Quarterly Report of Air Quality Monitoring January 1 to March 31, 2023, at the Gregory – Portland Community Air Monitoring Stations

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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 (NAAQS). This project has now collected and validated data for three years for all three stations.

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, i.e., the one-hour, 24-hour or annual average values of the standards. Furthermore, measured hydrocarbon concentrations have not exceeded the levels of concern published by the Texas Commission on Environmental Quality (TCEQ). In fact, the measured concentrations of two EPA criteria pollutants – sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) have the lowest NAAQS concentrations in the state, and average hydrocarbon concentrations are among the lowest of the Texas auto-GCs across the state.

This quarterly report contains a discussion of “good air quality and bad air quality”, two subjective terms to which UT provides some quantitative information.

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 April 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 early 2023 with some comparisons to earlier data.

2.0 Summary of Activities January 1 through March 31, 2023

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 greater than 75% data completeness.

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 April 2023).

As was noted in the earlier quarterly reports in 2022, the GCGV ethane-cracking facility has been fully operational since January 2022. Operations at the GCGV facility and the Cheniere Energy facility do not appear to have affected the level of pollutants measured at project stations.

The United States Environmental Protection Agency (EPA) announced a proposed decision to change their annual PM2.5 standard from its current level of 12.0 micro-grams per cubic meter ($\mu g/m^3$) to somewhere in the range of 9.0 to 10.0 $\mu g/m^3$. Future reports and the website will provide updates once a final decision is made by the EPA.

In March and early April 2023, the UT staff collaborated with GCGV to produce a brief three-year report card using this monitoring program's findings at the end of the first three years of continuous monitoring.

This report focuses on the data collected at the three air monitoring stations during the period January 1 through March 31, 2023, 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 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 (EtO) 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 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 an emission 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 wind 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.

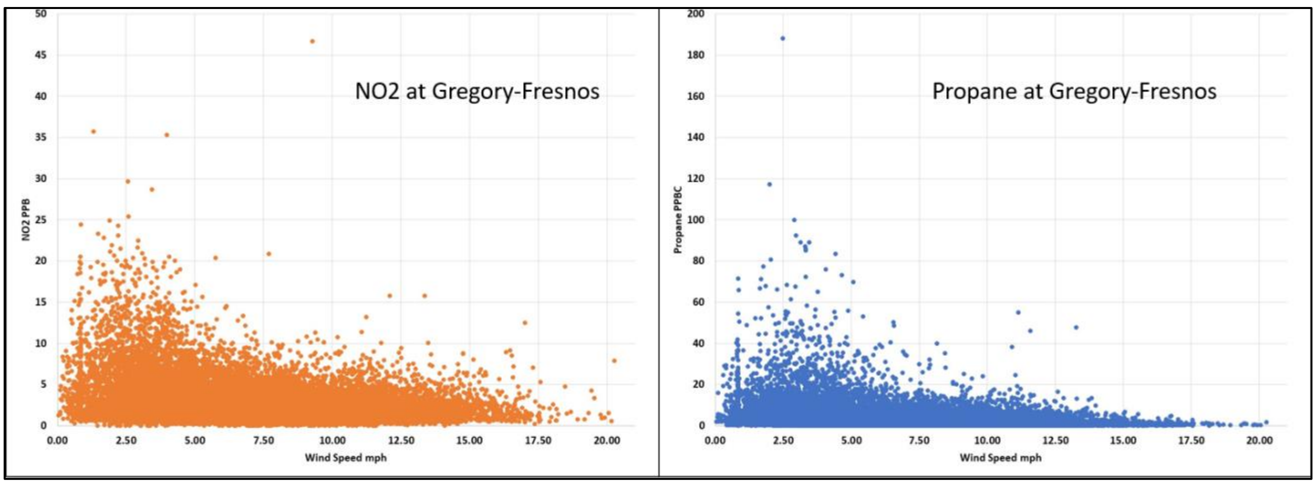

Figure 2. Effect of wind speed on primary pollutants

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
- EtO canister data – within 60 days of the date the sample was collected.

Although all these measurements, except EtO, 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 EtO data are collected at the station and then sent to a laboratory where EtO 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 EtO data were available through January 31, 2023, and all other data were available through March 31, 2023.

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 January 31, 2023 (13 months). 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 April 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 December 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 90 to 92 percent data completeness of the planned collection hours over 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 April 2023). To make a request, contact Dr. Dave Sullivan at sullivan231@mail.utexas.edu or 512-471-7805.

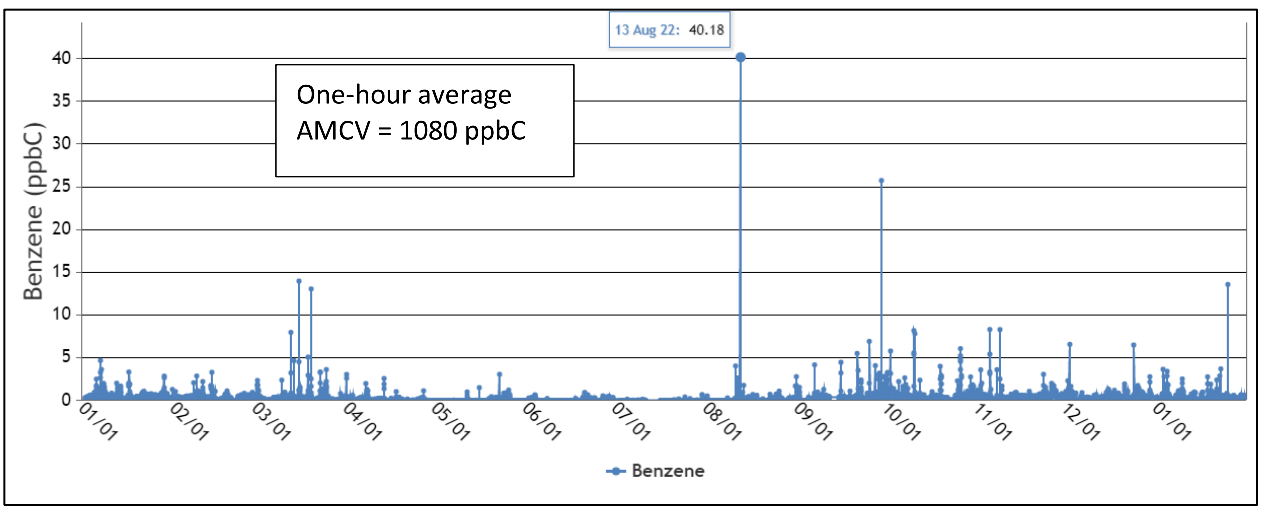

Figure 3. Hourly benzene concentrations at GF station, Jan. 1, 2022 – Jan. 31, 2023, ppbC units

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

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMHC	7,231	2786.3	193.81	40.571
TNMTC	7,231	2489.3	175.99	37.497
Ethane	7,312	227.0	47.62	10.156
Ethylene	7,312	19.3	3.99	0.691
Propane	7,312	216.8	41.94	7.970
Propylene	7,312	18.6	3.09	0.868
Isobutane	7,312	170.3	16.31	2.680
n-Butane	7,312	288.6	25.35	4.688
Acetylene	7,312	9.0	1.77	0.447
trans-2-Butene	7,310	22.0	1.62	0.105
1-Butene	7,306	32.4	2.02	0.193
cis-2-Butene	7,305	71.1	6.67	0.095
Cyclopentane	7,312	24.1	1.50	0.152
Isopentane	7,312	327.4	20.52	2.588
n-Pentane	7,312	260.3	15.89	2.165
1,3-Butadiene	7,308	9.9	0.48	0.052
trans-2-Pentene	7,312	1.0	0.13	0.019
1-Pentene	7,222	2.9	0.23	0.044
cis-2-Pentene	7,312	1.5	0.12	0.005
2,2-Dimethylbutane	7,312	28.0	1.72	0.131
Isoprene	7,312	1.8	0.33	0.059
n-Hexane	7,393	165.9	9.47	0.679
Methylcyclopentane	7,393	81.2	4.77	0.304
2,4-Dimethylpentane	7,393	14.8	0.92	0.080
Benzene	7,393	40.2	2.22	0.236
Cyclohexane	7,393	161.8	9.22	0.372
2-Methylhexane	7,393	46.3	2.39	0.064
2,3-Dimethylpentane	7,393	28.4	1.45	0.025
3-Methylhexane	7,393	52.6	2.81	0.099
2,2,4-Trimethylpentane	7,393	31.2	1.78	0.123
n-Heptane	7,393	88.4	4.78	0.192
Methylcyclohexane	7,393	135.3	8.22	0.422
2,3,4-Trimethylpentane	7,393	1.4	0.21	0.013
Toluene	7,393	48.9	2.90	0.357
2-Methylheptane	7,393	10.6	0.60	0.042
3-Methylheptane	7,393	7.4	0.43	0.033
n-Octane	7,393	27.1	1.56	0.118
Ethyl Benzene	7,393	14.5	0.91	0.038
p-Xylene + m-Xylene	7,393	52.5	3.46	0.229
Styrene	7,393	0.6	0.22	0.015
o-Xylene	7,393	10.9	0.80	0.051
n-Nonane	7,393	4.8	0.47	0.055
Isopropyl Benzene - Cumene	7,393	1.9	0.34	0.006
n-Propylbenzene	7,319	1.2	0.40	0.022
1,3,5-Trimethylbenzene	7,333	1.6	0.20	0.013
1,2,4-Trimethylbenzene	7,272	3.8	0.56	0.152
n-Decane	7,333	6.8	0.91	0.111
1,2,3-Trimethylbenzene	7,333	3.4	0.69	0.052

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 January 31, 2023.

