ATTACHMENT 3

Emissions Inventory Development and Modeling for the August 25-September 1, 2000 Episode

Technical Analysis Division
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Attachment 3

Introduction

This document details the development of the modeling inventory used to model the August 25-September 1, 2000 ozone episode. The modeling is being developed to support the planned 2004 Mid-Course Review, and development on the modeling inventory is continuing. At this writing, the basic modeling inventory for the 8-county nonattainment area is essentially complete, including incorporation of the TexAQS 2000 Special Inventory and on-road emissions developed with MOBILE6. Most remaining work will involve improving the modeling inventory in areas outside the HGA, although some significant improvements are expected to be made in the HGA itself, including more realistic treatment of shipping and aircraft emissions. Outside the HGA, planned inventory enhancements include applying MOBILE6 across the modeling domain, updating area and non-road mobile source emissions, and adjusting biogenic emissions to account for drought and heat stress effects (the latter will also affect emissions in HGA somewhat).

Possibly the most significant changes to the modeling inventory will involve adjustments to the industrial VOC inventory to provide congruence with the findings of the TexAQS 2000 researchers. A preliminary adjustment to olefin emissions was used in the analysis described in the Technical Support Document for the June, 2002 proposed SIP revision, but this adjustment will likely be revised (and probably be extended to other hydrocarbons) in the coming months.

The modeling inventory consists of four major parts: biogenic, on-road mobile, point, and area/nonroad mobile sources. Each section below provides details on the development of one of these categories and, in many cases, refers the reader to supplementary materials developed by TCEQ's contractors. Also included is a discussion of the development of an interim 2007 future case inventory which was used to support the proposed June, 2002 SIP revision.

On-Road Mobile Source Inventory Development

On-Road Mobile Source Inventory Development

Under contract to the TCEQ, the Texas Transportation Institute (TTI) developed link-based MOBILE5b on-road mobile source emission inventories for the entire 8-County HGA nonattainment area for the episode days ranging from August 15 to September 7, 2000. For the purposes of modeling the August 25 - September 1, 2000 base case episode, the link-based inventories from August 22 - September 1, 2000 were chosen. The August 22-24 inventories are for "ramp-up" purposes. At the time that these inventories were developed by TTI, MOBILE6 had not yet been officially released by EPA. Instead, MOBILE5b was used so that initial 2000 base case runs of the photochemical model could proceed. Only on-road mobile source inventories for the 2000 base case were developed with MOBILE5b. During the development process, it was decided to not proceed with a 2007 future case on-road mobile source inventory utilizing MOBILE5b. At the time, the official release of MOBILE6 was imminent and it would have been a waste of both time and resources to proceed with MOBILE5b-based inventories for 2007. A more complete discussion of the development of these MOBILE5b-based inventories can be found in Attachment 3-1, which is a TTI report entitled *Texas Air Quality Study (TxAQS) On-Road Mobile Source Emissions Estimation, August 2001*.

Subsequent to the official release of MOBILE6 by EPA in January of 2002, TTI commenced work on development of MOBILE6-based emissions inventories for the 8-County HGA area. A complete discussion of the 2000 MOBILE6 inventory for the August 22-September 1 episode days can be found in Attachment 3-2, which is a TTI report entitled *2000 On-Road Mobile Source Episode Specific Emissions Inventories for the Houston-Galveston Ozone Nonattainment Area, March 2002*. A similar report detailing the development of the MOBILE6 HGA inventory for 2007 can be found in Attachment 3-3, which is a TTI report entitled *2007 On-Road Mobile Source Episode Specific Emissions Inventories for the Houston-Galveston Ozone Nonattainment Area, March 2002*. On February 4, 2002, HGAC, TCEQ, and TTI staff representatives participated in a conference call to discuss the various inputs which were to be used in the development of the MOBILE6 2000 and 2007 inventories. At the time that they were developed, all of the 8-County HGA emission inventories prepared by TTI were based on the most recently available travel demand model output from HGAC. Both the travel demand model output and the various MOBILE6 inputs which were used to develop these inventories are discussed in greater detail in the TTI reports mentioned above.

For the 3-County Beaumont/Port Arthur (BPA) nonattainment area, TTI also developed 2000 and 2007 MOBILE6 link-based emission inventories which cover the duration of this ozone episode. Upon receipt, these inventories were processed and included with the overall on-road mobile source inventories being input into the photochemical model. A complete discussion of the 2000 MOBILE6 inventory for the BPA area can be found in Attachment 3-7, which is a TTI report entitled *2000 On-Road Mobile Source Emissions Inventories for the Beaumont-Port Arthur Ozone Nonattainment Area, August 2002*. A similar report detailing the development of the MOBILE6 BPA inventory for 2007 can be found in Attachment 3-8, which is a TTI report entitled *2007 On-Road Mobile Source Emissions Inventories for the Beaumont-Port Arthur Ozone Nonattainment Area, August 2002*. TTI has also completed development of 2000 and 2007 "non-link" county-wide MOBILE6 emission inventories for all the counties in Texas outside the HGA

and BPA nonattainment areas. These inventories are currently being processed for inclusion in ongoing efforts to photochemically model this ozone episode.

The MOBILE5b and MOBILE6 emissions inventory summaries are provided below without in-depth discussion of the differences between the two emission models. A satisfactory discussion of the differences between the MOBILE5 and MOBILE6 emission models would be extremely extensive and is not appropriate for inclusion in this summary. Various reports, draft reports, presentations, summaries, etc. on the development of the MOBILE6 model can be accessed on EPA's MOBILE6 web page at http://www.epa.gov/otaq/m6.htm. The MOBILE5 web page can be accessed at http://www.epa.gov/otaq/m5.htm. One of the most obvious differences between the two models is that MOBILE5 reports emission rates for 8 vehicle types, while MOBILE6 breaks out these 8 vehicle types into 28. Table 1 provides a summary of the MOBILE5-MOBILE6 vehicle type relationship. For more detail, refer to the *User's Guide to MOBILE6, January 2002*, which is available on the MOBILE6 website.

Table 1. Summary of MOBILE5 & MOBILE6 Vehicle Types

MOBILE5 Code	***MOBILE6 Code***	***MOBILE6 Description***
LDGV	LDGV	Light-Duty Gasoline Vehicles (Passenger Cars)
LDGT1	LDGT1	Light-Duty Gasoline Trucks 1 (0-6,000 lbs. GVWR, 0-3,750 lbs. LVW)
	LDGT2	Light-Duty Gasoline Trucks 2 (0-6,000 lbs. GVWR, 3,751-5,750 lbs. LVW)
LDGT2	LDGT3	Light-Duty Gasoline Trucks 3 (6,001-8,500 lbs. GVWR, 0-5,750 lbs. ALVW)
	LDGT4	Light-Duty Gasoline Trucks 4 (6,001-8,500 lbs. GVWR, 5,751 lbs. and greater ALVW)
HDGV	HDGV2b	Class 2b Heavy-Duty Gasoline Vehicles (8,501-10,000 lbs. GVWR)
	HDGV3	Class 3 Heavy-Duty Gasoline Vehicles (10,001-14,000 lbs. GVWR)
	HDGV4	Class 4 Heavy-Duty Gasoline Vehicles (14,001-16,000 lbs. GVWR)
	HDGV5	Class 5 Heavy-Duty Gasoline Vehicles (16,001-19,500 lbs. GVWR)
	HDGV6	Class 6 Heavy-Duty Gasoline Vehicles (19,501-26,000 lbs. GVWR)
	HDGV7	Class 7 Heavy-Duty Gasoline Vehicles (26,001-33,000 lbs. GVWR)
	HDGV8a	Class 8a Heavy-Duty Gasoline Vehicles (33,001-60,000 lbs. GVWR)
	HDGV8b	Class 8b Heavy-Duty Gasoline Vehicles (>60,000 lbs. GVWR)
	HDGB	Gasoline Buses (School, Transit and Urban)
LDDV	LDDV	Light-Duty Diesel Vehicles (Passenger Cars)
LDDT	LDDT12	Light-Duty Diesel Trucks 1and 2 (0-6,000 lbs. GVWR)

	LDDT34	Light-Duty Diesel Trucks 3 and 4 (6,001-8,500 lbs. GVWR)
HDDV	HDDV2b	Class 2b Heavy-Duty Diesel Vehicles (8,501-10,000 lbs. GVWR)
	HDDV3	Class 3 Heavy-Duty Diesel Vehicles (10,001-14,000 lbs. GVWR)
	HDDV4	Class 4 Heavy-Duty Diesel Vehicles (14,001-16,000 lbs. GVWR)
	HDDV5	Class 5 Heavy-Duty Diesel Vehicles (16,001-19,500 lbs. GVWR)
	HDDV6	Class 6 Heavy-Duty Diesel Vehicles (19,501-26,000 lbs. GVWR)
	HDDV7	Class 7 Heavy-Duty Diesel Vehicles (26,001-33,000 lbs. GVWR)
	HDDV8a	Class 8a Heavy-Duty Diesel Vehicles (33,001-60,000 lbs. GVWR)
	HDDV8b	Class 8b Heavy-Duty Diesel Vehicles (>60,000 lbs. GVWR)
	HDDBT	Diesel Transit and Urban Buses
	HDDBS	Diesel School Buses
MC	MC	Motorcycles (Gasoline)

Public Access of MOBILE6 Inventory Data

The TCEQ has made various MOBILE6 inventory data available on an FTP site, which can be accessed through a link entitled "On-Road Mobile" on the following website:

http://www.tnrcc.state.tx.us/air/aqp/airquality_photomod.html

The actual FTP site address is not provided here because it could change over the next several months. In the event that the FTP address does change, members of the public will still be able to access the data through the link on the above-referenced web page. If any changes are made to this website address and/or specific on-road mobile source data are not available, please contact Mr. Chris Kite of the TCEQ at ckite@tceq.state.tx.us. Please note that some of the emissions inventory files are extremely large in size, even when stored in a compressed state. Consequently, not all of the inventory files will remain on the FTP site indefinitely. However, many of the smaller files will be kept on the FTP site until such time that they are either replaced with newer data or are no longer needed by members of the public. Currently, the FTP site contains:

- MOBILE6 input and output files from TTI for the 2000 (HG00M6.ZIP) and 2007 (HG07M6.ZIP) inventories;
- tab-delimited summary tables which easily load into spreadsheet software for each day of each episode (aug00tab.ZIP, aug07tab.ZIP, and aug55tab.ZIP);
- gridded emission files suitable for photochemical model input; and
- various other files suitable for the processing of on-road mobile source emissions data.

A "Read Me" file is included on the FTP site which further describes the contents of each file.

Summary of 2000 MOBILE5b Inventory for 8-County HGA Area

Table 2 provides a summary of the total vehicle miles traveled (VMT), NO_x, VOC, and CO MOBILE5b emissions for the entire 8-County HGA area for each day of the episode. Even though Tuesday August 22nd through Thursday August 24th are considered "ramp-up" days for the 2000 episode, they are included in this table. Overall, the Monday-Thursday episodes have very similar VMT totals and are considered to be "average weekdays". As expected, the Friday episodes have the highest total VMT of the week, with the Saturday and Sunday episodes having the least amount of VMT.

Table 2. Summary of VMT, NO_x, VOC, & CO for 2000 MOBILE5b 8-County HGA Inventory

Day of Week	***2000 Episode Day***	***8-County VMT Total***	***Total Emissions*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Tuesday	*August 22, 2000*	119,846,528	309.0	127.8	1,158.0
Wednesday	*August 23, 2000*	120,561,857	311.1	125.5	1,154.7
Thursday	*August 24, 2000*	120,696,020	312.1	127.2	1,160.8
Friday	*August 25, 2000*	131,186,144	301.4	140.3	1,242.9
Saturday	*August 26, 2000*	111,978,544	239.9	119.5	1,053.7
Sunday	*August 27, 2000*	90,323,953	184.2	96.6	857.5
Monday	*August 28, 2000*	117,113,716	303.3	133.9	1,162.8
Tuesday	*August 29, 2000*	118,537,596	306.7	137.8	1,183.7
Wednesday	*August 30, 2000*	120,242,871	310.8	145.1	1,216.6
Thursday	*August 31, 2000*	123,533,499	320.2	157.1	1,284.1
Friday	*September 1, 2000*	133,351,006	306.9	156.8	1,300.1

It would be expected that in addition to having the highest VMT of the week, Fridays would also have the highest emissions levels. However, the NO_X emissions on Fridays are actually lower than some of the Monday-Thursday episodes. This due to the fact that the VMT from heavy-duty diesel vehicles (HDDVs) is lower on Fridays than on Monday-Thursdays, as Table 3 demonstrates. HDDVs are significant NO_X emitters, but contribute rather minor portions of VOC and CO.

Table 3. Distribution of 2000 HGA VMT by MOBILE5 Vehicle Type & Day of Week

MOBILE5 Vehicle Type	***8-County VMT Distribution***			
	Weekday	*Friday*	*Saturday*	*Sunday*
LDGV	61.2%	66.4%	68.9%	65.1%
LDGT1	24.4%	22.6%	22.4%	26.8%
LDGT2	4.9%	4.6%	4.3%	4.9%
HDGV	3.2%	1.9%	1.3%	0.9%
LDDV	0.1%	0.2%	0.2%	0.2%
LDDT	0.2%	0.2%	0.2%	0.2%
HDDV	5.9%	4.0%	2.7%	1.9%
MC	0.1%	0.1%	0.1%	0.1%
Total	100.0%	100.0%	100.0%	100.0%

For the purposes of detailing on-road mobile source emissions, it is often desirable to choose a single "average weekday". As Table 4 indicates, if the VMT, NO_X, VOC, and CO from the Monday-Thursday episodes from August 28-31 are averaged together, the Wednesday August 30th episode day is the one which ends up most closely conforming to the average for each of these parameters. Therefore, for the purposes of this documentation, the Wednesday August 30th episode day has been selected as the sample "average weekday" for detailing the on-road mobile source inventory in the 8-County HGA area. By coincidence, the highest monitored hourly ozone value of this episode (199 ppb) occurred on Wednesday August 30, 2000.

Table 4. HGA "Average Weekday" VMT, NO_X, VOC, & CO MOBILE5b Emissions for 2000

Comparison of Each Weekday to Average		***8-County VMT Total***	***Emission Totals*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Average of 4 Weekdays		119,856,921	310.2	143.5	1,211.8
Monday	*August 28, 2000*	-2.3%	-2.2%	-6.7%	-4.0%
Tuesday	*August 29, 2000*	-1.1%	-1.2%	-3.9%	-2.3%
Wednesday	*August 30, 2000*	0.3%	0.2%	1.1%	0.4%
Thursday	*August 31, 2000*	3.1%	3.2%	9.5%	6.0%

Table 5 summarizes the contributions of the eight MOBILE5 vehicle types to the overall inventory for Wednesday August 30, 2000. Notice that the HDDV class is a significant NO_X contributor, but a relatively minor VOC and CO contributor, while the light-duty gasoline vehicles comprise roughly 90% of the overall VMT from the fleet.

Table 5. HGA Vehicle Type Summary of 2000 MOBILE5b Wednesday August 30th Inventory

MOBILE5 Vehicle Type	***8-County VMT***		***Total Emissions*** *(tons per day)*		
	Total	***Distribution***	*NO_X*	*VOC*	*CO*
LDGV	73,590,377	61.2%	123.6	77.0	622.4
LDGT1	29,285,492	24.4%	55.2	36.7	331.4
LDGT2	5,902,683	4.9%	9.8	6.3	59.8
HDGV	3,873,547	3.2%	23.1	13.9	145.4
LDDV	175,673	0.1%	0.3	0.1	0.2
LDDT	198,670	0.2%	0.4	0.1	0.2
HDDV	7,096,187	5.9%	98.3	10.3	54.8
MC	120,243	0.1%	0.1	0.8	2.5
Total	120,242,871	100.0%	310.8	145.1	1,216.6

Table 6 summarizes the distribution of VMT, NO_X, VOC, and CO among the eight counties in the HGA nonattainment area for the Wednesday August 30, 2000 episode day. As expected, Harris County is the largest single contributor among all eight counties in the area.

Table 6. Summary of 2000 HGA MOBILE5b Wednesday August 30th Inventory by County

County	***VMT***		***Total Emissions*** *(tons per day)*		
	Total	***Distribution***	*NO_X*	*VOC*	*CO*
Brazoria	5,213,317	4.3%	16.0	7.3	69.6
Chambers	2,053,470	1.7%	7.0	2.6	32.5
Fort Bend	6,715,324	5.6%	21.5	9.1	84.6
Galveston	5,742,494	4.8%	16.7	8.2	80.5
Harris	89,631,427	74.5%	209.2	102.5	790.7
Liberty	2,012,059	1.7%	7.3	2.9	30.4
Montgomery	7,173,226	6.0%	26.1	9.8	98.7
Waller	1,701,554	1.4%	7.0	2.6	29.7
Total	120,242,871	100.0%	310.8	145.1	1,216.6

<u>Summary of 2000 MOBILE6 Inventory for 8-County HGA Area</u>

Table 7 summarizes the VMT, NO_X, VOC, and CO MOBILE6 emissions for each of the August 22-September 1, 2000 episode days. When developing the MOBILE5b inventory, it was decided to use HPMS adjustment factors to the link-based inventory for each individual episode day. This approach has the benefit of making the overall VMT unique to each episode day. However, it also has the drawback of possibly introducing statistical "noise" from the HPMS data to estimated VMT for each episode day. When developing the MOBILE6 inventory, it was decided to develop "average" August 2000 HPMS adjustment factors for Monday-Thursday, Friday, Saturday, and Sunday episode days. This process is explained in more detail starting on page 4 of Attachment 3-2. Consequently, all of the Monday-Thursday episode days have the same total VMT, and both of

the Friday episode days have the same total VMT.

Table 7. Summary of VMT, NO_X, VOC, & CO for 2000 MOBILE6 8-County HGA Inventory

Day of Week	***2000 Episode Day***	***8-County VMT Total***	***Total Emissions*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Tuesday	*August 22, 2000*	124,033,918	243.9	137.6	1,954.5
Wednesday	*August 23, 2000*	124,033,918	242.1	135.5	1,885.4
Thursday	*August 24, 2000*	124,033,918	242.0	135.1	1,872.2
Friday	*August 25, 2000*	135,297,532	224.6	154.9	2,134.9
Saturday	*August 26, 2000*	111,965,181	158.2	113.4	1,708.0
Sunday	*August 27, 2000*	92,456,016	121.0	93.8	1,457.5
Monday	*August 28, 2000*	124,033,918	245.2	143.6	2,025.5
Tuesday	*August 29, 2000*	124,033,918	245.3	145.1	2,035.9
Wednesday	*August 30, 2000*	124,033,918	245.8	149.5	2,095.6
Thursday	*August 31, 2000*	124,033,918	246.9	155.0	2,167.0
Friday	*September 1, 2000*	135,297,532	228.2	165.8	2,323.0

Even though both the MOBILE5b and MOBILE6 emission inventories are for the August 2000 episode, different travel demand model results were used to predict the VMT for each hour and roadway link. It is standard practice to use the most recently available travel demand model output at the time that a mobile source inventory is developed. Between the time that the MOBILE5b and MOBILE6 2000 inventories were developed by TTI, newer travel demand model output became available from HGAC and this accounts for the overall VMT differences between the two inventories.

For episode days with the same VMT, the reason for the relatively minor overall differences in NO_X, VOC, and CO emissions is due to the different hourly temperature and absolute humidity inputs distinct to each episode day. These inputs are included in Appendices E and F of the TTI 2000 MOBILE6 report, which is included as Attachment 3-2. The hourly temperatures specific to each episode day were developed by obtaining county-wide averages from various monitoring locations throughout the 8-County area. A similar approach was taken with relative humidity and barometric pressure data, which were used to develop the absolute humidity inputs. The temperature and humidity raw data and associated calculations are included in the following Excel spreadsheets available as a zipped file named “mobile_hg_met_data.zip” through the FTP site referenced above:

- hg-aug-2000-temp.xls; and
- hg-aug-2000-hum.xls.

A more complete discussion of the humidity inputs is provided later. For the SUNRISE/SUNSET command in MOBILE6, TCEQ staff accessed local sunrise and sunset times for each day of the August 2000 episode from the U.S. Naval Observatory Astronomical Applications Department website at http://aa.usno.navy.mil/. The data were converted to the nearest hour and 6:00 AM

Central Standard Time (CST) and 7:00 AM Central Daylight Time (CDT) became the sunrise inputs for each day, while the sunset inputs for each day were 7:00 PM CST and 8:00 PM CDT.

Even though the two Friday episodes have the highest VMT, the NO_X emissions for these days are actually lower than the Monday-Thursday episodes. As with the MOBILE5b inventory, the reason for the lower NO_X is that the VMT contributed from heavy-duty diesel vehicles is lower on Fridays than on the other weekdays. Table 8 summarizes the distribution of VMT by each of the 28 vehicle types found in MOBILE6 for each of the Monday-Thursday, Friday, Saturday, and Sunday "day types".

Table 8. Distribution of 2000 HGA VMT by MOBILE6 Vehicle Type & Day of Week

MOBILE6	***8-County VMT Distribution***			
Vehicle Type	***Weekday***	***Friday***	***Saturday***	***Sunday***
LDGV	61.37%	66.67%	69.35%	65.57%
LDGT1	5.63%	5.22%	5.16%	6.16%
LDGT2	18.73%	17.37%	17.17%	20.49%
LDGT3	3.39%	3.17%	2.95%	3.37%
LDGT4	1.56%	1.46%	1.35%	1.55%
HDGV2b	1.59%	0.92%	0.58%	0.39%
HDGV3	0.60%	0.35%	0.22%	0.15%
HDGV4	0.28%	0.16%	0.10%	0.07%
HDGV5	0.12%	0.07%	0.04%	0.03%
HDGV6	0.29%	0.16%	0.10%	0.07%
HDGV7	0.11%	0.07%	0.04%	0.03%
HDGV8a	0.11%	0.06%	0.04%	0.03%
HDGV8b	0.01%	0.01%	0.00%	0.00%
LDDV	0.14%	0.15%	0.16%	0.15%
LDDT12	0.02%	0.02%	0.02%	0.02%
HDDV2b	1.40%	0.94%	0.60%	0.41%
HDDV3	0.73%	0.49%	0.31%	0.21%
HDDV4	0.43%	0.29%	0.18%	0.12%
HDDV5	0.28%	0.19%	0.12%	0.08%
HDDV6	0.88%	0.59%	0.38%	0.25%
HDDV7	0.58%	0.39%	0.25%	0.17%
HDDV8a	0.98%	0.66%	0.42%	0.29%
HDDV8b	0.25%	0.17%	0.11%	0.07%
MC	0.10%	0.10%	0.10%	0.10%
HDGB	0.06%	0.04%	0.02%	0.02%
HDDBT	0.10%	0.07%	0.04%	0.03%
HDDBS	0.15%	0.10%	0.06%	0.04%
LDDT34	0.11%	0.11%	0.10%	0.12%
Total	100.00%	100.00%	100.00%	100.00%

As previously mentioned with the MOBILE5b inventory, it is desirable to focus on an "average weekday" for the purposes of detailing on-road mobile source emissions for a specific regional

area. Similar to the work presented above in Table 4, Table 9 averaged the VMT, NO_X, VOC, and CO MOBILE6 emissions for the Monday August 28 through the Thursday August 31, 2000 inventories. It ended up that the Wednesday August 30, 2000 inventory most closely conformed to the average of these four weekdays for each of these parameters. Therefore, Wednesday August 30, 2000 will be the "average weekday" for MOBILE6 discussion purposes.

Table 9. HGA "Average Weekday" VMT, NO_X, VOC, & CO MOBILE6 Emissions for 2000

Comparison of Each Weekday to Average		***8-County VMT Total***	***Total Emissions*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Average of 4 Weekdays		124,033,918	245.8	148.3	2,081.0
Monday	*August 28, 2000*	0.0%	0.2%	3.2%	2.7%
Tuesday	*August 29, 2000*	0.0%	0.2%	2.1%	2.2%
Wednesday	*August 30, 2000*	0.0%	0.0%	-0.8%	-0.7%
Thursday	*August 31, 2000*	0.0%	-0.4%	-4.5%	-4.1%

Table 10 presents a summary of the VMT, NO_X, VOC, & CO MOBILE6 emissions for the entire 8-County HGA area by each of the 28 MOBILE6 vehicle types for the Wednesday August 30, 2000 episode day.

Table 10. HGA Vehicle Type Summary of 2000 MOBILE6 Wednesday August 30th Inventory

MOBILE6 Vehicle Type	***8-County VMT***		***Total Emissions*** *(tons per day)*		
	Total	***Distribution***	*NO_X*	*VOC*	*CO*
LDGV	76,121,686	61.37%	82.8	91.8	1,274.2
LDGT1	6,979,806	5.63%	7.0	9.4	135.1
LDGT2	23,235,581	18.73%	28.6	32.1	467.1
LDGT3	4,207,284	3.39%	4.3	3.7	67.0
LDGT4	1,934,775	1.56%	2.5	1.8	31.3
HDGV2b	1,973,926	1.59%	10.4	2.1	28.9
HDGV3	742,627	0.60%	4.5	1.0	16.9
HDGV4	342,454	0.28%	1.9	0.5	6.6
HDGV5	146,218	0.12%	1.1	0.5	7.4
HDGV6	354,000	0.29%	2.7	1.1	15.6
HDGV7	142,366	0.11%	1.1	0.4	6.0
HDGV8a	130,827	0.11%	1.2	0.5	8.8
HDGV8b	15,391	0.01%	0.2	0.0	0.3
LDDV	174,398	0.14%	0.4	0.1	0.3
LDDT12	27,566	0.02%	0.1	0.1	0.1
HDDV2b	1,733,013	1.40%	8.9	0.4	1.6
HDDV3	904,178	0.73%	5.7	0.2	1.0
HDDV4	527,438	0.43%	3.9	0.2	0.7
HDDV5	342,492	0.28%	2.8	0.1	0.5
HDDV6	1,089,127	0.88%	13.7	0.5	2.0

HDDV7	719,233	0.58%	11.3	0.5	1.7
HDDV8a	1,219,275	0.98%	33.5	1.0	6.0
HDDV8b	315,094	0.25%	9.6	0.2	1.3
MC	124,034	0.10%	0.1	0.5	2.6
HDGB	79,520	0.06%	0.7	0.6	11.2
HDDBT	126,517	0.10%	3.4	0.1	0.8
HDDBS	182,862	0.15%	3.1	0.1	0.5
LDDT34	142,234	0.11%	0.2	0.1	0.1
Total	124,033,918	100.00%	245.8	149.5	2,095.6

Table 11 presents a summary of the VMT, NO_X, VOC, and CO MOBILE6 emissions for each of the eight counties in the HGA area. As expected, Harris County accounts for roughly 70-75% of the estimated VMT, NO_X, VOC, and CO from the entire HGA nonattainment area.

Table 11. Summary of 2000 HGA MOBILE6 Wednesday August 30th Inventory by County

County	***VMT***		***Total Emissions*** *(tons per day)*		
	Total	***Distribution***	*NO_X*	*VOC*	*CO*
Brazoria	5,666,101	4.6%	11.8	7.2	108.4
Chambers	2,231,815	1.8%	5.7	2.9	50.7
Fort Bend	6,881,975	5.5%	13.8	8.2	122.8
Galveston	6,241,237	5.0%	12.8	8.3	117.3
Harris	91,855,778	74.1%	177.0	107.9	1,459.6
Liberty	2,061,992	1.7%	4.6	2.9	45.0
Montgomery	7,351,240	5.9%	15.8	9.2	147.3
Waller	1,743,780	1.4%	4.2	2.8	44.5
Total	124,033,918	100.0%	245.8	149.5	2,095.6

Summary of 2000 MOBILE6 Inventory for 3-County BPA Area

In addition to developing an 8-County HGA MOBILE6 inventory for the August 2000 episode, TTI also used MOBILE6 to develop 3-County BPA area inventories for the same episode. Provided below are tables for the 3-County BPA area which are very similar to those presented above for the 8-County HGA area. As with the MOBILE6 HGA inventories for 2000, the Wednesday August 30th episode day in BPA most closely conforms to the average VMT, NO_X, VOC, and CO from the Monday-Thursday day types throughout the 2000 ozone episode. Thus, the 2000 Wednesday August 30th episode day was chosen as the sample day for presentation purposes. In lieu of repeating much of the same language presented above for the 2000 MOBILE6 HGA inventory, the tables below are simply presented with no added discussion.

Table 12. Summary of VMT, NO_X, VOC, & CO for 2000 MOBILE6 3-County BPA Inventory

Day of Week	***2000 Episode Day***	***3-County VMT Total***	***Total Emissions*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Tuesday	*August 22, 2000*	11,873,828	34.2	18.6	246.8
Wednesday	*August 23, 2000*	11,873,828	34.1	18.4	242.1
Thursday	*August 24, 2000*	11,873,828	33.9	17.7	230.6
Friday	*August 25, 2000*	13,841,617	32.7	22.7	289.8
Saturday	*August 26, 2000*	11,609,049	22.3	17.0	232.0
Sunday	*August 27, 2000*	10,031,217	17.0	14.8	207.3
Monday	*August 28, 2000*	11,873,828	34.3	19.4	255.5
Tuesday	*August 29, 2000*	11,873,828	34.3	19.8	258.2
Wednesday	*August 30, 2000*	11,873,828	34.4	20.8	269.4
Thursday	*August 31, 2000*	11,873,828	34.5	21.6	278.6
Friday	*September 1, 2000*	13,841,617	33.1	23.9	312.4

Table 13. Distribution of 2000 BPA VMT by MOBILE6 Vehicle Type & Day of Week

MOBILE6 Vehicle Type	***3-County VMT Distribution***			
	Weekday	***Friday***	***Saturday***	***Sunday***
LDGV	49.99%	56.28%	59.78%	56.01%
LDGT1	6.92%	6.63%	6.68%	7.90%
LDGT2	23.03%	22.08%	22.24%	26.30%
LDGT3	3.27%	3.16%	2.99%	3.39%
LDGT4	1.50%	1.45%	1.37%	1.56%
HDGV2b	2.03%	1.23%	0.80%	0.54%
HDGV3	1.00%	0.60%	0.39%	0.27%
HDGV4	0.43%	0.26%	0.17%	0.11%
HDGV5	0.27%	0.16%	0.11%	0.07%
HDGV6	1.02%	0.62%	0.40%	0.27%
HDGV7	0.28%	0.17%	0.11%	0.07%
HDGV8a	0.32%	0.19%	0.13%	0.09%
HDGV8b	0.01%	0.00%	0.00%	0.00%
LDDV	0.11%	0.13%	0.14%	0.13%
LDDT12	0.03%	0.03%	0.03%	0.03%
HDDV2b	2.37%	1.68%	1.10%	0.75%
HDDV3	0.95%	0.67%	0.44%	0.30%
HDDV4	0.53%	0.38%	0.25%	0.17%
HDDV5	0.31%	0.22%	0.14%	0.10%
HDDV6	1.25%	0.89%	0.58%	0.39%
HDDV7	0.60%	0.42%	0.28%	0.19%
HDDV8a	1.70%	1.21%	0.79%	0.53%
HDDV8b	1.48%	1.05%	0.69%	0.46%
MC	0.10%	0.10%	0.10%	0.10%
HDGB	0.08%	0.05%	0.03%	0.02%
HDDBT	0.12%	0.08%	0.05%	0.04%
HDDBS	0.17%	0.12%	0.08%	0.05%
LDDT34	0.14%	0.14%	0.14%	0.16%
Total	100.00%	100.00%	100.00%	100.00%

Table 14. BPA "Average Weekday" VMT, NO_X, VOC, & CO MOBILE6 Emissions for 2000

Comparison of Each Weekday to Average		***3-County VMT Total***	***Total Emissions*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Average of 4 Weekdays		11,873,828	34.4	20.4	265.4
Monday	*August 28, 2000*	0.0%	0.2%	4.8%	3.7%
Tuesday	*August 29, 2000*	0.0%	0.2%	3.1%	2.7%
Wednesday	*August 30, 2000*	0.0%	-0.1%	-2.1%	-1.5%
Thursday	*August 31, 2000*	0.0%	-0.3%	-5.9%	-5.0%

Table 15. BPA Vehicle Type Summary of 2000 MOBILE6 Wednesday August 30th Inventory

MOBILE6 Vehicle Type	***3-County VMT***		***Total Emissions*** *(tons per day)*		
	Total	***Distribution***	*NO_X*	*VOC*	*CO*
LDGV	5,935,398	49.99%	7.10	10.50	129.78
LDGT1	821,516	6.92%	0.96	1.64	21.64
LDGT2	2,734,805	23.03%	3.81	5.58	74.13
LDGT3	388,516	3.27%	0.44	0.49	7.92
LDGT4	178,664	1.50%	0.25	0.23	3.68
HDGV2b	240,487	2.03%	1.37	0.37	5.46
HDGV3	118,657	1.00%	0.77	0.25	4.44
HDGV4	50,762	0.43%	0.32	0.12	1.71
HDGV5	31,727	0.27%	0.24	0.13	2.08
HDGV6	121,195	1.02%	0.94	0.50	8.12
HDGV7	32,996	0.28%	0.29	0.16	2.73
HDGV8a	38,072	0.32%	0.35	0.19	3.32
HDGV8b	635	0.01%	0.01	0.00	0.02
LDDV	13,604	0.11%	0.03	0.01	0.02
LDDT12	3,245	0.03%	0.01	0.01	0.01
HDDV2b	281,559	2.37%	1.38	0.05	0.24
HDDV3	112,405	0.95%	0.68	0.03	0.12
HDDV4	63,296	0.53%	0.45	0.02	0.07
HDDV5	37,105	0.31%	0.29	0.01	0.05
HDDV6	148,418	1.25%	1.83	0.07	0.25
HDDV7	70,935	0.60%	1.09	0.04	0.16
HDDV8a	201,893	1.70%	5.73	0.17	1.08
HDDV8b	175,701	1.48%	5.32	0.08	0.44
MC	11,874	0.10%	0.01	0.05	0.24
HDGB	8,920	0.08%	0.08	0.07	1.50
HDDBT	14,192	0.12%	0.34	0.01	0.09
HDDBS	20,512	0.17%	0.32	0.02	0.05
LDDT34	16,741	0.14%	0.02	0.01	0.02
Total	11,873,828	100.00%	34.42	20.82	269.36

Table 16. Summary of 2000 BPA MOBILE6 Wednesday August 30th Inventory by County

County	***VMT***		***Total Emissions*** *(tons per day)*		
	Total	***Distribution***	*NO_X*	*VOC*	*CO*
Hardin	1,406,934	11.8%	3.3	2.5	32.1
Jefferson	7,568,804	63.7%	22.5	13.3	170.8
Orange	2,898,089	24.4%	8.6	5.1	66.5
Total	11,873,827	100.0%	34.4	20.8	269.4

Summary of 2007 MOBILE6 Inventory for 8-County HGA Area

In addition to developing an 8-County HGA MOBILE6 inventory for the August 2000 episode, TTI also used MOBILE6 to develop 2007 projected inventories for each episode day for the following two scenarios:

- speed limits on all roadways in the 8-County HGA area consistent with those used for the 2000 inventory; and
- 55 mph speed limits for all roadways which had posted speed limits of 55 mph or above in the 8-County HGA area for the 2000 inventory.

The purpose of developing the 55 mph scenario was to determine the estimated MOBILE6 benefits which could be obtained if all vehicle types were subjected to a 55 mph speed limit. These benefits are discussed later in this summary, and more detail can be obtained in Attachment 3-3 beginning on page 56.

The following discussion will focus on the non-55 mph speed limit scenario, which will simply be referred to as the 2007 future case MOBILE6 inventory. Provided below are tables very similar to those above when the MOBILE6 2000 inventory was presented. The primary changes in the figures are due to the expected increase in projected VMT and the expected reduction in MOBILE6 emissions rates as individual vehicle types become "cleaner" due to fleet turnover. As with the MOBILE5b and MOBILE6 inventories for 2000, the Wednesday August 30th episode day for 2007 most closely conforms to the average VMT, NO_X, VOC, and CO from the Monday-Thursday day types in the 2007 inventory. Thus, the 2007 Wednesday August 30th episode day was chosen as the sample day for presentation purposes. In lieu of repeating much of the same language presented above for the 2000 MOBILE6 inventory, the tables below are simply presented with no added discussion.

Table 17. Summary of VMT, NO_X, VOC, & CO for 2007 MOBILE6 8-County HGA Inventory

Day of Week	***2007 Episode Day***	***8-County VMT Total***	***Total Emissions*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Tuesday	*August 22nd*	133,274,706	144.4	77.1	1,184.5
Wednesday	*August 23rd*	133,274,706	143.4	76.4	1,156.0
Thursday	*August 24th*	133,274,706	143.4	76.3	1,151.3
Friday	*August 25th*	145,378,096	130.7	86.2	1,299.8
Saturday	*August 26th*	120,306,412	90.9	62.8	1,026.8
Sunday	*August 27th*	99,344,645	69.2	51.7	866.1
Monday	*August 28th*	133,274,706	145.6	79.7	1,205.9
Tuesday	*August 29th*	133,274,706	145.6	80.5	1,207.5
Wednesday	*August 30th*	133,274,706	146.0	82.4	1,225.5
Thursday	*August 31st*	133,274,706	146.9	84.9	1,244.9
Friday	*September 1st*	145,378,096	133.0	90.8	1,365.4

Table 18. Distribution of 2007 HGA VMT by MOBILE6 Vehicle Type & Day of Week

MOBILE6 Vehicle Type	***8-County VMT Distribution***			
	Weekday	***Friday***	***Saturday***	***Sunday***
LDGV	61.29%	66.59%	69.29%	65.49%
LDGT1	5.65%	5.25%	5.19%	6.19%
LDGT2	18.82%	17.46%	17.26%	20.59%
LDGT3	3.42%	3.20%	2.97%	3.40%
LDGT4	1.57%	1.47%	1.36%	1.56%
HDGV2b	1.60%	0.92%	0.58%	0.40%
HDGV3	0.60%	0.35%	0.22%	0.15%
HDGV4	0.28%	0.16%	0.10%	0.07%
HDGV5	0.12%	0.07%	0.04%	0.03%
HDGV6	0.29%	0.17%	0.10%	0.07%
HDGV7	0.12%	0.07%	0.04%	0.03%
HDGV8a	0.11%	0.06%	0.04%	0.03%
HDGV8b	0.01%	0.01%	0.00%	0.00%
LDDV	0.06%	0.07%	0.07%	0.07%
LDDT12	0.00%	0.00%	0.00%	0.00%
HDDV2b	1.40%	0.95%	0.60%	0.41%
HDDV3	0.73%	0.49%	0.31%	0.21%
HDDV4	0.43%	0.29%	0.18%	0.12%
HDDV5	0.28%	0.19%	0.12%	0.08%
HDDV6	0.88%	0.60%	0.38%	0.26%
HDDV7	0.58%	0.39%	0.25%	0.17%
HDDV8a	0.99%	0.67%	0.42%	0.29%
HDDV8b	0.25%	0.17%	0.11%	0.07%
MC	0.10%	0.10%	0.10%	0.10%
HDGB	0.03%	0.02%	0.01%	0.01%
HDDBT	0.10%	0.07%	0.04%	0.03%
HDDBS	0.18%	0.12%	0.08%	0.05%
LDDT34	0.12%	0.11%	0.11%	0.13%
Total	100.00%	100.00%	100.00%	100.00%

Table 19. HGA "Average Weekday" VMT, NO_X, VOC, & CO MOBILE6 Emissions for 2007

Comparison of Each 2007 Weekday to Average		***8-County VMT Total***	***Total Emissions*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Average of 4 Weekdays		133,274,706	146.0	81.9	1,221.0
Monday	*August 28th*	0.0%	0.3%	2.7%	1.2%
Tuesday	*August 29th*	0.0%	0.3%	1.7%	1.1%
Wednesday	*August 30th*	0.0%	0.0%	-0.7%	-0.4%
Thursday	*August 31st*	0.0%	-0.6%	-3.6%	-2.0%

Table 20. HGA Vehicle Type Summary of 2007 MOBILE6 Wednesday August 30th Inventory

MOBILE6	***8-County VMT***		***Total Emissions*** *(tons per day)*		
Vehicle Type	***Total***	***Distribution***	*NO_X*	*VOC*	*CO*
LDGV	81,678,560	61.29%	43.1	50.6	778.3
LDGT1	7,535,460	5.65%	3.8	4.9	72.8
LDGT2	25,085,022	18.82%	18.3	17.1	261.0
LDGT3	4,551,876	3.42%	2.6	1.9	34.7
LDGT4	2,093,291	1.57%	1.7	1.0	16.6
HDGV2b	2,125,806	1.60%	6.7	1.5	16.9
HDGV3	799,767	0.60%	2.9	0.6	9.6
HDGV4	368,803	0.28%	1.3	0.3	4.1
HDGV5	157,469	0.12%	0.9	0.4	4.0
HDGV6	381,237	0.29%	2.0	0.6	5.7
HDGV7	153,320	0.12%	0.8	0.2	1.7
HDGV8a	140,893	0.11%	0.9	0.2	1.8
HDGV8b	16,575	0.01%	0.2	0.0	0.3
LDDV	81,999	0.06%	0.1	0.0	0.1
LDDT12	5,744	0.00%	0.0	0.0	0.0
HDDV2b	1,867,582	1.40%	5.8	0.3	1.4
HDDV3	974,388	0.73%	3.9	0.2	0.9
HDDV4	568,394	0.43%	2.7	0.1	0.6
HDDV5	369,086	0.28%	1.9	0.1	0.4
HDDV6	1,173,698	0.88%	8.6	0.4	1.5
HDDV7	775,081	0.58%	7.6	0.3	1.3
HDDV8a	1,313,952	0.99%	19.8	0.6	3.7
HDDV8b	339,561	0.25%	3.9	0.1	0.8
MC	133,275	0.10%	0.2	0.4	2.8
HDGB	39,025	0.03%	0.4	0.2	3.2
HDDBT	135,726	0.10%	2.5	0.1	0.5
HDDBS	244,268	0.18%	3.2	0.2	0.6
LDDT34	164,848	0.12%	0.1	0.0	0.1
Total	133,274,705	100.00%	146.0	82.4	1,225.5

Table 21. Summary of 2007 HGA MOBILE6 Wednesday August 30th Inventory by County

County	***VMT***		***Total Emissions*** *(tons per day)*		
	Total	***Distribution***	*NO_X*	*VOC*	*CO*
Brazoria	5,567,884	4.2%	6.6	3.5	54.0
Chambers	2,853,985	2.1%	4.1	1.8	32.7
Fort Bend	9,062,875	6.8%	10.0	5.0	80.9
Galveston	5,229,558	3.9%	6.0	3.4	49.8
Harris	96,442,269	72.4%	101.5	59.7	864.4
Liberty	2,282,493	1.7%	3.0	1.6	24.3
Montgomery	10,265,784	7.7%	12.7	6.2	100.5
Waller	1,569,857	1.2%	2.1	1.2	19.0
Total	133,274,706	100.0%	146.0	82.4	1,225.5

<u>Summary of 2007 MOBILE6 Inventory for 3-County BPA Area</u>

In addition to developing 2007 HGA future case MOBILE6 inventories for the August 2000 episode, TTI also used MOBILE6 to develop future case 3-County BPA area inventories for the same episode. Provided below are tables for the 3-County BPA area which are very similar to those presented above for the 8-County HGA area. As with the MOBILE6 HGA inventories for 2007, the Wednesday August 30th episode day in BPA most closely conforms to the average VMT, NO_X, VOC, and CO from the Monday-Thursday day types throughout the entire 2007 inventory. Thus, the 2007 Wednesday August 30th episode day was chosen as the sample day for presentation purposes. In lieu of repeating much of the same language presented above for the 2007 MOBILE6 HGA inventory, the tables below are simply presented with no added discussion. Unlike the 8-County HGA inventory, a 55 mph speed analysis was not considered for the 3-County BPA nonattainment area.

