TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
AGENDA ITEM REQUEST
for Proposed State Implementation Plan Revision

AGENDA REQUESTED: September 11, 2019

DATE OF REQUEST: August 23, 2019

INDIVIDUAL TO CONTACT REGARDING CHANGES TO THIS REQUEST, IF NEEDED: Jamie Zech, (512) 239-3935

CAPTION: **Docket No. 2019-0693-SIP.** Consideration for publication of, and hearing on, the proposed Dallas-Fort Worth Serious Classification Attainment Demonstration State Implementation Plan (SIP) Revision for the 2008 Eight-Hour Ozone National Ambient Air Quality Standard.

To meet Federal Clean Air Act requirements, the proposed SIP revision would include a photochemical modeling analysis, a weight of evidence analysis, a reasonably available control technology (RACT) analysis, a reasonably available control measures analysis, motor vehicle emissions budgets for 2020, and a contingency plan. This SIP revision would also incorporate proposed revisions to the 30 Texas Administrative Code Chapters 115 and 117 rules to address major source RACT requirements for nitrogen oxides and volatile organic compounds associated with reclassification from moderate to serious. (Kristin Jacobsen, Terry Salem) (Project No. 2019-078-SIP-NR)

Tonya Baer

Deputy Director

Donna F. Huff

Division Director

Jamie Zech

Agenda Coordinator

Copy to CCC Secretary? NO X YES

Texas Commission on Environmental Quality
Interoffice Memorandum

To: Commissioners **Date:** August 23, 2019

Thru: Bridget C. Bohac, Chief Clerk
Toby Baker, Executive Director

From: Tonya Baer, Deputy Director
Office of Air

Docket No.: 2019-0693-SIP

Subject: Commission Approval for Proposed Dallas-Fort Worth (DFW) Serious Classification Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 2008 Eight-Hour Ozone National Ambient Air Quality Standard (NAAQS)

DFW 2008 Eight-Hour Ozone Serious Classification AD SIP Revision
Rule Project No. 2019-078-SIP-NR

Background and reason(s) for the SIP revision:
The DFW area, consisting of Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties, was designated as moderate nonattainment for the 2008 eight-hour ozone NAAQS of 0.075 parts per million (ppm) with a July 20, 2018 attainment date. Based on 2017 monitoring data, the DFW area did not attain the 2008 eight-hour ozone NAAQS in 2017[1] and did not qualify for a one-year attainment date extension in accordance with Federal Clean Air Act (FCAA), §181(a)(5).[2] On November 14, 2018, the United States Environmental Protection Agency (EPA) proposed to reclassify the DFW area to serious nonattainment for the 2008 eight-hour ozone NAAQS (83 *Federal Register* (FR) 56781). On August 7, 2019, the EPA signed the final reclassification notice.

Since the DFW area has been reclassified by the EPA, the area is now subject to the serious nonattainment area requirements in FCAA, §182(c), and the TCEQ is required to submit serious classification AD and reasonable further progress (RFP) SIP revisions to the EPA. As indicated in the EPA's *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule) published in the *Federal Register* on March 6, 2015 (80 FR 12264), the attainment date for a serious classification is July 20, 2021 with a 2020 attainment year. The EPA set an August 3, 2020 deadline for states to submit AD and RFP SIP revisions to address the 2008 eight-hour ozone standard serious nonattainment area requirements.

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[1] The attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment date.
[2] An area that fails to attain the 2008 eight-hour ozone NAAQS by its attainment date would be eligible for the first one-year extension if, for the attainment year, the area's 4th highest daily maximum eight-hour average is at or below the level of the standard (75 parts per billion (ppb)); the DFW area's fourth highest daily maximum eight-hour average for 2017 was 77 ppb as measured at the Dallas North No. 2 monitor C63/C679). The DFW area's design value for 2017 was 79 ppb.

Scope of the SIP revision:
As a result of the reclassification, the commission is required to submit to the EPA an AD SIP revision consistent with FCAA requirements for areas classified as serious nonattainment for the 2008 eight-hour ozone NAAQS. The attainment date for the DFW serious ozone nonattainment area is July 20, 2021 with an attainment year of 2020. This memo applies to the attainment demonstration requirement under a serious ozone nonattainment classification. The details of the RFP SIP revision, also required for the area, are covered in a separate memo (Project No. 2019-079-SIP-NR).

A.) Summary of what the SIP revision will do:
The proposed DFW AD SIP revision would contain all FCAA-required AD SIP elements for an area with a serious nonattainment classification. This SIP revision would meet the requirements to demonstrate attainment of the 2008 eight-hour ozone NAAQS through photochemical modeling, and further supported by a corroborative weight of evidence (WoE) analysis. This DFW AD SIP revision would also include an analysis of reasonably available control measures (RACM), including reasonably available control technology (RACT), and contingency measures that would provide additional emissions reductions that could be implemented without further rulemaking if the area fails to attain the standard by the attainment date. To ensure that federal transportation funding conforms to the SIP, this DFW AD SIP revision would also contain motor vehicle emissions budgets (MVEBs) for 2020.

The proposed SIP revision would also incorporate proposed revisions to the 30 Texas Administrative Code Chapters 115 and 117 rules to address major source RACT requirements for nitrogen oxides (NO_X) and volatile organic compounds (VOC) associated with reclassification from moderate to serious.

B.) Scope required by federal regulations or state statutes:
This proposed DFW AD SIP revision would be consistent with the requirements of FCAA, §182(b)(1) and the EPA's final 2008 eight-hour ozone standard SIP requirements rule. The FCAA-required SIP elements include analyses for RACT and RACM, MVEBs, and a contingency plan. Consistent with the EPA's November 2018 modeling guidance,[3] this proposed DFW AD SIP revision would also include a modeled attainment demonstration and a WoE analysis.

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

[3] EPA. *Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze.* November 29, 2018. https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf.

resources from pollution; TCAA, §382.011, which authorizes the commission to control the quality of the state's air; and TCAA, §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.

Effect on the:

A.) Regulated community:
The affected regulated community would be those associated with the proposed rulemakings incorporated as part of this DFW AD SIP revision. For further information, see the executive summaries for Rule Project No. 2019-074-117-AI, NO_x RACT Rules for the DFW 2008 Eight-Hour Ozone Nonattainment Area Reclassification, and Rule Project No. 2019-075-115-AI, VOC RACT Rules for the 2008 DFW Eight-Hour Ozone Nonattainment Area Reclassification, which are being proposed concurrently with this SIP revision.

B.) Public:
The general public in the DFW ozone nonattainment area may benefit from the DFW area ultimately meeting the ozone NAAQS and the area being redesignated as attainment for the 2008 eight-hour ozone NAAQS.

C.) Agency programs:
Development of this SIP revision would affect certain parts of the agency. A significant amount of staff hours would be required from the Air Quality Division to develop this SIP revision. Staff from the Environmental Law Division would be consulted for legal advice.

The Office of Compliance and Enforcement (OCE) conducts field investigations to verify compliance with the rules addressed in SIP revisions. Enforcement of any proposed revised rules in this DFW AD SIP revision would not significantly increase the number of facilities investigated by state and local governments.

No additional burden on agency programs is anticipated as a result of this SIP revision.

Stakeholder meetings:
The TCEQ hosted a meeting on July 16, 2019 in the DFW area. Agenda topics included the status of DFW photochemical modeling development for the DFW 2008 Eight-Hour Ozone Serious Classification AD SIP Revision. Attendees included representatives from industry, county and city government, environmental groups, and the public.

If the proposed DFW AD SIP revision is approved by the commission for public comment and public hearing, then a formal public comment period would be opened, and a public hearing would be held.

Potential controversial concerns and legislative interest:
Although the EPA finalized its 2015 eight-hour ozone standard SIP requirements rule (83 FR 25776), the final rule did not revoke the 2008 eight-hour ozone standard. The EPA

stated that revocation of the 2008 eight-hour ozone standard would be addressed in a separate future action. However, because of the February 16, 2018 United States Court of Appeals for the District of Columbia Circuit opinion in the case *South Coast Air Quality Management District v. EPA, 882 F.3d 1138 (D.C. Cir. 2018)*, the requirement for the EPA to reclassify the area and for the TCEQ to submit this AD SIP revision is expected to remain even if the 2008 eight-hour ozone standard is revoked.

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

What are the consequences if this SIP revision does not go forward? Are there alternatives to this SIP revision?
The commission could choose to not comply with requirements to develop and submit this DFW AD SIP revision to the EPA. However, if an AD SIP revision is not submitted to the EPA, the EPA could issue a finding of failure to submit, requiring that the TCEQ submit the required SIP revision within a specified time period, and imposing sanctions on the state. The EPA would be required to promulgate a Federal Implementation Plan (FIP) any time within two years after finding the TCEQ failed to make the required submission. Sanctions could include transportation funding restrictions, grant withholdings, and 2-to-1 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: September 11, 2019
Anticipated public hearing date: October 17, 2019 (Arlington)
Anticipated public comment period: September 13, 2019 through October 28, 2019
Anticipated adoption date: March 4, 2020

Agency contacts:
Kristin Jacobsen, SIP Project Manager, Air Quality Division, (512) 239-4907
Terry Salem, Staff Attorney, (512) 239-0469
Jamie Zech, Agenda Coordinator, (512) 239-3935

cc: Chief Clerk, 2 copies
Executive Director's Office
Jim Rizk
Martha Landwehr
Office of General Counsel
Kristin Jacobsen
Jamie Zech

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

DALLAS-FORT WORTH 2008 EIGHT-HOUR OZONE STANDARD
NONATTAINMENT AREA

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

DALLAS-FORT WORTH SERIOUS CLASSIFICATION ATTAINMENT DEMONSTRATION STATE IMPLEMENTATION PLAN REVISION FOR THE 2008 EIGHT-HOUR OZONE NATIONAL AMBIENT AIR QUALITY STANDARD

PROJECT NUMBER 2019-078-SIP-NR

Proposal
September 11, 2019

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EXECUTIVE SUMMARY

The Dallas-Fort Worth (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 NAAQS of 0.075 parts per million (ppm) with a July 20, 2018 attainment date. Based on 2017 monitoring data, the DFW area did not attain the 2008 eight-hour ozone NAAQS in 2017[1] and did not qualify for a one-year attainment date extension in accordance with Federal Clean Air Act (FCAA), §181(a)(5)[2]. On November 14, 2018, the United States Environmental Protection Agency (EPA) proposed to reclassify the DFW area to serious nonattainment for the 2008 eight-hour ozone NAAQS (83 *Federal Register* (FR) 56781). On August 7, 2019, the EPA signed the final reclassification notice.

Since the DFW area has been reclassified by the EPA, it is now subject to the serious ozone nonattainment area requirements in FCAA, §182(c), and the Texas Commission on Environmental Quality (TCEQ) is required to submit serious ozone classification attainment demonstration (AD) and reasonable further progress (RFP) SIP revisions to the EPA. As indicated in the EPA's *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule) published on March 6, 2015 (80 FR 12264), the attainment date for a serious classification is July 20, 2021 with a 2020 attainment year. The EPA set an August 3, 2020 deadline for states to submit AD and RFP SIP revisions to address the 2008 eight-hour ozone standard serious nonattainment area requirements.

This proposed DFW AD SIP revision includes the following FCAA-required SIP elements for an area with a serious ozone nonattainment classification: a modeled attainment demonstration, a reasonably available control technology (RACT) analysis, a reasonably available control measures (RACM) analysis, a weight of evidence (WoE) analysis, a contingency plan, and motor vehicle emissions budgets (MVEBs). This DFW AD SIP revision is being proposed in conjunction with the DFW and Houston-Galveston-Brazoria (HGB) 2008 Eight-Hour Ozone Serious Classification RFP SIP Revision (Project No. 2019-079-SIP-NR).

This proposed DFW AD SIP revision demonstrates attainment of the 2008 eight-hour ozone NAAQS by July 20, 2021 based on a photochemical modeling analysis of reductions in nitrogen oxides (NO_X) and volatile organic compounds (VOC) emissions from existing control strategies, and further supported by a WoE analysis. The peak ozone design value for the DFW nonattainment area is projected to be 72 ppb in 2020, predicted through credited reductions but without considering additional reductions discussed as WoE. The quantitative and qualitative corroborative analyses in Chapter 5: *Weight of Evidence* supplements the photochemical modeling analysis presented in

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[1] The attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment date.

[2] An area that fails to attain the 2008 eight-hour ozone NAAQS by its attainment date would be eligible for the first one-year extension if, for the attainment year, the area's 4th highest daily maximum eight-hour average is at or below the level of the standard (75 parts per billion (ppb)); the DFW area's fourth highest daily maximum eight-hour average for 2017 was 77 ppb as measured at the Dallas North No. 2 monitor C63/C679). The DFW area's design value for 2017 was 79 ppb.

Chapter 3: *Photochemical Modeling* to support the conclusion that the DFW nonattainment area will attain the 2008 eight-hour ozone standard by July 20, 2021.

This proposed DFW AD SIP revision includes base case modeling of an eight-hour ozone episode that occurred during May through September of 2012. This modeling episode was chosen because the period is 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 2012 base case indicates the modeling is suitable for use in conducting the modeling attainment test. The modeling attainment test was applied by modeling a 2012 baseline year and 2020 future year to project 2020 eight-hour ozone design values.

Table ES-1: *Summary of 2012 Baseline and 2020 Future Year Anthropogenic Modeling Emissions for DFW* lists the anthropogenic modeling emissions in tons per day (tpd) by source category for the 2012 baseline and 2020 future year for NO_X and VOC ozone precursors. The differences in modeling emissions between the 2012 baseline and the 2020 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 2012 ozone season are monthly averages of actual emission measurements, while the 2020 electric utility emission projections are based on the maximum ozone season caps required under the Cross-State Air Pollution Rule (CSAPR) Update Rule.[3] The emission inputs in Table ES-1 were based on the latest available information at the time development work was done for this proposed DFW AD SIP revision.

[3] On July 28, 2015, the United States Court of Appeals for the District of Columbia Circuit found that the CSAPR 2014 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. The EPA finalized a new ozone season NO_X budget in its September 7, 2016 final CSAPR Update Rule to address interstate transport with respect to the 2008 eight-hour ozone NAAQS and determined that Texas will no longer be subject to the emissions budget calculated to address the 1997 eight-hour ozone NAAQS. On December 21, 2018, the EPA published a final close-out of CSAPR, determining that the CSAPR Update Rule fully addresses interstate pollution transport obligations for the 2008 eight-hour ozone NAAQS in 20 covered states, including Texas (83 FR 65878).

Table ES-1: Summary of 2012 Baseline and 2020 Future Year Anthropogenic Modeling Emissions for DFW

DFW Nonattainment Area Source Type	2012 NO_X (tpd)	2020 NO_X (tpd)	2012 VOC (tpd)	2020 VOC (tpd)
On-Road	216.64	88.27	92.45	53.05
Non-Road	65.38	38.18	41.82	28.76
Off-Road – Airports	14.65	19.21	5.61	3.36
Off-Road - Locomotives	14.96	11.74	0.91	0.58
Area Sources	18.49	34.47	227.39	303.98
Oil and Gas - Drilling	6.60	0.12	0.32	0.01
Oil and Gas - Production	19.33	6.67	71.65	43.13
Point - Oil and Gas	17.07	6.04	27.05	11.59
Point - Cement Kilns (Ozone Season Average)	9.03	15.21	0.86	1.80
Point - EGUs (August Average)	9.78	8.05	3.87	0.45
Point - Non-EGUs (Ozone Season Average)	7.00	6.79	19.83	16.31
10-County DFW Total	398.93	234.75	491.76	463.02

Table ES-2: *Summary of Modeled 2012 Baseline and 2020 Future Year Eight-Hour Ozone Design Values for DFW Monitors* lists the eight-hour ozone DVs in ppb for the 2012 baseline year design value (DV_B) and 2020 future year design value (DV_F) for the regulatory ozone monitors in the DFW nonattainment area. In accordance with the EPA's November 2018 *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$ and Regional Haze*, the 2020 DV_F figures presented have been rounded to one decimal place and then truncated. Since the modeling cannot provide an absolute prediction of ozone DV_Fs, additional information from corroborative analyses is used in assessing whether the area will attain the ozone standard by July 20, 2021.

Table ES-2: Summary of Modeled 2012 Baseline and 2020 Future Year Eight-Hour Ozone Design Values for DFW Monitors

Monitor Name	Site Code	2012 DV_B (ppb)	Relative Response Factor	2020 DV_F (ppb)
Grapevine Fairway - C70	GRAP	84.00	0.862	72
Denton Airport South - C56	DENN	83.67	0.858	71
Keller - C17	KELC	83.00	0.853	70
Frisco - C31	FRIC	81.67	0.863	70
Dallas Hinton Street - C401	DHIC	81.33	0.864	70
Pilot Point - C1032	PIPT	81.67	0.857	70
Dallas North #2 - C63	DALN	80.33	0.867	69
Fort Worth Northwest - C13	FWMC	80.33	0.864	69
Eagle Mountain Lake - C75	EMTL	80.67	0.855	68
Arlington Municipal Airport - C61	ARLA	79.33	0.858	68
Cleburne Airport - C77	CLEB	78.00	0.852	66
Dallas Executive Airport - C402	REDB	78.00	0.846	66

Monitor Name	Site Code	2012 DV_B (ppb)	Relative Response Factor	2020 DV_F (ppb)
Rockwall Heath - C69	RKWL	75.67	0.868	65
Parker County - C76	WTFD	77.00	0.853	65
Midlothian OFW - C52	MDLO	74.67	0.871	65
Granbury - C73	GRAN	76.67	0.842	64
Greenville - C1006	GRVL	71.67	0.856	61
Kaufman - C71	KAUF	71.33	0.858	61
Corsicana Airport - C1051	CRSA	70.00	0.854	59
Italy - C1044	ITLY	69.33	0.852	59

The future year on-road mobile source emission inventories for this proposed DFW AD SIP revision were developed using the 2014a version of the Motor Vehicle Emission Simulator (MOVES2014a) model. These 2020 attainment year inventories establish the NO_X and VOC MVEBs that, once found adequate or approved by the EPA, must be used in transportation conformity analyses. Areas must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed the applicable MVEBs. The attainment MVEBs represent the updated future year on-road mobile source emissions that have been modeled for the attainment demonstration and include all of the on-road control measures. The MVEBs can be found in Table 4-2: *2020 Attainment Demonstration MVEBs for the 10-County DFW Area*.

This proposed DFW AD SIP revision incorporates two concurrent proposed rulemakings to address NO_X and VOC major source RACT requirements associated with reclassification from moderate to serious. Of the 10 DFW-area counties designated nonattainment for the 2008 eight-hour ozone NAAQS, nine are already subject to major source RACT requirements for serious ozone nonattainment areas based on a previous classification of serious nonattainment under the 1997 eight-hour ozone NAAQS. The two proposed rulemakings associated with this SIP revision would ensure RACT is in place for all major sources in Wise County, which was not previously classified as serious nonattainment under any ozone NAAQS. With a moderate ozone nonattainment classification under the 2008 eight-hour ozone NAAQS, Wise County had a major source threshold of the potential to emit (PTE) of 100 tons per year (tpy). With reclassification to serious under the 2008 eight-hour ozone NAAQS, the major source threshold for the 10-county DFW area, including Wise County, is 50 tpy.

The concurrent proposed rulemaking to address NO_X requirements (Rule Project No. 2019-074-117-AI) would revise 30 Texas Administrative Code (TAC) Chapter 117 to amend the existing DFW NO_X RACT rules applicable in Wise County to apply at a threshold of 50 tpy. All unit types located at major source sites in the 2017 point source emissions inventory would be addressed by this RACT rulemaking. The concurrent proposed rulemaking to address VOC requirements (Rule Project No.2019-075-115-AI) would revise 30 TAC Chapter 115, Subchapter B, Division 1, Storage of VOC, to amend the existing DFW VOC RACT rules in Wise County for fixed roof oil and condensate storage tanks to apply at a threshold of 50 tpy.

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 proposed 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, 2013, 2015, and 2017. 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). 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. 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.

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

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

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

Applicable Law

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

Statutes

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

TEXAS HEALTH & SAFETY CODE, Chapter 382	September 1, 2017
TEXAS WATER CODE	September 1, 2017

Chapter 5: Texas Natural Resource Conservation Commission

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

Chapter 7: Enforcement

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

Rules

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

Chapter 7: Memoranda of Understanding, §§7.110 and 7.119	December 13, 1996 and May 2, 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	May 31, 2018
Chapter 55: Requests for Reconsideration and Contested Case Hearings; Public Comment, all of the chapter except §55.125(a)(5) and (6)	May 31, 2018
Chapter 101: General Air Quality Rules	October 12, 2017
Chapter 106: Permits by Rule, Subchapter A	April 17, 2014
Chapter 111: Control of Air Pollution from Visible Emissions and Particulate Matter	August 3, 2017
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	April 26, 2018
Chapter 115: Control of Air Pollution from Volatile Organic Compounds	January 5, 2017
Chapter 116: Permits for New Construction or Modification	November 24, 2016
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	February 23, 2017

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

A. Introduction (No change)

B. Ozone (Revised)

  1. Dallas-Fort Worth (Revised)
     Chapter 1: General
     Chapter 2: Anthropogenic Emissions Inventory (EI) Description
     Chapter 3: Photochemical Modeling
     Chapter 4: Control Strategies and Required Elements
     Chapter 5: Weight of Evidence
     Chapter 6: Ongoing and Future Initiatives
  2. Houston-Galveston-Brazoria (No change)
  3. Beaumont-Port Arthur (No change)
  4. El Paso (No change)
  5. Regional Strategies (No change)
  6. Northeast Texas (No change)
  7. Austin Area (No change)
  8. San Antonio Area (No change)
  9. Victoria Area (No change)

C. Particulate Matter (No change)

D. Carbon Monoxide (No change)

E. Lead (No change)

F. Oxides of Nitrogen (No change)

G. Sulfur Dioxide (No change)

H. Conformity with the National Ambient Air Quality Standards (No change)

I. Site Specific (No change)

J. Mobile Sources Strategies (No change)

K. Clean Air Interstate Rule (No change)

L. Transport (No change)

M. Regional Haze (No change)

TABLE OF CONTENTS

Executive Summary
Section V-A: Legal Authority
Section VI: Control Strategy
Table of Contents
List of Acronyms
List of Previous State Implementation Plan (SIP) Revisions and Reports
List of Tables
List of Figures
List of Appendices
Chapter 1: General
- 1.1 Background
- 1.2 Introduction
  - 1.2.1 One-Hour Ozone National Ambient Air Quality Standard (NAAQS) History
    - 1.2.1.1 March 1999
    - 1.2.1.2 April 2000
    - 1.2.1.3 August 2001
    - 1.2.1.4 March 2003
    - 1.2.1.5 EPA Determination of Attainment for the One-Hour Ozone NAAQS
    - 1.2.1.6 Redesignation Substitute for the One-Hour Ozone NAAQS
    - 1.2.1.7 Redesignation Request and Maintenance Plan SIP Revision for the One-Hour Ozone NAAQS
  - 1.2.2 1997 Eight-Hour Ozone NAAQS History
    - 1.2.2.1 April 2005
    - 1.2.2.2 May 2007
    - 1.2.2.3 Reclassification to Serious for the 1997 Eight-Hour Ozone NAAQS
    - 1.2.2.4 EPA Determination of Attainment for the 1997 Eight-Hour Ozone NAAQS
    - 1.2.2.5 Redesignation Substitute for the 1997 Eight-Hour Ozone NAAQS
    - 1.2.2.6 Redesignation Request and Maintenance Plan SIP Revision for the 1997 Eight-Hour Ozone NAAQS
  - 1.2.3 2008 Eight-Hour Ozone NAAQS History
    - 1.2.3.1 Moderate Classification Attainment Demonstration for the 2008 Eight-Hour Ozone NAAQS
    - 1.2.3.2 Reclassification to Serious for the 2008 Eight-Hour Ozone NAAQS
  - 1.2.4 Current Serious Classification Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone NAAQS
  - 1.2.5 Existing Ozone Control Strategies

1.3 Health Effects
1.4 Stakeholder Participation and Public Meetings
1.4.1 DFW Stakeholder Meeting
1.5 Public Hearing and Comment Information
1.6 Social and Economic Considerations
1.7 Fiscal and Manpower Resources
Chapter 2: Anthropogenic Emissions Inventory Description
2.1 Introduction
2.2 Point Sources
2.3 Area Sources
2.4 Non-Road Mobile Sources
2.4.1 NONROAD Model Categories Emissions Estimation Methodology
2.4.2 Drilling Rig Diesel Engines Emissions Estimation Methodology
2.4.3 Locomotive Emissions Estimation Methodology
2.4.4 Airport Emissions Estimation Methodology
2.5 On-Road Mobile Sources
2.6 EI Improvement
Chapter 3: Photochemical Modeling
3.1 Introduction
3.2 Overview of the Ozone Photochemical Modeling Process
3.3 Ozone Modeling Process
3.3.1 Base Case Modeling
3.3.2 Future Year Modeling
3.4 Episode Selection
3.4.1 Modeling Guidance for Episode Selection
3.4.2 Episode Selection Process
3.4.3 Summary of the May through September 2012 Ozone Episode
3.4.3.1 May 2012
1.1.1.1 June 2012
1.1.1.2 July 2012
1.1.1.3 August 2012
1.1.1.4 September 2012
3.5 Meteorological Model
3.5.1 Modeling Domains
3.5.2 Meteorological Model Configuration
3.5.3 WRF Model Performance Evaluation
3.6 Modeling Emissions
3.6.1 Biogenic Emissions

3.6.2 2012 Base Case Emissions
3.6.2.1 Point Sources
3.6.2.2 On-Road Mobile Sources
3.6.2.3 Non-Road and Off-Road Mobile Sources
3.6.2.4 Area Sources
3.6.2.5 Base Case Summary
3.6.3 2012 Baseline Emissions
3.6.4 2020 Future Case Emissions
3.6.4.1 Point Sources
3.6.4.2 On-Road Mobile Sources
3.6.4.3 Non-Road and Off-Road Mobile Sources
3.6.4.4 Area Sources
3.6.4.5 Future Case Summary
3.6.5 2012 and 2020 Modeling Emissions Summary for DFW
3.7 Photochemical Modeling
3.7.1 Modeling Domains and Horizontal Grid Cell Size
3.7.2 Vertical Layer Structure
3.7.3 Model Configuration
3.7.4 Model Performance Evaluation
3.7.4.1 Performance Evaluations Overview
3.7.4.2 Operational Evaluations
3.7.4.3 Diagnostic Evaluations
3.8 Attainment Test
3.8.1 Relative Response Factor and Future Design Values
3.8.2 Unmonitored Area Analysis
3.9 Modeling Archive and References
3.9.1 Modeling Archive
3.9.2 Modeling References
Chapter 4: Control Strategies and Required Elements
4.1 Introduction
4.2 Existing Control Measures
4.3 Updates to Existing Control Measures
4.3.1 Updates to NO_X Control Measures
4.3.2 Updates to VOC Control Measures
4.3.3 Revisions to Vehicle Inspection and Maintenance (I/M) Program
4.4 New Control Measures
4.4.1 Stationary Sources
4.5 RACT Analysis

4.5.1 General Discussion
4.5.2 NO_x RACT Determination
4.5.3 VOC RACT Determination
4.6 RACM Analysis
4.6.1 General Discussion
4.6.2 Results of RACM Analysis
4.7 Motor Vehicle Emissions Budgets
4.8 Monitoring Network
4.9 Contingency Plan
4.10 Additional FCAA Requirements
4.11 Emission Credit Generation
Chapter 5: Weight of Evidence
5.1 Introduction
5.2 Analysis of Ambient Trends and Emissions Trends
5.2.1 Ozone Trends
5.2.1.1 Ozone Design Value Trends
5.2.1.2 Background Ozone Trends
5.2.2 Ambient NO_x Trends
5.2.3 VOC and NO_x Limitations
5.2.4 Weekday/Weekend Effect
5.2.5 VOC Trends
5.3 Literature Survey
5.3.1 Trend Analyses: Surface Observations and Satellites
5.3.2 DFW Area Meteorological Patterns Conducive to High Ozone
5.3.3 Background and International Contributions
5.3.4 VOC- and NO_x-Sensitivity of Ozone Formation in DFW
5.3.5 Potential Effects of Economically-Driven Coal-Burning Power Plant Closures
5.3.6 Analysis of Smoke/Wildfire Impact on Specific High Ozone Days
5.4 Qualitative Corroborative Analysis
5.4.1 Additional Measures
5.4.1.1 SmartWay Transport Partnership and the Blue Skyways Collaborative
5.4.1.2 Energy Efficiency and Renewable Energy (EE/RE) Measures
5.4.1.3 Cement Kiln Consent Decree
5.4.1.4 Clean Air Interstate Rule (CAIR) and Cross-State Air Pollution Rule (CSAPR)
5.4.1.5 Texas Emissions Reduction Plan (TERP)
5.4.1.6 Clean School Bus Program
5.4.1.7 86th Texas Legislature, 2019

5.4.1.8 Local Initiatives
5.4.1.9 Voluntary Measures
5.5 Conclusions
5.6 References
Chapter 6: Ongoing and Future Initiatives
6.1 Introduction
6.2 Ongoing Work
6.2.1 Emissions Inventory (EI) Improvement Projects
6.2.2 Air Quality Research Program
6.2.3 2016 Collaborative Modeling Platform Development
6.2.4 International Emissions and Background Contribution
6.2.5 Inter-Precursor Trading Ratio for Nonattainment New Source Review Permit Offset Requirements
6.2.6 Supplemental Flare Operations Training
6.2.7 Optical Gas Imaging Technology
6.3 References

LIST OF ACRONYMS

ABY	adjusted base year
AD	attainment demonstration
AEDT	Aviation Environmental Design Tool
AMPD	Air Markets Program Database
APU	auxiliary power unit
AQRP	Air Quality Research Program
AQS	Air Quality System
auto-GC	automated gas chromatographs
BACT	best available control technology
BEIS	Biogenic Emission Inventory System
CAIR	Clean Air Interstate Rule
CAMS	continuous ambient monitoring station
CAMx	Comprehensive Air Quality Model with Extensions
CASTNET	Clean Air Status and Trends Network
CB6	Carbon Bond 6
CFR	Code of Federal Regulations
CMV	commercial marine vessel
CSAPR	Cross-State Air Pollution Rule
CTG	control techniques guidelines
D.C.	District of Columbia
DDM	decoupled direct method
DERC	Discrete Emissions Reduction Credit
DERI	Diesel Emissions Reduction Incentive program
DFW	Dallas-Fort Worth
DPS	Texas Department of Public Safety
DV	design value
DV_B	baseline year design value
DV_F	future year design value
EBT	Emissions Banking and Trading
EE	energy efficiency
EGU	electric generating unit
EI	emissions inventory

EIA	Energy Information Administration
EPA	United States Environmental Protection Agency
EPS3	Emissions Processing System
ERC	Emission Reduction Credit
ERG	Eastern Research Group
ESL	environmental speed limit
FAA	Federal Aviation Administration
FCAA	Federal Clean Air Act
FINN	Fire Inventory of National Center for Atmospheric Research
FR	*Federal Register*
FY	fiscal year
GEOS-Chem	Goddard Earth Observing System
GSE	ground support equipment
GW	gigawatt
HB	House Bill
HCHO	formaldehyde
H-GAC	Houston-Galveston Area Council
HGB	Houston-Galveston-Brazoria
HPMS	Highway Performance Monitoring System
HRVOC	highly reactive volatile organic compounds
I/M	inspection and maintenance
IOP	increment of progress
ITAC	Independent Technical Advisory Committee
km	kilometer
Kv	vertical diffusivity
LAI	leaf area index
LCC	Lambert Conformal Conic
LIP	Local Initiatives Projects Program
LIRAP	Low Income Vehicle Repair Assistance, Retrofit, and Accelerated Vehicle Retirement Program
LST	local standard time
m	meter
m/s	meters per second
MACT	maximum achievable control technology

MATS	Modeled Attainment Test Software
MCR	mid-course review
MDA8	maximum daily average eight-hour ozone
MODIS	Moderate-Resolution Imaging Spectroradiometer
MOS	mineral oil scrubber
MOVES	Motor Vehicle Emissions Simulator
MPE	model performance evaluation
MPO	metropolitan planning organization
MVEB	motor vehicle emissions budget
MW	megawatt
MWh	megawatt-hours
NAAQS	National Ambient Air Quality Standard
NADP	National Acid Deposition Program
NASA	National Aeronautics and Space Administration
NCTCOG	North Central Texas Council of Governments
NEI	National Emissions Inventory
NLCD	National Land Cover Dataset
NMB	Normalized Mean Bias
NME	Normalized Mean Error
NMIM	National Mobile Inventory Model
NO	nitric oxide
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
NSPS	New Source Performance Standards
NSR	New Source Review
OMI	Ozone Monitoring Instrument
ORVR	Onboard Refueling Vapor Recovery systems
PAMS	photochemical assessment monitoring station
PBL	planetary boundary layer
PEI	periodic emissions inventory
pH_2O_2	hydrogen peroxide
$pHNO_3$	nitric acid
PiG	Plume-in-Grid

$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 micrometers
ppb	parts per billion
ppbC	parts per billion by carbon
ppbV	parts per billion by volume
ppm	parts per million
psia	pounds per square inch absolute
PTE	potential to emit
PUCT	Public Utility Commission of Texas
RACM	reasonably available control measures
RACT	reasonably available control technology
RE	renewable energy
RFP	reasonable further progress
ROP	rate of progress
RRC	Railroad Commission of Texas
RRF	relative response factor
RS	redesignation substitute
SB	Senate Bill
SECO	State Energy Conservation Office
SIC	Standard Industrial Classification
SIP	state implementation plan
SMOKE	Sparse Matrix Operation Kernel Emissions
SO_2	sulfur dioxide
SOF	solar occultation flux
SPRY	Seaport and Rail Yard Areas Emissions Reduction Program
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 Emissions Reduction Plan
TexAER	Texas Air Emissions Repository
TexAQS	Texas Air Quality
TexN	Texas NONROAD model
THSC	Texas Health and Safety Code
TMC	Texas Motorist's Choice Program
TNGVGP	Texas Natural Gas Vehicle Grant Program
TNMHC	total non-methane hydrocarbon
TNRCC	Texas Natural Resource Conservation Commission
tpd	tons per day
tpy	tons per year
TTI	Texas Transportation Institute
TUC	Texas Utilities Code
TxDMV	Texas Department of Motor Vehicles
TxDOT	Texas Department of Transportation
TxLED	Texas Low Emission Diesel
UMA	unmonitored area
U.S.	United States
VMEP	Voluntary Mobile Source Emissions Reduction Program
VMT	vehicle miles traveled
VOC	volatile organic compounds
WoE	weight of evidence
WPS	Weather Research and Forecasting Model Processing System
WRF	Weather Research and Forecasting

LIST OF PREVIOUS STATE IMPLEMENTATION PLAN (SIP) REVISIONS AND REPORTS

The following list references SIP revisions and reports that were previously adopted by the commission and submitted to the United States Environmental Protection Agency (EPA). The list identifies how these SIP revisions are referenced in this document and contains the project number, adoption date, full title, and a hyperlink for each SIP revision or report.

1999 DFW One-Hour Ozone AD SIP Revision (TCEQ Project No. 1998-046-SIP-AI, adopted February 24, 1999) Dallas-Fort Worth (DFW), One-Hour Ozone Attainment Demonstration (AD) State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/airquality/sip/feb1999dfw.html)

2000 DFW One-Hour Ozone AD SIP Revision (TCEQ Project No. 1999-055-SIP-AI, adopted April 19, 2000) Dallas-Fort Worth (DFW), One Hour Ozone Attainment Demonstration (AD) State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/2000-04-DFW/DFW_AD_2000.pdf)

2000 DFW One-Hour Ozone I/M SIP Revision (TCEQ Project No. 2000-055C-SIP-AI, adopted April 19, 2000) Dallas-Fort Worth (DFW), One-Hour Ozone Vehicle Inspection and Maintenance (I/M) State IMplementation Plan (SIP) Revision (https://www.tceq.texas.gov/airquality/mobilesource/dec2000imhgb.html)

2001 DFW One-Hour Ozone AD SIP Revision (TCEQ Project No. 2001-025-SIP-AI, adopted August 22, 2001) Dallas-Fort Worth (DFW), One Hour Ozone Attainment Demonstration (AD) State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/2001-08-DFW/DFW_AD_8-22-2001_archive.pdf)

2003 DFW One-Hour Ozone AD SIP Revision (TCEQ Project No. 2003-008-114-SIP-AI, adopted March 5, 2003) Dallas-Fort Worth (DFW), One-Hour Ozone Attainment Demonstration (AD) State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/DFW_1-HR_Ozone_March 2003.pdf)

2005 DFW Eight-Hour Ozone 5% IOP SIP Revision (TCEQ Project No. 2004-096-SIP-NR, adopted April 27, 2005) Dallas-Fort Worth (DFW), 5 Percent Increment of Progress (IOP) State Implementation Plan (SIP) Revision for the 1997 Eight-Hour Ozone Standard (https://www.tceq.texas.gov/airquality/sip/apr2005dal_iop.html#background)

2007 DFW Eight-Hour Ozone AD SIP Revision (TCEQ Project No. 2006-013-SIP-NR, adopted May 2, 2007) Dallas-Fort Worth (DFW), 1997 Eight-Hour Ozone Moderate Nonattainment Area, Attainment Demonstration (AD) State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/dfw_ad_sip_2007/DFW_AD_RFP_May2007.pdf)

2007 DFW Eight-Hour Ozone RFP SIP Revision (TCEQ Project No. 2006-031-SIP-NR, adopted May 23, 2007) Dallas-Fort Worth (DFW), 1997 Eight-Hour Ozone Moderate Nonattainment Area, Reasonable Further Progress (RFP) State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/dfw_ad_sip_2007/DFW_AD_RFP_May2007.pdf)

2008 DFW Eight-Hour Ozone AD (Contingency Measures Plan) SIP Revision (TCEQ Project No. 2008-016A-SIP-NR, adopted November 5, 2008) Dallas-Fort Worth (DFW), 1997 Eight-Hour Ozone Moderate Nonattainment Area, Attainment Demonstration (AD) Contingency Plan State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/dfw_ad_sip_2007/DFW_AD_RFP_May2007.pdf)

2008 DFW Eight-Hour Ozone AD (DERC) SIP Revision (TCEQ Project No. 2008-016-SIP-NR, adopted December 10, 2008) Dallas-Fort Worth (DFW), 1997 Eight-Hour Ozone Standard DERC Program State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/dfw_ad_sip_2007/DFW_AD_RFP_May2007.pdf)

2010 DFW Eight-Hour Ozone RACT, Rule, and Contingency SIP Revision (TCEQ Project No. 2009-018-SIP-NR, adopted March 10, 2010) Dallas-Fort Worth (DFW), RACT Update, 30 TAC Chapter 117 Rule, and Modified Failure to Attain Contingency Plan State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/dfw_ad_sip_2007/DFW_AD_RFP_May2007.pdf)

2010 DFW Eight-Hour Ozone ESL SIP Revision (TCEQ Project No. 2009-026-SIP-NR, adopted August 25, 2010) Dallas-Fort Worth (DFW), Environmental Speed Limit (ESL) Control Strategy Conversion to a Transportation Control Measure (TCM) State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/080610/SIP_WEB_06AUG10.pdf)

2011 DFW Eight-Hour Ozone AD SIP Revision (TCEQ Project No. 2010-022-SIP-NR, adopted December 7, 2011) Dallas-Fort Worth (DFW) Attainment Demonstration State Implementation Plan (SIP) Revision for the 1997 Eight-Hour Ozone Standard (https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/2011-AD-RFP-DFW/DFWAD_2011_archive.pdf)

2011 DFW Eight-Hour Ozone RFP Revision (TCEQ Project No. 2010-023-SIP-NR, adopted December 7, 2011) Dallas-Fort Worth (DFW) Reasonable Further Progress (RFP) State Implementation Plan (SIP) Revision for the 1997 Eight-Hour Ozone Standard. (https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/2011-AD-RFP-DFW/DFWRFP_2011_archive.pdf)

2015 DFW 2008 Eight-Hour Ozone Standard AD SIP Revision (TCEQ Project No. 2013-015-SIP-NR, adopted June 3, 2015) Dallas-Fort Worth (DFW) 2008 Eight-Hour Ozone Nonattainment Area Attainment Demonstration (AD) State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/2015-AD-RFP-DFW/DFWAD_2015_archive.pdf)

2015 DFW 2008 Eight-Hour Ozone Standard RFP SIP Revision (TCEQ Project No. 2013-014-SIP-NR, adopted June 3, 2015) Dallas-Fort Worth (DFW) 2008 Eight-Hour Ozone Nonattainment Area Reasonable Further Progress (RFP) State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/2015-AD-RFP-DFW/DFWRFP_2015_archive.pdf)

2015 DFW One-Hour and 1997 Eight-Hour Ozone RS Report (Submitted to the EPA on August 18, 2015) Dallas-Fort Worth Redesignation Substitute Report for the One-Hour and 1997 Eight-Hour Ozone Standard (https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/RedesigationSubstitutes/DFW_1hr_1997-8hr_RS_archive.pdf)

2016 DFW 2008 Eight-Hour Ozone Standard AD SIP Revision (TCEQ Project No. 2015-014-SIP-NR, adopted July 6, 2016) Dallas-Fort Worth (DFW) 2008 Eight-Hour Ozone Nonattainment Area Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 2017 Attainment Year (https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/2016-AD-DFW/DFWAD_2016_archive.pdf)

2018 DFW RACT Update SIP Revision (TCEQ Project No. 2017-001-SIP-NR, adopted August 8, 2018) Dallas-Fort Worth (DFW) 2008 Eight-Hour Ozone Standard Nonattainment Area Reasonably Available Control Technology (RACT) Update State Implementation Plan (SIP) Revision (https://www.tceq.texas.gov/assets/public/implementation/air/sip/sipdocs/2018_DFWRACTUpdate/DFW_RACT_Update_SIP-AO_archive.pdf)

2019 DFW One-Hour and 1997 Eight-Hour Ozone Redesignation SIP Revision (TCEQ Project No. 2018-028-SIP-NR, adopted March 27, 2019) Dallas-Fort Worth (DFW) Redesignation Request and Maintenance Plan State Implementation Plan (SIP) Revision for One-Hour and 1997 Eight-Hour Ozone NAAQS (https://www.tceq.texas.gov/assets/public/implementation/air/sip/dfw/DFW_ReMain18028SIP_ado_all.pdf)

LIST OF TABLES

Table ES-1: Summary of 2012 Baseline and 2020 Future Year Anthropogenic Modeling Emissions for DFW

Table ES-2: Summary of Modeled 2012 Baseline and 2020 Future Year Eight-Hour Ozone Design Values for DFW Monitors

Table 1-1: Public Hearing Information

Table 3-1: Days with MDA8 Ozone Concentrations Exceeding 75 ppb by Month from 2011 through 2013

Table 3-2: Regulatory Monitor-Specific Ozone Conditions During May through September 2012 Episode

Table 3-3: WRF Modeling Domain Definitions

Table 3-4: WRF Vertical Layer and Sigma Layer Details

Table 3-5: WRF Model Configuration Parameters

Table 3-6: WRF Meteorological Modeling Percent Accuracy by 2012 Month for the DFW Area

Table 3-7: Emissions Processing Modules

Table 3-8: 2012 Sample Base Case Point Source Emissions for 10-County DFW

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

Table 3-10: 2012 Base Case On-Road Modeling Emissions for the 10-County DFW Area

Table 3-11: 2012 Base Case Non-Road Model Source Emissions for the 10-County DFW Area

Table 3-12: 2012 Base Case Non-Road Modeling Emissions by Day Type for the 10-County DFW Area

Table 3-13: 2012 Base Case Airport Modeling Emissions for the 10-County DFW Area

Table 3-14: 2012 Base Case Locomotive Modeling Emissions for the 10-County DFW Area

Table 3-15: 2012 Base Case Non-Oil and Gas Area Source Emissions for the 10-County DFW Area

Table 3-16: 2012 Base Case Oil and Gas Drilling and Production Emissions for the 10-County DFW Area

Table 3-17: 2012 Sample Base Case Anthropogenic Emissions for the 10-County DFW Area

Table 3-18: 2012 August Baseline Anthropogenic Emissions for the 10-County DFW Area

Table 3-19: 2012 DFW Point Source Baseline Emission Estimates by Industry Type

Table 3-20: 2020 DFW Point Source Future Case Emission Projections by Industry Type

Table 3-21: 2020 Future Case On-Road Modeling Emissions for the 10-County DFW Area
Table 3-22: 2020 Future Case Non-Road Model Source Emissions for the 10-County DFW Area
Table 3-23: 2020 Future Case Non-Road Modeling Emissions for the 10-County DFW Area
Table 3-24: 2020 Future Case Airport Modeling Emissions for the 10-County DFW Area
Table 3-25: 2020 Future Case Locomotive Emissions for the 10-County DFW Area
Table 3-26: 2020 Future Case Non-Oil and Gas Area Source Emissions for 10-County DFW
Table 3-27: 2020 Oil and Gas Drilling and Production Emissions for the 10-County DFW Area
Table 3-28: 2020 Future Case Anthropogenic Emissions for the 10-County DFW Area
Table 3-29: 2012 Baseline and 2020 Future Modeling Emissions for the 10-County DFW Area
Table 3-30: CAMx Modeling Domain Definitions
Table 3-31: CAMx Vertical Layer Structure
Table 3-32: DFW Monitor-Specific Relative Response Factors for Attainment Test
Table 3-33: Summary of RRF and 2020 Future Ozone Design Values
Table 4-1: Existing Ozone Control and Voluntary Measures Applicable to the DFW 10-County Nonattainment Area
Table 4-2: 2020 Attainment Demonstration MVEBs for the 10-County DFW Area
Table 4-3: 2021 DFW Attainment Contingency Demonstration (tons per day)
Table 5-1: NO_2 Trends Measured by Satellites for the DFW Area

LIST OF FIGURES

Figure 1-1: Ozone Design Values and Population in the Dallas-Fort Worth Area

Figure 3-1: Example Baseline Design Value Calculation

Figure 3-2: DFW Eight-Hour Ozone Exceedance Days by Month from 1990 through 2017

Figure 3-3: DFW Number of Days MDA8 Ozone Concentrations Greater than 75 ppb by Year from 2000 to 2018

Figure 3-4: August 9, 2011 United States (U.S.) Drought Monitor Map of Texas

Figure 3-5: 2012 DFW Number of Days with MDA8 Ozone Concentrations Greater than 75 ppb by Monitor

Figure 3-6: August 7, 2012 U.S. Drought Monitor Map of Texas

Figure 3-7: DFW Area Regulatory Ozone Monitoring Locations

Figure 3-8: May 2012 MDA8 Ozone Concentrations at Regulatory DFW Monitors

Figure 3-9: June 2012 MDA8 Ozone Concentrations Observed at Regulatory DFW Monitors

Figure 3-10: July 2012 MDA8 Ozone Concentrations Observed at Regulatory DFW Monitors

Figure 3-11: August 2012 MDA8 Ozone Concentrations at Regulatory DFW Monitors

Figure 3-12: September 2012 MDA8 Ozone Concentrations at Regulatory DFW Monitors

Figure 3-13: WRF Modeling Domains

Figure 3-14: WRF Vertical Layer Structure

Figure 3-15: 2012 DFW Area Average Meteorological Modeling Performance Statistics

Figure 3-16: Sample Biogenic VOC Emissions for June 26, 2012 Episode Day

Figure 3-17: 2012 Baseline and 2020 Future Modeling Emissions for the 10-County DFW Area

Figure 3-18: CAMx Modeling Domains

Figure 3-19: May 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors

Figure 3-20: May 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors

Figure 3-21: May 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)

Figure 3-22: May 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway

Figure 3-23: May 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)

Figure 3-24: June 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors

Figure 3-25: June 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors
Figure 3-26: June 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)
Figure 3-27: June 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)
Figure 3-28: June 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)
Figure 3-29: July 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors
Figure 3-30: July 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors
Figure 3-31: July 2012 versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)
Figure 3-32: July 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)
Figure 3-33: July 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)
Figure 3-34: August 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors
Figure 3-35: August 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors
Figure 3-36: August 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)
Figure 3-37: August 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)
Figure 3-38: August 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)
Figure 3-39: September 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors
Figure 3-40: September 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors
Figure 3-41: September 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)
Figure 3-42: September 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)
Figure 3-43: September 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)
Figure 3-44: Location of DFW Ozone Monitors with 4 km Grid Cell Array
Figure 3-45: 2020 Future Design Values by DFW Monitoring Location
Figure 3-46: Spatially Interpolated 2012 Baseline Design Values for the DFW Area
Figure 3-47: Spatially Interpolated 2020 Future Design Values for the DFW Area

Figure 5-1: On-Road Emissions Trends in the DFW Area from 1999 through 2050
Figure 5-2: Non-Road Emissions Trends in the DFW Area from 1999 through 2050
Figure 5-3: EGU Emissions Trends in the DFW Area from 1999 through 2018
Figure 5-4: One-Hour and Eight-Hour Ozone Design Values in the DFW Area from 2005 through 2018
Figure 5-5: Background Ozone on Days with Eight-Hour Ozone Concentrations Greater than 70 ppb
Figure 5-6: Ozone Season (March through October) Daily Peak Ambient NO_X Trends in the DFW Area
Figure 5-7: 50th Percentile Daily Peak NO_X Concentrations in the DFW Area
Figure 5-8: Trend in VOC to NO_X Ratios using Auto-GC Data
Figure 5-9: Day of Week NO_X Concentrations (maximum range of 2005 - 2018)
Figure 5-10: Weekday/Weekend Effect for Ozone in the DFW Area
Figure 5-11: PAMS VOC Trends
Figure 5-12: DFW Area Trends of NO_X, VOCs, and CO from Sather and Cavender (2016)
Figure 5-13: Trends in NO_2 as Observed by OMI
Figure 5-14: NO_2 Imagery from the OMI Satellite
Figure 5-15: Wind Patterns Observed in DFW During the 2000 through 2014 Ozone Seasons and the Average MDA8 Ozone Concentration Observed During Each Pattern
Figure 5-16: DFW Ozone Trends for Each Wind Pattern for Ozone Season Days from 2000 through 2014
Figure 5-17: Annual Frequency of Each Wind Pattern and Relative Frequency Compared to Average
Figure 5-18: Peak MDA8 Ozone Concentrations and Regional Background Ozone for Three Texas Urban Areas, Averaged by Ozone Season Day for 2004 through 2014
Figure 5-19: Relative Contributions in Percent to the Anthropogenic Component of the 10 Days with the Highest MDA8 Ozone Concentrations
Figure 5-20: Source Apportionment from CAMx Runs
Figure 5-21: Ozone Production Rates (ppb per day) for June 21 through 27, 2012, as Calculated by Chemical Process Analysis
Figure 5-22: Day-of-Week Variations in NO_X Concentrations at Surface Monitors throughout DFW Area, 2005 through 2018
Figure 5-23: Frequency of High Ozone Days by Day of Week from 1997 through 2013
Figure 5-24: Frequency of MDA8 Ozone Concentrations Greater than 75 ppb by Year, in Number of Days per Year
Figure 5-25: Frequency of high ozone days by day of week, updated to 2005 through 2018

Figure 5-26: Modeling Impacts upon MDA8 Ozone Concentrations at Key Monitors from Hypothetical Closure of Individual Coal-Burning Power Plants in Texas

LIST OF APPENDICES

Appendix	Appendix Name
Appendix A	Meteorological Modeling for the DFW and HGB Attainment Demonstration SIP Revisions for the 2008 Eight-Hour Ozone Standard
Appendix B	Emissions Modeling for the DFW and HGB Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard
Appendix C	Regional and Global Photochemical Modeling for the DFW and HGB Attainment Demonstration SIP Revisions 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
Appendix E	Modeling Protocol for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard
Appendix F	Reasonably Available Control Technology Analysis
Appendix G	Reasonably Available Control Measures Analysis
Appendix H:	Local Initiatives Submitted by the North Central Texas Council of Governments

CHAPTER 1: GENERAL

1.1 BACKGROUND

Information on the Texas State Implementation Plan (SIP) and a list of SIP revisions and other air quality plans adopted by the commission can be found on the Texas State Implementation Plan webpage (http://www.tceq.texas.gov/airquality/sip) on the Texas Commission on Environmental Quality's (TCEQ) website (http://www.tceq.texas.gov/).

1.2 INTRODUCTION

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

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

On February 8, 1979, the United States Environmental Protection Agency (EPA) set the one-hour ozone standard at 0.12 parts per million (ppm) (44 *Federal Register* (FR) 8202). A design value of 0.124 ppm, or 124 parts per billion (ppb), would round down and meet the NAAQS while a design value of 0.125 ppm, or 125 ppb, would round up and exceed the NAAQS. Because of these rounding conventions, the one-hour ozone NAAQS of 0.12 ppm is commonly referenced as 124 ppb. Violation of the one-hour ozone NAAQS is based on the maximum number of expected exceedances over all the monitors in an area with a threshold of 1.0 expected exceedances per year averaged over a three-year period.

In 1991, the EPA designated a four-county DFW area (Collin, Dallas, Denton, and Tarrant Counties) as moderate ozone nonattainment for the one-hour ozone NAAQS in accordance with the 1990 Federal Clean Air Act (FCAA) Amendments (56 FR 56694). As a moderate ozone nonattainment area, the four-county DFW area was required to demonstrate attainment of the one-hour ozone standard by November 15, 1996. Ambient air monitoring data for the years 1994 through 1996, however, showed that the one-hour ozone standard was exceeded more than one day per year over the three-year period. As a result, the EPA reclassified the four-county DFW area from a moderate to a serious ozone nonattainment area (effective March 20, 1998) for failure to attain the one-hour ozone standard by the November 1996 deadline (63 FR 8128). The EPA required the State of Texas to submit a SIP revision within one year that demonstrated attainment of the one-hour ozone NAAQS and addressed FCAA requirements for serious ozone nonattainment areas.

1.2.1.1 March 1999

The Texas Natural Resource Conservation Commission, a predecessor to the TCEQ, submitted the 1999 DFW One-Hour Ozone Attainment Demonstration (AD) SIP Revision, which contained a rate-of-progress (ROP) demonstration and numerous control strategies, to the EPA on March 18, 1999. The photochemical modeling contained in the revision indicated that additional reductions in nitrogen oxides (NO_X) emissions would be needed to attain the standard by November 1999. The following rules were developed and included in the SIP revision:

- reasonably available control technology (RACT) for NO_X point sources;

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

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

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

1.2.1.2 April 2000

On April 19, 2000, the commission adopted an AD SIP revision and associated rules for the DFW one-hour ozone nonattainment area. The 2000 DFW One-Hour Ozone AD SIP Revision contained a number of control strategies and the following elements:

- a modeling demonstration that showed air quality in the DFW ozone nonattainment area was influenced at times by transport from the Houston-Galveston-Brazoria (HGB) ozone nonattainment area (Under the EPA's July 16, 1998 transport policy[4], if photochemical modeling demonstrated that emissions from an upwind area located in the same state and with a later attainment date interfered with the downwind area's ability to attain, the downwind area's attainment date could be extended to no later than that of the upwind area. For the DFW ozone nonattainment area, following this policy would extend the attainment date to November 15, 2007, the same attainment date as the HGB area.);
- photochemical modeling of specific control measures and future state and national rules for attainment of the one-hour ozone standard in the DFW ozone nonattainment area by the attainment deadline of November 15, 2007;
- identification of the VOC and NO_X emissions reductions necessary to attain the one-hour ozone standard by 2007. The reductions of 141 tons per day (tpd) NO_X from federal measures and 225 tpd NO_X from state measures resulted in a total of 366 tpd NO_X reductions for the AD;
- a 2007 motor vehicle emissions budget (MVEB) for transportation conformity; and
- a commitment to perform and submit a mid-course review by May 1, 2004.

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

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

On April 19, 2000, the commission also adopted the 2000 DFW One-Hour Ozone Vehicle Inspection and Maintenance (I/M) SIP Revision to expand the I/M program in the DFW area. The enhanced I/M program was implemented in the DFW ozone nonattainment area on May 1, 2002 in Collin, Dallas, Denton, and Tarrant Counties and on May 1, 2003 in Ellis, Johnson, Kaufman, Parker, and Rockwall Counties.

1.2.1.3 August 2001

The next commission action was required by legislative mandate. Senate Bill (SB) 5, passed by the 77th Texas Legislature in May 2001, required the repeal of two rules contained in the 2000 DFW One-Hour Ozone AD SIP Revision. The first rule restricted the use of construction and industrial equipment (non-road, heavy-duty diesel equipment). The second rule required the replacement of diesel-powered construction, industrial, commercial, and lawn and garden equipment. SB 5 also established the Texas Emissions Reduction Plan (TERP) grant incentive program. The TERP program's reductions in NO_x replaced the NO_x emissions reductions previously claimed for the two repealed programs. The commission implemented the legislative mandate of SB 5 by submitting the rule repeals as part of the 2001 DFW One-Hour Ozone AD SIP Revision adopted in August 2001.

1.2.1.4 March 2003

On March 5, 2003, the SIP was further revised through the 2003 DFW One-Hour Ozone AD SIP Revision to include the following:

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

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

1.2.1.5 EPA Determination of Attainment for the One-Hour Ozone NAAQS

Since the early 1990s, when the DFW area was designated as nonattainment for the one-hour ozone standard, much has been done to bring the area into attainment with federal air quality standards. Contributions to improved air quality in the DFW ozone nonattainment area include: TCEQ-implemented control strategies, local control strategies adopted by the North Central Texas Council of Governments (NCTCOG), and on-road and non-road mobile source measures implemented by the EPA. Despite the EPA's lack of approval for multiple SIP revisions, air quality in the DFW ozone nonattainment area continued 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, certified ambient monitoring data reflected attainment of the one-hour ozone standard. On October 16, 2008, the EPA published a final determination (73 FR 61357) that the DFW area one-hour ozone nonattainment counties (Collin, Dallas, Denton, and Tarrant) had attained the one-hour ozone standard with a design value of 124 ppb, based on certified 2004 through 2006 ambient monitoring data.

1.2.1.6 Redesignation Substitute for the One-Hour Ozone NAAQS

On August 18, 2015, the TCEQ submitted the 2015 DFW One-Hour and 1997 Eight-Hour Ozone Redesignation Substitute (RS) Report to the EPA. This report fulfilled the EPA's redesignation substitute requirements in its *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements; Final Rule* (2008 eight-hour ozone standard SIP requirements rule) to lift anti-backsliding obligations under a revoked ozone NAAQS by ensuring that specific redesignation requirements are met for the DFW area under the revoked standard (78 FR 34178). This redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. On November 8, 2016, the EPA published its final approval of the 2015 DFW One-Hour and 1997 Eight-Hour Ozone RS Report (81 FR 78688). The effective date of the rule was December 8, 2016.

1.2.1.7 Redesignation Request and Maintenance Plan SIP Revision for the One-Hour Ozone NAAQS

On February 16, 2018, the United States Court of Appeals for the District of Columbia Circuit (D.C. Circuit Court) issued an opinion in the case *South Coast Air Quality Management District v. EPA, 882 F.3d 1138 (D.C. Cir. 2018)*. The case was a challenge to the EPA's final 2008 eight-hour ozone standard SIP requirements rule, which revoked the 1997 eight-hour ozone NAAQS as part of the implementation of the more stringent 2008 eight-hour ozone NAAQS. The court's decision vacated parts of the EPA's final 2008 eight-hour ozone standard SIP requirements rule, including the redesignation substitute, removal of anti-backsliding requirements for areas designated nonattainment under the revoked 1997 eight-hour ozone NAAQS, waiving requirements for transportation conformity for maintenance areas under the revoked 1997 eight-hour ozone NAAQS, and elimination of the requirement to submit a second 10-year maintenance plan. The court's vacatur of removal of anti-backsliding requirements for areas designated nonattainment under the 1997 eight-hour ozone NAAQS may also apply to areas that were designated nonattainment under the one-hour ozone NAAQS.

