APPENDIX B

EMISSIONS MODELING FOR THE DFW ATTAINMENT DEMONSTRATION SIP REVISION FOR THE 2008 EIGHT-HOUR OZONE STANDARD

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1. GENERAL MODELING EMISSIONS DEVELOPMENT

The EPA's *Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, $PM_{2.5}$, and Regional Haze* (EPA, 2007) specifies a procedure for demonstrating attainment through modeling. Instead of using the model results in an absolute sense, the eight-hour ozone procedure uses the modeling results in a relative sense. This relative approach is based on how the model responds to the reduction in emissions between a baseline and a future year. Therefore, the photochemical modeling process for attainment demonstration requires four modeling emissions data sets:

- base case emissions;
- baseline emissions;
- future year emissions; and
- future year control strategy and/or sensitivity analyses emissions.

1.1 Base Case Modeling Emissions

In order for the photochemical model to be used in the attainment demonstration, the model needs to be capable of adequately replicating historical episodes (base cases) for which high daily eight-hour ozone was measured. To maximize model performance, base case emission inputs are estimated as accurately as possible. In the development of the base case modeling emissions, a number of quality assurance techniques are used to evaluate the reasonableness of the emission magnitudes, along with their spatial distribution and temporal profile. Using the quality assured episode-specific emissions along with other modeling inputs (e.g., meteorology), the photochemical model is run and the simulated concentrations of both ozone and ozone precursors of nitrogen oxides (NO_X) and volatile organic compounds (VOC) are compared to the measured concentrations to evaluate the adequacy of the photochemical model in replicating the base case. If the evaluation indicates that the base case is not adequately replicated, then diagnostics are conducted to determine which modeling inputs are unsatisfactory. When the emissions are implicated, the modeling emissions are reviewed and pertinent revisions are made as appropriate. If the evaluation implicated other inputs, or once the photochemical model adequately replicates the base case, then the modeling emissions are considered to be sufficiently representative of the episode.

A summary of the primary data sources for the development of the base case modeling emissions is provided in Table 1-1: Summary of Base Case Point Source Emission Data Sources, Table 1-2: Summary of Base Case On-Road Mobile Source Emission Data Sources, and Table 1-3: Summary of Base Case Non-Road Mobile, Area, Oil and Gas, and Biogenic Source Emission Data Sources.

Table 1-1: Summary of Base Case Point Source Emission Data Sources

Region	Data Source
Texas	2006 State of Texas Air Reporting System (STARS)
Regional	2008 National Emissions Inventory (NEI) based EPA Modeling Platform
All States	2006 EPA Clean Air Markets Division (CAMD) Air Markets Program Data (AMPD) hourly data
Harris County	2006 hourly Harris County Tank Landing Loss surveys
HGB	2006 HGB Highly Reactive Volatile Organic Compound (HRVOC) reconciliation
Offshore	2005 Bureau of Ocean Energy Management (BOEM) Gulf-Wide Emissions Inventory (GWEI) platforms of western Gulf of Mexico
Mexico	1999 Phase III Mexico National Emissions Inventory
Canada	2006 National Pollutant Release Inventory (NPRI)

Table 1-2: Summary of Base Case On-Road Mobile Source Emission Data Sources

Region	Data Source
DFW	2006 based on MOVES2010a and local travel demand model (TDM) for vehicle miles traveled (VMT)
Other Texas	2006 based on MOVES2010b and Highway Performance Monitoring System (HPMS) for VMT
Outside Texas	2006 based on MOVES2010b default analyses

Table 1-3: Summary of Base Case Non-Road Mobile, Area, Oil and Gas, and Biogenic Source Emission Data Sources

Region	Non-Road Mobile Sources	Area Sources	Oil and Gas Sources	Biogenics
Texas	Texas NONROAD (TexN) model	2008 TexAER	2008 TexAER, 2006 Texas Railroad Commission data	MEGAN 2.1 model

Region	Non-Road Mobile Sources	Area Sources	Oil and Gas Sources	Biogenics
Outside Texas	2006 NMIM	2008 EPA NEI	2008 EPA NEI	MEGAN 2.1 model

Emissions modelers generally use a hierarchical approach, such that the closer the area is to the nonattainment area of interest, the more detailed the resolution of the emissions, i.e., Canadian emissions are expected to have very little influence on model performance in DFW, so the TCEQ does not attempt to gather hourly power plant emissions from Canada. Emissions are developed for the ozone precursors of NO_X, VOC, and carbon monoxide (CO). The emission inventories (EIs) are prepared for photochemical modeling input using Version 3 of the Emissions Processing System (EPS3)[1].

1.2 Baseline Modeling Emissions

The EPA procedure for demonstrating attainment requires the development of modeling emissions for a baseline year to be used with similarly developed future year emissions. In order to keep the baseline and future year modeling emissions commensurate, more generic non-episodic ozone season day (OSD) emissions are developed for the baseline year. The OSD modeling emissions for the baseline and future years are developed using the same averaging and estimating procedures, which provides an appropriate basis for assessing the photochemical model response to emission reductions.

The major difference between the base case and baseline modeling emissions is the treatment of the hourly-specific emissions for elevated point sources, such as electric generating units (EGUs). Emissions for the other source categories are identical between the base cases and baseline modeling emissions. 2006 was chosen as the baseline year and Section 2.2 describes the averaging processes used in the development of the baseline inventory.

1.3 Future Year Modeling Emissions

The 10-county DFW area is classified as moderate nonattainment under the 2008 eight-hour ozone standard. The attainment date for DFW is December 31, 2018 and the modeling attainment year is 2018. Modeling emissions for the 2018 future year were estimated by applying growth projections, existing control measures, and emissions caps to the baseline (in general) modeling emissions. The 2018 modeling emissions include the benefits of the Federal Motor Vehicle Control Program (FMVCP), Ellis County Cement Kiln Cap, Mass Emissions Cap and Trade (MECT) Program, the Highly Reactive VOC Emission Cap and Trade (HECT) Program in the Houston-Galveston-Brazoria (HGB) area, and Phase II of the Clean Air Interstate Rule (CAIR).

1.4 Future Year Control Strategy and/or Sensitivity Analyses Emissions

Existing controls with compliance dates that have passed or are between the baseline and the future years are modeled in the future case identified above. Any new control strategies, other rules, potential rules, or sensitivity analyses that are modeled are applied on top of the future case modeling in order to determine the efficacy in the future. The point source sensitivity analyses performed for this DFW attainment demonstration are a

[1] Environ product, maintained by Environ

Discrete Emission Reduction Credit (DERC) Flow Control sensitivity and a Cross State Air Pollution Rule (CSAPR) sensitivity. See Section 2.4 2018 Point Source Control Strategy and/or Sensitivity Analyses of this appendix for details.

2. POINT SOURCE MODELING EMISSIONS DEVELOPMENT

Much of the point source emissions development began where the December 2011 DFW SIP Revision[2] left off, with this SIP Revision providing large upgrades to the TCEQ Modeling Platform as described in Chapter 3 of this SIP Revision, including new and extended modeling domain definitions that include the entire continental U.S. (CONUS), new versions of the Comprehensive Air Quality Model with Extensions (CAMx) and Version 3 of the Emissions Processor System (EPS3), and the updated Carbon Bond 6 (CB6) chemical mechanism. The two modeled episodes of the 2006 base case ("June" and "AQS1") were originally modeled in the March 2010 HGB SIP Revision[3] , and then upgraded for the TCEQ Rider 8[4] Modeling Platform, which is equivalent to this DFW Modeling Platform. Some of the descriptions of this DFW modeling development will refer to the work performed for the SIP Revisions noted above and footnoted (for proper reference), especially for descriptions of HGB-specific emissions development, and will hereafter be referred to as "previous SIP documentation."

The various data sources that went into the development of the point source modeling emissions are summarized in Table 2-1: Sources of Point Source Emissions Data. The TCEQ compiled and formatted the data to generate modeling datasets for the base case, the baseline, and the future case studies as detailed in subsequent sections.

Table 2-1: Sources of Point Source Emissions Data

Sources of Data	Calendar Year(s) Used
TCEQ State of Texas Air Reporting System (STARS)	2006, 2012
TCEQ Hourly Floating Roof Tank Landing Loss (TLL) Surveys	2006
TCEQ-derived Highly Reactive Volatile Organic Compound (HRVOC) Reconciliation using Potential Source Contribution Factor (PSCF) Methodology	2006
EPA Clean Air Markets Division (CAMD) Air Markets Program Data (AMPD) of power plant Continuous Emissions Monitors (CEMs) for all states	2006, 2013
EPA/TCEQ Clean Air Interstate Rule (CAIR) allocation estimates for entire modeling domain	2018
Electric Reliability Council of Texas, Capacity, Demand, and Reserve report	2014
U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM) Gulf-Wide Emissions Inventory (GWEI) of Offshore Platforms	2005, 2008
EPA Emissions Modeling Clearinghouse (EMCH) Modeling Platform	2008, 2018

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[2] December 7, 2011 DFW Attainment Demonstration for the 1997 Eight-Hour Ozone Standard at http://www.tceq.texas.gov/airquality/sip/dfw_revisions.html

[3] March 10, 2010 HGB Attainment Demonstration for the 1997 Eight-Hour Ozone Standard at http://www.tceq.texas.gov/airquality/sip/HGB_eight_hour.html#AD

[4] TCEQ program to support local air quality planning for the ozone NAAQS at http://www.tceq.texas.gov/airquality/airmod/rider8

Sources of Data	Calendar Year(s) Used
Environment Canada National Pollutant Release Inventory (NPRI)	2006
Phase III Mexico National Emissions Inventory and future case projection	1999, 2018

2.1 2006 Base Case Point Source Modeling Emissions Development

The following subsections describe development of the base case point source modeling emissions for all portions of the domain used for the June 2006 and August-September 2006 (AQS1) DFW modeling episodes.

2.1.1. Texas Point Sources

For Texas point sources, ozone season daily (OSD) emissions data from State of Texas Air Reporting System (STARS) and hourly emissions data from the EPA's Air Markets Program Data (AMPD) provided the basis for modeling the 2006 base case episode. Additionally, the supplemental "extra olefins" file was used from previous SIP Revisions to account for reconciled highly reactive volatile organic compound (HRVOC) emissions in the HGB area. HRVOC include ethylene, propylene, 1,3-butadiene, and all isomers of butene. The episode-specific survey results of HGB floating roof tank landing losses (TLL) were used to develop files of hourly emissions for the 2006 episode. The following subsections describe the development of modeling emissions for each of these components.

2.1.1.1. State of Texas Air Reporting System (STARS)

Point source emissions and industrial process operating data are collected annually from sites that meet the reporting requirements of 30 Texas Administrative Code (TAC) §101.10. Subject entities are required to report levels of emissions subject to regulation from all emissions-generating units and emissions points, and also must provide representative samples of calculations used to estimate the emissions. Descriptive information is also required on process equipment, including operating schedules, emission control devices, abatement device control efficiencies, and emission point discharge parameters such as location, height, diameter, temperature, and exhaust gas flow rate. All data submitted in the annual emissions inventory questionnaires (EIQ) are subjected to TCEQ quality assurance (QA) procedures. The data are then stored in the STARS database. The TCEQ reports point source emissions data to the EPA for inclusion in the National Emissions Inventory (NEI).

Annually, the TCEQ collects emissions information from approximately 2000 major point sources. In nonattainment areas, major point sources are defined for inventory reporting purposes as industrial, commercial, or institutional sources that emit actual levels of criteria pollutants at or above the following amounts: 10 tons per year (tpy) of volatile organic compound (VOC); 25 tpy of nitrogen oxides (NO_X); or 100 tpy of any of the other criteria pollutants including carbon monoxide (CO), sulfur dioxide (SO_2), 10-micron threshold particulate matter (PM_{10}), or lead (Pb). For the attainment areas of the state, any company that emits a minimum of 100 tpy of any criteria pollutant must submit an inventory. Additionally, any source that either generates or has the potential to generate at least 10 tpy of any single Hazardous Air Pollutant (HAP) or 25 tpy of aggregate HAPs is required to report emissions to the TCEQ. The reporting requirements, guidance documents, trends, and summaries of the most recently quality assured year of reported data can be found on the TCEQ Point Source Emissions Inventory website at http://www.tceq.state.tx.us/implementation/air/industei/psei/psei.html.

Development of the Texas point source emission modeling files began with queries of the quality-assured data of the STARS database. Updated modeling query reports are typically run when significant STARS updates are completed. The STARS modeling extract report ("STARS extract") is simply a snapshot of Texas emissions, since emissions from previous years can be updated by the regulated entities.

SAS computer programming code was written, updated, and/or modified to parse the STARS extract, perform various logical checks and comparisons, assign defaults for missing data, apply rule effectiveness to VOC paths with control devices, and format the data into an AIRS Facility Subsystem (AFS) file that can be processed with the modules of EPS3.

The STARS extract contains four types of emission rates: annual, OSD, emission events (EE), and scheduled maintenance startup and shutdown (SMSS). When supplied, the OSD emissions in tons per day (tpd) are modeled, plus any EE/SMSS for the source (after conversion to tpd). When OSD is not provided by the source, an OSD is computed from the reported summer use percentage of the source and the other reported operational parameters of the source, plus any reported EE/SMSS for the source. The modeled OSD emission rate is representative of average daily emissions during the summer. For 2006, the ozone season for emission inventory (EI) reporting purposes is June through August. This is generally the time of the year that monitored ozone concentrations are highest. An example of STARS extract data is available in the March 2010 HGB SIP Appendix B, Section 2.1.1.

2.1.1.2. Rule Effectiveness (RE)

The TCEQ continue to apply RE to the STARS VOC emissions where appropriate, as a legacy procedure. The purpose is to account for the possibility that not all facilities covered by a rule are in compliance with the rule 100% of the time and that control equipment does not always operate at its assumed control efficiency. Additional details about rule effectiveness and how it is applied by the TCEQ are described in previous SIP documentation.

2.1.1.3. Preparation of AFS File for EPS3 Input

The resultant OSD AFS file is in a format ready for input to EPS3. The STARS-derived AFS file for all criteria pollutants typically has more than 200,000 records. Each point source emissions path contains references for the TCEQ account (RN), equipment (FIN), and exhaust point (EPN). For ozone modeling purposes, values for the ozone precursors of NO_X, VOC, and CO are retained in the AFS file for EPS3 input. An example AFS record with explanations, specific QA steps, and file naming conventions can be found in previous SIP documentation. The AFS file format used by the TCEQ for this modeling, including field descriptions and options, which is an expansion of the standard EPS3 AFS format, can be found on the [TCEQ FTP modeling](ftp://amdaftp.tceq.texas.gov/pub/TX/ei/basecase/point/AFS/AFS-EPS3-v3.docx) webpage, ftp://amdaftp.tceq.texas.gov/pub/TX/ei/basecase/point/AFS/AFS-EPS3-v3.docx.

2.1.1.4. Preparation of Photochemical Model-Ready Files with EPS3

EPS3 is used to process the emissions in the AFS file into a format ready for photochemical model input. Photochemical model inputs require that the emissions be (in EPS3 order performed by the TCEQ):

- chemically speciated into groups of compounds with similar reactivity for the formation of ozone;
- temporally allocated by hour of day, day of week, etc.; and
- spatially allocated to grid cells or assigned to fixed points.

The *EPS3 User's Guide*[5] provides additional details for processing the point source emissions for photochemical model input. The remainder of this section discusses some of the specific point source emissions processing procedures. Excerpts of the data, which provide a better visual understanding of the processes, can be found in previous SIP documentation.

2.1.1.4.1. *Chemical Speciation with EPS3*

VOC emissions in STARS can be reported as individual compounds, mixtures, classes of compounds, total VOC, and unclassified VOC. The VOC values that are included in the AFS file are speciated into carbon bond groups of similar ozone reactivity that will be recognized by the specific chemical mechanism of the photochemical model. For operational efficiency, most photochemical modeling studies are not based on separate algorithms for each individual reaction. Instead, for SIP modeling purposes, groups of compounds with similar reactivity for the formation of ozone are grouped together and input into the photochemical model. The TCEQ used the CB6 "lumped" chemical mechanism, implemented via EPS3 module SPCEMS.

The majority of TCEQ EIQ responses include constituent VOC emission rates, which are used to develop point-specific speciation profiles. When the composition of the VOC reported for a specific source is unknown or not fully-speciated, the default speciation profile is applied based on the source classification code (SCC) and the default speciation from EPA's SPECIATE[6] database software program. More detail on the TCEQ source-specific speciation approach is available in previous SIP documentation and in an international emission inventory conference paper[7].

Ethane and acetone, which are technically not VOCs by EPA's definition, are also extracted from STARS and processed in the emissions model, and are subjected to the same speciation as all of the other STARS compounds. Ethane, acetone and VOC are now included in VOC totals in tables and tile plots in subsections below, because the photochemical model can use these compounds as CB6 lumped species categories of their own. This is a new procedure for TCEQ that was brought about by CB6 implementation. Because ethane and acetone are additive to the VOC, the modeled and tabulated VOC will almost always be greater than reported (STARS) VOC. The Tank Landing Losses and Extra Olefins datasets were created prior to this new procedure, so those datasets do not include ethane or acetone.

2.1.1.4.2. Temporal Allocation with EPS3

Even though OSD is typically used for processing of photochemical modeling emissions, EPS3 can temporally distribute emissions by month, day of the week, and hour of a specific episode when sufficient detail is provided in the EIQ. Previous SIP documentation provides detail about temporal allocation, along with examples of the cross reference and profile records.

2.1.1.4.3. Spatial Allocation with EPS3

Photochemical models generally rely on a three-dimensional Eulerian system in which emissions are allocated to individual grid cells. Emissions occur at or near the surface for most

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[5] Written and updated by Environ to accompany their software. The TCEQ posts a courtesy copy at ftp://amdaftp.tceq.texas.gov/pub/TX/ei/basecase/point/eps3/EPS3UG_UserGuide_200908.pdf

[6] http://www.epa.gov/ttn/chief/software/speciate/

[7] Thomas, et al, Emissions Modeling of Specific Highly-Reactive Volatile Organic Compounds (HRVOC) in the Houston-Galveston-Brazoria Ozone Nonattainment Area, EPA-sponsored 17th Annual International Emission Inventory Conference, Portland, Oregon, June 2008.
Paper: http://www.epa.gov/ttn/chief/conference/ei17/session6/thomas.pdf
Presentation: http://www.epa.gov/ttn/chief/conference/ei17/session6/thomas_pres.pdf

source categories such as area, biogenic, some on-road mobile, and some non-road mobile, and are classified as low-level, being released at the same time, mixed throughout the grid cell. Numerous point sources also fall into the low-level source category, but large combustion sources, such as power plants, are categorized as elevated sources, because their hot exhaust gases can rise several hundred meters into the atmosphere.

Low-level point sources are allocated to grid cells and merged with the other low-level source categories prior to photochemical model input. Whereas, elevated point sources are kept at their reported X-Y locations and assumed to emit from the calculated effective plume height of Z to better simulate physical mixing in the elevated layers of the photochemical model. As with other advanced emissions processors, EPS3 processing of point source emissions is divided into low-level and elevated streams, which provides better simulation of how elevated emissions are distributed prior to mixing and reacting with surface emissions. The drawbacks of using the dual regimes are more complicated EPS3 processing and longer photochemical model run times.

The photochemical model inputs for point sources consist of a single low-level gridded merged file and a single file of elevated sources. A plume cutoff height of 30 meters was chosen to divide the point sources into low-level and elevated categories. The emissions from elevated sources can be individually tracked, and NO_X reaction chemistry can be enhanced by treating these plumes as Lagrangian puffs by use of the optional Plume-in-Grid (PiG) treatment. The TCEQ uses the Greatly Reduced Execution and Simplified Dynamics (GREASD) PiG option[8] in CAMx, which is most applicable to large NO_X plumes. More detail on the GREASD PiG approach is provided below in Section 2.1.3.

Figure 2-1: Tile Plot of DFW 10-County OSD Non-EGU Low-Level NO_X Emissions for June 1, 2006 is a tile plot of the low-level OSD (non-EGU) NO_X emissions for the DFW ten county area at the 4 km by 4 km grid cell resolution. The specific day of the episode is irrelevant for OSD emissions, because each modeled day of OSD emissions is identical. Figure 2-2: Tile Plot of DFW 10-County OSD Non-EGU Elevated NO_X Emissions for June 1, 2006 is a plot of the elevated OSD (non-EGU) NO_X emissions for the DFW 10-County area. Note that a vast majority of the NO_X emissions are from elevated sources (mainly combustion with hot exit gas and taller stacks). Also note that the diurnal profiles of the OSD sources are generally flat (don't vary across the day) on average, indicating that the non-EGUs are dominated by sources that operate continuously.

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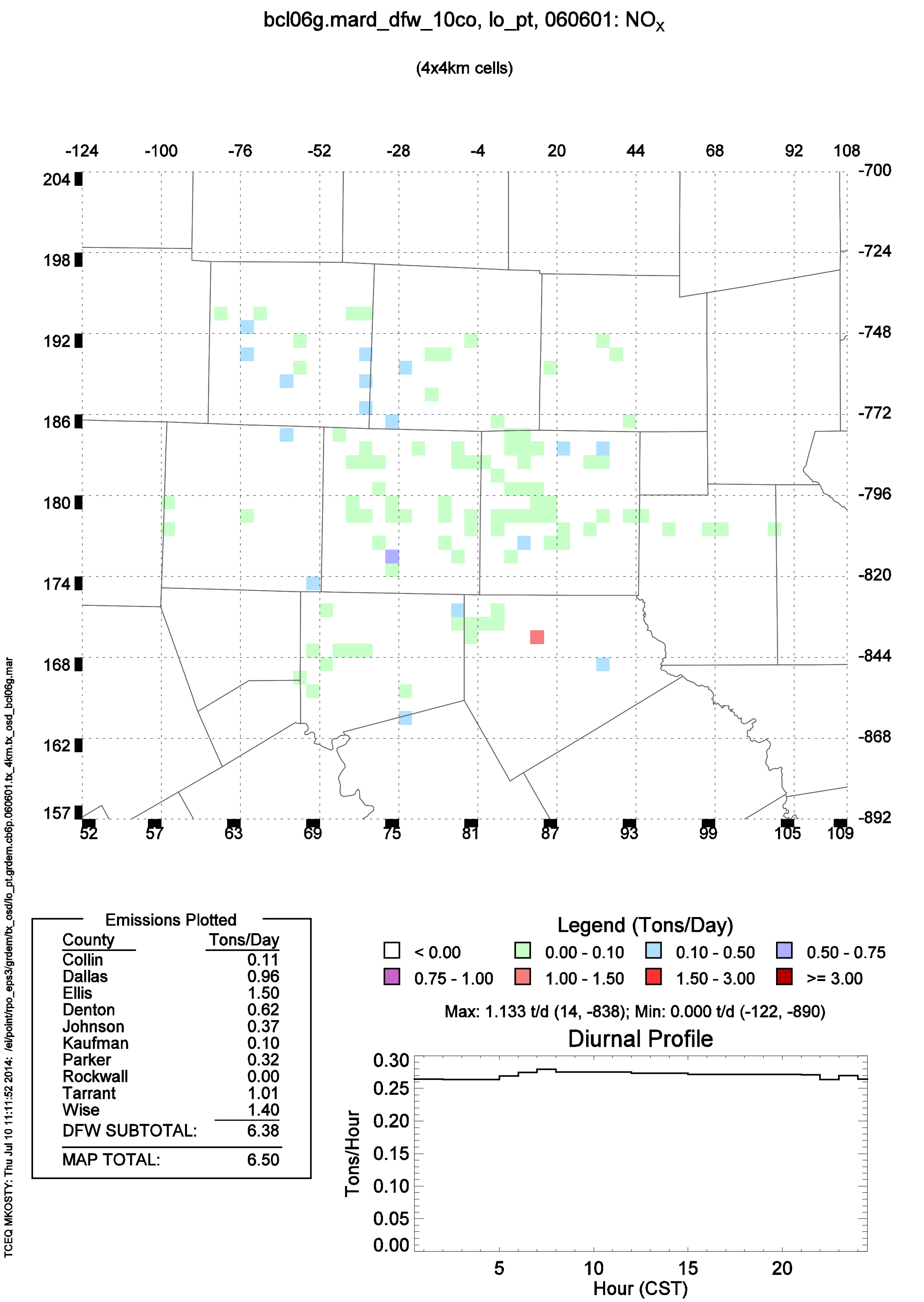
[8] See Environ's CAMx User's Guide at http://www.camx.com/download/default.aspx



Emissions Plotted

County	Tons/Day
Collin	0.11
Dallas	0.96
Ellis	1.50
Denton	0.62
Johnson	0.37
Kaufman	0.10
Parker	0.32
Rockwall	0.00
Tarrant	1.01
Wise	1.40
DFW SUBTOTAL:	6.38
MAP TOTAL:	6.50

Figure 2-1: Tile Plot of DFW 10-County OSD Non-EGU Low-Level NO_X Emissions for June 1, 2006

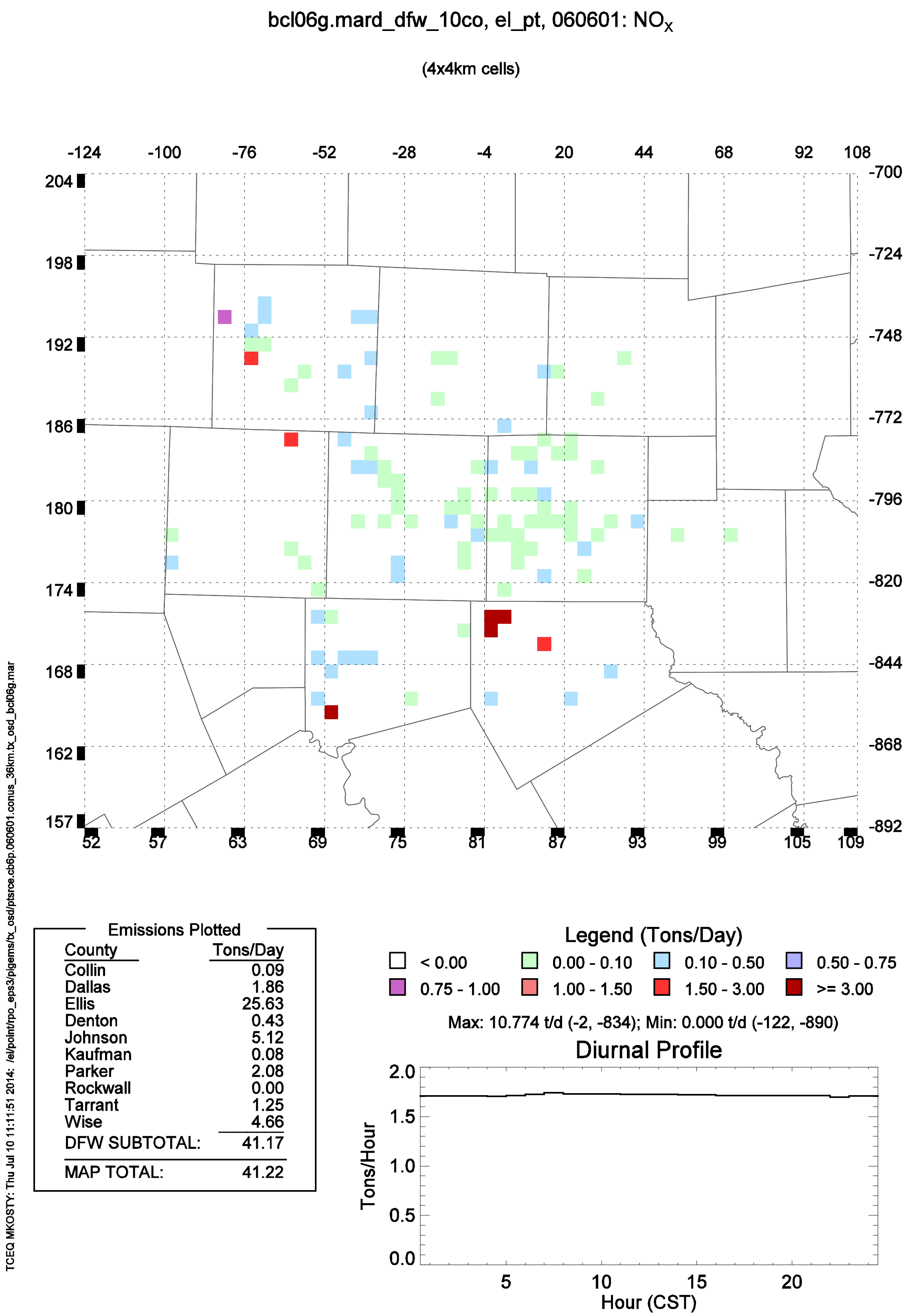


Figure 2-2: Tile Plot of DFW 10-County OSD Non-EGU Elevated NO_X Emissions for June 1, 2006

2.1.1.5. Hourly Air Markets Program Data (AMPD)

To enhance emissions accuracy for the base case, the TCEQ increases temporal resolution by replacing some of the daily OSD emission records with as much monthly, daily, or hourly data[9] as available. For the electrical generating units (EGU) in the state, hourly records from the EPA's AMPD database are substituted for the STARS OSD records. "AMPD" refers to EGU (a.k.a. power plants) emissions in which a continuous emission monitoring (CEM) system must be used to record and store emissions data. "AMPD" is an updated database name for what TCEQ has previously referred to as "Clean Air Markets Division (CAMD)" data or "Acid Rain Data (ARD)." This substitution occurs simultaneously removing the AMPD source from the OSD files while adding hourly records for the source to the AMPD file, to avoid any double counting of emissions.

Under the Clean Air Act's Acid Rain Program and the other budget/cap programs for EGUs, each unit reports its emissions of SO_2, NO_X, and CO2, along with other parameters such as heat input. The EPA quality assures the raw hourly data and provides datasets and a query wizard on the AMPD website[10] for downloading the data. Missing or invalid hourly data that arise from CEM equipment problems are generated by the EPA using specific substitution criteria. Thus, EGU-reported data (such as input to STARS or the NEI) do not always match that from EPA's AMPD.

Hourly data were downloaded from EPA's AMPD website for Texas and the rest of the country for the 2006 episodes. The AMPD database uniquely identifies point sources by FACILITY ID/ORIS (Office of Research Information Systems) number and UNIT ID/BLRID (boiler identification). FACILITY ID/ORIS identifies the site and UNIT ID/BRLID specifies the source (piece of equipment generating the emissions, not to be confused with the stack, which is the exit point of the emissions to the atmosphere) within the site. The TCEQ maintains an internal cross reference that links the FACILITY ID and UNIT ID emissions data to a NEI and STARS FIPS/plant/stack/point emissions "path" which provides location, stack, and other parameters needed to model the point source. Corresponding hourly VOC and CO records for sources matched with the cross reference were generated using their VOC-to-NO_X and CO-to-NO_X ratios. This was still the procedure for the 2006 work. In later work for this SIP, the TCEQ upgraded this procedure by basing the hourly VOC and CO emissions on the hourly heat input instead of the hourly NO_X emissions. AFS files with "ARD" in the name contain these hourly emission records, although in later work, the designation has been changed to "AMP" to more accurately reflect the data source. Previous SIP documentation describes, in more detail, with examples, how ARD/AMPD point sources are converted to hourly AFS emissions records.

Figure 2-3: Tile Plot of DFW 10-County AMPD EGU NO_X Emissions for June 6, 2006 is a tile plot of AMPD NO_X emissions of the 10-County DFW area for June 6, 2006. The tile plot is used to graphically QA the modeled emissions. Reported on the tile plots are the emissions totals by county in the lower left hand corner and the

corresponding total diurnal profile of the sources in the lower right corner of the graphic. The colored/shaded tiles represent the quantity of emissions within that grid cell. A colored/shaded

[9] Thomas, et al, Development of an Hourly Modeling Emissions Inventory from Several Sources of Regulatory Speciated Hourly Data for the Houston-Galveston-Brazoria Ozone Nonattainment Area, EPA-sponsored 17th Annual International Emission Inventory Conference, Portland, Oregon, June 2008. Poster Presentation: http://www.epa.gov/ttn/chief/conference/ei17/poster/thomas.pdf

[10] http://ampd.epa.gov/ampd/

tile represents the AMPD EGU NO_X tons for a modeled day's 4 km-by-4 km grid cell within the 10-County DFW area.

Figure 2-4: Tile Plot of DFW 10-County AMPD EGU NO_X Emissions for June 14, 2006 is a tile plot similar to Figure 2-1, except that it represents a day in the June episode that has fewer EGU emissions. Note that the tabulated June 14 NO_X emissions are approximately 1.5 tons lower than the June 6 NO_X emissions for the 10-County EGUs. Also note from the diurnal profile that the maximum hourly emissions total for June 14 occurs during the hour beginning at 3:00 PM at a level of approximately 0.52 tons per hour. Whereas, the diurnal profile for June 6 has a lower low NO_X tons per hour and a higher high NO_X tons per hour, with the maximum (approximately 0.75 tons per hour) shifted to the 4:00 PM hour. The comparison of Figure 2-3 and Figure 2-4 points out the variability of the overall DFW EGU emissions, even within the same month.

Figure 2-5: Tile Plot of Texas AMPD EGU NO_X Emissions for August 31, 2006 is a tile plot of the entire AMPD NO_X emissions for August 31, 2006, during the AQS1 episode. This day is one of the days that recorded some of the highest ozone at most of the DFW area monitors. Note that to cover the entire state, Figure 2-3 grid cell size is 12 km. Also note that the baseload (run almost continuously) EGUs in the remainder of Texas flatten out the diurnal profile a bit compared to the peaking or intermediate units in the DFW area.

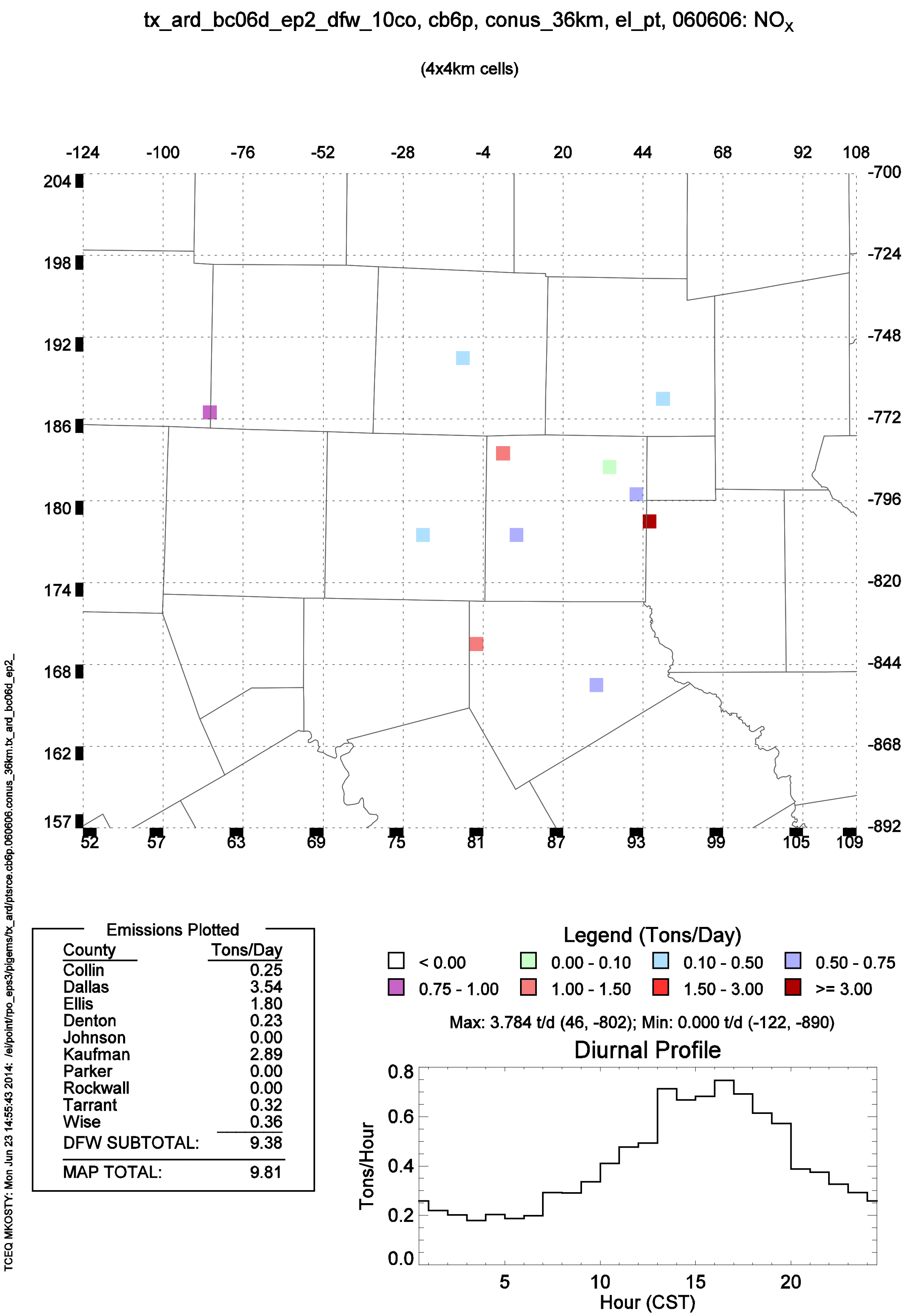


Figure 2-3: Tile Plot of DFW 10-County AMPD EGU NO_X Emissions for June 6, 2006

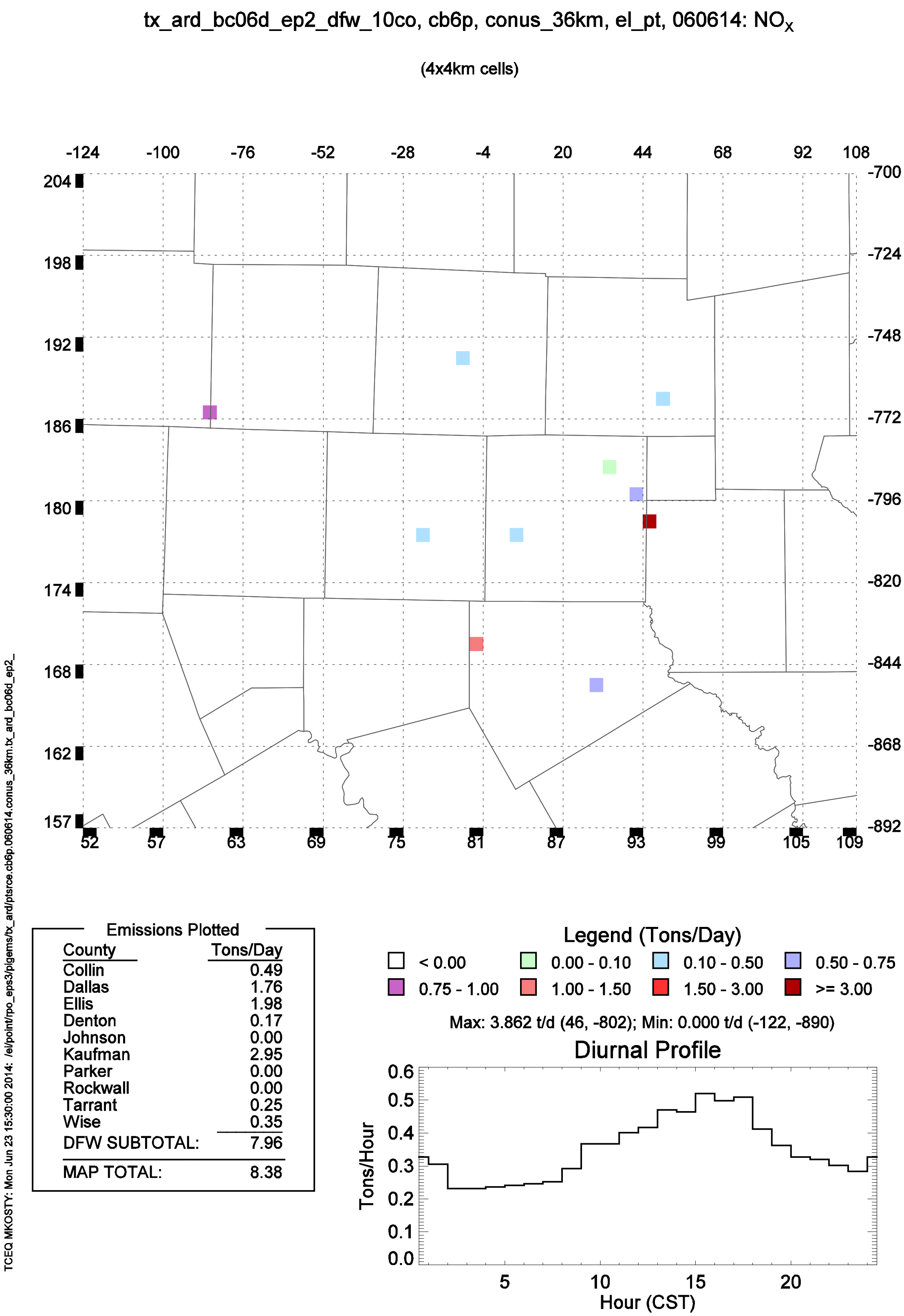


Figure 2-4: Tile Plot of DFW 10-County AMPD EGU NO_X Emissions for June 14, 2006

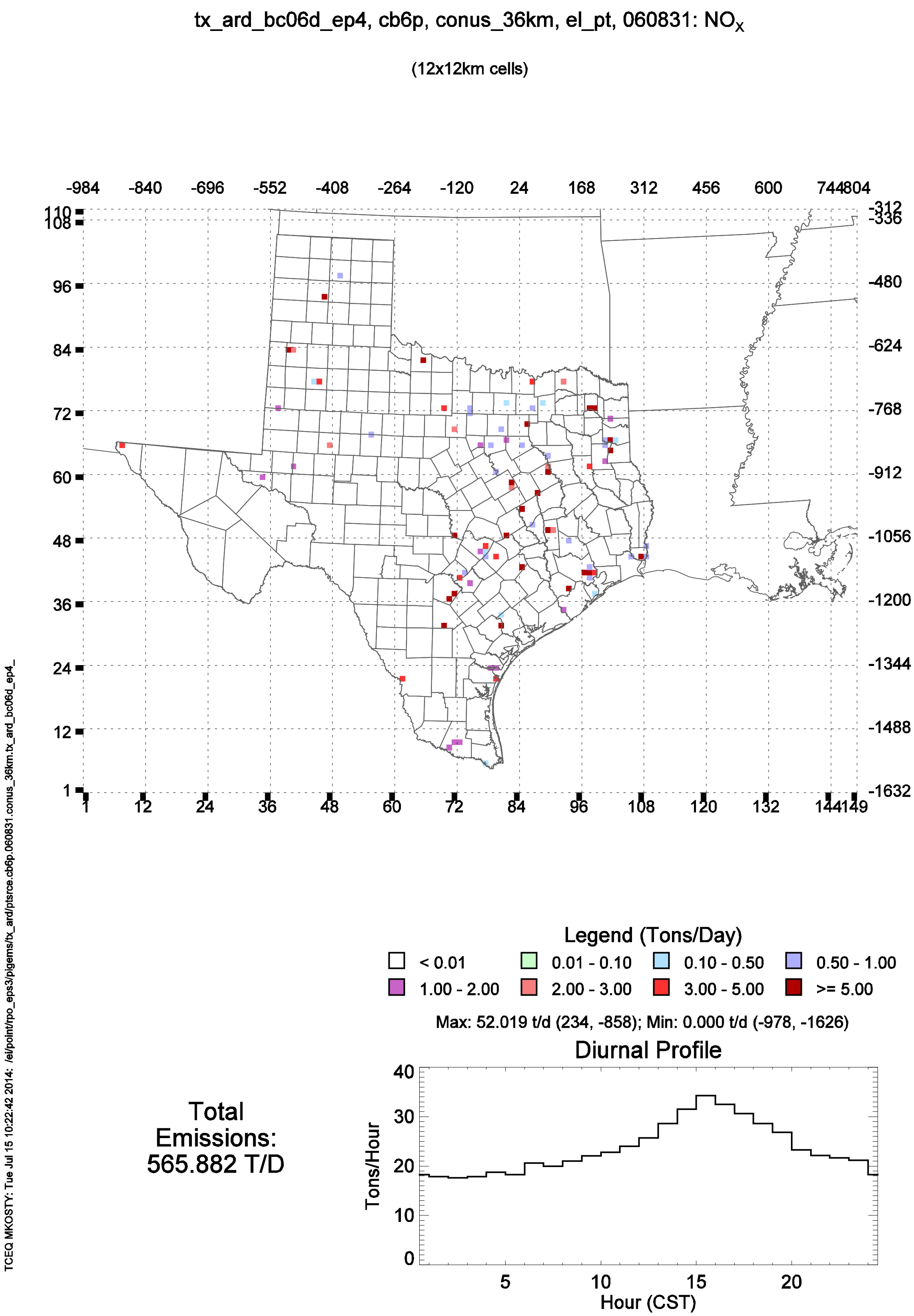


Figure 2-5: Tile Plot of Texas AMPD EGU NO_X Emissions for August 31, 2006

2.1.1.6. 2006 Tank Landing Loss (TLL) Survey in HGB

As a result of a Texas Air Quality Study II (TexAQS II) remote sensing VOC project in July 2005, large storage tanks in specific service (e.g., tanks-for-hire at terminal facilities and crude oil breakout stations) in the Houston Ship Channel (HSC) area were found to be landing their floating roofs (internal and external) on the tank legs and not reporting those vapor space losses. As a result, a TCEQ Chapter 115 rule was written that limits the number of permissible "convenience" roof landings, and additional VOC emissions from special inventory surveys specific for these events were added to the sources that replied to the survey. Additional details about the under-reported VOC emissions and data development for modeling are in the March 2010 HGB SIP Appendix B, Section 2.1.1.7.

