

APPENDIX A

**EVALUATION OF ON-ROAD MOBILE SOURCE EMISSIONS DEVELOPED WITH
THE MOVES2010A MODEL REPLACING EMISSIONS DEVELOPED WITH THE
MOBILE6.2 MODEL FOR THE HGB ATTAINMENT DEMONSTRATION SIP
REVISION FOR THE 1997 EIGHT-HOUR OZONE STANDARD,
ADOPTED MARCH 10, 2010**

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1 OVERVIEW

This appendix supplements Appendix B: *Emissions Modeling for the HGB Attainment Demonstration SIP Revision for the 1997 Eight-Hour Ozone Standard of the 2010 Houston-Galveston-Brazoria (HGB) Attainment Demonstration (AD) State Implementation Plan (SIP) Revision for the 1997 Eight-Hour Ozone Standard (2010 HGB AD SIP Revision)*. Appendix B for the 2010 HGB AD SIP Revision contains over 200 pages covering the area, biogenic, on-road, non-road, off-road, and point source emission categories that were modeled for the base, baseline, and future cases. This document only addresses the on-road emission source category because the only substantive change between the 2010 HGB AD SIP Revision and this one is use of the 2010a version of the Motor Vehicle Emission Simulator (MOVES2010a) model instead of the older MOBILE6.2 model.

On-road emission models and inventories are typically based on the latest available technical information at the time they are developed. The 2010 HGB AD SIP Revision relied on the use of the MOBILE6.2 model from the United States (U.S.) Environmental Protection Agency (EPA). In March 2010, the EPA officially released the MOVES2010 model for SIP use. The subsequent MOVES2010a version was released in September 2010, and it was the latest available model at the time that on-road inventory development efforts needed to commence for this SIP revision. The most current version of the on-road model is MOVES2010b, but it was not released until April 2012, which is well after on-road inventory development efforts began.

Table 1: *Comparison of MOBILE6.2 and MOVES2010a HGB On-Road Inventories* is a comparison of 2006 and 2018 summer weekday emission estimates for the MOBILE6.2-based on-road inventories previously developed for HGB and the most current ones that rely on MOVES2010a. Estimates are provided for the primary pollutants of nitrogen oxides (NO_x), volatile organic compounds (VOC), and carbon monoxide (CO).

Table 1: Comparison of MOBILE6.2 and MOVES2010a HGB On-Road Inventories

Calendar Year and Day Type	Development Date	EPA On-Road Model	Vehicle Miles Traveled	NO _x (tpd)	VOC (tpd)	CO (tpd)
2006 Summer Weekday	Summer 2007	MOBILE6.2	133,868,661	206.74	90.71	1,115.28
2006 Summer Weekday	Summer 2011	MOVES2010a	143,408,584	270.00	104.74	1,024.03
2006 Difference			9,539,923	63.26	14.03	-91.25
2006 Change			7.13%	30.60%	15.47%	-8.18%
2018 Summer Weekday	Spring 2009	MOBILE6.2	180,993,087	52.55	45.97	733.18
2018 Summer Weekday	Winter 2012	MOVES2010a	180,955,402	103.34	50.13	656.24
2018 Difference			-37,685	50.79	4.16	-76.94
2018 Change			-0.02%	96.65%	9.05%	-10.49%

An extensive comparison of the differences between MOBILE6.2 and MOVES2010a is beyond the scope of this text. Such information is available for interested parties on the [EPA MOBILE6 \(http://www.epa.gov/otaq/m6.htm\)](http://www.epa.gov/otaq/m6.htm) and the [EPA MOVES \(http://www.epa.gov/otaq/models/moves/\)](http://www.epa.gov/otaq/models/moves/) Web pages. A more in-depth discussion of the MOBILE6.2 on-road inventories previously developed is available on pages 120-141 of [Appendix B of the 2010 HGB AD SIP Revision \(http://www.tceq.texas.gov/airquality/sip/HGB_eight_hour.html\)](#) and on the [Texas Commission on Environmental Quality \(TCEQ\) FTP site \(ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/HGB/m62/\)](#). The remainder of this appendix will focus exclusively on the most recent MOVES2010a on-road emission inventories. Unlike the

MOBILE6.2 model, MOVES2010a estimates nitrogen oxide (NO) and nitrogen dioxide (NO₂) emissions separately, with total NO_x then being the combination of NO and NO₂. Where appropriate, NO, NO₂, and NO_x emission estimates are reported separately.

2 ON-ROAD EMISSIONS INVENTORY DEVELOPMENT WITH MOVES2010a

The purpose of this section is to provide a brief overview of the eight-county (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller Counties) HGB area on-road mobile source emissions inventory files that were input into the photochemical model for the 2006 base cases, the 2006 baseline, and the 2018 future case. These inventory data sets were developed under contract by the Texas Transportation Institute (TTI) based on travel demand model (TDM) output from the Houston-Galveston Area Council (H-GAC). For each of the eight HGB counties, TTI combined vehicle miles traveled (VMT) estimates from the local TDM with emission factors from the MOVES2010a model. The net result is referred to as a link-based inventory because both hourly VMT and emission factor estimates are developed for each roadway segment (or “link”) in the network. For each year, summer and school season on-road emission inventories were developed for the four day types of weekday (i.e., Monday through Thursday average), Friday, Saturday, and Sunday. Since these day types are based on seasonal average activity inputs, development of separate baseline ozone season day emissions was not needed. For the on-road source category, 2006 base case and baseline emissions are the same.