To address the court's ruling, the commission adopted a formal redesignation request and maintenance plan SIP revision for the DFW area for the one-hour and 1997 eight-hour ozone NAAQS on March 27, 2019. The 2019 DFW One-Hour and 1997 Eight-Hour Ozone Redesignation SIP Revision includes a request that the DFW area be redesignated to attainment for the revoked one-hour and 1997 eight-hour ozone NAAQS. The SIP revision also includes a maintenance plan that ensures the area remains in attainment of the revoked standards through 2032. The maintenance plan uses a 2014 base year inventory and includes interim year inventories for 2020 and 2026, establishes MVEBs for 2032, and includes a contingency plan. The 2019 DFW One-Hour and 1997 Eight-Hour Ozone Redesignation SIP Revision was submitted to the EPA on April 5, 2019.

1.2.2 1997 Eight-Hour Ozone NAAQS History

On July 18, 1997, the EPA published the revised NAAQS for ground-level ozone in the *Federal Register* (62 FR 38856), and it became effective on September 16, 1997. The EPA phased out and replaced the previous one-hour ozone NAAQS with an eight-hour NAAQS set at 0.08 ppm based on the three-year average of the annual fourth-highest daily maximum eight-hour average ozone concentrations measured at each monitor within an area. A design value of 0.084 ppm, or 84 ppb, would round down and meet the NAAQS while a design value of 0.085 ppm, or 85 ppb, would round up and exceed the NAAQS. Because of these rounding conventions the 1997 eight-hour ozone NAAQS is commonly referenced as 84 ppb.

Effective June 15, 2004, a nine-county DFW area (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties) was designated as nonattainment in the first phase of the EPA's implementation rule for the 1997 eight-hour ozone NAAQS (69 FR 23951). The DFW area was classified moderate ozone nonattainment for the standard, with an attainment deadline of June 15, 2010. The EPA addressed the control obligations that apply to areas designated nonattainment for the 1997 eight-hour ozone NAAQS in the second phase of the implementation rule (70 FR 71612).

1.2.2.1 April 2005

On April 27, 2005, the commission adopted the 2005 DFW Eight-Hour Ozone 5% Increment of Progress (IOP) SIP Revision to satisfy the requirements of Phase I of the 1997 eight-hour ozone standard implementation rule (69 FR 23951). The revision used a 5% IOP from the area’s 2002 emissions baseline beyond the reductions from federal and state measures already approved by the EPA and was the first DFW SIP revision submitted under the 1997 eight-hour ozone standard.

1.2.2.2 May 2007

The commission adopted the 2007 DFW Eight-Hour Ozone AD SIP Revision and the 2007 DFW Eight-Hour Ozone Reasonable Further Progress (RFP) SIP Revision for the DFW 1997 eight-hour ozone nonattainment area on May 23, 2007. The 2007 DFW Eight-Hour Ozone AD SIP Revision contained photochemical modeling and weight of evidence, including corroborative analysis and additional measures not included in the model. In addition to the existing control strategies in the DFW nonattainment area, the SIP revision included new rules for DFW ozone nonattainment area cement kilns, electric generating units, industrial, commercial, and institutional major sources, area minor sources, and East Texas combustion sources in 33 counties beyond the DFW ozone nonattainment area. The SIP revision included additional commitments for a Voluntary Mobile Emissions Reduction Program (VMEP) and transportation control measures (TCM). The revision also contained the reasonably available control measure (RACM) analysis, reasonably available control technology (RACT) analysis, contingency measures, emissions inventories, and MVEBs.

On March 7, 2008, the EPA requested specific clarifications and supplemental information regarding the AD SIP revision. The TCEQ provided the requested information to the EPA on April 23, 2008. Items addressed included updated information regarding airport emissions and Discrete Emission Reduction Credits (DERCs), which has led to adjustments made for more accurate projections of emissions estimates from these categories. Additional and updated information regarding the TERP and AirCheckTexas funding and program enhancements was also provided.

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

An additional condition stipulated by the EPA for final approval of the 2007 DFW Eight-Hour Ozone AD SIP Revision was that the TCEQ adopt and submit rule and SIP revisions to implement an enforceable mechanism to limit the use of DERCs in the DFW ozone nonattainment area by March 1, 2009. The 2008 DFW Eight-Hour Ozone AD (DERC) SIP Revision adopted on December 10, 2008 incorporated rulemaking that amended 30 TAC Chapter 101, Subchapter H, Division 4: Discrete Emission Credit Banking and Trading rules to set a limit on DERC use for the DFW ozone nonattainment area.

On January 14, 2009, the EPA published final conditional approval of components of the 2007 DFW Eight-Hour Ozone AD SIP Revision, the 2008 DFW Eight-Hour Ozone AD DERC SIP Revision supplement, and the 2008 DFW Eight-Hour Ozone AD Contingency Measures Plan supplement (74 FR 1903). The approval provided conditional approval of the 2009 attainment MVEBs, RACM demonstration, and failure-to-attain contingency plan, full approval of local VMEP measures and TCMs, full approval of the VOC RACT demonstrations for the one-hour and 1997 eight-hour ozone standards, and a statement that all control measures and reductions relied upon to demonstrate attainment were approved by the EPA.

On March 10, 2010, the commission adopted the 2010 DFW Eight-Hour Ozone RACT, Rule, and Contingency SIP Revision. This SIP revision incorporated several actions adopted by the commission and supplemented the 2007 DFW Eight-Hour Ozone AD SIP by demonstrating that the revised 30 TAC Chapter 117 rule does not interfere with the 2007 DFW Eight-Hour Ozone AD SIP Revision.

On August 25, 2010, the commission adopted a SIP revision to convert an environmental speed limit (ESL) control strategy to a TCM for the 1997 eight-hour ozone standard in the DFW ozone nonattainment area. The EPA approved the 2010 DFW Eight-Hour Ozone ESL SIP Revision to re-categorize a local ESL control measure as a TCM effective on March 10, 2014 (79 FR 1596).

1.2.2.3 Reclassification to Serious for the 1997 Eight-Hour Ozone NAAQS

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

As required by the FCAA, the TCEQ published a notice in the *Texas Register*, on May 21, 2010, (https://texashistory.unt.edu/ark:/67531/metapth101187/m1/1/), implementing the area's contingency measures for failure to attain the 1997 eight-hour ozone standard by the June 15, 2010 deadline.

On December 7, 2011, the commission adopted the 2011 DFW Eight-Hour Ozone AD SIP Revision and the 2011 DFW Eight-Hour Ozone RFP Revision for the DFW serious ozone nonattainment area under the 1997 eight-hour ozone standard. The EPA published final approval of the 2011 DFW RFP SIP revision on November 12, 2014 (79 FR 67068).

The 2011 DFW Eight-Hour Ozone AD SIP Revision included photochemical modeling and weight of evidence analysis to demonstrate attainment by June 15, 2013. The SIP revision included MVEBs for 2012 that represented the on-road mobile source emissions that were modeled for the AD and showed that by 2012, the DFW ozone nonattainment area would meet other serious ozone nonattainment area requirements, including an enhanced Inspection and Maintenance Program (already implemented in all nine counties), Stage II vapor recovery systems at gas stations (already implemented in Collin, Dallas, Denton, and Tarrant Counties), a Clean Fuel Fleet Program (not required if emissions reductions from the National Low-Emissions Vehicle Program are more than what would be achieved under such a program), TCMs (already implemented in all nine counties), and enhanced monitoring.

Concurrent with the 2011 DFW Eight-Hour Ozone AD SIP Revision, the commission adopted revised and new RACT requirements to address the following control techniques guidelines (CTG) documents issued by the EPA from 2006 through 2008 (Rule Project Number 2010-016-115-EN): Flexible Package Printing; Industrial Cleaning Solvents; Large Appliance Coatings; Metal Furniture Coatings; Paper, Film, and Foil Coatings; Miscellaneous Industrial Adhesives; Miscellaneous Metal and Plastic Parts

Coatings; and Auto and Light-Duty Truck Assembly Coatings. Concurrent with this AD SIP revision, the commission also adopted revised and new RACT requirements for VOC storage tanks (Rule Project Number 2010-025-115-EN).

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

Under the serious classification, the DFW ozone nonattainment area was given until June 15, 2013 to attain the 1997 eight-hour ozone NAAQS. The DFW area did not monitor attainment by that date; however, at the end of the 2014 ozone season, the eight-hour ozone 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 Eight-Hour Ozone AD SIP Revision (80 FR 52630). A revised AD for the 1997 eight-hour ozone standard was not required as a result of the EPA's determination of attainment.

The EPA revoked the 1997 eight-hour ozone standard in its 2008 eight-hour ozone standard SIP requirements rule (80 FR 12264).

1.2.2.5 Redesignation Substitute for the 1997 Eight-Hour Ozone NAAQS

On August 18, 2015, the TCEQ submitted the 2015 DFW One-Hour and 1997 Eight-Hour Ozone RS Report to the EPA, which fulfilled the EPA's redesignation substitute requirements in its 2008 eight-hour ozone standard SIP requirements rule to lift anti-backsliding obligations for the revoked 1997 eight-hour ozone NAAQS by ensuring that specific redesignation requirements are met for the DFW area under the revoked standard. This redesignation substitute took the place of a redesignation request and maintenance plan that the EPA would require for a standard that has not been revoked. The EPA approved the 1997 eight-hour ozone DFW redesignation substitute demonstration on November 8, 2016 (81 FR 78688).

1.2.2.6 Redesignation Request and Maintenance Plan SIP Revision for the 1997 Eight-Hour Ozone NAAQS

To address the D.C. Circuit Court's ruling in *South Coast Air Quality Management District v. EPA, 882 F.3d 1138 (D.C. Cir. 2018)*, the commission adopted a formal redesignation request and maintenance plan SIP revision for the DFW area for the one-hour and 1997 eight-hour ozone NAAQS on March 27, 2019. The 2019 DFW One-Hour and 1997 Eight-Hour Ozone Redesignation SIP Revision includes a request that the DFW area be redesignated to attainment for the revoked one-hour and 1997 eight-hour ozone NAAQS. The SIP revision also includes a maintenance plan that would ensure the area remains in attainment of the standards through 2032. The maintenance plan uses a 2014 base year inventory and includes interim year inventories for 2020 and 2026, establishes motor vehicle emissions budgets for 2032, and includes a contingency plan. The 2019 DFW One-Hour and 1997 Eight-Hour Ozone Redesignation SIP Revision was submitted to the EPA on April 5, 2019.

1.2.3 2008 Eight-Hour Ozone NAAQS History

On March 12, 2008, the EPA lowered the primary and secondary eight-hour ozone NAAQS to 0.075 ppm (73 FR 16436). On May 21, 2012, the EPA published in the *Federal Register* (77 FR 30088) final designations for the 2008 eight-hour ozone standard of 0.075 ppm. A 10-county DFW area including Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties was designated ozone nonattainment and classified moderate under the 2008 eight-hour ozone NAAQS, effective July 20, 2012.

1.2.3.1 Moderate Classification Attainment Demonstration for the 2008 Eight-Hour Ozone NAAQS

On May 21, 2012, the EPA published the implementation rule for the 2008 eight-hour ozone standard which set the attainment date for the DFW moderate ozone nonattainment area as December 31, 2018 (77 FR 30160). On December 23, 2014, the 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 eight-hour ozone NAAQS. As part of the EPA's final 2008 eight-hour ozone standard SIP requirements rule, published in the *Federal Register* on March 6, 2015 (80 FR 12264), the EPA modified 40 Code of Federal Regulations (CFR) §51.1103 consistent with the D.C. Circuit Court decision to establish attainment dates that run from the effective date of designation, i.e., July 20, 2012, rather than the end of the 2012 calendar year. As a result, the attainment date for the DFW moderate nonattainment ozone area changed from December 31, 2018 to July 20, 2018. In addition, because the attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment date, the attainment year for the DFW moderate ozone nonattainment area changed from 2018 to 2017. The deadline to submit AD SIP revisions for areas classified as moderate for the 2008 eight-hour ozone NAAQS was July 20, 2015, which was not altered by the change in the attainment date.

On June 3, 2015, the commission adopted the 2015 DFW 2008 Eight-Hour Ozone Standard AD SIP Revision, which was developed based on a 2018 attainment year. Due to the timing of the court's ruling and the EPA's subsequent rulemaking action, it was not possible to complete all work necessary for the SIP revision to demonstrate attainment in 2017. Therefore, the SIP revision included the work completed to demonstrate that the DFW ozone nonattainment area would attain the 2008 eight-hour ozone NAAQS by 2018 as proposed, and to demonstrate progress toward attainment by the new 2017 attainment year. The 2015 DFW 2008 Eight-Hour Ozone Standard AD SIP Revision included:

- photochemical modeling and a weight of evidence analysis to demonstrate attainment by December 31, 2018;
- two rulemakings for RACT requirements for all CTG and all non-CTG major source emission source categories of VOC and NO_X;
- a contingency plan; and
- a commitment to develop a new SIP revision to include an attainment demonstration, RACM analysis, and MVEBs for the 2017 attainment year.

On July 6, 2016, the commission adopted the 2016 DFW 2008 Eight-Hour Ozone Standard AD SIP Revision which included the following analyses to reflect the 2017 attainment year: a modeled AD, corroborative analysis, a RACM analysis, and MVEBs.

On December 21, 2017, the EPA published approval of VOC RACT (82 FR 60546), and on October 23, 2017, the EPA published conditional approval of NO_x RACT (82 FR 44320). The conditional approval was based on a commitment to submit specific enforceable measures (i.e. an agreed order or rule) that incorporate certain permit conditions for the Martin Marietta cement manufacturing plant in Ellis County to limit NO_x emissions to 1.95 lb. NO_x per ton of clinker. On August 8, 2018, the commission adopted the 2018 DFW RACT Update SIP Revision and a voluntary Agreed Order with TXI Operations, LP. On February 22, 2019, the EPA published a final action to approve the DFW RACT Update SIP Revision (84 FR 5601).

1.2.3.2 Reclassification to Serious for the 2008 Eight-Hour Ozone NAAQS

Based on 2017 monitoring data, the DFW area did not attain the 2008 eight-hour ozone NAAQS in 2017[5] and did not qualify for a one-year attainment date extension in accordance with FCAA, §181(a)(5)[6]. On November 14, 2018, the EPA proposed to reclassify the DFW area to serious ozone nonattainment for the 2008 eight-hour ozone NAAQS (83 FR 56781). On August 7, 2019, the EPA signed the final reclassification notice. As indicated in the EPA's 2008 eight-hour ozone standard SIP requirements rule, the attainment date for a serious classification is July 20, 2021 with a 2020 attainment year. The EPA set an August 3, 2020 deadline for states to submit AD and RFP SIP revisions to address the 2008 eight-hour ozone standard serious nonattainment area requirements.

1.2.4 Current Serious Classification Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone NAAQS

This proposed DFW AD SIP Revision contains all FCAA-required AD SIP elements for an area with a serious ozone nonattainment classification. This SIP revision uses photochemical modeling, further supported by a corroborative weight-of-evidence (WoE) analysis, to demonstrate that the area will attain the 2008 eight-hour ozone standard by the July 20, 2021 attainment date based on reductions in NO_x and VOC emissions. This SIP revision also includes an analysis of RACM, including RACT, as well as contingency measures that would provide additional emissions reductions that could be implemented without further rulemaking if the area fails to attain the standard by the attainment date. To ensure that federal transportation funding conforms to the SIP, this SIP revision contains MVEBs for the 2020 attainment year.

This proposed DFW AD SIP revision incorporates two concurrent proposed rulemakings to address NO_x and VOC major source RACT requirements associated with reclassification from moderate to serious. The concurrent proposed rulemaking

[5] The attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment date.

[6] An area that fails to attain the 2008 eight-hour ozone NAAQS by its attainment date would be eligible for the first one-year extension if, for the attainment year, the area's 4th highest daily maximum eight-hour average is at or below the level of the standard (75 ppb); the DFW area's fourth highest daily maximum eight-hour average for 2017 was 77 ppb as measured at the Dallas North No. 2 monitor C63/C679). The DFW area's design value for 2017 was 79 ppb.

to address NO_x requirements (Rule Project No. 2019-074-117-AI) would revise 30 TAC Chapter 117 to amend the existing DFW NO_x RACT rules applicable in Wise County to apply at a threshold of 50 tons per year (tpy). All unit types located at major source sites in the 2017 point source emissions inventory would be addressed by this RACT rulemaking. The concurrent proposed rulemaking to address VOC requirements (Rule Project No.2019-075-115-AI) would revise 30 TAC Chapter 115, Subchapter B, Division 1, Storage of VOC, to amend the existing DFW VOC RACT rules in Wise County for fixed roof oil and condensate storage tanks to apply at a threshold of 50 tpy.

1.2.5 Existing Ozone Control Strategies

Existing control strategies implemented to address the one-hour and eight-hour ozone standards are expected to continue to reduce emissions of ozone precursors in the DFW ozone nonattainment area and positively impact progress toward attainment of the 2008 eight-hour ozone standard and the 2015 eight-hour ozone standard. The one-hour and eight-hour ozone design values for the DFW ozone nonattainment area from 1991 through 2018 are illustrated in Figure 1-1: *Ozone Design Values and Population in the Dallas-Fort Worth Area*. Both design values have decreased over the past 28 years. The 2018 one-hour ozone design value was 101 ppb, representing a 28% decrease from the value for 1991 (140 ppb). The 2018 eight-hour ozone design value was 76 ppb, a 28% decrease from the 1991 value of 105 ppb. These decreases occurred despite an 83% increase in area population from 1991 through 2018, as shown in Figure 1-1.

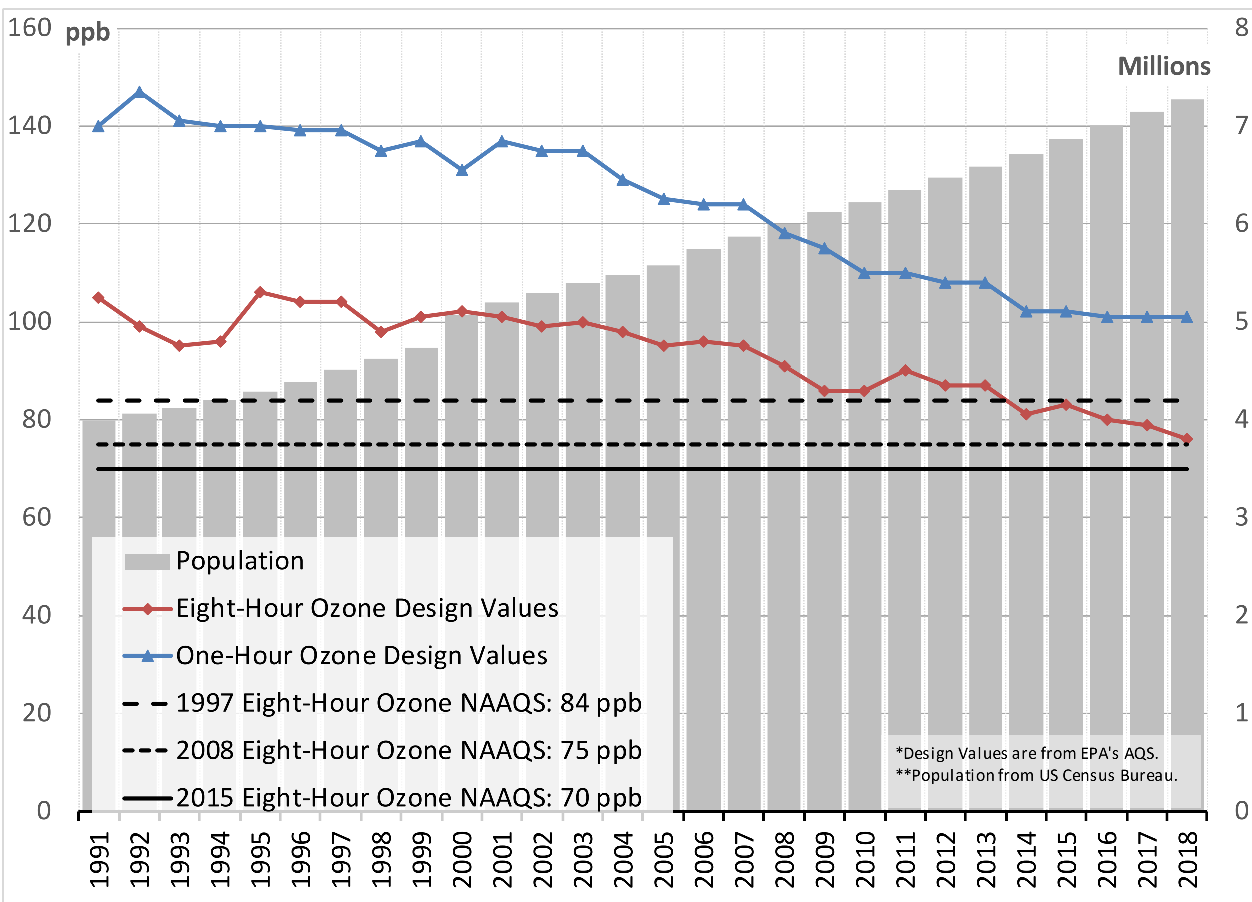

Figure 1-1: Ozone Design Values and Population in the Dallas-Fort Worth Area

1.3 HEALTH EFFECTS

In 2008, the EPA revised the primary eight-hour ozone NAAQS to 0.075 ppm (75 ppb). To support the 2008 eight-hour primary ozone standard, the EPA provided information that suggested that health effects may potentially occur at levels lower than the previous 0.08 ppm (84 ppb) standard. Breathing relatively high levels of ground-level ozone can cause acute respiratory problems like cough and decreases in lung function and can aggravate the symptoms of asthma. Repeated exposures to high levels of ozone can potentially make people more susceptible to allergic responses and lung inflammation.

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

1.4 STAKEHOLDER PARTICIPATION AND PUBLIC MEETINGS

1.4.1 DFW Stakeholder Meeting

The TCEQ hosted a meeting on July 16, 2019 in the DFW area. Agenda topics included the status of DFW photochemical modeling development for the DFW 2008 Eight-Hour Ozone Serious Classification AD SIP Revision. Attendees included representatives from industry, county and city government, environmental groups, and the public.

1.5 PUBLIC HEARING AND COMMENT INFORMATION

The commission will hold a public hearing for this proposed SIP revision at the following time and location:

Table 1-1: Public Hearing Information

City	Date	Time	Location
Arlington	October 17, 2019	2:00 p.m.	Arlington City Council Chambers 101 W. Abram St. Arlington, TX 76010

The public comment period will open on September 13, 2019 and close on October 28, 2019. Written comments will be accepted via mail, fax, or through the eComments (https://www6.tceq.texas.gov/rules/ecomments/) system. All comments should reference the "DFW 2008 Eight-Hour Ozone Serious Classification AD SIP Revision" and should reference Project Number 2019-078-SIP-NR. Comments may be submitted to Kristin Jacobsen, 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 October 28, 2019.

An electronic version of the DFW 2008 Eight-Hour Ozone Serious Classification AD SIP Revision and appendices can be found at the TCEQ's [DFW: Latest Ozone Planning Activities](https://www.tceq.texas.gov/airquality/sip/dfw/dfw-latest-ozone) webpage (https://www.tceq.texas.gov/airquality/sip/dfw/dfw-latest-ozone).

1.6 SOCIAL AND ECONOMIC CONSIDERATIONS

For a detailed explanation of the social and economic issues involved with the rule revisions associated with this SIP revision (Rule Project No. 2019-074-117-AI and Rule Project No.2019-075-115-AI), please refer to the preamble that precedes each rule package.

1.7 FISCAL AND MANPOWER RESOURCES

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

CHAPTER 2: ANTHROPOGENIC EMISSIONS INVENTORY DESCRIPTION

2.1 INTRODUCTION

The Federal Clean Air Act (FCAA) Amendments of 1990 require that attainment demonstration (AD) emissions inventories (EIs) be prepared for ozone nonattainment areas (57 *Federal Register* (FR) 13498). Ground-level (tropospheric) ozone is produced when ozone precursors, volatile organic compounds (VOC) and nitrogen oxides (NO_X), undergo photochemical reactions in the presence of sunlight.

The Texas Commission on Environmental Quality (TCEQ) maintains an inventory of current information for sources of NO_X and VOC emissions that identifies the types of emissions sources present in an area, the amount of each pollutant emitted, and the types of processes and control devices employed at each facility or source category. The total anthropogenic inventory of NO_X and VOC emissions for an area is derived from estimates developed for three general categories of emissions sources: point, area, and mobile (both non-road and on-road).

The EI also provides data for a variety of air quality planning tasks, including establishing baseline emissions levels, calculating reduction targets, developing control strategies to achieve emissions reductions, developing emissions inputs for air quality models, and tracking actual emissions reductions against established emissions growth and control budgets.

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

2.2 POINT SOURCES

Stationary point source emissions data are collected annually from sites that meet the reporting requirements of 30 Texas Administrative Code (TAC) §101.10. This rule establishes EI reporting thresholds in ozone nonattainment areas that are currently at or less than major source thresholds in the DFW area. Therefore, some minor sources in the DFW ozone nonattainment area report to the point source EI.

To collect the data, the TCEQ provides detailed reporting instructions and tools for completing and submitting an EI. Companies submit EI data using a web-based system called the Annual Emissions Inventory Report System. Companies are required to report emissions data and to provide sample calculations used to determine the emissions. Information characterizing the process equipment, the abatement units, and the emission points is also required. Per FCAA §182(a)(3)(B), company representatives certify that reported emissions are true, accurate, and fully represent emissions that occurred during the calendar year to the best of the representative's knowledge.

All data submitted in the EI are reviewed for quality assurance purposes and then stored in the State of Texas Air Reporting System (STARS) database. The TCEQ's Point Source Emissions Inventory webpage (https://www.tceq.texas.gov/airquality/point-source-ei/psei.html) contains guidance documents and historical point source emissions data. Additional information is available upon request from the TCEQ's Air Quality Division.

For this proposed DFW AD State Implementation Plan (SIP) revision, the TCEQ has designated the projection-base year for point sources as 2018 for electric generating units (EGUs) with emissions recorded in the United States Environmental Protection Agency's (EPA) Air Markets Program Data and 2016 for all other stationary point sources (non-EGUs). For more detail on the projection-base year for point sources, please see Chapter 3, Section 3.6.4.1: *Point Sources* and Appendix B: *Emissions Modeling for the DFW and HGB Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard*.

The TCEQ requested regulated entities submit revisions to the 2016 or 2018 (as appropriate) point source EI by January 4, 2019. The TCEQ did not receive any point source EI revisions for the 10-county DFW area.

2.3 AREA SOURCES

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

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

The emissions data for the different area source categories are developed, reviewed for quality assurance, stored in the Texas Air Emissions Repository database system, and compiled to develop the statewide area source EI.

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 agricultural equipment, commercial and industrial equipment, construction and mining equipment, lawn and garden equipment, aircraft and airport equipment, locomotives, and commercial marine vessels (CMVs).

For this proposed DFW AD SIP revision, EIs for non-road sources were developed for the following subcategories: NONROAD model categories, airports, locomotives, and drilling rigs used in upstream oil and gas exploration activities. Since no commercial marine activities occur in the DFW area, CMV EIs were not developed. The airport subcategory includes estimates for emissions from the aircraft, auxiliary power units (APUs), and ground support equipment (GSE) subcategories. The following sections describe the emissions estimates methodologies used for the non-road mobile source subcategories.

2.4.1 NONROAD Model Categories Emissions Estimation Methodology

The Motor Vehicle Emission Simulator 2014b (MOVES2014b) model is the EPA's latest mobile source emissions model for estimating non-road source category emissions. The most recent Texas-specific utility used in conjunction with the non-road mobile component of MOVES2014b model, called Texas NONROAD (TexN2), was used to calculate emissions from all non-road mobile source equipment and recreational vehicles, except for airports, locomotives, and drilling rigs used in upstream oil and gas exploration activities for this proposed DFW AD SIP revision.

Because emissions for airports and locomotives are not included in either the MOVES2014b model or the TexN2 utility, the emissions for these categories are estimated using other EPA-approved methods and guidance. Emissions for the source categories that are not in the MOVES2014b model are estimated using other EPA-approved methods and guidance documents.

2.4.2 Drilling Rig Diesel Engines Emissions Estimation Methodology

Although emissions for drilling rig diesel engines are included in the MOVES2014b model, alternate emissions estimates were developed for that source category to develop more accurate county-level inventories. The equipment populations for drilling rigs were set to zero in the TexN2 utility to avoid double counting emissions from these sources.

Due to significant growth in the oil and gas exploration and production industry, a 2015 TCEQ-commissioned survey of oil and gas exploration and production companies was used to develop updated drilling rig emissions characterization profiles. The drilling rig emissions characterization profiles from this study were combined with county-level drilling activity data obtained from the Texas Railroad Commission to develop the EI.

2.4.3 Locomotive Emissions Estimation Methodology

The locomotive EI was developed from a TCEQ-commissioned study using EPA-accepted EI development methods. The locomotive EI includes line haul and yard emissions activity data from all Class I, II, and III locomotive activity and emissions by rail segment. The method and procedures used to develop the 10-county DFW ozone nonattainment area locomotive EI for this attainment demonstration SIP revision can be found in the Eastern Research Group, Inc. report *2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories*, available at: https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/582155153802FY15-20150826-erg-locomotive_2014aerr_inventory_trends_2008to2040.pdf.

2.4.4 Airport Emissions Estimation Methodology

The airport EI was developed from a TCEQ-commissioned study using the Federal Aviation Administration's (FAA) Aviation Environmental Design Tool (AEDT). AEDT is the most recent FAA model for estimating airport emissions and has replaced the FAA's Emissions and Dispersion Modeling System The airport emissions categories used for this DFW AD SIP revision included aircraft (commercial air carriers, air taxis, general aviation, and military), APU, and GSE operations. The method and procedures used to develop the 10-county DFW ozone nonattainment area airport EIs for this attainment demonstration SIP revision can be found in the Eastern Research Group, Inc. reports:

- *Development of the Statewide Aircraft Inventory for 2011* (available at: https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/582188250819-20190515-erg-2011_statewide_airport_emissions_inventory.pdf); and
- *Development of the Statewide Aircraft Inventory for 2020* (available at: https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/582188250819-20190515-erg-2020_statewide_airport_emissions_inventory.pdf).

2.5 ON-ROAD MOBILE SOURCES

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

Updated on-road EIs and emission factors for this proposed DFW AD SIP revision were developed using the EPA's mobile emissions factor model, MOVES2014a[7]. The MOVES2014a model may be run using national default information or the default information may be modified to simulate data specific to the DFW area, such as the control programs, driving behavior, meteorological conditions, and vehicle characteristics. Because modifications to the national default values influence the emission factors calculated by the MOVES2014a model, to the extent that local values are available, parameters that are used reflect local conditions. The localized inputs used for the on-road mobile EI development include vehicle speeds for each roadway link, vehicle populations, vehicle hours idling, temperature, humidity, vehicle age distributions for each vehicle type, percentage of miles traveled for each vehicle type, type of inspection and maintenance program, fuel control programs, and gasoline vapor pressure controls.

To estimate on-road mobile source emissions, emission factors calculated by the MOVES2014a model must be multiplied by the level of vehicle activity. On-road mobile source emissions factors are expressed in units of grams per mile, grams per vehicle (evaporative), and grams per hour (extended idle); therefore, the activity data required to complete the inventory calculation are vehicle miles traveled (VMT) in units of miles per day, vehicle populations, and source hours idling. The level of vehicle travel

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[7] For on-road EI development, MOVES2014a is technically the most recent on-road release. The more recent MOVES2014b update only impacts non-road model components and does not change the on-road portion of the model.

activity is developed using travel demand models (TDMs) run by the Texas Department of Transportation or by the local metropolitan planning organizations. The TDMs are validated against a large number of ground counts, i.e., traffic passing over counters placed in various locations throughout a county or area. For SIP inventories, VMT estimates are calibrated against outputs from the federal Highway Performance Monitoring System, a model built from a different set of traffic counters. Vehicle populations by source type are derived from the Texas Department of Motor Vehicles' registration database and, as needed, national estimates for vehicle source type population.

In addition to the number of miles traveled on each roadway link, the speed on each roadway type or segment is also needed to complete an on-road EI. Roadway speeds, required inputs for the MOVES2014a model, are calculated by using the activity volumes from the TDM and a post-processor speed model.

2.6 EI IMPROVEMENT

The TCEQ EI reflects years of emissions data improvement, including extensive point and area source inventory reconciliation with ambient emissions monitoring data. Reports detailing recent TCEQ EI improvement projects can be found at the TCEQ's Air Quality Research and Contract Projects webpage (https://www.tceq.texas.gov/airquality/airmod/project/pj.html)

CHAPTER 3: PHOTOCHEMICAL MODELING

3.1 INTRODUCTION

This chapter describes modeling conducted in support of the Dallas-Fort Worth (DFW) Serious Classification Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 2008 Eight-Hour Ozone Standard. The DFW ozone nonattainment area consists of Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties. The 1990 Federal Clean Air Act (FCAA) Amendments require that attainment demonstrations be based on photochemical grid modeling or any other analytical methods determined by the United States Environmental Protection Agency (EPA) to be at least as effective. The EPA's November 2018 *Modeling Guidance for Demonstrating Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze*[8] (EPA, 2018; hereafter referred to as modeling guidance) recommends procedures for air quality modeling for attainment demonstrations for the eight-hour ozone National Ambient Air Quality Standard (NAAQS).

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

This DFW AD SIP revision uses photochemical modeling and other analyses to meet the requirements of the EPA's final *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements* (2008 eight-hour ozone standard SIP requirements rule) published on March 6, 2015 (80 *Federal Register* (FR) 12264).

3.2 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. Most 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 an ozone precursor, but much less effective than either NO_X or VOC in forming ozone. Because of these multiple factors, higher concentrations of ozone are most

[8] https://www3.epa.gov/ttn/scram/guidance/guide/O3-PM-RH-Modeling_Guidance-2018.pdf

common during the summer with concentrations peaking during the day and falling during the night and early morning hours.

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

3.3 OZONE MODELING PROCESS

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 replicate measured ozone and ozone precursor concentrations during recent periods with high ozone concentrations. The purpose of the future year modeling is to predict attainment year design values (DV) at each monitor and to evaluate the effectiveness of controls in reaching attainment. The Texas Commission on Environmental Quality (TCEQ) developed a modeling protocol, as detailed in Appendix E*: Modeling Protocol for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard*, describing the modeling configuration, performance evaluation, and quality assurance process and submitted the plan to the EPA on February 25, 2019 as prescribed in the modeling guidance.

3.3.1 Base Case Modeling

Base case modeling involves several steps. First, recent 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 entered into 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. This step is an iterative process incorporating feedback from successive evaluations to ensure that the model is adequately replicating observations throughout the modeling episode. The adequacy of the model in replicating observations is assessed statistically and graphically as recommended in the modeling guidance. Additional analyses using special study data are included when available. Satisfactory performance of the base case modeling provides a degree of certainty that the model can be used to predict future year ozone concentrations (future year design value or DV_F), as well as to evaluate the effectiveness of possible control measures.

3.3.2 Future Year Modeling

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

Both the baseline and future years are modeled using their respective ozone season emissions and the base case episode meteorological data as inputs. The same meteorological data are used for modeling both the baseline and future years, and 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 DV_F is calculated by multiplying the RRF by a baseline year design value (DV_B). The DV_B is the average of the regulatory DVs for the three consecutive years containing the baseline year, as shown in Figure 3-1: *Example Baseline Design Value Calculation*. A calculated DV_F of less than or equal to 75 parts per billion (ppb) signifies modeled attainment of the 2008 eight-hour ozone NAAQS.

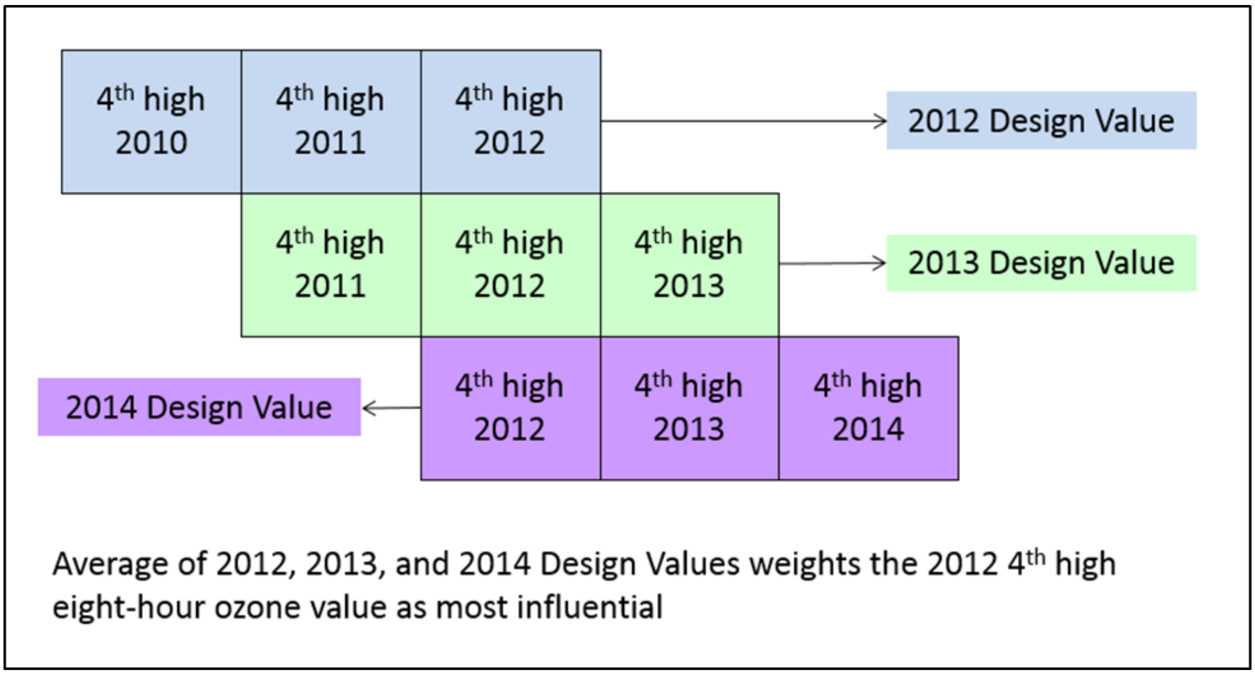


Figure 3-1: Example Baseline Design Value Calculation

3.4 EPISODE SELECTION

3.4.1 Modeling Guidance for Episode Selection

The recently finalized EPA modeling guidance (2018) notes that "…computer speed and storage issues are no longer an impediment to modeling long time periods. In fact, the majority of recent regulatory assessment modeling platforms have been inclusive of entire summers and/or full years (as appropriate) for ozone, $PM_{2.5}$, and regional haze," and consistent with that guidance the TCEQ modeled an entire ozone season for this attainment demonstration. The revised guidance also recommends the following criteria that should be considered in the episode selection process:

- Model time periods that are close to the most recently compiled and quality assured National Emission Inventory (NEI). However, other factors should be considered when selecting a base modeling year, such as the availability and magnitude of observed ambient data, meteorology, and availability of special study data. After consideration of all factors, the most appropriate base year may or may not be an NEI year.
- Model time periods in which observed concentrations are close to the appropriate base year DV or level of visibility impairment and ensure there are a sufficient number of days so that the modeled test applied at each monitor is based on multiple days.
- Model time periods both before and following elevated pollution concentration (poor air quality) episodes to ensure the modeling system appropriately characterizes low pollution periods, development of elevated periods, and transition back to low pollution periods through synoptic cycles.
- Simulate a variety of meteorological conditions conducive to elevated/poor air quality. For eight-hour ozone, choose time periods which reflect a variety of meteorological conditions that frequently correspond with observed eight-hour daily maxima concentrations greater than the level of the NAAQS at monitoring sites in the nonattainment area.

3.4.2 Episode Selection Process

The modeling for this attainment demonstration utilizes an updated version of the 2012 modeling platform that was used previously for the December 15, 2016 Houston-Galveston-Brazoria (HGB) AD SIP revision for the 2008 eight-hour ozone standard and the August 8, 2018 ozone transport SIP revision for the 2015 eight-hour ozone standard. Though the 2012 platform was chosen originally for the HGB area, as shown in this section it is well-suited for demonstrating attainment for the DFW area as well.

When originally selecting the episode for the 10-county DFW and eight-county HGB areas, analyses were performed to identify time periods with elevated eight-hour ozone concentrations that complied with the primary selection criteria and were representative of historical periods with high ozone. Entire ozone seasons were the focus, as many recent years did not have individual months where DFW and HGB area monitors observed 10 days above the NAAQS necessary for a robust attainment test, which reflects the continuing improvement in measured ozone concentrations in both the DFW and HGB areas. Modeling an entire ozone season also allows the attainment demonstration to reflect the historical bimodal (two peak) pattern of elevated eight-hour ozone concentrations that occurs during the DFW and HGB ozone seasons. This bimodal pattern for DFW is demonstrated in Figure 3-2: *DFW Eight-Hour Ozone Exceedance Days by Month from 1990 through 2017*.

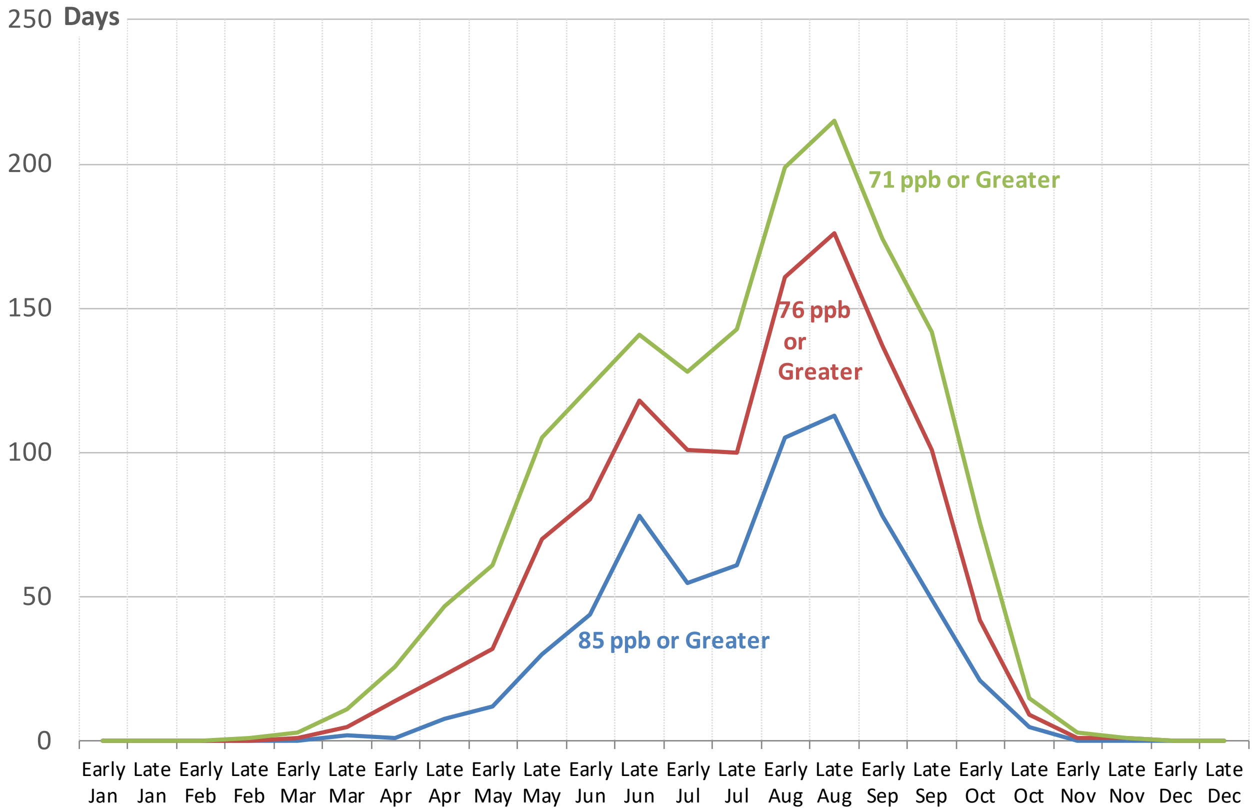


Figure 3-2: DFW Eight-Hour Ozone Exceedance Days by Month from 1990 through 2017

As discussed previously, since ozone and precursor concentrations have declined, it was important to evaluate entire ozone seasons to have sufficient high ozone days for the attainment test. Years 2011 through 2013 were reviewed because DV_Bs could be calculated using five complete years of official monitoring data. The number of days the DFW area measured a maximum daily average eight-hour (MDA8) ozone concentration above 75 ppb is shown in Figure 3-3: *DFW Number of Days MDA8 Ozone Concentrations Greater than 75 ppb by Year from 2000 to 2018*.

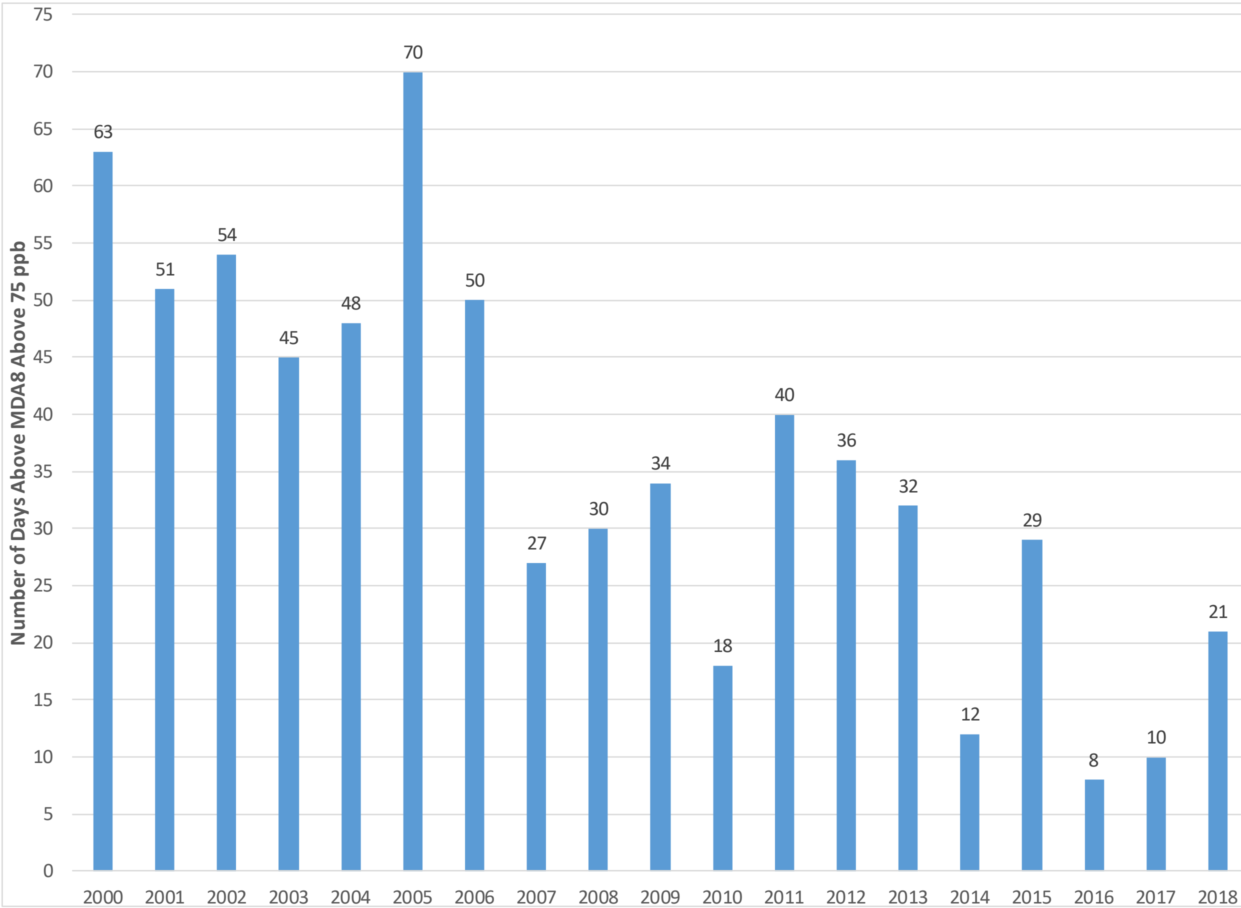


Figure 3-3: DFW Number of Days MDA8 Ozone Concentrations Greater than 75 ppb by Year from 2000 to 2018

June, typically a month with multiple exceedances (see Figure 3-2), only had two days in 2013 with regulatory monitored MDA8 ozone values greater than 75 ppb as shown in Table 3-1: *Days with MDA8 Ozone Concentrations Exceeding 75 ppb by Month from 2011 through 2013*. July 2013 had eight exceedances, which is unusual compared to typical July trends.

Table 3-1: Days with MDA8 Ozone Concentrations Exceeding 75 ppb by Month from 2011 through 2013

Month	2011	2012	2013
January	0	0	0
February	0	0	0
March	0	2	0
April	2	0	0
May	0	4	1
June	4	9	2
July	6	5	8
August	15	11	7
September	11	5	13
October	2	0	1
November	0	0	0
December	0	0	0
Annual Total	40	36	32
June/August-September Total	30	25	22

For 2011, an NEI year, the DFW ozone nonattainment area monitors recorded many days above 75 ppb. However, 2011 was an anomalous year as it was the hottest year on record and the single-worst drought year recorded in Texas since record-keeping began in 1895. Figure 3-4: *August 9, 2011 United States (U.S.) Drought Monitor Map of Texas* shows the extent of the drought across the state. Temperatures were much above normal and annual precipitation was the lowest in recorded history (Nielsen-Gammon, 2011) due to high pressure dominating the synoptic (large-scale) meteorological conditions. The unusually extended period of high pressure in 2011 decreased wind speeds, limited cloud formation, and reduced soil moisture; all are conditions conducive to ozone formation. As shown in Table 3-1, 2011 is also anomalous because there were zero exceedance days in May and relatively few in June compared with the subsequent months of July, August, and September. As discussed previously and demonstrated in Figure 3-2, June is typically a peak ozone month for DFW with a relatively higher number of exceedance days than July. Because 2011 was atypical of recent ozone seasons, it was not considered for ozone season modeling.

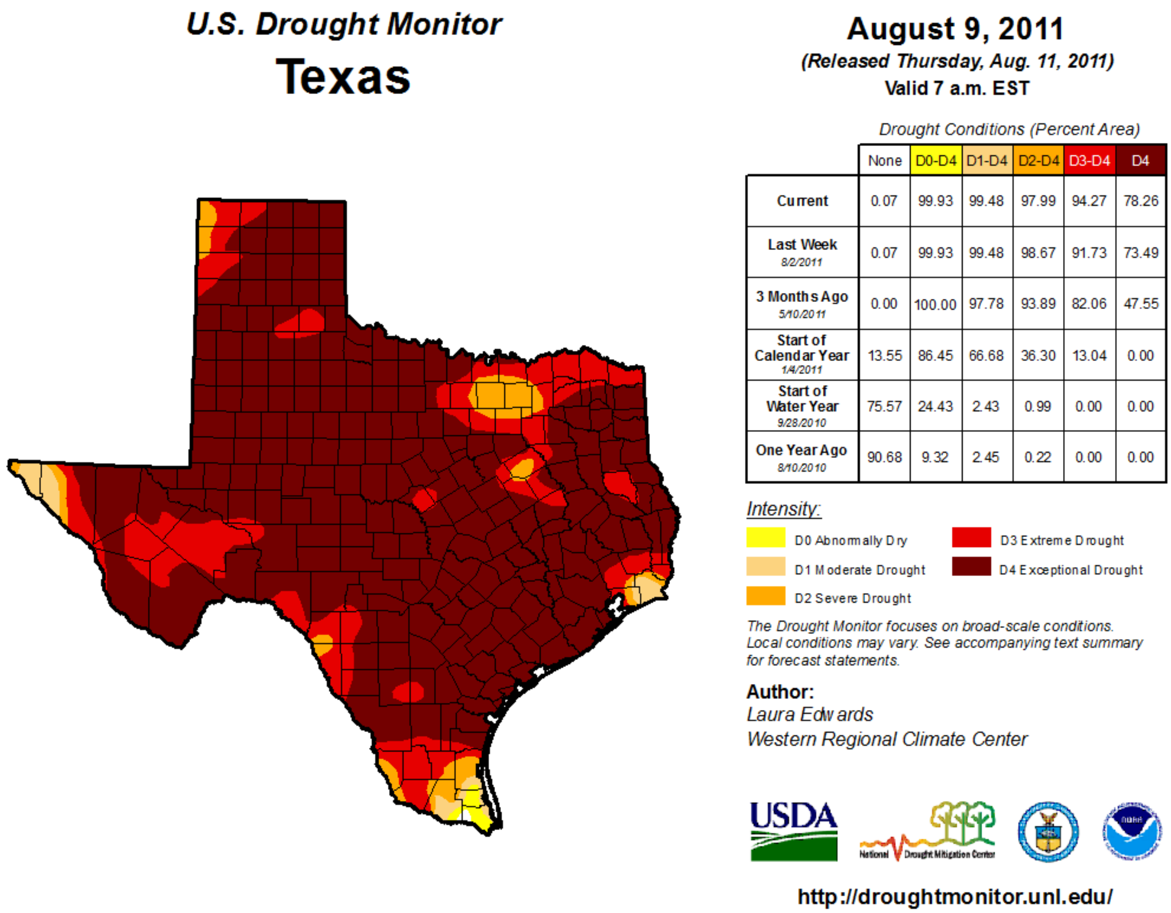


Figure 3-4: August 9, 2011 United States (U.S.) Drought Monitor Map of Texas

In 2012, the DFW ozone nonattainment area observed ozone concentrations above 75 ppb during most of the ozone season, especially during the typical months of June, August, and September as shown in Table 3-1. All regulatory monitors experienced elevated ozone concentrations as shown in Figure 3-5: *2012 DFW Number of Days with MDA8 Ozone Concentrations Greater than 75 ppb by Monitor*. In 2012, the Frisco (C31) monitor had the most days exceeding 75 ppb at 15, followed by Dallas North #2 (C63) monitor with 13 exceedances, and the Grapevine Fairway (C70) monitor with 12 exceedances.

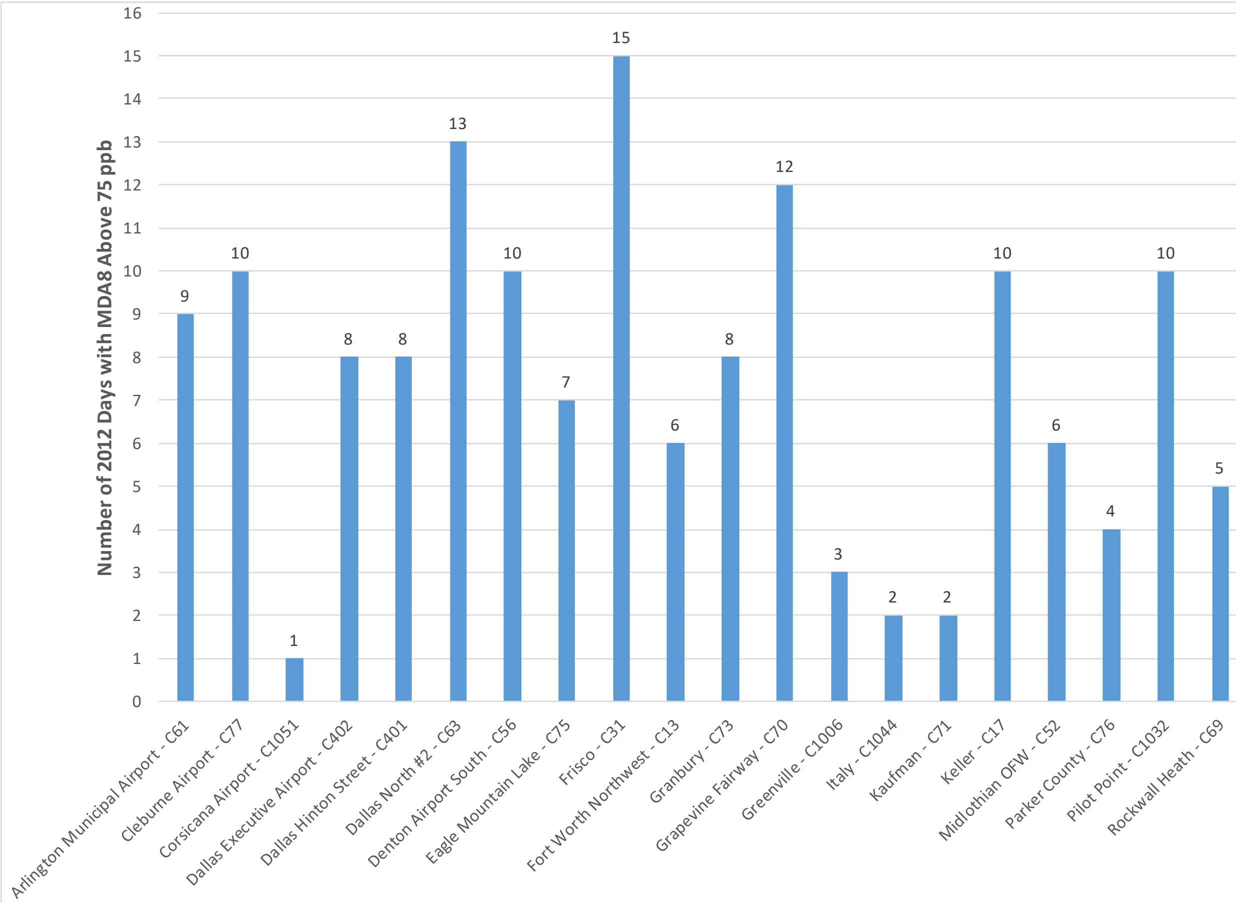


Figure 3-5: 2012 DFW Number of Days with MDA8 Ozone Concentrations Greater than 75 ppb by Monitor

Texas drought conditions in 2012 were typical of previous years, with the exception of 2011, as depicted in Figure 3-6: *August 7, 2012 U.S. Drought Monitor Map of Texas*. The DFW area was not in an extreme or exceptional drought for most of the 2012 ozone season. The episode selection analysis identified 2012 as a representative year, with the May through September period monitoring the majority of elevated ozone concentrations, and suitable for ozone season modeling.

