APPENDIX E

DEVELOPMENT OF ANNUAL EMISSIONS INVENTORIES AND ACTIVITY DATA FOR AIRPORTS IN THE 12-COUNTY DALLAS-FORT WORTH AREA

2013-016-SIP-NR

Adoption
July 2, 2014

DEVELOPMENT OF ANNUAL EMISSIONS INVENTORIES AND ACTIVITY DATA FOR AIRPORTS IN THE 12-COUNTY DALLAS-FORT WORTH AREA

This appendix provides the detailed documentation of methodologies and procedures used in developing the emissions inventories and activity data in the 12-county DFW area.

Development of Annual Emissions Inventories and Activity Data for Airports in the 12-County Dallas-Fort Worth Area

Collin	Hunt
Dallas	Johnson
Denton	Kaufman
Ellis	Parker
Henderson	Rockwall
Hood	Tarrant

North Central Texas Aircraft Emissions Inventory
August 2011

North Central Texas
Council of Governments
Transportation Department

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The North Central Texas Council of Governments is a voluntary association of cities, counties, school districts, and special districts which was established in January 1966 to assist local governments in **planning** for common needs, **cooperating** for mutual benefit, and **coordinating** for sound regional development.

It serves a 16-county metropolitan region centered around the two urban centers of Dallas and Fort Worth. Currently the Council has **240 members**, including 16 counties, 170 cities, 24 independent school districts, and 30 special districts. The area of the region is approximately **12,800 square miles**, which is larger than nine states, and the population of the region is over **6.5 million**, which is larger than 38 states.

NCTCOG's structure is relatively simple; each member government appoints a voting representative from the governing body. These voting representatives make up the **General Assembly** which annually elects a 15-member Executive Board. The **Executive Board** is supported by policy development, technical advisory, and study committees, as well as a professional staff of 315.

NCTCOG's offices are located in Arlington in the Centerpoint Two Building at 616 Six Flags Drive (approximately one-half mile south of the main entrance to Six Flags Over Texas).

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NCTCOG's Department of Transportation

Since 1974 NCTCOG has served as the Metropolitan Planning Organization (MPO) for transportation for the Dallas-Fort Worth area. NCTCOG's Department of Transportation is responsible for the regional planning process for all modes of transportation. The department provides technical support and staff assistance to the Regional Transportation Council and its technical committees, which compose the MPO policy-making structure. In addition, the department provides technical assistance to the local governments of North Central Texas in planning, coordinating, and implementing transportation decisions.

Prepared in cooperation with the Texas Department of Transportation and the U. S. Department of Transportation, Federal Highway Administration, and Federal Transit Administration.

"The contents of this report reflect the views of the authors who are responsible for the opinions, findings, and conclusions presented herein. The contents do not necessarily reflect the views or policies of the Federal Highway Administration, the Federal Transit Administration, or the Texas Department of Transportation."

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ABSTRACT

TITLE:	Development of Annual Emissions Inventories and Activity Data for Airports in the 12-County Dallas-Fort Worth Area
DATE:	August 2011
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SUBJECT:	Annual Airport Emissions Inventory
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ABSTRACT:	The North Central Texas Council of Governments conducted an emission inventory for airports in the North central Texas Counties. In this analysis, airport emissions and activity data were estimated for the 12 -county Metropolitan Statistical Area that encompasses Collin, Dallas, Denton, Ellis, Henderson, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties for 1996, 2000, 2002, 2008, 2011, 2014, 2017, 2020, 2023, 2026, and 2029 analysis years. This estimate will assist the Texas Commission on Environmental Quality in the State Implementation Plan development and other airport related inquiries which require annual emissions inventory estimates of criteria pollutants, criteria precursor pollutants, and hazardous air pollutants.

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GLOSSARY OF ABBREVIATIONS

APU	-	Auxiliary Power Units
ATADS	-	Air Traffic Activity System
CA	-	Commercial Airline
CAAA	-	Clean Air Act Amendments
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
DAL	-	Dallas Love Field International Airport
DFW	-	Dallas-Fort Worth
DFWIA	-	Dallas/Fort Worth International Airport
EDMS	-	Emission and Dispersion Modeling Systems
EPA	-	Environmental Protection Agency
FAA	-	Federal Aviation Administration
GISDK	-	Geographic Information System Developer Kit
GSE	-	Ground Support Equipment
HAPS	-	Hazardous Air Pollutants
ICAO	-	International Civil Aviation Organization
LTO	-	Landing and Takeoff
MPA	-	Metropolitan Planning Area
MPO	-	Metropolitan Planning Organization
MSA	-	Metropolitan Statistical Area
NAAQS	-	National Ambient Air Quality Standards
NCT	-	North Central Texas
NCTCOG	-	North Central Texas Council of Governments
NEI	-	National Emission Inventory
NFW	-	Fort Worth NAS JRB
NMHC	-	Non-Methane Hydrocarbons
NO_X	-	Nitrogen Oxides
NPIAS	-	National Plan of Integrated Airport Systems
Pb	-	Lead
$PM_{2.5}$	-	Particulate Matter, 2.5 microns
PM_{10}	-	Particulate Matter, 10 microns
QA	-	Quality Assurance
QAPP	-	Quality Assurance Project Plan
SIP	-	State Implementation Plan
SO_X	-	Sulfur Oxides
TAF	-	Terminal Area Forecast
TCEQ	-	Texas Commission on Environmental Quality
THC	-	Total Hydrocarbons
TOG	-	Total Organic Compounds
TxDOT	-	Texas Department of Transportation
USAF	-	United States Air Force
VOC	-	Volatile Organic Compounds

EXECUTIVE SUMMARY

This task required the North Central Texas Council of Governments (NCTCOG) to develop annual emissions inventory and activity data for airports for 1996, 2000, 2002, 2008, 2011, 2014, 2017, 2020, 2023, 2026, and 2029 analysis years. This inventory was developed for the 12-County Metropolitan Statistical Area (MSA) that covers Collin, Dallas, Denton, Ellis, Henderson, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties. The inventory will be used to support State Implementation Plan (SIP) development and other airport related inquiries which require annual emissions inventory estimates of criteria pollutants, criteria precursor pollutants, and hazardous air pollutants (HAPs).

There are 344 facilities in this 12-county MSA area that provide aviation services to the region. Among these, 282 facilities had no reported activities and 62 facilities with reported activities which were grouped into three categories for data collection and modeling purposes. Among the 62 facilities, Dallas Love Field International Airport (DAL) and Dallas/Fort Worth International Airport (DFWIA) are major commercial facilities with significant activities, Fort Worth NAS JRB (NFW) is a military base, 27 facilities were identified as significant airports with annual operations of more than 18,000 along with airports identified in the National Plan of Integrated Airport Systems (NPIAS) system, and the remaining 32 airports were grouped as other and had less than 18,000 annual operations reported.

The U.S. Federal Aviation Administration (FAA)'s Emission and Dispersion Modeling System (EDMS) was utilized to model the emission inventory for all 62 airports for all analysis years. EDMS requires aircraft-specific activity data such as the make, model, and engine of the aircraft. This information is readily available for medium and large commercial airports and air carriers, but is not available for air taxis, general aviation, or military aircraft. To estimate emissions from these sources, the methodology documented in the Environmental Protection Agency (EPA)'s National Emission Inventory (NEI) was used. Lead emissions from the aircraft were estimated following EPA's "Calculating Piston-Engine Aircraft Airport Inventories for Lead for the 2008 National Emissions Inventory" methodology.

Activity data required for emission estimation was gathered for all modeled facilities where data was easily available. The major airports were contacted for detailed aircraft activity data and other EDMS model input parameters. Data gaps, where appropriate, were filled using most closely related data that was available.

A data collection survey was conducted by NCTCOG's Aviation Team to collect most up to date information on the aircraft activity, fleet mix, ground support equipment (GSE), and auxiliary power unit (APU) inventory from the rest of the facilities. Compiled data was reviewed and identified data gaps were analyzed and filled in by experts from the aviation team.

Once the input data was quality checked, the EDMS model was populated and emission estimation from aircraft activity utilizing default GSE and APU assignment for all analysis years were produced. The uncontrolled results for major pollutants are summarized in Exhibit 1.

EXHIBIT 1

Emissions Without Controls (tons per year)

Pollutant	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
CO	24,314	24,120	24,600	17,381	13,880	13,363	13,147	13,492	14,050	14,774	15,641
THC	1,485.40	1,474.80	1,496.95	1,082.75	998.25	1,045.18	1,111.21	1,181.24	1,229.47	1,278.04	1,328.56
NMHC	2,083.80	2,049.46	2,064.55	1,411.50	1,241.31	1,258.89	1,306.30	1,373.85	1,424.49	1,478.87	1,537.30
VOC	2,088.44	2,052.69	2,066.87	1,409.36	1,236.97	1,252.73	1,298.52	1,365.03	1,415.11	1,469.06	1,527.12
NOX	6,191.76	6,014.07	5,751.04	4,496.11	4,005.51	4,166.80	4,351.85	4,645.36	4,998.59	5,391.51	5,827.58
SO x	684.82	679.04	661.93	491.46	434.16	466.89	503.54	547.13	590.23	636.62	687.91
PM10	214.81	181.37	167.06	122.71	105.92	105.62	105.83	107.06	106.56	105.90	104.88
PM2.5	211.93	179.47	165.41	121.90	105.33	105.11	105.39	106.67	106.18	105.51	104.48
Lead	4.67	4.95	4.91	4.74	4.29	4.42	4.56	4.70	4.84	4.98	5.13
TOG	2,154.21	2,117.79	2,132.96	1,452.25	1,269.36	1,281.89	1,325.47	1,391.58	1,441.98	1,496.65	1,555.66

A set of control strategies was identified from the reported survey that provided percentage conversion of GSE and APU to electric. The base emissions were post processed to reflect emission credits from the GSE and APU electric conversions. Post processed results reflecting controls are shown in Exhibit 2. Detailed emissions inventories of all other pollutants including HAPs for controlled and uncontrolled scenarios are organized in Appendix D.

EXHIBIT 2

Emissions After Implementing Controls (tons per year)

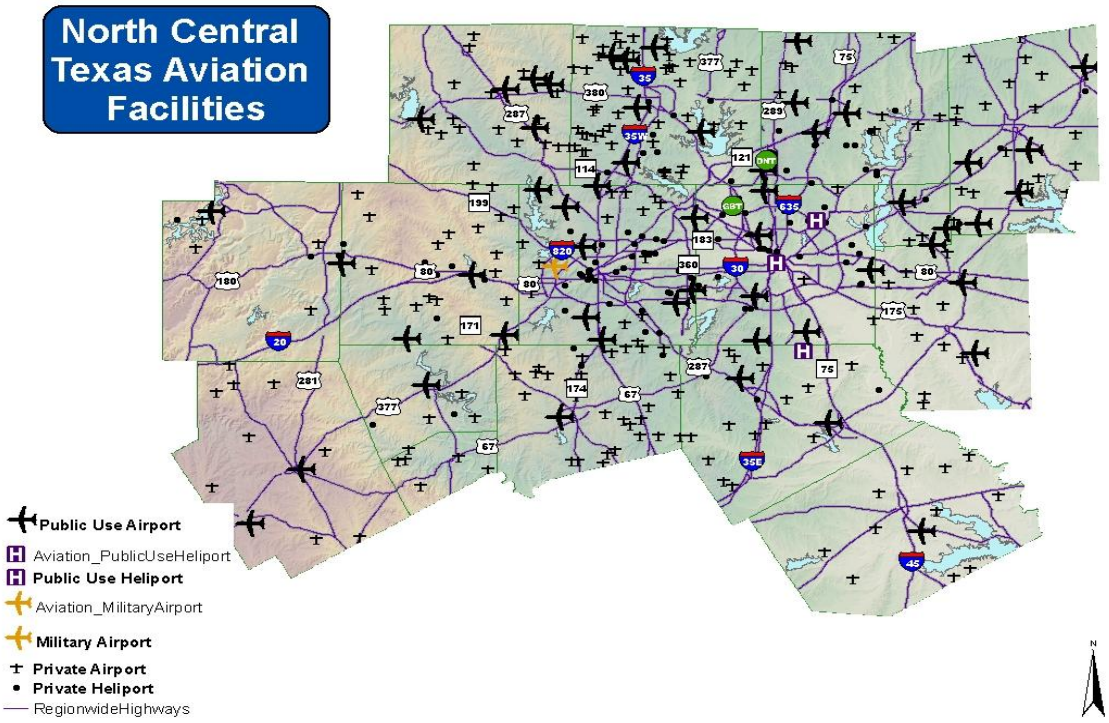
Pollutant	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
CO	24,250	24,056	24,545	15,412	12,616	12,428	12,482	12,920	13,516	14,244	15,095
THC	1,485.40	1,474.80	1,496.95	1,068.98	987.04	1,033.65	1,099.29	1,167.53	1,215.41	1,263.66	1,313.90
NMHC	2,081.48	2,047.23	2,062.61	1,337.50	1,192.48	1,220.58	1,275.98	1,344.90	1,396.37	1,450.48	1,508.04
VOC	2,086.03	2,050.37	2,064.85	1,333.03	1,186.70	1,213.42	1,267.53	1,335.55	1,386.51	1,440.18	1,497.35
NOX	6,183.47	6,006.30	5,744.39	4,204.85	3,799.91	3,991.09	4,198.64	4,488.38	4,838.87	5,223.54	5,647.81
SO x	684.32	678.54	661.50	469.39	417.41	449.23	484.76	525.09	566.56	611.21	660.63
PM10	214.37	181.10	166.86	95.83	84.32	84.06	84.15	82.63	81.33	79.69	77.55
PM2.5	211.51	179.20	165.22	95.26	83.90	83.70	83.84	82.36	81.07	79.43	77.29
Lead	4.67	4.95	4.91	4.74	4.29	4.42	4.56	4.70	4.84	4.98	5.13
TOG	2,151.55	2,115.22	2,130.73	1,369.63	1,215.24	1,239.96	1,292.84	1,360.85	1,412.27	1,466.69	1,524.76

