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METROPOLITAN PLANNING ORGANIZATION

**Emissions Trend Analysis for the
San Antonio-New Braunfels MSA:
1999, 2002, 2006, 2012, 2018, and 2023**

Technical Report

October 2013

Prepared by the Alamo Area Council of Governments

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<p>Abstract: This report focuses on the federally regulated emission of volatile organic compounds (VOCs) and nitrogen oxides (NO_x) that are released in the atmosphere within the eight-county San Antonio-New Braunfels Metropolitan Statistical Area (MSA). The report provides information on trends from 1999 to 2023 for on-road, non-road, off-road, area, and point emissions sources. The emissions associated with Eagle Ford oil and gas exploration are also independently discussed. This historical emission trend analysis is for the purpose of understanding the area's air quality, in terms of tropospheric ozone and its precursors, and can serve both as a measurement for evaluating the effectiveness of implemented air quality control strategies and a guide for maintenance of federal ozone standards throughout the region. The results of this study indicate that the generation of anthropogenic NO_x emissions in the San Antonio-New Braunfels MSA will continue to decline through 2023, however release of anthropogenic VOCs will slightly increase. For the year 2023, the total emission of VOCs is expected to reach 244.39 tons/day indicating an increase of 11.20 tons/day as compared to 1999. NO_x emissions are predicted to reach 124.83 tons/day indicating a reduction of 264.84 tons/day as compared to 1999. In light of continuous population growth in the region through 2023, these NO_x emission reductions are significant.</p>			
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Executive Summary

In order to complete the air quality planning required by the Clean Air Act, state and local agencies utilize a variety of tools that support such analyses as predicting changes in pollution concentrations over time and evaluating control strategy effectiveness. An emissions trend analysis is one such tool that allows analysts to compare and predict emission rates over multiple time periods. In the case of tropospheric ozone, a trend analysis is developed for the primary precursor chemicals that form ozone: nitrogen oxides (NO_x) and volatile organic compounds (VOCs). For this analysis, emissions of VOC and NO_x were compared and documented for non-road mobile, area, point, off-road, on-road mobile, and Eagle Ford sources for the years 1999, 2002, 2006, 2012, 2018, and 2023 to determine emissions trends.

The results indicate that the amount of anthropogenic NO_x emissions generated by sources in the eight-county San Antonio-New Braunfels MSA will continue to decline through 2023, however anthropogenic VOCs will slightly increase. For the year 2023, the total emission of VOCs is expected to reach 244.39 tons/day indicating an increase of 11.20 tons/day as compared to 1999. NO_x emissions are predicted to reach 124.83 tons/day in 2023 indicating a reduction of 264.84 tons/day as compared to 1999. On-road vehicles were the greatest source of NO_x emissions prior to 2012, but represent the greatest source of emission reductions in the coming years (Tables E.S. 1 and E.S. 2).

Table E.S. 1: VOC Emissions Trend in San Antonio-New Braunfels MSA, tons/ozone season day

Emission Source	1999	2002	2006	2012	2018	2023
On-Road	68.92	57.98	46.34	32.93	22.28	19.29
Non-Road	45.04	38.08	24.52	27.10	18.99	17.33
Area	110.12	116.47	147.16	151.25	153.78	190.22
Point	7.64	5.37	8.26	6.11	6.98	6.67
Off-road	1.47	1.94	3.38	3.26	3.45	3.47
Eagle Ford Shale	-	-	-	3.07	7.44	7.41
Total	233.19	219.84	229.67	223.70	212.92	244.39

Table E.S. 2: NO_x Emissions Trend in San Antonio-New Braunfels MSA, tons/ozone season day

Emission Source	1999	2002	2006	2012	2018	2023
On-Road	186.18	163.57	127.88	76.71	43.21	31.89
Non-Road	56.07	41.74	25.75	19.59	11.35	8.40
Area	13.25	13.82	16.51	15.61	15.90	16.73
Point	120.13	95.95	71.30	66.35	63.52	56.92
Off-road	14.04	13.28	8.89	8.13	7.74	7.29
Eagle Ford Shale	-	-	-	3.85	4.09	3.60
Total	389.67	328.36	250.32	190.24	145.81	124.83

Although there are major sources of emissions in Atascosa, Comal, and Guadalupe counties, VOC and NO_x emissions generated in Bexar County account for the greatest share of the 2023 total emissions inventory for the San Antonio-New Braunfels MSA. The projections indicate that every county in the San Antonio-New Braunfels MSA will experience reductions in NO_x emissions in coming years, but the 2012 VOC levels will not be sustainable. In light of forecasts for continuous population growth in the region through 2023, the NO_x emission reductions are significant.

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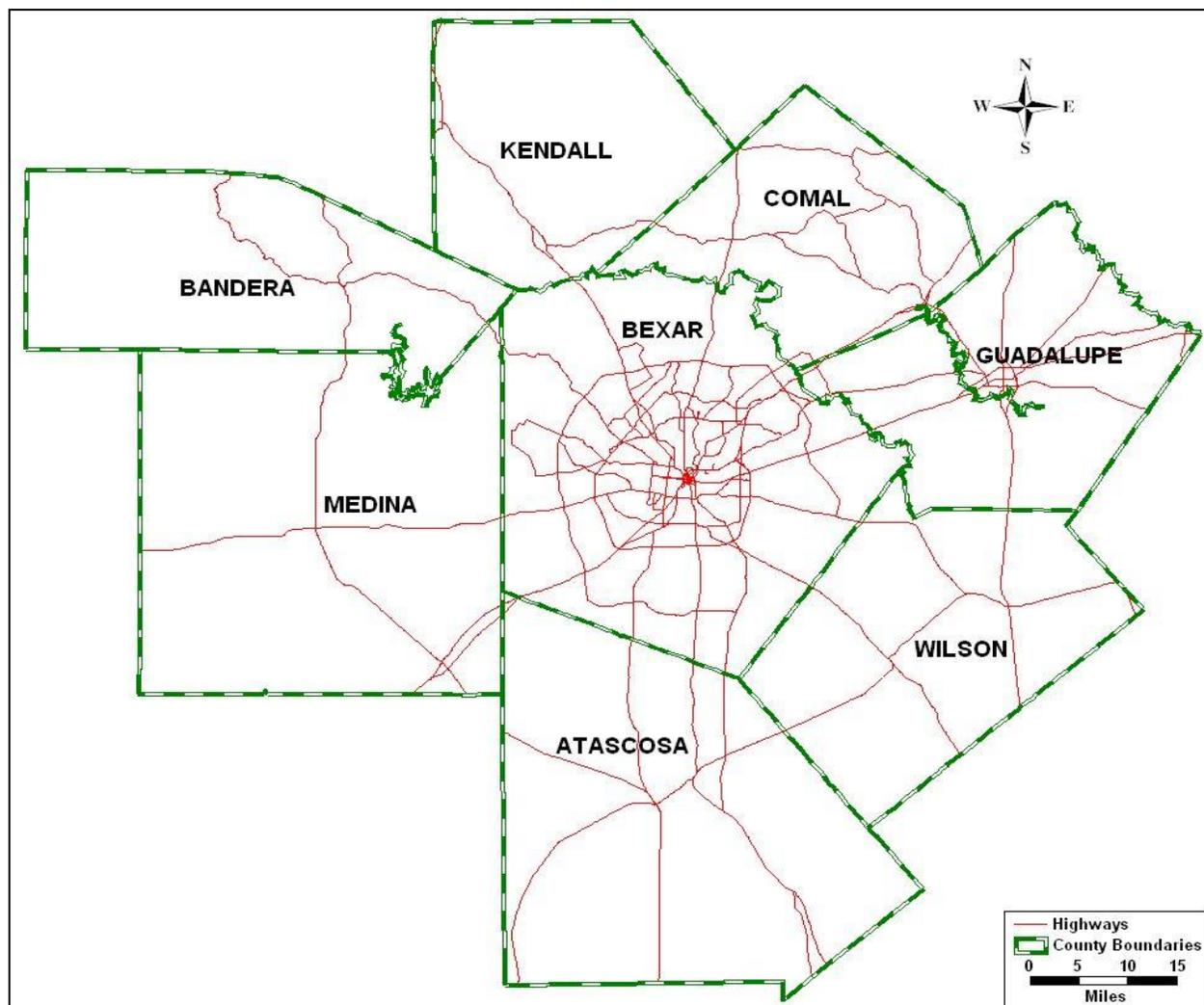
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1 Introduction

The purpose of this trend analysis for the San Antonio-New Braunfels Metropolitan Statistical Area (MSA) is to evaluate the status of ozone precursor emissions as it relates to the National Ambient Air Quality Standards (NAAQS) in a historical context, as well as forecasting the status of emissions in the future years. This will determine whether or not emission levels in the region are increasing or decreasing. The results of this analysis can be used for air quality planning and development of control strategies in Atascosa, Bandera, Bexar, Comal, Guadalupe, Kendall, Medina, and Wilson counties, which constitute the MSA. These counties are shown in Figure 1-1.

Figure 1-1: San Antonio – New Braunfels Metropolitan Statistical Area Boundaries



Plot Date: January 5, 2008
Map Compilation: January 5, 2008
Source: U.S. Census Bureau

VOC and NO_x emissions are the two main pollutants that form ozone and are, therefore, the focus of this trend analysis for the San Antonio-New Braunfels MSA. Emissions are organized by non-road, off-road, area, point, and on-road emission sources, with the Eagle Ford oil shale being discussed independently. Emission totals are provided for each county for a “typical ozone season weekday.” Arranged chronologically, these historic and future emission estimates between 1999 and 2023 provide planners an indication of the change in emission levels, by source, over time.

1.1 National Ambient Air Quality Standards

The U.S. Environmental Protection Agency (EPA) is charged with the maintenance of regional air quality across the United States through enforcement of a series of standards, the National Ambient Air Quality Standards, which apply to outdoor air quality throughout the country. Primary standards are designed to protect human health including sensitive groups such as children, the elderly, and individuals suffering from respiratory diseases. Secondary standards are meant to protect public welfare from any known or anticipated adverse effects of a pollutant. When a region meets these standards, the region is an "attainment area," otherwise the region can be declared a "non-attainment area".¹ To attain the ozone standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.75 parts per billion. (Effective May 27, 2008)²

1.2 Status of Ozone Attainment in San Antonio-New Braunfels MSA

The San Antonio region is considered to be an “attainment area”, however since the 3-year average of the fourth highest daily maximum ozone averages has exceeded the 0.75 ppb threshold, the region could be designated as “non-attainment”. The following table shows data for regulatory ozone monitoring stations in the San Antonio-New Braunfels MSA.

Table 1-1: 8-hour Ozone Attainment Values in San Antonio-New Braunfels MSA, 2012

Monitoring Site	Fourth Highest (ppb)			3-Year Average
	2010	2011	2012	
San Antonio Northwest C23	72	79	81	77
Camp Bullis C58	78	75	87	80
Calaveras Lake C59	67	71	70	69

More information on ozone monitoring stations and historical ozone concentrations collected in the San Antonio-New Braunfels MSA can be found in Appendix A.

¹ Environmental Protection Agency (EPA), “The Plain English Guide to the Clean Air Act.” Available online: <http://www.epa.gov/air/caa/peg/>. Accessed 4/18/2013.

² TCEQ, “Air and Water Monitoring”. Available online: http://www.tceq.state.tx.us/cgi-bin/compliance/monops/8hr_attainment.pl. Accessed 4/18/2013.

1.3 Data Used for Emissions Trend Analysis

The regional photochemical model's databases from TCEQ were used for analysis of 2006, 2012, and 2018 emissions, while for other years locally collected empirical data, as well as the databases in the MOVES2010b³, EGAS⁴, EDMS⁵, and TexN⁶ models were used. Each emission category includes the emission reduction effects of applicable federal, state, and/or local regulatory measures. The following is a list of EPA-approved software and models that were used to project emissions and develop emission trends.

<u>Category</u>	<u>Data Source</u>
Non-road	Houston and Dallas SIP submittals, TexN model; TexAER model ⁷ ; Eastern Research Group's (ERG) drill rig emission inventory; local data for construction equipment, quarry equipment, mining equipment, landfill equipment, agricultural tractors, and combines
Off-road	Houston and Dallas SIP submittals; Terminal Area Forecast (TAF) ⁸ ; Emission & Dispersion Modeling System (EDMS) version 5.1.3; local data for Randolph AFB, San Antonio International Airport, and Lackland; ERG for 2011-based switcher and line-haul locomotives; Pechan & Associates locomotive emission inventory
Area	Houston and Dallas SIP submittals, Economic Growth Analysis System (EGAS) 5.0
Point	Dallas SIP submittals, State of Texas Air Reporting System (STARS) ⁹ , local data for EGUs in the San Antonio-New Braunfels MSA (CPS Energy and San Miguel power plants) and local data for Cement kilns (Alamo Cement, Chemical Lime, Capitol Cement, TXI, and CEMEX)
On-Road	MOVES2010a and the data developed by the Texas Transportation Institute (TTI). The vehicle miles traveled (VMT) estimates are based on travel demand modeling (TDM) for major metropolitan areas and the Highway Performance Monitoring System (HPMS) for rural areas, and local data are used for Extended diesel truck idling.

³ U.S. EPA, December 2009. Office of Transportation and Air Quality Washington, DC. "Motor Vehicle Emission Simulator". Available online: <http://www.epa.gov/otaq/models/moves/index.htm>. Accessed 08/22/2013.

⁴ U.S. EPA, April 27, 2010. Models and Tools. "Economic Growth Analysis System Version 5.0". Available online: <http://www.epa.gov/ttn/ecas/econtool.html>. Accessed 08/22/2013.

⁵ FAA, Nov. 2010. "Emissions & Dispersion Modeling System, Version 5.1.3". Available online: http://www.faa.gov/about/office_org/headquarters_offices/aep/models/edms_model. Accessed 08/22/2013.

⁶ TCEQ, Dec. 2008, Non-road Emissions Modeling, "TexN." Available online: ftp://amdaftp.tceq.texas.gov/pub/Nonroad_EI/TexN/. Accessed 08/22/2013.

⁷ TCEQ, 2011, "Texas Air Emissions Repository" (TexAER). Available online: <http://www5.tceq.state.tx.us/texaer/>. Accessed 08/22/2013.

⁸ Federal Aviation Administration, 2009. "Terminal Area Forecast". Washington, DC. Available online: <http://aspm.faa.gov/main/taf.asp>. Accessed 08/22/2013.

⁹ TCEQ, 2013, "Point Source Emissions Inventory". Available online: <http://www.tceq.texas.gov/airquality/point-source-ei/psei.html>. Accessed 08/22/2013.

Eagle Ford

Draft Eagle Ford Emission Inventories, moderate emission projection based on projected number of drill rigs, well decline curves, estimated ultimate recover (EUR), MOVES2010b, TexN model, Tier4 standards, and other emission controls

2 Non-road Source Emissions

Non-road emission sources cover a wide range of mobile and stationary equipment. Unlike on-road vehicles, non-road” equipment sources are not registered for on-road operation and include farming, quarry, industrial, lawn and garden, commercial, and construction equipment. This category does not include commercial marine vessels, railroad locomotives, and aircraft. These types of equipment are discussed under the section on “off-road” equipment. The primary non-road equipment categories include:

- Recreational Vehicles (ATVs, off-highway motorcycles)
- Agricultural
- Construction/Mining/landfills
- Commercial (e.g., warehouse forklifts)
- Industrial
- Lawn and Garden (commercial and residential)
- Recreational Marine Engines
- Airport Ground Support Equipment
- Railway Maintenance
- Drilling Rigs

2.1 Non-road Equipment Emissions Projection

Apart from drilling rigs, the TexN model, which mimics the EPA's NONROAD2008a model,¹⁰ was used to estimate 2023 emissions from all non-road equipment. Emission growth rates, from 2018 to 2023, were determined by comparing the TexN model's emissions output files, and then these rates were applied to the 2018 photochemical model's emission data by equipment type. The “Texas NONROAD Model (TexN) provides emissions estimates for a large number of non-road equipment categories operating in Texas.”¹¹ “The TexN model incorporates the unmodified NONROAD2005 model to generate its core emission estimates, utilizing region-specific adjustment factors in order to refine the NONROAD outputs for Texas. The model also incorporates geographic and equipment-specific improvements to the NONROAD model, reflecting the efforts of numerous TCEQ studies.”¹²

The TexN model accounts for several future federal programs that set tighter emissions standards for off-road equipment based on type of equipment, fuel, and horsepower. The federal programs include: Standards for Compression-ignition Vehicles and Equipment, Standards for Spark-ignition Off-road Vehicles and Equipment, Tier 1 to Tier 4 Heavy-duty

¹⁰ EPA, July 2009. “Modeling and Inventories”. Available online: <http://www.epa.gov/otaq/nonrdmdl.htm#model>. Accessed 05/02/2013

¹¹ Eastern Research Group, Inc. April 26, 2013. “Texas NONROAD (TexN) Model”. Austin, Texas. Available online: ftp://amdaftp.tceq.texas.gov/pub/Nonroad_EI/TexN/. Accessed 07/03/2013.

¹² Eastern Research Group, Inc. April 26, 2013. “Texas NONROAD (TexN) Model”. Austin, Texas. Available online: ftp://amdaftp.tceq.texas.gov/pub/Nonroad_EI/TexN/. Accessed 07/03/2013.

Diesel Equipment, Recreational Marine Standards, and Lawn and Garden Equipment standards¹³. Also, the requirements established by the Texas Low Emission Diesel (TxLED) program, small marine rule, and reformulated gasoline were included. According to TCEQ, “TxLED requirements are intended to result in reductions in NO_x emissions from diesel engines. Currently, reduction factors of 5.7% (0.057) for on-road use and 7.0% (0.07) for non-road use have been accepted as a NO_x reduction estimate resulting from use of TxLED fuel. However, this reduction estimate is subject to change, based on the standards accepted by the EPA for use in the Texas State Implementation Plan (SIP).”¹⁴

The TexN model run specifications used to project emissions were:

- Analysis Year = 2006, 2012, 2018 and 2023
- Max Tech. Year = 2006, 2012, 2018 and 2023
- Met Year = Typical Year
- Period = Ozone season day
- Summation Type = Typical weekday for summer
- Post Processing Adjustments = All including TxLED
- Rules Enabled = All
- Regions = San Antonio-New Braunfels MSA counties
- Sources = All fuels and all classes of equipment

The following equation describes the procedure for calculating emissions from non-road equipment in 2023. The county-based emission totals for a particular county were determined by aggregating all equipment emissions.

Equation 2-1, Non-road Projections

$$PYE_A = BCE_A \times (FCNR_{A, \text{TexN}} / BCNR_{A, \text{TexN}})$$

Where,

- PYE_A = Projected Year Emissions for Equipment Type A for (VOC or NO_x)
- BCE_A = Base Case 2018 Emissions for Equipment Type A (from 2018 photochemical modeling emission inventory)
- FCNR_{A, TexN} = 2023 VOC or NO_x Emissions for Equipment Type A (from TexN model)
- BCNR_{A, TexN} = 2018 VOC or NO_x Emissions for Equipment Type A (from TexN model)

Sample Equation: NO_x emissions for a diesel scraper in Bexar County in 2023

$$PYE_A = 0.0021 \text{ tons of NO}_x/\text{day from 2018 photochemical model} \times (0.0132 \text{ tons of NO}_x/\text{day from 2023 TexN model} / 0.0227 \text{ tons of NO}_x/\text{day from 2018 TexN model})$$

¹³ Eastern Research Group, Inc., Sept. 28, 2012. "TexN 1.6". Available online: http://amdaftp.tceq.texas.gov/pub/Nonroad_EI/TexN/. Accessed 02/22/2013.

¹⁴ TCEQ, July 24, 2012. "Texas Emissions Reduction Plan (TERP) Emissions Reduction Incentive Grants Program". Austin, Texas. Available online: http://www.tceq.texas.gov/assets/public/implementation/air/terp/techsup/2012onvehicle_ts.pdf. Accessed 8/27/2013.

= 0.0012 tons of NO_x day for a 2023 diesel scraper in Bexar County

2.2 Drilling Rigs

Historical emissions from drilling rig operations were obtained from the ERG’s drilling rig emission inventory for Texas. The purpose of ERG’s “study was to develop a comprehensive emissions inventory for drilling rig engines associated with onshore oil and gas exploration activities occurring in Texas in 2008.”¹⁵ “While drilling activities are generally short-term in duration, typically covering a few weeks to a few months, the associated diesel engines are usually very large, resulting in substantial amount of NO_x emissions.”¹⁶ Drill Rig emissions were back cast to 2006 using BakerHughes.com and RigData.com drill rig counts.¹⁷ Tables 2-1 and 2-2 list emissions from drill rigs in the San Antonio-New Braunfels MSA. Emissions associated with horizontal oil and gas well drilling, a technique which is used for oil and gas exploration in the Eagle Ford Shale, are not included in the table. Emissions from horizontal drill rigs in the Eagle Ford are provided in section 6.