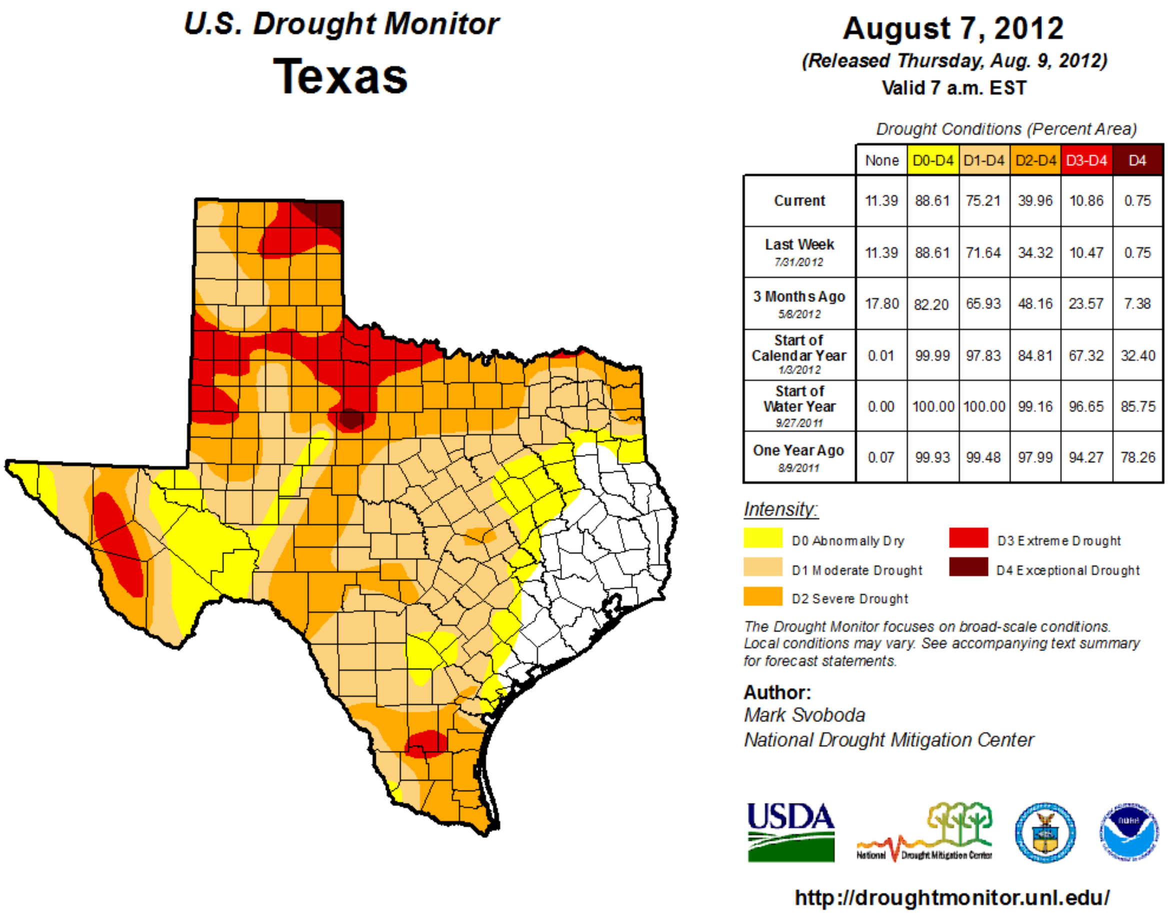


Figure 3-6: August 7, 2012 U.S. Drought Monitor Map of Texas

3.4.3 Summary of the May through September 2012 Ozone Episode

The May through September 2012 ozone episode was characterized by one- to six-day periods of ozone concentrations above the 2008 eight-hour ozone standard of 75 ppb, typical of recent years. The elevated ozone concentrations were usually confined to a few monitors per high ozone day, but on some days the high ozone concentrations were widespread, affecting most monitors in the area. For example, on both June 26 and August 9, 16 of the 20 monitors observed ozone concentrations above 75 ppb. Six of the 20 monitors experienced 10 or more days above 75 ppb during the 153-day ozone episode as shown in Table 3-2: *Regulatory Monitor-Specific Ozone Conditions During May through September 2012 Episode*. Figure 3-7: *DFW Area Regulatory Ozone Monitoring Locations* shows the distribution of the DFW regulatory monitors active during the May through September 2012 episode. All 20 regulatory monitors that operated during the 2012 ozone season recorded more than 10 days above 60 ppb. The modeling guidance suggests using the top 10 modeled days above 60 ppb for the modeled attainment test.

Table 3-2: Regulatory Monitor-Specific Ozone Conditions During May through September 2012 Episode

DFW Regulatory Monitor and CAMS Code	Site Code	Episode Maximum Eight-Hour Ozone (ppb)	Number of Days Above 60 ppb	Number of Days Above 70 ppb	Number of Days Above 75 ppb	Number of Days Above 85 ppb	Baseline Design Value (ppb)
Arlington Municipal Airport - C61	ARLA	110	44	16	9	4	79.33
Cleburne Airport - C77	CLEB	108	41	15	10	1	78.00
Corsicana Airport - C1051	CRSA	89	23	2	1	1	70.00
Dallas Executive Airport - C402	REDB	101	30	13	8	3	78.00
Dallas Hinton Street - C401	DHIC	104	38	12	8	5	81.33
Dallas North #2 - C63	DALN	97	49	19	12	4	80.33
Denton Airport South - C56	DENN	95	48	24	10	3	83.67
Eagle Mountain Lake - C75	EMTL	89	36	12	6	4	80.67
Frisco - C31	FRIC	89	65	26	14	3	81.67
Fort Worth Northwest - C13	FWMC	101	30	9	6	2	80.33
Granbury - C73	GRAN	82	32	16	8	0	76.67
Grapevine Fairway - C70	GRAP	97	57	28	11	4	84.00
Greenville - C1006	GRVL	95	33	6	3	1	71.67
Italy - C1044	ITLY	92	26	4	2	1	69.33
Kaufman - C71	KAUF	86	30	5	2	1	71.33
Keller - C17	KELC	93	46	13	9	3	83.00
Midlothian OFW - C52	MDLO	106	36	11	6	2	74.67
Parker County - C76	WTFD	92	43	9	4	2	77.00
Pilot Point - C1032	PIPT	86	51	19	11	1	81.67
Rockwall Heath - C69	RKWL	109	36	10	5	2	75.67

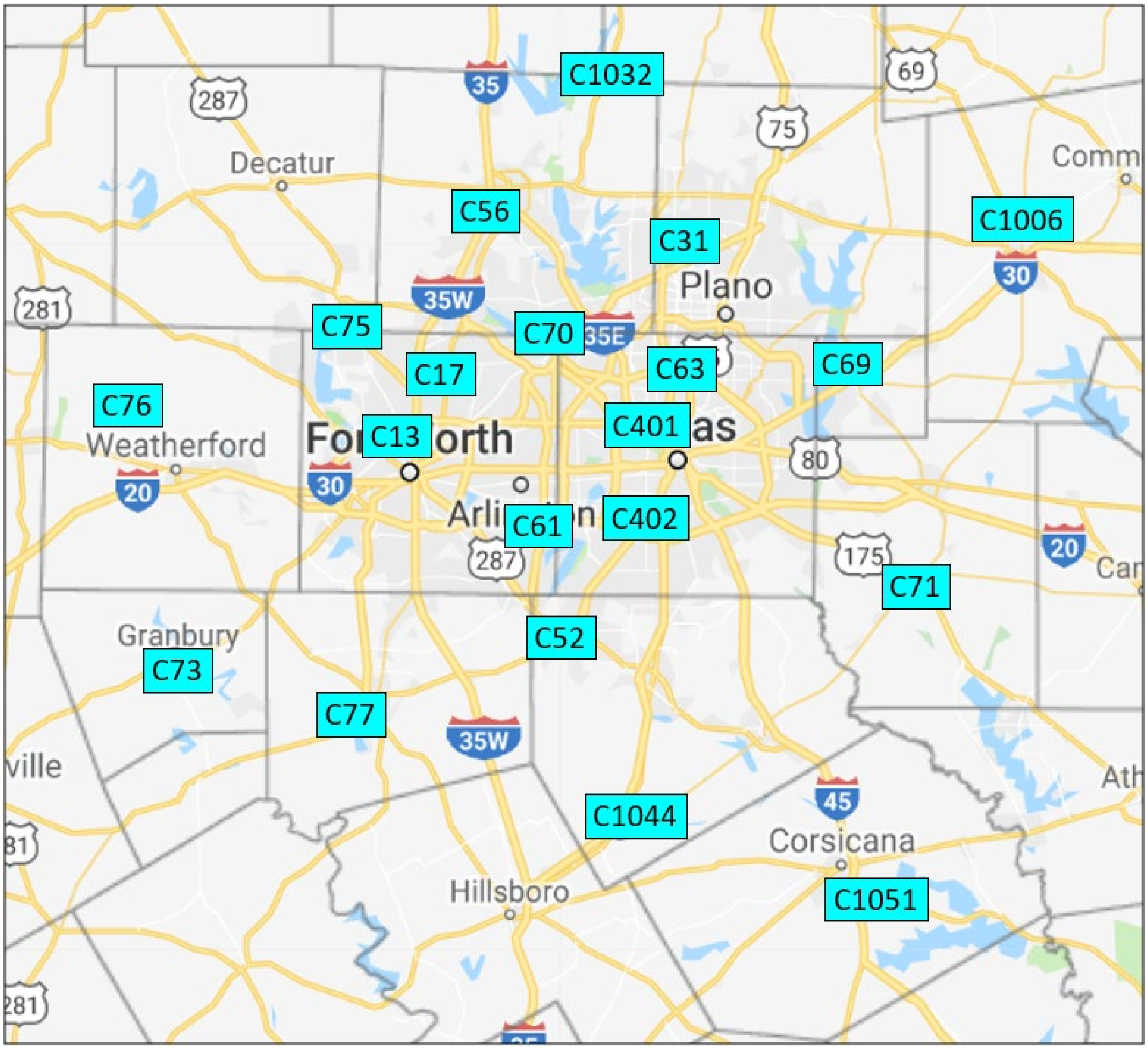


Figure 3-7: DFW Area Regulatory Ozone Monitoring Locations

Appendix D: *Conceptual Model for the DFW Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard* describes the meteorological conditions that are generally present on days when the eight-hour ozone concentration exceeds the 2008 eight-hour ozone NAAQS. High ozone concentrations are typically formed in the DFW area on sunny days with slow wind speeds.

<u>3.4.3.1 May 2012</u>

May is a month that historically observes high ozone concentrations (see Figure 3-2) and four days in 2012 saw DFW area monitors exceed 75 ppb as shown in Figure 3-8: *May 2012 MDA8 Ozone Concentrations at Regulatory DFW Monitors*. The highest observed ozone concentrations in May occurred on May 16, 2012 where 10 monitors exceeded 75 ppb. The Arlington Municipal Airport (C61) monitor measured the maximum eight-hour ozone concentration of 92 ppb in the area. The four exceedance days came within the seven-day period from May 16 through May 22.

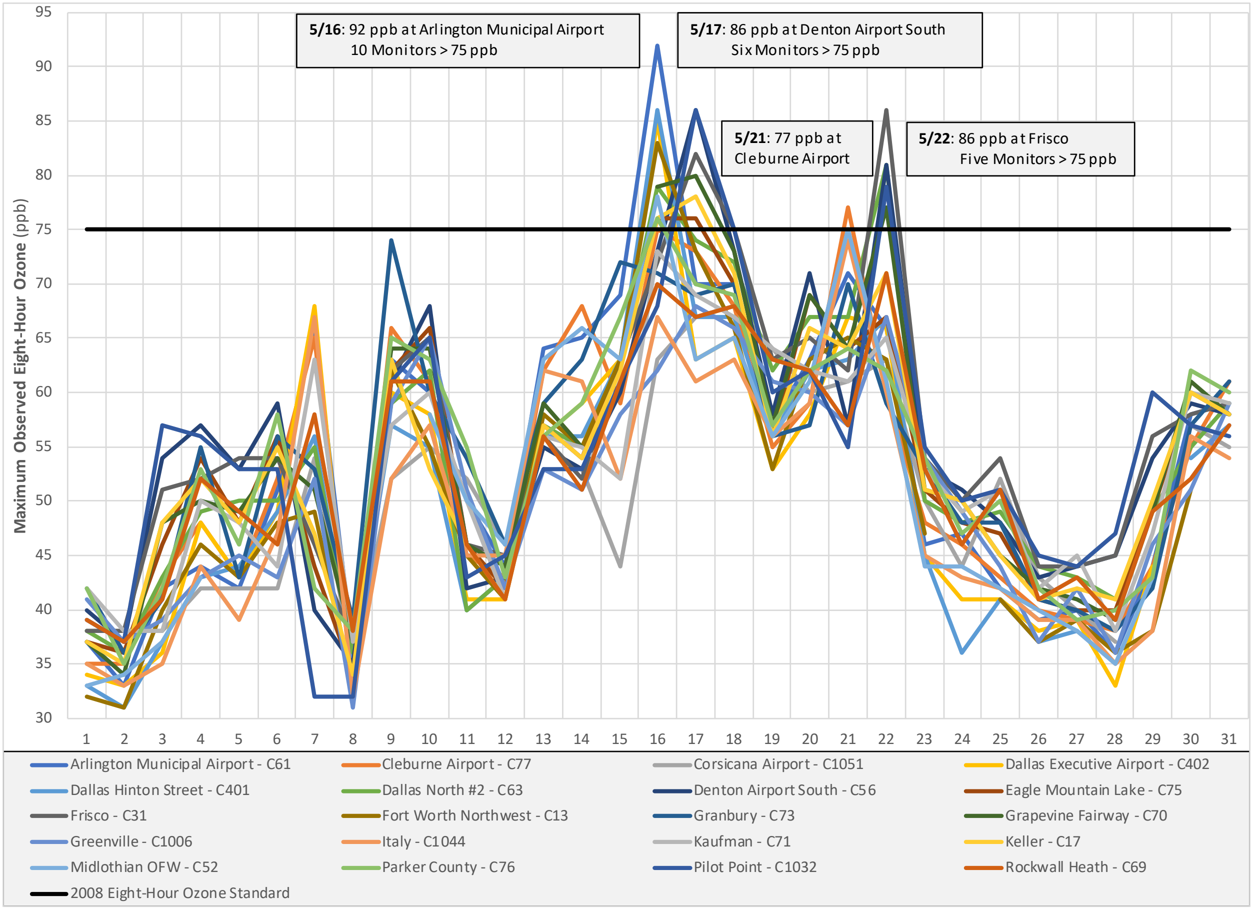


Figure 3-8: May 2012 MDA8 Ozone Concentrations at Regulatory DFW Monitors

1.1.1.1 June 2012

June is the first month of the bi-modal peak of high ozone concentrations in the DFW area (see Figure 3-2). The maximum eight-hour ozone measured at area monitors was 76 ppb or higher on nine days in June 2012 as shown in Figure 3-9: *June 2012 MDA8 Ozone Concentrations Observed at Regulatory DFW Monitors*. The Arlington Municipal Airport (C61) monitor measured an eight-hour ozone maximum of 110 ppb on June 26, 2012. Fifteen other regulatory DFW area monitors also measured exceedances on June 26, 2012.

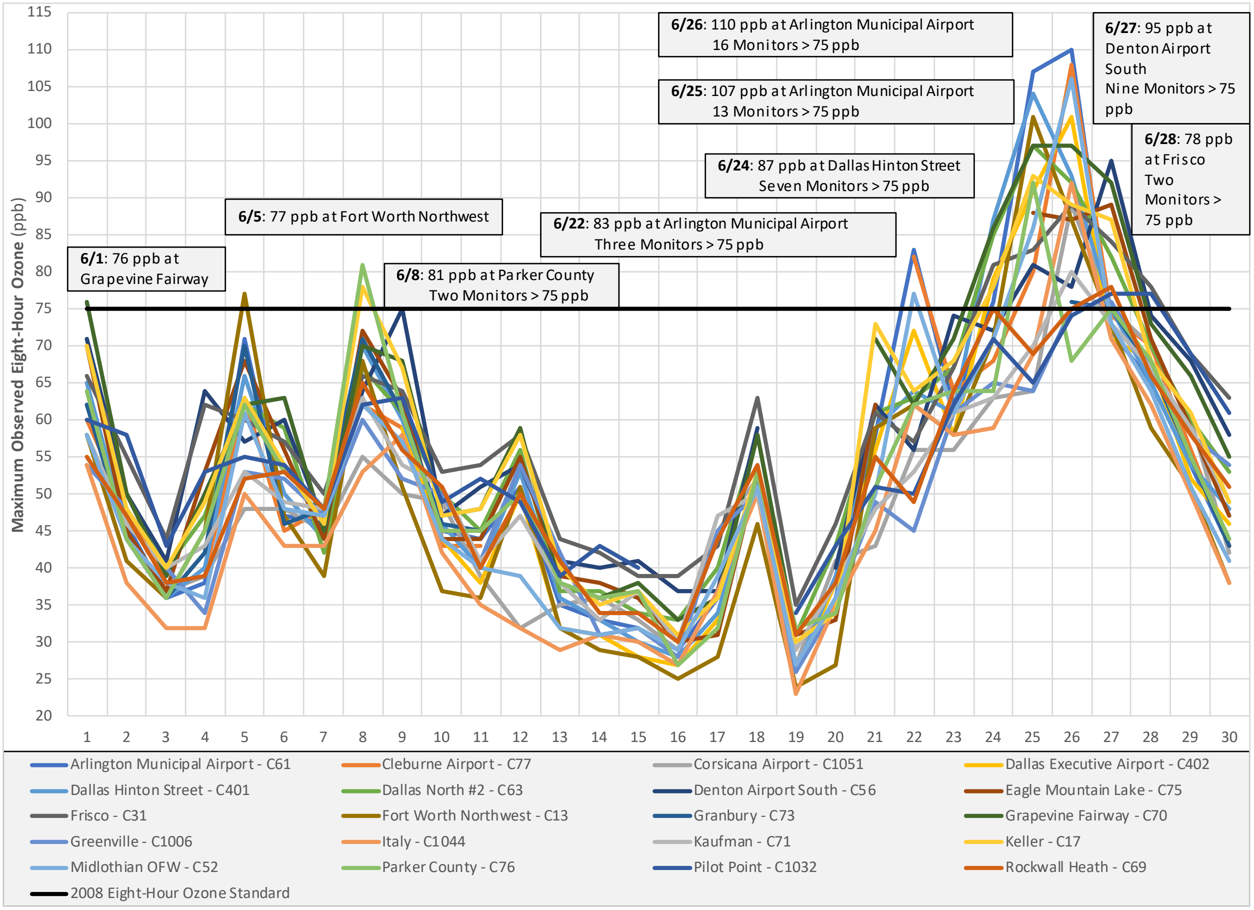


Figure 3-9: June 2012 MDA8 Ozone Concentrations Observed at Regulatory DFW Monitors

1.1.1.2 July 2012

As shown in Figure 3-2, the DFW monitors in July do not typically observe as many elevated eight-hour ozone concentrations as other ozone season months. The location of the Bermuda High (the persistent high-pressure center in the Atlantic Ocean that strongly influences weather patterns throughout the southeast U.S. and the Gulf of Mexico) in July usually directs strong southerly flow from the Gulf of Mexico, bringing cleaner air into the region (Wang, 2015). As shown in Figure 3-10: *July 2012 MDA8 Ozone Concentrations Observed at Regulatory DFW Monitors*, elevated eight-hour ozone concentrations ranging from 76 to 86 ppb were observed on five days in July at six monitors in the DFW area, with four monitors above 75 ppb on July 21, 2012, and the Rockwall Heath (C69) monitor measuring the maximum eight-hour ozone concentration of 86 ppb.

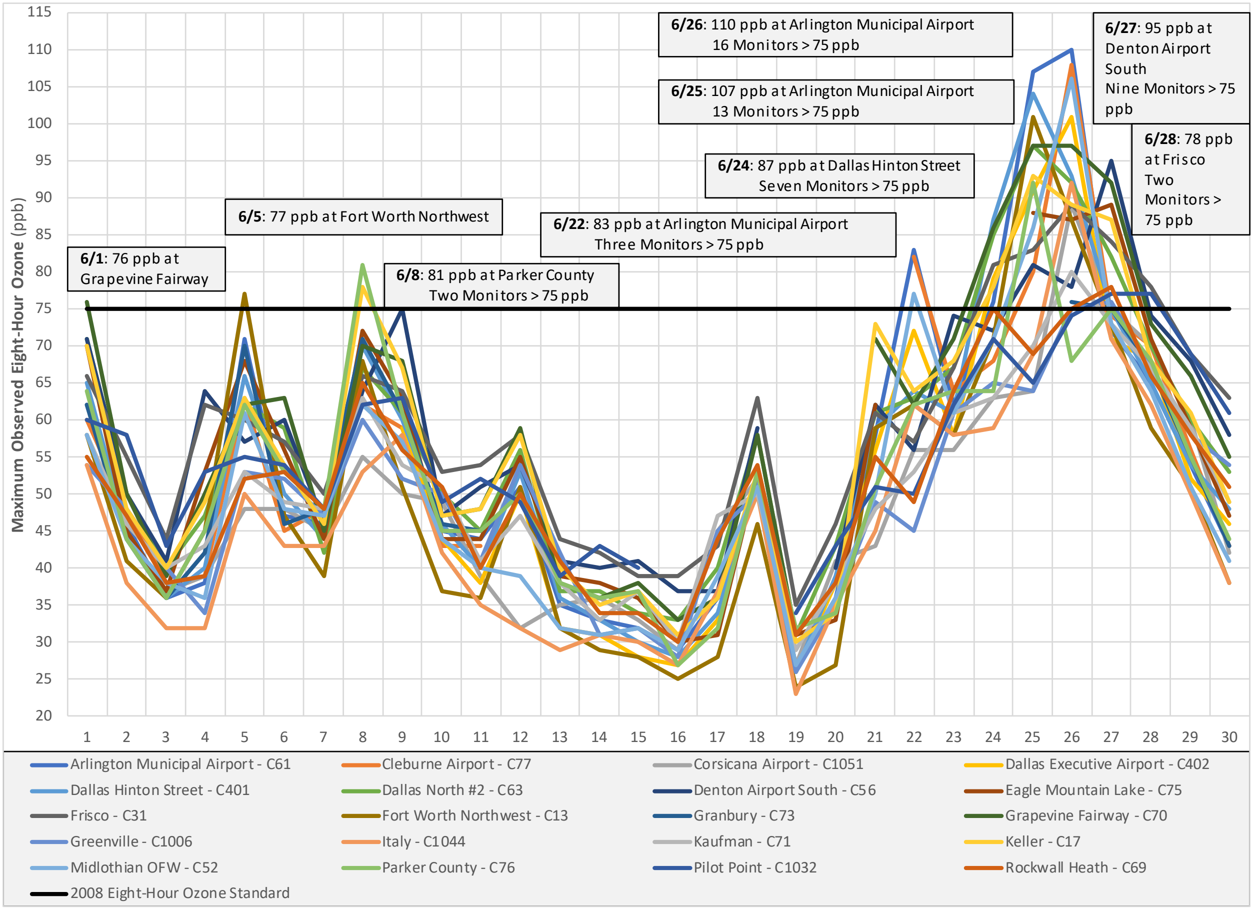


Figure 3-10: July 2012 MDA8 Ozone Concentrations Observed at Regulatory DFW Monitors

1.1.1.3 August 2012

Historically, August is the beginning of the period with the most eight-hour ozone exceedances as shown in Figure 3-2. Six consecutive days recorded eight-hour ozone concentrations exceeding 75 ppb, beginning on August 6, 2012 and ending on August 11, 2012. On August 9, 2012, 16 monitors recorded maximum eight-hour ozone concentrations in excess of 75 ppb, with the Rockwall Heath (C69) monitor measuring a peak eight-hour average of 109 ppb. Eleven other days had monitors with maximum eight-hour ozone above the 2008 eight-hour ozone NAAQS as shown in Figure 3-11: *August 2012 MDA8 Ozone Concentrations at Regulatory DFW Monitors.*

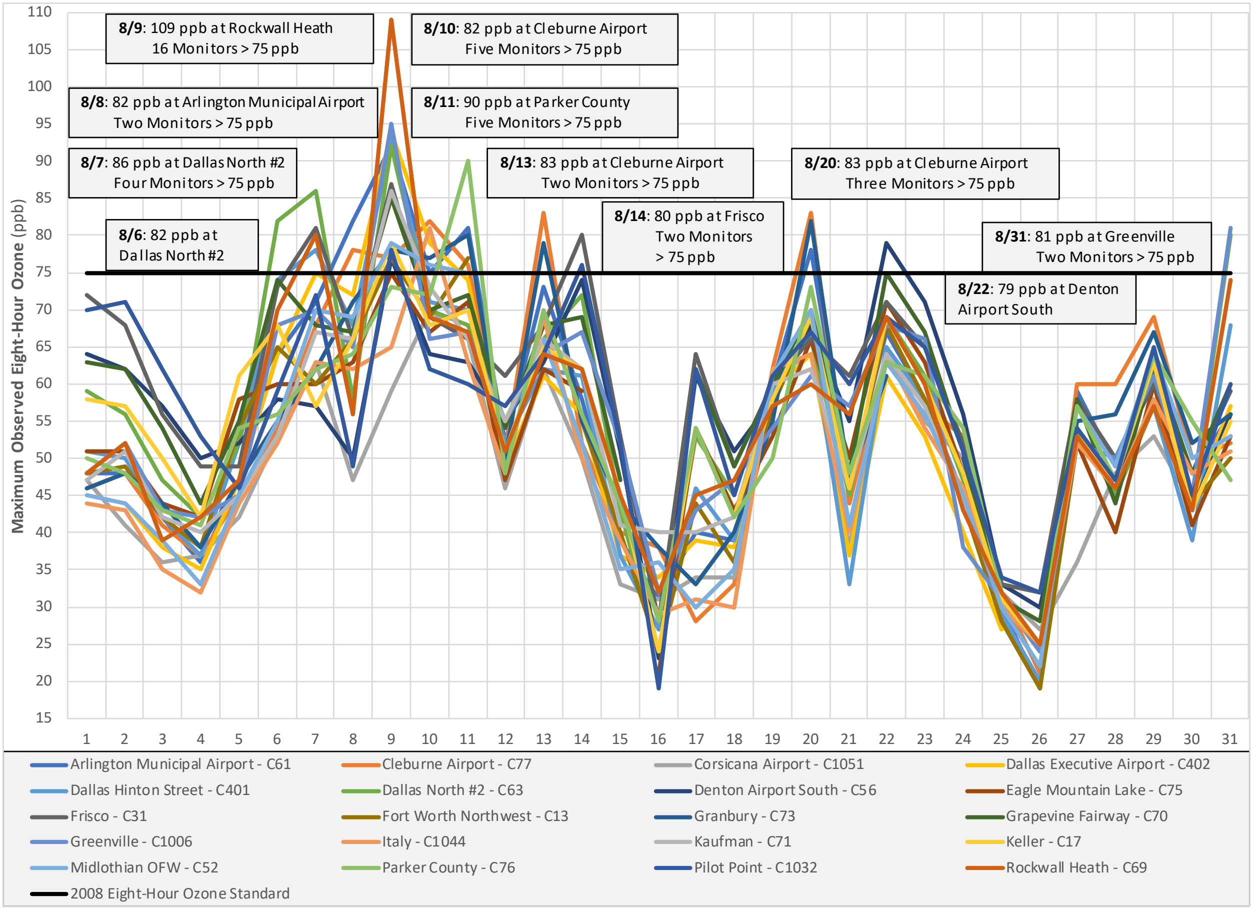


Figure 3-11: August 2012 MDA8 Ozone Concentrations at Regulatory DFW Monitors

1.1.1.4 September 2012

The latter bi-modal peak of eight-hour ozone exceedances in the DFW area typically ends during September, as shown in Figure 3-2. Eight DFW area monitors measured exceedances in September 2012. The highest eight-hour ozone concentration of the month was 89 ppb measured at the Denton Airport South (C56) monitor on September 6, 2012. As shown in Figure 3-12: *September 2012 MDA8 Ozone Concentrations at Regulatory DFW Monitors,* the ozone exceedance days in September 2012 had between two to five monitors each day with peak concentrations above 75 ppb. September 20, 2012 through September 22, 2012 saw three consecutive days with measurements exceeding 75 ppb: Frisco (C31) with peaks of 79 ppb and 82 ppb on September 20, 2012 and September 21, 2012, respectively; and Rockwall Heath (C69) with a peak of 80 ppb on September 22, 2012.

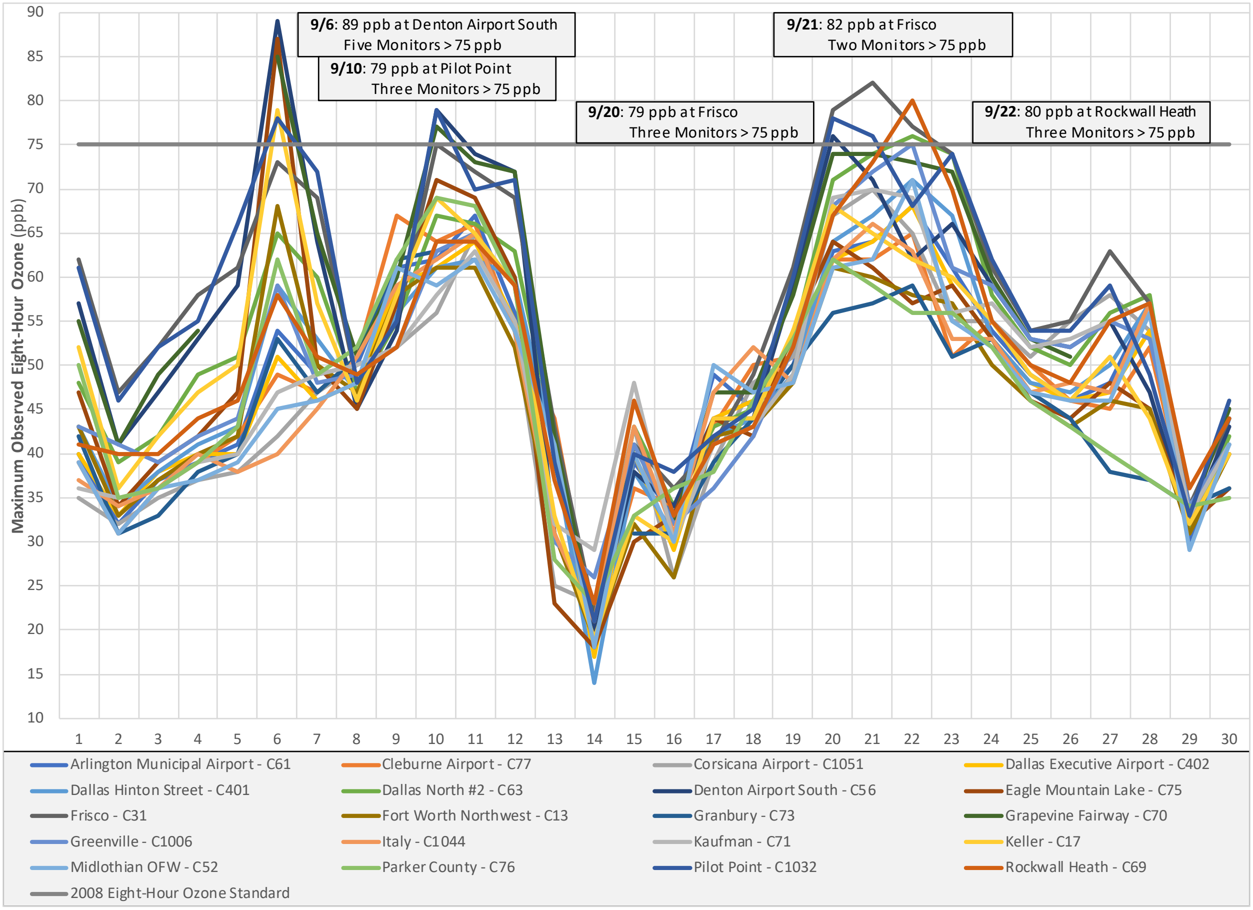


Figure 3-12: September 2012 MDA8 Ozone Concentrations at Regulatory DFW Monitors

3.5 METEOROLOGICAL MODEL

The TCEQ is using the Weather Research and Forecasting (WRF) model to create the meteorological inputs for the photochemical model. The WRF model development is driven by a community effort to provide a modeling platform that supports the most recent research and allows testing in forecast environments. The WRF model was designed to be completely mass conservative and built to allow better flux calculations, both of which help to improve air quality modeling. The WRF model is used by Texas universities, the Central Regional Air Planning Association, the EPA, and many other organizations for their respective meteorological modeling platforms.

3.5.1 Modeling Domains

As shown in Figure 3-13: *WRF Modeling Domains*, the meteorological modeling was configured with three nested grids at a resolution of 36 kilometers (km) for North America (na_36 km), 12 km for Texas plus portions of surrounding states (sus_12 km), and 4 km for the eastern portion of Texas (tx_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 3-3: *WRF Modeling Domain Definitions* provides the specific northing and easting parameters for these grid projections.

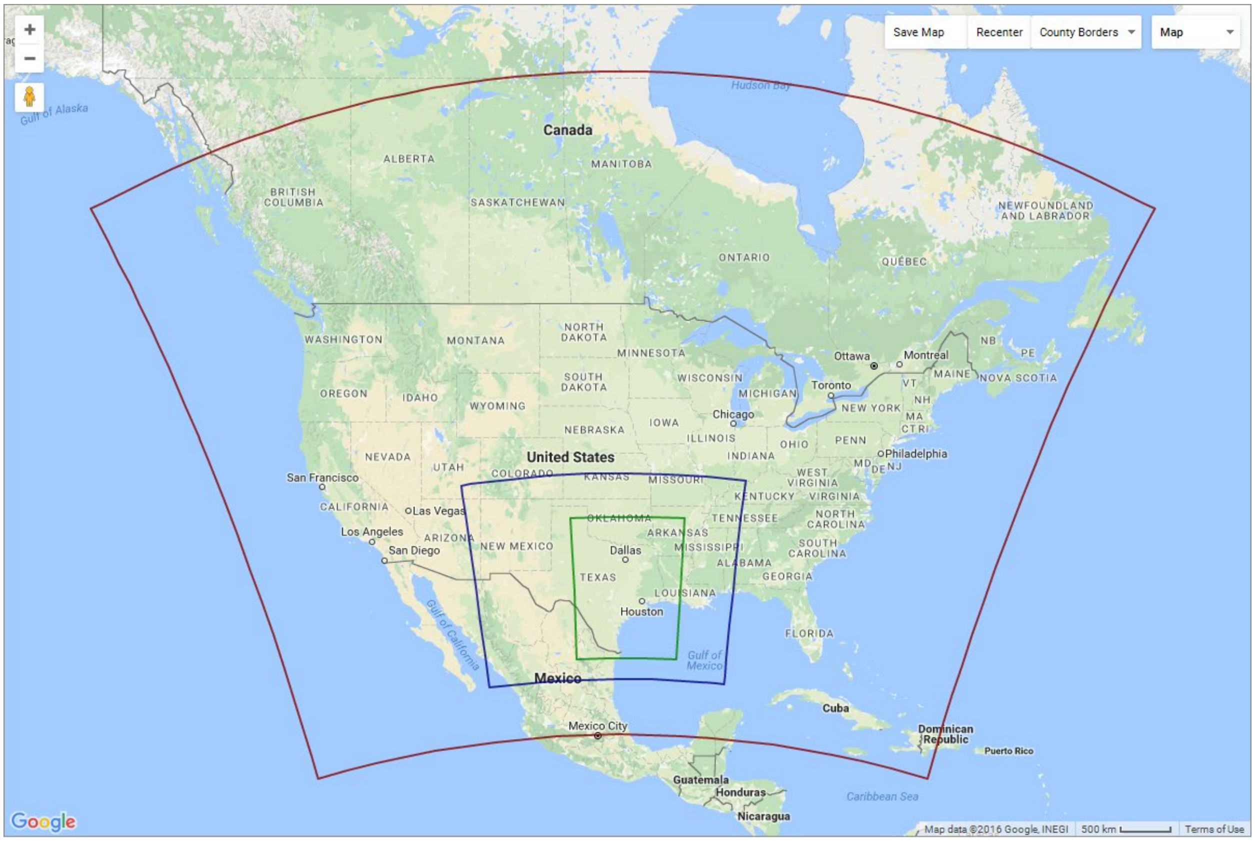


Figure 3-13: WRF Modeling Domains

Table 3-3: WRF Modeling Domain Definitions

Domain	Easting Range (km)	Northing Range (km)	East/West Grid Points	North/South Grid Points	Grid Cell Size (km)
na_36 km	(-2916,2916)	(-2304,2304)	163	129	36
sus_12 km	(-1188,900)	(-1800,-144)	175	139	12
tx_4 km	(-396,468)	(-1620,-468)	217	289	4

The vertical configuration of the WRF modeling domains consists of a varying 44-layer structure used with the three horizontal domains, as shown in Figure 3-14: *WRF Vertical Layer Structure.* Table 3-4: *WRF Vertical Layer and Sigma Layer Details* provides details about the sigma coordinate system, which is used to represent scaled pressure levels. Layers two through 21 are identical to the layers used with the Comprehensive Air Quality Model with Extensions (CAMx), while the other CAMx layers comprise multiple WRF model layers.

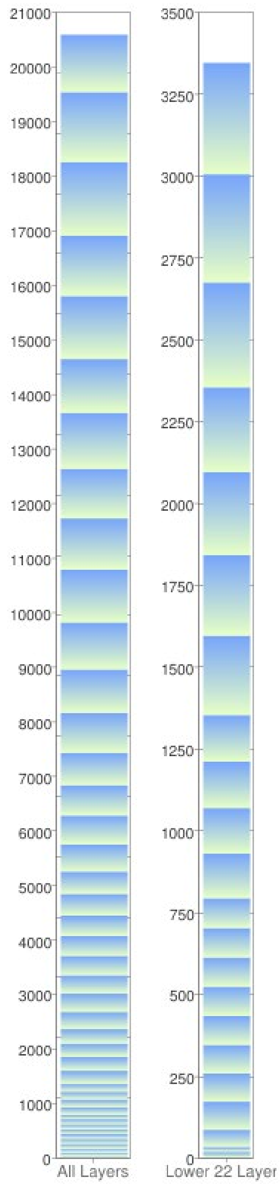


Figure 3-14: WRF Vertical Layer Structure

Table 3-4: WRF Vertical Layer and Sigma Layer Details

WRF Layer	Sigma Level	Top (m AGL)	Center (m AGL)	Thickness (m)
44	0.000	20581	20054	1054
43	0.010	19527	18888	1278
42	0.025	18249	17573	1353
41	0.045	16896	16344	1103
40	0.065	15793	15215	1156
39	0.090	14637	14144	987
38	0.115	13650	13136	1029
37	0.145	12621	12168	906

WRF Layer	Sigma Level	Top (m AGL)	Center (m AGL)	Thickness (m)
36	0.175	11716	11245	941
35	0.210	10774	10294	962
34	0.250	9813	9379	867
33	0.290	8946	8550	792
32	0.330	8154	7790	729
31	0.370	7425	7128	594
30	0.405	6830	6551	559
29	0.440	6271	6007	528
28	0.475	5743	5492	501
27	0.510	5242	5037	410
26	0.540	4832	4636	393
25	0.570	4439	4250	378
24	0.600	4061	3878	365
23	0.630	3696	3520	352
22	0.660	3344	3173	341
21	0.690	3003	2838	330
20	0.720	2673	2513	320
19	0.750	2353	2224	259
18	0.775	2094	1967	253
17	0.800	1841	1717	247
16	0.825	1593	1472	242
15	0.850	1352	1280	143
14	0.865	1209	1138	141
13	0.880	1068	999	139
12	0.895	929	860	137
11	0.910	792	746	91
10	0.920	701	656	90
9	0.930	611	566	89
8	0.940	522	477	89
7	0.950	433	389	88
6	0.960	345	301	87
5	0.970	258	214	87
4	0.980	171	128	86
3	0.990	85	60	51
2	0.996	34	26	17
1	0.998	17	8	17
0	1.000	0	0	0

3.5.2 Meteorological Model Configuration

The selection of the final meteorological modeling configuration for the May through September 2012 episode resulted from numerous sensitivity tests and model performance evaluations. The preparation of WRF input files involves the execution of different models within the Weather Research and Forecasting Model Preprocessing System (WPS). Analysis nudging[9] files are generated as part of WPS preparation of WRF input and boundary condition files. Observational nudging files with radar profiler data were developed separately by the TCEQ.

For optimal photochemical model performance, low-level wind speed and direction are of greater importance than surface temperature. Wind speed and direction determine the placement of emissions while temperature has a minor contribution to ozone formation reactions. 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 radar profiler data and one-hour surface analysis nudging improved wind performance. Using the Pleim-Xiu Land-Surface Model improved the representation of precipitation, temperature, vertical mixing, and PBL depths.

WRF model output was post-processed using the WRFCAMx version 4.3 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 Community Multi-Scale Air Quality modeling system Kv option was used to create the meteorological input for the 2012 CAMx runs. The vertical diffusivity coefficients were modified on a land-use basis to maintain vertical mixing within the first 100 meters of the model overnight using the KVPATCH program (Ramboll Environ, 2012). The diagnosis of sub-grid stratiform clouds was turned on for the 36 km and 12 km domains.

The TCEQ improved the performance of the WRF model through a series of sensitivities. The final WRF model 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 from previous SIP revisions and other modeling exercises. Among all the meteorological variables that can be validated, minimizing wind speed bias was the highest priority for model performance consideration.

[9] Nudging is a form of data assimilation that adjusts dynamic model variables to provide a more realistic representation of atmospheric processes at a specific time. Nudging is a continuous, four-dimensional technique, since the assimilation is applied to a three-dimensional model at every time step over a specified period.

Table 3-5: WRF Model Configuration Parameters

Domain	Nudging Type	PBL	Cumulus	Radiation	Land-Surface	Microphysics
36 km and 12 km	3-D Analysis, and Observations	YSU	Multi-scale Kain-Fritsch	RRTM/ Dudhia *	Pleim-Xiu	WSM5 †
4 km	3-D, Surface Analysis, Soil, and Observations	YSU	Multi-scale Kain-Fritsch	RRTM/ Dudhia *	Pleim-Xiu	WSM6 †

* RRTM = Rapid Radiative Transfer Model
† WSM6 = WRF Single-Moment 5 or 6-Class Microphysics Scheme

3.5.3 WRF Model Performance Evaluation

The WRF modeling was evaluated by comparing the hourly modeled and measured wind speed, wind direction, and temperature for all monitors in the DFW area. Figure 3-15: *2012 DFW Area Average Meteorological Modeling Performance Statistics* 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 the average of DFW area monitors by 2012 episode month. 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.

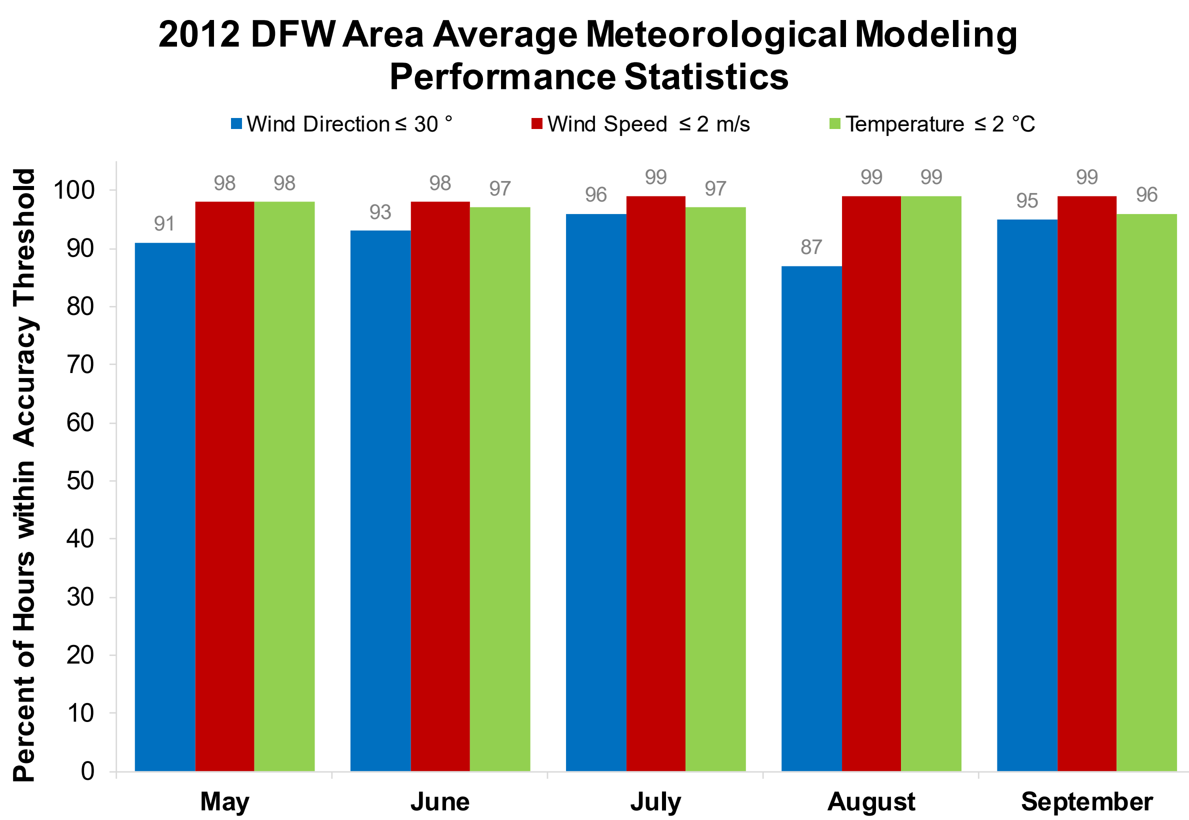


Figure 3-15: 2012 DFW Area Average Meteorological Modeling Performance Statistics

As Figure 3-15 shows, the WRF model performed well for wind speed, wind direction, and temperature for the DFW area. As detailed in Section 3.5.2: *Meteorological Model Configuration*, the WRF model configuration was selected for optimal performance on low-level wind speed since this meteorological variable strongly affects CAMx performance. Wind speed performance was excellent at the individual monitors but observed wind direction is less accurate when wind speeds are low, a condition often observed during ozone exceedances. Table 3-6: *WRF Meteorological Modeling Percent Accuracy by 2012 Month for the DFW Area* 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.

Table 3-6: WRF Meteorological Modeling Percent Accuracy by 2012 Month for the DFW Area

2012 Month for DFW Area Average	Wind Direction (˚) Error ≤ 30 / 20 / 10	Wind Speed (m/s) Error ≤ 2 / 1 / 0.5	Temperature (˚C) Error ≤ 2 / 1 / 0.5
May	91 / 86 / 71	98 / 76 / 48	98 / 73 / 36
June	93 / 88 / 68	98 / 87 / 60	97 / 81 / 45
July	96 / 92 / 71	99 / 89 / 54	97 / 82 / 57
August	87 / 79 / 59	99 / 90 / 58	96 / 73 / 48
September	95 / 91 / 73	99 / 89 / 58	96 / 75 / 41

Appendix A: *Meteorological Modeling for the DFW and HGB Attainment Demonstration SIP Revisions for the 2008 Eight-Hour Ozone Standard* provides additional detail on the development and model performance evaluation of the meteorological modeling for the May through September 2012 period.

3.6 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, on-road mobile source emissions were derived from vehicle miles traveled (VMT) activity output coupled with emission rates from the EPA Motor Vehicle Emission Simulator (MOVES) model. Non-road mobile source emissions were derived from version 2.0 of the Texas NONROAD (TexN2) model and MOVES. 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; Ramboll Environ, 2015). Biogenic emissions were derived from version 3.61 of the Biogenic Emission Inventory System (BEIS; Bash et al., 2016).

An overview is provided in this section of the emission inputs used for the 2012 base case, 2012 baseline, and 2020 future case. Appendix B: *Emissions Modeling for the DFW and HGB Attainment Demonstration SIP Revisions for the 2008 Eight-Hour Ozone Standard* contains more detail on the development and processing of the emissions. 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.

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 (NO), 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	Assign Plume-in-Grid (PiG) emissions and merges elevated point source files

Model-ready emissions were developed for the May through September 2012 period. The following sections give a brief description of the development of each emissions source category.

3.6.1 Biogenic Emissions

The TCEQ used version 3.61 of the BEIS (Bash et al., 2016) within the Sparse Matrix Operation Kernel Emissions (SMOKE) System version 3.7 (available at https://www.cmascenter.org/smoke/). BEIS inputs from SMOKE defaults include the emissions factors input file (b360fac_beld4_csv_nlcd2006.txt) and the CB05 VOC speciation profiles (gspro.cmaq_cb05_soa.txt). The Biogenic Emission Landuse Database version 4.1 (BELD4.1) from EPA Modeling Platform 2011v6_v3 was re-gridded with the Spatial Allocator to create the grid-specific (rpo_36km, tx_12km, and tx_4km) land-use input files.

The WRF model provided the meteorological data needed to run the BEIS model for each 2012episode day. Since biogenic emissions are dependent upon the meteorological conditions on a given day, the same episode-specific emissions were used in the 2012 baseline and 2020 future case modeling scenarios. The summaries of biogenic emissions for each day of the May through September 2012 episode are provided in Appendix B. Figure 3-16: *Sample Biogenic VOC Emissions for June 26, 2012 Episode Day* provides a graphical plot of biogenic VOC emissions distribution at a resolution of 4 km throughout eastern Texas.

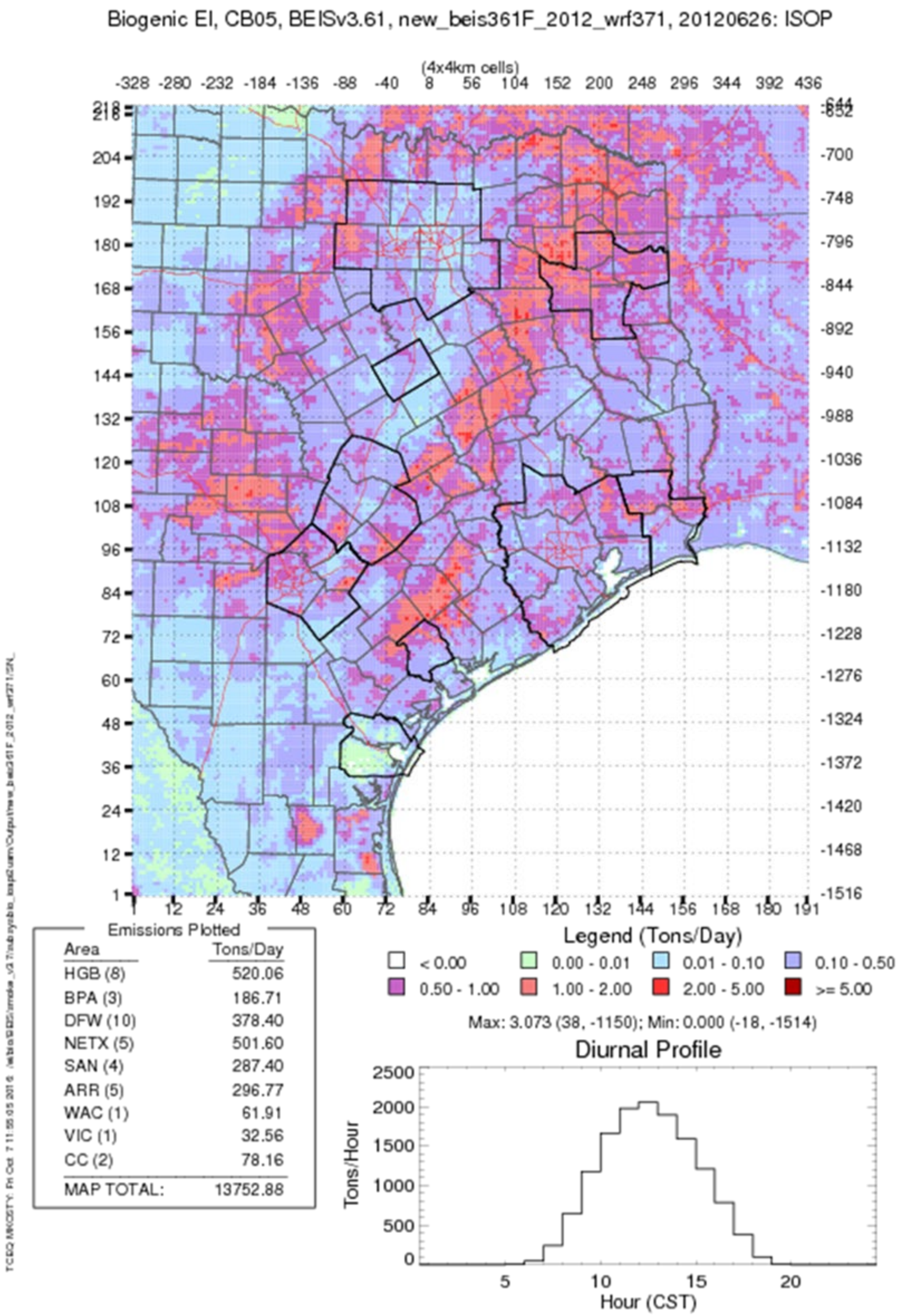


Figure 3-16: Sample Biogenic VOC Emissions for June 26, 2012 Episode Day

3.6.2 2012 Base Case Emissions

3.6.2.1 Point Sources

Point source modeling emissions were developed from regional inventories such as the EPA's 2011 Modeling Platform, the EPA's Air Markets Program Database (AMPD), state inventories including the State of Texas Air Reporting System (STARS), and local inventories. Data were processed with EPS3 to generate model-ready emissions.

Outside Texas

Point source emissions data for the regions of the modeling domains outside of Texas were obtained from several different sources. Emissions from point sources in the Gulf of Mexico (e.g., oil and gas production platforms) were obtained from the 2011 Gulf-Wide Emissions Inventory provided by the U.S. Bureau of Ocean Energy Management. Canadian emissions were obtained from the 2010 National Pollutant Release Inventory from Environment Canada, while Mexican emissions data were interpolated from the EPA's 2011 Modeling Platform (EPA, 2015). For the non-Texas U.S. portion of the modeling domain, hourly NO_X emissions for major electric generating units (EGUs) were obtained from the AMPD for each hour of each base case episode day. Emissions for non-EGU sources in states beyond Texas were obtained from the EPA's 2011 Modeling Platform.

Within Texas

Hourly NO_X emissions from EGUs within Texas were obtained from the AMPD for each base case episode day. Emissions from non-EGU sources were obtained from the STARS database for the year 2012. In addition, agricultural and forest fire emissions for 2012 were created from the Fire Inventory from the National Center for Atmospheric Research, or FINN model. Fires are treated as point sources.

Table 3-8: *2012 Sample Base Case Point Source Emissions for 10-County DFW* provides a summary of the DFW area point source emissions for the Tuesday, August 7, 2012 episode day. The EGU emissions vary each hour of each episode day based on real-time continuous emissions monitoring data that are reported to the EPA's AMPD. Emission estimates for the remaining non-EGU point sources do not vary by specific episode day but are averaged by month for the May through September 2012 period.

Table 3-8: 2012 Sample Base Case Point Source Emissions for 10-County DFW

DFW Point Source Category	NO_X tons per day (tpd)	VOC (tpd)	CO (tpd)
Point – EGUs on August 7, 2012	12.72	4.54	20.59
Point - Cement Kilns	9.03	0.86	9.20
Point - Oil and Gas	17.07	27.05	13.98
Point – Other	7.00	19.83	15.74
10-County DFW Point Source Total	45.82	52.28	59.51

3.6.2.2 On-Road Mobile Sources

The 2012 on-road mobile source emission inputs were developed using the 2014a version of the MOVES model (MOVES2014a). The VMT activity data sets that were used for these efforts are:

- travel demand model (TDM) output from the North Central Texas Council of Governments (NCTCOG) for the DFW area (including Hood and Hunt Counties);
- TDM output from the Houston-Galveston Area Council (H-GAC) for the eight-county HGB area;
- the Highway Performance Monitoring System (HPMS) data collected by the Texas Department of Transportation (TxDOT) for the 234 Texas counties outside of DFW and HGB; and
- the EPA default information included with the MOVES2014a database for the non-Texas U.S. portions of the modeling domain.

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

DFW Area

For the 10-county DFW area, the on-road emissions were developed by the North Central Texas Council of Governments (NCTCOG) using 2012 TDM VMT estimates and MOVES2014a emission rates to generate average school and summer season on-road emissions for four day types: average weekday (Monday-Thursday), Friday, Saturday, and Sunday.

Non-DFW Portions of Texas

For the 234 Texas counties outside of the DFW and HGB areas, on-road emissions were developed by the Texas Transportation Institute (TTI) using MOVES2014a emission rates and 2012 HPMS VMT estimates. Average school and summer season emissions by vehicle type and roadway type were estimated for the four day types of average weekday (Monday-Thursday), Friday, Saturday, and Sunday. TTI also developed link-based on-road emission inventories for the HGB area using 2012 TDM output from H-GAC.

Outside Texas

For the non-Texas U.S. portions of the modeling domain, the TCEQ used MOVES2014a in default mode to generate 2012 July weekday emission estimates for every non-Texas U.S. county. To create the non-Texas Friday, Saturday, and Sunday day types for the summer and school seasons, the 2012 Texas on-road temporal profiles were applied to the non-Texas 2012 summer weekday emissions. For the Canada portion of the modeling domain, a 2012 on-road inventory was interpolated between 2010 and 2017 on-road inventories available from the EPA's 2011 Modeling Platform (EPA, 2014). For the Mexico portion of the modeling domain, a 2012 on-road inventory was interpolated between 2011 and 2023 on-road inventories developed with MOVES-Mexico that were obtained from the EPA's 2011 Modeling Platform (EPA, 2014).

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 and HGB	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
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 Roadway Link	Varies by Hour and Roadway Type	MOVES2014a 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: *2012 Base Case On-Road Modeling Emissions for the 10-County DFW Area* summarizes the on-road mobile source emission estimates for the 2012 base case episode for the 10-county DFW area for all combinations of season and day type. The summer season on-road inventories presented in Table 3-10 were used for modeling episode days from June 1 through August 26, 2012, while the school season inventories were used for modeling episode days from May 1 through May 31, 2012 and August 27 through September 30, 2012.

Table 3-10: 2012 Base Case On-Road Modeling Emissions for the 10-County DFW Area

Season and Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	216.64	92.45	1,194.47
Summer Friday	221.09	94.53	1,290.28
Summer Saturday	159.20	85.20	1,125.34
Summer Sunday	143.88	80.68	970.00
School Weekday	213.30	91.81	1,180.38
School Friday	221.93	94.76	1,296.00
School Saturday	159.01	85.24	1,127.55
School Sunday	141.09	80.14	955.59

3.6.2.3 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 TexN2 for non-road emissions within Texas, MOVES2014b 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 MOVES2014b to generate average summer weekday non-road mobile source emissions by county, specifically for 2012. For the off-road categories of aircraft, locomotive, and commercial marine, the TCEQ used the EPA's 2014 and 2011 NEI to create 2012 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 TexN2 model (ERG, 2018) to generate average summer weekday non-road mobile source category emissions by county for 2012 except for airports and oil and gas drilling rigs emissions, which were estimated separately. Aggregate weekday 2012 non-road emission estimates for the DFW area are detailed in Table 3-11: *2012 Base Case Non-Road Model Source Emissions for the 10-County DFW Area*. During EPS3 processing, temporal adjustments were made to create Saturday and Sunday non-road emission estimates. Table 3-12: *2012 Base Case Non-Road Modeling Emissions by Day Type for the 10-County DFW Area* summarizes these non-road inputs by day type.

Table 3-11: 2012 Base Case Non-Road Model Source Emissions for the 10-County DFW Area

Non-Road Source Classification	NO_X (tpd)	VOC (tpd)	CO (tpd)
Construction and Mining Equipment	27.58	4.88	48.13
Industrial Equipment	17.54	3.16	64.58
Agricultural Equipment	9.99	1.19	9.08
Commercial Equipment	6.95	8.86	190.22
Lawn and Garden Equipment	2.60	15.02	166.16
Pleasure Craft	0.43	3.37	9.01
Recreational Equipment	0.23	5.33	23.54
Railroad Equipment	0.06	0.01	0.06
10-County DFW Non-Road Total	65.38	41.82	510.78

Table 3-12: 2012 Base Case Non-Road Modeling Emissions by Day Type for the 10-County DFW Area

Ozone Season Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	65.38	41.82	510.78
Saturday	49.02	65.78	637.73
Sunday	37.58	58.43	542.45

Airport emission inventories were developed with the Federal Aviation Administration (FAA) Aviation Environmental Design Tool (AEDT) version 2d for 2011 under contract to Eastern Research Group (ERG, 2019). 2011 emission estimates were held constant to

2012. AEDT estimates emissions for aircraft engines, auxiliary power units (APUs), and GSE. The 2012 DFW 10-county area airport emissions are summarized in Table 3-13: *2012 Base Case Airport Modeling Emissions for the 10-County DFW Area*.

