TEXAS
Health and Human Services

Texas Department of State Health Services

John Hellerstedt, M.D.
Commissioner

July 3, 2019

Mike Honeycutt, Ph.D.
Director, Toxicology, Risk Assessment, and Research Division
Texas Commission on Environmental Quality
12100 Park 35 Circle, Bldg. F
Austin, TX 78753

RE: Review of Texas Commission on Environmental Quality continuous air monitoring data collected during the ITC Fire in Deer Park, TX.

Dear Dr. Honeycutt:

Per your request, the Texas Department of State Health Services (DSHS) evaluated air monitoring data from continuous air monitoring stations in Harris County near the location of the ITC fire. We have reviewed the data you provided and have summarized our findings in this letter.

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Background and Statement of Issues

On Sunday March 17, 2019, around 10:30 AM, an 80,000-barrel tank storing naphtha ignited at the Intercontinental Terminals Company, LLC (ITC) [1]. The ITC facility is located at 2621 Tidal Road, Deer Park, Texas and on the southern shore of the Houston ship channel. That same day, the fire spread to another tank containing xylenes, which is also a component of gasoline [2]. On March 18, 2019, ITC reported the fire had spread to six additional adjacent tanks containing base oil, gas blend stocks, and toluene [3, 4]. On March 19, 2019, two more tanks containing pyrolysis gasoline (Pygas) caught fire [5]. ITC announced that the fire in all 10 tanks was extinguished at 3:00 AM on March 20, 2019 [6]. Shortly before 12:30 PM on Friday, March 22, 2019, ITC announced a breach surrounding the western tank farm, releasing foam and detritus into the ditch that runs east to west on Tidal Road. That same day, three tanks reignited and the fire spread to the liquid that had escaped through the containment wall into the adjacent ditch [7].

Discussion

Environmental Sampling Data

Available Data

DSHS evaluated air monitoring data from the Texas Commission on Environmental Quality (TCEQ) continuous air monitoring stations in southeast Harris County (Table 1 and Figure 1). The data included results for volatile organic compounds (VOCs), particulate matter $_{2.5}$ ($PM_{2.5}$), and nitrogen oxides (NOx), collected from March 17, 2019 to March 27, 2019.

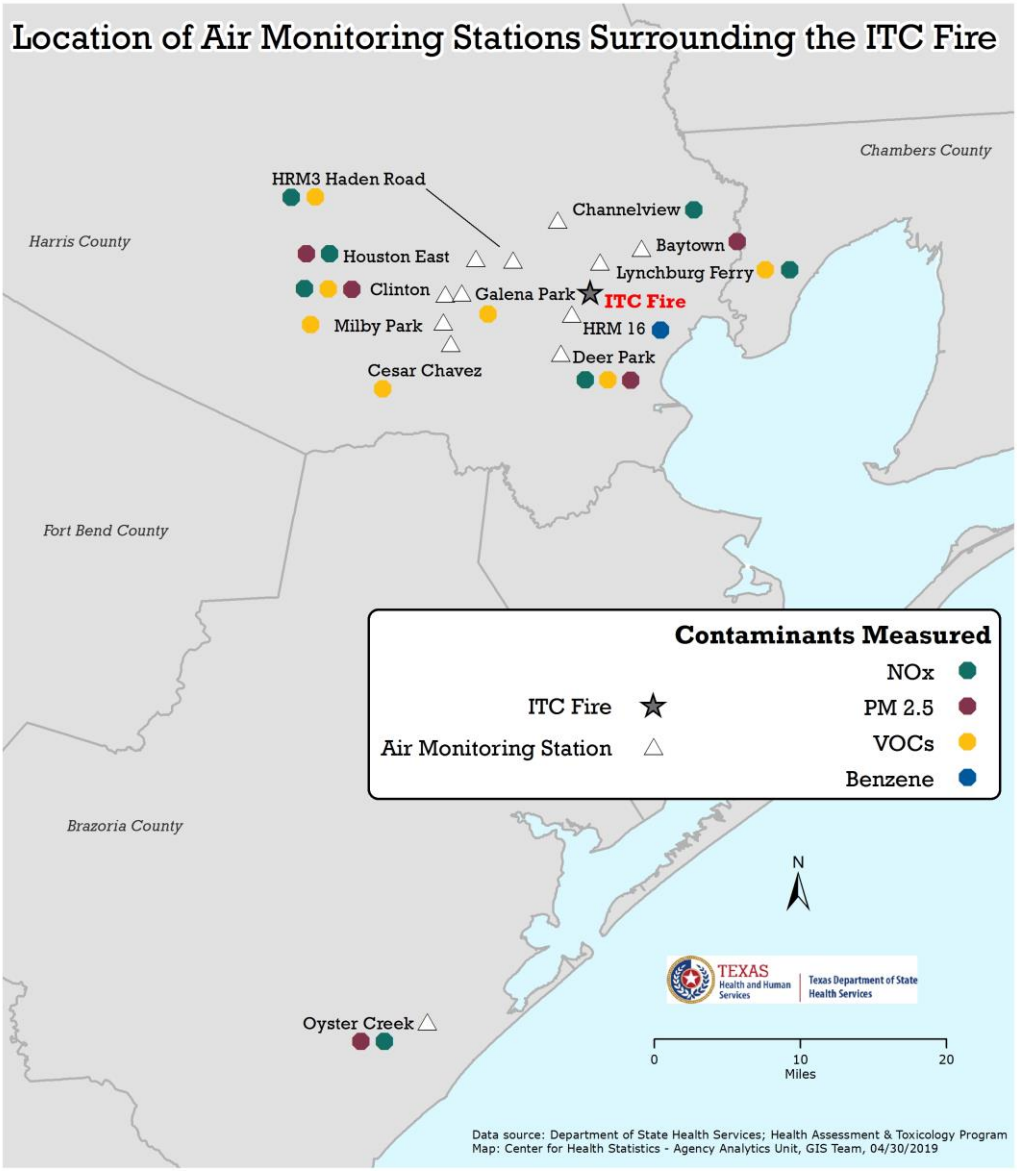
DSHS also evaluated air monitoring data from the Houston Regional Monitoring Corporation (HRM) in southeast Harris County. Data included results for benzene from March 17, 2019 to March 22, 2019. HRM is supported by 50 individual companies in the Greater Houston Metropolitan Area. This privately-sponsored ambient air monitoring company has 12 stations monitoring VOCs and six criteria pollutants (i.e. carbon monoxide, lead, ground-level ozone, nitrogen dioxide, particulate matter, and sulfur dioxide) [8].

