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Northeast Texas Air Care Ozone Advance Action Plan

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CONTENTS

TABLES

FIGURES

EXECUTIVE SUMMARY

Northeast Texas Air Care (NETAC) is participating in the U.S. EPA's Ozone Advance Program on behalf of the Tyler-Longview-Marshall (TLM) area in Northeast Texas. NETAC is a voluntary stakeholder group that was formed in 1996 to fill the need for an organized and comprehensive approach to improving air quality based on regional needs. NETAC consists of representatives from local government, local business and industry, EPA technical staff, TCEQ technical staff, Texas Department of Transportation planning staff, environmental interest groups and the general public. The five counties with representation at NETAC are Gregg, Smith, Harrison, Upshur and Rusk. More information on NETAC may be found at http://www.netac.org.

The ozone design value for the TLM area as of December 2014 is 71 parts per billion (ppb), which attains the 75 ppb 2008 National Ambient Air Quality Standard (NAAQS) for ozone. Under the Clean Air Act, the EPA is required to review the NAAQS periodically. On November 26, 2014, the EPA announced their intention to lower the NAAQS to a value in the 65-70 ppb range and to finalize the NAAQS by October, 2015 (EPA, 2014). Designations of attainment status are anticipated by October 2017 and will likely be based on monitored ozone for 2014, 2015 and 2016. Depending on where the NAAQS is set, one or more of the TLM area monitors could be out of compliance. Because failure to comply with the NAAQS carries adverse public health impacts and significant economic penalties, ozone air quality planning is important for Northeast Texas.

Ozone forms in the atmosphere from emissions of ozone precursors, namely nitrogen oxides (NOx) and volatile organic compounds (VOCs.) High ozone in Northeast Texas typically occurs on days when there is ample sunshine, local temperatures exceed 90°F, wind speeds are low, and wind directions range between northerly clockwise through southeasterly. These wind directions are favorable for transport of polluted air masses of continental origin into Northeast Texas. High ozone days in Northeast Texas are generally characterized by high background ozone levels plus a small contribution from local emissions sources. Although the ozone contribution from local sources can be relatively small, ozone reductions are possible via reductions in local ozone precursor emissions.

Northeast Texas's NOx emission inventory is dominated by emissions from power plants, motor vehicles, and oil and gas exploration and production. The contribution to VOC emissions from biogenic sources such as trees far exceeds the contribution from human activities. The abundance of biogenic VOC ensures that there is always enough VOC available to form ozone so that the amount of ozone formed from local emissions is determined by the amount of NOx emissions. The overall VOC/NOx emission ratio in the 5-county area is within the NOx-limited ozone formation regime. As a result, reductions in NOx will be generally more effective in controlling ozone on a regional basis than reductions in anthropogenic VOC. In addition, highly reactive VOCs (HRVOCs) emitted from petrochemical manufacturing facilities may contribute to rapid localized formation of ozone during days when the meteorology is favorable. Sensitivity tests and source apportionment modeling using NETAC's ozone models confirm that NOx reductions are more effective than VOC reductions in controlling ozone in Northeast Texas.

Therefore, local emission control strategies are focused on reducing NOx as well as HRVOCs that have been shown to play a role in ozone formation at the Gregg County monitor in Longview.

As part of its participation in the EPA's Ozone Advance Program, NETAC has prepared this Ozone Action Plan. The Action Plan summarizes NETAC's understanding of ozone formation in Northeast Texas and outlines measures being taken to reduce local ozone levels. The schedule for implementation of each measure/program is provided as well as the means of verification of emissions reductions, where applicable.

The following measures and programs are being taken in order to reduce ozone in Northeast Texas:

- Reductions in ozone precursor emissions, including NOx and highly reactive VOCs, from local and regional industrial facilities and power plants
- Cleaner municipal fleet vehicle use by local cities
- Energy efficiency measures implemented by local cities
- Ozone awareness programs enacted by local cities
- NETAC public outreach activities including:
  - Public web site with links to daily ozone air quality forecasts, information on ozone and specific actions citizens can take to improve air quality as well as contact information for citizens who would like to become more involved in addressing local air quality issues
  - Radio and television public service announcements

This Ozone Advance Action Plan is intended to be a living document that will be updated annually to incorporate developments in Northeast Texas' air quality planning.

1.0 INTRODUCTION

Northeast Texas Air Care (NETAC) is participating in the U.S. EPA's Ozone Advance Program on behalf of the Tyler-Longview-Marshall (TLM) area in Northeast Texas. NETAC is a voluntary stakeholder group that was formed in 1996 to fill the need for an organized and comprehensive approach to improving air quality based on regional needs. NETAC consists of representatives from local government, local business and industry, EPA technical staff, TCEQ technical staff, Texas Department of Transportation planning staff, environmental interest groups and the general public. The five counties with representation at NETAC are Gregg, Smith, Harrison, Upshur and Rusk. More information on NETAC may be found at http://www.netac.org.

As part of its participation in Ozone Advance, NETAC has prepared this Ozone Action Plan. The Action Plan gives an overview of ozone air quality and describes the 5-county TLM area of Northeast Texas (Section 1), summarizes our understanding of ozone formation in Northeast Texas (Section 2) and outlines measures being taken to reduce 5-county area ozone levels (Sections 3 and 4). In Section 2, we discuss the TLM area emission inventory of ozone precursors and summarize analyses of ambient monitoring data and photochemical modeling that inform the selection of emissions control strategies. Stakeholder involvement is discussed in Section 3. Finally, in Section 4, we describe the emissions reductions measures and/or programs that have been and will be implemented in the 5-county area. The schedule for implementation of each measure/program is shown as well as the responsible party and means of verification of emissions reductions, where applicable. Plans described in this Ozone Action Plan are effective through December, 2015.

1.1 Ozone Air Quality: Background

Ozone is the main ingredient in photochemical smog. Ozone affects human lung function, increasing the prevalence and severity of asthma and bronchitis, and damages vegetation (EPA, 2006). The U.S. EPA sets a National Ambient Air Quality Standard (NAAQS) for ozone in order to protect public health and the environment. The NAAQS is based on health impacts for sensitive groups and there are economic penalties for areas that fail to attain it.

The eight-hour NAAQS is currently set at 75 parts per billion (ppb). The Texas Commission on Environmental Quality (TCEQ) operates three Continuous Air Monitoring Station (CAMS) ozone monitors in Northeast Texas that determine whether the 5-county TLM area is in compliance with the NAAQS. In 2011, the TLM area was designated as attainment for ozone based on the 2008-2010 readings from these three monitors. At the end of the 2014 ozone season, the Longview monitor (CAMS 19) in Gregg County and the Tyler monitor in Smith County (CAMS 82) currently have design values of 71 ppb and the Karnack monitor (CAMS 85) in Harrison County has a design value of 69 ppb; these design values are in compliance with the 2008 ozone NAAQS of 75 ppb.

Under the Clean Air Act, the EPA is required to review the NAAQS periodically. On November 26, 2014, the EPA announced their intention to lower the eight-hour ozone NAAQS to a value in the 65-70 ppb range and to finalize the NAAQS by October, 2015 (EPA, 2014). Designations of attainment status are anticipated by October 2017 and will likely be based on monitored ozone levels in 2014, 2015 and 2016. Depending on where the NAAQS is set, one or more of the TLM area monitors could be out of compliance. Because failure to comply with the NAAQS carries adverse public health impacts and significant economic penalties, ozone air quality planning is important for Northeast Texas.

Ozone is not emitted directly into the atmosphere, but forms from nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight. NOx and VOCs are emitted by both natural processes and human activities. Conditions that favor the formation of ground-level ozone are strong sunlight, high temperatures, and high precursor (NOx and VOC) concentrations. Elevated precursor concentrations in the atmosphere occur when emissions are large and/or weather conditions allow precursors to accumulate. When winds are calm and the atmosphere is stable, emitted precursors do not disperse and are available for ozone formation. On the other hand, if the atmosphere is unstable and winds are brisk, emitted pollutants are transported away from the area so that ozone does not build up.

Ozone is removed from the atmosphere by chemical reactions, photolysis (destruction by sunlight), deposition onto surfaces and uptake by plants. Ozone has a lifetime of several days to weeks at ground level; this lifetime is long enough to allow ozone to be transported thousands of miles. At any given location, therefore, measured ozone is partly due to a contribution from local emissions and partly due to transported ozone, which is often referred to as background ozone. High background ozone exacerbates local ozone problems, but is not a necessary condition for an area to have high ozone. Ozone problems solely from transport can occur, but are rare.

In order to reduce ozone in a given area, the ozone problem must be studied to determine the relative importance of local emissions and transported ozone. Photochemical modeling is used to assess the magnitude of the local and transported contributions. Regional and national emissions control measures such as the Federal vehicle emissions standards aim to reduce the contribution from transported ozone. If local ozone precursor emissions are shown to contribute to ozone levels, then local emissions control measures can be developed. The Ozone Advance Program was developed to assist areas in air quality planning and in developing local emissions control strategies designed to reduce ozone.

1.2 Northeast Texas

The 5-county TLM area lies on the Northeast Texas plain approximately 100 miles east of the Dallas-Fort Worth metropolitan area and 15 miles west of the city of Shreveport, LA. A map of Northeast Texas and the surrounding area is shown in Figure 1-1. The region is relatively flat, with the highest terrain reaching a height of approximately 200 meters above sea level. The population in Northeast Texas is concentrated in the cities of Tyler, Longview and Marshall. There are smaller towns throughout the area (Figure 1-1), but much of the area in all 5 counties is rural land. Northeast Texas is densely wooded with a mixture of deciduous and coniferous

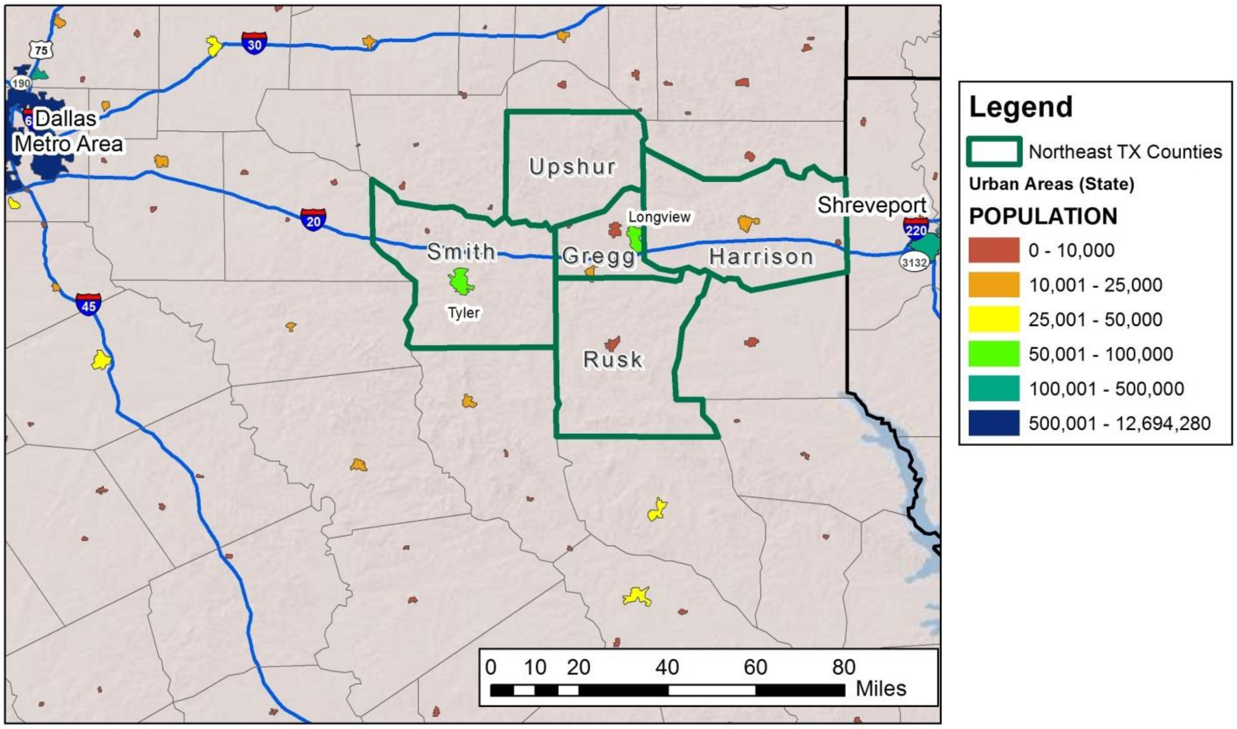


Figure 1-1. Population distribution of Northeast Texas and surrounding region. Urban areas are shaded and color of shading indicates population as of 2012. The 5 NETAC counties are outlined in dark green.

trees. A major interstate highway, I-20, passes through the area. The main population centers in Northeast Texas are connected by I-20.

U.S. Census data (Figure 1-2) indicate that the 5-county area had a population of approximately 500,000 in 2012. During the period 2006-2012, all of the TLM area counties saw moderate (6-15%) growth in population. Smith County has the largest population of the 5 counties, and saw the largest increase in population (21,634) between 2006 and 2012. Rusk County had the largest percentage change in population (15%) between 2006 and 2012. Figure 1-3 shows that Texas urban areas to the south and southwest of the 5-county area saw significant (>20%) growth in population from 2000 to 2010. The Houston, San Antonio and Austin areas all had two or more counties with >40% growth and these areas can be upwind of Northeast Texas on days that could exceed a more stringent NAAQS (see Section 2 and Kemball-Cook et al., 2014a).

Northeast Texas overlies productive oil and natural gas fields. There are a large number of natural gas wells in Harrison and Rusk Counties that access conventional natural gas reservoirs as well as the Hayesville Shale. Gregg, Smith and Upshur Counties also have natural gas production, but have fewer wells and lower production levels than Harrison and Rusk Counties. There is oil production in all five counties, with the highest levels of production in Gregg and Rusk. Other industries in Northeast Texas include electric power generation and transmission, chemicals and plastics production, and petroleum refining.

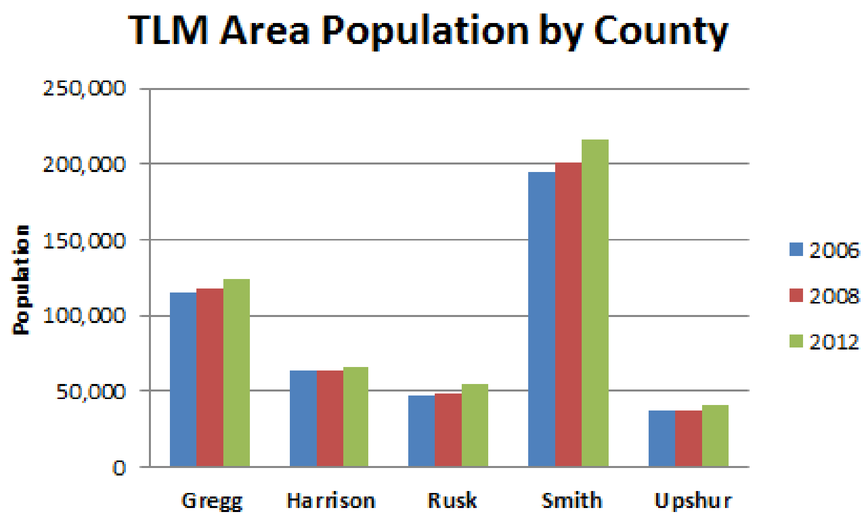


Figure 1-2. Northeast Texas population trends by county based on U.S. Census data from http://quickfacts.census.gov/qfd/states/48/48309.html.

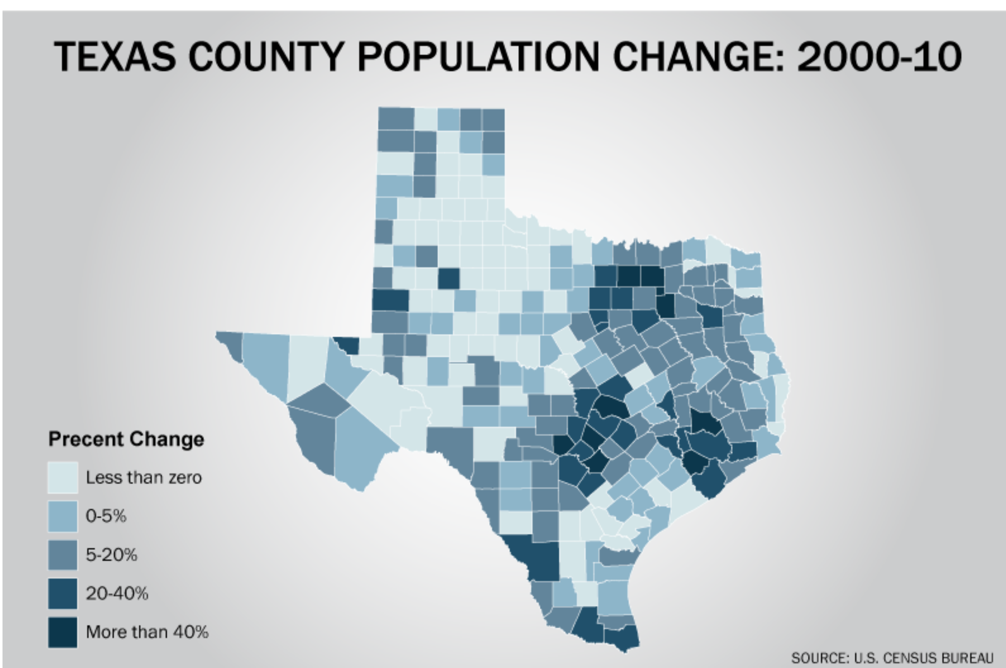


Figure 1-3. Texas population growth from 2000-2010. Figure from the Texas Tribune based on U.S. Census data. http://www.texastribune.org/library/data/census-2010/.

1.3 Ozone Attainment Status History of Northeast Texas

The Northeast Texas ozone monitoring data are used to calculate the design values that determine whether the area is in compliance with the NAAQS for ozone. The locations of the three TCEQ CAMS ozone monitors are shown in Figure 1-4. The 5-county TLM area ozone monitors have seen large reductions in ozone during the last two decades (Figure 1-5) that have allowed the area to demonstrate compliance with increasingly stringent NAAQS. The TLM area achieved the 1-hour National Ambient Air Quality Standard (NAAQS) for ozone, successfully concluded its Early Action Compact (EAC) in 2007 with attainment of the 1997 0.08 ppm 8-hour ozone standard (dashed red line in Figure 1-5), and demonstrated attainment of the 75 ppb 2008 NAAQS (solid red line in Figure 1-5). In this section, we review the definition of the 1-hour and 8-hour ozone standards and give a brief history of the attainment status of the TLM area and the measures taken by NETAC to bring the 5-county area into attainment of each of these standards.

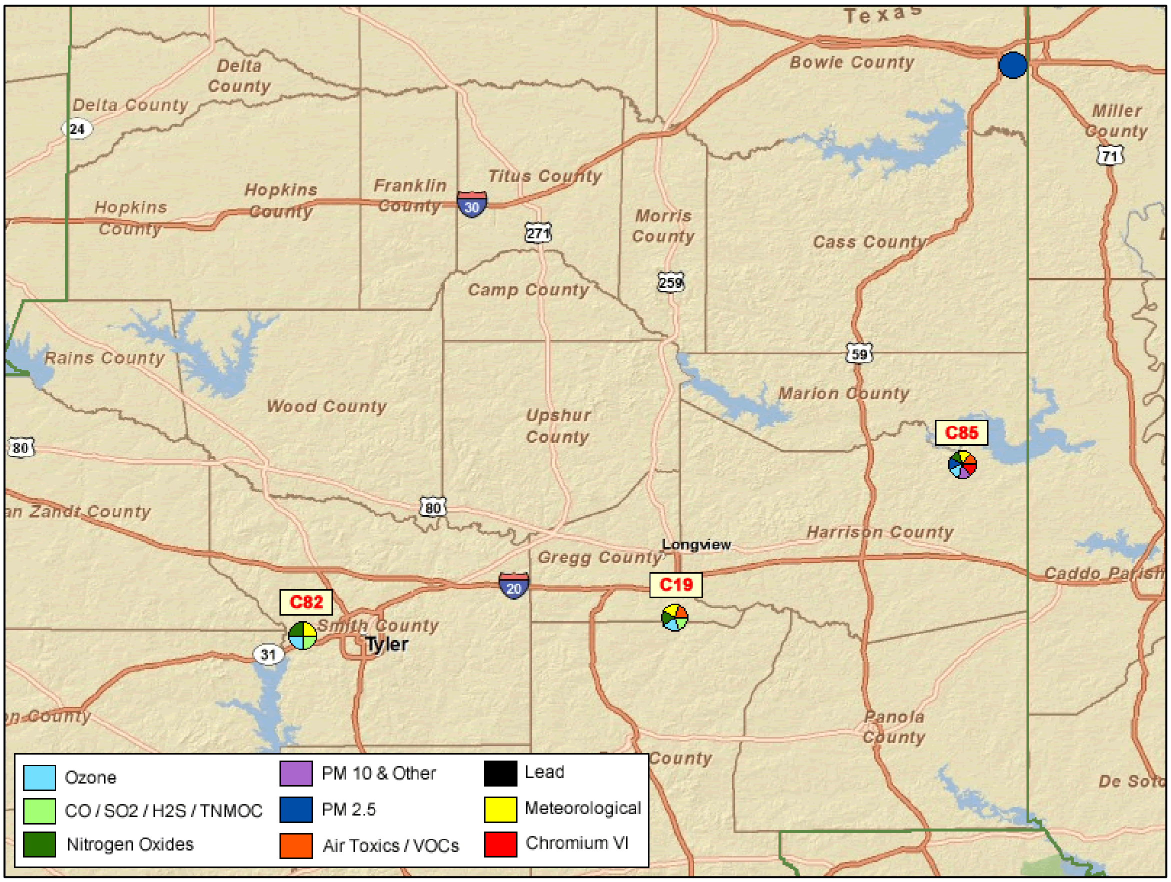


Figure 1-4. Northeast Texas and TCEQ CAMS monitor locations. TCEQ figure from http://gis3.tceq.state.tx.us/geotam/index.html.

The 1979 1-hour NAAQS for ozone (no longer in effect) limited the frequency with which the daily maximum 1-hour average concentration can exceed 0.12 ppm to once per year (averaged over three years), while the 1997 8-hour standard set a maximum level (0.08 ppm) for the three year running average of annual fourth highest daily maximum 8-hour average (MDA8) concentration. The 1-hour standard was violated if the fourth highest concentration in a period of three consecutive years exceeded 0.12 ppm. Although a single year of data was not considered sufficient to demonstrate attainment, the value of the second highest daily maximum 1-hour concentration in a year was frequently used as an informal indicator of attainment/nonattainment status. This is referred to as the annual 1-hour design value. The 8-hour standard is violated if the annual fourth highest daily maximum 8-hour average concentration averaged over three consecutive years exceeds a threshold value, which was 0.08 ppm for the 1997 standard and is 0.075 ppm (75 ppb) for the 2008 standard. A single year of data is not considered sufficient to demonstrate attainment; instead, the fourth highest value in a given year is used as an indicator of attainment status (upper panel of Figure 1-5). Consequently, we refer to this statistic as the annual 8-hour design value (lower panel of Figure 1-5).

In 1996, the TLM area became a Flexible Attainment Region (FAR) and a mechanism for developing strategies to attain the 1-hour ozone standard was implemented under a Memorandum of Agreement (Flexible Attainment Region Memorandum of Agreement, September 16, 1996). Significant NOx and VOC emission reductions were made by Eastman Chemical Company, TXU (now Luminant) and SWEPCO (also known as AEP-SWEPCO) as part of the FAR and 1-hour ozone SIP that helped the area demonstrate attainment of the 1-hour ozone standard (Table 1-1). Under the 2002 Northeast Texas Region 1-Hour Ozone SIP Revision, Agreed Orders entered into by the Texas Natural Resources Conservation Commission and SWEPCO, Eastman Chemical Company and TXU made enforceable certain surplus voluntary emission reductions of NOx and VOC. The affected companies voluntarily agreed to implement controls to reduce emissions of ozone precursors. NOx emissions reductions affecting Northeast Texas point sources included low-NOx burner projects at SWEPCO's Wilkes, Pirkey and Knox Lee power plants and TXU's Martin Lake and Monticello power plants. NOx emissions reductions programs implemented by Eastman Chemical Company included shutdown of coal-fired boilers and changes to synthesis gas engines, reformer furnaces and heaters, and shutdown of olefin hydration units. Enhanced monitoring programs aimed at reducing HRVOC emissions were implemented.

In May 2002, the Texas Natural Resource Conservation Commission (now the TCEQ) submitted a State Implementation Plan (SIP) for Northeast Texas that demonstrated attainment of the 1-hour ozone standard by 2007.

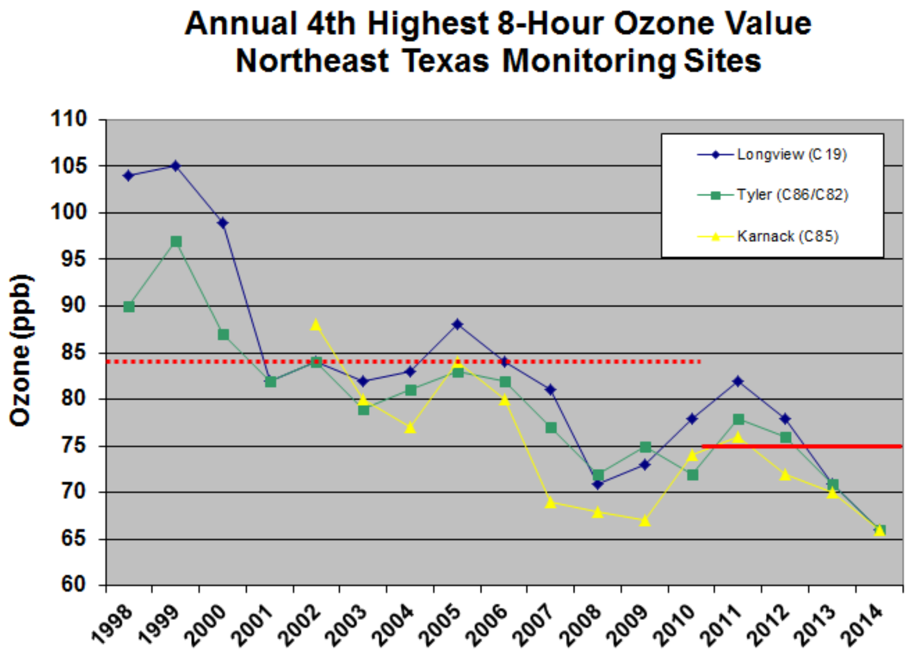
In 1997, the EPA promulgated a new 8-hour NAAQS for ozone that superseded the 1-hour standard. The 8-hour ozone NAAQS was challenged in court and was eventually upheld in 2002 by the U.S. Supreme Court. However, the Court required that the EPA revise its implementation policy. EPA issued a draft revised implementation policy on June 2, 2003. EPA designated all five NETAC counties as 8-hour ozone attainment areas on April 15, 2004 (69 FR 23858).

On December 20, 2002, local governments in the 5-county TLM area entered into an EAC with the U.S. EPA and the TCEQ. The purpose of the EAC was to develop and implement a Clean Air Action Plan (CAAP) to reduce ground level ozone concentrations in the 5-County area and comply with the 8-hour ozone standard by December 31, 2007 and maintain the standard beyond that date. The EAC included a series of milestones to guide progress toward the development of the CAAP as shown in Table 1-1. On December 31, 2007, all three TCEQ CAMS monitors had 8-hour ozone design values less than 85 ppb, indicating that the Tyler-Longview-Marshall area was in compliance with the 1997 8-hour ozone standard, thereby meeting its final milestone under the EAC.

In March, 2008, the EPA promulgated a new, more stringent 8-hour ozone standard of 0.075 ppm (75 ppb). On April 30, 2012, the EPA designated all Northeast Texas counties as being in attainment of the 2008 ozone standard. The EPA carried out its designation process under the 2008 standard using data from the years 2008-2010. Using 2008-2010 data, the design values for all three Northeast Texas monitors were less than 75 ppb and met the 2008 ozone standard.

Table 1-1. Key milestone dates for Northeast Texas NOx and VOC emissions reductions and the Northeast Texas Early Action Compact.

