TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

AGENDA ITEM REQUEST

for Proposed State Implementation Plan Revision

AGENDA REQUESTED: December 9, 2015

DATE OF REQUEST: November 20, 2015

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

CAPTION: Docket No. 2015-1380-SIP. Consideration for publication of, and hearing on, the proposed Dallas-Fort Worth (DFW) 2008 Eight-Hour Ozone Nonattainment Area Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 2017 Attainment Year. The counties affected include Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise.

In the DFW AD SIP revision for the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS) submitted to the EPA on July 10, 2015, a commitment was made to address the United States Court of Appeals for the District of Columbia Circuit decision that changed the attainment deadlines for the 2008 eight-hour ozone NAAQS to a July 20, 2018 attainment date and a 2017 attainment year. This SIP revision includes a photochemical modeling analysis, a weight of evidence analysis, and a reasonably available control measures analysis that reflect the 2017 attainment year. (Kathy Singleton, Terry Salem) (Non-rule Project No. 2015-014-SIP-NR)

Steve Hagle, P.E.
Deputy Director

David Brymer
Division Director

Joyce Nelson
Agenda Coordinator

Copy to CCC Secretary? NO X YES

Texas Commission on Environmental Quality
Interoffice Memorandum

To: Commissioners **Date:** November 20, 2015

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.: 2015-1380-SIP

Subject: Commission Approval for Proposed Dallas-Fort Worth (DFW) 2008 Eight-Hour Ozone Nonattainment Area Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 2017 Attainment Year

DFW 2008 Eight-Hour Ozone Standard AD SIP Revision
SIP Project No. 2015-014-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. The attainment date for the DFW moderate nonattainment area was established in the United States Environmental Protection Agency's (EPA) implementation rule for the 2008 ozone NAAQS published in the *Federal Register* (FR) on May 21, 2012 (77 FR 30160) and was set as December 31, 2018. 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).

On December 23, 2014, the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit Court) ruled on a lawsuit that resulted in vacatur of the EPA's December 31, 2018 attainment date for the 2008 0zone NAAQS. As a result of the court case, the attainment date for the DFW moderate nonattainment area was changed to July 20, 2018 with a 2017 attainment year (80 FR 12264). Due to the timing of the D.C. Circuit Court ruling and finalization of the 2008 ozone SIP requirements rule (effective April 6, 2015), the SIP development schedule did not allow for a full update of the DFW AD SIP revision to address the change in attainment year from 2018 to 2017. The DFW AD SIP revision that was submitted to the EPA on July 10, 2015 was developed based on the EPA's May 21, 2012 implementation rule for the 2008 ozone NAAQS (77 FR 30160), which set 2018 as the attainment year for areas classified as moderate. The deadline to submit AD SIP revisions for areas classified as moderate for the 2008 ozone NAAQS was July 20, 2015, which the EPA did not alter. The DFW AD SIP revision included a commitment to develop a new AD SIP revision for the DFW 2008 eight-hour ozone nonattainment area to reflect the 2017 attainment year. This proposed DFW AD SIP revision would include the following analyses to reflect the 2017 attainment year: a modeled AD, a reasonably available control measures (RACM) analysis, a weight of evidence (WoE) analysis and a motor vehicle emissions budget (MVEB).

Re: Docket No. 2015-1380-SIP

Scope of the SIP revision:
This memo applies to the DFW AD SIP revision for the 2008 Ozone NAAQS requirement under a moderate ozone nonattainment classification for the 2017 attainment year.

A.) Summary of what the SIP revision will do:
This proposed DFW AD SIP revision would demonstrate attainment of the 2008 eight-hour ozone NAAQS by July 20, 2018 based on a photochemical modeling analysis of reductions in nitrogen oxides (NO_X) and volatile organic compounds (VOC) emissions from existing control strategies and a weight of evidence (WoE) analysis.

B.) Scope required by federal regulations or state statutes:
The proposed DFW AD SIP revision would be consistent with the requirements of FCAA, §182(b)(1) and the EPA's 2008 ozone standard SIP requirements rule, published on March 6, 2015 (80 FR 12264). The FCAA-required SIP elements include analyses for RACM, an MVEB. Consistent with EPA guidance, this proposed DFW AD SIP revision would also include a modeled AD and a WoE analysis. As discussed above, due to the change in the required attainment date, this proposed DFW AD SIP revision, including the modeled AD, WoE, RACM, and MVEB elements, would be updated to address the 2017 attainment year. The peak ozone design value in 2017 for the DFW nonattainment area is projected to be 77 ppb using older EPA modeling guidance from 2007 and 76 ppb using newer draft guidance released by the EPA in December 2014.

C.) Additional staff recommendations that are not required by federal rule or state statute:
None

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 DFW AD 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 nonattainment 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.

Effect on the:

A.) Regulated community:
None

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:
None

Stakeholder meetings:
The North Central Texas Council of Governments 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 nonattainment area. Agenda topics include the status of DFW photochemical modeling development and research initiatives 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. In addition, the commission plans to hold a public hearing on this proposed DFW AD SIP revision.

Potential controversial concerns and legislative interest:
In its comments on the previous DFW AD SIP revision for the 2008 ozone NAAQS submitted to the EPA on July 10, 2015, the EPA indicated that the proposed, reasonably available control technology (RACT) analysis for cement kilns should be reevaluated. In particular, the EPA indicated that the retirement of the higher emitting wet kilns and operation of more energy efficient and lower emitting dry kilns in Ellis County makes it necessary for the Texas Commission on Environmental Quality to revisit its NO_X cap limit, set forth in 2007 at 17.4 tons per day. The EPA further indicated that failure to conduct a thorough RACT analysis for cement kilns, which would include appropriate emission limits, would prevent it from approving the RACT portion of the attainment plan submittal. This proposed SIP revision would not make any revisions to the cement kiln NO_X cap limit.

The EPA also indicated that the loss of a year to demonstrate attainment presents challenges for the state and that additional ozone reductions will be necessary to demonstrate attainment. This proposed SIP revision would include no additional ozone control measures.

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

Re: Docket No. 2015-1380-SIP

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 DFW AD SIP revision to the EPA. If the DFW AD SIP revision is not submitted, the EPA could impose sanctions on the state and promulgate a federal implementation plan (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 nonattainment 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.

Key points in the proposal SIP revision schedule:
Anticipated proposal date: December 9, 2015
Anticipated public hearing date: January 2016
Anticipated public comment period: December 11, 2015 through January 29, 2016
Anticipated adoption date: June 29, 2016

Agency contacts:
Kathy Singleton, SIP Project Manager, (512) 239-0703, Air Quality Division
Terry Salem, Staff Attorney, (512) 239-0469, Environmental Law Division

cc: Chief Clerk, 2 copies
Executive Director's Office
Marshall Coover
Jim Rizk
Stephen Tatum
Office of General Counsel
Kathy Singleton
Joyce Spencer-Nelson

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 2008 EIGHT-HOUR OZONE STANDARD NONATTAINMENT AREA ATTAINMENT DEMONSTRATION STATE IMPLEMENTATION PLAN REVISION FOR THE 2017 ATTAINMENT YEAR

PROJECT NUMBER 2015-014-SIP-NR

Proposal
December 9, 2015

EXECUTIVE SUMMARY

On March 12, 2008, the United States Environmental Protection Agency (EPA) strengthened the eight-hour ozone standard from 0.08 parts per million (ppm) to 0.075 ppm. Under the 0.075 ppm (75 parts per billion (ppb)) standard, the EPA designated Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties as nonattainment with a moderate classification, effective July 20, 2012. These 10 counties form the Dallas-Fort Worth (DFW) 2008 eight-hour ozone standard moderate nonattainment area. The attainment date for moderate nonattainment areas was established in the EPA's implementation rule for the 2008 ozone National Ambient Air Quality Standard (NAAQS), published in the *Federal Register* (FR) on May 21, 2012 (77 FR 30160), and was set as December 31, 2018.

On December 23, 2014, the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit Court) ruled on a lawsuit which resulted in vacatur of the EPA's December 31, 2018 attainment date for the 2008 0zone NAAQS. As a result of the court case, the attainment date for the DFW moderate nonattainment area was changed to July 20, 2018 with a 2017 attainment year (80 FR 12264). Due to the timing of the D.C. Circuit Court ruling and finalization of the 2008 ozone state implementation plan (SIP) requirements rule (effective April 6, 2015), the SIP development schedule did not allow for a full update of the DFW attainment demonstration (AD) SIP revision to address the change in attainment year from 2018 to 2017. The DFW AD SIP revision that was submitted to the EPA on July 10, 2015 was developed based on the EPA's May 21, 2012 implementation rule for the 2008 ozone NAAQS (77 FR 30160), which set 2018 as the attainment year for areas classified as moderate. The deadline to submit AD SIP revisions for areas classified as moderate for the 2008 ozone NAAQS was July 20, 2015, which the EPA did not alter. The DFW AD SIP revision included a commitment to develop a new AD SIP revision for the DFW 2008 eight-hour ozone nonattainment to reflect the 2017 attainment year.

This proposed new DFW AD SIP revision includes the following analyses to reflect the 2017 attainment year: a modeled AD, a reasonably available control measures (RACM) analysis, a weight of evidence (WoE), and a motor vehicle emissions budget . This DFW AD SIP revision demonstrates attainment of the 2008 eight-hour ozone NAAQS by July 20, 2018 based on a photochemical modeling analysis of reductions in nitrogen oxides (NO_X) and volatile organic compounds (VOC) emissions from existing control strategies and a WoE analysis. The peak ozone design value in 2017 for the DFW nonattainment area is projected to be 77 ppb using EPA guidance from April 2007 and 76 ppb using draft guidance released by the EPA in December 2014.

This proposed DFW 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 July 20, 2018 attainment date. The quantitative and qualitative corroborative analyses in Chapter 5: *Weight of Evidence* demonstrates attainment of the 2008 eight-hour ozone standard. This DFW AD SIP revision includes base case modeling of an eight-hour ozone 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 eight-hour ozone levels above 75 ppb have historically been monitored within the DFW nonattainment 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 2017 future year to project 2017 eight-hour ozone design values.

Table ES-1: *Summary of 2006 Baseline and 2017 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 2017 future year for NO_X and VOC ozone precursors. The differences in modeling emissions between the 2006 baseline and the 2017 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 ozone season are an average of actual emission measurements, while the 2017 electric utility emission projections are based on the maximum ozone season caps required under the Cross-State Air Pollution Rule (CSAPR).[1] The emission inputs in Table ES-1 were based on the latest available information at the time development work was done for this SIP proposal. If new information becomes available in a timely manner, some of these emission inputs may be revised for the adopted SIP revision.

Table ES-1: Summary of 2006 Baseline and 2017 Future Year Anthropogenic Modeling Emissions for DFW

DFW Nonattainment Area Source Type	2006 NO_X (tpd)	2017 NO_X (tpd)	2006 VOC (tpd)	2017 VOC (tpd)
On-Road	284.27	130.77	116.50	64.91
Non-Road	98.06	45.54	64.69	34.01
Off-Road – Locomotives	20.14	12.88	1.28	0.67
Off-Road – Airports	12.78	12.32	4.46	2.89
Area Sources	29.02	26.55	290.46	236.70
Oil and Gas – Production	61.84	10.80	43.72	31.86
Oil and Gas – Drill Rigs	18.23	3.07	1.16	0.32
Point – Oil and Gas	11.53	16.50	21.82	25.80
Point – Electric Utilities	9.63	13.98	1.03	0.55
Point – Cement Kilns	22.08	17.64	1.94	0.77
Point – Other	14.31	6.68	25.65	20.26
Total	581.89	296.73	572.71	418.74

Table ES-2: *Summary of Modeled 2006 Baseline and 2017 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 2017 future year design value (DV_F) for the regulatory ozone monitors in the DFW nonattainment area. In accordance with the EPA's *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5 and Regional Haze*, April 2007, the 2017 DV_F figures presented have been rounded to one decimal place and then truncated. The 2007 version of this modeling guidance recommends that the attainment test used to calculate DV_F figures rely on all baseline episode days modeled above a specific threshold such as 75 ppb. The EPA released a draft update to this modeling guidance in December 2014 that recommends the attainment test rely

[1] On July 28, 2015, the D.C. Circuit Court found that the CSAPR 2014 SO_2 and ozone season NO_X budgets for Texas and certain other states were invalid because the budgets required more emission reductions than were necessary. The court remanded the rule without vacatur to the EPA for reconsideration of the emission budgets. Therefore, while the current CSAPR budgets for Texas are still in effect, the budgets may be subject to change in the future after the EPA's reconsideration or changes resulting from further appeals.

on only the 10 days from the baseline episode with the highest modeled ozone. Table ES-2 includes the DV_F figures for both the "all days" and "top 10 days" tests. 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 July 20, 2018.

Table ES-2: Summary of Modeled 2006 Baseline and 2017 Future Year Eight-Hour Ozone Design Values for DFW Monitors

2006 DFW Nonattainment Area Monitor and Continuous Air Monitoring Station (CAMS) Code	DFW Monitor Alpha Code	2006 Baseline Design Value (ppb)	2017 "All Days" DV_F (ppb)	2017 "Top 10 Days" DV_F (ppb)
Denton Airport South - C56	DENT	93.33	77	76
Eagle Mountain Lake - C75	EMTL	93.33	77	76
Grapevine Fairway - C70	GRAP	90.67	77	75
Keller - C17	KELC	91.00	76	75
Fort Worth Northwest - C13	FWMC	89.33	75	74
Frisco - C31	FRIC	87.67	74	73
Dallas North #2 - C63	DALN	85.00	73	72
Dallas Executive Airport - C402	REDB	85.00	72	72
Parker County - C76	WTFD	87.67	72	72
Cleburne Airport - C77	CLEB	85.00	71	69
Dallas Hinton Street - C401	DHIC	81.67	71	69
Arlington Municipal Airport - C61	ARLA	83.33	70	69
Granbury - C73	GRAN	83.00	68	68
Midlothian Tower - C94*	MDLT	80.50	67	67
Pilot Point - C1032*	PIPT	81.00	67	66
Rockwall Heath - C69	RKWL	77.67	65	65
Midlothian OFW - C52*	MDLO	75.00	63	62
Kaufman - C71	KAUF	74.67	62	62
Greenville - C1006	GRVL	75.00	61	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.

The 2017 DV_F calculations are provided using both the all days and top 10 days attainment tests discussed above. A WoE range of 73-78 ppb is inferred from the April 2007 guidance, and use of the older "all days" attainment test results in a peak ozone design value of 77 ppb that falls within this 73-78 ppb range. The draft guidance from December 2014 does not specify a WoE range, and instead requires that the DV_F figures be "close to the NAAQS." The newer "top 10 days" attainment test results in a peak ozone design value of 76 ppb that meets this requirement. Differences in the application of these two tests are more thoroughly described in Chapter 3: *Photochemical Modeling*, Section 3.7.2: *Future Baseline Modeling*.

Because this SIP revision only provides an analyses to reflect the 2017 attainment year, all other sections have been labeled “no change.” An electronic version of the AD SIP revision for the 2008 Ozone NAAQS submitted to the EPA on July 10, 2015 can be found at the Texas Commission on Environmental Quality’s (TCEQ) Dallas-Fort Worth: Latest Ozone Planning Activities Web page (https://www.tceq.texas.gov/airquality/sip/dfw/dfw-latest-ozone).

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 DFW 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 and 2015. 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.

<u>Applicable Law</u>
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.

<u>Statutes</u>
All sections of each subchapter are included, unless otherwise noted.

Texas Health and Safety Code, Chapter 382	September 1, 2015
Texas Water Code	September 1, 2015

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

<u>Rules</u>
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, 2002
Chapter 19: Electronic Reporting	March 15, 2007
Chapter 35: Subchapters A-C, K: Emergency and Temporary Orders and Permits; Temporary Suspension or Amendment of Permit Conditions	July 20, 2006

Chapter 39: Public Notice, §§39.402(a)(1) - (6), (8), and (10) - (12), 39.405(f)(3) and (g), (h)(1)(A) - (4), (6), (8) - (11), (i) and (j), 39.407, 39.409, 39.411(a), (e)(1) - (4)(A)(i) and (iii), (4)(B), (5)(A) and (B), and (6) - (10), (11)(A)(i) and (iii) and (iv), (11)(B) - (F), (13) and (15), and (f)(1) - (8), (g) and (h), 39.418(a), (b)(2)(A), (b)(3), and (c), 39.419(e), 39.420 (c)(1)(A) - (D)(i)(I) and (II), (D)(ii), (c)(2), (d) - (e), and (h), and 39.601 - 39.605	April 17, 2014
Chapter 55: Requests for Reconsideration and Contested Case Hearings; Public Comment, §§55.150, 55.152(a)(1), (2), (5), and (6) and (b), 55.154(a), (b), (c)(1) - (3), and (5), and (d) - (g), and 55.156(a), (b), (c)(1), (e), and (g)	June 24, 2010
Chapter 101: General Air Quality Rules	June 25, 2015
Chapter 106: Permits by Rule, Subchapter A	April 17, 2014
Chapter 111: Control of Air Pollution from Visible Emissions and Particulate Matter	February 6, 2014
Chapter 112: Control of Air Pollution from Sulfur Compounds	July 16, 1997
Chapter 113: Standards of Performance for Hazardous Air Pollutants and for Designated Facilities and Pollutants	May 14, 2009
Chapter 114: Control of Air Pollution from Motor Vehicles	May 21, 2015
Chapter 115: Control of Air Pollution from Volatile Organic Compounds	June 25, 2015
Chapter 116: Permits for New Construction or Modification	July 31, 2014
Chapter 117: Control of Air Pollution from Nitrogen Compounds	June 25, 2015
Chapter 118: Control of Air Pollution Episodes	March 5, 2000
Chapter 122: §122.122: Potential to Emit	April 17, 2014
Chapter 122: §122.215: Minor Permit Revisions	June 3, 2001
Chapter 122: §122.216: Applications for Minor Permit Revisions	June 3, 2001
Chapter 122: §122.217: Procedures for Minor Permit Revisions	December 11, 2002
Chapter 122: §122.218: Minor Permit Revision Procedures for Permit Revisions Involving the Use of Economic Incentives, Marketable Permits, and Emissions Trading	June 3, 2001

SECTION VI: CONTROL STRATEGY

TABLE OF CONTENTS

LIST OF ACRONYMS

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
BOEMRE	United States Bureau of Ocean Energy Management Service
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
CISL	Computational and Information Systems Laboratory
CLEB	Cleburne Monitor (C77)
CLVL	Clarksville Monitor (C648)
CO	carbon monoxide
CSAPR	Cross-State Air Pollution Rule
CTG	control techniques guidelines
D.C.	District of Columbia
DALN	Dallas North Monitor (C63)
DENT	Denton Monitor (C56)
DERI	Diesel Emissions Reduction Incentive Program
DFW	Dallas-Fort Worth
DHIC	Dallas Hinton Monitor (C401)
DV_B	baseline year design value
DV_F	future year design value
DV_R	regulatory design value

EDMS	Emissions Dispersion Modeling System
EE	energy efficiency
EE/RE	energy efficiency and renewable energy
EGU	electric generating unit
EI	emissions inventory
EMTL	Eagle Mountain Lake Monitor (C75)
EPA	United States Environmental Protection Agency
EPS	Emissions Processing System
ERG	Eastern Research Group, Inc.
ESL	Energy Systems Laboratory
FAA	Federal Aviation Administration
FCAA	Federal Clean Air Act
FINN	Fire Inventory of NCAR
FR	*Federal Register*
FTP	File Transfer Protocol
FRIC	Frisco Monitor (C31)
FWMC	Fort Worth Northwest Monitor (C13)
FY	fiscal year
GCIP	Continental-International Project
GEOS-Chem	Goddard Earth Observing Station global atmospheric model with Chemistry
GEWEX	Global Energy and Water Cycle Experiment
GloBEIS	Global Biosphere Emissions and Interactions System
gm/hp-hr	grams per horsepower-hour
GOES	Geostationary Operational Environmental Satellite
GRAN	Granbury Monitor (C73)
GRAP	Grapevine Monitor (C70)
GRVL	Greenville Monitor (C1006)
GSE	ground support equipment
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
ITHS	Italy High School (C60)
KAUF	Kaufman Monitor (C71)
KELC	Keller Monitor (C17)
km	kilometer
Kv	vertical diffusity
KVPATCH	landuse based minimum Kv for all domains
LAI	leaf area index
LAIv	fractional vegetated leaf area index
LANDFIRE	Landscape Fire and Resource Management
LCC	Lambert Conformal Conic
LIRAP	Low Income Vehicle Repair Assistance, Retrofit, and Accelerated Vehicle Retirement Program
m	meter
m/s	meters per second
MATS	Modeled Attainment Test Software
MACT	maximum achievable control technology
MDA8	maximum daily average eight-hour
MDLO	Midlothian Old Fort Worth Monitor (C52)
MDLT	Midlothian Tower Monitor (C94)
MECT	Mass Emissions Cap and Trade
MEGAN	Model of Emissions of Gases and Aerosols from Nature
MM5	Mesoscale Meteorological Model, Fifth Generation
MMBTU	million British Thermal Units
MMcf	million cubic feet
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

MVEB	motor vehicle emissions budget
NAAQS	National Ambient Air Quality Standard
NCAR	National Center for Atmospheric Research
NCEP	National Center for Environmental Prediction
NCore	National Core network
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	National Centers for Environmental Prediction, Oregon State, Air Force, and Hydrologic Research Laboratory
NO_X	nitrogen oxides
NPRI	National Pollutant Release Inventory
OMI	Ozone Monitoring Instrument
OSAT	Ozone Source Apportionment Technology
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
ppm	parts per million
PUCT	Public Utility Commission of Texas
RACM	reasonably available control measures
RACT	reasonably available control technology
RE	renewable energy
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
RRF	relative response factor
RRTM	Rapid Radiative Transfer Model
RS	redesignation substitute
RVP	Reid vapor pressure
SAGA	San Augustine Airport Monitor (C646)
SB	Senate Bill
SECO	State Energy Conservation Office
SEER	Seasonal Energy Efficiency Ratio
SIC	standard industrial classification
SIP	state implementation plan
SLAMS	State and Local Air Monitoring Stations
SO_2	sulfur dioxide
STARS	State of Texas Air Reporting System
TAC	Texas Administrative Code
TACB	Texas Air Control Board
TATU	TCEQ Attainment Test for Unmonitored Areas
TCAA	Texas Clean Air Act
TCEQ	Texas Commission on Environmental Quality (commission)
TCFP	Texas Clean Fleet Program
TCM	transportation control measure
TDM	travel demand model
TERP	Texas Emission Reduction Plan
TexAER	Texas Air Emissions Repository
TexAQS II	Texas Air Quality Study 2006
TexN	Texas NONROAD
TNMOC	total non-methane organic carbon
TNRCC	Texas Natural Resource Conservation Commission
tpd	tons per day
tpy	tons per year
TTI	Texas Transportation Institute
TUC	Texas Utilities Code
TxDOT	Texas Department of Transportation
TxLED	Texas Low Emission Diesel
U.S.	United States

UMA	unmonitored area
UPA	Unpaired Peak Accuracy
VMT	vehicle miles traveled
VNA	Voroni Neighbor Averaging
VOC	volatile organic compounds
WoE	weight of evidence
WPS	Weather Research and Forecasting Model Preprocessing System
WRF	Weather Research and Forecasting Model
WTFD	Weatherford Parker County Monitor (C76)
YSU	Yonsei University

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: GENERAL

1.1 BACKGROUND (NO CHANGE)

1.2 INTRODUCTION (NO CHANGE)

1.2.1 One-Hour National Ambient Air Quality Standard (NAAQS) History (No change)

1.2.1.1 March 1999 (No change)

1.2.1.2 April 2000 (No change)

1.2.1.3 August 2001 (No change)

1.2.1.4 March 2003 (No change)

1.2.1.5 EPA Determination of One-Hour Ozone Attainment

Since the early 1990s, when the Dallas-Fort Worth (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 nonattainment area include: Texas Commission on Environmental Quality (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 United States Environmental Protection Agency (EPA). Multiple state implementation plan (SIP) revisions have been submitted to the EPA and air quality in the DFW nonattainment area continues to improve.

In June 2005, the one-hour ozone standard was revoked after being replaced by the more stringent eight-hour ozone standard in 1997. By 2006, ambient monitoring data reflected attainment of the one-hour standard. On October 16, 2008, the EPA published final determination (73 *Federal* Register [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 and continues to demonstrate attainment with a design value of 102 ppb based on certified data through 2014.

Since the DFW four-county area was not redesignated to attainment prior to the revocation of the one-hour ozone standard, anti-backsliding requirements for contingency measures and new source review (NSR) permitting requirements for serious nonattainment areas still apply. The EPA's *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 ozone standard SIP requirements rule) published in the *Federal Register* on March 6, 2015 (80 FR 12264), includes a mechanism for lifting anti-backsliding obligations under a revoked ozone NAAQS, termed a redesignation substitute (RS), based on Federal Clean Air Act (FCAA), §107(d)(3)(E) redesignation criteria. The EPA's approval of an RS would have the same effect on the area's nonattainment anti-backsliding obligations as would a redesignation to attainment for the revoked standard.

On August 18, 2015, the TCEQ submitted a DFW RS demonstration to the EPA in the form of a letter and attached report, which will be followed by the formal SIP notice and comment process should submittal of a SIP revision be necessary. The DFW RS demonstration is intended to satisfy the anti-backsliding obligations for the revoked one-hour and 1997 eight-hour ozone NAAQS by ensuring that the EPA's requirements for the redesignation of revoked ozone standards are met for the DFW ozone nonattainment area. The DFW RS demonstration was submitted to the EPA as provided for by the 2008 ozone standard SIP requirements rule instead of a redesignation request and maintenance plan, which the FCAA requires to remove anti-backsliding obligations under a standard that has not been revoked.

The DFW RS demonstrates that the DFW one-hour and 1997 eight-hour ozone areas will continue to attain the standards due to permanent and enforceable emission reductions and demonstrates continued attainment of both standards through 2028 via emissions inventory trends, 2012 attainment inventory, and projected future emissions. Since removing anti-backsliding obligations is contingent upon the EPA's approval, the TCEQ has set a horizon year of 2028. This 10-year period also aligns with the EPA's requirement of maintenance plans to demonstrate attainment for a 10-year period following the date of redesignation.

1.2.2 1997 Eight-Hour Ozone NAAQS History (No change)

1.2.2.1 May 23, 2007 (No change)

1.2.2.2 Reclassification to Serious for the 1997 Eight-Hour Ozone Standard (No change)

1.2.2.3 EPA Determination of Attainment for the 1997 Eight-Hour Ozone NAAQS

Under the serious classification, the DFW nonattainment area was given until June 15, 2013 to attain the 1997 eight-hour ozone NAAQS. The area did not monitor attainment by that date but at the end of the 2014 ozone season, the eight-hour design value was 81 ppb, based on 2012, 2013, and 2014 air monitoring data, which is in attainment of the 1997 eight-hour ozone standard. On February 24, 2015, the TCEQ submitted early certification of 2014 ozone air monitoring data to the EPA, along with a request for a determination of attainment for the 1997 eight-hour ozone standard for the DFW area. On September 1, 2015, the EPA published a determination of attainment for the DFW 1997 eight-hour ozone nonattainment area and disapproval of portions of the 2011 DFW 1997 Eight-Hour Ozone Attainment Demonstration (AD) SIP Revision (80 FR 52630). A revised attainment demonstration for the 1997 eight-hour ozone standard will not be required as a result of the EPA's determination of attainment.

The EPA revoked the 1997 eight-hour ozone standard in its 2008 ozone standard SIP requirements rule (80 FR 12264). Since the DFW nine-county area was not redesignated to attainment prior to the revocation of the one-hour or the 1997 eight-hour ozone standards, anti-backsliding requirements for contingency measures and NSR permitting requirements for serious nonattainment areas still apply.

As discussed in Section 1.2.1.5, *EPA Determination of One-Hour Ozone Attainment*, the TCEQ submitted a DFW RS demonstration to the EPA on August 18, 2015 in the form of a letter and attached report which will be followed by the formal SIP notice and comment process should submittal be necessary. The DFW RS is intended to satisfy the anti-backsliding obligations for the revoked one-hour and 1997 eight-hour ozone NAAQS by ensuring that the EPA's requirements for the redesignation of revoked ozone standards are met for the DFW ozone nonattainment area.

1.2.3 2008 Eight-Hour Ozone NAAQS (No change)

1.2.4 AD SIP Revision for the 2008 Ozone NAAQS (No change)

1.2.5 Current AD SIP Revision for 2008 Ozone NAAQS for the 2017 Attainment Year

In the *DFW AD SIP Revision for the 2008 Ozone NAAQS* submitted to the EPA on July 10, 2015, the TCEQ committed to develop a new AD SIP revision for the DFW 2008 eight-hour ozone nonattainment area to include the following analyses to reflect the 2017 attainment year: a modeled AD, corroborative analysis, a reasonably available control measures (RACM) analysis, and a motor vehicle emissions budget (MVEB).

Because this SIP revision only provides an analyses to reflect the 2017 attainment year, all other sections have been labeled "no change." An electronic version of the AD SIP revision for the 2008 Ozone NAAQS submitted to the EPA on July 10, 2015 can be found at the TCEQ's Dallas-Fort Worth: Latest Ozone Planning Activities Web page (https://www.tceq.texas.gov/airquality/sip/dfw/dfw-latest-ozone).

This proposed DFW AD SIP revision demonstrates attainment of the 2008 eight-hour ozone NAAQS by July 20, 2018 based on a photochemical modeling analysis of reductions in nitrogen oxides (NO_X) and volatile organic compounds (VOC) emissions from existing control strategies and a weight of evidence analysis. The peak ozone design value in 2017 for the DFW nonattainment area is projected to be 77 ppb using EPA guidance from April 2007 and 76 ppb using draft guidance released by the EPA in December 2014.

1.2.6 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 nonattainment 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 nonattainment area from 1991 through 2014 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 24 years. The 2014 one-hour ozone design value was 102 ppb, representing a 27% decrease from the value for 1991 (140 ppb). The 2014 eight-hour ozone design value was 81 ppb, a 23% decrease from the 1991 value of 105 ppb. These decreases occurred despite a 69% increase in area population from 1991 through 2014, as shown in Figure 1-1.

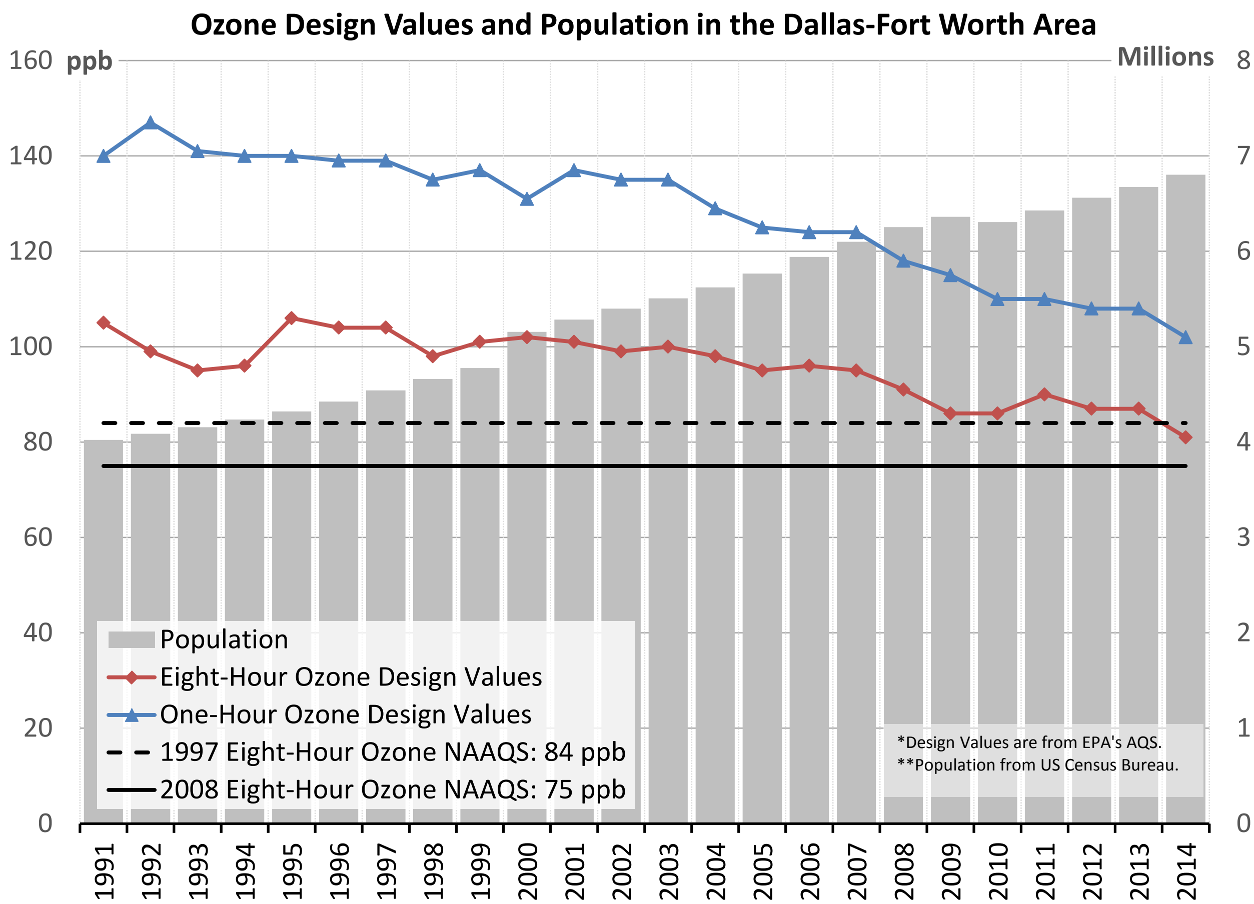


Figure 1-1: One-Hour and Eight-Hour Ozone Design Values and DFW Population

1.3 HEALTH EFFECTS (NO CHANGE)

1.4 STAKEHOLDER PARTICIPATION (NO CHANGE)

1.4.1 DFW Air Quality Technical Committee Meetings (No change)

1.5 PUBLIC HEARING 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 21, 2016	6:30 P.M.	North Central Texas Council of Governments 616 Six Flags Drive Arlington, TX 76011
Austin	January 26, 2016	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 11, 2015, and close on January 29, 2016. Written comments will be accepted via mail, fax, or through the eComments (http://www1.tceq.texas.gov/rules/ecomments/index.cfm) system. All comments should reference the "Dallas-Fort Worth Attainment Demonstration for the 2008 Eight-Hour Ozone Nonattainment Area" and should reference Project Number 2015-014-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 29, 2016.

An electronic version of the AD SIP revision for the 2008 Ozone NAAQS and appendices can be found at the TCEQ's Dallas-Fort Worth: Latest Ozone Planning Activities Web page (https://www.tceq.texas.gov/airquality/sip/dfw/dfw-latest-ozone).

1.6 SOCIAL AND ECONOMIC CONSIDERATIONS (NO CHANGE)

1.7 FISCAL AND MANPOWER RESOURCES (NO CHANGE).

CHAPTER 2: ANTHROPOGENIC EMISSIONS INVENTORY (EI) DESCRIPTION

2.1 INTRODUCTION (NO CHANGE)

2.2 POINT SOURCES (NO CHANGE)

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 volatile organic compounds (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 a United States Environmental Protection Agency (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 National Emissions Inventory (NEI). The Texas Commission on Environmental Quality (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. TexN 1.7.1 was used to estimate non-road emissions for this proposed Dallas-Fort Worth (DFW) Attainment Demonstration (AD) State Implementation Plan (SIP) revision.

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. 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. Drilling rig inventories are developed using improved drilling rig emissions characterization profiles based on 2015 survey data from Texas oil and gas companies. These drilling rig emissions characterization profiles are combined with drilling activity data obtained from the Railroad Commission of Texas (RRC) to develop drilling rig emissions estimates. 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 (NO CHANGE)

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 nitrogen oxides (NO_X) and VOC emissions from various oil and gas processes and produced water storage tanks at upstream oil and gas operations Texas, 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 EI under the authority of 30 Texas Administrative Code (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 profiles in both the DFW nine-county 1997 eight-hour ozone nonattainment area as well as the ozone nonattainment Barnett Shale counties. 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 Barnett Shale 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 Barnett Shale 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 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 ten-county 2008 eight-hour ozone nonattainment 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.
- A study contracted to Eastern Research Group, Inc. (ERG) was completed on August 1, 2014 that updated emission rates for hydraulic pump engines and mud degassing activities associated with oil and gas production. The oil and gas emissions estimates included with the proposed DFW AD SIP revision were developed with older emission factors for this type of activity.
- Revised 2014 historical production data became available from the RRC, which impacted 2017 projections of emissions from natural gas compressor engines. These updated RRC data sets were used for projecting the 2017 oil and gas emission estimates included with this DFW AD SIP revision.

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 page (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 ADs 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. When development work on this DFW AD SIP revision commenced in 2012, 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) was the latest modeling guidance available. The EPA released an update to this guidance in December 2014 entitled *Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze* (EPA, 2014). The April 2007 document will be referred to as either the "2007 guidance" or "2007 modeling guidance," and the December 2014 version will be referred to as either the "draft guidance" or "draft modeling guidance."

Both the 2007 and draft guidance documents recommend air quality modeling procedures for predicting attainment of the eight-hour ozone National Ambient Air Quality Standard (NAAQS). They recommend several qualitative methods for preparing ADs that acknowledge the limitations and uncertainties of photochemical models when used to project ozone concentrations into future years. First, both modeling guidance documents recommend using model results in a relative sense and applying the model response to the observed ozone data. Second, both modeling guidance documents recommend 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, both modeling guidance documents recommend 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.

A large portion of the modeling and technical analysis for this DFW AD SIP revision was done prior to release of the current draft guidance, so the development work is consistent with the 2007 guidance. However, most of these procedures are very similar between the 2007 guidance and draft guidance. A notable difference is that the 2007 guidance recommends the attainment test be performed for all baseline episode days modeled above a specific threshold, while the draft guidance recommends performing the test for only the 10 days from the baseline with the highest modeled ozone values. Chapter 3: *Photochemical Modeling*, Section 3.7.2: *Future Baseline Modeling*, summarizes these attainment tests in more detail and provides the results for both approaches.

