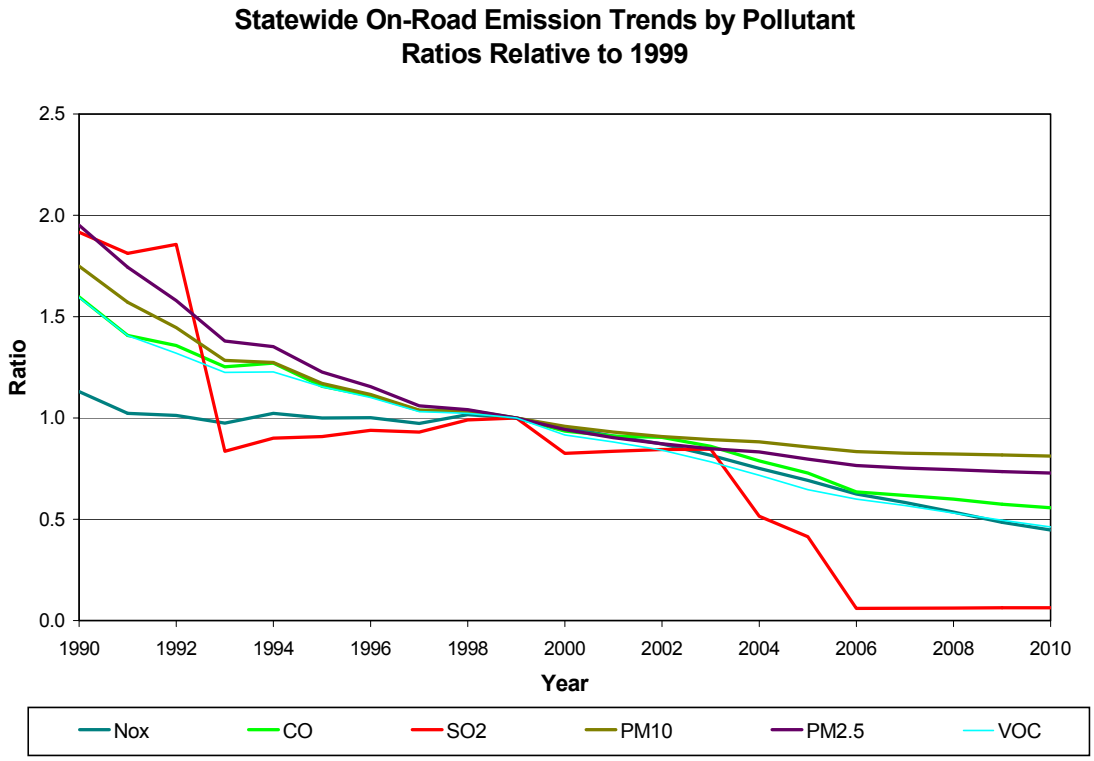

Statewide On-Road NOx Emission Trends
Emissions (Tons per Day)
2500.0
2000.0
1500.0
1000.0
500.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide On-Road CO Emission Trends
Emissions (Tons per Day)
30000.0
25000.0
20000.0
15000.0
10000.0
5000.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide On-Road PM10 Emission Trends
(Exhaust + Brake Wear + Tire Wear)
Emissions (Tons per Day)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide On-Road PM2.5 Emission Trends
(Exhaust + Brake Wear + Tire Wear)
Emissions (Tons per Day)
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide On-Road SO2 Emission Trends
Emissions (Tons per Day)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Annual
Summer


Statewide On-Road Emission Trends by Pollutant
Ratios Relative to 1999
Ratio
2.5
2.0
1.5
1.0
0.5
0.0
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
Year
Nox
CO
SO2
PM10
PM2.5
VOC

9.0 QUALITY ASSURANCE CHECKS

This section describes quality assurance (QA) procedures followed to assure that the emission inventory calculations were done as intended in the methodology descriptions. QA procedures and examples are described below for each of the major source category groupings. In general, QA checks include review of calculation files by staff other than the people who performed the work, internal totals consistency checks, reasonableness checks, and visual QA (pie charts for the 1999 EI and trends graphs for the 1990-2010 inventories).

9.1 AREA SOURCES

For the 1999 area sources emissions, QA review of activity data and emission factors was conducted by a staff member that was not responsible for preparing emission estimates for each category. The QA reviewer compared data entered in electronic spreadsheets and Access data bases against the original sources of data to identify and correct data entry errors. The QA reviewer also verified that the correct SCCs were used and verifies that equations used to calculate emissions were correct. In addition, when spreadsheet and Access data base files were converted to NIF 2.0, the ENVIRON team compared record counts and emission totals before and after file conversions to make sure that the conversions were completed correctly.

For the area source emission trends effort, QA review of activity data and control parameters (CE, RP, and RE) was conducted by a staff member that was not responsible for preparing emission estimates for each category. The QA reviewer compared data entered in electronic spreadsheets and Access data bases against the original sources of data to identify and correct data entry errors. The QA reviewer also verified that the algorithms used to calculate emissions were correct, that the 1999 annual and OSD emissions in the 1999 NIF 2.0 inventory matched the 1999 annual and OSD emissions in the final emission trends Access data base, and that the correct SCCs were used. For the SCCs which were grown using the general emission projections approach (i.e., the approach that relies on the use of EGAS 4.0 growth factors), the ENVIRON team compared the record count from the projected emissions table with the record count from the 1999 inventory file used as the basis for projecting emissions. This step ensured that growth factors were applied to each record in the 1999 inventory file.

In addition, the ENVIRON team reviewed the graphics and tables that are presented in Section 8 for reasonableness. For any anomaly, the team reviewed the source of the emission estimates to ensure that the input data and calculations were performed correctly and also identified the explanation for the apparent anomaly (e.g., the large 1996-1997 reduction in annual and OSD NO_X emissions in the Waste Disposal & Recycling Tier 1 category results from the state's open burning regulation that was implemented beginning in 1997). The team also compared the emission values in the Section 8 summary tables with values calculated from the final Access data base containing the annual and OSD emission trends data set records.

9.2 BIOGENIC EMISSIONS

The 1999 Statewide county-level biogenic emissions inventory was quality assured through a number of procedures to ensure the accuracy and consistency of the emission estimates. Various quality assurance checks were made of the input data and results from each of the processing steps required during the inventory development. These included verification of consistent input LULC data, accurate and consistent temperature and cloud cover data, and comparison of emission totals with previously developed similar inventories.

The Land use/Land cover data processed in ArcView GIS system underwent numerous accuracy and consistency checks throughout the various processing steps. These included visual inspection of LULC polygon coverages and various quality assurance calculations to ensure that all land area was accounted for with respect to vegetation cover. These QA procedures are further described in the Yarwood, et al., 2001. The processed LULC data was exported from the GIS and the data was investigated on a county basis to ensure that all land area for each county was fully accounted for prior to input to the Globeis Access database. The additional input data required by Globeis, including county-level temperature and cloud cover data, was checked for accuracy prior to the final model application. County temperature data were plotted and visually inspected and reviewed for consistency. Cloud cover data was also inspected and reviewed through graphical visualization of the data. The Globeis model includes a extensive QA/QC modules to ensure integrity of input data. These features were exercised to ensure consistency in the relationships between data including verification that LULC data are consistent with the internal model data tables specifying the attributes of the LULC categories. Additional QA checks are made to verify that all data association in the database are intact to avoid dropping emissions, and to verify that all data associations are unique so that emission are not double counted or calculated arbitrarily. More detailed discussion of the internal quality assurance features of the Globeis model can be found in Yarwood, et al., 1999.

The final QA procedures for the biogenic emission inventory involved comparison with previously developed inventories. The emissions calculated for a 5 county region within East Texas were compared previous calculation made with the same version of the model and underlying LULC datasets. While the temperature and cloud cover data used in the previous inventory development differed, the two inventories were determined to be consistent given the differences in the input data.

9.3 NONROAD SOURCES

Quality assurance procedures were performed at various points in the development of the non-road emissions inventories. Because the non-road emissions involved the use of various methods and/or tools, different checks were employed as appropriate.

Various staff members performed QA on the EPA NONROAD model inputs and outputs. A staff member not involved in creating the input files conducted spot checks on the input

parameters used in the EPA NONROAD model. The input parameters in the options file for the NONROAD model depended on the county and year being modeled. Thus, several individual options files were checked for the correct fuel RVP, oxygen weight %, sulfur levels, and temperatures.

Further checks were performed on the NONROAD output. In particular, a staff member that was not responsible for the model runs verified that the non-default equipment populations for the GSE, recreational marine, and diesel construction source categories were reflected in the output. For the trends and projections runs, the output populations were checked to confirm that there was no change over time, since NONROAD was run at zero growth.

Post-processing steps taken on the NONROAD output also required QA. Since the NONROAD model was run with no growth for the years 1990 through 2010, growth factors for the NONROAD source categories were applied outside the model using a PERL program. To check that the growth was correctly implemented, a staff member compared the NONROAD emissions with and without growth. Each source category was checked for several counties, comparing the post-processing output with hand-calculated results. Graphs were also prepared to visually confirm that growth trends occurred as expected.

The control factors, the growth for the three non-traditional NONROAD categories, and the trends associations between counties and representative NONROAD runs were implemented in an Access database. The 1999 emissions totals for each source category for each pollutant resulting from the Access queries were checked against the established 1999 emissions inventory. Spot checks were also performed on the implementation of the control and growth factors to make sure the calculations in the queries were correct.

The final emissions for several categories were compared with NEI or SIP numbers to check the reasonableness of the estimates. For example, the recreational marine emissions for 1999 were checked against the 1999 NEI numbers. Because this work used a non-default, increased recreational marine equipment population, emissions were expected to rise by a factor of 2 to 3, depending on the pollutant. Pie charts were also created for the 1999 state total emissions by source category as a QA measure. This visual aid helped to determine whether the portion of emissions attributed to a certain source was reasonable. For example, locomotives were expected to contribute a large portion of the state NOx emissions, while only a tiny fraction should have been attributed to lawn and garden equipment. Pie charts were created for each pollutant, for summer and annual emissions.

Finally, the trends and projections charts, displaying emissions over time by source category and area, also served as a QA tool. Each pollutant, source category, and geographical region was checked to see that increases and/or decreases in emissions occurred at expected times and at anticipated magnitudes.

9.4 ON-ROAD SOURCES

In order to assure that emissions estimates developed in this work effort are accurate given the choice of methodology and tools, quality assurance (QA) procedures were performed at important junctures during the processing as well as upon the final estimates. In general, someone other than the person(s) performing the calculations inspected the particular portion. This afforded a 'fresh perspective' and increased the likelihood of catching subtle errors. In most cases, the staff carrying out the processing also did self checks. The process of QA often involved comparison of results arrived at through various means, including the one ultimately reported. Another type of check seeks reasonable explanations for the observed values. The discussion which follows outlines the different steps taken to assure the integrity of the final on-road mobile source emissions trends results from this work.

One of the best methods to determine if certain features of the calculations were implemented correctly in the processing stream was to do random 'spot checks'. This entailed choosing a scenario which requires a particular feature, performing parallel hand calculations for that scenario, and comparing the results. These spot checks were done for both MOBILE6- and PART5-based emissions since these required different post-processing schemes. Spot checks are incomplete by nature so subtotals were also utilized to check the results. These types of checks mostly reveal the reasonableness of the numbers relative to one another and are made simple with the aid of visual plots. Any anomaly can then be examined in more detail. For instance, ozone summer day (OSD) emissions were compared to annual total estimates to determine whether there was something close to a 1:365 ratio (within expected deviations from that ratio). The distribution of particular pollutants among the vehicle classes was also another useful check. For example, expectations were that heavy-duty diesel trucks would predominate NOx and PM emissions while gasoline vehicles would account for most of the CO and evaporative VOC. Another type of check tracks the increase and reduction of specific pollutants over time. These trends should be explainable given the phase-in of control programs, introduction of new emission control standards, VMT growth etc. Nowhere is this more obvious than the case of sulfur dioxide emissions, especially as plotted by vehicle class. Since PART5 calculates SO2 based upon fuel sulfur content, the emissions clearly indicate the years where significant reductions of sulfur in diesel and different types gasoline fuel. Emissions grouped by attainment and non- or near non-attainment areas also gave an idea of the how well the various region-specific controls were modeled. As a final check, the 1996 emissions for a handful of counties generated as part of this work were compared to the corresponding emissions found at TNRCC's web site (http:\\www.tnrcc.state.tx.us\air\aqp\ei\namap1.htm). Given that the input data, methodology, and tools used were expectedly divergent, the results were very close for some OSD values. Overall, the emissions from these sources were of the same order of magnitude.

9.5 1999 DATA TO NIF FORMAT

An EPA computer program was run on the area and nonroad source inventories prepared in NIF 2.0 using EPA's Access data base shells. The QA program did not identify any QA

issues with data field specifications (i.e., character type and length), data code specifications (e.g., checks on validity of county Federal Information Processing Standards (FIPS) codes, and consistent use of pollutant codes and other coding conventions), and referential integrity requirements of NEI 2.0. When the biogenic inventory was prepared in NIF 2.0, an EPA QA program was not available. The biogenic inventory files were reviewed by a staff member that was not involved with compiling the inventory into EPA's Access data base shell to verify that the inventory complied with the NIF 2.0 requirements.

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Appendix 2-A

Refueling County Categories

Refueling Counties

Floyd	Brown	El Paso	De Witt	Webb	Angelina	Orange	Dallas
Andrews	Brewster	El_Paso	Aransas	Bandera	Anderson	Hardin	Brazoria
Archer	Brown		Atascosa	Blanco	Angelina	Jefferson	Chambers
Armstrong	Clay		Bastrop	Brooks	Austin	Orange	Collin
Bailey	Coke		Bee	Burnet	Bosque		Dallas
Baylor	Coleman		Bell	Cameron	Bowie		Denton
Borden	Comanche		Bexar	Dimmit	Brazos		Fort Bend
Briscoe	Concho		Burleson	Duval	Camp		Galveston
Callahan	Crane		Caldwell	Frio	Cass		Harris
Carson	Crockett		Calhoun	Gillespie	Cherokee		Liberty
Castro	Culberson		Comal	Hidalgo	Colorado		Montgomery
Childress	Ector		Coryell	Jim_Hogg	Cooke		Tarrant
Cochran	Edwards		DeWitt	Jim_Wells	Delta		Waller
Collingsworth	Erath		Fayette	Kendall	Ellis		
Cottle	Glasscock		Goliad	Kenedy	Falls		
Crosby	Hamilton		Gonzales	Kerr	Fannin		
Dallam	Hudspeth		Guadalupe	Kinney	Franklin		
Dawson	Irion		Hays	Kleberg	Freestone		
Deaf_Smith	Jack		Jackson	La_Salle	Grayson		
Dickens	Jeff_Davis		Karnes	Lampasas	Gregg		
Donley	Kimble		Lavaca	Llano	Grimes		
Eastland	Loving		Lee	Mason	Harrison		
Fisher	McCulloch		Live_Oak	Maverick	Henderson		
Floyd	Menard		Milam	McMullen	Hill		
Foard	Midland		Nueces	Medina	Hood		
Gaines	Montague		Refugio	Mills	Hopkins		
Garza	Palo_Pinto		San_Patricio	San_Saba	Houston		
Gray	Pecos		Travis	Starr	Hunt		
Hale	Presidio		Victoria	Uvalde	Jasper		
Hall	Reagan		Washington	Webb	Johnson		
Hansford	Real		Williamson	Willacy	Kaufman		
Hardeman	Reeves		Wilson	Zapata	Lamar		
Hartley	Runnels			Zavala	Leon		
Haskell	Schleicher				Limestone		
Hemphill	Sterling				Madison		
Hockley	Sutton				Marion		
Howard	Terrell				Matagorda		
Hutchinson	Tom_Green				McLennan		
Jones	Upton				Morris		
Kent	Val_Verde				Nacogdoches		
King	Ward				Navarro		
Knox	Winkler				Newton		
Lamb					Panola		
Lipscomb					Parker		
Lubbock					Polk		
Lynn					Rains		
Martin					Red_River		
Mitchell					Robertson		
Moore					Rockwall		
Motley					Rusk		

Floyd	Brown	El Paso	De Witt	Webb	Angelina	Orange	Dallas
Nolan					Sabine		
Ochiltree					San_Augustine		
Oldham					San_Jacinto		
Parmer					Shelby		
Potter					Smith		
Randall					Somervell		
Roberts					Titus		
Scurry					Trinity		
Shackelford					Tyler		
Sherman					Upshur		
Stephens					Van_Zandt		
Stonewall					Walker		
Swisher					Wharton		
Taylor					Wise		
Terry					Wood		
Throckmorton							
Wheeler							
Wichita							
Wilbarger							
Yoakum							
Young							

Appendix 2-B

Final Refueling Emission Factors

Final Refueling Emission Factors

Floyd	Brown	El Paso	De Witt	Webb	Angelina	Orange	Dallas
Andrews	Brewster	El_Paso	Aransas	Bandera	Anderson	Hardin	Brazoria
Archer	Brown		Atascosa	Blanco	Angelina	Jefferson	Chambers
Armstrong	Clay		Bastrop	Brooks	Austin	Orange	Collin
Bailey	Coke		Bee	Burnet	Bosque		Dallas
Baylor	Coleman		Bell	Cameron	Bowie		Denton
Borden	Comanche		Bexar	Dimmit	Brazos		Fort Bend
Briscoe	Concho		Burleson	Duval	Camp		Galveston
Callahan	Crane		Caldwell	Frio	Cass		Harris
Carson	Crockett		Calhoun	Gillespie	Cherokee		Liberty
Castro	Culberson		Comal	Hidalgo	Colorado		Montgomery
Childress	Ector		Coryell	Jim_Hogg	Cooke		Tarrant
Cochran	Edwards		DeWitt	Jim_Wells	Delta		Waller
Collingsworth	Erath		Fayette	Kendall	Ellis		
Cottle	Glasscock		Goliad	Kenedy	Falls		
Crosby	Hamilton		Gonzales	Kerr	Fannin		
Dallam	Hudspeth		Guadalupe	Kinney	Franklin		
Dawson	Irion		Hays	Kleberg	Freestone		
Deaf_Smith	Jack		Jackson	La_Salle	Grayson		
Dickens	Jeff_Davis		Karnes	Lampasas	Gregg		
Donley	Kimble		Lavaca	Llano	Grimes		
Eastland	Loving		Lee	Mason	Harrison		
Fisher	McCulloch		Live_Oak	Maverick	Henderson		
Floyd	Menard		Milam	McMullen	Hill		
Foard	Midland		Nueces	Medina	Hood		
Gaines	Montague		Refugio	Mills	Hopkins		
Garza	Palo_Pinto		San_Patricio	San_Saba	Houston		
Gray	Pecos		Travis	Starr	Hunt		
Hale	Presidio		Victoria	Uvalde	Jasper		
Hall	Reagan		Washington	Webb	Johnson		
Hansford	Real		Williamson	Willacy	Kaufman		
Hardeman	Reeves		Wilson	Zapata	Lamar		
Hartley	Runnels			Zavala	Leon		
Haskell	Schleicher				Limestone		
Hemphill	Sterling				Madison		
Hockley	Sutton				Marion		
Howard	Terrell				Matagorda		
Hutchinson	Tom_Green				McLennan		
Jones	Upton				Morris		
Kent	Val_Verde				Nacogdoches		
King	Ward				Navarro		
Knox	Winkler				Newton		
Lamb					Panola		
Lipscomb					Parker		
Lubbock					Polk		
Lynn					Rains		
Martin					Red_River		
Mitchell					Robertson		
Moore					Rockwall		
Motley					Rusk		