Table 2-1: Drilling Rigs VOC Emissions in San Antonio-New Braunfels MSA, tons/day

County	1999	2002	2006	2012	2018	2023
Atascosa	0.0094	0.0070	0.0101	0.0024	0.0017	0.0014
Bandera	-	0.0010	0.0001	-	-	-
Bexar	-	-	-	-	-	-
Comal	-	-	-	-	-	-
Guadalupe	-	0.0001	0.0004	0.0004	0.0003	0.0003
Kendall	-	-	-	-	-	-
Medina	-	-	0.0001	0.0004	0.0003	0.0003
Wilson	0.0147	0.0023	0.0020	0.0029	0.0018	0.0013
Total	0.0241	0.0104	0.0127	0.0061	0.0041	0.0033

note: This table does not include emissions from drill rigs operating in the Eagle Ford.

¹⁵ Eastern Research Group, Inc. July 15, 2009. “Drilling Rig Emission Inventory for the State of Texas”. Austin, Texas. p. 2-1. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/5820783985FY0901-20090715-erg-Drilling_Rig_EI.pdf. Accessed 07/03/13.

¹⁶ Eastern Research Group, Inc. July 15, 2009. “Drilling Rig Emission Inventory for the State of Texas”. Austin, Texas. p. 2-1. Available online: http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/5820783985FY0901-20090715-erg-Drilling_Rig_EI.pdf. Accessed 07/03/13.

¹⁷ Doug Boyer, TCEQ, Nov. 5, 2010. “2006/2012 DFW Modeling Update”. Presented to the DFW Photochemical Modeling Technical Committee. p. 6. Available online: http://www.tceq.texas.gov/assets/public/implementation/air/am/committees/pmt_dfw/20101105/20101105_PMTC_modeling_update.pdf. Accessed 08/08/2013.

Table 2-2: Drilling Rigs NO_x Emissions in San Antonio-New Braunfels MSA, tons/day

County	1999	2002	2006	2012	2018	2023
Atascosa	0.0809	0.0735	0.1169	0.0323	0.0178	0.0114
Bandera	-	0.0081	0.0015	-	-	-
Bexar	-	0.0005	-	0.0002	0.0001	-
Comal	-	-	-	-	-	-
Guadalupe	-	0.0014	0.0066	0.0077	0.0047	0.0042
Kendall	-	-	-	-	-	-
Medina	-	-	0.0020	0.0073	0.0028	0.0009
Wilson	0.1554	0.0227	0.0357	0.0309	0.0236	0.0197
Total	0.2363	0.1062	0.1627	0.0784	0.0490	0.0362

note: This table does not include emissions from drill rigs operating in the Eagle Ford.

2.3 Construction Equipment

Construction equipment is used to build roads, highways, commercial buildings, houses, and utility lines. When calculating local construction equipment populations, surrogate factors were used to adjust the TexN model's equipment population for each county. To determine surrogate factors for the MSA, each Diesel Construction Equipment (DCE) subsector was calculated separately based on comparisons of industry trends and other data closely related to diesel construction equipment populations. Data sources for the surrogate factors included employment¹⁸, population¹⁹, TxDOT's letting schedule²⁰, and the U.S. Census Bureau's building permits database²¹. To estimate 2023 emissions from construction equipment, emission growth rates from 2018 to 2023 were determined by comparing the TexN model's emissions output files.

2.4 Quarry, Landfill, and Mining Equipment

Due to the abundance of limestone, aggregate, granite, sand, and gravel deposits, there are numerous quarries in the San Antonio-New Braunfels MSA. In addition, there are six active landfills and one lignite mine. Data on quarry, landfill, and mining equipment was collected using a survey questionnaire that was sent to quarries, landfills, and mines, which had been identified through use of TCEQ's Permits²² directory, Mineral Locations Database²³, Find the

¹⁸ U.S. Census Bureau. June 30, 2011. "County Business Patterns (CBP)". Available online: <http://www.census.gov/econ/cbp/index.html>. Accessed 08/08/2013.

¹⁹ U.S. Census Bureau, Population Division. "Population Estimates". Available online: <http://www.census.gov/popfinder/>. Accessed 08/08/2013.

²⁰ Texas Department of Transportation. "TxDOT Letting Schedule". Finance Division. Austin, Texas. Available online: <http://www.dot.state.tx.us/business/schedule.htm>. Accessed 08/08/2013.

²¹ U.S. Census Bureau. "Building Permits". Available online: <http://censtats.census.gov/bldg/bldgprmt.shtml>. Accessed 08/08/2013.

²² TCEQ, "Permit Database". Austin Texas. Available online: <https://webmail.tceq.state.tx.us/gw/webpub>. Accessed 08/08/2013.

Best directory²⁴, and aerial photographs. For estimation of the 2023 emissions from all equipment, the methodology used to project non-road emissions was applied.

2.5 Agricultural Tractors and Combines

Agricultural tasks that use tractors include soil preparation, plowing, planting, fertilizing, cultivating, and applying pesticides, while combines are used for harvesting. To calculate tractor and combine emissions, crop acres planted and harvested for every county in the San Antonio-New Braunfels MSA was collected. Volume I of the 2007 Census of Agriculture, which was made available by the United States Department of Agriculture (USDA), contained acreage of hay by county.²⁵ Crop acreages for all other crop types were retrieved from the 2008 Texas Agricultural Statistics report published by USDA.²⁶ Local activity data and existing data in the TexN Model were used to calculate tractor and combine emissions. To estimate 2023 emissions from agricultural tractors and combines, emission growth rates from 2018 to 2023 from the TexN model were used.

2.6 Non-road Emissions Summary

Tables 2-3 and 2-4 show estimated VOC and NO_x emissions for non-road equipment for each county. Historical total VOC and NO_x emissions for non-road sources indicate a downward trend after 2012. This decrease in emissions can be attributed to implemented state and federal fuel and exhaust emission regulations for non-road equipment. The EPA has developed a lengthy list of emissions standards for various non-road engine sizes and fuel types. Their effect will be more noticeable by the year 2018, resulting in reductions of both NO_x and VOC emissions as compared to 2012.²⁷ Reductions of sulfur levels from 500 ppm to 15 ppm in diesel fuel, for example, will be finalized by 2014.²⁸

²³ MineralMundi, "Mineral Locations Database". United States Geological Survey Mineral Resources Program. Available online: <http://www.mineralmundi.com/texas.htm>. Accessed 08/08/2013.

²⁴ Find the Best, 2011. "Texas Active Mines". Available online: <http://active-mines.findthebest.com/directory/d/Texas>. Accessed 08/08/2013.

²⁵ United States Department of Agriculture, Updated December 2009. "2007 Census of Agriculture". AC-07-A-51. National Agricultural Statistics Service. Available online: http://www.agcensus.usda.gov/Publications/2007/Full_Report/Volume_1,_Chapter_2_County_Level/Texas/st48_2_027_027.pdf. Accessed 8/08/2013.

²⁶ United States Department of Agriculture, Updated December 2009. "Texas Agricultural Statistics, 2008". National Agricultural Statistics Service, Texas Field Office". Available online: http://www.nass.usda.gov/Statistics_by_State/Texas/Publications/Annual_Statistical_Bulletin/index.asp. Accessed 8/08/2013.

²⁷ EPA, Nov. 14, 2012, Emission Standards Reference Guide. "Non-road Engines and Vehicles". Available online: <http://www.epa.gov/otaq/standards/nonroad/>. Accessed 08/22/2013.

²⁸ EPA, Nov. 14, 2012, Emission Standards Reference Guide. "Highway, Nonroad, Locomotive, and Marine Diesel Fuel Sulfur Standards". Available online: <http://www.epa.gov/otaq/standards/fuels/diesel-sulfur.htm>. Accessed 08/22/2013.

Table 2-3: Non-road Source VOC Emissions in San Antonio-New Braunfels MSA, ton/day

County	1999	2002	2006	2012	2018	2023
Atascosa	0.89	1.03	0.58	0.62	0.40	0.37
Bandera	0.73	1.54	2.24	3.40	1.56	1.30
Bexar	35.84	26.03	13.97	13.37	11.67	10.93
Comal	2.69	3.89	3.69	4.97	2.62	2.24
Guadalupe	2.37	2.33	1.60	1.73	1.08	1.01
Kendall	0.87	1.37	1.42	2.00	1.00	0.87
Medina	0.93	1.22	0.75	0.79	0.49	0.44
Wilson	0.71	0.67	0.28	0.22	0.18	0.18
Total	45.04	38.08	24.52	27.10	18.99	17.33

Table 2-4: Non-road Source NO_x Emissions in San Antonio-New Braunfels MSA, ton/day

County	1999	2002	2006	2012	2018	2023
Atascosa	1.96	2.43	1.29	0.81	0.62	0.33
Bandera	0.32	0.20	0.30	0.26	0.16	0.13
Bexar	41.88	28.17	16.47	12.60	7.83	5.82
Comal	3.04	4.08	2.26	1.66	0.90	0.74
Guadalupe	4.63	4.09	1.97	1.46	0.74	0.54
Kendall	0.91	0.39	0.49	0.40	0.22	0.21
Medina	2.51	1.47	2.06	1.65	0.60	0.44
Wilson	0.82	0.91	0.91	0.75	0.28	0.21
Total	56.07	41.74	25.75	19.59	11.35	8.40

3 Off-road Source Emissions

Emissions from commercial marine vessels, locomotives, and aircraft are referred to as off-road mobile sources to distinguish them from other non-road sources²⁹. Data was locally collected for military installations, railways, and airports. Only non-stationary emissions from locomotives and aircraft operations are included. Emissions from aircraft ground support equipment used at military bases and airports, as well as emissions from maintenance of rail yards are included in the non-road category described in the previous section.

Locomotive emissions are associated with line haul and switching yards, and aircraft emissions include landing and take-off cycles for military, commercial, and general aviation aircraft at civil and military airports in the region. Emissions from commercial marine vessels are not included, since commercial marine vessel activity is insignificant in the San Antonio-New Braunfels MSA.

3.1 Locomotives Emissions

The EPA's new regulatory requirements for locomotives became effective in 2009³⁰ as part of the EPA's National Clean Diesel Campaign (NCDC) goal to reduce across the board harmful emissions from diesel engines. Later on, the much stricter Tier 4 standards were devised to require significantly lower VOC and NO_x emissions, as compared to the Tier 3 standards³¹. The Tier 4 standards will become effective in 2015 and are expected to reduce NO_x emissions by 80% when fully implemented.

The emission data for line-haul and yard locomotives, for 2006 thru 2018, come from TCEQ data used in the regional photochemical model emission inventories. The 2006 emissions were calculated by TCEQ using the EGAS model, which took into account all of EPA's new locomotive control regulations.³² The 2012, 2018, and 2023 projections were compiled based on data developed by Pechan & Associates for 1990 through 2040³³. These Pechan & Associates datasets for 2006, 2012, 2018, and 2023 were compared to determine emission growth rates (Table 3-1), and then these growth rates were applied to the 2006 emissions using Equation 3-1.

²⁹ TCEQ, December 2012, "Non-road and Off-road Mobile Source Emissions Data". Available online: http://m.tceq.texas.gov/airquality/airmod/overview/am_ei.html#nonroad. Accessed 05/03/2013.

³⁰ *Ibid.*

³¹ DieselNet, Emission Standards, Locomotives. Available online: <http://www.dieselnet.com/standards/us/loco.php>. Accessed 05/03/2013.

³² EPA, Sept. 2012, "Locomotives." Available online: <http://www.epa.gov/otaq/locomotives.htm>. Accessed 07/05/2013.

³³ Ms. Kirstin B. Thesing. E.H. Pechan & Associates, Inc., July 2010. "Development of Locomotive and Commercial Marine Emissions Inventory - 1990 TO 2040". Durham, NC. TCEQ Grant Agreement No. 582-07-84008. p. 1. Available online: ftp://amdaftp.tceq.texas.gov/pub/Offroad_EI/Locomotives/. Accessed 08/04/2013.

Table 3-1: Locomotive Projection Factors, San Antonio-New Braunfels MSA

County	2006 to 2012		2006 to 2018		2018 to 2023	
	VOC	NO _x	VOC	NO _x	VOC	NO _x
Atascosa	0.6522	0.6517	0.7101	0.7174	0.8000	0.8353
Bandera*	-	-	-	-	-	-
Bexar	0.6309	0.6314	0.6560	0.6565	0.7358	0.8023
Comal	0.6484	0.6477	0.7060	0.7052	0.7592	0.8301
Guadalupe	0.6343	0.6361	0.6686	0.6709	0.7347	0.8107
Kendall*	-	-	-	-	-	-
Medina	0.6364	0.6366	0.6727	0.6720	0.7419	0.8117
Wilson*	-	-	-	-	-	-

* Counties with no railways in the San Antonio-New Braunfels MSA

Equation 3-1, Daily emissions from locomotives, 2012, 2018, and 2023

$$E_{D,2018,A,B} = E_{TCEQ,D,06,A,B} \times (E_{Pechan,2018,B} / E_{Pechan,2006,B})$$

Where,

$E_{D,2018,A,B}$ = Daily 2012, 2018, or 2023 emissions in county A for locomotive type B (NO_x or VOC)

$E_{TCEQ,D,06,A,B}$ = Daily 2006 emissions in county A for locomotive type B (NO_x or VOC from TCEQ data)

$E_{Pechan,2018,B}$ = Annual 2012, 2018, or 2023 emissions for locomotive type B from Pechan & Associates (NO_x or VOC)

$E_{Pechan,2006,B}$ = Annual 2006 emissions for locomotive type B from Pechan & Associates (NO_x or VOC)

Sample Equation: Daily 2018 NO_x emissions from large line-haul locomotives in Bexar County

$$E_{Local,FY,A,B} = 2.04 \text{ tons of NO}_x \text{ in 2006} \times (215.46 \text{ tons of NO}_x \text{ per year in 2018 from Pechan \& Associates} / 328.20 \text{ tons of NO}_x \text{ per year in 2006 from Pechan \& Associates})$$

$$= 1.34 \text{ tons of NO}_x \text{ per day from line-haul locomotives in Bexar County, 2018}$$

As shown in Table 3-2, based on the calculations described above, emissions from locomotives will follow a gradual declining curve in years beyond 2006 as regulatory requirements are implemented and newer locomotives come online.

Table 3-2: Emissions from Locomotive Operations in San Antonio-New Braunfels MSA, tons/day

County	2006		2012		2018		2023	
	VOC	NO _x						
Atascosa	0.01	0.18	0.01	0.12	0.01	0.13	0.01	0.11
Bandera	-	-	-	-	-	-	-	-
Bexar	0.12	2.04	0.07	1.29	0.08	1.34	0.06	1.08
Comal	0.03	0.54	0.02	0.35	0.02	0.38	0.02	0.32
Guadalupe	0.08	1.40	0.05	0.89	0.05	0.94	0.04	0.76
Kendall	-	-	-	-	-	-	-	-
Medina	0.05	0.82	0.03	0.52	0.03	0.55	0.02	0.45
Wilson	-	-	-	-	-	-	-	-
Total	0.29	4.98	0.18	3.17	0.19	3.34	0.14	2.60

3.2 Projected Emissions for Airports at Military Bases

The 2006, 2012, and 2018 emissions for aircraft operating at San Antonio International airport, and small airports in the San Antonio-New Braunfels MSA, come from the regional photochemical model's databases. Since these databases do not include emissions from aircraft at military airports, emissions associated with aircraft landing and take-off cycles at Lackland and Randolph military airports were added to the emission totals. Data for aircraft operating at military bases was obtained from Lackland and Randolph military bases.

As a result of the 2005 Base Closure and Realignment (BRAC) Selection Criteria process, San Antonio lost Kelly and Brooks, which were two of the four Air Force Bases in Bexar County. The remaining military installations, including Lackland and Randolph Air Force bases, Fort Sam Houston and Camp Bullis are now managed together as Joint Base San Antonio (JBSA).³⁴ Port San Antonio, a business park developed on the site of the former Kelly Air Force Base owns the building that currently houses the 24th Air Force and has leased it back to the Air Force.³⁵ The runway at Port San Antonio is owned and operated by JBSA-Lackland.

JBSA-Lackland

"JBSA-Lackland is classified as a major source of emissions and has an Air Pollution Control Title V Permit to Operate (LAFB 2009b). In addition, JBSA-Lackland holds three New Source Review Permits, and numerous sources registered under Permit-By-Rule requirements. As required by the TCEQ, 30 Texas Administrative Code (TAC) §101.10, JBSA-Lackland calculates annual criteria pollutant emissions from stationary sources and provides this

³⁴ San Antonio Business Journal, Apr. 5, 2013. "San Antonio seeks to leverage its cyber-security advantage". Available online: <http://www.bizjournals.com/sanantonio/print-edition/2013/04/05/alamo-city-seeks-to-leverage-its.html>. Accessed 07/11/2013.

³⁵ *Ibid.*

information to the TCEQ. There are various sources at these bases that emit criteria pollutants, including generators, boilers, hot water heaters, fuel storage tanks, gasoline service stations, surface coatings/paint booths, and use of miscellaneous chemicals. JBSA-Lackland is required to prepare an Air Emissions Inventory (AEI) each year.³⁶ Flight activities have increased at JBSA-Lackland since 2007 due to the relocation of C-5 flight training from Altus AFB in Oklahoma to Lackland AFB.³⁷ Table 3-3 lists emission estimates for C-5 training coupled with regular aircraft emissions at JBSA-Lackland for the years 2012, 2018, and 2023.

JBSA-Randolph

JBSA-Randolph is located in Bexar County, Texas, northeast of the City of San Antonio. The base has a variety of missions and is a part of Joint Base San Antonio’s 502nd Air Base Wing. The base is home to the 12th Flying Training Wing and is one of the few bases that conduct instructor pilot training. The 2008 emissions data presented here are based on the aircraft activity data that come from a report on the compatibility of JBSA-Randolph air installation with its adjacent neighborhoods³⁸. About 209,367 annual aircraft operations were estimated for calendar year 2008 at JBSA-Randolph. Aircraft emissions were calculated by applying the EDMS airport emission model. Numbers of sorties per each airplane type were entered into the EDMS model and the annual and daily emissions were generated for each aircraft type. The following table shows aggregation of these emissions.

Table 3-3: Aircraft Emissions at Military Bases, ton/day

Military Base	Pollutant	1999	2002	2006	2012	2018	2023
JBSA-Lackland	VOC	0.19	0.35	0.35	0.50	0.61	0.61
	NO _x	1.09	2.34	2.34	3.47	2.73	2.73
JBSA-Randolph	VOC	0.27	0.27	1.92	1.92	1.92	1.92
	NO _x	0.52	0.52	0.17	0.17	0.17	0.17

3.3 San Antonio International and Small Airports

Emissions from aircraft landing and take-off cycles for the San Antonio International Airport, Stinson, and smaller regional public and private airports throughout the San Antonio-New Braunfels MSA were based on the data collected by the ERG for airports in Texas. ERG developed “statewide annual emission inventories for Texas airport activities for the calendar years 1996, 2000, 2002, 2011, 2014, 2017, 2020, 2023, 2026, 2029, and the base year 2008.”

³⁶ 802d Civil Engineer Squadron, October 2012, “Environmental Assessment Addressing the Transportation Security Administration Canine Academy and Associated Training Facilities at Joint Base San Antonio-Lackland”. Available online: <http://www.jbsa.af.mil/library/environmentalinformation.asp> Accessed 08/02/2013.

³⁷ Jan. 2005 “Environmental Impact Statement for the Relocation of the C-5 Formal Training Unit from Altus AFB, Oklahoma to Lackland AFB, Texas”, Headquarters Air Force Reserve Command Environmental Division: Georgia.

³⁸ Randolph Air Force Base, Texas, April 2008, “Air Installation Compatible Use Zone Study” Available online: <http://www.jbsa.af.mil/shared/media/document/AFD-120516-026.pdf> . Accessed 08/02/2013.

ERG used “publically available 2008 activity data and supplemented them with 2008 activity data obtained from local airports. Two approaches were used to estimate emissions from the compiled activity data. If the activity data had aircraft specific data, the EDMS was employed. If such detailed data were not available, then ERG applied a more general approach for different aircraft types (i.e., air taxis, general aviation, and military aircraft) using available generic emission estimating procedures. Once the base year of 2008 was established, the inventory was backcasted and forecasted based on FAA’s Terminal Area Forecast (TAF) data.”³⁹ For this trend analysis, annual rates of growth between 2002 and 2020 were calculated based on ERG data. The growth rates for any year of interest, such as 2012, were applied to the preceding year’s total emissions for specific SSC codes and the annual emissions for that year were calculated. The emissions from GSEs and APUs were removed to remain consistent with the regional photochemical model, which classifies emissions from these equipment types as non-road source emissions. Using the ERG-generated data, the following equation was used for calculating the 2012 aircraft emissions for any particular county in Texas.

