Eastern Research Group, Inc.

SAMPLING AND LABORATORY ANALYSIS OF RETAIL GASOLINE AND DIESEL FUEL FOR SELECTED TEXAS CITIES – SUMMER 2011

FINAL REPORT

Prepared for:

Texas Commission of Environmental Quality (TCEQ)

August 31, 2011

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1. Project Overview

The purpose of this Work Order was to develop physical properties and speciation profiles, and to report laboratory test results for samples of gasoline and diesel fuel collected from retail stations across Texas. Testing of various properties was completed in an approved laboratory which involved speciation of volatile organic compounds (VOC) including oxygenates, determination of Reid vapor pressure (RVP), and estimation of sulfur in gasoline, and quantification of aromatics, cetane and sulfur in diesel fuel.

In order to maintain a high confidence level in the fuel parameters used in the development of on-road emission inventories, trend analysis and control strategy analysis, the TCEQ has undertaken a program to periodically collect and analyze fuel samples. The data will ensure the accuracy of local specific fuel information and also provide the best data available to be used for analysis to support Texas State Implementation Plan (SIP) and control strategy development.

Samples of regular, mid-grade, and premium gasoline, and diesel fuel were taken from 92 retail gas stations, from the 25 areas across the state. The 25 areas corresponded to the 25 Texas Department of Transportation (TxDOT) Districts.

The following summarizes the results of this study, including sample collection and lab analysis, the development of fuel parameter files for use in EPA's MOVES emission factor model, based on this data. Detailed electronic files with supporting data and analysis are provided separately on CD.

2. Site Selection

In this task ERG developed a fuel sampling plan to be implemented by Southwest Research Institute (SwRI) during the summer of 2011. ERG obtained background information to help assess the geographic and temporal boundaries for sampling at retail stations. This information included:

- The geographic boundaries of the 25 TxDOT districts throughout the state;
- Surrogates for estimating sales volumes from readily available data, including underground storage tank numbers and sizes (obtained from the TCEQ Petroleum Storage Tank Database).

ERG used this information to develop the strata for the fuel sampling task, specifying the areas within the districts and station sizes.

2.1 Fuel Sampling Plan and Site Selection

A Sampling Plan was developed to specify the number of stations per area, the total number of samples (including number of diesel and gas samples, across gas grades), and the allocation of stations across the different areas. The sampling plan specifications included the following:

- Each fuel sampling region has a minimum of three sample sites;
- Both diesel and gasoline samples are to be collected at each location;
- Regular, mid-grade, and premium gasoline grades are to be sampled; and
- Gasoline and diesel samples are to be collected separately (no compositing).

This approach required a lab test of every sample. As a result, it was more costly and limited the total number of stations that could be sampled. However, it did provide an indication of differences within areas that would not be discernable using a compositing approach. Specifically, this approach enabled the determination of minimum, maximum, and average fuel parameter values, instead of just averages for each region. This characterization is more consistent with MOVES modeling, in that it will allow the TCEQ to specify maximum and average parameter values for model inputs, such as fuel sulfur levels.

Table 1 summarizes the number of stations to be initially sampled for each TxDOT Region. At each station, three gasoline samples and one diesel sample were obtained.

Table 1. Initial Sampling Plan Summary Table

TxDOT District	Number of Stations	Area Designation
Abilene	3	Attainment Area
Amarillo	3	Attainment Area
Atlanta	3	Attainment Area
Austin	5	Attainment Area (Former Early Action Compact Area)
Beaumont	5	Beaumont-Port Arthur Nonattainment Area
Brownwood	3	Attainment Area
Bryan	3	Attainment Area
Childress	3	Attainment Area
Corpus Christi	4	Corpus Christi Near Nonattainment Area
Dallas	4	Dallas-Ft. Worth Nonattainment Area
El Paso	4	Attainment Area (Maintenance)
Fort Worth	4	Dallas-Ft. Worth Nonattainment Area
Houston	7*	Houston-Galveston-Brazoria Nonattainment Area
Laredo	3	Attainment Area
Lubbock	3	Attainment Area
Lufkin	3	Attainment Area
Odessa	3	Attainment Area
Paris	3	Attainment Area
Pharr	3	Attainment Area
San Angelo	3	Attainment Area
San Antonio	5	San Antonio Early Action Compact Area
Tyler	5	Northeast Texas Early Action Compact Area
Waco	3	Attainment Area
Wichita Falls	3	Attainment Area
Yoakum	4	Victoria Near Nonattainment Area
Total	92	

* These stations were sampled a second time later in the summer, as described below.

In order to identify specific fuel stations for sampling, the latest Petroleum Storage Tank (PST) Database was obtained from the TCEQ, consisting of several large text files.[1] The following data were selected from these files.

- Owner information (name, contact, enforcement actions, etc.);
- Facility information (location, number of tanks, facility type);
- Tank information (tank size and status [active or inactive]); and
- Composition information (tank-specific information including fuel type).

[1] Data was obtained from the TCEQ PST Registration Database (http://www.tceq.state.tx.us/permitting/registration/pst/pst_query.html), downloaded 2-4-11.

These files were merged into one master file for site selection purposes. Next, only retail establishments were selected where the status was "active" within the PST database. It should be noted that retail service stations are only one type of facility that can have tanks; other facility types include bulk fuel terminals, state agency fleet tanks, municipal fleet tanks, etc. The next step was to include only stations that sell both gasoline and diesel. Also, to ensure that the larger service stations will be sampled – size being used as a surrogate for fuel throughput, since actual throughput data is only available at the wholesale level – the list was narrowed down by extracting only those facilities that had tank capacities greater than or equal to 10,000 gallons. Furthermore, ERG filtered out the stations with enforcement actions against them from the TCEQ. Each of the retail stations remaining on the list was then assigned to the appropriate TxDOT district based on county designation.

From this master list, ERG selected primary and alternate sampling candidates. The alternate sampling candidates were selected in the event that sampling at any primary sampling candidate was not possible (i.e., out of business, temporarily closed, or otherwise inaccessible). As indicated in the initial sampling plan presented in Table 1, three to seven primary sampling candidates were selected for each TxDOT district. In addition, another three to seven alternate sampling candidates were also selected for each TxDOT district. The primary and alternate sampling candidates were selected using a weighted random sample where weights were applied to each station that were directly proportional to the total number of gasoline plus diesel tanks listed for each station in the PST database. Random numbers between 0 and 1 were then assigned to each station, and multiplied by the weighting factor. The resulting list was then sorted by weighted random number in descending order for station selection. In a few instances, stations located in isolated rural counties were replaced with another more accessible station in the same TxDOT district, in order to reduce sample collection costs and time. The final list of primary sampling candidates is presented in Attachment 1.

In addition to the initial round of sampling, a second round of testing was conducted in an attempt to obtain a better understanding of temporal variability of fuel composition within a region. For a small subset of fueling stations (the seven located in the Houston area), SwRI conducted a second round of sampling, ensuring that enough time has elapsed for complete tank turnover (at least 4 weeks). This second round of sampling was intended to make a preliminary assessment of the temporal variability of fuel parameters at the station level.

3. Sampling and Laboratory Analysis

3.1.1 Objective

The following describes the sampling protocol and laboratory test results for the study. Under this project, SwRI provided containers and packaging, gasoline and diesel sample acquisition services from retail station pumps, shipping, sample handling and testing for summer fuels in 2011. Service station locations were identified by ERG, as described above.

3.2 Retail Station and Sample Collection and Handling Procedures

Independent contractors (IC) working with SwRI acquired fuel samples from retail stations. Each IC received written instructions, service station sampling procedures, sample containers, and shipping instructions. All contractors were instructed on retail station sample acquisition with special emphasis on sample handling and safe disposal of flushed gasoline.

SwRI used U.S. Department of Transportation (DOT) and International Air Transport Association (IATA) approved fuel sample containers and shipping cartons. Each carton held four aluminum containers. Boxes are assembled at SwRI by trained staff, and all appropriate shipping materials are provided to IC along with DHL-approved instructions for shipment of hazardous materials.

The containers were delivered cleaned and dried to the independent contractors. IC purged three gallons of gasoline product through the pump nozzle before obtaining a sample, or purged ½ gallon of the appropriate fuel immediately after the appropriate grade was purchased by the previous customer. When possible the temperature of the flushed sample was recorded. Immediately after the fuel was flushed from the pump, IC attached a spacer, if needed, to the pump nozzle. The nozzle extension was inserted into the sample container. The pump nozzle was then inserted into the extension with slot over the air bleed hole. The sample container was slowly filled through the nozzle extension to 70 to 85% full. The nozzle extension was removed. The seal and cap were inserted in the sample container at once. Checks were performed for leaks and the sample was prepared for air shipment. Contractors also recorded the ground cover type around the pumps at each station.

When diesel samples were acquired, the independent contractors filled the sample container slowly to 70 to 85% full. The seal and cap were inserted into the sample container at once. Checks for leaks were performed and then the sample was prepared for air shipment.

SwRI used DHL for sample shipment return to SwRI. Members of the SwRI shipping and receiving team meet regularly with DHL and attend IATA and International Civil Aviation Association (ICAO) hazardous materials shipping and handling training sessions to keep abreast of current regulations. All samples were chilled.

3.3 Sample Locations and Grades of Fuel

Four fuel samples were acquired at each station visited, including three grades of gasoline and one diesel sample. Sampling took place at a minimum of three retail stations for each of the 25 districts of the state, as discussed above. Attachment 2 contains the listing of all samples acquired, date of sampling, location name, brand of fuel, address, gasoline grades acquired, posted octane, temperature of flushed sample and pad cover of sampling location.

3.4 Laboratory Testing

All testing was accomplished in the PPRD laboratories of the Automotive Products and Emissions Research Division at Southwest Research Institute. The facilities are located at 6220 Culebra Road, San Antonio, Texas.

3.4.1 Gasoline Testing

Gasoline testing was performed on individual regular, mid-grade, and premium gasoline samples. There was no compositing of samples, as discussed above. Key testing methods included:

- Reid vapor pressure (ASTM D5191-10b)
- Sulfur (ASTM D2622-10)
- Distillation (ASTM D86-10a)
- Benzene (ASTM D3606-EPA Method)
- Total aromatics and olefins (ASTM D1319-10)
- Oxygenates (ASTM D5599-00(2010))
- Detailed Hydrocarbon Analysis (ASTM D6729-04-(2009))

Uncertainty values are listed in Table 2. Test results are provided in Attachment 2.

Table 2. Uncertainty Estimates on Composite Data Results

Property	Test Method	Level Measured	Uncertainty
Flash point	D93	118.4 F	2.6
Distillation	D86	Initial Boiling Point	2.54
Distillation	D86	10%	2.36
Distillation	D86	50%	1.96
Distillation	D86	90%	1.57

Property	Test Method	Level Measured	Uncertainty
Distillation	D86	Final Boiling Point	5.11
Cetane number	D 613	38.51-55.69	2.7
API	D 287	23.71-65.6	0.2
Aromatics	D 1319	30%	0.54
Saturates	D 1319	60%	0.59
Olefins	D 1319	10%	0.64
Relative Density	D 1298	0.71876 - 0.96492	0.001308
Sulfur	D 2622	450 ppm	11.3
Sulfur	D 2622	50 ppm	4.2
Poly Aromatics	D 5186	7.49 mass %	1.55
Mono Aromatics	D 5186	26.33 mass %	0.84
Total Aromatics	D 5186	34.51 mass%	1.38
Nitrogen	D 4629	50 mg/kg	3.67
Nitrogen	D 4629	150 mg/kg	6.9
Relative Density	D 4052	1.00000	0.00003
Relative Density	D 4052	0.6884	0.00004
Benzene	D 3606	0.800 vol%	0.036
RVP	D 5191	6.400 psi	0.048
RVP	D 5191	9.960 psi	0.07
TAME	D 5599	5.790 wt%	0.062
Ethanol	D 5599	10.100 wt%	0.235
Sulfur	D 5453	250 mg/kg	15.598
Sulfur	D 5453	25 mg/kg	1.665

3.4.2 Diesel Testing

Diesel samples were acquired and tested at all retail fuel sites. Sample testing performed on each sample included:

- Cetane Number (ASTM D613-10a)
- Calculated cetane index (ASTM D976-06)
- API Gravity (ASTM D4052(2009))
- Sulfur (ASTM D5453-09)
- Nitrogen (ASTM D4629-10)
- Aromaticity (ASTM D1319-10)
- Total aromatic content (ASTM D5186-03(2009))
- Polycyclic aromatic content (ASTM D5186-03(2009))
- Distillation (ASTM D86-10a)
- Flash point (ASTM D93-10a)

Sample identification and test results for diesel fuel are listed in Attachment 3. Uncertainty results for diesel analyses are not available.[2]

[2] See the applicable ASTM test procedures for repeatability and reproducibility precision estimates.