Table 22. Summary of VMT, NO_X, VOC, & CO for 2007 MOBILE6 3-County BPA Inventory

Day of Week	***2007 Episode Day***	***3-County VMT Total***	***Total Emissions*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Tuesday	*August 22nd*	12,438,297	20.4	10.6	140.9
Wednesday	*August 23rd*	12,438,297	20.3	10.5	139.5
Thursday	*August 24th*	12,438,297	20.1	10.3	136.0
Friday	*August 25th*	14,499,681	19.4	12.8	165.7
Saturday	*August 26th*	12,161,001	13.4	9.4	131.8
Sunday	*August 27th*	10,508,003	10.4	8.1	116.7
Monday	*August 28th*	12,438,297	20.5	11.0	143.1
Tuesday	*August 29th*	12,438,297	20.5	11.2	143.6
Wednesday	*August 30th*	12,438,297	20.6	11.7	146.2
Thursday	*August 31st*	12,438,297	20.7	12.1	148.4
Friday	*September 1st*	14,499,681	19.7	13.3	172.2

Table 23. Distribution of 2007 BPA VMT by MOBILE6 Vehicle Type & Day of Week

MOBILE6 Vehicle Type	***3-County VMT Distribution***			
	Weekday	***Friday***	***Saturday***	***Sunday***
LDGV	50.07%	56.38%	59.86%	56.09%
LDGT1	6.92%	6.64%	6.68%	7.90%
LDGT2	23.04%	22.09%	22.25%	26.30%
LDGT3	3.27%	3.16%	2.99%	3.39%
LDGT4	1.50%	1.45%	1.37%	1.56%
HDGV2b	2.02%	1.22%	0.80%	0.54%
HDGV3	1.00%	0.60%	0.39%	0.27%
HDGV4	0.43%	0.26%	0.17%	0.11%
HDGV5	0.27%	0.16%	0.11%	0.07%
HDGV6	1.02%	0.62%	0.40%	0.27%
HDGV7	0.28%	0.17%	0.11%	0.07%
HDGV8a	0.32%	0.19%	0.13%	0.09%
HDGV8b	0.01%	0.00%	0.00%	0.00%
LDDV	0.05%	0.06%	0.06%	0.06%
LDDT12	0.01%	0.01%	0.01%	0.01%
HDDV2b	2.37%	1.68%	1.10%	0.74%
HDDV3	0.95%	0.67%	0.44%	0.30%
HDDV4	0.53%	0.38%	0.25%	0.17%
HDDV5	0.31%	0.22%	0.14%	0.10%
HDDV6	1.25%	0.85%	0.58%	0.39%
HDDV7	0.60%	0.42%	0.28%	0.19%
HDDV8a	1.70%	1.21%	0.79%	0.53%
HDDV8b	1.48%	1.05%	0.69%	0.46%
MC	0.10%	0.10%	0.10%	0.10%
HDGB	0.03%	0.02%	0.01%	0.01%
HDDBT	0.12%	0.08%	0.05%	0.04%
HDDBS	0.21%	0.15%	0.10%	0.07%
LDDT34	0.15%	0.15%	0.15%	0.17%
Total	100.00%	100.00%	100.00%	100.00%

Table 24. BPA "Average Weekday" VMT, NO_X, VOC, & CO MOBILE6 Emissions for 2007

Comparison of Each Weekday to Average		***3-County VMT Total***	***Total Emissions*** *(tons per day)*		
			NO_X	*VOC*	*CO*
Average of 4 Weekdays		12,438,297	20.6	11.5	145.3
Monday	*August 28th*	0.0%	0.4%	4.3%	1.5%
Tuesday	*August 29th*	0.0%	0.3%	2.7%	1.2%
Wednesday	*August 30th*	0.0%	-0.1%	-1.9%	-0.6%
Thursday	*August 31st*	0.0%	-0.5%	-5.2%	-2.1%

Table 25. BPA Vehicle Type Summary of 2007 MOBILE6 Wednesday August 30th Inventory

MOBILE6 Vehicle Type	***3-County VMT***		***Total Emissions (tons per day)***		
	Total	***Distribution***	***NO_X***	***VOC***	***CO***
LDGV	6,227,273	50.07%	4.14	5.79	73.12
LDGT1	860,869	6.92%	0.59	0.87	11.23
LDGT2	2,865,772	23.04%	2.65	3.02	39.70
LDGT3	406,939	3.27%	0.29	0.26	3.99
LDGT4	187,141	1.50%	0.19	0.13	1.89
HDGV2b	251,727	2.02%	0.78	0.24	2.82
HDGV3	124,203	1.00%	0.49	0.14	2.19
HDGV4	53,135	0.43%	0.26	0.12	1.55
HDGV5	33,210	0.27%	0.18	0.10	1.05
HDGV6	126,860	1.02%	0.88	0.47	4.74
HDGV7	34,538	0.28%	0.28	0.09	0.54
HDGV8a	39,851	0.32%	0.27	0.07	0.58
HDGV8b	664	0.01%	0.01	0.01	0.25
LDDV	6,254	0.05%	0.01	0.00	0.01
LDDT12	656	0.01%	0.00	0.00	0.00
HDDV2b	294,700	2.37%	0.87	0.04	0.19
HDDV3	117,652	0.95%	0.46	0.02	0.10
HDDV4	66,251	0.53%	0.32	0.01	0.07
HDDV5	38,836	0.31%	0.20	0.01	0.05
HDDV6	155,346	1.25%	1.12	0.05	0.20
HDDV7	74,246	0.60%	0.71	0.03	0.13
HDDV8a	211,316	1.70%	3.43	0.10	0.60
HDDV8b	183,902	1.48%	1.86	0.07	0.37
MC	12,438	0.10%	0.01	0.05	0.24
HDGB	4,255	0.03%	0.04	0.02	0.44
HDDBT	14,799	0.12%	0.25	0.01	0.05
HDDBS	26,635	0.21%	0.32	0.02	0.06
LDDT34	18,833	0.15%	0.01	0.01	0.01
Total	12,438,297	100.00%	20.60	11.74	146.17

Table 26. Summary of 2007 BPA MOBILE6 Wednesday August 30th Inventory by County

County	***VMT***		***Total Emissions*** *(tons per day)*		
	Total	***Distribution***	*NO_X*	*VOC*	*CO*
Hardin	1,479,898	11.9%	2.0	1.4	17.4
Jefferson	7,855,906	63.2%	13.2	7.4	91.8
Orange	3,102,493	24.9%	5.4	2.9	37.0
Total	12,438,297	100.0%	20.6	11.7	146.2

Summary of 8-County HGA MOBILE6 55 mph Speed Limit Benefits for 2007

As detailed starting on page 56 of Attachment 3-3, TTI reran the speed model for the hourly link-based inventory to account for the effects in calendar year 2007 of having all posted speed limits above 55 mph reduced to 55 mph. Other than the changes to the average hourly speeds on specific roadway links, all the inventory development inputs remained consistent with those used for the 2007 future case MOBILE6 inventory previously discussed. The MOBILE6 55 mph speed limit benefits are determined by taking the net difference between the 55 mph and non-55 mph inventories. For presentations purposes, the 2007 Wednesday August 30th episode day has been chosen.

For the entire 8-County area, the estimated MOBILE6 55 mph speed limit benefits are 5.86 tons per day of NO_X and -0.50 tons per day of VOC, as presented in Table 27. In this case, the negative benefits imply that the overall VOC inventory would increase by 0.50 tons. Of the 8-County total, Harris County accounts for 3.41 tons per day (roughly 58%) of the overall NO_X benefit. Due to the fact that Harris County has more widespread roadway congestion on a daily basis than the other seven counties, it would be expected that the 55 mph speed limit benefits would be relatively lower in Harris County than its overall contribution to the 8-County VMT would otherwise suggest.

Table 27. Summary of 2007 HGA MOBILE6 NO_X & VOC Benefits for 55 mph Speed Limit

County	***NO_X Benefits***		***VOC Benefits***	
	Tons per Day	*Contribution*	*Tons per Day*	*Contribution*
Brazoria	0.36	6.1%	-0.03	5.4%
Chambers	0.25	4.3%	-0.02	3.1%
Fort Bend	0.46	7.8%	-0.03	5.7%
Galveston	0.28	4.8%	-0.02	4.7%
Harris	3.41	58.1%	-0.32	63.0%
Liberty	0.21	3.5%	-0.02	4.0%
Montgomery	0.77	13.1%	-0.06	11.5%
Waller	0.13	2.2%	-0.01	2.6%
8-County Total	5.86	100.0%	-0.50	100.0%

Table 28 summarizes the contribution of each of the MOBILE6 28 vehicle types to the 5.86 NO_X tons per day benefit estimate from the 55 mph speed limit scenario. Due to the very small effects of the 55 mph speed limit scenario on VOC emissions, they are not included here.

Table 28. HGA 2007 MOBILE6 NO_X Benefits of 55 mph Speed Limit by Vehicle Type

MOBILE6 Vehicle Type	***8-County NO_X Benefits*** *(tons per day)*
LDGV	0.28
LDGT1	0.04
LDGT2	0.15
LDGT3	0.02
LDGT4	0.01
HDGV2b	0.11
HDGV3	0.05
HDGV4	0.02
HDGV5	0.01
HDGV6	0.03
HDGV7	0.01
HDGV8a	0.01
HDGV8b	0.00
LDDV	0.01
LDDT12	0.00
HDDV2b	0.52
HDDV3	0.35
HDDV4	0.24
HDDV5	0.17
HDDV6	0.77
HDDV7	0.67
HDDV8a	1.53
HDDV8b	0.31
MC	0.01
HDGB	0.01
HDDBT	0.23
HDDBS	0.29
LDDT34	0.01
Total	5.86

As Table 28 indicates, the primary benefits to be achieved from the 55 mph speed limit benefits are from diesel-powered vehicles above 10,000 pounds gross vehicle weight rating (GVWR). Table 29 groups the MOBILE6 28 vehicle types into those under 10,000 pounds GVWR, those over 10,000 pounds GVWR, and buses. All vehicles over 10,000 pounds GVWR with the exception of buses are estimated to account for over 70% of the total benefit, even though they account for only 5.7% of the overall VMT.

Table 29. 2007 MOBILE6 NO_X 55 mph Speed Limit Benefits by County & Vehicle Grouping

County	***Vehicles Under 10,000 Pounds GVWR***	***Vehicles Over 10,000 Pounds GVWR***	***Gasoline & Diesel Buses***	***Total NO_X Benefit*** *(tons per day)*
Brazoria	0.07	0.26	0.03	0.36
Chambers	0.05	0.19	0.02	0.25
Fort Bend	0.08	0.33	0.04	0.46
Galveston	0.05	0.20	0.02	0.28
Harris	0.71	2.39	0.31	3.41
Liberty	0.04	0.15	0.02	0.21
Montgomery	0.13	0.57	0.06	0.77
Waller	0.02	0.09	0.01	0.13
8-County Total	1.15	4.19	0.52	5.86
Contribution	19.6%	71.5%	8.8%	100.0%
VMT Total	125,323,462	7,532,224	419,020	133,274,705
VMT Contribution	94.0%	5.7%	0.3%	100.0%

TCEQ staff used the same 2007 Harris County input files utilized by TTI for the Wednesday August 30th hourly link analysis and modified them for generation of 24-hour composite freeway emission rates. These emission rates were then plotted by average freeway speed from 2.5-65 mph. The results are presented for light-duty gasoline NO_X emissions in Figure 1, heavy-duty diesel NO_X emissions in Figure 2, light-duty gasoline VOC emissions in Figure 3, and heavy-duty diesel VOC emissions in Figure 4. Only light-duty gasoline and heavy-duty diesel vehicles are presented here because these two groupings dominate the VMT from the overall inventory. As light-duty gasoline vehicles increase in speed from 55-65 mph, there is roughly a 3-4% increase in freeway NO_X emission rates. For heavy-duty diesel vehicles, an increase in speed from 55-65 mph results in roughly a 30-40% increase in NO_X emission rates. For almost all of the 28 vehicle types in MOBILE6, an increase in speed from 55-65 mph results in a very slight decrease in VOC emission rates.

The “U-shaped” NO_X curve seen with the diesel-powered vehicles was similar in shape for virtually all of the eight vehicle types contained in MOBILE5. This is why the MOBILE5 emissions model predicted a more significant difference between 55-65 mph for the light-duty gasoline NO_X emission rates. MOBILE6 includes the effects of newer technology light-duty gasoline vehicles, which demonstrate a much “flatter” response of NO_X emissions to average speed than MOBILE5. The newer technologies found on recently available light-duty gasoline vehicles have resulted in lower emissions, better performance, and significantly reduced deterioration rates than those vehicles manufactured in the 1970's and 1980's. Due to the fact that MOBILE5 was originally developed in the early 1990's, it understandably contained data taken from in-use vehicles which were manufactured in the 1970's and 1980's.

Figure 1 - MOBILE6 Freeway NO_X Emission Rates
2007 Harris County - Wednesday August 30th Episode Day
Light-Duty Gasoline Vehicles & Trucks

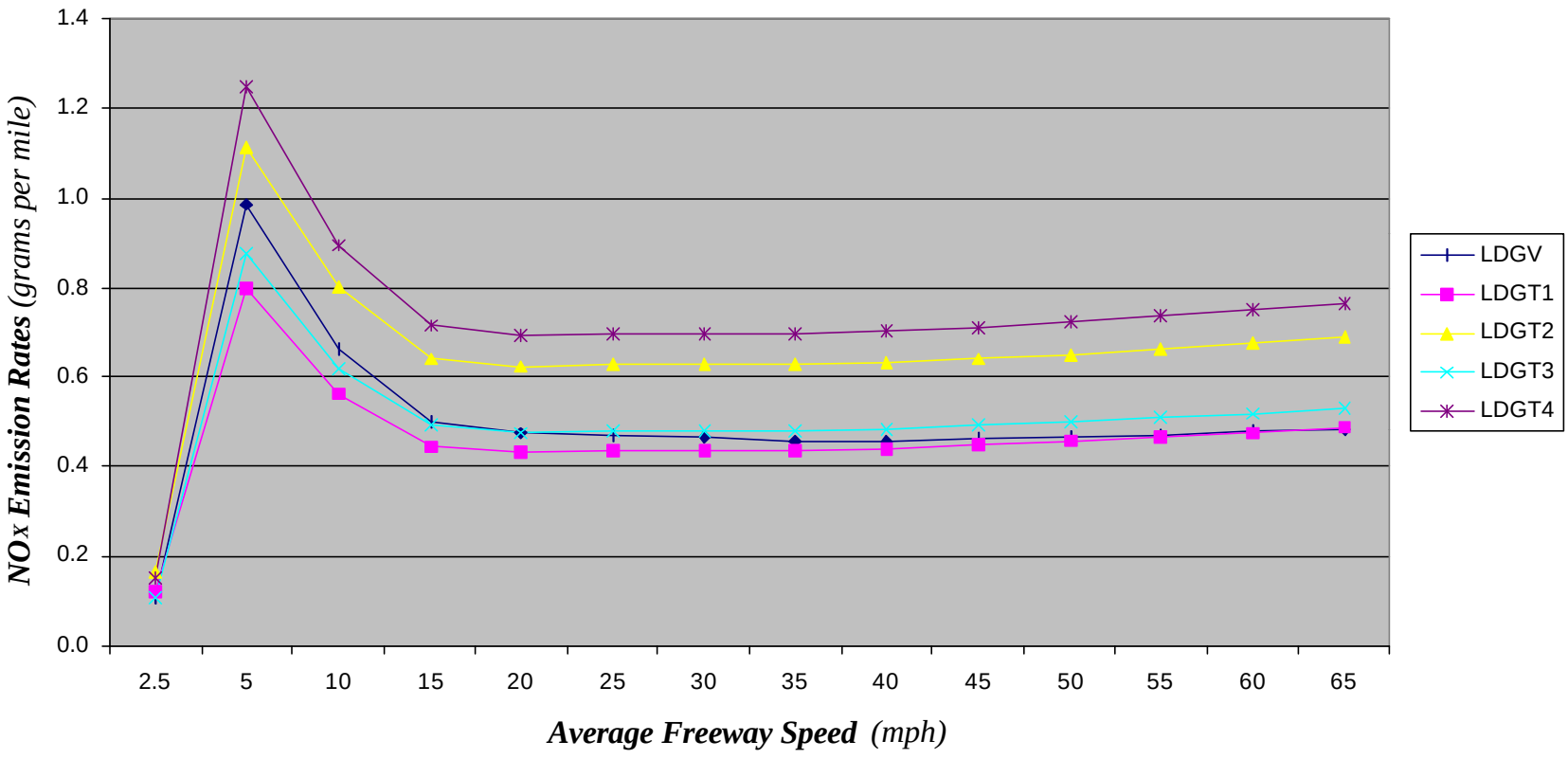


Figure 2 - MOBILE6 Freeway NO_X Emission Rates
2007 Harris County - Wednesday August 30th Episode Day
Heavy-Duty Diesel Vehicles

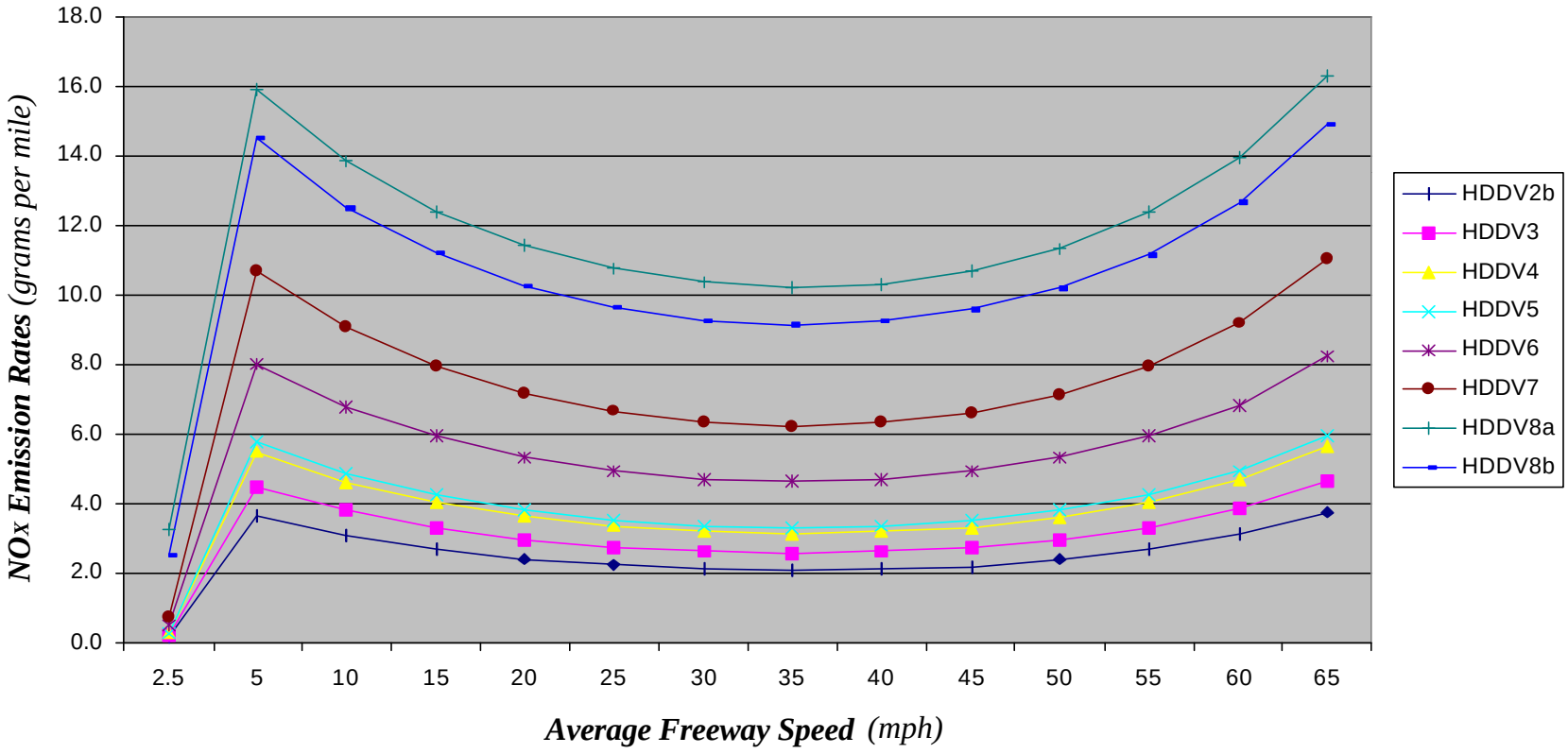


Figure 3 - MOBILE6 Freeway VOC Emission Rates
2007 Harris County - Wednesday August 30th Episode Day
Light-Duty Gasoline Vehicles & Trucks

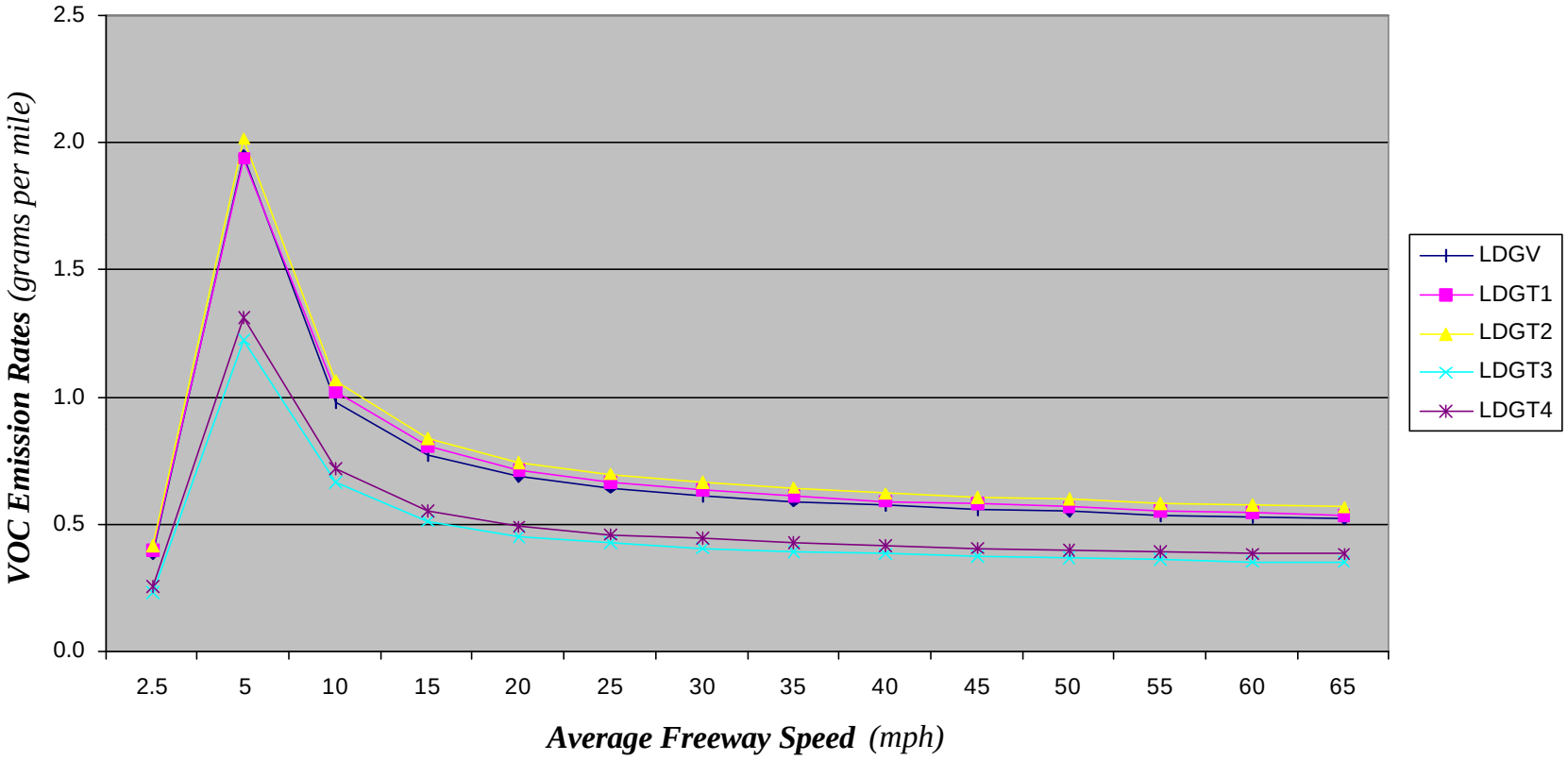
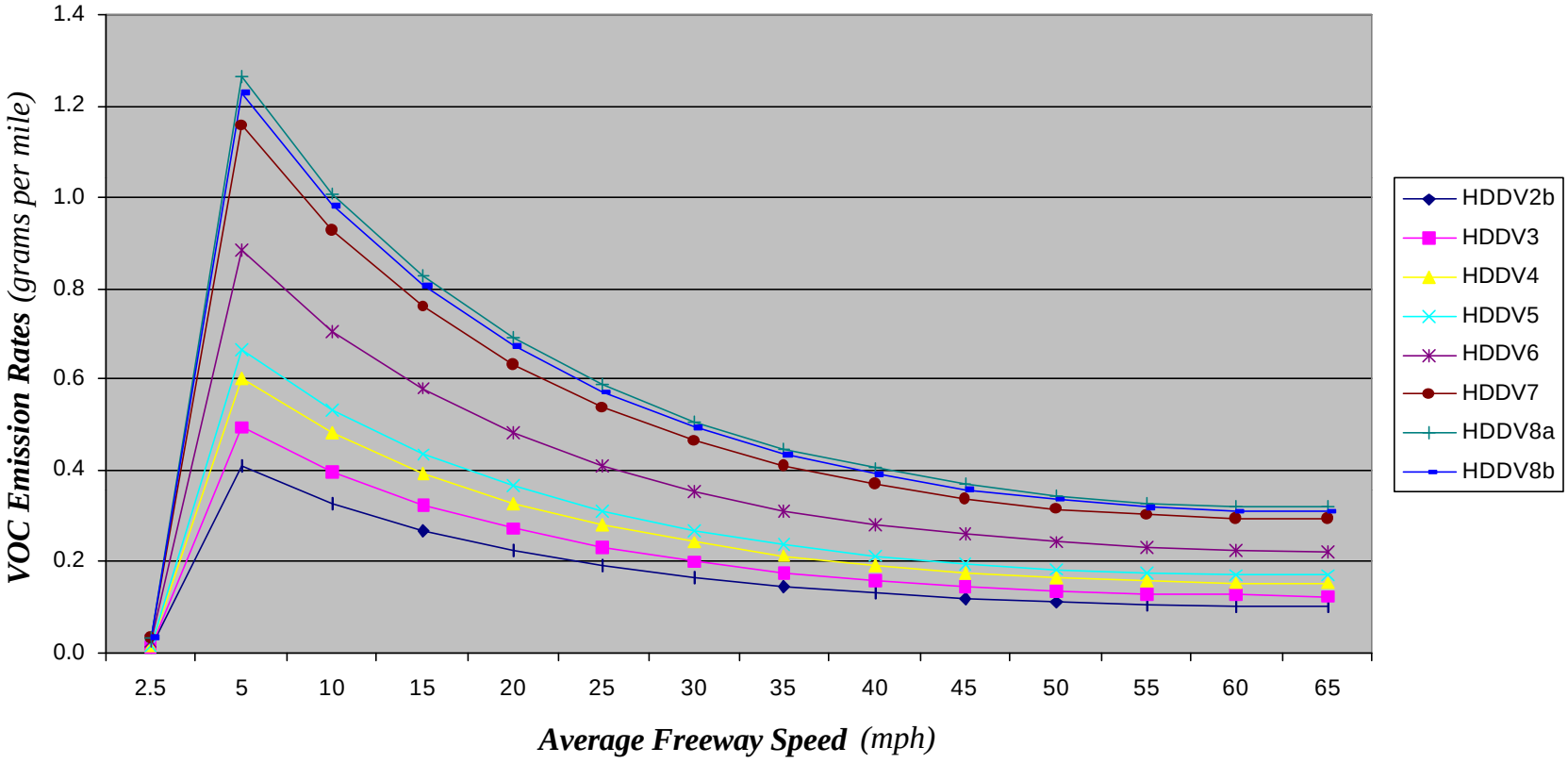


Figure 4 - MOBILE6 Freeway VOC Emission Rates
2007 Harris County - Wednesday August 30th Episode Day
Heavy-Duty Diesel Vehicles



Use of Humidity Inputs with 2000 & 2007 MOBILE6 Emissions Inventories

In order to account for the effects of humidity on NO_X, VOC, and CO emissions, MOBILE6 allows the user to input a value with the ABSOLUTE HUMIDITY command. MOBILE6 does not allow the user to input separate hourly values for relative humidity. Instead, it is required that a single 24-hour value for absolute humidity be input in units of grains of water per pound of dry air (grains/pound). Absolute humidity is sometimes referred to as humidity ratio. On the MOBILE6 website (http://www.epa.gov/otaq/m6.htm), EPA has made a spreadsheet available entitled rel-hum1.xls which allows the user to calculate absolute humidity in units of grains/pound based on inputs of temperature, relative humidity, and barometric pressure. The spreadsheet requests that temperature and relative humidity be input, but barometric pressure is kept constant at 29.92 inches of mercury (Hg). However, the formula can easily be modified to account for different values of barometric pressure.

EPA guidance on use of the ABSOLUTE HUMIDITY command can be found in Section 2.5 on page 6 of the *Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, January 2002*. This guidance states that "EPA now recommends and encourages states to use local humidity as an input in MOBILE6 for estimates of summer day emissions that will be used for SIP or conformity purposes...Based on the analysis of new data incorporated in MOBILE6, EPA now believes that states should incorporate humidity effects in SIP and conformity related modeling." TCEQ staff followed this guidance and utilized the formula contained within the EPA rel-hum1.xls spreadsheet to calculate average values of absolute humidity for each county, episode day, and hour. The TCEQ spreadsheet containing all of these calculations is entitled hg-aug-2000-hum.xls and can be accessed on the FTP site referenced above. Please note that the hg-aug-2000-hum.xls file references temperature data from the hg-aug-2000-temp.xls file mentioned earlier. Therefore, it is advised that both files be downloaded by interested parties.

Similar to the approach taken with the development of average hourly temperatures for each county, numerous data points were collected from various monitoring locations for relative humidity and barometric pressure. For each hour and episode day, the data were averaged together to obtain a single average county-wide value. For any county that did not contain one or more data points for that hour, data from monitors located in adjacent counties were used. This approach is summarized in more detail on the "Read Me" page of the hg-aug-2000-hum.xls spreadsheet. For demonstration purposes, sample data inputs and results for Wednesday August 30th in Harris County are presented below in Table 30. Due to its complexity, the calculation formula is not repeated here. Instead of using the standard figure of 29.92 inches of Hg for barometric pressure, TCEQ staff used locally observed data. However, varying the barometric pressure value in the calculation did not have a substantial effect on the results. For purposes of completeness, a total of 25 hours of data are presented to account for both Central Standard Time (CST) and Central Daylight Time (CDT).

Table 30. Harris County Absolute Humidity Calculations for Wednesday August 30, 2000

Central Standard Time	***Central Daylight Time***	***Temperature*** *(Degrees Fahrenheit)*	***Relative Humidity*** *(Percent)*	***Barometric Pressure*** *(Inches Hg)*	***Absolute Humidity*** *(grains/pound)*
11 PM - 12 AM	12-1 AM	80.5	88.7%	29.82	137.8
12-1 AM	1-2 AM	79.8	90.8%	29.81	138.1
1-2 AM	2-3 AM	79.1	92.6%	29.81	137.6
2-3 AM	3-4 AM	78.3	94.8%	29.81	137.2
3-4 AM	4-5 AM	78.0	94.2%	29.81	135.1
4-5 AM	5-6 AM	77.9	95.2%	29.82	135.8
5-6 AM	6-7 AM	78.1	93.7%	29.83	134.7
6-7 AM	7-8 AM	78.8	90.4%	29.84	132.8
7-8 AM	8-9 AM	81.1	82.0%	29.85	129.6
8-9 AM	9-10 AM	84.3	71.2%	29.85	124.6
9-10 AM	10-11 AM	87.9	59.5%	29.84	116.7
10-11 AM	11 AM - 12 PM	91.1	50.1%	29.82	108.7
11 AM - 12 PM	12-1 PM	94.4	40.0%	29.79	96.0
12-1 PM	1-2 PM	97.2	34.3%	29.76	89.6
1-2 PM	2-3 PM	99.3	30.1%	29.72	83.9
2-3 PM	3-4 PM	100.9	27.3%	29.70	79.6
3-4 PM	4-5 PM	101.6	26.9%	29.69	80.1
4-5 PM	5-6 PM	101.1	30.4%	29.69	89.8
5-6 PM	6-7 PM	98.9	36.5%	29.69	100.9
6-7 PM	7-8 PM	94.6	51.6%	29.71	125.8
7-8 PM	8-9 PM	90.3	66.9%	29.72	142.9
8-9 PM	9-10 PM	88.0	72.1%	29.73	143.2
9-10 PM	10-11 PM	86.4	73.6%	29.73	139.0
10-11 PM	11 PM - 12 AM	85.2	71.6%	29.72	129.8
11 PM - 12 AM	12-1 AM	83.8	73.2%	29.71	126.9

Unfortunately, obtaining a single 24-hour value for the MOBILE6 absolute humidity input is not a straightforward calculation. MOBILE6 takes the 24-hour absolute humidity input and then calculates hourly relative humidity values based on the hourly temperatures provided, while assuming a constant barometric pressure of 29.92 inches Hg. As indicated in the guidance, it is necessary to ensure that the single 24-hour absolute humidity input will not result in a relative humidity of greater than 100% once hourly temperature variations are taken into account. EPA's *User's Guide to MOBILE6.0 January 2002* states that the model does not perform this check on its own. Simply taking an average of all of the hourly absolute humidity data is inappropriate because it could result in calculated hourly relative humidity values of greater than 100%. In order to ensure that this does not occur, the EPA guidance recommends that the lowest absolute humidity value found throughout the day be used. However, if this approach is taken, hourly relative humidity data which are calculated by MOBILE6 will then be too low. For example, Table 30 indicates that the lowest Harris County absolute humidity figure calculated for Wednesday August 30, 2000 is 79.6 grains/pound. If this figure is input into EPA's absolute

humidity formula and then relative humidity is recalculated for each hour based on the observed temperatures, the results in Table 31 are obtained. Please note that barometric pressure was kept constant at 29.92 inches Hg for the purposes of these calculations to ensure consistency with the manner in which MOBILE6 calculates hourly relative humidity values from the 24-hour absolute humidity input.

Table 31. MOBILE6 Relative Humidity Calculations Based on Minimum Absolute Humidity

Central Standard Time	*Central Daylight Time*	*Observed Relative Humidity*	*Calculated Relative Humidity*	*Relative Humidity Difference*
11 PM - 12 AM	12-1 AM	88.7%	52.1%	36.6%
12-1 AM	1-2 AM	90.8%	53.2%	37.6%
1-2 AM	2-3 AM	92.6%	54.5%	38.1%
2-3 AM	3-4 AM	94.8%	55.9%	38.9%
3-4 AM	4-5 AM	94.2%	56.4%	37.8%
4-5 AM	5-6 AM	95.2%	56.7%	38.5%
5-6 AM	6-7 AM	93.7%	56.2%	37.5%
6-7 AM	7-8 AM	90.4%	55.0%	35.4%
7-8 AM	8-9 AM	82.0%	51.1%	30.9%
8-9 AM	9-10 AM	71.2%	46.1%	25.1%
9-10 AM	10-11 AM	59.5%	41.1%	18.5%
10-11 AM	11 AM - 12 PM	50.1%	37.1%	13.0%
11 AM - 12 PM	12-1 PM	40.0%	33.5%	6.5%
12-1 PM	1-2 PM	34.3%	30.7%	3.6%
1-2 PM	2-3 PM	30.1%	28.8%	1.3%
2-3 PM	3-4 PM	27.3%	27.5%	-0.2%
3-4 PM	4-5 PM	26.9%	26.9%	0.0%
4-5 PM	5-6 PM	30.4%	27.3%	3.2%
5-6 PM	6-7 PM	36.5%	29.1%	7.3%
6-7 PM	7-8 PM	51.6%	33.2%	18.4%
7-8 PM	8-9 PM	66.9%	38.0%	28.8%
8-9 PM	9-10 PM	72.1%	40.9%	31.2%
9-10 PM	10-11 PM	73.6%	43.0%	30.6%
10-11 PM	11 PM - 12 AM	71.6%	44.7%	26.9%
11 PM - 12 AM	12-1 AM	73.2%	46.7%	26.5%

As Table 31 demonstrates, all of the relative humidity values which would be calculated by MOBILE6 are below 60%. If the relative humidity differences by hour are averaged, a figure of 22.9% is obtained. Even though choosing the lowest absolute humidity is recommended by EPA, the MOBILE6 guidance does state that “an acceptable alternative approach would be to use the highest humidity ratio that does not result in a relative humidity value greater than 100%.” When this approach is taken while keeping the barometric pressure value constant at 29.92 inches Hg, the 24-hour absolute humidity input becomes 142.4 grains/pound. When relative humidity is

recalculated throughout the day using this input, the results presented in Table 32 are obtained.

Table 32. Relative Humidity Calculations Based on 100% Maximum Hourly Value

Central Standard Time	*Central Daylight Time*	*Observed Relative Humidity*	*Calculated Relative Humidity*	*Relative Humidity Difference*
11 PM - 12 AM	12-1 AM	88.7%	91.9%	-3.2%
12-1 AM	1-2 AM	90.8%	93.8%	-3.1%
1-2 AM	2-3 AM	92.6%	96.2%	-3.5%
2-3 AM	3-4 AM	94.8%	98.6%	-3.8%
3-4 AM	4-5 AM	94.2%	99.5%	-5.3%
4-5 AM	5-6 AM	95.2%	100.0%	-4.8%
5-6 AM	6-7 AM	93.7%	99.2%	-5.5%
6-7 AM	7-8 AM	90.4%	97.0%	-6.6%
7-8 AM	8-9 AM	82.0%	90.1%	-8.1%
8-9 AM	9-10 AM	71.2%	81.2%	-10.1%
9-10 AM	10-11 AM	59.5%	72.4%	-12.9%
10-11 AM	11 AM - 12 PM	50.1%	65.4%	-15.3%
11 AM - 12 PM	12-1 PM	40.0%	59.0%	-19.0%
12-1 PM	1-2 PM	34.3%	54.2%	-19.9%
1-2 PM	2-3 PM	30.1%	50.8%	-20.6%
2-3 PM	3-4 PM	27.3%	48.5%	-21.2%
3-4 PM	4-5 PM	26.9%	47.4%	-20.6%
4-5 PM	5-6 PM	30.4%	48.1%	-17.7%
5-6 PM	6-7 PM	36.5%	51.4%	-14.9%
6-7 PM	7-8 PM	51.6%	58.6%	-7.0%
7-8 PM	8-9 PM	66.9%	67.1%	-0.2%
8-9 PM	9-10 PM	72.1%	72.2%	-0.1%
9-10 PM	10-11 PM	73.6%	75.8%	-2.2%
10-11 PM	11 PM - 12 AM	71.6%	78.9%	-7.3%
11 PM - 12 AM	12-1 AM	73.2%	82.4%	-9.2%

As Table 32 demonstrates, the calculated MOBILE6 relative humidity values under this scenario are more consistent with the observed data than under the minimum absolute humidity scenario. If the relative humidity differences by hour are averaged, a figure of -9.7% is obtained. Unfortunately, both of the approaches outlined in the MOBILE6 guidance result in error between the observed and calculated relative humidity values. Taking the highest absolute humidity value that does not allow the calculated relative humidity to exceed 100% was chosen by TCEQ staff because it resulted in lower overall error than choosing the lowest absolute humidity figure.

Due to the fact that choosing a single 24-hour value for absolute humidity is going to unavoidably result in some level of error, the TCEQ sent a request to EPA staff in July of 2001 to the mobile@epa.gov E-mail address. The purpose of this request was to encourage EPA to allow

MOBILE6 users the option of inputting hourly relative humidity data as an alternative approach to being forced to input a single 24-hour absolute humidity value in the units of grains/pound. Such an approach would be similar to the options given with respect to MOBILE6 temperature inputs. With temperatures, the user has the option of inputting either minimum and maximum daily temperatures or 24 separate hourly temperatures. It is TCEQ's understanding from EPA that several MOBILE6 users made similar recommendations and that the upcoming MOBILE6.2 model will allow users the option of inputting hourly relative humidity values in lieu of using the ABSOLUTE HUMIDITY command. Subsequent to the official release of MOBILE6.2, the TCEQ plans to use the RELATIVE HUMIDITY command for future inventory development.

Distribution of Vehicle Miles Traveled by Vehicle Type

In addition to the overall daily amount of VMT estimated for a specific area, one of the most important input parameters in the on-road mobile source emissions estimation process is the distribution of VMT by vehicle type. This parameter is often referred to as "VMT mix". For example, on a given roadway segment for a specific hour of the day, it is necessary to know the amount of VMT contributed by each of the MOBILE6 28 vehicle classes because the emission rates among the different classes can vary significantly.

For the purposes of developing MOBILE6 for nationwide applications, EPA has provided default VMT mix parameters for each of the 28 vehicle types. The development of the MOBILE6 default VMT mix data is documented in an EPA report entitled *Fleet Characterization Data for MOBILE6: Development and Use of Age Distributions, Average Annual Mileage Accumulation Rates, and Projected Vehicle Counts for Use in MOBILE6, EPA420-R-01-047, September 2001, M6.FLT.007*, which can be obtained at http://www.epa.gov/otaq/models/mobile6/m6tech.htm. This report is based in part on work summarized in another EPA report entitled *Update of Fleet Characterization Data for Use in MOBILE6, EPA420-P-98-016, June 1998, M6.FLT.002*, which can be obtained at http://www.epa.gov/otaq/models/mobile6/m6drafts.htm.

As documented in the M6.FLT.007 report, EPA developed estimates of the number of registered vehicles of various types and ages in operation in the U.S. as of July 1, 1996. In order to avoid the excessive variation associated with any set of "snapshot" data, EPA fit curves through the nationwide vehicle registration data to make them more applicable for use in various calendar years. In addition, the average annual mileage accumulation rate for each vehicle type was estimated based on 1996 data. These data were also "smoothed" with curve fitting for application in various calendar years.

EPA estimated the total nationwide light-duty vehicle population (i.e., passenger cars, pickup trucks, and SUVs) to be 176,385,176 as of July 1, 1996. Subsequent to 1996, new sales were assumed to grow at a rate of 0.5% per year. Different fleet attrition ("scrappage") rates were assumed for each year subsequent to 1996. When all of these factors are combined, the total light-duty vehicle population is estimated for each calendar year from 1996 to 2007. Table 33 summarizes these calculations and shows similar results to those displayed in Table 8 on page 20 of EPA's M6.FLT.007 report.

Table 33. EPA MOBILE6 Estimates of Nationwide Light-Duty Vehicle Fleet Growth

Calendar Year	*New Sales*	*Scrappage Rate*	*Scrapped Vehicles*	*Total Population*	*Annual Growth*	*Cumulative Growth*
1996	NA	NA	NA	176,385,176	NA	NA
1997	14,560,429	5.77%	11,017,561	179,928,043	2.0%	2.0%
1998	14,633,231	5.77%	11,226,186	183,335,089	1.9%	3.9%
1999	14,706,397	5.77%	11,426,994	186,614,492	1.8%	5.8%
2000	14,779,929	5.70%	11,479,482	189,914,939	1.8%	7.7%
2001	14,853,829	5.70%	11,671,820	193,096,948	1.7%	9.5%
2002	14,928,098	5.70%	11,857,428	196,167,619	1.6%	11.2%
2003	15,002,738	5.70%	12,036,710	199,133,647	1.5%	12.9%
2004	15,077,752	5.70%	12,210,050	202,001,349	1.4%	14.5%
2005	15,153,141	6.09%	13,224,708	203,929,782	1.0%	15.6%
2006	15,228,907	6.09%	13,346,764	205,811,924	0.9%	16.7%
2007	15,305,051	6.09%	13,466,024	207,650,951	0.9%	17.7%

As the table indicates, the light-duty fleet is expected to grow between roughly 1-2% per year. The cumulative light-duty vehicle fleet growth from 1996 to 2000 is expected to be 7.7%, and from 1996 to 2007 is expected to be 17.7%. In a similar fashion, the heavy-duty fleet was grouped together and the total number of nationwide in-use registered heavy-duty vehicles was estimated to be 11,897,859 as of July 1, 1996. As with the light-duty calculations, different scrappage rates were assumed for each year subsequent to 1996. When all of these factors are combined, the total heavy-duty vehicle population is estimated for each calendar year from 1996 to 2007. Table 34 summarizes these calculations and shows similar results to those displayed in Table 15 on page 27 of EPA's M6.FLT.007 report. Some very minor inconsistencies between the two tables exist and are assumed to be due to rounding error.

Table 34. EPA MOBILE6 Estimates of Nationwide Heavy-Duty Vehicle Fleet Growth

Calendar Year	*New Sales*	*Scrappage Rate*	*Scrapped Vehicles*	*Total Population*	*Annual Growth*	*Cumulative Growth*
1996	1,071,131	NA	NA	11,897,859	NA	NA
1997	1,092,554	4.39%	570,279	12,420,134	4.4%	4.4%
1998	1,114,405	4.39%	594,166	12,940,372	4.2%	8.8%
1999	1,136,693	4.39%	617,983	13,459,082	4.0%	13.1%
2000	1,159,427	5.55%	811,327	13,807,181	2.6%	16.0%
2001	1,182,615	5.55%	831,934	14,157,863	2.5%	19.0%
2002	1,206,267	5.55%	852,709	14,511,421	2.5%	22.0%
2003	1,230,393	5.55%	873,671	14,868,143	2.5%	25.0%
2004	1,255,001	5.55%	894,834	15,228,309	2.4%	28.0%
2005	1,280,101	6.45%	1,064,792	15,443,617	1.4%	29.8%
2006	1,305,703	6.45%	1,080,331	15,668,989	1.5%	31.7%
2007	1,331,817	6.45%	1,096,552	15,904,254	1.5%	33.7%

When the cumulative light-duty and heavy-duty growth rates for each year are compared, it becomes apparent that the MOBILE6 default data assume that the heavy-duty vehicle population is growing roughly twice as fast as the light-duty vehicle population. This is due primarily to the assumption that light-duty vehicle sales increase by only 0.5% per year, while heavy-duty vehicle sales are assumed by EPA to increase by 2% per year, which is an annual rate of growth that is four times greater than the light-duty vehicle sales growth. This assumption is important because it increases the relative contribution of heavy-duty vehicles to the estimated VMT mix and decreases the relative contribution of light-duty vehicles.

In order to calculate the default VMT mix for a given calendar year, EPA combines the 1996-based age distribution data by vehicle type with both the 1996 mileage accumulation rate data and overall vehicle count data for each vehicle type. For example, in calendar year 2000, MOBILE6 assumes that there are a total of 113,061,267 light-duty gasoline vehicles (LDGVs) registered nationwide. If the default LDGV age distribution (based on 1996 registration data) is applied to this figure, 5,990,511 vehicles (5.30%) are assumed to be one-year old and 7,986,645 (7.06%) are assumed to be two-years old. This calculation is repeated for LDGVs from 3-25+ years according to the age distribution data in Table 5 on page 9 of the M6.FLT.007 report.

Next, the LDGV annual mileage accumulation rates (based on 1996 data) are multiplied by the corresponding number of vehicles for that age. For example, 1-year old LDGVs are assumed to accumulate 14,910 miles per year, while 2-year old vehicles are assumed to accumulate 14,174 miles per year. When the 5,990,511 number of 1-year old LDGVs is multiplied by the 14,910 miles accumulated per year by 1-year old LDGVs, the result is an assumption that all 1-year-old LDGVs combined accumulated 89.3 billion miles per year nationwide in 2000. The equivalent calculation for 2-year old LDGVs in 2000 is 113.2 billion miles. Similar calculations are then repeated for the remaining vehicle ages (3-25+) to determine the total number of miles accumulated nationwide by LDGVs in 2000. Table 6 on pages 15-16 of the M6.FLT.007 report summarizes the mileage accumulation rate data for all vehicle classes.

This same process is then repeated for each of the 28 vehicle types in MOBILE6 for vehicle ages 1-25+, and the total number of miles accumulated nationwide by all vehicle types in calendar year 2000 is estimated. Finally, the nationwide VMT mix to be attributed to each vehicle type is obtained by dividing the total miles accumulated annually by each vehicle type from the total number of miles accumulated from all vehicle types in 2000. In the case of LDGVs, the default VMT mix figure for 2000 is calculated to be 48.4%.

It is understandable that EPA would take such an approach in the development of nationwide default VMT mix data for application with MOBILE6. However, these default VMT mix data would only be appropriate for estimating vehicle emissions on a large-scale regional basis, such as for an entire state, set of states, or nationwide. The default VMT mix data do not distinguish by roadway type, time-of-day, and day-of-week. In the event that they are available, local VMT mix data which can account for variations in these factors are much more appropriate for the development of episode-specific on-road mobile source emissions estimates in a metropolitan area such as HGA.

