

# Texas Commission on Environmental Quality

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## INTEROFFICE MEMORANDUM

**To:** Don Thompson, Regional Director, R12  
Donna Phillips, Assist. Regional Director, R12  
Marsha Hill, Air Section Manager, R12  
Linda Vasse, Air Section Manager, R12  
Richard Hyde, Director, Air Permits Division  
John Sadlier, Director, Enforcement Division  
Candy Garrett, Director, Air Quality Planning  
& Implementation Division

**Date:** January 6, 2006

**From:** Joseph T. Haney, Jr., Toxicology Section, Chief Engineer's Office

**Subject:** Health Effects Review of Air Monitoring Data Collected in TCEQ Region  
12-Houston during 2004

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### Background

This memorandum conveys the Toxicology Section's evaluation of ambient air sampling conducted at monitoring network sites in Region 12-Houston during 2004. We reviewed summary results for volatile organic compounds (VOCs) from 1- and 24-hour canister samples, 1-hour autoGC VOC samples, 1- and 24-hour carbonyl samples, and 24-hour metals samples (from PM<sub>2.5</sub>, PM<sub>10</sub>, and TSP filters). Air monitoring in 2004 is summarized below and detailed information regarding [monitoring sites](#) and target analytes is presented in Table 1.

- 1-hour canister VOC sampling at 3 sites
- 24-hour canister VOC sampling at 16 sites
- 1- and 24-hour carbonyl sampling at 3 sites
- 24-hour metals sampling at 8 sites
- 1-hour autoGC VOC monitoring at
  - ▶ 4 TCEQ sites, and
  - ▶ 7 Enhanced Industry-Sponsored Monitoring (EISM) sites

One-hour canister VOC, autoGC VOC, and carbonyl data were evaluated for potential acute health and odor concerns. Twenty-four-hour air samples are designed to provide representative long-term average concentrations when collected over a period of time representing seasonal variations in meteorology. Therefore, annual averages from 24-hour samples were evaluated for potential chronic health concerns. Twenty-four-hour samples do not show short-term or peak concentrations, and therefore, have limited use in evaluating the potential for acute health effects or odors.

Measured chemical concentrations were compared to TCEQ health-based and odor-based Effects Screening Levels (ESLs). An ESL is a guideline concentration which is protective of the general public, including sensitive members of the population such as the elderly, children, and persons with pre-existing health conditions. Health-based ESLs are guideline comparison levels set well below levels at which adverse health effects have been reported in the scientific literature. If an air

concentration of a pollutant is below the ESL, we do not expect adverse health effects to occur. If an air concentration of a pollutant is above the health-based ESL, it is not indicative that adverse effects will necessarily occur, but rather, that further evaluation may be warranted.

Odor-based ESLs are typically based on detection or recognition thresholds (e.g., concentrations at which 50% of the tested individuals detected an odor or recognized the odor as that of a particular chemical). Therefore, as the concentration of a chemical increases over its odor threshold, the percentage of people expected to perceive an odor increases. Chemical concentrations that are below an odor threshold are less likely to be odorous, but the perception of odor by some individuals cannot be ruled out.

The health effects evaluation may include the estimation of cancer risk. This is accomplished using EPA unit risk factors to calculate *upper-bound* excess lifetime cancer risk that is estimated to result from *continuous lifetime exposure* to the 2004 monitored average concentration. However, due to many factors (e.g., population mobility and daily activity patterns, differences in distance and direction from the source(s) monitored, variability in area emissions, differences in indoor and outdoor concentrations), *the 2004 monitored average concentration at a particular site is not expected to be representative of actual lifetime exposure levels for surrounding communities*. As a result, the risk estimates presented should not be construed to be actual upper-bound excess lifetime cancer risk for the surrounding communities. *These cancer risk estimates are only to allow comparison of potential relative risk, based on the unrealistic assumption that the 2004 monitored average concentration is representative of actual lifetime exposure levels*. *Upper-bound* means the true risk may be lower but is unlikely to be higher than the estimate. *Excess lifetime* risk means the additional or extra risk of developing cancer due to exposure to a toxic substance over the lifetime of an individual. The highest excess cancer risk considered to be acceptable is generally between 1 in 10,000 and 1 in 1 million (or  $10^{-4}$  to  $10^{-6}$ )<sup>1</sup>. The target risk goal of the Toxicology Section (TS) is 1 in 100,000 ( $10^{-5}$ ) for individual chemicals and 1 in 10,000 ( $10^{-4}$ ) for cumulative risk. This memorandum evaluates air monitoring data on a chemical-by-chemical basis.

The Texas Department of State Health Services estimates that approximately two out of every five persons alive today (40%) will develop some type of cancer in their lifetime<sup>2</sup>. Lifestyle choices such

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<sup>1</sup>40 CFR Ch. 1, 300.430, 7-1-98 Edition.

<sup>2</sup>Texas Department of State Health Services, Texas Cancer Epidemiology and Surveillance Branch. *Summary of Investigation Into the Occurrence of Cancer, Zip Codes 77531 (Clute), 77541 (Freeport), 77012, 77017 (Houston), 77520 (Baytown), 77619 (Groves), 77640/77642 (Port Arthur), and 77651 (Port Neches), Brazoria, Harris, and Jefferson County Texas, 1993-2002, September 3, 2004.*

as tobacco use and diet have been associated with 50-75% of cancer deaths<sup>3</sup>, while environmental pollution has been estimated to cause a relatively small percentage of cancers. For example, the Harvard Center for Cancer Prevention estimates that 2% of cancer deaths are attributable to environmental pollution (including water, soil, and air)<sup>4</sup>. These are overall estimates regarding causes of cancer and may not reflect the relative importance of risk factors in select subpopulations and individuals.

## **Evaluation**

### One-Hour Concentrations

*The vast majority of one-hour canister VOC, autoGC VOC, and carbonyl concentrations were below their respective short-term health- and odor-based ESLs. Over 99.99% of the approximately 3,800,000 one-hour VOC measurements from autoGC monitors in Region 12 in 2004 were below short-term health- and odor-based ESLs. Less than 0.006% of the hourly autoGC measurements collected in Region 12 in 2004 exceeded health-based ESLs. Less than 0.004% exceeded odor-based ESLs, and the vast majority of them occurred at two sites in close proximity to industrial sources and the Houston ship channel. One-hundred percent of the approximately 9,600 one-hour VOC concentrations from canister samples were below short-term health- and odor-based ESLs. Additionally, the vast majority of one-hour carbonyl concentrations measured in Region 12 in 2004 were below short-term health- and odor-based ESLs. Therefore, we would not expect short-term adverse health effects or odors to be associated with the vast majority of hourly measurements collected in Region 12 in 2004.*

For the few chemicals that exceeded their respective short-term health-based ESLs (i.e., formaldehyde, methyl ethyl ketone/methacrolein, 1,3-butadiene, benzene, styrene, toluene), further evaluation determined that we would not expect adverse short-term health effects (e.g., eye and respiratory irritation) to occur as a result of exposure to the reported one-hour concentrations. However, some hourly benzene levels are notable because of their magnitude and/or frequency. The highest hourly benzene concentration at the Baytown-Lynchburg Ferry autoGC site, which is 1 to 2 miles from residential areas, was 1,552 ppbv. While this level is less than the lowest levels shown to cause adverse health effects (e.g., hematological) in short-term human and animal studies, it is

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<sup>3</sup>National Cancer Institute. *Cancer Progress Report - 2003 Update*. NIH, DHHS, Bethesda, MD, February 2004, <http://progressreport.cancer.gov/doc.asp?pid=1&did=21&mid=vcol&chid=9&click=Prevention> (accessed 08/26/05).