4. MOVES Fuel Parameter Input Files for Texas Counties

4.1 Overview

ERG used gasoline fuel sample data collected by SwRI to develop fuel parameter input data for EPA's MOVES2010 model. Fuel parameter files were developed for each county in Texas using fuel sample data obtained from the 92 gasoline and diesel retail locations across the State in the summer of 2011.

4.1.1 Methodology

The SwRI gasoline data required significant formatting prior to development of the average MOVES parameter values. The source data was compiled in a spreadsheet with each station and gasoline grade results presented on separate worksheets. The header section of the data contained service station information, RVP, and fuel sulfur content. The body of the workbook contained chemical name, Chemical Abstracts Service (CAS) number, and percent weight by volume (mol weight was also included). ERG proceeded to extract the required parameters into one large flat file.

SwRI was first consulted as to how to interpret the results, which contained multiple entries for certain contaminants and combinations of contaminants. SwRI processed their data and the following parameters were sent to ERG:

- RVP (EPA Method)
- Sulfur (ppm)
- Aromatics
- I-Paraffins
- Naphthalenes
- Olefins
- Paraffins
- Benzene
- Ethanol
- MTBE
- ETBE
- TAME

MS Excel macro programs were developed to extract the specific contaminants from each sample and their associated CAS number, percent weight, percent volume, and percent MOL. ERG used a separate summary sheet to gather all of the extracted data from each tab, and then wrote the summary to a comma separated variable (.CSV) file for export. The summary contained sample identification number (ID), sample date, survey area, location name, city, zip code, fuel grade, RVP, and sulfur content (ppm).

To extract component data, ERG set up a filter to display compounds of interest (e.g., benzene, ETBE, MTBE, TAME, and EtOH) on each tab. ERG then copied the filtered data into a separate summary sheet (titled "Contams"), and exported the data to a .CSV file. This summary included sample ID, group code, compound name, CAS #, weight percent, volume percent, and MOL percent.

These files were then processed for further evaluation using SAS™. A query was written to extract station information along with fuel parameters, resulting in several dependent tables. Six dependent tables were then merged by the station sample ID number assigned by SwRI. Attachment 4 provides the SAS program used for this task.

Since three grades of gasoline were sampled, regular, mid-grade, and premium blend data were extracted from the master file separately for each grade. Parameters for RVP, fuel sulfur, benzene, ethanol, MTBE, ETBE, and TAME were then averaged by geographic area. For example, benzene for gasoline was averaged for each of the 25 districts, for regular, mid-grade, and premium blends.

ERG then used the SwRI results to calculate the required MOVES fuel parameter inputs, weighting across fuel grades using the latest available sales data from the Energy Information Administration (EIA).3 According to EIA data for Texas in 2009, regular gasoline comprised 87.8% of the market, mid-grade gasoline comprised 6.5%, and premium gasoline comprised 5.7%. These weighting factors were applied to each of the geographic areas for each parameter. Such a weighting process can be applied to any of the over 50 chemical compounds evaluated in the SwRI analysis.

The resulting weighted MOVES fuel parameter inputs for gasoline included:

- RVP (psi)
- Sulfur (ppm)
- Olefins (% wt)
- Aromtaics (% wt)
- Benzene (% wt)
- Oxygentates (% vol)

Additional MOVES fuel input requirements include lower volatility percentage (E200) and upper volatility percentage (E300). SwRI performed distillate analysis, providing

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3 Table 39: Refiner Motor Gasoline Volumes by Grade, Sales Type, PAD District, and State from the Preliminary Petroleum Marketing Annual 2009, Energy Information Administration.
http://www.eia.doe.gov/pub/oil_gas/petroleum/data_publications/petroleum_marketing_annual/current/pdf/pmaall.pdf

the temperatures corresponding to specific sample fractions (e.g., 5%, 10%, 20%, etc.), as shown in Attachment 2. In order to estimate E200 and E300 fractions as required by the MOVES model, ERG performed a simple interpolation of the SwRI distillation data.

ERG then used the TxDOT mappings, assigning each county in the state to a unique TxDOT district. The county assignments were identical to those developed for the 2005, 2007 and 2008 sampling studies. Figure 1 indicates the TxDOT District boundaries and major city locations.

The fuel specifications for the 2007, 2008, and 2011 summer sampling results were compiled, processed, and formatted for use as an input file for the MOVES2010a model. ERG first used the MOVES County Data Manager, exporting the fuel data template as an Excel file. Next, ERG updated each tab of the template with the 2007, 2008, and 2011 summer fuel sampling data for the following parameters:

1. MonthGroupofAnyYear: Consistent with the TCEQ's TexN model, summer months are defined as May through October.
2. FuelSupplyYear: 2007, 2008, and 2011.
3. County: Parameters specified for all 254 counties.
4. FuelSubtype: Included a record for each fuel type found in the dataset (e.g., diesel, conventional gasoline, RFG, etc.).
5. FuelFormulation: NOTE: In theory, MOVES should allow a user to create new fuel formulation ID numbers, and enter all the associated parameters. However, the current version of MOVES has a bug and this feature is still under development. Therefore, existing fuel formulation IDs with the appropriate fuelsubtype IDs were selected for updating.
6. FuelSupply: Created a record for each county-year-month combination and mapped it to the correct fuel formulation ID.

This process resulted in populating a master Excel file containing the 2007, 2008, 2011 summer fuel data collected by the TCEQ. This file may be edited according to user needs and imported directly into MOVES using the County Data Manager within MOVES.

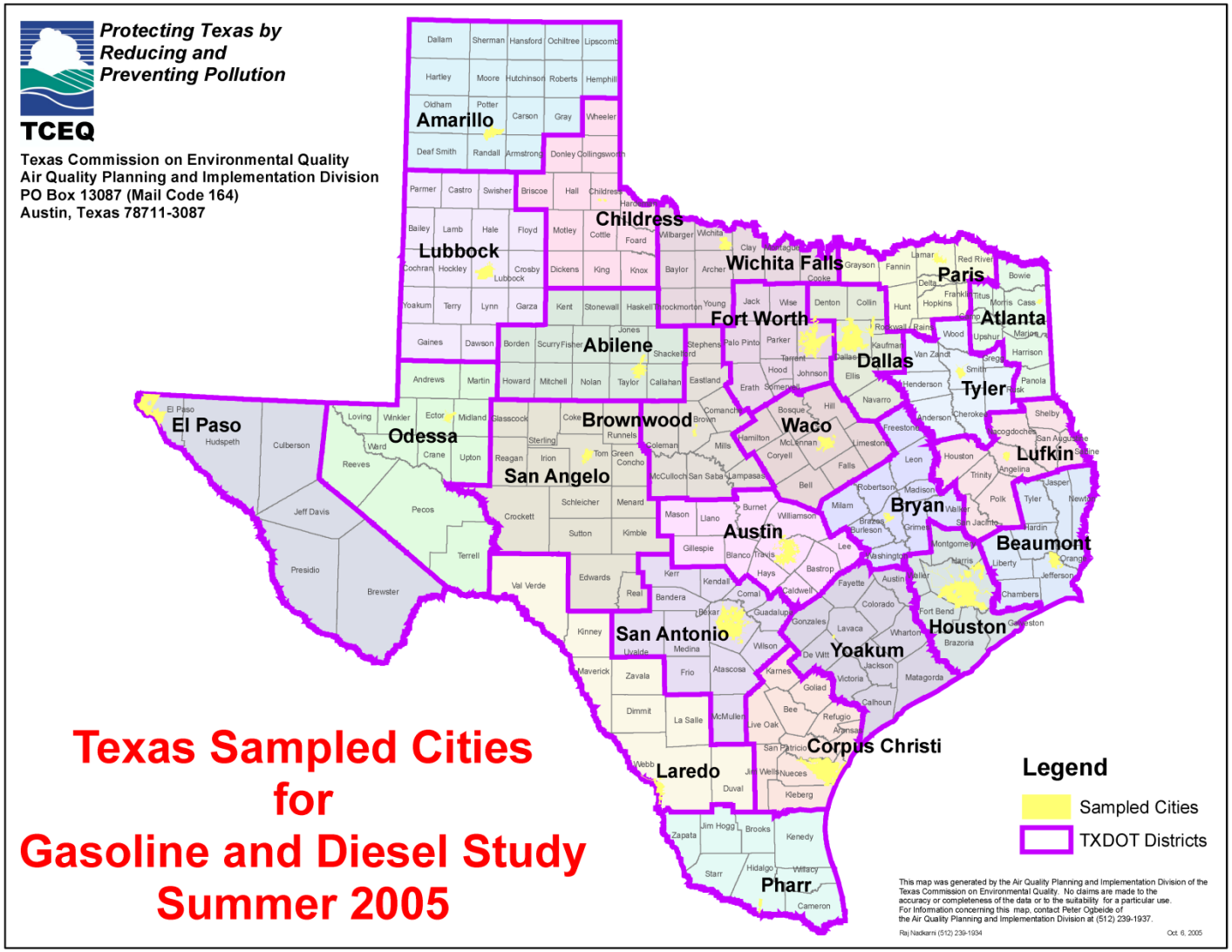


Figure 1. TxDOT Districts and Sampling Areas

4.1.2 Findings - Gasoline

The resulting MOVES fuel parameter input values are presented in Table 3 for each of the 25 sampling regions, along with selected descriptive statistics. Note that statewide average values are not weighted by fuel consumption or other activity metrics, and are used only for identifying directional trends in fuel quality.

By-county fuel parameter inputs for the summers of 2003 through 2011 (excluding 2011) can be found in Attachment 5, on the "NTI Inputs" worksheet. Fuel parameters for each sampling location, weighted across fuel grades and the specific sampling location/county assignments can be found on the "Master_output from SAS program" worksheet.

Figures 2 through 9 illustrate the trends in gasoline parameters for selected areas from 2003 through 2011. (Note that no testing was conducted in the summers of 2006, 2009, and 2010. In addition, aromatics, olefins, and benzene values are presented on a percent volume basis, as percent weights were not available for all historical years.)