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 December 2022.

Based on the 22 hours per day planned ambient measurements, the PBG station has collected data with an 84 to 92 percent data completeness based on planned collection hours for 2022, and the PBway station has between 90 and 92 percent data completeness of the planned collection hours over the same one-year 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.

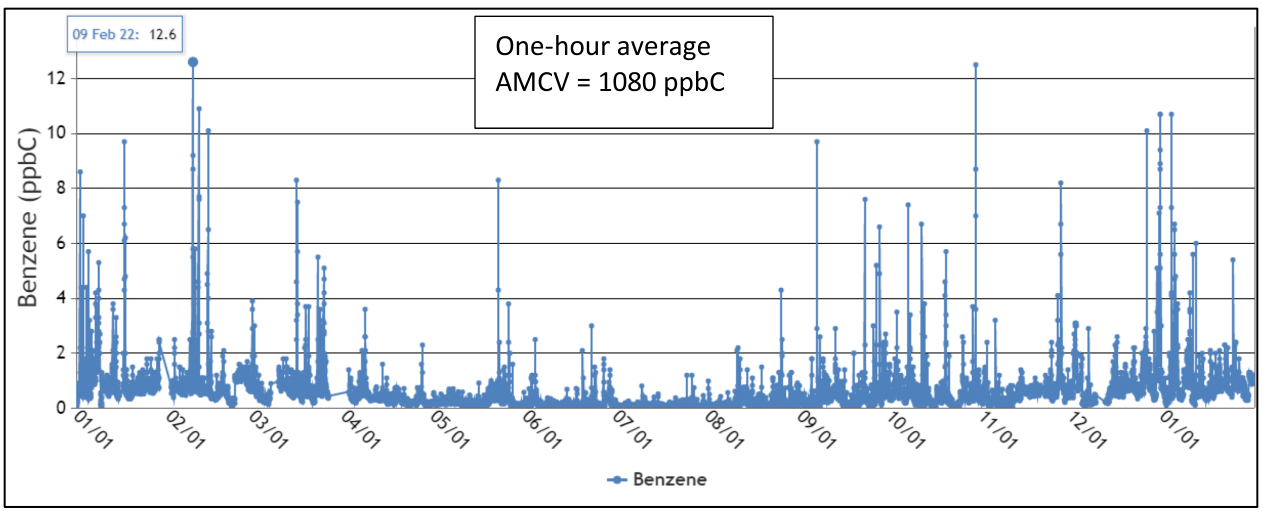

Figure 4. Hourly benzene concentrations at PBG station, Jan. 1, 2022 – Jan. 31, 2023, ppbC units

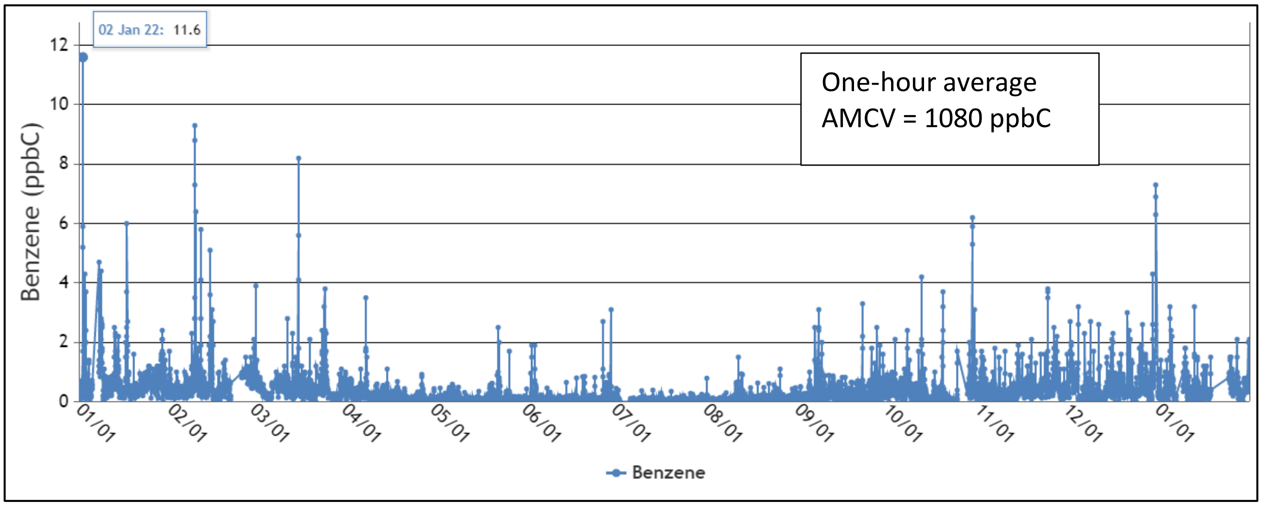

Figure 5. Hourly benzene concentrations at PBway station, Jan. 1, 2022 – Jan. 31, 2023, ppbC units

Table 3. PBG Auto-GC statistics for Jan. – Dec. 2022

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMHC	6,893	1329.9	369.58	51.025
TNMTC	6,893	1244.3	344.80	46.848
Ethane	6,893	619.0	83.98	12.690
Ethylene	6,893	54.7	8.82	0.997
Propane	6,893	251.0	78.23	10.425
Propylene	6,893	9.3	2.13	0.530
Isobutane	6,893	235.0	33.57	3.412
n-Butane	6,893	127.0	43.30	5.680
Acetylene	6,756	5.7	2.04	0.321
trans-2-Butene	6,893	1.9	0.34	0.205
1-Butene	6,892	26.9	1.84	0.261
cis-2-Butene	6,893	1.0	0.41	0.066
Cyclopentane	6,893	4.2	1.17	0.155
Isopentane	6,893	87.8	22.82	2.998
n-Pentane	6,891	69.1	17.86	2.349
1,3-Butadiene	6,893	32.6	1.64	0.099
trans-2-Pentene	6,892	1.8	0.11	0.016
1-Pentene	6,890	2.2	0.41	0.039
cis-2-Pentene	6,892	1.0	0.11	0.004
2,2-Dimethylbutane	6,893	5.5	0.99	0.087
Isoprene	6,893	16.4	0.86	0.195
n-Hexane	7,365	41.1	7.17	0.730
Methylcyclopentane	7,365	15.6	2.79	0.300
2,4-Dimethylpentane	7,365	4.1	0.24	0.006
Benzene	7,365	12.6	4.02	0.578
Cyclohexane	7,365	25.6	4.99	0.425
2-Methylhexane	7,365	10.7	1.88	0.157
2,3-Dimethylpentane	7,365	4.8	0.86	0.065
3-Methylhexane	7,365	11.3	2.08	0.216
2,2,4-Trimethylpentane	7,365	5.9	1.82	0.260
n-Heptane	7,365	27.1	4.36	0.364
Methylcyclohexane	7,365	36.7	7.08	0.517
2,3,4-Trimethylpentane	7,365	1.4	0.30	0.039
Toluene	7,365	20.4	6.31	0.771
2-Methylheptane	7,365	4.8	1.10	0.093
3-Methylheptane	7,365	4.3	0.90	0.071
n-Octane	7,365	11.4	2.25	0.203
Ethyl Benzene	7,365	17.0	0.88	0.102
p-Xylene + m-Xylene	7,365	75.1	3.73	0.329
Styrene	7,365	1.4	0.85	0.073
o-Xylene	7,365	20.3	1.03	0.106
n-Nonane	7,365	4.8	2.25	0.113
Isopropyl Benzene - Cumene	7,365	1.7	0.42	0.019
n-Propylbenzene	7,365	1.1	0.34	0.033
1,3,5-Trimethylbenzene	7,355	2.6	1.03	0.043
1,2,4-Trimethylbenzene	7,365	5.5	0.95	0.197
n-Decane	7,365	8.2	3.62	0.414

Table 4. PBway Auto-GC statistics for Jan. – Dec. 2022

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMHC	7,395	1624.1	708.40	46.909
TNMTC	7,395	1549.9	674.99	43.700
Ethane	7,304	387.0	142.36	13.252
Ethylene	7,304	84.3	8.53	1.163
Propane	7,395	388.0	159.75	9.006
Propylene	7,395	13.0	5.44	0.646
Isobutane	7,395	128.0	58.51	3.163
n-Butane	7,395	320.0	114.15	5.915
Acetylene	7,219	5.8	1.70	0.329
trans-2-Butene	7,392	10.4	0.95	0.112
1-Butene	7,395	32.6	2.30	0.245
cis-2-Butene	7,395	4.3	0.28	0.061
Cyclopentane	7,395	8.3	3.02	0.170
Isopentane	7,395	172.0	50.95	3.075
n-Pentane	7,395	144.0	43.24	2.380
1,3-Butadiene	7,395	200.0	9.26	0.091
trans-2-Pentene	7,395	3.3	0.40	0.029
1-Pentene	7,395	6.5	1.22	0.074
cis-2-Pentene	7,391	2.7	0.23	0.012
2,2-Dimethylbutane	7,395	4.6	1.52	0.101
Isoprene	7,395	3.6	1.33	0.336
n-Hexane	7,395	38.7	14.17	0.465
Methylcyclopentane	7,395	21.6	8.06	0.204
2,4-Dimethylpentane	7,395	2.4	0.12	0.001
Benzene	7,395	11.6	3.59	0.347
Cyclohexane	7,395	19.4	8.03	0.289
2-Methylhexane	7,395	5.5	2.20	0.049
2,3-Dimethylpentane	7,395	4.0	1.60	0.025
3-Methylhexane	7,395	7.4	3.03	0.082
2,2,4-Trimethylpentane	7,395	21.8	4.34	0.174
n-Heptane	7,395	14.5	5.59	0.145
Methylcyclohexane	7,395	26.6	10.71	0.324
2,3,4-Trimethylpentane	7,393	6.2	0.66	0.045
Toluene	7,395	16.5	7.24	0.573
2-Methylheptane	7,394	6.4	2.60	0.071
3-Methylheptane	7,395	2.8	1.19	0.042
n-Octane	7,395	7.6	3.04	0.089
Ethyl Benzene	7,395	3.6	0.65	0.023
p-Xylene + m-Xylene	7,395	12.8	3.69	0.214
Styrene	7,395	1.0	0.17	0.006
o-Xylene	7,395	5.3	0.93	0.028
n-Nonane	7,395	7.4	0.94	0.035
Isopropyl Benzene - Cumene	7,395	0.9	0.19	0.009
n-Propylbenzene	7,395	1.6	0.10	0.006
1,3,5-Trimethylbenzene	7,395	3.4	0.37	0.009
1,2,4-Trimethylbenzene	7,213	4.6	1.41	0.417
n-Decane	7,395	13.3	0.81	0.090