Floyd	Brown	El Paso	De Witt	Webb	Angelina	Orange	Dallas
Nolan					Sabine		
Ochiltree					San_Augustine		
Oldham					San_Jacinto		
Parmer					Shelby		
Potter					Smith		
Randall					Somervell		
Roberts					Titus		
Scurry					Trinity		
Shackelford					Tyler		
Sherman					Upshur		
Stephens					Van_Zandt		
Stonewall					Walker		
Swisher					Wharton		
Taylor					Wise		
Terry					Wood		
Throckmorton							
Wheeler							
Wichita							
Wilbarger							
Yoakum							
Young							

Angelina County

Year	Season	fleet avg tot refueling (g/gal)	fleet avg Spillage (g/gal)	fleet avg displ (g/gal)
1990	summer	4.745	0.310	4.435
1990	winter	4.378	0.310	4.068
1991	summer	4.745	0.310	4.435
1991	winter	4.378	0.310	4.068
1992	summer	4.745	0.310	4.435
1992	winter	4.378	0.310	4.068
1993	summer	4.745	0.310	4.435
1993	winter	4.378	0.310	4.068
1994	summer	4.745	0.310	4.435
1994	winter	4.378	0.310	4.068
1995	summer	4.745	0.310	4.435
1995	winter	4.378	0.310	4.068
1996	summer	4.745	0.310	4.435
1996	winter	4.378	0.310	4.068
1997	summer	4.745	0.310	4.435
1997	winter	4.378	0.310	4.068
1998	summer	4.727	0.309	4.418
1998	winter	4.373	0.310	4.063
1999	summer	4.609	0.305	4.303
1999	winter	4.273	0.306	3.967
2000	summer	3.861	0.298	3.563
2000	winter	3.902	0.299	3.603
2001	summer	3.636	0.289	3.347
2001	winter	3.686	0.290	3.396
2002	summer	3.379	0.279	3.100
2002	winter	3.435	0.280	3.155
2003	summer	3.105	0.268	2.837
2003	winter	3.161	0.270	2.892
2004	summer	2.828	0.257	2.571
2004	winter	2.881	0.258	2.622
2005	summer	2.537	0.246	2.291
2005	winter	2.607	0.248	2.360
2006	summer	2.236	0.236	2.000
2006	winter	2.304	0.237	2.067
2007	summer	1.949	0.226	1.723
2007	winter	2.006	0.228	1.778
2008	summer	1.693	0.218	1.475
2008	winter	1.739	0.219	1.520
2009	summer	1.465	0.211	1.254
2009	winter	1.502	0.212	1.290
2010	summer	1.289	0.205	1.084
2010	winter	1.320	0.205	1.114

Brown County

Year	Season	fleet avg tot refueling (g/gal)	fleet avg Spillage (g/gal)	fleet avg displ (g/gal)
1990	summer	4.539	0.310	4.229
1990	winter	4.287	0.310	3.977
1991	summer	4.539	0.310	4.229
1991	winter	4.287	0.310	3.977
1992	summer	4.539	0.310	4.229
1992	winter	4.287	0.310	3.977
1993	summer	4.539	0.310	4.229
1993	winter	4.287	0.310	3.977
1994	summer	4.539	0.310	4.229
1994	winter	4.287	0.310	3.977
1995	summer	4.539	0.310	4.229
1995	winter	4.287	0.310	3.977
1996	summer	4.539	0.310	4.229
1996	winter	4.287	0.310	3.977
1997	summer	4.539	0.310	4.229
1997	winter	4.287	0.310	3.977
1998	summer	4.526	0.310	4.217
1998	winter	4.283	0.310	3.973
1999	summer	4.437	0.306	4.130
1999	winter	4.205	0.307	3.899
2000	summer	4.134	0.300	3.833
2000	winter	3.867	0.301	3.566
2001	summer	3.915	0.292	3.623
2001	winter	3.678	0.293	3.384
2002	summer	3.637	0.282	3.356
2002	winter	3.431	0.283	3.148
2003	summer	3.340	0.270	3.069
2003	winter	3.156	0.272	2.884
2004	summer	3.033	0.259	2.774
2004	winter	2.874	0.261	2.613
2005	summer	2.703	0.247	2.456
2005	winter	2.595	0.249	2.346
2006	summer	2.376	0.236	2.140
2006	winter	2.292	0.238	2.054
2007	summer	2.082	0.226	1.855
2007	winter	2.008	0.228	1.780
2008	summer	1.825	0.218	1.607
2008	winter	1.758	0.219	1.539
2009	summer	1.600	0.210	1.390
2009	winter	1.539	0.211	1.328
2010	summer	1.410	0.203	1.207
2010	winter	1.357	0.204	1.153

Dallas County

Year	Season	fleet avg tot refueling (g/gal)	fleet avg Spillage (g/gal)	fleet avg displ (g/gal)
1990	summer	4.259	0.310	3.949
1990	winter	4.572	0.310	4.262
1991	summer	4.357	0.310	4.047
1991	winter	4.572	0.310	4.262
1992	summer	3.823	0.310	3.513
1992	winter	4.330	0.310	4.020
1993	summer	3.920	0.310	3.610
1993	winter	4.233	0.310	3.923
1994	summer	2.564	0.310	2.254
1994	winter	2.606	0.310	2.296
1995	summer	1.068	0.310	0.758
1995	winter	1.201	0.310	0.891
1996	summer	1.067	0.310	0.757
1996	winter	1.211	0.310	0.901
1997	summer	1.067	0.310	0.757
1997	winter	1.211	0.310	0.901
1998	summer	1.061	0.309	0.753
1998	winter	1.178	0.310	0.868
1999	summer	1.032	0.303	0.729
1999	winter	1.149	0.304	0.844
2000	summer	0.949	0.294	0.655
2000	winter	1.091	0.296	0.795
2001	summer	0.902	0.284	0.618
2001	winter	1.038	0.286	0.752
2002	summer	0.846	0.273	0.574
2002	winter	0.976	0.275	0.701
2003	summer	0.795	0.260	0.535
2003	winter	0.908	0.263	0.645
2004	summer	0.734	0.248	0.486
2004	winter	0.837	0.250	0.587
2005	summer	0.669	0.235	0.434
2005	winter	0.767	0.238	0.529
2006	summer	0.596	0.223	0.373
2006	winter	0.682	0.226	0.456
2007	summer	0.533	0.213	0.319
2007	winter	0.605	0.215	0.390
2008	summer	0.483	0.205	0.279
2008	winter	0.546	0.206	0.340
2009	summer	0.441	0.197	0.244
2009	winter	0.496	0.199	0.297
2010	summer	0.407	0.191	0.216
2010	winter	0.455	0.192	0.263

Dewitt County

Year	Season	fleet avg tot refueling (g/gal)	fleet avg Spillage (g/gal)	fleet avg displ (g/gal)
1990	summer	4.540	0.310	4.230
1990	winter	4.883	0.310	4.573
1991	summer	4.540	0.310	4.230
1991	winter	4.883	0.310	4.573
1992	summer	4.540	0.310	4.230
1992	winter	4.883	0.310	4.573
1993	summer	4.540	0.310	4.230
1993	winter	4.883	0.310	4.573
1994	summer	4.540	0.310	4.230
1994	winter	4.883	0.310	4.573
1995	summer	4.540	0.310	4.230
1995	winter	4.883	0.310	4.573
1996	summer	4.540	0.310	4.230
1996	winter	4.883	0.310	4.573
1997	summer	4.540	0.310	4.230
1997	winter	4.883	0.310	4.573
1998	summer	4.526	0.310	4.217
1998	winter	4.878	0.310	4.568
1999	summer	4.446	0.307	4.139
1999	winter	4.801	0.307	4.493
2000	summer	3.741	0.301	3.440
2000	winter	4.450	0.302	4.149
2001	summer	3.558	0.293	3.265
2001	winter	4.243	0.294	3.949
2002	summer	3.338	0.284	3.054
2002	winter	3.989	0.285	3.704
2003	summer	3.098	0.274	2.824
2003	winter	3.705	0.275	3.430
2004	summer	2.841	0.263	2.578
2004	winter	3.397	0.265	3.132
2005	summer	2.554	0.252	2.302
2005	winter	3.087	0.254	2.833
2006	summer	2.257	0.242	2.015
2006	winter	2.734	0.243	2.491
2007	summer	1.976	0.233	1.744
2007	winter	2.388	0.234	2.155
2008	summer	1.730	0.224	1.506
2008	winter	2.084	0.225	1.859
2009	summer	1.526	0.217	1.309
2009	winter	1.831	0.217	1.614
2010	summer	1.349	0.210	1.139
2010	winter	1.615	0.211	1.404

El Paso County

Year	Season	fleet avg tot refueling (g/gal)	fleet avg Spillage (g/gal)	fleet avg displ (g/gal)
1990	summer	3.909	0.310	3.599
1990	winter	3.753	0.310	3.443
1991	summer	3.957	0.310	3.647
1991	winter	3.753	0.310	3.443
1992	summer	3.569	0.310	3.259
1992	winter	4.335	0.310	4.025
1993	summer	3.618	0.310	3.308
1993	winter	3.899	0.310	3.589
1994	summer	2.377	0.310	2.067
1994	winter	2.222	0.310	1.912
1995	summer	1.065	0.310	0.755
1995	winter	1.174	0.310	0.864
1996	summer	1.041	0.310	0.731
1996	winter	1.061	0.310	0.751
1997	summer	1.041	0.310	0.731
1997	winter	1.061	0.310	0.751
1998	summer	1.003	0.309	0.694
1998	winter	1.216	0.310	0.906
1999	summer	1.007	0.305	0.702
1999	winter	1.250	0.306	0.944
2000	summer	0.978	0.299	0.679
2000	winter	1.141	0.300	0.840
2001	summer	0.944	0.292	0.652
2001	winter	1.102	0.293	0.809
2002	summer	0.903	0.283	0.620
2002	winter	1.055	0.284	0.770
2003	summer	0.858	0.273	0.585
2003	winter	1.003	0.275	0.728
2004	summer	0.812	0.263	0.550
2004	winter	0.948	0.265	0.683
2005	summer	0.763	0.253	0.510
2005	winter	0.895	0.255	0.640
2006	summer	0.701	0.244	0.457
2006	winter	0.822	0.245	0.576
2007	summer	0.641	0.235	0.406
2007	winter	0.748	0.236	0.512
2008	summer	0.592	0.227	0.365
2008	winter	0.688	0.228	0.460
2009	summer	0.548	0.220	0.328
2009	winter	0.634	0.221	0.413
2010	summer	0.510	0.213	0.297
2010	winter	0.589	0.214	0.375

Floyd County

Year	Season	fleet avg tot refueling (g/gal)	fleet avg Spillage (g/gal)	fleet avg displ (g/gal)
1990	summer	4.352	0.310	4.042
1990	winter	4.077	0.310	3.767
1991	summer	4.352	0.310	4.042
1991	winter	4.077	0.310	3.767
1992	summer	4.352	0.310	4.042
1992	winter	4.077	0.310	3.767
1993	summer	4.352	0.310	4.042
1993	winter	4.077	0.310	3.767
1994	summer	4.352	0.310	4.042
1994	winter	4.077	0.310	3.767
1995	summer	4.352	0.310	4.042
1995	winter	4.077	0.310	3.767
1996	summer	4.352	0.310	4.042
1996	winter	4.077	0.310	3.767
1997	summer	4.352	0.310	4.042
1997	winter	4.077	0.310	3.767
1998	summer	4.344	0.310	4.034
1998	winter	4.074	0.310	3.764
1999	summer	4.278	0.307	3.971
1999	winter	4.018	0.308	3.710
2000	summer	4.007	0.302	3.704
2000	winter	3.710	0.303	3.407
2001	summer	3.828	0.295	3.533
2001	winter	3.552	0.296	3.256
2002	summer	3.584	0.286	3.298
2002	winter	3.333	0.287	3.047
2003	summer	3.307	0.275	3.032
2003	winter	3.079	0.276	2.804
2004	summer	3.009	0.263	2.746
2004	winter	2.806	0.264	2.542
2005	summer	2.692	0.251	2.441
2005	winter	2.533	0.252	2.281
2006	summer	2.390	0.240	2.151
2006	winter	2.257	0.241	2.017
2007	summer	2.118	0.230	1.889
2007	winter	2.000	0.231	1.769
2008	summer	1.880	0.221	1.659
2008	winter	1.775	0.221	1.554
2009	summer	1.640	0.212	1.428
2009	winter	1.548	0.212	1.335
2010	summer	1.456	0.205	1.251
2010	winter	1.373	0.205	1.167

Orange County

Year	Season	fleet avg tot refueling (g/gal)	fleet avg Spillage (g/gal)	fleet avg displ (g/gal)
1990	summer	4.622	0.310	4.312
1990	winter	5.044	0.310	4.734
1991	summer	4.622	0.310	4.312
1991	winter	5.044	0.310	4.734
1992	summer	4.040	0.310	3.730
1992	winter	5.044	0.310	4.734
1993	summer	4.040	0.310	3.730
1993	winter	4.753	0.310	4.443
1994	summer	2.594	0.310	2.284
1994	winter	2.852	0.310	2.542
1995	summer	1.145	0.310	0.835
1995	winter	1.282	0.310	0.972
1996	summer	1.145	0.310	0.835
1996	winter	1.282	0.310	0.972
1997	summer	1.144	0.310	0.834
1997	winter	1.281	0.310	0.971
1998	summer	1.142	0.309	0.833
1998	winter	1.259	0.310	0.949
1999	summer	1.123	0.306	0.817
1999	winter	1.250	0.307	0.943
2000	summer	1.088	0.300	0.789
2000	winter	1.181	0.300	0.881
2001	summer	1.043	0.291	0.752
2001	winter	1.133	0.292	0.841
2002	summer	0.990	0.281	0.709
2002	winter	1.077	0.282	0.795
2003	summer	0.931	0.270	0.661
2003	winter	1.012	0.271	0.741
2004	summer	0.867	0.258	0.609
2004	winter	0.942	0.259	0.683
2005	summer	0.797	0.246	0.552
2005	winter	0.873	0.247	0.626
2006	summer	0.728	0.234	0.493
2006	winter	0.798	0.235	0.562
2007	summer	0.649	0.224	0.425
2007	winter	0.709	0.225	0.484
2008	summer	0.587	0.215	0.372
2008	winter	0.639	0.216	0.423
2009	summer	0.536	0.207	0.328
2009	winter	0.581	0.208	0.373
2010	summer	0.494	0.201	0.293
2010	winter	0.534	0.201	0.333

Webb County

Year	Season	fleet avg tot refueling (g/gal)	fleet avg Spillage (g/gal)	fleet avg displ (g/gal)
1990	summer	4.594	0.310	4.284
1990	winter	4.633	0.310	4.323
1991	summer	4.594	0.310	4.284
1991	winter	4.633	0.310	4.323
1992	summer	4.594	0.310	4.284
1992	winter	4.633	0.310	4.323
1993	summer	4.594	0.310	4.284
1993	winter	4.633	0.310	4.323
1994	summer	4.594	0.310	4.284
1994	winter	4.633	0.310	4.323
1995	summer	4.594	0.310	4.284
1995	winter	4.633	0.310	4.323
1996	summer	4.594	0.310	4.284
1996	winter	4.633	0.310	4.323
1997	summer	4.594	0.310	4.284
1997	winter	4.633	0.310	4.323
1998	summer	4.570	0.309	4.261
1998	winter	4.625	0.310	4.315
1999	summer	4.435	0.304	4.131
1999	winter	4.503	0.305	4.198
2000	summer	4.095	0.297	3.798
2000	winter	4.119	0.298	3.821
2001	summer	3.858	0.288	3.570
2001	winter	3.900	0.290	3.610
2002	summer	3.572	0.277	3.294
2002	winter	3.630	0.280	3.350
2003	summer	3.263	0.266	2.997
2003	winter	3.323	0.269	3.055
2004	summer	2.958	0.255	2.704
2004	winter	3.018	0.257	2.761
2005	summer	2.645	0.244	2.402
2005	winter	2.721	0.246	2.475
2006	summer	2.315	0.233	2.082
2006	winter	2.387	0.235	2.152
2007	summer	2.029	0.223	1.806
2007	winter	2.089	0.225	1.864
2008	summer	1.782	0.215	1.568
2008	winter	1.831	0.216	1.615
2009	summer	1.567	0.207	1.359
2009	winter	1.608	0.208	1.399
2010	summer	1.374	0.200	1.173
2010	winter	1.408	0.201	1.207

Appendix 3-A

Summary of Houston Survey Results and Surrogates

Attachment 1

Matrix of Relevant Dodge Construction Groupings

	Rental	State/Municipal Owners	State/Municipal Contractors	Residential Contractors	Commercial Bld Contractors	Highway Contractors	Industrial Construction & Maintenance
Residential							
One-family Houses	Y			Y			
Two-family Houses	Y			Y			
Apartments	Y			Y			
Commercial and Industrial Type Bld							
Offices	Y				Y		
Stores	Y				Y		
Commercial Warehouses	Y				Y		
Hotels	Y				Y		
Parking Garages and Service Stations	Y				Y		
Manufacturing Bldgs							Y
Institutional							
Educational Bldgs	Y				Y		
Dormitories	Y				Y		
Health Care Bldgs	Y				Y		
Public Buildings	Y				Y		
Amusement Bldgs	Y				Y		
Religious Bldgs	Y				Y		
Transportation Related Bldgs	Y				Y		
Public Works and Utilities							
Streets and Roadways	Y					Y	
Bridges	Y					Y	
Sewer Lines, Treatment Plants, and Waste Disposal	Y		Y				
Water Lines and Drinking Water Treatment Plants	Y		Y				
Dams, Rivers, Reservouirs and Harbour Projects	Y		Y				
Landscaping, RailwayLines and Mass Transit, Stadiums, Airport Runways, etc	Y		Y				
Electric Power Plants, Natural Gas Plants, Tellecommunications Towers, etc	Y		Y				

Table 3.A-1. Commercial Building Contractors Houston Surveys (Surrogate Value $2,607,046,134 F.W. Dodge Permits 1999; 1992 dollars).

