Annual Report of Air Quality Monitoring January 1 to December 31, 2021 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.

As described in earlier reports, a large-scale slowdown in the world economy owing to the COVID 19 pandemic has been underway since early 2020, but this has had minimal impact on air monitoring operations. The instruments in the stations operate automatically and can be accessed remotely. Station operators are locally based and need only travel a short distance to conduct standard operations and maintenance. The University of Texas at Austin (UT Austin) personnel have been working from home and from the office with no loss of effectiveness.

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).

Since monitoring began, some measured pollutant concentrations have exceeded the concentration levels of National Ambient Air Quality Standards (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).

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 2021.

2.0 Summary of Activities January 1 through December 31, 2021

The international COVID 19 pandemic has caused a large-scale slowdown in a wide range of activities since March 2020. While this has had no impact on air monitoring operations, it may have had some effect on activities in the community, which could have effects on air quality.

The data completeness acceptable minimum for regulatory monitoring of criteria air pollutants is 75 percent. These three non-regulatory air monitoring stations reported quality assured data during the fourth quarter of 2021 at a level in excess of 75%. The three auto-GC meet a 75% data completion rate from January through October 30, despite data loss associated with Winter Storm Uri and its aftermath (Feb. 15 – 25). The 75% data completeness is also met without consideration of the few days when data were missing due to annual equipment maintenance, in addition to the weekly, monthly and quarterly routine quality assurance activities, when equipment is also offline while it is being checked. The data completeness estimates are made taking into account the fact that two hours of each day monitoring instrumentation is offline for quality assurance activities. So each day is considered to have 22 hours of ambient monitoring operation.

Although the GF station sulfur dioxide (SO_2) instrument was operating within specifications, it was showing some degradation and was replaced with a new instrument on August 12, 2021, as a precaution. Data collected since then have been very stable and more reliable.

There were a series of short duration power outages at the Gregory Fresnos station on December 30 and 31 at year’s end. This led to partial data losses for several hours.

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).

This report focuses on the data collected at the three air monitoring stations during the period January 1 through December 31, 2021.

3.0 Air Monitoring Station Locations & Information

As mentioned above, 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 (image date Jan. 31, 2020) in Figure 1. Also shown in Figure 1 are the locations of the Cheniere liquefied natural gas facility under expansion and the under-construction 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