As pointed out in Section 4.1.1 of the *Technical Guidance on the Use of MOBILE6 for Emission Inventory Preparation, January 2002*, "the fraction of vehicle miles traveled (VMT) by vehicle class varies from area to area and can have a significant effect on overall emissions from highway mobile sources. For SIP-related highway vehicle emission inventory development in moderate and above nonattainment areas, EPA expects states to develop and use their own specific estimates of VMT by vehicle class. The VMT fractions by vehicle class used in inventory modeling should be consistent, where possible, with assumptions used in other highway vehicle related planning. Metropolitan Planning Organizations (MPOs) and state Departments of Transportation (DOTs) should be consulted for information to determine the proportion of passenger vehicles and light duty trucks relative to heavy duty trucks by time of day and facility class."

In accordance with this guidance, a MOBILE6 Subcommittee to the Technical Working Group (TWG) in Texas elected to not use the EPA MOBILE6 default VMT mix data as inputs for the development of the episode-specific 8-County HGA on-road mobile source emission inventories. Instead, locally collected vehicle classification data from the Texas Department of Transportation (TxDOT) were used and distributed into the MOBILE6 28 vehicle types. TxDOT regularly collects vehicle classification data throughout the 8-County HGA area at approximately 96 locations. Some of these 96 locations are actually co-located in that data are collected for each direction of traffic flow at a given site. With these data, VMT mix variations in roadway class, time-of-day, and day-of-week can be obtained. Consequently, improved temporal and spatial distribution of the gridded on-road mobile source emissions estimates are available for photochemical modeling purposes. A more complete discussion of the manner in which locally collected vehicle classification data are converted into VMT mix inputs is provided by TTI on page 11 of Attachment 3-2 and page 14 of Attachment 3-3. In early March of 2002, a draft version of this VMT mix estimation methodology was distributed by TTI among members of the TWG MOBILE6 Subcommittee for final comment prior to use in the development of these inventories. Recipients of this draft VMT mix estimation methodology document included staff from AACOG, CAMPO, FHWA, HGAC, NCTCOG, TCEQ, TTI, and TxDOT.

Contribution of VMT Mix from Sport Utility Vehicles (SUVs)

The TCEQ has regularly received comment from various parties that the on-road mobile source emission inventories developed in the past have significantly underestimated the fraction of VMT contributed by increasingly popular sport utility vehicles (SUVs) in the on-road fleet. Consequently, it has been concluded that the overall inventories have significantly lower NO_X, VOC, and CO emission estimates due to the assumption that SUVs in general emit more of these pollutants than the passenger cars, which essentially comprise the LDGV class in MOBILE6.

TCEQ staff performed quality assurance checks on the link-based emission inventories submitted by TTI for the August 2000 episode. For example, for the 2000 Wednesday August 30th episode day in Harris County, MOBILE6 runs were performed to develop 24-hour composite emission rates by vehicle type. TCEQ staff used the same MOBILE6 input files as TTI, but included the use of the VMT BY FACILITY, VMT BY HOUR, and SPEED VMT commands. With a detailed hourly link-based analysis such as that performed by TTI, these commands are not applicable because they are typically for 24-hour composite emission rate calculations only. The results of this analysis are compared with the more comprehensive TTI analysis in Table 35.

Table 35. Comparison of Hourly Link and 24-Hour MOBILE6 Analyses for Harris County

Inventory Description	***24-Hour Emissions*** *(tons per day)*		
	NO_X	*VOC*	*CO*
TTI Hourly Link Analysis	177.0	107.9	1459.6
24-Hour Composite Analysis	174.0	107.1	1450.3
Relative Difference	-1.7%	-0.7%	-0.6%

A more in-depth summary of how the 24-hour composite emission estimates were obtained is provided in Table 36. The table provides the 24-hour composite NO_X, VOC, and CO emission rates for each of the 28 vehicle types in MOBILE6. The grams/mile emission rates for each pollutant and vehicle type are multiplied by the corresponding VMT for that vehicle type and, after converting the units from grams to tons, 24-hour emission estimates for each pollutant are obtained.

Table 36. Harris County Wednesday August 30, 2000 24-Hour MOBILE6 Analysis

Vehicle Type	***Emission Factors*** *(grams/mile)*			***24-Hour VMT***	***24-Hour Emissions*** *(tons/day)*		
	NO_X	***VOC***	***CO***		***NO_X***	***VOC***	***CO***
LDGV	0.9756	1.0664	14.3220	56,804,554	61.1	66.8	896.8
LDGT1	0.8843	1.1816	16.5257	5,106,984	5.0	6.7	93.0
LDGT2	1.0826	1.2141	17.2011	17,001,008	20.3	22.8	322.4
LDGT3	0.9049	0.7725	13.6030	3,054,873	3.0	2.6	45.8
LDGT4	1.1464	0.8029	13.8234	1,404,823	1.8	1.2	21.4
HDGV2b	4.6860	0.8532	10.7838	1,448,433	7.5	1.4	17.2
HDGV3	5.2338	1.0468	14.9994	544,927	3.1	0.6	9.0
HDGV4	4.8755	1.0029	12.5136	251,287	1.4	0.3	3.5
HDGV5	6.7443	2.8626	36.4964	107,292	0.8	0.3	4.3
HDGV6	6.5056	2.2831	30.2420	259,759	1.9	0.7	8.7
HDGV7	6.7879	1.7684	25.1474	104,465	0.8	0.2	2.9
HDGV8a	7.5975	3.0077	43.7296	95,999	0.8	0.3	4.6
HDGV8b	10.0526	1.2132	17.1887	11,294	0.1	0.0	0.2
LDDV	1.7965	0.6730	1.5400	130,140	0.3	0.1	0.2
LDDT12	3.0551	2.2132	3.7421	20,169	0.1	0.0	0.1
HDDV2b	4.3304	0.1888	0.8112	1,272,875	6.1	0.3	1.1
HDDV3	5.2177	0.2382	0.9354	664,107	3.8	0.2	0.7
HDDV4	6.1550	0.2719	1.0895	387,396	2.6	0.1	0.5
HDDV5	6.6584	0.3183	1.3135	251,556	1.8	0.1	0.4
HDDV6	10.4246	0.4419	1.4972	799,950	9.2	0.4	1.3
HDDV7	13.1463	0.5764	2.0177	528,267	7.7	0.3	1.2
HDDV8a	23.4679	0.6897	4.0036	895,541	23.2	0.7	4.0
HDDV8b	25.8863	0.5982	3.5638	231,432	6.6	0.2	0.9
MC	0.9650	3.1554	16.6207	91,856	0.1	0.3	1.7
HDGB	7.7840	6.4044	117.6954	57,810	0.5	0.4	7.5
HDDBT	22.7264	0.9111	5.4710	91,976	2.3	0.1	0.6
HDDBS	14.6388	0.6925	2.3887	132,938	2.1	0.1	0.4
LDDT34	1.2921	0.4156	0.7918	104,070	0.1	0.0	0.1
Total				91,855,778	174.0	107.1	1450.3

In order to determine the effect of different SUV VMT mix data on the estimated level of pollutant emissions, just the light-duty gasoline (LDG) fleet will be analyzed. This portion of the fleet consists of the LDGV, LDGT1, LDGT2, LDGT3, and LDGT4 categories and is collectively responsible for roughly 90.8% of the overall fleet VMT. What are commonly accepted as SUVs actually span vehicle categories other than the LDGT1-4 classes. For example, any SUV with a gross vehicle weight rating (GVWR) between 8,501-10,000 pounds would be classified as either an HDGV2b or HDDV2b, depending on whether it uses gasoline or diesel fuel, respectively. Nonetheless, the bulk of the SUVs are spread among the LDGT1-4 categories.

Table 37 simply isolates the LDG NO_X and VMT data from Table 36 and considers the 83,372,242 light-duty gasoline VMT figure to be 100%. Notice that the NO_X emission rates from these vehicle classes range between 0.88 and 1.15 grams/mile, with the lowest emission rates

attributed to the LDGT1 and LDGT3 categories.

Table 37. Harris County Wednesday August 30, 2000 Light-Duty Gasoline 24-Hour NO_X Emissions with TTI/TxDOT VMT Mix

MOBILE6 Vehicle Class	***24-Hour VMT***	***Relative Portion***	***Emission Rate*** *(gpm)*	***NO_X*** *(tpd)*
LDGV	56,804,554	68.1%	0.9756	61.1
LDGT1	5,106,984	6.1%	0.8843	5.0
LDGT2	17,001,008	20.4%	1.0826	20.3
LDGT3	3,054,873	3.7%	0.9049	3.0
LDGT4	1,404,823	1.7%	1.1464	1.8
Total	83,372,242	100.0%		91.2

If the same emission rates are applied but EPA's MOBILE6 2000 default VMT mix distribution among the LDGs is used, the results presented in Table 38 are obtained. Application of the MOBILE6 2000 default VMT mix more heavily weights the LDGT categories and the result is a slight increase in the total estimated NO_X emissions from 91.2 to 91.6 tons per day (roughly 0.4%) compared with the TTI/TxDOT VMT mix approach.

Table 38. Harris County Wednesday August 30, 2000 Light-Duty Gasoline 24-Hour NO_X Emissions with 2000 EPA MOBILE6 Default VMT Mix

MOBILE6 Vehicle Class	***24-Hour VMT***	***Relative Portion***	***Emission Rate*** *(gpm)*	***NO_X*** *(tpd)*
LDGV	46,226,024	55.4%	0.9756	49.7
LDGT1	6,383,748	7.7%	0.8843	6.2
LDGT2	21,251,212	25.5%	1.0826	25.4
LDGT3	6,515,151	7.8%	0.9049	6.5
LDGT4	2,996,106	3.6%	1.1464	3.8
Total	83,372,242	100.0%		91.6

The TCEQ recently received an alternative analysis of the TxDOT registration database for the 8-County HGA area based on the MOBILE5 categories of LDGV, LDGT1, and LDGT2. It was suggested that the VMT distribution among these vehicle types should be roughly 60%, 25%, and 15%, respectively, rather than the figures currently used. In order to determine the impact of this alternate 60/25/15 distribution analysis, it is first necessary to convert the MOBILE6 emission rates for LDGT1 and LDGT2 into a single MOBILE5 emission rate for LDGT1. This was accomplished by weighting each emission rate by its relative contribution of VMT to the combined VMT from both. A similar approach was taken with the MOBILE6 classes of LDGT3 and LDGT4 being converted to a MOBILE5 LDGT2 class. The results are provided in Table 39.

Table 39. Harris County Wednesday August 30, 2000 Light-Duty Gasoline 24-Hour NO_X Emissions with TTI/TxDOT VMT Mix by MOBILE5 Classes

MOBILE5 Vehicle Class	***24-Hour VMT***	***Relative Portion***	***Emission Rate*** *(gpm)*	***NO_X*** *(tpd)*
LDGV	56,804,554	68.1%	0.9756	61.1
LDGT1	22,107,992	26.5%	1.0368	25.3
LDGT2	4,459,696	5.3%	0.9810	4.8
Total	83,372,242	100.0%		91.2

The alternate 60/25/15 distribution can now be applied and the effects determined. The results are presented in Table 40.

Table 40. Harris County Wednesday August 30, 2000 Light-Duty Gasoline 24-Hour NO_X Emissions with 60/25/15 VMT Mix by MOBILE5 Classes

MOBILE5 Vehicle Class	***24-Hour VMT***	***Relative Portion***	***Emission Rate*** *(gpm)*	***NO_X*** *(tpd)*
LDGV	50,023,345	60.0%	0.9756	53.8
LDGT1	20,843,061	25.0%	1.0368	23.8
LDGT2	12,505,836	15.0%	0.9810	13.5
Total	83,372,242	100.0%		91.1

As demonstrated, applying the 60/25/15 VMT mix very slightly reduced the overall NO_X emission estimates from 91.2 to 91.1 tons per day (roughly 0.04%) compared with the TTI/TxDOT VMT mix approach. Similar analyses were performed for total VOC and CO emission estimates in Harris County for the Wednesday August 30, 2000 episode day. These data are summarized along with the NO_X results in Table 41.

Table 41. Summary of Different VMT Mix Inputs on MOBILE6 Light-Duty Gasoline Emissions in Harris County on Wednesday August 30, 2000

VMT Mix Applied	***24-Hour Emissions*** *(tons/day)*			***Percent Difference***		
	NO_X	*VOC*	*CO*	*NO_X*	*VOC*	*CO*
TTI/TxDOT	91.2	100.0	1379.4	NA	NA	NA
MOBILE6 Default	91.6	99.3	1392.3	0.44%	-0.73%	0.94%
60/25/15	91.1	97.3	1369.8	-0.04%	-2.72%	-0.69%

As can be seen, the overall MOBILE6 light-duty gasoline emission estimates are not very sensitive to changes in VMT mix inputs from the various light-duty gasoline vehicle classes. This is because little difference exists among the emission rates predicted by MOBILE6 for these vehicle classes. At first, this seems counter-intuitive because heavier vehicles generally consume more fuel and therefore emit more pollution than lighter vehicles. However, new emission certification

standards for the light-duty gasoline vehicle classes are both getting lower and converging closer together. This trend will likely continue in the future, particularly with the phase-in of Tier 2 certification standards which begin with the 2004 model year.

The LDG emission rates also do not vary significantly from each other because the heavier LDG classes on average are newer than the lighter LDG classes. It is certainly true that sales of new SUVs have increased significantly throughout the last decade as these vehicle types have become more popular. The net effect of this trend has been to increase the average age of the LDGV portion of the fleet (relative to the LDGT3 and LDGT4 portions) because many people have not replaced their older passenger cars with new passenger cars, but instead have purchased new SUVs. This effect is reflected in the local age distribution data by vehicle type obtained from the TxDOT registration database for Harris County. Provided in Table 42 are the age registration distribution data for each of the five light-duty vehicle classes that were used by TTI as MOBILE6 inputs in the development of the 2000 Harris County MOBILE6 inventories.

Table 42. Harris County 2000 Light-Duty Vehicle Age Distribution from TxDOT Database

Vehicle Age	***Contribution to Total***				
(Years)	*LDGV*	*LDTG1*	*LDTG2*	*LDTG3*	*LDTG4*
1	7.892%	8.115%	8.115%	16.084%	16.084%
2	9.895%	9.501%	9.501%	15.268%	15.268%
3	8.422%	8.484%	8.484%	18.323%	18.323%
4	7.826%	8.191%	8.191%	7.186%	7.186%
5	7.504%	8.049%	8.049%	9.405%	9.405%
6	6.776%	5.821%	5.821%	5.987%	5.987%
7	7.337%	6.596%	6.596%	5.714%	5.714%
8	5.967%	6.453%	6.453%	3.501%	3.501%
9	5.812%	5.390%	5.390%	3.181%	3.181%
10	5.125%	4.646%	4.646%	2.372%	2.372%
11	4.920%	4.316%	4.316%	1.886%	1.886%
12	4.396%	3.578%	3.578%	1.562%	1.562%
13	3.783%	3.559%	3.559%	1.527%	1.527%
14	3.080%	2.944%	2.944%	1.179%	1.179%
15	2.344%	2.133%	2.133%	0.697%	0.697%
16	1.946%	2.141%	2.141%	0.919%	0.919%
17	1.705%	1.986%	1.986%	0.955%	0.955%
18	1.276%	1.703%	1.703%	0.904%	0.904%
19	0.749%	0.959%	0.959%	0.533%	0.533%
20	0.556%	1.113%	1.113%	0.589%	0.589%
21	0.397%	0.850%	0.850%	0.328%	0.328%
22	0.293%	0.431%	0.431%	0.298%	0.298%
23	0.354%	0.569%	0.569%	0.454%	0.454%
24	0.277%	0.506%	0.506%	0.278%	0.278%
25+	1.368%	1.966%	1.966%	0.870%	0.870%
Total	100.000%	100.000%	100.000%	100.000%	100.000

If these data are grouped by age and categorized into 25% "bins", the average age differences between the "lighter" and "heavier" LDGs become more apparent. As Table 43 indicates, the LDGT3 and LDGT4 categories are almost half the age of the LDGV, LDGT1, and LDGT2 categories. As a result, the emissions performance of the LDGT3 and LDGT4 vehicles has not deteriorated to the same extent as the "lighter" categories. This contributes to the fact that there is little difference in the overall composite emission rates of the light-duty gasoline fleet. It must be noted that the LDGT3 and LDGT4 classes have historically contained a much smaller number of registered vehicles than the LDGV, LDGT1, and LDGT2 classes. Therefore, the recent increase in sales of "heavier" SUVs had a significant impact on the average age of the LDGT3 and LDGT4 categories because they were not heavily populated to begin with. Conversely, the LDGV, LDGT1, and LDGT2 categories have historically been very heavily populated and consequently, it would take an extremely large and sustained surge in new vehicle sales to significantly impact the average age of these classes.

Table 43. Harris County 2000 Age Distribution of Light-Duty Gasoline Fleet by 25% Bins

Portion of Fleet	***MOBILE6 Light-Duty Gasoline Vehicle Age*** *(Years)*				
	LDGV	*LDTG1*	*LDTG2*	*LDTG3*	*LDTG4*
25%	2.9 & Newer	2.9 & Newer	2.9 & Newer	1.6 & Newer	1.6 & Newer
50%	6.2 & Newer	6.3 & Newer	6.3 & Newer	3.0 & Newer	3.0 & Newer
75%	10.5 & Newer	10.9 & Newer	10.9 & Newer	6.5 & Newer	6.5 & Newer

<u>Contribution of VMT from Heavy-Duty Diesel Vehicles</u>

The overall NO_X emissions level of a MOBILE6-based inventory is sensitive to the amount of VMT attributed to the heavy-duty diesel vehicles in the fleet, particularly the HDDV8a and HDDV8b categories. Even though there are many different axle configurations and gross vehicle weight rating (GVWR) classifications among these two vehicle types, the five-axle "18-wheelers" familiar to many freeway drivers comprise a significant portion of both these categories. As indicated above in Table 36, the HDDV8a and HDDV8b classes have the highest 2000 NO_X emission rates among all the 28 MOBILE6 vehicle types.

As summarized above, the EPA MOBILE6 default VMT mix figures are based on nationwide annual mileage accumulation estimates by vehicle type. For the purposes of estimating the combined HDDV8ab portion of the VMT mix for a heavily populated metropolitan area such as Houston, it would be inappropriate to use the EPA MOBILE6 defaults. These default VMT mix figures do not distinguish between urban and rural areas, which is a crucial distinction for "long-haul" truck traffic. The VMT from most vehicle types can be roughly correlated with population. For example, light-duty VMT is going to be concentrated in population centers where people live and work. The same is true for "light" or "moderate" heavy-duty vehicles such as local delivery trucks along with school buses, transit buses, etc. However, most of the VMT accumulated by "long-haul" trucks takes place in rural and not urban areas.

For example, assume that an HDDV8a or HDDV8b vehicle makes a trip from the center of

Houston to the center of Dallas. Most of the VMT for that entire trip has been accumulated in rural areas. The same could be said for any trips occurring between cities spaced very far apart in large states such as Texas, California, etc. This would not necessarily be the case in areas such as the Northeastern U.S. where urban areas are more closely spaced together. For application in most urban areas, the problem with applying EPA's default VMT mix for the combined HDDV8ab categories is that these figures are heavily weighted with the substantial "heavy-truck" VMT which occurs in rural areas.

The significant accumulation of heavy truck VMT in rural areas was evident in a Federal Highway Administration (FHWA) study conducted in conjunction with the California Air Resources Board (CARB). The title of the report for this study is *Heavy-Duty Truck Activity Data, April 30, 1999* and it can be obtained at http://www.fhwa.dot.gov/ohim/tvtw/tvtwpage.htm. In 1998, a sample of trucks operating throughout California was equipped with global positioning system (GPS) equipment to track their location throughout the duration of the study. The sample was more heavily weighted with the larger "long-haul" trucks due to the fact that they have both the highest emissions and VMT accumulation rates. The GPS data collected allowed the researchers to determine the amount of VMT accumulated in both urban and rural areas. Table 44 provided below is an excerpt from Table 8 of the FHWA report.

Table 44. Sample Truck Activity Data (VMT) in Urban and Rural Areas

Urban Area Class	***Truck Category & GVWR Rating*** *(pounds)*					
	T4	***T5***	***T6***	***T7***	***T8***	***Totals***
	8,5001-10,000	*10,001-14,000*	*14,001-33,000*	*33,001-60,000*	*Over 60,000*	
Large Urban (200,000+)	0.0%	0.0%	0.0%	0.4%	0.1%	0.5%
Urbanized (50,000-200,000)	1.1%	0.6%	2.8%	3.2%	1.7%	9.5%
Small Urban (5,000-50,000)	0.9%	1.0%	6.0%	21.3%	11.1%	40.2%
Rural	0.9%	0.1%	2.9%	26.8%	19.1%	49.8%
Total	2.8%	1.7%	11.7%	51.7%	32.1%	100.0%

The T7 and T8 categories in the report are roughly equivalent to the HDDV8a and HDDV8b MOBILE6 categories, respectively, because very few gasoline-powered vehicles have these weight ratings. As the table indicates, roughly half of the VMT from the T7 and T8 categories occurred in rural areas, while roughly 40% occurred in small urban areas with populations between 5,000-50,000. The large urban and urbanized areas combined accounted for about 10% of the VMT from these vehicles. Both Figure 2 and Table 4 from the FHWA report summarize the urban areas of California, but are not reported here. Not surprisingly, the very large cities of California (Los Angeles, San Francisco, San Diego, etc.) are included in the large urban category.

Instead of relying on the MOBILE6 default VMT mix data for heavy-duty vehicles, TTI used the locally collected vehicle classification from TxDOT as described above. These data are then converted into the heavy-duty vehicle classes from MOBILE6 as described beginning on page 11 of Attachment 3-2 and page 14 of Attachment 3-3.

With MOBILE5, heavy duty vehicles above 8,500 pounds GVWR were simply aggregated into gasoline-powered and diesel-powered categories. The significantly increased number of heavy-duty vehicle classifications in MOBILE6 has presented new challenges for researchers estimating heavy-duty vehicle activity. From July-September of 2002, the TCEQ contracted with TTI to conduct additional vehicle classification counts in the 8-County HGA area to supplement the existing TxDOT data sets which are used. Once these data are reviewed and quality assured, they will be included in the development of future on-road mobile source inventories for the 8-County HGA area. Due to the sensitivity of MOBILE6 inventories to the heavy-duty diesel VMT mix, the TCEQ in conjunction with TTI, the TWG MOBILE6 Subcommittee, and other interested parties will continue to investigate methods of further refining the VMT mix estimation process.

Emissions Processing of MOBILE5 & MOBILE6 Inventories

For each episode day, TTI submitted separate emissions inventory files for both county and hour, resulting in a total of 192 separate files for the entire 8-County HGA area. The 2000 MOBILE5b, 2000 MOBILE6, and 2007 MOBILE6 inventories were processed by TCEQ staff so that they could be converted into a binary gridded format suitable for input into the photochemical model. Many of the tables shown below use the MOBILE5b inventory as an example because it has a much smaller number of vehicle types and is therefore easier to use for explanation purposes. Nonetheless, little difference exists between the processing steps between the MOBILE5b and MOBILE6 inventories. Both the naming convention and structure of the submitted files are detailed below in Table 45 for a sample MOBILE5b inventory.

Table 45. Link Emissions File Structure for "County_mmmdd.Thh" MOBILE5b Files

- "County" is Harris, Brazoria, Galveston, etc.
- "mmm" is Month (AUG, SEP, etc.)
- "dd" is Day (28, 29, 30, etc.)
- "hh" is Hour (01, 02, 03, etc.) in Local Time or Central Daylight Time (CDT) and not Central Standard Time (CST)

Column(s)	***Contents***	***Example(s) or Remarks***
1-5	X_1-Y_1 Reference	Refer to "all2000.srt" coordinate file (see Table 46)
6-10	X_2-Y_2 Reference	Refer to "all2000.srt" coordinate file (see Table 46)
14-15	Functional Class	0, 1, 2, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15 (see Table 47)
18-21	Pollutant Code	VOC, CO, NOX, EXHS, RNLS, RSTL, CC, HTSK, DIRN
24-32	LDGV Emissions	Light-Duty Gasoline Vehicle emissions in grams
34-42	LDGT1 Emissions	Light-Duty Gasoline Truck 1 emissions in grams
44-52	LDGT2 Emissions	Light-Duty Gasoline Truck 2 emissions in grams
54-62	HDGV Emissions	Heavy-Duty Gasoline Vehicle emissions in grams
64-72	LDDV Emissions	Light-Duty Diesel Vehicle emissions in grams
74-82	LDDT Emissions	Light-Duty Diesel Truck emissions in grams
84-92	HDDV Emissions	Heavy-Duty Diesel Vehicle emissions in grams
94-102	MC Emissions	Motorcycle emissions in grams

A separate file entitled ***all2000.srt*** was provided by TTI which contains the coordinates for the X_1-Y_1 and X_2-Y_2 link nodes. A summary of this file structure is contained below in Table 46. TCEQ staff converted the X-Y link nodes from the Universal Transverse Mercator (UTM) NAD83 Zone 15 projection to the Lambert Conformal Conic Spherical projection being used for modeling the 2000 HGA episode. Table 47 details the 13 different functional classes (i.e., roadway types)

specified in the inventory files.

Table 46. Coordinate File Structure for "all2000.srt"

Column(s)	*Contents*	*Example(s) or Remarks*
2-6	Numeric Code	Coordinate reference number with 5-digit maximum
8-20	X Reference	UTM Zone 15 Point (XXXXXX.XXXXXX) in meters
22-35	Y Reference	UTM Zone 15 Point (YYYYYYY.YYYYYY) in meters

Table 47. Functional Class Code Summary

Aggregated Functional Class	*Numeric Code*	*Network Functional Class*
Freeways	1	Urban Interstate Freeway
	2	Urban Other Freeway
	10	Rural Interstate Freeway
	11	Rural Other Freeway
Arterials	5	Urban Principal Arterial
	6	Urban Other Arterial
	12	Rural Principal Arterial
	13	Rural Other Arterial
Collectors/Locals	7	Urban Collector
	8	Centroid Connector
	14	Rural Major Collector
	15	Rural Collector
	0	Local (Intrazonal)

Provided in Table 48 is a sample excerpt from the TTI inventory file entitled ***Harris_AUG30.T12***. The emissions specified are from an urban interstate freeway link located in Harris County on Wednesday August 30, 2000 during the twelfth hour of the day, which is 11 AM - 12 PM CDT and 10-11 AM CST. Prior to being input into the photochemical model, these emission inventory data were run through the 2X version of the Emissions Preprocessor System (EPS2X). The first module of EPS2X for link-based on-road mobile source emission inventories is entitled LBASE. Prior to being input into LBASE, the TTI inventory data were reformatted with custom-written SAS code. The SAS code has been written to prepare the on-road mobile source emissions for LBASE in Central Standard Time (CST) for each episode day. Since the files received from TTI

are in Central Daylight Time (CDT), the SAS code has been written to obtain the TTI inventory file for 1-2 AM CDT when it is preparing the LBASE input file for 12-1 AM CST on any given day. This same approach occurs for each of the 24 hours of an episode day. When preparing the LBASE input file for 11 PM - 12 AM CST, the SAS code obtains the 12-1 AM CDT file from TTI for the next episode day. Provided in Table 49 is a sample excerpt from the LBASE input file for the same roadway link emissions that are presented in Table 48.

Table 48. Sample Link Emissions from Harris_AUG30.T12 MOBILE5b TTI File

2790	3302	1	VOC	7271.175	2819.486	480.800	1548.865	7.016	8.672	1189.562	72.988
2790	3302	1	CO	47677.808	19431.278	3523.658	12194.029	15.673	16.418	5688.832	177.523
2790	3302	1	NOX	7284.107	2695.767	480.192	1801.428	16.984	17.384	6328.551	7.412
2790	3302	1	EXHS	4056.388	1638.045	293.730	639.130	7.016	8.672	1189.562	15.127
2790	3302	1	RNLS	1026.168	386.029	65.469	114.279	0.000	0.000	0.000	0.000
2790	3302	1	RSTL	472.769	150.320	19.781	45.905	0.000	0.000	0.000	6.182
2790	3302	1	CC	30.205	8.407	1.556	3.431	0.000	0.000	0.000	0.000
2790	3302	1	HTSK	518.126	175.434	26.794	434.888	0.000	0.000	0.000	22.343
2790	3302	1	DIRN	1167.519	461.252	73.470	311.233	0.000	0.000	0.000	29.336

Table 49. Sample Excerpt from LBASE Input MOBILE5b File for Harris County Freeway Link

48201	MV01230EXH	00083010	00083011	446038	-1100168	445580	-1098922	0	10460.066	6028.331	70632.744
48201	MV04230EXH	00083010	00083011	446038	-1100168	445580	-1098922	0	1801.428	642.561	12194.029
48201	MV05230EXH	00083010	00083011	446038	-1100168	445580	-1098922	0	34.368	15.688	32.091
48201	MV07230EXH	00083010	00083011	446038	-1100168	445580	-1098922	0	6328.551	1189.562	5688.832
48201	MV08230EXH	00083010	00083011	446038	-1100168	445580	-1098922	0	7.412	15.127	177.523
48201	MV01230HOT	00083010	00083011	446038	-1100168	445580	-1098922	0	0	2422.595	0
48201	MV04230HOT	00083010	00083011	446038	-1100168	445580	-1098922	0	0	746.121	0
48201	MV08230HOT	00083010	00083011	446038	-1100168	445580	-1098922	0	0	51.679	0
48201	MV01230RNL	00083010	00083011	446038	-1100168	445580	-1098922	0	0	1477.666	0
48201	MV04230RNL	00083010	00083011	446038	-1100168	445580	-1098922	0	0	114.279	0
48201	MV01230RST	00083010	00083011	446038	-1100168	445580	-1098922	0	0	642.87	0
48201	MV04230RST	00083010	00083011	446038	-1100168	445580	-1098922	0	0	45.905	0
48201	MV08230RST	00083010	00083011	446038	-1100168	445580	-1098922	0	0	6.182	0

A more detailed description of the format structure for the LBASE input files is provided below in Table 50. It is neither necessary nor advisable to have the LBASE input file break out the emissions for each link by the 13 functional classes, 9 pollutant codes, and 8 vehicle types provided in the MOBILE5b TTI files. Such an approach would make the LBASE input files extremely large and result in longer processing times with the EPS2X system. Instead, the emissions are aggregated by functional class into freeways and arterials.

The pollutant codes are combined as appropriate for equivalent chemical speciation profiles. The vehicle types are aggregated from the 8 vehicle types from MOBILE5 into the 5 categories of light-duty gasoline, heavy-duty gasoline, light-duty diesel, heavy-duty diesel, and motorcycles. This aggregation allows for greater operational efficiency with the EPS2X system.

Table 50. LBASE Input File Structure

Column(s)	***Contents***	***Example(s) or Remarks***
1-5	FIPS County Code	48201 for Harris, 48039 for Brazoria, etc.
12-13	MV	Alpha reference for “motor vehicles”
14-15	MOBILE5-based Vehicle Code	01 for LDGV + LDGT1 + LDGT2 04 for HDGV 05 for LDDV + LDDT 07 for HDDV 08 for MC
16-18	Functional Class Code	230 for Freeways 270 for Arterials
19-21	Pollutant Code	EXH for tailpipe emissions (CO, NO_X, VOC exhaust, & VOC crankcase emissions) HOT for hot soak and diurnal emissions (VOCs only) RNL for running loss emissions (VOCs only) RST for resting loss emissions (VOCs only)
23-24	Year Code	“00" for 2000, “07" for 2007, etc.
25-26	Month Code	“08" for August, “09" for September, etc.
27-28	Day Code	“28", “29", “30", etc.
29-30	Beginning of Hour	“10" for 10 AM Central Standard Time (CST)
32-33	Year Code	“00" for 2000, “07" for 2007, etc.
34-35	Month Code	“08" for August, “09" for September, etc.
36-37	Day Code	“28", “29", “30", etc.
38-39	End of Hour	“11" for 11 AM Central Standard Time (CST)
41-49	X_1 Link Position	X_1 Reference in Lambert Conformal Projection (meters)
51-59	Y_1 Link Position	Y_1 Reference in Lambert Conformal Projection (meters)
61-69	X_2 Link Position	X_2 Reference in Lambert Conformal Projection (meters)
71-79	Y_2 Link Position	Y_2 Reference in Lambert Conformal Projection (meters)
81-82	UTM Zone	Using “0" for Lambert Conformal Projection
94-102	NO_X Emissions	Units of grams

104-112	VOC Emissions	Units of grams
114-122	CO Emissions	Units of grams

Even greater aggregation could occur. For instance, separate roadway types are not necessarily needed and the 8 vehicle types could simply be broken down into the categories of gasoline and diesel. However, TCEQ staff desired to have a sufficient level of disaggregation in the mobile source inventories so that control strategy adjustments could later be properly applied during various scenario runs with the photochemical model. For example, the LDGV, LDGT1, and LDGT2 categories can be combined into one because any control strategy which will apply to one (such as I/M program, fuel type, etc.) will likely apply to all. For the same reason, the LDDV and LDDT categories are combined. However, the HDGV, HDDV, and MC categories are kept separate. The functional classes of freeway and arterial are kept separate as well because MOBILE6 uses different drive cycles to estimate the emission rates for these roadway types. If necessary, the SAS code could easily be revised and the emissions be reprocessed if an increased level of disaggregation is determined to be necessary at a later date.

The MOBILE6-based inventories were also processed with both SAS and EPS2X in a manner very similar to that for the MOBILE5b-based inventories previously described. Instead of repeating each of these steps here, only the manner in which the MOBILE6 inventory processing differs from that for MOBILE5b will be discussed. Instead of the 9 pollutant codes provided with the MOBILE5b inventories, as described in Table 45, 14 pollutant codes were used with the MOBILE6 inventories. Provided below in Table 51 is a summary of how the pollutant codes in the TTI files differ between the MOBILE5 and MOBILE6 inventories.

Table 51. Pollutant Code Differences Between MOBILE5b & MOBILE6 Inventories

MOBILE5	***MOBILE6***	***Description***
VOC	VOC COMPOSITE	Total VOC Emissions
EXHS	VOC EXH_RUNNING	“Running” VOC Tailpipe Emissions
	VOC START	“Start” VOC Tailpipe Emissions
HTSK	VOC Hot_Soak	VOC Hot Soak Emissions
DIRN	VOC Diurnal	VOC Diurnal Emissions
RSTL	VOC Rest_Loss	VOC Resting Loss Emissions
RNLS	VOC Run_Loss	VOC Running Loss Emissions
CC	VOC Crankcase	VOC Crankcase Emissions
CO	CO COMPOSITE	Total CO Emissions

Not Used	CO EXH_RUNNING	"Running" CO Tailpipe Emissions
	CO START	"Start" CO Tailpipe Emissions
NO_X	NO_X COMPOSITE	Total NO_X Emissions
Not Used	NO_X EXH_RUNNING	"Running" NO_X Tailpipe Emissions
	NO_X START	"Start" NO_X Tailpipe Emissions

However, the primary difference between the MOBILE5b and MOBILE6 inventories was the breakdown of emissions by vehicle type. As described above in Table 1, MOBILE6 disaggregates the 8 MOBILE5 vehicle types into 28 different vehicle types. The link emissions format for the MOBILE6 inventory files received from TTI look very similar to the MOBILE5 example described above in Table 45. The only significant differences are that the MOBILE6 files have more pollutant codes and vehicle types. A sample excerpt from one of the MOBILE6 inventory files is not provided here due to the fact that each line contains over 300 characters to accommodate the emissions from all 28 vehicle types. For EPS2X processing purposes, the 8 vehicle types from MOBILE5 were aggregated into 5 vehicle types, as shown in Table 50. For the MOBILE6 inventory files, the 28 vehicle types were aggregated into 11 vehicle types as shown below in Table 52.

Table 52. Vehicle Type Aggregation for MOBILE6 LBASE Input Files

LBASE Vehicle Code	***Total Vehicles***
01	LDGV + LDGT1 + LDGT2 + LDGT3 + LDGT4
06	HDGV2B
07	HDGV3 + HDGV4 + HDGV5 + HDGV6 + HDGV7 + HDGV8a + HDGV8b
14	LDDV + LDDT12 + LDDT34
16	HDDV2B
17	HDDV3 + HDDV4 + HDDV5 + HDDV6 + HDDV7
22	HDDV8a + HDDV8b
24	MC
25	HDGB
26	HDDBT
27	HDDBS

The primary functions of the LBASE module of EPS2X are:

- to identify the link-based emissions which are contained within the modeling domain;
- to spatially allocate the link-based emissions contained both within and among the grid cells chosen for the modeling domain;
- to disaggregate the link-based emissions into the various exhaust and evaporative components; and
- to reformat the emissions into a binary file suitable for further EPS2X processing.

In order to disaggregate the emissions into their appropriate exhaust and evaporative components, a speciation cross-reference file is needed. During the period of the 2000 TxAQS study, motor vehicle exhaust and evaporative emission data were collected from the Washburn Tunnel in the Houston area and speciated into various chemical components. These data were analyzed under contract to the TCEQ and eventually converted by Environ into a format suitable for use with EPS2X. Provided below in Table 53 is a sample excerpt from the speciation cross-reference file used to process the link-based MOBILE5b emissions for the 8-County HGA area.

Table 53. Sample Excerpt From MOBILE5b Speciation Cross-Reference File

```
00000        -9 MV01230DNL H2KGV 1.000  0   .04   .12 1.000  .000 1.000
00000        -9 MV01230EXH H2KWT  .974  0   .12   .31 1.000  .000 1.000
00000        -9 MV01230HOT H2KGV 1.000  0   .04   .12 1.000  .000 1.000
00000        -9 MV01230RNL H2KWT 1.000  0   .04   .12 1.000  .000 1.000
00000        -9 MV01230RST H2KGS 1.000  0   .13   .32 1.000  .000 1.000
00000        -9 MV01270DNL H2KGV 1.000  0   .04   .12 1.000  .000 1.000
00000        -9 MV01270EXH H2KWT  .974  0   .12   .31 1.000  .000 1.000
00000        -9 MV01270HOT H2KGV 1.000  0   .04   .12 1.000  .000 1.000
00000        -9 MV01270RNL H2KWT 1.000  0   .04   .12 1.000  .000 1.000
00000        -9 MV01270RST H2KGS 1.000  0   .13   .32 1.000  .000 1.000
00000        -9 MV07230EXH  D201  .996  0   .04   .18 1.000  .000 1.000
00000        -9 MV07270EXH  D201  .996  0   .04   .18 1.000  .000 1.000
```

A review of the table indicates that:

- the VOC diurnal and hot soak emissions have the same profile;
- the gasoline exhaust category has its own profile;
- the running loss emissions category has its own profile;
- the resting loss emissions category has its own profile; and
- the diesel exhaust emissions category has its own profile.

Each of the gasoline-powered vehicles follows the “MV01" profiles presented above in Table 53. Likewise, each of the diesel-powered vehicles follows the “MV07" profiles presented above. The format for the speciation cross-reference file is provided below in Table 54.

Table 54. File Structure for Speciation Cross-Reference File

Column(s)	***Contents***	***Example(s) or Remarks***
1-5	FIPS County Code	Use “00000" to apply to all counties
13-15	AFS “Stack” Code	Use “-9" to apply to all “stacks” or “sources”
17-26	Motor Vehicle Source Classification Code (SCC)	SCC codes should match those in LBASE input file as shown in Tables 49 and 50
28-32	Profile Code	H2KGV - Houston 2000 Gasoline Vapor H2KWT - Houston 2000 Washburn Tunnel H2KGS - Houston 2000 Gasoline Sample D201 - Diesel Exhaust Emissions
34-38	VOC Profile Fraction	Fraction of total mass that is to be speciated
40-41	CTG Flag	Use “0"for non-CTG sources
43-47	Toxic Portion	Maximum percentage of any one toxic substance
49-53	Toxic Total	Total percentage of all toxic substances
55-59	Ethane Correction Factor	Use 1.000 for default
61-65	Formaldehyde Correction Factor	Use 0 for default
67-71	Overall Correction Factor	Use 1.000 for default

The next step for link-based emissions in the EPS2X system is called the CHMSPL (“chemical split”) module. The primary function of the CHMSPL module is to disaggregate the pollutant emissions into the chemical species used in the Carbon Bond IV (CB-IV) mechanism employed by the photochemical model. Similar to LBASE, the output of CHMSPL is a binary emissions file suitable for further processing. Like LBASE, CHMSPL also uses the speciation cross-reference file described in Tables 53 and 54. CHMSPL also needs a separate split factors file which provides for the further CB-IV disaggregation of the VOCs into classes with similar carbon bonds. These VOC speciation classes are shown below in Table 55.

Table 55. Carbon Bond IV (CB-IV) VOC Classes

CB-IV Code	***Description***
OLE	Olefinic Carbon Bonds
PAR	Paraffinic Carbon Bonds
TOL	Toluene Grouping
XYL	Xylene Grouping
FORM	Formaldehyde Grouping
ALD2	High Molecular Weight Aldehydes
ETH	Ethene Grouping
MEOH	Methanol Grouping
ETOH	Ethanol Grouping
ISOP	Isoprene Grouping

The complete split factors file used for processing the HGA link-based emissions is provided below in Table 56.

Table 56. Houston Area Motor Vehicle Emissions Split Factors File

```
   10
OLE         32.0 VOC
PAR         16.0 VOC
TOL        112.0 VOC
XYL        128.0 VOC
FORM        16.0 VOC
ALD2        32.0 VOC
ETH         32.0 VOC
MEOH        16.0 VOC
ETOH        32.0 VOC
ISOP        80.0 VOC
H2KGS 0.138E-03 0.490E-01 0.962E-03 0.108E-02 0.113E-03 0.103E-02 0.000E+00 0.000E+00 0.000E+00 0.592E-05
H2KGV 0.340E-03 0.560E-01 0.304E-03 0.139E-03 0.302E-03 0.246E-02 0.000E+00 0.000E+00 0.000E+00 0.102E-04
H2KWT 0.112E-02 0.413E-01 0.768E-03 0.919E-03 0.130E-02 0.131E-02 0.209E-02 0.153E-03 0.787E-04 0.464E-04
D201  0.894E-03 0.328E-01 0.405E-03 0.287E-02 0.113E-02 0.706E-03 0.132E-02 0.000E+00 0.000E+00 0.000E+00
```

The “10" in the first line refers to the total number of different VOC species. The 32.0 value on the “OLE” line refers to the molecular weight of olefinic compounds. The “VOC” listed is the criteria pollutant from which the olefinic compounds are created. The remaining 9 compounds listed follow a similar approach. Included at the beginning of each of the last four lines are the profile codes which should match those contained within the speciation cross-reference file. The rest of each line contains the “splitting factors” for each of the 10 CB-IV compounds for that specific speciation profile. As a result of the molecular weight allocation from the CB-IV

speciation process, the total VOC (as reported in tons per day) eventually input into the photochemical model is typically slightly different than that reported by TTI.

After CHMSPL, the speciated link-based emissions are now ready to be aggregated and spatially allocated into the appropriate grid cells contained within the modeling domain. The GRDEM ("grid emissions") module accomplishes this task. After completing the GRDEM step, the gridded emissions file is ready either for direct input into the photochemical model or for merging with other gridded emissions files (area, low-level point, other mobile, etc.) that have been processed with EPS2X. Once emissions are allocated to specific grid cells by hour within GRDEM, the exact link location of the emissions is no longer maintained. For each hour of the episode day, the emissions within each grid cell are assumed to be uniformly distributed in both a spatial and temporal fashion.

When the LBASE input files were discussed earlier, the levels of disaggregation by vehicle type, pollutant type, and roadway type were specified. For each grid cell, one of the GRDEM output files maintains a record of the amount of emissions to be attributed to each motor vehicle source classification code by hour. By doing this, the GRDCTL ("grid control") module can be used to make adjustments to each grid cell for the purposes of testing the impact of various ozone control scenarios. This approach is far more efficient than completely redeveloping and reprocessing the on-road mobile source inventory from the "bottom up" just to test the effects of one specific strategy. For example, suppose that MOBILE6 is run and it is determined that a specific control strategy reduces all light-duty gasoline (i.e., cars, pickups, & SUVs) NO_X emissions by 10%. A factor of 0.9 can be multiplied by all of the "MV01...EXH" codes for NO_X so that the emissions are reduced by 10% across all roadway types. Or, suppose that MOBILE6 is run and it is determined that a specific control strategy will reduce freeway NO_X emissions from the HDDV8a and HDDV8b categories by 5%. In this case, a factor of 0.95 is applied to all of the "MV22230EXH" codes for NO_X in the GRDEM output file so that it applies only to these vehicle types on freeways. If a specific grid cell did not contain any freeways, then this adjustment would not result in reduced NO_X emissions for that grid cell.

Table 57 summarizes the 2000 HGA MOBILE5b 24-hour NO_X emissions by county which were input into the photochemical model for each episode day. Tables 58 and 59 provide similar summaries for VOC and CO, respectively. If these figures are compared with the emissions data provided by TTI, there are often some slight discrepancies in the totals, particularly for VOC emissions. The primary reason for these minor discrepancies is due to the manner in which the emissions are speciated by the CHMSPL module into compounds with different molecular weights. The other reason for the discrepancies is that the emissions reported by TTI are in Central Daylight Time, but the emissions are processed and input into the photochemical model in Central Standard Time. For example, the TTI totals for Wednesday August 30th data cover 12 AM CDT on August 30th to 12 AM CDT on August 31st. The data input into the photochemical model cover 12 AM - 12 AM CST, which is actually 11 PM CDT on Tuesday August 29th to 11 PM CDT on Wednesday August 30th. The net change in reported 24-hour totals would be due to very minor emission differences between the 11 PM -12 AM hours of each episode day. For each episode day:

- Tables 60-62 contain NO_X, VOC, and CO summaries for the 2000 HGA MOBILE6 inventory;
- Tables 63-65 contain NO_X, VOC, and CO summaries for the 2007 HGA MOBILE6 inventory;
- Tables 66-68 contain NO_X, VOC, and CO summaries for the 2007 55mph HGA MOBILE6 inventory;
- Tables 69-71 contain NO_X, VOC, and CO summaries for the 2000 BPA MOBILE6 inventory; and
- Tables 72-74 contain NO_X, VOC, and CO summaries for the 2007 BPA MOBILE6 inventory.