Table 3. Gasoline Properties by Region (Summer 2011)

Region	RVP	Sulfur (ppm)	Aromatics (% wt)	Olefins (% wt)	Benzene (% wt)	EtOH (% vol)	MTBE (% vol)	ETBE (% vol)	TAME (% vol)	E200 (%)	E300 (%)
ABILENE	9.41	23.7	37.50	8.97	0.676	4.898	0.000	0.000	0.000	46.536	82.12
AMARILLO	9.55	19.2	32.54	6.28	0.692	8.281	0.000	0.000	0.000	60.139	88.135
ATLANTA	7.27	26.3	38.74	6.94	2.156	9.205	0.039	0.000	0.000	47.733	80.959
AUSTIN	7.54	42.6	29.45	12.02	0.605	8.667	0.027	0.000	0.000	51.193	80.365
BEAUMONT	7.29	27.7	30.03	8.73	1.228	8.855	0.000	0.000	0.000	49.87	81.93
BROWNWOOD	8.19	28.3	30.41	9.19	0.710	4.971	0.037	0.000	0.000	45.68	83.294
BRYAN	7.35	24.7	29.67	8.32	0.746	7.877	0.000	0.000	0.000	49.276	82.463
CHILDRESS	9.49	19.4	31.57	6.18	0.696	9.078	0.000	0.000	0.000	59.575	87.577
CORPUS CHRISTI	7.70	27.8	23.94	10.17	0.528	9.44	0.031	0.000	0.000	49.859	83.442
DALLAS	7.13	24.1	24.58	8.89	0.543	8.383	0.000	0.000	0.000	47.49	83.792
EL PASO	7.25	26.6	41.80	13.44	0.736	1.988	0.000	0.000	0.000	44.676	81.714
FORT WORTH	7.09	22.7	23.26	9.37	0.537	9.054	0.000	0.000	0.000	47.23	83.519
HOUSTON	7.00	24.7	22.14	10.61	0.617	8.851	0.000	0.000	0.000	49.067	83.389
LAREDO	8.99	18.5	29.08	7.85	0.363	7.507	0.000	0.000	0.000	55.599	84.94
LUBBOCK	9.38	25.2	33.09	6.23	0.622	8.229	0.039	0.000	0.000	55.081	85.118
LUFKIN	7.29	33.5	36.59	8.57	1.793	8.311	0.003	0.000	0.000	48.627	80.035
ODESSA	9.31	24.4	37.08	10.75	0.668	2.595	0.003	0.000	0.000	45.839	82.137
PARIS	7.05	17.7	30.09	8.44	1.276	8.267	0.002	0.000	0.000	46.873	82.897
PHARR	9.31	33.9	31.41	11.31	0.62	6.565	0.000	0.000	0.000	52.77	82.535
SAN ANGELO	9.22	24.9	34.26	12.27	0.758	2.575	0.000	0.000	0.000	47.213	82.083
SAN ANTONIO	7.56	31.6	31.45	11.04	0.524	7.755	0.000	0.000	0.000	50.308	79.917
TYLER	7.33	12.6	36.75	7.59	2.467	8.828	0.001	0.000	0.000	45.383	82.718
WACO	7.46	34.2	27.93	10.19	0.677	8.563	0.000	0.000	0.000	50.319	82.239
WICHITA FALLS	8.40	31.3	34.28	8.70	0.788	4.665	0.001	0.000	0.000	43.662	82.209
YOAKUM	7.35	35.1	24.36	11.59	0.593	9.027	0.000	0.000	0.000	50.812	81.629
average	**8.04**	**26.43**	**31.28**	**9.34**	**0.865**	**7.30**	**0.007**	**0.00**	**0.00**	**49.63**	**82.85**

Region	RVP	Sulfur (ppm)	Aromatics (% wt)	Olefins (% wt)	Benzene (% wt)	EtOH (% vol)	MTBE (% vol)	ETBE (% vol)	TAME (% vol)	E200 (%)	E300 (%)
min	**7.00**	**12.60**	**22.14**	**6.18**	**0.363**	**1.99**	**0.000**	**0.00**	**0.00**	**43.66**	**79.92**
max	**9.55**	**42.60**	**41.80**	**13.44**	**2.467**	**9.44**	**0.039**	**0.00**	**0.00**	**60.14**	**88.14**
range	**2.55**	**30.00**	**19.67**	**7.26**	**2.104**	**7.45**	**0.039**	**0.00**	**0.00**	**16.48**	**8.22**
std deviation	**0.96**	**6.56**	**5.16**	**1.97**	**0.526**	**2.28**	**0.014**	**0.00**	**0.00**	**4.26**	**1.98**