The remainder of this chapter includes an overview of the photochemical modeling, while portions of Chapter 5: *Weight of Evidence* discuss the conceptual model and WoE analyses. More detail on each of these components can be found in the following appendices to this DFW AD 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 1997, the EPA classified the DFW area as a moderate ozone nonattainment area in 2004 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 nonattainment 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 ozone standard. The DFW area was classified as moderate nonattainment with a required attainment date of December 31, 2018. In July 2015, photochemical modeling and other analyses conducted by the 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 December 31, 2018.

On December 23, 2014, the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit Court) ruled on a lawsuit filed by the Natural Resources Defense Council, which resulted in vacatur of the EPA's December 31 attainment date for the 2008 0zone NAAQS. As a result, the attainment date for the DFW moderate nonattainment area was changed from December 31, 2018 to July 20, 2018, which requires modeling a 2017 future year for the AD because it contains the full ozone season immediately preceding the attainment date. This proposed DFW 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 July 20, 2018. Also, the limited data collected in the DFW nonattainment 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 2007 and draft modeling guidance documents strongly recommend 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 as prescribed by the 2007 guidance available at the time. This modeling protocol was originally submitted 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 2007 and draft modeling guidance documents. 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 by applying growth and control factors to the baseline year emissions. Growth projections are based on expected increases in factors such as human population, vehicle miles traveled (VMT), and demand for goods and services. Controls are applied to reflect expected emission rate reductions that are scheduled to occur from state, local, and federal programs. For example, the periodic tightening of vehicle emission standards leads to lower average tailpipe emission rates over time.

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.

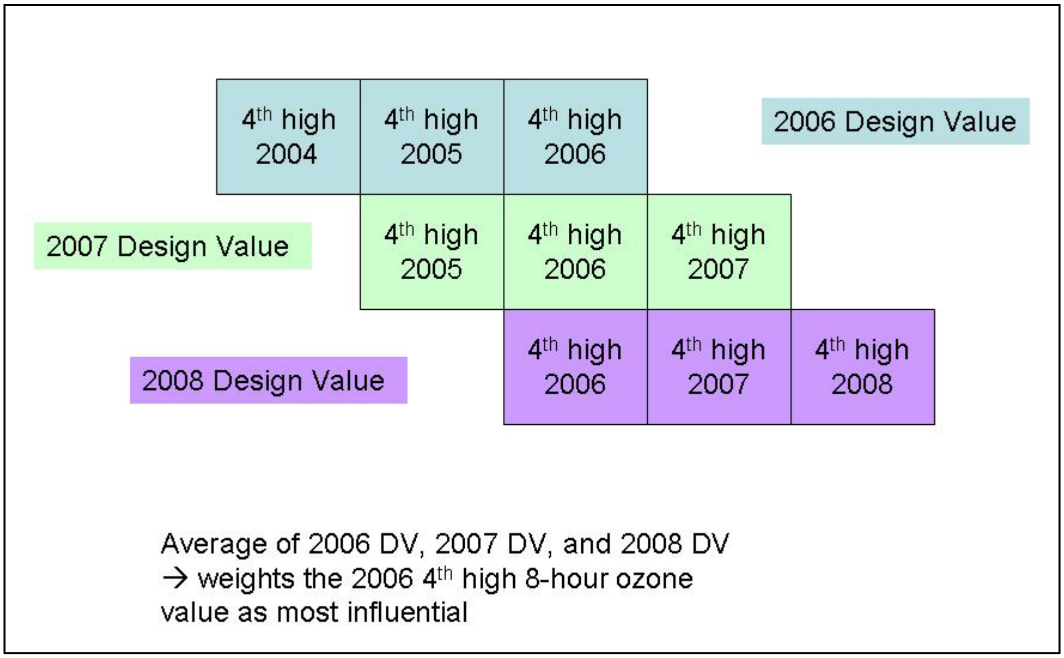


Figure 3-1: 2006 Baseline Design Value Calculation

3.3 EPISODE SELECTION

3.3.1 EPA Guidance for Episode Selection

When development work commenced for this DFW AD SIP revision in 2012, the EPA's 2007 guidance for the 1997 eight-hour ozone standard of 84 ppb was in effect. The episode selection work for this attainment analysis was done in accordance with this 2007 guidance, but the requirements are similar for the draft guidance. The primary criteria for selecting ozone episodes for eight-hour ozone AD modeling are set forth in the 2007 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 DFW AD SIP revision.

3.3.2 DFW Ozone Episode Selection Process

As shown in Figure 3-2: *DFW Eight-Hour Ozone Days Above 75 ppb by Month from 1991 through 2014*, 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 AD 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.

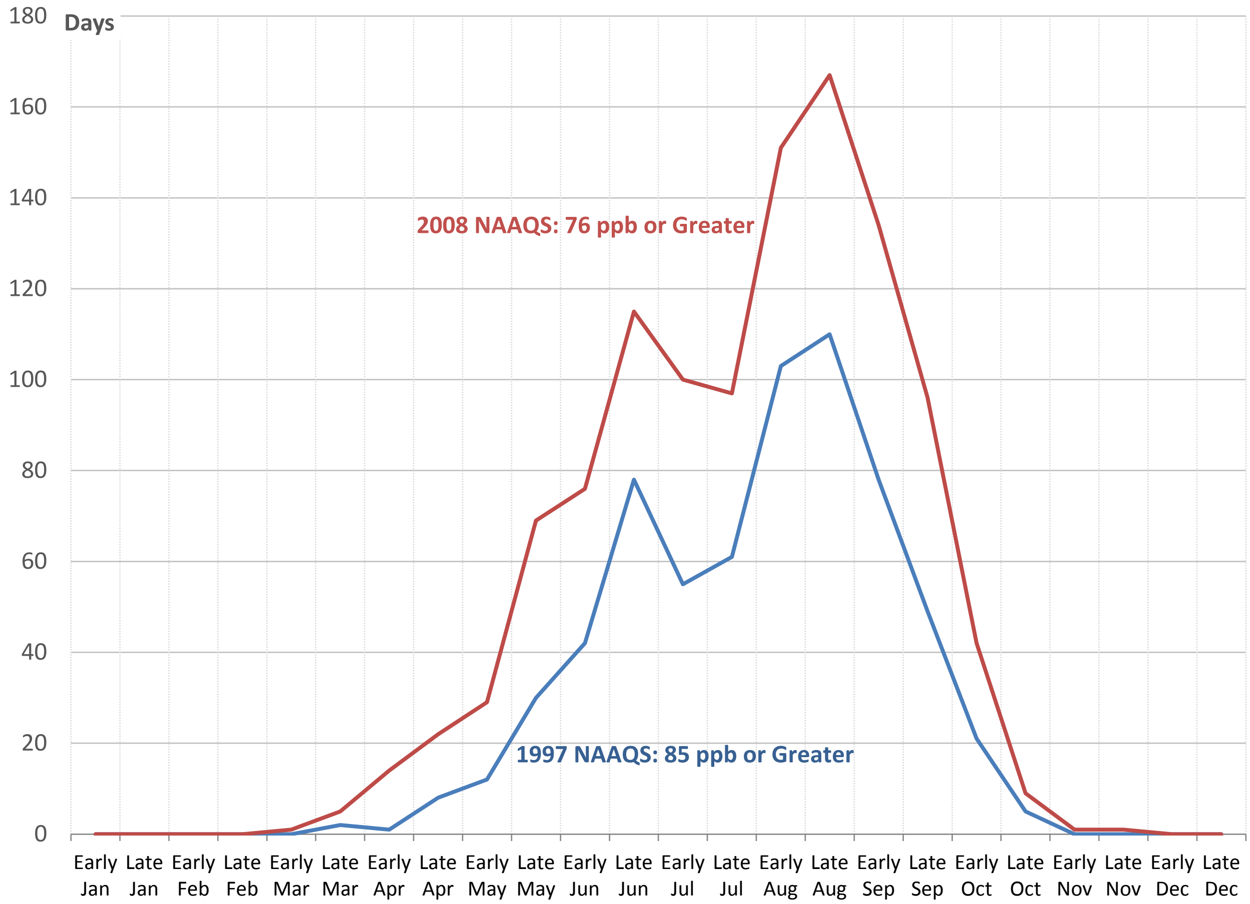


Figure 3-2: DFW Eight-Hour Ozone Days Above 75 ppb by Month from 1991 through 2014

Table 3-1: *DFW Days with Ozone Above 75 ppb by Month from 2006 through 2014* shows that there were 50 days with a DFW area monitor above 75 ppb in 2006 with 18 occurring in June and 13 in August-September. Annual days with a DFW area monitor measuring above 75 ppb in subsequent years ranged from 12 in 2014 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 days above 75 ppb in June 2012 combined with the 16 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 days in June and 26 in August-September with ozone monitored above 75 ppb, which is an unusual ozone season distribution for the DFW nonattainment area. The years 2007, 2010, 2013, and 2014 also had a relatively low number of days above 75 ppb in June compared with August-September.

Both 2008 and 2009 had a June/August-September total of 21 days with at least one monitor measuring above 75 ppb. 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 the EPA. Also, the 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 nonattainment area high ozone days 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 AD SIP submissions, and therefore work on this newer episode is still in progress.

Table 3-1: DFW Days with Ozone Above 75 ppb by Month from 2006 through 2014

Month	2006	2007	2008	2009	2010	2011	2012	2013	2014
January	0	0	0	0	0	0	0	0	0
February	0	0	0	0	0	0	0	0	0
March	1	0	0	0	0	0	2	0	0
April	2	3	1	1	0	2	0	0	0
May	3	1	3	5	4	0	4	1	0
June	18	2	6	8	3	4	9	2	1
July	9	3	5	7	0	6	5	8	5
August	8	11	7	8	9	15	11	7	3
September	5	5	8	5	2	11	5	13	3
October	4	2	0	0	0	2	0	1	0
November	0	0	0	0	0	0	0	0	0
December	0	0	0	0	0	0	0	0	0
Annual Total	50	27	30	34	18	40	36	32	12
June Only	18	2	6	8	3	4	9	2	1
August-September Only	13	16	15	13	11	26	16	20	6
June/August-September Total	31	18	21	21	14	30	25	22	7

To ensure that both early and late summer ozone periods are represented in the current modeling, and that all necessary modeling work for this AD could be completed in a timely manner, the 34-day period from August 13 through September 15, 2006 was added to the 33-day June 2006 episode for a total 67-day period representative of historical high ozone 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 AD 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 nonattainment 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 Days Above 75 ppb During 67-Day Combined 2006 Episode* shows that 12 of the DFW area monitors measured ozone above the 75 ppb standard on at least 10 days of the 2006 episodes, which is the minimum preferred by the 2007 modeling guidance. Use of the 67-day combined episode results in a range of 19 to 25 days above 75 ppb at the five downwind northwestern monitors that have typically monitored the highest ozone levels in the DFW nonattainment area: Denton Airport South, Eagle Mountain Lake, Grapevine Fairway, Keller, and Fort Worth Northwest. Seven of the DFW nonattainment area monitors had fewer than 10 days with eight-hour ozone above 75 ppb 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 2007 modeling guidance results in all of the monitors above the preferred 10 days for RRF calculations.

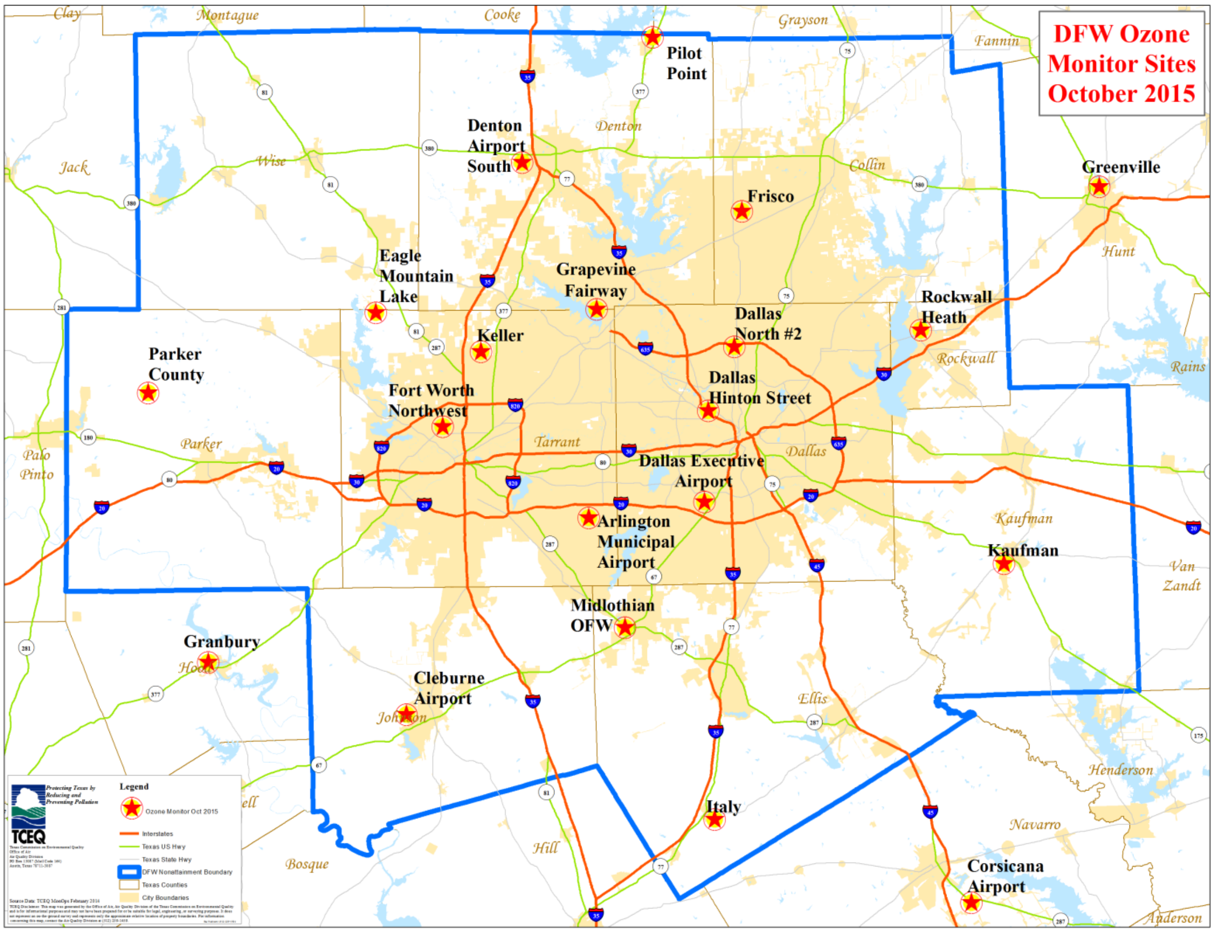


Figure 3-3: DFW Area Ozone Monitoring Locations

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 Days Above 75 ppb During 67-Day Combined 2006 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	93.33
Eagle Mountain Lake - C75	107	27	22	9	93.33
Grapevine Fairway - C70	98	26	19	9	90.67
Keller - C17	103	33	25	11	91.00
Fort Worth Northwest - C13	101	27	21	9	89.33
Frisco - C31	101	25	20	9	87.67
Dallas North #2 - C63	90	19	14	3	85.00
Parker - County - C76	101	19	12	4	87.67
Dallas Executive Airport - C402	95	28	18	5	85.00
Cleburne Airport - C77	98	18	8	2	85.00
Arlington Municipal Airport - C61	91	18	14	3	83.33
Dallas Hinton Street - C401	96	22	13	2	81.67
Granbury - C73	92	16	8	3	83.00
Midlothian Tower - C94	98	17	8	1	NA
Pilot Point - C1032	101	23	17	9	NA
Rockwall Heath - C69	86	16	9	1	77.67
Midlothian OFW - C52	96	14	5	1	NA
Greenville - C1006	84	13	3	0	75.00
Kaufman - C71	86	11	5	1	74.67

Midlothian Tower, Pilot Point, and Midlothian OFW did not measure enough data from 2004 through 2008 for calculation of a complete 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 monitored eight-hour ozone concentrations are higher than 75 ppb. High ozone is typically formed in the DFW nonattainment 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 nonattainment 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 nonattainment 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 nonattainment 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.

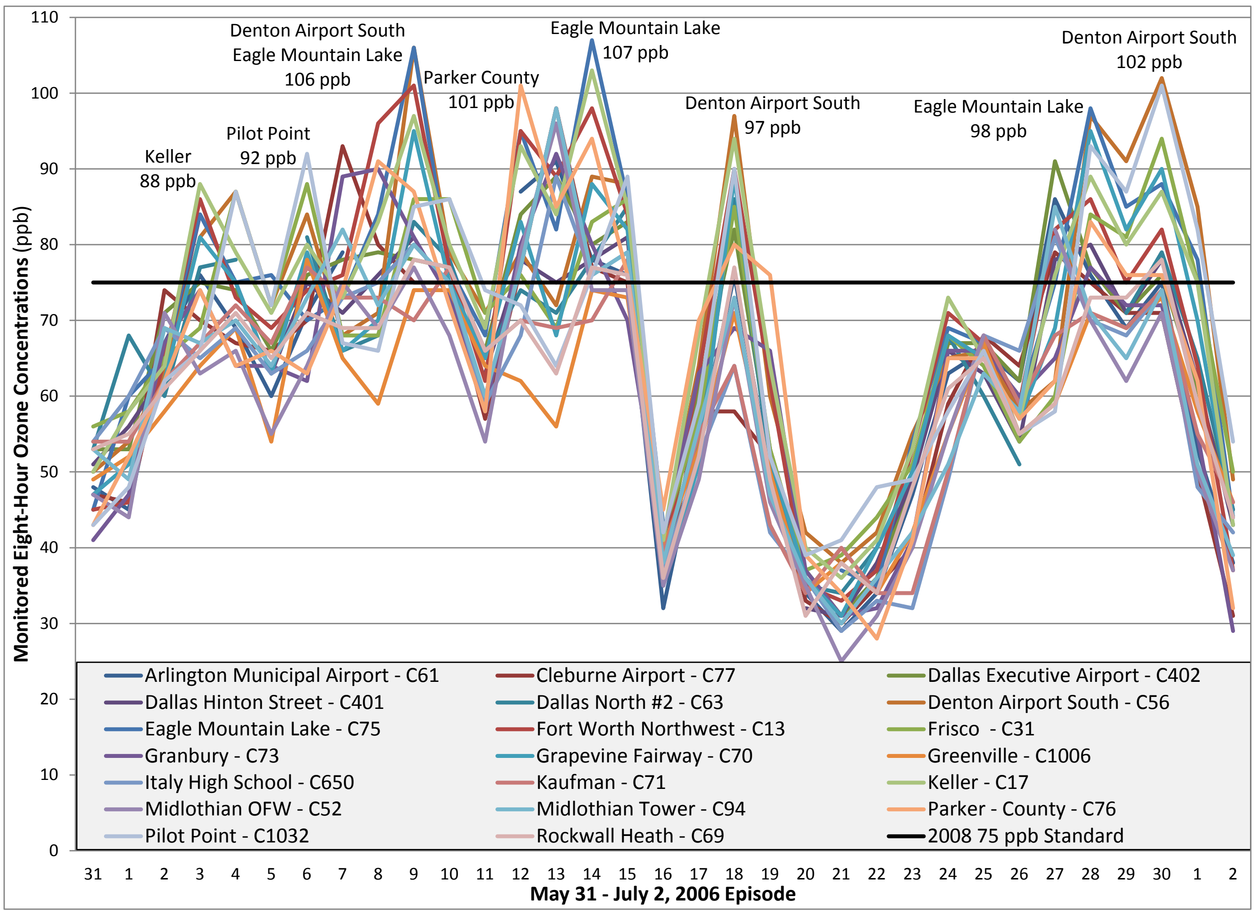


Figure 3-4: Maximum Eight-Hour Ozone by Monitor from May 31 through July 2, 2006

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 nonattainment 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 nonattainment 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.

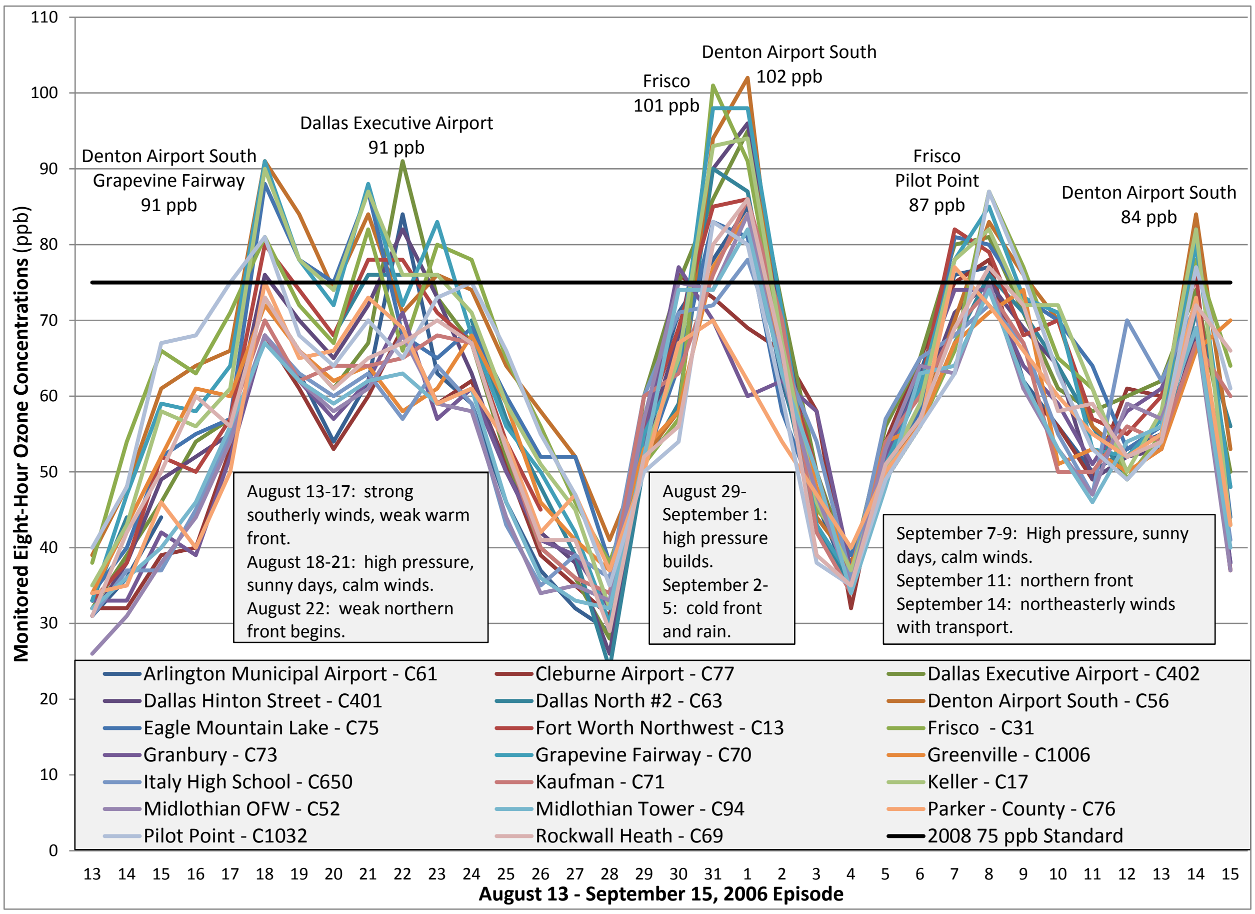


Figure 3-5: Maximum Eight-Hour Ozone by Monitor from August 13 through September 15, 2006

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 nonattainment 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.

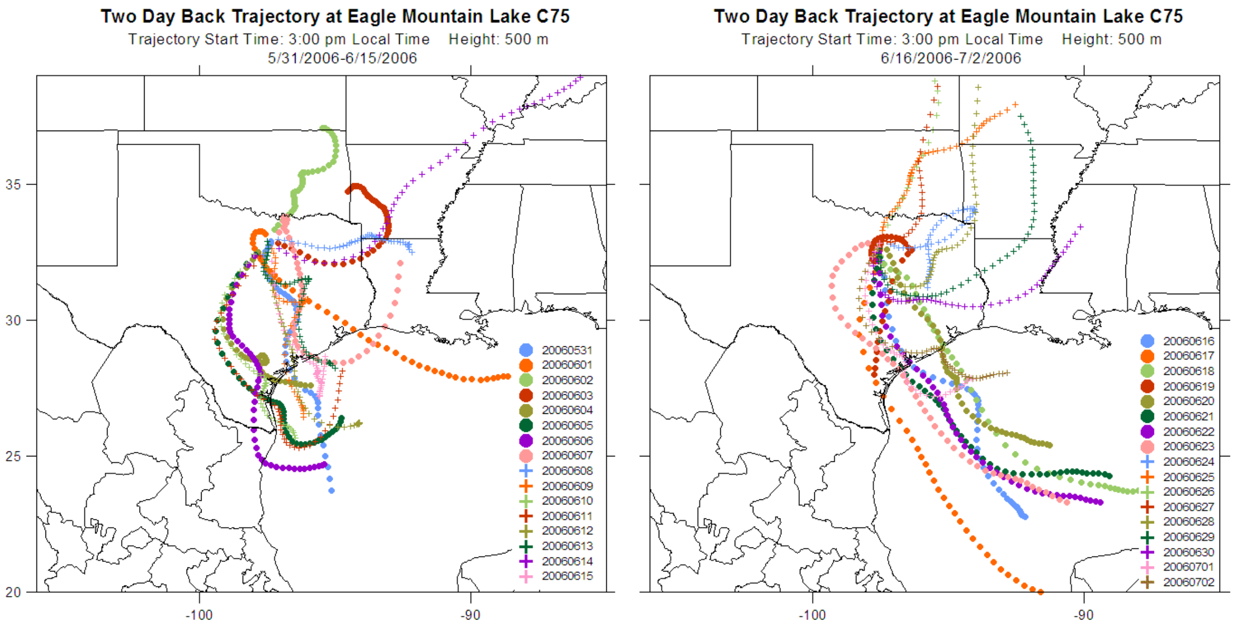


Figure 3-6: Eagle Mountain Lake Monitor Back Trajectories for May 31 through July 2, 2006

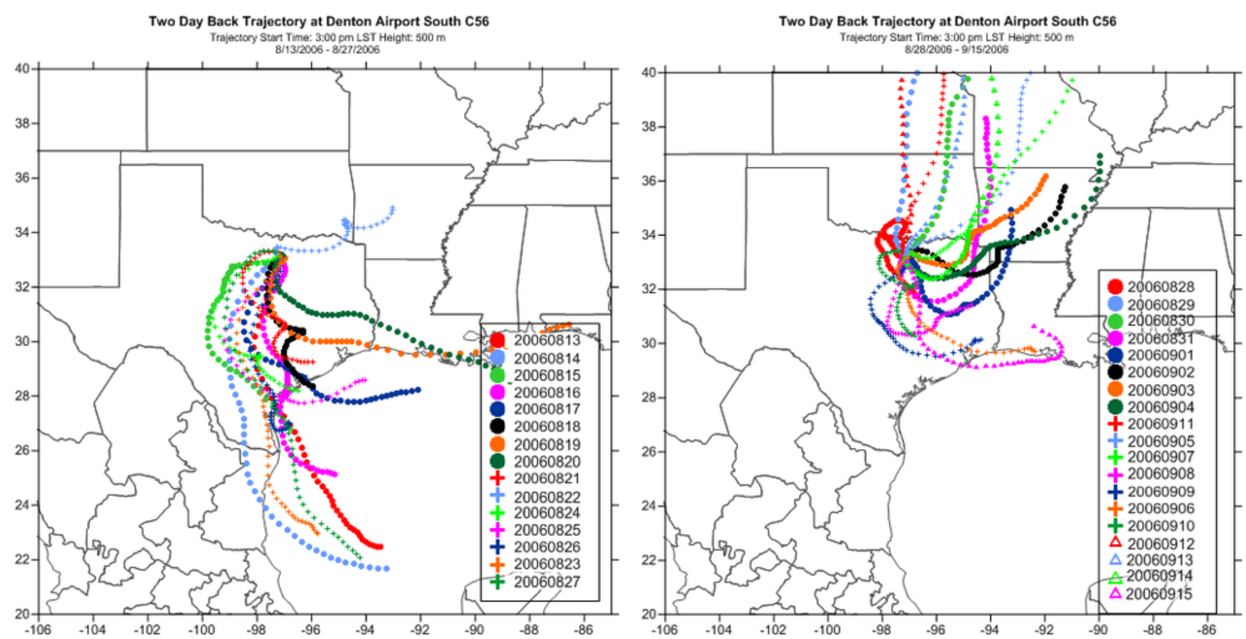


Figure 3-7: Denton Airport South Monitor Back Trajectories for August 13 through September 15, 2006

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.

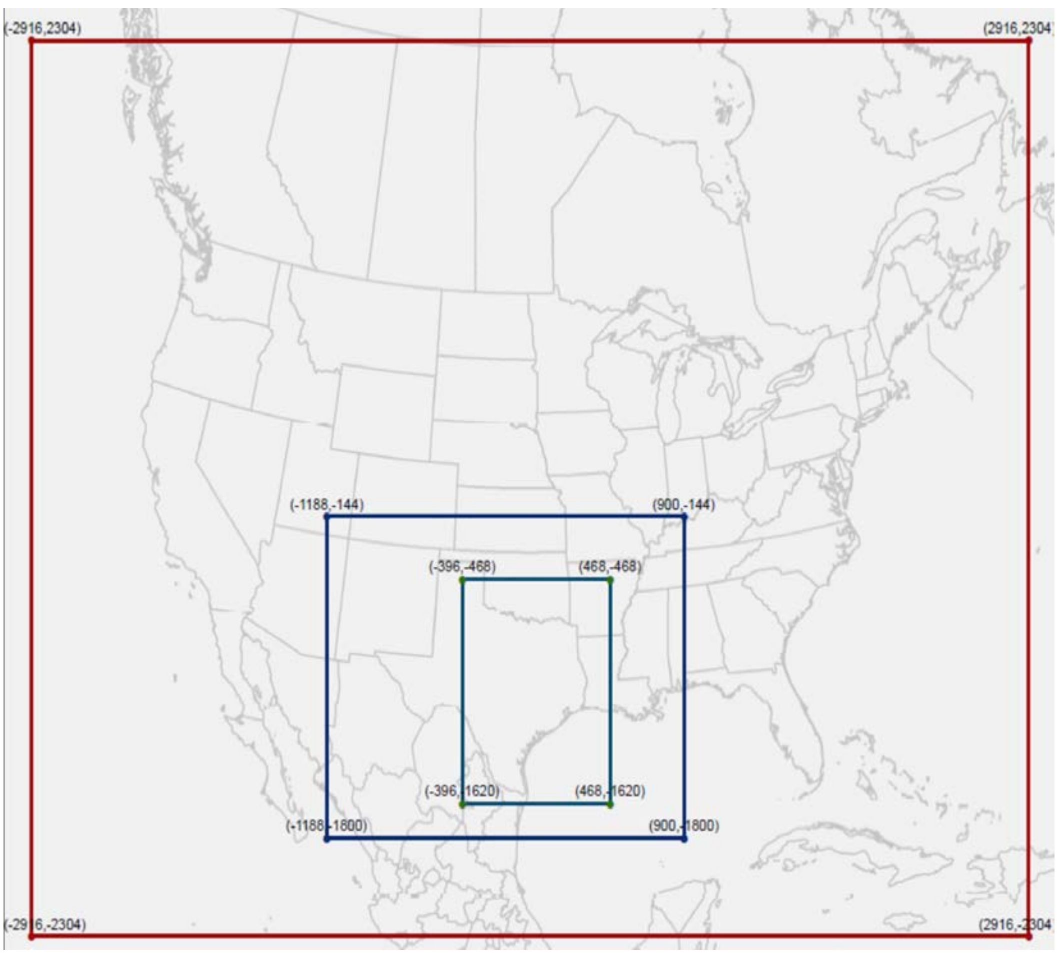


Figure 3-8: WRF Modeling Domains

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.

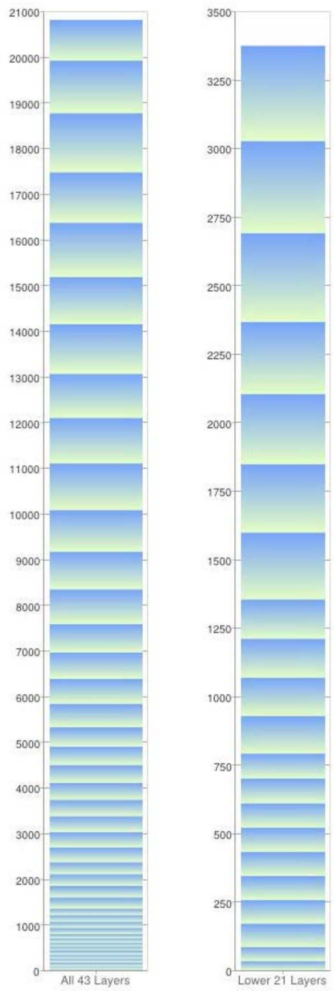


Figure 3-9: WRF Vertical Layer Structure

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). To further improve WRF performance, two types of nudging were utilized that help keep modeled meteorological values in line with observational data. The first type is the analysis nudging, both three-dimensional (3-D) and surface. The 3-D analysis nudging was used on all three domains (4 km, 12 km, and 36 km) to nudge the wind, temperature and moisture. The surface analysis nudging was only used on the 4 km domain to nudge the wind and temperature. The second type is the observational nudging, which uses the radar profiler data for nudging the wind to the 4 km domain. The analysis nudging files are generated as part of WPS preparation of WRF input and boundary condition files. The observational nudging files were developed separately using TCEQ generated programs.

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 (National Centers for Environmental Prediction, Oregon State, Air Force, and Hydrologic 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 Kv coefficients were also modified on a land-use basis to maintain vertical mixing within the first 100 meters of the model overnight using the landuse based minimum for Kv for all domains (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	YSU	Kain-Fritsch	RRTM / Dudhia *	5-layer soil model	WSM6 †
4 km	3-D, Surface Analysis, and Observations	YSU	N/A	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 nonattainment 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 nonattainment 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.

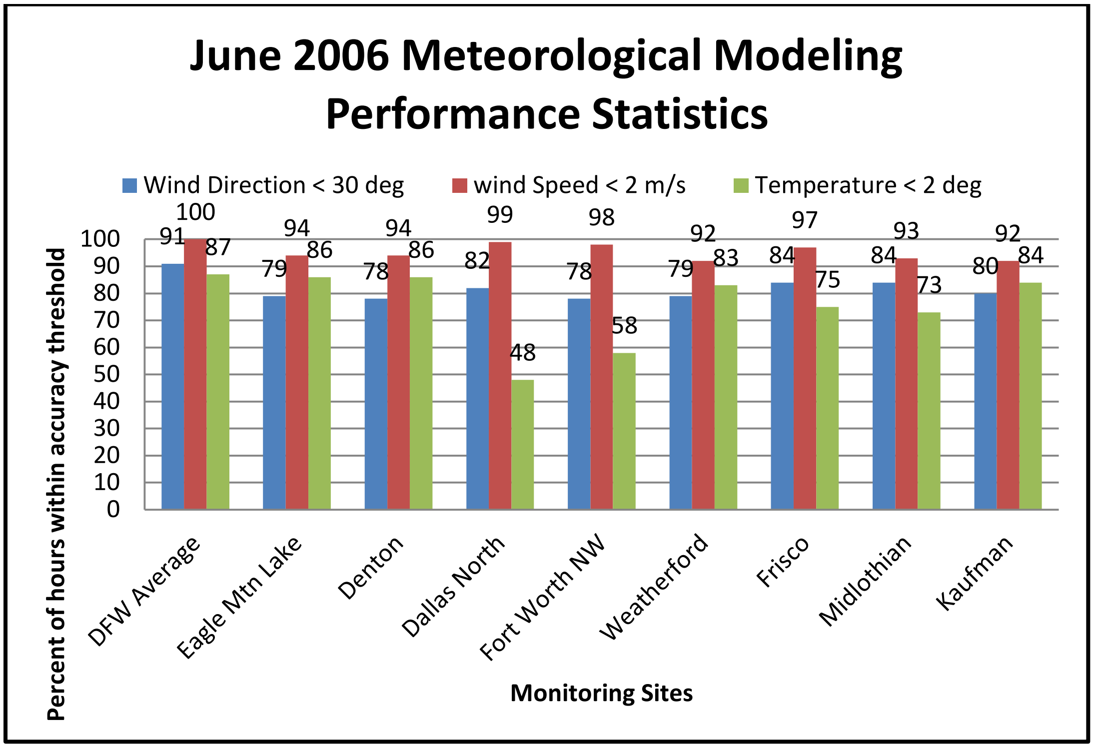


Figure 3-10: June 2006 WRF Modeling Performance

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 high ozone days. 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 Monitor	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

DFW Area Monitor	Wind Direction (°) Error ≤ 30 / 20 / 10	Wind Speed (m/s) Error ≤ 2 / 1 / 0.5	Temperature (°C) Error ≤ 2 / 1 / 0.5
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. 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, 2015). 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 2017 future case. These emission inputs were based on the latest available information at the time development work was done for this SIP proposal. If new information becomes available in a timely manner, some of these emission inputs may be revised for the adopted SIP revision. 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 2017 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.

