TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

AGENDA ITEM REQUEST

for Proposed State Implementation Plan Revision

AGENDA REQUESTED: December 10, 2014

DATE OF REQUEST: November 21, 2014

INDIVIDUAL TO CONTACT REGARDING CHANGES TO THIS REQUEST, IF NEEDED: Joyce Spencer-Nelson, (512) 239-5017

CAPTION: Docket No. 2014-1262-SIP. Consideration for publication of, and hearing on, the proposed Dallas-Fort Worth (DFW) Attainment Demonstration State Implementation Plan (SIP) revision to meet the 2008 Eight-Hour Ozone National Ambient Air Quality Standard. The counties affected include Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise.

To meet Federal Clean Air Act requirements, the proposed SIP revision would include a photochemical modeling analysis, a weight of evidence analysis, a reasonably available control technology (RACT) analysis, a reasonably available control measures analysis, a motor vehicle emissions budget for 2018, and a contingency plan. This SIP revision would also incorporate two proposed rulemakings to fulfill RACT requirements for any sources identified in the DFW area that are not already subject to the existing 30 Texas Administrative Code Chapters 115 and 117 rules. (Kathy Singleton, Terry Salem) (Rule Project No. 2013-015-SIP-NR)

Steve Hagle, P.E.
Deputy Director

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Agenda Coordinator

Copy to CCC Secretary? NO X YES

Texas Commission on Environmental Quality
Interoffice Memorandum

To: Commissioners **Date:** November 21, 2014

Thru: Bridget C. Bohac, Chief Clerk
Richard A. Hyde, P.E., Executive Director

From: Steve Hagle, P.E., Deputy Director
Office of Air

Docket No.: 2014-1262-SIP

Subject: Commission Approval for Proposed Dallas-Fort Worth (DFW) 2008 Eight-Hour Ozone Nonattainment Area Attainment Demonstration (AD) State Implementation Plan (SIP) Revision

DFW 2008 Eight-Hour Ozone Standard AD SIP Revision
SIP Project No. 2013-015-SIP-NR

Background and reason(s) for the SIP Revision:
The Federal Clean Air Act (FCAA) requires states to submit plans to demonstrate attainment of the National Ambient Air Quality Standards (NAAQS) for nonattainment areas within the state. On May 1, 2012, the 10-county DFW area, consisting of Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties, was designated a moderate nonattainment area for the 2008 eight-hour ozone standard, with a December 31, 2018 attainment deadline. Attainment of the standard (expressed as 0.075 parts per million) is achieved when an area's design value does not exceed 75 parts per billion (ppb).

Scope of the proposed SIP revision:
This memo applies to the DFW AD SIP Revision for the 2008 Ozone NAAQS requirement under a moderate ozone nonattainment classification. There will also be a new reasonable further progress (RFP) demonstration required for the DFW area, the details of which are covered in a separate memo (Project No. 2013-014-SIP-NR).

A.) Summary of what the SIP revision will do:
The proposed SIP revision uses photochemical modeling and corroborative analysis to demonstrate that the area will attain the 2008 eight-hour ozone standard by the December 31, 2018 attainment deadline. This SIP revision would demonstrate attainment based on reductions in nitrogen oxides (NO_X) and volatile organic compounds (VOC) emissions from existing control strategies as well as any new strategies proposed concurrently with this SIP revision.

This SIP revision would incorporate two proposed rulemakings (Rule Project Numbers 2013-048-115-AI and 2013-049-117-AI) to fulfill reasonably available control technology (RACT) requirements for all control techniques guidelines (CTG) emission source categories and all non-CTG major sources of VOC and NO_X as required by FCAA, §172(c)(1) and §182(b)(2). The major source threshold for moderate nonattainment areas is a potential to emit (PTE) 100 tons per year (tpy) or more of either NO_X or VOC. The PTE 100 tpy major source threshold applies in the newly designated Wise County. A PTE 50 tpy major source threshold is retained for the remaining nine counties, which are currently classified as a serious nonattainment area under the 1997 eight-hour ozone NAAQS. The state has previously adopted Chapter 115 VOC and Chapter 117 NO_X rules to satisfy RACT requirements for sources in the nine-county DFW area as part of the SIP for the 1997 eight-hour ozone standard. The proposed rulemakings would satisfy RACT requirements for Wise County and for any sources identified in the DFW area that are not already subject to the existing rules.

This AD plan would be proposed and adopted in conjunction with the 2008 Eight-Hour Ozone Standard RFP SIP revision (Project No. 2013-014-SIP-NR).

B.) Scope required by federal regulations or state statutes:
The proposed AD SIP revision is consistent with the requirements of FCAA, §182(b)(1) and the EPA's *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Proposed Rule* (proposed 2008 ozone standard SIP requirements rule), published in the *Federal Register* (FR) on June 6, 2013 (78 FR 34178). To date, the proposed 2008 ozone standard SIP requirement rule has not been adopted by the EPA. The FCAA-required SIP elements, include analyses for RACT and reasonably available control measures, a motor vehicle emissions budget (MVEB), and a contingency plan.

The FCAA requires that attainment demonstrations be based on photochemical grid modeling or any other analytical methods determined by the EPA to be at least as effective, such as weight of evidence (WoE), to supplement and corroborate the model results and support the adequacy of a proposed control strategy package. The EPA has not yet finalized modeling guidance applicable to the 2008 eight-hour ozone standard of 75 ppb, therefore, the EPA's April 2007 *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze* for the 1997 eight-hour ozone standard of 84 ppb is defaulted to instead.

C.) Additional staff recommendations that are not required by federal rule or state statute:
It is recommended that the DFW AD SIP revision be proposed with on-road mobile source emission inventories developed using the Motor Vehicle Emission Simulator (MOVES) 2010b model and as long as there are no problems with the MOVES2014 model, the revision will be adopted with this new version. Due to the timing of the MOVES2014 model release on July 31, 2014, the SIP development schedule did not allow time for inclusion of link-based MOVES2014 inventory estimates in this proposal. The Texas Commission on Environmental Quality (TCEQ) is working with the North Central Texas Council of Governments (NCTCOG) to develop 2018 on-road emission inventories using MOVES2014 for the DFW area. Provided that there are no problems encountered with the MOVES2014 model, staff plans to use the updated on-road inventories to replace the current ones that

are the basis of the MVEB in the proposal version of this SIP revision. The planning assumptions, fleet characteristics, and vehicle miles traveled (VMT) estimates would also be updated to incorporate the latest available information at the time the revised inventories are developed. It is expected that the final on-road emission estimates would be different than those reported in this proposal. As a result, the SIP narrative would likely change between proposal and adoption to reflect the updated on-road mobile emissions inventories.

The MVEB must be used in transportation conformity analyses. Areas must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed the MVEB. The MVEB represents the on-road mobile source emissions that have been modeled for the attainment demonstration and includes all of the on-road control measures.

The EPA provides MOVES2014 use in *Policy Guidance on the Use of MOVES2014 for State Implementation Plan Development, Transportation Conformity, and other Purposes.* The grace period for MOVES 2014 transportation conformity analyses will be established as two years after publication in the *Federal Register*. Approved MOVES2014-based budgets for the DFW-area would allow for a direct comparison with the MOVES2014-based regional emissions analyses performed for future transportation conformity analyses.

MOVES2014 includes impacts of the more stringent Tier 3 emission standards that begin with the 2017 model year and gasoline with a reduced sulfur content that results in lower NO_X, VOC, and carbon monoxide emissions.

Statutory authority:
The authority to propose and adopt SIP revisions is derived from the following sections of Texas Health and Safety Code, Chapter 382, Texas Clean Air Act (TCAA), §382.002, which provides that the policy and purpose of the TCAA is to safeguard the state's air resources from pollution; §382.011, which authorizes the commission to control the quality of the state's air; and §382.012, which authorizes the commission to prepare and develop a general, comprehensive plan for the control of the state's air. This SIP revision is required by FCAA, §110(a)(1) and implementing rules in 40 Code of Federal Regulations Part 51.

Under the 1997 eight-hour ozone standard, the DFW area is required to continue to meet the mandates of FCAA, §172(c)(2) and §182(c)(2)(B) and requirements established under Phase II of the EPA's implementation rule for the 1997 eight-hour ozone NAAQS (70 FR 71615) for nonattainment areas classified as serious.

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Effect on the:
A.) Regulated community:
The affected regulated community will be those associated with the rulemakings that are part of this SIP revision. For further information, see the executive summaries for the following rulemakings, which are being proposed concurrently with this SIP revision.

- Rule Project No. 2013-049-117-AI; NO_X RACT Rules for the DFW 2008 Eight-Hour Ozone Nonattainment Area
- Rule Project No. 2013-048-115-AI; VOC RACT Rules for the DFW 2008 Eight-Hour Ozone Nonattainment Area
- Rule Project No. 2014-007-101-AI; Chapter 101 Emissions Banking and Trading Rulemaking w/ DERC Flow Control

B.) Public:
The general public in the DFW ozone nonattainment area would benefit from improved air quality as a result of lower ozone levels.

C.) Agency programs:
If the rules associated with this SIP revision are adopted, the Office of Compliance and Enforcement would be involved in enforcing NO_X RACT Rules (Rule Project No. 2013-049-117-AI) and VOC RACT Rules (Rule Project No. 2013-048-115-AI) for the DFW 2008 Eight-Hour Ozone Nonattainment Area. Similarly, the Environmental Assistance Division could face an increased workload if the demand for compliance assistance increases as a result of new control measures.

Stakeholder meetings:
A public information meeting to provide information on the development of revisions to the SIP for the 2008 eight-hour ozone National Ambient Air Quality Standard in the 10-county DFW nonattainment area was held on September 5, 2013 at 10:00 a.m. at the NCTCOG, in Arlington, Texas. Stakeholders were asked to submit any ideas or suggestions to staff prior to proposal of the SIP revision. NCTCOG and EPA representatives also provided updates on local and federal initiatives. The DFW 2008 Eight-Hour Ozone AD SIP Revision will go through a public review and comment period, including public hearings.

Potential controversial concerns and legislative interest:
The EPA's proposed implementation rule for the 2008 eight-hour ozone standard (78 FR 34178, June 6, 2013) included two alternative deadlines for submitting the various SIP elements: (1) submit the emissions inventory and RACT SIP revisions by July 20, 2014 and the other major SIP elements by July 20, 2015; or (2) submit all required SIP elements together by January 20, 2015. The timeline for this SIP revision is to submit all elements together by July 20, 2015. This is consistent with the approach taken in 2007 during the transition to the 1997 eight-hour NAAQS in both the DFW and Houston-Galveston-Brazoria areas. Because this proposed SIP revision that includes a RACT demonstration will not be submitted by the deadline specified in the implementation rule or the FCAA, the

EPA could issue a finding of failure to submit. Such a finding could result in the imposition of sanctions on the state and promulgation of a federal implementation plan (FIP) under FCAA, §179, unless a plan is submitted to the EPA within 18 months after the EPA makes such a finding (not earlier than January 20, 2016). The current schedule would have the SIP submitted to the EPA by July 2015. Sanctions could include transportation funding restrictions, grant withholding, and increased emissions offsets requirements for new construction and major modification of stationary sources in the DFW ozone nonattainment area. The EPA would be required to impose such sanctions and implement a FIP until the DFW 2008 Eight-Hour Ozone AD SIP revision is approved for the area.

The TCEQ received a letter from State Representative Lon Burnam, District 90, Fort Worth, Texas, dated April 17, 2014, and a follow-up letter, dated June 10, 2014, requesting information regarding the SIP activities for the DFW 2008 eight-hour ozone nonattainment area. The focus of the inquiry was the EPA criteria for control measures that are included in the TCEQ air quality model and those that are considered to be WoE and the estimated impact on ozone levels in the DFW area by 2018. Representative Burnam's questions were responded to in writing as requested.

The TCEQ submitted two AD SIP revisions for the nine-county DFW 1997 eight-hour ozone nonattainment area. Both included a weight of evidence analysis, which supported the commission's conclusion that the DFW area would attain the 1997 eight-hour ozone standard by its attainment deadline. The DFW area did not meet its attainment deadline in both cases, first in 2009 and again in 2012. Some stakeholders have pointed to this fact, and called for the TCEQ to develop additional regulations to reduce ozone to ensure that the DFW area meets the 2008 ozone standard on or before December 31, 2018.

This proposed SIP revision includes Wise County as part of the DFW 2008 eight-hour ozone standard nonattainment area since it was designated as nonattainment by the EPA in the final designations rule published in the *Federal Register* on May 21, 2012 (77 FR 30088). However, the TCEQ, and other concerned parties are currently challenging whether the EPA's inclusion of Wise County in the DFW 2008 eight-hour ozone nonattainment area was lawful. These challenges are currently pending in the United States Court of Appeals for the District of Columbia Circuit. If the inclusion of Wise County in the DFW 2008 eight-hour ozone nonattainment area is overturned, this plan would be revised appropriately.

Will this SIP revision affect any current policies or require development of new policies?
No.

What are the consequences if this SIP revision does not go forward? Are there alternatives to this SIP revision?
The commission could choose to not comply with requirements to develop and submit this AD SIP revision to the EPA. If an AD SIP revision is not submitted by July 20, 2015, the

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EPA could impose sanctions on the state and promulgate a FIP. Sanctions could include transportation funding restrictions, grant withholdings, and 200% emissions offsets requirements for new construction and major modifications of stationary sources in the DFW area. The EPA could impose such sanctions and implement a FIP until the state submitted and the EPA approved a replacement DFW 2008 eight-hour ozone AD SIP revision for the area. Additionally, staff could choose to wait until the EPA finalizes the 2008 ozone standard SIP requirements rule before proposing the DFW AD SIP revision. However, by delaying proposal the DFW AD SIP revision would not be submitted by the July 20, 2015 deadline and would result in the same consequences.

Key points in the proposal SIP revision schedule:

Anticipated proposal date: December 10, 2014
Anticipated public hearing dates: January 15, 2015 in Arlington, Texas and January 22, 2015 in Austin, Texas.
Anticipated public comment period: December 26, 2014 through January 30, 2015
Anticipated adoption date: June 3, 2015

Agency contacts:
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REVISIONS TO THE STATE OF TEXAS AIR QUALITY IMPLEMENTATION PLAN FOR THE CONTROL OF OZONE AIR POLLUTION

DALLAS-FORT WORTH EIGHT-HOUR OZONE NONATTAINMENT AREA

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
P.O. BOX 13087
AUSTIN, TEXAS 78711-3087

DALLAS-FORT WORTH ATTAINMENT DEMONSTRATION STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE STANDARD NONATTAINMENT AREA

PROJECT NUMBER 2013-015-SIP-NR

Proposal
December 10, 2014

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EXECUTIVE SUMMARY

On May 21, 2012, the United States Environmental Protection Agency (EPA) published final designations for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS) (77 *Federal Register* (FR) 30088). The Dallas-Fort Worth (DFW) area was designated as a moderate nonattainment area under this standard, which was effective on July 20, 2012.

The DFW 10-county nonattainment area includes Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties. The deadline for Texas to submit a state implementation plan (SIP) revision addressing the moderate ozone nonattainment area requirements of the 1990 Federal Clean Air Act (FCAA) Amendments is July 20, 2015. The DFW area must attain the 2008 eight-hour ozone standard of 0.075 parts per million as expeditiously as practicable, but no later than December 31, 2018.

This proposed attainment demonstration (AD) SIP revision includes base case modeling of an eight-hour ozone exceedance episode that occurred during June and August/September 2006. These time periods were chosen because they are representative of the times of the year that ozone exceedances have historically been monitored with the DFW area. The model performance evaluation of the 2006 base case indicates the modeling is suitable for use in conducting the modeling attainment test. The modeling attainment test was applied by modeling a 2006 baseline year and 2018 future year to project 2018 eight-hour ozone design values.

Table ES-1: *Summary of 2006 Baseline and 2018 Future Year Anthropogenic Modeling Emissions for DFW* lists the anthropogenic modeling emissions in tons per day (tpd) by source category for the 2006 baseline and 2018 future year for nitrogen oxides (NO_X) and volatile organic compounds (VOC) ozone precursors. The differences in modeling emissions between the 2006 baseline and the 2018 future year reflect the net of growth and reductions from existing controls. The existing controls include both state and federal measures that have already been promulgated. The electric utility emissions for the 2006 are an ozone season average of actual emission measurements, while the 2018 electric utility emission projections are based on the maximum ozone season caps required under Phase II of the Clean Air Interstate Rule (CAIR).

Table ES-1: Summary of 2006 Baseline and 2018 Future Year Anthropogenic Modeling Emissions for DFW

DFW Area Source Type	2006 NO_X (tpd)	2018 NO_X (tpd)	2006 VOC (tpd)	2018 VOC (tpd)
On-Road	265.87	113.36	113.15	55.63
Non-Road	88.75	39.87	63.84	32.80
Area Sources	29.02	30.76	290.46	284.94
Off-Road – Locomotives	29.97	18.90	1.72	0.93
Off-Road – Airports	12.78	13.06	4.46	3.55
Oil and Gas – Production	61.84	7.15	43.72	23.79
Oil and Gas – Drill Rigs	18.23	2.82	1.16	0.21
Point – Oil and Gas	11.53	16.37	21.82	26.02
Point – Electric Utilities	9.63	16.91	1.03	4.44
Point – Cement Kilns	22.08	17.64	1.94	0.78
Point – Other	14.31	6.62	25.65	20.43

DFW Area Source Type	2006 NO_X (tpd)	2018 NO_X (tpd)	2006 VOC (tpd)	2018 VOC (tpd)
Total	564.01	283.46	568.95	453.52

Table ES-2: *Summary of Modeled 2006 Baseline and 2018 Future Year Eight-Hour Ozone Design Values for DFW Monitors* lists the eight-hour ozone design values in parts per billion (ppb) for the 2006 baseline year design value (DV_B) and 2018 future year design value (DV_F) for the regulatory ozone monitors in the DFW area. In accordance with EPA modeling guidance, the 2018 DV_F figures presented have been rounded to one decimal place and then truncated. Since the modeling cannot provide an absolute prediction of future year ozone design values, additional information from corroborative analyses are used in assessing whether the area will attain the ozone standard by December 31, 2018.

Table ES-2: Summary of Modeled 2006 Baseline and 2018 Future Year Eight-Hour Ozone Design Values for DFW Monitors

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 Baseline Design Value (ppb)[#]	Relative Response Factor	2018 Future Design Value (ppb)
Denton Airport South - C56	DENT	93.33	0.8215	76
Eagle Mountain Lake - C75	EMTL	93.33	0.8133	75
Grapevine Fairway - C70	GRAP	90.67	0.8358	75
Keller - C17	KELC	91.00	0.8238	75
Fort Worth Northwest - C13	FWMC	89.33	0.8226	73
Frisco - C31	FRIC	87.67	0.8338	73
Dallas North #2 - C63	DALN	85.00	0.8416	71
Parker County - C76	WTFD	87.67	0.8119	71
Dallas Executive Airport - C402	REDB	85.00	0.8334	70
Cleburne Airport - C77	CLEB	85.00	0.8265	70
Arlington Municipal Airport - C61	ARLA	83.33	0.8328	69
Dallas Hinton Street - C401	DHIC	81.67	0.8392	68
Granbury - C73	GRAN	83.00	0.8174	67
Midlothian Tower - C94*	MDLT*	80.50	0.8379	67
Pilot Point - C1032*	PIPT*	81.00	0.8222	66
Rockwall Heath - C69	RKWL	77.67	0.8452	65
Midlothian OFW - C52*	MDLO*	75.00	0.8399	63
Greenville - C1006	GRVL	75.00	0.8329	62
Kaufman - C71	KAUF	74.67	0.8327	62

*PIPT, MDLT, and MDLO did not measure enough data from 2004 through 2008 to calculate a complete DV_B. The DV_B shown uses all available data.

[#]The 2006 DV_B is different from the 2006 regulatory design value (DV_R). Figure 3-1: 2006 *Baseline Design Value Calculation* illustrates how the 2006 DV_B is calculated using the three years of DV_R data.

This AD SIP revision also provides ozone reduction trends analyses and other supplementary data and information to demonstrate that the DFW 10-county nonattainment area will attain the

2008 eight-hour ozone standard by the December 31, 2018 attainment date. The quantitative and qualitative corroborative analyses in Chapter 5: *Weight of Evidence* further support a conclusion that this SIP revision demonstrates attainment of the 2008 eight-hour ozone standard.

This proposed SIP revision incorporates two proposed rulemakings (Rule Project Numbers 2013-048-115-AI and 2013-049-117-AI) to fulfill reasonably available control technology (RACT) requirements for all control techniques guidelines (CTG) emission source categories and all non-CTG major sources of VOC and NO_X as required by FCAA, §172(c)(1) and §182(b)(2). The major source threshold for moderate nonattainment areas is a potential to emit 100 tons per year (tpy) or more of either NO_X or VOC. The 100 tpy major source threshold applies in the newly designated Wise County. A 50 tpy major source threshold is retained for the remaining nine counties, which are currently classified as a serious nonattainment area under the 1997 eight-hour ozone NAAQS. These counties must continue to apply the more stringent threshold. The commission has previously adopted Chapter 115 VOC and Chapter 117 NO_X rules to satisfy RACT requirements for sources in the nine-county DFW area as part of the SIP for the one-hour ozone standard and the 1997 eight-hour ozone standard. The proposed rulemakings would satisfy RACT requirements for Wise County and for any sources identified in the DFW area that are not already subject to the existing rules.

This SIP revision also includes the following FCAA-required SIP elements: a reasonably available control measures analysis, a RACT analysis, motor vehicle emissions budgets (MVEB), and a contingency plan. The MVEB can be found in Table 4-2: *2018 Attainment Demonstration MVEB*[1] *for the 10-County DFW Area*.

The on-road mobile source emission inventories for this proposed SIP revision were developed using the MOVES2010b model. However, the EPA released the updated version of MOVES (MOVES2014) on July 31, 2014. The schedule for the inventory development for this SIP revision did not allow time to incorporate MOVES2014. The TCEQ is working with the North Central Texas Council of Governments (NCTCOG) to develop 2018 on-road emission inventories using MOVES2014 for the DFW area. Provided that there are no problems encountered with the MOVES2014 model, staff plans to use the updated inventories to replace the current ones that are the basis of the MVEB in the proposal version of this SIP revision. The planning assumptions, fleet characteristics, and vehicle miles traveled estimates would also be updated to incorporate the latest available information at the time the revised inventories are developed. It is expected that the final on-road emission estimates will be different than those reported in this proposal. As a result, the SIP narrative may change between proposal and adoption to reflect the updated on-road mobile emissions inventories.

The MVEB must be used in transportation conformity analyses. Areas must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed the MVEB. The attainment MVEB represents the on-road mobile source emissions that have been modeled for the attainment demonstration, and includes all of the on-road control measures. MOVES2014 includes impacts of the more stringent Tier 3 emission standards that begin with the 2017 model year, and gasoline with a reduced sulfur content that results in lower emissions of NO_X, VOC, and carbon monoxide.

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[1] The MVEB can be found in Table 4-2: *2018 Attainment Demonstration* [1]*MVEB for the 10-County DFW Area*.

This SIP revision includes Wise County as part of the DFW 2008 eight-hour ozone standard nonattainment area since it was designated as nonattainment by the EPA in the final designations rule published in the *Federal Register* on May 21, 2012 (77 FR 30088). However, the TCEQ and other concerned parties are currently challenging whether the EPA's inclusion of Wise County in the DFW 2008 eight-hour ozone nonattainment area was lawful. These challenges are currently pending in the United States Court of Appeals for the District of Columbia Circuit. If the inclusion of Wise County in the DFW 2008 eight-hour ozone nonattainment area is overturned, the TCEQ will take action to revise this plan appropriately.

The TCEQ is committed to developing and applying the best science and technology towards addressing and reducing ozone formation as required in the DFW and other ozone nonattainment areas in Texas. This AD SIP revision also includes a description of how the TCEQ continues to use new technology and investigate possible emission reduction strategies and other practical methods to make progress in air quality improvement.

SECTION V-A: LEGAL AUTHORITY

General

The Texas Commission on Environmental Quality (TCEQ) has the legal authority to implement, maintain, and enforce the National Ambient Air Quality Standards (NAAQS) and to control the quality of the state's air, including maintaining adequate visibility.

The first air pollution control act, known as the Clean Air Act of Texas, was passed by the Texas Legislature in 1965. In 1967, the Clean Air Act of Texas was superseded by a more comprehensive statute, the Texas Clean Air Act (TCAA), found in Article 4477-5, Vernon's Texas Civil Statutes. The legislature amended the TCAA in 1969, 1971, 1973, 1979, 1985, 1987, 1989, 1991, 1993, 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011, and 2013. In 1989, the TCAA was codified as Chapter 382 of the Texas Health and Safety Code.

Originally, the TCAA stated that the Texas Air Control Board (TACB) is the state air pollution control agency and is the principal authority in the state on matters relating to the quality of air resources. In 1991, the legislature abolished the TACB effective September 1, 1993, and its powers, duties, responsibilities, and functions were transferred to the Texas Natural Resource Conservation Commission (TNRCC). With the creation of the TNRCC, the authority over air quality is found in both the Texas Water Code and the TCAA. Specifically, the authority of the TNRCC is found in Chapters 5 and 7. Chapter 5, Subchapters A - F, H - J, and L, include the general provisions, organization, and general powers and duties of the TNRCC, and the responsibilities and authority of the executive director. Chapter 5 also authorizes the TNRCC to implement action when emergency conditions arise and to conduct hearings. Chapter 7 gives the TNRCC enforcement authority. In 2001, the 77th Texas Legislature continued the existence of the TNRCC until September 1, 2013, and changed the name of the TNRCC to the TCEQ. In 2009, the 81st Texas Legislature, during a special session, amended section 5.014 of the Texas Water Code, changing the expiration date of the TCEQ to September 1, 2011, unless continued in existence by the Texas Sunset Act. In 2011, the 82nd Texas Legislature continued the existence of the TCEQ until 2023.

The TCAA specifically authorizes the TCEQ to establish the level of quality to be maintained in the state's air and to control the quality of the state's air by preparing and developing a general, comprehensive plan. The TCAA, Subchapters A - D, also authorize the TCEQ to collect information to enable the commission to develop an inventory of emissions; to conduct research and investigations; to enter property and examine records; to prescribe monitoring requirements; to institute enforcement proceedings; to enter into contracts and execute instruments; to formulate rules; to issue orders taking into consideration factors bearing upon health, welfare, social and economic factors, and practicability and reasonableness; to conduct hearings; to establish air quality control regions; to encourage cooperation with citizens' groups and other agencies and political subdivisions of the state as well as with industries and the federal government; and to establish and operate a system of permits for construction or modification of facilities.

Local government authority is found in Subchapter E of the TCAA. Local governments have the same power as the TCEQ to enter property and make inspections. They also may make recommendations to the commission concerning any action of the TCEQ that affects their territorial jurisdiction, may bring enforcement actions, and may execute cooperative agreements with the TCEQ or other local governments. In addition, a city or town may enact and enforce ordinances for the control and abatement of air pollution not inconsistent with the provisions of the TCAA and the rules or orders of the commission.

Subchapters G and H of the TCAA authorize the TCEQ to establish vehicle inspection and maintenance programs in certain areas of the state, consistent with the requirements of the Federal Clean Air Act; coordinate with federal, state, and local transportation planning agencies to develop and implement transportation programs and measures necessary to attain and maintain the NAAQS; establish gasoline volatility and low emission diesel standards; and fund and authorize participating counties to implement vehicle repair assistance, retrofit, and accelerated vehicle retirement programs.

Applicable Law

The following statutes and rules provide necessary authority to adopt and implement the state implementation plan (SIP). The rules listed below have previously been submitted as part of the SIP.

Statutes

All sections of each subchapter are included, unless otherwise noted.

Texas Health and Safety Code, Chapter 382	September 1, 2013
Texas Water Code	September 1, 2013

Chapter 5: Texas Natural Resource Conservation Commission
- Subchapter A: General Provisions
- Subchapter B: Organization of the Texas Natural Resource Conservation Commission
- Subchapter C: Texas Natural Resource Conservation Commission
- Subchapter D: General Powers and Duties of the Commission
- Subchapter E: Administrative Provisions for Commission
- Subchapter F: Executive Director (except §§5.225, 5.226, 5.227, 5.2275,5.231, 5.232, and 5.236)
- Subchapter H: Delegation of Hearings
- Subchapter I: Judicial Review
- Subchapter J: Consolidated Permit Processing
- Subchapter L: Emergency and Temporary Orders (§§5.514, 5.5145, and 5.515 only)
- Subchapter M: Environmental Permitting Procedures (§5.558 only)

Chapter 7: Enforcement
- Subchapter A: General Provisions (§§7.001, 7.002, 7.0025, 7.004, and 7.005 only)
- Subchapter B: Corrective Action and Injunctive Relief (§7.032 only)
- Subchapter C: Administrative Penalties
- Subchapter D: Civil Penalties (except §7.109)
- Subchapter E: Criminal Offenses and Penalties: §§7.177, 7.179-7.183

Rules

All of the following rules are found in 30 Texas Administrative Code, as of the following latest effective dates:

Chapter 7: Memoranda of Understanding, §§7.110 and 7.119	December 13, 1996 and May 2, 2012
Chapter 19: Electronic Reporting	November 11, 2010
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ABY	adjusted base year
ACT	alternative control techniques
AD	attainment demonstration
AGL	above ground level
APCA	Anthropogenic Precursor Culpability Assessment
APU	auxiliary power unit
AQRP	Air Quality Research Program
ARD	Acid Rain Database
ARLA	Arlington Monitor (C61)
Auto-GC	automated gas chromatograph
BACT	best available control technology
BELD	Biogenic Emissions Landuse Database
BOEMRE	U.S. Bureau of Ocean Energy Management Service
BPA	Beaumont-Port Arthur
CAIR	Clean Air Interstate Rule
CAMS	continuous air monitoring station
CAMx	Comprehensive Air Model with Extension(s)
CB05	Carbon Bond 05
CB6	Carbon Bond 6
CFR	Code of Federal Regulations
CLEB	Cleburne Monitor (C77)
CLVL	Clarksville Monitor (C648)
CTG	control techniques guidelines
DALN	Dallas North Monitor (C63)
DACM	AirCheckTexas Drive a Clean Machine
DENT	Denton Monitor (C56)
DERC	discrete emission reduction credit
DFW	Dallas-Fort Worth
DHIC	Dallas Hinton Monitor (C401)
DV_B	baseline year design value
DV_F	future year design value
DV_P	projected design value
DV_R	regulatory design value

EE/RE	energy efficiency and renewable energy
EGU	electric generating unit
EI	emissions inventory
EIQ	emissions inventory questionnaire
EMTL	Eagle Mountain Lake Monitor (C75)
EPA	United States Environmental Protection Agency
EPS3	Emissions Processing System, Version 3
ESL	environmental speed limit
FCAA	Federal Clean Air Act
FINN	Fire INventory
FR	*Federal Register*
FTP	File Transfer Protocol
FRIC	Frisco Monitor (C31)
FWMC	Fort Worth Northwest Monitor (C13)
GCIP	Continental- International Project
GEWEX	Global Energy and Water Cycle Experiment
GloBEIS	Global Biosphere Emissions and Interactions System
GOES	Geostationary Operational Environmental Satellite
GRAN	Granbury Monitor (C73)
GRAP	Grapevine Monitor (C70)
GRVL	Greenville Monitor (C1006)
GWEI	Gulf-Wide Emissions Inventory
HB	House Bill
HECT	Highly Reactive Volatile Organic Compound Emissions Cap and Trade
HGB	Houston-Galveston-Brazoria
hp	horsepower
HPMS	Highway Performance Monitoring System
HRVOC	highly reactive volatile organic compounds
I/M	Inspection and Maintenance
ICI	industrial, commercial, and institutional
INEGI	National Institute of Statistics and Geography
IOP	increment-of-progress
KAUF	Kaufman Monitor (C71)
KELC	Keller Monitor (C17)
km	kilometer

LAI	leaf area index
LAIv	fractional vegetated leaf area index
LANDFIRE	Landscape Fire and Resource Management
LGVW	Longview Monitor (C19)
LIRAP	Low Income Vehicle Repair Assistance, Retrofit, and Accelerated Vehicle Retirement Program
LULC	land-use/land-cover
MACT	maximum achievable control technology
MDLO	Midlothian OFW Monitor (C52)
MDLT	Midlothian Tower Monitor (C94)
MEGAN	Model of Emissions of Gases and Aerosols from Nature
MECT	Mass Emissions Cap and Trade
MM5	Mesoscale Meteorological Model, Fifth Generation
MNB	Mean Normalized Bias
MNGE	Mean Normalized Gross Error
MODIS	Moderate-Resolution Imaging Spectroradiometer
MOVES	Motor Vehicle Emission Simulator
MOZART	Model for Ozone and Related Chemical Tracers
MPE	model performance evaluation
mph	miles per hour
MVEB	motor vehicle emissions budget
NAAQS	National Ambient Air Quality Standard
NCAR	National Center for Atmospheric Research
NCEP	National Center for Environmental Prediction
NCTCOG	North Central Texas Council of Governments
NEI	National Emissions Inventory
NLCD	National Land Cover Dataset
NMIM	National Mobile Inventory Model
NO_2	nitrogen dioxide
NOAH	NCEP Oregon State Air Force Hydrological Research Laboratory
NO_X	nitrogen oxides
NPRI	National Pollutant Release Inventory
O_3	ozone
OFW	Old Fort Worth
OMI	Ozone Monitoring Instrument

OSAT	Ozone Source Apportionment Technology
PAMS	Photochemical Assessment Monitoring Station
PAR	photosynthetically active radiation
PBL	Planetary Boundary Layer
PEI	periodic emissions inventory
PFT	plant functional types
PiG	Plume-in-Grid
PIPT	Pilot Point Monitor (C1032)
PLTN	Palestine Monitor (C647)
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
ppb	parts per billion
ppbC	parts per billion, Carbon
ppm	parts per million
QQ	quantile-quantile
RACM	reasonably available control measures
RACT	reasonably available control technology
REDB	Dallas Executive Airport Monitor (C402)
RFG	reformulated gasoline
RFP	reasonable further progress
RKWL	Rockwall Health Monitor (C69)
ROP	rate-of-progress
RRC	Railroad Commission of Texas
RRTM	Rapid Radiative Transfer Model
RVP	Reid vapor pressure
SAGA	San Augustine Airport Monitor (C646)
SB	Senate Bill
SECO	State Energy Conservation Office
SEER	Seasonal Energy Efficiency Ratio
SIP	state implementation plan
SO_2	sulfur dioxide
STARS	State of Texas Air Reporting System
TAC	Texas Administrative Code
TACB	Texas Air Control Board
TCAA	Texas Clean Air Act

TCEQ	Texas Commission on Environmental Quality (commission)
TCM	transportation control measure
TERP	Texas Emission Reduction Plan
TexAER	Texas Air Emissions Repository
TexAQS 2000	Texas Air Quality Study 2000
TexAQS II	Texas Air Quality Study 2006
TexN	Texas NONROAD
TNMHC	total non-methane hydrocarbons
TNMOC	total non-methane organic carbon
TNRCC	Texas Natural Resource Conservation Commission
tpd	tons per day
tpy	tons per year
TTI	Texas Transportation Institute
TxDOT	Texas Department of Transportation
TxLED	Texas Low Emission Diesel
UPA	Unpaired Peak Accuracy
VMEP	Voluntary Mobile Emissions Reduction Program
VMT	vehicle miles traveled
VOC	volatile organic compounds
WMBA	Wamba Monitor (C645)
WoE	weight of evidence
WRF	Weather Research and Forecasting Model
WTFD	Weatherford Parker County Monitor (C76)

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CHAPTER 1: GENERAL

1.1 BACKGROUND

The *History of the Texas State Implementation Plan*, a comprehensive overview of the state implementation plan (SIP) revisions submitted to the United States Environmental Protection Agency (EPA) by the State of Texas, is available on the Introduction to the SIP Web page (http://www.tceq.texas.gov/airquality/sip/sipintro.html#what-is-the-history) on the Texas Commission on Environmental Quality's (TCEQ) Web site (http://www.tceq.texas.gov/).

1.2 INTRODUCTION

The following history of the one-hour and eight-hour ozone standards and summaries of the Dallas-Fort Worth (DFW) area one-hour and 1997 eight-hour ozone SIP revisions are provided to give context and greater understanding of the complex issues involved in DFW's ozone challenge.

1.2.1 One-Hour National Ambient Air Quality Standard (NAAQS) History

The EPA established the one-hour ozone NAAQS of 0.08 parts per million (ppm) in the April 30, 1971 issue of the *Federal Register* (FR) (36 FR 8186). The EPA revised the one-hour ozone standard to 0.12 ppm on February 8, 1979 (44 FR 4202). The DFW one-hour ozone nonattainment area (Collin, Dallas, Denton, and Tarrant Counties) was designated in 1991 as moderate in accordance with the 1990 Federal Clean Air Act (FCAA) Amendments (56 FR 56694). As a moderate nonattainment area, the DFW area was required to demonstrate attainment of the one-hour ozone standard by November 15, 1996. Ambient air monitoring data for the years 1994 through 1996, however, showed that the one-hour ozone standard was exceeded more than one day per year over the three-year period. As a result, the EPA reclassified the DFW area from a moderate to a serious nonattainment area (effective March 20, 1998) for failure to attain the one-hour ozone standard by the November 1996 deadline (63 FR 8128). The EPA required the State of Texas to submit a SIP revision within one year that demonstrated attainment of the one-hour ozone NAAQS and addressed FCAA requirements for serious ozone nonattainment areas.

1.2.1.1 March 1999

The TCEQ submitted the Attainment Demonstration for the Dallas-Fort Worth Ozone Nonattainment Area SIP revision, which contained a rate-of-progress (ROP) demonstration, to the EPA on March 18, 1999. The photochemical modeling contained in the revision indicated that additional reductions in nitrogen oxides (NO_X) emissions would be needed to attain the standard by November 1999. The following rules were developed and included in the SIP revision:

- reasonably available control technology (RACT) for NO_X point sources;
- nonattainment new source review for NO_X point sources; and
- revisions resulting from the change in the major source threshold for RACT applicability for volatile organic compounds (VOC).

Additionally, the commission indicated that, due to time constraints, the ROP demonstration for the serious classification, would not incorporate all rules that were necessary to bring the DFW area into attainment by the November 1999 deadline and that a complete attainment demonstration (AD) would be submitted in the spring of 2000. The EPA determined that the AD and ROP demonstration were incomplete.

Additional local control strategies were necessary for the DFW area to reach attainment. To develop further control strategy options to augment the federal and state programs in the AD and ROP SIP revision, the DFW area established the North Texas Clean Air Steering Committee. The committee members included local elected officials, business leaders, and other community stakeholders. This committee identified specific control strategies for review by technical subcommittee members.

1.2.1.2 April 2000

On April 19, 2000, the commission adopted a SIP revision and associated rules for the DFW one-hour ozone attainment demonstration. The April 2000 One-Hour Ozone Attainment Demonstration SIP revision contained a number of control strategies and the following elements:

- a modeling demonstration that showed air quality in the DFW area was influenced at times by transport from the HGB nonattainment area (Under the EPA's July 16, 1998 transport policy[2], if photochemical modeling demonstrated that emissions from an upwind area located in the same state and with a later attainment date interfered with the downwind area's ability to attain, the downwind area's attainment date could be extended to no later than that of the upwind area. For the DFW area, following this policy would extend the attainment date to November 15, 2007, the same attainment date as the HGB area.);
- photochemical modeling of specific control measures and future state and national rules for attainment of the one-hour ozone standard in the DFW area by the attainment deadline of November 15, 2007;
- identification of the VOC and NO_X emissions reductions necessary to attain the one-hour ozone standard by 2007. The reductions of 141 tons per day (tpd) NO_X from federal measures and 225 tpd NO_X from state measures resulted in a total of 366 tpd NO_X reductions for the attainment demonstration;
- a 2007 motor vehicle emissions budget (MVEB) for transportation conformity; and
- a commitment to perform and submit a mid-course review by May 1, 2004.

At the time it was submitted, the April 2000 One-Hour Ozone Attainment Demonstration SIP revision allowed the EPA to determine that the DFW area should not be reclassified from serious to severe under the conditions of the EPA's July 16, 1998 transport policy.

1.2.1.3 August 2001

The next commission action was required by legislative mandate. Senate Bill 5 (SB5), passed by the 77th Texas Legislature in May 2001, required the repeal of two rules contained in the April 2000 one-hour AD SIP revision. The first rule restricted the use of construction and industrial equipment (non-road, heavy-duty diesel equipment rated at 50 horsepower (hp) or greater). The second rule required the replacement of diesel-powered construction, industrial, commercial, and lawn and garden equipment rated at 50 hp or greater with newer Tier 2 or Tier 3 equipment. The Texas Emissions Reduction Plan (TERP) grant incentive program established by SB5 replaced the NO_X emissions reductions previously claimed for the two programs. The

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[2] Additional information on EPA's *Guidance on Extension of Attainment Dates for Downwind Transport Areas* is available at http://www.epa.gov/ttn/oarpg/t1/memoranda/transpor.pdf.

commission implemented the legislative mandate of SB5 by submitting the rule repeals as part of a SIP revision adopted in August 2001.

1.2.1.4 March 2003

On March 5, 2003, the SIP was further revised to include the following:

- the adoption of revised 30 Texas Administrative Code (TAC) Chapter 117 NO_X emission limits for cement kilns;
- the estimation of NO_X reductions from energy efficiency measures, using a methodology that was to be further refined before energy efficiency credit was formally requested in the SIP revision; and
- the commitment to perform modeling with MOBILE6, the latest version of the EPA's emission factor model for mobile sources at that time.

Meanwhile, the EPA's July 16, 1998, transport policy, on which the extension of the DFW area's attainment date to November 15, 2007 was based, was challenged by environmental groups. A suit was filed challenging the extension of the Beaumont-Port Arthur (BPA) area's attainment date based on transport from the HGB area. On December 11, 2002, the United States Fifth Circuit Court of Appeals ruled that the EPA was not authorized to extend the BPA area's attainment date based on transport. The EPA published a final action in the *Federal Register* on March 30, 2004 reclassifying the BPA area to serious with an attainment date of November 15, 2005 and requiring a new attainment demonstration to be submitted by April 30, 2005. Although the court decision was specifically for the BPA area, the direct implication for the DFW area was that the EPA could not approve extensions of the DFW one-hour ozone attainment date past 1999, the date mandated by the FCAA for serious areas. In addition, the EPA did not approve the April 2000 One-Hour Ozone DFW Attainment Demonstration SIP revision.

1.2.1.5 EPA Determination of One-Hour Ozone Attainment

Since the early 1990s, when the DFW area was designated as nonattainment for the one-hour ozone standard, much has been done to bring the area into attainment with federal air quality standards. Contributions to improved air quality in the DFW area include: TCEQ-implemented control strategies, local control strategies adopted by the North Central Texas Council of Governments (NCTCOG), and on-road and non-road mobile source measures implemented by the EPA. Despite the EPA's lack of approval for multiple SIP revisions, air quality in the DFW area continued to improve.

By 2006, ambient monitoring data reflected attainment of the one-hour standard. On October 16, 2008, the EPA published final determination (73 FR 61357) that the DFW area one-hour ozone nonattainment counties (Collin, Dallas, Denton, and Tarrant) had attained the one-hour ozone standard with a design value of 124 parts per billion (ppb), based on verified 2004 through 2006 monitoring data.

1.2.2 1997 Eight-Hour Ozone NAAQS History

In 1997, the EPA revised the NAAQS for ozone, setting it at 0.08 ppm averaged over an eight-hour time frame. The final 1997 eight-hour ozone NAAQS was published in the *Federal Register* on July 18, 1997 (62 FR 38856) and became effective on September 16, 1997. On April 30, 2004, the EPA finalized its designations and promulgated the first phase of its implementation rule for the 1997 eight-hour ozone standard (69 FR 23951). These actions became effective on June 15, 2004. The EPA designated the nine-county (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties) DFW area as nonattainment for the standard with a moderate classification. The TCEQ was required to submit a SIP revision for the 1997 eight-hour ozone NAAQS to the EPA by June 15, 2007, and demonstrate attainment of the standard by June 15, 2010. In the November 29, 2005 issue of the *Federal Register* (70 FR 71612), the EPA published its second phase of the implementation rule for the 1997 eight-hour ozone NAAQS, which addressed the control obligations that apply to areas designated nonattainment for the standard.

In Phase I of its implementation rule (40 Code of Federal Regulations (CFR) §51.905(a)(ii)) and subsequent guidance, the EPA provided three options for areas such as the DFW area that did not have an approved one-hour ozone attainment plan at the time of designation:

A. submit a one-hour AD SIP revision no later than one year after designation (by June 15, 2005);
B. submit an eight-hour ozone plan no later than one year after designation (by June 15, 2005) that provided a 5% increment of emissions reductions from the area's 2002 emissions baseline, in addition to federal and state measures already approved by the EPA, and achieve those reductions by June 15, 2007; or
C. submit an eight-hour ozone attainment demonstration by June 15, 2005.

Texas selected option B, the 5% increment-of-progress (IOP) plan, as a technically sound and expeditious approach to initiating the reductions ultimately needed for attainment of the eight-hour ozone standard. The 5% IOP SIP revision, adopted by the commission on April 27, 2005 contained several elements:

- 2002 periodic emissions inventory for the nine-county DFW eight-hour ozone nonattainment area;
- a 5% reduction in emissions from the 2002 emissions inventory baseline;
- identification of the control measures to achieve the necessary NO_X and VOC emission reductions; and
- MVEBs for use in transportation conformity demonstrations.

1.2.2.1 May 23, 2007

The commission adopted the May 2007 DFW Attainment Demonstration SIP revision and the reasonable further progress (RFP) SIP revision for the DFW area on May 23, 2007. These SIP revisions were the first step in addressing the 1997 eight-hour ozone standard in the DFW area.

This eight-hour ozone SIP revision for the DFW area contained photochemical modeling and weight of evidence, including corroborative analysis and additional measures not included in the model. In addition to the existing control strategies in the DFW area, the SIP revision included new rules for the following sources:

- DFW area cement kilns;
- DFW area electric generating utilities (EGUs);
- DFW area industrial, commercial, and institutional (ICI) major sources;
- DFW area minor sources; and
- East Texas combustion sources in 33 counties beyond the DFW area.

The SIP revision included additional commitments for a Voluntary Mobile Emissions Reduction Program (VMEP) and transportation control measures (TCM). The revision also contained the reasonably available control measure (RACM) analysis, RACT analysis, contingency measures, emissions inventories, and MVEBs.

On July 14, 2008, the EPA proposed conditional approval (73 FR 40203) of the May 2007 DFW AD SIP Revision, providing that final conditional approval was contingent upon the State of Texas adopting and submitting to the EPA an approvable contingency plan SIP revision for the DFW area. The Dallas-Fort Worth Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard (Contingency Measures Plan) was adopted by the commission on November 5, 2008 and submitted to the EPA on November 15, 2008. The SIP revision identified measures to satisfy the EPA's 3% reduction contingency requirement for 2010 for the DFW area, to apply in the event that the DFW area failed to meet the 1997 eight-hour ozone standard by the attainment deadline.

An additional condition stipulated by the EPA for final approval of the May 2007 DFW AD SIP Revision was that the TCEQ adopt and submit rule and SIP revisions to implement an enforceable mechanism to limit the use of discrete emission reduction credits (DERC) in the DFW area by March 1, 2009. The DFW AD SIP Revision for the 1997 Eight-Hour Ozone Standard DERC Program incorporated rulemaking that amended Chapter 101, Subchapter H, Division 4: *Discrete Emission Credit Banking and Trading* rules to set a limit on DERC use for the DFW area.

On January 14, 2009, the EPA published final conditional approval of components of the 2007 AD SIP revision, including the May 2007 DFW AD SIP revision, the April 2008, and November 2008 supplements. The approval provided conditional approval of the 2009 attainment MVEBs, RACM demonstration, and failure-to-attain contingency plan, full approval of local VMEP and TCMs, full approval of the VOC RACT demonstrations for the one-hour and 1997 eight-hour ozone standards, and a statement that all control measures and reductions relied upon to demonstrate attainment were approved by the EPA.

On March 10, 2010, the commission adopted the DFW RACT Update, 30 TAC Chapter 117 Rule Revision Noninterference Demonstration, and Modified Failure-to-Attain Contingency Plan SIP Revision. This SIP revision incorporated several actions adopted by the commission, and supplemented the 1997 eight-hour ozone AD by demonstrating that the revised Chapter 117 rule does not interfere with the DFW AD SIP Revision.

On August 25, 2010, the commission adopted a SIP revision to convert an environmental speed limit (ESL) control strategy to a transportation control measure (TCM) for the 1997 eight-hour ozone standard in the DFW nonattainment area. The EPA approved this revision to the SIP for the DFW ozone nonattainment area to recategorize a local ESL control measure as a TCM effective on March 10, 2014.

1.2.2.2 Reclassification to Serious for the 1997 Eight-Hour Ozone Standard

The DFW 1997 eight-hour ozone standard nonattainment area is currently classified as serious nonattainment. In 2009, the monitored design value (complete ozone season prior to the attainment date) for the DFW area was 86 ppb. Effective January 19, 2011, EPA finalized a determination that the DFW nonattainment area did not attain the 1997 eight-hour ozone standard by June 15, 2010, the deadline set by the Phase I implementation guidance for the 1997 ozone standard for areas classified as moderate (75 FR 79302). Based on that determination, the EPA reclassified the DFW nonattainment area to serious and set a January 19, 2012 deadline for the state to submit an AD SIP revision that addressed the 1997 eight-hour ozone standard serious nonattainment area requirements, including RFP. The DFW area's new attainment date for the 1997 eight-hour ozone standard was as expeditiously as practicable, but no later than June 15, 2013 which required that only data through 2012 could be used to determine attainment under EPA's rules.

As required by the FCAA, the TCEQ published a notice in the *Texas Register*, on May 21, 2010, (http://www.sos.state.tx.us/texreg/pdf/backview/0521/0521is.pdf), implementing the area's contingency measures for failure to attain the 1997 eight-hour ozone standard by the June 15, 2010 deadline.

Concurrent with the 2011 AD SIP revision, the commission adopted revised and new RACT requirements to address the following control techniques guidelines (CTG) documents issued by the EPA from 2006 through 2008 (Rule Project Number 2010-016-115-EN): Flexible Package Printing; Industrial Cleaning Solvents; Large Appliance Coatings; Metal Furniture Coatings; Paper, Film, and Foil Coatings; Miscellaneous Industrial Adhesives; Miscellaneous Metal and Plastic Parts Coatings; and Auto and Light-Duty Truck Assembly Coatings. Concurrent with this AD SIP revision, the commission also adopted revised and new RACT requirements for VOC storage tanks (Rule Project Number 2010-025-115-EN).

This 2011 AD SIP revision included an MVEB for 2012 that represented the on-road mobile source emissions that were modeled for the attainment demonstration. The DFW area's metropolitan planning organization must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed the MVEB. Additionally, this 2011 AD SIP revision showed that by 2012, the DFW area would meet other serious nonattainment area requirements, including an enhanced Inspection and Maintenance Program (which had already been implemented in all nine counties), Stage II vapor recovery systems at gas stations (which had already been implemented in Collin, Dallas, Denton, and Tarrant Counties), a Clean Fuel Fleet Program (which is not required if emissions reductions from the National Low-Emissions Vehicle Program are more than what would be achieved under such a program), TCMs (which have already been implemented in all nine counties), and enhanced monitoring.

1.2.3 2008 Eight-Hour Ozone NAAQS

On March 27, 2008, the EPA lowered the primary and secondary eight-hour ozone NAAQS to 0.075 ppm (73 FR 16436). On May 21, 2012, the EPA published in the *Federal Register* final designations for the 2008 eight-hour ozone standard of 0.075 ppm. A ten-county DFW area including Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties was designated nonattainment and classified moderate under the 2008 eight-hour ozone NAAQS, effective July 20, 2012.

The EPA is currently reviewing the 2008 ozone NAAQS and the agency is under consent decree to propose its recommendations by December 1, 2014 and to finalize by October 1, 2015.

1.2.4 Current AD SIP Revision for the 2008 Ozone NAAQS

The DFW 2008 eight-hour ozone standard nonattainment area is currently classified as moderate nonattainment. The deadline for Texas to submit a SIP revision addressing the moderate ozone nonattainment area requirements of the 1990 FCAA Amendments is July 20, 2015. The DFW area must attain the 2008 eight-hour ozone standard of 0.075 ppm as expeditiously as practicable, but no later than December 31, 2018.

This AD SIP revision for the 2008 Ozone NAAQS also provides ozone reduction trends analyses and other supplementary data and information to demonstrate that the DFW 10-county nonattainment area will attain the 2008 eight-hour ozone standard by the December 31, 2018 attainment date. The quantitative and qualitative corroborative analyses in Chapter 5: *Weight of Evidence* further support a conclusion that this SIP revision demonstrates attainment of the 2008 eight-hour ozone standard.

This proposed SIP revision incorporates two proposed rulemakings (Rule Project Numbers 2013-048-115-AI and 2013-049-117-AI) to fulfill RACT requirements for all CTG emission source categories and all non-CTG major sources of VOC and NO_X as required by FCAA, §172(c)(1) and §182(b)(2). The major source threshold for moderate nonattainment areas is a potential to emit 100 tons per year (tpy) or more of either NO_X or VOC. The 100 tpy major source threshold applies in the newly designated Wise County. A 50 tpy major source threshold is retained for the remaining nine counties, which are currently classified as a serious nonattainment area under the 1997 eight-hour ozone NAAQS and therefore must continue to apply this more stringent threshold. The state has previously adopted Chapter 115 VOC and Chapter 117 NO_X rules to satisfy RACT requirements for sources in the nine-county DFW area as part of the SIP for the 1997 eight-hour ozone standard. In 2008, the EPA approved the DFW NO_X rules in 30 TAC Chapter 117 (73 FR 73562). In 2009, the EPA approved the DFW VOC rules in 30 TAC Chapter 115 and NO_X rules for cement kilns in 30 TAC Chapter 117 as meeting the FCAA RACT requirements (74 FR 1903 and 74 FR 1927). In 2014, the EPA approved the 30 TAC Chapter 115 rules for offset lithographic printing and VOC storage tanks as meeting the FCAA RACT requirements (79 FR 45105 and 53299). The proposed rulemakings would satisfy RACT requirements for Wise County and for any sources identified in the DFW area that are not already subject to the existing rules.

This revision also includes the following FCAA-required SIP elements: a RACM analysis, MVEB, and a contingency plan. The MVEB can be found in Table 4-2: *2018 Attainment Demonstration MVEB for the 10-County DFW Area.*

The on-road mobile source emission inventories for this proposed SIP revision were developed using the MOVES2010b model. However, the EPA released the updated version of MOVES (MOVES2014) on July 31, 2014. The schedule for the inventory development for this SIP revision did not allow time to incorporate MOVES2014. The TCEQ is working with the North Central Texas Council of Governments (NCTCOG) to develop 2018 on-road emission inventories using MOVES2014 for the DFW area. Provided that there are no problems encountered with the MOVES2014 model, staff plans to use the updated inventories to replace the current ones that are the basis of the MVEB in the proposal version of this SIP revision. The planning assumptions, fleet characteristics, and VMT estimates may also be updated to incorporate the latest available information at the time the revised inventories are developed. It is expected that the final on-road emission estimates may be different than those reported in this proposal. As a result, the SIP narrative may change between proposal and adoption to reflect the updated on-road mobile emission inventories.

The MVEB must be used in transportation conformity analyses. Areas must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed the MVEB. The attainment MVEB represents the on-road mobile source emissions that have been modeled for the attainment demonstration, and includes all of the on-road control measures. MOVES2014 includes impacts of the more stringent Tier 3 emission standards that begin with the 2017 model year and gasoline with a reduced sulfur content that results in lower emissions of NO_X, VOC, and CO.

This SIP revision includes Wise County as part of the DFW 2008 eight-hour ozone standard nonattainment area since it was designated as nonattainment by the EPA in the final designations rule published in the *Federal Register* on May 21, 2012 (77 FR 30088). However, the TCEQ and other concerned parties are currently challenging whether the EPA's inclusion of Wise County in the DFW 2008 eight-hour ozone nonattainment area was lawful. These challenges are currently pending in the United States Court of Appeals for the District of

Columbia Circuit. If the inclusion of Wise County in the DFW 2008 eight-hour ozone nonattainment area is overturned, the TCEQ will take action to revise this plan appropriately.

1.2.5 Existing Ozone Control Strategies

Existing control strategies implemented to address the one-hour and eight-hour ozone standards are expected to continue to reduce emissions of ozone precursors in the DFW area and positively impact progress toward attainment of the 1997 eight-hour ozone standard and the 2008 eight-hour ozone standard. The one-hour and eight-hour ozone design values for the DFW area from 1991 through 2013 are illustrated in Figure 1-1: *One-Hour and Eight-Hour Ozone Design Values and DFW Population*. Both design values have decreased over the past 23 years. The 2013 one-hour ozone design value was 108 ppb, representing a 23% decrease from the value for 1991 (140 ppb). The 2013 eight-hour ozone design value was 87 ppb, a 17% decrease from the 1991 value of 105 ppb. These decreases occurred despite a 66% increase in area population, as shown in Figure 1-1. As of October 2014, the preliminary eight-hour ozone design value for the DFW area is 81 ppb, which reflects a 23% decrease since 1991.

