Annual Report of Air Quality Monitoring January 1 to December 31, 2022, at the Gregory – Portland Community Air Monitoring Stations

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Austin, Texas

January 29, 2023

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Executive Summary

There are three continuous air quality monitoring stations operating in the Gregory-Portland area. The Gregory Fresnos Community Air Monitoring Station on Fresnos St. began continuous monitoring operations October 1, 2019. Two additional air-monitoring stations in Portland, TX near the intersection of Buddy Ganem Dr. and Wildcat Dr. on the campus of the Gregory-Portland High School and on Broadway Blvd. on the campus of the old East Cliff Elementary School began operations on January 1, 2020. The U.S. Environmental Protection Agency (EPA) generally uses three years of data collection to assess attainment with the National Ambient Air Quality Standards. This project has now collected data for three years for all three stations, and at this point the project has data from all or most of a year during which the Gulf Coast Growth Venture (GCGV) industrial facility has been in operation.

Since monitoring began, some measured pollutant concentrations have exceeded the concentration levels of NAAQS; however, these values have not been sustained long enough or measured frequently enough to violate a NAAQS. Furthermore, measured hydrocarbon concentrations have not exceeded the levels of concern published by the Texas Commission on Environmental Quality (TCEQ). In fact, the average total nonmethane hydrocarbon concentrations at the three Gregory-Portland (GP) air monitors for the twelve-month period November 1, 2021 – October 31, 2022, were less than 50 parts per billion carbon (ppbC), some of the lowest values measured in comparison to TCEQ automated gas chromatographs (auto-GCs) at their continuous ambient monitoring stations (CAMS) across the state.

The public website developed as the community's source for information about the community air monitors continues to provide information about air quality and monitoring data from the three air monitoring stations (https://gpair.ceer.utexas.edu accessed January 2023).

UT Austin would be happy to answer any questions or conduct additional analysis at the community's or sponsors' requests. Contact Vincent Torres at vmtorres@mail.utexas.edu for information on the website or Dave Sullivan at sullivan231@mail.utexas.edu with questions about the monitoring data and analyses in this report.

1.0 Introduction

This report is jointly funded by Cheniere Energy and Gulf Coast Growth Ventures LLC (GCGV) as part of their separate community air-monitoring programs. This report includes reviews and analyses conducted by The University of Texas at Austin (UT) of the air monitoring data obtained at the three stations since their continuous monitoring operations began. UT established the Gregory Fresnos (GF) station for Cheniere Energy and has managed the station since continuous monitoring operations began on October 1, 2019. AECOM, an engineering company, established the Portland Buddy Ganem (PBG) and Portland Broadway (PBway) stations for GCGV and has managed the stations since continuous monitoring operations began on January 1, 2020. The primary emphasis in this report is the examination of data collected in 2022 with some comparisons with earlier data.

2.0 Summary of Activities January 1 through December 31, 2022

The data completeness acceptable minimum for regulatory monitoring of criteria air pollutants is 75 percent. These three non-regulatory air monitoring stations have generally reported quality assured data at a level in excess of 75%. However, the Portland Buddy Ganem station auto-gas chromatograph (auto-GC) underwent maintenance during much of March 2022 and thus had a 63% data completeness for the first quarter of 2022, although for several species the data completeness was 76%. In the second and third quarters, data completeness exceeded 75%. Fourth quarter data have not been completely validated yet. The other two auto-GCs meet a 75% data completion rate for the first, second, and third quarters of 2022. The data completion rates for 2.5 micron-sized particulate matter (PM2.5), oxides of nitrogen (NOx), and sulfur dioxide (SO_2) all exceed 75% for 2022.

The public website developed as the community's source for information about the community air monitors continues to provide information about air quality and monitoring data from the three air monitoring stations (https://gpair.ceer.utexas.edu, accessed January 2023).

As was noted in the earlier quarterly reports in 2022, AECOM reported in April 2022 that the GCGV ethane-cracking facility became fully operational (all units producing product) in January 2022. Some GCGV processes began on September 15, 2021, with other processes beginning up through January 2022.

This report focuses on the data collected at the three air monitoring stations during the period January 1 through December 31, 2022, but also includes some summaries from earlier monitoring.

3.0 Air Monitoring Station Locations & Information

As noted earlier in this report, currently there are three air monitoring stations in the Gregory-Portland area in operation, one station operated by UT in Gregory, TX and two operated by AECOM in Portland, TX. The locations of the three stations and parameters measured are summarized in Table 1. The locations of the three stations are shown in satellite view (latest available image date March 2022) in Figure 1. Also shown in Figure 1 are the locations of the Cheniere liquefied natural gas facility under expansion and the GCGV ethane-cracker facility.

Table 1. Gregory-Portland Community Air Monitoring Stations and Parameters Measured

Air Monitoring Station Name & Address	Volatile Organic Compounds (VOCs) 46 compounds	Ethylene oxide (EO) 24 hr canister every 6th day	Nitrogen Oxides (NOx, NO, & NO2)	Sulfur Dioxide (SO_2)	Particulate Matter (PM) Mass, particles < 2.5 micron diameter	Wind Speed (WS), Wind Direction (WD), Ambient Temperature (T), Relative Humidity (RH), & Barometric Pressure (BP)
Gregory Fresnos Stephen Austin Elementary 401 Fresnos St. Gregory, TX	Yes	No	Yes	Yes	Yes	Yes
Portland Buddy Ganem 307 Buddy Ganem St. GP High School Portland, TX	Yes	Yes	No	No	Yes	Yes. + precipitation
Portland Broadway 175 Broadway Blvd. Old East Cliff Elementary School Portland, TX	Yes	Yes	No	No	Yes	Only WS, WD

Figure 1. Location of Gregory-Fresnos Community Air Monitoring Station (GF, pin G), and two Portland community stations on GPISD campuses on Buddy Ganem (PBG, pin 1) and on Broadway (PBway, pin 2) and the Cheniere Energy and GCGV industrial facilities

4.0 Summary of Measurement Data

As described in each report, the reader is reminded that pollutant concentrations are affected by several factors. One, of course, is the emission of a gas or smoke from an emission source or the availability of dust to become airborne. Another is the weather. Regarding weather, rain can reduce concentrations of several pollutants, especially particulate matter. The “mixing height” is the lower level of the atmosphere wherein gases and particles mix vertically. Temperature inversions such as those experienced at night have low mixing heights and can lead to air pollutants emitted near the surface being trapped at lower altitudes, thus allowing concentrations to increase. The converse is midday periods when the mixing height of the lower atmosphere rises, and air pollutants are diluted in a larger volume of air. The wind plays a significant role in moving air pollutants from a source to other locations. For this reason, a large majority of air monitoring stations operated by the TCEQ and all three Gregory-Portland stations measure wind speed and direction. Under high wind speeds, many gas pollutants are dispersed and diluted; however, under high-speed winds, dust on the surface can be picked up and transported, leading to higher particulate concentrations. Higher speed winds passing over the roof of a storage tank can lower the atmospheric pressure on that roof, leading to vapors being drawn out of the tank and into the air. However, in general, low speed winds often lead to higher concentrations of pollutants. Figure 2 shows how higher concentrations of NO_2 and propane at the GF station are associated with low-speed winds, with lower concentrations under higher speed winds. Winds can be thought of as being local – near the surface – and regional – at higher altitudes. The local wind direction affects pollutant concentrations in terms of whether a pollution source is in the upwind direction, or along the local upwind path of the air if wind directions are changing. Similarly, but on a larger scale, the regional wind direction affects pollutant concentrations in terms of whether or not a source such as another major city, a large power plant, a forest fire, etc., is along the regional upwind path of the air. In the graphs that follow, some short-term concentration measurements are significantly higher than the balance of the data. In some cases, this is likely the combination of emission and meteorological (Met) factors, and in other cases, normal emissions can result in unusually high concentrations owing to a source being nearby under low wind speeds or air stagnation.

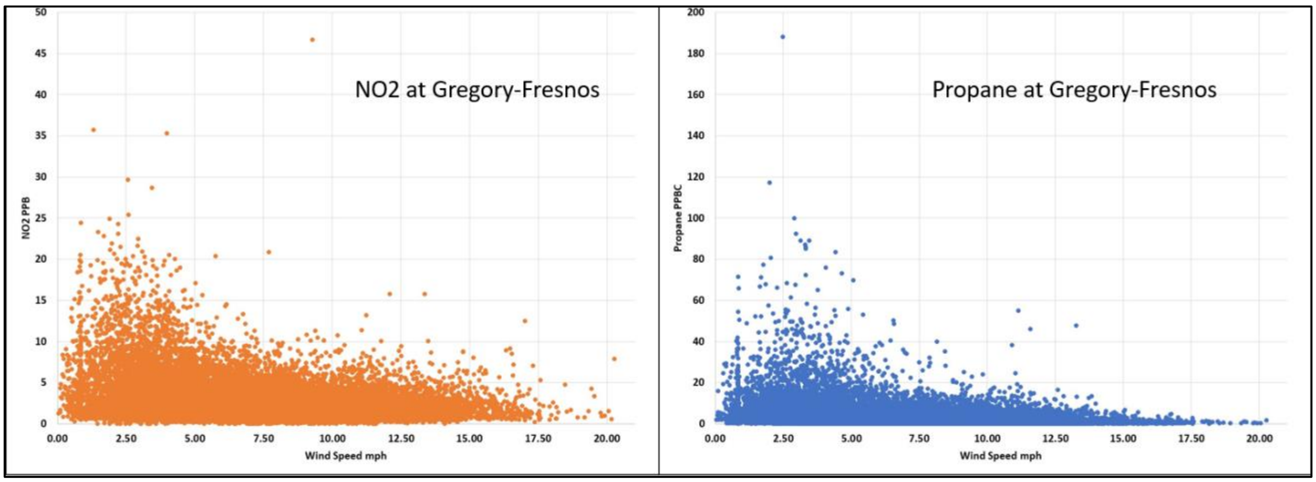

Figure 2. Effect of wind speed on primary pollutants

Please note that the measurement data in this report are quality assured station data made available at different submission frequencies:

- NOx, NO, & NO_2, SO_2, PM2.5 & Met measurements – weekly;
- Auto-GC VOC measurements – within 90 days of the measurement; and
- EO canister data – within 60 days of the date the sample was collected.

Although all these measurements, except EO, are made in near-real time, the nature of the complexity in quality assuring the 46 auto-GC target hydrocarbons among the thousands of different organic compounds that exist in the air leads to a lengthy delay in releasing the quality assured target species data. Air samples for EO data are collected at the station and then sent to a laboratory where EO concentrations are then derived upon analysis of the air samples. Hence, the data available at the time this report was written will not all have the same date ranges. For this report, auto-GC and EO data were available through October 31, 2022, and all other data were available through December 31, 2022, or later.

4.1 Gregory Fresnos Station Hydrocarbon Data

Figure 3 shows the time series graph for hourly concentrations of benzene at the Gregory-Fresnos (GF) station. The graph shows benzene hourly average concentrations for each hour from January 1, 2022, through October 31, 2022. Benzene concentrations in the air can be of health concern but to date their concentrations have been much lower than TCEQ Air Monitoring Comparison Values (AMCV) of 1,080 ppbC for a single one-hour value or 8.4 ppbC for an annual hourly average concentration. Other AMCVs for auto-GC hydrocarbons can be found at https://www.tceq.texas.gov/cgi-bin/compliance/monops/agc_amcvs.pl (accessed January 2023). Note that a straight line or a gap in a time series graph represents missing data. Data may be missing owing to equipment failure, planned equipment or site maintenance, or external factors such as power loss or severe weather.

Table 2 lists all target hydrocarbon species measured and reported by the GF auto-GC, with the peak one-hour concentration, maximum 24-hour day concentration, and the January through October 2022 average hourly concentration for each species. Note that the total sum of the target species (TNMTC) and the total sum of the hydrocarbons (target species plus non-target species and unknown species) (TNMHC) are included in the table.

Data completeness for auto-GCs is based on the planned collection of 22 hours per day – as two hours per day are reserved for quality assurance activities. The GF station has collected data on the 46 individual hydrocarbon compounds with 89 to 91 percent data completeness of the planned collection hours over the first ten months of 2022.

Time series graphs of other hydrocarbon species are also available upon request and any graphs can be made with timescale (x-axis) or concentration-scale (y-axis) adjustments. Also, concentrations can be averaged by day, month, or other time period upon request. A user can also make graphs of data on the project website at https://gpair.ceer.utexas.edu/custom-data-request.php (accessed January 2023). To make a request, contact Dr. Dave Sullivan at sullivan231@mail.utexas.edu or 512-471-7805.

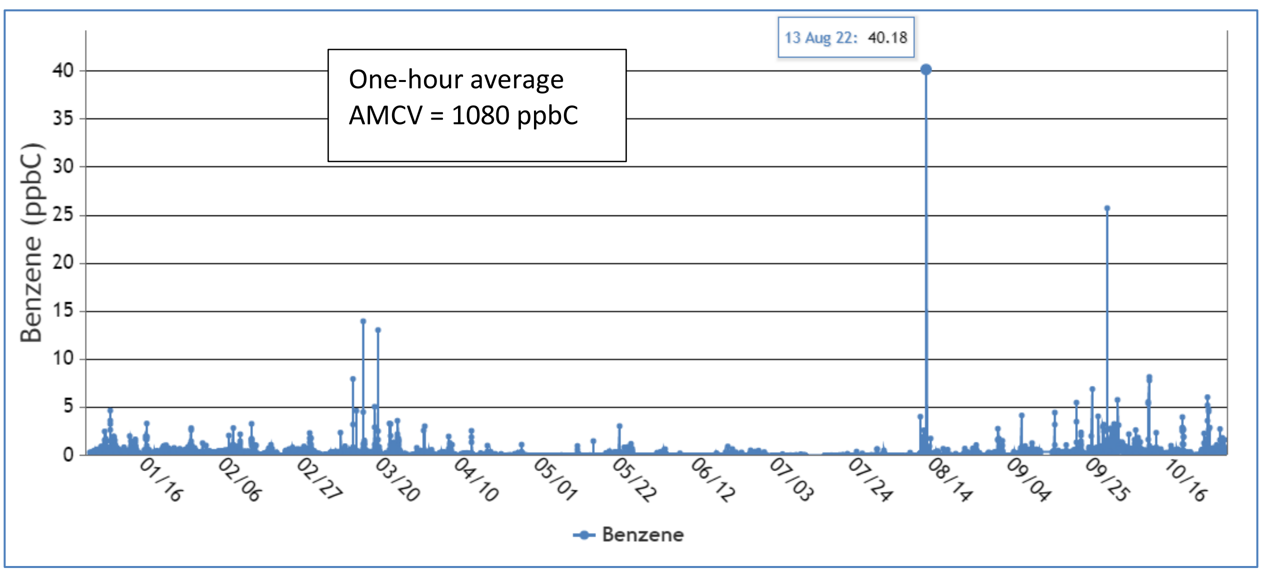

Figure 3. Hourly benzene concentrations at GF station, Jan. 1, 2022 – October 31, 2022, ppbC units

