ABSTRACT

TITLE:	Dallas-Fort Worth On-Road Mobile 2014 Air Emissions Reporting Requirements and Hazardous Air Pollutants Inventory
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ABSTRACT:	The North Central Texas Council of Governments conducted a summer and annual 2014 on-road emission inventory to support the Texas Commission on Environmental Quality's Air Emission Reporting Requirements for the Dallas-Fort Worth region. This report documents the on-road mobile methodologies applied and estimated emissions results for the 2014 analysis year. This analysis covers counties of Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise. The 12-county estimated on-road mobile source emissions are reported for criteria pollutants, criteria precursor pollutants, and hazardous air pollutants for summer weekday and annual total for the year 2014.

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GLOSSARY OF ABBREVIATIONS

AADT - Annual Average Daily Traffic
AERR - Air Emissions Reporting Requirements
APU - Auxiliary Power Unit
AS - Arsenic Compounds
ASWT - Average School Season Weekday
ASM - Acceleration Simulation Mode
ATR - Automatic Traffic Recorder
AVFT - Alternative Vehicle Fuel Technology
CAAA - Clean Air Act Amendments
CDB - County Database
CERR - Consolidated Emissions Report Rule
CO - Carbon Monoxide
CO_2 - Carbon Dioxide
CR+3 - Chromium 3+
CR+6 - Chromium 6+
DEOG - Diesel Exhaust Organic Gases
DFW - Dallas-Fort Worth
DFX - Dallas-Fort Worth Travel Model for the Expanded Area
EPA - Environmental Protection Agency
ETBE - Ethyl Tertiary Butyl Ether
GIS - Geographic Information System
GISDK - Geographic Information System Developer Kit
HAPs - Hazardous Air Pollutants
H_2O - Water vapor
HBW - Home-Based Work
Hg - Mercury Particulate
Hg Dgas - Mercury Divalent Gaseous
Hg Egas - Mercury Elemental Gaseous
HNW - Home-Based Non-Work
HONO - Nitrous Acid
HOV - High Occupancy Vehicle
HPMS - Highway Performance Monitoring System
I/M - Inspection & Maintenance Program
LEADS - Leading Environmental Analysis and Display System
LED - Low Emissions Diesel
MAWDT - Monthly Average Weekday Daily Traffic
Mn - Manganese Compounds
MOVES2014 - Motor Vehicle Emissions Simulator version 2014
MPA - Metropolitan Planning Area
MPO - Metropolitan Planning Organization
MRS - MOVES Run Specifications
MSAT - Mobile Source Air Toxics
MTBE - Methyl Tertiary Butyl Ether
NAAQS - National Ambient Air Quality Standards
NCT - North Central Texas
NCTCOG - North Central Texas Council of Governments
NEI - National Emissions Inventory
NH_3 - Ammonia
NH_4 - Ammonium
NHB - Non-Home Based
Ni - Nickel Compounds
NO - Nitrogen Oxide
NO_2 - Nitrogen Dioxide
NO_3 - Nitrate
NO_X - Oxides of Nitrogen
O_3 - Ozone
PAH - Polycyclic Aromatic Hydrocarbon
PM - Particulate Matter
$PM_{2.5}$ - Particulate Matter 2.5 Microns
PM_{10} - Particulate Matter 10 Microns
ppb - parts per billion
RFG - Reformulated Gasoline
RPM - Revolutions Per Minute
RVP - Reid Vapor Pressure
SCC - Source Classification Code
SHI - Source Hours Idling
SHO - Source Hours Operating
SHP - Source Hours Parked
SO_2 - Sulfur Dioxide
SUT - Source Use Type
TAME - Tertiary Amyl Methyl Ether
TCEQ - Texas Commission on Environmental Quality
TDM - Travel Demand Model

TOD	-	Time-of-Day
TSZ	-	Traffic Survey Zone
TTI	-	Texas Transportation Institute
TxDMV	-	Texas Department of Motor Vehicles
TxDOT	-	Texas Department of Transportation
TxLED	-	Texas Low Emission Diesel
UI	-	User Interface
US	-	United States
VHT	-	Vehicle Hours of Travel
VMT	-	Vehicle Miles of Travel
VDF	-	Volume Delay Function
VOC	-	Volatile Organic Compounds

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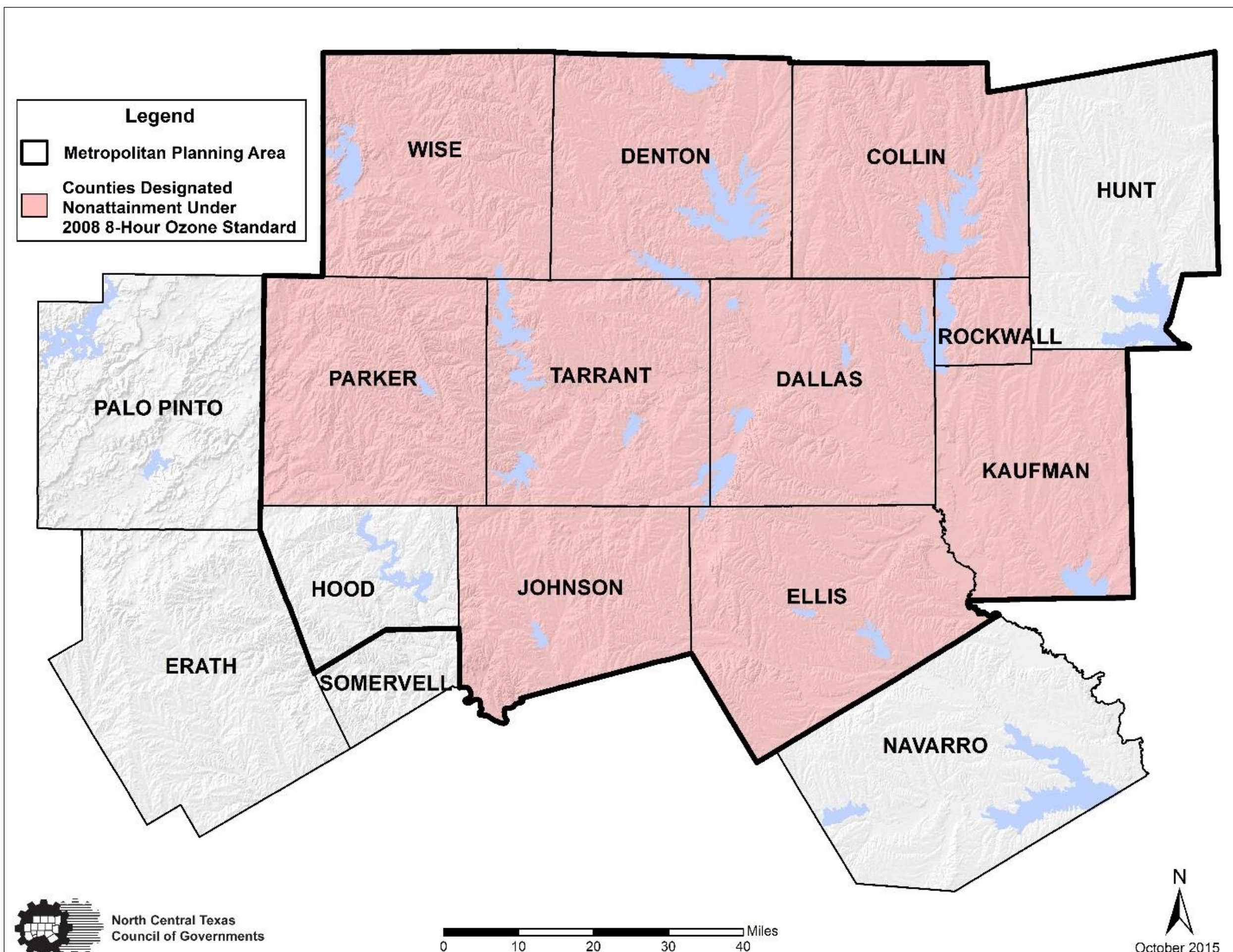
CHAPTER 1: INTRODUCTION

Purpose and Scope of Study

The North Central Texas Council of Governments (NCTCOG) conducted Motor Vehicle Emission Simulator (MOVES)-based Dallas-Fort Worth (DFW) area on-road mobile source annual and summer weekday emissions inventories for the 2014 evaluation year, as needed for the State of Texas under the Air Emission Reporting Requirements (AERR). The emissions inventories cover the North Central Texas (NCT) area of Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties, as shown in Exhibit 1. Pollutants being evaluated are volatile organic compounds (VOCs), carbon monoxide (CO), oxides of nitrogen (NO_X), carbon dioxide (CO_2), particulate matter 2.5 ($PM_{2.5}$), particulate matter 10 (PM_{10}), ammonia (NH_3), sulfur dioxide (SO_2), and hazardous air pollutants (HAPs).

This report documents the methodology and results of the 2014 AERR On-Road Mobile Source Emissions Inventories. Chapter 1 outlines the background, purpose, scope, and modeling approach for the emissions inventories and provides a summary of the 12-county estimated emissions totals.

Exhibit 1: North Central Texas Counties



Chapter 2 documents the procedures used to develop regional vehicle activity estimates in terms of vehicle miles of travel (VMT) and average vehicle speed. These procedures include development of adjustment factors to better reflect regional conditions. Seasonal and hourly adjustment factors were applied to produce summer vehicle activity, and report vehicle activity in hourly periods. Consistent with previous emissions inventory practice, a comparison was made between travel demand model VMT estimates and appropriate Highway Performance Monitoring System (HPMS) VMT, to develop HPMS adjustment factors. Also, a nonrecurring congestion adjustment was applied to account for vehicle emissions due to traffic accidents not captured in the standard four-step travel modeling process.

Chapter 3 documents the procedures used to develop off-network activity. This activity includes starts, source hours parked, source hours idling, and auxiliary power unit hours.

Chapter 4 documents the parameters and inputs used to develop on-road mobile source emission factors by utilizing the United States (US) Environmental Protection Agency's (EPA) 2014 Motor Vehicle Emissions Simulator (MOVES2014). This chapter documents regionally specific calculations, procedures, MOVES2014 emission factors, and adjustments to better reflect vehicle emissions discharged in the region. The calculations and procedures include source use type, age distribution, fuel engine fractions, hourly VMT, etc. The adjustments include low emission diesel NO_X adjustments.

Chapter 5 documents the 12-county area vehicle emission calculation procedure and estimates, while Chapter 6 includes the annualization methodology.

Chapter 7 includes the details of the additional summer and annual county databases created for use with MOVES2014 inventory mode.

Chapter 8 documents VMT, off-network activity, and VOCs, CO, NO_X, SO_2, CO_2, NH_3, PM_{10}, $PM_{2.5}$, Mobile Source Air Toxics (MSAT), and HAP's emissions by county.

Chapter 9 is a listing of the Appendices, which contains supplemental information referenced in this document as well as the electronic data supporting the Dallas-Fort Worth 2014 AERR Summer and Annual On-Road Mobile Emissions Inventory.

Background

EPA combined the Periodic Emission Inventory and National Emissions Inventory (excluding the HAPs component) requirements into a single emissions inventory requirement called the Consolidated Emissions Report Rule (CERR) on June 10, 2002 (*Federal Register* Vol. 67, No. 111, pp. 39602-39616). In an effort to improve EPA's ability to combine national inventories of air pollutant emissions, EPA finalized the Air Emission Reporting Requirements (AERR) in December 17, 2008 (*Federal Register* Vol. 73, No. 243, pp. 76539-76558), which simplifies the requirements for the CERR providing additional flexibility and accelerates the reporting of emissions data to the EPA by the State and local agencies. Under this rule HAPs are not included, but for consistency purposes, states are encouraged to submit them on a voluntary basis using the requirements of the AERR.

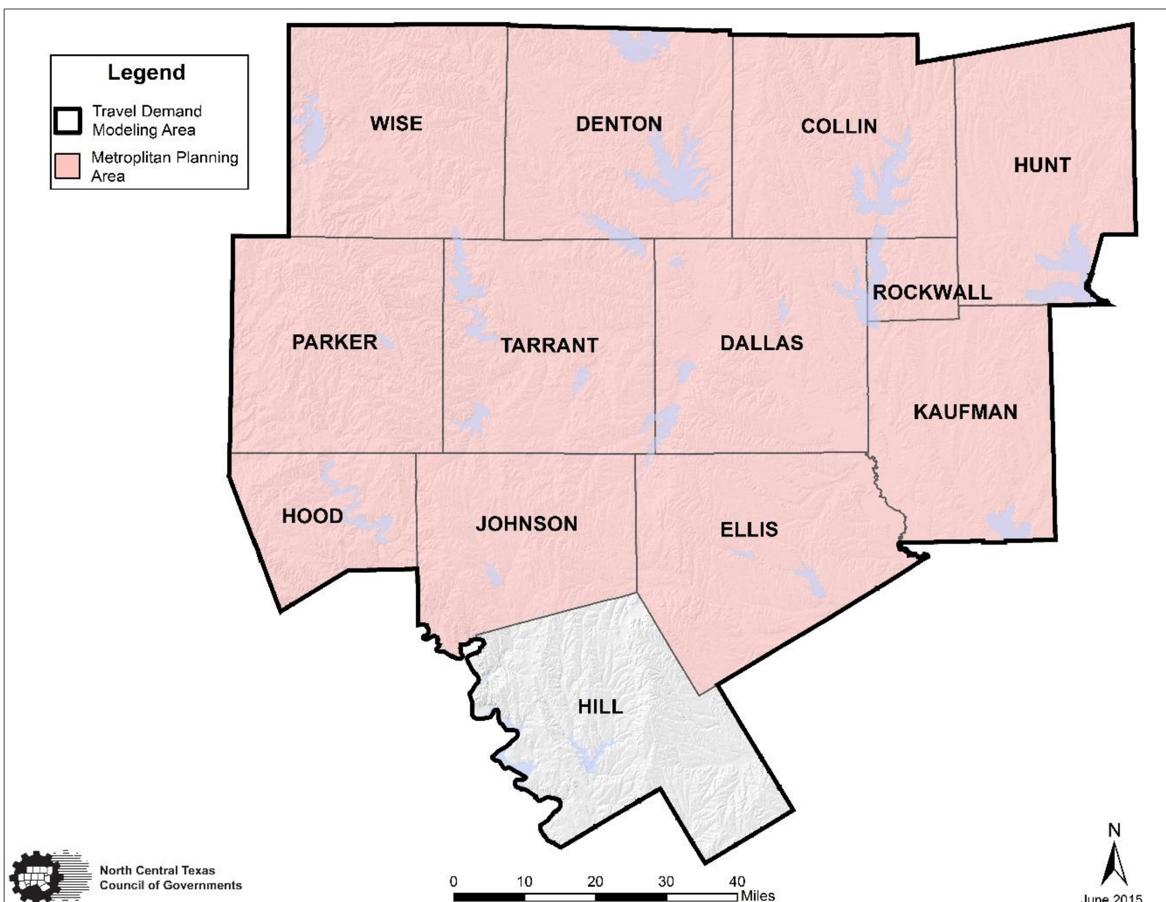
NCTCOG serves as the Metropolitan Planning Organization for transportation in the DFW area and is responsible for developing and maintaining on-road mobile source emission inventories for the region. Traditionally, NCTCOG has assisted the TCEQ with on-road emission inventory development activities that include inventory production, methodology updates, data gathering, analysis and assessment, and planning for future requirements. In addition to meeting the basic inventory production requirements, NCTCOG will employ state-of-the-art methodologies and up-to-date data sets to produce highly detailed and defensible on-road mobile AERR inventories.

Accurate emissions inventories are critical if State, local, and federal agencies are to attain and maintain the National Ambient Air Quality Standard the EPA has established for criteria pollutants such as ozone, PM, and CO, as well as control HAPs emissions. Under this grant, NCTCOG will develop on-road mobile source annual and summer weekday emissions inventories for the 2014 evaluation year for criteria pollutants, criteria precursor pollutants, and HAPs for mobile sources. An on-road mobile subset of HAPs in the MSAT includes various VOCs and metals, as well as diesel PM and diesel exhaust organic gases (DEOG). EPA identified and labelled 21 HAPs as MSATs, and in 2001 designated six of these MSATs as priority: benzene, methyl tertiary butyl ether, 1,3-butadiene, formaldehyde, acetaldehyde, DEOG, and acrolein. MOVES2014 will be used to estimate emission factors for these six priority MSATs.

Modeling Approach

The Dallas-Fort Worth Travel Model for the Expanded Area (DFX) is employed to estimate VMT and emissions for the 2014 summer and annual season. DFX's modeling domain includes Collin, Dallas, Denton, Ellis, Hill, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties. Hill County is not part of the NCT planning area. To capture travel from outside areas, Hill County is included in the modeling domain. The 12-county NCT modeling domain plus Hill County is shown in the Exhibit 2.

Exhibit 2: North Central Texas Modeling Domain Plus Hill County



Several components of the model were updated as part of this model expansion. These updates include improvements to the following: mode-choice model; vehicle ownership model; external stations;

volume-delay-function; transit assignment, and traffic assignment convergence criteria, which are discussed in Chapter 2.

CHAPTER 2: ESTIMATION OF VEHICLE MILES OF TRAVEL

This chapter discusses the methodology used in estimating the vehicle activity measures influencing the air quality in the North Central Texas (NCT) area. These measures include the vehicle miles of travel (VMT) and the average speed. The current expanded travel model covers the 12-county area of Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties. The VMT and speeds were estimated with Dallas-Fort Worth Travel Model for the Expanded Area (DFX) using a link-based methodology for each time period and each day type.

Dallas-Fort Worth Travel Model for the Expanded Area

The source of VMT estimates for the 2014 summer and annual emission inventories for the NCT counties is the network-based DFX executed by the North Central Texas Council of Governments (NCTCOG) Transportation Department in the TransCAD environment. TransCAD is a Geographic Information System-based commercial travel demand software package for transportation planning. DFX supports federally required regional transportation planning efforts for the Dallas-Fort Worth (DFW) region. Since 1974, NCTCOG has served as the Metropolitan Planning Organization (MPO) for the DFW area. The Transportation Department provides technical support and staff assistance to the Regional Transportation Council and its technical committees that comprise the MPO policy-making structure.

Multimodal Transportation Analysis Process

The forecasting technique of the DFX is based on a four-step sequential process designed to model travel behavior and predict travel demand at regional, sub-area, or corridor levels. These four steps are: Trip Generation, Trip Distribution, Mode Choice, and Roadway Assignment.