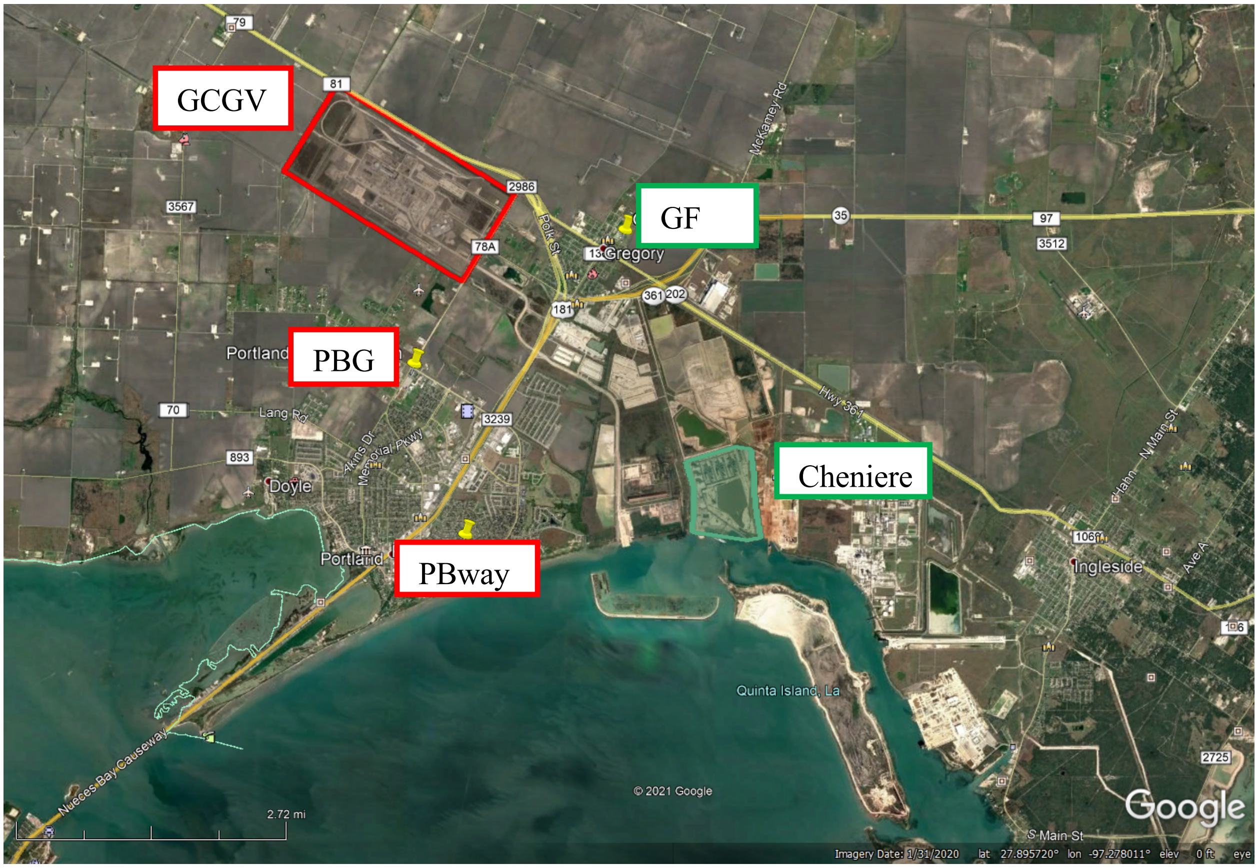

Figure 1. Location of Gregory-Fresnos Community Air Monitoring Station (GF), and two Portland community stations on GPISD campuses on Buddy Ganem (PBG) and on Broadway (PBway) and the Cheniere Energy and GCGV industrial facilities

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. 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 or not 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.

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 of 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, 2021 and all other data were available through December 31, 2021.

4.1 Gregory Fresnos Station Hydrocarbon Data

Figure 2 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 through October 31, 2021. 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 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 2022). 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 2021 average concentration for each species through October 31. 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. The row in Table 2 for ethylene shows an unusually high value of the peak one-hour and 24-hour values. This is discussed in Section 5.0 later in this report.

Data completeness for the GF auto-GC 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 between 84 and 87 percent of hours, with a large amount of the data loss associated with the February storms. The data completeness acceptable minimum is 75 percent.

Time series graphs of other hydrocarbon species are also available upon request and any graphs can be made with time-scale (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 2022). To make a request, contact Dr. Dave Sullivan at sullivan231@mail.utexas.edu or 512-471-7805.

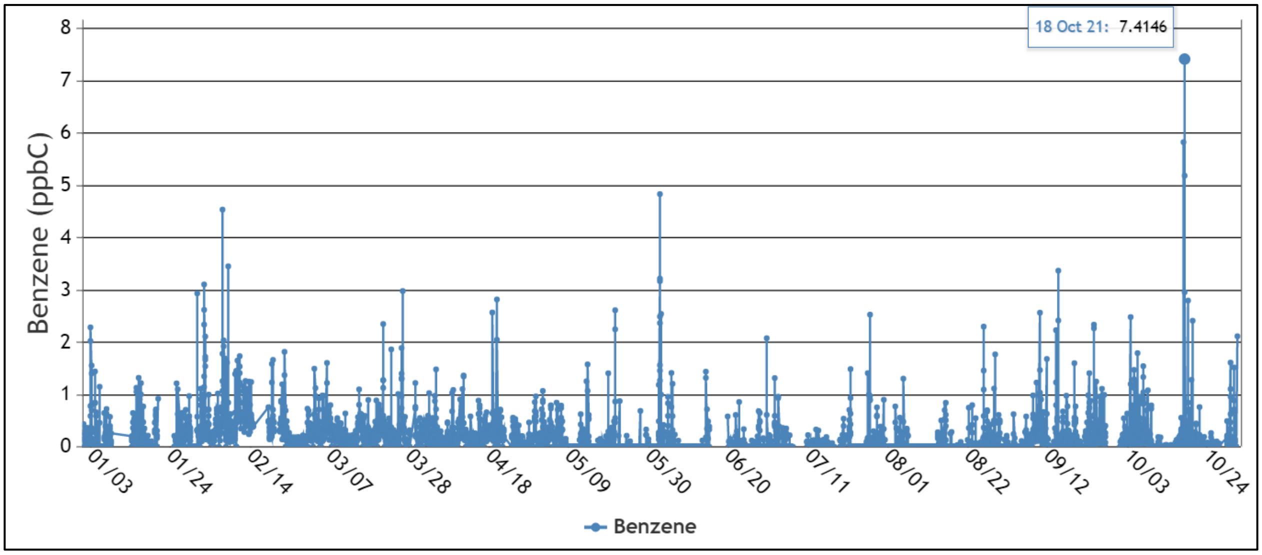

Figure 2. Hourly benzene concentrations at GF station, Jan. 1 – Oct. 31, 2021, ppbC units