Figure 2. Gasoline RVP Trends for Selected Regions

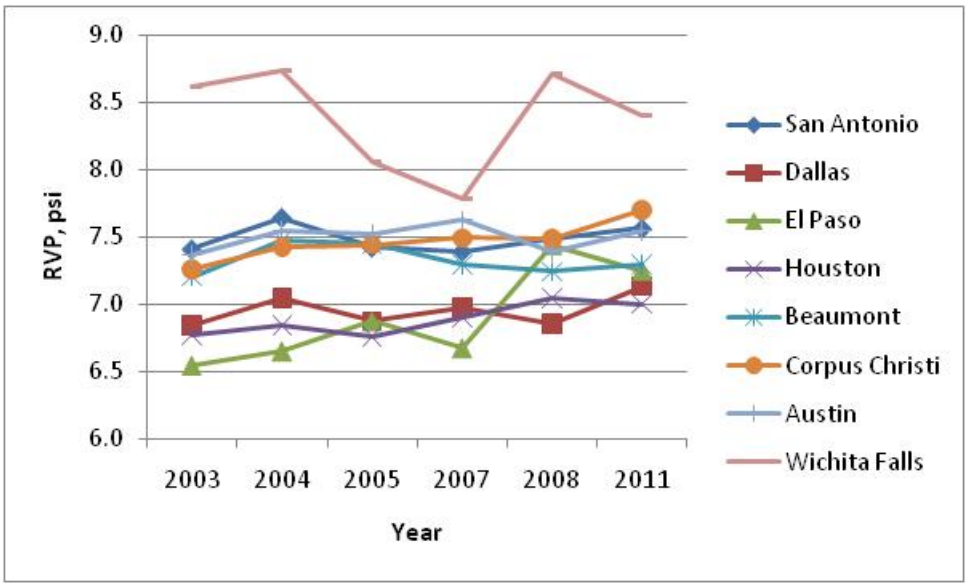


Figure 3. Gasoline Sulfur Trends for Selected Regions

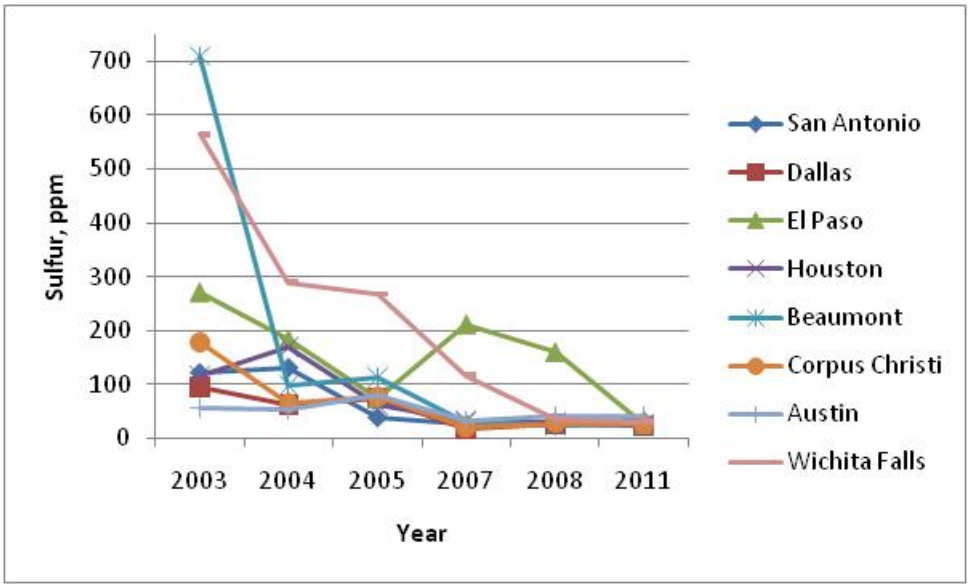


Figure 4. Gasoline Olefins Trends for Selected Regions

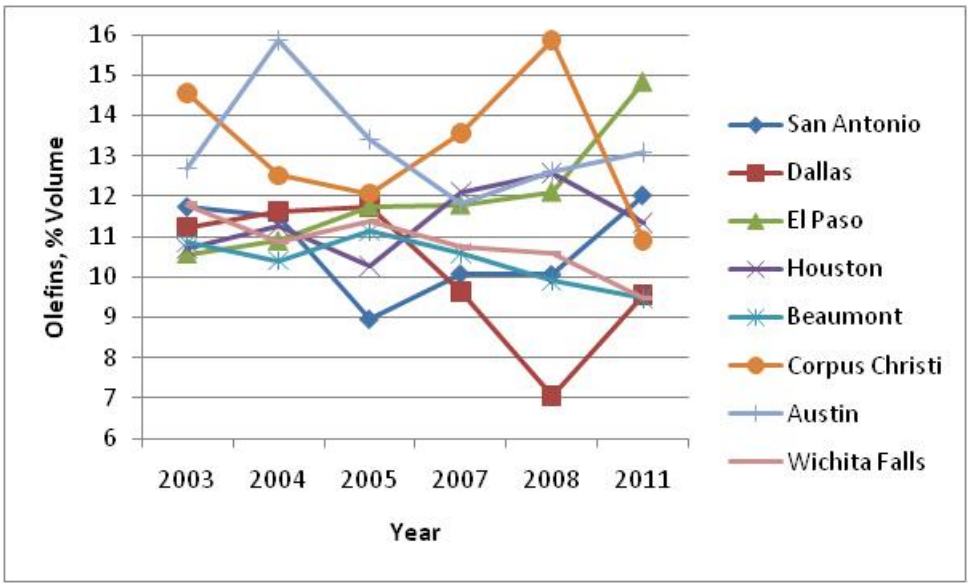


Figure 5. Gasoline Aromatics Trends for Selected Regions

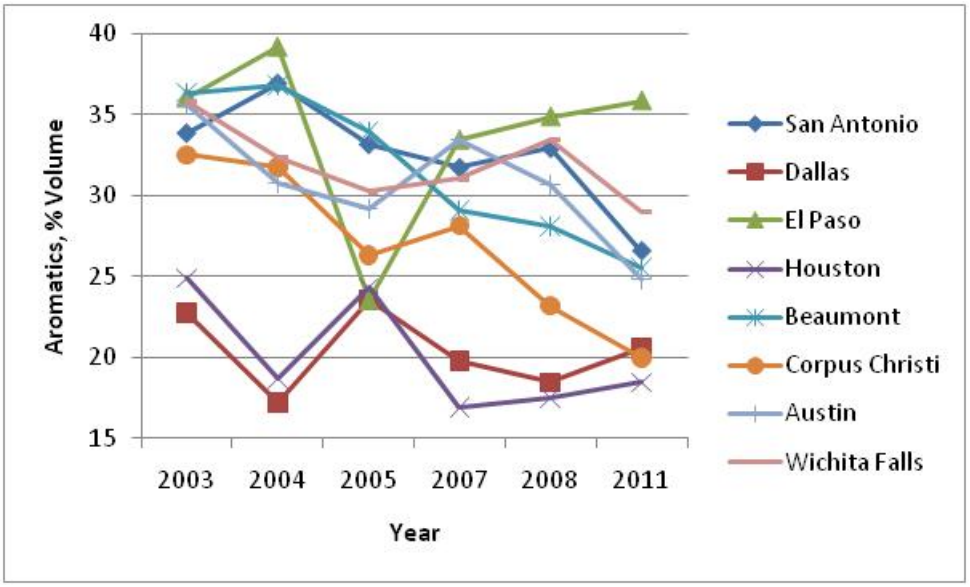


Figure 6. Gasoline Benzene Trends for Selected Regions

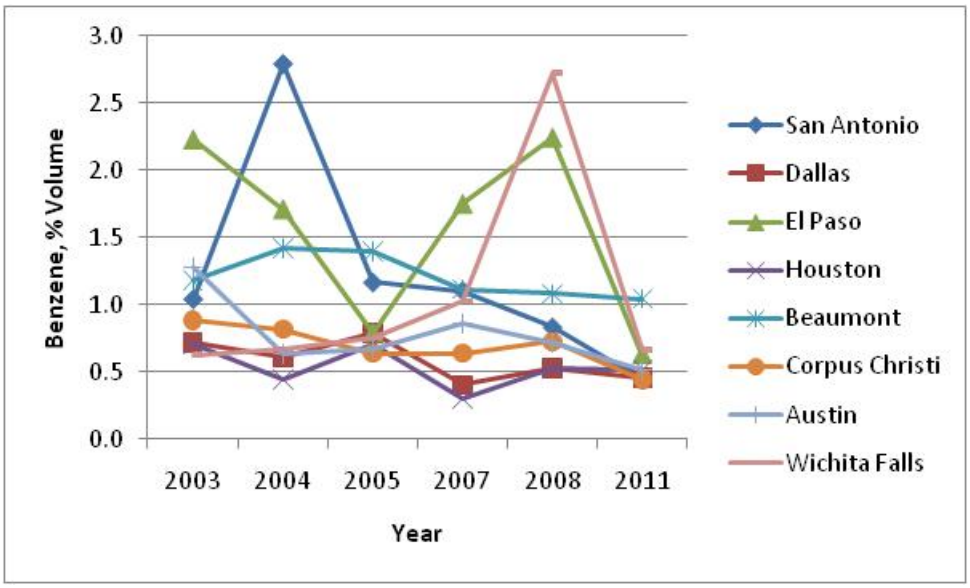


Figure 7. Gasoline MTBE Trends for Selected Regions

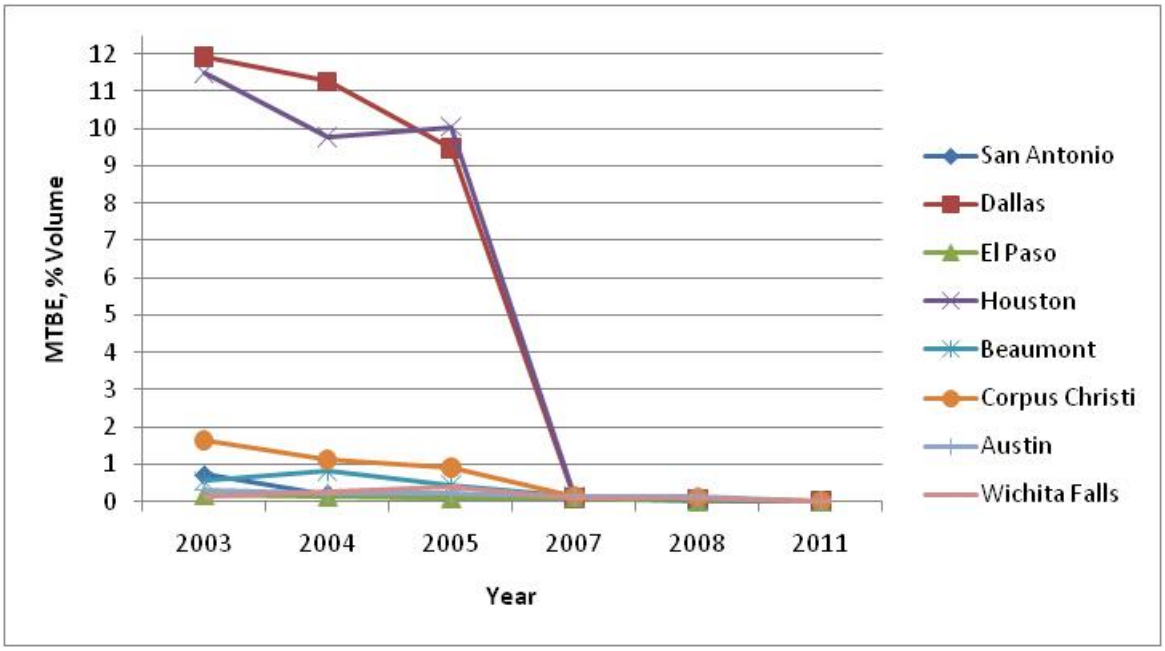


Figure 8. Gasoline ETBE Trends for Selected Regions

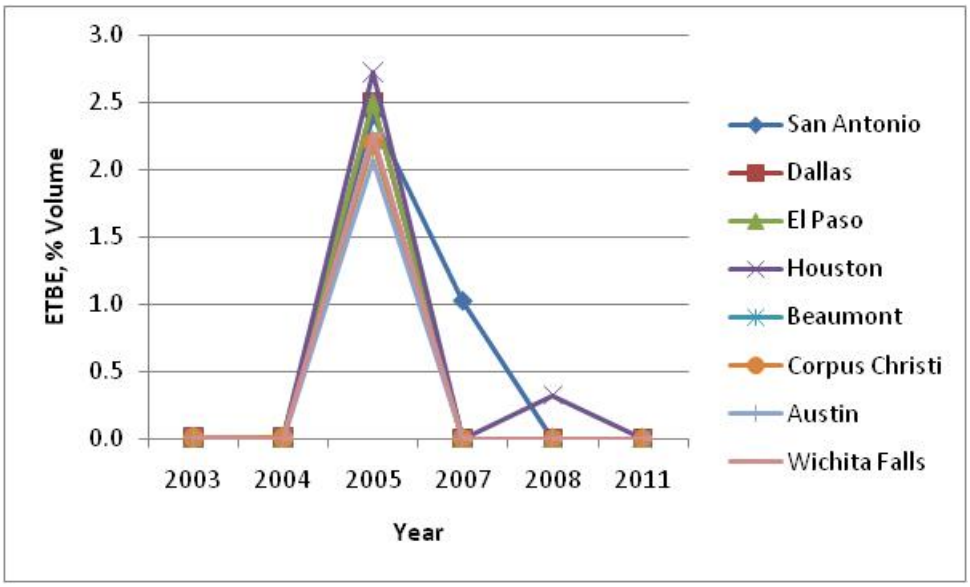
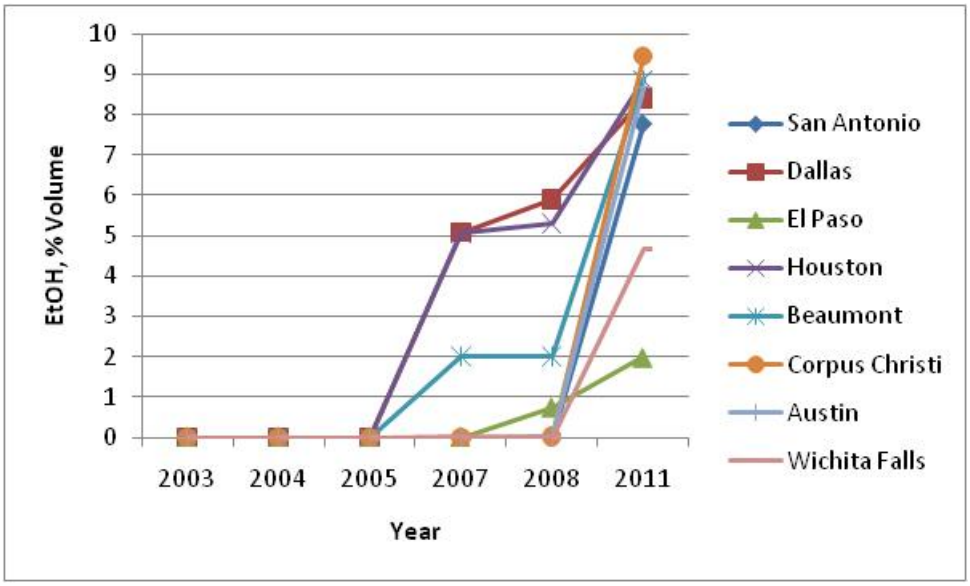


Figure 9. Gasoline Ethanol Trends for Selected Regions



Figures 10 through 12 show trends for TAME, E200, and E300 from 2007 to 2008. (Prior years are not available for comparison.)

Figure 10. Gasoline TAME Trends for Selected Regions

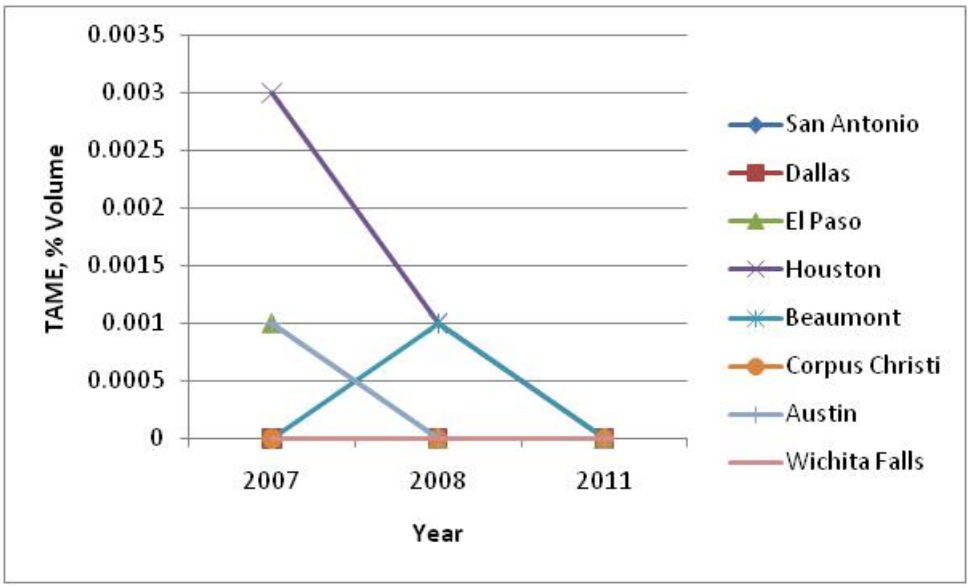


Figure 11. Gasoline E200 Trends for Selected Regions

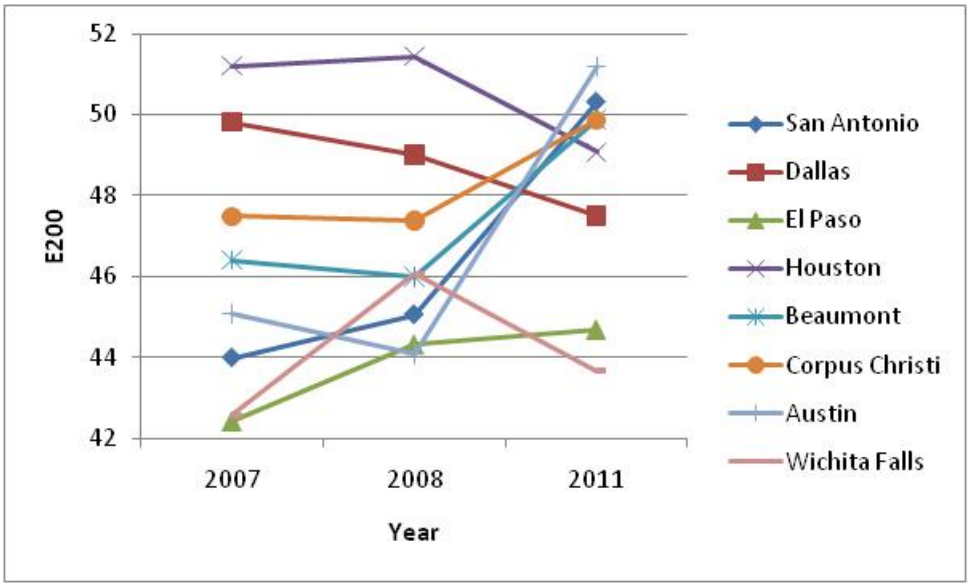
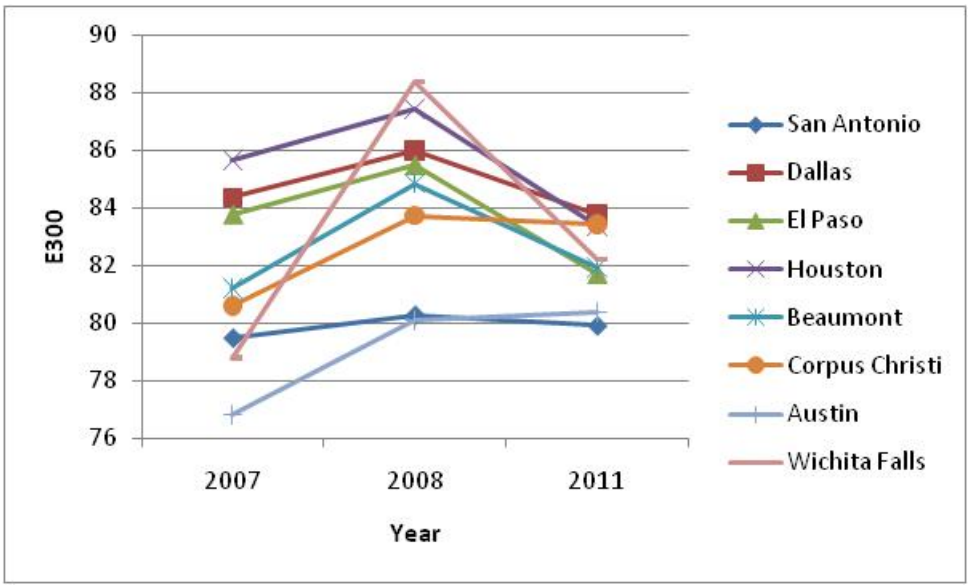


Figure 12. Gasoline E300 Trends for Selected Regions



A brief comparison of maximum differences for each fuel parameter across the selected counties is provided in Table 4. Sample sites corresponding to the maximum differentials are shown in parentheses. A table of how the regions sampled in 2008 compared to the TxDOT districts sampled in 2011 is available in Attachment 4 on the "District comp – 2011 vs. 2008" worksheet.