Table 2: *VMT and Emissions Day Type Summary for 2006 HGB On-Road Inventory* and Table 3: *VMT and Emissions Day Type Summary for 2018 HGB On-Road Inventory* provide summaries of the total VMT, NO, NO₂, NO_x, VOC, and CO emissions for the entire eight-county HGB area for each day type for the 2006 base case and 2018 future case, respectively. As shown, Fridays have the highest total VMT of the week, while Saturdays and Sundays have the lowest total daily VMT. While overall VMT increases with future growth, total emissions decrease from 2006 through 2018 as a result of more stringent emissions standards for newer vehicles entering the fleet, combined with the simultaneous attrition of older, higher-emitting vehicles. Consistent with current federal and state rules, the on-road inventories from TTI include the benefits of:

- reformulated gasoline (RFG) in all eight HGB counties;
- the inspection and maintenance (I/M) vehicle testing program in Brazoria, Fort Bend, Galveston, Harris, and Montgomery Counties; and
- Texas low emission diesel (TxLED) fuel for all eight HGB counties.

Table 2: VMT and Emissions Day Type Summary for 2006 HGB On-Road Inventory

Season and Day Type	Vehicle Miles Traveled	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	143,408,584	248.97	21.02	270.00	104.74	1,024.03
Summer Friday	155,151,259	262.31	22.38	284.69	108.78	1,088.33
Summer Saturday	124,752,878	188.13	16.43	204.56	88.27	856.57
Summer Sunday	104,841,414	155.39	13.54	168.93	81.76	757.25
School Weekday	148,105,334	255.88	21.67	277.55	106.50	1,049.60
School Friday	161,135,764	271.03	23.20	294.24	111.11	1,121.65
School Saturday	127,409,483	191.21	16.74	207.95	89.10	870.39
School Sunday	105,902,763	156.41	13.65	170.06	82.07	762.78

Table 3: VMT and Emissions Day Type Summary for 2018 HGB On-Road Inventory

Season and Day Type	Vehicle Miles Traveled	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	180,955,402	87.01	16.33	103.34	50.13	656.24
Summer Friday	195,069,658	91.33	17.20	108.54	51.46	693.97
Summer Saturday	157,008,112	66.37	11.96	78.33	43.11	540.43
Summer Sunday	131,735,508	55.73	9.59	65.33	40.83	480.17
School Weekday	184,578,133	88.34	16.62	104.96	50.51	665.79
School Friday	201,855,603	93.91	17.77	111.67	52.19	712.23
School Saturday	159,778,394	67.19	12.13	79.31	43.33	547.52
School Sunday	132,426,639	55.84	9.62	65.46	40.88	482.02

Even though all of the day type on-road inventory data sets were used for photochemical model input, only the summer weekday emissions will be detailed here. For the 2006 base case and 2018 future case, Table 4: *Summary of 2006 HGB Summer Weekday On-Road Inventory by County* and Table 5: *Summary of 2018 HGB Summer Weekday On-Road Inventory by County* present respective summaries of the VMT, NO, NO₂, NO_x, VOC, and CO emissions for each of the eight counties in the HGB area.

Table 4: Summary of 2006 HGB Summer Weekday On-Road Inventory by County

HGB Area County	Vehicle Miles Traveled	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Brazoria	5,891,489	11.11	0.90	12.01	5.02	46.11
Chambers	2,760,121	10.20	0.79	11.00	1.46	18.82
Fort Bend	8,498,717	15.16	1.27	16.42	6.96	60.91
Galveston	6,023,802	9.90	0.82	10.73	5.05	47.36
Harris	105,560,026	171.13	14.67	185.80	75.22	741.49
Liberty	2,549,213	7.05	0.56	7.61	2.22	22.66
Montgomery	10,218,902	19.69	1.63	21.32	7.42	70.62
Waller	1,906,314	4.74	0.38	5.12	1.40	16.06
Eight-County Total	143,408,584	248.97	21.02	270.00	104.74	1,024.03

Table 5: Summary of 2018 HGB Summer Weekday On-Road Inventory by County

HGB Area County	Vehicle Miles Traveled	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Brazoria	8,477,177	4.34	0.72	5.07	2.93	34.53
Chambers	3,831,327	3.33	0.71	4.04	0.71	11.94
Fort Bend	13,818,366	6.96	1.34	8.30	4.89	54.26
Galveston	6,898,244	3.16	0.54	3.69	2.24	27.35
Harris	126,846,143	56.93	10.59	67.51	32.89	448.17
Liberty	3,570,614	2.67	0.49	3.16	1.20	14.94
Montgomery	14,873,870	7.76	1.53	9.30	4.56	54.45

HGB Area County	Vehicle Miles Traveled	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Waller	2,639,660	1.86	0.40	2.26	0.71	10.60
Eight-County Total	180,955,402	87.01	16.33	103.34	50.13	656.24

Table 6: Summary of 2006 HGB Summer Weekday On-Road Inventory by Vehicle Type and Table 7: Summary of 2018 HGB Summer Weekday On-Road Inventory by Vehicle Type present respective summaries for 2006 and 2018 of the VMT, NO, NO₂, NO_x, VOC, and CO emissions for each of the gasoline and diesel fuel source use type combinations from the MOVES2010a model.