Equation 3-2, Daily Aircraft Emissions by SSC Code by County, 2012

$$E_{Yol,A,B} = [(EPY_{A,B} - EFY_{A,B}) / (FY - PY) \times (PY - Yol) + EPY_{A,B}] / 365 \text{ days per year}$$

Where,

- $E_{Yol,A,B}$ = Emissions for Year of Interest in county A for SCC code B (NO_x or VOC)
- $EPY_{A,B}$ = Emissions of Preceding Year in county A for SCC code B (NO_x or VOC)
- $EFY_{A,B}$ = Emissions of Following Year in county A for SCC code B (NO_x or VOC)
- FY = Following Year (2014, ERG studied year)
- PY = Preceding Year (2011, ERG studied year)
- Yol = Year of Interest for which emission estimation is intended

Sample Equation: 2012 NO_x emissions from general aviation aircraft in Bexar County

$$E_{Yol,A,B} = [(27.8 \text{ tons of NO}_x \text{ in 2011} - 29.2 \text{ tons of NO}_x \text{ in 2014}) / (2014_{FY} - 2011_{PY}) \times (2011_{PY} - 2012_{Yol}) + 27.8 \text{ tons of NO}_x \text{ in 2011 from ERG report}] / 365 \text{ days per year}$$

= 0.077 daily tons of NO_x generated by general aviation aircraft (2275050000 SCC) in Bexar County, 2012

The resultant emission data are shown in the following tables (Table 3-4 and Table 3-5). The ERG-generated 2023 data are also used in these tables.

³⁹ Eastern Research Group, Inc. July 15, 2011. “Development of Statewide Annual Emissions Inventory and Activity Data for Airports”. 582-11-99776. Morrisville, North Carolina. p. ES-1.

Table 3-4: Civilian Airport Aircraft VOC Emission, San Antonio-New Braunfels MSA, tons/day

County	2006	2012	2018	2023
Atascosa	0.013	0.013	0.013	0.013
Bandera	0.006	0.005	0.005	0.005
Bexar	0.614	0.432	0.491	0.547
Comal	0.015	0.013	0.014	0.015
Guadalupe	0.094	0.128	0.138	0.146
Kendall	0.007	0.006	0.006	0.007
Medina	0.066	0.054	0.058	0.062
Wilson	0.004	0.003	0.003	0.003
Total	0.820	0.653	0.728	0.799

Table 3-5: Civilian Airport Aircraft NO_x Emission, San Antonio-New Braunfels MSA, tons/day

County	2006	2012	2018	2023
Atascosa	0.009	0.008	0.008	0.008
Bandera	0.006	0.004	0.005	0.005
Bexar	1.288	1.204	1.376	1.538
Comal	0.009	0.007	0.008	0.008
Guadalupe	0.040	0.057	0.061	0.065
Kendall	0.007	0.005	0.006	0.006
Medina	0.038	0.031	0.033	0.035
Wilson	0.003	0.003	0.003	0.003
Total	1.399	1.319	1.498	1.667

3.4 Total Off-road Emissions Summary

Table 3-6 and Table 3-7 list aggregated emissions from aircraft and railroad locomotives. Gradual reductions of NO_x emissions, however, are mainly due to implementation of air quality control strategies that target exhaust related NO_x reductions.

Table 3-6: Off-road Source VOC Emissions in San Antonio-New Braunfels MSA, tons/day

County	1999	2002	2006	2012	2018	2023
Atascosa	0.01	0.07	0.02	0.02	0.02	0.02
Bandera	0.00	0.00	0.01	0.00	0.01	0.01
Bexar	1.22	1.55	3.01	2.93	3.10	3.13
Comal	0.04	0.07	0.05	0.03	0.04	0.03
Guadalupe	0.11	0.15	0.18	0.18	0.19	0.19
Kendall	0.00	0.00	0.01	0.01	0.01	0.01
Medina	0.10	0.10	0.11	0.08	0.09	0.09
Wilson	0.00	0.00	0.00	0.00	0.00	0.00
Total	1.47	1.94	3.38	3.26	3.45	3.47

Table 3-7: Off-road Source NO_x Emissions in San Antonio-New Braunfels MSA, tons/day

County	1999	2002	2006	2012	2018	2023
Atascosa	0.25	0.41	0.18	0.12	0.13	0.12
Bandera	0.00	0.00	0.01	0.00	0.00	0.00
Bexar	8.78	8.10	5.85	6.14	5.63	5.52
Comal	0.82	1.49	0.55	0.36	0.39	0.32
Guadalupe	2.26	2.39	1.44	0.95	1.00	0.83
Kendall	0.00	0.00	0.01	0.01	0.01	0.01
Medina	1.93	0.85	0.86	0.55	0.58	0.48
Wilson	0.00	0.03	0.00	0.00	0.00	0.00
Total	14.04	13.28	8.89	8.13	7.74	7.29

4 Area Source Emissions

“Area source emissions come from of a variety of anthropogenic (human-made) sources that are too small, too abundant, or too dispersed geographically to inventory individually. Examples of these sources include dry cleaning, vehicle refueling, cooking, and solvent usage”⁴⁰. Analysis of historical data for area sources indicates that emissions will have an upward trend due to increases in population and economic activities in the coming years. Major categories of area sources include⁴¹:

- Stationary source fuel combustion (residential, commercial, and industrial)
- Solvent use (e.g., small surface coating operations)
- Product storage and transport distribution (e.g., gasoline)
- Oil and gas exploration
- Light industrial/commercial sources
- Agriculture (e.g., pesticides, fertilizer)
- Waste management (e.g., landfills, wastewater)

4.1 Projected Area Source Emissions

Area source emissions were based on the 2008 Texas Air Emissions Repository (TexAER) v4 database. “TexAER contains historical, current, and projected future case emissions inventory data, as well as control strategy information. You can customize your report to include specific locations, source classification codes (SCCs), time periods, units of measure, and other parameters.”⁴²

Projected area source emissions were generated using emissions growth rates calculated by the Economic Growth Analysis System (EGAS)⁴³. The EGAS model was developed by the EPA to provide "creditable growth factors" for projecting future emissions.⁴⁴ EPA endorses the use of EGAS when emission source growth estimates are not available by facility survey or other local sources. EGAS output files for each year were compared for specific SSC and FIPS codes to determine the growth rates and develop emission growth factors for these years. The EGAS model did not generate reasonable growth rates for the oil and gas emission category for the year 2023; therefore the 2018 oil and gas emissions were used for 2023. The EGAS models run configuration option selected generated output data organized by SCC codes.

⁴⁰ TCEQ, Area Source Emissions Data. Available online: http://www.tceq.texas.gov/airquality/airmod/overview/am_ei.html#area. Accessed 07/17/2013

⁴¹ *Ibid.*

⁴² TCEQ. “TexAER (Texas Air Emissions Repository)”. Austin, Texas. Available online: <http://www.tceq.texas.gov/airquality/areasource/TexAER.html>. Accessed 07/03/2013.

⁴³ E.H. Pechan & Associates, 2001. “EGAS 5.0 Reference Manual”. Available online: <http://www.epa.gov/ttn/ecas/gfmodels.html>. Accessed 08/08/2013

⁴⁴ *Ibid.*

Parameters Selected to Run EGAS Version 5.0:

Configuration: Default REMI 6.0 SCC Configuration
FIPS 48000 Texas
Projection Years: 2012, 2018, and 2023
Base Year: 2006

EGAS model growth rates were calculated and future emissions were calculated using the following formula.

Equation 4-1, Daily area source emissions

$$E_{\text{Local.FY.A.B}} = E_{\text{Local.18.A.B}} \times E_{\text{EGAS.23.A.B}}$$

Where,

$E_{\text{Local.FY.A.B}}$ = Daily 2023 emissions in county A for SCC code B (NO_x or VOC)
 $E_{\text{Local.18.A.B}}$ = Daily 2018 emissions in county A for SCC code B (NO_x or VOC)
 $E_{\text{EGAS.23.A.B}}$ = EGAS Growth Rate from 2018 to 2023 in county A for SCC code B (NO_x or VOC)

Sample Equation: 2023 NO_x emissions from Distillate Oil fuel combustion in Atascosa County, SCC code 2102004000

$$\begin{aligned} E_{\text{Local.FY.A.B}} &= 0.0078 \text{ tons of NO}_x \text{ in 2018} \times 1.027 \text{ EGAS Growth Rate for 2023} \\ &= 0.0083 \text{ tons of NO}_x \text{ per day from Distillate Oil fuel combustion in Atascosa} \\ &\quad \text{County, 2023} \end{aligned}$$

4.2 Oil and Gas Production Emissions

The data used for oil and gas production come from the ERG-generated 2008 emission inventory. ERG “identified and characterized area source emissions from upstream onshore oil and gas production sites that operated in Texas in 2008 and developed a 2008 base year emissions inventory from these sites by obtaining both county-level activity data, and specific emissions and emission factor data for each emission source type. This data was obtained from a variety of sources, including existing databases (such as the Texas Railroad Commission (TRC) oil and gas production data), point source emissions inventory reports submitted to TCEQ (for dehydrators), vendor data (for compression engines and pumpjack engines), and published emission factor and activity data from the Houston Advanced Research Center (HARC), the Central Regional Air Planning Association (CENRAP), and the U.S. Environmental Protection Agency (EPA).”⁴⁵ Emissions calculations were based on a new methodology developed by ERG using 2006 and June 2010 natural gas production data.⁴⁶ A 10% growth

⁴⁵ ERG, 2010. “Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions”. Final Report to the Texas Commission on Environmental Quality (TCEQ), Contract No. 582-7-84003-FY10-26. p. IV-V.

<http://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5820784003FY1026-20101124-ergj-oilGasEmissionsInventory.pdf>. Accessed 07/03/2013.

⁴⁶ *Ibid.*

rate was assigned to the remainder of the Texas counties in the domain. No additional air quality controls were assumed between 2010 and 2012.”⁴⁷

4.3 Total Area Source Emissions Summary

Area source emissions from 1999 to 2023 for each county are shown in Tables 4-1 and 4-2. Area source emissions are expected to increase through the year 2023, due to population growth and increased oil exploration and other economic activities.

Table 4-1: Area Source VOC Emissions in San Antonio-New Braunfels MSA, ton/day

County	1999	2002	2006	2012	2018	2023
Atascosa	3.69	6.99	9.82	10.79	10.87	14.33
Bandera	0.89	0.81	1.44	1.51	1.55	2.85
Bexar	81.19	69.71	90.04	93.05	94.95	105.25
Comal	10.37	4.33	6.35	6.73	6.87	6.90
Guadalupe	6.02	12.55	18.77	18.23	18.40	25.19
Kendall	1.60	7.74	6.60	6.69	6.76	13.24
Medina	3.45	8.45	9.44	9.75	9.84	15.61
Wilson	2.91	5.89	4.71	4.50	4.55	6.85
Total	110.12	116.47	147.16	151.25	153.78	190.22

Table 4-2: Area Source NO_x Emissions in San Antonio-New Braunfels MSA, ton/day

County	1999	2002	2006	2012	2018	2023
Atascosa	1.07	2.25	1.74	1.59	1.60	1.70
Bandera	0.11	0.11	0.12	0.13	0.13	0.20
Bexar	4.74	6.05	8.75	8.16	8.38	8.66
Comal	1.13	0.51	0.51	0.54	0.57	0.59
Guadalupe	2.60	1.97	2.67	2.45	2.48	2.75
Kendall	0.72	0.16	0.16	0.17	0.18	0.25
Medina	0.87	1.27	1.69	1.75	1.75	1.88
Wilson	2.01	1.50	0.86	0.81	0.81	0.88
Total	13.25	13.82	16.51	15.61	15.90	16.73

⁴⁷ TCEQ. “Appendix B: Emissions Modeling for the DFW Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard”. Austin, Texas. p. B-76. Available online: http://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/ad_2011/AppB_EI_ado.pdf. Accessed 07/03/2013.

5 Point Source Emissions

Point source emissions are generated at stationary facilities engaging in industrial or commercial activities. A facility is considered a point source if it generates at least 10 tons per year of VOC, 25 tons per year of NO_x, or 100 tons per year of any other contaminant subject to NAAQS.⁴⁸ Examples of point sources are cement kilns, power plants, and large manufacturing plants.

To collect data for point sources, “TCEQ mails annual emissions inventory questionnaires (EIQs) to all sources identified as meeting the reporting requirements. Subject entities are required to report levels of emissions subject to regulation from all emissions-generating units and emissions points, and also must provide representative samples of calculations used to estimate the emissions. Descriptive information is also required on process equipment, including operating schedules, emission control devices, abatement device control efficiencies, and emission point discharge parameters such as location, height, diameter, temperature, and exhaust gas flow rate.”⁴⁹

5.1 Projected Point Source Emissions

The future years’ emissions for the San Antonio-New Braunfels MSA from electric generating units (EGU) and non-electric generating units (NEGU), two subcategories of point source emissions, come from databases developed by TCEQ, CPS Energy, and San Miguel power plant. Properly assessing future point source emissions also requires identifying and calculating emissions from new point source facilities that are slated for construction. For this reason, the 2018 and 2023 projected emission estimates include emissions from expansion of the Toyota truck manufacturing and other new point source facilities and take into account the effects of installation of emission control devices at San Miguel Electric Corporative power plant.

⁴⁸ Texas Administrative code, amended December 23, 1999 “Chapter 101: General Rules, Rule § 101.10 (1)”. Available online: [http://info.sos.state.tx.us/pls/pub/readtac\\$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=101&rl=10](http://info.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=101&rl=10). Accessed 06/17/2013.

⁴⁹ TCEQ. “Appendix B: Emissions Modeling for the DFW Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard”. Austin, Texas. p. B-12. Available online: http://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/ad_2011/AppB_EI_ado.pdf. Accessed 07/03/2013.

5.2 CPS Energy Emissions

“CPS Energy is the nation’s largest municipally owned energy utility providing both natural gas and electric service. Acquired by the City of San Antonio in 1942, CPS Energy serves customers in Bexar County and portions of Atascosa, Bandera, Comal, Guadalupe, Kendall, Medina, and Wilson Counties.”⁵⁰ The 2012 emissions data, which are also the basis of forecasted years, were obtained from CPS Energy. The emission calculation procedure took into consideration that in 2012, the Rio Nogales natural gas plant in Seguin, Texas, was acquired⁵¹ by CPS and the J. T. Deely, a coal burning power plant, would be taken off line by 2023⁵².

The projected levels of emissions for 2018 and 2023 may change in the future, because of market demand. The annual totals were derived using variable daily generation rates, i.e., some days with higher generation and some days with lower generation. Therefore, multiplying daily figures by 365 does not produce annual emissions rates. Overall, the emissions from CPS Energy’s power plants are expected to decrease in coming years (Table 5-1).

Table 5-1: CPS Energy Facilities Emissions, ton/day

CPS Energy Plant	1999		2002		2006		2012		2018		2023	
	VOC	NO _x										
O.W. Sommers	0.07	3.91	0.07	3.91	0.15	2.98	0.15	3.94	0.15	3.94	0.15	3.94
J.T. Deely	0.34	18.19	0.34	18.19	0.39	14.8	0.00	6.84	0.00	6.83	-	-
J.K. Spruce	0.03	15.12	0.03	15.12	0.01	10.3	0.09	11.36	0.09	11.36	0.09	11.36
V.H. Brauning	0.04	2.28	0.04	2.28	0.20	7.70	0.13	2.97	0.13	2.97	0.13	2.97
Rio	-	-	0.00	1.18*	0.00	1.18*	0.04	1.03	0.04	1.03	0.05	1.27
Leon Creek	-	-	0.00	0.08	0.00	0.08	0.00	0.02	0.00	0.02	0.00	0.02
W.B. Tuttle	0.11	3.80	0.11	3.80	0.11	3.80	-	-	-	-	-	-
A. V. Rosenberg	0.00	0.93	0.00	0.93	0.07	1.05	0.00	0.28	0.00	0.28	0.00	0.28
Total	0.59	44.23	0.59	44.31	0.93	40.71	0.41	26.46	0.41	26.46	0.42	19.86

*Not CPS Energy totals because Rio was not owned by CPS Energy before 2012.

⁵⁰ CPS Energy, “Who We Are”, Available online: http://www.cpsenergy.com/About_CPS_Energy/Who_We_Are/. Accessed 07/09/2013.

⁵¹ CPS Energy, “The History of CPS Energy”, Available online: http://www.cpsenergy.com/About_CPS_Energy/Who_We_Are/History/History_of_CPS_Energy.asp Accessed 07/09/2013.

⁵² Reuters, Available online: <http://www.reuters.com/article/2011/06/20/utilities-texas-coal-idAFN1E75J24420110620>. Accessed 07/09/2013.

5.3 San Miguel Electric Corporative

San Miguel is a power plant located in the city of Christine in Atascosa County. “San Miguel Electric Cooperative, Inc. (San Miguel) was created on February 17, 1977, under the Rural Electric Cooperative Act of the State of Texas, for the purpose of owning and operating a 400-MW mine-mouth, lignite-fired generating plant and associated mining facilities that furnish power and energy to Brazos Electric Power Cooperative, Inc. and South Texas Electric Cooperative, Inc.”⁵³ The 2012 emissions data, consisting of 10.18 tons/day of NO_x and 0.22 ton/day of VOC emissions, were obtained from the power plant. Due to installation of emission control equipment, it is estimated that the 2018 emissions will decrease to 7.98 tons/day of NO_x and 0.22 ton/day of VOC emissions.⁵⁴

5.4 Cement Kiln Emissions

Due to the abundance of limestone in the San Antonio-New Braunfels MSA, several cement companies have been active in this area. Currently major cement manufacturers in the region are TXI, Alamo Cement, Capitol Cement, APG Lime Corp, and lately CEMEX, which is a Mexico-based cement company⁵⁵. Although these companies have spent significant amounts of resources to control their emissions by adopting modern emission control technologies⁵⁶, they will remain major contributors to air pollution in coming years. Table 5-2 summarizes a historical review of emissions associated with operation of cement factories in the San Antonio-New Braunfels MSA.

⁵³ San Miguel Electric Cooperative, Inc. Available online: <http://www.smece.net/index2.htm>. Accessed 08/05/2013.

⁵⁴ Eutizi, Joe. San Miguel Electric Cooperative. Atascosa County, Texas. “Projected San Miguel Power Plant Emissions”. Email to Steven Smeltzer. 11/29/2012.

⁵⁵ CarrTracks, “A Short History and Production Statistics of the Cement Industry for Rail fans”. Available online: <http://www.carrtracks.com/cement.htm>. Accessed 08/27/2013.

⁵⁶ By Ron Maloney, Sept. 21, 2006. “Breath of Fresh Air”, The Herald-Zeitung. Available online http://herald-zeitung.com/news/article_cd4b36aa-cee7-5102-8d6c-df9351094667.html. Accessed 08/27/2013.

Table 5-2: Historical Cement Kilns Emissions in San Antonio-New Braunfels MSA, ton/day

Plant	County	Kiln	1999		2002		2006		2012		2018		2023	
			VOC	NO _x										
APG Lime Corp	Comal	Kiln 1	0.00	1.15	0.01	1.59	0.00	1.07	0.00	1.07	0.00	1.07	0.00	1.07
		Kiln 2	-	-	-	-	0.00	0.74	0.00	0.74	0.00	0.74	0.00	0.74
Alamo Cement	Bexar		0.12	6.95	0.09	6.89	0.11	6.57	0.11	6.57	0.11	6.57	0.11	6.57
Capitol Cement	Bexar	Kiln 1	0.20	1.37	0.26	3.93	0.20	2.48	0.28	2.49	0.28	2.49	0.28	2.49
		Kiln 2	0.13	4.38	0.11	3.64	0.12	2.33	-	-	-	-	-	-
CEMEX	Comal	Kiln 1	0.12	7.60	0.12	6.21	0.01	5.99	0.01	5.99	0.01	5.99	0.01	5.99
TXI	Comal	Kiln 1	0.15	3.34	0.16	3.62	0.16	3.72	0.24	2.78	0.24	2.78	0.24	2.78
		Kiln 2	-	-	-	-	-	-	0.18	3.51	0.18	3.51	0.18	3.51
Total			0.71	24.79	0.75	25.88	0.60	22.90	0.82	23.15	0.82	23.15	0.82	23.15

5.5 Point Source Emission Summary

Tables 5-3 and 5-4 below summarize point source emission totals for the San Antonio-New Braunfels MSA. Projected emissions totals reflect the additional point source facilities, such as the additional CPS Energy power plant and Toyota manufacturing plant. As shown in these tables, decreases in total emissions from point sources are expected during coming years as alternative fuels and newer emission control technologies are being used to make operations of these facilities comply with stricter air quality and pollution standards.