CHAPTER 1: INTRODUCTION

Aviation is a vital transportation element that is critical in sustaining the region's economic growth and development, and North Central Texas (NCT) is home to an astounding number of airports and aviation employers. There are 13 airports within NCT that have an air traffic control tower. In 2009, the region's towered reliever airports conducted over 875,000 operations (Source: FAA ATADS). According to FAA, in 2009 Dallas Fort Worth International Airport (DFWIA) was ranked as the third busiest airport in the United States with 636,000 operations. Within NCT, an approximate 15,696 square mile area, there are over 400 aviation facilities, 57 of which are public-use. Of these public-use airports, approximately 21 are located within 30 nautical miles of Dallas-Fort Worth (DFW). Within the NCT 12-county MSA area, there are 344 facilities providing aviation related services as airport, heliport or glide ports. Exhibit 1.1 below shows all the facilities within the region.

EXHIBIT 1.1

Locations of Aviation Facilities Within the 12-County Modeling Area



This report documents the methodology and results of aircraft emission inventory for all facilities in the NCT area. The emission inventory analysis period includes 1996, 2000, 2002, 2008, 2011, 2014, 2017, 2020, 2023, 2026, and 2029. Chapter 1 of this report discusses the DFW region, emission sources, and the scope of the study.

Chapter 2 documents procedures utilized to develop airport activities and the grouping criteria utilized for modeling purposes , development of survey to gather airport specific information , estimates in terms of aircraft landings and take offs (LTO's) and the development of backcast and forecast factors.

Chapter 3 documents the parameters and inputs used to develop emissions inventories for airports by utilizing U.S. Federal Aviation Administration (FAA)'s Emission and Dispersion Modeling System (EDMS). This chapter documents regionally specific calculations, procedures, and adjustments to better reflect regional emissions emitted. The calculations and procedures include LTO distribution to estimate Fleet Mix, and APU and GSE assignments and adjustments. Also application of Lead emission factors to estimate emissions from aircrafts utilizing leaded aviation fuels which are not part of EDMS model output.

Chapter 4 documents the 12-county MSA area airport emission calculation procedure. Chapter 5 summarizes emissions of all pollutants by county and analysis years. The appendix contains supplemental information and electronic data that supports the airport emissions inventory.

1.1 Background

The Clean Air Act Amendments of 1990 (CAAA) requires the EPA to set National Ambient Air Quality Standards (NAAQS) for widespread pollutants considered harmful to public health and the environment. EPA has set NAAQS for six principal pollutants; Ozone, Particulate Matter, Carbon Monoxide, Sulfur Dioxide, Nitrogen Oxides, and Lead.

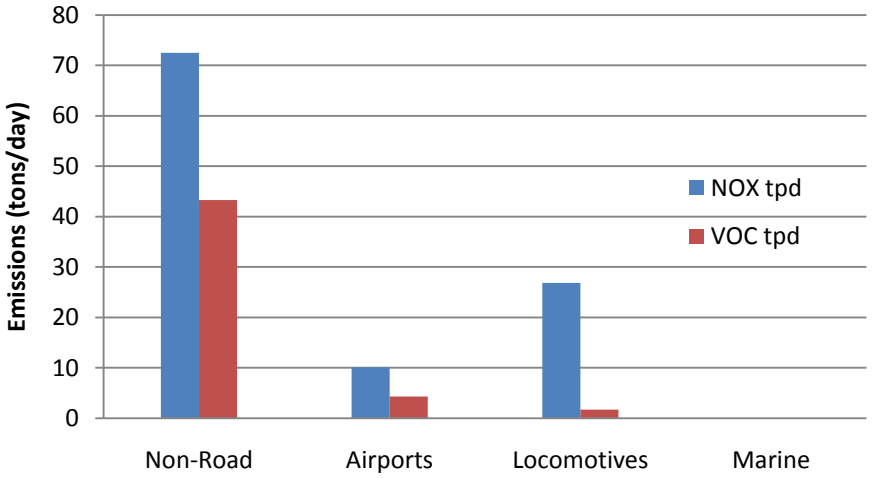
With the signing of the CAAA into law, the four counties of Collin, Dallas, Denton, and Tarrant County in the DFW region were designated as nonattainment under the 1-hour NAAQS for the pollutant ozone. The law also requires the EPA to periodically review the NAAQS to ensure that they provide adequate health and environmental protection and to update these standards as necessary. Upon completion of a scientific review of the 1-hour NAAQS, EPA determined that the 1-hour NAAQS was insufficient to protect human health. As a result, EPA developed the 1997 8-hour NAAQS to place greater emphasis on prolonged exposure to pollutants.

In April 2004, EPA announced that Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant Counties comprise the new DFW nine-county nonattainment area for the pollutant ozone under the new stricter 1997 8-hour NAAQS. With an effective designation date of June 15, 2004, for the 8-hour NAAQS, these nine counties received a "Moderate" ozone classification. That gave the NCT region until June 15, 2010, to reach attainment or face a reclassification to "serious". As a result of not reaching attainment by June 2010, the DFW region was classified as serious with the new attainment date of June 2013.

TCEQ, the State's environmental agency, is required under the CAAA to determine how best to meet the CAAA goals through developing a SIP to achieve the NAAQS. The SIP is an air quality plan that contains a collection of regulations and measures to reduce emissions from stationary, area and mobile (on- and non-road) sources, and demonstrate attainment of the air quality standards. Exhibit 1.2 shows the aircraft emissions accounted in the 2013 reclassification State Implementation Plan (SIP)

EXHIBIT 1.2

2013 Attainment Demonstration SIP Emissions Contribution by Source



Source: TCEQ

1.2 Purpose and Scope of the Study

The project required the North Central Texas Council of Governments (NCTCOG) to develop annual activity and emissions inventory for airports for the years 1996, 2000, 2002, 2008, 2011, 2014, 2017, 2020, 2023, 2026 and 2029. This inventory will be developed for 12-County Metropolitan Statistical Area (MSA) that covers Collin, Dallas, Denton, Rockwall, Tarrant, Ellis, Johnson, Kaufman, Parker, Henderson, Hood and Hunt Counties. The inventories developed will be used to support State Implementation Plan (SIP) and other airport related inquiries which require annual emissions inventory estimates of criteria pollutants, criteria precursor pollutants, and hazardous air pollutants (HAPs).

NCTCOG serves as the Metropolitan Planning Organization (MPO) for transportation sector in the DFW area and is responsible for developing and maintaining emission inventories for the region. NCTCOG has worked with all the airports in the region and has developed a process that is now available to facilitate regional aviation planning. It hosts a variety of information about regional aviation facilities and is available for public and airport use. A variety of data has been collected through a collaborative effort with airports which will be useful in developing a comprehensive emissions inventory for airport.

1.3 Emission Sources

Research has identified that majority of the airport emissions are from aircraft operations. These processes include aircraft engines, auxiliary power units, and ground support equipment. This section discusses source categories considered for this study.

Aircrafts

Aviation industry has advanced tremendously in recent decades and aircrafts are extensively used for public, private, and military purposes. They are also a significant source of NOx, VOC, and CO emissions. Aircraft operations are generally grouped into the following categories as shown in Exhibit 1.3

EXIBIT 1.3

Airport Grouping

Aircraft Type	Properties
Commercial Air Carriers	Transport passengers, freight, or both Larger Aircrafts, Frequent Operations
Air Taxis	Air taxis carry passengers, freight, or both Smaller Aircrafts, Limited Operations
General Aviation	Recreational and personal transportation Smaller Aircrafts, Limited Operations
Military	Transport personnel, freight, or both Wide range of aircrafts with varying sizes

Emissions from aircraft are associated with a landing and takeoff (LTO) cycle. The cycle begins when the aircraft approaches the airport on its descent from cruising altitude, lands, and taxis to the gate. It continues as the aircraft taxis back out to the runway for subsequent takeoff and climbout as it heads back up to cruising altitude. The description of five specific operating modes in a LTO cycle is shown in Exhibit 1.4 and 1.5:

EXHIBIT 1.4

Landing and Takeoff Cycle

Operations	Description
Approach	The airborne segment of an aircraft's arrival extending from the start of the flight profile (or the mixing height, whichever is lower) to touchdown on the runway.
Taxi In	The landing ground roll segment (from touchdown to the runway exit) of an arriving aircraft, including reverse thrust, and the taxiing from the runway exit to a gate.
Startup	Aircraft main engine startup occurs at the gate. This methodology is only applied to aircraft with ICAO certified engines. All other aircraft will not have startup emissions. Aircraft main engine startup produces only THC, VOC, NMHC, and TOG emissions. A detailed speciated organic gases profile does not exist for main engine startup emissions.
Taxi Out	The taxiing from the gate to a runway end.
Takeoff	The portion from the start of the ground roll on the runway, through wheels off, and the airborne portion of the ascent up to cutback during which the aircraft operates at maximum thrust.
Climb Out	The portion from engine cutback to the end of the flight profile (or the mixing height, whichever is lower).

Source: EDMS User Manual

The LTO cycle is one of the essential inputs for calculating aircraft emissions. During each mode of operation, an aircraft engine operates at a specific power setting and fuel consumption rate for a given aircraft type. Emissions from aircrafts generally vary with the engine and fuel type. Exhibit 1.6 shows the emission for different pollutants per LTO cycle for different aircraft types. Exhibit 1.7 shows the emission by source type for all analysis years.