Date	Item
1999-2000	SWEPCO (also known as AEP-SWEPCO) carried out burner projects resulting in over 5,000 tpy NOx emissions reductions at the Wilkes, Pirkey, and Knox-Lee Power Plants in Northeast Texas
September, 2001	Eastman entered into Voluntary Agreed Board order committing to NOx emission reductions of over 1,000 tpy that were accomplished by May 31, 2003.
2003	TXU (now Luminant) carried out emissions reductions projects resulting in over 21,000 tpy NOx reductions at the Martin Lake and Monticello Power Plants in Northeast Texas
December 31, 2002	Signed EAC agreement
June 16, 2003	Identified/described potential local emission reduction strategies
November 30, 2003	Initial modeling emission inventory completed Conceptual model completed Base case (1999) modeling completed
December 31, 2003	Future year (2007) emission inventory completed Emission inventory comparison for 1999 and 2007 Future case modeling completed
January 31, 2004	Schedule for developing further episodes completed Local emission reduction strategies selected One or more control cases modeled for 2007 Attainment maintenance analysis (to 2012) completed Submit preliminary Clean Air Action Plan (CAAP) to TCEQ and EPA
March 31, 2004	Final revisions to 2007 control case modeling completed Final revisions to local emission reduction strategies completed Final attainment maintenance analysis completed Submit final CAAP to TCEQ and EPA
December 31, 2004	State submits SIP incorporating the CAAP to EPA
December 31, 2005	Local emission reduction strategies implemented 1. Eastman Chemical Company enhanced leak detection/repair (LDAR) 2. Flint Hills Resources (formerly Huntsman Chemical Company) enhanced leak detection/repair (LDAR) 3. NOx reduction strategies for gas compressor engines 4. DOE "Clean Cities Program" voluntary on-road vehicle emission reductions 5. Incentive Grants to Reduce Emissions from Gas Compressor Engines
December 31, 2007	Attained the 1997 8-hour ozone standard



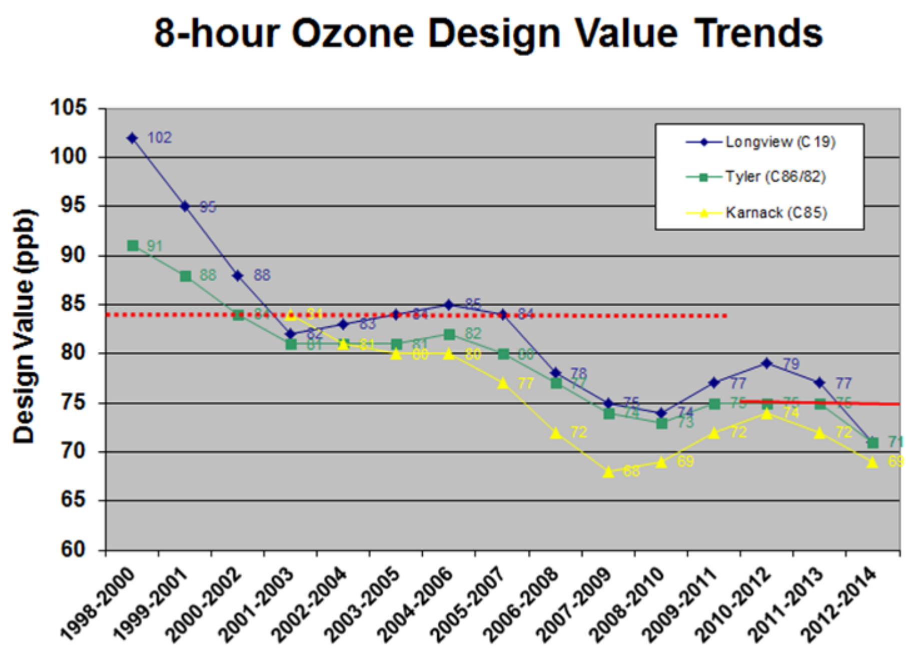


Figure 1-5. Trends in annual 4th highest 8-hour ozone values (upper panel) and design values (lower panel) at the Longview, Tyler, and Karnack monitors in Northeast Texas. The dashed red line indicates the 1996 84 ppb NAAQS and the solid red line shows the 2008 75 ppb NAAQS. All data have been validated by the TCEQ.

Under the Clean Air Act, the EPA is required to review the NAAQS periodically. On November 26, 2014, the EPA announced their intention to lower the NAAQS to a value in the 65-70 ppb range and to finalize the NAAQS by October, 2015. Designations of attainment status are anticipated by October 2017 and will likely be based on monitored ozone levels in 2014-2016. The ozone design value for the TLM area as of December 2014 is 71 parts per billion (ppb), which attains the 75 ppb 2008 National Ambient Air Quality Standard (NAAQS) for ozone.

Depending on where the NAAQS is set, one or more of the TLM area monitors could be out of compliance. The potential for a more stringent ozone standard in the near future underscores the importance of air quality planning in Northeast Texas. Air quality planning, including participation in EPA's Ozone Advance Program, is critical as Northeast Texas strives to protect public health, the environment and the regional economy.

2.0 CONCEPTUAL MODEL OF OZONE FORMATION IN NORTHEAST TEXAS

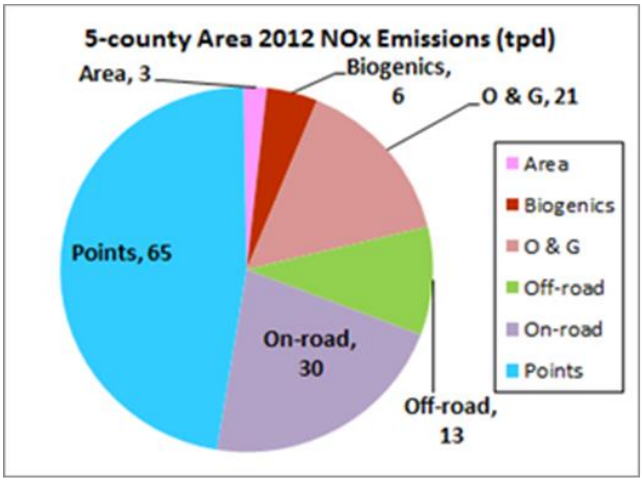
EPA guidance on modeled attainment demonstrations and analyses for ozone (EPA, 2007) indicates that one of the first activities to be completed in ozone air quality planning is the formulation of a conceptual model that qualitatively describes ozone formation mechanisms and provides a rationale for selection of episodes to be modeled. The purpose of a conceptual model is to provide a basis of understanding of ozone in Northeast Texas and a foundation for all ozone air quality planning activities. EPA (2007) specifies that the key components of the conceptual model are analyses of air quality, meteorological and emissions data. Through these analyses, relationships between weather conditions and high ozone events may be established, important emissions sources and trends may be identified, and periods of high ozone suitable for modeling may be selected. Ozone modeling may be used to shed light on the causes of high ozone events as well as the likely effectiveness of proposed control strategies. NETAC has developed a conceptual model for Northeast Texas, and updates this model regularly (e.g. Kemball-Cook et al., 2014a; Kemball-Cook et al., 2013a; Kemball-Cook and Yarwood, 2010a,b; Stoeckenius and Yarwood, 2004). This section of the Ozone Action Plan document summarizes the conceptual model of ozone formation in Northeast Texas and describes results of recent analyses of air quality, emissions and meteorological data and trends.

2.1 Emissions

In this section, we review the emission inventory of ozone precursors for Northeast Texas. The most important ozone precursors are NOx and VOCs. This analysis shows the source categories that make the most important contributions to Northeast Texas' ozone precursor emission inventory.

At the time this Action Plan was prepared, 2012 was the most recent year for which a full TLM area emission inventory (i.e. anthropogenic and biogenic emissions) was available. The 2012 emission inventory was developed by the TCEQ for use in ozone modeling by the Texas Near-Nonattainment Areas, and is broken down by emissions source category. The inventories were downloaded from the TCEQ's Rider 8 ozone modeling website at http://www.tceq.texas.gov/airquality/airmod/rider8/rider8Modeling. We also analyzed 2006 emissions for some anthropogenic emission source categories in order to identify emissions trends in the 5-county area from 2006 to 2012. Area source emissions presented in this section have been divided into two components, non-oil and gas area sources and oil and gas area sources, to facilitate understanding of contributions from oil and gas area sources; oil and gas sources comprise a larger fraction of the area source NOx and VOC inventories than any other single area emissions source category.

Figure 2-1 shows NOx and VOC emissions by source category in the TLM area for 2012. Point sources are the largest contributor to the NOx emission inventory, accounting for 65 tpd or 49% of the total NOx emissions in 2012. Point sources are large, stationary, emissions sources that exceed a specified emissions threshold. In attainment areas of Texas, such as the TLM area, any facility that emits a minimum of 100 tpy of any criteria pollutant must submit a point source emissions inventory to the TCEQ.



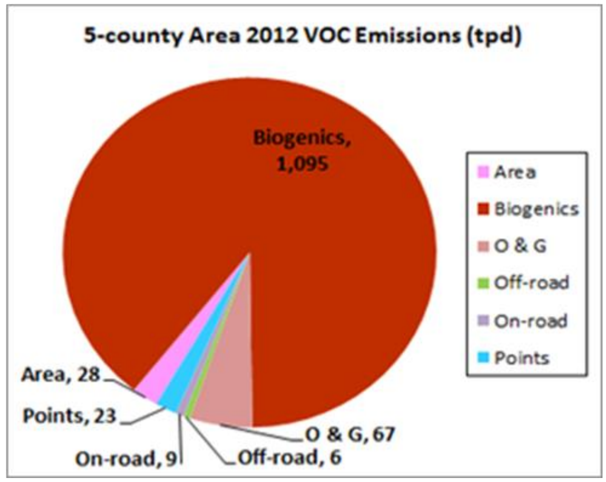


Figure 2-1. TLM 5-county area total 2012 emissions by source category for NOx (left) and VOCs (right). Figure from Grant et al. (2014).

On-road mobile is the next largest contributor to the TLM area NOx emission inventory (30 tpd). On-road emissions were developed by the TCEQ using the EPA's MOVES emissions model (EPA, 2010a, b). The emissions totals represent county-wide emissions for a summer weekday. On-road NOx emissions were computed as the sum of the MOVES output compounds NO, NO_2, and HONO. Oil and gas sources (21 tpd in 2012) are the third largest contributor to NOx emissions. NOx emissions from off-road mobile sources total 13 tpd in 2012. NOx emissions from non-oil and gas area sources (3 tpd) and NOx emissions from biogenics (6 tpd) are relatively small compared to NOx emissions from the other categories.

Oil and gas sources account for approximately 6% of VOC emissions in 2012. Non-oil and gas area sources, on-road vehicles, and point sources are minor contributors to TLM area VOC emissions, each accounting for 1-2% of the total VOC emissions. Approximately 90% of the 2012 VOC emissions in the TLM area come from biogenic sources. Biogenic emissions are naturally-occurring (i.e., not from human activities) emissions from sources such as trees, agricultural crops, or microbial activity in soils or water. The 2012 biogenic emission inventory was developed by the TCEQ using the Model of Emissions of Gases and Aerosols from Nature (MEGAN; Guenther et al., 2012) version 2.10. MEGAN calculates hourly, day-specific emissions that depend on photosynthetically active solar radiation and temperature as well as other inputs such as land cover. Episode average biogenic emissions were extracted from the TCEQ biogenic emission inventory for the 5-county area for the period June 14-30, 2012. VOC emissions in Northeast Texas are dominated by highly reactive biogenic VOCs such as isoprene and pinenes; anthropogenic sources account for a much smaller fraction of total daily highly reactive VOC emissions in the NETAC area.

2.1.1 Relative Importance of Anthropogenic NOx and VOC Emissions in Ozone Formation

In order to develop emission control strategies for Northeast Texas that will reduce the local contribution to ozone, it is necessary to understand how ozone formation in the area depends on the amount of available NOx and VOC. Ozone formation depends on the amount of NOx and VOC present as well as on the ratio of VOC to NOx, where the ratio is taken in terms of ppbC/ppb, where ppbC stands for parts per billion of carbon. When the VOC/NOx ratio is higher than about 10, ozone formation is limited by the amount of available NOx and reducing NOx tends to decrease peak ozone concentrations. However, if the VOC/NOx ratio is less than about 7, reducing NOx tends to increase ozone levels, and the area is said to be VOC-limited. In this situation, which can occur in urban cores of large cities, ozone is suppressed in the urban area due to titration by large amounts of fresh NO emissions. When NOx emissions are reduced, the suppression of ozone by NO is lessened and ozone increases.

We calculated the VOC/NOx ratio in the June 2012 emission inventories for the 5-county area as a whole (Figure 2-1). The VOC/NOx ratio is 29 ppbC/ppb. The VOC/NOx ratio is far greater than 10, which indicates that the TLM 5-county area as a whole is a region where ozone formation is generally limited by the amount of available NOx. This finding is consistent with the results of NETAC's ozone modeling, which also indicate that ozone formation in Northeast Texas is NOx-limited (Kemball-Cook et al., 2013b, 2014b).

2.1.2 Point Source Emission Inventory

In this section, we summarize the point source emission inventory for Northeast Texas. We treat point sources separately from the remainder of the inventory because of their importance in the TLM area NOx emission inventory. A detailed description of the 2012 point source emission inventory for the TLM area is given in Grant et al. (2014). The TCEQ's 2012 point source emission inventory for Northeast Texas was compiled from data from the TCEQ's State of Texas Air Reporting System (STARS) and the EPA's Acid Rain Program Database (ARPDB). The STARS database is administered by the TCEQ. Each year, the TCEQ sends questionnaires to all facilities that meet the reporting requirements of 30 Texas Administrative Code (TAC) §101.10. The TCEQ collects point source emissions data as well as industrial process operating data. For all sources except electric generating units (EGUs), the TCEQ uses this data to compile Ozone Season Day (OSD) emissions. The OSD emission rate represents average daily emissions during the summer, when ambient ozone in Texas is highest.

Point sources are the largest contributor to NOx emissions, accounting for 49% of the total emissions in 2012. Point source emissions make a minor contribution to total VOC emissions (1.8%). Figure 2-2 shows the location of TLM area point sources in the 2012 TCEQ emission inventory. The size of the facility location circle is representative of the magnitude of facility-level NOx emissions. There are a number of large NOx sources in the vicinity of the CAMS 19 monitor in Longview. While the greatest number of point sources is in Harrison County and Gregg County, Harrison County and Rusk County have the highest point source NOx emissions while Harrison and Smith County have the highest point source VOC emissions.

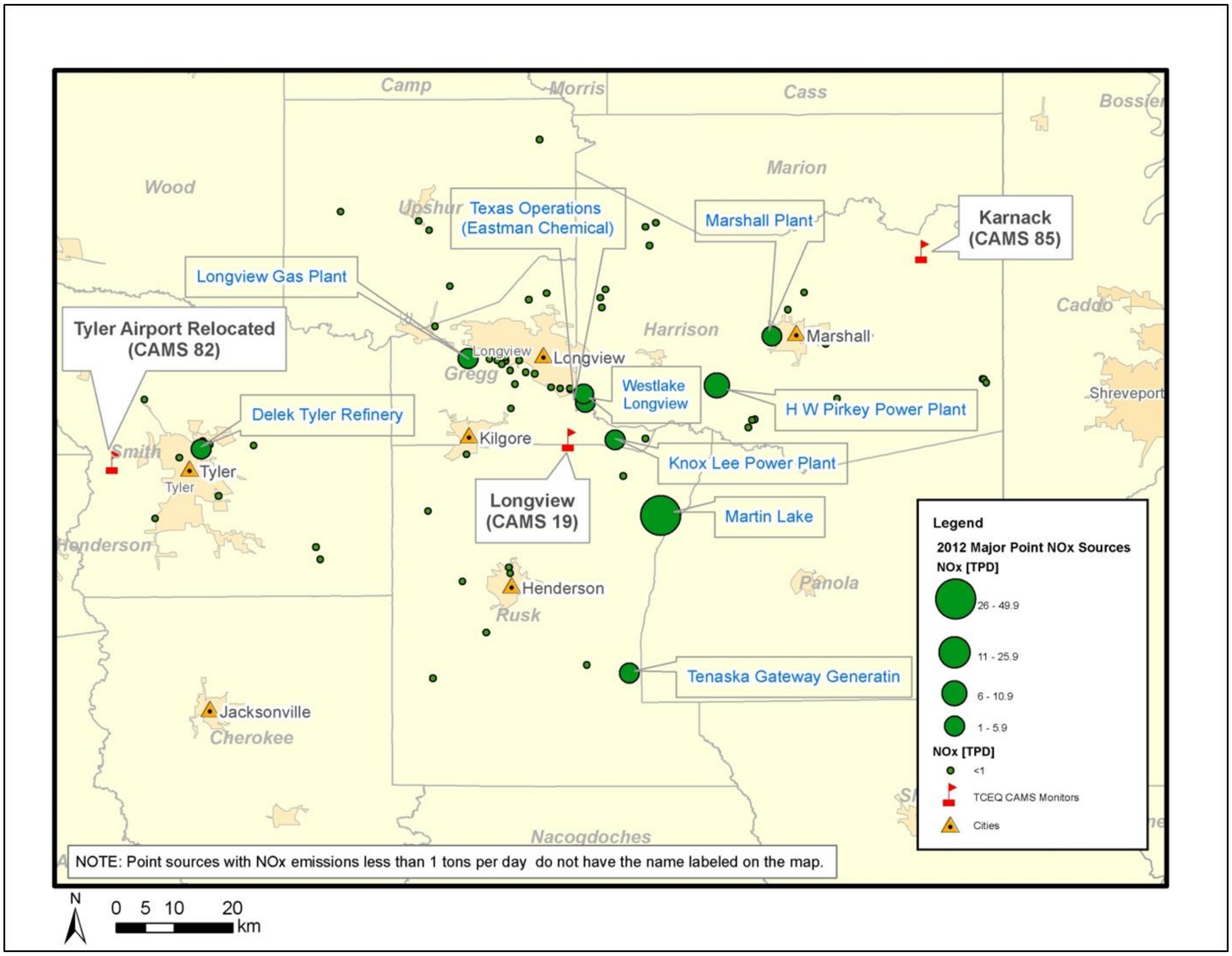


Figure 2-2. Map showing location of TLM 5-county point sources in the TCEQ 2012 emission inventory and their NOx emissions.

Figure 2-2 shows the top 15 NOx emitting point sources in the 2012 emission inventory which comprise 96% of NOx point source emissions in the TLM area. The Martin Lake Electrical Station is by far the largest NOx emissions source, accounting for 51% of point source NOx emissions; the Pirkey Power Plant is the second largest NOx emissions source, accounting for 17% of NOx point source emissions. The Texas Operations facility (Eastman Chemical Company) is the largest VOC point source, accounting for 28% of VOC emissions from point sources. Four of the top 15 NOx emission sources are part of the electric generation sector, five are part of the oil and gas sector, and the remaining six sources are a mix of other types of industrial facilities. The top 15 VOC emissions sources are comprised of two electric generation sector facilities, four oil and gas sector facilities, while the remaining nine facilities are a mix of other types of industrial facilities.

Table 2-1. NOx and VOC point sources in the TLM area ranked by emissions.

Facility	County	2012 NOx tons/day	2012 NOx Percent of TLM point emissions		Facility	County	2012 VOC tons/day	2012 VOC Percent of TLM point emissions
Martin Lake Electrical Station	Rusk	33.3	51%		Texas Operations (Eastman Chemical Company)	Harrison	6.3	28%
Pirkey Power Plant	Harrison	11.0	17%		Westlake Longview	Harrison	3.1	14%
Texas Operations	Harrison	4.0	6%		Delek Tyler Refinery	Smith	2.0	9%
Knox Lee Power Plant	Gregg	2.3	4%		Martin Lake Electrical Station	Rusk	0.8	4%
Delek Tyler Refinery	Smith	2.2	3%		Henderson Lumber Mill	Rusk	0.6	3%
Longview Gas Plant	Gregg	1.9	3%		Republic Industries Inc.	Harrison	0.5	2%
Marshall Plant	Harrison	1.5	2%		Trane Residential Solution	Smith	0.5	2%
Electric Power Generation (Tenaska Gateway Partners)	Rusk	1.4	2%		Marshall Plant	Harrison	0.4	2%
Westlake Longview	Harrison	1.4	2%		Harrison County Power Project	Harrison	0.4	2%
Stateline Compressor Station	Harrison	1.0	2%		Henderson Gas Plant	Rusk	0.4	2%
Eastman Cogeneration Facility	Harrison	0.9	1%		Trinity Industries Plant 19	Harrison	0.3	1%
Crossroads Gas Plant	Harrison	0.3	1%		Willow Springs Plant	Gregg	0.3	1%
Waskom Gas Plant	Harrison	0.3	1%		Rexam Beverage Can Co	Gregg	0.3	1%
Henderson Gas Plant	Rusk	0.3	1%		Crossroads Gas Plant	Harrison	0.3	1%
Joy Global Longview Operation	Gregg	0.3	<0.5%		Longview Gas Plant	Gregg	0.3	1%

The Sabine Industrial District (SID) is a large chemical plant near Longview and includes facilities owned by Eastman Chemical Company, Westlake Chemical Corporation and Flint Hills Resources (Figure 2-3). The SID reports emissions of highly reactive VOCs (HRVOCs; i.e. alkenes such as ethene and propene) as well as NOx; HRVOCs and NOx are ozone precursors. Rapid and efficient formation of ozone is possible downwind of a source that emits both HRVOCs and NOx (e.g. Kleinman et al., 2002). NETAC field studies and modeling efforts indicate that HRVOCs from the SID can play a role in high ozone events at the CAMS 19 monitor in Longview.

Much work has been completed in point source emissions characterization and minimization at the Sabine Industrial District (SID). Significant NOx and VOC emission reductions were made by Eastman Chemical Company as part of the FAR and 1-hour ozone SIP that helped the area demonstrate attainment of the 1-hour ozone standard (See Section 1.3). In addition to these emissions reduction projects, various means of emissions characterization have been employed to support NETAC's rigorous modeling efforts. Below is a description of the various emissions characterization methods.

Emissions Inventory:

Emissions Inventories are the basis for numerous efforts including trends analysis, regional and local scale air quality modeling, regulatory impact assessments, and human exposure modeling. SID facilities submit annual reports that comply with the EPA's protocol for emissions inventories as set forth by the EPA on http://www.epa.gov/ttn/chief/. NETAC has utilized SID emissions inventory information in development of the conceptual ozone model for Northeast Texas.

Baylor Aircraft Study:

NETAC's September 9, 2005 aircraft flight found overlapping plumes of HRVOC, NOx and ozone downwind of the SID (Alvarez et al., 2006a,b; 2007). The highest ozone concentration measured by the aircraft exceeded 200 ppb and was co-located with an HRVOC plume that extended downwind from the SID. A records review found no reports of unusual operating conditions at chemical plants on this day. Data acquired during this flight showed that rapid and efficient ozone formation can occur immediately downwind of the SID. This is important given the proximity of the SID to the Longview monitor (Figure 2-3). Estimates of SID ethene (HRVOC) emissions derived from this single-day 2006 NETAC aircraft flight are consistent with the TCEQ 2005 emission inventory for a typical ozone season day (Kemball-Cook and Yarwood, 2008).

Canister Sampling:

NETAC has collected canister VOC samples at CAMS 19 to augment the TCEQ's monitoring activities at Longview. During August-October, 2008, NETAC carried out a successful monitoring program which confirmed the presence of intermittent plumes of HRVOCs at CAMS 19 (Jobson et al., 2008). HRVOCs were analyzed using a reactive alkene detector (RAD) which made a measurement of total HRVOCs once every second, 24 hours a day, providing a nearly continuous record of HRVOCs at CAMS 19 over a 2 month period. The high time resolution RAD data confirmed the intermittent character of the HRVOC impacts (i.e., HRVOC spikes) and showed that HRVOCs were present on a significant fraction of days, with 10 of 64 sampled days showing strong RAD signals above 30 ppb. The natural background for HRVOCs (i.e. biogenic HRVOCs whose primary constituent is isoprene) at CAMS 19 is expected to be approximately 10 ppb at midday.

NETAC investigated the relationship between periods of high ozone and high HRVOC levels at CAMS 19 during August-September, 2008. Many short periods of high HRVOC levels (HRVOC spikes) were not associated with high ozone at CAMS 19; most of these spikes occurred at night. Some days with HRVOC spikes may not have been conducive to ozone formation (lower temperatures, clouds). However, high 1-hour ozone values coincided with HRVOC spikes on 3 days in September showing that HRVOC spikes have the potential to influence the attainment status of CAMS 19. The wind direction during HRVOC spikes suggests that the nearby SID is the source of the HRVOCs.

In 2010 and 2011, NETAC carried out additional HRVOC monitoring to determine the chemical speciation of the HRVOC plumes that impact CAMS 19 and to quantify the magnitude of HRVOC emissions from the SID. In August-November 2010, speciated VOC measurements were made at CAMS 19 during HRVOC plume impacts using event-triggered canister collection (Jobson et al., 2011). During the event-triggered canister sampling, a continuously-operating HRVOC detector (RAD) monitored the ambient air. When the measured HRVOC levels rose above a threshold value, an automated sampling system opened a canister and pumped ambient air into the canister for a pre-determined time period in order to sample the HRVOC plume. At the end of the sampling period, the canister was sealed and later taken to a laboratory and analyzed in order to determine the chemical composition of the sample. Analysis of canister samples taken during HRVOC spikes may permit chemical fingerprinting of the source(s) of the plumes. Continuous monitoring for alkenes using a RAD to measure HRVOCs was conducted at the CAMS 19 monitoring site from August 25 to November 2, 2010 (Jobson and Pressley, 2011).

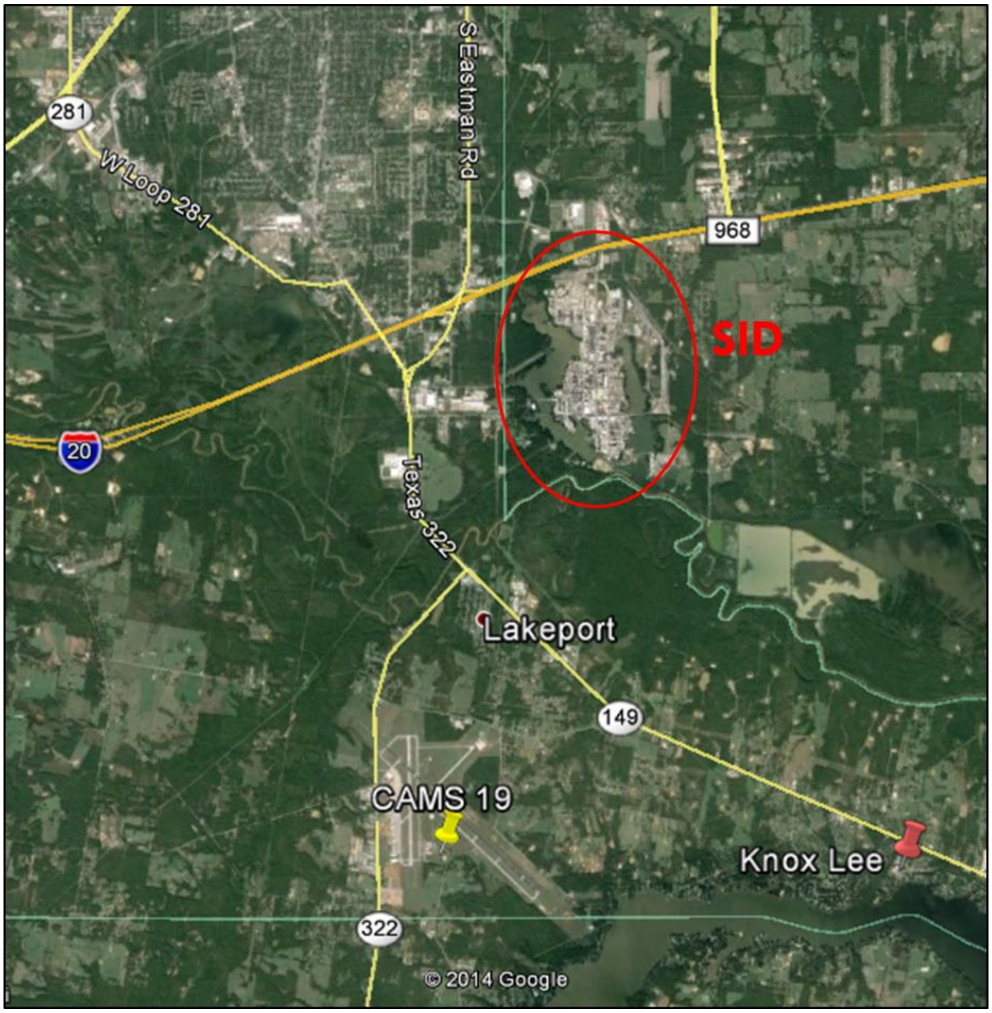


Figure 2-3. Location of the SID, CAMS 19, and other nearby major emissions sources. Map from Google Earth.

Eight canister samples were collected from two HRVOC spikes observed on August 26 and 27. The canisters were analyzed to identify HRVOCs and other hydrocarbons in the plumes. The canister sample analysis showed that ethene and propene were the dominant HRVOCs in the plumes with lesser contributions from other alkenes such as butenes, pentenes, hexenes, and styrene. The highest mixing ratios of ethene and propene were observed in an August 26 canister sample at 81.6 and 51.2 ppb, respectively. Ethane and propane mixing ratios were correlated with those of ethene, consistent with impacts from an ethane cracking facility.

In the RAD-triggered canister sampling study, HRVOCs were detected at CAMS 19, but there were fewer high HRVOC events detected in 2010 than during the 2008 RAD study. Analysis of the CAMS 19 winds shows that the winds in 2010 blew more frequently out of the south than in 2008 and were therefore less favorable for plume impacts from the SID at CAMS 19.

Solar Occultation Flux (SOF) Studies:

In May, 2012, NETAC carried out a study designed to measure HRVOC emissions from the SID (Johansson et al., 2012) The study used SOF (Solar Occultation Flux) measurements to estimate emissions of ethene, propene, alkanes, and other VOCs in plumes detected immediately downwind of the SID. The SOF method is illustrated in Figure 2-4.