Table 57. HGA 2000 MOBILE5b 24-Hour NO_X Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	15.73	15.79	16.06	16.38	14.20	11.70	15.86	15.97	16.00	16.55	16.86
Chambers	6.93	6.95	7.06	7.41	6.56	5.49	6.98	7.03	7.05	7.30	7.63
Fort Bend	21.54	21.59	21.62	20.16	15.10	11.06	20.92	21.21	21.56	22.15	20.53
Galveston	16.39	16.45	16.73	17.19	14.98	12.38	16.52	16.63	16.66	17.23	17.70
Harris	208.58	209.07	209.55	203.38	160.35	121.23	203.11	206.06	209.27	215.07	206.76
Liberty	7.30	7.32	7.33	7.02	5.34	3.95	7.09	7.19	7.31	7.50	7.14
Montgomery	26.08	26.22	26.33	24.52	18.31	13.39	25.33	25.70	26.09	26.81	24.93
Waller	7.02	7.04	7.06	6.70	5.06	3.71	6.82	6.92	7.03	7.22	6.81
Total	309.57	310.44	311.74	302.75	239.89	182.91	302.63	306.70	310.96	319.84	308.37

Table 58. HGA 2000 MOBILE5b 24-Hour VOC Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	6.66	6.56	6.52	7.47	6.98	6.13	6.78	6.94	7.30	7.80	8.36
Chambers	2.55	2.50	2.52	2.94	2.78	2.43	2.58	2.61	2.65	2.83	3.11
Fort Bend	8.28	8.07	8.03	8.64	7.15	5.59	8.29	8.49	9.12	9.89	9.76
Galveston	7.85	7.66	7.72	8.81	8.18	7.11	7.94	8.04	8.18	8.79	9.41
Harris	89.21	87.09	88.58	98.04	81.96	64.46	93.83	96.97	102.53	111.18	110.30
Liberty	2.62	2.60	2.57	2.82	2.36	1.85	2.65	2.69	2.88	3.11	3.12
Montgomery	8.44	8.37	8.83	9.60	8.08	6.41	9.13	9.56	9.84	10.65	10.55
Waller	2.28	2.25	2.31	2.48	2.12	1.68	2.38	2.44	2.59	2.79	2.76
Total	127.89	125.10	127.08	140.81	119.60	95.66	133.58	137.74	145.08	157.03	157.36

Table 59. HGA 2000 MOBILE5b 24-Hour CO Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	66.72	66.38	66.79	75.40	70.32	61.38	67.70	68.54	69.62	73.74	80.03
Chambers	27.57	27.37	27.77	29.96	29.18	26.02	27.61	27.79	27.99	29.42	31.21
Fort Bend	81.36	80.55	80.34	84.75	69.94	54.99	80.15	81.51	84.68	89.39	89.22
Galveston	77.97	77.20	77.80	87.05	80.36	70.08	78.77	79.52	79.98	84.28	91.15
Harris	751.24	746.88	751.12	799.42	664.80	525.13	749.79	765.12	788.17	830.34	832.69
Liberty	28.88	28.73	28.53	30.74	25.72	20.24	28.67	29.16	30.38	32.18	32.67
Montgomery	91.07	91.60	94.45	99.36	82.66	65.50	93.16	96.24	98.74	104.28	104.56
Waller	27.51	27.45	27.63	28.99	25.00	19.74	27.83	28.45	29.43	31.28	30.65
Total	1,152.33	1,146.15	1,154.42	1,235.67	1,047.97	843.08	1,153.68	1,176.32	1,209.01	1,274.93	1,292.18

Table 60. HGA 2000 MOBILE6 24-Hour NO_X Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	11.81	11.77	11.69	10.82	7.52	5.77	11.82	11.83	11.84	11.90	10.95
Chambers	5.66	5.62	5.60	5.07	3.40	2.55	5.67	5.66	5.68	5.70	5.08
Fort Bend	13.70	13.66	13.61	12.54	8.75	6.66	13.77	13.77	13.83	13.87	12.73
Galveston	12.90	12.72	12.69	11.82	8.29	6.42	12.88	12.81	12.78	12.85	11.97
Harris	175.14	173.57	173.08	161.31	114.14	87.53	175.92	176.00	176.81	177.54	164.63
Liberty	4.56	4.56	4.56	4.29	2.98	2.28	4.63	4.64	4.62	4.63	4.26
Montgomery	15.65	15.77	16.22	14.71	10.18	7.86	16.07	16.11	15.78	15.80	14.41
Waller	4.20	4.20	4.19	3.89	2.68	2.02	4.23	4.23	4.23	4.22	3.88
Total	243.63	241.88	241.63	224.44	157.94	121.10	244.99	245.05	245.58	246.53	227.93

Table 61. HGA 2000 MOBILE6 24-Hour VOC Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	6.86	6.76	6.64	7.44	5.47	4.59	6.98	7.03	7.23	7.48	7.92
Chambers	2.71	2.63	2.62	2.98	2.17	1.81	2.78	2.82	2.93	3.05	3.21
Fort Bend	7.53	7.49	7.51	8.44	6.24	5.19	7.93	7.99	8.20	8.46	8.95
Galveston	7.98	7.82	7.78	8.68	6.32	5.32	8.10	8.09	8.24	8.54	9.08
Harris	98.95	97.25	96.98	111.32	81.47	67.55	103.19	104.37	107.71	111.82	119.60
Liberty	2.65	2.64	2.65	3.03	2.21	1.86	2.80	2.85	2.95	3.06	3.22
Montgomery	8.08	8.11	8.40	9.55	7.02	5.88	8.87	9.08	9.23	9.55	10.11
Waller	2.48	2.46	2.49	2.85	2.09	1.76	2.64	2.68	2.75	2.86	3.05
Total	137.26	135.16	135.05	154.29	112.99	93.94	143.29	144.92	149.24	154.83	165.13

Table 62. HGA 2000 MOBILE6 24-Hour CO Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	104.58	102.35	98.64	111.07	88.12	75.69	105.86	106.61	108.36	112.74	120.32
Chambers	47.18	44.36	43.67	50.98	40.39	33.99	48.58	48.55	50.69	53.32	55.27
Fort Bend	114.54	113.10	112.11	126.12	99.97	84.34	119.18	119.64	122.81	126.40	135.28
Galveston	119.35	112.35	111.15	124.33	97.58	84.66	119.37	117.00	117.24	121.86	131.58
Harris	1,362.77	1,307.71	1,298.58	1,479.73	1,191.41	1,018.97	1,406.85	1,415.14	1,458.79	1,508.68	1,619.05
Liberty	39.99	39.59	39.61	45.72	35.81	30.05	42.54	43.28	44.98	46.96	49.23
Montgomery	124.06	124.14	128.81	148.67	116.94	98.12	138.29	141.57	147.23	150.74	160.39
Waller	39.99	39.56	39.45	46.50	36.10	30.02	43.11	43.26	44.45	45.16	48.42
Total	1,952.45	1,883.16	1,872.01	2,133.11	1,706.31	1,455.84	2,023.77	2,035.03	2,094.56	2,165.85	2,319.53

Table 63. HGA 2007 MOBILE6 24-Hour NO_X Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	6.58	6.56	6.51	5.88	4.02	3.05	6.60	6.60	6.62	6.66	5.97
Chambers	4.11	4.08	4.06	3.60	2.38	1.77	4.12	4.12	4.14	4.16	3.62
Fort Bend	9.72	9.69	9.66	8.68	5.93	4.45	9.78	9.78	9.83	9.86	8.82
Galveston	5.99	5.91	5.89	5.34	3.68	2.83	5.99	5.96	5.95	5.99	5.42
Harris	99.99	99.03	98.74	90.75	63.61	48.70	100.60	100.68	101.24	101.78	92.86
Liberty	2.94	2.94	2.93	2.69	1.84	1.39	2.99	3.00	2.99	3.01	2.69
Montgomery	12.52	12.61	12.95	11.42	7.74	5.89	12.88	12.92	12.69	12.71	11.23
Waller	2.08	2.07	2.07	1.90	1.30	0.98	2.10	2.09	2.10	2.10	1.90
Total	143.94	142.89	142.80	130.27	90.50	69.06	145.05	145.15	145.54	146.26	132.52

Table 64. HGA 2007 MOBILE6 24-Hour VOC Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	3.31	3.28	3.24	3.58	2.60	2.16	3.36	3.38	3.47	3.56	3.75
Chambers	1.70	1.67	1.67	1.86	1.34	1.11	1.74	1.76	1.82	1.87	1.98
Fort Bend	4.60	4.58	4.59	5.09	3.74	3.10	4.80	4.83	4.94	5.07	5.34
Galveston	3.27	3.23	3.22	3.53	2.55	2.13	3.31	3.31	3.37	3.47	3.65
Harris	55.67	55.11	55.01	62.20	45.33	37.47	57.46	58.04	59.53	61.36	65.71
Liberty	1.51	1.50	1.51	1.69	1.23	1.03	1.57	1.59	1.64	1.69	1.78
Montgomery	5.57	5.58	5.74	6.40	4.67	3.90	5.97	6.09	6.15	6.33	6.70
Waller	1.12	1.12	1.13	1.27	0.93	0.78	1.18	1.19	1.22	1.26	1.34
Total	76.75	76.07	76.11	85.61	62.37	51.68	79.38	80.20	82.12	84.61	90.24

Table 65. HGA 2007 MOBILE6 24-Hour CO Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	53.11	52.35	50.95	57.31	45.13	38.52	53.40	53.62	53.94	55.24	60.43
Chambers	31.45	29.98	29.63	34.14	26.92	22.58	32.03	31.85	32.72	33.79	35.81
Fort Bend	77.14	76.42	75.81	85.29	66.73	55.88	78.57	78.63	79.74	80.88	88.99
Galveston	50.44	48.02	47.63	53.11	41.47	35.57	50.20	49.27	49.00	50.14	55.16
Harris	836.57	813.43	810.11	912.94	723.85	611.06	848.21	849.56	862.31	875.93	961.40
Liberty	22.69	22.54	22.54	25.76	20.15	16.84	23.58	23.81	24.29	24.85	26.89
Montgomery	90.72	90.84	93.51	105.77	82.46	69.02	96.74	98.01	100.43	101.38	110.23
Waller	18.06	17.93	17.82	20.66	15.98	13.23	18.88	18.80	19.01	18.91	20.72
Total	1,180.17	1,151.50	1,147.99	1,294.98	1,022.69	862.68	1,201.61	1,203.56	1,221.44	1,241.12	1,359.63

Table 66. HGA 2007 55 mph MOBILE6 24-Hour NO_X Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	6.23	6.20	6.15	5.61	3.86	2.96	6.24	6.25	6.26	6.30	5.70
Chambers	3.85	3.82	3.81	3.40	2.27	1.70	3.87	3.87	3.89	3.91	3.42
Fort Bend	9.26	9.24	9.20	8.34	5.73	4.33	9.32	9.33	9.37	9.41	8.48
Galveston	5.72	5.63	5.61	5.13	3.56	2.75	5.71	5.68	5.67	5.71	5.22
Harris	96.58	95.61	95.32	88.26	62.06	47.65	97.20	97.27	97.84	98.40	90.40
Liberty	2.73	2.73	2.73	2.53	1.75	1.33	2.79	2.80	2.79	2.80	2.53
Montgomery	11.74	11.83	12.17	10.84	7.40	5.67	12.10	12.14	11.92	11.94	10.66
Waller	1.94	1.94	1.94	1.80	1.25	0.95	1.97	1.96	1.97	1.97	1.80
Total	138.07	137.00	136.92	125.91	87.88	67.35	139.19	139.30	139.70	140.44	128.21

Table 67. HGA 2007 55 mph MOBILE6 24-Hour VOC Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	3.34	3.30	3.27	3.60	2.62	2.18	3.38	3.41	3.49	3.59	3.78
Chambers	1.72	1.69	1.68	1.87	1.35	1.12	1.75	1.77	1.83	1.89	1.99
Fort Bend	4.62	4.60	4.62	5.12	3.76	3.12	4.82	4.86	4.97	5.10	5.37
Galveston	3.29	3.25	3.25	3.55	2.57	2.14	3.33	3.34	3.39	3.50	3.68
Harris	55.95	55.39	55.29	62.51	45.60	37.71	57.76	58.34	59.84	61.69	66.04
Liberty	1.53	1.52	1.52	1.71	1.24	1.04	1.59	1.61	1.66	1.71	1.80
Montgomery	5.62	5.63	5.79	6.46	4.72	3.94	6.02	6.15	6.21	6.39	6.76
Waller	1.13	1.13	1.14	1.28	0.94	0.79	1.19	1.20	1.23	1.28	1.36
Total	77.20	76.52	76.55	86.11	62.80	52.04	79.85	80.69	82.63	85.14	90.77

Table 68. HGA 2007 55mph MOBILE6 24-Hour CO Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Brazoria	51.33	50.60	49.27	55.47	43.59	37.21	51.59	51.81	52.11	53.33	58.42
Chambers	30.23	28.84	28.52	32.90	25.90	21.74	30.78	30.61	31.43	32.44	34.48
Fort Bend	74.96	74.27	73.68	82.95	64.76	54.24	76.32	76.38	77.44	78.53	86.49
Galveston	48.85	46.54	46.18	51.54	40.16	34.45	48.62	47.73	47.47	48.56	53.49
Harris	817.77	795.46	792.24	893.71	706.05	595.35	828.97	830.26	842.52	855.64	940.50
Liberty	21.73	21.60	21.59	24.71	19.27	16.11	22.57	22.79	23.22	23.75	25.75
Montgomery	87.45	87.59	90.18	102.03	79.28	66.38	93.11	94.31	96.56	97.45	106.17
Waller	17.32	17.20	17.09	19.84	15.32	12.70	18.10	18.02	18.21	18.11	19.90
Total	1,149.64	1,122.09	1,118.75	1,263.16	994.34	838.18	1,170.05	1,171.89	1,188.96	1,207.81	1,325.20

Table 69. BPA 2000 MOBILE6 24-Hour NO_X Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Hardin	3.25	3.24	3.21	3.20	2.25	1.78	3.27	3.27	3.28	3.30	3.26
Jefferson	22.41	22.35	22.21	21.29	14.48	11.02	22.46	22.46	22.54	22.62	21.59
Orange	8.51	8.55	8.47	8.15	5.56	4.23	8.60	8.60	8.59	8.60	8.20
Total	34.17	34.13	33.89	32.64	22.29	17.02	34.32	34.33	34.41	34.52	33.05

Table 70. BPA 2000 MOBILE6 24-Hour VOC Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Hardin	2.24	2.20	2.11	2.67	2.02	1.78	2.32	2.38	2.49	2.58	2.84
Jefferson	11.91	11.74	11.34	14.44	10.82	9.46	12.39	12.55	13.26	13.78	15.23
Orange	4.44	4.41	4.29	5.53	4.11	3.56	4.70	4.84	5.08	5.25	5.78
Total	18.58	18.35	17.74	22.64	16.95	14.80	19.41	19.77	20.83	21.62	23.85

Table 71. BPA 2000 MOBILE6 24-Hour CO Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Hardin	29.59	28.70	27.20	34.03	27.47	24.56	30.50	30.93	32.06	33.37	37.33
Jefferson	157.71	154.43	146.97	183.86	147.40	132.46	162.57	163.44	170.80	177.13	198.51
Orange	59.52	58.89	56.62	71.47	57.00	50.47	62.46	63.88	66.53	68.30	76.04
Total	246.82	242.01	230.79	289.35	231.87	207.49	255.53	258.25	269.38	278.80	311.88

Table 72. BPA 2007 MOBILE6 24-Hour NO_X Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Hardin	2.01	2.00	1.97	1.96	1.39	1.11	2.02	2.02	2.04	2.05	2.01
Jefferson	13.06	13.01	12.90	12.39	8.54	6.60	13.11	13.11	13.19	13.25	12.61
Orange	5.30	5.32	5.27	5.05	3.48	2.67	5.37	5.38	5.37	5.38	5.09
Total	20.37	20.33	20.14	19.40	13.42	10.39	20.50	20.52	20.60	20.69	19.71

Table 73. BPA 2007 MOBILE6 24-Hour VOC Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Hardin	1.28	1.26	1.23	1.52	1.13	0.98	1.32	1.35	1.41	1.45	1.59
Jefferson	6.75	6.68	6.52	8.08	5.96	5.18	6.98	7.07	7.43	7.69	8.42
Orange	2.58	2.57	2.53	3.14	2.32	2.01	2.72	2.79	2.91	3.00	3.25
Total	10.61	10.52	10.27	12.75	9.40	8.17	11.02	11.21	11.74	12.13	13.26

Table 74. BPA 2007 MOBILE6 24-Hour CO Emissions by County Input Into Photochemical Model

County	Tuesday August 22	Wednesday August 23	Thursday August 24	Friday August 25	Saturday August 26	Sunday August 27	Monday August 28	Tuesday August 29	Wednesday August 30	Thursday August 31	Friday September 1
Hardin	16.87	16.59	16.16	19.58	15.57	13.78	17.09	17.16	17.42	17.76	20.53
Jefferson	88.85	87.80	85.65	103.95	82.83	73.71	89.93	90.03	91.78	93.37	108.21
Orange	35.19	35.11	34.35	41.89	33.33	29.40	36.04	36.42	36.96	37.38	43.18
Total	140.91	139.50	136.16	165.42	131.72	116.89	143.06	143.62	146.17	148.51	171.93

Table 55 summarized the ten CB-IV speciation categories into which the total VOC emissions are grouped. For the Wednesday August 30th episode day, Table 75 provides a breakdown of the total 8-County VOC emissions by each of these ten categories. As the table demonstrates, there are slight differences in the 2000 MOBILE5b, 2000 MOBILE6, and 2007 MOBILE6 contributions by category. This is due to the fact that the different versions of the MOBILE model will produce differing emission rate estimates for the various VOC emission categories described in Table 51. In addition, even the same version of the MOBILE model will produce different estimates for different inputs and calendar years. Due to the fact that these categories have different speciation profiles (e.g., VOC tailpipe exhaust versus VOC hot soak emissions), the overall contributions by the ten CB-IV categories differ among the inventories. For the total NO_X emissions from each inventory, roughly 90% was allocated to NO and 10% to NO_2.

Table 75. 8-County HGA VOC Emissions by Carbon Bond IV Speciation Category

Carbon Bond IV Speciation Grouping	2000 MOBILE5b	2000 MOBILE6	2007 MOBILE6
Olefinic Carbon Bonds	2.7%	2.7%	2.4%
Paraffinic Carbon Bonds	67.8%	67.7%	70.1%
Toluene Grouping	7.1%	7.7%	7.2%
Xylene Grouping	11.2%	10.7%	9.9%
Formaldehyde Grouping	1.6%	1.6%	1.3%
High Molecular Weight Aldehydes	4.6%	4.4%	4.7%
Ethene Grouping	4.5%	4.7%	3.8%
Methanol Grouping	0.2%	0.2%	0.1%
Ethanol Grouping	0.2%	0.2%	0.1%
Isoprene Grouping	0.3%	0.3%	0.2%
Total	100.0%	100.0%	100.0%

On-Road Mobile Source Portion of Overall Attainment Demonstration Inventory

For the purposes of modeling the 2007 attainment demonstration, a review was conducted of the on-road mobile source control strategies which were previously considered in the 12-6-00 HGA Attainment Demonstration SIP. Several of these control strategies have already been included in the 2007 MOBILE6 inventory for HGA. For example, Inspection/Maintenance (I/M) program parameters were included as MOBILE6 inputs. For a complete discussion of the MOBILE6 inputs used, refer to pages 25-56 of Attachment 3-3 to the Technical Support Document.

As described in Table 3.8-22 on page 3-37 of the 12-6-00 HGA SIP, 10.41 tons of NO_X were modeled as the on-road mobile source portion of the Voluntary Mobile Source Emission Reduction Programs (VMEP) for the 8-County HGA area. Until revised VMEP figures are available, the TCEQ will continue to input 10.41 tons of NO_X as the on-road mobile portion of VMEP. Table 6.1-2 in both the 12-6-00 and 9-26-01 HGA Attainment SIPs contained a number of "gap measures" that were not included with the inventories input into the photochemical model. The on-road mobile "gap" strategies from the 12-6-00 and 9-26-01 HGA SIPs were the 55 mph speed limit, vehicle idling restrictions, and transportation control measures (TCMs).

For the current attainment demonstration modeling, the 55 mph speed limit benefit was included. Please note that the 55 mph speed limit measure was suspended on September 25, 2002 until May 1, 2005. Consequently, the 55 mph measure was included in the 2007 attainment demonstration modeling because it is currently scheduled to resume implementation in May of 2005. The vehicle idling restriction measure in the 12-6-00 HGA SIP was estimated to yield benefits of 0.48 NO_X tons and 0.19 VOC tons. Until the vehicle idling restriction benefit estimates are revised, these figures will be used in ongoing attainment demonstration modeling. No additional TCM benefits were included in the current attainment demonstration modeling because it was assumed that the more recent travel demand model output used in the development of the 2007 MOBILE6 inventory already accounted for them.

The combined VMEP and vehicle idling benefits are 10.88 tons of NO_X and 0.19 tons of VOC. If these benefits are included with the 2007 55 mph Wednesday August 30th inventory (from Tables 66 and 67), a revised attainment demonstration inventory of 128.83 tons of NO_X and 82.44 tons of VOC is obtained. The CO tons of 1,188.96 from Table 68 remains unchanged. By taking the ratio of the attainment inventory figure of 128.83 NO_X tons to the 55 mph figure of 139.70 NO_X tons, an adjustment factor of 0.9222 is obtained, as shown in Table 76. In a similar fashion, a VOC adjustment factor of 0.9977 is obtained. These adjustments were applied to the 2007 8-County HGA 55 mph speed limit inventories for each episode day. Tables 77 and 78 summarize the adjusted NO_X and VOC on-road mobile source inventories which were included in the attainment demonstration photochemical modeling runs.

Table 76. 8-County HGA Attainment Demonstration Inventory Adjustment Summary

2007 Wednesday August 30th Inventory	*NO_X (tpd)*	*VOC (tpd)*
8-County HGA 55 mph Inventory	139.70	82.63
VMEP & Vehicle Idling Restriction Benefits	10.87	0.19
Revised Attainment Inventory	128.83	82.44
Adjustment Factor	0.9222	0.9977

Table 77. HGA 2007 Attainment Demonstration MOBILE6 24-Hour NO_X Emissions by County Input Into Photochemical Model

County	*Tuesday August 22*	*Wednesday August 23*	*Thursday August 24*	*Friday August 25*	*Saturday August 26*	*Sunday August 27*	*Monday August 28*	*Tuesday August 29*	*Wednesday August 30*	*Thursday August 31*	*Friday September 1*
Brazoria	5.74	5.72	5.67	5.17	3.56	2.73	5.75	5.76	5.77	5.81	5.26
Chambers	3.55	3.52	3.51	3.14	2.10	1.57	3.57	3.56	3.58	3.60	3.16
Fort Bend	8.54	8.52	8.49	7.69	5.28	3.99	8.60	8.60	8.64	8.68	7.82
Galveston	5.27	5.19	5.17	4.73	3.29	2.54	5.27	5.24	5.23	5.27	4.81
Harris	89.07	88.17	87.90	81.39	57.23	43.95	89.64	89.71	90.23	90.74	83.36
Liberty	2.52	2.52	2.51	2.34	1.61	1.23	2.57	2.58	2.57	2.58	2.34
Montgomery	10.83	10.91	11.22	9.99	6.82	5.23	11.16	11.20	10.99	11.01	9.83
Waller	1.79	1.79	1.78	1.66	1.15	0.87	1.81	1.81	1.82	1.81	1.66
Total	127.32	126.34	126.26	116.12	81.04	62.11	128.36	128.46	128.83	129.51	118.23

Table 78. HGA 2007 Attainment Demonstration MOBILE6 24-Hour VOC Emissions by County Input Into Photochemical Model

County	*Tuesday August 22*	*Wednesday August 23*	*Thursday August 24*	*Friday August 25*	*Saturday August 26*	*Sunday August 27*	*Monday August 28*	*Tuesday August 29*	*Wednesday August 30*	*Thursday August 31*	*Friday September 1*
Brazoria	3.33	3.29	3.26	3.59	2.62	2.18	3.38	3.40	3.49	3.58	3.77
Chambers	1.71	1.68	1.68	1.87	1.35	1.12	1.75	1.77	1.83	1.88	1.99
Fort Bend	4.61	4.59	4.61	5.11	3.75	3.11	4.81	4.85	4.96	5.08	5.35
Galveston	3.28	3.25	3.24	3.55	2.56	2.14	3.32	3.33	3.38	3.49	3.67
Harris	55.82	55.27	55.16	62.36	45.50	37.62	57.63	58.21	59.71	61.55	65.89
Liberty	1.52	1.52	1.52	1.71	1.24	1.04	1.59	1.61	1.65	1.70	1.79
Montgomery	5.61	5.62	5.78	6.45	4.71	3.93	6.01	6.13	6.19	6.38	6.75
Waller	1.13	1.12	1.14	1.28	0.94	0.78	1.19	1.20	1.23	1.27	1.35
Total	77.02	76.34	76.38	85.91	62.66	51.92	79.67	80.50	82.44	84.95	90.56

Quality Assurance of Gridded Mobile Emission Files

TCEQ staff have written custom code for PV-WAVE software which is used to quality assure the gridded emissions files prior to input into the photochemical model. With the PV-WAVE output file, TCEQ staff are able to determine that the correct amount of emission are occurring in the "right place" at the "right time". The PV-WAVE code plots the gridded emissions on a map of the 8-County HGA and 3-County BPA areas. Even though the emissions data are input into the photochemical model in 4 kilometer (km) square grids, the mobile source emissions are processed at 2 km to obtain improved spatial resolution for quality assurance purposes. The 2 km grids are then aggregated to 4 km before being input into the photochemical model.

A sample MOBILE5b plot of NO_X emissions for the Wednesday August 30, 2000 episode day is included as Figure 5. The gridded emissions are grouped by bins and color-coded so that the spatial distribution of emissions can be reviewed. As shown, the highest emissions are concentrated along freeways such as IH-610 in Harris County, while the rural areas of the 8-County domain are sparsely populated with mobile emissions. Also included is a temporal profile in CST of the 24-hour emissions distribution. For an average weekday, the morning peak should occur between 7-8 AM CDT, which is 6-7 AM CST as shown on the plot. A typical weekday contains "peaks" for the congested morning and evening rush hours, a "shallow valley" for mid-day, and a "deep valley" for overnight. Similar profiles are seen with MOBILE5b VOC and CO emission plots, as provided in Figures 6 and 7 for the Wednesday August 30, 2000 episode day. The PV-WAVE code also tabulates county-wide emission totals. These figures are cross-checked with the data provided by TTI to ensure consistency. Some minor differences are expected due to the county boundary coverage file utilized by the PV-WAVE script.

Similar plots for the Wednesday August 30th episode day for both the 2000 and 2007 MOBILE6 inventories are presented in Figures 8-13. Other than the overall emission totals, the primary difference between the MOBILE5b and MOBILE6 plots has to do with the temporal profile of NO_X emissions. Compared with MOBILE5b, heavy-duty diesel vehicles in MOBILE6 contribute a larger portion of the NO_X emissions. In addition, the locally collected vehicle classification data mentioned earlier indicate that heavy-duty diesel vehicles contribute their highest hourly VMT in the early afternoon and not during rush hours. This contrasts with light-duty gasoline vehicles which contribute their highest hourly VMT in the morning and evening rush hours. This shows up in the MOBILE6 NO_X emission temporal plots as a mid-day "hump". It does not show up on the MOBILE6 VOC and CO plots because diesel vehicles are not significant contributors to these pollutants.

For the purposes of brevity, only the Wednesday August 30th episode day plots are shown for each of the MOBILE5b 2000, MOBILE6 2000, and MOBILE6 2007 inventories. However, similar quality assurance checks are performed for all episode days. Fridays typically have much wider "peaks" for the evening rush hour, which reflects the increased congestion typically found in the mid-afternoon to early evening hours on Fridays. The Saturday and Sunday temporal profiles are typically "hill-shaped" with mid-day peaks.

Figure 5. 2000 MOBILE5b 8-County HGA NO_X Emissions for Wednesday August 30th

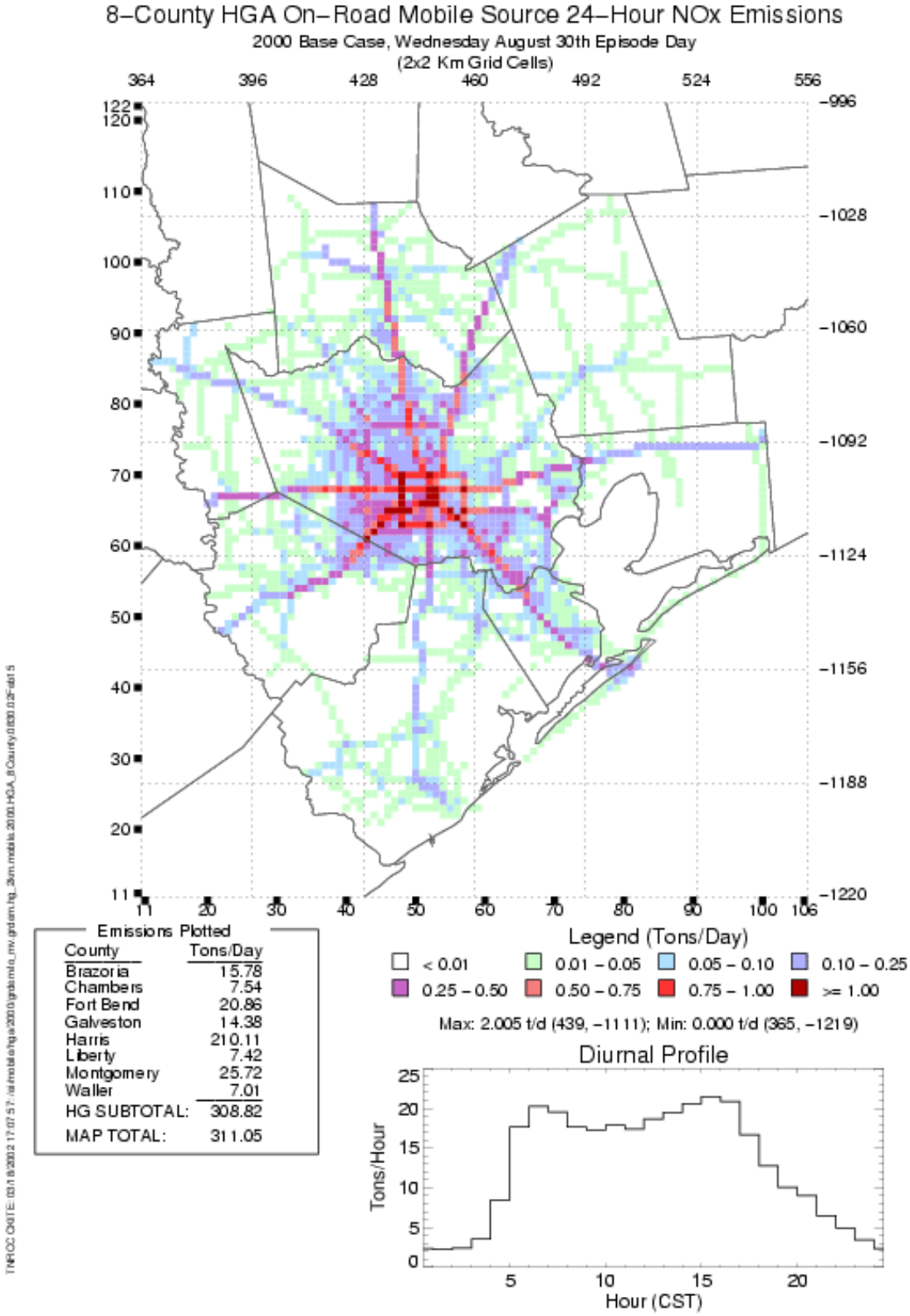


Figure 6. 2000 MOBILE5b 8-County HGA VOC Emissions for Wednesday August 30th

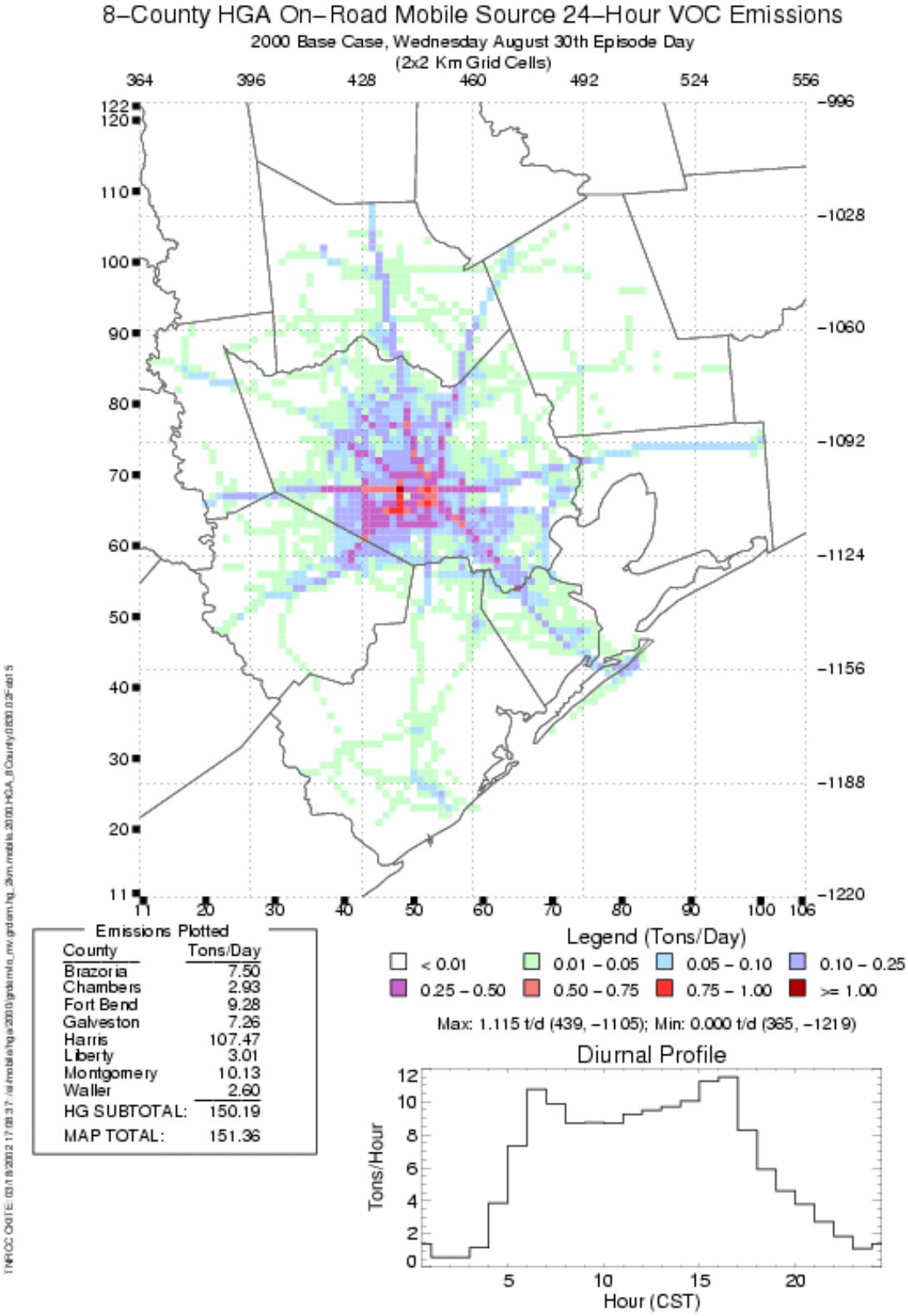


Figure 7. 2000 MOBILE5b 8-County HGA CO Emissions for Wednesday August 30th

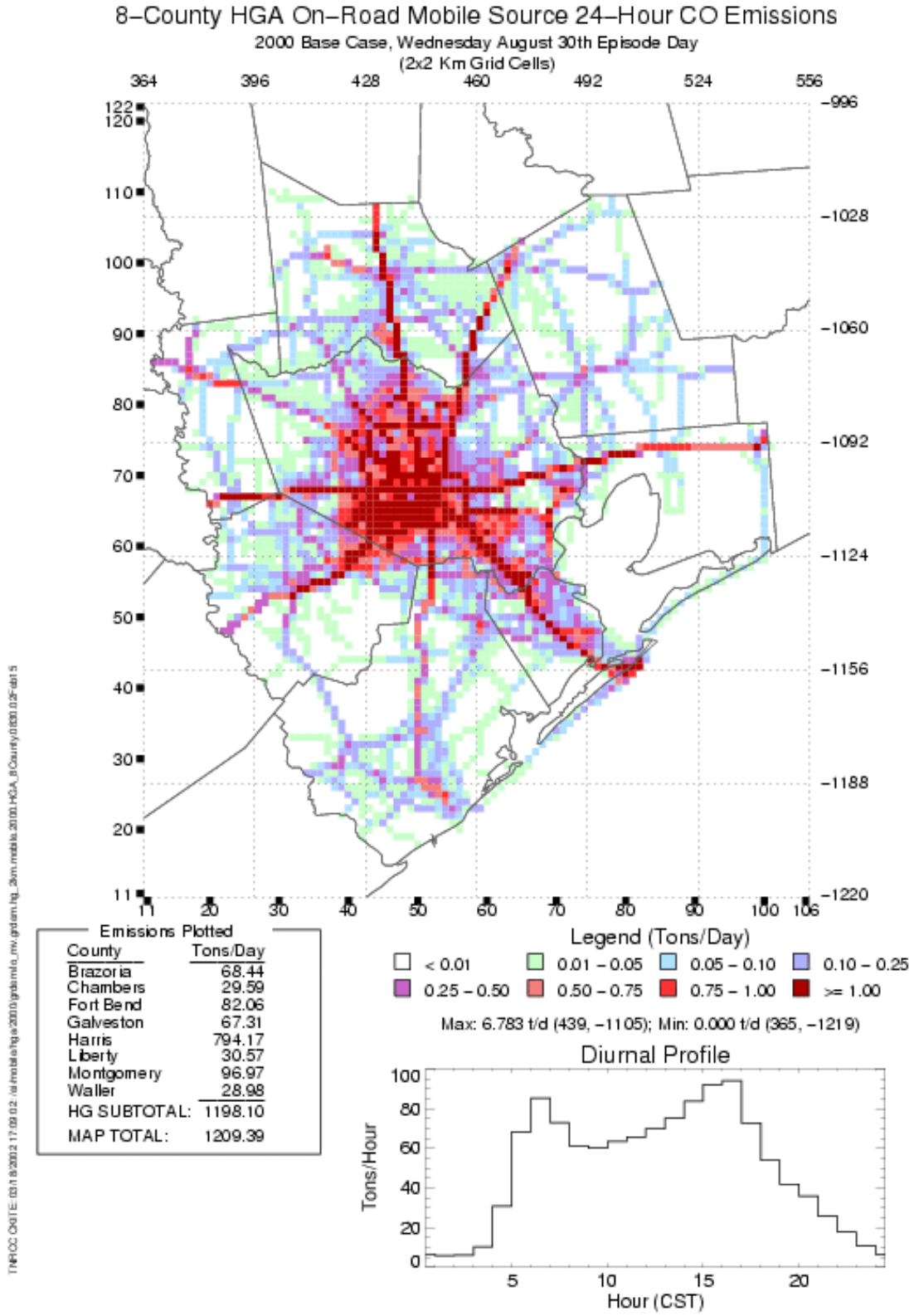
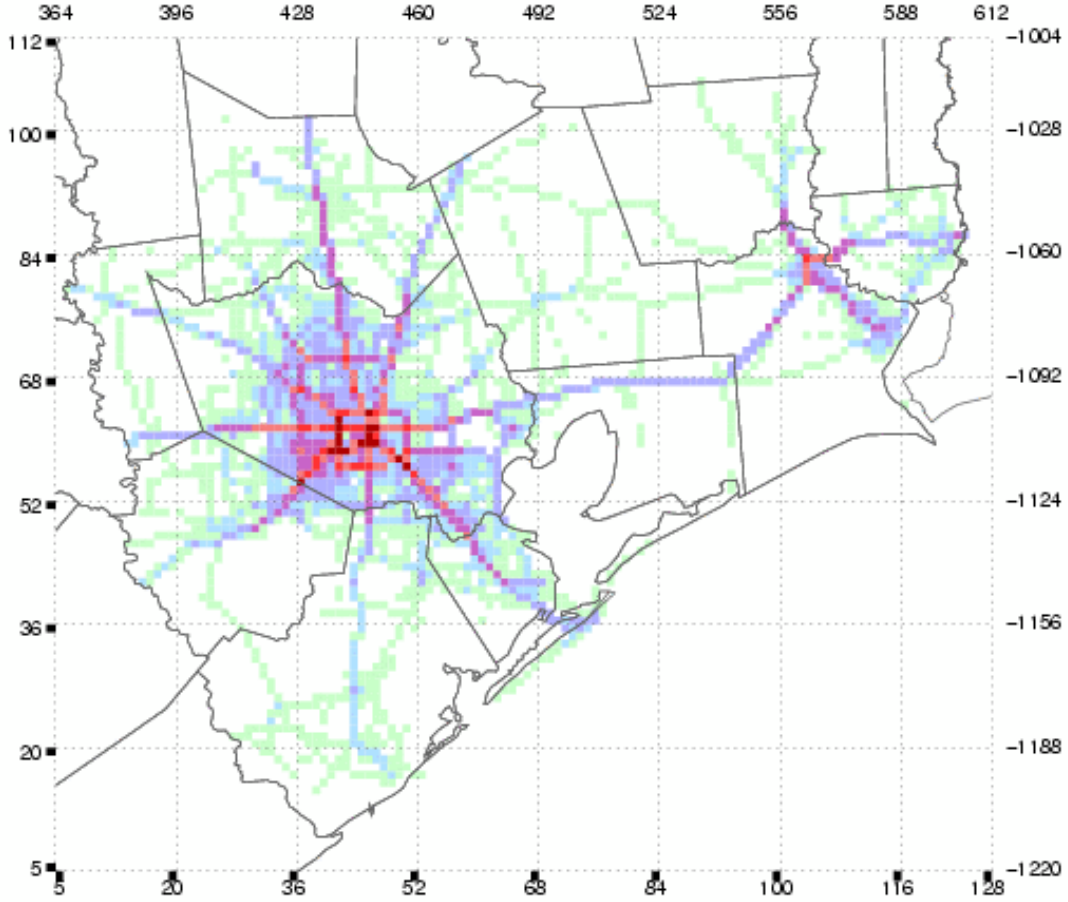


Figure 8. 2000 MOBILE6 HGA & BPA Nox Emissions for Wednesday August 30th

HGA–BPA On–Road Mobile Source 24–Hour MOBILE6 NOx Emissions

2000 Base Case, Wednesday August 30th Episode Day

(2x2 Km Grid Cells)



Emissions Plotted

County	Tons/Day
Brazoria	11.66
Chambers	6.12
Fort Bend	13.46
Galveston	10.99
Harris	177.47
Liberty	4.69
Montgomery	15.69
Waller	4.15
HG SUBTOTAL:	244.25
Hardin	3.29
Jefferson	22.06
Orange	8.61
BPA SUBTOTAL:	33.97
MAP TOTAL:	280.18

Legend (Tons/Day)

< 0.01 | 0.01 – 0.05 | 0.05 – 0.10 | 0.10 – 0.25 | 0.25 – 0.50 | 0.50 – 0.75 | 0.75 – 1.00 | >= 1.00

Max: 1.778 t/d (439, –1105); Min: 0.000 t/d (365, –1219)

Diurnal Profile

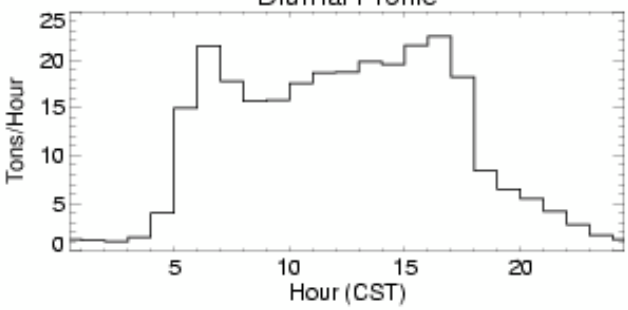
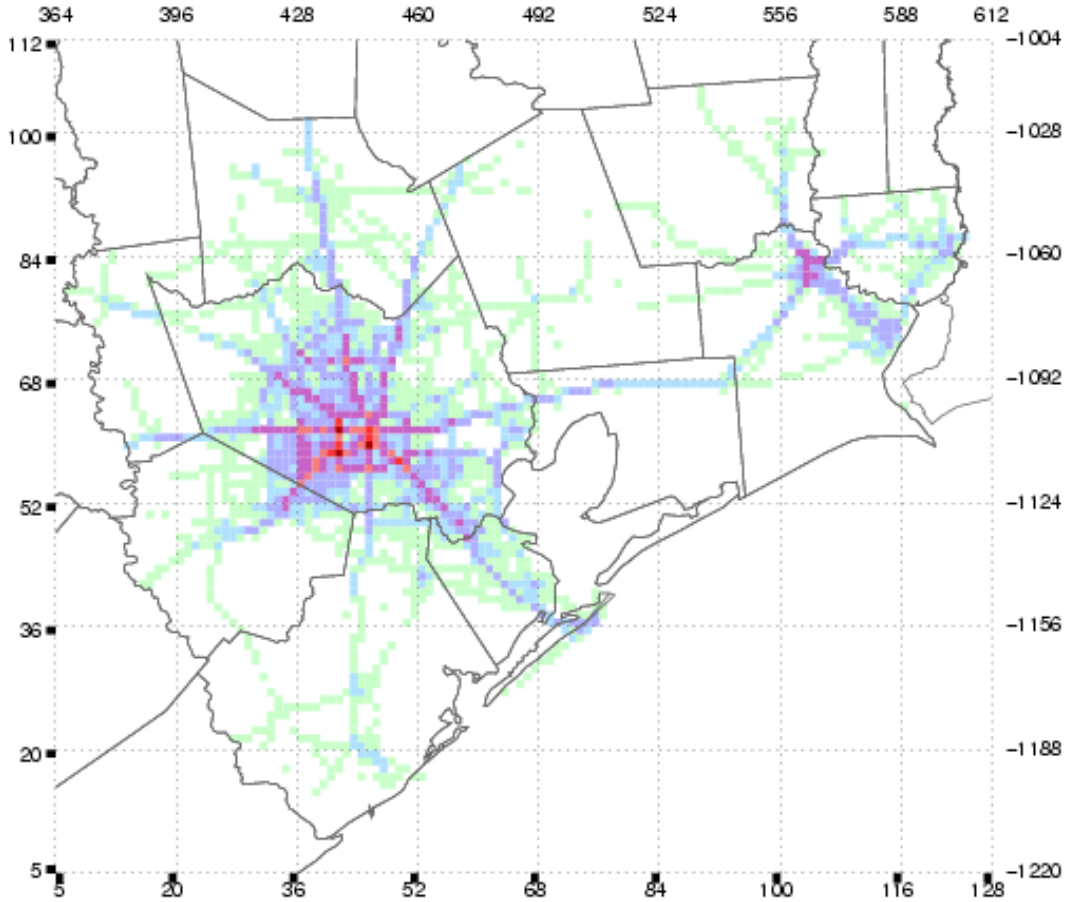