Table 3-13: 2012 Base Case Airport Modeling Emissions for the 10-County DFW Area

10-County DFW Area Airport	NO_X (tpd)	VOC (tpd)	CO (tpd)
Dallas-Fort Worth International	11.03	1.89	18.23
Dallas Love Field	1.43	0.66	4.92
Fort Worth Alliance	1.05	0.47	3.57
Other Regional Airports	1.14	2.59	30.62
10-County DFW Airport Total	14.65	5.61	57.34

The 2012 locomotive emissions estimates were developed under contract to ERG (ERG, 2015a). Emissions were estimated separately for Class I line-haul locomotives, Class II and III line-haul locomotives, and railyard switcher locomotives. Table 3-14: *2012 Base Case Locomotive Modeling Emissions for the 10-County DFW Area* summarizes the estimates for all locomotive activity in DFW.

Table 3-14: 2012 Base Case Locomotive Modeling Emissions for the 10-County DFW Area

Locomotive Source Classification	NO_X (tpd)	VOC (tpd)	CO (tpd)
Line-Haul Locomotives - Class I	11.64	0.68	2.42
Line-Haul Locomotives - Classes II and III	0.37	0.03	0.04
Rail Yard Switcher Locomotives	2.95	0.20	0.41
10-County DFW Locomotive Total	14.96	0.91	2.87

3.6.2.4 Area Sources

Area source modeling emissions were developed using the EPA's 2014 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 projected the EPA's 2014 NEI to create 2012 daily area source emissions.

Within Texas

The TCEQ obtained emissions data from the 2014 TexAER database (TCEQ, 2014) and backcast these estimates to 2012 using Texas-specific economic growth factors for non-oil and gas sources. Temporal profiles were applied with EPS3 to obtain the figures presented in Table 3-15: *2012 Base Case Non-Oil and Gas Area Source Emissions for the 10-County DFW Area*.

Table 3-15: 2012 Base Case Non-Oil and Gas Area Source Emissions for the 10-County DFW Area

Ozone Season Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	18.49	227.39	43.50
Saturday	13.71	131.49	37.15
Sunday	8.94	83.44	30.86

The 2012 oil and gas drilling and production emissions were based on contract research projects by ERG (ERG, 2010; ERG, 2011; ERG, 2015) using activity data from the Railroad Commission of Texas (RRC) and emission factors compiled in the 2010, 2011, and 2015b ERG studies. Drilling rigs are non-road sources but are included in the oil and gas production category since the majority of drilling rigs are used for oil and gas production. Emission estimates by equipment type are summarized in Table 3-16: *2012 Base Case Oil and Gas Drilling and Production Emissions for the 10-County DFW Area*.

Table 3-16: 2012 Base Case Oil and Gas Drilling and Production Emissions for the 10-County DFW Area

Aggregate Oil and Gas SCC Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
On-Shore Gas Production	15.15	50.65	11.84
Drilling Rigs	6.60	0.32	1.39
All Processes Not Otherwise Specified	4.15	2.89	1.30
Natural Gas	0.02	0.03	0.04
On-Shore Oil Production	0.01	1.80	0.03
On-Shore Gas Exploration	0.00	15.66	0.00
Crude Petroleum	0.00	0.41	0.00
On-Shore Oil Exploration	0.00	0.21	0.00
10-County DFW Oil and Gas Total	25.93	71.97	14.60

3.6.2.5 Base Case Summary

Typical base case weekday emissions in the 10-county DFW area are summarized by source type in Table 3-17: *2012 Sample Base Case Anthropogenic Emissions for the 10-County DFW Area*. The EGU emissions presented in Table 3-17 are specific to the August 7, 2012 episode day and are different for each of the remaining 152 episode days from May through September 2012.

Table 3-17: 2012 Sample Base Case Anthropogenic Emissions for the 10-County DFW Area

DFW Emission Source Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
On-Road	216.64	92.45	1,194.47
Non-Road	65.38	41.82	510.78
Off-Road – Airports	14.65	5.61	57.34
Off-Road - Locomotives	14.96	0.91	2.87

DFW Emission Source Type	NO_x (tpd)	VOC (tpd)	CO (tpd)
Area Sources	18.49	227.39	43.50
Oil and Gas - Drilling	6.60	0.32	1.39
Oil and Gas - Production	19.33	71.65	13.21
Point - Oil and Gas	17.07	27.05	13.98
Point - Cement Kilns (Ozone Season Average)	9.03	0.86	9.20
Point - EGUs (August 7, 2012)	12.72	4.54	20.59
Point - Non-EGUs (Ozone Season Average)	7.00	19.83	15.74
10-County DFW Total	401.87	492.43	1,883.07

3.6.3 2012 Baseline Emissions

The baseline modeling emissions are based on typical ozone season emissions, except for biogenic 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 2012 base case and baseline. The 2012 baseline emissions for on-road, non-road, off-road, oil and gas, and area sources are the same as used for the 2012 base case episode, since they are based on typical ozone season emissions. The EGU emissions were represented by monthly averages of the 2012 hourly AMPD emissions to reflect EGU emissions throughout the ozone season. Unlike the base case, fire emissions were not included in the 2012 baseline as they are not typical ozone season day emissions.

Table 3-18: *2012 August Baseline Anthropogenic Emissions for the 10-County DFW Area* provides the baseline emissions for an average August weekday. The only difference between Table 3-17 and Table 3-18 is that the former has episode day-specific EGU emissions.

Table 3-18: 2012 August Baseline Anthropogenic Emissions for the 10-County DFW Area

DFW Emission Source Type	NO_x (tpd)	VOC (tpd)	CO (tpd)
On-Road	216.64	92.45	1,194.47
Non-Road	65.38	41.82	510.78
Off-Road – Airports	14.65	5.61	57.34
Off-Road - Locomotives	14.96	0.91	2.87
Area Sources	18.49	227.39	43.50
Oil and Gas - Drilling	6.60	0.32	1.39
Oil and Gas - Production	19.33	71.65	13.21
Point - Oil and Gas	17.07	27.05	13.98
Point - Cement Kilns (Ozone Season Average)	9.03	0.86	9.20
Point - EGUs (August Average)	9.78	3.87	16.61
Point - Non-EGUs (Ozone Season Average)	7.00	19.83	15.74
10-County DFW Total	398.93	491.76	1,879.09

A summary of the 2012 point source baseline emissions by Standard Industrial Classification (SIC) within the 10-county DFW ozone nonattainment area is provided in Table 3-19: *2012 DFW Point Source Baseline Emission Estimates by Industry Type*. The 424 DFW point source facilities operating in 2012 were represented by 94 different SIC types. Nine of these industry types emitted more than 0.5 NO_X tpd in 2012, with 85 other SICs reporting smaller emissions. The crude petroleum and natural gas, electric services, hydraulic cement, and natural gas liquids SICs reported the majority of NO_X and VOC emissions.

Table 3-19: 2012 DFW Point Source Baseline Emission Estimates by Industry Type

SIC Code	SIC Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
1311	Crude Petroleum and Natural Gas	11.21	17.32	9.01
4911	Electric Services	9.93	3.93	17.28
3241	Cement, Hydraulic	9.03	0.86	9.20
1321	Natural Gas Liquids	4.66	5.44	3.97
3274	Lime	1.43	0.01	0.34
4922	Natural Gas Transmission	1.09	2.21	0.77
3312	Blast Furnaces and Steel Mills	0.88	0.89	4.10
3296	Mineral Wool	0.57	0.55	1.27
4953	Refuse Systems	0.55	0.67	2.16
	Remaining 85 SICs Less than 0.5 NO_X tpd	3.53	19.73	7.43
	10-County DFW Point Source Total (94 SICs)	42.88	51.61	55.53

3.6.4 2020 Future Case Emissions

The biogenic emissions used for the 2020 future case modeling are the same episode day-specific emissions used in the base case. Similar to the 2012 baseline, fire emissions were not included in the 2020 future case modeling.

3.6.4.1 Point Sources

Outside Texas

The 2020 non-EGU point source emissions data in Mexico and the non-Texas states were derived by interpolating between the EPA's 2017 and 2023 non-EGU files from the EPA's 2011 Emissions Modeling Platform (EPA, 2014). Non-Texas EGU point source emissions for 2020 were determined based on 2018 AMPD emissions and whether the state had an emissions budget under the 2016 Cross-State Air Pollution Rule (CSAPR) Update.

For non-Texas EGUs in states with prescribed budgets under the CSAPR Update Rule ozone season NO_X program, the 2018 AMPD emissions were scaled to meet the applicable state budgets. For non-Texas EGUs not subject to the CSAPR Update Rule, the 2018 AMPD emissions were used for the 2020 future year. For the Gulf of Mexico point sources, the 2020 emissions were set equal to the 2012 baseline. Canadian point sources were 2023 projections sourced from the EPA's 2011 Modeling Platform (EPA, 2014).

Within Texas

The 2020 future case EGU emission estimates within Texas were based on the 2018 AMPD data and the prescribed CSAPR Update Rule ozone season NO_X program budget of 52,301 NO_X tons for the five-month ozone season of May through September. Since electricity generation varies based on energy demand (higher emissions during hotter days due to increased demand), operational profiles based on 2018 AMPD data were used to allocate hourly emissions for ozone season modeling purposes. Future case EGU estimates accounted for retirements as well as newly permitted EGUs. More details regarding Texas EGU point sources and CSAPR can be found in Appendix B, Section 2.3: *2020 Future Year Point Source Modeling Emissions Development*.

For DFW non-EGU point sources, the 2020 future year emissions were projected from the 2016 STARS data considering the effect of all applicable rules and regulations, including the Emissions Banking and Trading (EBT) programs and expected growth (ERG, 2016). The three cement kilns operating within the DFW ozone nonattainment area were assigned either the maximum ozone season caps that are specified in 30 Texas Administrative Code (TAC) §117.3123 or the EPA's SIP-approved NO_X emissions limit. For non-EGU, non-cement kiln DFW point sources, the available certified emission reduction credits (ERCs), discrete emission reduction credits, and mobile discrete emission reduction credits as of February 2, 2019 needed to offset future emissions growth per nonattainment New Source Review permitting rules were considered when determining 2020 future year emissions. Details regarding the certified credits, the methodology used for determining the appropriate amount of credits that might be used to offset emissions growth in 2020, and the methodology used to distribute the associated emissions are provided in Appendix B, Section 2.3.2.4: *Non-EGU Sources in Nonattainment Areas*.

Table 3-20: *2020 DFW Point Source Future Case Emission Projections by Industry Type* provides a summary of the 2020 point source emission projections by SIC. If a specific facility or group of facilities is subject to an emission program cap threshold or a directly enforceable emissions limit, then that limit is modeled in the future year even if historical operational levels were lower. For example, the cement kilns operated at an average ozone season day level of 9.03 NO_X tpd in 2012, but the 2020 future year is modeled at 15.12 NO_X tpd. This conservative approach of modeling the maximum allowable emission levels ensures that future emissions are not underestimated. Table 3-20 reports 15.21 NO_X tpd for the cement kilns because of an additional 0.09 NO_X tpd of support equipment located at these facilities.

Table 3-20: 2020 DFW Point Source Future Case Emission Projections by Industry Type

SIC Code	SIC Description	NO_X (tpd)	VOC (tpd)	CO (tpd)
3241	Cement, Hydraulic	15.21	1.80	19.39
4911	Electric Services	8.15	0.54	8.23
1311	Crude Petroleum and Natural Gas	3.41	5.71	1.87
3274	Lime	1.85	0.02	0.47
1321	Natural Gas Liquids	1.37	1.22	0.67
4922	Natural Gas Transmission	1.13	1.99	0.65
4953	Refuse Systems	0.68	0.72	2.84
3312	Blast Furnaces and Steel Mills	0.64	0.66	3.01
3296	Mineral Wool	0.57	0.56	1.72
	Remaining 78 SICs Less than 0.5 NO_X tpd	3.08	16.93	6.28
	10-County DFW Point Source Total (87 SICs)	36.09	30.15	45.13

SIP Emissions Year and Emission Credit Generation

The EBT rules in 30 Texas Administrative Code §101.300 and §101.370 define SIP emissions as the state's emission inventory (EI) data from the year that was used to develop the projection-base year inventory for the modeling included in the most recent AD SIP revision. This DFW AD SIP revision revises the SIP emissions years used for point source credit generation to 2018 for EGUs with emissions recorded in the EPA's AMPD and 2016 for all other point sources.

Emission Credit Modeling Sensitivity

As stated earlier, future year emissions estimation in DFW accounts for future year growth projections and the availability of credits to offset possible emissions growth. In the DFW area, emissions from specific point source sectors are projected to decline between 2016 and 2020. A sensitivity modeling run was performed to determine the impact of having future year emissions include all the certified ERCs on 2020 future design value in the DFW area. The sensitivity was performed to ensure that the emissions associated with certified ERCs remain surplus, as required by 30 TAC Chapter 101, Subchapter H, Division 1.

To determine the impact of modeling all certified ERCs as future year emissions, the 2016 historical emissions and unused ERCs (43.4 tons per year of NO_X and 23.6 tons per year of VOC) were modeled as future year emissions for non-EGU, non-cement kiln point sources. The modeling of all ERCs in addition to 2016 historical emissions resulted in a 0.1 ppb increase to the maximum 2020 DV_F (72.65 ppb to 72.75 ppb at the Grapevine Fairway (C70) monitor). The DV_F increased across all monitors in the DFW area with the maximum increase of 0.17 ppb occurring at the Eagle Mountain Lake (C75) monitor. After rounding and truncation, the DV_F of the emission credit sensitivity remains at 72 ppb. Additional details of the emission sensitivity development are provided in Appendix B, Section 2.3.2.4: *Non-EGU Sources in Nonattainment Areas*.

3.6.4.2 On-Road Mobile Sources

The 2020 on-road mobile source emission inputs were developed using MOVES2014a in combination with the following vehicle activity data sets:

- TDM output from NCTCOG for the DFW area (including Hood and Hunt Counties);
- TDM output from H-GAC for the eight-county HGB area;
- HPMS data collected by TxDOT for the 234 Texas counties outside of DFW and HGB; and
- the EPA default information included with the MOVES2014a database for the non-Texas U.S. portions of the modeling domain.

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

DFW Area

For the 10-county DFW area, the on-road emissions were developed by NCTCOG using 2020 TDM VMT estimates from NCTCOG and MOVES2014a emission rates to generate average school and summer season on-road emissions for the four day types of

Monday-Thursday average weekday, Friday, Saturday, and Sunday. On-road mobile source emissions for the 2020 future case for the 10-county DFW area for each season and day type is summarized in Table 3-21: *2020 Future Case On-Road Modeling Emissions for the 10-County DFW Area*.

Table 3-21: 2020 Future Case On-Road Modeling Emissions for the 10-County DFW Area

Season and Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	88.27	53.05	948.01
Summer Friday	89.08	53.84	1,028.46
Summer Saturday	64.34	49.97	903.85
Summer Sunday	59.53	48.22	776.60
School Weekday	86.92	52.77	936.60
School Friday	89.31	53.91	1,032.06
School Saturday	64.18	49.97	905.16
School Sunday	58.42	47.99	764.51

For the 10-county DFW area, the on-road mobile source NO_X emissions are reduced approximately 59% from the 2012 baseline (216.64 tpd) to the 2020 future case (88.27 tpd). VOC emissions are reduced approximately 43% from the 2012 baseline (92.45 tpd) to the 2020 future case (53.05 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 growth in VMT from 2012 through 2020.

Non-DFW Portions of Texas

For the 234 Texas counties outside of DFW and HGB, on-road emissions were developed by the TTI using MOVES2014a emission rates and 2020 HPMS VMT projections for each county. Average school and summer season emissions by vehicle type and roadway type were estimated for the four day types of average weekday (Monday-Thursday), Friday, Saturday, and Sunday. TTI also developed link-based on-road emission inventories for the HGB area using 2020 TDM output from H-GAC.

Outside Texas

For the non-Texas U.S. portions of the modeling domain, the TCEQ used MOVES2014a in default mode to generate 2020 July weekday emission estimates for every non-Texas U.S. county. To create the non-Texas Friday, Saturday, and Sunday day types for the summer and school seasons, the 2020 Texas on-road temporal profiles were applied to the non-Texas 2020 summer weekday emissions. For the Canada portion of the modeling domain, a 2020 on-road inventory was interpolated between 2017 and 2023 on-road inventories available from the EPA's 2011 Modeling Platform (EPA, 2014). For the Mexico portion of the modeling domain, a 2020 on-road inventory was interpolated between 2011 and 2023 on-road inventories developed with MOVES-Mexico that were obtained from the EPA's 2011 Modeling Platform (EPA, 2014).

3.6.4.3 Non-Road and Off-Road Mobile Sources

Outside Texas

For the non-Texas U.S. portion of the modeling domains, the TCEQ used MOVES2014b to generate average summer weekday non-road mobile source emissions by county for 2020. For the off-road categories of aircraft, locomotive, and commercial marine, the TCEQ used the EPA's 2014 NEI to create 2020 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 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 TexN2 model (ERG, 2018) to generate average summer weekday non-road mobile source emissions by county for 2020 except for airports and oil and gas drilling rigs, which were estimated separately. Aggregate weekday 2020 non-road emission estimates for the DFW area are detailed in Table 3-22: *2020 Future Case Non-Road Model Source Emissions for the 10-County DFW Area*. During EPS3 processing, temporal adjustments were made to create Saturday and Sunday non-road emission estimates. Table 3-23: *2020 Future Case Non-Road Modeling Emissions for the 10-County DFW Area* summarizes these non-road inputs by day type.

For the 10-county DFW area, non-road NO_x emissions are reduced by approximately 42% from the 2012 baseline (65.38 tpd) to the 2020 future case (38.18 tpd). VOC emissions decreased approximately 31% from the 2012 baseline (41.82 tpd) to the 2020 future case (28.76 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 growth in overall non-road equipment population and activity from 2012 through 2020.

Table 3-22: 2020 Future Case Non-Road Model Source Emissions for the 10-County DFW Area

Non-Road Source Classification	NO_x (tpd)	VOC (tpd)	CO (tpd)
Construction and Mining Equipment	16.79	3.05	36.98
Industrial Equipment	8.65	0.83	21.84
Agricultural Equipment	4.46	0.41	4.49
Commercial Equipment	5.61	7.14	206.87
Lawn and Garden Equipment	1.98	12.43	165.92
Pleasure Craft	0.43	1.62	7.27
Recreational Equipment	0.22	3.27	23.82
Railroad Equipment	0.04	0.01	0.04
10-County DFW Non-Road Total	38.18	28.76	467.23

Table 3-23: 2020 Future Case Non-Road Modeling Emissions for the 10-County DFW Area

Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	38.18	28.76	467.23
Saturday	29.55	41.77	600.42
Sunday	23.16	37.21	522.32

Airport emission inventories were developed by ERG under contract to TCEQ (ERG, 2019a) with the FAA AEDT tool, which estimates emissions for aircraft engines, APUs, and GSE. The 2020 emission estimates for the DFW 10-county ozone nonattainment area airports are summarized in Table 3-24: *2020 Future Case Airport Modeling Emissions for the 10-County DFW Area*.

Table 3-24: 2020 Future Case Airport Modeling Emissions for the 10-County DFW Area

DFW Area Airport	NO_X (tpd)	VOC (tpd)	CO (tpd)
Dallas-Fort Worth International	15.97	2.35	22.69
Dallas Love Field	2.09	0.39	3.72
Fort Worth Alliance	0.88	0.23	1.49
Other Regional Airports	0.27	0.39	12.82
10-County DFW Airport Total	19.21	3.36	40.72

The 2020 locomotive emission estimates were developed using emission rate and activity adjustment factors from an ERG study (ERG, 2015a). Emissions were estimated separately for Class I line-haul locomotives, Class II and III line-haul locomotives, and rail-yard switcher locomotives. Table 3-25: *2020 Future Case Locomotive Emissions for the 10-County DFW Area* summarizes these estimates for all locomotive activity.

For the 10-county DFW area, the locomotive NO_X emissions are estimated to be reduced by about 22% from the 2012 baseline (14.96 tpd) to the 2020 future case (11.74 tpd), and the VOC emissions are decreased about 36% from the 2012 baseline (0.91 tpd) to the 2020 future case (0.58 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 3-25: 2020 Future Case Locomotive Emissions for the 10-County DFW Area

Locomotive Source Classification	NO_X (tpd)	VOC (tpd)	CO (tpd)
Line-Haul Locomotives - Class I	8.66	0.37	2.62
Line-Haul Locomotives - Classes II and III	0.38	0.03	0.05
Rail Yard Switcher Locomotives	2.70	0.18	0.45
10-County DFW Locomotive Total	11.74	0.58	3.12

3.6.4.4 Area Sources

Outside Texas

For the non-Texas U.S. within the modeling domains, the TCEQ used the EPA's 2014 NEI projected to 2020 for area source emissions.

Within Texas

The TCEQ used area source data from the 2017 TexAER database (TCEQ, 2017), and projected these estimates to 2020 using the Texas-specific growth factors for 2017 through 2020 for non-oil and gas sources (ERG, 2016). Temporal profiles were applied with EPS3 to obtain the figures presented in Table 3-26: *2020 Future Case Non-Oil and Gas Area Source Emissions for 10-County DFW*.

Table 3-26: 2020 Future Case Non-Oil and Gas Area Source Emissions for 10-County DFW

Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
Monday – Friday Average Weekday	34.47	303.98	46.09
Saturday	24.12	163.81	35.46
Sunday	13.78	106.83	24.91

For oil and gas sources, DFW production emissions estimated for 2017 based on RRC data were projected to the 2020 future case using historical RRC production data from 2017-to-2018 and basin-specific growth factors from 2018-to-2020 (ERG, 2016). County-level drilling rig emission estimates were based on the latest available drilling activity data from the RRC for 2017 and 2020 emission rates from an ERG study (ERG, 2015). Drilling rigs are non-road sources but are reported with oil and gas production sources. The results are summarized in Table 3-27: *2020 Oil and Gas Drilling and Production Emissions for the 10-County DFW Area*.

Table 3-27: 2020 Oil and Gas Drilling and Production Emissions for the 10-County DFW Area

Aggregate Oil and Gas Equipment Type	NO_X (tpd)	VOC (tpd)	CO (tpd)
On-Shore Gas Production	6.40	30.17	4.73
Drilling Rigs	0.12	0.01	0.01
All Processes Not Otherwise Specified	0.26	0.96	0.33
Natural Gas	0.00	0.01	0.01
On-Shore Oil Production	0.01	0.82	0.01
On-Shore Gas Exploration	0.00	9.77	0.00
Crude Petroleum	0.00	1.32	0.00
On-Shore Oil Exploration	0.00	0.08	0.00
10-County DFW Oil and Gas Total	6.79	43.14	5.09

3.6.4.5 Future Case Summary

Typical 2020 future case weekday emissions in the 10-county DFW area are summarized by source type in Table 3-28: *2020 Future Case Anthropogenic Emissions for the 10-County DFW Area*.

Table 3-28: 2020 Future Case Anthropogenic Emissions for the 10-County DFW Area

DFW Emission Source Type	NO_x (tpd)	VOC (tpd)	CO (tpd)
On-Road	88.27	53.05	948.01
Non-Road	38.18	28.76	467.23
Off-Road – Airports	19.21	3.36	40.72
Off-Road – Locomotives	11.74	0.58	3.12
Area Sources	34.47	303.98	46.09
Oil and Gas – Drilling	0.12	0.01	0.01
Oil and Gas – Production	6.67	43.13	5.08
Point - Oil and Gas	6.04	11.59	3.51
Point - Cement Kilns (Ozone Season Average)	15.21	1.80	19.39
Point - EGUs (August Average)	8.05	0.45	7.89
Point - Non-EGUs (Ozone Season Average)	6.79	16.31	14.34
10-County DFW Total	234.75	463.02	1,555.39

3.6.5 2012 and 2020 Modeling Emissions Summary for DFW

Table 3-29: *2012 Baseline and 2020 Future Modeling Emissions for the 10-County DFW Area* provides side-by-side comparisons of the NO_x and VOC emissions by source category from Table 3-18 and Table 3-28 for an average August summer weekday. The total 10-county DFW area anthropogenic NO_x emissions are projected to be reduced by approximately 41% from 2012 (398.93 tpd) to 2020 (234.75 tpd). The total 10-county DFW area anthropogenic VOC emissions are projected to be reduced by 6% from 2012 (491.76 tpd) to 2020 (463.02 tpd).

Table 3-29: 2012 Baseline and 2020 Future Modeling Emissions for the 10-County DFW Area

DFW Emission Source Type	2012 NO_x (tpd)	2020 NO_x (tpd)	2012 VOC (tpd)	2020 VOC (tpd)
On-Road	216.64	88.27	92.45	53.05
Non-Road	65.38	38.18	41.82	28.76
Off-Road – Airports	14.65	19.21	5.61	3.36
Off-Road – Locomotives	14.96	11.74	0.91	0.58
Area Sources	18.49	34.47	227.39	303.98
Oil and Gas – Drilling	6.60	0.12	0.32	0.01
Oil and Gas – Production	19.33	6.67	71.65	43.13
Point - Oil and Gas	17.07	6.04	27.05	11.59
Point - Cement Kilns (Ozone Season Average)	9.03	15.21	0.86	1.80
Point - EGUs (August Average)	9.78	8.05	3.87	0.45
Point - Non-EGUs (Ozone Season Average)	7.00	6.79	19.83	16.31
10-County DFW Total	398.93	234.75	491.76	463.02

Figure 3-17: *2012 Baseline and 2020 Future Modeling Emissions for the 10-County DFW Area* graphically compares the anthropogenic NO_x and VOC emission estimates presented in Table 3-29.

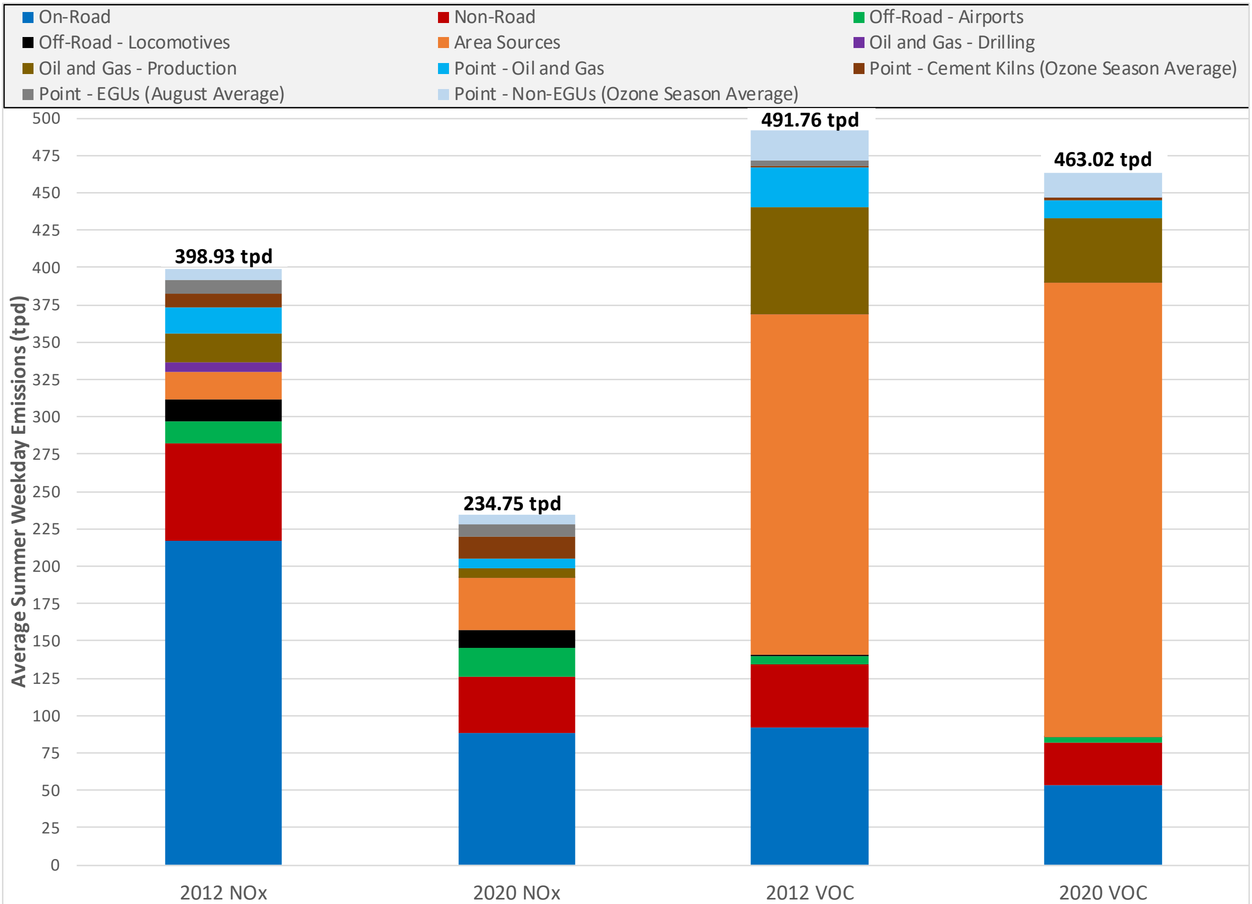


Figure 3-17: 2012 Baseline and 2020 Future Modeling Emissions for the 10-County DFW Area

3.7 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. Consistent with the modeling guidance, the TCEQ used the following three prerequisites for selecting the air quality model to be used in the DFW attainment demonstration. The model must:

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

The only model to meet all three of these criteria is CAMx. The model is based on well-established treatments of advection, diffusion, deposition, and chemistry. Another important feature is that NO_X emissions from large point sources can be treated with the Plume-in-Grid (PiG) sub-model, which helps avoid the artificial diffusion that occurs when large, hot, point source emissions are introduced into a grid volume. The model software and the CAMx user's guide are publicly available (Ramboll, 2018). In addition, the TCEQ has many years of experience with CAMx. CAMx was used in previous HGB and DFW attainment demonstration SIP revisions, as well as for modeling being conducted in other areas of Texas by the TCEQ and other groups.

3.7.1 Modeling Domains and Horizontal Grid Cell Size

Figure 3-18: *CAMx Modeling Domains* and Table 3-30: *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 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.

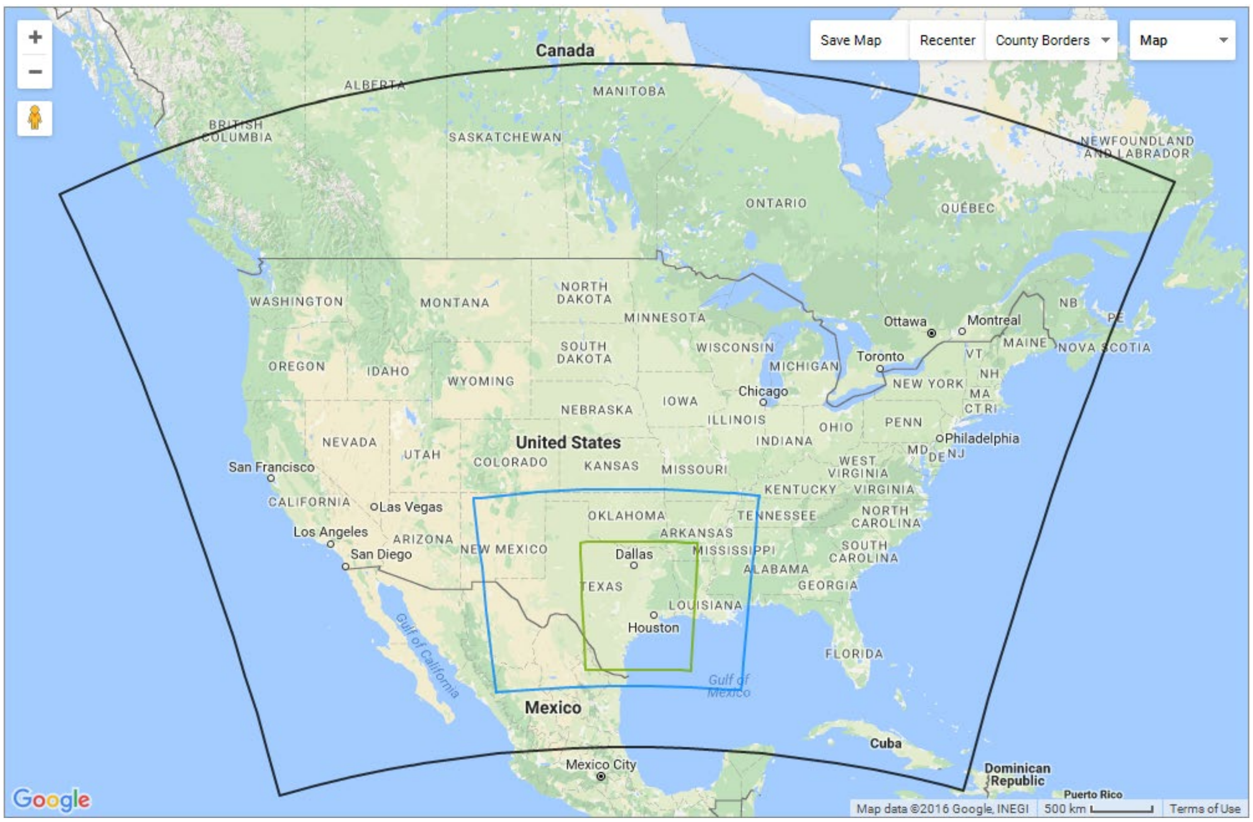


Figure 3-18: CAMx Modeling Domains

Table 3-30: 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)

3.7.2 Vertical Layer Structure

The vertical configuration of the CAMx modeling domains consists of 29 layers of varying depths in units of meters (m) above ground level (AGL) as shown in Table 3-31: *CAMx Vertical Layer Structure*.

Table 3-31: CAMx Vertical Layer Structure

CAMx Layer	WRF Layer	Top (m AGL)	Center (m AGL)	Thickness (m)
29	42	18250	16445	3611
28	39	14639	13632	2015
27	37	12624	10786	3675
26	33	8949	7891	2115
25	30	6833	6289	1088
24	28	5746	5290	911
23	26	4835	4449	772
22	24	4063	3704	717
21	22	3346	3175	341
20	21	3005	2840	330
19	20	2675	2515	320
18	19	2355	2225	259
17	18	2096	1969	253
16	17	1842	1718	248
15	16	1595	1474	242
14	15	1353	1281	143
13	14	1210	1140	141
12	13	1069	1000	139
11	12	930	861	138
10	11	792	747	91
9	10	702	656	90
8	9	612	567	89
7	8	522	478	89
6	7	433	389	88
5	6	345	302	87
4	5	258	215	87
3	4	171	128	86
2	3	85	60	51
1	2	34	17	34

3.7.3 Model Configuration

The TCEQ used CAMx version 6.50, which includes a number of upgrades and features from previous versions (Ramboll Environ, 2016). The following CAMx 6.50 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;
- new gas-phase chemistry mechanisms for Carbon Bond 6 (CB6) speciation and CB6 "revision 4" (CB6r4h), which added condensed halogen chemistry and inline sea salt emissions; and
- Wesely dry deposition scheme.

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 ran the global atmospheric chemistry model driven by assimilated meteorological observations from the Goddard Earth Observing System (GEOS-Chem) for 2012 and 2020 to derive episode-specific boundary and initial conditions. Boundary conditions were developed for each grid cell along all four edges of the outer 36 km modeling domain at each of the 29 vertical layers for each episode hour. Boundary conditions for the top of the modeling domain were also developed.

Surface characteristic parameters, including topographic elevation, leaf area index (LAI), vegetative distribution, and water/land boundaries are input to CAMx via a land-use file. The land-use file provides the fractional contribution (zero to one) 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 Land use Database 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, LandSat, National Institute of Statistics and Geography, and the NLCD. Monthly averaged LAI was created from the eight-day 1 km resolution Moderate-Resolution Imaging Spectroradiometer (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 Tropospheric Ultraviolet Visible model.

3.7.4 Model Performance Evaluation

The CAMx model configuration was applied to the 2012 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 many modeling iterations to implement improvements to the meteorological modeling, emissions modeling, and subsequent CAMx modeling. A detailed performance evaluation for the 2012 base case modeling episode is included in Appendix C: *Regional and Global Photochemical Modeling for the DFW and HGB Attainment Demonstration SIP Revisions for the 2008 Serious Classification Eight-Hour Ozone Standard*. Model performance evaluation products are available on the TCEQ modeling files FTP site (ftp://amdaftp.tceq.texas.gov/pub/TX/). Interactive model performance evaluation tools are available on the TCEQ Photochemical Modeling webpage (https://www.tceq.texas.gov/airquality/airmod/data/tx2012).

3.7.4.1 Performance Evaluations Overview

The performance evaluation of the base case modeling demonstrates the adequacy of the model to replicate the relationship between levels of ozone and the emissions of NO_x and VOC precursors. 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 modeling guidance (EPA, 2018), the TCEQ has incorporated the recommended eight-hour performance measures into its evaluations but also focuses on one-hour performance analyses, especially in the DFW area. The localized small-scale (i.e., high resolution) meteorological and emissions features characteristic of the DFW area require model evaluations to be performed at the highest resolution possible to determine whether the model is getting the right answer for the right reasons.

3.7.4.2 Operational Evaluations

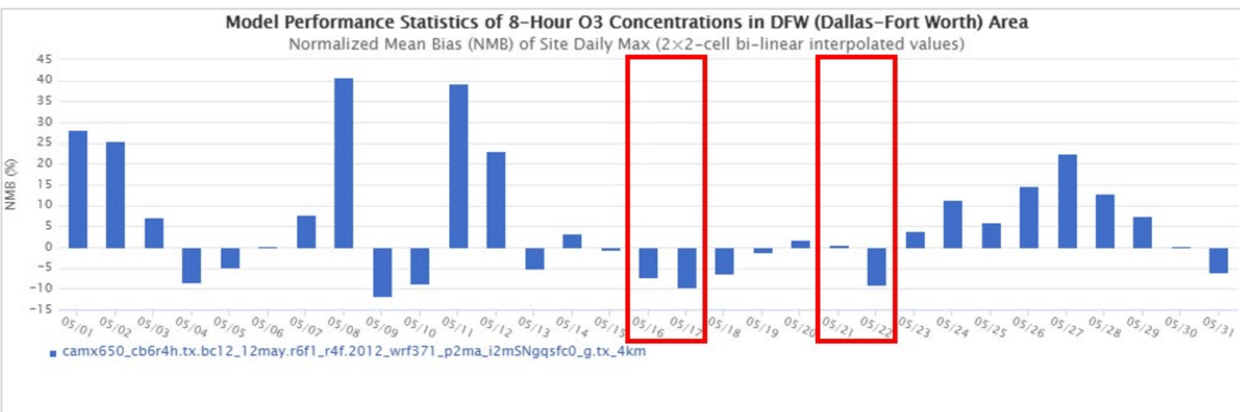
Statistical measures of the Normalized Mean Bias (NMB) and the Normalized Mean Error (NME) were calculated by comparing monitored (measured) and four-cell bi-linearly interpolated modeled ozone concentrations for all episode days and monitors. For one-hour ozone comparisons, the EPA formerly recommended ranges of ±15% for bias and a 30% level for error, which is always positive because it is an absolute value. There are no recommended eight-hour ozone criteria for NMB and NME. Graphical measures including time series and scatter plots of hourly measured and bi-linearly interpolated modeled ozone were developed. 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. 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 2012 base case modeling episode are included in Appendix C.

May through September Statistical and Graphical Evaluations

Modeling the May through September 2012 period has provided a wealth of data to evaluate. Because of the limited time for development of this DFW AD SIP revision, evaluations were limited to DFW area monthly summary statistics along with time series and scatter plots for the design-value setting Grapevine Fairway (C70) monitor. These performance evaluations provide many of the operational evaluation metrics suggested in the EPA's modeling guidance. Overall, the modeling replicated the periods of high ozone well, though under-predicted some of the highest peaks. Additional model performance evaluation is included in Appendix C and available on the TCEQ Texas Air Quality Modeling Files webpage (https://www.tceq.texas.gov/airquality/airmod/data/tx2012).

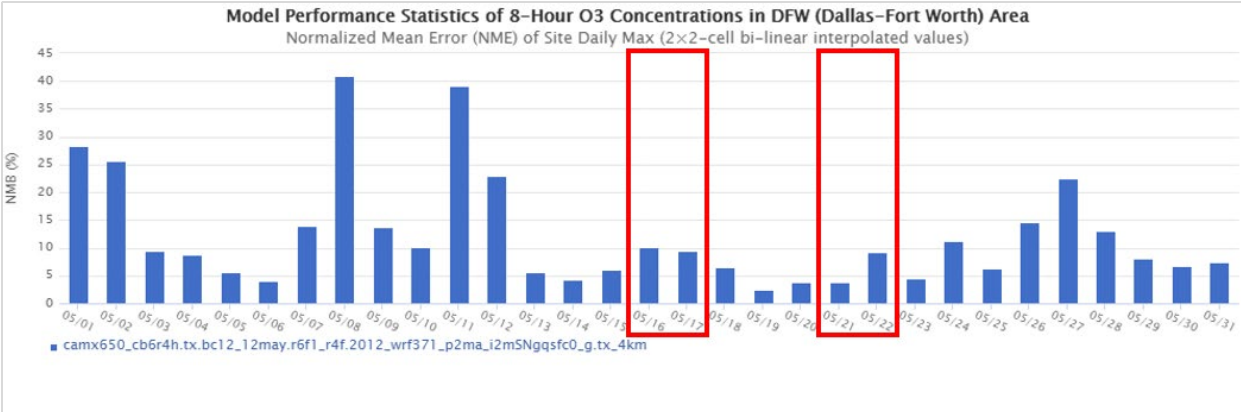
May 2012

May 2012 had four days with site MDA8 concentrations above 75 ppb (see Figure 3-8). On those days the model under-predicted the site daily maximums slightly as shown in Figure 3-19: *May 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors*. On the high ozone days the photochemical model performed well, replicating the average site daily maximum eight-hour ozone concentrations within approximately 10% as shown in Figure 3-20: *May 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors*. The model performed well on most other days during the period, with a few days, e.g., May 8, performing poorly. Those poor performing days had peak eight-hour concentrations less than 60 ppb and were not included in the attainment test calculation.



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-19: May 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-20: May 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors

At the Grapevine Fairway (C70) monitor, the photochemical model primarily followed the diurnal pattern of eight-hour ozone but under-predicted the nighttime minimums frequently as shown in Figure 3-21: *May 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)*. The model prediction for May 1 through May 31 (x-axis) is shown as the continuous line with the three-by-three cell maximum and minimum range shown as the shaded region. The observations are shown as dots corresponding to the y-axis. Eight-hour ozone peaks on the four days above 75 ppb were under-predicted by the model. Hourly NO_X concentrations were well represented, although the model over-predicted the overnight minimums on May 14, 16, and 17, perhaps due to improper vertical mixing as shown in Figure 3-22: *May 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)*. The scatter plot of hourly ozone at the Grapevine Fairway (C70) monitor exhibits the model's ability to replicate the concentrations (shown as dots) throughout May, with only the highest concentrations not matched, as shown in Figure 3-23: *May 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)*. The squares exhibit the Quantile-Quantile plot (Q-Q plot), which compares how well the model predicts concentrations in the same range as the observed without respect to time.

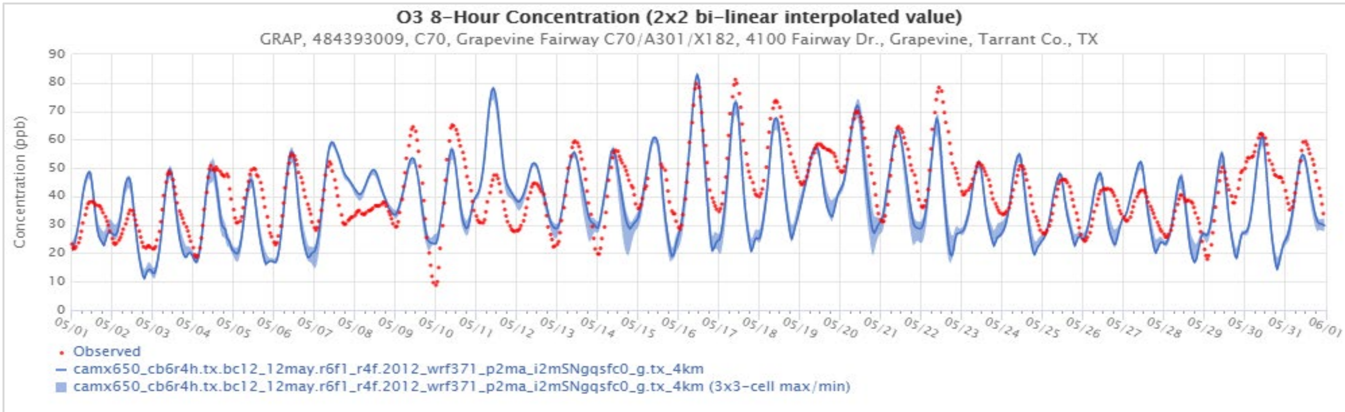


Figure 3-21: May 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)

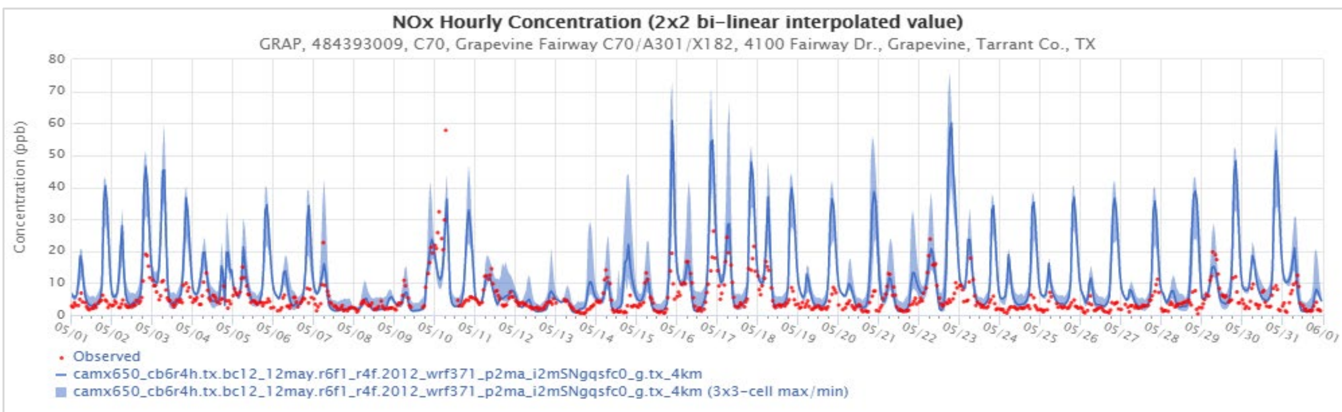


Figure 3-22: May 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway

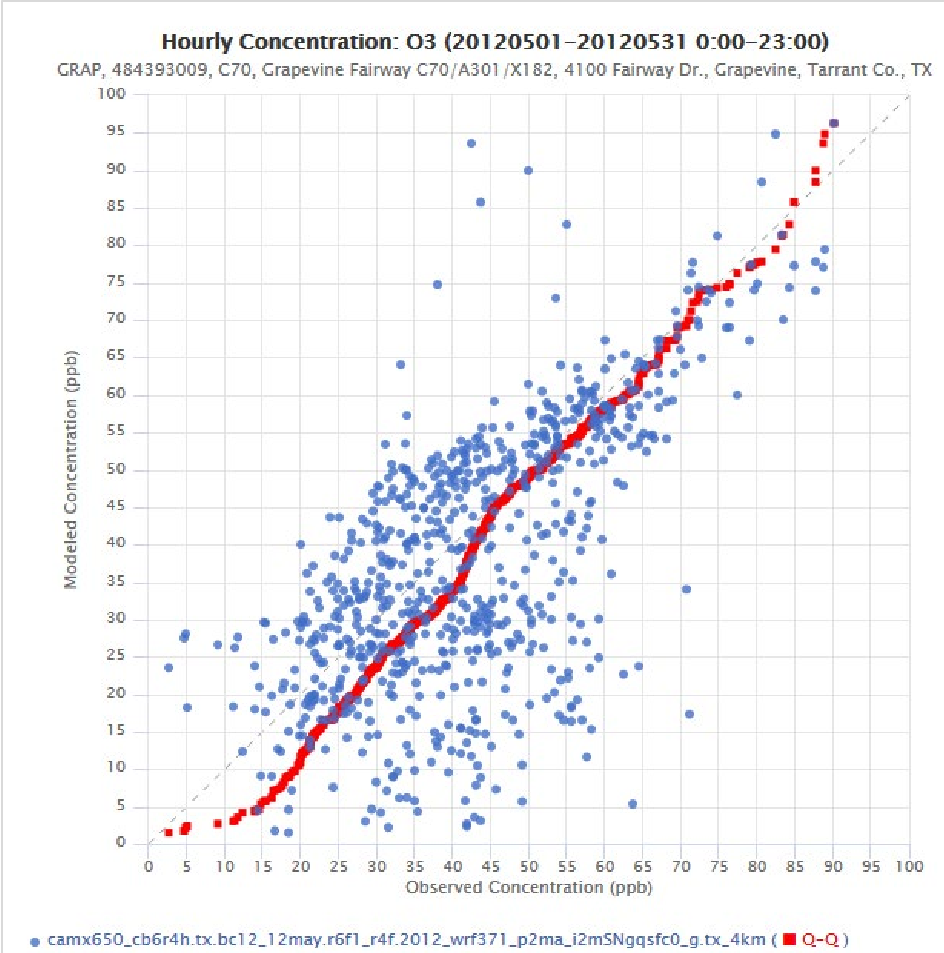
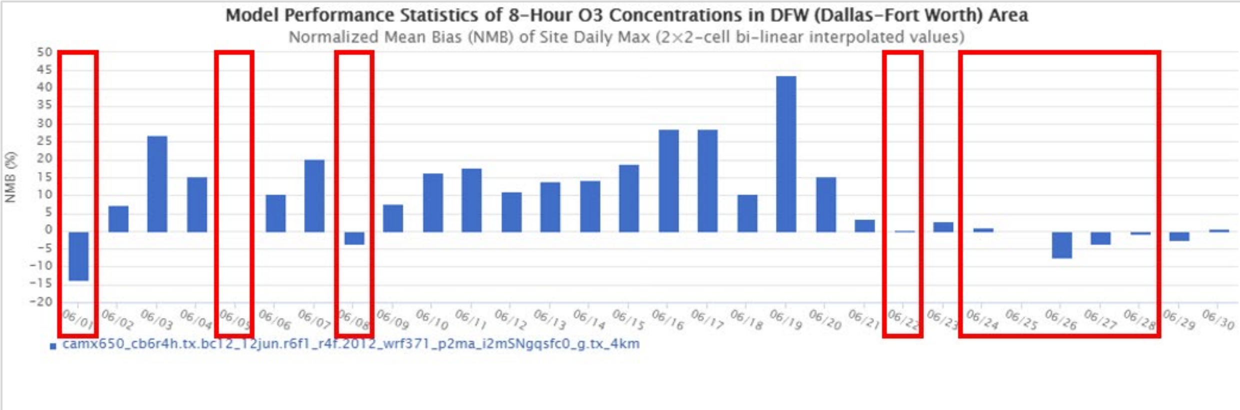


Figure 3-23: May 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)

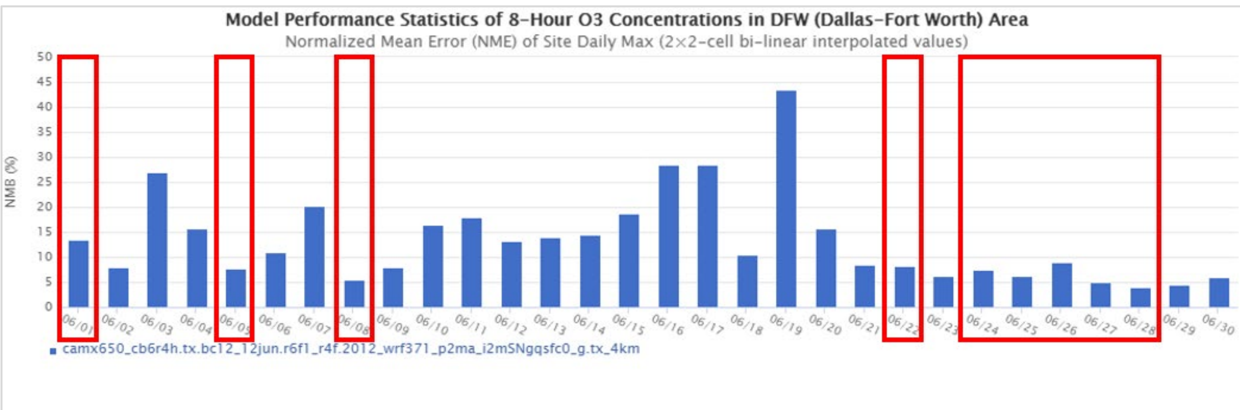
<u>June 2012</u>

June 2012 had nine days where DFW monitors observed eight-hour ozone concentrations greater than 75 ppb (see Figure 3-9). On the highest monitored day of 2012, June 26, the model under-predicted the DFW site MDA8 ozone concentrations but bias was within 10% of the measured ozone values as depicted in Figure 3-24: *June 2012 Normalized Mean Bias of Site* MDA8 *Ozone for the DFW Area Monitors*. In general, the photochemical model produced site daily maximum concentrations within 15% of observations on those days, outlined in boxes, in Figure 3-25: *June 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors.*



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-24: June 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-25: June 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors

In June 2012, the photochemical model predicted the observed eight-hour ozone concentrations at the Grapevine Fairway (C70) monitor very well. The Grapevine Fairway (C70) monitor measured its highest eight-hour concentration of 2012 on June 25 and 26 at 97 ppb. The model underpredicted both days as shown in Figure 3-26: *June 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)*. Observed NO_X at the Grapevine Fairway (C70) monitor on June 26 and 26 peaked in the afternoons above 25 ppb, which the model matched well, as depicted in Figure 3-27: *June 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)*. However, the model had a significant high bias on most morning hours, which may have limited ozone formation. Most afternoons during the month were simulated well for NO_X at the Grapevine Fairway (C70) monitor. The scatter plot of hourly ozone at the Grapevine Fairway (C70) monitor, Figure 3-28: *June 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)*, shows the model correctly predicts the low and moderate concentrations of hourly ozone but misses the highest concentrations in June 2012.

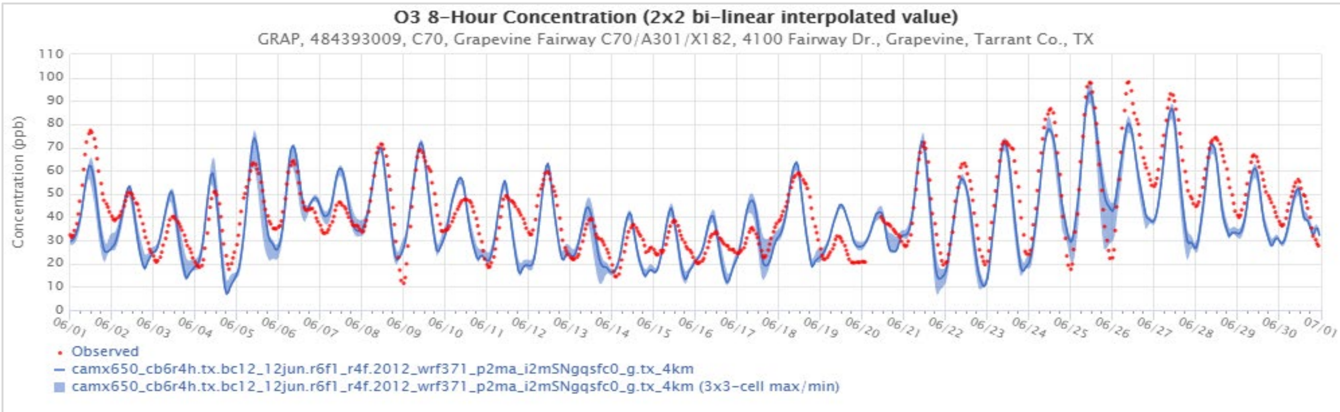


Figure 3-26: June 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)

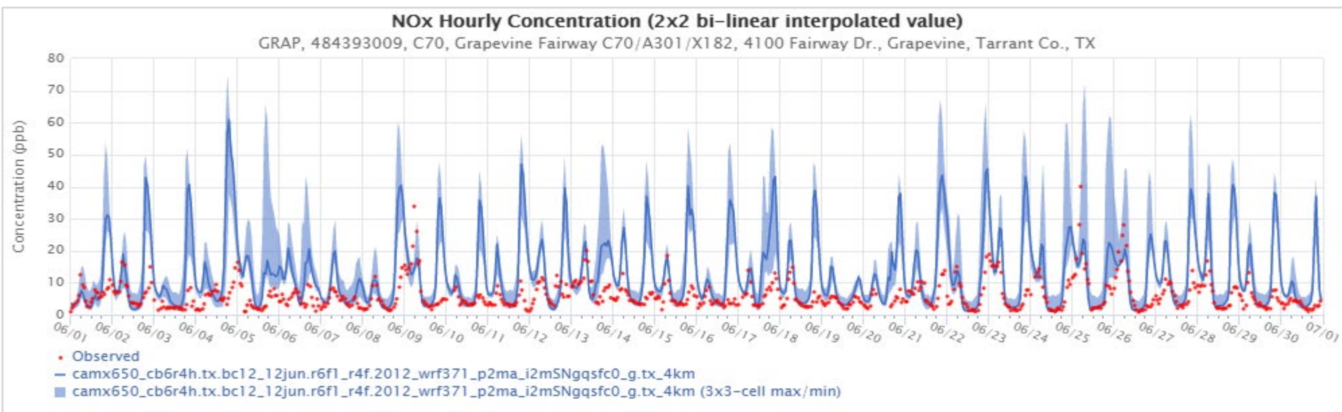


Figure 3-27: June 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)

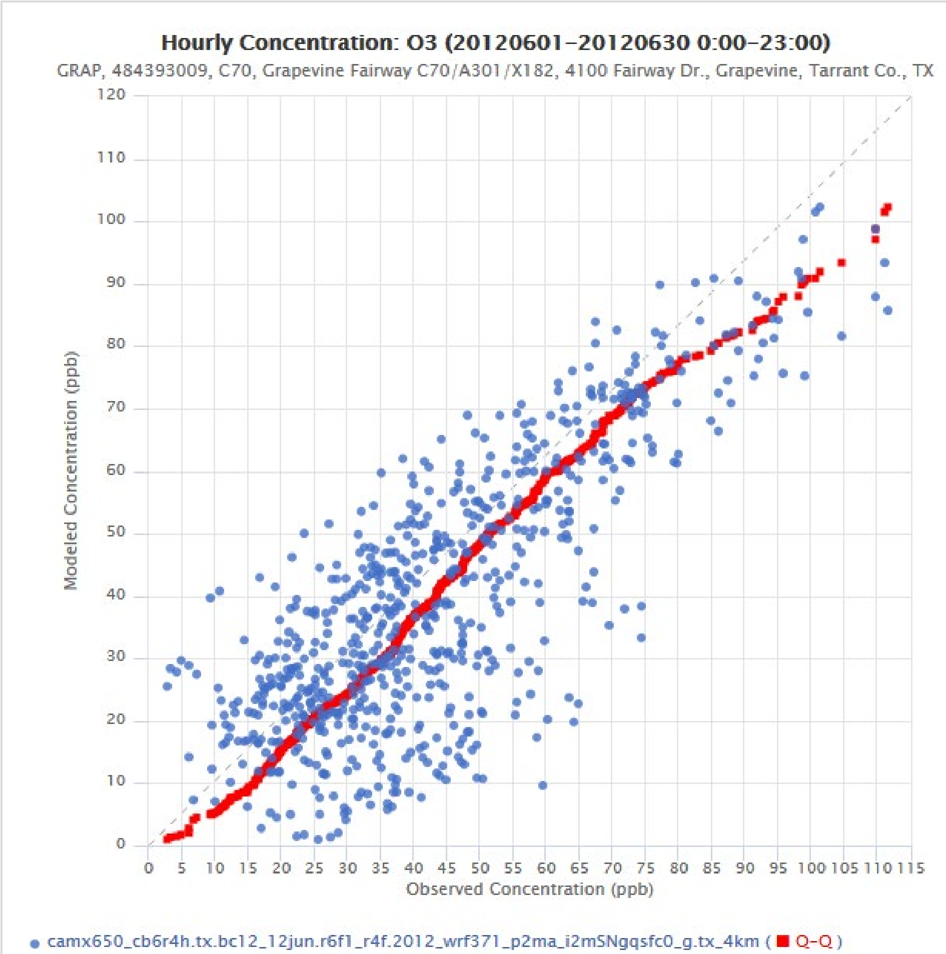
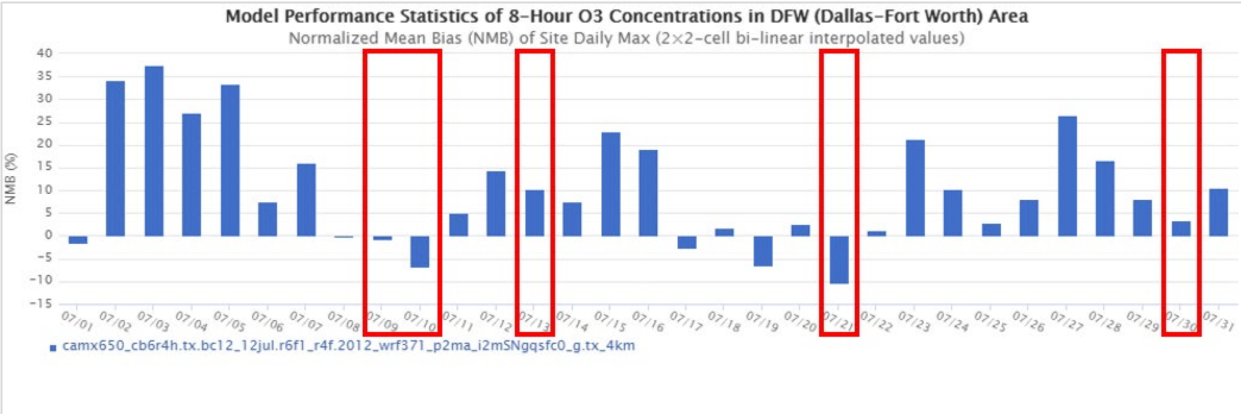


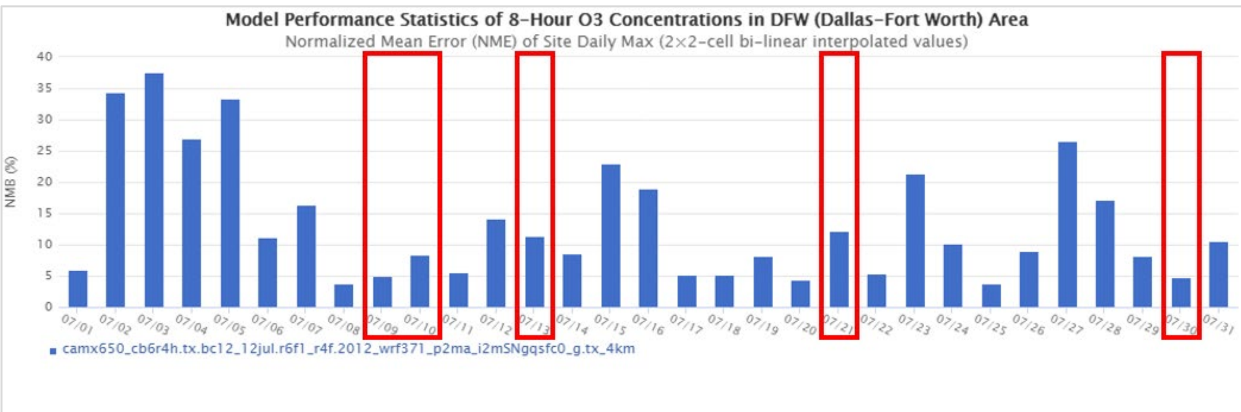
Figure 3-28: June 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)

<u>July 2012</u>
Five July 2012 days observed eight-hour ozone concentrations above 75 ppb (see Figure 3-10). The mean normalized bias of the site daily maximum eight-hour ozone concentrations was less than 12% of the measured values and showed no systematic underprediction or overprediction on the high ozone days as shown in Figure 3-29: *July 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors*. In general, the photochemical model produced site daily maximum concentrations within 15% of observations on those days, outlined in boxes in Figure 3-30: *July 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors*.