SCC	Description	Population
2270002003	Pavers	0
2270002015	Rollers	0
2270002018	Scrapers	0
2270002021	Paving Equipment	0
2270002024	Surfacing Equipment	0
2270002027	Signal Boards\Light Plants	0
2270002030	Trenchers	0
2270002033	Bore\Drill Rigs	540
2270002036	Excavators	62
2270002039	Concrete\Industrial Saws	0
2270002045	Cranes	49
2270002048	Graders	61
2270002051	Off-highway Trucks	0
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	0
2270002060	Rubber Tire Loaders	66
2270002063	Rubber Tire Tractors	0
2270002066	Tractors\Loaders\Backhoes	44
2270002069	Crawler Tractors	56
2270002072	Skid Steer Loaders	62
2270002075	Off-highway Tractors	0
2270002081	Other Construction Equipment	0

Table 3.A-2. Highway Contractors Houston Surveys (Surrogate Value $537,452,454 F.W. Dodge Permits 1999; 1992 dollars).

SCC	Description	Population
2270002003	Pavers	23
2270002015	Rollers	142
2270002018	Scrapers	0
2270002021	Paving Equipment	16
2270002024	Surfacing Equipment	68
2270002027	Signal Boards\Light Plants	13
2270002030	Trenchers	11
2270002033	Bore\Drill Rigs	31
2270002036	Excavators	114
2270002039	Concrete\Industrial Saws	0
2270002045	Cranes	156
2270002048	Graders	55
2270002051	Off-highway Trucks	2
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	3
2270002060	Rubber Tire Loaders	100
2270002063	Rubber Tire Tractors	25
2270002066	Tractors\Loaders\Backhoes	84
2270002069	Crawler Tractors	132
2270002072	Skid Steer Loaders	5
2270002075	Off-highway Tractors	0
2270002081	Other Construction Equipment	21

Table 3.A-3. Industrial Construction and Maintenance Contractors Houston Surveys (Surrogate Value $292,715,059 F.W. Dodge Permits 1999; 1992 dollars).

SCC	Description	Population
2270002003	Pavers	0
2270002015	Rollers	35
2270002018	Scrapers	0
2270002021	Paving Equipment	0
2270002024	Surfacing Equipment	3
2270002027	Signal Boards\Light Plants	0
2270002030	Trenchers	0
2270002033	Bore\Drill Rigs	0
2270002036	Excavators	21
2270002039	Concrete\Industrial Saws	0
2270002045	Cranes	136
2270002048	Graders	14
2270002051	Off-highway Trucks	0
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	60
2270002060	Rubber Tire Loaders	38
2270002063	Rubber Tire Tractors	3
2270002066	Tractors\Loaders\Backhoes	78
2270002069	Crawler Tractors	47
2270002072	Skid Steer Loaders	7
2270002075	Off-highway Tractors	0
2270002081	Other Construction Equipment	0

Table 3.A-4. Municipal Contractors Houston Surveys (Surrogate Value $932,737,536 F.W. Dodge Permits 1999; 1992 dollars).

SCC	Description	Population
2270002003	Pavers	103
2270002015	Rollers	602
2270002018	Scrapers	13
2270002021	Paving Equipment	65
2270002024	Surfacing Equipment	112
2270002027	Signal Boards\Light Plants	11
2270002030	Trenchers	22
2270002033	Bore\Drill Rigs	25
2270002036	Excavators	613
2270002039	Concrete\Industrial Saws	19
2270002045	Cranes	0
2270002048	Graders	232
2270002051	Off-highway Trucks	44
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	5
2270002060	Rubber Tire Loaders	485
2270002063	Rubber Tire Tractors	0
2270002066	Tractors\Loaders\Backhoes	546
2270002069	Crawler Tractors	558
2270002072	Skid Steer Loaders	49
2270002075	Off-highway Tractors	0
2270002081	Other Construction Equipment	162

Table 3.A-5. Residential Building Contractors Houston Surveys (Surrogate Value $3,405,854,641 F.W. Dodge Permits 1999; 1992 dollars).

SCC	Description	Population
2270002003	Pavers	29
2270002015	Rollers	210
2270002018	Scrapers	0
2270002021	Paving Equipment	0
2270002024	Surfacing Equipment	125
2270002027	Signal Boards\Light Plants	0
2270002030	Trenchers	79
2270002033	Bore\Drill Rigs	30
2270002036	Excavators	264
2270002039	Concrete\Industrial Saws	0
2270002045	Cranes	0
2270002048	Graders	29
2270002051	Off-highway Trucks	0
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	0
2270002060	Rubber Tire Loaders	272
2270002063	Rubber Tire Tractors	0
2270002066	Tractors\Loaders\Backhoes	91
2270002069	Crawler Tractors	328
2270002072	Skid Steer Loaders	29
2270002075	Off-highway Tractors	0
2270002081	Other Construction Equipment	0

Table 3.A-6. Rental Owners Houston Surveys (Surrogate Value $7,483,090,767 F.W. Dodge Permits 1999; 1992 dollars).

SCC	Description	Population
2270002003	Pavers	0
2270002015	Rollers	466
2270002018	Scrapers	13
2270002021	Paving Equipment	0
2270002024	Surfacing Equipment	43
2270002027	Signal Boards\Light Plants	116
2270002030	Trenchers	97
2270002033	Bore\Drill Rigs	0
2270002036	Excavators	845
2270002039	Concrete\Industrial Saws	62
2270002045	Cranes	29
2270002048	Graders	145
2270002051	Off-highway Trucks	0
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	370
2270002060	Rubber Tire Loaders	111
2270002063	Rubber Tire Tractors	77
2270002066	Tractors\Loaders\Backhoes	1496
2270002069	Crawler Tractors	837
2270002072	Skid Steer Loaders	1144
2270002075	Off-highway Tractors	0
2270002081	Other Construction Equipment	122

Table 3.A-7. Municipal and Other Public Owners Houston Surveys (Surrogate Value Human Population for Houston 4,493,741).

SCC	Description	Population
2270002003	Pavers	28
2270002015	Rollers	135
2270002018	Scrapers	6
2270002021	Paving Equipment	6
2270002024	Surfacing Equipment	39
2270002027	Signal Boards\Light Plants	3
2270002030	Trenchers	16
2270002033	Bore\Drill Rigs	8
2270002036	Excavators	248
2270002039	Concrete\Industrial Saws	16
2270002045	Cranes	18
2270002048	Graders	134
2270002051	Off-highway Trucks	9
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	3
2270002060	Rubber Tire Loaders	113
2270002063	Rubber Tire Tractors	0
2270002066	Tractors\Loaders\Backhoes	551
2270002069	Crawler Tractors	81
2270002072	Skid Steer Loaders	31
2270002075	Off-highway Tractors	6
2270002081	Other Construction Equipment	22

Table 3.A-8. Mining Owners Houston Surveys (Surrogate Value Mining Employees for Houston 635).

SCC	Description	Population
2270002003	Pavers	0
2270002015	Rollers	0
2270002018	Scrapers	0
2270002021	Paving Equipment	0
2270002024	Surfacing Equipment	0
2270002027	Signal Boards\Light Plants	0
2270002030	Trenchers	0
2270002033	Bore\Drill Rigs	0
2270002036	Excavators	0
2270002039	Concrete\Industrial Saws	0
2270002045	Cranes	0
2270002048	Graders	0
2270002051	Off-highway Trucks	0
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	0
2270002060	Rubber Tire Loaders	51
2270002063	Rubber Tire Tractors	0
2270002066	Tractors\Loaders\Backhoes	28
2270002069	Crawler Tractors	0
2270002072	Skid Steer Loaders	0
2270002075	Off-highway Tractors	0
2270002081	Other Construction Equipment	0

Table 3.A-9. Aggregate Owners Houston Surveys (Surrogate Value Mining and Aggregate Employees for Houston 4951).

SCC	Description	Population
2270002003	Pavers	0
2270002015	Rollers	0
2270002018	Scrapers	0
2270002021	Paving Equipment	0
2270002024	Surfacing Equipment	0
2270002027	Signal Boards\Light Plants	0
2270002030	Trenchers	0
2270002033	Bore\Drill Rigs	0
2270002036	Excavators	0
2270002039	Concrete\Industrial Saws	0
2270002045	Cranes	0
2270002048	Graders	0
2270002051	Off-highway Trucks	0
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	0
2270002060	Rubber Tire Loaders	245
2270002063	Rubber Tire Tractors	0
2270002066	Tractors\Loaders\Backhoes	0
2270002069	Crawler Tractors	0
2270002072	Skid Steer Loaders	0
2270002075	Off-highway Tractors	0
2270002081	Other Construction Equipment	0

Table 3.A-10. Landfill Owners Houston Surveys (Surrogate Value Landfill Tonnage for Houston area 7,529,932).

SCC	Description	Population
2270002003	Pavers	0
2270002015	Rollers	29
2270002018	Scrapers	2
2270002021	Paving Equipment	0
2270002024	Surfacing Equipment	0
2270002027	Signal Boards\Light Plants	0
2270002030	Trenchers	0
2270002033	Bore\Drill Rigs	0
2270002036	Excavators	13
2270002039	Concrete\Industrial Saws	0
2270002045	Cranes	0
2270002048	Graders	15
2270002051	Off-highway Trucks	4
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	0
2270002060	Rubber Tire Loaders	2
2270002063	Rubber Tire Tractors	0
2270002066	Tractors\Loaders\Backhoes	2
2270002069	Crawler Tractors	46
2270002072	Skid Steer Loaders	0
2270002075	Off-highway Tractors	0
2270002081	Other Construction Equipment	0

Table 3.A-11. Port-related Owners Houston Surveys (Surrogate Value Cargo Tonnage for Houston area 246,742,589).

SCC	Description	Population
2270002003	Pavers	0
2270002015	Rollers	0
2270002018	Scrapers	0
2270002021	Paving Equipment	0
2270002024	Surfacing Equipment	0
2270002027	Signal Boards\Light Plants	0
2270002030	Trenchers	0
2270002033	Bore\Drill Rigs	0
2270002036	Excavators	0
2270002039	Concrete\Industrial Saws	0
2270002045	Cranes	57
2270002048	Graders	2
2270002051	Off-highway Trucks	1
2270002054	Crushing\Processing Equipment	0
2270002057	Rough Terrain Forklifts	1
2270002060	Rubber Tire Loaders	2
2270002063	Rubber Tire Tractors	0
2270002066	Tractors\Loaders\Backhoes	4
2270002069	Crawler Tractors	4
2270002072	Skid Steer Loaders	7
2270002075	Off-highway Tractors	1
2270002081	Other Construction Equipment	4

Appendix 7-A

Seasonal Adjustment Factors Used to Combine
Season-specific Emission Factors into Annual Average

Table 7.A-1. Seasonal factors by county.

OBS	FIPS	COUNTY	DISTRICT	SUM_FAC	WIN_FAC
1	1	Anderson	Tyler	1.03767	0.96212
2	3	Andrews	Odessa	1.02088	0.97841
3	5	Angelina	Lufkin	1.01371	0.98621
4	7	Aransas	Corpus_Christi	1.03959	0.96019
5	9	Archer	Wichita_Falls	1.04010	0.95968
6	11	Armstrong	Amarillo	1.05892	0.93821
7	13	Atascosa	San_Antonio	1.00547	0.99458
8	15	Austin	Yoakum	1.01530	0.98462
9	17	Bailey	Lubbock	1.01921	0.98068
10	19	Bandera	San_Antonio	1.00547	0.99458
11	21	Bastrop	Austin	1.01582	0.98395
12	23	Baylor	Wichita_Falls	1.04010	0.95968
13	25	Bee	Corpus_Christi	1.03959	0.96019
14	27	Bell	Waco	1.02826	0.97158
15	29	Bexar	San_Antonio	1.00547	0.99458
16	31	Blanco	Austin	1.01582	0.98395
17	33	Borden	Abilene	1.06184	0.94062
18	35	Bosque	Waco	1.02826	0.97158
19	37	Bowie	Atlanta	1.03039	0.96944
20	39	Brazoria	Houston	1.06078	0.93890
21	41	Brazos	Bryan	1.02095	0.98294
22	43	Brewster	El_Paso	1.00110	0.99886
23	45	Briscoe	Childress	1.07652	0.92307
24	47	Brooks	Pharr	1.00193	0.99806
25	49	Brown	Brownwood	1.03469	0.96512
26	51	Burleson	Bryan	1.02095	0.98294
27	53	Burnet	Austin	1.01582	0.98395
28	55	Caldwell	Austin	1.01582	0.98395
29	57	Calhoun	Yoakum	1.01530	0.98462
30	59	Callahan	Abilene	1.06184	0.94062
31	61	Cameron	Pharr	1.00193	0.99806
32	63	Camp	Atlanta	1.03039	0.96944
33	65	Carson	Amarillo	1.05892	0.93821
34	67	Cass	Atlanta	1.03039	0.96944
35	69	Castro	Lubbock	1.01921	0.98068
36	71	Chambers	Beaumont	1.01314	0.98679
37	73	Cherokee	Tyler	1.03767	0.96212
38	75	Childress	Childress	1.07652	0.92307
39	77	Clay	Wichita_Falls	1.04010	0.95968
40	79	Cochran	Lubbock	1.01921	0.98068
41	81	Coke	San_Angelo	1.02537	0.97449
42	83	Coleman	Brownwood	1.03469	0.96512
43	85	Collin	Dallas	1.00999	0.99076
44	87	Collingsworth	Childress	1.07652	0.92307
45	89	Colorado	Yoakum	1.01530	0.98462
46	91	Comal	San_Antonio	1.00547	0.99458
47	93	Comanche	Brownwood	1.03469	0.96512
48	95	Concho	San_Angelo	1.02537	0.97449

49	97	Cooke	Wichita_Falls	1.04010	0.95968
50	99	Coryell	Waco	1.02826	0.97158
51	101	Cottle	Childress	1.07652	0.92307
52	103	Crane	Odessa	1.02088	0.97841
53	105	Crockett	San_Angelo	1.02537	0.97449
54	107	Crosby	Lubbock	1.01921	0.98068
55	109	Culberson	El_Paso	1.00110	0.99886
56	111	Dallam	Amarillo	1.05892	0.93821
57	113	Dallas	Dallas	1.00999	0.99076
58	115	Dawson	Lubbock	1.01921	0.98068
59	123	DeWitt	Yoakum	1.01530	0.98462
60	117	Deaf_Smith	Amarillo	1.05892	0.93821
61	119	Delta	Paris	1.02426	0.97560
62	121	Denton	Dallas	1.00999	0.99076
63	125	Dickens	Childress	1.07652	0.92307
64	127	Dimmit	Laredo	0.96042	1.03868
65	129	Donley	Childress	1.07652	0.92307
66	131	Duval	Laredo	0.96042	1.03868
67	133	Eastland	Brownwood	1.03469	0.96512
68	135	Ector	Odessa	1.02088	0.97841
69	137	Edwards	San_Angelo	1.02537	0.97449
70	141	El_Paso	El_Paso	1.00110	0.99886
71	139	Ellis	Dallas	1.00999	0.99076
72	143	Erath	Fort_Worth	1.04760	0.94941
73	145	Falls	Waco	1.02826	0.97158
74	147	Fannin	Paris	1.02426	0.97560
75	149	Fayette	Yoakum	1.01530	0.98462
76	151	Fisher	Abilene	1.06184	0.94062
77	153	Floyd	Lubbock	1.01921	0.98068
78	155	Foard	Childress	1.07652	0.92307
79	157	Fort_Bend	Houston	1.06078	0.93890
80	159	Franklin	Paris	1.02426	0.97560
81	161	Freestone	Bryan	1.02095	0.98294
82	163	Frio	San_Antonio	1.00547	0.99458
83	165	Gaines	Lubbock	1.01921	0.98068
84	167	Galveston	Houston	1.06078	0.93890
85	169	Garza	Lubbock	1.01921	0.98068
86	171	Gillespie	Austin	1.01582	0.98395
87	173	Glasscock	San_Angelo	1.02537	0.97449
88	175	Goliad	Corpus_Christi	1.03959	0.96019
89	177	Gonzales	Yoakum	1.01530	0.98462
90	179	Gray	Amarillo	1.05892	0.93821
91	181	Grayson	Paris	1.02426	0.97560
92	183	Gregg	Tyler	1.03767	0.96212
93	185	Grimes	Bryan	1.02095	0.98294
94	187	Guadalupe	San_Antonio	1.00547	0.99458
95	189	Hale	Lubbock	1.01921	0.98068
96	191	Hall	Childress	1.07652	0.92307
97	193	Hamilton	Waco	1.02826	0.97158
98	195	Hansford	Amarillo	1.05892	0.93821
99	197	Hardeman	Childress	1.07652	0.92307
100	199	Hardin	Beaumont	1.01314	0.98679
101	201	Harris	Houston	1.06078	0.93890