Table 2. Gregory-Fresnos Auto-GC statistics for Jan. - October 2022

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMHC	6,023	2,786.25	193.81	37.94
TNMTC	6,023	2,489.29	175.99	34.82
Ethane	6,030	226.95	47.62	9.34
Ethylene	6,030	15.49	3.99	0.62
Propane	6,030	216.79	41.94	7.26
Propylene	6,030	5.29	3.09	0.71
Isobutane	6,030	170.29	16.31	2.53
n-Butane	6,030	288.61	25.35	4.28
Acetylene	6,030	8.96	1.77	0.44
trans-2-Butene	6,028	21.99	1.62	0.12
1-Butene	6,024	13.51	2.02	0.18
cis-2-Butene	6,023	71.11	6.67	0.10
Cyclopentane	6,030	24.07	1.50	0.14
Isopentane	6,030	327.38	20.52	2.44
n-Pentane	6,030	260.29	15.89	2.04
1,3-Butadiene	6,030	9.86	0.48	0.05
trans-2-Pentene	6,030	0.79	0.13	0.02
1-Pentene	5,940	1.89	0.20	0.05
cis-2-Pentene	6,030	0.40	0.04	0.00
2,2-Dimethylbutane	6,030	27.95	1.72	0.13
Isoprene	6,030	1.77	0.33	0.06
n-Hexane	6,111	165.87	9.47	0.63
Methylcyclopentane	6,111	81.24	4.77	0.28
2,4-Dimethylpentane	6,111	14.82	0.92	0.08
Benzene	6,111	40.18	2.22	0.20
Cyclohexane	6,111	161.79	9.22	0.36
2-Methylhexane	6,111	46.29	2.39	0.06
2,3-Dimethylpentane	6,111	28.36	1.45	0.03
3-Methylhexane	6,111	52.55	2.81	0.09
2,2,4-Trimethylpentane	6,111	31.19	1.78	0.11
n-Heptane	6,111	88.44	4.78	0.17
Methylcyclohexane	6,111	135.34	8.22	0.40
2,3,4-Trimethylpentane	6,111	1.39	0.21	0.01
Toluene	6,111	48.88	2.90	0.32
2-Methylheptane	6,111	10.58	0.60	0.04
3-Methylheptane	6,111	7.44	0.43	0.03
n-Octane	6,111	27.08	1.56	0.11
Ethyl Benzene	6,111	14.48	0.91	0.03
p-Xylene + m-Xylene	6,111	52.54	3.46	0.22
Styrene	6,111	0.64	0.22	0.02
o-Xylene	6,111	10.90	0.80	0.05
n-Nonane	6,111	4.81	0.38	0.05
Isopropyl Benzene - Cumene	6,111	1.92	0.34	0.01
n-Propylbenzene	6,111	1.16	0.40	0.02
1,3,5-Trimethylbenzene	6,111	1.60	0.20	0.01
1,2,4-Trimethylbenzene	6,064	3.81	0.56	0.15
n-Decane	6,111	6.84	0.91	0.10
1,2,3-Trimethylbenzene	6,111	3.36	0.69	0.05

4.2 Portland Buddy Ganem & Portland Broadway Stations Hydrocarbon Data

Figure 4 shows the time series graph for hourly concentrations of benzene at the Portland Buddy Ganem (PBG) station, and Figure 5 shows the time series graph for the hourly concentrations of benzene at the Portland Broadway (PBway) station. Both graphs show benzene hourly average concentrations for each hour from January 1, 2022, through October 31, 2022.

As was the case at the Gregory Fresnos station, hydrocarbon concentrations to date are much lower than the TCEQ AMCVs. Table 3 lists the target hydrocarbon species measured and reported by the Portland Buddy Ganem (PBG) auto-GC and Table 4 lists the target hydrocarbon species measured and reported by the Portland Broadway (PBway) auto-GC with the peak one-hour concentration, maximum 24-hour day concentration, and average hourly concentration for each species for January through October 2022.

Based on the 22 hours per day planned ambient measurements, the PBG station has collected data with an 83 to 92 percent data completeness based on planned collection hours for the first ten months of 2022, and the PBway station has between 89 and 91 percent data completeness of the planned collection hours over the same period.

Time series graphs of other hydrocarbon species are also available upon request, and any graphs can be made with timescale (x-axis) or concentration-scale (y-axis) adjustments. In addition, concentrations can be averaged by day, week, or month upon request. As mentioned earlier in the report, a user can also make graphs on the project website.

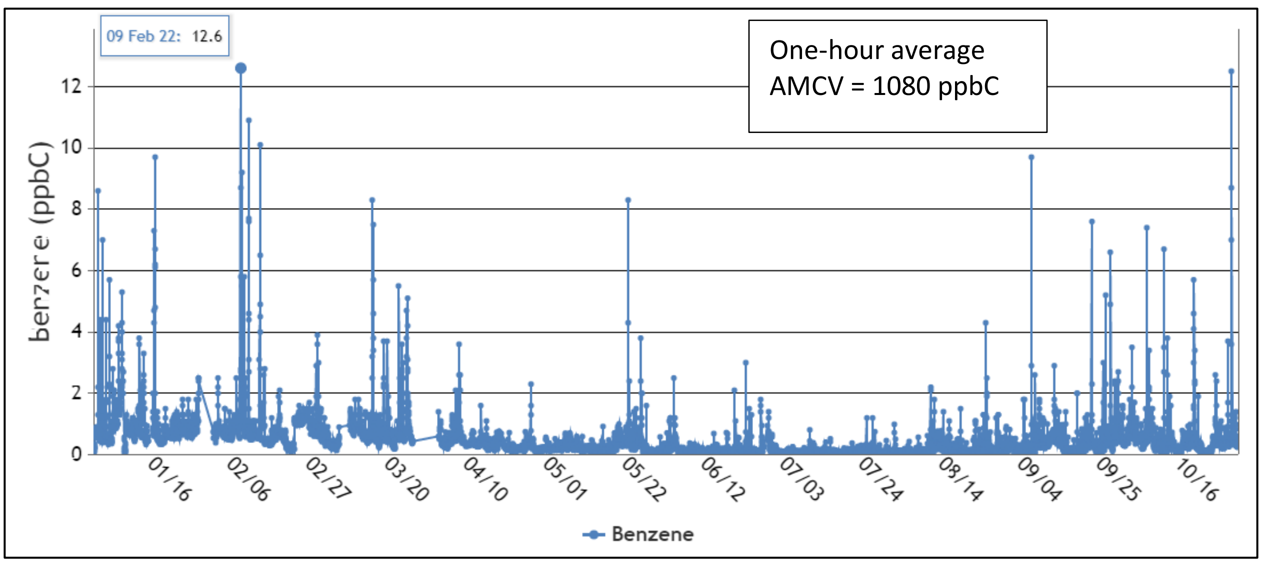

Figure 4. Hourly benzene concentrations at PBG station, Jan. 1, 2022 – October 31, 2022, ppbC units

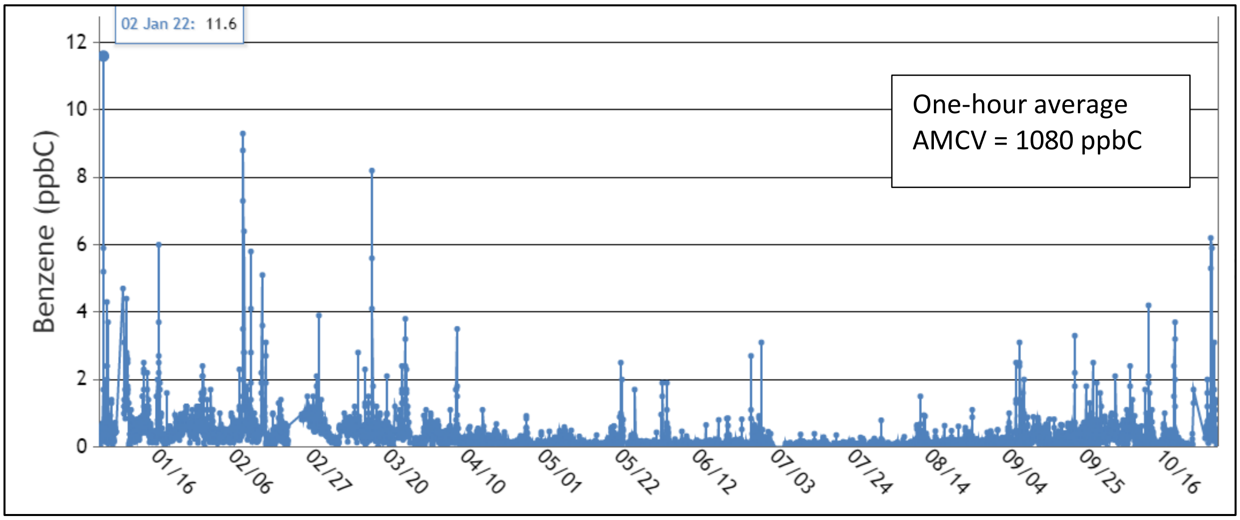

Figure 5. Hourly benzene concentrations at PBway station, Jan. 1, 2022 – October 31, 2022, ppbC units

Table 3. PBG Auto-GC statistics for Jan. - October 2022

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMHC	5,684	1,329.89	238.19	42.86
TNMTC	5,684	1,244.30	224.71	39.36
Ethane	5,684	619.00	55.07	10.61
Ethylene	5,684	54.70	8.82	0.78
Propane	5,684	251.00	54.12	8.58
Propylene	5,684	9.30	1.70	0.48
Isobutane	5,684	235.00	27.42	2.89
n-Butane	5,684	127.00	33.31	4.54
Acetylene	5,547	5.30	1.48	0.26
trans-2-Butene	5,684	1.90	0.29	0.20
1-Butene	5,683	26.90	1.84	0.26
cis-2-Butene	5,684	1.00	0.41	0.06
Cyclopentane	5,684	4.20	0.88	0.13
Isopentane	5,684	87.80	15.89	2.54
n-Pentane	5,682	69.10	12.79	1.97
1,3-Butadiene	5,684	32.60	1.64	0.10
trans-2-Pentene	5,684	0.47	0.07	0.02
1-Pentene	5,682	1.20	0.41	0.04
cis-2-Pentene	5,683	1.00	0.11	0.01
2,2-Dimethylbutane	5,684	5.50	0.73	0.08
Isoprene	5,684	16.40	0.86	0.24
n-Hexane	6,156	41.10	5.78	0.66
Methylcyclopentane	6,156	15.60	2.46	0.27
2,4-Dimethylpentane	6,156	4.10	0.24	0.01
Benzene	6,156	12.60	3.06	0.52
Cyclohexane	6,156	25.60	3.27	0.38
2-Methylhexane	6,156	10.70	1.24	0.14
2,3-Dimethylpentane	6,156	4.80	0.55	0.06
3-Methylhexane	6,156	11.30	1.38	0.20
2,2,4-Trimethylpentane	6,156	5.90	1.25	0.24
n-Heptane	6,156	27.10	2.64	0.32
Methylcyclohexane	6,156	36.70	4.29	0.46
2,3,4-Trimethylpentane	6,156	1.40	0.19	0.03
Toluene	6,156	20.40	3.13	0.67
2-Methylheptane	6,156	4.80	0.61	0.08
3-Methylheptane	6,156	4.30	0.57	0.06
n-Octane	6,156	11.40	1.64	0.18
Ethyl Benzene	6,156	17.00	0.88	0.09
p-Xylene + m-Xylene	6,156	75.10	3.73	0.30
Styrene	6,156	1.40	0.85	0.07
o-Xylene	6,156	20.30	1.03	0.09
n-Nonane	6,156	4.80	2.25	0.10
Isopropyl Benzene - Cumene	6,156	1.70	0.42	0.02
n-Propylbenzene	6,156	1.10	0.34	0.03
1,3,5-Trimethylbenzene	6,147	2.60	1.03	0.04
1,2,4-Trimethylbenzene	6,156	5.50	0.95	0.19
n-Decane	6,156	8.20	3.62	0.38

Table 4. PBway Auto-GC statistics for Jan. - October 2022

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMHC	6,109	921.25	273.99	39.15
TNMTC	6,109	864.17	264.45	36.16
Ethane	6,018	387.00	73.49	11.13
Ethylene	6,018	84.30	8.53	1.02
Propane	6,109	157.00	60.55	7.19
Propylene	6,109	6.60	2.69	0.52
Isobutane	6,109	127.00	30.77	2.64
n-Butane	6,109	115.00	40.13	4.68
Acetylene	5,933	5.80	1.70	0.31
trans-2-Butene	6,106	10.40	0.95	0.10
1-Butene	6,109	25.10	1.47	0.24
cis-2-Butene	6,109	4.30	0.26	0.05
Cyclopentane	6,109	4.90	0.85	0.14
Isopentane	6,109	172.0	19.94	2.55
n-Pentane	6,109	144.0	15.02	1.91
1,3-Butadiene	6,109	200.0	9.26	0.09
trans-2-Pentene	6,109	3.30	0.19	0.02
1-Pentene	6,109	6.50	1.22	0.07
cis-2-Pentene	6,105	1.20	0.23	0.01
2,2-Dimethylbutane	6,109	4.60	0.77	0.09
Isoprene	6,109	3.60	1.33	0.39
n-Hexane	6,109	24.70	5.24	0.37
Methylcyclopentane	6,109	10.40	2.49	0.16
2,4-Dimethylpentane	6,109	2.40	0.12	0.00
Benzene	6,109	11.60	2.71	0.30
Cyclohexane	6,109	16.70	3.00	0.23
2-Methylhexane	6,109	4.60	0.75	0.04
2,3-Dimethylpentane	6,109	3.20	0.57	0.02
3-Methylhexane	6,109	6.10	0.97	0.07
2,2,4-Trimethylpentane	6,109	21.80	1.85	0.15
n-Heptane	6,109	10.00	1.96	0.11
Methylcyclohexane	6,109	18.30	3.42	0.25
2,3,4-Trimethylpentane	6,109	6.20	0.54	0.04
Toluene	6,109	13.70	3.29	0.49
2-Methylheptane	6,109	5.30	0.56	0.05
3-Methylheptane	6,109	2.00	0.30	0.03
n-Octane	6,109	4.80	0.88	0.07
Ethyl Benzene	6,109	2.80	0.19	0.02
p-Xylene + m-Xylene	6,109	12.40	1.49	0.17
Styrene	6,109	0.33	0.05	0.01
o-Xylene	6,109	2.80	0.29	0.02
n-Nonane	6,109	1.40	0.34	0.03
Isopropyl Benzene - Cumene	6,109	0.88	0.19	0.01
n-Propylbenzene	6,109	0.63	0.06	0.01
1,3,5-Trimethylbenzene	6,109	1.30	0.10	0.01
1,2,4-Trimethylbenzene	5,930	3.50	0.98	0.41
n-Decane	6,109	1.80	0.34	0.09

4.3 Ethylene Oxide Measurements

As was noted earlier in this report, the GCGV ethylene-cracking industrial facility began operating in late 2021 through early 2022. As shown in Figure 6 through Figure 9, the levels of EO measured at the two GCGV stations have remained low, with no discernable trends. Note that values of 0.0 ppbC were recorded from the laboratory as non-detects. The TCEQ effects screening level (ESL) for chronic exposure to EO is 2.4 ppbV or 4.8 ppbC. An ESL is defined in Appendix A.2. (https://www.tceq.texas.gov/downloads/toxicology/dsd/final/eto.pdf, accessed January 2023). It is notable that there has been no change in concentrations during 2022 while the GCGV industrial facility has been in operation.