The roadway network developed for the 2014 summer and annual emissions inventory contains over 30,000 unique segments constructed to replicate the transportation system of the coverage area. The transportation network for this inventory was developed specifically for the year 2014. Each facility link in the network has the following attributes:

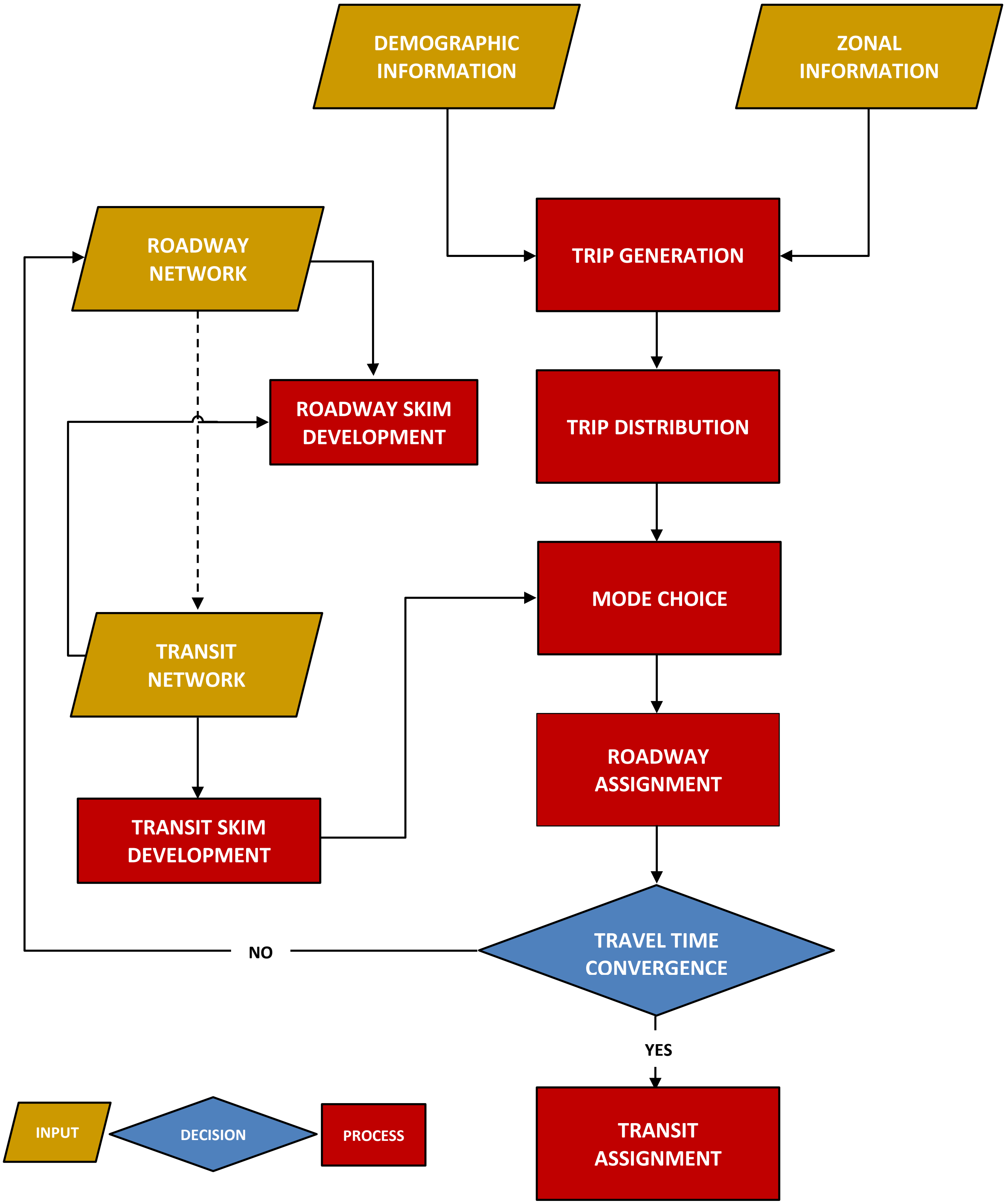
- Network Node Numbers (Defining the Beginning and End of Each Link)
- Number of Operational Lanes In the AM and PM Peak Periods
- Functional Classification
- Divided/Undivided Roadway Code
- Type of Traffic Control At Each End of the Link
- Traffic Direction (One-Way or Two-Way)
- Length of Link
- Estimated Loaded Speeds In Each Period
- Number of Operational Lanes In the Off-Peak Period
- Speed Limit
- Traffic Survey Zone
- Tolls
- Area Type
- Free-Flow Speeds
- Hourly Capacities
- Truck Exclusion Code

Every roadway segment in the network falls into one of the functional classes of centroid connectors, freeways, principal arterials, minor arterials, collectors, ramps, frontage roads, and high occupancy vehicle (HOV) lanes.

Trip purposes in the DFX are defined in one of four ways: home-based work (HBW), which includes trips from home to work or work to home; home-based non-work (HNW), which includes non-work trip beginning or ending at home; non-home based (NHB), which includes trips where home is neither the origin nor the destination; and other trips that include all truck trips as well as all external-internal, internal-external, and external-external vehicle trips.

The model process begins with an estimate of the socioeconomic variables for each zone. The data is organized by traffic survey zone (TSZ), the smallest zone size available in DFX. There are 5,386 TSZs in DFX modeling area (5,303 internal plus 83 external TSZs). The data for each TSZ includes: zone centroid; median household income; number of households; population; basic, retail, and service employment; and land area. This level of detail is retained in all four modeling steps. The Trip Generation Model generates the number of weekday person trips sent to and received from each zone. The Trip Distribution Model determines the trip interaction between each zone and the rest of the zones in the Metropolitan Planning Area. The Mode Choice Model divides the person trips into two categories of transit and automobile trips. The Assignment Model loads the auto demand onto the roadway network, and the transit passenger trips onto the transit network. Exhibit 3 depicts the flowchart of the DFW expanded travel model process, commonly referred to as the four-step transportation modeling process. The DFX model application is written by NCTCOG staff in the TransCAD script language known as the Geographic Information System Developer Kit (GISDK), and integrated with a user interface developed in Visual Basic programming language.

Exhibit 3: DFW Travel Model for the Expanded Area Process TransCAD Travel Forecast Flowchart



Trip Generation Model

The Trip Generation Model is a computer program written in GISDK script language by NCTCOG staff. The Trip Generation Model converts the population and employment data into person trip ends and outputs the total number of trips produced by and attracted to each zone by trip purpose. The 2014 population and employment forecasts were generated with the Disaggregate Residential Allocation Model using travel times from the Roadway and Transit Assignment Steps, consistent with current planning practice. The data can be seen in Exhibit 4. The cross-classified trip production model is stratified by income quartile and household size. The allocation of TSZ households into the four income quartiles and six household size categories is based on distribution curves developed from the United States Census Population data. The cross-classified trip attraction model is stratified by area type, employment type (basic, retail, and service), and, for the case of the HBW trip purpose, income quartile. Area type designations are a function of the population and employment density of a zone.

Exhibit 4: Socioeconomic Demographic Summary for the DFW 12-County Modeling Domain

	2014
Population	6,904,428
Number of Households	2,467,446
Employment Types	
Basic	1,102,156
Retail	753,894
Service	2,518,739
Total Employment	4,374,789

The Trip Generation Model allows the user to input trip rates and trip generation units associated with special generators such as regional shopping malls, hospitals, and colleges/universities. At the end of the generation process, HBW trips are balanced to the estimated trip attractions. All other purposes are balanced to the estimated trip productions in that zone. Due to the uniqueness of the NHB trips, zonal productions for NHB trips are later set equal to the attractions in a given zone.

The regional trip productions and attractions are balanced for each trip purpose. The total trip attractions are balanced to the estimated trip productions in that zone for all other trip purposes.

Trip Distribution Model

The Trip Distribution Model creates the production-attraction person trip tables for each of the 5,386 TSZs. The Trip Distribution Model uses the person trips produced by and attracted to each zone, generated in the Trip Generation Model, plus zone-to-zone minimum travel time information from the roadway network to estimate the number of person trips between each pair of zones for each trip purpose. All estimates of roadway travel times include a representation of the time needed for locating a parking space, paying for parking, and walking from the car to the final destination. Estimates of these terminal times were derived from NCTCOG's 1994 Workplace Travel Survey and 1996 Household Travel Survey. The model uses a gamma-based gravity formulation technique to estimate the zone-to-zone interchange of trips. Iterations of the gravity model are required to ensure the estimated number of zonal trips received equals the projected number of trip attractions generated by the Trip Generation Model.

Mode Choice Model

The Mode Choice Model determines the mode of travel and auto occupancy. Using the information regarding trip maker characteristics (e.g., income and auto ownership), roadway and transit system characteristics (e.g., in-vehicle time and out-of-vehicle time), and travel costs (e.g., auto operating costs, parking costs, and transit fare), the model splits the trips among all applicable modes of travel. The model uses a nested logic formulation for all the trip purposes. The “other” trips are assumed to be vehicle trips with one occupant and are not processed by the Mode Choice Model. The trip purposes of HBW, HNW, and NHB have nine choice sets: drive alone, two occupant shared ride, three + occupancy shared ride, walk access to bus service, auto access to bus service, walk access to rail service, auto access to rail service, walk access to bus and rail service with transfer, and auto access to bus and rail service with transfer.

Roadway Assignment

The Roadway Assignment Model consists of simultaneous user equilibrium origin-destination assignments of drive alone, shared-ride, and truck vehicle classes for three separate time-of-day periods (6:30 a.m. – 8:59 a.m. Morning Peak, 3:00 p.m. – 6:29 p.m. Evening Peak, and the 18-Hour Off-peak). The drive alone vehicle class is kept separate from the shared-ride vehicle class so that HOV assignments can be performed as an integral part of an equilibrium assignment. Trucks are kept separate from the other vehicle classes so the modeled truck volumes on all links can be tracked, and a separate value-of-time can be defined for them. A generalized-cost path building technique is embedded within the model, in which the iterative calculation of zone-to-zone impedances are based on weighting factors applied to the capacity-restrained travel time, the distance (representing fuel cost), and tolls. As is standard with all User Equilibrium procedures, the TransCAD program uses an iterative process to achieve a convergent solution in which no travelers can improve their path by shifting routes. Since the results of the three time-of-day assignments can be combined to obtain total weekday modeled volumes, validation checks can be performed with either time-of-day or weekday observed traffic counts.

Speed Estimation Procedure

The link speed in the DFX is estimated by dividing the length of the link by its loaded travel time. The loaded travel time is the sum of the free-flow travel time, traffic congestion delay, and the delay caused by the traffic control devices (e.g., stop signs, yield signs, and signals). These three elements of the loaded travel time are all functions of the link volume to capacity ratio. These functions are programmed in the volume delay function (VDF) that is an essential input to the traffic assignment step. The result of the traffic assignment step is the final time-period-specific average loaded speeds for each of the 30,000+ links in the roadway network. The VMT and vehicle hours of travel (VHT) for different time periods is included in the output as well to obtain an overall average speed (VMT/VHT) for any desired length of time.

The free-flow (uncongested) speed is defined as the speed limit. Free-flow speeds are an important link attribute since they are the base for calculating the congested (loaded) speeds in the Traffic Assignment step.

The VDF in the DFX uses a conical congestion delay form defined for each link functional classification, a non-linear delay curve based on the Webster’s uniform delay formulation at signalized intersections, and a linear delay curve for the stop and yield controlled approaches.

The volume-delay curves were calibrated based on the available 2004 daily link traffic counts at more than 10,000 locations (collected by the Texas Department of Transportation [TxDOT]), and the travel time runs along freeway and arterial corridors (performed by several consultants as part of other projects). The time-of-day link counts were not available for the calibration of the model in each time period.

Finally, all of the delay elements are added to the uncongested travel time (based on the free-flow speeds) to produce the total loaded travel time on each roadway segment. Appendix D contains speeds by county for each hour of the day. The resulting congested DFX county speeds are listed in Exhibit 5.

Exhibit 5: 2014 Average Daily Speeds

County	Average Speed
Collin	36.68
Dallas	36.33
Denton	37.49
Ellis	44.83
Hood	40.71
Hunt	45.62
Johnson	40.99
Kaufman	44.94
Parker	44.28
Rockwall	40.41
Tarrant	37.56
Wise	45.77
Average	**41.30**

Local Street VMT

The roadway network of the DFX does not contain the details of local (residential) streets. However, a VMT estimate is possible based on data provided by the travel model. Local street VMT is calculated for each county by multiplying the number of intrazonal trips by the intrazonal trip length and then adding the VMT from the zone centroid connectors. The temporal distribution is assumed to be the same as for non-local streets.

Adjustments

Seasonal, Daily, and Hourly Adjustments

The vehicle activity data used for this analysis is representative of 2014 summer and annual season. This section outlines the process used to convert the DFX average school season weekday activity to summer activity to represent this analysis period.

The Automatic Traffic Recorder (ATR) data collected by TxDOT is used to calculate the necessary conversions. Exhibit 6 lists the stations used in this analysis and Exhibit 7 is a map showing the ATR locations.

Exhibit 6: ATR Stations

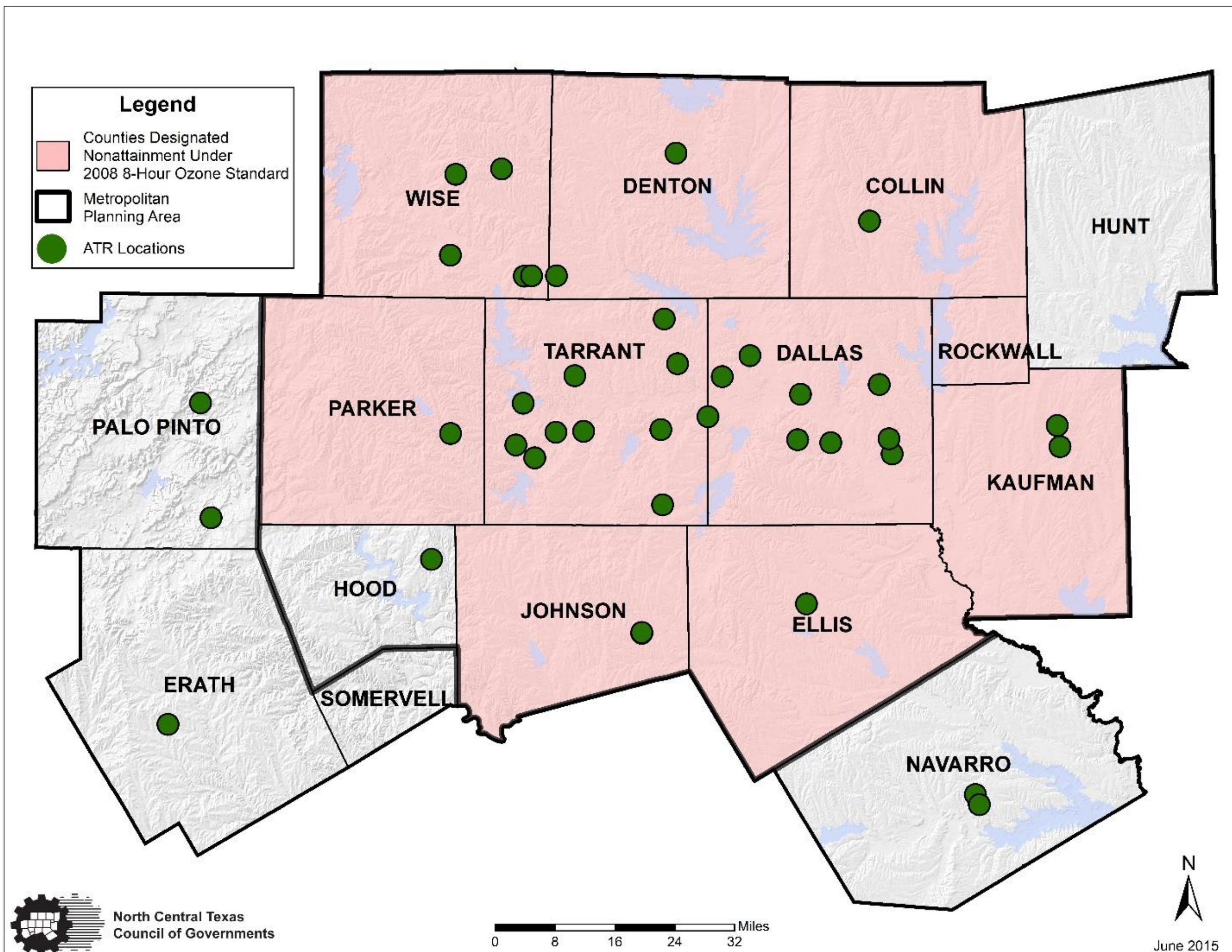
Station	Name	Road	County
1	A301 ARLINGTON	US0080	Tarrant
3	S017 DALLAS	US0175	Dallas
5	S027 DENTON	FM0428 S	Denton
6	S040 CORSICANA	IH0045	Navarro
7	S055 DALLAS	SH0183	Dallas
8	S121 MCKINNEY	US0075	Collin
9	S126 DALLAS	IH035E	Dallas
10	S130 FT. WORTH	IH0030	Tarrant
11	S133 TERRELL	US0080	Kaufman
12	S145 TERRELL	IH0020	Kaufman
13	S148 DALLAS	IH035E	Dallas
15	S171 DALLAS	IH0635	Dallas
17	S192 ARLINGTON	IH0030	Tarrant
18	S193 FT. WORTH	IH0820	Tarrant
19	S208 WEATHERFORD	IH0020	Parker
20	S220 DALLAS	IH0045	Dallas
21	S221 DALLAS	IH0030	Dallas
22	S237 DALLAS	SS0348	Dallas
24	S264 WISE	SH0114	Wise
26	S292 ERATH	US0067	Erath
28	S297 TARRANT	IH0020	Tarrant
29	S337 WISE	SH 114	Wise
30	S338 WISE	USE 380	Wise
31	S339 WISE	US0081	Wise
32	S340 HOOD	US0377	Hood
33	S341 PALO PINTO	IH0020	Palo Pinto
34	S342 JOHNSON	IH 35W	Johnson
35	A109 FORT WORTH	IH 35W	Tarrant
36	S293 MINERAL WELLS	US 180	Palo Pinto
38	S336 SOUTHLAKE	SH 114	Tarrant
39	S361 FORT WORTH	IH 820	Tarrant
40	S387 DECATUR	US 81	Wise
41	S522 COLLEYVILLE	SH 121	Tarrant

Exhibit 6: Automatic Traffic Recorder Stations (continued)

Station	Name	Road	County
42	S524 FORT WORTH	IH 820	Tarrant
43	S525 MANSFIELD	US 287	Tarrant
44	S501 WAXAHACHIE	US 287	Ellis
45	W539 MUSTANG	IH 45	Navarro
46	LW550 ALVARADO	IH 35W	Johnson
47	W527 WISE	SH 114	Wise

Source: TxDOT

Exhibit 7: ATR Station Map



Seasonal and Daily Adjustments

ATR data averaged over five years (2009-2013) is organized into five day types: Sunday, Monday, Midweek (Tuesday, Wednesday, and Thursday), Friday, and Saturday. To adjust the representative average school season weekday (ASWT) VMT from the DFX to the specified day types in the school and summer season, ratios are calculated. The summer portion of the ratio uses traffic volumes recorded for June, July, and August months and the annual average daily traffic (AADT) is estimated from yearly sum. Seasonal and daily adjustments for DFX counties, and the equations used to calculate these adjustments are listed in Exhibit 8.