Table 4. Gasoline Comparison of 2011 with 2008 Findings*

Fuel Parameter	Maximum Delta
RVP	+1.61 (Laredo)
Sulfur (ppm)	-134.11 (El Paso)
Olefins (% vol)	+5.67 (Bryan)
Aromatics (% vol)	-14.02 (Bryan)
Benzene (% vol)	-2.06 (Wichita Falls)
Ethanol (% vol)	+9.41 (Corpus Christi)
MTBE (% vol)	-0.14 (San Angelo)
ETBE (% vol)	-0.32 (Houston)
TAME (% vol)	-0.00 (All regions)

Fuel Parameter	Maximum Delta
E200	+11.55 (Laredo)
E300	+6.16 (Wichita Falls)

*Changes are expressed in absolute terms. Positive values indicate increases relative to 2008, negative values indicate decreases.

The following provides some general observations regarding the gasoline sampling data.

- RVP in most regions appears relatively stable over time, although Wichita Falls showed a sharp increase in average RVP between 2007 and 2008. Most values range from 6.5 to about 7.5 for all years, with the exception of Wichita Falls, which ranges from about 7.7 in 2007, to over 8.5 in 2004 and 2008. There is no clear upward or downward trend for any given city.
- Sulfur levels fell below 50 ppm in 2008, as expected with the new Federal fuel standards, with the exception of the Wichita Falls region. The 2011 reading for this region is now in line with other regions.
- There doesn't appear to be any apparent obvious trend for olefins, aromatics, or benzene in most regions. RFG regions Dallas and Houston appear to have generally lower aromatics values, between 15 and 25 percent, compared to other areas generally around 30 percent.
- Wichita Falls and El Paso regions showed sharp declines in benzene averages between 2008 and 2011.
- MTBE volumes remain at or near zero, as expected.
- Other non-ethanol oxygenates were only observed in trace amounts, if at all.
- Ethanol averages continue to rise in most regions, as expected.
- All key regions had E200 levels between 43 and 52 in 2011. Upward trends are seen for El Paso, San Antonio, Austin, and Corpus Christi, while downward trends are seen for Houston and Dallas. No trend is evident for Wichita Falls.
- All key regions had E300 levels between 80 and 84 in 2011. All regions rise from 2007 to 2008, and then fall again by 2011, with the exception of Austin, which has essentially no change from 2008 to 2011.

4.1.3 Findings - Diesel

The diesel fuel the analysis focused on cetane, aromatics, specific gravity, T50 (°F), olefins, saturates, and fuel sulfur. Note that all diesel fuel sampled was labeled as ultra-low sulfur. The detailed data analysis performed for the diesel fuel samples is provided in Attachment 7. Summary results for 2011 are shown in Table 5, with selected descriptive statistics.

Table 5. Diesel Fuel Properties by Region (Summer 2011)

Region	Aromatics, % wt	Olefins, % wt	Saturate, % wt	Sulfur, ppm	Cetane No.	Specific Gravity	T50, deg F
ABILENE	36.21	1.26	62.53	7.83	46.3	0.848	506.1
AMARILLO	23.77	1.84	74.40	5.07	48.9	0.833	478.8
ATLANTA	27.81	1.20	71.00	6.93	51.4	0.836	496.3
AUSTIN	29.33	1.07	69.59	5.48	47.0	0.843	512.5
BEAUMONT	37.52	1.58	60.90	6.36	48.5	0.845	503.6
BROWNWOOD	35.34	1.65	63.01	6.80	45.5	0.844	503.7
BRYAN	32.39	1.89	65.72	5.87	48.4	0.840	492.1
CHILDRESS	22.02	1.26	76.72	4.30	49.7	0.829	478.3
CORPUS CHRISTI	22.46	1.01	76.54	3.28	50.6	0.829	479.4
DALLAS	32.17	1.40	66.43	6.55	47.5	0.844	506.8
EL PASO	28.13	1.38	70.49	5.43	47.5	0.839	495.3
FORT WORTH	28.57	1.10	70.33	5.38	48.5	0.838	501.6
HOUSTON	34.03	1.44	64.53	6.04	47.3	0.849	511.6
LAREDO	15.47	1.24	83.29	4.53	51.2	0.821	473.8
LUBBOCK	22.13	1.03	76.84	3.90	50.2	0.829	482.8
LUFKIN	32.28	0.72	67.00	7.60	49.2	0.836	487.2
ODESSA	32.61	1.07	66.32	6.03	46.6	0.843	501.6
PARIS	26.71	0.92	72.36	5.73	50.3	0.838	497.5
PHARR	21.47	1.53	77.00	3.83	50.0	0.827	484.6
SAN ANGELO	33.05	1.26	65.70	6.83	47.4	0.845	501.7
SAN ANTONIO	23.88	1.01	75.12	5.18	50.3	0.833	493.8
TYLER	28.57	0.90	70.53	7.42	48.7	0.836	494.9
WACO	29.66	0.94	69.40	5.40	46.8	0.841	501.9
WICHITA FALLS	38.18	1.22	60.60	7.20	45.7	0.849	504.3
YOAKUM	29.77	1.76	68.47	4.00	44.9	0.844	499.6
average	**28.94**	**1.27**	**69.79**	**5.72**	**48.34**	**0.838**	**495.60**
min	**15.47**	**0.72**	**60.60**	**3.28**	**44.93**	**0.821**	**473.80**
max	**38.18**	**1.89**	**83.29**	**7.83**	**51.40**	**0.849**	**512.54**
range	**22.71**	**1.17**	**22.69**	**4.56**	**6.48**	**0.028**	**38.74**
std deviation	**5.69**	**0.31**	**5.75**	**1.27**	**1.83**	**0.007**	**10.88**

Figures 13 through 19 illustrate the diesel composition trends from 2003 through 2011. (Note that no testing was conducted in the summers of 2006, 2009, and 2010. In addition, aromatics and olefin values are presented on a percent volume basis, as percent weights were not available for all historical years.)