Table 5-3: Point Source VOC Emissions in San Antonio-New Braunfels MSA, ton/day

County	1999	2002	2006	2012	2018	2023
Atascosa	0.34	0.24	0.46	0.30	0.30	0.30
Bandera	0.04	0.04	0.07	0.04	0.04	0.04
Bexar	6.31	4.08	6.19	3.53	4.34	4.03
Comal	0.52	0.34	0.33	0.64	0.64	0.64
Guadalupe	0.46	0.67	1.20	1.55	1.61	1.61
Kendall	0.00	0.00	0.01	0.00	0.02	0.02
Medina	0.00	0.00	0.00	0.00	0.00	0.00
Wilson	0.00	0.00	0.00	0.04	0.04	0.04
Total	7.64	5.37	8.26	6.11	6.98	6.67

Table 5-4: Point Source NO_x Emissions in San Antonio-New Braunfels MSA, ton/day

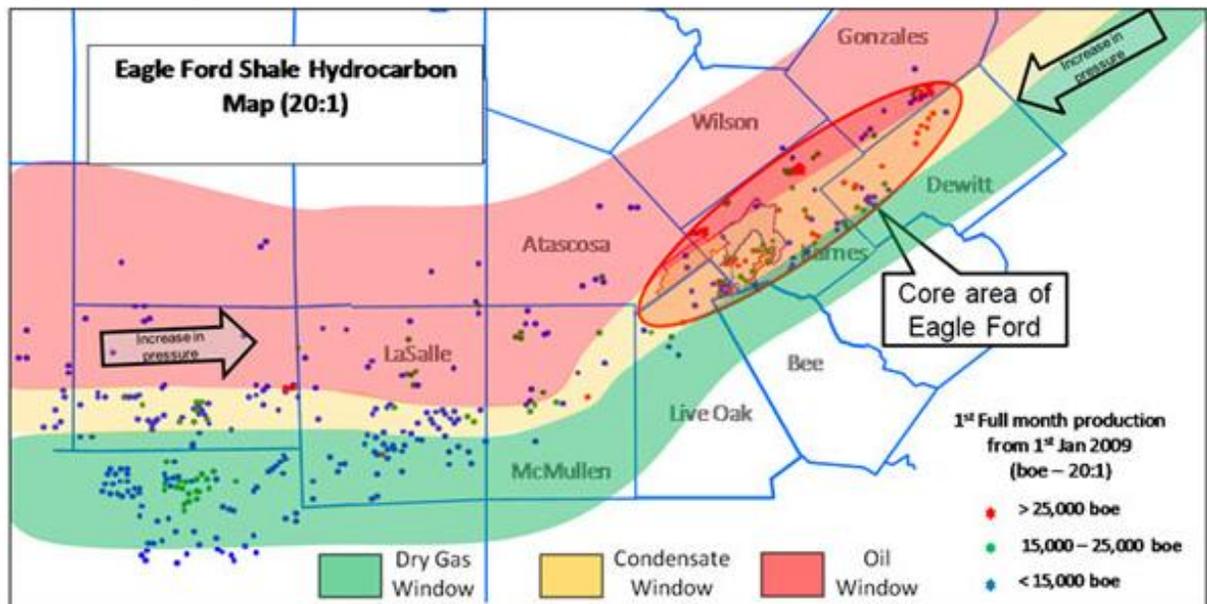
County	1999	2002	2006	2012	2018	2023
Atascosa	19.27	19.07	11.78	10.34	8.12	8.12
Bandera	3.74	2.88	3.00	0.34	0.34	0.34
Bexar	83.91	59.23	39.63	39.06	39.18	32.58
Comal	12.16	11.42	11.52	14.09	14.09	14.09
Guadalupe	0.49	2.82	4.86	2.46	1.72	1.72
Kendall	0.53	0.53	0.51	0.06	0.06	0.06
Medina	0.02	0.00	0.00	0.00	0.00	0.00
Wilson	0.00	0.00	0.00	0.000	0.000	0.00
Total	120.13	95.95	71.30	66.35	63.52	56.92

6 Eagle Ford Shale Oil and Gas Exploration

Existing oil and gas drilling studies for Texas and databases maintained by the Railroad Commission of Texas were used to develop historical emissions inventories for the Eagle Ford Shale. These studies include: Eastern Research Group's (ERG) "Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions", ERG's Drilling Rig Emission Inventory for the State of Texas, and ENVIRON's "An Emission Inventory for Natural Gas Development in the Haynesville Shale and Evaluation of Ozone Impacts".

The core area of Eagle Ford production is centered in Karnes County. This section of the Eagle Ford Shale, which contains the most intensive development and potential for future growth, includes two of the San Antonio-New Braunfels MSA's counties: Atascosa and Wilson. Emissions associated with Eagle Ford oil and gas exploration in Atascosa and Wilson counties are included in the emissions trends.

Figure 6-1: Eagle Ford Shale Hydrocarbon Map⁵⁷



Emissions were calculated for various phases including: exploration and pad construction, drilling, hydraulic fracturing and completion operations, production, and midstream facilities. The on-road emissions associated with the phases listed below are described in more detail in the following sections.

⁵⁷ Aurora Oil & Gas Limited, "Production Results". Available online: <http://auroraoag.com.au/IRM/Company/ShowPage.aspx/PDFs/1320-45194824/QuarterlyUpdateandAppendix5B>. Accessed 07/15/2013.

- Exploration and Pad Construction: Exploration uses vibrator trucks to produce sound waves beneath the surface that are useful in the exploration for oil and natural gas. Construction of the drill pad requires clearing, grubbing, and grading, followed by placement of a base material by construction equipment and trucks. Reserve pits are also usually required at each well pad because the drilling and hydraulic fracturing process uses a large volume of fluid that is circulated through the well and back to the surface.
- Drilling Operation: “Drilling of a new well is typically a two to three week process from start to finish and involves several large diesel-fueled generators.”⁵⁸ Other emission sources related to drilling operations includes construction equipment and trucks to haul supplies, equipment, fluids, and employees.
- Hydraulic Fracturing and Completion Operation: Hydraulic fracturing “is the high pressure injection of water mixed with sand and a variety of chemical additives into the well to fracture the shale and stimulate natural gas production from the well. Fracking operations can last for several weeks and involve many large diesel-fueled generators”⁵⁹ “Once drilling and other well construction activities are finished, a well must be completed in order to begin producing. The completion process requires venting of the well for a sustained period of time to remove mud and other solid debris in the well, to remove any inert gas used to stimulate the well (such as CO₂ and/or N₂) and to bring the gas composition to pipeline grade”.⁶⁰ In the Eagle Ford, vented gas from completion is usually flared.
- Production: Once the product is collected from the well, emissions may be released at well sites from compressors, flares, heaters, and pneumatic devices. There can also be significant emissions from equipment leaks, storage tanks, and loading operations fugitives. Trucks are often used to transport product to processing facilities and refineries; consequently, on-road emissions may be associated with the production phase.
- Midstream Sources: Midstream sources in the Eagle Ford consist mostly of compressor stations and processing facilities, but other sources can include cryogenic plants, saltwater disposal facilities, tank batteries, and other facilities. “The most significant emissions from compressors stations are usually from combustion at the compressor engines or turbines. Other emissions sources may include equipment leaks, storage tanks, glycol dehydrators, flares, and condensate and/or wastewater loading. Processing facilities generally remove impurities from the

⁵⁸ University of Arkansas and Argonne National Laboratory. “Fayetteville Shale Natural Gas: Reducing Environmental Impacts: Site Preparation”. Available online: <http://lingo.cast.uark.edu/LINGOPUBLIC/natgas/siteprep/index.htm>. Accessed 08/2/2013

⁵⁹ *Ibid.*

⁶⁰ Amnon Bar-Ilan, Rajashi Parikh, John Grant, Tejas Shah, Alison K. Pollack, ENVIRON International Corporation. Nov. 13, 2008. “Recommendations for Improvements to the CENRAP States’ Oil and Gas Emissions Inventories”. Novato, CA. p. 48. Available online: http://www.wrapair.org/forums/ogwg/documents/2008-11_CENRAP_O&G_Report_11-13.pdf Accessed 07/30/2013.

natural gas, such as carbon dioxide, water, and hydrogen sulfide. These facilities may also be designed to remove ethane, propane, and butane fractions from the natural gas for downstream marketing. Processing facilities are usually the largest emitting natural gas-related point sources including multiple emission sources such as, but not limited to equipment leaks, storage tanks, separator vents, glycol dehydrators, flares, condensate and wastewater loading, compressors, amine treatment and sulfur recovery units.”⁶¹

6.1 On-Road Emissions Exploration/Pad Construction

On-road emissions associated with gas and oil production in the Eagle Ford Shale originate from heavy duty diesel trucks that carry equipment and light duty trucks that transport employees and supplies to the well pads. Surveys from other regions found between 20 and 75 heavy duty truck trips are required for pad construction, while there was a wide variation in the number of trips by light duty trucks needed during the construction process. ENVIRON provided detailed information on vehicle activity rates, speeds, and idling hours for each trip made during well pad construction in the Piceance Basin of Northwestern Colorado. There were 22.86 trips by heavy duty vehicles and 82.46 trips by light duty trucks to construct each well pad. The study found that idling times by heavy duty trucks was 0.40 hours for each trip and light duty trucks varied between 2.00 and 2.15 idling hours per trip.⁶² TxDOT reported an average of 70 heavy duty truck loads were needed for pad construction in the Barnett shale development.⁶³

A study by New York City’s Department of Environmental Protection on the Marcellus Shale Gas Development found 20 to 40 heavy duty diesel truck trips were needed for pad construction, which was similar to ENVIRON’s survey.⁶⁴ Other studies by Cornell University⁶⁵, the National Park Service⁶⁶, and All Consulting⁶⁷, regarding development of the

⁶¹ Eastern Research Group Inc. July 13, 2011. “Fort Worth Natural Gas Air Quality Study Final Report”. Prepared for City of Fort Worth, Fort Worth, Texas. p. 3-2. Available online: <http://fortworthtexas.gov/gaswells/?id=87074>. Accessed 08/02/2013.

⁶² Amnon Bar-Ilan, John Grant, Rajashi Parikh, Ralph Morris, ENVIRON International Corporation, July 2011. “Oil and Gas Mobile Sources Pilot Study”. Novato, California. pp. 11-12. Available online: [http://www.wrapair2.org/pdf/2011-07_P3%20Study%20Report%20\(Final%20July-2011\).pdf](http://www.wrapair2.org/pdf/2011-07_P3%20Study%20Report%20(Final%20July-2011).pdf). Accessed: 04/12/2012.

⁶³ Richard Schiller, P.E. Fort, Worth District. Aug. 5, 2010. “Barnett Shale Gas Exploration Impact on TxDOT Roadways”. TxDOT, Fort Worth. Slide 15.

⁶⁴ Haxen and Sawyer, Environmental Engineers & Scientists, Sept. 2009. “Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed Rapid Impact Assessment Report”. New York City Department of Environmental Protection. p. 47. Available online: http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/rapid_impact_assessment_091609.pdf. Accessed: 04/20/2012.

⁶⁵ Santoro, R.L.; R.W. Howarth; A.R. Ingraffea. 2011. Indirect Emissions of Carbon Dioxide from Marcellus Shale Gas Development. A Technical Report from the Agriculture, Energy, & Environment Program at Cornell University. June 30, 2011. p. 8. Available online: http://www.eeb.cornell.edu/howarth/IndirectEmissionsofCarbonDioxidefromMarcellusShaleGasDevelopment_June302011%20.pdf. Accessed: 04/02/2012.

⁶⁶ National Park Service U.S. Department of the Interior, Dec. 2008. “Potential Development of the

Marcellus Shale documented similar results for the number of trips by heavy duty trucks. ENVIRON's study of exploration and pad construction at the Southern Ute Indian Reservation reported slightly more activity, with 56 heavy duty truck loads.⁶⁸

With regard to light duty vehicle use, the Pinedale Anticline Project in Wyoming⁶⁹ reported significantly more trips⁷⁰ during the pad construction phase than ENVIRON's survey, while studies about the San Juan Public Lands Center in Colorado⁷¹, Tumbleweed II in Utah⁷², Jonah Infill in Wyoming⁷³ and West Tavaputs Plateau in Utah⁷⁴ found less light duty truck trips compared to ENVIRON's report for the Piceance Basin of Northwestern Colorado. Since data for development in the Eagle Ford Shale area is not available, the number of

Natural Gas Resources in the Marcellus Shale: New York, Pennsylvania, West Virginia, and Ohio". p. 9. Available online: http://www.nps.gov/frhi/parkmgmt/upload/GRD-M-Shale_12-11-2008_high_res.pdf. Accessed: 04/22/2012.

⁶⁷ All Consulting, Sept. 16, 2010. "NY DEC SGEIS Information Requests". Prepared for Independent Oil & Gas Association, Project no.: 1284. Available online: http://catskillcitizens.org/learnmore/20100916IOGAResponsetoDECChesapeake_IOGAResponsetoDEC.pdf. Accessed: 04/16/2012.

⁶⁸ ENVIRON, August 2009. "Programmatic Environmental Assessment for 80 Acre Infill Oil and Gas Development on the Southern Ute Indian Reservation". Novato, California. Appendix A, p. 62. Available online: http://www.suitdoe.com/Documents/Appendix_G_AirQualityTSD.pdf. Accessed: 04/25/2012.

⁶⁹ U.S. Department of the Interior, Bureau of Land Management, Sept. 2008. "Final Supplemental Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project: Pinedale Anticline Project Area Supplemental Environmental Impact Statement". Sheyenne, Wyoming. p. F42. Available online: <http://www.blm.gov/pgdata/etc/medialib/blm/wy/information/NEPA/pfodocs/anticline/rd-seis/tsd.Par.13395.File.dat/07appF.pdf>. Accessed: 04/12/2012.

⁷⁰ U.S. Department of the Interior, Bureau of Land Management, Sept. 2008. "Final Supplemental Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project: Pinedale Anticline Project Area Supplemental Environmental Impact Statement". Sheyenne, Wyoming. pp. F39-F40. Available online: <http://www.blm.gov/pgdata/etc/medialib/blm/wy/information/NEPA/pfodocs/anticline/rd-seis/tsd.Par.13395.File.dat/07appF.pdf>. Accessed: 04/12/2012.

⁷¹ BLM National Operations Center, Division of Resource Services, December, 2007. "San Juan Public Lands Center Draft Land Management Plan & Draft Environmental Impact Statement: Air Quality Impact Assessment Technical Support Document". Bureau of Land Management, San Juan Public Lands Center, Durango, Colorado. p. A-4. Available online: http://ocs.fortlewis.edu/forestplan/DEIS/pdf/120507_TSD&App%20A.pdf. Accessed: 04/03/2012.

⁷² U.S. Department of the Interior, Bureau of Land Management. June 2010. "Tumbleweed II Exploratory Natural Gas Drilling Project". East City, Utah. DOI-BLM-UTG010-2009-0090-EA. p. 12 of 29. Available online: http://www.blm.gov/pgdata/etc/medialib/blm/ut/lands_and_minerals/oil_and_gas/november_2011.Par.24530.File.dat/. Accessed: 04/12/2012.

⁷³ Amnon Bar-Ilan, ENVIRON Corporation, June 2010. "Oil and Gas Mobile Source Emissions Pilot Study: Background Research Report". UNC-EMAQ (3-12)-006.v1. Novato, CA. p. 17. Available online: [http://www.wrapair2.org/documents/2010-06y_WRAP%20P3%20Background%20Literature%20Review%20\(06-06%20REV\).pdf](http://www.wrapair2.org/documents/2010-06y_WRAP%20P3%20Background%20Literature%20Review%20(06-06%20REV).pdf). Accessed: 04/03/2012.

⁷⁴ Buys & Associates, Inc., Sept. 2008. "APPENDIX J: Near-Field Air Quality Technical Support Document for the West Tavaputs Plateau Oil and Gas Producing Region Environmental Impact Statement". Prepared for: Bureau of Land Management Price Field Office Littleton, Colorado. Available online: http://www.blm.gov/ut/st/en/fo/price/energy/Oil_Gas/wtp_final_eis.html. Accessed: 04/20/2012.

trips by vehicle type and the idling time per vehicle trip was based on TxDOT findings for the Barnett shale and ENVIRON's Colorado reports. These reports were selected because the TxDOT report provided data from well pad construction in a similar area in Texas and ENVIRON's report is the only report with specific data on idling rates.

6.2 On-Road Emissions for Drilling

Energy in Depth, a research, education, and outreach program created by the Independent Petroleum Association of America, states that it takes approximately 35-45 semi trucks (10,000 foot well) trips to move and assemble a rig.⁷⁵ This result is very similar to TxDOT's findings that 44 heavy duty trucks are needed to move a rig in the Barnett Shale.⁷⁶ TxDOT also states that an additional 73 heavy duty truck trips are needed to move additional equipment and deliver supplies. The results are similar to most other studies that predicted between 80 and 235 truck trips are needed including Cornell University's report about the Marcellus⁷⁷, Buys & Associates' research in Utah⁷⁸, and Jonah Infill's field study in Wyoming.⁷⁹ The TxDOT report was used because it contains data in Texas from a comparable area.

6.3 On-Road Emissions for Hydraulic Fracturing

Heavy duty trucks are needed to provide equipment, water, sand/proppant, chemicals, and supplies, while trucks are sometimes also needed to remove flowback from the well site. Previous studies found between 15 and 2,100 truck trips are needed during hydraulic fracturing and completion of the well site. Jonah Infill in Wyoming⁸⁰ and NCTCOG⁸¹ found

⁷⁵ Energy in Depth: A coalition led by Independent Petroleum Association of America. Available online: <http://www.energyindepth.org/rig/index.html>. Accessed: 04/18/2012.

⁷⁶ Richard Schiller, P.E. Fort, Worth District. Aug. 5, 2010. "Barnett Shale Gas Exploration Impact on TxDOT Roadways". TxDOT, Fort Worth. Slide 15.

⁷⁷ Santoro, R.L.; R.W. Howarth; A.R. Ingraffea. 2011. Indirect Emissions of Carbon Dioxide from Marcellus Shale Gas Development. A Technical Report from the Agriculture, Energy, & Environment Program at Cornell University. June 30, 2011. p. 8. Available online: http://www.eeb.cornell.edu/howarth/IndirectEmissionsofCarbonDioxidefromMarcellusShaleGasDevelopment_June302011%20.pdf. Accessed: 04/02/2012.

⁷⁸ Buys & Associates, Inc., Sept. 2008. "APPENDIX J: Near-Field Air Quality Technical Support Document for the West Tavaputs Plateau Oil and Gas Producing Region Environmental Impact Statement". Prepared for: Bureau of Land Management Price Field Office Littleton, Colorado. Available online: http://www.blm.gov/ut/st/en/fo/price/energy/Oil_Gas/wtp_final_eis.html. Accessed: 04/20/2012.

⁷⁹ Amnon Bar-Ilan, ENVIRON Corporation, June 2010. "Oil and Gas Mobile Source Emissions Pilot Study: Background Research Report". UNC-EMAQ (3-12)-006.v1. Novato, CA. pp. 17-18. Available online: [http://www.wrapair2.org/documents/2010-06y_WRAP%20P3%20Background%20Literature%20Review%20\(06-06%20REV\).pdf](http://www.wrapair2.org/documents/2010-06y_WRAP%20P3%20Background%20Literature%20Review%20(06-06%20REV).pdf). Accessed: 04/03/2012.

⁸⁰ Amnon Bar-Ilan, ENVIRON Corporation, June 2010. "Oil and Gas Mobile Source Emissions Pilot Study: Background Research Report". UNC-EMAQ (3-12)-006.v1. Novato, CA. p. 17. Available online: [http://www.wrapair2.org/documents/2010-06y_WRAP%20P3%20Background%20Literature%20Review%20\(06-06%20REV\).pdf](http://www.wrapair2.org/documents/2010-06y_WRAP%20P3%20Background%20Literature%20Review%20(06-06%20REV).pdf). Accessed: 04/03/2012.