Table 6: Summary of 2006 HGB Summer Weekday On-Road Inventory by Vehicle Type

Fuel and Source Use Type Combination	Vehicle Miles Traveled	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Gasoline - Motorcycle	103,546	0.07	0.00	0.08	1.15	1.88
Gasoline - Passenger Car	103,344,259	76.62	7.90	84.52	57.66	549.62
Gasoline - Passenger Truck	20,872,356	32.58	3.13	35.70	24.68	263.14
Gasoline - Light Commercial Truck	6,607,937	11.31	1.11	12.42	8.47	94.06
Gasoline - School Bus	2,194	0.01	0.00	0.01	0.01	0.10
Gasoline - Refuse Truck	40,086	0.22	0.01	0.24	0.09	2.80
Gasoline - Single Unit Short-Haul Truck	1,532,070	4.67	0.30	4.97	1.75	39.56
Gasoline - Single Unit Long-Haul Truck	177,981	0.52	0.03	0.55	0.20	4.00
Gasoline - Motor Home	86,121	0.36	0.02	0.38	0.16	3.02
Gasoline - Combination Short-Haul Truck	214,057	1.41	0.09	1.51	0.53	19.60
Diesel - Passenger Car	103,546	0.17	0.01	0.18	0.01	0.06
Diesel - Passenger Truck	534,122	2.65	0.18	2.83	0.40	2.49
Diesel - Light Commercial Truck	527,932	2.68	0.19	2.87	0.40	2.47
Diesel - Intercity Bus	188,751	3.41	0.24	3.65	0.16	1.09
Diesel - Transit Bus	62,750	0.88	0.06	0.94	0.06	0.35
Diesel - School Bus	212,478	1.73	0.12	1.85	0.17	0.74
Diesel - Refuse Truck	83,173	1.23	0.09	1.32	0.07	0.41
Diesel - Single Unit Short-Haul Truck	3,152,021	17.99	1.25	19.25	2.35	8.83
Diesel - Single Unit Long-Haul Truck	360,470	1.98	0.14	2.12	0.27	0.97
Diesel - Motor Home	177,350	1.43	0.10	1.53	0.19	0.54
Diesel - Combination Short-Haul Truck	2,515,600	38.15	2.65	40.80	1.94	11.90
Diesel - Combination Long-Haul Truck	2,509,787	48.88	3.40	52.27	4.02	16.37
Total	143,408,584	248.97	21.02	270.00	104.74	1,024.03

Table 7: Summary of 2018 HGB Summer Weekday On-Road Inventory by Vehicle Type

Fuel and Source Use Type Combination	Vehicle Miles Traveled	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Gasoline - Motorcycle	129,712	0.08	0.00	0.08	1.64	1.45
Gasoline - Passenger Car	128,968,039	24.46	3.19	27.65	26.88	351.64
Gasoline - Passenger Truck	26,329,962	14.60	1.89	16.49	11.68	159.08
Gasoline - Light Commercial Truck	8,683,276	5.88	0.81	6.70	4.26	64.80
Gasoline - School Bus	1,884	0.00	0.00	0.01	0.00	0.06
Gasoline - Refuse Truck	20,833	0.08	0.01	0.10	0.03	0.72
Gasoline - Single Unit Short-Haul Truck	1,945,147	4.42	0.78	5.20	1.46	39.96
Gasoline - Single Unit Long-Haul Truck	208,684	0.45	0.08	0.53	0.15	3.68
Gasoline - Motor Home	104,969	0.29	0.04	0.33	0.12	2.51
Gasoline - Combination Short-Haul Truck	262,652	1.18	0.18	1.36	0.37	8.71
Diesel - Passenger Car	387,701	0.13	0.02	0.16	0.01	0.77
Diesel - Passenger Truck	1,589,804	2.21	0.63	2.83	0.23	2.79
Diesel - Light Commercial Truck	623,310	1.09	0.25	1.34	0.13	1.27
Diesel - Intercity Bus	236,512	1.35	0.17	1.52	0.08	0.59
Diesel - Transit Bus	68,526	0.28	0.04	0.32	0.03	0.17
Diesel - School Bus	260,108	0.74	0.10	0.84	0.08	0.50
Diesel - Refuse Truck	41,404	0.16	0.03	0.19	0.01	0.08
Diesel - Single Unit Short-Haul Truck	3,954,656	3.08	1.27	4.35	0.37	4.04
Diesel - Single Unit Long-Haul Truck	416,123	0.34	0.13	0.47	0.04	0.39
Diesel - Motor Home	212,803	0.50	0.09	0.58	0.08	0.31
Diesel - Combination Short-Haul Truck	3,240,791	8.93	2.14	11.07	0.53	3.98
Diesel - Combination Long-Haul Truck	3,268,503	16.74	4.49	21.23	1.94	8.76
Total	180,955,402	87.01	16.33	103.34	50.13	656.24

The MOVES2010a run specification and county database files used to develop these inventories, along with detailed reports and tab-delimited summary output tables, can be found on the [2006 HGB MOVES FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/HGB/mvs/2006/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/HGB/mvs/2006/) and the [2018 HGB MOVES FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/HGB/mvs/2018/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/HGB/mvs/2018/), respectively.

3 PHOTOCHEMICAL MODEL INPUT PROCESSING OF ON-ROAD EMISSIONS

The on-road emissions inventory data provided by TTI were prepared for input into the photochemical model using version 3 of the Emissions Processor System (EPS3). When input into EPS3, the inventory data are in a readable text-based format. However, once within EPS3, the emissions data are maintained in a binary format. Table 8: *EPS3 Modules Used to Process Eight-County HGB On-Road Emissions Data* summarizes the EPS3 modules that were used to process the eight-county HGB on-road emission inventories.