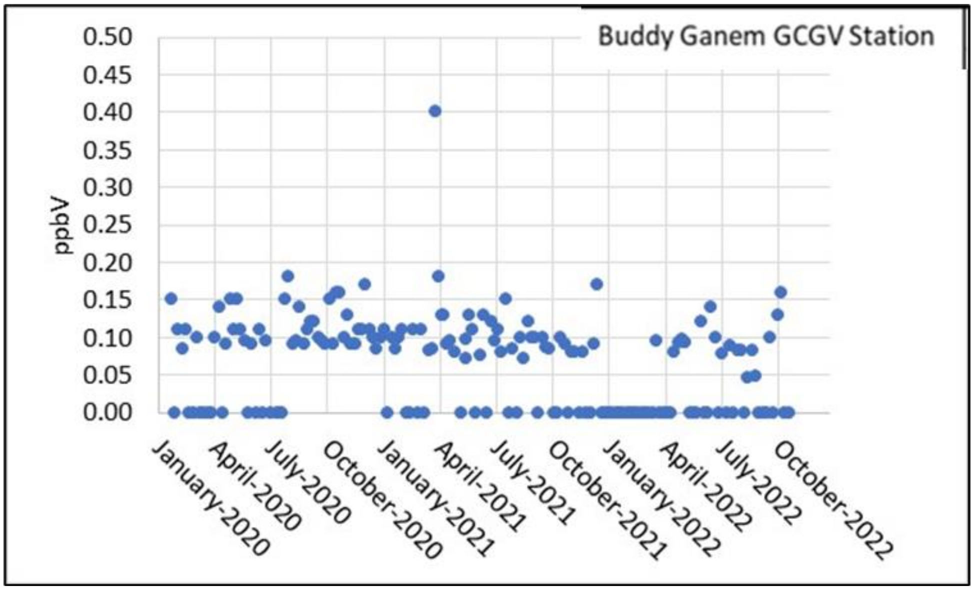

Figure 6. PBG EO concentrations, every 6th day samples Jan. 2020 through October 2022

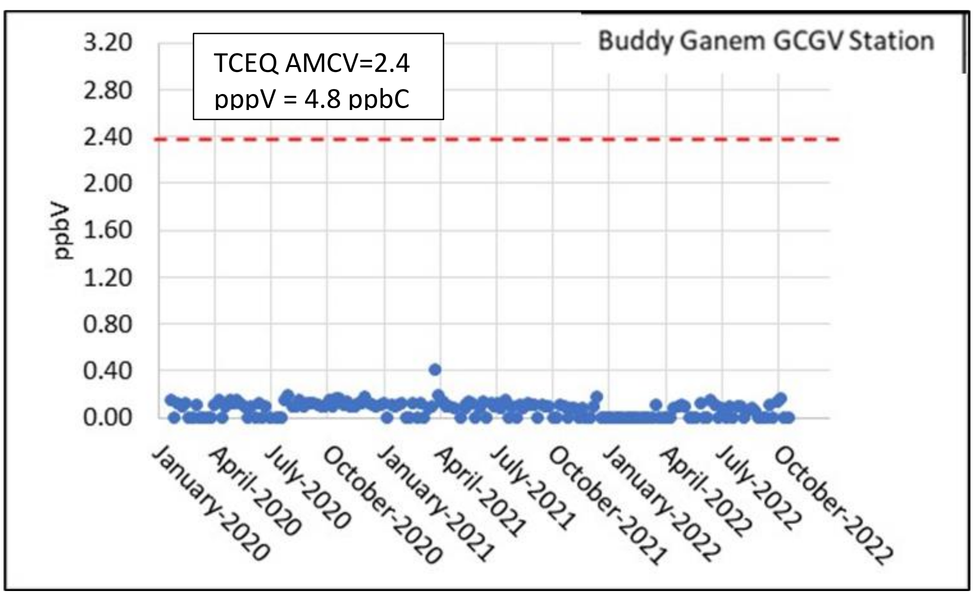

Figure 7. PBG EO concentrations, every 6th day samples Jan. 2020 through October 2022 in comparison to TCEQ Effect Screening Level

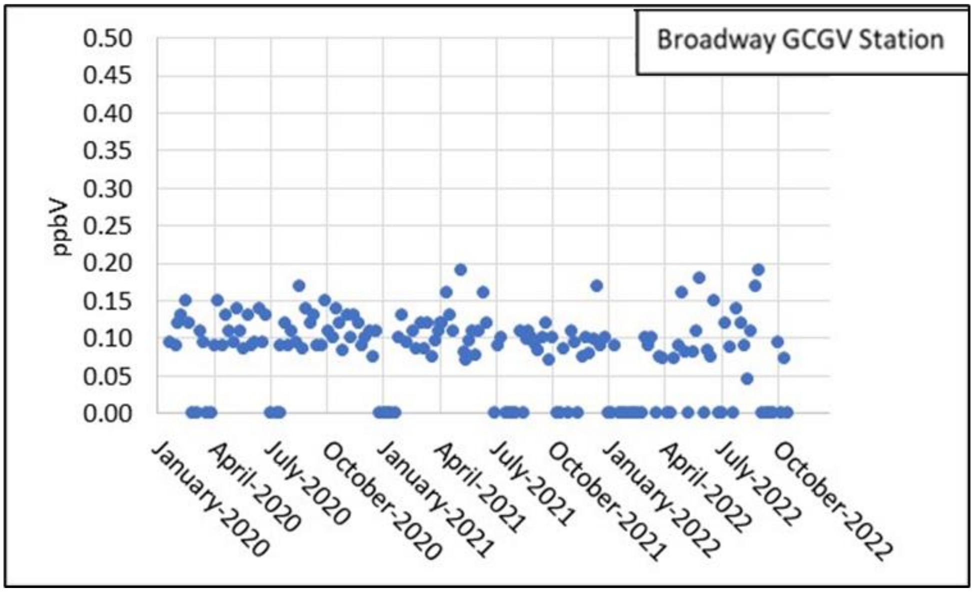

Figure 8. PBway EO concentrations, every 6th day samples Jan. 2020 through October 2022

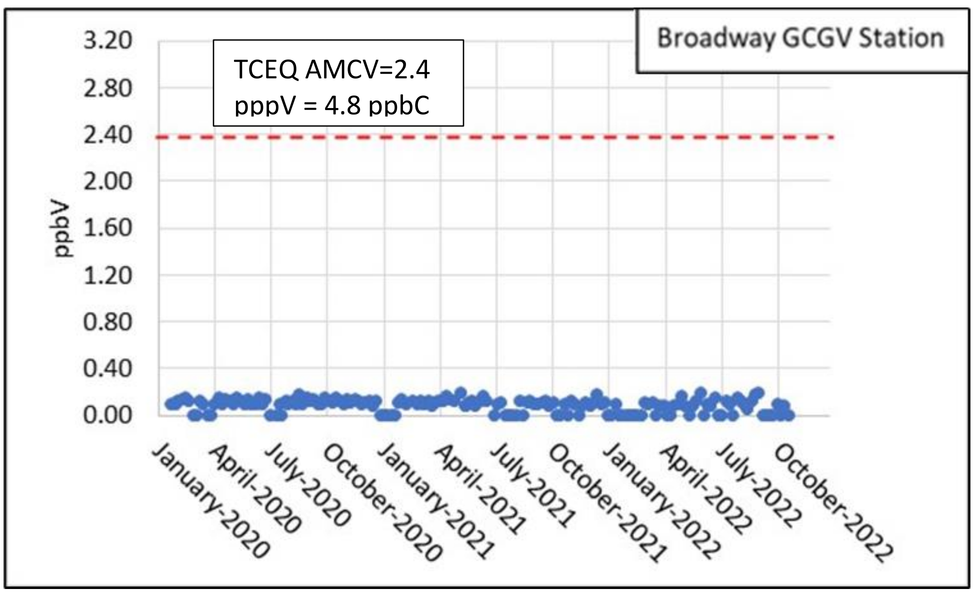

Figure 9. PBway EO concentrations, every 6th day samples Jan. 2020 through October 2022 in comparison to TCEQ Effect Screening Level

4.4 Comparing Hydrocarbon Data between Stations

Figure 10 shows a bar graph comparison between the average concentrations for the first ten months of 2022 of hydrocarbons including TNMTC and TNMHC among the three stations. The graph shows relatively close agreement among the three stations. Figure 11 is a similar graph excluding TNMTC and TNMHC. This second graph allows for a better comparison of the similarity among the stations. The most common nonmethane hydrocarbons in the atmosphere in urban areas are ethane and propane, followed by other alkane species such as butanes and pentanes. These species have low chemical reactivities and thus can persist in the air longer than more reactive species. Some ethane and propane are likely transported into the region from nearby oil and gas extraction fields.

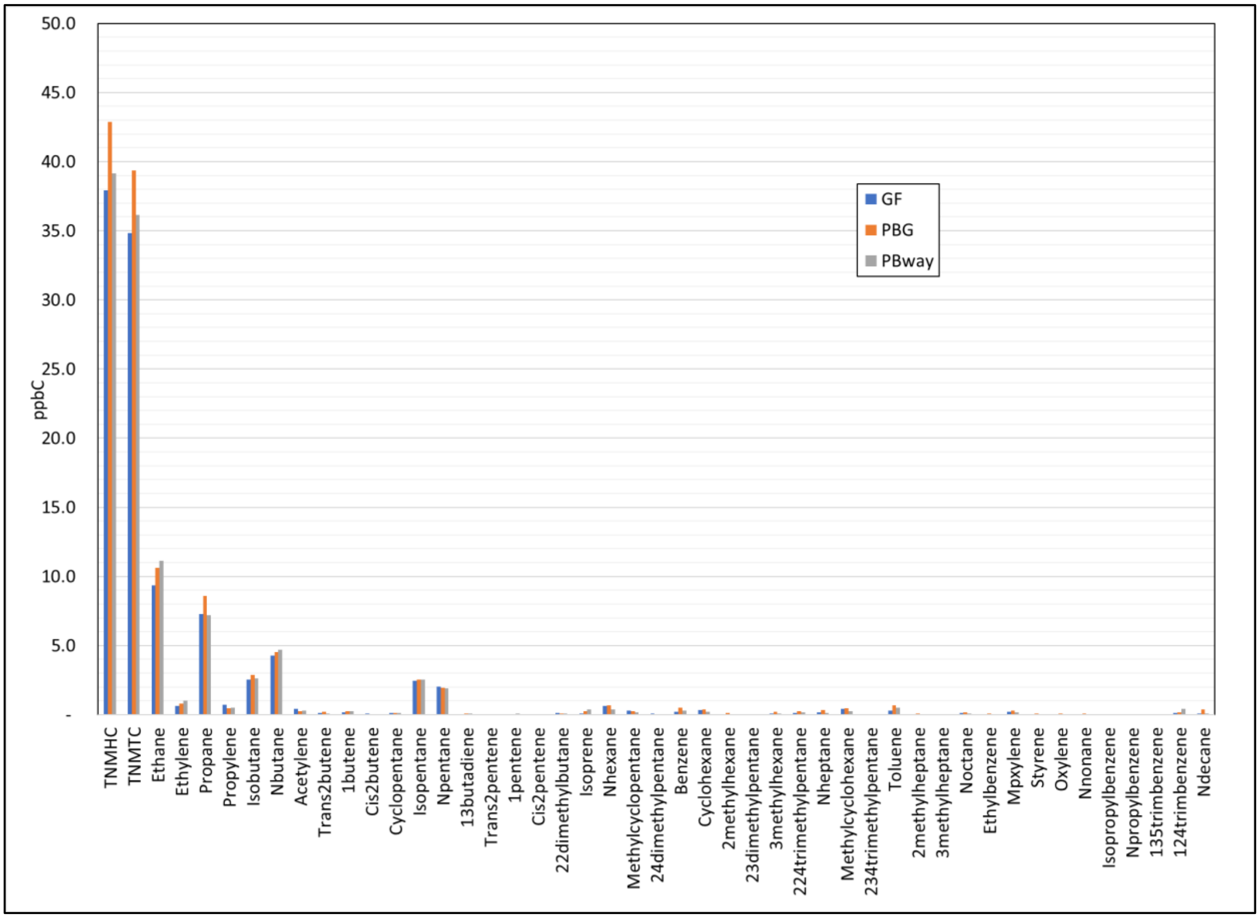

Figure 10. January through October 2022 mean concentrations of TNMTC, TNMHC, and hydrocarbon species at three stations

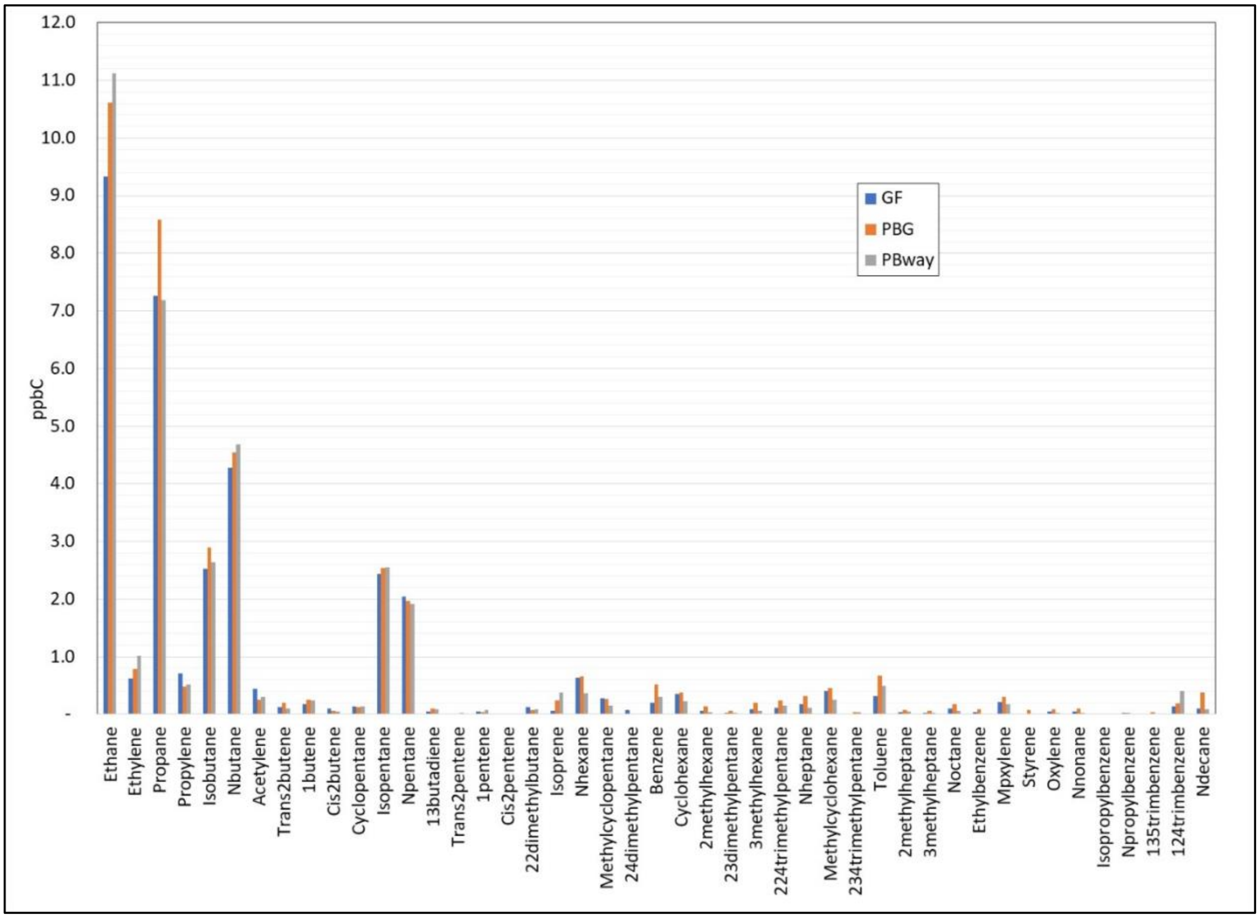

Figure 11. January through October 2022 mean concentrations of hydrocarbon species at the three air monitoring stations

4.4 Gregory Fresnos Station Criteria Pollutant Data

Sulfur dioxide (SO_2), fine particulate matter (PM2.5), and nitrogen dioxide (NO_2) are three pollutants measured at the GF site that are regulated by the U.S. Environmental Protection Agency (EPA). These pollutants, along with ozone, lead, combined coarse and fine particulate matter (PM10), and carbon monoxide are referred to as "criteria pollutants" and are governed by National Ambient Air Quality Standards (NAAQS). Some NAAQS are based on annual average concentrations, and some are based on the frequency with which very high concentrations are measured. The rationale is that different pollutants affect human health in different ways.