Figure 2-6: Tile Plot for HGB Tank Landing Loss Surveys for a Representative Summer Day in 2006 in 2006 is a tile plot of a representative day of the TLL that was added to HGB. Note the diurnal variation of these emissions.

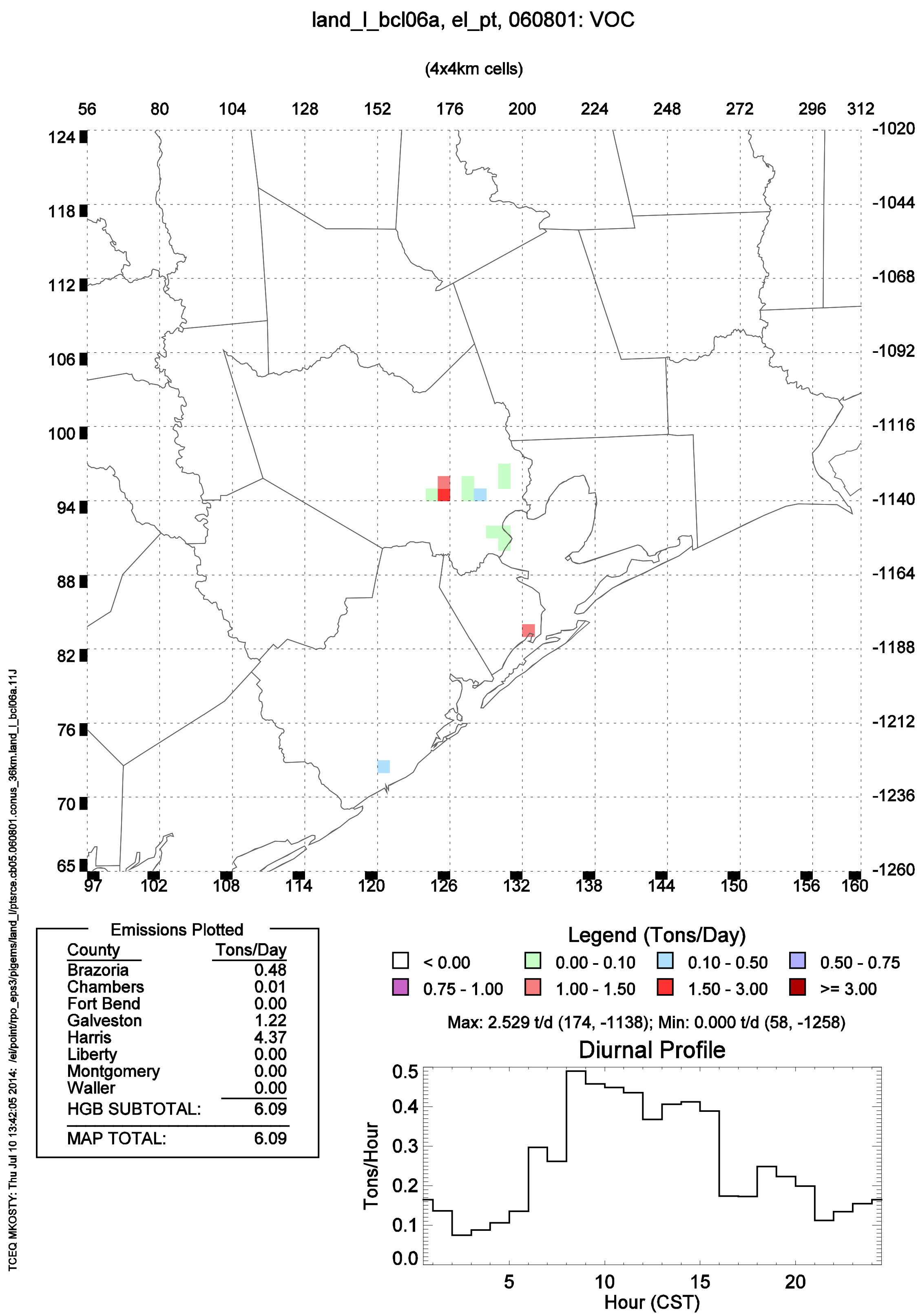


Figure 2-6: Tile Plot for HGB Tank Landing Loss Surveys for a Representative Summer Day in 2006

2.1.1.7. Emissions Inventory Reconciliation in HGB (aka, HRVOC Reconciliation, Extra Olefins)

EI Reconciliation is the process by which the reported EI is adjusted so that modeled emissions more closely match the concentrations measured at monitors during the episodes. TexAQS II confirmed the need for this, as TexAQS 2000 first affirmed. VOC, and especially HRVOC, continue to be under-reported in the annual EIQs, according to monitors and aircraft measurements. In previous SIP revisions, as with this SIP revision, the TCEQ generated a day-specific “extra olefins” file to add to each episode day of the modeling EI in HGB to account for the under-reporting. Rather than placing the reconciled extra emissions at the locations of existing point sources, the TCEQ placed a single pseudo point in each affected modeling cell, and assigned an emission rate for each HRVOC to best offset the difference between modeled and calculated concentrations, according to the Potential Source Contribution Function (PSCF). This same file was modeled unchanged. Additional details about the under-reported HRVOC emissions, the PSCF technique, and data development for modeling are in the March 2010 HGB SIP Appendix B, Section 2.1.1.9.

Figure 2-7: Tile Plot of HGB HRVOC Reconciliation Emissions for a Representative Summer Day in 2006 is a tile plot of modeled VOC representing the HRVOC reconciliation (PSCFv3).

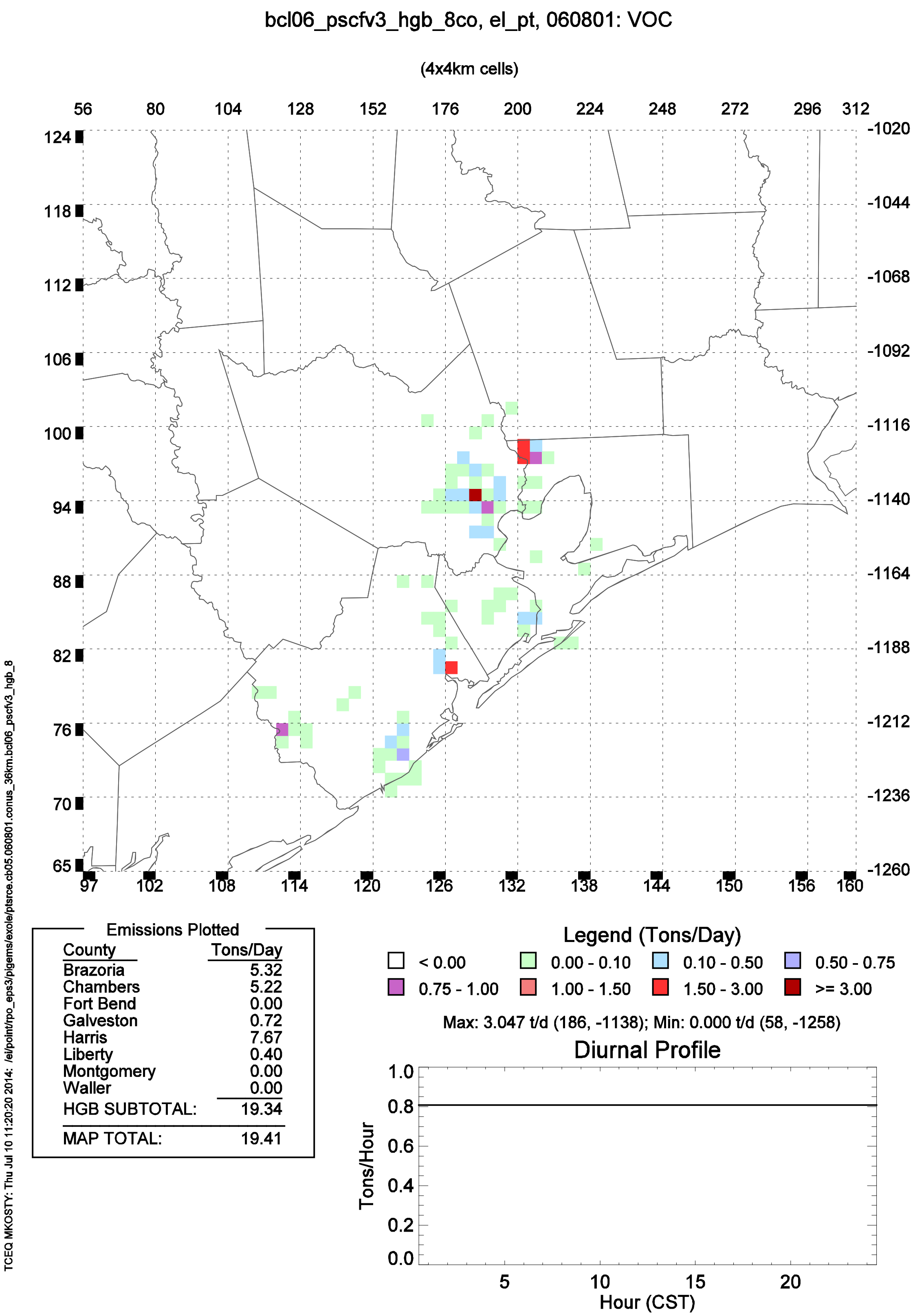


Figure 2-7: Tile Plot of HGB HRVOC Reconciliation Emissions for a Representative Summer Day in 2006

2.1.2. Regional (Outside of Texas) Point Sources

This section and its subsections discuss the point source modeling emissions development for all areas outside of Texas within the modeled CAMx domain. The modeled Regional area includes the following parts:

- Continental U.S.A. outside of Texas ;
- Offshore (Gulf of Mexico);
- Mexico; and
- Canada.

2.1.2.1. Continental USA Outside of Texas, non-EGU NEI

The 2006 EI for states outside of Texas were developed from EPA's 2008 NEI based Modeling Platform. The TCEQ downloaded the annual emissions inventory data[11] from the EPA Emissions Modeling Clearinghouse (EMCH) in the Flat File 2010 (FF10) format, a format suitable for Sparse Matrix Operator Kernel Emissions (SMOKE) processing. To be consistent with the area source data modeled, the 2008 data were used without back-casting to 2006. The 2008 NEI was used as an upgrade from the 2005 NEI, because the 2008 NEI touted to be a more thorough and detailed inventory than the 2005. Records for certain SCCs, for rail and airports, were removed to avoid duplicating emissions with area source categories. An AFS-formatted file, including all necessary and relevant modeling parameters, was produced for EPS3 processing. The associated temporal allocation file for SMOKE was converted to create the daily temporal distribution. A June day was selected to represent a typical ozone season day. Details on AFS file creation from the NEI-based data, including QA, speciation, and temporal allocation, are described in previous SIP documentation.

2.1.2.2. States Outside of Texas, Hourly AMPD Substitution for EGUs

The TCEQ replaced the original emission records with hourly records for all the AMPD EGUs in all states outside of Texas by matching the AMPD identifiers, ORIS and Unit ID. The TCEQ maintains a (ORIS and Unit ID keyed) cross reference that links the 2008-based NEI to the AMPD data.

Location and stack parameters, obtained from the NEI are appended to the AMPD point sources. All AMPD points in the adjacent states of Louisiana, Arkansas, and Oklahoma are cross referenced; thus, AMPD emissions in these states are accurately placed for the model. Corresponding hourly VOC and CO records for EGUs matched with the cross reference were generated using their VOC-to-NO_X and CO-to-NO_X ratios.

AMPD NO_X emissions for the EGUs of the adjacent states for a specific episode day modeled in 2006 are shown in Figure 2-8: Tile Plot of AMPD EGU NO_X Emissions for the Adjacent States for June 14, 2006. This is a tile plot of the 12 km by 12 km grid cell domain with Texas in the center. Note that the emissions summary in this tile plot is for the entire 12 km domain, minus Texas. AMPD NO_X emissions for the EGUs of the continental USA outside of Texas for the same specific modeled episode day are shown in Figure 2-9: Tile Plot of AMPD EGU NO_X Emissions for the USA (outside of Texas) for June 14, 2006. This is a tile plot of the 36 km grid cell domain.

[11] The TCEQ extracted the "CAP_BAFM_2008NEI_v2_POINT_20120202_09feb2012_v1" annual emissions data file, which does not include Integrated Planning Model (IPM), or EGU, units

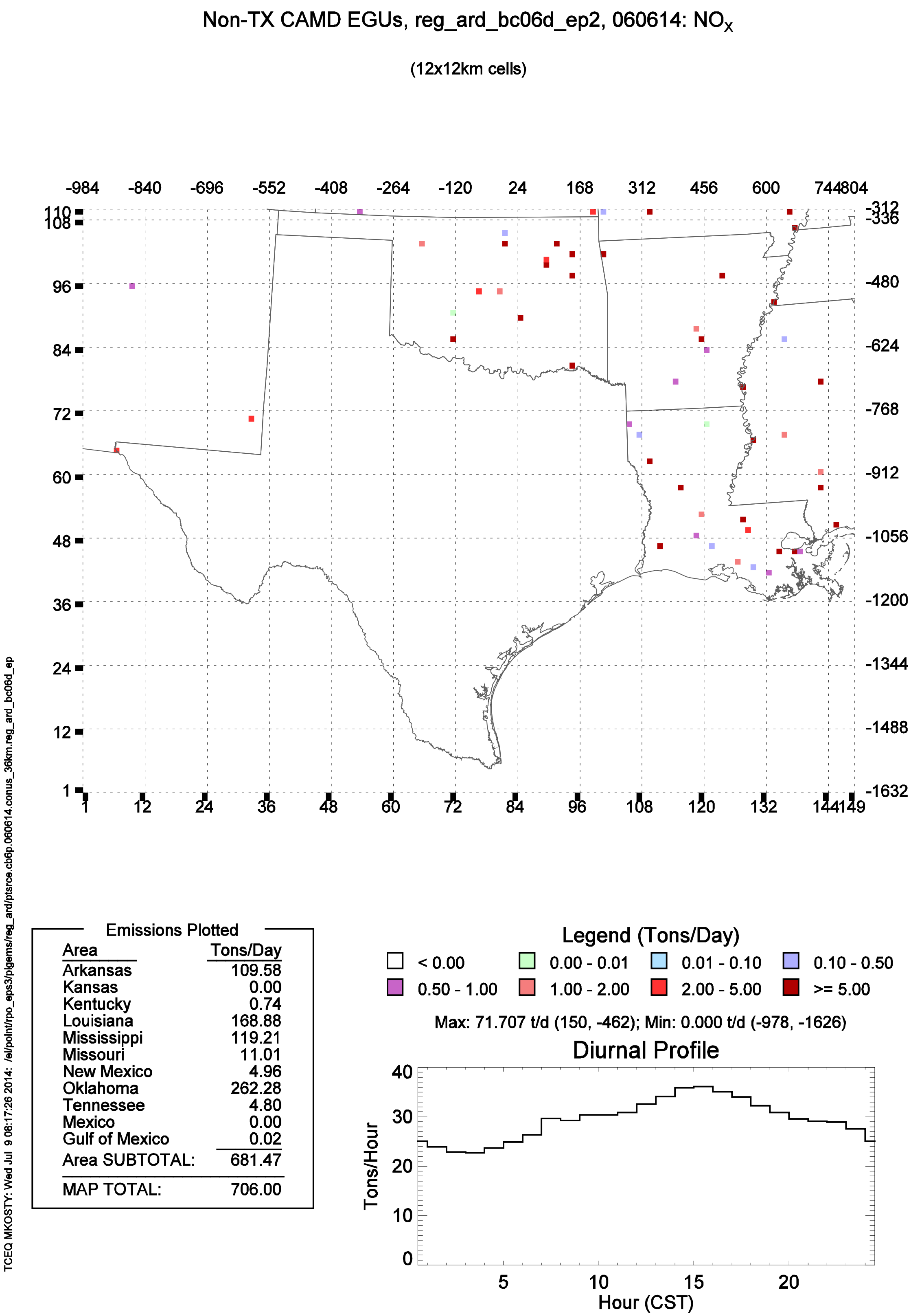


Figure 2-8: Tile Plot of AMPD EGU NO_X Emissions for the Adjacent States for June 14, 2006

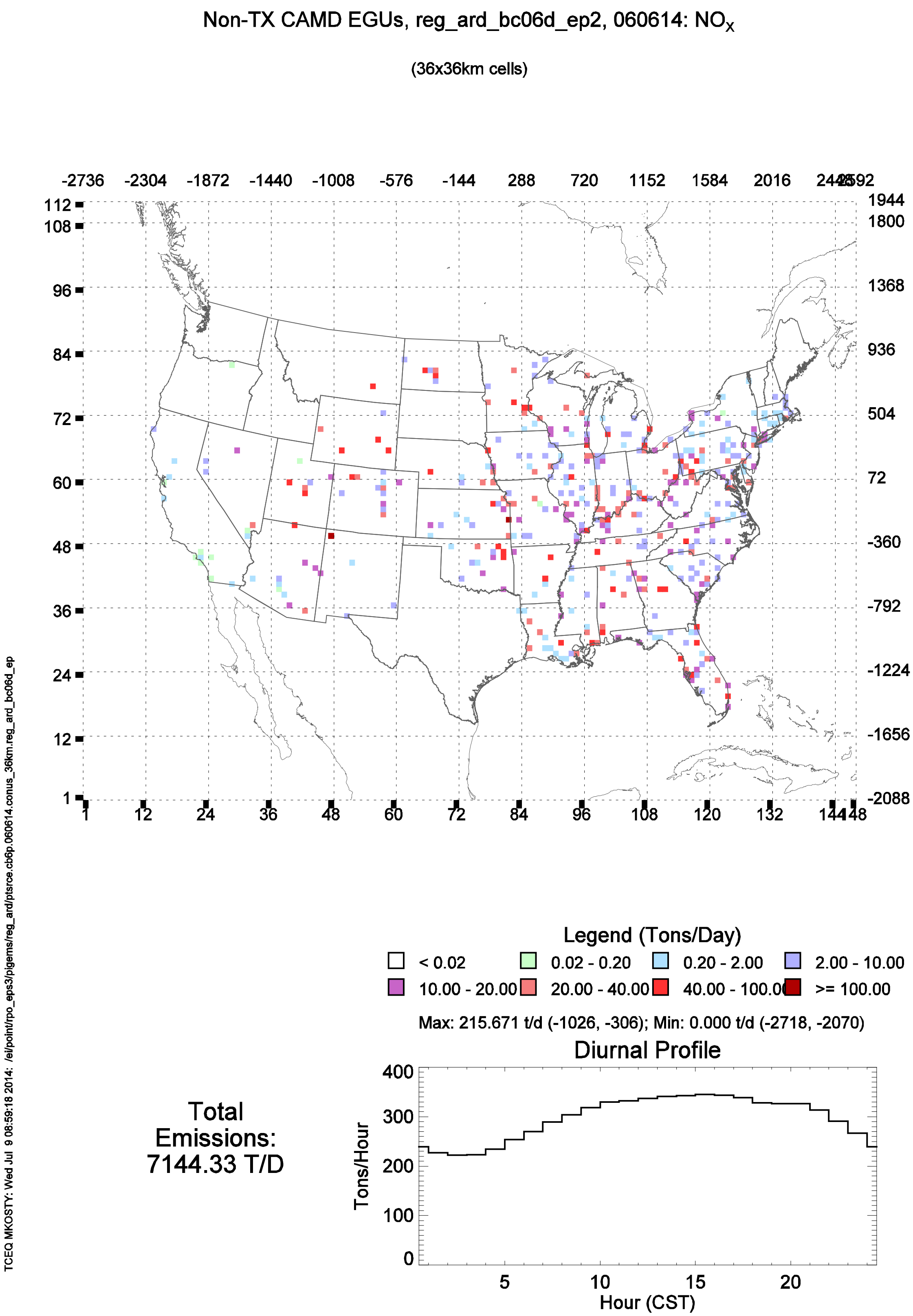


Figure 2-9: Tile Plot of AMPD EGU NO_X Emissions for the USA (outside of Texas) for June 14, 2006

2.1.2.3. Offshore Point Sources

The TCEQ obtained the 2005 Gulf-Wide Emissions Inventory (GWEI), developed by Eastern Research Group (ERG) under contract to the Bureau of Ocean Energy Management (BOEM). These are the same data modeled and documented in the two previous SIP revisions. The report and data are divided into two parts, oil and gas exploration and production platform (point) sources, and non-platform (area) sources. The TCEQ obtained the 2005 GWEI data and documentation from BOEM[12]. Previous SIP documentation discusses the formatting of the data, QA, justification for using June 2005 as representative data, and creation of temporal profiles. The offshore emissions are illustrated in Figure 2-10: Tile Plot of Offshore Platform NO_X Emissions for a Representative June day of 2005.

[12] in Microsoft Access (zipped) and PDF format, respectively. These can be downloaded from the BOEM webpage, http://www.boem.gov/Environmental-Stewardship/Environmental-Studies/Gulf-of-Mexico-Region/Air-Quality/2005-Gulfwide-Emission-Inventory.aspx

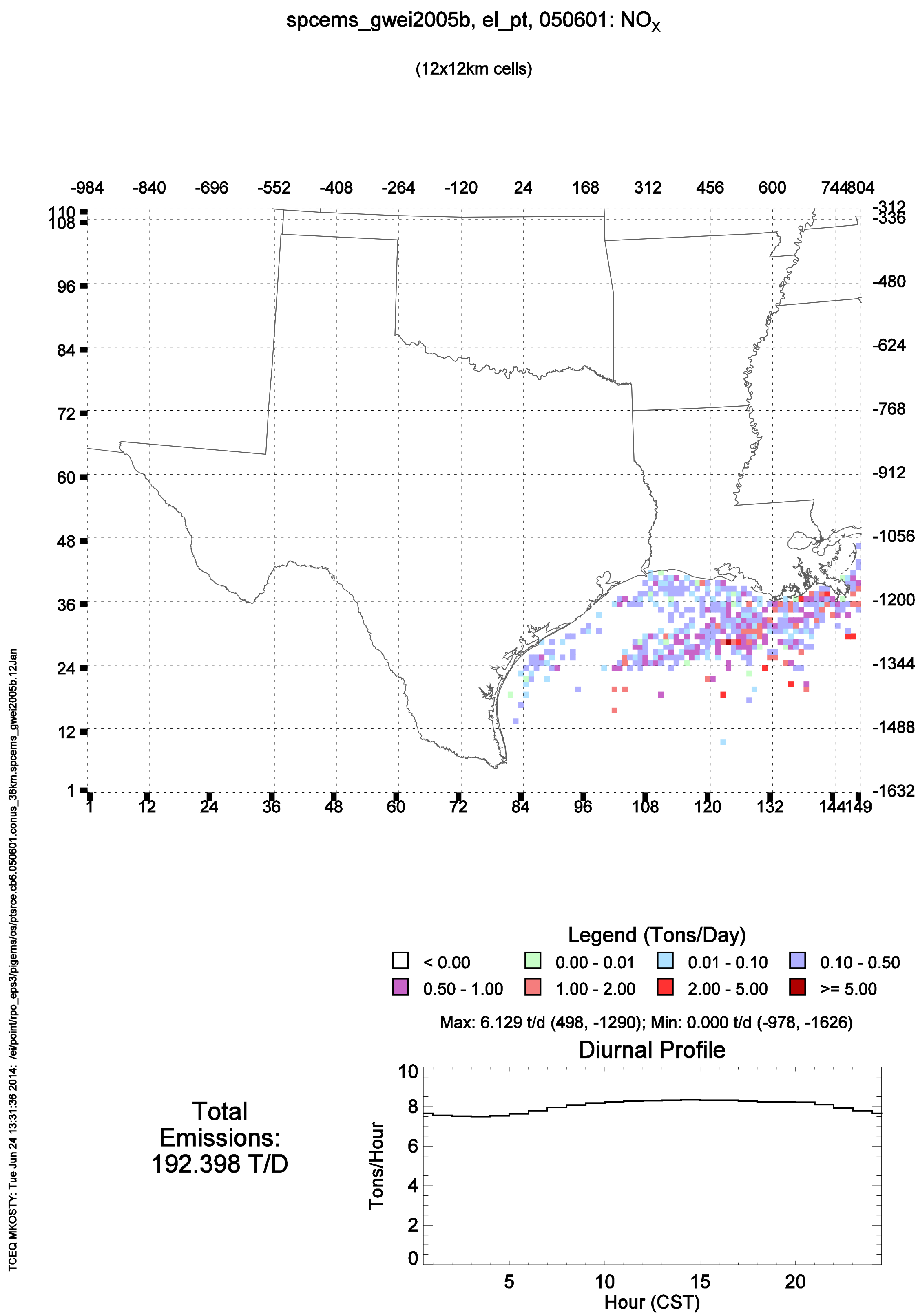


Figure 2-10: Tile Plot of Offshore Platform NO_X Emissions for a Representative June day of 2005

2.1.2.4. Mexican Point Sources

The TCEQ used the data from Phase III of the 1999 Mexico NEI, which is the most current data used by EPA and the regional planning organizations (RPO). These are the same data modeled and documented in the two previous SIP revisions. The TCEQ downloaded the NIF format versions of the files from the EPA North American Emissions Inventory webpage (http://www.epa.gov/ttn/chief/net/mexico.html) and parsed the files into AFS files.

The 1999 data were used for the 2006 episode without growth because there is no information on growth and controls for Mexican point sources. No temporal allocation or speciation data were available, so defaults were used. A tile plot of the Mexican OSD NO_X emissions of Phase III of the 1999 Mexico NEI for a representative OSD is provided as Figure 2-11: Tile Plot of Mexican NEI NO_X Emissions for a Day in 1999.

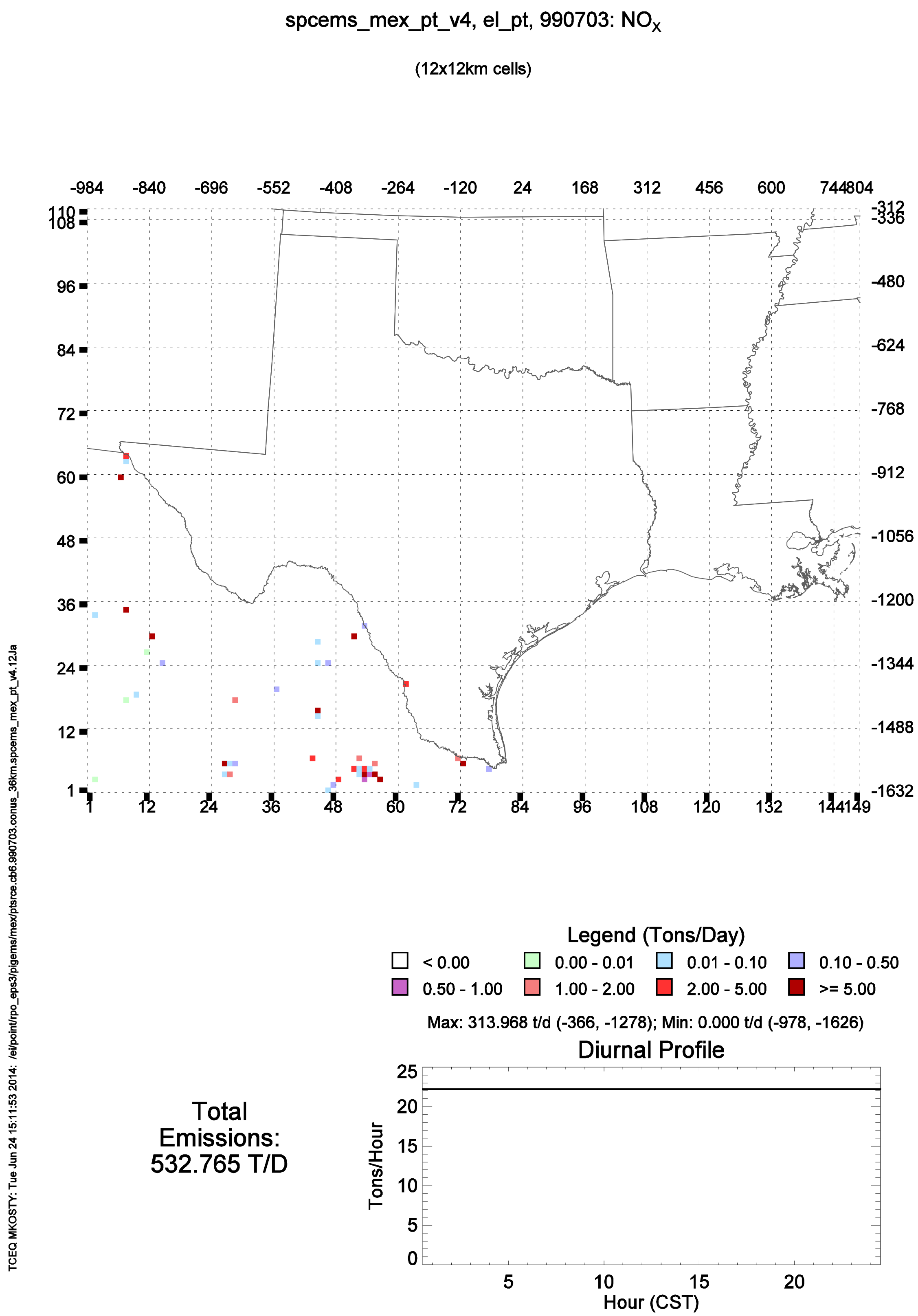


Figure 2-11: Tile Plot of Mexican NEI NO_X Emissions for a Day in 1999

2.1.2.5. Canadian Point Sources

The TCEQ obtained 2006 point source emissions from the Canadian National Pollutant Release Inventory (NPRI). These data are the first upgrade to the Canadian emissions since the last three SIP revisions. The data were provided to the TCEQ in the one-record-per-line (ORL) format by staff at Environment Canada. The VOC emissions were developed for the CB05 chemical mechanism. The TCEQ converted the files to AFS records for further processing with EPS3. No temporal allocation or speciation data were available, so defaults were used. The NO_X emissions for this dataset are illustrated in Figure 2-12: Tile Plot of Canadian NPRI NO_X Emissions for a Day in 2006.

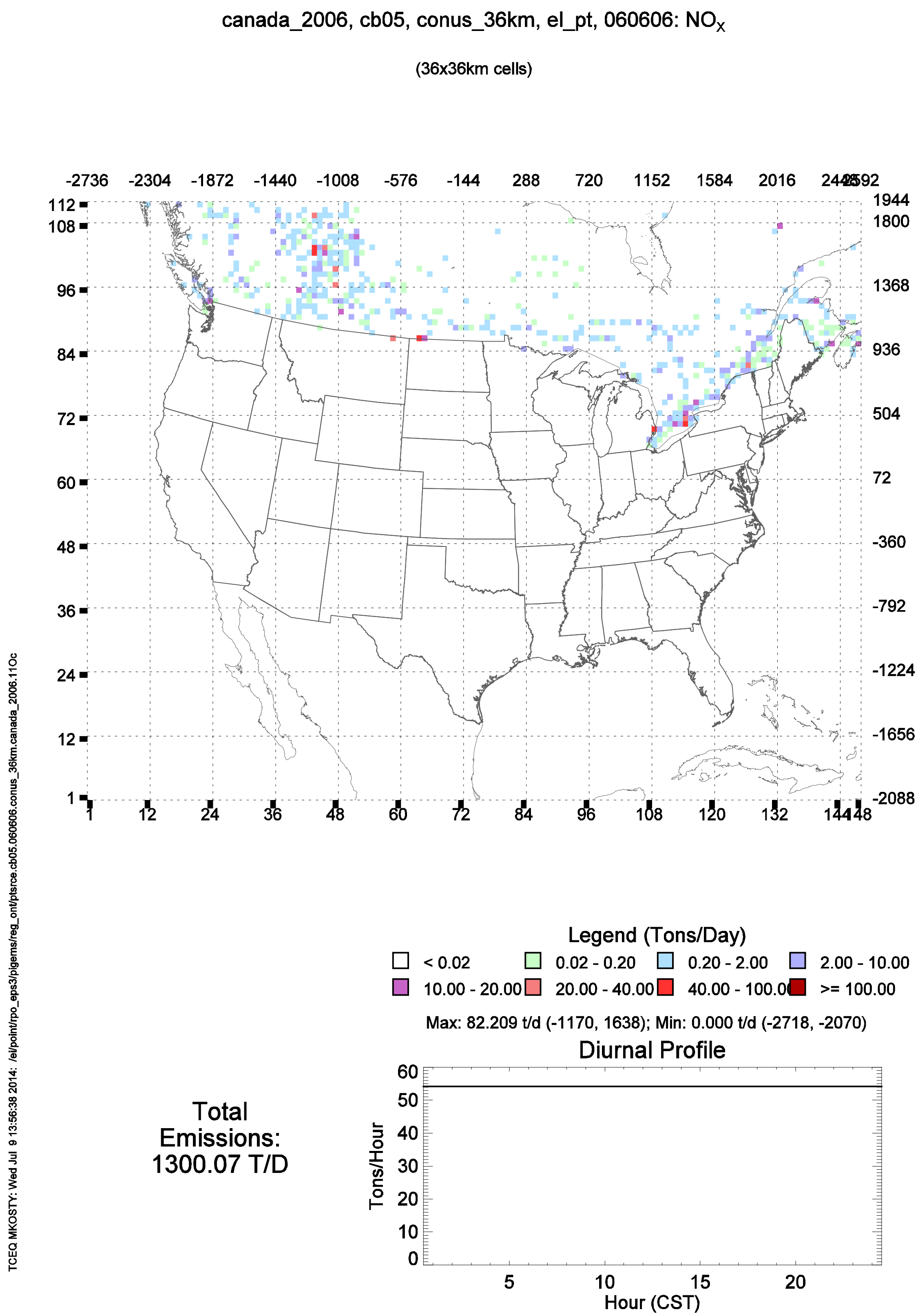


Figure 2-12: Tile Plot of Canadian NPRI NO_X Emissions for a Day in 2006

2.1.3. Plume-in-Grid (PiG) Source Selection

CAMx provides the option to model selected point sources with a PiG algorithm. NO_X reaction chemistry is enhanced by treating these selected point source plumes as Lagrangian puffs. The TCEQ uses the GREASD PiG option in CAMx, which is most applicable to large NO_X plumes. The GREASD PiG option was used for all point sources that met the criteria in Table 2-2: Summary of PiG Thresholds Chosen.

Table 2-2: Summary of PiG Thresholds Chosen

Modeled Area	NO_X Threshold (tpd)
Texas	5.0
Adjacent States (LA, AR, OK) & Mexico	7.5
Next ring of States (MS, etc.)	10.0
Next distant ring of States (AL, etc.)	15.0
Other States, Canada & Offshore	25.0

The NO_X threshold of 5.0 tpd in Texas denotes that any individual stack or co-located group of nearby stacks that totaled 5.0 or more tpd of NO_X emissions on an episode day were tracked as a PiG source. If multiple stacks were close enough together for their plumes to merge (within 200 meters of each other), and the aggregate NO_X emission rate for the cluster exceeded the threshold value, a new source was created with the combined NO_X emission rate of the cluster, and this source was flagged for PiG treatment. The stack parameters of the new source became an average of the stack parameters of all of the sources in the cluster. The TCEQ modeled both individual PiGs and combined PiGs within each of the modeled areas of Table 2-2. The EPS3 module, PiGEMS, provides a summary of the PiG treatment. There were a total of 258 PiG sources chosen for the entire domain, 200 of which are co-located combined new stacks.

2.1.4. Summary of June 2006 Base Case Point Sources

Snapshots of the point source emission files processed with EPS3 for CAMx in each episode are presented in Table 2-3: Base Case AFS Files for the DFW June 2006 Episode and Table 2-4: Base Case AFS Files for the DFW AQS1 Aug 15-Sep 15, 2006 Episode . As discussed earlier, the AMPD files may be referred to as ARD or CAMD in file name conventions. The version number on each dataset indicates a change from the previous version (e.g., “v8”). The regional AFS file for the GWEI contains monthly emissions for June only and the regional AFS file for Canadian emissions contains annual emissions. The FTP download website for these files (or their successors) is ftp://amdaftp.tceq.texas.gov/pub/TX/ei/basecase/point.

Table 2-3: Base Case AFS Files for the DFW June 2006 Episode

Area	AFS Point Source Emissions File	Hourly	Daily	Special
Texas	afs.osd_2006_with_ards_removed_CB06_RPOlcp_v3		X	
Texas	afs.ard_TX_29may_thru_02jul2006_RPOlcp	X		
Texas	afs.aggVOC_extra_alkenes_for_2006_lcpRPO.v3		X	
Texas	afs.landing_losses_3Q06_aver_day_episode_lcpRPO.v1		X	
Regional	afs.2008NEIv2_noTX_noIPM_noRail_noAirport		X	
Regional	afs.ard_USA_29may_thru_02jul2006_RPOlcp	X		
Regional	afs.gwei.2005.4pol.lcpRPO			Monthly
Regional	afs.Mexico_from_phaseIII_1999NEI_4pols.RPOlcp		X	

Area	AFS Point Source Emissions File	Hourly	Daily	Special
Regional	afs.canada_2006_all_pols.RPOlcp			Annual

Table 2-4: Base Case AFS Files for the DFW AQS1 Aug 15-Sep 15, 2006 Episode

Area	AFS Point Source Emissions File	Hourly	Daily	Special
Texas	afs.osd_2006_with_ards_removed_CB06_RPOlcp_v3		X	
Texas	afs.ard_TX_15aug_thru_15sep2006_RPOlcp	X		
Texas	afs.aggVOC_extra_alkenes_for_2006_lcpRPO.v3		X	
Texas	afs.landing_losses_3Q06_aver_day_episode_lcpRPO.v1		X	
Regional	afs.2008NEIv2_noTX_noIPM_noRail_noAirport		X	
Regional	afs.ard_USA_15aug_thru_15sep2006_RPOlcp	X		
Regional	afs.gwei.2005.4pol.lcpRPO			Monthly
Regional	afs.Mexico_from_phaseIII_1999NEI_4pols.RPOlcp		X	
Regional	afs.canada_2006_all_pols.RPOlcp			Annual

The TCEQ chose the second Wednesday of the June 2006 episode as a representative day for reporting base case emissions totals. Table 2-5: 2006 DFW Base Case Episode Day (June 14, 2006) Emissions Summary summarizes emissions for that day.

Table 2-5: 2006 DFW Base Case Episode Day (June 14, 2006) Emissions Summary

Emissions Source	DFW NO_X (tpd)	DFW VOC (tpd)	TX minus DFW NO_X (tpd)	TX minus DFW VOC (tpd)	U.S. minus TX NO_X (tpd)	U.S. minus TX VOC (tpd)
Non-EGUs (OSD)	48.0	49.5	704.5	569.0	4538.8	2457.5
EGUs (ARD)	8.4	1.0	513.7	15.4	7144.3	82.2
Tank Landing Losses				6.5		
HRVOC Reconciliation				19.3		

2.2 2006 Baseline Point Source Modeling Emissions Development

The 2006 point source emissions used in the base case are specific to individual days and hours, for the AMPD EGU portion of the EI. For the baseline case, the TCEQ created files that represent a typical ozone season (summer) day in 2006. The subsections that follow discuss how the baseline emissions differ from the base case.