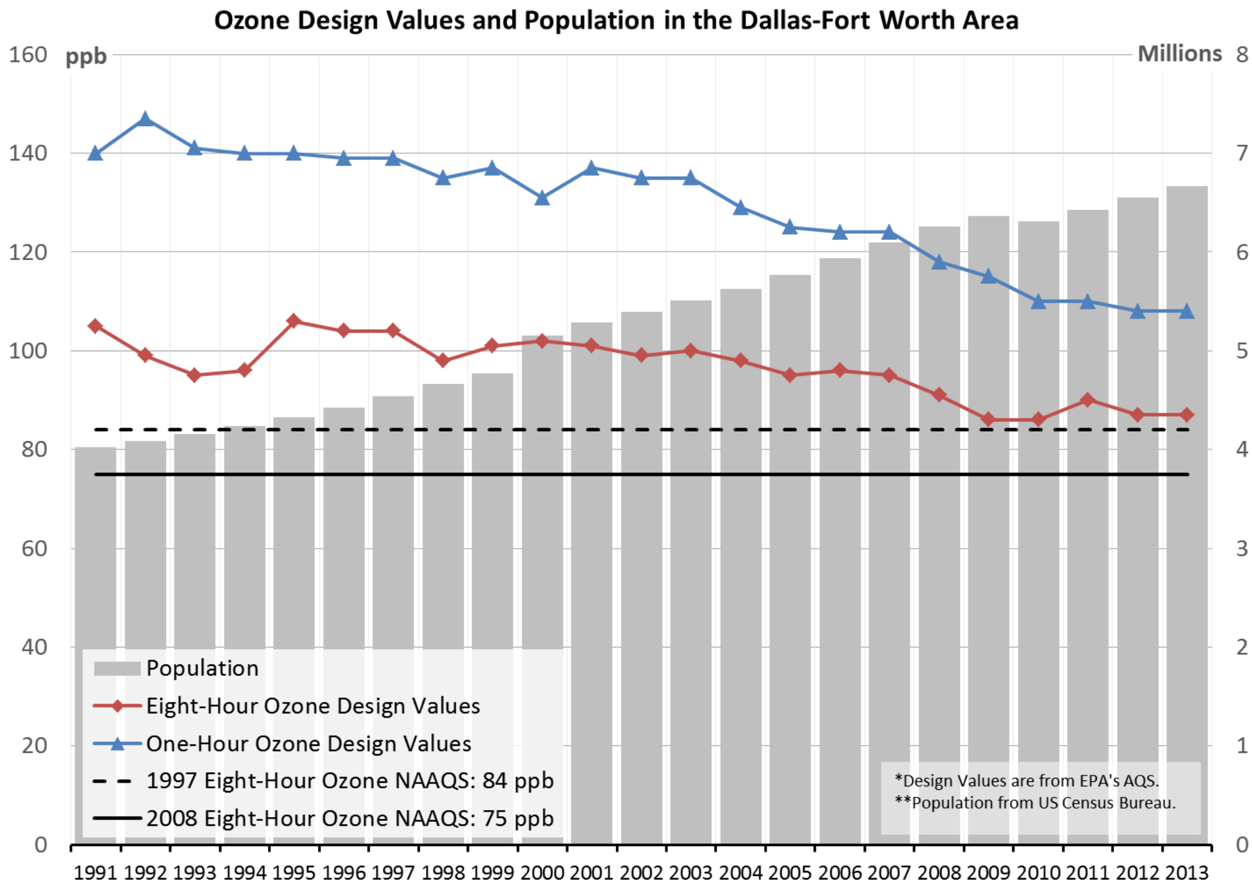


Figure 1-1: One-Hour and Eight-Hour Ozone Design Values and DFW Population

1.3 HEALTH EFFECTS

In 2008, the EPA revised the primary ozone standard to 0.075 ppm. To support the 2008 eight-hour primary ozone standard, the EPA provided information that suggested that health effects may potentially occur at levels lower than the previous 0.080 ppm standard. Breathing relatively high levels of ground-level ozone can cause acute respiratory problems like cough and decreases in lung function and can and can aggravate the symptoms of asthma. Repeated exposures to high levels of ozone can potentially make people more susceptible to allergic responses and lung inflammation.

Children are at a relatively higher risk from exposure to ozone when compared to adults, since they breathe more air per pound of body weight than adults and because children's respiratory systems are still developing. Children also spend a considerable amount of time outdoors during summer and during the start of the school year (August through October) when high ozone levels are typically recorded. Adults most at risk from exposures to elevated ozone levels are people working or exercising outdoors and individuals with preexisting respiratory diseases.

1.4 STAKEHOLDER PARTICIPATION AND PUBLIC HEARINGS

1.4.1 Dallas-Fort Worth Air Quality Technical Committee Meetings

The NCTCOG hosts periodic meetings of the Air Quality Technical Committee. The purpose of this committee is to exchange information and provide a forum for public input on air quality issues in the DFW area. Agenda topics include the status of DFW photochemical modeling development, research initiatives, and control strategy review in preparation for the DFW AD SIP revision for the 2008 Ozone NAAQS. The committee includes representatives from industry, county and city government, environmental groups, and the public. More information about this committee is available at (http://www.nctcog.org/trans/committees/AQTC/index.asp).

1.5 PUBLIC HEARING AND COMMENT INFORMATION

The commission will hold public hearings on this proposed DFW AD SIP revision at the following times and locations:

Table 1-1: Public Hearing Information

City	Date	Time	Location
Arlington	January 15, 2015	6:30 P.M.	Arlington City Council Chambers 101 W. Abram St. Arlington, TX 76010
Austin	January 22, 2015	10:00 A.M.	TCEQ Headquarters 12100 Park 35 Circle Bldg. E, Rm. 201 Austin, TX 78753

The public comment period will open on December 26, 2014, and close on January 30, 2015. Written comments will be accepted via mail, fax, or through the eComments (http://www5.tceq.state.tx.us/rules/ecomments) system. All comments should reference the "Dallas-Fort Worth Attainment Demonstration for the 2008 Eight-Hour Ozone Nonattainment Area and should reference Project Number 2013-015-SIP-NR. Comments may be submitted to Kathy Singleton, MC 206, State Implementation Plan Team, Air Quality Division, Texas Commission on Environmental Quality, P.O. Box 13087, Austin, Texas 78711-3087 or faxed to (512) 239-6188. If you choose to submit electronic comments, they must be submitted through the eComments system. File size restrictions may apply to comments being submitted via the eComments system. Comments must be received by January 30, 2015.

An electronic version of the AD SIP revision for the 2008 Ozone NAAQS and appendices can be found at the TCEQ's Texas State Implementation Plan Web page (http://www.tceq.texas.gov/airquality/sip/texas-sip).

1.6 SOCIAL AND ECONOMIC CONSIDERATIONS

For a detailed explanation of the social and economic issues involved with any of the measures, please refer to the preambles that precede each rule package accompanying this proposed SIP revision.

1.7 FISCAL AND MANPOWER RESOURCES

The state has determined that its fiscal and manpower resources are adequate and will not be adversely affected through the implementation of this plan.

CHAPTER 2: ANTHROPOGENIC EMISSIONS INVENTORY (EI) DESCRIPTION

2.1 INTRODUCTION

The Federal Clean Air Act (FCAA) Amendments of 1990 require that attainment demonstration (AD) emissions inventories (EIs) be prepared for ozone nonattainment areas. Ground-level ozone is produced when volatile organic compounds (VOC) and nitrogen oxides (NO_X) undergo photochemical reactions. The Texas Commission on Environmental Quality (TCEQ) maintains an EI of up-to-date information on NO_X and VOC sources. The EI identifies the types of emissions sources present in an area, the amount of each pollutant emitted, and the types of process and control devices employed at each plant or source category. The EI provides data for a variety of air quality planning tasks, including establishing baseline emission levels, calculating emission reduction targets, control strategy development for reducing emissions, emission inputs into air quality simulation models, and tracking actual emissions. These EIs are critical for the efforts of state, local, and federal agencies to demonstrate attainment of the National Ambient Air Quality Standards.

This chapter discusses general EI development for each of the anthropogenic source categories. Chapter 3: *Photochemical Modeling* details specific EIs and emissions inputs developed for the Dallas-Fort Worth (DFW) area ozone photochemical modeling.

2.2 POINT SOURCES

Stationary point source emissions data are collected annually from sites that meet the reporting requirements of 30 Texas Administrative Code (TAC) §101.10. To collect the data, the TCEQ provides detailed reporting instructions and tools for completing and submitting emissions inventory questionnaires (EIQs). Companies either download and complete a paper EIQ or submit emissions inventory data using a Web-based system. Companies are required to report emissions data and to provide sample calculations used to determine the emissions. Information characterizing the process equipment, the abatement units, and the emission points are also required.

All data submitted in the EIQ are reviewed for quality assurance purposes and then stored in the State of Texas Air Reporting System database. At the end of the annual reporting cycle, point source emissions data are reported to the United States Environmental Protection Agency (EPA) for inclusion in the National Emissions Inventory (NEI).

2.3 AREA SOURCES

Stationary sources that do not meet the reporting requirements for point sources are classified as area sources. Area sources are small-scale industrial, commercial, and residential sources that use materials or perform processes that generate emissions. Examples of sources of VOC emissions include the following: oil and gas production facilities, printing processes, industrial coating and degreasing operations, gasoline service station underground tank filling, and vehicle refueling operations. Examples of typical fuel combustion sources include the following: oil and gas production facilities, stationary source fossil fuel combustion at residences and businesses, outdoor burning, structural fires, and wildfires.

Emissions for area sources are calculated as county-wide totals rather than as individual sources. Area source emissions are typically calculated by applying an EPA-established emission factor (emissions per unit of activity) by the appropriate activity or activity surrogate responsible for generating emissions. Population is one of the more commonly used activity surrogates for area source calculations. Other activity data commonly used are the amount of gasoline sold in an area, employment by industry type, and crude oil and natural gas production.

The air emissions data from the different area source categories are collected, reviewed for quality assurance, stored in the Texas Air Emissions Repository database system, and compiled to develop the statewide area source EI. This area source periodic emissions inventory (PEI) is reported every third year (triennially) to the EPA for inclusion in the NEI. The TCEQ submitted the most recent PEI for calendar year 2011.

2.4 NON-ROAD MOBILE SOURCES

Non-road vehicles do not normally operate on roads or highways and are often referred to as off-road or off-highway vehicles. Non-road emissions sources include, but are not limited to: agricultural equipment; commercial and industrial equipment; construction and mining equipment; lawn and garden equipment; aircraft and airport equipment; locomotives; and commercial marine vessels. A Texas-specific version of the EPA's latest NONROAD 2008a model, called the Texas NONROAD (TexN) model, was used to calculate emissions from all non-road mobile source equipment and recreational vehicles, with the exception of airports, locomotives, and drilling rigs used in upstream oil and gas exploration activities. While the TexN model utilizes input files and post-processing routines to estimate Texas specific emissions estimates, it retains the EPA NONROAD 2008a model to conduct the basic emissions estimation calculations. Several input files provide necessary information to calculate and allocate emission estimates. The inputs used in the TexN model include emission factors, base year equipment population, activity, load factor, meteorological data, average lifetime, scrappage function, growth estimates, emission standard phase-in schedule, and geographic and temporal allocation.

Because emissions for airports and locomotives are not included in either the NONROAD model or the TexN model, the emissions for these categories are estimated using other EPA-approved methods and guidance. Emissions for the source categories that are not in the EPA NONROAD 2008a model are estimated using other EPA-approved methods and guidance documents. Airport emissions are calculated using the Federal Aviation Administration's Emissions and Dispersion Modeling System, version 5.1.3. Locomotive emission estimates for Texas are based on specific fuel usage data derived from railway segment level gross ton mileage activity (line haul locomotives) and hours of operation (yard locomotives) provided directly by the Class I railroad companies operating in Texas. Although emissions for oilfield drilling rigs are included in the NONROAD model, alternate emissions estimates were developed for that source category in order to develop more accurate inventories. The equipment populations for drilling rigs were set to zero in the TexN model to avoid double counting emissions from these sources.

2.5 ON-ROAD MOBILE SOURCES

On-road mobile sources consist of passenger cars, passenger trucks, motorcycles, buses, heavy-duty trucks, and other motor vehicles traveling on public roadways. On-road mobile source ozone precursor emissions are usually categorized as combustion-related emissions or evaporative hydrocarbon emissions. Combustion-related emissions are estimated for vehicle engine exhaust, and evaporative hydrocarbon emissions are estimated for the fuel tank and other non-tailpipe sources from the vehicle. To calculate emissions, both the rate of emissions per unit of activity (emission factors) and the number of units of activity must be determined.

Emission factors for this proposal were developed using the EPA's Motor Vehicle Emission Simulator (MOVES) 2010b model. The MOVES2010b model may be run using national default information or may be modified to simulate data specific to the DFW area, such as control programs, driving behavior, meteorological conditions, and vehicle characteristics. Because modifications influence the emission factors calculated by the MOVES2010b model, to the extent that local values are available, parameters that are used reflect local conditions rather than national default values. The localized inputs used for the on-road mobile emissions inventory development include vehicle speeds for each roadway link, temperature, humidity, vehicle age distributions for each vehicle type, percentage of miles traveled for each vehicle type, type of inspection and maintenance (I/M) program, fuel control programs, and gasoline vapor pressure controls.

To estimate on-road mobile source emissions, emission factors calculated by the MOVES2010b model must be multiplied by the level of vehicle activity. On-road mobile source emission factors are expressed in units of grams per mile, grams per vehicles (evaporative), and grams per hour (extended idle mode); therefore, the activity information that is required to complete the inventory calculation is vehicle miles traveled (VMT) in units of miles per day, vehicle populations, and source hours idling. The level of vehicle travel activity is developed using travel demand models (TDM) run by the Texas Department of Transportation (TxDOT) or by the local metropolitan planning organizations. The TDMs are validated against a large number of ground counts, i.e., traffic passing over counters placed in various locations throughout a county or area. For SIP inventories, VMT estimates are calibrated against outputs from the federal Highway Performance Monitoring System, a model built from a different set of traffic counters. Vehicle populations are derived from the Texas Department of Motor Vehicle registration database and national estimates for vehicle source type population ratios.

In addition to the number of miles traveled on each roadway link, the speed on each roadway type or segment is also needed to complete an on-road emissions inventory. Roadway speeds, required inputs for the MOVES2010b model, are calculated by using the activity volumes from the TDM and a post-processor speed model.

2.6 EI IMPROVEMENT

The TCEQ EI reflects years of emissions data improvement, including extensive point and area source inventory reconciliation with ambient emissions monitoring data. The following projects have significantly improved the DFW point source and area source inventory for oil and gas related activities in recent years.

- TCEQ Work Order Nos. 582-7-84003-FY-10-26 and 582-7-84005-FY-10-29 quantified NO_X and VOC emissions from various oil and gas processes and produced water storage tanks at upstream oil and gas operations in the DFW area, which the TCEQ has added to the area source inventory.
- The TCEQ conducted a special inventory of companies that own or operate leases or facilities associated with Barnett Shale oil and gas operations. The TCEQ conducted the special emissions inventory under the authority of 30 TAC §101.10(b)(3) to determine the location, number, and type of emission sources associated with upstream and midstream oil and gas operations in the Barnett Shale. The results of the special inventory were used to improve the compressor engine population profile in the DFW area. This improved profile was used in determining the area source emissions estimates for this source category.
- The TCEQ conducted two surveys of pneumatic devices at oil and gas wells. The first survey was conducted in 2011 and focused on the DFW area. The second survey was conducted in 2012 and focused on the remainder of the state. The results of the 2011 pneumatic device survey were used to update emission factors and activity data (including the average number of pneumatic devices per well) in the DFW area. In addition, revised bleed rate information from the EPA's Oil and Gas Emission Estimation Tool was used in the development of the emission factors.
- TCEQ Work Order No. 582-11-99776-FY11-05 developed improved drilling rig emissions characterization profiles. The drilling rig emissions characterization profiles from this study

were combined with drilling activity data obtained from the Railroad Commission of Texas (RRC) to develop area source emissions estimates for this source category.

- TCEQ Work Order No. 582-11-99776-FY12-12 developed projection factors for oil and gas sources from a 2011 baseline year through 2035. Using historical data from the RRC, different projection methodologies were considered with the most robust one being based on the Hubbert peak curve theory. Yearly production factors are provided for the Barnett, Eagle Ford, and Haynesville shale formations, with separate factors for oil, natural gas, and condensate. The Barnett Shale factors were used for the DFW area.
- TCEQ Work Order No. 582-11-99776-FY12-11 refined emissions factors and methods to estimate emissions from condensate storage tanks for area source inventory development at the county-level. The project developed region-specific emission factors and control factors for eight geographic regions in the state.

In addition to these projects, the TCEQ annually updates and publishes *Emissions Inventory Guidelines* (RG-360), a comprehensive guidance document that explains all aspects of the point source EI process. The latest version of this document is available on the TCEQ's Point Source Emissions Inventory Web site (http://www.tceq.state.tx.us/implementation/air/industei/psei/psei.html). Currently, six technical supplements provide detailed guidance on determining emissions from potentially underreported VOC emissions sources such as cooling towers, flares, and storage tanks.

CHAPTER 3: PHOTOCHEMICAL MODELING

3.0 INTRODUCTION

This chapter describes modeling conducted in support of the Dallas-Fort Worth (DFW) Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 2008 Eight-Hour Ozone Standard. The DFW ozone nonattainment area consists of Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties. The 1990 Federal Clean Air Act (FCAA) Amendments require that attainment demonstrations be based on photochemical grid modeling or any other analytical methods determined by the United States Environmental Protection Agency (EPA) to be at least as effective. The EPA's April 2007 *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze* (EPA, 2007; hereafter referred to as "modeling guidance") is the latest available guidance at the time of development of this SIP revision. This guidance recommends procedures for air quality modeling for attainment demonstrations of the eight-hour ozone National Ambient Air Quality Standard (NAAQS).

The modeling guidance recommends several qualitative methods for preparing attainment demonstrations that acknowledge the limitations and uncertainties of photochemical models when used to project ozone concentrations into future years. First, the modeling guidance recommends using model results in a relative sense and applying the model response to the observed ozone data. Second, the modeling guidance recommends using available air quality, meteorology, and emissions data to develop a conceptual model for eight-hour ozone formation and to use that analysis in episode selection. Third, the modeling guidance recommends using other analyses, i.e., weight of evidence (WoE), to supplement and corroborate the model results and support the adequacy of a proposed control strategy package.

The remaining chapters and sections include an overview of the photochemical modeling, conceptual model, and WoE analyses. More detail on each of these components can be found in the following appendices to this SIP revision:

- Appendix A: Meteorological Modeling for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard;
- Appendix B: Emissions Modeling for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard;
- Appendix C: Photochemical Modeling for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard;
- Appendix D: Conceptual Model for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard; and
- Appendix E: Modeling Protocol for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard.

The 1990 FCAA Amendments established five classifications for ozone nonattainment areas based on the magnitude of the regional one-hour ozone design value. Based on the monitored one-hour ozone design value at that time, four counties in the DFW area (Collin, Dallas, Denton, and Tarrant) were classified as a moderate nonattainment area. As published in the October 16, 2008 edition of the *Federal Register* (FR), the EPA determined the four-county DFW area to be in attainment of the one-hour ozone standard based on 2004 through 2006 monitored data (73 FR 61357).

With the change of the ozone NAAQS from a one-hour standard to an eight-hour standard in 2004, the EPA classified the DFW area as a moderate ozone nonattainment area with an attainment date of June 15, 2010. Five additional counties (Ellis, Johnson, Kaufman, Parker, and Rockwall) were added to the four original one-hour standard nonattainment counties to create the nonattainment area for the 1997 eight-hour standard. Ozone AD SIP revisions addressing the 1997 eight-hour ozone standard were required to be submitted to the EPA by June 15, 2007. In May 2007, photochemical modeling and other analyses conducted by the Texas Commission on Environmental Quality (TCEQ) were included in the AD SIP revision submitted to the EPA supporting the DFW area's attainment of the 1997 eight-hour ozone standard by June 15, 2010. The EPA published final conditional approval of the May 2007 DFW AD SIP Revision on January 14, 2009 (*74 FR 1903*).

In 2009, the monitored design value (complete ozone season prior to the attainment date) for the DFW area was 86 parts per billion (ppb), which is 2 ppb above the attainment level. The EPA published the final rule to determine the DFW area's failure to attain the 1997 eight-hour ozone standard and reclassify the DFW area as a serious nonattainment area on December 10, 2010 (*75 FR 79302*). The attainment date for the serious classification was June 15, 2013. The EPA prescribed that the attainment test be applied to the 2012 previous ozone season to determine compliance with the 2013 attainment date. Based on the fourth highest ozone readings per monitor from 2010, 2011, and 2012, 15 of the 17 regulatory monitors active within DFW during this time period had three-year ozone design values ranging from 69 to 83 ppb. However, two regulatory monitors had three-year ozone design values above the 84 ppb standard. The Keller monitor had a 2012 design value of 87 ppb, and the Grapevine Fairway monitor had a 2012 design value of 86 ppb. Both of these monitors are located in the northwest quadrant of the DFW area where the highest ozone concentrations have historically been measured.

Ozone nonattainment designations under the revised 2008 eight-hour ozone standard became effective on July 20, 2012. Wise County was added to the nine nonattainment counties, which resulted in a 10-county DFW nonattainment area for the 2008 eight-hour zone standard. The DFW area was classified as moderate nonattainment with a required attainment date of December 31, 2018. This AD SIP revision uses photochemical modeling in combination with corroborative analyses to support a conclusion that the 10-county DFW nonattainment area will attain the 2008 eight-hour ozone standard of 75 ppb by December 31, 2018. Also, the limited data collected in the DFW area during Texas Air Quality Study 2006 (TexAQS II) is used to evaluate the model's performance and to improve understanding of the physical and chemical processes leading to ozone formation.

3.1 OVERVIEW OF THE OZONE PHOTOCHEMICAL MODELING PROCESS

The modeling system is composed of a meteorological model, several emissions processing models, and a photochemical air quality model. The meteorological and emission models provide the major inputs to the air quality model.

Ozone is a secondary pollutant; it is not generally emitted directly into the atmosphere. Ozone is created in the atmosphere by a complex set of chemical reactions between sunlight and several primary (directly emitted) pollutants. The reactions are photochemical and require ultraviolet energy from sunlight. The majority of primary pollutants directly involved in ozone formation fall into two groups, nitrogen oxides (NO_X) and volatile organic compounds (VOC). In addition, carbon monoxide (CO) is also an ozone precursor, but much less effective than either NO_X or VOC in forming ozone. As a result of NO_X and VOC reacting in the presence of sunlight, higher eight-hour concentrations of ozone are most common during the summer when daytime hours are extended, with concentrations peaking during the day and falling during the night and early morning hours.

Ozone chemistry is complex, involving hundreds of chemical compounds and chemical reactions. As a result, ozone cannot be evaluated using simple dilution and dispersion algorithms. Due to this chemical complexity, the modeling guidance strongly recommends using photochemical computer models to simulate ozone formation and to evaluate the effectiveness of future control strategies. Computer simulations are the most effective tools to address both the chemical complexity and the future case evaluation.

3.2 OZONE MODELING

Ozone modeling involves two major phases, the base case modeling phase and the future year modeling phase. The purpose of the base case modeling phase is to evaluate the model's ability to adequately replicate measured ozone and ozone precursor concentrations during recent periods with high ozone concentrations. The purpose of the future year modeling phase is to predict attainment year ozone design values at each monitor and to evaluate the effectiveness of controls in reaching attainment. The TCEQ developed a modeling protocol, which is attached as Appendix E describing the process to be followed to evaluate the ozone in the urban area and submitted the plan, as prescribed in the modeling guidance to the EPA in August 2013.

3.2.1 Base Case Modeling

Base case modeling involves several steps. First, ozone episodes are analyzed to determine what factors were associated with ozone formation in the area and whether those factors were consistent with the conceptual model and the EPA's episode selection criteria. Once an episode is selected, emissions and meteorological data are generated and quality assured. Then the meteorological and emissions (NO_X, VOC, and CO) data are input to the photochemical model and the ozone photochemistry is simulated, resulting in predicted ozone and ozone precursor concentrations.

Base case modeling results are evaluated by comparing them to the observed measurements of ozone and ozone precursors that were monitored during the base case period. Typically, this step is an iterative process incorporating feedback from successive evaluations to ensure that the model is adequately replicating observations throughout the modeling episode. The adequacy of the model in replicating observations is assessed statistically and graphically as recommended in the modeling guidance. Additional analyses using special study data are included when available. Satisfactory performance of the base case modeling provides a degree of reliability that the model can be used to predict future year ozone concentrations (future year design values), as well as to evaluate the effectiveness of possible control measures.

3.2.2 Future Year Modeling

Future year modeling involves several steps. The procedure for predicting a future year ozone design value (attainment test) involves determining the ratio of the future year to the baseline year modeled ozone concentrations. This ratio is called the relative response factor (RRF). Whereas the emissions data for the base case modeling are episode-specific, the emissions data for the baseline year are based on typical ozone season emissions. Similarly, the emissions data for the future year are developed applying growth and control factors to the baseline year emissions. The growth and control factors are developed based on the projected growth in the demand for goods and services, along with the reduction in emissions expected from state, local, and federal control programs.

Both the baseline and future years are modeled using their respective ozone season emissions and the base case episode meteorological data as inputs. The same meteorological data are used for modeling both the baseline and future years. Thus, the ratio of future year modeled ozone concentrations to the baseline year concentrations provides a measure of the response of ozone concentrations to the change in emissions from projected growth and controls.

A future year ozone design value is calculated by multiplying the RRF by a baseline year ozone design value (DV_B). The DV_B is the average of the regulatory design values for the three consecutive years containing the baseline year, as show in Figure 3-1: *2006 Baseline Design Value Calculation*. A calculated future year ozone design value of less than or equal to 75 ppb signifies modeled attainment. The model can also be used to test the effectiveness of various control measures when evaluating control strategies.

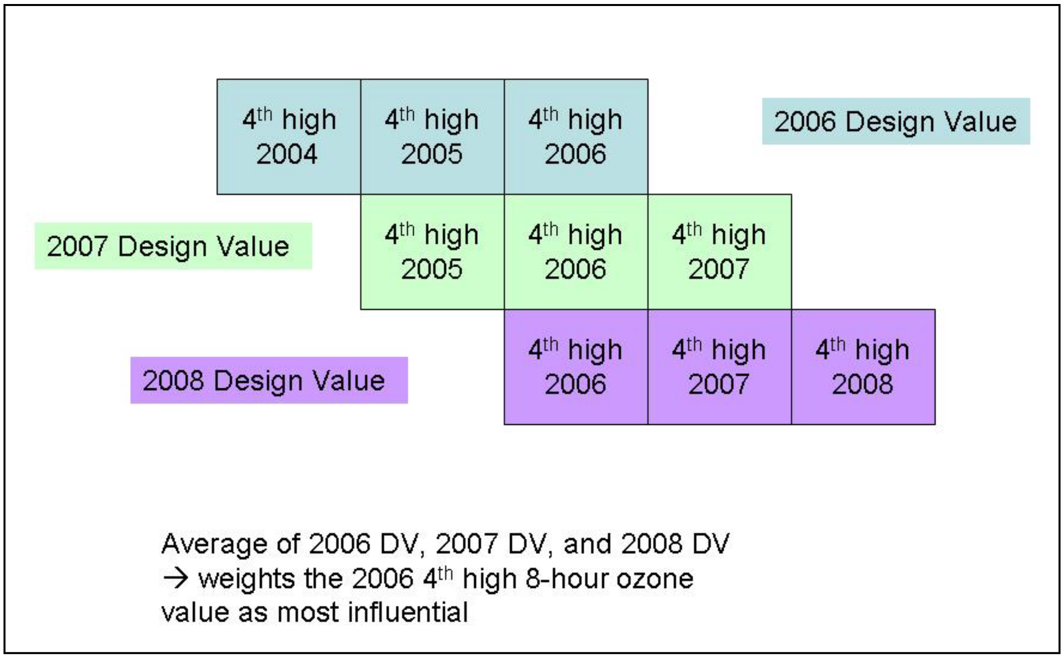


Figure 3-1: 2006 Baseline Design Value Calculation

3.3 EPISODE SELECTION

3.3.1 EPA Guidance for Episode Selection

The EPA's 2007 modeling guidance currently in effect was developed for the previous 84 ppb ozone standard. If the EPA releases a final revision to the current guidance with updates for the 2008 eight-hour ozone standard, the TCEQ intends to revise the modeling procedures accordingly, provided that such changes are received in time to meet the July 20, 2015 SIP revision submittal deadline. The TCEQ has applied the provisions of the guidance for the 84 ppb standard to the current 75 ppb standard.

The primary criteria for selecting ozone episodes for eight-hour ozone attainment demonstration modeling are set forth in the modeling guidance (as modified for the 2008 eight-hour ozone standard) and shown below.

- Select periods reflecting a variety of meteorological conditions that frequently correspond to observed eight-hour daily maximum ozone concentrations greater than 75 ppb at different monitoring sites.
- Select periods during which observed eight-hour ozone concentrations are close to the eight-hour ozone design values at monitors with a DV_B greater than or equal to 75 ppb.
- Select periods for which extensive air quality and/or meteorological data sets exist.
- Model a sufficient number of days so that the modeled attainment test can be applied at all of the ozone monitoring sites that are in violation of the eight-hour ozone NAAQS.

Based on these criteria, the TCEQ selected ozone episodes from June 2006 and August/September 2006 for use in this attainment demonstration SIP revision.

3.3.2 DFW Ozone Episode Selection Process

As shown in Figure 3-2: *DFW Eight-Hour Ozone Exceedance Days by Month from 1991 through 2012*, the highest ozone levels in DFW typically follow a bi-modal pattern with peaks in

June and August-September. The 1997 eight-hour ozone DFW attainment demonstration SIP revision from December 2011 relied on a 33-day June 2006 episode ranging from May 31 through July 2, 2006. A primary goal of the episode selection process for the current modeling work was to reflect this historical bi-modal pattern by including both June and August-September (August 13 through September 15, 2006) episodes.

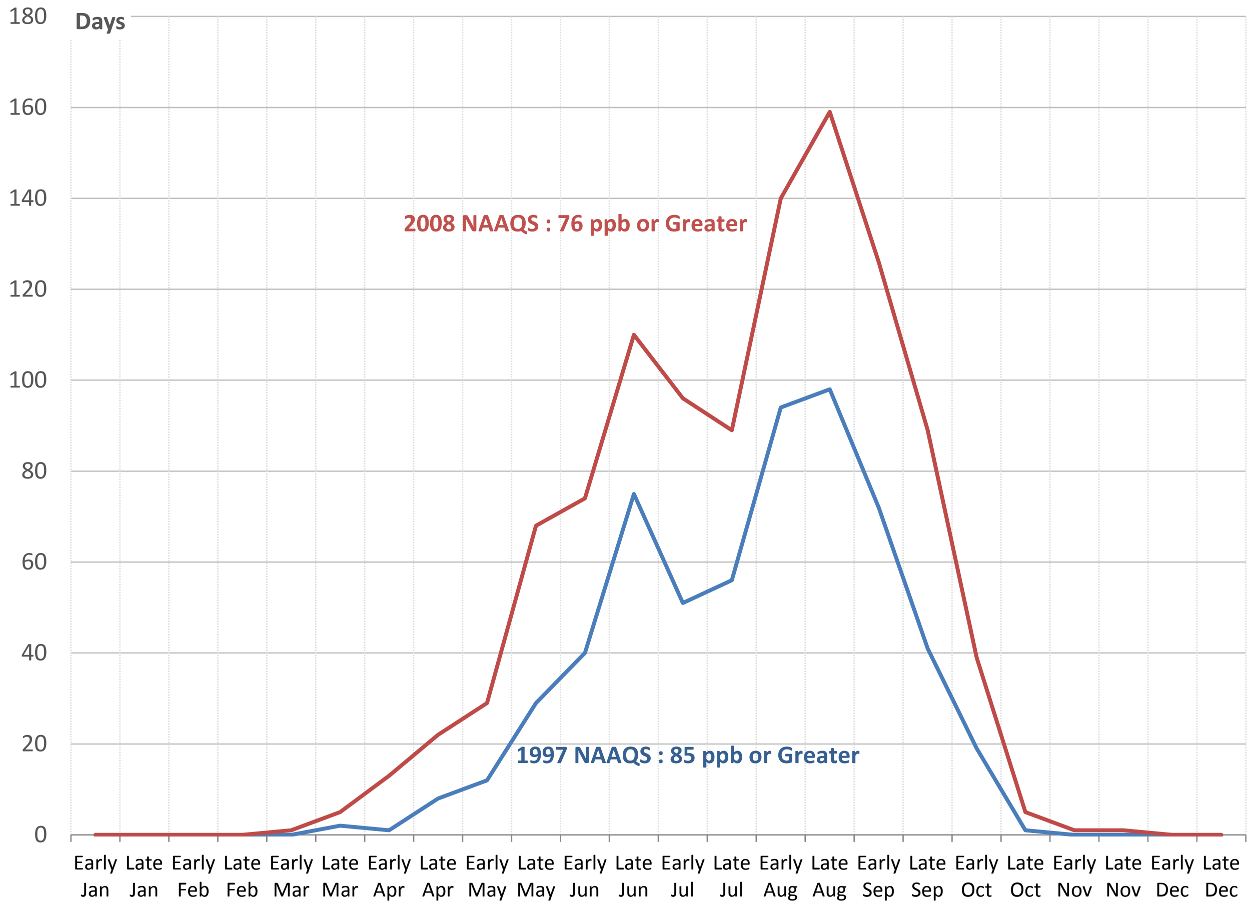


Figure 3-2: DFW Eight-Hour Ozone Exceedance Days by Month from 1991 through 2012

Table 3-1: *DFW 75 ppb Ozone Exceedance Days by Month from 2006 through 2012* shows that there were 50 total ozone exceedance days in 2006 with 18 occurring in June and 13 in August-September. Annual ozone exceedance days in subsequent years ranged from 18 in 2010 to 40 in 2011. An evaluation of these post-2006 years indicated that 2012 would be the best candidate for development of a new ozone episode. The nine exceedance days in June 2012 combined with the 12 in August-September correlate well with the historical bi-modal pattern shown in Figure 3-2. The 2011 calendar year was not representative of this historical norm because there were only four exceedance days in June and 26 in August-September, which is an unusual ozone season distribution for the DFW area. Both 2007 and 2010 also had a relatively low number of exceedance days in June compared with August-September.

All three years of 2008, 2009, and 2012 had a June/August-September ozone exceedance day total of 21. While 2008 and 2009 could be considered as suitable candidates for seasonal ozone modeling, 2012 is a more recent option that would benefit from the use of more recently available emission inventory data sets, such as the 2011 National Emissions Inventory (NEI) submitted by states to EPA. Also, EPA has a 2011 national scale modeling platform that will provide useful data sets for a 2012 Texas ozone episode. Even though only the DFW area ozone exceedances are shown here, the TCEQ has begun development of a 2012 seasonal episode because it is a suitable representation for DFW and other metropolitan areas of the state such as Houston-Galveston-Brazoria (HGB). However, the 2012 ozone episode is not within the performance bounds required for attainment demonstration SIP submissions, and therefore work on this new episode is still in progress.

Table 3-1: DFW 75 ppb Ozone Exceedance Days by Month from 2006 through 2012

Month	2006	2007	2008	2009	2010	2011	2012
January	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0
March	1	0	0	0	0	0	2
April	2	3	1	1	0	2	0
May	3	1	3	5	4	0	4
June	18	2	6	8	3	4	9
July	9	3	5	7	0	6	5
August	8	11	7	8	9	15	11
September	5	5	8	5	2	11	1
October	4	2	0	0	0	2	0
November	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0
Annual Total	50	27	30	34	18	40	32
June Only	18	2	6	8	3	4	9
August-September Only	13	16	15	13	11	26	12
June/August-September Total	31	18	21	21	14	30	21

To ensure that both early and late summer ozone periods are represented in the current modeling, and that all necessary modeling work for this attainment demonstration could be completed in a timely manner, the 34-day period from August 13 through September 15, 2006 was added to with the 33-day June 2006 episode for a total 67-day period representative of historical exceedance patterns in DFW. This August-September episode incorporates the extensive monitoring data collected during TexAQS II, including data from radar wind profilers and was used in the March 2010 HGB attainment demonstration SIP revision. Throughout this discussion, the terms June episode and August-September episode will be used when the episodes need to be referenced separately. When analyses are performed on both, the term 67-day episode will be used to reflect the combination.

3.3.3 Summary of the Combined 67-Day 2006 Ozone Episode

Figure 3-3: *DFW Area Ozone Monitoring Locations* shows the spatial distribution of ozone monitors in the DFW area. Monitors are located in the upwind areas to the east and south, within the urban core, and in the downwind locations to the north and west. Table 3-2: *Greater DFW Area Ozone Monitor Reference Table* provides the names, Continuous Ambient

Monitoring Station (CAMS) code, alpha code, and activation/deactivation dates for 22 ozone monitors located within and surrounding the DFW nonattainment counties. 19 of these monitors had been active for a sufficient amount of time in 2006 that DV_B figures are available for the attainment test that utilizes RRF values. Table 3-3: *Monitor Specific Ozone Exceedances During 67-Day Combined Episode* shows that 12 of the DFW area ozone monitors exceeded the 75 ppb standard on at least 10 days of the 2006 episodes, which is the minimum preferred by the EPA modeling guidance. Use of the 67-day combined episode results in a range of 19 to 25 exceedance days at the five downwind northwestern monitors that have typically monitored the highest ozone levels in the DFW area: Denton Airport South, Eagle Mountain Lake, Grapevine Fairway, Keller, and Fort Worth Northwest. Seven of the DFW area monitors had fewer than 10 eight-hour ozone exceedance days during this period. However, these seven are all located along the upwind eastern and southern perimeters of DFW where the lowest regional ozone levels are typically monitored. Use of the secondary 70 ppb threshold suggested by the EPA modeling guidance results in all of the monitors above the preferred 10 days for RRF calculations.

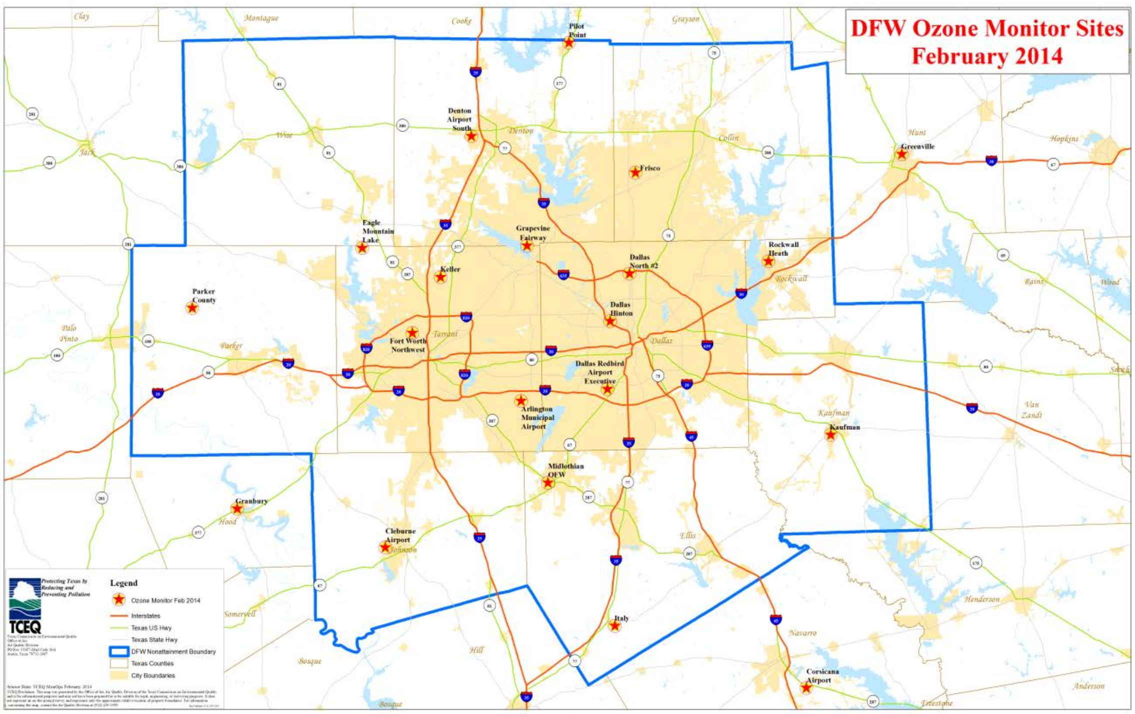


Figure 3-3: DFW Area Ozone Monitoring Locations

Table 3-2: Greater DFW Area Ozone Monitor Reference Table

DFW Area Ozone Monitor Name	CAMS Code	Alpha Code	County of Operation	Date Ozone Active	Date Ozone Deactivated
Frisco	C31	FRIC	Collin	07/29/1997	NA
Dallas Executive Airport	C402	REDB	Dallas	12/13/1999	NA
Dallas Hinton Street	C401	DHIC	Dallas	12/15/1999	NA
Dallas North #2	C63	DALN	Dallas	11/13/1998	NA
Denton Airport South	C56	DENT	Denton	03/22/1998	NA
Pilot Point	C1032	PIPT	Denton	05/03/2006	NA
Italy	C1044	ITLY	Ellis	09/09/2007	NA
Italy High School	C650	ITHS	Ellis	08/23/2005	11/05/2006
Midlothian OFW	C52	MDLO	Ellis	03/29/2006	NA
Midlothian Tower	C94	MDLT	Ellis	08/31/1997	08/22/2007
Cleburne Airport	C77	CLEB	Johnson	05/10/2000	NA
Kaufman	C71	KAUF	Kaufman	09/23/2000	NA
Parker County	C76	WTFD	Parker	08/03/2000	NA
Rockwall Heath	C69	RKWL	Rockwall	08/08/2000	NA
Arlington Municipal Airport	C61	ARLA	Tarrant	01/17/2002	NA
Eagle Mountain Lake	C75	EMTL	Tarrant	06/06/2000	NA
Fort Worth Northwest	C13	FWMC	Tarrant	08/14/1997	NA
Grapevine Fairway	C70	GRAP	Tarrant	08/23/2000	NA
Keller	C17	KELC	Tarrant	07/16/1997	NA
Granbury	C73	GRAN	Hood	05/10/2000	NA
Greenville	C1006	GRVL	Hunt	03/21/2003	NA
Corsicana Airport	C1051	CRSA	Navarro	06/17/2009	NA

Table 3-3: Monitor Specific Ozone Exceedances During 67-Day Combined Episode

DFW Area Monitor and CAMS Code	Maximum Eight-Hour Ozone (ppb)	Number of Days Above 70 ppb	Number of Days Above 75 ppb	Number of Days Above 85 ppb	Baseline Design Value (ppb)
Denton Airport South - C56	106	29	22	11	93.3
Eagle Mountain Lake - C75	107	27	22	9	93.3
Grapevine Fairway - C70	98	26	19	9	90.7
Keller - C17	103	33	25	11	91.0
Fort Worth Northwest - C13	101	27	21	9	89.3
Frisco - C31	101	25	20	9	87.7
Dallas North #2 - C63	90	19	14	3	85.0
Parker - County - C76	101	19	12	4	87.7
Dallas Executive Airport - C402	95	28	18	5	85.0
Cleburne Airport - C77	98	18	8	2	85.0
Arlington Municipal Airport - C61	91	18	14	3	83.3
Dallas Hinton Street - C401	96	22	13	2	81.7
Granbury - C73	92	16	8	3	83.0
Midlothian Tower - C94	98	17	8	1	NA
Pilot Point - C1032	101	23	17	9	NA
Rockwall Heath - C69	86	16	9	1	77.7
Midlothian OFW - C52	96	14	5	1	NA
Greenville - C1006	84	13	3	0	75
Kaufman - C71	86	11	5	1	74.7

Midlothian Tower, Pilot Point, and Midlothian OFW did not measure enough data from 2004 through 2008 for calculation of a 2006 baseline design value. Greenville and Granbury are not in the 2008 eight-hour ozone nonattainment area.

Appendix D describes the general meteorological conditions that are typically present on days when the eight-hour ozone concentration exceeds the 2008 eight-hour ozone NAAQS. High ozone is typically formed in the DFW area on days with slower wind speeds out of the east and southeast. These prevailing winds also typically bring higher background ozone levels into the DFW area. High background ozone concentrations are then amplified as an air mass moves over the urban core of Dallas and Tarrant Counties. Both of which contain large amounts of NO_X emissions. Those emissions are then transported across the DFW area to the northwest, where the highest eight-hour ozone concentrations are observed.

The conditions that typically lead to high ozone were present in the 33-day June 2006 episode. High pressure developed over the area from June 5 through June 10, which resulted in mostly sunny days with high temperatures above 90 degrees Fahrenheit. High pressure also caused winds that were calm or light out of the southeast. With light winds a gradual buildup of ozone and ozone precursors developed over the DFW area, peaking in an eight-hour ozone concentration of 106 ppb at Eagle Mountain Lake and Denton Airport South on June 9, as shown in Figure 3-4: *Maximum Eight-Hour Ozone by Monitor from May 31 through July 2,* *2006*. High pressure began to erode away as a weak frontal boundary approached from the north. Wind speeds then increased over the area, causing ozone dilution and lowering the eight-hour ozone concentrations over the area. As winds switched directions and began blowing from the east-northeast on the backside of the frontal boundary, ozone concentrations again increased. Winds from the east-northeast have the potential for long range transport from the direction of the Ohio River Valley. Transport from the east-northeast likely contributed to an eight-hour ozone concentration of 107 ppb at Eagle Mountain Lake on June 14. Over the next few days, low pressure moved into the area from the Gulf of Mexico. This low pressure caused an increase in cloudiness and wind speed, which reduced the potential for ozone formation. High pressure returned to the area from June 27 through June 30. With the resultant high temperatures and low wind speeds, conditions were again favorable for ozone formation.

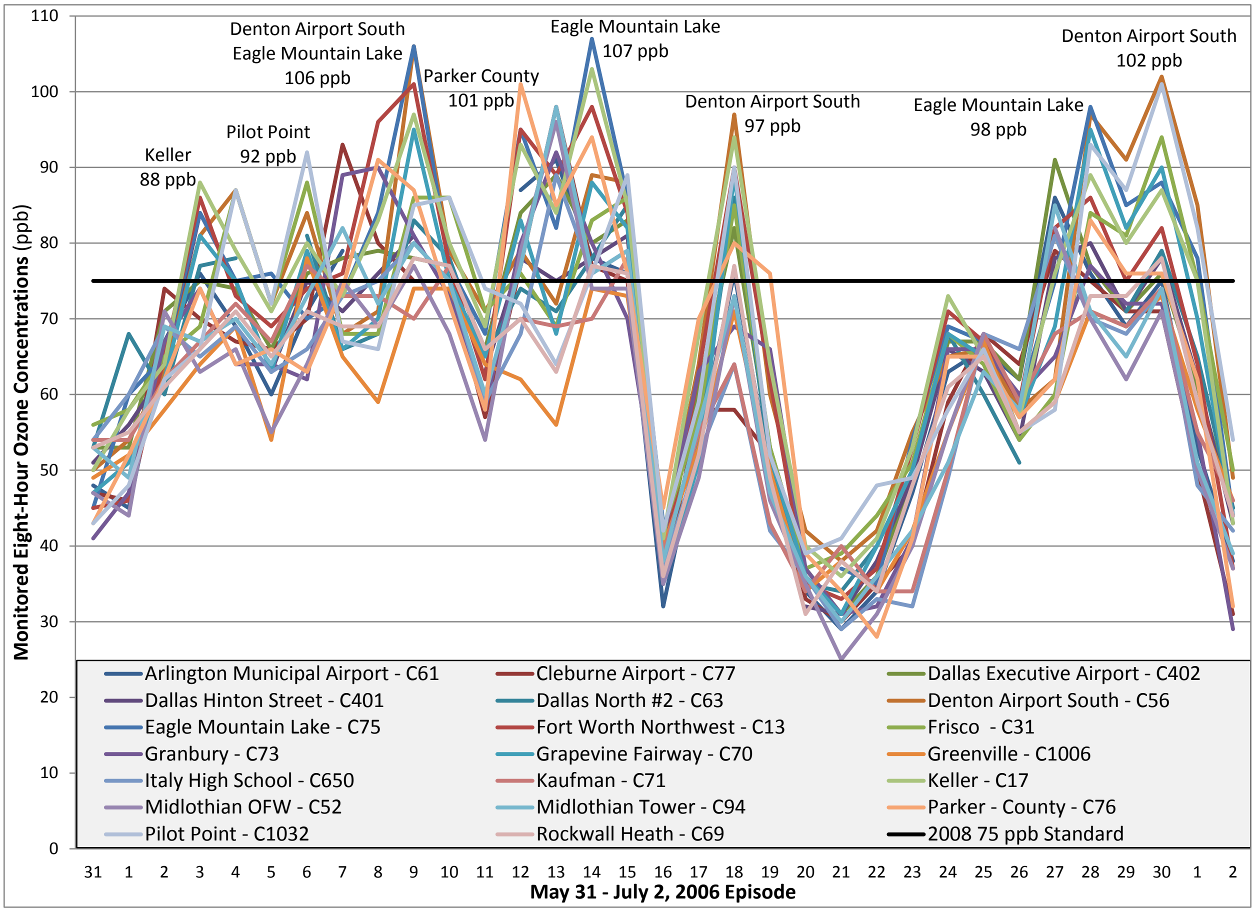


Figure 3-4: Maximum Eight-Hour Ozone by Monitor from May 31 through July 2, 2006

As shown in Figure 3-5: *Maximum Eight-Hour Ozone by Monitor from August 13 through September 15, 2006*, the 34-day August-September episode also had conditions favorable for elevated ozone concentrations. Strong southerly winds and a weak warm front kept ozone concentrations below 76 ppb from August 13 through August 17. High pressure settled in by August 18 with clear sunny skies and slow southerly winds allowing for the build-up of ozone concentrations, such as the 91 ppb peaks at Denton Airport South and Grapevine Fairway. Another weak front entered the area on August 22, causing winds to shift from the northeast, indicating possible transport of polluted air from the Ohio and Mississippi River valleys. The weak front stalled just north of the DFW area through August 24 keeping winds slow and allowing pollutants to accumulate. Stronger south winds returned by August 25, keeping ozone concentrations low through August 28. A stronger cold front moved through the DFW area on August 29, bringing north winds and clouds. Clear skies with light north winds followed, which allowed for ozone concentrations to exceed the NAAQS through September 1, such as the 101 ppb peak at Frisco and 102 ppb peak at Denton Airport South. Another cold front brought cloudy skies and cooler temperatures, which limited ozone production. High pressure and ozone-conducive conditions returned from September 7 through 10 resulting in peak levels of 87 ppb at Frisco and Pilot Point. Northeast winds after a cold front may have again transported polluted air from areas east and north of DFW on September 14.

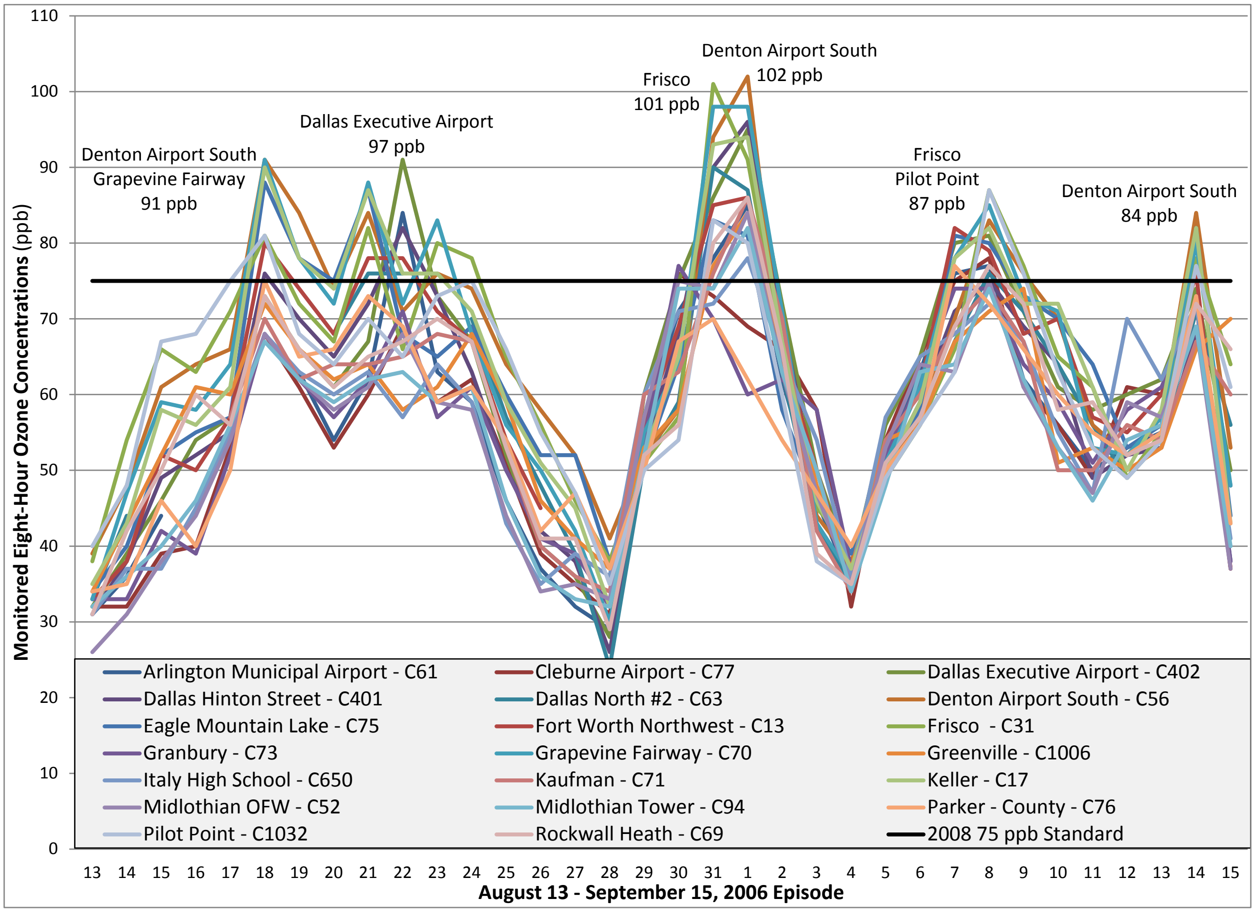


Figure 3-5: Maximum Eight-Hour Ozone by Monitor from August 13 through September 15, 2006

Back trajectories from the Eagle Mountain Lake monitor extending backwards in time for 48 hours and terminating at 500 meters above ground level (AGL) are shown for every day of the extended June 2006 episode in Figure 3-6: *Eagle Mountain Lake Monitor Back Trajectories for May 31 through July 2, 2006*. The left panel shows the May 31 through June 15, 2006, period while the right panel shows the June 16 through July 2, 2006, period. Similar 48-hour back trajectories for every day of the August-September episode are shown in Figure 3-7: *Denton Airport South Monitor Back Trajectories for August 13 through September 15, 2006*. The trajectories in both Figure 3-6 and Figure 3-7 depict air coming from north, east, and southerly directions. Westerly winds are not common during the summer months in the DFW area, so there are no trajectories coming from the west to northwest. These trajectories illustrate that the combined 67-day episode includes periods of synoptic flow from each of the directions commonly associated with elevated eight-hour ozone concentrations as more fully described in Appendix D.

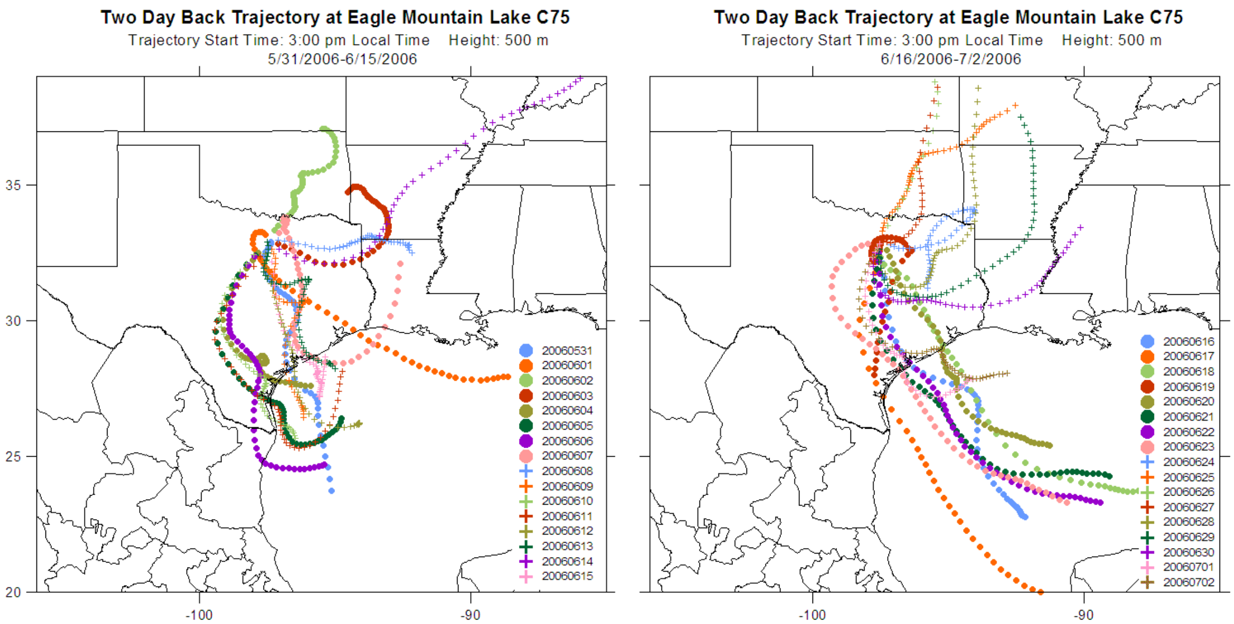


Figure 3-6: Eagle Mountain Lake Monitor Back Trajectories for May 31 through July 2, 2006

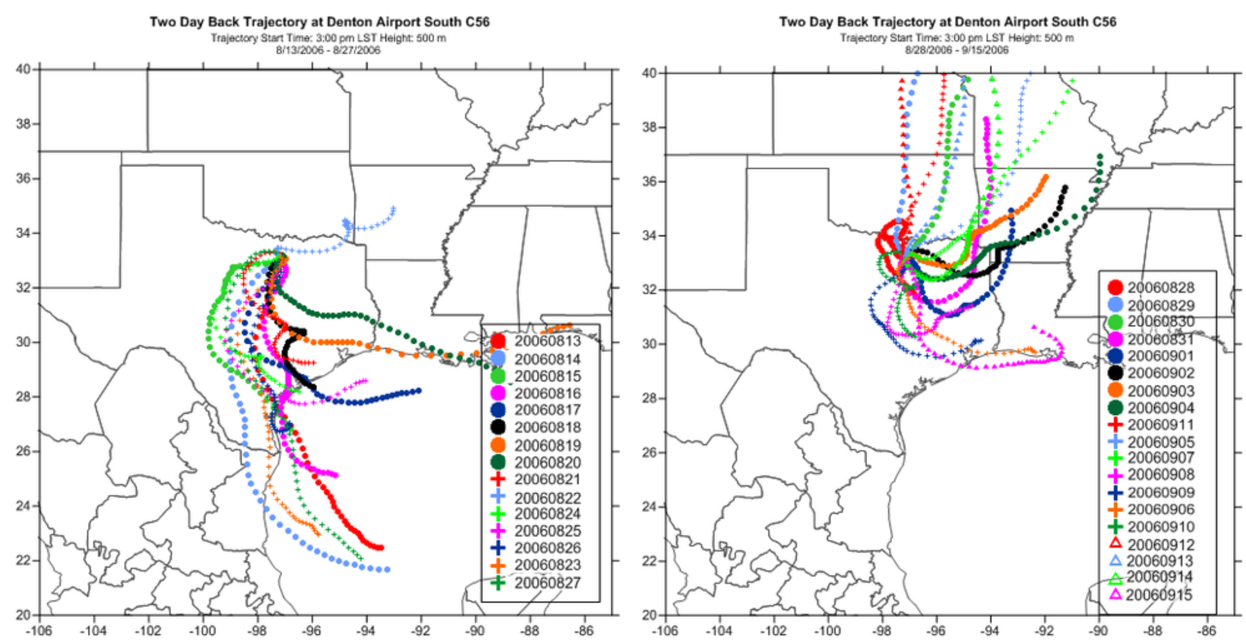


Figure 3-7: Denton Airport South Monitor Back Trajectories for August 13 through September 15, 2006

3.4 METEOROLOGICAL MODEL

The TCEQ is using the Weather Research and Forecasting Model (WRF), which has now largely replaced the Penn State University/National Center for Atmospheric Research (NCAR) Mesoscale Meteorological Model, Fifth Generation (MM5) for both forecasting and retrospective modeling of historical episodes. The WRF model development was driven by a community effort to provide a modeling platform that supported the most recent research and allowed testing in forecast environments. WRF was designed to be completely mass conservative and built to allow better flux calculations, both of which are of central importance to the air quality community. The model was also designed with higher order numerical techniques than MM5 for many physical calculations. These model improvements over MM5 as well as a decision by NCAR to no longer support MM5 prompted the TCEQ as well as various Texas universities, the Central Regional Air Planning Association, and the EPA to adopt WRF for their respective meteorological modeling platforms.