- PM2.5 has both an annual average NAAQS and 24-hour NAAQS. For the PM2.5 24-hour NAAQS, the three-year average of the 98th percentile 24-hour (midnight to midnight, using standard time) concentration each year must be less than 35 micrograms per cubic meter ($\mu g/m^3$). The annual average, averaged over three years, is calculated by first averaging 24-hour averages by quarter and then averaging the four quarters, must be less than 12 $\mu g/m^3$.
- The NAAQS for NO_2 is for the one-hour values to average less than 53 ppb in a calendar year and for the three-year average of the 98th percentile daily maximum values to be less than 100 ppb.
- SO_2 has a 1-hour NAAQS, based on ranking the daily maximum one-hour values for each

day in a year, selecting the 99th percentile daily maximum values, and then calculating a three-year average, which must be less than 75 ppb.

No concentrations at levels that violate the NAAQS have been seen at the GF station. Several recorded PM2.5 one-hour values exceeded the level of the 24-hour NAAQS, 35 μg/m^3, but as noted above, the NAAQS is not violated unless the 98th percentile of 24-hour averaged concentrations in a year, averaged over three years violates the 24-hour NAAQS, or unless the overall annual average, averaged over three years, exceeds the level of the annual NAAQS (12 μg/m^3).

Figure 12 shows the 24-hour averaged daily PM2.5 concentrations since the start of monitoring in October 2019. This graph is provided to illustrate the roughly seasonal pattern of PM2.5, with higher concentrations in the summers associated with transported dust from Northern Africa. The average concentration for 2022 was 8.1 μg/m^3. Table 5 lists the annual mean PM2.5 concentration from each of the past three years and the three-year average for the GF station.

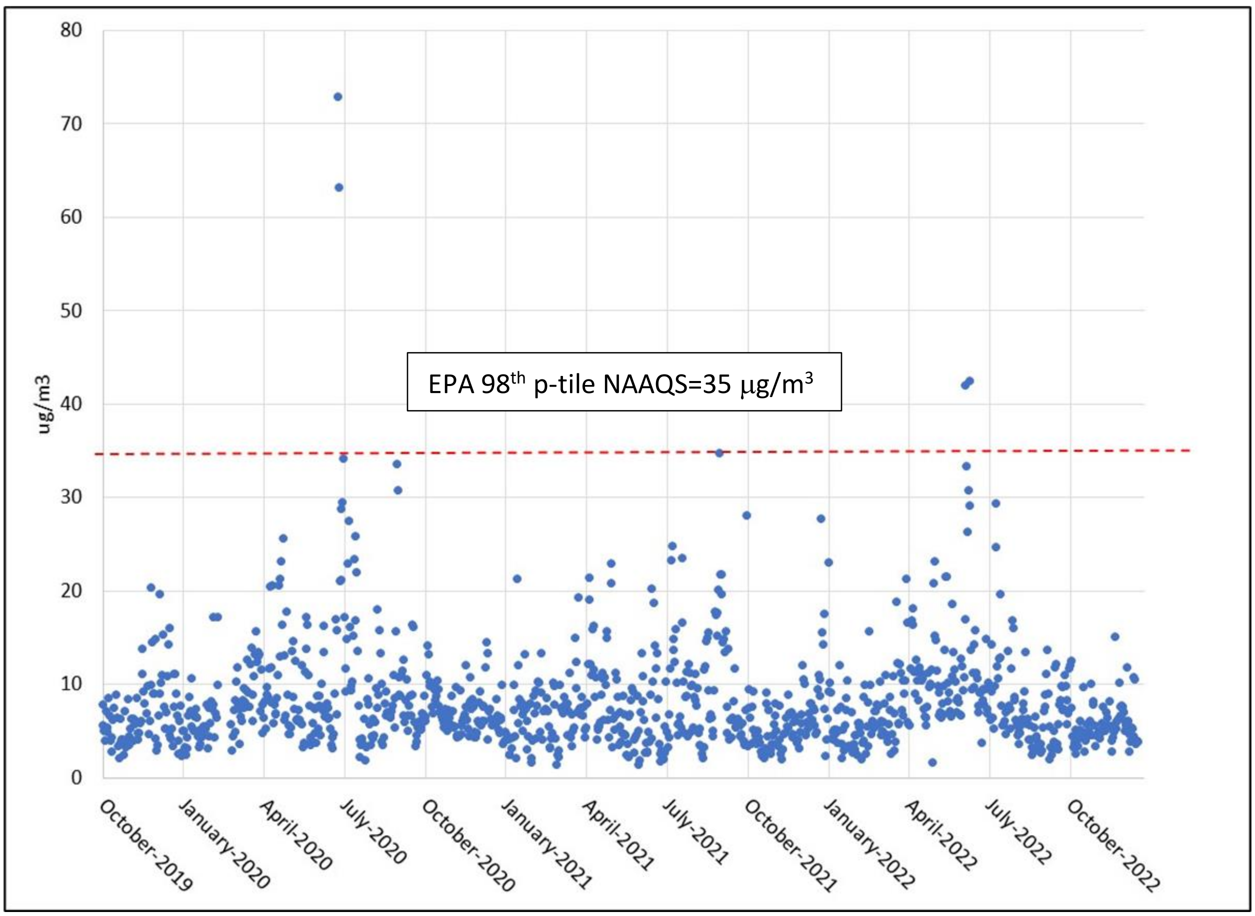

Figure 12. Averaged 24-Hour PM2.5 at GF, Oct. 1, 2019 – Dec. 31, 2022, with NAAQS

Table 5. GF PM2.5 annual mean and three-year average showing NAAQS compliance.

Year	Annual Mean μg/m³	NAAQS 3-Year Annual Average Value, μg/m³	Annual 98th Percentile Value μg/m³	NAAQS 3-Year 98th Percentile Average Value, μg/m³
2020	8.9		27.4	
2021	7.6		21.7	
2022	8.1		24.3	
3-year average	8.2	12.0	24.4	35.0

Figure 13 shows the hourly average time series graph for NO_2 at the Gregory Fresnos station from October 1, 2019, through December 31, 2022. The figure also shows the 24-hour 100 ppb NAAQS level. The figure shows concentrations well below the level of the NAAQS. Table 6 lists for the past three years the NO_2 annual 98th percentile and the annual averages showing NAAQS compliance of these standards by margins in excess of 81 and 46 ppb, respectively.

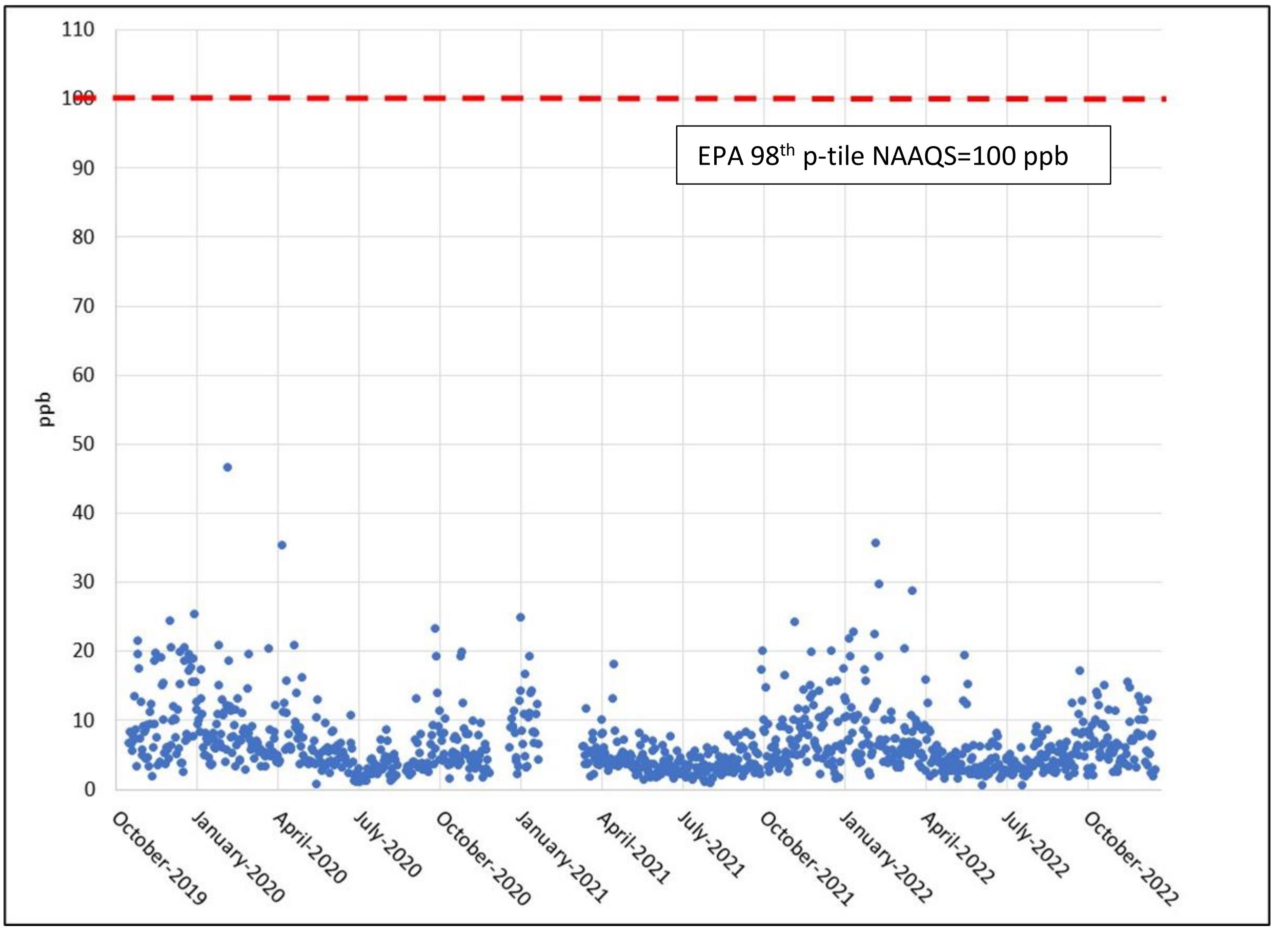

Figure 13. Hourly NO_2 at GF, ppb units, Oct. 1, 2019 – Dec. 31, 2022, with NAAQS

Table 6. GF NO_2 annual 98^{th} percentile values and three-year average showing NAAQS compliance

Year	Annual Average Values, ppb	NAAQS Annual Average Value, ppb	Annual 98^{th} percentile ppb	NAAQS 3-Year 98^{th} Percentile Average Value, ppb
2020	6.3	53	19.7	
2021	5.6		17.9	
2022	6.2		19.4	
3-year Average	6.0		19.0	100

SO_2 is rarely found in ambient air, and the SO_2 instruments are calibrated to accurately measure high concentrations that are a risk to public health. As a result, the large majority of SO_2 concentrations measurements are close to 0.0. Many instruments measuring low concentrations will produce time series with much scatter near 0.0 owing to the nature of carrying out the chemical or electrical reaction that is associated with the measurement and converting that to a number representing the concentration. When an instrument has been calibrated to accurately measure high concentrations to safeguard public health, generally at low concentrations near zero there can be high relative error. The time series graph for the three years of SO_2 at the GF station is shown in Figure 14. The graph is scaled to illustrate how low the concentrations have been compared to the 75-ppb level of the NAAQS. The only likely actual recent SO_2 plume in 2022 was an 8 ppb concentration earlier in the year on January 23, 2022. Table 7 lists the annual 99^{th} percentile values of SO_2 for the past three complete years, again showing compliance between the level of the NAAQS and observed concentrations by more than 70 ppb.

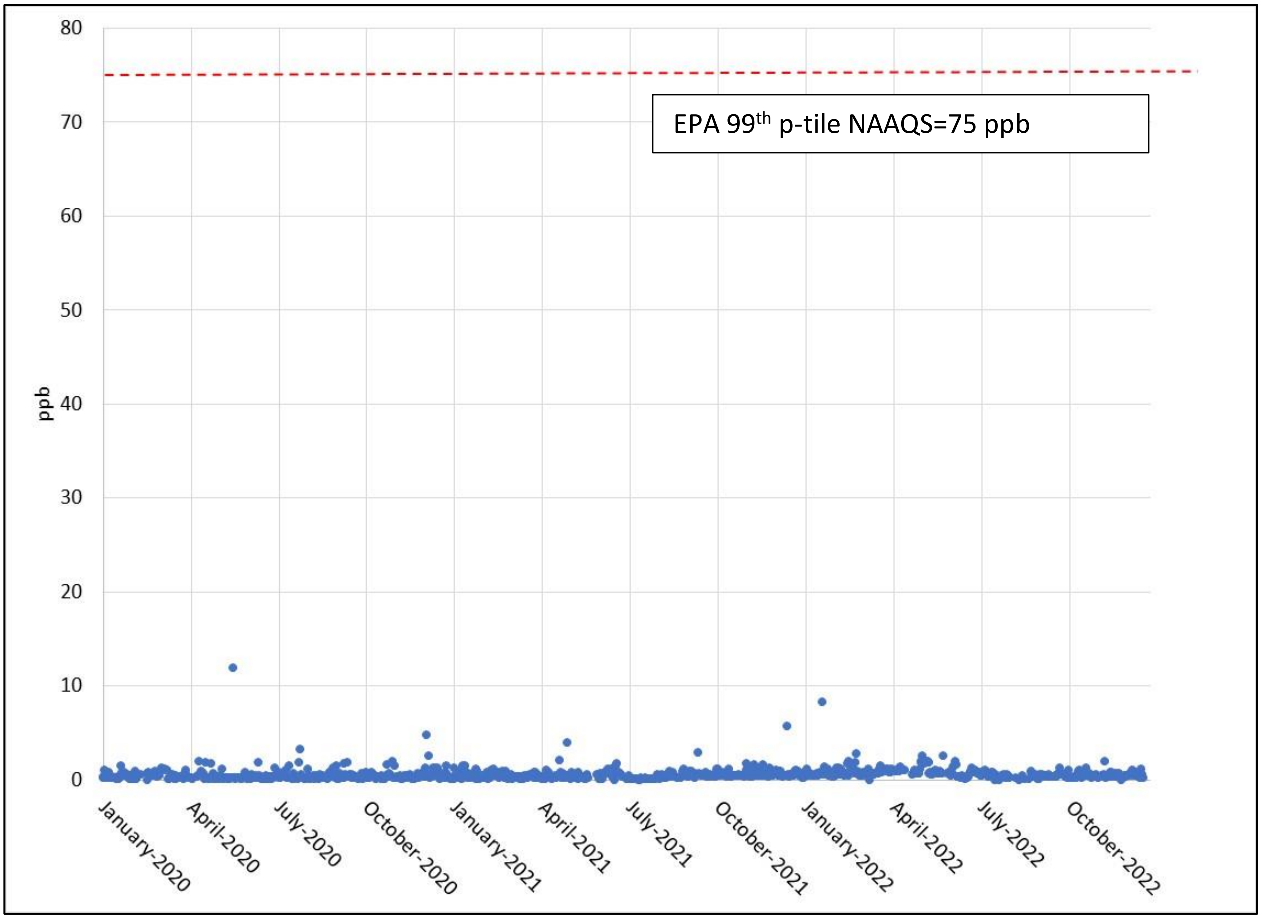

Figure 14. Hourly average SO_2 at GF, Jan. 1, 2020 – Dec. 31, 2022, with NAAQS at 75 ppb

Table 7. GF SO_2 annual 99th percentile value of daily maximums and three-year average showing NAAQS compliance

Year	Annual 99th percentile ppb	NAAQS 99th Percentile Average Value, ppb
2020	2.5	
2021	2.0	
2022	2.6	
3-year 99th Percentile Average	2.3	75

4.5 Portland Buddy Ganem & Portland Broadway Stations Criteria Pollutant Data

Fine particulate matter (PM2.5) is the only NAAQS-regulated pollutant measured at the PBG and PBway stations. Figure 15 shows the 24-hour average concentrations at the PBG site from 2020 through 2022, and Figure 16 shows the same time series for the PBway site. The 3-year average concentration PBG is 7.1 μg/m³ and is 8.2 μg/m³ at PBway. As was the case with the GF station, there were periods of elevated PM2.5 in summer months associated with transported dust from Northern Africa.