4.3 Ethylene Oxide Measurements

As was noted earlier in this report, the GCGV ethane-cracking industrial facility began operating in late 2021 through early 2022. As shown in Figure 6 through Figure 9, the levels of EtO 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) and Air Monitoring Comparative Value (AMCV) for chronic exposure to EtO is 2.4 ppbV or 4.8 ppbC. The terms AMCV and ESL are defined in Appendix A.2. (https://www.tceq.texas.gov/downloads/toxicology/dsd/final/eto.pdf, accessed April 2023). It is notable that there has been no change in concentrations during 2022 into early 2023 while the GCGV industrial facility has been in operation.

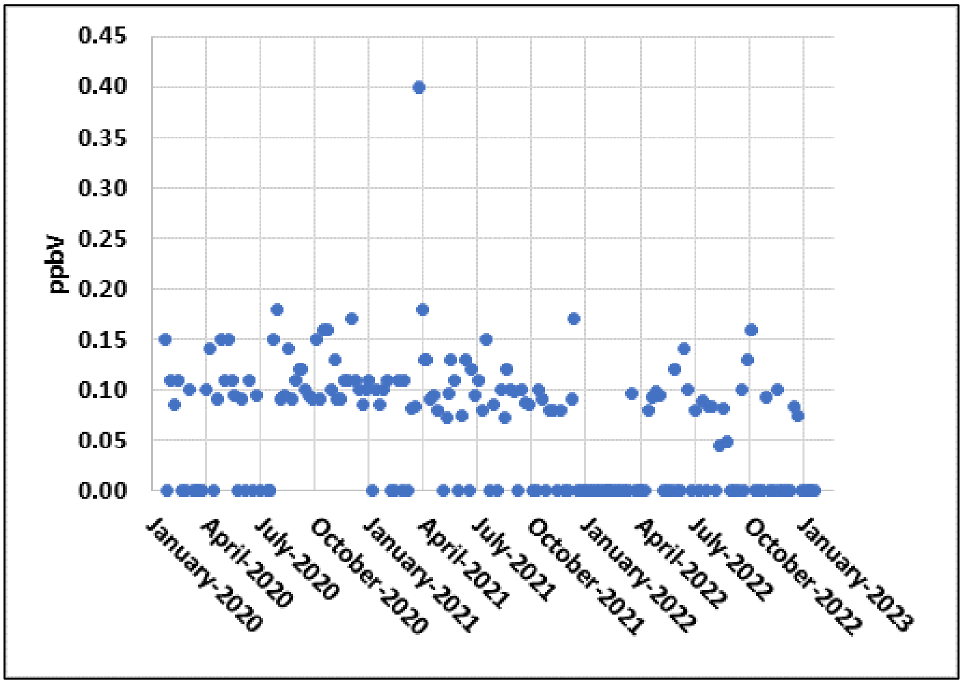

Figure 6. PBG EtO concentrations, every 6th day samples Jan. 2020 through Jan. 2023

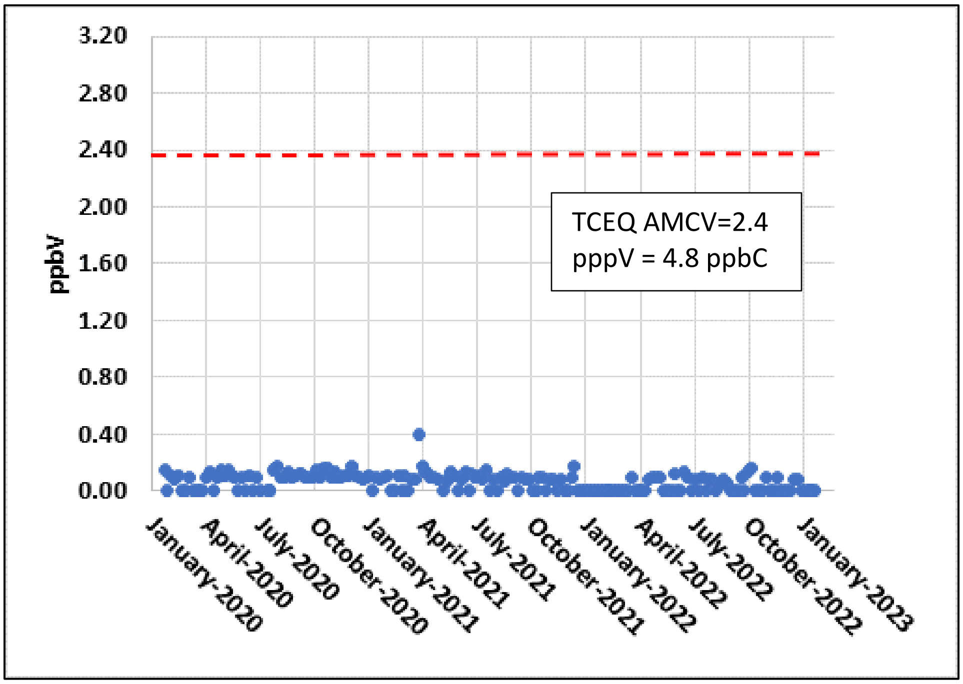

Figure 7. PBG EtO concentrations, every 6th day samples Jan. 2020 through Jan. 2023 in comparison to TCEQ Air Monitoring Comparative Value

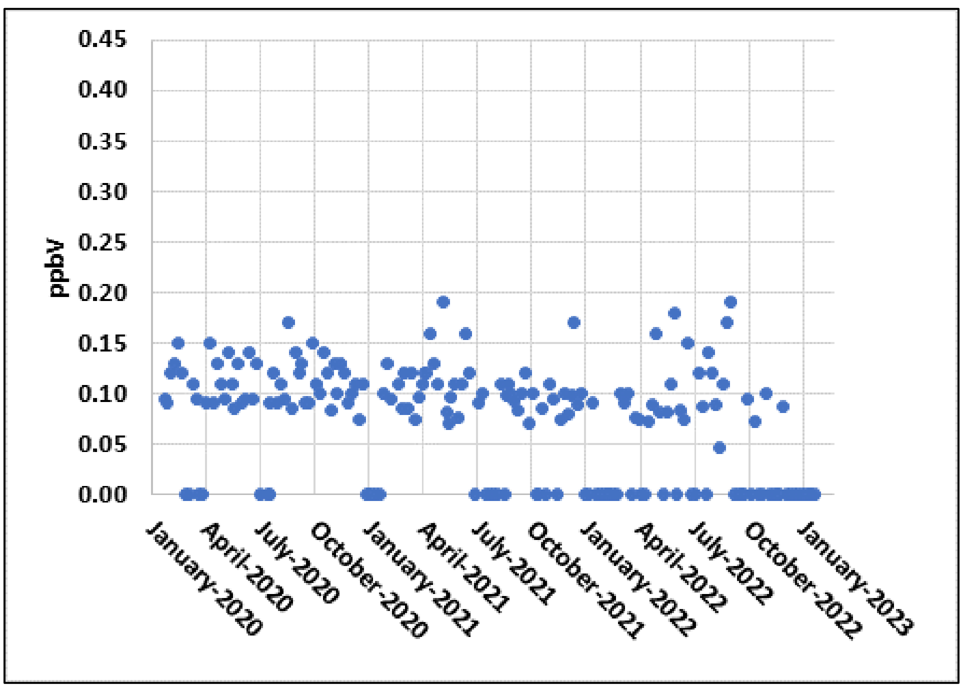

Figure 8. PBway EtO concentrations, every 6th day samples Jan. 2020 through Jan. 2023

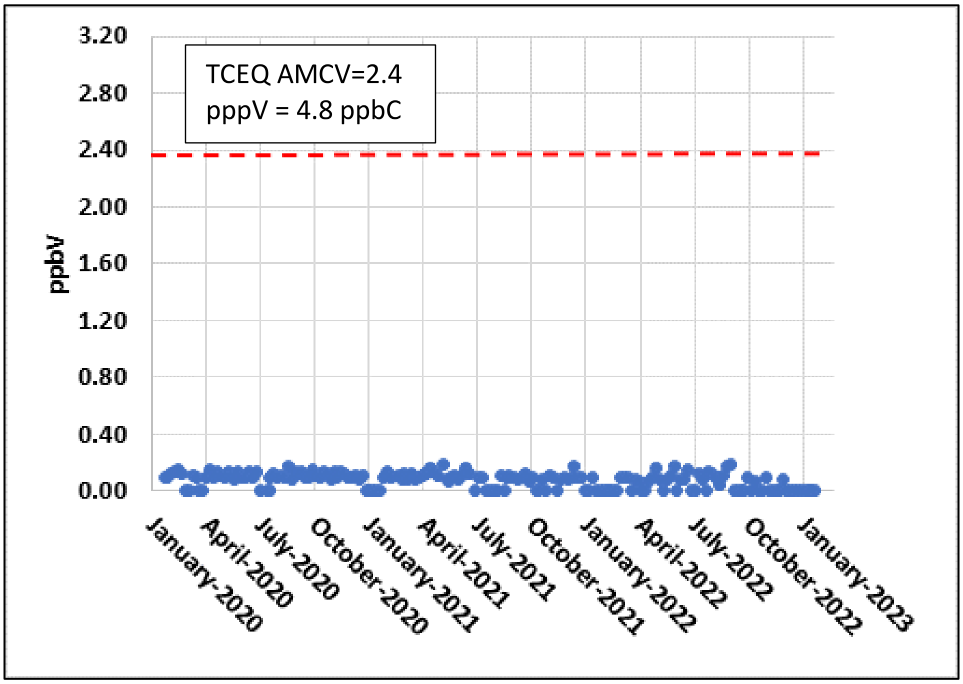

Figure 9. PBway EtO concentrations, every 6th day samples Jan. 2020 through Jan. 2023 in comparison to TCEQ Air Monitoring Comparative Value

4.4 Comparing Hydrocarbon Data between Stations

Figure 10 shows a bar graph comparison between the average concentrations for the twelve months of 2022 of the hydrocarbons measured by auto-GC, including TNMTC and TNMHC, at 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.