Figure 13. Diesel Aromatics Trends for Selected Regions

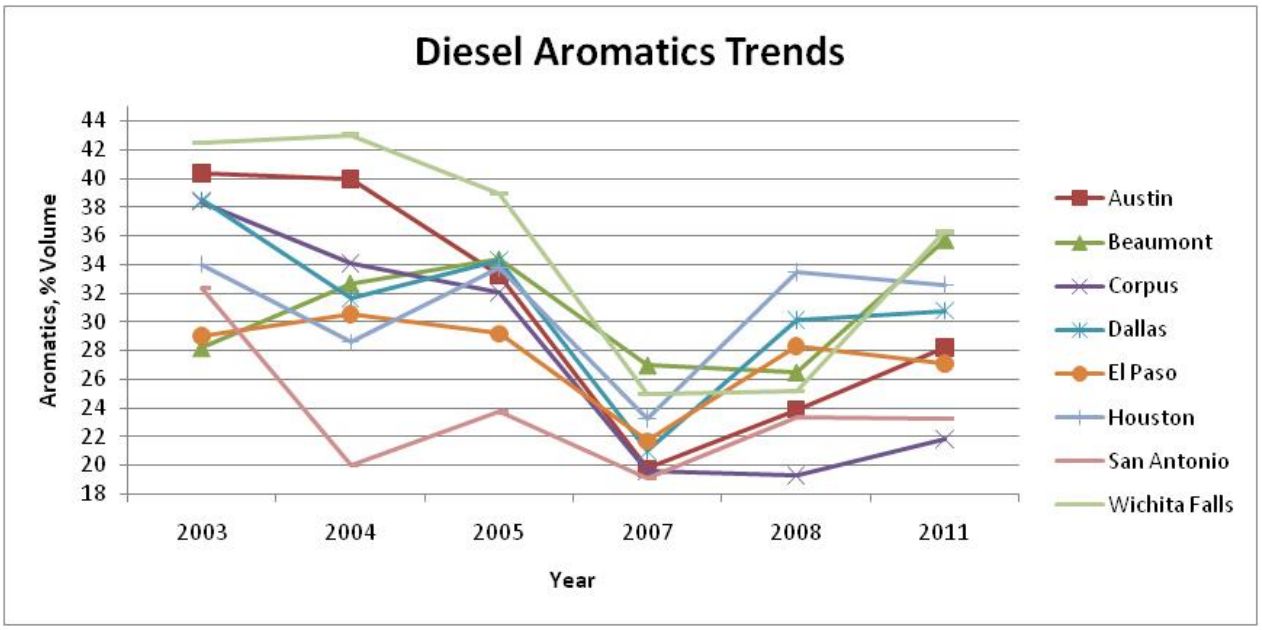


Figure 14. Diesel Olefins Trends for Selected Regions

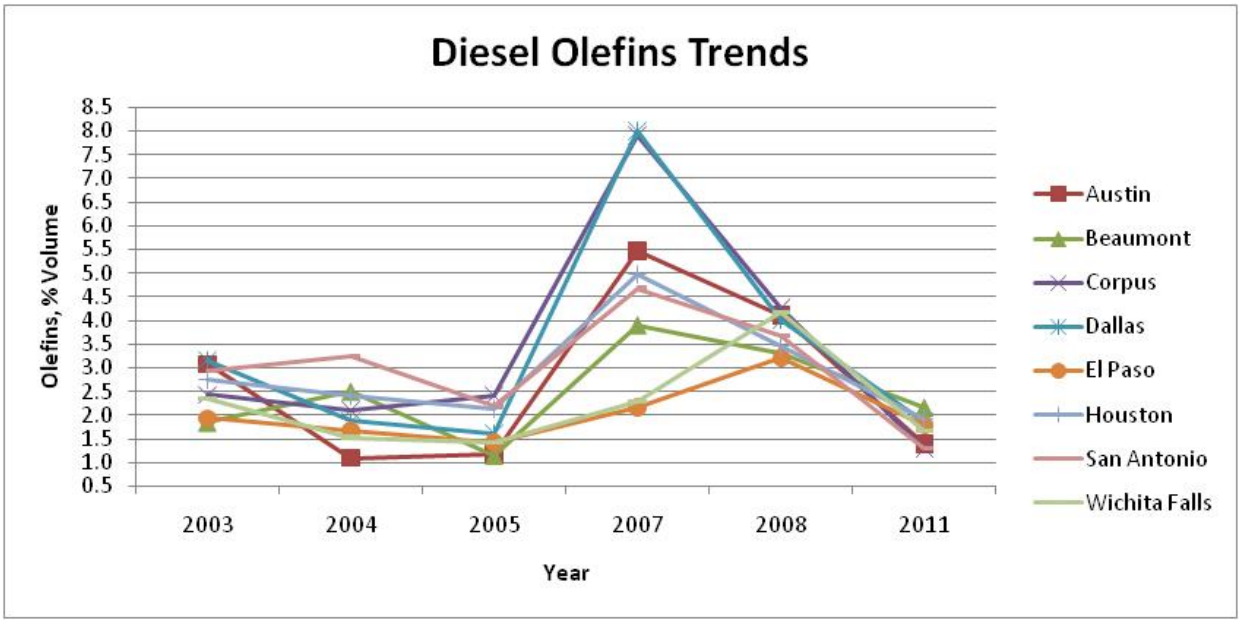


Figure 15. Diesel Saturates Trends for Selected Regions

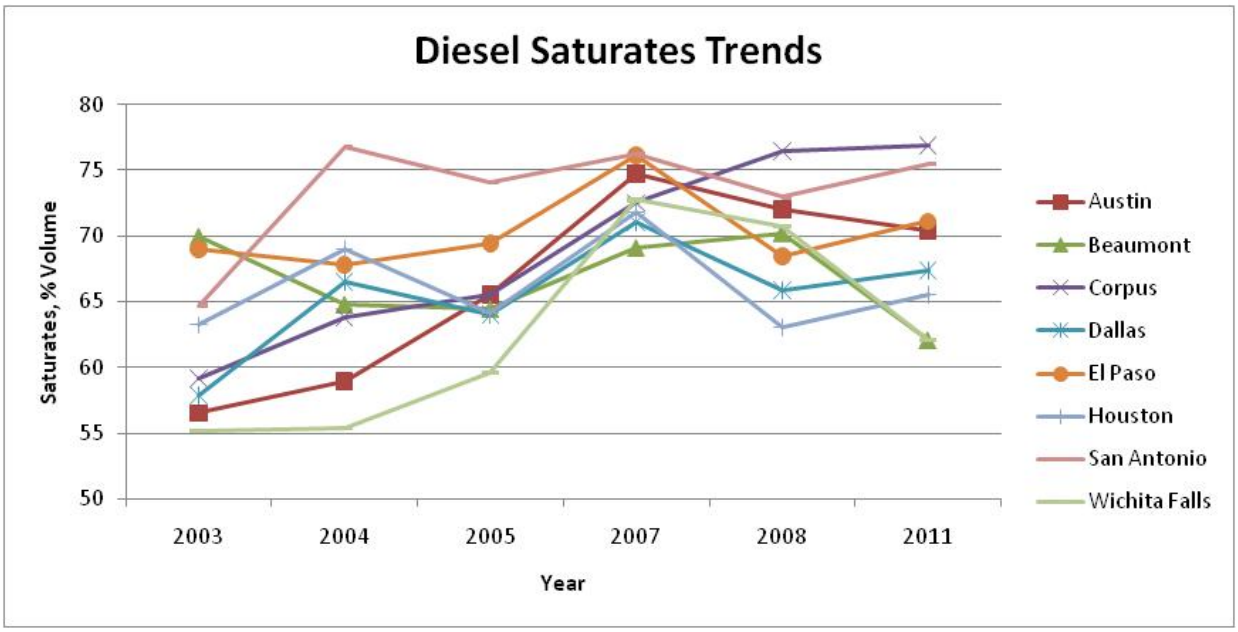


Figure 16. Diesel Sulfur Trends for Selected Regions

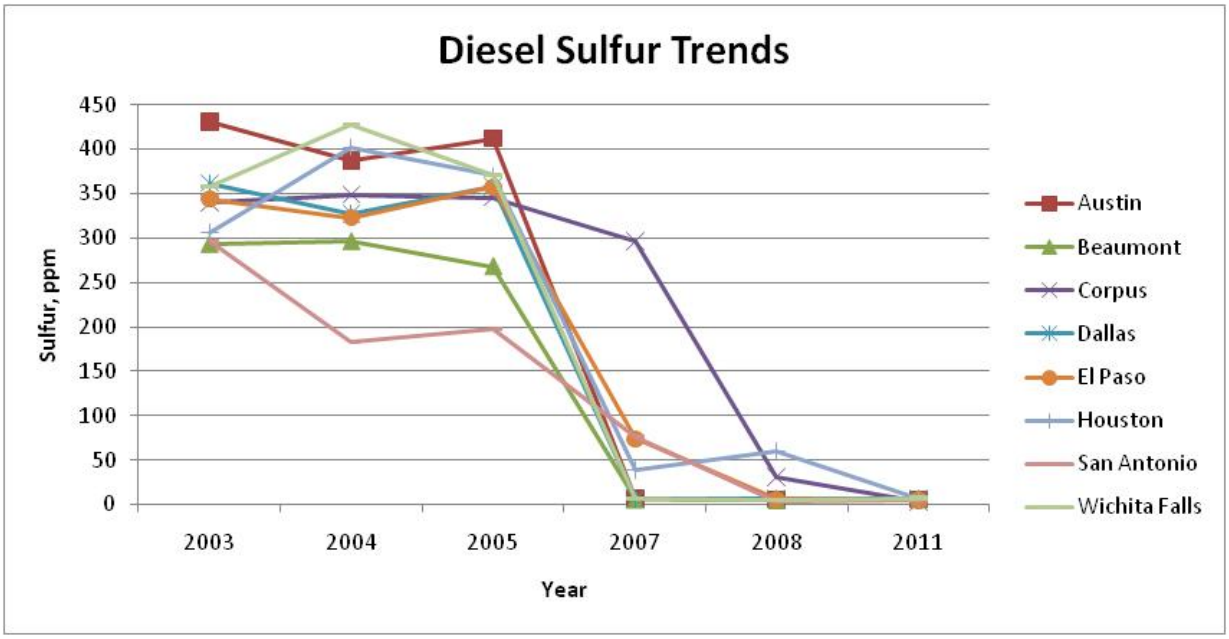


Figure 17. Diesel Cetane Trends for Selected Regions

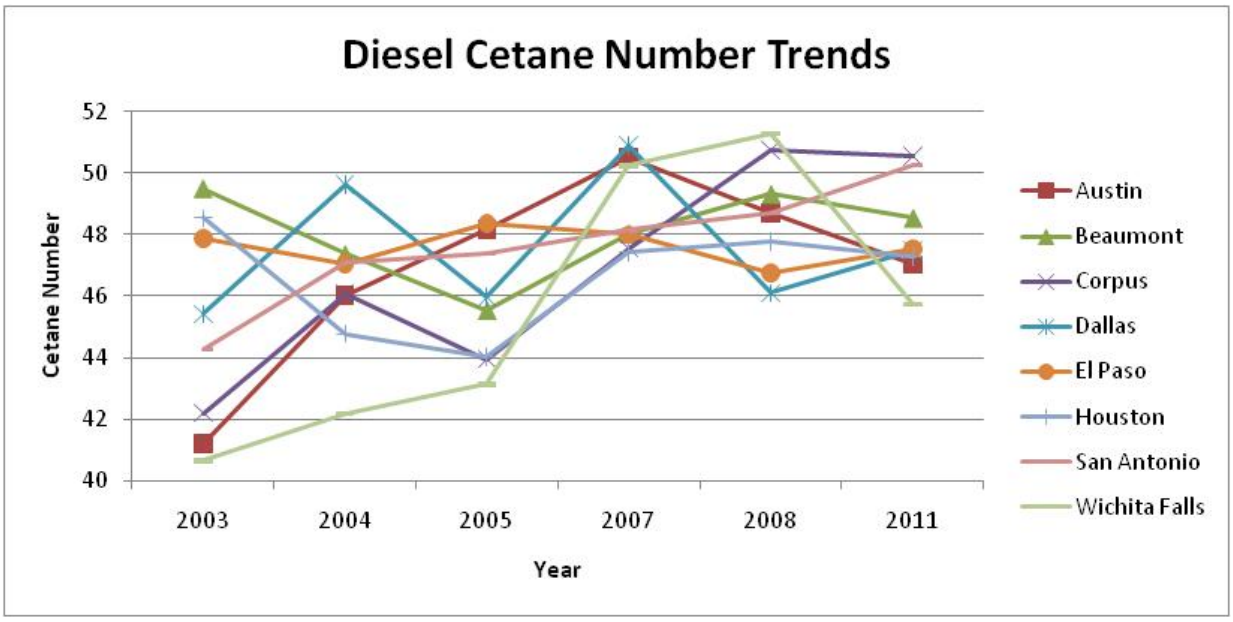


Figure 18. Diesel Specific Gravity Trends for Selected Regions

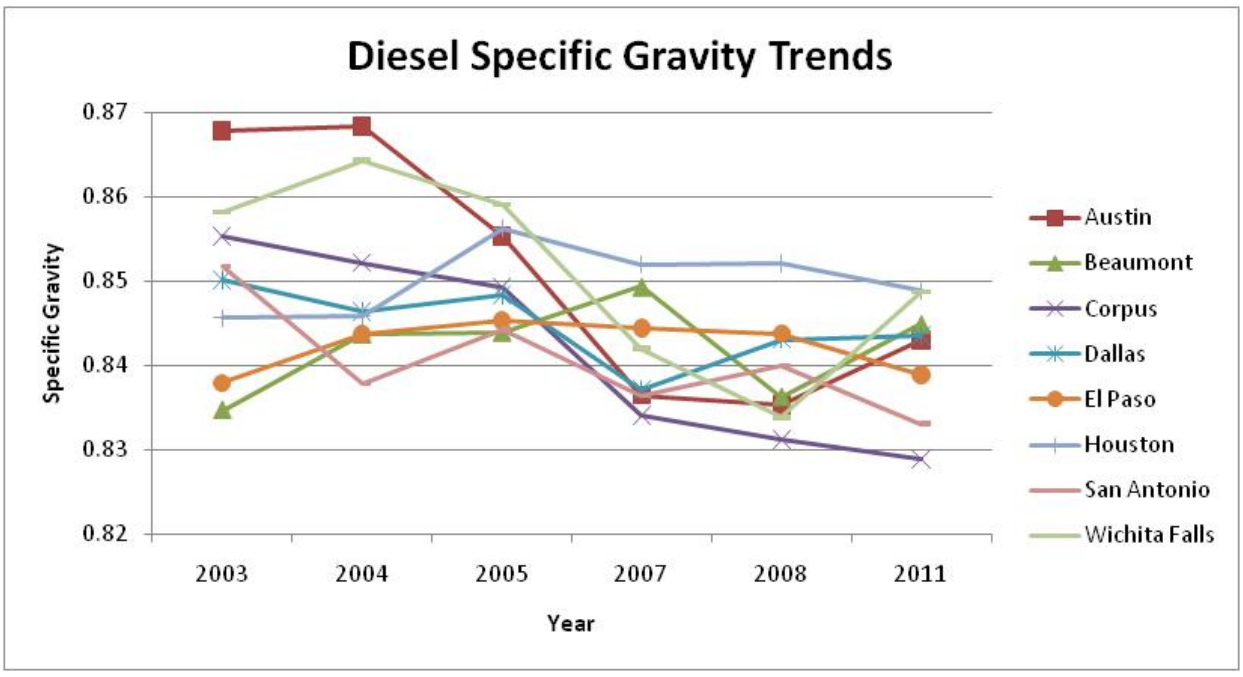
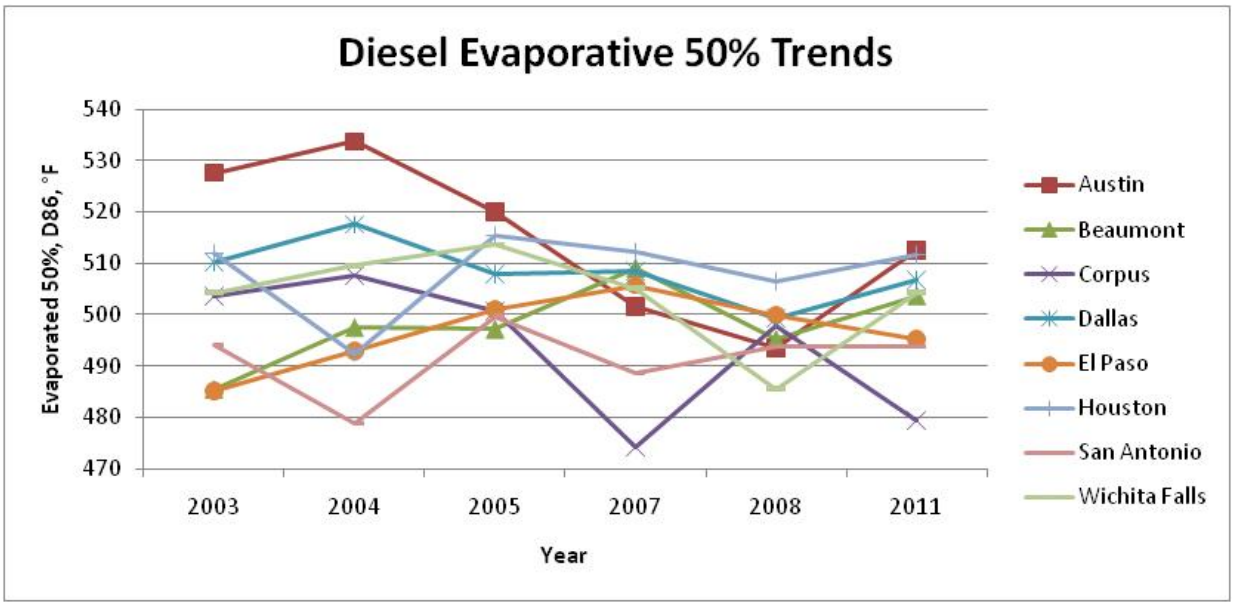


Figure 19. Diesel T50 Trends for Selected Regions



Some general observations about the diesel sampling data follow.