2.2.1. Texas Point Sources

2.2.1.1. Ozone Season Daily (OSD)

The OSD point source emissions for the typical 2006 baseline day are the same as the 2006 base case OSD emissions, as these are the average OSD emissions extracted from STARS.

Table 2-6: 2006 Baseline OSD Emissions in Texas shows the modeled ozone precursor 2006 baseline totals for point sources in the DFW 10-County nonattainment area (NAA), HGB, and the rest of Texas.

Table 2-6: 2006 Baseline OSD Emissions in Texas

Area	NO_X #points	NO_X tpd	VOC #points	VOC tpd
DFW	1,427	41.67	4,421	42.83
HGB	4,628	125.42	24,150	206.37
Rest of TX	8,893	584.49	27,046	369.21

The "#points" entry in Table 2-6 is the total number of point sources in that area. Emissions were summed within the area to give the area emissions total. The TCEQ typically eliminates zero emissions records, and the EPS3 processor drops VOC records with zero emissions because they do not have a speciation cross reference.

2.2.1.2. Hourly AMPD Point Sources

To develop an AMPD EGU baseline, the TCEQ averaged the AMPD NO_X for each hour of the day for each unit for four months of 2006 to cover the two episodes (June 1 through September 30). These data records represent the typical ozone season day that maintains the temporal profile of the individual units. Corresponding hourly average CO and VOC emissions were calculated from STARS OSD, stack-specific emissions by multiplying CO:NO_X and VOC:NO_X ratios by the hourly NO_X rate for each AMPD unit.

2.2.1.3. Tank Landing Loss (TLL) Survey

The 2006 baseline for floating roof TLL surveys in HGB was calculated as the average of the hourly emissions for each tank point source of the survey for the third quarter modeled episode days of 2006. This average was used for both the base case and baseline modeling. Details about these sources are available in previous SIP documentation, namely the March 2010 HGB SIP Appendix B, Section 2.2.1.4.

2.2.1.4. Emissions Inventory Reconciliation in HGB (aka, HRVOC Reconciliation, Extra Olefins)

The 2006 HRVOC Reconciliation emissions remain unchanged from the 2006 base case.

2.2.2. Outside Texas

2.2.2.1. States Outside of Texas, Non-EGU NEI

For the states outside of Texas, the TCEQ used the same2008 NEI-based non-EGU file generated for the base case. A typical June day was already being used in the base case for the non-EGUs (NEGU). Table 2-7: 2006 Baseline Emissions Summary for Non-AMPD Points Outside of Texas summarizes the non-AMPD emissions for the 2006 baseline.

Table 2-7: 2006 Baseline Emissions Summary for Non-AMPD Points Outside of Texas

STATE	NO_X tpd	VOC tpd
Arkansas	94.11	73.98
Louisiana	391.31	183.45
Oklahoma	171.66	66.89
Other States, outside Texas	4346.26	2323.33

2.2.2.2. States Outside of Texas, EGUs

The 2006 baseline for the AMPD sources of the other states is a calculated typical summer day with hourly emissions that are the average for each Acid Rain point source for the four months of 2006 to cover the two episodes (June 1 through September 30). VOC and CO emissions for each hour of the typical summer day come from the hourly NO_X emissions and the VOC:NO_X and CO:NO_X ratios, computed from the daily emissions data for each AMPD point.

2.2.2.3. Offshore, Mexico, and Canada

The Offshore 2005 GWEI, the 1999 Mexican NEI, and the 1995 Canadian baseline point source files are the same as the base case files, since they are already being modeled as an average day.

2.2.3. Summary of 2006 Baseline Point Sources

The point source emission files that were processed with EPS3 for CAMx for the baseline (typical summer day) are presented in Table 2-8: AFS Files for the 2006 Baseline. The regional AFS file for the GWEI contains monthly emissions for June only and the regional AFS file for Canadian emissions contains annual emissions. The version number on each dataset indicates a change from the previous version (e.g., "v2"). As discussed earlier, the AMPD files may be referred to as ARD or CAMD in file name conventions. The FTP download website for the point source files or their successors is ftp://amdaftp.tceq.texas.gov/pub/TX/ei/baseline/point.

Table 2-8: AFS Files for the 2006 Baseline

Area	AFS Point Source Emissions File	Hourly	Daily	Special
TEXAS	afs.ard_JUN2SEP_2006_CAIR_avg_day_all_pols_RPOlcp	X		
TEXAS	afs.osd_2006_with_ards_removed_CB06_RPOlcp_v3		X	
TEXAS	afs.landing_losses_3Q06_aver_day_episode_lcpRPO.v1	X		
TEXAS	afs.aggVOC_extra_alkenes_for_2006_lcpRPO.v3		X	
REGIONAL	afs.ard_usa_episode_minus_texas_JUN2SEP_2006_RPOlcp	X		
REGIONAL	afs.2008NEIv2_noTX_noIPM_noRail_noAirport		X	
REGIONAL	afs.gwei.2005.4pol.lcpRPO			Monthly
REGIONAL	afs.Mexico_from_phaseIII_1999NEI_4pols.RPOlcp		X	
REGIONAL	afs.canada_2006_all_pols.RPOlcp			Annual

Table 2-9: 2006 Baseline Point Source Emissions Summary summarizes the baseline emissions. These tabulated emissions are AFS totals input to EPS3. CAMx input values may differ.

Table 2-9: 2006 Baseline Point Source Emissions Summary

Emission Source	DFW NO_X (tpd)	DFW VOC (tpd)	TX minus DFW NO_X (tpd)	TX minus DFW VOC (tpd)	U.S. minus TX NO_X (tpd)	U.S. minus TX VOC (tpd)
NEGUs (OSD)	48.0	49.5	704.5	562.2	4538.8	2457.5
EGUs (ARD)	9.6	1.0	534.7	21.7	7757.3	88.3

Emission Source	DFW NO_X (tpd)	DFW VOC (tpd)	TX minus DFW NO_X (tpd)	TX minus DFW VOC (tpd)	U.S. minus TX NO_X (tpd)	U.S. minus TX VOC (tpd)
Tank Landing Losses				6.5		
HRVOC Reconciliation				19.3		

Below in Table 2-10: DFW10-County EGU emissions for the 2006 Baseline, is a summary of the 10-County Baseline EGU emissions for the 2006 Episodes.

Table 2-10: DFW10-County EGU emissions for the 2006 Baseline

Owner/Sitename	County	NO_X (tpd)	VOC (tpd)	CO (tpd)	PM (tpd)	SO_2 (tpd)	NH_3 (tpd)
FPLE Forney Electric	Kaufman	3.48	0.01	0.23	0.75	0.07	0.00
Midlothian Energy	Ellis	1.23	0.28	1.30	0.74	0.06	0.02
Luminant Lake Ray Hubbard	Dallas	0.85	0.09	0.36	0.12	0.01	0.00
Garland Power Ray Olinger	Collin	0.76	0.07	0.68	0.08	0.01	0.00
Wise County Power Plant	Wise	0.76	0.19	0.20	0.08	0.03	0.08
Extex LaPorte Mountain Creek	Dallas	0.67	0.11	0.72	0.16	0.01	0.01
Luminant North Lake	Dallas	0.56	0.03	0.18	0.03	0.00	0.00
Ennis Power	Ellis	0.55	0.00	0.13	0.15	0.01	0.04
Extex LaPorte Handley	Tarrant	0.30	0.14	0.52	0.19	0.02	0.02
Brazos Electric Johnson County	Johnson	0.25	0.07	0.16	0.28	0.00	0.01
Garland Power Spencer	Denton	0.18	0.03	0.29	0.04	0.00	0.00
Garland Power C.E.Newman	Dallas	0.03	0.00	0.00	0.00	0.00	0.00
DFW Area Electric Utility Total	-	9.63	1.03	4.77	2.61	0.22	0.18

2.3 2018 Future Year Point Source Modeling Emissions Development

This section describes the development of the 2018 future year point source EI. The 2008 eight-hour ozone attainment date for the DFW nonattainment area, classified as Moderate, is December 31, 2018. The modeled attainment year is 2018.

Many factors create the foundation for the future case point source EI prior to control strategies and/or sensitivity analyses, including a starting point that we refer to as the "projection base", emission credits in the bank for permit expansion offsets and compliance, economic projections, EGU expansions, newly-permitted EGUs, shutdown EGUs, EGUs to be retired, existing emissions controls, source caps, trading programs, other state measures, and other federal measures,

The TCEQ uses the most complete and accurate emissions data available, when given enough time and resources to complete a SIP revision. This effort is most important for Texas emissions data, since the modeling results may provide a basis for future banking and trading considerations, and the basis for many other determinations. For this SIP revision, the TCEQ used the most current STARS and AMPD data sets available – 2012 and 2013, respectively, -- from which to develop a future case EI. These "projection base" years also become the baseline for emission credit generation.

The 2012/13 projection base emissions are projected into the future to develop 2018 future case emissions. All of the ozone precursor emissions are projected. The future case EI provides the basis to determine if attainment has been reached and is the starting point for any 2018 control strategy testing and/or sensitivity analyses, if required.

In general, baseline emissions are projected, i.e. they are grown to the attainment year and on-the-books controls (those that will be in place after the baseline year and prior to the attainment year) are applied. The on-the-books controls are controls for which enforceable emissions reductions rules have been written already; they are not additional proposed rules that result from this SIP revision. Proposed rules would be modeled in a 2018 control strategy EI or as part of Reasonably Available Control Measure (RACM) analyses.

This section of this appendix addresses the above issues.

2.3.1. Regulations and the Cap-and-Trade Programs

In some instances, growth of future emissions is limited by regulation. Prior to discussing growth and the development of emission files for specific categories and areas of the state, a description of the various regulations and trading programs is provided here, since they are referenced in several sections below.

The Clean Air Interstate Rule (CAIR) limits NO_X and SO_2 emissions for affected power plants throughout Texas, as well as NO_X emissions in certain states during ozone season. In the eight county HGB region, the Mass Emissions Cap and Trade program (MECT) limits NO_X emissions for accounts in the program. In Harris County, HRVOC Emissions Cap and Trade (HECT) limits HRVOC emissions for certain point sources. Besides MECT, HECT, and CAIR, there are other regulations and agreements that affect certain NO_X sources in the state, some of which have compliance dates between the projection base year(s) and the attainment year, but for most, the compliance date has already passed and are accurately modeled using the reported projection base year(s) emissions. Again, the projection base years are 2013 for AMPD EGUs and 2012 for all other Texas point sources, and the attainment year is 2018.

2.3.1.1. <u>Clean Air Interstate Rule Background</u>

The EPA's CAIR program limits NO_X and SO_2 emissions for affected power plants in 27 eastern states and the District of Columbia. The definition of an EGU for the CAIR program is approximately the same definition as that for a Federal Clean Air Act Title IV Acid Rain unit, i.e., larger than 25 MW and more than one-third of its generation going to the public grid for sale. CAIR is a cap-and-trade program, with each of the CAIR-applicable states given calculated NO_X and SO_2 budgets by the EPA. EPA's modeling determined that Texas significantly contributed to the nonattainment of the particulate matter of 2.5 microns and less ($PM_{2.5}$) standard of two counties in Illinois. Texas was not included for eight-hour ozone contribution. Thus, Texas is not part of the CAIR ozone season (May through September) NO_X budget, only the annual NO_X budget program. More details on CAIR are available on EPA's "CAIR for Texas" webpage, http://www.epa.gov/cair/tx.html.

CAIR is implemented in two phases. For NO_X, Phase I covers the years 2009-2014 and Phase II covers the years 2015 and later; for SO_2, Phase I covers the years 2010-2014 and Phase II covers the years 2015 and later. Because 2018 is the DFW ozone attainment year, this DFW SIP revision incorporates the stricter CAIR Phase II, which provides for a Texas state-wide NO_X budget of 150,845 tpy or 413 tpd. The CAIR allocations and past transactions for all relevant states can be found at EPA's Air Market Programs data query or prepackaged data website, http://ampd.epa.gov/ampd/.

CAIR provides a NO_X emissions cap for most AMPD EGUs in Texas (and other CAIR states). CAIR sources (i.e., pieces of equipment) at applicable sites are allocated a specific amount of allowances for each compliance year referred to as allocations. The sum of each state's allocations of all CAIR sources equals the EPA-prescribed state's budget. At the end of each year, each site with CAIR sources must have sufficient allowances to cover the total emissions from all its CAIR sources. Subject sources can purchase or sell allocated allowances; their emissions in any year are not limited to their allocation for that year. The "reconciliation" of available allowances and annual emissions is done by EPA following the completion of the compliance year. Any allowances not needed for a compliance year can be banked and are available for the site to use in future years. It should be noted that though the state budget is distributed to each subject source, compliance is a done at the site level. As CAIR is a cap-and-trade program, modeling each CAIR source solely at its assigned allocation would be inaccurate, because many sources in Texas consistently operate above their CAIR allocation, while others are consistently below. In addition, some points in CAIR are in the HGB MECT program as well, which complicates the modeling of these sources. TCEQ accounts for the cap-and-trade aspects of CAIR and the overlap of CAIR and MECT sources, as described below in Section 2.3.1.4, Modeling the Cap-and-Trade Programs.

2.3.1.2. Mass Emission Cap and Trade (MECT) Background

The MECT program provides NO_X emission limits for applicable sources as specified in 30 TAC §101.351. The MECT program covers almost all pieces of NO_X-emitting equipment in HGB. Sites with these point sources comply with the source category emissions limits via the cap-and-trade method. The TCEQ allocates allowances to each point source (i.e., piece of equipment) at a site (account, RN). Similar to the CAIR program, the MECT program also allows trading and banking of allowances. A key difference between the CAIR and MECT programs is that in the MECT program unused allowances can be banked only for one additional compliance year, while in CAIR, unused allowances can be banked indefinitely. To comply with the MECT program, each site in the MECT program should have sufficient allowances to cover the total annual emissions from all its MECT sources. The TCEQ's Emissions Banking and Trading (EBT) Team QCs the annual reports, submitted by subject sites, to verify that the site has allowances equivalent to the total NO_X emissions from the MECT points at the site. Similar to the CAIR program, in the MECT program though, the MECT cap is distributed to each subject source (in the form of annual allocations), and compliance is a done at the site level. More detail about the MECT program can be found in in the March 2010 HGB SIP Appendix B.

The MECT cap, as of December 31, 2013, was 40,176 tpy or 110 tpd. In previous SIPs, MECT sites were modeled at their future year allocations, regardless of their trading history. The fact that some MECT sites sell all or a portion of their allowances each year permanently via "stream trades" or each year, gave TCEQ the impetus to model a more spatially-realistic future case distribution of MECT Source emissions, as described below in Section 2.3.1.4.

2.3.1.3. HRVOC Emissions Cap and Trade (HECT) Background

The HRVOCs are ethylene, propylene, butadiene, and the butenes. The HECT program limits HRVOC emissions discharged from applicable point sources in Harris County as specified in 30 TAC §101.391. The HECT program is a cap-and- trade program similar to the MECT program with compliance being handled by TCEQ's EBT team. The HECT cap applies to HRVOC. Commonly included sources are flares, non-tank stacks, and cooling tower emissions. However, unlike the MECT program, the HECT cap is distributed by site (RN, account) via annual allocations. The HECT cap, as of December 9, 2013, was 2590.3 tpy or 7.1 tpd. See footnote 7 in Section 2.1.1.4.1 above for additional background, speciation procedures, and development of the HRVOCs and HECT program.

HECT allowances were allocated to applicable sites in proportion to the site's level of activity, determined from each site's selection of a twelve-consecutive-month baseline from 2000 through 2004. HECT sites were given the greater of 5.0 tons of HECT allowances or the allocation from the site, determined from using the equation listed in 30 TAC §101.394(a)(1). Additional details of this Harris County control program are described in previous SIP documentation.

2.3.1.4. Modeling the Cap-and-Trade Programs

The TCEQ administers four cap and trade programs in Texas: (1) the Emissions Banking and Trading of Allowances program (also known as the SB7 program) for SO_2 and NO_X emissions, (2) the MECT program for NO_X emissions, (3) the HECT program for HRVOC emissions, and (4) the CAIR program for SO_2 and NO_X emissions. The TCEQ models these cap and trade programs by limiting the future emissions of sources subject to these cap and trade programs to the appropriate program's total future year cap. If multiple programs cover a set of sources, the most stringent (smallest total cap) program is modeled. Three cap and trade programs were used to limit future year emissions for select sources in Texas: MECT, HECT, and CAIR. The SB7 program, which affects EGUs, is not modeled as it is less stringent than CAIR Phase. The three cap and trade programs used to model future year NO_X and HRVOC emissions are summarized in Table 2-11: Texas Cap-and-Trade Program Summary. SO_2 is not a modeled precursor for ozone.

Table 2-11: Texas Cap-and-Trade Program Summary

Program	Pollutant Affected	Geographical Scope	2018 Program Cap for Texas Sources (tpy)
CAIR	NO_X	27 eastern states and the District of Columbia	150,845
MECT	NO_X	HGB Nonattainment Area	40,176.2
HECT	HRVOC	Harris County	2,588.6

The spatial representation of future year emissions of the sources subject to these cap-and-trade programs has typically been based on the source's future year allocation of allowances specified for the relevant cap and trade program(s). Since future year allocations are typically distributed many years in advance[13], the sources that received future year allowances in many cases may not

[13] Details regarding future year allocations for CAIR, MECT, and HECT can be found in 30 TAC §101.506, §101.353, and§101.394, respectively.

be operational in the future year. While the total future emissions from all the sources subject to each of the programs is limited to the 2018 program cap listed in Table 2-11, the TCEQ spatially distributed the 2018 cap to sources that are expected to be operational in the future using historical trend analysis for each program, as detailed below. The distributed annual 2018 site emissions (tons/year) were then converted to future year ozone season day emissions (tons/day). The distribution of the 2018 program cap described here is only intended to spatially represent future year emissions for modeling purposes and does not take the place of official allocation of allowances associated with these programs. The official future year allocations can be found at the EBT program web page (http://www.tceq.texas.gov/airquality/banking/banking.html).

The general procedure for the historical trend analysis used to spatially distribute the future year program caps consisted of the following steps[14].

1. For each site, the difference between the total reported site emissions and the site's annual allocation for all past compliance periods for a program was calculated. The difference was termed "site cap gap".
2. A positive site cap gap for a compliance year indicated that the site had leftover allowances that it could potentially sell to other sites in the program (a spatial trade) or bank for future use (a temporal trade). A site with a positive cap gap is a potential "Seller" (spatial or temporal). Similarly, a site with a negative site cap gap indicated that the site purchased allowances (spatially or temporally) for compliance purposes and was termed "Buyer". The terms "Seller" and "Buyer" are used to refer to the potential to trade and not actual trades. In each compliance year, a site is a "Seller" or a "Buyer" in each program based on the site cap gap for that program, i.e., in 2009 a site could be a "Seller" in the CAIR program but a "Buyer" in the MECT program.
3. If a site was a "Seller" (had a positive cap gap) 80%[15] of the time then site was termed to have a "Seller" trend. Similarly, if a site was a "Buyer" (negative cap gap) 80% of the time then the site was termed to have a "Buyer" trend. The 80% cut off for a trend translates into a site being a "Buyer" or a "Seller" for a certain number of years depending on the total number of completed compliance years for each program (4 out of 5 years for the CAIR program, 5 out of 6 times for the HECT program and 8 out of 10 times for the MECT program).
4. If a site exhibited a trend and the site's behavior for the latest projection-base year followed the trend, then the annual emissions for the projection-base year was assigned as future year emissions to the site. This is because if a site exhibited a trend then it can be reasonable expected to have a similar behavior in the future year, i.e., a site with a "Seller" trend can be expected to have a positive site cap gap in the future year and a site with a "Buyer" trend can be expected to have a negative cap gap in the future year. Since the annual emissions from the projection-base year were representative of the trend behavior, the future year site emissions were represented by the projection-base year emissions. The projection-base year used for HECT sources is 2012 and the projection-base year used for CAIR is 2013. For MECT, the 2012 projection-base year was used for all sources including those that were also in CAIR, since this was the latest year for which MECT compliance related information was available from the EBT database.

[14] Data regarding annual emissions and allocations was obtained from the TCEQ's EBT database for MECT and HECT programs and from EPA's AMPD web query tool for CAIR.

[15] The 80% cut-off was chosen qualitatively based on the number of completed compliance years for the three programs (at the time of SIP development). CAIR had the smallest number of years completed compliance years (5 years compared to 6 years for HECT and 10 years for MECT), a trend of 4/5 years equals 80%.

5. Sites below the 80% threshold were termed as "Neither." Sites that did not have an identifiable trend or sites that had a trend but the behavior in the projection-base year did not follow the identified trend, then the future year site emissions were represented using future allocations of allowances.
6. To be conservative and to account for possible yearly variations, the assigned caps were proportionally scaled up such that total annual modeled emissions for sources subject to these programs equal the program's respective 2018 available caps. The available program caps for MECT and HECT are those listed in Table 2-11. For CAIR, the available program cap was reduced from the 150,845 tons to accommodate newly permitted (but not yet constructed) EGUs.

The historical trend analysis was performed individually for each of the three programs. For sources subject to both CAIR and MECT, the 2018 annual site emissions determined using the historical trend analysis for the MECT program was used as it is the more stringent program. Detailed tables with the results of the historical trend analysis for each program are available at the TCEQ FTP modeling website at (ftp://amdaftp.tceq.texas.gov/pub/TX/ei/fy2018/point/cap_trade/).

2.3.1.5. Ellis County (Midlothian) Cement Kilns

Site-wide (by account) NO_X caps were modeled based on this Chapter 117 rule that applies to each of the kilns in Ellis County (in the DFW nonattainment area, city of Midlothian). The rule applies ozone season (March 1 through October 31) caps, totaling 17.6 tpd to the ten kilns at the three sites. Slight modification to the modeled distribution of this cap among a few of the kilns has been made in this SIP revision, based on consent decrees and permit modifications. The details regarding the current implementation of this cap are described in Section 2.3.3 below.

2.3.2. Attainment Areas of Texas

The attainment areas of Texas include all of Texas except DFW and HGB. The subsections below address growth and control implementation separately. Subsection 2.3.2.1.2, Newly-Permitted EGUs, below, includes new units in attainment and non-attainment areas.

2.3.2.1. Attainment Area 2018 Growth Projections

Different growth projection techniques were applied to the EGUs that have AMPD hourly data versus the non-EGUs (NEGU). The techniques used are similar to EPA projection methods for modeling future cases, except that the TCEQ does not use the Integrated Planning Model (IPM).

2.3.2.1.1. EGUs

To develop the AMPD EGU 2013 projection-base, the TCEQ averaged the AMPD NO_X for each hour of the day for each unit for the June through September time period, similar to the procedure that generated the 2006 baseline EGUs. The TCEQ chose the more recent dataset from which to project because it is newer and contains more of the actual emissions growth from newer units. Not all EGUs have hourly AMPD data and not all NO_X point sources at EGU facilities are AMPD point sources. The non-AMPD EGUs were projected from their 2012 emissions along with the NEGU point sources, as discussed below in Subsection 2.3.2.1.3, Non-EGUs (NEGU).

The TCEQ generates hourly emissions records for the non-AMPD pollutants (NH_3, CO, $PM_{2.5}$, and VOC) for AMPD point sources using 2013 heat input data. From STARS, the TCEQ obtains annual emissions for each pollutant and computes a pollutant-to-heat input ratio from the annual totals. Computationally, the heat input and emission totals need to be from the same year, but a given year's set of ratios can be used for another year if, for example, one of the datasets (STARS, for example) is not available. With a valid set of pollutant-to-heat ratios, the TCEQ computed hourly emissions for each pollutant based on the AMP hourly heat input.

The complete set of 2018 Texas EGUs, for future case modeling, consists of the 2013 AMPD EGUs, the post-2013 new EGUs (a.k.a., newly-permitted EGUs) discussed in the following section, and the projected 2012 non-AMPD EGUs. As with previous SIP revisions, the TCEQ assumes that the EGU growth in the state comes from newly-permitted EGUs.

2.3.2.1.2. Newly-Permitted EGUs

It is always better to provide known growth/expansions at the physical locations where they are projected to occur, rather than growing existing emissions in place. Growth in EGUs in Texas is accomplished with the addition of newly-permitted EGUs since the projection-base year, all within the constraints described in the controls subsection below, in addition to TCEQ New Source Review permitting requirements. This subsection describes the procedures for developing the newly-permitted EGU EI. It includes the new units in attainment and non-attainment areas.

Texas EGU emissions for 2018 were developed by researching and compiling data from various sources. These sources include:

- Electric Reliability Council of Texas (ERCOT): http://www.ercot.com/;
- TCEQ air permitting projects with combustion turbines; http://www.tceq.state.tx.us/assets/public/permitting/air/memos/turbine_lst.pdf; and
- TCEQ New Source Review Permits Information Management System (NSRP IMS) internal document server.

Information from these sources includes individual units' disposition (i.e., operating status), new units coming online, units to be mothballed, and units to be shut down or retired. The criteria the TCEQ uses for adding new units are: (1) the units are expected to be operational by the end of 2018, (2) the owners applied for, and were granted, a TCEQ air permit, and (3) the owners obtained an Interconnection Agreement (IA) from ERCOT (for those units planned within the ERCOT grid). All three of these conditions must be met in order for the unit(s) to be included in the future case modeling. The TCEQ assumed that by the 2018 ozone season, all current (as of October 2013) mothballed and reliability-must-run (RMR) units would be retired. All data sources were reconciled to ensure all units were accounted for, and that their status as of May 2014 was modeled. As the most recent EGU emissions data for modeling is from 2013 AMPD, new EGUs are based on additions and changes subsequent to 2013.

ERCOT covers approximately 85% of the power grid in the state. For the five years between December 2013 and December 2018, a comparative analysis was performed to verify that all new units planned by ERCOT are accounted for, and there is ample generation proposed from the newly permitted units to meet the projected demand in electricity. ERCOT projects approximately 3800 megawatts of new non-wind resources with a reserve margin of approximately 12.5%. The modeled new units meet this projection.

For the newly-permitted EGUs, emissions were calculated based on the permit Maximum Allowable Emission Rates Table (MAERT), which is always greater than the actual operating emissions. Pollutants acquired from the permits were NO_X, VOC, and CO. The method of determining the allowable emissions differs based on the type of unit and its primary purpose for being constructed. For example, coal plants may have a 30-day rolling average emission rate, while gas turbines may have a short term allowable emission rate in pounds per hour (pph) and/or a long term allowable emission rate in tpy. In some cases, a unit may have a combination of the above, in addition to maintenance, startup and shutdown (MSS) emission limits.

When available, the 30-day pph emissions limitation was used. These have most often been available for solid fuel-fired units. This time frame represents a good compromise between the standard short-term allowable, which sometimes includes MSS, and the standard long-term permit allowable. The short term allowable in pph, when converted to tpd, is often substantially more than a unit would realistically emit in any day; the long-term allowable in tpy, when converted to tpd, may under-represent what a unit could emit during any one day, especially during a summer day during the ozone season.

MSS permitting has become more routine in the last several years. These activities help provide a more realistic operating scenario than the maximum of the short-term or long-term emission rates. This is especially important for those units that have many MSS events during a typical summer, such as the peaking units, which operate only during the peak demand times. MSS limits vary between permits, depending on specific representation in permit applications. Examples of permitted MSS and how they are modeled are described in previous SIP documentation.

The emission rates calculated represent worst case for some units, but for most, they represent a typical summer day during the ozone season, corresponding to some of the highest days of electricity demand. Some facilities on the “new” list may have operating data in the 2013 base year but, if the AMPD reported emissions are not reasonable for a complete year of operation, these facilities are modeled at their permitted values. The complete list of newly-permitted EGUs added as the EGU growth in the state sorted by area is provided as Table 2-12: Newly Permitted EGUs (post 2013) in Texas as of May 2014.

Table 2-12: Newly Permitted EGUs (post 2013) in Texas as of May 2014

Area	Sitename	County	Permit NO_X (tpd)	Operating in 2013
ELP	Montana Power Station	El Paso	0.105	
ELP	Montana Power Station	El Paso	0.105	
ELP	Montana Power Station	El Paso	0.105	
ELP	Montana Power Station	El Paso	0.105	
ETX	Panda Temple Power	Bell	0.454	
ETX	Panda Temple Power	Bell	0.454	
ETX	Panda Temple Power	Bell	0.454	
ETX	Panda Temple Power	Bell	0.454	
ETX	Panda Sherman	Grayson	0.675	
ETX	Panda Sherman	Grayson	0.675	
ETX	Woodville Renewable Power Project	Tyler	0.890	
HGB	W. A. Parish	Fort Bend	0.310	Y
HGB	Deer Park Energy Center	Harris	1.226	
HGB	Channel Energy Center	Harris	0.880	

Area	Sitename	County	Permit NO_X (tpd)	Operating in 2013
SAN	Guadalupe Generating Station	Guadalupe	1.017	
SAN	Guadalupe Generating Station	Guadalupe	1.017	
WTX	Jones Peaking Facility	Lubbock	1.380	Y
WTX	Mustang 6	Yoakum	0.822	Y
WTX	TC Ferguson Power Plant	Llano	0.365	
WTX	TC Ferguson Power Plant	Llano	0.365	
WTX	FGE Texas	Mitchell	0.309	
WTX	FGE Texas	Mitchell	0.309	

Table 2-12 includes (1) the calculated NO_X emissions from permit applications and MAERTs, representing realistic average day emissions, and (2) the NO_X emission rates after incorporating the existing rules that may apply to AMPD EGUs. The TCEQ assumed NO_X controls, offsets, or credit purchases will be used to meet these NO_X emissions rates. VOC and CO rates are modeled at their permitted levels. There were sufficient CAIR and MECT allowances available for all new EGUs to be modeled at their permitted rate.

The temporal distributions of the newly-permitted EGU emissions are based on those of existing units of similar equipment type or SCCs. For each SCC included in the newly-permitted EGU list, an average temporal distribution was calculated, based on diurnal profiles of existing units with the same SCC within the state. For some units on the new EGU list, a corresponding SCC did not exist for existing units. In these cases, the default flat profile was assigned. An example of the profile used for a natural gas turbine is discussed in previous SIP documentation.

2.3.2.1.3. Non-EGUs (NEGU)

When the AMPD units are removed from the point source EI for hourly treatment, the remainder is OSD. The TCEQ refers to these remaining units as NEGUs. The basis for future growth (projection base year) for NEGUs in the Texas attainment areas was the most current complete and quality control checked year of STARS emissions: 2012 OSD emissions, already an average OSD from STARS.

The TCEQ estimated projection base (2012) to future case (2018) growth projections using growth factors developed via contract to TCEQ by ERG. The ERG growth factors webpage at (ftp://amdaftp.tceq.texas.gov/pub/TX/ei/fy2018/point/AFS/ERG_growth_factors/) are based on county (FIPS) and North American Industry Classification System (NAICS). To manage the growth factors, TCEQ developed a table that assigned growth factors for all 2012 STARS emission paths. The ERG data provided growth factors for most of the STARS paths (uniquely identified by FIPS, plant, stack and point). In situations where there was not a FIPS/NAICS match, the pathway was assigned a growth factor equal to the NAICS average for the state. If there was no NAICS match, the next default was the county (FIPS) average growth, and then the State average. All pollutants for a path were assigned the same growth factor.

Projection factors were assigned individually to each NEGU path that does not have a recent rule applied to it. No factor was applied to a path that must comply with a recent rule, since the rule provides an emission limit on that path. A summary of the EGU and NEGU growth in the Texas attainment areas is provided as Table 2-13: Summary of Texas Attainment Area Growth

Projections to 2018. In Table 2-13, a Growth Method of 1 indicates ERG growth factors were applied to points that do not have recent existing rule limitations; and a Growth Method of 2 indicates the addition of post-2012 point sources and CAIR applied to all points.

Table 2-13: Summary of Texas Attainment Area Growth Projections to 2018

EI	Future Case Baseline Data	Future Case Baseline # points	Future Case Baseline NO_X (tpd)	Growth Method	2012 Future Case #points	2012 Projected NO_X (tpd)	Baseline to 2012 Growth
NEGUs	2012 STARS	9469	389	1	9469	413	6%
EGUs	2013 STARS/ AMPD	257	387	2	268	430	11%

2.3.2.2. <u>Texas Attainment Areas 2018 Control Implementation</u>

For this SIP revision, all of the existing TCEQ on-the-books controls are accounted for in the 2012 projection base. To develop the future case, emissions from EGUs in the state are controlled via EPA's CAIR program. For the NEGUs in attainment areas of the state, several existing controls were modeled, as described in following subsections.

2.3.2.2.1. EGUs

The TCEQ modeled the CAIR source emissions, using the trend analysis described above in Section 2.3.1.4, after accounting for the ozone season peak in AMPD EGU NO_X emissions. The CAIR caps are annual limits, and CAIR participants will collectively use more of their CAIR NO_X emission credits during the summer ozone season months when electric demand is higher. To capture this seasonal variation, the TCEQ scaled historical emissions for each point to match the cap, thereby applying the cap over the total time span while preserving emission variations within the span.

As noted above, in Section 2.3.2.1.2, the newly-permitted units can be modeled at their permitted values using the CAIR cap remaining after distributing the cap to existing EGUs. A summary of the distribution of the general and new CAIR pools to areas of Texas is provided as Table 2-14: Distribution of NO_X CAIR Allowances in Texas.

Table 2-14: Distribution of NO_X CAIR Allowances in Texas[16]

Area	Emissions Basis	Modeled Allowance for 2013 Units, tpd	Modeled Allowance for Post-2013 Units, tpd
DFW	CAIR AMPD	16.76	
MECT	MECT OSD		0.61
HGB	MECT AMPD	36.09	
Attainment	CAIR OSD		10.06
Attainment	CAIR ARD	420.01	

The EGU portions of the HGB MECT program also count against the CAIR budget. Overall, MECT is more restrictive than CAIR, i.e., lower controlled allowable emission rate, ignoring trading, so the difference between CAIR and MECT was distributed to CAIR EGUs not subject to the MECT program.

2.3.2.2.2. NEGUs

One existing program expected to further reduce emissions between the future base and 2018 in the attainment areas of the state is the Refinery Initiative. The reductions are in attainment counties as well as nonattainment counties throughout the state. Unfortunately, the emissions reductions are not easily quantifiable (see the description below).

2.3.2.2.2.1. Refinery Initiative

Since the late 1990s, petroleum refineries have been the focus of an EPA enforcement initiative. This initiative alleges that, in general, petroleum refineries violated and/or continue to violate one or more of the regulatory Clean Air Act provisions. In the interest of settling these allegations, without admitting to the alleged violations, many petroleum refiners entered into consent decrees with EPA. Since March 2000, the EPA has entered into settlements with 32 petroleum refiners that, collectively, represent 90 percent of U.S. petroleum refining capacity. According to EPA, these settlements, covering 109 refineries in 32 states, including Texas, will result in a reduction of approximately 93,000 tpy of NO_X and 256,000 tpy of SO_2 upon full implementation. See EPA's Petroleum Refinery Initiative webpage at http://www2.epa.gov/enforcement/petroleum-refinery-national-case-results for more details.

The TCEQ has not modeled any reductions for these consent decrees, because most of the agreements do not require NO_X reductions, and most of them lack enforceable requirements of quantified reductions. The TCEQ can verify that several refineries (some in HGB and BPA) have modified permits to comply with their consent decrees, but permit reductions do not always result in actual reported emission reductions.

2.3.3. Nonattainment Areas (NAA) of Texas

This section describes the specific growth and control implementation applied to the two ozone NAAs, DFW and HGB. The NAAs were modeled similarly, although HGB is more complex due to the number of TCEQ programs that apply to it. The growth projections to 2018 and any existing controls that will affect the areas between the projection base year(s) and 2018 are described in subsections below. Since emissions growth in NAAs is strictly limited by

[16] The tpd includes seasonal adjustments of CAIR and MECT caps based on AMPD data.

nonattainment New Source Review (NSR) rules, the subsections below address growth and control implementation together.

2.3.3.1. <u>2018 NAA Growth Projections and Control Implementation</u>

Growth projections were applied to the 2012 and 2013 projection base EIs to obtain the 2018 future case EI. Different techniques were applied to the EGUs (2013 projection base year) and the NEGUs (2012 projection base year).

2.3.3.1.1. NAA EGUs Projections and Control Implementation

As with the attainment areas of the state, the projection into the future begins with a projection base EI for NAA EGUs that is the typical (average) summer day calculated from AMPD hourly emissions for all days in the June through September 2013 time period. Not all EGUs are AMPD units. The projection base for non-AMPD EGUs is their 2012 OSD emissions, as if they were NEGUs.

The complete set of 2018 Texas EGUs, for future case modeling, consists of the 2013 AMPD EGUs, the post-2013 newly-permitted EGUs, and the projected 2012 non-AMPD EGUs. As with previous SIP revisions, the TCEQ assumes that the EGU growth in the state comes from newly-permitted EGUs. Similarly, the Integrated Planning Model (IPM) that EPA used for its future case EGU projections would add new units when it calculates that new capacity (to meet demand) is needed. The growth of EGUs in Texas is spatially allocated based on permit applications.

2.3.3.1.1.1. <u>Existing EGUs in NAAs</u>

All AMPD EGUs in DFW must comply with the control program, CAIR, and those in HGB must comply with CAIR and the more stringent MECT. Just as with the attainment areas, as described above in Section 2.3.2.2.1 , an ozone season scaling factor is calculated and applied to CAIR because CAIR is an annual cap, yet we are modeling the higher electrical demand ozone season.

Similarly, MECT is an annual cap, and account holders do not use these NO_X allowances uniformly across the year – they use more during the peak electrical demand ozone season. To compensate for this seasonal variation, the TCEQ computes a set of scaling factors by numerically dividing the annual MECT cap for each account by the sum of its emissions over the entire year. This factor is a multiplier that, when applied to the projection base (2013) average summer emissions, yields a future case set of emissions that are at their MECT cap for the ozone season.

2.3.3.1.1.2. <u>Newly-Permitted EGUs in NAAs</u>

Table 2-12, in Section 2.3.2.1.2 above, lists all of the newly-permitted EGUs in each area of the state. Again, these new units represent all of the EGU growth in all areas of Texas. There are no new planned units in DFW and three newly-permitted units in HGB. These new units were assumed to fit into the Texas CAIR cap, except in HGB, where the new units must also fit into the MECT cap limit. There was enough CAIR and MECT allowances available [due to shutdowns, units that drop from the program, and Discrete Emission Reduction Credits (DERCs) that can be used for MECT allowances] to easily model the new units at their permitted allowables.

2.3.3.1.2. NAA NEGU Projections and Control Implementation

As with the attainment areas of the state, the projection into the future begins with a projection base EI for Texas NAA NEGUs -- the 2012 OSD emissions. No individual new NEGU permits were modeled as growth, as such a process would be extremely resource intensive for all NEGU permit actions in the state. Emissions from NEGUs in the NAAs of the state were projected to 2018 using the lesser of the ERG growth factors or the emission credits in the bank, described in the following paragraphs, except for HGB NO_X, which is additionally subject to the MECT program. The ERG growth factors are discussed in Section 2.3.2.1.3 Non EGUs (NEGUs).

NAAs cannot grow in major sources of emissions of ozone precursors, NO_X and VOC, except by purchasing from the bank to obtain emissions offsets during New Source Review of permit applications or by sitewide contemporaneous period reductions. The TCEQ assumes that the emissions in the TCEQ EBT Registry, i.e., bank, are available to come back into the airshed in the future, but are limited by the projected growth of point sources within the NAA. In other words, sources will only purchase from the bank what they actually need, and that need is projected by TCEQ with the ERG growth factors. Conversely, sources in need of large emissions growth in the future (predicted by ERG), can only purchase as much credit as exists in the bank. For 2018 future case NO_X emissions, there were sufficient bank credits to allow growth with the ERG factors. 2018 future case VOC growth, however, was limited by the available bank credits.

The procedure for potentially incorporating the banked emissions in the future case begins with extracting the banked emissions from the TCEQ's EBT Emission Reduction Credit (ERC) and DERC Registries, which can be found on EBT's Registry webpage at http://www2.tceq.texas.gov/airperm/index.cfm?fuseaction=registry.registry.

ERC and DERC totals for each of the NAAs, as of June 19, 2013 were extracted, tabulated, and summarized. Table 2-15: Banked Emissions as of June 2013 summarizes these results. Modelable emissions in Table 2-15 refers to the maximum amount of emissions that could be added as growth to the area from banked emissions, with the exception of HGB as noted below.

Table 2-15: Banked Emissions as of June 2013

NAA	NO_X ERCs (tpy)	VOC ERCs (tpy)	NO_X DERCs (tons)	VOC DERCs (tons)	CO DERCs (tons)	Total Model-able NO_X Bank (tpd)	Total Model-able VOC Bank (tpd)	Total Model-able CO Bank (tpd)
HGB Registry	47.3	788.5	39018.9	1837.4	0.0		6.2	0.0
HGB Modeled Bank (Growth)	36.4	606.5	25894.6	1653.7		60.8	6.2	0.0
HGB Model Bank used for MECT Compliance			1247.1			3.4		
DFW Registry	363.0	153.2	6343.7	4.0	0.0			
DFW Modeled Bank	315.7	133.2	5703.3	3.6	0.0	17.0	0.6	0.0

Chapter 101 of 30 TAC requires that an ERC must be surplus to any federal, state or local rule. Also, the Chapter 101 MECT program DERC-use restrictions for HGB were incorporated in the NO_X total. 30 TAC Chapter 101.379, DFW DERC Flow Control Rule for 2018, did not offer a limitation on the growth for this SIP revision, because the ERG growth projected for DFW was less than the DFW banked emissions.

As a worst case, the Modelable bank totals indicated in Table 2-15 incorporate the designated eight-hour ozone offset ratios used for the TCEQ NSR program for each of the NAAs as of June 19, 2013, where an offset ratio of 1.15:1 for moderate areas indicates that the purchaser of ERCs must buy 11.5 ton per year of credits for each 10 tpy of increase proposed. Additionally, the modelable bank took into account the requirement of Chapter 101 to retire 10 percent of the DERCs, as an environmental contribution, upon DERC usage.

Table 2-16: Texas NEGU "No-Rules" Growth Summary shows the growth projected in each of the NAAs. Again, the growth was only applied to the sources that were not already limited by existing TCEQ rules.