102	203	Harrison	Atlanta	1.03039	0.96944
103	205	Hartley	Amarillo	1.05892	0.93821
104	207	Haskell	Abilene	1.06184	0.94062
105	209	Hays	Austin	1.01582	0.98395
106	211	Hemphill	Amarillo	1.05892	0.93821
107	213	Henderson	Tyler	1.03767	0.96212
108	215	Hidalgo	Pharr	1.00193	0.99806
109	217	Hill	Waco	1.02826	0.97158
110	219	Hockley	Lubbock	1.01921	0.98068
111	221	Hood	Fort_Worth	1.04760	0.94941
112	223	Hopkins	Paris	1.02426	0.97560
113	225	Houston	Lufkin	1.01371	0.98621
114	227	Howard	Abilene	1.06184	0.94062
115	229	Hudspeth	El_Paso	1.00110	0.99886
116	231	Hunt	Paris	1.02426	0.97560
117	233	Hutchinson	Amarillo	1.05892	0.93821
118	235	Irion	San_Angelo	1.02537	0.97449
119	237	Jack	Fort_Worth	1.04760	0.94941
120	239	Jackson	Yoakum	1.01530	0.98462
121	241	Jasper	Beaumont	1.01314	0.98679
122	243	Jeff_Davis	El_Paso	1.00110	0.99886
123	245	Jefferson	Beaumont	1.01314	0.98679
124	247	Jim_Hogg	Pharr	1.00193	0.99806
125	249	Jim_Wells	Corpus_Christi	1.03959	0.96019
126	251	Johnson	Fort_Worth	1.04760	0.94941
127	253	Jones	Abilene	1.06184	0.94062
128	255	Karnes	Corpus_Christi	1.03959	0.96019
129	257	Kaufman	Dallas	1.00999	0.99076
130	259	Kendall	San_Antonio	1.00547	0.99458
131	261	Kenedy	Pharr	1.00193	0.99806
132	263	Kent	Abilene	1.06184	0.94062
133	265	Kerr	San_Antonio	1.00547	0.99458
134	267	Kimble	San_Angelo	1.02537	0.97449
135	269	King	Childress	1.07652	0.92307
136	271	Kinney	Laredo	0.96042	1.03868
137	273	Kleberg	Corpus_Christi	1.03959	0.96019
138	275	Knox	Childress	1.07652	0.92307
139	283	La_Salle	Laredo	0.96042	1.03868
140	277	Lamar	Paris	1.02426	0.97560
141	279	Lamb	Lubbock	1.01921	0.98068
142	281	Lampasas	Brownwood	1.03469	0.96512
143	285	Lavaca	Yoakum	1.01530	0.98462
144	287	Lee	Austin	1.01582	0.98395
145	289	Leon	Bryan	1.02095	0.98294
146	291	Liberty	Beaumont	1.01314	0.98679
147	293	Limestone	Waco	1.02826	0.97158
148	295	Lipscomb	Amarillo	1.05892	0.93821
149	297	Live_Oak	Corpus_Christi	1.03959	0.96019
150	299	Llano	Austin	1.01582	0.98395
151	301	Loving	Odessa	1.02088	0.97841
152	303	Lubbock	Lubbock	1.01921	0.98068
153	305	Lynn	Lubbock	1.01921	0.98068
154	313	Madison	Bryan	1.02095	0.98294

155	315	Marion	Atlanta	1.03039	0.96944
156	317	Martin	Odessa	1.02088	0.97841
157	319	Mason	Austin	1.01582	0.98395
158	321	Matagorda	Yoakum	1.01530	0.98462
159	323	Maverick	Laredo	0.96042	1.03868
160	307	McCulloch	Brownwood	1.03469	0.96512
161	309	McLennan	Waco	1.02826	0.97158
162	311	McMullen	San_Antonio	1.00547	0.99458
163	325	Medina	San_Antonio	1.00547	0.99458
164	327	Menard	San_Angelo	1.02537	0.97449
165	329	Midland	Odessa	1.02088	0.97841
166	331	Milam	Bryan	1.02095	0.98294
167	333	Mills	Brownwood	1.03469	0.96512
168	335	Mitchell	Abilene	1.06184	0.94062
169	337	Montague	Wichita_Falls	1.04010	0.95968
170	339	Montgomery	Houston	1.06078	0.93890
171	341	Moore	Amarillo	1.05892	0.93821
172	343	Morris	Atlanta	1.03039	0.96944
173	345	Motley	Childress	1.07652	0.92307
174	347	Nacogdoches	Lufkin	1.01371	0.98621
175	349	Navarro	Dallas	1.00999	0.99076
176	351	Newton	Beaumont	1.01314	0.98679
177	353	Nolan	Abilene	1.06184	0.94062
178	355	Nueces	Corpus_Christi	1.03959	0.96019
179	357	Ochiltree	Amarillo	1.05892	0.93821
180	359	Oldham	Amarillo	1.05892	0.93821
181	361	Orange	Beaumont	1.01314	0.98679
182	363	Palo_Pinto	Fort_Worth	1.04760	0.94941
183	365	Panola	Atlanta	1.03039	0.96944
184	367	Parker	Fort_Worth	1.04760	0.94941
185	369	Parmer	Lubbock	1.01921	0.98068
186	371	Pecos	Odessa	1.02088	0.97841
187	373	Polk	Lufkin	1.01371	0.98621
188	375	Potter	Amarillo	1.05892	0.93821
189	377	Presidio	El_Paso	1.00110	0.99886
190	379	Rains	Paris	1.02426	0.97560
191	381	Randall	Amarillo	1.05892	0.93821
192	383	Reagan	San_Angelo	1.02537	0.97449
193	385	Real	San_Angelo	1.02537	0.97449
194	387	Red_River	Paris	1.02426	0.97560
195	389	Reeves	Odessa	1.02088	0.97841
196	391	Refugio	Corpus_Christi	1.03959	0.96019
197	393	Roberts	Amarillo	1.05892	0.93821
198	395	Robertson	Bryan	1.02095	0.98294
199	397	Rockwall	Dallas	1.00999	0.99076
200	399	Runnels	San_Angelo	1.02537	0.97449
201	401	Rusk	Tyler	1.03767	0.96212
202	403	Sabine	Lufkin	1.01371	0.98621
203	405	San_Augustine	Lufkin	1.01371	0.98621
204	407	San_Jacinto	Lufkin	1.01371	0.98621
205	409	San_Patricio	Corpus_Christi	1.03959	0.96019
206	411	San_Saba	Brownwood	1.03469	0.96512
207	413	Schleicher	San_Angelo	1.02537	0.97449

208	415	Scurry	Abilene	1.06184	0.94062
209	417	Shackelford	Abilene	1.06184	0.94062
210	419	Shelby	Lufkin	1.01371	0.98621
211	421	Sherman	Amarillo	1.05892	0.93821
212	423	Smith	Tyler	1.03767	0.96212
213	425	Somervell	Fort_Worth	1.04760	0.94941
214	427	Starr	Pharr	1.00193	0.99806
215	429	Stephens	Brownwood	1.03469	0.96512
216	431	Sterling	San_Angelo	1.02537	0.97449
217	433	Stonewall	Abilene	1.06184	0.94062
218	435	Sutton	San_Angelo	1.02537	0.97449
219	437	Swisher	Lubbock	1.01921	0.98068
220	439	Tarrant	Fort_Worth	1.04760	0.94941
221	441	Taylor	Abilene	1.06184	0.94062
222	443	Terrell	Odessa	1.02088	0.97841
223	445	Terry	Lubbock	1.01921	0.98068
224	447	Throckmorton	Wichita_Falls	1.04010	0.95968
225	449	Titus	Atlanta	1.03039	0.96944
226	451	Tom_Green	San_Angelo	1.02537	0.97449
227	453	Travis	Austin	1.01582	0.98395
228	455	Trinity	Lufkin	1.01371	0.98621
229	457	Tyler	Beaumont	1.01314	0.98679
230	459	Upshur	Atlanta	1.03039	0.96944
231	461	Upton	Odessa	1.02088	0.97841
232	463	Uvalde	San_Antonio	1.00547	0.99458
233	465	Val_Verde	Laredo	0.96042	1.03868
234	467	Van_Zandt	Tyler	1.03767	0.96212
235	469	Victoria	Yoakum	1.01530	0.98462
236	471	Walker	Bryan	1.02095	0.98294
237	473	Waller	Houston	1.06078	0.93890
238	475	Ward	Odessa	1.02088	0.97841
239	477	Washington	Bryan	1.02095	0.98294
240	479	Webb	Laredo	0.96042	1.03868
241	481	Wharton	Yoakum	1.01530	0.98462
242	483	Wheeler	Childress	1.07652	0.92307
243	485	Wichita	Wichita_Falls	1.04010	0.95968
244	487	Wilbarger	Wichita_Falls	1.04010	0.95968
245	489	Willacy	Pharr	1.00193	0.99806
246	491	Williamson	Austin	1.01582	0.98395
247	493	Wilson	San_Antonio	1.00547	0.99458
248	495	Winkler	Odessa	1.02088	0.97841
249	497	Wise	Fort_Worth	1.04760	0.94941
250	499	Wood	Tyler	1.03767	0.96212
251	501	Yoakum	Lubbock	1.01921	0.98068
252	503	Young	Wichita_Falls	1.04010	0.95968
253	505	Zapata	Pharr	1.00193	0.99806
254	507	Zavala	Laredo	0.96042	1.03868

Appendix 7-B

TTI Documentation of Temperatures Provided
To ENVIRON for Draft MOBILE6 Modeling

For the 1996 analysis, TNRCC grouped counties based on their climatological similarities into six climate regions. For this 1999 analysis, the regions were adjusted to include a seventh for the northernmost part of the state (the Amarillo area). Within each of the seven regions, temperature data were used from a single centrally located weather station in a metropolitan area. Weather station identifiers and the cities in which each station is located by region are:

Table 7.B-1. Weather station identifiers and the cities in which each station is located by region

Region	City	Site Identifier
1	Lubbock	LBB
2	Dallas	DFW
3	Houston	IAH
4	Corpus Christi	CRP
5	Midland	MAF
6	San Antonio	SAT
7	Amarillo	AMA

From these stations, TNRCC provided 1999 monthly minimum and maximum averages (accessed from the National Climatological Data Center). The TTI used these data to develop MOBILE temperature inputs, by region, for application at the county level. Counties listed by climate region are presented in Table 7.B-2.

The monthly average minimums and maximums were used to produce the typical daily minimum, maximum and ambient temperature inputs for the 1999 summer and winter seasons. The 1999 monthly average minimum and average maximum temperatures for the period June through August and for the period January, February, December were averaged, yielding the seasonal average daily minimum and maximum inputs. The ambient temperature inputs were then calculated as two-thirds of the average daily temperature range (maximum minus minimum) added to the average daily minimum temperature. Table 7.B-3 contains the calculated regional 1999 summer and winter temperature inputs.

Table 7.B-2. Counties by climate region.

1. Lubbock	2. Dallas	3. Houston	4. Corpu Christi	5. Midland	6. San Antonio	7. Amarillo
Andrews	Anderson	Austin	Aransas	Brewster	Atascosa	Armstrong
Archer	Angelina	Brazoria	Bee	Brown	Bandera	Briscoe
Bailey	Bosque	Brazos	Brooks	Coke	Bastrop	Carson
Baylor	Bowie	Chambers	Calhoun	Coleman	Bell	Castro
Borden	Camp	Colorado	Cameron	Concho	Bexar	Childress
Callahan	Cass	FortBend	DeWitt	Crane	Blanco	Collingsworth
Cochran	Cherokee	Galveston	Duval	Crockett	Burleson	Dallam
Cottle	Clay	Grimes	Goliad	Culberson	Burnet	DeafSmith
Crosby	Collin	Hardin	Hidalgo	Ector	Caldwell	Donley
Dawson	Comanche	Harris	Jackson	Edwards	Comal	Gray
Dickens	Cooke	Houston	JimHogg	ElPaso	Coryell	Hall
Eastland	Dallas	Jasper	JimWells	Glasscock	Dimmit	Hansford
Fisher	Delta	Jefferson	Karnes	Hudspeth	Fayette	Hartley
Floyd	Denton	Leon	Kenedy	Irion	Frio	Hemphill
Foard	Ellis	Liberty	Kleberg	JeffDavis	Gillespie	Hutchinson
Gaines	Erath	Madison	Lavaca	Kimble	Gonzales	Lipscomb
Garza	Falls	Matagorda	LiveOak	Loving	Guadalupe	Moore
Hale	Fannin	Montgomery	McMullen	McCulloch	Hays	Ochiltree
Hardeman	Franklin	Newton	Nueces	Menard	Kendall	Oldham
Haskell	Freestone	Orange	Refugio	Midland	Kerr	Parmer
Hockley	Grayson	Polk	SanPatricio	Pecos	Kinney	Potter
Howard	Gregg	Robertson	Starr	Presidio	Lampasas	Randall
Jones	Hamilton	SanJacinto	Victoria	Reagan	LaSalle	Roberts
Kent	Harrison	Trinity	Willacy	Real	Lee	Sherman
King	Henderson	Tyler	Zapata	Reeves	Llano	Swisher
Knox	Hill	Walker		Runnels	Mason	Wheeler
Lamb	Hood	Waller		Schleicher	Maverick	
Lubbock	Hopkins	Wharton		Sterling	Medina	
Lynn	Hunt			Sutton	Milam	
Martin	Jack			Terrell	Mills	
Mitchell	Johnson			TomGreen	SanSaba	
Motley	Kaufman			Upton	Travis	
Nolan	Lamar			ValVerde	Uvalde	
Scurry	Limestone			Ward	Washington	
Shackelford	Marion			Winkler	Webb	
Stephens	McLennan				Williamson	
Stonewall	Montague				Wilson	
Taylor	Morris				Zavala	
Terry	Nacogdoches					
Throckmorton	Navarro					
Wichita	PaloPinto					
Wilbarger	Panola					
Yoakum	Parker					
Young	Rains					
	RedRiver					
	Rockwall					
	Rusk					
	Sabine					
	SanAugustine					
	Shelby					
	Smith					
	Somervell					
	Tarrant					
	Titus					
	Upshur					
	VanZandt					
	Wise					
	Wood					

Table 7.B-3. Summer and Winter MOBILE Input: Temperature by Climate Region.

Region	Summer			Winter		
	Minimum	**Maximum**	**Ambient**	**Minimum**	**Maximum**	**Ambient**
1	66.7	91.5	83.3	29.5	60.3	50.0
2	76.0	96.2	89.5	40.6	63.1	55.6
3	74.0	93.9	87.2	44.9	69.9	61.6
4	74.1	92.3	86.2	50.5	73.9	66.1
5	70.1	94.0	86.0	33.9	64.7	54.4
6	73.6	93.5	86.9	43.6	70.0	61.2
7	63.5	88.0	79.8	27.5	55.7	46.3

Appendix 7-C

Absolute Humidity Values (grams/lb) Used in Draft MOBILE6 Modeling

Table 7.C-1.

County	FIPS	CTYFIPS	Winter (Dec - Feb)	Summer (Jun - Aug)
Anderson	001	1	43.58231942	114.38
Andrews	003	3	31.76278076	96.66
Angelina	005	5	43.58231942	114.38
Aransas	007	7	62.89466294	136.49
Archer	009	9	31.76278076	96.66
Armstrong	011	11	28.99762153	87.73
Atascosa	013	13	53.45599851	125.52
Austin	015	15	53.47609737	130.21
Bailey	017	17	31.76278076	96.66
Bandera	019	19	53.45599851	125.52
Bastrop	021	21	53.45599851	125.52
Baylor	023	23	31.76278076	96.66
Bee	025	25	62.89466294	136.49
Bell	027	27	53.45599851	125.52
Bexar	029	29	53.45599851	125.52
Blanco	031	31	53.45599851	125.52
Borden	033	33	31.76278076	96.66
Bosque	035	35	43.58231942	114.38
Bowie	037	37	43.58231942	114.38
Brazoria	039	39	53.47609737	130.21
Brazos	041	41	53.47609737	130.21
Brewster	043	43	35.69625843	92.67
Briscoe	045	45	28.99762153	87.73
Brooks	047	47	62.89466294	136.49
Brown	049	49	35.69625843	92.67
Burleson	051	51	53.45599851	125.52
Burnet	053	53	53.45599851	125.52
Caldwell	055	55	53.45599851	125.52
Calhoun	057	57	62.89466294	136.49
Callahan	059	59	31.76278076	96.66
Cameron	061	61	62.89466294	136.49
Camp	063	63	43.58231942	114.38
Carson	065	65	28.99762153	87.73
Cass	067	67	43.58231942	114.38
Castro	069	69	28.99762153	87.73
Chambers	071	71	53.47609737	130.21
Cherokee	073	73	43.58231942	114.38
Childress	075	75	28.99762153	87.73
Clay	077	77	43.58231942	114.38
Cochran	079	79	31.76278076	96.66
Coke	081	81	35.69625843	92.67
Coleman	083	83	35.69625843	92.67
Collin	085	85	43.58231942	114.38
Collingsworth	087	87	28.99762153	87.73
Colorado	089	89	53.47609737	130.21
Comal	091	91	53.45599851	125.52
Comanche	093	93	43.58231942	114.38

County	FIPS	CTYFIPS	Winter (Dec - Feb)	Summer (Jun - Aug)
Concho	095	95	35.69625843	92.67
Cooke	097	97	43.58231942	114.38
Coryell	099	99	53.45599851	125.52
Cottle	101	101	31.76278076	96.66
Crane	103	103	35.69625843	92.67
Crockett	105	105	35.69625843	92.67
Crosby	107	107	31.76278076	96.66
Culberson	109	109	35.69625843	92.67
Dallam	111	111	28.99762153	87.73
Dallas	113	113	43.58231942	114.38
Dawson	115	115	31.76278076	96.66
Deaf Smith	117	117	28.99762153	87.73
Delta	119	119	43.58231942	114.38
Denton	121	121	43.58231942	114.38
DeWitt	123	123	62.89466294	136.49
Dickens	125	125	31.76278076	96.66
Dimmit	127	127	53.45599851	125.52
Donley	129	129	28.99762153	87.73
Duval	131	131	62.89466294	136.49
Eastland	133	133	31.76278076	96.66
Ector	135	135	35.69625843	92.67
Edwards	137	137	35.69625843	92.67
Ellis	139	139	43.58231942	114.38
El Paso	141	141	35.69625843	92.67
Erath	143	143	43.58231942	114.38
Falls	145	145	43.58231942	114.38
Fannin	147	147	43.58231942	114.38
Fayette	149	149	53.45599851	125.52
Fisher	151	151	31.76278076	96.66
Floyd	153	153	31.76278076	96.66
Foard	155	155	31.76278076	96.66
Fort Bend	157	157	53.47609737	130.21
Franklin	159	159	43.58231942	114.38
Freestone	161	161	43.58231942	114.38
Frio	163	163	53.45599851	125.52
Gaines	165	165	31.76278076	96.66
Galveston	167	167	53.47609737	130.21
Garza	169	169	31.76278076	96.66
Gillespie	171	171	53.45599851	125.52
Glasscock	173	173	35.69625843	92.67
Goliad	175	175	62.89466294	136.49
Gonzales	177	177	53.45599851	125.52
Gray	179	179	28.99762153	87.73
Grayson	181	181	43.58231942	114.38
Gregg	183	183	43.58231942	114.38
Grimes	185	185	53.47609737	130.21
Guadalupe	187	187	53.45599851	125.52
Hale	189	189	31.76278076	96.66