The SOF technique measures integrated concentrations of airborne pollutants present in a plume. These concentrations, taken together with measurements of wind speed, allow estimation (±35% error; Johansson et al., 2012) of the emissions from the source. The SOF instrumentation is mounted on a vehicle, which is driven downwind of the facility of interest to intercept plumes of pollutants emanating from the facility (Figure 2-3). As the vehicle drives across a plume, concentrations of pollutant species are measured through the depth of the plume. A mirror/telescope located at the top of the vehicle tracks the sun and reflects sunlight into a Fourier transform infrared (FTIR) spectrometer, which analyses the infrared radiation from the sun. As light from the sun passes through the plume, molecules (including HRVOCs) in the plume absorb some of the incoming sunlight. Molecules have characteristic absorption spectra that can be used to identify their presence and quantify their abundance. The more molecules of a given chemical species are present in the plume, the more sunlight will be absorbed by those molecules as the solar beam passes through the plume. The spectrum of light emerging from the plume is compared with laboratory-measured reference spectra for the pollutants found in the plume. Through comparison of these spectra, the path-integrated concentration (in units of mg m^{-2}) is retrieved for chemical species found in the plume (See Johansson et al. 2012 for details of this procedure and an analysis of its inherent uncertainties).

In situ wind measurements were made by the SOF study team using an extendable met tower and balloon-borne instrument packages that were launched during plume measurements. The wind measurement is the component of the emissions calculations that has the largest uncertainty (Johansson et al., 2012). Once the winds and in-plume pollutant concentrations are measured, emissions estimates can be made for the source(s). An advantage of the SOF technique is that the combination of information on the HRVOC plume location and wind direction can be used to indicate the location of the sources within the facility. Measurements inside the SID were not performed during the 2012 study, so the determination of source locations in this study is approximate.

From May 1-11, 2012, the SOF Team sampled ambient air downwind of the SID. An example of the data collected during a single measurement traverse downwind of the SID is shown in Figure 2-5. The wind was from the southeast during this traverse. The SOF vehicle drove along I-20, north of the SID, and intercepted plumes of ethene and propene. Wind measurements taken during the traverse were used to derive the wind barbs for each measured spectrum that show the direction from which the wind was blowing at the time the spectrum was recorded. The wind barbs indicate that the measured plumes of ethene and propene originated within the SID.

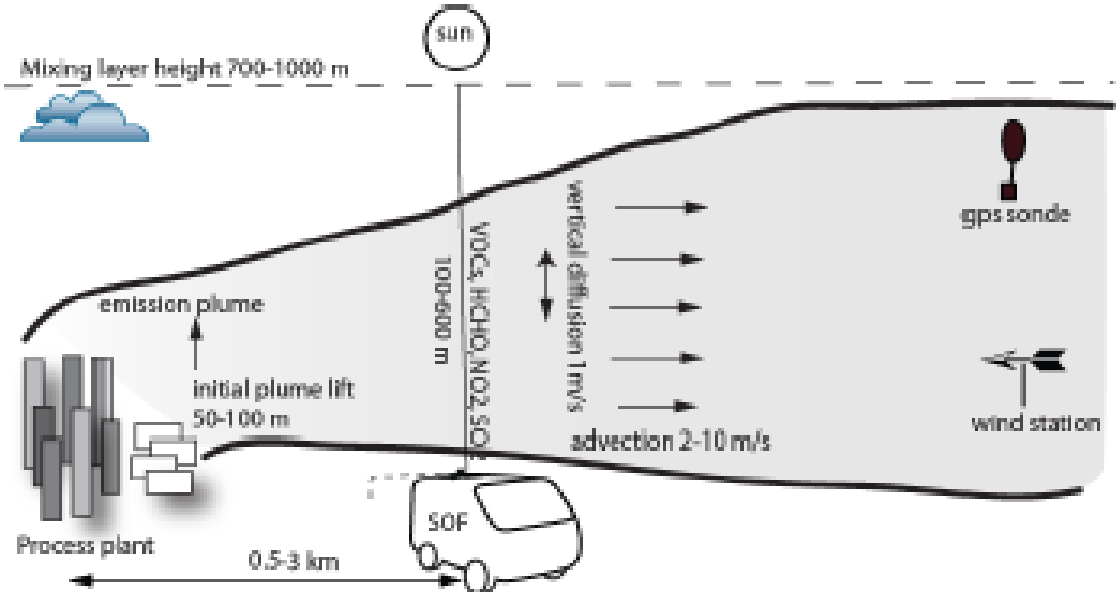


Figure 2-4. Schematic of SOF measurement technique. Figure from Johansson et al. (2012).

The SOF Team were unable to measure HRVOCs upwind of the SID for comparison with the downwind traverse shown in Figure 2-5 because there is no public road access to the south of the SID (upwind). Nevertheless, there is little doubt that the HRVOCs detected immediately downwind of the SID in Figure 2-5 are from emissions within the SID because the HRVOCs fluxes drop to near zero on both sides (east and west) of the downwind plume. The SOF team obtained 67 ethene traverses and 60 propene traverses downwind of the SID during May 2-10, 2012.

Ethene and propene emissions rates were calculated for each traverse. On two of the 8 study days, emissions of propene (436 kg hr^{-1}, equivalent to 12 tpd) and ethene (335 kg hr^{-1}, equivalent to 8.8 tpd) were measured that were significantly higher than on the other days of the study. On these days, the site experienced a startup that was reported via Title V deviation reporting in accordance with TCEQ requirements (November 30, 2012 Semi-annual Title V Potential Deviation Report). Because these startup emissions were much higher than normal operation emissions, traverses made on emission event days were excluded when calculating "typical day" SOF measurement-based emission estimates for 2012. In 2011, a single day of SOF measurements was made by the same SOF team downwind of the SID, as described in Johansson et al. (2011). SOF measurement-based emissions estimates for propene (7.5 tpd) and ethene (12 tpd) in the 2011 study were comparable to the emissions rates on the two high emissions days of the 2012 study. It is important to note that the 2011 study sampled only one day, while the 2012 study sampled 8 days. The average emissions rates from the 2012 study that were calculated without the unusually high days (days with atypical emissions events) are therefore the SOF measurement-based emissions estimates that are most comparable to the average ozone season SID emissions inventory estimates in the TCEQ emission inventory.

Johansson et al. (2012) reported 2012 SOF measurement-based emissions estimates with and without the data from two days that had larger emissions than the other days. When the two atypical days were excluded, the average SOF measurement-based emissions estimates for ethene (5.4 tpd) agreed with the 2012 TCEQ typical day ethene emissions inventory estimates (4.1 tpd) within the experimental uncertainty of ±35%. In contrast, the SOF measurement-based emissions estimates for propene (4.6 tpd) were a factor of 4 higher than the TCEQ typical day propene emissions inventory estimates (0.96 tpd). Propene has a greater tendency to form ozone (reactivity) than ethene, and can accelerate ozone formation and affect air quality in the Longview urban area and at the CAMS 19 monitor. This difference between SOF measurement-based emissions estimates and emissions inventory estimates is large and may point to significant emission estimation issues (measured and/or reported). A factor of 4 underestimate in the propene emission inventory can also affect the accuracy of NETAC's ozone modeling. It should be noted that a discrepancy between emissions inventory and SOF results has been observed in many studies. The 2012 SOF report states "The SOF method has been applied in several larger campaigns in both Europe and the US and in more than 45 individual plant surveys over the last 7 years. In the various campaign studies it has been found that the measured emissions obtained with SOF are 5-10 times higher than the reported emission obtained by calculations" (Johansson et al., 2012).

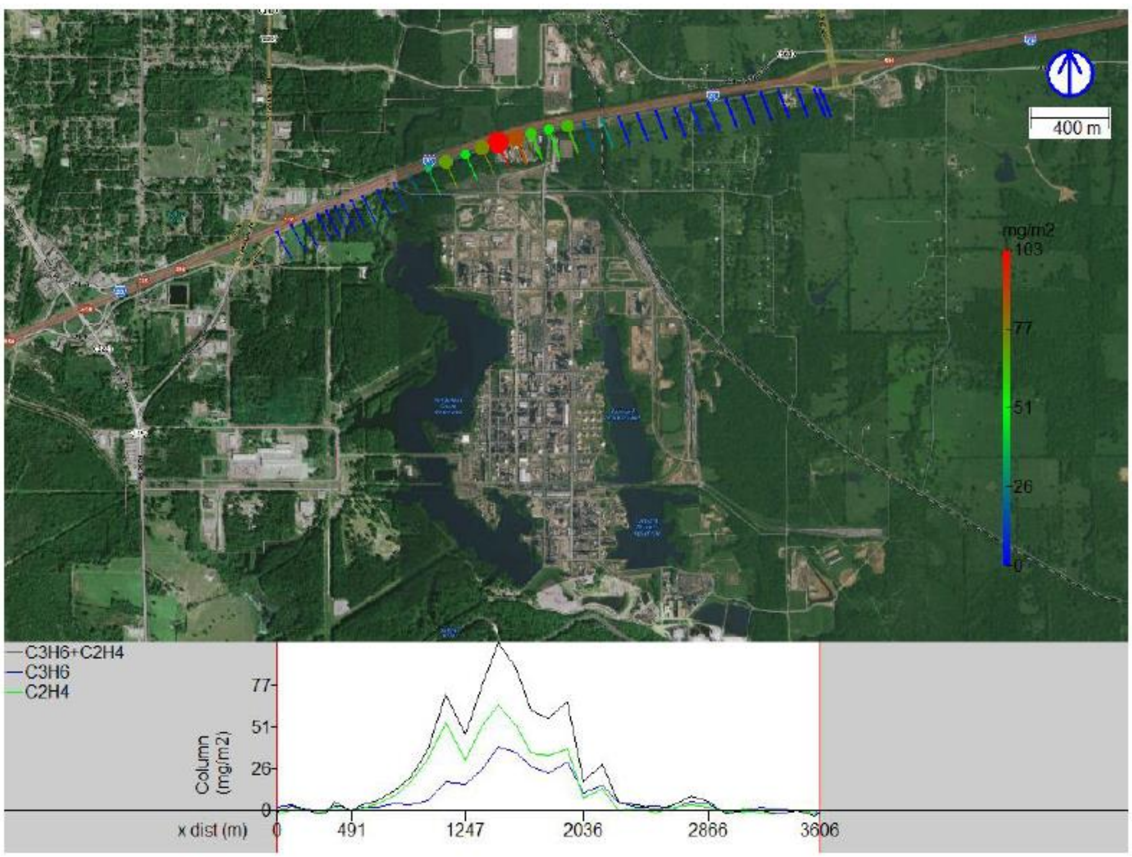


Figure 2-5. Example of SOF measurements of ethene and propene made during a single traverse downwind of the SID on May 3, 2012. Figure from (Johansson et al., 2012). In the

upper panel, each measured spectrum is represented with a point, for which color and size indicate the evaluated integrated vertical column of ethene and propene. A line from each point indicates the direction from which the wind is blowing. The lower panel shows ethene (green line), propene (blue line) and total (black line) columns by distance driven through the plume.

An additional SOF study was completed in April 2015 that adds to the robustness of the 2012 study and included improvements intended to minimize uncertainties in the SOF measurement methodology.

Emissions Characterization Comparisons:

Table 2-2 summarizes recent ethene emissions estimates for a typical day for the SID based on the multi-day SOF study (without the two atypical high emissions days) and TCEQ emission inventories. The Baylor aircraft study and 2011 SOF studies are not shown because they are single day studies that may not be representative of typical day emissions. Multi-day studies are preferred for estimating typical day emissions. The estimates of typical ozone season day SID emissions shown in Table 2-2 range between 3.0 and 5.4 tpd. The 2012 SOF ethene emissions are 30% higher than the reported emission inventory, but within the 35% error bounds of the measurement method. Note that the reported emission estimate also contains uncertainty arising from the estimation method and data. One reason for the increase in the ethene emissions inventory between 2009 and 2012 is the startup of one of Eastman's ethylene cracking plants in 2011[1].

Table 2-2. Estimates of typical day SID ethene and propene emissions.

Source of Emissions Estimate	Ethene Emissions (tpd)	Propene Emissions (tpd)
TCEQ 2005 EI	4.6	--[2]
2009 STARS EI	3.0	0.85
2012 SOF Study*	5.4	4.6
TCEQ 2012 Modeling EI	4.1	0.96

*Excludes periods of unusually high emissions measurements

Our current understanding is that emissions of HRVOCs from the SID can contribute to high ozone at CAMS 19 and that such contributions occur intermittently according to wind direction and/or day-to-day variations in emissions (i.e. 3 out of 64 days in NETAC's 2008 RAD HRVOC monitoring study). CAMS 19 has historically had the highest design value of the three Northeast Texas monitors and drives the area's attainment status. The 2010 RAD-triggered canister study

[1] "Eastman is restarting cracker capacity at its Longview, Texas, complex", Chemical & Engineering News, 89(10), March 07, 2011

[2] Calculation of emissions from the TCEQ 2005 EI from Kemball-Cook and Yarwood (2008) was performed for ethene only.

showed that the HRVOCs of anthropogenic origin that are measured most frequently and in the largest quantities are ethene and propene.

Daily emissions data from the 2012 SOF study (Table 2-2) agree within experimental uncertainty with SID emissions of ethene reported in current emission inventories collected by TCEQ. However, SID emissions of propene reported in current emission inventories do not compare as well. There are a number of possible explanations for the differences, including known uncertainties in both the SOF emission measurements and in the prescribed TCEQ and EPA emissions estimating methods as well as emissions that are currently not well-characterized. A number of SOF study improvements have been developed by NETAC and were included in another SOF study that was conducted around the SID in the spring of 2015. The purpose of this 2015 study was to improve the characterization of emissions from the SID to further our understanding of ozone formation and to increase the accuracy of the HRVOC emissions used for ozone modeling. Measurements of HRVOCs and ozone at CAMS19 have demonstrated that HRVOC emissions from the SID can increase ozone at CAMS19. Consequently, NETAC's ozone modeling should use the best possible HRVOC emission inventory in order to identify the most effective emissions control strategies.

2.1.3 Oil and Gas Emission Inventories

Oil and gas emissions make up a large fraction of the 2012 TLM area anthropogenic VOC and NOx emission inventories due to the number of oil and gas wells in the TLM area. As shown in Figure 2-6, there are thousands of oil and gas wells in the TLM area, with the largest number of gas wells in the counties of Harrison and Rusk. Northeast Texas has conventional oil and gas production as well as unconventional natural gas production from the Haynesville Shale. In this section, we give an overview of oil and gas production in the 5-county area from both conventional and shale sources, and then focus on the Haynesville Shale and NETAC's efforts to characterize emissions from its development.

2.1.3.1 Overview of Oil and Gas Production and Emissions in the 5-County Area

Figure 2-7 shows TLM area total estimates of oil and gas production and well count. The number of oil wells in the 5-county area has stayed relatively constant during the last decade, while oil production has declined. Most of the 5-county area oil wells are located in Gregg and Rusk Counties (Figure 2-8). The TLM area natural gas well count increased by more than a factor of two between 2000 and 2015. The growth in the number of new wells was largest over the three year period from 2006 to 2009; Harrison and Rusk Counties each saw an increase of about one thousand natural gas wells during this time (Figure 2-8). This period of intense drilling activity coincided with high natural gas prices and the rapid development of the Haynesville Shale. Harrison and Rusk are the two TLM counties with the largest number of Haynesville wells and showed the largest increases in well count and natural gas production of all of the TLM area counties.

After 2009, drilling slowed due to the economic recession and low natural gas prices. TLM area natural gas production reached its peak in 2008 and then declined as the rate of drilling of new wells slowed and production from existing wells declined. While counts of active oil and gas wells have been relatively constant since 2009, factors such as an increase in natural gas price and/or development of liquefied natural gas export facilities have the potential to lead to increase natural gas well development, especially in the Haynesville Shale natural gas formation. Recent reports suggest that liquefied natural gas facilities may be developed in close proximity to the Haynesville Shale which would provide increased demand for Haynesville Shale natural gas. It was reported that the South African Fuels Corporation, Sasol, intends to build an ethene cracker and derivatives complex in Lake Charles, Louisiana to take advantage of low cost shale gas[3]. Natural gas production increased slightly between 2012 and 2014.

For the period from 2006 to 2012, there was a net decrease in TLM area crude oil production, condensate production, gas production, and oil well counts (gas well counts increase over the 2006 to 2012 period). Given the decreases in all oil and gas activity metrics (excepting gas well counts), a reduction in oil and gas emissions over this period is generally expected; a notable potential exception to this trend is compressor engine emissions, for which activity is dependent on both the amount of gas produced and the field pressure associated with the produced gas.

[3] "Sasol green-lights big Louisiana chemicals project". Chemical and Engineering News. November 3, 2014.

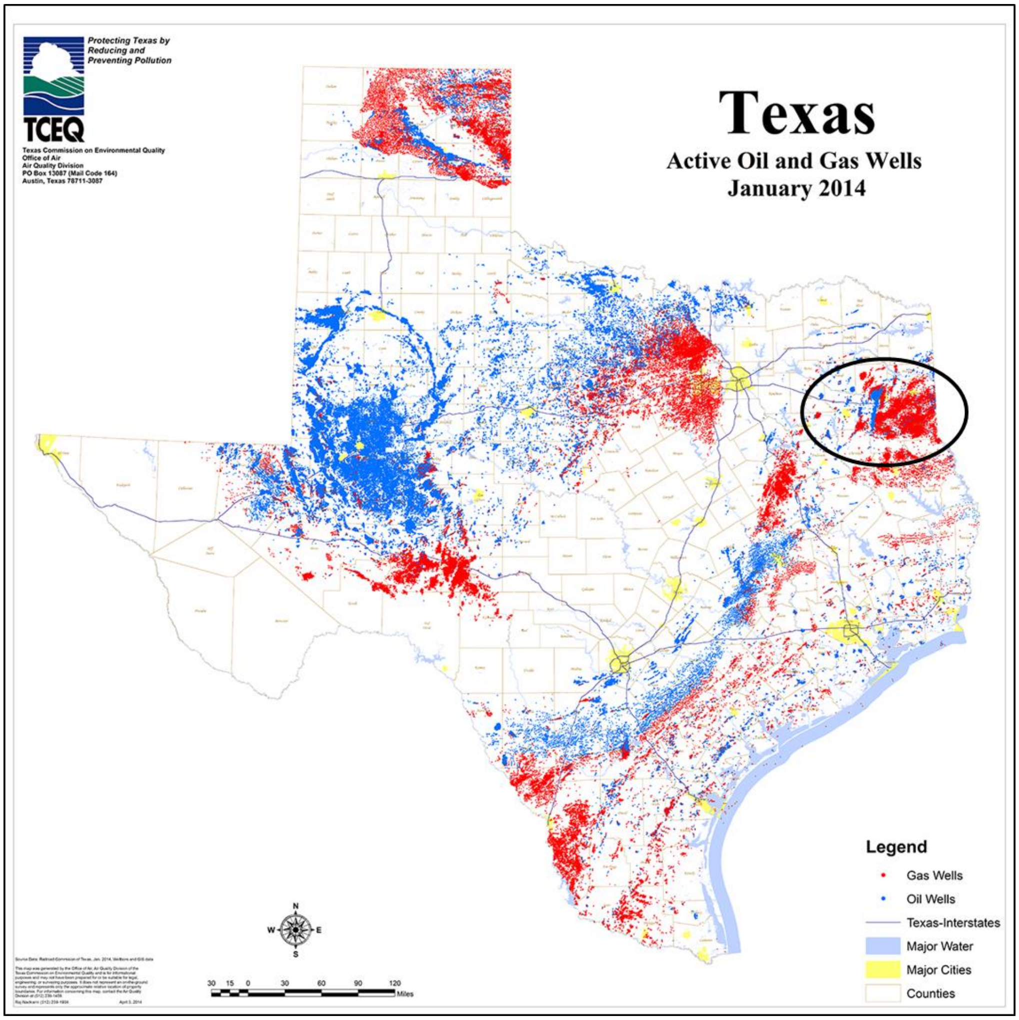


Figure 2-6. Texas oil and gas well locations as of January 2014. TCEQ figure from http://www.tceq.state.tx.us/assets/public/implementation/barnett_shale/bs_images/txOilGasWells.png. Black circle indicates the location of the Northeast Texas 5-county area.

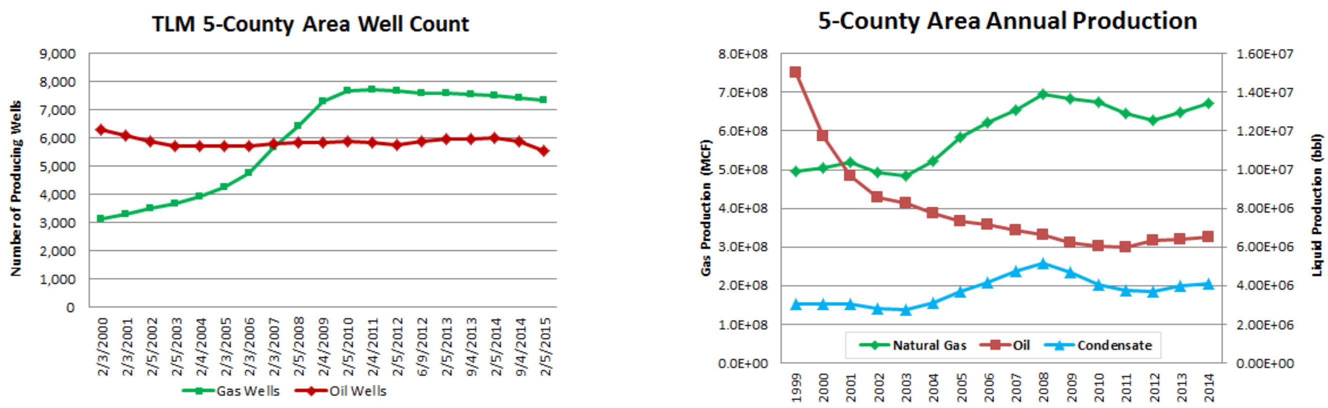


Figure 2-7. **2000-2015 oil and gas production (left) and well count (right) totals for the TLM area.**

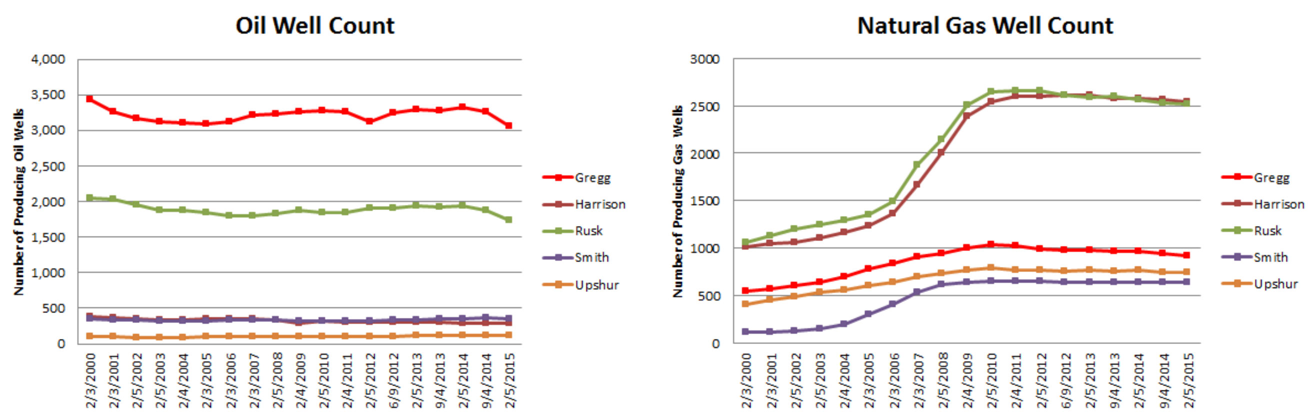


Figure 2-8. **2000-2015 well count for each County in the TLM Area for oil wells (left) and natural gas wells (right).**

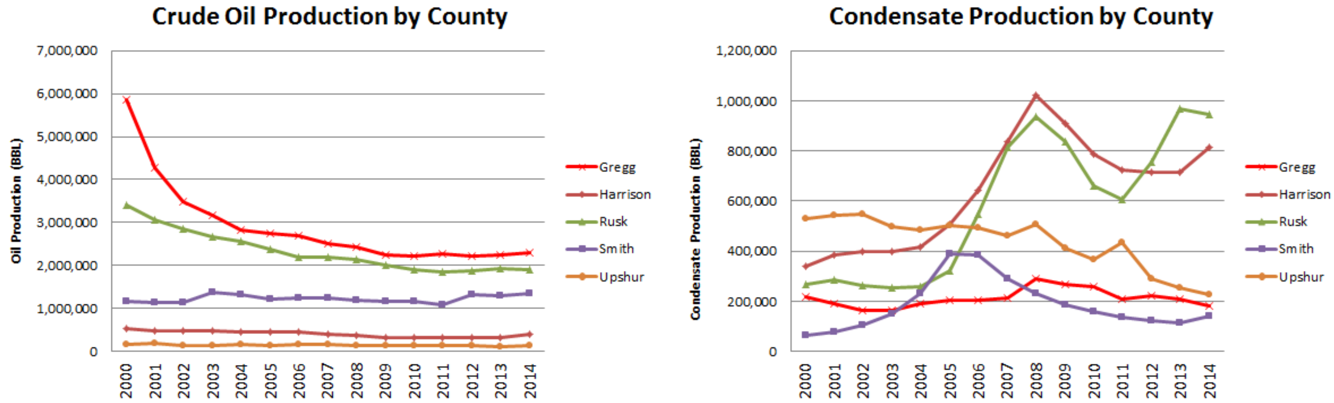


Figure 2-9. Crude oil production for 2000-2014 liquid hydrocarbon production for each County in the TLM Area for crude oil (left) and condensate (right).

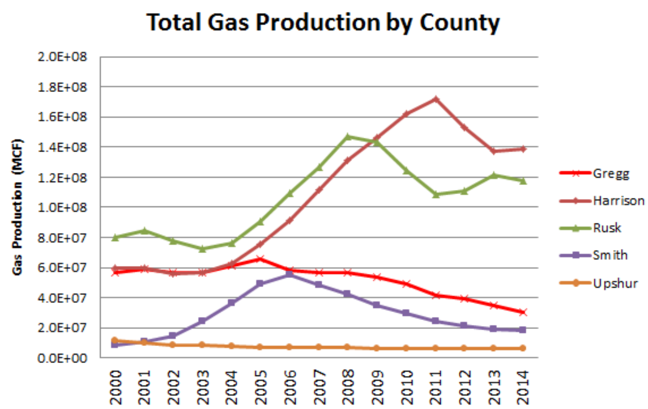


Figure 2-10. Total gas production for 2000-2014 in the TLM Area.

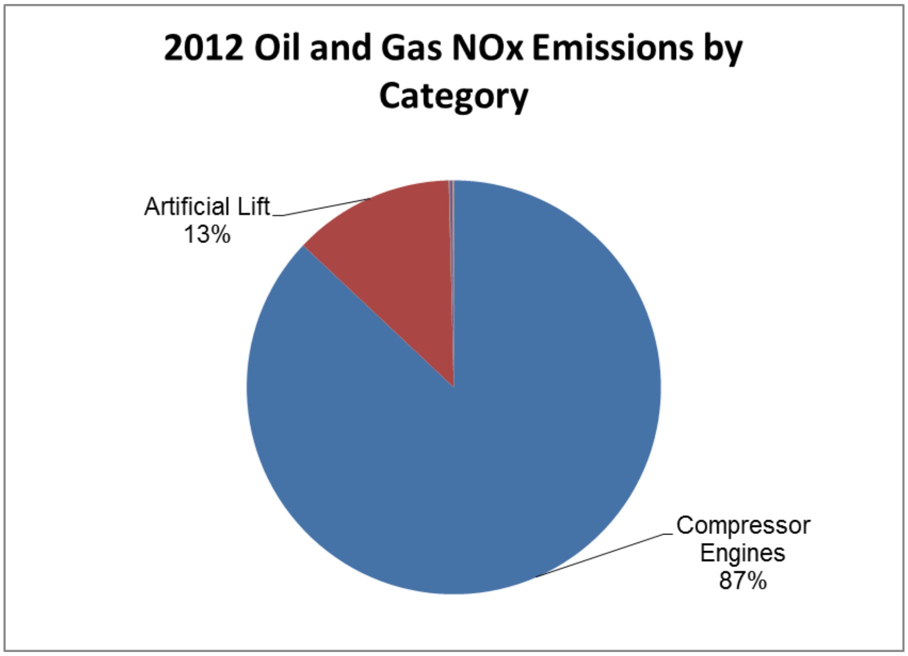


Figure 2-11. TLM 2012 oil and gas source NOx emissions by source category.