To a large extent, PM2.5 concentrations are of a regional nature, in that transported dust or smoke, or locally formed aerosols generally affect a multi-county or larger area. As an example, all three stations exceeded the 35 μg/m³ 24-hour NAAQS on the same two dates, June 12 and June 16, owing to the transported North African dust. Across the State of Texas, with 66 regulatory PM2.5 monitors, 22 stations had June 12 in the top four highest days in the first six months of 2022, and 48 stations had June 16 in the top four highest days in the first six months of 2022. Among TCEQ regions, all parts of the state had some elevated concentrations between June 12 and June 16. The next section 5.0 Data Analysis, goes into more detail on the comparisons of concentrations among the three stations. Table 8 and Table 9 summarize the average annual PM2.5 concentrations for the PBG and PBway stations and the three-year average annual concentrations.

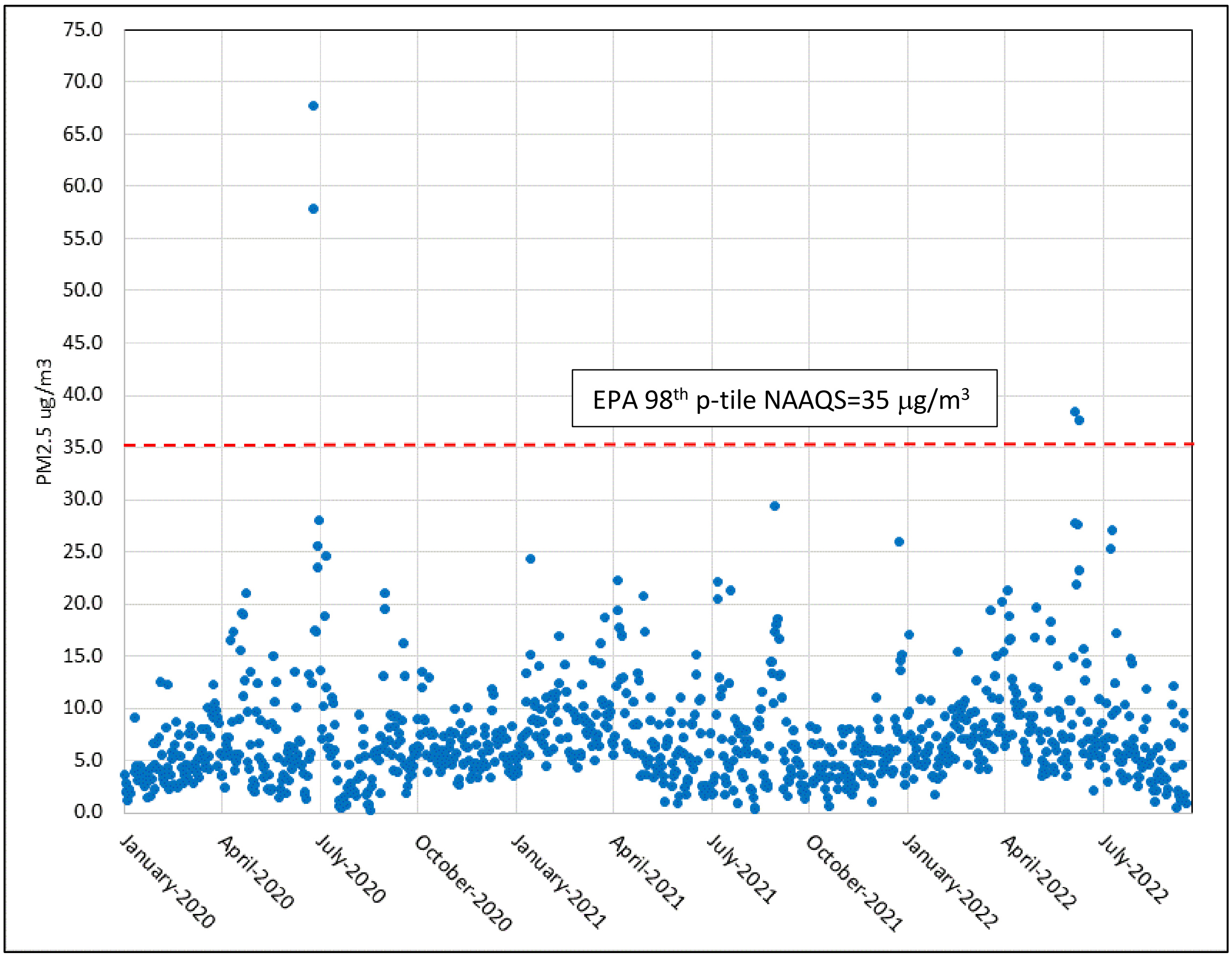

Figure 15. Averaged 24-Hour PM2.5 at PBG, Jan. 1, 2020 – Sept. 25, 2022, NAAQS scale

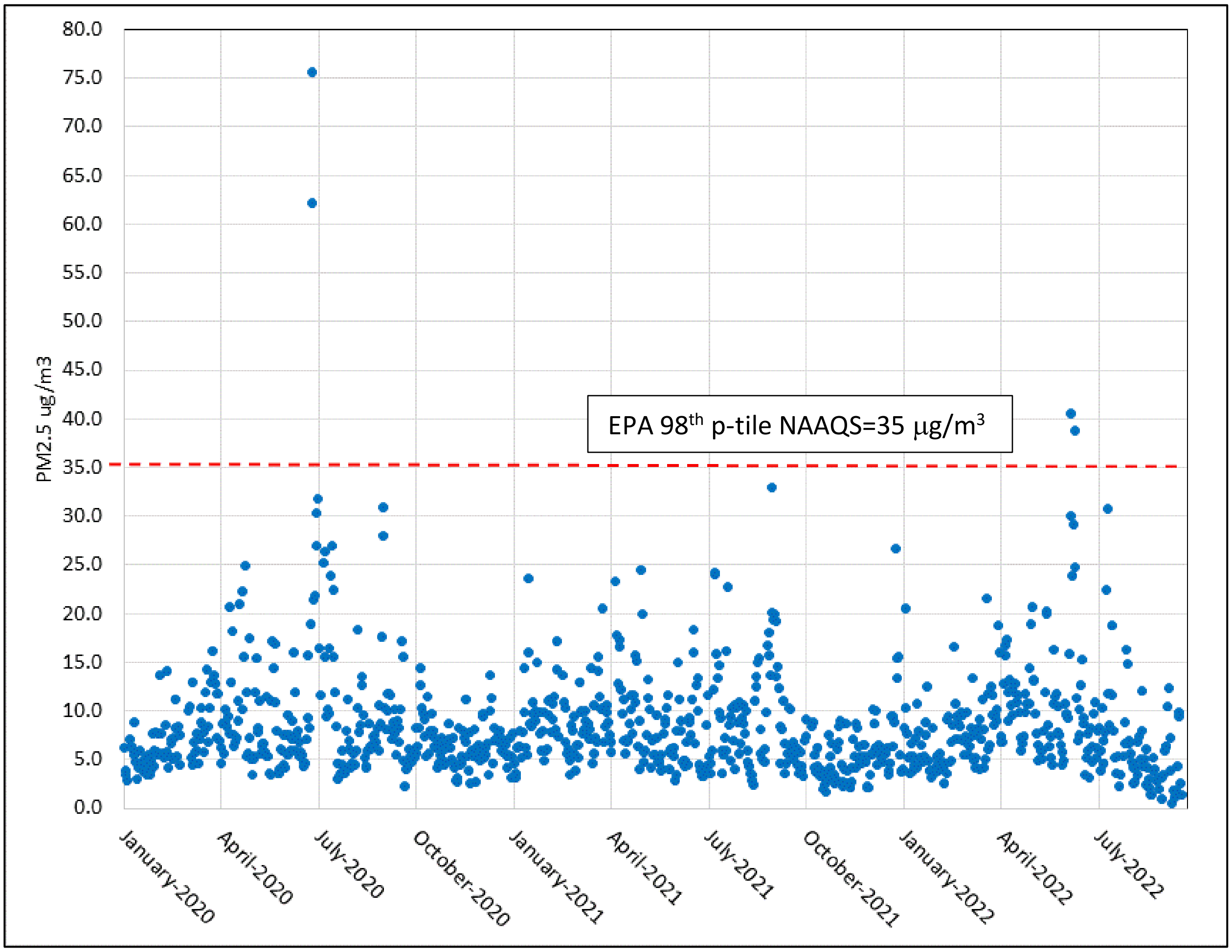

Figure 16. Averaged 24-Hour PM2.5 at PBway, Jan. 1, 2020 – Sept. 25, 2022, with NAAQS value

Table 8. PBG PM2.5 annual and three-year average showing NAAQS compliance.

Year	Annual Mean µg/m^3	NAAQS 3-Year Annual Average Value, µg/m^3	Annual 98th Percentile Value µg/m^3	NAAQS 3-Year 98th Percentile Average Value, µg/m^3
2020	6.6		20.6	
2021	7.2		20.4	
2022	7.4		21.9	
3-year Average	7.1	12.0	20.9	35.0

Table 9. PBway PM2.5 annual and three-year average showing NAAQS compliance.

Year	Annual Mean µg/m^3	NAAQS 3-Year Annual Average Value, µg/m^3	Annual 98th Percentile Value µg/m^3	NAAQS 3-Year 98th Percentile Average Value, µg/m^3
2020	8.7		26.9	
2021	8.2		22.4	
2022	7.6		22.3	
3-year Average	8.1	12.0	23.8	35.0

5.0 Data Analysis

San Patricio County Hydrocarbon Monitoring Data Compared to Other Stations in Texas

Not all auto-GC data collected in 2022 have been validated yet among project stations and among stations operated by the TCEQ and other entities in Texas. As a result, in order to compare the San Patricio monitoring data to the balance of the State of Texas, data for 12 months from November 2021 through October 2022 were examined. The hydrocarbons selected for examination include a handful of air toxics for which the TCEQ toxicologists do an annual risk evaluation, and total nonmethane hydrocarbon (TNMHC) mass which sums up all measured identified species and unidentified species within a given one-hour sample. The individual hydrocarbons examined are:

- Benzene
- Toluene
- Ethylbenzene
- m-Xylene and p-Xylene (combined in one measurement)
- o-Xylene
- 1,3-Butadiene

Figure 17 through Figure 23 show the average concentrations for stations around the state indicated by their U.S. EPA database number. The first two characters in each number are "48" for Texas, and the next three numbers indicate the county. County 201 is Harris County, 355 is Nueces County, and other counties can be identified by looking up Texas county FIPS codes. The three San Patricio County stations are generally among the lowest long-term concentrations for these species and for total hydrocarbon mass in the state.

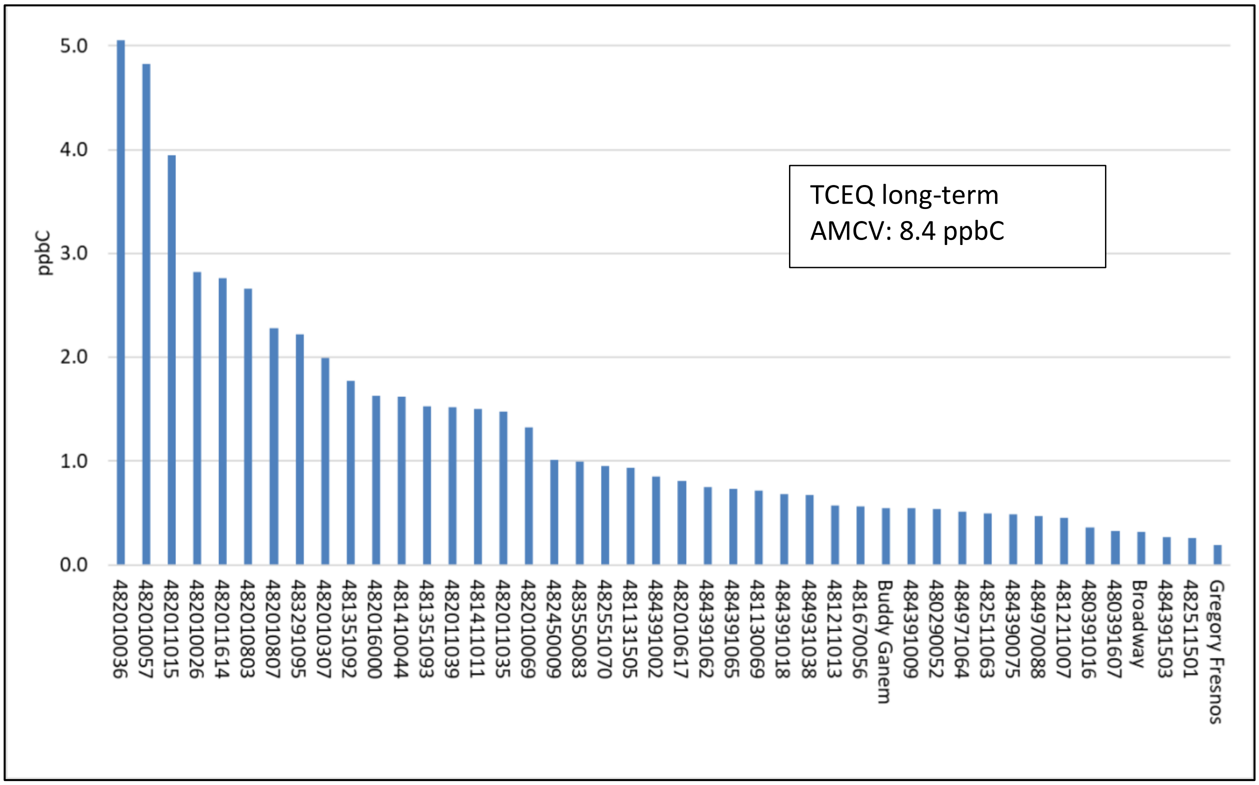

Figure 17. Average benzene concentrations, Nov. 1, 2021 – Oct. 31, 2022, data from TCEQ and UT.

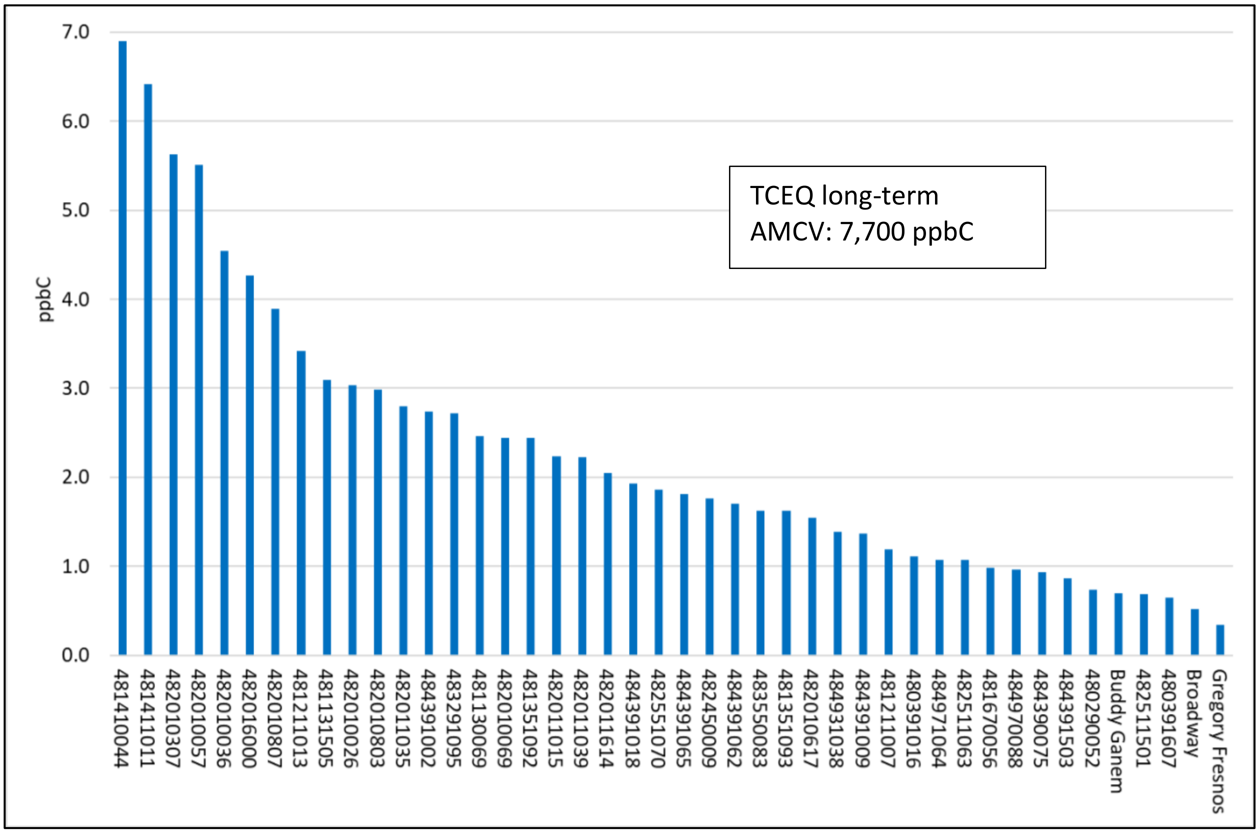

Figure 18. Average toluene concentrations, Nov. 1, 2021 – Oct. 31, 2022, data from TCEQ and UT.