Table 8: EPS3 Modules Used to Process Eight-County HGB On-Road Emissions Data

EPS3 Module	Description
LBASE	Spatially allocate link-based emissions among grid cells.
PREAM	Prepare non-link “roadway type” emissions for further processing.
PREPNT	Prepare stationary extended idling emissions for further processing.
CNTLEM	Apply controls to model strategies, apply adjustments, etc.
TMPRL	Apply temporal profiles to extended idling emissions.
CHMSPL	Chemically speciate emissions into olefins, paraffins, etc.
GRDEM	Sum emissions by grid cell for photochemical model input.
MARGUAM	Merge and adjust multiple gridded files for photochemical model input.

The MOVES2010a model also estimates extended idling emissions but only for the diesel fuel combination long-haul truck category. Using a combination of SAS and LINUX code, these extended idling emissions were aggregated into an eight-county HGB total and spatially assigned to known truck stop locations. The extended idling emissions were then processed through EPS3 as if they were stationary low-level point sources. The summer weekday extended idling emissions by county are presented below in Table 9: *2006 Diesel Fuel Combination Long-Haul Truck Extended Idling Emissions for Eight-County HGB* and Table 10: *2018 Diesel Fuel Combination Long-Haul Truck Extended Idling Emissions for Eight-County HGB*. Greater detail on heavy-duty vehicle idling activity specific to Texas metropolitan areas can be found on the [TCEQ On-Road Air Quality Research and Contract Reports Web page](http://www.tceq.texas.gov/airquality/airmod/project/pj_report_mob.html) (http://www.tceq.texas.gov/airquality/airmod/project/pj_report_mob.html).

Table 9: 2006 Diesel Fuel Combination Long-Haul Truck Extended Idling Emissions for Eight-County HGB

HGB Area County	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Brazoria	0.02	0.002	0.03	0.01	0.01
Chambers	0.31	0.02	0.33	0.12	0.18
Fort Bend	0.49	0.03	0.53	0.20	0.29
Galveston	0.08	0.01	0.09	0.03	0.05
Harris	3.05	0.21	3.26	1.22	1.78
Liberty	0.08	0.01	0.08	0.03	0.05
Montgomery	0.66	0.05	0.70	0.26	0.38
Waller	0.38	0.03	0.41	0.15	0.22
Eight-County Total	5.08	0.35	5.43	2.03	2.96

Table 10: 2018 Diesel Fuel Combination Long-Haul Truck Extended Idling Emissions for Eight-County HGB

HGB Area County	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Brazoria	0.02	0.01	0.03	0.01	0.02
Chambers	0.29	0.13	0.42	0.08	0.24

HGB Area County	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Fort Bend	0.46	0.21	0.66	0.13	0.38
Galveston	0.08	0.04	0.11	0.02	0.07
Harris	2.81	1.28	4.10	0.78	2.37
Liberty	0.07	0.03	0.10	0.02	0.06
Montgomery	0.61	0.28	0.88	0.17	0.51
Waller	0.35	0.16	0.51	0.10	0.30
Eight-County Total	4.68	2.14	6.82	1.30	3.95

Based on an EPA memorandum entitled *Texas Low Emission Diesel (TxLED) Fuel Benefits*, September 27, 2001, a 4.8% NO_x TxLED reduction should be claimed for 2002-and-newer diesel vehicles and a 6.2% NO_x TxLED reduction should be claimed for 2001-and-older diesel vehicles. In order to determine the specific TxLED adjustment factors that should apply to each of the twelve diesel fuel source use types, MOVES2010a runs were performed to determine NO_x emission factors by model year. By using these data, the 4.8% and 6.2% TxLED reductions were weighted according to NO_x emission model year contributions for each diesel fuel source use type. More detail can be obtained on the [TxLED Adjustment Factor Analysis](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/txled/) FTP site (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/txled/). The resulting TxLED adjustment factors and benefits for both 2006 and 2018 are summarized in Table 11: *Summary of 2006 Summer Weekday TxLED Benefits by Vehicle Type* and Table 12: *Summary of 2018 Summer Weekday TxLED Benefits by Vehicle Type*, respectively. The TxLED adjustment factors were incorporated by TTI into the on-road inventories by post-processing the MOVES2010a diesel fuel source use type NO, NO₂, and NO_x emission rates.

Table 11: Summary of 2006 Summer Weekday TxLED Benefits by Vehicle Type

Diesel Fuel Source Use Type	NO _x Reduction	Adjustment Factor	NO _x Benefit (tpd)
Passenger Car	5.06%	0.9494	0.01
Passenger Truck	5.68%	0.9432	0.17
Light Commercial Truck	5.56%	0.9444	0.17
Intercity Bus	5.97%	0.9403	0.23
Transit Bus	5.94%	0.9406	0.06
School Bus	5.92%	0.9408	0.12
Refuse Truck	5.85%	0.9415	0.08
Single Unit Short-Haul Truck	5.31%	0.9469	1.08
Single Unit Long-Haul Truck	5.35%	0.9465	0.12
Motor Home	5.77%	0.9423	0.09
Combination Short-Haul Truck	5.82%	0.9418	2.52
Combination Long-Haul Truck	5.83%	0.9417	3.24
Total			7.89

Table 12: Summary of 2018 Summer Weekday TxLED Benefits by Vehicle Type

Diesel Fuel Source Use Type	NO _x Reduction	Adjustment Factor	NO _x Benefit (tpd)
Passenger Car	5.02%	0.9498	0.01
Passenger Truck	5.32%	0.9468	0.15
Light Commercial Truck	5.29%	0.9471	0.07
Intercity Bus	5.80%	0.9420	0.09
Transit Bus	5.77%	0.9423	0.02
School Bus	5.76%	0.9424	0.05
Refuse Truck	5.69%	0.9431	0.01
Single Unit Short-Haul Truck	5.04%	0.9496	0.22
Single Unit Long-Haul Truck	5.08%	0.9492	0.02
Motor Home	5.53%	0.9447	0.03
Combination Short-Haul Truck	5.47%	0.9453	0.60
Combination Long-Haul Truck	5.45%	0.9455	1.15
Total			2.43