Exhibit 8: Seasonal/Daily Adjustment Factors for the DFW 12-County Modeling Domain

	County Type	Midweek	Methodology
ASWT to Summer	**Core (Dallas/Tarrant)**	0.991	[(MAWDT June + MAWDT July + MAWDT August)/3]/[(MAWDT February + MAWDT April + MAWDT May + MAWDT September + MAWDT October)/5]
	Rural (Collin/Denton)	0.971	
	Perimeter (Other Counties)	1.030	
ASWT to AADT	**Core (Dallas/Tarrant)**	0.983	[(MAWDT June + MAWDT July + MAWDT August)/3]/[(MAWDT February + MAWDT April + MAWDT May + MAWDT September + MAWDT October)/5]
	Rural (Collin/Denton)	0.972	
	Perimeter (Other Counties)	1.010	

Hourly Adjustments

Daily volumes recorded for midweek, described above, are aggregated by hour to determine the percent of daily traffic occurring during each hour, representing hourly vehicle activity estimates. The DFX county midweek is further detailed by utilizing a time period volume for aggregation. These time periods correspond to the time periods used in the DFX, where, AM Peak is 6:30 a.m. to 8:59 a.m., PM Peak is 3:00 p.m. to 6:29 p.m., and Off-Peak represents all other hours of the day (12:00 a.m. to 6:29 a.m., 9:00 a.m. to 2:59 p.m., and 6:30 p.m. to 11:59 p.m.) Periods split by mid-hour times use an equal division of traffic recorded during the hour. The hourly adjustments for DFX counties and the equation to calculate these adjustments are shown in Exhibit 9.

Exhibit 9: Hourly Adjustment Factors for DFW 12-County Modeling Domain

Time of Day	Midweek	Methodology
12:00 a.m. – 12:59 a.m.	0.92%	Hourly Traffic/ Total Hourly Traffic for any Given Day
1:00 a.m. – 1:59 a.m.	0.63%	
2:00 a.m. – 2:59 a.m.	0.59%	
3:00 a.m. – 3:59 a.m.	0.64%	
4:00 a.m. – 4:59 a.m.	1.10%	
5:00 a.m. – 5:59 a.m.	2.72%	
6:00 a.m. – 6:29 a.m.	2.70%	
6:30 a.m. – 6:59 a.m.	2.70%	
7:00 a.m. – 7:59 a.m.	7.02%	
8:00 a.m. – 8:59 a.m.	6.18%	
9:00 a.m. – 9:59 a.m.	5.19%	
10:00 a.m. – 10:59 a.m.	4.96%	
11:00 a.m. – 11:59 a.m.	5.20%	
12:00 p.m. – 12:59 p.m.	5.42%	
1:00 p.m. – 1:59 p.m.	5.57%	
2:00 p.m. –2:59 p.m.	5.95%	
3:00 p.m. – 3:59 p.m.	6.68%	
4:00 p.m. – 4:59 p.m.	7.49%	
5:00 p.m. – 5:59 p.m.	7.81%	
6:00 p.m. – 6:29 p.m.	3.09%	
6:30 p.m. – 6:59 p.m.	3.09%	
7:00 p.m. – 7:59 p.m.	4.38%	
8:00 p.m. – 8:59 p.m.	3.41%	
9:00 p.m. – 9:59 p.m.	2.88%	
10:00 p.m. – 10:59 p.m.	2.20%	
11:00 p.m. – 11:59 p.m.	1.48%	

Model VMT Adjustments (HPMS VS DFX)

Consistent with previous emission inventory practices, the DFW MPO used TxDOT's Highway Performance Monitoring System (HPMS) data to adjust modeled VMT to reflect the HPMS data for consistent reporting across the State. This adjustment is based on EPA's guidance for emission inventory development. Exhibit 10 shows the calculation performed to develop the new HPMS adjustment factor, 0.9703, based on a comparison of 2010 VMT for HPMS and DFX.

Exhibit 10: DFW HPMS and VMT Analysis

Model VMT Adjustment Factor	
	2010 VMT
HPMS (ASWT)[1]	165,292,084
DFX (ASWT)	170,346,118
HPMS/DFX Ratio	**0.9703**

Source: NCTCOG

[1]Annual Average Daily Traffic to ASWT conversion factor applied.

Non-Recurring Congestion

According to a paper published in the January 1987 *Institute of Transportation Engineers*' journal by Jeffrey A. Lindley titled Urban Freeway Congestion: Quantification of the Problem and Effectiveness of Potential Solutions, congestion due to traffic incidents accounts for twice as much as congestion from bottleneck situations. Congestion due to incidents, or nonrecurring congestion, causes emissions not represented in the VMT-based calculations of the base emissions. In order to include these effects, the delay caused by nonrecurring congestion is added to the freeway travel times and congestion delay due to bottlenecks to obtain an increased freeway travel time, which translates into reduced speed on freeway facilities. Reducing the freeway speeds increases volatile organic compounds (VOCs) and oxides of nitrogen (NO_X) emissions by 4.9 percent, resulting in a factor of 0.961 for freeway VOCs and NO_X emissions in urban and rural counties. This is thought to be a conservative estimate of increased emissions due to nonrecurring congestion. Arterial street emissions are not significantly affected by incidents because alternate routes on the arterial system are generally available; therefore, this factor is not applied to non-freeway type facilities.

VMT Estimates

The 2014 VMT estimates for different day types are shown in Exhibit 11 for the 12-county area. Appendix D shows the VMT by county by day for each hour for all counties.

Exhibit 11: 2014 Vehicle Miles of Travel (miles)

Counties	Summer Daily	Annual
Collin	21,917,877	7,566,943,925
Dallas	71,809,390	24,791,526,490
Denton	17,985,338	6,209,271,227
Ellis	7,687,545	2,654,053,531
Hood	1,923,161	638,064,480
Hunt	5,211,116	1,691,162,003
Johnson	5,991,934	1,987,997,962
Kaufman	6,455,313	2,228,636,885
Rockwall	5,116,558	1,697,566,401
Parker	2,484,997	857,922,142
Tarrant	47,310,860	15,696,749,687
Wise	3,655,534	1,212,829,289
DFW Total	**197,549,623**	**67,232,724,022**

Source: NCTCOG

CHAPTER 3: ESTIMATION OF OFF-NETWORK ACTIVITY

To estimate the off-network (or parked vehicle) emissions using the mass per activity emissions rates, county-level analysis year 2014 summer weekday estimates of the source hours parked (SHP), starts, source hours idling (SHI), and auxiliary power units (APU) hours are required by hour and vehicle (SHI and APU hours are for diesel combination long-haul trucks only). One of the main components of the SHP and starts off-network activity estimation is the analysis year county-level vehicle population. Appendix A contains the vehicle population and hourly SHP, starts, SHI, and APU hours.

Texas Transportation Institute's (TTI) MOVESpopulationBuild module is used to convert Motor Vehicle Emissions Simulator version 2014 (MOVES2014) based Texas Department of Motor Vehicles registration data for each county into 13 MOVES2014 source use type (SUT) population (or vehicle population). The county-level SHP, starts, SHI, and APU hours of off- network activity were developed using the "OffNetActCalc" utility provided by TTI.

Estimation of SHP

The first activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level analysis year summer weekday estimates of SHP by hour and vehicle type. For each hour, the county-level vehicle type SHP was calculated by taking the difference between the vehicle type total available hours minus the vehicle type vehicle hours travelled (VHT). Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type population. The Source Hours Operating (SHO) was calculated using the link vehicle miles of travel (VMT) and speeds and the VMT mixes by MOVES road-type category. Appendix A includes the 24-hour summaries of the county-level weekday estimates of SHP by hour and vehicle type.

Vehicle Type Total Available Hours

The vehicle type total available hours is typically calculated as the vehicle type population times the number of hours in the time period. Since this calculation was performed at the hourly level, the vehicle type total available hours was set equal to the vehicle type vehicle.

Vehicle Type VHT

To calculate the VHT for a given link, the VMT was allocated to each vehicle type using the Texas Department of Transportation district-level vehicle type VMT mixes by MOVES road-type category, which was then divided by the link speed to calculate the link vehicle type VHT. These VMT mixes are the same VMT mixes used to estimate emissions in the emissions estimation process. This SHO calculation was performed for each link in a given hour, aggregating the VHT to one value per vehicle type per hour.

Estimation of Starts

The second activity measure needed to estimate the off-network emissions using the mass per activity emissions rates are county-level analysis year summer weekday estimates of starts by hour and vehicle type. The vehicle type hourly default starts per vehicle were multiplied by the analysis year county-level vehicle type vehicle population to estimate the county-level vehicle type starts by hour. Appendix A includes the 24-hour summaries of the county-level vehicle type starts by hour.

For the hourly default starts per vehicle, the MOVES defaults were used. The MOVES activity output was used to estimate the hourly starts per vehicle for a MOVES weekday run by dividing the MOVES start output by the MOVES vehicle population output. These MOVES national default starts per vehicle do not vary by year, only by MOVES day type. For this summer weekday analysis, the MOVES national default "weekday" starts per vehicle were used.

Estimation of SHI and APU Hours

The remaining activity measures needed to estimate the off-network emissions using the mass per activity emissions rates are the hourly, county-level analysis year summer weekday heavy-duty diesel truck (SUT 62, fuel type 2 [CLhT_Diesel]) SHI and APU hours (hotelling activity). During hotelling, the truck's main engine is assumed to be in idling mode or its APU is in use. To calculate the SHI and APU hours activity, the hotelling hours activity were calculated, which was then allocated to the SHI and APU hours components.

The hotelling activity was based on information from a Texas Commission on Environmental Quality extended idling study, which produced 2004 summer weekday extended idling estimates for each Texas County and hotelling activity data from MOVES. Hotelling scaling factors (by analysis year) were applied to the base 2004 summer weekday hotelling values from the study to estimate the 24-hour hotelling by analysis year. Hotelling hourly factors were then applied to allocate the 24-hour hotelling by analysis year to each hour of the day. To ensure that valid hourly hotelling values are used, the hourly hotelling activity was compared to the CLhT_Diesel hourly SHP (i.e., hourly hotelling values cannot exceed the hourly SHP values). SHI and APU hours factors were then applied to the hotelling hours to produce the hourly SHI and APU hours of activity. Appendix A incudes the 24-hour summaries of the county-level estimates of hotelling hours, SHI, and APU hours.

Hotelling Activity Scaling Factors

To estimate the analysis year county-level 24-hour hotelling activity, county-level hotelling activity scaling factors were developed using the county-level 2004 summer weekday link-level VMT and speeds, the VMT mix (by MOVES road type), the county-level analysis year summer weekday link-level VMT and speeds, and the VMT mix (by MOVES road type). The 2004 summer weekday link-level VMT and speeds were developed using a process similar to the 2014 summer weekday link-level VMT speed estimation. The vehicle type VMT mixes were the same VMT mixes used to estimate emissions in the emissions estimation process. For the base weekday vehicle type VMT mix, the 2006 weekday vehicle type VMT mix was used.

For each link in the 2004 summer weekday link-level VMT and speeds, the link VMT was allocated to CLhT_Diesel using the base weekday vehicle type VMT mix. This VMT allocation was performed for each link and hour in the 2004 summer weekday link-level VMT and speeds, with the individual link VMT aggregated by hour to produce the CLhT_Diesel hourly and 24- hour 2004 summer weekday VMT. Using a similar allocation process, the analysis year summer weekday CLhT_Diesel hourly and 24-hour VMT was calculated using the analysis year summer weekday link-level VMT and speeds and the analysis year vehicle type VMT mix. The county- level 24-hour hotelling activity scaling factors by analysis year were calculated by dividing the analysis year and day type CLhT_Diesel 24-hour VMT by the CLhT_Diesel 24-hour 2004 summer weekday VMT.

Hotelling Activity Hourly Factors

To allocate the analysis year summer weekday county-level 24-hour hotelling activity to each hour of the day, hotelling activity hourly factors were used. These hotelling activity hourly factors were calculated as the inverse of the analysis year summer weekday CLhT_Diesel hourly VMT fractions. The analysis year summer weekday CLhT_Diesel hourly VMT fractions were calculated using the hourly analysis year summer weekday CLhT_Diesel VMT. The hourly analysis year summer weekday

CLhT_Diesel VMT was converted to hourly fractions, therefore creating analysis year summer weekday CLhT_Diesel hourly VMT fractions. The inverse of these hourly VMT fractions were calculated and the inverse for each hour was divided by the sum of the inverse hourly VMT fractions across all hours to calculate the county-level analysis year summer weekday hotelling activity hourly factors.

County-Level CLhT_Diesel Hotelling Activity by Hour Estimation

The initial analysis year summer weekday CLhT_Diesel hotelling activity by hour was calculated by multiplying the 24-hour 2004 summer weekday hotelling hours by the analysis year hotelling activity scaling factor and by the analysis year hotelling activity hourly factors. For each hour, the initial analysis year weekday hotelling activity was then compared to the analysis year weekday CLhT_Diesel SHP to estimate the final analysis year weekday hotelling activity by hour. If the initial analysis year weekday hotelling activity value was greater than the analysis year weekday SHP value, then the final analysis year weekday hotelling activity for that hour was set to the analysis year weekday CLhT_Diesel SHP value. Otherwise, the final analysis year weekday hotelling activity for that hour was set to the base analysis year weekday hotelling activity value. All calculations (scaling factors, hotelling activity hourly factors, and hotelling activity by hour calculations) were performed by county and analysis year (i.e., eight hotelling activity scaling factors were calculated per analysis year).

County-Level CLhT_Diesel SHI and APU Hours Estimation

The analysis year summer weekday hourly county-level hotelling activity was then allocated to SHI and APU hours activity components using the aggregate extended idle mode and APU mode fractions. For each hour, the analysis year summer weekday hotelling activity was multiplied by the SHI fraction to calculate the analysis year summer weekday hourly SHI activity and by the APU fraction to calculate the analysis year summer weekday hourly APU activity.

The aggregate SHI and the APU fractions were estimated using model year travel fractions (based on source type age distribution and relative mileage accumulation rates used in the MOVES runs) and the MOVES default hotelling activity distribution (i.e., a bi-modal distribution of 1.0 SHI prior to the 2010 model year and a 0.7/0.3 SHI/APU activity allocation for 2010 and later model years). The associated travel fractions were applied to the appropriate extended idle and APU operating mode fractions (of the hotelling operating mode distribution) by model year and summed within each mode to estimate the aggregate (across model years) individual SHI and APU fractions (which sum to 1.0).

CHAPTER 4: ESTIMATION OF EMISSION FACTORS

MOVES2014 Model and Input Parameters

The Environmental Protection Agency's (EPA) 2014 Motor Vehicle Emissions Simulator (MOVES2014) model is used to develop 2014 vehicle emission factors for this analysis. The emission factors are one component in the equation to determine emissions from the region's on-road vehicles. MOVES2014 parameters are listed below in Exhibits 12 through 20 with the appropriate data source and/or methodology applied. Information listed applies to all counties unless otherwise specified. Referenced files identifying specific local data are included in Appendix A. MOVES2014 input files utilizing these parameters and data for each county are included in Appendix B.

Exhibit 12: Modeled Pollutants

Pollutant ID	Pollutant Name	Pollutant Abbreviation
87	Volatile Organic Compounds	VOC
2	Carbon Monoxide	CO
3	Oxides of Nitrogen	NOx
30	Ammonia	NH_3
31	Sulfur Dioxide	SO_2
100	Primary Exhaust PM_{10} - Total	PM10TOT_EXH
106	Primary PM10 - Brakewear Particulate	PM10BW
107	Primary PM10 - Tirewear Particulate	PM10TW
110	Primary Exhaust $PM_{2.5}$ - Total	PM25TOT_EXH
111	Organic Carbon	Organic Carbon
112	Elemental Carbon	Elemental Carbon
115	Sulfate Particulate	Sulfate Particulate
116	Primary $PM_{2.5}$ - Brakewear Particulate	PM25BW
117	Primary $PM_{2.5}$ - Tirewear Particulate	PM25TW
90	Atmospheric CO_2	CO_2
20	Benzene	BENZ
21	Ethanol	ETHNL
22	Methyl Tertiary-butyl Ether	MTBE
24	1,3-Butadiene	BUTA
25	Formaldehyde	Formaldehyde
26	Acetaldehyde	Acetaldehyde
27	Acrolein	Acrolein
40	2,2,4-Trimethylpentane	224-Trimethylpentane
41	Ethyl Benzene	EthylBenzene
42	Hexane	Hexane
43	Propionaldehyde	Propionaldehyde
44	Styrene	Styrene
45	Toluene	Toluene

Exhibit 12: Modeled Pollutants (continued)

Pollutant ID	Pollutant Name	Pollutant Abbreviation
46	Xylene	Xylene
60	Mercury Elemental Gaseous	Hg Egas
61	Mercury Divalent Gaseous	Hg Dgas
62	Mercury Particulate	Hg
63	Arsenic Compounds	As
64	Chromium 3+	Cr+3
65	Chromium 6+	Cr+6
66	Manganese Compounds	Mn
67	Nickel Compounds	Ni
68, 168	Dibenzo(a,h)anthracene particle & gas	Dibenzo(ah)anthracene^
69, 169	Fluoranthene particle & gas	Fluoranthene^
70, 170	Acenaphthene particle & gas	Acenaphthene^
71, 171	Acenaphthylene particle & gas	Acenaphthylene^
72, 172	Anthracene particle & gas	Anthracene^
73, 173	Benz(a)anthracene particle & gas	Benz(a)anthracene^
74, 174	Benzo(a)pyrene particle & gas	Benzo(a)Pyrene^
75, 175	Benzo(b)fluoranthene particle & gas	Benzo(b)fluoranthene^
76, 176	Benzo(g,h,i)perylene particle & gas	Benzo(ghi)perylene^
77, 177	Benzo(k)fluoranthene particle & gas	Benzo(k)fluoranthene^
78, 178	Chrysene particle & gas	Chrysene^
81, 181	Fluorene particle & gas	Fluorene^
82, 182	Indeno(1,2,3,c,d)pyrene particle & gas	Indeno(123cd)pyrene^
83, 183	Phenanthrene particle & gas	Phenanthrene^
84, 184	Pyrene particle & gas	Pyrene^
23, 185	Naphthalene particle & gas	Naphthalene
130	1,2,3,7,8,9-Hexachlorodibenzo-p-Dioxin	123789-Hexachlorodibenzo-p-Dioxin *
131	Octachlorodibenzo-p-dioxin	Octachlorodibenzo-p-dioxin*
132	1,2,3,4,6,7,8-Heptachlorodibenzo-p-Dioxin	1234678-Heptachlorodibenzo-p-Dioxin*
133	Octachlorodibenzofuran	Octachlorodibenzofuran*
134	1,2,3,4,7,8-Hexachlorodibenzo-p-Dioxin	123478-Hexachlorodibenzo-p-Dioxin*
135	1,2,3,7,8-Pentachlorodibenzo-p-Dioxin	12378-Pentachlorodibenzo-p-Dioxin*
136	2,3,7,8-Tetrachlorodibenzofuran	2378-Tetrachlorodibenzofuran*
137	1,2,3,4,7,8,9-Heptachlorodibenzofuran	1234789-Heptachlorodibenzofuran*
138	2,3,4,7,8-Pentachlorodibenzofuran	23478-Pentachlorodibenzofuran*
139	1,2,3,7,8-Pentachlorodibenzofuran	12378-Pentachlorodibenzofuran*
140	1,2,3,6,7,8-Hexachlorodibenzofuran	123678-Hexachlorodibenzofuran*
141	1,2,3,6,7,8-Hexachlorodibenzo-p-Dioxin	123678-Hexachlorodibenzo-p-Dioxin*
142	2,3,7,8-Tetrachlorodibenzo-p-Dioxin	2378-Tetrachlorodibenzo-p-Dioxin*

Exhibit 12: Modeled Pollutants (continued)

Pollutant ID	Pollutant Name	Pollutant Abbreviation
143	2,3,4,6,7,8-Hexachlorodibenzofuran	234678-Hexachlorodibenzofuran*
144	1,2,3,4,6,7,8-Heptachlorodibenzofuran	1234678-Heptachlorodibenzofuran*
145	1,2,3,4,7,8-Hexachlorodibenzofuran	123478-Hexachlorodibenzofuran*
146	1,2,3,7,8,9-Hexachlorodibenzofuran	123789-Hexachlorodibenzofuran*

^ Polycyclic Aromatic Hydrocarbons (PAH), summed to report total PAH emissions.
*Dioxin and Furans, summed to report total Dioxin and Furan emissions.