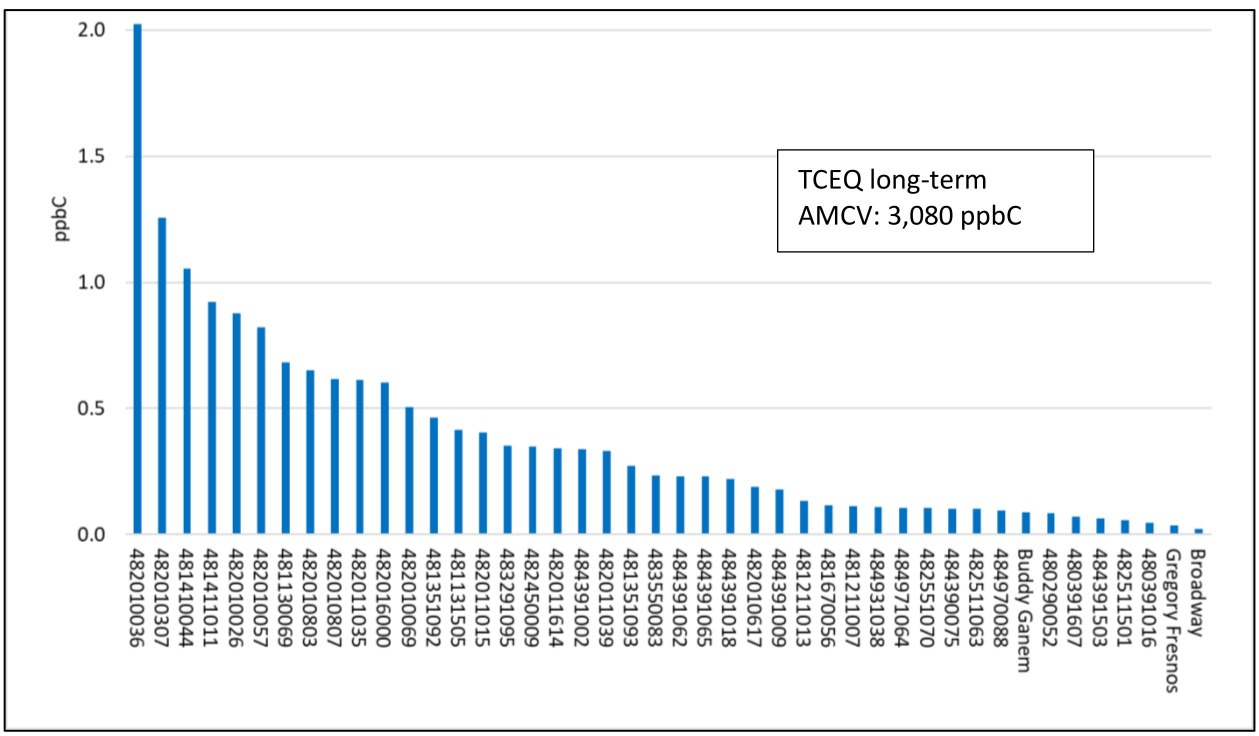

Figure 19. Average ethylbenzene concentrations, Nov. 1, 2021 – Oct. 31, 2022, data from TCEQ and UT.

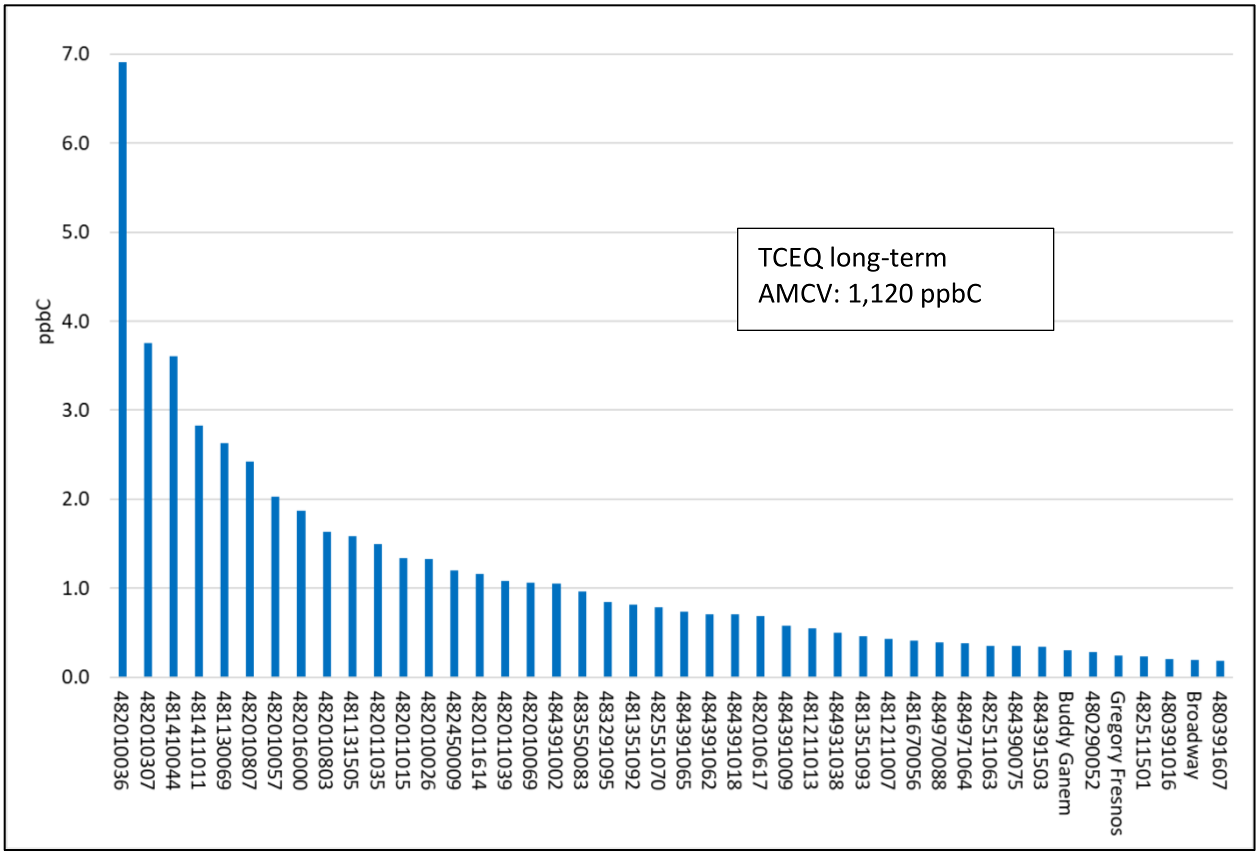

Figure 20. Average m/p-xylene concentrations, Nov. 1, 2021 – Oct. 31, 2022, data from TCEQ and UT.

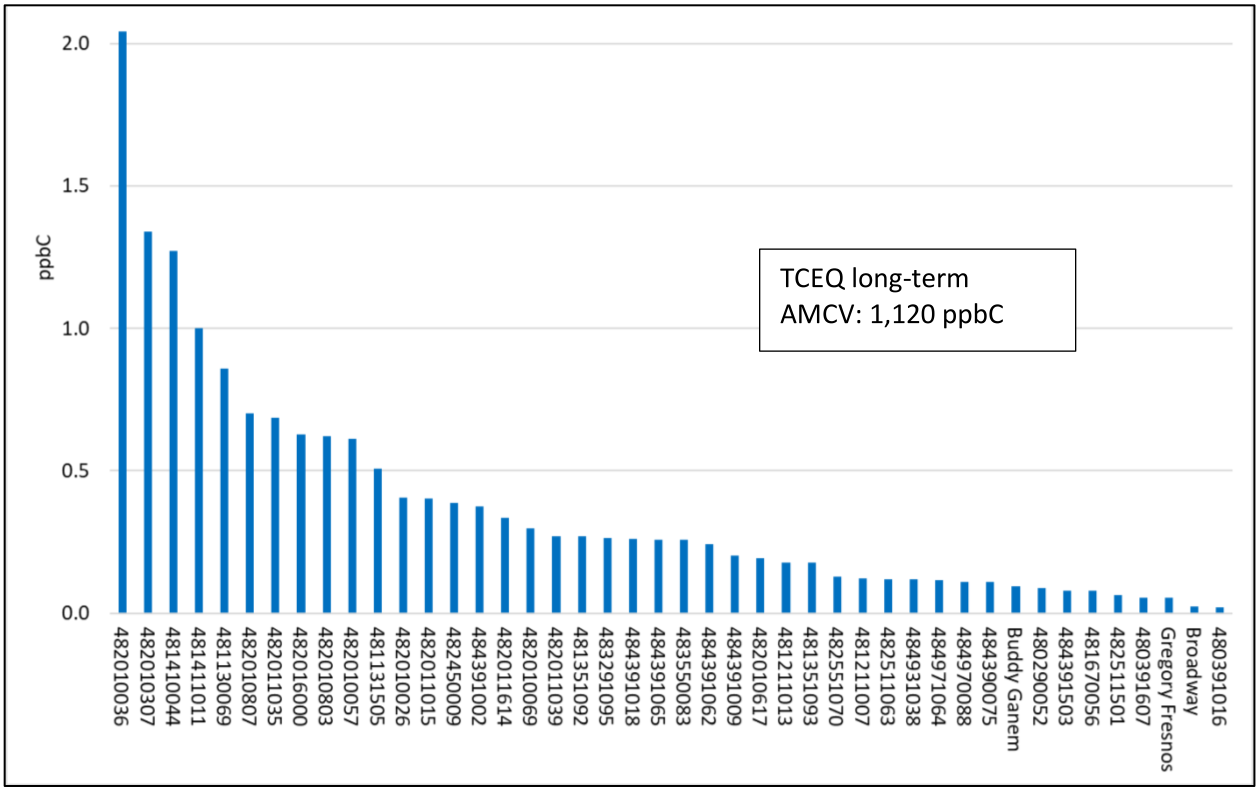

Figure 21. Average o-xylene concentrations, Nov. 1, 2021 – Oct. 31, 2022, data from TCEQ and UT.

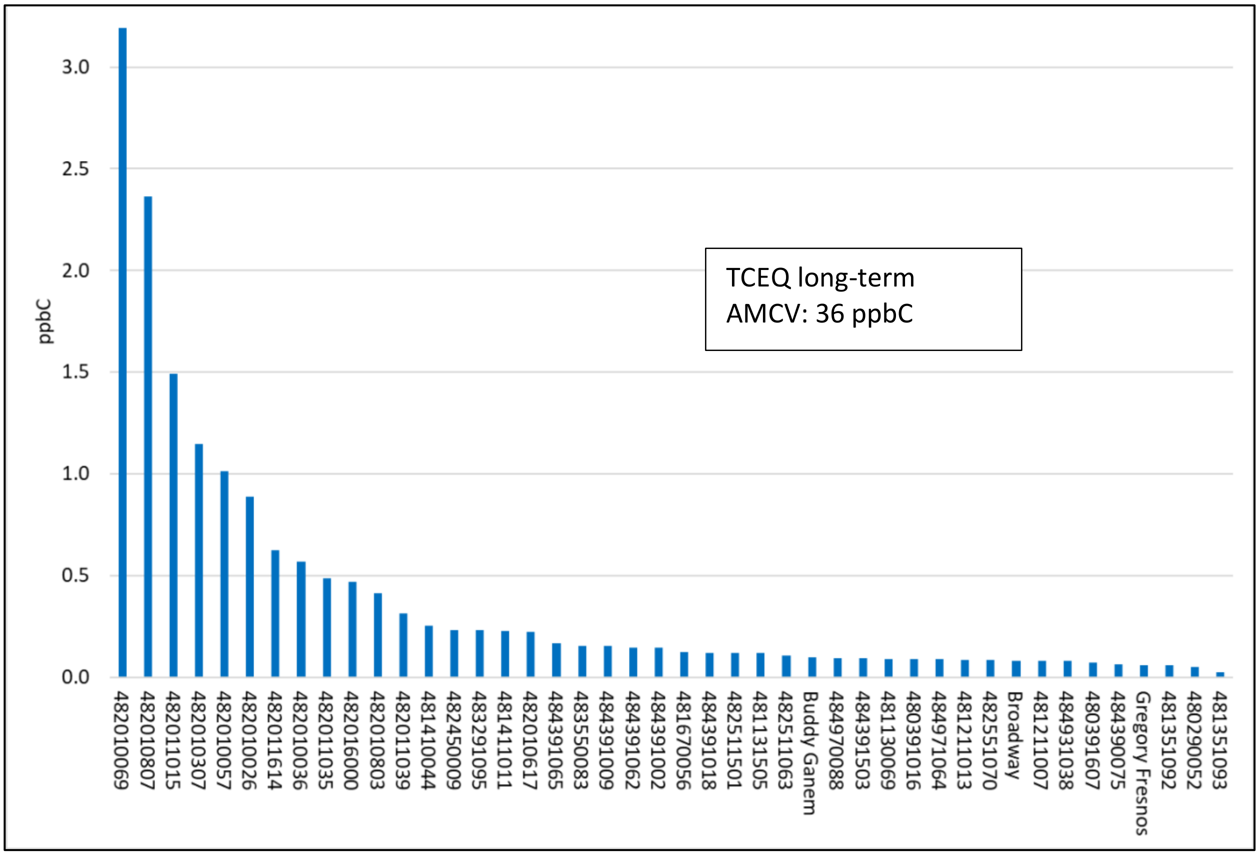

Figure 22. Average 1,3-butadiene concentrations, Nov. 1, 2021 – Oct. 31, 2022, data from TCEQ and UT.