Table 2-16: Texas NEGU "No-Rules" Growth Summary

Area	Projection Index	2012 STARS NO_X, tpd	2018 NO_X, tpd	2012 STARS VOC, tpd	2018 VOC, tpd
DFW	ERG with bank limit	23.72	23.17	46.69	49.29
HGB	ERG with bank limit	17.63	20.73	109.27	115.48
Attainment	from ERG factors	409.00	412.94	285.90	316.96

The DFW banked emissions and growth from the ERG factors were compared on a path-by-path basis, automated with SAS programming. The bank growth in each NAA was the bank divided by the total emissions in the NAA. A path's share of the bank was based on its fractional emissions of the total, and was added to that path. Only the paths not already limited by rules were allowed to grow via the bank or the ERG factors.

2.3.3.1.2.1. <u>HGB MECT NEGU NO_X Control Implementation</u>
The HGB MECT program also limits the amount of NO_X from all applicable NEGU sources with a cap. The application of this program and its limits are discussed in Sections 2.3.1.2 and 2.3.1.4 above.

2.3.3.1.2.2. <u>HGB HECT NEGU HRVOC Control Implementation</u>
The other cap-and-trade program within HGB that applies to NEGUs is the HECT program. No EGUs are in the HECT program. This rule only applies in Harris County. The application of this program and its limits are discussed in Sections 2.3.1.3 and 2.3.1.4 above. The HRVOC modeling procedure adopted by the TCEQ does not affect the mass flow rates of other non-HRVOC compounds in HECT qualifying point sources.

2.3.3.1.2.3. <u>DFW Ellis County (Midlothian) Cement Kiln Cap Control Implementation</u>
As previously discussed in Section 2.3.1.5, the DFW Cement Kilns Source Cap remains 17.6 tpd. In the past, these have been modeled as shown in Table 2-17: Ellis County Cement Kiln NO_X Caps, below. The table below also shows the projected 2012 NO_X emissions from the December 2011 DFW SIP Revision[17] and the 2012 STARS Annual emissions. Thus, by modeling the Cement Kiln Cap we are modeling approximately twice the emissions the kilns actually emitted. Doubling of kiln emissions by 2018 is very unlikely; therefore, the modeled future case for these sources is a conservative projection.

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[17] December 7, 2011 DFW Attainment Demonstration for the 1997 Eight-Hour Ozone Standard at http://www.tceq.texas.gov/airquality/sip/dfw_revisions.html

TXI received a permit modification June 30, 2011 to cease operation of its four wet kilns (future emissions of 0.00 tpd) in exchange for increasing clinker production in its newer dry kiln process.

On August 14, 2013, Ash Grove entered into a Consent Decree with EPA that would require Kiln 1 and Kiln 2 to be shutdown/retired by September 2014 and Kiln 3 reconstructed as a dry kiln. Emissions limits were specified for Kiln 3's NO_X, SO_2 and PM emissions in this agreement, but this does not change the enforceable NO_X Source Cap for the entire site of 4.4 tpd.

Table 2-17: Ellis County Cement Kiln NO_X Caps

Sitename	FIN	EPN	Projected 2012 NO_X Emissions from December 2011 DFW SIP (tpd)	2012 STARS Annual Emissions (tpd)	2018 Updated Allocation NO_X Emissions (tpd)
Ash Grove	2-1	2	1.43	1.13	-
Ash Grove	2-2	6	1.51	1.39	-
Ash Grove	2-3	12	1.45	1.38	4.4
Holcim	62*	62*	2.10	0.00	2.61
Holcim	07*	07*	3.20	1.64	2.69
TXI Operations	E-2-2	E2-2	0.00	-	-
TXI Operations	E-2-4	E2-4	0.00	-	-
TXI Operations	E-2-6	E2-6	0.00	-	-
TXI Operations	E-2-8	E2-8	0.00	-	-
TXI Operations	E2-22	E2-22	7.90	3.45	7.9

2.3.3.1.2.4. DFW 2018 EI Summary

The future case EI is composed of two datasets, hourly average 3Q2008 for the ARD sources and 2008 OSD for the remainder of the point sources. The 2012 future base is built upon these datasets by incorporating the changes expected due to growth, emission caps, and on-the-books controls. Table 2-18: Detailed NO_X 2018 Emissions Summary by Region provides a 2012 emissions summary.

Table 2-18: Detailed NO_X 2018 Emissions Summary by Region

Region	Projection	Affected Sources	2012 STARS NO_X, tpd	2013 AMPD NO_X, tpd	2018 NO_X Projection, tpd
DFW	CAIR	EGUs		7.23	16.77
DFW	Controls	Midlothian Kilns	6.47		14.91
DFW	Growth	NEGUs	23.73		23.17

Region	Projection	Affected Sources	2012 STARS NO_X, tpd	2013 AMPD NO_X, tpd	2018 NO_X Projection, tpd
HGB	MECT	OSD point sources	52.48		75.35
HGB	MECT	Growth under the cap			1.78
HGB	MECT	AMPD point sources		28.72	46.22
HGB	MECT	New EGU Growth			2.42
HGB	Growth/bank	NEGUs	17.62		20.73
Rest of TX	CAIR	AMPD point sources		375.70	420.01
Rest of TX	Growth	OSD point sources	388.7		412.94

2.3.4. 2018 Regional (Outside of Texas) Point Sources

Regional emissions include states outside of Texas within the modeling domain, offshore Gulf of Mexico, and the parts of Mexico and Canada within the modeling domain.

2.3.4.1. States Outside of Texas

2.3.4.1.1. EGUs

The TCEQ distinguishes between EGUs and AMPD units. Not all EGUs are AMPD units, e.g., true cogeneration units are not AMPD units, but large cogeneration units that supply more than one-third of their electricity to the public electrical grid are AMPD units. Non-AMPD EGUs are treated as NEGUs. This is the same definition that the EPA applies to EGUs for CAIR purposes, i.e., an EGU, as defined by CAIR, is an AMPD unit.

To develop projection base USA AMPD, the TCEQ compiled and maintains a USA cross reference file that links AMPD identifiers to a record NEI identifiers, where the NEI also carries FIPS, plant, stack, point, location parameters, stack parameters, and (in some instances) site name. Thus, the USA AMPD-to-NEI cross reference provides enough information to make an AFS record without matching another (OSD type) emission record. The USA cross reference file matches a high percentage (over 99%) of the USA AMPD units. The cross reference is based on a variety of sources, primarily the NEI which, for 2011, also provided ORIS and BOILER identifiers, For these points sources, TCEQ was able to attach total heat input values from the (same year) 2011 AMPD and, from the composite, compute emission-to-heat input ratios for many EGUs in the 2011 NEI. TCEQ used these emission ratios to compute hourly pollutant emissions for selected points in the 2013 projection base year using the hourly heat inputs. For the unmatched points, TCEQ distributed the unmatched NO_X emissions proportionally to all the matched points within the respective state.

To develop the 2018 future case EGUs for states outside of Texas, the TCEQ used CAIR Phase II for states subject to the CAIR program and 2013 AMPD data. TCEQ used the CAIR state budgets specified in 40 CFR Part 96 for each state and a historical trend analysis to determine the future year state emissions. The historical trend analysis looked at which states where below or above their assigned state budgets to better estimate future year state emissions for CAIR states. Scaling statewide emissions to match the assigned cap took into account the effect of seasonal variation.

The TCEQ did not account for growth outside Texas. An alternative to TCEQ's approach that includes growth and controls is to use EGU emission projection tools such as the EPA's IPM or the Eastern Regional Technical Advisory Committee (ERTAC) EGU Forecasting Tool. A comparison was made to the total state emissions predicted by IPM and ERTAC EGU Forecasting Tool for 2018 with TCEQ's method and it was found that TCEQ's method resulted in a more conservative regional emissions total with most of the CAIR regional cap (93%) have been modeled.

Table 2-19: 2018 Modeled Emissions for States in the Modeling Domain gives the future year emissions along with modeled CAIR (ozone or annual) emissions, where applicable, for each state outside Texas in the modeling domain. An empty cell indicates CAIR is not applicable for that state.

Table 2-19: 2018 Modeled Emissions for States in the Modeling Domain

State	Ozone Season CAIR Cap, NO_X tons per ozone season	Annual CAIR Cap, NO_X tpy	2018 Modeled Emissions, NO_X tpd
AL	22095.52		146.45
AR	17339.36		117.53
AZ			155.72
CA			14.59
CO			131.21
CT	578.983		4.12
DC	94		0.67
DE	912.096		6.24
FL	27081.29		182.16
GA		35599.31	103.67
IA	15253.83		106.55
ID			0.74
IL	18671.13		126.10
IN	39273		258.63
KS			86.80
KY	30587		201.93
LA	17788.95		121.20
MA	1607.635		11.38
MD	5303.099		36.61
ME			1.34
MI	24142		160.86
MN			73.63
MO	22231		153.14
MS	11320.76		80.17
MT			46.89
NC	22633.86		157.38
ND			128.82

State	Ozone Season CAIR Cap, NO_X tons per ozone season	Annual CAIR Cap, NO_X tpy	2018 Modeled Emissions, NO_X tpd
NE			79.62
NH			4.93
NJ	2679.769		18.60
NM			162.78
NV			27.56
NY	10856.86		73.04
OH	37150.73		248.28
OK			160.48
OR			12.34
PA	57246.25		378.14
RI			1.92
SC	7361.666		51.00
SD			32.82
TN	11252.72		74.80
UT			163.01
VA	13328		91.38
VT			0.51
WA			25.35
WI	10864.1		73.93
WV	25470.17		172.27
WY			134.45

2.3.4.1.2. NEGUs

For 2018 NEGUs for other states, the TCEQ used the EPA's 2018 non-IPM (non-EGU) files from EPA's 2018 Emissions Modeling Platform[18]. The non-IPM portion of the platform consists of several emissions files including the primary points file containing emissions for all states, plus additional files for ethanol and biodiesel plants and cement kilns. These files were already grown and controlled, but for the most part represent the 2011 NEI for the country with federal rules and some state rules applied. After extracting Texas from the list, the TCEQ generated an AFS-formatted file, including all necessary and relevant modeling parameters for EPS3 processing. The associated temporal allocation file was utilized to create the daily temporal distribution. A June day was selected to represent a typical ozone season day. Summary files provided by EPA contain individual state totals for NEGU (non-IPM) emissions. These summaries can be found at the EPA Emissions Inventory website at ftp://ftp.epa.gov/EmisInventory/2011v6/v1platform/reports/2018_emissions/.

Table 2-20: 2018 Regional States Emissions Summary provides an overall summary of the 2018 emissions for all the states within the modeling domain (continental USA), outside of Texas

[18] From EPA's Emissions Modeling Clearinghouse page: http://www.epa.gov/ttnchie1/emch/, the TCEQ chose the link "2011 and 2018 Emissions Modeling Platform Data Files and Summaries" which takes the reader to ftp://ftp.epa.gov/EmisInventory/2011v6/v1platform/2018emissions/

Table 2-20: 2018 Regional States Emissions Summary

Model Year	Source Category	NO_X Emissions, tpd	VOC Emissions, tpd	CO Emissions, tpd
2006 Baseline	EGU	7757	88	885
2018 Future Case	EGU	4602	76	1673
2006 Baseline	NEGU[19]	4539	2457	5953
2018 Future Case	NEGU	3820	2248	4883

2.3.5. Offshore, Mexico, and Canada

For lack of projections data, the 2018 EIs for the Gulf of Mexico offshore area, Mexico, and Canada were the same as those used in the 2006 baseline and the base case, as described in previous sections. The TCEQ used the EPA's 2018 modeling platform for Mexico. These files were already grown, based on 1999 NEI.

2.3.6. Summary of Future Case Point Source Data Files

The point source emission files that were processed with EPS3 for CAMx are presented in Table 2-21: AFS Files for the 2018 Future Case Episode. The regional AFS file for the GWEI contains monthly emissions for June only and the regional AFS file for Canadian emissions contains annual emissions. The version number on each dataset indicates a change from the previous version (e.g., "v8"). The FTP download website for these files is ftp://amdaftp.tceq.texas.gov/pub/TX/ei/fy2018/point.

Table 2-21: AFS Files for the 2018 Future Case Episode

Area	AFS Point Source Emissions Dataset	Hourly	Daily	Special
Texas	afs.ard_JUN2SEP_2018_MECT_NO_X_aver_day_RPOlcp_v8	X		
Texas	afs.ard_JUN2SEP_2018_nonNO_X_aver_day_RPOlcp_v9	X		1
Texas	afs.ard_JUN2SEP_2018_CAIR_NO_X_aver_day_RPOlcp_v10	X		
Texas	afs.osd_no_controls_grown_to_2018.RPOlcp_v8		X	
Texas	afs.2018_HECT_cap_n_trade_HarrisCo_2012_basis_all_pts_v3		X	
Texas	afs.osd_hgb_dfw_growth_with_bank_v12		X	
Texas	afs.osd_new_egus_2013_to_2018_v7		X	
Texas	afs.osd_mect_2018_based_on_2012_RPOlcp_v8		X	
Texas	afs.osd_2018_CAIR_NO_X_records_v11		X	
Texas	afs.midlokilns_2018_NO_X_emissions.RPOlcp		X	
Regional	afs.amp_USA_JUN2SEP_2018_CAIR_avg_day_all_pols_RPOlcp	X		
Regional	afs.2018_USA_noTX_noEGU.RPOlcp		X	
Regional	afs.gwei.2008.lcpRPO			Monthly
Regional	afs.Mexico_2018_from_EPA2011Platform_1999NEI.RPOlcp		X	
Regional	afs.canada_2006_all_pols.RPOlcp			Annual

[19] Based on EPA's 2008 NEI.

Table 2-22: 2018 Future Case Point Source Emissions Summary summarizes the future case emissions. These tabulated emissions are AFS totals input to EPS3. CAMx input values may differ. The U.S. minus Texas column includes some points outside the modeling domain. The TX minus DFW column includes some points in Texas outside the modeling domain. As noted earlier in Section 2.1.1.4.1, VOC emission totals include acetone and ethane.

Table 2-22: 2018 Future Case Point Source Emissions Summary

Emission Source	DFW NO_X (tpd)	DFW VOC (tpd)	TX minus DFW NO_X (tpd)	TX minus DFW VOC (tpd)	U.S. minus TX NO_X (tpd)	U.S. minus TX VOC (tpd)
NEGUs (OSD)	40.8	47.3	523.3	461.9	3820.4	2248.1
EGUs (ARD)	16.8	4.4	466.2	27.3	4601.8	76.5

2.4 2018 Point Source Control Strategy and/or Sensitivity Analyses

Existing controls with compliance dates that were in the past, were between the baseline and the projection base year, or were included in the projection base year, were modeled in the future case identified above. Any new control strategies, RACT, RACM, other rules, potential rules, or sensitivity analyses that are modeled are applied on top of the future case modeling in order to determine the efficacy in the future. The point source sensitivity analyses performed for this DFW attainment demonstration are (1) a DERC Flow Control sensitivity, and (2) a Cross State Air Pollution Rule (CSAPR) sensitivity.

3. ON-ROAD MOBILE SOURCE MODELING EMISSIONS DEVELOPMENT

3.1 On-Road Mobile Source Emissions Inventories for 10-County DFW

This section provides a brief overview of the development of the 10-county DFW area on-road mobile source emissions inventory files that were input into the photochemical model for the 2006 base case, the 2006 baseline case, and the 2018 future case. The on-road emission inventories were developed with the 2014 version of the Motor Vehicle Emission Simulator (MOVES2014) model.

The on-road emissions inventory datasets were developed under contract by the North Central Texas Council of Governments (NCTCOG) and the Texas Transportation Institute (TTI). NCTCOG developed 2006 and 2018 link-based on-road emission estimates using MOVES2014 and travel demand model (TDM) output for the DFW area as the basis for vehicle miles traveled (VMT) estimates. MOVES2014 outputs nitrogen oxide (NO), nitrogen dioxide (NO_2), and nitrous acid (HONO), which are components of oxides of nitrogen (NO_X). The tables in this section report NO, NO_2, and NO_X separately. Due to space limitations, HONO is not reported separately, but MOVES2014 calculates it as 0.8% of total NO_X emissions. For both the 2006 base case and the 2018 future case, school and summer season on-road emission inventories were developed for the four day types of weekday (i.e., Monday through Thursday average), Friday, Saturday, and Sunday. For the on-road category, base case and baseline emissions are the same.

Table 3-1: VMT and Emissions by Day Type for 2006 DFW On-Road Inventory and Table 3-2: VMT and Emissions by Day Type for 2018 DFW On-Road Inventory provide summaries of the total VMT, NO, NO_2, NO_X, volatile organic compound (VOC), and carbon monoxide (CO) emissions for the 10-county DFW 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 to 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 NCTCOG include the benefits of:

- reformulated gasoline (RFG) in Collin, Dallas, Denton, and Tarrant counties;
- low Reid vapor pressure (RVP) gasoline in Ellis, Johnson, Kaufman, Parker, Rockwall, and Wise counties;
- the inspection and maintenance (I/M) Program in Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, and Tarrant counties; and
- Texas low emission diesel (TxLED) fuel for all 10 DFW area counties.

Table 3-1: VMT and Emissions by Day Type for 2006 DFW On-Road Inventory

Season and Day Type	Vehicle Miles Traveled	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	158,661,182	262.07	19.92	284.27	116.50	1,315.46
Summer Friday	175,991,883	270.83	21.05	294.23	120.22	1,425.40
Summer Saturday	143,694,618	191.61	15.37	208.65	107.88	1,227.77
Summer Sunday	118,574,926	174.06	13.51	189.08	101.60	1,074.31
School Weekday	159,475,888	262.64	19.98	284.90	116.80	1,320.26
School Friday	174,982,511	269.33	20.92	292.59	119.89	1,419.01
School Saturday	141,989,731	189.25	15.17	206.07	107.37	1,216.12
School Sunday	117,230,204	172.04	13.34	186.88	101.19	1,065.03

Table 3-2: VMT and Emissions by Day Type for 2018 DFW On-Road Inventory

Season and Day Type	Vehicle Miles Traveled	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	221,520,532	101.77	16.96	119.69	62.20	989.88
Summer Friday	245,575,338	104.30	17.27	122.56	63.73	1,079.37
Summer Saturday	196,388,570	77.25	12.34	90.32	58.73	923.96
Summer Sunday	164,875,239	72.49	11.63	84.81	56.67	811.78
School Weekday	222,641,360	102.01	17.00	119.97	62.32	993.96
School Friday	245,090,234	103.97	17.22	122.16	63.67	1,077.47
School Saturday	194,774,800	76.66	12.25	89.63	58.59	918.23
School Sunday	162,559,712	71.63	11.49	83.79	56.46	803.01

Even though all of the day type on-road inventory datasets were used for photochemical model input, only the summer weekday emissions will be detailed here. For the 2006 base case and 2018 future case, the summaries of the VMT, NO, NO_2, NO_X, VOC, and CO emissions for each of the 10 counties in the DFW area are shown in Table 3-3: VMT and Emissions by County for 2006 DFW On-Road Inventory and Table 3-4: VMT and Emissions by County for 2018 DFW On-Road Inventory, respectively.

Table 3-3: VMT and Emissions by County for 2006 DFW On-Road Inventory

DFW Area County	Vehicle Miles Traveled	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Collin	16,785,092	24.50	1.91	26.62	11.53	124.25
Dallas	64,064,555	98.08	7.54	106.47	47.02	546.96
Denton	13,812,713	23.16	1.75	25.11	10.04	103.14
Ellis	5,460,324	14.92	1.05	16.10	4.46	49.67
Johnson	4,472,201	9.14	0.68	9.89	3.56	42.89
Kaufman	4,557,637	11.74	0.85	12.70	3.34	40.09
Parker	3,903,299	10.50	0.73	11.33	3.03	32.19
Rockwall	1,863,468	3.93	0.29	4.25	1.61	17.98
Tarrant	41,236,585	59.81	4.65	64.98	29.99	333.12
Wise	2,505,308	6.29	0.47	6.81	1.89	25.18
Total	158,661,182	262.07	19.92	284.27	116.50	1,315.46

Table 3-4: VMT and Emissions by County for 2018 DFW On-Road Inventory

DFW Area County	Vehicle Miles Traveled	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Collin	27,052,719	10.02	1.58	11.69	7.07	112.48
Dallas	82,293,890	33.67	5.07	39.05	22.46	383.98
Denton	21,999,802	9.48	1.60	11.16	5.95	88.13
Ellis	8,530,620	7.28	1.57	8.92	2.57	33.96
Johnson	6,274,070	3.83	0.72	4.59	1.94	26.63
Kaufman	7,245,585	5.54	1.22	6.82	1.92	27.74
Parker	5,801,400	5.92	1.32	7.31	1.97	26.26
Rockwall	2,795,026	1.60	0.30	1.92	0.91	11.65
Tarrant	55,850,317	22.16	3.20	25.57	16.43	263.30
Wise	3,677,105	2.27	0.38	2.68	0.97	15.76
Total	221,520,532	101.77	16.96	119.69	62.20	989.88

Summaries for 2006 and 2018 of the VMT, NO, NO_2, NO_X, VOC, and CO emissions for the gasoline and diesel fuel source use type (SUT) combinations from the MOVES2014 model are presented in Table 3-5: VMT and Emissions by Vehicle Type for 2006 DFW On-Road Inventory and Table 3-6: VMT and Emissions by Vehicle Type for 2018 DFW On-Road Inventory.

Table 3-5: VMT and Emissions by Vehicle Type for 2006 DFW On-Road Inventory

Fuel and Source Use Type Combination	VMT	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Gasoline - Motorcycle	117,737	0.09	0.00	0.09	1.00	2.44
Gasoline - Passenger Car	117,291,095	82.50	7.83	91.06	65.04	746.70
Gasoline - Passenger Truck	22,776,540	34.59	2.99	37.88	26.72	342.96
Gasoline - Light Commercial Truck	6,844,055	11.16	0.99	12.25	8.54	109.29
Gasoline - Transit Bus	447	0.00	0.00	0.00	0.00	0.02

Fuel and Source Use Type Combination	VMT	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Gasoline - School Bus	13,989	0.09	0.00	0.09	0.06	0.96
Gasoline - Refuse Truck	4,527	0.03	0.00	0.03	0.01	0.33
Gasoline - Single Unit Short-Haul Truck	1,171,839	4.52	0.25	4.81	1.71	42.80
Gasoline - Single Unit Long-Haul Truck	161,348	0.57	0.03	0.61	0.20	4.76
Gasoline - Motor Home	143,841	0.67	0.03	0.71	0.25	6.43
Gasoline - Combination Short-Haul Truck	1,016	0.01	0.00	0.01	0.00	0.09
Diesel - Passenger Car	446,134	0.36	0.02	0.38	0.35	5.96
Diesel - Passenger Truck	322,243	1.12	0.07	1.20	0.35	4.06
Diesel - Light Commercial Truck	393,137	1.56	0.10	1.67	0.46	4.01
Diesel - Intercity Bus	163,006	3.07	0.19	3.29	0.19	0.91
Diesel - Transit Bus	45,423	0.69	0.04	0.73	0.04	0.27
Diesel - School Bus	169,433	1.48	0.09	1.58	0.22	0.63
Diesel - Refuse Truck	108,653	1.64	0.10	1.75	0.10	0.55
Diesel - Single Unit Short-Haul Truck	2,593,132	17.14	1.04	18.33	2.35	7.79
Diesel - Single Unit Long-Haul Truck	363,000	2.20	0.13	2.36	0.32	1.03
Diesel - Motor Home	83,758	0.71	0.04	0.76	0.11	0.28
Diesel - Combination Short-Haul Truck	2,245,963	32.40	1.98	34.65	1.94	10.90
Diesel - Combination Long-Haul Truck	3,200,863	65.49	3.99	70.04	6.53	22.30
Total	158,661,182	262.07	19.92	284.27	116.50	1,315.5

Table 3-6: VMT and Emissions by Vehicle Type for 2018 DFW On-Road Inventory

Fuel and Source Use Type Combination	VMT	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Gasoline - Motorcycle	155,855	0.10	0.00	0.10	1.17	2.00
Gasoline - Passenger Car	154,569,516	24.66	2.77	27.65	33.58	565.15
Gasoline - Passenger Truck	29,925,824	14.26	1.57	15.96	12.10	214.56
Gasoline - Light Commercial Truck	18,434,314	9.53	1.05	10.67	7.95	140.22
Gasoline - Transit Bus	477	0.00	0.00	0.00	0.00	0.01
Gasoline - School Bus	14,914	0.06	0.00	0.06	0.05	0.84
Gasoline - Refuse Truck	5,999	0.03	0.00	0.03	0.01	0.31
Gasoline - Single Unit Short-Haul Truck	1,552,802	1.04	0.12	1.17	0.70	21.77
Gasoline - Single Unit Long-Haul Truck	213,802	0.12	0.02	0.14	0.08	2.50
Gasoline - Motor Home	190,603	0.37	0.03	0.40	0.18	4.41
Gasoline - Combination Short-Haul Truck	1,683	0.00	0.00	0.00	0.00	0.03
Diesel - Passenger Car	1,285,165	0.13	0.05	0.18	0.10	4.82
Diesel - Passenger Truck	542,270	0.79	0.15	0.95	0.19	2.49
Diesel - Light Commercial Truck	1,032,692	1.60	0.25	1.87	0.44	5.74
Diesel - Intercity Bus	173,786	1.41	0.14	1.55	0.11	0.57
Diesel - Transit Bus	48,427	0.26	0.03	0.29	0.02	0.16
Diesel - School Bus	180,639	0.70	0.07	0.78	0.13	0.46
Diesel - Refuse Truck	143,976	0.54	0.09	0.64	0.04	0.26
Diesel - Single Unit Short-Haul Truck	3,436,158	3.74	1.28	5.06	0.44	3.18
Diesel - Single Unit Long-Haul Truck	481,011	0.45	0.16	0.62	0.05	0.41
Diesel - Motor Home	110,988	0.34	0.04	0.38	0.06	0.19

Fuel and Source Use Type Combination	VMT	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Diesel - Combination Short-Haul Truck	3,719,186	9.29	2.20	11.59	0.61	4.20
Diesel - Combination Long-Haul Truck	5,300,445	32.33	6.95	39.59	4.21	15.61
Total	221,520,532	101.77	16.96	119.69	62.20	989.88

The MOVES2014 run specification files used to develop these inventories for 2006, along with detailed reports and summary output data, can be found on the 2006 DFW on-road FTP site at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/DFW/mvs/2006/. The MOVES2014 run specification files used to develop these inventories for 2018, along with detailed reports and summary output data, can be found on the 2018 DFW on-road FTP site at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/DFW/mvs/2018/.

3.2 On-Road Mobile Source Emissions Processing

The on-road emissions inventory data provided by NCTCOG 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, the emissions data are maintained in a binary format within EPS3. Table 3-7: EPS3 Modules for Processing On-Road Emissions summarizes the EPS3 modules that were used to process the 10-county DFW on-road inventories.

Table 3-7: EPS3 Modules for Processing On-Road Emissions

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.
SPCEMS	Chemically speciate VOC emissions into olefins, paraffins, etc.
GRDEM	Sum emissions by grid cell for photochemical model input.
MRGUAM	Merge and adjust multiple gridded files for photochemical model input.

The MOVES2014 model only estimates extended idling emissions for the diesel fuel combination long-haul truck category. Using a combination of SAS and LINUX code, the extended idling emissions were aggregated into a 10-county 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 3-8: 2006 and 2018 DFW Area Long-Haul Truck Extended Idling Emissions. Greater detail on heavy-duty vehicle idling activity specific to Texas metropolitan areas can be found in a report entitled Heavy-Duty Vehicle Idle Activity and Emissions Characterization Study, which is available at http://www.tceq.texas.gov/airquality/airmod/project/pj_report_mob.html.

Table 3-8: 2006 and 2018 DFW Area Long-Haul Truck Extended Idling Emissions

Calendar Year	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
2006	9.88	0.60	10.57	3.75	4.90
2018	9.66	3.29	13.06	2.85	6.77

3.2.1. Texas Low Emission Diesel Fuel Benefits

Based on the EPA memorandum *Texas Low Emission Diesel (LED) 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, MOVES2014 model runs were performed to determine NO_X emissions rates by model year. By using these data, the 4.8% and 6.2% TxLED reduction factors were weighted according to the model year specific diesel NO_X emission rates. The TCEQ TxLED factors FTP site at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/txled/ contains more detail on this analysis. The resulting TxLED adjustment factors and benefits for both 2006 and 2018 are summarized in Table 3-9: 2006 DFW On-Road TxLED Benefits by Vehicle Type and Table 3-10: 2018 DFW On-Road TxLED Benefits by Vehicle Type, respectively. The TxLED adjustment factors were incorporated by NCTCOG and TTI into the on-road inventories by post-processing the MOVES2014 diesel fuel source use type NO_X emission rates.

Table 3-9: 2006 DFW On-Road TxLED Benefits by Vehicle Type

Diesel Fuel Source Use Type	NO_X Reduction	Adjustment Factor	NO_X Benefit (tpd)
Passenger Car	6.07%	0.9393	0.02
Passenger Truck	5.56%	0.9444	0.07
Light Commercial Truck	5.88%	0.9412	0.10
Intercity Bus	5.98%	0.9402	0.21
Transit Bus	5.93%	0.9407	0.05
School Bus	5.91%	0.9409	0.10
Refuse Truck	5.82%	0.9418	0.11
Single Unit Short-Haul Truck	5.41%	0.9459	1.05
Single Unit Long-Haul Truck	5.29%	0.9471	0.13
Motor Home	5.71%	0.9429	0.05
Combination Short-Haul Truck	5.89%	0.9411	2.17
Combination Long-Haul Truck	5.92%	0.9408	4.41
Total			8.46

Table 3-10: 2018 DFW On-Road TxLED Benefits by Vehicle Type

Diesel Fuel Source Use Type	NO_X Reduction	Adjustment Factor	NO_X Benefit (tpd)
Passenger Car	4.99%	0.9501	0.01
Passenger Truck	5.04%	0.9496	0.05
Light Commercial Truck	5.32%	0.9468	0.10

Diesel Fuel Source Use Type	NO_X Reduction	Adjustment Factor	NO_X Benefit (tpd)
Intercity Bus	5.65%	0.9435	0.09
Transit Bus	5.62%	0.9438	0.02
School Bus	5.63%	0.9437	0.05
Refuse Truck	5.30%	0.9470	0.04
Single Unit Short-Haul Truck	4.89%	0.9511	0.26
Single Unit Long-Haul Truck	4.88%	0.9512	0.03
Motor Home	5.36%	0.9464	0.02
Combination Short-Haul Truck	5.18%	0.9482	0.63
Combination Long-Haul Truck	5.21%	0.9479	2.18
Total			3.48

3.3 10-County DFW Photochemical Modeling Input

The summer weekday on-road emissions by county that were input into the photochemical model are summarized below in Table 3-11: 2006 DFW Area Summer Weekday On-Road Emissions by County and Table 3-12: 2018 DFW Area Summer Weekday On-Road Emissions by County. These on-road inventory summaries are a combination of running exhaust, evaporative, off-network, and extended idling emissions. Differences by individual counties between these figures and those referenced above in Table 3-3 and Table 3-4 are due to the spatial reallocation of extended idling emissions presented above in Table 3-8. However, the 10-county total on-road emission estimates do not differ.

Table 3-11: 2006 DFW Area Summer Weekday On-Road Emissions by County

DFW Area County	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Collin	24.69	1.92	26.82	11.60	124.34
Dallas	99.81	7.65	108.32	47.68	547.82
Denton	22.65	1.72	24.57	9.85	102.89
Ellis	13.65	0.97	14.74	3.98	49.04
Johnson	8.67	0.65	9.39	3.38	42.65
Kaufman	11.59	0.84	12.53	3.28	40.01
Parker	10.30	0.72	11.11	2.97	32.10
Rockwall	4.15	0.30	4.48	1.69	18.09
Tarrant	60.38	4.68	65.58	30.21	333.40
Wise	6.19	0.46	6.71	1.86	25.13
Total	262.07	19.92	284.27	116.50	1,315.46

Table 3-12: 2018 DFW Area Summer Weekday On-Road Emissions by County

DFW Area County	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Collin	10.25	1.65	12.00	7.13	112.63
Dallas	35.77	5.78	41.89	23.08	385.45
Denton	9.26	1.53	10.88	5.89	87.99

DFW Area County	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Ellis	5.79	1.06	6.90	2.13	32.91
Johnson	3.13	0.48	3.64	1.73	26.12
Kaufman	5.21	1.11	6.37	1.82	27.49
Parker	5.33	1.12	6.51	1.81	25.88
Rockwall	1.82	0.38	2.22	0.98	11.80
Tarrant	23.07	3.51	26.80	16.70	263.94
Wise	2.13	0.34	2.49	0.93	15.67
Total	101.77	16.96	119.69	62.20	989.88

The total 10-county DFW on-road emissions input to the photochemical model by day type are summarized below in Table 3-13: 2006 DFW Area On-Road Emissions by Season and Day Type and Table 3-14: 2018 DFW Area On-Road Emissions by Season and Day Type. Slight differences by day type between these figures and those presented in Table 3-1 and Table 3-2 are due to the on-road emission inventories being developed in Central Daylight Time (CDT), but processed for photochemical model input in Central Standard Time (CST). For example, the 11 PM – 12 AM CST emissions on a Friday evening are based on 12-1 AM CDT emissions from a Saturday.

Table 3-13: 2006 DFW Area On-Road Emissions by Season and Day Type

Season and Day Type	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	262.07	19.92	284.27	116.50	1,315.46
Summer Friday	271.10	21.09	294.54	120.41	1,430.74
Summer Saturday	191.89	15.39	208.95	107.91	1,228.21
Summer Sunday	173.23	13.42	188.15	101.29	1,066.20
School Weekday	262.64	19.98	284.90	116.80	1,320.26
School Friday	269.57	20.97	292.87	120.07	1,424.23
School Saturday	189.54	15.19	206.38	107.40	1,216.60
School Sunday	171.25	13.25	185.99	100.89	1,057.09

Table 3-14: 2018 DFW Area On-Road Emissions by Season and Day Type

Season and Day Type	NO (tpd)	NO_2 (tpd)	NO_X (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	101.77	16.96	119.69	62.20	989.88
Summer Friday	104.40	17.28	122.67	63.80	1,083.31
Summer Saturday	77.34	12.36	90.42	58.74	924.25
Summer Sunday	72.27	11.60	84.54	56.58	806.43
School Weekday	102.01	17.00	119.97	62.32	993.96
School Friday	104.06	17.23	122.27	63.73	1,081.33
School Saturday	76.75	12.26	89.72	58.60	918.48
School Sunday	71.43	11.46	83.55	56.37	797.80

The EPS3 message files for 2006 DFW along with the gridded files input into the photochemical model are available on the TCEQ DFW 2006 FTP site at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/DFW/eps3/2006/. The EPS3 message files for 2018 DFW along with the gridded files input into the photochemical model are available on the 2018 DFW FTP site at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/DFW/eps3/2018/.

Similar on-road mobile EPS3 message and gridded files for the Texas-only portion of the modeling domain are available for both 2006 and 2018 at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/eps3/2006/, and ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/eps3/2018/, respectively.

Similar on-road mobile EPS3 message and gridded files for the non-Texas U.S. portions of the modeling domain are available for both 2006 and 2018 at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/eps3/2006/, and ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/eps3/2018/, respectively.

Similar 2006 and 2018 on-road mobile EPS3 message and gridded files for the Canada and Mexico portions of the modeling domain are available at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/CAN/eps3/, and ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/MEX/eps3/, respectively.

3.4 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 season and day type for this purpose, and are presented below in Table 3-15: Attainment Demonstration MVEB for the 10-County DFW Area. As shown, these 2018 figures match those provided by NCTCOG as summarized above in Table 3-2, Table 3-4, and Table 3-6. No emission reduction credits were taken for local transportation control measures (TCMs) and voluntary mobile source emission reduction program (VMEP) strategies.

Table 3-15: Attainment Demonstration MVEB for the 10-County DFW Area

10-County DFW Area On-Road Emissions	NO_X (tpd)	VOC (tpd)
2018 On-Road Inventory From NCTCOG (Table 3-2) Includes RFG, Low RVP, I/M, and TxLED	119.69	62.20

The following pages contain graphical plots of the spatial and temporal distribution of 2006 and 2018 on-road summer weekday NO_X and VOC emissions for the greater DFW area. The plots show that the morning rush hour peak is appropriately allocated to 6-7 AM CST, which is 7-8 AM CDT. These plots are respectively entitled Figure 3-1: 2006 Summer Weekday DFW On-Road NO_X Emissions Distribution, Figure 3-2: 2006 Summer Weekday DFW On-Road VOC Emissions Distribution, Figure 3-3: 2018 Summer Weekday DFW On-Road NO_X Emissions Distribution, and Figure 3-4: 2018 Summer Weekday DFW On-Road VOC Emissions Distribution.