Table 2. Gregory-Fresnos Auto-GC statistics for 2021 (through Oct. 31)

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMHC	5,650	1,320.91	170.28	43.62
TNMTC	5,650	1,234.77	155.91	39.46
Ethane	5,835	446.22	81.01	10.97
Ethylene	5,836	881.75	94.32	1.08
Propane	5,836	260.82	69.29	8.29
Propylene	5,836	29.73	2.66	0.68
Isobutane	5,836	151.04	35.60	2.96
n-Butane	5,836	170.23	47.75	4.86
Acetylene	5,836	50.38	5.40	0.46
trans-2-Butene	5,836	0.60	0.11	0.05
1-Butene	5,835	5.14	0.81	0.17
cis-2-Butene	5,825	10.10	1.03	0.04
Cyclopentane	5,836	5.15	0.71	0.15
Isopentane	5,836	71.88	19.14	2.73
n-Pentane	5,836	64.75	17.24	3.92
1,3-Butadiene	5,836	4.62	0.51	0.07
trans-2-Pentene	5,836	2.54	0.23	0.04
1-Pentene	5,836	16.83	1.36	0.06
cis-2-Pentene	5,836	4.60	0.37	0.03
2,2-Dimethylbutane	5,836	6.08	0.96	0.14
Isoprene	5,836	2.12	0.51	0.11
n-Hexane	5,704	40.14	4.86	0.73
Methylcyclopentane	5,703	40.28	4.22	0.36
2,4-Dimethylpentane	5,655	22.95	1.79	0.10
Benzene	5,704	7.41	0.96	0.17
Cyclohexane	5,704	37.81	4.03	0.41
2-Methylhexane	5,704	12.19	1.17	0.09
2,3-Dimethylpentane	5,684	7.23	0.73	0.08
3-Methylhexane	5,704	15.51	1.59	0.14
2,2,4-Trimethylpentane	5,704	11.80	0.97	0.19
n-Heptane	5,697	33.88	3.35	0.20
Methylcyclohexane	5,700	53.81	5.66	0.44
2,3,4-Trimethylpentane	5,704	3.16	0.23	0.02
Toluene	5,704	23.53	2.55	0.36
2-Methylheptane	5,704	8.97	0.95	0.04
3-Methylheptane	5,704	4.94	0.55	0.03
n-Octane	5,704	25.66	2.67	0.13
Ethyl Benzene	5,704	2.58	0.27	0.03
p-Xylene + m-Xylene	5,704	9.40	1.10	0.28
Styrene	5,704	0.80	0.11	0.00
o-Xylene	5,704	3.76	0.39	0.04
n-Nonane	5,704	10.58	1.11	0.06
Isopropyl Benzene - Cumene	5,704	10.88	0.73	0.01
n-Propylbenzene	5,704	2.35	0.63	0.05
1,3,5-Trimethylbenzene	5,704	1.47	0.19	0.01
1,2,4-Trimethylbenzene	5,683	3.17	0.88	0.19
n-Decane	5,704	4.00	0.56	0.13
1,2,3-Trimethylbenzene	5,704	5.57	0.85	0.10

4.2 Portland Buddy Ganem & Portland Broadway Stations Hydrocarbon Data

Figure 3 shows the time series graph for hourly concentrations of benzene at the Portland Buddy Ganem (PBG) station, and Figure 4 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, 2021 through October 31, 2021. As was mentioned in the previous quarterly report, the PBG station data are missing for the first three weeks in July. The AECOM operators had reported:

> "Data from 7/1-7/23 are invalid due to frequent electronic interference attributed to a malfunction of the compressor's auto-drain solenoid valve and associated troubleshooting of the issue."

The solenoid valve was replaced and no further data loss occurred.

As was the case at the Gregory Fresnos station, hydrocarbon concentrations to date are much lower than TCEQ AMCVs or ESLs. 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 concentration for each species for calendar year 2021 through October 31.

Based on the 22 hours per day planned ambient measurements, the PBG station has collected data with between 83 and 84 percent of hours for the 46 different compounds, and the PBway station has collected data with between 78 and 88 percent of hours, with a large amount of the data loss associated with the February storms. The data completeness acceptable minimum is 75 percent.

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.