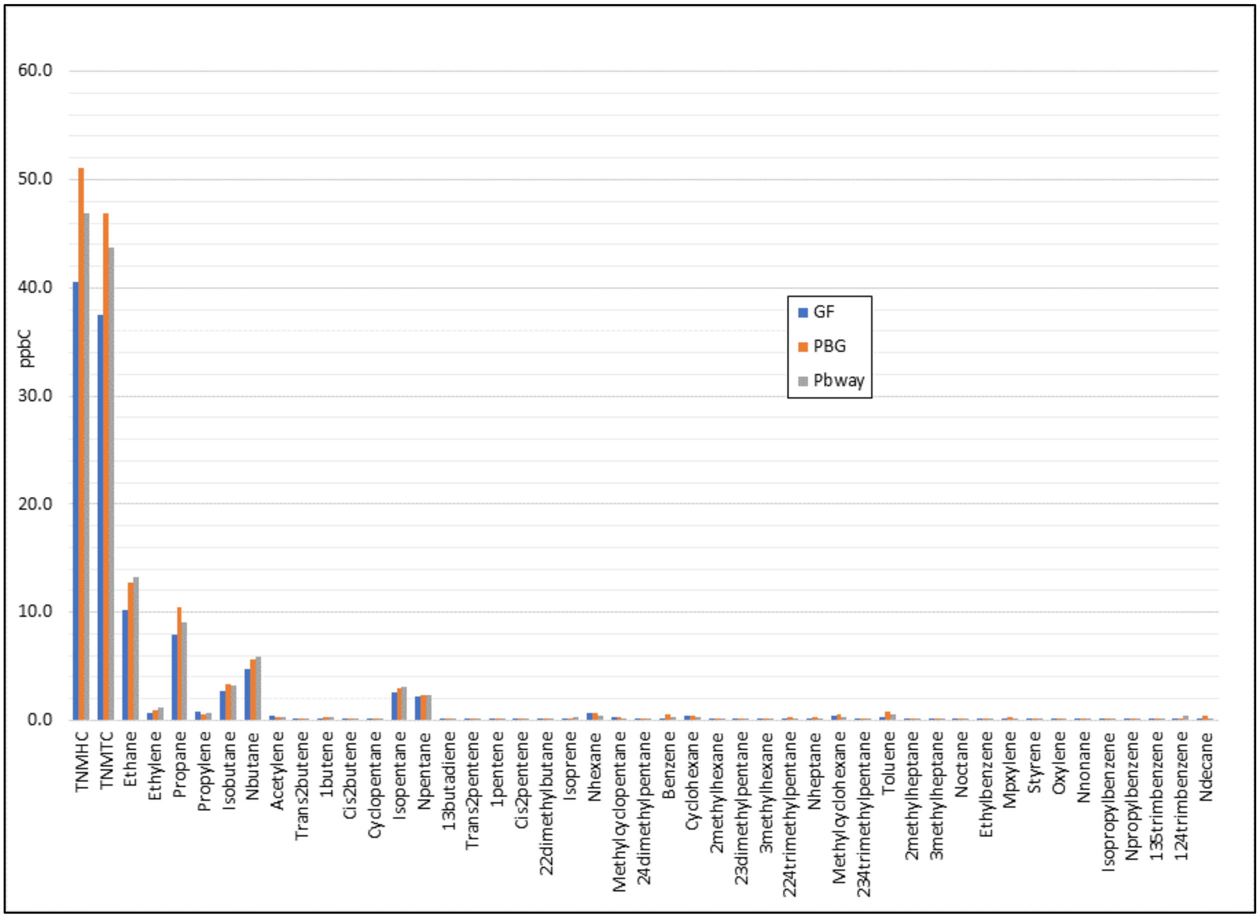

Figure 10. January through December 2022 mean concentrations of TNMTC, TNMHC, and hydrocarbon species at three stations.

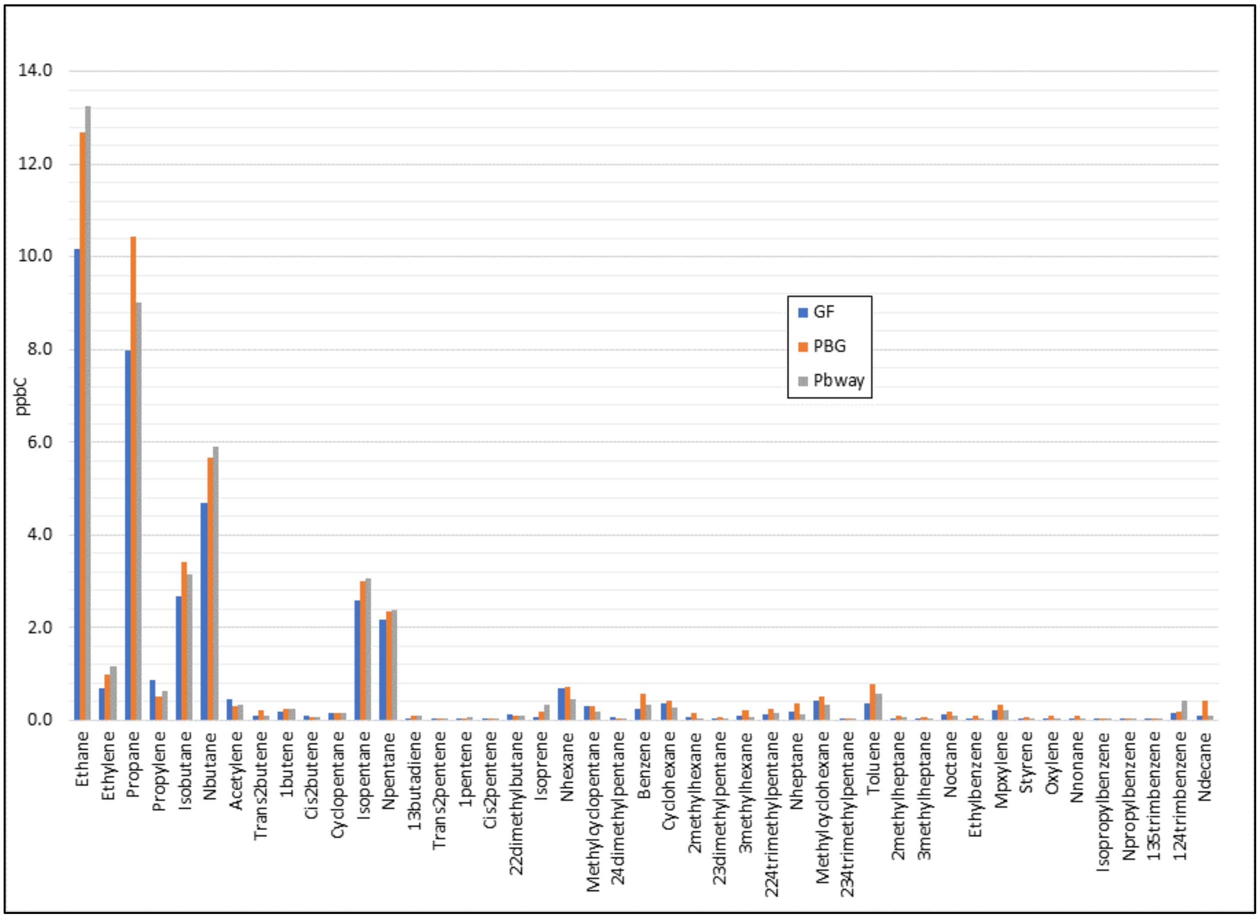

Figure 11. January through December 2022 mean concentrations of hydrocarbon species at three air monitoring stations.

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 one-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. The average PM2.5 concentration for the first quarter of 2023 was 8.7 μg/m^3.