Table 1. Air Monitoring Station Locations and Contaminants Measured Near the ITC Fire

Continuous Air Monitoring Station	Address	Contaminants measured
Baytown	7210 1/2 Bayway Drive, Baytown, TX 77520	PM 2.5
Cesar Chavez	4829 A Galveston Rd, Houston, TX 77017	VOCs
Channelview	1405 Sheldon Road, Channelview, TX 77530	NOx
Clinton	9525 1/2 Clinton Drive, Houston, TX 77029	VOCs, PM 2.5, NOx
Deer Park	4514 1/2 Durant St, Deer Park, TX 77536	VOCs, PM 2.5, NOx

Galena Park	1713 2nd Street, Galena Park, TX 77547	VOCs
Houston East	1262 1/2 Mae Drive, Houston, TX 77029	PM 2.5, NOx
HRM3 Haden Road	1504 1/2 Haden Road, Houston, TX 77015	VOCs, NOx
Lynchburg Ferry	4364 Independence Parkway South, La Porte, TX 77571	VOCs, NOx
Milby Park	2201 Central St, Houston, TX 77017	VOCs
Oyster Creek	901 County Road 792, Freeport, TX 77541	PM 2.5, NOx
HRM Site 16	600-658 Luella Ave, Deer Park, TX 77536 110 ft E	Benzene

Figure 1. Location of Air Monitoring Stations near the ITC fire



Data Quality
TCEQ air monitoring station data reviewed in this report were hourly data collected at TCEQ Automated Gas Chromatograph (AutoGC) monitoring stations using standard procedures. Thus, DSHS assumed adequate quality assurance/quality control procedures were followed with regards to data collection and reporting.

Exposure Evaluation

Chemical contamination in the environment can only harm a person's health if there is contact with (exposure to) the chemical and if the amount of the chemical the person comes into contact with is high enough to cause harm. Whether people can come into contact with a chemical depends on several factors, including:

1) the source of contamination (where the chemical comes from)
2) how the chemical is transported through environmental media (e.g. movement through the air)
3) a point of exposure (e.g. outdoor air)
4) a route of human exposure (e.g. breathing in the outdoor air)
5) an exposed population (e.g. people living and working in the area with contaminated air)[9].

Contact with a chemical will only happen if there is a completed exposure pathway. All five of these factors must be present in order for an exposure pathway to be completed. DSHS evaluated relevant exposure pathways to determine if any were completed based on the available data.

Pathway Analysis

Completed Exposure Pathways
Outdoor air contamination represents a completed exposure pathway. VOCs (including benzene), $PM_{2.5}$, and NO_x were released into the air during the ITC fire. Workers, residents, and children in nearby schools, workplaces, and residential areas may have inhaled these contaminants. Therefore, DSHS evaluated continuous air monitoring data, representative of concentrations in the outdoor air.

The compounds stored in the tanks involved in the fire are volatile organic compounds, which easily become vapors or gases. DSHS assessed acute (less than 14 days) inhalation exposures, given the nature of the contaminants and short duration of the release. DSHS did not have sufficient data to assess exposure to contaminants in other environmental media.

Screening Analysis

VOCs

DSHS analyzed data from each continuous air monitoring station separately. Chemicals detected in the outdoor air were selected for further analysis. Since most samples were collected hourly during this timeframe, DSHS assumed a one-hour exposure duration based on the maximum concentration. DSHS compared the maximum hourly concentrations of chemicals detected to health-protective comparison values (CVs). For VOCs, DSHS used the Texas Commission on Environmental Quality (TCEQ) short-term Air Monitoring Comparisons Values (AMCVs) as the CVs[10]. The short-term AMCVs provided an appropriate health value for an assumed 1-hour exposure duration. DSHS also used the Environmental Protection Agency (EPA) Acute Exposure Guidelines Level 1 (AEGL-1) value for benzene [11].

Data included 46 VOCs from five TCEQ stations, 48 VOCs from two TCEQ stations, and benzene from one HRM station (Tables 4-11). Out of the all the VOCs analyzed, p-xylene + m-xylene, and toluene were the primary chemicals of concern because they were present in the burning tanks at ITC. Only benzene exceeded its short-term AMCV (180 ppb) in the TCEQ Deer Park and HRM 16 monitoring stations (Table 6 and 11). The remaining VOCs analyzed did not exceed their AMCVs. No VOC exceeded the 1-hour AEGL-1 of 52,000 ppb.

The highest concentration of benzene detected in the air was 1,227 ppb during the morning of March 21, 2019. The TCEQ Deer Park monitor had an exceedance of the short-term AMCV with a concentration of 190 ppb on the morning of March 21, 2019. The HRM 16 monitor in Deer Park had two 1-hour concentrations on the morning of March 20, 2019, and three 1-hour concentrations the morning of March 21, 2019, that exceeded the short-term AMCV. The highest concentrations occurred around 5:00 AM on March 21st. Concentrations decreased to less than 180 ppb after three hours.

$PM_{2.5}$

TCEQ monitoring stations also measured NO_x and $PM_{2.5}$ (Tables 12-13). EPA has established a U.S. National Ambient Air Quality Standards (NAAQS) primary standard of 35 µg/m^3 (24-hour average) for $PM_{2.5}$ [12]. . DSHS compared daily 24-hour average $PM_{2.5}$ concentrations (calculated from midnight to midnight) for each station from March 17 to March 27, 2019. None of these $PM_{2.5}$ daily 24-hour averages exceeded the EPA standard.

EPA has developed an Air Quality Index (AQI) for $PM_{2.5}$ and NO_x (Table 2). This is an index for reporting daily air quality and provides a way to determine if any potential health effects could occur from breathing in the polluted air [13]. The higher the AQI value, the greater level of air pollution. Since the AQI for $PM_{2.5}$ is based on 24-hour average concentrations, DSHS compared daily 24-hour average $PM_{2.5}$ concentrations for the sampling period to the AQI categories. From March 19 to March 20, 2019, all 24-hour average concentrations for all monitors were within

the “Moderate” AQI category. By March 23, 2019, all 24-hour average concentrations were within the “Good” AQI category (Table 12) [13, 14].