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-29: July 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-30: July 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors

At the Grapevine Fairway (C70) monitor in July 2012 the photochemical model reproduces the diurnal trend of eight-hour ozone well, though the model underpredicts morning lows on some days. The model underpredicted the July 21 high ozone day significantly as shown in Figure 3-31: *July 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)*. Hourly NO_x concentrations were overpredicted during the morning and afternoon rush hours, though the diurnal pattern was similar, as depicted in Figure 3-32: *July 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)*. The scatter plot of hourly ozone at Grapevine Fairway (C70) shows the model on average represented most concentrations well with the Q-Q line falling near the one-to-one line (see Figure 3-33: *July 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)*).

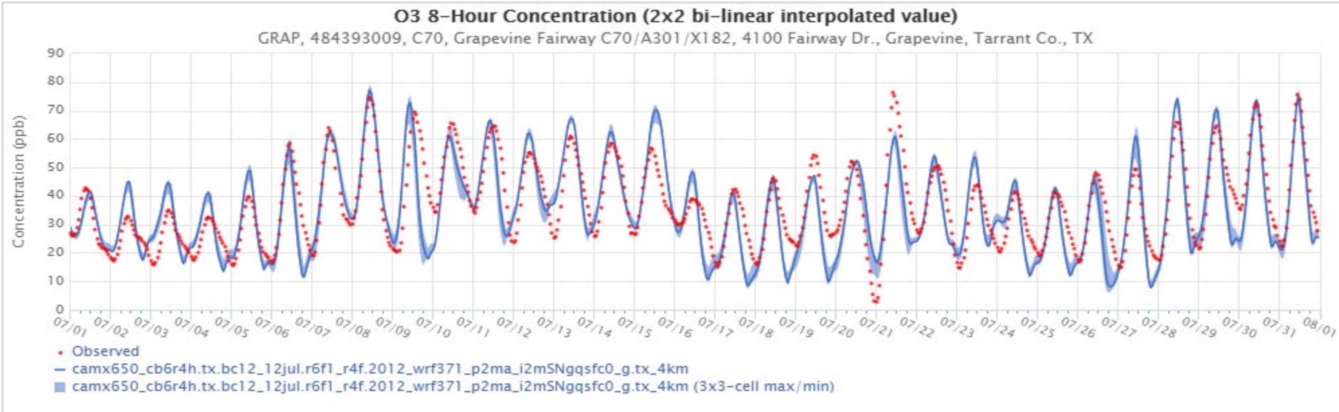


Figure 3-31: July 2012 versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)

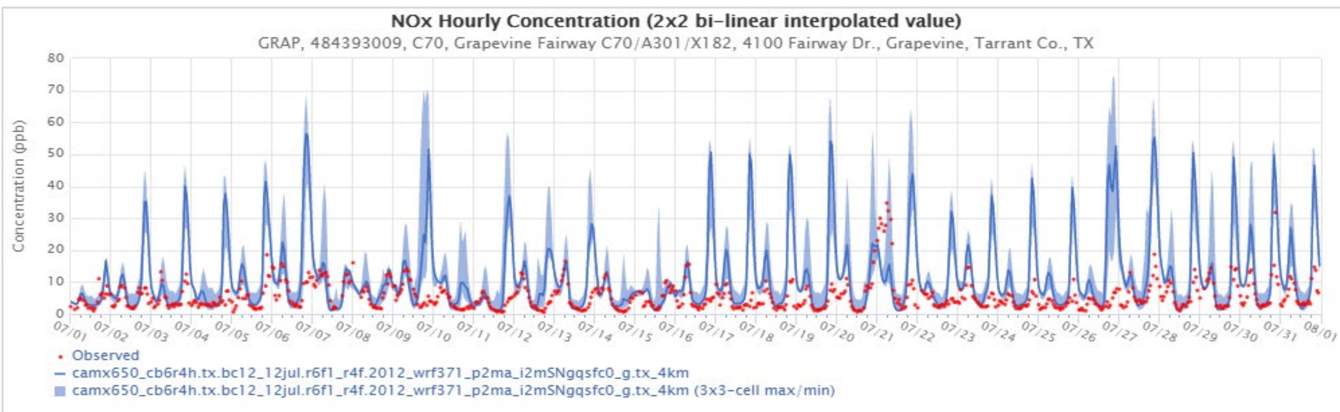


Figure 3-32: July 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)

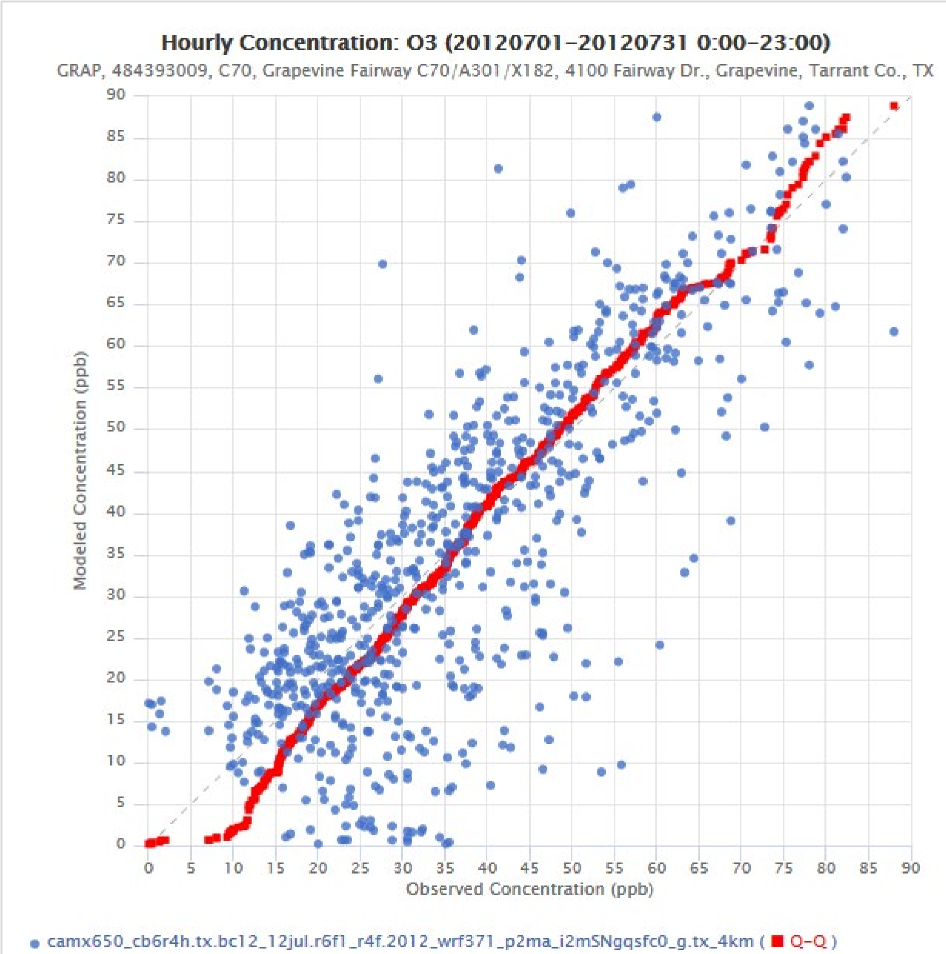
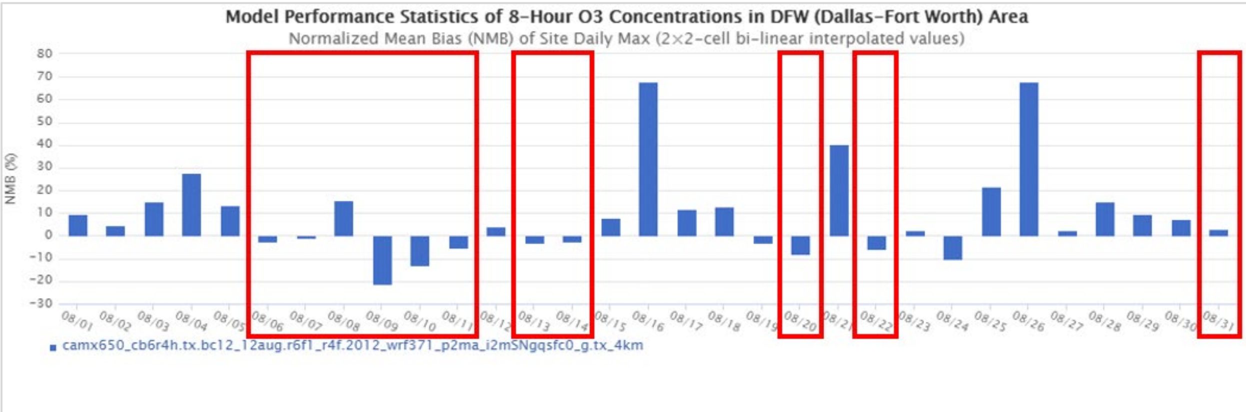


Figure 3-33: July 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)

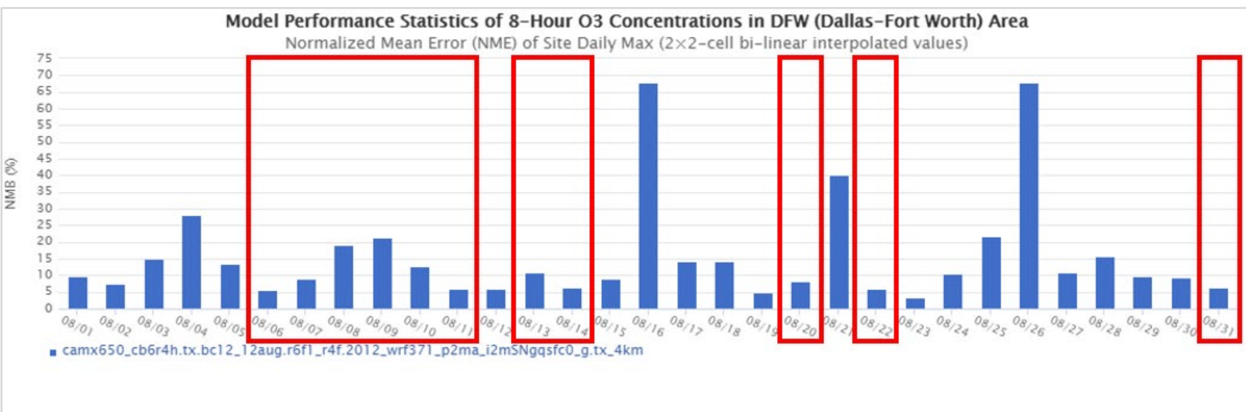
<u>August 2012</u>

Eleven August 2012 days observed eight-hour ozone concentrations above 75 ppb (see Figure 3-11). The NMB of the site daily maximum eight-hour ozone on the highest ozone days was very small, indicating the model performed well on the most important days (see Figure 3-34: *August 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors).* The NME of the site daily maximums was below 20% for the high ozone days except August 9, 2012, as shown in Figure 3-35: *August 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors*. The NME was highest in August on days with observed site daily hourly ozone maximums below 60 ppb. When ozone concentrations were high in August, the model simulation matched well.



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-34: August 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-35: August 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors

The model's pattern of replicating the high ozone periods well and under-predicting the lower concentrations is shown for the Grapevine Fairway (C70) monitor in Figure 3-36: *August 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)*. As with other 2012 months, the model overpredicts afternoon NO_x peaks as shown in Figure 3-37: *August 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)*. For NO_x, the model simulates the observed concentrations well at the Grapevine Fairway (C70) monitor. The model grossly underpredicted the high ozone day of August 9. The scatter plot of hourly ozone at Grapevine Fairway (C70) also shows this pattern (Figure 3-38: *August 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)*).

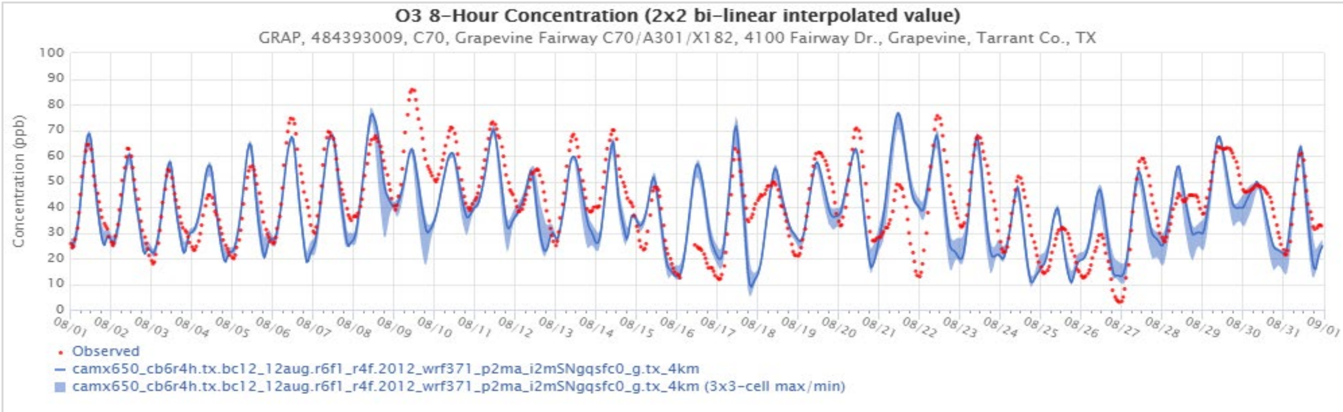


Figure 3-36: August 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)

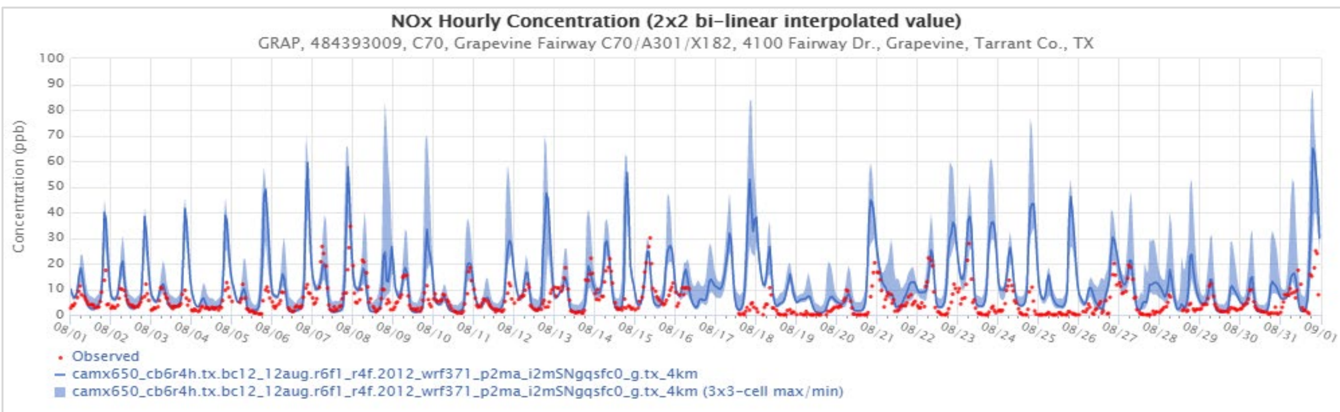


Figure 3-37: August 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)

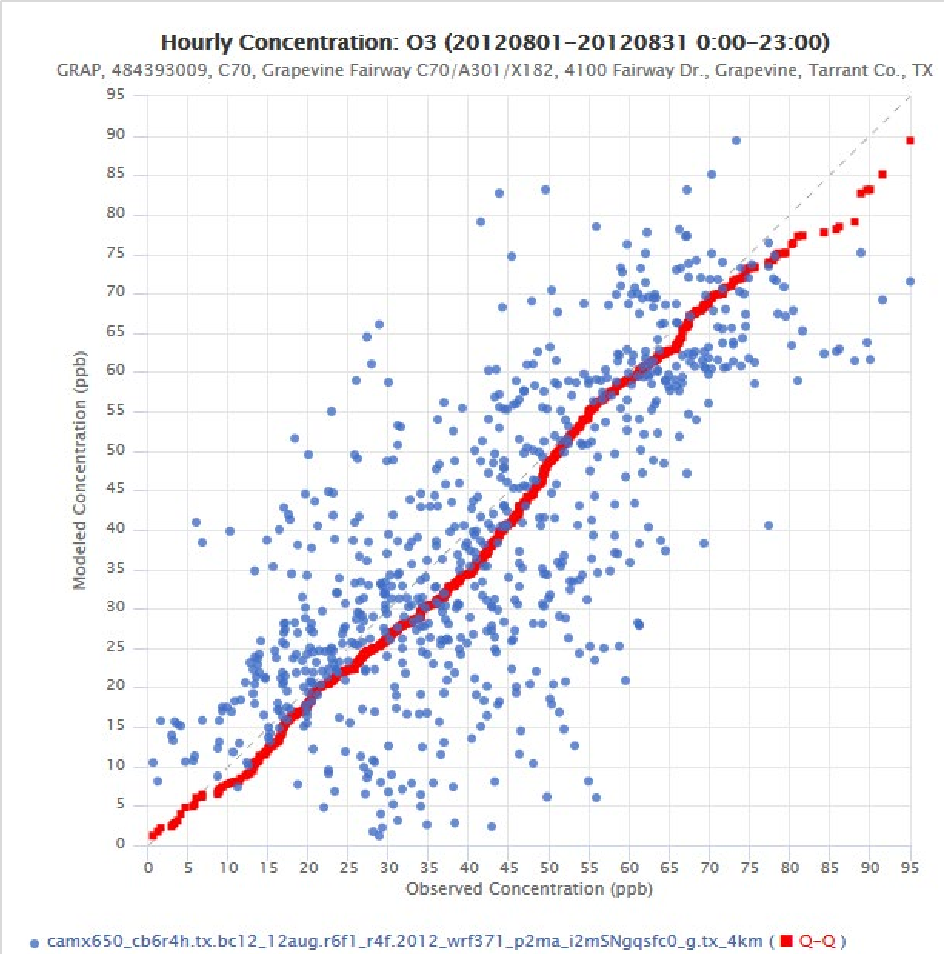
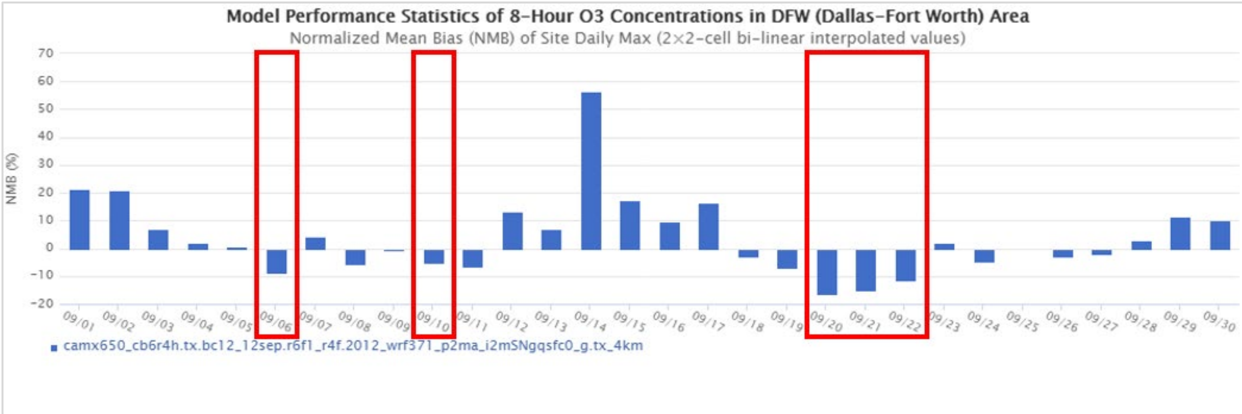


Figure 3-38: August 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)

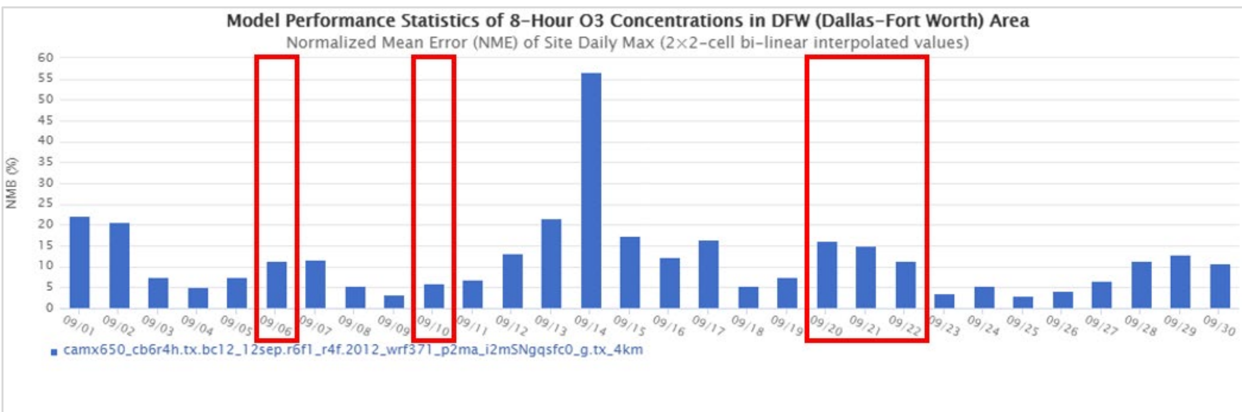
<u>September 2012</u>

Five days in September 2012 exceeded the 2008 eight-hour ozone NAAQS (see Figure 3-12). The model slightly under-predicted the high ozone days as with the other 2012 months (see Figure 3-39: *September 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors*). As with the other 2012 months, the model performed well in September by matching the site daily maximums as shown in Figure 3-40: *September 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors*. The model did not replicate well the days with the lowest daily maximums, but those days were not included in the attainment test.



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-39: September 2012 Normalized Mean Bias of Site MDA8 Ozone for the DFW Area Monitors



Days with eight-hour daily maximum concentrations above 75 ppb outlined in boxes.

Figure 3-40: September 2012 Normalized Mean Error of Site MDA8 Ozone for the DFW Area Monitors

At the Grapevine Fairway (C70) monitor, the model under-predicted the daily eight-hour peaks when observed ozone was 60 ppb or greater as shown in Figure 3-41: *September 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)*. As shown in Figure 3-36, the model also had difficulty replicating the diurnal range, under-predicting the nighttime minimum concentrations. NO_X concentrations were generally over-predicted, which may have influenced the modeled ozone minimums (see Figure 3-42: *September 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)*). The hourly ozone scatter plot for the Grapevine Fairway (C70) monitor exhibits the low bias in the lower concentrations and the under-prediction of the highest peaks in September 2012, as displayed in Figure 3-43: *September 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)*.

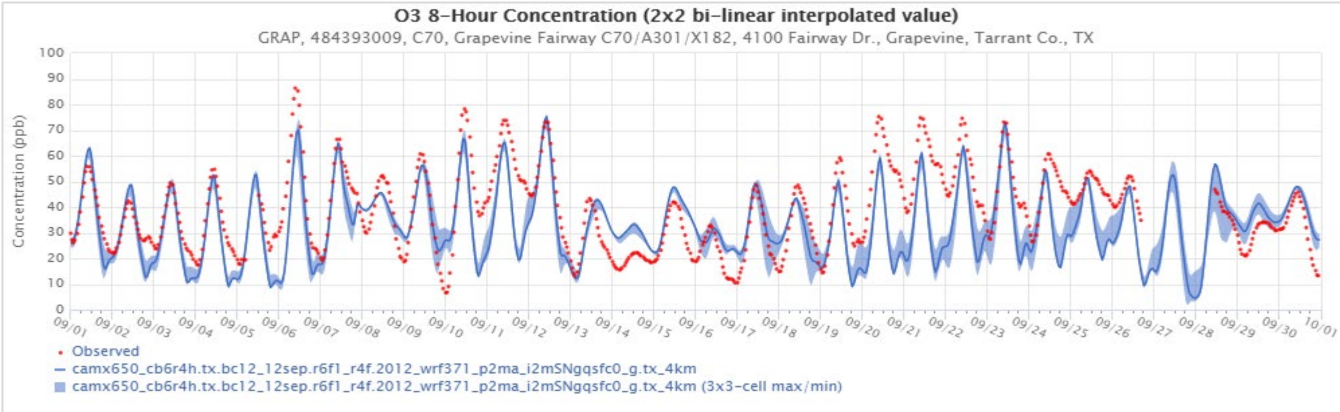


Figure 3-41: September 2012 Observed versus Modeled Eight-Hour Ozone at Grapevine Fairway (C70)

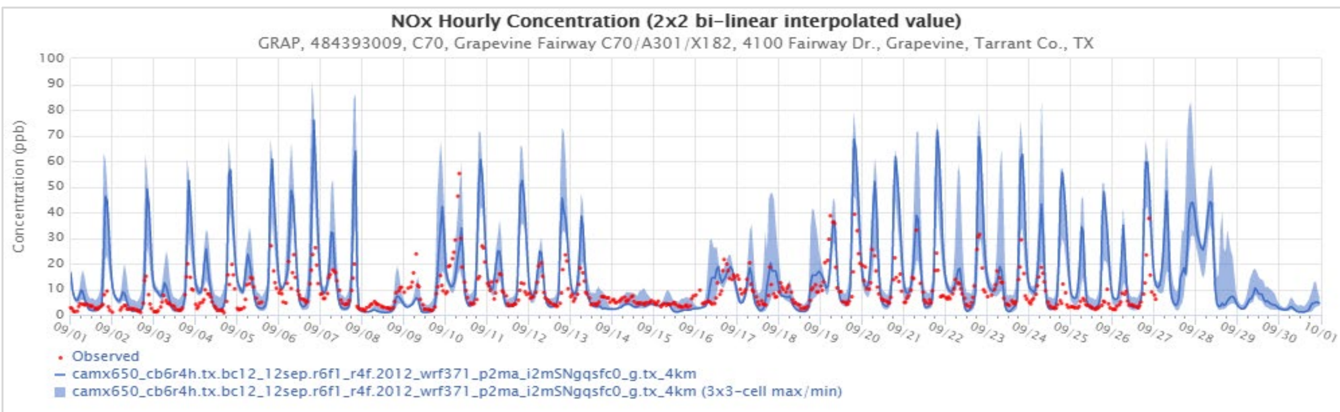


Figure 3-42: September 2012 Observed versus Modeled Hourly Nitrogen Oxides at Grapevine Fairway (C70)

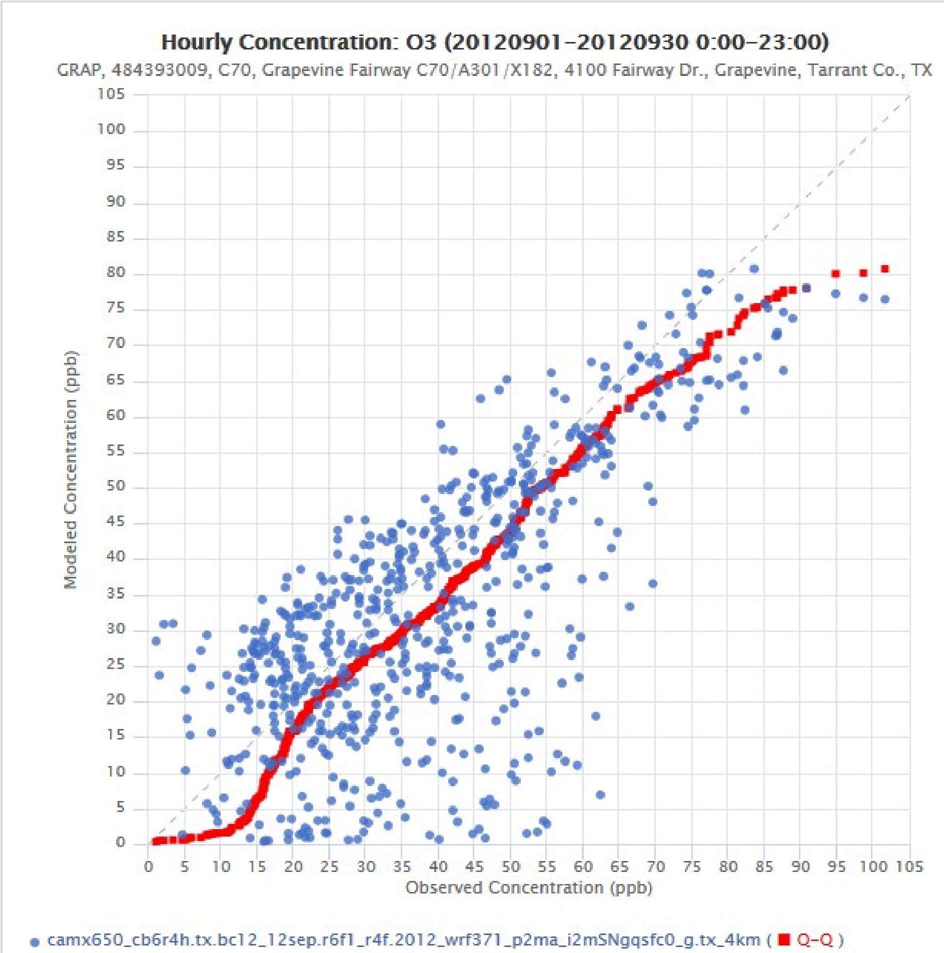


Figure 3-43: September 2012 Observed versus Modeled Hourly Ozone Scatter Plot at Grapevine Fairway (C70)

3.7.4.3 Diagnostic Evaluations

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

Because of the limited time for development of this DFW AD SIP revision, the diagnostic evaluations were not completed.

3.8 ATTAINMENT TEST

3.8.1 Relative Response Factor and Future Design Values

The TCEQ selected 2012 as the baseline year for conducting the attainment modeling and used the 2012 baseline emissions discussed in Section 3.6.3: *2012 Baseline Emissions* as model inputs. In accordance with modeling guidance (EPA, 2018), the top 10 baseline episode days with modeled eight-hour maximum concentrations above 60 ppb per monitor were used for the modeled attainment test. All regulatory DFW monitors that operated the entire season had 10 modeled baseline days above 60 ppb. Similar to the 2012 baseline modeling, 2020 future case modeling was conducted for each of the 2012 episode days using the emission inputs discussed in Section 3.6.4: *2020 Future Case Emissions*.

From the baseline modeling, the maximum concentration of the three-by-three grid cell array surrounding each monitor (see Figure 3-44: *Location of DFW Ozone Monitors with 4 km Grid Cell Array*) for each top 10 modeled day was averaged and used for the denominator of the RRF. From the future year modeling, the concentrations from the corresponding baseline top 10 modeled days and maximum grid cells were averaged for the numerator of the RRF, as shown in Table 3-32: *DFW Monitor-Specific Relative Response Factors for Attainment Test*.

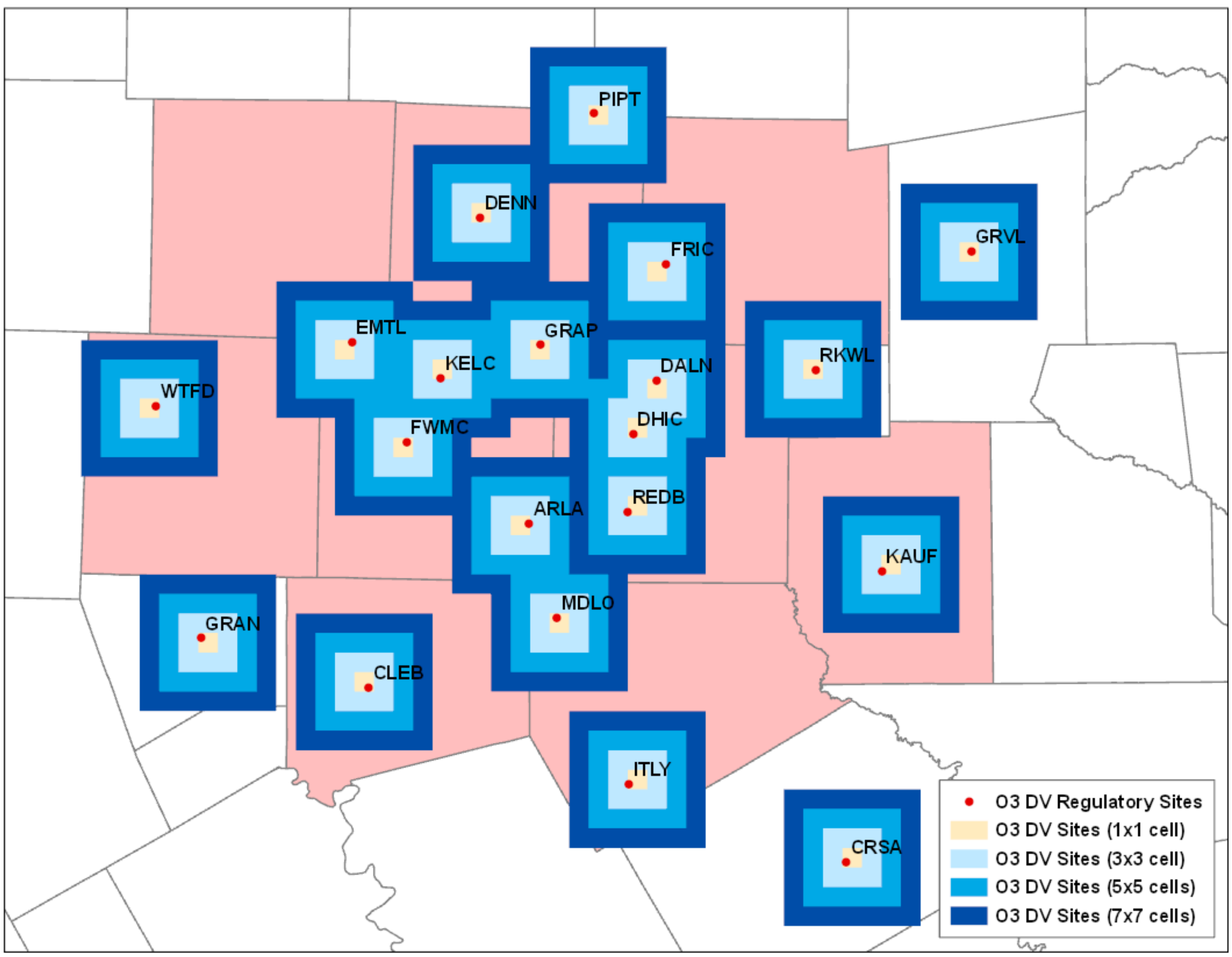


Figure 3-44: Location of DFW Ozone Monitors with 4 km Grid Cell Array

Table 3-32: DFW Monitor-Specific Relative Response Factors for Attainment Test

DFW Monitor	Site Code	2012 Baseline Top 10-Day Mean (ppb)	2020 Future Top 10-Day Mean (ppb)	Relative Response Factor (RRF)
Grapevine Fairway - C70	GRAP	82.27	70.89	0.862
Denton Airport South - C56	DENN	79.06	67.86	0.858
Keller - C17	KELC	80.64	68.82	0.853
Frisco - C31	FRIC	79.91	68.95	0.863
Dallas Hinton Street - C401	DHIC	86.17	74.41	0.864
Pilot Point - C1032	PIPT	76.88	65.85	0.857
Dallas North #2 - C63	DALN	83.81	72.69	0.867
Fort Worth Northwest - C13	FWMC	83.17	71.86	0.864
Eagle Mountain Lake - C75	EMTL	76.41	65.29	0.855
Arlington Municipal Airport - C61	ARLA	87.81	75.35	0.858
Cleburne Airport - C77	CLEB	79.83	68.04	0.852
Dallas Executive Airport - C402	REDB	85.77	72.60	0.846
Rockwall Heath - C69	RKWL	80.69	70.05	0.868
Parker County - C76	WTFD	72.47	61.82	0.853
Midlothian OFW - C52	MDLO	83.52	72.76	0.871
Granbury - C73	GRAN	77.31	65.13	0.842
Greenville - C1006	GRVL	69.28	59.28	0.856
Kaufman - C71	KAUF	66.66	57.22	0.858
Corsicana Airport - C1051	CRSA	68.73	58.68	0.854
Italy - C1044	ITLY	74.34	63.36	0.852

The RRF is multiplied by the 2012 baseline design value (DV_B) to obtain the 2020 future design value (DV_F) for each ozone monitor. In accordance with modeling guidance (EPA, 2018), the final regulatory future DV_F is obtained by rounding to the tenths digit and truncating to zero decimal places. The DV_Fs are presented in Table 3-33: *Summary of RRF and 2020 Future Ozone Design Values* and Figure 3-45: *2020 Future Design Values by DFW Monitoring Location*. Application of the attainment test results in zero monitors above the 2008 eight-hour ozone standard of 75 ppb in 2020, with the highest DV_F of 72 ppb for the Grapevine Fairway monitor.

Table 3-33: Summary of RRF and 2020 Future Ozone Design Values

DFW Monitor	Site Code	2012 DV_B (ppb)	RRF	2020 DV_F (ppb)	Regulatory 2020 DV_F (ppb)
Grapevine Fairway - C70	GRAP	84.00	0.862	72.374	72
Denton Airport South - C56	DENN	83.67	0.858	71.822	71
Keller - C17	KELC	83.00	0.853	70.837	70
Frisco - C31	FRIC	81.67	0.863	70.468	70
Dallas Hinton Street - C401	DHIC	81.33	0.864	70.231	70
Pilot Point - C1032	PIPT	81.67	0.857	69.951	70
Dallas North #2 - C63	DALN	80.33	0.867	69.678	69
Fort Worth Northwest - C13	FWMC	80.33	0.864	69.413	69
Eagle Mountain Lake - C75	EMTL	80.67	0.855	68.936	68
Arlington Municipal Airport - C61	ARLA	79.33	0.858	68.068	68
Cleburne Airport - C77	CLEB	78.00	0.852	66.478	66
Dallas Executive Airport - C402	REDB	78.00	0.846	66.023	66
Rockwall Heath - C69	RKWL	75.67	0.868	65.692	65
Parker County - C76	WTFD	77.00	0.853	65.686	65
Midlothian OFW - C52	MDLO	74.67	0.871	65.049	65
Granbury - C73	GRAN	76.67	0.842	64.587	64
Greenville - C1006	GRVL	71.67	0.856	61.326	61
Kaufman - C71	KAUF	71.33	0.858	61.232	61
Corsicana Airport - C1051	CRSA	70.00	0.854	59.766	59
Italy - C1044	ITLY	69.33	0.852	59.095	59

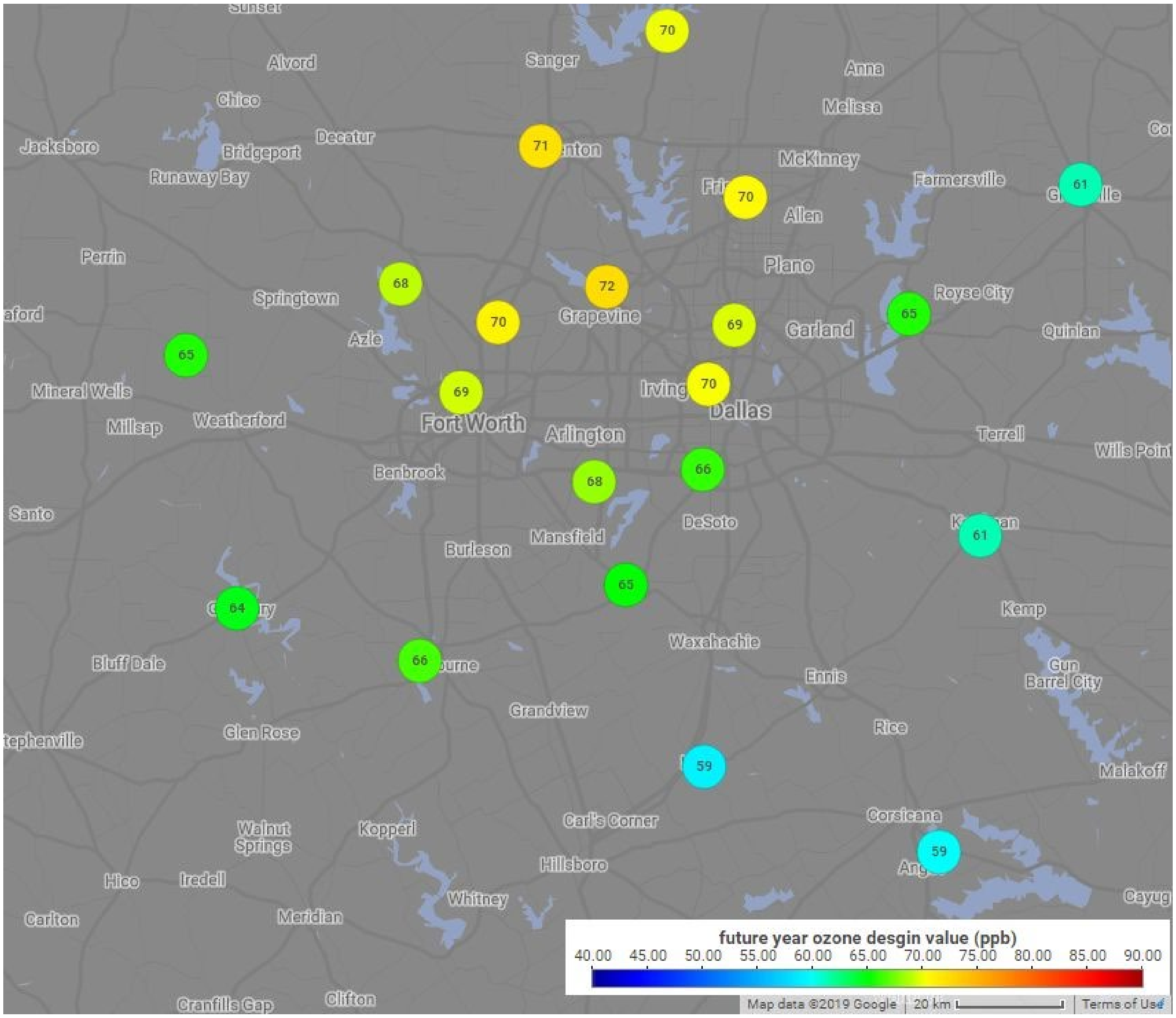


Figure 3-45: 2020 Future Design Values by DFW Monitoring Location

3.8.2 Unmonitored Area Analysis

The modeling guidance (EPA, 2018) recommends that areas not near monitoring locations (unmonitored areas) be subjected to an unmonitored area (UMA) analysis to demonstrate that these areas are expected to reach attainment by the required future year. The standard attainment test is applied only at monitor locations, and the UMA analysis is intended to identify any areas not near a monitoring location that are at risk of not meeting the attainment date. Recently, the EPA provided Modeled Attainment Test Software (MATS), which can be used to conduct UMA analyses, but has not specifically recommended using its software in the modeling guidance, instead stating, "Air agencies can use the EPA-provided software or are free to develop alternative techniques that may be appropriate for their areas or situations."

The TCEQ used its own procedure to conduct the UMA analysis for several reasons. Both procedures incorporate modeled predictions into a spatial interpolation procedure, using the Voronoi Neighbor Averaging technique. 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. More information about TATU is provided in Appendix C: *Photochemical Modeling for the HGB Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard* of the 2010 HGB 1997 Eight-Hour Ozone AD SIP Revision.

Color contour maps of ozone concentrations for the 2012 baseline and the 2020 future case DV_Fs are presented in Figure 3-46: *Spatially Interpolated 2012 Baseline Design Values for the DFW Area* and Figure 3-47: *Spatially Interpolated 2020 Future Design Values for the DFW Area*. The figures show the extent and magnitude of the expected improvements in ozone DVs, with zero grid cells at or above 76 ppb in the future case plot. The area wide maximum is located southeast of Denton in Denton County. A small, unmonitored area southeast of Grapevine in Tarrant county is also predicted to have similar future DV_Fs but below the 2008 eight-hour ozone standard in 2020.

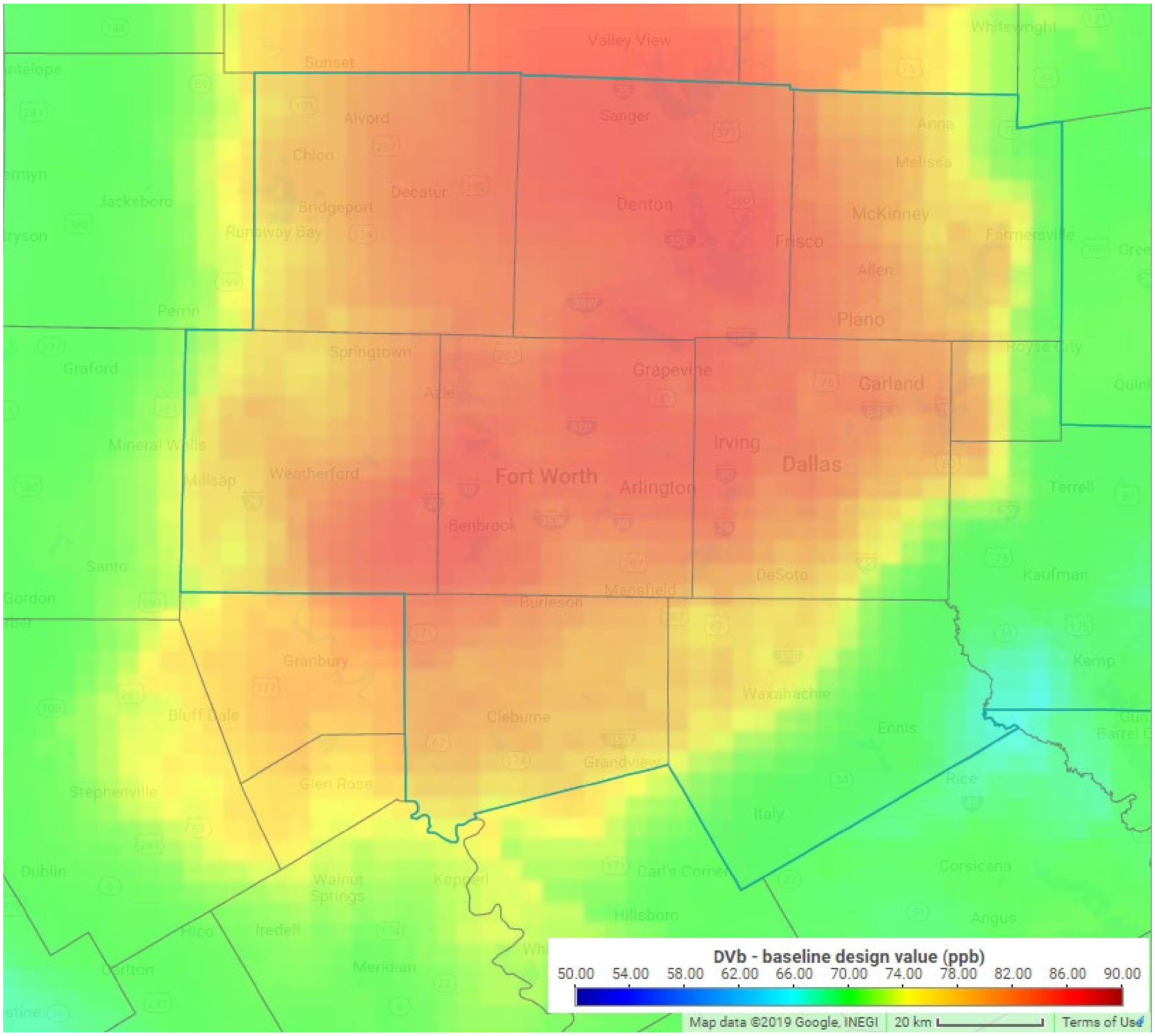


Figure 3-46: Spatially Interpolated 2012 Baseline Design Values for the DFW Area

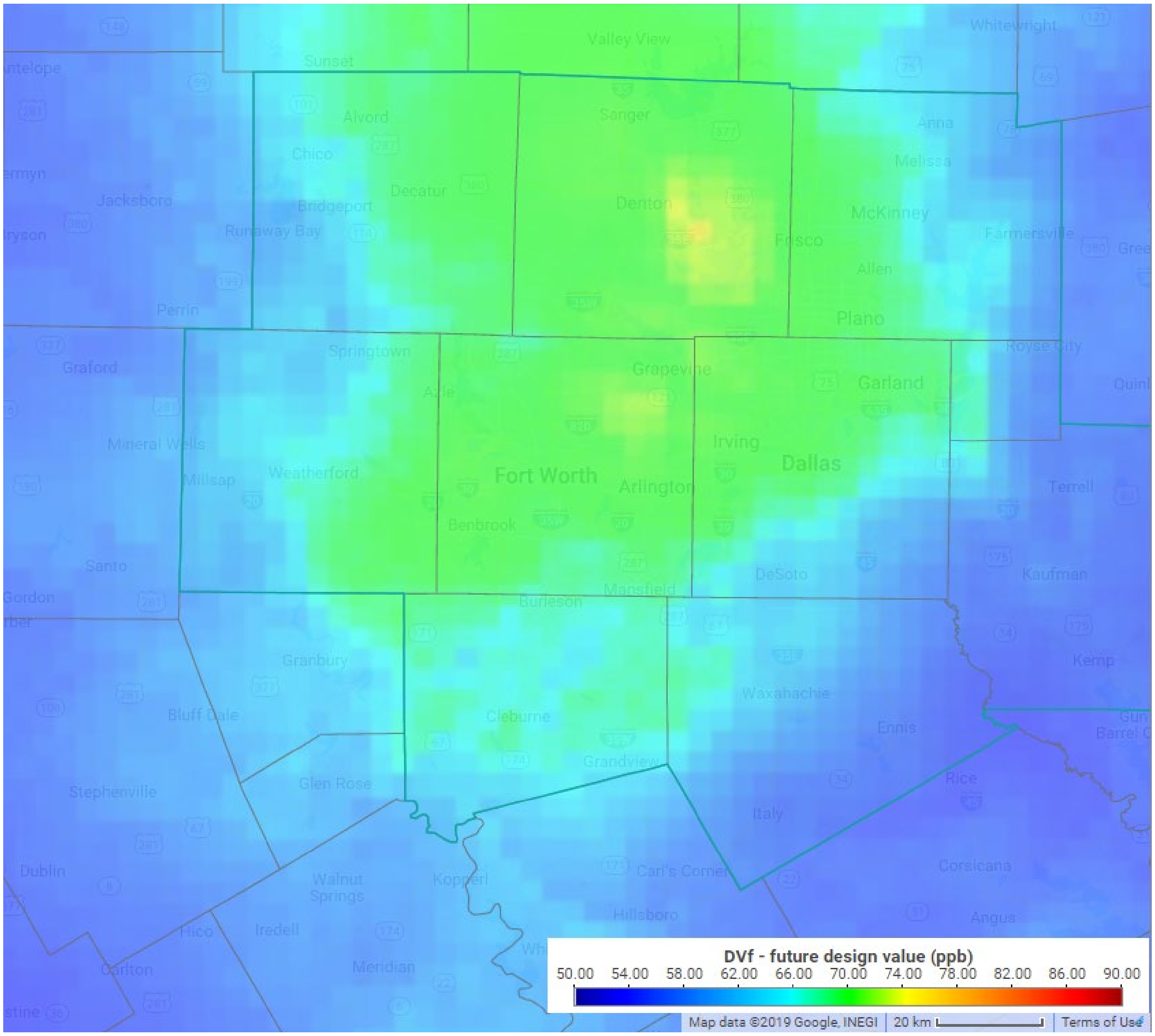


Figure 3-47: Spatially Interpolated 2020 Future Design Values for the DFW Area

3.9 MODELING ARCHIVE AND REFERENCES

3.9.1 Modeling Archive

The TCEQ has archived all modeling documentation and modeling input/output files generated as part of this 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/) (ftp://amdaftp.tceq.texas.gov/pub/TX/camx/). The 2012 base case and baseline EI component files for each source category are available on the [TCEQ modeling FTP site](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/dfw_hgb_fy20_sip/base_2012) (ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/dfw_hgb_fy20_sip/base_2012). The 2020 future case EI component files are available on the [TCEQ modeling FTP site](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/dfw_hgb_fy20_sip/future_2020) (ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/dfw_hgb_fy20_sip/future_2020).

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CHAPTER 4: CONTROL STRATEGIES AND REQUIRED ELEMENTS

4.1 INTRODUCTION

The Dallas-Fort Worth (DFW) ozone 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 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 ozone 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 budgets (MVEBs), 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 ozone nonattainment area. For the one-hour ozone NAAQS, the DFW ozone nonattainment area consisted of four counties: Collin, Dallas, Denton, and Tarrant. For the 1997 eight-hour ozone NAAQS, the DFW ozone nonattainment area consisted 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, resulting in a 10-county ozone nonattainment area. 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 ozone nonattainment area.