EXHIBIT 1.5

International Civil Aviation Organization (ICAO) LTO cycle

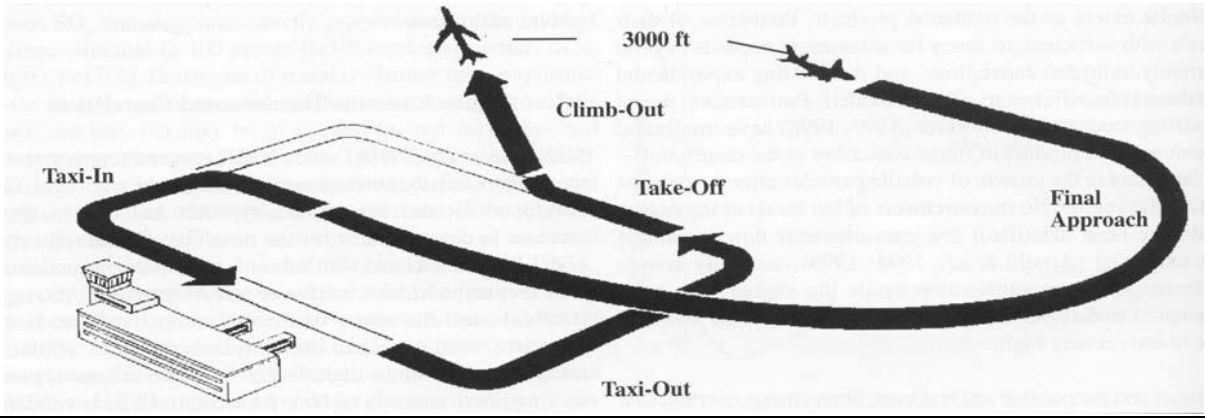
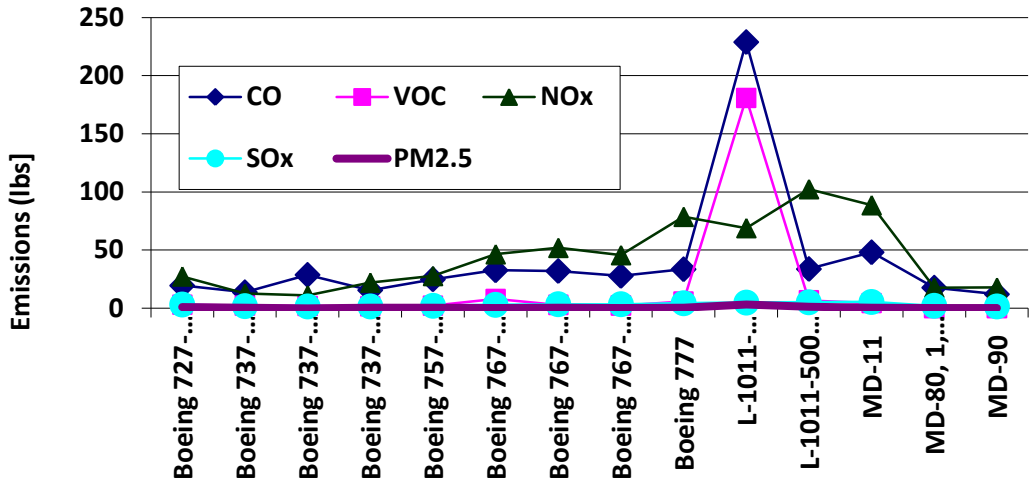


EXHIBIT 1.6

Emissions per LTO



Ground Support Equipment and Auxiliary Power Units

Other sources of emissions from the airport considered for this analysis include Ground Support Equipment (GSE) and Auxiliary Power Units (APU). When large aircraft are on the ground with their engines shut down, they need power and preconditioned air to maintain the aircraft's operability. If a ground-based power and air source is unavailable, an auxiliary power unit (APU), which is part of the aircraft, is operated. These units are essentially small jet engines, which generate electricity and compressed air. Detailed information about GSE and APU are discussed in Chapter 3.

EXHIBIT 1.7

Emissions by Source Type

Emission Source	Pollutant	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
AIRCRAFT	CO	13,312	13,270	13,844	11,371	10,170	10,724	11,390	12,137	12,827	13,576	14,411
APU	CO	329	327	329	302	244	250	259	268	274	279	283
GSE	CO	10,672	10,522	10,427	5,708	3,467	2,389	1,499	1,086	949	919	947
AIRCRAFT	THC	1,469	1,458	1,481	1,066	985	1,031	1,097	1,166	1,214	1,262	1,313
APU	THC	17	17	16	16	13	14	14	15	15	16	16
GSE	THC	0	0	0	0	0	0	0	0	0	0	0
AIRCRAFT	NMHC	1,665	1,653	1,676	1,201	1,110	1,162	1,237	1,316	1,370	1,425	1,482
APU	NMHC	19	19	19	19	16	16	17	17	18	18	19
GSE	NMHC	400	378	370	192	116	81	53	40	36	36	37
AIRCRAFT	VOC	1,652	1,640	1,663	1,190	1,100	1,153	1,227	1,305	1,359	1,414	1,470
APU	VOC	19	19	19	19	15	16	16	17	18	18	18
GSE	VOC	417	393	385	200	121	84	55	42	38	37	39
AIRCRAFT	NOX	4,495	4,450	4,228	3,687	3,477	3,757	4,038	4,379	4,747	5,138	5,564
APU	NOX	167	166	162	127	112	120	129	139	151	163	176
GSE	NOX	1,530	1,399	1,361	682	417	290	185	127	101	90	88
AIRCRAFT	SO x	561	556	539	452	408	440	475	517	558	602	651
APU	SO x	26	25	25	22	19	20	21	22	24	26	27
GSE	SO x	99	98	98	18	8	7	8	8	9	9	10
AIRCRAFT	PM10	99	98	93	76	70	71	73	75	75	73	71
APU	PM10	27	27	26	25	22	22	23	25	26	27	28
GSE	PM10	88	56	47	21	15	12	9	7	6	6	6
AIRCRAFT	PM2.5	99	98	93	76	70	71	73	75	75	73	71
APU	PM2.5	27	27	26	25	22	22	23	25	26	27	28
GSE	PM2.5	86	54	46	20	14	11	9	7	6	5	6
AIRCRAFT	Lead(Pb)	4.67	4.95	4.91	4.74	4.29	4.42	4.56	4.70	4.84	4.98	5.13
APU	Lead(Pb)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GSE	Lead(Pb)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AIRCRAFT	TOG	1,677	1,665	1,690	1,213	1,121	1,174	1,249	1,328	1,383	1,438	1,495
APU	TOG	19	19	19	19	16	16	17	17	18	18	19
GSE	TOG	458	433	424	221	133	92	60	46	41	40	42

CHAPTER 2: AIRPORT ACTIVITY

This Chapter describes the procedures used to develop activity estimates in terms of vehicle landings and take offs (LTOs). The LTO refers to the number of aircraft that land and then takeoff. LTOs are typically equal to the number of total aircraft operations (the sum of all arrivals and departures) divided by 2. Most aircraft go through a similar sequence during a complete operating cycle. Helicopters may combine certain modes such as takeoff and climbout. During each mode of operation, the aircraft engines operate at a fairly standard power setting for a given aircraft category. Emissions for one complete cycle for a given aircraft can be calculated by knowing emission factors for specific aircraft engines at those power settings. Then, if the activity of all aircraft in the modeling zone can be determined for the inventory period, the total emissions can be calculated.

2.1 Airports Modeled

Within the 12-county North Central Texas Metropolitan Statistical Area (MSA), there are 344 facilities identified under various ownership types. Exhibit 2.1 shows total number of facilities with their ownership types. Among these 344 facilities, 62 facilities had reported activities, data collection and modeling effort were focused on these 62 facilities. In order to simplify modeling efforts, these 62 airports are grouped into 3 categories which are shown in the Exhibit 2.2. Lists of facilities within the NCT MSA area is provided in the Appendix A.

EXHIBIT 2.1

Facility Type by Ownership Type

Facility Type	Ownership Type	Number of Facility
AIRPORT	MUNICIPAL	1
AIRPORT	PRIVATE	189
AIRPORT	PUBLIC	26
GLIDERPORT	PRIVATE	1
HELIPORT	PRIVATE	105
HELIPORT	PUBLIC	17
STOLPORT	PRIVATE	2
ULTRALIGHT	PRIVATE	3
TOTAL FACILITY		344

EXHIBIT 2.2

Airport Modeling Groups

Airport Group Names	Description	Number of Facilities
Major Airports	Major commercial Airports	2
NIPIAS and Significant	Airports identified as NPIAS along with airports reported annual LTOs over 18,000.	28
Other Airports	Airports not identified as NPIAS and with reported annual LTOs less than 18,000.	32

A list of facilities within each group is provided in Appendix A.

2.2 Data Collection

The historic and forecasted activity data for major airports was collected from the specific airports. Historic and forecasted activity data for other facilities were collected from the Federal Aviation Administration (FAA)'s 2010 Terminal Area Forecast (TAF). A data collection survey was sent to all facilities in the region for gathering specific inputs along with activity data required for the airport modeling. The collected data was analyzed against the TAF data. Exhibit 2.3 shows an example survey form employed for this study. In this survey process, detailed information on LTO's was obtained for all major airports and limited survey results were obtained for other airports. Our aviation team expertise was utilized to deduce LTO's distribution. Detailed information on ground support equipment (GSE)and auxiliary power units (APU) were not obtained for this study due to time and resource required to gather the data. However other required information required to estimate GSE and APU's emissions and emission credits were collected.

EXHIBIT 2.3

Sample Survey Form

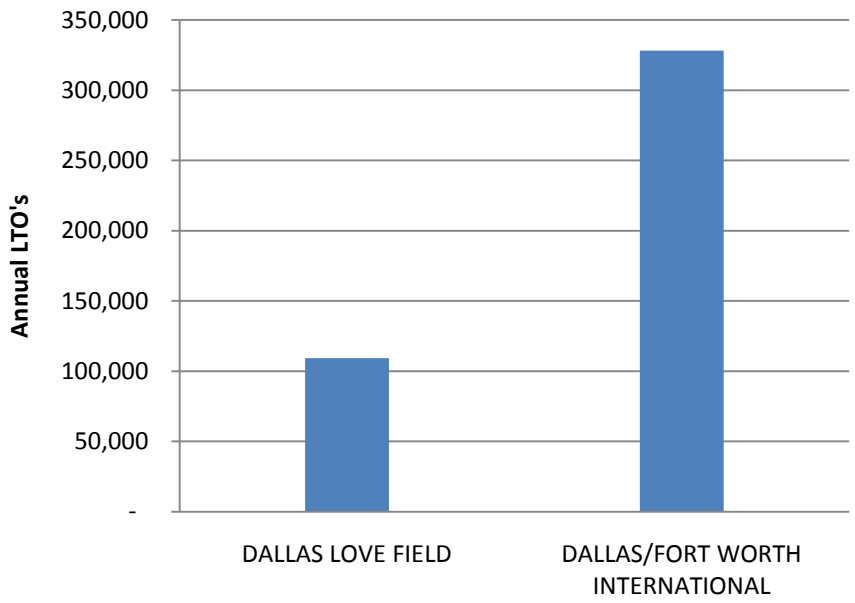
	Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
Operations												
Operations	**Annual Operations**											
	Annual LTOs	0	0	0	0	0	0	0	0	0	0	0
	Operation Source	Information requested from Airport Staff										
Fleet Mix												
Fleet Mix	**Fleet Mix (LTOs by Aircraft Type)**	Requested (please attach)	Requested (please attach)	Requested (please attach)	Requested (please attach)	Requested (please attach)	Requested (please attach)	Requested (please attach)	Requested (please attach)	Requested (please attach)	Requested (please attach)	Requested (please attach)
	Source/Comments	Information requested. Please see tab "Example-fleet mix" for example.				Employ 2010 fleet mix and forecasted operations; incorporating airport staff recommendations and future fleet change assumption where applicable or available.						
Performance (Taxi-Time)												
Taxi Time	**Taxi-In (Minutes)**											
	Taxi-Out (Minutes)											
	Comments	EDMS default, unless airport specific data is provided.										
GSE												
GSE	**Total GSE Units**											
	% of Electric Vehicle											
	% Alternative Fuel Vehicle (AFV)											
	Comments	If airport specific data unavailable, aircraft specific EDMS default will be employed for baseline emission. Emission credits from AFV/electric will be post processed.										
APU												
APU	**APU Units**											
	APU Operating Time / LTO (minutes)											
	% of Electric											
	% Alternative Fuel											
	Comments	If airport specific data unavailable, aircraft specific EDMS default will be employed for baseline emission. Emission credits from AFV/electric will be post processed.										

Major Airports

Major airports which include Dallas/Fort Worth International Airport (DFWIA) and Dallas Love Field (DAL) were contacted to gather these input parameters. Actual input parameter work sheets sent to each major airport are attached in Appendix B. Exhibit 2.4 shows 2008 annual LTOs for the major airports.