NO_x

EPA has established a 1-hour NAAQS primary standard of 100 ppb for nitrogen dioxide (NO_2) and DSHS compared all 1-hour NO_x concentrations to this standard. From March 17, 2019 to March 27, 2019, no concentration exceeded the standard. The majority of the daily maximum 1-hour NOx concentrations were within the “Good” AQI (for NO_x) category (Table 13).

Table 2: Air Quality Index Category Table for PM $_{2.5}$ and Nitrogen Dioxide

AQI Category	AQI Value	24-hour Average PM2.5 Concentration (µg/m3)	1- hour Nitrogen Dioxide (ppb)
Good	0 - 50	0 - 12.0	0 - 53
Moderate	51 - 100	12.1 - 35.4	54 - 100
Unhealthy for sensitive groups	101 - 150	35.5 - 55.4	101 - 360
Unhealthy	151 - 200	55.5 - 150.4	361 - 649
Very Unhealthy	201 - 300	150.5 - 250.4	650 - 1249
Hazardous	301 - 500	250.5 - 500.4	1250 - 2049

Source: EPA Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009)

Health Evaluation

Contaminants that exceeded their corresponding CV in the screening analysis were further evaluated to determine if exposure to these chemicals could harm people’s health.

Benzene

Non-Cancer Health Effects

The TCEQ 1-hour short-term health AMCV of 180 ppb is based on a study in which mice showed hematotoxicity after exposure [15]. Occupational studies have shown it takes much higher concentrations (>50,000 ppb) over a longer time period (several hours a day for >2 days) to cause symptoms such as dizziness and difficulty breathing in humans (Table 3). However, these health effects and chronic health effects associated with benzene are not expected to have occurred during this incident due to the short amount of time that these levels were detected. Sensitive groups of people, such as children and older adults, may experience symptoms such as eye irritation and headache at lower levels of exposure [16].

The EPA AEGLs are used as a guidance when dealing with accidental chemical releases into the air. They are threshold levels designated to protect the general population including sensitive groups. AEGLs have three levels, 1 being the least and 3 being the most severe regarding toxic

effects. AEGL-1 is the airborne concentration above which it is predicted the general population could experience irritation and notable discomfort. However, effects are transient and reversible upon cessation of exposure [11]. This is the most adequate comparison value for this scenario, considering the fire lasted less than 14 days. The 1-hour AEGL-1 for benzene (52,000 ppb) was not exceeded at any of the monitoring stations.

Table 3. Health Effects among Humans as a Result of Acute Benzene Exposure

Benzene Concentration (ppb)	Exposure Duration (minutes)	Health Effects
1,500 – 4,700 [17]	N/A	• Odor: sweet, gasoline-like
47,000 – 110,000 [18]	120	• No health effects
50,000 – 150,000 [19]	300	• Headache • Lassitude • Weariness
52,000 (EPA AEGL-1) [11]	60	• Eye and airway irritation
300,000 – 3,000,000 [20]	30	• Drowsiness • Dizziness • Headaches • Loss of consciousness
3,400,000 – 4,900,000 [21]	10	• Dizziness • Airway irritation

Cancer Health Effects

Although benzene is a carcinogen, the short-term, low-level exposure that occurred among the general population during and after the fire in Deer Park, TX, is not expected to increase people's risk of cancer [22].

$PM_{2.5}$

Non-Cancer Health Effects

The two 1-hour concentrations that exceeded the NAAQS 35 $\mu g/m^3$ (24-hour average) standard were classified as "unhealthy for sensitive groups" by the AQI calculator. During these short durations of exceedance, sensitive populations such as persons with heart disease or lung disease, older adults, and children may experience respiratory symptoms.

Cancer Health Effects
Based on the short-term, low-level exposure that occurred among the general population during and after the fire in Deer Park, TX, $PM_{2.5}$ is not expected to increase people's risk of cancer [23].

Limitations

There are several limitations to consider regarding this report:

- Locations of the monitors varied in distance to the ITC fire, and are not necessarily representative of exposures among the entire population.
- Individuals could have been exposed to different concentrations of the contaminants during this timeframe due to variations with respect to time, weather conditions, e.g. sunny, cloudy, rainy, etc. and meteorological factors, including, but not limited to, relative humidity, wind speed and direction.
- The closest monitor was approximately 2.75 miles away from the ITC facility. Persons closer to the facility such as workers and emergency response staff could have been exposed to greater concentrations.

Conclusions

Based on the data evaluated in this LHC, DSHS concludes that:

Conclusion 1: Past acute inhalation exposure to VOCs in the outdoor air from March 17 to March 27, 2019 is not expected to have harmed people's health.
Basis for Conclusion: The majority of the VOC concentrations measured at the continuous air monitoring stations were not above any health-based values. Only benzene exceeded any health-based comparison value. Based on the short duration that these concentrations were detected, it is unlikely that exposure would result in lasting health effects.

Conclusion 2: Daily 24-hour average $PM_{2.5}$ and hourly NO_x concentrations detected at these monitors from March 17 to March 27, 2019 did not exceed relevant NAAQS values during or after the fire.

Conclusion 3: Exposure to the even the highest measured benzene concentrations in the outdoor air during the fire are unlikely to lead to persistent or chronic health effects due to the length of time they were detected. Sensitive populations may have experienced symptoms such as headache and eye irritation. Any symptoms that could be associated with the fire would dissipate after the exposure stopped.

If you have any questions, please contact me at (512) 776-3714.