<sup>4</sup>Harvard Center for Cancer Prevention. *Harvard Reports on Cancer Prevention. Volume I: Human Causes of Cancer*, [http://www.hsph.harvard.edu/cancer/publications/reports/vol1\\_summary.html](http://www.hsph.harvard.edu/cancer/publications/reports/vol1_summary.html) (accessed 08/26/05).

notably high and contributed to the annual benzene average exceeding the long-term ESL at the Baytown-Lynchburg Ferry site along with the other 85 hourly ESL exceedances for benzene (see *Annual Average Concentrations* below). Region 12 investigators identified several violations during a recent compliance investigation of one of the barge facilities located just north of the Baytown-Lynchburg Ferry site, including not routing certain tanks to the vapor destruction unit and failure to maintain records of continuous monitoring of the thermal oxidizer during degassing activities of benzene. However, the extent to which the violations identified may have contributed to the elevated benzene levels measured at the site is not known. The violations were referred to TCEQ's Enforcement Division for formal enforcement. At the Texas City autoGC site, 113 hourly benzene concentrations (maximum of 177 ppbv) exceeded the short-term ESL and contributed to the annual average exceeding the long-term ESL (see *Annual Average Concentrations* below). The Galveston County Health District is planning an investigation into potential benzene sources at a nearby facility and their compliance with applicable requirements. Region 12 staff will provide technical guidance and/or assistance as needed.

As shown in Table 2, some hourly autoGC VOC measurements exceeded their respective odor-based ESLs. Additionally, the highest and second highest 24-hour levels of butyraldehyde at Houston-Clinton Dr. (6.7 and 5.3 ppbv) exceeded the odor threshold (5 ppbv), and the highest 24-hour level of styrene at Baytown-Lynchburg Ferry (27.9 ppbv) exceeded the odor threshold (25 ppbv).

Table 2. Exceedances of Odor-Based ESLs by 2004 Monitored Hourly AutoGC Levels

Site	Chemical	Number of Hourly Samples > Odor-Based ESL	Highest Concentration (ppbv)	Odor-Oased ESL (ppbv)
Baytown-Lynchburg Ferry EISM U23 (Jan - Dec)	isoprene	14	27.0	5
	1-butene	1	70.4	69
	1-hexene	4	118.6	20
	t-2-hexene	1	34.2	20
	isopropylbenzene	1	101.4	100
	4-methyl-1-pentene	1	46.4	20
	1-pentene	1	46.6	30
	styrene	56	257.5	25
Houston-Clinton Dr. (Jan - Dec)	isoprene	5	47.4	5
Channelview (Jan - Dec)	1-butene	1	73.8	69

Site	Chemical	Number of Hourly Samples > Odor-Based ESL	Highest Concentration (ppbv)	Odor-Oased ESL (ppbv)
Dancigar EISM U28 (Jan - Dec)	isoprene	4	10.6	5
Cesar Chavez (May - Dec)	1-butene	1	113.8	69
	1-pentene	1	38.7	30
	2-methylpentane	1	128.3	83
	c-2-pentene	1	45.6	30
	t-2-pentene	2	91.9	30
	isoprene	1	11.3	5
Houston-Haden Rd. EISM U22 (Jan - Dec)	styrene	1	25.3	25
	isoprene	16	14.4	5
	1-hexene	9	81.6	20
	1-butene	20	144.2	69
Lake Jackson EISM U26 (Jan - Dec)	isoprene	1	5.3	5

At the Baytown-Lynchburg Ferry site, 56 hourly styrene concentrations (including a maximum of 257.5 ppbv) exceeded the odor-based ESL of 25 ppbv. Additionally, TCEQ mobile monitoring in 2004 detected elevated styrene levels (up to 390 ppbv) downwind of nearby barge facilities. Although these styrene concentrations would not be expected to cause direct acute health effects such as eye and skin irritation<sup>5</sup>, exposure to strong unpleasant odors can cause odor-related effects such as headache and nausea. During the 2004 mobile monitoring, TCEQ staff observed barge loading/unloading in progress, and reported styrene odors and that citizens waiting for the ferry and ferry workers commented on the odors. As indicated above, Region 12 investigators recently conducted a compliance investigation of one of the barge facilities located to the north of the Baytown-Lynchburg Ferry site. Several violations were identified and referred to TCEQ's

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<sup>5</sup>ATSDR, 1992. Toxicological Profile for Styrene. Agency for Toxic Substances and Disease Registry, U.S. Public Health Service. September, 1992, <http://www.atsdr.cdc.gov/toxprofiles/tp53.html> (accessed 08/26/05); and California EPA, 1999. Acute Toxicity Summary for Styrene. March, 1999, [http://www.oehha.org/air/acute\\_rels/pdf/100425A.pdf](http://www.oehha.org/air/acute_rels/pdf/100425A.pdf) (accessed 08/26/05).

Enforcement Division for formal enforcement, and a proposed agreed order has been presented to the company, but whether and the extent to which the violations identified have contributed to the elevated styrene levels measured at the Baytown-Lynchburg Ferry site is not known. Additionally, TS understands that Harris County Pollution Control recently filed a lawsuit against this facility for nuisance odors caused by the stripping and degassing a styrene barge. In an August 30, 2005 interoffice memorandum to the Air Permits Division, TS recommended *not issuing* an existing facility permit to the “grandfathered” part of the barge facility because of elevated modeled and monitored off-site benzene and styrene levels, and recommended reducing overall emissions and characterizing the unexpected/unreported emission sources revealed by a recent HAWK infrared camera inspection. In a September 23, 2005 interoffice memorandum to the Air Permits Division, TS supported issuing of the permit due to reductions of 67-90% in hourly styrene emissions and 79-94% in hourly benzene emissions (35% reduction in annual emissions), as well as other reductions.

In June 2005, the office of Harris County Precinct 2 Commissioner Sylvia R. Garcia reported that eight ferry employees filed incident reports complaining of headaches, nausea, and burning throats and chests on three different days, on which odors were extremely strong during particular times. As mentioned above, headache and nausea can result from experiencing strong unpleasant odors, and during the referenced period on the third day, the hourly concentration of styrene at the Baytown-Lynchburg Ferry site (located near the north ferry landing) was 83.3 ppbv, over three-times the odor threshold. Additionally, earlier on the third day an hourly styrene concentration of 433 ppbv was reported. While headache and nausea can result from experiencing strong unpleasant odors, these styrene concentrations would not be expected to cause direct acute health effects such as burning throats and chests.<sup>5</sup> For the other periods referenced by the office of Commissioner Garcia, data show that styrene levels are well below the odor threshold, and levels of the other chemicals reported are not of health concern. The concentration of total non-methane organic carbon compounds (TNMOC) appears to have been elevated during some of the referenced periods. However, since analytical methodology limits elucidation of the chemicals comprising TNMOC to the chemicals reported, TNMOC cannot be further evaluated from an odor or health effects perspective.

#### Annual Average Concentrations

*The vast majority of annual average concentrations calculated for autoGC and 24-hour canister VOCs, 24-hour carbonyls, and 24-hour metals were less than their respective long-term ESLs and are not expected to pose an appreciable health concern. Approximately 99.9% of the over 1,560 annual averages calculated for VOCs based on 24-hour canister samples collected in Region 12 in 2004, and 99.7 % of the over 620 annual averages calculated for VOCs based on one-hour autoGC samples, were less than their respective long-term ESLs. Additionally, 100% of the annual averages for metals<sup>6</sup> were less than their respective long-term ESLs, and the vast majority of annual averages for carbonyls were below long-term ESLs.*

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<sup>6</sup> Fourth quarter PM<sub>10</sub> metals data is not available at this time for the Houston-Clinton Dr. monitoring site and was not included in the 2004 average for this site.

Only benzene and formaldehyde exceeded their respective long-term ESLs and merited further discussion. Of the twenty-one Region 12 monitoring sites which analyze for benzene, the long-term ESL for benzene was exceeded at three sites, which are located in close proximity to industrial sources and/or the Houston ship channel. While measured formaldehyde levels are also above the long-term ESL at three sites, these levels are not expected to pose an appreciable health concern for reasons discussed below. Additionally, 1,3-butadiene levels at the Milby Park monitoring site were determined to merit further discussion.