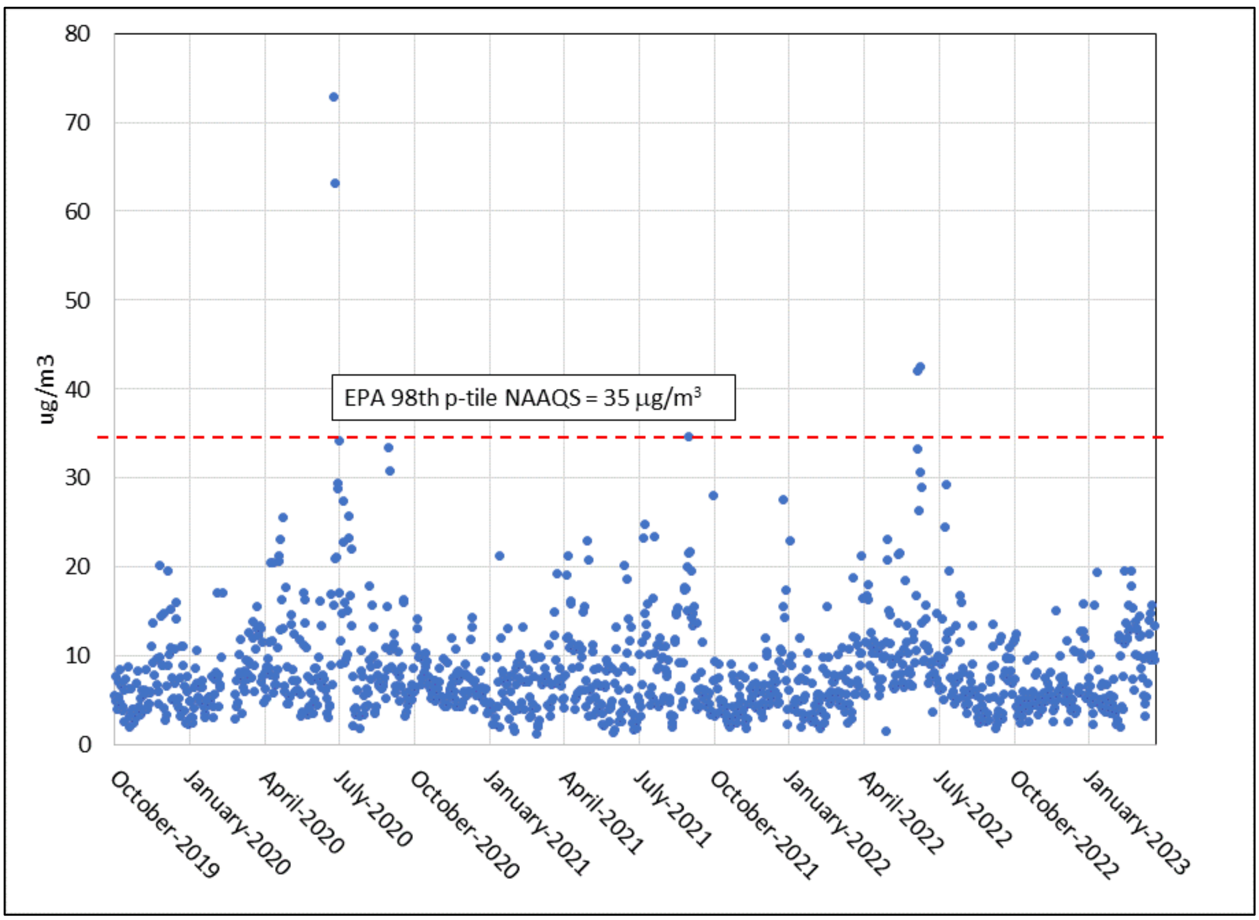

Figure 12. Averaged 24-Hour PM2.5 at GF, Oct. 1, 2019 – Mar. 31, 2023, with NAAQS

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 daily maximum 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 large margins.

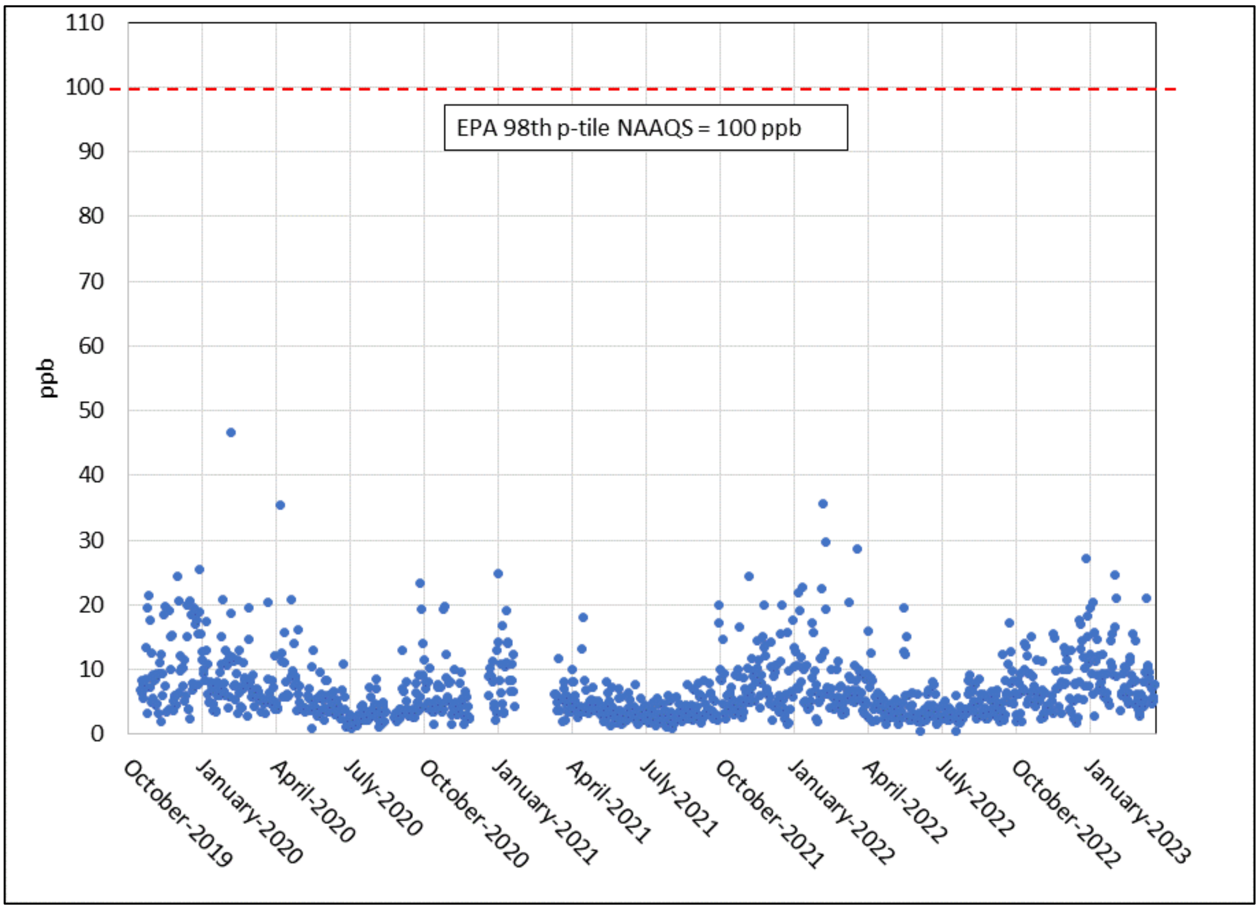

Figure 13. Daily maximum NO_2 at GF, ppb units, Oct. 1, 2019 – Mar. 31, 2023, with NAAQS

Table 6. GF NO_2 annual 98^{th} p-tile values, three-year mean 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. Table 7 lists the annual 99^{th} percentile values of daily maximum 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.

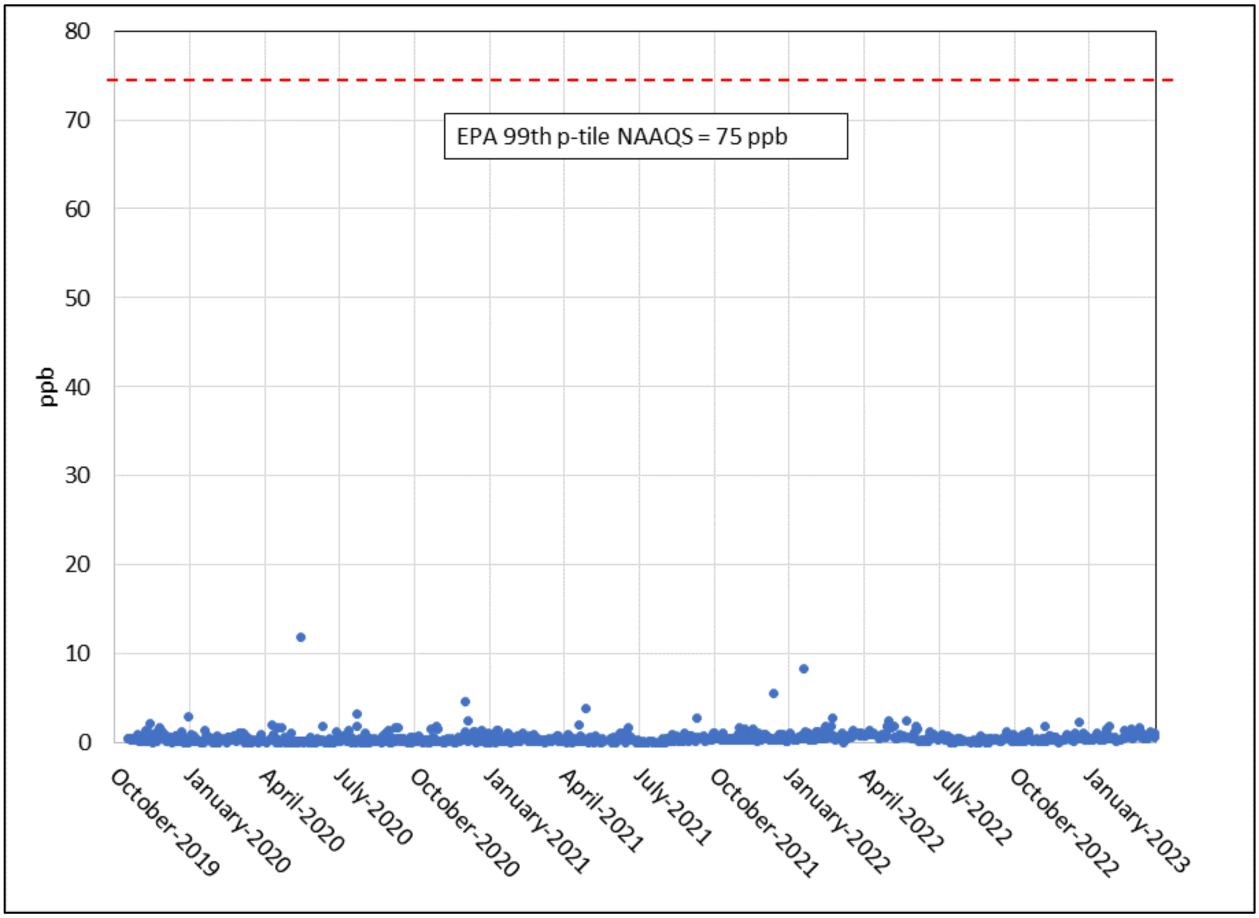

Figure 14. Daily maximum SO_2 at GF, Oct. 1, 2019 – Mar. 31, 2023, with NAAQS at 75 ppb