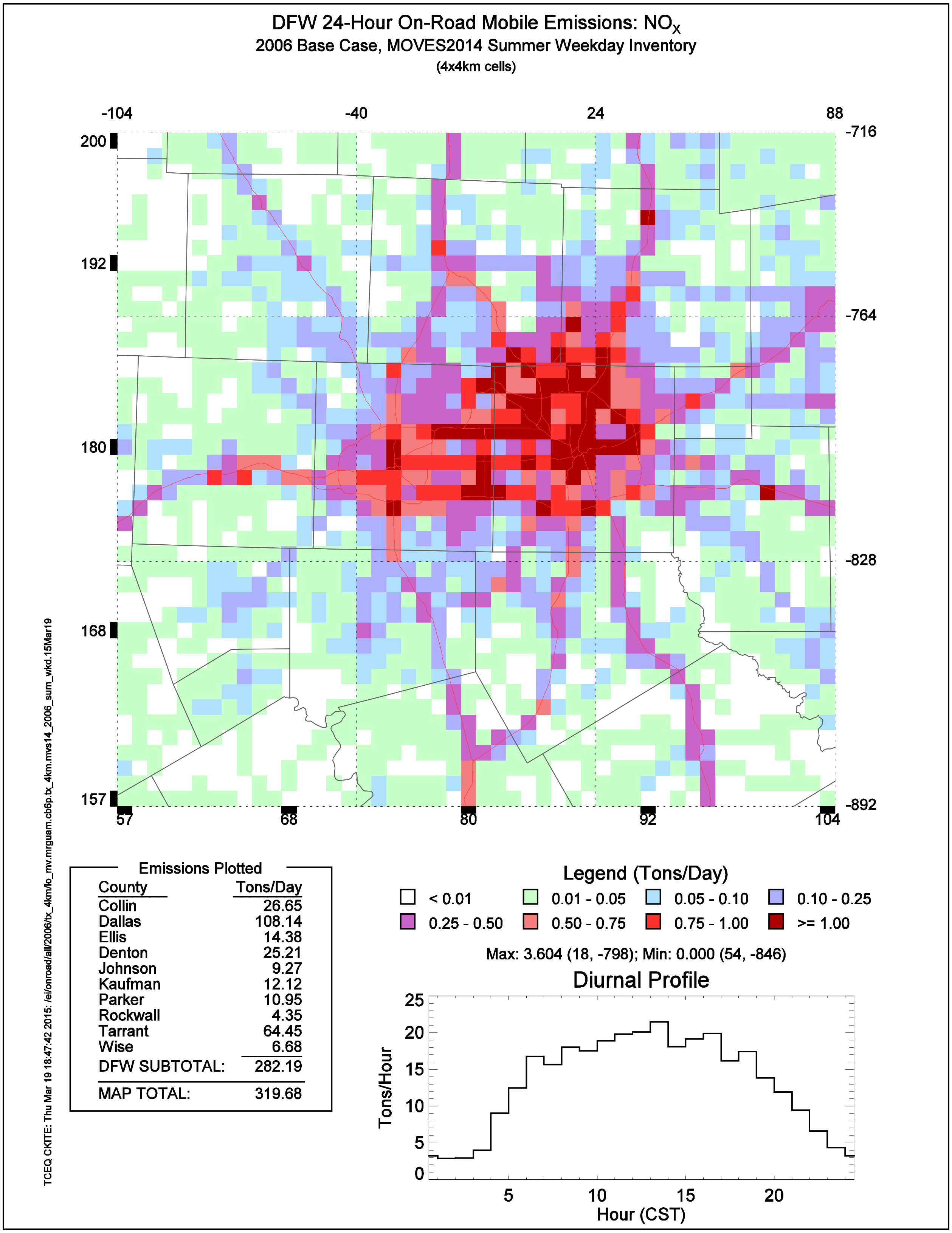

Figure 3-1: 2006 Summer Weekday DFW On-Road NO_X Emissions Distribution

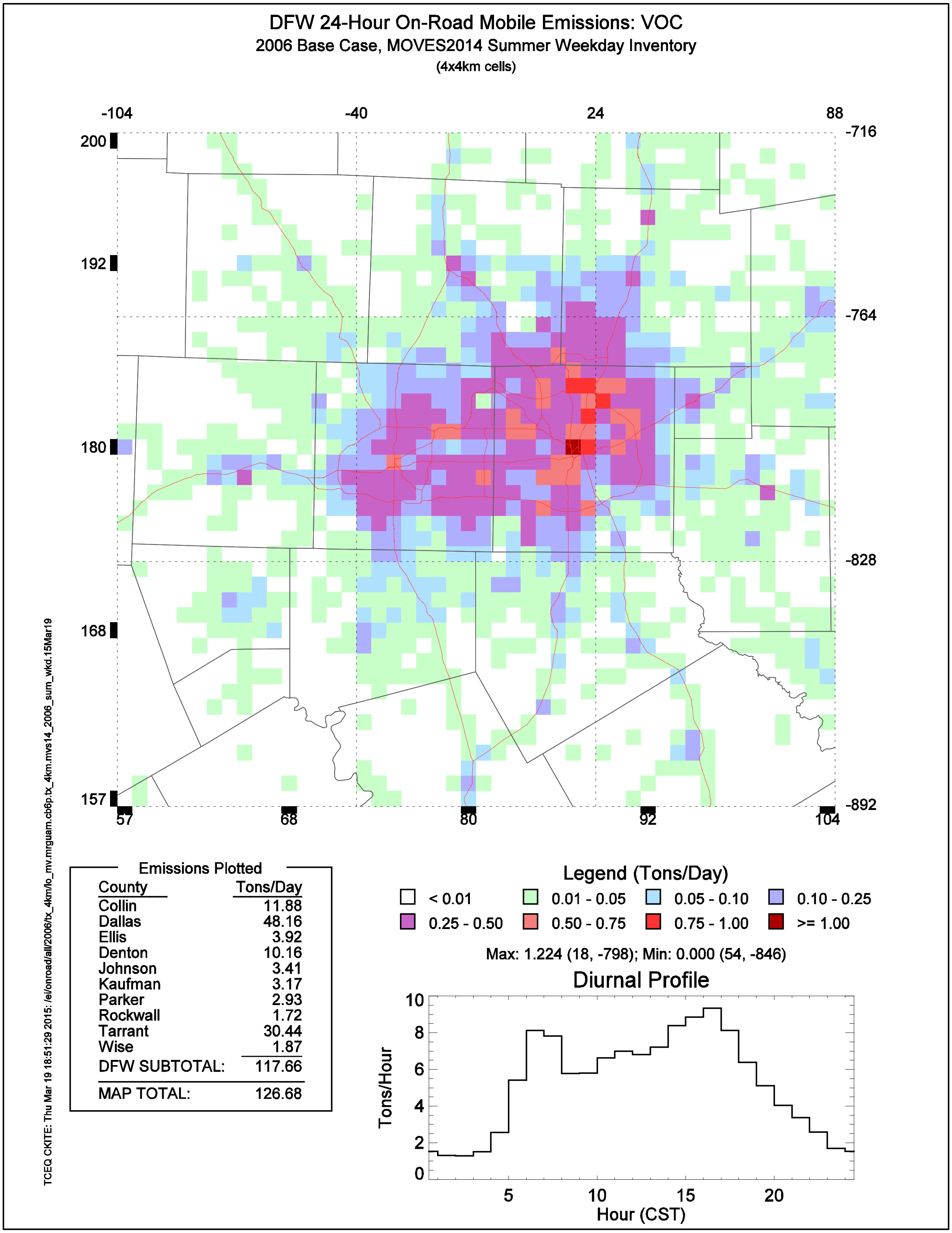

Figure 3-2: 2006 Summer Weekday DFW On-Road VOC Emissions Distribution

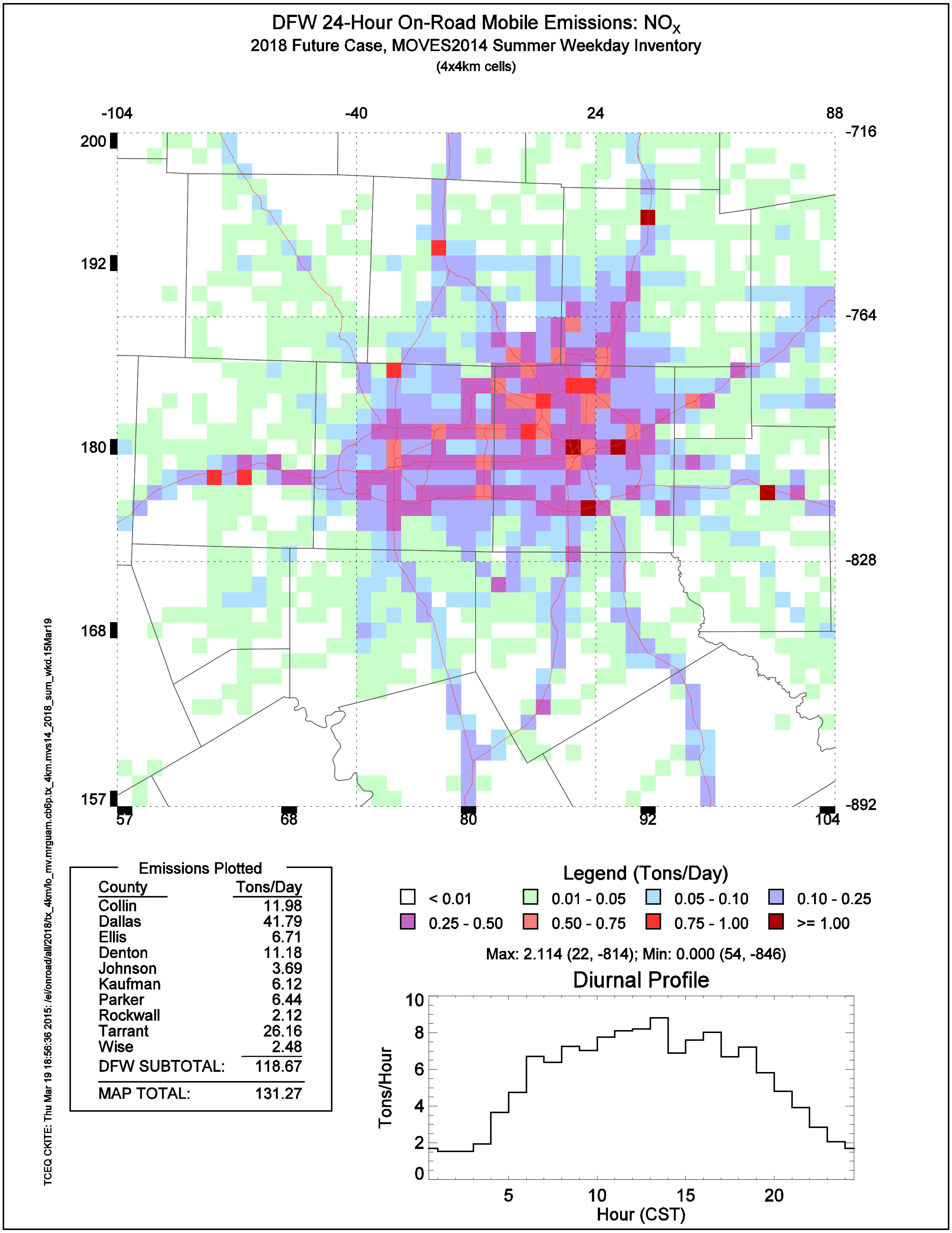

Figure 3-3: 2018 Summer Weekday DFW On-Road NO_X Emissions Distribution

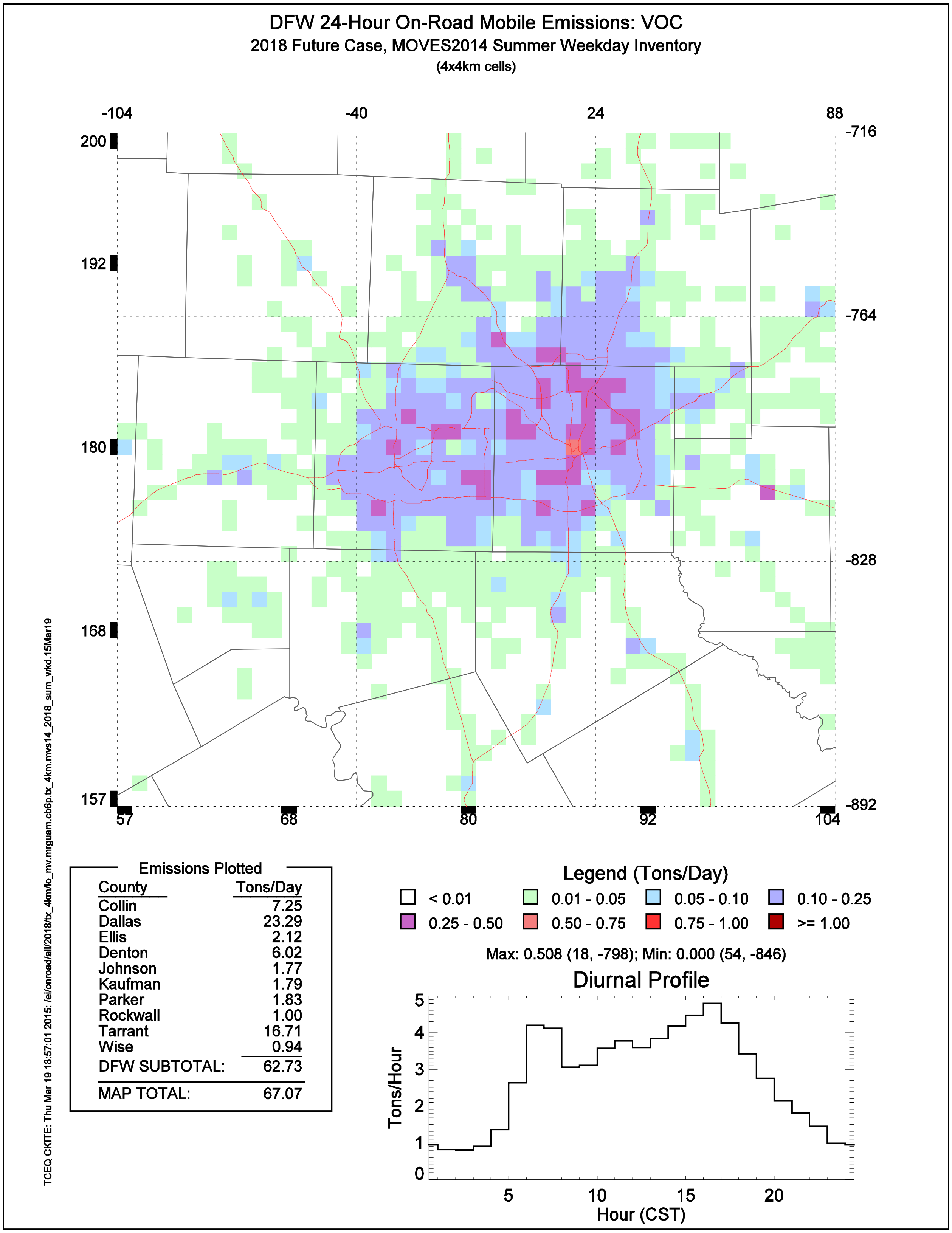

Figure 3-4: 2018 Summer Weekday DFW On-Road VOC Emissions Distribution

3.5 On-Road Mobile Source Emissions Inventories for Non-DFW Areas

For the Texas counties outside of the DFW area, on-road emissions were developed by TTI using HPMS data as the basis for VMT estimates. Both school and summer season emission estimates were developed for the four day types of weekday, Friday, Saturday, and Sunday. Hourly emission rates from MOVES2014 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 datasets can be found on the TCEQ Texas 2006 FTP site and the TCEQ Texas 2018 FTP site at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/2006/, and ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/Statewide/mvs/2018/, respectively.

On-road emission estimates for non-Texas states within the photochemical modeling domain were developed for both 2006 and 2018 using default runs from the MOVES2014 model, which is available on EPA's MOVES web page at http://www.epa.gov/otaq/models/moves/. For both 2006 and 2018, default on-road emissions were estimated for the July weekday option available with MOVES2014. These summer weekday emission totals were then adjusted with EPS3 to obtain inputs for the other season and day type combinations. More detail on the development of the MOVES2014 on-road datasets can be found on the TCEQ U.S. 2006 FTP site and the TCEQ U.S. 2018 FTP site at ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/mvs/2006/, and ftp://amdaftp.tceq.texas.gov/pub/Mobile_EI/USA/mvs/2018/, respectively.

More detail on this analysis 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*, which was presented at an EPA workshop in June of 2011 and is available at http://www.epa.gov/otaq/models/moves/conference2011/inventory-regional-moves-2011.pdf. A summary of the different on-road emission estimation approaches by geographic area taken for this DFW SIP revision is provided in Table 3-16: On-Road Inventory Development Methodologies by Geographic Area.

Table 3-16: On-Road Inventory Development Methodologies by Geographic Area

On-Road Inventory Development Parameter	DFW Area	Non-DFW Texas Counties	Non-Texas States and Counties
VMT Source	TDM	HPMS	MOVES2014 Defaults
VMT Resolution	Roadway Links From TDM	19 Roadway Types	12 Roadway Types
Season Types	School and Summer	School and Summer	School and Summer
Day Types	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday
Hourly Variation in VMT?	Yes	Yes	Yes
Roadway Speed Distribution	Varies by Hour and Link	Varies by Hour and Roadway Type	MOVES2014 Defaults
Spatial Resolution	Excellent	Very Good	Good
Temporal Resolution	Excellent	Very Good	Good
MOVES Fuel and Source Use Types	Gasoline and Diesel 13 Source Use Types	Gasoline and Diesel 13 Source Use Types	Gasoline and Diesel 13 Source Use Types

4. NON-ROAD, OFF-ROAD, AND AREA SOURCE MODELING EMISSIONS

4.1 Oil and Gas Production and Drilling Emission Inventory Development

Oil and gas production emission estimates were developed based on activity data from the Railroad Commission of Texas (RRC) multiplied by emission factors for specific operations and types of equipment from an Eastern Research Group (ERG) study entitled *Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions*. This report is available on the TCEQ Air Quality Research and Contracts Reports: Emissions Inventory web page at http://www.tceq.texas.gov/airquality/airmod/project/pj_report_ei.html. Activity data from the RRC specific to 2006 and 2013 were obtained for production of natural gas, crude oil, and condensate, along with additional information for parameters such as the total number of operational gas wells, operational oil wells, etc. These activity figures were then multiplied by appropriate emission factors from the ERG study to obtain oil and gas production emission estimates. For example, compressor engine emissions are a function of natural gas production, so compressor engine emission rates were multiplied by total natural gas produced. Condensate storage tank emission estimates were calculated as a function of condensate production. In a similar manner, emissions from crude oil storage tanks are a function of crude oil production. The ERG study referenced above contains a summary of how each calculation is performed. The 2006 oil and gas production emission estimates for the 10-county DFW area are summarized in Table 4-1: 2006 DFW Area Oil and Gas Production Emissions by Equipment Type. Emission estimates for nitrogen oxides (NO_X), volatile organic compounds (VOC), carbon monoxide (CO), sulfur dioxide (SO_2), and 2.5 micron particulate matter ($PM_{2.5}$) are provided.

Table 4-1: 2006 DFW Area Oil and Gas Production Emissions by Equipment Type

Oil and Gas Production Equipment	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Natural Gas 4-Cycle Rich Burn Compressors 50 To 499 HP	56.19	0.10	2.54	0.00	0.01
Natural Gas Well Heaters	2.11	0.12	1.77	0.00	0.16
Natural Gas 2-Cycle Lean Burn Compressors 50 To 499 HP	1.45	0.14	0.21	0.00	0.03
Natural Gas 4-Cycle Rich Burn Compressors 500+ HP w/NSCR	0.84	0.16	7.25	0.00	0.05
Natural Gas 4-Cycle Lean Burn Compressors 500+ HP	0.71	1.43	6.77	0.01	0.03
Oil Production - Artificial Lift	0.32	0.00	0.50	0.00	0.00
Oil Production - Heater Treater	0.14	0.01	0.11	0.00	0.01
Natural Gas Well Dehydrators	0.08	1.65	0.23	0.00	0.00
Oil Production - All Processes	0.00	0.01	0.01	0.02	0.00
Natural Gas 4-Cycle Rich Burn Compressors 50 To 499 HP w/NSCR	0.00	0.01	0.61	0.00	0.02
Natural Gas Condensate - Storage Tanks	0.00	18.06	0.00	0.00	0.00
Natural Gas Well Pneumatic Devices	0.00	7.07	0.00	0.00	0.00
Natural Gas Exploration - Well Completion, All Processes	0.00	3.34	0.00	0.00	0.00
Oil and Gas Production - Produced Water	0.00	2.30	0.00	0.00	0.00
Natural Gas Fugitives – Other	0.00	2.04	0.00	0.00	0.00
Natural Gas Fugitives – Valves	0.00	1.73	0.00	0.00	0.00
Natural Gas Well Venting	0.00	1.19	0.00	0.00	0.00
Crude Oil Storage Tanks	0.00	1.18	0.00	0.00	0.00
Natural Gas Condensate - Tank Truck/Railcar Loading	0.00	0.57	0.00	0.00	0.00
Oil Production – Wellhead	0.00	0.55	0.00	0.00	0.00
Oil Well Pneumatic Devices	0.00	0.46	0.00	0.00	0.00
Natural Gas Fugitives – Flanges	0.00	0.28	0.00	0.00	0.00

Oil and Gas Production Equipment	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Natural Gas Fugitives – Connectors	0.00	0.27	0.00	0.00	0.00
Oil Well Completion - All Processes	0.00	0.23	0.00	0.00	0.00
Natural Gas Fugitives - Open Ended Lines	0.00	0.21	0.00	0.00	0.00
Oil Production Fugitives – Other	0.00	0.15	0.00	0.00	0.00
Crude Oil Truck/Railcar Loading	0.00	0.11	0.00	0.00	0.00
Natural Gas Fugitives – Pumps	0.00	0.11	0.00	0.00	0.00
Oil Production Fugitives – Valves	0.00	0.10	0.00	0.00	0.00
Oil Production Fugitives – Pumps	0.00	0.05	0.00	0.00	0.00
Natural Gas Production - Compressor Engines	0.00	0.04	0.06	0.00	0.01
Oil Production Fugitives – Connectors	0.00	0.04	0.00	0.00	0.00
Oil Production Fugitives - Open Ended Lines	0.00	0.01	0.00	0.00	0.00
Natural Gas 2-Cycle Lean Burn Compressors < 50 HP	0.00	0.00	0.01	0.00	0.00
Oil Production Fugitives – Flanges	0.00	0.00	0.00	0.00	0.00
Natural Gas 4-Cycle Rich Burn Compressors <50 HP	0.00	0.00	0.01	0.00	0.00
Oil and Gas Production Total	61.84	43.72	20.09	0.03	0.32

2018 future year emission estimates for oil and gas production were projected using 2013 RRC data, which is the latest full year for which such activity information is available. The 2013-to-2018 projection factors were obtained from an ERG study entitled *Forecasting Oil and Gas Activities*, which is also available on the TCEQ Air Quality Research and Contracts Reports: Emissions Inventory web page. ERG evaluated several methodologies for the purposes of projecting oil and gas production levels, and recommended the best one to be the Hubbert peak theory, which relies on a bell-shaped curve to predict the rate of fossil fuel extraction over time from a specific region. Table 4-2: Barnett Shale Emission Projection Factors from 2013 to 2018 summarizes these projection factors from the ERG study for natural gas, crude oil, and condensate. The 2013 emission estimates, based directly on historical RRC data, were then multiplied by these factors to obtain the 2018 estimates by equipment type presented in Table 4-3: 2018 DFW Area Oil and Gas Production Emissions by Equipment Type. Table 4-1 and Table 4-3 show that compressor engine emissions are the primary source of NO_X from oil and gas activity in the Barnett Shale, but that the 2018 levels are much lower than 2006. This is primarily due to the introduction of rules for compressor engines above 50 horsepower that were not in place during 2006. Without these rules, the average natural gas compressor engine emission rate would be 6.94 NO_X grams/horsepower-hour (gm/hp-hr). Introduction of this rule lowered this emission rate by roughly 91% to 0.61 NO_X gm/hp-hr.

Table 4-2: Barnett Shale Emission Projection Factors from 2013 to 2018

Fossil Fuel Type	Barnett Shale Projection Factor from 2013 to 2018
Natural Gas	47.69%
Crude Oil	52.13%
Condensate	13.67%

Table 4-3: 2018 DFW Area Oil and Gas Production Emissions by Equipment Type

Oil and Gas Production Equipment	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Natural Gas 4-Cycle Rich Burn Compressors 50 To 499 HP	4.68	0.05	1.81	0.00	0.01
Natural Gas 4-Cycle Rich Burn Compressors 50 To 499 HP w/NSCR	1.13	0.05	2.15	0.01	0.09
Natural Gas 4-Cycle Rich Burn Compressors <50 HP	0.69	0.00	0.07	0.00	0.00
Natural Gas 4-Cycle Rich Burn Compressors 500+ HP w/NSCR	0.53	0.02	0.85	0.00	0.04
Oil Production - Artificial Lift	0.15	0.00	0.23	0.00	0.00
Natural Gas 4-Cycle Rich Burn Compressors 500+ HP	0.07	0.00	0.06	0.00	0.00
Natural Gas 4-Cycle Lean Burn Compressors 50 To 499 HP	0.06	0.03	0.14	0.00	0.00
Natural Gas 4-Cycle Lean Burn Compressors <50 HP	0.04	0.00	0.01	0.00	0.00
Natural Gas 2-Cycle Lean Burn Compressors 50 To 499 HP	0.02	0.04	0.07	0.00	0.01
Natural Gas 2-Cycle Lean Burn Compressors 500+ HP	0.02	0.00	0.00	0.00	0.00
Natural Gas Well Dehydrators	0.01	1.62	0.16	0.00	0.00
Natural Gas Well Heaters	0.01	0.00	0.01	0.00	0.00
Natural Gas 4-Cycle Lean Burn Compressors 500+ HP	0.00	0.00	0.02	0.00	0.00
Natural Gas Production - Compressor Engines	0.00	0.01	0.01	0.00	0.00
Oil Production - All Processes	0.00	0.01	0.01	0.02	0.00
Oil Production - Heater Treater	0.00	0.00	0.00	0.00	0.00
Oil and Gas Production - Hydraulic Fracturing Pumps	0.88	0.06	0.19	0.00	0.00
Natural Gas Well Pneumatic Devices	0.00	5.81	0.00	0.00	0.00
Natural Gas Exploration - Well Pneumatic Pumps	0.00	5.57	0.00	0.00	0.00
Natural Gas Condensate - Storage Tanks	0.00	2.87	0.00	0.00	0.00
Natural Gas Fugitives - Other	0.00	2.04	0.00	0.00	0.00
Natural Gas Well Venting	0.00	1.19	0.00	0.00	0.00
Natural Gas Fugitives - Valves	0.00	1.09	0.00	0.00	0.00
Oil and Gas Production - Produced Water	0.00	0.87	0.00	0.00	0.00
Crude Oil Storage Tanks	0.00	0.51	0.00	0.00	0.00
Natural Gas Exploration - Well Completion, All Processes	0.00	0.02	0.00	0.00	0.00
Natural Gas Fugitives - Flanges	0.00	0.28	0.00	0.00	0.00
Natural Gas Fugitives - Connectors	0.00	0.27	0.00	0.00	0.00
Oil Production - Wellhead	0.00	0.26	0.00	0.00	0.00
Natural Gas Fugitives - Open Ended Lines	0.00	0.21	0.00	0.00	0.00
Oil Well Pneumatic Devices	0.00	0.20	0.00	0.00	0.00
Natural Gas Fugitives - Pumps	0.00	0.11	0.00	0.00	0.00
Natural Gas Condensate - Tank Truck/Railcar Loading	0.00	0.09	0.00	0.00	0.00
Oil Production Fugitives - Other	0.00	0.07	0.00	0.00	0.00
Oil Well Completion - All Processes	0.00	0.06	0.00	0.00	0.00
Oil Exploration - Mud Degassing	0.00	0.02	0.00	0.00	0.00
Oil Well Pneumatic Pumps	0.00	0.06	0.00	0.00	0.00
Crude Oil Truck/Railcar Loading	0.00	0.05	0.00	0.00	0.00
Oil Production Fugitives - Valves	0.00	0.05	0.00	0.00	0.00
Oil Production Fugitives - Pumps	0.00	0.03	0.00	0.00	0.00
Oil Production Fugitives - Connectors	0.00	0.02	0.00	0.00	0.00
Natural Gas Exploration - Mud Degassing	0.00	0.60	0.00	0.00	0.00
Oil Production Fugitives - Open Ended Lines	0.00	0.00	0.00	0.00	0.00

Oil and Gas Production Equipment	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Oil Production Fugitives - Flanges	0.00	0.00	0.00	0.00	0.00
Oil and Gas Production Total	8.31	24.24	5.80	0.03	0.15

The 2006 and 2018 oil and gas production emissions presented in Table 4-3 do not include those from large point sources that are required to report emissions directly to the TCEQ. Table 4-4: 2006 DFW Area Point Source Oil and Gas Emission by Industry Type and Table 4-5: 2018 DFW Area Point Source Oil and Gas Emissions by Industry Type present respective 2006 and 2018 summaries of the point source emission estimates by industry type associated with oil and gas production. Additional detail on point source emissions inventory development and processing can be found in Chapter 2 of this Appendix.

Table 4-4: 2006 DFW Area Point Source Oil and Gas Emission by Industry Type

Standard Industrial Classification (SIC) Description	SIC Code	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Crude Petroleum and Natural Gas	1311	4.78	15.67	4.88	0.00	0.20
Natural Gas Liquids	1321	5.43	2.70	2.58	0.01	0.17
Natural Gas Transmission	4922	1.03	0.81	0.96	0.00	0.04
Petroleum Bulk Stations and Terminals	5171	0.08	1.89	0.12	0.00	0.00
Mixed, Manufactured, LPG Production	4925	0.21	0.00	0.19	0.04	0.01
Refined Petroleum Pipelines	4613	0.01	0.74	0.02	0.00	0.00
DFW Area Total	NA	11.53	21.82	8.74	0.05	0.42

Table 4-5: 2018 DFW Area Point Source Oil and Gas Emissions by Industry Type

Standard Industrial Classification (SIC) Description	SIC Code	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Crude Petroleum and Natural Gas	1311	10.74	16.70	8.44	0.03	0.67
Natural Gas Liquids	1321	4.48	5.01	3.24	0.01	0.20
Natural Gas Transmission	4922	1.06	2.29	0.79	0.01	0.19
Petroleum Bulk Stations and Terminals	5171	0.06	1.66	0.15	0.00	0.00
Mixed, Manufactured, LPG Production	4925	0.02	0.00	0.11	0.01	0.01
Refined Petroleum Pipelines	4613	0.01	0.37	0.02	0.00	0.00
DFW Area Total	NA	16.37	26.02	12.75	0.07	1.07

Daily average drilling rig emission estimates for 2006 and 2018 are summarized in Table 4-6: 2006 and 2018 DFW Area Drilling Rig Emission Estimates. The 2006 estimates were based on an ERG study entitled *Development of Texas Statewide Drilling Rigs Emission Inventories*, which is available on the TCEQ Air Quality Research and Contracts Reports: Emissions Inventory web page.

Table 4-6: 2006 and 2018 DFW Area Drilling Rig Emission Estimates

Calendar Year for Drilling Rig Activity	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
2006 Drilling Rig Emissions	18.23	1.16	3.57	1.65	0.59
2018 Drilling Rig Emissions	2.82	0.21	0.45	0.00	0.06

The 2018 drilling rig emission estimates were obtained by applying 2018 emission factors to the 2013 drilling activity summarized in Table 4-7: 2013 DFW Area Oil and Gas Drilling Activity. Different emission rates apply based on average well depth and whether conventional "vertical only" drilling is being done versus the horizontal drilling commonly associated with fracturing. Since drilling rig equipment is subject to federal non-road emission standards, average emission rates decline over time due to fleet turnover. Drilling rig emission rates for each year from 1999-2040 are summarized in Chapter 4: Emissions Inventory Development and Results of the *Development of Texas Statewide Drilling Rigs Emission Inventories* ERG study.

Table 4-7: 2013 DFW Area Oil and Gas Drilling Activity

Type and Depth of 2013 Drilling Levels	2013 Feet Drilled
Vertical/Horizontal Drilling	5,556,499
Vertical Drilling less than 7,000 Feet	17,608
Vertical Drilling greater than 7,000 Feet	16,073

Figure 4-1: Barnett Shale Drilling and Natural Gas Production from 1993-2014 summarizes Barnett Shale drilling and production levels from 1993 through the present based on regularly updated information available on the RRC Barnett Shale Information web page. The blue line in Figure 4-1 is the daily average natural gas production rate from 1993 through 2014. As shown, Barnett Shale natural gas production has followed a bell-shaped curve with production levels peaking in 2012 when the daily average extraction rate was 5,743 million cubic feet (MMcf) per day. From this 2012 peak, the 2013 daily average was 5,355 MMcf/day (7% lower) and the current 2014 daily average was 4,877 MMcf/day (15% lower).

The black line in Figure 4-1 is the Henry Hub natural gas spot price, which hovered in the $7-9 range during the Barnett Shale drilling boom years of 2005 through 2008, and then dropped to the $3-4 range where it has remained since. The red line in Figure 4-1 shows how the number of drilling permits issued reached a peak of roughly 4,000 in 2008, declined steeply through 2009 as natural gas prices fell, and since 2012 have been in the range of roughly 1,000 per year, similar to the pre-drilling boom years of 2001-2004. A University of Texas at Austin study entitled *Barnett Study Determines Full-Field Reserves, Production Forecast* evaluated historical production data per well to determine that the natural gas extraction rate is highest in the first year and then begins to decline exponentially. For an average production span of 25 years per well, roughly 50% of the natural gas is extracted in the first five years, with the remaining 50% extracted within the subsequent twenty years. The decline in natural gas production since 2012 is expected because wells that began producing during the drilling boom years of 2005 through 2008 are now past this five-year mark, and drilling levels from 2009 onwards have not been sufficient to keep production either at or near the 2012 peak. The TCEQ will continue to monitor the monthly updates provided by the RRC to determine if any changes occur in these recent drilling and production trends.

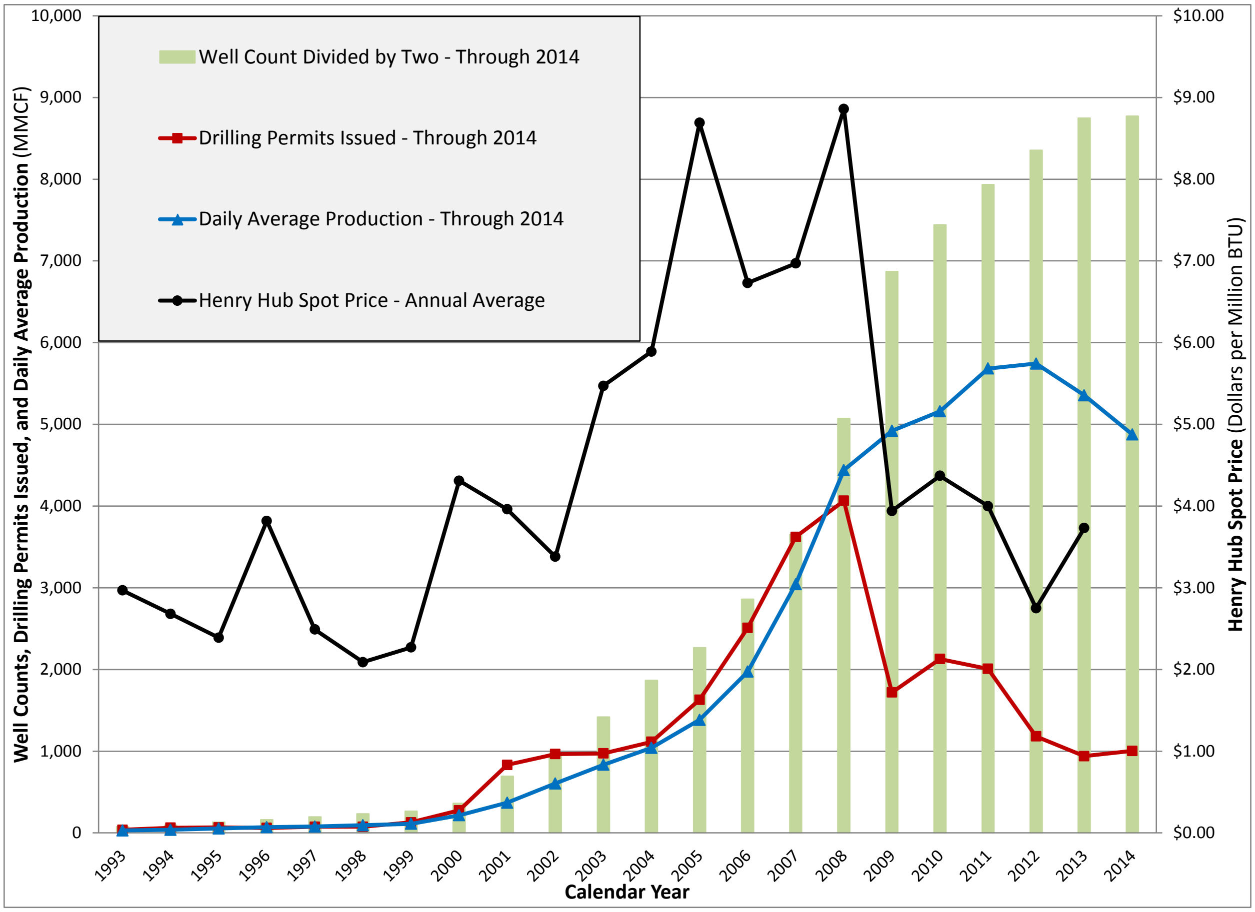

Figure 4-1: Barnett Shale Drilling and Natural Gas Production from 1993-2014

The production and drilling rig emission estimates presented above were prepared for photochemical model input using version 3 of the Emissions Processor System (EPS3). Spatial allocation of these emission estimates was based on the latest available activity data from the RRC. For example, 2013 natural gas production data for each operational well were used to develop a weighted surrogate for allocating 2018 natural gas production emissions. A similar approach was used to develop separate weighted surrogates for emissions associated with crude oil and condensate production. 2018 drilling rig emissions were allocated to locations where 2013 wells were drilled. Even though it is unlikely that 2018 drilling will occur in the exact same locations as 2013, low-level emissions are evenly distributed within 4 kilometer (km) grid cells for photochemical model input. Since 2018 production and drilling is likely to be concentrated near currently operational wells, this spatial allocation approach is reasonable. 2006 production and drilling rig emissions were allocated based on available RRC data specific to that year.

For the non-DFW areas of Texas, all of the steps described above are similar for the development and EPS3 processing of emissions associated with drilling rigs and production of natural gas, crude oil, and condensate. For projecting to 2018, the latest available RRC activity data from 2013 were obtained for every Texas county. The ERG *Forecasting Oil and Gas Activities* study provided different projection factors for the Barnett, Eagle Ford, and Haynesville Shale formations. The EPS3 processing streams for emissions from oil and gas activities are divided into seven separate streams for:

- the 10-county DFW area;
- the eight Barnett Shale counties of Cooke, Erath, Hill, Hood, Jack, Montague, Palo Pinto, and Somervell not included within the 10-county DFW area;
- the eight counties in the Houston-Galveston-Brazoria (HGB) area;
- the 10 counties comprising the Texas portion of the Haynesville Shale;
- 26 counties within the Eagle Ford Shale in South Texas;
- 45 counties within the Permian Basin in West Texas; and
- the remaining 147 Texas counties.

The complete EPS3 processing streams for all of these areas are available for both 2006 and 2018 at ftp://amdaftp.tceq.texas.gov/pub/Oil_Gas_EI/2006/ and ftp://amdaftp.tceq.texas.gov/pub/Oil_Gas_EI/2018/. The following pages contain graphical plots of the 2006 and 2018 oil and gas production and drilling NO_X and VOC emissions for the DFW area. As shown, these emissions are concentrated in the western portion of the DFW area where oil and gas production occurs. These plots are respectively entitled Figure 4-2: 2006 DFW Oil and Gas Production NO_X Emissions Distribution, Figure 4-3: 2006 DFW Oil and Gas Production VOC Emissions Distribution, Figure 4-4: 2018 DFW Oil and Gas Production NO_X Emissions Distribution, and Figure 4-5: 2018 DFW Oil and Gas Production VOC Emissions Distribution. Spatial allocation of drilling rig emission estimates for 2006 and 2018, respectively, are provided in Figure 4-6: 2006 DFW Drilling Rig NO_X Emissions Distribution and Figure 4-7: 2018 DFW Drilling Rig NO_X Emissions Distribution. Since diesel-powered drilling rig equipment emits low levels of VOC, only NO_X plots are provided here. As shown, drilling rig emissions are also concentrated in the western half of DFW where oil and gas activity occurs.

For the non-Texas U.S. areas of the modeling domain, oil and gas production and drilling rig emission estimates from the EPA National Emissions Inventory (NEI) were used. The 2008 NEI was used for the 2006 inputs, and the 2011 NEI was used for the 2018 inputs. The emission estimates from these NEI datasets were processed through EPS3 in a manner similar to that described above for Texas.