### *Benzene*

The 2004 average benzene levels based on 24-hour canister samples collected at Baytown-Lynchburg Ferry (1.7 ppbv) and Galena Park (1.6 ppbv) exceeded the long-term benzene ESL (1 ppbv). The 2004 benzene averages based on autoGC data collected at the Baytown-Lynchburg Ferry (2.4 ppbv) and Texas City (1.6 ppbv) sites also exceeded the long-term ESL. The EPA has published a range of risk estimates for benzene carcinogenicity because of uncertainty in the low-dose exposure scenarios and lack of clear understanding of the mode of action. The risk estimates range from  $2.2 \times 10^{-6}$  to  $7.8 \times 10^{-6}$  risk per microgram/m<sup>3</sup> with each having equal scientific plausibility<sup>7</sup>. Assuming continuous lifetime exposure to the 2004 average measured benzene levels and using both the low and high ends of the unit risk factor range, theoretical upper-bound excess lifetime cancer risk estimates at these sites range from approximately 1 in 100,000 to 6 in 100,000.

Continuous long-term exposure would not be expected to occur at the Baytown-Lynchburg Ferry site as it is not located in a residential area. As shown in Figure 1, residential areas begin at distances of approximately 1 to 2 miles from the Baytown-Lynchburg Ferry site. However, the 2004 autoGC benzene level at this site is noteworthy considering that this is not “fenceline” monitoring, and both industrial benzene sources and residential areas lie within 1 to 2 miles of the monitoring site. Assuming continuous lifetime exposure to the 2004 average at the Baytown-Lynchburg Ferry autoGC site, upper-bound excess lifetime cancer risk is estimated to range from 2 in 100,000 to 6 in 100,000, which exceeds our target risk goal. Based on three calendar quarters of limited sampling, the 2003 average at Baytown-Lynchburg Ferry based on 24-hour canisters (2.7 ppbv) is similar to that in 2004 based on autoGC data (2.4 ppbv). The average at the Baytown-Lynchburg Ferry autoGC site through the third quarter of 2005 (2.9 ppbv) is higher than the average through the third quarter of 2004 (2.3 ppbv). A preliminary evaluation of source direction using the hourly 2004 autoGC data at this site indicates that higher benzene levels were associated with winds blowing from the north and southwest (Figure 2). The intersection of Battleground Road and Tidal Road is located approximately 2 miles to the south/southwest of the Baytown-Lynchburg Ferry site, and TCEQ mobile monitoring detected elevated benzene levels in this area in 2002 and 2004. Possible benzene sources (e.g., barge facilities) are located much closer to the north, and mobile monitoring detected elevated benzene (and styrene) levels downwind of these sources in 2004. As mentioned previously,

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<sup>7</sup>USEPA, 2003. Integrated Risk Information System. Benzene. Carcinogenicity Assessment for Lifetime Exposure. April 17, 2003, <http://www.epa.gov/iris/subst/0276.htm#carc> (accessed 08/26/05).

Region 12 investigators recently conducted a compliance investigation of one of the barge facilities located to the north of the Baytown-Lynchburg Ferry site. Several violations were identified, including not routing certain tanks to the vapor destruction unit and failure to maintain records of continuous monitoring of the thermal oxidizer during degassing activities of benzene. However, the extent to which the violations identified may have contributed to the elevated benzene levels measured at the Baytown-Lynchburg Ferry site is not known. The violations have been referred to TCEQ's Enforcement Division for formal enforcement, and a proposed agreed order has been presented to the company. A more definitive identification of sources (e.g., through evaluation of source directionality) and information on their relative contributions to the measured benzene levels are needed to determine how ambient levels in residential areas would be expected to compare with measured levels at Baytown-Lynchburg Ferry.

Continuous lifetime exposure to the 2004 benzene average at the Texas City autoGC site would be associated with an upper-bound excess lifetime cancer risk estimate ranging from 1 in 100,000 to 4 in 100,000. The high end of this upper-bound cancer risk estimate range exceeds our target risk goal ( $10^{-5}$ ). The Texas City site is located within approximately 1/10 to 1/2 mile of residences, and a preliminary evaluation of source direction using the hourly 2004 autoGC data at this site indicates that higher benzene levels were associated with winds blowing from the northeast (Figure 6). Additionally, TCEQ mobile monitoring in 2004 measured elevated benzene levels (up to 390 ppbv) downwind of a facility which is less than 1/2 mile northeast of the Texas City autoGC site, and on the same day hourly benzene levels at the site were elevated (2.2 to 47.2 ppbv) when the resultant wind direction would indicate the facility was generally upwind (northeast winds from approximately 30 to 50 degrees). The Galveston County Health District is planning an investigation into potential benzene sources at the facility and their compliance with applicable requirements, and Region 12 staff will provide technical guidance and/or assistance as needed. The average at the Texas City autoGC site through the third quarter of 2005 (0.8 ppbv) is below the long-term ESL.

Continuous lifetime exposure to the 2004 benzene average at the Galena Park site would also be associated with an upper-bound excess lifetime cancer risk estimate ranging from 1 in 100,000 to 4 in 100,000. The high end of this upper-bound cancer risk estimate range exceeds our target risk goal ( $10^{-5}$ ). Additionally, the high end of the upper-bound risk range associated with the 1998-2004 average benzene level at Galena Park (1.5 ppbv) exceeds our target risk goal. The Galena Park site is located in a residential area. A preliminary evaluation of source direction using the 24-hour data from this site in 2004 indicates that higher benzene levels were associated with winds blowing from the southeast (Figure 7), and based on the aerial photograph it appears that facility tanks are located nearby to the southeast (Figure 8). During mobile monitoring, in 2004 an instantaneous canister sample collected downwind of a nearby facility southeast of the site contained 20 ppbv of benzene, and in 2005 a 30-minute canister collected downwind of the same facility contained 84 ppbv. Also, during 2005 mobile monitoring, an 8-hour benzene level of 110 ppbv, 1-hour level of 260 ppbv, and maximum level of 380 ppbv were measured downwind of a facility located to the south/southeast.

*TS believes a reduction in ambient benzene levels is advisable near the Galena Park and Baytown-Lynchburg Ferry sites because the 2004 average benzene level at Galena Park (and 1998-2004 average level) would represent a theoretical upper-bound excess cancer risk range that is equal to or higher than our target risk goal ( $10^{-5}$ ), and the 2004 average benzene level at Baytown-Lynchburg Ferry would represent a theoretical upper-bound cancer risk range that is higher than our target risk goal.*

### *Formaldehyde*

The 2004 average formaldehyde concentrations at Channelview (3.0 ppbv), Houston-Clinton Dr. (2.7 ppbv), and Houston-Deer Park (4.6 ppbv) exceeded the current long-term ESL (1.2 ppbv). Assuming continuous lifetime exposure to the measured levels and using the EPA unit risk factor, cancer risk estimates range from 4 in 100,000 to 7 in 100,000. However, the current EPA formaldehyde unit risk factor, which was promulgated in 1991 based on rat data from a 1987 study, does not represent the best available science in the peer-reviewed literature and is generally believed to substantially overestimate risk. EPA is currently reviewing this risk factor in light of significant new data and analyses. Use of a new risk factor<sup>8</sup> (published in 2004) that incorporates more recent toxicological research affecting formaldehyde carcinogenicity (e.g., anatomical differences between rat and human nasal passages, regional dosimetry throughout the human respiratory tract, mode of action information) results in *de minimus* risk estimates of 1 in 10 million to 2 in 10 million for lifetime exposure to these formaldehyde levels. The new risk factor is considered more scientifically-defensible as it utilizes more recently available mechanistic and dosimetric science on the dose-response for portal of entry (i.e., respiratory tract) cancers due to formaldehyde exposure.

### *1,3-Butadiene*

Annual average 1,3-butadiene levels did not exceed the current long-term ESL (5 ppbv). However, we expect a new 1,3-butadiene ESL to be developed and published subsequent to TS finalizing the new ESL development methodology. While we do not know what the new long-term ESL will be, it may be lower than the current value.