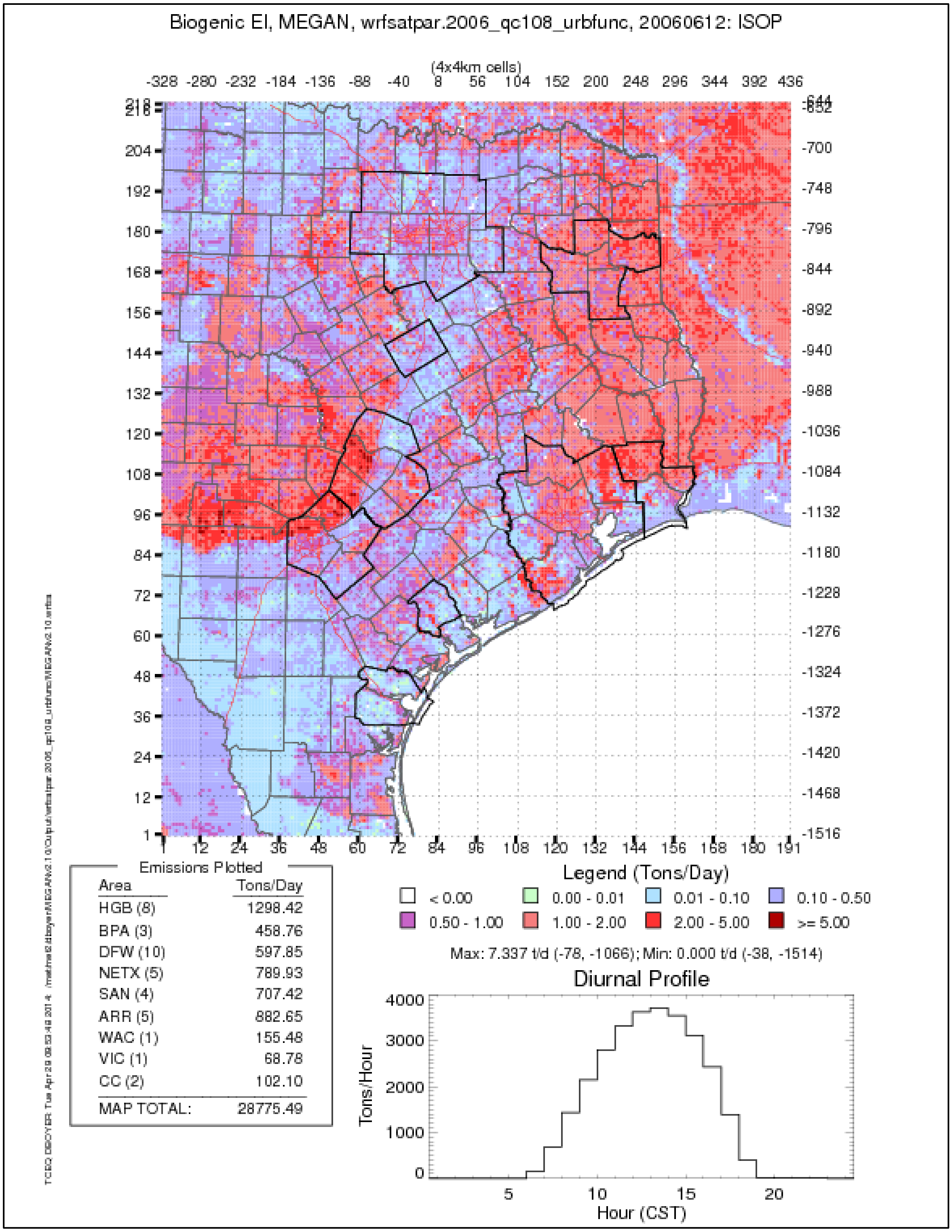


Figure 3-11: Sample Biogenic VOC Emissions for June 12, 2006 Episode Day

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 (EGU) 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 nonattainment 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 data that are reported to the 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 Area

DFW Point Source Category	NO_X tons per day (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 Nonattainment Area Total	56.34	50.43	47.30

On-Road Mobile Sources

The 2006 on-road mobile source emission inputs were developed using the 2014 version of the MOVES model (MOVES2014). The 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 nonattainment area;
- Highway Performance Monitoring System (HPMS) 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 MOVES2014 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 Nonattainment Area

For the 10-county DFW nonattainment area, link-based on-road emissions were developed by NCTCOG using 2006 TDM output and MOVES2014 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 nonattainment area, on-road emissions were developed by the Texas Transportation Institute (TTI) using MOVES2014 emission rates and 2006 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 MOVES2014 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	MOVES2014 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	MOVES2014 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 nonattainment area for all combinations of season and day type.

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

Season and Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	284.27	116.50	1,315.46
Summer Friday	294.54	120.41	1,430.74
Summer Saturday	208.95	107.91	1,228.21
Summer Sunday	188.15	101.29	1,066.20
School Weekday	284.90	116.80	1,320.26
School Friday	292.87	120.07	1,424.23
School Saturday	206.38	107.40	1,216.60
School Sunday	185.99	100.89	1,057.09

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 Texas NONROAD (TexN) for non-road emissions within Texas, the National Mobile Inventory Model (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* Area summarizes these non-road inputs by day type. The non-road emission estimates in Table 3-11 were developed with version 1.7.1 of TexN.

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

2006 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	98.06	64.69	806.01
Saturday	68.72	94.19	977.67
Sunday	50.08	82.22	823.17

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 (APUs), and GSE. Table 3-12: *2006 Base Case Airport Modeling Emissions for 10-County DFW* Area summarizes these estimates for DFW International Airport, Love Field, and the remaining 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 3-12: 2006 Base Case Airport Modeling Emissions for 10-County DFW Area

DFW Nonattainment 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
Regional Airports	1.72	1.52	28.01
DFW Area Total for All Airports	12.78	4.46	48.09

The 2006 locomotive emission estimates were developed by backcasting 2008 data from an Eastern Research Group (ERG, 2015) trends study done for the years from 2008 through 2040. Emissions were estimated separately for Class I line-haul locomotives, Class II and III line-haul locomotives, and rail yard switcher locomotives. The 2008 emissions were adjusted to 2006 levels based on fleet average emission factors available from the EPA. Table 3-13: *2006 Base Case Locomotive Modeling Emissions for 10-County DFW* Area summarizes the estimates for all locomotive activity in DFW.

Table 3-13: 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	16.19	1.00	2.67
Line-Haul Locomotives – Classes II and III	0.39	0.02	0.04
Rail Yard Switcher Locomotives	3.56	0.25	0.44
DFW Nonattainment Area Total	20.14	1.28	3.16

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 Area*.

Table 3-14: 2006 Base Case Area Source Emissions for 10-County DFW Area

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, Inc. (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 3-15: 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 3-16: 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, such as natural gas processing plants and compressor stations, 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 3-17: 2006 Point Source Oil and Gas Emissions for 10-County DFW Area

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 Nonattainment 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 Area* summarizes the typical weekday emissions in the 10-county DFW nonattainment 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 in Table 3-10 were used.

Table 3-18: 2006 Sample Base Case Anthropogenic Emissions for 10-County DFW Area

DFW Nonattainment Area Source Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
On-Road	284.27	116.50	1,315.46
Non-Road	98.06	64.69	806.01
Off-Road – Locomotives	20.14	1.28	3.16
Off-Road – Airports	12.78	4.46	48.09
Area Sources	29.02	290.46	85.59
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	580.68	572.70	2,329.27

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 Area* 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 3-19: 2006 Summer Baseline Anthropogenic Emissions for 10-County DFW Area

DFW Nonattainment Area Source Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
On-Road	284.27	116.50	1,315.46
Non-Road	98.06	64.69	806.01
Off-Road – Locomotives	20.14	1.28	3.16
Off-Road – Airports	12.78	4.46	48.09
Area Sources	29.02	290.46	85.59
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	581.89	572.71	2,330.19

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 nonattainment 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 nonattainment 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 3-20: 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

3.5.4 2017 Future Case Emissions

The biogenic emissions used for the 2017 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 2017 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 the EPA's 2018 emissions modeling platform, which is projected from the 2011 NEI. For non-Texas EGUs, the TCEQ applied Cross-State Air Pollution Rule (CSAPR) caps at the state level. For the Canada and Mexico portions of the modeling domain, the 2017 point source emissions were the same as the emissions used in the 2006 baseline. The Gulf of Mexico emissions for 2017 were based on 2011 estimates, and held constant at 2011 levels for the 2017 future year.

Within Texas

2017 future case EGU emission estimates within Texas were based on the prescribed CSAPR state budgets of 137,701 NO_X tons for an entire calendar year and 65,560 NO_X tons for the five-month ozone season of May through September.[2] Future year operational NO_X caps were based on the ozone season budget and its latest unit level allocations from the EPA. Since electricity generation is higher during the hottest months, operational profiles based on 2014 measurements were used to allocate higher estimates for ozone season modeling purposes. Assignment of ozone season NO_X emissions to EGUs operational in 2014 resulted in a total less than the 2017 CSAPR unit level allocations. The remaining NO_X was combined with the set aside allocations for new units under CSAPR. This NO_X combination was first assigned to the maximum allowable emission levels for newly permitted EGUS, and then spread proportionally among all existing EGUs.

The three cement kilns operating within the DFW nonattainment 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 nonattainment 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 nonattainment 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 nonattainment 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 3-21: 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

[2] On July 28, 2015, the United States Court of Appeals for the District of Columbia Circuit found that the CSAPR 2014 SO_2 and ozone season NO_X budgets for Texas and certain other states were invalid because the budgets required more emission reductions than were necessary. The court remanded without vacatur to the EPA for reconsideration of the emission budgets. Therefore, while the current CSAPR budgets for Texas are still in effect, the budgets may be subject to change in the future after the EPA's reconsideration or changes resulting from further appeals.

SIC Code	SIC Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
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
	DFW Area Total for 94 SIC Codes	40.82	49.88	51.95

Table 3-22: *2017 DFW Area Point Source Emission Projections by Industry Type* provides a summary of the 2017 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 2017 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 2017 future year is modeled at the CSAPR caps of 13.98 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 23.18 NO_X tpd in 2017 after application of the ERG projection factors discussed previously.

Table 3-22: 2017 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	0.77	10.92
4911	Electric Services	13.98	0.55	6.87
1311	Crude Petroleum and Natural Gas	10.83	16.56	8.59
1321	Natural Gas Liquids	4.52	4.96	3.36
3274	Lime	1.41	0.01	0.38
4922	Natural Gas Transmission	1.07	2.27	0.78
3312	Blast Furnaces and Steel Mills	0.87	0.89	4.86
3296	Mineral Wool	0.56	0.56	1.59
4953	Refuse Systems	0.54	0.67	2.28
2952	Asphalt Felts and Coatings	0.45	0.49	0.57
4581	Airports, Flying Fields, and Services	0.33	0.17	0.07
3711	Motor Vehicles and Car Bodies	0.22	3.79	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

SIC Code	SIC Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
2631	Paperboard Mills	0.16	0.06	0.21
3341	Secondary Nonferrous Metals	0.16	0.16	2.05
4952	Sewerage Systems	0.14	0.03	0.14
	Remaining 77 SICs Below 0.1 NO_X tpd	1.54	15.23	3.93
	DFW Area Total for 94 SIC Codes	54.80	47.38	47.68

A similar approach was taken for projecting non-EGU emission levels from 2012 to 2017 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 2017 point source levels for both EGUs and non-EGUs operating in the HGB area.

3.5.4.2 On-Road Mobile Sources

The 2017 on-road mobile source inputs were developed using MOVES2014 in combination with the following vehicle activity data sets:

- the TDM managed by NCTCOG for the DFW nonattainment 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 MOVES2014 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 2017 using MOVES2014. Similar to the approach taken for 2006, 2017 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 nonattainment area, 2017 link-based on-road emissions were estimated using MOVES2014 and TDM output from NCTCOG.

Outside of Texas

For the non-Texas U.S. portions of the modeling domain, the TCEQ used MOVES2014 in default mode to generate 2017 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: *2017 Future Case On-Road Modeling Emissions for 10-County DFW* summarizes the on-road mobile source emissions for the 2017 future case for the 10-county DFW nonattainment area for all combinations of season and day type.

Table 3-23: 2017 Future Case On-Road Modeling Emissions for 10-County DFW

Season and Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	130.77	64.91	1,016.95
Summer Friday	134.55	66.63	1,113.21
Summer Saturday	99.46	61.22	948.41
Summer Sunday	92.87	58.90	828.74
School Weekday	131.08	65.04	1,021.32
School Friday	134.11	66.56	1,111.16
School Saturday	98.68	61.08	942.45
School Sunday	91.74	58.67	819.69

For the 10-county DFW nonattainment area, the on-road mobile source NO_X emissions are reduced roughly 54% from the 2006 baseline (284.27 tpd) to the 2017 future case (130.77 tpd). VOC emissions are reduced roughly 44% from the 2006 baseline (116.50 tpd) to the 2017 future case (64.91 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 2017.

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 the EPA's NMIM specifically for 2017 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 2017 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 2017. 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: *2017 Future Case Non-Road Modeling Emissions for 10-County DFW* summarizes these non-road inputs by day type. The non-road emission estimates in Table 3-24 were developed with version 1.7.1 of TexN.

For the 10-county DFW nonattainment area, non-road NO_X emissions are reduced by roughly 54% from the 2006 baseline (98.06 tpd) to the 2017 future case (45.54 tpd). VOC emissions are decreased roughly 47% from the 2006 baseline (64.69 tpd) to the 2017 future case (34.01 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 2017.

Table 3-24: 2017 Future Case Non-Road Modeling Emissions for 10-County DFW

2017 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	45.54	34.01	580.39
Saturday	33.18	49.19	741.99
Sunday	25.23	43.93	642.77

Airport emission inventories were developed with the FAA EDMS tool, which outputs emission estimates for aircraft engines, APUs, and GSE. Table 3-25: *2017 Future Case Airport Modeling Emissions for 10-County DFW* summarizes these estimates for DFW International Airport, Love Field, and the remaining smaller regional airports within DFW. Love Field contracted with Leigh-Fisher to develop emission estimates for 2018 using EDMS, and these were held constant for modeling 2017. The remaining airport specific emission estimates are based on an ERG airport emissions trends study for 2008 through 2040 (ERG, 2015a) done under contract to the TCEQ.

Table 3-25: 2017 Future Case Airport Modeling Emissions for 10-County DFW

DFW Nonattainment Area Airport or Airport Group	NO_X (tpd)	VOC (tpd)	CO (tpd)
DFW International	10.28	2.13	13.06
Love Field	1.70	0.43	2.43
Regional Airports	0.34	0.33	8.73
DFW Area Total	12.32	2.89	24.22

The 2017 locomotive emission estimates were developed from an ERG trends study (ERG, 2015). 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: *2017 Future Case Locomotive Emissions for 10-County DFW* summarizes these estimates for all locomotive activity in DFW.

For the 10-county DFW nonattainment area, the locomotive NO_X emissions are reduced by about 36% from the 2006 baseline (20.14 tpd) to the 2017 future case (12.88 tpd), and the VOC emissions are decreased about 48% from the 2006 baseline (1.28 tpd) to the 2017 future case (0.67 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 3-26: 2017 Future Case Locomotive Emissions for 10-County DFW

Locomotive Source Classification Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
Line-Haul Locomotives – Class I	9.63	0.46	2.51
Line-Haul Locomotives – Classes II and III	0.38	0.02	0.04
Rail Yard Switcher Locomotives	2.87	0.19	0.43
DFW Nonattainment Area Total	12.88	0.67	2.99

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 2014 TexAER database (TCEQ, 2015), and projected these estimates to 2017 using the Texas-specific economic growth factors for 2014 to 2017. Temporal profiles were applied with EPS3 to obtain the figures presented in Table 3-27: *2017 Future Case Area Source Emissions for 10-County DFW*.

Table 3-27: 2017 Future Case Area Source Emissions for 10-County DFW

2017 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	26.55	236.70	61.25
Saturday	20.76	133.80	53.72
Sunday	14.98	85.58	46.26

The 2017 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: *2014 Oil and Gas Drilling Activity for the 10-County DFW Area*. A 2017 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 2012 through 2040 are documented in Chapter 6 of an ERG report entitled *2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventories* (ERG, 2015b). The results are summarized in Table 3-29: *2017 Oil and Gas Drilling Rig Emissions for 10-County DFW Area*.

Table 3-28: 2014 Oil and Gas Drilling Activity for the 10-County DFW Area

Type and Depth of 2014 Drilling Levels	2014 Thousands of Feet Drilled
Vertical/Horizontal Drilling	3,256
Vertical Drilling less than 7,000 Feet	540
Vertical Drilling greater than 7,000 Feet	1,467

Table 3-29: 2017 Oil and Gas Drilling Rig Emissions for 10-County DFW Area

Equipment Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Drilling Rigs	3.07	0.32	1.05

The 2017 future year emission estimates for oil and gas production were projected using 2014 RRC data, which is the latest full year for which such activity information is available. The 2014-to-2017 projection factors were obtained from an ERG study entitled [*Forecasting Oil and Gas Activities*](https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5821199776FY1212-20120831-erg-forecasting_oild_gas_activities.pdf) (https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5821199776FY1212-20120831-erg-forecasting_oild_gas_activities.pdf) (ERG, 2012) 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 2014 to 2017 summarizes these projection factors from the ERG study for natural gas, crude oil, and condensate.

Table 3-30: Barnett Shale Emission Projection Factors from 2014 to 2017

Fossil Fuel Type	Barnett Shale Projection Factor from 2014 to 2017
Natural Gas	62.82%
Crude Oil	67.11%
Condensate	29.70%

The 2014 emission estimates based directly on historical RRC data were then multiplied by the projection factors in Table 3-30 to obtain the 2017 emissions estimates by equipment type presented in Table 3-31: *2017 Oil and Gas Production Emissions for 10-County DFW Area*.

Table 3-31: 2017 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 50-499 HP	6.13	0.07	2.36
Natural Gas 4-Cycle Rich Burn Compressors 50-499 HP w/NSCR	1.33	0.06	2.53
Oil and Gas Production - Hydraulic Fracturing Pumps	1.18	0.08	0.00
Natural Gas 4-Cycle Rich Burn Compressors <50 HP	0.82	0.00	0.09
Natural Gas 4-Cycle Rich Burn Compressors 500+ HP w/NSCR	0.81	0.03	1.36
Oil Production - Artificial Lift	0.19	0.00	0.00
Natural Gas 4-Cycle Rich Burn Compressors 500+ HP	0.09	0.00	0.08
Natural Gas 4-Cycle Lean Burn Compressors 50 To 499 HP	0.07	0.04	0.16
Natural Gas 4-Cycle Lean Burn Compressors <50 HP	0.04	0.00	0.01
Natural Gas 2-Cycle Lean Burn Compressors 50 To 499 HP	0.03	0.04	0.08
Natural Gas 2-Cycle Lean Burn Compressors 500+ HP	0.03	0.00	0.00
Natural Gas Well Heaters	0.02	0.00	0.00
Natural Gas Well Dehydrators	0.02	1.85	0.17
Natural Gas 4-Cycle Lean Burn Compressors 500+ HP	0.01	0.01	0.04
Natural Gas Condensate - Storage Tanks	0.01	3.37	0.03
Natural Gas Production - Compressor Engines	0.01	0.01	0.02
Oil Production - All Processes	<0.01	0.01	0.01
Oil Production - Heater Treater	<0.01	0.00	0.00
Crude Oil Storage Tanks	<0.01	0.51	0.00
Natural Gas Condensate - Tank Truck/Railcar Loading	<0.01	0.06	0.00
Crude Oil Truck/Railcar Loading	<0.01	0.04	0.00
Natural Gas Well Pneumatic Devices	0.00	7.69	0.00
Natural Gas Exploration - Well Pneumatic Pumps	0.00	7.37	0.00
Natural Gas Fugitives - Other	0.00	2.70	0.00
Natural Gas Exploration - Mud Degassing	0.00	1.71	0.00
Natural Gas Well Venting	0.00	1.57	0.00
Natural Gas Fugitives - Valves	0.00	1.37	0.00

Oil and Gas Production Equipment	NO_X (tpd)	VOC (tpd)	CO (tpd)
Oil and Gas Production - Produced Water	0.00	1.04	0.00
Natural Gas Fugitives - Flanges	0.00	0.37	0.00
Natural Gas Fugitives - Connectors	0.00	0.36	0.00
Oil Production - Wellhead	0.00	0.33	0.00
Natural Gas Fugitives - Open Ended Lines	0.00	0.28	0.00
Oil Well Pneumatic Devices	0.00	0.25	0.00
Natural Gas Fugitives - Pumps	0.00	0.15	0.00
Oil Well Completion - All Processes	0.00	0.10	0.00
Oil Production Fugitives - Other	0.00	0.09	0.00
Oil Exploration - Mud Degassing	0.00	0.08	0.00
Oil Well Pneumatic Pumps	0.00	0.07	0.00
Oil Production Fugitives - Valves	0.00	0.06	0.00
Oil Production Fugitives - Pumps	0.00	0.03	0.00
Oil Production Fugitives - Connectors	0.00	0.02	0.00
Natural Gas Exploration - Well Completion, All Processes	0.00	0.02	0.00
Oil Production Fugitives - Open Ended Lines	0.00	<0.01	0.00
Oil Production Fugitives - Flanges	0.00	<0.01	0.00
Oil and Gas Production Total	10.80	31.86	6.96

Comparison of the 2006 oil and gas production emission estimates in Table 3-16 with the 2017 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 2017 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 7.57 NO_X grams/horsepower-hour (gm/hp-hr). Introduction of this rule lowered this emission rate by roughly 93% to 0.56 NO_X gm/hp-hr.

Some facilities associated with oil and gas production, such as natural gas processing plants and compressor stations, are required to report to the TCEQ as point sources. The 2017 emission projections for these facilities are not included within Table 3-31, but are summarized by SIC in Table 3-32: *2017 Point Source Oil and Gas Emissions for 10-County DFW Area*. The emissions in Table 3-32 are part of the total 2017 emissions detailed in Table 3-22.

Table 3-32: 2017 Point Source Oil and Gas Emissions for 10-County DFW Area

SIC Description	SIC Code	NO_X (tpd)	VOC (tpd)	CO (tpd)
Crude Petroleum and Natural Gas	1311	10.83	16.56	8.59
Natural Gas Liquids	1321	4.52	4.96	3.36
Natural Gas Transmission	4922	1.07	2.27	0.78
Petroleum Bulk Stations and Terminals	5171	0.06	1.64	0.14
Mixed, Manufactured, LPG Production	4925	0.02	0.00	0.11
Refined Petroleum Pipelines	4613	0.01	0.37	0.02

SIC Description	SIC Code	NO_X (tpd)	VOC (tpd)	CO (tpd)
DFW Nonattainment Area Total	NA	16.50	25.80	13.00

Figure 3-12: *Barnett Shale Drilling and Natural Gas Production from 1993-2015* 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 June 2015. 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 5,743 million cubic feet (MMcf) per day. From this 2012 peak, the 2013 daily average was 5,353 MMcf/day (7% lower), the 2014 daily average was 4,920 MMcf/day (14% lower), and the 2015 average to date is 4,476 MMcf/day (22% 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 were in the range of roughly 1,000 per year from 2012 through 2014, similar to the pre-drilling boom years of 2001-2004. As of July, there have been 130 drilling permits issued for the Barnett Shale in 2015. A University of Texas at Austin study entitled *Barnett Study Determines Full-Field Reserves, Production Forecast* (http://www.beg.utexas.edu/info/docs/OGJ_SFSGAS_pt2.pdf) (UT-Austin, 2013) 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.

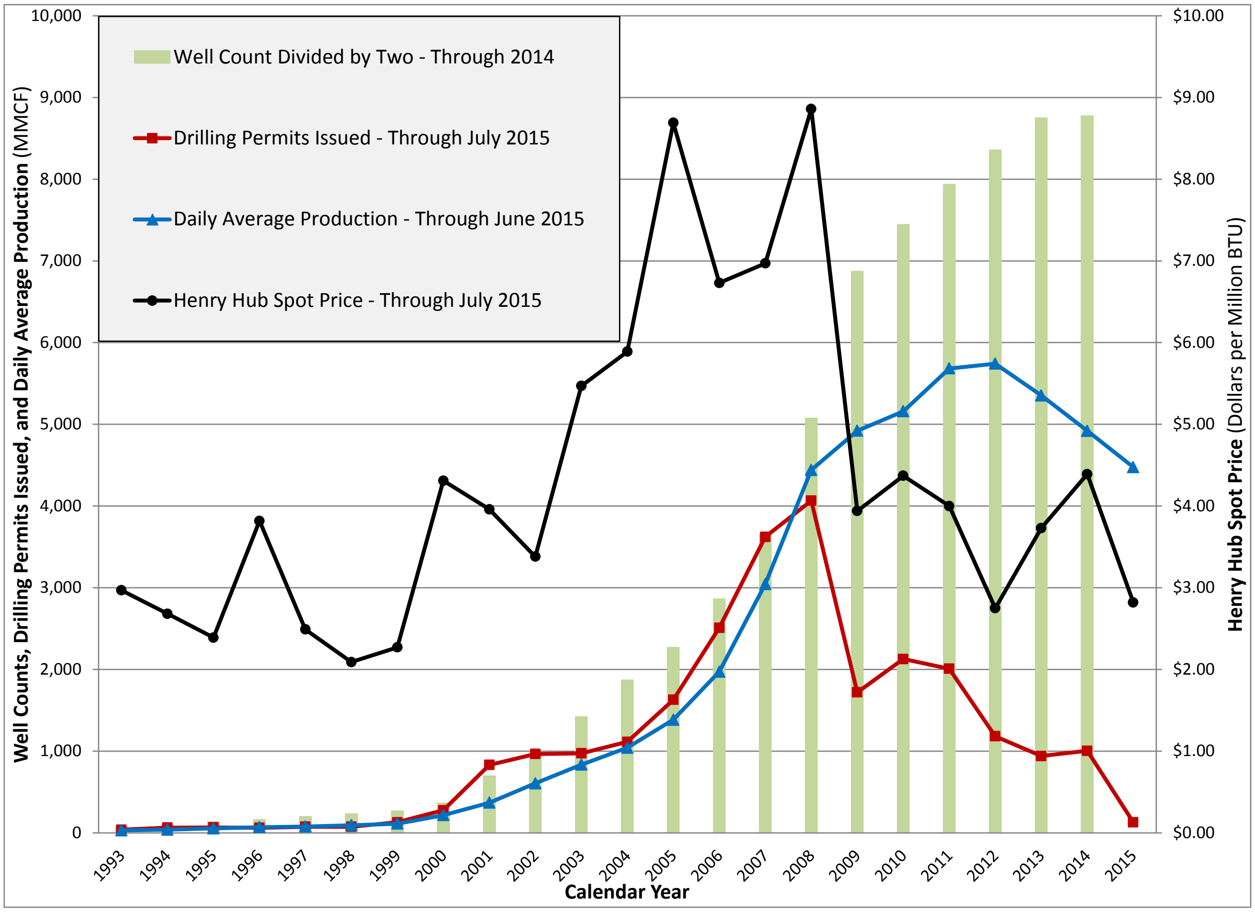


Figure 3-12: Barnett Shale Drilling and Natural Gas Production from 1993-2015

3.5.4.5 Future Base Summary

Table 3-33: *2017 Future Case Anthropogenic Emissions for 10-County DFW* summarizes the typical summer weekday emissions in the 10-county DFW nonattainment area by source type for the 2017 future case modeling.

Table 3-33: 2017 Future Case Anthropogenic Emissions for 10-County DFW

DFW Nonattainment Area Source Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
On-Road	130.77	64.91	1,016.96
Non-Road	45.54	34.01	580.39
Off-Road – Locomotives	12.88	0.67	2.99
Off-Road – Airports	12.32	2.89	24.25
Area Sources	26.55	236.70	61.25
Oil and Gas – Production	10.80	31.86	6.96
Oil and Gas – Drill Rigs	3.07	0.32	1.05
Point – Oil and Gas	16.50	25.80	13.00
Point – EGUs (Peak Ozone Season Average)	13.98	0.55	6.87
Point – Cement Kilns	17.64	0.77	10.92
Point – Other	6.68	20.26	16.88
Total	296.73	418.74	1,741.52

3.5.5 2006 and 2017 Modeling Emissions Summary for DFW

Table 3-34: *2006 Baseline and 2017 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 nonattainment area anthropogenic NO_X emissions are projected to be reduced by roughly 49% from 2006 (581.89 tpd) to 2017 (296.73 tpd). The total 10-county DFW nonattainment area anthropogenic VOC emissions are projected to be reduced by 27% from 2006 (572.71 tpd) to 2017 (418.74 tpd).

Table 3-34: 2006 Baseline and 2017 Future Modeling Emissions for DFW Area

DFW Nonattainment Area Source Type	2006 NO_X (tpd)	2017 NO_X (tpd)	2006 VOC (tpd)	2017 VOC (tpd)
On-Road	284.27	130.77	116.50	64.91
Non-Road	98.06	45.54	64.69	34.01
Off-Road – Locomotives	20.14	12.88	1.28	0.67
Off-Road – Airports	12.78	12.32	4.46	2.89
Area Sources	29.02	26.55	290.46	236.70
Oil and Gas – Production	61.84	10.80	43.72	31.86
Oil and Gas – Drill Rigs	18.23	3.07	1.16	0.32
Point – Oil and Gas	11.53	16.50	21.82	25.80
Point – EGUs (Ozone Season Average)	9.63	13.98	1.03	0.55
Point – Cement Kilns	22.08	17.64	1.94	0.77
Point – Other	14.31	6.68	25.65	20.26
Total	581.89	296.73	572.71	418.74

Figure 3-13: *2006 Baseline and 2017 Future Modeling Emissions for DFW Area* graphically compares the anthropogenic NO_X and VOC emission estimates presented in Table 3-34.

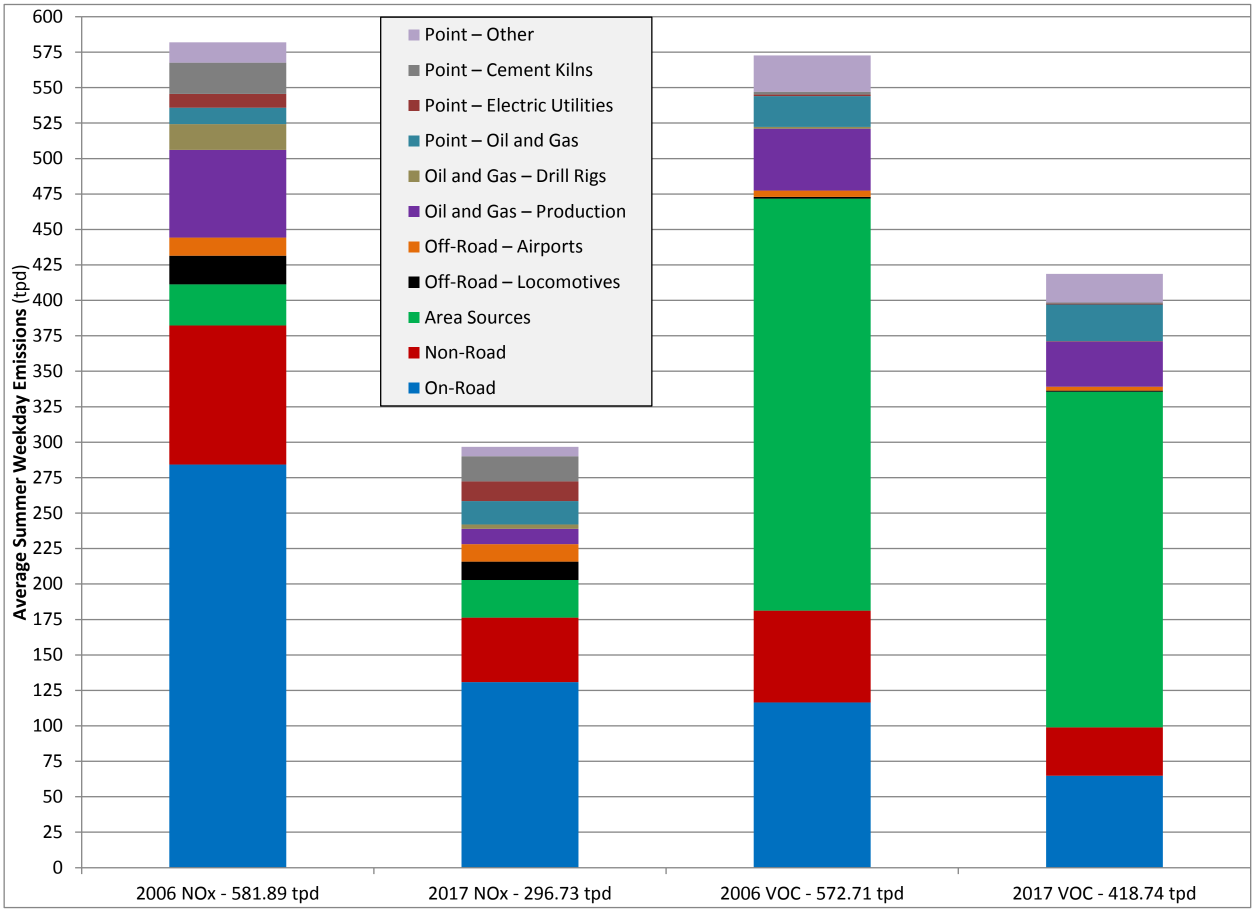


Figure 3-13: 2006 Baseline and 2017 Future Modeling Emissions for DFW Area

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 AD. 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 ADs, 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.

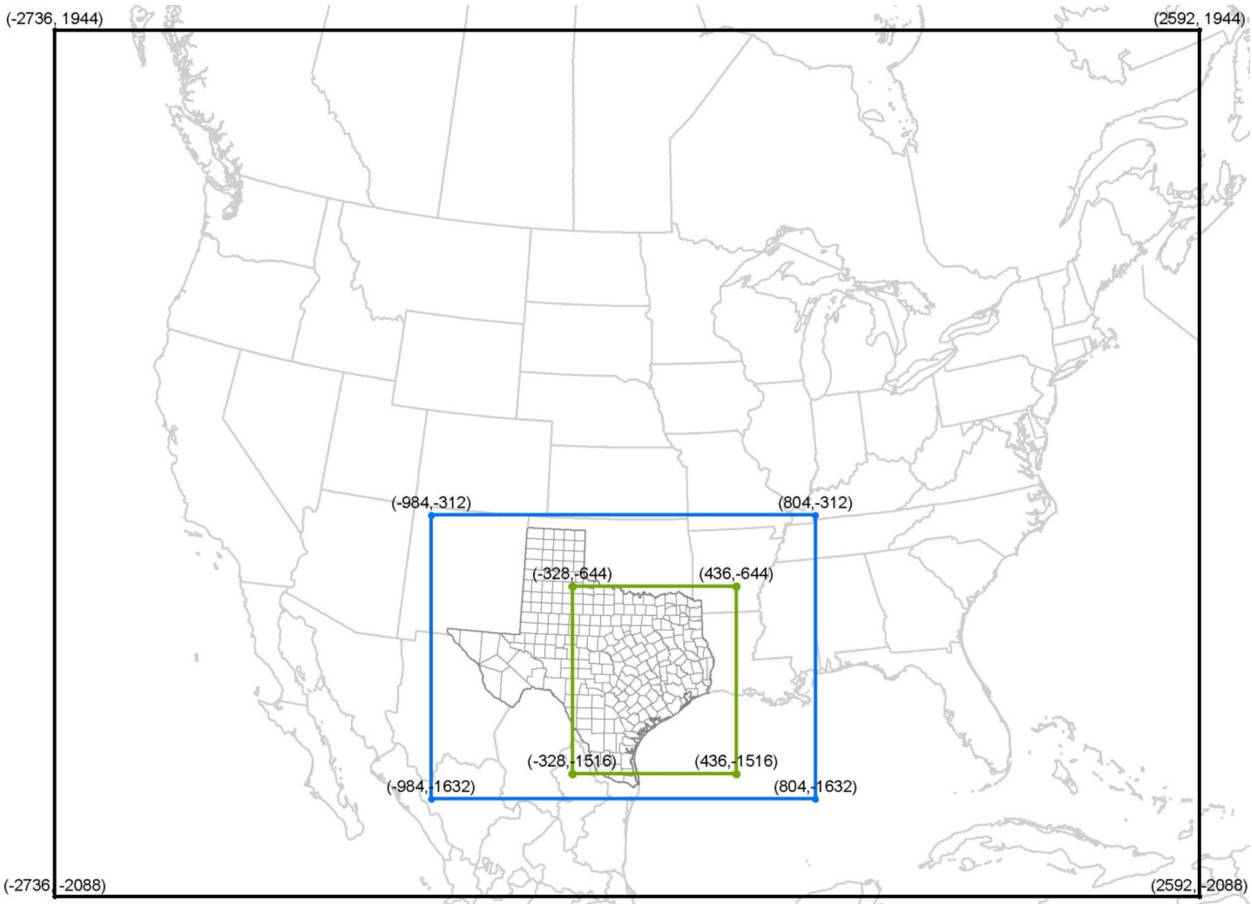


Figure 3-14: CAMx Modeling Domains

Table 3-35: 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 3-36: 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 6.20, which includes a number of upgrades and features from previous versions. The following CAMx 6.20 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 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. The 2018 boundary conditions were applied to the 2017 future case. 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 26 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 File Transfer Protocol (FTP) site (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 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 2007 modeling guidance, 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 nonattainment area. The localized small-scale (i.e., high resolution) meteorological and emissions features characteristic of the DFW nonattainment 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, the 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 nitrogen oxide, 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: *DFW 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 level. Figure 3-16: *DFW 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 ozone levels below 75 ppb.