Figure 9. 2000 MOBILE6 HGA & BPA VOC Emissions for Wednesday August 30th

HGA–BPA On–Road Mobile Source 24–Hour MOBILE6 VOC Emissions

2000 Base Case, Wednesday August 30th Episode Day

(2x2 Km Grid Cells)



Emissions Plotted

County	Tons/Day
Brazoria	7.43
Chambers	3.26
Fort Bend	8.37
Galveston	7.38
Harris	113.06
Liberty	3.08
Montgomery	9.59
Waller	2.72
HG SUBTOTAL:	154.89
Hardin	2.58
Jefferson	13.56
Orange	5.34
BPA SUBTOTAL:	21.48
MAP TOTAL:	177.68

Legend (Tons/Day)

< 0.01 | 0.01 – 0.05 | 0.05 – 0.10 | 0.10 – 0.25 | 0.25 – 0.50 | 0.50 – 0.75 | 0.75 – 1.00 | >= 1.00

Max: 1.131 t/d (439, –1105); Min: 0.000 t/d (365, –1219)

Diurnal Profile

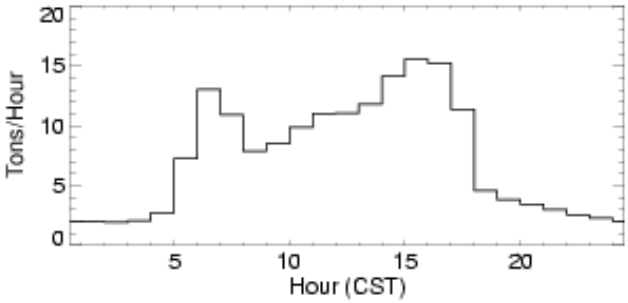


Figure 10. 2000 MOBILE6 HGA & BPA CO Emissions for Wednesday August 30th

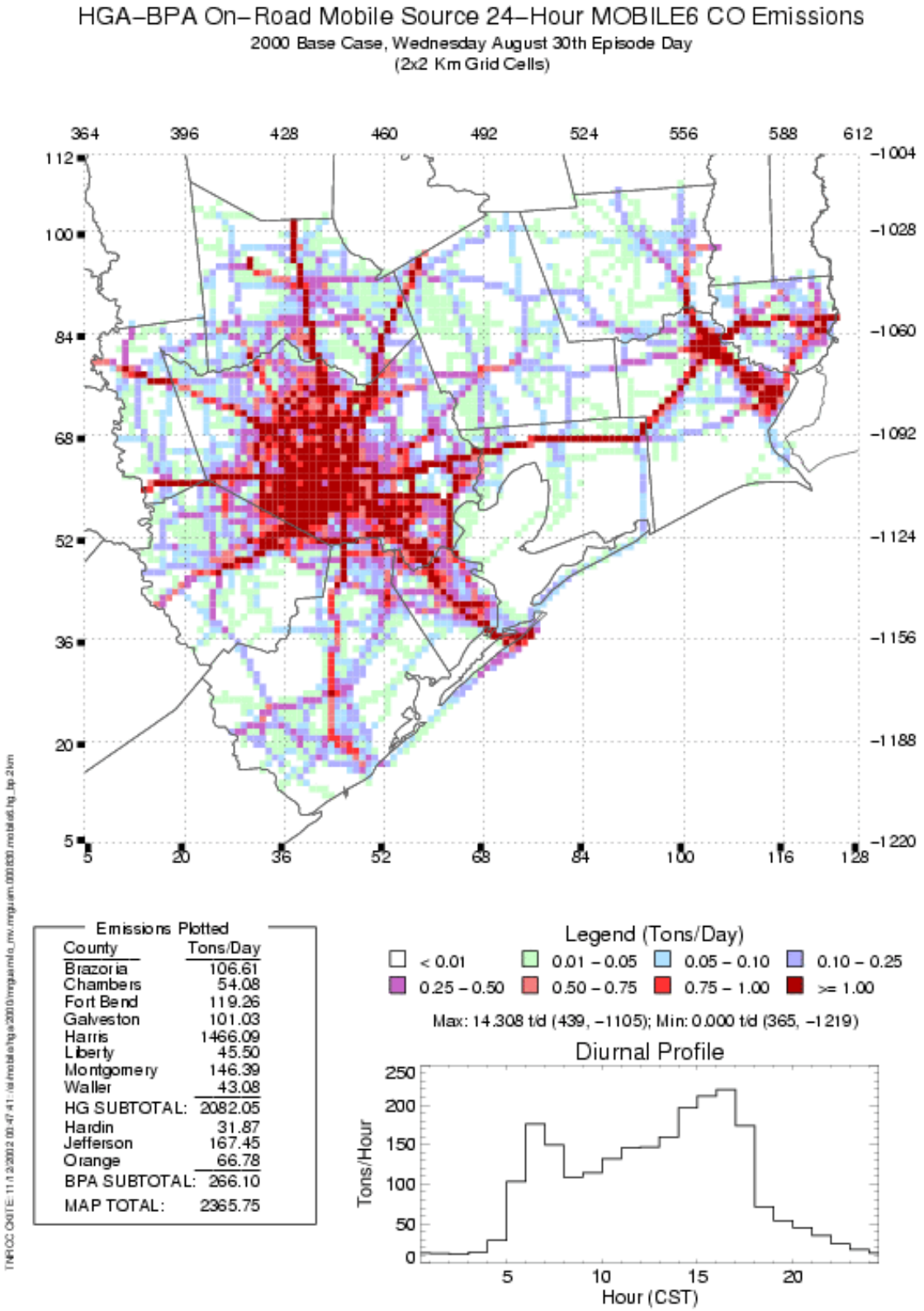


Figure 11. 2007 MOBILE6 HGA & BPA NO_X Emissions for Wednesday August 30th

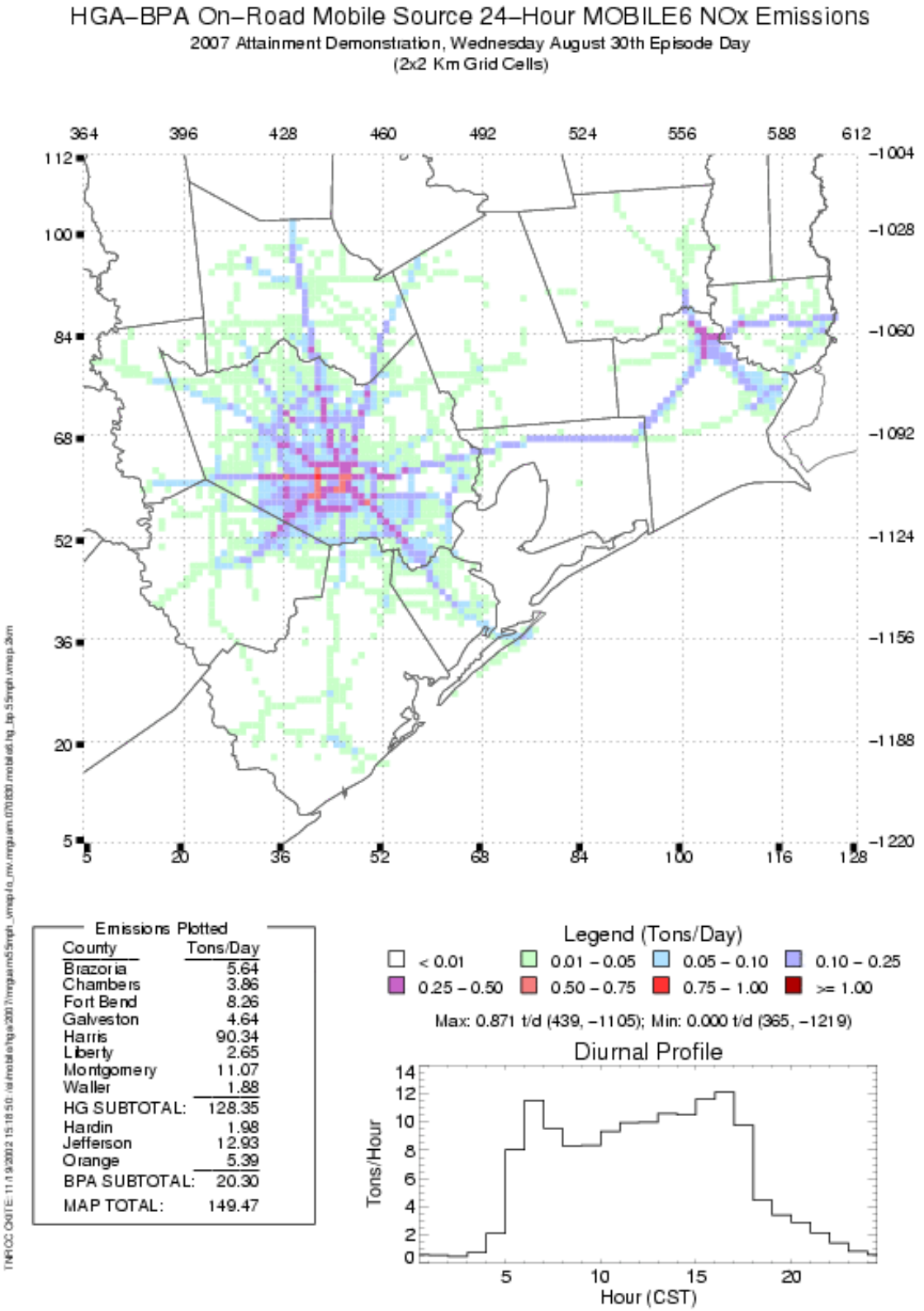


Figure 12. 2007 MOBILE6 HGA & BPA VOC Emissions for Wednesday August 30th

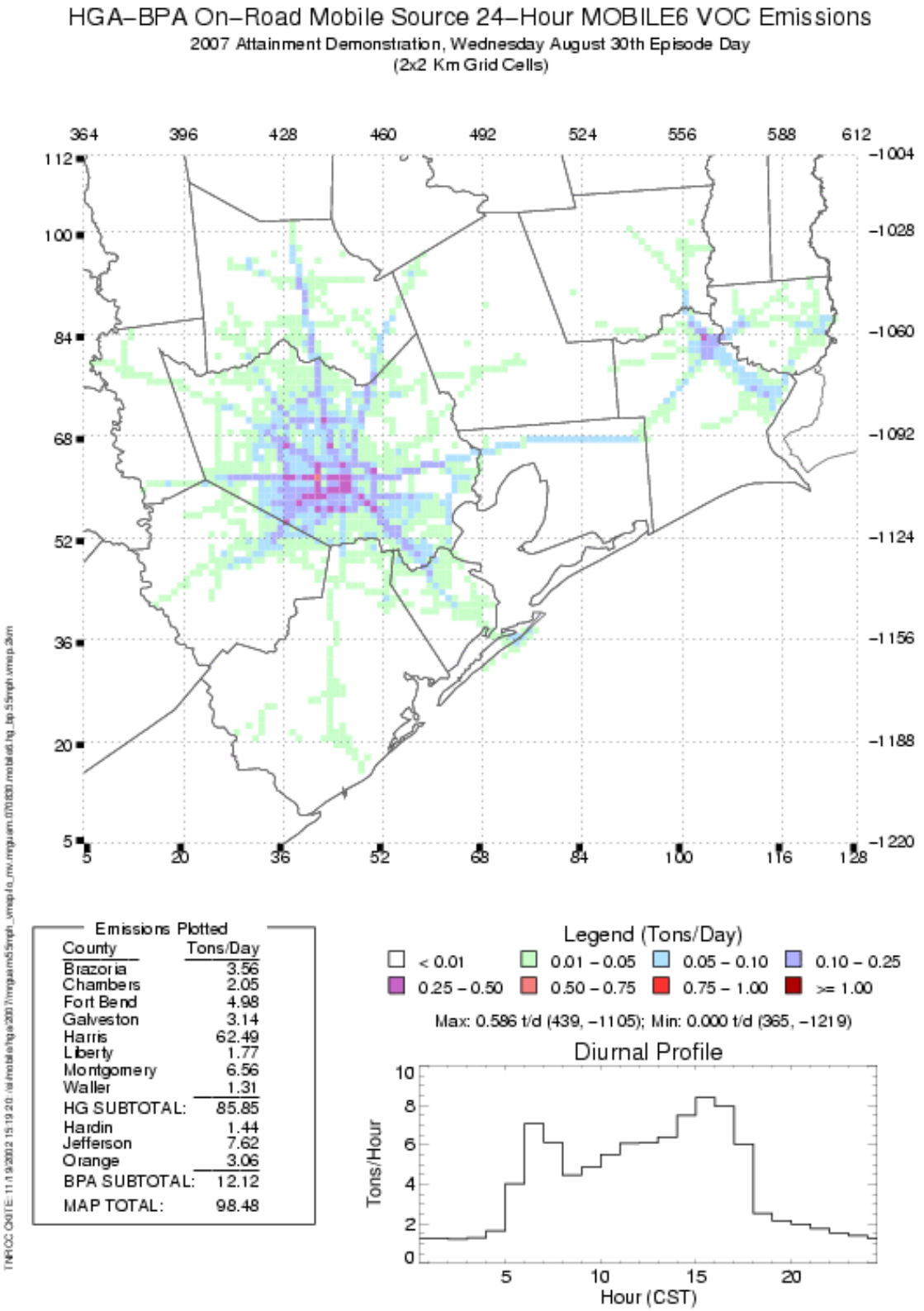
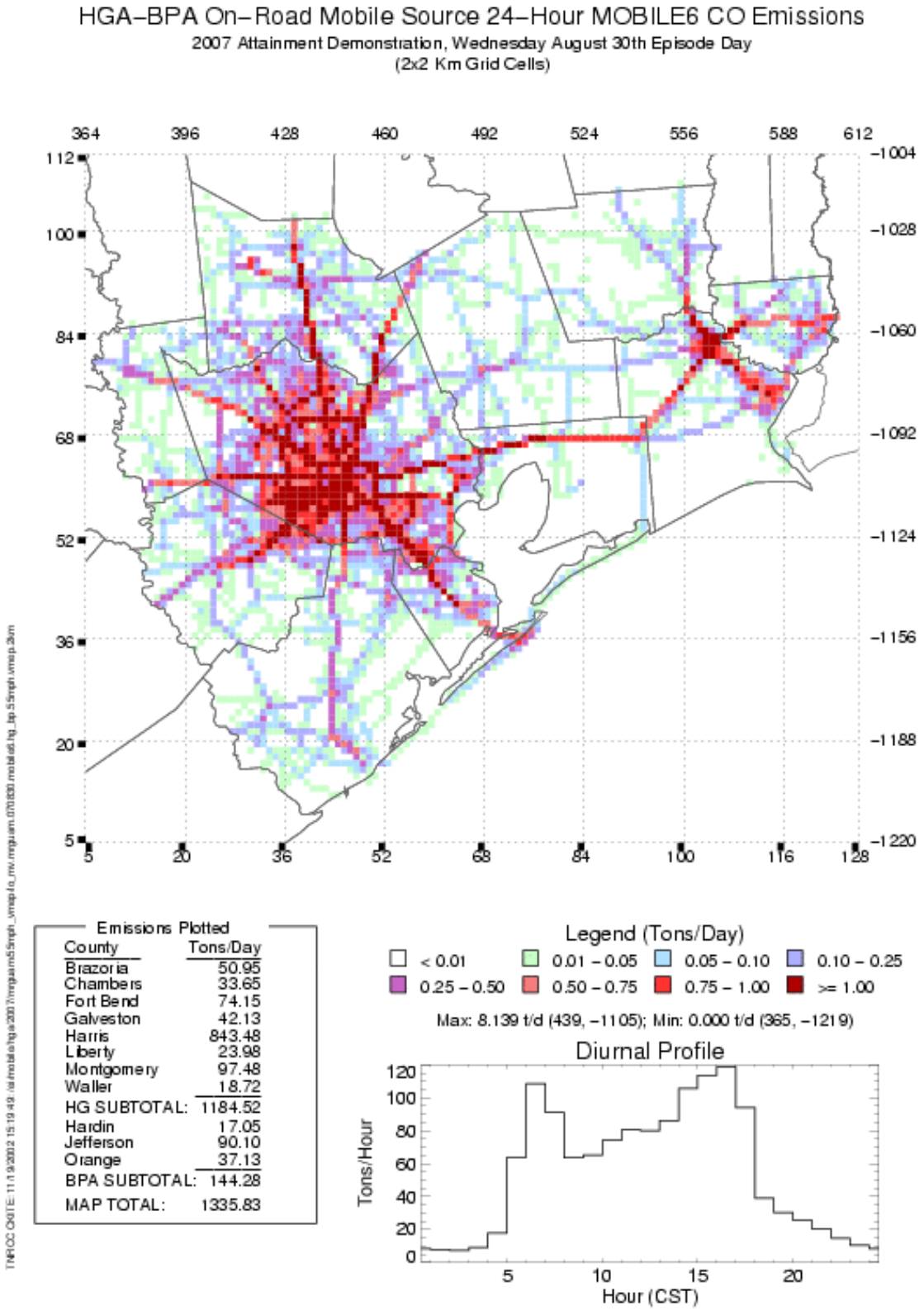


Figure 13. 2007 MOBILE6 HGA & BPA CO Emissions for Wednesday August 30th



Mobile Source Emissions Inventory for Modeling Domain Outside of 8-County HGA Area

In order for the initial base case photochemical modeling runs to commence in March of 2002, TCEQ staff felt that it was worth investing resources in the development of MOBILE5b inventories for the 8-County HGA area. Even though these inventories were soon replaced by MOBILE6 ones for the 2000 episode, investing resources in the development of the MOBILE5b inventory was worth the effort due to the uncertainty surrounding the release of MOBILE6 prior to January 2002. However, TCEQ staff did not feel it would be worth investing resources in the development of MOBILE5b-based inventories for the August 2000 episode for both the 3-County BPA area and the remaining counties in Texas. As previously mentioned, TTI has developed MOBILE6-based inventories for these areas and they have either already been processed and included in the modeling inventories, or they are currently being processed for inclusion in the photochemical model.

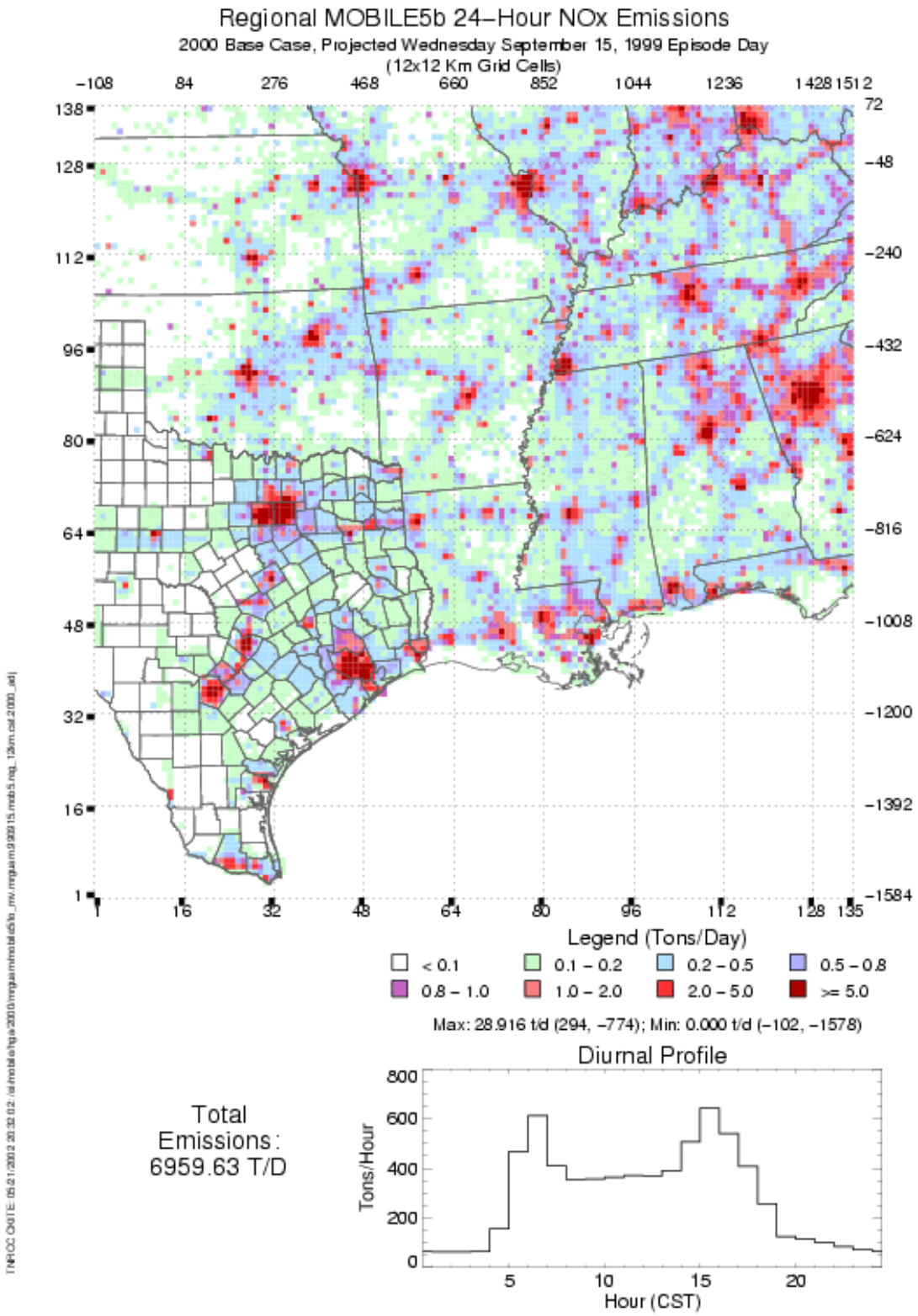
As a temporary measure, TCEQ staff have obtained 1999 MOBILE5a_h inventories which were originally developed by TTI for a September 13-20, 1999 ozone episode for the Texas near nonattainment areas of Austin, San Antonio, Corpus Christi, and Victoria. Under contract, Environ processed these Texas inventories with 1999 National Emissions Inventory (NEI) data from other states into gridded emission files for each of the September 1999 episode days. The September 1999 emission files used the same gridding and projection parameters as those used for the HGA August 2000 inventories.

TCEQ staff developed adjustment factors to apply to the September 1999 inventories to account for growth in VMT and changes in default composite emission rates between runs of different MOBILE models. For example, based on a VMT trends analysis conducted by TTI, it was expected that statewide VMT in Texas grew by 1.94% from 1999 to 2000, and 15.27% from 1999 to 2007. If MOBILE5a_h is run with EPA default inputs for 1999 and MOBILE5b is run with EPA default inputs for 2000, composite fleet-wide NO_X emission rates of 2.309 grams/mile and 2.240 grams/mile, respectively, are obtained. The 2.240 emission rate is 98.35% of the 2.309 emission rate. In order to adjust the 1999 MOBILE5a_h inventory to a 2000 MOBILE5b one, a combined NO_X adjustment factor of 1.0026 is obtained by multiplying 1.0194 for the VMT growth by 0.9835 for the change in NO_X emission rates. This process was repeated for each pollutant while keeping the VMT adjustment factor constant. It was then repeated to develop factors which would adjust the 1999 MOBILE5a_h inventories to 2000 and 2007 MOBILE6 ones.

A rather coarse adjustment approach such as this would be highly inappropriate for the development of 8-County HGA and 3-County BPA inventories. However, for counties outside of HGA and BPA that contribute relatively small amounts of on-road mobile source emissions, it is a necessary approximation for photochemical modeling purposes until more refined MOBILE6 inventories are available. For the non-Texas states contained within the modeling domain, the MOBILE5 1999 NEI inventories will be adjusted as necessary until the MOBILE6 ones are available. Figure 14 is a sample plot of MOBILE5b NO_X emissions for the Wednesday September 15, 1999 episode day projected into 2000. This emissions file was then combined with the more detailed Wednesday August 30, 2000 8-County HGA MOBILE5b file to create the entire on-road

mobile source emissions inventory input into the photochemical model. A similar approach was taken for each episode day of each inventory.

Figure 14. 2000 MOBILE5b Projection of Regional NOx Emissions for Wednesday, September 15, 1999



Point Source Emissions Inventory Development

Point Source Emissions Inventory Development

The point source emission inventories are composed of information from several data sources. These data sources are discussed in the subsections below in the following order: Texas, Louisiana, Offshore, Regional, and Mexico.

Texas Sources

Base Case Development

For the Texas portion of the emission inventory (EI), data from the TCEQ Point Source Data Base (PSDB) has been the basis for modeling of the 2000 base case episode. As usual, the Texas EI has been divided into electric generating utilities (EGUs) and non-EGUs, as separate AIRS Facility Subsystem (AFS) files, for EPS2x processing. The EGU portion of the Texas EI was supplemented with hourly data from EPA's Acid Rain Program Database (ARPDB), upon completion of the update of the PSDB-to-ARPDB cross reference list, such that the ozone-season daily emission records in the AFS file were replaced with hourly ARPDB emissions for each hour of each day of the modeled episode. Since the June 2002 Proposal, one small change has been made to the EGU files: the hourly values were "unshifted" forward to Standard time. For the June 2002 Proposal, the hourly EGUs (Acid Rain sources that had hourly CEM data) were shifted back an hour during processing. This has been corrected in the current modeling, and now all hourly EGU data is on Standard time. Sources of point source molecular chlorine (Cl_2) are currently very minimal in the 2000 PSDB, and have not been included in Phase I of the Mid-Course Review (MCR) modeling runs. Much thought will go into the inventory development of chlorine emissions and TCEQ modeling staff may incorporate a chlorine inventory into Phase II MCR modeing runs..

Chemical Speciation of Texas Sources

Through contracts with the TCEQ, Environ and Pacific Environmental Services (PES) have prepared updated chemical speciation profiles based on the 2000 PSDB speciated EI data provided by Texas companies during their annual EI submittal period. When companies provided speciated data for 75% or greater of the VOC for a given source, this speciation profile was normalized and used for that specific source. For sources that provided less than 75% speciation, Texas-specific average speciation profiles, by SCC, or the EPA default profiles were used. The addition of the Texas SCC average profiles is new since June 2002. Also new is the inclusion of the most recently available CB-IV splits file from EPA's CHIEF website. Attachment 3-5 contains the Environ/PES speciation reports.

PES developed the Texas average SCC profiles for all SCCs in the PSDB extract for those points that were speciated at least 75%. Upon further analysis by TCEQ staff, only those Texas average SCC profiles with 8 or more accounts associated with each SCC were deemed valid profiles. This resulted in 75 Texas-specific average SCC profiles. This analysis was based on TCEQ

accounts rather than individual emission points, because the majority of points at an account are typically speciated with the same compounds in the same percentages.

TCEQ has a contract in place to prepare speciation profiles using the SAPRC mechanism. During Phase II MCR modeling, TCEQ modeling staff may use the SAPRC mechanism in some sensitivity modeling runs.

Special Inventory

Episode-day and hour-specific point source emissions data were collected for the TexAQS-2000 period. All of the Special Inventory data that have been quality-assured have been incorporated into the modeling runs. A summary of the entire special inventory that is planned to be modeled is included in Attachment 3-4.

Special Inventory data were obtained by surveying the largest sources of NO_X and VOC in the HGA and BPA areas to account for specific operating conditions, upsets, start-ups, and shut-downs during the specified time period. Sources emitting at least 250 tons per year of NMOC or 1000 tons per year of NO_X were requested to participate in the survey. Because many of the factors that constitute the notion of rule effectiveness were directly accounted for in the survey, no rule effectiveness adjustments were applied to emissions reported in the survey.

In addition to these special inventories, the TCEQ modeling staff has reviewed the data submitted to the TCEQ Region 12 (Houston) upset/maintenance database. Staff reviewed those reports submitted by companies that were not already included in the Special Inventory survey. Events that were found to be significant were also included in the base case modeling. A summary of these sources is also included in Attachment 3-4.

Many small corrections were made to the Special Inventory files since the June 2002 Proposal, including a large reporting error that was found and corrected for TCEQ account BL0042G. This correction accounts for approximately 15 tons per day (tpd) VOC Special Inventory reduction. The cause for the original error seems to be a data entry error of misplaced decimal points on the part of the company. As QA of the Special Inventory continues, other small corrections may be made prior to Phase II MCR. See Attachment 3-4 for further information on the Special Inventory.

Special Inventory Speciation

Companies supplied chemical speciation profiles for their hourly emissions as part of the TexAQS-2000 survey. When available, these data were used to develop the CB-IV speciation profiles used in the EPS2x preprocessor to CAMx. In cases where TexAQS-2000 speciation data were not available, or was speciated to a degree of less that 75%, source-specific speciation from the 2000 PSDB point-specific profiles were used. In cases where no source-specific data were available, Texas-specific average SCC profiles were used. If no average SCC profile was available, then EPA default speciation profiles were used. This succession of speciation profile matches is new since the June 2002 Proposal.

Also new to the Special Inventory speciation is further speciation of poorly-defined mixtures, such as naphthas, crude oil, mineral spirits, gasoline, fuel oils, other refinery distillates, and a few unspeciated categories of compounds. This methodology is similar to that used by PES in development of the 2000 point-specific profiles, as described in Attachment 3-5.

Highly Reactive VOC Adjustment

In the June 2002 Proposal, this section was referred to as "Adjustments to Olefins". Since June 2002, TCEQ has refined its definition of these highly reactive compounds.

One of the sensitivity analyses conducted to examine the causes for model underprediction involved setting olefin emissions at several large olefin producers equal to those facilities' NO_X emissions. This analysis was motivated by an analysis of airborne NO_X and olefin measurements made by the Baylor Aircraft in 2001 near several industrial facilities in the Houston Ship Channel area. These aircraft data show the collocation of NO_Y and olefin plumes downwind of several facilities. See the analyses of data in the Technical Support Document. In many of these collocated plumes the concentrations of NO_Y and olefins are very similar, with olefin concentrations ranging from about half to approximately twice the NO_Y concentrations. The conclusion is that at least for several large olefin sources, olefin emissions are about equal to NO_X emissions (NO_Y consists of NO_X plus the photochemical reaction products of NO_X such as nitric acid).

TCEQ modeling staff analyzed the speciated inventory derived from the reported 2000 PSDB in order to identify candidates for Highly Reactive VOC (HRVOC) adjustment. From this analysis, twenty-seven accounts (see Table 79) in the Houston/Galveston area were selected for HRVOC adjustment. The resulting table of twenty-seven accounts and their associated emissions differs from that reported in the June 2002 proposal due to updates to the PSDB and chemical speciation. The same criteria were used to select the accounts:

- In HG 8 county non-attainment area
- HRVOC emissions sum greater than 0.2 ton/day
- Total NOx emissions greater than total VOC emissions
- Non-electric generating facility

Highly Reactive VOCs (HRVOCs) were defined as:

- propylene
- ethylene
- formaldehyde
- acetaldehyde
- isoprene
- all butenes (butylenes)
- 1,3-butadiene
- toluene

- all pentenes
- all trimethylbenzenes
- all xylenes
- all ethyltoluenes

Each species was summed for each account, and species totals greater than 0.0005 ton/day (1.0 lb/day) were used to calculate total HRVOC emissions.

Table 79. Selected Accounts for HRVOC Adjustment

ACCOUNT	Total NOx (tpd)	Total HRVOC (tpd)	Total VOC (tpd)	HRVOC/NOx
BL0002S	5.7	1.0	1.8	0.18
BL0023K	2.1	0.3	0.7	0.17
BL0042G	6.2	0.5	2.2	0.08
BL0082R	28.6	1.6	2.5	0.06
BL0113I	1.9	0.2	0.8	0.12
BL0758C	3.7	1.1	2.6	0.31
GB0001R	2.4	1.0	1.5	0.40
GB0004L	19.8	2.8	12.3	0.14
GB0055R	2.6	0.3	1.3	0.11
GB0060B	3.0	0.3	1.6	0.10
GB0073P	4.9	1.0	3.5	0.21
HG0033B	14.2	3.3	6.7	0.23
HG0035U	1.4	0.3	0.5	0.20
HG0048L	8.2	2.1	6.4	0.25
HG0126Q	3.1	0.2	1.3	0.07
HG0130C	3.4	0.5	2.1	0.15
HG0175D	2.2	0.4	1.9	0.21
HG0228H	6.7	0.4	0.7	0.07
HG0229F	2.2	1.0	2.0	0.45
HG0232Q	17.3	1.7	11.5	0.10
HG0310V	3.6	0.8	1.3	0.22
HG0562P	5.5	0.8	1.3	0.14
HG0659W	19.8	2.5	10.4	0.13
HG0713S	6.6	0.3	1.5	0.04
HG0770G	1.7	1.0	1.4	0.61
HG1575W	3.8	0.3	1.3	0.09

HX2334A	0.5	0.3	0.5	0.57

In order to model individual points/stacks, HRVOC emissions totals were calculated for each combination of Account, FIN, and EPN for each of the 27 selected accounts. Individual species totals greater than 0.0005 ton/day (1.0 lb/day) for each Account, FIN, EPN "link" were used in this calculation. Adjusted HRVOC emissions for each "link" were then calculated as:

$$\text{extra_ hrvoc_ emis} = \text{hrvoc_ emis} \times \left(\frac{1}{\text{HRVOC}/\text{NOx}} - 1 \right).$$

This equation yields an HRVOC amount minus the original HRVOC emissions from the reported inventory. These extra HRVOC emissions were written to a separate "extra HRVOC" file in order to manipulate them separately from the base inventory. In the formula above, one over the HRVOC-to-NO_X ratio would provide the factor with which to multiply the HRVOC emissions by to make them equal to the NO_X emissions for that account. Each link within each of the selected accounts was multiplied by the factor given in the formula above.

For the purposes of this analysis, a new CB-IV speciation profile was written to split these extra HRVOC emissions into approximately 60% CB-IV OLE and 40% CB-IV ETH, based on the ratio of these two CB-IV compound totals for the area. All twelve HRVOC groups were treated as olefins in the modeling, while in reality, some of the highly reactive compounds have different photochemical reaction pathways. TCEQ modeling staff will revise the methodology employed in this analysis for Phase II MCR modeling and repeat the analysis using improved assumptions. Typical operating schedules for these 27 accounts were 24 hours/day for 7 days/week, therefore, these extra HRVOC emissions were assigned "24/7" temporal profiles. Overall, the additional HRVOC emissions added 149 tons/day to the modeling episode.

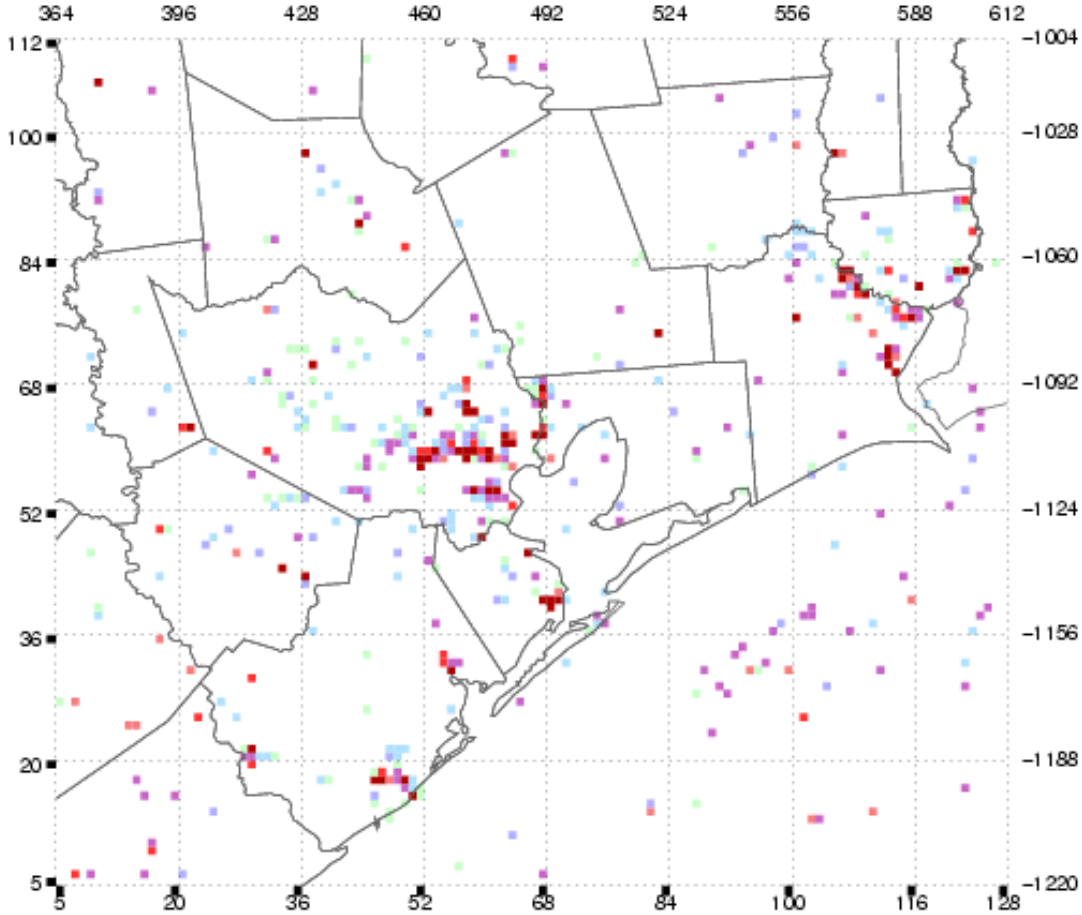
Figures 15 and 16 illustrate the spatial allocation of the unadjusted ("regular") 2000 base case point source NO_X and VOC emissions, respectively, for August 30. Recall that modeled "VOC" is actually CB-IV methane-equivalent hydrocarbon. These tileplots also report tabulated county total emissions and the overall diurnal profile for the mapped area. Figures 17 and 18 illustrate the adjusted ("extra HRVOC") 2000 base case point source NO_X and VOC emissions, respectively, for August 30. Note that the NO_X emissions did not change between Figures 15 and 17.

Since it is likely that VOCs , and more importantly, the reactive olefin species, have been underestimated in the emissions reported to the PSDB, more top-down adjustments will be made to the point source inventory for Phase II MCR modeling runs.

Figure 15. 2000 base4a Total Point Source NOx

all_pts_base4a_regular Total Point Source NO_x Emissions, 08/30/2000

(2x2 Km Grid Cells)



Emissions Plotted	
County	Tons/Day
Brazoria	59.54
Chambers	25.39
Fort Bend	103.12
Galveston	89.69
Harris	186.23
Liberty	6.59
Montgomery	13.74
Waller	5.39
HG SUBTOTAL:	489.70
Hardin	1.53
Jefferson	75.22
Orange	54.70
BPA SUBTOTAL:	131.45
MAP TOTAL:	667.05

Legend (Tons/Day)

< 0.00 | 0.00 – 0.01 | 0.01 – 0.05 | 0.05 – 0.10
0.10 – 0.50 | 0.50 – 1.00 | 1.00 – 2.00 | >= 2.00

Max: 97.569 t/d (423, -1139); Min: 0.000 t/d (365, -1219)

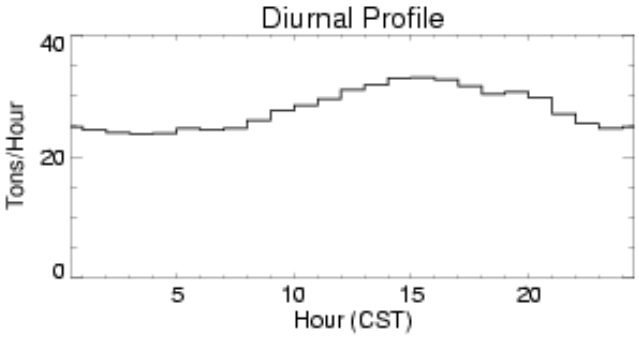
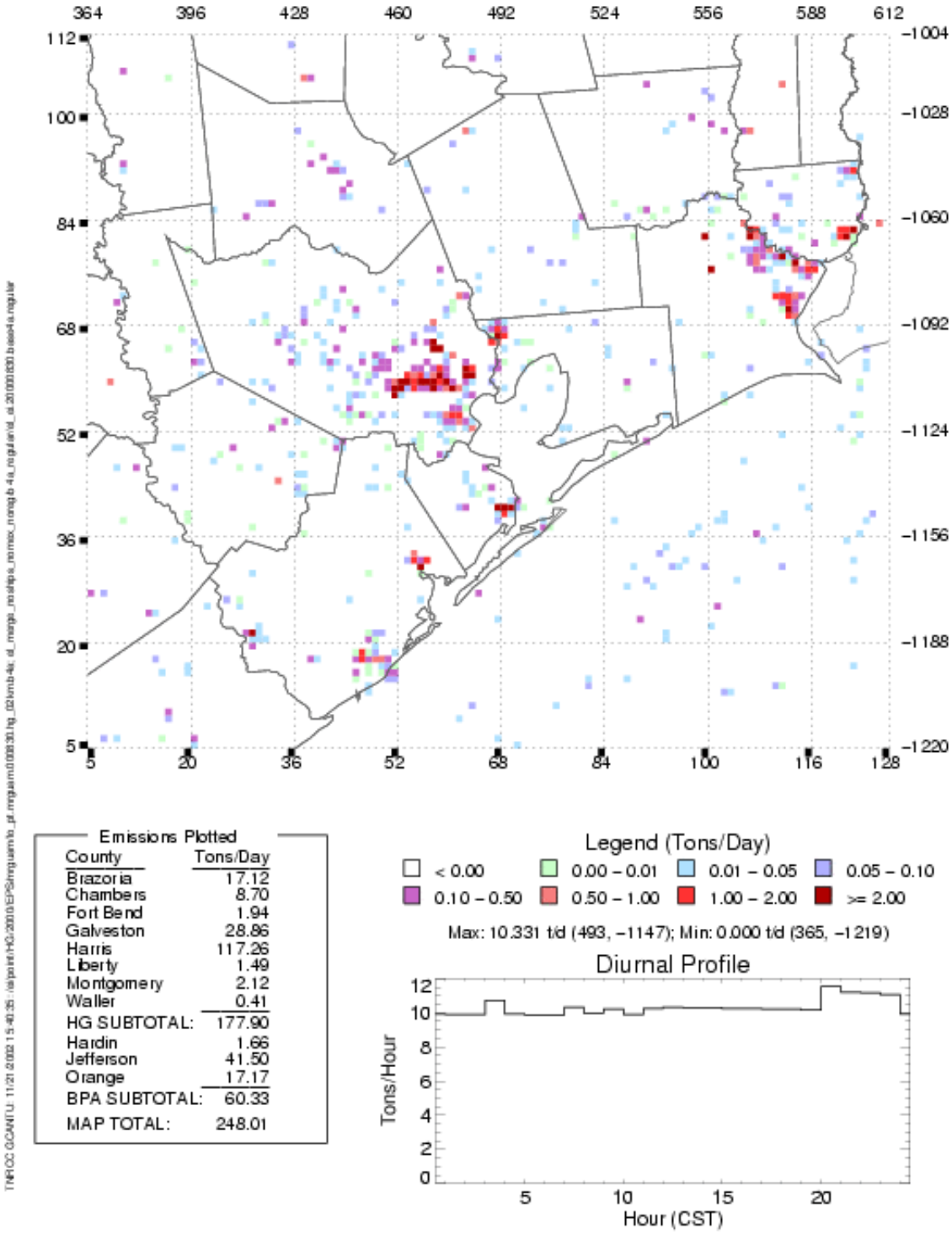


Figure 16. 2000 base4a Total Point Source VOC

all_pts_base4a_regular Total Point Source CB–IV HC Emissions, 08/30/2000



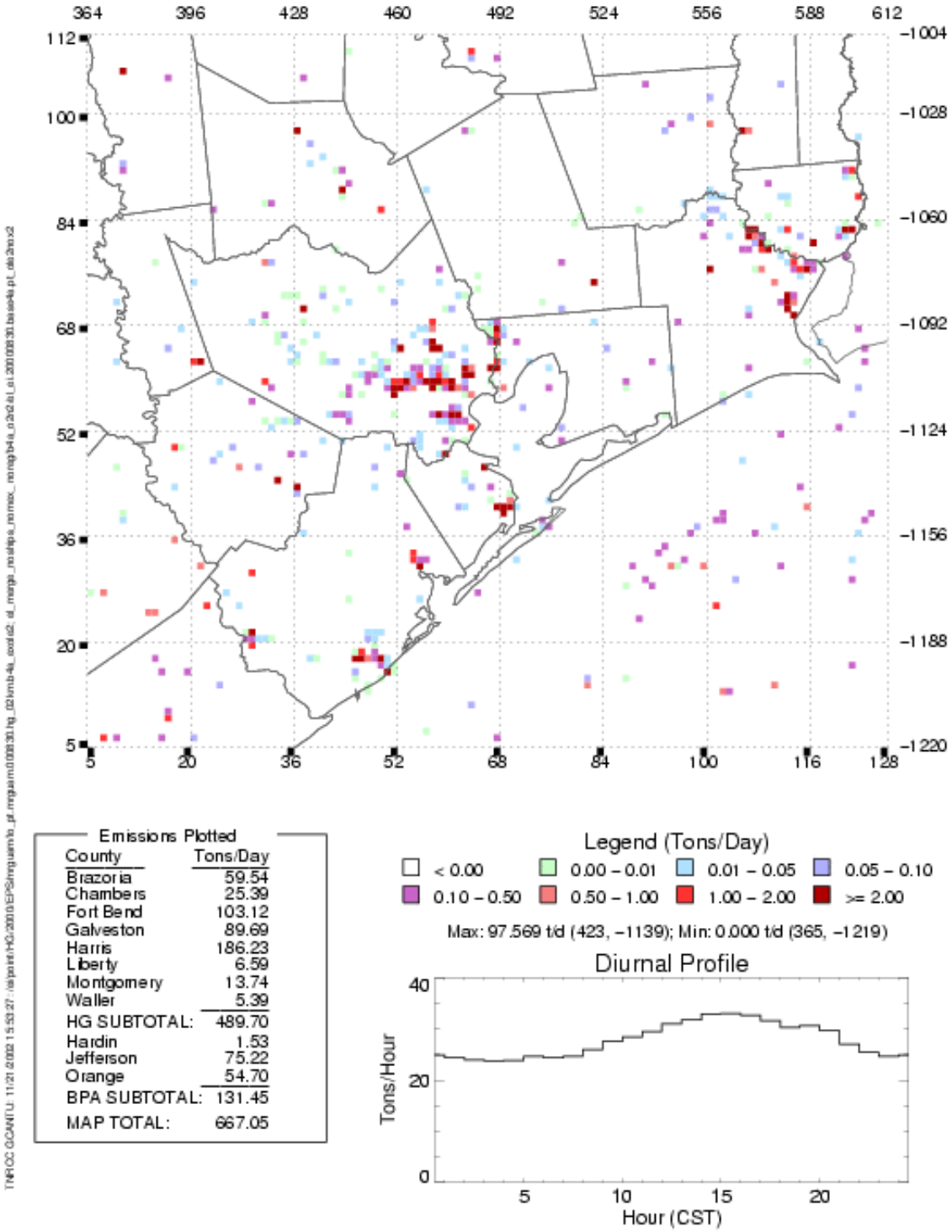
Emissions Plotted

County	Tons/Day
Brazoria	17.12
Chambers	8.70
Fort Bend	1.94
Galveston	28.86
Harris	117.26
Liberty	1.49
Montgomery	2.12
Waller	0.41
HG SUBTOTAL:	177.90
Hardin	1.66
Jefferson	41.50
Orange	17.17
BPA SUBTOTAL:	60.33
MAP TOTAL:	248.01

Figure 17. Adjusted (Extra HRVOC) 2000 base4a Total Point Source NOx

all_pts_base4a_o2n2 Total Point Source NO_x Emissions, 08/30/2000

(2x2 Km Grid Cells)

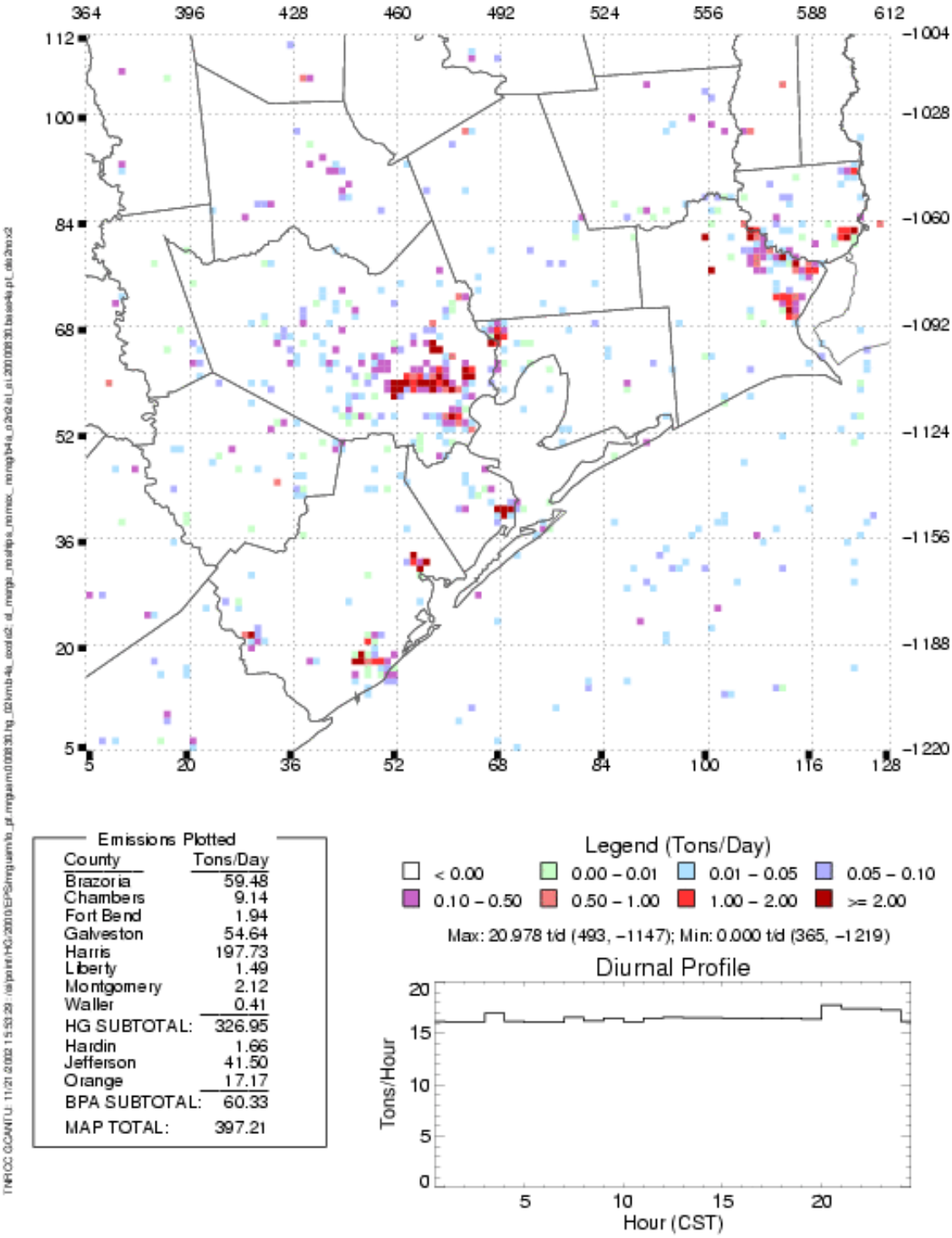


Emissions Plotted

County	Tons/Day
Brazoria	59.54
Chambers	25.39
Fort Bend	103.12
Galveston	89.69
Harris	186.23
Liberty	6.59
Montgomery	13.74
Waller	5.39
HG SUBTOTAL:	489.70
Hardin	1.53
Jefferson	75.22
Orange	54.70
BPA SUBTOTAL:	131.45
MAP TOTAL:	667.05

Figure 18. ***Adjusted (Extra HRVOC) 2000 base4a Total Point Source VOC***

all_pts_base4a_o2n2 Total Point Source CB–IV HC Emissions, 08/30/2000



Future Case Development

TCEQ then developed a future modeling inventory based on current and proposed ("alternate") NOx Emission Specifications for Attainment Demonstration (ESADs) as well as proposed HRVOC reduction strategies. This 2007 point source emissions inventory contains the following NOx controls for Texas:

- HGA NOx Cap
  - revised and alternate ESADs for HGA EGUs based on 30-day highest heat input period
  - ESADs and alternate ESADs for HGA non-EGUs
- SB7 EGU controls (attainment areas of Texas)
- DFW Tier II EGU controls
- BPA Tier I EGU controls

Projection to 2007 is typically performed for an average weekday or weekend day, as is performed for area, nonroad, and on-road mobile parts of the inventory. Since weekday point source emissions are roughly the same as weekend point source emissions, a single future case day for point sources was modeled for every future day; a "typical Tuesday", August 29,2000, was chosen for future case inventory development. Additionally, after supplementing the PSDB files with Special Inventory data, August 29 emissions represented the average daily emissions for the episode.