3.4.1 Modeling Domains

As shown in Figure 3-8: *WRF Modeling Domains*, the meteorological modeling was configured with three nested grids at a resolution of 36 kilometers (km) for North America (na_36km), 12 km for Texas plus portions of surrounding states (sus_12km), and 4 km for the eastern portion of Texas (4 km). The extent of each of the WRF modeling domains was selected to accommodate the embedding of the commensurate air quality modeling domains. Table 3-4: *WRF Modeling Domain Definitions* provides the specific northing and easting parameters for these grid projections.

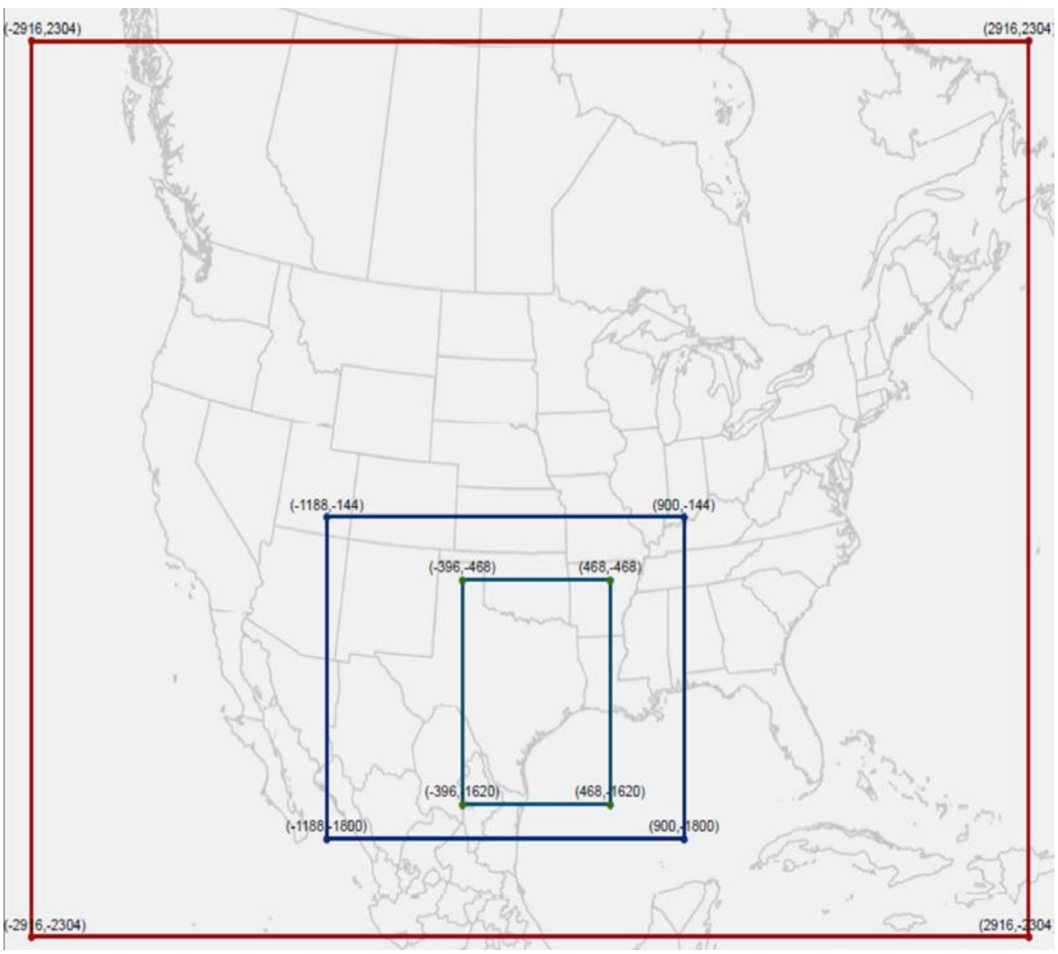


Figure 3-8: WRF Modeling Domains

Table 3-4: WRF Modeling Domain Definitions

Domain	Easting Range (km)	Northing Range (km)	East/West Grid Points	North/South Grid Points
na_36 km	(-2916,2916)	(-2304,2304)	163	129
sus_12km	(-1188,900)	(-1800,-144)	175	139
4 km	(-396,468)	(-1620,-468)	217	289

As shown in Figure 3-9: *WRF Vertical Layer Structure*, the vertical configuration of the WRF modeling domains consists of a varying 43-layer structure used with all of the horizontal domains. The first 21 vertical layers are identical to the same layers used with the Comprehensive Air Quality Model with Extensions (CAMx), while CAMx layers 22 through 28 each comprise multiple WRF layers.

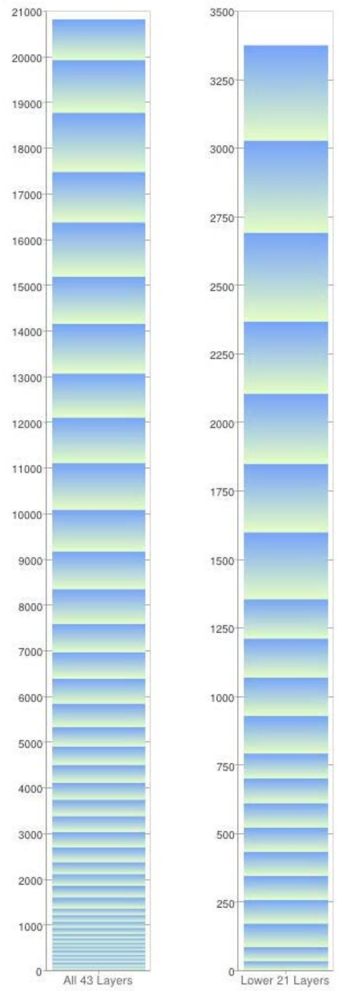


Figure 3-9: WRF Vertical Layer Structure

3.4.2 Meteorological Model Configuration

The selection of the final meteorological modeling configuration for the two episodes during 2006 resulted from numerous sensitivity tests and model performance evaluation. The preparation of WRF input files involves the execution of different models within the WRF Preprocessing System (WPS). Analysis nudging files are generated as part of WPS preparation of

WRF input and boundary condition files. Observational nudging files with radar profiler data were developed separately by the TCEQ.

For optimal photochemical model performance, low-level wind speed and direction are of greater importance than surface temperature. Additional meteorological features of critical importance for air quality modeling include cloud coverage and the strength and depth of the planetary boundary layer (PBL). Observational nudging using TexAQS II radar profiler data and one-hour surface analysis nudging improved wind performance. Switching from the NOAH (NCEP Oregon State Air Force Hydrological Research Laboratory) Land-Surface Model to the five-layer soil model also improved the representation of precipitation, temperature, and PBL depths.

The TCEQ continued to improve upon the performance of WRF for the June and August-September 2006 episodes through a series of sensitivities. The final WRF parameterization schemes and options selected are shown in Table 3-5: *WRF Model Configuration Parameters*. The selection of these schemes and options was based on extensive testing of model configurations that built upon experience with MM5 in previous SIP modeling. Among all the meteorological variables that can be validated, minimizing wind speed bias was the highest priority for model performance consideration. WRF output was post-processed using the WRFCAMx version 6.3 utility to convert the WRF meteorological fields to the appropriate CAMx grid and input format. The WRFCAMx now generates several alternative vertical diffusivity (Kv) files based upon multiple methodologies for estimating mixing given the same WRF meteorological fields. The Kv option to match the WRF Yonsei University (YSU) PBL scheme was used for the CAMx runs for the 2006 episodes. The vertical diffusivity coefficients were also modified on a land-use basis to maintain vertical mixing within the first 100 meters of the model overnight using the KVPATCH program (Environ, 2005).

Table 3-5: WRF Model Configuration Parameters

Domain	Nudging Type	PBL	Cumulus	Radiation	Land-Surface	Microphysics
36 km and 12 km	3-D, Surface Analysis, and Observations	YSU	Kain-Fritsch	RRTM / Dudhia *	5-layer soil model	WSM6 †
4 km	3-D, Surface Analysis, and Observations	YSU	Kain-Fritsch	RRTM / Dudhia *	5-layer soil model	WSM6 †

* RRTM = Rapid Radiative Transfer Model

† WSM6 = WRF Single-Moment 6-Class Microphysics Scheme

Appendix A provides additional detail on the meteorological modeling inputs presented here.

3.4.3 WRF Performance Evaluation

The WRF modeling was evaluated by comparing the hourly modeled and measured wind speed, wind direction, and temperature for all monitors in the DFW area. Figure 3-10: *June 2006 WRF Modeling Performance* exhibits the percent of hours for which the average absolute difference between the modeled and measured wind speed and direction was within the specified accuracy benchmarks for specific DFW area monitors, as well as a regional average. These benchmarks are less than 30 degrees for wind direction, less than 2 meters per second (m/s) for wind speed, and less than 2 degrees Fahrenheit for temperature.

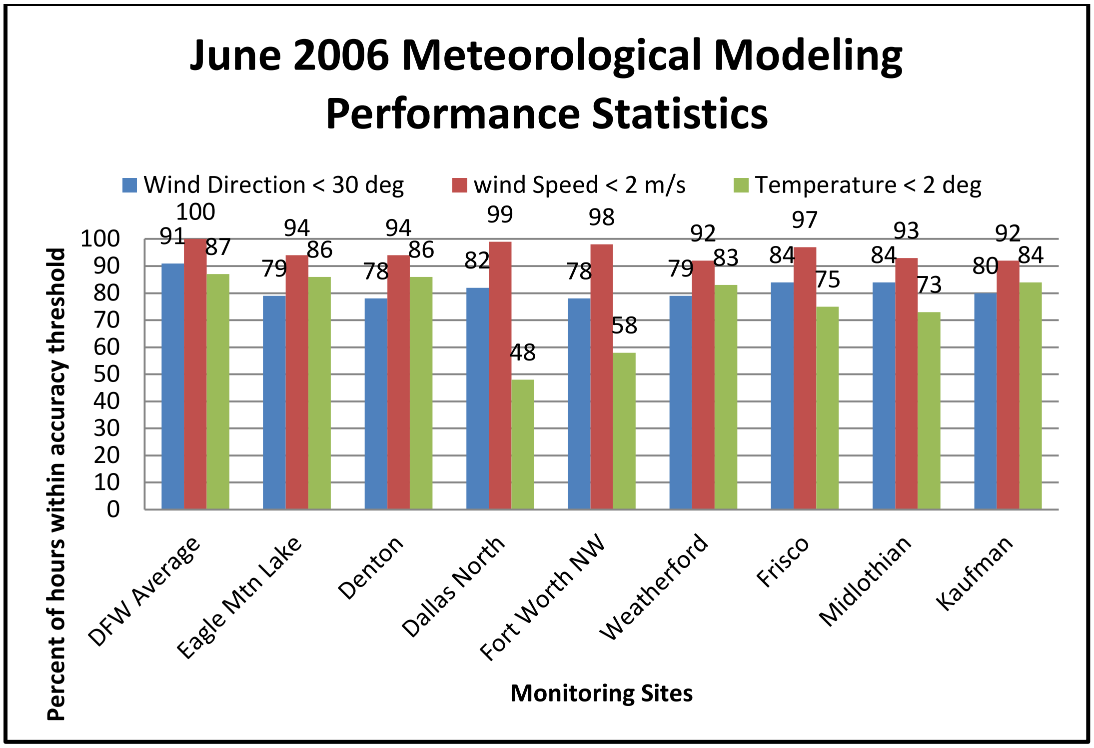


Figure 3-10: June 2006 WRF Modeling Performance

As Figure 3-10 shows, WRF performed well for wind speed and wind direction, and reasonably well for temperature. As noted above, the WRF configuration was selected for optimal performance on low-level wind speed since this meteorological variable strongly impacts CAMx performance. Wind speed performance was excellent at the individual monitors, but observed wind direction is less accurate when wind speeds are low, a condition often observed during ozone exceedances. Table 3-6: *WRF Meteorological Modeling Percent Accuracy for June 2006* provides an additional evaluation of WRF predictions to stricter benchmarks (Emery et al., 2001). The model's ability to replicate wind direction and speed within 20 degrees and 1 m/s on average enhances the confidence in this modeling setup. Appendix A includes more detail on the June, August, and September 2006 WRF modeling performance.

Table 3-6: WRF Meteorological Modeling Percent Accuracy for June 2006

DFW Area	Wind Direction (°) Error ≤ 30 / 20 / 10	Wind Speed (m/s) Error ≤ 2 / 1 / 0.5	Temperature (°C) Error ≤ 2 / 1 / 0.5
DFW Area Average	91 / 83 / 65	100 / 89 / 64	87 / 39 / 14
Eagle Mountain Lake	79 / 69 / 48	94 / 68 / 40	86 / 44 / 18
Denton	78 / 64 / 35	94 / 64 / 32	86 / 66 / 45
Dallas North	82 / 71 / 42	99 / 83 / 51	48 / 23 / 08
Fort Worth NW	78 / 68 / 42	98 / 83 / 54	58 / 20 / 08
Weatherford	79 / 67 / 42	92 / 66 / 37	83 / 44 / 20
Frisco	84 / 73 / 47	97 / 74 / 42	75 / 35 / 16
Midlothian Tower	84 / 72 / 45	93 / 70 / 41	73 / 41 / 24
Kaufman	80 / 68 / 43	92 / 67 / 34	84 / 46 / 25

3.5 MODELING EMISSIONS

For the stationary emission source types, which consist of point and area sources, routine emission inventories provided the major inputs for the emissions modeling processing. Emissions from mobile and biogenic sources were derived from relevant emission models. Specifically, link-based on-road mobile source emissions were derived from travel demand model (TDM) activity output coupled with the EPA Motor Vehicle Emissions Simulator (MOVES) emission factor model. Non-road mobile source emissions were derived from the Texas NONROAD (TexN) model and EPA's National Mobile Inventory Model (NMIM). The point, area, on-road, non-road, and off-road emission estimates were processed to air quality model-ready format using version three of the Emissions Processing System (EPS3; Environ, 2007). Biogenic emissions were derived from version 2.1 of the Model of Emissions of Gases and Aerosols from Nature (MEGAN 2.1), which outputs air quality model-ready emissions (Guenther, et al., 2012).

An overview is provided here of the emission inputs used for the 2006 base case, 2006 baseline, and 2018 future case. Appendix B contains more detail on the development and processing of the emissions using the various EPS3 modules. Table 3-7: *Emissions Processing Modules* summarizes many of the steps taken to prepare chemically speciated, temporally allocated, and spatially distributed emission files needed for the air quality model. Model-ready emissions were developed for the combined 67-day episode. The following sections give a brief description of the development of each emissions source category.

Table 3-7: Emissions Processing Modules

EPS3 Module	Description
PREAM	Prepare area and non-link based area and mobile sources emissions for further processing
LBASE	Spatially allocate link-based mobile source emissions among grid cells
PREPNT	Group point source emissions into elevated and low-level categories for further processing
CNTLEM	Apply controls to model strategies, apply adjustments, make projections, etc.
TMPRL	Apply temporal profiles to allocate emissions by day type and hour
SPCEMS	Chemically speciate emissions into nitrogen oxide, nitrogen dioxide (NO_2), and various Carbon Bond 6 (CB6) VOC species
GRDEM	Spatially distribute emissions by grid cell using source category surrogates
MRGUAM	Merge and adjust multiple gridded files for model-ready input
PIGEMS	Assigns Plume-in-Grid (PiG) emissions and merges elevated point source files

3.5.1 Biogenic Emissions

The TCEQ used MEGAN 2.1 to develop the biogenic emission inputs for CAMx. The MEGAN model requires inputs by model grid cell area of:

- emission factors for nineteen chemical compounds or compound groups;
- plant functional types (PFT);
- leaf area index (LAI) and fractional vegetated leaf area index (LAIv); and
- meteorological information including air and soil temperatures, photosynthetically active radiation (PAR), barometric pressure, wind speed, water vapor mixing ratio, and accumulated precipitation.

The TCEQ used the default emission factors and PFTs that are provided with MEGAN. To process the emission factors and PFTs to the TCEQ air modeling domain structures, gridded layers of each emission factor file were created in ArcMap version 9.3. The TCEQ created 2006-specific LAIv data using the level-4 Moderate-Resolution Imaging Spectroradiometer (MODIS) global LAI MCD15A2 product. For each eight-day period, the satellite tiles covering North America in a Sinusoidal grid were mosaicked together using the MODIS Reprojection Tool. Urban LAI cells, which MODIS excludes, were filled according to a function that follows the North American average for four urban land cover types. The MODIS quality control flags were applied to use only the high quality data from the main retrieval algorithm. The resultant LAI was divided by the percentage of vegetated PFT per grid cell to yield the final LAIv.

The WRF model provided the meteorological data needed for MEGAN input, except for PAR. The episode-specific satellite-based PAR inputs were obtained from the historical data center operated by the Global Energy and Water Cycle Experiment (GEWEX) Continental International Project (GCIP) and GEWEX Americas Prediction Project at the University of Maryland. The PAR data were derived from hourly Geostationary Operational Environmental Satellite (GOES) imagery of cloud cover, which were processed with a solar irradiation model.

The MEGAN model was run for each 2006 episode day. Since biogenic emissions are dependent upon the meteorological conditions on a given day, the same episode-specific emissions for the 2006 baseline were used in the 2018 future case modeling scenarios. The summaries of biogenic emissions for each day of the 67-day combined episode are provided in Appendix B. Figure 3-11: *Sample Biogenic VOC Emissions for June 12, 2006 Episode Day* provides a graphical plot of biogenic VOC emissions distribution at a resolution of 4 km throughout eastern Texas.

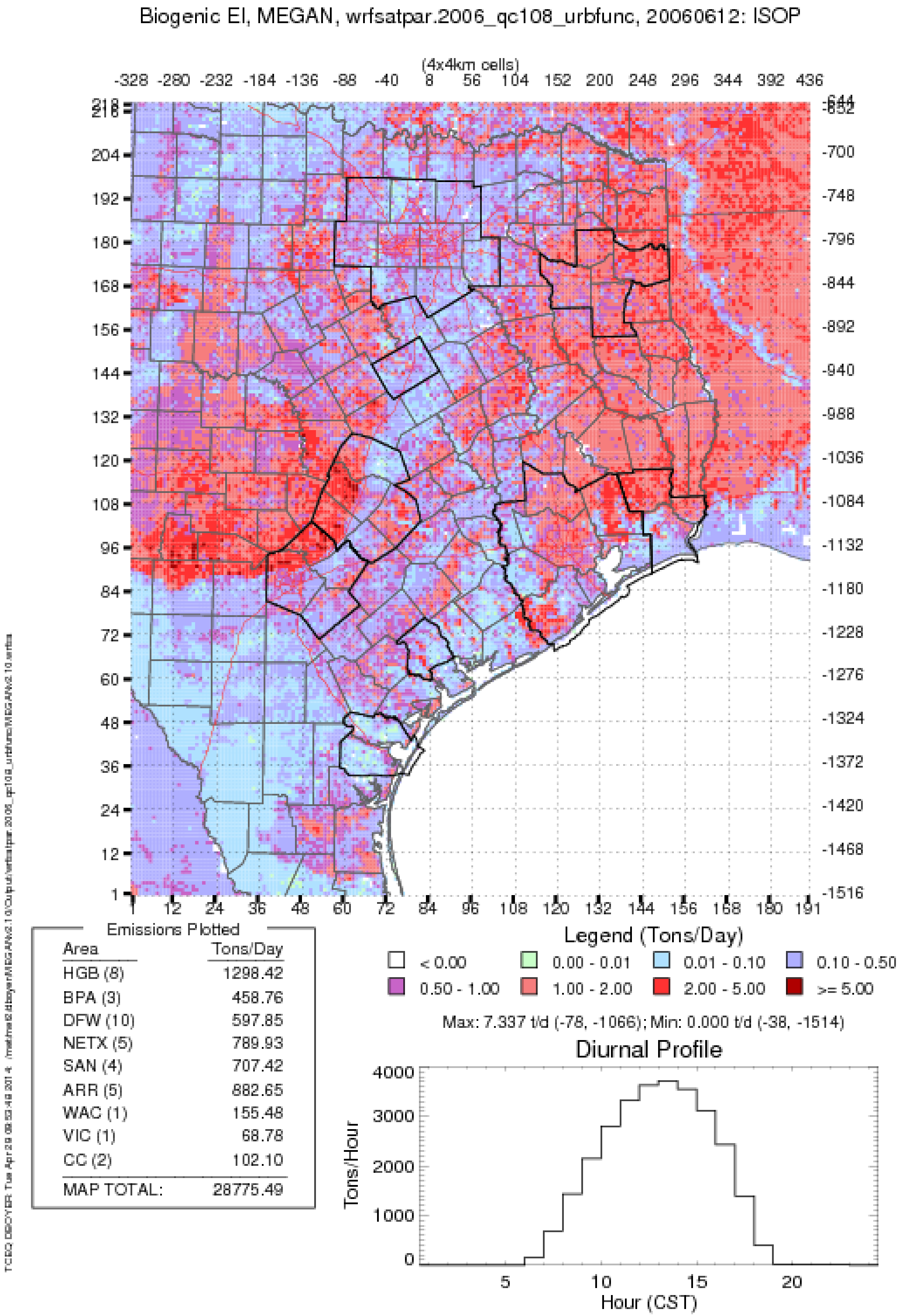


Figure 3-11: Sample Biogenic VOC Emissions for June 12, 2006 Episode Day

3.5.2 2006 Base Case

3.5.2.1 Point Sources

Point source modeling emissions were developed from regional inventories such as the EPA's NEI, the EPA's Acid Rain Database (ARD), state inventories including the State of Texas Air Reporting System (STARS), and local inventories. Data were processed with EPS3 to generate model-ready emissions, and similar procedures were used to develop the 67-day base case episode.

Outside Texas

Point source emissions data for the regions of the modeling domains outside of Texas were obtained from a number of different sources. Emissions from point sources in the Gulf of Mexico (e.g., oil and gas production platforms) were obtained from the 2005 Gulf-Wide Emissions Inventory (GWEI) provided by the United States (U.S.)Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), formerly the Minerals Management Service, as monthly totals. Canadian emissions were obtained from the 2006 National Pollutant Release Inventory (NPRI) from Environment Canada, while 1999 Mexican emissions data were obtained from Phase III of the Mexican NEI. The Gulf of Mexico and 1999 Mexican inventories were not grown to 2006 due to the lack of historical operations data, applied controls, and/or a projection methodology. For the non-Texas U.S. portion of the modeling domain, hourly NO_X emissions for major electric generating units (EGUs) were obtained from the ARD for each hour of each base case episode day. Emissions for non-ARD sources in states beyond Texas were obtained from the EPA's 2008 NEI-based modeling platform.

Within Texas

Hourly NO_X emissions from EGUs within Texas were obtained from the ARD for each base case episode day. Emissions from non-ARD sources were obtained from a STARS database emissions extract for the year 2006. In addition, agricultural and forest fire emissions for 2006 were obtained from the Fire INventory of NCAR (FINN) database, courtesy of Environ's work for the East Texas Council of Governments (Environ, 2008). Fires are treated as point sources.

Table 3-8: *2006 Sample Base Case Point Source Emissions for 10-County DFW* provides a summary of the DFW area point source emissions for the Wednesday June 14, 2006 episode day. The EGU emissions are different for each day and hour of the episode based on real-time continuous emissions monitoring (CEM) data that are reported to EPA's ARD. Emission estimates for the remaining non-ARD point source categories of cement kilns, oil and gas facilities, and "other" do not vary by specific episode day, but are averaged over the entire period of June 1 through August 31, 2006.

Table 3-8: 2006 Sample Base Case Point Source Emissions for 10-County DFW

DFW Point Source Category	NO_X (tpd)	VOC (tpd)	CO (tpd)
Point - EGUs on June 14, 2006	8.42	1.02	3.85
Point - Cement Kilns	22.08	1.94	17.45
Point - Oil and Gas	11.53	21.82	8.74
Point – Other	14.31	25.65	17.26
DFW Area Total	56.34	50.43	47.30

On-Road Mobile Sources

Depending on the time the work was performed, 2006 on-road mobile source emission inputs were developed using either MOVES2010a or MOVES2010b. The vehicle miles traveled (VMT) activity data sets that were used for these efforts are:

- the TDM managed by the North Central Texas Council of Governments (NCTCOG) for the DFW area;
- Highway Performance Monitoring System data collected by the Texas Department of Transportation (TxDOT) for the non-DFW portions of Texas contained within the modeling domain; and
- the EPA default information included with the MOVES2010b database for the non-Texas U.S. portions of the modeling domain.

The output from these emission modeling applications were processed through EPS3 to generate the on-road speciated and gridded inputs for photochemical modeling applications.

DFW Area

For the 10-county DFW area, link-based on-road emissions were developed by NCTCOG using 2006 TDM output and MOVES2010a emission rates to generate average school and summer season on-road emissions for four day types of Monday-Thursday average weekday, Friday, Saturday, and Sunday. For the June 2006 base case episode, the summer season day-type emissions were used. For the August-September 2006 period, the school season day-type emissions were used.

Non-DFW Portions of Texas

For the Texas counties outside of the DFW area, on-road emissions were developed by the Texas Transportation Institute (TTI) using MOVES2010b emission rates and 2006 Highway Performance Monitoring System (HPMS) VMT estimates for each county. Average school and summer season emissions by vehicle type and roadway type were estimated for the four day types of Monday-Thursday average weekday, Friday, Saturday, and Sunday.

Outside of Texas

For the non-Texas U.S. portions of the modeling domain, the TCEQ used MOVES2010b in default mode to generate 2006 average summer weekday emission estimates for every non-Texas U.S. county. Temporal profiles based on the Texas on-road inventories from TTI and NCTCOG were developed to adjust these summer weekday emissions to the remaining day and season type combinations referenced above.

Table 3-9: *Summary of On-Road Mobile Source Emissions Development* contains additional detail about the on-road mobile inventory development in different regions of the modeling domain.

Table 3-9: Summary of On-Road Mobile Source Emissions Development

On-Road Inventory Development Parameter	DFW	Non-DFW Texas	Non-Texas States/Counties
VMT Source and Resolution	TDM Roadway Links	HPMS Data Sets 19 Roadway Types	MOVES2010b 12 Roadway Types
Season Types	School and Summer Seasons	School and Summer Seasons	Summer Season Adjusted to School

On-Road Inventory Development Parameter	DFW	Non-DFW Texas	Non-Texas States/Counties
Day Types	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday	Weekday Adjusted to Friday, Saturday, and Sunday
Roadway Speed Distribution	Varies by Hour and Link	Varies by Hour and Roadway Type	MOVES2010b Default
MOVES Fuel and Source Use Types	Gasoline and Diesel 13 Source Use Types	Gasoline and Diesel 13 Source Use Types	Gasoline and Diesel 13 Source Use Types

Table 3-10: *2006 Base Case On-Road Modeling Emissions for 10-County DFW* summarizes the on-road mobile source emission estimates for the 2006 base case episode for the 10-county DFW area for all combinations of season and day type.

Table 3-10: 2006 Base Case On-Road Modeling Emissions for 10-County DFW

Season and Day Type	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	244.61	21.26	265.87	113.15	1,237.75
Summer Friday	249.64	22.28	271.92	116.97	1,343.06
Summer Saturday	179.13	16.40	195.53	105.38	1,161.81
Summer Sunday	160.23	14.21	174.44	98.68	1,017.86
School Weekday	245.31	21.33	266.64	113.45	1,241.61
School Friday	248.24	22.14	270.38	116.65	1,337.14
School Saturday	177.00	16.18	193.18	104.87	1,150.74
School Sunday	158.39	14.02	172.42	98.26	1,008.85

3.5.2.2 Non-Road and Off-Road Mobile Sources

Non-road mobile sources include vehicles, engines, and equipment used for construction, agriculture, transportation, recreation, and many other purposes. Off-road mobile sources include aircraft, locomotives, and commercial marine vessels. Non-road and off-road mobile source modeling emissions were developed using TexN for non-road emissions within Texas, NMIM for non-road emissions outside of Texas, the EPA's NEI databases, and data sets from the TCEQ Texas Air Emissions Repository (TexAER). The output from these emission modeling applications and databases were processed through EPS3 to generate the air quality model-ready emission files for non-road and off-road sources.

Outside Texas

For the non-Texas U.S. portion of the modeling domains, the TCEQ used the EPA's NMIM to generate average summer weekday non-road mobile source emissions by county and ran it specifically for 2006. For the off-road categories of aircraft, locomotive, and commercial marine, the TCEQ used the EPA's 2008 NEI to create 2006 average summer weekday off-road emissions for the non-Texas U.S. portions of the modeling domain. Summer weekend day emissions for the non-road and off-road mobile source categories were developed as part of the EPS3 processing using temporal profiles specific to each source category.

Within Texas

The TCEQ used the TexN model to generate average summer weekday non-road mobile source category emissions by county for 2006. Airport ground support equipment (GSE) and oil and gas drilling rig emissions were estimated separately as detailed below. During EPS3 processing, temporal adjustments were made to create Saturday and Sunday non-road emission estimates. Table 3-11: *2006 Base Case Non-Road Modeling Emissions for 10-County DFW* summarizes these non-road inputs by day type.

Table 3-11: 2006 Base Case Non-Road Modeling Emissions for 10-County DFW

2006 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	88.75	63.84	802.52
Saturday	64.06	93.78	976.15
Sunday	47.29	81.99	822.53

Airport emission inventories were developed with the Federal Aviation Administration (FAA) Emissions Dispersion Modeling System (EDMS). EDMS outputs emission estimates for aircraft engines, auxiliary power units (APU), and GSE. Table 3-12: *2006 Base Case Airport Modeling Emissions for 10-County DFW* summarizes these estimates for DFW International Airport, Love Field, and the remaining 59 smaller regional airports within DFW. Love Field contracted with Leigh-Fisher to develop emission estimates for 2006 using EDMS. The remaining airport specific emission estimates are based on an NCTCOG study done under contract to the TCEQ.

Table 123-13: 2006 Base Case Airport Modeling Emissions for 10-County DFW

DFW Area Airport or Airport Group	NO_X (tpd)	VOC (tpd)	CO (tpd)
DFW International	9.84	2.37	16.69
Love Field	1.22	0.57	3.39
59 Regional Airports	1.72	1.52	28.01
DFW Area Total for 61 Airports	12.78	4.46	48.09

2006 locomotive emission estimates were developed by backcasting 2011 data from TexAER using emission rate and activity adjustment factors. Emissions were estimated separately for Class I line-haul locomotives, Class II and III line-haul locomotives, and rail yard switcher locomotives. Table 3-13: *2006 Base Case Locomotive Modeling Emissions for 10-County DFW* summarizes the estimates for all locomotive activity in DFW.

Table 3-14: 2006 Base Case Locomotive Modeling Emissions for 10-County DFW

Locomotive Source Classification Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
Line-Haul Locomotives – Class I	21.42	1.19	3.22
Line-Haul Locomotives – Classes II and III	0.60	0.02	0.06
Rail Yard Switcher Locomotives	7.95	0.51	0.84
DFW Area Total	29.97	1.72	4.12

3.5.2.3 Area Sources

Area source modeling emissions were developed using the EPA NEI and the TCEQ's TexAER database. The emissions information in these databases was processed through EPS3 to generate the air quality model-ready area source emission files.

Outside Texas

For the non-Texas U.S. portions of the modeling domain, the TCEQ used the EPA's 2008 NEI to create 2006 daily area source emissions.

Within Texas

The TCEQ obtained emissions data from the 2008 TexAER database (TCEQ, 2011) and backcast these estimates to 2006 using Texas-specific economic growth factors for 2008 to 2006. Temporal profiles were applied with EPS3 to obtain the figures presented in Table 3-14: *2006 Base Case Area Source Emissions for 10-County DFW*.

Table 3-15: 2006 Base Case Area Source Emissions for 10-County DFW

2006 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	29.02	290.46	85.59
Saturday	22.21	136.92	75.57
Sunday	15.41	88.36	65.69

The 2006 county-level drilling rig emissions were based on work done under contract by Eastern Research Group (ERG, 2011) using activity data from the Railroad Commission of Texas (RRC), and are summarized in Table 3-15: *2006 Oil and Gas Drilling Rig Emissions for 10-County DFW Area*.

Table 3-16: 2006 Oil and Gas Drilling Rig Emissions for 10-County DFW Area

Equipment Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Drilling Rigs	18.23	1.16	3.57

For oil and gas production sources, county-specific 2006 oil and gas emissions were calculated based on a TCEQ-contracted research project (ERG, 2010). The emissions were estimated according to 2006 county-specific oil and gas production information from the RRC and emission factors compiled in the 2010 ERG study. Emission estimates by equipment type are summarized in Table 3-16: *2006 Oil and Gas Production Emissions for 10-County DFW Area*.

Table 3-17: 2006 Oil and Gas Production Emissions for 10-County DFW Area

Oil and Gas Production Equipment	NO_X (tpd)	VOC (tpd)	CO (tpd)
Natural Gas 4-Cycle Rich Burn Compressors - 50 To 499 HP	56.19	0.10	2.54
Natural Gas Well Heaters	2.11	0.12	1.77
Natural Gas 2-Cycle Lean Burn Compressors - 50 To 499 HP	1.45	0.14	0.21
Natural Gas 4-Cycle Rich Burn Compressors - 500+ HP w/NSCR	0.84	0.16	7.25
Natural Gas 4-Cycle Lean Burn Compressors - 500+ HP	0.71	1.43	6.77
Oil Production - Artificial Lift	0.32	0.00	0.50
Oil Production - Heater Treater	0.14	0.01	0.11
Natural Gas Well Dehydrators	0.08	1.65	0.23
Oil Production - All Processes	0.00	0.01	0.01
Natural Gas 4-Cycle Rich Burn Compressors - 50 To 499 HP w/NSCR	0.00	0.01	0.61
Natural Gas Condensate - Storage Tanks	0.00	18.06	0.00
Natural Gas Well Pneumatic Devices	0.00	7.07	0.00
Natural Gas Exploration - Well Completion, All Processes	0.00	3.34	0.00
Oil and Gas Production - Produced Water	0.00	2.30	0.00
Natural Gas Fugitives – Other	0.00	2.04	0.00
Natural Gas Fugitives – Valves	0.00	1.73	0.00
Natural Gas Well Venting	0.00	1.19	0.00
Crude Oil Storage Tanks	0.00	1.18	0.00
Natural Gas Condensate - Tank Truck/Railcar Loading	0.00	0.57	0.00
Oil Production – Wellhead	0.00	0.55	0.00
Oil Well Pneumatic Devices	0.00	0.46	0.00
Natural Gas Fugitives – Flanges	0.00	0.28	0.00
Natural Gas Fugitives – Connectors	0.00	0.27	0.00
Oil Well Completion - All Processes	0.00	0.23	0.00
Natural Gas Fugitives - Open Ended Lines	0.00	0.21	0.00
Oil Production Fugitives – Other	0.00	0.15	0.00
Crude Oil Truck/Railcar Loading	0.00	0.11	0.00
Natural Gas Fugitives – Pumps	0.00	0.11	0.00
Oil Production Fugitives – Valves	0.00	0.10	0.00
Oil Production Fugitives – Pumps	0.00	0.05	0.00
Natural Gas Production - Compressor Engines	0.00	0.04	0.06
Oil Production Fugitives – Connectors	0.00	0.04	0.00
Oil Production Fugitives - Open Ended Lines	0.00	0.01	0.00
Natural Gas 2-Cycle Lean Burn Compressors < 50 HP	0.00	0.00	0.01
Oil Production Fugitives – Flanges	0.00	0.00	0.00
Natural Gas 4-Cycle Rich Burn Compressors - <50 HP	0.00	0.00	0.01
Oil and Gas Production Total	61.84	43.72	20.09

Some facilities associated with oil and gas production are required to report to the TCEQ as point sources. Emissions for 2006 from these facilities are not included above within Table 3-16, but are summarized by standard industrial classification (SIC) in Table 3-17: *2006 Point Source Oil and Gas Emissions for 10-County DFW Area*. Table 3-17 provides detail for the "Point - Oil and Gas" category from Table 3-8.

Table 3-18: 2006 Point Source Oil and Gas Emissions for 10-County DFW Area

Standard Industrial Classification (SIC) Description	SIC Code	NO_X (tpd)	VOC (tpd)	CO (tpd)
Crude Petroleum and Natural Gas	1311	4.78	15.67	4.88
Natural Gas Liquids	1321	5.43	2.70	2.58
Natural Gas Transmission	4922	1.03	0.81	0.96
Petroleum Bulk Stations and Terminals	5171	0.08	1.89	0.12
Mixed, Manufactured, LPG Production	4925	0.21	0.00	0.19
Refined Petroleum Pipelines	4613	0.01	0.74	0.02
DFW Area Total	NA	11.53	21.82	8.74

3.5.2.4 Base Case Summary

Table 3-18: *2006 Sample Base Case Anthropogenic Emissions for 10-County DFW* summarizes the typical weekday emissions in the 10-county DFW area by source type for the base case episode. The EGU emissions presented are specific to the June 14, 2006 episode day, and are different for each of the remaining 66 days in the combined 67-day episode. Table 3-18 is for an average weekday during the June episode, which uses the summer season on-road inventories. For the August-September base case emissions, the school season on-road inventories presented above in Table 3-10 were used.

Table 3-19: 2006 Sample Base Case Anthropogenic Emissions for 10-County DFW

DFW Area Source Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
On-Road	265.87	113.15	1,237.75
Non-Road	88.75	63.84	802.52
Area Sources	29.02	290.46	85.59
Off-Road – Locomotives	29.97	1.72	4.12
Off-Road – Airports	12.78	4.46	48.09
Oil and Gas – Production	61.84	43.72	20.09
Oil and Gas – Drill Rigs	18.23	1.16	3.57
Point – Oil and Gas	11.53	21.82	8.74
Point – EGUs on June 14, 2006	8.42	1.02	3.85
Point – Cement Kilns	22.08	1.94	17.45
Point – Other	14.31	25.65	17.26
Total	562.80	568.94	2,249.03

3.5.3 2006 Baseline

The baseline modeling emissions are based on typical ozone season emissions, whereas the base case modeling emissions are episode day-specific. The biogenic emissions, dependent on the day-specific meteorology, are an exception in that the same episode day-specific emissions are used in both the 2006 base case and baseline. In addition, the 2006 baseline emissions for on-road, non-road, off-road, oil and gas, and area sources are the same as used for the 2006 base case episode, since they are based on typical ozone season emissions. Unlike the base case, fire emissions were not included in the 2006 baseline as they are not typical ozone season day emissions.

For the non-ARD point sources, the 2006 baseline emissions are the same as the modeling emissions used for the 67-day episode base case with a couple of exceptions. The 2006 baseline ARD EGU emissions were estimated using the average of the 2006 third quarter hourly ARD emissions to more accurately reflect EGU emissions during the peak ozone season. The highly reactive VOC (HRVOC) emissions reconciliation in the HGB area developed for the 2006 base case was used for the 2006 baseline. For the Gulf of Mexico, Canada, and Mexico, the 2006 baseline used the same emissions as the base case.

Table 3-19: *2006 Summer Baseline Anthropogenic Emissions for 10-County DFW* provides the baseline emissions for an average summer weekday. The non-ARD emissions are the same as the base case, since they are ozone season day averages. The averaged baseline ARD emissions are not the same as any specific day in the base case, but typical of the entire episode. The only difference between Table 3-18 and Table 3-19 is that the former has episode day specific EGU emissions of 8.42 NO_X tpd for June 14, 2006 while the latter has a peak ozone season average of 9.63 NO_X tpd. The 2006 August-September baseline has the same emission estimates with the exception of including school season on-road emissions instead of those for summer.

Table 3-20: 2006 Summer Baseline Anthropogenic Emissions for 10-County DFW

DFW Area Source Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
On-Road	265.87	113.15	1,237.75
Non-Road	88.75	63.84	802.52
Area Sources	29.02	290.46	85.59
Off-Road – Locomotives	29.97	1.72	4.12
Off-Road – Airports	12.78	4.46	48.09
Oil and Gas – Production	61.84	43.72	20.09
Oil and Gas – Drill Rigs	18.23	1.16	3.57
Point – Oil and Gas	11.53	21.82	8.74
Point – EGUs (Ozone Season Average)	9.63	1.03	4.77
Point – Cement Kilns	22.08	1.94	17.45
Point – Other	14.31	25.65	17.26
Total	564.01	568.95	2,249.95

Table 3-20: *2006 DFW Point Source Baseline Emission Estimates by Industry Type* provides a summary by SIC of the 17 major industrial categories within the DFW area that each emitted more than 0.25 NO_X tpd in 2006, with the remaining 73 industry types emitting a total of 3.26 NO_X tpd. As of 2006, there were 394 point source facilities throughout the DFW area with three in the cement kiln category (SIC of 3241), twelve in electric services (SIC of 4911), and 379 that comprise the remaining 88 SIC types. Based on submissions to the TCEQ STARS database, these 379 non-cement kiln non-EGU facilities were estimated to emit 25.84 NO_X tpd in 2006.

Table 3-21: 2006 DFW Point Source Baseline Emission Estimates by Industry Type

SIC Code	SIC Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
3241	Cement, Hydraulic	22.08	1.94	17.45
4911	Electric Services	9.63	1.03	4.77
1321	Natural Gas Liquids	5.43	2.70	2.58
1311	Crude Petroleum and Natural Gas	4.78	15.67	4.88
3274	Lime	3.83	0.02	0.46
3296	Mineral Wool	2.20	0.73	1.69
3312	Blast Furnaces and Steel Mills	1.37	1.00	4.74
4922	Natural Gas Transmission	1.03	0.81	0.96
3221	Glass Containers	0.88	0.04	0.04
2099	Food Preparations	0.57	0.03	0.25
2952	Asphalt Felts and Coatings	0.46	0.60	0.63
4581	Airports, Flying Fields, and Services	0.43	0.24	0.20
3511	Turbines and Turbine Generator Sets	0.40	0.08	0.07
2013	Sausages and Other Prepared Meat Products	0.33	0.01	0.16
3674	Semiconductors and Related Devices	0.32	0.79	0.23
4953	Refuse Systems	0.30	0.47	1.20
3251	Brick and Structural Clay Tile	0.26	0.43	0.99
	Remaining 73 SICs Below 0.25 NO_X tpd	3.26	23.86	6.92
	DFW Area Total for 90 SIC Codes	57.55	50.44	48.21
	Non-EGU Non-Cement Kiln Total	25.84	47.47	26.00

3.5.4 2018 Future Case Emissions

The biogenic emissions used for the 2018 future case modeling are the same episode day-specific emissions used in the base case. In addition, similar to the 2006 baseline, no fire emissions were included in the 2018 future case modeling.

3.5.4.1 Point Sources

Outside Texas

The non-ARD point source emissions data in the regions outside Texas were derived from EPA's 2018 emissions modeling platform, which is projected from the 2011 NEI. For non-Texas EGUs, TCEQ applied Clean Air Interstate Rule (CAIR) Phase II caps at the state level. For the Gulf, Canada, and Mexico portions of the modeling domain, the 2018 point source emissions were the same as the emissions used in the 2006 baseline.

Within Texas

2018 future case EGU emission estimates within Texas were based on the CAIR Phase II program that specifies an annual statewide limit starting in 2015 of 150,845 tons per year of NO_X emissions, which corresponds to a daily average of 413 NO_X tpd. Since electricity generation is higher during the ozone season than other times of year, historical operational profiles were used to allocate higher estimates for ozone season modeling purposes. To assign future operational NO_X caps to each existing EGU, their operational histories were evaluated for compliance with CAIR Phase I caps that have been in effect from 2009 through 2013. State law assigns 90.5% of the CAIR budgets to existing EGUs, with the remaining 9.5% set aside for newly permitted EGUs. Assignment of ozone season NO_X emissions to each existing EGU resulted in a total less than the 90.5% level, so the remainder was spread proportionally among all existing EGUs. Newly permitted EGUs were assigned their maximum permit allowable emissions.

The three cement kilns operating within the DFW area were assigned the maximum ozone season caps that are specified in 30 Texas Administrative Code (TAC) §117.3123. Emissions for the remaining non-EGU facilities within the DFW area were projected from the 2012 levels reported to STARS by each point source facility. An ERG study (ERG, 2010) entitled *Projection Factors for Point and Area Sources* was used as the basis for providing adjustments to the reported 2012 levels based on a combination of the type of industry and county of operation for each facility. Table 3-21: *2012 DFW Area Point Source Emission Estimates by Industry Type* provides a summary by SIC of the 17 major industries within the DFW area that emitted more than 0.1 NO_X tpd in 2012, with the remaining 77 industry types emitting a total of 1.57 NO_X tpd. As of 2012 there were 412 point source facilities throughout the DFW area: three in the cement kiln category, 12 in electric services, and 397 that comprise the remaining 92 SIC types. Based on submissions to the TCEQ STARS database, these 397 non-cement kiln non-EGU facilities were estimated to emit 23.54 NO_X tpd in 2012.

Table 3-22: 2012 DFW Area Point Source Emission Estimates by Industry Type

SIC Code	SIC Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
3241	Cement, Hydraulic	9.03	0.86	9.20
4911	Electric Services	8.25	3.16	13.86
1311	Crude Petroleum and Natural Gas	11.00	16.49	9.00
1321	Natural Gas Liquids	4.59	4.94	3.88
3274	Lime	1.43	0.01	0.34
4922	Natural Gas Transmission	1.09	2.26	0.77
3312	Blast Furnaces and Steel Mills	0.88	0.89	4.10
3296	Mineral Wool	0.57	0.56	1.27
4953	Refuse Systems	0.55	0.67	2.16
2952	Asphalt Felts and Coatings	0.46	0.49	0.59
4581	Airports, Flying Fields, and Services	0.33	0.17	0.05
3711	Motor Vehicles and Car Bodies	0.23	3.78	0.16
3253	Ceramic Wall and Floor Tile	0.20	0.16	0.82
3511	Turbines and Turbine Generator Sets	0.19	0.05	0.05
2631	Paperboard Mills	0.16	0.06	0.17
3341	Secondary Nonferrous Metals	0.16	0.16	1.88
4952	Sewerage Systems	0.15	0.03	0.12
	Remaining 77 SICs Below 0.1 NO_X tpd	1.57	15.16	3.53

SIC Code	SIC Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
	DFW Area Total for 94 SIC Codes	40.82	49.88	51.95
	Non-Cement Kiln Non-EGU Total (92 SICs)	23.54	45.87	28.89

Table 3-22: *2018 DFW Area Point Source Emission Projections by Industry Type* provides a summary of the 2018 point source emission projections by SIC. For the cement kiln and electric utility sources, the required emission caps are modeled in the future year even if historical operational levels have only been roughly 50% of these caps. For example, the cement kilns operated at an average ozone season day level of 9.03 NO_X tpd in 2012, but the 2018 future year is still modeled at the 17.64 NO_X tpd cap. In a similar fashion, the EGUs emitted an average of 8.25 NO_X tpd in 2012, but the 2018 future year is modeled at the CAIR Phase II caps of 16.91 NO_X tpd. This conservative approach of modeling the maximum allowable emission levels ensures that future estimates are not underestimated for these large NO_X sources on high ozone days. Specific caps do not apply to the non-cement kiln non-EGU facilities, which are projected to emit 22.99 NO_X tpd in 2018 after application of the ERG projection factors discussed previously.

Table 3-23: 2018 DFW Area Point Source Emission Projections by Industry Type

SIC Code	SIC Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
3241	Cement, Hydraulic	17.64	0.78	11.45
4911	Electric Services	16.91	4.44	20.61
1311	Crude Petroleum and Natural Gas	10.74	16.70	8.44
1321	Natural Gas Liquids	4.48	5.01	3.24
3274	Lime	1.40	0.01	0.39
4922	Natural Gas Transmission	1.06	2.29	0.79
3312	Blast Furnaces and Steel Mills	0.86	0.90	4.97
3296	Mineral Wool	0.56	0.57	1.66
4953	Refuse Systems	0.53	0.67	2.30
2952	Asphalt Felts and Coatings	0.44	0.50	0.56
4581	Airports, Flying Fields, and Services	0.33	0.17	0.07
3711	Motor Vehicles and Car Bodies	0.22	3.82	0.15
3253	Ceramic Wall and Floor Tile	0.20	0.16	0.86
3511	Turbines and Turbine Generator Sets	0.19	0.05	0.06
2631	Paperboard Mills	0.16	0.06	0.22
3341	Secondary Nonferrous Metals	0.15	0.16	2.07
4952	Sewerage Systems	0.14	0.03	0.14
	Remaining 77 SICs Below 0.1 NO_X tpd	1.53	15.36	3.97
	DFW Area Total for 94 SIC Codes	57.54	51.67	61.95
	Non-Cement Kiln Non-EGU Total (92 SICs)	22.99	46.46	29.89

A similar approach was taken for projecting non-EGU emission levels from 2012 to 2018 in the non-DFW areas of Texas. Within the eight-county HGB area, point source NO_X emissions are limited by the Mass Emissions Cap and Trade Program (MECT), while HRVOC emissions are limited by the HRVOC Emissions Cap and Trade Program (HECT). These MECT and HECT limits were taken into account while projecting 2018 point source levels for both EGUs and non-EGUs operating in the HGB area.

3.5.4.2 On-Road Mobile Sources

2018 on-road mobile source inputs were developed using MOVES2010b in combination with the following vehicle activity data sets:

- the TDM managed by NCTCOG for the DFW area;
- HPMS data collected by TxDOT for the non-DFW portions of Texas contained within the modeling domain; and
- the EPA default information included with the MOVES2010b database for the non-Texas U.S. portions of the modeling domain.

The output from these emission modeling applications were processed through EPS3 to generate the on-road speciated and gridded inputs for photochemical modeling applications.

DFW and Non-DFW Areas of Texas

For all 254 Texas counties, HPMS-based on-road emissions were developed by TTI for 2018 using MOVES2010b. Similar to the approach taken for 2006, 2018 on-road emissions were estimated for the four day types of weekday, Friday, Saturday, and Sunday for both the school and summer seasons. For the 10-county DFW area, 2012 link-based on-road emissions estimated with MOVES2010a and TDM output from NCTCOG were adjusted to be equivalent to the 2018 HPMS-based estimates from TTI. This approach allowed for reasonable 2018 on-road emission estimates while maintaining the excellent spatial and temporal resolution offered by link-based emission estimates from TDM output. The EPA released the updated version of MOVES (MOVES2014) on July 31, 2014. The inventory development schedule for this SIP revision did not allow time to incorporate MOVES2014. The TCEQ is working with the NCTCOG to develop updated link-based inventories for DFW using TDM output, and will also work with TTI to develop updated HPMS-based inventories for all remaining Texas counties. Provided that there are no problems encountered with the MOVES2014 model, the updated on-road emission inventories will replace the current ones referenced in this SIP revision. The planning assumptions, fleet characteristics, and VMT estimates will also be updated to incorporate the latest available information at the time revised the inventories are developed. It is expected that the final on-road emission estimates will be different than those in this proposal. As a result, the SIP narrative would likely change between proposal and adoption to reflect these differences.

Outside of Texas

For the non-Texas U.S. portions of the modeling domain, the TCEQ used MOVES2010b in default mode to generate 2018 average summer weekday emissions for every non-Texas county. Temporal profiles based on the Texas on-road inventories from TTI and NCTCOG were developed to adjust these summer weekday emissions to the remaining day and season type combinations referenced above.

Table 3-23: *2018 Future Case On-Road Modeling Emissions for 10-County DFW* summarizes the on-road mobile source emissions for the 2018 future case for the 10-county DFW area for all combinations of season and day type.

Table 3-24: 2018 Future Case On-Road Modeling Emissions for 10-County DFW

Season and Day Type	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	95.95	17.41	113.36	55.63	671.77
Summer Friday	101.18	18.36	119.54	57.21	719.92
Summer Saturday	73.32	12.68	86.01	48.95	570.29
Summer Sunday	61.04	10.21	71.26	46.41	501.41
School Weekday	94.67	17.15	111.81	55.39	664.54
School Friday	101.57	18.34	119.91	58.27	726.52
School Saturday	73.74	12.69	86.43	49.99	577.13
School Sunday	60.60	10.04	70.65	47.25	501.76

For the 10-county DFW area, the on-road mobile source NO_X emissions are reduced roughly 57% from the 2006 baseline (265.87 tpd) to the 2018 future case (113.36 tpd). VOC emissions are reduced roughly 51% from the 2006 baseline (113.15 tpd) to the 2018 future case (55.63 tpd). Due to the ongoing fleet turnover effect where older high-emitting vehicles are replaced with newer low-emitting ones, these substantial on-road reductions are projected to occur even with projected growth in VMT between the years of 2006 and 2018.

3.5.4.3 Non- and Off-Road Mobile Sources

Outside Texas

For the non-Texas U.S. portion of the modeling domains, the TCEQ used EPA's NMIM specifically for 2018 to generate average summer weekday non-road mobile source emission projections by county. For the off-road categories of aircraft, locomotive, and commercial marine, the TCEQ used the EPA's 2011 NEI to create 2018 average summer weekday off-road emissions for the non-Texas U.S. portions of the modeling domain. Summer weekend day emissions for the non-road and off-road mobile source categories were developed as part of the EPS3 processing using temporal profiles specific to each source category.

Within Texas

The TCEQ used the TexN model to generate average summer weekday non-road mobile source category emissions by county for 2018. Airport GSE and oil and gas drilling rig emissions were estimated separately as detailed below. During EPS3 processing, temporal adjustments were made to create Saturday and Sunday non-road emission estimates. Table 3-24: *2018 Future Case Non-Road Modeling Emissions for 10-County DFW* summarizes these non-road inputs by day type.

For the 10-county DFW area, non-road NO_X emissions are reduced by roughly 55% from the 2006 baseline (88.75 tpd) to the 2018 future case (39.87 tpd). VOC emissions are decreased roughly 49% from the 2006 baseline (63.84 tpd) to the 2018 future case (32.80 tpd). Due to the ongoing fleet turnover effect where older high-emitting equipment is replaced with newer low-emitting equipment, these substantial non-road reductions are projected to occur even with expected growth in overall non-road equipment population and activity between the years of 2006 and 2018.

Table 3-25: 2018 Future Case Non-Road Modeling Emissions for 10-County DFW

2018 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	39.87	32.80	577.61
Saturday	29.78	46.95	742.28
Sunday	22.91	41.94	644.85

Airport emission inventories were developed with the FAA EDMS tool, which outputs emission estimates for aircraft engines, APUs, and GSE. Table 3-25: *2018 Future Case Airport Modeling Emissions for 10-County DFW* summarizes these estimates for DFW International Airport, Love Field, and the remaining 59 smaller regional airports within DFW. Love Field contracted with Leigh-Fisher to develop emission estimates for 2018 using EDMS. The remaining airport specific emission estimates are based on an NCTCOG study done under contract to the TCEQ.

Table 3-26: 2018 Future Case Airport Modeling Emissions for 10-County DFW

DFW Area Airport or Airport Group	NO_X (tpd)	VOC (tpd)	CO (tpd)
DFW International	10.50	2.02	10.65
Love Field	1.70	0.43	2.43
59 Regional Airports	0.86	1.10	20.99
DFW Area Total for 61 Airports	13.06	3.55	34.07

2018 locomotive emission estimates were developed by projecting 2011 figures from TexAER using emission rate and activity adjustment factors. Emissions were estimated separately for Class I line-haul locomotives, Class II and III line-haul locomotives, and rail yard switcher locomotives. Table 3-26: *2018 Future Case Locomotive Emissions for 10-County DFW* summarizes these estimates for all locomotive activity in DFW.

For the 10-county DFW area, the locomotive NO_X emissions are reduced by about 34% from the 2006 baseline (28.67 tpd) to the 2018 future case (18.90 tpd), and the VOC emissions are decreased about 46% from the 2006 baseline (1.72 tpd) to the 2018 future case (0.93 tpd). These substantial locomotive emissions reductions are projected to occur due to the ongoing fleet turnover effect where older high-emitting locomotive diesel engines are replaced with newer low-emitting ones.

Table 3-27: 2018 Future Case Locomotive Emissions for 10-County DFW

Locomotive Source Classification Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
Line-Haul Locomotives – Class I	12.22	0.52	3.20
Line-Haul Locomotives – Classes II and III	0.56	0.02	0.06
Rail Yard Switcher Locomotives	6.11	0.39	0.84
DFW Area Total	18.90	0.93	4.10

3.5.4.4 Area Sources

Outside Texas

For the non-Texas U.S. within the modeling domains, the TCEQ used the EPA's 2011 NEI with to create 2018 daily area source emissions.

Within Texas

The TCEQ used data from the 2011 TexAER database (TCEQ, 2011), and projected these estimates to 2018 using the Texas-specific economic growth factors for 2011 to 2018. Temporal profiles were applied with EPS3 to obtain the figures presented in Table 3-27: *2018 Future Case Area Source Emissions for 10-County DFW*.

Table 3-28: 2018 Future Case Area Source Emissions for 10-County DFW

2018 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	30.76	284.94	78.09
Saturday	23.61	137.45	67.38
Sunday	16.46	88.12	56.79

The 2018 county-level drilling rig emission estimates were based on the latest available drilling activity data obtained from the RRC, which are summarized in Table 3-28: *2013 Oil and Gas Drilling Activity for the 10-County DFW Area*. A 2018 drilling rig emission rate for each of the three categories referenced in Table 3-28 was multiplied by the corresponding number of feet drilled. These emission rates for 1999 through 2040 are documented in Chapter 4 of an ERG report entitled *Development of Texas Statewide Drilling Rigs Emission Inventories for the Years 1990, 1993, 1996, and 1999 through 2040* (ERG, 2011). The results are summarized in Table 3-29: *2018 Oil and Gas Drilling Rig Emissions for 10-County DFW Area*.