⁸¹ North Central Texas Council of Governments. "Barnett Shale Truck Traffic Survey". Dallas, Texas. Slide 9. Available online: <http://www.nctcog.org/trans/air/barnettshale.asp>. Accessed 05/04/2012.

between 400 and 440 heavy duty truck trips are needed during hydraulic fracturing. A Cornell University report determined that 790 heavy duty truck trips were made in the Marcellus during the fracturing process.⁸² These results are similar to All Consulting's vehicle count of 868 heavy duty trucks⁸³ and the National Park Service's average of 695 heavy duty truck trips in the Marcellus.⁸⁴

Data from TxDOT's study of the Barnett Shale indicating use of 807 heavy duty truck trips during facturing, was used for calculating fracturing-related on-road emissions in the Eagle Ford. When calculating truck trips, TxDOT assumed that 50% of the freshwater used during the fracturing process was provided by pipeline. This is similar to operations conducted by some companies in the Eagle Ford. For example, Rosetta Resources, one of the companies operating in the Eagle Ford, "has built water gathering pipelines to eliminate the need to truck water to the fracturing crew."⁸⁵

The number of trips made with light duty vehicles during the fracturing process ranged from 30 found in the San Juan Public Lands Center study in Colorado⁸⁶ to All Consulting's estimation of 461 in the Marcellus. Most of the studies found approximately 140 light duty vehicle trips were needed including ENVIRON's Southern Ute⁸⁷ and Buys & Associates' research in Utah.⁸⁸ To calculate on-road vehicle emissions associated with fracturing

⁸² Santoro, R.L.; R.W. Howarth; A.R. Ingraffea. 2011. Indirect Emissions of Carbon Dioxide from Marcellus Shale Gas Development. A Technical Report from the Agriculture, Energy, & Environment Program at Cornell University. June 30, 2011. p. 8. Available online: http://www.eeb.cornell.edu/howarth/IndirectEmissionsofCarbonDioxidefromMarcellusShaleGasDevelopment_June302011%20.pdf. Accessed: 04/02/2012.

⁸³ All Consulting, Sept. 16, 2010. "NY DEC SGEIS Information Requests". Prepared for Independent Oil & Gas Association, Project no.: 1284. Available online: http://catskillcitizens.org/learnmore/20100916IOGAResponsetoDECChesapeake_IOGAResponsetoDEC.pdf. Accessed: 04/16/2012.

⁸⁴ National Park Service U.S. Department of the Interior, Dec. 2008. "Potential Development of the Natural Gas Resources in the Marcellus Shale: New York, Pennsylvania, West Virginia, and Ohio". p. 9. Available online: http://www.nps.gov/frhi/parkmgmt/upload/GRD-M-Shale_12-11-2008_high_res.pdf. Accessed: 04/22/2012.

⁸⁵ Colter Cookson. June, 2011. "Operators Converge On Eagle Ford's Oil and Liquids-Rich Gas". The American Oil and Gas Reporter. p. 3. Available online: <http://www.laredoenergy.com/sites/default/files/0611LaredoEnergyEprint.pdf>. Accessed: 04/12/2012.

⁸⁶ BLM National Operations Center, Division of Resource Services, December, 2007. "San Juan Public Lands Center Draft Land Management Plan & Draft Environmental Impact Statement: Air Quality Impact Assessment Technical Support Document". Bureau of Land Management, San Juan Public Lands Center, Durango, Colorado. p. A-9. Available online: http://ocs.fortlewis.edu/forestplan/DEIS/pdf/120507_TSD&App%20A.pdf. Accessed: 04/03/2012.

⁸⁷ ENVIRON, August 2009. "Programmatic Environmental Assessment for 80 Acre Infill Oil and Gas Development on the Southern Ute Indian Reservation". Novato, California. Appendix A, p. 68. Available online: http://www.suitdoe.com/Documents/Appendix_G_AirQualityTSD.pdf. Accessed: 04/25/2012.

⁸⁸ Buys & Associates, Inc., Sept. 2008. "APPENDIX J: Near-Field Air Quality Technical Support Document for the West Tavaputs Plateau Oil and Gas Producing Region Environmental Impact Statement". Prepared for: Bureau of Land Management Price Field Office Littleton, Colorado. Available online: http://www.blm.gov/ut/st/en/fo/price/energy/Oil_Gas/wtp_final_eis.html. Accessed: 04/20/2012.

activities in the Eagle Ford, the number of light duty vehicles and idling rates per trip were based on ENVIRON's survey in the Piceance Basin of Northwestern Colorado.⁸⁹ This report contains the most comprehensive data on vehicles used for hydraulic fracturing and there was very little data available in Texas.

6.4 On-Road Emissions for Production Phase

Documentation on annual truck traffic per well pad during the production phase varies widely: from 2 - 3 trucks per year according to New York City's study of the Marcellus⁹⁰ to 365 trucks per year as reported by the BLM for the Pinedale Anticline Project in Wyoming.⁹¹ Cornell University estimated only 15 truck trips per well pad in the Marcellus,⁹² while San Juan Public Lands Center estimated the use of 158 truck trips in Colorado.⁹³

For light duty vehicle use during production, the Tumble-weed II study in Utah reported 365 vehicles annually,⁹⁴ while Jonah Infill in Wyoming stated that there were 122 light duty vehicles used during production.⁹⁵ Data from ENVIRON's report in the Piceance Basin of

⁸⁹ Amnon Bar-Ilan, John Grant, Rajashi Parikh, Ralph Morris, ENVIRON International Corporation, July 2011. "Oil and Gas Mobile Sources Pilot Study". Novato, California. p. 11. Available online: [http://www.wrapair2.org/documents/2011-07_P3%20Study%20Report%20\(Final%20July-2011\).pdf](http://www.wrapair2.org/documents/2011-07_P3%20Study%20Report%20(Final%20July-2011).pdf). Accessed: 04/12/2012.

⁹⁰ Haxen and Sawyer, Environmental Engineers & Scientists, Sept. 2009. "Impact Assessment of Natural Gas Production in the New York City Water Supply Watershed Rapid Impact Assessment Report" New York City Department of Environmental Protection. p. 47. Available online: http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/rapid_impact_assessment_091609.pdf. Accessed: 04/20/2012.

⁹¹ U.S. Department of the Interior, Bureau of Land Management, Sept. 2008. "Final Supplemental Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project: Pinedale Anticline Project Area Supplemental Environmental Impact Statement". Sheyenne, Wyoming. pp. F51-52. Available online: <http://www.blm.gov/pgdata/etc/medialib/blm/wy/information/NEPA/pfodocs/anticline/rd-seis/tsd.Par.13395.File.dat/07appF.pdf>. Accessed: 04/12/2012.

⁹² Santoro, R.L.; R.W. Howarth; A.R. Ingraffea. 2011. Indirect Emissions of Carbon Dioxide from Marcellus Shale Gas Development. A Technical Report from the Agriculture, Energy, & Environment Program at Cornell University. June 30, 2011. Available online: http://www.eeb.cornell.edu/howarth/IndirectEmissionsofCarbonDioxidefromMarcellusShaleGasDevelopment_June302011%20.pdf Accessed: 04/02/2012.

⁹³ BLM National Operations Center, Division of Resource Services, December, 2007. "San Juan Public Lands Center Draft Land Management Plan & Draft Environmental Impact Statement: Air Quality Impact Assessment Technical Support Document". Bureau of Land Management, San Juan Public Lands Center, Durango, Colorado. p. A-16. Available online: http://ocs.fortlewis.edu/forestplan/DEIS/pdf/120507_TSD&App%20A.pdf. Accessed: 04/03/2012.

⁹⁴ U.S. Department of the Interior, Bureau of Land Management. June 2010. "Tumbleweed II Exploratory Natural Gas Drilling Project". East City, Utah. DOI-BLM-UTG010-2009-0090-EA. p. 24 of 29. Available online: http://www.blm.gov/pgdata/etc/medialib/blm/ut/lands_and_minerals/oil_and_gas/november_2011.Par.24530.File.dat/. Accessed: 04/12/2012.

⁹⁵ Amnon Bar-Ilan, ENVIRON Corporation, June 2010. "Oil and Gas Mobile Source Emissions Pilot Study: Background Research Report". UNC-EMAQ (3-12)-006.v1. Novato, CA. p. 18. Available online: [http://www.wrapair2.org/documents/2010-06y_WRAP%20P3%20Background%20Literature%20Review%20\(06-06%20REV\).pdf](http://www.wrapair2.org/documents/2010-06y_WRAP%20P3%20Background%20Literature%20Review%20(06-06%20REV).pdf). Accessed: 04/03/2012.

Northwestern Colorado, 73.2 light duty vehicles trips annually per pad site, was used to estimate emissions from light duty vehicles during well production in the Eagle Ford. ENVIRON's report was the only study that had detailed light duty vehicle counts and idling hours.

TxDOT's estimation of 353 heavy duty truck trips per year for each well in the Barnett Shale was used to calculate heavy duty truck emissions from production in the Eagle Ford.⁹⁶ The TxDOT report was used because it contains data in Texas from a comparable area. The number of trucks provided by TxDOT match very closely to Chesapeake Energy's statement that there is one truck per well pad per day during production.⁹⁷ Data on idling rates from the ENVIRON report was used to estimate idling emissions. In the report, ENVIRON estimated that heavy duty trucks idle between 0.9 hours to 3 hours, while light duty vehicles idle approximately 2.5 hours per trip.⁹⁸

A survey of 66 wells in the Eagle Ford found that almost all oil and condensate was transported by truck. Condensate was transported by pipeline at only three wells and no oil was transported by pipeline.⁹⁹ Over time, the number of trips by trucks will decrease during production as the number of pipelines to haul product increases in the Eagle Ford. However, many of the wells will remain unconnected to the pipelines. Also, the number of truck trips will decrease over time due to steep liquid decline curves at wells in the Eagle Ford. As the well ages, production will significantly decline and fewer truck visits will be needed for each well. The parameters used to calculate on-road emissions for each stage of oil and gas production in the Eagle Ford are provided in Table 6-1.

⁹⁶ Richard Schiller, P.E. Fort, Worth District. Aug. 5, 2010. "Barnett Shale Gas Exploration Impact on TxDOT Roadways". TxDOT, Fort Worth. Slide 18.

⁹⁷ Chesapeake Energy Corporation, 2012. "Part 1 – Drilling". Available online: <http://www.askchesapeake.com/Barnett-Shale/Multimedia/Educational-Videos/Pages/Information.aspx>. Accessed: 04/22/2012.

⁹⁸ Amnon Bar-Ilan, John Grant, Rajashi Parikh, Ralph Morris, ENVIRON International Corporation, July 2011. "Oil and Gas Mobile Sources Pilot Study". Novato, California. pp. 11-12. Available online: [http://www.wrapair2.org/documents/2011-07_P3%20Study%20Report%20\(Final%20July-2011\).pdf](http://www.wrapair2.org/documents/2011-07_P3%20Study%20Report%20(Final%20July-2011).pdf). Accessed: 04/12/2012.

⁹⁹ Railroad Commission of Texas. "Specific Lease Query". Austin, Texas. Available online: <http://webapps.rrc.state.tx.us/PDQ/quickLeaseReportBuilderAction.do>. Accessed 06/01/2012.

Table 6-1: Eagle Ford Shale Parameters and Pertaining Phases for Estimate of On-Road Vehicle Emissions

Vehicle Type	Parameter	Well Pad Construction	Drilling	Hydraulic Fracturing and Completion	Production
Heavy Duty Diesel Trucks (HDDV)	Number per pad	70	187	807	353 per year
	Distance (miles)	50	50	50	22
	Speed (mph)	35	35	35	35
	Idling Hours per Trip	0.4	0.7	1.1	0.9
Light Duty Trucks (LDT)	Number per pad	12.86 (Construction) 69.60 (Employees)	68.1 (Rig and Eq.), 66 (Employees)	41 (Eq. and Supplies), 86.7 (Employees)	68.5 (Production), 4.7 (Maintenance)
	Distance (miles)	To the nearest Town	To the nearest Town	To the nearest Town	To the nearest Town
	Speed (mph)	35	35	35	35
	Idling Hours/Trip	2.00 (Eq. and supplies), 2.15 (Employees)	1.55 (Rig and Eq.), 2.1 (Employees)	2.0 (Eq. and Supplies), 2.1 (Employees)	2.5 (Production), 2.55 (Maintenance)

6.5 On-Road Vehicle Emission Factors

Emission factors for light duty trucks were obtained from the EPA's MOVES 2010b model for categories of gasoline and diesel passenger trucks and light commercial trucks (Table 6-2).¹⁰⁰ For heavy duty trucks, the MOVES model's emissions factors for diesel combination short haul trucks were used. The combination short-haul trucks are classified in MOVES as trucks that are primarily operated within 200 miles of home base.¹⁰¹ Similar to the Pinedale Anticline Project in Wyoming, an average speed of 35 miles per hour was used for both vehicle types because the 25 mph speed used in other studies was considered too slow for a typical rural area in the Eagle Ford. Idling emission factors for heavy duty trucks and light duty trucks were obtained from the EPA.¹⁰²

Table 6-2: Ozone Season Day Emission Factors for On-Road Vehicles in Eagle Ford Counties

Vehicle Type	2012		2018		2023	
	VOC	NO _x	VOC	NO _x	VOC	NO _x
Heavy Duty Truck Exhaust(g/mil)	0.45	8.43	0.37	3.73	0.15	2.04
Heavy Duty Truck Idling(g/hour)	40.64	177.11	29.88	170.98	25.28	168.29
Light Duty Truck Exhaust(g/mil)	1.00	1.55	0.62	0.97	0.45	0.70
Light Duty Truck Idling(g/mil)	4.09	11.11	4.092	11.11	4.09	11.11

The on-road VOC and NO_x exhaust and idling emissions for vehicles were calculated using the formulas described below. The various parameters of these formulas come from collected local data, the MOVES 2010b model's emission factors, TxDOT's databases, and data from the survey conducted by ENVIRON in Colorado. Heavy duty vehicle trip lengths were set at 50 miles, since this is similar to data collected by NCTCOG.¹⁰³ Average distance to the nearest town, which is maintained by the Railroad Commission of Texas, was used as an approximation of the traveling distance for light duty vehicle trips because resources and housing are usually located in these nearby towns.

¹⁰⁰ Office of Transportation and Air Quality, August 2010. "MOVES". U.S. Environmental Protection Agency, Washington, DC. Available online: <http://www.epa.gov/otaq/models/moves/index.htm>. Accessed 07/12/2013.

¹⁰¹ John Koupal, Mitch Cumberworth, and Megan Beardsley, June 9, 2004. "Introducing MOVES2004, the initial release of EPA's new generation mobile source emission model". U.S. EPA Office of Transportation and Air Quality, Assessment and Standards Division. Ann Arbor, MI. Available online: <http://www.epa.gov/ttn/chief/conference/ei13/ghg/koupal.pdf>. Accessed 07/12/2013.

¹⁰² Brzezinski, Office of Transportation and Air Quality, U.S. Environmental Protection Agency, Washington, DC, e-mail dated 05/19/2012.

¹⁰³ Lori Clark, Shannon Stevenson, and Chris Klaus North Central Texas Council of Governments, August 2012. "Development of Oil and Gas Mobile Source Inventory in the Barnett Shale in the 12-County Dallas-Fort Worth Area". Arlington, Texas. Texas Commission on Environmental Quality Grant Number: 582-11-13174. pp. 11, 13. Available online: <http://www.nctcog.org/trans/air/barnettshale.asp>. Accessed 07/12/2013.

NO_x emission reductions from the use of TxLED diesel fuel were taken into account for calculating the on-road emissions. According to TCEQ, “TxLED requirements are intended to result in reductions in NO_x emissions from diesel engines. Currently, reduction factors of 5.7% (0.057) for on-road use and 7.0% (0.07) for non-road use have been accepted as a NO_x reduction estimate resulting from use of TxLED fuel. However, this reduction estimate is subject to change, based on the standards accepted by the EPA for use in the Texas State Implementation Plan (SIP).”¹⁰⁴

Equation 6-1, Ozone season day on-road emissions during pad construction

$$E_{\text{pad,road,ABC}} = \text{NUM}_{\text{BC}} \times \text{TRIPS}_{\text{A,TXDOT}} \times (\text{DIST}_{\text{B,RCC}} \times 2) \times (1 - \text{TxLED}_{\text{TCEQ}}) \times \text{OEF}_{\text{A,MOVES}} / \text{WPAD}_{\text{B,RCC}} / 907,184.74 \text{ grams per ton} / 365 \text{ days/year}$$

Where,

- $E_{\text{pad,road,ABC}}$ = Ozone season day NO_x or VOC emissions from type A on-road vehicles in county B for Eagle Ford development type C wells (Gas or Oil)
- NUM_{BC} = Annual number of wells drilled in county B for Eagle Ford development type C wells (from Schlumberger Limited)
- $\text{TRIPS}_{\text{A,TXDOT}}$ = Annual number of trips for vehicle type A per pad, 70 for heavy duty trucks (from TxDOT 's Barnett report) and 82.46 for light duty trucks in Table 6-1 (from ENVIRON's Colorado report)
- $\text{DIST}_{\text{B,RCC}}$ = Distance, 25 miles (25 miles one way, 50 miles per round trip) for heavy duty trucks and to the nearest town for light duty vehicles in county B (from Railroad Commission of Texas)
- $\text{TxLED}_{\text{TCEQ}}$ = On-road emission reductions from TxLED, 0.057 for NO_x from Heavy Duty Diesel Trucks, 0.0 for VOC, and 0.0 for Gasoline Light Duty Vehicles (from TCEQ)
- $\text{OEF}_{\text{A,MOVES}}$ = NO_x or VOC on-road emission factor for vehicle type A in Table 6-2 (from MOVES2010b Model)
- $\text{WPAD}_{\text{B,RCC}}$ = Number of wells per pad for county B (calculated from data provided by the Railroad Commission of Texas)

Sample Equation: 2012 Wilson County NO_x emissions for Heavy Duty Truck Exhaust during the construction of oil well pads

$$E_{\text{pad,road,ABC}} = 62 \text{ oil wells} \times 70 \text{ trips} \times (25 \text{ miles} \times 2) \times (1 - 0.057) \times 8.43 \text{ g/mile} / 1.1 \text{ wells per well pad} / 907,184.74 \text{ grams per ton} / 365 \text{ days/year}$$

$$= 0.005 \text{ tons of NO}_x \text{ per day from heavy duty truck exhaust in Wilson County during the construction of oil well pads}$$

¹⁰⁴ TCEQ, July 24, 2012. “Texas Emissions Reduction Plan (TERP) Emissions Reduction Incentive Grants Program”. Austin, Texas. Available online: http://www.tceq.texas.gov/assets/public/implementation/air/terp/techsup/2012onvehicle_ts.pdf. Accessed 8/27/2013.

Equation 6-2, Ozone season day idling emissions during pad construction

$$E_{\text{pad.idling.ABC}} = \text{NUM}_{\text{BC}} \times \text{TRIPS}_{\text{A.TXDOT}} \times \text{IDLE}_{\text{A}} \times (1 - \text{TxDLED}_{\text{TCEQ}}) \times \text{IEF}_{\text{A.EPA}} / \text{WPAD}_{\text{BC.RCC}} / 907,184.74 \text{ grams per ton} / 365 \text{ days/year}$$

Where,

- $E_{\text{pad.idling.ABC}}$ = Ozone season day NO_x or VOC emissions from idling vehicles in county B for Eagle Ford development type C wells (Gas or Oil)
- NUM_{BC} = Annual number of wells drilled in county B for Eagle Ford development type C wells (from Schlumberger Limited)
- $\text{TRIPS}_{\text{A.TXDOT}}$ = Annual number of trips for vehicle type A per pad, 70 for heavy duty trucks (from TxDOT 's Barnett report), 12.86 for light duty trucks for equipment, and 69.6 light duty trucks for employees in Table 6-1 (from ENVIRON's Colorado report)
- IDLE_{A} = Number of idling hours/trip for vehicle type A, 0.4 hours for heavy duty trucks, 2.0 for light duty trucks for equipment, and 2.15 light duty trucks for employees (from ENVIRON's Colorado report)
- $\text{TxDLED}_{\text{TCEQ}}$ = On-road emission reductions from TxDLED, 0.057 for NO_x from Heavy Duty Diesel Trucks, 0.0 for VOC, and 0.0 for Gasoline Light Duty Vehicles (from TCEQ)
- $\text{IEF}_{\text{A.EPA}}$ = NO_x or VOC idling emission factor for vehicle type A in Table 6-2 (from EPA based on the MOVES model)
- $\text{WPAD}_{\text{B.RCC}}$ = Number of wells per pad for county B (calculated from data provided by the Railroad Commission of Texas)

Sample Equation: 2012 NO_x emissions from Heavy Duty Truck Idling in Wilson County during the construction of oil well pads

$$E_{\text{pad.road.ABC}} = 62 \text{ oil wells} \times 70 \text{ trips} \times 0.4 \text{ hours idling} \times (1 - 0.057) \times 177.11 \text{ g/hour} / 1.1 \text{ wells per well pad} / 907,184.74 \text{ grams per ton} / 365 \text{ days/year}$$

$$= 0.001 \text{ tons of NO}_x \text{ per day from heavy duty truck idling in Wilson County during the construction of oil well pads}$$

6.6 Non-Road and Area Source Emissions in the Eagle Ford

Emissions associated with area sources and non-road equipment in the Eagle Ford were calculated using local industry data, emission factors from the TexN model, manufacturers' information, TCEQ, and the results of surveys conducted by the Texas Center for Applied Technology (TCAT). Existing data in the TexN Model was used to calculate emission factors for non-road equipment, although default horsepower ratings were replaced with horsepower inputs that matched equipment used in the Eagle Ford. Counts of drill rigs operating in the Eagle Ford and number of wells drilled were provided by Schlumberger Limited.¹⁰⁵ Similarly, well characteristics and production data were collected from Schlumberger and the Railroad Commission of Texas¹⁰⁶. The following equation was used to calculate emissions from non-road equipment

¹⁰⁵ Schlumberger Limited. "STATS Rig Count History". Available online: <http://stats.smith.com/new/history/statshistory.htm>. Accessed: 04/21/2012.