The summer weekday on-road emissions by county that were input into the photochemical model are summarized below in Table 13: *2006 Summer Weekday On-Road Mobile Source Inventory by County* and Table 14: *2018 Summer Weekday On-Road Mobile Source Inventory by County*. These on-road inventory summaries are a combination of running exhaust, start exhaust, evaporative, and extended idling emissions. Differences by individual counties between these figures and those referenced above in Table 4 and Table 5 are due to the spatial reallocation of extended idling emissions presented above in Table 9 and Table 10. However, the eight-county total on-road emission estimates do not differ.

Table 13: 2006 Summer Weekday On-Road Mobile Source Inventory by County

HGB Area County	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Brazoria	11.11	0.90	12.01	5.02	46.11
Chambers	10.33	0.80	11.13	1.50	18.88
Fort Bend	15.11	1.26	16.37	6.95	60.89
Galveston	9.90	0.82	10.72	5.05	47.36
Harris	171.00	14.66	185.66	75.17	741.41
Liberty	7.04	0.56	7.60	2.22	22.66
Montgomery	19.65	1.62	21.28	7.41	70.61
Waller	4.83	0.39	5.23	1.43	16.12
Eight-County Total	248.97	21.02	270.00	104.74	1,024.03

Table 14: 2018 Summer Weekday On-Road Mobile Source Inventory by County

HGB Area County	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Brazoria	4.34	0.72	5.06	2.93	34.52
Chambers	3.34	0.72	4.06	0.71	11.94
Fort Bend	6.81	1.27	8.08	4.85	54.14
Galveston	3.17	0.54	3.71	2.24	27.36
Harris	57.08	10.66	67.74	32.93	448.29
Liberty	2.65	0.49	3.14	1.20	14.93
Montgomery	7.67	1.49	9.16	4.54	54.39
Waller	1.95	0.44	2.39	0.73	10.67
Eight-County Total	87.01	16.33	103.34	50.13	656.24

The total eight-county HGB on-road emissions input to the photochemical model by day type are summarized below in Table 15: *2006 On-Road Mobile Source Inventory by Day Type* and Table 16: *2018 On-Road Mobile Source Inventory by Day Type*. Slight differences by day type between these figures and those presented above in Table 2 and Table 3 are due to how these on-road emission inventories are developed in Central Daylight Time (CDT) but must be processed for photochemical model input in Central Standard Time (CST). For example, the 11 p.m. to 12 a.m. CST emissions on a Friday evening are based on 12 p.m. to 1 a.m. CDT emissions from a Saturday.

Table 15: 2006 On-Road Mobile Source Inventory by Day Type

Season and Day Type	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	248.97	21.02	270.00	104.74	1,024.03
Summer Friday	263.65	22.51	286.16	109.26	1,096.07
Summer Saturday	188.11	16.44	204.55	88.28	857.40
Summer Sunday	154.03	13.40	167.43	81.24	748.53
School Weekday	255.88	21.67	277.55	106.50	1,049.60
School Friday	272.38	23.33	295.71	111.58	1,129.50
School Saturday	197.00	16.97	213.97	96.45	932.44
School Sunday	155.01	13.51	168.52	81.55	753.79

Table 16: 2018 On-Road Mobile Source Inventory by Day Type

Season and Day Type	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	87.01	16.33	103.34	50.13	656.24
Summer Friday	91.60	17.17	108.77	51.65	698.62
Summer Saturday	66.33	11.93	78.25	43.10	540.96
Summer Sunday	55.48	9.65	65.13	40.63	474.88
School Weekday	88.34	16.62	104.96	50.51	665.79
School Friday	94.15	17.72	111.87	52.38	716.92

Season and Day Type	NO (tpd)	NO ₂ (tpd)	NO _x (tpd)	VOC (tpd)	CO (tpd)
School Saturday	67.15	12.10	79.25	43.33	548.17
School Sunday	55.59	9.68	65.27	40.69	476.57

For the on-road mobile inventory portion of the HGB subdomain, the EPS3 message files along with the gridded files input into the photochemical model are available on the [2006 HGB EPS3 FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/HGB/eps3/2006/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/HGB/eps3/2006/) and the [2018 HGB EPS3 FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/HGB/eps3/2018/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/HGB/eps3/2018/).

Similar on-road mobile EPS3 message and gridded files for the Texas-only portion of the larger 12 km modeling domain are available on the [2006 Texas EPS3 FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/eps3/2006/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/eps3/2006/) and the [2018 Texas EPS3 FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/eps3/2018/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/eps3/2018/).

Similar on-road mobile EPS3 message and gridded files for the non-Texas portions of the larger 12 km modeling domain are available on the [2006 U.S. EPS3 FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/eps3/2006/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/eps3/2006/) and the [2018 U.S. EPS3 FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/eps3/2018/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/eps3/2018/).

4 ATTAINMENT DEMONSTRATION MOTOR VEHICLE EMISSIONS BUDGET

By definition, the future case on-road NO_x and VOC emission estimates input into the final attainment demonstration photochemical modeling run should establish the motor vehicle emissions budget (MVEB). The 2018 summer weekday on-road emissions are the most representative day type for this purpose and are presented below in Table 17: *2018 Attainment Demonstration MVEB for the Eight-County HGB Area*. As shown, these 2018 summer weekday figures match those provided by TTI as summarized above in Table 3, Table 5, and Table 7. Since they were not needed to demonstrate attainment in the 2018 future year, no emission reduction credits were taken for either local transportation control measures (TCMs) or voluntary mobile source emission reduction program (VMEP) strategies.