Exhibit 13: Model Details

Command	Input Parameter Values	Description
MOVES Model Version	MOVES2014	EPA made MOVES2014 available on July 31, 2014, officially released the MOVES2014 for SIP applications on October 7, 2014 (70 FR 60343), and released an update on October 27, 2014
Calendar Year	2014	Analysis Year

Exhibit 14: MOVES Input Parameters

Input Parameter Name	Description	Source
Source Type Population	Input number of vehicles in geographic area to be modeled for each vehicle. Texas Transportation Institute's (TTI) MOVESpopulationBuild module is used to convert MOVES2014 based Texas Department of Motor Vehicles (TxDMV) registration data for each county into 13 MOVES2014 Source Use Type (SUT) population.	2014 TxDMV registration data
Source Type Age Distribution	Input provides distribution of vehicle counts by age for each calendar year and vehicle type. TxDMV registration data used to estimate age distribution of vehicle types up to 30 years. Distribution of Age fractions should sum up to 1.0 for all vehicle types for each analysis year.	2014 TxDMV registration data MOVES default used for buses
Vehicle Type Vehicle Miles of Travel	County specific vehicle miles of travel (VMT) distributed to six highway performance monitoring system (HPMS) Vehicle types.	Travel Model Output
Average Speed Distribution	Input average speed data specific to vehicle type, road type, and time of day/type of day into 16 speed bins. Sum of speed distribution to all speed bins for each road type, vehicle type, and time/day type is 1.0.	Travel Model Output
Road Type Distribution (VMT Fractions)	Input county specific VMT by road type. VMT fraction distributed between the road type and must sum to 1.0 for each source type.	Travel Model Output
Ramp Fraction	Input county specific fraction of ramp driving time on rural and urban restricted roadway type.	Travel Model Output
Fuel Supply	Input to assign existing fuels to counties, months, and years, and to assign the associated market share for each fuel.	Texas Commission on Environmental Quality (TCEQ), EPA Fuel Surveys and default MOVES2014 input where local data unavailable; See Exhibits 19 & 20
Evaluation Month	7	Representing summer season
Minimum/Maximum Temperature	N/A	See Hourly Temperatures

Exhibit 14: MOVES Input Parameters (continued)

Input Parameter Name	Description	Source
Hourly Temperatures	2014 County Level Average Data (June – August)	Dallas-Fort Worth (DFW) Regional, provided by the TCEQ; See Exhibit 15
Relative Humidity	2014 County Level Average Data (June – August)	DFW Regional, provided by the TCEQ; See Exhibit 16
Barometric Pressure	2014 County Level Average Data (June – August)	DFW Regional, provided by the TCEQ; See Exhibit 17
Fuel Formulation	Input county specific fuel properties in the MOVES2014 database.	TCEQ, EPA Fuel Surveys and default MOVES input where local data unavailable; See Exhibits 19 & 20
Inspection and Maintenance Coverage	Input inspection and maintenance (I/M) coverage record for each combination of pollutants, process, county, fuel type, regulatory class and model year are specified using this input.	Local data from the TCEQ; See Exhibit 18
Fuel Engine Fraction / Diesel Fraction (AVFT)	Input fuel engine fractions (i.e. Gasoline vs. Diesel Engines types in the vehicle population) for all vehicle types.	2014 TxDMV registration data. MOVES default used for light-duty vehicles and buses

Exhibit 15: 2014 Average Hourly Temperatures (June – August)[1]

Hour ID	Collin	Dallas	Denton	Ellis	Hood	Hunt	Johnson	Kaufman	Parker	Rockwall	Tarrant	Wise
1	76.75	79.03	77.56	77.05	80.70	75.51	78.55	78.81	78.84	77.11	79.76	77.82
2	75.83	78.09	76.44	76.00	79.29	75.02	77.36	77.87	77.64	76.37	78.88	76.69
3	74.98	77.25	75.38	75.13	78.33	74.32	76.37	77.23	76.70	75.62	77.83	75.85
4	74.23	76.48	74.65	74.39	77.19	73.70	75.59	76.36	75.74	74.99	76.97	74.96
5	73.77	75.70	74.09	73.78	76.44	73.28	74.62	75.80	75.00	74.26	76.35	74.26
6	73.23	75.05	73.34	73.00	75.67	72.97	73.86	75.30	74.25	73.73	75.55	73.46
7	72.99	74.38	72.92	72.53	75.00	72.52	73.09	75.07	73.53	73.15	75.01	72.58
8	74.74	75.36	74.74	72.53	74.69	72.79	73.15	76.61	74.03	73.40	76.21	72.44
9	77.45	77.72	77.62	75.17	77.21	75.34	75.47	79.54	76.55	75.52	79.09	74.62
10	80.29	80.40	80.39	78.33	80.49	78.19	78.37	82.39	79.55	78.38	81.81	77.49
11	82.92	82.78	82.79	81.00	83.18	80.76	80.89	84.81	82.26	80.72	83.99	80.10
12	85.17	85.40	85.00	83.43	85.82	83.15	83.45	86.75	84.71	83.03	86.69	82.56
13	87.16	87.31	87.03	85.63	87.87	85.15	85.63	88.88	86.94	85.20	88.70	84.92
14	88.62	88.95	88.54	87.55	89.73	86.81	87.47	90.44	88.65	86.89	89.95	86.71
15	89.55	90.01	89.55	88.79	91.22	88.39	88.82	91.47	90.02	88.48	91.14	88.19
16	89.97	90.43	90.27	89.64	92.14	89.40	89.99	92.13	90.96	89.45	91.76	89.33
17	90.20	90.62	90.06	90.26	92.75	89.46	90.66	92.06	91.10	89.48	91.80	89.33
18	89.65	90.15	89.56	90.29	92.88	89.26	90.64	91.27	90.95	89.44	91.44	89.32
19	88.26	89.21	88.46	89.24	92.13	88.39	89.74	89.80	90.01	88.53	90.23	88.72
20	85.57	87.18	86.10	87.39	90.58	86.12	88.07	87.39	88.10	86.62	88.49	87.24
21	82.63	85.49	83.01	84.18	88.15	81.98	85.29	84.01	85.36	83.42	85.49	84.50
22	80.54	82.54	81.22	81.11	85.39	78.98	82.88	82.12	82.93	80.81	83.54	81.70
23	78.97	81.24	79.93	79.46	83.39	77.45	81.17	80.71	81.34	79.29	82.35	80.19
24	77.80	80.07	78.90	78.10	82.03	76.59	79.78	79.56	80.06	78.10	80.92	78.97

[1]Information provided by the TCEQ, based on combined data sets from Leading Environmental Analysis and Display System (LEADS), NWS, and U.S. Air Force

Exhibit 16: 2014 Average Hourly Relative Humidity (June – August)[1]

Hour ID	Collin	Dallas	Denton	Ellis	Hood	Hunt	Johnson	Kaufman	Parker	Rockwall	Tarrant	Wise
1	78.05	68.91	72.63	70.90	63.52	78.42	76.24	77.89	65.87	78.09	66.46	65.71
2	80.21	71.16	75.38	73.70	66.97	79.08	80.23	80.61	69.12	80.25	68.54	69.04
3	81.87	73.10	77.93	76.09	69.14	81.03	82.87	82.33	71.71	82.01	71.08	71.75
4	84.24	75.15	80.20	78.63	72.02	81.93	85.16	85.05	74.43	83.92	73.32	74.42
5	84.83	77.07	81.76	80.72	73.98	83.10	88.10	86.24	76.40	85.37	75.12	76.43
6	85.92	78.83	83.79	83.00	76.09	84.03	90.56	87.45	78.12	86.54	77.00	78.22
7	86.43	80.32	84.43	84.49	77.66	85.18	92.26	88.41	80.07	87.91	78.46	80.52
8	83.12	79.17	81.02	85.41	78.72	85.03	92.64	85.18	79.61	88.10	76.47	81.62
9	76.55	73.79	74.35	80.07	74.00	78.92	88.16	77.97	74.29	83.50	70.23	76.61
10	69.13	67.53	67.58	71.70	67.01	71.85	81.21	69.97	67.44	77.18	64.10	69.53
11	63.24	61.95	62.18	63.71	60.88	65.57	74.20	62.99	61.33	71.70	59.26	63.56
12	58.42	55.92	57.10	57.66	55.29	59.61	67.71	58.15	55.87	66.59	53.78	57.71
13	54.30	51.86	52.22	52.65	50.65	55.27	61.95	52.72	51.13	61.72	49.65	52.35
14	50.92	48.35	49.43	48.12	46.82	51.31	57.56	49.01	47.28	57.93	47.15	48.37
15	48.57	46.08	47.46	45.84	43.85	47.78	54.16	46.43	44.38	54.51	44.65	45.11
16	47.66	45.01	45.09	43.88	42.11	45.13	51.31	45.03	42.43	52.19	43.32	42.49
17	47.33	44.37	45.32	41.90	40.22	45.04	49.76	44.40	41.86	52.09	42.78	42.41
18	47.88	44.85	45.89	41.66	39.67	45.55	48.49	45.80	41.67	52.00	42.69	42.08
19	50.40	46.32	47.12	42.79	40.73	47.11	49.76	48.78	42.99	53.25	44.30	42.94
20	55.66	49.96	51.46	46.07	43.43	51.71	53.03	53.54	46.22	56.61	47.20	45.47
21	61.60	52.89	57.95	52.48	47.86	61.72	58.94	61.70	51.14	62.38	52.76	50.39
22	66.90	60.24	62.38	59.66	53.67	69.15	64.62	66.92	56.16	68.51	57.33	55.74
23	71.67	63.40	66.18	64.67	57.99	73.25	68.77	71.30	59.92	72.46	60.37	59.25
24	75.21	66.35	69.36	68.56	60.68	75.78	72.74	75.35	62.85	75.53	63.75	62.47

[1]Information provided by the TCEQ, based on combined data sets from LEADS, NWS, and U.S. Air Force

Exhibit 17: 2014 Average Barometric Pressure (June – August)

County	Barometric Pressure
Collin	29.96
Dallas	29.94
Denton	29.94
Ellis	29.94
Hood	29.93
Hunt	29.96
Johnson	29.94
Kaufman	29.96
Parker	29.93
Rockwall	29.96
Tarrant	29.94
Wise	29.92

[1]Information provided by the TCEQ, based on combined data sets from LEADS, NWS, and U.S. Air Force

Exhibit 18: 2014 Inspection and Maintenance Details

Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant I/M Data*						
I/M Program ID	20	21	22	23	24	Identifies program number with MOVES2014 Database
Pollutant Process ID	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	101, 102, 201, 202, 301, 302	112	112	
Source Use Type	21, 31, 32	21, 31, 32	52, 54	21, 31, 32	21, 31, 32	
Begin Model Year	1996	X	X	X	1996	
End Model Year	Y	1995	Y	1995	Y	
Inspect Frequency	1	1	1	1	1	Annual testing; program specifications
Test Standards Description	Exhaust OBD Check	ASM 2525/5015 Phase-in Cut Points	Two-mode, 2500 RPM/Idle Test	Evaporative Gas Cap Check	Evaporative Gas Cap and OBD Check	
I/M Compliance	93.12% for source type 21, 91.26% for source type 31 and 86.6% for source type 32^					Expected compliance (%)

Source: TCEQ
ASM – Acceleration Simulation Mode; RPM – Revolutions Per Minute
Note: Begin Model Year and End Model Year define the range of vehicle model years covered by I/M program. Begin Model Year, represented by "X" is calculated as YearID – 2 and End Model Year, represented by "Y" is calculated as YearID – 24.
*Wise County does not have an I/M program
^http://www.epa.gov/otaq/models/moves/documents/420b15007.pdf

Exhibit 19: MOVES2014 Fuel Properties – Summer 2014

Counties	Core	Perimeter	All
Fuel Type	**Gasoline**[1]		**Diesel**[2]
Fuel Formulation ID	10704	10702	30002
Fuel Subtype ID	12	12	20
RVP	7.10	7.52	0.00
Sulfur Level	28.47	30.84	6.18
Ethanol Volume	9.70	9.76	0.00
Methyl Tertiary Butyl Ether (MTBE) Volume	0.00	0.00	0.00
Ethyl Tertiary Butyl Ether (ETBE) Volume	0.00	0.00	0.00
Tertiary Amyl Methyl Ether (TAME) Volume	0.00	0.00	0.00
Aromatic Content	14.42	22.65	0.00
Olefin Content	13.36	11.75	0.00
Benzene Content	0.44	0.55	0.00
e200	49.00	49.82	0.00
e300	84.30	83.70	0.00
Vol To Wt Percent Oxy	3.38	3.38	0.00
BioDiesel Ester Volume	0.00	0.00	0.00
Cetane Index	0.00	0.00	0.00
PAH Content	0.00	0.00	0.00
T50	203.6	203.22	0.00
T90	329.78	322.54	0.00

[1]TTI produced these fuel formulation estimates using local summer 2014 fuel survey sample data (TCEQ survey by ERG for non-RFG counties and EPA Texas RFG survey data). The overall average fuel properties for each region were calculated using the standard procedure of aggregating and averaging by fuel grade (regular [RU], mid-grade [MU], and premium [PU]), and combining them into the final overall averages using latest available statewide gasoline relative sales volumes by grade (U.S. Energy Information Administration: RU – 0.88; MU – 0.062; PU – 0.058).

[2] TTI produced diesel average sulfur estimates using the summer 2014 TCEQ fuel survey diesel sample data by aggregating and averaging sulfur content values for Texas Low-Emission Diesel (TxLED) counties.

Exhibit 20: MOVES2014 Fuel Properties – Winter 2014

Counties	Core	Perimeter	All
Fuel Type	**Gasoline[1]**		**Diesel[2]**
Fuel Formulation ID	10104	13067	30002
Fuel Subtype ID	12	12	20
RVP	10.85	12.07	0.00
Sulfur Level	35.09	30.00	6.18
Ethanol Volume	10.09	10.00	0.00
Methyl Tertiary Butyl Ether (MTBE) Volume	0.00	0.00	0.00
Ethyl Tertiary Butyl Ether (ETBE) Volume	0.00	0.00	0.00
Tertiary Amyl Methyl Ether (TAME) Volume	0.00	0.00	0.00
Aromatic Content	13.86	19.29	0.00
Olefin Content	11.02	10.46	0.00
Benzene Content	0.47	0.61	0.00
e200	58.39	54.30	0.00
e300	86.61	83.59	0.00
Vol To Wt Percent Oxy	3.38	3.38	0.00
BioDiesel Ester Volume	0.00	0.00	0.00
Cetane Index	0.00	0.00	0.00
PAH Content	0.00	0.00	0.00
T50	155.64	186.68	0.00
T90	317.30	326.93	0.00

[1] TTI produced the RFG fuel formulation estimates using local winter 2014 fuel survey sample data (EPA Texas RFG survey data), except for RVP, which is the MOVES default (RVP is not available in the EPA winter RFG data). RFG properties were calculated using the standard procedure of aggregating and averaging by fuel grade (regular [RU], mid-grade [MU], and premium [PU]), and combining them into the final overall averages using latest available statewide sales volumes by grade (U.S. Energy Information Administration: RU – 0.88; MU – 0.062; PU – 0.058). In the absence of recent winter survey data for non-RFG counties, MOVES default formulations were used for the non-RFG counties.

[2] TTI produced diesel average sulfur estimates using the summer 2014 TCEQ fuel survey diesel sample data by aggregating and averaging sulfur content values for TxLED counties.

Summary of Control Programs Modeled

Exhibit 21 summarizes the control measures modeled and the methodology.

Exhibit 21: Emission Control Strategies and Methodology

Individual Control Measures	Approach
Federal Motor Vehicle Control Program Standards	MOVES model – defaults.
Federal Heavy-Duty Diesel Engines Rebuild and 2004 Pull-Ahead Programs to Mitigate NOx Off-Cycle Effects	MOVES model – defaults.
Reformulated Gasoline (RFG)[1]	Local Inputs to MOVES. Used the EPA's 2014 summer season Texas retail outlets RFG survey data to estimate actual summer season 2014 RFG fuel formulations.
Texas Low-Emission Diesel[2]	Sulfur: Local Inputs. Used the TCEQ's summer 2014 statewide retail outlets fuel survey data (diesel samples) to estimate the actual average diesel sulfur levels for the TxLED and non-TxLED region counties. TxLED: For TxLED fuel program counties, post-processed diesel vehicle NO_x emissions factors using evaluation-year-specific average NO_x reduction factors (based on a 4.8% reduction for 2002 and later model year vehicles and a 6.2% reduction for 2001 and earlier model year vehicles).[2]
Inspection and Maintenance (I/M) Program	Used MOVES I/M coverage set-ups for I/M program counties based on the available MOVES I/M parameters (in terms of MOVES I/M "teststandards" and associated "imfactors") pertaining to the group of I/M vehicles, consistent with current program descriptions and latest I/M modeling protocols. The MOVES I/M compliance factors input were per EPA's latest *Technical Guidance* to include the regulatory class adjustments (See Exhibit 18).