¹⁰⁶ Railroad Commission of Texas, April 3, 2012. "Eagle Ford Information". Austin, Texas. Available online <http://www.rrc.state.tx.us/eagleford/index.php>. Accessed: 05/01/2012.

Equation 6-3, Ozone season day seismic trucks emissions

$$E_{\text{Seismic.BC}} = (\text{NUM}_{\text{BC}} / \text{WPAD}_{\text{B}}) \times \text{POP} \times \text{HP} \times \text{HRS} \times \text{LF}_{\text{TexN}} \times \text{EF}_{\text{TexN}} / 907,184.74 \text{ grams per ton} / 365 \text{ days/year}$$

Where,

- $E_{\text{Seismic.BC}}$ = Ozone season day NO_x or VOC emissions from seismic trucks in county B for Eagle Ford development type C wells (gas or oil)
- NUM_{BC} = Annual number of wells drilled in county B for Eagle Ford development type C wells, (from Schlumberger Limited)
- WPAD_{B} = Number of wells per pad for county B, (calculated from data provided by the Railroad Commission of Texas)
- POP = Number of seismic trucks, 3 (from Marathon Oil Corporation in the Eagle Ford)
- HP = Average horsepower seismic trucks, 400hp (based on average hp of seismic trucks from Equipment Manufactures)
- HRS = Hours per pad construction, 2 hours per well pad (from Marathon Oil Corporation in the Eagle Ford)
- LF_{TexN} = Load factor for off road trucks, 0.59 (from TexN Model)
- EF_{TexN} = Emission factor for off road trucks, 2.23 g/hp-hr for NO_x , 0.176 g/hp-hr for VOC (from TexN Model)

Sample Equation: 2012 NO_x emissions from seismic trucks in Wilson County for Oil Wells

$$E_{\text{Pad.ABC}} = (62 \text{ oil wells} / 1.1 \text{ wells per well pad}) \times 3 \text{ trucks} \times 634 \text{ hp} \times 2 \text{ hours} \times 0.43 \times 2.23 \text{ grams of } \text{NO}_x/\text{hp-hr} / 907,184.74 \text{ grams per ton} / 365 \text{ days/year} \\ = 0.001 \text{ tons of } \text{NO}_x/\text{day from seismic trucks in Wilson County for Oil Wells}$$

6.7 2023 Projected Emission Data

VOC and NO_x emissions were projected using the latest information extracted from published studies, local data, and regional data. Projections of future activities in the Eagle Ford were completed using a methodology similar to what ENVIRON used in development of the Haynesville Shale emission inventory, which was based on three growth scenarios: low development, moderate development, and high development.¹⁰⁷ The Eagle Ford moderate growth scenario was used for 2018. For the year 2023, input data such as number of wells, equipment population, HP, hours, and load factor from the 2018 moderate growth scenario were used with growth factors from the TexN model, EPA, and TCEQ to calculate emissions in 2023.

6.8 Eagle Ford Emissions Summary

Emissions from the various oil and gas exploration phases described above were calculated based on emission factors for each piece of equipment, projected level of activities associated with number of wells that will be drilled, and the productivity level of these wells. The calculated emissions are shown in the Table 6-3.

¹⁰⁷ John Grant, Lynsey Parker, Amnon Bar-Ilan, Sue Kembal-Cook, and Greg Yarwood, ENVIRON International Corporation. August 31, 2009. "Development of an Emission Inventory for Natural Gas Exploration and Production in the Haynesville Shale and Evaluation of Ozone Impacts". Novato, CA. p. 13. Available online: http://www.netac.org/UserFiles/File/NETAC/9_29_09/Enclosure_2b.pdf. Accessed: 04/19/2012.

Table 6-3: Eagle Ford Shale Emissions within San Antonio-New Braunfels MSA, ton/day

County	Operation Phase	2012		2018		2023	
		VOC	NO _x	VOC	NO _x	VOC	NO _x
Atascosa	Exploration/Pad Construction	0.003	0.033	0.002	0.015	0.002	0.010
	Drilling	0.057	0.951	0.038	0.373	0.032	0.125
	Hydraulic Fracturing	0.051	0.664	0.040	0.229	0.036	0.205
	Production	1.073	0.383	3.304	1.267	3.298	1.238
	Midstream	0.826	0.467	1.446	0.941	1.446	0.941
Wilson	Exploration/Pad Construction	0.002	0.023	0.002	0.010	0.001	0.007
	Drilling	0.034	0.566	0.023	0.221	0.019	0.075
	Hydraulic Fracturing	0.036	0.455	0.028	0.161	0.025	0.141
	Production	0.416	0.134	1.560	0.521	1.556	0.504
	Midstream	0.567	0.176	0.994	0.355	0.994	0.355
TOTAL		3.067	3.853	7.437	4.092	7.411	3.602

7 On-Road Source Emissions

On-road source emissions are produced during the operation of vehicles on urban and rural roadway networks. Due to the significantly adverse contribution of on-road sources to air quality, these emissions are regulated by the EPA and subject to certain standards. The on-road emissions for all 254 counties within the state of Texas are regularly estimated by the Texas Transportation Institute (TTI). TTI utilizes vehicle miles traveled (VMT) data, compiled by the Texas Department of Transportation (TxDOT), to estimate “link-based” and “virtual-link-based” hourly emissions. The “virtual-link-based” network is based on the Highway Performance Monitoring System (HPMS) road network. The results are used both in the transportation conformity determination process and mobile source inventory development in support of the Federal Clean Air Act¹⁰⁸.

In developing the current trend analysis, TTI’s latest trend emission inventories report for all of the 254 counties within the state of Texas was used. Published in July 2011, this report gives an account of HPMS-based annual on-road emissions, as well as summer weekday emissions, and covers the time period from 1990 through 2030.¹⁰⁹

“To capture the effects of the early control programs implemented in response to the CAA of 1990, the trends inventories begin with analysis year 1990. To capture the substantial effects of fleet turnover to the newest federal motor vehicle control program new vehicle certification standards, the trend inventories were developed through the year 2030. Because the trend inventories may be used for many purposes, trend inventories were developed for every Texas County, for all analysis years from 1990 through 2030, and included estimates for both summer day and annual emissions. Because MOVES does not allow the years 1991 through 1998 to be analyzed, those years were not included in the trend inventories.”¹¹⁰

TTI used county-based historical TxDOT VMT data to forecast future years’ emissions using U.S. Census population statistics and projections and a methodology consistent with current practice for virtual link applications. These on-road mobile source emissions estimates are sufficient to assess general trends for all 254 Texas counties, for 1990 and each year from 1999 through 2030. Emissions from MOVES gasoline and diesel source use types (SUT), shown in Table 7-1,¹¹¹ were estimated. The annual emissions for each analysis year were calculated

¹⁰⁸ TCEQ, July 2011. “On-Road, Mobile Source Trend Emissions Inventories for All 254 Counties in Texas for 1999 – 2030”. TTI, College Station, Texas. p. 1.

¹⁰⁹ *Ibid.*

¹¹⁰ *Ibid.* p.2.

¹¹¹ TTI, July 2011. “Production of Statewide Non-Link-Based, On-Road Emissions Inventories with the Moves Model for the Eight-Hour Ozone Standard Attainment Demonstration Modeling”. College Station,

using the annual emissions factors, the county-level annual VMT, and the annual off network activity.

Table 7-1: MOVES2010a Source Use Type

Source Use Type Description	Source Use Type ID	Source Use Type Abbreviation
Motorcycle	11	MC
Passenger Car	21	PC
Passenger Truck	31	PT
Light Commercial Truck	32	LCT
Intercity Bus	41	IBus
Transit Bus	42	TBus
School Bus	43	SBus
Refuse Truck	51	RT
Single Unit Short-Haul Truck	52	SUSHT
Single Unit Long-Haul Truck	53	SULHT
Motor Home	54	MH
Combination Short-Haul Truck	61	CShT
Combination Long-Haul Truck	62	CLHT

7.1 Emissions Calculations

For calculating on-road emissions relative to San Antonio-New Braunfels MSA the following were taken into account by TTI:

- “The ozone season daily activity level day type of Monday through Friday was used.
- Used temperature and humidity input provided by TCEQ
- Age distributions input for historical and future years were based on available and suitable local vehicle registration data in conjunction with MOVES default age distributions as needed.
- Modeled the effects of all the federal motor vehicle control programs that are included as defaults in the MOVES model.
- Modeled federally regulated gasoline and diesel sulfur levels.
- VMT by county was forecast for future years using historical TxDOT VMT data and U.S. Census population statistics and projections, consistent with the current practice for virtual-link applications.
- Post-processed the diesel vehicle NO_x emissions factors to account for the TexLED program, consistent with Sections 114.312-114.319 of the TCEQ rules. NO_x adjustment factors were developed by TTI using reductions of 4.8 percent for 2002-and-newer model year vehicles, and 6.2 percent for 2001-and-older model-year vehicles.”¹¹²

Texas. College Station, Texas. pp. 7-8. Available online: ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/reports/. Accessed 07/05/13.

¹¹² *Ibid.* p. 3.

7.2 Estimation of Vehicle Miles Traveled

“The county annual VMT control total estimates were developed using the county AADT VMT estimates. Since these estimates are for an average day (i.e., annual average daily traffic), the county annual VMT control estimates were calculated by multiplying the county AADT VMT estimates by 365.”¹¹³

7.3 Estimation of Vehicle Population

“For the analysis years where actual TxDOT registration data exists (analysis years 2002 through 2010), the vehicle population estimates are based on the TxDOT registration data for the analysis year. For the future analysis years where TxDOT registration data does not exist (analysis years 2011 through 2030), the vehicle population is based on the most recent year (2010) TxDOT registration data set and a population scaling factor is applied to estimate the future year vehicle population estimate. Since the TxDOT registration data was not available for those years prior to 2002, the vehicle population estimates for analysis years 1990 and 1999 through 2001 were calculated as future years using the 2002 TxDOT registration data.”¹¹⁴ “To estimate the future analysis year county-level vehicle population, future year county-level vehicle population scaling factors were applied to the base SUT/fuel type population for 2010.”¹¹⁵

7.4 Highway Diesel

“The highway diesel fuel controls implemented during the trend analysis period are the initial and subsequent federal requirements limiting sulfur content and the TxLED program, which changes specifications of conventional diesel to reduce NO_x emissions. The typical pre-regulated diesel fuel used in motor vehicles was 3,000 ppm. In October 1993, federal highway diesel fuel sulfur content was limited to 500 ppm. This limit was in effect until 2006, when the limit on sulfur content of highway diesel was reduced to 15 ppm. The TxLED fuel was implemented in October 2005.”¹¹⁶ Diesel vehicle NO_x emissions factors were post-processed. “For TxLED counties, the modeled NO_x reductions beginning in late 2005 are within the range of 4.8 to 6.2 percent, diminishing to a constant 4.8 percent for 2026 and later, based on EPA’s best estimate of TxLED NO_x reductions.”¹¹⁷ In the San Antonio-New Braunfels MSA, Atascosa, Bexar, Comal, Guadalupe, and Wilson counties are subject to the low RVP and TxLED rules.

7.5 Heavy Duty Trucks Extended Idling

The Department of Transportation requires rest of 10 hours after every 11 hours driving for property-carrying commercial motor vehicle drivers. Since IH-35, IH-10, and other major

¹¹³ *Ibid.* p. 14.

¹¹⁴ *Ibid.* p. 15.

¹¹⁵ *Ibid.* p. 18.

¹¹⁶ *Ibid.* p. 34.

¹¹⁷ *Ibid.* p. 35.

highways converge in San Antonio, truck drivers frequently use truck stops, rest areas, picnic areas, and other facilities in the San Antonio area to comply with the mandatory rest breaks. Some truck drivers idle their engines throughout their rest periods to provide electricity for cooling and heating their cabins, or to keep their engine fluids warm.

Locations where long haul trucks idle their engines in the San Antonio-New Braunfels MSA were identified and surveyed. Table 7-2 shows estimated daily truck idling emissions for each county. Because no idling trucks were observed in Bandera and Wilson counties, nor do they have large facilities where trucks idle, no idling emissions were calculated for these counties. The EPA's MOVES 2010b model's idling emission factors that were used and the results of this survey are explained in detail in Appendix B.

Table 7-2: Truck Idling Emissions Trend for San Antonio-New Braunfels MSA, tons/day

County	1999		2002		2006		2012		2018		2023	
	NO _x	VOC										
Atascosa	0.12	0.03	0.12	0.03	0.12	0.03	0.09	0.02	0.09	0.02	0.09	0.02
Bexar	1.52	0.40	1.55	0.39	1.57	0.40	1.23	0.28	1.19	0.31	1.17	0.30
Comal	0.42	0.11	0.43	0.11	0.43	0.11	0.34	0.08	0.33	0.08	0.32	0.08
Guadalupe	0.15	0.04	0.15	0.04	0.15	0.04	0.12	0.03	0.12	0.03	0.11	0.03
Kendall	0.05	0.01	0.05	0.01	0.05	0.01	0.04	0.01	0.04	0.01	0.04	0.01
Medina	0.08	0.02	0.09	0.02	0.09	0.02	0.07	0.02	0.07	0.02	0.07	0.02
Total	2.33	0.61	2.39	0.60	2.42	0.62	1.90	0.43	1.83	0.47	1.80	0.46

7.6 Total On-road Emission Summary

TTI's emissions results for the years 1999, 2002, 2006, 2012, 2018, and 2023 were added to the truck idling emissions to determine total emissions from on-road vehicles. The data is shown in Table 7-3 and Table 7-4. Notice significant decreases in VOC and NO_x emissions from 1999 to 2023, as on-road control strategies become fully effective and older vehicles are replaced with newer vehicles. Between 1999 and 2023, VOC emissions are expected to decrease by 49.63 tons per day, whereas NO_x emissions are expected to decrease by 154.29 tons per day. In light of population and economic increases in the region, these emission reductions are significant.

Table 7-3: Weekday On-road VOC Emission for San Antonio-New Braunfels MSA, ton/day

County	1999	2002	2006	2012	2018	2023
Atascosa	1.61	1.55	1.18	0.82	0.55	0.47
Bandera	0.72	0.64	0.53	0.42	0.29	0.26
Bexar	54.44	44.59	35.48	24.80	16.60	14.27
Comal	4.17	3.82	3.07	2.30	1.64	1.47
Guadalupe	3.85	3.49	2.87	2.10	1.46	1.29
Kendall	1.24	1.19	1.02	0.84	0.59	0.53
Medina	1.65	1.51	1.24	0.92	0.63	0.55
Wilson	1.23	1.18	0.96	0.74	0.51	0.45
Total	68.92	57.98	46.34	32.93	22.28	19.29

Table 7-4: Weekday On-road NO_x Emission for San Antonio-New Braunfels MSA, ton/day

County	1999	2002	2006	2012	2018	2023
Atascosa	7.38	7.17	5.27	3.19	1.78	1.33
Bandera	1.88	1.71	1.35	0.89	0.89	0.38
Bexar	134.37	114.52	89.38	54.17	29.90	22.06
Comal	13.95	13.19	10.39	6.10	3.65	2.87
Guadalupe	13.88	12.83	10.30	5.47	3.08	2.30
Kendall	5.29	5.17	3.97	2.38	1.34	1.00
Medina	6.02	5.66	4.62	2.83	1.61	1.21
Wilson	3.40	3.31	2.60	1.69	0.98	0.74
Total	186.18	163.57	127.88	76.71	43.21	31.89

8 Summary

The San Antonio-New Braunfels MSA emissions trends analyses provide insight into historical and future emissions that may also serve as supplementary analysis to the modeling conducted for attainment demonstrations or to support control strategy effectiveness evaluations. Data on the status of emissions in future years should assist local authorities in planning efforts to maintain federal air quality standards throughout the region. During the development of the trend analysis, all federal and state regulations currently in use or scheduled to be implemented as of 2023 were accounted for and integrated into the projected emissions calculations.

In addition to state and federally mandated reduction measures, various transportation control measures were voluntarily implemented or promoted in the San Antonio-New Braunfels MSA. Although these voluntarily control strategies would further reduce VOC and NO_x emissions, their impacts are not included in future emission estimations. Such voluntary measures include, but are not limited to:

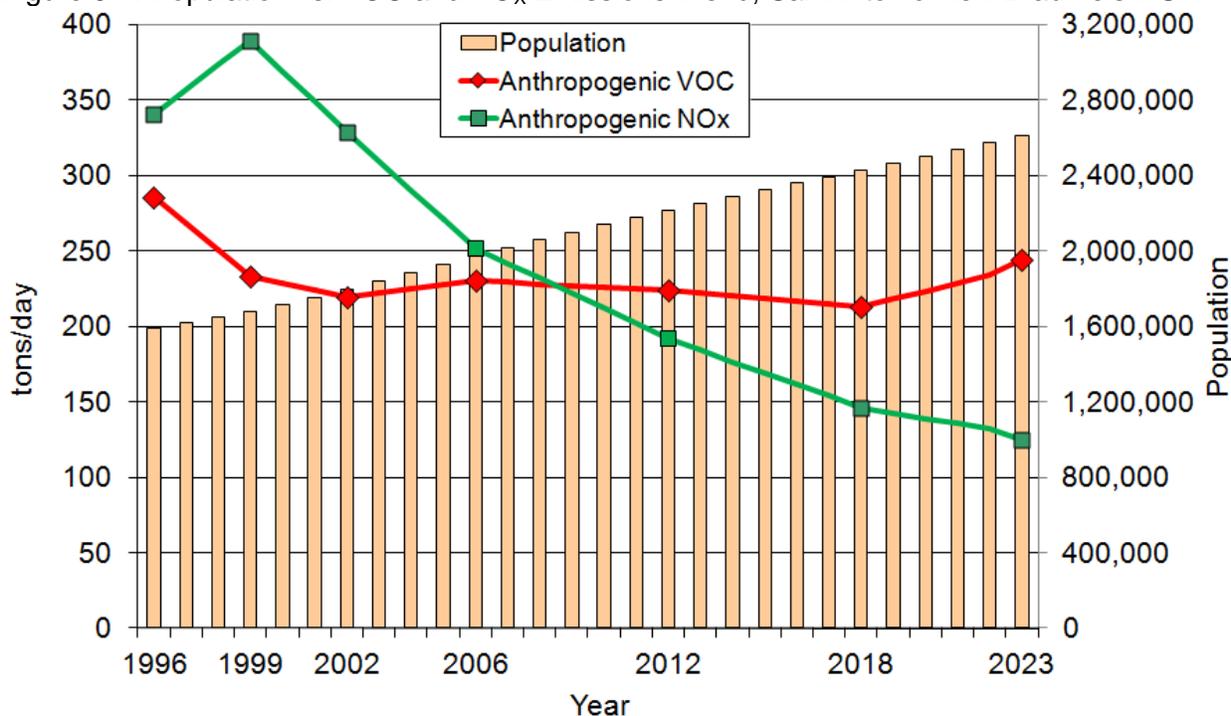
- Ridesharing
- Public education on air quality issues
- Air quality health alerts
- Traffic re-signalization
- Intersection improvements
- Intelligent Transportation Systems (TransGuide)
- Reduction of governmental non-road fleet usage on air quality health alert days
- Stage II vapor recovery systems at nine refueling stations in city of San Antonio
- Use of alternative fuels
- Promotion of mixed land use planning for trip length reduction and trip reduction
- CNG fueled garbage trucks used by city of San Antonio
- Promotion of electric cars and recharging stations
- Promotion of alternative transportation modes such as bicycling
- Use of alternative energy sources such as solar energy

8.1 Population and Emissions Trends

The following figure depicts the results of the emission trend analysis coupled with data on population growth. It indicates a general downward trend in total NO_x and VOC emissions through 2018, despite continued predicted growth in the region's population and economic activities. After this point, NO_x emissions are predicted to continue a downward trend through the year 2023, while VOC emissions are forecast to crawl back up to levels higher than 1999. This is indicative of the impact of air quality controls that mainly target NO_x emissions reductions. The increase in VOC emissions estimates is attributed to the application of growth factors that account for predicted increases in population and economic activity levels, as the area source emissions appear to be contributing the most. Population forecasts used for

construction of this line chart come from the Texas Water Development Board population projections for the San Antonio-New Braunfels MSA.¹¹⁸

Figure 8-1: Population vs. VOC and NO_x Emissions Trend, San Antonio-New Braunfels MSA



8.2 Emission Trend by Emission Sources

The results of this emission trend analysis for various studied years and emission sources are shown in table 8-1 and table 8-2. Emissions from Eagle Ford oil and gas activities are shown independently for better understanding of the impacts of these new sources of emissions.