EXHIBIT 2.4

2008 Annual LTOs for Major Airports

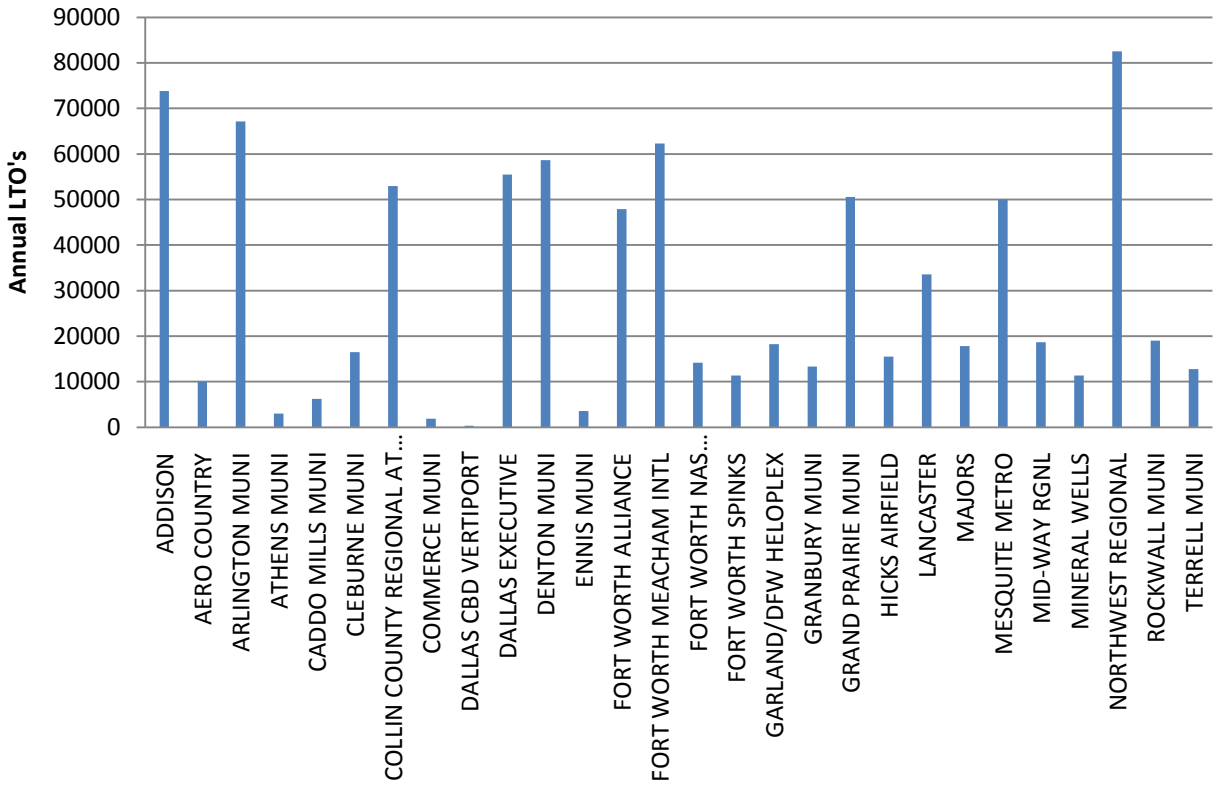


NPIAS and Significant Airports

A data collection survey was sent out to all other facilities for their inputs for the modeling parameters and fleet distribution. The North Central Texas Council of Governments (NCTCOG) Aviation Team conducted a data collection survey to collect most up to date data on the aircraft activity, fleet mix distribution, GSE and APU inventory from rest of the facilities. Compiled data was reviewed and data gaps identified were discussed and where possible was filled in by the experts from aviation team. Exhibit 2.5 shows 2008 annual LTOs for the NPIAS and significant airports.

EXHIBIT 2.5

2008 Annual LTOs for NPIAS and Significant Airports

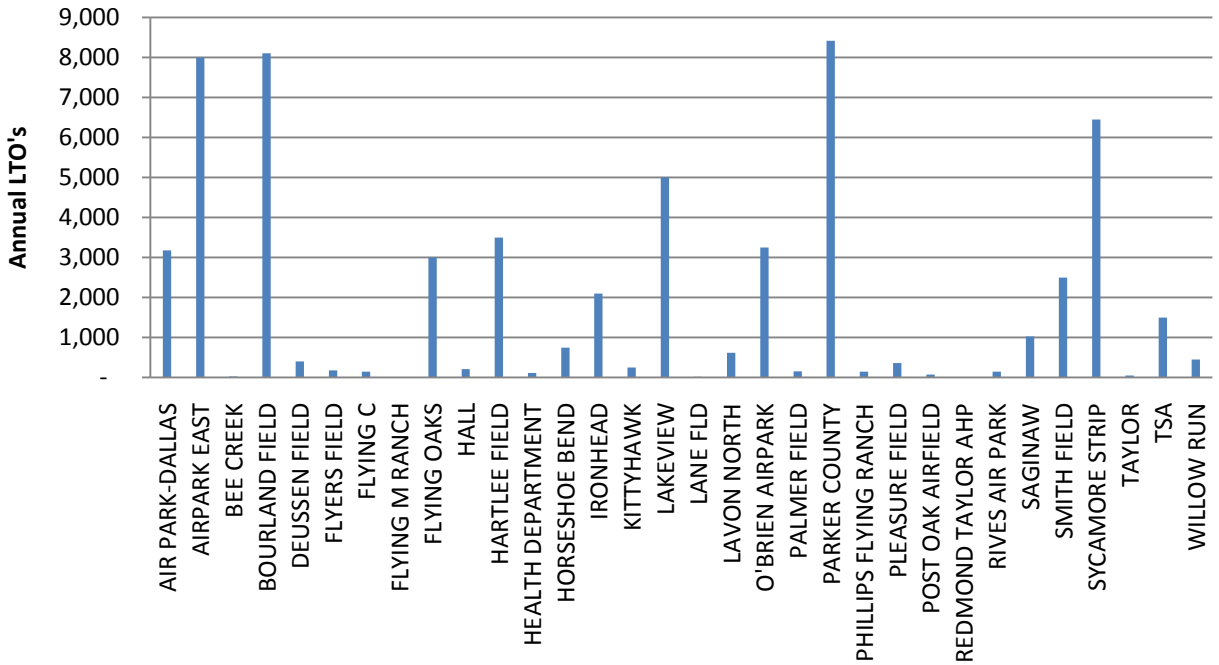


Other Airports

Similar to National Plan of Integrated Airport Systems (NPIAS) and significant airports, a collection survey was sent to all other facilities for their inputs for the modeling parameters and fleet distribution. NCTCOG's Aviation Team conducted a data collection survey to collect most up to date data on the aircraft activity, fleet mix distribution, GSE and APU inventory from rest of the facilities. Compiled data was reviewed and data gaps identified were discussed and where possible was filled in by the experts from aviation team. Exhibit 2.6 shows 2008 annual LTOs for the other airports.

EXHIBIT 2.6

2008 Annual LTOs for Other Airports



2.3 Backcast & Forecast Factors

After collecting historic and forecasted operations data for all 344 airports, for all analysis years, a backcast and forecast factors were estimated for all analysis years based on 2008 operations.

Forecast/ Backcast factor = [operations of each analysis year]/ [operations of 2008]

The forecast /back ast factors are organized in Appendix B.

CHAPTER 3: EDMS INPUT PARAMETERS

After gathering the annual land and takeoff (LTO)'s for all airports and in order to estimate emissions, LTO's must be assigned to specific aircraft and engine types. This chapter describes techniques and data sources for determining the critical variables in the inventory calculations. Emission and Dispersion Modeling system (EDMS) version 5.1.3 was used to estimate the emissions for all airports in the region. The model was developed by the Federal Aviation Administration (FAA) in cooperation with the United States Air Force (USAF).

3.1 EDMS Inputs

When an emission inventory is being created for a particular area, the fleet make-up, aircraft activity, and times-in-mode need to be specific to that area. Engine emission indexes, on the other hand, depend on the engine design and are available as options to select in the EDMS model. In this study following factors used in creating an inventory were collected for individual airports where available.

1. Weather Data
2. Fleet-Mix and Engine Assignments
3. Taxi-in and Taxi-out times
4. GSE and APU Assignment
5. Control strategies in place and future plans

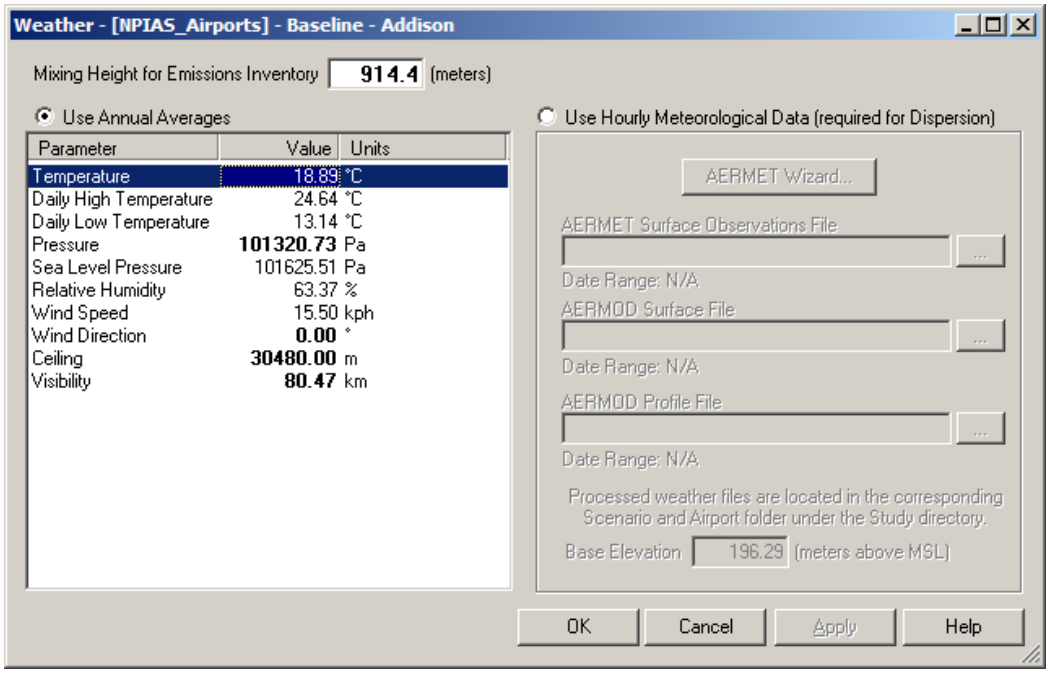
Weather Data

The EDMS default meteorological data setting which is specific to each scenario-airport combination was employed for this study. Annual average weather values were used for all airports in the region. The following weather parameters are used by EDMS. Detailed information on individual weather parameters can be found in the EDMS manual. Exhibit 3.1 shows the Addison airport weather data used for this study

1. Mixing Height
2. Temperature (ambient, daily high, daily low)
3. Relative humidity
4. Wind direction
5. Wind speed
6. Sea level pressure
7. Cloud ceiling height
8. Horizontal visibility

EXHIBIT 3.1

Addison Airport Weather Data



Fleet-Mix and Engine Assignments

For a single LTO cycle, aircraft emissions vary considerably depending on the category of aircraft and the resulting typical flight profile. Aircraft activity for individual facility is a critical modeling element for this analysis. But obtaining site specific fleet mix was not possible for all the facilities. Thus, emphasis was provided on gathering total operations of facilities where LTO's by individual aircraft type was not available. Even for the airports where LTO's were available by aircraft type, some aircrafts types reported could not be matched with aircraft types available in the EDMS model. These EDMS unidentifiable aircrafts were matched with closely related available aircraft types. Finally some that could not be matched in any manner were excluded from the study but their LTO's were redistributed to the identified aircrafts. Appendix B contains fleet mix distribution collected and utilized for emission modeling.

The aircraft engines are the source of emissions of the key pollutants that result from fuel combustion. Emission rates vary depending on the fuel consumption rate and engine specific design factors. EDMS treats each aircraft as a combination of a specific aircraft type and engine type. For each aircraft type

there may be several different engine types available for use and emission factors may vary from engine to engine. Consequently, different aircraft may generate identical emissions because they are equipped with identical engines, or older aircraft may be outfitted with technologically newer engines and generate fewer emissions. Where applicable most common or the most widely used engine available in the EDMS options (Exhibit 3.2) for that particular aircraft type was utilized in this study. For an aircraft if the reported engine type was not available as an option in EDMS model, it was reallocated to the engines data that was available. Exhibit 3.3 shows the data sources of the fleet mix.