The 2004 average 1,3-butadiene level at Milby Park was 4 ppbv. Since 1999, annual average 1,3-butadiene levels at Milby Park (Figure 3) have varied between 2.1 and 4.4 ppbv, with a six-year average of 3.3 ppbv. The highest 24-hour concentrations have trended upwards from 2001-2004, with the highest 24-hour levels in 2004 levels being similar to those in 1999 and 2000. The 2004 annual average 1,3-butadiene level at Milby Park is substantially higher than at other air toxics monitoring sites (see Figure 4). *However, it appears that the 2005 average will be significantly lower, as the average at Milby Park based on available autoGC data from February through*

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<sup>8</sup> 4.77E-7 risk per 0.010 ppm (risk-conservative factor for smokers from the hockey stick-shaped dose-response model) in R. Conolly, et al., 2004. Human Respiratory Tract Cancer Risks of Inhaled Formaldehyde: Dose-Response Predictions Derived from Biologically-Motivated Computational Modeling of a Combined Rodent and Human Dataset. Toxicological Sciences 82:1, 279-296.

*November of 2005 (1.6 ppbv) is significantly lower than the 2004 average based on 24-hour canister samples over the same period (4.1 ppbv).*

As indicated in the health effects review of 2003 air monitoring data for Region 12, high 1,3-butadiene levels measured at Milby Park are associated with winds blowing from the direction of the industrial complex (including Texas Petrochemicals, Goodyear, and ExxonMobil) located approximately ¼ to 1¼ miles southeast of the Milby Park monitor. As shown in Figure 5, preliminary evaluation of source direction for 1,3-butadiene levels measured at nearby autoGC monitors at Clinton Dr. and Cesar Chavez High School in 2004 (and Milby Park in 2005) also primarily points to the same industrial complex. TCEQ has recently entered into agreements with the two biggest 1,3-butadiene emitters of the complex (i.e., Texas Petrochemicals, Goodyear) aimed at significantly reducing emissions. Some of the provisions include a total reduction in emissions of over 90,000 pounds per year by the end of 2008, reductions in permitted emissions following each emissions reduction project, company fence line monitoring with a goal of 1 ppbv by the end of 2007, the use of new technologies (i.e., HAWK infrared camera and/or Cerex UV Hound camera) to identify leak emission sources, and quarterly reports to the TCEQ. TS understands that ExxonMobil has informed TCEQ that they will shut down their olefin plant in early 2006, which would result in further reductions of 1,3-butadiene emissions in the Milby Park area.

Assuming continuous lifetime exposure to the 1,3-butadiene levels monitored in 2004 and using the EPA unit risk factor, theoretical cancer risk estimates for 1,3-butadiene at other Region 12 monitoring sites ranged from 1 in 1 million to 4 in 100,000. However, for the 2004 average 1,3-butadiene level (4.0 ppbv) at Milby Park, the theoretical cancer risk estimate is 3 in 10,000. To put the estimated 3 in 10,000 risk in perspective, this would theoretically increase cancer incidence from a background of approximately 40% to 40.03%. For the 1999-2004 six-year average (3.3 ppbv), the theoretical cancer risk estimate is also about 3 in 10,000.

The Manchester community lies between the Clinton Dr. monitoring site and the Texas Petrochemicals/Goodyear/ExxonMobil complex. While 2004 TCEQ monitoring data are not available for this community, TCEQ installed a monitor in Manchester in 2005 and data from the monitor will be reviewed for the health effects evaluation of 2005 Region 12 data. As mentioned in the health effects review of 2003 Region 12 air monitoring data, the Texas Cancer Epidemiology and Surveillance (TCES) Branch of the Texas Department of State Health Services investigated the occurrence of cancer in several zip codes including 77012 (includes Manchester) and 77017 (includes Milby Park and Cesar Chavez area). Cancer cluster studies are limited by the amount and quality of available data. The TCES noted that while the study could have detected a large increase in cancer risk if it were present, it was limited in its power to detect a small effect from some environmental or other type of exposure. Cancer incidence data from January 1, 1995 through December 31, 2001 and cancer mortality data from January 1, 1993 through December 31, 2002 were analyzed. TCES concluded that *the cancer incidence and mortality data for all examined types*

*of cancer were within normal ranges among both males and females<sup>9</sup>. Nevertheless, TS believes a reduction in ambient 1,3-butadiene levels is necessary near Milby Park because the long-term level monitored at Milby Park would represent a theoretical cancer risk that is higher than both the federal acceptable risk range ( $10^{-6}$  to  $10^{-4}$ ) and our target risk goal ( $10^{-5}$ ).*

TCEQ was recently awarded Clean Air Act funds from USEPA Region 6 for the Houston Exposure to Air Toxics Study (HEATS), which will be conducted by the University of Texas School of Public Health at Houston. The two-year study will examine personal exposure to VOCs and carbonyls in Manchester and nearby neighborhoods adjacent to the Houston ship channel, as well as in a reference population. Personal exposure information will also be compared to TCEQ ambient air monitoring data, which will allow TCEQ to more effectively target and utilize resources in specific areas of concern.

As indicated in the health effects review of 2003 Region 12 air monitoring data, several air monitoring projects over the last several years have focused on characterizing ambient VOC levels (including 1,3-butadiene) in the Milby Park/Manchester/Cesar Chavez High School area. TCEQ interest in air quality in this area has been shared by local residents, local government, and legislators. Air monitoring conducted in early 2001 by the City of Houston at Cesar Chavez High School and Fire Station No. 29, and mobile monitoring conducted at Cesar Chavez High School in March 2001 by the TCEQ, did not detect 1,3-butadiene concentrations of concern. However, mobile monitoring in April-May 2001 and May 2002 detected 1,3-butadiene levels that were a potential health concern, and the health effects evaluation called for reductions. Additional mobile monitoring in November 2002 detected much lower 1,3-butadiene concentrations than during the previous two monitoring trips. As previously mentioned, a TCEQ monitoring site has been established in the Manchester neighborhood to better characterize ambient air quality there. The 2004 TCEQ Houston Air Pilot Project was conducted for the Environmental Monitoring and Response System (EMRS) and focused on highly reactive VOCs (HRVOCs) such as 1,3-butadiene that are important in the formation of ozone. The ongoing EMRS project is focusing additional attention on 1,3-butadiene in this area as a HRVOC. In addition to EMRS, other agency efforts such as the HRVOC Rules, special reviews of air permit applications involving 1,3-butadiene, and agreements with and inspections of the major 1,3-butadiene emission sources are expected to result in decreased ambient 1,3-butadiene levels. In fact, it appears that the 2005 1,3-butadiene average at the Milby Park autoGC site will be significantly lower than in recent years (Figure 3).