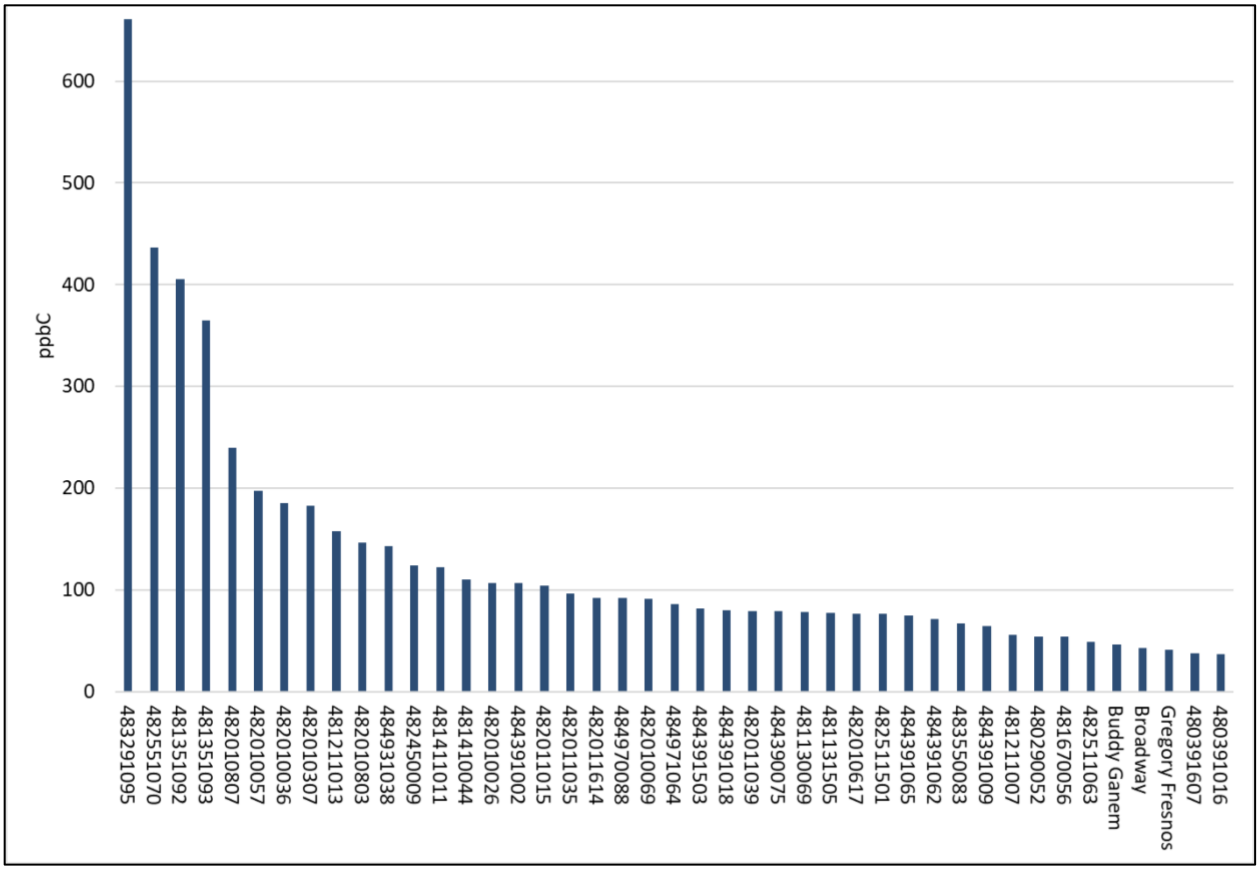

Figure 23. Average TNMHC concentrations, Nov. 1, 2021 – Oct. 31, 2022, data from TCEQ and UT

Examination of Local and Regional PM2.5 Concentrations

The every-sixth-day Corpus Christi Dona Park (DP) total PM2.5 mass data were regressed against the three San Patricio County monitors daily average PM2.5 data. In addition, the three San Patricio monitors were regressed against each other. The reason for this initial comparison with the Corpus Christi Dona Park station is that the Dona Park station uses a different monitoring technology (24-hour filter-based sampling) that allows speciation of the components of fine-particulate matter to be assessed in a laboratory. The results, shown in Table 10 and in Figure 24 through Figure 29, show very close agreement among the four stations. Based on the good agreement with the three Gregory Portland community monitors, a reasonable hypothesis is that the characterization of the make-up of the particulate matter found in Dona Park PM2.5 is likely to generally reflect the make-up of the three Gregory Portland community monitors. One must keep in mind, however, that the three Gregory Portland community monitors collect data every day, while the Dona Park instrument only samples the air every sixth-day, collecting 60 or 61 samples per year.

Characterization of the DP PM2.5 speciated data can be done using several mathematical techniques. The simplest approach is to look at the correlation of the Dona Park species. Correlation analysis tells what elements and ions occur together but does not tell us how much mass each factor contributes to the PM2.5 mass. The correlation results suggest that

- crustal material,

- sea salt,
- ammonium sulfate,
- fire/smoke,
- motor vehicle exhaust, and
- combusted oil

can be identified as contributing to PM2.5 mass. Hence, a similar composition will likely be present in the particulate matter found at the Gregory Portland community monitors. A more exhaustive method called Positive Matrix Factorization can do mass apportionment and will be presented in the next quarterly report in 2023.

Table 10. Regression results between the Dona Park PM2.5 monitor and the three San Patricio County monitors, and results among the three San Patricio monitors

X variable	Y variable	Number of paired observations	R-squared	Slope	Y-intercept
GF PM2.5	DP PM2.5	136	0.91	0.81	1.68
PBG PM2.5	DP PM2.5	126	0.91	0.85	2.38
PBway PM2.5	DP PM2.5	126	0.93	0.81	1.84
PBG PM2.5	GF PM2.5	1048	0.84	1.02	1.04
PBway PM2.5	GF PM2.5	1046	0.91	0.98	0.17
PBway PM2.5	PBG PM2.5	1048	0.89	0.86	-0.09