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

Measure	Description	Start Date(s)
DFW Industrial, Commercial, and Institutional (ICI) Major Source Rule 30 Texas Administrative Code (TAC) Chapter 117, Subchapter B, Division 4	Applies to 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 NO_X emission limits for affected source categories include: 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; natural gas-fired dryers used in organic solvent, printing ink, clay, brick, ceramic tile, calcining, and vitrifying processes; and wood-fired boilers	March 1, 2009 or March 1, 2010, depending on source category January 1, 2017 for Wise County and for wood-fired boilers in all 10 counties of the DFW area
DFW ICI Minor Source Rule 30 TAC Chapter 117, Subchapter D, Division 2	Applies to all minor sources (less than 50 tpy of NO_X) with stationary internal combustion engines in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties NO_X emission limits for stationary gas-fired, dual-fuel, and diesel-fired reciprocating internal combustion engines	March 1, 2009 for rich-burn gas-fired engines, diesel-fired engines, and dual-fuel engines March 1, 2010 for lean-burn gas-fired engines
Stationary Diesel and Dual-Fuel Engines 30 TAC Chapter 117, Subchapter B, Division 4 and Subchapter D, Division 2	Restrictions 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

Measure	Description	Start Date(s)
DFW 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 Applies to utility boilers, auxiliary steam boilers, stationary gas turbines, and duct burners used in turbine exhaust ducts used in electric power generating systems	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 emission limits for electric power boilers and stationary gas turbines (including duct burners used in turbine exhaust ducts) at utility electric generation sites in East and Central Texas, including Parker County	May 1, 2003 through May 1, 2005
DFW Cement Kiln Rule 30 TAC Chapter 117, Subchapter E, Division 2	NO_x emission limits for all Portland cement kilns located in Ellis County Voluntary agreed order No. 2017-1648-SIP with TXI Operations, LP, limits #5 Kiln to 1.95 pounds of NO_x per ton of clinker	March 1, 2009 and August 8, 2018
NO_x Emission Standards for Nitric Acid Manufacturing – General 30 TAC Chapter 117, Subchapter F, Division 3	NO_x emission limits for nitric acid manufacturing facilities (state-wide rule – no nitric acid facilities in the DFW area)	November 15, 1999
East Texas Combustion Sources 30 TAC Chapter 117, Subchapter E, Division 4	NO_x emission limits for stationary rich-burn, gas-fired internal combustion engines (240 horsepower and greater) Measure implemented to reduce ozone in the DFW area although controls not applicable in the DFW area	March 1, 2010
Natural Gas-Fired Small Boilers, Process Heaters, and Water Heaters 30 TAC Chapter 117, Subchapter E, Division 3	NO_x emission limits on small-scale residential and industrial boilers, process heaters, and water heaters equal to or less than 2.0 million British thermal units per hour (state-wide rule)	July 1, 2002

Measure	Description	Start Date(s)
VOC Control Measures 30 TAC Chapter 115	VOC control measures adopted to satisfy reasonably available control technology (RACT) and other SIP planning requirements for sources including: vent gas, industrial wastewater, water separation, municipal solid waste landfills, batch processes, loading and unloading operations, VOC leak detection and repair, solvent-using processes, fugitive emission control in petroleum refining, natural gas/gasoline processing, and petrochemical processing, cutback asphalt, and pharmaceutical manufacturing facilities	December 31, 2002 and earlier for Collin, Dallas, Denton, and Tarrant Counties March 1, 2009 for Ellis, Johnson, Kaufman, Parker, and Rockwall Counties January 1, 2017 for Wise County
Degassing Operations 30 TAC, Chapter 115, Subchapter F, Division 3	VOC control requirements for degassing during, or in preparation of, cleaning any storage tanks and transport vessels in Collin, Dallas, Denton, and Tarrant Counties	May 21, 2011
Storage of VOC 30 TAC Chapter 115, Subchapter B, Division 1	Controls on fixed and floating roof tanks storing VOC liquids, including oil and condensate, based on the size of the tank and vapor pressure of the liquid being stored in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties Audio-visual-olfactory inspections, repair requirements, and associated recordkeeping for certain fixed-roof oil and condensate tanks	January 1, 2017 and earlier
Solvent-Using Processes 30 TAC Chapter 115, Subchapter E	Revised to implement RACT requirements per control technique guidelines published by the EPA Control, testing, monitoring and recordkeeping requirements for: paper, film, and foil coatings; large appliance coatings; metal furniture coatings; miscellaneous metal and plastic parts coatings; automobile and light-duty truck coating; industrial cleaning solvents; miscellaneous industrial adhesives; offset lithographic printing; and flexible package printing in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties	March 1, 2013 for industrial cleaning solvents March 1, 2011 for major source offset lithographic printing lines March 1, 2012 for minor source offset lithographic printing lines January 1, 2017 for Wise County

Measure	Description	Start Date(s)
Petroleum Dry Cleaning Systems 30 TAC Chapter 115, Subchapter F, Division 4	Control requirements for petroleum dry cleaning system dryers and filters at sources that use less than 2,000 gallons of petroleum solvent per year in Collin, Dallas, Denton, and Tarrant Counties	May 21, 2011
Refueling – Stage I 30 TAC, Chapter 115, Subchapter C, Division 2	Captures gasoline vapors that are released when gasoline is delivered to a storage tank Vapors returned to tank truck as storage tank is filled with fuel, rather than released into ambient air	1979 January 1, 2017 for Wise County A SIP revision related to Stage I regulations was approved by the EPA, effective June 29, 2015
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.	January 2002 See Section 5.4.1.5: *Texas Emissions Reduction Plan (TERP)*
Texas Low Emission Diesel 30 TAC Chapter 114, Subchapter H, Division 2	Requires all diesel fuel for both on-road and non-road use to have a lower aromatic content and a higher cetane number	Phased in from October 31, 2005 through January 31, 2006
Texas Low Reid Vapor Pressure (RVP) Gasoline 30 TAC Chapter 114, Subchapter H, Division 1	Requires all gasoline for both on-road and non-road use to have RVP of 7.8 pounds per square inch or less from May 1 through October 1 each year	April 2000 in Ellis, Johnson, Kaufman, Parker, Rockwall, and Wise Counties
Vehicle Inspection/ Maintenance (I/M) 30 TAC Chapter 114, Subchapter C	Yearly treadmill-type testing for pre-1996 vehicles and computer checks for 1996 and newer vehicles 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.	May 1, 2002 in Collin, Dallas, Denton, and Tarrant Counties May 1, 2003 in Ellis, Johnson, Kaufman, Parker, and Rockwall Counties
California Gasoline Engines	California standards for non-road gasoline engines 25 horsepower and larger	May 1, 2004

Measure	Description	Start Date(s)
Transportation Control Measures	Various measures implemented under the previous one-hour and 1997 eight-hour ozone standards (see Appendix F: *Reasonably Available Control Technology Analysis* of the 2007 DFW 1997 Eight-Hour Ozone Attainment Demonstration SIP Revision) The North Central Texas Council of Governments (NCTCOG) has implemented all TCM commitments and provides an accounting of TCMs as part of the transportation conformity process.	Phased in through 2016
Voluntary Energy Efficiency/Renewable Energy (EE/RE)	See Section 5.4.1.2: *Energy Efficiency and Renewable Energy Measures*	See Section 5.4.1.2
Voluntary Mobile Emissions Reduction Program	Various pedestrian, bicycle, traffic, and mass transit voluntary measures committed to as part of the 2007 DFW 1997 Eight-Hour Ozone Attainment Demonstration SIP Revision and administered by NCTCOG	Phased in through 2009
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
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

4.3 UPDATES TO EXISTING CONTROL MEASURES

4.3.1 Updates to NO_x Control Measures

The concurrent NO_x rulemaking (Rule Project No. 2019-074-117-AI) would satisfy major source NO_x RACT requirements for the DFW serious ozone nonattainment area. While RACT is currently in place through the existing 30 Texas Administrative Code (TAC) Chapter 117 NO_x rules for nine of the DFW area counties, rulemaking is necessary to ensure RACT is in place for all major sources in Wise County. With a moderate ozone nonattainment classification under the 2008 eight-hour ozone NAAQS, Wise County had a major source threshold of the potential to emit (PTE) of 100 tons per year (tpy), while the other nine counties retained a 50 tpy major source threshold because of a previous nonattainment classification. Since the DFW area has been reclassified to serious ozone nonattainment under the 2008 eight-hour ozone NAAQS, the major source threshold for the 10-county DFW area, including Wise County, is 50 tpy. The concurrent NO_X rulemaking would revise 30 TAC Chapter 117 to amend the existing DFW NO_X RACT rules applicable in Wise County to apply at a threshold of 50 tpy. All unit types located at major source sites in the 2017 point source emissions inventory (EI) would be addressed by this RACT rulemaking.

4.3.2 Updates to VOC Control Measures

The concurrent VOC rulemaking (Rule Project No.2019-075-115-AI) would satisfy VOC RACT requirements for Wise County. With a moderate ozone nonattainment classification under the 2008 eight-hour ozone NAAQS, Wise County had a major source threshold of 100 tpy, while the other nine counties retained a 50 tpy major source threshold because of a previous nonattainment classification. Since the DFW area has been reclassified to serious ozone nonattainment under the 2008 eight-hour ozone NAAQS, the major source threshold for the 10-county DFW area, including Wise County, is 50 tpy. This rulemaking would revise 30 TAC Chapter 115, Subchapter B, Division 1, Storage of VOC, to amend the existing DFW VOC RACT rules in Wise County for fixed roof oil and condensate storage tanks to apply at a threshold of 50 tpy.

4.3.3 Revisions to Vehicle Inspection and Maintenance (I/M) Program

House Bill (HB) 2305, 83rd Texas Legislature, 2013, Regular Session, replaced the previous Texas dual inspection and registration sticker system with a single vehicle registration insignia sticker system (single sticker system). HB 2305, which became effective on September 1, 2013, required:

- eliminating the use of the safety and emissions inspection windshield certificate, also known as the safety and emissions inspection windshield sticker;
- verifying compliance with inspection requirements using the vehicle inspection report or vehicle registration sticker instead of the current safety and emissions inspection windshield sticker; and
- passing of the vehicle safety and emissions inspection no more than 90 days prior to the expiration of the vehicle's registration instead of on the expiration of the vehicle's safety and emissions inspection windshield sticker.

HB 2305 required the commission to adopt rules by March 1, 2014 and implement the changes by March 1, 2015. The commission adopted rules and revisions to the I/M SIP on February 12, 2014, modifying the design of the vehicle emissions I/M program. On March 1, 2015, the single sticker system and additional I/M program design changes were implemented by the commission and in conjunction with the Texas Department of Public Safety (DPS) and the Texas Department of Motor Vehicles (TxDMV).

Prior to HB 2305, the vehicle emissions I/M program required vehicles subject to emissions inspections to demonstrate compliance by displaying a valid, current safety and emissions inspection sticker and a valid, current registration sticker on vehicle windshields. Since the expiration dates for vehicle registration and vehicle inspection did not match for most Texas vehicle owners, the TxDMV, the DPS, and the commission decided to implement the requirements of HB 2305 in two phases.

Phase one, which began on March 1, 2015, allowed vehicle owners one year to synchronize their inspection and registration dates. During phase one, vehicle owners were permitted to delay annual vehicle inspection until the month that vehicle registration expired. Phase one provided a method for transitioning to the single sticker system without penalizing vehicle owners whose vehicle inspection and vehicle registration expiration dates did not match, which may have required their vehicles to be inspected twice within a 12-month window.

Full implementation of the single sticker program, or phase two, started on March 1, 2016. Beginning March 1, 2016, the TxDMV only allows vehicle registration issuance or renewal after receiving proof that a vehicle has passed vehicle safety and emissions inspection within the 90-day window immediately prior to the vehicle's registration expiration date.

4.4 NEW CONTROL MEASURES

4.4.1 Stationary Sources

No new control measures will be added for this SIP revision, only updates to existing NO_X and VOC control measures affecting Wise County.

4.5 RACT ANALYSIS

4.5.1 General Discussion

Ozone nonattainment areas classified as moderate and above are required to meet the mandates of the Federal Clean Air Act (FCAA) under §172(c)(1) and §182(b)(2) and (f). According to the United States Environmental Protection Agency's (EPA) *Implementation of the 2008 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements: Final Rule* (2008 eight-hour ozone standard SIP requirements rule) published on March 6, 2015, states containing areas classified as moderate ozone 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. Specifically, this proposed DFW Attainment Demonstration SIP Revision must contain adopted RACT regulations, certifications where appropriate that existing provisions are RACT, and/or negative declarations that there are no sources in the nonattainment area covered by a specific CTG source category (80 *Federal Register* (FR) 12264).

The DFW area was classified as moderate ozone nonattainment for the 2008 eight-hour ozone NAAQS with a July 20, 2018 attainment date. Based on 2017 monitoring data, the DFW moderate ozone nonattainment area did not attain the 2008 eight-hour ozone NAAQS in the 2017[10] attainment year and did not qualify for a one-year attainment date extension in accordance with FCAA, §181(a)(5).[11] On November 14, 2018, the EPA

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[10] The attainment year ozone season is the ozone season immediately preceding a nonattainment area's attainment deadline.

[11] An area that fails to attain the 2008 eight-hour ozone NAAQS by its attainment date would be eligible for the first one-year extension if, for the attainment year, the area's 4th highest daily maximum eight-

proposed to reclassify the DFW area to serious nonattainment for the 2008 eight-hour ozone NAAQS (83 FR 56781). On August 7, 2019, the EPA signed the final reclassification notice.

The major source threshold for serious nonattainment areas is a PTE of 50 tpy or more of either NO_x or VOC. In past analyses, sources in the DFW area, except in Wise County, were evaluated for RACT at a 50 tpy major source threshold because of a serious classification under previous ozone NAAQS. However, because the most stringent classification for Wise County under any ozone NAAQS was moderate nonattainment, sources in the county have only been evaluated for RACT at a 100 tpy of NO_x or VOC major source threshold. This analysis will evaluate RACT at a major source threshold of 50 tpy of NO_x or VOC in all 10 counties of the DFW area. Details of the TCEQ's analysis of the sources and the applicable rules to demonstrate that the state is fulfilling the RACT requirements for the DFW area are in Appendix F: *Reasonably Available Control Technology Analysis*.

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 levels required for major sources of hazardous air pollutants.

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

In 2008, the EPA approved the DFW NO_x rules in 30 TAC Chapter 117 under the 1997 eight-hour ozone NAAQS (73 FR 73562, December 3, 2008) and in 2017, fully approved the 30 TAC Chapter 117 NO_x rules for the DFW moderate ozone nonattainment area as satisfying FCAA RACT under the 2008 eight-hour ozone NAAQS (82 FR 44320, September 22, 2017). In 2019, the EPA approved Agreed Order No. 2017-1648-SIP as satisfying the state's NO_x RACT requirements for the TXI Operations, LP cement kiln located in Ellis County (84 FR 5601, February 22, 2019). The EPA approved the DFW VOC rules in 30 TAC Chapter 115 as meeting FCAA RACT for the one-hour NAAQS in 2009 (74 FR 1903, January 14, 2009). Between 2006 and 2008, the EPA issued 11 CTG documents with recommendations for VOC controls on a variety of consumer and commercial products and approved the 30 TAC Chapter 115 rules addressing these CTGs in 2014 for offset lithographic printing (79 FR 45105, August 4, 2014) and in

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hour average is at or below the level of the standard (75 parts per billion (ppb)); the DFW area's fourth highest daily maximum eight-hour average for 2017 was 77 ppb as measured at the Dallas North No. 2 monitor C63/C679). The DFW area's design value for 2017 was 79 ppb.

2015 for the remaining CTGs 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, March 27, 2015). In 2017, the EPA approved the 30 TAC Chapter 115 rules as meeting FCAA RACT for the area's moderate nonattainment classification under the 2008 eight-hour ozone NAAQS (82 FR 60546, December 21, 2017).

4.5.2 NO_X RACT Determination

The 30 TAC Chapter 117 rules represent one of the most comprehensive NO_X control strategies in the nation. The TCEQ reviewed the 2017 point source EI to verify that the NO_X controls and reductions implemented through 30 TAC Chapter 117 for the 10-county DFW ozone nonattainment continue to address RACT for the 2008 eight-hour ozone standard. The current EPA-approved 30 TAC Chapter 117 rules continue to fulfill RACT requirements for ACT NO_X source categories that exist in the 10-county DFW ozone nonattainment area and all NO_X major sources in the DFW 2008 eight-hour ozone nonattainment area, except Wise County. The concurrent proposed rulemaking (Rule Project No. 2019-074-117-AI) would address all identified major sources of NO_X in Wise County. Details of this analysis are included in Appendix F.

4.5.3 VOC RACT Determination

In the 10 counties that were previously classified moderate nonattainment under the 2008 eight-hour NAAQS, all VOC emission source categories addressed by CTG and ACT documents that exist in the area are controlled by existing rules in 30 TAC Chapter 115 or other EPA-approved regulations that fulfill RACT requirements. Tables F-2: *State Rules Addressing VOC RACT Requirements in CTG Reference Documents* and F-3: *State Rules Addressing VOC RACT Requirements in ACT Reference Documents* of Appendix F provide additional details on the CTG and ACT source categories.

The TCEQ previously submitted negative declarations for the following CTG source categories for the 10-county DFW 2008 eight-hour ozone nonattainment area, and is resubmitting these negative declarations as part of this SIP revision:

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

For all non-CTG and non-ACT major VOC emission sources for which VOC controls are technologically and economically feasible, RACT is fulfilled by existing 30 TAC Chapter 115 rules, other federally enforceable measures, and by concurrent proposed revisions to 30 TAC Chapter 115. Additional VOC controls on certain major sources were determined to be either not economically feasible or not technologically feasible. Appendix F, Table F-5: *State Rules Addressing VOC RACT Requirements for Major Emission Sources in the 10-County DFW Area* provides additional detail on the non-CTG and non-ACT major emission sources.

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 stationary source control strategies evaluated during the RACM analysis for the DFW Attainment Demonstration SIP revision for the 2008 eight-hour ozone NAAQS submitted to the EPA on July 10, 2015. The same list was used for this proposed DFW 2008 Eight-Hour Ozone Serious Classification 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 area and existing sources of VOC and NO_X in the DFW area. A draft list of potential control strategy concepts was developed from this initial evaluation. The TCEQ also invited stakeholders to suggest any additional strategies that might help advance attainment of the DFW area. The final list of potential control strategy concepts for RACM analysis includes the strategies on the initial draft list and the strategies suggested by stakeholders during the informal stakeholder comment process.

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

RACM is defined by the EPA as any potential control measure for application to point, area, on-road and non-road emission source categories that meets the following criteria:

- the control measure is technologically feasible;
- the control measure is economically feasible;
- the control measure does not cause "substantial widespread and long-term adverse impacts";
- the control measure is not "absurd, unenforceable, or impracticable"; and
- 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, 2021 attainment date for this proposed DFW Attainment Demonstration SIP revision, the TCEQ evaluated this aspect of RACM based on advancing the attainment date by one year, to July 20, 2020.

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, 2020 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, 2020, suggested control measures would have to be fully implemented by March 1, 2019. 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; availability of testing; and time needed for testing.

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

4.6.2 Results of RACM Analysis

Based on the RACM analysis, the TCEQ determined that no potential control measures met the criteria to be considered RACM. All potential control measures evaluated for stationary sources were determined to not be RACM due to technological or economic feasibility, enforceability, adverse impacts, or ability of the measure to advance attainment of the NAAQS. In general, the inability to advance attainment is the primary determining factor in the RACM analyses. As discussed in Chapter 3: *Photochemical Modeling* and Chapter 5: *Weight of Evidence* of this SIP revision, the current modeling results indicate that the DFW area will demonstrate attainment. Based on a July 20, 2021 attainment date, and a 2020 attainment year, a control measure would have to be in place prior to the beginning of ozone season in the attainment year to be considered RACM, or March 1, 2020. Furthermore, a control measure would have to be in place by March 1, 2019 for the measure to advance the attainment date by one year. The TCEQ's evaluation of the potential control measures indicates that it is not possible to reasonably implement any control measures that would advance attainment of the NAAQS.

4.7 MOTOR VEHICLE EMISSIONS BUDGETS

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. Adequate or approved budgets must be used in transportation conformity analyses. Areas must demonstrate that the estimated emissions from transportation plans, programs, and projects do not exceed applicable MVEBs. The attainment NO_X and VOC budgets represent the summer weekday on-road mobile source NO_X and VOC emissions that have been modeled for this proposed DFW Attainment Demonstration SIP revision and include all of the on-road control measures reflected in Chapter 4: *Control Strategies* *and Required Elements* of the demonstration. The on-road NO_X and VOC emissions inventories (EIs) establishing these MVEBs were developed with the 2014a version of the EPA's Motor Vehicle Emission Simulator (MOVES2014a) model and are shown in Table 4-2: *2020 AD MVEBs for the 10-County DFW Area*. For additional detail, refer to Appendix B*: Emissions Modeling for the DFW and HGB Attainment Demonstration SIP Revisions for the 2008 Eight-Hour Ozone Standard.*

Table 4-2: 2020 Attainment Demonstration MVEBs for the 10-County DFW Area

10-County DFW Area On-Road Emissions Inventory Description	NO_X tons per day (tpd)	VOC (tpd)
2020 On-Road MVEBs Based on MOVES2014a	88.27	53.05

4.8 MONITORING NETWORK

The ambient air quality monitoring network provides data to verify the attainment status of the 2008 eight-hour ozone NAAQS.

The DFW area monitoring network in 2019 consists of 17 regulatory ambient air ozone monitors located in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant counties. The City of Dallas operates four monitors: Dallas Hinton (C0060/C401), Dallas Redbird Airport (C402), Dallas North Number 2 (C0063), and Rockwall Heath (C0069). The City of Fort Worth operates three monitors: Arlington Municipal Airport (C0061), Eagle Mountain Lake (C0075), and Keller (C0017). The Texas Commission on Environmental Quality (TCEQ) operates the remaining 10 ozone monitors: Cleburne Airport (C0077), Denton Airport South (C0056), Fort Worth Northwest (C0013), Frisco (C0031), Grapevine Fairway (C0070), Italy (C1044), Kaufman (C0071), Midlothian OFW (C0052), Parker County (C0076), and Pilot Point (C1032).

The monitors are managed in accordance with 40 Code of Federal Regulations (CFR) Part 58 to verify the area's attainment status. The TCEQ commits to maintaining an air monitoring network that meets regulatory requirements in the DFW area. The TCEQ continues to work with the EPA through the air monitoring network review process, as required by 40 CFR Part 58, to determine: the adequacy of the ozone monitoring network, additional monitoring needs, and recommended monitor decommissions. Air monitoring data from these monitors continue to be quality assured, reported, and certified according to 40 CFR Part 58.

4.9 CONTINGENCY PLAN

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

The EPA's final 2008 eight-hour ozone standard SIP requirements rule removed the requirement for states to account for non-creditable reductions when determining compliance with RFP emission reduction requirements. Although previously AD contingency calculations were based on the RFP EI, one result of removing the non-creditable reductions from the RFP calculations is the RFP ABY inventory becomes equal to the RFP base year EI. Accordingly, AD contingency reductions for the 2008 eight-hour ozone standard are calculated based on the RFP base year EI.

This proposed DFW Attainment Demonstration SIP revision uses the 2011 RFP base year inventory from the concurrent proposed DFW and Houston-Galveston Brazoria (HGB) Serious Classification RFP SIP Revision for the 2008 Eight-Hour Ozone NAAQS (Project Number 2019-079-SIP-NR) as the inventory from which to calculate the required 3% contingency reductions. The 3% contingency analysis for 2021 is based on a 2% reduction in NO_x and a 1% reduction in VOC, to be achieved between 2020 and 2021. Analyses were performed to assess emissions reductions between 2020 and 2021 from the federal emissions certification programs and for fuel control programs for both on-road and non-road vehicles.

A summary of the 2021 contingency analysis is provided in Table 4-2: *2021 DFW Attainment Contingency Demonstration (tons per day)*. The analysis demonstrates that the 2021 contingency reductions exceed the 3% reduction requirement; therefore, the AD contingency requirement is met. Additional documentation for the attainment contingency demonstration calculations is available in the DFW and HGB Serious Classification RFP SIP revision being proposed concurrently with this DFW Attainment Demonstration SIP revision.

Table 4-3: 2021 DFW Attainment Contingency Demonstration (tons per day)

Contingency Element Description	NO_x	VOC
2011 DFW RFP base year[1] (BY) EI	422.04	464.92
Percent for contingency calculation (total of 3%)	2.00	1.00
2020 to 2021 attainment demonstration required contingency reductions (RFP BY EI x [contingency percent])	**8.44**	**4.65**
Control reductions to meet contingency requirements		
2020 to 2021 emission reductions due to Post-1990 Federal Motor Vehicle Control Program, Inspection/Maintenance Program, ultra low sulfur diesel, on-road reformulated gasoline (RFG)[2], East Texas Regional Low Reid vapor pressure (RVP) [2], 2017 Low Sulfur Gasoline Standard, and on-road Texas Low Emissions Diesel (TxLED)	24.69	9.12
2020 to 2021 emission reductions due to federal non-road mobile new vehicle certification standards, non-road RFG, and non-road TxLED	2.75	2.48
Total attainment demonstration contingency reductions	**27.44**	**11.60**
Contingency Excess (+) or Shortfall (-)	**+19.00**	**+6.95**

Note 1: The EPA's final 2008 eight-hour ozone standard SIP requirements rule (80 FR 12263, March 6, 2015) removed the requirement for states to account for non-creditable reductions when determining compliance with RFP emissions reduction requirements. One result of removing the non-creditable reductions from the RFP calculations is the RFP ABY inventory becomes equal to the RFP BY inventory. The DFW AD contingency calculations use the 2011 RFP base year EI to calculate required contingency reductions.

Note 2: The 10-county DFW area includes counties with federal RFG and counties with Texas Regional Low RVP. The four counties with federal RFG are: Collin, Dallas Denton and Tarrant. The six counties with Texas Regional Low RVP are: Ellis, Johnson, Kaufman, Parker, Rockwall and Wise.

Note 3: This SIP revision does not provide a transportation conformity safety margin for the 2020 AD MVEBs. Therefore, emissions reductions reserved for an MVEB safety margin are not included in the post attainment year contingency calculation (refer to Appendix 1: *DFW Reasonable Further Progress Demonstration Spreadsheet* in the RFP SIP revision).

4.10 ADDITIONAL FCAA REQUIREMENTS

FCAA, §182 sets out a graduated control program for ozone nonattainment areas. On June 14, 2017, the EPA approved portions of the 2016 DFW 2008 Eight-Hour Ozone Standard AD SIP Revision that describes how FCAA requirements for vehicle inspection and maintenance and nonattainment new source review are met in the DFW area for the 2008 eight-hour ozone NAAQS (82 FR 27122). Section 4.9 of the 2018 DFW RACT Update SIP Revision adopted by the commission on August 8, 2018 included a description of how FCAA requirements for emission statements from stationary point sources are met in the DFW area for the 2008 eight-hour ozone NAAQS. On December 4, 2018, the EPA published a direct final rule to approve the portion of the DFW RACT Update SIP revision addressing emissions statement requirements for the DFW 2008 eight-hour ozone nonattainment area (83 FR 62468) with an effective date of March 4, 2019. The TCEQ will monitor current aggregate vehicle mileage, aggregate vehicle emissions, and congestion levels as required by FCAA, §182(c)(5). The commission will determine if submittal of a demonstration to the EPA regarding transportation control would be necessary in the future if current levels exceed those included in this AD SIP revision.

4.11 EMISSION CREDIT GENERATION

The Emissions Banking and Trading (EBT) rules in 30 TAC Chapter 101, Subchapter H, Divisions 1 and 4 require sources in nonattainment areas to have SIP emissions to be eligible to generate emission credits. SIP emissions are the actual emissions from a facility or mobile source during the SIP emissions year, not to exceed any applicable local, state, or federal requirement. For point sources, the SIP emissions cannot exceed the amount reported to the state’s EI; if no emissions were reported for a point source facility in SIP emissions year, then the facility is not eligible for credits.

This proposed DFW Attainment Demonstration SIP revision would revise the SIP emissions year used for emission credit generation. If adopted, the new SIP emissions year will be 2018 for point source electric generating units with emissions recorded in the EPA’s Air Markets Program Database for 2018, 2016 for all other point sources, and 2017 for all area and mobile sources. In anticipation of this change, the TCEQ posted notice on the EBT webpages and sent notice through the EBT email notification system informing the public that emission credit applications submitted after January 18, 2019 must use the new SIP emissions year in the baseline assessment for sources in nonattainment areas.

CHAPTER 5: WEIGHT OF EVIDENCE

5.1 INTRODUCTION

The corroborative analyses presented in this chapter demonstrate the progress towards attainment of the 2008 eight-hour ozone National Ambient Air Quality Standard (NAAQS) that the Dallas-Fort Worth (DFW) ozone nonattainment area continues to make. This corroborative information supplements the photochemical modeling analysis presented in Chapter 3: *Photochemical Modeling* to support a conclusion that the DFW ozone nonattainment area will attain the 2008 eight-hour ozone standard by July 20, 2021. 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, $PM_{2.5}$, and Regional Haze* (EPA, 2018; hereafter referred to as modeling guidance) 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 proposed DFW AD State Implementation Plan (SIP) revision.

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 ozone 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 ozone nonattainment area. More detail on these ozone and emissions 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.

5.2 ANALYSIS OF AMBIENT TRENDS AND EMISSIONS TRENDS

The EPA's modeling guidance states in Section 6.0: *How Can Additional Analyses Be Used to Support an Ozone or $PM_{2.5}$ Attainment Demonstration*, that examining recently observed air quality and emissions trends is an acceptable method to qualitatively assess progress toward attainment. Declining trends in observed concentrations of ozone and its precursors 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. The 10-county DFW ozone nonattainment area has an extensive monitoring network that currently has 17 operational ozone monitors, 14 nitrogen oxides (NO_x) monitors, 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](https://www.tceq.texas.gov/airquality/monops/sites/air-mon-sites) webpage (https://www.tceq.texas.gov/airquality/monops/sites/air-mon-sites).

This section examines both emissions trends as well as the ambient trends from the extensive ozone and ozone precursor monitoring network in the DFW area. Overall, despite a continuous increase in the population of the 10-county DFW ozone nonattainment area, a strong economic development pattern, and growth in vehicle miles traveled (VMT), the observed trends are declining for ozone concentrations and NO_x and VOC precursor emissions.

Appendix D provides an extensive set of graphics that detail ozone trends in the region primarily from 1990 through 2016. 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 (DV) both have overall sustained decreasing trends over the past 10 years, and the DFW area has monitored attainment of the revoked one-hour ozone standard since 2006. At the end of the 2018 ozone season, the eight-hour DV was 76 parts per billion (ppb), which is in attainment of the 1997 eight-hour ozone standard of 84 ppb and one ppb above the 2008 NAAQS of 75 ppb.

The categories of on-road, non-road, and electric generating units (EGUs) have historically been primary sources of anthropogenic NO_x emissions in the DFW ozone nonattainment area. From the late 1990s to the present, Federal, state, and local measures have resulted in significant NO_x reductions from these source categories within DFW. The TCEQ funded a study by the Texas Transportation Institute (TTI) to estimate on-road emissions trends throughout Texas from 1999 through 2050 using the 2014a version of the Motor Vehicle Emission Simulator (MOVES2014a) model (TTI, 2015). As shown in Figure 5-1: *On-Road Emissions Trends in the DFW Area from 1999 through 2050*, DFW on-road emissions were estimated to be 526 NO_x tpd in 1999 and have decreased roughly 80% by 2018, even as daily vehicle miles traveled (VMT) is estimated to have increased by 30% during this period. Figure 5-1 also shows that this reduction in on-road NO_x is projected to continue as older higher-emitting vehicles are removed from the fleet and are replaced wither newer lower-emitting ones.

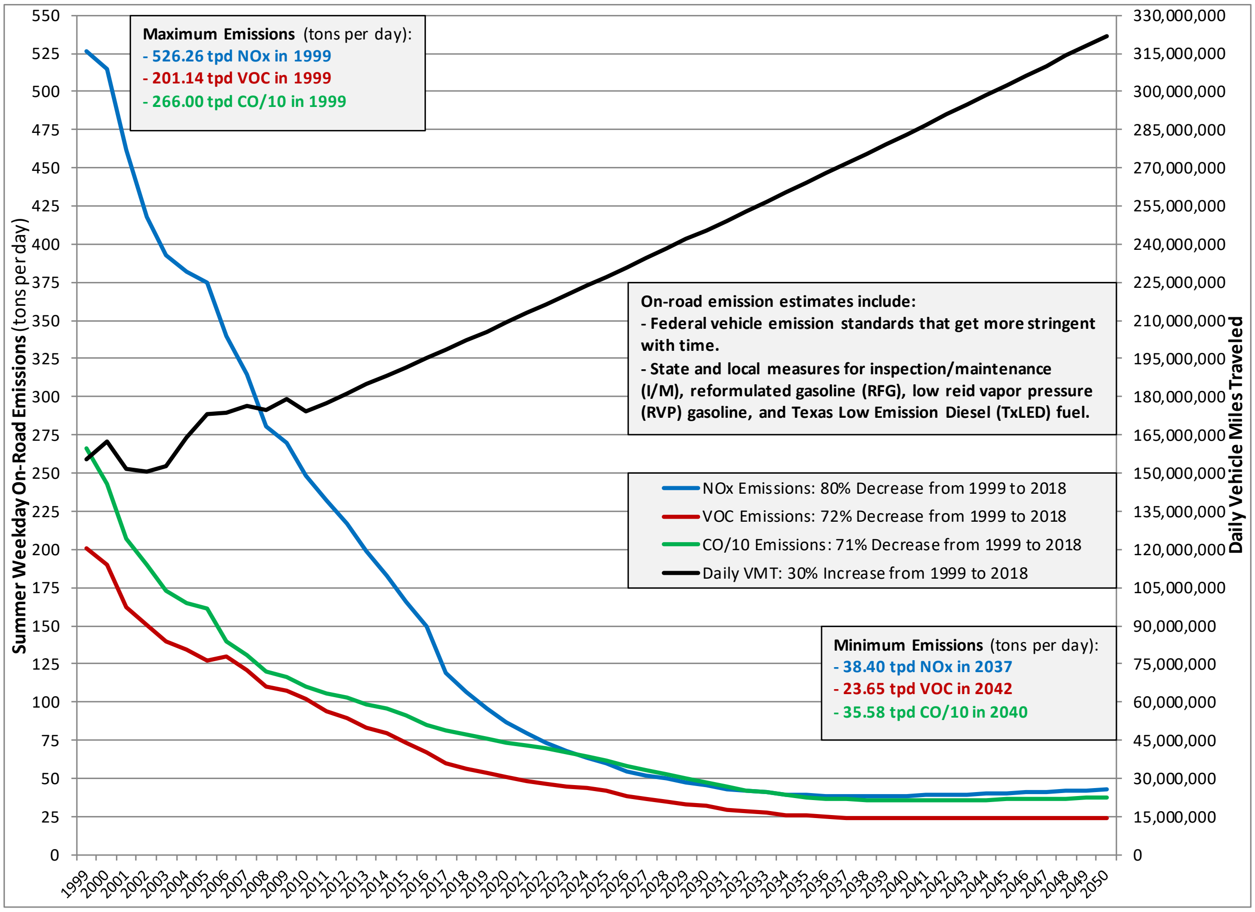


Figure 5-1: On-Road Emissions Trends in the DFW Area from 1999 through 2050

A similar pattern is reflected in a TCEQ non-road emissions trends analysis using the Texas NONROAD (TexN) model (TCEQ, 2015). As shown in Figure 5-2: *Non-Road Emissions Trends in the DFW Area from 1999 through 2050*, non-road emissions were estimated to be 133 NO_x tpd in 1999 and have decreased roughly 65% by 2018, even as the number of non-road engines (equipment population) has increased by 47% during this period. As with the on-road fleet turnover effect presented in Figure 5-1, Figure 5-2 shows that reductions in non-road NO_x emissions are projected to continue as older high-emitting equipment is removed from the fleet and replaced with newer lower-emitting equipment.

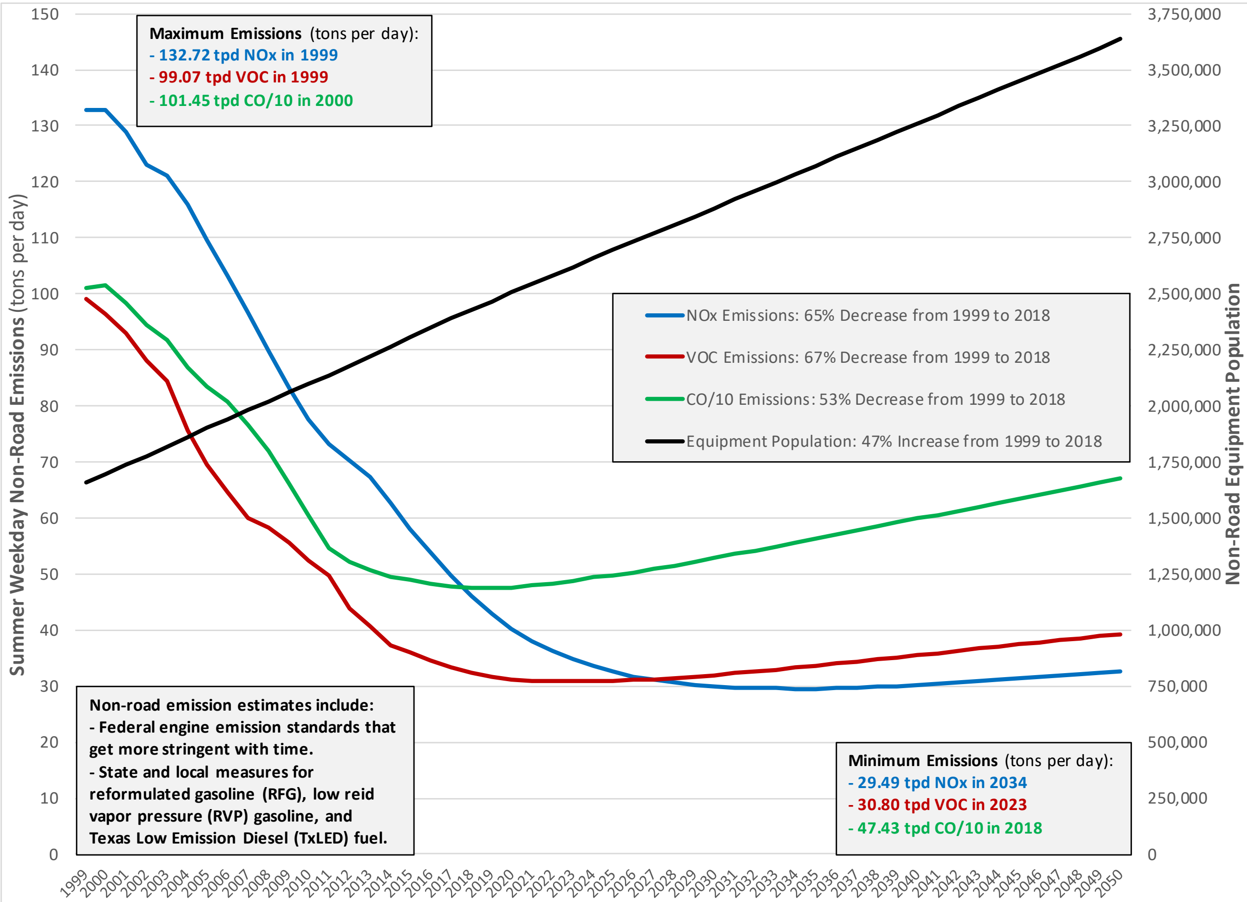


Figure 5-2: Non-Road Emissions Trends in the DFW Area from 1999 through 2050

Operational data for DFW area EGUs from 1997 through 2018 were extracted from the EPA's Air Markets Program Data (AMPD) tool and are presented in Figure 5-3: *EGU Emissions Trends in the DFW Area from 1999 through 2018*. As shown, DFW area EGUs emitted an average of 79 NO_X tpd during the summer of 1997 and have reduced these emissions by 89% through 2018, even though the amount of electricity generated during this time has increased by 65%. Due to the emission controls installed on existing units and the retirement of older plants, the summer daily average EGU NO_X has not exceeded 10 tpd from 2009 through 2018.

These trends in on-road, non-road, and EGU sources demonstrate the substantial progress in reducing DFW area NO_X emissions that has already occurred and will be sustained in the future.

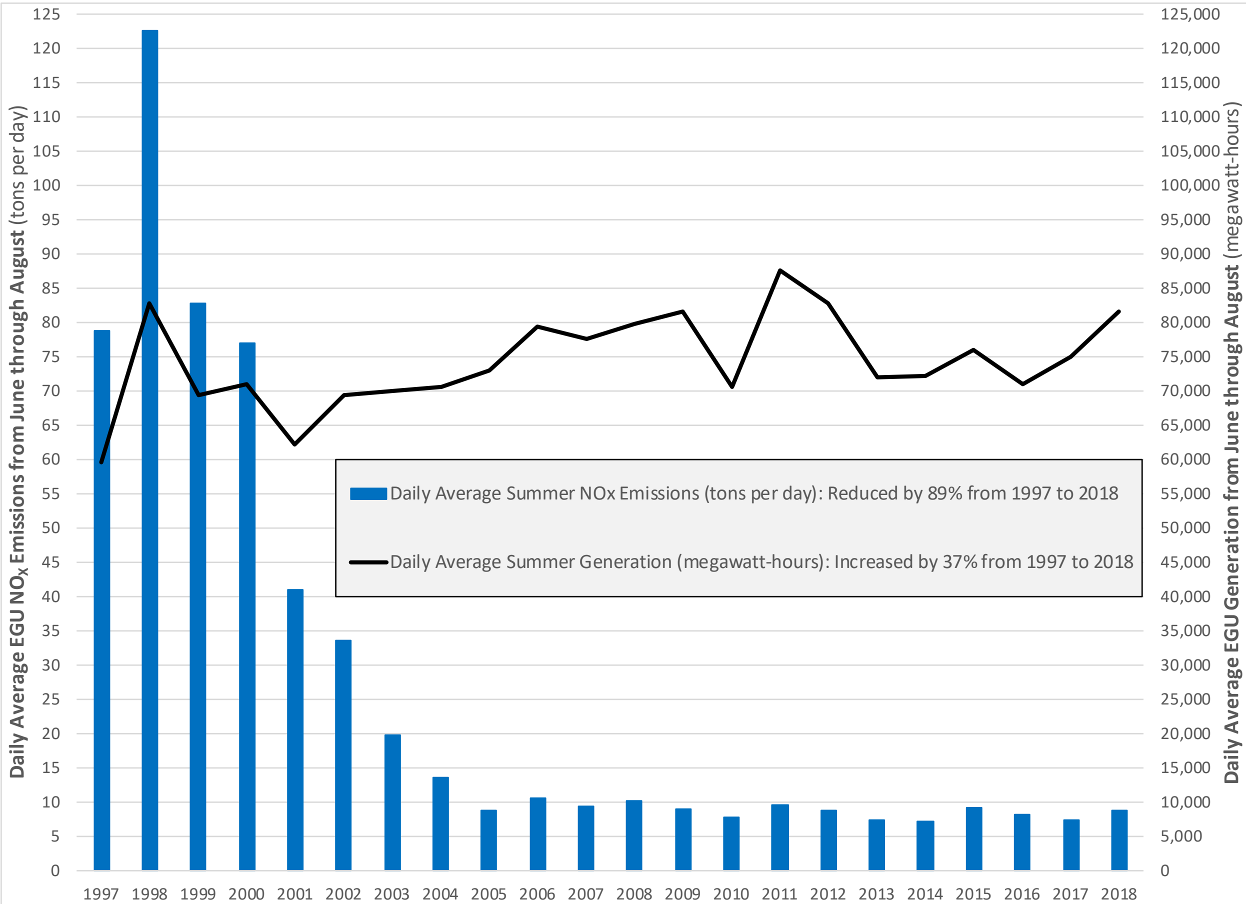


Figure 5-3: EGU Emissions Trends in the DFW Area from 1999 through 2018

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. Due to an abundance of naturally occurring reactive VOC from biogenic sources such as isoprene emitted by oak trees, ozone formation in the DFW area is more sensitive to anthropogenic NO_x than to anthropogenic VOC. Much of the anthropogenic VOC emitted in the DFW ozone 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 the DFW area.

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 ozone 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 at select monitors indicates that the urban core of the DFW ozone nonattainment area is transitional, just outside of the VOC-limited classification, and the more rural areas of the DFW ozone nonattainment area are also transitional, just outside of the NO_x-limited classification.

Emissions in the DFW urban core, which is transitional, are primarily from on-road mobile sources for which the TCEQ has limited authority to regulate. However, NO_X reductions have contributed to the downward trend in ozone levels monitored within the DFW urban core.

The following conclusions can be inferred from both the ambient ozone trends as well as on-road mobile source trends:

- Monitored ambient concentrations of NO_X and VOC have been decreasing across the DFW ozone nonattainment area, despite an expanding population.
- Observed NO_X concentrations are trending downward, which suggests lower ozone concentrations should follow as supported by weekday versus weekend ozone concentrations.
- The decrease in ambient NO_X concentrations 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 ozone nonattainment area and statewide contribute to NO_X concentration reductions.
- Modeled emissions from on-road and non-road mobile sources as well as trend analyses indicate that NO_X concentrations continue to trend downward out to the modeled attainment year of 2020 and beyond.
- The one-hour ozone DV has decreased from 125 in 2005 to 101 ppb in 2018. The eight-hour ozone DV decreased from 95 ppb in 2005 to 76 ppb in 2018.
- Given the currently implemented control programs, total DFW ozone nonattainment area NO_X in 2020 is expected to be reduced by roughly 41% from 2012 levels, with projected NO_X reductions of 55% for both on-road sources and non-road sources. More detail is contained in Chapter 3 on these expected reductions from 2012 through 2020.

Accordingly, the strong and lasting historic downward trends in observed air quality measurements are consistent with progress toward the DFW ozone nonattainment area attaining the 2008 ozone NAAQS by July 20, 2021.

5.2.1 Ozone Trends

Because ozone varies both temporally and spatially, there are several methods to analyze the trends in ozone concentrations. This section discusses ozone DV trends and background ozone trends. These trends will help to support the conclusion that the 10-county DFW area is making progress towards attainment of the 2008 eight-hour ozone NAAQS. Ozone data used in this section is only from regulatory monitors that report to the EPA's Air Quality System (AQS) data mart unless otherwise noted.

5.2.1.1 Ozone Design Value Trends

A DV is the statistic used to determine compliance with the NAAQS. For the 2008 eight-hour ozone NAAQS, DVs are calculated by averaging fourth-highest daily-maximum eight-hour averaged ozone value at each monitor site over three years. The eight-hour ozone DV for a metropolitan area is the maximum DV from all the area's monitors' individual DVs. DVs of 76 ppb and greater exceed the 2008 eight-hour ozone NAAQS of 75 ppb. Although this SIP focuses on eight-hour ozone, the one-hour ozone

DVs can also be useful to determine ozone trends. The one-hour ozone DVs are calculated differently than the eight-hour ozone DVs. The one-hour ozone DV is calculated by determining the fourth-highest daily-maximum one-hour ozone value over three years at each monitor. Like the eight-hour ozone DVs, the one-hour ozone DV for a metropolitan area is the maximum DV from all the monitors within that area.

Both eight-hour and one-hour ozone DVs have decreased over the past 14 years, as shown in Figure 5-4: *One-Hour and Eight-Hour Ozone Design Values in the DFW Area from 2005 through 2018*. The 2018 one-hour ozone DV for the DFW ozone nonattainment area is 101 ppb, which demonstrates continued attainment of the revoked one-hour ozone NAAQS. The 2018 eight-hour ozone DV for the DFW ozone nonattainment area is 76 ppb, which is in attainment of the former 84 ppb standard and demonstrates progress toward the current 75 ppb standard. This value was recorded at both the Grapevine Fairway and Cleburne Airport monitors. The Grapevine Fairway monitor is located at a northerly position within the DFW ozone nonattainment area, and the Cleburne Airport monitor is located at a south-southwesterly position within the nonattainment area. Although roughly on opposite sides of the nonattainment area, both monitors have the potential to be downwind of the urban core based on the wind direction on a given day.

The trendline for the one-hour ozone DV shows a decrease of about 2.1 ppb per year from 2005 through 2018, and the trendline for the eight-hour ozone DV shows a decrease of about 1.4 ppb per year over this same time period. The one-hour ozone DV decreased roughly 19% from 2005 through 2018 and the eight-hour ozone DV decreased roughly 20% over this same time period.

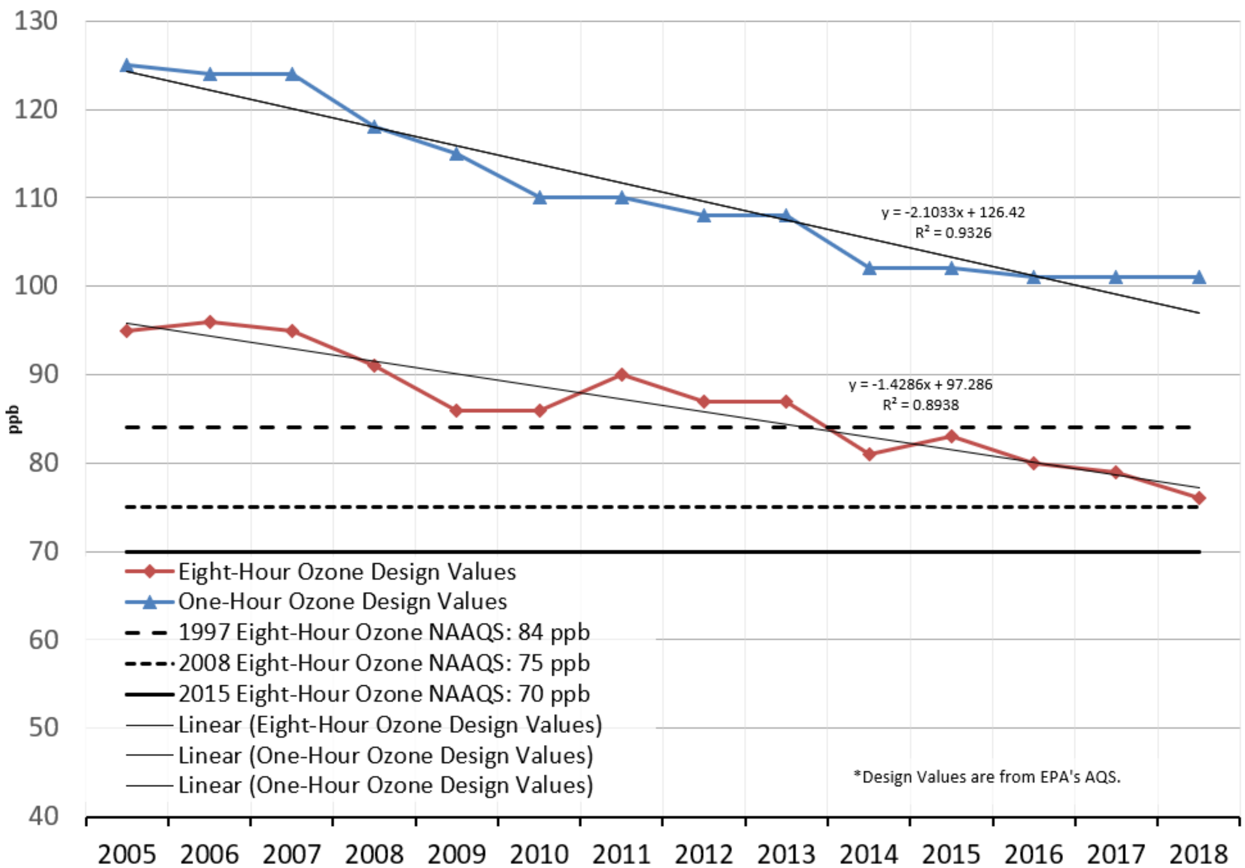


Figure 5-4: One-Hour and Eight-Hour Ozone Design Values in the DFW Area from 2005 through 2018

5.2.1.2 Background Ozone Trends

Ozone levels in the DFW ozone nonattainment area are the sum of the background ozone entering the area and the locally produced ozone. Background ozone reflects the ozone produced from all sources outside of the 10-county DFW ozone nonattainment area. Determining the background ozone concentrations in the DFW area will indicate how much ozone is produced from local emissions. The local component of ozone formation is then the amount of ozone that the area could potentially control to meet the 2008 eight-hour ozone NAAQS. Estimates of seasonal mean United States background ozone concentrations can be as high as 40 to 50 ppb depending upon location and time of year (EPA, 2015).

The technique for estimating background ozone concentrations is described in Berlin et al. (2013); it is similar to methods used by Nielsen-Gammon et al. (2005). To estimate background ozone concentrations, monitoring sites capable of measuring background ozone were selected based upon their distance from local emission sources in the urban core and industrial areas of the DFW. Each of these selected sites is expected to receive air with regional background ozone when it is upwind (or at least, not downwind) of the urban and industrial areas.

The following monitors were chosen as background monitors in this study: Parker County (C76), Eagle Mountain Lake (C75), Pilot Point (C1032), Frisco (C31), Greenville

(C1006), Rockwall Heath (C69), Kaufman (C71), Italy (C1044), Cleburne Airport (C77), and Granbury (C73). These perimeter (outside of the DFW urban core) monitors are selected to avoid low, biased ozone concentrations found in the urban core as a result of high NO_x concentrations (NO_x titration). NO_x-influenced, low urban concentrations can underestimate background ozone concentrations.

From these monitors, the highest daily one-hour ozone concentration and associated hour this concentration was recorded were identified. Using the hour of the daily maximum one-hour ozone concentration, the minimum one-hour ozone concentration was identified for the same hour from the remaining monitors included in this study. This concentration is considered the background ozone concentration for the day. To further narrow down the results, only ozone values from the hours of 10:00 through 19:00 on days with eight-hour ozone concentrations above 70 ppb were considered. Hours outside of 10:00-19:00 are not generally associated with ozone production. Inherent in this calculation method is the assumption that the lowest daily one-hour ozone concentration at the hour the highest one-hour ozone concentration was recorded represents background ozone. If there is a gradient in background ozone across the metropolitan area, the method will select the lowest end of the gradient as background; therefore, the method is conservative in that it represents the lowest measured background value.

Figure 5-5: *Background Ozone on Days with Eight-Hour Ozone Concentrations Greater than 70 ppb* displays results aggregated to yearly values and shown as boxplots with connected percentiles. The boxplots contain a connected median (red line) which is trending slightly downward. The two gray lines in the figure connect the 75th and 25th percentile values, respectively. In 2005, the calculated 75th percentile value was 69 ppb, the median value was 62 ppb, and the 25th percentile value was 58 ppb. In 2018 the calculated 75th percentile value was 59 ppb, the median value was 58 ppb, and the 25th percentile value was 51. Typical meteorological variation plays a role in yearly trend variation.

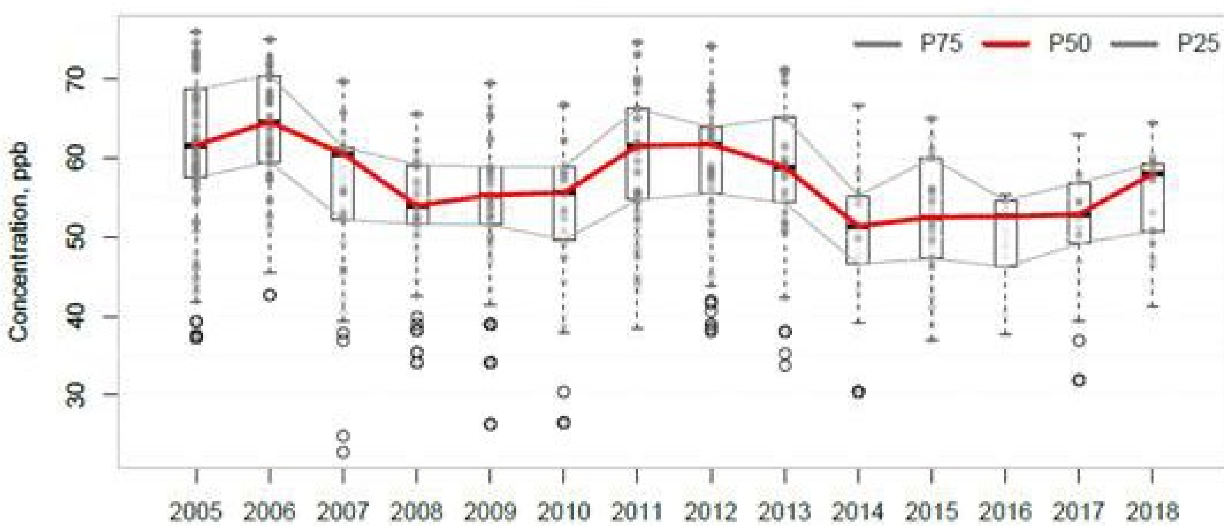


Figure 5-5: Background Ozone on Days with Eight-Hour Ozone Concentrations Greater than 70 ppb

5.2.2 Ambient 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 ozone nonattainment area.

Trends for ambient NO_x concentrations are presented in Figure 5-6: *Ozone Season (March through October) Daily Peak Ambient NO_x Trends in the DFW Area*. Trends are for the years 2005 through 2018 and represent the 90th percentile, 50th percentile, and 10th percentile of daily peak NO_x concentrations in the 10-county DFW ozone nonattainment area. All three concentrations are decreasing over the years covered. A dotted line is provided to highlight the trend in ambient NO_x concentrations.

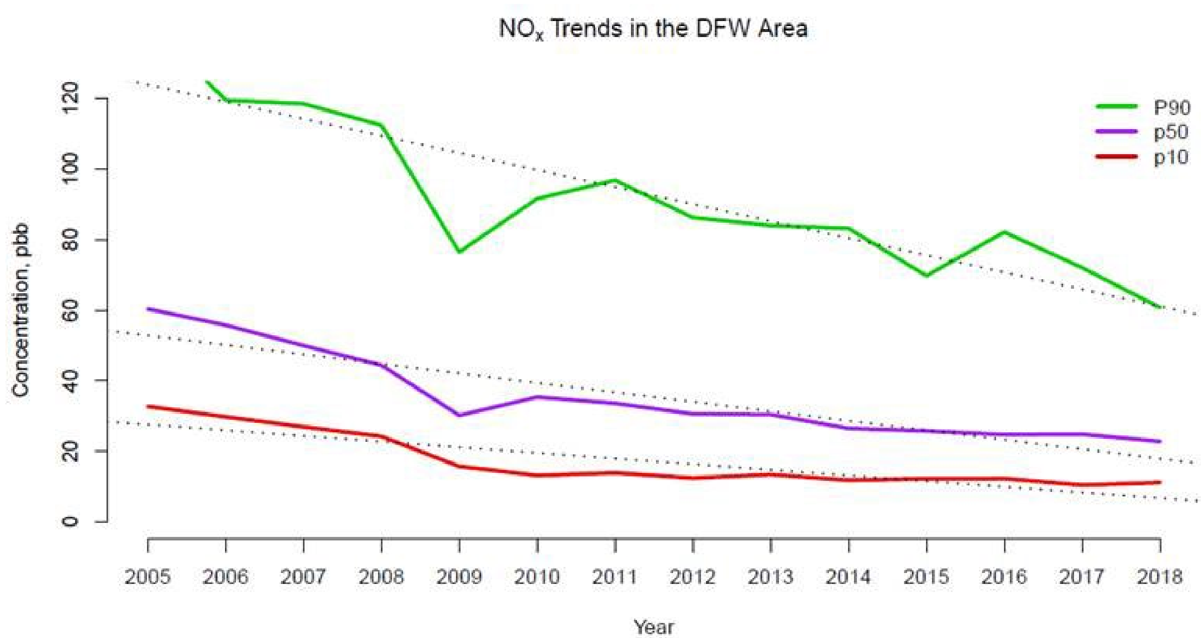


Figure 5-6: Ozone Season (March through October) Daily Peak Ambient NO_x Trends in the DFW Area

NO_x trends at individual monitors in the DFW ozone nonattainment area are presented in Figure 5-7: *50th Percentile Daily Peak NO_x Concentrations in the DFW Area*. The 50th percentile was chosen because the data are right-tailed skewed, and the 50th percentile is a good indicator of the central tendency. Fourteen of the 15 monitors included in Figure 5-7 are located in the DFW ozone nonattainment area. The Greenville monitor, although located in a county just outside the DFW ozone nonattainment area, was included in the figure to provide additional results from monitors outside of the DFW urban core.

As seen in Figure 5-7, downward NO_x trends in the DFW ozone nonattainment area are most distinct at urban monitors. The monitors with smaller downward trends monitor lower NO_x concentrations, primarily because they are rural monitors in areas of reduced on-road activity relative to monitors closer to the DFW urban core. NO_x concentrations at urban monitors tend to be affected more by on-road emissions; therefore, these monitors are more influenced by the technology or age of the on-road fleet. This influence is reflected in the slope of the trend, and accordingly, these monitors tend to have sharper downward NO_x trends than their rural counterparts.

Only one of the 15 monitors does not display a downward trend. This monitor (Fort Worth California Parkway North) is a near-road monitor that began operating in 2014. A monitor positioned next to a heavily-traveled road is expected to measure higher NO_x values than monitors positioned a greater distance from a major roadway.