Table 17: 2018 Attainment Demonstration MVEB for the Eight-County HGB Area

Eight-County HGB Area On-Road Emissions	NO _x (tpd)	VOC (tpd)
2018 Summer Weekday On-Road Inventory From TTI Includes RFG, I/M, and TxLED Benefits Excludes Local TCM or VMEP Strategies	103.34	50.13

The following pages contain graphical plots of the 2006 and 2018 on-road summer weekday NO_x and VOC emissions for the greater HGB area. These plots are respectively entitled Figure 1: *2006 HGB Summer Weekday NO_x Emissions*, Figure 2: *2006 HGB Summer Weekday VOC Emissions*, Figure 3: *2018 HGB Summer Weekday NO_x Emissions*, and Figure 4: *2018 HGB Summer Weekday VOC Emissions*.

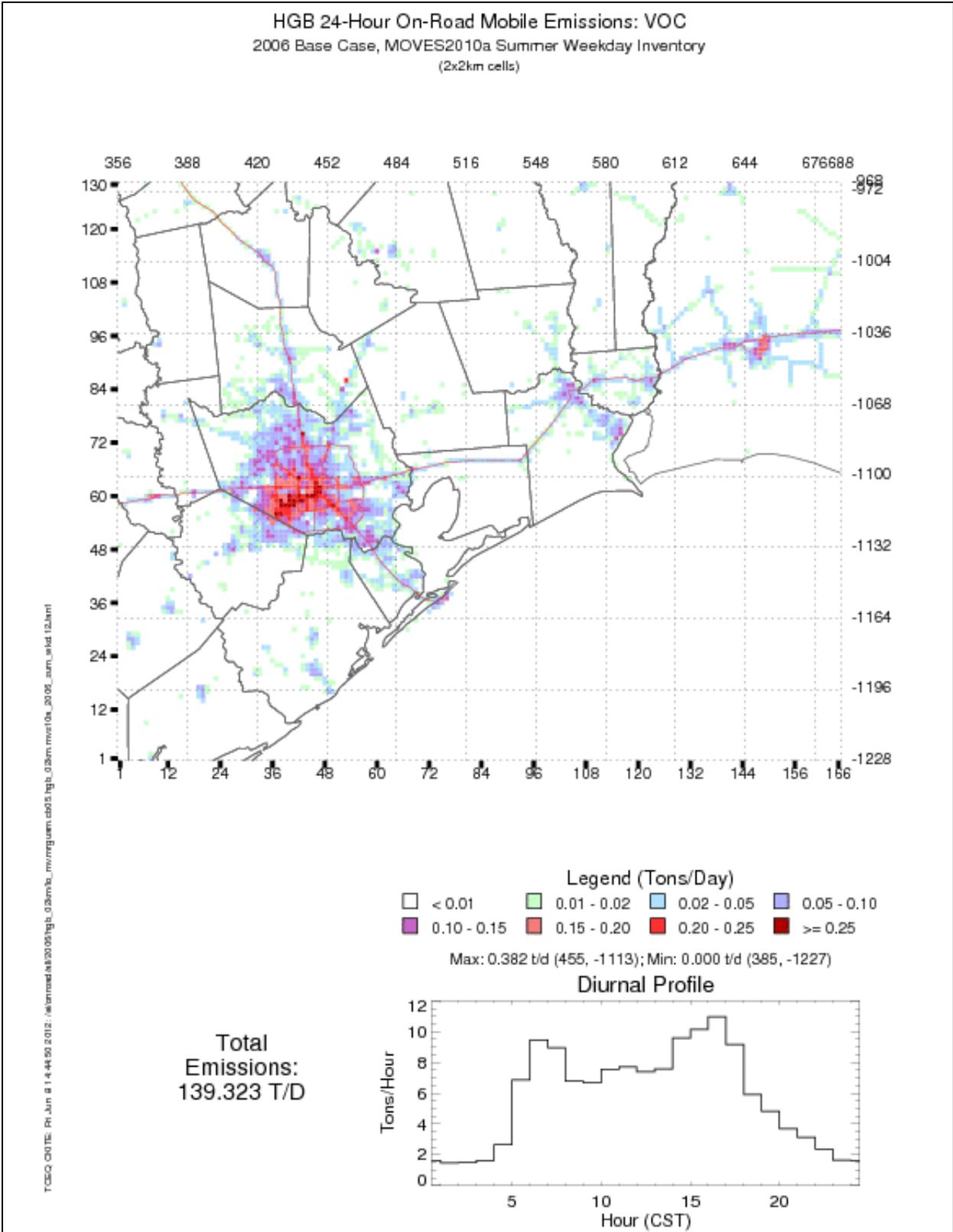
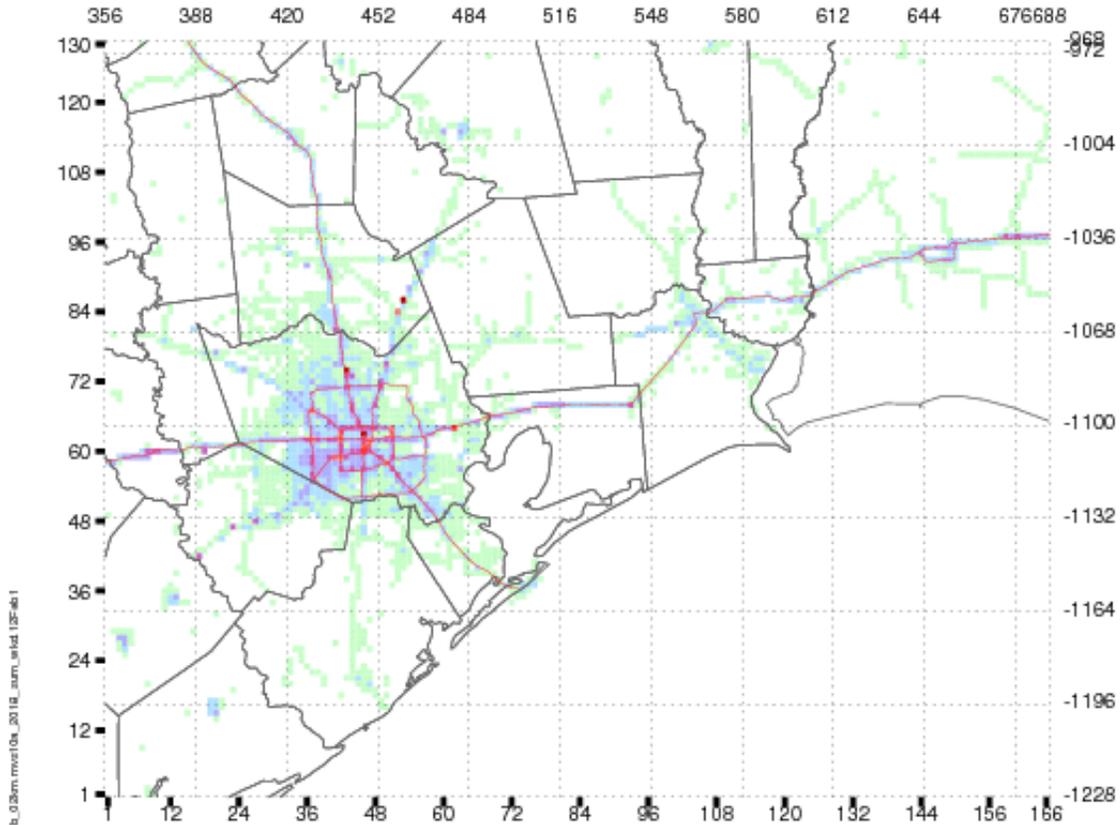
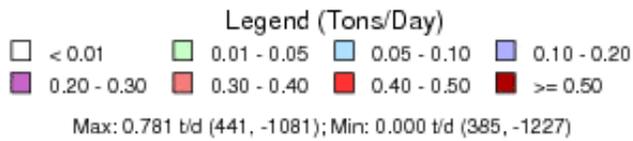