Sincerely,

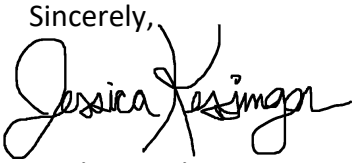


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Table 4: Volatile organic compounds outdoor air data from the Cesar Chavez continuous air monitoring station from March 17, 2019 to March 27, 2019

Chemical	Number of Samples	Concentration Range (ppb)	TCEQ Short-term AMCV (ppb)
1_2_3-Trimethylbenzene	236	ND - 0.56	3,000
1_2_4-Trimethylbenzene	236	ND - 0.42	3,000
1_3_5-Trimethylbenzene	236	ND - 0.35	3,000
1_3-Butadiene	236	ND - 0.61	1,700
1-Butene	236	ND - 1.39	27,000
1-Pentene	236	ND - 0.59	12,000
2_2_4-Trimethylpentane	236	ND - 4.89	4,100
2_2-Dimethylbutane	236	ND - 0.38	5,400
2_3_4-Trimethylpentane	236	ND - 1.07	4,100
2_3-Dimethylpentane	236	ND - 1.11	8,300
2_4-Dimethylpentane	236	ND - 1.08	8,300
2-Methylheptane	236	ND - 0.38	4,100
2-Methylhexane	236	ND - 0.84	8,300
3-Methylheptane	236	ND - 0.41	4,100
3-Methylhexane	236	ND - 1.12	8,300
Acetylene	236	0.06 - 16.56	25,000
Benzene	236	0.11 - 2.25	180
c-2-Butene	236	ND - 0.93	15,000
c-2-Pentene	236	ND - 0.66	12,000
Cyclohexane	236	ND - 1.63	1,000
Cyclopentane	236	ND - 1.21	5,900
Ethane	236	2.73 - 38.05	Simple Asphyxiant
Ethyl Benzene	236	ND - 0.47	20,000
Ethylene	236	ND - 9.96	500,000
Isobutane	236	0.2 - 11.23	33,000
Isopentane	236	0.29 - 38.86	68,000
Isoprene	236	ND - 0.13	1,400
Isopropyl Benzene - Cumene	236	ND - 0.15	510
Methylcyclohexane	236	ND - 1.99	4,000
Methylcyclopentane	236	ND - 2.11	750
n-Butane	236	0.58 - 53.15	92,000
n-Decane	236	ND - 0.72	1,000
n-Heptane	236	ND - 1.05	8,300
n-Hexane	236	0.01 - 4.1	5,400
n-Nonane	236	ND - 0.69	3,000
n-Octane	236	ND - 1.17	4,100
n-Pentane	236	0.04 - 19.65	68,000
n-Propylbenzene	236	ND - 0.17	510
o-Xylene	236	0.01 - 0.53	1,700
Propane	236	0.67 - 72.58	Simple Asphyxiant
Propylene	236	0.28 - 15.71	Simple Asphyxiant
p-Xylene + m-Xylene	236	0.03 - 1.52	1,700
Styrene	236	ND - 0.26	5,200
t-2-Butene	236	ND - 1.24	15,000
t-2-Pentene	236	ND - 1.7	12,000
Toluene	236	0.11 - 4.7	4,000

ND = Not detected; ppb = parts per billion

Table 5: Volatile organic compounds outdoor air data from the Clinton continuous air monitoring station from March 17, 2019 to March 27, 2019.

Chemical	Number of Samples	Concentration Range (ppb)	TCEQ Short-term AMCV (ppb)
1_2_3-Trimethylbenzene	238	ND - 0.58	3,000
1_2_4-Trimethylbenzene	238	ND - 0.45	3,000
1_3_5-Trimethylbenzene	238	ND - 0.19	3,000
1_3-Butadiene	238	ND - 1.54	1,700
1-Butene	238	0.04 - 0.75	27,000
1-Pentene	238	ND - 0.72	12,000
2_2_4-Trimethylpentane	238	ND - 4.47	4,100
2_2-Dimethylbutane	238	ND - 0.27	5,400
2_3_4-Trimethylpentane	238	ND - 0.31	4,100
2_3-Dimethylpentane	238	ND - 0.34	8,300
2_4-Dimethylpentane	238	ND - 0.28	8,300
2-Methylheptane	238	ND - 0.52	4,100
2-Methylhexane	238	ND - 0.59	8,300
3-Methylheptane	238	ND - 0.47	4,100
3-Methylhexane	238	ND - 0.7	8,300
Acetylene	238	0.06 - 1.75	25,000
Benzene	238	ND - 12.83	180
c-2-Butene	238	0.02 - 0.57	15,000
c-2-Pentene	238	ND - 0.26	12,000
Cyclohexane	238	ND - 1.14	1,000
Cyclopentane	238	0.01 - 1.2	5,900
Ethane	238	2.44 - 31.46	Simple Asphyxiant
Ethyl Benzene	238	ND - 0.5	20,000
Ethylene	238	0.15 - 8.85	500,000
Isobutane	238	0.21 - 11.8	33,000
Isopentane	238	0.31 - 36.01	68,000
Isoprene	238	ND - 0.21	1,400
Isopropyl Benzene - Cumene	238	ND - 0.16	510
Methylcyclohexane	238	ND - 1.06	4,000
Methylcyclopentane	238	ND - 1.49	750
n-Butane	238	0.79 - 26.24	92,000
n-Decane	238	ND - 0.6	1,000
n-Heptane	238	ND - 1.09	8,300
n-Hexane	238	0.07 - 3.22	5,400
n-Nonane	238	ND - 0.7	3,000
n-Octane	238	ND - 1.34	4,100
n-Pentane	238	0.22 - 24.52	68,000
n-Propylbenzene	238	ND - 0.15	510
o-Xylene	238	ND - 0.65	1,700
Propane	238	0.78 - 25.52	Simple Asphyxiant
Propylene	238	ND - 6.28	Simple Asphyxiant
p-Xylene + m-Xylene	238	0.03 - 2.04	1,700
Styrene	238	ND - 0.41	5,200
t-2-Butene	238	0.05 - 0.71	15,000
t-2-Pentene	238	ND - 0.69	12,000
Toluene	238	0.11 - 2.53	4,000

ND = Not detected; ppb = parts per billion

Table 6: Volatile organic compounds outdoor air data from the Deer Park continuous air monitoring station from March 17, 2019 to March 27, 2019.