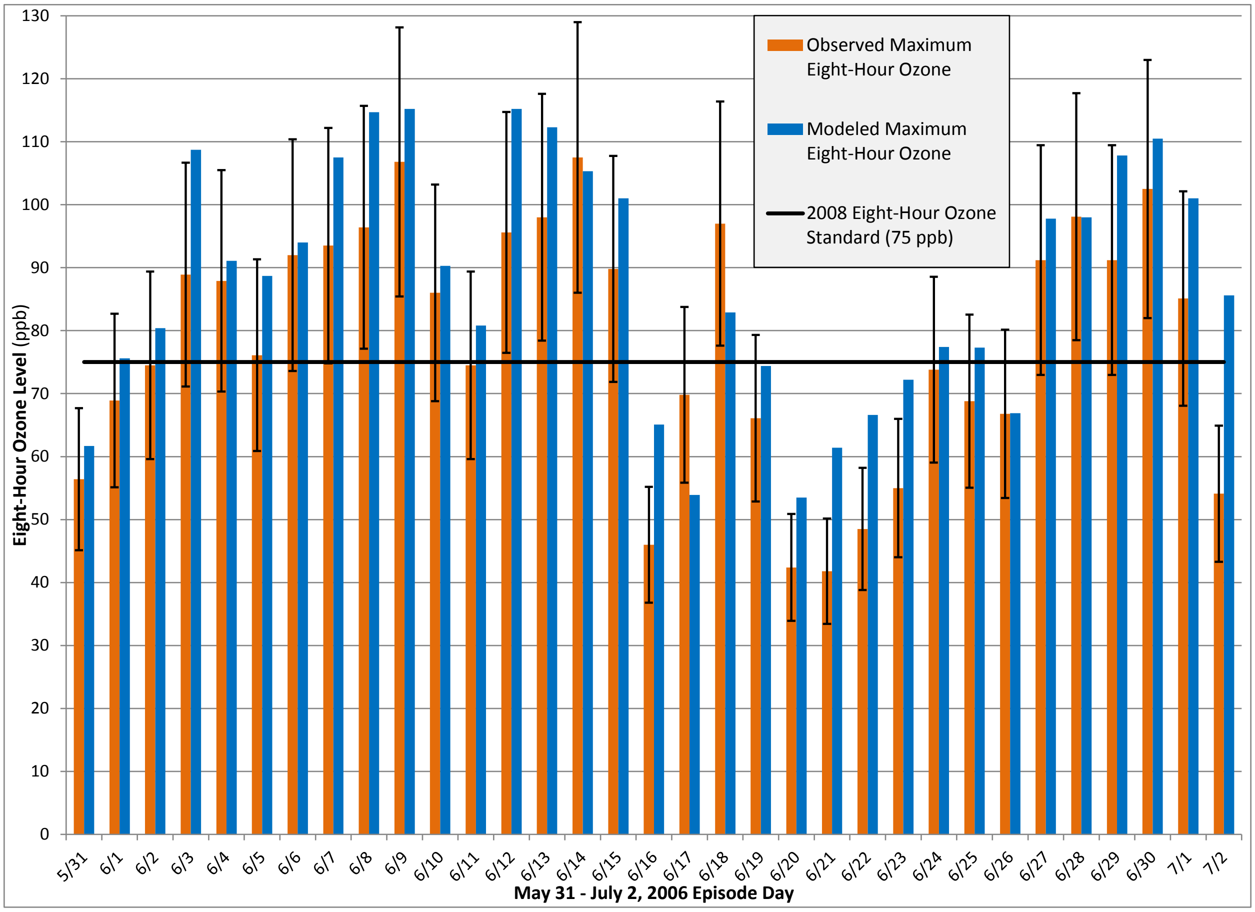


Figure 3-15: DFW Observed versus Modeled Peak Eight-Hour Ozone for June Episode

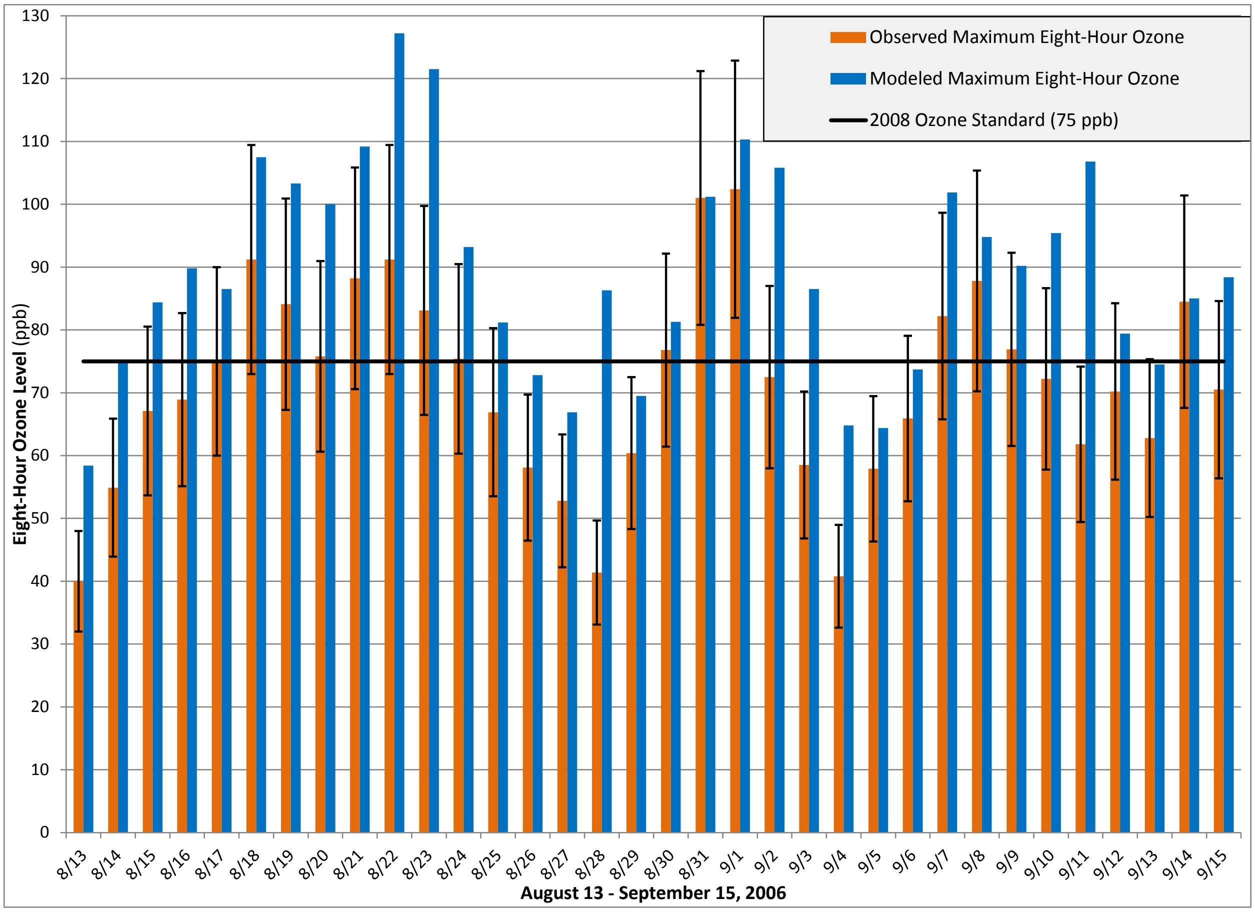


Figure 3-16: DFW Observed versus Modeled Peak Eight-Hour Ozone for August-September Episode

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.

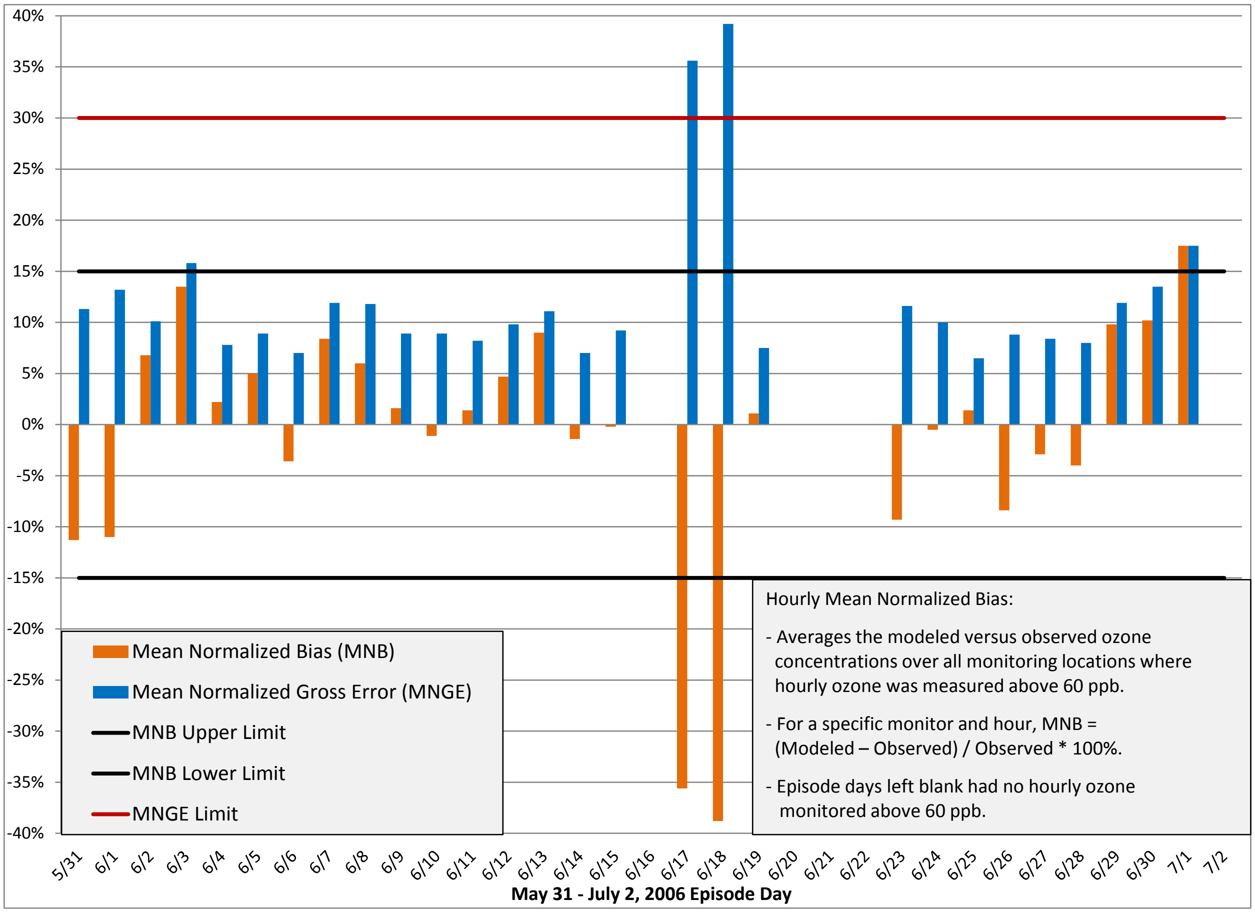


Figure 3-17: MNB and MNGE Hourly Ozone Statistics for June Episode Days

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.

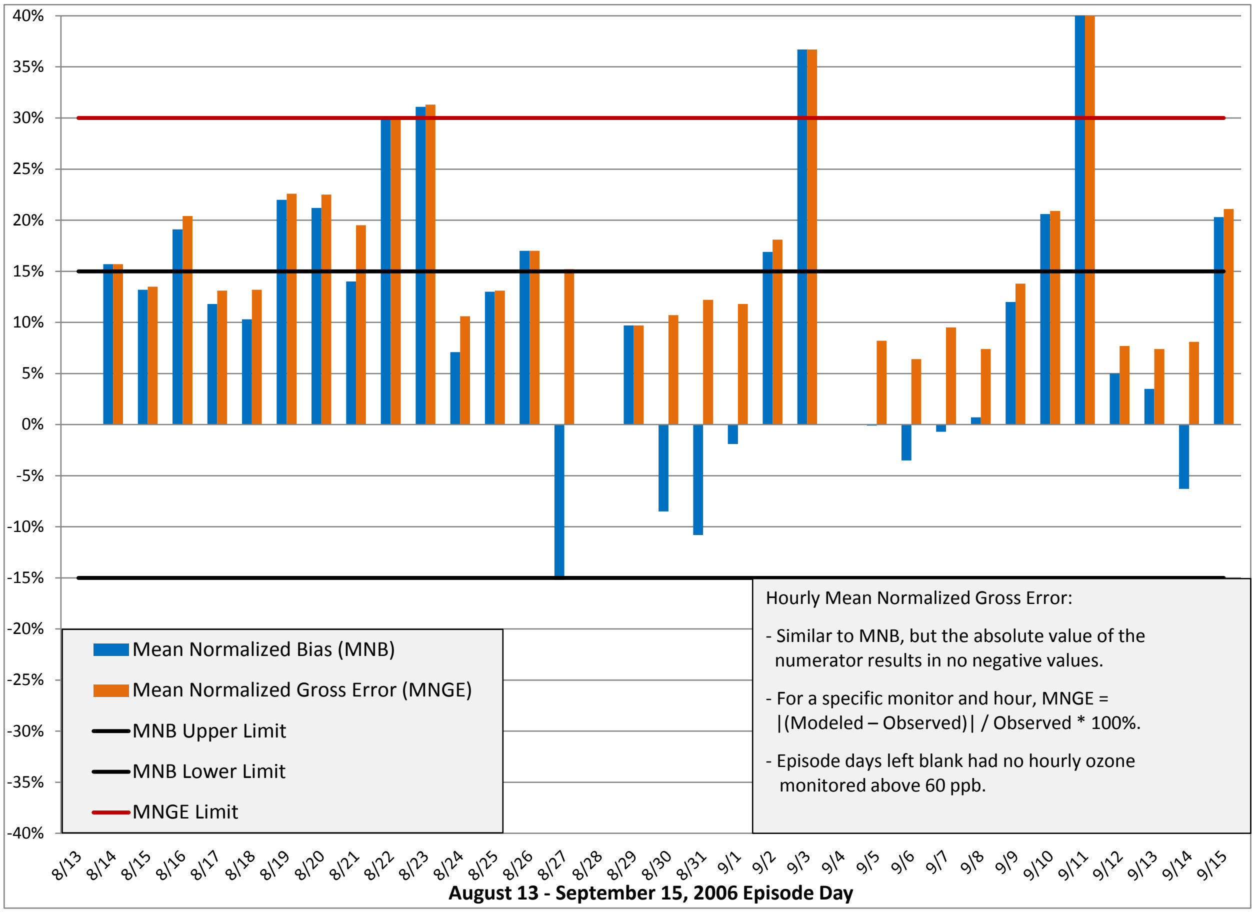


Figure 3-18: MNB and MNGE Hourly Ozone Statistics for August-September Days

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 days above 75 ppb 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 days above 75 ppb 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 nonattainment 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.

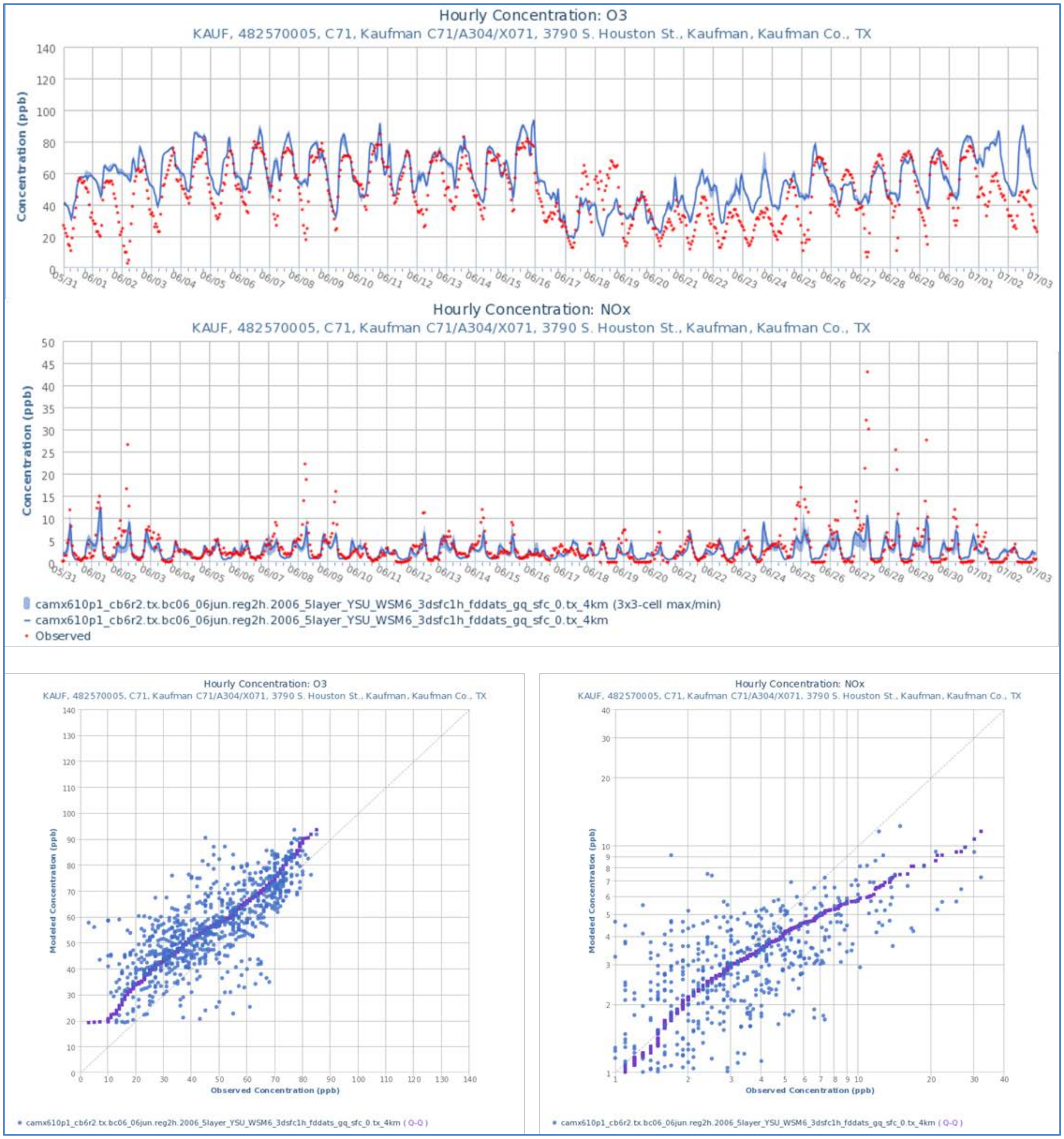


Figure 3-19: Kaufman June Episode Time Series and Scatter Plots

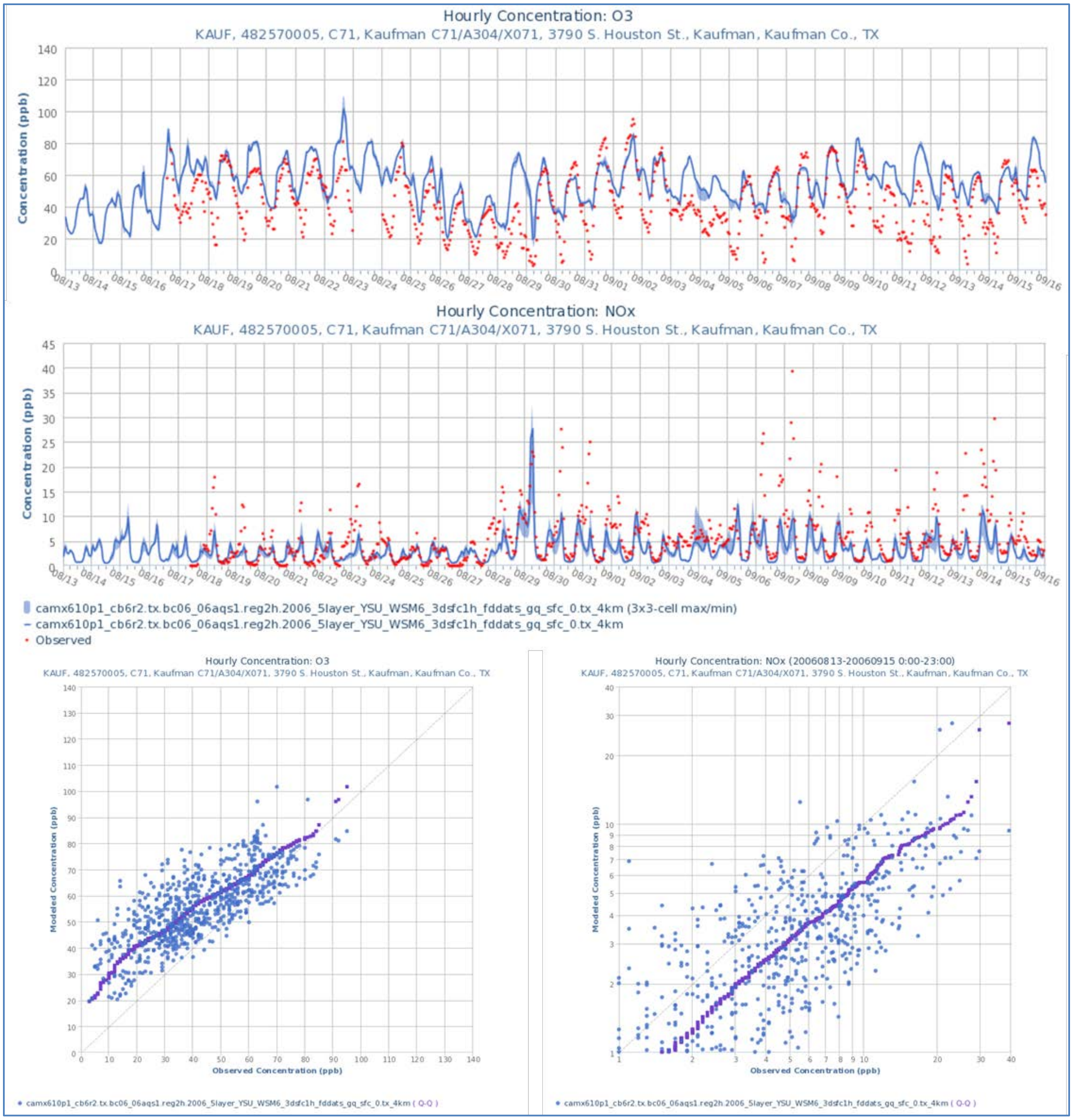


Figure 3-20: Kaufman August-September Episode Time Series and Scatter Plots

As shown in Figure 3-3, the Denton Airport South monitor is located in the far northwestern corner of the DFW nonattainment 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 day (June 18) when eight-hour ozone was measured above 75 ppb, which was due to the previously mentioned difficulty that the meteorological model encountered in replicating a slow moving frontal passage.

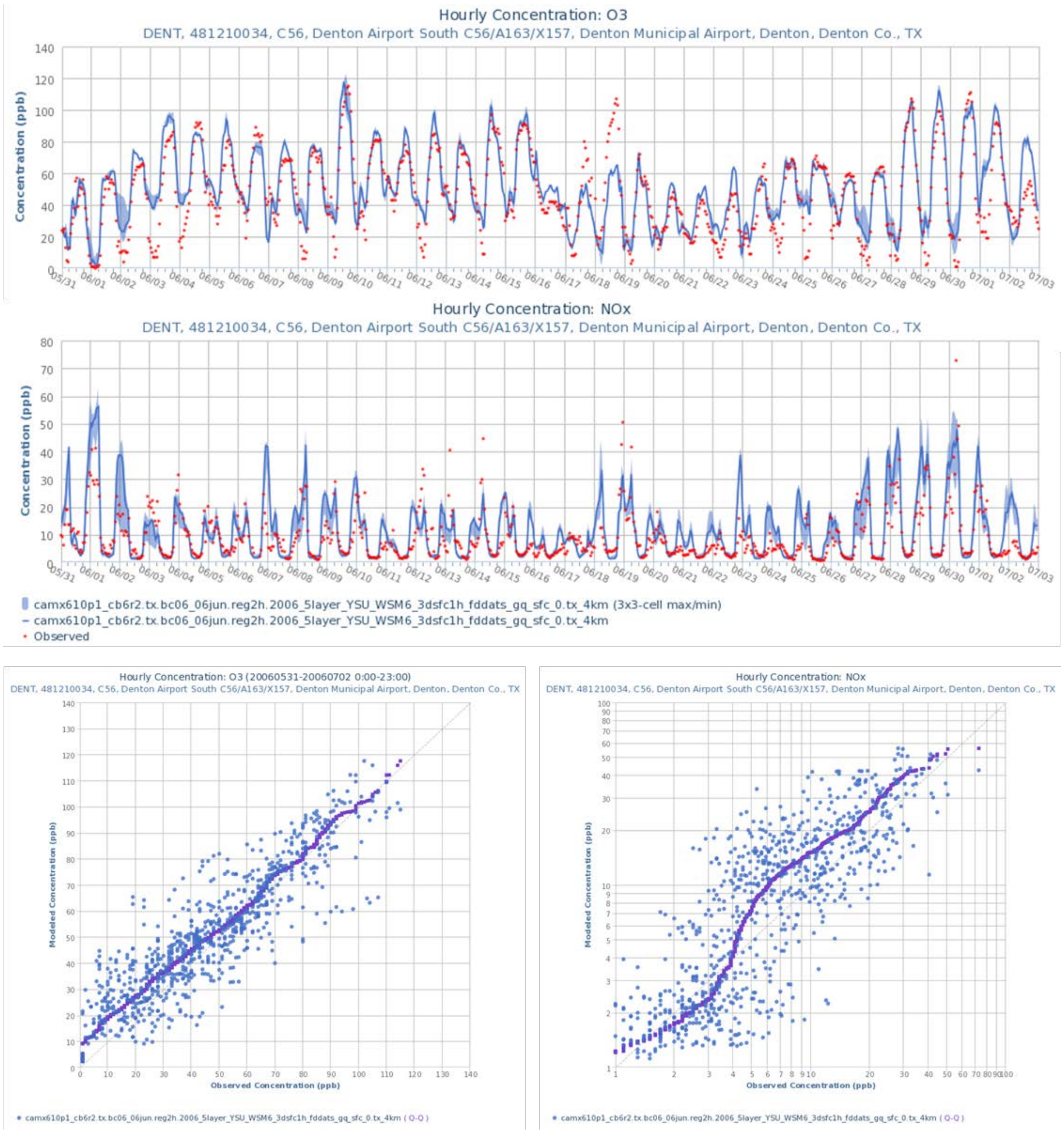


Figure 3-21: Denton June Episode Time Series and Scatter Plots

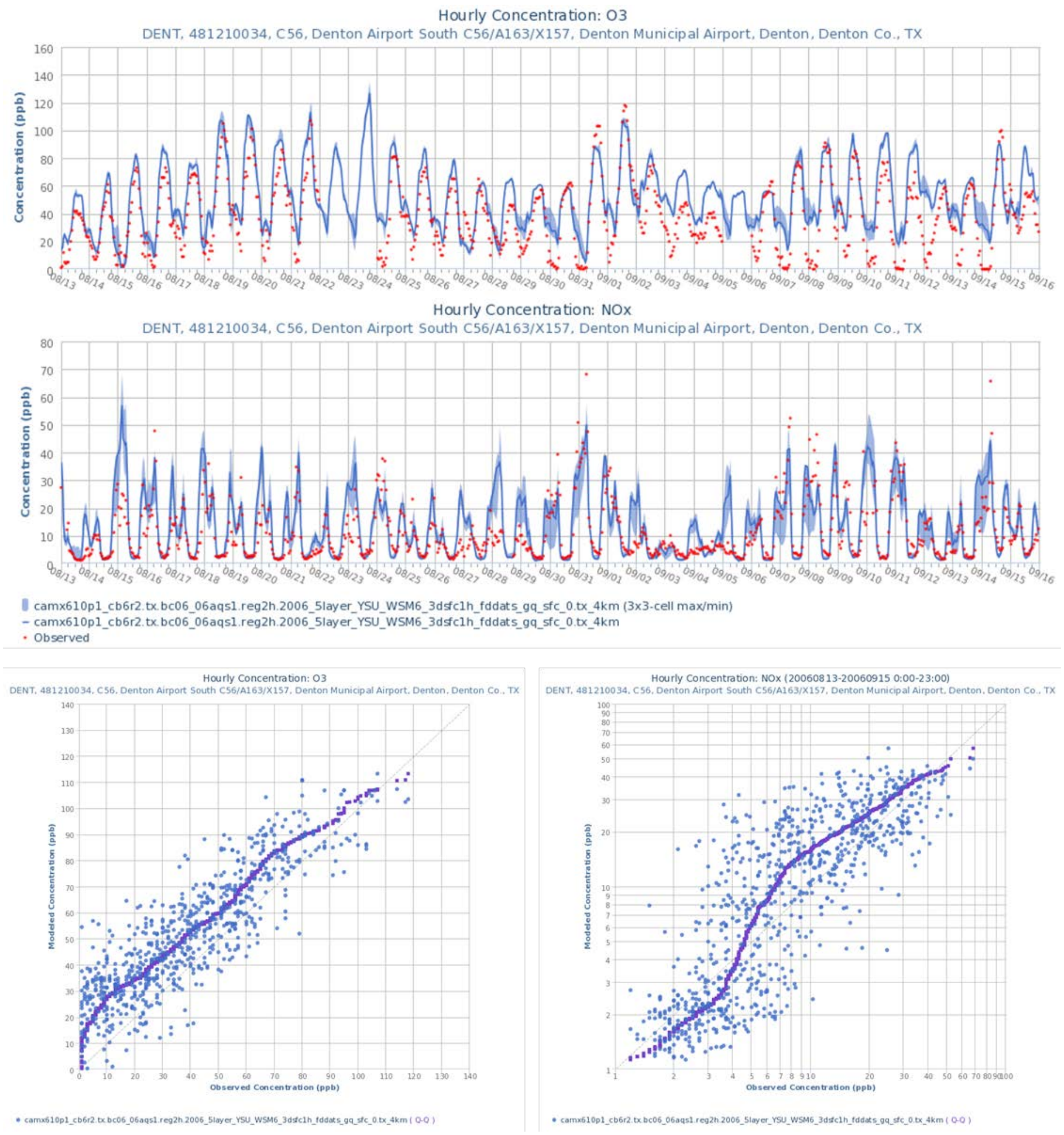


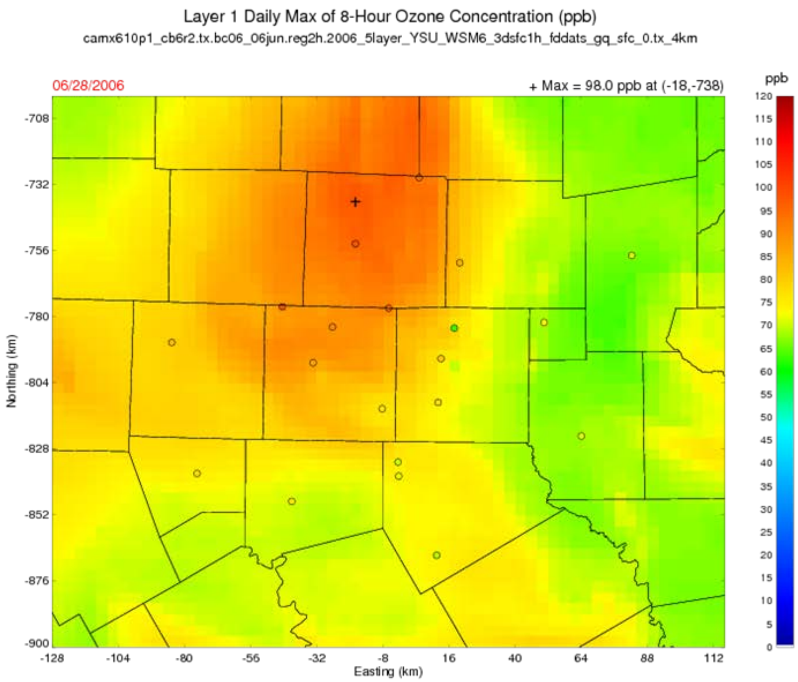
Figure 3-22: Denton August-September Episode Time Series and Scatter Plots

The Kaufman and Denton Airport South monitors were chosen as examples for discussing model performance because they generally 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.

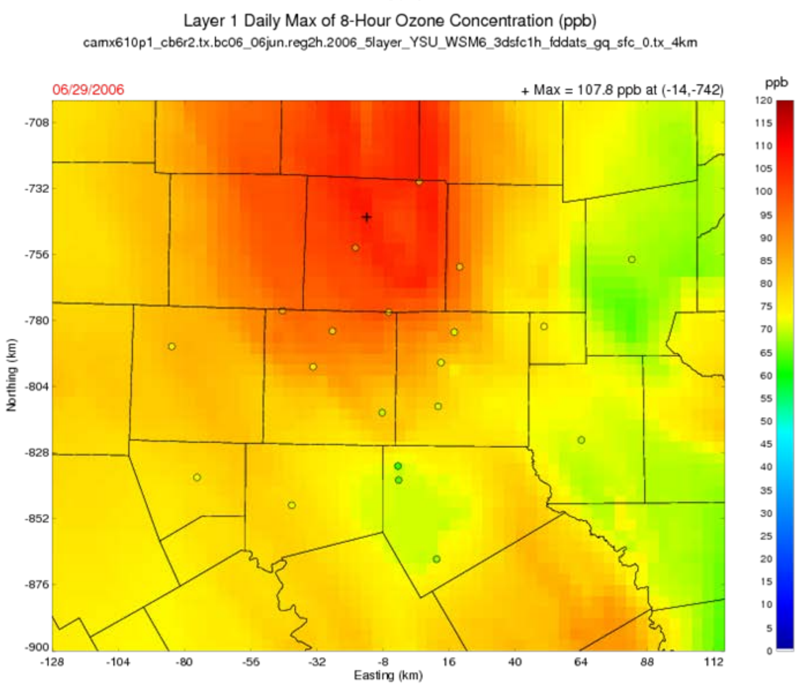
When evaluating model performance, the TCEQ also employs graphical plots showing the daily peak ozone across the modeling domain. This plot is akin to the contour plots often used to display terrain elevations, and is a good tool for visually comparing the modeled peak ozone across the domain with observations. 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 30 through 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

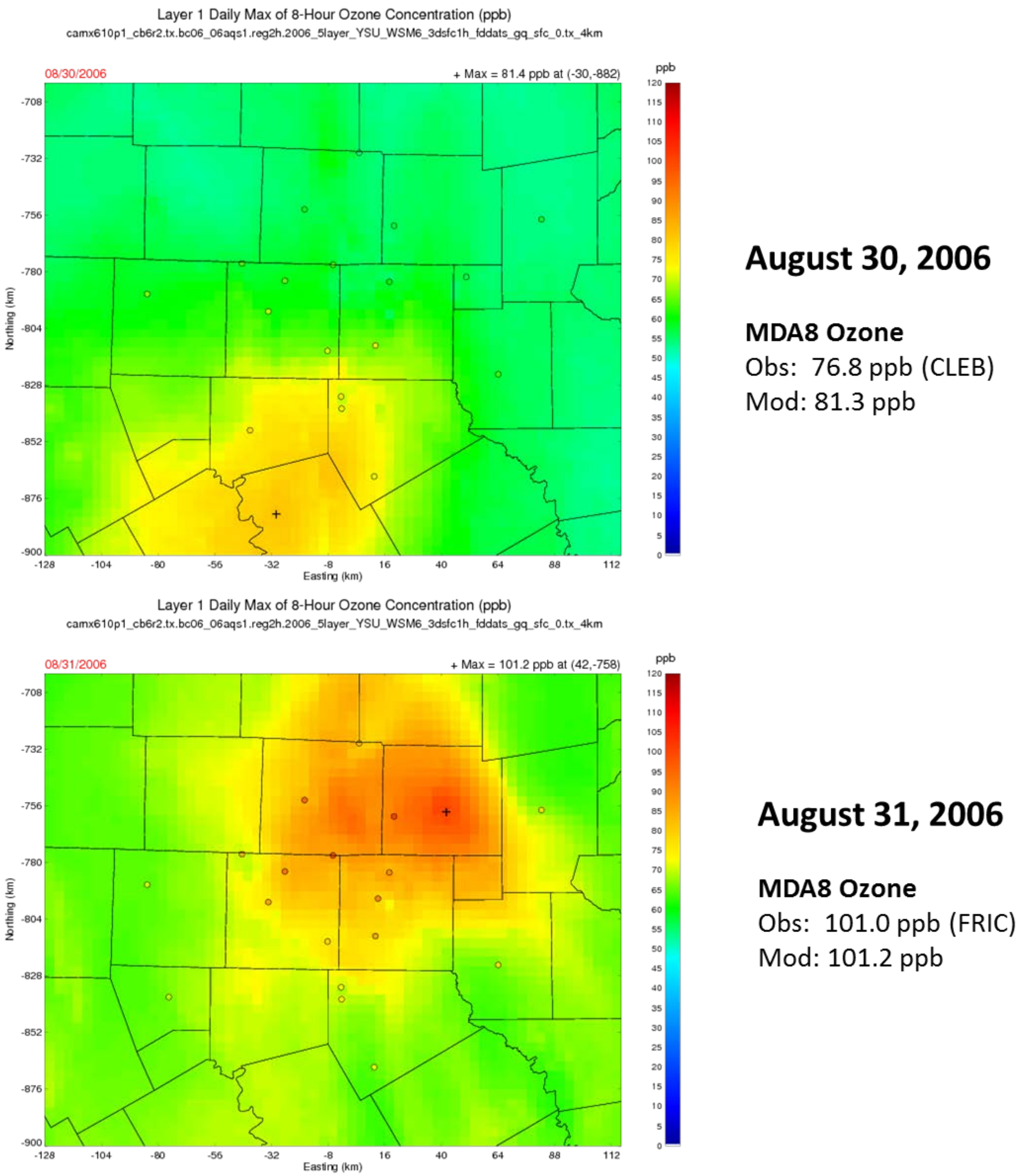


Figure 3-24: Modeled versus Observed Maximum Ozone on August 30 and 31

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 nonattainment 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.

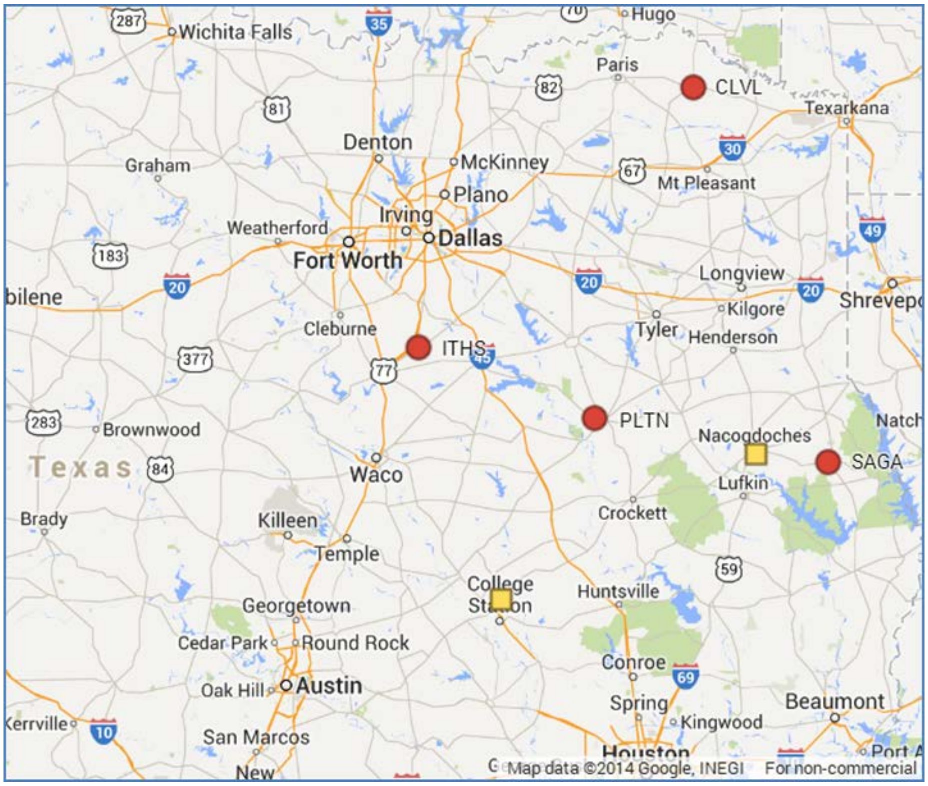


Figure 3-25: Rural Monitoring Sites Used for Performance Evaluation

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 nonattainment 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 AD 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 2007 and draft guidance documents recommend 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 3-37: Summary of Ozone Modeling Platform Changes

Modeling Platform Category	December 2011 AD SIP Revision	Proposed 2016 AD SIP Revision
4 km Fine Grid Modeling Domain	DFW nonattainment 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 2016 AD SIP Revision
Meteorological Model	MM5 3.7.3	WRF 3.2
CAMx Version	CAMx 5.20.1	CAMx 6.20
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	Global Biosphere Emissions and Interactions System (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 the 2007 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 measured regulatory design value (DV_R) values cannot be provided for the Midlothian Tower monitor, which is no longer operational.