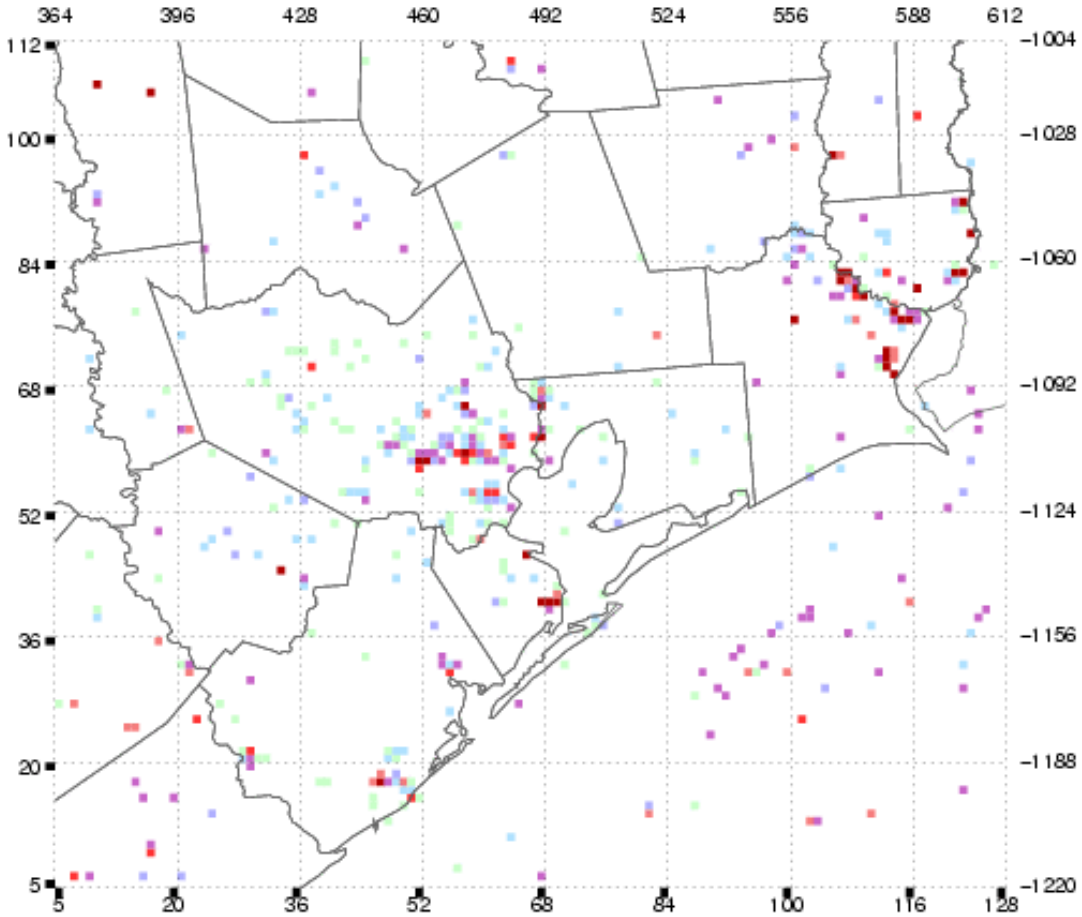
The 2007 future case inventory contains the currently implemented reduction to industrial NO_X emissions, which is nominally 90%. In the June 2002 Proposal, TCEQ staff modeled the original Tier III ESAD rates for EGUs. For this Phase I MCR modeling, TCEQ staff modeled the revised ESAD rates for EGUs, as adopted in September 2001. Henceforth, "90%" NOx reductions refers to these revised ESADs. Figures 19 and 20 depict the 2007 unadjusted future base case ("90%" NOx reductions) NOx and VOC, respectively. Figures 21 and 22 are the adjusted (extra HRVOC) future base case NOx and VOC tileplots. Note, the NOx emissions are unchanged between these two cases.

The future point source inventory also includes the banked (ERCs and DERCs) NOx emissions based on the revised and alternate HGA ESADs, as well as the banked VOCs. These totaled 3.8 tpd of banked NOx and 17.9 tpd of VOC in HGA. Additionally, 29.2 tpd of NOx and 3.3 tpd of VOC in BPA were included in the future case modeling. These banked emissions are in excess of the HGA NOx Cap. The capped emissions for HGA total 68.3 tpd of NOx under the revised ESADs. Modeling staff calculated an alternate NOx Cap of 122.7 tpd for the alternate ESADs, because such had not been calculated previously. These alternate ESADs would also result in more banked emissions, therefore modeling staff calculated alternate banked emissions of 4.9 tpd of NOx.

Figure 19. 2007 Total Point Source NOx with "90%" NOx Reduction

all_pts_fy07b_regular Total Point Source NO_x Emissions, 08/30/2000

(2x2 Km Grid Cells)



Emissions Plotted

County	Tons/Day
Brazoria	11.29
Chambers	5.40
Fort Bend	15.42
Galveston	13.55
Harris	37.50
Liberty	1.12
Montgomery	2.21
Waller	0.96
HG SUBTOTAL:	87.46
Hardin	1.92
Jefferson	98.38
Orange	45.48
BPA SUBTOTAL:	145.78
MAP TOTAL:	278.40

Legend (Tons/Day)

< 0.00 | 0.00 – 0.01 | 0.01 – 0.05 | 0.05 – 0.10 | 0.10 – 0.50 | 0.50 – 1.00 | 1.00 – 2.00 | >= 2.00

Max: 29.511 t/d (575, -1069); Min: 0.000 t/d (365, -1219)

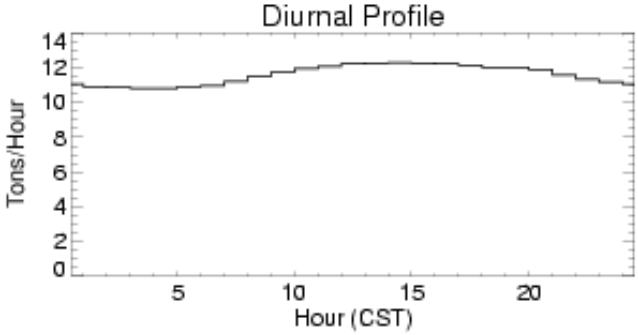


Figure 20. 2007 Total Point Source VOC with "90%" NOx Reduction

all_pts_fy07b_regular Total Point Source CB–IV HC Emissions, 08/30/2000

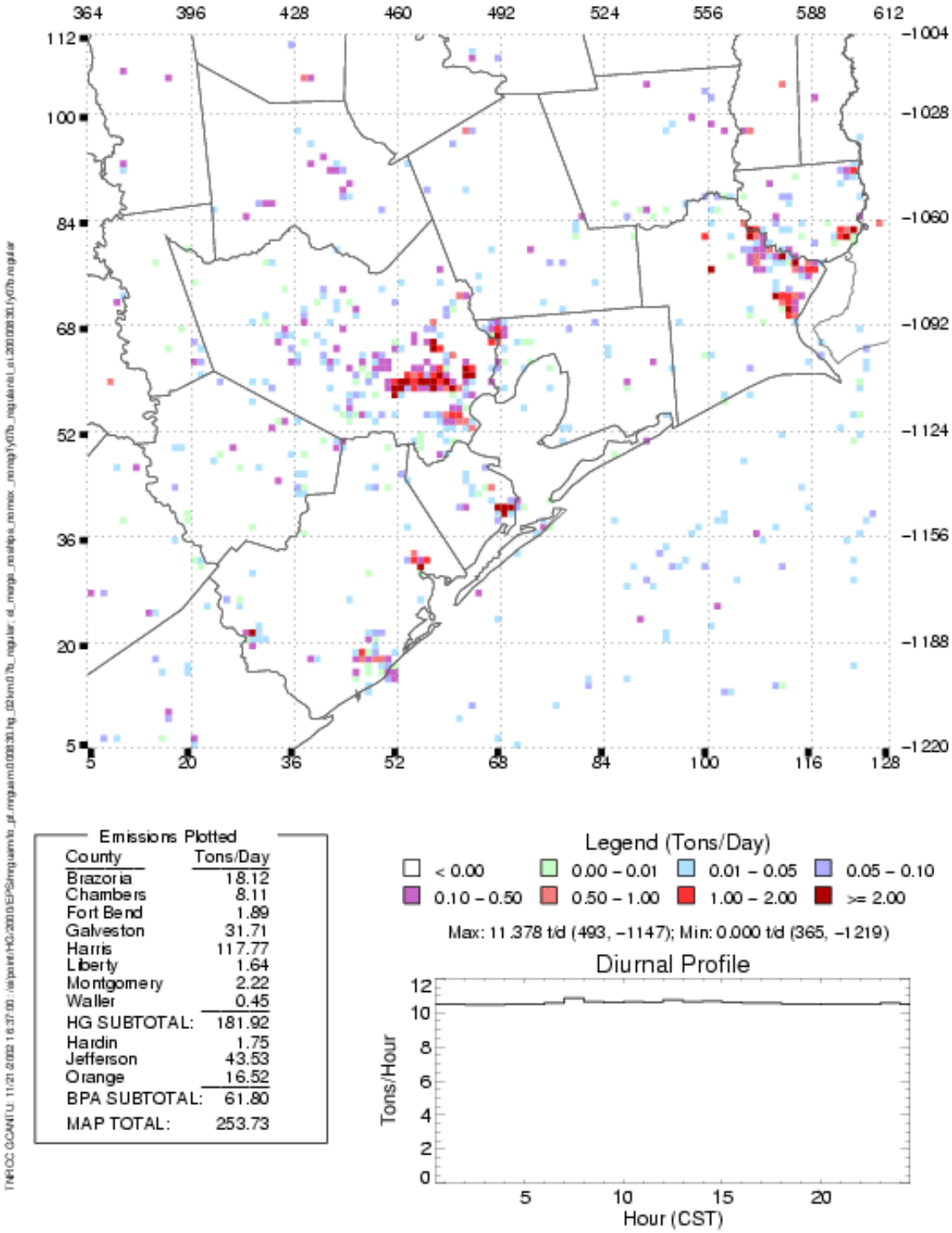


Figure 21. Adjusted (Extra HRVOC) 2007 Total Point Source NOx with "90%" NOx Reduction

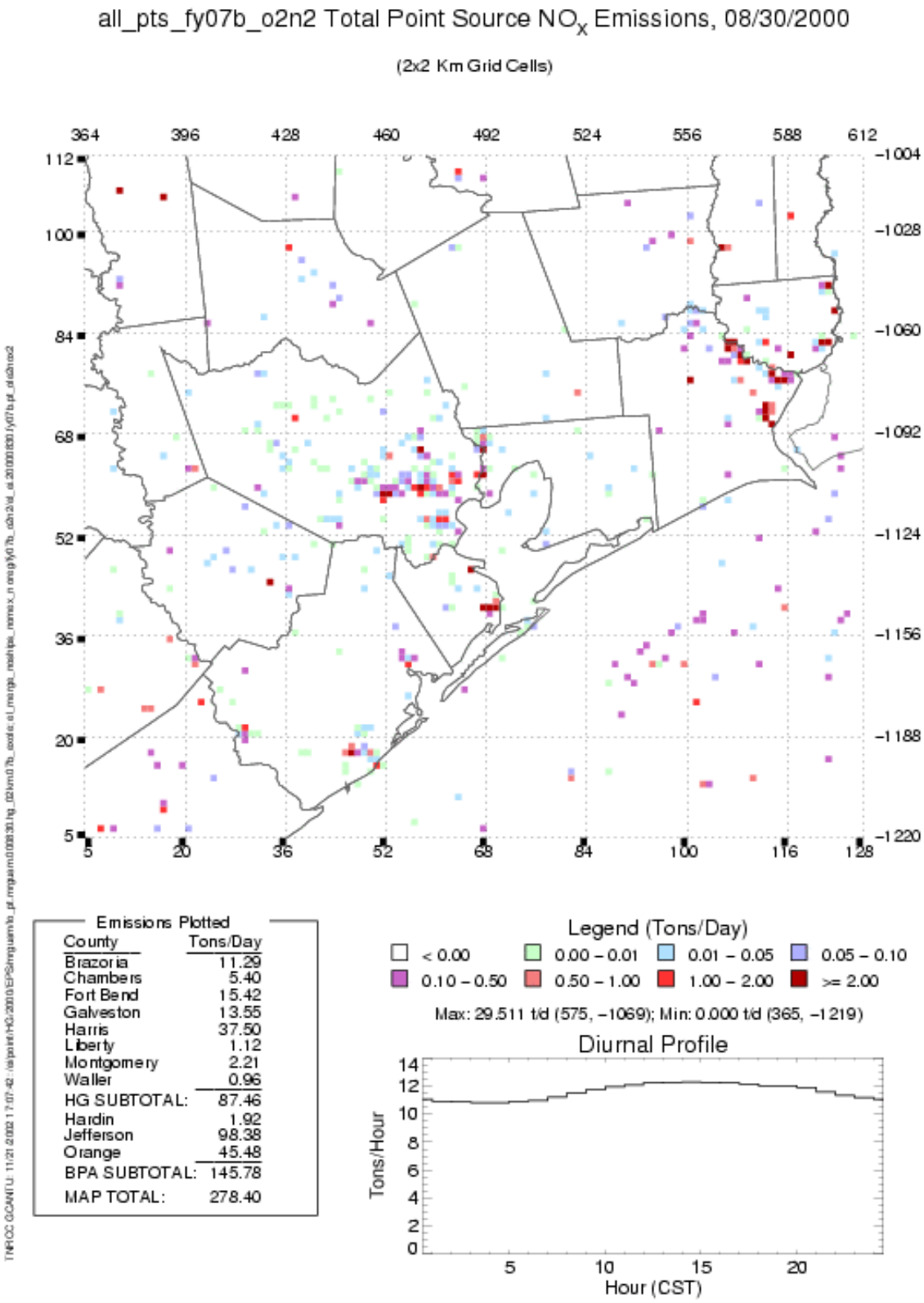
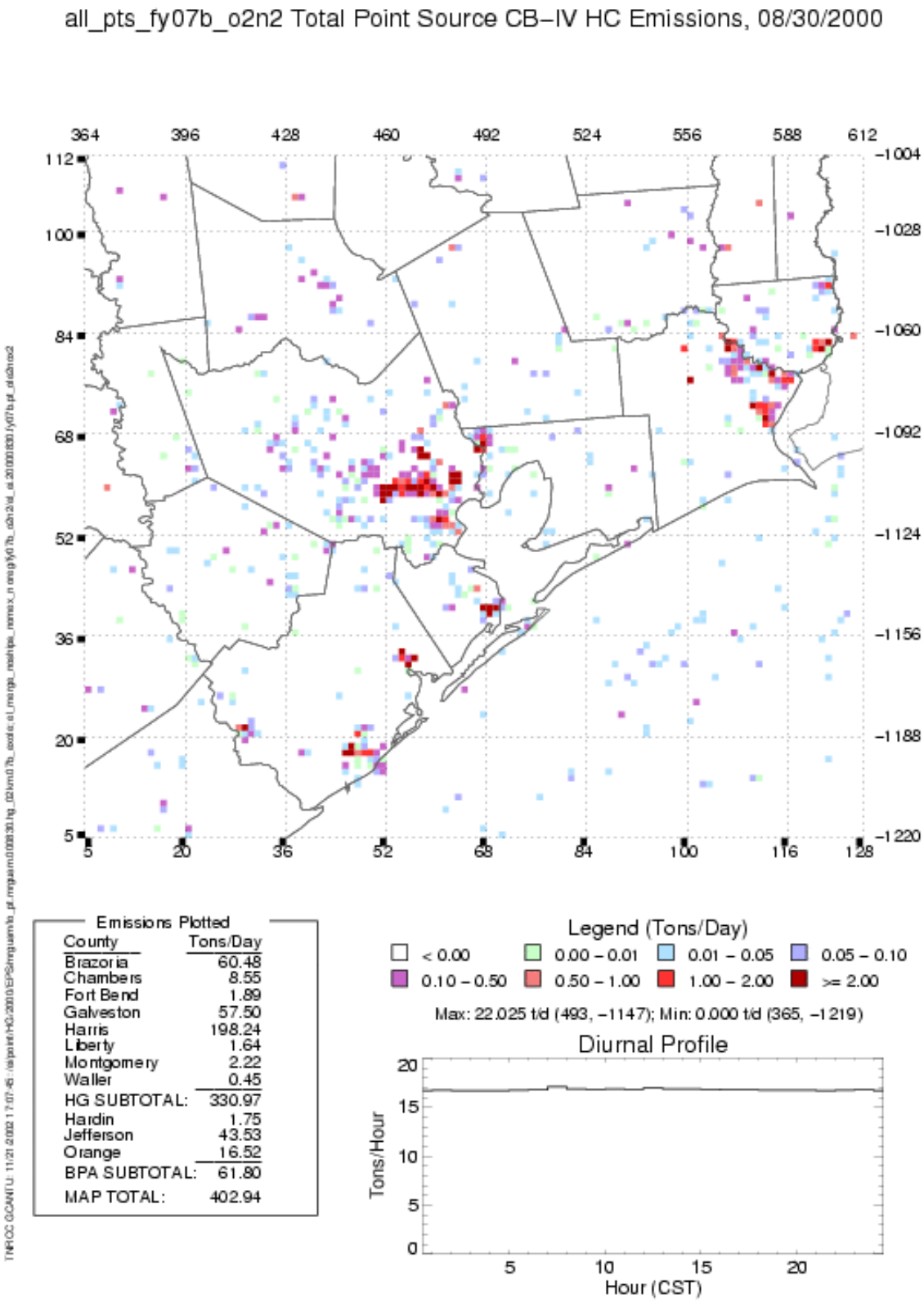


Figure 22. Adjusted (Extra HRVOC) 2007 Total Point Source VOC with "90%" NOx Reduction



The future case scenarios modeled next were designed to address the VOC/NO_X tradeoff issue by preparing variations of the 2007 control case. Based on the results discussed in Section 2 of the TSD, the TCEQ developed a control strategy which will provide greater air quality benefits than those achievable with controls propagated in previous SIP revisions. This new strategy targets four HRVOC categories: ethylene, propylene, 1,3-butadiene, and butenes. This strategy calls for a reduction of all four HRVOCs in Harris County, while the remaining counties receive reductions in only the two most important categories, ethylene and propylene.

As discussed in Section 2 of the TSD, it is necessary to reduce emissions of HRVOCs by 36% from the adjusted 2000 base case emissions to achieve the same benefit as the “last 10%” of NO_X reductions (80% versus 90%). The current strategy will reduce HRVOC emissions in Harris County by approximately 50% (on a reactivity basis), and will significantly reduce HRVOC emissions in the remaining seven counties in the nonattainment area. This strategy is referred to in this section as the har37e55 HRVOC reduction strategy. This “har37e55" nomenclature, which stands for 63% reduction of all HRVOCs in Harris county and 45% reduction of all HRVOCs in the surrounding seven counties, is a result of manipulating only the extra HRVOC modeling file to achieve the proposed reduction of 64%.

Figures 23 and 24 are tileplots of this har37e55 HRVOC control strategy with the 90% ESADs, and Figures 25 and 26 are tileplots of this har37e55 HRVOC control strategy with the 80% alternate ESADs. Comparison between Figures 22 and 24 demonstrate that this strategy accounts for an 82 tpd VOC reduction.

Figure 23. 2007 Total Point Source NOx with "90%" NOx Reduction and har37e55 HRVOC Reduction Strategy

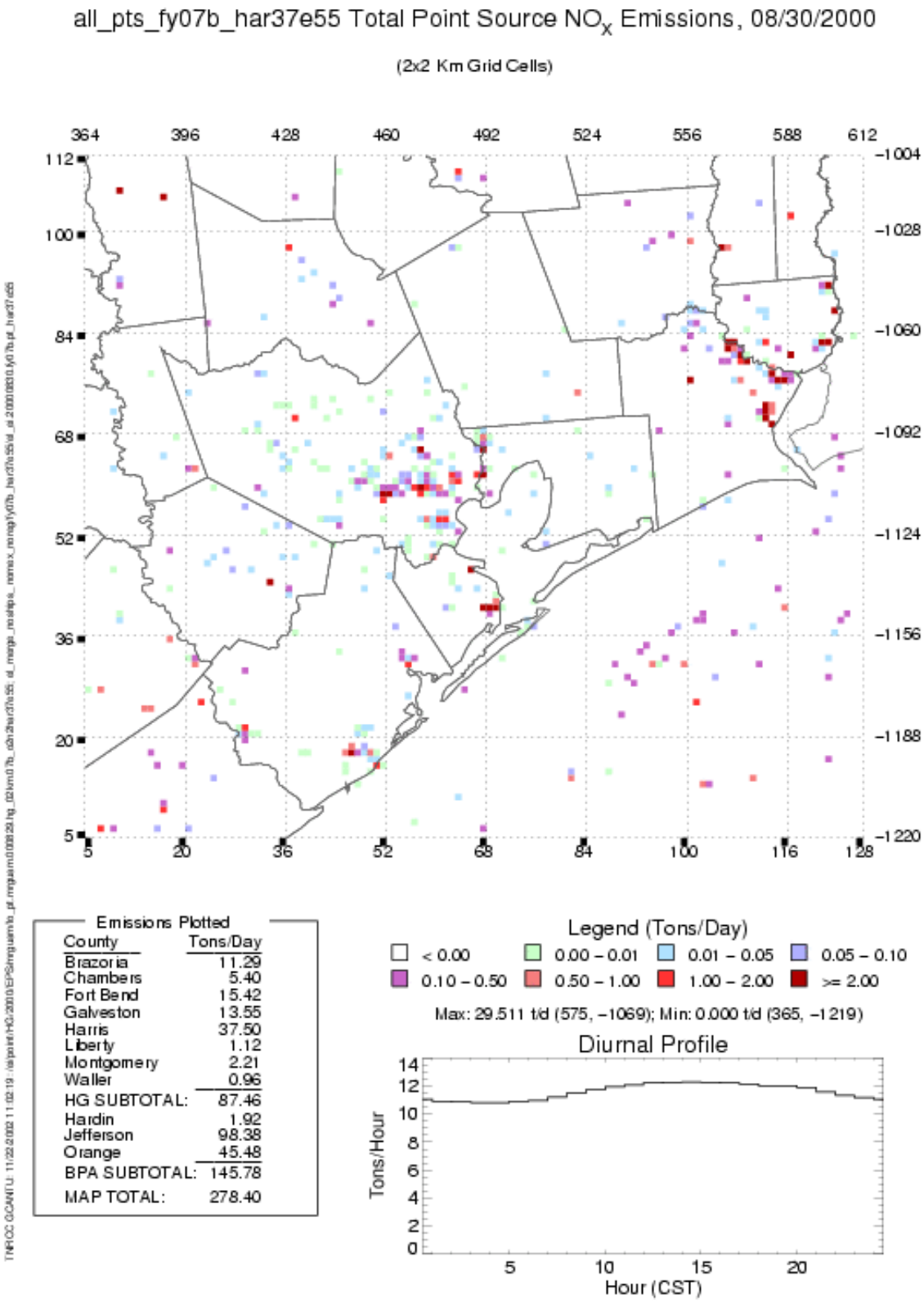


Figure 24. 2007 Total Point Source VOC with "90%" NOx Reduction and har37e55 HRVOC Reduction Strategy

all_pts_fy07b_har37e55 Total Point Source CB–IV HC Emissions, 08/30/2000

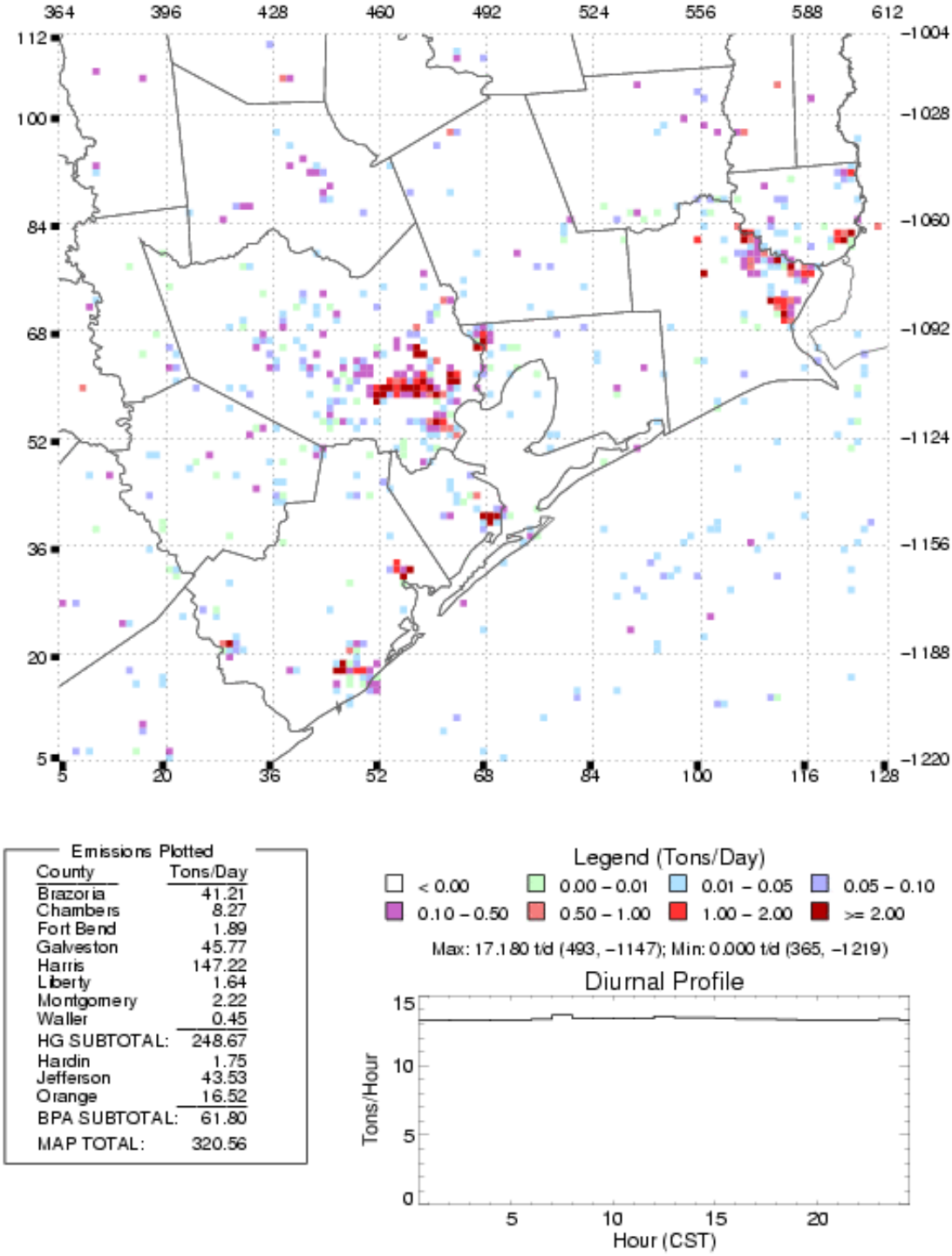


Figure 25. 2007 Total Point Source NOx with "80%" NOx Reduction and har37e55 HRVOC Reduction Strategy

all_pts_fy07b_har37e55altE Total Point Source NO_x Emissions, 08/30/2000

(2x2 Km Grid Cells)

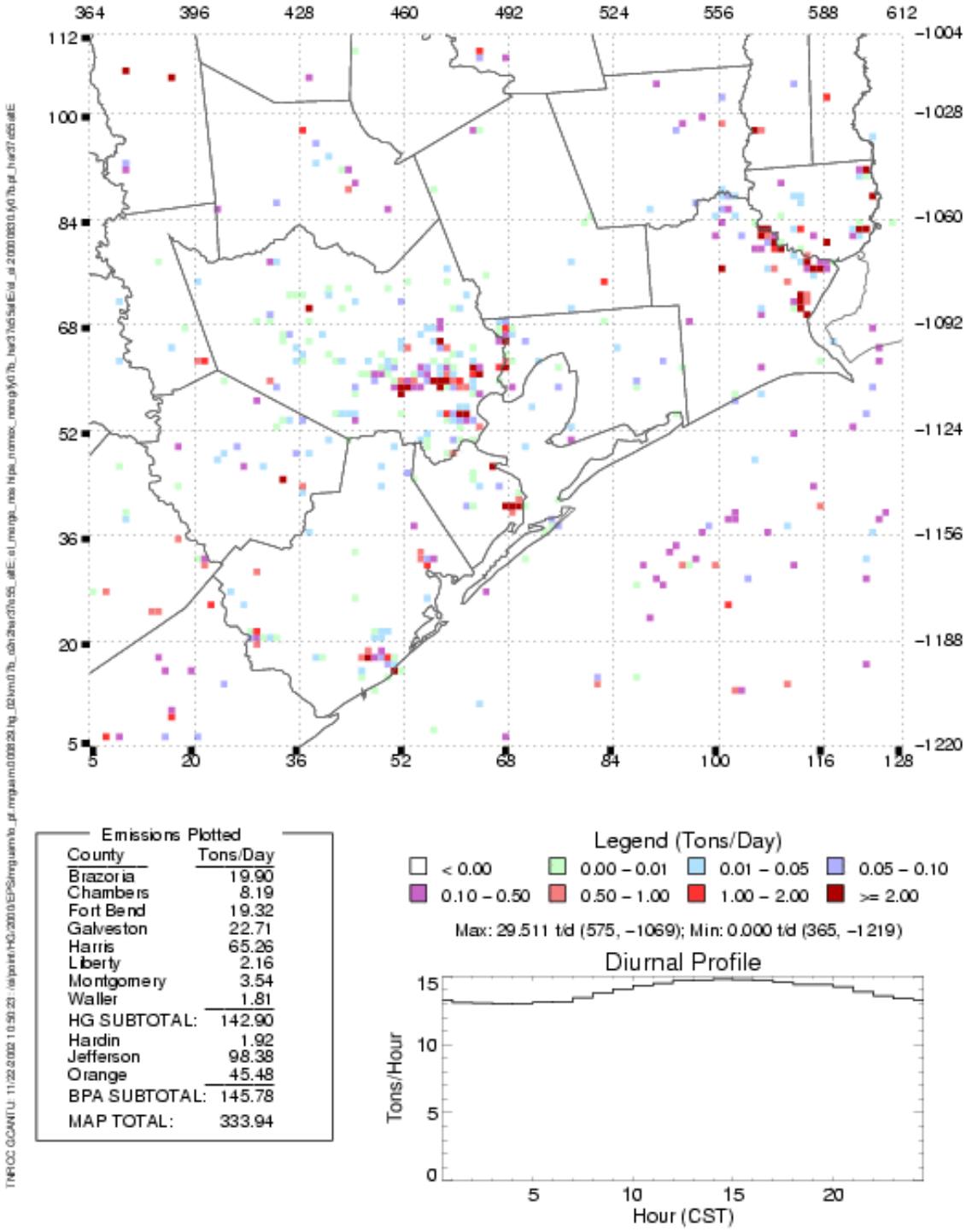
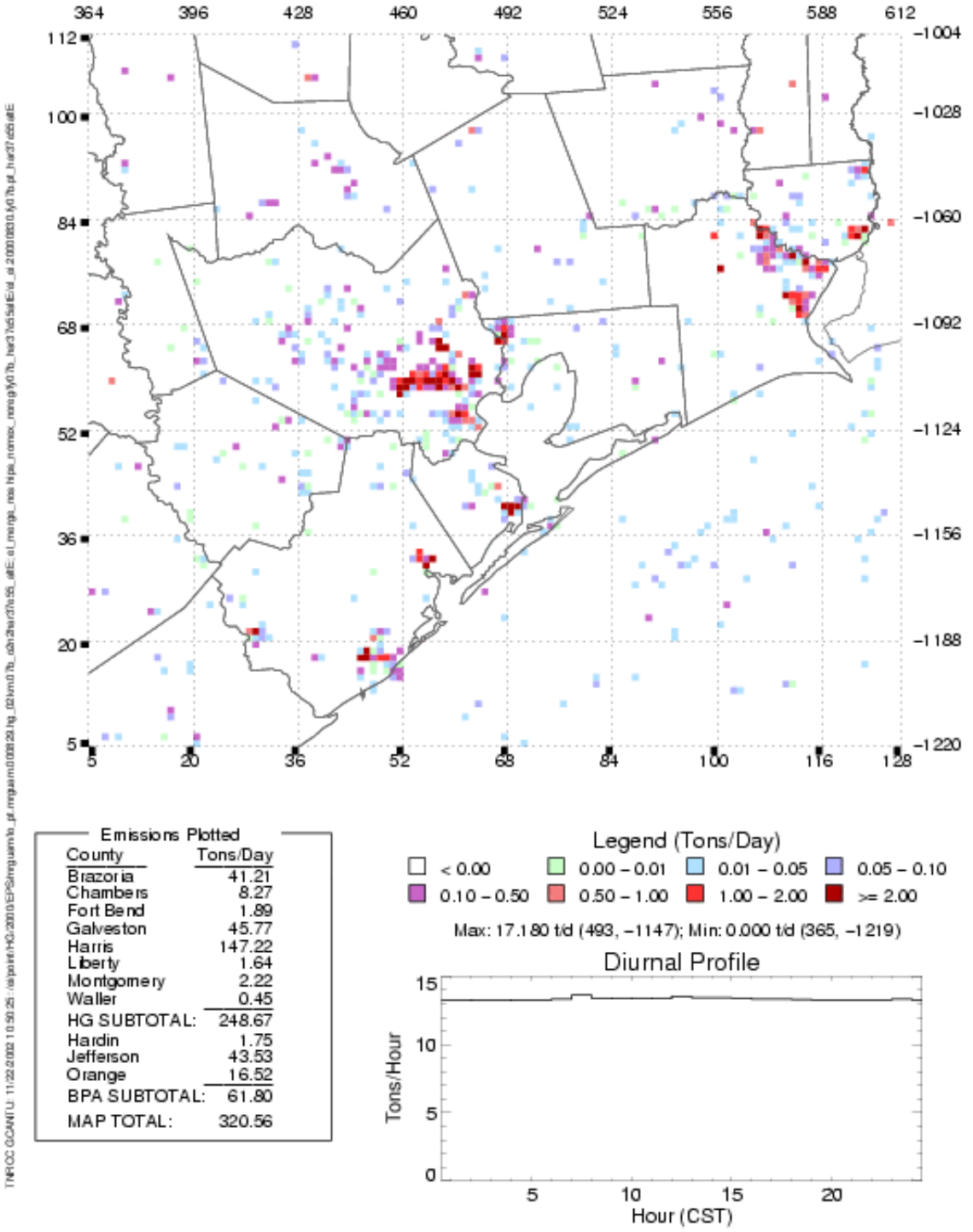


Figure 26. 2007 Total Point Source VOC with "80%" NOx Reduction and har37e55 HRVOC Reduction Strategy

all_pts_fy07b_har37e55altE Total Point Source CB–IV HC Emissions, 08/30/2000



Louisiana Point Sources

Base Case Development

The modeled base case for Louisiana is unchanged since the June 2002 Proposal.

Louisiana Department of Environmental Quality (LDEQ) supplied TCEQ modeling staff with a copy of their 2000 point source emissions inventory in AFS format. The TCEQ modeling staff, split the LDEQ AFS file into EGU and non-EGU files, and with assistance and QA from LDEQ point source emissions staff, completed an AFS-to-ARPDB cross-reference list. As with the Texas cross-reference, this list links Louisiana acid rain boilers (from the EPA database) to their corresponding LDEQ stack identifiers. With this cross reference list completed, modeling staff replaced LDEQ annual EGU emission records in the AFS file with hourly ARPDB emissions for each of the episode days. These data were used in the base case modeling.

Default stack parameters were used when such were missing in the LDEQ AFS file. Because the LDEQ AFS records contained no starting hour (e.g., start operations at 8:00 am) information, the EPS2x preprocessor assumed a default starting hour of midnight for all records. Because many sources (not typically the largest emitters) operated less than 24 hours a day, this assumption led to a noticeable decline in emissions through the course of each day modeled. The TCEQ modeling staff corrected this by applying a "temporal fix" to the file that ultimately shifted the emissions such that they were centered more around midday. For example, if a plant operated 8 hours per day, modelers assumed it started at 9:00 am and ended at 5:00 pm, instead of the default of midnight til 8:00 am.

Future Case Development

TCEQ modeling staff used the 2000 inventory for future case modeling. TCEQ modeling staff received and modeled NOx SIP control strategy information from LDEQ's recent Baton Rouge attainment demonstration, resulting in a 34% Baton Rouge 9-parish EGU and non-EGU NOx reduction. LDEQ confirmed that these are the only expected Louisiana point source emission reductions.

Offshore Point Sources

Base Case Development

According to a November 2001 *draft GOADS (Gulfwide Offshore Activities Data System) QA/QC Summary* memorandum from MMS's contractor, ERG, the number of offshore platforms counted for 2000 were 3,154. According to the 1995 revised final draft report, *Gulf of Mexico Air Quality Study (GMAQS)* by MMS's contractor, SAI, the number of platforms counted for 1992 was 1,857 with an 85% response rate. Assuming that 2,185 (1857/0.85) would be the number of platforms in 1992 (and thus providing a more conservative growth estimate), the number of offshore platforms has grown approximately 44% (3154/2185) between 1992 and 2000.

Assuming that the ancillary stationary point source equipment would grow at the same rate as the number of offshore platforms, TCEQ modeling staff "grew" the entire point source offshore file by 44%, and assumed that is representative of 2000 emissions. Since the 2000 offshore inventory has not yet been officially released by MMS, the TCEQ does not have information on the locations of these new platforms, so the emissions are being grown "in place". This "grown" offshore EI has been incorporated into the 2000 base case model runs.

Future Case Development

For this Phase I MCR modeling, the TCEQ modeling staff used the 2000 base case offshore EI. A discussion with MMS staff concluded that it may be appropriate to grow the offshore platforms and ancillary equipment by approximately another 44%, but would be very inaccurate to perform this growth in place. The trend in new offshore equipment in Texas and Louisiana is to move much farther offshore. No accurate growth projections are available, but trends indicate such. During Phase II MCR modeling, TCEQ staff may perform a sensitivity analysis on distance-from-shore to determine if there is any impact beyond the 50 or 100-mile markers on HGA from offshore points that far into the Gulf of Mexico.

Point Sources Outside of Texas (Regional Inventory)

Base Case Development

For emissions outside of the State of Texas, the TCEQ obtained point source emission records in the AIRS facility subsystem (AFS) format from Environ, Inc. These 1999 National Emissions Inventory (NEI) data had already been prepared for near-nonattainment modeling that Environ was performing for several areas of Texas. TCEQ modeling staff reviewed the AFS file, removed Texas and Louisiana records from the file, and processed the remainder (as "regional") through EPS2x. This process served as not only a method to prepare them for the CAMx model, but also as a QA tool. See the *Photochemical Modeling QA/QC Plan* which is an attachment to the Modeling Protocol for general point source QA procedures. These emissions were used as the basis for the 2000 base case modeling efforts.

TCEQ modeling staff created an AFS-to-ARPDB cross-reference list for the regional boilers larger than 750 MW capacity that are subject to EPA's Acid Rain Program. This cross-reference list links these boilers to their corresponding NEI/AFS stack identifiers. With this cross-reference, modeling staff replaced the ozone-season daily emission records in the AFS file with hourly ARPDB emissions for each hour of the modeled episode. These hourly emissions have been incorporated into the 2000 base case model runs.

Future Case Development

TCEQ modeling staff used the 1999 regional EI as the basis for future case modeling. TCEQ modeling staff applied revised (since June 2002 Proposal) estimates of EPA's NOx SIP Call control strategies to EGUs outside the State of Texas. This should also approximate the Clear

Skies Act, if it is promulgated. The NOx SIP Call control strategies modeled, obtained from the Federal Register, dated February 2, 2002, included EGU NOx reductions of

- 27% in Illinois
- 32% in Indiana and Kentucky
- 33% in Ohio
- 23% in Tennessee
- 29% in northern counties of Alabama
- 28% in Northern counties of Georgia
- 34% in Eastern counties of Missouri

No control strategies were assumed for non-EGUs outside the State of Texas. For Phase I MCR modeling, no growth was assumed outside the State of Texas for lack of good data (EPA's EGAS). During Phase II MCR modeling, TCEQ modeling staff may "grow" the 1999/2000 regional EI to 2007.

Point Sources in Mexico

Base Case Development

The introduction of Mexican point sources is new to this Phase I MCR modeling. The Desert Research Institute provided TCEQ modeing staff with a 1999 Big Bend Regional Aerosol and Visibility Observational (BRAVO) Study Emissions Inventory in Inventory Data Analyzer (IDA) format; see Attachment 3-9 for more details. Modeling staff reviewed the inventory, subset out emissions from sources in Mexico, and converted the data to AFS format for processing through EPS2x.