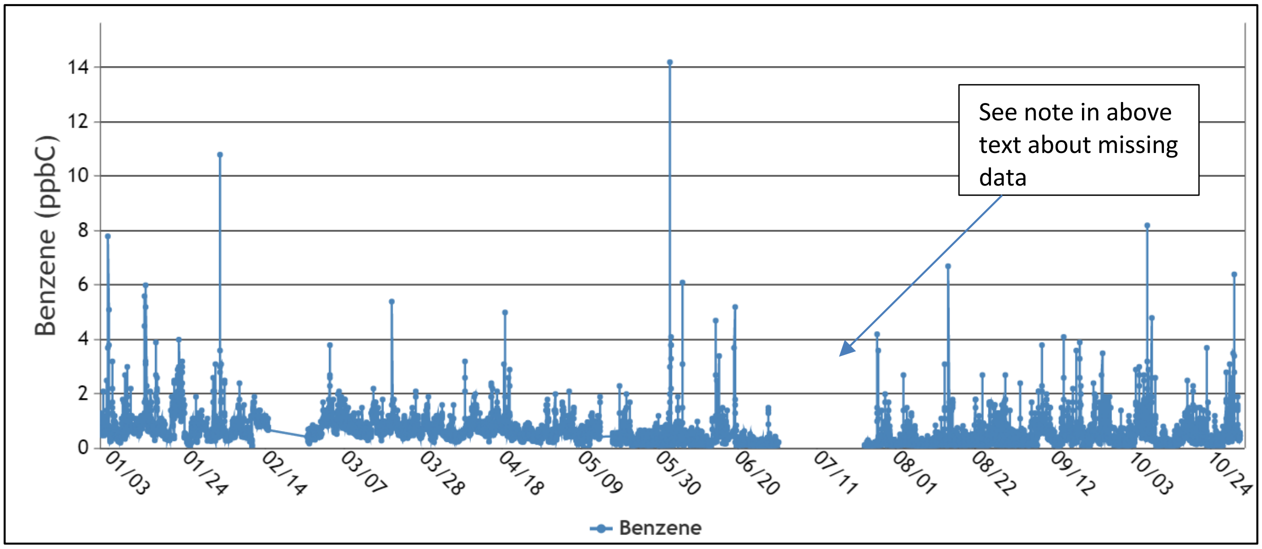

Figure 3. Hourly benzene concentrations at PBG station, Jan. 1 – Oct. 31, 2021, ppbC units

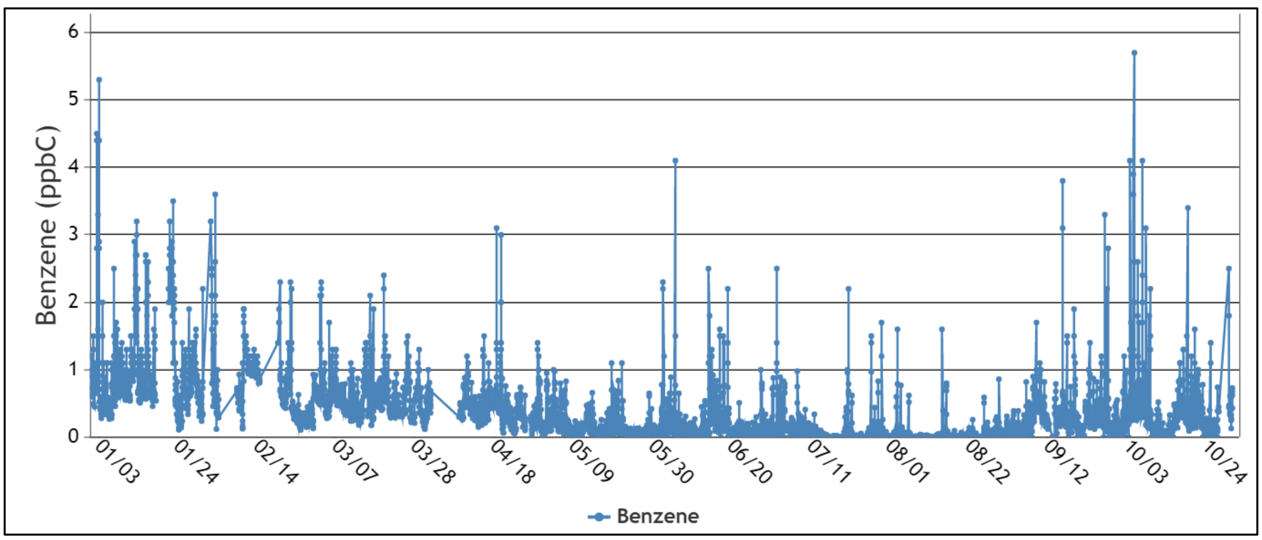

Figure 4. Hourly benzene concentrations at PBway station, Jan. 1 – Oct. 31, 2021, ppbC units