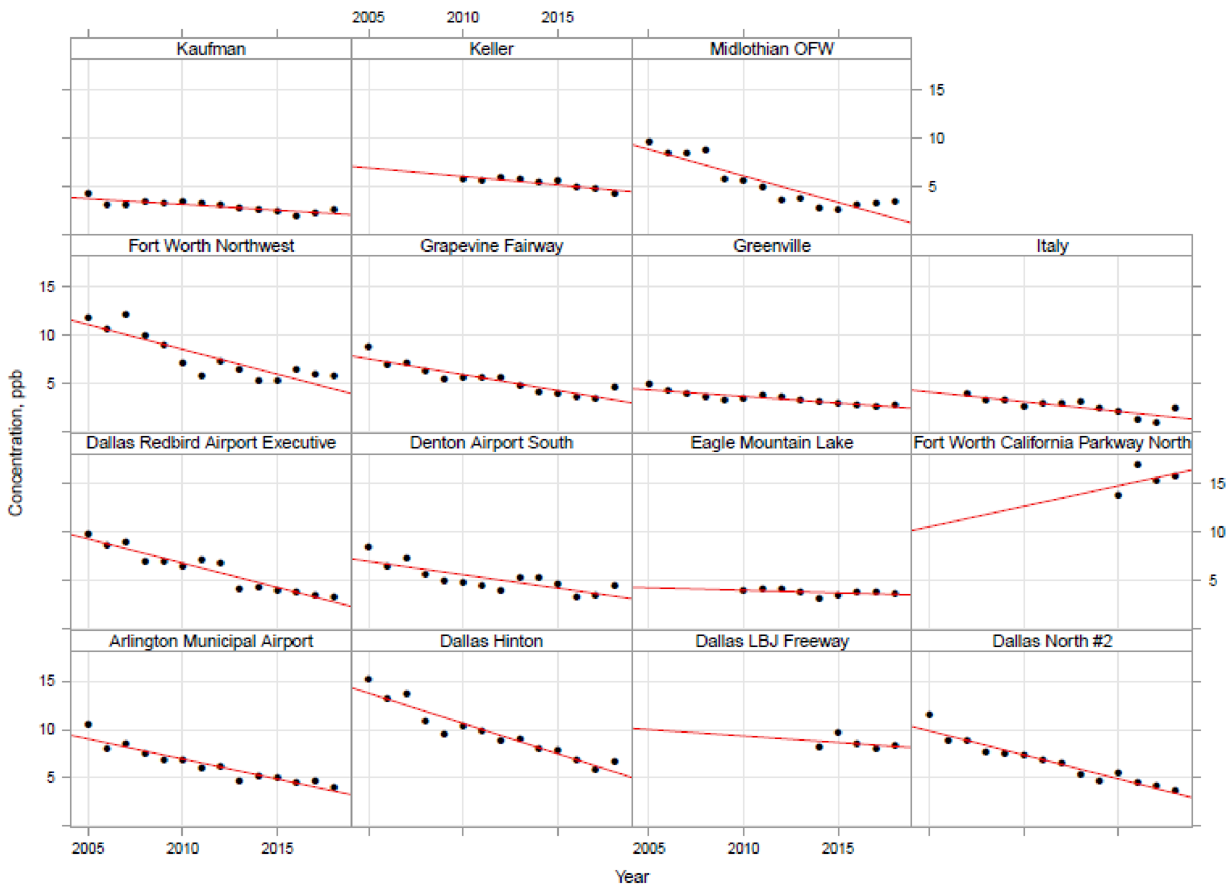


Figure 5-7: 50th Percentile Daily Peak NO_x Concentrations in the DFW Area

Ambient NO_x concentrations in the overall DFW ozone nonattainment area are trending downward, especially in the DFW urban areas. This downward trend likely results from the state controls placed on point sources, along with the federal standards implemented for on-road vehicles and non-road equipment. Due to prevailing winds during the ozone season, typical ozone DV setting monitors are located outside of the DFW urban core and receive transported NO_x from the DFW urban areas; therefore, these locations benefit from lower transported NO_x emissions.

The overall downward trends in ambient NO_x concentrations in the DFW ozone nonattainment area are another positive factor indicating support for the photochemical modeling results documented in Chapter 3.

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 ozone concentrations. In VOC-limited regions, NO_x is abundant, and therefore the ozone formation is more sensitive to the quantity of radicals from VOC oxidation present in the atmosphere. In VOC-limited regions, controlling VOC emissions would be more effective in reducing 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 locations.

VOC to NO_x ratios are calculated by dividing hourly total non-methane hydrocarbon (TNMHC) concentrations in parts per billion by carbon (ppbC) by hourly NO_x concentrations in parts per billion by volume (ppbV). Ratios less than 5 ppbC/ppbV are considered VOC-limited, ratios above 15 ppbC/ppbV are considered NO_x-limited, and ratios between 5 ppbC/ppbV and 15 ppbC/ppbV are considered transitional. Calculation of VOC to NO_x ratios are limited by the number of collocated auto-GC and NO_x monitors available in the area. In addition, auto-GC monitors are often source-oriented and therefore they will only provide information on the air mass located near the source and not throughout the whole area.

The annual median VOC to NO_x ratios at the Dallas Hinton, Eagle Mountain Lake, and Fort Worth Northwest auto-GC monitors are shown in Figure 5-8: *Trend in VOC to NO_x Ratios using Auto-GC Data.* As displayed in Figure 5-8, the Dallas Hinton and Fort Worth Northwest monitors were previously VOC-limited and are currently at the low end of the transitional classification. This result can be attributed to the lower ambient NO_x concentrations due to NO_x reductions taking place in the urban DFW ozone nonattainment area.

The more rural Eagle Mountain Lake monitor has fluctuated between transitional and NO_x-limited conditions during its operational history. This monitor is located close to biogenic emissions sources and natural gas wells, but downwind of the urban DFW ozone nonattainment area due to prevailing winds during peak ozone months. The fluctuation between NO_x-limited and transitional classifications at this monitor may be due to variation in natural gas production in the area.

Per Texas Railroad Commission (RRC) data (RRC, 2019), natural gas production in the Barnett Shale increased from an average of 4,441 million cubic feet per day in 2008 to a peak of 5,743 million cubic feet in 2012, which is a relative increase of 29%. Potentially as a result of this upward production trend and eventual peak in 2012, coupled with decreasing NO_x emissions from the urban DFW ozone nonattainment area, the VOC-to-NO_x ratio trended upward from 2010. The RRC reports 2018 daily average natural gas production in the Barnett Shale at 3,166 million cubic feet per day, which is a relative decline of 45% from 2012. This coincides with the drop in VOC-to-

NO_x ratio and subsequent change from NO_x-limited to transitional classifications at this monitoring location.

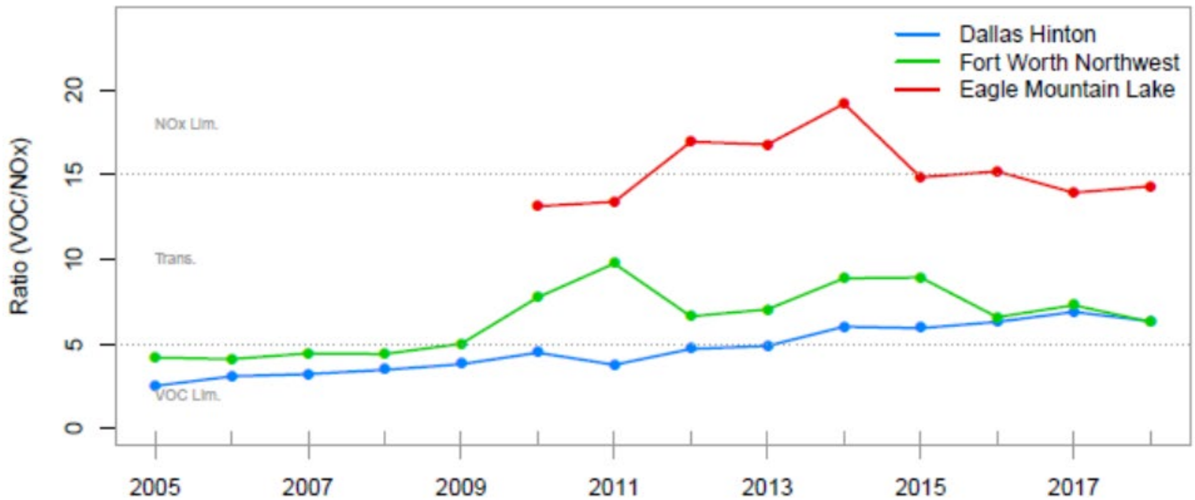


Figure 5-8: Trend in VOC to NO_x Ratios using Auto-GC Data

5.2.4 Weekday/Weekend Effect

The trends in NO_x concentrations by day of the week show how local control strategies might affect ozone concentrations. Examining ozone concentrations on days with lower NO_x concentrations will help demonstrate how ozone concentrations might be affected if there were overall reductions in NO_x. To investigate if there is a day-of-the-week effect in the DFW ozone nonattainment area, NO_x concentrations were calculated by day from a maximum range of 2005 through 2018. The years with data available for each monitor can be seen in Figure 5-7 located in Section 5.2.2: *Ambient* NO_x *Trends*. Results displayed in Figure 5-9: *Day of Week* NO_x *Concentrations (maximum range of 2005 - 2018)* demonstrate that at urban monitors, lower NO_x concentrations are recorded on weekends than on weekdays. This indicates 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: *Regional and Global Photochemical Modeling for the DFW and HGB Attainment Demonstration SIP Revisions for the 2008 Serious Classification Eight-Hour Ozone Standard*. Since NO_x is a precursor to ozone formation, controlling NO_x should in turn reduce ozone concentrations.

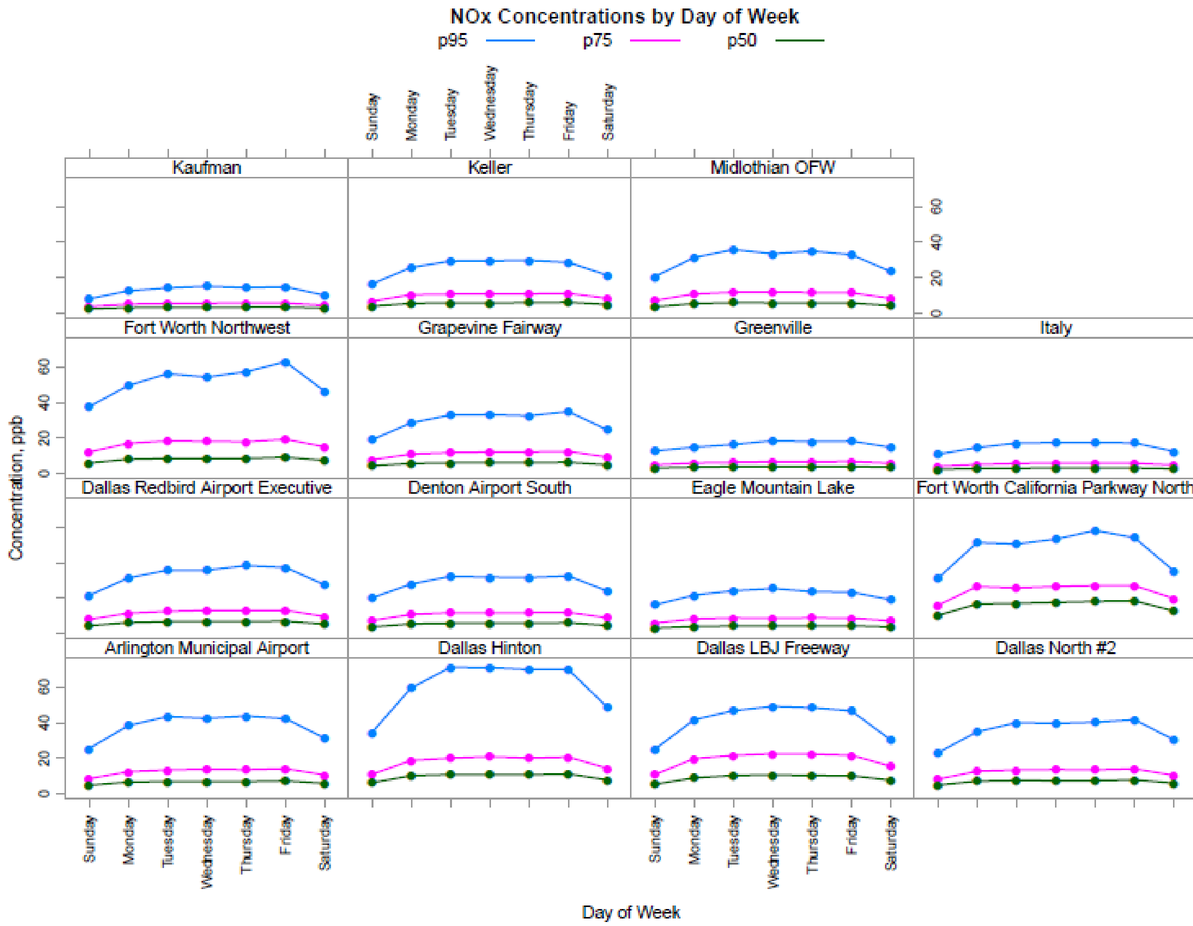


Figure 5-9: Day of Week NO_x Concentrations (maximum range of 2005 - 2018)

Since less NO_x is generated on weekends, there should be fewer high ozone days on weekends in the DFW area. Figure 5-10: *Weekday/Weekend Effect for Ozone in the DFW Area* shows that from 2005 through 2018, eight-hour ozone concentrations greater than 75 ppb occurred on weekdays more frequently than on weekends. The fewest high eight-hour ozone days occurred on Sundays (30 days). Specifically, Sunday had 27 fewer high eight-hour ozone days than Mondays, which had the lowest number of weekday, high eight-hour ozone days (57 days). The largest number of eight-hour ozone days greater than 75 ppb occurred on Thursdays (75 days). As the week progresses, the DFW ozone nonattainment area begins to experience more high ozone days as well as higher NO_x emissions. This result corroborates the hypothesis that local NO_x reductions would lead to lower ozone concentrations.

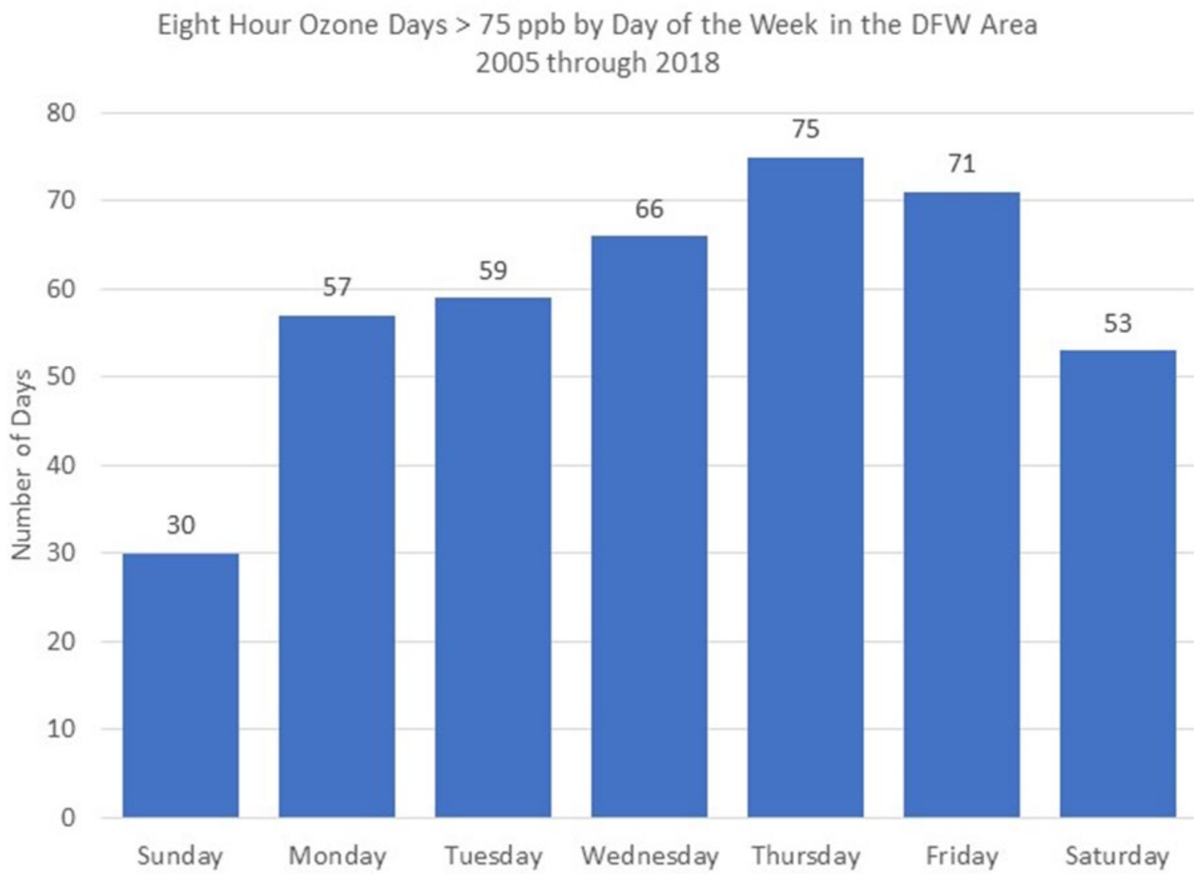


Figure 5-10: Weekday/Weekend Effect for Ozone in the DFW Area

5.2.5 VOC Trends

VOCs play an important role in the production of ozone; therefore, tracking VOC trends can provide insight on potential changes in future ozone concentrations. To characterize VOCs, the sum of a collection of 58 VOCs identified as target parameters for photochemical assessment monitoring stations (PAMS) (EPA, 2016) were used. The data used in this study were reported in hourly concentrations that have been aggregated to a yearly value by using the 50th percentile as a measure of the yearly central tendency. The 50th percentile was chosen because the data are very right-tailed (skewed to the right). Data from as early as 2005 through 2018 were analyzed. Although a complete year of data was not available for all years, all available data were included in the study.

Results from the study are presented in Figure 5-11: *PAMS VOC Trends*. The results show that 12 of the 15 monitors display a downward trend in the 50th percentile value. Monitors with slight upward trends in the 50th percentile value include: Fort Worth Northwest, Eagle Mountain Lake, and Dallas Hinton. The Fort Worth Northwest monitor is located approximately four miles northwest of downtown Fort Worth, and the Dallas Hinton monitor is located approximately five miles northwest of Downtown Dallas. The Eagle Mountain Lake monitor is located in a rural area, northwest of the DFW urban core in an area of oil and gas activity. Although the overall trend in the

50th percentile value of PAMS VOC concentrations at these three monitors is slightly upward, since 2014 the 50th percentile value at these monitors has declined.

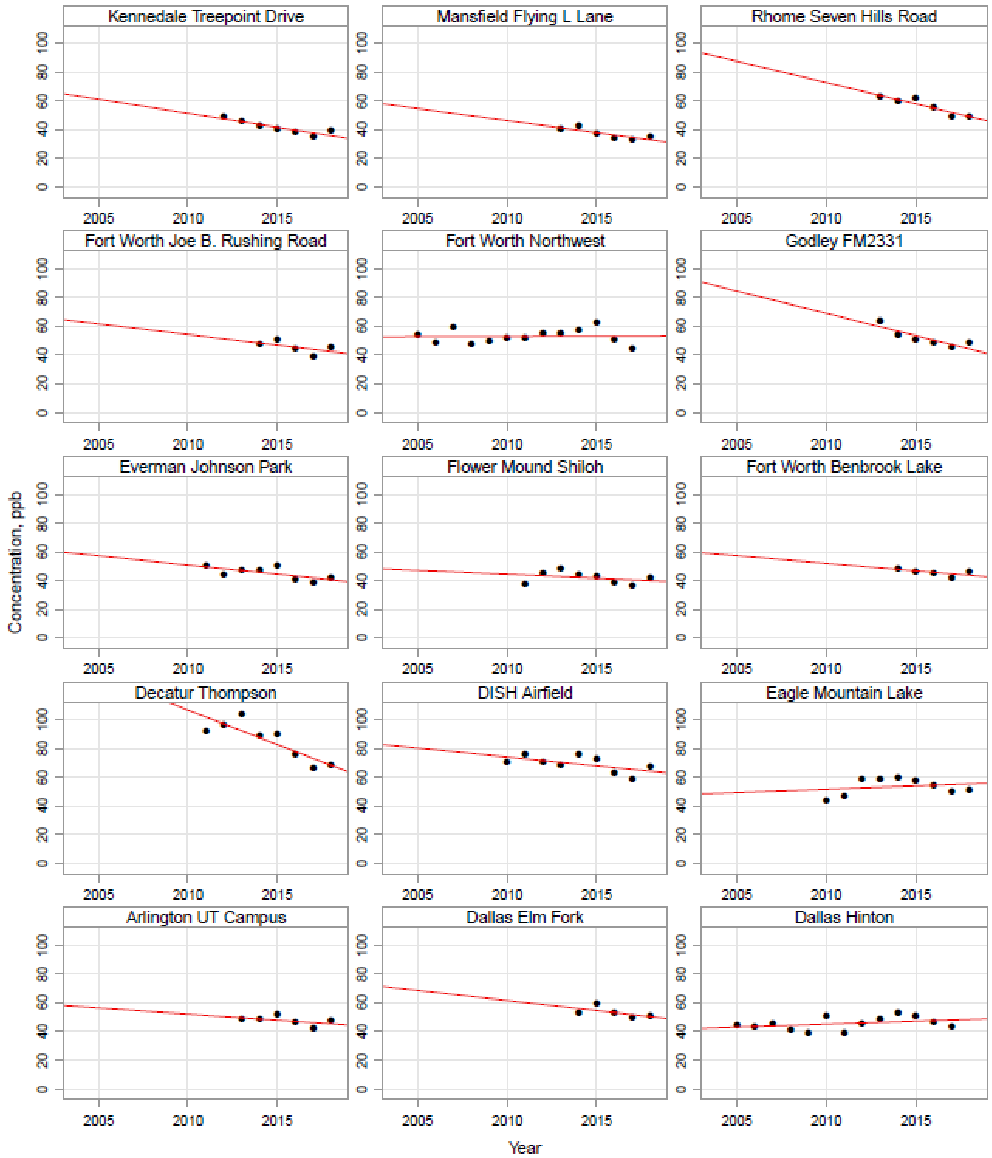


Figure 5-11: PAMS VOC Trends

5.3 LITERATURE SURVEY

In this section, details are presented regarding the literature and modeling studies that the TCEQ reviewed as part of its efforts to understand and evaluate ozone formation and the attainment status of the DFW ozone nonattainment area.

Air quality studies in peer-reviewed literature related to ozone formation in the DFW area have focused primarily on correlation of precursor emission estimates with monitored concentrations, historical trends in monitored precursors and ozone levels, effects of precipitation on biogenic emissions, obtaining VOC profiles for oil and gas production, and the use of models for predicting ozone attainment and effects of oil and gas operations. A literature review of this work is provided in this section, and each study is referenced in Section 5.6: *References*. Section 5.6 also includes a list of air quality studies in the DFW area that are not relevant to ozone attainment.

Topics analyzed include:

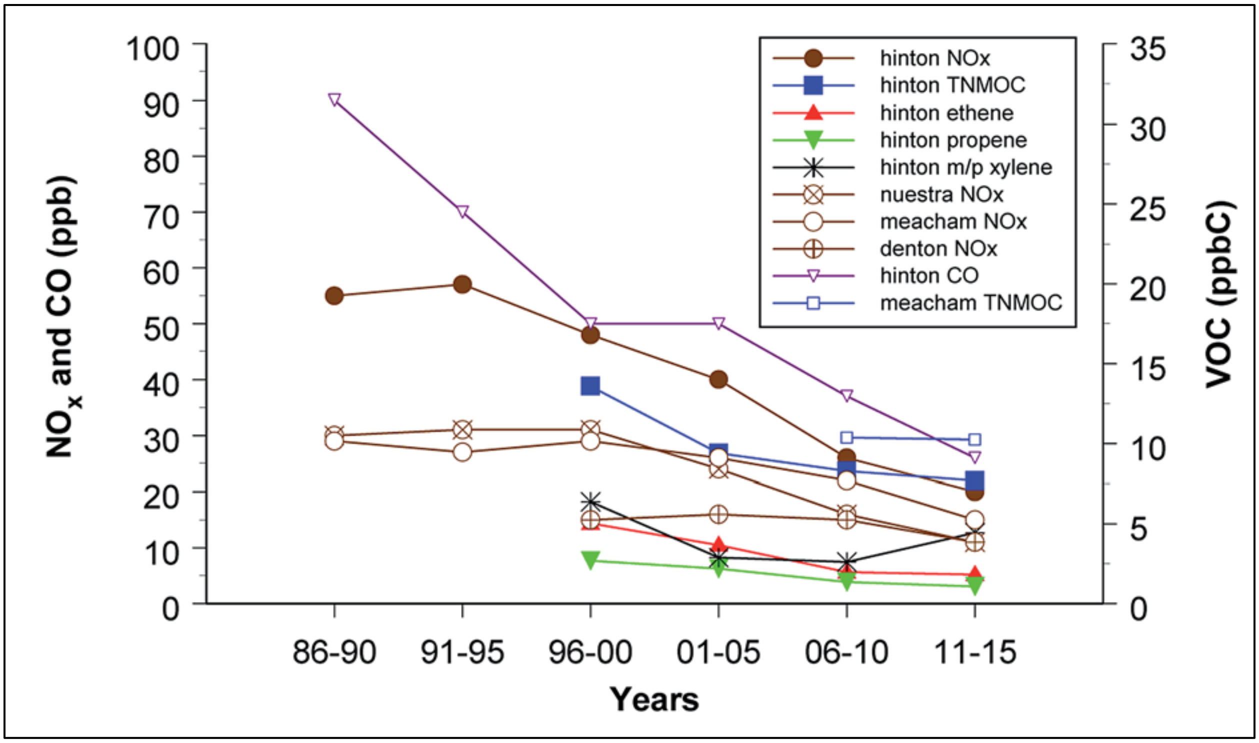
- Trend analyses: surface observations and satellites
- Meteorological patterns conducive to high ozone in the DFW area, and their relation to ozone trends
- Background ozone and its sources
- Photochemical grid modeling of the DFW area
- VOC- and NO_X-sensitivity of ozone formation in the DFW area
- Barnett Shale emissions and air quality impacts
- Evaluating the effects of closing coal-burning power plants

5.3.1 Trend Analyses: Surface Observations and Satellites

Earlier in this chapter, TCEQ has presented trend analyses of ozone (Section 5.2.1, *Ozone Trends*, NO_X (Section 5.2.2, *Ambient NO_X Trends*), and VOCs (Section 5.2.5, *VOC Trends*) observed in the DFW area. Two other studies have looked at VOC trends in the DFW area (Qin et al., 2007; Myers et al., 2015), and their findings are consistent with the current TCEQ analyses in this chapter. Sather and Cavender (2016) presented similar trend analyses, ranging back to the 1980s. Figure 5-12: *DFW Area Trends of NO_X, VOCs, and CO from Sather and Cavender (2016)* presents some of their results. Note that trends were evaluated during June-August weekdays at 0500-0800 local standard time (LST), and that total non-methane organic compounds and carbon monoxide (CO) concentrations should be multiplied by a factor of 10. Most ozone precursor concentrations exhibit pronounced downward trends across the 30-year period. Considering that the population of the DFW area has more than doubled since the 1980s, this decrease in air pollution has arisen from a series of highly effective emissions controls across many emissions categories, especially mobile sources.

Another method of evaluating pollutant trends is with satellite observations. Recently, researchers have examined NO_2 and formaldehyde (HCHO) trends in the DFW area using the Ozone Monitoring Instrument (OMI) satellite. Satellites do not measure concentrations at the surface, as a continuous ambient monitoring station (CAMS) does, but measure the pollutants present in a vertical column of air from the surface to the top of the atmosphere. In order to estimate the amount of a pollutant within the column, the researchers make assumptions about the vertical distribution of the pollutant within this column of air and take into account the characteristics of the remote sensing instrument itself.

Some researchers simply measure the trends in the vertical column densities, whereas others use modeling or other analytical techniques to estimate emissions rates from the vertical pollutant data. Other researchers use the pollutant data as a surrogate for another chemical that the satellite cannot measure. For example, Kaiser et al. (2018) and others have used HCHO column densities in northeast Texas as a surrogate for biogenic isoprene emissions, because isoprene rapidly reacts to create HCHO.



Note: Trends were evaluated during June through August weekdays at 0500-0800 LST. TNMOC and CO concentrations should be multiplied by a factor of 10.

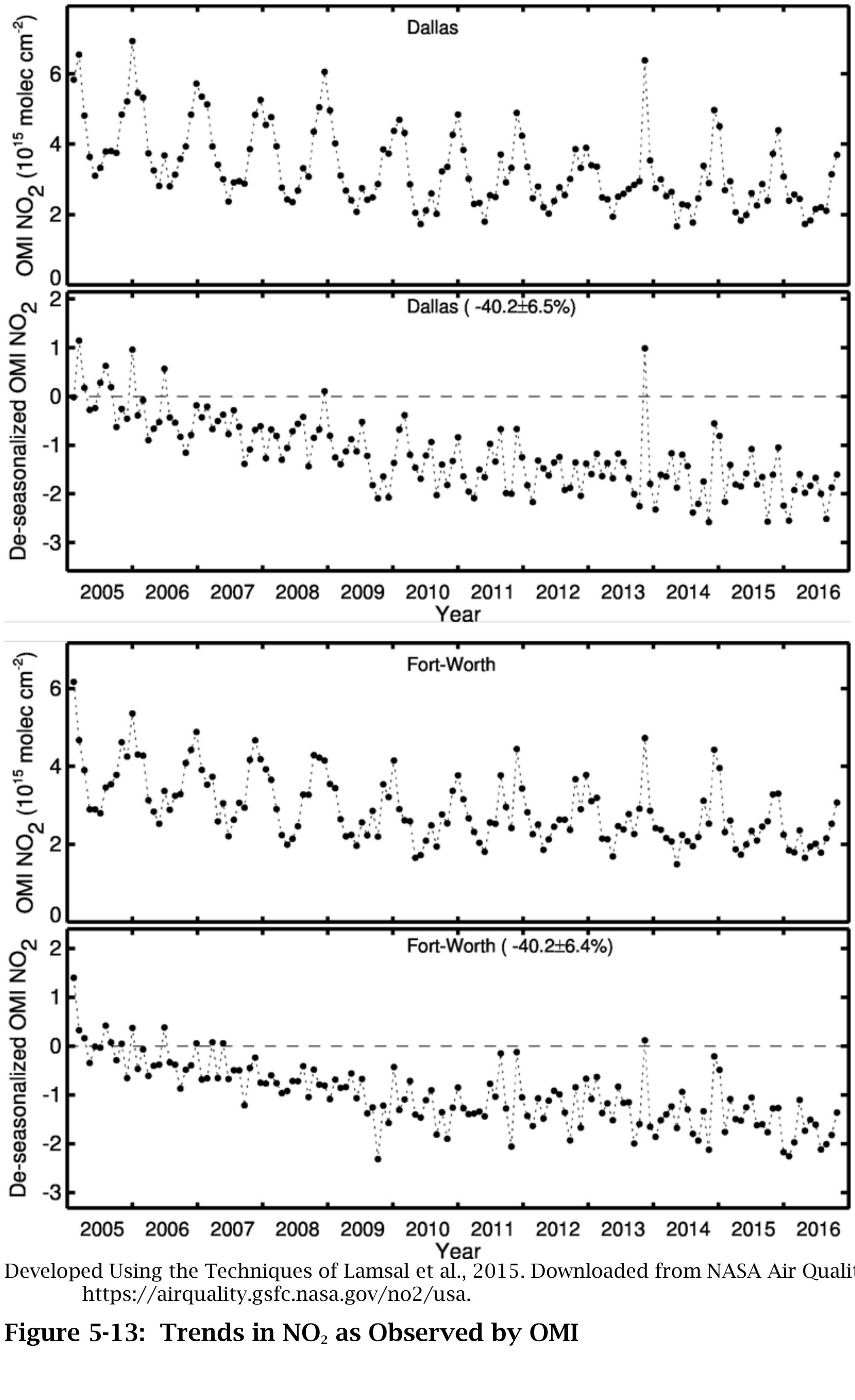
Figure 5-12: DFW Area Trends of NO_X, VOCs, and CO from Sather and Cavender (2016)

Table 5-1: *NO_2 Trends Measured by Satellites for the DFW Area* presents the results from several recent studies of the NO_2 trends as measured by satellite for the DFW area. Overall, the trends among all studies listed are essentially in agreement, both for the changes in NO_2 since about 2005 and for the variations in rate of change. Two studies, Tong et al. (2015) and de Foy et al. (2016), assessed whether the rate of NO_2 decrease accelerated during the economic downturn from 2008 through 2010. De Foy et al. found that DFW had the largest drop in NO_2 during the recession compared to Houston and San Antonio. After 2009, the NO_2 trends either became level or increased (Russell et al., 2012; Tong et al., 2015; deFoy et al., 2016; Lamsal et al., 2015). Some of the leveling can be attributed to the recovery from the recession, but the latest National Aeronautics and Space Administration (NASA) data (Figure 5-13: *Trends in NO_2 as Observed by OMI* and Figure 5-14: NO_2 *Imagery from the OMI Satellite* show that even after the recovery, the NO_2 trend has become level: NO_2 column densities have changed little since about 2011.

Since the EPA's National Emissions Inventory (NEI) data indicate that NO_X emissions have continued to decrease since 2011, researchers have investigated whether these NEI inventories are accurate. For example, Jiang et al. (2018) have noted a "significant slowdown in decreasing United States (U.S.) emissions of NO_X and carbon monoxide (CO) for 2011–2015 using satellite and surface measurements. This observed slowdown in emissions reductions is significantly different from the trend expected using EPA bottom-up inventories…" In response, a recent study by Silvern et al. (2019) addresses these discrepancies by examining several long-term, well-respected measurement data sets. The trends found in these data sets, which are independent of the satellite data, the inventory data, or the CAMS monitoring data, should help assess which trend is correct. Silvern et al. (2019) examined satellite NO_2 columns, Air Quality System (AQS) and Clean Air Status and Trends Network (CASTNET) rural monitoring data, NEI data, and National Acid Deposition Program (NADP) wet deposition data, as well as simulations of these data sets with global atmospheric chemistry model driven by assimilated meteorological observations from the Goddard Earth Observing System (GEOS-Chem). OMI and NADP trends drop until about 2009, then flatten and appear to remain approximately constant through 2017. Trends observed with AQS and CASTNET match NEI trends, but NADP and OMI NO_2 do not. GEOS-Chem results replicate the trends, showing that NADP and OMI NO_2 trends are more dependent upon background NO_2 than the other data sets. Thus, Silvern et al. (2019) conclude that the NEI trend is relatively accurate. Further research is necessary to confirm this conclusion.

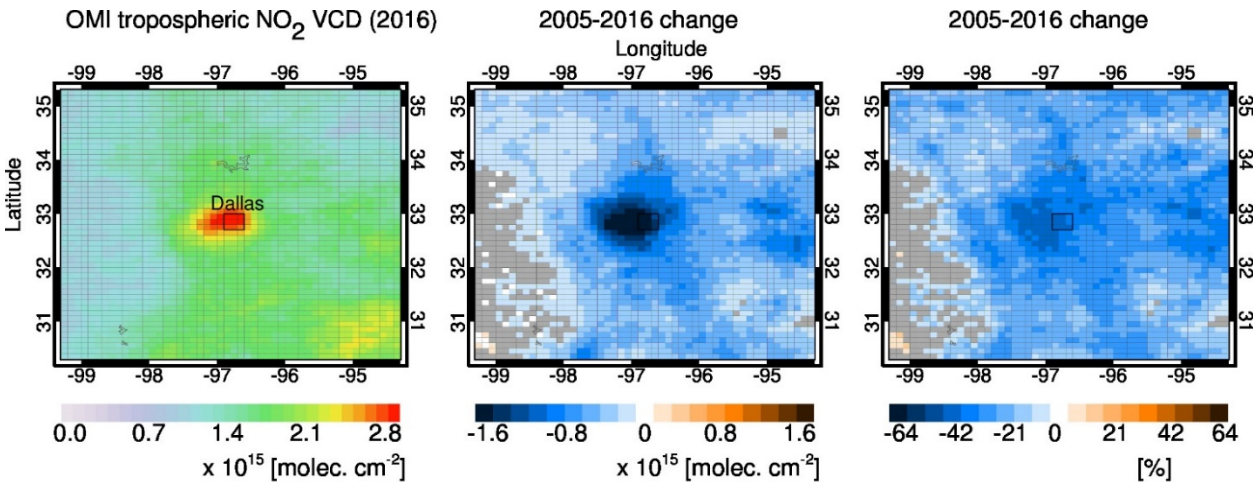
Table 5-1: NO_2 Trends Measured by Satellites for the DFW Area

Reference	Total Percent Reduction	Annual trends (Percent/year)
Silvern et al., 2019	N/A	AIRS: -4.9±0.4 SEARCH: -6.9±3.5 NADP: -2.7±0.3 OMI: -6±0.5 (2005-2009), ~0% (2010-2017)
Lamsal et al., 2015	-38.5±5.2% from2005-2013	-4.1±0.5 2005-08 -1.4±0.6
Lu et al., 2015	N/A	-12.2±5.1 (calculated as 3-year averages from 2005-2014)
deFoy et al., 2016	N/A	Overall: -3.7 2008: -4.4 2009: -13.2 2010: -15.3 2011: -0.3
Russell et al., 2012	-26.57% from2005-2011	2005-07: -5.89 2007-09: -6.94 2009-2011: -1.68 Overall: -4.43
Tong et al., 2015	-34% from 2005-2012	2005-07 = -7.5 2007-09 = -8.9 2009-2011 = -2.1
Choi and Souri, 2015	Dallas: -21% from2005-2013 Ft. Worth: -16% from 2005-2013	N/A



Developed Using the Techniques of Lamsal et al., 2015. Downloaded from NASA Air Quality website: https://airquality.gsfc.nasa.gov/no2/usa.

Figure 5-13: Trends in NO_2 as Observed by OMI



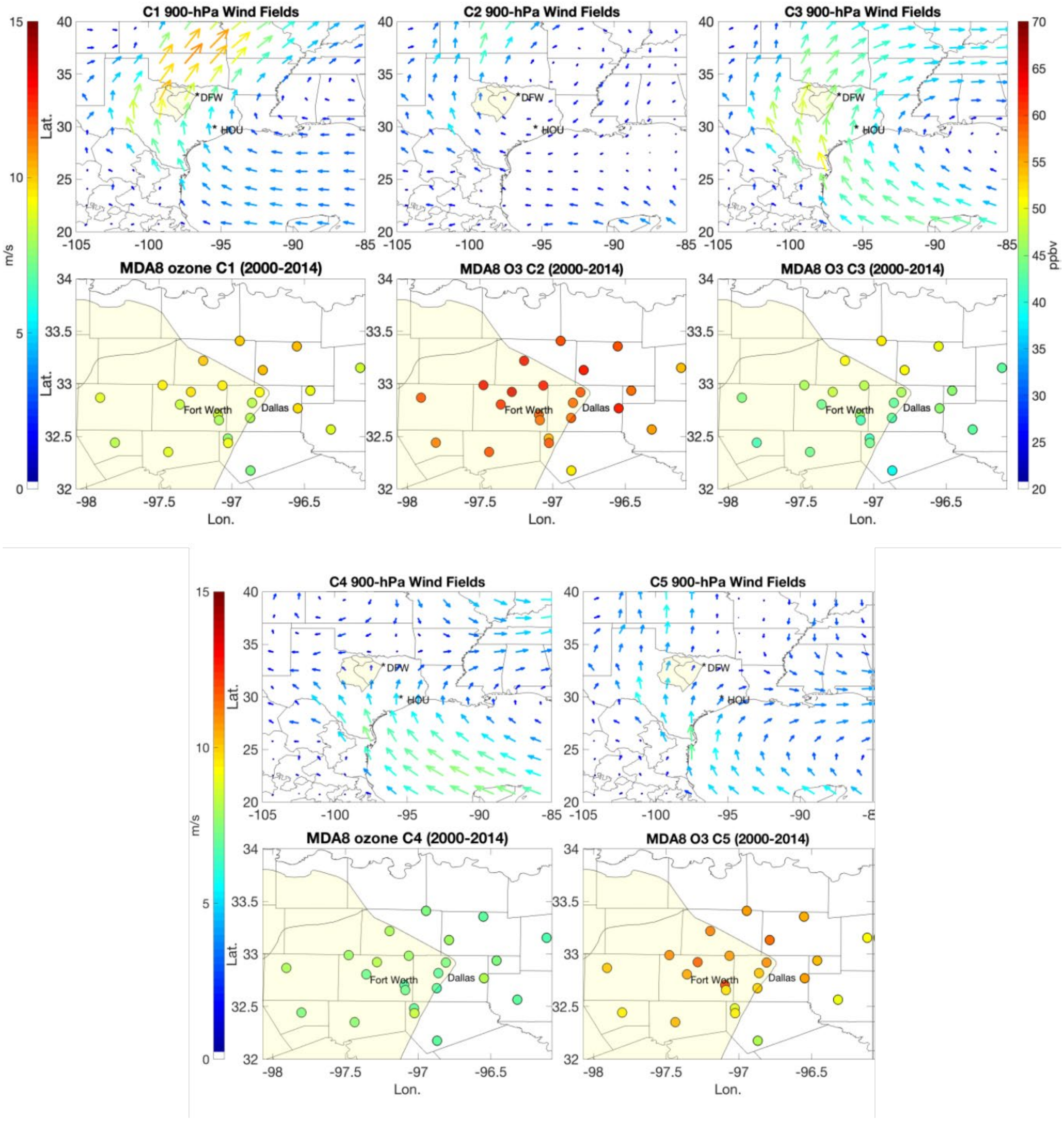
Left: NO_2 column density over DFW; Middle: Absolute NO_2 column density change from 2005 to 2016 over DFW; Right: Percent NO_2 column density change from 2005 to 2016 over DFW.

Figure 5-14: NO_2 Imagery from the OMI Satellite

5.3.2 DFW Area Meteorological Patterns Conducive to High Ozone

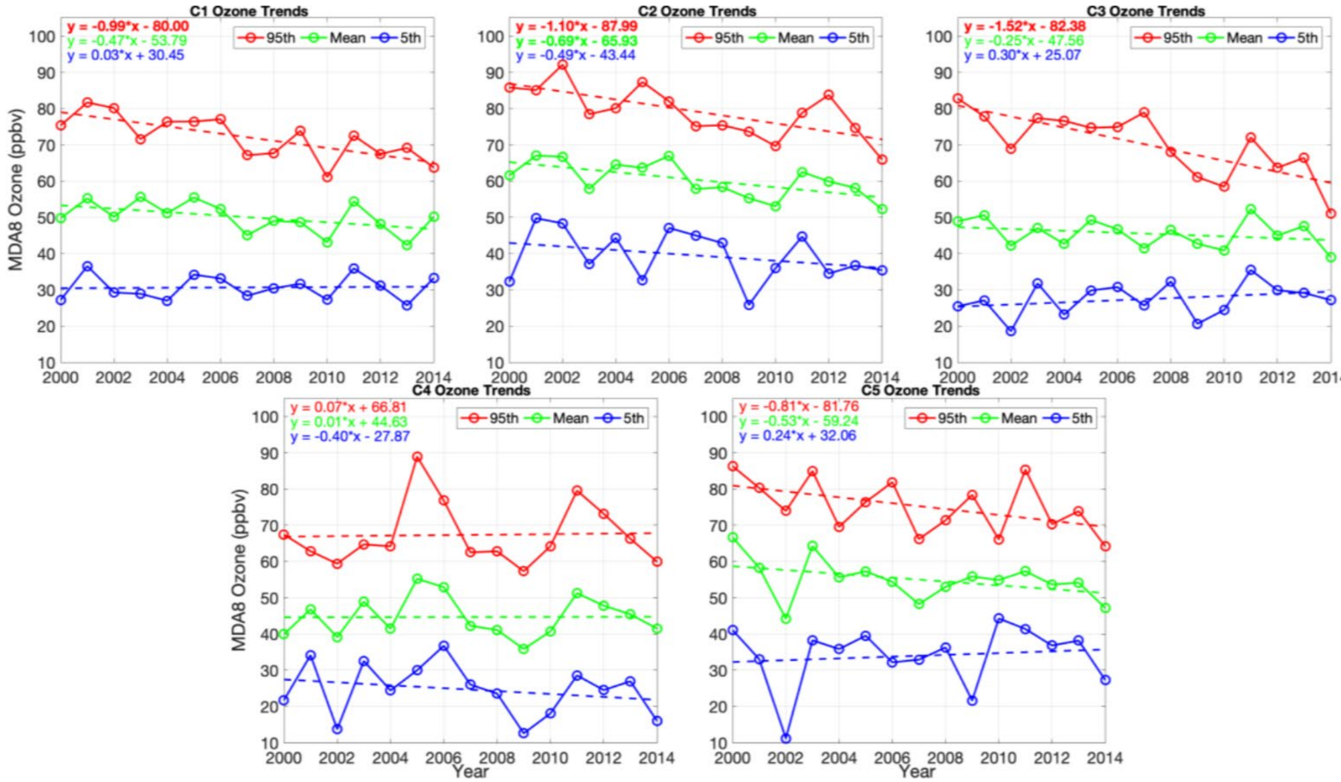
A recent study by Kotsakis et al. (2018) performed a cluster analysis of winds to find patterns linked to high ozone days. Eleven patterns were found in the 900 millibar North American Regional Reanalysis data, but only five are significant; see Figure 5-15: *Wind Patterns Observed in DFW During the 2000 through 2014 Ozone Seasons and The Average MDA8 Ozone Concentration Observed During Each Pattern.* The Bermuda High pattern (cluster 3 or C3) is most common, bringing strong southerly winds, and dominating the mid-summer period; this pattern is characterized by low ozone. Cluster 2 (C2) is the highest ozone pattern, resulting in exceedances 59% of the time, with peak frequency in August and September. The synoptic (large-scale) pattern during C2 is characterized by weak high pressure east of DFW, along the Oklahoma-Arkansas border, bringing light easterly winds to the DFW area. The maximum daily average eight-hour (MDA8) ozone concentration 5th percentile (used as a surrogate for background ozone) is highest during this pattern. Cluster 5 is also a high ozone pattern—low pressure *north* of the typical Bermuda High location in the eastern U.S. creates a stagnation zone on its west side, as northerly winds generated by the low-pressure center interact with and oppose the southerly Bermuda High winds. This pattern peaks in frequency during July. When winds are from the southwest, Barnett Shale emissions are hypothesized to be a potential contributor to high ozone, but little evidence is available to support this point. Kotsakis' modeling shows a contribution of only 1 to 2 ppb ozone from the Houston area.

This study can be used to examine one of the highest recent ozone years, 2011. During this year, there were 40 days with MDA8 ozone concentrations above 75 ppb. Most of Texas experienced exceptional drought conditions, daily peak temperatures often exceeded 100˚F, and numerous significant wildfires occurred throughout the state. Kotsakis' study can be used to analyze whether these severe conditions were linked to one meteorological transport pattern. Figure 5-16: *DFW Ozone Trends for Each Wind Pattern for Ozone Season Days from 2000 through 2014* demonstrates that 2011 is a high year for each of the five major transport patterns. Figure 5-17: *Annual Frequency of Each Wind Pattern and Relative Frequency Compared to Average* shows the frequency of each pattern for each year relative to the average frequency, indicates that none of the patterns were unusually frequent during 2011. These two facts suggest that it is not the presence of a distinctive pattern that caused the high ozone during 2011, but the fact that *every pattern* had higher ozone. The implication is that factors other than wind patterns alone were responsible for the high ozone during 2011.



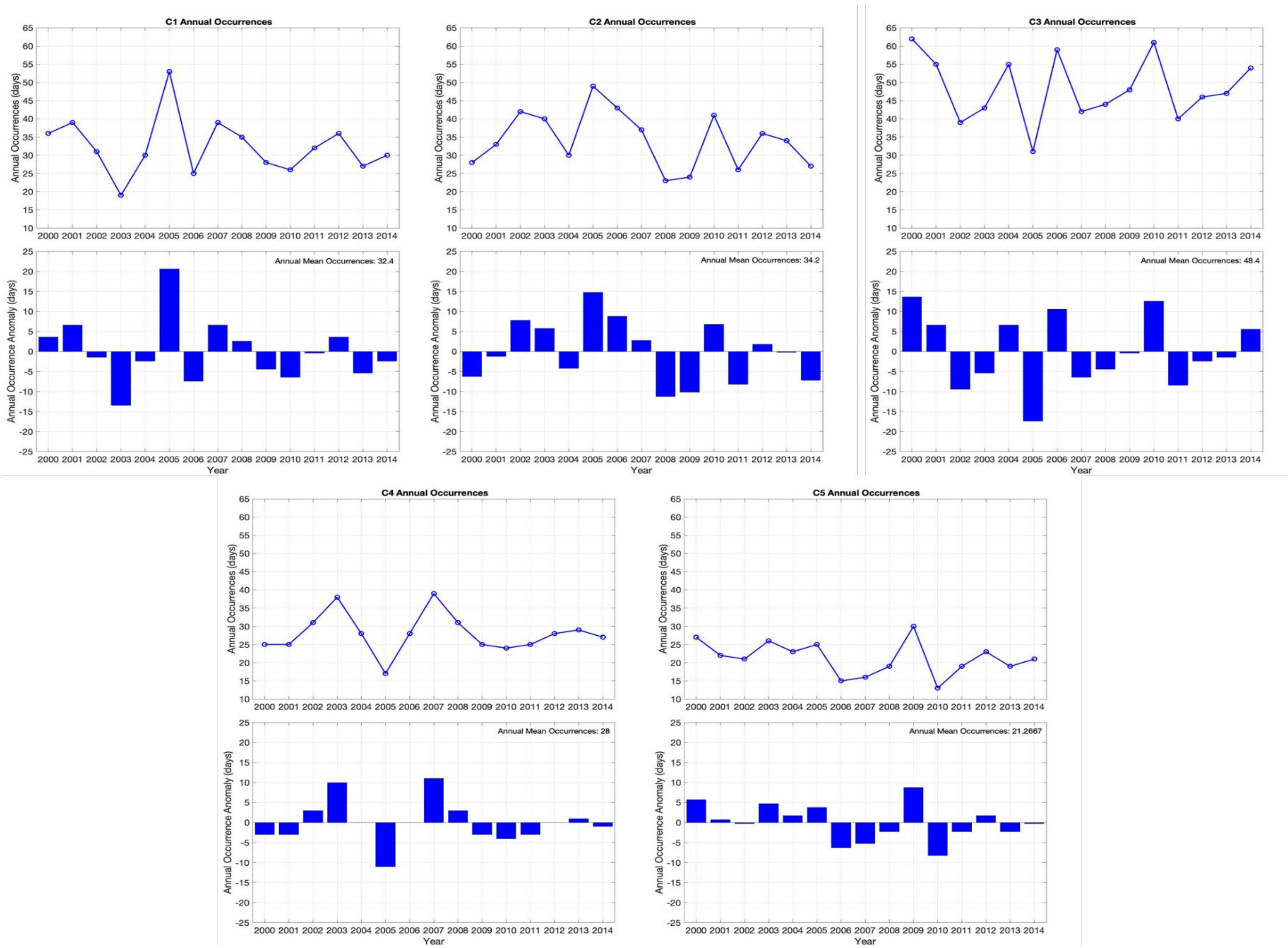
From Kotsakis et al., 2019

Figure 5-15: Wind Patterns Observed in DFW During the 2000 through 2014 Ozone Seasons and the Average MDA8 Ozone Concentration Observed During Each Pattern



From Kotsakis et al., 2019

Figure 5-16: DFW Ozone Trends for Each Wind Pattern for Ozone Season Days from 2000 through 2014



Kotsakis, personal communication, 2019

Figure 5-17: Annual Frequency of Each Wind Pattern and Relative Frequency Compared to Average

5.3.3 Background and International Contributions

The trends in estimated regional background ozone on days with MDA8 ozone concentrations exceeding 70 ppb were presented in Figure 5-5. Regional background ozone was estimated using the technique described for TCEQ background ozone estimates in Berlin et al. (2013). Figure 5-18: *Peak MDA8 Ozone Concentrations and Regional Background Ozone for Three Texas Urban Areas, Averaged by Ozone Season Day for 2004 through 2014* shows how background and peak ozone vary monthly through the ozone season. Although the DFW area has an ozone season from March through November, very few high ozone days occur outside of the months of April through October. To focus on the months that observed the highest eight-hour ozone levels, this analysis uses ozone data from only the months of April through October, which is referred to as "ozone season." In Houston and San Antonio, there is a pronounced drop in background and peak ozone in mid-summer, when the Bermuda High dominates the wind patterns in the eastern half of Texas, bringing strong southerly flow into the state. The DFW area, however, does not observe a regional background decrease from mid-June to mid-August. One reason for this lack of a mid-summer drop is that Houston and San Antonio are closer to the Gulf of Mexico, so that the clean maritime air from the Gulf of Mexico can enter these cities without much modification by pollutants from other cities or other sources. With southerly flow, DFW is sometimes downwind of Houston and, cities in central Texas. Therefore, the seasonal variation of background ozone is lessened for DFW.

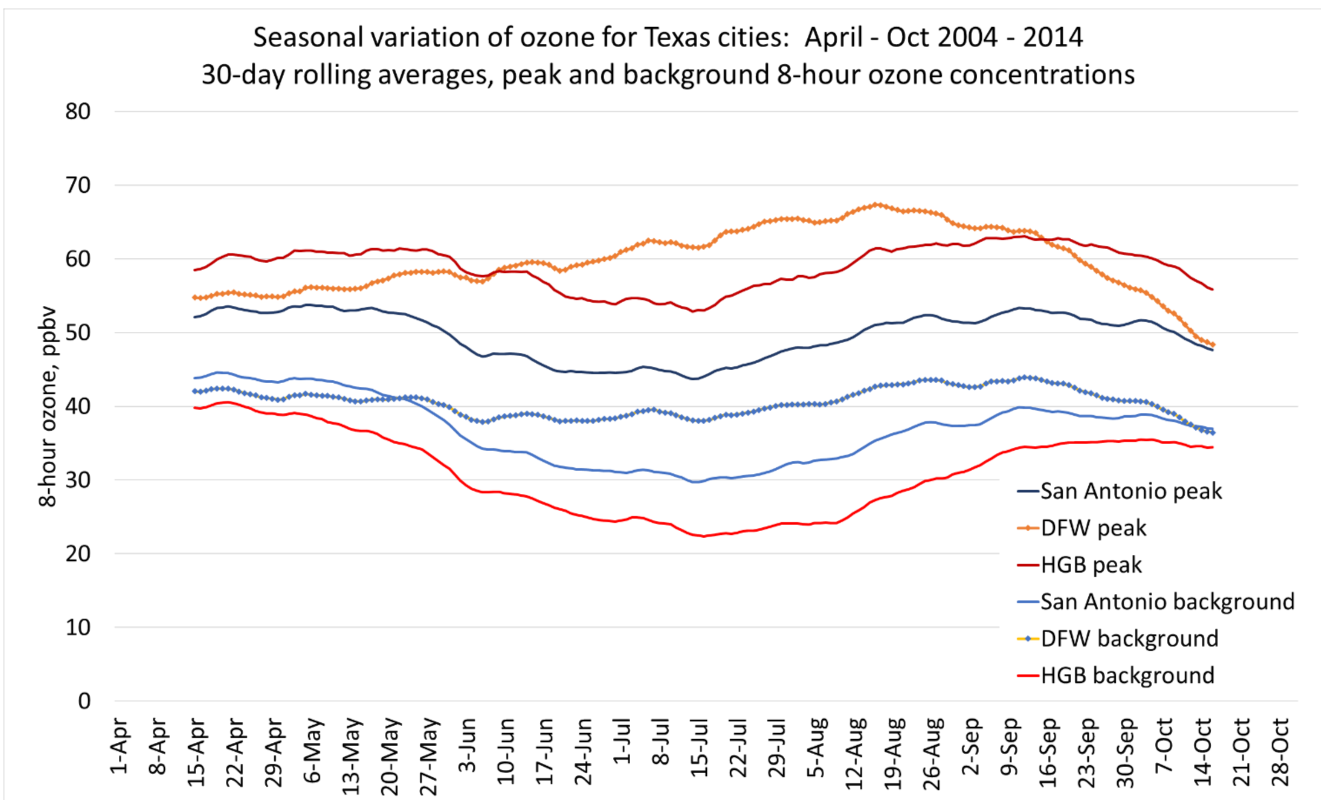
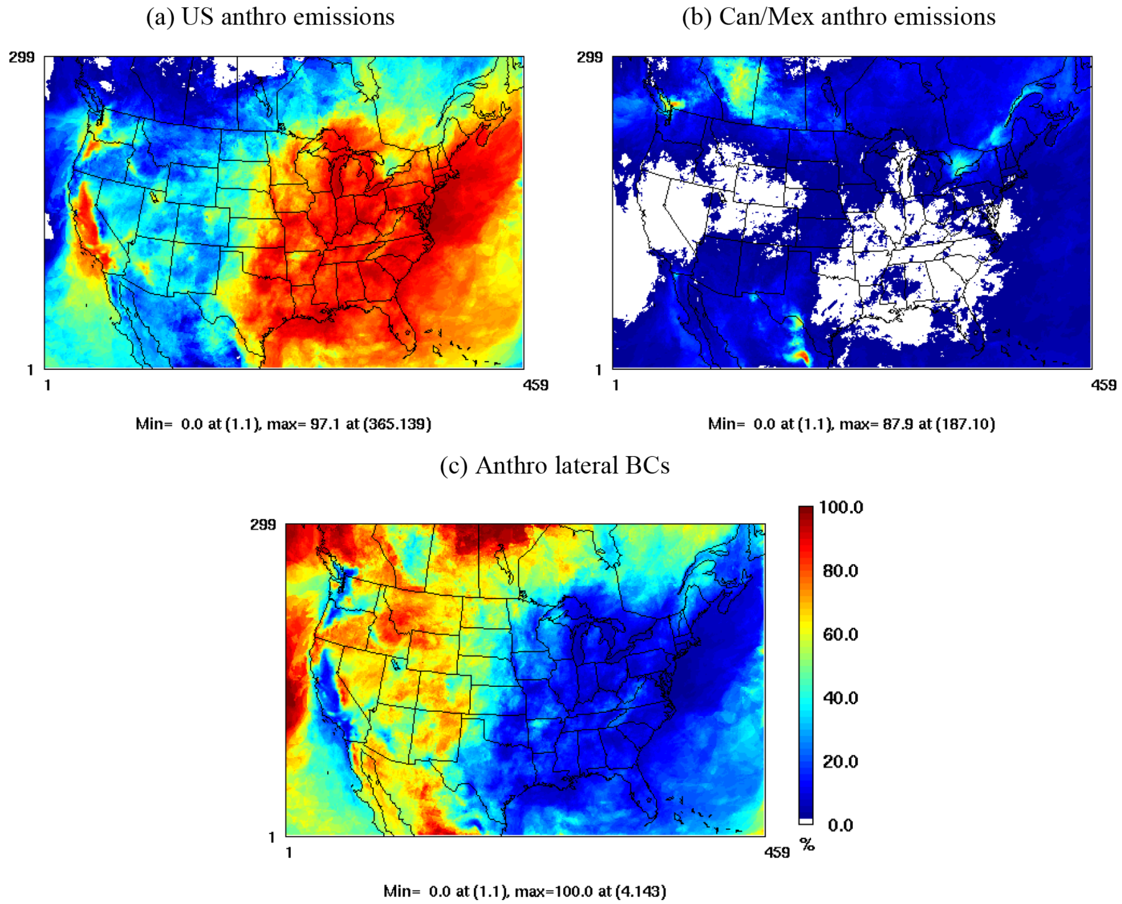


Figure 5-18: Peak MDA8 Ozone Concentrations and Regional Background Ozone for Three Texas Urban Areas, Averaged by Ozone Season Day for 2004 through 2014

Dunker et al. (2017) carried out a modeling exercise for the continental U.S. using GEOS-Chem and Comprehensive Air Quality Model with Extensions (CAMx) run for March through September 2010. CAMx was run with the path integral method invoked, which calculates sensitivities to emissions; emissions were set at levels from zero to normal. At higher ozone concentrations, the background ozone was less important (by ppb and by percent), whereas the U.S. anthropogenic component was more important. Non-U.S. anthropogenic became more important at low concentrations.