[1] RFG required for Collin, Dallas, Denton, and Tarrant Counties

[2] Consistent with benefit information described in the EPA *Memorandum on Texas Low Emission Diesel Fuel Benefits* (EPA, September 2001).

Area Specific Calculations and Procedures

SourceUse Type Distribution

SourceUse type age distributions are calculated from the TxDMV vehicle registration data. July data sets from 2014 are used for light- and heavy-duty vehicle classes. MOVES2014 default values are used for bus categories. Light-duty registration data for Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant and Wise Counties are weighted for commute patterns with the County-to-County Worker Flow data from the American Community Survey for the five-year period between 2006 and 2010. Exhibit 22 identifies the percentages applied for this weighted adjustment. The TTI methodology is applied to the heavy-duty vehicle data for developing registration for all heavy-duty vehicles. These files are included in Appendix B.

Exhibit 22: County to County Worker Flow

	County of Employment											
Resident County	**Collin**	**Dallas**	**Denton**	**Ellis**	**Hood**	**Hunt**	**Johnson**	**Kaufman**	**Parker**	**Rockwall**	**Tarrant**	**Wise**
Collin	65.38%	10.25%	5.08%	0.28%	0.14%	4.24%	0.20%	0.97%	0.05%	7.63%	0.87%	0.00%
Dallas	19.09%	65.97%	10.19%	10.73%	0.91%	3.94%	1.32%	15.83%	0.98%	23.65%	7.69%	0.69%
Denton	11.45%	7.85%	75.56%	0.37%	0.32%	0.04%	0.17%	0.66%	0.94%	0.58%	3.30%	3.12%
Ellis	0.16%	1.79%	0.17%	79.39%	0.18%	0.08%	1.43%	0.74%	0.10%	0.00%	0.55%	0.21%
Hood	0.03%	0.06%	0.05%	0.10%	83.97%	0.00%	2.27%	0.00%	2.39%	0.00%	0.53%	0.37%
Hunt	0.76%	0.42%	0.13%	0.12%	0.00%	84.35%	0.00%	4.37%	0.03%	9.42%	0.03%	0.00%
Johnson	0.05%	0.32%	0.32%	3.46%	3.18%	0.02%	76.23%	0.00%	1.45%	0.16%	3.21%	0.69%
Kaufman	0.29%	1.57%	0.14%	0.74%	0.11%	1.19%	0.02%	72.64%	0.00%	3.59%	0.11%	0.02%
Parker	0.02%	0.14%	0.09%	0.06%	4.33%	0.00%	0.52%	0.02%	77.41%	0.00%	2.57%	5.86%
Rockwall	0.68%	1.23%	0.14%	0.12%	0.49%	5.56%	0.06%	3.70%	0.00%	53.95%	0.06%	0.13%
Tarrant	2.02%	10.29%	7.36%	4.63%	6.17%	0.42%	17.47%	1.06%	14.11%	1.02%	80.26%	10.75%
Wise	0.07%	0.11%	0.76%	0.01%	0.20%	0.17%	0.31%	0.02%	2.55%	0.00%	0.82%	78.15%

Source: American Community Survey for the five-year period between 2006 and 2010.

Fuel Engine Fractions
Diesel fractions for heavy-duty vehicle categories utilized 12-county summed July 2014 registration data. Light-duty and bus categories applied MOVES2014 default values. All diesel fraction files, included in Appendix B, list specific data used for this analysis.

Local Meteorological Data
The meteorological inputs, provided by the TCEQ, were input via the "county" (barometric pressure) and "zonemonthhour" (temperature and relative humidity) tables. These county-level input data were developed as June 1 through August 31, 2014, hourly temperature and relative humidity, and 24-hour barometric pressure averages, using the aggregated hourly observations over this period from the available weather station data in each county (or adjacent county, if needed).

Altitude, also an input of the county table, was set to "low" for all counties. Appendix B summarizes the temperatures, relative humidity, and barometric pressure input values.

MOVES2014 Emission Factors
MOVES2014 emission factors after adjustment of Low Emission Diesel oxides of nitrogen adjustments are reported in Appendix C.

Adjustments
Adjustments are applied to the emission factors in a post-process step. Texas Low Emission Diesel NO_X Adjustment is applied to the emission factors. VMT Mix adjustment is applied simultaneously with the emission calculation procedure discussed in Chapter 5 (See Exhibit 25).

TxLED NO_x Adjustment
The North Central Texas Council of Governments (NCTCOG) developed TxLED factors for the DFW region for the analysis year 2014 using the TCEQ Excel template (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI /Statewide/mvs/txled/). The factors produced employed the TCEQ average diesel source use types NO_X adjustments using 4.8 percent reductions for 2002 and later, and 6.2 percent reductions for 2001 and earlier model years. NO_X reductions are from the EPA Memorandum, *Texas Low Emission Diesel (LED) Fuel Benefits*, September 2001. The TxLED analyses employed 2014 regional age distribution factors for MOVES2014 runs. NO_X, NO, and NO_2 emissions for Dallas County (DFW area representative county) for all vehicle models years were produced for all analysis years. MOVES2014 emissions were extracted from the MOVES2014 output table. The extracted emissions were used in the template to estimate TxLED factors for all diesel vehicles for the pollutants NO_X, NO, and NO_2. Exhibit 23 shows the TxLED factors used for each vehicle class.

Exhibit 23: TxLED NO_X Adjustments

Source Use Type	Adjustment Factors
Passenger Car	0.94409
Passenger Truck	0.94749
Light Commercial Truck	0.94400
Intercity Bus	0.94199
Transit Bus	0.94223
School Bus	0.94231
Refuse Truck	0.94465
Single Unit Short-Haul Truck	0.94970
Single Unit Long-Haul Truck	0.95006
Motor Home	0.94440
Combination Short-Haul Truck	0.94727
Combination Long-Haul Truck	0.94495

Source: NCTCOG

Vehicle Miles of Travel Mix (or Fractions) (VMT Mix)

VMT Mix is a factor applied to the link VMT in conjunction with emission factors in a post-process methodology. The VMT mix enables assignment of VMT by vehicle type to a total VMT/volume on the link to calculate emissions on a link. VMT mix is estimated for each county for MOVES2014 roadway types.

Vehicle counts reported in the Texas Department of Transportation Vehicle Classification Report provide a base for the distribution of vehicles by area type and roadway type. Classification counts from functional classes of frontage roads, and minor and major arterials are aggregated to restricted and unrestricted roadway roadways to correspond to MOVES2014 roadway types. The number of vehicles in each of the 12 axle-based categories are combined into six HPMS vehicle type groups, and then disaggregated into MOVES2014 SUT by applying appropriate TxDMV registration data, and/or MOVES2014 defaults. Motorcycles are allocated as 0.1 percent of the passenger cars and subtracted from the passenger car category. For each roadway type, the values are normalized to the total counts to determine the fraction for each vehicle class and fuel type. Exhibit 24 outlines this process.

This calculated VMT mix is then normalized after applying local truck and non-truck split percentages identified by the DFX model. This process is performed for each of the three functional classes and three time periods, where AM peak is 6:30 a.m. – 8:59 a.m., PM peak is 3:00 p.m. – 6:29 p.m., and Off-peak represents all other hours of the day. Motorcycles, light-duty vehicles, and two-axle light-duty trucks are classified as non-trucks. Trucks and heavy-duty vehicles with three axles or more, including buses, are defined as trucks.

Exhibit 24: Vehicle Classification Process

<table>
<tr><th colspan="2">Axle-based Vehicle Classifications</th><th colspan="2">Intermediate Groups/HPMSVtypeID</th><th colspan="2">Detailed Groups</th></tr>
<tr><td rowspan="3">C</td><td rowspan="3">Passenger Vehicles</td><td rowspan="5">Passenger Vehicles</td><td rowspan="3">Passenger Vehicles (20)</td><td rowspan="3">Passenger Car</td><td>Passenger Gasoline Vehicle</td></tr>
<tr><td>Passenger Diesel Vehicle</td></tr>
<tr><td>Motorcycle^</td></tr>
<tr><td rowspan="2">P</td><td rowspan="2">2 Axle, 4 Tire Single Unit</td><td rowspan="2">Light-duty Trucks (30)</td><td>Passenger Truck</td><td>Passenger Gasoline Truck</td></tr>
<tr><td>Light Commercial Truck</td><td>Light Commercial Gasoline Truck</td></tr>
<tr><td rowspan="5">B</td><td rowspan="5">Buses</td><td rowspan="5">Bus</td><td rowspan="5">Buses (40)</td><td rowspan="2">School Bus</td><td>Gasoline School Bus*</td></tr>
<tr><td>Diesel School Bus*</td></tr>
<tr><td rowspan="2">Transit Bus</td><td>Gasoline Transit Bus*</td></tr>
<tr><td>Diesel Transit Bus*</td></tr>
<tr><td colspan="2">Diesel Intercity Bus*</td></tr>
<tr><td>SU2</td><td>2 Axle, 6 Tire Single Unit</td><td rowspan="4">Heavy Duty Trucks</td><td rowspan="4">Single Unit Heavy-duty Vehicles (50)</td><td rowspan="2">Single Unit Short-haul Truck</td><td>* Single Unit Short-haul Gasoline Truck</td></tr>
<tr><td>SU3</td><td>3 Axle, Single Unit</td><td>Single Unit Short-haul Diesel Truck*</td></tr>
<tr><td>SU4</td><td>4+ Axle, Single Unit</td><td rowspan="2">Single Unit Long-haul Truck</td><td>Single Unit Long-haul Gasoline Truck*</td></tr>
<tr><td>SE4</td><td>3 or 4 Axle, Single Trailer</td><td>Single Unit Long-haul Diesel Truck*</td></tr>
<tr><td>SE5</td><td>5 Axle, Single Trailer</td><td rowspan="5">Heavy Duty Trucks</td><td rowspan="5">Combination Heavy-duty Vehicles (60)</td><td rowspan="3">Combination Short-haul Truck</td><td rowspan="2">Combination Short-haul Gasoline Truck*</td></tr>
<tr><td>SE6</td><td>6+ Axle, Single Trailer</td></tr>
<tr><td>SD5</td><td>5 Axle, Multi Trailer</td><td>Combination Short-haul Diesel Truck*</td></tr>
<tr><td>SD6</td><td>6 Axle, Multi Trailer</td><td colspan="2" rowspan="2">Combination Long-haul Diesel Truck*</td></tr>
<tr><td>SD7</td><td>7+ Axle, Multi Trailer</td></tr>
</table>

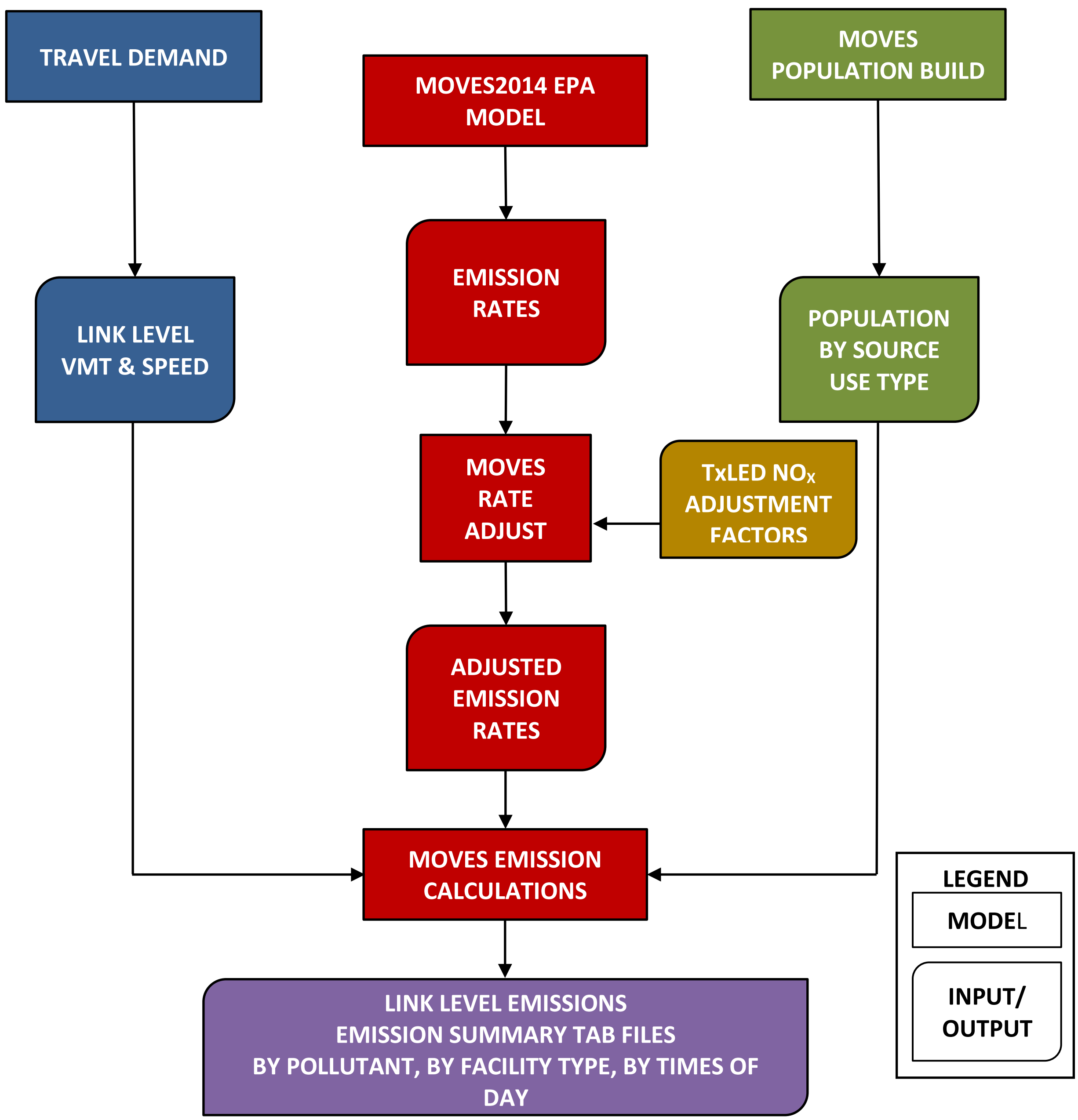
Source: Dallas/Fort Worth Ozone Nonattainment Area State Implementation Plan Support, 2003,Texas Transportation Institute
* Categories calculated using MOVES2014 defaults
^ Motorcycles are allocated as 0.1 percent for each functional class, subtracted from the Light-Duty

CHAPTER 5: ESTIMATION OF EMISSIONS

Emissions estimates are calculated using the "EmsCalc" utility, developed by the Texas Transportation Institute. This software combines vehicle activity and emission factors to create emission estimates.

Exhibit 25 outlines the emission calculation modeling process used to calculate the emissions estimates for the Dallas-Fort Worth (DFW) ozone nonattainment area. Different procedures were applied for DFW Travel Model for the Expanded Area counties outlined in the following sections.

Exhibit 25: MOVES2014 Emission Calculation Modeling Process



Source: NCTCOG

Emissions calculations fall into two categories: vehicle miles of travel (VMT)-based and off-network. The VMT-based emissions calculations use the roadway-based rates and the travel demand model (TDM)-based VMT and speeds to estimate emissions at the TDM network link (or roadway segment) level. The off-network emissions process calculations use off-network rates and off-network activity (Source Hours Parked, starts, Source Hours Idling, and APU hours) to estimate emissions at the county level. Exhibit 26 provides the breakdown of these two types of emission calculations.

EmsCalc output for each county and year included three files: a listing file (of run execution information), a standard tab-delimited inventory summary (with both hourly and 24-hour summary tables), and a tab-delimited 24-hour inventory summary by Source Classification Code.

Exhibit 26: Emission Rates by Process and Activity Factor

<table>
<tr><th>Emissions Processes</th><th>Activity</th><th>Emissions Factor</th></tr>
<tr><td>Running Exhaust
Crankcase Running Exhaust
Brake Wear
Tire Wear</td><td>VMT</td><td>mass/mile</td></tr>
<tr><td rowspan="2">Evaporative Permeation
Evaporative Fuel Vapor Venting
Evaporative Fuel Leaks</td><td>VMT</td><td>mass/mile</td></tr>
<tr><td>SHP</td><td>mass/shp</td></tr>
<tr><td>Start Exhaust
Crankcase Start Exhaust</td><td>Starts</td><td>mass/start</td></tr>
<tr><td>Auxiliary Power Exhaust</td><td>APU hours</td><td>mass/APU hour</td></tr>
<tr><td>Extended Idle Exhaust
Crankcase Extended Idle Exhaust</td><td>SHI</td><td>mass/shi</td></tr>
</table>

CHAPTER 6: ESTIMATION OF ANNUAL ACTIVITY AND EMISSIONS

Two of the main components of the summer weekday emissions are activity and emissions rates. To incorporate seasonal changes in both the activity and emissions rates, activity and emissions rate annualization factors were used in the annualization methodology.

The activity annualization factors consist of a vehicle miles of travel (VMT) annualization factor, a hotelling hours annualization factor (used for source hours idling (SHI) and auxiliary power unit (APU) hours, starts annualization factors by source use type (SUT), and source hours parked (SHP) annualization factors by SUT. These factors were used to convert the seasonal weekday activity component of the emissions and to annualize the summer weekday activity.

The emissions rate annualization factors by pollutant, process, SUT, fuel type, and aggregate road type (restricted access, unrestricted access, and off-network) are calculated from Motor Vehicle Emissions Simulator (MOVES) inventory mode runs. These factors were needed to accommodate changes in emissions rates between the summer weekday season and the remainder of the year due to the variation in various seasonal parameters.

Generally, the summer weekday activity was annualized by applying the appropriate activity annualization factor to the summer weekday activity and the summer weekday emissions were annualized by applying the appropriate activity annualization factor and emissions rate annualization factor to the summer weekday emissions. In some cases, emissions rate annualization factors do not exist (mainly due to emissions existing in some seasons but not in summer weekday). In these cases, the annual emissions are calculated by multiplying the annual emissions rate (from the emissions rate annualization factor procedures) by the annual activity.