Table 3-38 also includes the 2012 DV_R (fourth column) and 2012 DV_B (last column) for each monitor. The 2012 DV_R is 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. These 2012 DV_B figures were obtained by averaging the 2012 DV_R, 2013 DV_R, and 2014 DV_R per monitor. 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 3-38: 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	83.67
Eagle Mountain Lake - C75	78	82	82	80.67
Grapevine Fairway - C70	76	82	86	84.00
Keller - C17	76	81	87	83.00
Fort Worth Northwest - C13	75	80	79	80.00
Frisco - C31	74	79	83	81.67
Dallas North #2 - C63	71	77	81	80.33
Parker County - C76	72	78	78	77.00

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)
Dallas Executive Airport - C402	70	77	81	78.00
Cleburne Airport - C77	70	76	79	78.00
Arlington Municipal Airport - C61	70	75	83	79.33
Dallas Hinton Street - C401	67	74	82	81.33
Granbury - C73	69	74	77	76.67
Midlothian Tower - C94	66	73	Not Operating	Not Operating
Pilot Point - C1032	67	73	82	81.67
Rockwall Heath - C69	63	70	77	75.67
Midlothian OFW - C52	62	68	76	74.67
Greenville - C1006	59	67	72	71.67
Kaufman - C71	60	67	70	71.33

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 3-39: 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	83.67
Eagle Mountain Lake - C75	78	82	82	80.67
Grapevine Fairway - C70	76	81	86	84.00
Keller - C17	76	81	87	83.00
Fort Worth Northwest - C13	75	79	79	80.00
Frisco - C31	74	79	83	81.67
Dallas North #2 - C63	71	77	81	80.33
Parker County - C76	72	77	78	77.00
Dallas Executive Airport - C402	70	76	81	78.00
Cleburne Airport - C77	70	75	79	78.00
Arlington Municipal Airport - C61	70	74	83	79.33
Dallas Hinton Street - C401	67	73	82	81.33
Granbury - C73	69	73	77	76.67

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)
Midlothian Tower - C94	66	72	Not Operating	Not Operating
Pilot Point - C1032	67	72	82	81.67
Rockwall Heath - C69	63	70	77	75.67
Midlothian OFW - C52	62	67	76	74.67
Greenville - C1006	59	67	72	71.67
Kaufman - C71	60	66	70	71.33

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.

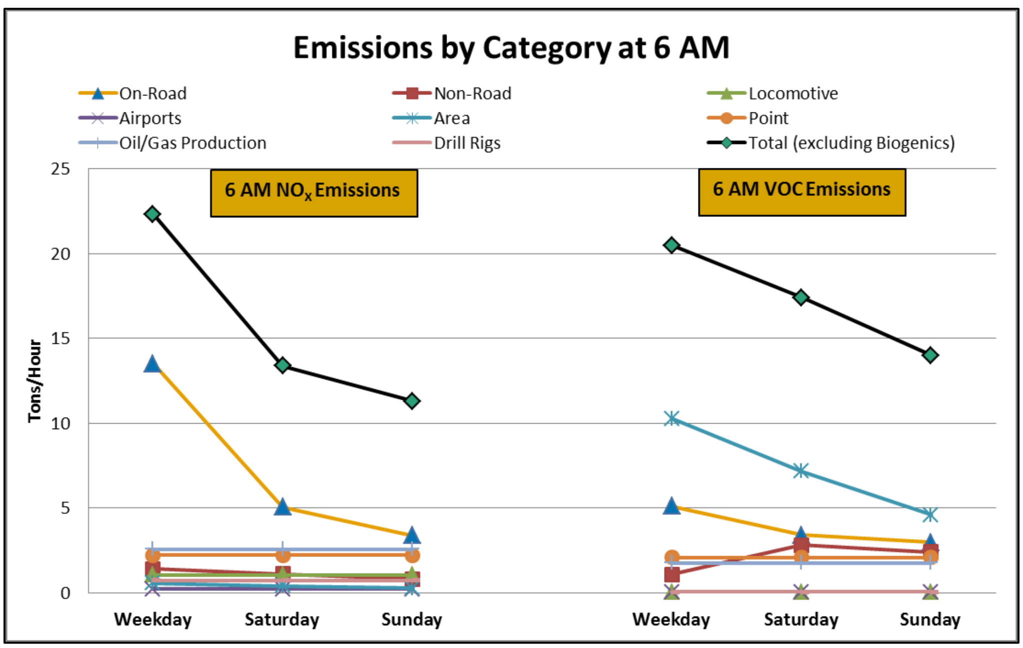


Figure 3-26: 2006 DFW Area 6 AM Anthropogenic Emissions by Day of Week

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%.

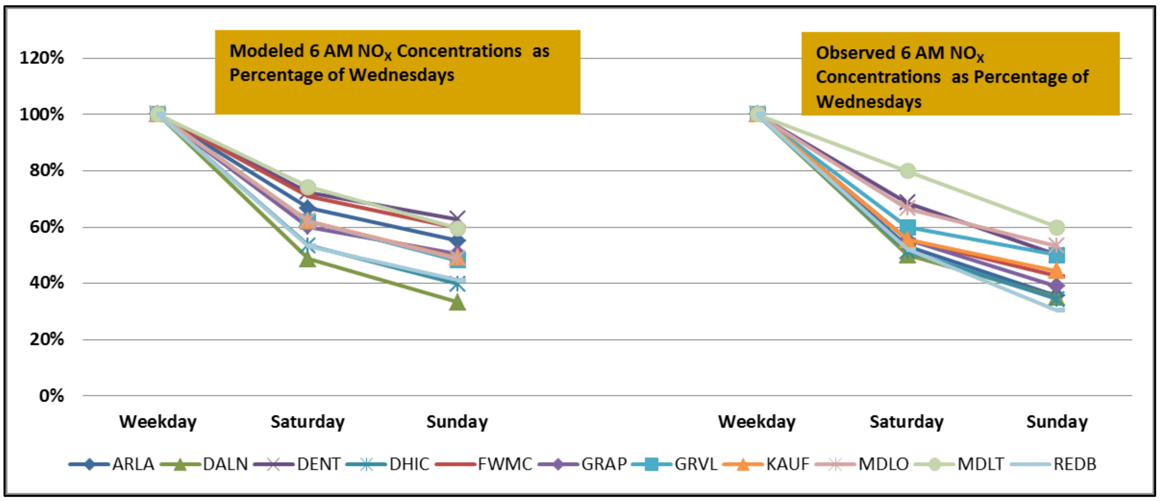


Figure 3-27: Mean 6 AM NO_X Concentrations by Monitor Relative to Wednesday

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.

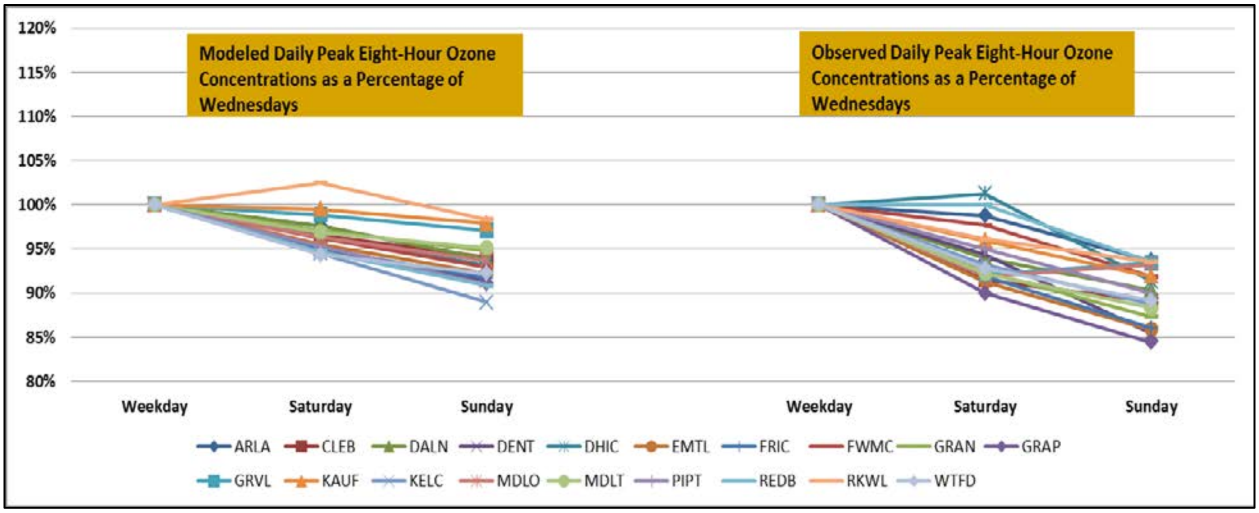


Figure 3-28: Observed and Modeled 95th Percentile Peak Ozone by Day Type

3.7 2006 BASELINE AND 2017 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: *2006 Baseline* 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 2007 modeling guidance. 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. The EPA's default recommendation for a 4 km domain in the 2007 guidance 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. The EPA's draft modeling guidance currently recommends a three-by-three array for the attainment test.

For each DFW area ozone monitor operational in 2006, Table 3-40: *2006 Baseline Design Value Summary for the All Days 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.

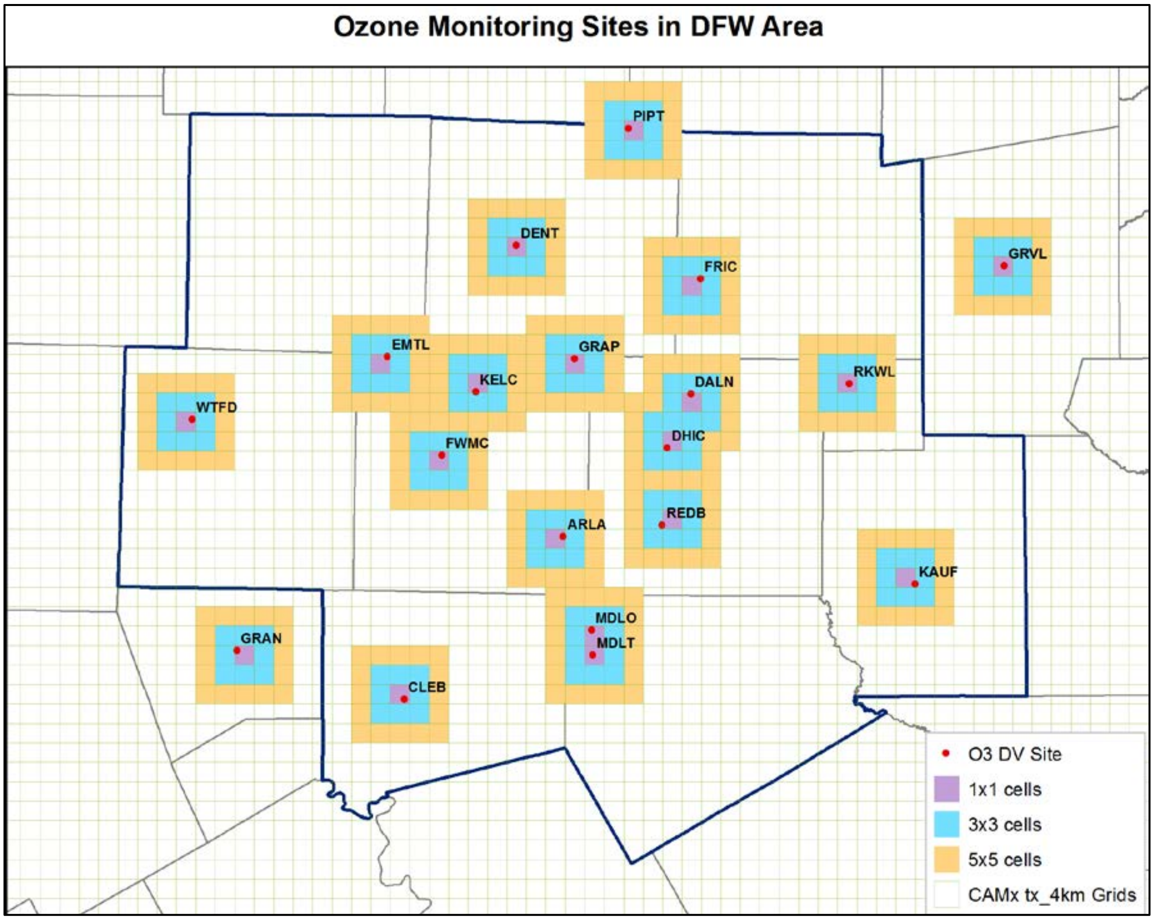


Figure 3-29: Location of DFW Ozone Monitors with 4 km Grid Cell Array

Table 3-40: 2006 Baseline Design Value Summary for the All Days 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	88.07	35
Eagle Mountain Lake - C75	EMTL	93.33	87.50	28
Grapevine Fairway - C70	GRAP	90.67	90.83	33
Keller - C17	KELC	91.00	89.07	32
Fort Worth Northwest - C13	FWMC	89.33	89.13	27
Frisco - C31	FRIC	87.67	86.83	34
Dallas North #2 - C63	DALN	85.00	85.65	31
Dallas Executive Airport - C402	REDB	85.00	84.46	27
Parker County - C76	WTFD	87.67	84.37	20
Cleburne Airport - C77	CLEB	85.00	83.06	16
Dallas Hinton Street - C401	DHIC	81.67	85.38	31
Arlington Municipal Airport - C61	ARLA	83.33	85.20	30
Granbury - C73*	GRAN	83.00	82.86	17

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
Midlothian Tower - C94†	MDLT	80.50	83.74	19
Pilot Point - C1032†	PIPT	81.00	86.41	33
Rockwall Heath - C69	RKWL	77.67	82.21	26
Midlothian OFW - C52†	MDLO	75.00	83.86	22
Kaufman - C71	KAUF	74.67	79.28	16
Greenville - C1006*	GRVL	75.00	79.16	16

* 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, 2017 future case modeling was conducted for each of the 67 episode days using the anthropogenic emission inputs discussed in Section 3.5.4: *2017 Future Case Emissions*. 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 2017 modeled peak eight-hour ozone average by the 2006 peak eight-hour modeled ozone average. For example, there were a total of 35 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 35 days is 88.07 ppb. The 2017 future case average for the same 35 days is 73.47 ppb. The Denton Airport South RRF is obtained by dividing the 73.47 ppb future year average by the 88.07 ppb baseline average to obtain 0.8342. A summary for all monitors is provided in Table 3-41: *RRF Calculations from the 2006 Baseline and 2017 Future Case for the All Days Attainment Test*.

Table 3-41: RRF Calculations from the 2006 Baseline and 2017 Future Case for the All Days Attainment Test

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 Average of Days >75 ppb	2017 Average of Days >75 ppb	Relative Response Factor (RRF)
Denton Airport South - C56	DENT	88.07	73.47	0.8342
Eagle Mountain Lake - C75	EMTL	87.50	72.67	0.8306
Grapevine Fairway - C70	GRAP	90.83	77.33	0.8513
Keller - C17	KELC	89.07	75.14	0.8436
Fort Worth Northwest - C13	FWMC	89.13	75.77	0.8501
Frisco - C31	FRIC	86.83	73.69	0.8486
Dallas North #2 - C63	DALN	85.65	73.91	0.8628
Dallas Executive Airport - C402	REDB	84.46	71.75	0.8495
Parker County - C76	WTFD	84.37	69.45	0.8231
Cleburne Airport - C77	CLEB	83.06	69.47	0.8364
Dallas Hinton Street - C401	DHIC	85.38	74.18	0.8688
Arlington Municipal Airport - C61	ARLA	85.20	72.15	0.8468

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 Average of Days >75 ppb	2017 Average of Days >75 ppb	Relative Response Factor (RRF)
Granbury - C73	GRAN	82.86	68.61	0.8280
Midlothian Tower - C94	MDLT	83.74	70.49	0.8417
Pilot Point - C1032	PIPT	86.41	71.89	0.8320
Rockwall Heath - C69	RKWL	82.21	69.48	0.8452
Midlothian OFW - C52	MDLO	83.86	70.63	0.8422
Kaufman - C71	KAUF	79.28	65.86	0.8308
Greenville - C1006	GRVL	79.16	65.20	0.8237

The RRF is then multiplied by the 2006 DV_B to obtain the 2017 DV_F for each ozone monitor. In accordance with the 2007 guidance, the final DV_F 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 2017 Future Ozone Design Values for the All Days Attainment Test*. Application of the all days attainment test results in the Denton Airport South, Eagle Mountain Lake, Grapevine Fairway, and Keller monitors above the 2008 eight-hour ozone standard of 75 ppb. The 2007 guidance for the 84 ppb standard states that when the maximum future design value falls within 82 through 87 ppb, a WoE "demonstration should be conducted to determine if aggregate supplemental analyses support the modeled attainment test." Application of the 82 through 87 ppb WoE range to the 75 ppb standard indicates that the currently applicable WoE range would be 73 through 78 ppb. As the DV_F for these four monitors falls within this range, a WoE demonstration is included in Chapter 5: *Weight of Evidence* of this DFW AD SIP revision.

Table 3-42: Summary of RRF and 2017 Future Ozone Design Values for the All Days Attainment Test

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 DV_B (ppb)	2017 DV_F (ppb)	2017 Truncated DV_F (ppb)
Denton Airport South - C56	DENT	93.33	77.85	77
Eagle Mountain Lake - C75	EMTL	93.33	77.52	77
Grapevine Fairway - C70	GRAP	90.67	77.19	77
Keller - C17	KELC	91.00	76.76	76
Fort Worth Northwest - C13	FWMC	89.33	75.94	75
Frisco - C31	FRIC	87.67	74.40	74
Dallas North #2 - C63	DALN	85.00	73.34	73
Dallas Executive Airport - C402	REDB	85.00	72.21	72
Parker County - C76	WTFD	87.67	72.16	72
Cleburne Airport - C77	CLEB	85.00	71.10	71
Dallas Hinton Street - C401	DHIC	81.67	70.96	71
Arlington Municipal Airport - C61	ARLA	83.33	70.56	70
Granbury - C73	GRAN	83.00	68.73	68
Midlothian Tower - C94	MDLT	80.50	67.76	67

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 DV_B (ppb)	2017 DV_F (ppb)	2017 Truncated DV_F (ppb)
Pilot Point - C1032	PIPT	81.00	67.39	67
Rockwall Heath - C69	RKWL	77.67	65.65	65
Midlothian OFW - C52	MDLO	75.00	63.17	63
Kaufman - C71	KAUF	74.67	62.04	62
Greenville - C1006	GRVL	75.00	61.78	61

The EPA draft modeling guidance recommends the attainment test be performed for each monitor on the 10 episode days from the baseline with the highest modeled eight-hour ozone. A summary of how the RRF is obtained for each monitor using this approach is provided in Table 3-43: *RRF Calculations Using the 10 Highest Days*. Please note that the Denton Airport South RRF with the top 10 days test is 0.8170 instead of the 0.8342 value from the all days test referenced in Table 3-41.

Table 3-43: RRF Calculations Using the 10 Highest Days

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 Average of 10 Highest Days	2017 Average of 10 Highest Days	Relative Response Factor (RRF)
Denton Airport South - C56	DENT	100.52	82.13	0.8170
Eagle Mountain Lake - C75	EMTL	96.29	78.98	0.8202
Grapevine Fairway - C70	GRAP	104.34	87.05	0.8343
Keller - C17	KELC	100.68	83.35	0.8279
Fort Worth Northwest - C13	FWMC	98.91	82.80	0.8371
Frisco - C31	FRIC	97.57	82.19	0.8424
Dallas North #2 - C63	DALN	95.68	81.30	0.8497
Dallas Executive Airport - C402	REDB	94.52	80.11	0.8476
Parker County - C76	WTFD	89.39	73.81	0.8258
Cleburne Airport - C77	CLEB	87.26	71.71	0.8218
Dallas Hinton Street - C401	DHIC	96.73	82.10	0.8487
Arlington Municipal Airport - C61	ARLA	97.26	81.53	0.8383
Granbury - C73	GRAN	87.02	71.72	0.8242
Midlothian Tower - C94	MDLT	90.04	75.42	0.8377
Pilot Point - C1032	PIPT	97.75	80.36	0.8221
Rockwall Heath - C69	RKWL	88.46	74.95	0.8473
Midlothian OFW - C52	MDLO	91.51	76.34	0.8342
Kaufman - C71	KAUF	81.28	67.60	0.8317
Greenville - C1006	GRVL	81.17	67.20	0.8279

The RRF from the top 10 days methodology is then multiplied by the 2006 DV_B for each monitor to obtain the revised 2017 DV_F figures presented in Table 3-44: *Summary of 2017 Future Ozone*

Design Values Using Top 10 Days Test. Similar to the 2007 guidance, the draft guidance recommends rounding the final DV_F to the tenths digit and truncating to zero decimal places. The results from Tables 3-42 and 3-44 are graphically displayed in Figure 3-30: *2017 Future Design Values by DFW Monitoring Location for All Days Test (top) and Top 10 Days Test (bottom)*. The draft guidance from December 2014 also recommends inclusion of WoE in an attainment demonstration, but does not specify a numeric DV_F range. Instead, the draft guidance requires that the DVF figures be "close to the NAAQS" for the purposes of demonstrating attainment.

Table 3-44: Summary of 2017 Future Ozone Design Values Using Top 10 Days Test

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2006 DV_B (ppb)	2017 DV_F (ppb)	2017 Truncated DV_F (ppb)
Denton Airport South - C56	DENT	93.33	76.25	76
Eagle Mountain Lake - C75	EMTL	93.33	76.55	76
Grapevine Fairway - C70	GRAP	90.67	75.65	75
Keller - C17	KELC	91.00	75.34	75
Fort Worth Northwest - C13	FWMC	89.33	74.78	74
Frisco - C31	FRIC	87.67	73.85	73
Dallas North #2 - C63	DALN	85.00	72.22	72
Dallas Executive Airport - C402	REDB	85.00	72.04	72
Parker County - C76	WTFD	87.67	72.39	72
Cleburne Airport - C77	CLEB	85.00	69.85	69
Dallas Hinton Street - C401	DHIC	81.67	69.31	69
Arlington Municipal Airport - C61	ARLA	83.33	69.85	69
Granbury - C73	GRAN	83.00	68.41	68
Midlothian Tower - C94	MDLT	80.50	67.43	67
Pilot Point - C1032	PIPT	81.00	66.59	66
Rockwall Heath - C69	RKWL	77.67	65.81	65
Midlothian OFW - C52	MDLO	75.00	62.56	62
Kaufman - C71	KAUF	74.67	62.10	62
Greenville - C1006	GRVL	75.00	62.09	62

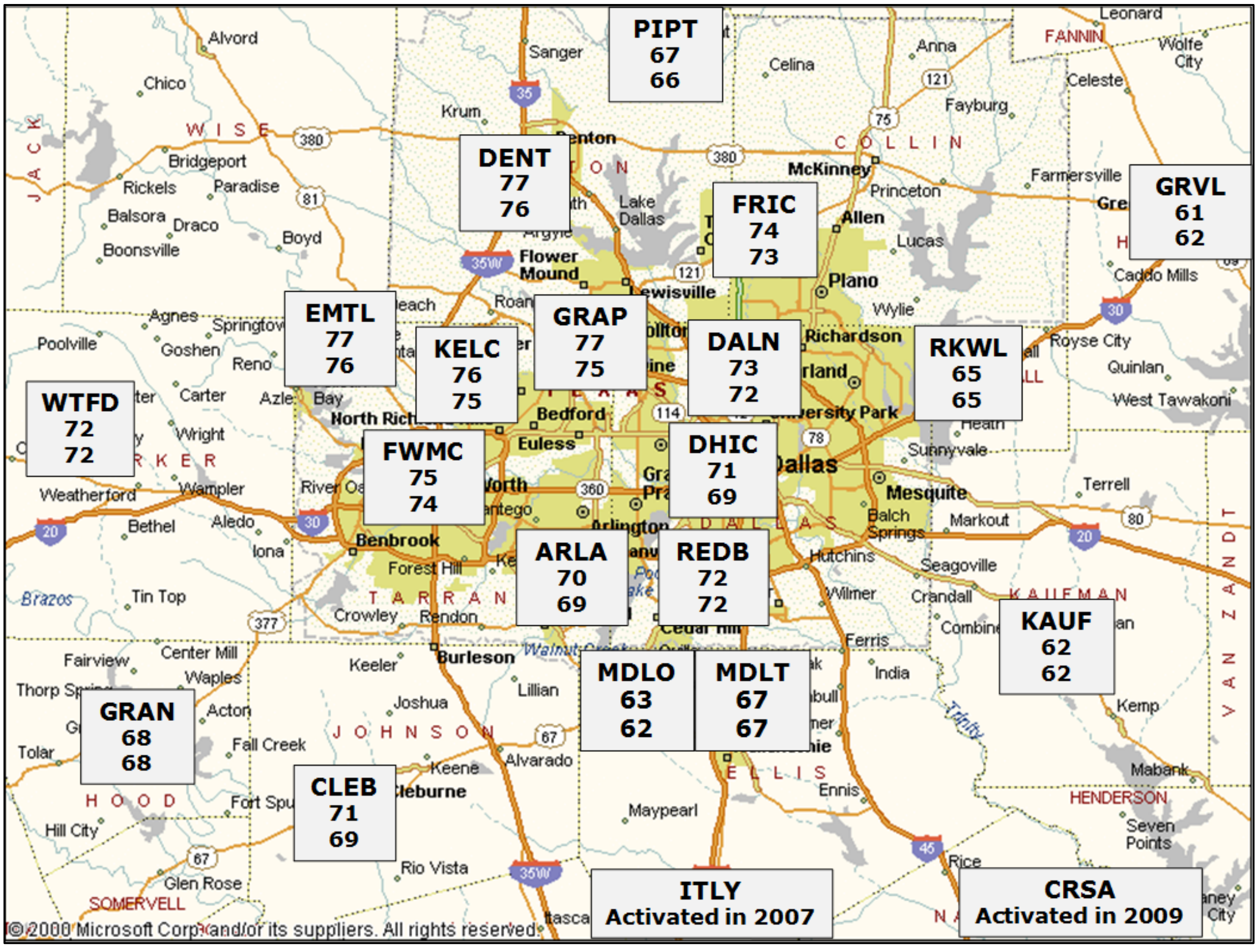


Figure 3-30: 2017 Future Design Value by DFW Monitoring Location for All Days Test (top) and Top 10 Days Test (bottom)

3.7.3 Ozone Source Apportionment Tool and Anthropogenic Precursor Culpability Analysis

A source apportionment analysis was conducted on the 2017 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 2017 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 3-45: *APCA Geographic Region and Source Category Combinations* summarizes these 17 groups.

Table 3-45: 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 2017 future year, oil and gas point source NO_X is 16.50 tpd and the remaining “other” is 6.68 NO_X tpd.

The full 67-day combined episode was run with APCA for the 2017 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: *2017 Ozone Contributions for Denton Airport South from May 31 through June 16* and Figure 3-32: *2017 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.

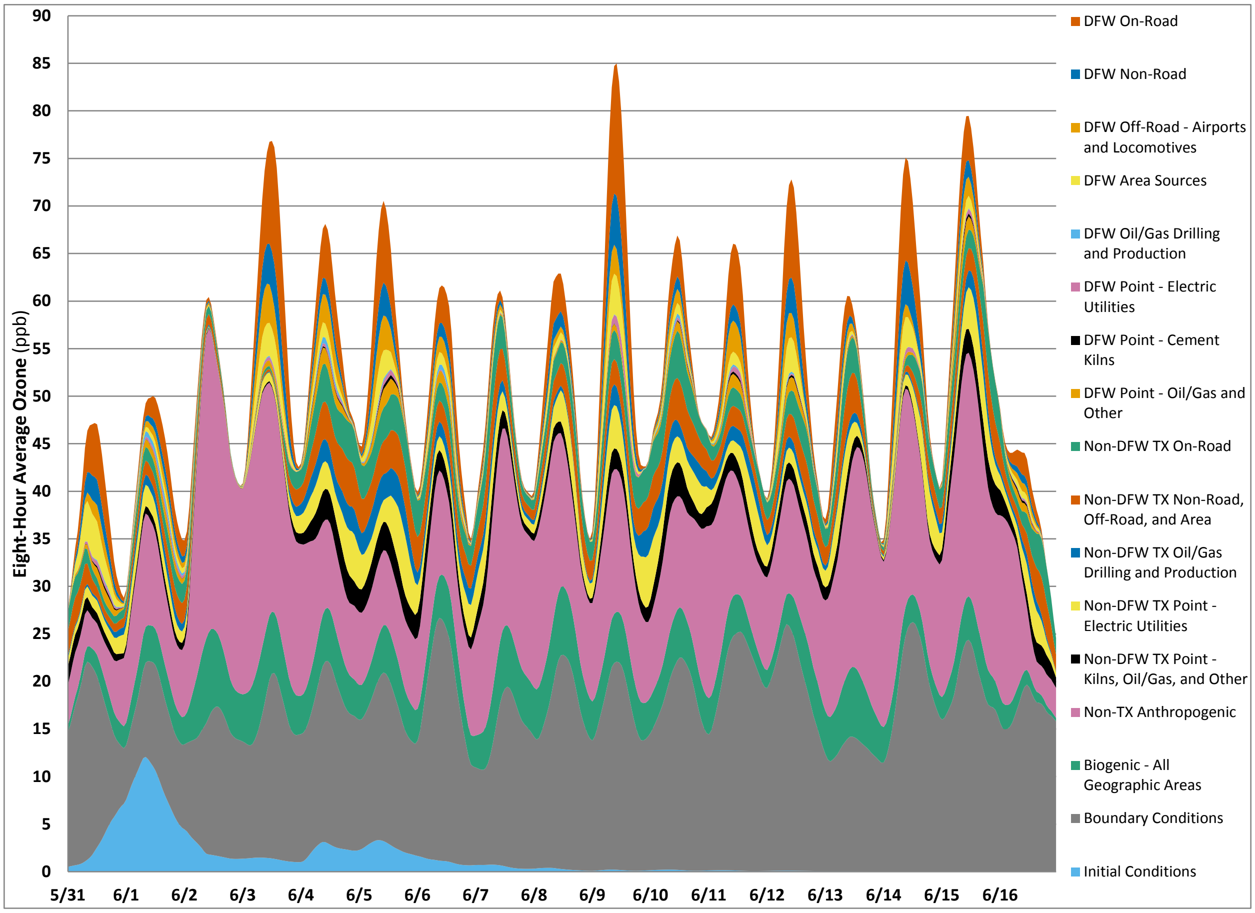


Figure 3-31: 2017 Ozone Contributions for Denton Airport South from May 31 through June 16

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 Tables 3-40 through 3-44. 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 2017 DV_F for each monitor. This approach was done separately for the all days attainment test and the top 10 days attainment test.

The results for the all days analysis are presented in Figure 3-33: *2017 Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the All Days Design Values*. The Denton Airport South monitor was chosen for review because it has the highest 2017 DV_F and is located in the far northwestern downwind portion of the DFW nonattainment area, so its APCA results represent the maximum total ozone contribution from DFW nonattainment area precursors. The Kaufman monitor was chosen for review because it has a low 2017 DV_F and is located in the far southeastern upwind portion of the DFW nonattainment 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 nonattainment area downwind of prevalent drilling and production activity.

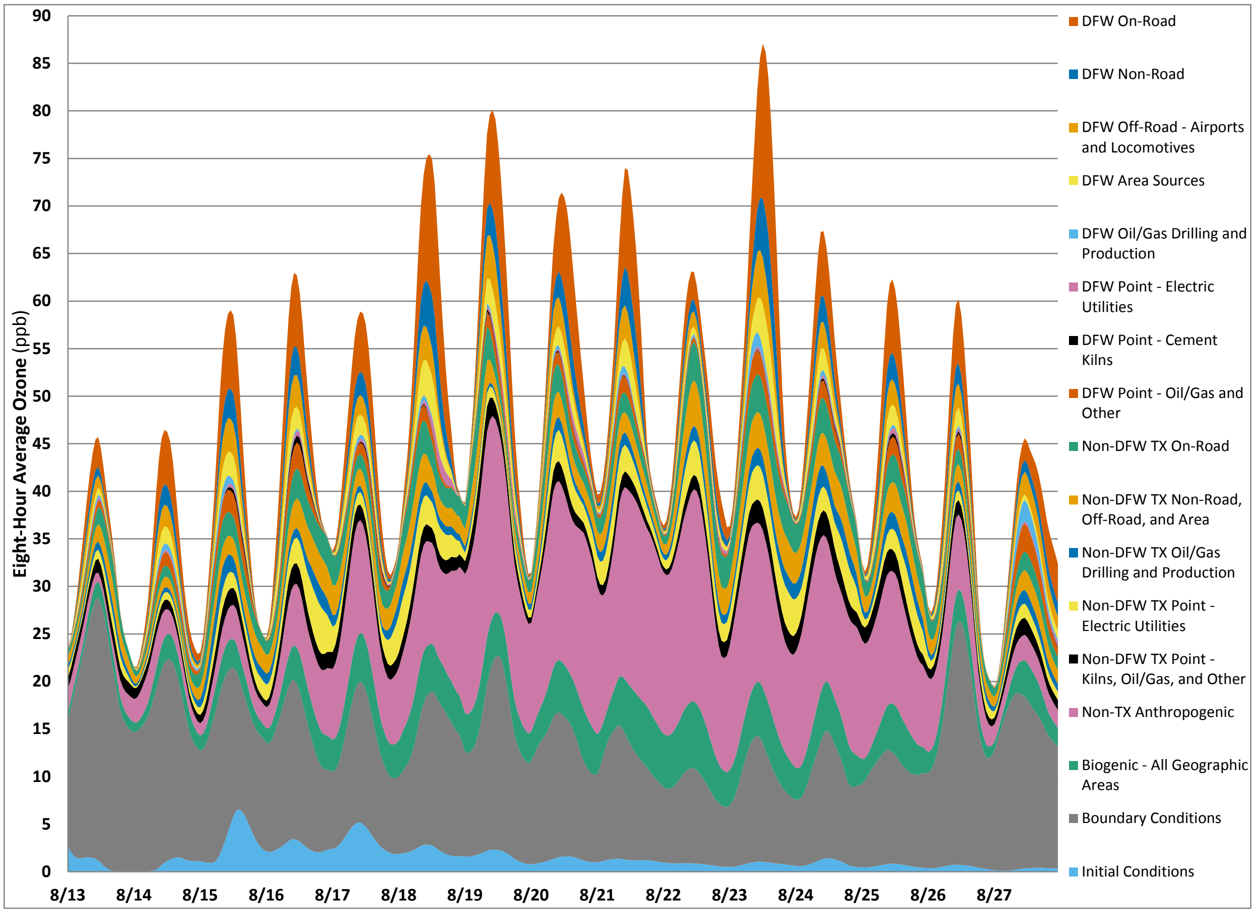


Figure 3-32: 2017 Ozone Contributions for Denton Airport South from August 13 through 27

Table 3-46: *2017 Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the All Days Design Values* presents the numeric results for each of the geographic area and source categories referenced in Figure 3-33. Table 3-47: *2017 Aggregate Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the All Days Design Values* groups the anthropogenic source category results from Table 3-46 into 10-County DFW, non-DFW Texas, and non-Texas areas. The southeastern upwind Kaufman monitor reflects the lowest DFW nonattainment area ozone contribution of 2.70 ppb to its DV_F, while the northwestern downwind Denton Airport South monitor reflects the highest DFW nonattainment area ozone contribution of 21.11 ppb. While the peak ozone at Kaufman is 15.81 ppb lower than at Denton Airport South, a greater portion of its ozone can be attributed to non-DFW Texas (16.38 ppb) and non-Texas (20.90 ppb) sources. The comparative non-DFW Texas and non-Texas anthropogenic contributions for Denton Airport South are 11.37 ppb and 18.61 ppb, respectively. As Tables 3-46 and 3-47 indicate, the remaining portions of the DV_F for each monitor are from biogenic sources, initial conditions for the start of the episode, and boundary conditions assigned to the borders of the modeling domain.

As shown in Table 3-46, the Parker monitor reflects higher ozone contributions from oil and gas operations compared with other DFW nonattainment area monitors. This is to be expected due its location downwind of much of this activity during ozone season. As noted in Table 3-45, the DFW nonattainment area point source contributions are divided into electric utilities, cement kilns, and a remaining category that combines oil and gas operations with “other”. The 2017 figures in Table 3-22 and Table 3-32 show that the oil and gas portion is 16.50 NO_X tpd with 6.68 NO_X tpd comprising the remainder of the total 23.18 NO_X tpd for non-cement kiln non-EGUs. Appendix C contains more detail on the APCA analyses presented here.