County	FIPS	CTYFIPS	Winter (Dec - Feb)	Summer (Jun - Aug)
Hall	191	191	28.99762153	87.73
Hamilton	193	193	43.58231942	114.38
Hansford	195	195	28.99762153	87.73
Hardeman	197	197	31.76278076	96.66
Hardin	199	199	53.47609737	130.21
Harris	201	201	53.47609737	130.21
Harrison	203	203	43.58231942	114.38
Hartley	205	205	28.99762153	87.73
Haskell	207	207	31.76278076	96.66
Hays	209	209	53.45599851	125.52
Hemphill	211	211	28.99762153	87.73
Henderson	213	213	43.58231942	114.38
Hidalgo	215	215	62.89466294	136.49
Hill	217	217	43.58231942	114.38
Hockley	219	219	31.76278076	96.66
Hood	221	221	43.58231942	114.38
Hopkins	223	223	43.58231942	114.38
Houston	225	225	53.47609737	130.21
Howard	227	227	31.76278076	96.66
Hudspeth	229	229	35.69625843	92.67
Hunt	231	231	43.58231942	114.38
Hutchinson	233	233	28.99762153	87.73
Irion	235	235	35.69625843	92.67
Jack	237	237	43.58231942	114.38
Jackson	239	239	62.89466294	136.49
Jasper	241	241	53.47609737	130.21
Jeff Davis	243	243	35.69625843	92.67
Jefferson	245	245	53.47609737	130.21
Jim Hogg	247	247	62.89466294	136.49
Jim Wells	249	249	62.89466294	136.49
Johnson	251	251	43.58231942	114.38
Jones	253	253	31.76278076	96.66
Karnes	255	255	62.89466294	136.49
Kaufman	257	257	43.58231942	114.38
Kendall	259	259	53.45599851	125.52
Kenedy	261	261	62.89466294	136.49
Kent	263	263	31.76278076	96.66
Kerr	265	265	53.45599851	125.52
Kimble	267	267	35.69625843	92.67
King	269	269	31.76278076	96.66
Kinney	271	271	53.45599851	125.52
Kleberg	273	273	62.89466294	136.49
Knox	275	275	31.76278076	96.66
Lamar	277	277	43.58231942	114.38
Lamb	279	279	31.76278076	96.66
Lampasas	281	281	53.45599851	125.52
La Salle	283	283	53.45599851	125.52
Lavaca	285	285	62.89466294	136.49

County	FIPS	CTYFIPS	Winter (Dec - Feb)	Summer (Jun - Aug)
Lee	287	287	53.45599851	125.52
Leon	289	289	53.47609737	130.21
Liberty	291	291	53.47609737	130.21
Limestone	293	293	43.58231942	114.38
Lipscomb	295	295	28.99762153	87.73
Live Oak	297	297	62.89466294	136.49
Llano	299	299	53.45599851	125.52
Loving	301	301	35.69625843	92.67
Lubbock	303	303	31.76278076	96.66
Lynn	305	305	31.76278076	96.66
McCulloch	307	307	35.69625843	92.67
McLennan	309	309	43.58231942	114.38
McMullen	311	311	62.89466294	136.49
Madison	313	313	53.47609737	130.21
Marion	315	315	43.58231942	114.38
Martin	317	317	31.76278076	96.66
Mason	319	319	53.45599851	125.52
Matagorda	321	321	53.47609737	130.21
Maverick	323	323	53.45599851	125.52
Medina	325	325	53.45599851	125.52
Menard	327	327	35.69625843	92.67
Midland	329	329	35.69625843	92.67
Milam	331	331	53.45599851	125.52
Mills	333	333	53.45599851	125.52
Mitchell	335	335	31.76278076	96.66
Montague	337	337	43.58231942	114.38
Montgomery	339	339	53.47609737	130.21
Moore	341	341	28.99762153	87.73
Morris	343	343	43.58231942	114.38
Motley	345	345	31.76278076	96.66
Nacogdoches	347	347	43.58231942	114.38
Navarro	349	349	43.58231942	114.38
Newton	351	351	53.47609737	130.21
Nolan	353	353	31.76278076	96.66
Nueces	355	355	62.89466294	136.49
Ochiltree	357	357	28.99762153	87.73
Oldham	359	359	28.99762153	87.73
Orange	361	361	53.47609737	130.21
Palo Pinto	363	363	43.58231942	114.38
Panola	365	365	43.58231942	114.38
Parker	367	367	43.58231942	114.38
Parmer	369	369	28.99762153	87.73
Pecos	371	371	35.69625843	92.67
Polk	373	373	53.47609737	130.21
Potter	375	375	28.99762153	87.73
Presidio	377	377	35.69625843	92.67
Rains	379	379	43.58231942	114.38
Randall	381	381	28.99762153	87.73

County	FIPS	CTYFIPS	Winter (Dec - Feb)	Summer (Jun - Aug)
Reagan	383	383	35.69625843	92.67
Real	385	385	35.69625843	92.67
Red River	387	387	43.58231942	114.38
Reeves	389	389	35.69625843	92.67
Refugio	391	391	62.89466294	136.49
Roberts	393	393	28.99762153	87.73
Robertson	395	395	53.47609737	130.21
Rockwall	397	397	43.58231942	114.38
Runnels	399	399	35.69625843	92.67
Rusk	401	401	43.58231942	114.38
Sabine	403	403	43.58231942	114.38
San Augustine	405	405	43.58231942	114.38
San Jacinto	407	407	53.47609737	130.21
San Patricio	409	409	62.89466294	136.49
San Saba	411	411	53.45599851	125.52
Schleicher	413	413	35.69625843	92.67
Scurry	415	415	31.76278076	96.66
Shackelford	417	417	31.76278076	96.66
Shelby	419	419	43.58231942	114.38
Sherman	421	421	28.99762153	87.73
Smith	423	423	43.58231942	114.38
Somervell	425	425	43.58231942	114.38
Starr	427	427	62.89466294	136.49
Stephens	429	429	31.76278076	96.66
Sterling	431	431	35.69625843	92.67
Stonewall	433	433	31.76278076	96.66
Sutton	435	435	35.69625843	92.67
Swisher	437	437	28.99762153	87.73
Tarrant	439	439	43.58231942	114.38
Taylor	441	441	31.76278076	96.66
Terrell	443	443	35.69625843	92.67
Terry	445	445	31.76278076	96.66
Throckmorton	447	447	31.76278076	96.66
Titus	449	449	43.58231942	114.38
Tom Green	451	451	35.69625843	92.67
Travis	453	453	53.45599851	125.52
Trinity	455	455	53.47609737	130.21
Tyler	457	457	53.47609737	130.21
Upshur	459	459	43.58231942	114.38
Upton	461	461	35.69625843	92.67
Uvalde	463	463	53.45599851	125.52
Val Verde	465	465	35.69625843	92.67
Van Zandt	467	467	43.58231942	114.38
Victoria	469	469	62.89466294	136.49
Walker	471	471	53.47609737	130.21
Waller	473	473	53.47609737	130.21
Ward	475	475	35.69625843	92.67
Washington	477	477	53.45599851	125.52

County	FIPS	CTYFIPS	Winter (Dec - Feb)	Summer (Jun - Aug)
Webb	479	479	53.45599851	125.52
Wharton	481	481	53.47609737	130.21
Wheeler	483	483	28.99762153	87.73
Wichita	485	485	31.76278076	96.66
Wilbarger	487	487	31.76278076	96.66
Willacy	489	489	62.89466294	136.49
Williamson	491	491	53.45599851	125.52
Wilson	493	493	53.45599851	125.52
Winkler	495	495	35.69625843	92.67
Wise	497	497	43.58231942	114.38
Wood	499	499	43.58231942	114.38
Yoakum	501	501	31.76278076	96.66
Young	503	503	31.76278076	96.66
Zapata	505	505	62.89466294	136.49
Zavala	507	507	53.45599851	125.52

Appendix 7-D

TTI Speeds by Facility Class

Table 7.D-1. Typical 24 hour speeds.

County Type	HPMS Roadway Functional Classification						
	Interstate FC1	**Freeway FC2**	**Principal Arterial FC3**	**Minor Arterial FC4**	**Major Collector FC5**	**Minor Collector FC6**	**Local FC7**
Rural	67	62	40	35	31	27	23
Urban	65	60	40	35	30	25	20

Urban = counties with link based models (Bexar, Collin, Dallas, Denton, Gregg, Hays, Nueces, Smith, Tarrant, Travis, Victoria, Williamson)

Appendix 7-E

RVP Values Used in Draft MOBILE6 Modeling

Table 7.E-1. Summer RVP values.

FIPS	COUNTY	Summer RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	Anderson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
3	Andrews	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
5	Angelina	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
7	Aransas	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
9	Archer	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
11	Armstrong	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
13	Atascosa	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
15	Austin	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
17	Bailey	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
19	Bandera	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
21	Bastrop	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
23	Baylor	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
25	Bee	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
27	Bell	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
29	Bexar	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
31	Blanco	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
33	Borden	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
35	Bosque	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
37	Bowie	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
39	Brazoria	8.1	8.3	7.2	7.3	7.3	7.0	7.2	7.2	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
41	Brazos	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
43	Brewster	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
45	Briscoe	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
47	Brooks	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
49	Brown	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
51	Burleson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
53	Burnet	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
55	Caldwell	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
57	Calhoun	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
59	Callahan	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
61	Cameron	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7

FIPS	COUNTY	Summer RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
63	Camp	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
65	Carson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
67	Cass	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
69	Castro	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
71	Chambers	8.1	8.3	7.2	7.3	7.3	7.0	7.2	7.2	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
73	Cherokee	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
75	Childress	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
77	Clay	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
79	Cochran	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
81	Coke	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
83	Coleman	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
85	Collin	8.0	8.2	7.1	7.3	7.5	7.0	7.1	7.2	7.0	7.0	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
87	Collingsworth	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
89	Colorado	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
91	Comal	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
93	Comanche	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
95	Concho	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
97	Cooke	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
99	Coryell	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
101	Cottle	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
103	Crane	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
105	Crockett	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
107	Crosby	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
109	Culberson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
111	Dallam	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
113	Dallas	8.0	8.2	7.1	7.3	7.5	7.0	7.1	7.2	7.0	7.0	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
115	Dawson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
117	Deaf_Smith	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
119	Delta	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
121	Denton	8.0	8.2	7.1	7.3	7.5	7.0	7.1	7.2	7.0	7.0	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
123	DeWitt	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
125	Dickens	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
127	Dimmit	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
129	Donley	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
131	Duval	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
133	Eastland	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
135	Ector	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
137	Edwards	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
141	El_Paso	7.7	7.8	7.0	7.1	7.2	7.0	6.8	6.8	6.5	6.7	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
139	Ellis	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8

FIPS	COUNTY	Summer RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
143	Erath	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
145	Falls	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
147	Fannin	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
149	Fayette	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
151	Fisher	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
153	Floyd	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
155	Foard	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
157	Fort_Bend	8.1	8.3	7.2	7.3	7.3	7.0	7.2	7.2	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
159	Franklin	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
161	Freestone	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
163	Frio	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
165	Gaines	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
167	Galveston	8.1	8.3	7.2	7.3	7.3	7.0	7.2	7.2	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
169	Garza	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
171	Gillespie	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
173	Glasscock	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
175	Goliad	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
177	Gonzales	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
179	Gray	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
181	Grayson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
183	Gregg	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
185	Grimes	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
187	Guadalupe	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
189	Hale	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
191	Hall	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
193	Hamilton	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
195	Hansford	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
197	Hardeman	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
199	Hardin	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8

FIPS	COUNTY	Summer RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
201	Harris	8.1	8.3	7.2	7.3	7.3	7.0	7.2	7.2	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
203	Harrison	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
205	Hartley	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
207	Haskell	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
209	Hays	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
211	Hemphill	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
213	Henderson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
215	Hidalgo	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
217	Hill	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
219	Hockley	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
221	Hood	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
223	Hopkins	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
225	Houston	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
227	Howard	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
229	Hudspeth	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
231	Hunt	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
233	Hutchinson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
235	Irion	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
237	Jack	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
239	Jackson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
241	Jasper	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
243	Jeff_Davis	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
245	Jefferson	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
247	Jim_Hogg	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
249	Jim_Wells	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
251	Johnson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
253	Jones	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
255	Karnes	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
257	Kaufman	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
259	Kendall	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
261	Kenedy	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
263	Kent	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
265	Kerr	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7

FIPS	COUNTY	Summer RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
267	Kimble	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
269	King	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
271	Kinney	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
273	Kleberg	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
275	Knox	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
283	La_Salle	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
277	Lamar	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
279	Lamb	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
281	Lampasas	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
285	Lavaca	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
287	Lee	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
289	Leon	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
291	Liberty	8.1	8.3	7.2	7.3	7.3	7.0	7.2	7.2	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
293	Limestone	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
295	Lipscomb	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
297	Live_Oak	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
299	Llano	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
301	Loving	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
303	Lubbock	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
305	Lynn	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
313	Madison	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
315	Marion	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
317	Martin	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
319	Mason	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
321	Matagorda	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
323	Maverick	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
307	McCulloch	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
309	McLennan	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
311	McMullen	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
325	Medina	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
327	Menard	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
329	Midland	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7

FIPS	COUNTY	Summer RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
331	Milam	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
333	Mills	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
335	Mitchell	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
337	Montague	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
339	Montgomery	8.1	8.3	7.2	7.3	7.3	7.0	7.2	7.2	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
341	Moore	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
343	Morris	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
345	Motley	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
347	Nacogdoches	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
349	Navarro	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
351	Newton	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
353	Nolan	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
355	Nueces	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
357	Ochiltree	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
359	Oldham	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
361	Orange	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
363	Palo_Pinto	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
365	Panola	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
367	Parker	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
369	Parmer	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
371	Pecos	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
373	Polk	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
375	Potter	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
377	Presidio	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
379	Rains	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
381	Randall	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
383	Reagan	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
385	Real	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
387	Red_River	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
389	Reeves	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
391	Refugio	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
393	Roberts	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
395	Robertson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
397	Rockwall	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
399	Runnels	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
401	Rusk	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
403	Sabine	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
405	San_Augustine	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
407	San_Jacinto	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8

FIPS	COUNTY	Summer RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
409	San_Patricio	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
411	San_Saba	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
413	Schleicher	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
415	Scurry	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
417	Shackelford	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
419	Shelby	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
421	Sherman	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
423	Smith	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
425	Somervell	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
427	Starr	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
429	Stephens	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
431	Sterling	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
433	Stonewall	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
435	Sutton	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
437	Swisher	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
439	Tarrant	8.0	8.2	7.1	7.3	7.5	7.0	7.1	7.2	7.0	7.0	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
441	Taylor	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
443	Terrell	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
445	Terry	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
447	Throckmorton	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
449	Titus	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
451	Tom_Green	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
453	Travis	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
455	Trinity	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
457	Tyler	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
459	Upshur	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
461	Upton	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
463	Uvalde	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
465	Val_Verde	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
467	Van_Zandt	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8

FIPS	COUNTY	Summer RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
469	Victoria	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
471	Walker	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
473	Waller	8.1	8.3	7.2	7.3	7.3	7.0	7.2	7.2	6.9	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8
475	Ward	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
477	Washington	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
479	Webb	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
481	Wharton	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
483	Wheeler	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
485	Wichita	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
487	Wilbarger	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
489	Willacy	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
491	Williamson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
493	Wilson	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
495	Winkler	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
497	Wise	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
499	Wood	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
501	Yoakum	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
503	Young	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
505	Zapata	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
507	Zavala	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7

Non-Attainment Areas

Houston - Galveston counties include Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller

Dallas-Fort Worth counties include Collin, Dallas, Denton, and Tarrant

El Paso counties include El Paso

Beaumont-Port Arthur counties include Hardin, Jefferson, and Orange

Table 7.E-2. Winter RVP values.

FIPS	COUNTY	Winter RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	Anderson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
3	Andrews	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
5	Angelina	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
7	Aransas	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
9	Archer	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
11	Armstrong	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
13	Atascosa	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
15	Austin	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
17	Bailey	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
19	Bandera	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
21	Bastrop	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
23	Baylor	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
25	Bee	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
27	Bell	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
29	Bexar	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
31	Blanco	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
33	Borden	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
35	Bosque	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
37	Bowie	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
39	Brazoria	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
41	Brazos	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
43	Brewster	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
45	Briscoe	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
47	Brooks	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
49	Brown	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
51	Burleson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
53	Burnet	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
55	Caldwell	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
57	Calhoun	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
59	Callahan	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
61	Cameron	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
63	Camp	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
65	Carson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
67	Cass	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
69	Castro	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
71	Chambers	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
73	Cherokee	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
75	Childress	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

FIPS	COUNTY	Winter RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
77	Clay	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
79	Cochran	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
81	Coke	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
83	Coleman	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
85	Collin	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
87	Collingsworth	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
89	Colorado	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
91	Comal	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
93	Comanche	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
95	Concho	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
97	Cooke	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
99	Coryell	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
101	Cottle	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
103	Crane	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
105	Crockett	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
107	Crosby	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
109	Culberson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
111	Dallam	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
113	Dallas	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
115	Dawson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
117	Deaf_Smith	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
119	Delta	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
121	Denton	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
123	DeWitt	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
125	Dickens	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
127	Dimmit	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
129	Donley	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
131	Duval	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
133	Eastland	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
135	Ector	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
137	Edwards	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
141	El_Paso	11	11	12.0	11.1	10	11	10	10	12	12	12	12	12	12	12	12	12	12	12	12	12
139	Ellis	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
143	Erath	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
145	Falls	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
147	Fannin	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
149	Fayette	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
151	Fisher	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
153	Floyd	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
155	Foard	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

FIPS	COUNTY	Winter RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
157	Fort_Bend	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
159	Franklin	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
161	Freestone	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
163	Frio	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
165	Gaines	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
167	Galveston	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
169	Garza	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
171	Gillespie	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
173	Glasscock	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
175	Goliad	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
177	Gonzales	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
179	Gray	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
181	Grayson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
183	Gregg	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
185	Grimes	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
187	Guadalupe	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
189	Hale	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
191	Hall	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
193	Hamilton	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
195	Hansford	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
197	Hardeman	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
199	Hardin	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
201	Harris	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
203	Harrison	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
205	Hartley	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
207	Haskell	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
209	Hays	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
211	Hemphill	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
213	Henderson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
215	Hidalgo	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
217	Hill	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
219	Hockley	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
221	Hood	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
223	Hopkins	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
225	Houston	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
227	Howard	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
229	Hudspeth	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
231	Hunt	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
233	Hutchinson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
235	Irion	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