Annual Activity and Annualization Factors

To estimate the annual emissions and build the annual MOVES inventory mode databases (discussed in a later section) in a consistent manner (i.e., annualized summer weekday activity is closely replicated by a MOVES inventory mode run), the summer weekday activity (VMT, hotelling hours, starts, and SHP) was converted to annual activity based on the MOVES calculation procedures to a format suitable for use with the MOVES inventory mode. This annual activity was then used to construct the activity annualization factors that were applied during the annual emissions estimation process.

Annual VMT and Annualization Factors

The MOVES calculation procedure for VMT allocates annual VMT by the MOVES defined Highway Performance Monitoring SystemHPMS vehicle types to summer weekday VMT by HPMS vehicle type using month VMT fractions, day VMT fractions, number of days in the month, and the number of days in the period for the day VMT fraction. The formula for the MOVES VMT allocation procedure is:

$$SWkdVMT_{HPMSVtype} = AVMT_{HPMSVtype} * monthFract_{Month} * dayFract_{Month,DayType} / (noOfDays/7) / noOfRealDays$$

Where:

$SWkdVMT_{HPMSVtype}$	=	summer weekday VMT by HPMS vehicle type;
$AVMT_{HPMSVtype}$	=	annual VMT by HPMS vehicle type;
$monthFract_{Month}$	=	month VMT fraction for the desired month;
$dayFract_{Month,DayType}$	=	day VMT fraction for the desired day type (weekday or weekend

day by month);

noOfDays = number of days in the desired month; and

noOfRealDays = number of days in the desired day type (5 for weekday, 2 for weekend day).

Since the objective is to estimate annual VMT from the summer weekday VMT, the formula from the MOVES VMT allocation procedure can be transformed to calculate the annual VMT from the summer weekday VMT by reversing the calculations. The formula for calculating the annual VMT by HPMS vehicle type from the summer weekday VMT is:

$$AVMT_{HPMSVtype} = SWkdVMT_{HPMSVtype} * noOfRealDays * (noOfDays/7) / dayFract_{Month,DayType} / monthFract_{Month}$$

The number of days in the day type (noOfRealDays) and number of days in the month (noOfDays) are determined by the emissions inventory being annualized. Since the inventories are for summer (July) weekday, the number of days in the day type was set to 5 and the number of days in the month was set to 31. Day VMT fractions and month VMT fractions were developed by TxDOT district using aggregated ATR data (years 2004 - 2013). For each county, this calculation procedure was applied to the summer weekday VMT for each HPMS vehicle type and saved for use in building the annual MOVES inventory mode databases.

The county-level VMT annualization factor was then calculated by dividing the county total annual VMT by the county total summer weekday VMT. The annual VMT, summer weekday VMT, and VMT annualization factors are shown in Chapter 8.

Annual Hotelling Hours and Annualization Factors

The annual hotelling hours were calculated using similar logic and input parameters as the VMT annualization procedure. Since the hotelling hours input to MOVES is required by age, the hourly summer weekday hotelling hours (from the emissions inventory development process) was distributed to each age category using travel fractions. The hourly summer weekday hotelling hours by age was then converted to hourly annual hotelling hours by age. The hourly annual hotelling hours by age was then converted to the proper format for use with the MOVES inventory mode databases (hotelling hours by month, day type, hour, and age). The county total annual hotelling hours were then used to calculate the hotelling annualization factor, which was used during the emissions annualization process to annualize the SHI and APU hours activity.

Travel fractions were used to distribute the hourly summer weekday hotelling hours to each of the MOVES age categories. These travel fractions were calculated using the county-specific age distribution for SUT 62 (also used in the MOVES emissions rate runs) and the county- specific relative mileage accumulation rates (adjusted to reflect the VMT mix in the summer weekday emissions inventory) for SUT 62. The travel fractions by age were calculated by multiplying the age distribution by the relative mileage accumulation rates for each age and dividing by the sum of the product for all the age categories. The travel fractions were calculated using the following formula:

$$TF_{Age} = (STAD_{Age} * RelMAR_{Age}) / \sum(STAD_{Age} * RelMAR_{Age})$$

Where:

TF_{Age} = the travel fractions by age category;

$STAD_{Age}$ = source type age distribution for SUT 62 by age;

$RelMAR_{Age}$	=	relative mileage accumulation rates by age (adjusted to reflect the VMT mix in the summer weekday emissions inventory) for SUT 62 by age; and
∑ ( )	=	sum of ($STAD_{Age}$ * $RelMAR_{Age}$) across all age categories.

The travel fractions were then used to calculate the hourly summer weekday hotelling hours by age from the hourly summer weekday hotelling hours used in the emissions inventory development process. The hourly summer weekday hotelling hours by age were calculated using the following formula:

$$SWkdHH_{Hour,Age} = SWkdHH_{Hour} * TF_{Age}$$

Where:

$SWkdHH_{Hour,Age}$	=	hourly summer weekday hotelling hours by age;
$SWkdHH_{Hour}$	=	hourly summer weekday hotelling hours from the emissions inventory development process; and
TF_{Age}	=	the travel fractions by age category.

The hourly annual hotelling hours by age are then calculated using a similar procedure to the annual VMT using the day and month fractions (see Appendix A):

$$AHH_{Hour,Age} = SWkdHH_{Hour,Age} * noOfRealDays *(noOfDays/7)/ dayFract_{Month,DayType} / monthFract_{Month}$$

Where:

$AHH_{Hour,Age}$	=	hourly annual hotelling hours by age;
$SWkdHH_{Hour,Age}$	=	hourly summer weekday hotelling hours by age; number of
NoOfRealDays	=	days in the desired day type – 5 for summer weekday;
noOfDays	=	number of days in the desired month – 31 for summer (July) weekday;
$dayFract_{Month,DayType}$	=	day VMT fraction for summer (July) weekday; and
$mmonthFract_{Month}$	=	month VMT fraction for summer (July) weekday.

Since the annual MOVES inventory mode databases also require the hotelling hours input for each month and day type (weekday and weekend day) portions of the week, the annual hotelling hours by age were calculated for each month and day type period (total of 24 sets of hotelling hours) using the following formula:

$$HH_{Month,DayPeriod,Hour,Age} = AHH_{Hour,Age} * monthFract_{Month} * dayFract_{Month,DayType} / (noOfDays/7)$$

Where:

$HH_{Month,DayPeriod,Hour,Age}$	=	hotelling hours by month, day type period, hour, and age;
$AHH_{Hour,Age}$	=	hourly annual hotelling hours by age;
$monthFract_{Month}$	=	month VMT fraction;
$dayFract_{Month,DayType}$	=	day VMT fraction; and
noOfDays	=	number of days in the month.

The hotelling annualization factor was then calculated by dividing the county total hotelling hours by the county total summer weekday hotelling hours. This hotelling annualization factor was used for annualizing the SHI and APU hours activity in the emissions annualization process. The annual hotelling hours, summer weekday hotelling hours, and annualization factors are shown in Chapter 8.

Annual Starts and Annualization Factors

The annual starts inputs to MOVES require starts by month, portion of the week (weekday portion and weekend day portion), hour, SUT, and age. These annual starts were calculated based on the summer weekday starts from the emissions inventory development process. The annual starts were also used, along with the summer weekday starts, to calculate county-level starts annualization factors by SUT.

In the emissions inventory development process, summer weekday starts were calculated by hour, SUT, and fuel type using the MOVES default weekday starts per vehicle. Since the MOVES default starts-per-vehicle do not vary by fuel type, all calculations were performed by SUT. To calculate the annual starts from the summer weekday starts, the starts for a summer weekend day must be calculated. This calculation was performed using weekend day equivalency factors, which were calculated by dividing the hourly MOVES default weekend day starts-per-vehicle by the hourly MOVES default weekday starts-per-vehicle. These equivalency factors were calculated using the formula:

$$WEDSEF_{Hour,SUT} = WEDSPV_{Hour,SUT} / WKDSPV_{Hour,SUT}$$

Where:

$WEDSEF_{Hour,SUT}$ = weekend day starts equivalency factors by hour and SUT;
$WEDSPV_{Hour,SUT}$ = MOVES default weekend day starts-per-vehicle by hour and SUT; and
$WKDSPV_{Hour,SUT}$ = MOVES default weekday starts-per-vehicle by hour and SUT.

These equivalency factors were then used to convert the summer weekday starts from the emissions inventory development process to summer weekend day starts. The hourly summer weekday starts (by SUT and fuel type) were aggregated by SUT to produce hourly summer weekday starts by SUT and the equivalency factors were applied to calculate the summer weekend day starts by SUT. The summer weekend day starts were calculated using the following formula:

$$WEDS_{Hour,SUT} = WKDS_{Hour,SUT} * WEDSEF_{Hour,SUT}$$

Where:

$WEDS_{Hour,SUT}$ = summer weekend day starts by hour and SUT;
$WKDS_{Hour,SUT}$ = summer weekday starts by hour and SUT; and
$WEDSEF_{Hour,SUT}$ = weekend day starts equivalency factors by hour and SUT.

MOVES requires starts by portion of the week (weekday portion and weekend portion), which means the summer weekday and summer weekend day starts by hour and SUT must be converted to portion of the week. This conversion is performed using the number of days in the portion of week (5 for weekday, 2 for weekend day). The following formula was used to convert both the summer weekday and summer weekend day starts to portions of the week:

$$StartsWeek_{Portion,Hour,SUT} = DailyStarts_{Day Type,Hour,SUT} * noOfRealDays$$

Where:

$Starts_{Week,Hour,SUT}$	=	starts by portion of the week, hour, and SUT;
$DailyStarts_{Hour,SUT}$	=	daily starts by day type, hour, and SUT (summer weekday and summer weekend day); and
noOfRealDays	=	number of days in the portion of the week (5 for weekday, 2 for weekend day).

Since the MOVES default starts-per-vehicle and the vehicle population used to calculate starts do not vary by month, the starts for each month were set equal to the summer weekday portion of the week and summer weekend day portion of the week starts by hour and SUT, which completes the data set required for the MOVES inventory mode database. To calculate the starts annualization factors by SUT, the annual starts by SUT must be calculated. Since the monthly starts are by portion of the week, weekly starts by SUT are calculated for each month by summing the portion of the week starts and the weekly starts by SUT are converted to monthly starts by SUT. These monthly starts were then summed to obtain the annual starts by SUT using the following formula:

$$AStarts_{SUT} = \sum [WStarts_{Month,SUT} * (noOfDays/7)]$$

Where:

$AStarts_{SUT}$	=	annual starts by SUT;
$WStarts_{Month,SUT}$	=	weekly starts by month and SUT;
noOfDays	=	number of days in the month; and
∑ [ ]	=	sum of the monthly starts.

The second component of the starts annualization factors by SUT is the summer weekday starts by SUT. The summer weekday starts by hour and SUT used in the emissions inventory development process were aggregated across hours and fuel types for each SUT to produce summer weekday starts by SUT. The annual starts by SUT were then divided by the summer weekday starts by SUT to produce the starts annualization factors by SUT. The annual starts, summer weekday starts, and annualization factors are shown in Chapter 8.

Annual SHP and Annualization Factors

The annual SHP required to calculate SHP annualization factors was calculated using a process very similar to MOVES. This annual SHP was then used, along with the summer weekday SHP, to calculate SHP annualization factors. All calculations were performed for each county.

The first step in calculating annual SHP is to calculate the SUT vehicle population by age using the source type age distribution. Following is the formula used to calculate the SUT vehicle population by age:

$$VehPop_{SUT,Age} = VehPop_{SUT} * AgeDist_{SUT,Age}$$

Where:

$VehPop_{SUT,Age}$	=	vehicle population by SUT and age;
$VehPop_{SUT}$	=	vehicle population by SUT; and
$AgeDist_{SUT,Age}$	=	source type age distribution by SUT and age.

The next step in calculating the annual SHP is to calculate the vehicle population within each MOVES designated HPMS vehicle class. Each SUT in the vehicle population by SUT is assigned an HPMS vehicle class and the vehicle population is summed for each HPMS vehicle type.

The next step in calculating the annual SHP is to calculate the vehicle population fractions within each HPMS vehicle class. For each SUT, the vehicle population by SUT and age is assigned an HPMS vehicle class and divided by the appropriate HPMS vehicle class. Following is the formula for calculating the vehicle population fractions within each HPMS vehicle class:

$$HVehFract_{SUT,Age} = VehPop_{SUT,Age} / VehPop_{HPMSvtype}$$

Where:

$HVehFract_{SUT,Age}$	=	vehicle population fractions within each HPMS vehicle class by SUT, and age;
$VehPop_{SUT,Age}$	=	vehicle population by SUT and age; and
$VehPop_{HPMSvtype}$	=	vehicle population by HMPS vehicle type.

The next step in calculating the annual SHP is to calculate the travel fractions by SUT and age. These travel fractions, which represent the amount of travel by SUT and age within each HPMS vehicle type, were calculated by multiplying the vehicle population fractions within each HPMS vehicle class (SUT and age) by the relative mileage accumulation rates (SUT and age) and divided by the sum of the product by HPMS vehicle type. The relative mileage accumulation rates were adjusted to reflect the 24-hour VMT mix contained in the summer weekday activity and emissions. Following is the formula for calculating the travel fractions by SUT and age:

$$TF_{SUT,Age} = HVehFract_{SUT,Age} * relMAR_{SUT,Age} / \sum(HVehFract_{SUT,Age} * relMAR_{SUT,Age})_{HPMSvtype}$$

Where:

$TF_{SUT,Age}$	=	travel fraction by SUT and age;
$HVehFract_{SUT,Age}$	=	vehicle population fractions within each HPMS vehicle class by SUT and age;
$relMAR_{SUT,Age}$	=	relative mileage accumulation rates by SUT and age; and
$\sum$ ( )	=	sum of ($HVehFract_{SUT,Age}$ * $relMAR_{SUT,Age}$) across HPMS vehicle type.

The annual VMT by road type, SUT, and age was then calculated by multiplying the annual VMT by HPMS vehicle type (from the VMT annualization process described previously), the road type distribution by SUT and road type, and the travel fractions. Following is the formula for calculating the annual VMT by road type, SUT, and age:

$$AVMT_{RoadType,SUT,Age} = AVMT_{HPMSVtype} * RDIST_{SUT,RoadType} * TF_{SUT,Age}$$

Where:

$AVMTR_{oadType,SUT,Age}$	=	annual VMT by road type, SUT and age;
$AVMT_{HPMSVtype}$	=	annual VMT by HPMS vehicle type; and
$TF_{SUT,Age}$	=	travel fraction by SUT and age.

The annual VMT by road type, SUT, and age was then allocated to each month, day period (weekday and weekend day), and hour by multiplying by the month VMT fraction, the day VMT fraction, hour VMT fraction and dividing by the number of weeks in the month (number of days in the month divided by seven). Following is the formula for calculating the VMT by month, day period, hour, road type, SUT, and age:

$$VMT_{Month,DayPeriod,Hour,Roadtype,SUT,Age} = AVMT_{RoadType,SUT,Age} * monthFract_{Month} * dayFract_{Month,DayType} * hourFract_{DayType,Hour} / (noOfDaysMonth / 7)$$

Where:

$VMT_{Month,DayPeriod,Hour,Roadtype,SUT,Age}$	=	VMT by month, day period, hour, road type, SUT, and age;
$AVMT_{RoadType,SUT,Age}$	=	annual VMT by road type, SUT and age;
$monthFract_{Month}$	=	month VMT fraction by month;
$dayFract_{Month,DayType}$	=	day VMT fraction by month and day type; and
noOfDays	=	number of days in the month.

The average speed by day type, hour, SUT, and road type was then calculated by multiplying the average speed distribution (day type, hour, SUT, road type, average speed bin) by the average speed bin speeds and summing across the speed bins. Following is the formula used to calculate the average speed by day type, hour, SUT, and road type:

$$ASPD_{DayType,Hour,SUT,RoadType} = \sum(SPDD_{DayType,Hour,SUT,RoadType,SpeedBin} * SPDB_{SpeedBin})$$

Where:

$ASPD_{DayType,Hour,SUT,RoadType}$	=	average speed by day type, hour, SUT, and road type;
$SPDD_{DayType,Hour,SUT,RoadType,SpeedBin}$	=	average speed distribution by day type, hour, SUT, road type, and average speed bin;
$SPDB_{SpeedBin}$	=	speed bin speeds by speed bin; and
$\sum ( )$	=	sum across speed bins.

The Source Hours Operating (SHO) by month, day period, hour, road type, SUT, and age was then calculated by dividing the VMT (month, day period, hour, road type, SUT, and age) by the average speed (day type, hour, SUT, and road type). Following is the formula used for calculating the SHO by month, day period, hour, road type, SUT, and age:

$$SHO_{Month,DayPeriod,Hour,Roadtype,SUT,Age} = VMT_{Month,DayPeriod,Hour,Roadtype,SUT,Age} / ASPD_{DayType,Hour,SUT,RoadType}$$

Where:

$SHO_{Month,DayPeriod,Hour,Roadtype,SUT,Age}$	=	SHO by month, day period, hour, road type, SUT, and age;
$VMT_{Month,DayPeriod,Hour,Roadtype,SUT,Age}$	=	VMT by month, day period, hour, road type, SUT, and age; and
$ASPD_{DayType,Hour,SUT,RoadType}$	=	average speed by day type, hour, SUT and road type.

The SHO by month, day period, hour, road type, SUT, and age was then summed across the road types to produce the SHO by month, day period, hour, SUT, and age. This SHO was then used to calculate the SHP by month, day period, hour, SUT, and age. The vehicle population (SUT and age) was multiplied by the number of days in the day period (5 for weekday period and 2 for weekend day period) to calculate the day period vehicle population. The SHO (month, day period, SUT, and age) was then subtracted from the day period vehicle population to calculate the SHP by month, day period, hour, SUT, and age. Following is the formula used to calculate the SHP by month, day period, hour, SUT, and age:

$$SHP_{Month,DayPeriod,Hour,SUT,Age} = (VehPop_{SUT,Age} * noOfRealDays) - SHO_{Month,DayPeriod,Hour,SUT,Age}$$

Where:

$SHP_{Month,DayPeriod,Hour,SUT,Age}$	=	SHP by month, day period, hour, SUT, and age;
$VehPop_{SUT,Age}$	=	vehicle population by SUT and age;
noOfRealDays	=	number of days in the day period (5 for weekday, 2 for weekend day); and
$SHO_{Month,DayPeriod,Hour,SUT,Age}$	=	SHO by month, day period, hour, SUT, and age.