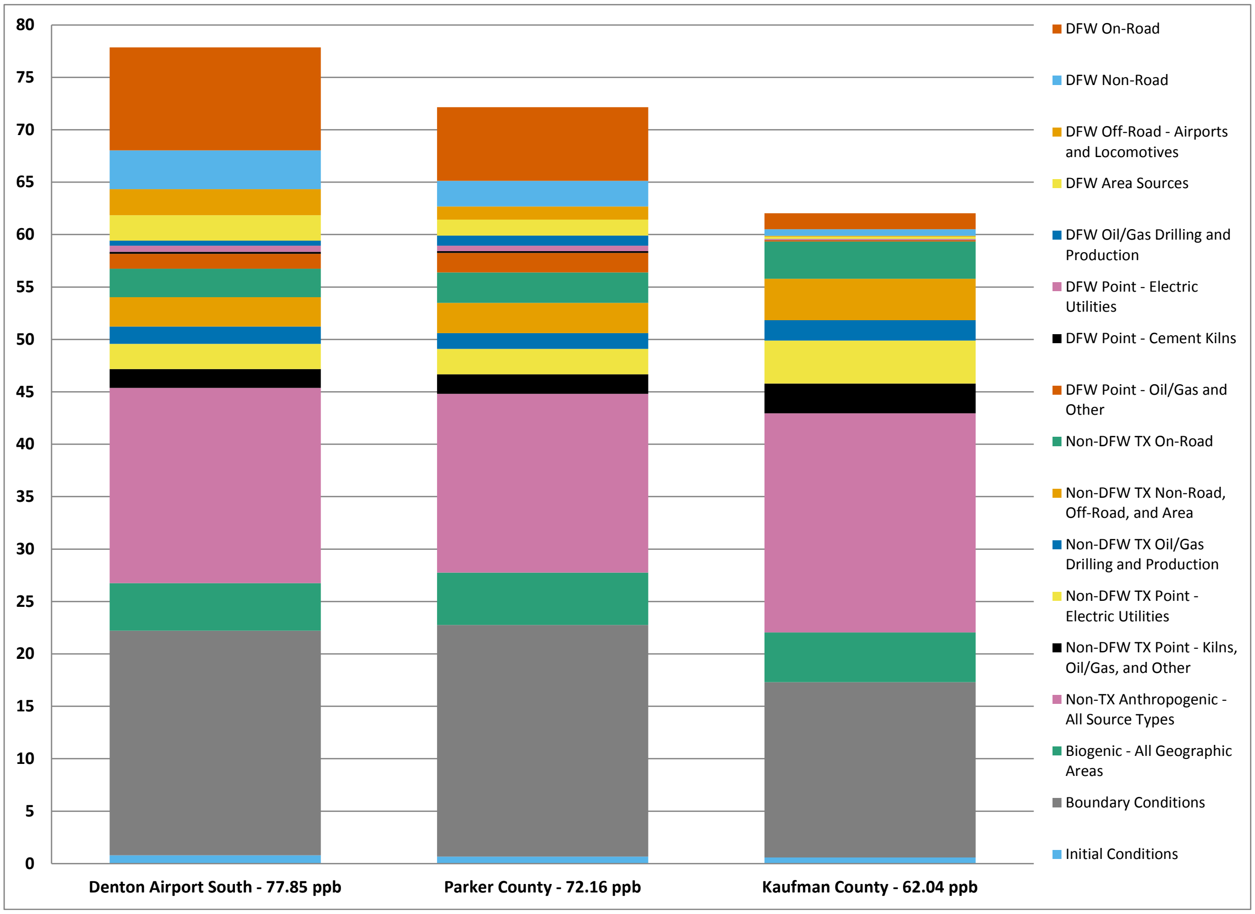


Figure 3-33: 2017 Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the All Days Design Values

Table 3-46: 2017 Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the All Days Design Values

Geographic Area and Source Type	Denton Airport South (ppb)	Parker County (ppb)	Kaufman County (ppb)
DFW On-Road	9.82	7.04	1.53
DFW Non-Road	3.68	2.44	0.63
DFW Off-Road - Airports and Locomotives	2.50	1.26	0.09
DFW Area Sources	2.43	1.52	0.20
DFW Oil/Gas Drilling and Production	0.47	0.95	0.02
DFW Point - Electric Utilities	0.58	0.53	0.10
DFW Point - Cement Kilns	0.19	0.16	0.01
DFW Point - Oil/Gas and Other	1.42	1.87	0.12

Geographic Area and Source Type	Denton Airport South (ppb)	Parker County (ppb)	Kaufman County (ppb)
Non-DFW TX On-Road	2.72	2.91	3.56
Non-DFW TX Non-Road, Off-Road, and Area Sources	2.80	2.87	3.94
Non-DFW TX Oil/Gas Drilling and Production	1.65	1.51	1.94
Non-DFW TX Point - Electric Utilities	2.40	2.43	4.10
Non-DFW TX Point - Cement Kilns, Oil/Gas, and Other	1.80	1.85	2.84
Non-TX Anthropogenic - All Source Types	18.61	17.05	20.90
Biogenic - All Geographic Areas	4.54	5.01	4.76
Boundary Conditions	21.42	22.10	16.71
Initial Conditions	0.80	0.66	0.59
2017 Future Design Value	77.85	72.16	62.04

Table 3-47: 2017 Aggregate Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the All Days Design Values

Aggregated Geographic Area and Source Type	Denton Airport South (ppb)	Parker County (ppb)	Kaufman County (ppb)
DFW Anthropogenic - All Source Types	21.11	15.77	2.70
Non-DFW Texas Anthropogenic - All Source Types	11.37	11.57	16.38
Non-Texas Anthropogenic - All Source Types	18.61	17.05	20.90
Biogenic - All Geographic Areas	4.54	5.01	4.76
Boundary and Initial Conditions	22.22	22.76	17.30
2017 Future Design Value	77.85	72.16	62.04

Table 3-48: *2017 Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the Top 10 Days Design Values* is similar to Table 3-46 but presents the results for the newer top 10 attainment test. Table 3-49: *2017 Aggregate Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the Top 10 Days Design Values* presents similar information at Table 3-47 but for the newer top 10 attainment test. The bar charts presented above in Figure 3-33 for the all days attainment test are not repeated for the top 10 results because the numeric differences are not large enough to show much distinction in bar charts. For the Denton Airport South monitor, Table 3-49 shows that DFW anthropogenic sources contribute 24.98 ppb for the top 10 days DV_F, which is 3.87 ppb higher than the 21.11 ppb contribution for the all days DV_F shown in Table 3-47. According to the EPA's draft guidance, this is expected because "on days with high ozone concentrations, there is a relatively higher percentage of locally generated ozone compared to days with low base concentrations. Days with low ozone concentrations are more likely to have a high percentage of ozone due to background and boundary conditions."

Table 3-48: 2017 Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the Top 10 Days Design Values

Geographic Area and Source Type	Denton Airport South (ppb)	Parker County (ppb)	Kaufman County (ppb)
DFW On-Road	11.81	10.07	1.68
DFW Non-Road	4.68	3.49	0.66
DFW Off-Road - Airports and Locomotives	3.13	1.87	0.10
DFW Area Sources	2.93	2.40	0.22
DFW Oil/Gas Drilling and Production	0.39	0.96	0.02
DFW Point - Electric Utilities	0.58	0.77	0.14
DFW Point - Cement Kilns	0.17	0.23	0.02
DFW Point - Oil/Gas and Other	1.29	2.11	0.15
Non-DFW TX On-Road	2.24	1.92	3.43
Non-DFW TX Non-Road, Off-Road, and Area Sources	2.21	1.91	3.98
Non-DFW TX Oil/Gas Drilling and Production	1.36	1.21	1.86
Non-DFW TX Point - Electric Utilities	2.27	2.08	4.20
Non-DFW TX Point - Cement Kilns, Oil/Gas, and Other	1.45	1.21	3.06
Non-TX Anthropogenic - All Source Types	17.44	14.98	21.92
Biogenic - All Geographic Areas	4.52	4.49	4.67
Boundary Conditions	18.90	22.16	15.31
Initial Conditions	0.89	0.53	0.68
2017 Future Design Value	76.25	72.39	62.10

Table 3-49: 2017 Aggregate Ozone Contributions for the Denton, Parker, and Kaufman Monitors Based on the Top 10 Days Design Values

Aggregated Geographic Area and Source Type	Denton Airport South (ppb)	Parker County (ppb)	Kaufman County (ppb)
DFW Anthropogenic - All Source Types	24.98	21.90	2.98
Non-DFW Texas Anthropogenic - All Source Types	9.52	8.33	16.53
Non-Texas Anthropogenic - All Source Types	17.44	14.98	21.92
Biogenic - All Geographic Areas	4.52	4.49	4.67
Boundary and Initial Conditions	19.79	22.69	16.00
2017 Future Design Value	76.25	72.39	62.10

3.7.4 Future Case Modeling Sensitivities

Section 3.7.2 presented the 2017 future design values obtained from the running the photochemical model with the 2006 baseline and 2017 future case emission inventories discussed in Sections 3.5.3 and 3.5.4, respectively. When a future case sensitivity analysis is performed, the future year anthropogenic emission inventory inputs are modified while the baseline emission inventories are typically held constant. For each future case sensitivity test, the RRF analysis is performed and the revised future case design values for each monitor are compared to the future baseline levels.

3.7.4.1 2017 Clean Air Interstate Rule (CAIR) Phase II Sensitivity

On July 28, 2015, the D.C. Circuit Court found that the CSAPR 2014 sulfur dioxide (SO_2) and ozone season NO_X budgets for Texas and certain other states were invalid because the budgets required more emission reductions than were necessary. The court remanded the rule without vacatur to the EPA for reconsideration of the emission budgets. Therefore, while the current CSAPR budgets for Texas are still in effect, the budgets may be subject to change in the future after the EPA's reconsideration or changes resulting from further appeals.

As described in Section 3.5.4.1, the 2017 future case EGU emissions for this DFW AD SIP revision were projected based on the latest available CSAPR unit level allocations from the EPA. The TCEQ performed a 2017 sensitivity analysis that replaced the 2017 EGU emission estimates based on CSAPR with those that would apply if the CAIR Phase II allocations were still in effect. The modeled 2017 ozone impacts for the DFW area monitors are presented in Table 3-50: *2017 Future Design Value Changes from CAIR II Instead of CSAPR for the All Days Attainment Test*. The maximum modeled reduction of 0.45 ppb is at the Fort Worth Northwest monitor, while the maximum modeled increase of 0.43 ppb is at the Rockwall Heath monitor located northeast of Dallas.

Table 3-50: 2017 Future Design Value Changes from CAIR II Instead of CSAPR for the All Days Attainment Test

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2017 DV_F for CSAPR (ppb)	2017 DV_F for CAIR II (ppb)	2017 DV_F Change (ppb)
Denton Airport South - C56	DENT	77.85	77.74	-0.11
Eagle Mountain Lake - C75	EMTL	77.52	77.29	-0.23
Grapevine Fairway - C70	GRAP	77.19	77.11	-0.08
Keller - C17	KELC	76.76	76.58	-0.18
Fort Worth Northwest - C13	FWMC	75.94	75.49	-0.45
Frisco - C31	FRIC	74.40	74.51	+0.11
Dallas North #2 - C63	DALN	73.34	73.48	+0.14
Dallas Executive Airport - C402	REDB	72.21	72.38	+0.17
Parker County - C76	WTFD	72.16	72.12	-0.04
Cleburne Airport - C77	CLEB	71.10	70.99	-0.11
Dallas Hinton Street - C401	DHIC	70.96	71.06	+0.10
Arlington Municipal Airport - C61	ARLA	70.56	70.58	+0.02
Granbury - C73	GRAN	68.73	68.78	+0.05
Midlothian Tower - C94	MDLT	67.76	67.94	+0.18
Pilot Point - C1032	PIPT	67.39	67.38	-0.01
Rockwall Heath - C69	RKWL	65.65	66.08	+0.43
Midlothian OFW - C52	MDLO	63.17	63.35	+0.18
Kaufman - C71	KAUF	62.04	62.39	+0.35

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2017 DV_F for CSAPR (ppb)	2017 DV_F for CAIR II (ppb)	2017 DV_F Change (ppb)
Greenville - C1006	GRVL	61.78	61.86	+0.08

The modeled 2017 ozone impacts for this same scenario using the top 10 days test are included in Table 3-51: *2017 Future Design Value Changes from CAIR II Instead of CSAPR for the Top 10 Days Attainment Test*. This approach has the maximum modeled reduction of 0.33 ppb at the Fort Worth Northwest monitor, while the maximum modeled increase of 0.37 ppb is at the Kaufman monitor located southeast of Dallas.

Table 3-51: 2017 Future Design Value Changes from CAIR II Instead of CSAPR for the Top 10 Days Attainment Test

2006 DFW Area Monitor and CAMS Code	DFW Area Monitor Alpha Code	2017 DV_F for CSAPR (ppb)	2017 DV_F for CAIR II (ppb)	2017 DV_F Change (ppb)
Denton Airport South - C56	DENT	76.25	76.33	+0.08
Eagle Mountain Lake - C75	EMTL	76.55	76.34	-0.21
Grapevine Fairway - C70	GRAP	75.65	75.68	+0.03
Keller - C17	KELC	75.34	75.29	-0.05
Fort Worth Northwest - C13	FWMC	74.78	74.45	-0.33
Frisco - C31	FRIC	73.85	74.05	+0.20
Dallas North #2 - C63	DALN	72.22	72.44	+0.22
Dallas Executive Airport - C402	REDB	72.04	72.17	+0.13
Parker County - C76	WTFD	72.39	72.23	-0.16
Cleburne Airport - C77	CLEB	69.85	69.59	-0.26
Dallas Hinton Street - C401	DHIC	69.31	69.53	+0.22
Arlington Municipal Airport - C61	ARLA	69.85	69.72	-0.13
Granbury - C73	GRAN	68.41	68.47	+0.06
Midlothian Tower - C94	MDLT	67.43	67.65	+0.22
Pilot Point - C1032	PIPT	66.59	66.60	+0.01
Rockwall Heath - C69	RKWL	65.81	66.00	+0.19
Midlothian OFW - C52	MDLO	62.56	62.75	+0.19
Kaufman - C71	KAUF	62.10	62.47	+0.37
Greenville - C1006	GRVL	62.09	62.13	+0.04

3.7.5 Unmonitored Area Analysis

The 2007 modeling guidance recommends that areas within or near nonattainment counties but not adjacent to monitoring locations (unmonitored areas (UMA)) be subjected to a 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 the 2007 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 Ozone Design Values for the 2006 Baseline and 2017 Future Case* shows two color contour maps of ozone concentrations produced by TATU, one for the 2006 baseline (bottom) and one for the 2017 future case (top). The 2006 plot shows that the maximum modeled baseline design value is in cell 78 in the X-direction and cell 191 in the Y-direction (78-X/191-Y) which is the same 4 km cell where the Denton Airport South monitor is located. The 2017 plot shows the extent and magnitude of the expected improvements in ozone design values compared with the 2006 baseline, with few grid cells at or above 76 ppb. The 2017 plot indicates that the maximum 2017 design value in the domain is 78.6 ppb, which is located in cell 79-X/186-Y between the Grapevine Fairway and Denton Airport South monitors. This value of 78.6 ppb is 0.7 ppb higher than the Denton Airport South future design value of 77.9 reported in Table 3-42.

Figure 3-29 shows the location of all ozone monitors within the entire 4 km grid cell array for DFW. The five monitors that typically record the highest ozone levels in DFW are located north and west of Fort Worth: Denton Airport South, Eagle Mountain Lake, Fort Worth Northwest, Grapevine Fairway, and Keller. Both the 2006 baseline and 2017 future case modeling for this 67-day episode are properly capturing the geographic locations of the monitored peaks.

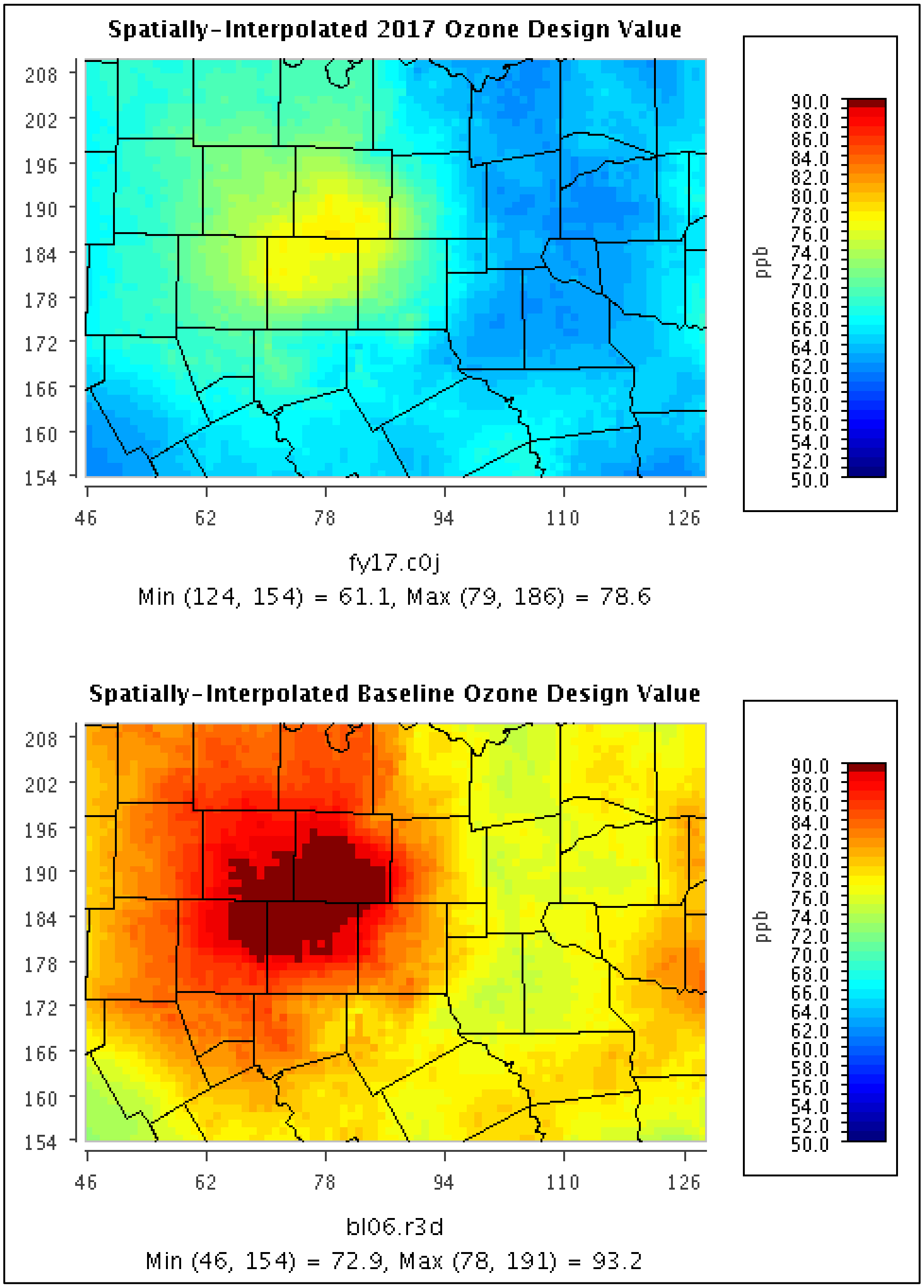


Figure 3-34: Spatially Interpolated Ozone Design Values for the 2006 Baseline and 2017 Future Case

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, (ftp://amdaftp.tceq.texas.gov/pub/TX/camx/).

3.8.2 Modeling References

Browning, J., Tinker, S., Ikonnikova, S., Gulen, G., Potter, E., Fu, Q., Horvath, S., Patzek, T., Male, F., Fisher, W., Roberts, F., Medlock, K., 2013, Barnett Study Determines Full-Field Reserves, Production Forecast, Oil & Gas Journal, September 2013, http://www.beg.utexas.edu/info/docs/OGJ_SFSGAS_pt2.pdf.

Emery, C., E. Tai, and G. Yarwood, 2001. Enhanced Meteorological Modeling and Performance Evaluation for Two Texas Ozone Episodes, Final Report to the Texas Natural Resource Conservation Commission under TNRCC Umbrella Contract No. 582-0-31984, Environ International Corporation, Novato, CA.

Environ, 2008. Boundary Conditions and Fire Emissions Modeling, Final Report to the Texas Commission on Environmental Quality (TCEQ), Contract No. 582-7-84005-FY08-06, Environ International Corporation, Novato, CA.

Environ, 2015. EPS3 User's Guide Emissions Processor, Version 3.22, Environ International Corporation, July 2015.

Environ, 2015. User's Guide Comprehensive Air Quality Model with Extensions (CAMx), Version 6.2, Environ International Corporation, March 2015, http://www.camx.com/files/camxusersguide_v6-20.pdf.

Environ, 2011. Improving the Representation of Vertical Mixing Processes in CAMx, Final Report to the Texas Commission on Environmental Quality (TCEQ), Contract No. 582-11-10365-FY11-02, http://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/pm/5821110365FY1102-20110822-environ-vertical_mixing_final_report.pdf, Environ International Corporation, Novato, CA.

EPA, 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-454/B-07-002, April 2007, http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf.

EPA, 2008. Approval and Promulgation of Air Quality Implementation Plans; Texas; Dallas/Fort Worth 1-Hour Ozone Nonattainment Area; Determination of Attainment of the 1-Hour Ozone Standard, http://edocket.access.gpo.gov/2008/pdf/E8-24592.pdf.

EPA, 2010. Determination of Nonattainment and Reclassification of 1997 8-hour Ozone Nonattainment Areas: Dallas/Fort Worth, TX, http://www.regulations.gov/search/Regs/home.html#documentDetail?R=0900006480b2c08e

EPA, 2014. Air Quality Modeling Technical Support Document: Tier 3 Motor Vehicle Emission and Standards, EPA-454/R-14-002, February 2014, http://www.epa.gov/otaq/documents/tier3/454r14002.pdf.

EPA, 2014a. The Effects of Ultra-Low Sulfur Gasoline on Emissions from Tier 2 Vehicles in the In-Use Fleet, EPA-420-R-14-002, March 2014, http://www.epa.gov/otaq/models/moves/documents/420r14002.pdf.

EPA, 2014b. Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM2.5, and Regional Haze, December 2014, http://www.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf.

ERG, 2010. Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions, November 2010, http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/5820784003FY1026-20101124-ergi-oilGasEmissionsInventory.pdf.

ERG, 2010. Projection Factors for Point and Area Sources, August 2012. Available within TCEQ TexAER system at http://www5.tceq.state.tx.us/texaer/index.cfm.

ERG, 2012. Forecasting Oil and Gas Activities, August 2012, http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/5821199776FY1212-20120831-erg-forecasting_oild_gas_activities.pdf.

ERG, 2014. Specified Oil and Gas Well Activities Emissions Inventory Update, August 2014, http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/ei/5821199776FY1426-20140801-erg-oil_gas_ei_update.pdf.

Feldman, M.S., T. Howard, E. McDonald-Buller, G. Mullins, D.T. Allen, A. Webb, Y. Kimura, 2007. Applications of Satellite Remote Sensing Data for Estimating Dry Deposition in Eastern Texas. Atmospheric Environment, 41(35): 7562-7576.

ERG, 2015. 2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories, August 2015.

ERG, 2015a. Aircraft Emissions Inventory for Texas Statewide 2014 AERR Inventory and 2008 to 2040 Trend Analysis Years, July 2015.

ERG, 2015b. 2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventories, July 2015.

Grell, G., J. Dudhia, and D. Stauffer, 1994. A Description of the Fifth Generation Penn State/NCAR Mesoscale Model (MM5), Technical Report NCAR/TN-398+STR, National Center of Atmospheric Research (NCAR) Tech Note.

Guenther, A., Jiang, X., Heald, C., Sakulyanontvittaya, T., Duhl, T., Emmons, L., et al., 2012. The Model of Emissions of Gases and Aerosols from Nature version 2.1 (MEGAN2.1): an extended and updated framework for modeling biogenic emissions. Geoscientific Model Development, 1471-1492.

Kinnee et al., 1997. United States Land Use Inventory for Estimating Biogenic Ozone Precursor Emissions. Ecological Applications 7(1): 46-58.

MacDonald, Nicole and Hakami, A, 2010. Temporal Source Apportionment of Policy-Relevant Air Quality Metrics, Presented at the 9th CMAS Conference Oct. 11-13, 2010, Chapel, Hill, N.C.

Mellor, G. L., and T. Yamada, 1974: A hierarchy of turbulence closure models for planetary boundary layers. J. Atmos. Sci., 31, 1791–1806.

Morris, G., 2006. Tropospheric Ozone Pollution Project, http://physics.valpo.edu/ozone/houstondata_2004_2007.htm#2006, Valparaiso University, Indiana, and the University of Houston, Texas.

NCAR, 2005. MM5 On-line Tutorial Home Pages, http://www.mmm.ucar.edu/mm5/On-Line-Tutorial/teachyourself.html, NCAR, Colorado.

NCEP, 2009. Global Energy and Water Cycle Experiment (GEWEX) Continental International Project (GCIP) National Centers for Environmental Prediction (NCEP) Eta Model Output, Computational and Information Systems Laboratory (CISL) Research Data Archive (RDA): ds609.2 Home Page, http://dss.ucar.edu/datasets/ds609.2/, NCEP.

NCTCOG, 2011. Development of Annual Emissions Inventories and Activity Data for Airports in the 12-County Dallas-Fort Worth Area, Report to TCEQ, North Central Texas Council of Governments Transportation Department, ftp://amdaftp.tceq.state.tx.us/pub/Offroad_EI/Airports/DFW/NCTCOG_DFW_Airport_EI_Report_August_2011.pdf.

NOAA, 2006. Texas Air Quality Study – Gulf of Mexico Atmospheric Composition and Climate Study 2006, http://www.esrl.noaa.gov/csd/projects/2006/, NOAA.

Popescu, Sorin C., Jared Stukey, Mark Karnauch, Jeremiah Bowling, Xuesong Zhang, William Booth, and Nian-Wei Ku, 2008. The New Central Texas Land Use Land Cover Classification Project, Final Report to the TCEQ, Contract No. 582-5-64593-FY08-23, http://www.tceq.state.tx.us/assets/public/implementation/air/am/contracts/reports/oth/5820564593FY0823-20081230-tamu-New_Central_TX_LULC.pdf, Texas A & M University, College Station, Texas.

Railroad Commission of Texas, Barnett Shale Information, http://www.rrc.state.tx.us/oil-gas/major-oil-gas-formations/barnett-shale-information.

Smith, Jim and Estes, M., 2010. Dynamic Model Performance Evaluation Using Weekday-Weekend and Retrospective Analysis, Presented at the 9th CMAS Conference Oct. 11-13, 2010, Chapel, Hill, N.C.

Stauffer, D. R. and N. L. Seaman, 1990. Use of Four-Dimensional Data Assimilation in a Limited-Area Mesoscale Model. Part I: Experiments with Synoptic-Scale Data. Monthly Weather Review, 118: 1250-1277.

Stauffer, D.R. and N.L. Seaman, 1994. Multiscale four-dimensional data assimilation. Journal of Applied Meteorology, 33: 416-434.

Stauffer, D. R., N. L. Seaman, and F. S. Binkowski, 1991. Use of Four-Dimensional Data Assimilation in a Limited-Area Mesoscale Model. Part II: Effects of Data Assimilation Within the Planetary Boundary Layer. Monthly Weather Review, 119: 734-754.

TCEQ, 2007a. Revisions to the State Implementation Plan (SIP) for the Control of Ozone Air Pollution, Dallas-Fort Worth Eight-Hour Ozone Nonattainment Area Attainment Demonstration, TCEQ, Austin, Texas.

TCEQ, 2010. Adopted HGB Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard (2009-017-SIP-NR), Texas Commission on Environmental Quality, March 2010, http://www.tceq.state.tx.us/implementation/air/sip/texas-sip/hgb/hgb-latest-ozone.

TCEQ, 2015, Texas Air Emissions Repository (TexAER) web site, http://www5.tceq.state.tx.us/texaer/.

Wiedinmyer, C., A. Guenther, M. Estes, I.W. Strange, G. Yarwood, and D. Allen, 2001. A Land Use Database and Examples of Biogenic Isoprene Emission Estimates for the State of Texas, USA. Atmospheric Environment, 35: 6465-6477.

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 for the DFW nonattainment area, as well as how Texas meets the following moderate ozone nonattainment area state implementation plan (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 nonattainment 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 and Voluntary Measures Applicable to the DFW 10-County Nonattainment Area* lists the existing ozone control strategies that have been implemented for the one-hour and the 1997 and 2008 eight-hour ozone standards for all 10 counties comprising the DFW nonattainment area.

Table 4-1: Existing Ozone Control and Voluntary Measures Applicable to the DFW 10-County Nonattainment Area

Measure	Description	Start Date(s)
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 in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties Applies to major sources (100 tpy of NO_X or more) with affected units in Wise County 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 January 1, 2017 for Wise County and for wood-fired boilers in all 10 counties of the DFW area

Measure	Description	Start Date(s)
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 in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties	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
Stationary Diesel Engines 30 TAC Chapter 117, Subchapter B, Division 4 and Subchapter D, Division 2	Prohibition on operating stationary diesel and dual-fuel engines for testing and maintenance purposes between 6:00 a.m. and noon in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties	March 1, 2009
Major Utility Electric Generation Source Rule 30 TAC Chapter 117, Subchapter C, Division 4	NO_X control requirements for major source (50 tpy of NO_X or more) utility electric generating facilities in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties NO_X control requirements for major source (100 tpy of NO_X or more) utility electric generating facilities in Wise County 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 for Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties January 1, 2017 for Wise County
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
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

Measure	Description	Start Date(s)
Nitric Acid Manufacturing Rule – 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 Rule 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 the DFW nonattainment area although controls not applicable in the DFW nonattainment area	March 1, 2010
Natural Gas-Fired Small Boilers, Process Heaters, and Water Heaters Rule 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 in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties	May 11, 2000
VOC Control Measures 30 TAC Chapter 115	Control technology requirements for VOC sources for RACT and other SIP planning purposes including: storage, general vent gas, industrial wastewater, loading and unloading operations, general VOC leak detection and repair, solvent using processes, etc.	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 January 1, 2017 for Wise County
Degassing of Storage Tanks, Transport Vessels, and Marine Vessels Rule 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

Measure	Description	Start Date(s)
Storage Tanks Rule 30 TAC Chapter 115, Subchapter B, Division 1	Applies to major source storage tanks (50 tpy of VOC or more) in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties Applies to major source storage tanks (100 tpy of VOC or more) in Wise County 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 January 1, 2017 for major source storage tanks in Wise County and for new inspection requirements to control flashed gases from storage tanks and corresponding recordkeeping requirements for fixed roof storage tanks in all 10 counties of the DFW area
Solvent-Using Processes Rules 30 TAC Chapter 115, Subchapter E	Implements control, testing, monitoring and recordkeeping requirements for eight emission source categories in the DFW nonattainment area for degreasing, surface coating, solvent cleaning, printing, and adhesive application processes. Certain rules were updated based on the control techniques guidelines issued by the United States Environmental Protection Agency (EPA) between 2006 and 2008 (see Dallas-Fort Worth Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard Nonattainment Area (2010-022-SIP-NR))	March 1, 2013 for Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties January 1, 2017 for Wise County March 1, 2011 for major source offset lithographic printing lines and March 1, 2012 for minor source offset lithographic printing lines in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties

Measure	Description	Start Date(s)
Refueling – Stage I Rule 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 for Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties January 1, 2017 for Wise County A SIP revision related to Stage I regulations was approved by the EPA, effective June 29, 2015
Refueling – Stage II Rule 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.
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
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
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

Measure	Description	Start Date(s)
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 (FY) 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 Houston-Galveston-Brazoria (HGB) and DFW nonattainment areas for FY 2002-2003. An application period limited to DFW, HGB, and Beaumont-Port Arthur 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

Measure	Description	Start Date(s)
Vehicle Inspection and Maintenance (I/M) Rule 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 Federal Clean Air Act (FCAA), §182(b)(4) requirements to implement an I/M program , and according to 40 Code of Federal Regulations (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.
California Gasoline Engines	California standards for non-road gasoline engines 25 hp and larger	May 1, 2004
Voluntary Mobile Emissions Reduction Program	Various pedestrian, bicycle, traffic, and mass transit voluntary measures administered by the North Central Texas Council of Governments (NCTCOG) (see Appendix H for more details)	2007
Voluntary Energy Efficiency/Renewable Energy (EE/RE)	EE/RE projects encouraged by the Texas Legislature are outlined in section 5.4.1.1	See section 5.4.1.1
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

Measure	Description	Start Date(s)
Transportation Control Measures	Various measures in NCTCOG's long-range transportation plans	2007

4.3 UPDATES TO EXISTING CONTROL MEASURES (NO CHANGE)

4.3.1 Updates to NO_X Control Measures (No change)

4.3.2 Updates to VOC Control Measures (No change)

4.3.3 Minor Source Stationary Diesel Engine Exemption (No change)

4.3.4 Decommissioning of Stage II Vapor Recovery (No change)

4.3.5 Updates to Stage I Vapor Recovery (No change)

4.4 NEW CONTROL MEASURES (NO CHANGE)

4.4.1 Stationary Sources (No change)

4.4.1.1 NO_X RACT Control Measures for Wise County (No change)

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 2008 eight-hour ozone SIP requirements rule (80 *Federal Register* [FR] 12264), 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. This SIP revision must also 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 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 VOC storage tanks as meeting the FCAA RACT requirements (79 FR 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.

In 2014, the EPA approved the 30 TAC Chapter 115 rules for offset lithographic printing as meeting the FCAA RACT requirements (79 FR 45105). In 2015, the EPA approved the DFW VOC rules in 30 TAC Chapter 115 addressing the remaining CTGs issued between 2006 and 2008, in addition to approving the DFW RACT analysis as meeting the FCAA RACT requirements for all affected VOC and NO_X sources under the 1997 eight-hour ozone NAAQS (80 FR 16291).

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 fulfilled FCAA RACT requirements for the 2008 eight-hour ozone NAAQS as part of the DFW Attainment Demonstration (AD) SIP revision for the 2008 eight-hour ozone NAAQS submitted to the EPA on July 10, 2015. However, as part of this proposed DFW AD SIP revision, the TCEQ reviewed the 2013 point source emissions inventory to verify that all CTG or ACT emission source categories and non-CTG or non-ACT major emission sources in the DFW nonattainment 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. The TCEQ concluded that RACT is in place for all emission sources in the DFW area and that no additional rulemaking is necessary as part of this proposed DFW AD SIP Revision.

4.5.2 NO_X RACT Determination (No change)

4.5.3 VOC RACT Determination (No change)

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 for the DFW AD SIP for the 2008 eight-hour ozone NAAQS submitted to the EPA on July 10, 2015. The same list was used for this DFW AD SIP revision. First, the TCEQ compiled a list of potential control strategy concepts based on an initial evaluation of the existing control strategies in the DFW nonattainment area and existing sources of VOC and NO_X in the DFW nonattainment 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 nonattainment 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 July 20, 2018 attainment date for this DFW AD SIP revision, the TCEQ evaluated this aspect of RACM based on advancing the deadline for implementing control measures by one year, to July 20, 2017. As a result of the December 23, 2014 court decision that vacated the previous December 31, 2018 attainment date, the commission reevaluated RACM as part of this DFW AD SIP revision based on the new attainment date of July 20, 2018, since the new attainment year is now 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, 2017 could not be considered RACM because the measures would not advance attainment. To "advance the attainment date by at least one year" to July 20, 2017, suggested control measures would have to be fully implemented by March 1, 2016. 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 nonattainment 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 of this DFW AD SIP revision, the current modeling results in conjunction with the weight of evidence analysis indicate that the DFW area will demonstrate attainment. Modeling results based on the April 2007 EPA modeling guidance project the future ozone design value to be 77 parts per billion (ppb). Use of the newer EPA draft guidance projects this 2018 future ozone design value to be 76 ppb. These 2018 design values and the weight of evidence analysis included in Chapter 5 of this SIP revision demonstrate attainment of the 2008 eight-hour ozone NAAQS. Based on a July 20, 2018 attainment deadline, a control measure would have to be in place by March 1, 2017 (prior to the beginning of ozone season in the attainment year) to be considered RACM. Furthermore, a control measure would have to be in place by March 1, 2016 in order for the measure to advance the attainment date by one year; to July 20, 2017; and it is not possible for the TCEQ to reasonably implement any control measures that would provide for earlier attainment of the NAAQS. Specifically, there is not adequate time to adopt additional rule requirements and have these rules go into effect or for sources to acquire, install, permit, and/or begin operation prior to this date. Negative RACM determinations for potential control measures that were based on technological or economic feasibility, enforceability, or adverse impacts remain relevant, regardless of attainment year.

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 summer weekday on-road mobile source emissions that have been modeled for the AD, and includes all of the on-road control measures reflected in Chapter 4: *Control Strategies and Required Elements* of the demonstration. The on-road emission inventory establishing this MVEB was developed with the 2014 version of the Motor Vehicle Emission Simulator (MOVES2014) model, and is shown in Table 4-2: *2017 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*.

Table 4-2: 2017 Attainment Demonstration MVEB for the 10-County DFW Area

10-County DFW Area On-Road Emissions Inventory Description	NO_X tons per day (tpd)	VOC (tpd)
2017 On-Road MVEB Based on MOVES2014	130.77	64.91

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 or Local Air Monitoring Stations network (SLAMS), Photochemical Assessment Monitoring Stations network, Chemical Speciation Network, National Air Toxics Trends Stations network, and National Core Multipollutant Monitoring Stations 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. 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 TCEQ's 2015 plan presented the current Texas network, as well as proposed changes to the network from July 1, 2014, through December 31, 2016. The plan was posted for public comment from May 22, 2015, through June 22, 2015, and was submitted to the EPA on July 1, 2015.

The current DFW area monitoring network in 2015 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. The 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. The TCEQ utilizes this data to support determinations regarding air quality in the DFW nonattainment area.

4.9 CONTINGENCY PLAN (NO CHANGE)

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) nonattainment area is making towards attainment of the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS) of 75 parts per billion (ppb). This corroborative information supplements the photochemical modeling analysis presented in Chapter 3: *Photochemical Modeling* to support a conclusion that the DFW nonattainment area will reach attainment of the 2008 eight-hour ozone standard by July 20, 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 (AD) 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 AD.

This chapter describes analyses that corroborate the conclusions of Chapter 3. First, information regarding trends in ambient concentrations of ozone, ozone precursors, and reported emissions in the DFW nonattainment area is presented. Analyses of ambient data and reported emissions trends corroborate the modeling analyses and independently support the AD. An overview is provided of background ozone levels transported into the DFW nonattainment 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 AD. 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 AD modeling discussed in Chapter 3. 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 nonattainment area.