Table 3. PBG Auto-GC statistics for 2021 (through October 31)

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMHC	5,547	975.80	368.74	51.03
TNMTC	5,547	932.10	355.36	45.68
Ethane	5,589	249.00	83.53	11.65
Ethylene	5,592	20.80	3.50	0.76
Propane	5,590	236.00	100.90	10.14
Propylene	5,592	7.50	1.48	0.45
Isobutane	5,589	166.00	36.75	3.49
n-Butane	5,591	142.00	60.66	5.67
Acetylene	5,571	10.70	1.56	0.49
trans-2-Butene	5,588	2.00	0.49	0.19
1-Butene	5,587	6.50	0.73	0.23
cis-2-Butene	5,591	2.60	0.60	0.08
Cyclopentane	5,593	3.10	0.92	0.19
Isopentane	5,592	76.20	24.74	2.98
n-Pentane	5,592	62.50	20.47	2.32
1,3-Butadiene	5,592	3.00	0.43	0.10
trans-2-Pentene	5,592	2.00	0.22	0.03
1-Pentene	5,592	2.00	0.28	0.06
cis-2-Pentene	5,591	1.30	0.14	0.01
2,2-Dimethylbutane	5,591	2.80	0.57	0.11
Isoprene	5,591	2.80	0.95	0.27
n-Hexane	5,581	21.90	5.28	0.72
Methylcyclopentane	5,587	8.80	2.06	0.41
2,4-Dimethylpentane	5,587	3.70	0.67	0.02
Benzene	5,587	14.20	2.07	0.65
Cyclohexane	5,587	14.50	2.39	0.43
2-Methylhexane	5,587	5.80	0.94	0.17
2,3-Dimethylpentane	5,586	3.30	0.70	0.08
3-Methylhexane	5,586	6.70	1.38	0.26
2,2,4-Trimethylpentane	5,584	11.60	1.40	0.35
n-Heptane	5,588	10.90	2.06	0.34
Methylcyclohexane	5,584	16.80	2.79	0.51
2,3,4-Trimethylpentane	5,588	3.20	0.25	0.07
Toluene	5,586	18.90	2.56	0.67
2-Methylheptane	5,584	9.70	0.63	0.09
3-Methylheptane	5,586	10.80	0.67	0.07
n-Octane	5,587	26.20	1.60	0.18
Ethyl Benzene	5,587	4.10	0.38	0.10
p-Xylene + m-Xylene	5,587	14.50	1.39	0.34
Styrene	5,587	2.70	0.34	0.04
o-Xylene	5,587	5.30	0.48	0.10
n-Nonane	5,588	17.60	1.21	0.11
Isopropyl Benzene - Cumene	5,588	2.00	0.10	0.01
n-Propylbenzene	5,588	1.30	0.12	0.02
1,3,5-Trimethylbenzene	5,588	2.30	0.23	0.04
1,2,4-Trimethylbenzene	5,588	6.30	0.49	0.13
n-Decane	5,545	6.60	1.10	0.34

Table 4. PBway Auto-GC statistics for 2021 (through October 31)