Table 3-29: 2013 Oil and Gas Drilling Activity for the 10-County DFW Area

Type and Depth of 2013 Drilling Levels	2013 Feet Drilled
Vertical/Horizontal Drilling	5,556,499
Vertical Drilling less than 7,000 Feet	17,608
Vertical Drilling greater than 7,000 Feet	16,073

Table 3-30: 2018 Oil and Gas Drilling Rig Emissions for 10-County DFW Area

Equipment Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Drilling Rigs	2.82	0.21	0.45

2018 future year emission estimates for oil and gas production were projected 2013 RRC data, which is the latest full year for which such activity information is available. The 2013-to-2018 projection factors were obtained from an ERG study entitled *Forecasting Oil and Gas Activities* (ERG, 2012) (http://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5821199776FY1212-20120831-erg-forecasting_oild_gas_activities.pdf) where several methodologies were evaluated for the purposes of projecting oil and gas production levels. The recommended approach is based on the Hubbert peak theory that relies on a bell-shaped curve to predict the rate of fossil fuel extraction over time from a specific region. Table 3-30: *Barnett Shale Emission Projection Factors from 2013 to 2018* summarizes these projection factors from the ERG study for natural gas, crude oil, and condensate.

Table 3-31: Barnett Shale Emission Projection Factors from 2013 to 2018

Fossil Fuel Type	Barnett Shale Projection Factor from 2013 to 2018
Natural Gas	47.69%
Crude Oil	52.13%
Condensate	13.67%

The 2013 emission estimates based directly on historical RRC data were then multiplied by the projection factors in Table 3-30 to obtain the 2018 emissions estimates by equipment type presented in Table 3-31: *2018 Oil and Gas Production Emissions for 10-County DFW Area*.

Table 3-32: 2018 Oil and Gas Production Emissions for 10-County DFW Area

Oil and Gas Production Equipment	NO_X (tpd)	VOC (tpd)	CO (tpd)
Natural Gas 4-Cycle Rich Burn Compressors 50 To 499 HP	4.49	0.05	1.73
Natural Gas 4-Cycle Rich Burn Compressors 50 To 499 HP w/NSCR	1.11	0.05	2.10
Natural Gas 4-Cycle Rich Burn Compressors <50 HP	0.68	0.00	0.07
Natural Gas 4-Cycle Rich Burn Compressors 500+ HP w/NSCR	0.51	0.02	0.81
Oil Production - Artificial Lift	0.13	0.00	0.20
Natural Gas 4-Cycle Rich Burn Compressors 500+ HP	0.07	0.00	0.06
Natural Gas 4-Cycle Lean Burn Compressors 50 To 499 HP	0.06	0.03	0.13
Natural Gas 4-Cycle Lean Burn Compressors <50 HP	0.03	0.00	0.01
Natural Gas 2-Cycle Lean Burn Compressors 50 To 499 HP	0.02	0.04	0.07
Natural Gas 2-Cycle Lean Burn Compressors 500+ HP	0.02	0.00	0.00
Natural Gas Well Dehydrators	0.01	1.57	0.16
Natural Gas Well Heaters	0.01	0.00	0.01
Natural Gas 4-Cycle Lean Burn Compressors 500+ HP	0.00	0.00	0.02
Natural Gas Production - Compressor Engines	0.00	0.01	0.01
Oil Production - All Processes	0.00	0.01	0.01
Oil Production - Heater Treater	0.00	0.00	0.00
Oil and Gas Production - Hydraulic Fracturing Pumps	0.00	0.00	0.00
Natural Gas Well Pneumatic Devices	0.00	6.68	0.00
Natural Gas Exploration - Well Pneumatic Pumps	0.00	5.27	0.00
Natural Gas Condensate - Storage Tanks	0.00	2.72	0.00
Natural Gas Fugitives – Other	0.00	1.93	0.00
Natural Gas Well Venting	0.00	1.13	0.00
Natural Gas Fugitives – Valves	0.00	1.00	0.00
Oil and Gas Production - Produced Water	0.00	0.87	0.00

Oil and Gas Production Equipment	NO_X (tpd)	VOC (tpd)	CO (tpd)
Crude Oil Storage Tanks	0.00	0.44	0.00
Natural Gas Exploration - Well Completion, All Processes	0.00	0.28	0.00
Natural Gas Fugitives – Flanges	0.00	0.27	0.00
Natural Gas Fugitives – Connectors	0.00	0.26	0.00
Oil Production – Wellhead	0.00	0.23	0.00
Natural Gas Fugitives - Open Ended Lines	0.00	0.20	0.00
Oil Well Pneumatic Devices	0.00	0.18	0.00
Natural Gas Fugitives – Pumps	0.00	0.11	0.00
Natural Gas Condensate - Tank Truck/Railcar Loading	0.00	0.08	0.00
Oil Production Fugitives – Other	0.00	0.06	0.00
Oil Well Completion - All Processes	0.00	0.06	0.00
Oil Exploration - Mud Degassing	0.00	0.05	0.00
Oil Well Pneumatic Pumps	0.00	0.05	0.00
Crude Oil Truck/Railcar Loading	0.00	0.04	0.00
Oil Production Fugitives – Valves	0.00	0.04	0.00
Oil Production Fugitives – Pumps	0.00	0.02	0.00
Oil Production Fugitives – Connectors	0.00	0.02	0.00
Natural Gas Exploration - Mud Degassing	0.00	0.01	0.00
Oil Production Fugitives - Open Ended Lines	0.00	0.00	0.00
Oil Production Fugitives – Flanges	0.00	0.00	0.00
Natural Gas 4-Cycle Rich Burn Compressors 50 To 499 HP	4.49	0.05	1.73
Oil and Gas Production Total	7.15	23.79	5.41

Comparison of the 2006 oil and gas production emission estimates in Table 3-16 with the 2018 projections in Table 3-31 shows that compressor engine emissions are the primary source of NO_X from oil and gas activity in the Barnett Shale, but that the 2018 levels are lower than 2006. This is primarily due to the introduction of TCEQ Chapter 117 rules for compressor engines rated above 50 horsepower, which took effect starting in 2007. Without these rules, the average natural gas compressor engine emission rate would be 6.94 NO_X grams/horsepower-hour (gm/hp-hr). Introduction of this rule lowered this emission rate by roughly 91% to 0.61 NO_X gm/hp-hr.

Some facilities associated with oil and gas production are required to report to the TCEQ as point sources. 2018 emission projections for these facilities are not included within Table 3-31, but are summarized by SIC in Table 3-32: *2018 Point Source Oil and Gas Emissions for 10-County DFW Area*. The emissions in Table 3-32 are part of the total 2018 emissions detailed in Table 3-22.

Table 3-33: 2018 Point Source Oil and Gas Emissions for 10-County DFW Area

Standard Industrial Classification (SIC) Description	SIC Code	NO_X (tpd)	VOC (tpd)	CO (tpd)
Crude Petroleum and Natural Gas	1311	10.74	16.70	8.44
Natural Gas Liquids	1321	4.48	5.01	3.24

Standard Industrial Classification (SIC) Description	SIC Code	NO_X (tpd)	VOC (tpd)	CO (tpd)
Natural Gas Transmission	4922	1.06	2.29	0.79
Petroleum Bulk Stations and Terminals	5171	0.06	1.66	0.15
Mixed, Manufactured, LPG Production	4925	0.02	0.00	0.11
Refined Petroleum Pipelines	4613	0.01	0.37	0.02
DFW Area Total	NA	16.37	26.02	12.75

Figure 3-12: *Barnett Shale Drilling and Natural Gas Production from 1993-2014* summarizes Barnett Shale drilling and production levels from 1993 through the present based on regularly updated information available on the RRC Barnett Shale Information Web page (http://www.rrc.state.tx.us/oil-gas/major-oil-gas-formations/barnett-shale-information/). The blue line in Figure 3-12 is the daily average natural gas production rate from 1993 through April 2014. As shown, Barnett Shale natural gas production has followed a bell-shaped curve with production levels peaking in 2012 when the daily average extraction rate was 5,748 million cubic feet (MMcf) per day. From this 2012 peak, the 2013 daily average was 5,335 MMcf/day (7% lower) and the current 2014 daily average is 4,751 MMcf/day (17% lower).

The black line in Figure 3-12 is the Henry Hub natural gas spot price, which hovered in the $7-9 range during the Barnett Shale drilling boom years of 2005-2008, and then dropped to the $3-4 range where it has remained since. The red line in Figure 3-12 shows how the number of drilling permits issued reached a peak of roughly 4,000 in 2008, declined steeply through 2009 as natural gas prices fell, and since 2012 have been in the range of roughly 1,000 per year, similar to the pre-drilling boom years of 2001-2004. A University of Texas at Austin study entitled *Barnett Study Determines Full-Field Reserves, Production Forecast* (UT-Austin, 2013) (http://www.beg.utexas.edu/info/docs/OGJ_SFSGAS_pt2.pdf) evaluated historical production data per well to determine that the natural gas extraction rate is highest in the first year and then begins to decline exponentially. For an average production span of 25 years per well, roughly 50% of the natural gas is extracted in the first five years, with the remaining 50% extracted within the subsequent twenty years. The decline in natural gas production since 2012 is expected because wells that began producing during the drilling boom years of 2005 through 2008 are now past this five-year mark, and drilling levels from 2009 onwards have not been sufficient to keep production either at or near the 2012 peak. The TCEQ will continue to monitor the monthly updates provided by the RRC to determine if any changes occur in these recent drilling and production trends.

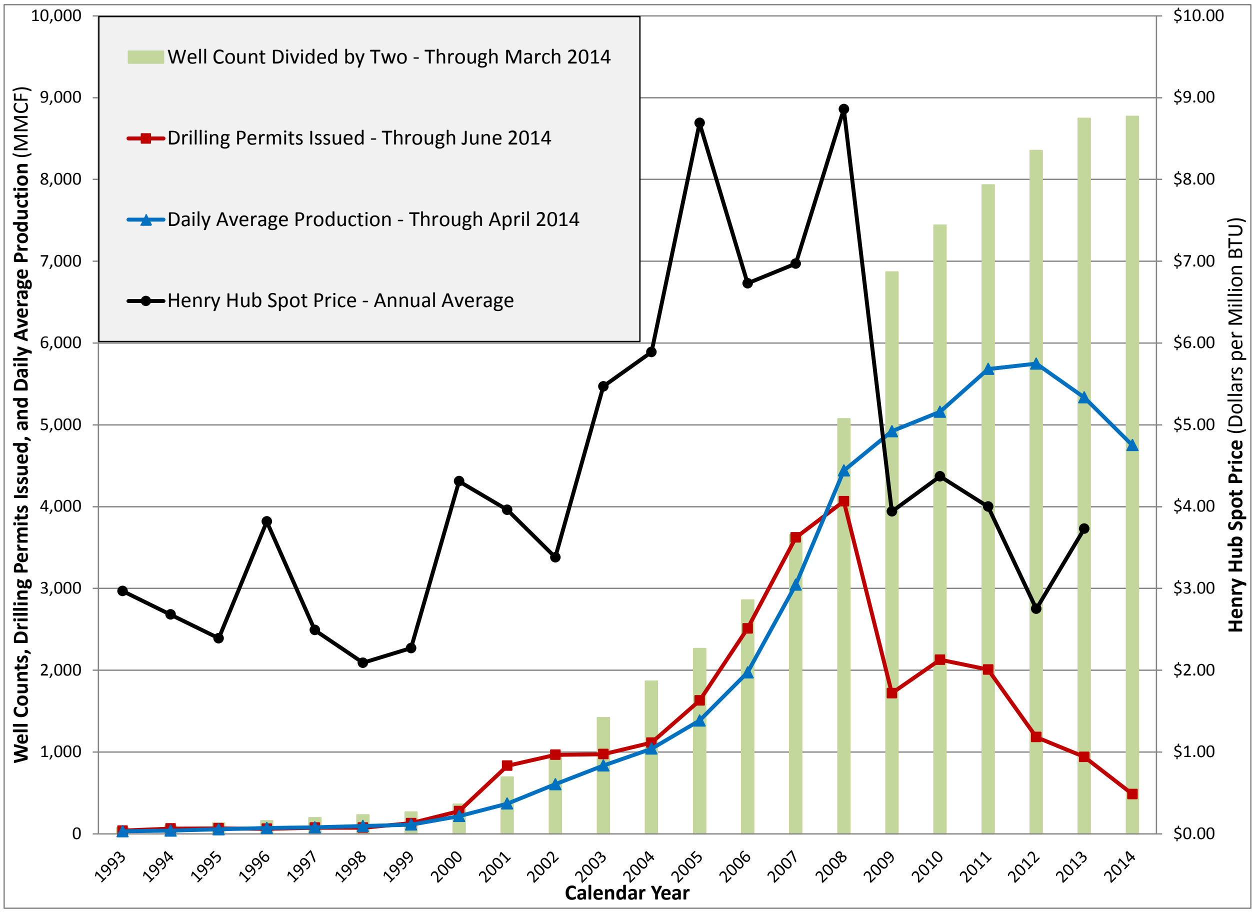


Figure 3-12: Barnett Shale Drilling and Natural Gas Production from 1993-2014

3.5.4.5 Future Base Summary

Table 3-33: *2018 Future Case Anthropogenic Emissions for 10-County DFW* summarizes the typical summer weekday emissions in the 10-county DFW area by source type for the 2018 future case modeling.

Table 3-34: 2018 Future Case Anthropogenic Emissions for 10-County DFW

DFW Area Source Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
On-Road	113.36	55.63	671.77
Non-Road	39.87	32.80	577.61
Area Sources	30.76	284.94	78.09
Off-Road – Locomotives	18.90	0.93	4.10
Off-Road – Airports	13.06	3.55	34.07
Oil and Gas – Production	7.15	23.79	5.41
Oil and Gas – Drill Rigs	2.82	0.21	0.45
Point – Oil and Gas	16.37	26.02	12.75
Point – EGUs (Peak Ozone Season Average)	16.91	4.44	20.61
Point – Cement Kilns	17.64	0.78	11.45
Point – Other	6.62	20.43	17.14

DFW Area Source Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Total	283.46	453.52	1,433.45

3.5.5 2006 and 2018 Modeling Emissions Summary for DFW

Table 3-34: *2006 Baseline and 2018 Future Modeling Emissions for DFW Area* provides side-by-side comparisons of the NO_X and VOC emissions by major source category from Table 3-19 and Table 3-33 for an average summer weekday. The total 10-county DFW area anthropogenic NO_X emissions are projected to be reduced by roughly 50% from 2006 (564.01 tpd) to 2018 (283.46 tpd). The total 10-county DFW area anthropogenic VOC emissions are projected to be reduced by 20% from 2006 (568.95 tpd) to 2018 (453.52 tpd).

Table 3-35: 2006 Baseline and 2018 Future Modeling Emissions for DFW Area

DFW Area Source Type	2006 NO_X (tpd)	2018 NO_X (tpd)	2006 VOC (tpd)	2018 VOC (tpd)
On-Road	265.87	113.36	113.15	55.63
Non-Road	88.75	39.87	63.84	32.80
Area Sources	29.02	30.76	290.46	284.94
Off-Road – Locomotives	29.97	18.90	1.72	0.93
Off-Road – Airports	12.78	13.06	4.46	3.55
Oil and Gas – Production	61.84	7.15	43.72	23.79
Oil and Gas – Drill Rigs	18.23	2.82	1.16	0.21
Point – Oil and Gas	11.53	16.37	21.82	26.02
Point – EGUs (Ozone Season Average)	9.63	16.91	1.03	4.44
Point – Cement Kilns	22.08	17.64	1.94	0.78
Point – Other	14.31	6.62	25.65	20.43
Total	564.01	283.46	568.95	453.52

Figure 3-13: *2006 Baseline and 2018 Future Modeling Emissions for DFW Area* graphically compares the anthropogenic NO_X and VOC emission estimates presented in Table 3-34.

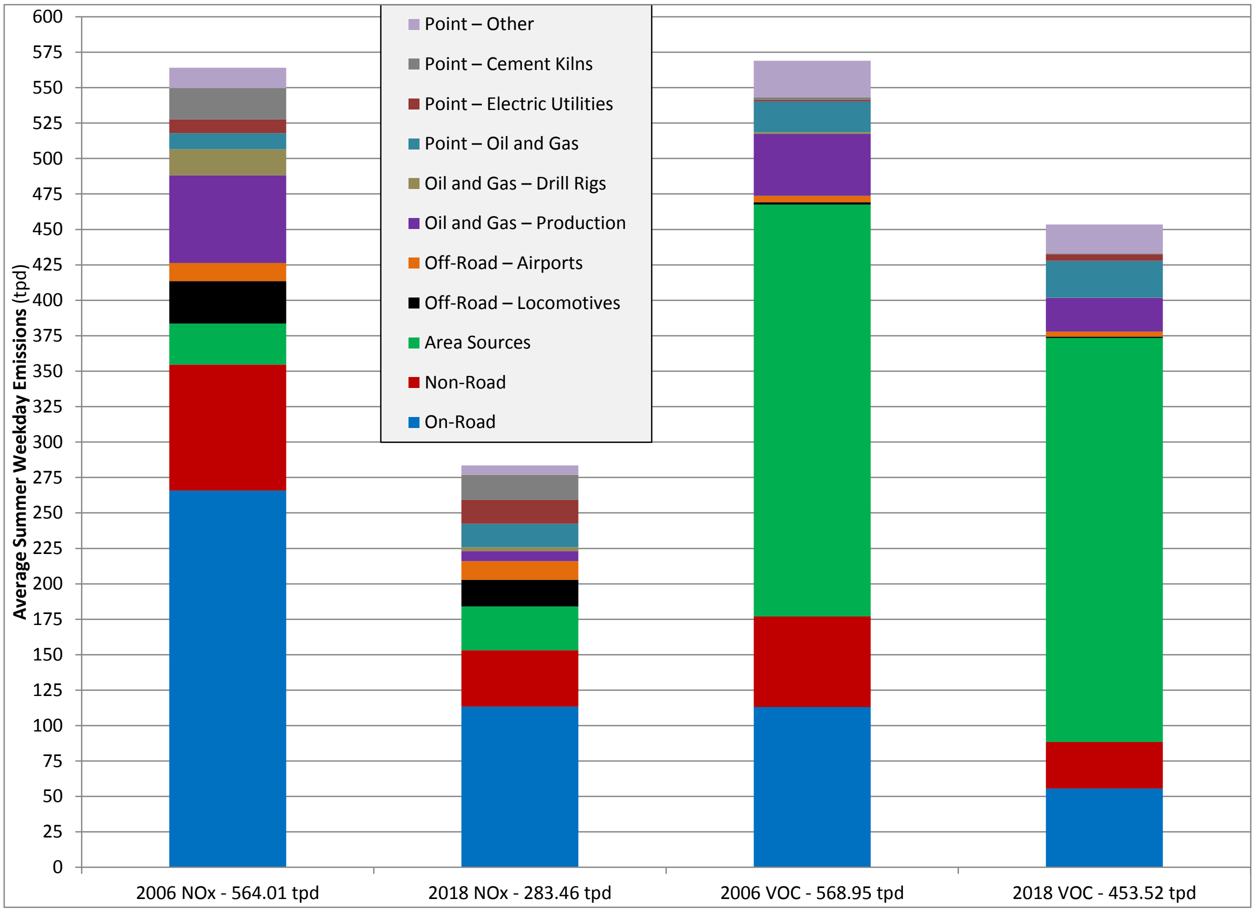


Figure 3-13: 2006 Baseline and 2018 Future Modeling Emissions for DFW Area

3.6 PHOTOCHEMICAL MODELING

To ensure that a modeling study can be successfully used as technical support for an AD SIP revision, the air quality model must be scientifically sound and appropriate for the intended application and freely accessible to all stakeholders. In a regulatory environment, it is crucial that oversight groups (e.g., the EPA), the regulated community, and the public have access to and have reasonable assurance of the suitability of the model. The following three prerequisites were identified for selecting the air quality model to be used in the DFW attainment demonstration. The model must:

- have a reasonably current, peer-reviewed, scientific formulation;
- be available at no or low cost to stakeholders; and
- be consistent with air quality models being used for Texas SIP development.

The only model to meet all three of these criteria is CAMx. The model is based on well-established treatments of advection, diffusion, deposition, and chemistry. Another important feature is that NO_X emissions from large point sources can be treated with the PiG submodel, which helps avoid the artificial diffusion that occurs when large, hot, point source emissions are introduced into a grid volume. The model software, including the PiG submodel, and the CAMx user's guide are publicly available (Environ, 2014). In addition, the TCEQ has many years of experience with CAMx as it was used for the modeling conducted in the HGB ozone nonattainment area, the Beaumont-Port Arthur ozone maintenance area, previous DFW attainment demonstrations, and modeling being conducted in other areas of Texas (e.g., Austin and San Antonio).

3.6.1 Modeling Domains and Horizontal Grid Cell Size

Figure 3-14: *CAMx Modeling Domains* and Table 3-35: *CAMx Modeling Domain Definitions* depict and define the fine resolution 4 km domain covering eastern Texas, a medium resolution 12 km domain covering all of Texas plus some or all of surrounding states, and a coarse resolution 36 km domain covering the continental U.S. plus southern Canada and northern Mexico. The 4 km domain is nested within the 12 km domain, which in turn is nested within the 36 km domain. All three domains were projected in a Lambert Conformal Conic (LCC) projection with the origin at 97 degrees west and 40 degrees north.

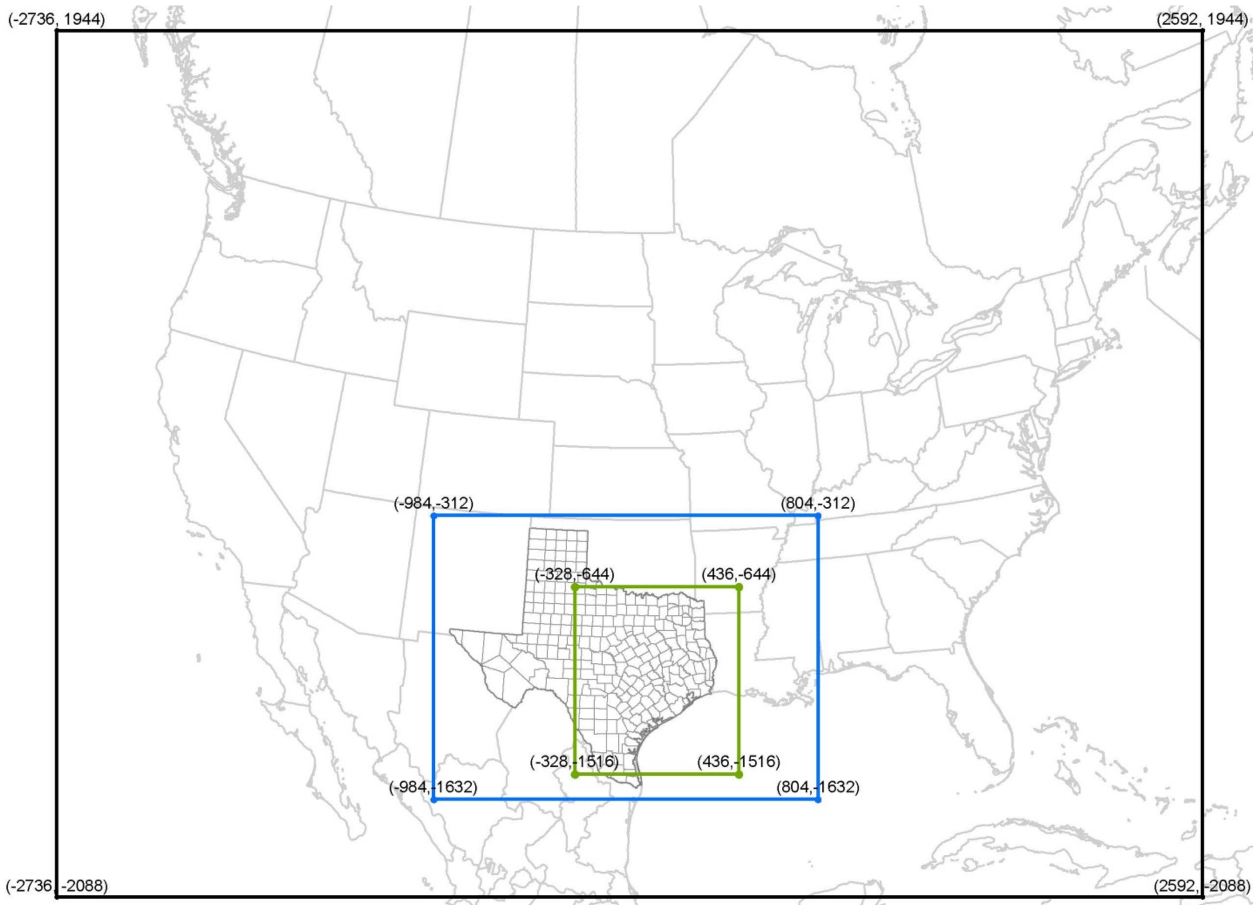


Figure 3-14: CAMx Modeling Domains

Table 3-36: CAMx Modeling Domain Definitions

Domain Code	Domain Cell Size	Dimensions (grid cells)	Lower left-hand corner	Upper right-hand corner
36 km	36 x 36 km	148 x 112	(-2736,-2088)	(2592,1944)
12 km	12 x 12 km	149 x 110	(-984,-1632)	(804,-312)
4 km	4 x 4 km	191 x 218	(-328,-1516)	(436,-644)

3.6.2 Vertical Layer Structure

The vertical configuration of the CAMx modeling domains consists of 28 layers of varying depths in units of meters (m) AGL as shown in Table 3-36: *CAMx Vertical Layer Structure*.

Table 3-37: CAMx Vertical Layer Structure

CAMx Layer	WRF Layer	Top (m AGL)	Center (m AGL)	Thickness (m)
28	38	15,179.1	13,637.9	3,082.5
27	36	12,096.6	10,631.6	2,930.0
26	32	9,166.6	8,063.8	2,205.7
25	29	6,960.9	6,398.4	1,125.0
24	27	5,835.9	5,367.0	937.9
23	25	4,898.0	4,502.2	791.6
22	23	4,106.4	3,739.9	733.0
21	21	3,373.5	3,199.9	347.2
20	20	3,026.3	2,858.3	335.9
19	19	2,690.4	2,528.3	324.3
18	18	2,366.1	2,234.7	262.8
17	17	2,103.3	1,975.2	256.2
16	16	1,847.2	1,722.2	249.9
15	15	1,597.3	1,475.3	243.9
14	14	1,353.4	1,281.6	143.6
13	13	1,209.8	1,139.0	141.6
12	12	1,068.2	998.3	139.7
11	11	928.5	859.5	137.8
10	10	790.6	745.2	90.9
9	9	699.7	654.7	90.1
8	8	609.7	565.0	89.3
7	7	520.3	476.1	88.5
6	6	431.8	387.9	87.8
5	5	344.0	300.5	87.1
4	4	256.9	213.8	86.3
3	3	170.6	127.8	85.6
2	2	85.0	59.4	51.0
1	1	33.9	17.0	33.9

3.6.3 Model Configuration

The TCEQ used CAMx version 6.10, which includes a number of upgrades and features from previous versions. The following CAMx 6.10 options were employed:

- revised gridded file formats for meteorology inputs, initial/boundary conditions, emission inputs, output concentration values, and deposition fields;
- photolysis rate updates based on inputs for surface albedo, height above ground, terrain height, solar zenith, clouds, temperature, and barometric pressure; and

- new gas-phase chemistry mechanisms for Carbon Bond 6 (CB6) speciation and CB6 “revision 2” (CB6r2), which revises isoprene and aromatics extensively, and has additional NO_X recycling from organic nitrates.

In addition to the CAMx inputs developed from the meteorological and emissions modeling, inputs are needed for initial and boundary conditions, spatially resolved surface characteristic parameters, spatially resolved albedo/haze/ozone (i.e., opacity) and photolysis rates, and a chemistry parameters file. The TCEQ contracted with Environ (Environ, 2012) to derive episode-specific boundary conditions from the Goddard Earth Observing Station global atmospheric model with Chemistry (GEOS-Chem) model runs for 2006 and 2018. Boundary conditions were developed for each grid cell along all four edges of the outer 36 km modeling domain at each of the 28 vertical layers for each episode hour. This work also produced initial conditions for each of the 67 days within both episodes. The TCEQ used these episode-specific initial and lateral boundary conditions for this modeling study.

Surface characteristic parameters, including topographic elevation, LAI, vegetative distribution, and water/land boundaries are input to CAMx via a land-use file. The land-use file provides the fractional contribution (0 to 1) of twenty-six land-use categories, as defined by Zhang et al (2003). For the 36 km domain, the TCEQ developed the land-use file using version 3 of the Biogenic Emissions Landuse Database (BELD3) for areas outside the U.S. and the 2006 National Land Cover Dataset (NLCD) for the U.S. For the 4 km and 12 km domains, the TCEQ used updated land-use files developed by Texas A&M University (Popescu et al., 2012), which were derived from more highly resolved data collected by the Texas Parks and Wildlife Department, Landscape Fire and Resource Management Planning Tools Project (LANDFIRE), LandSat, National Institute of Statistics and Geography (INEGI), and the NLCD. Monthly averaged LAI was created from the eight-day 1 km resolution MODIS MCD15A2 product.

Spatially-resolved opacity and photolysis rates are input to CAMx via a photolysis rates file and an opacity file. These rates, which are specific to the chemistry parameters file for the CB6 mechanism, are also input to CAMx. The TCEQ used episode-specific satellite data from the Total Ozone Mapping Spectrometer to prepare the clear-sky photolysis rates and opacity files. Photolysis rates are internally adjusted by CAMx according to cloud and aerosol properties using the inline Troposheric Ultraviolet Visible model.

3.6.4 Model Performance Evaluation

The CAMx model configuration was applied to the 2006 base case using the episode-specific meteorological parameters, biogenic emission inputs, and anthropogenic emission inputs. The CAMx modeling results were compared to the measured ozone and ozone precursor concentrations at all regulatory monitoring sites, which resulted in a number of modeling iterations to implement improvements to the meteorological modeling, emissions modeling, and subsequent CAMx modeling. A detailed performance evaluation for the 2006 base case modeling episode is included in Appendix C. In addition, all performance evaluation products are available on the [TCEQ modeling files](ftp://amdaftp.tceq.texas.gov/pub/TX/) FTP site at ftp://amdaftp.tceq.texas.gov/pub/TX/.

3.6.4.1 Performance Evaluations Overview

The performance evaluation of the base case modeling demonstrates the adequacy of the model to correctly replicate the relationship between meteorological conditions, emissions of NO_X and VOC precursors, and the levels of ozone formed. The model's ability to The model's ability to suitably replicate this relationship is necessary to have confidence in the model's prediction of the future year ozone and the response to various control measures. As recommended in the EPA modeling guidance (EPA, 2007), the TCEQ has incorporated the recommended eight-hour performance measures into its evaluations but also focuses on one-hour performance analyses, especially in the DFW area. The localized small-scale (i.e., high resolution) meteorological and emissions features characteristic of the DFW area require model evaluations to be performed at the highest resolution possible to determine whether or not the model is getting the right answer for the right reasons.

3.6.4.2 Operational Evaluations

Statistical measures including the Unpaired Peak Accuracy (UPA), the Mean Normalized Bias (MNB), and the Mean Normalized Gross Error (MNGE) were calculated by comparing monitored (measured) and four-cell bi-linearly interpolated modeled ozone concentrations for all episode days and monitors. For one-hour ozone comparisons, EPA recommends ranges of ±20% for UPA and ±15% for MNB, and a 30% level for MNGE, which is always positive because it is an absolute value. There are no recommended eight-hour ozone criteria for UPA, MNB, and MNGE. Graphical measures including time series and scatter plots of hourly measured and bi-linearly interpolated modeled ozone were developed. For monitoring locations where specific measurements were available, similar graphical plots were developed for ozone precursors such as NO, NO_2, ethylene, and isoprene. In addition, plots of modeled daily maximum eight-hour ozone concentrations were developed and overlaid with the measured daily maximum eight-hour ozone concentrations. Detailed operational evaluations for the 2006 base case modeling episode are included in Appendix C.

Statistical Evaluations

Figure 3-15: *Observed versus Modeled Peak Eight-Hour Ozone for June Episode* compares the observed and modeled daily maximum eight-hour ozone concentrations for each of the 33 days in the June episode. Although there are no recommended criteria for the eight-hour UPA, error bars of ±20% are shown. In general, ozone concentrations are over-estimated on most days, but the majority of modeled maximum values fall within the ±20% range. Nine of the 33 episode days are out of this ±20% range, but seven of these nine days had monitored peak ozone values between 40-70 ppb, which is well below the 75 ppb exceedance level. Figure 3-16: *Observed versus Modeled Peak Eight-Hour Ozone for August-September Episode* compares the observed and modeled daily maximum eight-hour ozone concentrations for each of the 34 days in the August-September episode. Compared with the June model performance, there is greater over-estimation of peak eight-hour ozone levels in the August-September episode. Twenty-one of the 34 days fall outside of the ±20% range, but 14 of these 21 days had peak eight-hour zone levels below 75 ppb.

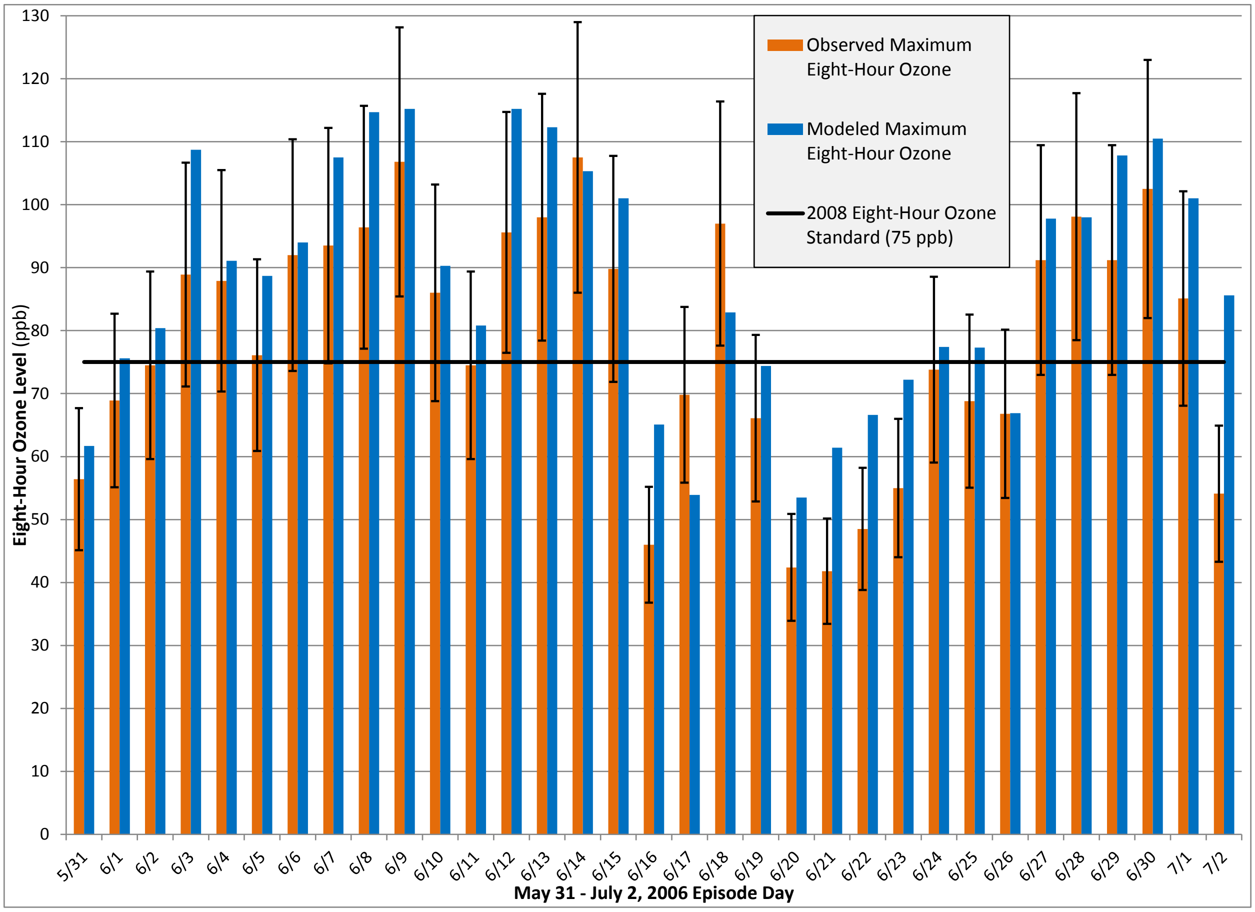


Figure 3-15: Observed versus Modeled Peak Eight-Hour Ozone for June Episode

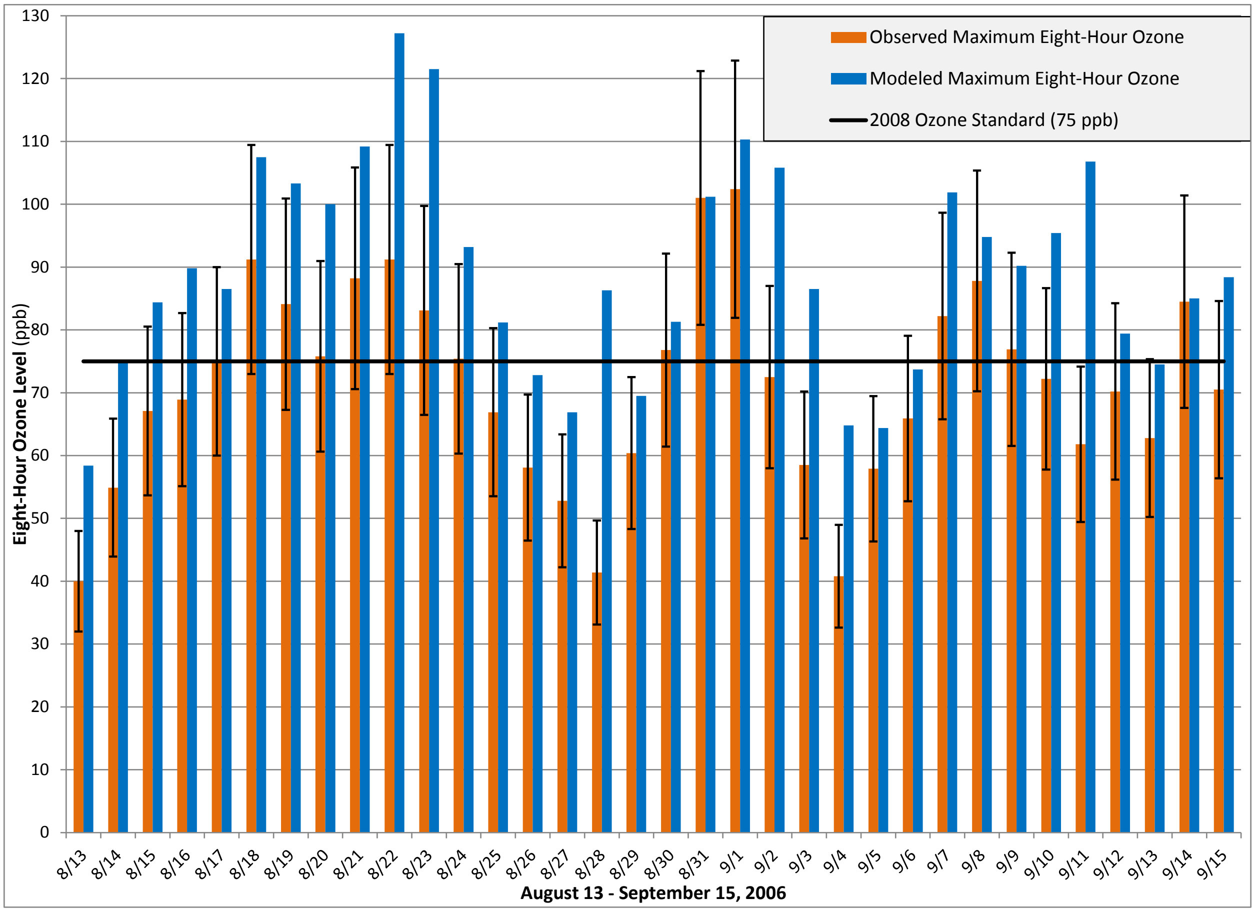


Figure 3-16: Observed versus Modeled Peak Eight-Hour Ozone for August-September Episode

Figure 3-17: *MNB and MNGE Hourly Ozone Statistics for June Episode Days* presents the hourly MNB and MNGE results from May 31 through July 2, 2006. The EPA recommended criteria of ±15% for MNB and 30% for MNGE are shown as the black and red bars, respectively. Three of the 33 days in this episode are out of the recommended MNB range, while two exceed the recommended MNGE level. June 17 is one of the three days exceeding the MNB range, but its peak eight-hour ozone level was below 75 ppb. The remaining two days out of the MNB range are June 18 and July 1. June 18 experienced a slow-moving frontal passage, which was difficult for the meteorological model to replicate. July 1 was a cloudy day, which limited ozone production, but the meteorological model predicted fewer clouds and thus more ozone.

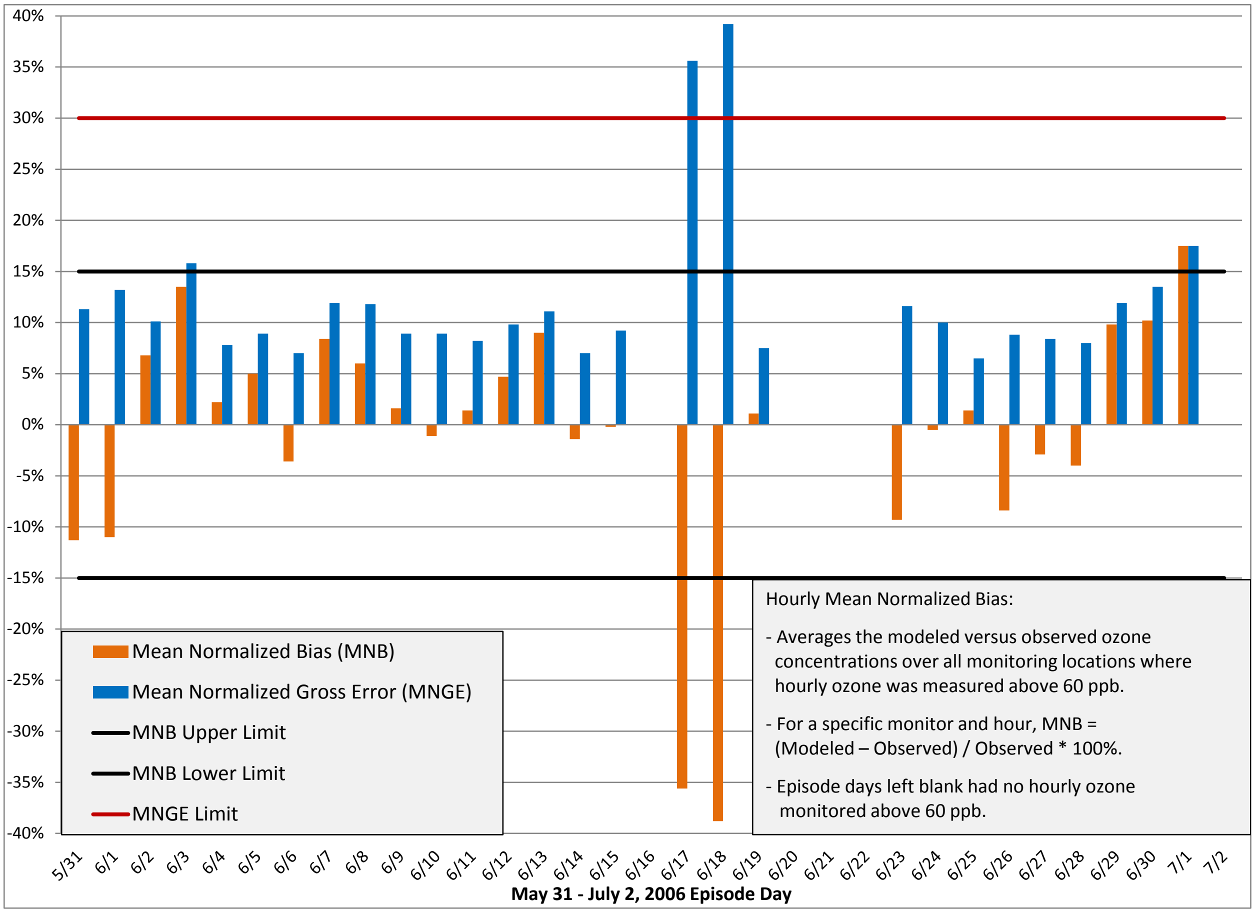


Figure 3-17: MNB and MNGE Hourly Ozone Statistics for June Episode Days

Figure 3-17: *MNB and MNGE Hourly Ozone Statistics for June Episode Days* presents the hourly MNB and MNGE results for August 13 through September 15, 2006. Similar to Figure 3-16, Figure 3-18 demonstrates the consistent over-prediction of modeled ozone during this episode, particularly for days when peak eight-hour ozone was monitored below 75 ppb. Twelve of the 34 episode days are out of the recommended MNB range, while three exceed the recommended MNGE level. Eight of the 12 episode days out of the MNB range are when peak eight-hour ozone was monitored below 75 ppb.

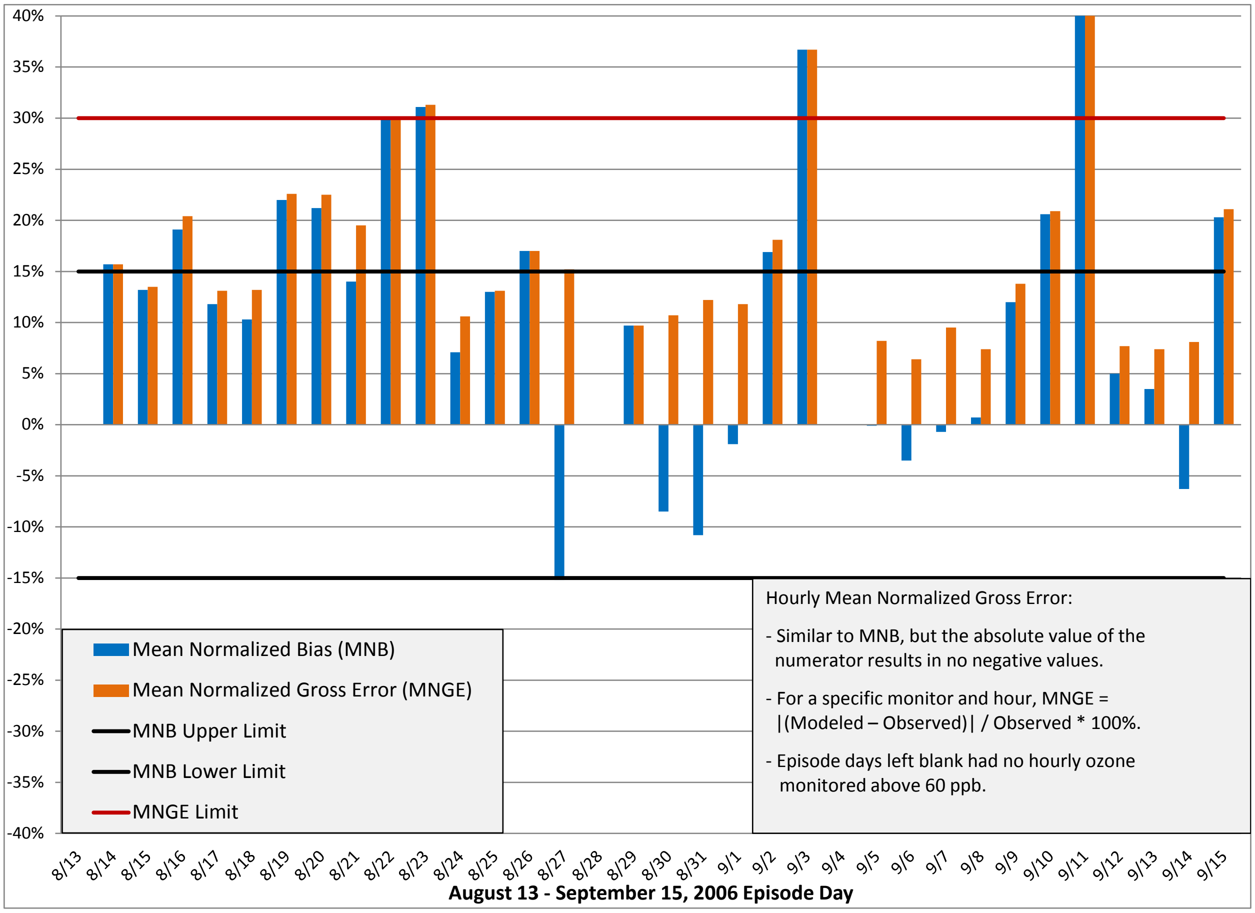


Figure 3-18: MNB and MNGE Hourly Ozone Statistics for August-September Days

In general, the modeling over-predicts monitored ozone for both the June and August-September episodes, but the effect tends to be more pronounced on low ozone days. For the June episode, 15 of the 33 days (45%) had peak eight-hour monitored levels below 75 ppb, while the August-September episode had 19 of 34 days (56%) with peak eight-hour monitored levels below 75 ppb. Compared with the June episode, the August-September episode also had more frontal passages and varying cloud conditions to simulate, both of which are challenging for meteorological modeling.

Combining the 67 days from both episodes, there are 34 days with peak eight-hour ozone levels below 75 ppb and 33 days above. Of these 33 exceedance days from the combined episode, 9 are out of the ±20% UPA range and 6 are out the ±15% MNB range. Those days that exceed the MNGE level of 30% are included within the 6 out of the MNB range. Considering that the majority of eight-hour exceedance days from the combined episodes meet the recommended performance criteria, the model suitably simulates the frequency and magnitude of daily maximum eight-hour ozone concentrations at area monitors.

Graphical Evaluations

A selection of graphical evaluations of modeling results is presented here, but more detail is contained in Appendix C where five representative monitoring locations were chosen for detailed evaluation. Time series and scatterplots are ideal for examining model performance at specific monitoring locations. Time series plots offer the opportunity to follow ozone formation through the course of a day, while scatter plots provide a visual means to see how the model performs across the range of observed ozone and precursor concentrations.

As shown in Figure 3-3, the Kaufman monitor is located in the far southeastern corner of the DFW area. Since it is primarily upwind during most of the ozone season, Kaufman is usually one of the monitors recording the lowest ozone levels in DFW. Figure 3-19: *Kaufman June Episode Time Series and Scatter Plots* presents time series of hourly ozone and NO_X concentrations from May 31 through July 2, 2006. Observed concentrations are shown as red dots and the blue lines are modeled concentrations. In general, the model well replicates the diurnal pattern of higher ozone during the day and decreasing at night. On average the model over-predicts ozone concentrations, particularly when monitored concentrations are quite low, such as the 20-40 ppb range that often occurs during the night and early morning hours. This is also evident in the ozone scatter plot, which shows improved correlation of modeled versus observed ozone at higher levels versus lower ones. Figure 3-20: *Kaufman August-September Episode Time Series and Scatter Plots* presents similar information at the Kaufman monitor for August 13 through September 15, 2006. The same pattern is shown here where the overall diurnal pattern and ozone peaks are relatively well modeled, but that lower levels of ozone during the night and early morning hours are over-predicted.

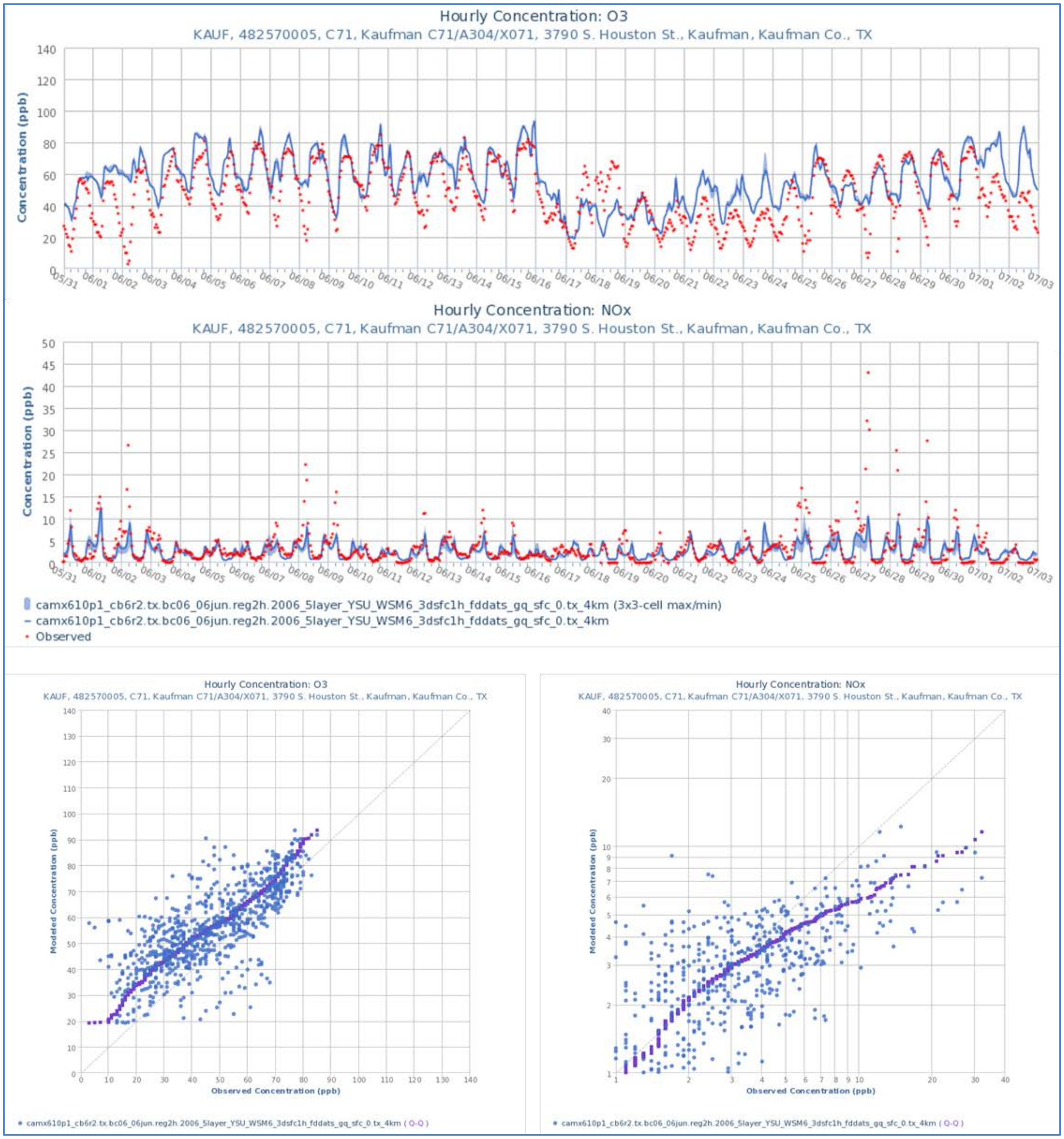


Figure 3-19: Kaufman June Episode Time Series and Scatter Plots

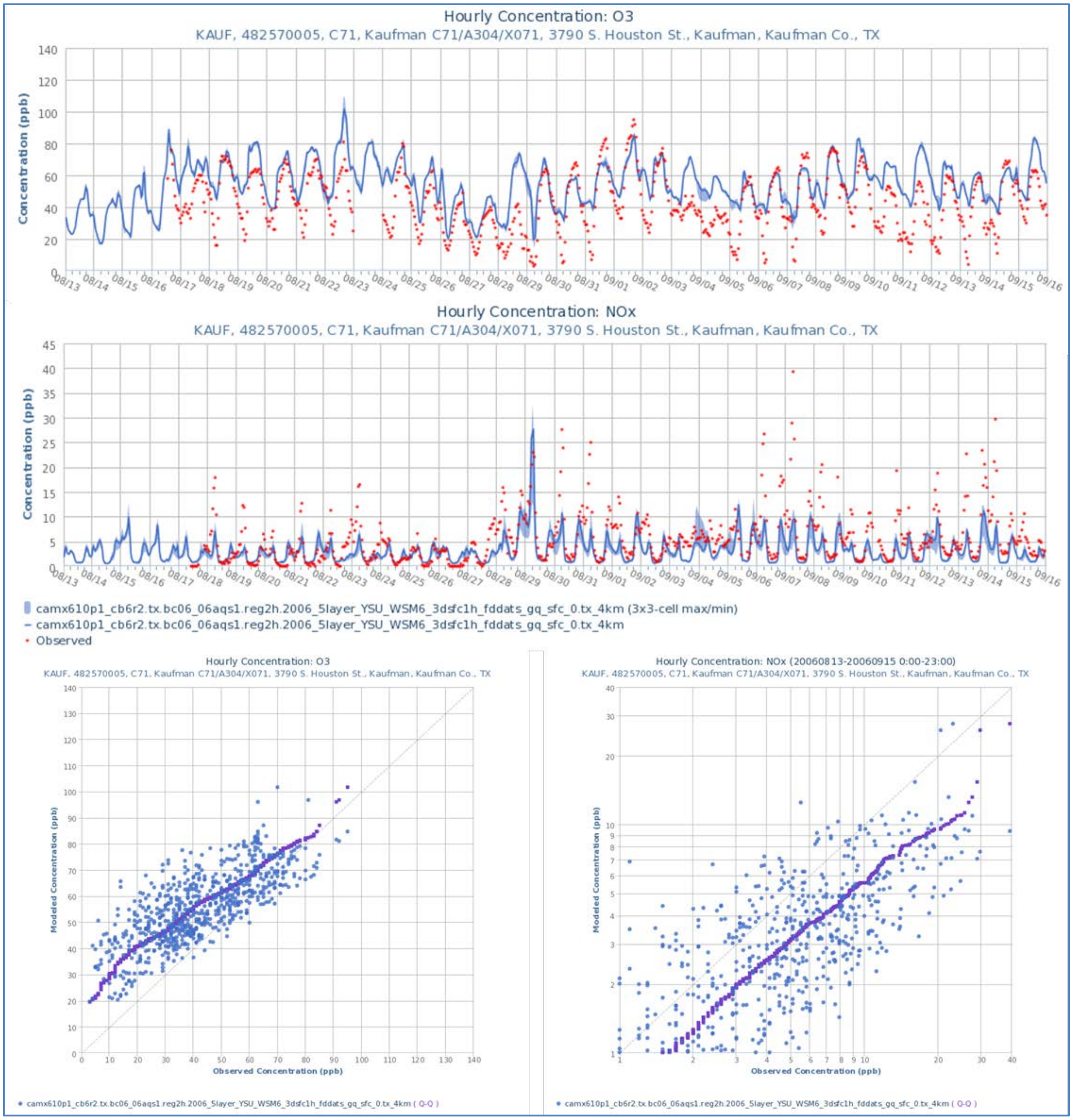


Figure 3-20: Kaufman August-September Episode Time Series and Scatter Plots

As shown in Figure 3-3, the Denton Airport South monitor is located in the far northwestern corner of the DFW area. Since it is primarily downwind of the urban core during most of the ozone season, Denton Airport South is usually one of the monitors recording the highest ozone levels in DFW. Comparisons of hourly modeled versus observed ozone are presented in Figure 3-21: *Denton June Episode Time Series and Scatter Plots* and Figure 3-22: *Denton August-September Episode Time Series and Scatter Plots*. As with the Kaufman performance presented in Figure 3-19 and Figure 3-20, the model does a reasonable job at Denton Airport South of replicating the diurnal peaks during both episodes with some over-prediction apparent, particularly at low ozone levels during the night and early morning hours. The model significantly under-predicted only one monitored eight-hour ozone exceedance on June 18 due to the previously mentioned difficulty that the meteorological model encountered in replicating a slow moving frontal passage.