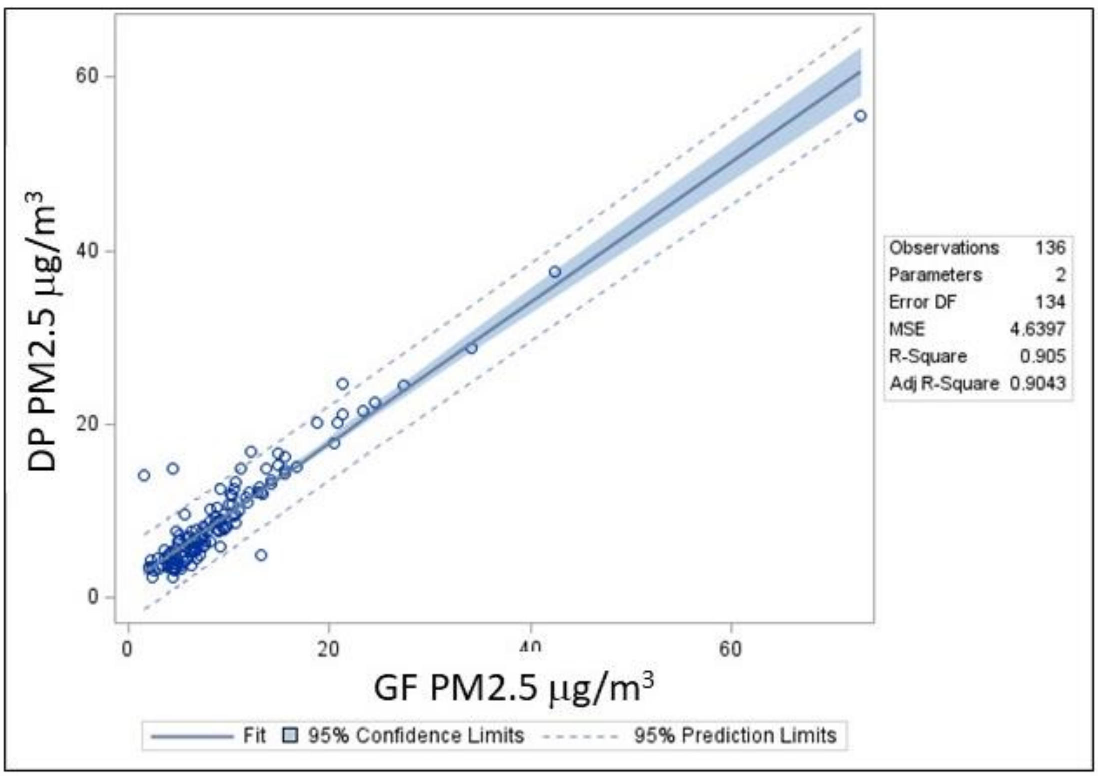

Figure 24. DP vs GF PM2.5

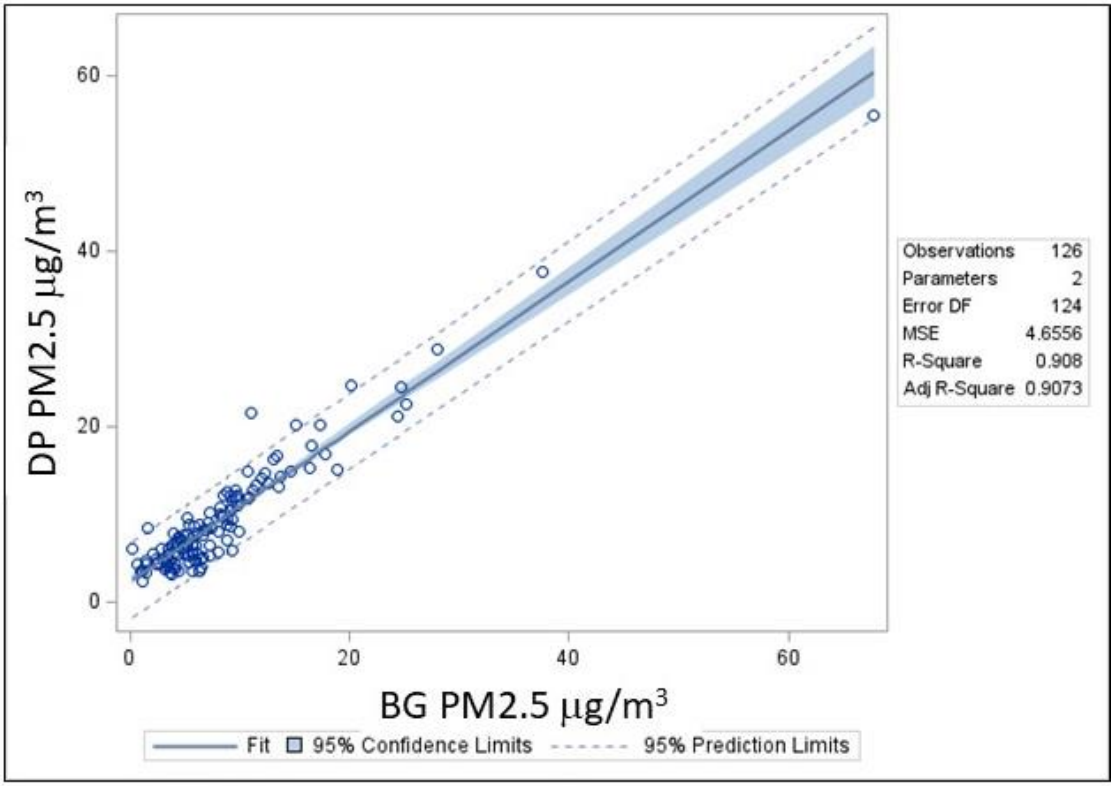

Figure 25. DP vs PBG PM2.5

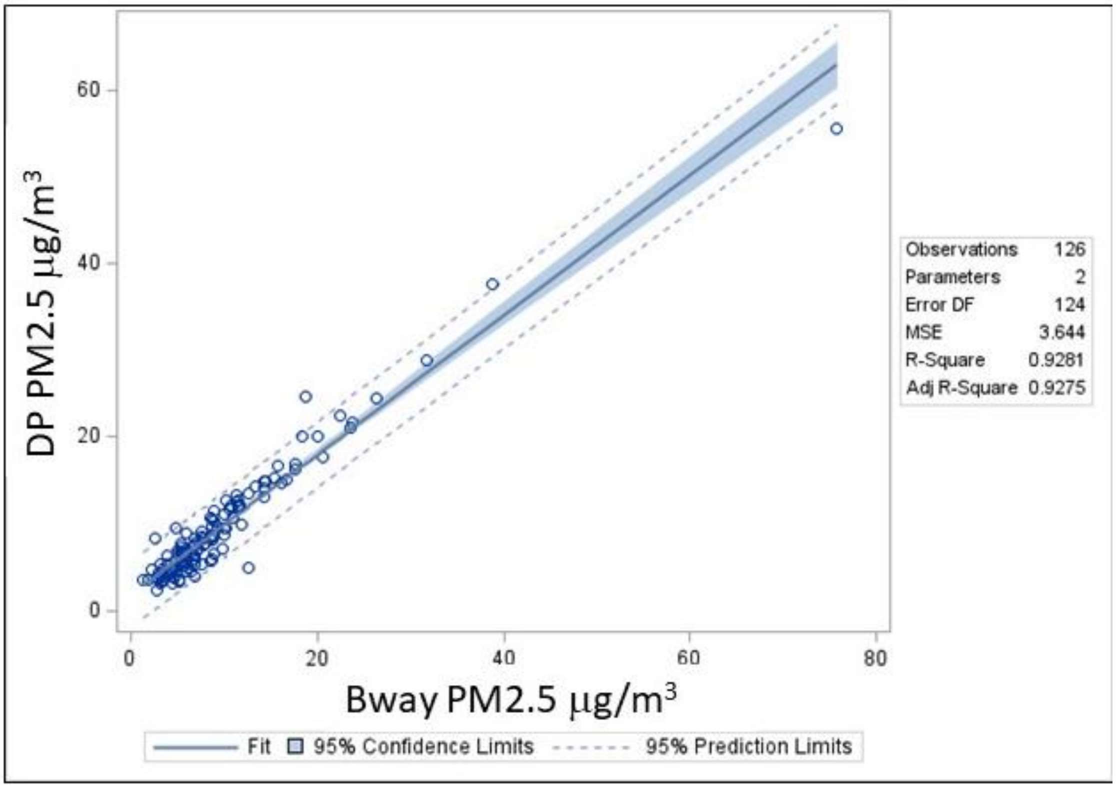

Figure 26. DP vs PBway PM2.5

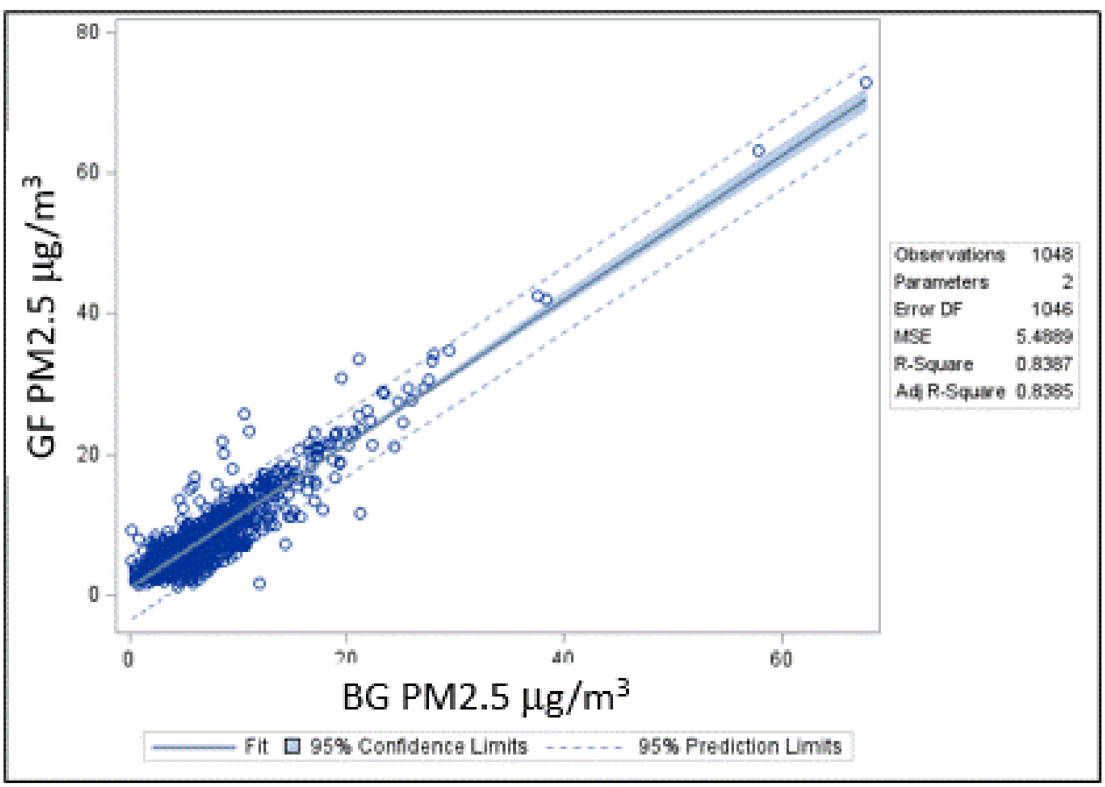

Figure 27. GF vs PBG PM2.5

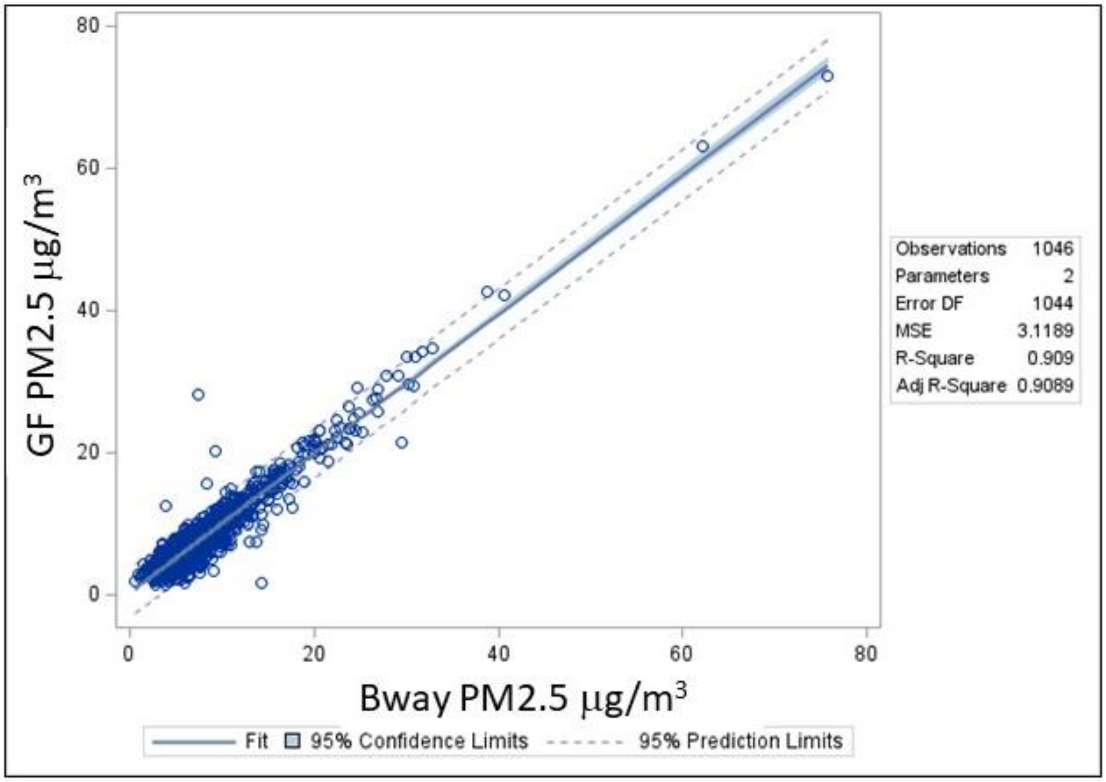

Figure 28. GF vs PBway PM2.5

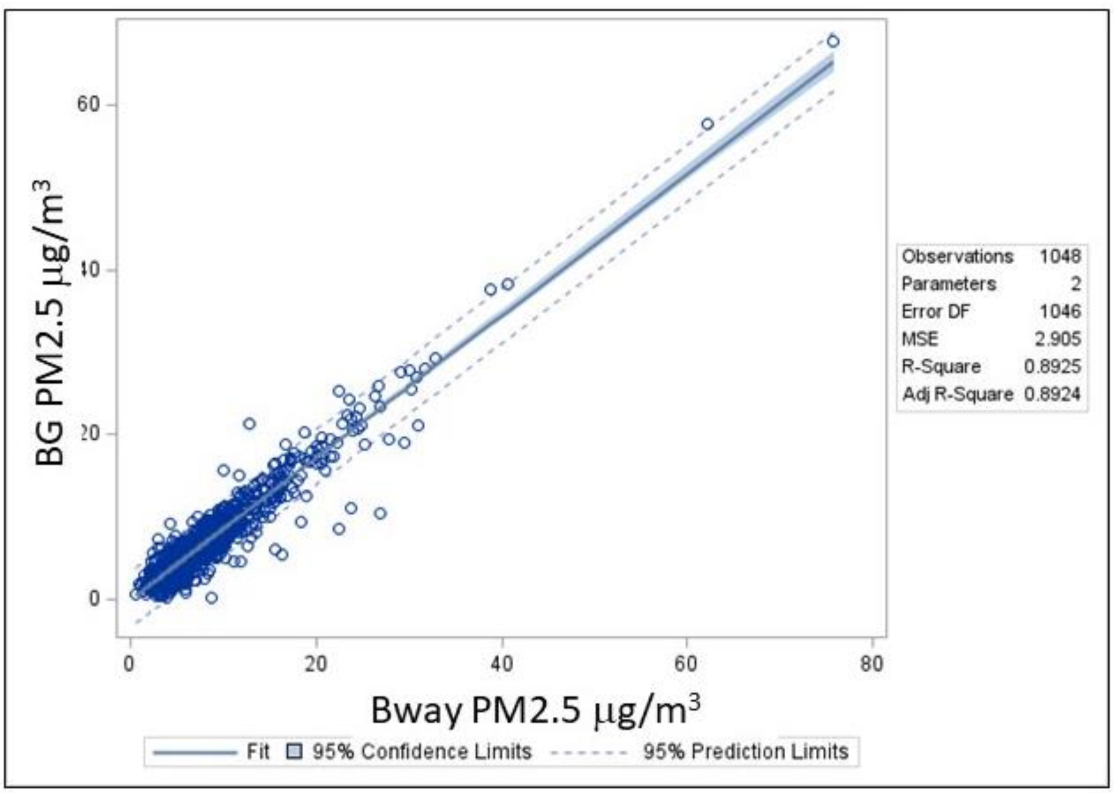

Figure 29. PBG vs PBway PM2.5

6.0 Conclusions

The air monitoring to date has been very successful. Although some concentrations have occasionally exceeded the concentration levels of the NAAQS, to date, the NAAQS have not been violated. Furthermore, measured hydrocarbon concentrations have not exceeded TCEQ long- term or short-term AMCVs. UT Austin would be happy to answer any questions or conduct additional analysis at the community's or sponsors' requests.

Appendices

A.1 Air Monitoring Station Locations & Information

Table A-1. Gregory-Portland Community Air Monitoring Stations and Parameters Measured

Air Monitoring Station Name & Address	Volatile Organic Compounds (VOCs) 46 compounds	Ethylene oxide (EO) 24 hr canister every 6th day	Nitrogen Oxides (NOx, NO, & NO_2)	Sulfur Dioxide (SO_2)	Particulate Matter (PM) Mass, particles < 2.5 micron diameter	Wind Speed (WS), Wind Direction (WD), Ambient Temperature (T), Relative Humidity (RH), & Barometric Pressure (BP)
Gregory Fresnos Stephen Austin Elementary 401 Fresnos St. Gregory, TX	Yes	No	Yes	Yes	Yes	Yes
Portland Buddy Ganem 307 Buddy Ganem St. GP High School Portland, TX	Yes	Yes	No	No	Yes	Yes. + precipitation
Portland Broadway 175 Broadway Blvd. Old East Cliff Elementary School Portland, TX	Yes	Yes	No	No	Yes	Only WS, WD

Figure 30. Location of Gregory-Fresnos Community Air Monitoring Station (GF, pin G), and two Portland community stations on GPISD campuses on Buddy Ganem (PBG, pin 1) and on Broadway (PBway, pin 2) and the Cheniere Energy and GCGV industrial facilities

A.2 Glossary of Terms and Terminology

Pollutant concentrations – Concentrations of most gaseous pollutants are expressed in units denoting their "mixing ratio" in air; i.e., the ratio of the number molecules of the pollutant to the total number of molecules per unit volume of air. Because concentrations for all gases other than molecular oxygen, nitrogen, and argon are very low, the mixing ratios are usually scaled to express a concentration in terms of "parts per million" (ppm) or "parts per billion" (ppb).

Sometimes the units are explicitly expressed as ppm-volume (pp<u>mV</u>) or ppb-volume (pp<u>bV</u>) where 1 ppmV indicates that one molecule in one million molecules of ambient air is the compound of interest and 1 ppbV indicates that one molecule in one billion molecules of ambient air is the compound of interest. In general, air pollution standards and health effects screening levels are expressed in ppmV or ppbV units. Because hydrocarbon species may have a chemical reactivity related to the number of carbon atoms in the molecule, mixing ratios for these species are often expressed in ppb-carbon (ppbV times the number of carbon atoms in the molecule), to reflect the ratio of carbon atoms in that species to the total number of molecules in the volume. This is relevant to our measurement of auto-GC species and TNMHC, which are reported in ppbC units. For the purpose of relating hydrocarbons to health effects, this report notes hydrocarbon concentrations in converted ppbV units. However, because TNMHC is a composite of all species with different numbers of carbons, it cannot be converted to ppbV. Pollutant concentration measurements are time-stamped based on the start time of the sample, in Central Standard Time (CST), with sample duration noted.

Auto-GC – The automated gas chromatograph collects a sample for 40 minutes, and then automatically analyzes the sample for a target list of 46 hydrocarbon species. These include benzene and 1,3-butadiene, which are air toxics, various species that have relatively low odor thresholds, and a range of gasoline and vehicle exhaust components.

Total non-methane hydrocarbons (TNMHC) – TNMHC represent a large fraction of the total volatile organic compounds released into the air by human and natural processes. TNMHC is an unspeciated total of all hydrocarbons, and individual species must be resolved by other means, such as with canisters or auto-GCs.

Canister – Electro-polished stainless-steel canisters are filled with 24-hour air samples on a regular every sixth-day schedule, or when an independent sensor detects that *elevated* (see below) levels of hydrocarbons (TNMHC or a specific chemical species) are present. Event-triggered samples are taken for a set time period to capture the chemical make-up of the air.

Air Monitoring Comparison Values (AMCV) – The TCEQ uses AMCVs in assessing ambient data. Two valuable online documents ("Fact Sheet" and "Uses of ESLs and AMCVs Document") that explain AMCVs are at https://www.tceq.texas.gov/toxicology/amcv/about (accessed January 2023). The following text is an excerpt from the TCEQ "Fact Sheet" document:

> Effects Screening Levels are chemical-specific air concentrations set to protect human health and welfare. Short-term ESLs are based on data concerning acute health effects, the potential for odors to be a nuisance, and effects on vegetation, while long-term ESLs are based on data concerning chronic health and vegetation effects. Health-based ESLs are set

below levels where health effects would occur whereas welfare-based ESLs (odor and vegetation) are set based on effect threshold concentrations. The ESLs are screening levels, **not ambient air standards.** Originally, the same long- and short-term ESLs were used for both air permitting and air monitoring.

There are significant differences between performing health effect reviews of air permits using ESLs, and the various forms of ambient air monitoring data. The Toxicology Division is using the term "air monitoring comparison values" (AMCVs) in evaluations of air monitoring data in order to make more meaningful comparisons. "AMCVs" is a collective term and refers to all odor-, vegetative-, and health-based values used in reviewing air monitoring data. Similar to ESLs, AMCVs are chemical-specific air concentrations set to protect human health and welfare. Different terminology is appropriate because air *permitting* and air *monitoring* programs are different.

Rationale for Differences between ESLs and AMCVs – A very specific difference between the permitting program and monitoring program is that permits are applied to one company or facility at a time, whereas monitors may collect data on emissions from several companies or facilities or other source types (e.g., motor vehicles). Thus, the protective ESL for permitting is set lower than the AMCV in anticipation that more than one permitted emission source may contribute to monitored concentrations.

National Ambient Air Quality Standards (NAAQS) – U.S. Environmental Protection Agency (EPA) has established a set of standards for several air pollutions described in the Federal Clean Air Act. NAAQS are defined in terms of *levels* of concentrations and particular *forms*. For example, the NAAQS for particulate matter with size at or less than microns (PM2.5) has a *level* of 12 micrograms per cubic meter averaged over 24- hours, and a *form* of the annual average based on four quarterly averages, averaged over three years. Individual concentrations measured above the level of the NAAQS are called *exceedances*. The number calculated from a monitoring site's data to compare to the level of the standard is called the site's *design value*, and the highest design value in the area for a year is the regional design value used to assess overall NAAQS compliance. A monitor or a region that does not comply with a NAAQS is said to be *noncompliant*. At some point after a monitor or region has been in noncompliance, the U.S. EPA may choose to label the region as *nonattainment*. A nonattainment designation triggers requirements under the Federal Clean Air Act for the development of a plan to bring the region back into compliance. A more detailed description of NAAQS can be found on the EPA's Website at https://www.epa.gov/criteria-air-pollutants#self (accessed January 2023)

One species measured by this project and regulated by a NAAQS is sulfur dioxide (SO_2). EPA set the SO_2 NAAQS to include a level of 75 ppb averaged over one hour, with a form of the three-year average of the annual 99th percentiles of the daily maximum one- hour averages. If measurements are taken for a full year at a monitor, then the 99th percentile would be the fourth highest daily one hour maximum. There is also a secondary SO_2 standard of 500 ppb over three hours, not to be exceeded more than once in any one year.

Elevated Concentrations – In the event that measured pollutant concentrations are above a set threshold they are referred to as "elevated concentrations." The values for these thresholds are summarized by pollutant below. As a precursor to reviewing the data, the reader should understand the term "*statistical significance*." In the event that a concentration is higher than one would typically measure over, say, the course of a week, then one might conclude that a specific transient assignable cause may have been a single upwind pollution source, because experience shows the probability of such a measurement occurring under normal operating conditions is small. Such an event may be labeled "statistically significant" at level 0.01, meaning the observed event is rare enough that it is not expected to happen more often than once in 100 trials. This does not necessarily imply the failure to meet a health-based standard. A discussion of "elevated concentrations" and "statistical significance" by pollutant type follows:

- For SO_2, any measured concentration greater than the level of the NAAQS, which is 75 ppb over one hour, is considered "elevated." Note that the concentrations of SO2 need not persist long enough to constitute an exceedance of the standard to be regarded as elevated. In addition, any closely spaced values that are statistically significantly (at 0.01 level) greater than the long-run average concentration for a period of one hour or more will be considered "elevated" because of their unusual appearance, as opposed to possible health consequence. The rationale for doing so is that unusually high concentrations at a monitor may suggest the existence of unmonitored concentrations closer to the source area that are potentially above the state's standards.
- For TNMHC, any measured concentration greater than the threshold of 2000 ppbC is considered "elevated."
- For benzene and other air toxics in canister samples or auto-GC measurements, any concentration above the AMCV is considered "elevated." Note that 40-minute auto-GC measurements are compared with the short-term AMCV.
- Some hydrocarbon species measured by the auto-GC generally appear in the air in very low concentrations close to the method detection level. Similar to the case above with SO_2, any values that are statistically significant (at 0.01 level) greater than the long-run average concentration at a given time or annual quarter will be considered "elevated" because of their unusual appearance, as opposed to possible health consequence. The rationale for doing so is that unusually high concentrations at a monitor may suggest an unusual emission event in the area upwind of the monitoring site.