Figure 2: 2006 HGB Summer Weekday VOC Emissions

HGB 24-Hour On-Road Mobile Emissions: NO_x
 2018 Future Case, MOVES2010a Summer Weekday Inventory
 (2x2km cells)



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Total Emissions:
141.423 T/D

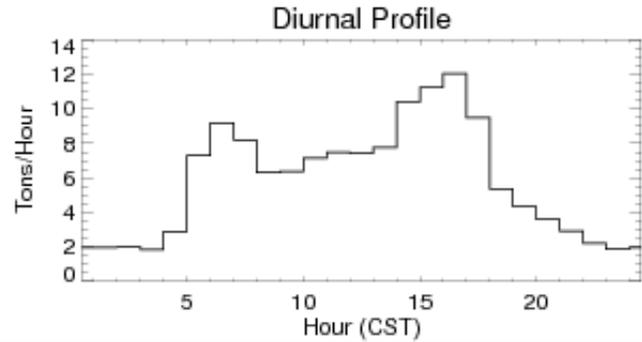


Figure 3: 2018 HGB Summer Weekday NO_x Emissions

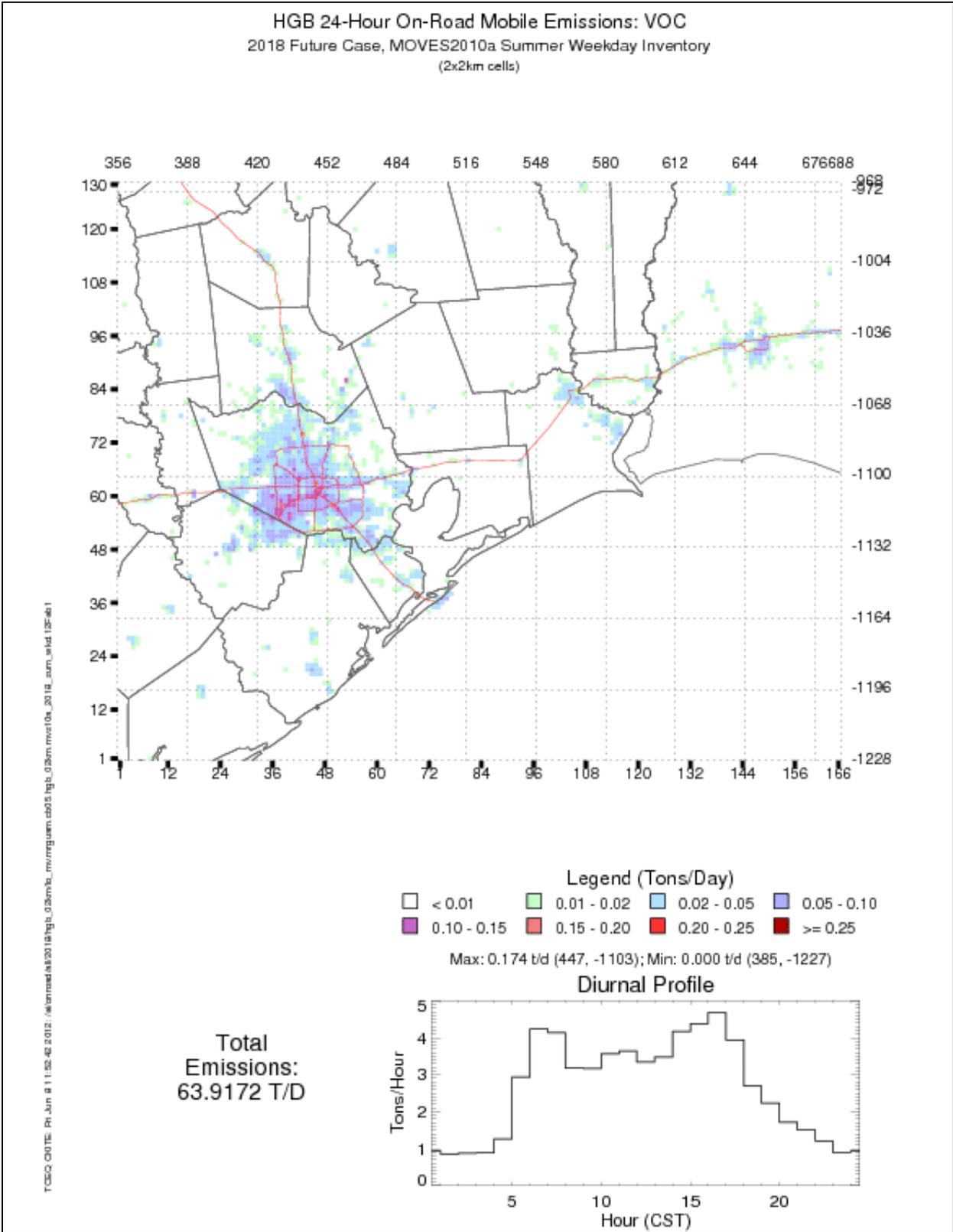


Figure 4: 2018 HGB Summer Weekday VOC Emissions

5 NON-HGB AREA ON-ROAD MOBILE SOURCE EMISSION INVENTORIES

On-road emission inventories for 2006 and 2018 were also developed for portions of the modeling domain outside of the eight-county HGB area. For twelve counties (Collin, Dallas, Denton, Ellis, Hood, Hunt, Johnson, Kaufman, Parker, Rockwall, Tarrant, and Wise Counties) in the Dallas-Fort Worth (DFW) metropolitan area, a similar link-based inventory development approach was taken by the North Central Texas Council of Governments for 2006 based on the MOVES2010a model and local TDM output. More detail on the development of these on-road link-based inventories is available on the following [2006 DFW MOVES FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/DFW/mvs/2006/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/DFW/mvs/2006/).

For the Texas counties outside of the HGB and DFW areas, on-road emissions were developed by TTI using Highway Performance Monitoring System (HPMS) data as the basis for VMT estimates. Summer season emission estimates were developed for the four day types of weekday, Friday, Saturday, and Sunday. Hourly emission factors from MOVES2010a were coupled with county-level VMT estimates by roadway type for 2006 and 2018. More detail on the development of these HPMS-based on-road inventories is available on the [2006 Texas MOVES FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/2006/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/2006/) and the [2018 Texas MOVES FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/2018/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/2018/).