Table 8-1: VOC Emissions by Source, San Antonio-New Braunfels MSA, tons/ozone season day

Emission Source	1999	2002	2006	2012	2018	2023
On-Road	68.92	57.98	46.34	32.93	22.28	19.29
Non-Road	45.04	38.08	24.52	27.10	18.99	17.33
Area	110.12	116.47	147.16	151.25	153.78	190.22
Point	7.64	5.37	8.26	6.11	6.98	6.67
Off-road	1.47	1.94	3.38	3.26	3.45	3.47
Eagle Ford Shale	-	-	-	3.07	7.44	7.41
Total	233.19	219.84	229.67	223.70	212.92	244.39

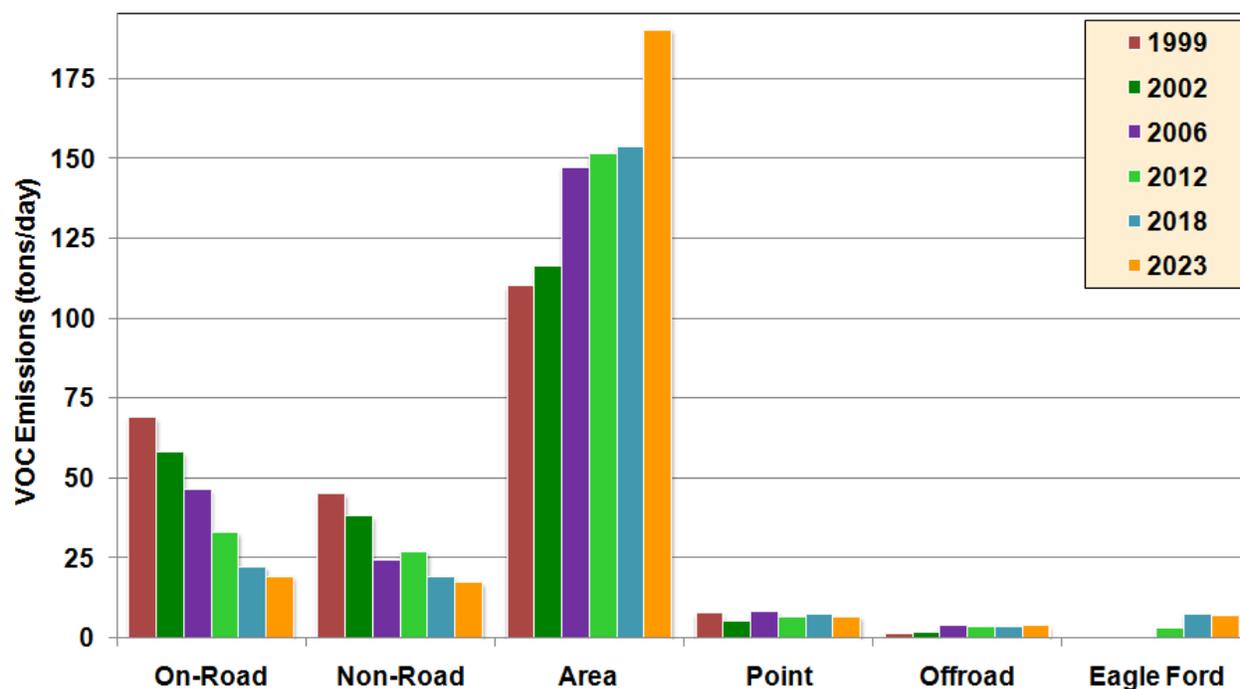
¹¹⁸ Texas Water Development Board. “2016 Regional and 2017 State Water Plan Projections Data”. Texas. Available online: <http://www.twdb.state.tx.us/waterplanning/data/projections/2017/demandproj.asp>. Accessed 09/24/2013.

Table 8-2: NO_x Emissions by Source, San Antonio-New Braunfels MSA, tons/ozone season day

Emission Source	1999	2002	2006	2012	2018	2023
On-Road	186.18	163.57	127.88	76.71	43.21	31.89
Non-Road	56.07	41.74	25.75	19.59	11.35	8.40
Area	13.25	13.82	16.51	15.61	15.90	16.73
Point	120.13	95.95	71.30	66.35	63.52	56.92
Off-road	14.04	13.28	8.89	8.13	7.74	7.29
Eagle Ford Shale	-	-	-	3.85	4.09	3.60
Total	389.67	328.36	250.32	190.24	145.81	124.83

Anthropogenic VOC emission totals by source category for each inventory year are provided in Figure 8-2. The largest source of anthropogenic VOC emissions is area sources followed by on-road and non-road sources. On-road and non-road emissions show a marked reduction between 1999 and the forecasted year of 2023. Changes in point source and off-road VOC emissions will not be significant in the coming years.

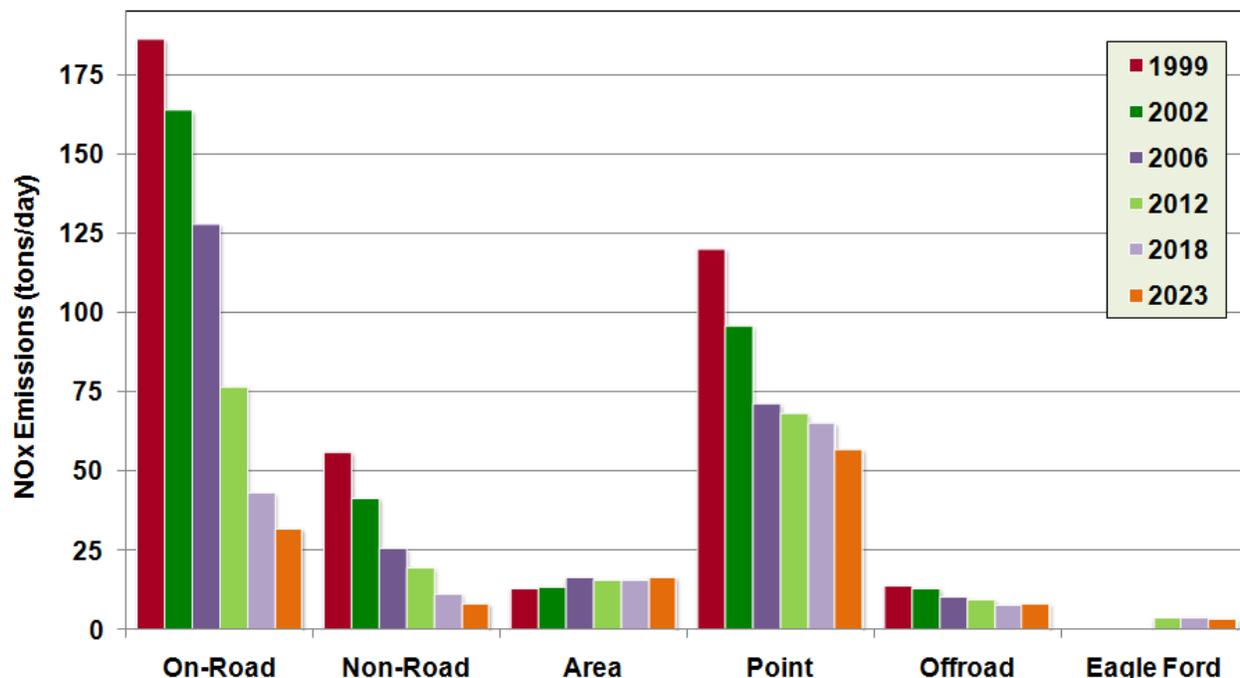
Figure 8-2: VOC Emission Trend by Source, San Antonio-New Braunfels MSA, tons/ozone season day



Anthropogenic NO_x emissions by source category for each inventory year are shown in Figure 8-3. The two largest sources of NO_x emissions are on-road and point sources. On-road emissions show the greatest reduction in NO_x emissions between 1999 and 2023. This

reduction is directly related to improvements in motor vehicle emission controls between 1999 and 2023. Non-road and area sources also emit significant amounts of NO_x emissions.

Figure 8-3: NO_x Emission Trend by Source, San Antonio-New Braunfels MSA, tons/ozone season day



8.3 Emission Trends by MSA Counties

Although there are major sources of emissions in Atascosa, Comal, and Guadalupe counties, VOC and NO_x emissions generated by emission sources in Bexar County account for the greatest share of the 2023 total emissions in the San Antonio-New Braunfels MSA. The projections indicate that every county in the San Antonio-New Braunfels MSA will experience considerable reductions in NO_x emissions in coming years (Tables 8-3 and 8-4).

Figures 8-4 and 8-5 provide VOC and NO_x emissions by county for each emission inventory year. Although Bexar County dominates the charts, there are also large sources of NO_x emissions in Comal, Atascosa, and Guadalupe counties. All counties show a reduction in NO_x emissions by 2023.

Table 8-3: County Level VOC Emission Trend in San Antonio-New Braunfels MSA, tons/ozone season day

County	1999	2002	2006	2012	2018	2023
Atascosa	6.54	9.88	12.05	14.55	16.96	20.30
Bandera	2.38	3.03	4.28	5.38	3.45	4.45
Bexar	179.00	145.96	148.68	137.68	130.66	137.60
Comal	17.78	12.45	13.49	14.67	11.81	11.28
Guadalupe	12.81	19.18	24.62	23.79	22.74	29.29
Kendall	3.72	10.31	9.06	9.54	8.37	14.66
Medina	6.13	11.28	11.54	11.54	11.04	16.68
Wilson	4.85	7.75	5.95	6.55	7.89	10.12
Total	233.19	219.84	229.67	223.70	212.92	244.39

Table 8-4: County Level NO_x Emission Trend in San Antonio-New Braunfels MSA, tons/ozone season day

County	1999	2002	2006	2012	2018	2023
Atascosa	29.93	31.34	20.28	18.55	15.07	14.12
Bandera	6.05	4.90	4.78	1.62	1.52	1.05
Bexar	273.68	216.07	160.08	120.13	90.91	74.64
Comal	31.11	30.69	25.23	22.75	19.61	18.62
Guadalupe	23.86	24.10	21.23	12.79	9.02	7.96
Kendall	7.45	6.25	5.13	3.02	1.80	1.52
Medina	11.34	9.25	9.23	6.77	4.54	4.02
Wilson	6.24	5.76	4.36	4.61	3.34	2.91
Total	389.67	328.36	250.32	190.24	145.81	124.83

Figure 8-4: Total VOC Emissions Trend by County, tons/ozone season day

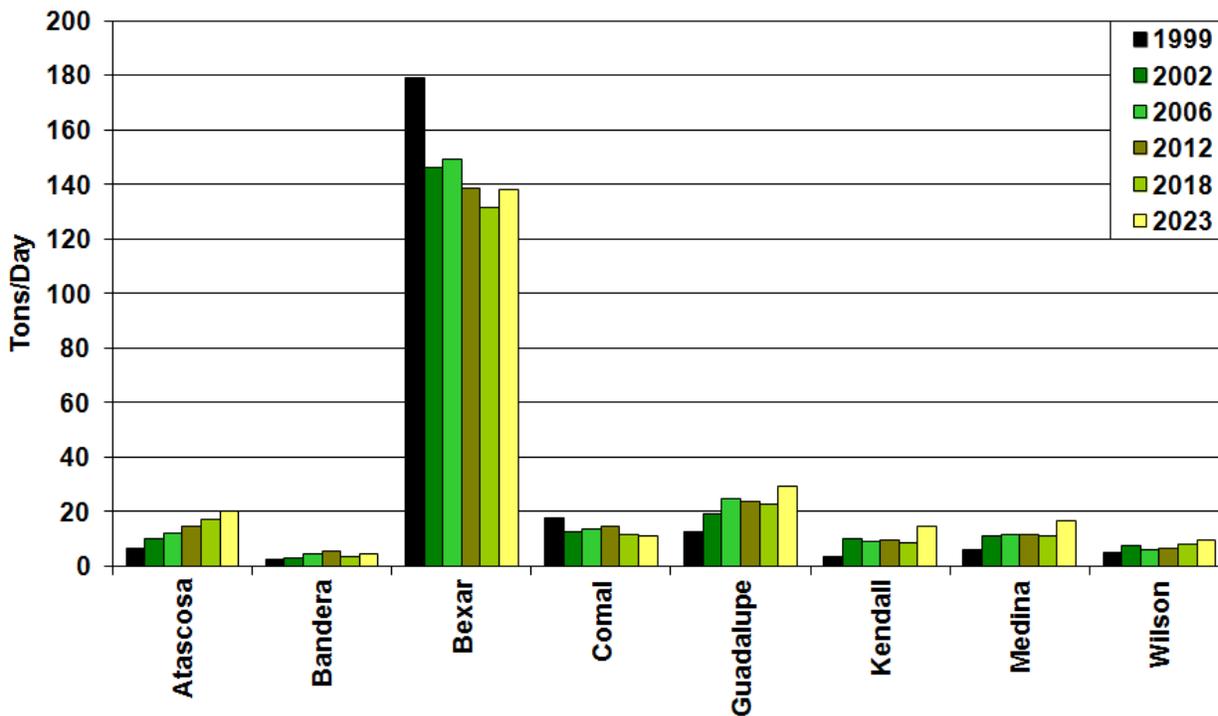
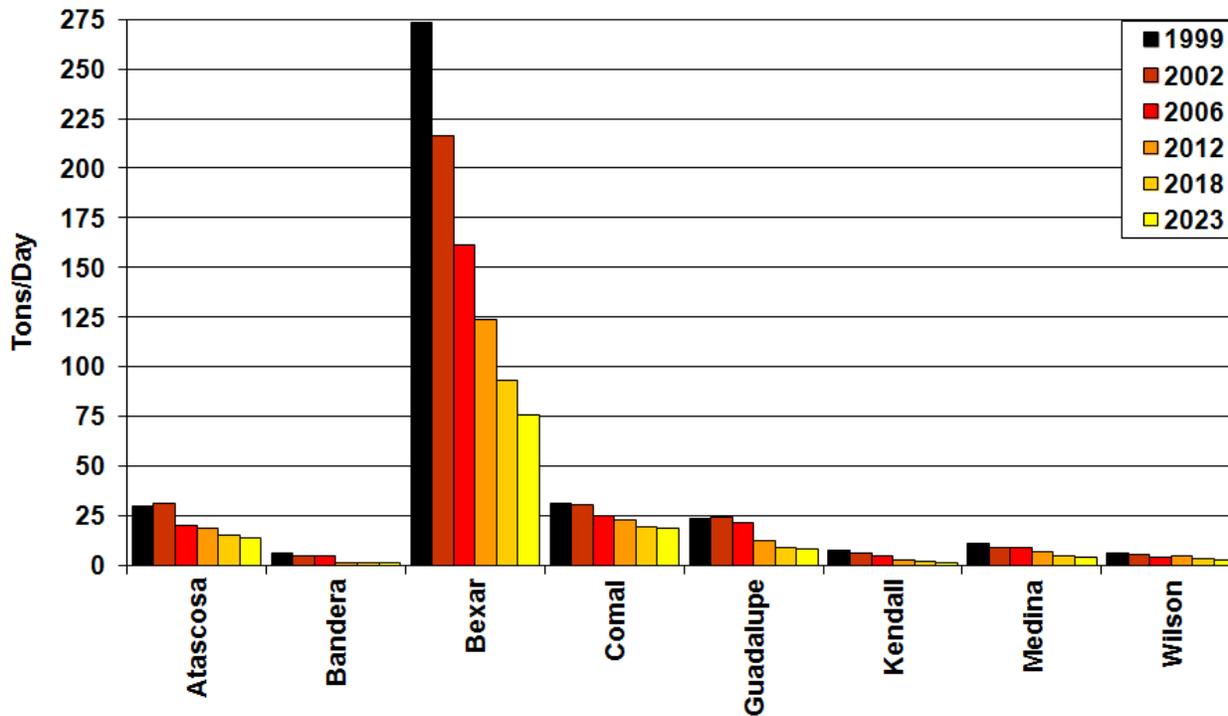


Figure 8-5: Total NO_x Emissions Trend by County, tons/ozone season day



concentrations, and non-real-time VOC), and C5004 sites (meteorological data). C23, C58, and C59 are the regulatory ozone monitors in the San Antonio region, meaning the data collected by these monitors is used to compare local ambient ozone with the NAAQS and the monitors have met site selection criteria, quality assurance, and other requirements of 40 CFR, Part 58. City Public Service Energy (CPS Energy) operates C622 and C678, which also meet all site and data criteria required by EPA for regulatory monitors.

C501, C502, C503, C504, C505, and C506, owned by AACOG and maintained by Dios-Dado Environmental, are non-regulatory monitors and cannot be used for determination of attainment status under current EPA guidelines. These monitors are non-regulatory because they do not meet all EPA guidelines for site selection¹²⁰ and the collected data does not meet EPA criteria for determination of attainment status. However, the AACOG-owned monitors provide useful data that allows analysts to determine pollution concentrations in the spatial gaps between regulatory monitors, to assess upwind contributions to ambient ozone levels, and to acquire additional information on which to base model refinements.

A.2 Historical Ozone Data and Design Value

Ground-level ozone is one of the most common air pollutants in the country as well as one of the six “criteria” pollutants for which the EPA has established standards. A region is in violation of the Clean Air Act if the annual fourth highest 8-hour average ozone concentration, averaged over three consecutive years at a regulatory monitor, exceeds 75 parts per billion (ppb) at any CAMS.¹²¹ This three-year average is referred to as the **design value**. The fourth highest annual 8-hour averages and design values for the three most recent years, 2011-2013, at the regulatory monitors in the San Antonio region are listed in Table A-1.

Table A- 1: 4th Highest Ozone Values¹²² and Design Values at San Antonio Regulatory Monitors

Monitor	2011 (ppb)	2012 (ppb)	2013 (ppb)*	2011-2013 Design Value
C23	79	81	76	78
C58	75	87	80	80
C59	71	70	69	69

*as of 1:12 pm CDT 9/1/2013

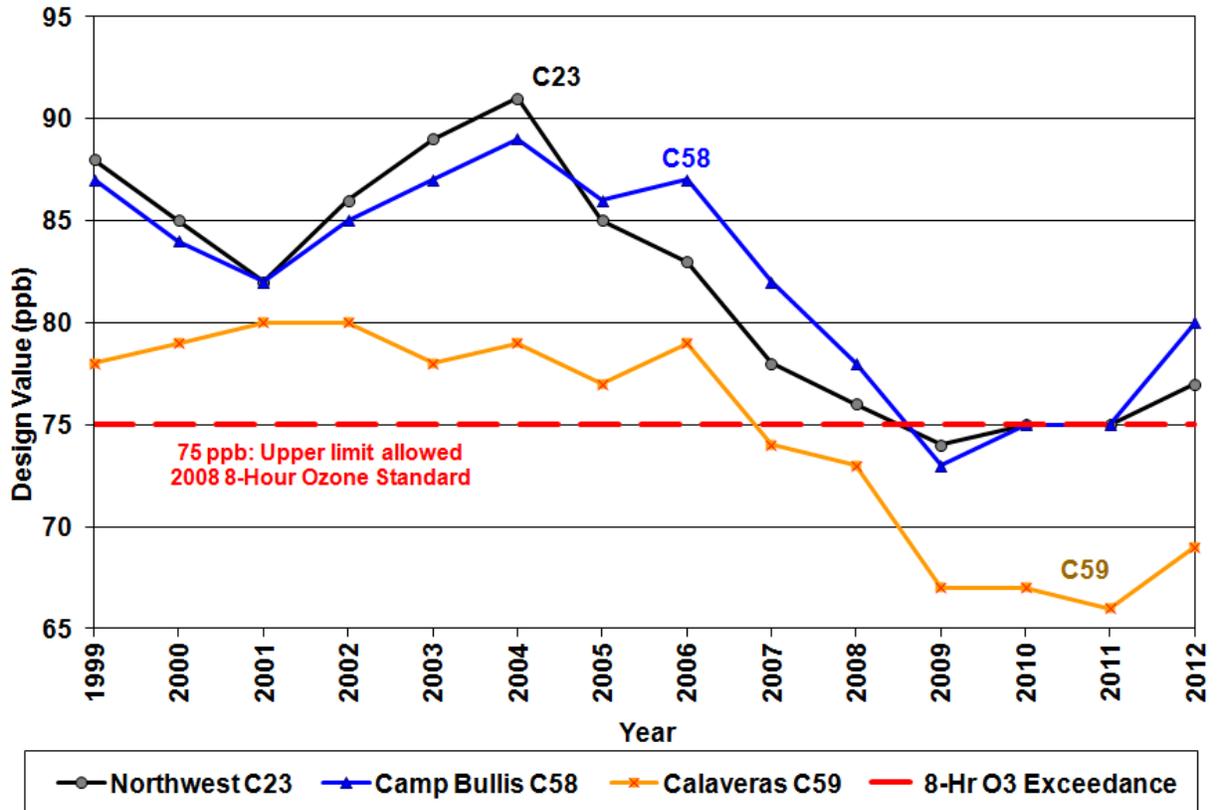
¹²⁰ EPA. August 1998. “Guideline on Ozone Monitoring Site Selection”. EPA-454/R-98-002. Office of Air and Radiation. Office of Air Quality Planning and Standards Research Triangle Park, NC. Available online: <http://www.epa.gov/ttnamti1/archive/files/ambient/criteria/reldocs/r-98-002.pdf>. Accessed 8/2/2013.