Species	Num. Samples	Peak 1-hr ppbC	Peak 24-hr ppbC	Mean ppbC
TNMHC	5,878	638.80	404.67	40.19
TNMTC	5,878	600.60	378.54	37.11
Ethane	5,860	164.00	112.51	10.82
Ethylene	5,843	31.80	4.09	1.00
Propane	5,878	156.00	100.12	7.57
Propylene	5,878	6.00	2.29	0.55
Isobutane	5,878	66.30	27.70	2.48
n-Butane	5,878	119.00	56.16	4.64
Acetylene	5,285	3.70	1.02	0.23
trans-2-Butene	5,866	4.10	0.95	0.17
1-Butene	5,871	22.90	1.49	0.33
cis-2-Butene	5,877	1.10	0.20	0.06
Cyclopentane	5,878	4.70	0.85	0.14
Isopentane	5,878	79.50	22.37	2.56
n-Pentane	5,878	49.40	20.35	1.78
1,3-Butadiene	5,878	3.30	0.40	0.08
trans-2-Pentene	5,872	5.20	0.32	0.02
1-Pentene	5,875	7.50	0.37	0.06
cis-2-Pentene	5,874	6.30	0.52	0.01
2,2-Dimethylbutane	5,877	2.00	0.51	0.07
Isoprene	5,877	5.00	1.68	0.48
n-Hexane	5,878	14.10	8.18	0.58
Methylcyclopentane	5,878	10.70	2.24	0.28
2,4-Dimethylpentane	5,878	5.20	0.33	0.01
Benzene	5,824	5.70	2.44	0.37
Cyclohexane	5,878	8.50	2.12	0.29
2-Methylhexane	5,878	3.20	1.21	0.09
2,3-Dimethylpentane	5,878	3.00	0.60	0.04
3-Methylhexane	5,878	3.50	1.60	0.14
2,2,4-Trimethylpentane	5,878	34.00	2.55	0.31
n-Heptane	5,878	6.70	2.17	0.20
Methylcyclohexane	5,877	12.70	2.43	0.33
2,3,4-Trimethylpentane	5,878	6.80	0.51	0.06
Toluene	5,878	14.60	2.87	0.59
2-Methylheptane	5,878	2.60	0.94	0.04
3-Methylheptane	5,878	1.70	0.47	0.03
n-Octane	5,877	4.30	0.89	0.09
Ethyl Benzene	5,877	1.70	0.30	0.04
p-Xylene + m-Xylene	5,878	8.40	0.96	0.23
Styrene	5,878	4.20	0.29	0.02
o-Xylene	5,878	2.80	0.22	0.03
n-Nonane	5,878	2.50	0.36	0.04
Isopropyl Benzene - Cumene	5,878	3.80	0.19	0.01
n-Propylbenzene	5,878	0.90	0.13	0.01
1,3,5-Trimethylbenzene	5,195	1.30	0.34	0.01
1,2,4-Trimethylbenzene	5,189	2.20	0.66	0.10
n-Decane	5,195	2.00	0.65	0.11

4.3 Comparing Hydrocarbon Data between Stations

Figure 5 shows a bar graph comparison between the average concentrations for 2021 through October 31 of hydrocarbons including TNMTC and TNMHC among the three stations. The graph shows relatively close agreement among the three stations. Figure 6 is a similar graph excluding TNMTC and TNMHC. This second graph allows for a better comparison of the similarity among the stations.