Table 7. GF SO_2 annual 99th percentile value of daily maximums 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/m^3 and is 8.2 μg/m^3 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/m^3 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. 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. The mean PM2.5 concentrations in the first quarter of 2023 were 8.8 at the PBway station and 8.0 and the PBG station.

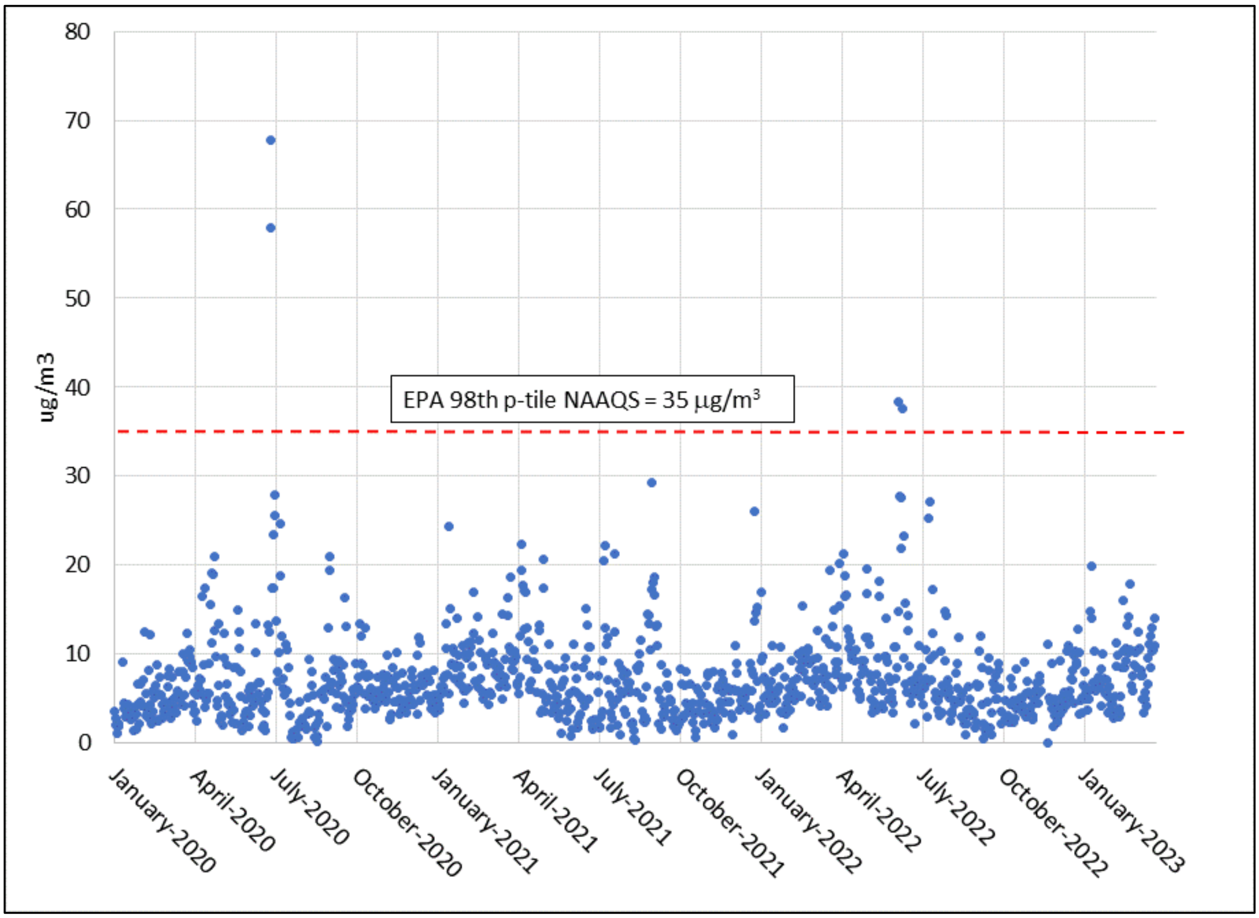

Figure 15. Mean 24-Hour PM2.5 at PBG, Jan. 1, 2020 – Mar. 31, 2023, NAAQS scale.

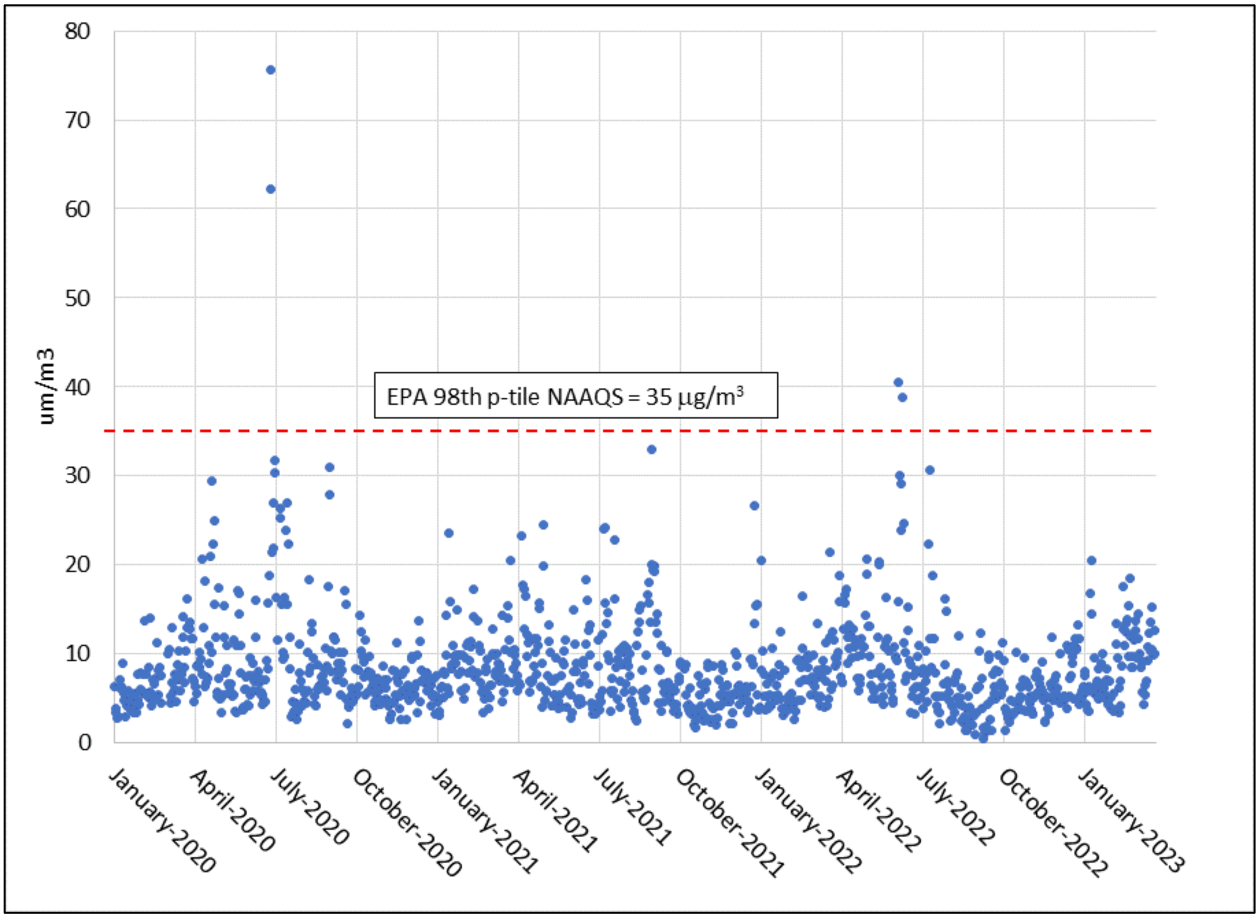

Figure 16. Mean 24-Hr PM2.5 at PBway, Jan. 1, 2020 – Mar. 31, 2023, with NAAQS value.