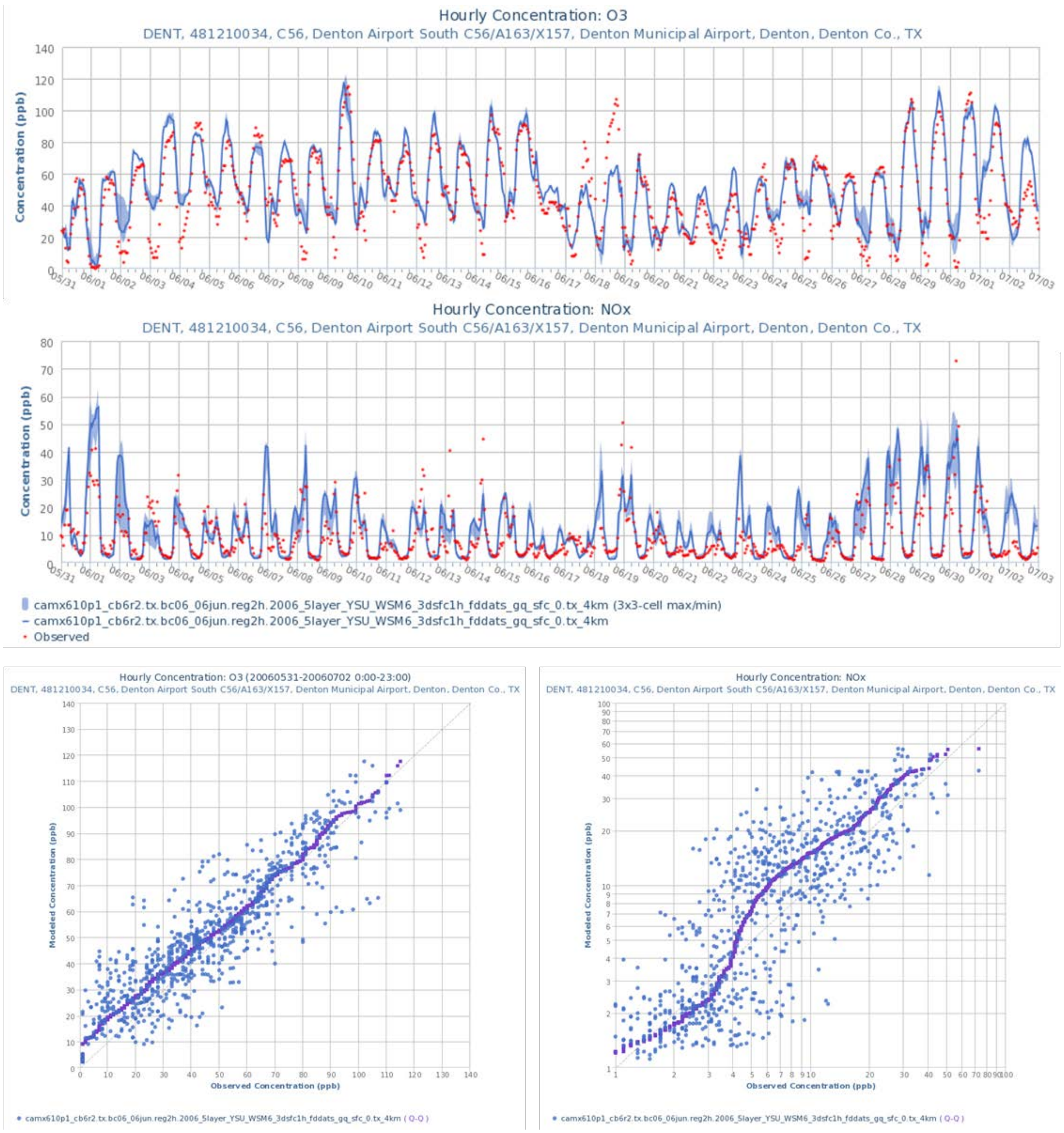


Figure 3-21: Denton June Episode Time Series and Scatter Plots

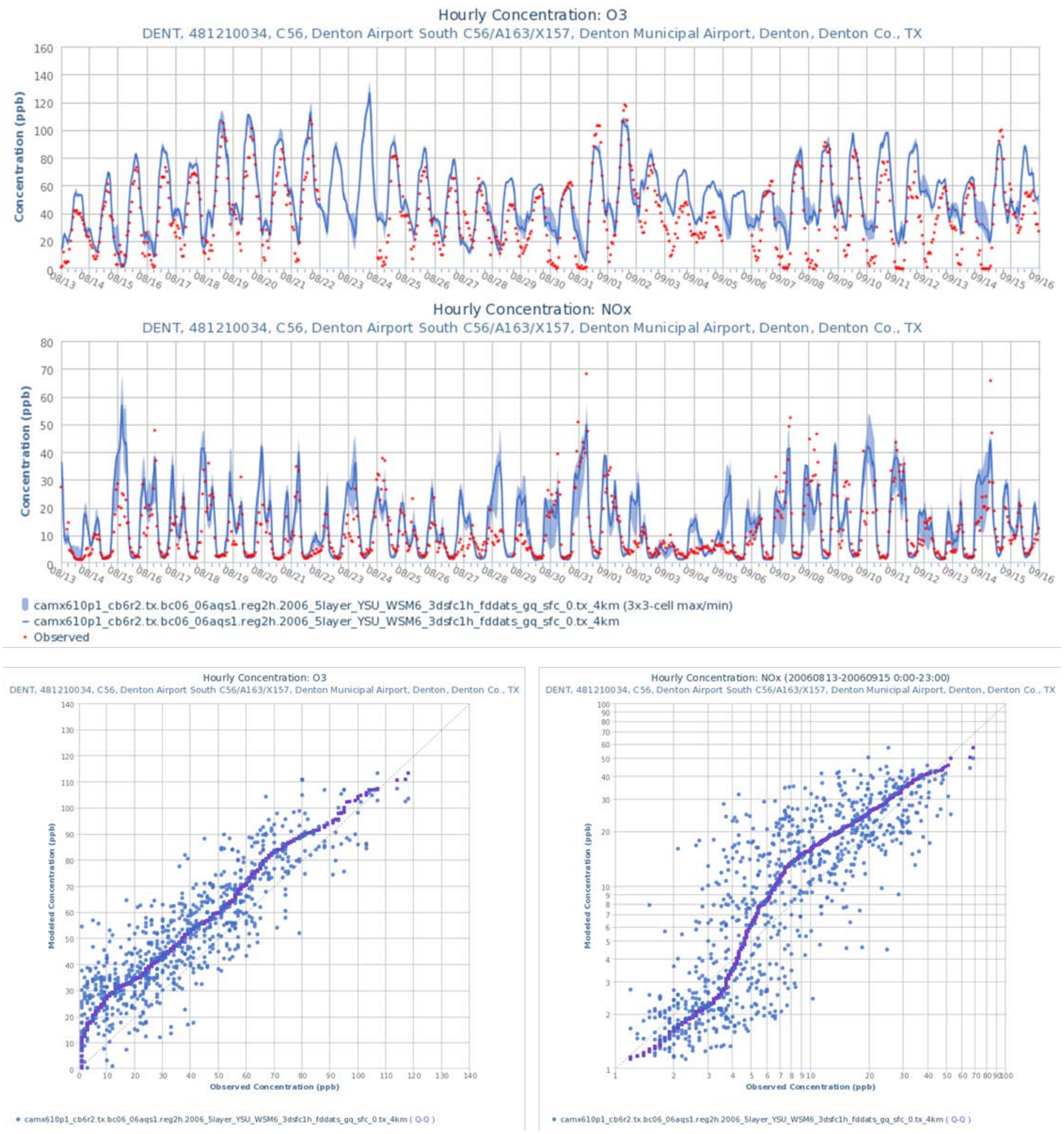
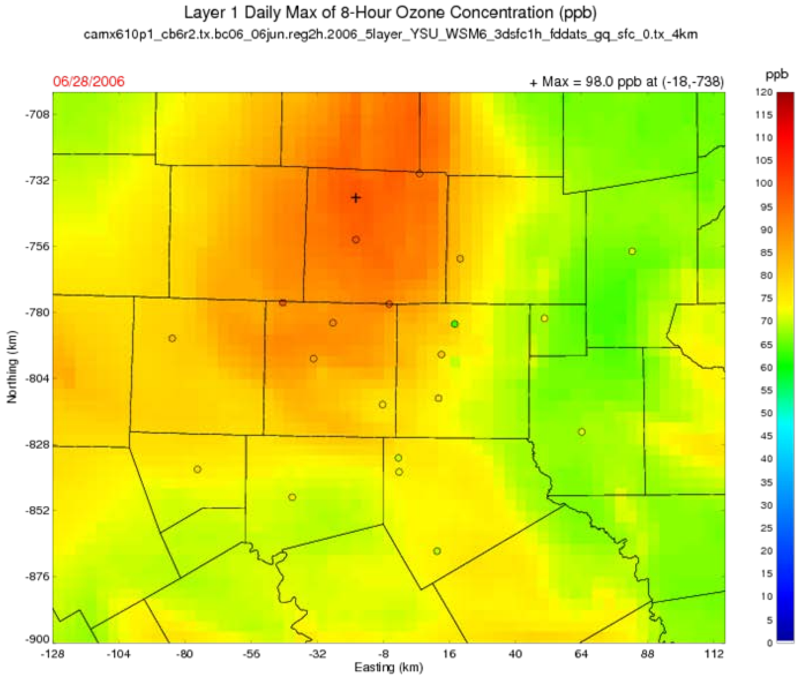


Figure 3-22: Denton August-September Episode Time Series and Scatter Plots

The Kaufman and Denton Airport South monitors were chosen as examples for discussing model performance because they represent the farthest upwind and downwind locations during ozone season, which roughly corresponds to the lowest and highest monitoring locations, respectively. Appendix C provides more detail with time series and scatter plots for the additional monitoring locations of Dallas Hinton Street, Eagle Mountain Lake, and Fort Worth Northwest. Comparison of modeled versus observed concentrations of VOC are presented for the Dallas Hinton Street and Fort Worth Northwest monitors because these locations are equipped with auto-GC instrumentation. In general, estimation of isoprene concentrations is quite good at Dallas Hinton Street, but weaker at Fort Worth Northwest. Conversely, estimation of concentrations for alkanes, ethylene, and olefins is better at Fort Worth Northwest than at Dallas Hinton Street.

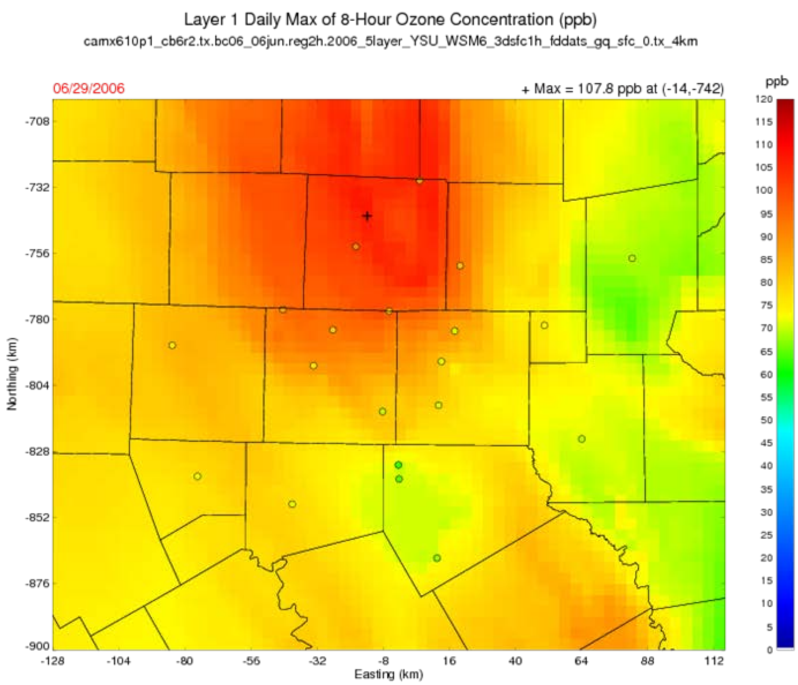
When evaluating model performance, the TCEQ also employs graphical plots showing the daily peak ozone across the modeling domain. This plot is akin to the contour plots often used to display terrain elevations, and is a good tool for visually comparing the modeled peak ozone across the domain with observations. The plots are not snapshots in time, but instead show the maximum eight-hour ozone value for each grid cell regardless of when it occurred during the day. Areas downwind of the urban core will generally have ozone peaks that occur later in the day than upwind areas.

Appendix C contains these graphical plots for each episode day where observed maximum daily average eight-hour ozone was above 75 ppb. These days are June 3 through 10, June 12 through 14, June 18, June 27 through July 1, August 17 through 24, August 30through September 1, September 7 through 9, and September 14. Example plots for four of these episode days are presented here in Figure 3-23: *Modeled versus Observed Maximum Ozone on June 28 and 29* and Figure 3-24: *Modeled versus Observed Maximum Ozone on August 30 and 31.* Observed maximum daily average eight-hour ozone concentrations are represented by small circles at the monitor locations. When the color of the dot matches closely the surrounding colors, the model is predicting the observed maximum values well. In general, the model performed very well during the June 2006 episode with a few days exhibiting weaker performance. The August-September 2006 episode is characterized by more over-prediction, particularly in August and early September. However, a few days in this latter episode do show good performance. In both episodes, the model locates the plumes of highest ozone concentration very well with a few exceptions.



June 28, 2006

MDA8 Ozone
Obs: 98.1 ppb (EMTL)
Mod: 98.0 ppb



June 29, 2006

MDA8 Ozone
Obs: 91.2 ppb (DENT)
Mod: 107.8 ppb

Figure 3-23: Modeled versus Observed Maximum Ozone on June 28 and 29

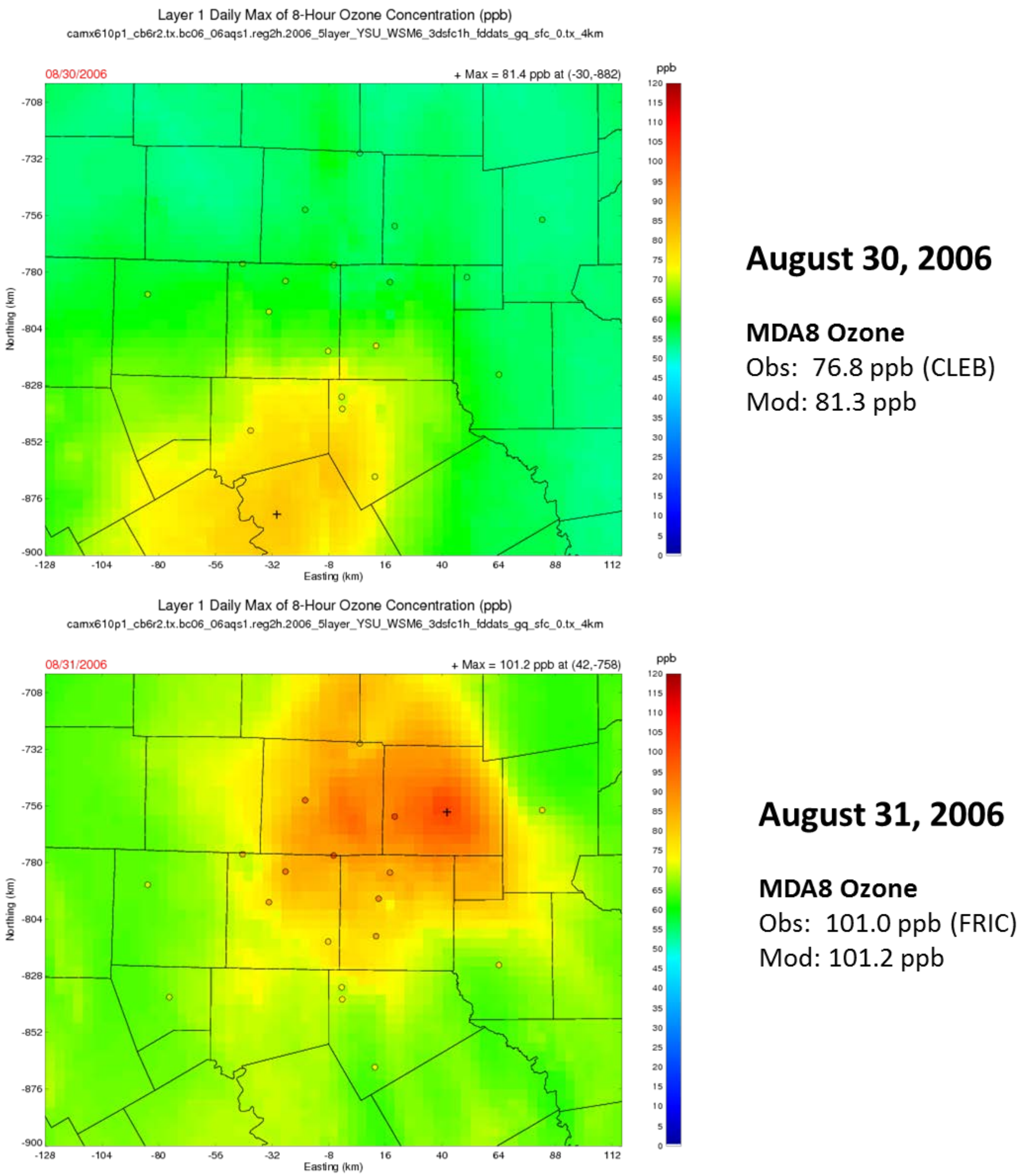


Figure 3-24: Modeled versus Observed Maximum Ozone on August 30 and 31

Evaluations Based on TexAQS II Rural Monitoring Network Data

The TCEQ also evaluated how well the model predicted ozone and precursor concentrations at rural sites located upwind of the DFW area during the episodes. A brief discussion is presented here, but more detail and references are provided in Appendix C. Figure 3-25: *Rural Monitoring Sites Used for Performance Evaluation* shows the locations of these sites as red dots. They are Italy High School (ITHS, C60) about 30 miles south of Dallas, Palestine (PLTN, C647) about 80 miles southeast of Dallas, Clarksville (CLVL, C648) about 100 miles northeast of Dallas, and San Augustine (SAGA, C646) about 160 miles from Dallas near the Louisiana border.

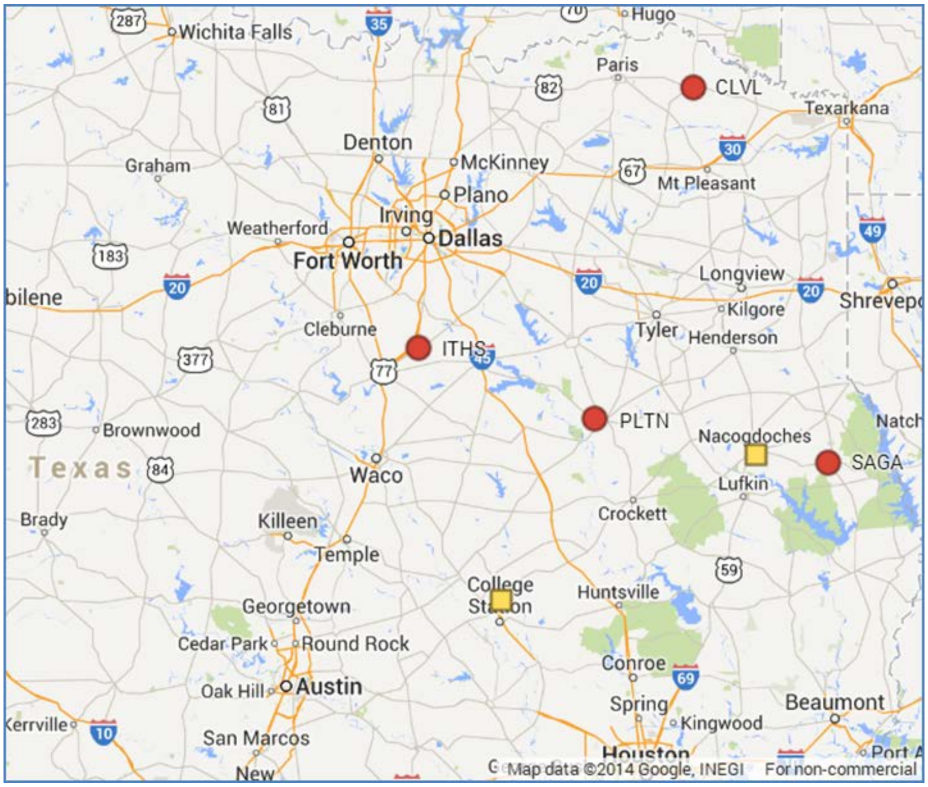


Figure 3-25: Rural Monitoring Sites Used for Performance Evaluation

In general, peak ozone during the June episode was well predicted at Italy High School and Clarksville, with moderate over-prediction at Palestine and San Augustine. During the August-September episode, Italy High School model performance was good, with over-prediction at the remaining three monitors, although the model predicted the peaks on some days quite well. Similar to the ozone monitors within or near the urban core, the model generally over-predicted overnight and early morning ozone concentrations during both episodes.

The yellow squares in Figure 3-25 show locations near College Station and Nacogdoches where instrumented balloons to measure ozone (ozonesondes) were launched during the June 2006 episode as part of the Tropospheric Ozone Pollution Project, which was conducted as part of the TexAQS II study (Morris, 2006). The ozonesonde data provided a unique and valuable means for assessing the model's performance. Besides simply allowing modeled concentrations to be compared with measurements aloft, the detailed profiles provided insight into how well the model characterizes vertical mixing compared to the real atmosphere. The most striking difference between observed and modeled vertical ozone profiles is the wide variability in ozone concentrations with altitude observed on most days. The model tends to vary much more slowly, which is not unexpected since it tends to organize wind flow and vertical motion, and also because the model's vertical resolution becomes coarser with increasing elevation.

Another aspect of the TexAQS II study included aircraft measurements of ozone and precursors within the DFW area on September 13, 2006 (Gulf of Mexico Atmospheric Composition and Climate Study, National Oceanic & Atmospheric Administration [NOAA], 2006). The instrumented aircraft flew at an elevation of around 500 meters from 1:30-4:00 PM on this day. Analysis of the aircraft measurements indicates that the model predicted the observed ozone quite well except for a small over-prediction as the aircraft passed through the urban plume downwind of the DFW metropolitan area. The modeled winds are more southerly than the observations, and showed little variability through the sampling period. Appendix C contains more detail than presented here on the evaluation of rural monitors, ozonesonde data, and aircraft flight measurements.

3.6.4.3 Diagnostic Evaluations

While most model performance evaluation (MPE) focuses on how well the model reproduces observations in the base case, a second and perhaps more important aspect of model performance is how well the model predicts changes as a result of modifications to its inputs (Smith, 2010). The former type of MPE is static in the sense that it is based on a fixed set of observations that never change, while evaluating the model's response to perturbations in its inputs is dynamic in the sense that the change in the model's output is evaluated. Dynamic MPE is performed much less often than static MPE, simply because there is often little observational data available that can be directly related to quantifiable changes in model inputs. Since the attainment demonstration is based on modeling the future by changing the model's inputs due to growth and controls, it is beneficial to pursue dynamic MPE. The EPA's modeling guidance recommends assessing the model's response to emission changes. Two such dynamic MPEs are described below: prospective modeling analysis and weekday/weekend analysis.

Prospective Modeling – Revised 2012 Future Case Analysis

The purpose of this diagnostic analysis is to test the model in a forecast mode where the answer is known in advance. For the DFW AD SIP revision in December 2011, a retrospective analysis was performed where 1999 ozone concentrations were estimated with 1999 anthropogenic emission inputs run with the June 2006 base case meteorological and biogenic inputs. These 1999 anthropogenic emission inputs were already available from the DFW AD SIP revision adopted in May 2007. These 1999 anthropogenic inputs cannot be used with the current 2006 modeling configuration because of incompatibility with the new modeling domains described in Table 3-35.

The TCEQ has started developing a 2012 base case episode on the newer domains shown in Figure 3-14, but has not yet obtained satisfactory model performance with it. However, the latest available 2012 anthropogenic emission inputs from these efforts were available to perform a prospective future case analysis with the 2006 base case meteorology and biogenic inputs. Ozone season emission inputs for the 2012 future year were needed for the DFW AD SIP revision adopted in December 2011. At the time that work was performed, the latest available scientific tools and inputs were used for modeling attainment in the 2012 future year. Table 3-37: *Summary of Ozone Modeling Platform Changes* summarizes these older tools and inputs, and compares them to the latest ones currently being used.

Table 3-38: Summary of Ozone Modeling Platform Changes

Modeling Platform Category	December 2011 AD SIP Revision	Proposed 2015 AD SIP Revision
4 km Fine Grid Modeling Domain	DFW area and adjacent counties	All of eastern Texas plus some non-Texas counties
12 km Medium Grid Modeling Domain	Eastern Texas plus some adjacent states	All of Texas plus some adjacent states
36 km Coarse Grid Modeling Domain	Eastern half of continental U.S.	All of continental U.S. plus southern Canada and northern Mexico

Modeling Platform Category	December 2011 AD SIP Revision	Proposed 2015 AD SIP Revision
Meteorological Model	MM5 3.7.3	WRF 3.2
CAMx Version	CAMx 5.20.1	CAMx 6.10
Chemical Mechanism	Carbon Bond 05 (CB05)	Carbon Bond 6 (CB6)
Boundary Conditions	Model for Ozone and Related Chemical Tracers (MOZART) Model	GEOS-Chem Model
Biogenics Model	GloBEIS	MEGAN 2.10

A prospective 2012 future case analysis was run with the June 2006 episode, but relied on all of the newer tools and inputs referenced in the far right column of Table 3-37. Table 3-38: *2012 Future Case with June 2006 Episode on Old and New Platforms* summarizes these results. For reference purposes, the 2012 future design value (DV_F) results from the December 2011 AD SIP are included and truncated in accordance with EPA modeling guidance. In Table 3-38, comparing the older 2012 DV_F figures (second column) with the DV_F figures from the new modeling platform (third column) indicates that the current projected eight-hour ozone design values are 4-8 ppb higher with the results varying by individual monitor. These results can only be presented for monitors that were operational during 2006. The 2012 DV_B and DV_R values cannot be provided for the Midlothian Tower monitor, which is no longer operational.

Table 3-38 also includes the 2012 regulatory design value (DV_R) (fourth column) and 2012 baseline design value (DV_B) (last column) for each monitor. The 2012 DV_R obtained by truncating the average of the fourth-highest eight-hour observation for each year over the full three years of 2010, 2011, and 2012. The DV_R is used to determine if the area is either in nonattainment or has reached attainment of the NAAQS. As was shown in Figure 3-1, a DV_B is an average of three years of DV_R values. For 2012, this would mean that the 2012 DV_R, 2013 DV_R, and 2014 DV_R would be averaged. Since the 2014 DV_R for each monitor is not yet known, the 2012 DV_B values presented in Table 3-38 are based only on the 2012 DV_R and 2013 DV_R. The attainment test of multiplying an RRF by a DV_B essentially predicts a future year DV_B, even though the DV_R in the future year is the final metric for determining attainment of the NAAQS.

Table 3-39: 2012 Future Case with June 2006 Episode on Old and New Platforms

2006 DFW Area Monitor and CAMS Code	2011 AD DV_F for 2012 (ppb)	Current DV_F for 2012 (ppb)	2012 DV_R (ppb)	2012 DV_B (ppb)
Denton Airport South - C56	77	84	83	84.63
Eagle Mountain Lake - C75	78	82	82	81.88
Grapevine Fairway - C70	76	82	86	86.13
Keller - C17	76	81	87	84.50
Fort Worth Northwest - C13	75	80	79	80.38
Frisco - C31	74	79	83	83.00
Dallas North #2 - C63	71	77	81	82.38

2006 DFW Area Monitor and CAMS Code	2011 AD DV_F for 2012 (ppb)	Current DV_F for 2012 (ppb)	2012 DV_R (ppb)	2012 DV_B (ppb)
Parker County - C76	72	78	78	77.75
Dallas Executive Airport - C402	70	77	81	80.63
Cleburne Airport - C77	70	76	79	79.50
Arlington Municipal Airport - C61	70	75	83	81.38
Dallas Hinton Street - C401	67	74	82	83.25
Granbury - C73	69	74	77	77.38
Midlothian Tower - C94	66	73	Not Operating	Not Operating
Pilot Point - C1032	67	73	82	82.75
Rockwall Heath - C69	63	70	77	77.38
Midlothian OFW - C52	62	68	76	77.00
Greenville - C1006	59	67	72	72.88
Kaufman - C71	60	67	70	72.63

Note: DV_F and DV_R figures are typically truncated, while DV_B figures are reported to two decimal places.

Table 3-39: *2012 Future Case with 67-Day Episode on Old and New Platforms* presents similar information as Table 3-38, but for the entire 67-day episode from both June 2006 and August-September 2006. Similar to the results shown in Table 3-38, the 2012 DV_F figures for the current modeling platform are 4-8 ppb higher than the older one with results varying by monitor. The results in both Table 3-38 and Table 3-39 demonstrate that the current modeling platform with a 2006 base case does a satisfactory job of forecasting ozone design values with anthropogenic emission inputs for alternate years. More detail on this analysis is included in Appendix C.

Table 3-40: 2012 Future Case with 67-Day Episode on Old and New Platforms

2006 DFW Area Monitor and CAMS Code	2011 AD DV_F for 2012 (ppb)	Current DV_F for 2012 (ppb)	2012 DV_R (ppb)	2012 DV_B (ppb)
Denton Airport South - C56	77	83	83	84.63
Eagle Mountain Lake - C75	78	82	82	81.88
Grapevine Fairway - C70	76	81	86	86.13
Keller - C17	76	81	87	84.50
Fort Worth Northwest - C13	75	79	79	80.38
Frisco - C31	74	79	83	83.00
Dallas North #2 - C63	71	77	81	82.38
Parker County - C76	72	77	78	77.75
Dallas Executive Airport - C402	70	76	81	80.63
Cleburne Airport - C77	70	75	79	79.50
Arlington Municipal Airport - C61	70	74	83	81.38
Dallas Hinton Street - C401	67	73	82	83.25

2006 DFW Area Monitor and CAMS Code	2011 AD DV_F for 2012 (ppb)	Current DV_F for 2012 (ppb)	2012 DV_R (ppb)	2012 DV_B (ppb)
Granbury - C73	69	73	77	77.38
Midlothian Tower - C94	66	72	Not Operating	Not Operating
Pilot Point - C1032	67	72	82	82.75
Rockwall Heath - C69	63	70	77	77.38
Midlothian OFW - C52	62	67	76	77.00
Greenville - C1006	59	67	72	72.88
Kaufman - C71	60	66	70	72.63

Note: DV_F and DV_R figures are typically truncated, while DV_B figures are reported to two decimal places.

Observational Modeling – Weekday/Weekend

Weekend emissions of NO_X and VOC in urban areas tend to be lower than weekday emissions because of fewer vehicle miles driven. The effect is most pronounced on weekend mornings, especially Sundays, since there is significantly reduced commuting for work purposes. Figure 3-26: *2006 DFW Area 6 AM Anthropogenic Emissions by Day of Week* shows a comparison of modeled 6 AM NO_X and VOC emissions for Wednesdays, Saturdays, and Sundays. The on-road mobile sources are the largest contributor to differences in emissions for weekdays and weekends. 6 AM was chosen because a more stable comparison of emission estimates and monitored concentrations can be made prior to the commencement of photochemical processes in the presence of sunlight.

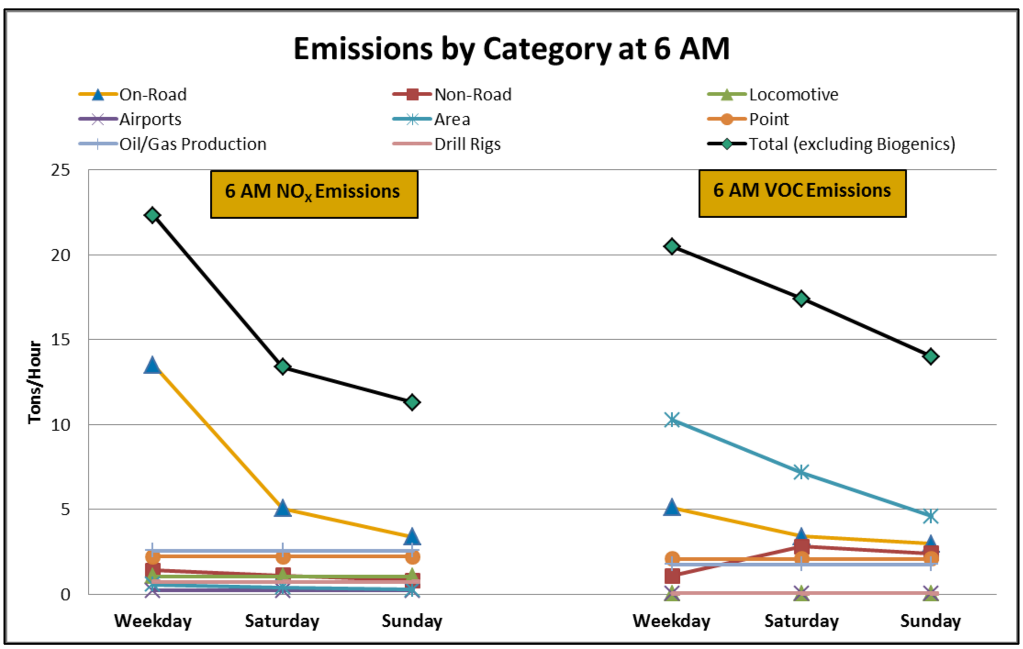


Figure 3-26: 2006 DFW Area 6 AM Anthropogenic Emissions by Day of Week

Early morning emissions tend to be especially important in determining peak eight-hour ozone levels (MacDonald, 2010), so the weekday/weekend differences should manifest themselves noticeably in the relative levels of weekday and weekend ozone concentrations. Since there are relatively few Saturdays, Sundays, and Wednesdays (chosen to represent typical weekdays) in the episode, the TCEQ employed a novel approach by applying Saturday, Sunday, and Wednesday emissions inputs to the meteorological inputs for each day of the episode, which resulted in a total of 67 episode days modeled for the 2006 baseline with anthropogenic emission estimates for each of these three day types. This approach is possible since meteorology is independent of the day of week. By replacing the emissions of any episode day with those for just a Wednesday, just a Saturday, and just a Sunday, a representation of the day of week effects can be obtained.

For comparison with the modeled emissions from each of these 67-day scenarios by inventory day type, median monitored 6:00 AM NO_X concentrations were calculated for every Wednesday, Saturday, and Sunday from May 15 through October 15 for the years 2004 through 2008. Within each year, a total of 79 to 133 observations were observed for this timeframe at 11 NO_X monitoring sites in DFW. Figure 3-27: *Mean 6 AM NO_X Concentrations by Monitor Relative to Wednesday* presents these results and compares them to the change in modeled concentrations from the Wednesday, Saturday, and Sunday day type modeling scenarios. All sites show observed NO_X concentrations declining from Wednesday to Saturday, and then from Saturday to Sunday. The modeled values show greater variability than their observed counterparts, with all sites having modeled decreases between 37% and 67% from Wednesday to Sunday. The observed decreases at all sites were in the range of 40% and 70%.

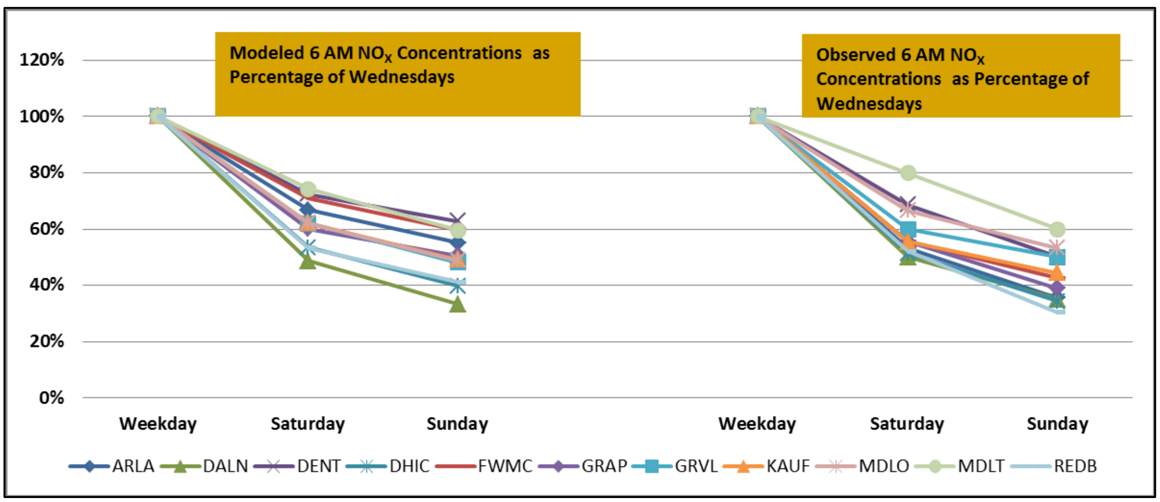


Figure 3-27: Mean 6 AM NO_X Concentrations by Monitor Relative to Wednesday

Figure 3-28: *Observed and Modeled 95th Percentile Peak Ozone by Day Type* compares the median observed concentrations for high ozone days with the modeled concentrations by day of week for 19 DFW area monitors. The observed 95th percentile concentrations range between a 1% increase to a 10% decrease on Saturday compared with Wednesday, while all sites showed a Sunday decrease between 6% and 16% compared with Wednesday. The modeled values consistently decreased between 2% and 6% on Saturday compared with Wednesday, and between 2% and 11% on Sunday compared with Wednesday. The model is satisfactorily replicating the observed weekday-weekend NO_X and ozone differences, especially for the higher ozone days. More detail on this analysis is included in Appendix C.

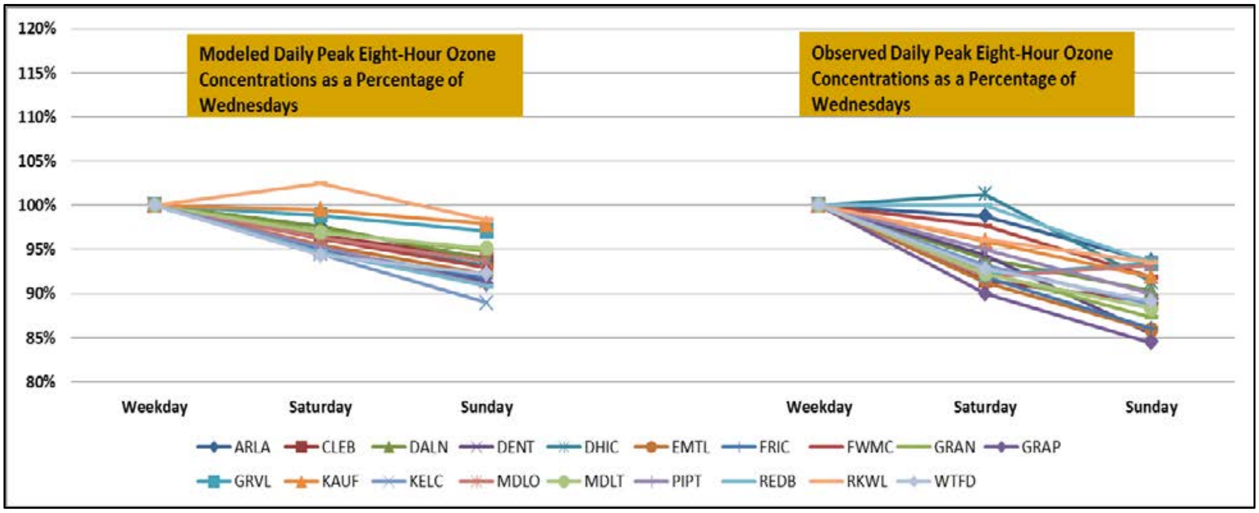


Figure 3-28: Observed and Modeled 95th Percentile Peak Ozone by Day Type

3.7 2006 BASELINE AND 2012 FUTURE CASE MODELING

3.7.1 2006 Baseline Modeling

The TCEQ selected 2006 as the baseline year for conducting the attainment modeling. The 2006 baseline emissions discussed in Section 3.5.3 were used as model inputs. All 2006 baseline episode days with modeled eight-hour maximum concentrations above 75 ppb were used for the modeled attainment test. Since there were more than 10 days for each monitor modeled above 75 ppb in the 2006 baseline, there was no need to fall back on a lower threshold, such as the 70 ppb level suggested in the EPA's modeling guidance (EPA, 2007). Figure 3-29: *Location of DFW Ozone Monitors with 4 km Grid Cell Array* shows the proximity of each monitor to adjacent ones within the 4 km fine grid domain. EPA's default recommendation for a 4 km domain is to use an array of seven-by-seven cells for application of the attainment test. This process is suitable for areas where ozone monitors are separated by several kilometers, but would lead to a significant blending of the results among monitors in the more dense DFW area network. The maximum concentrations from an array of three-by-three grid cells surrounding each monitor was chosen for the DFW area attainment test so that better resolution could be obtained in the results for individual monitors.

For each DFW area ozone monitor operational in 2006, Table 3-40: *2006 Baseline Design Value Summary for the Attainment Test* details the DV_B, the modeled average of episode days above 75 ppb, and the total number of days from the 67-day episode when eight-hour ozone concentrations were modeled above 75 ppb.

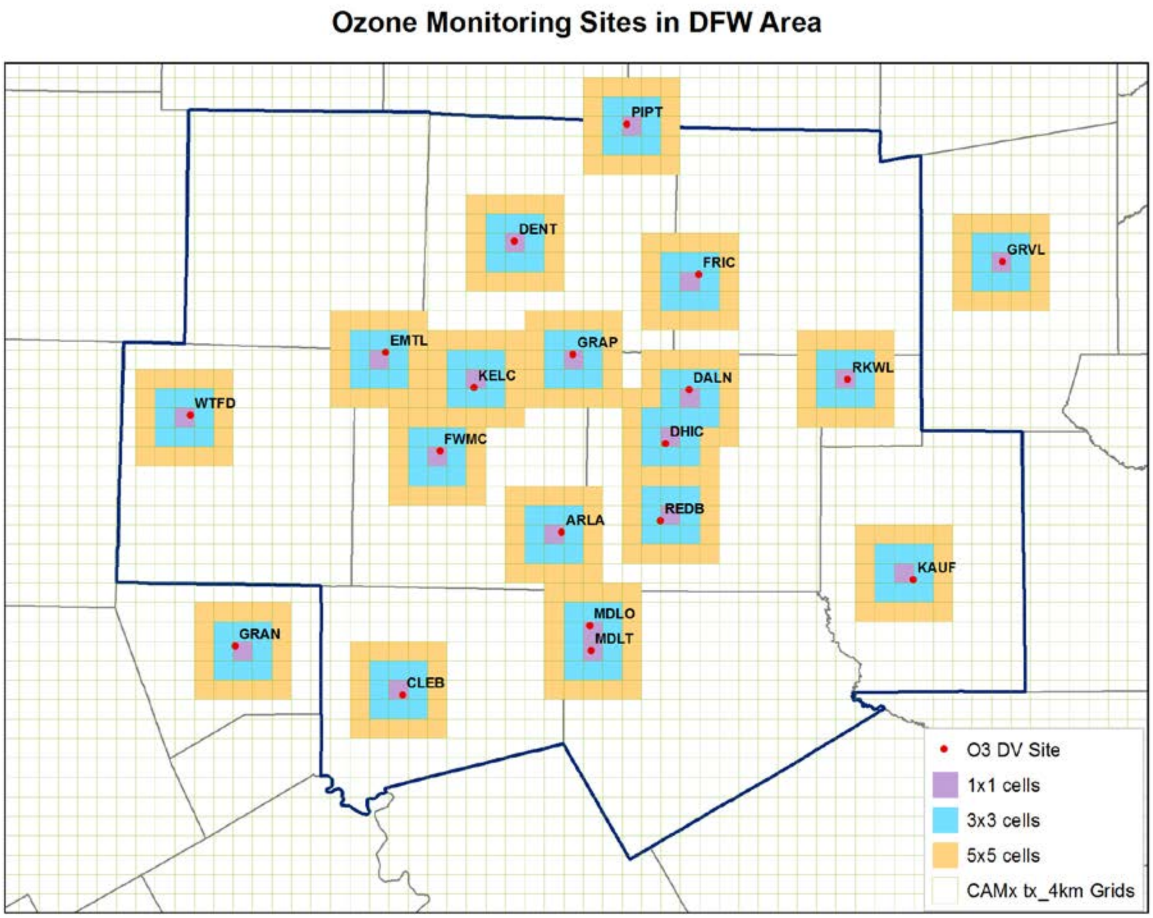


Figure 3-29: Location of DFW Ozone Monitors with 4 km Grid Cell Array

Table 3-41: 2006 Baseline Design Value Summary for the Attainment Test

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 DV_B (ppb)	Modeled Average of Days >75 ppb	Number of Modeled Days > 75ppb
Denton Airport South - C56	DENT	93.33	89.04	37
Eagle Mountain Lake - C75	EMTL	93.33	88.32	31
Grapevine Fairway - C70	GRAP	90.67	91.68	35
Keller - C17	KELC	91.00	91.06	32
Fort Worth Northwest - C13	FWMC	89.33	89.87	30
Frisco - C31	FRIC	87.67	87.42	37
Dallas North #2 - C63	DALN	85.00	87.07	32
Parker County - C76	WTFD	87.67	86.33	20
Dallas Executive Airport - C402	REDB	85.00	84.93	29
Cleburne Airport - C77	CLEB	85.00	83.41	19
Arlington Municipal Airport - C61	ARLA	83.33	86.34	31

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 DV_B (ppb)	Modeled Average of Days >75 ppb	Number of Modeled Days > 75ppb
Dallas Hinton Street - C401	DHIC	81.67	87.00	33
Granbury - C73*	GRAN	83.00	83.40	20
Midlothian Tower - C94†	MDLT	80.50	82.82	26
Pilot Point - C1032†	PIPT	81.00	88.03	33
Rockwall Heath - C69	RKWL	77.67	82.99	26
Midlothian OFW - C52†	MDLO	75.00	83.19	28
Greenville - C1006*	GRVL	75.00	79.12	18
Kaufman - C71	KAUF	74.67	79.74	19

* Granbury and Greenville are located outside of the 10-County DFW nonattainment area.

† Midlothian OFW, Midlothian Tower, and Pilot Point did not measure enough data from 2004 through 2008 to calculate a complete DV_B. The DV_B shown uses all available data.

3.7.2 Future Baseline Modeling

Similar to the 2006 baseline modeling, 2018 future case modeling was conducted for each of the 67 episode days using the anthropogenic emission inputs discussed in Section 3.5.4. Using the same days from the 2006 baseline where eight-hour ozone concentrations were modeled above 75 ppb, the RRF for each monitor was calculated by dividing the 2018 modeled peak eight-hour ozone average by the 2006 peak eight-hour modeled ozone average. For example, there were a total of 37 days in the 67-day episode where the Denton Airport South monitor was modeled above 75 ppb in the 2006 baseline. Table 3-40 shows that the 2006 baseline average of the maximum eight-hour modeled ozone for these 37 days is 89.04 ppb. The 2018 future case average for the same 37 days is 73.15 ppb. The Denton Airport South RRF is obtained by dividing the 73.15 ppb future year average by the 89.04 ppb baseline average to obtain 0.8215. A summary for all monitors is provided in Table 3-41: *RRF Calculations from the 2006 Baseline and 2018 Future Case.*

Table 3-42: RRF Calculations from the 2006 Baseline and 2018 Future Case

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 Average of Days >75 ppb	2018 Average of Days >75 ppb	Relative Response Factor *(RRF)*
Denton Airport South - C56	DENT	89.04	73.15	0.8215
Eagle Mountain Lake - C75	EMTL	88.32	71.83	0.8133
Grapevine Fairway - C70	GRAP	91.68	76.63	0.8358
Keller - C17	KELC	91.06	75.01	0.8238
Fort Worth Northwest - C13	FWMC	89.87	73.92	0.8226
Frisco - C31	FRIC	87.42	72.90	0.8338
Dallas North #2 - C63	DALN	87.07	73.28	0.8416
Parker County - C76	WTFD	86.33	70.09	0.8119
Dallas Executive Airport - C402	REDB	84.93	70.77	0.8334
Cleburne Airport - C77	CLEB	83.41	68.94	0.8265
Arlington Municipal Airport - C61	ARLA	86.34	71.90	0.8328

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 Average of Days >75 ppb	2018 Average of Days >75 ppb	Relative Response Factor *(RRF)*
Dallas Hinton Street - C401	DHIC	87.00	73.01	0.8392
Granbury - C73	GRAN	83.40	68.17	0.8174
Midlothian Tower - C94	MDLT	82.82	69.40	0.8379
Pilot Point - C1032	PIPT	88.03	72.38	0.8222
Rockwall Heath - C69	RKWL	82.99	70.14	0.8452
Midlothian OFW - C52	MDLO	83.19	69.88	0.8399
Greenville - C1006	GRVL	79.12	65.90	0.8329
Kaufman - C71	KAUF	79.74	66.40	0.8327

The RRF is then multiplied by the 2006 DV_B to obtain the 2018 DV_F for each ozone monitor. In accordance with EPA modeling guidance (EPA, 2007), the final future design value is obtained by rounding to the tenths digit and truncating to zero decimal places. These results are presented in Table 3-42: *Summary of RRF and 2018 Future Ozone Design Values* and Figure 3-30: *2018 Future Design Values by DFW Monitoring Location*. Application of the attainment test results in only the Denton Airport South monitor above the 2008 eight-hour ozone standard of 75 ppb. The EPA has not yet finalized modeling guidance applicable to this specific standard, so the most recently available guidance for the 1997 eight-hour ozone standard of 84 ppb was used instead (EPA, 2007). The 84 ppb guidance states that when the maximum future design value falls within 82 and 87 ppb, a weight of evidence (WoE) "demonstration should be conducted to determine if aggregate supplemental analyses support the modeled attainment test." Application of the 82 to 87 ppb WoE range to the 75 ppb standard indicates that the currently applicable WoE range could be 73 to 78 ppb. As the Denton Airport South DV_F falls within this range, a WoE demonstration is included in Chapter 5: Weight of Evidence of this SIP revision.

Table 3-43: Summary of RRF and 2018 Future Ozone Design Values

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 DV_B (ppb)	2018 DV_F (ppb)	2018 Truncated DV_F (ppb)
Denton Airport South - C56	DENT	93.33	76.67	76
Eagle Mountain Lake - C75	EMTL	93.33	75.90	75
Grapevine Fairway - C70	GRAP	90.67	75.78	75
Keller - C17	KELC	91.00	74.96	75
Fort Worth Northwest - C13	FWMC	89.33	73.48	73
Frisco - C31	FRIC	87.67	73.10	73
Dallas North #2 - C63	DALN	85.00	71.54	71
Parker County - C76	WTFD	87.67	71.18	71
Dallas Executive Airport - C402	REDB	85.00	70.84	70
Cleburne Airport - C77	CLEB	85.00	70.26	70
Arlington Municipal Airport - C61	ARLA	83.33	69.39	69
Dallas Hinton Street - C401	DHIC	81.67	68.54	68

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 DV_B (ppb)	2018 DV_F (ppb)	2018 Truncated DV_F (ppb)
Granbury - C73	GRAN	83.00	67.84	67
Midlothian Tower - C94	MDLT	80.50	67.45	67
Pilot Point - C1032	PIPT	81.00	66.60	66
Rockwall Heath - C69	RKWL	77.67	65.64	65
Midlothian OFW - C52	MDLO	75.00	62.99	63
Greenville - C1006	GRVL	75.00	62.46	62
Kaufman - C71	KAUF	74.67	62.18	62

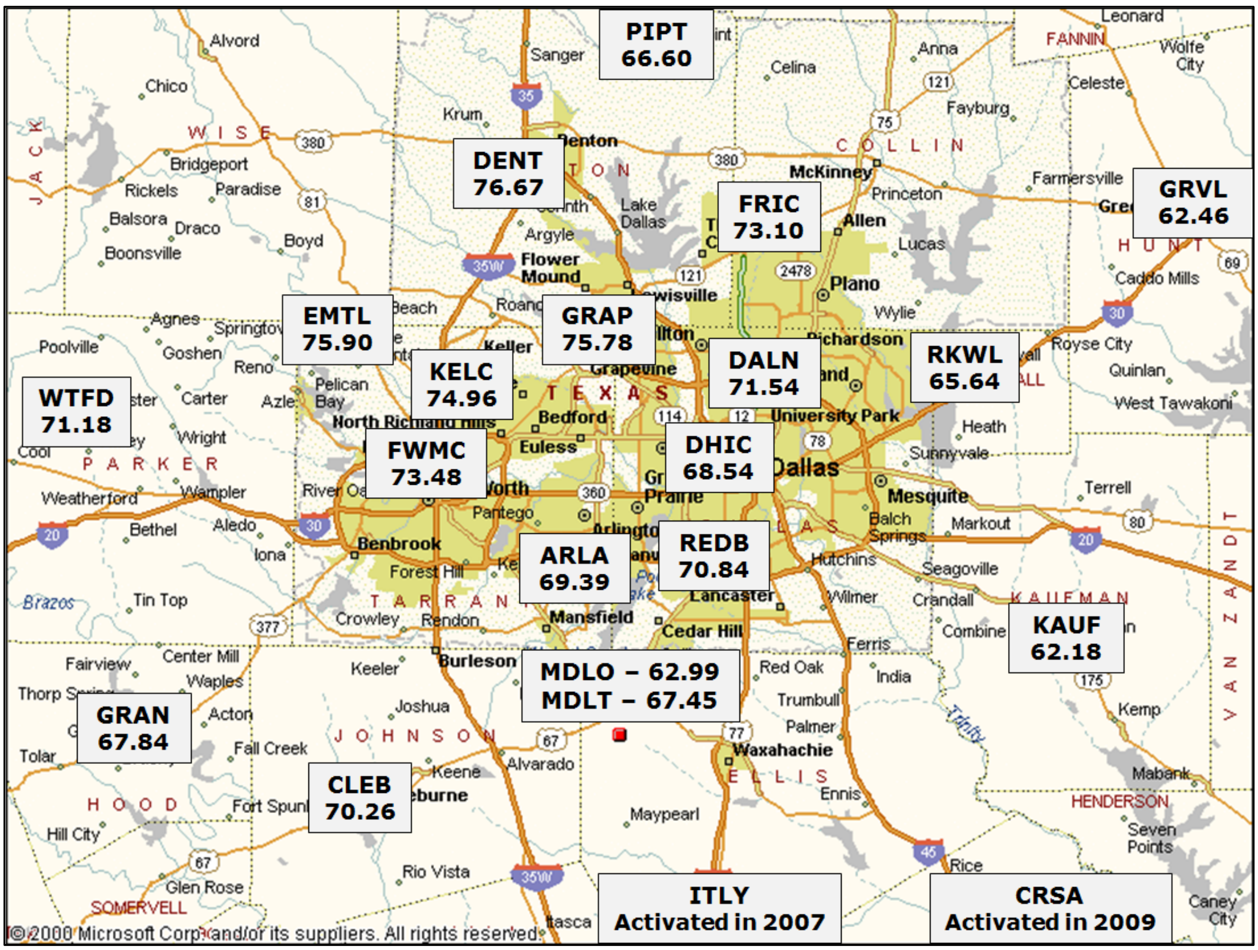


Figure 3-30: 2018 Future Design Values by DFW Monitoring Location

3.7.3 Ozone Source Apportionment Tool and Anthropogenic Precursor Culpability Analysis

A source apportionment analysis was conducted on the 2018 future case modeling. The two techniques of Anthropogenic Precursor Culpability Assessment (APCA) and Ozone Source Apportionment Technology (OSAT) were used to analyze contributions by different emission source categories in selected regions to the 2018 modeled ozone concentrations. Both APCA and

OSAT keep track of the origin of the NO_X and VOC precursors creating the ozone during the model run, which can then be apportioned to specific user-defined geographic regions and source categories. A key difference between APCA and OSAT is that APCA recognizes that the biogenic source category is not controllable. Where OSAT would apportion ozone production to biogenic emissions, APCA reallocates that ozone production to the controllable or anthropogenic emissions that combined with the biogenic emissions to create ozone. Only ozone created from both biogenic NO_X and VOC precursors is apportioned to the biogenic emission source group by APCA.

For the APCA analysis, the three geographic regions of 10-county DFW, non-DFW Texas, and non-Texas were chosen. For display purposes, the anthropogenic emissions were divided into eight source categories for DFW, five for non-DFW Texas, and one aggregate category for non-Texas. The highest level of resolution in the anthropogenic emission categories that can be obtained for APCA analyses is driven by the number of separate EPS3 processing streams for CAMx input. For example, the on-road emissions processing with EPS3 is not split between streams for passenger cars and heavy-duty diesel trucks, so an APCA analysis is not able to provide separate ozone contribution estimates for these categories. Use of APCA requires tracking of biogenic emissions, initial conditions, and boundary conditions, but these are not allocated to any specific geographic area. Table 3-43: *APCA Geographic Region and Source Category Combinations* summarizes these 17 groups.

Table 3-44: APCA Geographic Region and Source Category Combinations

Geographic Region	Source Category
10-County DFW	On-Road
10-County DFW	Non-Road
10-County DFW	Off-Road - Airports and Locomotives
10-County DFW	Area Sources
10-County DFW	Oil and Gas Drilling and Production
10-County DFW	Point - Electric Utilities
10-County DFW	Point - Cement Kilns
10-County DFW	Point - Oil and Gas and Other *
Non-DFW Texas	On-Road
Non-DFW Texas	Non-Road, Off-Road, and Area Sources
Non-DFW Texas	Oil and Gas Drilling and Production
Non-DFW Texas	Point - Electric Utilities
Non-DFW Texas	Point - Cement Kilns, Oil and Gas, and Other
Non-Texas	All Anthropogenic
All Geographic Areas	Biogenic
NA	Boundary Conditions
NA	Initial Conditions

* For the 2018 future year, oil and gas point source NO_X is 16.37 tpd and the remaining “other” is 6.62 NO_X tpd.

The full 67-day combined episode was run with APCA for the 2018 future case to estimate the geographic region and source category contributions to the ozone formed for each hour and day.