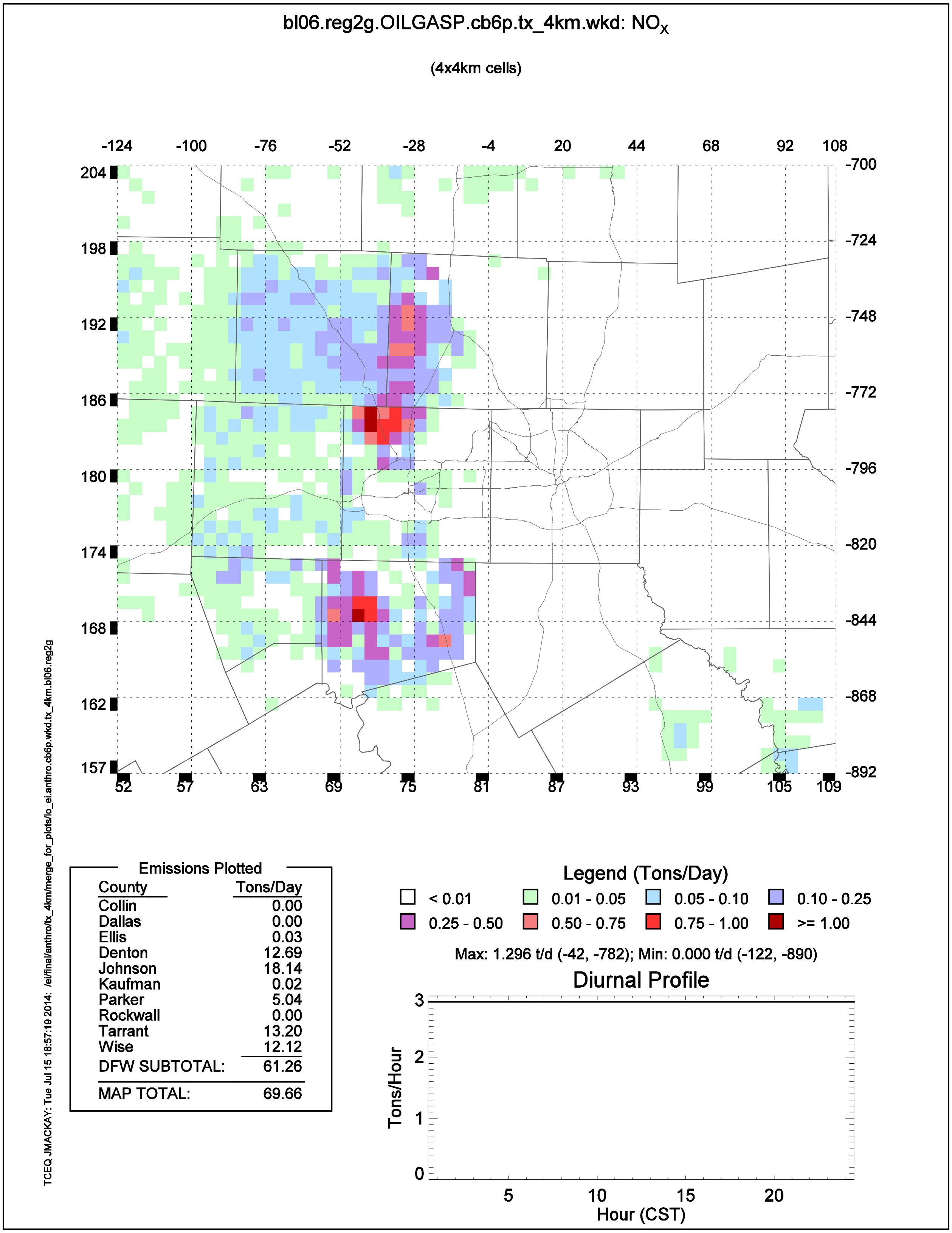

Figure 4-2: 2006 DFW Oil and Gas Production NO_X Emissions Distribution

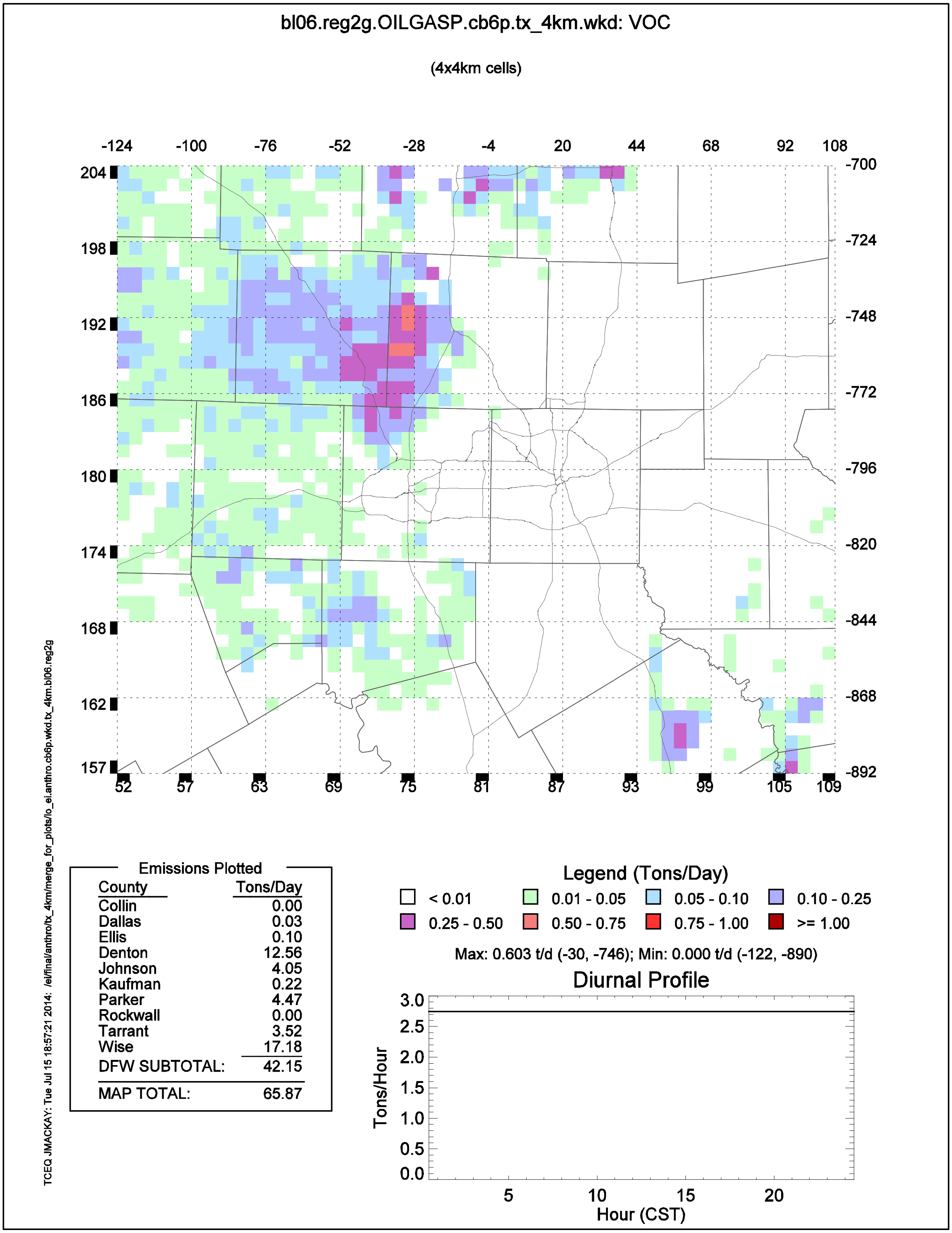

Figure 4-3: 2006 DFW Oil and Gas Production VOC Emissions Distribution

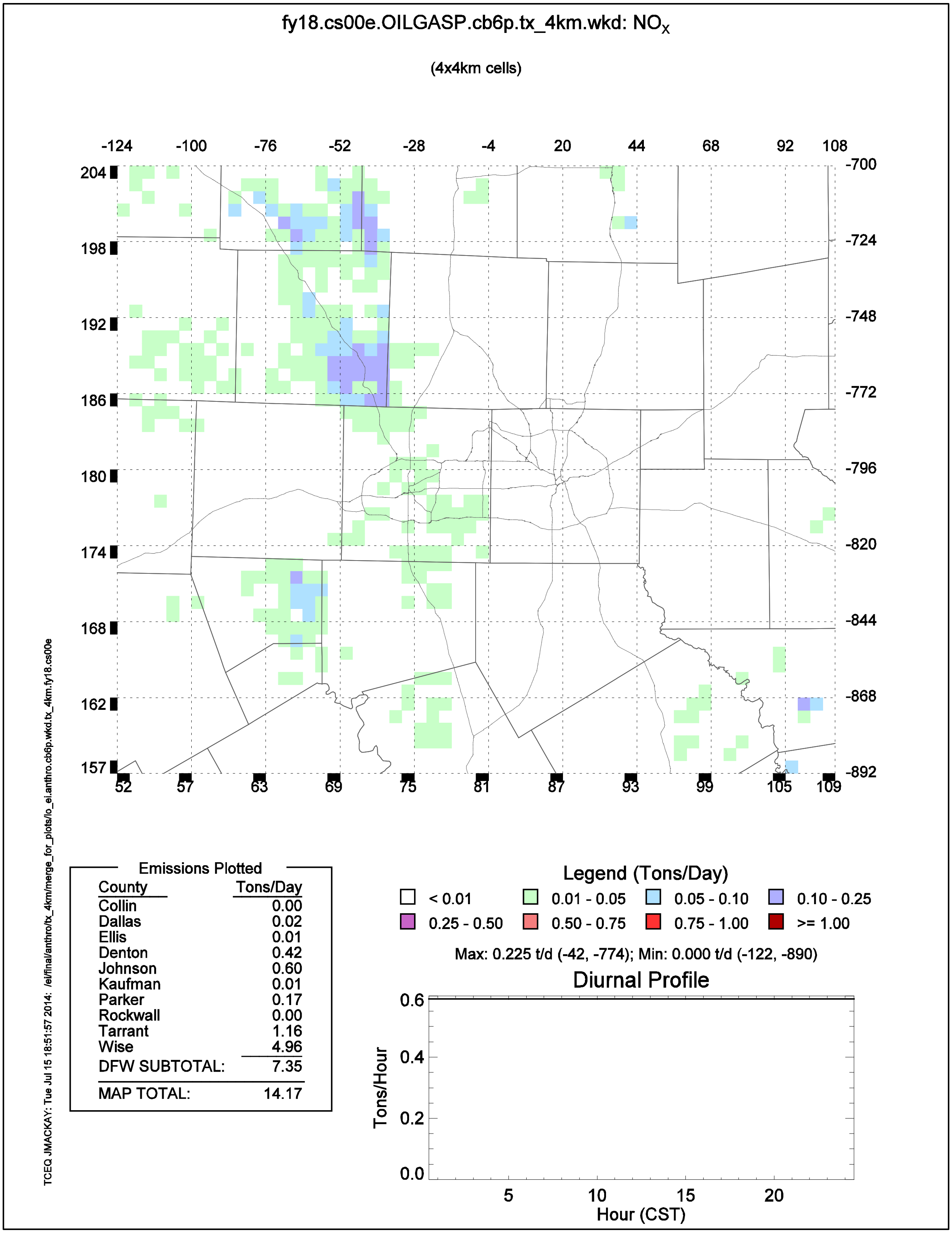

Figure 4-4: 2018 DFW Oil and Gas Production NO_X Emissions Distribution

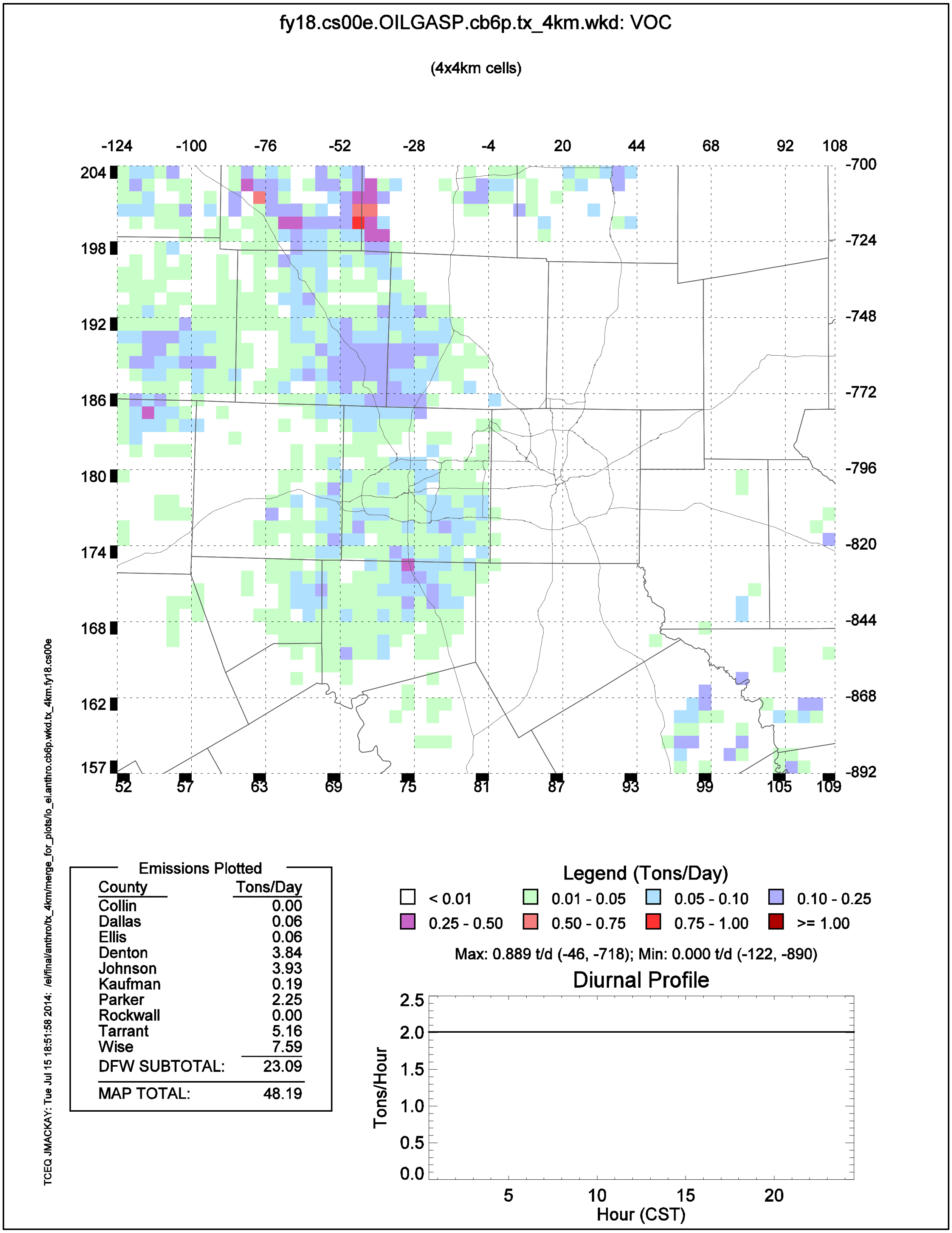

Figure 4-5: 2018 DFW Oil and Gas Production VOC Emissions Distribution

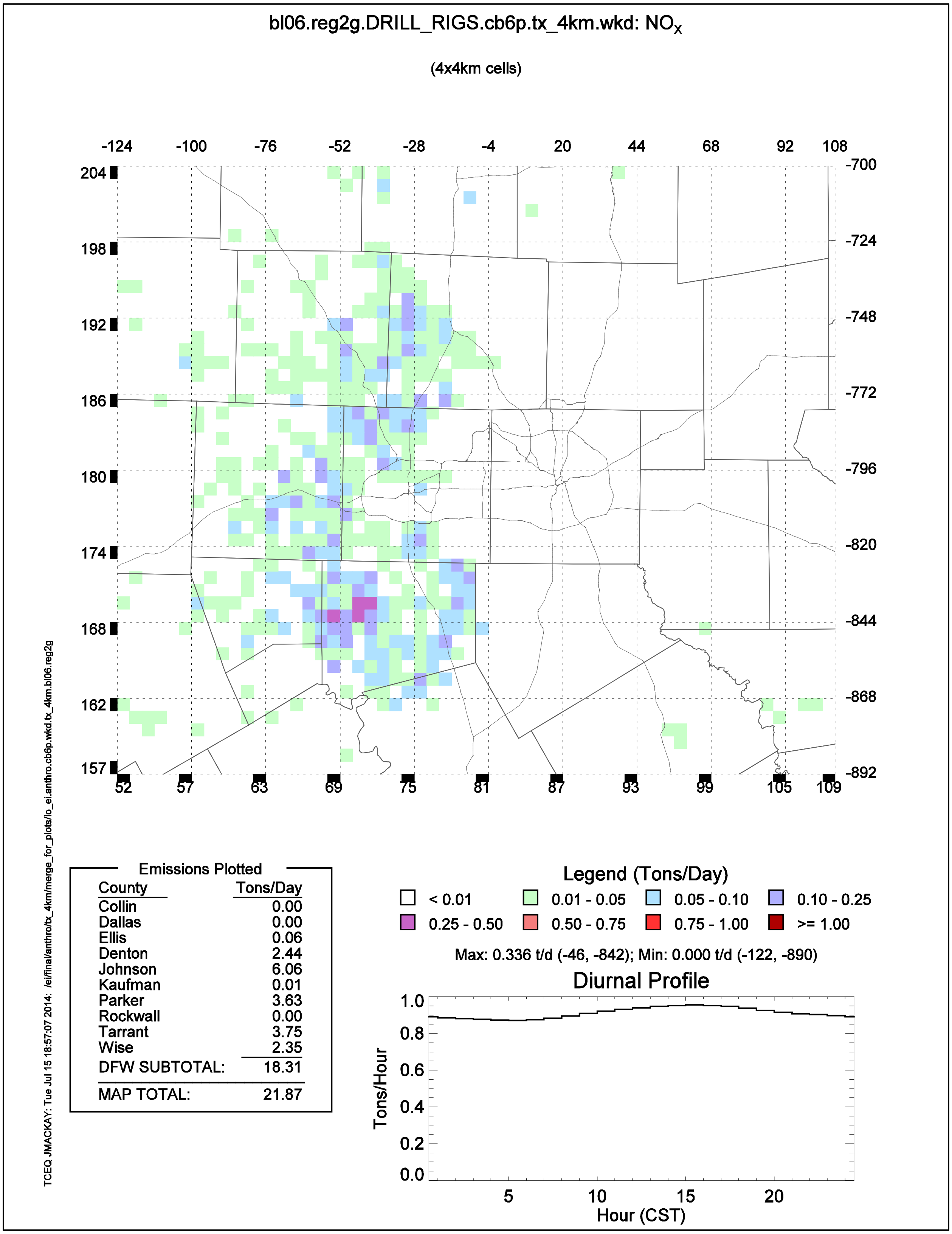

Figure 4-6: 2006 DFW Drilling Rig NO_X Emissions Distribution

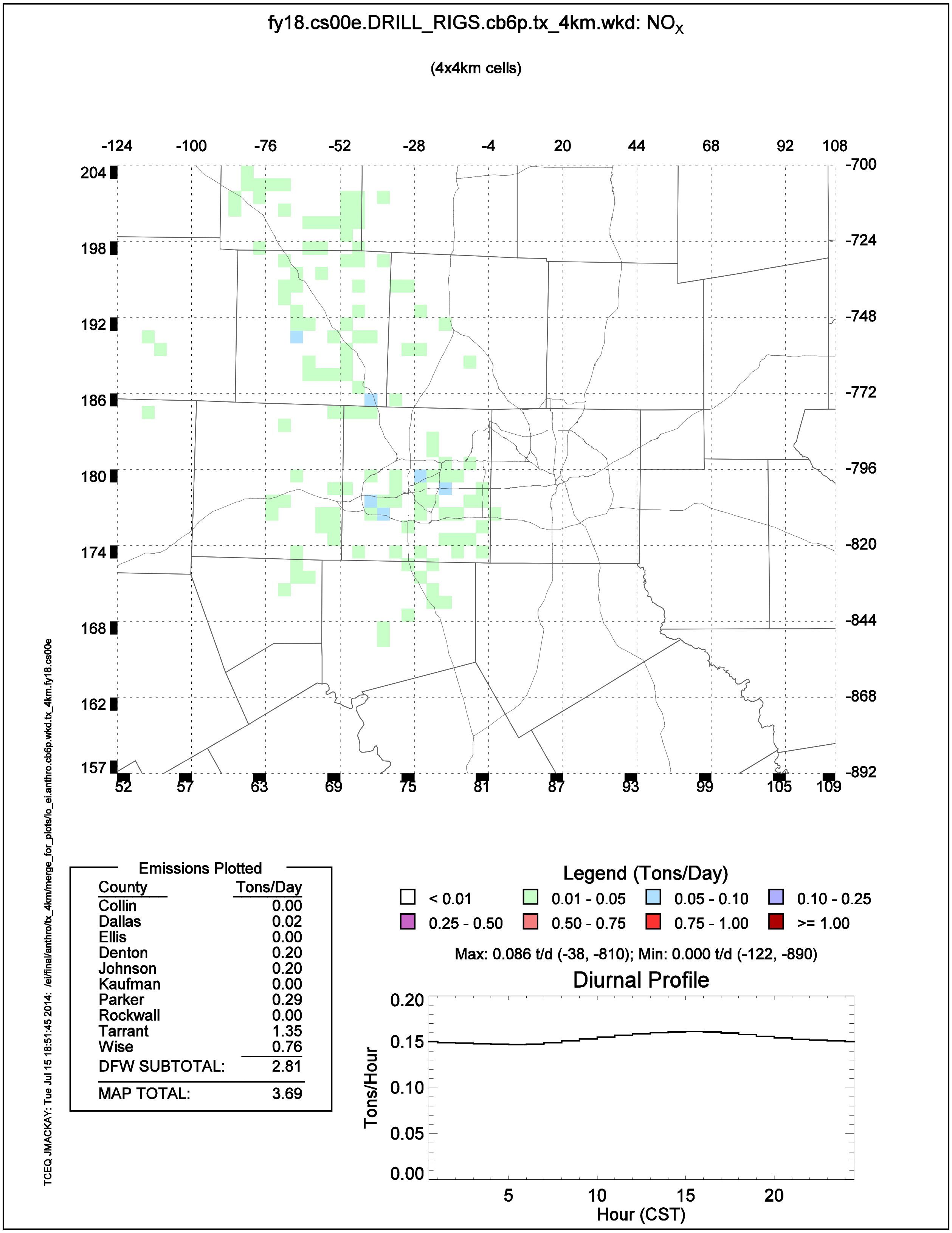

Figure 4-7: 2018 DFW Drilling Rig NO_X Emissions Distribution

4.2 Airports

The TCEQ contracted with the North Central Texas Council of Governments (NCTCOG) to develop DFW area airport emission inventories for several years from 1996 through 2029. The report and associated electronic files are available on the TCEQ DFW airport emissions FTP site at ftp://amdaftp.tceq.texas.gov/pub/Offroad_EI/Airports/DFW/. Emission estimates were prepared for DFW International, Love Field, and 59 regional airports. The 2006 base case and 2018 future year inventories were not developed under this study, but estimates were obtained by interpolating the results between 2002 and 2008 for 2006, and between 2017 and 2020 for 2018. An Excel spreadsheet available on the TCEQ DFW airport emissions FTP site summarizes this interpolation work. A separate study to update Love Field emission estimates was funded by the City of Dallas Aviation Department and contracted to the consulting firm Leigh Fisher. This study and associated electronic files are also available on the TCEQ DFW airport emissions FTP site. Love Field emission estimates were prepared directly by Leigh Fisher for both the 2006 and 2018 years.

At the time both the NCTCOG and Leigh Fisher work was performed, the latest version of the Emissions Dispersion and Modeling System (EDMS) from the Federal Aviation Administration (FAA) was used. For past years, historical flight activity for each airport is input to the EDMS model. Future year flight activity projections are based on Terminal Area Forecast (TAF) datasets available from FAA. In addition to estimating emissions from aircraft activity, the EDMS model outputs estimates for auxiliary power units (APUs) and ground support equipment (GSE) at major airports. 2006 summaries of aircraft, APU, and GSE emission estimates for DFW International, Love Field, and the 59 smaller regional airports throughout DFW are presented in Table 4-8: 2006 DFW International Airport Emissions by Source Type, Table 4-9: 2006 Love Field Airport Emissions by Source Type, and Table 4-10: 2006 DFW Area Regional Airport Emissions by Source Type, respectively. The EDMS model estimates emissions associated with parking garage activity and routine construction at major airports, but these are already included in the comprehensive TCEQ on-road and non-road construction emission inventories. 2006 emission totals for DFW International, Love Field, and the 59 smaller regional airports are presented in
Table 4-11: 2006 DFW Area Major and Regional Airport Emissions.

Table 4-8: 2006 DFW International Airport Emissions by Source Type

DFW International Airport Source Category	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Aircraft Operation	8.73	2.05	8.07	0.97	0.18
Auxiliary Power Units	0.10	0.01	0.20	0.02	0.02
Ground Support Equipment	1.01	0.30	8.42	0.05	0.03
DFW International Airport Total	9.84	2.37	16.69	1.04	0.23

Table 4-9: 2006 Love Field Airport Emissions by Source Type

Love Field Airport Source Category	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Aircraft Operation	1.12	0.55	3.06	0.14	0.03
Auxiliary Power Units	0.03	0.01	0.12	0.01	0.01
Ground Support Equipment	0.07	0.01	0.21	0.01	0.00
Love Field Airport Total	1.22	0.57	3.39	0.16	0.04

Table 4-10: 2006 DFW Area Regional Airport Emissions by Source Type

59 Regional Airports Source Category	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Aircraft Operation	0.89	1.32	22.60	0.19	0.02
Auxiliary Power Units	0.09	0.01	0.21	0.01	0.01
Ground Support Equipment	0.75	0.20	5.20	0.04	0.02
59 Regional Airports Total	1.72	1.52	28.01	0.24	0.06

Table 4-11: 2006 DFW Area Major and Regional Airport Emissions

DFW Area Airport or Airport Group	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
DFW International	9.84	2.37	16.69	1.04	0.23
Love Field	1.22	0.57	3.39	0.16	0.04
59 Regional Airports	1.72	1.52	28.01	0.24	0.06
DFW Area Total for 61 Airports	12.78	4.46	48.09	1.44	0.33

2018 summaries of aircraft, APU, and GSE emission estimates for DFW International are shown in Table 4-12: 2018 DFW International Airport Emissions by Source Type, Table 4-13: 2018 Love Field Airport Emissions by Source Type, and Table 4-14: 2018 DFW Area Regional Airport Emissions by Source Type, respectively. 2018 emission totals for DFW International, Love Field, and the 59 smaller regional airports are presented in Table 4-15: 2018 DFW Area Major and Regional Airport Emissions.

Table 4-12: 2018 DFW International Airport Emissions by Source Type

DFW International Airport Source Category	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Aircraft Operation	10.31	1.96	9.12	1.14	0.18
Auxiliary Power Units	0.02	0.00	0.03	0.00	0.00
Ground Support Equipment	0.18	0.06	1.50	0.01	0.01
DFW International Airport Total	10.50	2.02	10.65	1.15	0.19

Table 4-13: 2018 Love Field Airport Emissions by Source Type

Love Field Airport Source Category	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Aircraft Operation	1.62	0.41	2.03	0.17	0.03
Auxiliary Power Units	0.03	0.00	0.06	0.00	0.00
Ground Support Equipment	0.05	0.01	0.34	0.00	0.00
Love Field Airport Total	1.70	0.42	2.43	0.18	0.03

Table 4-14: 2018 DFW Area Regional Airport Emissions by Source Type

59 Regional Airports Source Category	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Aircraft Operation	0.69	1.07	20.01	0.15	0.02
Auxiliary Power Units	0.06	0.00	0.15	0.01	0.01
Ground Support Equipment	0.12	0.03	0.83	0.00	0.01

59 Regional Airports Source Category	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
59 Regional Airports Total	0.86	1.10	20.99	0.16	0.03

Table 4-15: 2018 DFW Area Major and Regional Airport Emissions

DFW Area Airport or Airport Group	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
DFW International	10.50	2.02	10.65	1.15	0.19
Love Field	1.70	0.43	2.43	0.18	0.03
59 Regional Airports	0.86	1.10	20.99	0.16	0.03
DFW Area Total for 61 Airports	13.06	3.55	34.07	1.49	0.25

The airport emissions were prepared for photochemical modeling input using EPS3. The emissions were allocated to grid cells using spatial surrogates based on the respective areal extent of each airport location. For the non-DFW areas of Texas, 2011 airport emission estimates from the Texas Air Emissions Repository System (TexAER) were backcast to 2006 and projected to 2018. The EPS3 processing for Texas airport emissions is divided into streams for:

- the 10-county DFW area;
- the eight-county HGB area; and
- the remaining 236 Texas counties.

The complete EPS3 processing streams for these areas are available for 2006 and 2018 at ftp://amdaftp.tceq.texas.gov/pub/Offroad_EI/Airports/2006/ and ftp://amdaftp.tceq.texas.gov/pub/Offroad_EI/Airports/2018/. The following pages contain graphical plots of the 2006 and 2018 airport NO_X emissions for the DFW area. These plots are respectively entitled Figure 4-8: 2006 DFW Airport NO_X Emissions Distribution and Figure 4-9: 2018 DFW Airport NO_X Emissions Distribution. Since airports are not significant contributors of VOC emissions, only NO_X plots are provided here.

For the non-Texas U.S. areas of the modeling domain, airport emission estimates from the EPA NEI were used. The 2008 NEI was used for the 2006 inputs, and the 2011 NEI was used for the 2018 inputs. The airport source emission estimates from these NEI datasets were processed through EPS3 in a manner similar to that described above for the airport source emissions within Texas.

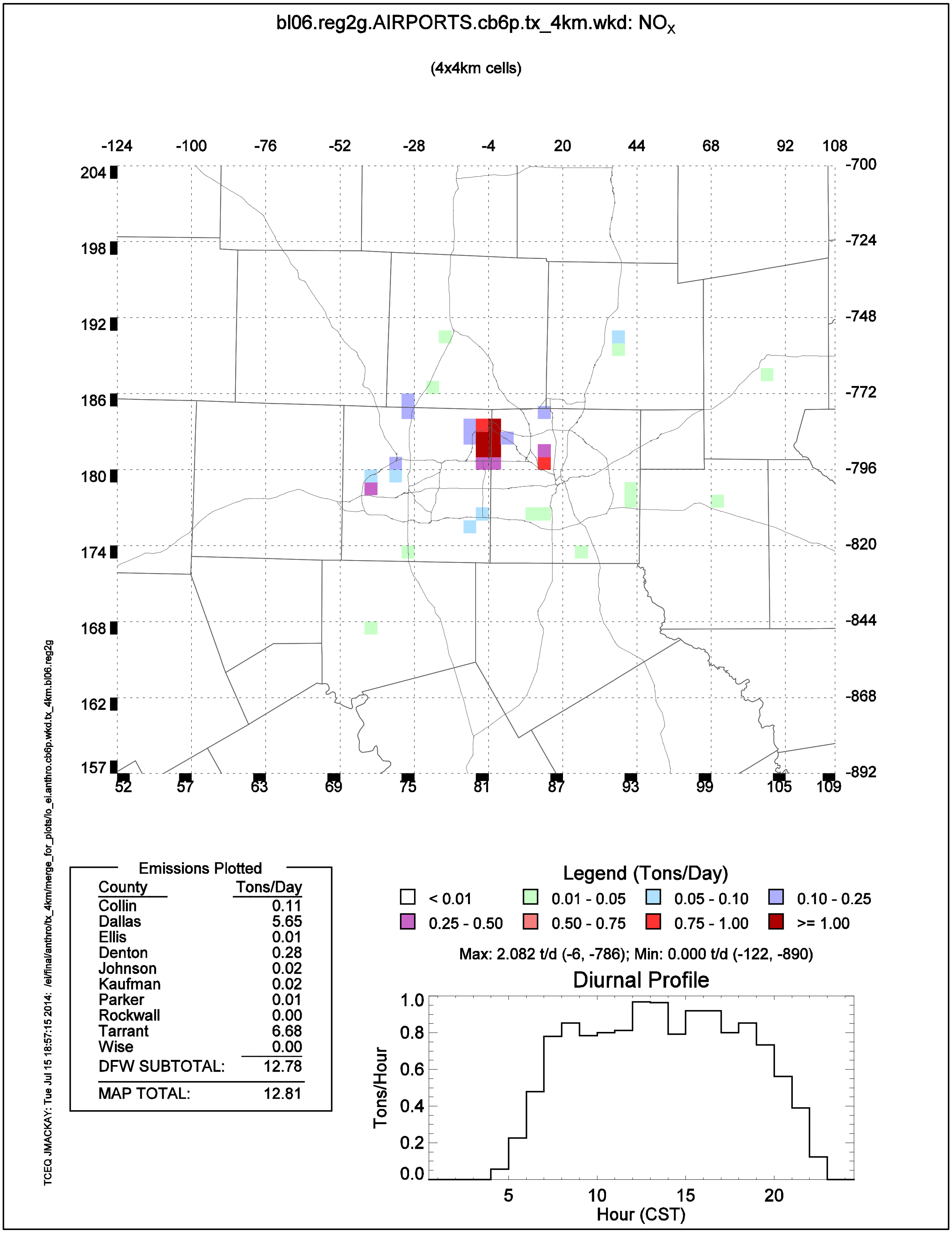

Figure 4-8: 2006 DFW Airport NO_X Emissions Distribution

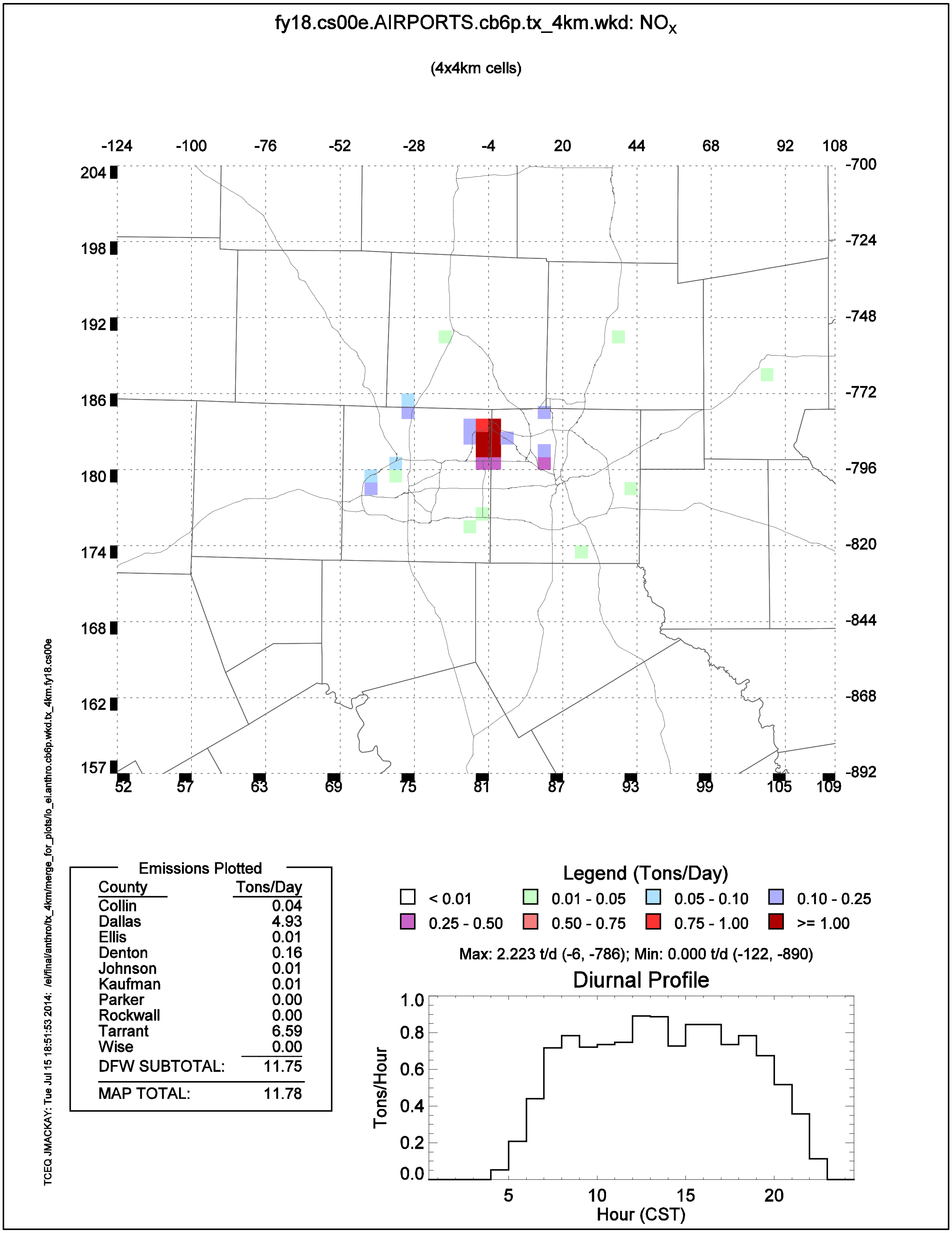

Figure 4-9: 2018 DFW Airport NO_X Emissions Distribution

4.3 Locomotives

Locomotive emission estimates were developed for the 2011 calendar year and are included within TexAER at http://www5.tceq.state.tx.us/texaer/index.cfm. A summary of the line-haul and rail-yard switcher categories is provided in Table 4-16: 2011 DFW Area Line-Haul and Switcher Locomotive Emissions. Ammonia (NH_3) emission estimates were available in this dataset and are included in the locomotive emissions summaries provided below.

Table 4-16: 2011 DFW Area Line-Haul and Switcher Locomotive Emissions

Locomotive Source Classification Description	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Line-Haul Locomotives – Class I	16.67	0.91	3.02	0.18	0.01	0.48
Line-Haul Locomotives – Classes II and III	0.57	0.02	0.06	0.00	0.00	0.01
Rail-Yard Switcher Locomotives	7.02	0.44	0.79	0.05	0.00	0.18
DFW Area Total	24.26	1.37	3.87	0.24	0.01	0.66

The locomotive emissions data output from TexAER were prepared for photochemical modeling using EPS3. Table 4-17: EPS3 Modules for Processing Locomotive Emissions summarizes the steps that were taken to process the 2006 and 2018 locomotive inventories.

Table 4-17: EPS3 Modules for Processing Locomotive Emissions

EPS3 Module	Description
PREAM	Convert text-based input files to binary format for further processing.
LBASE	Assign line-haul emissions to known railway segments (not for switchers).
CNTLEM	Apply activity, emission rate, and temperature/humidity NO_X correction.
TMPRL	Apply profiles to temporally allocate daily emission totals.
SPCEMS	Chemically speciate VOC emissions into olefins, paraffins, etc.
GRDEM	Spatially allocate switcher emissions with surrogates.
MRGUAM	Merge and adjust multiple gridded files for photochemical model input.

The 2011 locomotive emission estimates were backcast to 2006 and forecast to 2018 with the EPS3 CNTLEM module based on changes in both emission rates and activity levels. Fleet average emission factors from 2006 through 2040 for NO_X, VOC, and PM were obtained from an April 2009 EPA document entitled *Emission Factors for Locomotives, EPA-420-F-09-025,* which accounts for fleet turnover effects from locomotive engines as new ones entering the fleet must comply with more stringent standards. The changes in SO_2 emission rates were obtained from an April 2009 EPA document entitled *Suggested Nationwide Average Fuel Properties, EPA-420-B-09-018,* which accounts for required changes in diesel fuel sulfur levels. The relative changes in these emission rates by locomotive category from both 2011-to-2006, and 2011-to-2018 are summarized in Table 4-18: 2011-to-2006 Locomotive Emission Rate Adjustment Factors and Table 4-19: 2011-to-2018 Locomotive Emission Rate Adjustment Factors, respectively. A value of 100% indicates no change, while values lower than 100% indicate a reduction in emissions, and values above 100% indicate an emissions increase.

Table 4-18: 2011-to-2006 Locomotive Emission Rate Adjustment Factors

Locomotive Category Description	NO_X Change	VOC Change	SO_2 Change	PM Change
Large Line-Haul	120.81%	123.38%	7006.25%	145.45%
Large Switchers	106.38%	107.14%	7006.25%	122.64%
Small Railroads	100.00%	100.00%	7006.25%	114.04%
Passenger/Commuter	146.11%	119.75%	7006.25%	144.44%
Overall Average	119.75%	121.95%	7006.25%	142.22%

Table 4-19: 2011-to-2018 Locomotive Emission Rate Adjustment Factors

Locomotive Category Description	NO_X Change	VOC Change	SO_2 Change	PM Change
Large Line-Haul	72.48%	54.55%	34.38%	61.36%
Large Switchers	85.96%	82.14%	34.38%	83.02%
Small Railroads	97.52%	100.00%	34.38%	94.74%
Passenger/Commuter	62.87%	50.62%	34.38%	57.78%
Overall Average	74.52%	58.54%	34.38%	62.22%

The activity levels were backcast to 2006 with the EPS3 CNTLEM module based on a U.S. Energy Information Administration (EIA) table entitled Transportation Sector Key Indicators and Delivered Energy Consumption. These annual tables provide historical estimates of locomotive activity. Future activity was held constant at 2011 levels. The 2006 and 2018 activity adjustments relative to 2011 are shown in Table 4-20: 2006 and 2018 Locomotive Activity Adjustments Relative to 2011.

Table 4-20: 2006 and 2018 Locomotive Activity Adjustments Relative to 2011

Activity Change Description	Change
Activity Change from 2011 to 2006	106.36%
Activity Change from 2011 to 2018	100.00%

Application of these emission factor and activity adjustments resulted in the 2006 and 2018 locomotive emission estimates summarized in Table 4-21: 2006 DFW Area Line-Haul and Switcher Locomotive Emissions and Table 4-22: 2018 DFW Area Line-Haul and Switcher Locomotive Emissions, respectively.

Table 4-21: 2006 DFW Area Line-Haul and Switcher Locomotive Emissions

Locomotive Source Classification Description	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Line-Haul Locomotives – Class I	21.42	1.19	3.22	13.41	0.01	0.74
Line-Haul Locomotives – Classes II and III	0.60	0.02	0.06	0.29	0.00	0.02
Rail-Yard Switcher Locomotives	7.95	0.51	0.84	3.86	0.00	0.23
DFW Area Total	29.97	1.72	4.12	17.57	0.01	0.98

Table 4-22: 2018 DFW Area Line-Haul and Switcher Locomotive Emissions

Locomotive Source Classification Description	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Line-Haul Locomotives – Class I	12.09	0.50	3.02	0.06	0.01	0.29
Line-Haul Locomotives – Classes II and III	0.55	0.02	0.06	0.00	0.00	0.01
Rail-Yard Switcher Locomotives	6.04	0.37	0.79	0.02	0.00	0.15
DFW Area Total	18.68	0.88	3.87	0.08	0.01	0.45

The 24-hour locomotive emission totals reported in TexAER do not account for the effects of hourly variation in temperature and humidity on NO_X emissions. Greater detail on the development of correction equations to account for these effects can be found in Appendices F.4: Humidity and Temperature Correction Factors for NO_X Emissions from Diesel Engines and F.5: Humidity and Temperature Correction Factors for NO_X Emissions from Spark Ignited Engines of the December 2004 HGB SIP revision. During EPS3 processing, the CNTLEM module is also used to apply an hourly temperature/humidity NO_X correction and the impacts on the 2006 and 2018 locomotive DFW inventories are presented in Table 4-23: Temperature/Humidity NO_X Correction for Locomotive Emissions.

Table 4-23: Temperature/Humidity NO_X Correction for Locomotive Emissions

Locomotive Source Classification Description	2006 NO_X Change (tpd)	2018 NO_X Change (tpd)
Line-Haul Locomotives – Class I	-0.94	-0.53
Line-Haul Locomotives – Classes II and III	-0.03	-0.03
Rail-Yard Switcher Locomotives	-0.34	-0.26
DFW Area Total	-1.31	-0.81

The activity level for locomotive activity does not vary much by day type, so there are negligible differences in weekday versus weekend emissions for this source category. The line-haul emissions were spatially allocated to individual railway segments based on gross ton miles (GTM) activity data. The switcher emissions were allocated to known rail yards within the DFW area. Table 4-24: 2006 DFW Adjusted Locomotive Emissions and Table 4-25: 2018 DFW Area Adjusted Locomotive Emissions present the 2006 and 2018 DFW area locomotive emission inputs for the photochemical model for each episode day in these respective years.

Table 4-24: 2006 DFW Adjusted Locomotive Emissions

Locomotive Source Classification Description	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Line-Haul Locomotives – Class I	20.48	1.19	3.22	13.41	0.01	0.74
Line-Haul Locomotives – Classes II and III	0.58	0.02	0.06	0.29	0.00	0.02
Rail-Yard Switcher Locomotives	7.61	0.51	0.84	3.86	0.00	0.23
DFW Area Total	28.67	1.72	4.12	17.57	0.01	0.98

Table 4-25: 2018 DFW Area Adjusted Locomotive Emissions

Locomotive Source Classification Description	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Line-Haul Locomotives – Class I	11.55	0.50	3.02	0.06	0.01	0.29

Locomotive Source Classification Description	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Line-Haul Locomotives – Classes II and III	0.53	0.02	0.06	0.00	0.00	0.01
Rail-Yard Switcher Locomotives	5.78	0.37	0.79	0.02	0.00	0.15
DFW Area Total	17.86	0.88	3.87	0.08	0.01	0.45

For the non-DFW areas of Texas, all of the steps described above are similar for the TexAER extraction and EPS3 processing of locomotive emission estimates for 2006 and 2018. The EPS3 processing for Texas non-road emissions is divided into streams for:

- the 10-county DFW area;
- the eight-county HGB area; and
- the remaining 236 Texas counties.

The complete EPS3 processing streams for all of these areas are available for both 2006 and 2018 at ftp://amdaftp.tceq.texas.gov/pub/Offroad_EI/Locomotives/2006/ and ftp://amdaftp.tceq.texas.gov/pub/Offroad_EI/Locomotives/2018/. The following pages contain graphical plots of the 2006 and 2018 locomotive NO_X emissions for the DFW area. These plots are respectively entitled Figure 4-10: 2006 DFW Locomotive NO_X Emissions Distribution and Figure 4-11: 2018 DFW Locomotive NO_X Emissions Distribution. Since the diesel engines that power locomotives are not significant contributors of VOC emissions, only NO_X plots are provided here.

For the non-Texas U.S. areas of the modeling domain, locomotive emission estimates from the EPA NEI were used. The 2008 NEI was used for the 2006 inputs, and the 2011 NEI was used for the 2018 inputs. The locomotive emission estimates from these NEI datasets were processed through EPS3 in a manner similar to that described above for the locomotive emissions within Texas.