The SHP by SUT for the month and day type to be annualized (July weekday in this case) was then calculated using the SHP by month, day period, hour, SUT, and age. For those SHP values greater than zero (negative SHP values are set to zero since those values indicate that SHP does not exist), the SHP (month, day period, hour, SUT, and age) was divided by the number of days in the day period (5 for weekday in this case) and summed across hour and age. Following is the formula for calculating the daily SHP by SUT:

$$DSHP_{SUT} = \sum MAX\ [SHP_{Month,DayPeriod,Hour,SUT,Age}\ /\ noOfRealDays, 0]$$

Where:

$DSHP_{SUT}$	=	daily SHP by SUT for the month and day type annualized (July weekday in this case);
$SHP_{Month,DayPeriod,Hour,SUT,Age}$	=	SHP by month, day period, hour, SUT, and age for the month and day type annualized (July weekday in this case);
noOfRealDays	=	number of days in the day period annualized (5 for weekday in this case); and
∑MAX[ ]	=	sum of the maximum value between ($SHP_{Month,DayPeriod,Hour,SUT,Age}$ / noOfRealDays) and 0 across hour and age

The annual SHP by SUT was calculated using a similar procedure as the daily SHP except that the calculations were performed for each month and day period. Following is the formula for calculating the annual SHP by SUT:

$$ASHP_{SUT} = \sum MAX\ [SHP_{Month,DayPeriod,Hour,SUT,Age}\ /\ noOfRealDays, 0]$$

Where:

$ASHP_{SUT}$	=	annual SHP by SUT;
$SHP_{Month,DayPeriod,Hour,SUT,Age}$	=	SHP by month, day period, hour, SUT;
noOfRealDays	=	number of days in the day period (5 for weekday, 2 for

		weekend day); and
∑ MAX[ ]	=	sum of the maximum value between ($SHP_{Month,DayPeriod,Hour,SUT,Age}$ / noOfRealDays) and 0 across month, day period, hour, and age

The annual SHP by SUT were then divided by the daily (July weekday) SHP by SUT to produce the SHP annualization factors by SUT. The annual starts, summer weekday starts, and annualization factors are shown in Chapter 8.

Emissions Rate Annualization Factors

Emissions rate annualization factors by pollutant, process, SUT, fuel type, and aggregate road type (restricted access, unrestricted access, off-network) were also used to create annual emissions from the summer weekday emissions. These factors were based on two MOVES inventory mode runs: one to produce annual activity and emissions (e.g., summer and winter seasonal inputs); and one to produce summer weekday emissions and activity (using similar inputs to the summer weekday MOVES emissions rate runs used to develop the summer weekday emissions inventories). Annual emissions rates, summer weekday emissions rates and annualization factors (annual rate divided by summer weekday rate) by pollutant, process, SUT, fuel type, and aggregate road type were calculated using the output from these two MOVES runs.

MOVES Inventory Mode Runs

For the development of the emissions rate annualization factors, two inventory mode runs were performed, one for a summer weekday, and one with a season variation for annual.

The inventory mode runs for rate annualization factor development are very similar to the rates mode runs; their differences in RunSpecs and County Databases (CDBs) are highlighted here.

RunSpecs: For the inventory mode runs, particular Scale, Time Spans, Geographic Bounds, and Output Emissions Detail settings are different. For inventory mode, “Calculation Type” is set to “Inventory” in the Scale panel; “Region” in the Geographic Bounds panel is changed from “Zone and Link” to “County;” and the appropriate CDB name is set. In the Time Spans panel, for summer weekday, there is no difference between inventory mode and rates mode, but for the generalized annual inventory mode run, for “Days,” both “Weekdays” and “Weekend” are selected, and for “Months,” both “January” and “July” are selected. Under Output Emissions Detail for inventory mode, “Time” is set to “24 Hour Day” for the summer weekday run, and to “Month” for the generalized annual run.

CDBs: For the inventory mode, two CDBs were used, one for the summer weekday run and one for the generalized annual run. For the summer weekday run, the same CDB was used as was used for the rates mode (average June through August) summer weekday run. (The summer weekday runs did not include any of the local winter season data that were developed for use in the generalized annual inventory mode runs.) For the generalized annual inventory mode run, the inputs were consistent with the summer weekday run, except that average (December, January, February) winter meteorology and winter fuels inputs. Additionally, month VMT fractions were changed to account for local semi- annual seasonal activity at the associated district level (July and January monthVMTfraction values, respectively, were set to one-sixth of the generalized, semi-annual summer [April through September] and one-sixth of the winter [remaining six months] Automatic Traffic Recorder counts). For Hunt County runs both summer and annual, MOVES default values were plugged into hpmsvtypeyear and sourcetypeyear tables since negative/null activity was found when County specific data was used.

NCTCOG built the Moves Run Specs (MRSs) and CDBs for each county and checked that they were prepared as intended. The MOVES runs were performed, checked for errors, and applied in the calculation of the emissions rate annualization factors for each county. The MRSs, CDBs, and MOVES output were provided as a part of the electronic data submittal (see Appendix B).

Emissions Rate Annualization Factor Calculations
The first component of the emissions rate annualization factors is the annual emissions rates. The emissions output from the annual MOVES inventory mode run was aggregated by pollutant, process, SUT, fuel type, and aggregate road type (restricted access, unrestricted access, off- network). The activity output was also aggregated by SUT, fuel type, aggregate road type, and activity type (i.e., VMT, starts, SHI, APU hours, and SHP). The annual emissions rates were then calculated by dividing the aggregated emissions output by the appropriate aggregated activity to produce annual emissions rates by pollutant, process, SUT, fuel type, and aggregate road type. Using the same procedure, summer weekday emissions rates were calculated using the output from the summer weekday MOVES inventory mode run.

The emissions rate annualization factors were then calculated by dividing the annual emissions rates (including any necessary units conversion factors) by the summer weekday emissions rates. In those cases where annual emissions rates exist but summer weekday rates do not, the emissions rate annualization factor was set to zero, which will cause the annual emissions rate to be used in the annual emissions calculation procedure.

Annual Activity and Emissions Calculations
The summer weekday inventory output consists of two formats: the main tab-delimited format (activity and emissions by pollutant, process, SUT/fuel type, and road type) and the SCC tab- delimited format (activity and emissions by pollutant and SCC). Although these files contain the same activity and emissions results, the format is quite different. Therefore, both formats were converted to annual emissions separately using the same procedures (i.e., two annual activity and emissions output formats were produced).

For the main tab-delimited format, the annual activity was calculated by multiplying the 24- hour activity from the summer weekday tab-delimited activity and emissions file by the appropriate activity factor. Annual activity was calculated for VMT, SHI, APU hours, starts, and SHP.

The annual emissions were also calculated using the 24-hour emissions from the summer weekday tab-delimited activity and emissions file. For each pollutant, the annual emissions were calculated for each process by multiplying the summer weekday emissions by the appropriate activity factor and emissions rate annualization factor. In the case where the emissions rate annualization factor is zero and the annual emissions rate is greater than zero, the annual emissions were calculated by multiplying the appropriate annual activity by the annual emissions rate. The composite pollutant emissions were also calculated by summing the emissions for each process associated with the pollutant.

For the SCC tab-delimited format, the summer weekday SCC tab-delimited activity and emissions were converted to annual activity and emissions using the same procedures as the main tab-delimited format. Thus creating an equivalent of the annual main tab-delimited format with the activity and emissions aggregated by SCC.

CHAPTER 7: ADDITIONAL CDBS FOR MOVES2014 INVENTORY MODE

The North Central Texas Council of Governments (NCTCOG) developed two extra sets of county databases (CDBs) for each county consistent with the emissions inventory data that may be used with Motor Vehicle Emissions Simulator version 2014 (MOVES2014) in the inventory mode: one set of summer weekday CDBs and one set of annual CDBs. These inventory mode CDBs were designed to input the appropriate (daily) activity data (daily for the summer weekday CDBs and annual for the annual CDBs), and with the appropriate MOVES Runspecs, produce summer weekday output inventory estimates consistent with, but not necessarily identical to, the summer weekday and annual inventories.

The summer weekday inventory CDBs include the 26 input data tables shown in Exhibit 27 with corresponding data sources. The inventory CDBs include the same 20 MOVES tables used in the link-based inventory analysis rates mode CDBs, plus six additional tables (hotellingactivitydistribution, hotellinghours, sourcetypeage, starts, monthofanyyear, and dayofanyweek).

The summer weekday inventory mode CDB data source categories are:

- Rates CDB (mainly local data directly from the link-based inventory analysis rates CDBs);
- OffNetActCalc utility output with adjustments (for hotellinghours, starts);
- MOVES defaults (only for hotellingactivitydistribution); and
- Adjusted MOVES defaults (for activity allocation factors modified as needed to produce daily output from daily activity input, and for sourcetypeage table relativeMAR adjustments to produce vehicle miles of travel (VMT) proportions between Highway Performance Monitoring System vehicle categories that more closely reflect the local VMT Mix).

Exhibit 27: Summer Weekday MOVES Inventory Mode CDB Data Sources

Table	Data Source
avft	Summer ER
avgspeeddistribution	Summer ER
county	Summer ER
countyyear	Summer ER
dayvmtfraction	MOVES default with dayVMTFraction = 1 (dayID = 5) and dayVMTFraction = 0 (dayID = 2)
fuelsupply	Summer ER
fuelformulation	Summer ER
hotellingactivitydistribution	MOVES defaults
hotellinghours	OffNetActCalc utility output with travel fractions (developed using the age distribution and relative MAR) applied to distribute to ageID
hourvmtfraction	Summer ER
hpmsvtypeyear	Summer ER
imcoverage	Summer ER
monthvmtfraction	Summer ER with monthVMTFraction = 1

Exhibit 27: Summer Weekday MOVES Inventory Mode CDB Data Sources (continued)

Table	Data Source
roadtype	Summer ER
roadtypedistribution	Summer ER
sourcetypeage	MOVES default with relativeMAR adjusted for VMT Mix (travel fractions calculated using relativeMAR adjusted to match 24-hour VMT from link-level inventory)
sourcetypeagedistribution	Summer ER
sourcetypeyear	Summer ER
starts	OffNetActCalc utility output with age distribution applied to distribute to ageID
state	Summer ER
year	Summer ER
zone	Summer ER
zonemonthhour	Summer ER
zoneroadtype	Summer ER
monthofanyyear	MOVES default with noOfDay = 7
dayofanyweek	MOVES default with noOfRealDays = 1

The annual inventory CDBs contain the same input data tables as the summer weekday inventory CDBs, excluding the monthofanyyear and dayofanyweek data tables (not required for annual inventory mode CDBs). However, these annual inventory CDBs do have different data requirements (i.e., annual activity instead of summer weekday activity) and sources (see Exhibit 28). The annual inventory mode CDB data source categories are:

- Annual inventory Mode CDB from the emissions rate annualization procedure (mainly local data directly from the link-based inventory analysis rates CDBs);
- Local data (2004-2013 ATR data by Texas Department of Transportation district to build day VMT fractions, hour VMT fractions, and month VMT fractions);
- MOVESactivityInputBuild utility output (for activity inputs built from the applicable link-based inventory data);
- VehiclePopulationBuild utility output (for vehicle population estimates);
- MOVES defaults;
- Annual activity from the activity annualization procedures; and
- Adjusted MOVES defaults (for activity allocation factors modified as needed to produce daily output from daily activity input, and for sourcetypeage table relativeMAR adjustments to produce VMT proportions between HPMS vehicle categories that more closely reflect the local VMT Mix)

Exhibit 28: Annual MOVES Inventory Mode CDB Data Sources

Table	Data Source
avft	Annual inventory mode CDB[1]
avgspeeddistribution	Summer ER annualized for both dayID 5 and dayID 2
county	Annual inventory mode CDB[1]
countyyear	Annual inventory mode CDB[1]
dayvmtfraction	County specific local data
fuelsupply	Annual inventory mode CDB[1] with monthID 1 data for months 1-3, 10-12; monthID 7 data for months 4-9
fuelformulation	Annual inventory mode CDB[1]
hotellingactivitydistribution	MOVES defaults
hotellinghours	Annual activity[2]
hourvmtfraction	County specific local data
hpmsvtypeyear	Annual activity[2]
imcoverage	Annual inventory mode CDB[1]
monthvmtfraction	County specific local data
roadtype	MOVESactivityInputBuild utility output
roadtypedistribution	MOVESactivityInputBuild utility output
sourcetypeage	MOVES default with relativeMAR adjusted for VMT Mix (travel fractions calculated using relativeMAR adjusted to match 24-hour VMT from link-level inventory)
sourcetypeagedistribution	Annual inventory mode CDB[1]
sourcetypeyear	County specific local data
starts	Annual activity[2]
state	Annual inventory mode CDB[1]
year	Annual inventory mode CDB[1]
zone	Annual inventory mode CDB[1]
zonemonthhour	Annual inventory mode CDB[1] with monthID 1 data for months 1-3, 10-12; monthID 7 data for months 4-9
zoneroadtype	Annual inventory mode CDB[1]

[1]From emissions rate annualization procedure.
[2]From the activity annualization procedures.

NCTCOG built the MOVES inventory mode CDBs, checked that each one contained all the required tables, and that they were populated as intended. These MOVES inventory mode CDBs can be found in Appendix B.

CHAPTER 8: SUMMARY OF VEHICLE MILES OF TRAVEL, OFF-NETWORK ACTIVITY, AND EMISSIONS

Vehicle Miles of Travel Estimates

Exhibits 29 and 36 show the summarized vehicle miles of travel (VMT) estimates for Summer Season and Annual Average for all counties. Appendix E contains the detailed tab summary of VMT by county.

Off-Network Activity

Exhibits 30, 31, 37, and 38 show the summarized off-network activity for Annual Average and Summer Season for all counties. Appendix A contains the detailed tab summary of off-network activity by county for Summer Season and Annual Average.

Emission Estimates

The final link-based county emission estimates for 2014 annual and summer weekday are summarized in Exhibits 23-35, and 40. Appendix D contains the detailed tab summary of emissions for all counties by time of day, functional class, and vehicle type.

Exhibit 29: 2014 Annual Vehicle Miles of Travel (miles/year) Estimates and Annualization Factors for the DFW 12-County Modeling Domain

County	VMT	Annualization Factor
Collin	7,566,943,925	345.24
Dallas	24,791,526,490	345.24
Denton	6,209,271,227	345.24
Ellis	2,654,053,531	345.24
Hood	638,064,480	331.78
Hunt	1,691,162,003	324.53
Johnson	1,987,997,962	331.78
Kaufman	2,228,636,885	345.24
Parker	1,697,566,401	331.78
Rockwall	857,922,142	345.24
Tarrant	15,696,749,687	331.78
Wise	1,212,829,289	331.78
Total	**67,232,724,022**	-

Source: NCTCOG

Exhibit 30: 2014 Annual Combination Long-haul Diesel Vehicles Off-Network Activity (hours/year) for the DFW 12-County Modeling Domain

County	Hotelling	SHI	APU
Collin	348,689	1,377,111	136,854
Dallas	1,009,593	3,987,281	396,247
Denton	345,100	1,362,937	135,446
Ellis	330,725	1,306,162	129,803
Hood[1]	N/A	N/A	N/A
Hunt	77,534	306,456	30,455
Johnson	24,174	95,491	9,490
Kaufman	339,722	1,341,694	133,335
Parker	564,239	2,228,851	221,498
Rockwall	153,457	606,063	60,229
Tarrant	404,258	1,596,897	158,696
Wise	246,540	973,879	96,782

[1]Data not available to calculate Hood County off-network activity.

Exhibit 31: 2014 Annual Source Hours Parked (hours/year) and Annualization Factors for the DFW 12-County Modeling Domain

Source Type ID	Collin		Dallas		Denton		Ellis		Hood		Hunt	
	Hours	Factor	Hours	Factor	Hours	Factor	Hours	Factor	Hours	Factor	Hours	Factor
11	123,621,207	365.03	215,934,797	365.05	117,017,013	365.02	30,598,722	365.02	14,147,332	365.02	18,201,854	365.04
21	4,125,972,183	365.87	10,975,847,291	366.04	3,208,599,175	365.86	649,510,781	366.24	236,750,934	366.60	333,881,531	367.41
31	529,660,719	366.30	1,856,365,260	366.09	495,890,957	366.15	199,647,386	365.85	81,203,823	365.81	116,589,304	366.73
32	338,426,680	366.30	1,186,090,337	366.09	316,845,907	366.15	127,567,694	365.85	51,883,037	365.81	74,488,371	366.73
41	2,028,473	367.31	8,085,505	366.84	2,078,370	366.51	637,781	366.78	335,880	365.75	277,335	377.04
42	571,576	367.31	2,276,422	366.81	588,082	366.50	180,050	366.78	94,757	365.74	72,162	378.14
43	2,277,608	367.32	9,097,141	366.84	2,343,611	366.51	719,682	366.78	370,199	365.76	305,428	377.32
51	1,549,107	367.092	6,612,524	366.66	1,583,590	366.62	745,949	366.72	422,190	365.73	344,655	376.75
52	51,516,852	367.09	219,892,567	366.66	52,591,539	366.63	24,804,198	366.72	14,035,536	365.73	11,443,450	376.77
53	7,169,119	367.09	30,622,177	366.66	7,323,330	366.63	3,459,464	366.72	1,955,861	365.73	1,590,226	376.80
54	3,114,376	367.10	13,299,080	366.66	3,183,623	366.62	1,500,097	366.72	844,304	365.74	697,330	376.67
61	12,462,626	369.42	110,936,502	366.71	10,531,814	370.66	3,255,708	377.99	1,347,288	371.88	692,846	408.40
62	17,747,106	369.42	158,034,495	366.71	15,001,899	370.66	4,654,336	378.97	1,917,863	371.88	1,008,355	417.76
Total	**5,216,117,632**	-	**14,793,094,098**	-	**4,233,578,910**	-	**1,047,281,848**	-	**405,309,004**	-	**559,592,847**	-

Exhibit 31: 2014 Annual Source Hours Parked (hours/year) and Annualization Factors for the DFW 12-County Modeling Domain (continued)