The APCA output was processed to obtain these contributions for each monitor within the DFW area. Graphical results for the Denton Airport South monitor are presented in Figure 3-31: *2018 Ozone Contributions for Denton Airport South from May 31 through June 16* and Figure 3-32: *2018 Ozone Contributions for Denton Airport South from August 13 through 27*. These time periods represent the first half of the June and August-September episodes, respectively. The photochemical model must be run with initial conditions that become less important once the earlier part of the episode has finished. Each peak represents the higher mid-day levels of modeled ozone, while each valley represents the nighttime low. Differing amounts of ozone are formed each day, and the contribution from each geographic region and source category combination varies due to changing meteorological conditions by day and hour. The gray, green, and pink colors towards the bottom of the charts reflect the boundary conditions, biogenic, and non-Texas anthropogenic contributions, respectively.

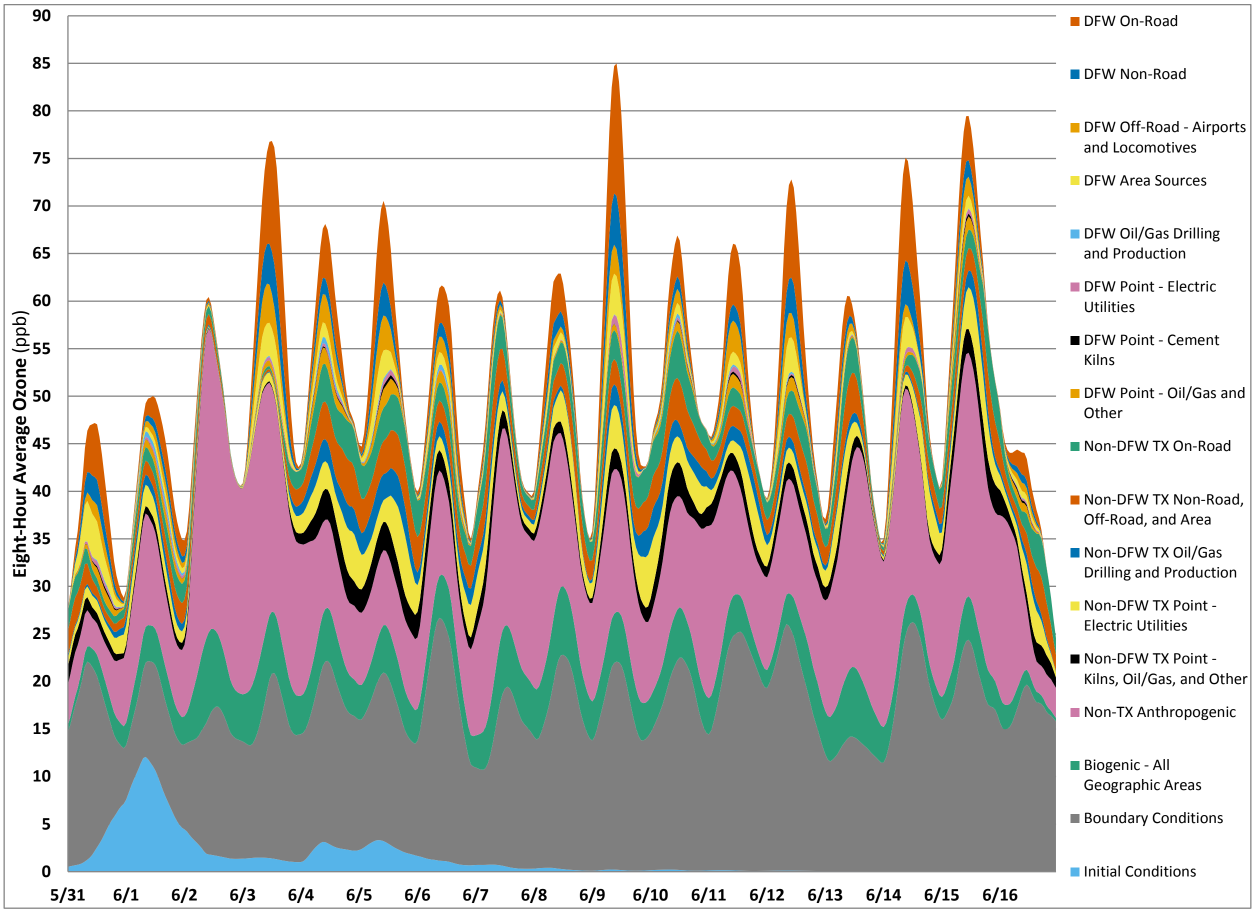


Figure 3-31: 2018 Ozone Contributions for Denton Airport South from May 31 through June 16

Figure 3-31 and Figure 3-32 present the ozone contributions for each day of the respective time periods, but not all of these days were used in the RRF calculations presented in Table 3-40, Table 3-41, and Table 3-42, which are based on the 2006 baseline episode days that had an eight-hour ozone modeled peak above 75 ppb. For each monitor, the maximum eight-hour ozone contributions from the APCA output were aggregated for the episode days used in the RRF calculations. A distribution by geographic area and source type was obtained by averaging the ozone contributions across the RRF days, and that distribution was then applied to the 2018 DV_F for each monitor.

The results of this analysis are presented in Figure 3-33: *2018 Ozone* DV_F *Contributions for Denton, Parker, and Kaufman* and for the Denton Airport South, Parker County, and Kaufman monitors. The Denton Airport South monitor was chosen for review because it has the highest 2018 DV_F and is located in the far northwestern downwind portion of the DFW area, so its APCA results represent the maximum total ozone contribution from DFW area precursors. The Kaufman monitor was chosen for review because it has the lowest 2018 DV_F and is located in the far southeastern upwind portion of the DFW area, so its APCA results can best represent the background contribution. The Parker County monitor was chosen to evaluate ozone impacts of oil and gas operations because it is located in the far western portion of the DFW area downwind of prevalent drilling and production activity.

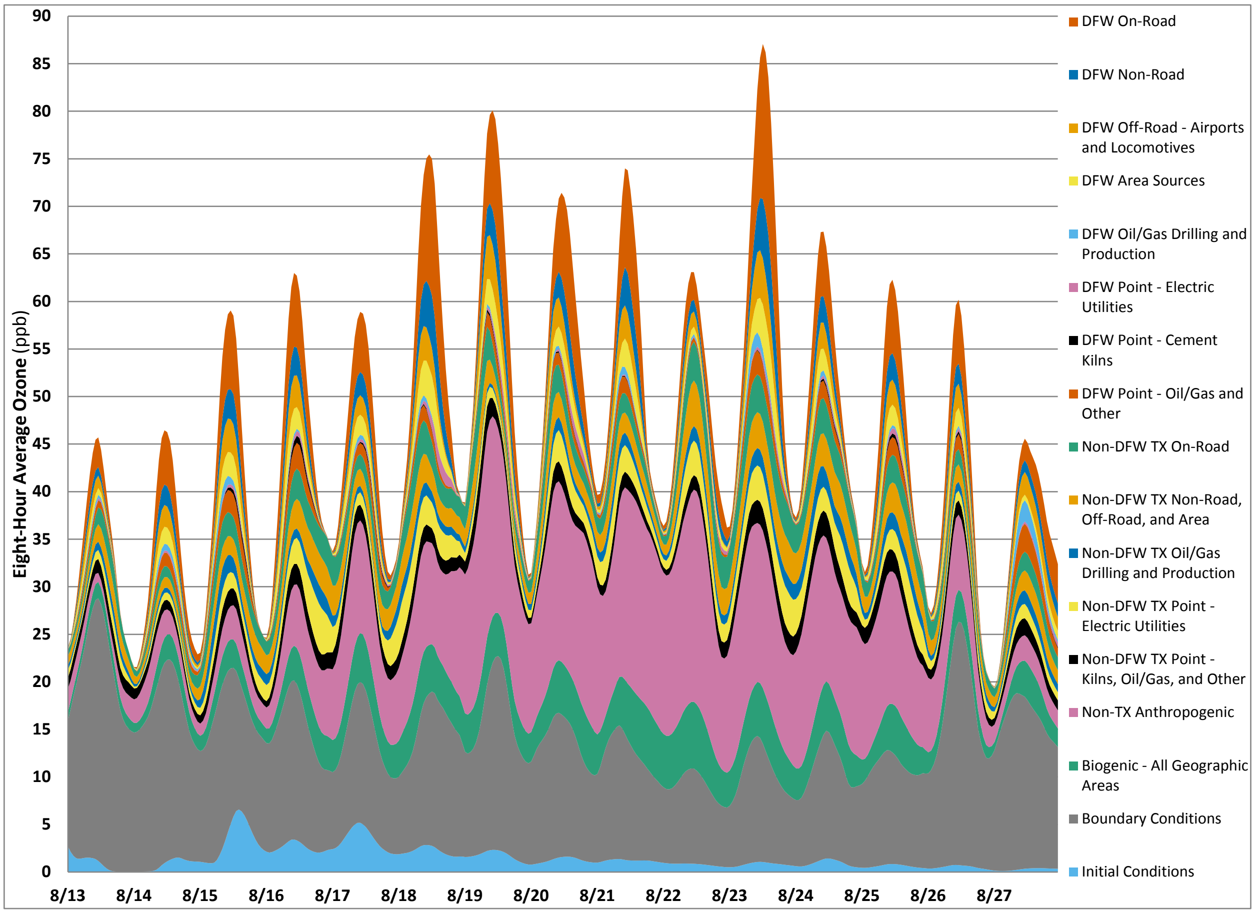


Figure 3-32: 2018 Ozone Contributions for Denton Airport South from August 13 through 27

Table 3-44: *2018 Ozone DVF Denton, Parker, and Kaufman Contributions* presents the values for each of the geographic area and source categories referenced in Figure 3-32. Table 3-45: *2018 Ozone DVF Denton, Parker, and Kaufman Aggregate Summary* groups the anthropogenic source category results from Table 3-44 into 10-County DFW, non-DFW Texas, and non-Texas areas. The southeastern upwind Kaufman monitor reflects the lowest DFW area ozone contribution of 2.5 ppb to its DV_F, while the northwestern downwind Denton Airport South monitor reflects the highest DFW area ozone contribution of 19.8 ppb. While the peak ozone at Kaufman is 14.5 ppb lower than at Denton Airport South, a greater portion of its ozone can be attributed to non-DFW Texas (16.6 ppb) and non-Texas (21.1 ppb) sources. The comparative non-DFW Texas and non-Texas anthropogenic contributions for Denton Airport South are 11.7 ppb and 18.7 ppb, respectively.

As shown in Table 3-44, the Parker monitor reflects higher ozone contributions from oil and gas operations compared with other DFW area monitors. This is to be expected due its location downwind of much of this activity during ozone season. As noted on Table 3-43, the DFW area point source contributions are divided into electric utilities, cement kilns, and a remaining category that combines oil and gas operations with “other”. The 2018 figures in Table 3-22 and Table 3-32 show that the oil and gas portion is 16.37 NO_X tpd with 6.62 NO_X tpd comprising the remainder of the total 22.99 NO_X tpd for non-cement kiln non-EGUs. Appendix C contains more detail on the APCA analyses presented here.

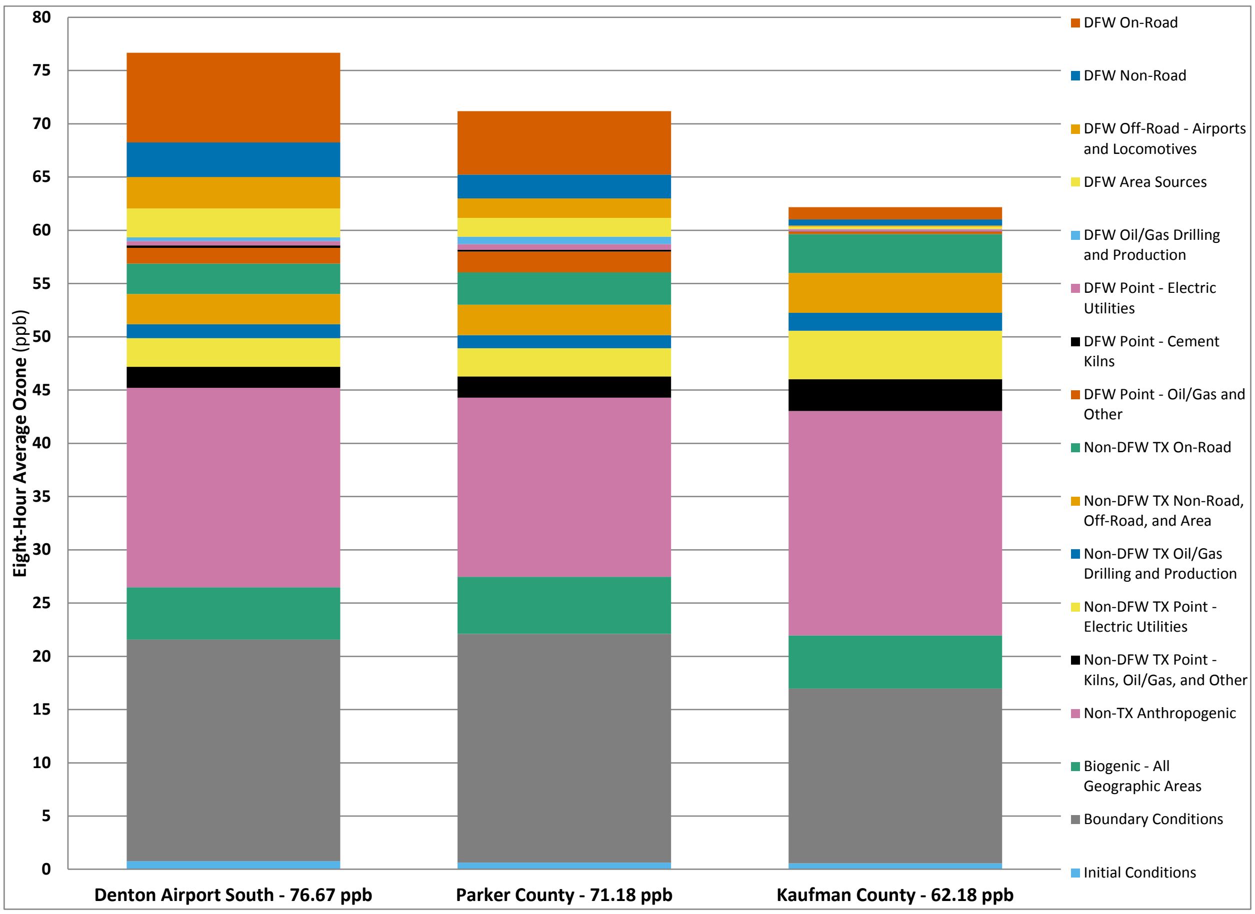


Figure 3-33: 2018 Ozone DV_F Contributions for Denton, Parker, and Kaufman

Table 3-45: 2018 Ozone DV_F Denton, Parker, and Kaufman Contributions

Geographic Area and Source Type	**Denton Airport South** (ppb)	**Parker County** (ppb)	**Kaufman County** (ppb)
DFW On-Road	8.43	5.94	1.17
DFW Non-Road	3.23	2.25	0.57
DFW Off-Road - Airports and Locomotives	2.96	1.82	0.10

Geographic Area and Source Type	Denton Airport South (ppb)	Parker County (ppb)	Kaufman County (ppb)
DFW Area Sources	2.71	1.76	0.23
DFW Oil/Gas Drilling and Production	0.36	0.72	0.02
DFW Point - Electric Utilities	0.41	0.53	0.21
DFW Point - Cement Kilns	0.21	0.17	0.02
DFW Point - Oil/Gas and Other	1.48	1.95	0.22
Non-DFW TX On-Road	2.85	3.03	3.67
Non-DFW TX Non-Road, Off-Road, and Area Sources	2.85	2.86	3.72
Non-DFW TX Oil/Gas Drilling and Production	1.31	1.23	1.69
Non-DFW TX Point - Electric Utilities	2.68	2.66	4.56
Non-DFW TX Point - Cement Kilns, Oil/Gas, and Other	1.99	1.99	2.97
Non-TX Anthropogenic - All Sources	18.72	16.82	21.08
Biogenic - All Geographic Areas	4.92	5.35	4.98
Boundary Conditions	20.80	21.48	16.42
Initial Conditions	0.77	0.63	0.56
2018 Future Design Value	76.67	71.18	62.18

Table 3-46: 2018 Ozone DV_F Denton, Parker, and Kaufman Aggregate Summary

Aggregated Geographic Area and Source Type	Denton Airport South (ppb)	Parker County (ppb)	Kaufman County (ppb)
DFW Anthropogenic	19.79	15.14	2.53
Non-DFW Texas Anthropogenic	11.68	11.77	16.61
Non-Texas Anthropogenic	18.72	16.82	21.08
Biogenic - All Geographic Areas	4.92	5.35	4.98
Boundary and Initial Conditions	21.56	22.11	16.98
2018 Future Design Value	76.67	71.18	62.18

3.7.4 Future Case Modeling Sensitivities

Section 3.7.2 presented the 2018 future design values obtained from the running the photochemical model with the 2006 baseline and 2018 future case emission inventories discussed in Sections 3.5.3 and 3.5.4, respectively. Three sensitivity analyses were performed by holding the 2006 baseline emission inventories constant, but modifying the 2018 future case emission inventories for specific source categories. For each sensitivity test, the RRF analysis was performed and the 2018 future case design value impacts for each monitor were determined.

3.7.4.1 Tier 3 Standards Sensitivity

The EPA finalized rulemaking in March 2014 that requires more stringent Tier 3 light-duty vehicle standards starting with the 2017 model year. The currently applicable Tier 2 standards began with the 2004 model year, and were accompanied by a requirement for gasoline with an average sulfur content of 30 parts per million (ppm) to be made available. In order for light-duty vehicles to meet the more stringent Tier 3 standards, gasoline with an average sulfur content of 10 ppm will be required. Research conducted by the EPA (EPA, 2013) shows that lowering the gasoline sulfur content from 30 ppm to 10 ppm increased catalytic converter efficiency from in-use Tier 2 vehicles, which resulted in lower NO_X, VOC, and CO emissions.

In the Notice of Proposed Rulemaking (NPRM) that accompanied the Tier 3 proposal, EPA made available a customized version of the MOVES model called MOVEST3NPRM. The TCEQ ran MOVEST3NPRM for scenarios with 10 ppm and 30 ppm gasoline sulfur content to obtain relative changes in 2018 emissions per light-duty gasoline vehicle type. These relative changes by pollutant were applied with EPS3 to the 2018 on-road emission inventories prepared for future case modeling. The net benefits by geographic area are presented in Table 3-46: *2018 On-Road Emission Reductions from 10 ppm Sulfur Gasoline.*

Table 3-47: 2018 On-Road Emission Reductions from 10 ppm Sulfur Gasoline

Geographic Area	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)
10-County DFW	9.98	2.39	13.25	0.54
Eight-County HGB	9.21	2.25	12.66	0.87
236 Texas Attainment Counties	26.97	5.52	27.74	1.41
Texas Total (254 Counties)	46.16	10.16	53.65	2.83
Non-Texas U.S. (2,856 Counties)	698.57	126.58	873.91	34.96
Grand Total	744.73	136.74	927.56	37.79

The 2018 future case was modeled with these revised on-road emission estimates for the entire U.S. The eight-hour ozone impacts are presented in Table 3-47: *2018 Future Design Value Impacts from 10 ppm Sulfur Gasoline*. The maximum reductions in the range of 0.7-0.8 ppb are at the monitors located north and west of the DFW urban core. The minimum reductions of 0.4-0.5 ppb are at the monitors located south and east of the DFW urban core. Due to the dominant southeasterly winds during the DFW ozone season, the modeling appropriately estimates the minimum impacts upwind and the maximum impacts downwind. The range of 2018 modeled benefits to the DVF figures in Table 3-47 is 0.39-0.80 ppb and is very similar to the 0.46-0.92 range of 2018 benefits that the EPA modeled for the DFW area in its technical analysis in support of the Tier 3 rule (EPA, 2014).

Table 3-48: 2018 Future Design Value Impacts from 10 ppm Sulfur Gasoline

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2018 DV_F for 30 ppm Sulfur (ppb)	2018 DV_F for 10 ppm Sulfur (ppb)	2018 DV_F Change (ppb)
Denton Airport South - C56	DENT	76.67	75.87	-0.80
Eagle Mountain Lake - C75	EMTL	75.90	75.15	-0.75
Grapevine Fairway - C70	GRAP	75.78	75.04	-0.74
Keller - C17	KELC	74.96	74.18	-0.78

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2018 DV_F for 30 ppm Sulfur (ppb)	2018 DV_F for 10 ppm Sulfur (ppb)	2018 DV_F Change (ppb)
Fort Worth Northwest - C13	FWMC	73.48	72.76	-0.72
Frisco - C31	FRIC	73.10	72.36	-0.75
Dallas North #2 - C63	DALN	71.54	70.90	-0.64
Parker County - C76	WTFD	71.18	70.55	-0.63
Dallas Executive Airport - C402	REDB	70.84	70.25	-0.59
Cleburne Airport - C77	CLEB	70.26	69.69	-0.56
Arlington Municipal Airport - C61	ARLA	69.39	68.78	-0.61
Dallas Hinton Street - C401	DHIC	68.54	67.92	-0.62
Granbury - C73	GRAN	67.84	67.33	-0.51
Midlothian Tower - C94	MDLT	67.45	66.96	-0.50
Pilot Point - C1032	PIPT	66.60	65.90	-0.70
Rockwall Heath - C69	RKWL	65.64	65.16	-0.49
Midlothian OFW - C52	MDLO	62.99	62.54	-0.45
Greenville - C1006	GRVL	62.46	62.03	-0.44
Kaufman - C71	KAUF	62.18	61.79	-0.39

3.7.4.2 2018 CSAPR Sensitivity

The 2018 future case EGU emissions for this AD SIP revision were projected based on CAIR Phase II allocations. In July of 2011, the EPA finalized the Cross State Air Pollution Rule (CSAPR), which was intended to be a replacement for CAIR. Since that time, implementation of CSAPR was halted due to legal proceedings. In April 2014, the U.S. Supreme Court reversed a D.C. Circuit opinion that had vacated CSAPR and remanded the case back to the D.C. Circuit. On October 23, 2014, the D.C. Circuit lifted the CSAPR stay. The court has set a briefing schedule, and oral arguments for the ongoing litigation have been scheduled for March 11, 2015. The EPA has not yet released guidance on how they intend to implement CSAPR. The TCEQ will continue to evaluate the rule and will take action to revise this plan appropriately as necessary.

The TCEQ performed a 2018 sensitivity analysis that replaced the 2018 EGU emission estimates based on CAIR Phase II with the latest available CSAPR allocations for 2017-and-later years. The 28 states subject to CSAPR are Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Virginia, West Virginia, and Wisconsin. The modeled 2018 ozone impacts for the DFW area monitors are presented in Table 3-48: *2018 Future Design Value Impacts from CSAPR Instead of CAIR II*. The maximum modeled reduction of 0.73 ppb is at the Rockwall Heath monitor located on the far eastern upwind side of DFW. The minimum reduction of 0.02 ppb is located at the Eagle Mountain Lake monitor located on the northwestern downwind side of DFW. The Fort Worth Northwest monitor is the only monitor that saw an ozone increase (0.22 ppb) for the CSAPR sensitivity.

Table 3-49: 2018 Future Design Value Impacts from CSAPR Instead of CAIR II

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2018 DV_F for CAIR II (ppb)	2018 DV_F for CSAPR (ppb)	2018 DVF Change (ppb)
Denton Airport South - C56	DENT	76.67	76.47	-0.20
Eagle Mountain Lake - C75	EMTL	75.90	75.89	-0.02
Grapevine Fairway - C70	GRAP	75.78	75.54	-0.24
Keller - C17	KELC	74.96	74.86	-0.11
Fort Worth Northwest - C13	FWMC	73.48	73.70	+0.22
Frisco - C31	FRIC	73.10	72.73	-0.37
Dallas North #2 - C63	DALN	71.54	71.14	-0.40
Parker County - C76	WTFD	71.18	70.88	-0.29
Dallas Executive Airport - C402	REDB	70.84	70.29	-0.54
Cleburne Airport - C77	CLEB	70.26	70.11	-0.14
Arlington Municipal Airport - C61	ARLA	69.39	69.08	-0.32
Dallas Hinton Street - C401	DHIC	68.54	68.20	-0.34
Granbury - C73	GRAN	67.84	67.51	-0.34
Midlothian Tower - C94	MDLT	67.45	66.98	-0.48
Pilot Point - C1032	PIPT	66.60	66.35	-0.25
Rockwall Heath - C69	RKWL	65.64	64.91	-0.73
Midlothian OFW - C52	MDLO	62.99	62.55	-0.44
Greenville - C1006	GRVL	62.46	62.13	-0.34
Kaufman - C71	KAUF	62.18	61.51	-0.66

3.7.4.3 DERC Sensitivity

When projecting DFW area point source emission estimates from the most recently available data sources to 2018, emission caps were applied to the cement kilns and EGUs. The projection for non-cement kiln non-EGUs is the lesser of an economic projection or the TCEQ Emissions Banking and Trading Registry. For the 2018 future year, projection from the 2012 point source STARS data using economic factors resulted in a 0.55 NO_X tpd decrease for the DFW area non-cement kiln non-EGU category. This is documented in Table 3-21 and Table 3-22, which show the 2012 non-cement kiln non-EGU emissions at 23.54 NO_X tpd and the 2018 level at 22.99 NO_X tpd.

A sensitivity analysis was performed where 17 NO_X tpd of Discrete Emission Reduction Credits (DERCs) were proportionally allocated to the 2018 non-cement kiln non-EGU emissions throughout DFW. If a single point source facility in this group comprised 1% of the non-cement kiln non-EGU total, then that facility's NO_X emission level was increased by 0.17 NO_X tpd from this DERC sensitivity. The TCEQ is currently proposing rulemaking (Rule Project No. 2014-007-101-AI) that would replace the existing annually-calculated NO_X DERC limit in §101.379(c) with a fixed limit of 17.0 tons per day (tpd) of NO_X DERC use in the nine-county DFW 1997 eight-hour ozone nonattainment area. . The proposed 17.0 tpd limit was selected based on the 2013 NO_X DERC limit of 16.9 tpd, which was the second highest limit that had been set at the time the modeling sensitivity was conducted. The proposed limit is one and a half times greater than the largest request to use DERCs submitted from 2009 through 2014 and more than eleven times greater than any actual DERC use during this same time. Table 3-49: *2018 DV_F Impacts from Maximum DERC Allocation to* non-EGUs summarizes the net ozone increases in the 2018 design values for each DFW area monitor.

Table 3-50: 2018 DV_F Impacts from Maximum DERC Allocation to Non-EGUs

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2018 DV_F (ppb)	2018 DV_F Add 17 NO_X tpd (ppb)	2018 DV_F Change (ppb)
Denton Airport South - C56	DENT	76.67	77.01	+0.34
Eagle Mountain Lake - C75	EMTL	75.90	76.39	+0.49
Grapevine Fairway - C70	GRAP	75.78	76.05	+0.27
Keller - C17	KELC	74.96	75.36	+0.39
Fort Worth Northwest - C13	FWMC	73.48	73.92	+0.44
Frisco - C31	FRIC	73.10	73.28	+0.18
Dallas North #2 - C63	DALN	71.54	71.70	+0.16
Parker County - C76	WTFD	71.18	71.73	+0.55
Dallas Executive Airport - C402	REDB	70.84	71.02	+0.19
Cleburne Airport - C77	CLEB	70.26	70.59	+0.33
Arlington Municipal Airport - C61	ARLA	69.39	69.67	+0.28
Dallas Hinton Street - C401	DHIC	68.54	68.71	+0.17
Granbury - C73	GRAN	67.84	68.32	+0.47
Midlothian Tower - C94	MDLT	67.45	67.63	+0.18
Pilot Point - C1032	PIPT	66.60	66.88	+0.28
Rockwall Heath - C69	RKWL	65.64	65.75	+0.10
Midlothian OFW - C52	MDLO	62.99	63.19	+0.19
Greenville - C1006	GRVL	62.46	62.51	+0.04
Kaufman - C71	KAUF	62.18	62.22	+0.04

3.7.5 Unmonitored Area Analysis

EPA guidance (EPA, 2007) recommends that areas within or near nonattainment counties but not adjacent to monitoring locations (unmonitored areas) be subjected to an unmonitored area (UMA) analysis to demonstrate that these areas are expected to reach attainment by the required future year. The standard attainment test is applied only at monitor locations, and the UMA analysis is intended to identify any areas not near a monitoring location that are at risk of not meeting the attainment date. Recently, the EPA provided Modeled Attainment Test Software (MATS), which can be used to conduct UMA analyses but has not specifically recommended using its software in EPA guidance, instead stating that “States will be able to use the EPA-provided software or are free to develop alternative techniques that may be appropriate for their areas or situations.”

The TCEQ chose to use its own procedure to conduct the UMA analysis instead of MATS for several reasons. Both procedures incorporate modeled predictions into a spatial interpolation procedure. However, the TCEQ Attainment Test for Unmonitored areas (TATU) is already integrated into the TCEQ's model post-processing stream while MATS requires that modeled concentrations be exported to a personal computer-based platform. Additionally, MATS requires input in latitude/longitude, while TATU works directly off the LCC projection data used in TCEQ modeling applications. Finally, MATS uses the Voronoi Neighbor Averaging (VNA) technique for spatial interpolation, while TATU relies on the more familiar kriging geospatial interpolation technique. More information about TATU is provided in Appendix C.

Figure 3-34: *Spatially Interpolated 2006 Baseline and 2018 Future Case Design Values for the DFW Area* shows two color contour maps of ozone concentrations produced by TATU, one for the 2006 baseline (top) and one for the 2018 future case (bottom). The figure shows the extent and magnitude of the expected improvements in ozone design values, with few grid cells at or above 76 ppb in the future case plot. Figure 3-34 indicates that the maximum 2018 design value in the domain of 76.8 ppb is located in cell 34 in the x-direction and 37 in the y-direction (34_X, 37_Y). This area wide maximum is located immediately to the southeast of the Denton Airport Monitor, which is in cell 33 in the x-direction and 38 in the y-direction (33_X, 38_Y). Table 3-42 shows that the Denton Airport South monitor has the highest 2018 DV_F of all DFW area monitors at 76.7 ppb, which is 0.1 ppb less than this area wide maximum of 76.8 ppb.

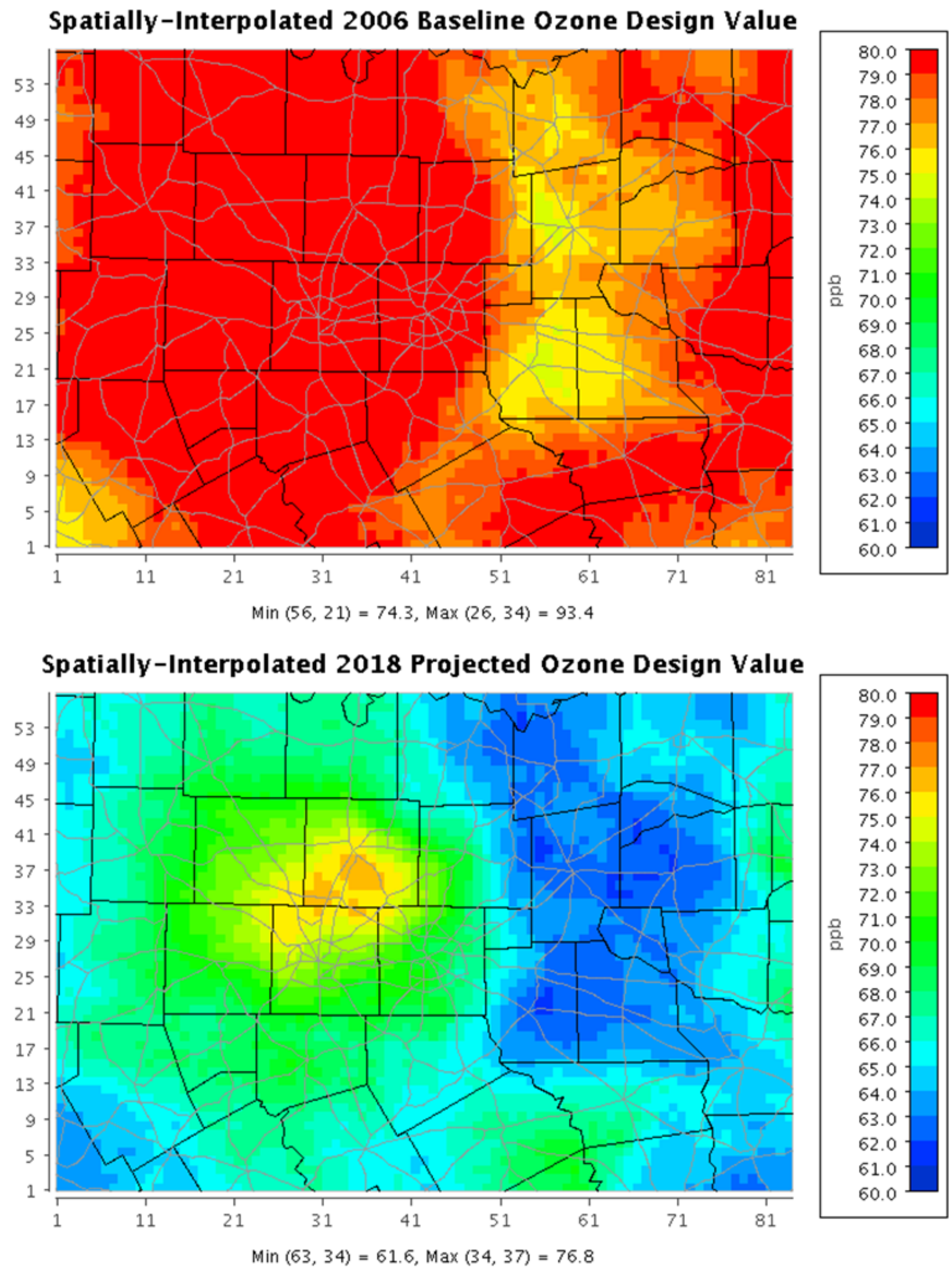


Figure 3-34: Spatially Interpolated 2006 Baseline and 2018 Future Case Design Values for the DFW Area

3.8 MODELING ARCHIVE AND REFERENCES

3.8.1 Modeling Archive

The TCEQ has archived all modeling documentation and modeling input/output files generated as part of the DFW AD SIP revision modeling analysis. Interested parties can contact the TCEQ for information regarding data access or project documentation. Most modeling files and performance evaluation products may be found on the TCEQ modeling FTP site, at ftp://amdaftp.tceq.texas.gov/pub/TX/camx/.

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CHAPTER 4: CONTROL STRATEGIES AND REQUIRED ELEMENTS

4.1 INTRODUCTION

The Dallas-Fort Worth (DFW) nonattainment area for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS), which consists of Collin, Dallas, Denton, Tarrant, Ellis, Johnson, Kaufman, Parker, Rockwall, and Wise Counties, includes a wide variety of major and minor industrial, commercial, and institutional entities. The Texas Commission on Environmental Quality (TCEQ) has implemented stringent and innovative regulations that address emissions of nitrogen oxides (NO_X) and volatile organic compounds (VOC) from these sources. This chapter describes existing ozone control measures and ozone control measures being adopted concurrently with this state implementation plan (SIP) revision for the DFW area, as well as how Texas meets the following moderate ozone nonattainment area SIP requirements for the 2008 eight-hour ozone NAAQS: reasonably available control technology (RACT), reasonably available control measures (RACM), motor vehicle emissions budget (MVEB), and contingency measures.

4.2 EXISTING CONTROL MEASURES

Since the early 1990s, a broad range of control measures have been implemented for each emission source category for ozone planning in the DFW area, formerly consisting of nine counties, Collin, Dallas, Denton, Tarrant, Ellis, Johnson, Kaufman, Parker, and Rockwall. Wise County was added to the nonattainment area for the 2008 eight-hour ozone NAAQS. Table 4-1: *Existing Ozone Control Measures Applicable to the DFW Nine-County Nonattainment Area* lists the existing ozone control strategies that have been implemented for the one-hour and 1997 eight-hour ozone standards in the nine-county DFW area.

Table 4-1: Existing Ozone Control Measures Applicable to the DFW Nine-County Nonattainment Area

Measure	Description	Start Date(s)
DFW Industrial, Commercial, and Institutional (ICI) Major Source Rule 30 Texas Administrative Code (TAC) Chapter 117, Subchapter B, Division 4	Applies to all major sources (50 tons per year (tpy) of NO_X or more) with affected units Affected source categories included in rule: boilers; process heaters; stationary gas turbines, and duct burners used in turbine exhaust ducts; lime kilns; heat treat and reheat metallurgical furnaces; stationary internal combustion engines; incinerators; glass, fiberglass, and mineral wool melting furnaces; fiberglass and mineral wool curing ovens; natural gas-fired ovens and heaters; brick and ceramic kilns; lead smelting reverberatory and blast furnaces; and natural gas-fired dryers used in organic solvent, printing ink, clay, brick, ceramic tile, calcining, and vitrifying processes	March 1, 2009 or March 1, 2010, depending on source category Note: these NO_X control requirements are in addition to the NO_X control strategies previously implemented for ICI major sources in Collin, Dallas, Denton, and Tarrant Counties in March 2002 for the one-hour ozone NAAQS

Measure	Description	Start Date(s)
DFW ICI Minor Source Rule 30 TAC Chapter 117, Subchapter D, Division 2	Applies to all minor sources (less than 50 tpy of NO_X) with stationary internal combustion engines	March 1, 2009 for rich-burn gas-fired engines, diesel-fired engines, and dual-fuel engines March 1, 2010 for lean-burn gas-fired engines
DFW Major Utility Electric Generation Source Rule 30 TAC Chapter 117, Subchapter C, Division 4	NO_X control requirements for DFW utility electric generating facilities Applies to utility boilers, auxiliary steam boilers, stationary gas turbines, and duct burners used in turbine exhaust ducts used in electric power generating systems Note: these NO_X control requirements are in addition to the NO_X control strategies implemented for utilities in Collin, Dallas, Denton, and Tarrant Counties in 2001 through 2005 for the one-hour ozone NAAQS	March 1, 2009
Utility Electric Generation in East and Central Texas 30 TAC Chapter 117, Subchapter E, Division 1	NO_X control requirements on utility boilers and stationary gas turbines (including duct burners used in turbine exhaust ducts) at utility electric generation sites in East and Central Texas, including Parker County	May 1, 2003 through May 1, 2005
DFW Cement Kiln Rule 30 TAC Chapter 117, Subchapter E, Division 2	NO_X control requirements for all Portland cement kilns located in Ellis County	March 1, 2009
NO_X Emission Standards for Nitric Acid Manufacturing – General 30 TAC Chapter 117, Subchapter F, Division 3	NO_X emission standards for nitric acid manufacturing facilities (state-wide rule – no nitric acid facilities in DFW)	November 15, 1999
East Texas Combustion Sources 30 TAC Chapter 117, Subchapter E, Division 4	NO_X control requirements for stationary rich-burn, gas-fired internal combustion engines (240 horsepower (hp) and greater) Measure implemented to reduce ozone in DFW area although controls not applicable in DFW area	March 1, 2010

Measure	Description	Start Date(s)
Natural Gas-Fired Small Boilers, Process Heaters, and Water Heaters 30 TAC Chapter 117, Subchapter E, Division 3	NO_X emission limits on small-scale residential and industrial boilers, process heaters, and water heaters equal to or less than 2.0 million British thermal units per hour	May 11, 2000
General VOC Control Measures 30 TAC, Chapter 115, Subchapters B, C, D, E, F, G, and J	Additional control technology requirements for VOC sources for RACT purposes including: storage, general vent gas, industrial wastewater, loading and unloading operations, general VOC leak detection and repair, solvent using processes, etc. (see Appendix F: *Reasonably Available Control Technology Analysis* for more details)	December 31, 2002 and earlier for Collin, Dallas, Denton, and Tarrant Counties June 15, 2007 or March 1, 2009 for Ellis, Johnson, Kaufman, Parker, and Rockwall Counties
Offset Lithographic Printing 30 TAC, Chapter 115, Subchapter E, Division 4	Control technology requirements for offset lithographic printing Revision to limit VOC content of solvents used by offset lithographic printing facilities and to include smaller sources in rule applicability	December 31, 2000 for Collin, Dallas, Denton, and Tarrant Counties and March 1, 2009 in Ellis, Johnson, Kaufman, Parker, and Rockwall Counties March 1, 2011 for major printing sources (50 tons of VOC per year or more) and March 1, 2012 for minor printing sources (less than 50 tons of VOC per year)
VOC Rules – Degassing Operations 30 TAC, Chapter 115, Subchapter F, Division 3	VOC control requirements for degassing during, or in preparation of, cleaning any storage tanks and transport vessels	May 21, 2011 for Collin, Dallas, Denton, and Tarrant Counties
VOC Control Measures – Storage Tanks 30 TAC Chapter 115, Subchapter B, Division 1	Requires controls for slotted guidepoles and more stringent controls for other fittings on floating roof tanks, and control requirements or operational limitations on landing floating roof tanks Eliminates exemption for storage tanks for crude oil or natural gas condensate and regulates flash emissions from these tanks	March 1, 2013

Measure	Description	Start Date(s)
VOC Control Measures – Solvent-Using Processes 30 TAC Chapter 115, Subchapter E	Revised rules to implement RACT requirements per control techniques guidelines issued by the United States Environmental Protection Agency (EPA) including new control, testing, monitoring and recordkeeping requirements for eight emission source categories in the DFW area: paper, film, and foil coatings; large appliance coatings; metal furniture coatings; miscellaneous metal and plastic parts coatings; automobile and light-duty truck coating; industrial cleaning solvents; miscellaneous industrial adhesives; and flexible package printing (see Dallas-Fort Worth Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard Nonattainment Area (2010-022-SIP-NR))	March 1, 2013
Voluntary Energy Efficiency/Renewable Energy	Energy efficiency and renewable energy projects established by Senate Bill (SB) 7 from 76th session of Texas Legislature and SB 5 from 77th session of Texas Legislature	September 1, 1999 and September 1, 2001
Automotive Windshield Washer Fluid 30 TAC, Chapter 115, Subchapter G, Division 1	VOC content limitation on automotive windshield washer fluid sold, supplied, distributed, or manufactured for use in Texas	January 1, 1995
Refueling – Stage I 30 TAC, Chapter 115, Subchapter C, Division 2	Captures gasoline vapors that are released when gasoline is delivered to a storage tank Vapors returned to tank truck as storage tank is filled with fuel, rather than released into ambient air	1990
Refueling – Stage II 30 TAC, Chapter 115, Subchapter C, Division 4	Captures gasoline vapors when vehicle is fueled at pump Vapors returned through pump hose to petroleum storage tank, rather than released into ambient air	1992 (Collin, Dallas, Denton, and Tarrant Counties) A SIP revision authorizing the decommissioning of Stage II vapor control equipment was approved by the EPA on March 17, 2014. Facilities may continue operating Stage II until August 31, 2018.

Measure	Description	Start Date(s)
Federal Area/Non-Road Measures	Series of emissions limits implemented by the EPA for area and non-road sources Examples: diesel and gasoline engine standards for locomotives and leaf-blowers	Phase in through 2018
Texas Emissions Reduction Plan (TERP) 30 TAC Chapter 114, Subchapter K	Provides grant funds for on-road and non-road heavy-duty diesel engine replacement/retrofit. The first emissions reduction incentive grant projects funded under TERP were for fiscal years 2002 - 2003 (September 1, 2001, through August 31, 2003). To focus the emissions reduction benefits for the areas that needed them the most, applications were accepted only for projects in the HGB and DFW nonattainment areas for fiscal years 2002 through 2003. An application period limited to DFW, HGB, and BPA was done in 2006 and 2007. The allocation approach established by the commission for TERP included several grant programs for reducing emissions from mobile sources and encouraging the use of cleaner alternative fuels for transportation, including the Diesel Emissions Reduction Incentive Program providing grants to replace or upgrade heavy-duty on-road vehicles, non-road equipment, locomotives, marine vessels, and some stationary engines.	January 2002
California Gasoline Engines	California standards for non-road gasoline engines 25 hp and larger	May 1, 2004
Texas Low Emission Diesel (TxLED) 30 TAC Chapter 114, Subchapter H, Division 2	Requires all diesel fuel for both on-road and non-road use to have a lower aromatic content and a higher cetane number	Phased in from October 31, 2005 through January 31, 2006
Texas Low Reid Vapor Pressure (RVP) Gasoline 30 TAC Chapter 114, Subchapter H, Division 1	Requires all gasoline for both on-road and non-road use to have RVP of 7.8 pounds per square inch or less from May 1 through October 1 each year	April 2000 in Ellis, Johnson, Kaufman, Parker, Rockwall, and Wise Counties
Voluntary Mobile Emissions Reduction Program (VMEP)	Voluntary measures administered by the North Central Texas Council of Governments (NCTCOG) (see Appendix H for more details)	2007

Measure	Description	Start Date(s)
Federal On-Road Measures	Series of emissions limits implemented by the EPA for on-road vehicles Included in measures: Tier 1, Tier 2, and Tier 3 light-duty and medium-duty passenger vehicle standards, heavy-duty vehicle standards, low sulfur diesel standards, National Low Emission Vehicle standards, and reformulated gasoline	Phase in through 2010 Tier 3 phase in from 2017 through 2025
Vehicle Inspection/ Maintenance (I/M) 30 TAC Chapter 114, Subchapter C	Yearly treadmill-type testing for pre-1996 vehicles and computer checks for 1996 and newer vehicles	May 1, 2002 in Collin, Dallas, Denton, and Tarrant Counties May 1, 2003 in Ellis, Johnson, Kaufman, Parker, and Rockwall Counties The DFW area meets the FCAA, §182(b)(4) requirements to implement an I/M program , and according to 40 CFR §51.350(b)(2), an I/M program is required to cover the entire urbanized area based on the 1990 census. The current I/M program in the DFW ozone nonattainment area sufficiently covers a population equal to the DFW urbanized area, thus expansion of the I/M program to include Wise County is not required.
Environmental Speed Limit (ESL)	Five miles per hour (mph) below what was posted before May 1, 2002, on roadways where speeds were 65 mph or higher ESLs adopted by the commission in April 2000 converted to Transportation Control Measures (TCMs) by the TCEQ in August 2010	September 2001

Measure	Description	Start Date(s)
Transportation Control Measures	Various measures in NCTCOG's long-range transportation plans	2007
Voluntary Energy Efficiency/Renewable Energy	Energy efficiency and renewable energy projects encouraged by SB 5 and SB 7 from the 80th session of the Texas Legislature (See Chapter 5: *Weight of Evidence* for more details.)	December 2000

4.3 UPDATES TO EXISTING CONTROL MEASURES

4.3.1 Updates to NO_X Control Measures

Concurrent with this SIP revision, the commission is proposing rulemaking (Rule Project Number 2013-049-117-AI) to update existing control requirements for NO_X major sources in the DFW area to implement RACT. Additional detail concerning these updated control measures can be found in the RACT discussion in Section 4.5.2: *NO_X RACT Determination* of this chapter.

4.3.2 Updates to VOC Control Measures

Concurrent with this SIP revision, the commission is proposing rulemaking (Rule Project Number 2013-048-115-AI) to update existing control requirements for VOC sources in the DFW area to implement RACT. Additional detail concerning these updated control measures can be found in the RACT discussion in Section 4.5.3: *VOC RACT Determination* of this chapter.

4.3.3 New Minor Source Stationary Diesel Engine Exemption

On April 10, 2013, the commission adopted a rule revision (Rule Project Number 2012-031-117-AI) to expand the list of sources exempt from the stationary diesel engine minor source rules in 30 TAC Chapter 117, Subchapter D, Division 2. This rulemaking revised §117.2103 to include stationary diesel engines that are used exclusively for product testing and personnel training, operate less than 1,000 hours per year on a rolling 12-month basis, and meet applicable Tier emission standards for non-road engines listed in 40 Code of Federal Regulations (CFR) §89.112(a), Table 1 (October 23, 1998) in effect at the time of installation, modification, reconstruction, or relocation. The adopted exemption was narrow in scope and consistent with the similar existing exemptions for stationary diesel engines located at minor sources.

4.3.4 Decommissioning of Stage II Vapor Recovery

The Stage II vapor recovery program involves use of technology that prevents gasoline vapors from escaping during refueling of on-road motor vehicles. The EPA mandated that Stage II refueling requirements apply to all public and private refueling facilities dispensing 10,000 gallons or more of gasoline per month. The federal throughput constitutes a minimum threshold, but a state may be more stringent in adopting a throughput standard. The TCEQ applied a more stringent throughput standard in the applicable ozone nonattainment counties by requiring all facilities constructed after November 15, 1992 to install Stage II vapor recovery regardless of throughput.

The EPA currently allows the state to revise its SIP to allow the removal of Stage II gasoline vapor recovery equipment if the state can demonstrate that widespread use of on onboard refueling vapor recovery has occurred at the gasoline dispensing facilities dedicated to corporate or commercial fleets. Onboard Refueling Vapor Recovery (ORVR) systems are passive systems that force gasoline vapors displaced from a vehicle's fuel tank during refueling to be directed to a carbon-canister holding system and ultimately to the engine where they are consumed.

In the May 16, 2012 issue of the *Federal Register* (77 FR 28772), the United States EPA finalized a rulemaking for 40 Code of Federal Regulations (CFR) Part 51 determining that vehicle ORVR technology is in widespread use for the purposes of controlling motor vehicle refueling emissions throughout the motor vehicle fleet. This action allows the EPA to waive the requirement for states to implement Stage II gasoline vapor recovery systems at gasoline dispensing facilities (GDF) in nonattainment areas classified as moderate and above for the ozone NAAQS. States that have implemented a Stage II program may revise their Stage II SIP showing that the air quality will be maintained after removing the Stage II equipment.

According to the EPA's guidance document for decommissioning Stage II, it is necessary for the executive director to demonstrate under the Federal Clean Air Act (FCAA), §110(l) that air quality is not affected by the decommissioning of, or failure to install, Stage II equipment. An assessment was performed of the amount of benefit loss from removing Stage II and any effect on air quality programs in the four Texas ozone air quality planning areas using the method documented in the EPA's guidance document. It was found that removal of Stage II requirements does not interfere with attainment or maintenance of the NAAQS in the Texas air quality plans.

On October 9, 2013, the commission adopted a revision (Rule Project Number 2013-001-115-AI) to 30 TAC Chapter 115, Subchapter C, Division 4 establishing that owners and operators of gasoline dispensing facilities are no longer required to install Stage II equipment and requiring the decommissioning of Stage II equipment at all gasoline dispensing facilities no later than August 31, 2018. This adopted rule change requires that gasoline dispensing facilities electing to retain Stage II equipment until the mandatory removal date of August 31, 2018 continue to comply with current Stage II rules. A SIP revision authorizing the decommissioning of Stage II vapor control equipment was approved by the EPA on March 17, 2014.

4.3.5 Updates to Stage I Vapor Recovery

The Stage I vapor recovery rules regulate the filling of gasoline storage tanks at gasoline stations by tank trucks. To comply with Stage I requirements, a vapor balance system is typically used to capture the vapors from the gasoline storage tanks that would otherwise be displaced to the atmosphere as these tanks are filled with gasoline. The captured vapors are routed back to the tanker truck and processed by a vapor control system when the tanker truck is subsequently refilled at a gasoline terminal or gasoline bulk plant. The effectiveness of Stage I vapor recovery rules depends on the captured vapors being: effectively contained within the gasoline tanker truck during transit; and controlled when the transport vessel is refilled at a gasoline terminal or gasoline bulk plant.

On September 10, 2014, the commission adopted a revision (Rule Project Number 2013-022-115-AI) to the requirements for Stage I vapor recovery testing in 30 TAC Chapter 115, Subchapter C, Division 2. This rulemaking will preserve existing Stage I testing requirements in ozone nonattainment counties and specify Stage I testing requirements for gasoline dispensing facilities located in the 12 ozone nonattainment and four ozone maintenance counties that will be affected by the decommissioning of the Stage II vapor recovery equipment rule revision and in the 95 counties that are subject to the state Stage I rule but not Stage II requirements. The Stage I rule revision will establish testing requirements that are more consistent with federal Stage I testing in 40 CFR Part 63, Subpart CCCCCC.

4.4 NEW CONTROL MEASURES

4.4.1 Stationary Sources

4.4.1.1 NO_X RACT Control Measures for Wise County

In addition to the revised control requirements discussed in Section 4.3.1: *Updates to NO_X Control Measures* of this chapter, concurrent with this SIP revision, the commission is proposing new rules (Rule Project Number 2013-049-117-AI) to implement RACT for major stationary sources in the ten-county DFW moderate nonattainment area. Additional detail concerning these new control measures can be found in the RACT discussion in Section 4.5.2 of this chapter.

4.5 RACT ANALYSIS

4.5.1 General Discussion

Nonattainment areas classified as moderate and above are required to meet the mandates of the FCAA under §172(c)(1) and §182(b)(2) and (f). According to the EPA's proposed implementation rule for the 2008 eight-hour ozone NAAQS (78 FR 34178, June 6, 2013), states containing areas classified as moderate nonattainment or higher must submit a SIP revision to fulfill the RACT requirements for all control techniques guidelines (CTG) emission source categories and all non-CTG major sources of NO_X and VOC, and this SIP revision must contain adopted RACT regulations, certifications where appropriate that existing provisions are RACT, and/or negative declarations that there are no sources in the nonattainment area covered by a specific CTG source category. The major source threshold for moderate nonattainment areas is a potential to emit 100 tpy or more of either NO_X or VOC. The 100 tpy major source threshold applies in the newly designated Wise County. A 50 tpy major source threshold is retained for the remaining nine counties, which are currently classified as a serious nonattainment area under the 1997 eight-hour ozone NAAQS.

RACT is defined as the lowest emissions limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility (44 FR 53762, September 17, 1979). RACT requirements for moderate and higher classification nonattainment areas are included in the FCAA to assure that significant source categories at major sources of ozone precursor emissions are controlled to a reasonable extent, but not necessarily to best available control technology (BACT) levels expected of new sources or to maximum achievable control technology (MACT) levels required for major sources of hazardous air pollutants.

While RACT and RACM have similar consideration factors like technological and economic feasibility, there is a significant distinction between RACT and RACM. A control measure must advance attainment of the area towards the meeting the NAAQS for that measure to be considered RACM. Advancing attainment of the area is not a factor of consideration when evaluating RACT because the benefit of implementing RACT is presumed under the FCAA.

In 2008, the EPA approved the DFW NO_X rules in 30 TAC Chapter 117 (73 FR 73562). In 2009, the EPA approved the DFW VOC rules in 30 TAC Chapter 115 and NO_X rules for cement kilns in 30 TAC Chapter 117 as meeting the FCAA RACT requirements (74 FR 1903 and 74 FR 1927). In 2014, the EPA approved the 30 TAC Chapter 115 rules for offset lithographic printing and VOC storage tanks as meeting the FCAA RACT requirements (79 FR 45105 and 53299). State regulations in Chapter 115 that implement the controls recommended in CTG or alternative control techniques (ACT) documents or that implement equivalent or superior emission control strategies were determined to fulfill RACT requirements for any CTG or ACT documents issued prior to 2006 for the nine-county DFW 1997 eight-hour ozone nonattainment area.

The EPA issued 11 CTG documents between 2006 and 2008 with recommendations for VOC controls on a variety of consumer and commercial products. The RACT analysis included in the DFW Attainment Demonstration SIP revision for the 1997 Eight-Hour Ozone Standard adopted on March 10, 2010 addressed the following three CTG documents:

- Flat Wood Paneling Coatings, Group II issued in 2006;
- Offset Lithographic and Letterpress Printing, Group II issued in 2006; and
- Fiberglass Boat Manufacturing Materials, Group IV issued in 2008.

The RACT analysis included in the DFW Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard adopted on December 7, 2011 addressed the remaining eight CTG documents:

- Flexible Packaging Printing Materials, Group II issued in 2006;
- Industrial Cleaning Solvents, Group II issued in 2006;
- Large Appliance Coatings, Group III issued in 2007;
- Metal Furniture Coatings, Group III issued in 2007;
- Paper, Film, and Foil Coatings, Group III issued in 2007;
- Miscellaneous Industrial Adhesives, Group IV issued in 2008;
- Miscellaneous Metal and Plastic Parts Coatings, Group IV issued in 2008; and
- Auto and Light-Duty Truck Assembly Coatings, Group IV issued in 2008.

TCEQ rules that are consistent with or more stringent than controls implemented in other nonattainment areas were also determined to fulfill RACT requirements. Federally approved state rules and rule approval dates can be found in 40 CFR §52.2270(c), EPA Approved Regulations in the Texas SIP. Emission sources subject to the more stringent BACT or MACT requirements were determined to also fulfill RACT requirements.

The TCEQ reviewed the emission sources in the DFW area and the applicable TCEQ rules to verify that all CTG or ACT emission source categories and non-CTG or non-ACT major emission sources in the DFW area were subject to requirements that meet or exceed the applicable RACT requirements, or that further emission controls on the sources were either not economically feasible or not technologically feasible. Additional detail can be found in Appendix F: *RACT Analysis* of this SIP revision.

4.5.2 NO_X RACT Determination

The Chapter 117 rules represent one of the most comprehensive NO_X control strategies in the nation. The NO_X controls and reductions implemented through Chapter 117 for the nine-county DFW ozone nonattainment area encompass both RACT and beyond-RACT levels of control for the 1997 eight-hour ozone standard. The current EPA-approved Chapter 117 rules continue to fulfill RACT requirements for ACT NO_X source categories that exist in the nine counties that were previously designated nonattainment under the 1997 eight-hour ozone NAAQS. Only one new major source in a category not previously addressed by the Chapter 117 rules, a wood-fired boiler, was identified in Kaufman County. The stationary source type categories identified in Wise County are process heaters, stationary internal combustion gas-fired engines, stationary gas turbines, and one utility electric generation source. The proposed rulemaking (Rule Project No. 2013-049-117-AI) would address these source categories for Wise County and the wood-fired boiler in Kaufman County. Table F-1: *State Rules Addressing NO_X RACT Requirements in ACT Reference Documents* of Appendix F provides additional details on the ACT source categories.

For non-ACT major NO_X emission sources for which NO_X controls are technologically and economically feasible, RACT is fulfilled by existing source-specific rules in Chapter 117, other federally enforceable measures, and by proposed revisions to Chapter 117. Additional NO_X controls on certain major sources were determined to be either not economically feasible or not technologically feasible. Tables F-4: *State Rules Addressing NO_X RACT Requirements for Major Emission Sources in the Nine-County DFW Area* and F-5: *State Rules Addressing NO_X RACT Requirements for Major Emission Sources in Wise County* provide additional detail on the non-ACT major emission sources.

4.5.2.1 Wise County Major Sources

The proposed rulemaking (Rule Project No. 2013-049-117-AI) would satisfy major source RACT requirements for Wise County, which has a major source threshold of 100 tpy. Proposed new §117.405(b) in 30 TAC Chapter 117, Subchapter B, Division 4, would include the proposed new emission specifications that would apply to the following unit types at major ICI stationary sources of NO_X located in Wise County: ICI process heaters; stationary, reciprocating internal combustion engines; and stationary gas turbines. Proposed revised Subchapter C, Division 4 would include the emission specifications that would apply to units that are part of utility electric generation sources located in Wise County.