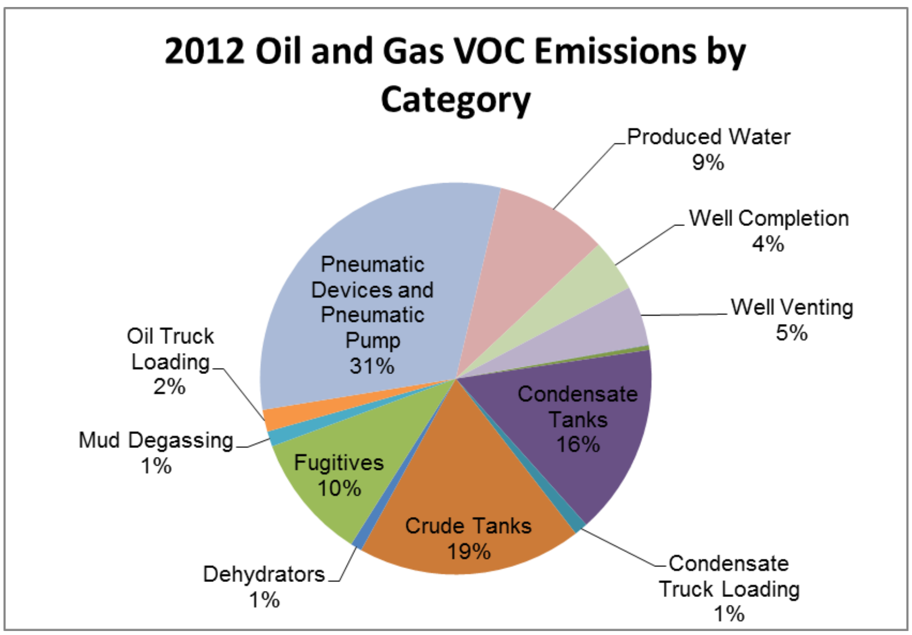


Figure 2-12. TLM 2012 oil and gas source VOC emissions by source category.

The breakdown by source category for the TLM area 2012 oil and gas emissions is shown in Figure 2-11 and Figure 2-12. The TLM area oil and gas NOx emission inventory is dominated by a single emissions source category. Figure 2-11 shows the contribution from gas compressor engines to the 2012 TLM area NOx emission inventory (18 tpd). Gas compressor engines are used to extract natural gas from a well when reservoir pressures alone are insufficient to bring the gas to the surface. Compressor engines are also used to transmit natural gas along pipelines from the well to gas processing plants and then to consumers. In a mature gas field, such as those found in Northeast Texas, the need for compression to produce the gas increases over time as the subsurface gas reservoir is drained and reservoir pressures drop.

The magnitude and distribution of compressor engine emissions influence ozone formation, and accurate characterization of these emissions is important to the success of ozone modeling of Northeast Texas. At the request of NETAC, Pollution Solutions compiled an inventory of ozone precursor emissions from gas compressor engines in the 5-county area of Northeast Texas for the year 2005 (Pollution Solutions, 2006). Pollution Solutions based county-level compressor engine emissions on the county well count and emission factors derived from survey data. The gas compressor engine inventory was checked against the TCEQ point source inventory to avoid double counting emissions, as large engines are already accounted for in the point source inventory. In 2005, gas compressor engines contributed approximately 33 tons of NOx per day in the 5-county area (Pollution Solutions, 2008). The Pollution Solutions study estimated that 94% of the NOx emitted by gas compressor engines in the 5-county area was generated by small gas compressor engines used for wellhead compression (Pollution Solutions (2006); these engines have emissions lower than the threshold for inclusion in point source emission inventories developed by the Texas Commission of Environmental Quality (TCEQ). While an individual wellhead gas compressor engine may have emissions that are too low to trigger emissions control requirements, the total 2012 NOx emission contribution from all gas compressor engines in the 5-county area taken together is of the same order of magnitude as a power plant.

In March, 2010, a Texas emissions reduction measure known as the East Texas Combustion Rule went into effect. The East Texas Combustion Rule requires owners and operators of stationary, rich-burn gas-fired, reciprocating internal combustion engines greater than or equal to 240 HP in 33 East Texas counties (including all five NETAC Counties) to meet NOx emission limits and follow specified reporting requirements. The fraction of engines in the 5-county area that have horsepower < 240 HP and are therefore not required to comply with the East Texas Combustion Rule is not known. A recent NETAC study (Alvarez et al., 2013) reviewed engine test reports made to the TCEQ's Tyler Office and found that the number of owners/operators of engines of ≥240 HP reporting to TCEQ in 2011 under the East Texas Combustion Rule is smaller than expected based on survey data from the Pollutions Solutions Study and more recent TCEQ data from the Barnett Shale. This could be associated with a shift in the TLM area engine population towards lower horsepower (< 240 HP) or to lean burn engines.

The TCEQ has gathered data on engine distribution for other areas of Texas. The TCEQ Special Inventory for the Barnett Shale collected survey data from oil and gas upstream and midstream facilities in order to determine the location, number, and type of emissions sources associated with oil and gas operations in the Barnett Shale formation during 2009. The TCEQ inventory surveys gathered equipment counts for stationary gas fired engines in selected horsepower range bins (0 to 50 HP, 50 to 240 HP and over 240 HP) and by engine type (rich burn versus lean burn). The results of the study show that in the Barnett Shale region as a whole and in Hill County, the majority (about 80 percent of the population) of the gas compressor engines are <240 HP in size. It also shows the majority of the engines in the <240 HP range are rich burn type engines (about 95 percent).

There is no survey data available to determine what fraction of engines with horsepower<240 HP in Northeast Texas are currently uncontrolled, but the Barnett Shale survey data suggests that there may be a significant number of gas compressor engines in the 5-county area that could be considered for low-cost, voluntary NOx emission controls implemented at the local level. In 2005, NETAC implemented a pilot project to demonstrate the effectiveness of retrofitting small (< 500 hp), spark-ignited, rich-burn compressor engines used in natural gas production with exhaust catalysts and electronic air/fuel ratio controllers (Friesen and Yarwood, 2007). At the end of a year-long test period, these controls were achieving an estimated emission reduction efficiency of greater than 90%, or 0.1 ton/day NOx per engine at a cost effectiveness of less than $200 per ton of NOx reduced.

Emissions sensitivity tests with NETAC's ozone models show that retrofit of compressor engines with catalysts to control NOx emissions can produce ozone reductions in the 5 county area (Kemball-Cook et al., 2010c). Improving our understanding of the TLM compressor engine emission inventory based on local data on compressor engine population, horsepower, and emission factors as a high priority based on the magnitude of NOx emissions from this source category, the uncertainty in the underlying engine data and the cost-effectiveness of potential NOx emission reductions from compressor engines.

2.1.3.2 The Haynesville Shale

The Haynesville Shale is located approximately 10,000-13,000 feet beneath Northeast Texas and Northwest Louisiana (Figure 2-13) and contains very large recoverable reserves of natural gas (EIA, 2011). Intensive exploration of the Haynesville began in 2008, and as of December 2012, there were nearly 3,000 wells producing natural gas from this formation. As of December, 2014, the number of producing wells had grown to more than 3,600. The development of natural gas resources in the Haynesville has been economically important, but also generates significant emissions of ozone precursors within the 5-county area as well as in a region of Louisiana that is often upwind of the TLM area ozone monitors on high ozone days.

During 2009, NETAC developed an emission inventory of ozone precursors for projected future Haynesville Shale development from 2009 through 2020 (Grant et al., 2009). Using well production data from state regulatory agencies and a review of the available literature, projections of future year Haynesville Shale natural gas production were derived for 2009-2020 for three scenarios corresponding to limited, moderate, and aggressive development. These production estimates were then used to develop an emission inventory for each of the three scenarios. The emission inventory covered 5 Texas counties and 6 Louisiana parishes. NETAC's photochemical modeling of the year 2012 using this emission inventory showed that 8-hour ozone impacts occurred within Northeast Texas and Northwest Louisiana as a result of development in the Haynesville Shale, with projected ozone design value increases ranging from 1-5 ppb at Northeast Texas ozone monitors for the aggressive development scenario. Modeled ozone increases due to Haynesville Shale emissions also affected regions outside Northeast Texas and Northwest Louisiana due to ozone transport (Kemball-Cook et al., 2010).

2009 and 2010 were years of rapid development in the Haynesville. In March 2010, there were over 160 rigs drilling in the Haynesville (Figure 2-14); this far exceeded even the aggressive scenario prediction of the Grant et al. (2009) study. Since 2010, the pace of development has slowed due to low natural gas prices and high oil-to-gas price ratio, which encouraged development of formations that contain hydrocarbon liquids, such as the Eagle Ford Shale. NETAC revised its Haynesville emission inventory and future year projections to reflect the changes in the rate of development and to incorporate information gathered from Haynesville operators concerning their operating practices (Parikh et al., 2013). NETAC also developed the first emission inventory for Haynesville Shale mobile sources, including truck traffic (DenBleyker et al. 2013),

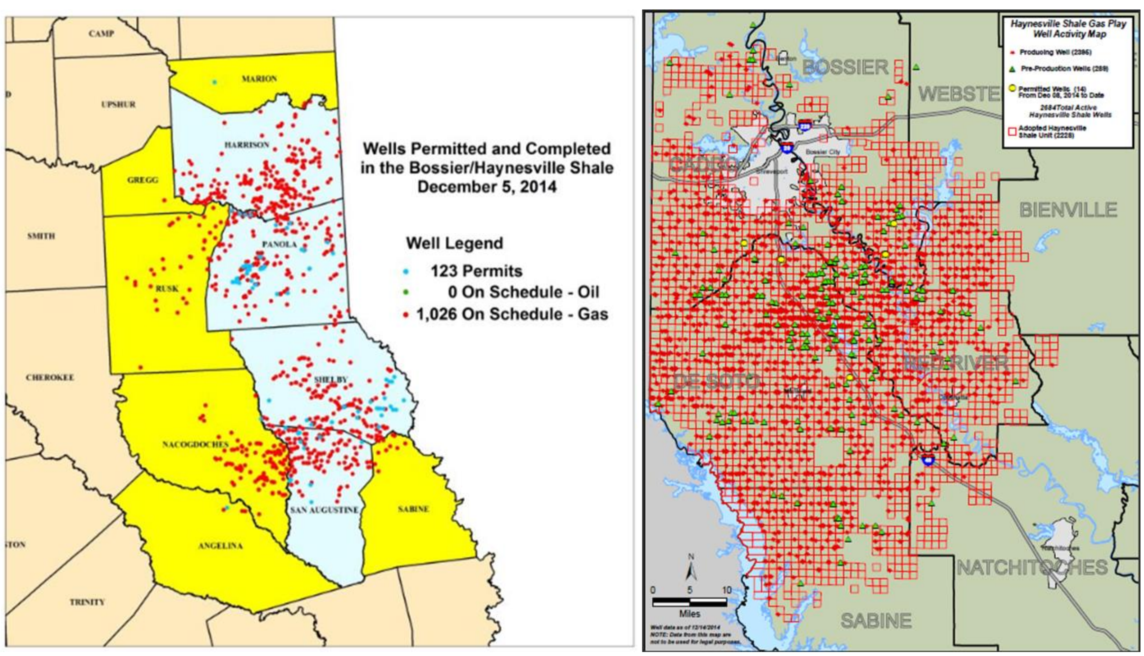


Figure 2-13. Left panel: Spatial extent of the Haynesville Shale in Texas by county and well locations as of December 2014. Figure from the Railroad Commission of Texas website[4]. Pale blue shading indicates that the TRRC considers that county to be a core Haynesville County. Yellow shading indicates that the TRRC considers that county to be a non-core Haynesville County. Lower panel: Extent of the Haynesville Shale in Louisiana as of December 2014[5].

[4] http://www.rrc.state.tx.us/oil-gas/major-oil-gas-formations/haynesvillebossier-shale/
[5] http://dnr.louisiana.gov/assets/OC/haynesville_shale/haynesville.pdf

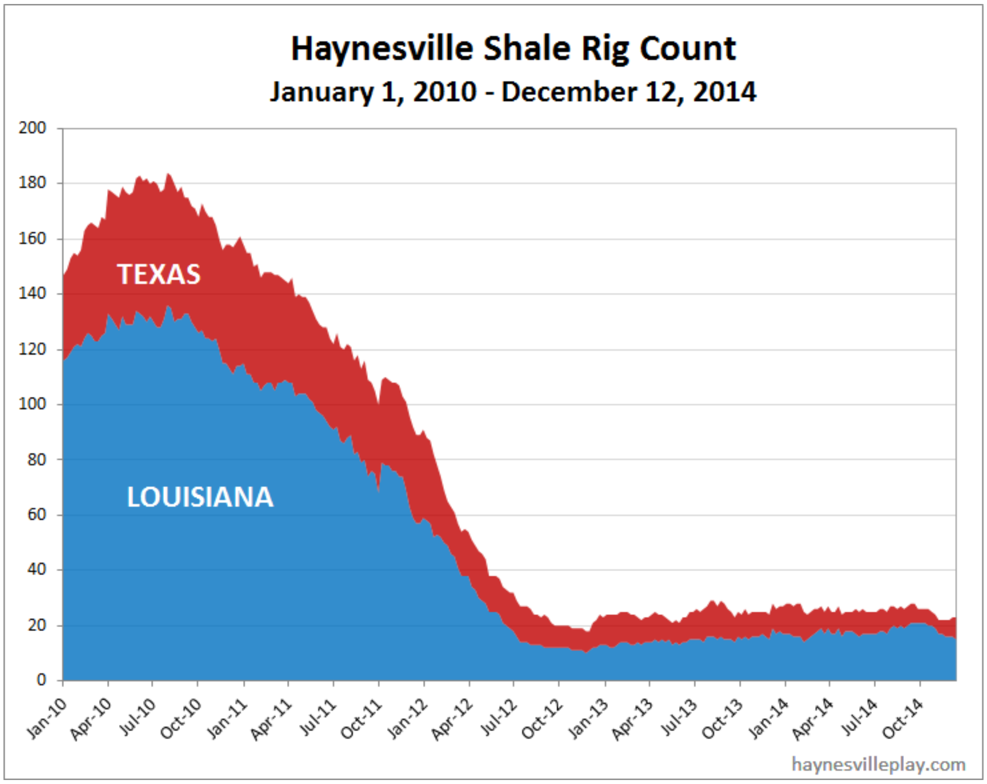


Figure 2-14. Count of drill rigs active in the Haynesville Shale from January 2010-December 2014. Figure from http://www.haynesvilleplay.com/.

which showed that mobile sources comprised 12% (4 tpd) of the total Hayneville emission inventory in 2012.

NETAC's recent emission inventory and ozone modeling efforts (Parikh et al. 2013; Kemball-Cook et al. 2014) show that while current estimates of emissions that are informed by operator data are lower than the original Haynesville emissions estimates of Grant et al. (2009), the development of the Haynesville Shale can have significant effects on air quality and ozone design values in Northeast Texas. As of December 2014, there are approximately 23 rigs active in the Haynesville. Given the large number of active, producing wells and ongoing development, the Haynesville Shale continues to be an emissions source that must be evaluated and accurately represented in NETAC's ozone modeling. While accurate characterization of Haynesville emissions remains a high priority for NETAC, the Haynesville Shale makes up a relatively small fraction of the total 5-county area natural gas production (Figure 2-16). 2011 was the year with the highest Haynesville Shale formation production, accounting for 22% of total TLM area production in that year.

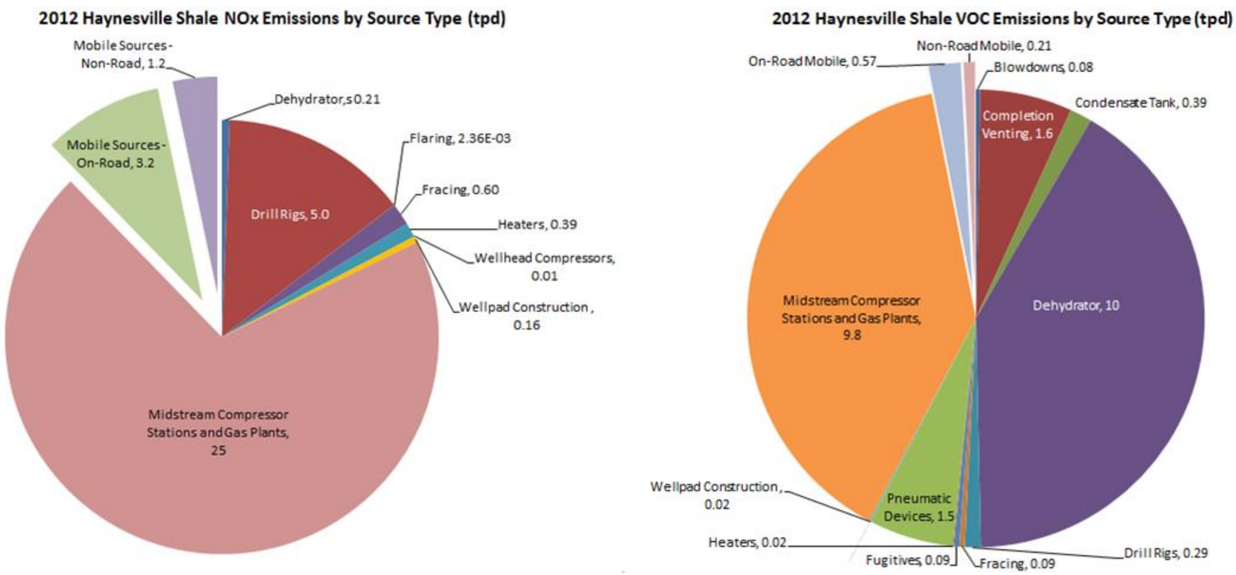


Figure 2-15. 2012 moderate development scenario Haynesville Shale formation NOx and VOC emissions by source category. Mobile source emission inventory is broken out from rest of inventory (protruding sections).

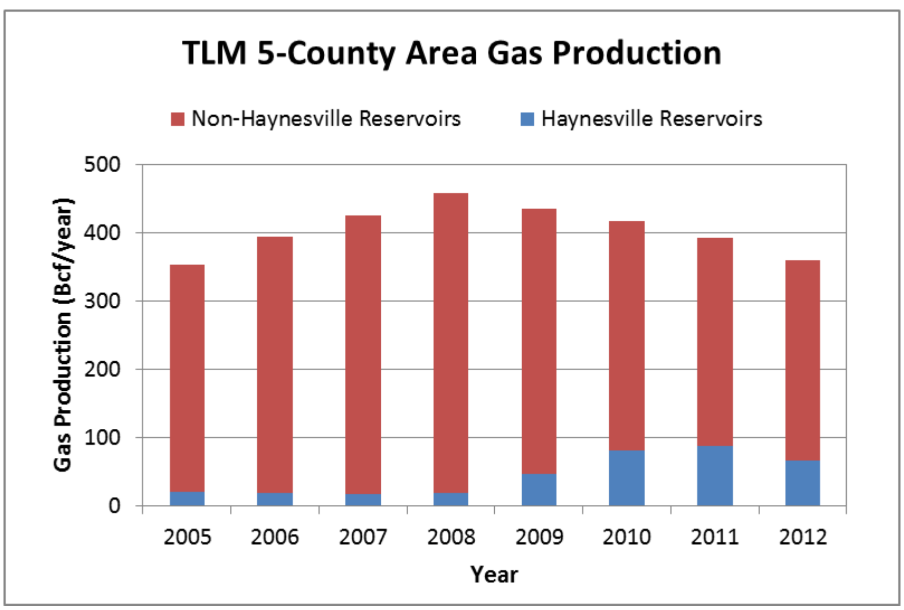


Figure 2-16. 2000-2012 gas production by Haynesville Shale formation and conventional formations for the TLM area[6].

[6] Includes data supplied by IHS Inc., its subsidiary and affiliated companies; Copyright (2011) all rights reserved.

2.1.4 Emissions Trend Analysis

In this section, we provide an overview of recent trends in ozone precursor emissions in the 5-county area. We then focus on trends in activity and emissions for two source categories that make important contributions to the 5-county area's NOx emissions inventory: on-road mobile sources and electric generating units (EGUs). We compare 2006 and 2012 ozone precursor emissions from two emission inventories developed by the TCEQ. The most recent emission inventory review (Grant et al., 2014) and conceptual model update (Kemball-Cook et al., 2014a) included a review of the 2012 and 2006 emission inventories for the NETAC 5-county area developed by the TCEQ for photochemical modeling by the Texas Near Non-attainment Areas.

Anthropogenic emissions for the 5-county area of Northeast Texas were extracted from the 2006 and 2012 state-wide inventories and compared. Both inventories compared here are composed of emissions from equivalent sectors: oil and gas area sources, non-oil and gas area sources, mobile off-road sources, mobile on-road sources and point source emissions. Figure 2-17 shows a side-by-side view of NOx emissions by sector in the 5-county area for a typical summer weekday during 2006 and 2012. Of all sectors, point sources are the largest contributor to NOx emissions in both years, with 85 tpd in 2006 and 65 tpd in 2012. EGUs make the largest contribution to the point source NOx emission inventory in both years.

Total anthropogenic NOx emissions for the 5-county area show a decline in 2012 relative to 2006, dropping from a total of 208 tpd to 132 tpd of NOx. This decrease is attributed to lower 2012 emissions from the point source sector (20 tpd decrease), oil and gas sources (17 tpd decrease), on-road motor vehicle emissions (23 tpd decrease) and area sources (12 tpd decrease). The majority of NOx area source emissions in the reviewed inventories are attributed to industrial, commercial and residential boilers. As a part of the Dallas–Fort Worth State Implementation Plan (SIP) Revision for 1997 Eight-Hour Ozone Standard, various rulemakings aimed at controlling combustion-related NOx emissions have become effective since 2007, such as the East Texas Combustion Rule, the Utility Electric Generation in East Texas and Central Texas Rule, and the Water Heaters, Small Boilers and Process Heaters Rule (all under Title 30) (TCEQ, 2013). It is likely that these regional-scale NOx controls contributed to the change in 5-county area NOx emissions from 2006 through 2012 for internal and external combustion sources in the oil and gas, area and point source sectors; however, further analysis of the 2012 emissions inventory is necessary to precisely determine the effect of these controls on regional NOx emissions.

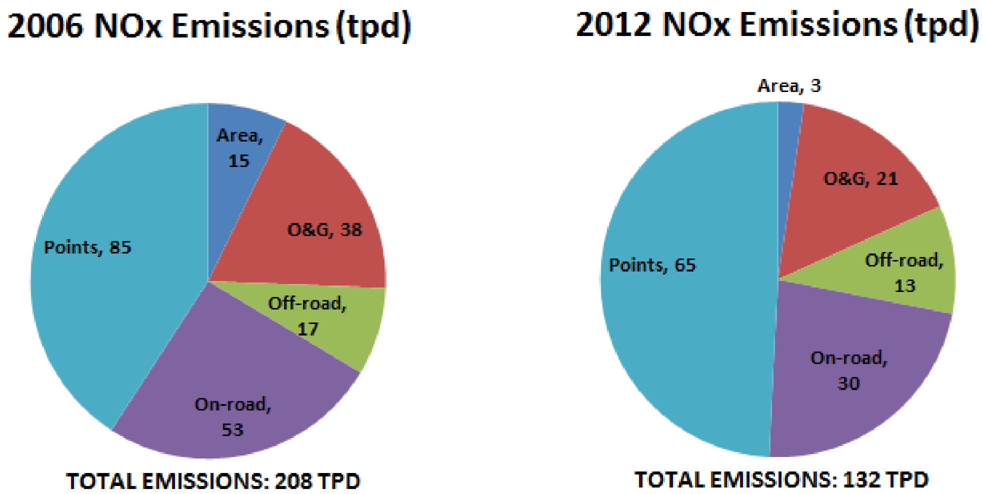


Figure 2-17. Typical summer weekday anthropogenic NOx emissions by sector for 5-county area in Northeast Texas. Comparison between 2006 (left) and 2012 (right) anthropogenic emissions). Oil and gas emissions in 2012 plot are for 2011, as 2012 emissions had not yet been developed at time of report.

While NOx emissions show a significant decrease from 2006 to 2012, the percentage contribution of each source category to the total NOx emission inventory does not change dramatically. Point sources made up 41% of the NOx emission inventory in 2006 and 48% in 2012. On-road mobile sources went from 26% of the inventory in 2006 to 22% in 2012, while off-road sources went from 8% in 2006 to 10% in 2012. Oil and gas area sources were 18% of the total NOx emissions in both 2006 and 2012 and non-oil and gas area sources went from 7% of the inventory in 2006 to 2% in 2012.

A significant decrease in on-road mobile NOx of 23 tpd is also apparent in Figure 2-17; this decrease could be due to fleet turnover to cleaner vehicle engines and/or related to a decrease in driving activity over the six-year period. Figure 2-18 shows summer weekday vehicle miles travelled (VMT) in 2006 and 2012 for Northeast Texas counties; these data were extracted from the TCEQ state-wide mobile source inventories for both years. The majority of Northeast Texas counties experienced a relatively small growth in total VMT between 2006 and 2012, with increases in VMT ranging from 3 to 9% over the six year span.

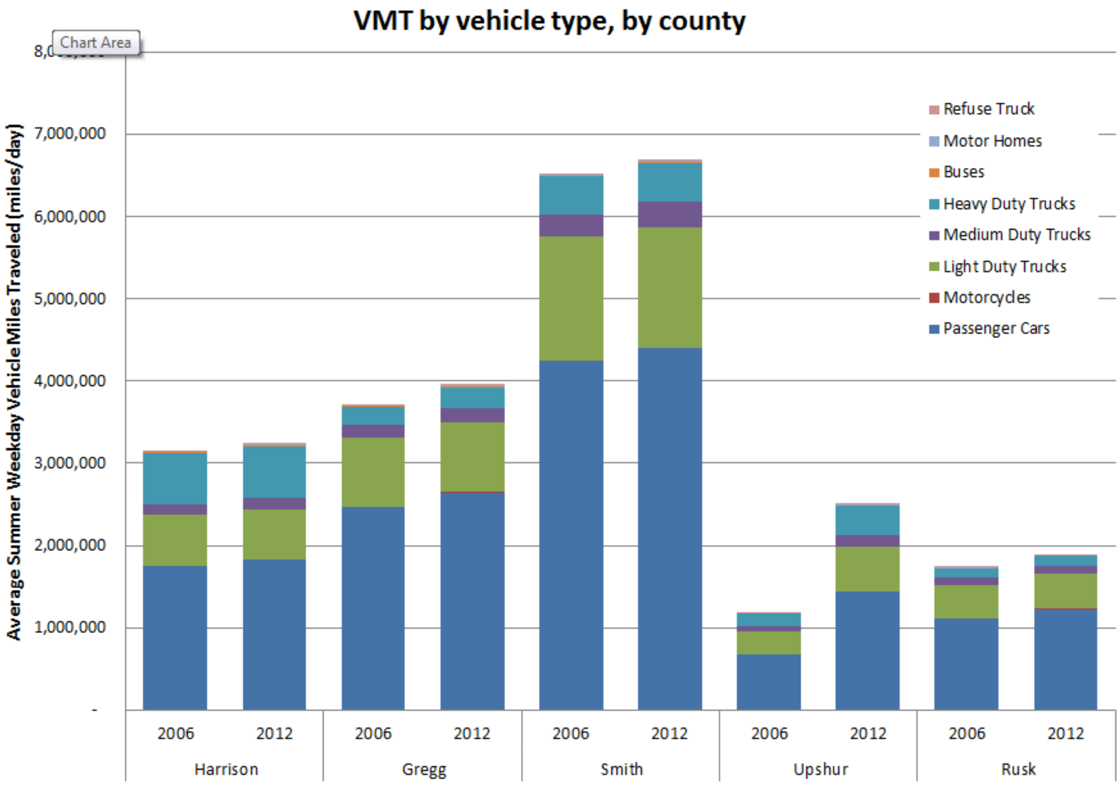


Figure 2-18. Summer Weekday Vehicle Miles of Travel for 2006 and 2012 in NETAC counties.

Overall, the total VMT for the 5-county area increased by 12%. This is broadly consistent with increases in population, shown in Table 2-3. The exception is Upshur County, where VMT changed by 112% between 2006 and 2012. The reason behind the VMT increase for Upshur County is unknown and requires further investigation.

Table 2-3. Population changes in the 5-county area between 2006 and 2012. Data sources: http://www.dshs.state.tx.us/chs/popdat/st2006.shtm and http://www.dshs.state.tx.us/chs/popdat/ST2012.shtm.

County	2006	2012	% Change
Gregg	117,743	123,376	5%
Smith	194,792	212,107	9%
Harrison	63,715	66,333	4%
Rusk	48,093	53,685	12%
Upshur	37,379	39,518	6%

The majority of the VMT in the 5-county area is attributed to passenger cars and accounts for about 60% of the total VMT while light/heavy duty trucks make up about 30% of the total. VMT growth between 2006 and 2012 for major vehicle groups such as passenger cars and light/heavy duty trucks was 13% and 9%, respectively, which is similar to the overall change in total VMT across the region, +12%. This small increase in overall VMT within the 5-county confirms that the decrease in NOx emissions from on-road sources from 2006 to 2012 is related to fleet turnover introducing cleaner vehicles rather than changes in driving patterns within the region. This trend is expected to continue into the future, although near-term emission declines may not be as a dramatic as those seen in the last decade (Vijayaraghavan et al., 2012).

Total anthropogenic VOC emissions for 2006 for the 5-county area were 271 tpd, whereas the 2012 inventory shows a 50 percent decrease in VOC emissions to 133 tpd (Figure 2-19). For both 2006 and 2012 inventories, the majority of anthropogenic VOC emissions are attributed to oil and gas sources, a sector for which VOC emissions changed significantly from 2006 to 2012 with a 60 percent decrease. This large decrease in oil and gas VOCs is consistent with decreases in production from 2006 to 2012. Other anthropogenic sources of VOC, including area sources, point sources and mobile sources (off-road and on-road) have remained at relatively similar levels from 2006 through 2012. It should be noted that the total VOC emission inventory is dominated by biogenic emissions (not shown here), which constituted more than 75 percent of the 5-county area VOC inventory in 2006and 2012, making biogenic sources by far the source category with the largest VOC emissions.