For the non-Texas U.S. portions of the modeling domain, the TCEQ ran MOVES2010a in default mode to generate July weekday mobile source emissions by county for both 2006 and 2018. Pollutant-specific ratios by hour were applied to these July weekday figures to yield emission estimates for Friday, Saturday, and Sunday day types. These ratios for non-Texas inventories were obtained from the 2006 and 2018 Texas on-road emission estimates developed specifically for each day type. More detail on the development of these default MOVES2010a on-road inventories is available on the [2006 U.S. MOVES FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/mvs/2006/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/mvs/2006/) and the [2018 U.S. MOVES FTP site](ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/mvs/2018/) (ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/mvs/2018/).

More detail on this approach is documented in a presentation entitled [Using the MOVES Model in Inventory Mode to Develop Regional On-Road Emission Inputs for Air Quality Modeling Applications](http://www.epa.gov/otaq/models/moves/conference2011/inventory-regional-moves-2011.pdf) (http://www.epa.gov/otaq/models/moves/conference2011/inventory-regional-moves-2011.pdf), which was presented at an EPA workshop in June of 2011. A summary of the different on-road emission estimation approaches by geographic area taken for this HGB SIP revision is provided in Table 18: *On-Road Inventory Development by Area Within the Modeling Domain*.

Table 18: On-Road Inventory Development by Area Within the Modeling Domain

On-Road Inventory Parameter	HGB and DFW	Non-HGB and Non-DFW Texas	Non-Texas U.S. States and Counties
VMT Source and Resolution	TDM Roadway Links	HPMS Data Sets 19 Roadway Types	MOVES2010a Database 12 Roadway Types
Season/Month Modeled	School and Summer	Summer Only	July Only
Day Types	Weekday, Friday, Saturday, and Sunday		
Roadway Speed Distribution	Varies by Hour and Link	Varies by Hour and Roadway Type	MOVES2010a Default
MOVES Source Use Types	All Thirteen		
MOVES Fuel Types	Gasoline and Diesel		
Extended Idling Emissions Allocation	Truck Stops	Interstates and Other Highway Types	