EXHIBIT 3.2

EDMS Aircraft and Engine Combination Window

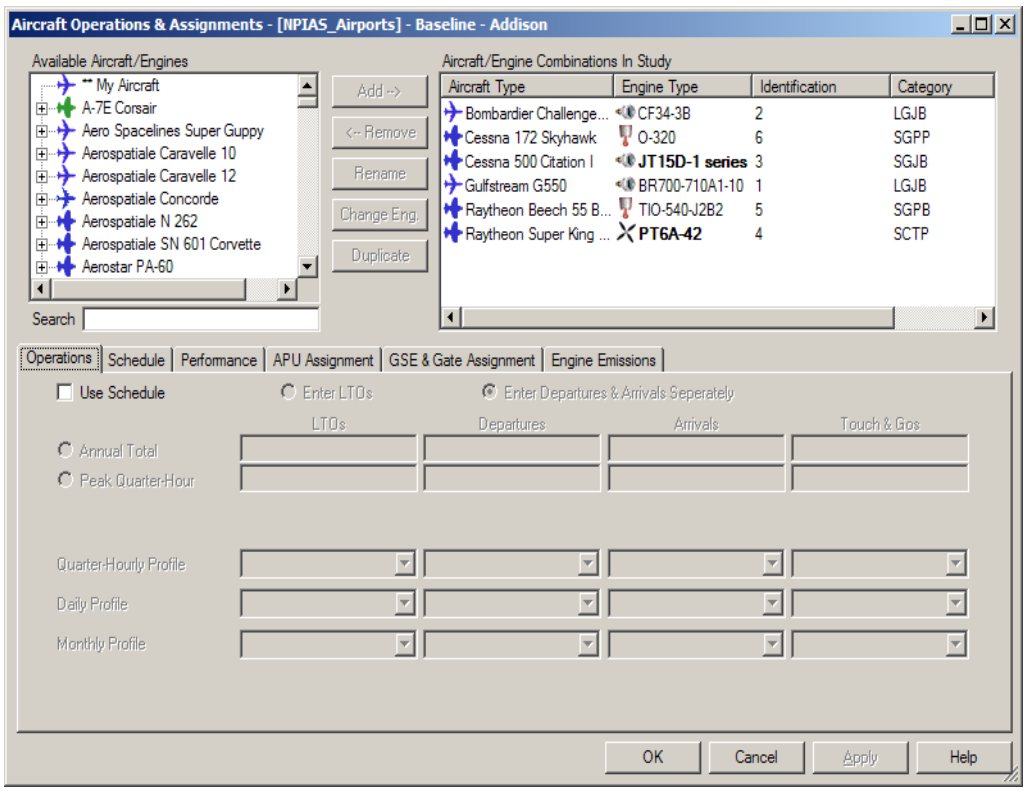


EXHIBIT 3.3

LTO's by Aircraft Data Identification

Airport Name	Fleet Mix Source
Major Airports	Airport Staff
NPIAS and Significant Airports	Airports and Aviation Team
Other Airports	Aviation Team

Dallas/Fort Worth International Airport (DFWIA) staff provided fleet mix and aircraft activity with engine combination for each aircraft type for modeled analysis 2009 through 2030. For analysis years between 1996 and 2007, previously collected 2002 fleet activity was utilized to model activity. For analysis year 2008 previously collected 2008 fleet activity along with 2009 fleet mix was employed. DAL airport staff provided flight count information for year 2002, 2010 and 2012. 2002 was utilized for historic years and 2012 was utilized to distribute future year fleet distribution.

Military airbase, NFW airport provided fleet mix distribution for year 2010. Fleet mix distribution for all analysis years were based on 2010 sample fleet mix. For all other airports in the region, survey results along with aviation team expertise were utilized to identify fleet mix. Total LTO were distributed according to this fleet mix. Exhibit 3.4 shows the most common aircraft for each category was recommended by the aviation team for modeling purposes. See Appendix B for detailed modeled fleet mix utilized for all airports.

EXHIBIT 3.4

Recommended Aircrafts Type

Aircraft Category	Aircraft Type
Jet (Heavy)	Gulfstream V (550)
Jet (Midsize)	Challenger 605
Jet (Light)	Cessna Citation 500/501
Turbo - Prop	Beechcraft King Air 200
Multi -Engine (Piston)	Beech Baron 55/58
Singe Engine (Piston)*	Cessna 172 Skyhawk at airports. For Heliports (T57 and 49T) use Robinson R44.

Taxi-in and Taxi-out Times

Taxi/idle time, whether from the runway to the gate (taxi/idle-in) or from the gate to the runway (taxi/idle-out), depends on the size and layout of the airport, the amount of traffic or congestion on the ground, and airport-specific operational procedures. Taxi/idle time is the most variable of the LTO modes. Taxi/idle time can vary significantly for each airport throughout the day, as aircraft activity changes, and seasonally, as general travel activity increases and decreases. In this study airport specific taxi-time were employed to estimate emissions for all modeled airports. Exhibit 3.5 shows the EDMS window to input taxi-in and taxi-out durations. All other parameters such as Takeoff, Climbout, Approach, and Landing Roll are automatically selected when user selects the aircraft and engine combination. Exhibit 3.6 shows taxi-time used for modeling major airports. A detailed list of taxi-times for all reports can be found in Appendix B

EXHIBIT 3.5

EDMS Taxi-in and Taxi-out Times

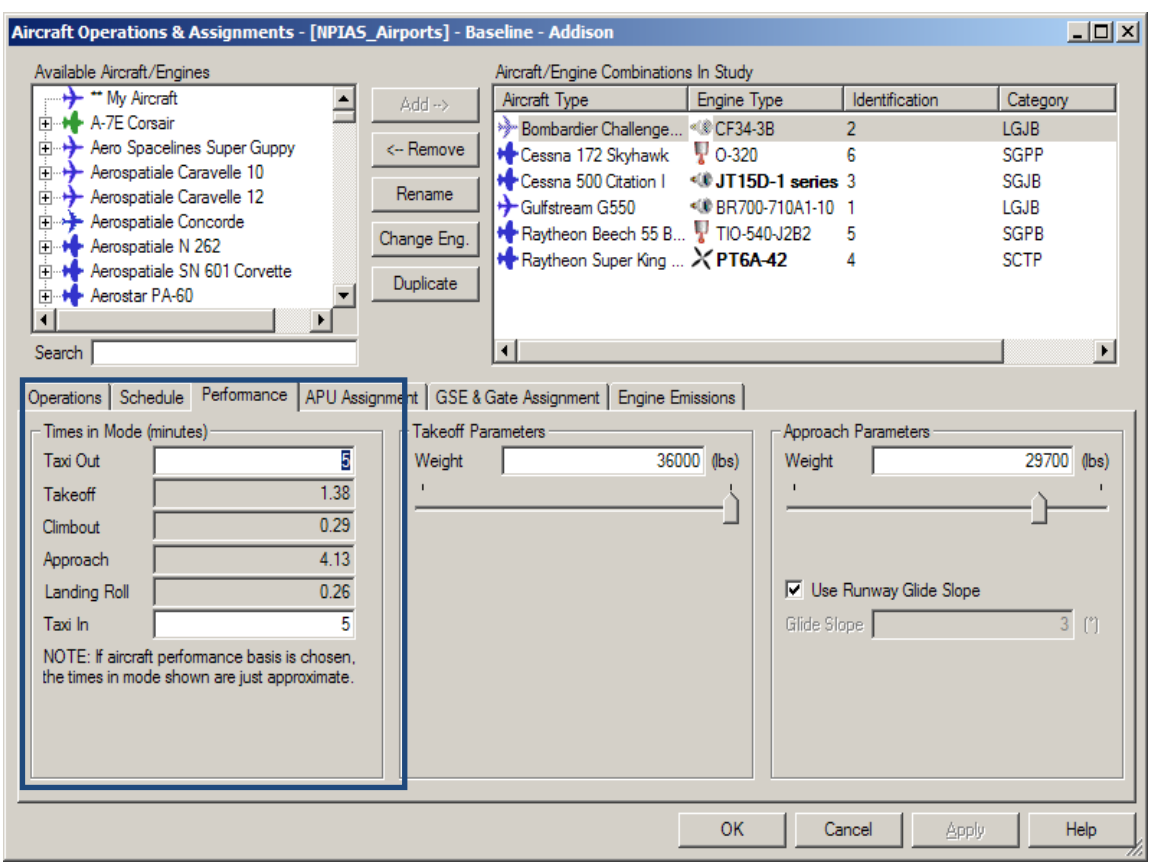


EXHIBIT 3.6

EDMS Taxi-in and Taxi-out Times of Major Airports

YEAR		1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
DFWIA	TAXI-IN (Minutes/LTO)	15.4	15.4	15.4	15.4	15.3	16.1	17.0	17.9	18.7	19.5	20.5
	TAXI-OUT (Minutes/LTO)	9.6	9.6	9.6	9.6	9.7	10.1	10.7	11.4	11.9	12.5	13.1
DAL	TAXI-IN (Minutes/LTO)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	TAXI-OUT (Minutes/LTO)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

Auxiliary Power Units and Ground Support Equipment Assignment

When large aircrafts are on the ground with their engines shut down, they need power and preconditioned air to maintain the aircraft's operability. If a ground-based power and air source is unavailable, an auxiliary power unit (APU), which is part of the aircraft, is operated. These units are essentially small jet engines, which generate electricity and compressed air. They burn jet fuel and generate exhaust emissions like larger engines. In use, APUs essentially runs at full throttle. For this study EDMS defaults APU's were employed for all the airports. Exhibit 3.7 shows the EDMS window where APU is assigned for aircraft types.

Ground support equipment (GSE) comprises vehicles or engines needed to support the aircraft while at the terminal or initiating takeoff. Prior to aircraft departure, GSE are present to load baggage, food and fuel. When an aircraft departs from a gate, a tug may be used to push or tow the aircraft away from the gate and to the taxiway. Exhibit 3.8 shows the EDMS window where GSE is assigned for aircraft types . Aircraft require a mix of ground support equipment that includes the following:

- External air conditioners
- Compressors to help with engine starts
- Aircraft tractors or tugs
- Baggage tractors
- Belt loaders
- Cabin service trucks
- Catering trucks
- Lavatory trucks
- Water supply trucks
- External generators
- Hydrant fueling trucks

EXHIBIT 3.7

EDMS Auxiliary Power Units Assignment

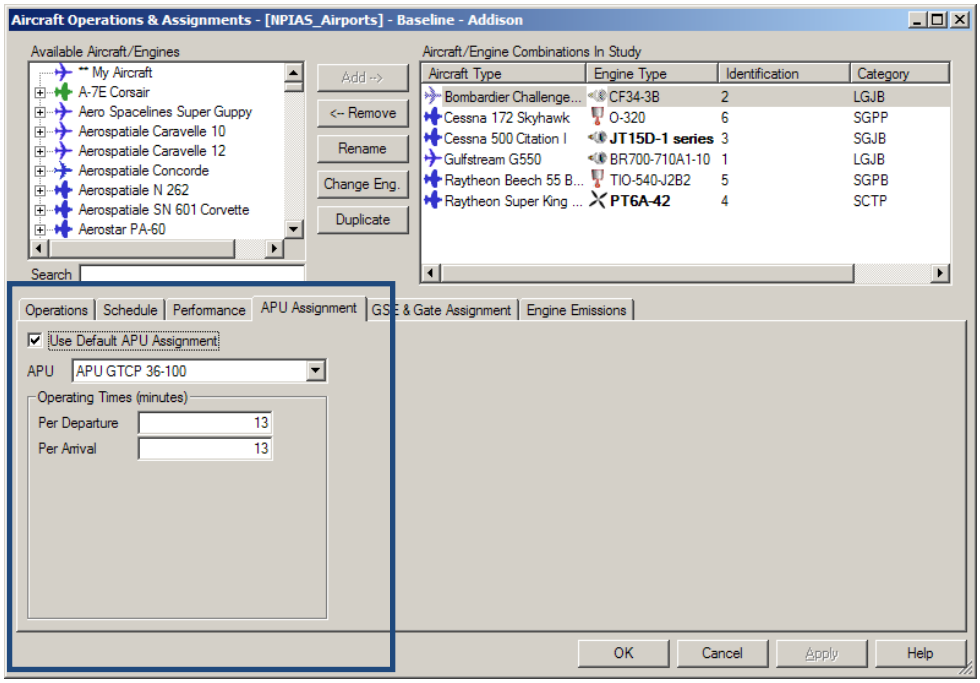
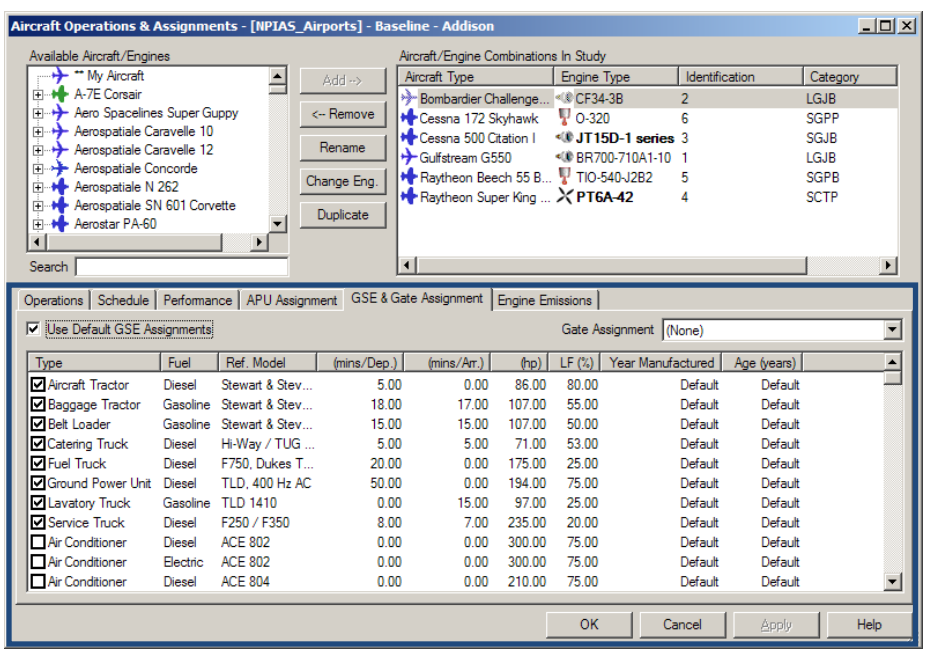


EXHIBIT 3.8

EDMS Ground Support Equipments



Control strategies in place and future plans

A set of control strategies was identified from the reported survey which included percentage conversion of GSE and APU to electric. The base emissions were post processed to reflect such emission credits from the GSE and APU electric conversions. These following control strategies were considered for airports. See Appendix B for airport specific percentage of APU and GSE conversion assignment.