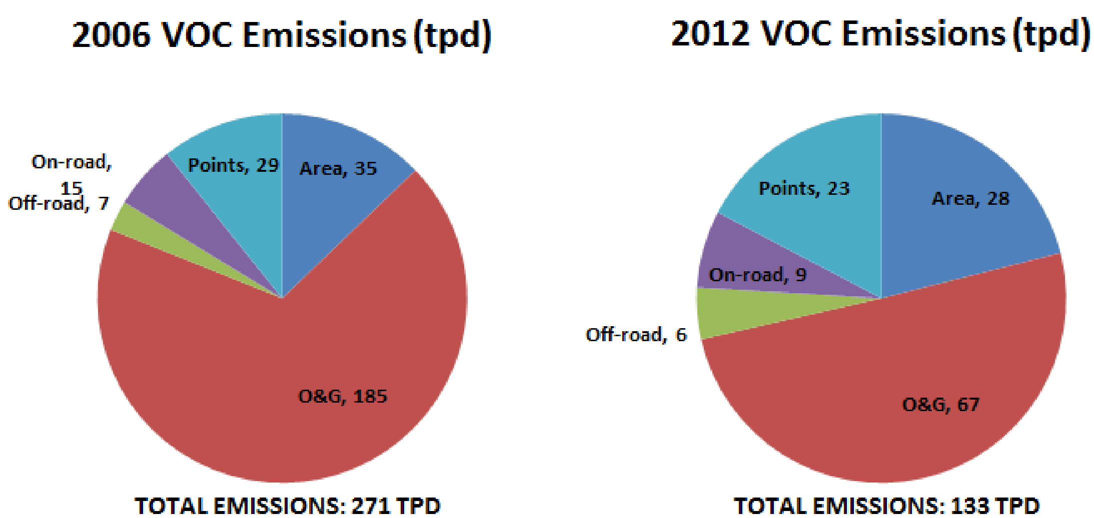


Figure 2-19. Typical summer anthropogenic weekday VOC emissions by sector for 5-county area in Northeast Texas. Comparison between 2006 (left) and 2012 (right) anthropogenic emissions. Oil and gas emissions in 2012 plot are for 2011, as 2012 emissions had not yet been developed at time of report.

Emission inventories for 2006, 2008, and 2010 as compiled in Grant et al. (2013; 2014) were compared to 2012 point source emissions to analyze recent trends in TLM area point source emissions. Figure 2-20 shows TLM point source emissions totals for NOx, VOC, and CO for the years 2006, 2008, 2010, and 2012. Point source NOx emissions decreased from 2006 to 2008, from 2008 to 2010, and again from 2010 to 2012. County-level VOC emissions (not shown) also show decreasing trends across all years for all TLM counties from 2006 to 2010 and from 2010 to 2012; VOC emissions increased from 2010 to 2012 as a results of VOC emission increases across all TLM area counties possibly as a result of economic recovery from the 2008 recession.

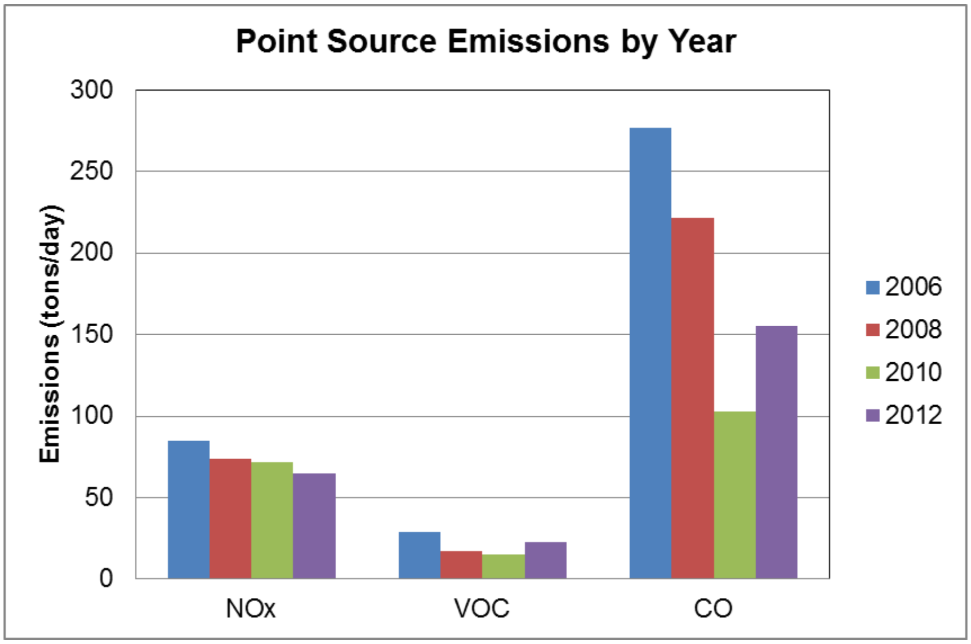


Figure 2-20. TLM area total ozone season day point source emissions for 2006, 2008, 2010 and 2012.

Table 2-4 shows the 2006, 2008, 2010, and 2012 emissions of NOx by facility for the TLM point sources with the largest NOx emissions. The largest changes in NOx emissions from 2006 to 2010 are a 5 tpd decrease at the Martin Lake Electrical Station, a 2.7 tpd decrease at the AEP Pirkey Power Plant and a 2.1 tpd decrease at the Texas Operations (Eastman Chemical Company). The most significant change in NOx emissions from 2010 to 2012 is a 10.7 tpd reduction in NOx emissions from the Martin Lake Electric Station. The inventory data available for this analysis does not allow us to determine the cause of emissions decrease at the Martin Lake Electrical Station from 2010 to 2012, but based on our knowledge of recent operations at this facility, we suspect that any reduction at this facility is likely due to lower activity rather than increased emissions control. We also note that reports[7] indicate that Luminant Energy decreased electricity production at the Martin Lake Electrical Station in 2013 during the winter months by idling one of three units. This unit was brought back online in early 2014[8].

[7] http://www.bizjournals.com/dallas/news/2013/09/18/luminant-will-shut-down-martin-lake.html?page=all, http://www.news-journal.com/panola/news/martin-lake-plant-cutting-output-by-a-third/article_044c0dbc-7f37-5846-b4ad-10ec79abf3c7.html

[8] http://www.dallasnews.com/business/energy/20140204-luminant-to-reopen-3-coal-plants-early.ece

Table 2-4. 2006, 2008, 2010 and 2012 NOx ozone season day point source emissions by year by facility.

County	Facility	SIC	NOx Emissions (tons per ozone season day) 2006	2008	2010	2012
Rusk	Martin Lake Electrical Station	4911	49.0	43.3	44.0	33.3
Harrison	Pirkey Power Plant	4911	13.0	11.8	10.3	11.0
Harrison	Texas Operations (Eastman Chemical Company)	2869	4.9	3.6	2.8	4.0
Smith	Delek Tyler Refinery	2911	2.3	1.3	1.3	2.2
Gregg	Longview Gas Plant	1321	1.8	1.9	2.1	1.9
Harrison	Westlake Longview	2821	1.7	1.5	1.3	1.4
Harrison	Marshall Plant	2819	1.6	1.4	1.6	1.5
Rusk	Electric Power Generation (Tenaska Gateway Partners)	4911	1.5	1.0	0.9	1.4
Gregg	Knox Lee Power Plant	4911	1.3	0.8	1.0	2.3
Harrison	Eastman Cogeneration Facility	4931	0.9	0.8	0.8	0.9
Harrison	Waskom Gas Plant	1321	0.6	0.4	0.3	0.3
Harrison	Stateline Compressor Station	4922	0.5	0.8	0.9	1.0
Gregg	Longview 1 Comp Station	4922	0.5	0.1	0.1	0.0
Harrison	Gas Blocker Compressor Station	4922	0.3	0.4	0.3	0.2
Smith	Perry Common Point Compressor Station	1311	0.3	0.1	0.1	0.1
Harrison	Harrison County Power Project	4911	0.2	0.2	0.2	0.2
Rusk	Henderson Gas Plant	1321	0.0	0.2	0.2	0.3
Harrison	Crossroads Gas Plant	1321	0.0	0.1	0.3	0.3
Remaining sources representing approximately <6% of NOx emissions			4.7	4.4	3.4	2.3
Totals			**85.1**	**74.0**	**71.9**	**64.7**

Because of the importance of EGU emissions in the 5-county area, we now focus on trends in Northeast Texas EGU NOx emissions. EGU NOx emissions contribute a large portion of the local 5-county NOx inventory for 2006 and 2012 under the point source category (Grant et al., 2013; 2014 and Table 2-1). NOx emission trends from the largest EGUs within and near the 5-county area over the past 13 years are shown in Figure 2-21 and Figure 2-22. Previous NETAC analyses have shown that emissions from facilities in Titus County (TX), Cherokee County (TX), Marion County (TX) and De Soto Parish (LA) can affect ozone in Northeast Texas (e.g. Alvarez et al., 2006a,b; Kemball-Cook et al., 2006; 2013a). Average summer day emissions shown in Figure 2-21 and Figure 2-22 were obtained from the Acid Rain Program (ARP) through EPA's Clean Air Markets Database (CAMD).

NOx emissions from the Dolet Hills plant in De Soto Parish, LA show a decreasing trend from 2000 through 2013. The Dolet Hills Power Plant in Louisiana had emissions of 39 tpd in 2005, but then implemented NOx controls that reduced NOx emissions to 18 tpd by 2007. Emissions from the Texas EGUs decreased dramatically from 2000 to 2005 and maintained a relatively constant level until 2011, when there was a slight peak for several EGUs, including the H.W. Pirkey and Martin Lake facilities. This increase in EGU emissions was likely related to the Texas heat wave in August 2011 which produced record high peak demands for electricity throughout the state of Texas (EIA, 2011a). Over the past decade, the total NOx emissions from all nearby and local EGUs decreased by 60 tpd, reaching 122 tpd in 2013. Projections of future year EGU emissions are uncertain and will depend upon economic and weather conditions as well as the regulatory environment.

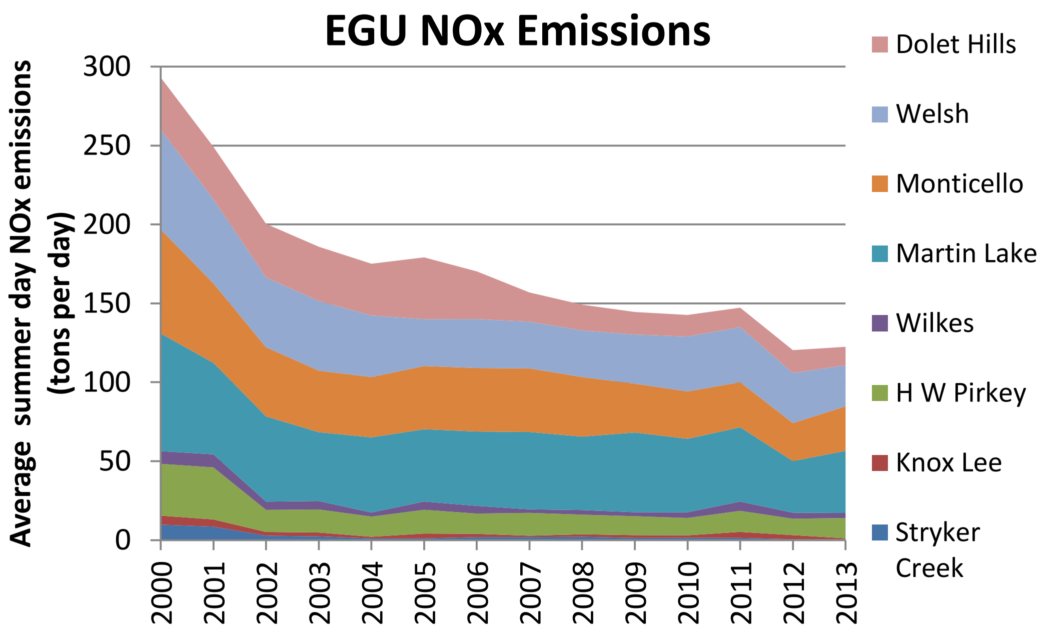


Figure 2-21. Recent trends in Northeast Texas EGU average summer day NOx emissions.

For instance, two of the units in the Monticello plant in Rusk County will only operate during high-peak demand season in 2014 (Thomson Reuters, 2013). Note that these changes in operating schedule will not affect NOx emissions from these facilities during most of the Texas ozone season, which extends from May 1 to September 30 (http://www.tceq.texas.gov/airquality/monops/ozonefacts.html).

Another change to regional EGU emissions will occur in April 2016, when AEP-SWEPCO will be retiring Welsh Unit 2, which is located near Cason, TX, in Titus County (Kelly Spencer; AEP_SWEPCO, personal communication, 2013). This unit had NOx emissions of approximately 3,000 tpy in 2012, and the retirement of this unit will reduce ozone season NOx emissions that can affect Northeast Texas.

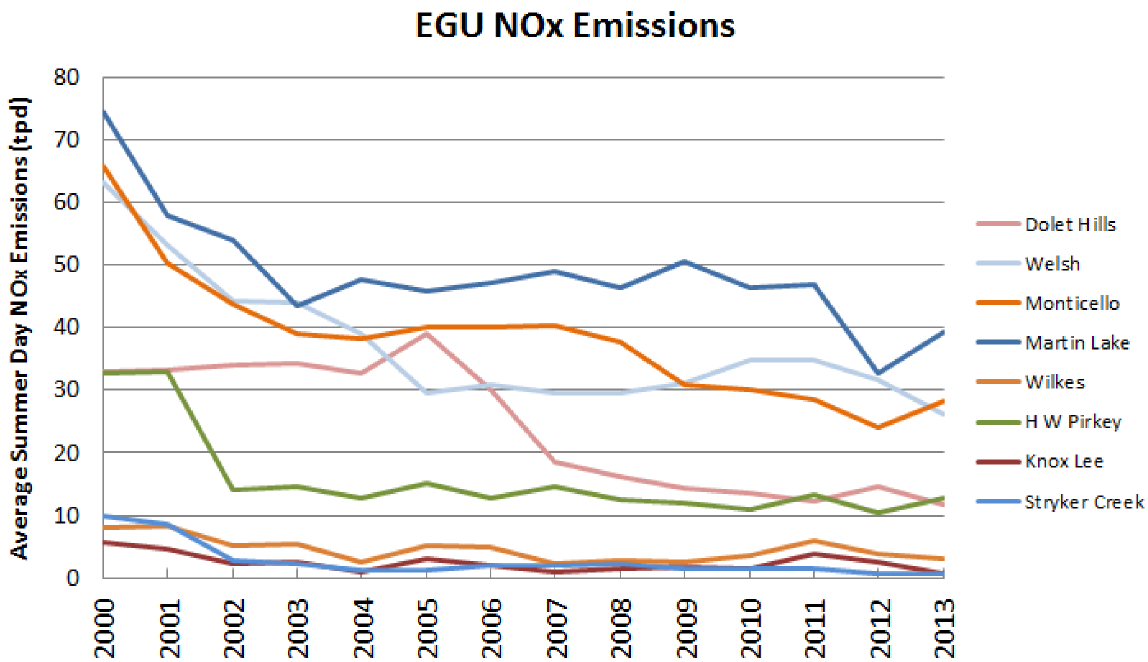


Figure 2-22. EGU NOx emissions by facility for Northeast Texas and nearby counties/parishes.

2.2 Meteorology

The Tyler-Longview Marshall (TLM) area is located on the plains of Northeast Texas, where the lack of major geographic features means that upper level wind patterns are driven primarily by synoptic-scale meteorological influences. Episodes of high surface ozone concentrations in Northeast Texas occur most often between June and September when the area is under the influence of a semi-permanent subtropical high-pressure system, vertical mixing of pollutants in the atmosphere is restricted, skies are clear to partly cloudy, temperatures are high, and winds are light. Most episodes are associated with near-surface winds from either the east/northeast or south/southwest with the latter direction appearing less consistently on the highest days and with greater variability in direction. Episodes can be classified as either “stagnant”, with very little inflow of air from outside of Northeast Texas or “transport”, with pollutants usually arriving in Northeast Texas through northwestern Louisiana, southern Arkansas, or southeastern Texas.

Ozone exceedances at the CAMS 19 monitoring site located at the Gregg County airport just south of Longview are often associated with daytime wind shifts that help keep locally-generated emissions within the area and cause plumes from major point sources to cross over the monitoring site. When these plume impacts occur in conjunction with already elevated regional ozone levels, exceedances of the ozone standard can result. Examination of 2005-6 Longview radar wind profiler data revealed the presence of moderately strong low-level southwesterly winds during the hours between midnight and sunrise on several days. Winds above this low-level flow varied from day to day but ranged from northeasterly to easterly on several of the high ozone days. By mid-day, convective mixing in response to surface heating breaks up the low-level southwest flow and brings the easterly component winds to the surface, causing a rotation of the surface winds from southwest to more easterly. The early morning southwest winds at Longview may represent the northward intrusion of the previous afternoon’s sea breeze from the Gulf of Mexico. Shifts in surface winds on high ozone days are also observed at the Tyler and Karnack monitors.

2.2.1 Wind Rose Analysis

In this section, wind roses are used to characterize station near-surface wind speed and direction at the three Northeast Texas monitors over the 2005-2013 period. In a wind rose diagram, the orientation and length of spokes indicates the frequency with which that wind direction occurs. The spokes show the direction from which wind blows toward the monitor, and the colored bands indicate the percentage of time the winds fall in a given speed range. Both morning (6 am – 11 am local time) and afternoon (12 noon – 5 pm) wind roses are shown. The morning and afternoon wind rose diagrams for each monitor and each MDA8 threshold present wind direction and speed for the same set of days. The difference between morning and afternoon wind rose diagrams is the time of day used to select wind data. The value of the MDA8, not the time of day during which the MDA8 occurred, determines the days that are selected. The number of input data points is the same for the morning and afternoon wind rose plots for each monitor and threshold (unless some wind data are missing). Because there are fewer days with very high ozone (MDA8≥75 ppb) than days with lower MDA8 (e.g. MDA8≥65 ppb), there are fewer days included in the MDA8>75 ppb plots than in the MDA8≥65 ppb plots.

Figure 2-23 shows the wind roses for all three monitors for low ozone days with MDA8<65 ppb. Morning and afternoon wind roses are similar at all three monitors. At Tyler and Longview, days with low ozone typically have flow from the south or the north; the incidence of easterly or westerly winds is far lower. Wind speeds fall more frequently in the 6-15 mph range on low ozone days than on days with higher ozone that are discussed below. Higher wind speeds indicate a more rapid flow of air through the TLM area which prevents ozone and precursors from building up. The Karnack wind rose shows that southerly winds occur frequently on low ozone days, as at Tyler and Longview; however, Karnack has a higher incidence of northeasterly and westerly winds on clean days than Longview and Tyler. For Longview and Tyler, this wind direction is more typically associated with transport of polluted continental air into the area.

On the highest ozone days (MDA8≥75 ppb), afternoon wind speeds are generally lower than on the low ozone days (note the lower frequency of red- and yellow-tipped spokes in the MDA8≥75 ppb compared with the wind roses for the MDA8≤65 ppb days). Lower wind speeds are more conducive to the buildup of pollutants as the stagnant air lingers over the TLM area. Wind speeds are generally lower at Karnack than at Longview or Tyler on days with MDA8≥75 ppb. Wind directions at Karnack on high ozone days are generally southwesterly to southeasterly in the morning and afternoon, respectively; northerly and westerly winds are less frequently associated with high ozone readings at Karnack site compared to Longview or Tyler. At Tyler, afternoon winds are most frequently out of the northeast/east on high ozone days, with a southerly contribution that is smaller than on days with MDA8 in the 65-70 ppb range, as discussed below. Like Tyler, Longview often has afternoon winds out of the northeast on days with MDA8>75 ppb, however in contrast, the east/southeasterly wind direction is dominant component for high ozone at Longview. Longview site also has a larger northerly wind component during high ozone days compared to Karnack or Tyler. Such wind direction-ozone correlations are consistent with the geographic distribution of local point sources of NOx emissions, located to the north of Longview but not Tyler or Karnack (see next section). The southwesterly wind direction is less frequent at Longview during periods of high ozone than at Tyler and Karnack in both the morning and afternoon.

On clean days where MDA8<65 ppb, the morning and afternoon wind direction and speed distributions are similar to one another at all three monitors. As the ozone level increases however, differences between the morning and afternoon wind distributions grow more pronounced. When MDA8>65 ppb, the Tyler monitor morning and afternoon wind directions are similar overall, but in the morning, the southwesterly direction is slightly more prominent than in the afternoon. At the MDA8>75 ppb level, this behavior is far more pronounced: in the morning, there are strong peaks in the wind distribution in the southwesterly and the east-southeasterly and east-northeasterly directions. In the afternoon, winds are much more likely to be out of the east/northeast than from any southerly direction. Wind speeds associated with southwesterly morning winds have higher peak speeds than winds from all other directions.

For MDA8>65 ppb, the Longview monitor has morning and afternoon wind direction distributions that are similar except that the southwesterly wind component is more pronounced in the morning than in the afternoon; this is similar to behavior noted above for Tyler and in the afternoon, the Longview monitor is more likely to see easterly/southeasterly flow than in the morning. When MDA8>75, morning winds are typically from the east/southeast or west/southwest. The afternoon wind distribution has a strong northeasterly component that is absent in the morning.

At Karnack, the morning and afternoon wind direction distributions are similar for MDA8<65 ppb. At the MDA8>65 ppb level, the Karnack monitor morning and afternoon differ with more dominant southwesterly component in the morning hours and frequent easterly component in the afternoon. Note that although the morning and afternoon wind direction distributions differ for all three monitors at higher ozone levels, the wind rose data cannot be used to demonstrate that wind shifts often occur over the course of high ozone days at the Northeast Texas monitors. This is because the morning and afternoon wind rose data show aggregated data for many days. However, inspection of data from previous NETAC analyses of high ozone days during the period 2005-2011 indicates that there are many high ozone days when wind shifts do occur at both the Longview and Tyler monitors, with different consequences because of the different distribution of sources around each monitor.

In summary, the wind rose data show that high ozone days in the TLM area are associated with slow wind speeds and winds from the east/northeast or southeast/south/southwest. By contrast, winds are faster on low ozone days and winds blow more frequently from the south.

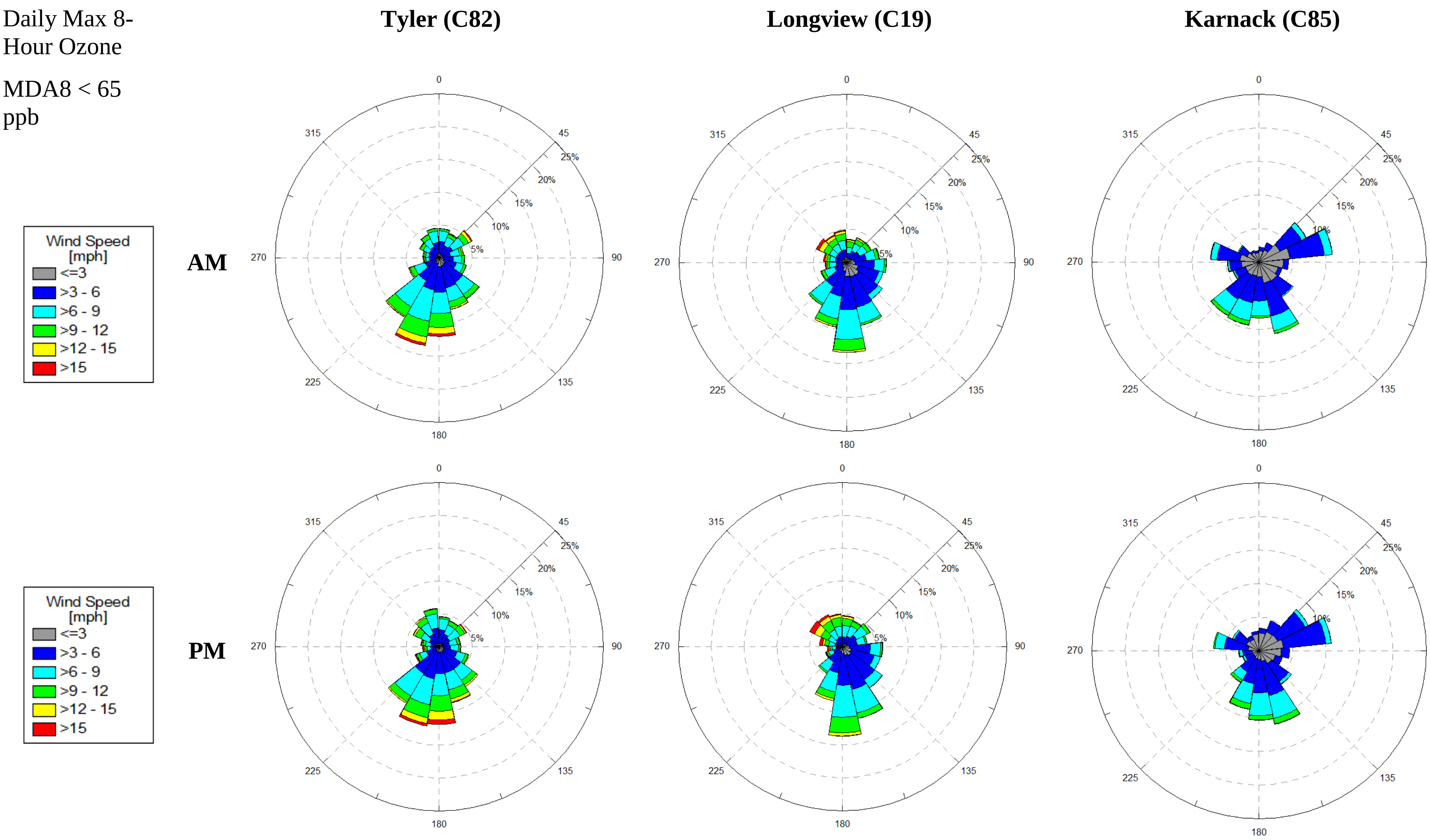


Figure 2-23 Wind Roses for Northeast Texas monitors in the 6-11 am period (upper panels) and 12-6 pm period (lower panels).

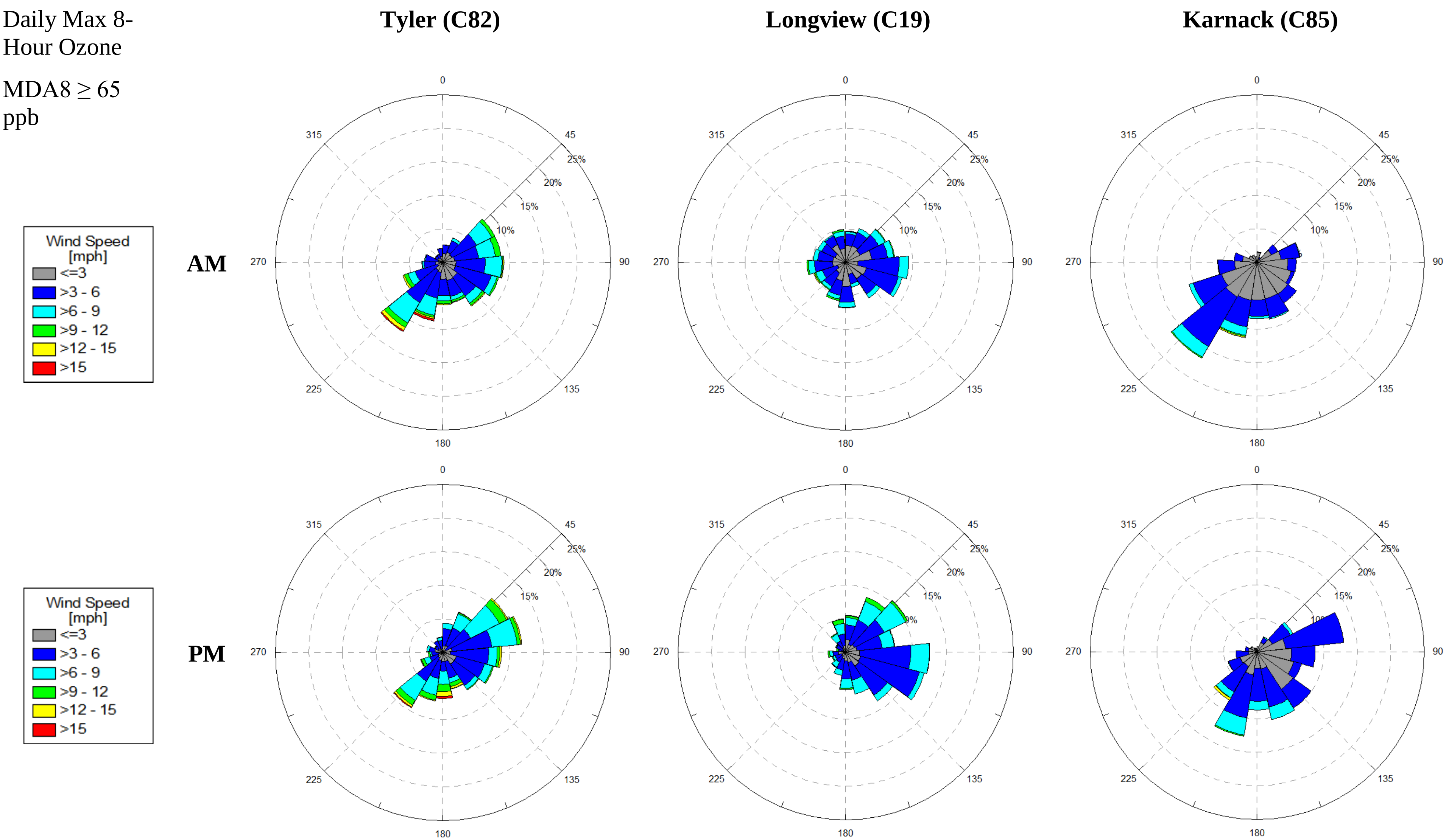


Figure 2-23. (continued). Wind Roses for Northeast Texas monitors in the 6-11 am period (upper panels) and 12-6 pm period (lower panels).