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

Good and Bad Air Quality

What is "good air quality" and what is "bad air quality"? As noted earlier in this report, these are subjective terms. Overall, in America air quality has improved in the past few decades following adoption of the Clean Air Act (CAA) in 1970 and subsequent updates to the CAA in 1977 and 1990[1]. Over time, as the air quality improved in America, the EPA has strengthened air quality standards to keep steering the nation toward cleaner and cleaner air. On January 6, 2023, the EPA announced, "after carefully reviewing the most recent available scientific evidence and technical information, and consulting with the Agency's independent scientific advisors, EPA announced its proposed decision to revise the primary (health based) annual PM2.5 standard from its current level of 12.0 µg/m^3 to within the range of 9.0 to 10.0 µg/m^3."[2] If EPA set a new standard in this range, many urban areas in Texas will be affected, and the San Patricio County stations will be closer to the level of the NAAQS, without worsening local air quality. Overall, however, one conclusion could be that any area that complies with the EPA NAAQS and has air toxics levels below the TCEQ's AMCV has "good air quality." Currently, San Patricio County meets these criteria.

Levels of air quality can be compared both across geographies and across time. Several figures below show how air quality varies by geography. Figure 17 shows a screen capture from the Website maintained by the IQAir organization, cited by CNN in a recent news article on air quality (https://www.cnn.com/2023/03/14/world/air-pollution-report-2022-climate/index.html accessed April 2023). In this figure, the Eastern Hemisphere is shown, with large areas in Northern Africa, the Arabian Peninsula, Central, South, and East Asia in red indicating unhealthy air quality. In Figure 18, the Western Hemisphere is shown, with only a relatively small area in Southern Mexico and in Northern Chile in red. Figure 19 zooms in on the U.S. and Mexico, at mid-day local time on 4/10/2023. It should be noted that the images shown were made at midday in Texas, meaning it was nighttime in the Eastern Hemisphere, when air quality is made worse by the nighttime temperature inversion and lower speed winds. However, the IQAir group publishes an annual report on world wide air quality, and they do cite countries in Africa and

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[1] See https://www.epa.gov/history/epa-history-clean-air-act-19701977 (accessed April 2023)

[2] See https://www.epa.gov/pm-pollution/proposed-decision-reconsideration-national-ambient-air-quality-standards-particulate (accessed April 2023)

Asia as having far worse air quality than the Western Hemisphere countries and Europe (www.iqair.com/us/world-air-quality-report accessed April 2023).

Figure 20 is from a different source using 2015 data, and it shows the result of bad air quality[3] – excess deaths attributable to PM2.5 in the air. Figure 21 expands the size of the scale in Figure 20 for easier reading. One finding in this paper shows the extent of different effects in different counties: "Pakistan, India, and Bangladesh had the highest age-adjusted mortality rates, more than seven times higher than those of Japan and the USA".

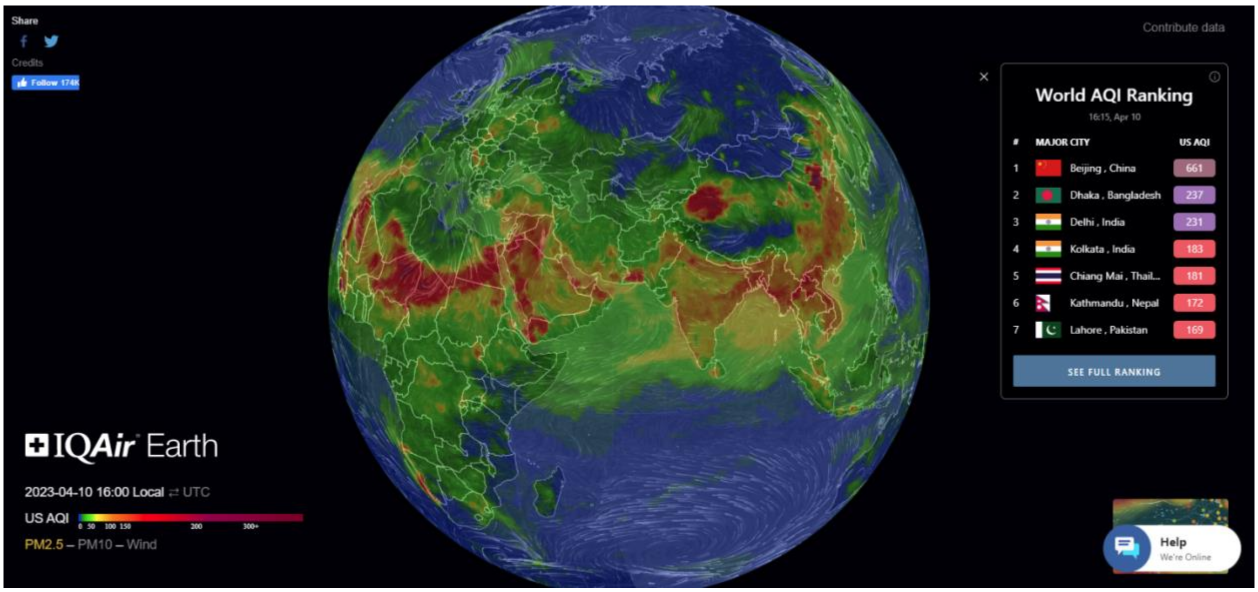

Figure 17. Eastern Hemisphere air quality using the EPA Air Quality Index coloring scheme, with red showing over North Africa, the Arabian Peninsula, and Central and Eastern Asia being worst.

[3] A. J. Cohen, et al., "Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015", www.thelancet.com, Vol 389, May 13, 2017

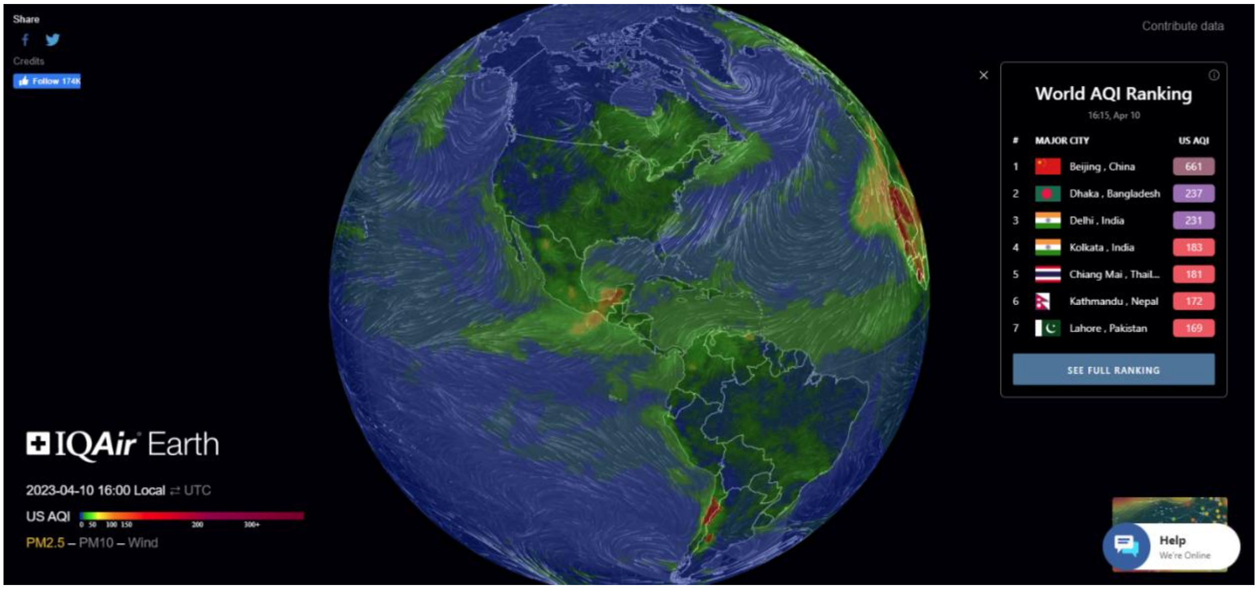

Figure 18. Western Hemisphere air quality using the EPA Air Quality Index coloring scheme, with red showing over Southern Mexico and a portion of Chile being worst.