- All key regions have an aromatics percentage between 20 and 44 percent in 2011. Most regions show a downward trend to a minimum in 2007, with a general upward trend to 2011. There is no clear relationship between area and aromatics level;
- All key regions have olefin percentages between 1 and 8 percent since 2003. Most regions show an upward trend to a maximum in 2007, with strong downward trend from 2008 to 2011. The 2011 measurements all close to 2 percent. There is no clear relationship between area and olefins level;
- All key regions have saturates concentrations between about 55 and 80 percent. Most regions show general upward trend, but this is not entirely consistent over time. There is no clear relationship between area and saturates level;
- All regions show clear, sharp downward trend in sulfur levels over time, with all key regions below 10 ppm by 2011;
- Some regions show general downward trend in specific gravity through 2007, although there is no clear trend thereafter. All key regions are tightly grouped between 0.83 and 0.85 by 2011. There is no clear relationship between area and specific gravity;
- Most regions show general upward trend in cetane number over time, although this is not strong, with all key regions at or above 46 by 2011. There is no clear relationship between area and cetane number.;
- The T50 values for the key regions are tightly grouped between 480 and 510 by 2011. There is no clear trend or relationship between area and T50.

4.1.4 Supplemental Testing – Houston Area Stations

In addition to the testing described above, a second round of sampling and lab analysis was conducted for a subset of fueling stations (the seven located in the Houston area). This testing took place approximately one month after the first round of sampling, to ensure complete tank turnover. Previous fuel sampling and analysis studies have gone to great lengths to assess geographic variation in fuel parameters, but little is known about how fuel quality varies over a season. Therefore this second round of sampling was intended to make an assessment of the temporal variability of fuel parameters at the station level.

Table 6 identifies the seven stations that were sampled for gasoline and diesel in the HGB area and the Station ID assigned to each. Tables 7 and 8, for gasoline and diesel fuels, respectively, show the results of the second round of testing compared to the first round of testing for the seven stations in the HGB area. Attachment 6 provides the SAS program used to create Table 7.

Table 6. HGB Station ID Numbers

Station ID	Station Name
1	VALERO CONROE
2	TEXACO HOUSTON
3	CONOCO HOUSTON
4	SHELL HOUSTON
5	VALERO ROSENBERG
6	VALERO BAYTOWN
7	VALERO HOUSTON

4.2 Gasoline Results

Table 7. Station-Specific Gasoline Sampling, Round 1 vs. Round 2

Station ID	Component	Round 1	Round 2	Difference (Round 2 – Round 1)
1	Aromatics, % Volume	18.20	17.61	-0.58
	Benzene, % Volume	0.52	0.50	-0.03
	E200	48.18	48.47	0.29
	E300	82.53	83.61	1.08
	ETBE, % Volume	0.00	0.00	0.00
	EtOH, % Volume	9.68	8.69	-1.00
	MTBE, % Volume	0.00	0.00	0.00
	Olefins, % Volume	10.79	10.78	-0.01
	RVP, psi	6.96	7.05	0.09
	Sulfur, ppm	23.10	23.10	0.00

Station ID	Component	Round 1	Round 2	Difference (Round 2 – Round 1)
	TAME, % Volume	0.00	0.00	0.00
2	Aromatics, % Volume	15.97	15.52	-0.45
	Benzene, % Volume	0.59	0.54	-0.04
	E200	51.35	51.41	0.06
	E300	84.26	84.91	0.65
	ETBE, % Volume	0.00	0.00	0.00
	EtOH, % Volume	8.18	9.31	1.13
	MTBE, % Volume	0.00	0.00	0.00
	Olefins, % Volume	12.28	10.95	-1.33
	RVP, psi	7.36	7.29	-0.07
	Sulfur, ppm	21.30	27.30	6.00
	TAME, % Volume	0.00	0.00	0.00
3	Aromatics, % Volume	20.32	22.05	1.73
	Benzene, % Volume	0.37	0.37	0.00
	E200	49.61	47.95	-1.66
	E300	85.18	83.05	-2.14
	ETBE, % Volume	0.00	0.00	0.00
	EtOH, % Volume	7.83	7.64	-0.19
	MTBE, % Volume	0.00	0.00	0.00
	Olefins, % Volume	11.06	11.92	0.86
	RVP, psi	6.70	6.76	0.06
	Sulfur, ppm	40.00	46.60	6.60
	TAME, % Volume	0.00	0.00	0.00
4	Aromatics, % Volume	19.12	17.48	-1.64
	Benzene, % Volume	0.56	0.55	0.00
	E200	49.72	50.06	0.33
	E300	83.28	84.74	1.46
	ETBE, % Volume	0.00	0.00	0.00
	EtOH, % Volume	9.15	7.66	-1.49
	MTBE, % Volume	0.00	0.00	0.00
	Olefins, % Volume	12.32	13.07	0.75
	RVP, psi	6.86	6.95	0.09
	Sulfur, ppm	25.70	31.60	5.90
	TAME, % Volume	0.00	0.00	0.00
5	Aromatics, % Volume	19.28	19.48	0.20
	Benzene, % Volume	0.56	0.53	-0.03
	E200	49.05	49.02	-0.03
	E300	83.42	82.94	-0.48
	ETBE, % Volume	0.00	0.00	0.00

Station ID	Component	Round 1	Round 2	Difference (Round 2 – Round 1)
	EtOH, % Volume	8.06	7.58	-0.47
	MTBE, % Volume	0.00	0.00	0.00
	Olefins, % Volume	10.67	11.20	0.53
	RVP, psi	6.99	7.34	0.35
	Sulfur, ppm	22.70	20.10	-2.60
	TAME, % Volume	0.00	0.00	0.00
6	Aromatics, % Volume	18.33	18.92	0.58
	Benzene, % Volume	0.46	0.59	0.14
	E200	46.88	47.40	0.52
	E300	82.08	84.68	2.60
	ETBE, % Volume	0.00	0.00	0.00
	EtOH, % Volume	9.40	9.20	-0.20
	MTBE, % Volume	0.00	0.00	0.00
	Olefins, % Volume	11.59	9.18	-2.41
	RVP, psi	6.95	6.86	-0.09
	Sulfur, ppm	21.50	17.00	-4.50
	TAME, % Volume	0.00	0.00	0.00
7	Aromatics, % Volume	17.95	17.11	-0.84
	Benzene, % Volume	0.56	0.51	-0.06
	E200	48.69	50.03	1.34
	E300	82.96	83.60	0.64
	ETBE, % Volume	0.00	0.00	0.00
	EtOH, % Volume	9.66	8.45	-1.22
	MTBE, % Volume	0.00	0.00	0.00
	Olefins, % Volume	10.66	11.83	1.17
	RVP, psi	7.21	7.21	0.00
	Sulfur, ppm	18.90	22.00	3.10
	TAME, % Volume	0.00	0.00	0.00

4.3 Diesel Results

Table 8. Station-Specific Diesel Sampling, Round 1 vs. Round 2

Station ID	Component	Round 1	Round 2	Difference (Round 2 - Round1)
1	Aromatics % vol	49.9	41.2	-8.7
	Cetane Number	48.9	46.8	-2.1
	T50, deg F	549.3	537.3	-12.0
	Olefins % vol	2.6	1.3	-1.3
	Saturate % vol	47.5	57.5	10.0
	Specific Gravity	0.8662	0.8602	-0.006

Station ID	Component	Round 1	Round 2	Difference (Round 2 - Round1)
	Sulfur ppm	7.1	12	4.9
2	Aromatics % vol	42.5	32.5	-10.0
	Cetane Number	44.5	44.8	0.3
	T50, deg F	523.7	524.8	1.1
	Olefins % vol	2.4	1.9	-0.5
	Saturate % vol	55.1	65.6	10.5
	Specific Gravity	0.8595	0.8607	0.0012
	Sulfur ppm	7.2	13	5.8
3	Aromatics % vol	25.2	28.7	3.5
	Cetane Number	47.6	44.6	-3.0
	T50, deg F	501.3	505.1	3.8
	Olefins % vol	1.3	0.9	-0.4
	Saturate % vol	73.5	70.4	-3.1
	Specific Gravity	0.8401	0.8429	0.0028
	Sulfur ppm	6	6.6	0.6
4	Aromatics % vol	30.1	31.6	1.5
	Cetane Number	47.3	44.6	-2.7
	T50, deg F	509.3	516.7	7.4
	Olefins % vol	1.6	2.1	0.5
	Saturate % vol	68.3	66.3	-2.0
	Specific Gravity	0.849	0.8574	0.0084
	Sulfur ppm	7.3	11.8	4.5
5	Aromatics % vol	28.4	26.9	-1.5
	Cetane Number	45.1	46.4	1.3
	T50, deg F	503.9	500.5	-3.4
	Olefins % vol	1.5	0.8	-0.7
	Saturate % vol	70.1	72.3	2.2
	Specific Gravity	0.8491	0.8432	-0.0059
	Sulfur ppm	5.5	6.7	1.2
6	Aromatics % vol	25.2	23.5	-1.7
	Cetane Number	48.1	47.3	-0.8
	T50, deg F	491.2	491.9	0.7
	Olefins % vol	2.3	1	-1.3
	Saturate % vol	72.5	75.5	3.0
	Specific Gravity	0.8377	0.8346	-0.0031
	Sulfur ppm	3.7	6.5	2.8
7	Aromatics % vol	26.5	31.4	4.9
	Cetane Number	49.5	45.2	-4.3
	T50, deg F	502.5	509.4	6.9
	Olefins % vol	1.7	1.2	-0.5
	Saturate % vol	71.8	67.4	-4.4
	Specific Gravity	0.8401	0.8483	0.0082
	Sulfur ppm	5.5	6.8	1.3

Some general observations about the second round of test results are discussed below.

- Even though there is substantial variation between stations, gasoline testing shows little variability for the same station between Round 1 and Round 2, with most parameters within the statewide standard deviation values shown in Table 3. The only notable exceptions included the E300 and Olefin values for Station 6, the RVP measurements for Station 5, and the E300 measurements for Station 3.
- Unlike the gasoline samples, several diesel parameters showed relatively large changes between Round 1 and 2, with every station having at least one measurement vary by more than a standard deviation between rounds one and two (see Table 5). The source of this variation is not known, although it may reflect contamination of one or more of the fuel samples prior to collection.

5. Quality Assurance

ERG performed a review of the lab analysis results for all gasoline and diesel samples, looking for possible outliers or unusual data distributions. ERG first flagged any observation that was more than four standard deviations from the average value for a given parameter. Only one fuel sample was flagged using this screening criteria – a diesel fuel sample from the Houston area, with the values for initial boiling point of 284.7 F and flash point of 102.0 F. These values are anomalously low compared with the data set averages of 338.7 F and 142.7, respectively.

ERG consulted with the SwRI program manager to obtain insight on the reasonableness of these values.[4] SwRI noted that initial boiling points and flash points can vary widely from batch to batch, even outside of specifications, often as a result of contamination prior to sampling. Therefore no adjustments were made to the SwRI data.

[4] Personal communication with Michelle Ratchford, Southwest Research Institute, August 30, 2011.