Source Type ID	Johnson		Kaufman		Parker		Rockwall		Tarrant		Wise	
	Hours	Hours	Hours	Factor	Hours	Factor	Hours	Factor	Hours	Factor	Hours	Factor
11	35,422,814	365.03	20,012,953	365.03	30,312,526	365.03	16,770,066	365.02	278,436,383	365.04	14,948,030	365.03
21	599,520,876	366.83	402,135,303	366.64	474,348,688	366.84	384,175,611	365.75	8,381,815,086	366.31	220,863,830	367.38
31	216,966,345	366.30	134,678,295	366.28	173,527,627	366.32	87,604,409	365.90	1,596,578,559	366.88	109,523,225	366.35
32	138,625,348	366.30	86,048,757	366.28	110,876,782	366.32	55,974,959	365.90	1,020,105,558	366.88	69,986,632	366.35
41	944,263	366.28	453,281	366.56	996,592	366.20	324,275	366.38	5,882,008	367.57	502,541	366.23
42	263,740	366.29	123,459	366.62	281,196	366.19	915,245	366.37	1,654,536	367.57	136,180	366.28
43	1,072,144	366.27	511,029	366.56	1,124,444	366.19	357,140	366.41	6,618,269	367.57	562,070	366.24
51	1,064,807	366.22	536,530	366.53	1,125,372	366.16	283,629	366.28	4,790,365	367.32	775,090	366.23
52	35,472,257	366.22	17,810,662	366.53	37,523,273	366.16	9,575,000	366.26	159,398,367	367.32	25,677,234	366.24
53	4,932,159	366.22	2,484,479	366.53	5,226,503	366.16	1,335,764	366.26	22,197,230	367.32	3,576,953	366.24
54	2,146,803	366.22	1,072,701	366.54	2,267,926	366.16	584,623	366.25	9,630,494	367.32	1,549,938	366.24
61	3,654,875	376.49	1,139,759	379.80	2,964,830	381.73	1,120,136	373.32	63,260,525	368.00	2,886,215	376.65
62	5,205,544	376.49	1,637,287	383.22	4,228,920	382.26	1,592,614	373.34	90,122,072	368.00	4,116,818	376.63
Total	**1,045,291,975**	-	**668,644,495**	-	**844,804,679**	-	**560,613,471**	-	**11,640,489,452**	-	**455,104,756**	-

Exhibit 32: 2014 Annual Vehicle Starts (starts/year) and Annualization Factors for the DFW 12-County Modeling Domain

Source Type ID	Collin		Dallas		Denton		Ellis		Hood		Hunt	
	Starts	Factor	Starts	Factor	Starts	Factor	Starts	Factor	Starts	Factor	Starts	Factor
11	3,906,970	610.34	6,831,806	610.34	3,697,382	610.34	966,927	610.34	446,827	610.34	575,124	610.34
21	940,264,388	357.57	2,520,583,556	357.57	731,016,783	357.57	150,227,867	357.57	53,879,980	357.57	77,440,573	357.57
31	124,150,370	348.62	431,963,888	348.62	115,634,936	348.62	46,294,413	348.62	18,570,646	348.62	27,000,538	348.62
32	85,514,616	348.33	297,528,072	348.33	79,648,350	348.33	31,888,262	348.33	12,790,934	348.33	18,596,421	348.33
41	220,467	303.88	866,995	303.88	219,592	303.88	68,240	303.88	34,120	303.88	33,245	303.88
42	124,503	368.82	489,243	368.81	124,503	368.8	38,578	368.82	19,289	368.82	17,536	368.82
43	482,534	289.86	1,901,148	289.86	482,534	289.86	150,046	289.86	73,318	289.86	71,613	289.86
51	217,090	295.31	914,960	295.31	218,227	295.31	103,430	295.31	55,693	295.31	53,420	295.31
52	12,936,831	285.13	54,521,246	285.13	12,987,747	285.13	6,162,917	285.13	3,317,711	285.13	3,179,218	285.13
53	1,185,350	301.52	4,998,852	301.52	1,190,714	301.52	565,857	301.52	304,383	301.52	290,974	301.52
54	80,028	365.35	337,410.00	365.35	80,445	365.35	38,138	365.35	20,424	365.35	19,799	365.35
61	2,903,001	288.14	23,652,465	288.14	2,546,247	288.14	1,010,804	288.14	309,537	288.14	437,199	288.14
62	2,959,098	291.99	24,117,150	291.99	2,596,095	291.99	1,031,428	291.99	315,437	291.99	445,617	291.99
Total	**1,174,945,246**	-	**3,368,706,791**	-	**950,443,555**	-	**238,546,907**	-	**90,138,299**	-	**128,161,277**	-

Exhibit 32: 2014 Annual Vehicle Starts (starts/year) for the DFW 12-County Modeling Domain (continued)

Source Type ID	Johnson		Kaufman		Parker		Rockwall		Tarrant		Wise	
	Starts	Factor	Starts	Factor	Starts	Factor	Starts	Factor	Starts	Factor	Starts	Factor
11	1,119,003	610.34	632,636	610.34	957,526	610.34	529,777	610.3435	8,798,563	610.34	99,184	610.34
21	137,942,824	357.57	94,838,455	357.57	109,248,240	357.57	87,435,510	357.5658	1,909,871,359	357.57	99,184,258	357.57
31	49,805,571	348.62	31,649,032	348.62	39,874,786	348.62	20,085,149	348.62	366,408,651	348.62	28,159,217	348.62
32	34,304,770	348.33	21,798,871	348.33	27,466,032	348.33	13,834,664	348.3307	252,375,215	348.33	17,991,793	348.33
41	97,110	303.88	48,118	303.88	102,360	303.88	34,120	303.8849	622,032	303.88	109,726	303.88
42	54,360	368.82	26,303	368.82	57,867	368.82	19,289	368.817	350,712	368.82	30,877	368.82
43	214,838	289.86	105,714	289.86	225,069	289.86	73,318	289.8613	1,364,053	289.86	123,469	289.86
51	142,075	295.31	73,879	295.31	150,031	295.31	38,644	295.3135	654,680	295.31	172,030	295.31
52	8,480,630	285.13	4,395,101	285.13	8,963,317	285.13	2,336,043	285.1315	39,034,524	285.13	5,722,635	285.13
53	776,377	301.52	403,609	301.52	821,968	301.52	214,543	301.5172	3,578,845	301.52	796,992	301.52
54	52,518	365.35	27,093	365.35	55,436	365.35	14,588	365.3513	241,335	365.35	345,943	365.35
61	914,620	288.14	461,682	288.14	823,683	288.14	293,798	288.1405	13,500,705	288.14	5,553,328	288.14
62	932,541	291.99	470,652	291.99	839,913	291.99	299,164	291.9914	13,766,566	291.99	7,910,817	291.99
Total	**234,837,237**	-	**154,931,145**	-	**189,586,228**	-	**125,208,607**	-	**2,610,567,240**	-	**166,200,269**	-

Exhibit 33: 2014 Annual Emissions Estimates (tons/year) for the DFW 12-County Modeling Domain

County	VOC	CO	NO_X	CO_2	NH_3	SO_2	$PM_{2.5}$ Total[1]	PM_{10} Total[1]
Collin	3,140.74	38,474.91	6,938.44	3,880,061.11	225.44	68.19	250.81	591.75
Dallas	10,517.48	137,751.01	24,343.72	12,898,264.46	785.49	225.17	896.06	2,055.46
Denton	2,613.61	31,012.35	6,213.45	3,246,159.12	184.63	55.39	223.91	501.15
Ellis	1,016.20	12,595.10	4,050.17	1,558,891.67	85.65	21.60	140.54	243.43
Hood	328.04	3,871.90	716.15	324,994.30	19.63	5.40	21.44	46.87
Hunt	717.39	8,661.21	3,595.42	1,198,096.40	54.29	13.62	140.79	225.01
Johnson	833.04	10,510.63	2,330.88	1,083,182.59	62.22	16.80	83.43	166.46
Kaufman	756.90	10,264.30	3,022.59	1,241,906.63	72.49	18.21	101.91	182.96
Parker	779.63	8,563.42	2,869.61	1,010,772.29	53.69	14.01	92.62	158.64
Rockwall	418.92	4,576.61	1,088.51	461,000.53	27.26	7.22	35.61	70.45
Tarrant	7,361.91	91,811.78	14,974.71	8,068,144.81	481.62	142.43	536.33	1,227.24
Wise	519.03	6,435.32	1,968.66	701,820.39	38.52	9.88	63.31	109.44
Total	**29,002.89**	**364,528.54**	**72,112.31**	**35,673,294.30**	**2,090.93**	**597.92**	**2,586.76**	**5,578.86**

Source: NCTCOG

[1] Includes PM brake wear and tire wear emissions along with PM total exhaust emissions.

Exhibit 34: 2014 Annual Mobile Source Air Toxics Emissions Estimates (tons/year) for the DFW 12-County Modeling Domain

County	Benzene	Ethanol	1,3-Butadiene	Formaldehyde	Acetaldehyde	Acrolein	MTBE	2,2,4-Trimethylpentane
Collin	71.27	205.79	15.16	52.87	40.64	3.62	0.00	61.55
Dallas	236.96	667.61	49.49	179.36	133.89	11.99	0.00	207.52
Denton	58.52	169.11	12.50	47.04	34.74	3.23	0.00	50.70
Ellis	23.84	50.99	4.18	28.32	16.45	1.98	0.00	17.69
Hood	8.57	20.02	1.48	4.59	3.81	0.32	0.00	6.61
Hunt	16.90	31.54	2.99	21.29	12.25	1.54	0.00	11.81
Johnson	21.06	48.69	3.64	14.50	10.61	1.03	0.00	16.17
Kaufman	17.60	36.51	3.02	22.68	12.64	1.56	0.00	12.99
Parker	17.35	37.71	3.11	27.06	14.34	1.85	0.00	12.83
Rockwall	10.15	23.76	1.81	9.80	6.19	0.68	0.00	7.76
Tarrant	165.81	497.30	35.17	110.46	89.19	7.45	0.00	148.14
Wise	12.49	23.76	2.17	15.68	8.85	1.07	0.00	8.80
Total	**660.52**	**1812.79**	**134.72**	**533.65**	**383.60**	**36.32**	**0.00**	**562.57**

Source: NCTCOG

Exhibit 35: 2014 Annual Other Hazardous Pollutants Emissions Estimates for the DFW 12-County Modeling Domain

County	Ethyl Benzene	Hexane	Propionaldehyde	Styrene	Toluene	Xylene	PAH	Dioxin-Furans	Metals	DPM+DEOG[2]
Collin	48.28	72.26	2.79	2.12	283.76	177.88	9.62	0.00	0.047	444.34
Dallas	162.61	237.29	9.49	7.20	951.98	598.76	32.50	0.00	0.155	1,518.24
Denton	39.70	59.38	2.45	1.78	233.32	146.16	8.40	0.00	0.039	424.49
Ellis	14.31	19.50	1.41	0.77	80.57	52.24	4.64	0.00	0.018	330.39
Hood	5.26	7.40	0.27	0.23	30.36	19.35	0.91	0.00	0.004	35.37
Hunt	9.93	12.72	1.12	0.58	53.85	35.89	3.65	0.00	0.013	304.36
Johnson	12.87	18.11	0.81	0.59	74.09	47.25	2.72	0.00	0.013	148.14
Kaufman	10.56	14.13	1.09	0.58	59.06	38.55	3.59	0.00	0.015	252.43
Parker	10.30	14.39	1.23	0.59	58.19	37.70	4.04	0.00	0.011	284.25
Rockwall	6.15	8.79	0.48	0.30	35.46	22.61	1.61	0.00	0.006	90.88
Tarrant	114.30	173.36	6.01	4.89	680.25	421.86	20.75	0.00	0.098	857.5
Wise	7.35	9.50	0.75	0.41	40.18	26.82	2.47	0.00	0.008	168.02
Total	**441.62**	**646.83**	**27.90**	**20.04**	**2,581.07**	**1,625.07**	**94.90**	**0.00**	**0.427**	**4,858.41**

Source: NCTCOG

[2]DPM+DEOG emission estimates included diesel VOC total exhaust and PM_{10} total exhaust.

Exhibit 36: 2014 Summer Weekday Vehicle Miles of Travel (miles/day) Estimates for the DFW 12-County Modeling Domain

County	VMT
Collin	21,917,877
Dallas	71,809,390
Denton	17,985,338
Ellis	7,687,545
Hood	1,923,161
Hunt	5,211,116
Johnson	5,991,934
Kaufman	6,455,313
Parker	5,116,558
Rockwall	2,484,997
Tarrant	47,310,860
Wise	3,655,534
Total	**197,549,623**

Source: NCTCOG

Exhibit 37: 2014 Summer Weekday Combination Long-haul Diesel Vehicles Off-Network Activity (hours/day) for the DFW 12-County Modeling Domain

County	Hotelling	SHI	APU
Collin	4,385	3,989	396
Dallas	12,697	11,549	1,1478
Denton	4,340	3,948	392
Ellis	4,159	3,783	376
Hood[1]	N/A	N/A	N/A
Hunt	1,038	944	94
Johnson	316	288	29
Kaufman	4,272	3,886	386
Parker	7,386	6,718	668
Rockwall	1,930	1,755	174
Tarrant	5,291	4,813	478
Wise	3,227	2,935	292

[1]Data not available to calculate Hood County off-network activity.

Exhibit 38: 2014 Summer Weekday Source Hours Parked (hours/day) for the DFW 12-County Modeling Domain

Source Type ID	Collin	Dallas	Denton	Ellis	Hood	Hunt	Johnson	Kaufman	Parker	Rockwall	Tarrant	Wise
11	338,661	591,516	320,574	83,826	38,757	49,862	97,041	54,825	83,041	45,943	762,747	40,950
21	11,277,168	29,985,186	8,770,108	1,773,470	645,808	908,732	1,634,331	1,096,827	1,293,082	1,050,373	22,881,543	601,194
31	1,445,991	5,070,755	1,354,346	545,713	221,982	317,915	592,308	367,691	473,703	239,421	4,351,784	298,956
32	923,916	3,239,866	865,350	348,691	141,830	203,114	378,441	234,925	302,676	152,978	2,780,495	191,037
41	5,522	22,041	5,671	1,739	918	736	2,578	1,237	2,721	885	16,002	1,372
42	1,556	6,206	1,605	491	259	191	720	337	768	250	4,501	372
43	6,201	24,799	6,394	1,962	1,012	809	2,927	1,394	3,071	975	18,005	1,535
51	4,220	18,034	4,319	2,034	1,154	915	2,908	1,464	3,073	774	13,041	2,116
52	140,337	599,711	143,448	67,637	38,377	30,372	96,860	48,592	102,478	26,142	433,951	70,111
53	19,529	83,516	19,975	9,434	5,348	4,220	13,468	6,778	14,274	3,647	60,430	9,767
54	8,484	36,271	8,684	4,091	2,309	1,851	5,862	2,927	6,194	1,596	26,218	4,232
61	33,736	302,519	28,413	8,613	3,623	1,697	9,708	3,001	7,767	3,000	171,901	7,663
62	48,041	430,953	40,473	12,281	5,157	2,414	13,827	4,272	11,063	4,266	244,894	10,931
Total	**14,253,362**	**40,411,373**	**11,569,360**	**2,859,982**	**1,106,534**	**1,522,828**	**2,850,979**	**1,824,270**	**2,303,911**	**1,530,250**	**31,765,512**	**1,240,236**

Exhibit 39: 2014 Summer Weekday Vehicle Starts (starts/day) for the DFW 12-County Modeling Domain

Source Type ID	Collin	Dallas	Denton	Ellis	Hood[1]	Hunt	Johnson	Kaufman	Parker	Rockwall	Tarrant	Wise
11	6,401	11,193	6,058	1,584	N/A	942	1,833	1,037	1,569	868	14,416	774
21	2,629,626	7,049,287	2,044,426	420,141	N/A	216,577	385,783	265,234	305,533	244,530	5,341,315	144,211
31	356,119	1,239,068	331,693	132,793	N/A	77,450	142,864	90,784	114,379	57,613	1,051,026	72,252
32	245,498	854,154	228,657	91,546	N/A	53,387	98,483	62,581	78,850	39,717	724,528	49,813
41	726	2,853	723	225	N/A	109	320	158	337	112	2,047	170
42	338	1,327	338	105	N/A	48	147	71	157	52	951	76
43	1,665	6,559	1,665	518	N/A	247	741	365	776	253	4,706	388
51	735	3,098	739	350	N/A	181	481	250	508	131	2,217	350
52	45,371	191,214	45,550	21,614	N/A	11,150	29,743	15,414	31,436	8,193	136,900	21,536
53	3,931	16,579	3,949	1,877	N/A	965	2575	1,339	2,726	712	11,869	1,868
54	219	924	220	104	N/A	54	144	74	152	40	661	104
61	10,075	82,087	8,837	3,508	N/A	1,517	3,174	1,602	2859	1,020	46,855	2,507
62	10,134	82,595	8,891	3,532	N/A	1,526	3,194	1,612	2,876	1,025	47,147	2,525
Total	**3,310,838**	**9,540,938**	**2,681,746**	**677,897**	**N/A**	**364,153**	**669,482**	**440,521**	**542,158**	**354,266**	**7,384,638**	**296,574**

[1]Data not available to calculate Hood County off-network activity.

Exhibit 40: 2014 Summer Weekday Emissions Estimates (tons/day) for the DFW 12-County Modeling Domain

County	VOC	CO	NO_X	CO_2	NH_3	SO_2	$PM_{2.5}$ Total[1]	PM_{10} Total[1]
Collin	8.90	113.15	18.50	11,568.11	0.65	0.18	0.68	1.66
Dallas	30.25	417.10	65.47	38,549.75	2.28	0.61	2.43	5.76
Denton	7.43	90.90	16.65	9,678.65	0.53	0.15	0.61	1.41
Ellis	2.93	38.34	10.96	4,647.86	0.25	0.07	0.39	0.69
Hood	0.97	12.21	2.03	1,009.14	0.06	0.02	0.06	0.14
Hunt	2.14	27.63	10.20	3,366.44	0.17	0.04	0.06	0.68
Johnson	2.43	32.94	6.43	3,729.96	0.19	0.05	0.24	0.49
Kaufman	2.20	32.42	8.07	3,366.44	0.21	0.06	0.28	0.52
Parker	2.19	29.31	7.84	3,729.96	0.16	0.04	0.27	0.47
Rockwall	1.20	13.69	2.90	1,374.06	0.08	0.02	0.10	0.20
Tarrant	21.50	283.22	41.70	25,063.24	1.45	0.40	1.50	3.57
Wise	1.53	20.34	5.55	2,173.50	0.12	0.03	0.18	0.32
Total	**83.67**	**1,111.25**	**196.30**	**108,257.10**	**6.15**	**1.67**	**6.80**	**15.91**

Source: NCTCOG

[1] Includes PM brake wear and tire wear emissions along with PM total exhaust emissions.

CHAPTER 9: LIST OF APPENDICES

Appendix A: MOVES2014 External Files and Off-network Activity

Appendix B: MOVES2014 Inputs and Outputs, Rate Annualization Factor Databases, and Additional County Databases(EPA)

Appendix C: MOVES2014 Emission Factors

Appendix D: Tab-Delimited VMT, VHT, Speed, Population, and Emission County Files

Appendix E: Tab-Delimited VMT, VHT, Speed, Population, and Emission Summary Files

Appendix F: XML and SCC

Appendix G: Project Quality Control Report