FIPS	COUNTY	Winter RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
237	Jack	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
239	Jackson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
241	Jasper	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
243	Jeff_Davis	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
245	Jefferson	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
247	Jim_Hogg	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
249	Jim_Wells	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
251	Johnson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
253	Jones	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
255	Karnes	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
257	Kaufman	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
259	Kendall	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
261	Kenedy	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
263	Kent	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
265	Kerr	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
267	Kimble	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
269	King	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
271	Kinney	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
273	Kleberg	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
275	Knox	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
283	La_Salle	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
277	Lamar	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
279	Lamb	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
281	Lampasas	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
285	Lavaca	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
287	Lee	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
289	Leon	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
291	Liberty	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
293	Limestone	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
295	Lipscomb	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
297	Live_Oak	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
299	Llano	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
301	Loving	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
303	Lubbock	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
305	Lynn	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
313	Madison	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
315	Marion	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
317	Martin	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
319	Mason	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
321	Matagorda	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

FIPS	COUNTY	Winter RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
323	Maverick	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
307	McCulloch	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
309	McLennan	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
311	McMullen	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
325	Medina	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
327	Menard	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
329	Midland	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
331	Milam	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
333	Mills	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
335	Mitchell	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
337	Montague	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
339	Montgomery	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
341	Moore	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
343	Morris	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
345	Motley	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
347	Nacogdoches	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
349	Navarro	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
351	Newton	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
353	Nolan	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
355	Nueces	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
357	Ochiltree	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
359	Oldham	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
361	Orange	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
363	Palo_Pinto	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
365	Panola	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
367	Parker	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
369	Parmer	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
371	Pecos	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
373	Polk	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
375	Potter	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
377	Presidio	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
379	Rains	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
381	Randall	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
383	Reagan	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
385	Real	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
387	Red_River	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
389	Reeves	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
391	Refugio	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
393	Roberts	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
395	Robertson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

FIPS	COUNTY	Winter RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
397	Rockwall	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
399	Runnels	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
401	Rusk	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
403	Sabine	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
405	San_Augustine	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
407	San_Jacinto	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
409	San_Patricio	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
411	San_Saba	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
413	Schleicher	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
415	Scurry	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
417	Shackelford	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
419	Shelby	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
421	Sherman	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
423	Smith	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
425	Somervell	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
427	Starr	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
429	Stephens	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
431	Sterling	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
433	Stonewall	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
435	Sutton	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
437	Swisher	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
439	Tarrant	12	12	12	12	11	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
441	Taylor	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
443	Terrell	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
445	Terry	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
447	Throckmorton	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
449	Titus	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
451	Tom_Green	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
453	Travis	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
455	Trinity	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
457	Tyler	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
459	Upshur	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
461	Upton	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
463	Uvalde	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
465	Val_Verde	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
467	Van_Zandt	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
469	Victoria	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
471	Walker	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
473	Waller	13	13	13	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
475	Ward	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

FIPS	COUNTY	Winter RVP Values																				
		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
477	Washington	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
479	Webb	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
481	Wharton	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
483	Wheeler	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
485	Wichita	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
487	Wilbarger	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
489	Willacy	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
491	Williamson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
493	Wilson	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
495	Winkler	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
497	Wise	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
499	Wood	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
501	Yoakum	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
503	Young	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
505	Zapata	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
507	Zavala	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12

Non-Attainment Areas

Houston - Galveston counties include Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller

Dallas-Fort Worth counties include Collin, Dallas, Denton, and Tarrant

El Paso counties include El Paso

Beaumont-Port Arthur counties include Hardin, Jefferson, and Orange

Appendix 7-F

TNRCC Documentation of I/M and
ATP Program Specifications for Use in MOBILE Modeling

Table 7.F-1. I/M Descriptive table for the El Paso For Base Year (1990 Emissions Inventory)

The design I/M program for the Based Year Inventory provided below is based on the information received from the I/M section of the Mobile Source Division. The designed parameters and description as applied to El Paso nonattainment areas are summarized in Table 7.F-1.

Table 7.F-1. Design Parameters for the Base year Inventory

I/M Program Parameter	El Paso Program for 1990 Base Year Inventory	
Network Type	decentralized	
Start Date I/M	1987	
Start Date for ATP	1986	
Inspection Frequency	Annual Inspection	
First Model Year Covered	75	
Last Model year Covered	20	
Exhaust Emission Test Type	2- Speed idle test	
Emission Standards	Default cut points: 220 ppm HC; 1.2% CO	
Purge	No Purge Test	
Pressure	Not required	
Stringency	18%	
Waiver Rate	0%	
Compliance Rate	073	
Vehicle Type subject to Inspection	LDGV, LDGT1, and LDGT2	
Program type	Decentralized	
ATP Program First model year covered Last model year cover	**Model year 1980 and older** **68** **79**	**Model year 1981 and newer** **80** **20**
Air Pump Inspection	Inspected	Inspected
Catalyst Inspection	Not Inspected	Inspected
Fuel Inlet Restrictor Inspection	Not Inspected	Inspected
Tailpipe lead Detection Test	Not Inspected	Inspected
EGR Inspection	Inspected	Inspected

I/M Program Parameter	El Paso Program for 1990 Base Year Inventory	
Evaporative Control System	Inspected	Inspected
PCV Inspection	Inspected	Inspected
Gas Cap Inspection	Inspected	Inspected

Table 7.F-2. I/M Descriptive table for the Texas Motorist Choice Program (TMCP)

The design I/M program for the Texas Motorist Choice provided below is based on the information received from the I/M section of the Mobile Source Division. The designed parameters and description of TMCP as applied to all nonattainment areas are summarized in Table 7.F-2.

Table 7.F-2. Design Parameters for the Texas Motorist Choice Program (TMCP)

I/M Program Parameter	TMCP	
Network Type	Test & Repair with 100% centralized credit.	
Start Date (I/M) Start Date (ATP)	1987 1986	
Test Frequency	Annual Inspection	
Model Year Coverage	2 year exempt for new vehicle and 24- year Rolling Window	
Vehicle Type Coverage	All vehicle type are subject to inspection	
Exhaust Emission Test Type	2- Speed idle test	
Emission Standards	Default cut points: 220 ppm HC; 1.2% CO	
Purge	No Purge Test	
Pressure	Pressure Test is required (The gas cap integrity test is the non-canister pressure test used in the TMC program)	
Stringency	20%	
Waiver Rate	3%	
Compliance Rate	96%	
Technician Training	yes	
Program Effectiveness	100	
ATP Program	**Model year 1980 and older**	**Model year 1981 and newer**
Air Pump Inspection	Inspected	Inspected
Catalyst Inspection	Not Inspected	Inspected

I/M Program Parameter	TMCP	
Fuel Inlet Restrictor Inspection	Not Inspected	Not Inspected
Tailpipe lead Detection Test	Not Inspected	Not Inspected
EGR Inspection	Inspected	Inspected
Evaporative Control System	Inspected	Inspected
PCV Inspection	Inspected	Inspected
Gas Cap Inspection	Inspected	Inspected

TAD Modeling Information Sheet Number 6
MOBILE Modeling Description for
2007 Dallas Fort-Worth Rate-of-Progress Inventories
Draft - 06 November 2000

Note: This is a technical document intended to provide experienced MOBILE modelers the recommended choices for the MOBILE input fields. It is beyond the scope of this description to describe how to use the model or to provide guidance on how to use the inputs for any particular analysis.

This document gives an overview of the activity inputs and detailed description of MOBILE inputs consistent with the 2007 Dallas Fort-Worth Rate-of-Progress(ROP) Inventories and the control strategy contingency estimates developed for use in the Phase 1 Dallas Fort-Worth Attainment Demonstration SIP. To complete ROP calculations four separate inventories are needed for each year: the 1990 base year(BY), an adjusted base year(ABY), a current control(CC) and a control strategy(CS). To complete contingency estimate calculations, two inventories are needed: a current control(CC) and a control strategy(CS).

In this document the Urban County Group includes: Dallas and Tarrant counties. The Rural County Group includes: Collin and Denton Counties.

Draft

MOBILE Input Description

The controls for 2007 ROP scenarios are described in Table 1. The model version and required MOBILE data files are described in Table 2. The MOBILE flag settings are described in Table 3. The local area parameter record input values and documentation of the value selection process are documented in Table 4. The scenario description, record one of the scenario input, parameter values and documentation of the value selection process are documented in Table 5. The MOBILE input parameter values and documentation of the value selection process for the NLEV program, record two of the scenario input, are documented in Table 6. The inputs required to model the alternative standards for HDDVs are described and documented in Table 7. The I/M record input values and documentation of the value selection process are documented in Tables 8 and 9. The ATP record input values and documentation of the value selection process are documented in Table 10. The pressure test record input values and documentation of the value selection process are documented in Table 11. An example nlev.d file with inputs consistent with the current plan for LEV standards phase-in for Texas in documented in Table 12.

Transportation Inputs

For all the inventories the average annual daily vehicle miles traveled(VMT) should be seasonally and daily adjusted to summer, weekday VMT to correspond to ozone season day. Two adjustments will be required: 1) seasonally adjust the annual VMT to summer levels, and, 2) adjust from average daily to weekday VMT.

As with a 1990 base year inventory for the ABY inventories, 1990 transportation inputs should be used.

For the CC and CS inventories ROP milestone year transportation inputs should be used. If a 2002 or 2005 transportation model does not exist it is appropriate to interpolate between existing models

Control Strategy Description

The controls included in the development of emission factors for 2007 ROP scenarios are described in Table 1.

Table 1

2007 Dallas Fort-Worth Rate-of-Progress Inventories Description of Emission Control Mechanisms Used for Developing Emission Factors		
Control Description	Start Date	Scenario description
Pre-1990 CAAA FMVCP(Tier 0)	Pre-1990	BY, ABY, both CC and both CS
1992 RVP summer control	1992	BY, ABY, both CC and both CS
Tier 1 FMVCP	1994	2002, 2005 and 2007 CS
Reformulated Gasoline Phase 1	1994	2002, 2005 and 2007 CS
Inspection & Maintenance Phase 1 2 speed idle, Urban & Rural	Jan 1900	I/M Phase 2 and 3 modeled for 2007
Reformulated Gasoline Phase 2	2000	2007 CS
NLEV	2001	2007 CS
Inspection & Maintenance Phase 2 ASM, OBD2,	Jan 2002	2007 CS,
Inspection & Maintenance Phase 3 ASM, OBD2, add urban counties	Jan 2003	2007 CS,
Inspection & Maintenance Phase 4 ASM, OBD2, add 3 rural counties	Jan 2004	2007 CS,
FMVCP for HDDV	2004	2007 CS
Tier 2 FMVCP	2004	2007 CS

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Table 2

2007 Dallas Fort-Worth Rate-of-Progress Inventories		
Model version and Data file Description		
Description	File size	Explanation
MOBILE5A or, MOB5A_H (needed for TTC) MOBILE5B (use for RFG correction)	889632 895216 920868	These represent the most recent versions of the model acceptable for use in preparing modeling information for EPA submittal. MOBILE5a_h is required to model the TMC I/M due to the technician training program component. MOBILE5b has a correction for the RFG NOx bug which is in both 5a and 5a_h. EPA's modeling information sheet #7 documents a modeling fix for the RFG NOx bug when using MOBILE5a or MOBILE5a_h using output from MOBILE5b.
IMDATA.d IMDATA3.d HYBRID.IMC imdata4.d (use this credit file renamed imdata.d) Imdata4h.d	584814(standard file for MOBILE5A) 661537(standard file with new ASM test type available) 617373(hybrid programs only) 753713(MOBILE5B version, new ASM test data) 705493(MOBILE5B hybrid credits)	The modeled program does not include hybrid components: do not use hybrid.imc, or, imdata4h.d. In order to access I/M credits for ASM based on Phoenix and California data: Use: imdata4.d, With: test type = "3" for MOBILE5a_h test type = "5" for MOBILE5b and Cutpoints: HC = 25. , CO = 50. , NOx = 2. See read me file, IMDATA4.txt, for IMDATA4.d for documentation of modeling methodology.
PPEFF.D	298(non hybrid programs, ppeffm5.d renamed to ppeff.d)) 293(hybrid programs only) 363(for use with MOBILE5B)	PPEFF.D is not needed when using MOBILE5A, Two pressure credit files were issued with MOBILE5A_H , one file for non-hybrid I/M programs, and one for hybrid. When using the MOB5A_H executable care should be exercised in selecting the correct file. Use the non-hybrid file for this analysis. Only one PPEFF.D file was issued with MOBILE5B.
TECH12.D	62558	same file for all current model versions

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2007 Dallas Fort-Worth Rate-of-Progress Inventories		
Model version and Data file Description		
nlev.d	3622	Data file describing the phase in schedule for NLEV compliant vehicles.

Table 3

2002, 2005 and 2007 Dallas Fort-Worth Rate-of-Progress Inventories		
Flag Settings Page 1 of 2		
Model Parameter Description	Assigned Value	Methodology Description
PROMPT	1 Adjusted base year 1 Current control 5 Control strategy	1: is the standard input when using the MOBILE models in batch run mode 5: is used to indicate that NLEV input parameters will be used and is appropriate for the control strategy runs for 2007 for DFW. Additional input requirements for the modeling the NLEV Program are documented in Table 6. The required external data file with the alternative vehicle technology phase-in schedule is documented in Table 12.
PROJID	modeler's choice	no effect on results
TAMFLG	1	Use MOBILE default tampering rates
SPDFLG	4	one speed for all vehicle types, and, use locality specific trip length distributions An additional input line is required for the TLDs The TLD values are determined by NCTGOG using transportation model output information. The development of these values is documented in the EI report
VMFLAG	3	MOBILE input VMT mix does not affect vehicle type emission factors, only the composite emission factor. To have locality specific composite emission factors use 3 to input one VMT mix for all scenarios.
MYMRFG	3	Use MOBILE default AMARs if there are no DFW specific AMARs available, Use county or county group specific registration distributions

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2002, 2005 and 2007 Dallas Fort-Worth Rate-of-Progress Inventories		
Flag Settings Page 1 of 2		
NEWFLG	5 (2007 adjusted base year) 5 (2007 current control) 2 (2007 control strategy)	5: pre-1990 controls only, Tier 1 is turned OFF; and, use MOBILE default BERs 2: Tier 1 FMVCP is turned ON; and, use user specified BERs for diesel vehicles consistent with the new diesel standards going into effect in 2004. Additional input is required as described in Table 6.

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Table 3, Continued

2007 Dallas Fort-Worth Rate-of-Progress Inventories		
Flag Settings Continued Page 2 of 2		
Model Parameter Description	Assigned Value	Methodology Description
IMFLAG	ABY & Current Control 1 All counties Control Strategy 2007 32 All counties	1: No I/M program 32: The 3 sets the input file up for input of two I/M programs. Two programs are needed because the OBD credit is applicable only to 1996 and newer vehicles. Note: A setting of 4 or 5 is not appropriate as it signals the model to include assumptions about the I/M program not needed for this analysis, and, The second flag set to 2 indicates to the model to calculate I/M emission reductions consistent with the existence of a technician training program Values determined based upon I/M program design information from TNRCC Mobile Source Section
ALHFLG	1	No load corrections done in modeling calculations; the load factor calculations for the current versions of MOBILE are not reliable enough to use for ROP inventories
ATPFLG	ABY and CC 1: All counties Control Strategy 2007 2 & 5 All counties	1: No ATP, no pressure test, no purge test 2: include input to model an ATP Values for the ATP are determined based upon the existing ATP 5: include input to model an ATP and a pressure test Values for the ATP and pressure test are based upon TMC program design information from the TNRCC Mobile Source Section.
RLFLAG	5	No refueling emissions calculated, refueling emissions are calculated as part of the area source inventory
LOCFLG	modeler's discretion	no effect on results
TEMFLG	1	MOBILE will calculate temperature corrections from minimum and maximum temperature
OUTFMT	modeler's discretion	no effect on results
PRTFLG	modeler's discretion	no effect on results
IDLFLG	1	No idle emissions calculated
NMHFLG	3	Hydrocarbon emission factors should be for VOC
HCFLAG	modeler's discretion	Diurnal runs will need to have appropriate flag setting. Otherwise use the value appropriate for obtaining output in the format needed for emissions calculation models.

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Table 4

2007 Dallas Fort-Worth Rate-of-Progress Inventories Local Area Parameter Record		
General comments: None.		
Model Parameter Description	Assigned Value	Methodology Description
Scenario name	modeler's discretion	Does not effect emission factor results, but may be used as a convenience to the modeler to indicate selected scenario information on output.
ASTM Class	B	ASTM regional map
Minimum daily temperature	Use values consistent with time-of-day and 24-hour average temperatures from 1990 Base year, 1996 ROP and 1999 ROP	Ozone season standard day minimum, maximum and ambient temperatures for DFW were developed for the 1990 Base Year EI, It is appropriate to use consistent values for future inventory modeling
Maximum daily temperature	Use values consistent with time-of-day and 24-hour average temperatures from 1990 Base year, 1996 ROP and 1999 ROP	Ozone season standard day minimum, maximum and ambient temperatures for DFW were developed for the 1990 Base Year EI, It is appropriate to use consistent values for future inventory modeling
Period 1 RVP	7.1*	Regulated value minus .3, as per MOBILE guidance. value will not affect results when RFG flag is on
Period 2 RVP	7.1*	Regulated value, as per MOBILE guidance, value will not affect results when RFG flag is on
Period 2 start year	92	92 RVP regulation
Oxygenated fuel flag	1	No oxygenated fuels program in DFW
Diesel sales fraction flag	1	No alternate diesel sales fractions will be used
Reformulated gasoline flag	1 Adjusted base year 1 Current control 2 Control strategy	1: No RFG 2: Turn ON RFG RFG is part of the DFW

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Table 5

2007 Dallas Fort-Worth Rate-of-Progress Inventories Scenario Input - Record #1 Scenario Description		
General comments: None.		
Model Parameter Description	Assigned Value	Methodology Description
Region	1 Base year 1 Adjusted base year 1 Current control 4 Control strategy	1: standard input for low altitude areas 4: used when the input file will contain LEV or NLEV information
Calendar Year of Evaluation	Link-based/Time-of-Day 2007	Inventory definition The Link-based/Time-of-day inventories are for July 2007
Average speed	XXXX	set to XXXX when creating an emission factor file for POLFAC
Ambient temperature	Use values consistent with time-of-day and 24-hour average temperatures from 1990 Base year, 1996 ROP and 1999 ROP	Ozone season standard day minimum, maximum and ambient temperatures for DFW were developed for the 1990 Base Year EI, It is appropriate to use consistent values for future inventory modeling
Operating mode fractions	Use values consistent with time-of-day and 24-hour operating mode fractions from 1990 Base year, 1996 ROP and 1999 ROP	Locality specific operating mode fractions for DFW were developed for the 1990 Base Year EI, It is appropriate to use consistent values for future inventory modeling
Month of evaluation	7	Ozone season is being modeled so July is the appropriate month for all inventories

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Table 6

2007 Dallas Fort-Worth Rate-of-Progress Inventories
Scenario Input - Record #2
LEV Program Parameter Record

General comments: 1) Used only for the control strategy inventory.
2) PROMPT must be set to 5.
3) Region in the Scenario record must be set to 4
4) Enter the LEV parameter record as detailed below
5) User must provide an alternative LEV phase-in schedule using an external data file, nlev.d. Any non-OTC state not opting into California Low Emission Vehicle Program(includes Texas) will use a standard phase-in schedule of 100% LEVs for passenger cars and for all light duty trucks less than 6,000 pounds Gross Vehicle Weight (GVW) beginning in the 2001 model year. Table 12 contains an example nlev.d file for use when modeling the NLEV program for Texas with the following phase-in schedule for LDGVs and LDGTs:

For LDGVs and LDGTs Less Than 6000 lbs. GVW

Model Year	Phase-in Scedule		
1999	100% Tier 1,	0% TLEV,	0% LEV
2000	100% Tier 1,	0% TLEV,	0% LEV
2001+	0% Tier 1,	0% TLEV,	100% LEV

For LDGTs Greater Than 6000 lbs. GVW

Model Year	Phase-in Scedule		
1999	100% Tier 1,	0% TLEV,	0% LEV
2000	100% Tier 1,	0% TLEV,	0% LEV
2000+	100% Tier 1,	0% TLEV,	0% LEV

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6) For additional information concerning how to model the effects of the NLEV program, see document titled, "MOBILE5, Information Sheet #6, Effect of the New National Low Emission Vehicle Standard for Light-Duty Gasoline Fueled Vehicles, EPA420-F-98-027, July 1998."