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<sup>9</sup> Texas Department of State Health Services, Texas Cancer Epidemiology and Surveillance Branch. *Summary of Investigation Into the Occurrence of Cancer, Zip Codes 77531 (Clute), 77541 (Freeport), 77012, 77017 (Houston), 77520 (Baytown), 77619 (Groves), 77640/77642 (Port Arthur), and 77651 (Port Neches), Brazoria, Harris, and Jefferson County Texas, 1993-2002, September 3, 2004.*

## Conclusions

- *The vast majority of one-hour canister VOC, autoGC VOC, and carbonyl concentrations were below their respective short-term health- and odor-based ESLs. Over 99.99% of the approximately 3,800,000 one-hour VOC measurements from autoGC monitors in Region 12 in 2004 were below short-term health- and odor-based ESLs. One-hundred percent of the approximately 9,600 one-hour VOC concentrations from canister samples were below short-term health- and odor-based ESLs. Additionally, the vast majority of one-hour carbonyl concentrations measured in Region 12 in 2004 were below short-term health- and odor-based ESLs. Therefore, we would not expect short-term adverse health effects or odors to be associated with the vast majority of hourly measurements collected in Region 12 in 2004.*
- *The vast majority of annual average concentrations calculated for autoGC and 24-hour canister VOCs, 24-hour carbonyls, and 24-hour metals were less than their respective long-term ESLs and are not expected to pose an appreciable health concern. Approximately 99.9% of the over 1,560 annual averages calculated for VOCs based on 24-hour canister samples collected in Region 12 in 2004, and 99.7 % of the over 620 annual averages calculated for VOCs based on one-hour autoGC samples, were less than their respective long-term ESLs. Additionally, 100% of the annual averages for metals were less than their respective long-term ESLs, and the vast majority of annual averages for carbonyls were below long-term ESLs.*
- *Continuous lifetime exposure to the 2004 annual average 1,3-butadiene level measured at Milby Park would be associated with a theoretical excess cancer risk of greater than 1 in 10,000. It appears that the 2005 average will be significantly lower, as the average based on available autoGC data from February through November of 2005 (1.6 ppbv) is significantly lower than the 2004 average based on 24-hour canister samples over the same period (4.1 ppbv). Reductions in ambient 1,3-butadiene levels in the Milby Park area are necessary in order to meet EPA and TCEQ target risk goals, and agency efforts such as those described in the bullet below should be pursued in order to accomplish these reductions.*
- *Evaluation of source direction using 2004 1,3-butadiene data from autoGC monitors at Clinton Dr. and Cesar Chavez High School (and Milby Park 2005 autoGC data) points toward the Texas Petrochemicals/Goodyear/ExxonMobil industrial complex southeast of Milby Park. TCEQ has recently entered into agreements with the two biggest 1,3-butadiene emitters of the complex (i.e., Texas Petrochemicals, Goodyear) which include a total reduction in emissions of over 90,000 pounds per year by the end of 2008 and company fence-line monitoring with a goal of 1 ppbv by the end of 2007. TS understands that ExxonMobil has informed TCEQ that they will shut down their olefin plant in early 2006, which would result in further reductions of 1,3-butadiene emissions in the Milby Park area. It appears that the 2005 1,3-butadiene annual average at the Milby Park site will be significantly lower than the 2004 average.*

- While 2004 TCEQ monitoring data are not available for the Manchester community, 2005 data from a recently installed Manchester monitor will be reviewed for the health effects evaluation of 2005 Region 12 data.
- The two-year Houston Exposure to Air Toxics study (HEATS) will examine personal exposure to VOCs and carbonyls in Manchester and nearby neighborhoods adjacent to the Houston ship channel, as well as in a reference population. Personal exposure information will also be compared to TCEQ ambient air monitoring data, which will allow TCEQ to more effectively target and utilize resources in specific areas of concern.
- Continuous lifetime exposure to the 2004 average benzene level at the Galena Park site (1.6 ppbv) would be associated with an upper-bound excess lifetime cancer risk range of 1 in 100,000 to 4 in 100,000. Continuous lifetime exposure to the 2004 average benzene level measured at the Baytown-Lynchburg Ferry autoGC (2.4 ppbv) is of interest because it is higher than typically seen in the monitoring network and would be associated with a theoretical excess cancer risk range of 2 in 100,000 to 6 in 100,000. Although continuous long-term exposure would not be expected to occur at this site, residential areas lie within 1 to 2 miles of the monitoring site. *TS believes a reduction in ambient benzene levels is advisable near the Galena Park and Baytown-Lynchburg Ferry sites because the 2004 average benzene level at Galena Park (and 1998-2004 average level) would represent a theoretical upper-bound excess cancer risk range that is equal to or higher than our target risk goal ( $10^{-5}$ ), and the 2004 average benzene level at Baytown-Lynchburg Ferry would represent a theoretical upper-bound cancer risk range that is higher than our target risk goal.*
- Recently, Region 12 investigators conducted a compliance investigation of one of the barge facilities located to the north of the Baytown-Lynchburg Ferry site. Violations were identified and referred to TCEQ's Enforcement Division for formal enforcement.
- Hourly levels of several VOCs (most notably, styrene at Baytown-Lynchburg Ferry) exceeded their respective odor-based ESLs and could be odorous to people if exposed. While the potentially odorous concentrations reported in 2004 would not be expected to cause direct health effects such as eye irritation, odor-related health effects such as headache and nausea may occur depending on the subjective experience of the person experiencing the odor, and the intensity, type, frequency, and duration of the odor. Region 12 investigators recently conducted a compliance investigation of one of the barge facilities located to the north of the Baytown-Lynchburg Ferry site where 56 hourly exceedances of the odor-based ESL for styrene occurred. Violations were identified and referred to TCEQ's Enforcement Division for formal enforcement.

Please contact me at (512) 239-5691 or [jhaney@tceq.state.tx.us](mailto:jhaney@tceq.state.tx.us) if you have any questions regarding this memorandum.

Table 1. 2004 TCEQ Region 12 Air Monitoring Sites and Data Types Collected.

County	AIRS Number	City, Site	Hourly AutoGC VOCs	24-Hour Canister VOCs	1-Hour Canister VOCs	24-Hour Carbonyls	1-Hour Carbonyls	24-Hour Metals
Brazoria	480391003	Clute, Cobb Field	no	Yes <sup>1,2</sup>	no	no	no	no
	480390618	Danciger, EISM U28	Yes <sup>1,3</sup>	no	no	no	no	no
	480391016	Lake Jackson, EISM U26	Yes <sup>1,3</sup>	no	no	no	no	no
	480390619	Liverpool, Mustang Bayou, EISM U27	Yes <sup>1,3</sup>	no	no	no	no	no
Galveston	481670014	Galveston, Airport	no	Yes <sup>1,2</sup>	Yes <sup>1,2</sup>	no	no	Yes <sup>5</sup>
	481670005	Texas City, Ball Park	no	Yes <sup>1,2</sup>	no	no	no	no
	481670053	Texas City, Nessler Pool	no	Yes <sup>1,2</sup>	Yes <sup>1,2</sup>	no	no	no
	481670056	Texas City, EISM U25	Yes <sup>1,3</sup>	no	no	no	no	no
Harris	482010024	Aldine, Hambrick Jr. High School	no	Yes <sup>1,2</sup>	no	no	no	Yes <sup>5</sup>
	482010058	Baytown	no	Yes <sup>1,2</sup>	no	no	no	no
	482011015	Baytown, Lynchburg Ferry	no	Yes <sup>1,2</sup>	no	no	no	no
		Baytown, Lynchburg Ferry, EISM U23	Yes <sup>1,3</sup>	no	no	no	no	no
	482010617	Baytown, Wallisville Rd., EISM U24	Yes <sup>1,3</sup>	no	no	no	no	no
	482010026	Channelview	Yes <sup>1,3</sup>	Yes <sup>1,2</sup>	no	Yes <sup>4</sup>	Yes <sup>4</sup>	Yes <sup>5</sup>
	482010057	Galena Park	no	Yes <sup>1,2</sup>	no	no	no	no
	482011034	Houston East	no	no	no	no	no	Yes <sup>6</sup>
	482011035	Houston, Clinton Dr.	Yes <sup>1,3</sup>	Yes <sup>1,2</sup>	no	Yes <sup>4</sup>	Yes <sup>4</sup>	Yes <sup>7</sup>
	482011039	Houston, Deer Park #2	Yes <sup>1,3</sup>	Yes <sup>1,2</sup>	no	Yes <sup>4</sup>	Yes <sup>4</sup>	Yes <sup>5,7</sup>
	482010055	Houston, Galleria	no	Yes <sup>1,2</sup>	no	no	no	Yes <sup>5</sup>
	482010803	Houston, Haden Rd.	no	Yes <sup>1,2</sup>	no	no	no	no
		Houston, Haden Rd., EISM U22	Yes <sup>1,3</sup>	no	no	no	no	no
	482010069	Houston, Milby Park	no	Yes <sup>1,2</sup>	no	no	no	no
482010029	Houston, Northwest Harris County	no	Yes <sup>1,2</sup>	Yes <sup>1,2</sup>	no	no	no	
482010061	La Porte, Shore Acres	no	Yes <sup>1,2</sup>	no	no	no	no	
Montgomery	483390078	Conroe, re-located	no	no	no	no	no	Yes <sup>3</sup>

Table 1 Footnotes.