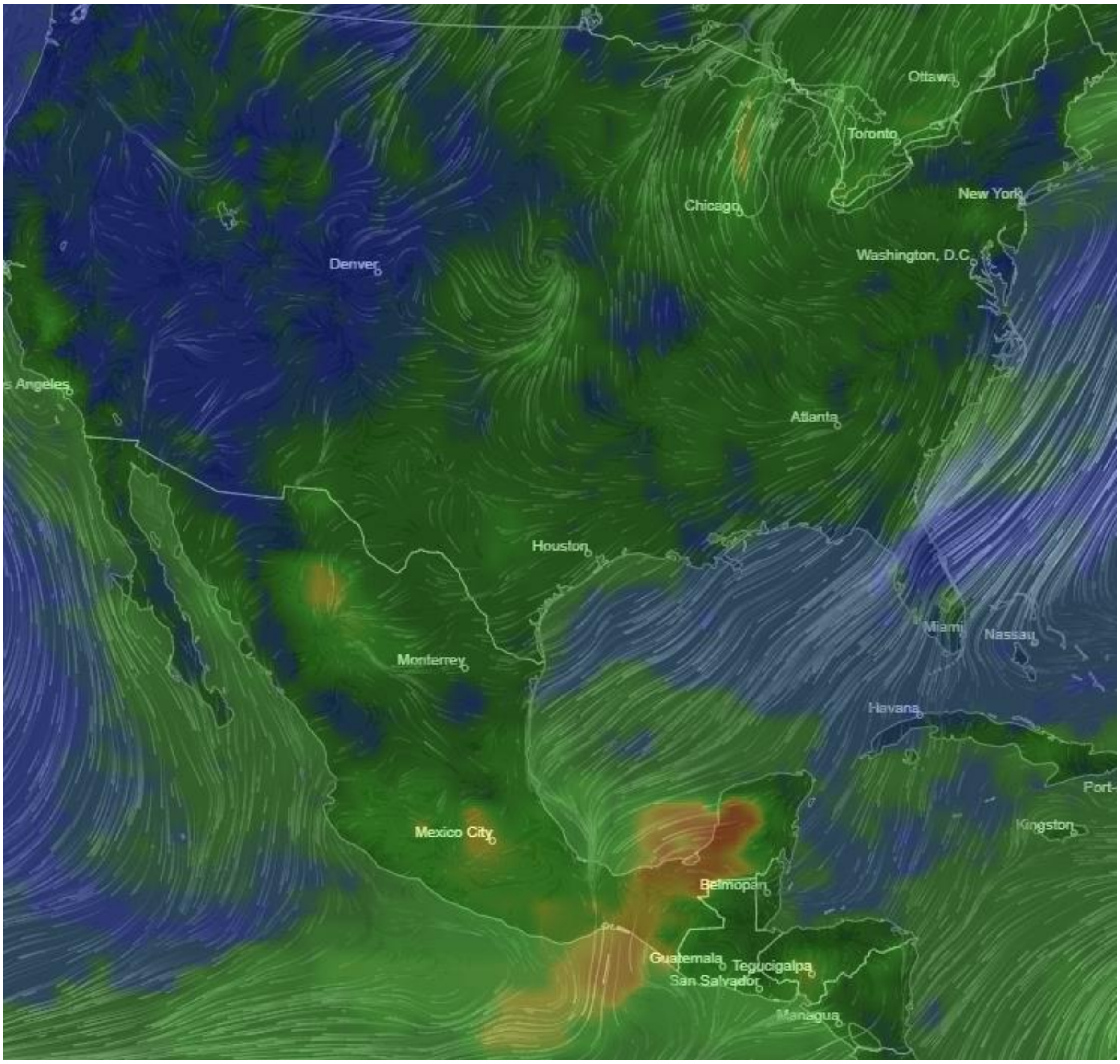

Figure 19. Air quality at a site in South Texas at mid-day local time on 3/23/2023.

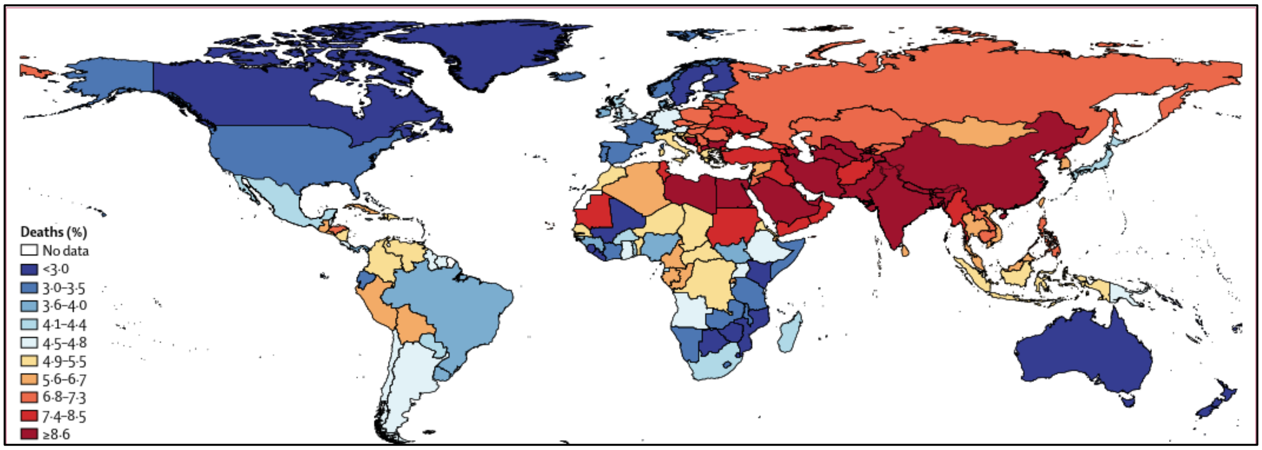

Figure 20. Deaths attributable to ambient particulate matter pollution in 2015

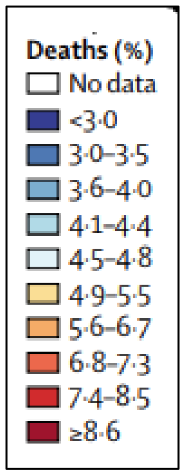

Figure 21. Death rate table from Figure 20.

As noted above, time can also be used to characterize or compare good to bad air quality. Using data from the EPA's Air Quality System (AQS) database, Figure 22 compares ozone concentrations from 1982 with ozone concentrations 39 years later in 2021, for a neighborhood just north of Houston, TX. In the San Patricio County area, there are no ozone monitors with data over such a long period, so a Houston area site at Aldine, Tx was used for this illustration. The daily 8-hour ozone average maximum for each calendar day in 1982 and in 2021 are plotted on the same graph in Figure 22, and it is clear that ozone concentrations in 1982 were much higher than in 2021. This is largely attributable to emission controls put in place for industrial facilities and motor vehicles over the past few decades. The Houston Aldine site was selected as an illustration of improvements in air quality, and other stations in Texas could also be examined upon request. Over the most recent three years, the Houston Aldine site shows attainment of the current ozone NAAQS with a design value of 69 ppb, whereas the same site from 1982 to 1984 would have had a severe nonattainment[4] design value of 119 ppb (in the early 1980s EPA used a different form of the NAAQS).

[4] See www.epa.gov/green-book/ozone-designation-and-classification-information accessed April 2023

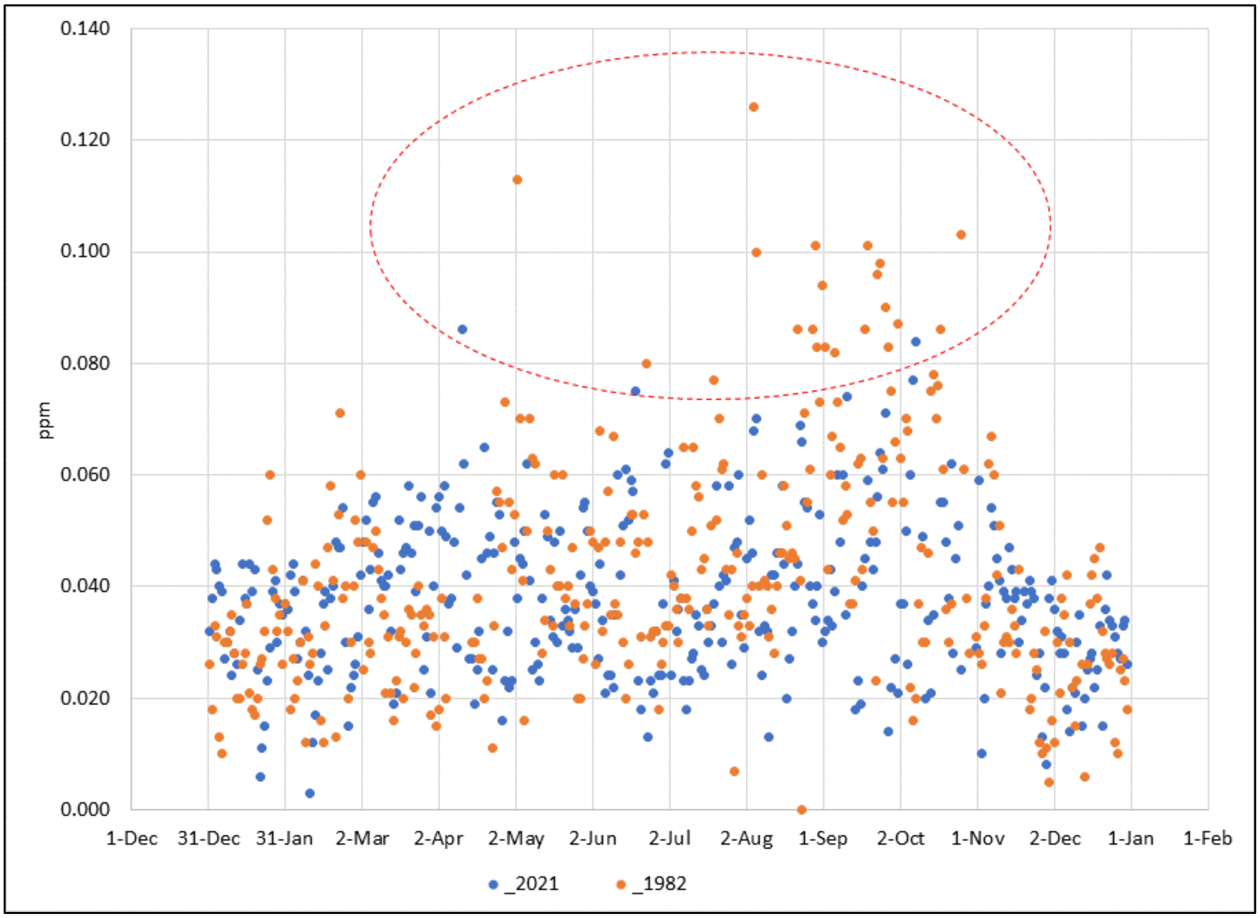

Figure 22. Daily 8-hour ozone maximums at the Houston Aldine station, 1982 and 2021, many more high values in 1982.

6.0 Conclusions

The air monitoring to date has been very successful. Although some concentrations have occasionally exceeded the concentration levels of the NAAQS, i.e., the one-hour, 24-hour or annual average values of the standards, to date, the NAAQS have not been violated. Furthermore, measured hydrocarbon concentrations have not exceeded TCEQ long-term (30-days) or short-term (24-hours) 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 (EtO) 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 23. 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 (ppmV) or ppb-volume (ppbV) 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.