Model Parameter Description	Assigned Value	Methodology Description
LEV start year	01	NLEV program will start in 2001
I/M Flag	1	I/M program for the NLEV vehicles same as for other vehicles

Table 7

2007 Dallas Fort-Worth Rate-of-Progress Inventories New 2004 Heavy Duty Diesel NOx Standards Record description					
General comments: Use only for the 2007 control strategy inventory. NEWFLAG must be set to 2.					
Model Parameter Description	Assigned Value				Methodology Description
Record 1	004				Program start year is 2004
Model Parameter Description	Record 2	Record 3	Record 4	Record 5	Methodology Description
Altitude 1 = low altitude	1	1	1	1	Heavy duty diesel standards phase in definition. These inputs are documented in EPA's MOBILE Information Sheet #5. The information sheet is available at the EPA web site.
Vehicle type 7 = HDDV	7	7	7	7	
Pollutant 3 = NOx	3	3	3	3	
Starting model year	90	91	98	04	
Ending model year	90	97	03	20	
New zero-mile value	05.639	04.598	03.679	01.840	
New deterioration rate	00.000	00.000	00.000	00.000	

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Table 8

2007 Dallas Fort-Worth Rate-of-Progress Inventories First I/M Program Descriptive Input Record		
General comments: DFW Counties began a 2-speed idle I/M program in 1990 as part of the TMC program.. In 2004 the ASM program was geographically expanded again to include the three rural non-attainment counties. For vehicles equipped with OBD, 1996 and newer vehicles, the ASM test is modeled as an IM 240 program. This modeling protocol is based upon discussion between TNRCC Mobile Source Section and EPA.		
Model Parameter Description	Assigned Value	Methodology Description
Program start year	90	program began January 1990
Stringency level	20	I/M program audit report
First model year	2007 83	program definition, 24 year rolling window
Last model year	2007 95	1996 and newer vehicles have OBD and will be modeled with IM 240 program
Waiver rate, pre-1981 my vehicles	03	I/M program definition
Waiver rate, my 1981 and later	03	I/M program definition
Compliance rate	96	I/M program definition
Program type	1	even though the I/M in Texas is a decentralized test and repair it is modeled as a centralized program when using
Inspection frequency	1	annual testing, program definition
Vehicle types subject to inspection	2222	all gasoline vehicles tested
Test type	5 MOBILE5b	user must input cut points
non-default cut points flag	2	user input cut points
alternative I/M credit flags	11	use the IMDATA.d credit file as received from EPA
HC cut point	25.	DFW program design, Two Mode 2525/5015 ASM with start up cutpoints
CO cut point	50.	DFW program design, Two Mode 2525/5015 ASM with start up cutpoints
NOx cut point	2.	DFW program design, Two Mode 2525/5015 ASM with start up cutpoints

Table 9

2007 Dallas Fort-Worth Rate-of-Progress Inventories Second I/M Program Descriptive Input Record		
General comments: DFW Counties began a 2-speed idle I/M program in 1990 as part of the TMC program. In 2004 the ASM program was geographically expanded again to include the three rural non-attainment counties. For vehicles equipped with OBD, 1996 and newer vehicles, the ASM test is modeled as an IM 240 program. This modeling protocol is based upon discussion between TNRCC Mobile Source Section and EPA.		
Model Parameter Description	Assigned Value	Methodology Description
Program start year	90 Urban Counties	Urban Counties program began January 1990.
Stringency level	20	I/M program audit report
First model year	2007 96	1995 and older vehicles do not have OBD and are modeled with the ASM program designed by TNRCC Mobile Source Section
Last model year	2007 05	program definition, two year new vehicle exemption
Waiver rate, pre-1981 my vehicles	03	I/M program definition
Waiver rate, my 1981 and later	03	I/M program definition
Compliance rate	96	I/M program definition
Program type	1	even though the I/M in Texas is a decentralized test and repair it is modeled as a centralized program when using MOBILE5a_h to prevent the program from assigning an automatic 50% rule effectiveness discount
Inspection frequency	1	annual testing, program definition
Vehicle types subject to inspection	2222	all gasoline vehicles tested
Test type	4	I/M 240 test is used to calculate credit for ASM with OBD, user must input cut points
non-default cut points flag	2	user input cut points
alternative I/M credit flags	11	use the IMDATA.d credit file as received from EPA
HC cut point	0.80	I/M 240 test is used to calculate credit for ASM with OBD, use phase-in cutpoints
CO cut point	15.0	I/M 240 test is used to calculate credit for ASM with OBD, use phase-in cutpoints

NOx cut point	2.00	I/M 240 test is used to calculate credit for ASM with OBD, use phase-in cutpoints

Table 10

2007 Dallas Fort-Worth Rate-of-Progress Inventories
ATP Descriptive Input Record
page 1 of 2

General comments:
1) Since 1990 DFW County has had an ATP.
2) The current control inventory ABY and current control inventories are modeled using parameters consistent with the pre-1990 existing program. The CS inventories are modeled using parameters consistent with the TMC program design. Where inputs are different both values are indicated.
3)Two ATP records are needed to fully describe the ATP program because equipment checks are different for newer model year vehicles. The methodology for calculating emission factors for fleets effected by multiple anti-tampering programs was determined during development of the 1990 base year inventories. The method requires multiple model runs with post processing to estimate the combined effect of the ATPs. For a fleet with two ATPs the method is summarized by the formula:

$$EF_{Combined} = EF_{No\ ATP} - [(EF_{No\ ATP} - EF_{ATP\#1}) + (EF_{No\ ATP} - EF_{ATP\#2})]$$

where,

$EF_{Combined}$ = Final Emission Factor,
$EF_{No\ ATP}$ = Emission factor for No ATP,
$EF_{ATP\#1}$ = Emission factor for ATP program #1, and
$EF_{ATP\#2}$ = Emission factors for ATP program #2.

The formula may be algebraically simplified to:

$$EF_{Combined} = EF_{ATP\#1} + EF_{ATP\#2} - EF_{No\ ATP}$$

Model Parameter Description	Assigned Value		Methodology Description
	ATP 1	ATP 2	
Program start year	03 UrbanCounties 04 Rural Counties	03 Urban Counties 04 Rural Counties	ATP operation began in January 1986
First model year	Current Control 68 all eval years Control Strategy 83 for 2007	Current Control 80 all eval years Control Strategy 84 for 2007	program design: existing program covered all model years TMC program has a 24 year rolling window and 2 year new vehicle exemption
Last model year	Current Control	Current Control	program design:

Table 10, continued

2007 Dallas Fort-Worth Rate-of-Progress Inventories ATP Descriptive Input Record page 2 of 2			
Model Parameter Description	Assigned Value		Methodology Description
	Model year vehicles ATP 1	Model year vehicles ATP 2	
Vehicle types subject to inspection	Current control 2221 Control strategy 2222	Current control 2221 Control strategy 2222	Pre-1990 program: no HDGV inspected Houston program: all gasoline vehicles tested
Program type	1	1	even though the I/M in Texas is a decentralized test and repair it is modeled as a centralized program whe using MOBILE5a_h to prevent the program from assigning an automatic 50% rule effectiveness discount
Inspection frequency	1	1	annual inspections required
Compliance rate	Current Control 85 Control Strategy 96	Current Control 85 Control Strategy 96	Current Control: I/M program audit report Control Strategy: Program design
Air pump system check flag	2	2	program design
Catalyst check flag	1	2	program design
Fuel inlet restrictor check flag	1	Current Control 2 Control Strategy 1	program design
Tailpipe lead deposit test flag	1	Current Control 2 Control Strategy 1	program design
EGR system check flag	2	2	program design
Evaporative control system check flag	2	2	program design
PCV system check flag	2	2	program design
Gas cap check flag	2	2	program design

Table 11

2007 Dallas Fort-Worth Rate-of-Progress Inventories Pressure Test Descriptive Input Record		
General comments: 1) DFW Area began a pressure test in 1997 as part of the TMC program. In 2003 the TMC was geographically expanded to include the four urban non-attainment counties. In 2004 the program was geographically expanded again to include the three rural non-attainment counties.		
Model Parameter Description	Assigned Value	Methodology Description
Program start year	90 Urban Counties 90 Rural Counties	program began in January 1990
First model year	2007 83	program definition, 24 year rolling window
Last model year	2007 05	program definition, two year new vehicle exemption
Vehicle types subject to inspection	2222	all gasoline vehicles tested
Program type	1	Even though the I/M program in Texas is decentralized, test and repair, it is modeled as a centralized program when using MOBILE5a_h to prevent the program from assigning an automatic 50% rule effectiveness discount
Inspection frequency	1	annual testing, program definition
Compliance rate	96	In/M program audit report

Table 12
2007 Dallas Fort-Worth Rate-of-Progress Inventories
Example Input File for nlev.d for the NLEV Program With 2001 Start

Note: For information concerning column and row definitions, or specific information about formats, see document titled, "MOBILE5, Information Sheet #6, Effect of the New National Low Emission Vehicle Standard for Light-Duty Gasoline Fueled Vehicles, EPA420-F-98-027, July 1998."

```
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  1994LDGV  Tier1/ITLEV, TLEV, ILEV, LEV, IULEV, ULEV,
ZEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    95      FedLEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    96
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    97
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    98
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    99
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  2000
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    01
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    02
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    03
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    04
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    05
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  1994LDGt1a Tier1/ITLEV, TLEV, ILEV, LEV, IULEV, ULEV,
ZEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    95       FedLEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    96
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    97
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    98
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    99
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  2000
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    01
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    02
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    03
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    04
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    05
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  1994LDGt1b Tier1/ITLEV, TLEV, ILEV, LEV, IULEV, ULEV,
ZEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    95       FedLEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    96
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    97
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    98
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    99
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  2000
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    01
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    02
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    03
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    04
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    05
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  1994LDG2a Tier1/ITLEV, TLEV, ILEV, LEV, IULEV, ULEV,
ZEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    95       FedLEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    96
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    97
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    98
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    99
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  2000
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    01
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    02
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    03
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    04
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    05
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  1994LDGt2b Tier1/ITLEV, TLEV, ILEV, LEV, IULEV, ULEV,
ZEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    95       FedLEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    96
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    97
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    98
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    99
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  2000
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    01
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    02
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    03
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    04
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    05
```

TAD Modeling Information Sheet Number 6
MOBILE Modeling Description for
2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories
Update to Final - 4 August 2000

Note: This is a technical document intended to provide experienced MOBILE modelers the recommended choices for the MOBILE input fields. It is beyond the scope of this description to describe how to use the model or to provide guidance on how to use the inputs for any particular analysis.

This document gives an overview of the activity inputs and detailed description of MOBILE inputs consistent with the 2002, 2005 and 2007 Houston-Galveston Rate-of-Progress(ROP) Inventories and the control strategy contingency estimates developed for use in the Phase 1 Houston-Galveston Attainment Demonstration SIP. To complete ROP calculations four separate inventories are needed for each year: the 1990 base year(BY), an adjusted base year(ABY), a current control(CC) and a control strategy(CS). To complete contingency estimate calculations, two inventories are needed: a current control(CC) and a control strategy(CS).

In this document the Urban County Group includes: Brazoria, Fort Bend, Galveston, and Montgomery Counties. And the Rural County Group includes: Chambers, Liberty, and Waller Counties.

MOBILE Input Description

The model version and required MOBILE data files are described in Table 2. The MOBILE flag settings are described in Table 3. The local area parameter record input values and documentation of the value selection process are documented in Table 4. The scenario description, record one of the scenario input, parameter values and documentation of the value selection process are documented in Table 5. The MOBILE input parameter values and documentation of the value selection process for the NLEV program, record two of the scenario input, are documented in Table 6. The inputs required to model the alternative standards for HDDVs are described and documented in Table 7. The I/M record input values and documentation of the value selection process are documented in Tables 8 and 9. The ATP record input values and documentation of the value selection process are documented in Table 10. The pressure test record input values and documentation of the value selection process are documented in Table 11. An example nlev.d file with inputs consistent with the current plan for LEV standards phase-in for Texas in documented in Table 12.

Transportation Inputs

For all the inventories the average annual daily vehicle miles traveled(VMT) should be seasonally and daily adjusted to summer, weekday VMT to correspond to ozone season day. Two adjustments will be required: 1) seasonally adjust the annual VMT to summer levels, and, 2) adjust from average daily to weekday VMT.

As with a 1990 base year inventory for the ABY inventories, 1990 transportation inputs should be used.

For the CC and CS inventories ROP milestone year transportation inputs should be used. If a 2002 or 2005 transportation model does not exist it is appropriate to interpolate between existing models

Control Strategy Description

The controls included in the development of emission factors for 2002, 2005 and 2007 ROP scenarios are described in Table 1.

Table 1

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories Description of Emission Control Mechanisms Used for Developing Emission Factors		
Control Description	Start Date	Scenario description
Pre-1990 CAAA FMVCP(Tier 0)	Pre-1990	BY, ABY, both CC and both CS
1992 RVP summer control	1992	BY, ABY, both CC and both CS
Tier 1 FMVCP	1994	2002, 2005 and 2007 CS
Reformulated Gasoline Phase 1	1994	2002, 2005 and 2007 CS
Inspection & Maintenance Phase 1 2 speed idle, Harris only	Jan 1997	I/M Phase 2 and 3 modeled for 2002, 2005 and 2007
Reformulated Gasoline Phase 2	2000	2002, 2005 and 2007 CS
NLEV	2001	2002, 2005 and 2007 CS
Inspection & Maintenance Phase 2 ASM, OBD2, Harris County	Jan 2002	2002, 2005 and 2007 CS, Harris County only
Inspection & Maintenance Phase 3 ASM, OBD2, add urban counties	Jan 2003	2005 and 2007 CS, Urban Counties only
Inspection & Maintenance Phase 4 ASM, OBD2, add 3 rural counties	Jan 2004	2005 and 2007 CS, Rural counties only
FMVCP for HDDV	2004	2005 and 2007 CS
Tier 2 FMVCP	2004	2005 and 2007 CS

Table 2

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories		
Model version and Data file Description		
Description	File size	Explanation
MOBILE5A or, MOB5A_H (needed for TTC) MOBILE5B (use for RFG correction)	889632 895216 920868	These represent the most recent versions of the model acceptable for use in preparing modeling information for EPA submittal. MOBILE5a_h is required to model the TMC I/M due to the technician training program component. MOBILE5b has a correction for the RFG NOx bug which is in both 5a and 5a_h. EPA's modeling information sheet #7 documents a modeling fix for the RFG NOx bug when using MOBILE5a or MOBILE5a_h using output from MOBILE5b.
IMDATA.d IMDATA3.d HYBRID.IMC imdata4.d (use this credit file renamed imdata.d) Imdata4h.d	584814(standard file for MOBILE5A) 661537(standard file with new ASM test type available) 617373(hybrid programs only) 753713(MOBILE5B version, new ASM test data) 705493(MOBILE5B hybrid credits)	The modeled program does not include hybrid components: do not use hybrid.imc, or, imdata4h.d. In order to access I/M credits for ASM based on Phoenix and California data: Use: imdata4.d, With: test type = "3" for MOBILE5a_h test type = "5" for MOBILE5b and Cutpoints: HC = 25. , CO = 50. , NOx = 2. See read me file, IMDATA4.txt, for IMDATA4.d for documentation of modeling methodology.
PPEFF.D	298(non hybrid programs, ppeffm5.d renamed to ppeff.d)) 293(hybrid programs only) 363(for use with MOBILE5B)	PPEFF.D is not needed when using MOBILE5A, Two pressure credit files were issued with MOBILE5A_H , one file for non-hybrid I/M programs, and one for hybrid. When using the MOB5A_H executable care should be exercised in selecting the correct file. Use the non-hybrid file for this analysis. Only one PPEFF.D file was issued with

TECH12.D	62558	same file for all current model versions
nlev.d	3622	Data file describing the phase in schedule for NLEV compliant vehicles.

Table 3

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories		
Flag Settings Page 1 of 2		
Model Parameter Description	Assigned Value	Methodology Description
PROMPT	1 Adjusted base year 1 Current control 5 Control strategy	1: is the standard input when using the MOBILE models in batch run mode 5: is used to indicate that NLEV input parameters will be used and is appropriate for the control strategy runs for both 2002, 2005 and 2007 for HGA. Additional input requirements for the modeling the NLEV Program are documented in Table 6. The required external data file with the alternative vehicle technology phase-in schedule is documented in Table 12.
PROJID	modeler's choice	no effect on results
TAMFLG	1	Use MOBILE default tampering rates
SPDFLG	4	one speed for all vehicle types, and, use locality specific trip length distributions An additional input line is required for the TLDs The TLD values are determined by HGAC using transportation model output information. The development of these values is documented in the EI report
VMFLAG	3	MOBILE input VMT mix does not affect vehicle type emission factors, only the composite emission factor. To have locality specific composite emission factors use 3 to input one VMT mix for all scenarios.
MYMRFG	3	Use MOBILE default AMARs as there are currently no Houston specific AMARs available, Use county or county group specific registration distributions

NEWFLG	5 (2002, 2005 and 2007 adjusted base year) 5 (2002, 2005 and 2007 current control) 1 (2002 control strategy) 2 (2005 & 2007 control strategy)	5: pre-1990 controls only, Tier 1 is turned OFF; and, use MOBILE default BERs 1: Tier 1 FMVCP is turned ON; and, use MOBILE default BERs. 2: Tier 1 FMVCP is turned ON; and, use user specified BERs for diesel vehicles consistent with the new diesel standards going into effect in 2004. Additional input is required as described in Table 6.