The 10 days with highest background concentrations in DFW were not exceedance days. The 10 days with the highest MDA8 ozone concentrations in DFW averaged 82.5 ppb. On the 10 days with highest MDA8 ozone concentrations in DFW, background concentrations were 31.3 ppb, with only a small portion of the background contributed by Canada, Mexico, or anthropogenic boundary conditions. Figure 5-19: *Relative Contributions in Percent to the Anthropogenic Component of the 10 Days with the Highest MDA8 Ozone Concentrations* illustrates the contributions by non-U.S. anthropogenic emissions for the top 10 MDA8 ozone days.

Another modeling study of background ozone in DFW was performed by Kemball-Cook et al. (2009). Their study examined aircraft observations collected upwind of DFW during the Texas Air Quality (TexAQS) I and II studies and performed CAMx modeling of the same periods. The results indicated background ozone levels near the NAAQS on some high ozone days; however, these background ozone values were not U.S. background, but regional background. CAMx modeling confirms that 50% or more of ozone could be attributed to regional background ozone on some days.

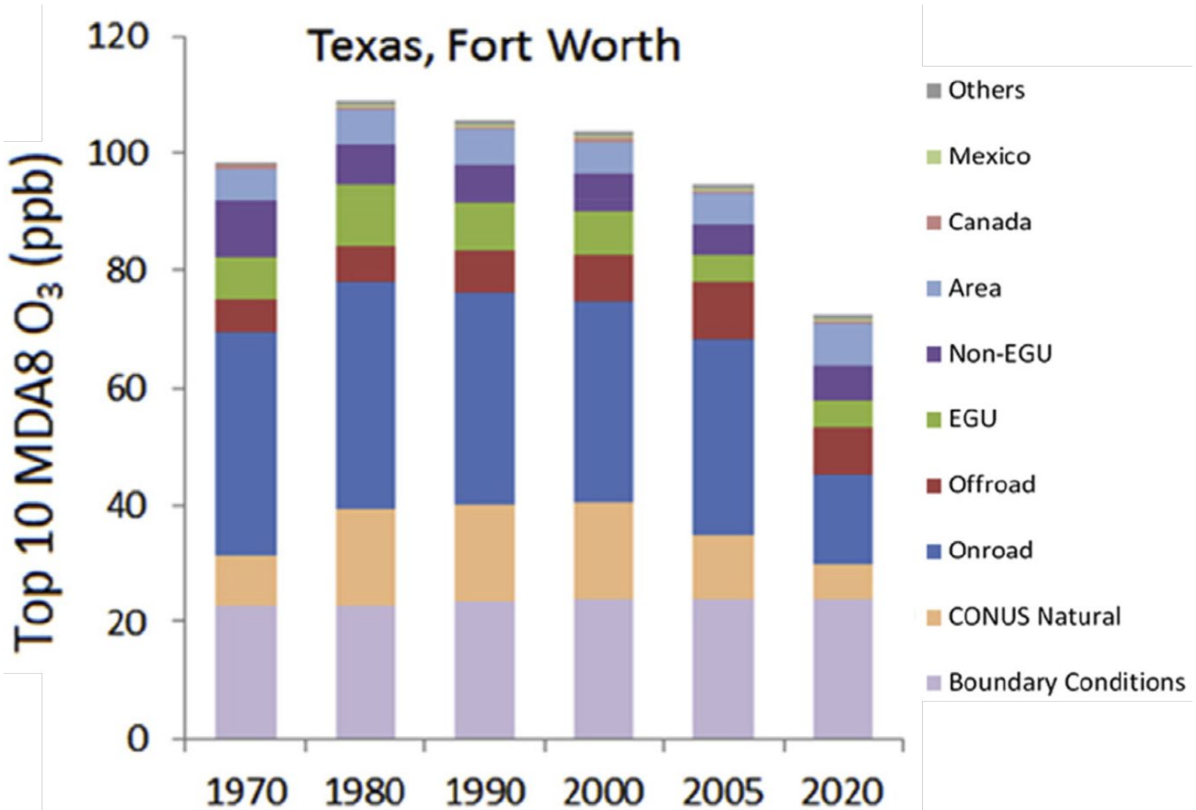


From Dunker et al., 2017

Figure 5-19: Relative Contributions in Percent to the Anthropogenic Component of the 10 Days with the Highest MDA8 Ozone Concentrations

Nopmongcol et al. (2016) studied the estimated effects of U.S. background ozone on high ozone days in the continental U.S. Figure 5-20: *Source Apportionment from CAMx Runs* illustrates estimated source contributions to peak ozone on the top 10 days with the highest MDA8 ozone concentrations days at the Fort Worth Northwest monitor. The study found contributions from Mexico and Canada in DFW are very low and have been low since 1970. Contributions from boundary conditions have been very steady, despite the increases in background ozone observed on the U.S. west coast (Parrish et al., 2017) since the 1970s, and the increases in Asian emissions (Liu, Souri et al.; Lin et al., 2012).

This finding is consistent with the Dunker et al. simulations, which show little anthropogenic contribution from Canada, Mexico, or the international emissions included in the boundary conditions. These results imply that most of the regional background ozone observed in DFW is contributed by (1) U.S. anthropogenic emissions, (2) U.S. biogenic/natural emissions, and (3) natural global emissions. Only a small percentage can be attributed to international anthropogenic emissions.



From Nopmongcol et al., 2016

Figure 5-20: Source Apportionment from CAMx Runs

5.3.4 VOC- and NO_X-Sensitivity of Ozone Formation in DFW

The TCEQ modeling described in Chapter 3 of this SIP revision has been analyzed to extract VOC- and NO_X-sensitivity information. Chemical process analysis (Ramboll, 2018) is a model probing technique used to calculate the chemical production of intermediate reaction products; it can be used to show the chemistry of ozone formation in great detail. From the information about individual chemical reactions, it is possible to directly calculate whether ozone formation in each grid cell during each hour is VOC-limited or NO_X-limited.

Chemical process analysis modeling calculates VOC- and NO_X-sensitivity of ozone production by examining the ratio of production of hydrogen peroxide (pH_2O_2) to production of nitric acid ($pHNO_3$). This ratio illustrates which reactants are present in abundance by comparing the production rates of termination products. If there is an abundance of NO_X, the rate of nitric acid production will be high, as the chemical free radicals driving ozone formation react with NO_2 instead of contributing to ozone formation. If there is a shortage of NO_X, the radicals react with each other, creating peroxides instead of contributing to ozone formation. The dividing line between VOC-sensitive ozone production and NO_X-sensitive ozone production is a $pH_2O_2/pHNO_3$ value of 0.35, with higher values indicating VOC-sensitive ozone production, and lower values indicating NO_X-sensitive production. The ratio is calculated each hour for each grid cell and each layer, and whatever ozone production is occurring in the grid cell and layer at that hour is assigned accordingly.

This ratio provides a sharp threshold between VOC- and NO_X-sensitivity; its significance requires careful interpretation. The ratio varies from hour to hour and from grid cell to grid cell, so the overall effectiveness of proposed controls cannot be derived from values for single hours or single cells. The metric can show, however, how the atmospheric chemistry over the city varies by hour and by site, which offers clues about the most important factors affecting ozone formation during each day.

Figure 5-21: *Ozone Production Rates (ppb per day) for June 21 through 27, 2012 as Calculated by Chemical Process Analysis* shows how the rate of ozone production and sensitivity to ozone production varies from site to site and day to day. The Denton Airport South site (DENN, C56) has been the DV monitoring site for certain historical years, and it consistently shows relatively high ozone production that is primarily NO_X-sensitive. The Cleburne Airport (CLEB, C77) and Italy (ITLY, C1044) monitors show relatively lower ozone production that is NO_X-sensitive on all of the days studied. The dominance of NO_X-sensitive conditions persists throughout the period evaluated. NO_X-sensitivity dominates at all monitoring sites, with a few notable exceptions. The Grapevine Fairway (GRAP, C70), Arlington Municipal Airport (ARLA, C61), and Dallas Hinton (DHIC, C401) monitors all show at least one day with VOC-limited ozone production. The Dallas Hinton (DHIC, C401) monitor, which is located in the urban core of Dallas, shows very low ozone formation rates, and these are exclusively VOC-sensitive. This behavior is consistent with the high NO_X concentrations observed at the Dallas Hinton (DHIC, C401) monitor, which suppresses ozone formation, and ensures that any ozone formation that does occur is not limited by NO_X availability.

The Arlington (ARLA, C61) and Dallas North #2 (DALN, C63) monitors both show VOC-limited ozone formation on June 22, 2012. On both of those days, NO_X concentrations are particularly high, peaking at about 40 ppb. Wind direction data indicate that winds shift from southerly to northerly on June 22, suggesting that the change in wind direction is altering the amount of ozone precursors available at the sites, and thus changing the ozone formation sensitivity. At Denton Airport South (DENN, C56), however, the NO_X concentrations are not notably different from the other episode days, so the ozone sensitivity remains stable at that site. Overall, the ozone behavior during this high ozone period is NO_X-sensitive, implying that VOC reductions are likely to be less effective at reducing ozone than NO_X reductions.

VOC-sensitive (i.e., NO_x-rich) ozone production is indicated by the bottom (blue) bars; NO_x-sensitive ozone production is indicated by the top (orange) bars; all single bars are blue except for the June 27, 2012 bar for the Arlington Municipal Airport Monitor, which is orange. DENN = the Denton Airport South (C56) monitor; GRAP = the Grapevine Fairway (C70 monitor; ITLY = the Italy (C1044) monitor; CLEB = the Cleburne Airport (C77) monitor; DHIC = the Dallas Hinton (C401) monitor; ARLA = the Arlington Municipal Airport (C61) monitor

Figure 5-21: Ozone Production Rates (ppb per day) for June 21 through 27, 2012, as Calculated by Chemical Process Analysis

Another recent modeling study of the DFW area (Digar et al., 2013) also found that ozone production was primarily NO_x-sensitive. The researchers performed CAMx modeling of DFW for the May 31 through July 2, 2006 episode; they assessed the sensitivity of ozone formation using the direct decoupled method. They found that ozone was 7.86 times more sensitive to changes in anthropogenic NO_x than to changes in anthropogenic VOC, indicating a strongly NO_x-sensitive regime in the DFW area.

These findings of NO_X-sensitivity are consistent with the weekend effect analysis performed for the DFW area and in the conceptual model for DFW, both of which are described in Appendix D: *Dallas-Fort Worth Nonattainment Area Ozone Conceptual Model*. In the weekend analyses, ozone concentrations increased on days with higher NO_X availability, i.e., weekdays, and decreased on days with lower NO_X availability, i.e., weekends.

Figure 5-22: *Day-of-Week Variations in NO_X Concentrations at Surface Monitors throughout DFW Area, 2005 through 2018* illustrates the lower concentrations of NO_X across the DFW area on weekends compared to weekdays. The following three figures show how there are fewer days with MDA8 ozone concentrations greater than 75 ppb on the weekends compared with during the week: Figure 5-23: *Frequency of High Ozone Days by Day of Week from 1997 through 2013*; Figure 5-24: *Frequency of MDA8 Ozone Concentrations Greater than 75 ppb by Year, in Number of Days per Year*; and Figure 5-25: *Frequency of High Ozone Days by Day of Week, Updated to 2005 through 2018*. A chi-squared goodness of fit test was performed upon the 1997 through 2013 data to test whether exceedance days were independent of day of the week. The test found that that the distribution was statistically different from a random distribution. Figure 5-24 shows how the day-of-week frequency of ozone exceedance days varies by year. The pattern for 2012, the base case modeling year, is consistent with the overall pattern. When the frequency distribution is updated to 2005 through 2018 (Figure 5-25), the weekend decrease in ozone exceedance frequency becomes more pronounced.

De Foy et al. (2016) investigated the systematic changes in NO_2 column densities during 2005 through 2014 over the DFW area. They found that there were notable decreases during Saturday (-23.6%) and Sunday (-35.7%) compared to weekdays, corroborating the surface monitoring data observations. Although satellite data has inherent uncertainties, these observations can capture the behavior of the entire urban area at once, and they are not subject to local variations caused by nearby sources.

If the DFW area observed atmospheric conditions that primarily supported VOC-sensitive ozone formation, ozone would increase on the weekends. The weekend decrease in NO_X concentrations in a NO_X-rich environment would result in less ozone suppression. Since the ozone is correlated with NO_X availability, however, the overall DFW urban system is NO_X-limited. Continuing decreases in NO_X concentrations are pushing the ozone formation even more toward NO_X-sensitivity. Therefore, the finding that the DFW ozone formation is primarily limited by NO_X availability is supported by both the chemical process analysis of base case 2012 modeling and by the analyses of the weekend effect.

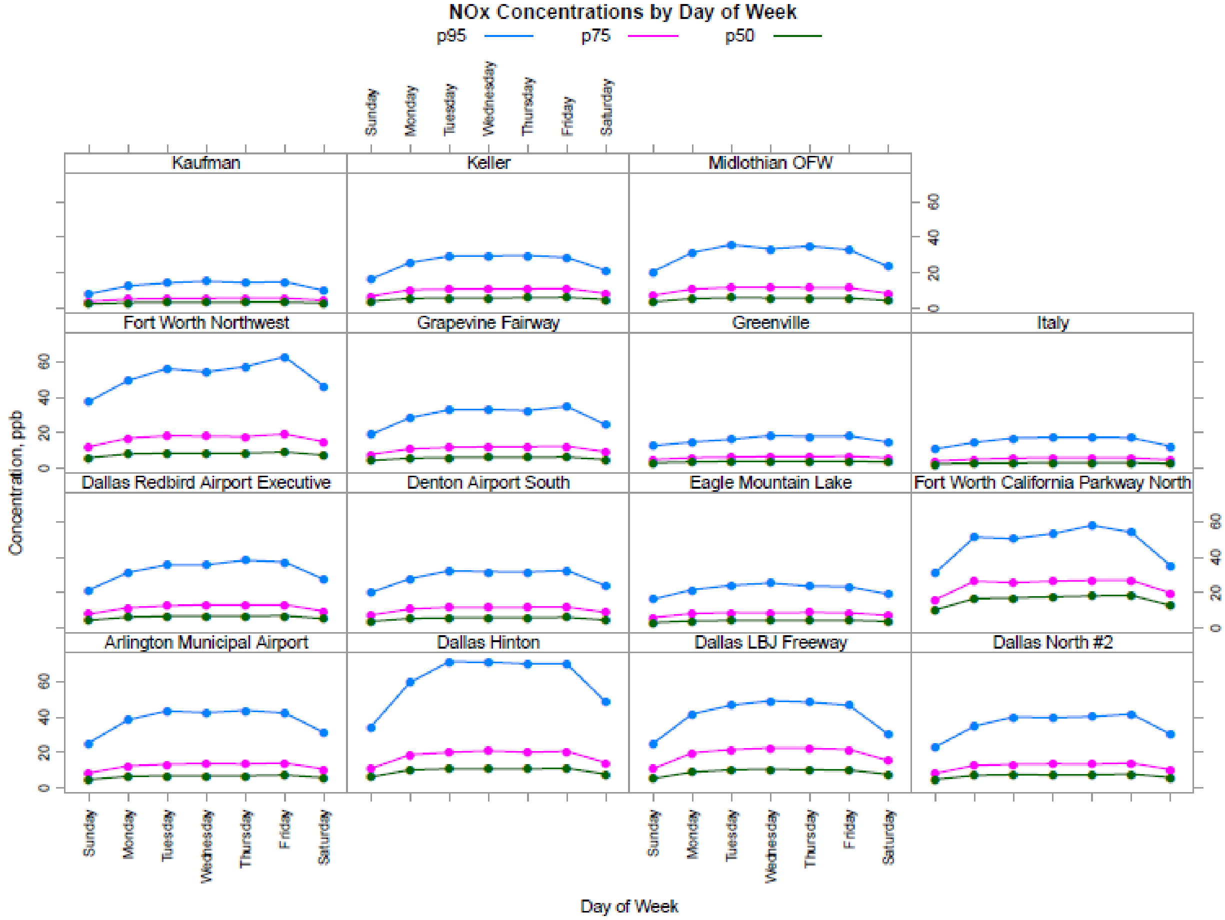
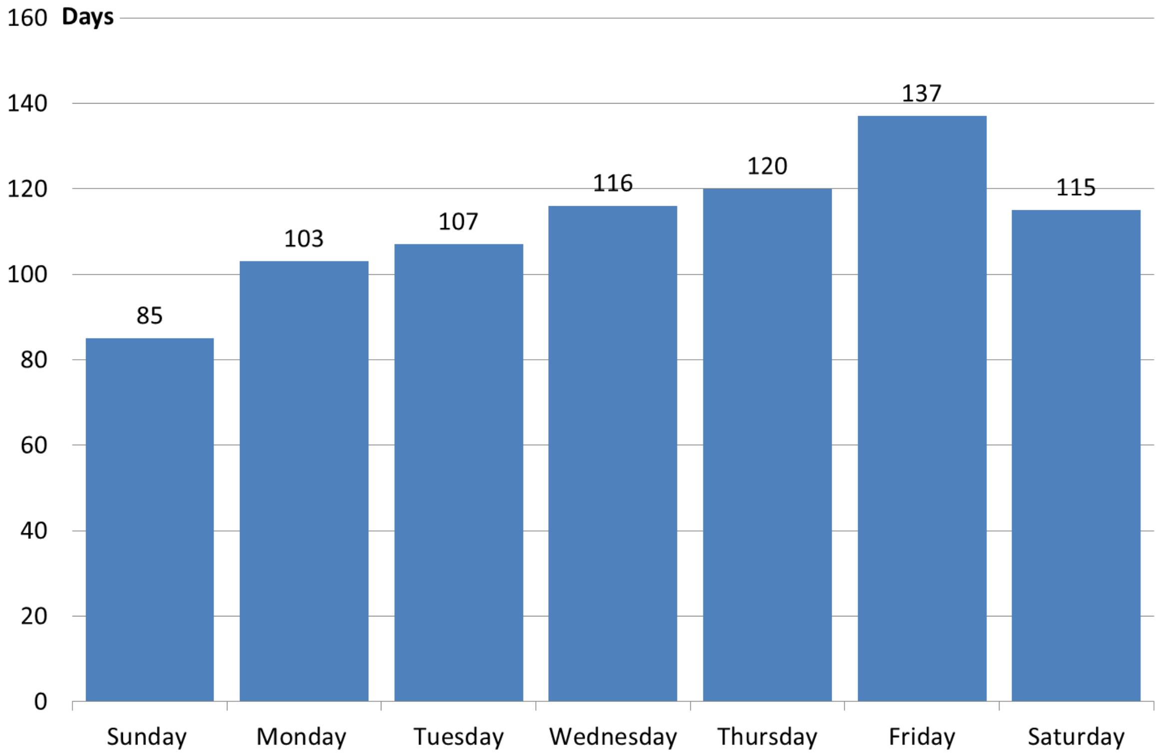


Figure 5-22: Day-of-Week Variations in NO_X Concentrations at Surface Monitors throughout DFW Area, 2005 through 2018

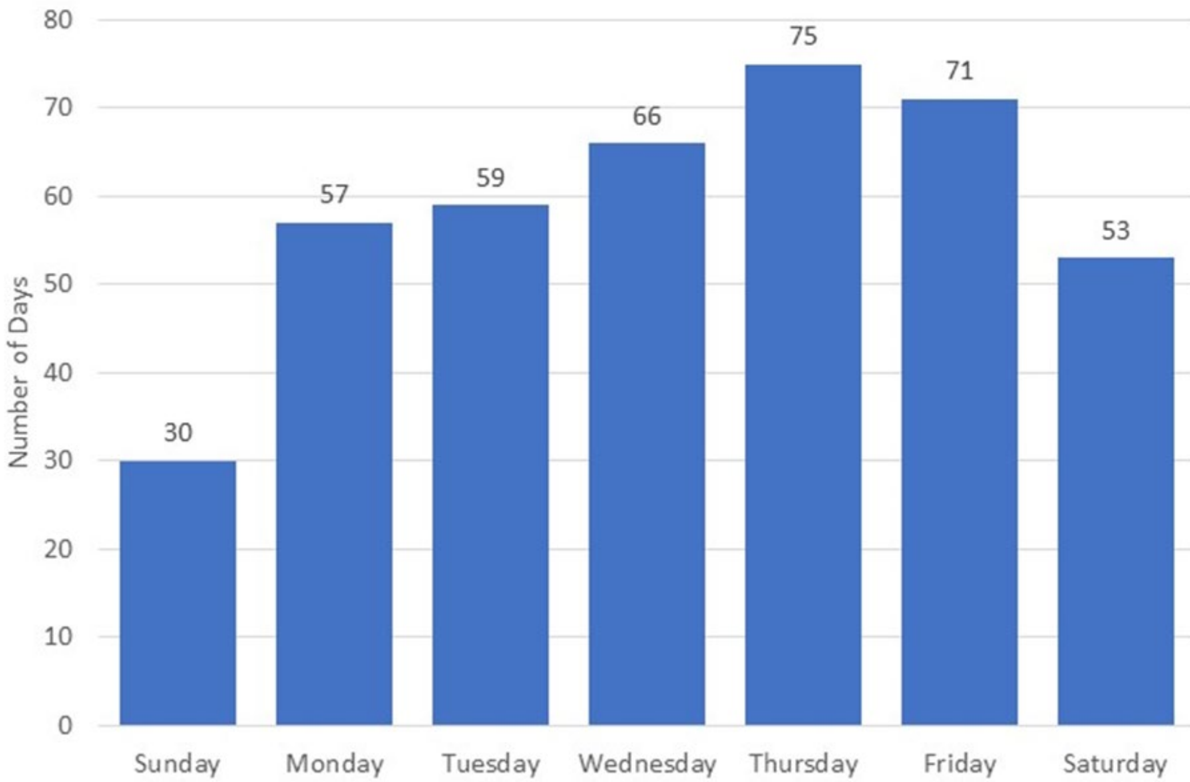


Note: In this case, a high ozone day is defined as MDA8 ozone concentration greater than 75 ppb.

Figure 5-23: Frequency of High Ozone Days by Day of Week from 1997 through 2013

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Sunday	6	9	8	10	7	6	6	4	9	4	3	3	3	0	3	2	2
Monday	8	7	6	7	7	7	8	7	10	8	3	4	1	1	8	8	3
Tuesday	7	10	9	6	9	7	3	7	9	6	4	5	6	1	9	6	1
Wednesday	9	10	10	8	9	8	5	6	11	6	2	4	7	4	8	4	5
Thursday	7	8	9	11	4	8	6	8	10	10	3	6	7	5	6	5	7
Friday	8	10	11	10	9	10	9	10	11	9	7	6	5	4	4	7	7
Saturday	9	13	11	11	6	8	8	6	10	7	5	2	5	3	2	4	5

Figure 5-24: Frequency of MDA8 Ozone Concentrations Greater than 75 ppb by Year, in Number of Days per Year



Note: The weekend decrease in high ozone is more pronounced in recent years.

Figure 5-25: Frequency of high ozone days by day of week, updated to 2005 through 2018

5.3.5 Potential Effects of Economically-Driven Coal-Burning Power Plant Closures

Within the past decade, the economic viability of coal-burning power plants has been transitioning. The advent of hydraulic fracturing, the resulting shale oil and gas production, federal rules that impact coal-fired power plants, and the carbon cost of emissions in certain states are some of the factors that have impacted the cost-effectiveness of coal-fired power generation.

The Energy Information Administration (EIA) reported that 12.9 gigawatts (GW) of coal-fired generating capacity was retired in 2018 in the United States[12]. Texas experienced the largest retirement of coal-fired generating capacity at 4.3 GW[12]. Specifically, the EIA included the retirements of Luminant Energy's Big Brown, Monticello, and Sandow (Units 4 and 5) plants, which permanently ceased operations in November 2017 through February 2018. Additional shutdowns include City Public Services' J.T. Deely plant, which ceased operations on December 31, 2018 and is currently mothballed, and Texas Municipal Power Agency's Gibbons Creek Steam Electric Station, which had been operating seasonally since 2017 but was mothballed indefinitely as of June 1, 2019.

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[12] https://www.eia.gov/todayinenergy/detail.php?id=38632

The closure of these large NO_x sources is likely to have air quality impacts, especially since many EGUs are located in rural areas, where biogenic VOC is available for reaction with the NO_x emitted by the coal plants. Known closures are accounted for in this SIP revision's modeling emissions inventory (EI), but there may be additional recent closures that are not accounted for. In addition, if a facility is mothballed but not closed, its emissions remain in the inventory, since its permit is still active, and the facility could resume operation in the future. Therefore, the SIP modeling demonstration may not include all the NO_x emission reductions that will take place before the attainment date, because the emissions from facilities whose closure have not yet been announced or from mothballed facilities are still part of the EI.

Though the emissions from the coal-burning power plants may cease, the electrical generating capacity must be replaced in some manner, and renewable, zero-emission power generation such as wind, solar, or nuclear may not be available to supply the missing capacity. It cannot be assumed, then, that the emissions will simply disappear; part of the generating capacity is likely to be met by another plant that has non-zero NO_x emissions. Given the complexity of power supply networks, it may not be possible to predict exactly how EGU NO_x emissions will redistribute, but despite the uncertainties, the overall trend is moving towards shutdown of coal-burning power plants. That opens the possibility that the modeling EI does not account for all the emissions reductions affecting background ozone concentrations. Therefore, this section of the literature review will examine the effects of coal-burning power plants, and the potential benefits to background ozone levels that may arise from their shutdown.

Ryerson et al. (2001) found that the rate and efficiency of ozone formation from power plant plumes depended in part upon the availability of reactive VOCs; in rural areas, biogenic isoprene filled that role very effectively. They also learned that power plants with extremely high emission rates (13.9 tons NO_x per hour) made ozone much less effectively than smaller plants (e.g., 1 to 2 tons NO_x per hour), because the very high NO_x concentrations fostered conversion of the NO_x to nitrates instead of supporting ozone formation. All the Texas coal-burning power plants fit into the second category of more efficient ozone production rather than the first.

Springston et al. (2005) examined data from 12 aircraft transects flown downwind and perpendicular to the Sandow Alcoa plume in September 2000. They found that the lignite-burning power plant plume enhanced ozone by 15 ppb above the background ozone. The ozone enhancement persisted even 63 kilometers (km) downwind of the facility.

Neuman et al. (2004) examined aircraft transect data for eight Texas power plants during TexAQS 2000 (W.A. Parish, Tradinghouse, Limestone, Big Brown, Sandow, Martin Lake, Monticello, and Welsh). Neuman et al. (2002) showed ozone enhancement of 8-12 ppb above background ozone levels at 77 km downwind of Tradinghouse power plant. Frost et al. (2006) examined the ozone production efficiency of the different Texas plants, along with other power plants throughout the eastern U.S., and found that for Welsh, Monticello, Limestone, Big Brown, Tradinghouse, and Martin Lake, the ozone production efficiency was about six molecules of ozone per molecule of NO_x oxidized. The Zhou et al. study found similar ozone production efficiency six years later during TexAQS 2006. All studies of W.A. Parish have shown different ozone production efficiency than other plants with similar rates of NO_x emission, probably due to Parish's proximity to Houston; the urban and industrial environment into which Parish releases its plume leads to lower ozone production efficiency than the rural environments of northeast and central Texas.

Zhou et al. (2012) showed that flights made downwind of Martin Lake, Monticello, and Welsh power plants in northeast Texas during TexAQS 2006 generated 4.5 to 9.7 ppb of ozone above the regional background ozone at approximately 70 km downwind. Ozone production efficiency within these plumes was high compared to some studies, with all three plumes generating six to 10 ozone molecules per molecule of NO_x oxidized, much higher than the ozone production efficiency of 2.2 observed by Ryerson for W.A. Parish plant in 2000 (Ryerson et al., 2003), but about the same order of magnitude as the Johnsonville power plant observed in 1999 (Ryerson et al., 2001). The Johnsonville plant was located in a similar rural, biogenic-isoprene-rich environment as the three northeast Texas plants, which may account for their similarity.

Strasert et al. (2019) is the most relevant analysis for this SIP revision. The researchers used part of the same modeling episode that TCEQ has used for this SIP revision, June 15 through 30, 2012 and August 1 through 15, 2012, and used a version of the same Texas EI that TCEQ employs. Strasert and his colleagues studied the potential air quality impacts of the hypothetical shutdown of individual coal-fired power plants in Texas. Specifically, this study focused on 13 out of the 21 coal-burning power plants located in eastern and central Texas: Big Brown, Coleto Creek, Fayette Power Project, J.K. Spruce, J.T. Deely, Limestone, Martin Lake, Monticello, Oak Grove, San Miguel, Sandow, W.A. Parish, and Welsh.

The NO_x emissions (EPA 2017 estimates) from these plants range from 5.6 tons/day for San Miguel to 27.3 tons/day for Martin Lake. This study quantified the potential individual impact of each plant upon MDA8 ozone concentrations in two ways: averaged over the entire domain for the entire 30-day modeling period, and for single monitors averaged over the 30-day modeling period. Unfortunately, these assessments do not quantify the contribution to background ozone on high ozone days in nonattainment areas, nor do the assessments quantify the contribution on MDA8 ozone concentrations on individual days at monitors that exceed the standard. The authors do discuss maximum impacts at a few monitors; for example, the WA Parish plant near Houston increased the MDA8 ozone concentration at the Northwest Harris (C26) monitor by 3.3 ppb, despite the stringent selective catalytic reduction controls installed at the facility, and Monticello increased MDA8 ozone concentration at the Dallas Hinton (C401) monitor by 1.7 ppb, which was the maximum impact in the DFW area.

Figure 5-26: *Modeling Impacts upon MDA8 Ozone Concentrations at Key Monitors from Hypothetical Closure of Individual Coal-Burning Power Plants in Texas* estimates the impact of hypothetically closing individual plants upon the peak ozone at selected monitoring sites in DFW, Houston-Galveston-Brazoria (HGB), and San Antonio. The analysis does not consider the accumulated impact of all closures at once, which might be more relevant to the current situation. Nine coal-burning power plant units have been shut down or mothballed since April 1, 2016; eight of these shutdowns/mothballs occurred in 2018. The TCEQ modeling for 2020 accounts for the shutdown of two units at Big Brown, three units at Sandow, one unit at Welsh, and three units at Monticello. In addition, two units at JT Deely are mothballed as of January 2019, but are still included in the EI, since they have not been completely decommissioned. The shutdown units accounted for 54 tpd NO_X emissions during the 2012 ozone season; mothballed units accounted for 9.5 tpd ozone season NO_X emissions in 2012. Shutdowns of multiple units are likely to decrease background ozone more than shutdowns of single units.

These estimated impacts are rather small for individual plants on the high ozone days of June 25 through 27, 2012. By contrast, the plume studies by Ryerson et al. (2001), Springston et al. (2005), Neuman et al. (2004), and Zhou et al. (2012) show that these plants can raise ozone concentrations by 10 ppb or more above the local background ozone. It is possible that the short time scale of the aircraft transects studied by these other researchers gives the impression of a larger impact than the modeled impact to the eight-hour ozone concentration as performed by Strasert et al. (2019). It is also possible that the high spatial resolution of the aircraft transects does not smear out the impact from the plumes as a photochemical grid model may do. The issue warrants further research and analysis, but one can conclude that the impact from closure of several coal-burning power plants in Texas lies between the low values observed from individual plant closures in Strasert et al. (2019) and the larger impacts observed from aircraft transects. Further study is needed to determine the exact impact, but there is ample evidence to suggest that the accelerating closure of coal-burning power facilities is likely to affect regional background ozone concentrations in the DFW area. This evidence indicates that higher reductions in MDA8 ozone concentrations than those modeled in this proposed DFW AD SIP revision are plausible.

			MDA8 Ozone Impact (ppb)				
Monitor	Column	Row	Big Brown	J T Deely	Monticell o	Sandow	Welsh
25-Jun							
San Antonio Northwest	42	88	0.020	0.179	0.003	0.071	0.003
Manvel Croix Park	121	88	0.010	0.000	0.001	0.000	0.001
Camp Bullis	43	91	0.056	0.137	0.001	0.085	0.002
Park Place	123	93	0.003	0.000	0.001	0.000	0.001
Houston Aldine	122	99	-0.002	0.000	0.004	0.000	0.011
Arlington Municipal Airport	79	175	0.103	0.000	0.107	0.041	0.021
Denton Airport South	77	191	0.077	0.007	0.031	0.066	-0.002
26-Jun							
San Antonio Northwest	42	88	0.169	0.273	0.217	0.087	0.118
Manvel Croix Park	121	88	-0.005	0.000	0.258	-0.001	0.061
Camp Bullis	43	91	0.179	0.234	0.245	0.032	0.135
Park Place	123	93	-0.006	0.000	0.202	-0.001	0.052
Houston Aldine	122	99	-0.012	-0.001	0.058	-0.002	0.022
Arlington Municipal Airport	79	175	0.040	0.002	0.039	0.024	0.016
Denton Airport South	77	191	0.037	0.005	0.025	0.026	0.006
27-Jun							
San Antonio Northwest	42	88	0.002	1.238	0.067	-0.001	0.022
Manvel Croix Park	121	88	-0.012	0.000	-0.005	-0.001	0.001
Camp Bullis	43	91	0.010	0.798	0.087	0.000	0.029
Park Place	123	93	-0.012	0.000	-0.005	-0.001	0.001
Houston Aldine	122	99	-0.015	-0.001	-0.010	-0.002	-0.001
Arlington Municipal Airport	79	175	0.156	0.000	0.059	-0.001	0.126
Denton Airport South	77	191	-0.004	0.000	0.138	0.000	0.190

Source: Strasert, Personal Communication, 2019

Figure 5-26: Modeling Impacts upon MDA8 Ozone Concentrations at Key Monitors from Hypothetical Closure of Individual Coal-Burning Power Plants in Texas

5.3.6 Analysis of Smoke/Wildfire Impact on Specific High Ozone Days

The TCEQ will continue to review ambient air monitoring data from monitors in the DFW area to evaluate if there are influences from wildfires. If the review and early analysis indicate wildfire influence, the TCEQ may flag the relevant data in the Air

Quality System as being influenced by emissions from wildfires and further investigating the circumstances that affected the development of these ozone episodes.

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 ozone 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 the EPA's standard tests of SIP creditability (permanent, enforceable, surplus, and quantifiable) but are crucial to the success of the air quality plan in the DFW area.

5.4.1 Additional Measures

5.4.1.1 SmartWay Transport Partnership and the Blue Skyways Collaborative

Among its various efforts to improve air quality in Texas, the TCEQ continues to promote two voluntary programs in cooperation with the EPA: SmartWay Transport Partnership and Blue Skyways Collaborative.

The SmartWay Transport Partnership is a market-driven partnership aimed at helping businesses move goods in the cleanest, most efficient way possible. This is a voluntary EPA program primarily for the freight transport industry that promotes strategies and technologies to help improve fleet efficiency while also reducing air emissions.

There are over 3,700 SmartWay partners in the U.S., including most of the nation's largest truck carriers, all the Class 1 rail companies, and many of the top Fortune 500 companies. Since its founding, SmartWay has reduced oil consumption by 215.4 million barrels.[13] Between 2009 and 2016, the SmartWay Truck Carrier Partners prevented the release of 1,700,000 tons of NO_X and 70,000 tons of particulate matter into the atmosphere.[14] Approximately 192 Texas companies are SmartWay partners, 76 of which are in the DFW area.[15] The SmartWay Transport Partnership will continue to benefit the DFW area by reducing emissions as more companies and affiliates join and additional idle reduction, trailer aerodynamic kits, low-rolling resistance tire, and retrofit technologies are incorporated into SmartWay-verified technologies.

The Blue Skyways Collaborative was created to encourage voluntary air emission reductions by planning or implementing projects that use innovations in diesel engines, alternative fuels, and renewable energy technologies applicable to on-road and non-road sources. The Blue Skyways Collaborative partnerships include international, federal, state, and local governments, non-profit organizations, environmental groups, and private industries.

5.4.1.2 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

[13] https://www.epa.gov/smartway/smartway-program-successes
[14] https://www.epa.gov/smartway/smartway-trends-indicators-and-partner-statistics-tips
[15] https://www.epa.gov/smartway/smartway-partner-list

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 the first quarter 2019, Texas has 24,895 megawatts (MW) of installed wind generation capacity,[16] 25.6% of all installed wind capacity in the U.S. In 2018, Texas' total net electrical generation from renewable wind generators was 75.7 million megawatt-hours (MWh), approximately 27.6% of the total wind net electrical generation for the U.S at that time. In 2018, Texas' total net electrical generation from renewable wind generators increased approximately 13% more than in 2017.[17]

Texas non-residential solar electricity generation in 2018 totaled 3.3 million MWh,[18] a 53% increase from 2017. The 2018 total installed solar electricity generation capacity in Texas was 2,924 MW,[19] a 52% increase from 2017.

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 or renewable energy efforts may not result in local emissions reductions or may be offset by increased demand in electricity. The difficulty in determining the accuracy of historical dispatch patterns and predicting future dispatch patterns makes accurately quantifying emission reductions from EE/RE measures difficult.

While specific emission reductions from EE/RE measures are not provided in the SIP, persons interested in estimates of energy savings and emission reductions from EE/RE measures can access additional information and reports from the Texas A&M Engineering Experiment Station's Energy Systems Laboratory (ESL) website (http://esl.tamu.edu/). TERP reports submitted to the TCEQ regarding EE/RE measures are available on the ESL website on the TERP Reports webpage (http://esl.tamu.edu/terp/documents/terp-reports/).

Finally, 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.

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[16] U.S. Department of Energy, National Renewable Energy Laboratory, https://windexchange.energy.gov/maps-data/321.

[17] U.S. Department of Energy, Energy Information Administration, https://www.eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=008&geo=0000000002&sec=g&linechart=ELEC.GEN.WND-TX-99.A&columnchart=ELEC.GEN.WND-TX-99.A&map=ELEC.GEN.WND-TXA&freq=A&ctype=linechart&ltype=pin&rtype=s&maptype=0&rse=0&pin=.

[18] U.S. Department of Energy, Energy Information Administration, https://www.eia.gov/electricity/data/browser/#/topic/0?agg=2,0,1&fuel=0000k&geo=0000000002&sec=g&freq=A&start=2001&end=2018&ctype=linechart&ltype=pin&rtype=s&pin=&rse=0&maptype=0

19 Solar Energy Industries Association, https://www.seia.org/state-solar-policy/texas-solar

76th Texas Legislature, 1999

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

77th Texas Legislature, 2001

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

78th Texas Legislature, 2003

- HB 1365 (Regular Session)

79th Texas Legislature, 2005

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

80th Texas Legislature, 2007

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

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)
- HB 362 (Regular Session)

83rd Texas Legislature, 2013

- None

84th Texas Legislature, 2015

- SB 1626
- HB 1736

85th Texas Legislature, 2017

- HB 1571 (Regular Session)

86th Texas Legislature, 2019

- HB 2546

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 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 RE 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, Regular Session, states in §388.003(a) that single-family residential construction must meet the EE performance standards established in the EE 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 EE performance standards established in the EE 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, updates THSC §388.003 to adopt, effective September 1, 2016, the EE chapter of the International Residential Code as it existed on May 1, 2015. HB 1736 also establishes 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).

Political Subdivisions Projects

SECO funds loans for EE 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 EE 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 EE goals to be at least 30% of annual growth beginning in 2013. The metric for the EE goal remains at 0.4% of peak summer demand when a utility program accrues that amount of EE. SB 1150, 82nd Texas Legislature, 2011, Regular Session, extended the EE 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 EE 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 EE 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 EE 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.

HB 1571, 85th Texas Legislature, 2017, Regular Session, expanded Education Code and Government Code provisions for local governmental entities, schools, and state agencies entering into energy saving performance contracts by authorizing the entities to use any available money to pay the provider for energy or water conservation measures. Previously, only money other than money borrowed from the state could be used to pay for such conservation measures.

HB 2546, 86th Texas Legislature, 2019, Regular Session, allows manufacturers or builders of industrialized housing to meet energy efficiency performance standards in the energy code (Texas Health and Safety Code, §388.003(a)) or in a local amendment to the energy code. The bill extends the benefits of energy code modifications to industrialized housing by allowing it to be eligible for the energy code modifications available to site-built homes.

5.4.1.3 Cement Kiln Consent Decree

Cement kilns located in Ellis County are subject to the requirements of 30 Texas Administrative Code (TAC) Chapter 117, Subchapter E, Division 2. Ash Grove Cement Company operated three kilns in Ellis County, with an established source cap under §117.3123 of 4.4 tpd. The AD modeling includes this 4.4 tpd source cap as the maximum allowable cement kiln NO_X emissions from this site.

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

5.4.1.4 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 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 TAC Chapter 101 resulting from legislation during the 80th Texas Legislature, 2007.

A December 2008 court decision found flaws in CAIR but kept CAIR requirements in place temporarily while directing the EPA to issue a replacement rule. In July 2011, the EPA finalized CSAPR to meet FCAA requirements and respond to the court's order to issue a replacement program. Texas was included in CSAPR for ozone season NO_X, annual NO_X, and annual SO_2 due to the EPA's determination that Texas significantly contributes to nonattainment or interferes with maintenance of the 1997 eight-hour ozone NAAQS and the 1997 $PM_{2.5}$ 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 began 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 over control of Texas emissions, and remanded these budgets back to the EPA without vacatur.

On June 27, 2016, the EPA issued a memorandum outlining the agency's approach for responding to the D.C. Circuit's July 2015 remand of the Phase 2 SO_2 emissions budgets, providing a choice of two paths for states with remanded budgets. Under the first path, states could voluntarily continue to participate in CSAPR at the state's current Phase 2 SO_2 and annual NO_X budget levels through a SIP revision. Under the second path, if a state did not choose to participate in CSAPR, the EPA would initiate rulemaking by fall of 2016 to remove the state's sources from CSAPR's SO_2 and annual NO_X programs and address any remaining interstate transport or regional haze obligations on a state-by-state basis. On November 10, 2016, the EPA published a proposed rule to remove Texas sources from the CSAPR SO_2 and annual NO_X trading programs. The EPA also proposed to determine that, following withdrawal of the federal implementation plan (FIP) requirements, sources in Texas would not contribute significantly to nonattainment or interfere with maintenance of the 1997 $PM_{2.5}$ NAAQS in any other state and that the EPA would have no obligation to issue new FIP requirements for Texas sources to address transport for the 1997 $PM_{2.5}$ NAAQS (81 FR 78954). The rule was finalized, effective immediately, on September 29, 2017 (82 FR 45481).

On September 7, 2016, the EPA signed the final CSAPR Update Rule for the 2008 eight-hour ozone standard. The EPA's modeling showed that emissions from within Texas no longer significantly contribute to downwind nonattainment or interference with maintenance for the 1997 eight-hour ozone NAAQS even without implementation of the original CSAPR ozone season NO_X emissions budget. Accordingly, sources in Texas are no longer subject to the emissions budget calculated to address the 1997 eight-hour ozone NAAQS. However, this rule finalized a new ozone season NO_X emissions budget for Texas to address interstate transport with respect to the 2008 eight-hour ozone NAAQS. This new budget became effective for the 2017 ozone season, the same period in which the Phase 2 budget that was invalidated by the court was scheduled to become effective. On July 10, 2018, the EPA published a proposed close-out of CSAPR, proposing to determine that the CSAPR Update Rule fully addresses interstate pollution transport obligations for the 2008 eight-hour ozone NAAQS in 20 covered states, including Texas. The EPA's modeling analysis projects that by 2023 there will be no remaining nonattainment or maintenance areas for the 2008 eight-hour ozone NAAQS in the CSAPR Update region and therefore the EPA would have no obligation to establish additional control requirements for sources in these states. As a result, these states would not need to submit SIP revisions establishing additional control requirements beyond the CSAPR Update. The final rule was published on December 21, 2018 with an effective date of February 19, 2019 (83 FR 65878).

5.4.1.5 Texas Emissions Reduction Plan (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 (DERI) program. 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 program where ground-level ozone is a concern.

From 2001 through August 2018, $1,102,232,075 in DERI grants were awarded for projects projected to help reduce an estimated 179,879 tons of NO_X in the period over which emissions reductions are reported for each project under the program. This includes $381,907,227 going to activities in the DFW area, with an estimated 63,308 tons of NO_x reduced in the DFW area in the period over which emissions reductions are reported for each project under the program. The TCEQ expects to award an additional $52.2 million in grants under the DERI program in FY 2019 for an estimated 5,044 tons of NO_x reduced.

Three other incentive programs under the TERP program will result in the reduction in NO_x emissions in the DFW area.

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 nonattainment areas. The name of this program was recently changed to the Seaport and Rail Yard Areas Emissions Reduction Program (SPRY), and replacement and repower of cargo handling equipment was added to the eligible project list. Through August 2018, the program awarded $6,209,424, with an estimated 362 tons of NO_x reduced in the period over which emissions reductions are reported for each project under the program. In the DFW area $501,524 was awarded to projects with an estimated 25 tons of NO_x reduced in the period over which emissions reductions are reported for each project under the program. The TCEQ expects to award an additional $9.3 million in grants under the SPRY program in FY 2019 for an estimated 298 tons of NO_x reduced.

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; therefore, applicants must commit to replacing at least 10 eligible diesel-powered vehicles with qualifying alternative fuel or hybrid vehicles. From 2009 through August 2018, $55,910,503 in TCFP grants were awarded for projects to help reduce an estimated 633 tons of NO_x in the period over which emissions reductions are reported for each project under the program. In the DFW area, $16,315,047 in TCFP grants were awarded with an estimated 245 tons of NO_x reduced in the period over which emissions reductions are reported for each project under the program. The TCEQ expects to award an additional $7.7 million in grants under the TCFP in FY 2019 for an estimated 44 tons of NO_x reduced.

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. From 2011 through August 2018, $42,396,348 in TNGVGP grants were awarded for projects to help reduce an estimated 1,495 tons of NO_x in the period over which emissions reductions are reported for each project under the program. In the DFW area, $14,030,888 in TNGVGP grants were awarded to projects with an estimated 515 tons of NO_x reduced in the period over which emissions reductions are reported for each project under the program. The TCEQ expects to award an additional $14.4 million in grants under the TNGVGP in FY 2019 for an estimated 74 tons of NO_x reduced.

Through FY 2017, both the TCFP and TNGVGP required that the majority of the grant-funded vehicle's operation 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, and Dallas-Fort Worth. Legislative changes in 2017 expanded the eligible areas into a new Clean Transportation Zone, to include the counties in and between an area bounded by Dallas-Fort Worth, Houston, Corpus Christi, Laredo, and San Antonio.

5.4.1.6 Clean School Bus Program

HB 3469, 79th Texas Legislature, 2005, Regular Session, established the Clean School Bus Program, which provides monetary incentives for school districts in the state for reducing emissions of diesel exhaust from school buses through retrofit of older school buses with diesel oxidation catalysts, diesel particulate filters, and closed crankcase filters. As a result of legislative changes in 2017, this program also includes replacement of older school buses with newer, lower-emitting models. Through August 2018, the TCEQ Clean School Bus Program had reimbursed approximately $37.5 million in grants for over 7,500 retrofit and replacement activities across the state. This amount included $4.7 million in federal funds. Of the total amount, approximately $5.1 million was used for 833 school bus retrofit projects, and 10 school bus replacement projects in the DFW area. The TCEQ awarded an additional $3.1 million in projects under the Clean School Bus Program in FY 2019 for an estimated 36 tons of NO_x reduced.

5.4.1.7 86th Texas Legislature, 2019

Summaries of the bills passed during the 86th Texas Legislature, 2019, Regular Session, that have the potential to impact the DFW area are discussed in this section. For legislative updates regarding EE/RE measures and programs, see Section 5.4.1.2: *Energy Efficiency and Renewable Energy Measures*.

House Bill 1346

HB 1346 gives the TCEQ authority to set the minimum usage of TERP grant funded equipment in nonattainment and affected areas under the DERI program lower than the current 75%, but not lower than 55%. This could increase the number of projects funded, though the NO_x emissions reductions for projects that include equipment used less than 75% in the eligible areas could be lower than projects to date.

House Bill 3745

HB 3745 creates a TERP Trust Fund, effective September 1, 2021, and extends the TERP fees until attainment, effective August 30, 2019. This fund would exist outside of the state treasury and would allow the TCEQ to expend all the revenue from the TERP fees that accrue over the state biennium. HB 3545 could potentially result in the TCEQ funding more TERP projects and achieving greater NO_x emissions reductions.

5.4.1.8 Local Initiatives

The North Central Texas Council of Governments submitted an assortment of locally implemented strategies in the DFW ozone nonattainment area including projects, programs, partnerships, and policies. These programs are expected to be implemented in the 10-county DFW ozone nonattainment area by 2020. Due to the continued progress of these measures, additional air quality benefits will be gained that 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.*

5.4.1.9 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 ozone 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 webpage (https://www.epa.gov/natural-gas-star-program/natural-gas-star-program).

5.5 CONCLUSIONS

The TCEQ has used several sophisticated technical tools to evaluate the past and present causes of high ozone in the DFW ozone nonattainment area in an effort to predict the area’s future air quality. Photochemical grid modeling performance has been rigorously evaluated, and the 2012 ozone episode from May through September has been used to match the times of year when the highest ozone levels have historically been measured in the DFW ozone 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 well, with one weakness being an overproduction of ozone primarily during night-time hours and days when lower ozone concentrations are measured. Issues observed with the base case ozone modeling are those that are known to exist in all photochemical modeling exercises, particularly when an entire ozone season is modeled rather than short time periods of just one or two weeks. The model can be used with confidence to predict future ozone DVs because the EPA’s modeling guidance recommends applying the relative response in modeled ozone to monitored DVs. Application of the EPA recommended top 10 days attainment test predicts a peak future DV of 72 ppb at the Grapevine Fairway (C70) monitor. This DFW AD SIP revision documents a fully-evaluated, high-quality modeling analysis with DV_F for all regulatory monitors below the 2008 eight-hour ozone standard for the DFW ozone nonattainment area.

For the cement kiln sources within DFW, the required emission caps or directly enforceable limits are modeled in the future year even if historical operational levels have been significantly less than the 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 2020 future year is still modeled at 15.21 NO_X tpd. This conservative approach of modeling the maximum allowable emission levels ensures that future estimates are not underestimated for large NO_X sources such as cement kilns on high ozone days.

Second, trend analyses show that ozone has decreased significantly since 2000 when the eight-hour ozone DV at the Denton Airport South monitor was 102 ppb. As of 2018, the Denton Airport South monitor is attaining the 2008 eight-hour ozone NAAQS since it has an eight-hour ozone DV of 75 ppb. NO_X and VOC precursor trends have significantly decreased, which has led to reduced ozone formation. These reductions in precursors in the DFW ozone nonattainment area are due to a combination of federal, state, and local emission controls. As shown in this chapter, Chapter 3, and Appendix B: *Emissions Modeling for the DFW and HGB Attainment Demonstration SIP Revision for the 2008 Eight-Hour Ozone Standard*, the on-road and non-road mobile source categories are the primary sources of NO_X emissions in the DFW ozone nonattainment area and are expected to continue to 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 2020 modeled attainment year as NO_X reductions from these sources will continue. Based on the photochemical grid modeling results, and further supported by these corroborative analyses, the DFW ozone nonattainment area will attain the 2008 eight-hour ozone standard by July 20, 2021.

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CHAPTER 6: ONGOING AND FUTURE INITIATIVES

6.1 INTRODUCTION

The Texas Commission on Environmental Quality (TCEQ) is committed to maintaining healthy air quality in the Dallas-Fort Worth area and continues to work toward this goal. Texas continues to invest resources in air quality scientific research and the advancement of pollution control technology, refining quantification of emissions, and improving the science for ozone modeling and state implementation plan (SIP) analysis. Additionally, the TCEQ is working with the United States Environmental Protection Agency (EPA), local area leaders, and the scientific community to evaluate new measures for addressing ozone precursors. This chapter describes ongoing technical work that will be beneficial to improving air quality in Texas and the DFW ozone nonattainment area.

6.2 ONGOING WORK

6.2.1 Emissions Inventory (EI) Improvement Projects

The TCEQ EI reflects years of emissions data improvement, including extensive point and area source inventory reconciliation with ambient emissions monitoring data. Other reports detailing recent TCEQ EI improvement projects can be found at the TCEQ's Air Quality Research and Contract Projects webpage (https://www.tceq.texas.gov/airquality/airmod/project/pj.html).

6.2.2 Air Quality Research Program

The specific goal of the State of Texas Air Quality Research Program (AQRP) is to support scientific research related to Texas air quality in the areas of EI development, atmospheric chemistry, meteorology, and air quality modeling. Research topics are identified and prioritized by an Independent Technical Advisory Committee (ITAC). Projects to be funded by the AQRP are selected from the list of ITAC recommended projects by the TCEQ and the AQRP Advisory Council.

The Texas AQRP is administered by the University of Texas at Austin and is funded by the TCEQ through the Texas Emission Reduction Plan (TERP) Program. TERP funds emissions reduction projects in communities throughout Texas. To help ensure that air quality strategies in Texas are as effective as possible in understanding and improving air quality, a portion of the TERP funding is used to improve our scientific understanding of how emissions impact air quality in Texas.

More information on the strategic research plan of the AQRP, lists of the current members of the ITAC and Council, and reports from completed projects can be found at the AQRP webpage (http://aqrp.ceer.utexas.edu/).

6.2.3 2016 Collaborative Modeling Platform Development

TCEQ has joined a collaborative group of the EPA, states, tribes, and multi-jurisdictional organizations (MJOs) in creating a 2016 national emissions modeling platform that can be used as the basis for future regulatory modeling activities. Workgroups for key emission sectors were formed to create 2016 emission inventories for photochemical modeling input including on-road, non-road, electric generating unit (EGU) points, non-EGU points, area, and biogenic sources. The beta version of the 2016 platform was released on March 13, 2019. Version 1.0 is planned for release in summer

2019. Details on the 2016 collaborative inventory are on the Inventory Collaborative 2016beta Emissions Modeling Platform webpage (http://views.cira.colostate.edu/ wiki/wiki/10197).

6.2.4 International Emissions and Background Contribution

The EPA has acknowledged that domestic air quality could be impacted by emissions from Canada, Mexico, and other continents (80 FR 12293). The EPA also acknowledged that sites along the United States (U.S.)-Mexico border could have overwhelming influence of background ozone (EPA, 2015). Background ozone is defined by the EPA as "ozone formed from sources or process other than U.S. manmade emissions of nitrogen oxides (NO_X), volatile organic compounds (VOC), methane (CH_4), and carbon monoxide (CO)" (EPA, 2015) and includes ozone due to natural events such as stratospheric intrusions, wildfires, and ozone from non-U.S. anthropogenic sources (80 FR 65436). The TCEQ plans to use a combination of modeling and data analysis to better understand international transport into the DFW ozone nonattainment area and quantify the contribution of international emissions and background to 2020 future year design values (DV_F) at the DFW monitors. The TCEQ will use a combination of a global photochemical model, the Goddard Earth Observing Station global atmospheric model with Chemistry (GEOS-Chem), and a regional photochemical model, the Comprehensive Air Quality Model with Extensions (CAMx), to estimate the contribution of international emissions and background to the 2020 DV_F at DFW monitors.

6.2.5 Inter-Precursor Trading Ratio for Nonattainment New Source Review Permit Offset Requirements

To satisfy nonattainment New Source Review permit offset requirements, 30 Texas Administrative Code §101.306(d) and §101.376(g) allow the use of emission credits and discrete emission credits of one ozone precursor to offset emissions of another ozone precursor (i.e., NO_X credits for VOC offsets and vice-versa). The TCEQ has developed guidance[20] on the use of regional photochemical modeling, with models such as the CAMx, to demonstrate on a case-by-case basis that inter-precursor trading (IPT) of credits will not adversely affect the air quality in the DFW ozone nonattainment area.

On November 17, 2016, as part of the proposed implementation requirements for the 2015 eight-hour ozone NAAQS, the EPA proposed provisions that would allow each state to establish a default IPT ratio for each nonattainment area. Once a nonattainment area's specific default IPT ratio has been established, photochemical modeling demonstrations will not be required for each IPT use. In May 2018, the EPA published a technical support document, *Technical Guidance for Demonstration of Inter-Precursor Trading (IPT) for Ozone in the Nonattainment New Source Review Program*, describing technical analysis that can be used by states to establish area-specific default IPT ratios. On December 6, 2018, the EPA finalized the implementation rule for the 2015 eight-hour ozone NAAQS providing states with the option to establish a default IPT ratio for each nonattainment area and requiring that the default

[20] "Guidance on the Inter-Pollutant Use of Credits for Nonattainment New Source Review Permit Offset Requirements", TCEQ, January 2017, available at https://www.tceq.texas.gov/assets/public/ implementation/air/banking/guidance/inter-pollutant.pdf

IPT ratio results in equivalent or improved ozone air quality in the nonattainment area (83 FR 63016).

The TCEQ has executed a contract with Ramboll to conduct the technical analysis required to establish a default IPT ratio for the DFW ozone nonattainment area. The technical analysis will use the decoupled direct method (DDM) feature in CAMx to examine the sensitivity of ozone to changes in emissions of NO_X, and VOC from hypothetical "model facilities" located within DFW. The number of "model facilities," their operating and physical parameters, and their emission rates and speciation profiles will be selected to represent the industrial activities typical of DFW. The DDM-CAMx runs will be conducted on a grid with four-kilometer resolution that will encompass only the 10 counties in the DFW ozone nonattainment area and the run(s) will cover time periods (episodes) that capture at least eight of the top 10 days used to calculate 2020 (DV_F) in this SIP revision. The outputs from the DDM-CAMx runs will provide sensitivities of maximum daily average eight-hour (MDA8) ozone concentrations to changes in NO_X, VOC, and highly-reactive volatile organic compounds emissions for each model plant in DFW. The sensitivities will then be used to determine the default IPT ratio for DFW.

6.2.6 Supplemental Flare Operations Training

The TCEQ and the University of Texas developed Supplemental Flare Operations Training based on findings from the 2010 TCEQ Flare Study. The training was developed for industry personnel and focuses on the proper operation of dual-service flares in routine or non-emergency service—specifically, elevated air- and steam-assisted flares. Please note that ground, pressure-assisted (sonic), enclosed, and non-assisted flares were outside the scope of the training.

This training provides practical information about key variables affecting flare performance, allowing operators to maximize flare efficiency using existing on-site resources. The training is free and available online 24 hours a day, seven days a week; users are required to register to track progress through the individual training modules and to receive a training completion certificate. To date, more than 1,300 users have registered to take the training. The Supplemental Flare Operations Training can be accessed at the following webpage: https://sfot.ceer.utexas.edu/.

6.2.7 Optical Gas Imaging Technology

Optical gas imaging technology has proved to be highly effective in detecting VOC emissions as well as individual sources of VOC emissions that are underestimated, underreported, unreported, or previously unregulated. Optical gas imaging systems assist the agency in actions such as facility investigations, reconnaissance investigations, mobile monitoring, and special projects.

The TCEQ manages 20 optical gas imaging cameras statewide, which provides staff the ability to quickly respond to on-demand and emergency response events whenever and wherever they occur. The TCEQ also continues to invest in periodic contracted aerial surveys allowing the agency to survey large geographic areas. Other specific examples of how the TCEQ uses this technology include: offsite surveillance to identify potential sources of contaminants in response to ambient or other monitoring results; identification of sites, or areas within a specific site, where a focused investigation may be conducted; identification of potential source control strategies or to assist in assessments of existing strategies; and identification of sources for EI issues.

The current state of optical gas imaging technology has some technical limitations, e.g., commercially available instruments are not capable of speciating contaminants. Emerging advancements in this technology have led to the development of at least one commercially available system for quantifying leak emissions rates. However, the composition of the imaged leak has to be known for the camera to quantify emissions. Additionally, effective use of optical gas imaging technology is highly dependent on the training and experience of the instrument operator.

Overall, optical gas imaging technology provides opportunities for more rapid detection and repair of VOC emission leaks. Many industrial facilities now use this technology as part of their VOC emissions minimization program and to enhance identification and repair of hydrocarbon leaks.

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Appendices Available Upon Request

Kristin Jacobsen
kristin.jacobsen@tceq.texas.gov
512.239.4907