Chemical	Number of Samples	Concentration Range (ppb)	TCEQ Short-term AMCV (ppb)
1_2_3-Trimethylbenzene	229	ND - 1.21	3,000
1_2_4-Trimethylbenzene	229	0.02 - 0.76	3,000
1_3_5-Trimethylbenzene	229	ND - 0.35	3,000
1_3-Butadiene	229	ND - 13.41	1,700
1-Butene	229	0.02 - 1.39	27,000
1-Pentene	229	ND - 19.04	12,000
2_2_4-Trimethylpentane	229	ND - 5.77	4,100
2_2-Dimethylbutane	229	0.02 - 2.42	5,400
2_3_4-Trimethylpentane	229	ND - 0.41	4,100
2_3-Dimethylpentane	229	ND - 3.22	8,300
2_4-Dimethylpentane	229	ND - 2.9	8,300
2-Methylheptane	229	ND - 3.76	4,100
2-Methylhexane	229	ND - 6.36	8,300
3-Methylheptane	229	ND - 3.35	4,100
3-Methylhexane	229	ND - 9.37	8,300
Acetylene	229	0.05 - 1.49	25,000
Benzene	229	0.01 - **190.68**	180
c-2-Butene	229	ND - 2.49	15,000
c-2-Pentene	229	ND - 2.31	12,000
Cyclohexane	229	ND - 10.06	1,000
Cyclopentane	229	ND - 1.89	5,900
Ethane	229	2.15 - 52.3	Simple Asphyxiant
Ethyl Benzene	229	ND - 1.9	20,000
Ethylene	229	0.06 - 20.93	500,000
Isobutane	229	0.19 - 21.48	33,000
Isopentane	229	ND - 21.97	68,000
Isoprene	229	0.01 - 13.66	1,400
Isopropyl Benzene - Cumene	229	ND - 0.17	510
Methylcyclohexane	229	ND - 10.96	4,000
Methylcyclopentane	229	ND - 12.11	750
n-Butane	229	0.37 - 35.39	92,000
n-Decane	229	ND - 0.84	1,000
n-Heptane	229	ND - 13.43	8,300
n-Hexane	229	ND - 26.02	5,400
n-Nonane	229	ND - 2.18	3,000
n-Octane	229	ND - 7.71	4,100
n-Pentane	229	0.11 - 15.6	68,000
n-Propylbenzene	229	ND - 0.3	510
o-Xylene	229	ND - 2.51	1,700
Propane	229	0.76 - 18.37	Simple Asphyxiant
Propylene	229	0.07 - 17.13	Simple Asphyxiant
p-Xylene + m-Xylene	229	0.04 - 7.85	1,700
Styrene	229	ND - 1.15	5,200
t-2-Butene	229	0.03 - 2.63	15,000
t-2-Pentene	229	ND - 4.97	12,000
Toluene	229	0.11 - 14.37	4,000

ND = Not detected; ppb = parts per billion

*Embolden numbers mean they exceed their screening value

Table 7: Volatile organic compounds outdoor air data from the Galena Park continuous air monitoring station from March 17, 2019 to March 27, 2019.

Chemical	Number of Samples	Concentration Range (ppb)	TCEQ Short-term AMCV (ppb)
1_2_3-Trimethylbenzene	236	ND - 0.45	3,000
1_2_4-Trimethylbenzene	236	ND - 0.37	3,000
1_3_5-Trimethylbenzene	236	ND - 0.21	3,000
1_3-Butadiene	236	ND - 2.89	1,700
1-Butene	236	0.02 - 0.85	27,000
1-Pentene	236	ND - 6.1	12,000
2_2_4-Trimethylpentane	236	ND - 8.94	4,100
2_2-Dimethylbutane	236	ND - 0.95	5,400
2_3_4-Trimethylpentane	236	ND - 1.02	4,100
2_3-Dimethylpentane	236	ND - 0.58	8,300
2_4-Dimethylpentane	236	ND - 0.89	8,300
2-Methylheptane	236	ND - 0.59	4,100
2-Methylhexane	236	ND - 0.6	8,300
3-Methylheptane	236	ND - 0.55	4,100
3-Methylhexane	236	ND - 0.87	8,300
Acetylene	236	0.12 - 2.25	25,000
Benzene	236	0.02 - 13.91	180
c-2-Butene	236	ND - 0.84	15,000
c-2-Pentene	236	ND - 0.87	12,000
Cyclohexane	236	ND - 2.08	1,000
Cyclopentane	236	0.01 - 2.39	5,900
Ethane	236	2.67 - 25.56	Simple Asphyxiant
Ethyl Benzene	236	ND - 0.67	20,000
Ethylene	236	0.08 - 6.53	500,000
Isobutane	236	0.31 - 12.14	33,000
Isopentane	236	0.44 - 108.7	68,000
Isoprene	236	ND - 1.07	1,400
Isopropyl Benzene - Cumene	236	ND - 0.17	510
Methylcyclohexane	236	ND - 1.37	4,000
Methylcyclopentane	236	ND - 1.89	750
n-Butane	236	1.05 - 35.73	92,000
n-Decane	236	ND - 0.47	1,000
n-Heptane	236	ND - 1.33	8,300
n-Hexane	236	0.03 - 4.78	5,400
n-Nonane	236	ND - 0.68	3,000
n-Octane	236	ND - 1.34	4,100
n-Pentane	236	0.25 - 85.84	68,000
n-Propylbenzene	236	ND - 0.14	510
o-Xylene	236	ND - 0.62	1,700
Propane	236	0.87 - 197.71	Simple Asphyxiant
Propylene	236	ND - 8.84	Simple Asphyxiant
p-Xylene + m-Xylene	236	0.03 - 2.04	1,700
Styrene	236	ND - 0.83	5,200
t-2-Butene	236	0.04 - 1.05	15,000
t-2-Pentene	236	ND - 1.94	12,000
Toluene	236	0.06 - 3.51	4,000

ND = Not detected; ppb = parts per billion

Table 8: Volatile organic compounds outdoor air data from the HRM3 Haden Rd continuous air monitoring station from March 17, 2019 to March 27, 2019.