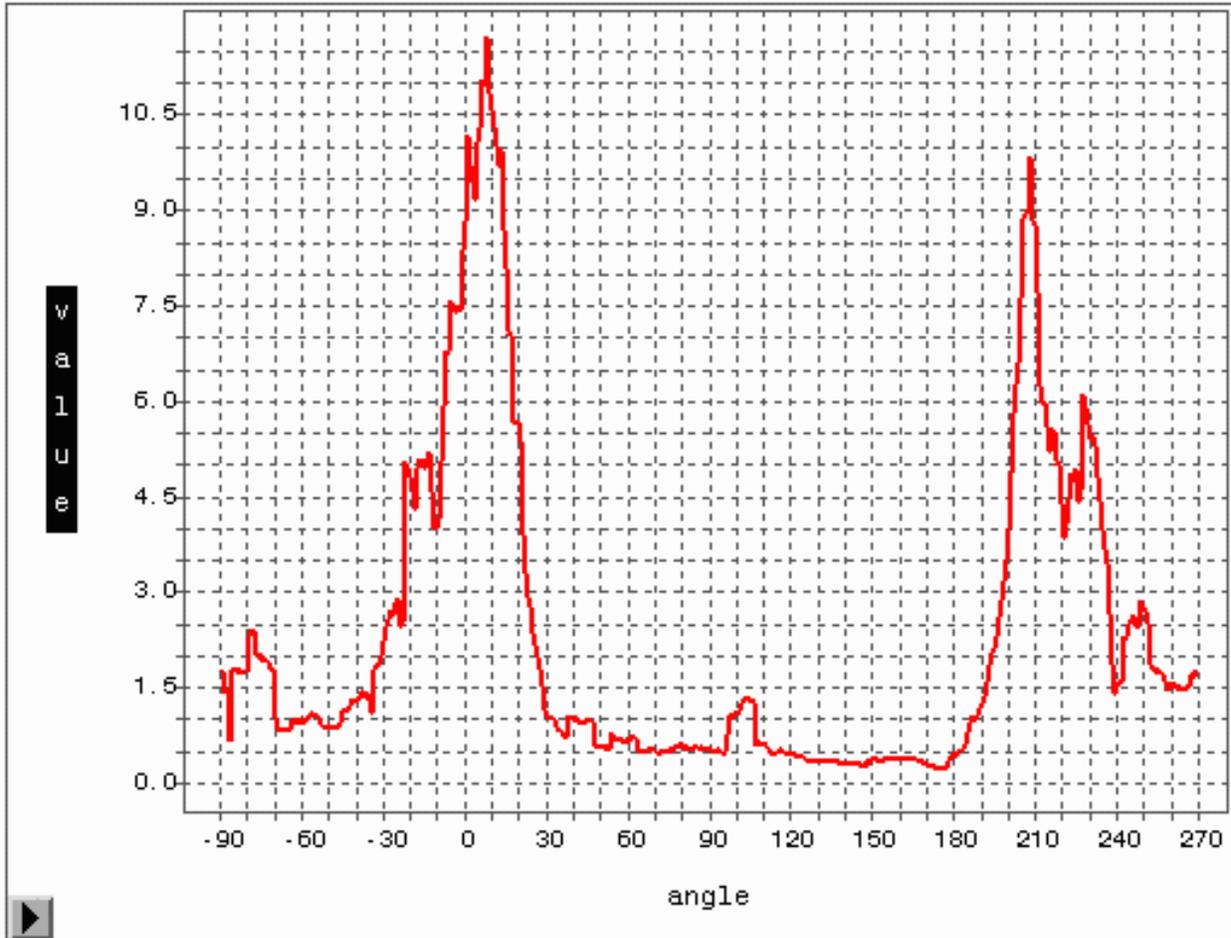
1 (autoGC & canister VOCs)		2 (additional canister VOCs)		3 (additional autoGC VOCs)
1,2,3-Trimethylbenzene	Isoprene	1,1,1-Trichloroethane	Trichlorofluoromethane	Isobutene
1,2,4-Trimethylbenzene	Isopropylbenzene	1,1,2,2-Tetrachloroethane	Vinyl Chloride	
1,3,5-Trimethylbenzene	Methylcyclohexane	1,1,2-Trichloroethane		
1,3-Butadiene	Methylcyclopentane	1,1-Dichloroethylene		
1-Butene	Propane	1,2-Dibromoethane		
1-Hexene + 2-Methyl-1-Pentene (analyzed separately in autoGC)	Propylene	1,2-Dichloroethane		
1-Pentene	Styrene	1,2-Dichloropropane		
2,2,4-Trimethylpentane	Toluene	2-Butanone		
2,2-Dimethylbutane - Neohexane	c-2-Butene	2-Chloropentane		
2,3,4-Trimethylpentane	c-2-Pentene	2-Methyl-3-hexanone		
2,3-Dimethylbutane	m-Diethylbenzene	3-Hexanone		
2,3-Dimethylpentane	m-Ethyltoluene	3-Pentanone		
2,4-Dimethylpentane	n-Butane	Bromomethane		
2-Methyl-2-Butene	n-Decane	Butyl Acetate		
2-Methylheptane	n-Heptane	Butyraldehyde		
2-Methylhexane	n-Hexane	Carbon Tetrachloride		
2-Methylpentane - Isohexane	n-Nonane	Chlorobenzene		
3-Methyl-1-Butene + Cyclopentene (analyzed separately in canisters)	n-Octane	Chloroform		
3-Methylheptane	n-Pentane	Chloroprene		
3-Methylhexane	n-Propylbenzene	Cis-1,3-Trichloropropylene		
3-Methylpentane	n-Undecane	Ethyl Acetate		
4-Methyl-1-Pentene	o-Ethyltoluene	Isobutyraldehyde		
Acetylene	o-Xylene	Methyl Butyl Ketone (MBK)		
Benzene	p-Diethylbenzene	Methyl Chloride		
Cyclohexane	p-Ethyltoluene	Methyl t-Butyl Ether		
Cyclopentane	p-Xylene + m-Xylene	Methylene Chloride		
Ethane	t-2-Butene	Methylisobutylketone		
Ethyl Benzene	t-2-Pentene	n-Propyl Acetate		
Ethylene	t-2-Hexene	Tetrachloroethylene - Perchloroethylene		
Isobutane	c-2-Hexene	Trans-1-3-Dichloropropylene		
Isopentane		Trichloroethylene		