¹²¹ EPA, March 2008. “Fact Sheet: Final Revisions to the National Ambient Air Quality Standards for Ozone”. Available online: http://www.epa.gov/groundlevelozone/pdfs/2008_03_factsheet.pdf. Accessed 6/17/2013

¹²² Texas Commission on Environmental Quality (TCEQ). “Four Highest Eight-Hour Ozone Concentrations”. Austin, Texas. Available online: http://www.tceq.state.tx.us/cgi-bin/compliance/monops/8hr_4highest.pl. Accessed 5/01/2013.

The 2011-2013 design value (truncated average) is 80 ppb at C58 and 77 ppb at C23, indicating that the San Antonio region had two monitors in violation of the 75 ppb eight hour ozone standard set by the EPA in 2008. The region was formally found in attainment of the old 0.08 parts per million (85 ppb) standard based on the 2005-2007 design values (82 ppb at C58). Figure A-2 shows historical 8-hour ozone design values for each regulatory monitor in San Antonio region. San Antonio's design values at various CAMS decreased fairly consistently between 2004 and 2009, but began climbing in 2010. This trend of increasing ozone concentrations has resulted in design values at C58 and C23 that exceed the 75 ppb standard.

Figure A- 2: Historical 8-Hour Ozone Design Values in San Antonio Region by Regulatory CAMS



Appendix B: Heavy Duty Trucks Extended Idling

Extended idling of truck engines consumes fuel, creates air and noise pollution, and is an inefficient use of the nation's energy supply. According to an estimate by the US Department of Energy, trucks in the U.S. consume over 25 million barrels of fuel a year during overnight truck idling. To address this issue in the San Antonio region and to quantify the pollution associated with idling, a survey was conducted between October 2010 and June 2011 that involved observing and documenting the incidence of extended engine idling (30 minutes or more) at truck stops and rest areas and using this information to calculate emissions due to idling. Since EPA has required that states begin using the MOVES model for on-road emission inventory development, this study did not use any on-road emission factors generated by the predecessor of the MOVES model, the MOBILE6.2 model. Likewise, the simplified extended idling emission estimation procedure outlined by EPA for use with MOBILE6.2 in the January 2004 "Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity" was not used. The following is a description of this study.

B.1 Study Area

The truck idling survey encompassed the 8-county San Antonio-New Braunfels MSA, which includes Bexar, the most populous county of the region, and the 7 adjacent counties of Atascosa, Bandera, Comal, Guadalupe, Kendall, Medina, and Wilson. Extensive research was conducted to identify and locate facilities in the region where truck idling would likely occur. All identified truck stops, rest stops, and picnic areas were included in this survey. Additional and undocumented truck stops were identified during the survey and were added to the inventory of facilities surveyed.

B.2 Definition of Heavy-Duty Trucks

The focus of this study was an on-site survey of engine idling practices by long-haul truck drivers. Survey results provided information that was used to estimate extended idling emissions for combination (tractor/trailer) long-haul trucks, the only vehicle type within the current version of the EPA's Motor Vehicle Emission Simulator model (MOVES) for which extended idling emissions can be estimated. This vehicle category is more commonly referred to as diesel-powered five-axle "eighteen-wheelers," but other four-axle and six-axle configurations were also included in this category. Combination long-haul trucks were classified in MOVES as trucks with a majority of their operation outside of 200 miles of home base.

B.3 Truck Idling Locations

Drivers idle their trucks' engines at the following locations:

- Truck Stops
- Rest Stops
- Picnic Areas
- Other Idling Locations

AACOG staff visited these locations on a preset Data Collection Schedule and recorded their observations on a survey sheet for aggregation and final analysis of the collected data. Tables B-1 and B-2 list the locations where AACOG staff conducted truck idling surveys.

Table B- 1: Truck Stops in the San Antonio-New Braunfels MSA

Truck Stop	Address	Exit Number	County	Parking Spaces*
Kuntry Korner Steak & Eggs	IH 37 / Jim Brite Rd, Pleasanton	104	Atascosa	45
ZS Super Stop	IH 37 / FM 97, Pleasanton	109	Atascosa	24
EZ Mart	15537 IH 37, Elmendorf	125	Bexar	25
Tex Best Travel Center	20290 IH 37, Elmendorf	125	Bexar	30
Valero Ram Travel Center	IH 37, Elmendorf	130	Bexar	12
Texas Best Fuel Stop (Exxon)	14650 IH 35, Von Ormy	140	Bexar	15
Valero AAA Travel Center	14555 IH 35, Von Ormy	140	Bexar	70
Shell Time Wise Landmark	13437 IH 35, Von Ormy	141	Bexar	24
Love's Country Store	11361 IH 35, S Von Ormy	145	Bexar	108
Valero	IH 35, S Von Ormy	145	Bexar	50
Shell Truck Stop	11607 N IH 35, San Antonio	169	Bexar	45
PICO	25284 IH 10, San Antonio	550	Bexar	15
Petro Travel Plaza	1112 Ackerman Rd, San Antonio	582	Bexar	320
Pilot Travel Center	5619 IH 10 E, San Antonio	582	Bexar	50
Flying J Travel Plaza	1815 Foster Rd., San Antonio	583	Bexar	283
TA Travel Center	6170 IH 10 E, San Antonio	583	Bexar	258
Shell Truck Stop	8755 IH 10 E, Converse	585	Bexar	60
Alamo Travel Center	13183 IH 10, Converse	591	Bexar	40
Texaco	IH 10, Converse	593	Bexar	30
Trainer Hale Truck Stop	14462 IH 10, Converse	593	Bexar	25
Pilot Travel Center	4142 Loop 337, New Braunfels	184	Comal	80
Tex Best Travel Center	2735 N IH 35, New Braunfels	191	Comal	28
TA Truck Stop	4817 IH 35, New Braunfels	193	Comal	250
Sunmart No 167	6150 W IH 10, Seguin	601	Guadalupe	40
Jud's Food and Fuel - Shell	IH10/Hwy 123, Seguin	610	Guadalupe	40
Chevron	IH 10, Comfort	523	Kendall	20
Exxon Valley Mart	US 90, Hondo	533	Medina	10
Total				1,997

*Data on number of parking spaces are from truck stop surveys

Construction of new rest stops with designated truck parking spaces and better amenities, such as air conditioned rooms and wireless Internet access, have made rest stops suitable resting

places for long-haul truckers.¹²³ Random visual inspections of smaller picnic areas that are not located on major highways indicated that no truck idling was occurring; therefore these sites were not included in the emission inventory. All of the rest stops and picnic areas that were surveyed, with the number of estimated parking spaces, are shown in Table B-2.

Table B- 2: Rest Areas and Picnic Areas in the San Antonio Region

Type	Location	Mile Marker	County	Parking Spaces*
Rest Areas	Northbound - IH 35	180	Comal	18
	Southbound - IH 35	180	Comal	18
	Eastbound - IH 10	619	Guadalupe	26
	Westbound - IH 10	619	Guadalupe	32
	Northbound - IH 35	130	Medina	17
	Southbound - IH 35	130	Medina	20
	Eastbound - US 90	518	Medina	15
	Westbound - US 90	518	Medina	13
Picnic Areas	Northbound - IH 37	112	Atascosa	28
	Southbound - IH 37	111	Atascosa	28
	Eastbound - IH 10	529	Kendall	17
	Westbound - IH 10	531	Kendall	25
	US 90	548	Medina	6

*Data on number of parking spaces are from truck surveys

Long term heavy-duty diesel truck idling occurs at other sites not included in the truck stops, rest areas, and picnic areas databases. Since long-haul truck idling is less predictable and tends to be minimal at these other locations due to limitations on space and facilities, they were not included in the idling survey. Other local sites where long term truck idling was observed included:

- Weigh stations
- Grain elevators
- Intersections of highways and local roads
- Highway service roads
- Warehouses parking lots
- Large department store parking lots
- Food stands
- Office building parking lots

¹²³ TxDOT, Sept. 2009. "Texas Safety Rest Area Program". Available online: ftp://ftp.dot.state.tx.us/pub/txdot-info/library/pubs/travel/sra_brochure.pdf. Accessed 07/11/2013.

Since fewer than 4 trucks were observed idling at these sites during the survey, the emissions impacts of the sites were considered small compared to the large truck stops, and the emissions were not included in the final emission results.

B.4 Data Collection Schedule

To ensure the results of the survey were statistically significant, each truck stop, or rest area and picnic area was surveyed at least 6 times: 3 times on weekdays and 3 times on weekends and for 3 time periods. Observations of truck engine idling were collected during the following three time periods:

- Morning (5 am – 10 am)
- Daytime (10 am – 10 pm)
- Evening/Night (10 pm – 5 am)

For data collected on weekdays, the morning and daytime periods included observations during local “rush hours” for consistency with how travel demand modeling is performed. The number of surveys and the truck parking spot observations are provided by hour in Table B-3. The results of the survey are grouped into the three time periods. Overall, 272 survey forms were filled out during the survey, of which 184 survey forms documented idling activity at truck stops, 57 survey forms were for rest areas, and 31 survey forms were for picnic areas. Each facility was surveyed for the time periods of weekday, weekend, morning, daytime, and nighttime.

Table B- 3: Data Collection Summary by Facility Type

Type	Time Period	Number of Surveys Conducted			Truck Parking Spaces Surveyed		
		Weekday	Weekend	Total	Weekday	Weekend	Total
Truck Stops	Morning	34	30	64	2,543	2,063	4,606
	Day	32	30	62	2,940	2,390	5,330
	Night	27	31	58	2,017	2,234	4,251
Rest Areas	Morning	10	8	18	195	159	354
	Day	10	11	21	196	201	397
	Night	8	10	18	180	196	376
Picnic Areas	Morning	5	7	12	104	160	264
	Day	5	4	9	104	90	194
	Night	4	6	10	76	132	208
Total		135	137	272	8,355	7,625	15,980

B.5 Idling Emission Factors

Data collected from the truck idling survey provided necessary data to estimate extended idling emissions for the combination long-haul truck category, which is the only source type (vehicle)

within the current version of the Motor Vehicle Emission Simulator model (MOVES)¹²⁴ for which extended idling emissions can be obtained. The primary inputs required by MOVES to estimate idling emissions are the number of source hours operating (SHO) in extended idling mode, which was obtained from the survey's results. Other local input data came from Texas Transportation Institute's (TTI) 2008 report, "On-Road Mobile Source Emissions Trends for all 254 Texas Counties: 1990 through 2040."¹²⁵ Idling emission factors for long-haul trucks are provided in table B-4.

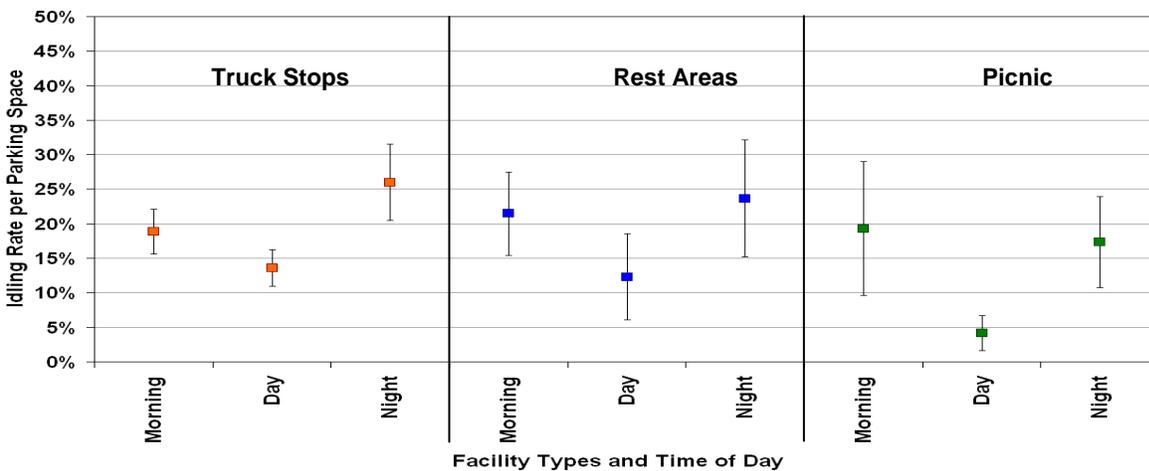
Table B- 4: Heavy Duty Truck Idling Emission Factors in MOVES Model

Year	NO _x grams/hour	VOC grams/hour
1999	218.14	57.17
2002	223.04	56.19
2006	226.01	57.90
2011	178.42	43.00
2012	177.11	40.46
2018	170.98	29.88
2023	168.29	25.28

B.6 Emission Calculation Methodology

Truck parking spaces in the San Antonio-New Braunfels MSA include a total of 1,997 parking spaces at truck stops, 159 parking spaces at rest areas, and 104 parking spaces at picnic areas. Idling rates used to calculate emissions per parking space by facility type and time of the day are provided in figure B-1 and table B-5. Data for picnic areas are limited because there are only five picnic areas on major highways.

Figure B 1: Idling Rate per Parking Space by Parking Facility Type and Time Period



¹²⁴ U.S. EPA, December 2009. Office of Transportation and Air Quality Washington, DC. Motor Vehicle Emission Simulator. Available online: <http://www.epa.gov/otaq/models/moves/index.htm>. Accessed 07/07/2013.

¹²⁵ TCEQ, August 2008. "On-Road Mobile Source Emissions Trends for all 254 Texas Counties: 1990 Through 2040". TTI. College Station, Texas.

Table B- 5: Idling Rates per Parking Space by Day Type, Facility Type, and Time Period

Day Type	Statistical Test	Weekday			Weekend		
		Truck Stops	Rest Areas	Picnic Areas	Truck Stops	Rest Areas	Picnic Areas
Total Morning	Low	17%	15%	1%	11%	11%	11%
	Mean	22%	24%	11%	15%	19%	25%
	High	27%	33%	20%	19%	27%	39%
	Standard Dev.	14%	14%	11%	11%	12%	19%
	N	34	10	5	30	8	7
	Confidence Level	5%	9%	10%	4%	8%	14%
Total Day	Low	9%	6%	2%	10%	3%	0%
	Mean	13%	17%	6%	14%	8%	2%
	High	17%	28%	10%	18%	13%	5%
	Standard Dev.	10%	18%	5%	11%	9%	3%
	N	32	10	5	30	11	4
	Confidence Level	4%	11%	4%	4%	5%	3%
Total Night	Low	19%	17%	9%	18%	7%	8%
	Mean	25%	32%	24%	26%	16%	14%
	High	32%	46%	38%	35%	26%	19%
	Standard Dev.	17%	21%	15%	25%	15%	7%
	N	27	8	4	31	10	6
	Confidence Level	7%	14%	15%	9%	9%	6%

Based on 95 % confidence level

The following equations were used to calculate county level total daily and annual emissions for extended truck idling at each facility type.

Equation B-1, Daily emissions for each facility type and time period per county

$$DE_{ABC} = RATE_{BC} \times SP_{AC} \times HRS \times EF / 907,184.74 \text{ grams/ton}$$

Where,

DE_{ABC} = Daily Emissions from County A for Time Period B and Facility Type C (tons)

$RATE_{BC}$ = Idling Rates per Parking Space for Time Period B and Facility Type C (from survey data located in Table B-5)

SP_{AC} = Number of Truck Parking Spaces in County A for Facility Type C (from survey data located in Table 2-1 and 2-2)

HRS = Number of Hours per Time Period B (Morning – 5 hrs, Daytime – 12 hrs, and Nighttime – 12 hrs)

EF = Idling Emissions factor for Combination Long-Haul Trucks in 2006, 226.01 grams of NO_x-hr and 57.90 grams of VOC-hr (from the MOVES model)

Sample calculation for morning NO_x emissions from truck stops in Bexar County

DE_{ABC} = 22.02% Idling Rate per Parking Space During Weekday Mornings x 1,434 Truck Stop Parking Spaces x 5 hours x 226.01 grams of NO_x-hr / 907,184.74 grams/ton
= 0.39 tons of NO_x/weekday morning emissions from truck stops in Bexar County

Equation (2) – Annual emissions per county for each facility type

AE_{AC} = [(DME_{AC} + DDE_{AC} + DNE_{AC}) x 261 weekdays/year] + [(EME_{AC} + EDE_{AC} + ENE_{AC}) x 104 weekend days/year]

Where,

AE_{AC} = Annual Emissions from County A for Facility Type C (tons/year)
DME_{ABC} = Idling Emissions for Weekday Morning for Facility Type C (from equation 1)
DDE_{ABC} = Idling Emissions for Weekday Daytime for Facility Type C (from equation 1)
DNE_{ABC} = Idling Emissions for Weekday Nighttime for Facility Type C (from equation 1)
EME_{ABC} = Idling Emissions for Weekend Morning for Facility Type C (from equation 1)
EDE_{ABC} = Idling Emissions for Weekend Daytime for Facility Type C (from equation 1)
ENE_{ABC} = Idling Emissions for Weekend Nighttime for Facility Type C (from equation 1)

Sample calculation for annual NO_x emissions from truck stops in Bexar County

DE_{ABC} = [(0.39 tons + 0.56 tons + 0.64 tons) x 261] + [(0.27 tons + 0.61 tons + 0.66 tons) x 104]
= 574.80 tons of NO_x/year from truck stops in Bexar County

B.7 Idling Emission Trend

The daily truck idling emissions totals for each county were calculated and aggregated with TTI's on-road source emissions. The on-road emissions are described in Chapter 6 and shown in tables 6-2 and 6-3. Table B-6 below shows the daily truck idling emissions. The two counties of Bandera and Wilson are not represented in this table, because no truck stops were observed in these counties during the time that AACOG staff was conducting the truck idling survey.

Table B- 6: Truck Idling Emissions Trend for San Antonio-New Braunfels MSA (tons/day)

County	2006		2012		2018		2023	
	NO _x	VOC						
Atascosa	0.12	0.03	0.09	0.02	0.09	0.02	0.09	0.02
Bexar	1.64	0.42	1.28	0.29	1.24	0.32	1.22	0.31
Comal	0.44	0.11	0.35	0.08	0.34	0.09	0.33	0.08
Guadalupe	0.16	0.04	0.12	0.03	0.12	0.03	0.12	0.03
Kendall	0.05	0.01	0.04	0.01	0.04	0.01	0.04	0.01
Medina	0.05	0.01	0.04	0.01	0.04	0.01	0.04	0.01
TOTAL	2.50	0.64	1.96	0.45	1.89	0.48	1.86	0.48

The 2006 total annual NO_x emissions from extended truck idling in the San Antonio-New Braunfels MSA were estimated to be 883 tons per year while total VOC emissions were estimated to be 226 tons per year. Bexar County dominates total emissions, because there is a concentration of large truck stops on the east side of the city near the IH-410 and IH-10 interchange. In addition, there are concentrations of truck stops on IH-35 in the southwest part of the county and on IH-37 in south Bexar County.

Comal County also has several large truck stops where significant amounts of emissions are generated from idling truck engines. These truck stops are concentrated along IH-35 between San Antonio and Austin. Rest areas are located in Comal, Guadalupe, and Medina counties. Truck idling also occurs at picnic areas, which are located in Atascosa and Kendall counties.