6. Conclusions

Evaluating the most recent three years of data a few points can be made:

1. The results of the 2011 data collection found no areas with sulfur values above the 80 ppm federal limit. The data set average was 26.4 ppm, with a maximum value of 42.6 ppm.
2. The EPA diesel regulations require the following transition to low sulfur blends by 2010:

- Mid-2006: 80% at 15 ppm maximum sulfur (up to 20% at 500 ppm sulfur under the TCO Hardship Provisions)
- Mid-2010: 100% at 15 ppm maximum sulfur

  The results of the 2011 data collection found no districts with average sulfur values above the 15 ppm limit. The data set average was 5.72 ppm, with a maximum value of 7.83 ppm.

3. The preliminary analysis of temporal variability at the station level, as evidenced in the second round test results for the Houston area, appear to indicate low variability for gasoline fuel parameters. Significant, unexplained temporal variability was identified in the diesel sample, however. The source of this variability is not known, although it may reflect contamination of one or more of the fuel samples prior to collection.

Attachment 1
Station Selection List

TxDOT District	Facility Name	Address	City	State	Zip Code
ABILENE	TOP-18	IH 20 EXIT 278 N	TYE	TX	79563
ABILENE	SWEETWATER CHEVRON	100 NW GEORGIA AVE	SWEETWATER	TX	79556
ABILENE	TOWN & COUNTRY 103	1101 LAMESA DR	BIG SPRING	TX	79720
AMARILLO	PILOT TRAVEL CENTER 436	715 S LAKESIDE DR	AMARILLO	TX	79118
AMARILLO	AMARILLO TRAVEL CENTER	7000 E INTERSTATE 40	AMARILLO	TX	79101
AMARILLO	JRS TRAVEL CENTER AMARILLO	11301 E INTERSTATE 40	AMARILLO	TX	79118
ATLANTA	JOES TEXACO	207 W BROADWAY	BIG SANDY	TX	75755
ATLANTA	MILLERS COVE GROCERY	1 MILLER ST	MILLERS COVE	TX	75493
ATLANTA	GREGS MIRACLE MART	1413 E 1ST ST	HUGHES SPRINGS	TX	75656
AUSTIN	WAG-A-BAG 16	10990 W HIGHWAY 29	LIBERTY HILL	TX	78642
AUSTIN	COURTESY SHELL 2	3906 S CONGRESS AVE	AUSTIN	TX	78704
AUSTIN	EXXON RS 60500	1625 E PARMER LN	AUSTIN	TX	78753
AUSTIN	KWIK CHEK 56	105 STATE HIGHWAY 71 W	BASTROP	TX	78602
AUSTIN	KWIK STAR	3839 AIRPORT BLVD	AUSTIN	TX	78704
BEAUMONT	NEWTON JIFFY MARKET	SH 87 & US HWY 190	NEWTON	TX	75966
BEAUMONT	LOVES TRAVEL STOP 293	107 FM 2025	CLEVELAND	TX	77328
BEAUMONT	PILOT TRAVEL CENTER 431	2205 N HIGHWAY 62	ORANGE	TX	77630
BEAUMONT	BINGO TRUCK STOP	46002 INTERSTATE 10	WINNIE	TX	77665
BEAUMONT	FLYING J TRAVEL PLAZA 735	7112 IH 10 W	ORANGE	TX	77630
BROWNWOOD	ALLSUPS 105	2205 CONRAD HILTON BLVD	CISCO	TX	76437
BROWNWOOD	FOOD PLAZA 1	1901 BELLE PLAIN ST	BROWNWOOD	TX	76801
BROWNWOOD	KEMPNER FOOD MART	12444 E HIGHWAY 190	KEMPNER	TX	76539
BRYAN	SPEEDY STOP 225	3401 HWY 21 E	BRYAN	TX	77808
BRYAN	JIF E MART 4	3207 E MAIN ST	MADISONVILLE	TX	77864
BRYAN	MAX EXPRESS SHELL	4150 STATE HIGHWAY 6 S	COLLEGE STATION	TX	77845
CHILDRESS	WESTSIDE SHELL	1200 W 11TH ST	QUANAH	TX	79252
CHILDRESS	LOVES TRAVEL STOP 247	219 S BOYKIN DR	MEMPHIS	TX	79245
CHILDRESS	TPC 6	I 40 & HWY 83	SHAMROCK	TX	79079
CORPUS CHRISTI	NAVIGATION GASCARD 260305	851 NAVIGATION BLVD	CORPUS CHRISTI	TX	78408
CORPUS CHRISTI	TEXAS STAR 171	2700 S US HWY 77 BYP	KINGSVILLE	TX	78363
CORPUS CHRISTI	STRIPES 2201	6240 S HIGHWAY 77	RIVIERA	TX	78379
CORPUS CHRISTI	STRIPES 7049	1723 E MAIN	ALICE	TX	78332

TxDOT District	Facility Name	Address	City	State	Zip Code
DALLAS	Ks FUEL STOP	412 N BELL AVE	DENTON	TX	76209
DALLAS	CRLLC 2706594	3321 S GARLAND AVE	GARLAND	TX	75041
DALLAS	DRIVERS TRAVEL MART	621 US HWY 75 N	ANNA	TX	75409
DALLAS	I-30 TRUCK STOP	801 E INTERSTATE 30	GARLAND	TX	75043
EL PASO	LOVES COUNTRY STORE 214	12800 HORIZON BLVD	EL PASO	TX	79927
EL PASO	PETRO STOPPING CENTER 350	601 VINTON AVE	CANUTILLO	TX	79835
EL PASO	VALERO CORNER STORE 1374	7960 GATEWAY BLVD E	EL PASO	TX	79907
EL PASO	FLYING J TRAVEL PLAZA 728	1301 N HORIZON BLVD	EL PASO	TX	79927
FORT WORTH	PILOT TRAVEL CENTER 206	1201 W INTERSTATE 20	WEATHERFORD	TX	76087
FORT WORTH	PETRO STOPPING CENTER 302	2003 SANTA FE DR	WEATHERFORD	TX	76086
FORT WORTH	SHELL 7556	1500 S COOPER ST	ARLINGTON	TX	76010
FORT WORTH	QUIKTRIP 873	101 W EVERMAN PKWY	FORT WORTH	TX	76134
HOUSTON	FLYING J TRAVEL PLAZA 729	15919 NORTH FWY	HOUSTON	TX	77090
HOUSTON	US 59 FUEL MART	26111 SOUTHWEST FWY	ROSENBERG	TX	77471
HOUSTON	WEST OREM VALERO	7104 W OREM	HOUSTON	TX	77085
HOUSTON	NORMANDY TRUCKSTOP	12823 EAST FWY	HOUSTON	TX	77015
HOUSTON	BAYTOWN VALERO TRAVEL CENTER	6110 INTERSTATE 10 E	BAYTOWN	TX	77521
HOUSTON	AIRWAY FOOD TEXACO	2201 GREENS RD	HOUSTON	TX	77032
HOUSTON	VALERO CORNER STORE 592	12464 FM 3083 RD	CONROE	TX	77301
LAREDO	SPEEDY STOP 78	900 ESPEJO MOLINA RD	LAREDO	TX	78043
LAREDO	SPEEDY STOP 75	7615 MCPHERSON	LAREDO	TX	78041
LAREDO	FLYING J TRAVEL PLAZA 730	1011 BELTWAY PKWY	LAREDO	TX	78045
LUBBOCK	FAST STOP 29	2510 W 5TH ST	PLAINVIEW	TX	79072
LUBBOCK	SHELL SWIF SHOP 4	DOWDEN RD & US HWY 62	WOLFFORTH	TX	79382
LUBBOCK	SHELL FOOD MART 127	7008 S UNIVERSITY AVE	LUBBOCK	TX	79413
LUFKIN	LOVES COUNTRY STORE 290	1003 S MEDFORD DR	LUFKIN	TX	75901
LUFKIN	DENNY OIL COMPANY	4123 OLD TYLER RD	NACOGDOCHES	TX	75964
LUFKIN	DIBOLL DEPOT	1605 N TEMPLE DR	DIBOLL	TX	75941
ODESSA	LOVES TRAVEL STOP 339	1901 W IH 20	ODESSA	TX	79766
ODESSA	LABODEGA QUICK STOP 2	3905 N FM 1936	ODESSA	TX	79764
ODESSA	FASTRAX 103	4401 W WADLEY AVE	MIDLAND	TX	79707
PARIS	PILOT TRAVEL CENTER 367	2725 FM 1903	CADDO MILLS	TX	75135
PARIS	VALERO CORNER STORE 4508	4801 MOULTON ST	GREENVILLE	TX	75401

TxDOT District	Facility Name	Address	City	State	Zip Code
PARIS	LONE STAR 50	2920 N US HIGHWAY 75 FWY	SHERMAN	TX	75090
PHARR	COMBES AUTO & TRUCK STOP	US HWY 77 & HWY 107	COMBES	TX	78535
PHARR	LOVES TRAVEL STOP 284	8420 N EXPRESSWAY 281	EDINBURG	TX	78539
PHARR	STRIPES 9111	806 E PALMA VISTA DR	PALMVIEW	TX	78572
SAN ANGELO	ALLSUPS 353	514 N MAIN ST	SAN ANGELO	TX	76903
SAN ANGELO	WES-T-GO 23	712 N CHADBOURNE ST	SAN ANGELO	TX	76903
SAN ANGELO	TOWN & COUNTRY 262	2901 N BRYANT BLVD	SAN ANGELO	TX	76903
SAN ANTONIO	TETCO 308	11390 IH 35 S	VON ORMY	TX	78073
SAN ANTONIO	VALERO CORNER STORE 1017	17500 N IH 35	SCHERTZ	TX	78154
SAN ANTONIO	KWIK CHEK 58	19995 STATE HWY 46 W	SPRING BRANCH	TX	78070
SAN ANTONIO	PIT STOP FOOD MART 5	1122 S IH 35	NEW BRAUNFELS	TX	78130
SAN ANTONIO	TIMEWISE FOOD STORE 9701	1526 N NEW BRAUNFELS AVE	SAN ANTONIO	TX	78208
TYLER	STOP & SHOP 5	HWY 14 S & PRICE ST	HAWKINS	TX	75765
TYLER	PILOT TRAVEL CENTER 486	12881 FM 14	TYLER	TX	75706
TYLER	BROOKSHIRE GROCERY DC1	1600 W SOUTHWEST LOOP 323	TYLER	TX	75701
TYLER	PAYLESS FOOD MART	360 E PINE ST	FRANKSTON	TX	75763
TYLER	LOVES COUNTRY STORE 287	1221 S OAK	VAN	TX	75790
WACO	WILLIES PLACE	101 CORNELIUS RD	HILLSBORO	TX	76645
WACO	LOVES COUNTRY STORE 231	INTERSTATE 35 & SR 22	HILLSBORO	TX	76645
WACO	EDS TRUCK STOP 4	337 S MCLENNAN LOOP	ELM MOTT	TX	76640
WICHITA FALLS	EXPRESSWAY CONOCO	602 U S HWY 287	ELECTRA	TX	76360
WICHITA FALLS	LOVES COUNTRY STORE 269	1124 CENTRAL FWY E	WICHITA FALLS	TX	76301
WICHITA FALLS	DANNYs 3	1508 SOUTHWEST PKWY	WICHITA FALLS	TX	76302
YOAKUM	EL CAMPO TRUCK STOP	21411 HIGHWAY 59	EL CAMPO	TX	77437
YOAKUM	EVERGREENS CONVENIENCE STORE	6724 US 59 RD	WHARTON	TX	77488
YOAKUM	STRIPES 1005	3204 S LAURENT	VICTORIA	TX	77901
YOAKUM	FASTOP 5	4102 US HIGHWAY 59 N	VICTORIA	TX	77905

Attachment 2
SwRI Testing Results for Gasoline – provided electronically

Attachment 3
SwRI Testing Results for Diesel – provided electronically

Attachment 4
SAS Program for Processing Round 1 Gasoline Data – provided electronically

Attachment 5
Data Analysis for Gasoline – provided electronically

Attachment 6
SAS Program for Round 1 vs Round 2 Gasoline Comparison – provided electronically

Attachment 7
Data Analysis for Diesel Samples – provided electronically