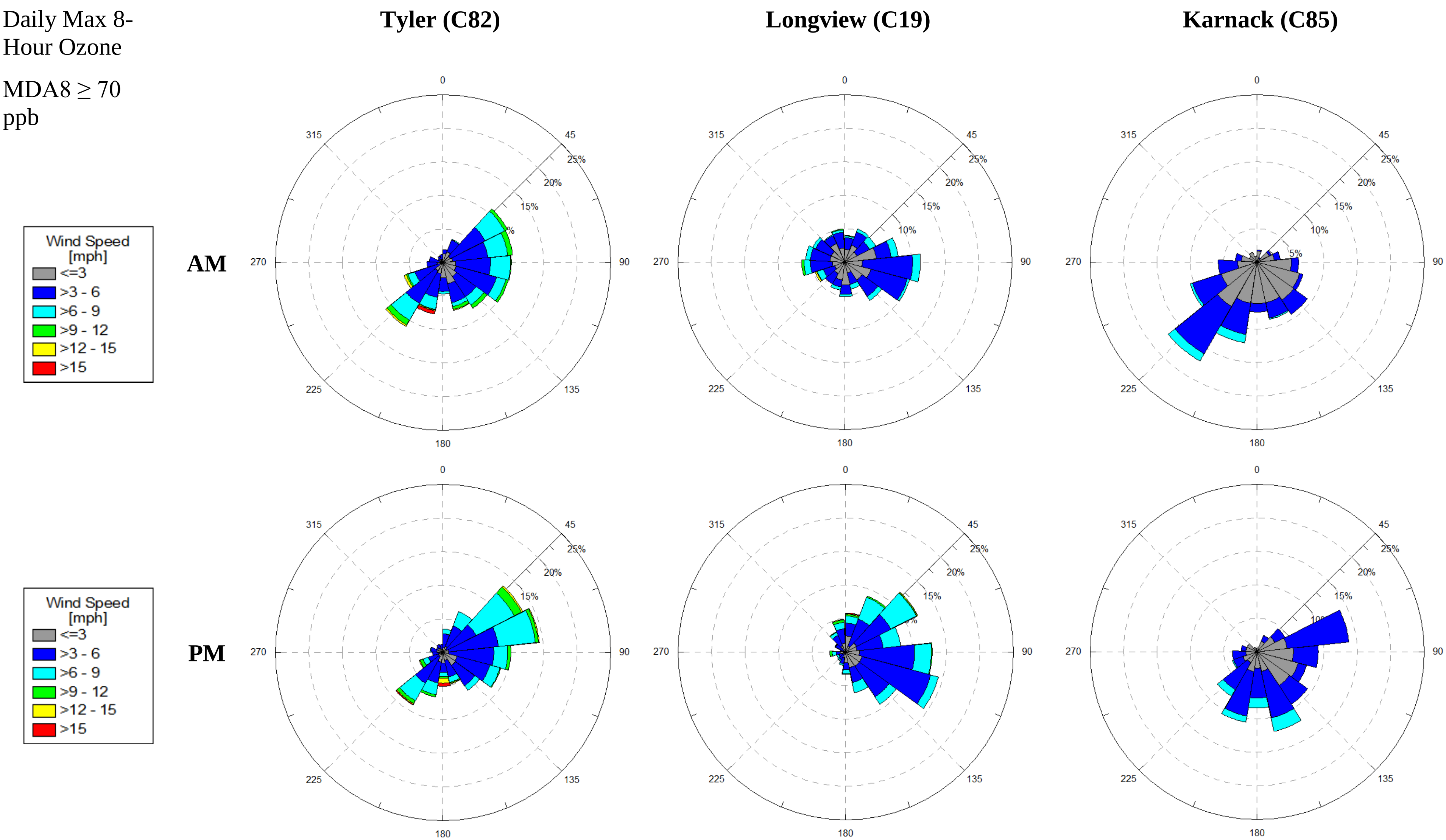


Figure 2-23. (continued). Wind Roses for Northeast Texas monitors in the 6-11 am period (upper panels) and 12-6 pm period (lower panels).

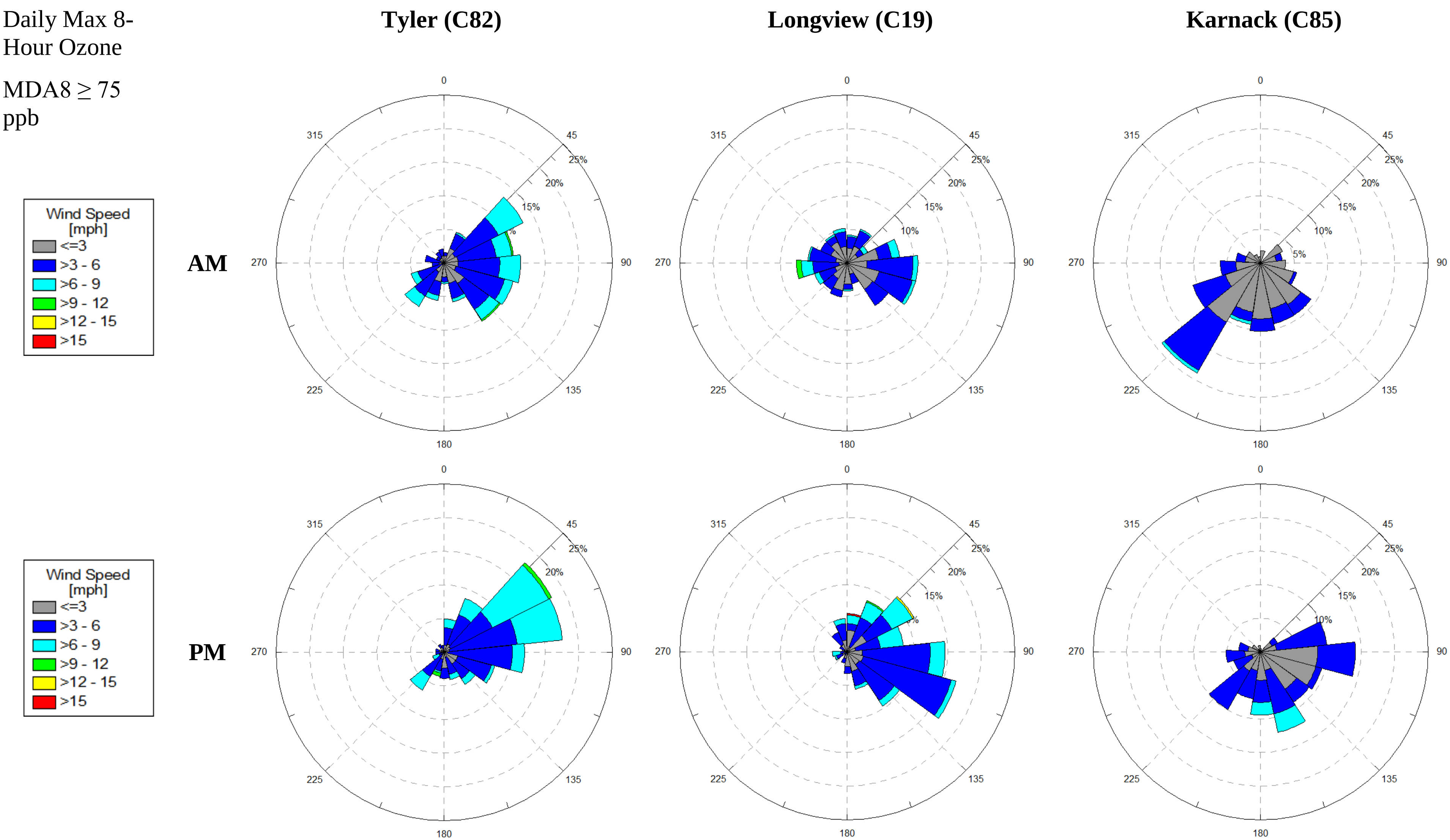


Figure 2-23. (concluded). Wind Roses for Northeast Texas monitors in the 6-11 am period (upper panels) and 12-6 pm period (lower panels).

2.2.1.1 HYSPLIT Back Trajectory Analysis

In order to determine possible source regions for air arriving in the TLM area on high ozone days, a back trajectory analysis was performed. 24-hour back trajectories were prepared using on-line tools provided by the National Oceanic and Atmospheric Administration (NOAA) at http://www.arl.noaa.gov/ready/hysplit4.html. These tools are based on application of NOAA's HYSPLIT model (Draxler et al., 2013) with archived weather forecast model data from the National Center for Environmental Prediction's EDAS forecast model. The EDAS data have a horizontal resolution of 40 km. Note that back trajectories are a qualitative tool subject to theoretical and data limitations and can only provide approximate information regarding possible source regions for pollutants transported to a monitor.

High ozone days during the 2005-2013 period were identified according to the three thresholds of 65 ppb, 70 ppb and 75 ppb. For each high ozone day during the 2005-2013 ozone seasons (April 1-October 31), back trajectory analysis was used to determine the approximate origin of air arriving at the TLM area monitors during the 8-hour ozone peak. The 24-hour back trajectories were grouped into days with MDA8 ≥ 65, 70 and 75 ppb respectively in order to assess which wind directions were most (and least) likely to affect TLM area ozone at different levels of the new ozone standard.

The three middle panels of Figure 2-24 show the HYSPLIT back trajectory analysis for the Longview monitor on days when the MDA8 was greater than or equal to 75 ppb (top panel), 70 ppb (center panel) and 65 ppb (lower panel). There are several features common to the back trajectory patterns for all three levels of the MDA8 threshold. High ozone days at the Longview monitor occurred most frequently when the flow was from the east, northeast or the south. Many of back trajectories extend back into Louisiana and Arkansas and into the region surrounding the Mississippi River. Winds from the north/northwest occur less frequently than from the other directions for all thresholds of the MDA8.

The Longview back trajectories indicate that the Karnack monitor serves effectively as an upwind monitor for days with east/northeasterly flow bringing air from Louisiana, Arkansas and beyond. At levels of the MDA8 below 70 ppb, the greater number of southerly trajectories indicates that transport from the south becomes increasingly important. These southerly trajectories frequently show the arrival in Longview of air that had recently been in the vicinity of the Texas Gulf Coast. These trajectories typically show a strong curvature to the right, arriving in Longview from the southwest.

Back trajectories for days when the Longview MDA8<65 ppb (Figure 2-25) tend to be longer than those of the higher ozone days; this indicates that wind speeds are generally faster on the lower ozone days than on the high ozone days. This is consistent with the results of the wind rose analysis, which showed generally higher wind speeds on low ozone days than on high ozone days. High ozone days in Northeast Texas often occur when air is relatively stagnant, allowing the buildup of ozone and precursors. On cleaner days, wind speeds tend to be higher, improving ventilation of the area. Wind directions differ between low and high ozone days as well. Low ozone days in Northeast Texas are often associated with the arrival of clean maritime air from the Gulf of Mexico during episodes of southerly winds. Figure 2-25 shows many back trajectories that originate over the Gulf of Mexico and then come ashore all along the Texas coast. The top left panels of Figure 2-24, on the other hand, shows that on 70 ppb days at Longview and Tyler, southerly trajectories were much more likely to pass over the Houston or Victoria areas while coming ashore and were generally shorter in length than the trajectories in Figure 2-25. Northerly and northeasterly trajectories were far more likely to occur on low ozone days than on high ozone days.

The corresponding HYSPLIT back trajectory analysis for the Tyler monitor is shown in the left hand panels of Figure 2-24. The back trajectories for Tyler are similar in many respects to those for Longview. For all three levels of the MDA8, flow from the east/northeast and the south were typical of high ozone days at Tyler. As at Longview, the frequency of southerly trajectories increases as the MDA8 threshold is lowered. Similar to Longview, clean (MDA8<65 ppb) days are marked by longer 24-hour back trajectories that are more likely to originate over the Gulf of Mexico or over regions to the north of the TLM area. The wind rose wind direction data from Tyler are consistent with the picture from the HYSPLIT back trajectories in which clean maritime air from the Gulf of Mexico enters the TLM area from the south or relatively unpolluted continental air arrives from the north.

The Karnack monitor (right hand panels of Figure 2-24) was even less likely than the Longview or Tyler monitors to have transport from the north on high ozone days; transport from the east or south on high ozone days is most frequent at Karnack. Note that there are large local NOx emissions sources to the north of Longview and the northeast of Tyler, but not Karnack.

The back trajectory analysis shows that high ozone days at the Karnack, Tyler and Longview monitors are most frequently associated with air arriving from the east/northeasterly and southerly directions. As the threshold of the MDA8 is lowered, transport from the south becomes more important. Trajectories that may be traced backward to the vicinity of Texas port cities show significant curvature resulting in their arriving in the TLM area from a southwesterly direction. The data show that any lowering of the ozone standard will enhance the importance of transport from the south in bringing ozone into Northeast Texas.

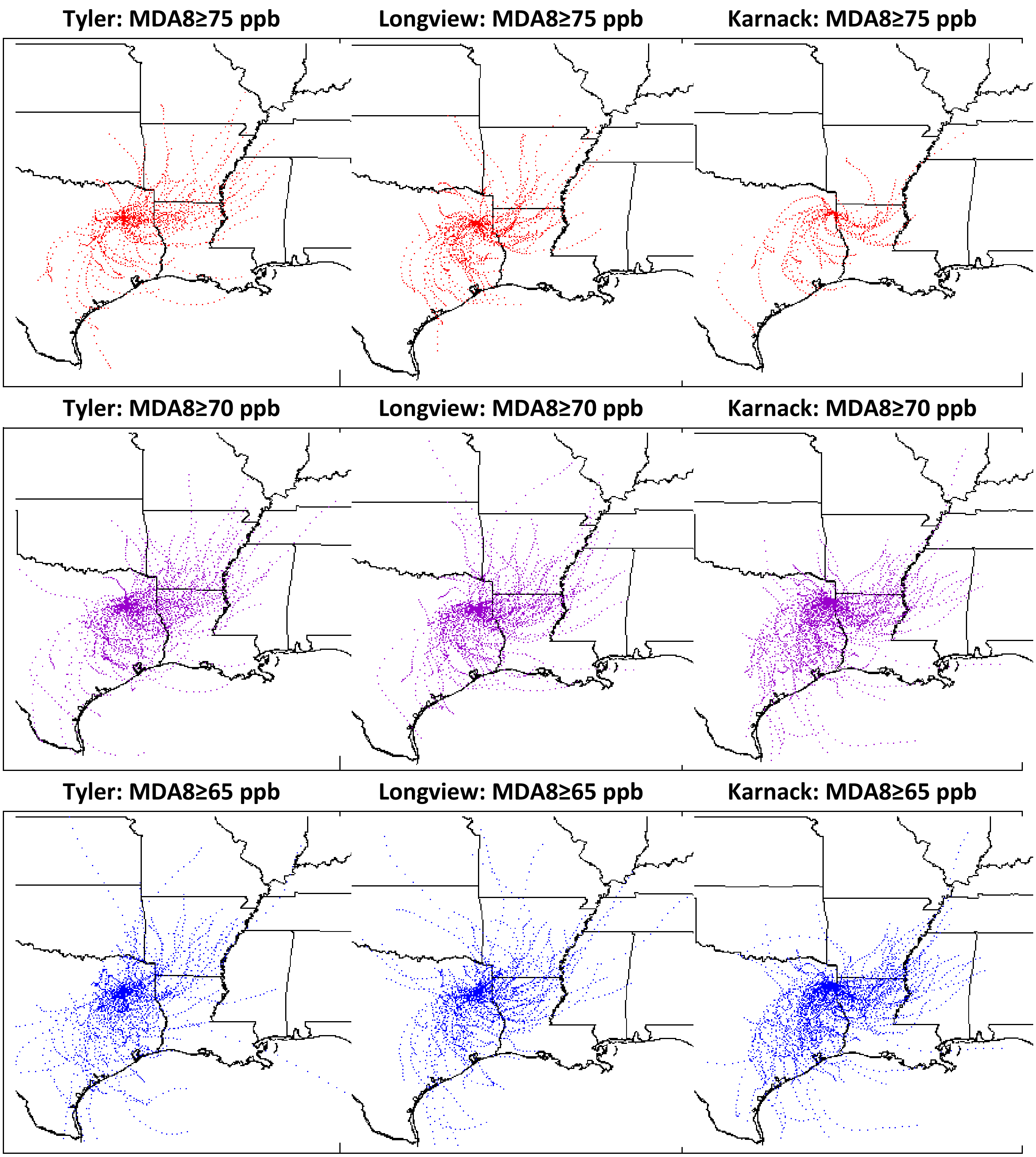


Figure 2-24. **24-hour HYSPLIT back trajectories for the Northeast Texas monitors for 2005-11. Left panels: back trajectories ending at the Tyler monitor at the time of daily maximum 8-hour ozone (MDA8) on days when the MDA8≥75 ppb (top panel), 70 ppb (middle panel), and 65 ppb (lower panel). Center panels: As for the left panels for the Longview monitor. Right panels: As for the left panels for the Karnack monitor. Black crosses indicate monitor locations.**

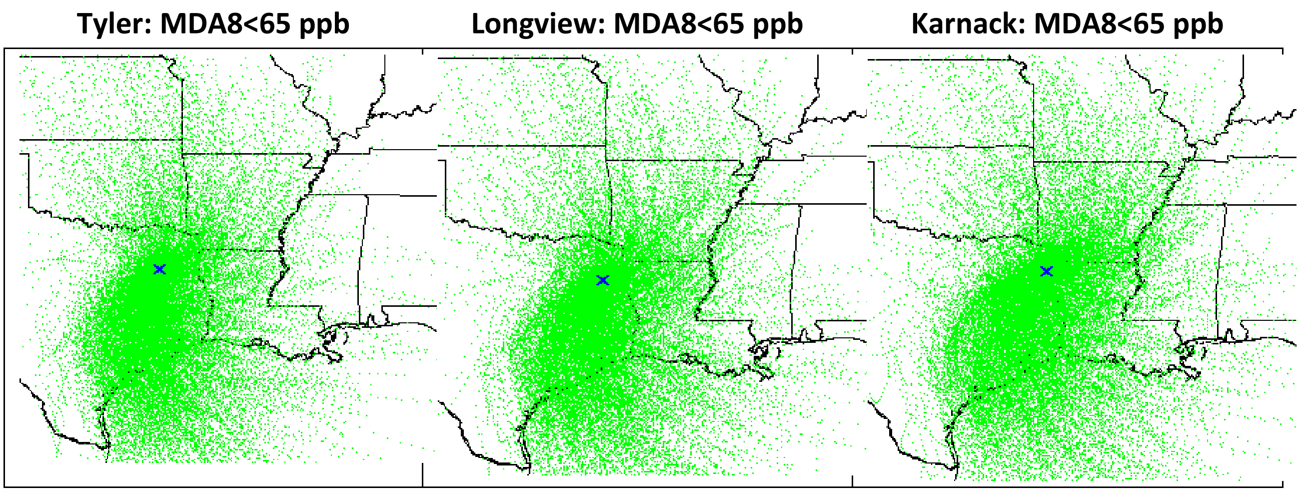


Figure 2-25. 24-hour HYSPLIT back trajectories for the Tyler, Longview and Karnack monitors (marked 'x'). Left panel: back trajectories ending at the Tyler monitor at the time of daily maximum 8-hour ozone (MDA8) on days when the DM8MDA8 was less than 65 ppb. Center panel: As for the left panel but for the Longview monitor. Right panel: As for the left panel but for the Karnack monitor.

2.3 Ozone Transport

Previous conceptual models have discussed NETAC's evaluation of the impact of transport on ozone levels monitored locally using both ambient monitoring and photochemical modeling to investigate the contribution of ozone transport to high ozone in Northeast Texas. Ozone measurements collected by aircraft are shown in Figure 2-26 and Figure 2-27 for days from 2002 and 2006 when easterly winds transported high concentrations of ozone (above 70 ppb) across the border and into Northeast Texas (Buhr et al., 2003; Alvarez et al., 2006; Alvarez et al., 2007). On August 29, 2002, Baylor University's aircraft found ozone above 70 ppb at an altitude of 500 to 600 m along the border between Texas and Louisiana. The MDA8 ozone recorded at the Karnack surface monitor was 88 ppb on this day. On September 8, 2006, an aircraft from the National Oceanic and Atmospheric Administration equipped with downward looking ozone LIDAR found ozone above 70 ppb through a deep layer along the border between Texas and Louisiana. Winds were easterly on this day and the daily 8-hr ozone at Karnack was 71 ppb. The aircraft data make clear that ozone transport contributed most of the ozone in Northeast Texas on these days.

The lower ozone standard proposed by the EPA in 2014 will enhance the importance of transported background ozone and precursors, and it is critical to understand the role of the transported background in ozone exceedance days in Northeast Texas. If the area's high ozone days are exclusively due to transport of ozone into the area, local controls strategies will not be effective. Conversely, if the contribution of local sources generally exceeds that of the transported background, then the benefits of local controls may be substantial. Although the aircraft flights are very useful for looking at ozone transport on a particular day, they are too costly to be undertaken on a routine basis. A photochemical model can be used to determine the relative contributions of source regions both near and distant, and can quantify the importance of transported ozone in causing high ozone days. The following analysis addresses the potential effectiveness of local control strategies in helping Northeast Texas achieve attainment of the ozone standard.

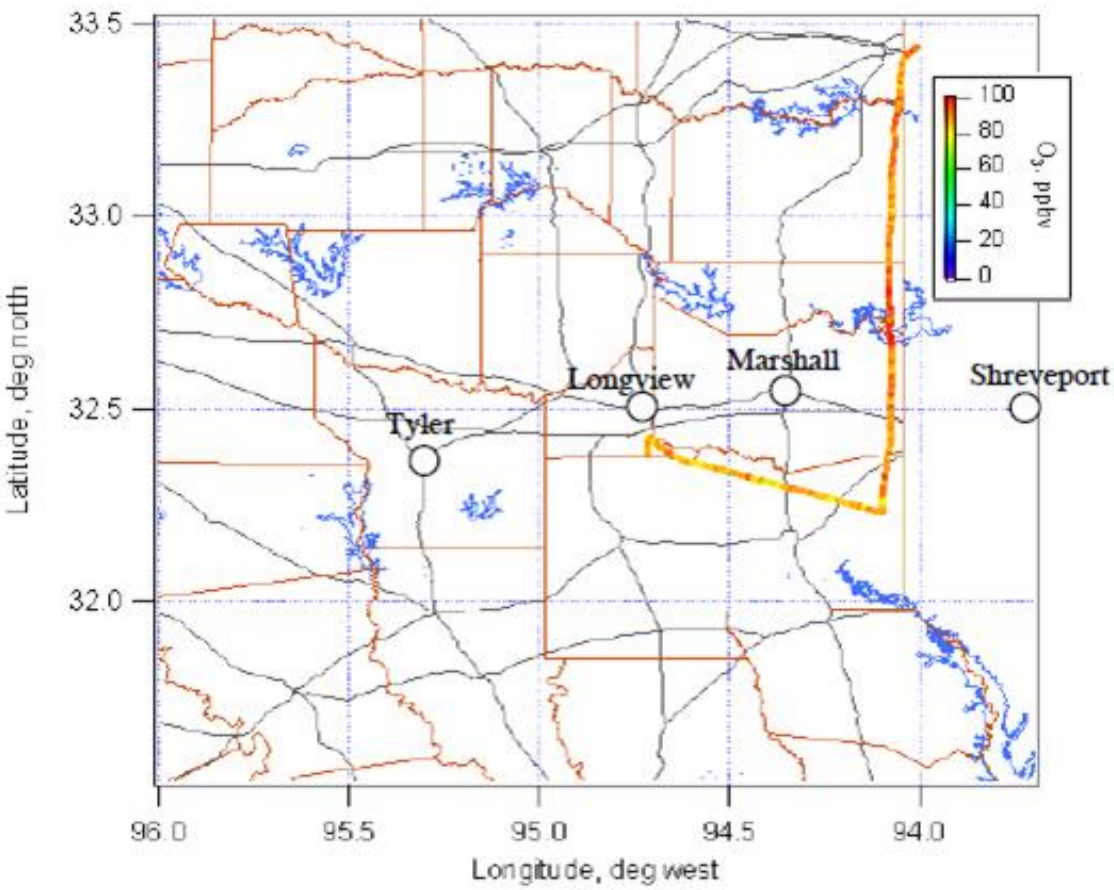


Figure 2-26. Ozone measured upwind of Northeast Texas on August 29, 2002 by the Baylor Aircraft. Under northeasterly winds, ozone was above 70 ppb at an altitude of 500 to 600 m along the border between Texas and Louisiana. The daily 8-hr ozone at Karnack (near Marshall) was 88 ppb on this day.

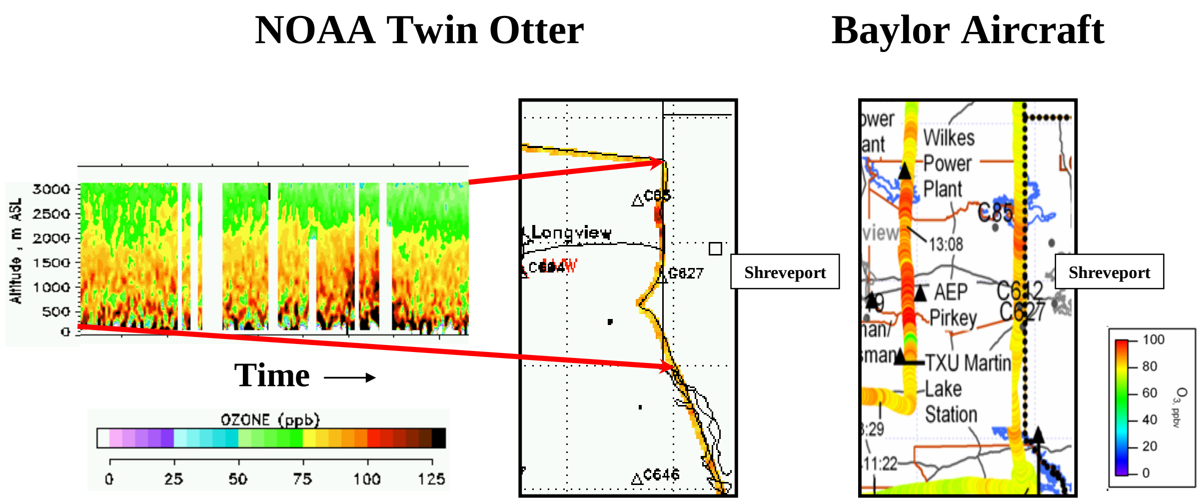


Figure 2-27. Ozone measured upwind of Northeast Texas on September 8, 2006 by the NOAA Twin Otter Aircraft. Under easterly winds, ozone was above 70 ppb through a deep layer along the border between Texas and Louisiana. The daily 8-hr ozone at Karnack (near Marshall) was 71 ppb on this day.

As the ozone standard becomes more stringent, the role played by transported ozone from outside Texas and from other regions within Texas becomes more important as the area can more easily be brought to the brink of an ozone exceedance through the effect of transport alone. In addition to U.S. sources of ozone and precursors, sources outside the U.S. (e.g. Asia) may also contribute. Parrish et al. (2009) measured the ozone mixing ratio in the onshore flow of marine air at the North American west coast and at higher elevation sites (e.g. Lassen National Park). Figure 2-28 shows trends in data collected at California stations and in aircraft flights in the vicinity of the west coast. Parrish et al. determined that along the U.S. west coast, springtime ozone has increased by ~0.5 ppbv/yr, i.e. ~10 ppbv in 20 years. This trend suggests that the policy-relevant background (PRB) ozone on the west coast may be increasing.

The policy-relevant background is defined by the EPA to be "the distribution of ozone concentrations that would be observed in the U.S. in the absence of anthropogenic (man-made) emissions of precursor emissions (e.g., VOC, NOx, and CO) in the U.S., Canada, and Mexico", which is equivalent to the lowest ozone that could possibly be achieved by air quality management efforts within the U.S. An increase in the policy-relevant background ozone would make it more difficult for Northeast Texas to attain the NAAQS.