During the conversion from IDA to AFS format, modeling staff identified and corrected several potential problems with the Mexico inventory:

- The state FIPS codes for Mexico in this inventory were two digit numeric codes. In order to avoid confusion with US point source data with identical state FIPS codes, modeling staff substituted two-character codes for the existing numeric codes.
- Standard Industrial Classification (SIC) codes were missing from the data. The accompanying documentation identified the inventoried power plants and modeling staff assigned them an SIC of 4911 (Electric Services) and assigned all other facilities a "dummy" code of 0000.
- Stack parameters were missing from the data. Modeling staff assigned representative stack parameters, by SCC, to each stack based on similar (average) facilities in Texas. The categories included power plants (identified by SIC 4911), copper smelters, cement manufacturing plants, iron and steel plants, nonferrous metals plants, coking plants, paper and pulp plants, petroleum refineries, and chemical plants.
- The data contained annual emission rates and not Ozone Season Daily emission rates. Because the throughput data, when present, indicated year round operation (25% percent of

total operations for each season of the year), modeling staff divided the annual emission rates by 365 days/year to achieve a daily emissions inventory for Mexico.

These emissions were incorporated into the 2000 base case model runs.

Future Case Development

For Phase I MCR modeling, TCEQ modeling staff used this same 1999 inventory to represent 2007 emissions.

Quality Assurance

For procedures used by TCEQ modeling staff to quality assure point source inventories, see the *Photochemical Modeling QA/QC Plan* of the modeling protocol.

Area/Nonroad Mobile Emissions Inventory Development

Area and Non-Road Mobile Emissions Inventory Development

Area and Non-Road mobile source emissions were primarily derived from the 1999 periodic emissions inventory. The 1999 PEI has been updated to incorporate many improvements developed in recent years, including use of the NONROAD model and survey-based emissions for shipping and construction activities. Spatial allocation for most categories used recently updated Lambert Conformal Projection (LCP) 2km surrogates.

Special treatment was accorded to ships, by treating them as pseudo-stacks spaced along the major waterways within the Galveston Bay region (as described in the December 6, 2000 SIP revision). The TCEQ has a contract to identify movements of large ships during the August 25-September 1, 2000 episode and plans to model them individually. If the appropriate data can be obtained, aircraft emissions will be treated in a fashion similar to that described in the April 19, 2000 Dallas-Fort Worth SIP revision. Emissions from states outside of Texas were obtained from Environ, who developed 1999 (based on the NEI) and 2007 inventories for their modeling of near-nonattainment areas in Texas.

When available, offshore emissions will be obtained from the Gulf Coast Ozone Study. Until that time, the emissions developed for the 1992 Gulf of Mexico Air Quality Study are being used. The GMAQS-based emissions will be projected to 2000 and 2007 using data obtained from the Minerals Management Service where available. New spatial surrogates for shipping lanes, developed by modeling staff, allowed offshore shipping emissions to be spatially allocated more accurately.

The primary QA method, as outlined in the QA Section of the *Photochemical Modeling QA/QC Plan*, was to divide the inventory into its separate constituents and separately process each constituent through EPS2x. Tables 80 and 81 summarize the data for a each emissions category on a typical 2000 ozone season weekday. Each category was individually plotted to check emissions totals, as well as temporal and spatial distribution for both the 2000 base case and the 2007 future case.

Figures 27 through 34 summarize the data in the tables as pie charts. The 2007 emissions, summarized in Tables 82 and 83, reflect a future base case before SIP controls were applied. The projections of the emissions to 2000 and 2007 for most categories were performed under contract by Environ. The resulting “trends” data was not completed at the same level of detail as the 1999 estimates at the time of this round of modeling. The projected data include both future growth in activity and federal controls in place at this time. The “trends” emissions for a few non-road categories were questionable and either not used or modified. The 8-county elevated shipping files use 1997 data for 2000 and are the result of a detailed shipping emissions project reported in previous SIPs. The 2007 shipping emissions derive from the same contract. The projections for recreational boating and non-road oil and gas equipment need further development, so 1999 data for these two categories were used for 2000 and 2007 without modification. The 2000 and 2007 lawn and garden categories were modified by deleting the emissions for a certain diesel commercial turf equipment type that had unreasonably high NOx emissions.

Table 80. 2000 Non-Road Mobile for HGA 8 Counties

Category	NOx (tpd)	VOC (tpd)
Agriculture	4.73	0.55
Aircraft	5.76	2.31
Commercial	7.97	8.79
Construction	34.11	7.33
GSE	4.00	3.76
Industrial	17.01	1.88
Lawn+Garden	5.08	58.28
Locomotives	53.34	2.21
Logging	0.27	1.51
Oil+Gas	1.71	0.16
Rec Equipment	0.27	1.95
Rec Boating	0.11	7.44
Ships	34.85	0.79
8 County Total	169.21	96.96

Table 81. 2000 Area Sources for HGA 8 Counties

Category	NOx (tpd)	VOC (tpd)
Architectural Coating	0.00	18.35
Asphalt Paving	0.00	4.95
Auto Refinishing	0.00	2.37
Bakeries+Breweries	0.00	0.69
Drycleaning	0.00	4.34
Graphic Arts	0.00	0.87
Industrial Fuel Use	11.63	0.32
Leaking UST	0.00	1.90
Oil+Gas Production	19.31	20.31
Open Burning	0.76	8.29
Pesticide Use	0.00	2.46
Petro Transport+Refueling	0.00	16.97
Residential Fuel Use	2.44	0.14
Solvent Use	0.00	39.17
Surface Cleaning	0.00	12.79
Surface Coating	0.00	11.63
Traffic Marking	0.00	0.48
Waste Treatment	0.00	2.75
8 County Total	34.14	148.7

Figure 27.

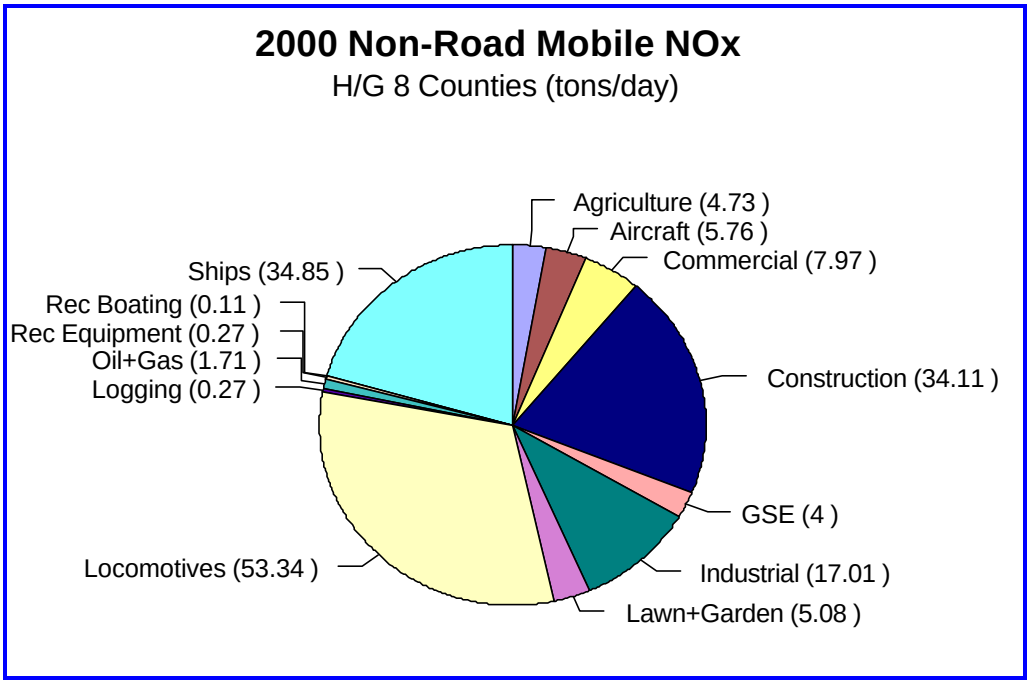


Figure 28.

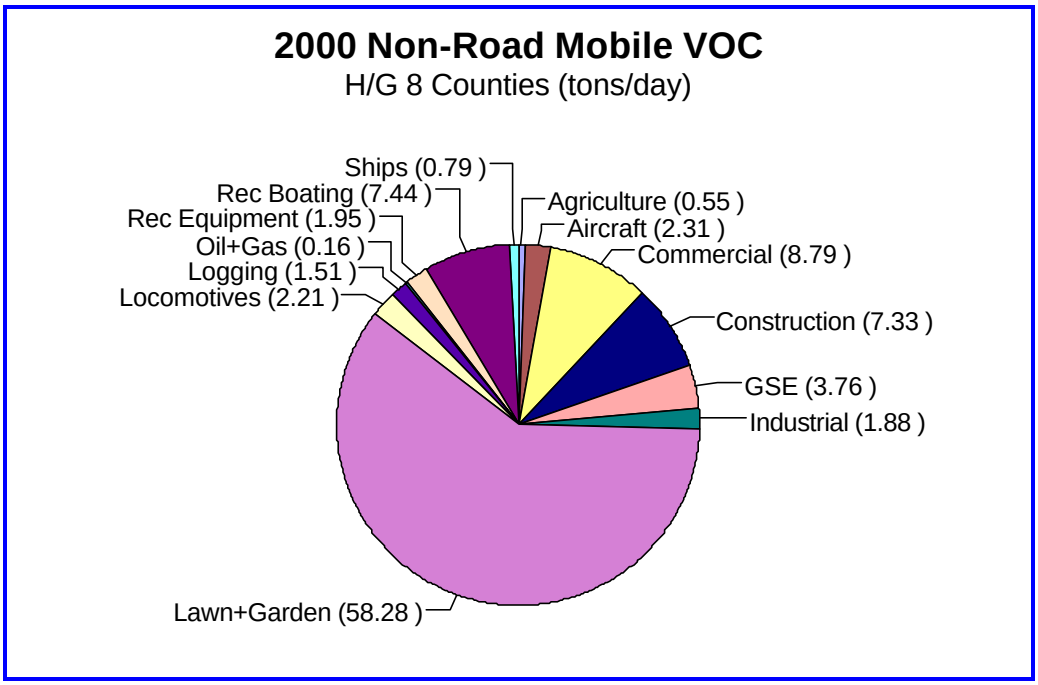


Figure 29.

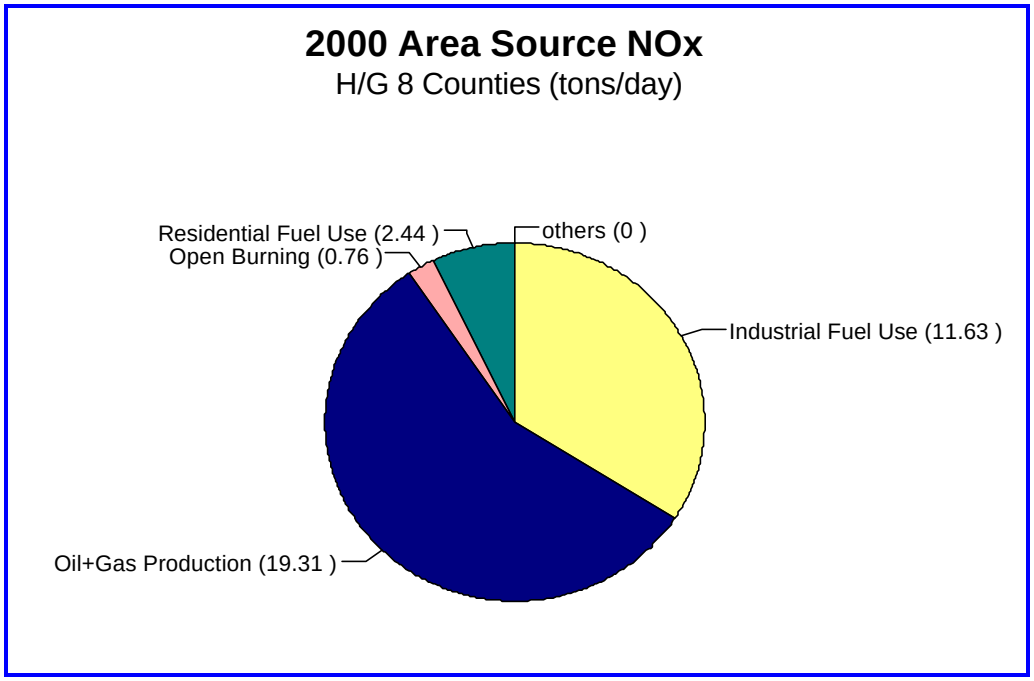


Figure 30.

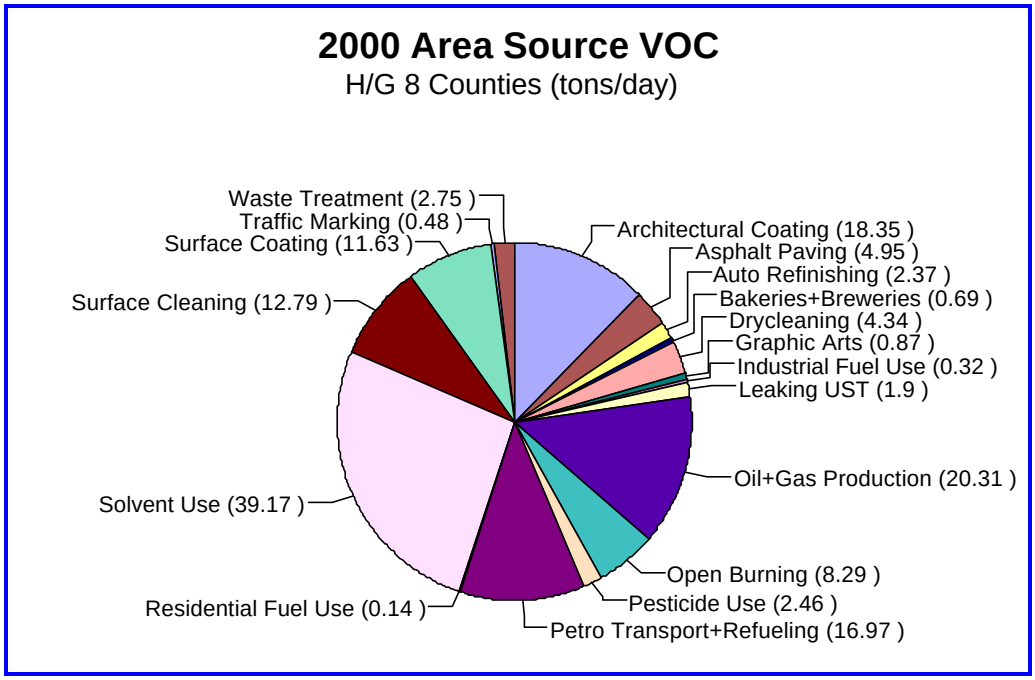


Table 82. 2007 Non-Road Mobile for HGA 8 Counties

Category	NOx (tpd)	VOC (tpd)
Agriculture	3.45	0.36
Aircraft	6.88	2.75
Commercial	8.17	7.21
Construction	29.87	4.92
GSE	3.20	2.78
Industrial	11.06	0.84
Lawn+Garden	4.44	36.98
Locomotives	60.70	2.49
Logging	0.18	0.73
Oil+Gas	1.71	0.16
Rec Equipment	0.25	2.12
Rec Boating	0.11	7.44
Ships	40.03	0.96
8 County Total	170.05	69.74

Table 83. 2007 Area Sources for HGA 8 Counties

Category	NOx (tpd)	VOC (tpd)
Architectural Coating	0.00	19.15
Asphalt Paving	0.00	5.70
Auto Refinishing	0.00	2.76
Bakeries+Breweries	0.00	0.77
Drycleaning	0.00	4.94
Graphic Arts	0.00	1.04
Industrial Fuel Use	13.39	0.39
Leaking UST	0.00	2.16
Oil+Gas Production	19.12	18.21
Open Burning	0.81	8.54
Pesticide Use	0.00	2.53
Petro Transport+Refueling	0.00	15.87
Residential Fuel Use	2.39	0.15
Solvent Use	0.00	45.15
Surface Cleaning	0.00	18.13
Surface Coating	0.00	15.87
Traffic Marking	0.00	0.44
Waste Treatment	0.00	3.13
8 County Total	35.71	164.93

Figure 31.

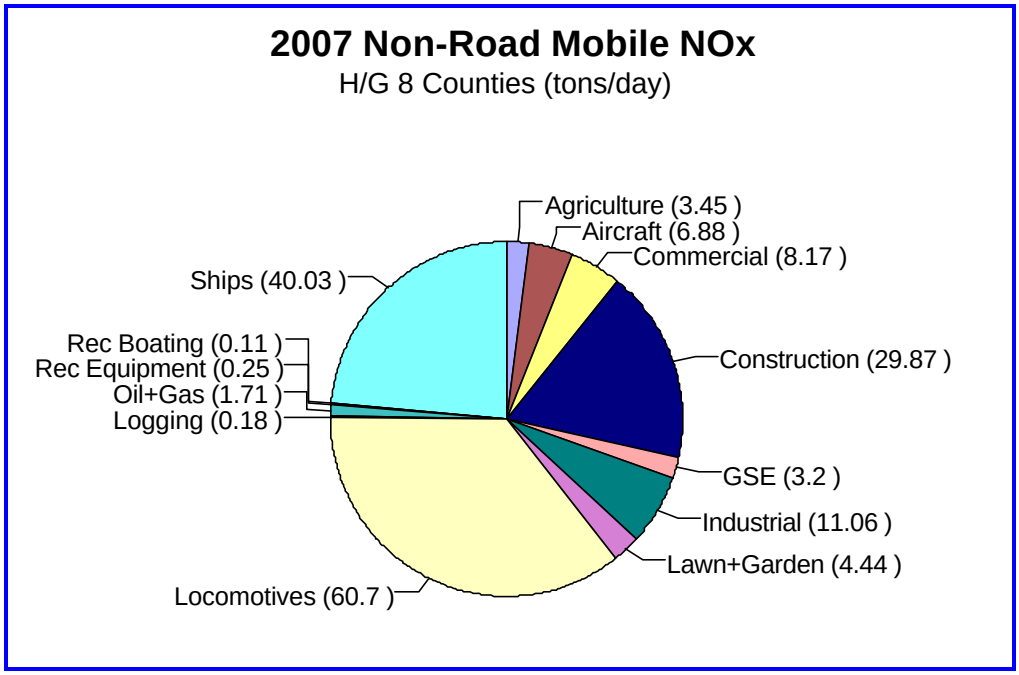


Figure 32.

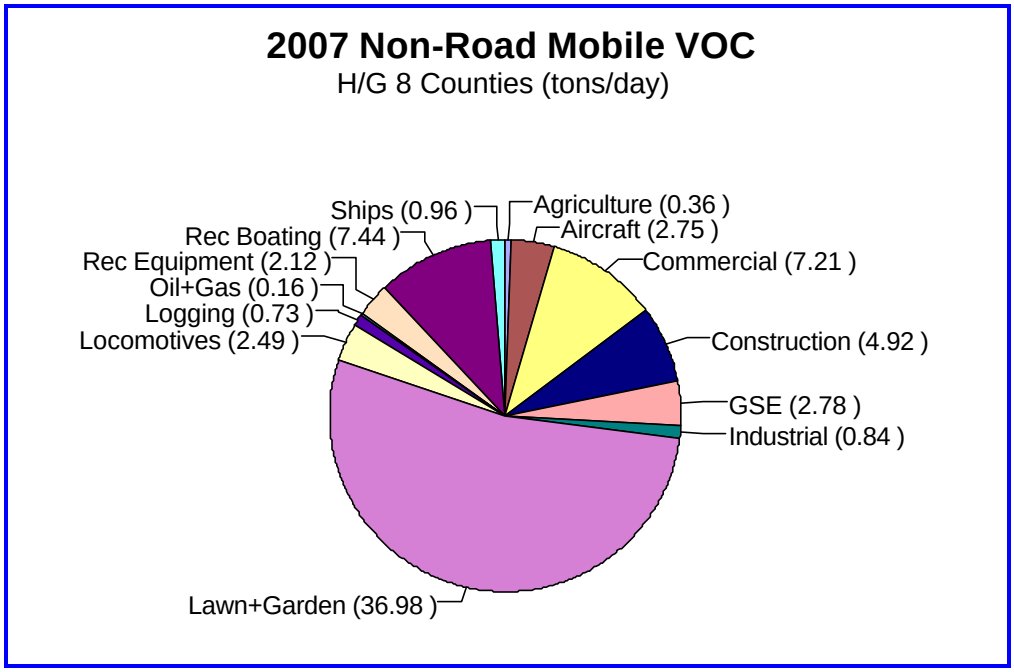


Figure 33.

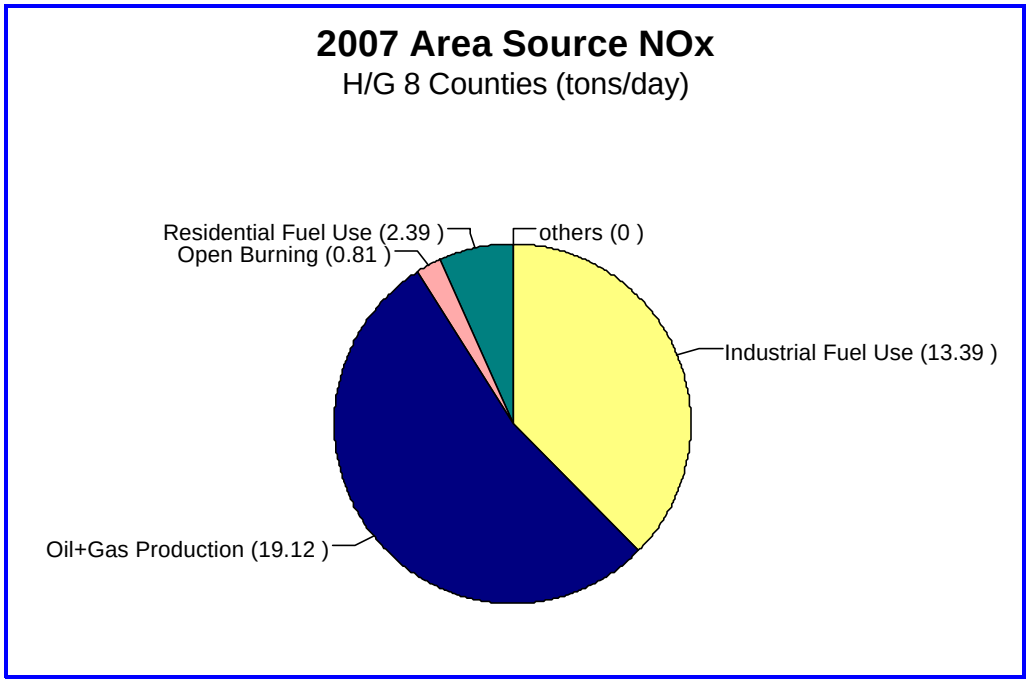
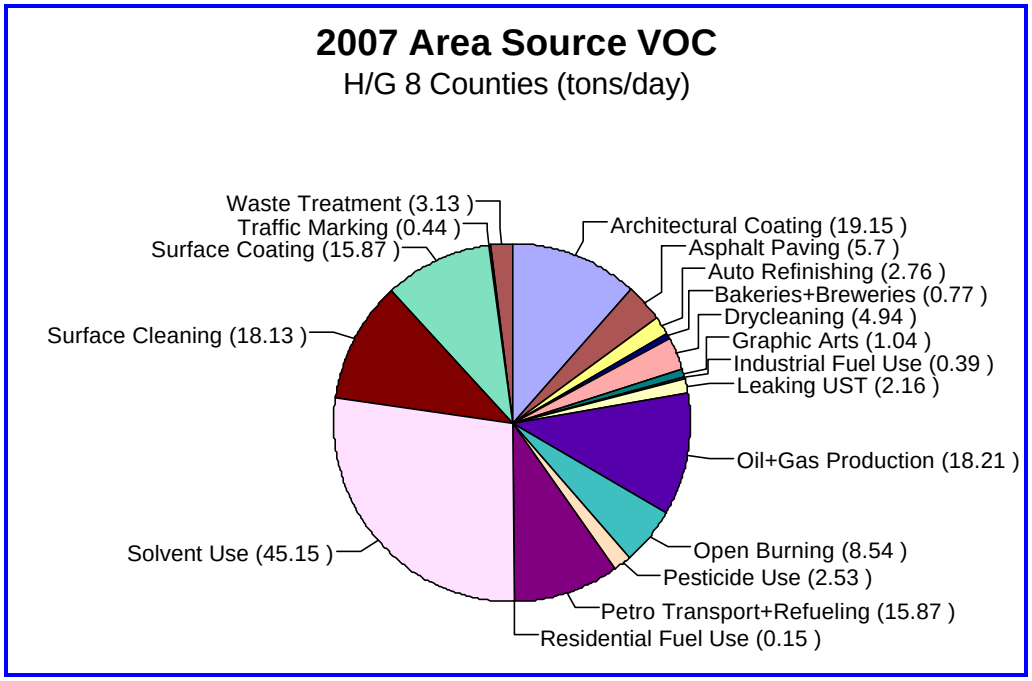


Figure 34.



Base Case Modeling Summary

Tileplots depicting the low level 2000 base case input modeling files covering the 4-km domain for area and non-road are shown in Figures 35 and 36. Note that the totals in the plots do not exactly match the tables. The plots of show CB-IV Hydrocarbons, not VOC, as in the data tables and pie charts (Carbon-Bond IV emissions are used internally in CAMx and differ in mass from the originally reported VOCs. In most cases the difference is less than five percent). The map total number is perfectly accurate, however the county total numbers are only approximate. They are based on a summing of county cell fractions and are subject to some error since the county area plots are limited to land area and totally included lakes. Some emissions in the bays are not yet incorporated into the plotting routine. Concentrated emissions near county borders also leads to some inaccuracy in the county total table of these plots. The use of shipping lanes in the gulf are also evident in these plots. Many plots similar to these were produced, as were test plots to look at the contractor, and in-house developed surrogates.

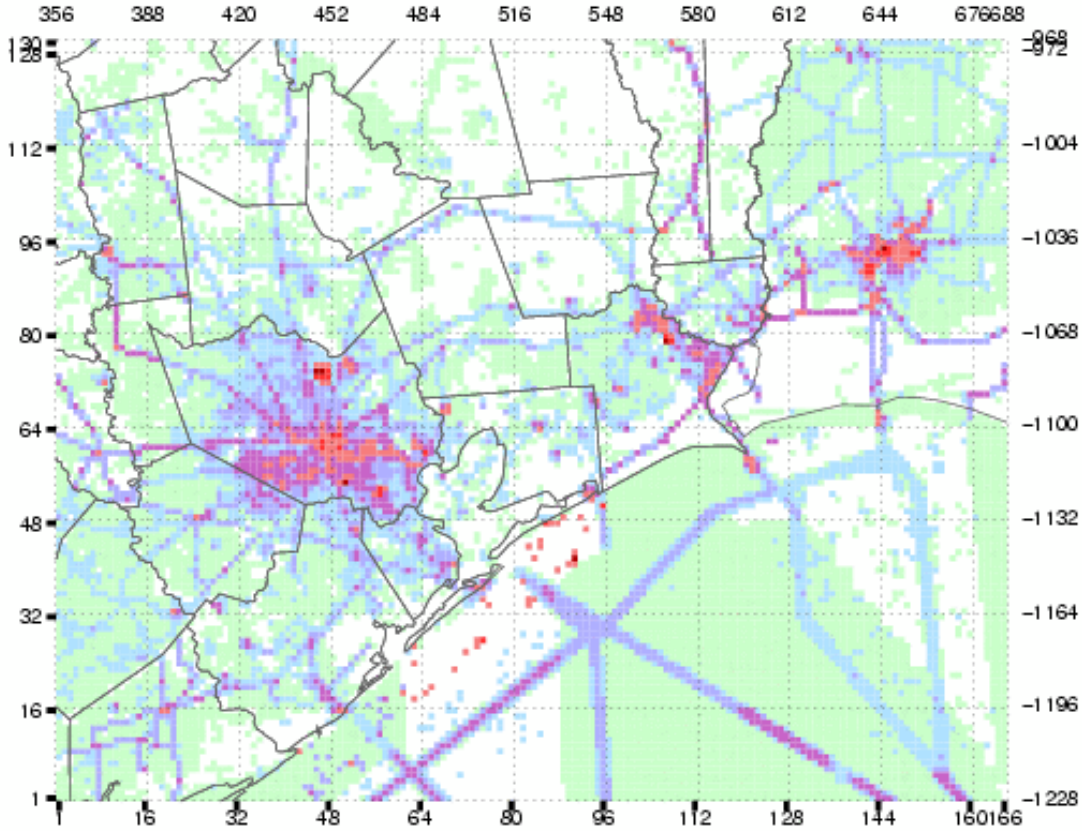
The shipping NOx emissions for the 8-counties is shown in Figure 37. Again note that the depicted county totals come with the above caveats, but the plot total is perfectly accurate.

Similar plots for 2007 will be shown after the next section which details the application of certain SIP controls and “gap” measures.

Figure 35. 2000 Low-level Area and Non-Road NOx emissions tileplot

base2 Area Source NO_x Emissions, 08/31/2000

(2x2 Km Grid Cells)



Emissions Plotted	
County	Tons/Day
Brazoria	17.60
Chambers	5.79
Fort Bend	14.21
Galveston	9.42
Harris	98.50
Liberty	6.98
Montgomery	8.73
Waller	5.23
HG SUBTOTAL:	166.46
Hardin	4.21
Jefferson	26.92
Orange	8.01
BPA SUBTOTAL:	39.14
MAP TOTAL:	409.23

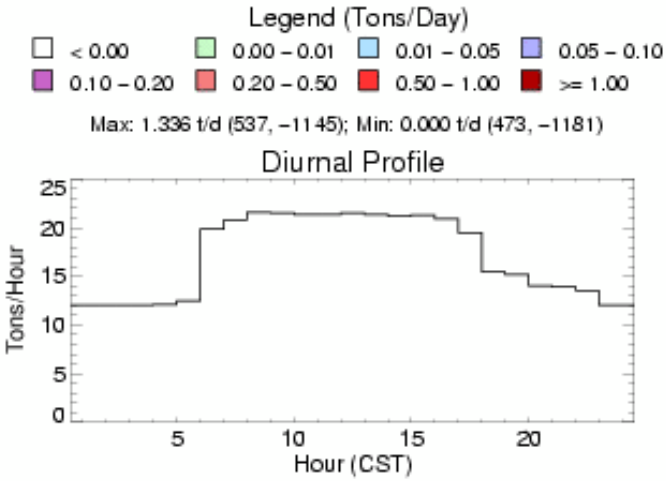
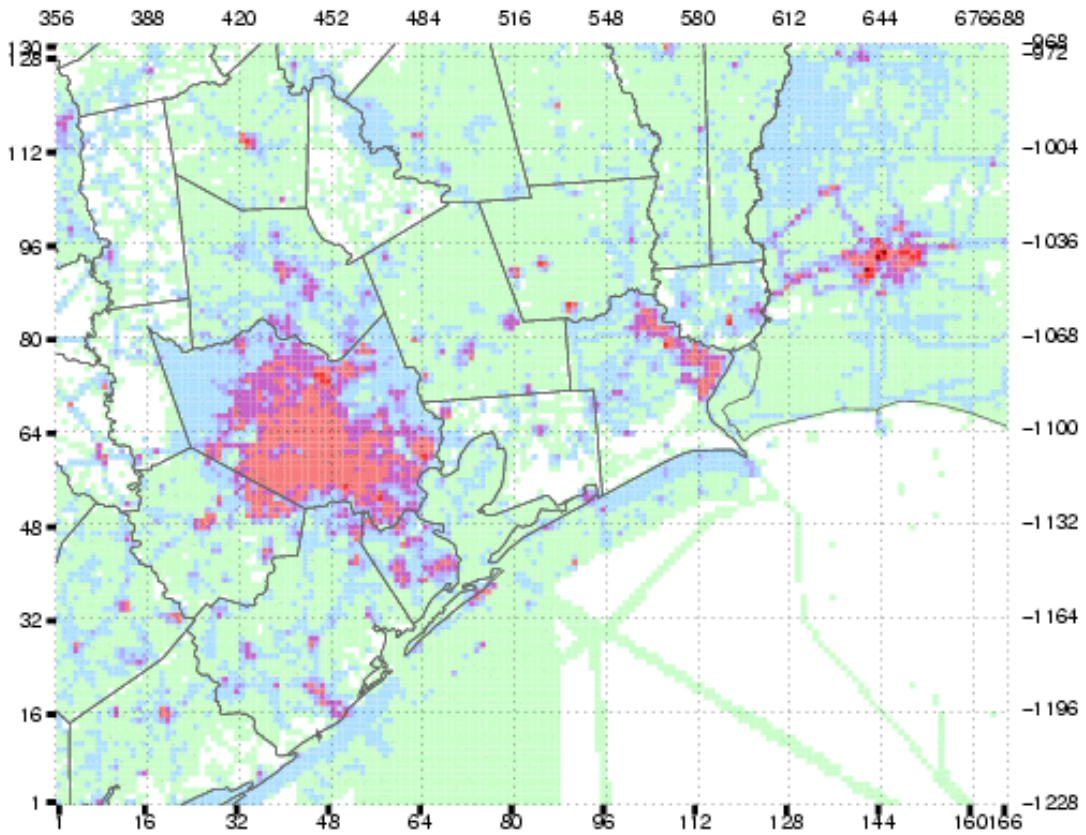


Figure 36. 2000 Low-level Area and Non-Road VOC emissions tileplot

base2 Area Source CB–IV HC Emissions, 08/31/2000



Emissions Plotted	
County	Tons/Day
Brazoria	18.22
Chambers	4.01
Fort Bend	17.51
Galveston	13.31
Harris	162.57
Liberty	7.56
Montgomery	14.63
Waller	2.21
HG SUBTOTAL:	240.02
Hardin	7.33
Jefferson	22.19
Orange	5.13
BPA SUBTOTAL:	34.65
MAP TOTAL:	409.76

Legend (Tons/Day)

< 0.00 | 0.00 – 0.01 | 0.01 – 0.05 | 0.05 – 0.10 | 0.10 – 0.20 | 0.20 – 0.50 | 0.50 – 1.00 | >= 1.00

Max: 1.336 t/d (645, –1039); Min: 0.000 t/d (601, –1131)

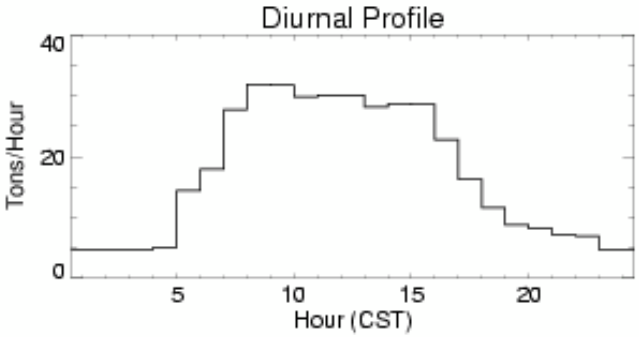
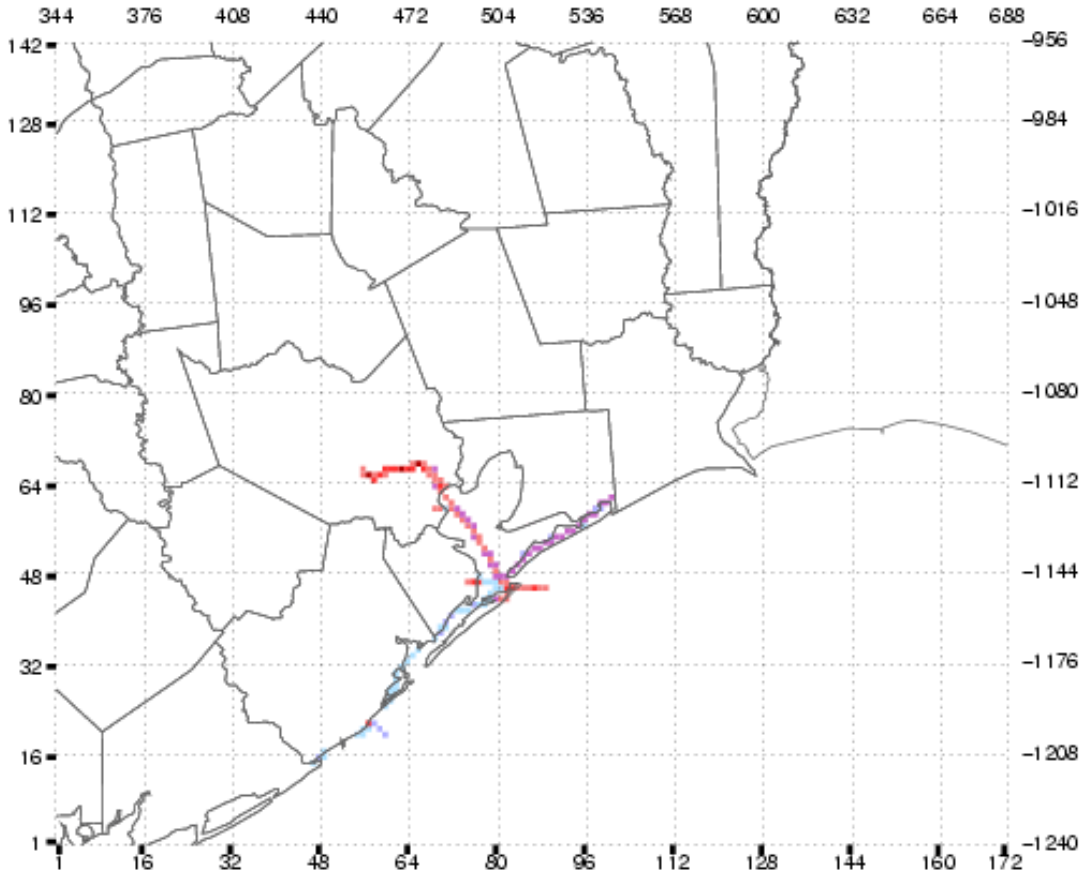


Figure 37. 2000 Elevated Shipping NOx emissions

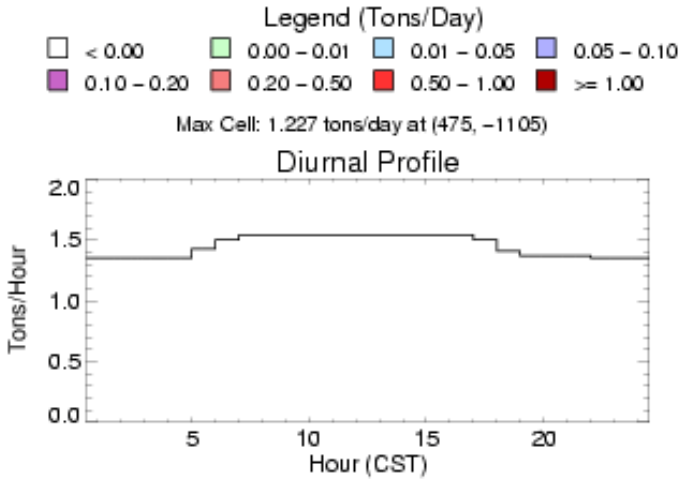
hg_2km_el_ships97 Elevated Ships NO_x Emissions, 08/31/1999

(2x2 Km Grid Cells)



Emissions Plotted

County	Tons/Day
Brazoria	1.42
Chambers	0.46
Fort Bend	0.00
Galveston	3.78
Harris	15.39
Liberty	0.00
Montgomery	0.00
Waller	0.00
HG SUBTOTAL:	21.05
Hardin	0.00
Jefferson	0.00
Orange	0.00
BPA SUBTOTAL:	0.00
MAP TOTAL:	34.85



Area and Nonroad Mobile Source Portions of Overall Attainment Demonstration Inventory

For the purposes of modeling the 2007 attainment demonstration, a review was conducted of the non-road mobile source control strategies which were previously considered in the 12-6-00 and 9-26-01 HGA Attainment Demonstration SIPs. Several of these control strategies have already been included in the current 2007 area and nonroad mobile source inventory for HGA. For example, the estimated benefits of the Construction Equipment Operating Restriction rules were to be replaced by the TERP Program. These benefits are listed as 6.70 NO_X tpd in Table 6.1-2 of the 9-26-01 HGA SIP. In addition to this 6.70 NO_X tpd benefit, the current attainment demonstration inventory also includes the Commercial Lawn Equipment Operating Restrictions and the non-road benefits from the Cleaner Diesel Fuel program.

As described in Section 3.8.3 on page 3-44 of the 12-6-00 HGA SIP, 12.61 tons of NO_X were modeled as the nonroad mobile source portion of the Voluntary Mobile Source Emission Reduction Programs (VMEP) for the 8-County HGA area. Until revised VMEP figures are available, the TCEQ will continue to input 12.61 tons of NO_X as the non-road mobile VMEP benefit which is input into the photochemical model.

Table 6.1-2 in both the 12-6-00 and 9-26-01 HGA Attainment SIPs contained a number of "gap measures" that were not included with the inventories input into the photochemical model. The non-road mobile "gap" strategies from the 12-6-00 and 9-26-01 HGA SIPs are:

- Accelerated Purchase of Tier 2/Tier 3 Diesel Equipment, which was replaced by the TERP Program (12.20 NO_X tpd and 1.86 VOC tpd);
- Airport Reductions (5.09 NO_X tpd);
- California Spark Ignition Engines (2.80 NO_X tpd and 7.58 VOC tpd);
- Gas-Fired Water Heaters, Small Boilers, and Process Heaters (0.50 NO_X tpd); and
- Stationary Diesel Engines (1.00 NO_X tpd).

The revised airport inventory figures which are included in the current photochemical modeling efforts already account for the 5.09 NO_X tpd airport reduction figure listed above. If this 5.09 NO_X tpd figure is excluded, these measures total 16.50 NO_X tpd and 9.44 VOC tpd. These benefits have also been included in the current 2007 area and non-road attainment demonstration inventory.

Summary of "Gap" Measures Included in Attainment Demonstration Inventory

Table 84 is an excerpt from Table 6.1-2 of the 9-26-01 HGA Attainment Demonstration SIP, which indicated the "Total Gap" was 96 NO_X tpd. Of this 96 NO_X tpd figure, approximately 40 tons were to be covered by identified strategies, with 56 NO_X tons defined as the "Remaining Gap to Fill".

Table 84. Summary of "Gap" Measures

Gap Measure	NO_X (tpd)	VOC (tpd)
Energy Efficiencies	3.57	
Accelerated Purchase of Tier 2/Tier 3 Diesel Equipment	12.20	1.86
Speed Limit Reduction	12.33	1.76
Airport Reductions	5.09	
California Spark-Ignition Engines	2.80	7.58
Vehicle Idling Restrictions	0.48	0.19
Gas-Fired Water Heaters, Small Boilers, Process Heaters	0.50	
Stationary Diesel Engines	1.06	
Transportation Control Measures (TCMs)		2.13
Total Gap Measures	39.03	13.52
Equivalent NO_X Reductions to 13.52 VOC tpd	1.14	
Remaining Gap to Fill	55.83	
Total Gap	96.00	

As detailed in Attachment 3, the on-road and non-road mobile control strategies listed in this table have been included in the current 2007 attainment demonstration inventory input into the photochemical model. The only strategy which has not been included is the Energy Efficiencies, which account for an estimated benefit of 3.57 NO_X tpd. If this figure is added to the remaining gap of 55.83 NO_X tpd, then the revised Remaining Gap to Fill becomes 59.40 tons of NO_X.

<u>Future Case Modeling Summary</u>

The future case tileplots in Figures 38 through 40 reflect the base 2007 emissions summarized in the above tables and pie charts, plus the additional SIP control measures detailed in the above attainment demonstration sections. Clean diesel fuel, TCAS gas, and California Large Spark Ignition rules were modeled using conventional control packets that applied to appropriate ASC codes and counties. The following measures: the 6.7 tpd TERP equivalent for Construct morning activity restrictions; the 12.61 t/d for VMEP; 12.2 t/d (1.86 t/d VOC) TERP equivalent for accelerated T2/T3 diesel equipment purchase; the 0.5 t/d for water heater rules; and 1.0 t/d stationary CI engines were applied by using 8-county-wide factors to remove the proper total tons across the non-road section of the modeling inventory. Figures 38 and 39 reflect the application of all the above control measures plus the commercial mowing activity restrictions.

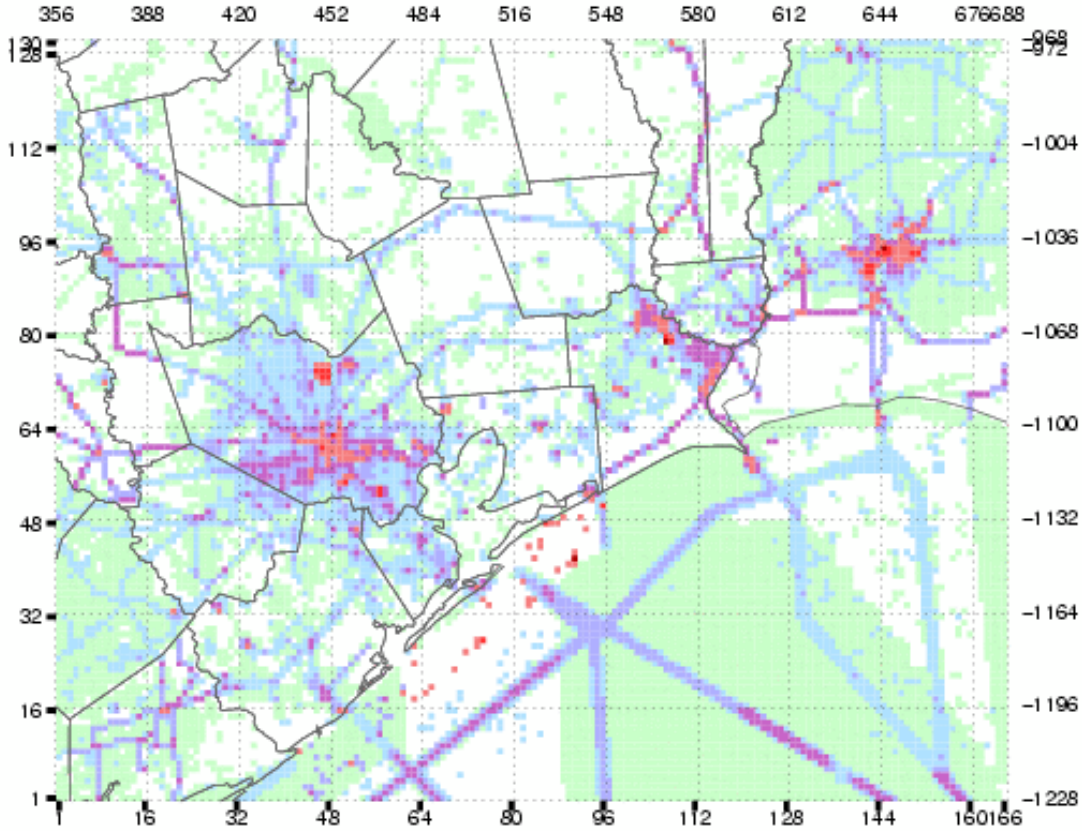
The cleaner gasoline, and start time delays do not affect the HGA 8-county emissions totals as cleaner gasoline applies to attainment counties, and the morning activity restrictions only affect the temporal distribution of the emissions.