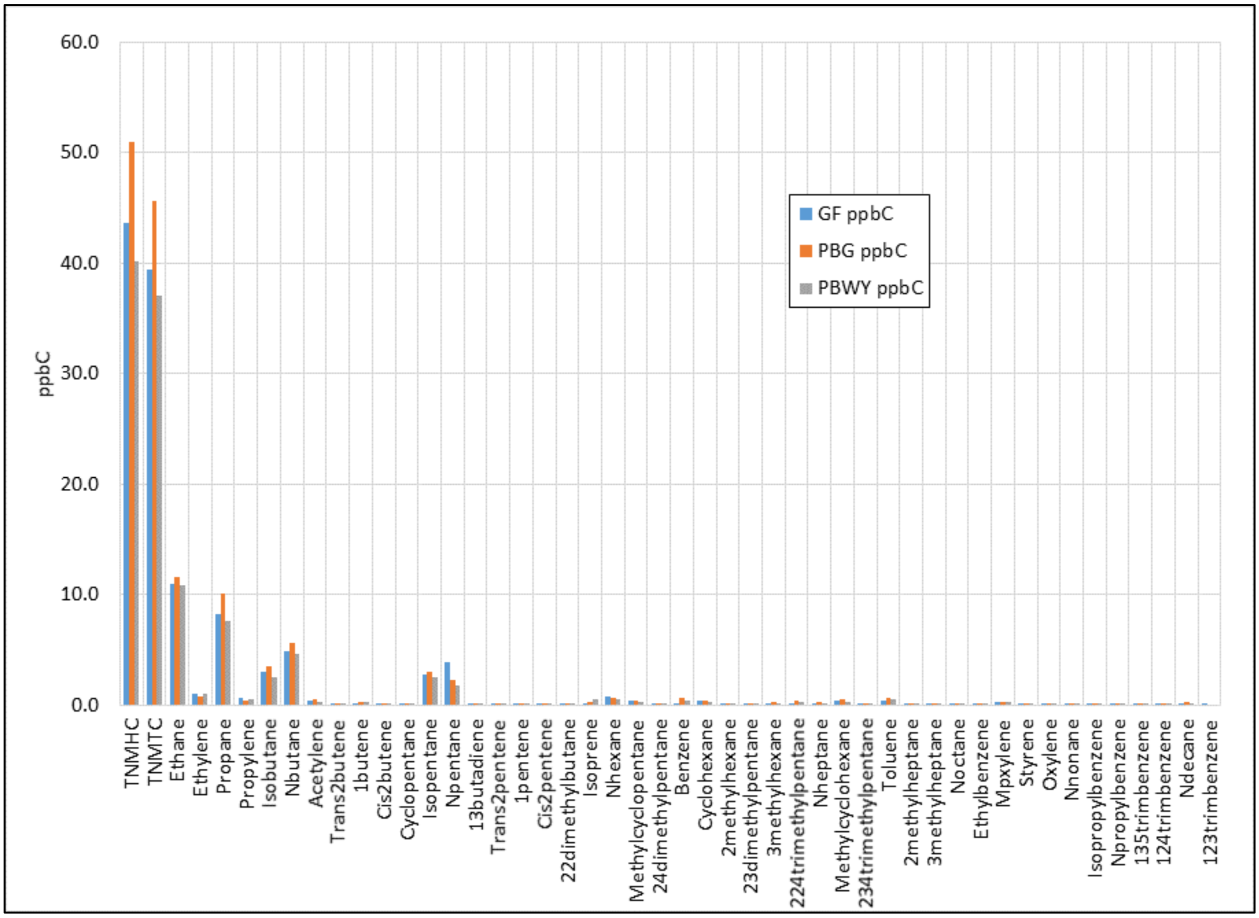

Figure 5. Mean concentrations of TNMTC, TNMHC, and 46 hydrocarbon species at three stations

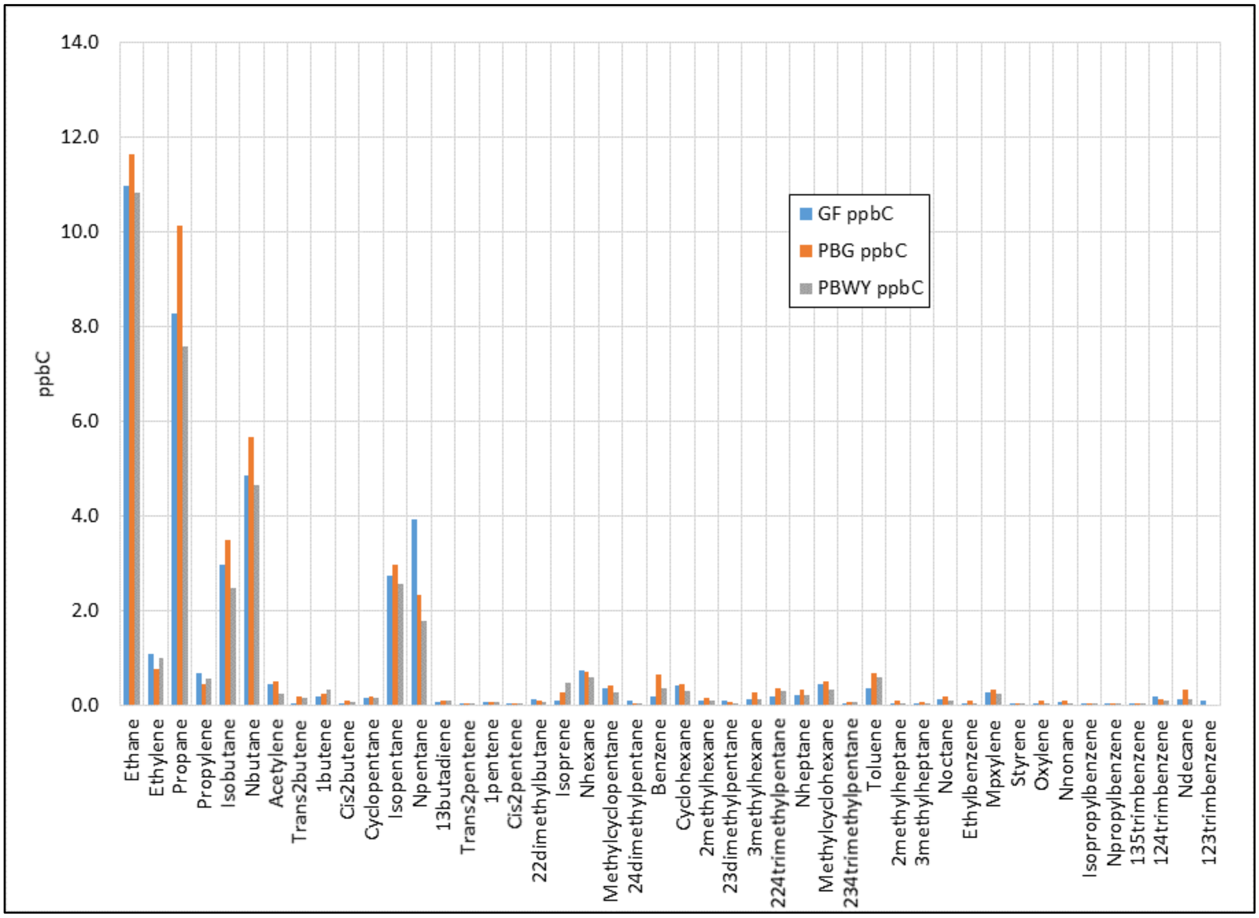

Figure 6. Mean concentrations of 45 hydrocarbon species at the three air monitoring stations