Chemical	Number of Samples	Concentration Range (ppb)	TCEQ Short-term AMCV (ppb)
1_2_3-Trimethylbenzene	236	ND - 0.37	3,000
1_2_4-Trimethylbenzene	236	ND - 1.65	3,000
1_3_5-Trimethylbenzene	236	ND - 0.51	3,000
1_3-Butadiene	236	ND - 3.54	1,700
1-Butene	236	ND - 2.53	27,000
1-Pentene	236	ND - 0.8	12,000
2_2_4-Trimethylpentane	236	ND - 2.39	4,100
2_2-Dimethylbutane	236	ND - 0.36	5,400
2_3_4-Trimethylpentane	236	ND - 0.55	4,100
2_3-Dimethylpentane	236	ND - 0.73	8,300
2_4-Dimethylpentane	236	ND - 0.65	8,300
2-Methyl-2-Butene	236	ND - 6.06	490
2-Methylheptane	236	ND - 1.63	4,100
2-Methylhexane	236	ND - 1.53	8,300
3-Methylheptane	236	ND - 1.54	4,100
3-Methylhexane	236	ND - 2.25	8,300
Acetylene	236	0.19 - 3.73	25,000
Benzene	236	0.08 - 30.49	180
c-2-Butene	236	ND - 2.66	15,000
c-2-Pentene	236	ND - 1.52	12,000
Cyclohexane	236	0.01 - 8.72	1,000
Cyclopentane	236	0.02 - 1.48	5,900
Ethane	236	3.08 - 38.13	Simple Asphyxiant
Ethyl Benzene	236	0.01 - 1.84	20,000
Ethylene	236	0.26 - 13.04	500,000
Isobutane	236	0.19 - 10.69	33,000
Isopentane	236	0.27 - 63.87	68,000
Isoprene	236	ND - 0.48	1,400
Isopropyl Benzene - Cumene	236	ND - 0.61	510
Methylcyclohexane	236	0.01 - 3.43	4,000
Methylcyclopentane	236	0.03 - 2.24	750
n-Butane	236	0.7 - 90.56	92,000
n-Decane	236	ND - 0.34	1,000
n-Heptane	236	0.01 - 3.44	8,300
n-Hexane	236	0.06 - 4.49	5,400
n-Nonane	236	ND - 2.01	3,000
n-Octane	236	ND - 4.29	4,100
n-Pentane	236	0.18 - 30.22	68,000
n-Propylbenzene	236	ND - 0.4	510
n-Undecane	236	ND - 0.09	550
o-Xylene	236	ND - 2.79	1,700
Propane	236	0.97 - 33.5	Simple Asphyxiant
Propylene	236	0.02 - 11.24	Simple Asphyxiant
p-Xylene + m-Xylene	236	0.02 - 8.43	1,700
Styrene	236	ND - 2.33	5,200
t-2-Butene	236	ND - 4.28	15,000
t-2-Pentene	236	ND - 4.56	12,000
Toluene	236	0.05 - 9.03	4,000

ND = Not detected; ppb = parts per billion

Table 9: Volatile organic compounds outdoor air data from the Lynchburg Ferry continuous air monitoring station from March 17, 2019 to March 27, 2019.

Chemical	Number of Samples	Concentration Range (ppb)	TCEQ Short-term AMCV (ppb)
1_2_3-Trimethylbenzene	207	ND - 10.67	3,000
1_2_4-Trimethylbenzene	207	ND - 35.8	3,000
1_3_5-Trimethylbenzene	207	ND - 20.26	3,000
1_3-Butadiene	207	ND - 6.81	1,700
1-Butene	207	ND - 2.33	27,000
1-Pentene	207	ND - 6.24	12,000
2_2_4-Trimethylpentane	207	ND - 3.16	4,100
2_2-Dimethylbutane	207	ND - 1.09	5,400
2_3_4-Trimethylpentane	207	ND - 0.89	4,100
2_3-Dimethylpentane	207	ND - 2.74	8,300
2_4-Dimethylpentane	207	ND - 2.47	8,300
2-Methyl-2-Butene	207	ND - 1.18	490
2-Methylheptane	207	ND - 3.99	4,100
2-Methylhexane	207	ND - 5.24	8,300
3-Methylheptane	207	ND - 2.42	4,100
3-Methylhexane	207	ND - 7.31	8,300
Acetylene	207	ND - 1.42	25,000
Benzene	207	ND - 176.14	180
c-2-Butene	207	ND - 2.17	15,000
c-2-Pentene	207	ND - 0.92	12,000
Cyclohexane	207	ND - 8.06	1,000
Cyclopentane	207	ND - 2.5	5,900
Ethane	207	ND - 39.38	Simple Asphyxiant
Ethyl Benzene	207	ND - 5.31	20,000
Ethylene	207	ND - 36.37	500,000
Isobutane	207	ND - 58.14	33,000
Isopentane	207	ND - 31.37	68,000
Isoprene	207	ND - 6.52	1,400
Isopropyl Benzene - Cumene	207	ND - 1.63	510
Methylcyclohexane	207	ND - 6.94	4,000
Methylcyclopentane	207	ND - 13.51	750
n-Butane	207	ND - 37.28	92,000
n-Decane	207	ND - 18.59	1,000
n-Heptane	207	ND - 8.02	8,300
n-Hexane	207	ND - 24.29	5,400
n-Nonane	207	ND - 43.33	3,000
n-Octane	207	ND - 7.43	4,100
n-Pentane	207	ND - 20.75	68,000
n-Propylbenzene	207	ND - 12.02	510
n-Undecane	207	ND - 2.39	550
o-Xylene	207	ND - 14.3	1,700
Propane	207	ND - 32.96	Simple Asphyxiant
Propylene	207	ND - 112.62	Simple Asphyxiant
p-Xylene + m-Xylene	207	ND - 27.3	1,700
Styrene	207	ND - 7.06	5,200
t-2-Butene	207	ND - 2.71	15,000
t-2-Pentene	207	ND - 1.92	12,000
Toluene	207	ND - 28.99	4,000

ND = Not detected; ppb = parts per billion

Table 10: Volatile organic compounds outdoor air data from the Milby Park continuous air monitoring station from March 17, 2019 to March 27, 2019.