The data of Parrish et al. suggest that over time, the policy-relevant background is increasing so that the PRB is converging with the level of the NAAQS. If the background ozone transported into the United States increases and the PRB continues to approach the level of the NAAQS, it may be increasingly hard for areas such as Northeast Texas to attain the ozone standard.

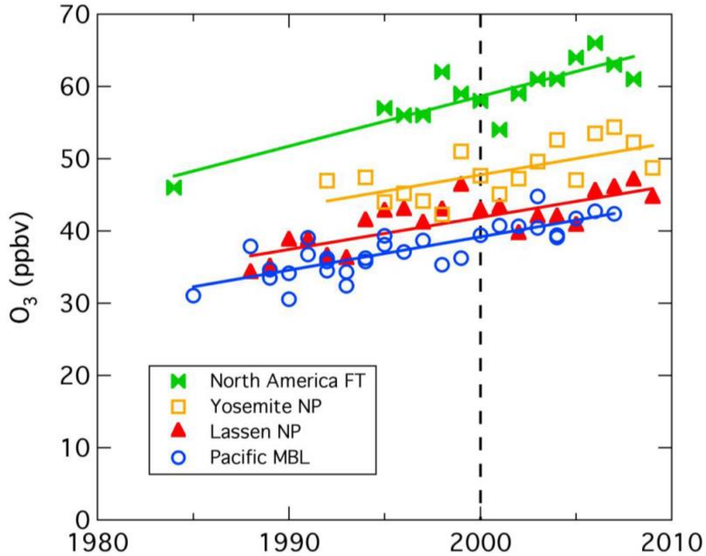


Figure 2-28. Trends in ozone measured in the marine boundary layer and aloft in the vicinity of the U.S. west coast. Figure from Cooper (2012).

Recent work performed by the TCEQ and NOAA (Berlin et al., 2013; Estes et al., 2014) evaluated regional background ozone levels entering Houston and Dallas. Figure 2-29 shows trends in regional background ozone entering the two metropolitan areas during the April-October ozone season. In this analysis, regional background ozone is defined to be "ozone transported into the area such that local emissions have little influence upon the ozone concentrations" (Estes et al., 2014). The regional background ozone can therefore include contributions from nearby and distant upwind areas, including other parts of the continental U.S., and is a different quantity than the North American background ozone measured at west coast sites.

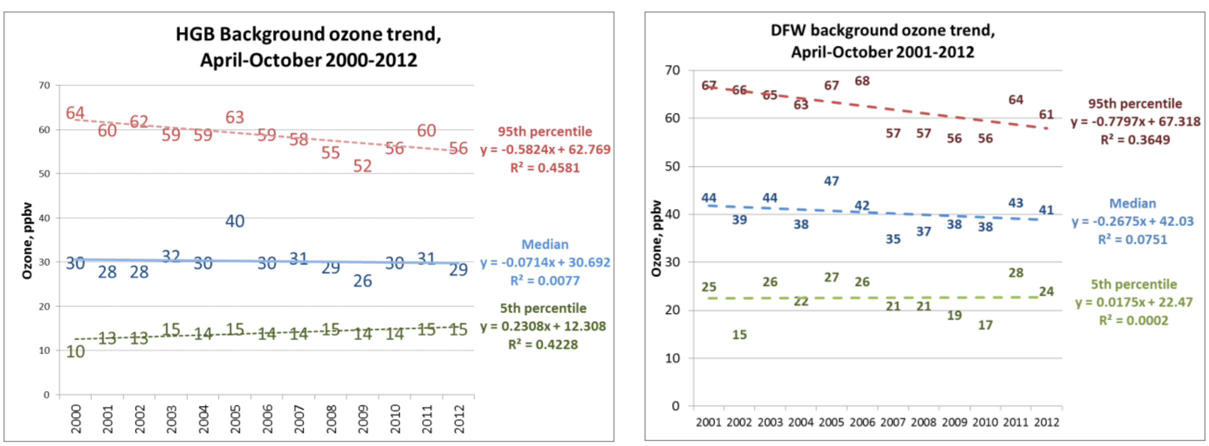


Figure 2-29. Recent trends in regional background ozone entering the Houston (left panel) and Dallas-Fort Worth (right panel) areas. Trends in 95th percentile values are statistically significant, but trends in median values are not. Figures from Estes et al. (2014).

The 95th percentile values of the background ozone for both Houston and Dallas-Fort Worth show statistically significant downward trends that are in marked contrast to the rising North American background ozone measured at U.S. west coast sites. Because the Houston area is strongly influenced by clean Gulf of Mexico air during periods of southerly winds, the Dallas results are more likely to be relevant to Northeast Texas than those of Houston; however a regional ozone transport trend analysis for Northeast Texas has not yet been done. NETAC will perform a regional background ozone trend analysis during 2015 as part of its regular update of the conceptual model of ozone formation in Northeast Texas. Understanding trends in ozone transport into Northeast Texas will allow an assessment of whether reductions in regional emissions are likely to play a key role in reducing transport and helping Northeast Texas achieve the new ozone standard to be set in 2015.

2.4 Ozone Modeling

In the preceding section, we described NETAC's evaluation of the impact of transport on ozone levels monitored locally using ambient monitoring such as aircraft flight data (e.g. Alvarez et al. 2006a,b). A more stringent ozone standard in the 60-70 ppb range will enhance the importance of transported background ozone and precursors, and it is important to understand the role of the transported background in ozone exceedance days in Northeast Texas. If the area's high ozone days are exclusively due to transport of ozone into the area, local emissions control strategies will not reduce ozone. Conversely, if the contribution of local sources generally exceeds that of the transported background, then the benefits of local controls may be substantial. Although aircraft flights are very useful for looking at ozone transport on a particular day, they are too costly to be undertaken on a routine basis. A photochemical model can be used to determine the relative contributions of source regions both near and distant, and can quantify the importance of transported ozone in causing high ozone days. Next, we describe recent NETAC efforts to quantify ozone transport into the TLM area.

A June 2006 Comprehensive Air Quality Model with Extensions (CAMx; ENVIRON, 2014) ozone model was developed from inputs provided by the TCEQ to the Texas Near Nonattainment Areas (Kemball-Cook et al., 2013b; 2014b). The nested 36/12/4 km modeling grids are shown in Figure 2-30. The Weather Research and Forecasting Model (WRF; Skamarock et al., 2005) was used to develop meteorological fields (winds, temperatures, pressures, precipitation) for CAMx. Day-specific emission inventories for June 2006 were also developed by the TCEQ.

Figure 2-30. TCEQ 36/12/4 km CAMx nested modeling grids for the Texas ozone modeling of June 2006. 36 km grid is outlined in black. The 12 km grid outlined in blue, and the 4 km grid is outlined in green. TCEQ figure from http://www.tceq.texas.gov/airquality/airmod/rider8/modeling/domain.

The June 2006 CAMx model was also run with the 2012 ozone season day emission inventory developed by the TCEQ that was described in Section 2. Using the 2012 inventory in the 2006 modeling platform allowed NETAC to assess how emissions changes from 2006 to 2012 affect Texas ozone under the meteorological conditions of June 2006. Note that this is different from development of a 2012 ozone model. In order to develop a true 2012 episode, a meteorological model such as WRF would be run for the 2012 period of interest and day-specific biogenic, wildfire and EGU emission inventories for 2012 would be required. Instead, we adapted the existing June 2006 modeling platform by removing the 2006 anthropogenic emissions for the 36/12/4 km grids and substituting TCEQ's 2012 anthropogenic emissions, except for the oil and gas emission inventory for counties that had Haynesville Shale natural gas development underway in 2012. For these counties, we removed the TCEQ oil and gas emission inventory and substituted emission inventories developed by ENVIRON for Haynesville Shale natural gas development emissions sources (Parikh et al., 2013) and for conventional oil and gas sources. A true 2012 ozone model is currently under development by the TCEQ.

The CAMx Anthropogenic Precursor Culpability Assessment (APCA) source apportionment tool was used to evaluate source regions and emissions categories contributing to ozone in Northeast Texas. The APCA tool uses multiple tracer species to track the fate of ozone precursor emissions (VOC and NOx) and the ozone formation caused by these emissions within a simulation. The tracers operate as spectators to the normal CAMx calculations so that the underlying CAMx predicted relationships between emission groups (sources) and ozone concentrations at specific locations (receptors) are not perturbed. Tracers of this type are conventionally referred to as "passive tracers," however it is important to realize that the tracers in the APCA tool track the effects of chemical reaction, transport, diffusion, emissions and deposition within CAMx. In recognition of this, they are described as "ozone reaction tracers." The ozone reaction tracers allow ozone formation from multiple "source groupings" to be tracked simultaneously within a single simulation. A source grouping can be defined in terms of geographical area and/or emission category. So that all sources of ozone precursors are accounted for, the CAMx boundary conditions and initial conditions are always tracked as separate source groupings. This will allow an assessment of the role of transported ozone and precursors in contributing to high ozone episodes within Northeast Texas.

The methodology is designed so that all ozone and precursor concentrations are attributed among the selected source groupings at all times. Thus, for all receptor locations and times, the ozone (or ozone precursor concentrations) predicted by CAMx is attributed among the source groupings. The methodology also estimates the fractions of ozone arriving at the receptor that were formed en route under VOC- or NOx-limited conditions. This information suggests whether ozone concentrations at the receptor may be responsive to reductions in VOC and NOx precursor emissions and can guide the development of additional sensitivity analyses.

APCA differs from the standard CAMx Ozone Source Apportionment Tool (OSAT) in recognizing that certain emission groups are not controllable (e.g., biogenic emissions) and that apportioning ozone production to these groups does not provide information that is relevant to development of control strategies. To address this, in situations where OSAT would attribute ozone production to non-controllable (i.e., biogenic) emissions, APCA re-allocates that ozone production to the controllable portion of precursors that participated in ozone formation with the non-controllable precursor. For example, when ozone formation is due to biogenic VOC and anthropogenic NOx under VOC-limited conditions (a situation in which OSAT would attribute ozone production to biogenic VOC), APCA re-directs that attribution to the anthropogenic NOx precursors present. The use of APCA instead of OSAT results in more ozone formation attributed to anthropogenic NOx sources and less ozone formation attributed to biogenic VOC sources, but generally does not change the partitioning of ozone attributed to local sources and the transported background for a given receptor.

Figure 2-31 shows the episode average contributions to the MDA8 at the three Northeast Texas monitors from local sources (emissions sources within the 5-county area) and transport from outside the TLM area. The local contribution from 5-county area sources is the contribution that can be reduced via local emission controls. For all three monitors, ozone transport makes a far larger contribution to modeled ozone than do local emissions from the 5-county area in both 2006 and 2012. In 2006 and 2012, the Longview monitor has the largest contribution from local emissions sources, while Karnack's local contribution is the smallest. In both 2006 and 2012, the Karnack monitor has the largest contribution from transport. The Karnack monitor is located closer to the Texas border with Louisiana than the Longview and Tyler monitors (Figure 1-4) zone when the wind blows from the east/northeast and brings polluted continental air into Northeast Texas, as is common on high ozone days (e.g. Figure 2-23). On such days, the local contribution is relatively small because most of the major sources of emissions in the 5-county area (e.g. power plants, most of the oil and gas wells) are downwind (west) of the Karnack monitor.

The importance of transport in determining ozone levels in Northeast Texas under the 2006 and 2012 emissions scenarios is consistent with NETAC's previous modeling of 2002, 2005 and 2012 (Kemball-Cook and Yarwood, 2010d). (Note that 2012 was previously modeled using a projected future year emissions scenario). At all three Northeast Texas monitors, ozone decreases in the 2012 emissions scenario relative to the 2006 emissions scenario. For all three monitors, both the local and transported contributions decline going from 2006 to 2012. The decline of the local contribution is consistent with the decrease in 5-county area ozone precursor emissions from 2006 to 2012 shown in Figure 2-17 and Figure 2-19. The model results therefore show the area to be strongly affected by transport. This finding is consistent with the results of previous NETAC monitoring (Buhr et al., 2003; Alvarez et al., 2006; Alvarez et al., 2007) and modeling (Kemball-Cook et al. 2010a) efforts.

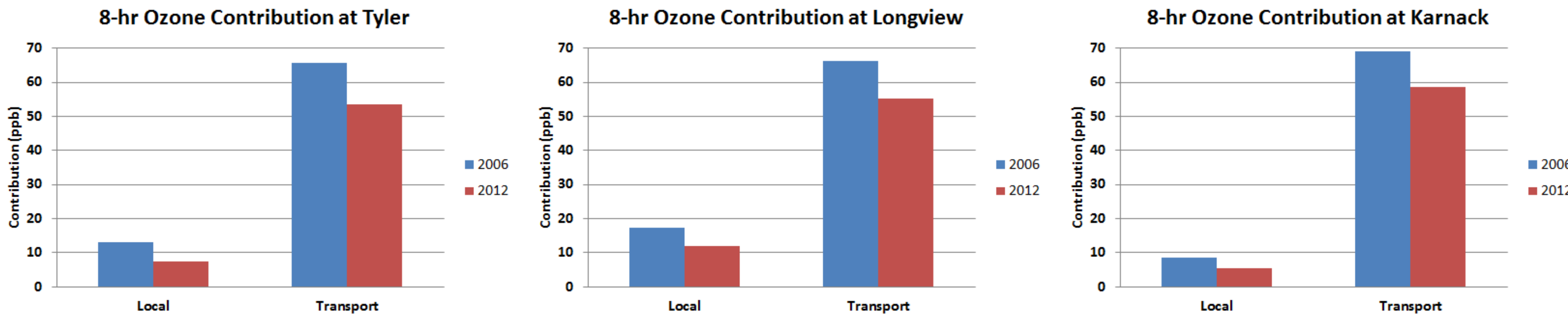


Figure 2-31. Modeled contributions from local emissions sources in the 5-county area of Northeast Texas and transported ozone at the Tyler (left panel), Longview (middle panel) and Karnack (right panel) monitors using 2006 and 2012 anthropogenic emissions in the June 2006 ozone model.

In Figure 2-32, the episode average 2012 ozone transport contribution shown for each monitor in Figure 2-31 is broken down into contributions from initial and boundary conditions and contributions from Texas sources outside the 5-county area and contributions from outside Texas. The 2012 contribution from local emissions sources within the 5-county area is also shown. The sum of contributions from initial and boundary conditions (IC+BC) may be taken as an estimate of the contribution to Northeast Texas ozone from sources outside the U.S. and from the stratosphere. This contribution is on average about 20 ppb and did not change significantly between the 2006 and 2012 emissions runs because the same boundary conditions were used in both simulations. The decrease in the ozone contributions from inside and outside Texas in Figure 2-32 indicates that emissions of ozone precursors are also lower in the rest of the U.S. in the 2012 inventory. This is consistent with the effect of federal controls on NOx emissions from EGUs in the eastern U.S. and controls on motor vehicles nationwide that are expected to lower ozone transport into Texas.

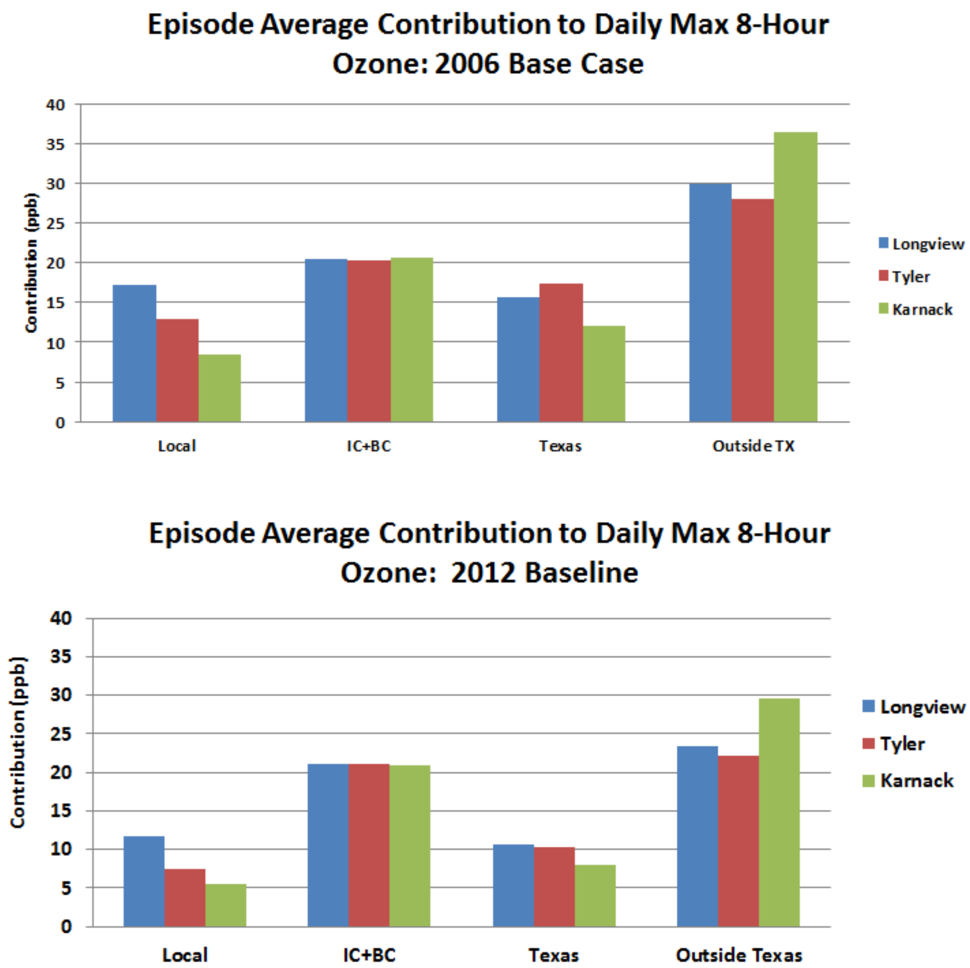


Figure 2-32. Episode average 8-hour ozone contribution to the Northeast Texas monitors from local emissions, the sum of model initial conditions and boundary conditions (IC+BC), sources outside the 5-county area but within Texas (Texas) and from regions outside Texas but within the 36 km modeling domain (Outside TX).

The 2006 APCA modeling results were also used to determine which local emissions source make the largest contributions to the local contribution to ozone shown in Figure 2-32. Figure 2-33 and Figure 2-34 show the breakdown of the local contribution by contribution from each emissions source category. Well head compression refers to the contribution from gas compressor engines in NETAC's emission inventory for the 5-county area and adjacent Panola County. Oil and gas (O&G) refers to the contribution from emissions from O&G sources that are not wellhead compressors.

Area refers to all area sources that are not related to O&G exploration and production. Elevated point sources are sources that emit from individual stacks with buoyant rise that may take their emissions into upper model layers. Most of the elevated point source emissions in Northeast Texas are due to EGUs. Emissions that do not have a buoyant rise are emitted into the model's lowest (surface) layer and are called "surface emissions". All emissions not due to elevated points are surface emissions and surface emissions include those from on-road and off-road mobile sources, area sources, oil and gas sources, and point sources emitted without buoyant plume rise (low points).

The episode maximum and contributions from each emissions source category are shown in Figure 2-33 and Figure 2-34, respectively. The largest values of the maximum and average contribution come from elevated point sources. It is reasonable that Longview should have the largest maximum contribution from point sources, because this monitor has several large point sources nearby and there are several different wind directions that will tend to bring ozone/precursor plumes from these facilities to the monitor (Figure 2-2). On-road mobile sources have the second largest maximum and average contribution at Longview. The Longview monitor lies relatively near Interstate 20, which passes through Gregg County. After on-road mobile, wellhead compression and non-road sources make the next largest contribution.

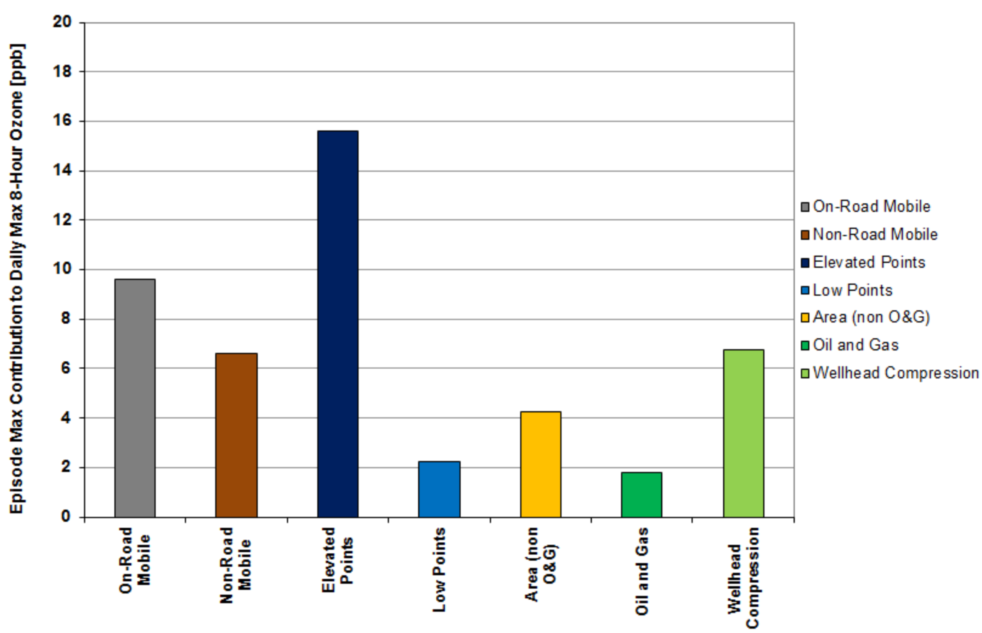


Figure 2-33. June 2006 episode maximum contribution to Longview ozone from 5-county area emissions.

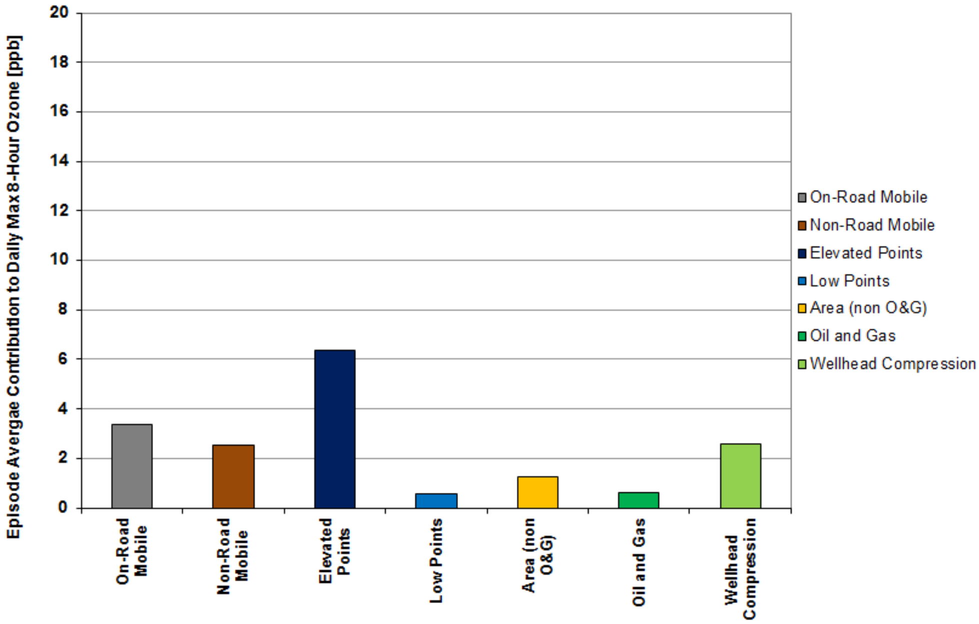


Figure 2-34. June 2006 episode average contribution to Longview ozone from 5-county area emissions.

The episode maximum contribution for each source category and the episode average for each source category for the Tyler monitor are shown in Figure 2-35 and Figure 2-36. Emissions from on-road mobile sources make the largest contribution to both the episode maximum and average. I-20 passes through Smith County near the Tyler monitor and the monitor is also influenced by the Tyler urban plume. The impact of elevated point sources is also apparent at the Tyler monitor, with the second largest episode maximum contribution coming from elevated point sources. Area sources make a larger contribution at the Tyler monitor than at Longview or Karnack.

The episode maximum and episode average contributions at Karnack are shown in Figure 2-37 and Figure 2-38. The contributions from elevated points and on-road mobile sources are of comparable importance at Karnack. The monitor lies to the north of I-20, and has several large power plants nearby.

The largest difference among the three monitors is the magnitude of the elevated point source contribution, which is largest at Longview. Both the episode maximum and average contributions from elevated points are higher at Longview than at either Tyler or Karnack. Figure 2-2 shows the location of the largest point sources of emissions in Northeast Texas. The Longview monitor has several large point sources nearby: Martin Lake power plant, the Pirkey power plant, and the Eastman facility. Several other large power plants (Monticello, Welsh and Dolet Hills) lie further to the north and east. Analysis of wind direction on high ozone days in

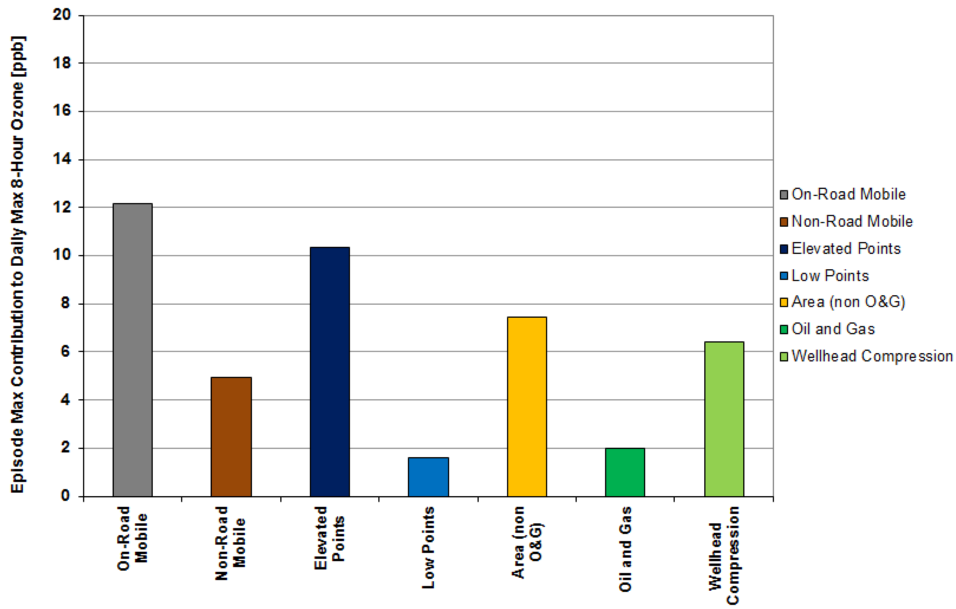


Figure 2-35. June 2006 episode maximum contribution to Tyler ozone from 5-county area emissions.

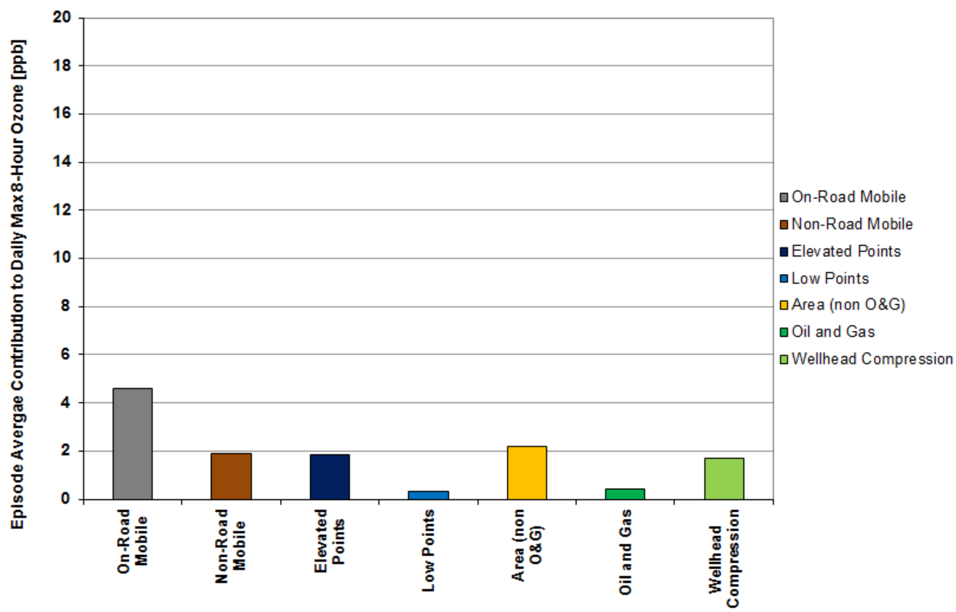


Figure 2-36. June 2006 episode average contribution to Tyler ozone from 5-county area emissions.