The affect of the commercial lawn & garden start time delay can be seen by carefully comparing the temporal profiles of the 2000 and 2007 VOC plots.

Figure 38. 2007 Low-level Area and Non-Road NOx emissions tileplot

base07a Area Source NO_x Emissions, 08/31/2000

(2x2 Km Grid Cells)



Emissions Plotted

County	Tons/Day
Brazoria	14.47
Chambers	5.89
Fort Bend	10.39
Galveston	8.14
Harris	69.89
Liberty	5.38
Montgomery	6.63
Waller	4.13
HG SUBTOTAL:	124.92
Hardin	4.32
Jefferson	26.92
Orange	8.13
BPA SUBTOTAL:	39.37
MAP TOTAL:	367.11

Legend (Tons/Day)

< 0.00 | 0.00 – 0.01 | 0.01 – 0.05 | 0.05 – 0.10
0.10 – 0.20 | 0.20 – 0.50 | 0.50 – 1.00 | >= 1.00

Max: 1.336 t/d (537, –1145); Min: 0.000 t/d (473, –1181)

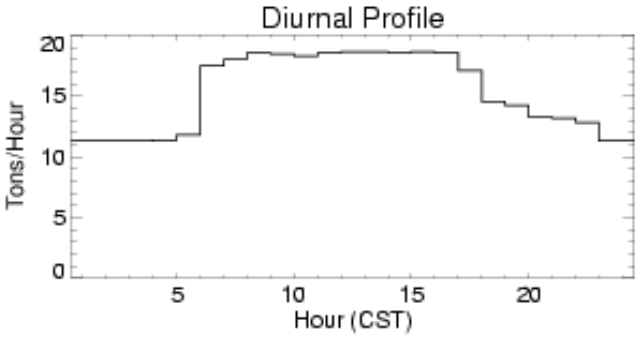
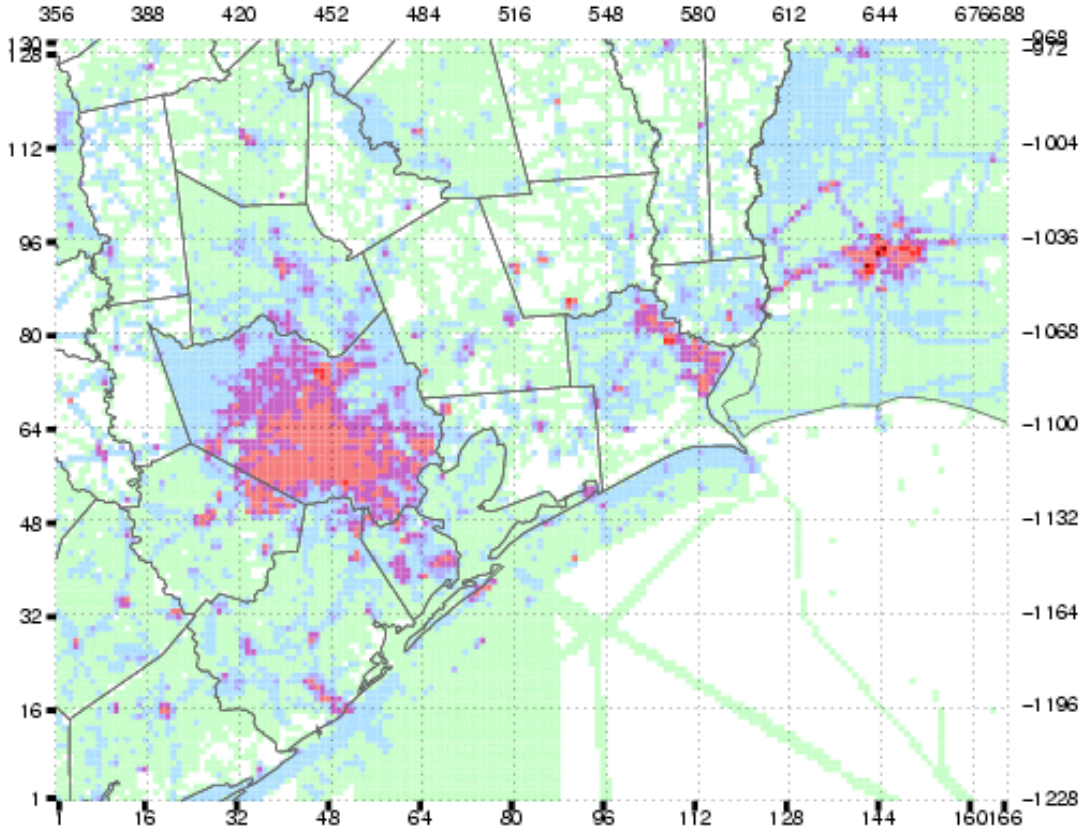


Figure 39. 2007 Low-level Area and Non-Road VOC emissions tileplot

base07a Area Source CB–IV HC Emissions, 08/31/2000



Emissions Plotted	
County	Tons/Day
Brazoria	18.41
Chambers	4.38
Fort Bend	16.49
Galveston	12.78
Harris	139.72
Liberty	6.11
Montgomery	13.95
Waller	2.17
HG SUBTOTAL:	214.01
Hardin	5.70
Jefferson	22.50
Orange	4.64
BPA SUBTOTAL:	32.84
MAP TOTAL:	374.16

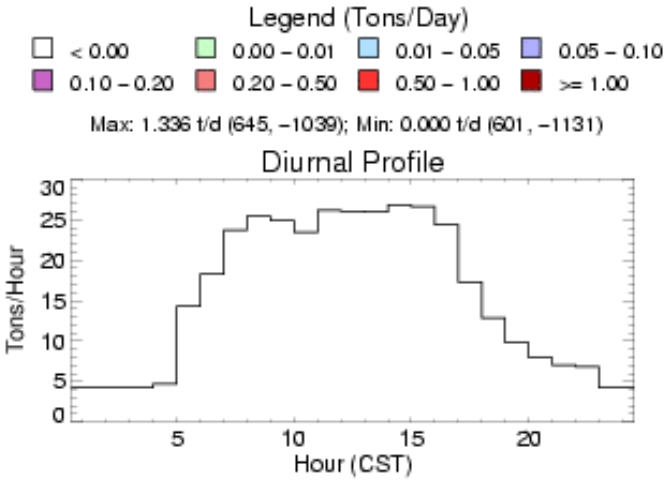
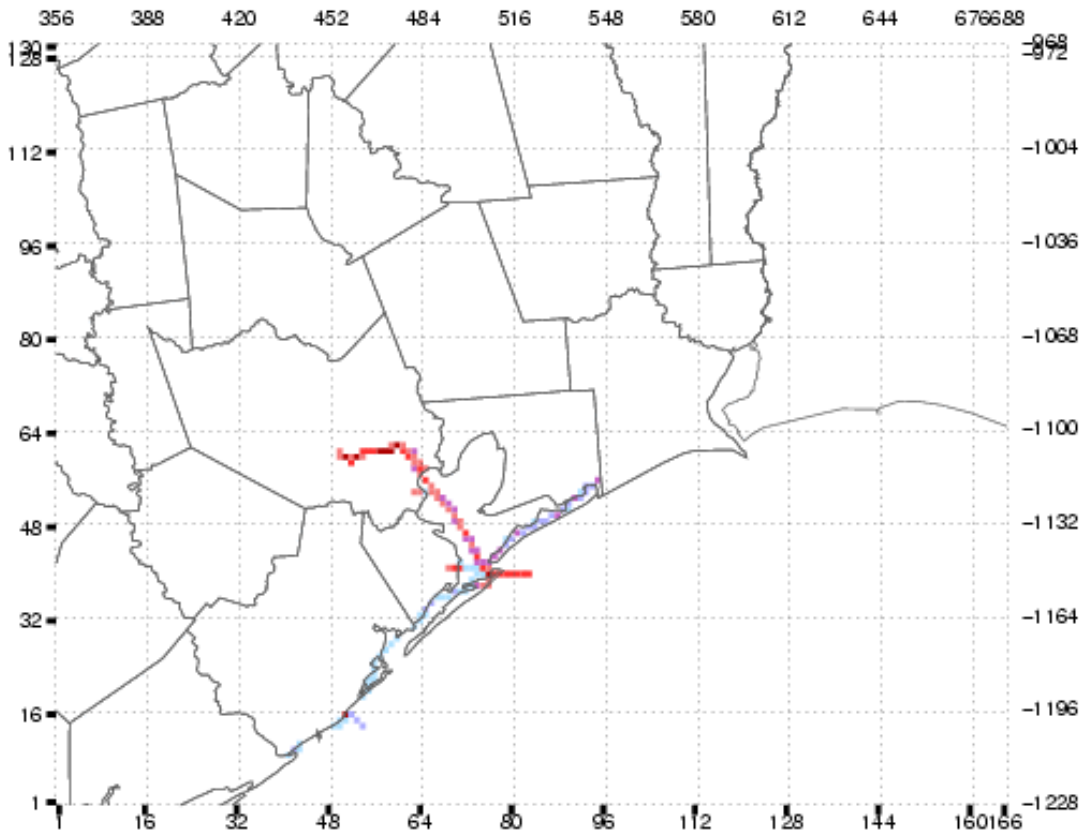


Figure 40. 2007 Elevated Shipping NOx emisisons

hg_2km_el_ships07 Elevated Ships NO_x Emissions, 08/31/1999

(2x2 Km Grid Cells)



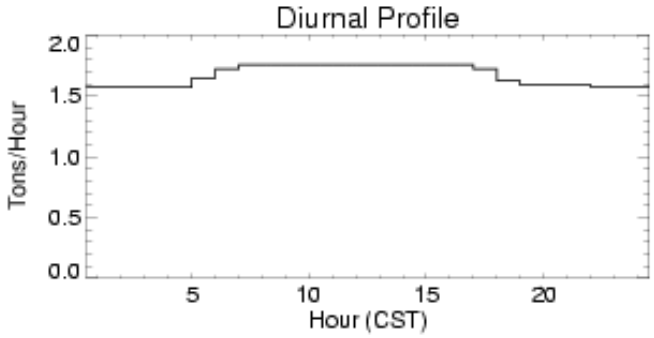
Emissions Plotted

County	Tons/Day
Brazoria	0.48
Chambers	0.00
Fort Bend	0.00
Galveston	11.75
Harris	19.19
Liberty	0.00
Montgomery	0.00
Waller	0.00
HG SUBTOTAL:	31.42
Hardin	0.00
Jefferson	0.00
Orange	0.00
BPA SUBTOTAL:	0.00
MAP TOTAL:	40.03

Legend (Tons/Day)

< 0.00 | 0.00 – 0.01 | 0.01 – 0.05 | 0.05 – 0.10
0.10 – 0.20 | 0.20 – 0.50 | 0.50 – 1.00 | >= 1.00

Max: 1.440 t/d (475, –1105); Min: 0.000 t/d (357, –1227)



Improvements planned for the next phase modeling:

1. New 12km East Texas Regional inventory: The model runs to date have used Environ CAMx-ready files for the 12-km and 36-km course grids. The 4-km grid emissions use essentially all new data. New LCP surrogates are available for all of East Texas and these surrogates and the latest emissions data will be processed for the 12-km domain.

2. Airport (update and elevate): The airport emissions from the TCEQ Periodic Inventory contractor seemed low compared to previous Dallas modeling. We have contacted HGA airport staff and have improved aircraft emissions data (an increase from about 5 tons/day NO_X to about 8 tons/day) for the 8 counties in the HGA area. We are hoping to get information on flight paths and plan to elevated the aircraft approach and take-off, as was done for DFW modeling, for both Houston Intercontinental and Hobby airports.

3. Animate Elevated Ships: A contract to track the movements of large ships during the August 2000 episode was completed. We plan to incorporate the day specific and spatially (by hour) varying emissions to simulate ship movements and place emissions in from each large ship in the correct location by hour as time permits.

4.Correct the projections for 2000 and 2007 for: lawn and garden; oil field non-road equipment; and recreational boating.

5. Project shipping emissions from 1997 to 2000: The shipping contract from previous SIP modeling provided shipping emissions for 1993, 1997 (study base year), and 2007. The 1997 data was used in the 2000 simulations. A reasonable projection will be developed to improve the 2000 shipping. Project 3 of simulating ship movements will supercede this projection, at least for large vessels.

6. Fix abandoned rail lines: Several rail lines in our Railroad surrogate have been identified as abandoned; again, we plan to fix this in the next modeling phase. In a longer term project we hope to have a railway surrogate reflecting freight traffic density, as well as switcher locomotives and switching yards modeled separately

7. New GIS spatial data has recently been obtained from HGAC (the local MPO) that provides sub-county population estimates from 1995 to at least 2015 for numerous Regional Analysis Zones (RAZ). TCEQ will convert these to our modeling grid for use as an improved spatial surrogate. It is hoped that construction some activity can be distributed in proportion to population change in each RAZ in the year to be modeled. An example of this method is to look at the difference in population between 2005 and 2010, and use difference to estimate 2007 construction activity. The greater the population change, the greater the percentage of county construction emissions to be placed in the given RAZ.

Biogenics Emissions Inventory Development

Biogenics Emissions Inventory Development

Introduction

Biogenic emissions can play a crucial role in the ozone chemistry of an urban area, so it is important to accurately estimate their magnitude. During the past five years, TCEQ has directly commissioned seven studies that have directly enhanced the biogenic emissions estimates within Texas. These studies have developed new land use, leaf biomass density, and photosynthetically active solar radiation databases, and have led to the development of a new biogenic emissions modeling platform, Globeis, that incorporates the latest science available.

Biogenic emissions model

TCEQ uses the Globeis biogenic emissions model (Yarwood et al., 2001; Yarwood et al., 2000). Globeis was originally developed by Alex Guenther at the National Center for Atmospheric Research (Guenther et al., 1995; Guenther et al., 1997; Guenther et al., 1999). Guenther et al. developed the original algorithms for the BEIS family of biogenic emissions models (Guenther et al., 1993; Geron et al., 1994), and developed Globeis originally as a research-grade model. TCEQ commissioned Guenther and the model developers at Environ in 1999 to adapt this model for photochemical grid modeling, so that the latest developments in the field of biogenic emissions could be swiftly incorporated into TCEQ's ozone episode modeling. The current version is Globeis 2.1. A new version of Globeis, version 3.0, has been commissioned by TCEQ and is undergoing testing. Globeis 3.0 has several new options, including the ability to account for the effects of drought on emission potential, the effects of leaf loss due to drought, and the effects of antecedent temperature. It will also have a new canopy energy balance model; older versions of Globeis assumed that air temperature and leaf temperature were identical, whereas Globeis 3.0 will calculate leaf temperatures in a physically realistic manner, based upon air temperature, solar radiation, humidity, and wind speed. TCEQ will evaluate Globeis 3.0, and will determine which new modules, if any, will be used in calculating a base case biogenic inventory. Even if none of the new modules are used in base case calculations, they can be used to calculate alternative inventories for use in sensitivity analyses. See Attachment 3-6 to this document for a report, *Environ/NCAR , Final Report, Biogenic VOC Emission Estimates for the TexAQS 2000 Emission Inventory: Estimating Emissions During Periods of Drought and Prolonged High Temperatures and Developing GloBEIS3, April 2002*

Chemical speciation of biogenic emissions

The chemical speciation of Globeis2.1 is the same as Globeis2 used in the December 2000 modeling (see Table 85)

Table 85. Comparison of factors used by Globeis2.1 to convert monoterpenes and other VOCs to Carbon Bond IV classes (units are moles/kg)

CBIV class	Total monoterpenes	Other Non-terpenoid VOCs
OLE	7.4	4.3
PAR	53.2	12.8
XYL	0.329	0
FORM	0	1.2
ALD2	6.2	3
ETH	0	2.1
MEOH	0	45
ETOH	0	2.1
NR	0.311	1.29

Land use/land cover and vegetation data

The land use/land cover and vegetation data are derived from the studies described in Wiedinmyer et al., 2001, Kinnee et al., 1997, and Mendoza-Dominguez et al., 2000. These data have not changed since the last phase of modeling. TCEQ commissioned the Wiedinmyer et al. studies specifically for the purpose of gathering data to estimate biogenic emissions in Texas. For more information, see Wiedinmyer et al., 2001, and the previous SIP revision, Appendix X. New LULC and leaf biomass data are being developed for the Houston area through the Texas GREEN project, a joint effort of TCEQ, the Texas Forest Service, the USDA Forest Service, and the Houston Advanced Research Center. However, these data will not be available until January 2003.

Temperature data

Biogenic emissions are sensitive to ambient temperature. The emission factors within Globeis vary with temperature, so spatially- and temporally-resolved temperature fields are an essential input to the model. Since Globeis is a stand-alone model with no direct coupling to the photochemical or meteorological models, it is possible to choose from several different methods of estimating hourly temperature fields.

Two methods of acquiring hourly temperature fields were considered. The first was to extract temperature fields from the output of the mesoscale meteorological model MM5. In previous modeling exercises, TCEQ has chosen not to use the output of a meteorological model, because the fields are often biased low during the middle of the day. Since biogenic emissions are usually the highest at that time, it is crucial for the temperature fields to be realistic. It would be appropriate to use MM5 fields for biogenics modeling only if the temperature fields are not biased during the most critical part of the day.

Another method is interpolation of measured temperatures. This method has the advantage of using actual data, but is limited by the uneven coverage of measurement sites. The measurements are

usually concentrated within the cities, but the highest emitting forests are usually rural. If urban temperatures are interpolated into the rural areas, the resultant temperature fields may be biased high, due to the urban heat island effect. Another problem is the presence of the Gulf of Mexico. The interpolation algorithms are unaware that temperatures over the Gulf will not vary as much during the day as they do over land, and will generally be cooler during the day and warmer at night than the land. Therefore, in order to create a realistic temperature field by interpolation, one must acquire data from rural sites and from sites along the Gulf Coast and in the Gulf.

TCEQ acquired temperature data from several data sources, listed in Table 86. Data from most of the sites were used in the interpolation, but data from a few sites were reserved to compare to the interpolated fields. To address the problem of interpolating rural temperatures, TCEQ obtained temperature data from a monitoring network that is specifically designed to track rural weather–the Crop Weather Program for South Texas, operated by Texas A&M University. Most of these sites are located in the Coastal Bend area, between Houston and Kingsville. To address the problem of Gulf and coastal temperatures, TCEQ also obtained oceanographic data from three sources: the Division of Nearshore Research at Texas A&M Corpus Christi, the National Data Buoy Center, and the Texas Automated Buoy System.

Ambient temperature data was interpolated for each hour of data to create hourly temperature fields. The interpolation scheme used was kriging with a default linear variogram, as implemented in the Surfer 7.0 software (Golden Software, 1999). Figure 41 depicts the results.

Photosynthetically Active Solar Radiation

TCEQ uses a new method of developing solar radiation fields for biogenic emissions modeling. This method relies upon a model that uses GOES satellite imagery of cloud fields to calculate ground-level solar radiation levels (Pinker and Laszlo, 1992, see Figure 43). The fields developed by this model can be compared to ground-level solar radiation measurements to ensure that the fields are realistic. Data at a coarse resolution (0.5E latitude x 0.5E longitude) can be downloaded routinely from the GCIP/SRB website. The coarse resolution is sufficient for regional scale modeling (i.e., 36 km x 36 km grid cells), but is less appropriate for urban-scale modeling. Therefore, TCEQ commissioned Rachel Pinker of the University of Maryland to develop PAR fields at 4 km x 4 km for the August/September 2000 ozone episode (see Figure 42). Those data have been received by TCEQ as of May 2002, but are still undergoing review, and will be included in subsequent modeling.

Emissions summary

The results of biogenic emissions modeling for 22 August - 1 September 2000 are summarized in Figure 44. Figures 45 and 46 show the spatial variation of biogenic VOC and NO_X emissions for 30 August. Figure 44 shows that the emissions steadily increase over the course of the episode, reflecting the steady increase in temperature and insolation. Note, however, that no drought effects have been incorporated into the biogenics modeling at this time. TCEQ is still testing Globeis 3,

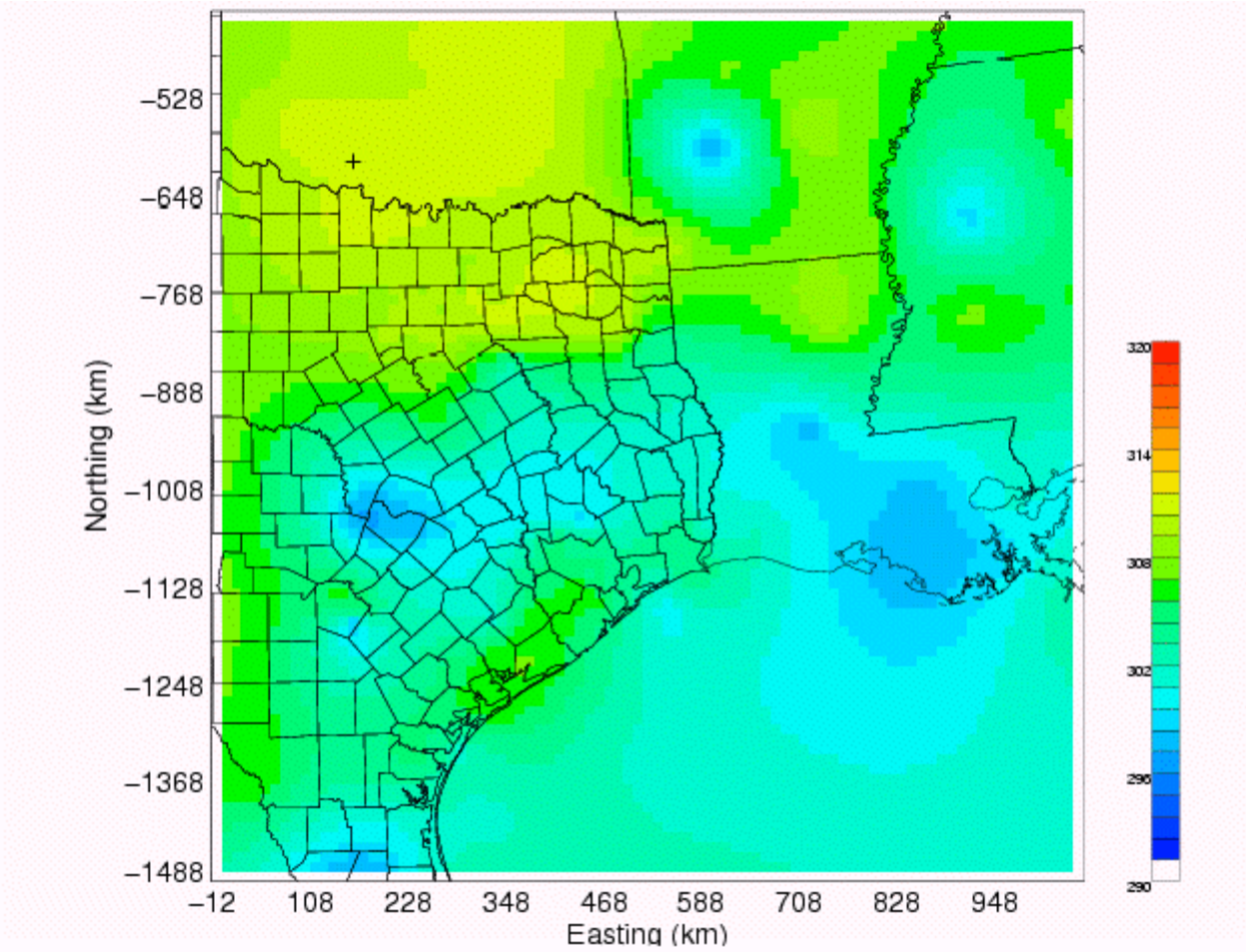
which includes some adjustments to emissions due to the stresses of drought and high temperature. These adjustments may affect the biogenic emissions estimated by the new model, but until it has been adequately tested and implemented, it is not known whether they will increase or decrease.

Table 86. Sources of temperature and solar radiation data

Data source	Web reference	Responsible Agency
GEWEX Continental Scale International Project (GCIP), Surface Radiation Budget (SRB) Data	http://metosrv2.umd.edu/~srb/gcip/cgi-bin/historic.cgi?auth=no	NOAA/NESDIS and University of Maryland
Automated Surface Observing System	http://205.156.54.206/asos/index.html	NOAA, FAA
Aerometric Information Retrieval System (AIRS)	http://www.epa.gov/airs/	EPA, TCEQ, and other state air quality agencies
Crop Weather Program (CWP) for South Texas	http://cwp.tamu.edu/	Texas A&M Corpus Christi
Conrad Blucher Institute, Division of Nearshore Research	http://dnr.cbi.tamucc.edu/	Texas A&M Corpus Christi
National Data Buoy Center	http://www.ndbc.noaa.gov/	NOAA
Texas Automated Buoy System	http://tabs.gerg.tamu.edu/Tglo/	TAMU, Texas General Land Office

The field in Figure 41 was generated by kriging surface temperature data using Surfer 7 software. Units are degrees Kelvin (i.e., Celsius + 273). Note the areas of lower temperature in southeastern Louisiana and central Texas.

Figure 41. Temperature Field for 22August 2000 at 1500 CST



The field illustrated in Figure 42 was generated from GOES satellite data using the method of Pinker and Laszlo, 1992. Units are expressed in watts/m^2. The areas of lower temperature in Figure 41 correspond to areas of low photosynthetically active solar radiation.

Figure 42. Photosynthetically Active Solar Radiation Field for 22 August 2000, 1500 CST

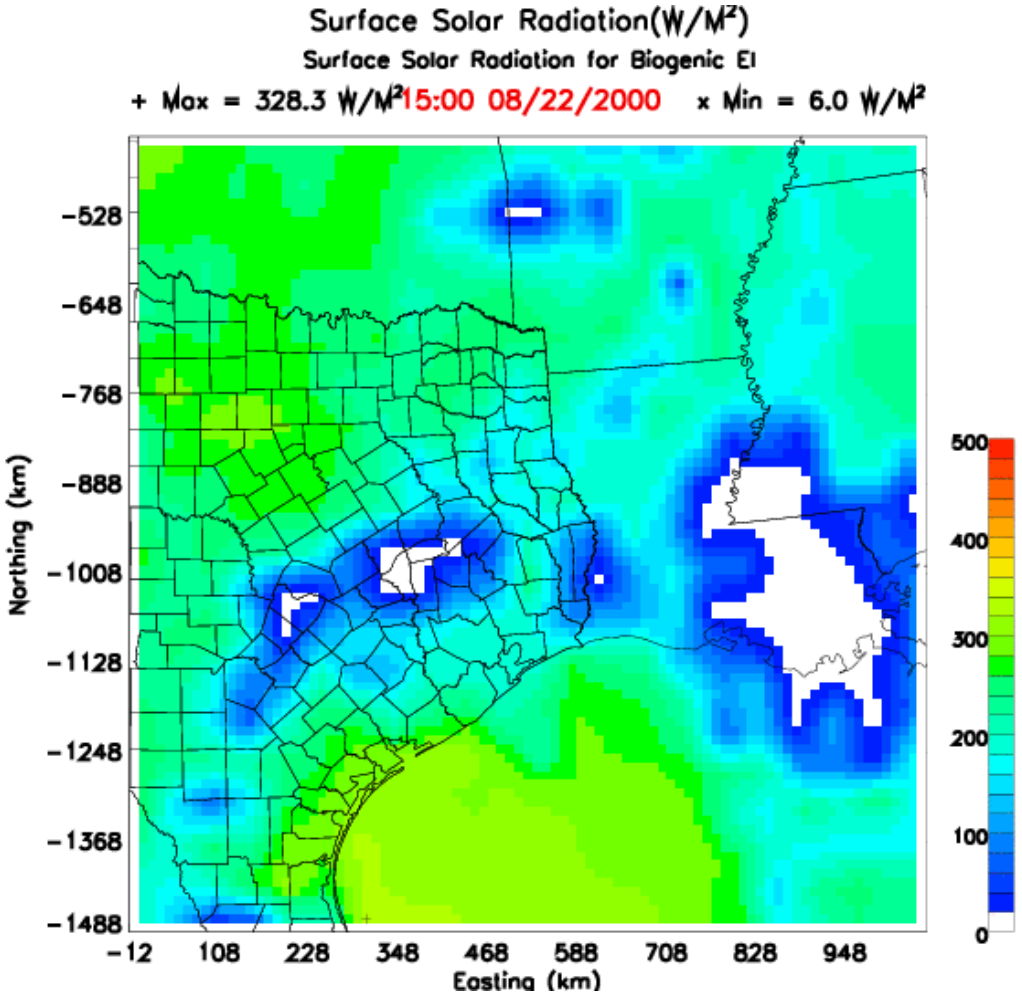


Figure 43 is a GOES-8 satellite image obtained from http://www.met.tamu.edu/t2k/TCEQ/metdata.html . Note that the locations of clouds correspond well with areas of low temperature and solar radiation in Figures 41 and 42.

Figure 43. GOES-8 Satellite Image for 22 August 2000, 1515 CST

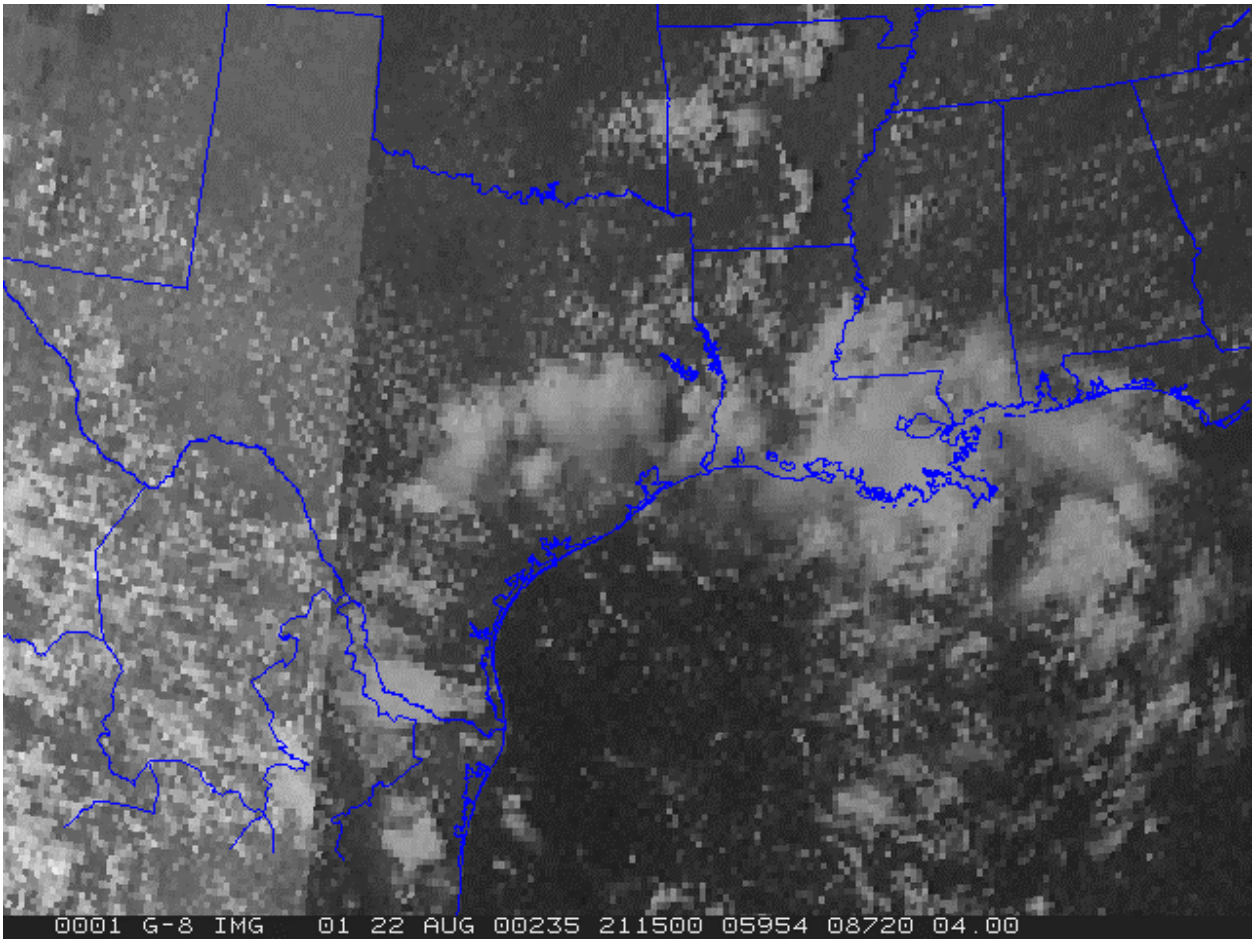


Figure 44 depicts tons of CB-IV hydrocarbons emitted by vegetation on each day of the episode.

Figure 44. Daily Variation of Biogenic VOC Emissions from 22 August - 1 September 2000 for the 8-county HGA

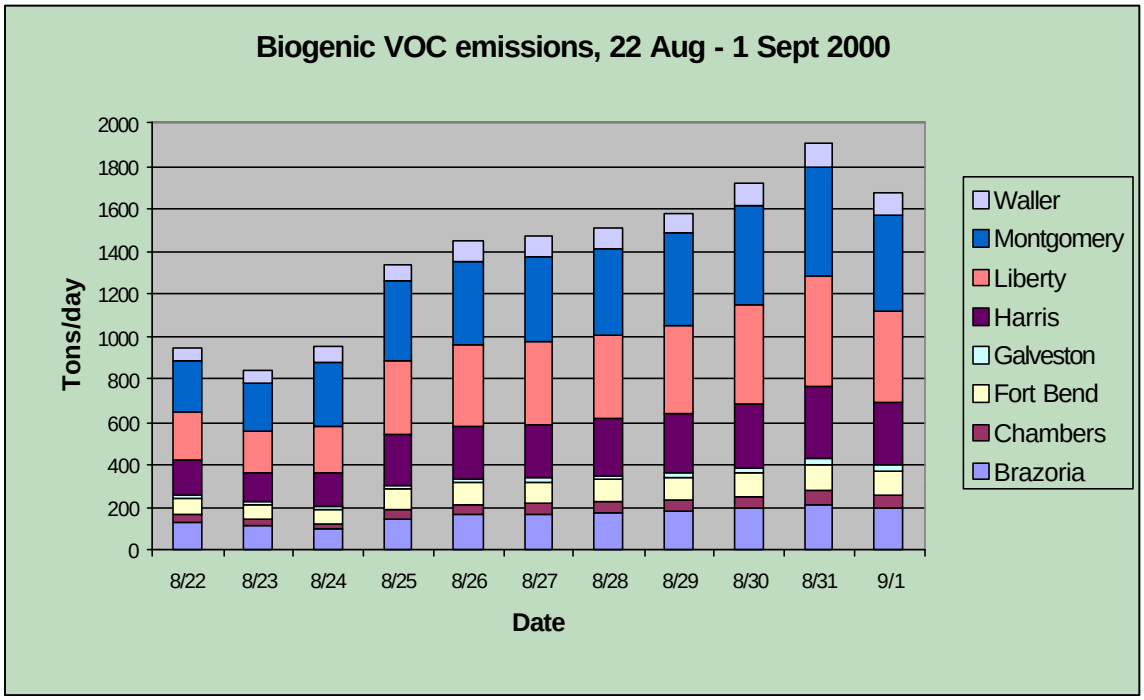


Figure 45. Spatial distribution of biogenic VOC emissions for the 4-km modeling domain

hgbpa_04km Biogenic CB–IV HC Emissions, 08/30/2000

(4x4 Km Grid Cells)

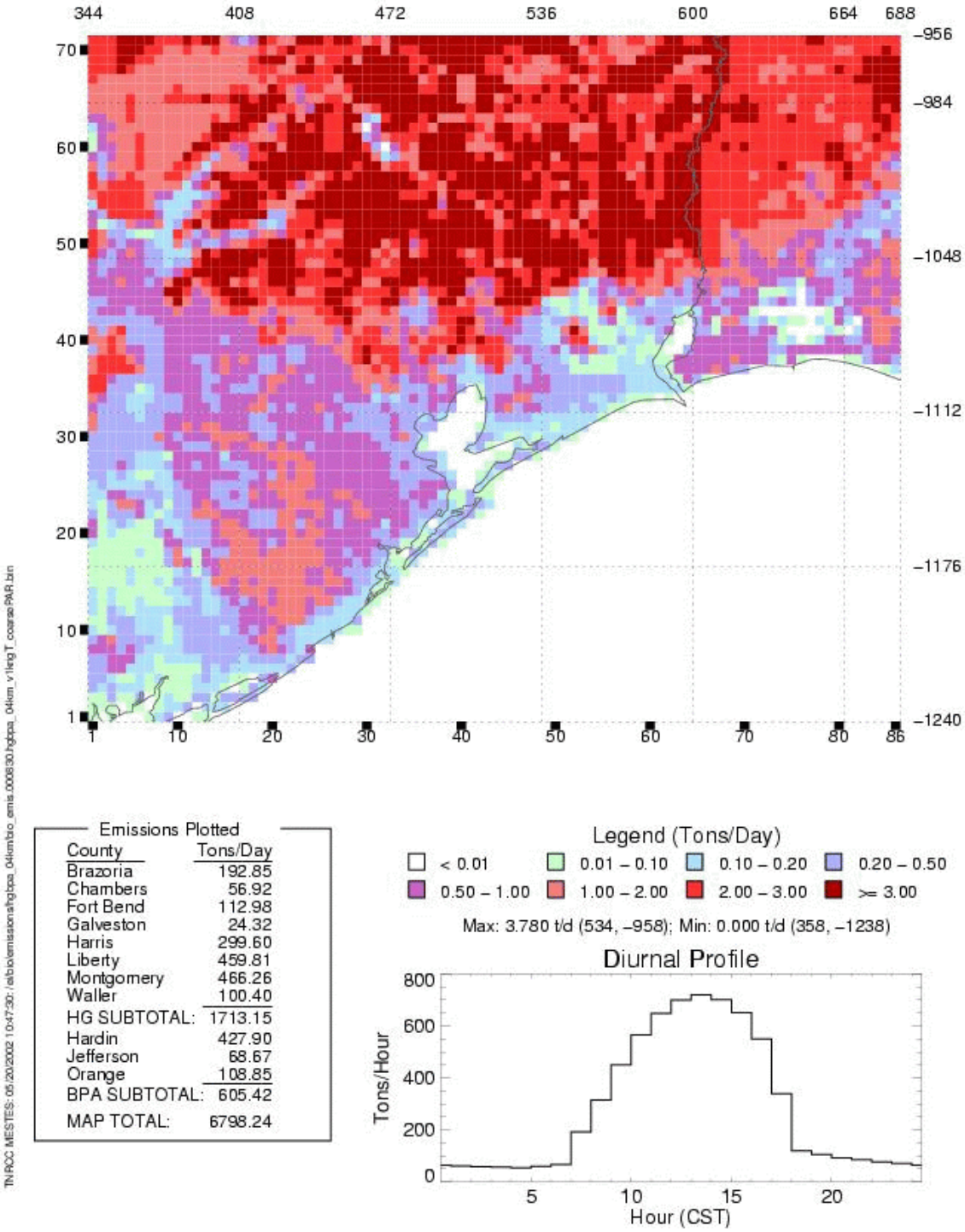
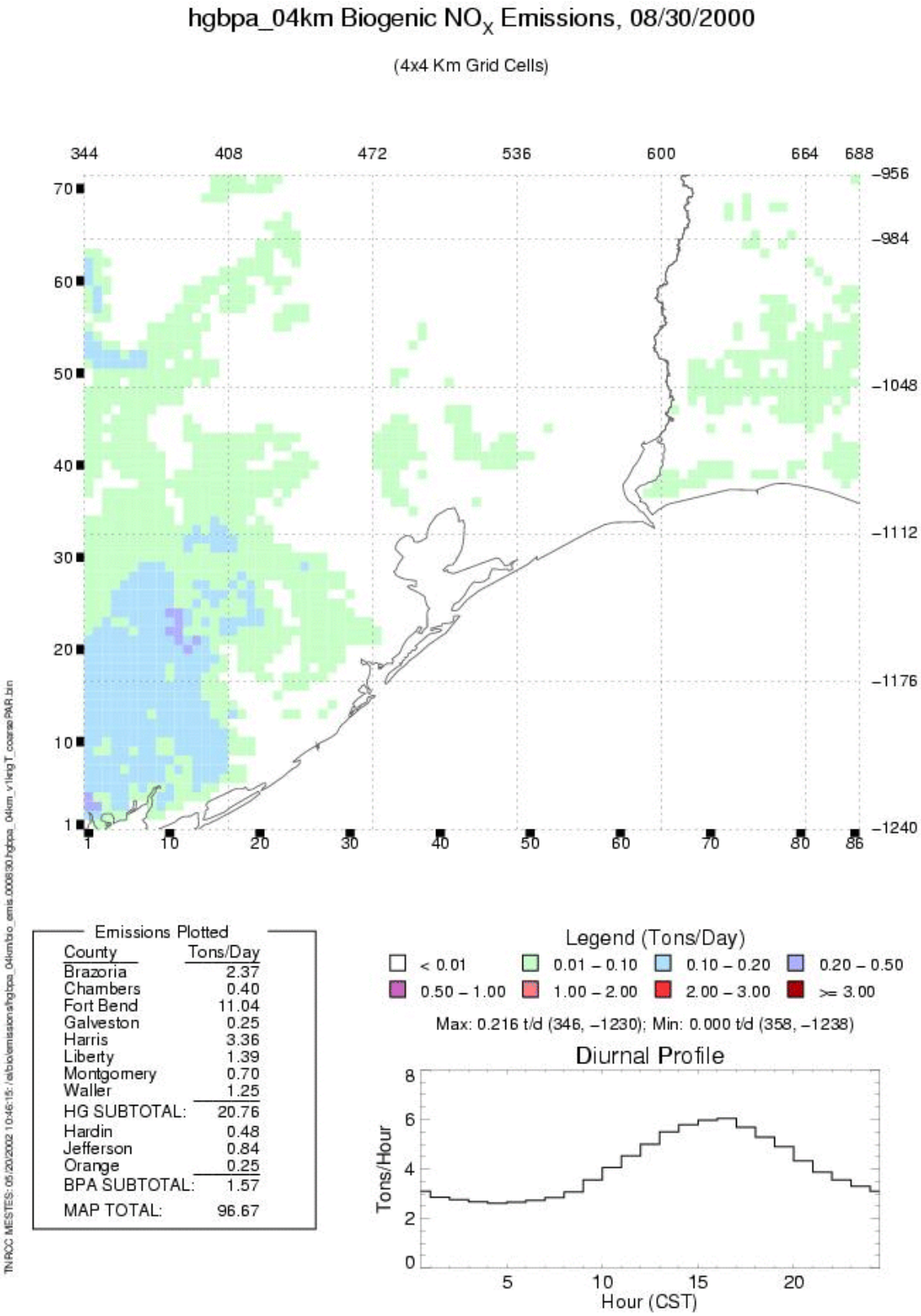


Figure 46. Spatial distribution of biogenic NO_X emissions for the 4-km domain



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Overall Emissions Summary

Overall Emissions Summary

Table 87. Summary of the Base Case emissions in the eight HGA nonattainment counties, Aug. 30, 2000

Emissions category		Emissions (tons/day)	
		NO_X	VOC[1]
On-road mobile		246	156
Area/Nonroad mobile		193	241
Point	unadjusted (Base4a.regular)	490	178
	adjusted (Base4a.pt_o2n2_070pbl)	490	327
Biogenic		21	1713
8-County Total	unadjusted (Base4a.regular)	950	2286
	adjusted (Base4a.pt_o2n2_070pbl)	950	2435

[1] Note that the VOC values reported here are the Carbon-Bond IV hydrocarbon masses used by CAMx and differ slightly from the true masses of the emitted species.

Table 88. Summary of the 2007 Future Case emissions in the eight HGA nonattainment counties, Aug. 30, 2000

Emissions category		Emissions (tons/day)	
		NO_X	VOC[1]
On-road mobile		129	86
Area/Nonroad mobile		156	215
Point	unadjusted (fy07b.regular)	87	182
	adjusted (fy07b.pt_o2n2_070pbl)	87	331
Biogenic		21	1713
8-County Total	unadjusted (fy07b.regular)	393	2196
	adjusted (fy07b.pt_o2n2_070pbl)	393	2345

[1] Note that the VOC values reported here are the Carbon-Bond IV hydrocarbon masses used by CAMx and differ slightly from the actual emissions.

ATTACHMENTS TO Attachment 3

(Emissions Inventory Development and Modeling for the August 25-September 1, 2000 Episode)

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(Emissions Inventory Development and Modeling for the August 25-September 1, 2000 Episode)

Attachment 3-1 - *TTI, Texas Air Quality Study (TxAQS) On-Road Mobile Source Emissions Estimation, August 2001*

Attachment 3-2 - *TTI, 2000 On-Road Mobile Source Episode Specific Emissions Inventories for the Houston-Galveston Ozone Nonattainment Area, March 2002*

Attachment 3-3 - *TTI, 2007 On-Road Mobile Source Episode Specific Emissions Inventories for the Houston-Galveston Ozone Nonattainment Area, March 2002*

Attachment 3-4 - *TCEQ, Special Inventory Development*

Attachment 3-5 - *Environ/PES speciation reports*

Attachment 3-6 - *Environ/NCAR , Final Report, Biogenic VOC Emission Estimates for the TexAQS 2000 Emission Inventory: Estimating Emissions During Periods of Drought and Prolonged High Temperatures and Developing GloBEIS3, April 2002*. Also available from http://www.tnrcc.state.tx.us/air/aqp/airquality_contracts.html#ei05

Attachment 3-7 - *TTI, 2000 On-Road Mobile Source Emissions Inventories for the Beaumont-Port Arthur Ozone Nonattainment Area, August 2002*

Attachment 3-8 - *TTI, 2007 On-Road Mobile Source Emissions Inventories for the Beaumont-Port Arthur Ozone Nonattainment Area, August 2002*

Attachment 3-9 - *DRI,* excerpt from *Big Bend Regional Aerosol and Visibility Observational (BRAVO) Study Emissions Inventory, November 16, 2001*