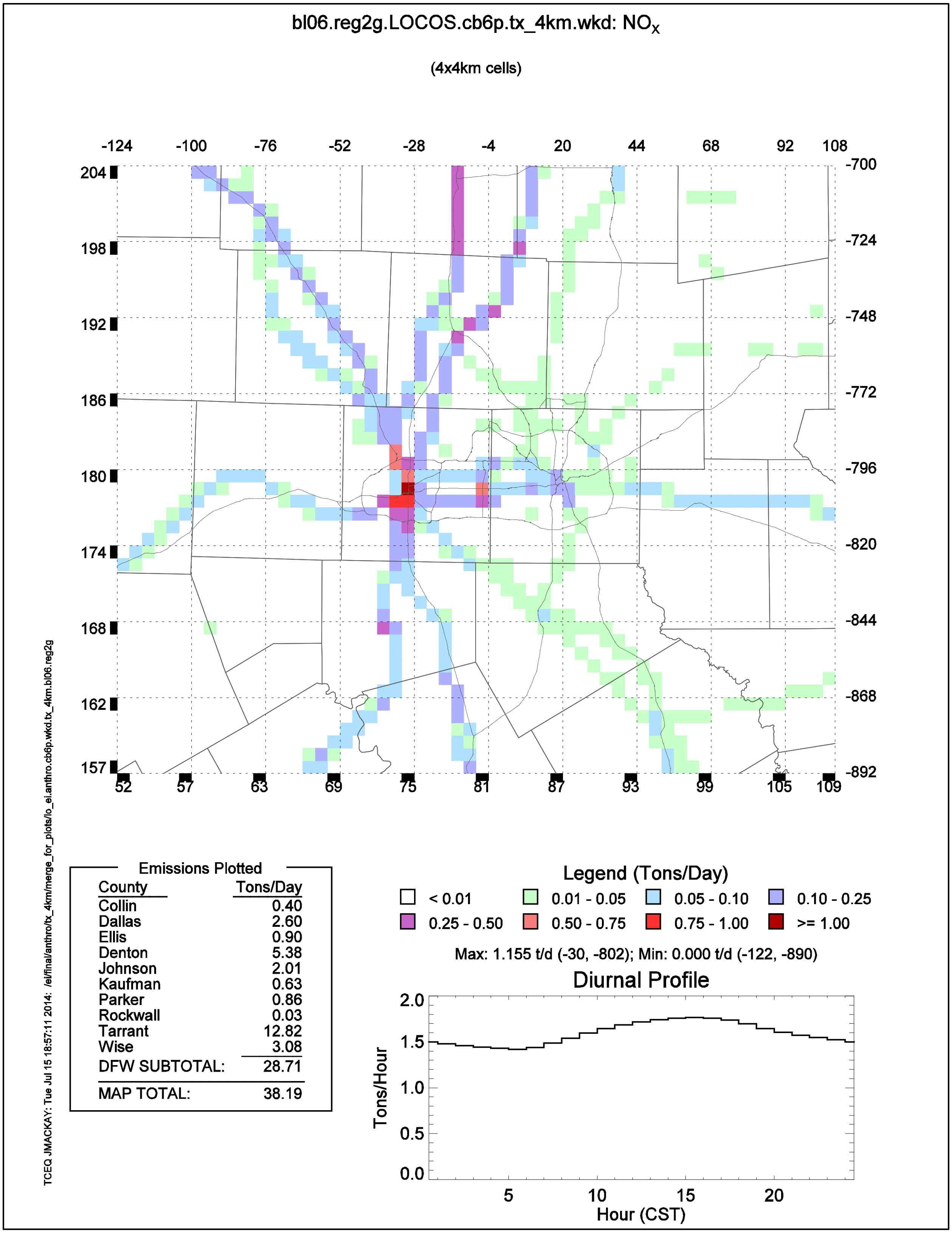

Figure 4-10: 2006 DFW Locomotive NO_X Emissions Distribution

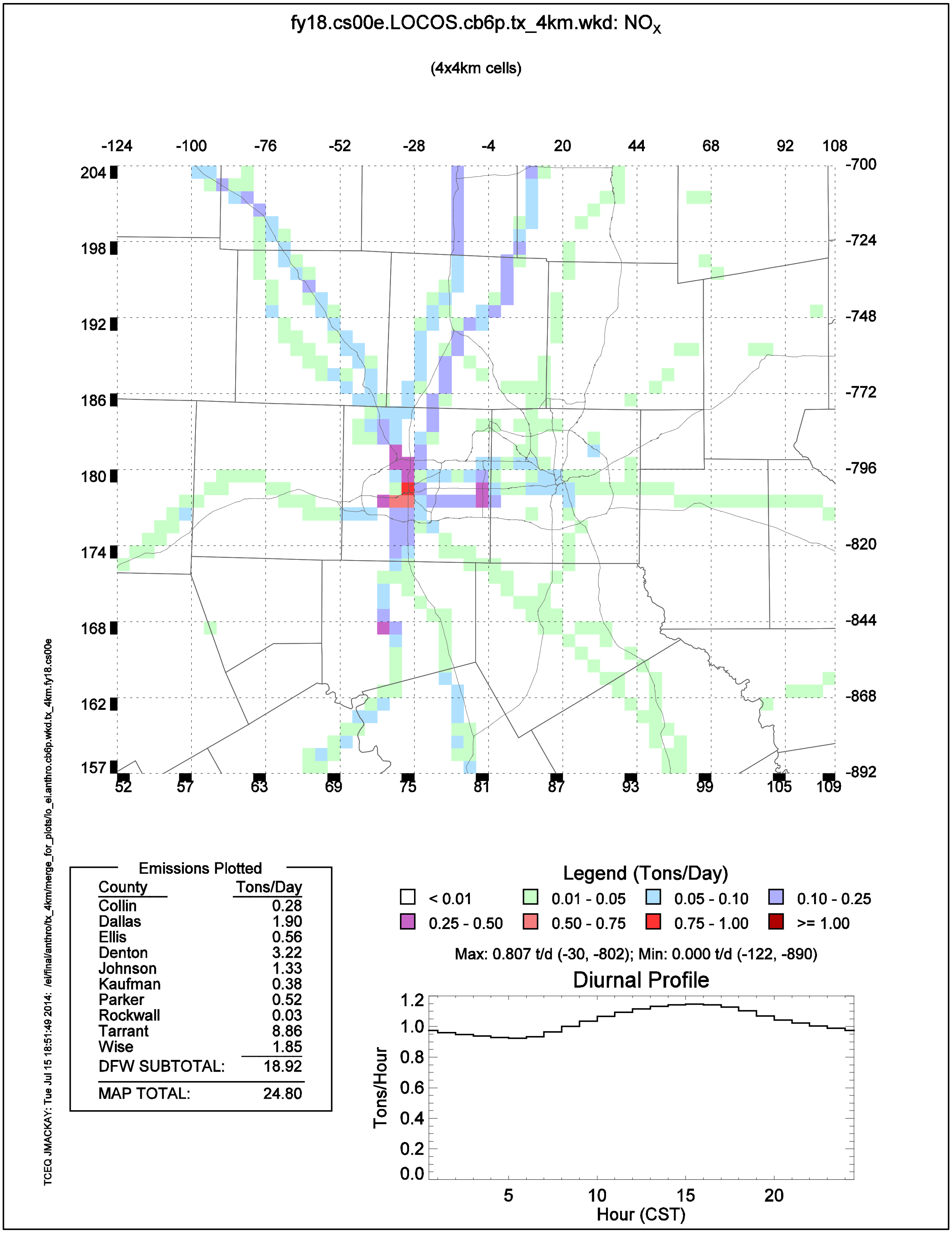

Figure 4-11: 2018 DFW Locomotive NO_X Emissions Distribution

4.4 Non-Road/TexN

Non-road emissions for 2006 and 2018 for the 10-county DFW area were estimated with a customized version of EPA's NONROAD model called Texas NONROAD (TexN). The full EPA web page address is http://www.epa.gov/otaq/nonrdmdl.htm and the full TCEQ TexN FTP site address is ftp://amdaftp.tceq.texas.gov/pub/Nonroad_EI/TexN/. For each county specified in a TexN scenario, 25 separate runs of the NONROAD model are performed for the following non-road categories outlined in Table 4-26: Texas NONROAD Model Subsector Categories. Runs 1 through 25 (excluding 24) are for specific diesel construction equipment (DCE) categories, while the numeric code of 0 is for all non-DCE categories.

Table 4-26: Texas NONROAD Model Subsector Categories

Numeric Code	NONROAD Model Subsector Description (Diesel Construction Equipment for 1-24)
0	Other - Non-Diesel Construction Equipment
1	DCE - Agricultural Activities
2	DCE - Boring and Drilling Equipment
3	DCE - Brick and Stone Operations
4	DCE - City and County Road Construction
5	DCE - Commercial Construction
6	DCE - Concrete Operations
7	DCE - County-Owned Construction Equipment
8	DCE – Cranes
9	DCE - Heavy Highway Construction
10	DCE - Landfill Operations
11	DCE - Landscaping Activities
12	DCE - Manufacturing Operations
13	DCE - Municipal-Owned Construction Equipment
14	DCE - Transportation/Sales/Services
15	DCE - Residential Construction
16	DCE - Rough Terrain Forklifts
17	DCE - Scrap/Recycling Operations
18	DCE - Skid Steer Loaders
19	DCE - Special Trades Construction
20	DCE - Trenchers
21	DCE - TxDOT Construction Equipment
22	DCE - Utility Construction
23	DCE - Mining and Quarry Operation
25	DCE - Off-Road Tractors, Miscellaneous, and Equipment Under 25 Horsepower

2006 and 2018 summer weekday scenarios were run with the TexN model for all 10 counties in the DFW area. 25 DCE subcategories for each of the 10 counties resulted in a total of 250 NONROAD model runs for each calendar year. The results of this work are available on the TCEQ non-road emissions FTP site at ftp://amdaftp.tceq.texas.gov/pub/Nonroad_EI/TEX/. The NO_X, VOC, CO, SO_2, and $PM_{2.5}$ emissions by county along with associated non-road equipment population figures are presented for 2006 and 2018, respectively, in Table 4-27:

2006 DFW Area Non-Road Emissions Inventory by County and Table 4-28: 2018 DFW Area Non-Road Emissions Inventory by County.

Table 4-27: 2006 DFW Area Non-Road Emissions Inventory by County

DFW Area County	Equipment Population	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Collin	211,540	11.20	7.58	88.28	1.29	1.05
Dallas	837,764	38.24	27.70	377.72	3.54	3.19
Denton	170,720	7.09	5.52	58.22	0.79	0.66
Ellis	43,816	4.82	1.99	20.75	0.46	0.34
Johnson	41,276	4.36	1.23	15.07	0.57	0.38
Kaufman	28,960	4.62	1.39	14.69	0.61	0.40
Parker	33,844	3.62	1.34	11.40	0.52	0.33
Rockwall	24,266	1.20	1.48	10.30	0.15	0.13
Tarrant	525,720	23.29	15.19	200.87	2.12	1.81
Wise	23,033	4.86	1.32	9.32	0.74	0.40
DFW Total	1,940,938	103.30	64.73	806.60	10.78	8.69

Table 4-28: 2018 DFW Area Non-Road Emissions Inventory by County

DFW Area County	Equipment Population	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Collin	266,332	5.88	4.15	64.77	0.01	0.56
Dallas	1,052,829	17.68	14.20	276.27	0.05	1.73
Denton	212,537	3.62	2.82	42.46	0.01	0.31
Ellis	55,015	1.87	1.00	12.48	0.00	0.15
Johnson	51,236	1.64	0.60	9.25	0.00	0.14
Kaufman	35,781	1.57	0.73	9.37	0.00	0.14
Parker	42,717	1.25	0.76	8.38	0.00	0.11
Rockwall	29,298	0.62	0.74	7.82	0.00	0.07
Tarrant	656,192	9.88	7.44	141.99	0.03	0.92
Wise	27,991	1.13	0.61	5.78	0.00	0.09
DFW Total	2,429,928	45.15	33.04	578.58	0.12	4.22

Even with overall growth in the non-road equipment population from roughly 1.9 million in 2006 to 2.4 million in 2018, total emissions decrease due to the more stringent emissions standards for new equipment purchases, combined with the simultaneous attrition of older, higher-emitting pieces of non-road equipment. The 10-county DFW non-road emissions inventory includes 193 different types of equipment referenced by source classification code (SCC). The files available on the TCEQ non-road emissions FTP site include a complete set of estimates by county and SCC. The 10-county DFW aggregate equipment categories for 2006 and 2018, respectively, are summarized in Table 4-29: 2006 DFW Area Non-Road Emissions Inventory by Equipment Group and Table 4-30: 2018 DFW Area Non-Road Emissions Inventory by Equipment Group.

Table 4-29: 2006 DFW Area Non-Road Emissions Inventory by Equipment Group

Equipment Category	Equipment Population	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Agricultural Equipment	9,117	12.74	1.43	20.31	1.74	1.10
Commercial Equipment	207,441	8.60	14.08	291.64	0.68	0.77
Construction and Mining Equipment	84,012	47.44	8.50	75.99	6.59	4.66
Industrial Equipment	46,923	31.33	8.01	123.01	1.61	1.09
Lawn and Garden Equipment	1,509,143	2.64	22.26	256.99	0.14	0.83
Pleasure Craft	37,985	0.27	4.50	12.21	0.01	0.06
Railroad Equipment	101	0.08	0.02	0.07	0.01	0.01
Recreational Equipment	46,216	0.20	5.93	26.39	0.01	0.16
DFW Total	1,940,938	103.30	64.73	806.60	10.78	8.69

Table 4-30: 2018 DFW Area Non-Road Emissions Inventory by Equipment Group

Equipment Category	Equipment Population	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Agricultural Equipment	11,286	4.95	0.64	5.24	0.01	0.33
Commercial Equipment	281,479	5.91	7.65	250.59	0.02	0.55
Construction and Mining Equipment	107,975	21.38	4.56	48.97	0.03	1.94
Industrial Equipment	59,642	10.65	1.50	30.29	0.04	0.32
Lawn and Garden Equipment	1,860,832	1.73	12.76	203.95	0.01	0.94
Pleasure Craft	41,419	0.31	1.99	9.57	0.00	0.02
Railroad Equipment	137	0.06	0.01	0.04	0.00	0.01
Recreational Equipment	67,158	0.17	3.94	29.93	0.00	0.10
DFW Total	2,429,928	45.15	33.04	578.58	0.12	4.22

The 10-county DFW non-road emissions are summarized by fuel type for 2006 and 2018, respectively, in Table 4-31: 2006 DFW Area Non-Road Emissions Inventory by Fuel Type and Table 4-32: 2018 DFW Area Non-Road Emissions Inventory by Fuel Type.

Table 4-31: 2006 DFW Area Non-Road Emissions Inventory by Fuel Type

Equipment Category	Equipment Population	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Two-Stroke Gasoline	593,205	0.25	20.05	50.50	0.00	1.13
Four-Stroke Gasoline	1,201,542	4.66	29.93	601.14	0.03	0.19
Diesel	119,469	75.33	7.90	38.34	10.72	7.23
Compressed Natural Gas (CNG)	1,998	1.78	1.05	13.76	0.00	0.02
Liquefied Petroleum Gas (LPG)	24,723	21.28	5.81	102.85	0.03	0.13
DFW Total	1,940,938	103.30	64.73	806.60	10.78	8.69

Table 4-32: 2018 DFW Area Non-Road Emissions Inventory by Fuel Type

Equipment Category	Equipment Population	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Two-Stroke Gasoline	730,319	0.35	13.23	53.80	0.00	1.19

Equipment Category	Equipment Population	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Four-Stroke Gasoline	1,499,476	2.24	14.49	476.30	0.03	0.23
Diesel	164,059	37.21	4.11	17.97	0.05	2.62
Compressed Natural Gas (CNG)	2,437	0.32	0.09	1.53	0.00	0.01
Liquefied Petroleum Gas (LPG)	33,637	5.03	1.12	28.98	0.03	0.17
DFW Total	2,429,928	45.15	33.04	578.58	0.12	4.22

The 10-county DFW non-road emissions for 2006 and 2018, respectively, are summarized by the 25 DCE subcategory codes from Table 4-26 in Table 4-33: 2006 DFW Area Non-Road Emissions Inventory by Diesel Subcategory and Table 4-34: 2018 DFW Area Non-Road Emissions Inventory by Diesel Subcategory.

Table 4-33: 2006 DFW Area Non-Road Emissions Inventory by Diesel Subcategory

Non-Road DCE Subsector	Equipment Population	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Non-Diesel Equipment	1,883,489	56.51	59.80	781.90	4.20	4.22
Agricultural Activities	895	1.31	0.14	0.71	0.20	0.13
Boring and Drilling Equipment	107	0.11	0.01	0.04	0.01	0.01
Brick and Stone Operations	206	0.68	0.05	0.27	0.11	0.05
City and County Road Construction	1,559	0.37	0.03	0.15	0.04	0.03
Commercial Construction	13,373	3.58	0.34	1.58	0.39	0.26
Concrete Operations	201	0.52	0.04	0.23	0.08	0.04
County-Owned Construction	283	0.23	0.02	0.11	0.03	0.02
Cranes	996	2.33	0.16	0.58	0.29	0.13
Heavy Highway Construction	626	0.97	0.08	0.40	0.14	0.08
Landfill Operations	110	0.80	0.05	0.29	0.14	0.05
Landscaping Activities	1,088	0.54	0.11	0.49	0.07	0.08
Manufacturing Operations	179	0.41	0.03	0.18	0.06	0.03
Municipal-Owned Construction	1,200	0.72	0.12	0.57	0.10	0.10
Transportation/Sales/Services	1,967	4.09	0.37	1.98	0.62	0.35
Residential Construction	3,930	7.37	0.57	2.84	1.02	0.55
Rough Terrain Forklifts	5,532	5.74	0.58	3.47	0.86	0.61
Scrap/Recycling Operations	124	0.37	0.03	0.12	0.06	0.03
Skid Steer Loaders	10,528	3.57	1.05	4.46	0.45	0.78
Special Trades Construction	184	0.09	0.01	0.07	0.01	0.01
Trenchers	4,012	3.35	0.33	2.10	0.52	0.37
TxDOT Construction Equipment	250	0.11	0.01	0.06	0.01	0.01
Utility Construction	3,279	1.78	0.14	0.76	0.19	0.15
Mining and Quarry Operations	984	4.78	0.34	1.57	0.82	0.33
Miscellaneous Equipment	5,836	2.93	0.33	1.68	0.35	0.27
DFW Total	1,940,938	103.30	64.73	806.60	10.78	8.69

Table 4-34: 2018 DFW Area Non-Road Emissions Inventory by Diesel Subcategory

Non-Road DCE Subsector	Equipment Population	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Non-Diesel Equipment	2,349,480	23.99	30.49	566.49	0.08	2.48
Agricultural Activities	877	0.37	0.05	0.22	0.00	0.03
Boring and Drilling Equipment	147	0.08	0.01	0.02	0.00	0.00
Brick and Stone Operations	137	0.09	0.02	0.04	0.00	0.01
City and County Road Construction	1,926	0.24	0.02	0.09	0.00	0.01
Commercial Construction	20,979	2.88	0.26	1.21	0.00	0.16
Concrete Operations	170	0.11	0.01	0.05	0.00	0.01
County-Owned Construction	345	0.12	0.01	0.05	0.00	0.01
Cranes	1,472	1.07	0.10	0.29	0.00	0.05
Heavy Highway Construction	1,051	0.50	0.06	0.23	0.00	0.04
Landfill Operations	135	0.11	0.03	0.04	0.00	0.00
Landscaping Activities	1,380	0.34	0.05	0.25	0.00	0.04
Manufacturing Operations	292	0.17	0.02	0.08	0.00	0.01
Municipal-Owned Construction	1,459	0.41	0.05	0.27	0.00	0.04
Transportation/Sales/Services	3,206	1.72	0.24	0.96	0.00	0.13
Residential Construction	2,001	1.10	0.12	0.46	0.00	0.08
Rough Terrain Forklifts	7,728	2.45	0.27	1.63	0.00	0.23
Scrap/Recycling Operations	151	0.06	0.01	0.02	0.00	0.00
Skid Steer Loaders	15,840	3.11	0.60	3.44	0.00	0.51
Special Trades Construction	324	0.07	0.01	0.05	0.00	0.01
Trenchers	5,521	2.05	0.15	0.82	0.00	0.09
TxDOT Construction Equipment	250	0.06	0.01	0.03	0.00	0.00
Utility Construction	7,132	1.96	0.17	0.76	0.00	0.12
Mining and Quarry Operations	383	0.25	0.06	0.08	0.00	0.01
Miscellaneous Equipment	7,540	1.82	0.21	0.97	0.00	0.14
DFW Total	2,429,928	45.15	33.04	578.58	0.12	4.22

The non-road emissions data output from TexN were prepared for photochemical modeling using EPS3. Table 4-35: EPS3 Modules for Processing Non-Road Emissions summarizes the steps that were taken to process the 2006 and 2018 non-road inventories.

Table 4-35: EPS3 Modules for Processing Non-Road Emissions

EPS3 Module	Description
PREAM	Convert text-based input files to binary format for further processing.
CNTLEM	Apply adjustments for temperature/humidity NO_X correction and TxLED.
TMPRL	Apply profiles to temporally allocate daily emission totals.
SPCEMS	Chemically speciate VOC emissions into olefins, paraffins, etc.
GRDEM	Spatially allocate emissions with surrogates and prepare model inputs.
MRGUAM	Merge and adjust multiple gridded files for photochemical model input.

When running a summer weekday scenario, the NONROAD model reports 24-hour emission totals and does not account for the effects of hourly variation in temperature and humidity on NO_X emissions. Greater detail on the development of correction equations to account for these effects can be found in Appendices F.4 and F.5 of the December 2004 HGB SIP revision. During EPS3 processing, the CNTLEM module is also used to apply an hourly temperature/humidity NO_X correction and the impacts on the 2006 and 2018 non-road DFW inventories are presented in Table 4-36: Temperature/Humidity NO_X Correction for Non-Road Emissions.

Table 4-36: Temperature/Humidity NO_X Correction for Non-Road Emissions

Calendar Year	**Temperature/Humidity NO_X Correction** (tpd)
2006	1.19
2018	1.46

The 2006 and 2018 non-road NO_X emission totals presented above in Table 4-27 through Table 4-34 exclude the benefits of Texas Low Emission Diesel (TxLED) fuel. Instead, TxLED benefits were accounted for by applying a NO_X reduction to the diesel non-road equipment categories through use of the EPS3 CNTLEM module. The specific adjustment factors vary by horsepower range and certification standard, as summarized in Table 4-37: Non-Road TxLED Adjustments by Horsepower and Standard. More detail on development of these post-processing adjustments can be found in a September 27, 2001 EPA memorandum entitled *Texas Low Emission Diesel (LED) Fuel Benefits*.

Table 4-37: Non-Road TxLED Adjustments by Horsepower and Standard

Non-Road Diesel Equipment Standard/Category	**TxLED NO_X Reduction Factor**
Under 50 Horsepower	0.0%
Base, Tier 0, Tier 1, and Tier 2	6.2%
Tier 3 and Tier 4	4.8%

The 2006 and 2018 non-road TxLED benefits for the 10-county DFW area are presented in Table 4-38: 2006 and 2018 DFW Area Non-Road TxLED Benefits.

Table 4-38: 2006 and 2018 DFW Area Non-Road TxLED Benefits

Calendar Year	**TxLED NO_X Reduction** (tpd)
2006	4.04
2018	1.55

The activity level for different non-road equipment varies between weekday and weekend day types. For example, commercial construction equipment is more commonly used on weekdays than weekends. Conversely, recreational boats are more commonly used on weekends than on weekdays. The EPS3 TMPRL module is used to adjust the average weekday emissions by equipment type for creating Saturday and Sunday day types. Within each day type, TMPRL also allocates daily totals to each hour. After the CNTLEM and TMPRL adjustments are made, the EPS3 GRDEM module is used to spatially allocate the non-road emissions with surrogates that vary based on SCC. The files output from GRDEM are in the binary gridded format required by the photochemical model. The 2006 and 2018 non-road emissions output from GRDEM by day type for the 10-county DFW area are respectively summarized in Table 4-39: 2006 DFW Area Non-Road Emissions Inventory by Day Type and Table 4-40: 2018 DFW Area Non-Road Emissions Inventory by Day Type.

Table 4-39: 2006 DFW Area Non-Road Emissions Inventory by Day Type

2006 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Monday – Friday Average Weekday	98.06	64.69	806.01	10.78	8.12
Saturday	68.72	94.19	977.67	6.99	5.73
Sunday	50.08	82.22	823.17	5.19	4.43

Table 4-40: 2018 DFW Area Non-Road Emissions Inventory by Day Type

2018 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	$PM_{2.5}$ (tpd)
Monday – Friday Average Weekday	42.13	33.02	578.12	0.11	3.59
Saturday	30.91	47.05	742.31	0.10	2.67
Sunday	23.59	42.00	644.62	0.08	2.14

Comparing Table 4-39 and Table 4-40 with Table 4-27 through Table 4-34 indicates that the weekday VOC, CO, and SO_2 totals remain unchanged, while the weekday NO_X totals are reduced by the temperature/humidity and TxLED adjustments presented in Table 4-36 and Table 4-38. The $PM_{2.5}$ totals are also slightly lower in Table 4-39 and Table 4-40 because they include only organic carbon, elemental carbon, and sulfate (SO_4). The $PM_{2.5}$ emissions from gasoline, compressed natural gas (CNG), and liquefied petroleum gas (LPG) equipment were allocated to these $PM_{2.5}$ categories based on profiles from the EPA SPECIATE Database. The amount allocated to these categories for diesel engines varies based on whether exhaust after-treatment is needed to meet applicable standards. To obtain these diesel $PM_{2.5}$ factors, the MOVES2010b model was run in default mode to obtain contributions by model year group for 2006-and-older and 2010-and newer diesel vehicles. The former group did not need after-treatment while the latter group does, and the 2007 through 2009 model years were not included in the analysis because they are transition years for the tighter standards. These $PM_{2.5}$ allocation methods are summarized in Table 4-41: Speciation of Non-Road $PM_{2.5}$ Emissions.

Table 4-41: Speciation of Non-Road $PM_{2.5}$ Emissions

Non-Road Fuel Type and/or Standard	$PM_{2.5}$ Allocation Approach
Gasoline	SPECIATE profile 92113 for non-road gasoline exhaust
CNG and LPG	SPECIATE profile 92112 for natural gas combustion
Diesel – Base and Tiers 0-3	MOVES2010b default runs for 2006-and-older without after-treatment
Diesel – Tier 4	MOVES2010b default for 2010-and-newer with after-treatment

For the non-DFW areas of Texas, all of the steps described above are similar for the TexN development and EPS3 processing of non-road emission estimates for 2006 and 2018. The EPS3 processing for Texas non-road emissions is divided into streams for:

- the 10-county DFW area;

- the eight-county HGB area;
- the remaining 92 of all 110 eastern Texas counties subject to TxLED; and
- the 144 counties of western Texas not subject to TxLED.

The complete EPS3 processing streams for all of these areas are available for both 2006 and 2018 at ftp://amdaftp.tceq.texas.gov/pub/Nonroad_EI/TEX/2006/ and ftp://amdaftp.tceq.texas.gov/pub/Nonroad_EI/TEX/2018/. The following pages contain graphical plots of the 2006 and 2018 summer weekday non-road NO_X and VOC emissions for the DFW area. These plots are respectively entitled Figure 4-12: 2006 Summer Weekday DFW Non-Road NO_X Emissions Distribution, Figure 4-13: 2006 Summer Weekday DFW Non-Road VOC Emissions Distribution, Figure 4-14: 2018 Summer Weekday DFW Non-Road NO_X Emissions Distribution, and Figure 4-15: 2018 Summer Weekday DFW Non-Road VOC Emissions Distribution.

For the non-Texas U.S. areas of the modeling domain, the EPA National Mobile Inventory Model (NMIM) was run for 2006 and 2018 to obtain non-road emission estimates for each county. The NMIM output was processed through EPS3 in a manner similar to that described above for non-road emissions within Texas.

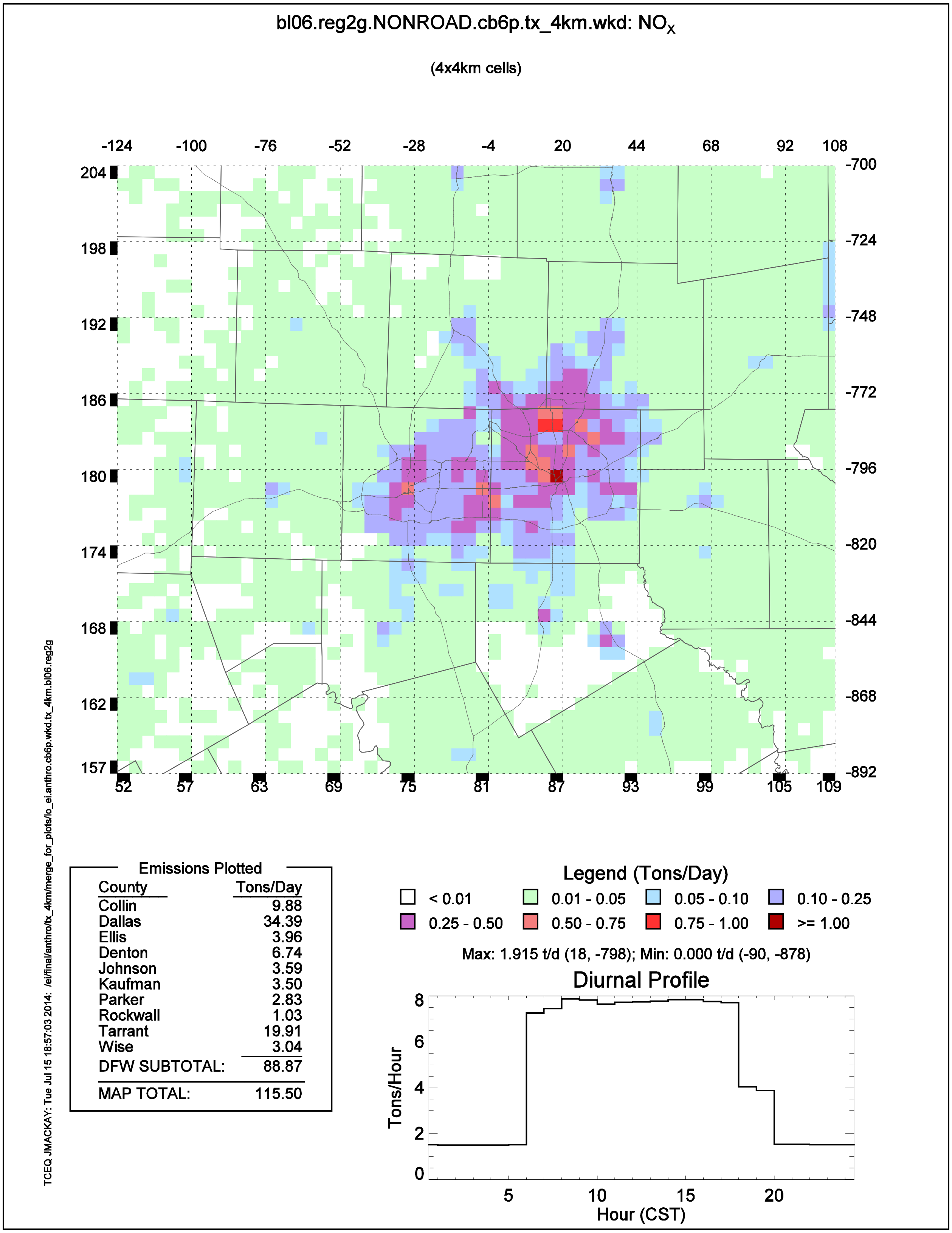

Figure 4-12: 2006 Summer Weekday DFW Non-Road NO_X Emissions Distribution

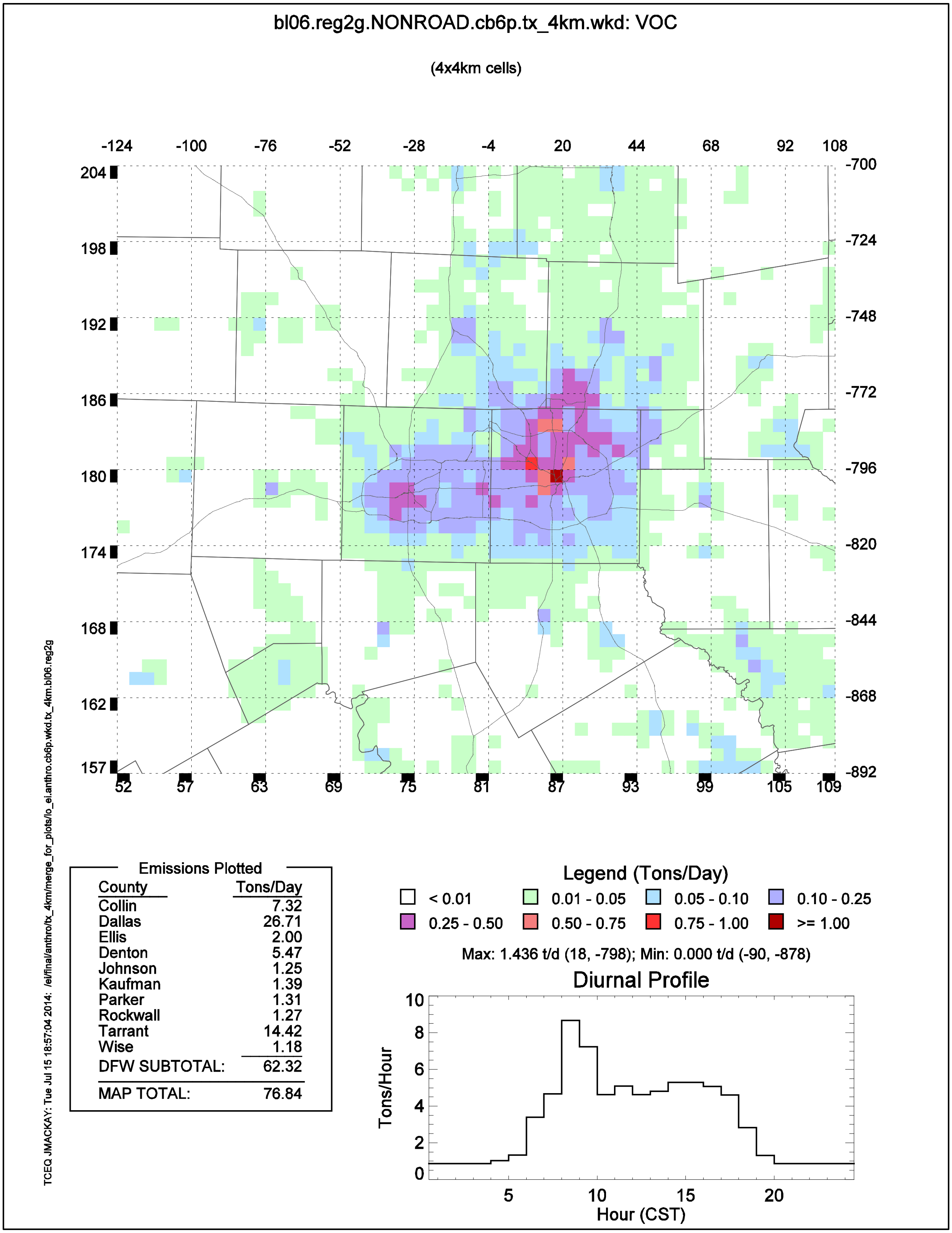

Figure 4-13: 2006 Summer Weekday DFW Non-Road VOC Emissions Distribution

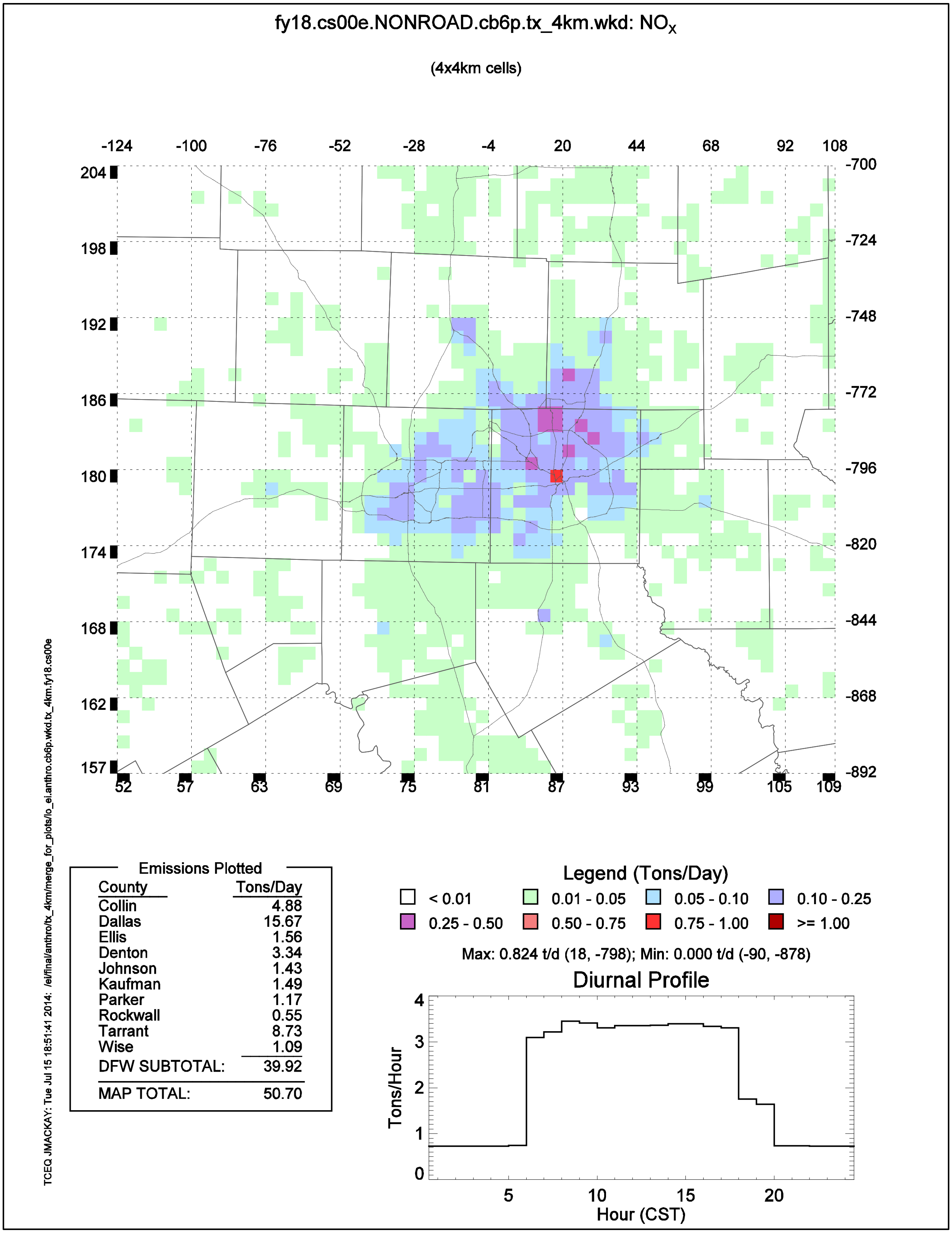

Figure 4-14: 2018 Summer Weekday DFW Non-Road NO_X Emissions Distribution

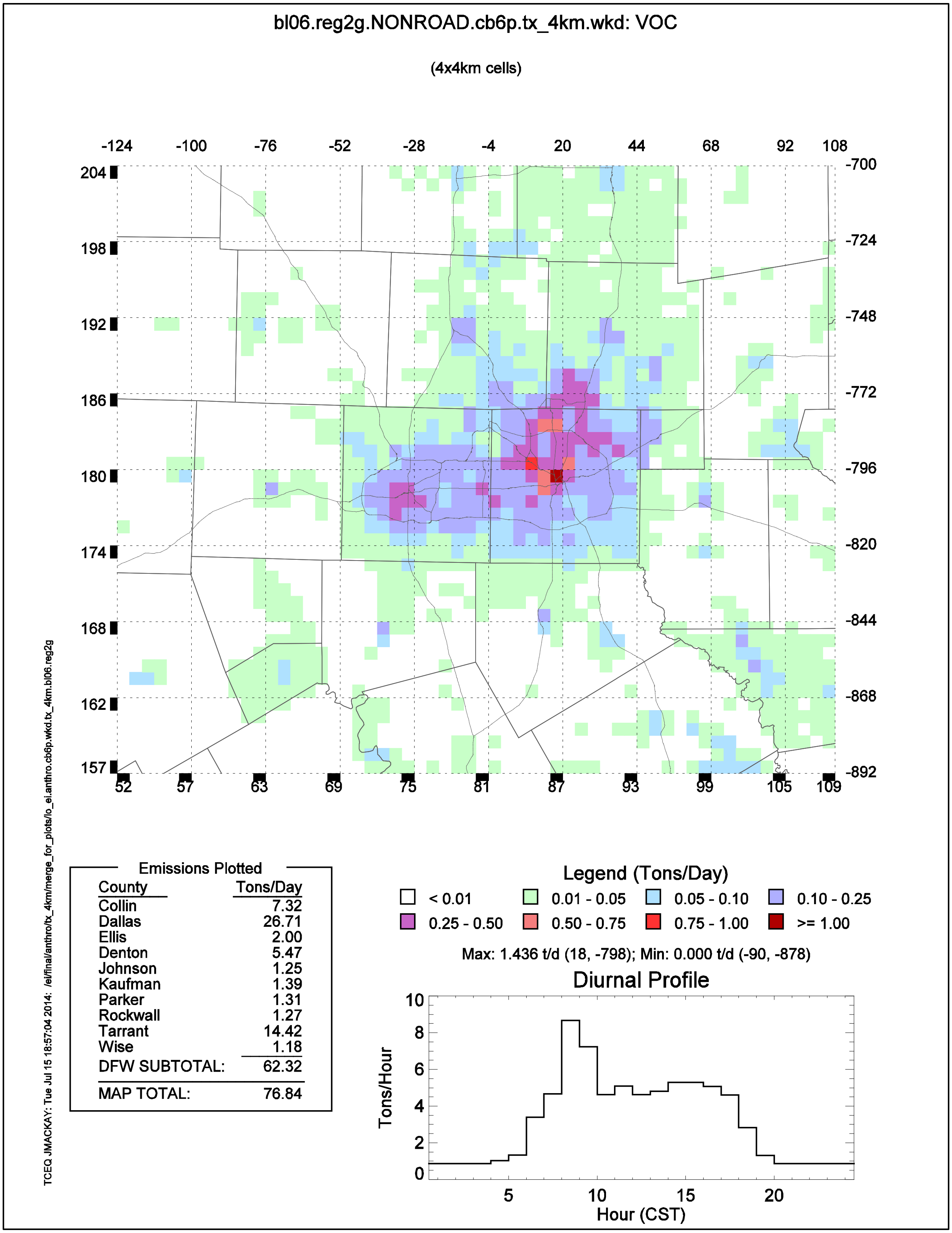

Figure 4-15: 2018 Summer Weekday DFW Non-Road VOC Emissions Distribution

4.5 Area Sources

Area sources include commercial, small-scale industrial, and residential activities that use materials or operate processes that can generate emissions. These sources of emissions fall below the point source reporting levels and are either too numerous or too small to identify individually. Emissions from these sources are estimated on a source category basis per county. Area source VOC emissions can result from either evaporation or fuel combustion. Examples of sources of evaporative losses include printing operations, industrial coatings, degreasing solvents, house paints, underground storage tanks, underground tank filling at gasoline service stations, and vehicle refueling operations. Fuel combustion sources include stationary source fossil fuel combustion at residences and businesses, along with outdoor burning and structural fires. With some exceptions, area source emission estimates are obtained by multiplying an established emission factor by the appropriate activity or activity surrogate responsible for generating the emissions. Human population is the most commonly used activity surrogate for many area source categories, while other activity data include the amount of gasoline sold in an area, employment by industry type, acres of cropland, etc. Area source modeling estimates were based primarily on data from the 2008 and 2011 periodic emissions inventories, which are available via TexAER at http://www5.tceq.state.tx.us/texaer/index.cfm.

The NO_X, VOC, CO, SO_2, NH_3, and $PM_{2.5}$ area source emissions by county from TexAER for 2008 and 2011, respectively, are presented below in Table 4-42: 2008 DFW Area Source Emissions Inventory by County and Table 4-43: 2011 DFW Area Source Emissions Inventory by County.