4.5.2.2 Wood-Fired Boilers

The proposed rulemaking (Rule Project No. 2013-049-117-AI) would satisfy RACT for the one wood-fired boiler located in Kaufman County in the 2012 Point Source Emissions Inventory. Proposed new §117.405(a) in 30 TAC Chapter 117, Subchapter B, Division 4, would include a proposed new emission specification for wood fuel-fired boilers in the ten-county DFW 2008 eight-hour ozone nonattainment area.

4.5.3 VOC RACT Determination

In the nine counties that were previously designated nonattainment under the 1997 eight-hour NAAQS, all VOC emission source categories addressed by CTG and ACT documents that exist in the area are controlled by existing rules in Chapter 115 or other EPA-approved regulations that fulfill RACT requirements. The proposed rulemaking (Rule Project No. 2013-048-115-AI) would address these source categories for Wise County. Tables F-2: *State Rules Addressing VOC RACT Requirements in CTG Reference Documents* and F-3: *State Rules Addressing VOC RACT Requirements in ACT Reference Documents* of Appendix F provide additional details on the CTG and ACT source categories.

The TCEQ previously submitted negative declarations for the following CTG source categories for the nine-county DFW 1997 eight-hour ozone nonattainment area, and is resubmitting these negative declarations as part of this SIP revision:

- Fiberglass Boat Manufacturing Materials;
- Manufacture of Pneumatic Rubber Tires;
- Shipbuilding and Ship Repair Surface Coating Operations;
- Flat Wood Paneling Coatings, Group II issued in 2006;
- Letterpress Printing; and
- Vegetable Oil Manufacturing.

For the newly designated Wise County, the TCEQ submits negative declarations for the following CTG source categories:

- Fiberglass Boat Manufacturing Materials;
- Graphic Arts – Rotogravure and Flexography;
- Flexible Package Printing;
- Refinery Vacuum Producing Systems and Process Unit Turnarounds;
- Manufacture of Pneumatic Rubber Tires;
- Shipbuilding and Ship Repair Surface Coating Operations;
- Flat Wood Paneling Coatings, Group II issued in 2006;
- Letterpress Printing;
- Wood Furniture Manufacturing;
- Manufacture of Synthesized Pharmaceutical Products; and
- Vegetable Oil Manufacturing.

For all non-CTG and non-ACT major VOC emission sources for which VOC controls are technologically and economically feasible, RACT is fulfilled by existing Chapter 115 rules, other federally enforceable measures, and by proposed revisions to Chapter 115. Additional VOC controls on certain major sources were determined to be either not economically feasible or not technologically feasible. Tables F-6: *State Rules Addressing VOC RACT Requirements for Major Emission Sources in the Nine-County DFW Area* and F-7: *State Rules Addressing VOC RACT Requirements for Major Emission Sources in Wise County* of Appendix F provide additional detail on the non-CTG and non-ACT major emission sources.

4.5.3.1 Wise County CTG and non-CTG Major Source RACT

The proposed rulemaking (Rule Project No. 2013-048-115-AI) would satisfy RACT requirements for Wise County, which has a major source threshold of 100 tpy. The following divisions of Chapter 115 would be revised to make the existing DFW VOC RACT rules applicable in Wise County:

- Subchapter B, Division 1, Storage of VOC;
- Subchapter B, Division 2, Vent Gas Control;
- Subchapter B, Division 3, Water Separation;
- Subchapter C, Division 1, Loading and Unloading of VOC;
- Subchapter C, Division 2, Filling of Gasoline Storage Vessels (Stage I) for Motor Vehicle Fuel Dispensing Facilities;
- Subchapter C, Division 3, Control of VOC Leaks from Transport Vessels;
- Subchapter D, Division 3, Fugitive Emission Control in Petroleum Refining, Natural Gas/Gasoline Processing, and Petrochemical Processes in Ozone Nonattainment Areas;
- Subchapter E, Division 1, Degreasing Processes;
- Subchapter E, Division 2, Surface Coating Processes;
- Subchapter E, Division 4, Offset Lithographic Printing;
- Subchapter E, Division 5, Control Requirements for Surface Coating Processes;
- Subchapter E, Division 6, Industrial Cleaning Solvents;
- Subchapter E, Division 7, Miscellaneous Industrial Adhesives; and
- Subchapter F, Division 1, Cutback Asphalt.

4.6 RACM ANALYSIS

4.6.1 General Discussion

FCAA, §172(c)(1) requires states to provide for implementation of all RACM as expeditiously as practicable and to include RACM analyses in the SIP. In the general preamble for implementation of the FCAA Amendments published in the April 16, 1992 issue of the *Federal*

Register (57 FR 13498), the EPA explains that it interprets FCAA, §172(c)(1) as a requirement that states incorporate into their SIP all RACM that would advance a region's attainment date; however, states are obligated to adopt only those measures that are reasonably available for implementation in light of local circumstances.

The TCEQ used a two-step process to develop the list of potential control strategies evaluated during the RACM analysis. First, the TCEQ compiled a list of potential control strategy concepts based on an initial evaluation of the existing control strategies in the DFW area and existing sources of VOC and NO_X in the DFW area. The EPA allows states the option to consider control measures outside the ozone nonattainment area that can be shown to advance attainment; however, consideration of these sources is not a requirement of the FCAA. A draft list of potential control strategy concepts was developed from this initial evaluation. The TCEQ also invited stakeholders to suggest any additional strategies that might help advance attainment of the DFW area. The final list of potential control strategy concepts for RACM analysis includes the strategies on the initial draft list and the strategies suggested by stakeholders during the informal stakeholder comment process.

Each control measure identified through the control strategy development process was evaluated to determine if the measure would meet established criteria to be considered reasonably available. The TCEQ used the general criteria specified by the EPA in the proposed approval of the New Jersey RACM analysis published in the January 16, 2009 issue of the *Federal Register* (74 FR 2945):

> *RACM is defined by the EPA as any potential control measure for application to point, area, on-road and non-road emission source categories that meets the following criteria:*
>
> - *The control measure is technologically feasible*
> - *The control measure is economically feasible*
> - *The control measure does not cause "substantial widespread and long-term adverse impacts"*
> - *The control measure is not "absurd, unenforceable, or impracticable"*
> - *The control measure can advance the attainment date by at least one year.*

The EPA did not provide guidance in the *Federal Register* notice on how to interpret the criteria "advance the attainment date by at least one year." Considering the December 31, 2018 attainment date for this attainment demonstration, the TCEQ evaluated this aspect of RACM based on advancing the deadline for implementing control measures by one year, to December 31, 2017.

In order for a control measure to "advance attainment," it would need to be implemented prior to the beginning of ozone season in the attainment year, so suggested control measures that could not be implemented by March 1, 2018 could not be considered RACM because the measures would not advance attainment. To "advance the attainment date by at least one year" to December 31, 2017, suggested control measures would have to be fully implemented by March 1, 2017. In order to provide a reasonable amount of time to fully implement a control measure, the following must be considered: availability and acquisition of materials; the permitting process; installation time; and the availability of and time needed for testing.

The TCEQ also considered whether the control measure was similar or identical to control measures already in place in the DFW area. If the suggested control measure would not provide substantive and quantifiable benefit over the existing control measure, then the suggested control measure was not considered RACM because reasonable controls were already in place. Tables G-1: *DFW Area Stationary Source RACM Analysis* and G-2: *DFW Area On-Road and Non-Road Mobile Source RACM Analysis* of Appendix G: *RACM Analysis* presents the final list of potential control measures as well as the RACM determination for each measure.

4.6.2 Results of the RACM Analysis

Based on the RACM analysis, the TCEQ determined that no potential control measures met the criteria to be considered RACM. All potential control measures evaluated for stationary sources were determined to not be RACM due to technological or economic feasibility, enforceability, adverse impacts, or ability of the measure to advance attainment of the NAAQS. In general, the inability to advance attainment is the primary determining factor in the RACM analyses. As discussed in Chapter 3: *Photochemical Modeling* and Chapter 5: *Weight of Evidence* of this SIP revision, modeling shows that the projected 2018 design value of 76 parts per billion (ppb) for the DFW area is expected to be within the weight of evidence range for the 2008 eight-hour ozone. A control measure would have to be in place prior to the beginning of ozone season in the attainment year to be considered RACM, or March 1, 2018. Furthermore, a control measure would have to be in place by March 1, 2017 in order for the measure to advance the attainment date by one year; and it is not possible for the TCEQ to reasonably implement any control measures that would provide for earlier attainment of the NAAQS.

4.7 MVEB

The MVEB refers to the maximum allowable emissions from on-road mobile sources for each applicable criteria pollutant or precursor as defined in the SIP. The budget must be used in transportation conformity analyses. Areas must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed the MVEB. The attainment budget represents the on-road mobile source emissions that have been modeled for the attainment demonstration, and includes all of the on-road control measures reflected in Chapter 4 of the demonstration. The on-road emission inventory establishing this MVEB was developed with the 2010b version of the Motor Vehicle Emission Simulator (MOVES) model, and is shown in Table 4-2: *2018 Attainment Demonstration MVEB for the 10-County DFW Area*. For additional detail, refer to Chapter 3 of Appendix B*: Emissions Modeling for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard*. The EPA released the updated version of MOVES, MOVES2014, on July 31, 2014. The schedule for the inventory development for this SIP revision did not allow time to incorporate MOVES2014. The TCEQ is working with the NCTCOG to develop a 2018 on-road emission inventory with MOVES2014 for the 10-county DFW area. Provided that there are no issues with the MOVES2014 model, the updated inventories may replace the current MVEB referenced in Table 4-2.

Table 4-2: 2018 Attainment Demonstration MVEB for the 10-County DFW Area

10-County DFW Area On-Road Emissions Inventory Description	NO_X (tpd)	VOC (tpd)
2018 On-Road MVEB Based on MOVES2010b	113.36	55.63

4.8 MONITORING NETWORK

The TCEQ operates a variety of monitors in support of assessing ambient air quality throughout the state of Texas. These monitors meet the requirements for several federally required networks including the State and Local Air Monitoring Stations network (SLAMS), Photochemical Assessment Monitoring Stations network, Chemical Speciation Network, National Air Toxics Trends Stations network, and National Core network (NCore).

The Texas annual monitoring network plan provides information on ambient air monitors established to meet federal ambient monitoring requirements including comparison to the NAAQS. The plan presents the current Texas network, as well as proposed changes to the network from July 1, 2013, through December 31, 2015. Under 40 CFR §58.10, all states are required to submit an annual monitoring network plan to the EPA by July 1 of each year. The annual monitoring network plan is made available for public inspection for at least 30 days prior to submission to the EPA. The plan and any comments received during the 30 day inspection period are forwarded to the EPA for final review and approval.

The current DFW area monitoring network in 2014 includes 20 regulatory ozone monitors. There are 17 ozone monitors located in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties and an additional three ozone monitors in Navarro, Hood, and Hunt Counties. TCEQ ensures compliance with monitoring siting criteria and data quality requirements for these and all other federally required monitors in accordance with 40 CFR Part 58. TCEQ utilizes this data to to support determinations regarding air quality in the DFW area.

4.9 CONTINGENCY PLAN

AD SIP revisions for nonattainment areas are required by FCAA, §172(c)(9) to provide for specific measures to be implemented should a nonattainment area fail to meet reasonable further progress (RFP) requirements or attain the applicable NAAQS by the EPA's prescribed attainment date. If these conditions are not met, these contingency measures are to be implemented without further action by the state or the EPA. In the General Preamble for implementation of the FCAA Amendments of 1990 published in the April 16, 1992 issue of the *Federal Register* (57 FR 13498), the EPA interprets the contingency requirement to mean additional emissions reductions that are sufficient to equal up to 3% of the emissions in the adjusted base year inventory. These emissions reductions should be realized in the year following the year in which the failure is identified (i.e., an RFP milestone year or attainment year).

This 2008 eight-hour ozone AD SIP revision uses the adjusted base year inventory as the inventory from which to calculate the required 3% reduction for contingency. The 3% contingency analysis for 2019 is based on a 3% reduction in NO_X, with no emissions reductions coming from VOC, to be achieved between 2018 and 2019. Emissions inventories analyses were performed on the fleet turnover effects for the federal emissions certification programs for on-road and non-road vehicles. The emissions reductions from 2018 through 2019 were estimated for those programs. A summary of the 2019 contingency analysis is provided in Table 4-1*: 2019 DFW Attainment Demonstration Contingency Demonstration (tons per day)*. The analysis demonstrates that the 2019 contingency reductions exceed the 3% reduction requirement; therefore, the attainment demonstration contingency requirement is fulfilled for the DFW area.

The on-road mobile source category emissions inventories and control reductions, which are components of the contingency demonstration calculations for this AD SIP, were developed using the MOVES2010b model. However, the EPA released the updated version of MOVES, MOVES2014, on July 31, 2014. The schedule for the inventory development for this DFW AD SIP revision did not allow time to incorporate MOVES2014. The TCEQ is working with the NCTCOG to develop 2011, 2017, 2018, and 2019 on-road emission inventories using MOVES2014 for the DFW area, which will replace the on-road components of the contingency calculations referenced in this section. The planning assumptions, fleet characteristics, and VMT estimates will also be updated to incorporate the latest available information at the time the inventories are developed. It is expected that the final milestone year and attainment year-AD contingency demonstrations would be different than those reported in this SIP proposal. As a result, the SIP narrative may change between proposal and adoption.

Table 4-3: 2019 DFW Attainment Demonstration Contingency Demonstration (tons per day)

Contingency Element Description	NO_X	VOC
2018 10 DFW nonattainment counties, adjusted base year (ABY) emissions inventory (EI)	447.56	482.26
Percent for contingency calculation (total of 3%)	3.00	0.00
2018 to 2019 AD required contingency reductions (ABY EI x contingency percent)	13.43	0.00
Excess reductions from 2018 attainment demonstration	0.00	0.00
Subtract reductions reserved for 2018 attainment demonstration MVEB safety margin	0.00	0.00
Federal Motor Vehicle Control Program (FMVCP), inspection and maintenance (I/M), reformulated gasoline (RFG), East Texas Regional Low Reid Vapor Pressure Gasoline Program and TxLED	31.38	11.24
Federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	9.12	4.70
Total attainment demonstration contingency reductions	**40.50**	**15.94**
Contingency Excess (+) or Shortfall (-)	**+27.07**	**+15.94**

4.10 REFERENCES

EPA, 1993. NO_X Substitution Guidance (http://www.epa.gov/ttncaaa1/t1/memoranda/noxsubst.pdf)

EPA, 2005. Clean-Fuel Vehicle Standards, no. CCD-05-1

CHAPTER 5: WEIGHT OF EVIDENCE

5.1 INTRODUCTION

The corroborative analyses presented in this chapter demonstrate the progress that the Dallas-Fort Worth (DFW) area is making towards attainment of the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS) of 75 parts per billion (ppb). Information that supplements the photochemical modeling is presented to support a conclusion that the DFW area will reach attainment of the 2008 eight-hour ozone standard by December 31, 2018. The United States Environmental Protection Agency's (EPA) *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze* (EPA, 2007) states that all modeled attainment demonstrations should include supplemental evidence that the conclusions derived from the basic attainment modeling are supported by other independent sources of information. This chapter details the supplemental evidence, i.e., the corroborative analyses, for this attainment demonstration.

This chapter describes analyses that corroborate the conclusions of Chapter 3: *Photochemical Modeling*. First, information regarding trends in ambient concentrations of ozone, ozone precursors, and reported emissions in the DFW area is presented. Analyses of ambient data and reported emissions trends corroborate the modeling analyses and independently support the attainment demonstration. An overview is provided of background ozone levels transported into the DFW area. More detail on these ozone and emission trends is provided in Appendix D: *Conceptual Model for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard*. Second, this chapter also discusses the results of additional air quality studies and their relevance to the DFW attainment demonstration. Third, this chapter describes air quality control measures that are not quantified but are nonetheless expected to yield tangible air quality benefits, even though they were not included in the attainment demonstration modeling discussed in Chapter 3: *Photochemical Modeling*. Finally, information is provided to inform the public regarding on-going initiatives that are expected to improve the scientific understanding of ozone formation in the DFW area.

5.2 ANALYSIS OF AMBIENT TRENDS AND EMISSION TRENDS

Section 7.0 of the currently available EPA modeling guidance from 2007 states that a simple way to qualitatively assess progress toward attainment is to examine recently observed air quality and emissions trends. Downward trends in observed air quality and in emissions (past and projected) are consistent with progress toward attainment. The strength of evidence produced by emissions and air quality trends is increased if an extensive monitoring network exists, which is the case in an area like DFW that currently has 20 operational monitors for ozone, 15 for nitrogen oxides (NO_X), and 15 automated gas chromatographs (Auto-GCs) for volatile organic compounds (VOC). More detail on these specific locations and pollutants measured per monitor can be found on the TCEQ Air Monitoring Sites Web page. This section examines the emissions and ambient trends from the extensive ozone and ozone precursor monitoring network in the DFW area. Despite a continuous increase in the population of the 10-county DFW area, a strong economic development pattern, and other factors that includes, but is not limited to, growth in vehicle miles traveled (VMT), the observed emission trends are downward for ozone and its precursors of nitrogen oxides (NO_X) and volatile organic compounds (VOC). More details regarding ambient and emissions trends are included in Appendix D.

Appendix D provides an extensive set of graphics that detail ozone trends in the region from 1991 through 2013. The graphics and analyses also illustrate the wealth of monitoring data examined including regulatory ozone monitors and a network of Auto-GCs. The one-hour and the eight-hour ozone design values both have overall sustained decreasing trends over the past

17 years. The DFW area has monitored attainment of the revoked one-hour ozone standard since 2006 and is making continued progress towards attaining the 1997 eight-hour ozone standard. While there was a two-year period of small changes in the eight-hour design value, the ozone design value for the area is 81 ppb as of mid-October 2014. The fourth highest ozone value for 2014 would have to be in excess of 89 ppb at Denton Airport South to keep the area out of attainment for the 1997 standard, but the fourth highest value as of mid-October 2014 was 77 ppb. No monitor in the region had measured a fourth high in 2014 above the 1997 standard of 84 ppb, and only two had fourth highs in 2014 above the 2008 ozone standard of 75 ppb.

An analysis conducted by the TCEQ and presented at a DFW area air quality technical meeting in November 2013 graphically shows changes in design value by monitor over the period 2003 through 2013 with the largest reduction of design values at the northwestern area monitors that historically have recorded the highest ozone levels. For example, the Keller monitor design value dropped 15 ppb in that period and Grapevine Fairway dropped 14 ppb. Additional analyses tracked the historic fourth highest eight-hour ozone levels at five northwest DFW monitors from 2001 to 2013. When 2012 and 2013 are examined, there is a strong suggestion that the 2011 fourth highest levels monitored may be outliers in the downward trend. These 2011 fourth-high values are included in the DFW area design value calculations from 2011 through 2013, but are not part of the 2014 design value determination. The ozone measurements to date in 2014 combined with the overall historic ozone trends at all DFW area monitors suggest that the region will reach attainment of the 2008 standard by the required attainment date of December 31, 2018.

As documented in Chapter 2: *Anthropogenic Emissions Inventory Description* of this SIP revision, emissions trends examined through reported and developed inventories support the downward trends in ozone and ozone precursors observed through the measurements of pollutant concentrations at monitors. While NO_X emissions are more significant in the formation of ozone in the DFW area, VOC trends are examined as well. On-road mobile sources are the single largest contributors to NO_X emissions in the DFW area. According to the TCEQ emissions inventory estimates for 2011, on-road mobile represents 54% of the total NO_X for the DFW area, non-road and off-road mobile accounts for 26.3%, area sources account for 10.3%, and point sources account for 9.1%. The downward trend in total NO_X emissions is in large part due to the downward trends in NO_X emissions from on-road mobile sources, which the TCEQ has limited ability to control. Even though human population and VMT in the DFW area have increased since 1999, NO_X emission trends from on-road mobile sources as well as total NO_X emissions have decreased since 1999, due largely due to targeted emissions reductions strategies implemented by state rules, federal measures, and local initiatives. Mobile strategies are listed with all existing DFW emission reduction strategies in Table 4.1: *Existing Ozone Control Measures Applicable to the DFW Nine-County Nonattainment Area* of this SIP revision. NO_X emissions from point sources, over which the TCEQ does have more direct regulatory control compared with mobile sources, have shown decreases of 62% over the past 16 years. Ambient NO_X monitoring data corroborate these trends in reported emissions, with decreases in ambient NO_X monitoring concentrations observed in the DFW area over the past 17 years.

Since the mid-1990s, the TCEQ has collected 40-minute measurements on an hourly basis of up to 58 VOC compounds using Auto-GC instruments. These instruments automatically measure and report chemical compounds resident in ambient air. The TCEQ has also employed two types of ambient monitoring canisters in the DFW area, one that samples ambient air over a 24-hour period and another that samples ambient air for a single hour at a time, usually at four different times of day. Since 1999, peak VOC concentrations above the 90th percentile have generally trended downward. During the same time period, mean VOC concentrations trended downward until roughly 2005 and have been relatively constant since 2006. On-road VOC emission trends discussed later in this chapter show a more distinct downward trend for 1999-2005 than for 2006-and-later years. Ozone formation in DFW is much more sensitive to anthropogenic NO_X than to anthropogenic VOC. This is due to the primarily NO_X-limited character of ozone formation in DFW, coupled with an abundance of naturally occurring reactive VOC from biogenic sources, such as isoprene emitted by oak trees. Much of the anthropogenic VOC emitted in the DFW area is in the form of compounds with relatively low reactivity such as ethane and propane. Appendix D provides more detail on these VOC trend analyses and their impacts on ozone formation in DFW.

The Anthropogenic Precursor Culpability Assessment (APCA) and Ozone Source Apportionment Technology (OSAT) analyses detailed in Chapter 3 and Appendix C: *Photochemical Modeling for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard* indicate that emission sources outside of the 10-county DFW area also contribute to the eight-hour ozone concentrations within the 10-county DFW area. On average, the ozone produced outside of the DFW area, in addition to the natural background ozone, accounts for a large portion of the maximum ozone concentrations within the DFW area. Analyses (Berlin et al., 2013; Cooper et al., 2012) suggest that background ozone is trending downward across the United States (U.S.), which can reduce peak ozone in the DFW area. The EPA Air Quality Trends Web page highlights the significant percent changes in NO_X reductions between 2000 and 2012. Some of these NO_X reductions can be attributed to strategies implemented in Texas. For example, electric generating units (EGU) in the counties east of the DFW area, which is the area that is predominately upwind on high ozone days, have reduced emissions of NO_X by about 58% over the past 16 years.

As part of the examination of emissions trends, it is also important to examine the variability of NO_X concentrations by the day of the week. As discussed in Chapter 3, NO_X concentrations are lower on Saturdays and Sundays compared to weekdays. The lower concentrations of ozone precursors on weekends are likely due to the absence of morning commuter traffic during that time. This finding further supports the conclusion that lowering NO_X reduces ozone since NO_X is the primary precursor in ozone formation when naturally occurring reactive VOC from biogenic sources is abundant.

The VOC or NO_X limitation of an air mass is an important way to evaluate how immediate reductions in VOC and NO_X concentrations affect ozone concentrations. A detailed analysis of the DFW area's NO_X or VOC limitation is included in Appendix D. Ozone responds best to VOC reductions in VOC-limited areas and to NO_X reductions in NO_X-limited areas. In transitional areas, both VOC and NO_X reductions should be effective. Analysis of VOC to NO_X ratios indicates that the urban core of the DFW area is transitional and trending towards NO_X-limitation, while the more rural parts of the DFW area are NO_X-limited and are trending towards more strongly NO_X-limited. Because the DFW area overall is trending towards NO_X-limited and the northwest locations of the design value setting monitors are NO_X-limited, this result also supports reducing NO_X as a method to control ozone overall in the DFW area.

It is more difficult to control ozone in the urban core because the emissions in that area, which is transitional and not strongly NO_X-limited, are primarily from on-road mobile sources, for which the TCEQ has limited authority to regulate. However, both state and federal regulation have resulted in estimated downward trends in NO_X emission and VOC emissions over the past 15 years from on-road and non-road mobile emission inventories. These reductions have contributed to the downward trend in ozone levels monitored within the urban core during the same 15 year period. More detail regarding emissions trends can be found in Chapter 3 as well as in Section 5.2.2.1: *NO_X Emission Trends* of this chapter. The ambient ozone and emissions trends briefly discussed above lead to the following conclusions:

- Emissions of NO_X, VOC, and their monitored ambient concentrations have been decreasing across the DFW area, despite a rapidly expanding population and strong continued economic development over a sustained period as documented by the Federal Reserve Bank of Dallas Economic Indicators, which are available at http://www.dallasfed.org/research/update/dfw/index.cfm.
- Observed NO_X concentrations and reported NO_X emissions are both trending downward, which suggests lower ozone concentrations should follow in an area that is primarily NO_X-limited.
- The decrease in NO_X emissions is largely due to reductions of on-road and non-road mobile sources, which are the largest source of NO_X in the DFW area. The reductions can be attributed to an increasingly modern and cleaner motor vehicle fleet, as well as implementation of on-road control programs such as inspection/maintenance (I/M) and Texas Low Emission Diesel (TxLED). In addition, controls on point sources both in the DFW area and statewide have contributed to these NO_X reductions.
- Modeled emissions from on-road and non-road mobile sources as well as trend analyses indicate that NO_X concentrations will continue trending downward out to the attainment year of 2018 and beyond.
- The one-hour ozone design value has decreased over the past few years to 108 parts per billion (ppb). The eight-hour ozone design value decreased from 100 ppb in 2003 to 87 ppb in 2013. As of mid-October 2014, the eight-hour design value for DFW is 81 ppb.
- Given the currently implemented control programs, total DFW area NO_X in 2018 is expected to be reduced by roughly 50% from 2006 levels, with projected NO_X reductions of 57% for on-road sources and 55% for non-road sources. More detail is contained in Chapter 3 on these expected reductions from 2006 to 2018.

5.2.1 Ozone Design Value and Background Ozone Trends

As noted above, eight-hour ozone design values have decreased over the past 17 years, as shown in Figure 5-1: *One-Hour and Eight-Hour Ozone Design Values in the DFW Area from 1991 through 2013*. The 2013 one-hour ozone design value is 108 ppb, which demonstrates continued attainment of the revoked one-hour ozone National Ambient Air Quality Standard (NAAQS). The 2013 eight-hour ozone design value for the DFW area is 87 ppb and occurred at Denton Airport South. This monitor is located to the north-northwest of the DFW area, which is downwind of the urban core considering prevailing winds. As of mid-October 2014, this Denton Airport South monitor design value is 81 ppb.

The trend line for the one-hour ozone design value shows a decrease of about 2.1 ppb per year, but the trend line for the eight-hour ozone design value only shows a decrease of about 1.1 ppb per year. The one-hour ozone design values decreased about 22% from 1991 through 2013 and the eight-hour ozone design values decreased about 16% over that same time. The slower change in the eight-hour ozone design values compared to the one-hour ozone design values could relate to the background ozone, which appears to affect the eight-hour ozone much more than the one-hour ozone.

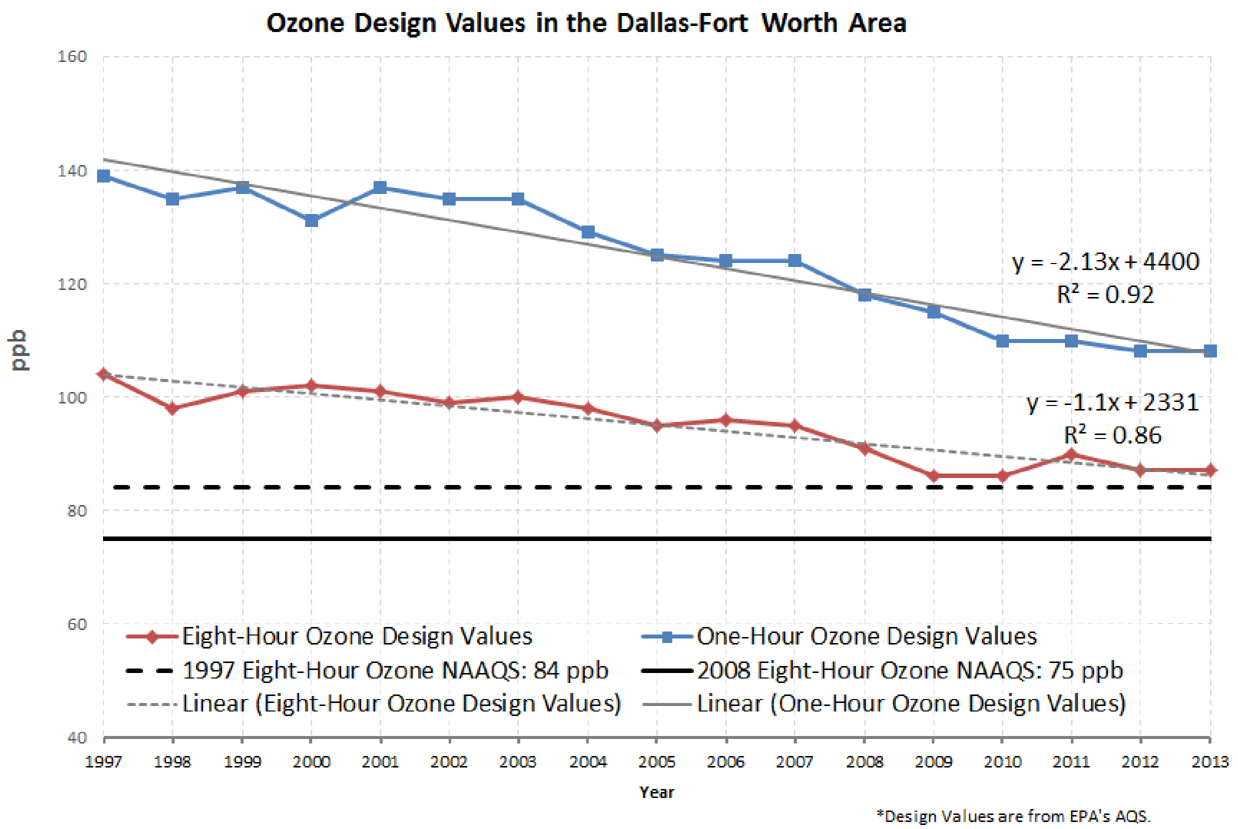

Figure 5-1: One-Hour and Eight-Hour Ozone Design Values in the DFW Area from 1991 through 2013

A background ozone trend analysis was conducted to define background ozone and the ozone concentration carried into the DFW area. Background ozone reflects the ozone produced from all sources outside of the 10-county DFW nonattainment area. Continental and natural background ozone concentrations are generally assumed to be about 40 ppb. Ozone levels in the DFW area are the sum of the background ozone entering the area and the locally produced ozone. The local ozone contribution is found by subtracting the background ozone concentration from the maximum ozone concentration.

To obtain the background ozone concentrations, monitors outside of the urban core were identified. The analysis used the months of May through September, the peak of ozone season, for years 1997 through 2013. Out of this subset of background ozone monitors, the minimum ozone concentration that occurred during the time the maximum ozone concentration was measured was determined. This minimum ozone concentration is considered the background ozone for the DFW area (Nielson-Gammon et al., 2004). Figure 5-2: *Eight-Hour Ozone in the DFW area from 1998 through 2003 (Nielson-Gammon et al., 2004)* shows that in the DFW area, the average background ozone contribution is a larger part of the maximum eight-hour ozone than the local ozone contribution. The inter-seasonal variability in the peak ozone concentrations seems to come from the seasonal variability in the background ozone concentrations as opposed to the local ozone contributions (Nielson-Gammon et al., 2004). Because background ozone contributes a large portion of the total eight-hour ozone in the DFW area, it would be difficult to see large decreases in the eight-hour ozone concentration if the background ozone does not also decrease.

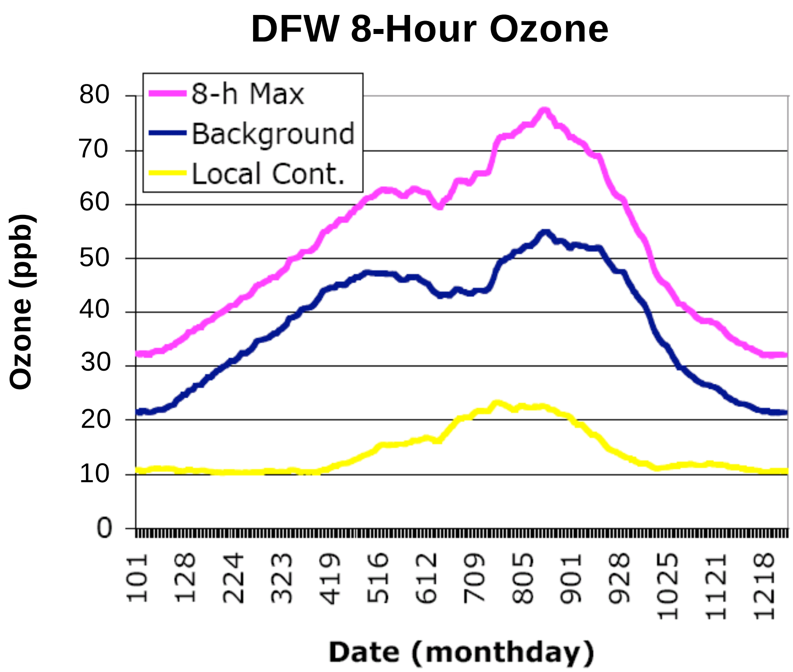

Figure 5-2: Eight-Hour Ozone in the DFW area from 1998 through 2003 (Nielson-Gammon et al., 2004)

Using a similar method, a background eight-hour ozone analysis was conducted for the 1997 through 2013 period to determine the background trend. Results from this analysis are shown in Figure 5-3: *DFW Background Ozone for 1997 through 2013*. The findings show that there is a slight downward trend in the background ozone. The percent change in average background ozone from 1997 to 2013 is 4.51% and the percent change in the 95th percentile average ozone concentrations is 5.67% over that same time. The current estimated average background ozone in the DFW area is 52 ppb, but can vary greatly depending on the day of interest.

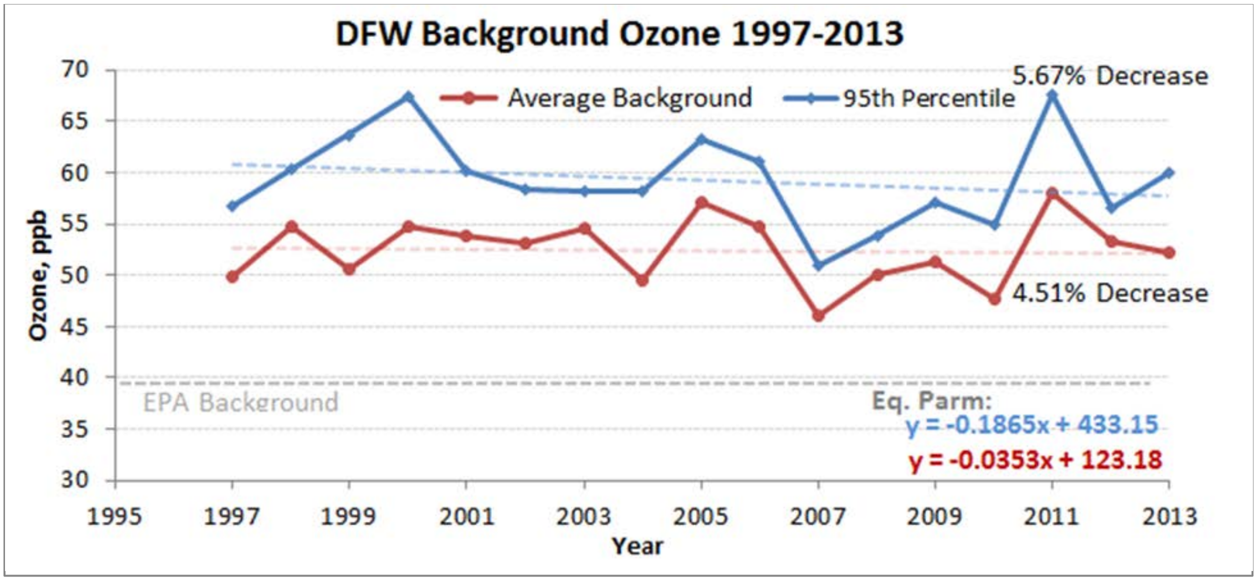

Figure 5-3: DFW Background Ozone for 1997 through 2013

5.2.2 NO_X Trends

NO_X, a precursor to ozone formation, is a mixture of nitrogen oxide and nitrogen dioxide (NO_2). NO_X is primarily emitted by fossil fuel combustion, lightning, biomass burning, and soil (Martin, et al., 2006). Examples of common NO_X emission sources in urban areas are automobiles, diesel engines, other small engines, residential water heaters, industrial heaters, flares, and industrial and commercial boilers. Mobile, residential, and commercial NO_X sources are usually numerous smaller sources distributed over a large geographic area, while industrial sources are usually large point sources, or numerous small sources, clustered in a small geographic area. Because of the large number of NO_X sources, elevated ambient NO_X concentrations can occur throughout the DFW area. This section will discuss trends in both NO_X emissions and ambient NO_X concentrations.

5.2.2.1 NO_X Emission Trends

DFW area anthropogenic emissions are from the following four aggregate categories: point sources, on-road mobile sources, non-road mobile sources, and area sources. Specific industry types can be categorized under one or more of these aggregate groups. The data used in this trend analysis come from several sources. Companies in the DFW area report annual point source emissions inventory (EI) data. The Texas Transportation Institute (TTI) prepared the on-road mobile source emission inventories for the TCEQ. The TCEQ prepared the area and the non-road mobile source data for 2006 and 2018 using EPA-approved models and techniques.

The annually reported point source NO_X emissions from 1997 through 2012 are shown in Figure 5-4: *Reported Point Source NO_X Emissions for the 10-County DFW Area*. The emissions are reported in tons per year (tpy) and are aggregated by year. The aggregation is of all NO_X sources located within the 10 counties of the DFW nonattainment area. The graph shows an overall downward trend in NO_X emissions and the pattern closely matches that of the observed NO_X concentrations at the DFW area monitors, which will be shown later in this document.

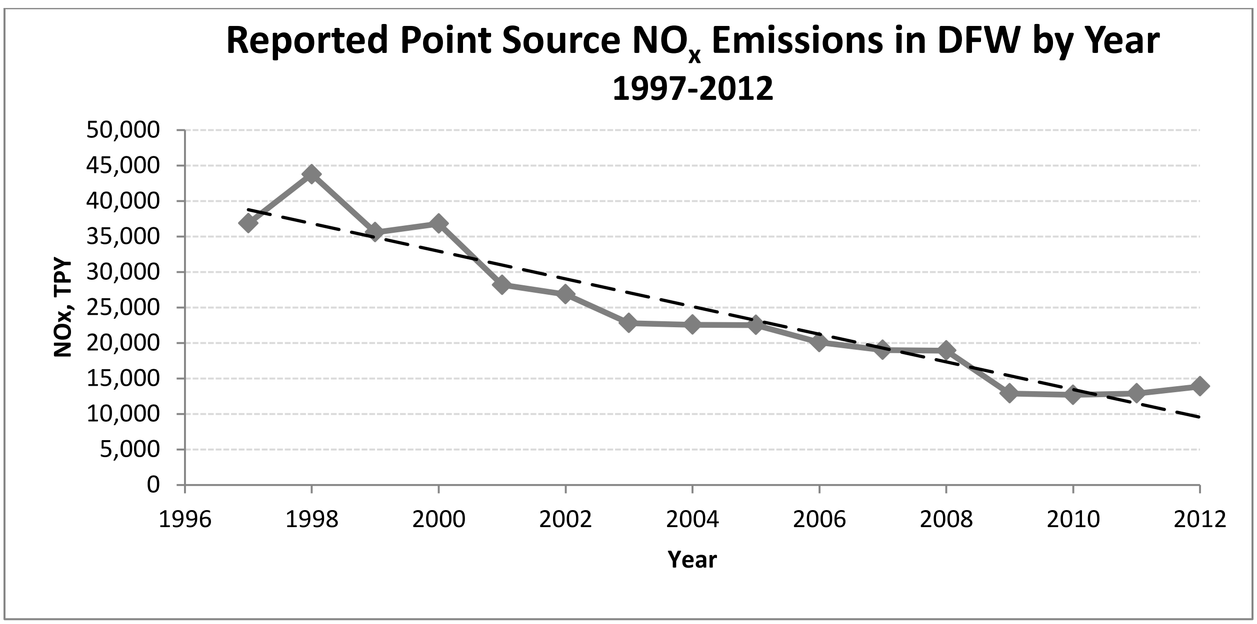

Figure 5-4: Reported Point Source NO_X Emissions for the 10-County DFW Area

Historically, much of the point source NO_X emission reductions have come from cement kilns located within Ellis County. In 2007, a source cap for cement kilns in Ellis County was adopted (30 Texas Administrative Code §117.3123). In 2008, 2010, and 2011, further reductions were achieved with changes in cement kiln operations and shutdown of certain processes and kilns. In large part, the downward trends in reported emissions are attributable to the reductions and facility shutdowns in Ellis County.

The decrease in point source NO_X emissions from 1997 through 2012 is seen more clearly in Figure 5-5: *Reported Point Source NO_X Emissions by DFW County*. Ellis County reports the greatest amounts of point source NO_X emissions as well as the greatest reductions in point source NO_X emissions. A large portion of these reductions took place from 2006 to 2009. Other large reductions in point source NO_X emissions can be seen in Dallas and Tarrant Counties due to the implementation of many of the point source rules summarized in Table 4-1: *Existing Ozone Control Measures Applicable to the DFW Nine-County Nonattainment Area*. The remaining counties consistently report substantially lower point source NO_X emissions, with no appreciable trend over the 2006 to 2009 period. Since Wise County was designated nonattainment in 2012, some facilities have only recently started to report as point sources because they exceed the 25 NO_X tons per year (tpy) and/or 10 VOC tpy thresholds applicable to nonattainment counties. Newly reported NO_X sources in Wise County are reflected by a small increase in the point source NO_X emission totals for the 2011 and 2012 periods.

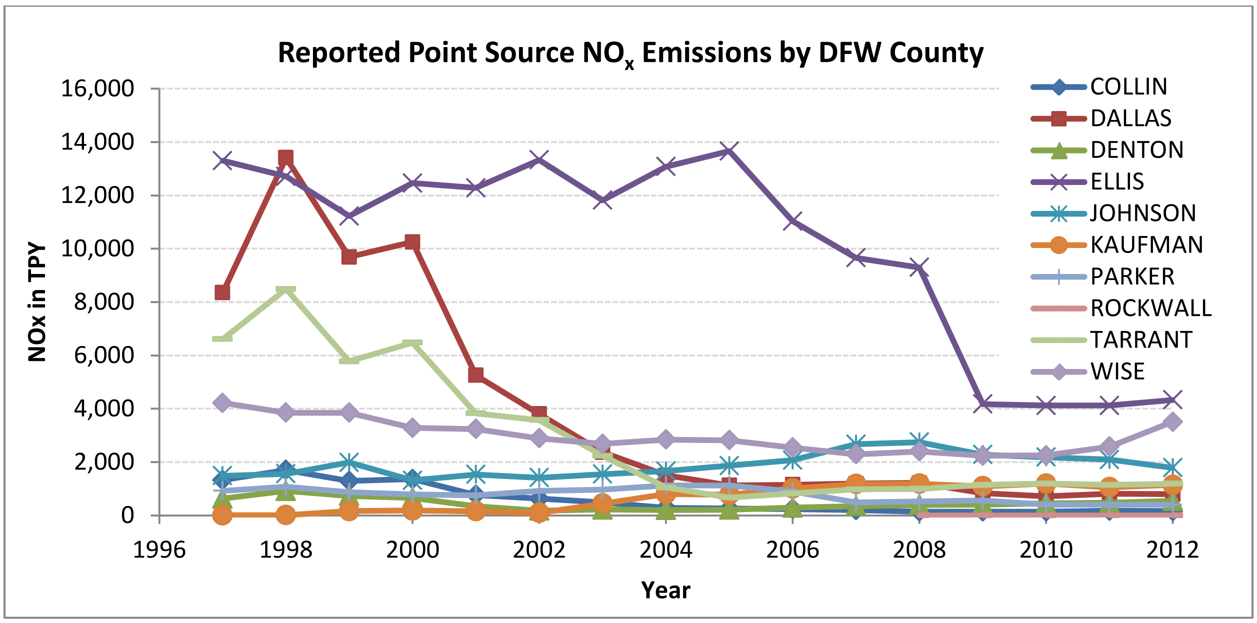

Figure 5-5: Reported Point Source NO_X Emissions by DFW County

Other point sources of NO_X are EGUs located within and outside of the DFW area. NO_X emissions from EGUs are displayed in Figure 5 6: *Trends in EGU NO_X Emissions in the DFW 10-County Area* and show a downward trend due to the implementation of EGU rules described in Table 4-1. NO_X emissions from EGUs in the 10-county DFW area have decreased by 88.9% from 1997 through 2012.

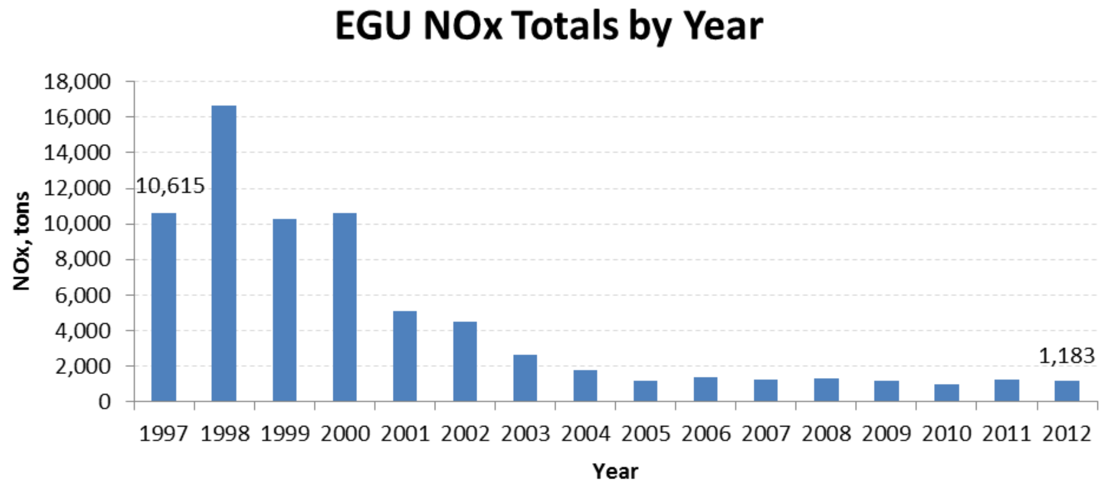

Figure 5-6: Trends in EGU NO_X Emissions in the DFW 10-County Area

On-road mobile sources are the biggest contributor to NO_X emissions in the DFW area. With on-road mobile NO_X sources accounting for over half of the total NO_X emissions in the DFW area, it is important to discuss the trends in NO_X emissions for this source category. TTI has estimated the emissions of NO_X, VOC, carbon monoxide (CO) and VMT from 1999 through 2030 using the 2010a version of EPA's Motor Vehicle Emission Simulator (MOVES2010a) model. Figure 5-7: *MOVES2010a 10-County DFW Area On-Road Emission Trends for 1999 through 2030* shows the results of this work from TTI. The estimates show that NO_X emissions have and will continue to decrease through to year 2028, though at different rates over time. These emission decreases occur even though VMT is projected to increase out to 2030 because cleaner newer vehicles will continuously replace higher-emitting older ones. The downward trend in NO_X emissions from on-road sources mirrors the trends in ambient NO_X concentrations observed at urban monitors, which will be discussed in the following section. If the downward trend in on-road NO_X emissions continues as projected, observed NO_X concentrations would be expected to decrease as well, thus reducing ozone-producing precursors in the DFW airshed.

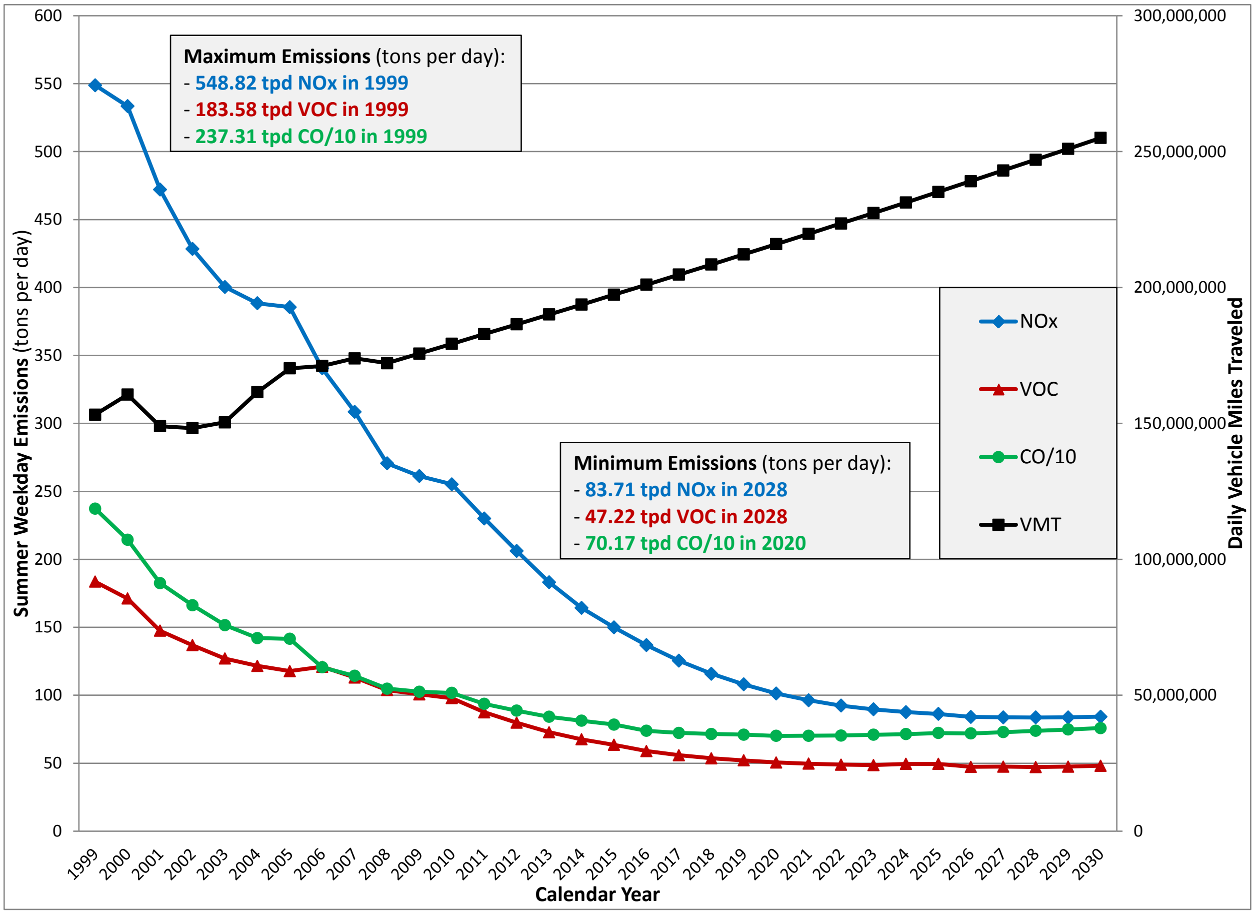

Figure 5-7: MOVES2010a 10-County DFW Area On-Road Emission Trends for 1999 through 2030

Similar to on-road, the non-road source category contributes sufficient amounts to total NO_X emissions in the DFW area. Emission projections of non-road NO_X emissions were estimated using the Texas NONROAD (TexN) model, and are shown in Figure 5-8: *TexN DFW Area Non-Road Emission Trends for 2000 through 2050*. The results show that NO_X emissions from non-road sources will decrease through year 2031, though at different rates over time. Since on-road and non-road NO_X sources account for the vast majority of NO_X emissions in the DFW area, and since these two source categories are projected to have continuously lower emissions over the next several years, and because ozone production is dependent on NO_X emissions, it is expected that future ozone concentrations will also be reduced.

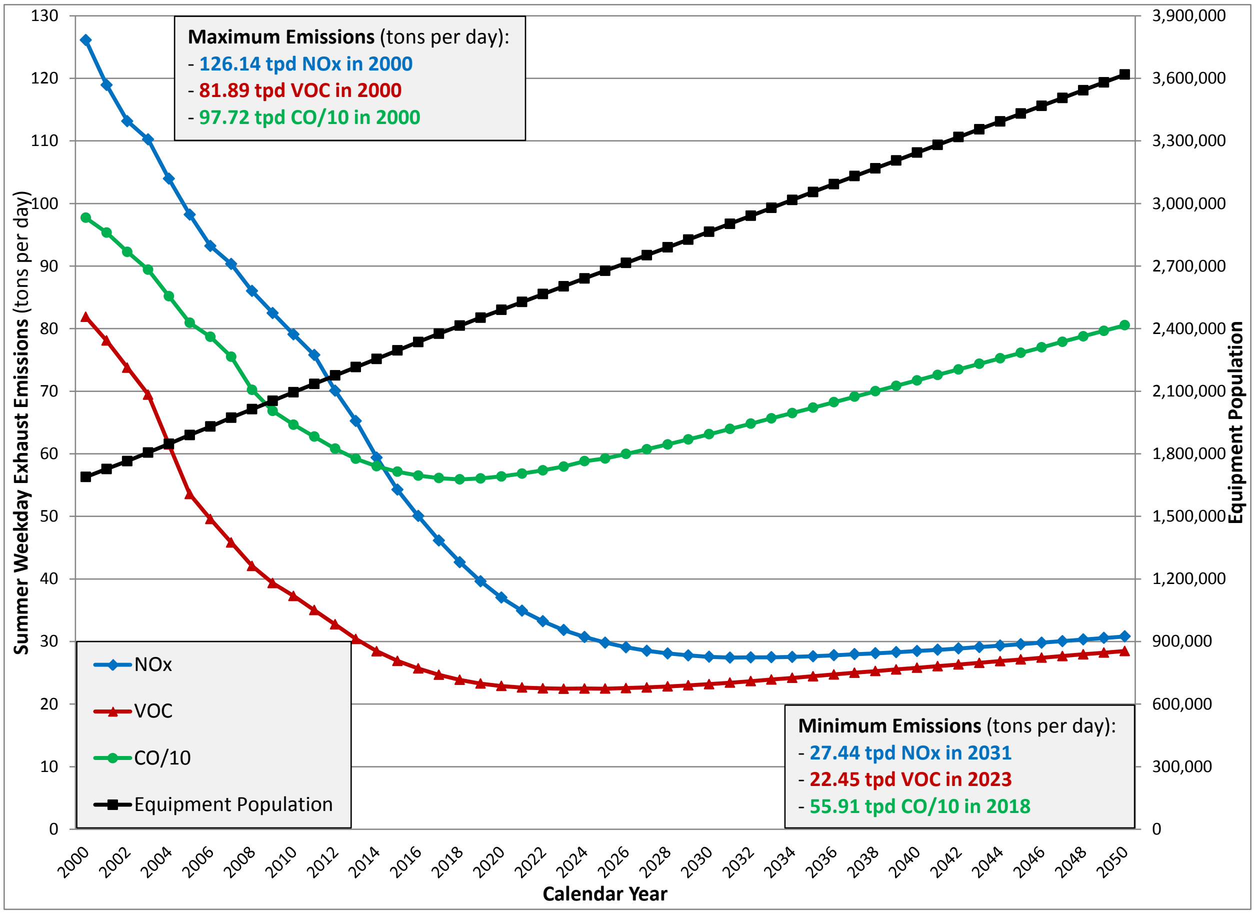

Figure 5-8: TexN DFW Area Non-Road Emission Trends for 2000 through 2050

5.2.2.2 Ambient NO_X Trends

Trends for ambient NO_X concentrations are presented in Figure 5-9: *Ozone Season (March through October) Daily Peak NO_X Trends in the DFW Area*. Trends are for the ozone season (March through October) and represent the 90th percentile, the 50th percentile, and the 10th percentile of daily peak NO_X concentrations in the DFW area. The largest NO_X concentrations and the median NO_X concentrations in the DFW area appear to be decreasing over time, while the 10th percentile concentrations have remained flat. A dotted line is provided to highlight the trend in ambient NO_X concentrations.

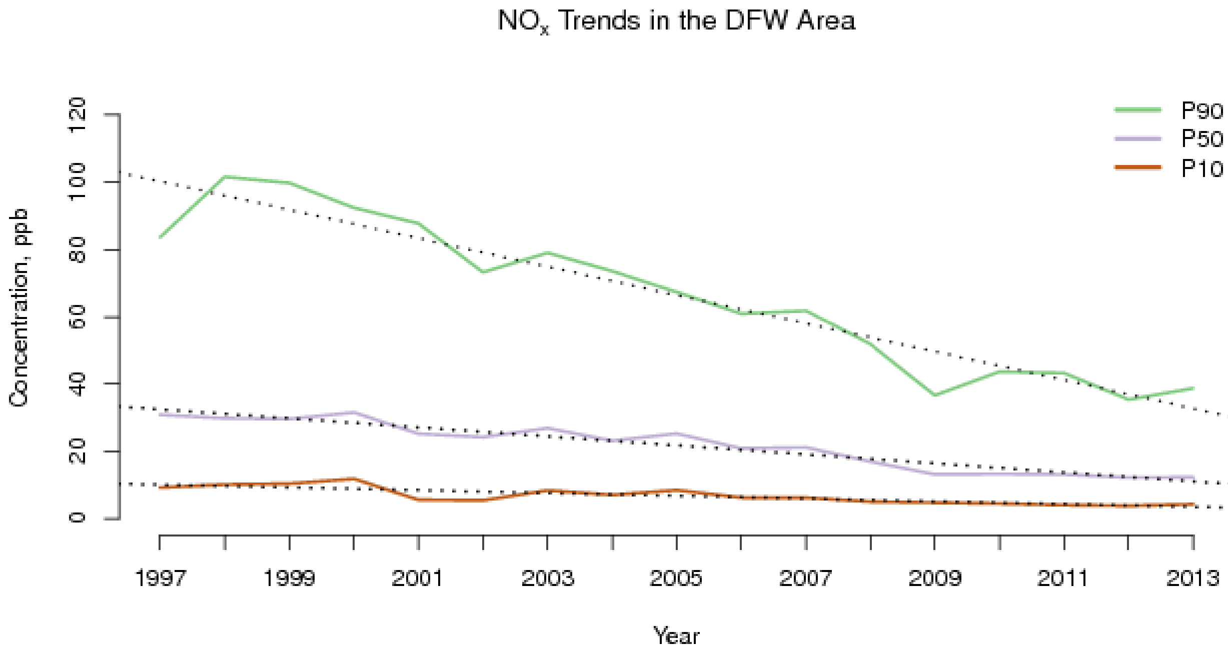

Figure 5-9: Ozone Season (March through October) Daily Peak NO_X Trends in the DFW Area

The NO_X trends in the DFW area are more pronounced at urban monitors as seen in Figure 5-10: *90th Percentile Daily Peak NO_X Concentrations in the DFW Area*. The downward trends in ambient NO_X concentrations are observed at all monitors except at the Parker County monitor, for which the trend is flat. The Parker County monitor measures the lowest NO_X concentrations because it is located in a rural area 34 miles west of the Fort Worth area with very little on-road activity or nearby NO_X sources. All other monitors, however, demonstrate downward NO_X trends. The monitors with smaller downward trends do not record high NO_X concentrations, mostly because they are rural monitors with little on-road activity. The typical ozone design value setting monitors (Denton Airport South, Keller, and Grapevine Fairway) show downward trends in ambient NO_X concentrations. Because of the prevailing winds during ozone season, these monitors also observe transported NO_X from the DFW urban areas and benefit from lower transported NO_X emissions.