CHAPTER 4: EMISSION MODELING

Airports emission inventories for all the airports in the North Central Texas Area were developed using the Federal Aviation Administration (FAA)'s Emission and Dispersion Modeling System (EDMS) model. This model is designed to estimate air quality impacts of airport emission sources, particularly aviation sources. In this study emissions from following sources were calculated by:

- Aircraft
- Auxiliary power units
- Ground support equipment

4.1 Aircraft Methodology

The Environmental Protection Agency (EPA) and FAA's EDMS model was utilized to develop the Dallas-Fort Worth Area Airport Emission Inventory.

EDMS uses the following equation to estimate aircraft emissions:

$$E_{il} = \Sigma\, T_k \times NE_{jl} \times (FF_{jlk} / 1000) \times (EI_{ilk}) \times LTO_{jl}$$

Where:

E_{il} = Emission of pollutant i in pounds produced by the aircraft make j and model l

T_k = Operating time in mode k (min)

NE_{jl} = Number of engines associated with aircraft make j and model l;

FF_j = Fuel flow for individual engine used on aircraft make type j and model l operating in mode (lbs/min);

EI_{ij} = Emission index for pollutant i for each engine associated with aircraft make j and model l operating in mode k (lbs of pollutant /1,000 lbs of fuel)

i = Pollutant (i.e, HC, CO, NOx SO2)

j = Aircraft make (e.g. Boeing, McDonald Douglas, Airbus)

l = Aircraft model (e.g., B-737 300 series)

k = Mode (approach, taxi, climbout)

Similarly, emissions from auxiliary power units are estimated using the following equation:

$$E_{ij} = T \times (FF_j/1{,}000) \times (EI_{ij})$$

Where:

E_{ij} = Emission of pollutant i in pounds produced by the auxiliary power unit installed on aircraft type j for one LTO cycle

T = Operating time per LTO cycle (min)

FF_j = Fuel flow for each auxiliary power unit used on aircraft type j (lbs/min)

EI_{ij} = Emission index for pollutant i for each auxiliary power unit used on aircraft type j (lbs of pollutant /1,000 lbs of fuel)

i = Pollutant (i.e, HC, CO, NOx SO2)

j = Aircraft type (e.g., B-737, MD-11)

EDMS calculates emissions of the following pollutants:

1. **CO2** (carbon dioxide) for aircraft only,
2. **CO** (carbon monoxide),
3. **THC** (total hydrocarbons) for aircraft and APUs only,
4. **NMHC** (non-methane hydrocarbons),
5. **VOC** (volatile organic compounds),
6. **TOG** (total organic compounds),
7. **NOx** (nitrogen oxides),
8. **SOx** (sulfur oxides),
9. **PM10** (particulate matter, 10 microns)
10. **PM2.5** (particulate matter, 2.5 microns), and
11. 394 **Speciated Organic Gases**
    a. 45 Hazardous Air Pollutants (HAPs)
    b. 349 non-toxic compounds

Lead Emission Estimation

Since lead emissions were not part of the EDMS model output, Lead (Pb) emissions from aircrafts and helicopters were calculated using EPA's "Calculating Piston-Engine Aircraft Airport Inventories for Lead for the 2008 National Emissions Inventory" methodologies.

LTO PB (tons) = (Piston Engine LTO) x (Avgas Pb g/LTO) (1- Pb retention) /(907,181 g/ton)

EPA's study suggests that about five percent of lead from the fuel is retained in the engine and engine oil. Thus, the emitted fraction is 0.95. The concentration of lead in avgas is 2.12 g/gal. This concentration was multiplied by the weighted average fuel usage rate for four types of Robinson helicopter engines to produce an overall average emission factor of 6.6 grams of lead per LTO of piston-engine powered helicopter. Similarly, lead content of 2.12g/gal of avgas were multiplied by the weighted average fuel usage rate of various types of piston engines to produce an overall average value of 7.34 grams of lead per LTO. Exhibit 4.1 shows the emission factors utilized to calculate the lead emissions.

EXHIBIT 4.1

EPA Recommended Lead Emission Factors

Engine Type	Lead Emission Factor (Grams/LTO)	Lead Emission Factor with Retention factor 5% (Grams/LTO)	Lead Emission Factor with Retention (kg/LTO)	Lead Emission Factor with Retention (Tons/LTO)
Piston Engine Helicopter	6.60	6.27	**6.27E-03**	**6.9E-06**
Piston Engine Aircrafts	7.34	6.97	**6.97E-03**	**7.7 E-06**

Simplified Equation:

Emissions (KG) = LTO x EF_R (kg/LTO)

Where,

EF_R = Lead emission factors with 5% retention factored in.

Since these lead emission factors are applicable to LTO and not specific to any mode, for simplifying calculations and ease reporting, emissions factors were applied to the Take-off mode, for aircrafts with piston engines only.

4.2 Ground Support Equipment Methodology

Ground Support Equipment (GSE) emission factors used by EDMS are derived from EPA's NONROAD2005 model and are based on the following variables: fuel, brake horsepower and load factor. In addition, a deterioration factor is applied based on the age of the engine. GSE emission factors are given in grams per horsepower-hour. EDMS allows users to select the EPA-derived national fleet average age for a particular vehicle type, or to specify the exact age of an individual piece of equipment.

$$E_{gse} = \sum_{i=1}^{n} [(ZHF_i) \cdot (Power_i) \cdot (LF_i) \cdot (Activity_i) \cdot (DF_i)]$$

Where:

E_{gse}	= Emission estimate for ground support equipment
N	= Number of units in the fleet
ZHF	= Zero-hour emission factor for equipment category i (g/bhp-hr)
Power	= Rated power for equipment i (break horsepower)
LF	= Load factor for equipment i (% of maximum power)
Activity	= Activity for equipment i (hours per year of use)
DF	= Deterioration factor for equipment i (factor >1.00 expressing increased emissions due to aging)
i	= Specific equipment type (e.g., baggage tractor, belt loader, catering truck, lavatory truck, water service truck, and fuel hydrant truck)

4.3 Auxiliary Power Units Methodology

Emission reductions associated with the use of gates equipped with electricity and preconditioned air was also quantified. The use of these gates reduces the amount of time auxiliary power units (APUs) are operating during an LTO cycle by percent identified by the airport personnel. APU emission estimates for aircraft operations were obtained directly from the EDMS model. The uncontrolled APU emission estimates from EDMS were reduced by a percentage to reflect the use of electricity and preconditioned air.

CHAPTER 5: EMISSION RESULTS

Emission estimates from the analysis are organized by counties for major air pollutants in Exhibit 5.1. Appendix D contains aggregated summary tables and emission tables for the entire analysis in two access databases.

EXHIBIT 5.1

Emissions of Major Pollutants by County without Controls

2011 Airport Emission Inventory without Controls 12 County MSA Totals Tons per Year											
CO											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	622	621	972	648	470	461	455	458	469	483	498
DALLAS	4,697	4,698	5,064	4,385	2,931	2,924	2,992	3,107	3,189	3,295	3,415
DENTON	1,603	1,601	1,368	1,464	1,622	1,651	1,685	1,729	1,780	1,836	1,894
ELLIS	100	100	129	228	224	221	218	217	216	216	216
HENDERSON	19	19	20	25	25	25	25	25	25	25	25
HOOD	35	35	52	114	113	111	111	110	110	110	110
HUNT	98	98	155	199	195	191	189	187	187	187	187
JOHNSON	125	125	125	132	131	132	133	135	138	142	146
KAUFMAN	118	118	156	141	132	124	117	114	112	112	111
PARKER	234	234	234	232	229	227	224	223	222	222	222
ROCKWALL	213	213	213	211	210	209	208	207	207	207	207
TARRANT	16,449	16,259	16,113	9,603	7,600	7,089	6,792	6,981	7,394	7,941	8,611
TOTAL	24,314	24,120	24,600	17,381	13,880	13,363	13,147	13,492	14,050	14,774	15,641

2011 Airport Emission Inventory without Controls 12 County MSA Totals Tons per Year											
	THC										
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	21.46	21.46	35.21	24.89	18.28	18.95	19.65	20.37	21.13	21.91	22.73
DALLAS	178.48	178.94	193.23	192.15	169.85	181.59	199.70	217.11	225.36	233.98	242.94
DENTON	31.25	31.25	25.97	28.88	33.17	34.26	35.38	36.55	37.77	39.02	40.32
ELLIS	1.85	1.85	2.44	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
HENDERSON	0.20	0.20	0.21	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
HOOD	0.60	0.60	0.91	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
HUNT	1.54	1.54	2.76	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78
JOHNSON	2.07	2.07	2.07	2.29	2.33	2.39	2.46	2.53	2.60	2.67	2.75
KAUFMAN	3.56	3.56	4.82	4.82	4.82	4.82	4.82	4.82	4.82	4.82	4.82
PARKER	4.89	4.89	4.89	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95
ROCKWALL	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59
TARRANT	1,235.92	1,224.85	1,220.85	810.52	750.61	783.97	829.99	880.65	918.60	956.44	995.80
TOTAL	1,485.40	1,474.80	1,496.95	1,082.75	998.25	1,045.18	1,111.21	1,181.24	1,229.47	1,278.04	1,328.56

	NMHC										
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	29.56	29.29	48.55	31.69	22.12	22.10	22.21	22.67	23.37	24.18	25.05
DALLAS	264.15	262.19	282.63	258.07	204.02	212.46	229.06	246.56	254.82	264.07	273.99
DENTON	34.66	34.27	27.73	29.99	33.97	34.32	34.82	35.68	36.76	37.94	39.20
ELLIS	1.91	1.89	2.57	4.88	4.74	4.63	4.54	4.50	4.48	4.47	4.47
HENDERSON	0.19	0.18	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
HOOD	0.63	0.62	0.94	2.00	1.95	1.91	1.88	1.87	1.86	1.86	1.86
HUNT	1.69	1.66	3.14	4.10	3.96	3.84	3.76	3.72	3.71	3.70	3.70
JOHNSON	2.75	2.71	2.70	2.75	2.67	2.64	2.62	2.65	2.71	2.77	2.85
KAUFMAN	5.11	5.06	6.90	6.34	6.02	5.75	5.53	5.42	5.38	5.36	5.35
PARKER	5.33	5.28	5.27	5.16	5.05	4.96	4.87	4.83	4.81	4.81	4.80
ROCKWALL	3.53	3.49	3.47	3.39	3.34	3.30	3.26	3.25	3.24	3.24	3.24
TARRANT	1,734.28	1,702.82	1,680.46	1,062.90	953.22	962.76	993.50	1,042.47	1,083.12	1,126.24	1,172.55
TOTAL	2,083.80	2,049.46	2,064.55	1,411.50	1,241.31	1,258.89	1,306.30	1,373.85	1,424.49	1,478.87	1,537.30

2011 Airport Emission Inventory without Controls 12 County MSA Totals Tons per Year											
VOC											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	29.51	29.22	48.47	31.52	21.94	21.88	21.96	22.39	23.08	23.87	24.74
DALLAS	264.85	262.70	283.14	257.64	202.66	210.79	227.08	244.33	252.47	261.61	271.43
DENTON	33.98	33.56	27.10	29.26	33.13	33.41	33.86	34.68	35.72	36.86	38.08
ELLIS	1.86	1.84	2.50	4.77	4.63	4.51	4.41	4.37	4.35	4.34	4.34
HENDERSON	0.18	0.17	0.19	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
HOOD	0.62	0.61	0.91	1.94	1.89	1.85	1.82	1.80	1.80	1.79	1.79
HUNT	1.65	1.63	3.09	4.01	3.86	3.74	3.65	3.62	3.60	3.60	3.60
JOHNSON	2.73	2.69	2.68	2.72	2.63	2.59	2.57	2.60	2.65	2.72	2.79
KAUFMAN	5.11	5.05	6.89	6.31	5.99	5.70	5.47	5.36	5.31	5.29	5.28
PARKER	5.22	5.17	5.15	5.03	4.92	4.83	4.74	4.69	4.68	4.67	4.66
ROCKWALL	3.42	3.37	3.36	3.27	3.22	3.17	3.14	3.12	3.12	3.12	3.12
TARRANT	1,739.30	1,706.68	1,683.40	1,062.66	951.88	960.03	989.59	1,037.84	1,078.12	1,120.96	1,167.05
TOTAL	2,088.44	2,052.69	2,066.87	1,409.36	1,236.97	1,252.73	1,298.52	1,365.03	1,415.11	1,469.06	1,527.12