Table 4-42: 2008 DFW Area Source Emissions Inventory by County

DFW Area County	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Collin	2.57	20.79	9.18	0.54	3.48	11.30
Dallas	12.53	95.66	25.05	3.27	6.36	16.02
Denton	1.75	19.61	8.42	0.29	5.66	8.26
Ellis	0.59	6.89	5.06	0.12	3.59	9.00
Johnson	0.64	7.42	4.82	0.26	3.44	7.88
Kaufman	0.44	4.86	4.47	0.17	2.73	5.52
Parker	0.41	4.81	4.15	0.15	3.23	7.33
Rockwall	0.22	2.48	1.90	0.06	0.59	2.18
Tarrant	7.88	65.05	17.58	2.24	4.47	11.58
Wise	0.28	3.88	4.14	0.09	2.40	4.62
DFW Total	27.32	231.45	84.77	7.19	35.96	83.70

Table 4-43: 2011 DFW Area Source Emissions Inventory by County

DFW Area County	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Collin	2.59	22.27	8.00	0.45	3.49	10.64
Dallas	12.16	89.24	22.74	2.75	6.40	11.67
Denton	1.65	20.59	5.26	0.25	5.66	7.96
Ellis	0.56	6.90	3.33	0.08	3.58	9.11
Johnson	0.62	6.51	3.75	0.19	3.43	7.96

DFW Area County	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Kaufman	0.43	4.96	3.04	0.13	2.72	5.63
Parker	0.39	4.83	2.29	0.11	3.22	7.31
Rockwall	0.22	2.77	1.81	0.05	0.59	2.20
Tarrant	7.36	62.23	15.42	1.87	4.50	10.72
Wise	0.25	3.71	1.51	0.07	2.38	4.69
DFW Total	26.24	224.01	67.15	5.95	35.96	77.89

The 2008 and 2011 area source emissions data from TexAER were prepared for photochemical modeling using EPS3. Table 4-44: EPS3 Modules for Processing Area Source Emission Inventories summarizes the steps that were taken to prepare the 2006 and 2018 area source emission inventories.

Table 4-44: EPS3 Modules for Processing Area Source Emission Inventories

EPS3 Module	Description
PREAM	Convert text-based input files to binary format for further processing.
CNTLEM	Back-cast 2008 emissions to 2006, and project 2011 emissions to 2018.
TMPRL	Apply profiles to temporally allocate daily emission totals.
SPCEMS	Chemically speciate VOC emissions into olefins, paraffins, etc.
GRDEM	Spatially allocate emissions with surrogates and prepare model inputs.
MRGUAM	Merge and adjust multiple gridded files for photochemical model input.

As shown, the EPS3 CNTLEM module was used to backcast 2008 DFW area source emission estimates from TexAER to 2006, and to project the 2011 DFW area source emission estimates to 2018. In both cases, a study done under contract by ERG was conducted to develop growth factors from 2005 through 2030 based on data available from Moody's Analytics and the U.S. EIA. More detail on this analysis is available within TexAER. The adjusted NO_X, VOC, CO, SO_2, NH_3, and $PM_{2.5}$ area source emissions for 2006 and 2018, respectively, by county are presented below in Table 4-45: 2006 DFW Area Source Emissions Inventories by County and Table 4-46: 2018 DFW Area Source Emission Inventories by County.

Table 4-45: 2006 DFW Area Source Emissions Inventories by County

DFW Area County	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Collin	2.60	25.01	8.72	0.55	3.48	11.18
Dallas	13.47	123.06	23.77	3.36	6.39	15.72
Denton	1.76	23.13	8.03	0.30	5.66	8.13
Ellis	0.65	8.90	5.72	0.15	3.60	9.10
Johnson	0.69	9.40	5.61	0.29	3.44	8.00
Kaufman	0.51	6.17	5.88	0.19	2.73	5.69
Parker	0.44	5.79	4.50	0.18	3.23	7.42
Rockwall	0.24	3.08	2.42	0.07	0.59	2.22
Tarrant	8.35	80.82	16.64	2.28	4.49	11.36

DFW Area County	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Wise	0.30	5.08	4.30	0.10	2.40	4.68
DFW Total	29.02	290.46	85.59	7.46	36.01	83.50

Table 4-46: 2018 DFW Area Source Emission Inventories by County

DFW Area County	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Collin	2.98	27.67	8.79	0.54	3.50	10.99
Dallas	14.31	113.79	25.71	3.31	6.46	12.45
Denton	1.87	26.72	5.82	0.30	5.66	8.23
Ellis	0.67	9.07	4.25	0.09	3.59	9.31
Johnson	0.73	8.15	4.78	0.22	3.44	8.16
Kaufman	0.52	6.55	4.26	0.16	2.72	5.85
Parker	0.45	6.15	2.82	0.13	3.22	7.47
Rockwall	0.26	3.59	2.44	0.05	0.59	2.30
Tarrant	8.68	78.53	17.43	2.26	4.54	11.28
Wise	0.29	4.71	1.79	0.08	2.38	4.79
DFW Total	30.76	284.94	78.09	7.14	36.09	80.82

The 10-county DFW area source emissions inventory includes 171 different types of SCCs. The files available on the TCEQ area source FTP site include a complete set of estimates by county and SCC. The 10-county DFW aggregate SCC categories for the area source emissions are summarized for 2006 and 2018, respectively, in Table 4-47: 2006 DFW Area Source Emission Inventories by Aggregate Category and Table 4-48: 2018 DFW Area Source Emission Inventories by Aggregate Category.

Table 4-47: 2006 DFW Area Source Emission Inventories by Aggregate Category

DFW Area County	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Agricultural Production	0.29	0.58	5.51	0.00	23.27	5.40
Catastrophic/Accidental Releases	0.00	0.15	0.00	0.00	0.00	0.00
Commercial/Institutional	8.34	77.70	5.54	0.39	0.07	0.59
Construction	0.00	0.00	0.00	0.00	0.00	18.32
Degreasing	0.00	11.61	0.00	0.00	0.00	0.00
Dry Cleaning	0.00	6.96	0.00	0.00	0.00	0.00
Fabricated Metals	0.00	1.01	0.00	0.00	0.00	0.00
Food and Kindred Products	0.00	1.63	1.50	0.00	0.00	4.06
Graphic Arts	0.00	47.24	0.00	0.00	0.00	0.00
Incineration, Burning, and Combustion	0.70	2.01	30.21	0.10	0.14	2.87
Industrial	13.42	8.19	8.16	6.86	0.60	0.41
Landfills	0.00	3.95	0.00	0.00	0.00	0.00
Petroleum Refining, Storage, and Transport	0.00	41.39	0.01	0.00	0.00	0.00
Residential	6.26	5.86	34.65	0.11	0.30	4.99

DFW Area County	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Roads - Paved and Unpaved	0.00	0.00	0.00	0.00	0.00	46.86
Rubber/Plastics	0.00	1.65	0.00	0.00	0.00	0.00
Secondary Metal Production	0.00	0.00	0.00	0.00	0.00	0.00
Surface Coating	0.00	80.04	0.00	0.00	0.00	0.00
Underground Storage Tanks	0.00	0.16	0.00	0.00	0.00	0.00
Waste Animal Emissions	0.00	0.00	0.00	0.00	11.57	0.00
Wastewater Treatment	0.00	0.32	0.00	0.00	0.06	0.00
DFW Area Total	29.02	290.46	85.59	7.46	36.01	83.50

Table 4-48: 2018 DFW Area Source Emission Inventories by Aggregate Category

DFW Area County	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Agricultural Production	0.29	0.58	5.51	0.00	23.27	5.40
Catastrophic/Accidental Releases	0.00	0.15	0.00	0.00	0.00	0.00
Commercial/Institutional	9.11	95.37	6.55	0.28	0.06	0.15
Construction	0.00	0.00	0.00	0.00	0.00	12.65
Degreasing	0.00	13.61	0.00	0.00	0.00	0.00
Dry Cleaning	0.00	0.08	0.00	0.00	0.00	0.00
Fabricated Metals	0.00	0.95	0.00	0.00	0.00	0.00
Food and Kindred Products	0.00	1.70	2.25	0.00	0.00	6.07
Graphic Arts	0.00	44.96	0.00	0.00	0.00	0.00
Incineration, Burning, and Combustion	0.59	1.19	17.20	0.09	0.00	2.82
Industrial	13.76	8.94	8.95	6.65	0.51	0.44
Landfills	0.00	4.30	0.00	0.00	0.00	0.00
Petroleum Refining, Storage, and Transport	0.00	40.52	0.01	0.00	0.00	0.00
Residential	7.01	6.31	37.62	0.12	0.33	5.39
Roads - Paved and Unpaved	0.00	0.00	0.00	0.00	0.00	47.90
Rubber/Plastics	0.00	2.23	0.00	0.00	0.00	0.00
Secondary Metal Production	0.00	0.00	0.00	0.00	0.00	0.00
Surface Coating	0.00	63.35	0.00	0.00	0.00	0.00
Underground Storage Tanks	0.00	0.32	0.00	0.00	0.00	0.00
Waste Animal Emissions	0.00	0.00	0.00	0.00	11.85	0.00
Wastewater Treatment	0.00	0.36	0.00	0.00	0.07	0.00
DFW Area Total	30.76	284.94	78.09	7.14	36.09	80.82

The activity level for different area source categories differs between weekday and weekend day types. The EPS3 TMPRL module is used to adjust the average weekday emissions by SCC for creating Saturday and Sunday day types. Within each day type, TMPRL also allocates daily totals to each hour. After the CNTLEM and TMPRL adjustments are made, the EPS3 GRDEM module is used to spatially allocate the area source emissions with surrogates that vary based on SCC. For example, residential fuel use emissions are spatially allocated to grid cells as a function of households. The files output from GRDEM are in the binary gridded format required by the photochemical model. The area source output from GRDEM by day type for the 10-county DFW area are summarized for 2006 and 2018, respectively, in Table 4-49: 2006 DFW Area Source Emission Inventories by Day Type and Table 4-50: 2018 DFW Area Source Emission Inventories by Day Type.

Table 4-49: 2006 DFW Area Source Emission Inventories by Day Type

2006 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Monday – Friday Average Weekday	29.02	290.46	85.59	7.46	36.01	83.50
Saturday	22.21	136.92	75.57	5.26	35.81	81.90
Sunday	15.41	88.36	65.69	3.06	35.61	80.34

Table 4-50: 2018 DFW Area Source Emission Inventories by Day Type

2018 Day Type	NO_X (tpd)	VOC (tpd)	CO (tpd)	SO_2 (tpd)	NH_3 (tpd)	$PM_{2.5}$ (tpd)
Monday – Friday Average Weekday	30.76	284.94	78.09	7.14	36.09	80.82
Saturday	23.61	137.45	67.38	5.03	35.92	79.27
Sunday	16.46	88.12	56.79	2.92	35.75	77.75

For the non-DFW areas of Texas, all of the steps described above are similar for the area source emissions inventory development where TexAER datasets from 2008 and 2011 were adjusted to create 2006 and 2018 inventories, respectively. The EPS3 processing for Texas area source emissions is divided into streams for:

- the 10-county DFW area;
- the eight-county HGB area;
- the remaining 236 counties of Texas outside of DFW and HGB.

The complete EPS3 processing streams for all of these areas are available for both 2006 and 2018 at ftp://amdaftp.tceq.texas.gov/pub/Area_EI/2006/ and ftp://amdaftp.tceq.texas.gov/pub/Area_EI/2018/. The following pages contain graphical plots of the 2006 and 2018 area source NO_X and VOC emissions for the DFW area. These plots are respectively entitled Figure 4-16: 2006 DFW Area Source NO_X Emissions Distribution, Figure 4-17: 2006 DFW Area Source VOC Emissions Distribution, Figure 4-18: 2018 DFW Area Source NO_X Emissions Distribution, and Figure 4-19: 2018 DFW Area Source VOC Emissions Distribution. For the non-Texas U.S. areas of the modeling domain, area source emission estimates from the EPA NEI were used. The 2008 NEI was used for the 2006 inputs, and the 2011 NEI was used for the 2018 inputs. The area source emission estimates from these NEI datasets were processed through EPS3 in a manner similar to that described above for the area source emissions within Texas.

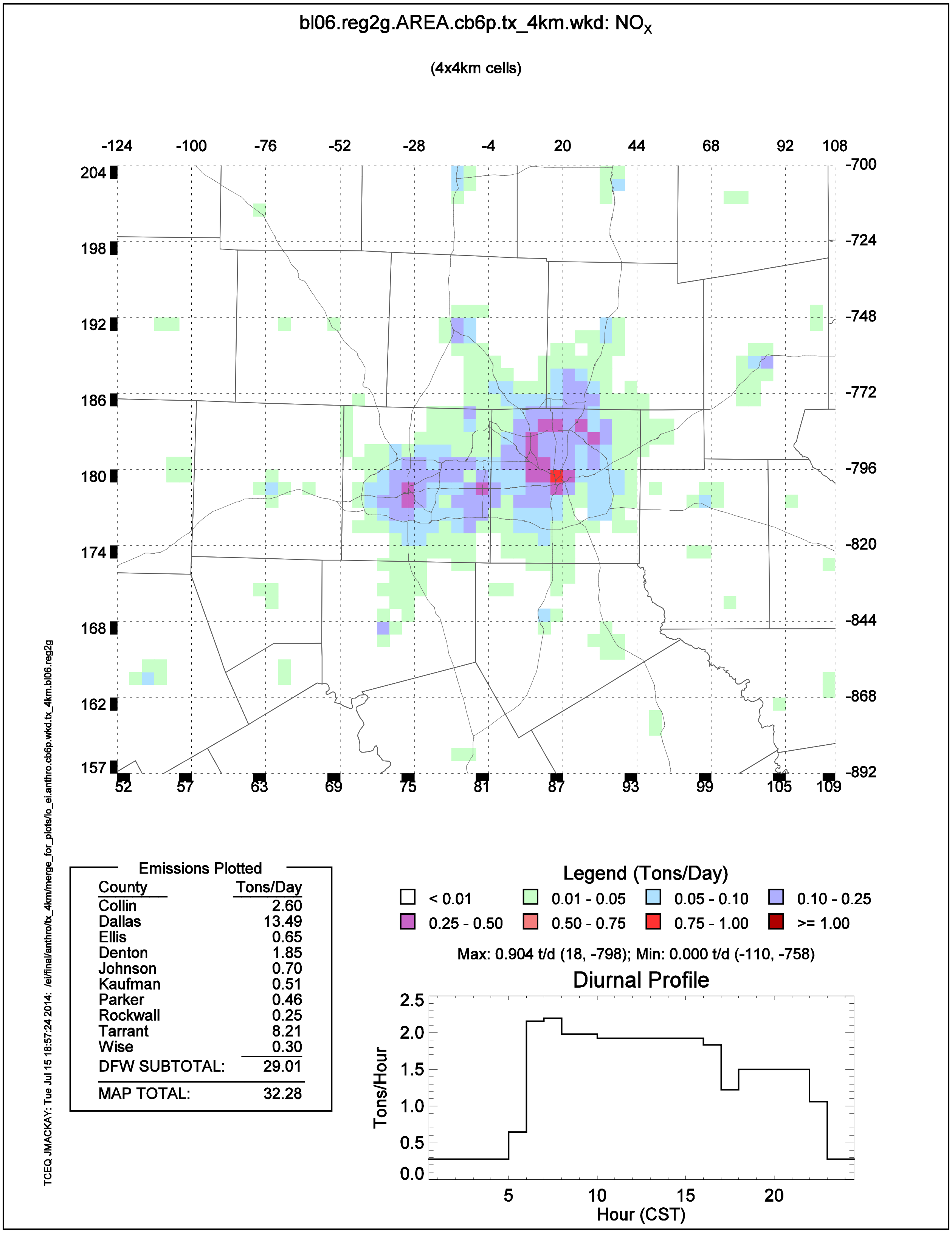

Figure 4-16: 2006 DFW Area Source NO_X Emissions Distribution

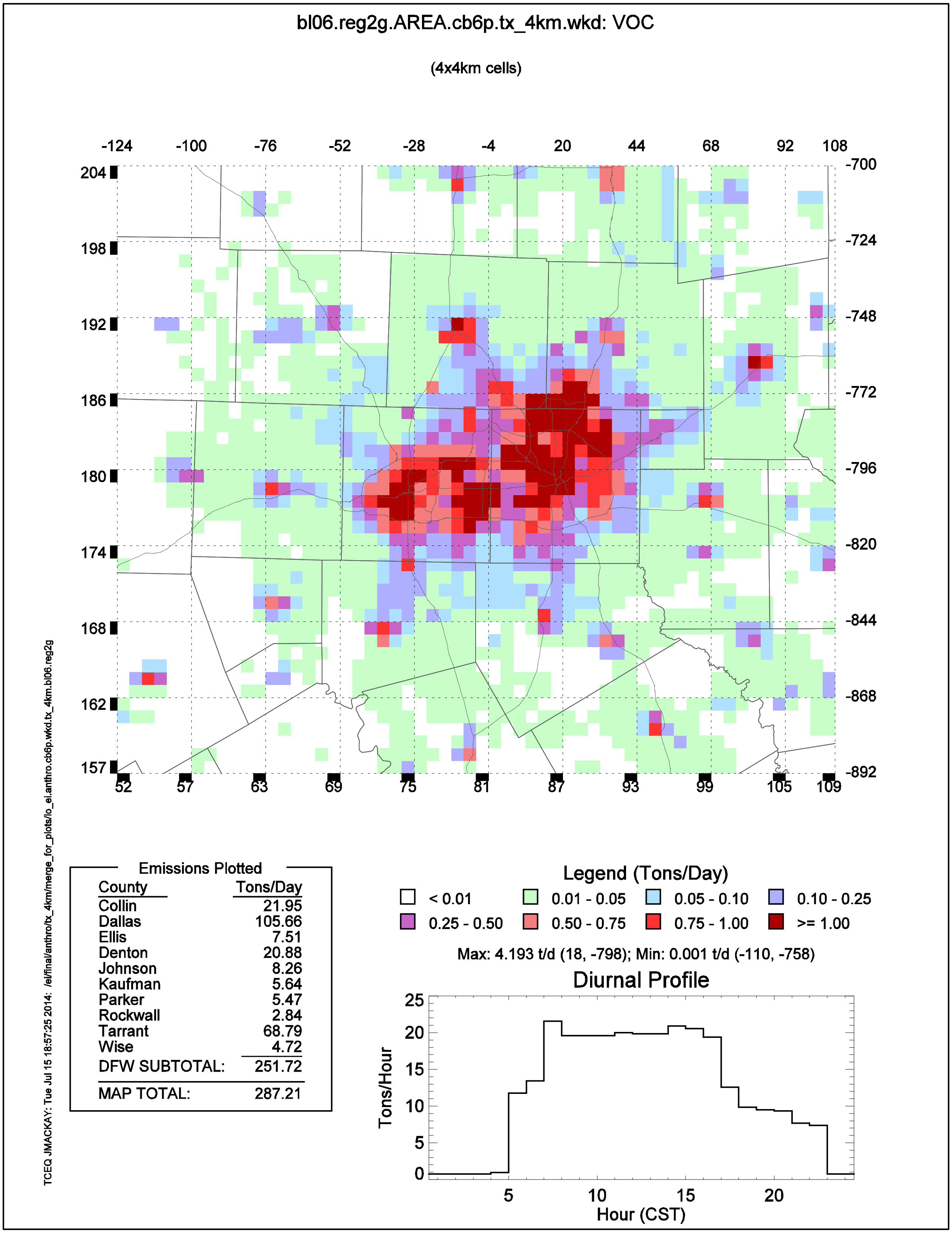

Figure 4-17: 2006 DFW Area Source VOC Emissions Distribution

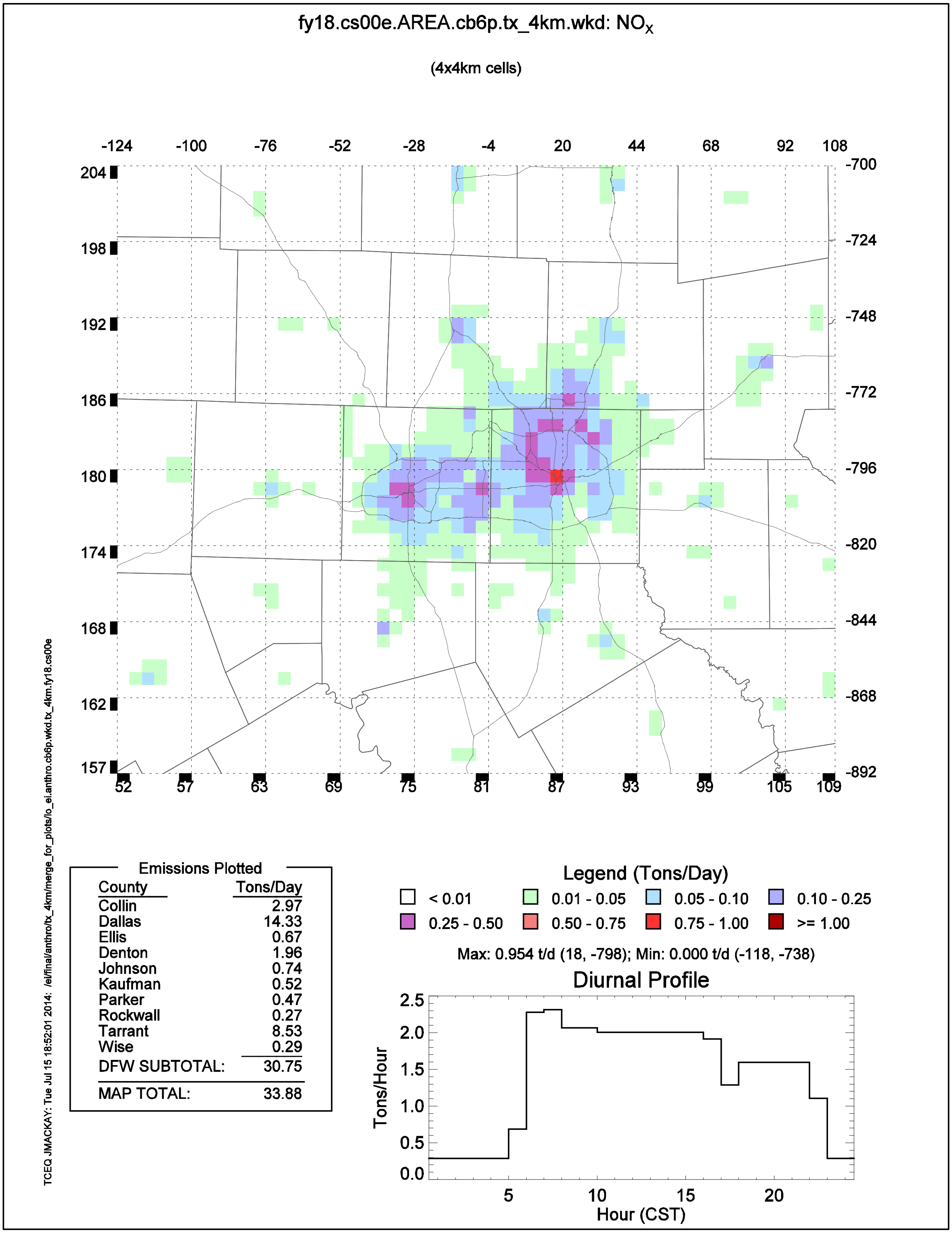

Figure 4-18: 2018 DFW Area Source NO_X Emissions Distribution

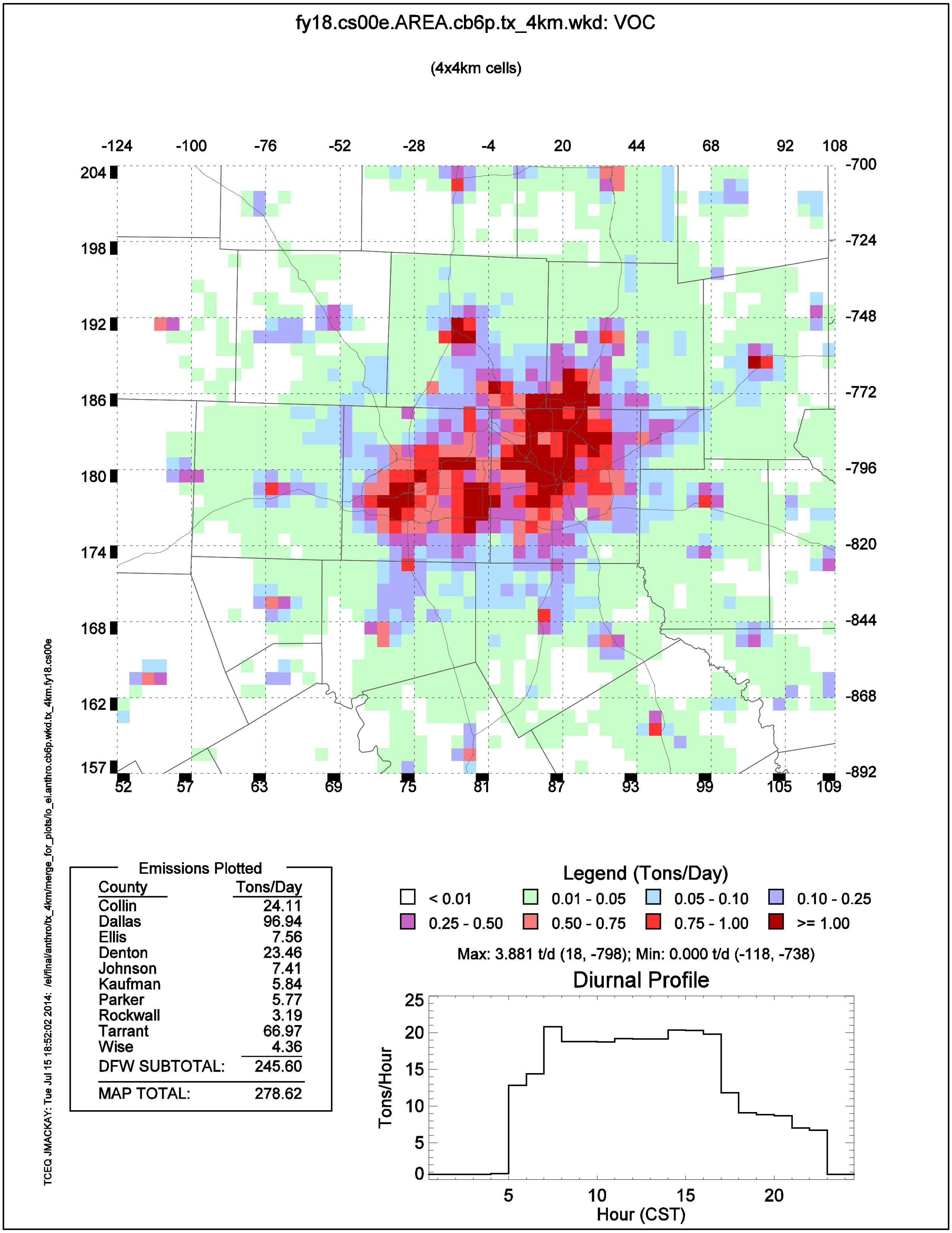

Figure 4-19: 2018 DFW Area Source VOC Emissions Distribution

5. BIOGENIC MODELING EMISSIONS

The TCEQ used version 2.1 of the Model for Emissions of Gases and Aerosols from Nature (MEGAN) (Guenther, et al., 2012). The MEGAN model code, User's Guide, and default input data are available at http://lar.wsu.edu/megan/index.html. The MEGAN model requires inputs by model grid cell area of:

- Emission factors for nineteen chemical compounds or compound groups.
- Plant Functional Types (PFTs).
- Fractional Vegetated Leaf Area Index (LAIv).
- Meteorological information including air and soil temperatures, photosynthetically active radiation (PAR), barometric pressure, wind speed, water vapor mixing ratio and accumulated precipitation.

5.1 Emission Factor and PFT Inputs

The TCEQ used the default emission factors and PFTs that are provided with the model for the entire globe in netCDF format. To process the emission factors and PFTs to the TCEQ air modeling domain structures, raster layers of each emission factor file were created in ArcMap version 9.3 using the *Make NetCDF Raster Layer* tool. The *Zonal Statistics as Table* tool was then used to tabulate averages per grid cell for each compound class and CAMx domain.

5.2 Fractional Vegetated Leaf Area Index Input

Leaf Area Index (LAI) is the one-sided leaf coverage over the same area of land. Fractional vegetated Leaf Area Index (LAIv) is LAI divided by the fraction of land defined as vegetated, and files for every eight-day period of 2008 are provided on the MEGAN website. The TCEQ created 2006-specific LAIv data using the level-4 Moderate-Resolution Imaging Spectroradiometer (MODIS) global LAI MCD15A2 product. For each eight-day period, the satellite tiles covering North America in a Sinusoidal grid were mosaicked together using the MODIS Reprojection Tool (MRT). Urban LAI cells, which MODIS excludes, were filled according to a function that follows the North American average for four urban land cover types. An urban LAI maximum was chosen based on Loughner et al (2012). MODIS' quality control flags were applied to use only the high quality data from the main retrieval algorithm. The resultant LAI was divided by the percentage of vegetated PFT per grid cell to yield the final LAIv.

5.3 Meteorological Input

The Weather Research and Forecasting (WRF) meteorological model provided the meteorological data needed for MEGAN input, except for PAR. The WRF output was processed through the Meteorology-Chemistry Interface Processor (MCIP). The episode-specific satellite-based PAR were obtained from the historical data center operated by the Global Energy and Water Cycle Experiment (GEWEX) Continental International Project (GCIP) and GEWEX Americas Prediction Project (GAPP) at the University of Maryland, which has a full site address of http://metosrv2.umd.edu/~srb/gcip/cgi-bin/historic.cgi. The PAR data were derived from hourly GOES satellite imagery of cloud cover, which were processed with a solar irradiation model (Pinker and Laszlo, 1992).

5.4 Biogenic Emission Summary

The MEGAN model was run for each 2006 episode day. Since biogenic emissions are dependent upon the meteorological conditions on a given day, the same episode-specific emissions for the 2006 baseline were used in the 2018 future case modeling scenarios. The summaries of biogenic emissions by episode day are shown in Table 5-1: Daily Summary of Biogenic Emissions for the June 2006 Episode and Table 5-2: Daily Summary of Biogenic Emissions for the August-September 2006 Episode.

Table 5-1: Daily Summary of Biogenic Emissions for the June 2006 Episode

Episode Day	Isoprene (tons/day)	Monoterpenes (tons/day)	Other VOC (tons/day)	Nitrogen Oxide (tons/day)	Total VOC (tons/day)
5/31/2006	215.84	39.72	119.01	11.64	374.58
6/1/2006	210.25	39.11	116.21	11.32	365.56
6/2/2006	377.91	50.29	171.77	13.82	599.97
6/3/2006	380.30	49.70	171.13	13.54	601.13
6/4/2006	467.68	60.58	201.22	17.40	729.48
6/5/2006	571.09	67.15	231.80	19.05	870.03
6/6/2006	622.20	71.68	252.33	20.23	946.21
6/7/2006	575.44	65.30	234.70	17.85	875.44
6/8/2006	564.75	65.14	233.06	17.92	862.94
6/9/2006	624.09	69.99	251.70	19.38	945.78
6/10/2006	687.47	73.64	265.82	20.22	1026.93
6/11/2006	512.00	64.38	214.69	18.59	791.06
6/12/2006	597.85	67.78	238.48	18.86	904.11
6/13/2006	566.64	65.80	230.37	18.45	862.80
6/14/2006	449.82	53.77	187.85	14.67	691.43
6/15/2006	514.22	61.32	209.33	17.25	784.87
6/16/2006	422.29	56.74	184.59	16.72	663.62
6/17/2006	284.39	46.46	137.32	13.58	468.16
6/18/2006	402.37	51.94	172.93	14.62	627.24
6/19/2006	462.57	56.10	190.84	15.55	709.51
6/20/2006	239.06	44.64	130.08	13.26	413.79
6/21/2006	374.30	54.65	174.27	15.97	603.22
6/22/2006	350.19	54.85	171.18	16.41	576.22
6/23/2006	221.58	45.98	129.08	14.18	396.64
6/24/2006	302.64	49.99	149.02	15.17	501.65
6/25/2006	471.44	58.84	200.56	16.66	730.84
6/26/2006	301.26	43.12	142.10	11.70	486.49
6/27/2006	291.39	41.74	134.71	11.49	467.84
6/28/2006	365.02	48.35	158.81	13.42	572.18
6/29/2006	392.48	51.28	170.41	14.23	614.18
6/30/2006	386.33	53.29	171.68	15.17	611.30
7/1/2006	386.03	52.84	169.97	14.83	608.84
7/2/2006	337.00	49.72	153.85	14.12	540.57

Table 5-2: Daily Summary of Biogenic Emissions for the August-September 2006 Episode

Episode Day	Isoprene (tons/day)	Monoterpenes (tons/day)	Other VOC (tons/day)	Nitrogen Oxide (tons/day)	Total VOC (tons/day)
8/15/2006	588.98	69.50	232.58	18.61	891.05
8/16/2006	683.25	75.31	257.01	19.88	1015.57
8/17/2006	673.03	75.49	255.37	20.22	1003.89
8/18/2006	624.47	74.96	245.79	20.53	945.22
8/19/2006	566.77	70.02	228.30	19.27	865.09
8/20/2006	543.67	68.02	219.99	18.81	831.68
8/21/2006	510.58	63.47	204.54	17.67	778.58
8/22/2006	322.45	51.03	145.91	14.96	519.39
8/23/2006	409.52	53.68	164.71	15.00	627.91
8/24/2006	522.62	64.45	201.85	18.11	788.92
8/25/2006	623.05	70.15	233.54	19.14	926.74
8/26/2006	538.64	65.19	211.70	18.09	815.53
8/27/2006	264.01	44.61	128.78	12.98	437.40
8/28/2006	64.40	28.29	59.85	8.22	152.53
8/29/2006	224.45	38.57	113.42	10.11	376.44
8/30/2006	265.08	40.02	125.45	10.25	430.55
8/31/2006	364.13	49.27	157.06	13.05	570.45
9/1/2006	341.07	49.71	154.27	13.33	545.04
9/2/2006	155.06	37.52	99.47	10.28	292.05
9/3/2006	68.18	27.95	62.04	7.37	158.17
9/4/2006	23.79	20.35	40.23	4.80	84.37
9/5/2006	142.67	30.52	85.08	7.56	258.26
9/6/2006	203.53	33.67	105.31	8.21	342.51
9/7/2006	201.75	34.72	106.52	8.72	342.99
9/8/2006	177.03	36.70	101.28	10.00	315.00
9/9/2006	179.80	38.10	104.43	10.40	322.33
9/10/2006	240.09	42.65	124.92	11.55	407.67
9/11/2006	241.79	42.06	122.53	11.22	406.37
9/12/2006	233.88	39.40	120.21	10.00	393.48
9/13/2006	164.82	29.88	91.07	7.17	285.77
9/14/2006	218.39	35.92	106.26	9.59	360.57
9/15/2006	260.56	46.57	131.23	13.47	438.36

Isoprene and other biogenic VOC emissions were plotted to visually determine the location of emissions matched to known forested areas as shown in Figure 5-1: Biogenic Isoprene Emissions on June 12, 2006 for the 4 km Domain. CAMx output concentrations of the same VOC for the same time period are also plotted to ensure concentrations follow emission magnitudes. An example isoprene concentration plot for June 12, 2006 at 12:00 is displayed in Figure 5-2: Modeled CAMx Isoprene Concentrations for June 12, 2006 at 12:00 CST.

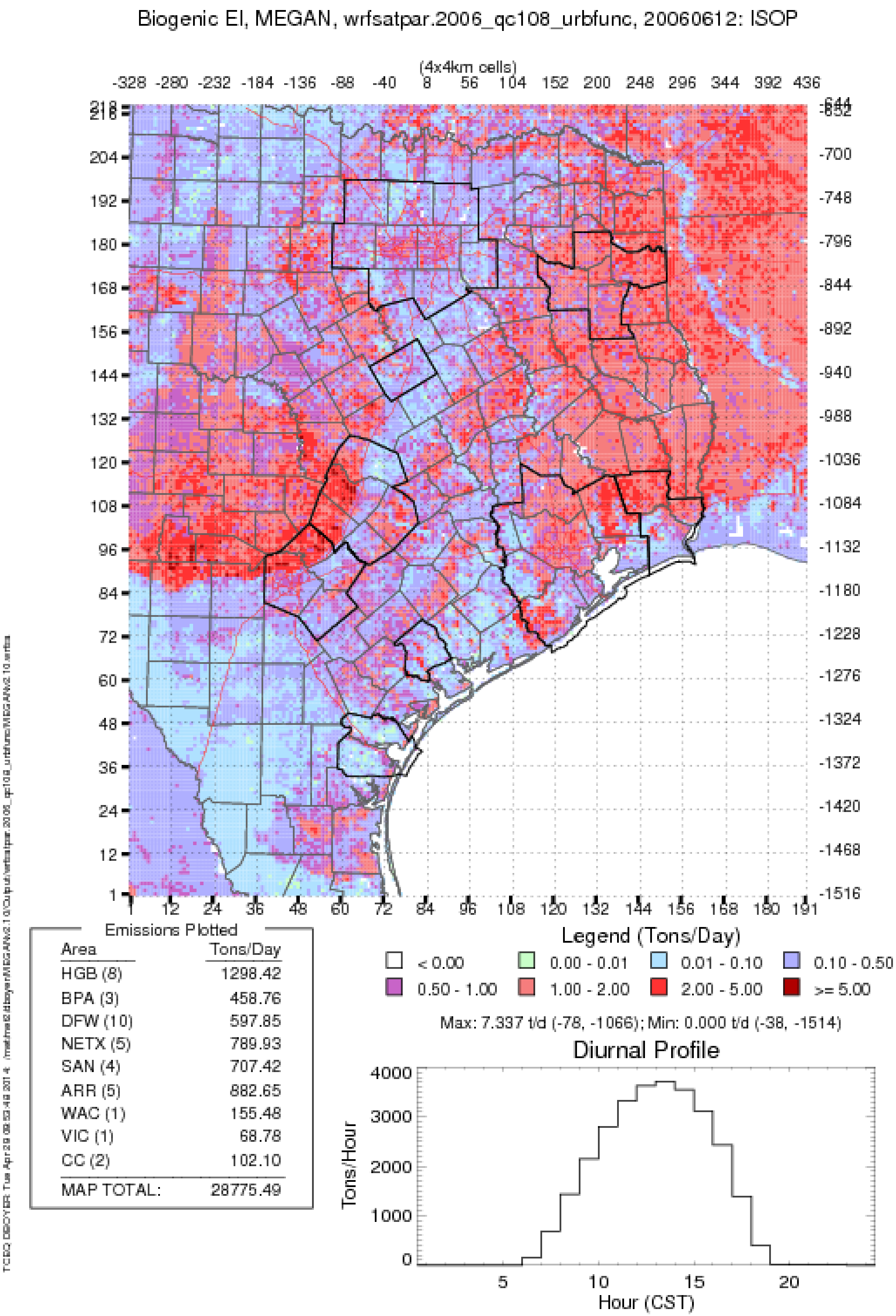

Figure 5-1: Biogenic Isoprene Emissions on June 12, 2006 for the 4 km Domain

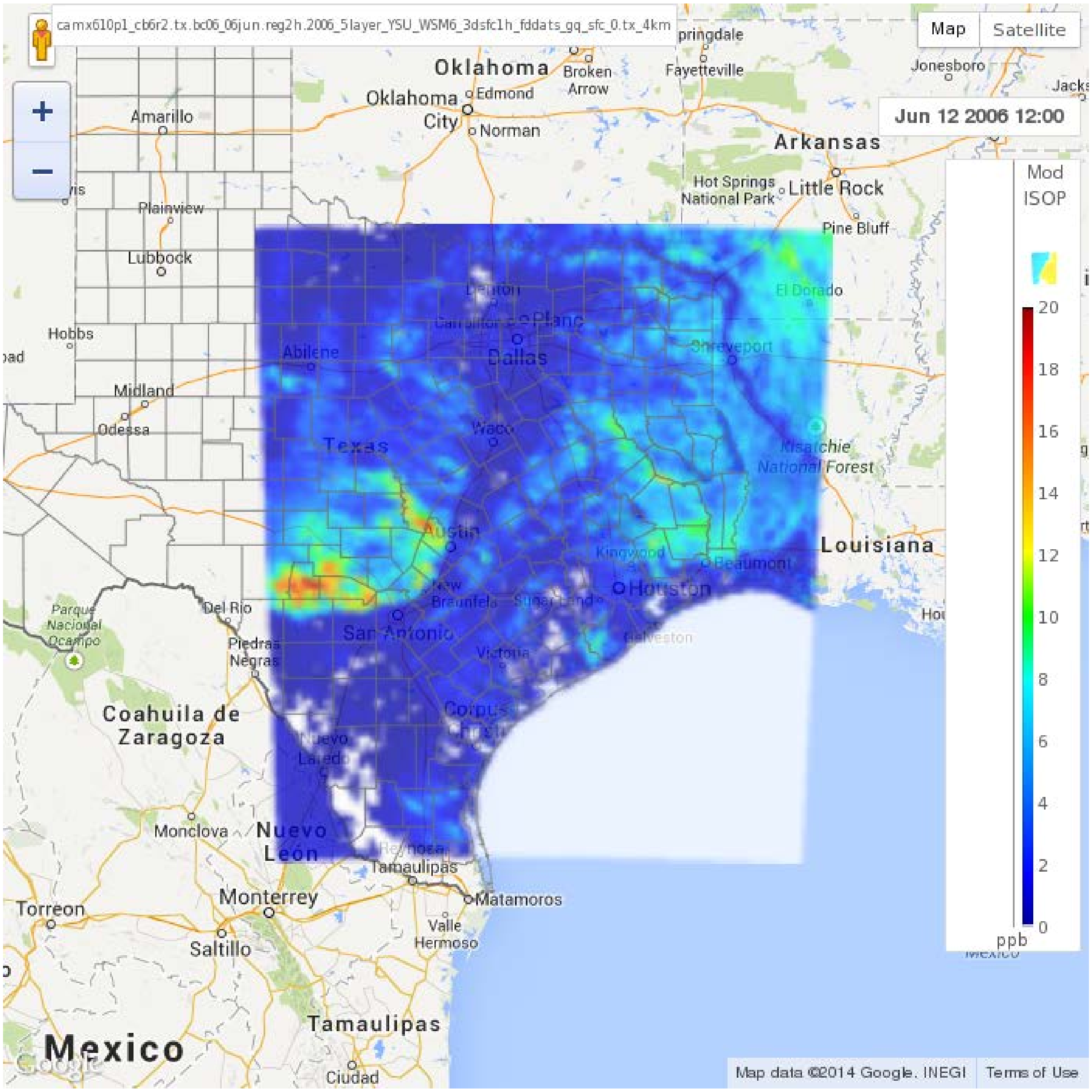

Figure 5-2: Modeled CAMx Isoprene Concentrations for June 12, 2006 at 12:00 CST

6. REFERENCES

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