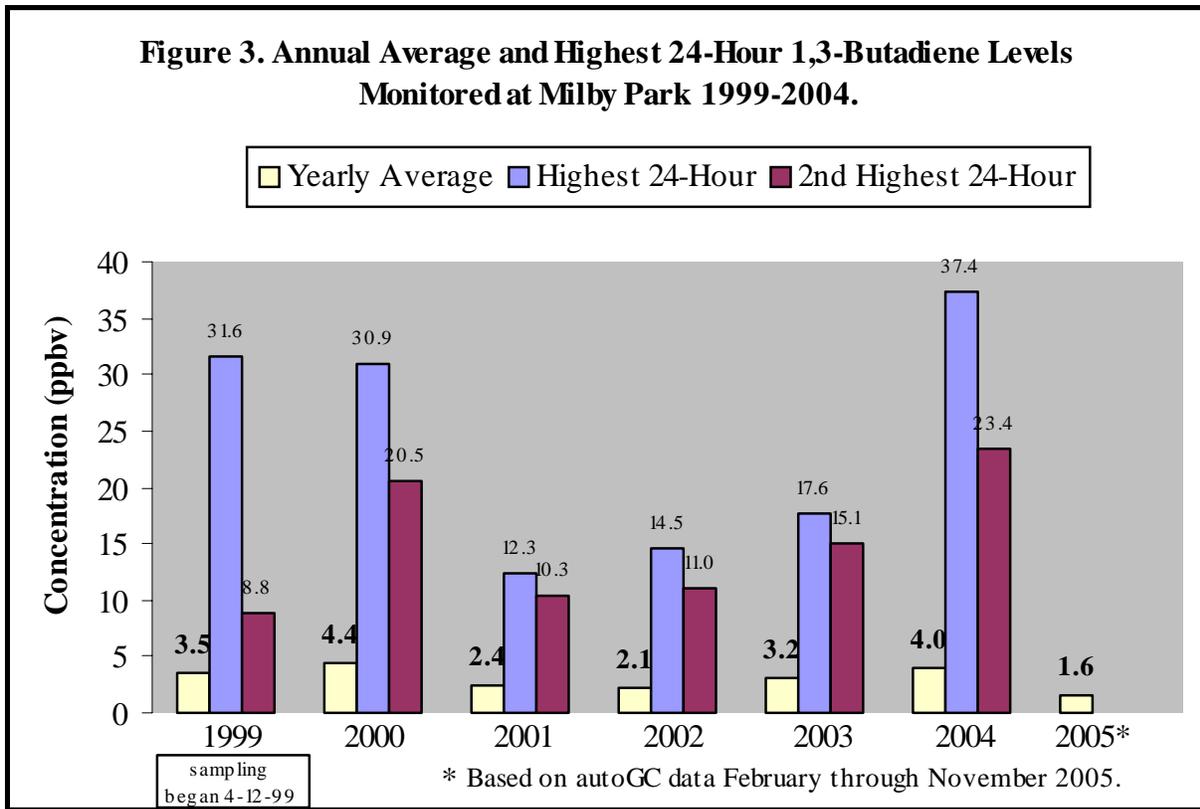
4 (carbonyls)	5 (selected metals)	6 (selected metals)	7 (selected metals)
2,5-Dimethylbenzaldehyde	Aluminum (PM2.5)	Aluminum (PM2.5)	Aluminum (PM10)
Acetaldehyde	Antimony (PM2.5)	Antimony (PM2.5)	Antimony (PM10)
Acetone	Arsenic (PM2.5)	Arsenic (PM2.5)	Arsenic (PM10)
Acrolein	Barium (PM2.5)	Barium (PM2.5)	Barium (PM10)
Benzaldehyde	Cadmium (PM2.5)	Cadmium (PM2.5)	Beryllium (PM10)
Butyraldehyde	Chromium (PM2.5)	Chromium (PM2.5)	Cadmium (PM10)
Crotonaldehyde - 2-Butenal	Cobalt (PM2.5)	Cobalt (PM2.5)	Chromium (PM10)
Formaldehyde	Copper (PM2.5)	Copper (PM2.5)	Cobalt (PM10)
Heptaldehyde	Lead (PM2.5)	Lead (PM2.5)	Copper (PM10)
Hexanaldehyde	Manganese (PM2.5)	Manganese (PM2.5)	Lead (PM10)
Isovaleraldehyde	Molybdenum (PM2.5)	Molybdenum (PM2.5)	Manganese (PM10)
m-Tolualdehyde	Nickel (PM2.5)	Nickel (PM2.5)	Molybdenum (PM10)
MEK/Methacrolein	Mercury (PM2.5)	Mercury (PM2.5)	Nickel (PM10)
o-Tolualdehyde	Selenium (PM2.5)	Selenium (PM2.5)	Mercury (PM10)
p-Tolualdehyde	Tin (PM2.5)	Tin (PM2.5)	Selenium (PM10)
Propanal - Propionaldehyde	Zinc (PM2.5)	Zinc (PM2.5)	Tin (PM10)
Valeraldehyde		Lead (TSP)	Zinc (PM10)

Figure 1. Lynchburg Ferry Area



Figure 2. Benzene at Baytown-Lynchburg Ferry: Wind Direction Resultant (degree or angle) versus Mean Benzene Concentration (ppbv).





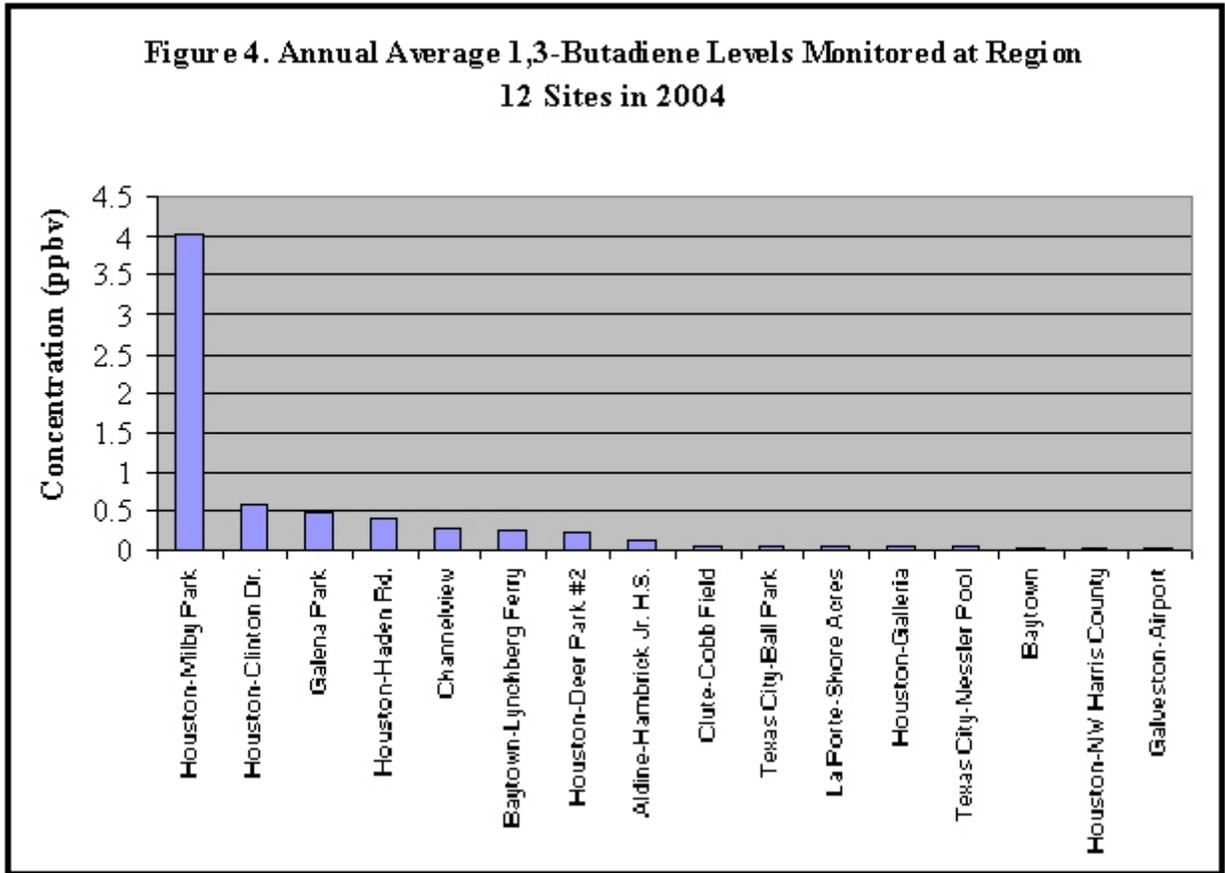


Figure 5. Preliminary Source Direction Evaluation of 2004 1,3-Butadiene AutoGC Data from Clinton Dr. and Cesar Chavez High School and 2005 AutoGC Data from Milby Park



Figure 6. Preliminary Source Direction Evaluation of 2004 Benzene AutoGC Data from Texas City EISM U25