5.2 ANALYSIS OF AMBIENT TRENDS AND EMISSION TRENDS

When development work on this DFW AD state implementation plan (SIP) revision commenced in 2012, 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* (http://www3.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf) (EPA, 2007) was the latest modeling guidance available. The EPA released an update to this guidance in December 2014 entitled *Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze* (http://www3.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf) (EPA, 2014). The April 2007 document will be referred to as either the "2007 guidance" or "2007 modeling guidance," and the December 2014 one will be referred to as the "draft guidance" or "draft modeling guidance." Section 7.0: *How Can Additional Analyses Be Used to Support the Attainment Demonstration?* of the 2007 guidance 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-GC) for volatile organic compounds (VOC). More detail on these specific locations and pollutants measured per monitor can be found on the Texas Commission on Environmental Quality (TCEQ) Air Monitoring Sites

Web page. (https://www.tceq.texas.gov/airquality/monops/sites/mon_sites.html). 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 nonattainment area, a strong economic development pattern, and growth in vehicle miles traveled (VMT), the observed emission trends are downward for ozone and its precursors of NO_X and 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 2014. 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 18 years. The DFW area has monitored attainment of the revoked one-hour ozone standard since 2006. At the end of the 2014 ozone season, the eight-hour design value was 81 ppb, which is in attainment of the 1997 eight-hour ozone standard of 84 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. These 2014 fourth high values of 77 ppb and 79 ppb were measured at the Denton Airport South and Fort Worth Northwest monitors, respectively. As of September 2015, the Denton Airport South monitor has a design value of 83 ppb.

An analysis conducted by the TCEQ (https://www.tceq.texas.gov/assets/public/implementation/air/am/committees/pmt_dfw/20131105/20131105-DFW-Ozone-75ppb-Kite.pdf) 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 nonattainment area design value calculations from 2011 through 2013, but are not part of the 2014 and 2015 design value determinations. The ozone measurements through 2015 combined with the overall historic ozone trends at all DFW area monitors suggest that the region will reach attainment of the 2008 standard by July 20, 2018.

As documented in Chapter 2: *Anthropogenic Emissions Inventory Description* of this DFW AD 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 nonattainment area, VOC trends are examined as well. On-road mobile sources are the single largest contributors to NO_X emissions in the DFW nonattainment area. According to the TCEQ emissions inventory (EI) estimates for 2011, on-road mobile represents 54% of the total NO_X for the DFW nonattainment 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. Even though human population and VMT in the DFW nonattainment area have both increased roughly 38% from 1999 to 2014, 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 and Voluntary Measures Applicable to the DFW Nine-County Nonattainment Area* of this DFW AD 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 nonattainment 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 nonattainment 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 nonattainment 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 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 nonattainment area also contribute to the eight-hour ozone concentrations within the 10-county DFW nonattainment area. On average, the ozone produced outside of the DFW nonattainment area, in addition to the natural background ozone, accounts for a large portion of the maximum ozone concentrations within the DFW nonattainment 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 nonattainment area. The EPA Air Quality Trends Web page (http://www.epa.gov/airtrends/aqtrends.html) highlights the significant percent changes in NO_X reductions between 2000 and 2013. 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 nonattainment 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 nonattainment 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 nonattainment area is transitional and trending towards NO_X-limitation, while the more rural parts of the DFW nonattainment area are NO_X-limited and are trending towards more strongly NO_X-limited. Because the DFW nonattainment 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 nonattainment 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 since 1999 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 nonattainment 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 (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 nonattainment 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 and maintenance, Texas Emission Reduction Plan (TERP), and Texas Low Emission Diesel. In addition, controls on point sources both in the DFW nonattainment area and statewide continue to contribute 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 modeled attainment year of 2017 and beyond.
- The one-hour ozone design value has decreased from 140 ppb when the 1990 Clean Air Act Amendments were signed to 102 ppb in 2014. The eight-hour ozone design value decreased from 100 ppb in 2003 to 83 ppb as of September 2015.
- Given the currently implemented control programs, total DFW nonattainment area NO_X in 2017 is expected to be reduced by roughly 49% from 2006 levels, with projected NO_X reductions of 54% for both on-road sources and non-road sources. More detail is contained in Chapter 3 on these expected reductions from 2006 through 2017.

Accordingly, the strong and lasting historic downward trends in observed air quality and in emissions (past and projected) are consistent with progress toward attainment and are positive evidence supporting the results of the photochemical modeling documented in Chapter 3, indicating that the DFW nonattainment area will attain the 2008 ozone NAAQS by July 20, 2018.

5.2.1 Ozone Design Value and Background Ozone Trends

As noted above, eight-hour ozone design values have decreased over the past 18 years, as shown in Figure 5-1: *One-Hour and Eight-Hour Ozone Design Values in the DFW Area from 1997 through 2014*. The 2014 one-hour ozone design value is 102 ppb, which demonstrates continued attainment of the revoked one-hour ozone NAAQS, at levels substantially below the one-hour ozone standard. The 2014 eight-hour ozone design value for the DFW nonattainment area was 81 ppb and occurred at Denton Airport South, which is in attainment of the former 84 ppb standard and demonstrates progress toward the current 75 ppb standard. This monitor is located to the north-northwest of the DFW nonattainment area, which is downwind of the urban core considering prevailing winds. As of September 2015, the Denton Airport South design value is 83 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 27% from 1991 through 2014 and the eight-hour ozone design values decreased about 23% 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.

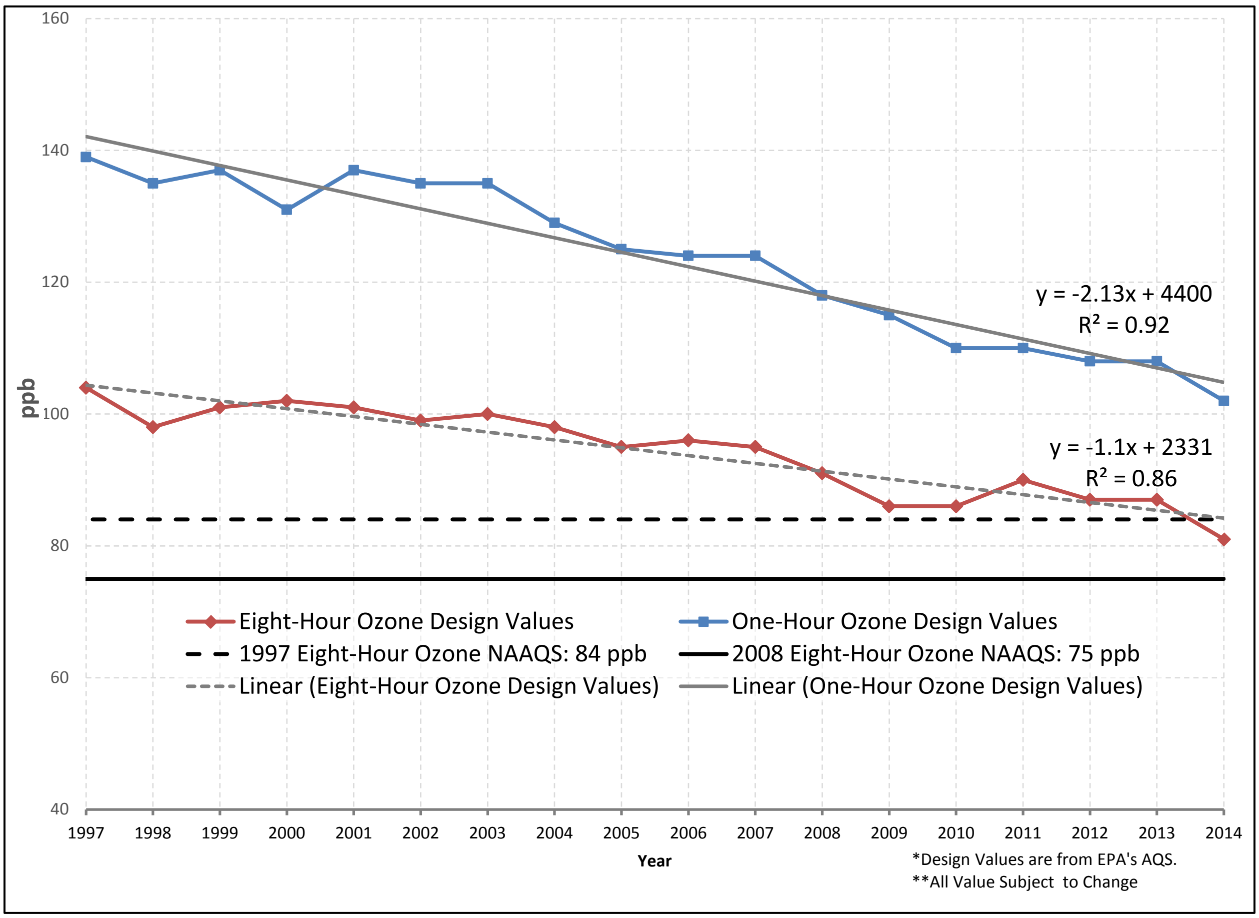


Figure 5-1: One-Hour and Eight-Hour Ozone Design Values in the DFW Area from 1997 through 2014

A background ozone trend analysis was conducted to define background ozone and the ozone concentration carried into the DFW nonattainment 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 nonattainment 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. Out of this subset of background ozone monitors, the minimum ozone concentration was identified during the time that the maximum ozone concentration was measured. This minimum eight-hour ozone concentration is considered the background ozone for the DFW nonattainment area. Figure 5-2: *Eight-Hour Ozone in the DFW area from 1997 through 2014* shows that in the DFW nonattainment 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. Because background ozone contributes a large portion of the total eight-hour ozone in the DFW nonattainment area, it would be difficult to see large decreases in the eight-hour ozone concentration if the background ozone does not also decrease.

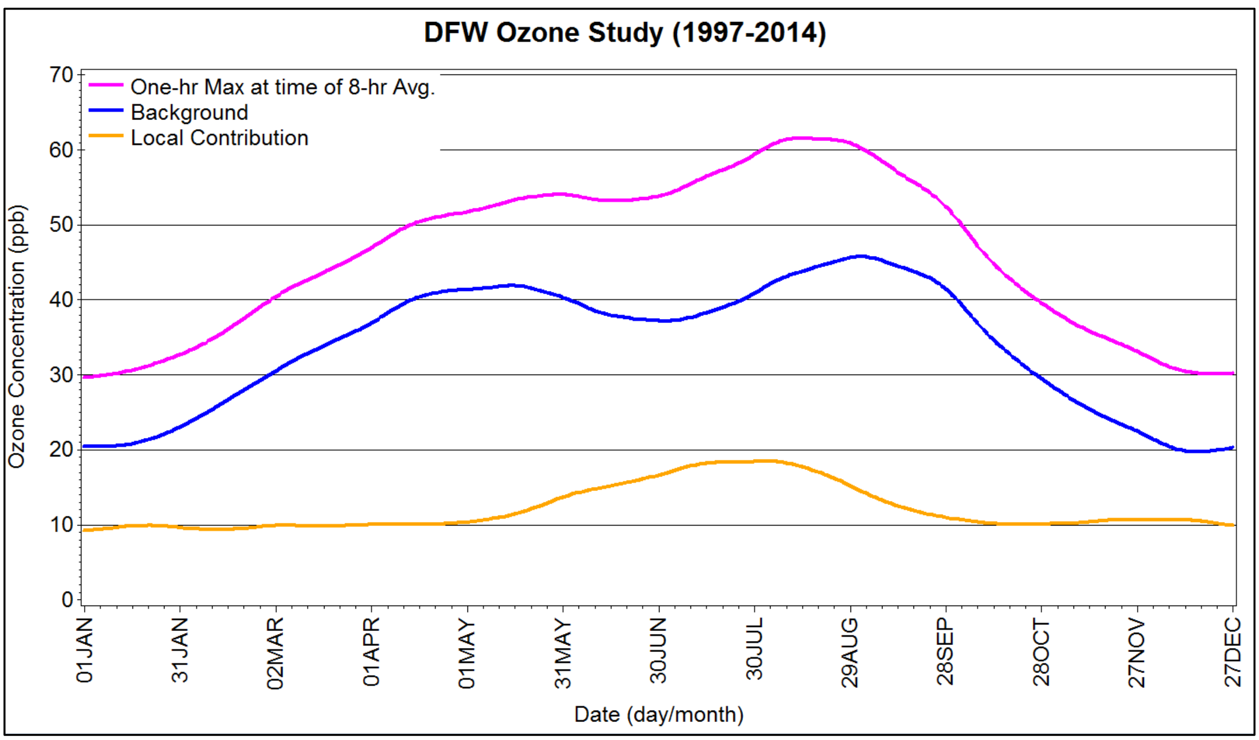


Figure 5-2: Eight-Hour Ozone in the DFW Area from 1997 through 2014

Using a similar method, the TCEQ conducted an analysis to determine the background trend in eight-hour ozone for the period from 1997 through 2014. Results from this analysis are shown in Figure 5-3: *DFW Background Ozone for 1997 through 2014*. The findings show that there is a slight downward trend in the background ozone. The percent change in average background ozone from the 1997 to 2014 ozone seasons 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 nonattainment area is 52 ppb, but can vary greatly depending on the day of interest. Evidence of background eight-hour ozone in the DFW nonattainment area is another positive factor indicating support for the photochemical modeling results documented in Chapter 3.

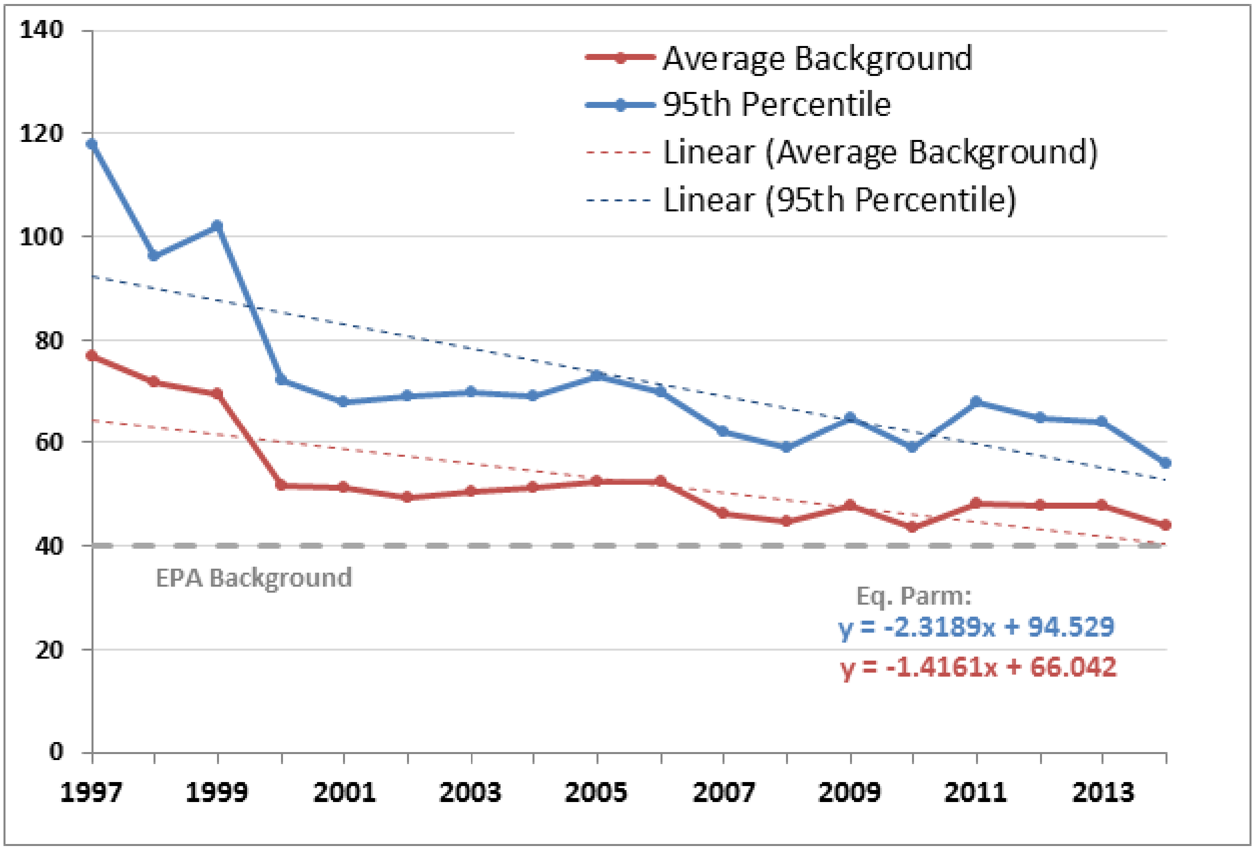


Figure 5-3: DFW Background Ozone for 1997 through 2014

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 nonattainment area. This section will discuss trends in both NO_X emissions and ambient NO_X concentrations. The overall downward trends in both NO_X emissions and ambient NO_X concentrations in the DFW nonattainment area are another positive factor indicating support for the photochemical modeling results documented in Chapter 3.

5.2.2.1 NO_X Emission Trends

DFW nonattainment 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 nonattainment area report annual point source 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 2017 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 nonattainment area monitors, which will be shown later in this document.

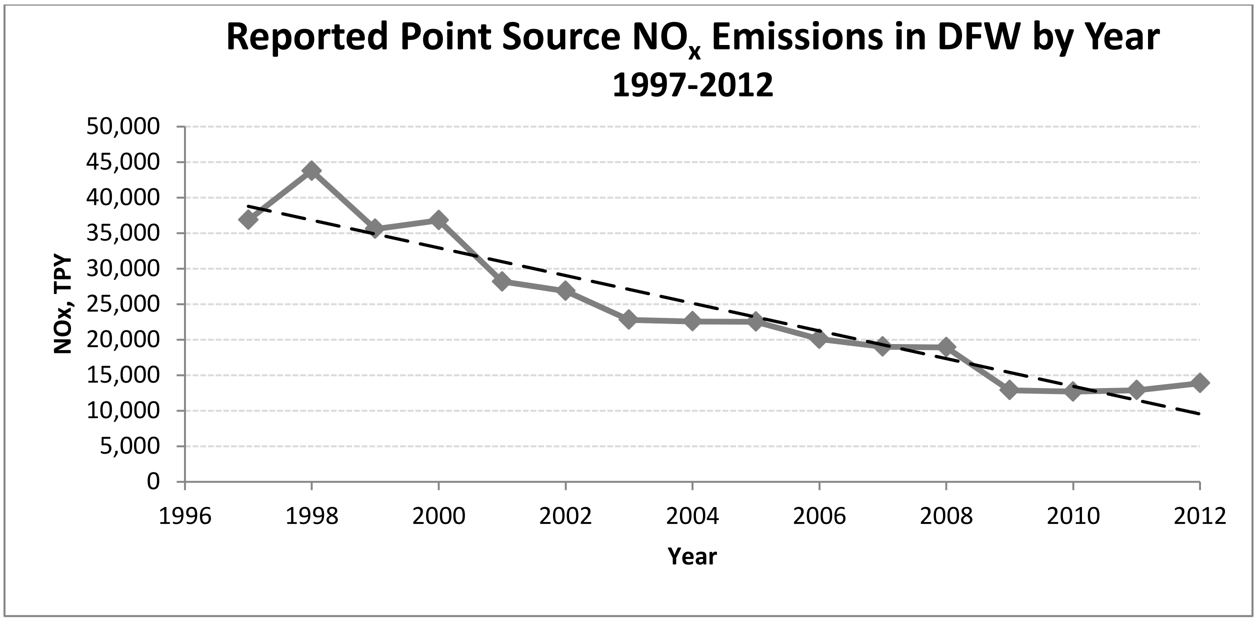


Figure 5-4: Reported Point Source NO_X Emissions for the 10-County DFW Area

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. 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 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.

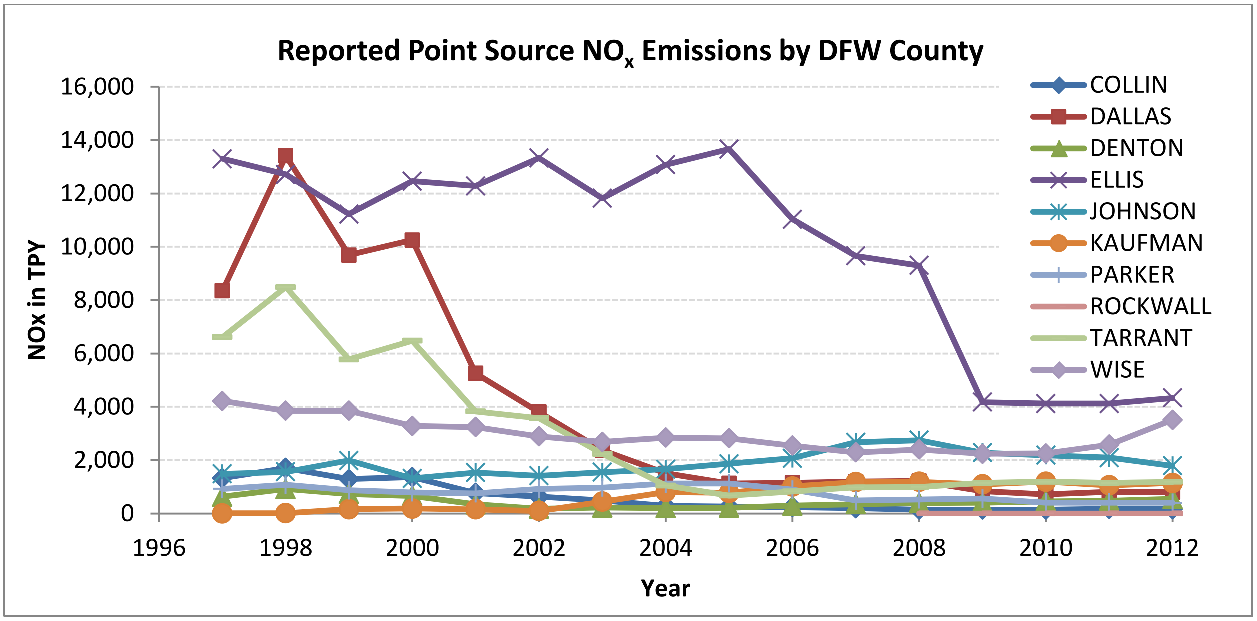


Figure 5-5: Reported Point Source NO_X Emissions by DFW County

Other point sources of NO_X are EGUs located within and outside of the DFW nonattainment 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 nonattainment area have decreased by 88.9% from 1997 through 2012.

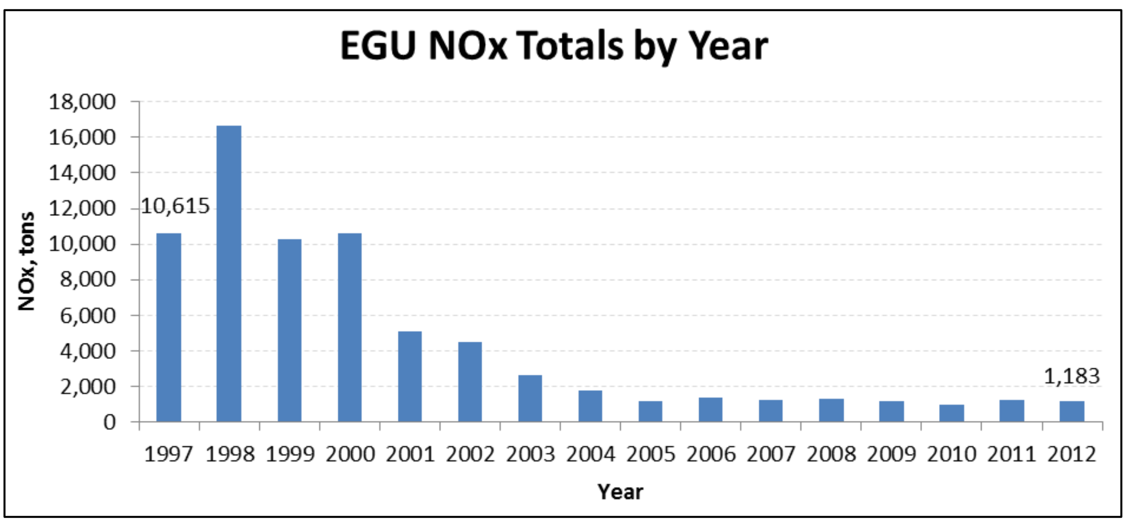


Figure 5-6: Trends in EGU NO_X Emissions in the DFW 10-County Area

On-road mobile sources are the biggest contributor to NO_X emissions in the DFW nonattainment area. With on-road mobile NO_X sources accounting for over half of the total NO_X emissions in the DFW nonattainment 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, and VMT from 1999 through 2050 using the 2014 version of the EPA's Motor Vehicle

Emission Simulator (MOVES2014) model. Figure 5-7: *MOVES2014 10-County DFW Area On-Road Emission Trends for 1999 through 2050* shows the results of this work from TTI. The estimates show that NO_X emissions have and will continue to decrease through to year 2037, though at different rates over time. These emission decreases occur even though VMT is projected to increase out to 2050 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.

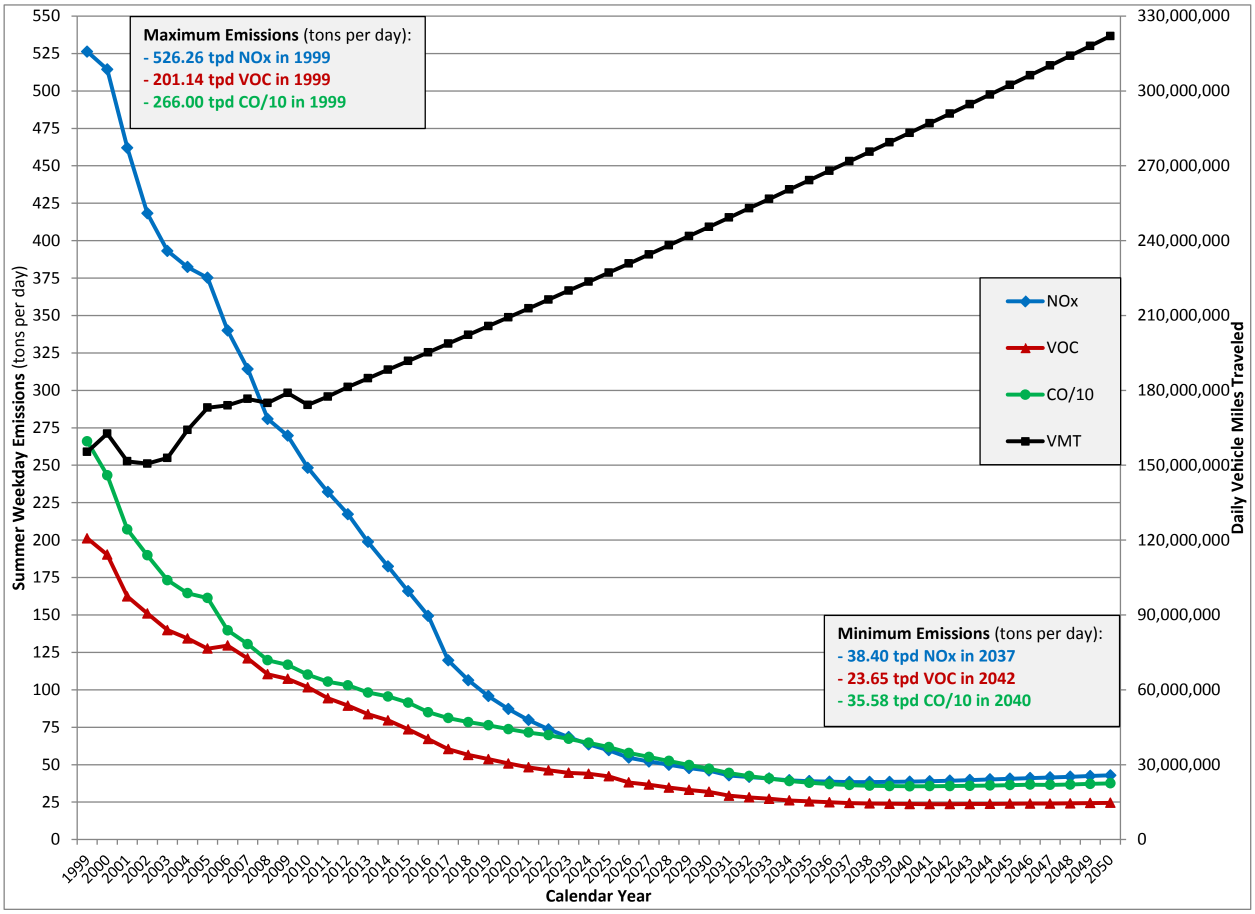


Figure 5-7: MOVES2014 10-County DFW Area On-Road Emission Trends for 1999 through 2050

Similar to on-road, the non-road source category contributes a significant amount to total NO_X emissions in the DFW nonattainment 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 nonattainment 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.

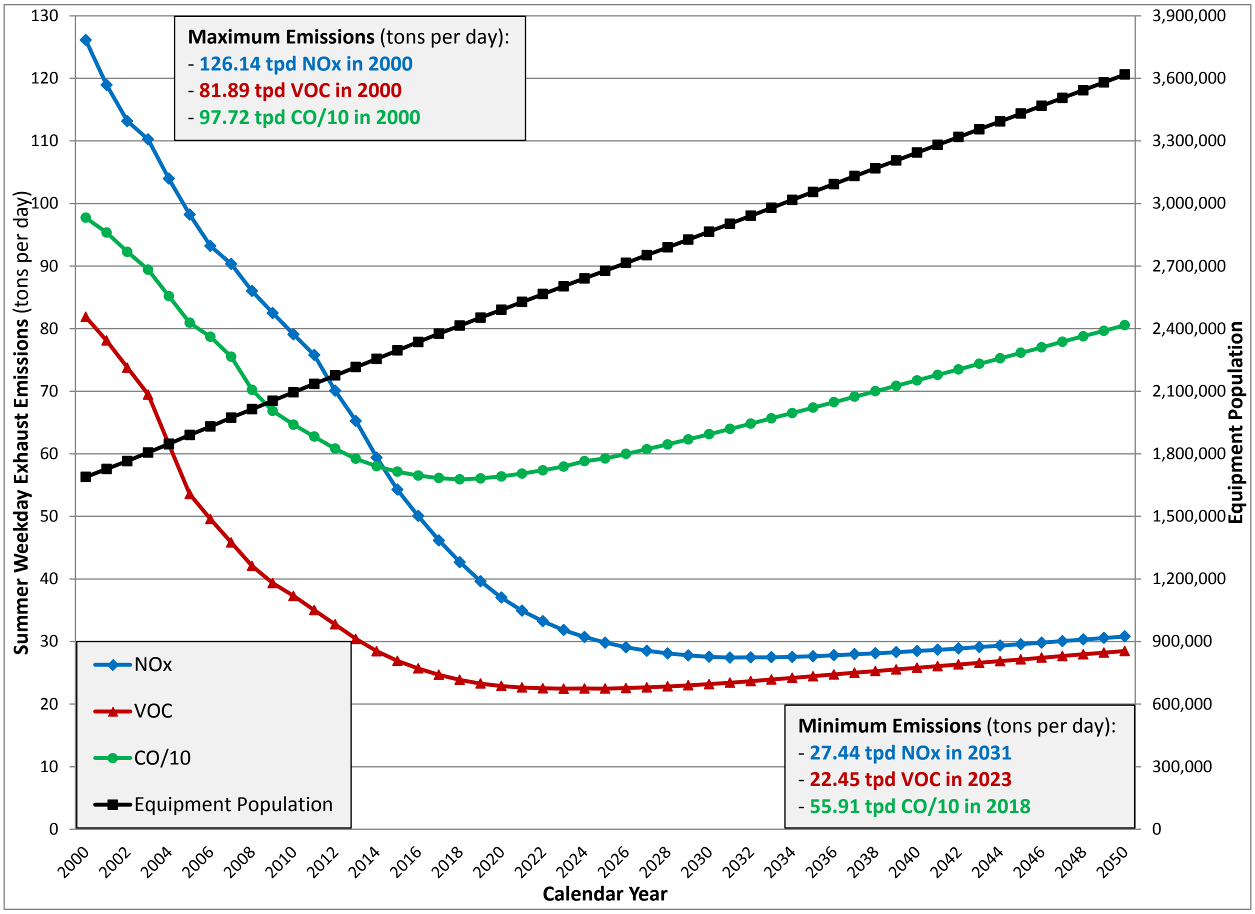


Figure 5-8: TexN DFW Area Non-Road Emission Trends for 2000 through 2050

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 nonattainment area. The largest NO_X concentrations and the median NO_X concentrations in the DFW nonattainment 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.

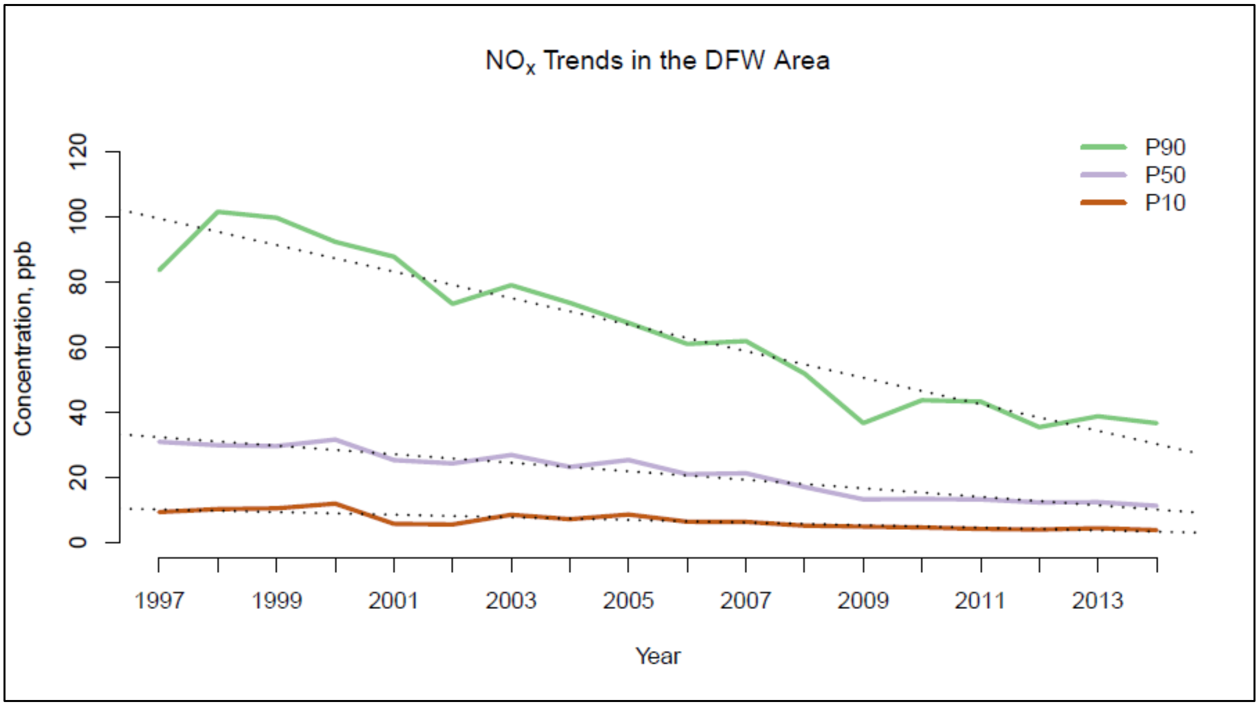


Figure 5-9: Ozone Season (March through October) Daily Peak NO_X Trends in the DFW Area

The NO_X trends in the DFW nonattainment 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.

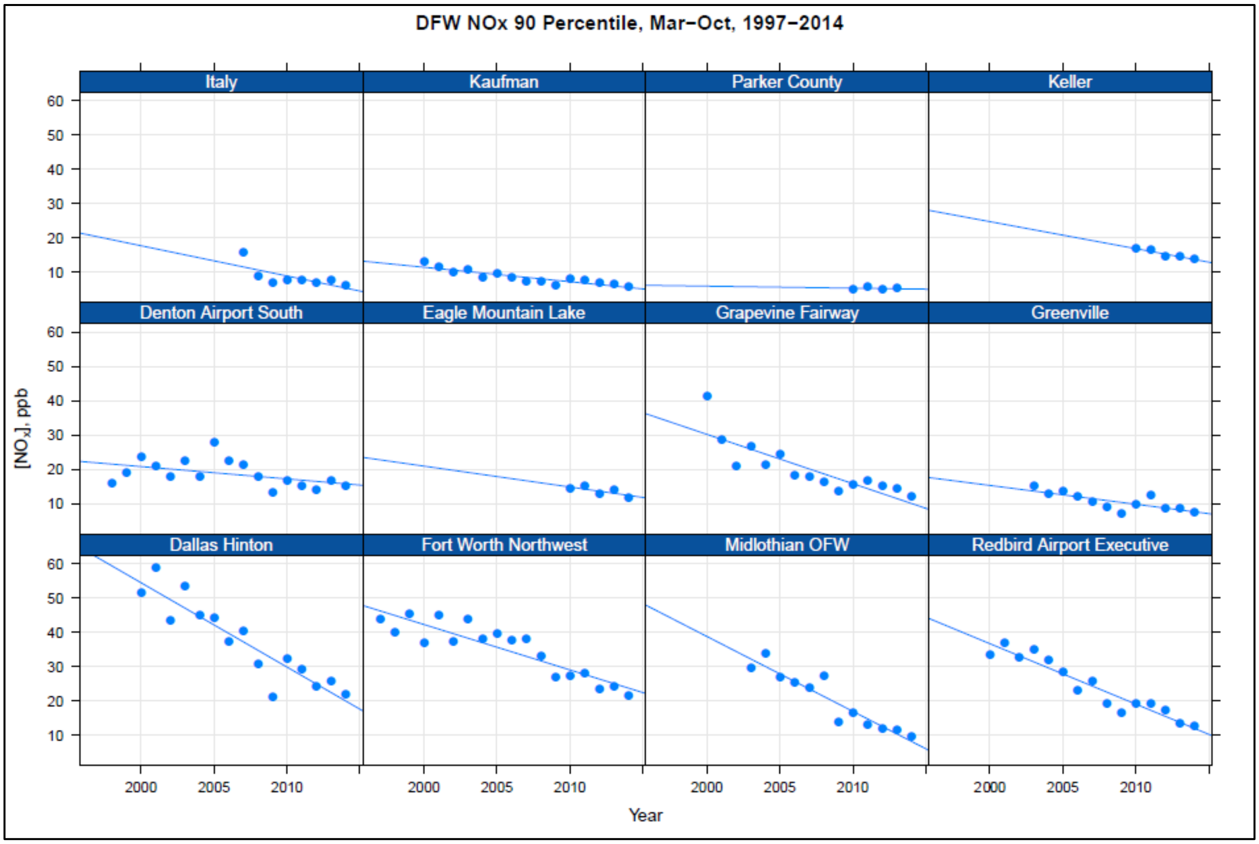


Figure 5-10: 90th Percentile Daily Peak NO_X Concentrations in the DFW Area

Ambient NO_X concentrations in the overall DFW nonattainment 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 nonattainment 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 nonattainment 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 nonattainment 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 nonattainment area.