NOX											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	31.67	29.80	49.00	25.74	15.22	12.71	10.58	9.56	9.34	9.47	9.75
DALLAS	618.31	603.81	651.00	609.07	216.09	210.82	215.73	225.24	228.93	235.34	243.25
DENTON	32.18	29.96	22.59	20.01	19.93	16.80	14.47	13.51	13.38	13.63	14.05
ELLIS	1.40	1.30	2.10	4.35	3.71	3.14	2.73	2.53	2.45	2.42	2.41
HENDERSON	0.18	0.16	0.17	0.17	0.14	0.12	0.11	0.10	0.10	0.10	0.10
HOOD	0.53	0.49	0.72	1.18	0.95	0.74	0.60	0.53	0.50	0.50	0.49
HUNT	3.11	2.99	6.44	8.00	7.41	6.92	6.59	6.44	6.39	6.36	6.36
JOHNSON	4.70	4.44	4.35	3.84	3.37	2.97	2.67	2.55	2.54	2.58	2.64
KAUFMAN	6.36	5.98	8.06	6.08	5.00	4.01	3.20	2.78	2.61	2.54	2.52
PARKER	4.12	3.86	3.78	2.93	2.40	1.95	1.62	1.46	1.40	1.37	1.36
ROCKWALL	2.47	2.25	2.19	1.60	1.25	0.96	0.76	0.68	0.65	0.64	0.64
TARRANT	5,486.75	5,329.02	5,000.63	3,813.13	3,730.05	3,905.68	4,092.80	4,379.98	4,730.30	5,116.54	5,544.01
TOTAL	6,191.76	6,014.07	5,751.04	4,496.11	4,005.51	4,166.80	4,351.85	4,645.36	4,998.59	5,391.51	5,827.58

2011 Airport Emission Inventory without Controls 12 County MSA Totals Tons per Year											
SO x											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	3.66	3.66	6.09	3.08	2.09	2.16	2.23	2.31	2.40	2.49	2.58
DALLAS	83.39	83.72	91.29	77.82	28.28	30.12	33.19	36.16	37.55	39.00	40.51
DENTON	4.79	4.80	3.86	3.08	3.38	3.49	3.60	3.72	3.84	3.98	4.11
ELLIS	0.24	0.24	0.36	0.60	0.56	0.56	0.55	0.55	0.55	0.55	0.55
HENDERSON	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
HOOD	0.08	0.08	0.13	0.19	0.17	0.17	0.17	0.17	0.17	0.17	0.17
HUNT	0.41	0.41	0.84	0.97	0.93	0.93	0.93	0.93	0.93	0.93	0.93
JOHNSON	0.56	0.56	0.56	0.45	0.43	0.44	0.45	0.46	0.47	0.49	0.50
KAUFMAN	0.70	0.70	0.96	0.68	0.64	0.63	0.63	0.63	0.63	0.63	0.63
PARKER	0.63	0.63	0.63	0.46	0.43	0.42	0.42	0.42	0.42	0.42	0.42
ROCKWALL	0.46	0.46	0.46	0.30	0.28	0.28	0.27	0.27	0.27	0.27	0.27
TARRANT	589.84	583.72	556.71	403.82	396.95	427.67	461.07	501.47	542.96	587.66	637.20
TOTAL	684.82	679.04	661.93	491.46	434.16	466.89	503.54	547.13	590.23	636.62	687.91

PM10											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	1.67	1.24	1.93	1.06	0.72	0.68	0.64	0.60	0.61	0.63	0.65
DALLAS	24.40	19.75	20.04	18.22	7.56	7.70	8.04	8.40	8.57	8.81	9.12
DENTON	2.05	1.26	0.83	0.67	0.75	0.70	0.63	0.59	0.59	0.61	0.63
ELLIS	0.10	0.05	0.07	0.14	0.13	0.12	0.11	0.10	0.10	0.09	0.09
HENDERSON	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HOOD	0.04	0.02	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
HUNT	0.15	0.09	0.18	0.21	0.20	0.19	0.18	0.18	0.17	0.17	0.17
JOHNSON	0.25	0.16	0.15	0.12	0.11	0.11	0.10	0.09	0.09	0.09	0.10
KAUFMAN	0.32	0.24	0.30	0.24	0.23	0.20	0.18	0.16	0.16	0.16	0.16
PARKER	0.28	0.16	0.13	0.09	0.08	0.08	0.07	0.06	0.06	0.06	0.06
ROCKWALL	0.20	0.09	0.07	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01
TARRANT	185.33	158.30	143.34	101.89	96.09	95.82	95.86	96.85	96.19	95.26	93.89
TOTAL	214.81	181.37	167.06	122.71	105.92	105.62	105.83	107.06	106.56	105.90	104.88

2011 Airport Emission Inventory without Controls 12 County MSA Totals Tons per Year											
PM2.5											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	1.63	1.22	1.89	1.05	0.71	0.67	0.63	0.59	0.60	0.62	0.64
DALLAS	23.99	19.48	19.78	18.06	7.48	7.62	7.97	8.34	8.51	8.75	9.06
DENTON	2.00	1.23	0.81	0.66	0.74	0.69	0.62	0.58	0.59	0.60	0.62
ELLIS	0.10	0.05	0.07	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.09
HENDERSON	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HOOD	0.03	0.02	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
HUNT	0.15	0.09	0.18	0.21	0.19	0.19	0.18	0.17	0.17	0.17	0.17
JOHNSON	0.24	0.16	0.14	0.12	0.11	0.11	0.10	0.09	0.09	0.09	0.09
KAUFMAN	0.32	0.23	0.30	0.23	0.22	0.20	0.18	0.16	0.16	0.16	0.16
PARKER	0.28	0.16	0.13	0.09	0.08	0.07	0.07	0.06	0.06	0.06	0.06
ROCKWALL	0.19	0.09	0.06	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00
TARRANT	182.99	156.74	142.02	101.29	95.62	95.41	95.51	96.54	95.88	94.95	93.56
TOTAL	211.93	179.47	165.41	121.90	105.33	105.11	105.39	106.67	106.18	105.51	104.48

Lead (Pb)											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	0.28	0.40	0.39	0.31	0.25	0.26	0.26	0.27	0.28	0.29	0.30
DALLAS	1.14	1.21	1.24	1.30	1.07	1.12	1.18	1.23	1.28	1.33	1.38
DENTON	1.13	1.01	1.06	1.07	1.17	1.21	1.24	1.28	1.32	1.36	1.40
ELLIS	0.09	0.11	0.18	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
HENDERSON	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
HOOD	0.03	0.04	0.04	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
HUNT	0.09	0.14	0.14	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
JOHNSON	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.13	0.13
KAUFMAN	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
PARKER	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
ROCKWALL	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
TARRANT	1.34	1.46	1.28	1.00	0.73	0.77	0.80	0.84	0.88	0.92	0.97
TOTAL	4.67	4.95	4.91	4.74	4.29	4.42	4.56	4.70	4.84	4.98	5.13

2011 Airport Emission Inventory without Controls 12 County MSA Totals Tons per Year											
TOG											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	31.17	30.87	51.08	33.15	23.08	22.96	23.00	23.42	24.13	24.95	25.85
DALLAS	277.61	275.45	296.90	268.95	210.06	217.92	234.15	251.52	259.78	269.13	279.20
DENTON	37.80	37.37	30.34	32.67	36.87	37.19	37.70	38.60	39.75	41.02	42.37
ELLIS	2.10	2.08	2.82	5.31	5.15	5.02	4.92	4.87	4.85	4.84	4.84
HENDERSON	0.21	0.20	0.22	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26
HOOD	0.70	0.69	1.04	2.21	2.15	2.11	2.07	2.06	2.05	2.05	2.05
HUNT	1.85	1.83	3.43	4.45	4.29	4.16	4.06	4.02	4.00	4.00	4.00
JOHNSON	2.97	2.92	2.91	2.95	2.86	2.81	2.78	2.81	2.87	2.94	3.02
KAUFMAN	5.42	5.36	7.30	6.66	6.30	5.99	5.73	5.60	5.55	5.53	5.52
PARKER	5.80	5.74	5.73	5.60	5.47	5.37	5.27	5.22	5.20	5.19	5.19
ROCKWALL	3.94	3.89	3.87	3.78	3.72	3.67	3.63	3.62	3.61	3.61	3.61
TARRANT	1,784.64	1,751.38	1,727.32	1,086.25	969.13	974.42	1,001.90	1,049.57	1,089.92	1,133.12	1,179.76
TOTAL	2,154.21	2,117.79	2,132.96	1,452.25	1,269.36	1,281.89	1,325.47	1,391.58	1,441.98	1,496.65	1,555.66

EXHIBIT 5.2

Emissions of Major Pollutants by County with Controls

2011 Airport Emission Inventory With Controls in Place 12 County MSA Totals Tons per Year											
CO											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	622	621	972	648	470	461	455	458	469	483	498
DALLAS	4,633	4,634	5,008	3,923	2,777	2,805	2,898	3,029	3,119	3,226	3,344
DENTON	1,603	1,601	1,368	1,464	1,622	1,651	1,685	1,729	1,780	1,836	1,894
ELLIS	100	100	129	228	224	221	218	217	216	216	216
HENDERSON	19	19	20	25	25	25	25	25	25	25	25
HOOD	35	35	52	114	113	111	111	110	110	110	110
HUNT	98	98	155	199	195	191	189	187	187	187	187
JOHNSON	125	125	125	132	131	132	133	135	138	142	146
KAUFMAN	118	118	156	141	132	124	117	114	112	112	111
PARKER	234	234	234	232	229	227	224	223	222	222	222
ROCKWALL	213	213	213	211	210	209	208	207	207	207	207
TARRANT	16,449	16,259	16,113	8,095	6,490	6,273	6,221	6,486	6,930	7,480	8,136
TOTAL	24,250	24,056	24,545	15,412	12,616	12,428	12,482	12,920	13,516	14,244	15,095

2011 Airport Emission Inventory With Controls in Place 12 County MSA Totals Tons per Year											
THC											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	21.46	21.46	35.21	24.89	18.28	18.95	19.65	20.37	21.13	21.91	22.73
DALLAS	178.48	178.94	193.23	189.01	169.27	180.96	198.98	216.30	224.53	233.11	242.04
DENTON	31.25	31.25	25.97	28.88	33.17	34.26	35.38	36.55	37.77	39.02	40.32
ELLIS	1.85	1.85	2.44	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
HENDERSON	0.20	0.20	0.21	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
HOOD	0.60	0.60	0.91	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
HUNT	1.54	1.54	2.76	3.78	3.78	3.78	3.78	3.78	3.78	3.78	3.78
JOHNSON	2.07	2.07	2.07	2.29	2.33	2.39	2.46	2.53	2.60	2.67	2.75
KAUFMAN	3.56	3.56	4.82	4.82	4.82	4.82	4.82	4.82	4.82	4.82	4.82
PARKER	4.89	4.89	4.89	4.95	4.95	4.95	4.95	4.95	4.95	4.95	4.95
ROCKWALL	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59
TARRANT	1,235.92	1,224.85	1,220.85	799.89	739.97	773.07	818.79	867.74	905.37	942.92	982.03
TOTAL	1,485	1,475	1,497	1,069	987	1,034	1,099	1,168	1,215	1,264	1,314