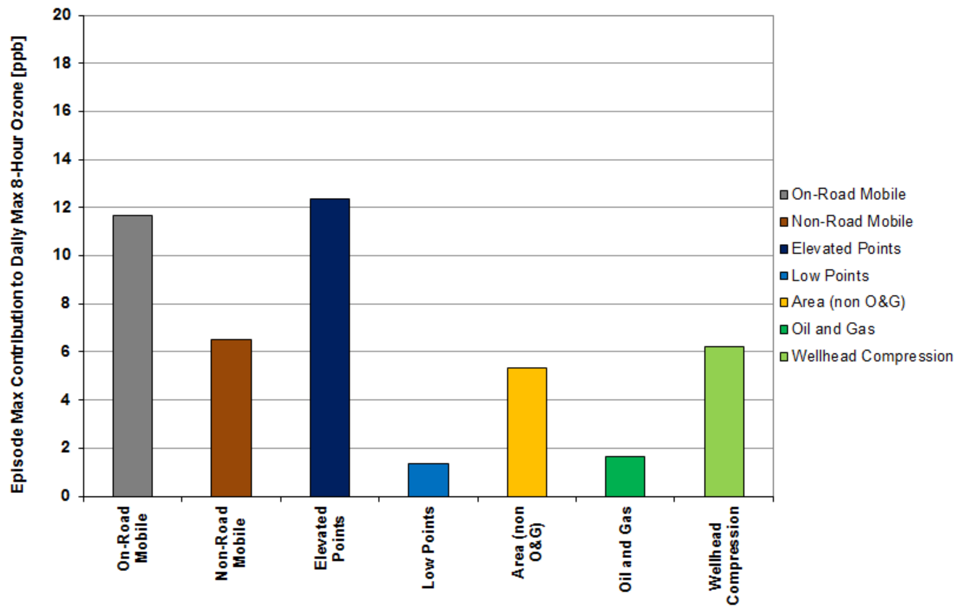


Figure 2-37. June 2006 episode maximum contribution to Karnack ozone from 5-county area emissions.

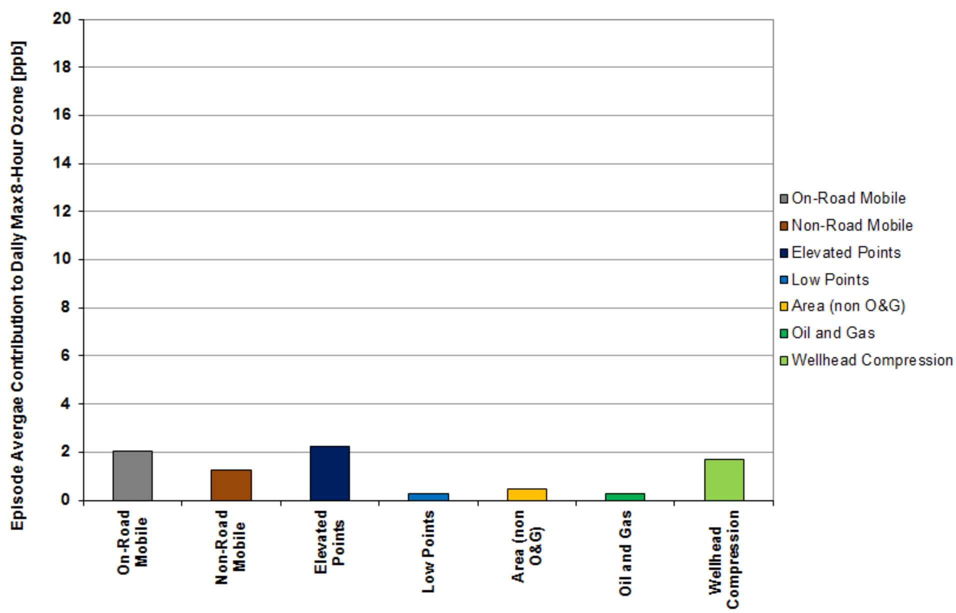


Figure 2-38. June 2006 episode average contribution to Karnack ozone from 5-county area emissions.

(Kemball-Cook et al. 2010a; 2013a) showed that high ozone at Longview occurs most frequently when the afternoon wind is blowing from northeasterly through southeasterly directions. While the Tyler and Karnack monitors also show a strong influence from point sources during the modeling episode these two monitors do not have the same number of large point sources in close proximity and across such a wide range of directions as the Longview monitor.

For all three monitors, on-road mobile source emissions make the second largest contribution after point sources. The contribution from on-road mobile sources is largest at Tyler and smallest at Karnack. Figure 1-4 shows the locations of the three Northeast Texas monitors relative to major roadways. The Tyler monitor lies within 9 miles of I-20, which is the most heavily travelled roadway in the area, and is within 5 miles of the Tyler metropolitan area. The Longview monitor is also located close to (~4 miles) I-20, while the Karnack monitor lies ~12 miles to the north of I-20.

At Longview and Karnack, off-road mobile and oil and gas sources make up the two next largest contributions. Contributions are similar at all three monitors for these distributed sources. Area sources make a larger contribution at Tyler than at Longview or Karnack. This is reasonable because many area source emissions categories are estimated based on population, and the Tyler monitor is closer to a large population center (the Tyler metropolitan area) that tends to be upwind on high ozone days than either the Longview or Karnack monitors.

The June 2006 APCA source apportionment modeling results were used to evaluate whether ozone formation in the TLM area is limited by the amount of available NOx or VOC emissions. Because the CAMx APCA tool was used, only the contributions from anthropogenic emissions are shown. Figure 2-39 shows the contribution to June 2006 episode maximum and average 1-hour ozone at the Northeast Texas monitors due to anthropogenic NOx and VOC emissions from elevated point sources and emissions from surface sources within the TLM area. The ozone contributions from 5-county area NOx emissions far exceed those from anthropogenic VOC emissions. This shows that ozone formation in the 5-county area is limited by the amount of available anthropogenic NOx and indicates that local NOx emissions reductions will be far more effective than VOC emissions reductions in decreasing the local ozone contribution. This result is consistent with the VOC/NOx ratio derived from the TLM area emission inventory, which indicates that there are sufficient biogenic VOCs available for ozone formation and that ozone formation in limited by the amount of available NOx.

NETAC’s ozone modeling, ambient monitoring, and emission inventory analyses combine to give a consistent picture of the causes of high ozone in the TLM area. High ozone in Northeast Texas typically occurs on days when local temperatures exceed 90°F, wind speeds are low, and wind directions range between northerly clockwise through southeasterly. These wind directions are favorable for transport of polluted air masses of continental origin into Northeast Texas. High ozone days in Northeast Texas are generally characterized by high background ozone levels plus a far smaller contribution from local emissions sources. Although the ozone contribution from local sources is relatively small, ozone reductions are possible via reductions in local ozone precursor emissions.

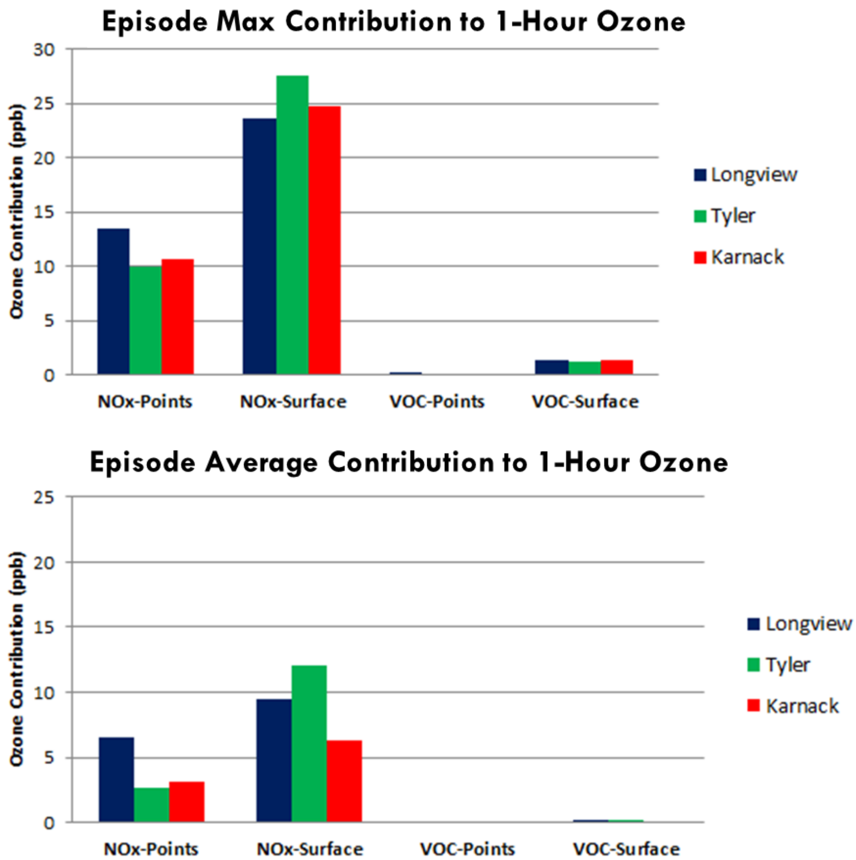


Figure 2-39. June 2006 episode maximum (upper panel) and episode average (lower panel) contributions to 1-hour average ozone from local 5-county area anthropogenic NOx and VOC emissions.

Northeast Texas's NOx emission inventory is dominated by emissions from power plants, motor vehicles, and oil and gas exploration and production. The contribution to VOC emissions from biogenic sources such as trees and other vegetation far exceeds the contribution from human activities. The abundance of biogenic VOC ensures that there is always enough VOC available to form ozone so that the amount of ozone formed from local emissions is determined by the amount of NOx emissions. In addition, highly reactive VOCs (HRVOCs) emitted from petrochemical manufacturing facilities may further enhance ozone. The overall VOC/NOx emission ratio in the 5-county area is well within the NOx-limited ozone formation regime. As a result, reductions in NOx will be generally more effective in controlling ozone on a regional basis than reductions in anthropogenic VOC. Sensitivity tests and source apportionment modeling using NETAC's ozone models confirm that NOx reductions are more effective than VOC reductions in controlling ozone in Northeast Texas. Therefore, local emission control strategies are focused on reducing NOx as well as highly reactive VOCs that have been shown to play a role in ozone formation at the Gregg County monitor in Longview.

3.0 STAKEHOLDER INVOLVEMENT

3.1 Northeast Texas Air Care

In 1996, local elected officials and other leaders in local government, business and industry created NETAC in order to provide leadership and guidance in addressing ozone air quality issues in the 5-county area. A Policy Committee consisting of representatives of local government, business and industry, the general public and environmental interest groups governs NETAC.

From its inception, NETAC has emphasized the need to ensure that air quality planning activities are developed using scientifically sound techniques. In order to achieve this objective NETAC created a Technical Advisory Committee to undertake, supervise, and guide technical studies such as emission inventory development, air quality modeling and control strategy development, and specialized monitoring studies. The Technical Advisory Committee reports to the Policy Committee. The Technical Advisory Committee consists of representatives from local government, local business and industry, EPA technical staff, TCEQ technical staff, Texas Department of Transportation planning staff, and the general public and environmental interest groups.

NETAC is actively involved in public education and outreach programs concerning ozone air quality issues. This work is guided by NETAC's Public Education/Outreach Committee, which consists of representatives from local government, local business and industry, TCEQ staff, and environmental interest groups. The Public Education/Outreach Committee reports to the NETAC Policy Committee.

NETAC receives staff support for its activities from the East Texas Council of Governments (ETCOG), which receives and administers grant funds provided by the Texas Legislature for air quality planning activities through the Rider 8 Program described below.

NETAC and its subcommittees meet on an as-needed basis. All meetings are open to the public and are posted at the East Texas Council of Governments and on the NETAC website (www.netac.org) and advertised through the distribution of information packets to local media outlets. The individuals comprising the NETAC Technical and Policy Committees are shown below.

NETAC Policy Committee Members

- Gregg County
  - Judge Bill Stoudt, Co-Chair
- Harrison County
  - Judge Hugh Taylor
- Rusk County
  - Judge Joel Hale

- Smith County
  - Judge Joel Baker
  - Cary Nix
- Upshur County
  - Judge Dean Fowler
- City of Gilmer
  - Jeff Ellington, City Manager
- City of Henderson
  - Mayor Pat Brack
- City of Kilgore
  - Scott Sellers, City Manager
- City of Longview
  - Mayor Jay Dean
  - Councilman Gary Smith
- City of Marshall
  - Frank Johnson
- City of Tyler
  - Mayor Martin Heines, Co-Chair
  - Greg Morgan, Managing Director, Utilities and Public Works
- Marshall Economic Development Corporation (MEDCO)
  - Donna Maisel, Director,
- Longview Economic Development Corporation (LEDCO)
  - Susan Mazarakes
- Tyler Economic Development Corporation
  - Tom Mullins, Executive Director
- AEP/SWEPCO
  - Keith Honey, General Manager
- Eastman Chemical Company
  - Tim Aldredge
- Luminant Energy
  - David Duncan, Environmental Regional Manager
- WE CAN
  - Tammy Campbell

- Westlake Chemical
  - Scott Snedden
- TCEQ
  - Holly Landuyt

NETAC Technical Advisory Committee Members

- City of Longview
  - Robert Ray, Assistant City Attorney
  - Karen Owen, Longview MPO
  - Brett Huntsman, Longview MPO
- City of Marshall
  - Frank Johnson
- City of Tyler
  - Greg Morgan
  - Heather Nick, Tyler MPO
  - Michael Howell, Tyler MPO
- EPA
  - Carrie Page
  - Erik Snyder
- TCEQ
  - Holly Landuyt
  - Doug Boyer
  - Michelle Baetz
  - Leroy Biggers
- NETAC General Counsel
  - Jim Mathews, Mathews and Freeland
- TxDOT
  - Dale Booth
- AEP/SWEPCO
  - Kelly Spencer
  - Kimberly Hughes
- CenterPoint Energy
  - Laura Guthrie

- Gary Thiemann

- Eastman Chemical Company
  - Shellie Dalby
- Luminant Energy
  - David Duncan
  - Jeremy Halland
- Caddo Lake Institute, Inc.
  - Rick Lowerre, Lowerre & Frederick
- Westlake Chemical Corporation
  - Scott Snedden
- Flint Hills Resources
  - Mark McMahon
- BP American Production Company
  - Dana Wood
- Environmental Defense Fund
  - Mr. Ramon Alvarez, Ph.D.
- Norit Americas
  - Kristin Bahus

4.0 DESCRIPTION OF MEASURES AND PROGRAMS

In this section, we describe programs and measures aimed at improving ozone air quality in the 5-county area of Northeast Texas. These programs and measures were implemented by NETAC and are either currently in place or are planned for the near future (i.e. 2015).

4.1 Participation in Legislative Appropriations for Near-Nonattainment Areas

Since 1997, the Texas Legislature has provided funding for ozone issues in Northeast Texas through riders to the TCEQ's appropriation. This funding under Rider 8 is designed to help Texas Near Nonattainment Areas (NNAs) maintain compliance with the ozone NAAQS. This program allows the NNAs to receive funding for their air quality planning efforts and to leverage the TCEQ's ongoing emission inventory development and photochemical modeling.

The TCEQ has established the following goals for the Texas NNAs under the Rider 8 Program[9]:

- Develop a conceptual understanding of local ozone formation processes;
- Evaluate local emissions inventories developed by the TCEQ (identifying possible areas of improvement);
- Analyze local ambient air quality monitoring
- Identify local emissions controls for future in-depth study
- Assess potential local monitoring networks and recommend enhancements or special studies;
- Improve local emissions inventories;
- Implement local emission control strategies;
- Use a photochemical modeling episode developed by the TCEQ to analyze ozone sources and conduct sensitivity tests
- Improve public understanding of the ozone problem and motivate the public to voluntarily reduce its contribution to ozone pollution; and
- Involve local stakeholders in local air quality planning so that these efforts have broad support within local communities.

The Rider 8 program activities align well with NETAC's participation in Ozone Advance.

4.1.1 Technical Studies Carried out Under the Rider 8 Program

Under the Rider 8 Program, NETAC has carried out many technical studies including development conceptual model of ozone formation, enhanced ambient monitoring, evaluation of TCEQ emission inventories for the TLM area, analysis of potential local emissions control strategies, and photochemical modeling. Reports summarizing these studies may be found on NETAC's web site www.netac.org.

[9] http://www.tceq.texas.gov/airquality/airmod/rider8/rider8-background

During 2015, the following technical studies will be carried out:

- Update of the conceptual model for ozone formation in the TLM area using data through the end of the 2014 ozone season
- Detailed review of TCEQ 2012 emission inventory for the 5-county area
- Update of TLM area oil and gas emission inventories and future year projections for both shale and conventional resources
- Update control strategy evaluation performed in 2013
- Photochemical modeling using 2012 episode under development by the TCEQ
- SOF study in the Sabine Industrial District

Schedule for Implementation: All technical studies will be completed by December 31, 2015.

Responsible Party: All technical studies will be carried out by ENVIRON with funding provided through the Rider 8 Program. Review of all technical studies will be provided by the NETAC Technical Committee and the TCEQ.

4.1.2 Public Outreach Programs Carried out Under the Rider 8 Program

NETAC carries out a number of public outreach activities under the Rider 8 Program. NETAC maintains a public web site to facilitate public access to air quality information and updates on technical and outreach activities (www.netac.org). The website provides information on ozone and specific actions citizens can take to improve air quality as well as contact information for citizens who would like to become more involved in addressing local air quality issues. The website shows TCEQ air quality forecasts for current and upcoming days and notes whether high ozone is expected in Northeast Texas during the current day or the next day. NETAC documents traffic on its website by counting the number of times the web site is “hit” during each quarter.

As part of its outreach to area schools, NETAC purchases and distributes approximately 40,000 school book covers to the areas school districts in the fall of every year. Another element of the education/outreach program is the development of television and radio public service announcements (PSAs) concerning citizen awareness and action. The PSAs air on local radio and TV stations throughout the summer. Public Education/Outreach funds have also been used for hosting quarterly conference calls of the Technical Advisory Committee, and the Annual Ozone Season Awareness event.

Schedule for Implementation: Ongoing.

Responsible Party: All public outreach programs will be implemented by NETAC with funding provided through the Rider 8 Program. Review of outreach programs will be provided by the TCEQ.

4.2 Point Source Emission Control Strategies

Operators of EGUs within and near the 5-county area and petrochemical plants in the Sabine Industrial District each contributed their own assessments of planned and potential future emission controls because they have detailed knowledge of the equipment to be controlled and strategies already employed. Responses were received from America Electric Power, Luminant Power, and Eastman Chemical Company. Of the three respondents, only Eastman Chemical will be implementing near-term planned emission reductions

4.2.1 American Electric Power

American Electric Power (AEP) does not have any planned controls for the near future on its two EGUs (Pirkey and Knox Lee) located in the 5-county area. However, AEP will be retiring Welsh Unit 2 in Titus County effective April of 2016. AEP provided the following information on planned controls:

> AEP-SWEPCO will be retiring Welsh Unit 2 (located near Cason, TX, in Titus County) in **April, 2016**. The associated emissions reductions can be included in NETAC's control strategy evaluation.
>
> Below please find the annual estimates for NOx and VOC emissions (tons/year) for Welsh Unit #2 for 2010-2012.
>
> 2010 NOx=3,334.65, VOC=30.65
> 2011 NOx=3,327.10, VOC=29.51
> 2012 NOx=3,014.70, VOC=28.31

The resulting NOx emissions reductions are summarized in Table 4-1.

Table 4-1. NOx reduction at AEP Welsh in Titus County.

Unit	Emission Reduction Strategy	NOx Reduction (Tons/Day)	Feasibility
Welsh #2	Retiring unit in April 2016.	8.3 TPD (based on 2012 baseline)	These emissions reductions will not affect the 2014 or 2015 ozone seasons but should affect the 2016 ozone season, which could be important for the next eight-hour ozone standard.

4.2.2 Luminant Power

Luminant does not have any planned controls for the near future on its one EGU (Martin Lake) located in the 5-county area. Luminant provided the following response to the request for information on planned emission controls:

Luminant does not have authorization for any NOx or HRVOCs emission reduction projects in what we understand to be your planning horizon and we do not anticipate any such reductions from our Martin Lake facility, our only facility in the 5-county Tyler-Longview-Marshall area.

4.2.3 Sabine Industrial District: Eastman Chemical Company, Texas Operations

Eastman Chemical Company has planned HRVOC reduction strategies, summarized in Table 4-2. These HRVOC reductions were implemented in 2014.

Table 4-2. HRVOC reduction strategies at Eastman Chemical Company, Texas Operations in the Sabine Industrial District.

Unit	Emission Reduction Strategy	HRVOC Reduction (Tons/Day)	Feasibility
Cracking Plant 4	New 28VHP Fugitive Emission Monitoring Program	0.34 TPD ethylene 0.12 TPD propylene	This program was implemented in May, 2014. The 28VHP Program prescribes that standard EPA Method 21 monitoring with a Total Vapor Analyzer be routinely conducted on fugitive equipment such as pumps, valves, and connectors throughout the process. This program also requires that repairs be made according to established permit timeframes for components that are found to be leaking. Actual VOC emissions will be calculated on the routinely monitored equipment for the 2015 Annual Emissions Inventory based on results of this monitoring using standard estimation methods prescribed by the TCEQ.

4.2.4 Measures Taken by Cities in the 5-County Area

In this section, we describe measures and programs enacted by TLM area cities as part of their vigorous and ongoing efforts to improve local air quality and reduce energy consumption. City government representatives contributed a written description of their current and planned programs that may benefit air quality.

4.2.4.1 City of Tyler (Smith County)

Since 1995, with the execution of the regional NETAC FAR agreement, the City of Tyler has actively participated in addressing air quality issues. Since the passage of Senate Bill 5 in 2001, the City of Tyler has implemented projects to reduce emissions resulting from City service operations. Examples include:

- <u>2004 Energy Efficiency Management and Modernization Phase II Program</u>-this project consisted of upgrading HVAC systems at ten separate city facilities, facility lighting upgrades at 29 separate locations, upgrading exterior park lighting at 17 city parks, cemeteries and museums, energy management systems upgrades at 21 city facilities and the conversion of all traffic signals from incandescent to LED bulbs. As a result of these improvements, the City of Tyler has realized a 21% (4,653,640 kWh) reduction in annual electricity consumption.
- <u>CNG Vehicle Program</u>-In 2012, the City of Tyler entered into a public/private partnership for the installation of the CNG fueling facility and the addition of 18 light duty and 10 medium/heavy duty CNG fueled vehicles. Through the use of the CNG fueled vehicles, the City of Tyler has realized an emissions reduction of 15,552 lbs., including 81 lbs. VOC and 2,012 lbs. NOx.

4.2.4.1.1 Future Programs

The City of Tyler is currently evaluating the next phase of its ongoing Energy Management and Modernization Program, which includes re-commissioning the return sludge activation process at one wastewater treatment plant, installation of high efficiency blowers at three treatment facilities, variable frequency drives for high volume pump motor replacements, space lighting retrofit and the installation of a biogas cogeneration system. The energy savings associated with the proposed projects are projected to be 1,134,000 kWh or a 16% reduction in electricity consumption.

The City of Tyler continues to participate in NETAC.

4.2.4.2 <u>City of Longview (Gregg County)</u>

The City of Longview, Texas has been working diligently since 2001 with the passage of Senate Bill 5, to design projects and manage operations in order to reduce emissions caused by the operations of our various services. These efforts have continued through the enactments of both Senate Bill 12 and Senate Bill 898. From 2001-2006, the City cut energy use by 46% saving more than 215 million kilowatt hours per year.

Below we provide examples of earlier projects and their current status:

- Replacement of equipment with energy-efficient and/or Energy-Star rated whenever possible or practical. This is on-going.
- Installation of energy saving devices such as timers and motion switches whenever possible and practical. On-going initiative.
- Installing LED traffic lights throughout the City. Complete
- Replaced incandescent with compact fluorescent bulbs, replaced magnetic ballasts with electronic ballasts, and converted fluorescent fixtures from T-12 to T-8. Complete
- Installed energy efficient windows in constructed or remodeled buildings whenever possible. On-going.

- Total renovation of swimming pools included installation of high efficiency electric motors on centrifugal pumps. Complete.

In 2009, the U.S. Department of Energy, through the President's American Recovery and Reinvestment Act's Energy Efficiency and Conservation Block Grant Program, provided $781,900 to the City of Longview. The City's programs which were approved through the process included:

- A CFL / Incandescent bulb swap program allowed the City to purchase 14,968 FE151S-19W 2700K mini-spiral, 10,000 hour CFL and citizens "traded in" 4 60 watt incandescent bulbs in return for 4 CFL. 3742 households were impacted with an estimated Life Cycle Air Pollution reduction of 12,923,933 lbs. of CO2. Complete
- The installation of technology to reduce, capture and to the maximum extent practicable use methane and other greenhouse gases generated by Wastewater Plant Digesters. The 65kW Biogas Capstone Micro Turbine provides for the energy / electricity generated to be routed back to the Wastewater Treatment Plant grid or to be sold back to AEP / SWEPCO. Energy savings continue.
- The retrofitting of Blowers at the Wastewater Treatment Plant with high efficiency blowers. Valve actuators were added to allow the redundant blower #3 to switch back and forth between aeration subsystems and the master control panel. Savings continue.

Other Projects / Programs:

- During Ozone Season (May 1-September 30) each year, when TCEQ issues "Ozone Action Days," City Crews are instructed to avoid grounds maintenance activities and to not fill-up vehicles due to continuing concerns about air quality. On-going.
- Relamping Street Lights / Parking Lot Lights / Park Security Lighting with more energy efficient technology as need is identified and funding becomes available: examples: Downtown Street lighting on Tyler and Fredonia Street (from Metal Halide to Induction Fixtures,) Cotton Street Parking Lots and converting the picnic pavilion at Flewellen Park to solar. The Fredonia Street relamping project in 2013, per the SWEPCO Commercial Solutions Program is saving 37.4 Metric tons of carbon dioxide equivalent. This program is on-going and is based on funding availability.
- Relamping (ballasts and bulbs) the Fire Training Center and Convention Center Exhibit Building provided incentive payments from SWEPCO of $7,496.43 and $3,652.87 respectively and combined, reduced kW usage by more than 11.
- HVAC decisions are also impacted by the need to reduce energy consumption: the replacement of the Library's Air-Cooled Chiller provided an incentive of $1,227.00. On-going.
- Replacing 200 standard desktop computers (180 watt) with 200 "zero-clients" (36 watt) for an estimated savings of 28,800 watts of comparative use. Energy efficient

technology decisions are on-going with such items as copiers, scanners and replacing desk-top printers with networked printers in office situations.

In FY 2013-14, the following significant actions were implemented:

- The City purchased 8 Heil Multipack CNG Sanitation Trucks and initiated once a week pick up of both refuse and recycling for the 23,000 + sanitation customers in Longview. When comparing the new vehicles and routes to the former collection program, there is an estimated 51.7% reduction in CO_2 emissions.
- The Longview City Council approved the 2011 National Electrical Code (NEC) and the 2012 International Building Code which impact development standards for both new construction and renovation / remodeling. Both codes provide for improved energy efficiency. There are no estimates on emission reductions.

Additionally, the City's Standard Operating Policies call for considering energy efficiency ratings along with final costs when making purchasing / construction decisions. The City of Longview is fully aware of the critical need to continue to reduce emissions and the City's Interdepartmental "Operations Lights Out" Team is tasked with keeping this issue in front of decision makers and co-workers. Simple initiatives like considering energy efficiency ratings along with final cost combine to allow for optimal decisions.

4.2.4.3 City of Henderson (Rusk County)

The City of Henderson has implemented the following Ozone Action Plan. These measures should be implemented immediately during the Ozone season of May through September with no significant impact on cost or productivity. Individual divisions will utilize the guidelines and determine how they can best be applied in specific areas of the City's operations.

- Turn off lights and equipment to reduce power load when not in use.
- Consider work schedules that will reduce equipment and vehicle usage in the morning hours.
- Delay fueling of vehicles until the advisory is over. If fueling is necessary, do so in the late afternoon or early evening. Avoid overfilling the tank and allowing fuel to spill onto the ground.
- Limit vehicle trips as much as possible. Coordinate activities to avoid duplication of trips. If possible, schedule trips for afternoons.
- Avoid idling vehicles unnecessarily.
- Emphasize need to keep vehicles properly maintained to reduce pollutants.
- Schedule the use of heavy equipment for non-ozone action days.
- Limit use of weed eaters, tractors, lawn mowers and power tools. Defer use to afternoon, if possible or delay non-essential use to a non-action day.

The City of Henderson has also implemented energy efficiency programs. The City of Henderson has dedicated itself to reducing energy consumption and complying with Texas

Senate Bill No. 12 and House Bill No. 3693. These bills require municipalities to reduce energy consumption by 5% each year, over the next 6 years. A team of employees has been comprised to monitor, educate, and implement ways to reduce energy use for local government. All municipal building remodeling/retrofitting is incorporated using energy savings techniques as required by energy code standards.

The City will strive to reduce energy usage by purchasing energy efficient equipment, retrofitting existing facilities to maximize the facilities' efficiency and effectiveness from the standpoint of energy use. Educate our directors and employees on day-to-day procedures that reduce energy consumption.

Under the provisions of this plan, the City will:

- Conduct preliminary energy audits to identify ways to eliminate and/or minimize energy waste.
- Using information derived from the energy audits to schedule a detailed Utility Assessment Report to determine precise energy-reducing initiatives that can be implemented by the City.
- Research and utilize agencies that provide programs on energy efficiency improvements and invest in remodeling/retrofitting projects for long term savings.
- Ensure that the construction of all new offices meets energy standards established by State Statutes
- Adopt a campaign to educate employees on ways to reduce energy consumption without sacrificing operational effectiveness or personal comfort.

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