Table 3, Continued

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories		
Flag Settings Continued Page 2 of 2		
Model Parameter Description	Assigned Value	Methodology Description
IMFLAG	ABY & Current Control 1 All counties Control Strategy 2002 1 Urban and Rural 32 Harris County 2005 and 2007 32 All counties	1: No I/M program 32: The 3 sets the input file up for input of two I/M programs. Two programs are needed because the OBD credit is applicable only to 1996 and newer vehicles. Note: A setting of 4 or 5 is not appropriate as it signals the model to include assumptions about the I/M program not needed for this analysis, and, The second flag set to 2 indicates to the model to calculate I/M emission reductions consistent with the existence of a technician training program Values determined based upon I/M program design information from TNRCC Mobile Source Section
ALHFLG	1	No load corrections done in modeling calculations; the load factor calculations for the current versions of MOBILE are not reliable enough to use for ROP inventories
ATPFLG	ABY and CC 1: All counties except Harris 2: Harris County Control Strategy* 2002 2 & 5 Harris County 1 Urban and Rural counties 2005 & 2007 2 & 5 All counties	1: No ATP, no pressure test, no purge test 2: include input to model an ATP Values for the ATP are determined based upon the existing ATP in Harris County. 5: include input to model an ATP and a pressure test Values for the ATP and pressure test are based upon TMC program design information from the TNRCC Mobile Source Section. * Note: the TMC pressure test is assigned to get only 40% of the MOBILE pressure test credit , so model runs with and without the pressure test are required to determine the emission factors
RLFLAG	5	No refueling emissions calculated, refueling emissions are calculated as part of the area source inventory
LOCFLG	modeler's discretion	no effect on results
TEMFLG	1	MOBILE will calculate temperature corrections from minimum and maximum temperature
OUTFMT	modeler's discretion	no effect on results
PRTFLG	modeler's discretion	no effect on results

IDLFLG	1	No idle emissions calculated
NMHFLG	3	Hydrocarbon emission factors should be for VOC
HCFLAG	modeler's discretion	Diurnal runs will need to have appropriate flag setting. Otherwise use the value appropriate for obtaining output in the format needed for emissions calculation models.

Table 4

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories Local Area Parameter Record		
General comments: None.		
Model Parameter Description	Assigned Value	Methodology Description
Scenario name	modeler's discretion	Does not effect emission factor results, but may be used as a convenience to the modeler to indicate selected scenario information on output.
ASTM Class	B	ASTM regional map
Minimum daily temperature	Use values consistent with time-of-day and 24-hour average temperatures from 1990 Base year, 1996 ROP and 1999 ROP	Ozone season standard day minimum, maximum and ambient temperatures for HGA were developed for the 1990 Base Year EI, It is appropriate to use consistent values for future inventory modeling
Maximum daily temperature	Use values consistent with time-of-day and 24-hour average temperatures from 1990 Base year, 1996 ROP and 1999 ROP	Ozone season standard day minimum, maximum and ambient temperatures for HGA were developed for the 1990 Base Year EI, It is appropriate to use consistent values for future inventory modeling
Period 1 RVP	8.0	Regulated value minus .3, as per MOBILE guidance
Period 2 RVP	7.8	Regulated value, as per MOBILE guidance, value will not affect results when RFG flag is on
Period 2 start year	92	92 RVP regulation
Oxygenated fuel flag	1	No oxygenated fuels program in Houston
Diesel sales fraction flag	1	No alternate diesel sales fractions will be used
Reformulated gasoline flag	1 Adjusted base year 1 Current control 2 Control strategy	1: No RFG 2: Turn ON RFG RFG is part of the HGA

Table 5

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories Scenario Input - Record #1 Scenario Description		
General comments: None.		
Model Parameter Description	Assigned Value	Methodology Description
Region	1 Base year 1 Adjusted base year 1 Current control 4 Control strategy	1: standard input for low altitude areas 4: used when the input file will contain LEV or NLEV information
Calendar Year of Evaluation	Link-based/Time-of-Day 2002, 2005 & 2007 For November 15 projection: Facility-type/24-hour 2002, 2003 2005, 2006 2007, 2008 For contingency estimates: CC and CS scenarios only Facility-type/24-hour 2004 2007 2009	Inventory definition The Link-based/Time-of-day inventories are for July of 2002, 2005 & 2007 As only July or January scenarios are available with MOBILE the facility-type/24-hour inventory values are used to project the inventories to November 15 of 2002, 2005 & 2007 with ratios determined using linear interpolation between July year 1and July year 2 Linear interpolation is also used to calculate estimated November 15 2003, 2006 & 2008 CC and CS inventories in order to estimate control strategy reductions for contingency measures in the Attainment Demonstration SIP
Average speed	XXXX	set to XXXX when creating an emission factor file for POLFAC
Ambient temperature	Use values consistent with time-of-day and 24-hour average temperatures from 1990 Base year, 1996 ROP and 1999 ROP	Ozone season standard day minimum, maximum and ambient temperatures for HGA were developed for the 1990 Base Year EI, It is appropriate to use consistent values for future inventory modeling

Operating mode fractions	Use values consistent with time-of-day and 24-hour operating mode fractions from 1990 Base year, 1996 ROP and 1999 ROP	Locality specific operating mode fractions for HGA were developed for the 1990 Base Year EI, It is appropriate to use consistent values for future inventory modeling
Month of evaluation	7	Ozone season is being modeled so July is the appropriate month for all inventories

Table 6

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories
Scenario Input - Record #2
LEV Program Parameter Record

General comments: 1) Used only for the control strategy inventory.
2) PROMPT must be set to 5.
3) Region in the Scenario record must be set to 4
4) Enter the LEV parameter record as detailed below
5) User must provide an alternative LEV phase-in schedule using an external data file, nlev.d. Any non-OTC state not opting into California Low Emission Vehicle Program(includes Texas) will use a standard phase-in schedule of 100% LEVs for passenger cars and for all light duty trucks less than 6,000 pounds Gross Vehicle Weight (GVW) beginning in the 2001 model year. Table 12 contains an example nlev.d file for use when modeling the NLEV program for Texas with the following phase-in schedule for LDGVs and LDGTs:

For LDGVs and LDGTs Less Than 6000 lbs. GVW

Model Year	Phase-in Scedule		
1999	100% Tier 1,	0% TLEV,	0% LEV
2000	100% Tier 1,	0% TLEV,	0% LEV
2001+	0% Tier 1,	0% TLEV,	100% LEV

For LDGTs Greater Than 6000 lbs. GVW

Model Year	Phase-in Scedule		
1999	100% Tier 1,	0% TLEV,	0% LEV
2000	100% Tier 1,	0% TLEV,	0% LEV
2000+	100% Tier 1,	0% TLEV,	0% LEV

6) For additional information concerning how to model the effects of the NLEV program, see document titled, "MOBILE5, Information Sheet #6, Effect of the New National Low Emission Vehicle Standard for Light-Duty Gasoline Fueled Vehicles, EPA420-F-98-027, July 1998."

Model Parameter Description	Assigned Value	Methodology Description
LEV start year	01	NLEV program will start in 2001
I/M Flag	1	I/M program for the NLEV vehicles same as for other vehicles

Table 7

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories New 2004 Heavy Duty Diesel NOx Standards Record description					
General comments: Use only for the 2007 control strategy inventory. NEWFLAG must be set to 2.					
Model Parameter Description	Assigned Value				Methodology Description
Record 1	004				Program start year is 2004
Model Parameter Description	Record 2	Record 3	Record 4	Record 5	Methodology Description
Altitude 1 = low altitude	1	1	1	1	Heavy duty diesel standards phase in definition. These inputs are documented in EPA's MOBILE Information Sheet #5. The information sheet is available at the EPA web site.
Vehicle type 7 = HDDV	7	7	7	7	
Pollutant 3 = NOx	3	3	3	3	
Starting model year	90	91	98	04	
Ending model year	90	97	03	20	
New zero-mile value	05.639	04.598	03.679	01.840	
New deterioration rate	00.000	00.000	00.000	00.000	

Table 8

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories First I/M Program Descriptive Input Record		
General comments: Harris County began a 2-speed idle I/M program in 1997 as part of the TMC program. In 2002 the Harris County test type was changed to ASM. In 2003 the ASM program was geographically expanded to include the four urban non-attainment counties. In 2004 the ASM program was geographically expanded again to include the three rural non-attainment counties. For vehicles equipped with OBD, 1996 and newer vehicles, the ASM test is modeled as an IM 240 program. This modeling protocol is based upon discussion between TNRCC Mobile Source Section and EPA.		
Model Parameter Description	Assigned Value	Methodology Description
Program start year	97 Harris County 03 Urban Counties 04 Rural Counties	Harris County program began January 1997, the program was geographically expanded in 2002 and 2003
Stringency level	20	I/M program audit report
First model year	2002 78 2005 81 2007 83	program definition, 24 year rolling window
Last model year	2002 95 2005 95 2007 95	1996 and newer vehicles have OBD and will be modeled with IM 240 program
Waiver rate, pre-1981 my vehicles	03	I/M program definition
Waiver rate, my 1981 and later	03	I/M program definition
Compliance rate	96	I/M program definition
Program type	1	even though the I/M in Texas is a decentralized test and repair it is modeled as a centralized program when using MOBILE5a_h to prevent the program from assigning an automatic 50% rule effectiveness discount
Inspection frequency	1	annual testing, program definition
Vehicle types subject to inspection	2222	all gasoline vehicles tested
Test type	3 MOBILE5a_h 5 MOBILE5b	ASM test based upon Houston program design, user must input cut points
non-default cut points flag	2	user input cut points
alternative I/M credit flags	11	use the IMDATA.d credit file as received from EPA
HC cut point	25.	Houston program design, Two Mode 2525/5015 ASM with start up cutpoints

CO cut point	50.	Houston program design, Two Mode 2525/5015 ASM with start up cutpoints
NOx cut point	2.	Houston program design, Two Mode 2525/5015 ASM with start up cutpoints

Table 9

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories Second I/M Program Descriptive Input Record		
General comments: Harris County began a 2-speed idle I/M program in 1997 as part of the TMC program. In 2002 the Harris County test type was changed to ASM. In 2003 the ASM program was geographically expanded to include the four urban non-attainment counties. In 2004 the ASM program was geographically expanded again to include the three rural non-attainment counties. For vehicles equipped with OBD, 1996 and newer vehicles, the ASM test is modeled as an IM 240 program. This modeling protocol is based upon discussion between TNRCC Mobile Source Section and EPA.		
Model Parameter Description	Assigned Value	Methodology Description
Program start year	97 Harris County 03 Urban Counties 04 Rural Counties	Harris County program began January 1997, the program was geographically expanded in 2002 and 2003
Stringency level	20	I/M program audit report
First model year	2002 96 2005 96 2007 96	1995 and older vehicles do not have OBD and are modeled with the ASM program designed by TNRCC Mobile Source Section
Last model year	2002 00 2005 03 2007 05	program definition, two year new vehicle exemption
Waiver rate, pre-1981 my vehicles	03	I/M program definition
Waiver rate, my 1981 and later	03	I/M program definition
Compliance rate	96	I/M program definition
Program type	1	even though the I/M in Texas is a decentralized test and repair it is modeled as a centralized program when using MOBILE5a_h to prevent the program from assigning an automatic 50% rule effectiveness discount
Inspection frequency	1	annual testing, program definition
Vehicle types subject to inspection	2222	all gasoline vehicles tested
Test type	4	I/M 240 test is used to calculate credit for ASM with OBD, user must input cut points
non-default cut points flag	2	user input cut points
alternative I/M credit flags	11	use the IMDATA.d credit file as received from EPA
HC cut point	0.80	I/M 240 test is used to calculate credit for ASM with OBD, use phase-in cutpoints

CO cut point	15.0	I/M 240 test is used to calculate credit for ASM with OBD, use phase-in cutpoints
NOx cut point	2.00	I/M 240 test is used to calculate credit for ASM with OBD, use phase-in cutpoints

Table 10

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories
ATP Descriptive Input Record
page 1 of 2

General comments:
1) Since 1984 Harris County has had an ATP. The Harris County ATP was modified in 1997 as part of the TMC I/M program. The TMC was geographically expanded in 2002 to include the four urban non-attainment counties and again in 2003 to include the three rural non-attainment counties.
2) The current control inventory ABY and current control inventories are modeled using parameters consistent with the pre-1990 existing program. The CS inventories are modeled using parameters consistent with the TMC program design. Where inputs are different both values are indicated.
3)Two ATP records are needed to fully describe the ATP program because equipment checks are different for newer model year vehicles. The methodology for calculating emission factors for fleets effected by multiple anti-tampering programs was determined during development of the 1990 base year inventories. The method requires multiple model runs with post processing to estimate the combined effect of the ATPs. For a fleet with two ATPs the method is summarized by the formula:

$$EF_{Combined} = EF_{No\ ATP} - [(EF_{No\ ATP} - EF_{ATP\#1}) + (EF_{No\ ATP} - EF_{ATP\#2})]$$

where,

$EF_{Combined}$ = Final Emission Factor,
$EF_{No\ ATP}$ = Emission factor for No ATP,
$EF_{ATP\#1}$ = Emission factor for ATP program #1, and
$EF_{ATP\#2}$ = Emission factors for ATP program #2.

The formula may be algebraically simplified to:

$$EF_{Combined} = EF_{ATP\#1} + EF_{ATP\#2} - EF_{No\ ATP}$$

Model Parameter Description	Assigned Value		Methodology Description
	ATP 1	ATP 2	
Program start year	84 Harris County 03 Urban Counties 04 Rural Counties	84 Harris County 03 Urban Counties 04 Rural Counties	operation began in early 1984 in Harris County geographically expanded in 2002 and 2003
First model year	Current Control 68 all eval years Control Strategy 78 for 2002 81 for 2005 83 for 2007	Current Control 80 all eval years Control Strategy 84 for 2002 84 for 2005 84 for 2007	program design: existing Harris County program covered all model years TMC program has a 24 year rolling window and 2 year new vehicle exemption
Last model year	Current Control 79 all eval years Control Strategy	Current Control 20 all eval years Control Strategy	program design: existing Harris County program covered all model years TMC program has a two year

Table 10, continued

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories ATP Descriptive Input Record page 2 of 2			
Model Parameter Description	Assigned Value		Methodology Description
	Model year vehicles ATP 1	Model year vehicles ATP 2	
Vehicle types subject to inspection	Current control 2221 Control strategy 2222	Current control 2221 Control strategy 2222	Pre-1990 program: no HDGV inspected Houston program: all gasoline vehicles tested
Program type	1	1	even though the I/M in Texas is a decentralized test and repair it is modeled as a centralized program whe using MOBILE5a_h to prevent the program from assigning an automatic 50% rule effectiveness discount
Inspection frequency	1	1	annual inspections required
Compliance rate	Current Control 85 Control Strategy 96	Current Control 85 Control Strategy 96	Current Control: I/M program audit report Control Strategy: Program design
Air pump system check flag	2	2	program design
Catalyst check flag	1	2	program design
Fuel inlet restrictor check flag	1	Current Control 2 Control Strategy 1	program design
Tailpipe lead deposit test flag	1	Current Control 2 Control Strategy 1	program design
EGR system check flag	2	2	program design
Evaporative control system check flag	2	2	program design
PCV system check flag	2	2	program design
Gas cap check flag	2	2	program design

Table 11

2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories Pressure Test Descriptive Input Record		
General comments: 1) Harris County began a pressure test in 1997 as part of the TMC program. In 2003 the TMC was geographically expanded to include the four urban non-attainment counties. In 2004 the program was geographically expanded again to include the three rural non-attainment counties. 2) The pressure test used in the TMC program has been determined to get only 40% of the pressure test emission factor reduction in the MOBILE credit file. Therefore, two model runs are required in order to determine the effect of TMC pressure test. The results from two model runs, one with the test and one without the test, are linearly interpolated to 40% of the pressure test emission factor reduction.		
Model Parameter Description	Assigned Value	Methodology Description
Program start year	97 Harris County 03 Urban Counties 04 Rural Counties	program began in Harris County in January 1997 program geographically expanded in 2003 and 2004
First model year	2002 78 2005 81 2007 83	program definition, 24 year rolling window
Last model year	2002 00 2005 03 2007 05	program definition, two year new vehicle exemption
Vehicle types subject to inspection	2222	all gasoline vehicles tested
Program type	1	Even though the I/M program in Texas is decentralized, test and repair, it is modeled as a centralized program when using MOBILE5a_h to prevent the program from assigning an automatic 50% rule effectiveness discount
Inspection frequency	1	annual testing, program definition
Compliance rate	96	In/M program audit report

Table 12
2002, 2005 and 2007 Houston-Galveston Rate-of-Progress Inventories
Example Input File for nlev.d for the NLEV Program With 2001 Start

Note: For information concerning column and row definitions, or specific information about formats, see document titled, "MOBILE5, Information Sheet #6, Effect of the New National Low Emission Vehicle Standard for Light-Duty Gasoline Fueled Vehicles, EPA420-F-98-027, July 1998."

```
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  1994LDGV  Tier1/ITLEV, TLEV, ILEV, LEV, IULEV, ULEV,
ZEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    95      FedLEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    96
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    97
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    98
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    99
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  2000
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    01
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    02
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    03
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    04
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    05
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  1994LDGt1a Tier1/ITLEV, TLEV, ILEV, LEV, IULEV, ULEV,
ZEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    95       FedLEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    96
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    97
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0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    01
0.000 0.000 0.000 0.000 1.000 0.000 0.000 0.000    02
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ZEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    95       FedLEV
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1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000  1994LDG2a Tier1/ITLEV, TLEV, ILEV, LEV, IULEV, ULEV,
ZEV
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    95       FedLEV
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ZEV
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1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    02
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    03
1.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000    04
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