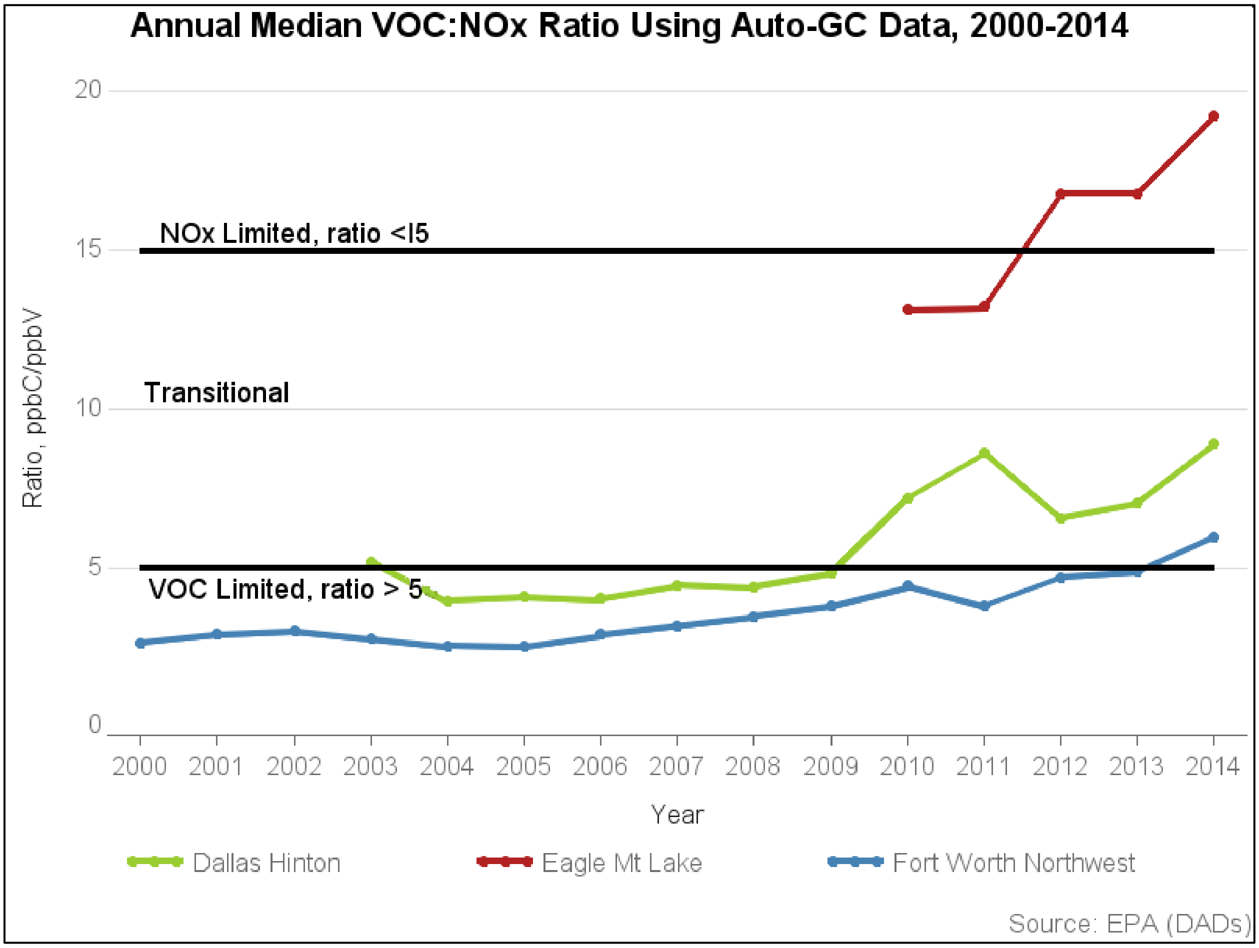


Figure 5-11: Trend in VOC to NO_X Ratios Using AutoGC Data

This evidence of continued NO_X-limitation in the DFW nonattainment area is another positive factor indicating support for the photochemical modeling results which also indicate the NO_X-limited nature of the DFW nonattainment area, as documented in Chapter 3.

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 nonattainment area, NO_X concentrations were calculated by the day of the week from 1997 through 2014. 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.

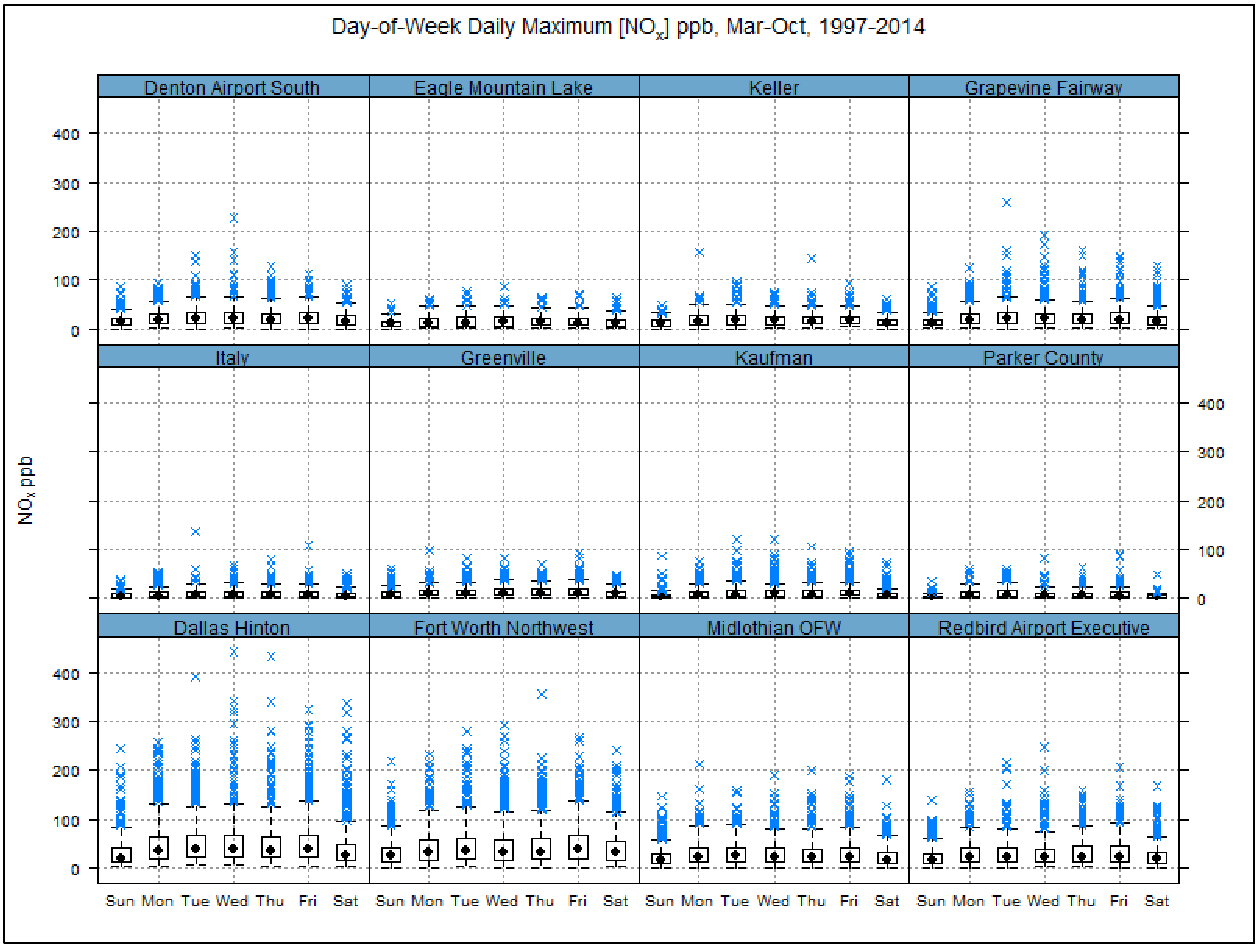


Figure 5-12: Day of Week NO_X Concentrations

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 nonattainment area begins to experience higher ozone as well as higher NO_X emissions. This result corroborates the hypothesis that local NO_X reductions will lead to lower ozone concentrations, and this weekday/weekend analysis using monitoring data corroborates the weekday/weekend modeling analysis summarized in Chapter 3.

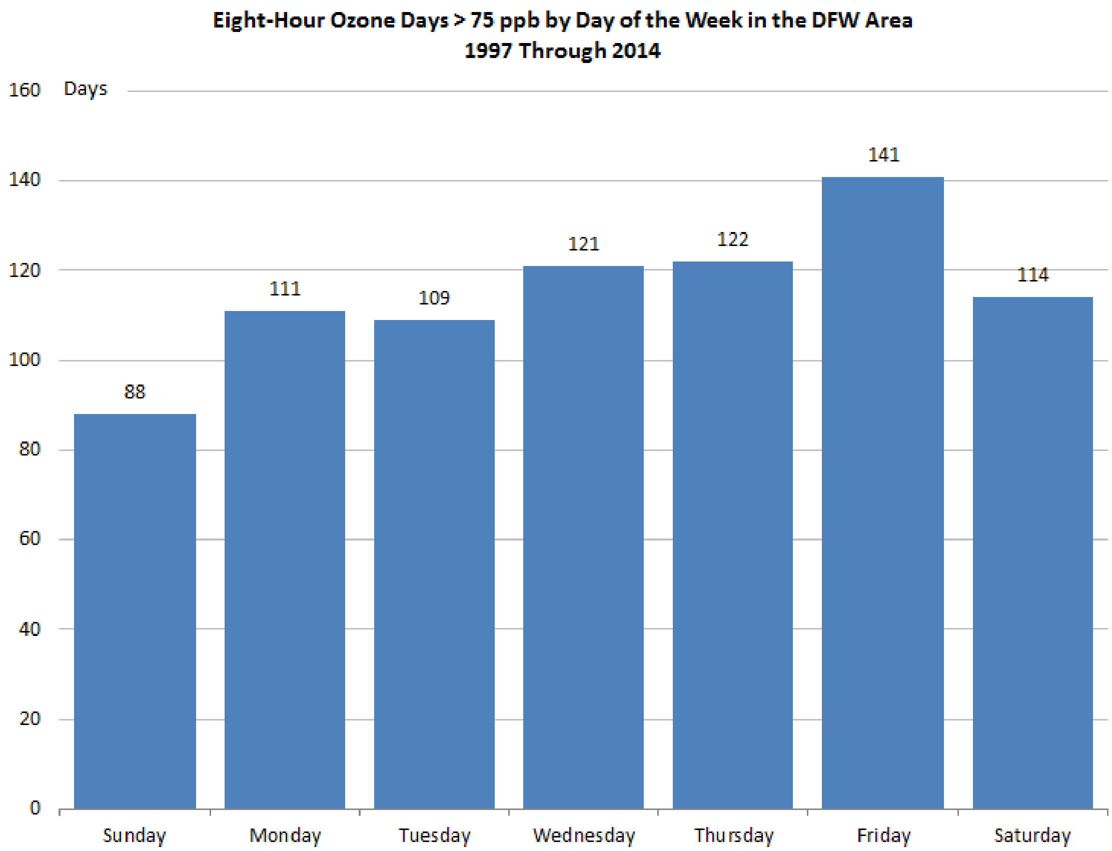


Figure 5-13: Weekday/Weekend Effect for Ozone in the DFW Area

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 nonattainment area: AutoGCs, which record hourly data, and canisters, which collect 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 collected using the seven canisters in the DFW nonattainment area are presented in Figure 5-14: *Annual Geometric Mean TNMOC Concentrations*. The chart shows that annual geometric mean TNMOC concentrations in the DFW nonattainment area are declining, although there appear to be fewer decreases occurring after 2006. Due to the NO_X-limited nature of the DFW nonattainment area, controlling TNMOC is not as effective at controlling NO_X to reduce ozone concentrations. Since the rate of decline in TNMOC concentrations since 2006 is much less pronounced than that for NO_X, we would expect TNMOC controls to have a much smaller effect for reducing ozone. This information also supports the photochemical modeling results documented in Chapter 3.

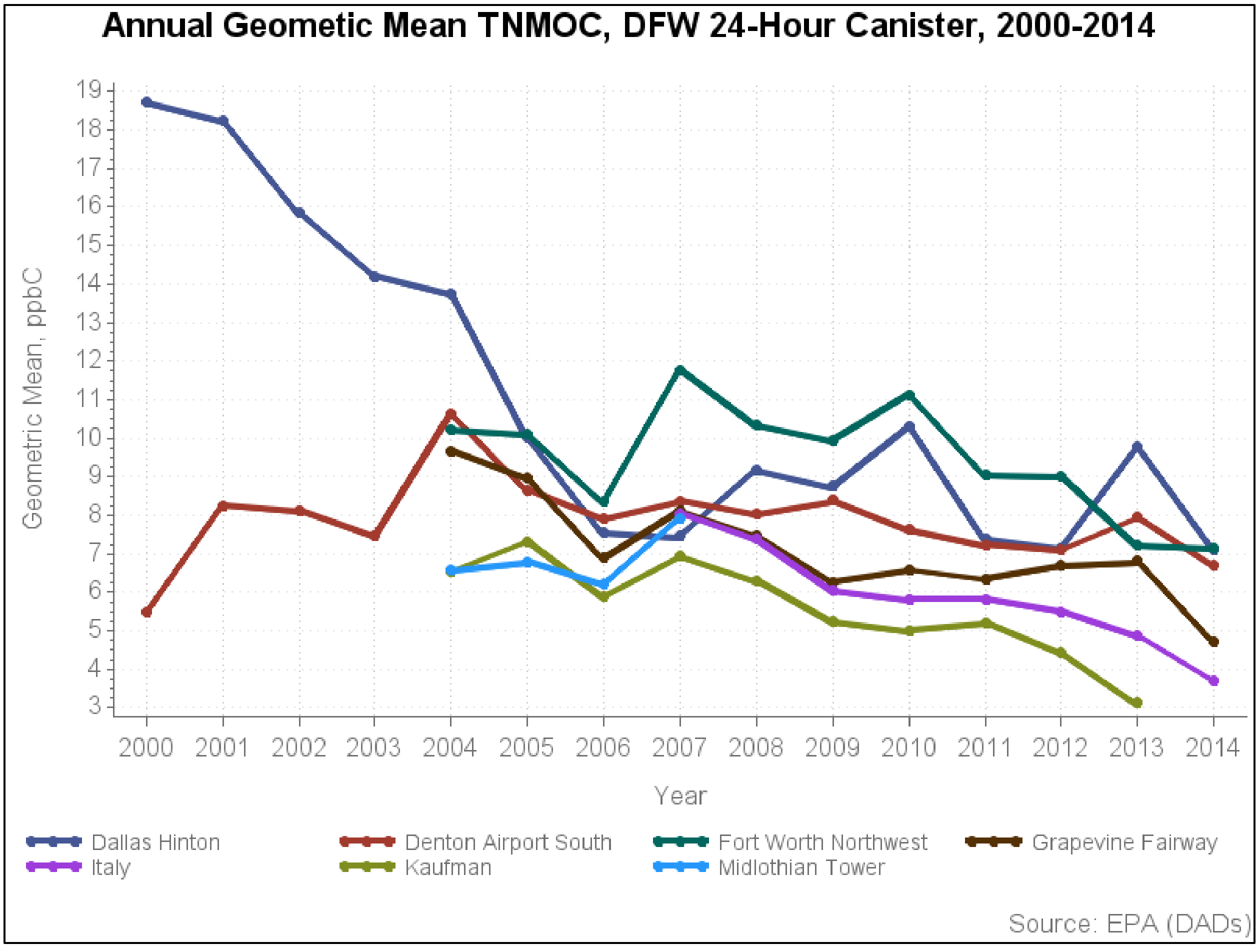


Figure 5-14: Annual Geometric Mean TNMOC Concentrations

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 nonattainment area and ozone ADs in general. These studies are an important component of the Weight of Evidence (WoE) analyses in that in several cases they corroborate 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 Cavender for NO_X and VOC matched those calculated by the TCEQ.

Another study by Tang et al. (2013) relating to emissions inventories used two advanced numerical techniques to estimate a top-down NO_X EI 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 NO_2 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 2017 SIP modeling performed for DFW.

A fourth study related to emissions evaluated by the 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 the 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 the 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 the TCEQ for the June 2006 ozone episode that was included with the DFW AD 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 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.

Overall, the studies evaluated by the TCEQ are supportive of the use of photochemical modeling as a predictive tool in determining attainment.

5.4 QUALITATIVE CORROBORATIVE ANALYSIS

This section outlines additional measures, not included in the photochemical modeling, that are expected to further reduce ozone levels in the DFW nonattainment area. Various federal, state, and local control measures exist that are anticipated to provide real emissions reductions; however, these measures are not included in the photochemical model because they may not meet all of the EPA's criteria for modeled reductions. While the modeling analysis described in Chapter 3 shows an estimated future ozone design value of 76 or 77 ppb, emissions reductions from these measures, in addition to those from the measures included in the photochemical model, support the conclusion that the DFW area will attain the 2008 ozone NAAQS by the end of 2017.

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 EE 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.

Texas leads the nation in RE generation from wind. As of December 2014, Texas has 14,098 megawatts (MW) of installed wind generation capacity[3]; more than double that of California, the state with the next highest amount of installed wind generation capacity. Texas' total net electrical generation from renewable wind generators for 2014 is estimated to be approximately 39 million megawatt-hours (MWh)[4], approximately 22% of the total wind net electrical generation for the U.S.

While EE/RE measures are beneficial and do result in lower overall emissions from fossil fuel-fired power plants in Texas, emission reductions resulting from these programs are not explicitly included in photochemical modeling for SIP purposes 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 users in a nonattainment area may not necessarily be generated solely within that nonattainment area. For example, some of the electricity used within a nonattainment area in East Texas could be generated by a power plant in a nearby attainment county or even in West Texas. If electrical demand is reduced in a nonattainment area due to local efficiency measures, the resulting emission reductions from power generation facilities may occur in any number of locations around the state. Similarly, increased RE generation may not necessarily replace electrical generation from local fossil fuel-fired power plants within a particular nonattainment area.

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

---

[3] U.S. Department of Energy, National Renewable Energy Laboratory, http://apps2.eere.energy.gov/wind/windexchange/wind_installed_capacity.asp

[4] U.S. Department of Energy, Energy Information Administration, Form EIA-923 data, http://www.eia.gov/electricity/data/eia923/

- 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

84th Texas Legislature, 2015

- SB 1626
- HB 1736

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 (ESL), 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 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 that require: 5,880 MW 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 (PUCT) to establish a target of 10,000 (MW) of installed renewable technologies by 2025. Wind power producers in Texas exceeded the renewable energy generation target by installing over 10,000 (MW) of wind electric generating capacity by 2010.

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.

HB 362, 82nd Texas Legislature, 2011, Regular Session, helps property owners install solar energy devices such as electric generating solar panels by establishing requirements for property owners associations' approval of installation of solar energy devices. HB 362 specifies the conditions that property owners associations may and may not deny approval of installing solar energy devices.

SB 1626, 84th Texas Legislature, 2015, modifies the provisions established by HB 362 from the 82nd Texas Legislature, 2011, Regular Session, regarding property owners associations' authority to approve and deny installations of solar energy devices such as electric generating solar panels. HB 362 included an exception that allowed developers to prohibit installation of solar energy devices during the development period. SB 1626 limits the exception during the development period to developments with 50 or fewer units.

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.

HB 1736, 84th Texas Legislature, 2015, update THSC §388.003 to adopt, effective September 1, 2016, the energy efficiency chapter of the International Residential Code as it existed on May 1, 2015. HB 1736 also established a schedule by which SECO could adopt updated editions of the International Residential Code in the future, not more often than once every six years.

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 Energy Systems Laboratory 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 MWh 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 (No change)

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 EGU emissions that transport from one state to another. The rule incorporated 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 was required to 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 consisted of two phases for implementing necessary NO_X and SO_2 reductions. Phase I addressed required reductions from 2009 through 2014. Phase II was intended to address 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 Texas Administrative Code 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 CSAPR to meet Federal Clean Air Act (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 $PM_{2.5}$ 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. CSAPR required an approximate 7% reduction in annual 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 CSAPR. Under the D.C. Circuit Court's ruling, CAIR remained in place until the EPA developed 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 on November 21, 2014, the EPA issued rulemaking, which shifted the effective dates of the CSAPR requirements to account for the time that had passed after the rule was stayed in 2011. Phase 1 of CSAPR took effect January 1, 2015 and Phase 2 is scheduled to begin January 1, 2017. On July 28, 2015, the D.C. Circuit Court ruled that the 2014 annual SO_2 budgets and the 2014 ozone season NO_X budgets for Texas were invalid because they required overcontrol of Texas emissions, and remanded these budgets back to the EPA without vacatur. Therefore, while the current CSAPR budgets for Texas are still in effect, the budgets may be subject to change in the future after the EPA's reconsideration or changes resulting from further appeals.

On January 22, 2015, the EPA issued a memorandum to provide information on how it intends to implement FCAA interstate transport requirements for the 2008 ozone NAAQS. The EPA provided preliminary modeling results for 2018, which show contribution to nonattainment of the 2008 ozone NAAQS in the DFW area from sources outside of Texas. On July 23, 2015, the EPA issued a notice of data availability regarding updated ozone transport modeling results for a 2017 attainment year. The EPA intends to use the data to address transport under the 2008 ozone standard in a proposed federal implementation plan (FIP) anticipated in December 2015.

As discussed in Section 3.5.4, *2017 Future Case Emissions*, the TCEQ used CSAPR as the basis for allocating EGU emission caps in the 2017 future year. Section 3.7.4.1, *CAIR Phase II Sensitivity*, presents the results of a sensitivity analysis where the CSAPR caps were replaced with those that would apply under Phase II of the CAIR program.

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.

From 2001 through August 2015, $968 million in DERI grants were awarded for projects projected to help reduce 168,289 tons of NO_X. Over $327 million in DERI grants were awarded to projects in the DFW area, with a projected 58,062 tons of NO_X reduced. These projects are estimated to reduce up to 18.7 tons per day of NO_X in the DFW area in 2015. The emissions reduction estimates will change yearly as older projects reach the end of the project life and new projects begin achieving emissions reductions.

Also, of the $327 million awarded in the DFW area, $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, as discussed below.

The Drayage Truck Incentive Program 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. Nine projects to replace 36 vehicles were awarded grants in FY 2015 totaling $3.95 million. One of these projects was in the DFW area and totaled $501,524. The project will result in a reduction of approximately 25 tons of NO_X, representing 0.02 tons per day of NO_x reduced starting in 2017.

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. From 2009 through August 2015, over $31.4 million in TCFP grants were awarded for projects to help reduce over 400 tons of NO_X. Over $9.1 million in TCFP grants were awarded to projects in the DFW area, with a projected 181.6 tons of NO_X reduced. The projects are projected to reduce up to 0.07 tons per day of NO_X in the DFW area starting in 2015.

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. From 2011 through August 2015 over $46.3 million in TNGVGP grants were awarded for projects to help reduce a projected 1,646 tons of NO_X. Over $18.5 million in TNGVGP grants were awarded to projects in the DFW area, with a projected 769 tons of NO_X reduced. These projects are estimated to reduce up to 0.4 tons per day of NO_X in the DFW area starting in 2015.

HB 1, General Appropriations Bill, 84th Texas Legislature, 2015, appropriated $118.1 million per year for implementation of the TERP in FYs 2016 and 2017. This represents an increase of $40.5 million per year over the appropriation amount in FYs 2014 and 2015. The additional funding will result in more grant projects that result in NO_X reductions in the eligible TERP areas, including the DFW area.

5.4.1.5 Low-Income Vehicle Repair Assistance, Retrofit, and Accelerated Vehicle Retirement Program (LIRAP)

The TCEQ established a financial assistance program for qualified owners of vehicles that fail the emissions test. The purpose of this voluntary program is to repair or remove older, higher emitting vehicles from use in certain counties with high ozone. The LIRAP provisions of House Bill (HB) 2134, 77th Texas Legislature 2001, created the program. In 2005, HB 1611, 79th Texas Legislature, modified the program to apply only to counties that implement a vehicle inspection and maintenance program and have elected to implement LIRAP fee provisions. The counties currently participating in the LIRAP are Brazoria, Fort Bend, Galveston, Harris, Montgomery, Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, Travis, and Williamson Counties.

SB 12, 80th Texas Legislature 2007, expanded the LIRAP participation criteria 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. HB 3272, 82nd Texas Legislature 2011, Regular Session, expanded the class of vehicles eligible for a $3,500 voucher to include hybrid, electric, natural gas, and federal Tier 2, Bin 3 or cleaner Bin certification vehicles. The program provides $3,500 for a replacement hybrid, electric, natural gas, and federal Tier 2, Bin 3 or cleaner Bin certification vehicle of the current model year or the previous three model years; $3,000 for cars of the current or three model years; and $3,000 for trucks of the current or previous two model years. The retired vehicle must be 10 years old or older or must have failed an emissions test. From December 12, 2007 through August 31, 2015, the program has retired and replaced 54,829 vehicles at a cost of $164,678,312.80. During the same period, an additional 38,205 vehicles have had emissions-related repairs at a cost of $20,246,296.85. The total retirement/replacement and repair expenditure from December 12, 2007 through August 31, 2015 is $184,924,609.65.

In the DFW nonattainment area, the LIRAP is currently available to vehicle owners in nine counties: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall and Tarrant. Between December 12, 2007 and August 31, 2015, the program has repaired 16,970 vehicles and retired and replaced 28,805 vehicles at a cost of $95,005,674.04. HB 1, General Appropriations Bill, 84th Texas Legislature 2015, appropriated $43.5 million per year for FY 2016 and FY 2017 to continue this clean air strategy in the 16 participating counties. Participating DFW area counties were allocated approximately $21.6 million per year for the LIRAP for FYs 2016 and 2017. This is an increase of approximately $18.8 million per year over the previous biennium.

5.4.1.6 Local Initiative Projects (LIP)

Funds are provided to counties participating in the LIRAP for implementation of air quality improvement strategies through local projects and initiatives. In the DFW area, LIP funding is available to the nine counties currently participating in the LIRAP: Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant. HB 1, General Appropriations Bill, 84th Texas Legislature 2015, appropriated $4.8 million per year for FY 2016 and FY 2017 to continue this clean air strategy. The nine DFW area counties were allocated approximately $2.4 million per year for FYs 2016 and 2017. This is an increase of approximately $2.1 million per year over the previous biennium.

Dallas County used LIP funds in 2008 to establish the Dallas County Clean Air Emissions Task Force. For its first seven years, the task force targeted high-emitting vehicles, smoking vehicles, and suspicious vehicles to verify that the state safety and emissions inspection windshield certificates on these vehicles were legitimate and in compliance with air quality standards. The task force's objective is to reduce the number of fraudulent, fictitious, or improperly issued safety and emissions inspection windshield certificates.

Following the success of Dallas County's emissions enforcement project, Denton (2009-2015), Ellis (2008-2014), Johnson (2010-2014), Kaufman (2012-2015), and Tarrant (2010-2015) Counties established similar task forces. Beginning in March 2015, the emission enforcement task forces adjusted their objectives to concentrate on the identification of vehicles with counterfeit registration insignia and the reduction of fraudulent vehicle inspection reports. These programs have partnered with local and state agencies to enforce state laws, codes, rules, and regulations regarding air quality and mobile emissions in the DFW area. The citizens of the entire north Texas region benefit from these programs as a result of the reduction in NO_X emissions from each vehicle brought into emissions compliance.

The City of Plano, through Interlocal Agreements with Collin County, used LIP funding in 2012 and 2014 for Local Initiative Projects. In 2012, LIP funding was used by the City of Plano to install auxiliary power units in Police Department vehicles to reduce vehicle emissions during the daily activities of traffic enforcement. This idle reduction technology powers equipment such as lights, radio, and computers so that law enforcement officers can shut-off their vehicles to perform traffic control, traffic accident investigations, lunch breaks, and other activities where the enforcement officer is outside their vehicle. In 2014, the City of Plano used LIP funding to install wireless communications technology at 20 intersections and additional pan/tilt cameras at 19 of those intersections. The project allows signal management from a traffic management center to reduce traffic congestion and idling in an effort to reduce emissions. The project reduces idling by improving traffic flow and decreasing the number of times vehicles must stop at traffic lights. The "Exhaust Phase" of an engine emits the most emissions during starting, idling, and breaking stationary inertia. The project increases the emissions reduction benefits by allowing real-time traffic management instead of a stagnate model to better manage peak-hour congestion, while minimizing cross-traffic congestion, and reducing emissions.

5.4.1.7 Local Initiatives

The NCTCOG submitted an assortment of locally implemented strategies in the DFW nonattainment 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 2017. 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.*

5.4.1.8 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 nonattainment 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 on the EPA's Natural Gas STAR Program Web page (http://www.epa.gov/gasstar/).

The TCEQ continues to attempt to quantify the extent and impacts of these voluntary measures through area source emissions inventory improvement projects, such as the projects detailed in Chapter 6: *Ongoing Initiatives*.

5.5 CONCLUSIONS

The TCEQ has used several sophisticated technical tools to evaluate the past and present causes of high ozone in the DFW nonattainment 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 nonattainment 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. The model can be used with confidence to project future ozone design values because the EPA's 2007 and draft guidance documents both recommend applying the relative response in modeled ozone to monitored design values. Under the all days attainment test from EPA's 2007 guidance, the photochemical grid modeling predicts that the 2017 future year ozone design value at four monitors located in the northwest portion of the DFW area will be above the 75 ppb standard: 77 ppb for Denton Airport South, Eagle Mountain Lake, and Grapevine Fairway monitors, and 76 ppb for the Keller monitor. The remaining 15 ozone monitors that were operational in 2006 have 2017 future design values ranging from 62-75 ppb. Use of the all days test results in the 2017 future design values for all DFW area monitors either below or within the 73-78 ppb WoE range inferred for the 75 ppb standard from the 82-87 ppb WoE range that is specified in the 2007 modeling guidance for the 84 ppb standard.

Application of the top 10 days attainment test recommended by the draft EPA modeling guidance from December 2014 projects a 76 ppb future design value at the Denton Airport South and Eagle Mountain Lake monitors, with the remaining 17 monitors ranging from 62-75 ppb. The draft guidance recommends the newer top 10 days test over the older all days test because "model response to decreasing emissions is generally most stable when the base ozone predictions are highest. The greater model response at higher concentrations is likely due to more 'controllable' ozone at higher concentrations." The TCEQ concurs with this assessment, and feels that the top 10 days test is a superior predictor of future ozone design values for this AD. The draft guidance no longer specifies a WoE range for future year design values, and instead requires "a fully-evaluated, high-quality modeling analysis that projects future values that are close to the NAAQS." With inclusion of the superior top 10 days test, this DFW AD SIP revision and all of its appendices document a fully-evaluated high-quality modeling analysis with future year design values that are close to or below the 75 ppb eight-hour ozone standard for all DFW area ozone monitors.

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 2017 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.

For the cement kiln and electric utility sources within DFW, 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 tons per day (tpd) in 2012, but the 2017 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 2017 future year is modeled at the CSAPR caps of 13.98 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.

Second, 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 September 2015, the Denton Airport South monitor has an eight-hour ozone design value of 83 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 nonattainment 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 nonattainment 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 decline through the 2017 modeled attainment year as lower amounts of NO_X are emitted from these sources. Based on the photochemical grid modeling results and these corroborative analyses, the WoE indicates that the DFW nonattainment area will attain the 2008 eight-hour ozone standard by July 20, 2018.

5.6 REFERENCES

Berlin, S.R., A.O. Langford, M. Estes, M. Dong, D.D. Parrish (2013), Magnitude, decadal changes, and impact of regional background ozone transported into the greater Houston, Texas area, Environ. Sci. Technol., 47(24): 13985-13992, doi: 10.1021/es4037644.

Cooper, O. R., R.-S. Gao, D. Tarasick, T. Leblanc, and C. Sweeney (2012), Long-term ozone trends at rural ozone monitoring sites across the United States, 1990–2010, J. Geophys. Res., 117, D22307, doi:10.1029/2012JD018261.

Huang, L., McDonald-Buller, E.C., McGaughey, G., Kimura, Y., Allen, D.T. (2014), Annual Variability in Leaf Area Index and Isoprene and Monoterpene Emissions during Drought Years in Texas, Atmospheric Environment (2014), doi: 10.1016/j.atmosenv.2014.04.016.

Kite, Chris, Preliminary Results of Ozone Modeling for the Dallas-Fort Worth (DFW) Area, DFW State Implementation Plan (SIP) Technical Information Meeting, November 5, 2013, http://www.tceq.texas.gov/assets/public/implementation/air/am/committees/pmt_dfw/20131105/20131105-DFW-Ozone-75ppb-Kite.pdf.

Lamsal, L. N., R. V. Martin, A. van Donkelaar, M. Steinbacher, E. A. Celarier, E. Bucsela, E. J. Dunlea, and J. P. Pinto (2008), Ground-level nitrogen dioxide concentrations inferred from the satellite-borne Ozone Monitoring Instrument, J. Geophys. Res., 113, D16308, doi:10.1029/2007JD009235.

Lefohn, A.S., C. Emery, D. Shadwick, H. Wernli, J. Jung, and S. Oltmans (2014), Estimates of background surface ozone concentrations in the United States based on model-derived source apportionment, Atmos. Environ., 84: 275-288, http://dx.doi.org/10.1016/j.atmosenv.2013.11.033.

Martin, R.V, C. E. Sioris, K. Chance, T. B. Ryerson, T. H. Bertram, P. J. Woodridge, R. C. Cohen, J. A. Neuman, A. Swanson, F. M. Flocke. 2006. Evaluation of space-based constraints on global nitrogen oxide emissions with regional aircraft measurements over and downwind of eastern North America, J. Geophys. Res., 111, D15308, doi:10.1029/2005JD006680.

Nielsen-Gammon, John W., James Tobin, and Andrew McNeel. “A Conceptual Model for Eight-Hour Ozone Exceedances in Houston, Texas. Part I: Background Ozone Levels in Eastern Texas.” Center for Atmospheric Chemistry and the Environment, Texas A&M University, 2004, p. 16-17.

Pacsi, A.P., N.S. Alhajeri, D. Zavela-Araiza, M.D. Webster, D.T. Allen, (2013), Regional air quality impacts of increased natural gas production and use in Texas, Environ. Sci. Technol., 47(7): 3521-3527, dx.doi.org/10.1021/es3044714.

Pegues et al. (2012), Efficacy of recent state implementation plans for 8-hour ozone, Journal of the Air & Waste Management Association, 62(2):252–261, DOI: 10.1080/10473289.2011.646049.

Sather, M.E., and K. Cavender (2012), Update of long-term trends analysis of ambient 8-hour ozone and precursor monitoring data in the South Central U.S.; encouraging news, J. Environ. Monit. 14: 666-676, doi: 10.1039/C2EM10862C.

Tang, W., D. Cohan, L. Lamsal, X. Xiao, and W. Zhou (2013), Inverse modeling of Texas NO_X emissions using space-based and ground-based NO_2 observations, Atmos. Chem. Phys., 13, 11005–11018, www.atmos-chem-phys.net/13/11005/2013/doi:10.5194/acp-13-11005-2013.

U.S. Environmental Protection Agency, Air Quality Trends, http://www.epa.gov/airtrends/aqtrends.html.

Texas Administrative Code. Title 30. Chapter 117. 2007.

CHAPTER 6: ONGOING INITIATIVES

6.1 INTRODUCTION (NO CHANGE)

6.2 ONGOING WORK

6.2.1 Oil and Gas Well Drilling Activities

There have been significant variations 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 Dallas-Fort Worth (DFW) ozone nonattainment area.

The Texas Commission on Environmental Quality (TCEQ) has contracted with Eastern Research Group, Inc. (ERG) to complete a study to develop 2014 periodic emissions inventory estimates as well as improve forecasted emissions for drilling rigs using Texas-specific data. The TCEQ has expedited finalizing this data and portions of it have been included in the area source oil and gas emissions inventory used in this state implementation plan (SIP) revision; see Chapter 3: *Photochemical Modeling,* Section 3.5.4.4: *Area Sources* for details. The TCEQ will evaluate using these data in other future attainment demonstration (AD) and reasonable further progress (RFP) SIP revisions as appropriate, as well as evaluate potential opportunities for follow-up research.

6.2.2 Upstream Oil and Condensate Storage Tanks and Loading Activities

The TCEQ has contracted with ERG to complete a study to evaluate the extent and types of controls on upstream oil and condensate storage tanks as well as loading activities. This study focused on shale formations producing hydrocarbon liquids in Texas, including the Barnett Shale. The results of this project will be used to improve upstream area source oil and gas volatile organic compounds (VOC) emissions estimates.

The TCEQ has expedited finalizing this data so that portions of it have been included in the area source oil and gas emissions inventory used in this SIP revision; see Chapter 3: *Photochemical Modeling,* Section 3.5.4.4: *Area Sources* for details. The TCEQ will evaluate using these data in other future AD and RFP SIP revisions as appropriate, as well as evaluate potential opportunities for follow-up research.

6.2.3 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 the DFW nonattainment area by expanding our understanding of biogenic emissions and the factors that drive them.

Appendices available upon request.

Kathy Singleton
SIP Project Manager
kathy.singleton@tceq.texas.gov
512.239.0703