Chemical	Number of Samples	Concentration Range (ppb)	TCEQ Short-term AMCV (ppb)
1_2_3-Trimethylbenzene	238	ND - 0.19	3,000
1_2_4-Trimethylbenzene	238	ND - 1.23	3,000
1_3_5-Trimethylbenzene	238	ND - 0.14	3,000
1_3-Butadiene	238	0.02 - 4.64	1,700
1-Butene	238	0.05 - 2.57	27,000
1-Pentene	238	ND - 0.72	12,000
2_2_4-Trimethylpentane	238	ND - 1.51	4,100
2_2-Dimethylbutane	238	ND - 0.15	5,400
2_3_4-Trimethylpentane	238	ND - 0.41	4,100
2_3-Dimethylpentane	238	ND - 0.41	8,300
2_4-Dimethylpentane	238	ND - 0.4	8,300
2-Methylheptane	238	ND - 0.26	4,100
2-Methylhexane	238	ND - 0.57	8,300
3-Methylheptane	238	ND - 0.25	4,100
3-Methylhexane	238	ND - 0.75	8,300
Acetylene	238	0.12 - 2.29	25,000
Benzene	238	0.01 - 14.27	180
c-2-Butene	238	0.02 - 1.2	15,000
c-2-Pentene	238	ND - 0.52	12,000
Cyclohexane	238	ND - 1.59	1,000
Cyclopentane	238	0.03 - 1.23	5,900
Ethane	238	2.72 - 27.43	Simple Asphyxiant
Ethyl Benzene	238	ND - 0.39	20,000
Ethylene	238	ND - 9	500,000
Isobutane	238	0.15 - 9.44	33,000
Isopentane	238	0.2 - 37.46	68,000
Isoprene	238	ND - 0.25	1,400
Isopropyl Benzene - Cumene	238	ND - 0.11	510
Methylcyclohexane	238	ND - 1.52	4,000
Methylcyclopentane	238	ND - 1.89	750
n-Butane	238	0.37 - 27.27	92,000
n-Decane	238	ND - 0.32	1,000
n-Heptane	238	ND - 1.03	8,300
n-Hexane	238	0.03 - 3.49	5,400
n-Nonane	238	ND - 0.28	3,000
n-Octane	238	ND - 0.53	4,100
n-Pentane	238	0.13 - 28.04	68,000
n-Propylbenzene	238	ND - 0.08	510
o-Xylene	238	ND - 0.51	1,700
Propane	238	0.63 - 27.27	Simple Asphyxiant
Propylene	238	0.1 - 58.08	Simple Asphyxiant
p-Xylene + m-Xylene	238	0.02 - 1.53	1,700
Styrene	238	ND - 7.16	5,200
t-2-Butene	238	0.03 - 1.66	15,000
t-2-Pentene	238	ND - 1.2	12,000
Toluene	238	0.05 - 3.63	4,000

ND = Not detected; ppb = parts per billion

Table 11. Benzene outdoor air data from the air monitoring station HRM 16 from March 17, 2019 to March 22, 2019.

Date	Daily 24-hour Average	1-hour Sample Concentration Range (µg/m^3)	Number of 1-hour Samples	Number of samples exceeding TCEQ Short-term AMCV (180 ppb)	Number of samples exceeding EPA AEGL-1 (52,000 ppb)
3/17/2019	1.2	0.1 - 10.3	21	0	0
3/18/2019	0.8	0.1 - 4.9	22	0	0
3/19/2019	0.8	0.1 - 7.4	22	0	0
3/20/2019	42.3	0.1 - 249.0	22	2	0
3/21/2019	128.1	0.3 - 1227.0	22	3	0
3/22/2019	0.6	0.3 - 1.7	8	0	0

Table 12: $PM_{2.5}$ outdoor air data from continuous air monitoring stations in southeast Houston from March 17, 2019 to March 27, 2019.

Monitor Location	Date	Daily 24-hour Average	1-hour Sample Concentration Range (µg/m³)	Number of 1-hour Samples	AQI Category for Daily 24-hour Average Concentration
Houston East	3/17/2019	10.5	2 - 20	24	Good
Deer Park Site 1		10	2 - 16	22	Good
Deer Park Site 2		8.2	0.7 - 14.3	24	Good
Baytown		7.8	0 - 21	24	Good
Oyster Creek		10.2	7 - 17	24	Good
Clinton		9.7	2.7 - 20.4	24	Good
Houston East	3/18/2019	15.7	4 - 28	24	Moderate
Deer Park Site 1		11.6	5 - 21	24	Good
Deer Park Site 2		9.3	2.1 - 18.9	24	Good
Baytown		14.6	7 - 30	24	Moderate
Oyster Creek		11.6	6 - 21	24	Good
Clinton		15.5	4.1 - 27.5	24	Moderate
Houston East	3/19/2019	19.5	9 - 30	24	Moderate
Deer Park Site 1		14.2	7 - 26	24	Moderate
Deer Park Site 2		12	7.6 - 21.6	24	Moderate
Baytown		15.5	5.0 - 27	24	Moderate
Oyster Creek		15.5	11 - 21	24	Moderate
Clinton		18.3	10.3 - 30.8	24	Moderate
Houston East	3/20/2019	17.8	11 - 26	24	Moderate
Deer Park Site 1		17.9	7 - 27	24	Moderate
Deer Park Site 2		14	2.8 - 31.4	24	Moderate
Baytown		14.8	8 - 19	24	Moderate
Oyster Creek		14.6	11 -19	23	Moderate
Clinton		16.9	11.3 - 21.7	24	Moderate
Houston East	3/21/2019	13.6	2 - 27	24	Moderate
Deer Park Site 1		14.8	5 - 46	24	Moderate
Deer Park Site 2		10.2	1.3 - 33.5	24	Good
Baytown		10.8	3 - 23	24	Good
Oyster Creek		12.2	7 - 20	24	Moderate
Clinton		12.9	4.8 - 20.1	24	Moderate
Houston East	3/22/2019	12.5	6 - 27	24	Moderate
Deer Park Site 1		11	-1 - 31	24	Good
Deer Park Site 2		9.4	2.8 - 24.8	24	Good
Baytown		13.5	5 to 49	24	Moderate
Oyster Creek		11.8	6 - 20	24	Good
Clinton		14.2	5.9 - 30.7	24	Moderate
Houston East	3/23/2019	9.4	5 - 14	24	Good
Deer Park Site 1		7.5	4 - 15	24	Good
Deer Park Site 2		7.1	4.5 - 10.9	24	Good