NMHC											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	29.56	29.29	48.55	31.69	22.12	22.10	22.21	22.67	23.37	24.18	25.05
DALLAS	261.84	259.96	280.69	241.10	198.63	208.24	225.62	243.59	252.09	261.36	271.16
DENTON	34.66	34.27	27.73	29.99	33.97	34.32	34.82	35.68	36.76	37.94	39.20
ELLIS	1.91	1.89	2.57	4.88	4.74	4.63	4.54	4.50	4.48	4.47	4.47
HENDERSON	0.19	0.18	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
HOOD	0.63	0.62	0.94	2.00	1.95	1.91	1.88	1.87	1.86	1.86	1.86
HUNT	1.69	1.66	3.14	4.10	3.96	3.84	3.76	3.72	3.71	3.70	3.70
JOHNSON	2.75	2.71	2.70	2.75	2.67	2.64	2.62	2.65	2.71	2.77	2.85
KAUFMAN	5.11	5.06	6.90	6.34	6.02	5.75	5.53	5.42	5.38	5.36	5.35
PARKER	5.33	5.28	5.27	5.16	5.05	4.96	4.87	4.83	4.81	4.81	4.80
ROCKWALL	3.53	3.49	3.47	3.39	3.34	3.30	3.26	3.25	3.24	3.24	3.24
TARRANT	1,734.28	1,702.82	1,680.46	1,005.87	909.79	928.68	966.64	1,016.49	1,057.73	1,100.56	1,146.12
TOTAL	2,081.48	2,047.23	2,062.61	1,337.50	1,192.48	1,220.58	1,275.98	1,344.90	1,396.37	1,450.48	1,508.04

2011 Airport Emission Inventory With Controls in Place 12 County MSA Totals Tons per Year											
VOC											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	29.51	29.22	48.47	31.52	21.94	21.88	21.96	22.39	23.08	23.87	24.74
DALLAS	262.44	260.38	281.12	240.14	197.07	206.43	223.53	241.28	249.66	258.82	268.52
DENTON	33.98	33.56	27.10	29.26	33.13	33.41	33.86	34.68	35.72	36.86	38.08
ELLIS	1.86	1.84	2.50	4.77	4.63	4.51	4.41	4.37	4.35	4.34	4.34
HENDERSON	0.18	0.17	0.19	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
HOOD	0.62	0.61	0.91	1.94	1.89	1.85	1.82	1.80	1.80	1.79	1.79
HUNT	1.65	1.63	3.09	4.01	3.86	3.74	3.65	3.62	3.60	3.60	3.60
JOHNSON	2.73	2.69	2.68	2.72	2.63	2.59	2.57	2.60	2.65	2.72	2.79
KAUFMAN	5.11	5.05	6.89	6.31	5.99	5.70	5.47	5.36	5.31	5.29	5.28
PARKER	5.22	5.17	5.15	5.03	4.92	4.83	4.74	4.69	4.68	4.67	4.66
ROCKWALL	3.42	3.37	3.36	3.27	3.22	3.17	3.14	3.12	3.12	3.12	3.12
TARRANT	1,739.30	1,706.68	1,683.40	1,003.83	907.20	925.09	962.16	1,011.42	1,052.32	1,094.88	1,140.19
TOTAL	2,086	2,050	2,065	1,333	1,187	1,213	1,268	1,336	1,387	1,440	1,497

NOX											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	31.67	29.80	49.00	25.74	15.22	12.71	10.58	9.56	9.34	9.47	9.75
DALLAS	610.02	596.04	644.36	549.91	195.94	194.64	202.22	213.60	218.48	225.24	233.03
DENTON	32.18	29.96	22.59	20.01	19.93	16.80	14.47	13.51	13.38	13.63	14.05
ELLIS	1.40	1.30	2.10	4.35	3.71	3.14	2.73	2.53	2.45	2.42	2.41
HENDERSON	0.18	0.16	0.17	0.17	0.14	0.12	0.11	0.10	0.10	0.10	0.10
HOOD	0.53	0.49	0.72	1.18	0.95	0.74	0.60	0.53	0.50	0.50	0.49
HUNT	3.11	2.99	6.44	8.00	7.41	6.92	6.59	6.44	6.39	6.36	6.36
JOHNSON	4.70	4.44	4.35	3.84	3.37	2.97	2.67	2.55	2.54	2.58	2.64
KAUFMAN	6.36	5.98	8.06	6.08	5.00	4.01	3.20	2.78	2.61	2.54	2.52
PARKER	4.12	3.86	3.78	2.93	2.40	1.95	1.62	1.46	1.40	1.37	1.36
ROCKWALL	2.47	2.25	2.19	1.60	1.25	0.96	0.76	0.68	0.65	0.64	0.64
TARRANT	5,487	5,329	5,001	3,581	3,545	3,746	3,953	4,235	4,581	4,959	5,374
TOTAL	6,183	6,006	5,744	4,205	3,800	3,991	4,199	4,488	4,839	5,224	5,648

2011 Airport Emission Inventory With Controls in Place 12 County MSA Totals Tons per Year											
SOx											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	3.66	3.66	6.09	3.08	2.09	2.16	2.23	2.31	2.40	2.49	2.58
DALLAS	82.90	83.23	90.85	73.39	27.22	28.99	31.90	34.72	36.05	37.43	38.85
DENTON	4.79	4.80	3.86	3.08	3.38	3.49	3.60	3.72	3.84	3.98	4.11
ELLIS	0.24	0.24	0.36	0.60	0.56	0.56	0.55	0.55	0.55	0.55	0.55
HENDERSON	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
HOOD	0.08	0.08	0.13	0.19	0.17	0.17	0.17	0.17	0.17	0.17	0.17
HUNT	0.41	0.41	0.84	0.97	0.93	0.93	0.93	0.93	0.93	0.93	0.93
JOHNSON	0.56	0.56	0.56	0.45	0.43	0.44	0.45	0.46	0.47	0.49	0.50
KAUFMAN	0.70	0.70	0.96	0.68	0.64	0.63	0.63	0.63	0.63	0.63	0.63
PARKER	0.63	0.63	0.63	0.46	0.43	0.42	0.42	0.42	0.42	0.42	0.42
ROCKWALL	0.46	0.46	0.46	0.30	0.28	0.28	0.27	0.27	0.27	0.27	0.27
TARRANT	589.84	583.72	556.71	386.17	381.26	411.14	443.58	480.87	520.78	563.82	611.57
TOTAL	684.32	678.54	661.50	469.39	417.41	449.23	484.76	525.09	566.56	611.21	660.63

PM10											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	1.67	1.24	1.93	1.06	0.72	0.68	0.64	0.60	0.61	0.63	0.65
DALLAS	23.97	19.47	19.84	12.59	6.19	6.30	6.56	6.86	7.02	7.23	7.47
DENTON	2.05	1.26	0.83	0.67	0.75	0.70	0.63	0.59	0.59	0.61	0.63
ELLIS	0.10	0.05	0.07	0.14	0.13	0.12	0.11	0.10	0.10	0.09	0.09
HENDERSON	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HOOD	0.04	0.02	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
HUNT	0.15	0.09	0.18	0.21	0.20	0.19	0.18	0.18	0.17	0.17	0.17
JOHNSON	0.25	0.16	0.15	0.12	0.11	0.11	0.10	0.09	0.09	0.09	0.10
KAUFMAN	0.32	0.24	0.30	0.24	0.23	0.20	0.18	0.16	0.16	0.16	0.16
PARKER	0.28	0.16	0.13	0.09	0.08	0.08	0.07	0.06	0.06	0.06	0.06
ROCKWALL	0.20	0.09	0.07	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.01
TARRANT	185.33	158.30	143.34	80.65	75.87	75.65	75.66	73.97	72.51	70.63	68.20
TOTAL	214.37	181.10	166.86	95.83	84.32	84.06	84.15	82.63	81.33	79.69	77.55

2011 Airport Emission Inventory With Controls in Place 12 County MSA Totals Tons per Year											
PM2.5											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	1.63	1.22	1.89	1.05	0.71	0.67	0.63	0.59	0.60	0.62	0.64
DALLAS	23.57	19.21	19.59	12.47	6.13	6.25	6.52	6.82	6.98	7.19	7.44
DENTON	2.00	1.23	0.81	0.66	0.74	0.69	0.62	0.58	0.59	0.60	0.62
ELLIS	0.10	0.05	0.07	0.14	0.13	0.12	0.11	0.10	0.09	0.09	0.09
HENDERSON	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HOOD	0.03	0.02	0.02	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01
HUNT	0.15	0.09	0.18	0.21	0.19	0.19	0.18	0.17	0.17	0.17	0.17
JOHNSON	0.24	0.16	0.14	0.12	0.11	0.11	0.10	0.09	0.09	0.09	0.09
KAUFMAN	0.32	0.23	0.30	0.23	0.22	0.20	0.18	0.16	0.16	0.16	0.16
PARKER	0.28	0.16	0.13	0.09	0.08	0.07	0.07	0.06	0.06	0.06	0.06
ROCKWALL	0.19	0.09	0.06	0.03	0.02	0.01	0.01	0.01	0.01	0.00	0.00
TARRANT	182.99	156.74	142.02	80.24	75.54	75.37	75.42	73.76	72.31	70.43	67.99
TOTAL	211.51	179.20	165.22	95.26	83.90	83.70	83.84	82.36	81.07	79.43	77.29

Lead (Pb)											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	0.28	0.40	0.39	0.31	0.25	0.26	0.26	0.27	0.28	0.29	0.30
DALLAS	1.14	1.21	1.24	1.30	1.07	1.12	1.18	1.23	1.28	1.33	1.38
DENTON	1.13	1.01	1.06	1.07	1.17	1.21	1.24	1.28	1.32	1.36	1.40
ELLIS	0.09	0.11	0.18	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
HENDERSON	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
HOOD	0.03	0.04	0.04	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
HUNT	0.09	0.14	0.14	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
JOHNSON	0.10	0.10	0.10	0.11	0.11	0.11	0.12	0.12	0.12	0.13	0.13
KAUFMAN	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
PARKER	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
ROCKWALL	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
TARRANT	1.34	1.46	1.28	1.00	0.73	0.77	0.80	0.84	0.88	0.92	0.97
TOTAL	4.67	4.95	4.91	4.74	4.29	4.42	4.56	4.70	4.84	4.98	5.13

2011 Airport Emission Inventory With Controls in Place 12 County MSA Totals Tons per Year											
TOG											
Analysis Years	1996	2000	2002	2008	2011	2014	2017	2020	2023	2026	2029
COLLIN	31.17	30.87	51.08	33.15	23.08	22.96	23.00	23.42	24.13	24.95	25.85
DALLAS	274.96	272.88	294.67	249.97	203.96	213.19	230.33	248.27	256.81	266.18	276.13
DENTON	37.80	37.37	30.34	32.67	36.87	37.19	37.70	38.60	39.75	41.02	42.37
ELLIS	2.10	2.08	2.82	5.31	5.15	5.02	4.92	4.87	4.85	4.84	4.84
HENDERSON	0.21	0.20	0.22	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26
HOOD	0.70	0.69	1.04	2.21	2.15	2.11	2.07	2.06	2.05	2.05	2.05
HUNT	1.85	1.83	3.43	4.45	4.29	4.16	4.06	4.02	4.00	4.00	4.00
JOHNSON	2.97	2.92	2.91	2.95	2.86	2.81	2.78	2.81	2.87	2.94	3.02
KAUFMAN	5.42	5.36	7.30	6.66	6.30	5.99	5.73	5.60	5.55	5.53	5.52
PARKER	5.80	5.74	5.73	5.60	5.47	5.37	5.27	5.22	5.20	5.19	5.19
ROCKWALL	3.94	3.89	3.87	3.78	3.72	3.67	3.63	3.62	3.61	3.61	3.61
TARRANT	1,784.64	1,751.38	1,727.32	1,022.61	921.12	937.23	973.09	1,022.10	1,063.18	1,106.12	1,151.93
TOTAL	2,152	2,115	2,131	1,370	1,215	1,240	1,293	1,361	1,412	1,467	1,525

REFERENCES

U.S. Environmental Protection Agency, *Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources*, 1992.

U.S. Environmental Protection Agency, NONROAD2005 Emissions Model, Ann Arbor, Michigan, 2005.

U.S. Environmental Protection Agency, *Calculating Piston-Engine Aircraft Airport Inventories for Lead for the 2008 National Emissions Inventory,* December 2010.

Federal Aviation Administration, *Emissions and Dispersion Modeling System (EDMS) User's Manual*, Washington, 2007.

Dallas/Fort Worth International Airport. 2011. Traffic Statistics. 28 March, 2011. *<http://www.dfwairport.com/stats/index.php>.*

Dallas Love Filed Airport. Traffic Statistics. 28 March, 2011. < http://www.dallas-lovefield.com/resources-traffic-statistics_current.html>.

Federal Aviation Administration, Terminal Area Forecast (TAF). 10 January, 2011. *2010 TAF Data*. 12 April 2011. < http://aspm.faa.gov/main/taf.asp>

Federal Aviation Administration. *Air Traffic Activity System (ATADS)*. 12 May 2011. <http://aspm.faa.gov/opsnet/sys/Airport.asp>.

APPENDICES

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