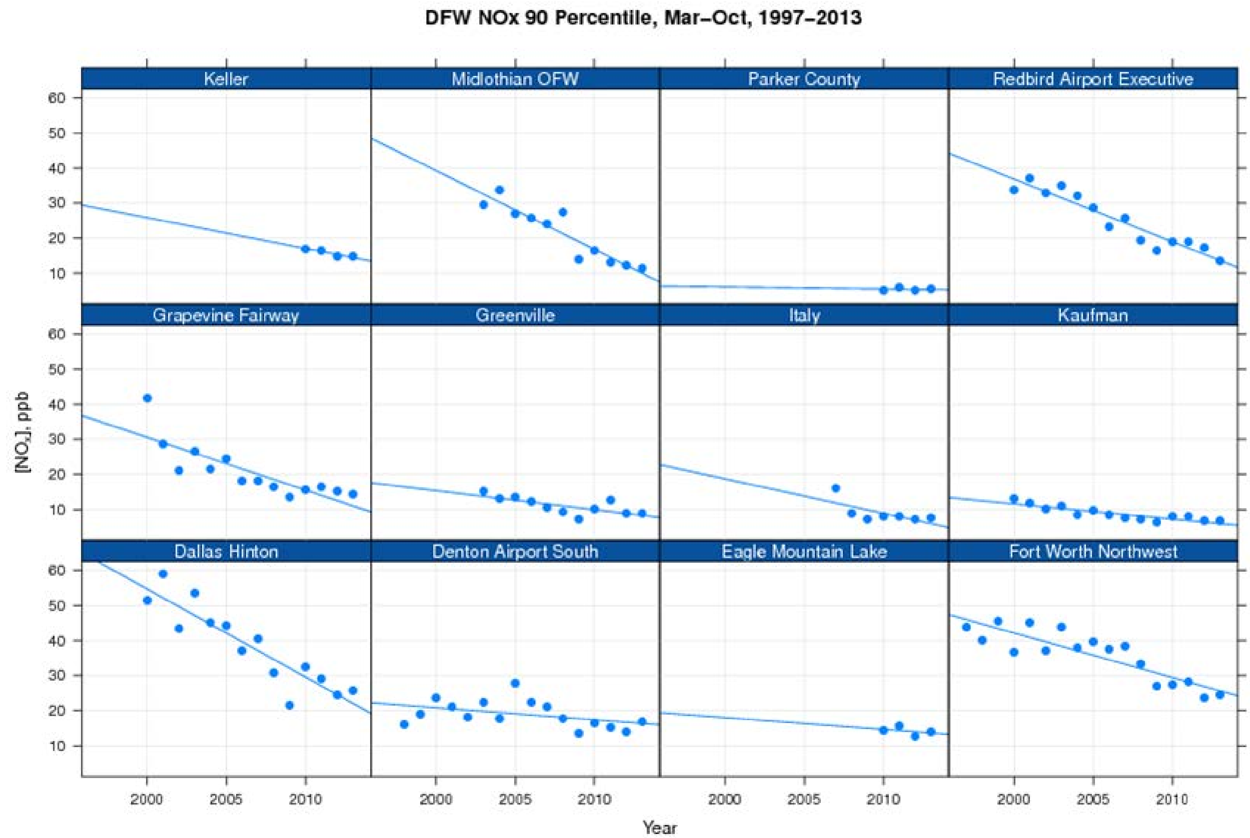

Figure 5-10: 90th Percentile Daily Peak NO_X Concentrations in the DFW Area

Ambient NO_X concentrations in the overall DFW area are trending downward, especially in the DFW urban areas. This downward trend results from the state controls placed on point sources, along with the federal standards implemented for on-road vehicles and non-road equipment.

5.2.3 VOC and NO_X Limitations

The VOC and NO_X limitation of an air mass can help determine how immediate reductions in VOC and NO_X concentrations might affect ozone concentrations. A NO_X-limited region occurs where the radicals from VOC oxidation are abundant, and therefore the ozone formation is more sensitive to the amount of NO_X present in the atmosphere. In these regions, controlling NO_X would be more effective in reducing the ozone concentrations. In VOC-limited regions, NO_X is abundant, and therefore the ozone formation is more sensitive to the amount of radicals from VOC oxidation present in the atmosphere. In VOC-limited regions, controlling VOC emissions would be more effective in reducing the ozone concentrations. Areas where ozone formation is not strongly limited by either VOC or NO_X are considered transitional, and controlling either VOC or NO_X emissions would reduce ozone concentrations in these regions.

The annual median VOC to NO_X ratios at the Dallas Hinton Street, Eagle Mountain Lake, and Fort Worth Northwest Auto-GC monitors are shown in Figure 5-11: *Trend in VOC to NO_X ratios using AutoGC Data*. VOC to NO_X ratios at the three AutoGC monitors show that the DFW area is becoming more NO_X-limited over time. The Dallas Hinton Street and Fort Worth Northwest monitors were VOC-limited, but have begun to trend towards NO_X-limited, and are currently showing transitional conditions. This result can be attributed to the lower ambient NO_X concentrations due to NO_X reductions taking place in the urban DFW area.

The more rural Eagle Mountain Lake monitor is NO_X-limited and shows a trend towards even more NO_X-limited conditions. This monitor not only observes biogenic emissions and oil and gas emissions, but also observes emissions from the urban DFW area because it is located downwind of the urban core. Because total VOC emissions at this monitor are not increasing, the increase in the VOC to NO_X ratio can be attributed to decreasing NO_X emissions from the urban DFW area.

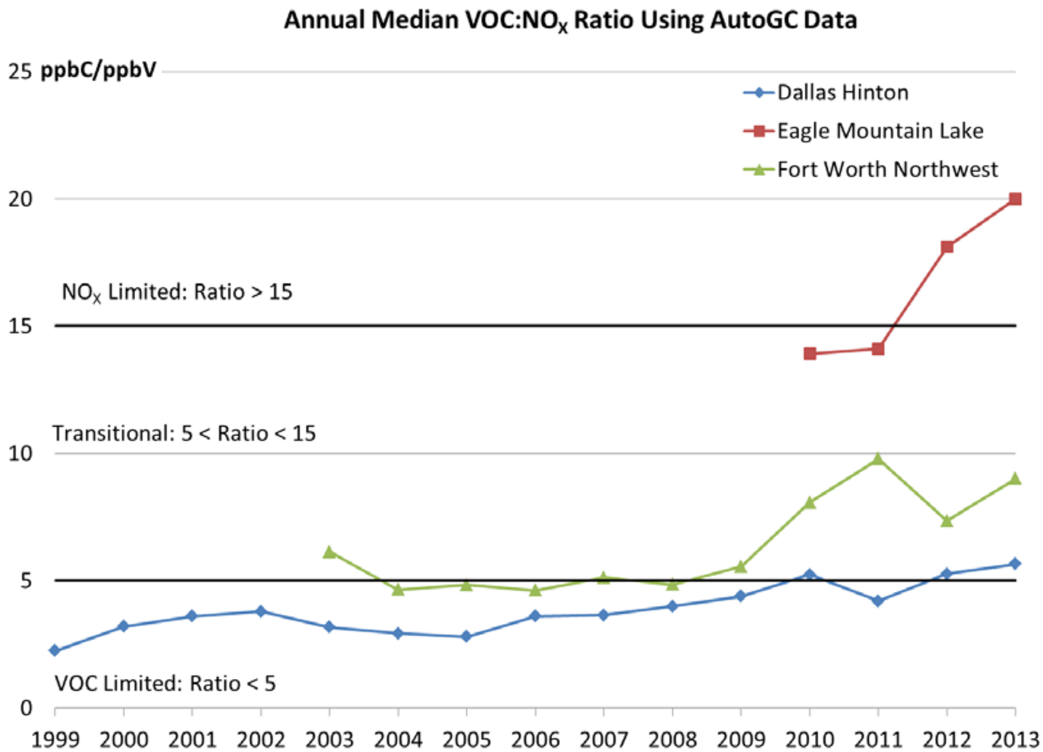

Figure 5-11: Trend in VOC to NO_X ratios using AutoGC Data

5.2.4 Weekday/Weekend Effect

The trends in NO_X concentrations by day of the week show how local control strategies might affect the ozone concentrations. Examining the way ozone behaves on days with lower NO_X concentrations will help demonstrate how ozone might behave if there were overall reductions in NO_X. To investigate if there is a day of the week effect in the DFW area, NO_X concentrations were calculated by the day of the week from 1997 to 2013. The NO_X data at Fort Worth Northwest are from 2003 and 2004 only.

Results displayed in Figure 5-12: *Day of Week NO_X Concentrations* show that at urban monitors, weekends observe lower NO_X than most weekdays. This implies that there is less NO_X generated on weekends, most likely due to less on-road activity as discussed in Chapter 3 and Appendix C. Since NO_X is a precursor to ozone formation, controlling NO_X should in turn reduce ozone concentrations.

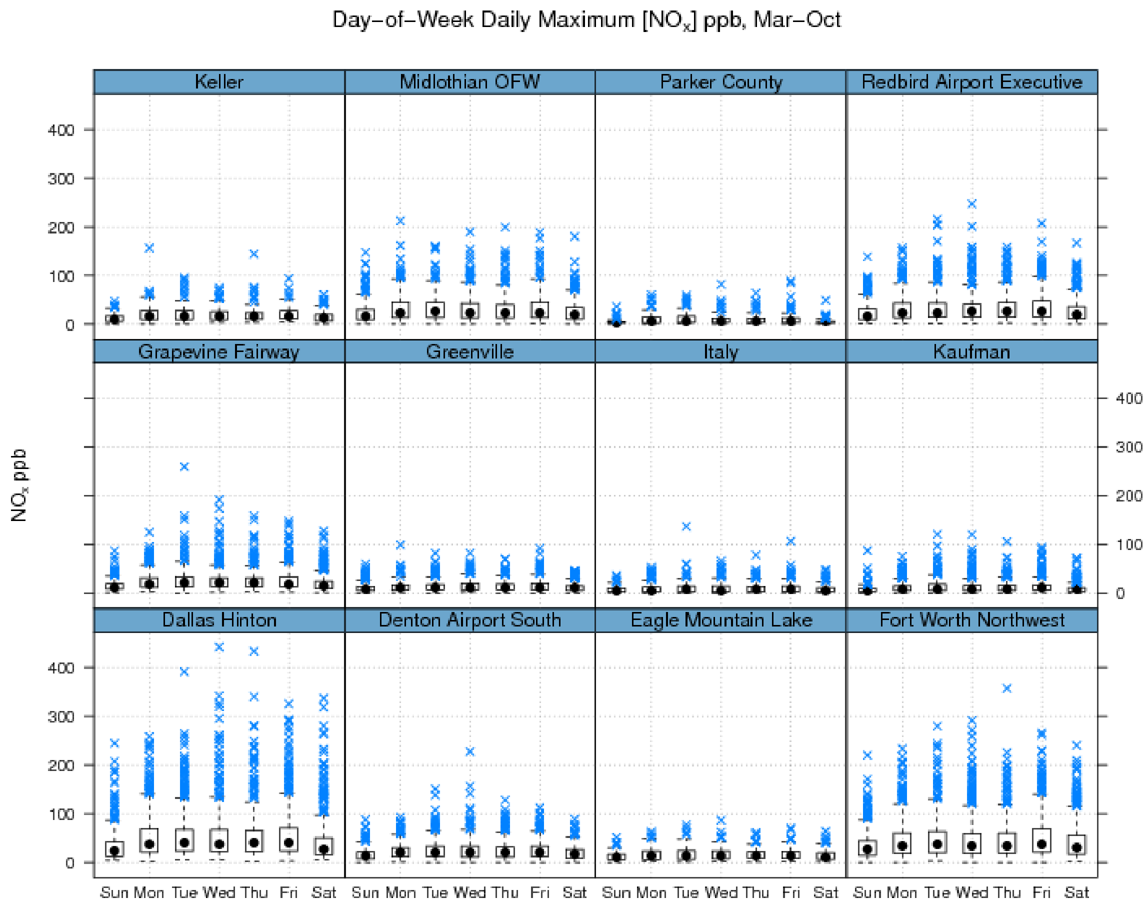

Figure 5-12: Day of Week NO_X Concentrations

Given that there is less NO_X generated on weekends, there accordingly should be fewer high ozone days on weekends. To determine the number of days with high eight-hour ozone on weekends, days with eight-hour ozone over 75 ppb were counted using all DFW area monitors.

Figure 5-13: *Weekday/Weekend Effect for Ozone in the DFW Area* shows that the total number of days with eight-hour ozone concentrations greater than 75 ppb is greater on weekdays compared to weekends. Fewer high eight-hour ozone days occur on Sundays (85 days) compared to other days of the week. Sunday had 18 fewer high eight-hour ozone days than Mondays, which had the second lowest amount of high eight-hour ozone days (103 days). High eight-hour ozone days occur most often on Fridays, with 137 days. It appears that high ozone occurs less frequently on Sunday, when there are also lower amounts of NO_X from on-road sources. By the end of the week, the DFW area begins to experience higher ozone as well as higher NO_X emissions. This result corroborates the hypothesis that NO_X reductions will lead to lower ozone concentrations.

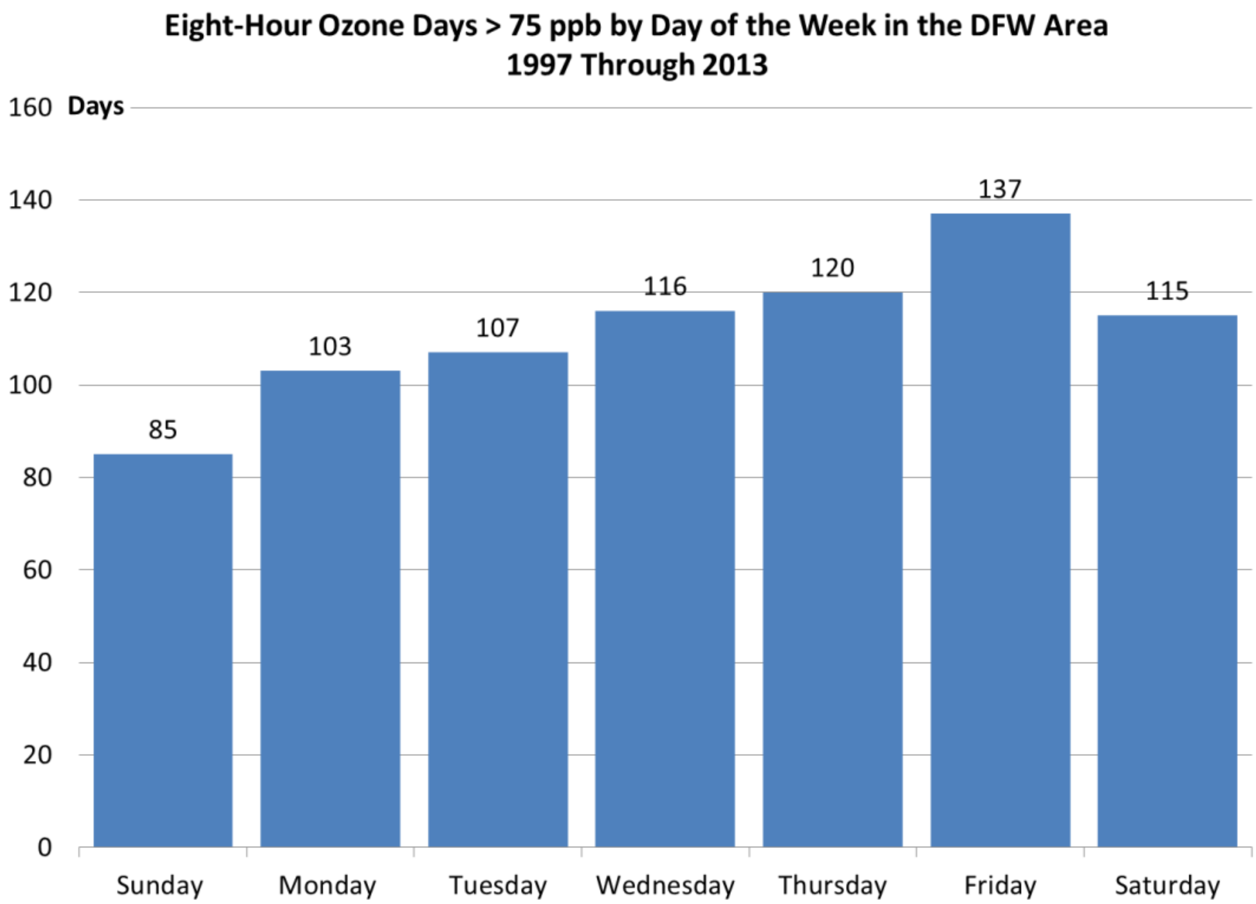

Figure 5-13: Weekday/Weekend Effect for Ozone in the DFW Area

5.2.5 VOC Trends

Total non-methane organic carbon (TNMOC), which is used to represent VOC concentrations, can enhance ozone production in combination with NO_X and sunlight. TNMOC is an important precursor to ozone formation. However, because the DFW air shed is more NO_X-limited, controlling TNMOC is not as effective as controlling NO_X to reduce ozone concentrations. Nevertheless, these precursors to ozone formation are discussed below.

Two types of monitors record TNMOC data in the DFW area: AutoGCs, which record hourly data, and canisters, which record 24-hour data. Because the canisters have more long-term data than the AutoGCs, they can provide more long-term trend information. The annual geometric mean TNMOC concentrations from the seven canisters in the DFW area are presented in Figure 5-14: *Annual Geometric Mean TNMOC Concentrations*. The chart shows that annual geometric mean TNMOC concentrations in the DFW area are declining, although there appear to be fewer decreases occurring after 2006.

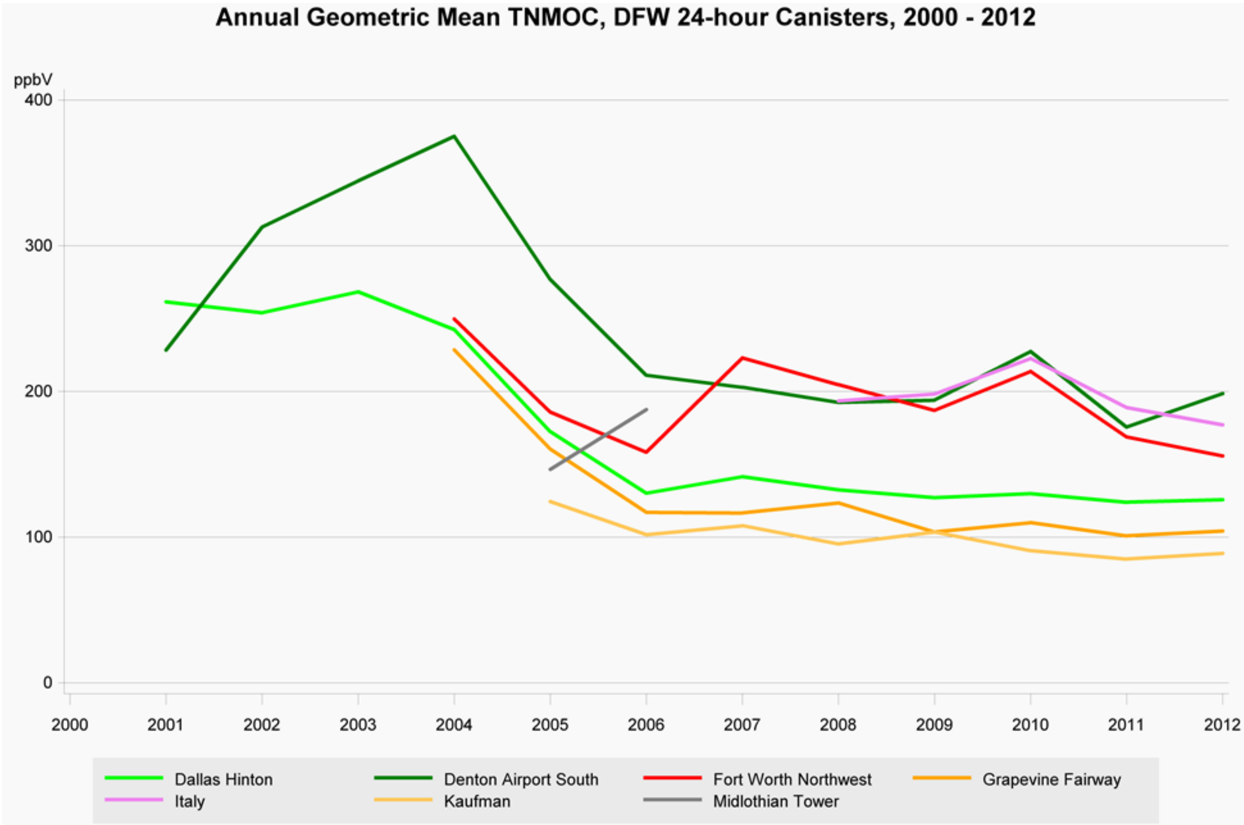

Figure 5-14: Annual Geometric Mean TNMOC Concentrations

5.3 STUDIES OF OZONE FORMATION, ACCUMULATION, AND TRANSPORT RELATED TO DFW

A number of peer-reviewed studies have been performed that relate to air quality in the DFW area and ozone attainment demonstrations in general. These studies are an important component of the WoE analyses in that in several cases it corroborates the conclusion that there are downward trends in ozone, NO_X, and VOC. Additional research also provides support of the improvements in the use of photochemical modeling as a predictive tool. Several of the studies summarized below relate to the effects of precipitation on biogenic emissions, VOC profiles for oil and gas production, and the effects of oil and gas operations on ozone formation. Each study is fully referenced in the bibliography.

One study by Sather and Cavender (2012) examined trends in ozone and its precursors at several cities in the south central U.S., including DFW. Several parameters associated with meteorology conducive to high ozone were also examined, including days with temperatures ≥90 degrees Fahrenheit, days with resultant wind speeds ≤4 miles per hour, and the number of days with precipitation. They evaluated five five-year periods from 1986 through 1990 and continuing from 2006 through 2010. They found that ozone-conducive days were lowest from 2001 through 2005, and highest during 1991 through 1995 and 2006 through 2010. In spite of the increase in ozone-conducive days during 2006 through 2010, the number of hours above 75 ppb at four DFW monitoring sites decreased by more than 70 hours per site compared to 2001 through 2005. The downward trends observed by Sather and Cavendar for NO_X and VOC matched those calculated by TCEQ.

Another study by Tang et al. (2013) relating to emissions inventories used two advanced numerical techniques to estimate a top-down NO_X emissions inventory based upon the NO_2 column density measurements from the Ozone Monitoring Instrument (OMI) satellite. These two techniques, the discrete Kalman filter and the decoupled direct method, allowed the Comprehensive Air Quality Model with Extensions (CAMx) to adjust the original bottom-up TCEQ inventory for 2006 ozone episodes iteratively until it matched the satellite-derived NO2 column observations. A second top-down adjustment was calculated based upon ground-based NO_X measurements. The two methods gave widely diverging results, with the OMI measurement pushing the inventory slightly higher, and the ground monitoring pushing the inventory much lower. The original TCEQ 2006 inventory included emissions of NO_X from lightning and other sources often not included in standard emissions inventories, but the two top-down inventories were still different.

Each of the top-down inventories was substituted into the CAMx modeling to see if ozone model performance was improved. Neither alternative inventory showed substantial improvements over the original inventory. The tendency of the Tang et al. modeling to overestimate ground NO_2 concentrations and underestimate column densities could not be corrected by the techniques used in this study. Other model weaknesses aside from potential emission inventory error could explain this discrepancy, particularly the simulation of planetary boundary layer dynamics. Another explanation is that different data retrieval techniques used for OMI data have shown large variations, even though they are supposed to match each other. Revisions to the retrieval algorithms are being implemented to try to correct the problem. The results of this study did not compel any changes in the SIP modeling for DFW.

A third emissions/modeling related study evaluated by TCEQ staff was by Lamsal et al. (2008), which attempted to infer the ground-based NO_2 concentrations based upon the OMI satellite data. Since the ground-based NO_2 monitors have a known high bias, due to their inability to distinguish between NO_2 and other oxidized nitrogen compounds, the authors developed a correction for the ground-based NO_2 data. They found that OMI NO_2 column analysis was able to predict ground NO_2 concentrations reasonably well, which may allow these data to fill gaps in the NO_2 measurement network across the country. Tarrant County was an area that they specifically examined to see how well OMI NO_2 column analysis could predict ground NO_2. However, the OMI NO_2 results for Tarrant County did not include sufficient resolution that could be used to alter the NO_X emission estimates by source category for the 2006 and 2018 SIP modeling performed for DFW.

A fourth study related to emissions evaluated by TCEQ was by Huang et al. (2014), which examined drought effects on biogenic emissions during two drought years (2006 and 2011) and one “wet” year (2007) to elucidate the relationship between leaf area index (LAI) and emissions. Drought severity was evaluated using the Standard Precipitation Index and the Palmer Drought Severity Index. Monthly average LAI was estimated from the Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data for four different regions in eastern Texas; DFW was included in the “North Central” region. The study found large differences in LAI between the wet year and the drought years, with up to 50% decreases during the drought years relative to 2007. Isoprene and monoterpene emissions estimated with the Model of Emissions of Gases and Aerosols from Nature (MEGAN) and Texas-specific land cover categories were lower during drought years by 25-30%. The authors also looked at which month showed the largest inter-annual variations, and determined which factor was most important (i.e., inter-annual meteorological variations or LAI). September showed the greatest emission variation due to LAI variations. April showed the largest emission variation due to meteorological conditions, and to the combination of meteorology and LAI. These results may ultimately help improve biogenic emissions modeling by taking into account drought conditions when modeling the emissions from vegetation.

A fifth modeling support study evaluated by TCEQ was Lefohn et al. (2014), which modeled background ozone using the Goddard Earth Observing System with Chemistry (GEOS-Chem) global model and CAMx for 2006. The source apportionment tools in CAMx were invoked to track the sources of background ozone simulated throughout the country. Many sites were examined in detail, including the Dallas Executive Airport monitoring site, which was used to assess the impact of background ozone on DFW. Twelve kilometer (km) CAMx modeling yielded decent mean fractional bias of hourly ozone in DFW during April, May, September, and October, but biased by about +20% during June and July, and by about -20% for the other months. For April, May, and October, the estimated global average background was about 58-63% of the total ozone for the Dallas Executive Airport site. During June through September, the global average background was only about 43-48% of the total ozone. Overall, the percentage of total ozone attributed to background tended to decrease at higher concentrations of total ozone. Using their estimation method, they found indications of stratospheric contributions to background in March and June 2006, though the contributions were not quantified or focused upon specific days. Because the contributions were not quantified, there is no quantification of the uncertainty of this assessment. The results presented in this paper are consistent with DFW regional background ozone assessments developed by the TCEQ using an upwind-downwind method.

A sixth study evaluated by TCEQ was Pacsi et al. (2013), which carried out CAMx modeling for eastern Texas at 12 km after making adjustments to the 2012 future case inventory used by TCEQ for the June 2006 ozone episode that was included with the DFW attainment demonstration SIP adopted in December 2011. The study estimated how regional NO_X emissions and consequent ozone formation would vary based on four natural gas price scenarios of $1.89, $2.88, $3.87, and $7.74 per Million British Thermal Units (MMBTU). Using the $2.88 scenario as a baseline, the $1.89 scenario resulted in lower NO_X at electric generating units (EGUs) since more natural gas was being used instead of coal. However, NO_X emissions from natural gas production were increased to account for the increase in demand from EGUs. The regional ozone decrease was 0.2-0.5 ppb for this $1.89 scenario, but some localized ozone increases were seen downwind of natural gas production areas. Conversely, the $3.87 and $7.74 scenarios resulted in regional ozone increases of 0.2-0.7 ppb because the use of higher NO_X emitting coal for EGUs was favored over natural gas.

A seventh study evaluated by TCEQ was Pegues et al. (2012), which examined how well photochemical grid models and weight of evidence (WoE) assessments in ozone SIPs were able to predict attainment of the 1997 eight-hour ozone standard of 84 ppb. This study included a review of the May 23, 2007 DFW SIP and the modeled 2009 future design value. They found that the photochemical grid model results were reliable: the photochemical grid modeling for 12 nonattainment areas correctly predicted attainment at 69 monitors, and correctly predicted nonattainment at six monitors, including two in DFW. The modeling gave false negative results (prediction of attainment that was not reached) at only 3% of the monitoring sites. By contrast, the WoE assessments resulted in five areas incorrectly predicting attainment, including DFW. The authors suggest that WoE arguments are still an essential and valuable part of the SIP process, but that greater scrutiny of WoE demonstrations may be needed to avert false negative predictions. These results verify that photochemical grid modeling can assess the effectiveness of control strategies. They also indicate, however, that WoE assessments, as they have been used in the past, may be less effective at predicting attainment. This indication is not inconsistent with EPA guidance on use of WoE and that WoE determinations can be used in some cases to demonstrate attainment conclusions that differ from conclusions of the model attainment test. The prospective modeling discussed in Chapter 3 shows that the newer tools available have improved the forecasting effectiveness of photochemical modeling efforts. The updated meteorological model, chemical mechanism, and emission inputs led to better correlation between measured 2012 ozone design values in the DFW area and those predicted by the photochemical model in forecast mode, compared to modeling conducted for the December 2011 DFW AD SIP revision.

5.4 QUALITATIVE CORROBORATIVE ANALYSIS

5.4.1 Additional Measures

5.4.1.1 Energy Efficiency and Renewable Energy (EE/RE) Measures

Energy efficiency (EE) measures are typically programs that reduce the amount of electricity and natural gas consumed by residential, commercial, industrial, and municipal energy consumers. Examples of energy efficiency measures include increasing insulation in homes, installing compact fluorescent light bulbs, and replacing motors and pumps with high efficiency units. Renewable energy (RE) measures include programs that generate energy from resources that are replenished or are otherwise not consumed as with traditional fuel-based energy production. Examples of renewable energy include wind energy and solar energy projects.

Emission reductions resulting from these programs were not explicitly included in the photochemical modeling for this SIP Revision because local efficiency efforts may not result in local emissions reductions or may be offset by increased demand in electricity. The complex nature of the electrical grid makes accurately quantifying emission reductions from EE/RE measures difficult. At any given time, it is impossible to determine exactly where a specific user's electricity was produced. The electricity for a user in the DFW area could be generated by a power plant in west Texas, in a nearby attainment county, or within the nonattainment area. If electrical demand is reduced in the DFW area due to these local efficiency measures, then emission reductions from power generation facilities may occur in any number of locations around the state.

The Texas Legislature has enacted a number of EE/RE measures and programs. The following is a summary of Texas EE/RE legislation since 1999.

76th Texas Legislature, 1999

- Senate Bill (SB) 7
- House Bill (HB) 2492
- HB 2960

77th Texas Legislature, 2001

- SB 5
- HB 2277
- HB 2278
- HB 2845

78th Texas Legislature, 2003

- HB 1365 (Regular Session)

79th Texas Legislature, 2005

- SB 20 (First Called Session)
- HB 2129 (Regular Session)
- HB 2481 (Regular Session)

80th Texas Legislature, 2007

- HB 66
- HB 3070
- HB 3693
- SB 12

81st Texas Legislature, 2009

- None

82nd Texas Legislature, 2011

- SB 898 (Regular Session)
- SB 924 (Regular Session)
- SB 981 (Regular Session)
- SB 1125 (Regular Session)
- SB 1150 (Regular Session)
- HB 51 (Regular Session)

83rd Texas Legislature, 2013

- None

Renewable Energy

SB 5, 77th Texas Legislature, 2001, set goals for political subdivisions in affected counties to implement measures to reduce energy consumption from existing facilities by 5% each year for five years from January 1, 2002 through January 1, 2006. In 2007, the 80th Texas Legislature passed SB 12, which extended the timeline set in SB 5 through 2007 and made the annual 5% reduction a goal instead of a requirement. The State Energy Conservation Office (SECO) is charged with tracking the implementation of SB 5 and SB 12. Also during the 77th Texas Legislature, the Energy Systems Laboratory, part of the Texas Engineering Experiment Station, Texas A&M University System, was mandated to provide an annual report on EE/RE efforts in the state as part of the Texas Emissions Reduction Plan (TERP) under Texas Health and Safety Code (THSC), §388.003(e).

The 79th Texas Legislature, 2005, Regular and First Called Sessions, amended SB 5 through SB 20, HB 2129, and HB 2481 to add, among other initiatives, renewable energy initiatives which require: 5,880 megawatts of generating capacity from renewable energy by 2015; the TCEQ to develop a methodology for calculating emission reductions from renewable energy initiatives and associated credits; the ESL to assist the TCEQ in quantifying emissions reductions from EE/RE programs; and the Public Utility Commission of Texas to establish a target of 10,000 megawatts of installed renewable technologies by 2025.

Wind power producers in Texas have exceeded the renewable energy generation target by installing over 10,000 megawatts of wind electric generating capacity by 2010 and total capacity should exceed 14,600 megawatts by December 2014.

HB 2129, 79th Texas Legislature, 2005, Regular Session, directed the ESL to collaborate with the TCEQ to develop a methodology for computing emission reductions attributable to use of renewable energy and for the ESL to annually quantify such emission reductions. HB 2129 directed the Texas Environmental Research Consortium to use the Texas Engineering Experiment Station to develop this methodology. With the TCEQ's guidance, the ESL produces an annual report, Statewide Air Emissions Calculations from Energy Efficiency, Wind and Renewables, detailing these efforts.

In addition to the programs discussed and analyzed in the ESL report, local governments may have enacted measures beyond what has been reported to SECO and the PUCT. The TCEQ encourages local political subdivisions to promote EE/RE measures in their respective communities and to ensure these measures are fully reported to SECO and the PUCT.

SB 981, 82nd Texas Legislature, 2011, Regular Session, allows a retail electric customer to contract with a third party to finance, install, or maintain a distributed renewable generation system on the customer's side of the electric meter, regardless of whether the customer owns the installed system. SB 981 also prohibits the PUCT from requiring registration of the system as an electric utility if the system is not projected to send power to the grid.

Residential and Commercial Building Codes and Programs

THSC, Chapter 388, Texas Building Energy Performance Standards, as adopted in SB 5 of the 77th Texas Legislature, 2001, states in §388.003(a) that single-family residential construction must meet the energy efficiency performance standards established in the energy efficiency chapter of the International Residential Code. The Furnace Pilot Light Program includes energy savings accomplished by retrofitting existing furnaces. Also included is a January 2006 federal mandate raising the minimum Seasonal Energy Efficiency Ratio (SEER) for air conditioners in single-family and multi-family buildings from 10 to 13.

THSC, Chapter 388, as adopted in SB 5 of the 77th Texas Legislature, 2001, states in §388.003(b) that non-single-family residential, commercial, and industrial construction must meet the energy efficiency performance standards established in the energy efficiency chapter of the International Energy Conservation Code.

HB 51, 82nd Legislature, 2011, Regular Session, requires municipalities to report implementation of residential and commercial building codes to SECO.

Federal Facility EE/RE Projects

Federal facilities are required to reduce energy use by Presidential Executive Order 13123 and the Energy Policy Act of 2005 (Public Law 109-58 EPACT20065). The ESL compiled energy reductions data for the federal EE/RE projects in Texas.

Political Subdivisions Projects

SECO funds loans for energy efficiency projects for state agencies, institutions of higher education, school districts, county hospitals, and local governments. Political subdivisions in nonattainment and affected counties are required by SB 5, 77th Texas Legislature, 2001, to report EE/RE projects to SECO. These projects are typically building systems retrofits, non-building lighting projects, and other mechanical and electrical systems retrofits such as municipal water and waste water treatment systems.

Electric Utility Sponsored Programs

Utilities are required by SB 7, 76th Texas Legislature, 1999, and SB 5, 77th Texas Legislature, 2001, to report demand-reducing energy efficiency projects to the PUCT (see THSC, §386.205 and Texas Utilities Code (TUC), §39.905). These projects are typically air conditioner replacements, ventilation duct tightening, and commercial and industrial equipment replacement.

SB 1125, 82nd Texas Legislature, 2011, Regular Session, amended the TUC, §39.905 to require energy efficiency goals to be at least 30% of annual growth beginning in 2013. The metric for the energy efficiency goal remains at 0.4% of peak summer demand when a utility program accrues that amount of energy efficiency. SB 1150, 82nd Texas Legislature, 2011, Regular Session, extended the energy efficiency goal requirements to utilities outside the Electric Reliability Council of Texas area.

State Energy Efficiency Programs

HB 3693, 80th Texas Legislature, 2007, amended the Texas Education Code, Texas Government Code, THSC, and TUC. The bill:

- requires state agencies, universities and local governments to adopt energy efficiency programs;
- provides additional incentives for electric utilities to expand energy conservation and efficiency programs;
- includes municipal-owned utilities and cooperatives in efficiency programs;
- increases incentives and provides consumer education to improve efficiency programs; and
- supports other programs such as revision of building codes and research into alternative technology and renewable energy.

HB 51, 82nd Texas Legislature, 2011, Regular Session, requires new state buildings and major renovations to be constructed to achieve certification under an approved high-performance design evaluation system.

HB 51 also requires, if practical, that certain new and renovated state-funded university buildings comply with approved high-performance building standards.

SB 898, 82nd Texas Legislature, 2011, Regular Session, extended the existing requirement for state agencies, state-funded universities, local governments, and school districts to adopt energy efficiency programs with a goal of reducing energy consumption by at least 5% per state fiscal year (FY) for 10 state FYs from September 1, 2011 through August 31, 2021.

SB 924, 82nd Texas Legislature, 2011, Regular Session, requires all municipally-owned utilities and electric cooperatives that had retail sales of more than 500,000 megawatt hours in 2005 to report each year to SECO information regarding the combined effects of the energy efficiency activities of the utility from the previous calendar year, including the utility's annual goals, programs enacted to achieve those goals, and any achieved energy demand or savings goals.

5.4.1.2 Cement Kiln Consent Decree

Cement kilns located in Ellis County are subject to the requirements of Chapter 117, Subchapter E, Division 2. Ash Grove Cement Company operated three kilns in Ellis County, with an established source cap under §117.3123 of 4.4 tpd . The attainment demonstration modeling includes this 4.4 tpd source cap as the maximum allowable cement kiln NO_X emissions from this site.

However, a 2013 consent decree between Ash Grove and the EPA required by September 10, 2014 shutdown of two kilns and reconstruction of kiln #3 with selective noncatalytic reduction with an emission limit of 1.5 lbs NO_X/ton of clinker and a 12-month rolling tonnage limit for NO_X of 975 tpy. The reconstructed kiln is a dry kiln with year-round SNCR operation. The redesign allows 949,000 tpy of clinker, or 1.95 tpd of NO_X, which is well below the 4.4 tpd source cap. Ash Grove's enforceable limit continues to be 4.4 tpd, which continues to be the value included in the attainment demonstration modeling, although actual emissions are expected to be below the consent decree limit. Any modifications or new construction would be required to meet nonattainment new source review with best available control technology requirements, and would be subject to the same 1.5 lbs NO_X/ton of clinker emission limit in the New Source Performance Standards for Portland Cement Plants. It would also be subject to other regulatory requirements, including the National Emission Standards for Hazardous Air Pollutants for the Portland Cement Manufacturing Industry.

5.4.1.3 Clean Air Interstate Rule (CAIR) and Cross-State Air Pollution Rule (CSAPR)

In March 2005, the EPA issued CAIR to address electric generating utility (EGU) emissions that transport from one state to another. The rule incorporates the use of three cap and trade programs to reduce sulfur dioxide (SO_2) and NO_X: the ozone-season NO_X trading program, the annual NO_X trading program, and the annual SO_2 trading program.

Texas was not included in the ozone season NO_X program but was included for the annual NO_X and SO_2 programs. As such, Texas must make necessary reductions in annual SO_2 and NO_X emissions from new and existing EGUs to demonstrate that emissions from Texas do not contribute to nonattainment or interfere with maintenance of the 1997 particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers ($PM_{2.5}$) NAAQS in another state. CAIR consists of two phases for implementing necessary NO_X and SO_2 reductions. Phase I addresses required reductions from 2009 through 2014. Phase II addresses reductions in 2015 and thereafter.

In July 2006, the commission adopted a SIP revision to address how the state would meet emissions allowance allocation budgets for NO_X and SO_2 established by the EPA to meet the federal obligations under CAIR. The commission adopted a second CAIR-related SIP revision in February 2010. This revision incorporated various federal rule revisions that the EPA had promulgated since the TCEQ's initial submittal. It also incorporated revisions to 30 TAC Chapter 101 resulting from legislation during the 80th Texas Legislature, 2007.

A December 2008 court decision found flaws in CAIR but kept CAIR requirements in place temporarily while directing the EPA to issue a replacement rule. In July 2011, the EPA finalized the CSAPR to meet FCAA requirements and respond to the court's order to issue a replacement program. Texas was included in CSAPR for ozone season NO_X, annual NO_X, and annual SO_2 due to the EPA's determination that Texas significantly contributes to nonattainment or interferes with maintenance of the 1997 eight-hour ozone NAAQS and the 1997 and 2006 $PM_{2.5}$ NAAQS in other states. As a result of numerous EGU emission reduction strategies already in place in Texas, the annual and ozone season NO_X reduction requirements from CSAPR were relatively small but still significant. The CSAPR required an approximate 7% reduction inannual NO_X emissions and less than 5% reduction in ozone season NO_X emissions.

On August 21, 2012, the U.S. Court of Appeals for the District of Columbia (D.C.) Circuit vacated the CSAPR. Under the D.C. Circuit Court's ruling, CAIR will remain in place until the EPA develops a valid replacement.

The EPA and various environmental groups petitioned the Supreme Court of the United States to review the D.C. Circuit Court's decision on CSAPR. On April 29, 2014, a decision by the Supreme Court reversed the D.C. Circuit and remanded the case. On October 23, 2014, the D.C. Circuit lifted the CSAPR stay and set a briefing schedule with oral arguments scheduled for March 11, 2015. The EPA has not yet released guidance on how they intend to implement CSAPR. The TCEQ will continue to evaluate the rule and will take action to revise this plan appropriately as necessary. In the meantime, the EPA has indicated that it is continuing to develop a new strategy to address interstate transport for current and future NAAQS.

5.4.1.4 TERP

The TERP program was created in 2001 by the 77th Texas Legislature to provide grants to offset the incremental costs associated with reducing NO_X emissions from high-emitting heavy-duty internal combustion engines on heavy-duty vehicles, non-road equipment, marine vessels, locomotives, and some stationary equipment.

The primary emissions reduction incentives are awarded under the Diesel Emissions Reduction Incentive Program (DERI). The DERI incentives are awarded to projects to replace, repower, or retrofit eligible vehicles and equipment to achieve NO_X emission reductions in Texas ozone nonattainment areas and other counties identified as affected counties under the TERP where ground-level ozone is a concern. The last DERI grants were awarded through August 31, 2013, with the current grant round having opened on September 3, 2014. From 2001 through August 2013, $943 million in DERI grants were awarded for projects projected to help reduce 176,364 tons of NO_X. Almost $330 million in DERI grants were awarded to projects in the DFW area, with a projected 63,820 tons of NO_X reduced. These projects are projected to reduce up to 22.64 tons per day of NO_X in the DFW area during 2014. Of that $330 million, $22 million were awarded to North Central Texas Council of Governments (NCTCOG) through third-party grants to administer subgrants in the DFW area.

Three other incentive programs under the TERP will result in the reduction in NO_X emissions in the DFW area. The Texas Clean Fleet Program (TCFP) was established in 2009 to provide grants for the replacement of light-duty and heavy-duty diesel vehicles with vehicles powered by alternative fuels, including: natural gas, liquefied petroleum gas, hydrogen, methanol (85% by volume), or electricity. This program is for larger fleets, with a requirement that an applicant apply for replacement of at least 20 vehicles at a time. The last TCFP grants were awarded by August 31, 2013 and the latest grant application period ended October 3, 2014. From 2009 through August 2013, over $23.6 million in TCFP grants were awarded for projects projectedto reduce a projected 314.5 tons of NO_X. Over $3.3 million in TCFP grants were awarded to projects in the DFW area, with a projected 89.4 tons of NO_X reduced. The projects are projected to reduce up to 0.9 tons per day of NO_X in the DFW area starting in 2015. The latest grant round with over $6.2 million in funding was open from July 9, 2014 to October 3, 2014.

The Texas Natural Gas Vehicle Grant Program (TNGVGP) was established in 2011 to provide grants for the replacement of medium-duty and heavy-duty diesel vehicles with vehicles powered by natural gas. This program may include grants for individual vehicles or multiple vehicles. The majority of the vehicle's operation must occur in the Texas nonattainment areas, other counties designated as affected counties under the TERP, and the counties in and between the triangular area between Houston, San Antonio, Dallas, and Fort Worth. The last TNGVGP grants were awarded by August 31, 2013, with a new grant round currently open and contracts pending. From 2011 through August 2013, almost $26 million in TNGVGP grants were awarded for projects to help reduce a projected 816 tons of NO_X. Over $10.5 million in TNGVGP grants were awarded to projects where the applicant indicated the primary operation of the vehicle would occur in and around the DFW area, with a projected 355.6 tons of NO_X reduced. These projects are projected to reduce up to 0.36 tons per day of NO_X in the DFW area starting in 2015. The latest grant application period will extend through May 31, 2015, or until all available funds are awarded, whichever occurs earlier. This program is allocated $24,830,772 for the fiscal biennium. A total of $25,806,300 in applications were either awarded or pending by October 1, 2014, so all allocated funds may be awarded by the end of 2014.

A new Drayage Truck Incentive Program (DTIP) was established in 2013 to provide grants for the replacement of drayage trucks operating in and from seaports and rail yards located in the nonattainment areas. The first grant application period for this program opened September 22, 2014, with an application deadline of May 29, 2015, or until all allocated funds totaling $3,103,846 for the fiscal biennium are awarded, whichever occurs earlier.

The TERP program is currently authorized through 2019, which will result in continued reductions in the significant emissions source categories of heavy-duty on-road and non-road engines. TERP projects require reporting and documentation of emissions reductions over a multiple-year activity period, and a number of the existing TERP projects will still be reporting emissions reductions during the attainment year.

5.4.1.5 LIRAP

SB 12, 80th Texas Legislature, 2007, enhanced the Low Income Vehicle Repair Assistance, Retrofit, and Accelerated Vehicle Retirement Program (LIRAP), also known as AirCheckTexas Drive a Clean Machine (DACM), to expand participation by increasing the income eligibility to 300% of the federal poverty rate and increasing the amount of assistance toward the replacement of a retired vehicle. HB3272, 82nd Texas Legislature, 2011, Regular Session, further enhanced the LIRAP to expand participation by allowing a motorist to participate if their vehicle has been registered in a participating county for 12 of the 15 months preceding application for assistance. HB3272 also revised program requirements for vehicles available as replacements.

The LIRAP provides $3,000 for cars of the current or previous three model-years; $3,000 for trucks of the current or previous two model-years; and $3,500 for hybrids, electric, natural gas, and all vehicles that have been certified to meet federal Tier 2, Bin 3 or cleaner standards of the current or previous three model-years. Replacement vehicles cannot cost more than $35,000, or $45,000 for hybrids, electric, natural gas, and all vehicles that have been certified to meet federal Tier 2, Bin 3 or cleaner standards before tax, title, and license fees. In addition, replacement vehicles must have an odometer reading of not more than 70,000 miles. The retired vehicle must be ten years or older or have failed an emissions test. The LIRAP also provides up to $600 for repair assistance to qualified motorists of a vehicle that has failed an emissions inspection.

In the DFW area, the LIRAP is available to vehicle owners in nine counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall and Tarrant. Between December 2007 and May 31, 2014, the LIRAP/DACM program has repaired 33,545 vehicles and retired and replaced

53,196 vehicles at a cost of $177,455,657.50. The LIRAP was appropriated $7 million annually for Fiscal Years 2014 and 2015 by the 82nd Texas Legislature.

5.4.1.6 Local Initiatives

The NCTCOG submitted an assortment of locally implemented strategies in the DFW area including pilot programs, new programs, or programs with pending methodologies. These programs are expected to be implemented in the ten-county nonattainment area by 2018. Due to the continued progress of these measures, additional air quality benefits will be gained and will further reduce precursors to ground level ozone formation. A summary of each strategy is included in Appendix H: *Local Initiatives Submitted by the North Central Texas Council of Governments.*

5.4.1.7 Voluntary Measures

While the oil and natural gas industry is required to install controls either due to state or federal requirements, the oil and natural gas industry has in some instances voluntarily implemented additional controls and practices to reduce VOC emissions from oil and natural gas operations in the DFW area as well as other areas of the state. Examples of these voluntary efforts include: installing vapor recovery units on condensate storage tanks; using low-bleed natural gas actuated pneumatic devices; installing plunger lift systems in gas wells to reduce gas well blowdown emissions; and implementing practices to reduce VOC emissions during well completions (i.e., "Green Completions"). The EPA's Natural Gas STAR Program provides details on these and other practices recommended by the EPA as voluntary measures to reduce emissions from oil and natural gas operations and improve efficiency. Additional information on the EPA Natural Gas STAR Program may be found at http://www.epa.gov/gasstar/.

The results from the TCEQ's Barnett Shale Special Inventory Phase One and Phase Two, which may include examples of these voluntary practices, have been analyzed and used to update controlled emissions estimates for area (nonpoint) sources. For example, special inventory data indicate approximately 12 percent of condensate production in the Barnett Shale area was controlled at an efficiency level of 97%. These data have been incorporated into the 2011 periodic inventory for area source condensate tank emissions; details may be found in the report *Condensate Tank Oil and Gas Activities* available at: http://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5821199776FY1211-20121031-ergi-condensate_tank.pdf.

Additional information on the Barnett Shale Special Inventory Phase One and Phase Two preliminary results may be found at http://www.tceq.texas.gov/airquality/point-source-ei/psei.html.

While voluntary industry practices are not enforceable under the SIP, these efforts help reduce VOC emissions in the nonattainment area. The TCEQ supports and encourages these proactive efforts to reduce emissions in the DFW area.

5.5 CONCLUSIONS

The TCEQ has used several sophisticated technical tools to evaluate the past and present causes of high ozone in the DFW area in an effort to predict the area's future air quality. Photochemical grid modeling performance has been rigorously evaluated, and 2006 ozone episodes from both June and August-September have been used to match the times of year when the highest ozone levels have historically been measured in the DFW area. Historical trends in ozone and ozone precursor concentrations and their causes have been investigated extensively. The following conclusions can be reached from these evaluations.

First, as documented in Chapter 3 and Appendix C, the photochemical grid modeling performs relatively well, with one weakness being an overproduction of ozone primarily during night-time hours and days when lower ozone concentrations are measured. Problems observed with the base case ozone modeling are those that are known to exist in all photochemical modeling exercises, particularly when multiple consecutive weeks are modeled rather than short time periods of just one or two weeks. In spite of the known shortcomings, the model can be used to project future ozone design values because the EPA guidance recommends applying the relative response in modeled ozone to monitored design values. The photochemical grid modeling predicts that the 2018 future year ozone design value at the Denton Airport South monitor will be 76 ppb, and that the remaining monitors will be either at or below the 75 ppb eight-hour ozone standard. The 2018 future design values for all DFW area monitors are either below or within the 73-78 ppb WoE range inferred for the 75 ppb standard from the 82-87 ppb WoE range specified in the current EPA guidance for the 84 ppb standard. The 76 ppb level for the Denton Airport South monitor does not include the benefits of the Tier 3 standards sensitivity analysis presented in Chapter 3. When the 0.80 ppb reduction at the Denton Airport South monitored is included, the future design value drops to 75 ppb. The Tier 3 impacts in 2018 for DFW modeled by the TCEQ are ozone reductions of 0.39-0.80 ppb, which agrees closely with the EPA's own DFW results of 0.46-0.92 ppb reduction.

The prospective and weekday-weekend evaluations presented in Chapter 3 show that the model response to emission decreases is similar to the response observed in the atmosphere, suggesting that the NO_X and VOC emission levels projected for 2018 will lead to lower ozone concentrations recorded at the DFW area monitors. The prospective analysis presented in Chapter 3 and Appendix C showed that applying 2012 emission estimates to the 2006 base case meteorology did a satisfactory job of estimating the 2012 eight-hour ozone design values at various DFW area monitors. This is particularly significant because this 2012 modeling performed significantly better than that submitted in the 2011 AD SIP revision. As summarized in Table 3-37: *Summary of Ozone Modeling Platform Changes*, the current modeling platform relies on improved tools and methodologies that were not available when the 2011 AD SIP revision work was performed: updated version of the photochemical model; improved meteorological model; improved chemical mechanism for VOC speciation; superior biogenic emissions model; updated anthropogenic emission inventories; and larger fine and coarse grid modeling domains.

Second, the ozone trend analyses show that ozone has decreased significantly since 2000 when the eight-hour ozone design value at the Denton Airport South monitor was 102 ppb. As of mid-October 2014, the Denton Airport South monitor has an eight-hour ozone design value of 81 ppb. NO_X and VOC precursor trends also show significant decreases, which has led to this reduced ozone formation. These reductions in precursors in the DFW area are due to a combination of federal, state, and local emission controls. As shown in this chapter, Chapter 3, and Appendix B, the on-road and non-road mobile source categories are the primary sources of NO_X emissions in the DFW area, and are expected to continue their downward decline due to fleet turnover where older high-emitting sources are replaced with newer low-emitting ones. The current TERP program managed by the TCEQ continues to accelerate the mobile source fleet turnover effect by providing financial incentives for purchases of lower-emitting vehicles and equipment. Ozone formation is expected to steadily decline through the 2018 attainment year as lower amounts of NO_X are emitted from these sources. Based on the photochemical grid modeling results, these corroborative analyses, and the expected Tier 3 impacts to 2018 ozone concentrations, the WoE indicates that the DFW area will attain the 2008 eight-hour ozone standard by December 31, 2018.

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CHAPTER 6: ONGOING INITIATIVES

6.1 INTRODUCTION

The Texas Commission on Environmental Quality (TCEQ) is committed to improving the air quality in the Dallas-Fort Worth (DFW) area and continues to work toward identifying and reducing ozone precursors. Texas is investing resources into technological research and development for advancing pollution control technology and refining quantification of emissions, improving the science for ozone modeling and analysis. Refining emissions quantification helps improve understanding of ozone formation, which benefits the state implementation plan (SIP). Additionally, the TCEQ is working with the United States Environmental Protection Agency (EPA), local area leaders, and the scientific community to evaluate new measures for reducing ozone precursors. This chapter describes ongoing technical work that will be beneficial to improving air quality in Texas and the DFW area.

6.2 ONGOING WORK

6.2.1 EPA Oil and Gas Emission Estimation Tool

Under EPA Contract EP-D-11-006, Work Assignment (WA) 2-05, Eastern Research Group (ERG) has developed a Microsoft Access-based tool that may be used by EPA, states, and local agencies to develop state- or region-specific non-point (area source) emission inventories for the upstream oil and gas sector based on user-supplied activity and emissions inputs. The tool is currently being reviewed by the Oil and Gas National Committee, a collection of representatives from national, state, and local environmental agencies. As part of the Oil and Gas National Committee, the TCEQ has provided feedback on the calculation methodologies used by the tool as well as provided Texas-specific emission factors and activity data for several source categories. The TCEQ also identified some source categories where additional research should be done to try to improve the default national tool activity data with Texas-specific data.

6.2.2 Oil and Gas Well Drilling Activities

There has been a large increase in drilling activity in certain regions of Texas over the past ten years, in particular for unconventional horizontal wells in shale formations such as the Barnett Shale, which overlaps the western portion of the 2008 DFW ozone nonattainment area. With the increase in horizontal drilling, the TCEQ has made efforts to improve emissions inventory estimates related to drilling activities. For example, emissions from mud degassing and hydraulic pump engines are a relatively new category of emissions that TCEQ has begun to report to the National Emissions Inventory. The TCEQ used the EPA Oil and Gas Emission Estimation Tool to calculate the 2011 emissions. Also, ERG is currently under contract with the TCEQ to improve the emission factors and activity data for these two categories with Texas basin-specific data. The updated factors and activity data will be used for future attainment demonstration (AD) and reasonable further progress (RFP) SIP revisions and other air quality analyses.

6.2.3 New Source Performance Standards Subpart OOOO

The New Source Performance Standards (NSPS) in 40 Code of Federal Regulations (CFR), Part 60, Subpart OOOO, require companies to reduce VOC emissions from newly constructed or modified oil and gas sources which were not previously regulated at the national level. The rule includes requirements to control emissions from unconventional natural gas well completions, oil and condensate storage tanks, and pneumatic devices, along with other sources. Many of the control requirements had a compliance date in 2012, although some sources have a compliance date in 2015. The TCEQ is currently evaluating how the NSPS Subpart OOOO rules will affect area source oil and gas emissions estimates now and in the future. These control requirements are not currently accounted for in this AD SIP revision, but will be considered for future AD and RFP SIP revisions and other air quality analyses.

6.2.4 Biogenic Emissions Projects

There are four ongoing Air Quality Research Program (AQRP) projects dedicated to improving the estimates of biogenic emissions throughout Texas.

- AQRP 14-008: Investigation of input parameters for biogenic emissions modeling in Texas during drought years (University of Texas).
- AQRP 14-016: Improved land cover and emission factor inputs for estimating biogenic isoprene and monoterpene emissions for Texas air quality simulations (Environ, National Oceanic and Atmospheric Administration, and Pacific Northwest National Laboratory).
- AQRP 14-017: Incorporating space-borne observations to improve biogenic emission estimates in Texas (University of Alabama-Huntsville, Rice University).
- AQRP 14-030: Improving modeled biogenic isoprene emissions under drought conditions and evaluating their impact on ozone formation (Texas A&M University).

These four projects will investigate biogenic emissions using modeling, aircraft-measured concentration data, satellite-estimated solar radiation and temperature data, and field study data from a forest research site, respectively. The wide-ranging efforts of these projects will benefit SIP modeling for th DFW area by expanding our understanding of biogenic emissions and the factors that drive them.

Appendices available upon request.

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