Baytown		11.3	6 - 22	24	Good
Oyster Creek		10	6 - 14	24	Good
Clinton		9.1	5.8 - 15.9	24	Good
Houston East	3/24/2019	10.2	5 - 26	24	Good
Deer Park Site 1		9	4 - 16	24	Good
Deer Park Site 2		7.2	4.3 - 21.9	24	Good
Baytown		8.5	2 - 16	24	Good
Oyster Creek		10.1	6 - 15	24	Good
Clinton		9.4	6.4 - 13.6	24	Good
Houston East	3/25/2019	11.1	4 - 25	24	Good
Deer Park Site 1		9	3 - 14	24	Good
Deer Park Site 2		7.6	1.7 - 26.4	24	Good
Baytown		9.9	-7 - 21	24	Good
Oyster Creek		10.1	7 - 15	24	Good
Clinton		11.3	3.8 - 26.4	24	Good
Houston East	3/26/2019	9.6	5 - 27	24	Good
Deer Park Site 1		10.1	5 - 25	24	Good
Deer Park Site 2		8	3.2 - 25.8	22	Good
Baytown		8	0 - 23	24	Good
Oyster Creek		11	7 - 16	24	Good
Clinton		7.5	1.3 - 21.5	24	Good
Houston East	3/27/2019	10.8	3 - 20	24	Good
Deer Park Site 1		6.8	2- 12	24	Good
Deer Park Site 2		6.6	4 - 13.6	24	Good
Baytown		7.7	3 - 12	24	Good
Oyster Creek		12.3	9. - 18	24	Moderate
Clinton		8.9	5.1 - 16.3	24	Good

AQI = Air Quality Index

Table 13: NO_x outdoor air data from continuous air monitoring stations in southeast Houston from March 17, 2019 to March 27, 2019.

Monitor Location	Date	1-hour Sample Concentration Range (ppb)	Number of Samples	AQI Category for Daily Maximum 1-hour Concentration
Houston East	3/17/2019	4.7 - 33	22	Good
Channelview		1.7 - 26	22	Good
Deer Park		2.9 - 18.3	21	Good
Clinton		2.2 - 30.3	22	Good
HRM3		3.1 - 41.5	21	Good
Lynchburg Ferry		2.2 - 33.5	22	Good
Oyster Creek		2 - 4.5	21	Good
Houston East	3/18/2019	5.6 - 36.2	24	Good
Channelview		6.7 - 31	24	Good
Deer Park		1.7 - 28.9	22	Good
Clinton		8.6 - 33.4	23	Good
HRM3		5.2 - 32.6	22	Good
Lynchburg Ferry		4.9 - 33.3	24	Good
Oyster Creek		1.6 - 16.2	24	Good
Houston East	3/19/2019	8.9 - 40.2	22	Good
Channelview		7.9 - 33.2	24	Good
Deer Park		2.1 - 35.5	24	Good
Clinton		6.7 - 31.1	24	Good
HRM3		11 - 53.5	23	Good
Lynchburg Ferry		3.2 - 31.5	19	Good
Oyster Creek		1.7 - 6	24	Good
Houston East	3/20/2019	8.6 - 37.8	24	Good
Channelview		3.4 - 31.7	24	Good
Deer Park		3.6 - 35.7	24	Good
Clinton		7.7 - 30.3	24	Good
HRM3		9.3 - 38.9	23	Good
Lynchburg Ferry		7.4 - 45	22	Good
Oyster Creek		1.8 - 11.1	24	Good
Houston East	3/21/2019	6.1 - 37.4	24	Good
Channelview		2.3 - 24.6	24	Good
Deer Park		3.6 - 18.4	24	Good
Clinton		5.7 - 30.7	24	Good
HRM3		4.6 - 40	23	Good
Lynchburg Ferry		6.6 - 47.5	24	Good
Oyster Creek		1.9 - 6.1	19	Good
Houston East	3/22/2019	4.8 - 54.7	24	Moderate
Channelview		5.7 - 30.5	24	Good

Deer Park		2.6 - 44.9	24	Good
Clinton		6.4 - 53.1	24	Good
HRM3		8.8 - 48.7	23	Good
Lynchburg Ferry		2.9 - 59.7	24	Moderate
Oyster Creek		1.8 - 8.6	24	Good
Houston East		5.5 - 21.2	24	Good
Channelview		3.4 - 35.9	24	Good
Deer Park		2.2 - 8.7	24	Good
Clinton	3/23/2019	5.3 - 18.1	24	Good
HRM3		7.7 - 37.6	24	Good
Lynchburg Ferry		1.9 - 13.6	24	Good
Oyster Creek		1 - 3.4	24	Good
Houston East		0.7 - 28.1	22	Good
Channelview		1.9 - 23.5	22	Good
Deer Park		0.9 - 10.8	23	Good
Clinton	3/24/2019	3.8 - 14.1	22	Good
HRM3		1.5 - 26.1	21	Good
Lynchburg Ferry		1.5 - 14.7	22	Good
Oyster Creek		0.8 - 2.3	21	Good
Houston East		0.3 - 21.2	24	Good
Channelview		2.7 - 17.1	24	Good
Deer Park		1.5 - 11.8	24	Good
Clinton	3/25/2019	3.2 - 28.5	24	Good
HRM3		6 - 23.9	23	Good
Lynchburg Ferry		2.5 - 26.1	24	Good
Oyster Creek		0 - 8.3	22	Good
Houston East		4.5 - 28.7	24	Good
Channelview		1.7 - 14.1	24	Good
Deer Park		2.2 - 14.3	23	Good
Clinton	3/26/2019	2.4 - 11.6	24	Good
HRM3		4.8 - 18.3	24	Good
Lynchburg Ferry		3.4 - 21	24	Good
Oyster Creek		0.4 - 1.9	24	Good
Houston East		6.3 - 38.6	24	Good
Channelview		4.6 - 21	24	Good
Deer Park		1.8 - 8.7	24	Good
Clinton	3/27/2019	5.6 - 22.6	24	Good
HRM3		7 - 25.1	24	Good
Lynchburg Ferry		3.4 - 10.3	24	Good
Oyster Creek		-0.4 - 2.6	24	Good

AQI = Air Quality Index