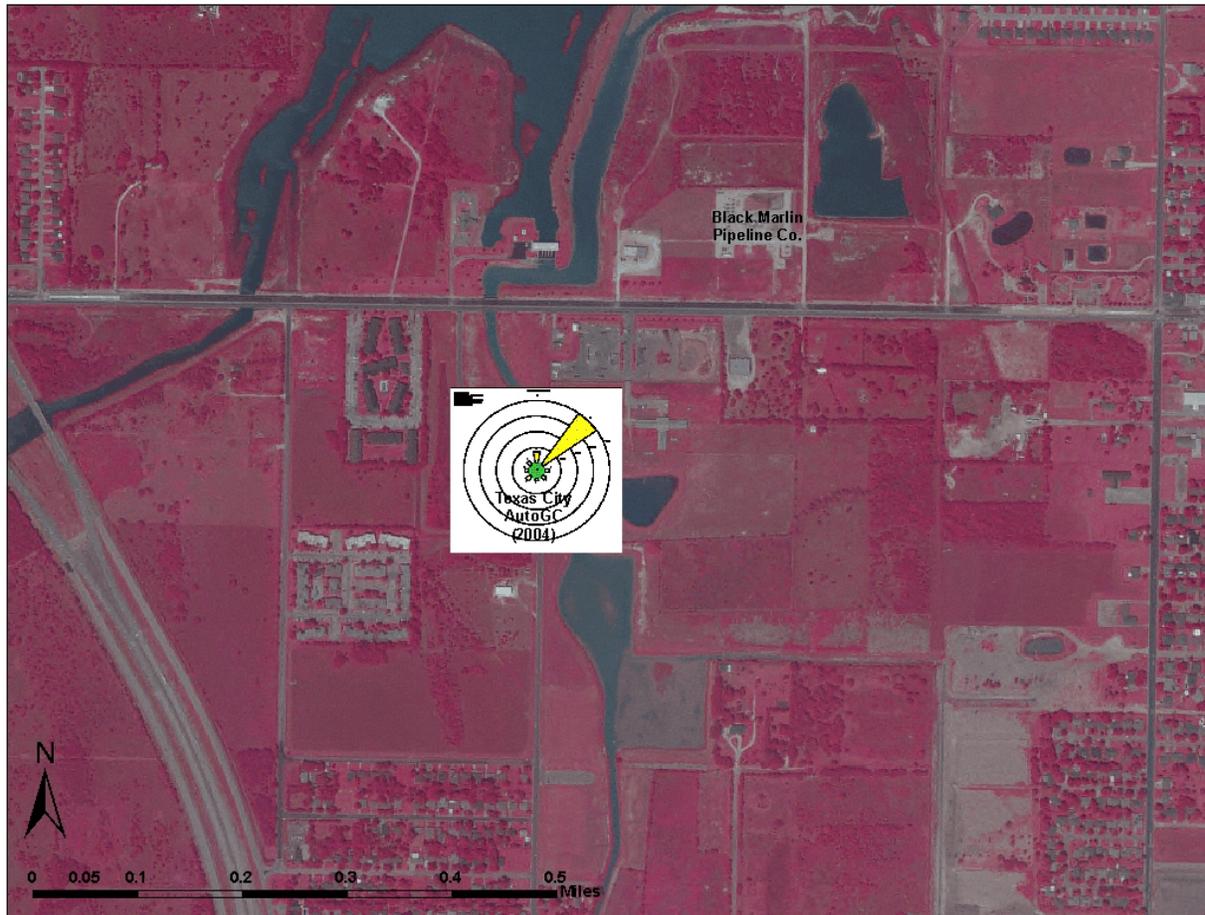
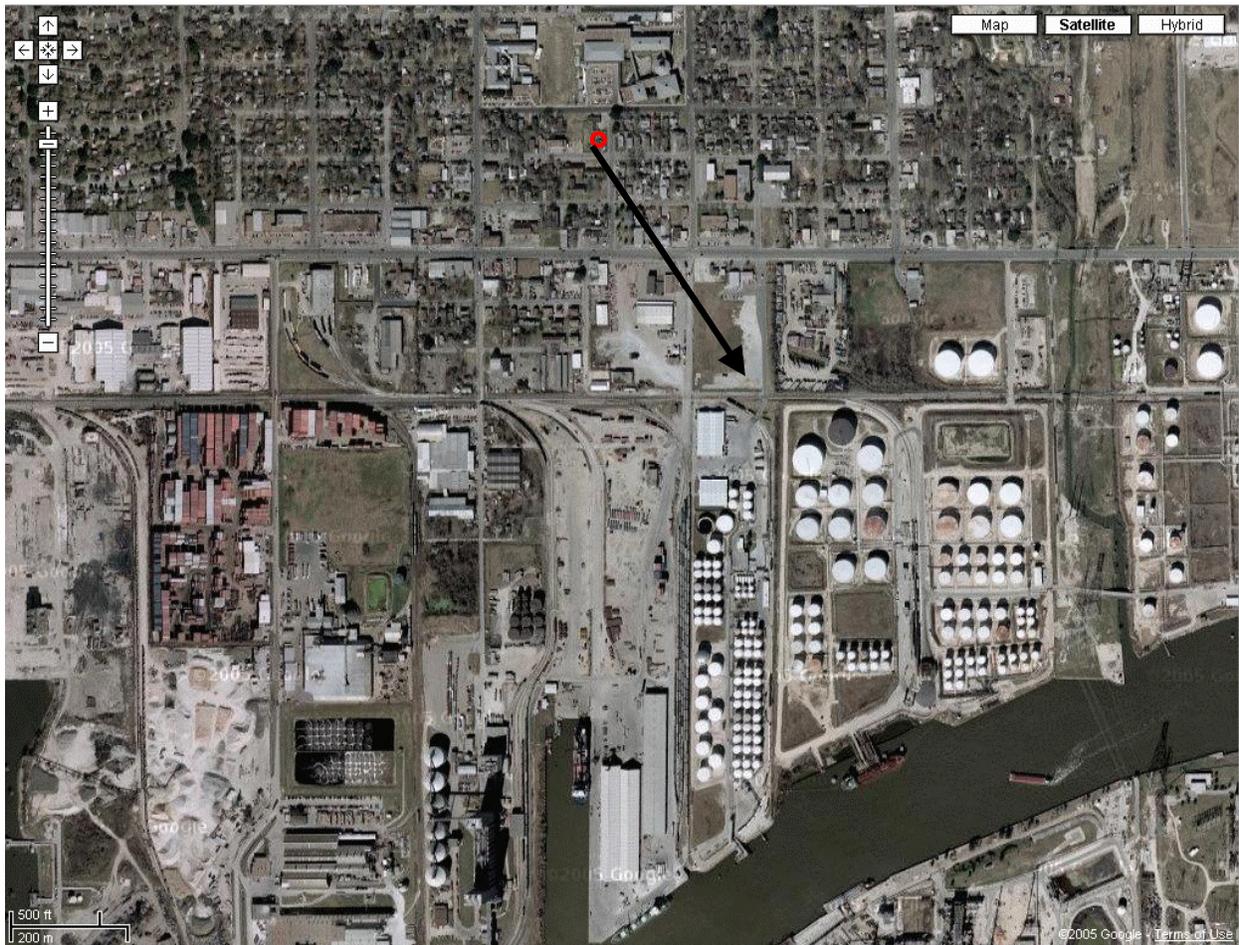


Figure 7. Preliminary Source Direction Evaluation of 24-Hour Benzene Data Collected in 2004 from the Galena Park Monitor



Figure 8. Location of the Galena Park Site and Arrow Indicating Direction of Source(s) of Elevated Benzene Levels



D. Thompson, D. Phillips, M. Hill, L. Vasse, R. Hyde, J. Sadlier, C. Garrett  
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Arturo Blanco, City of Houston  
Bob Allen, Harris County Pollution Control  
Ronnie Schultz, Galveston County Health District  
Ruben Casso, USEPA Region 6, Dallas