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, 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 values to average less than 53 ppb in a calendar year and for the 98th percentile daily maximum value 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, which must be less than 75 ppb.

- With PM2.5, SO_2, and NO_2, the $98^{th}/99^{th}$ percentile values are averaged with the similar statistic from the previous two years and then compared to the level of the NAAQS. For PM2.5 and NO_2, the annual average is averaged with the similar statistic from the previous two years and then compared to the level of the NAAQS.

No concentrations at levels that violate the NAAQS have been seen at the GF station. Several recorded PM2.5 1-hour values exceeded the level of the 24-hour NAAQS, 35 $\mu g/m^3$, but as noted above, the NAAQS is not violated unless the 98^{th} 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 $\mu g/m^3$).

Figure 7 shows the hourly average time series graph for PM2.5 at the GF station from January 1 through December 31, 2021. The average concentration for 2021 was 7.9 $\mu g/m^3$ compared with the primary one-year NAAQS value (annual mean averaged over three years) of 12 $\mu g/m^3$. Occasional elevated concentrations have been associated with nearby construction work (June 18, 2021), patriotic celebratory fireworks (September 11, 2021). Despite the elevated one-hour concentrations, the 24-hour average concentration on these dates were modest. Figure 8 shows the 24-hour averaged daily PM2.5 concentrations for 2021.

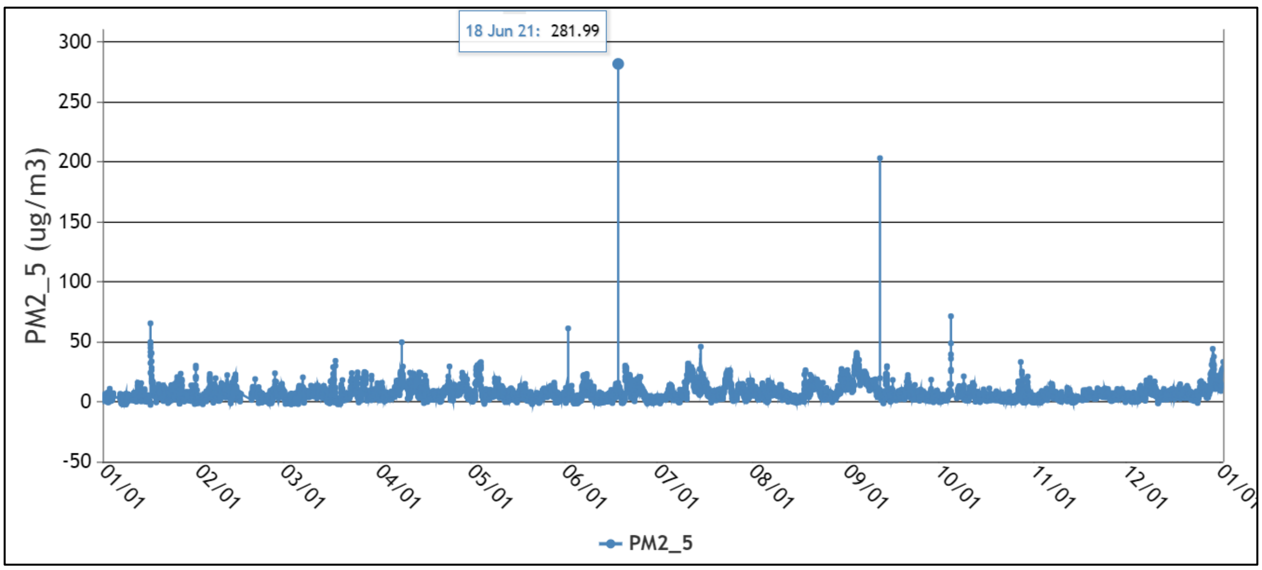

Figure 7. Hourly average PM2.5 at GF, $\mu g/m^3$, Jan. 1 – Dec. 31, 2021

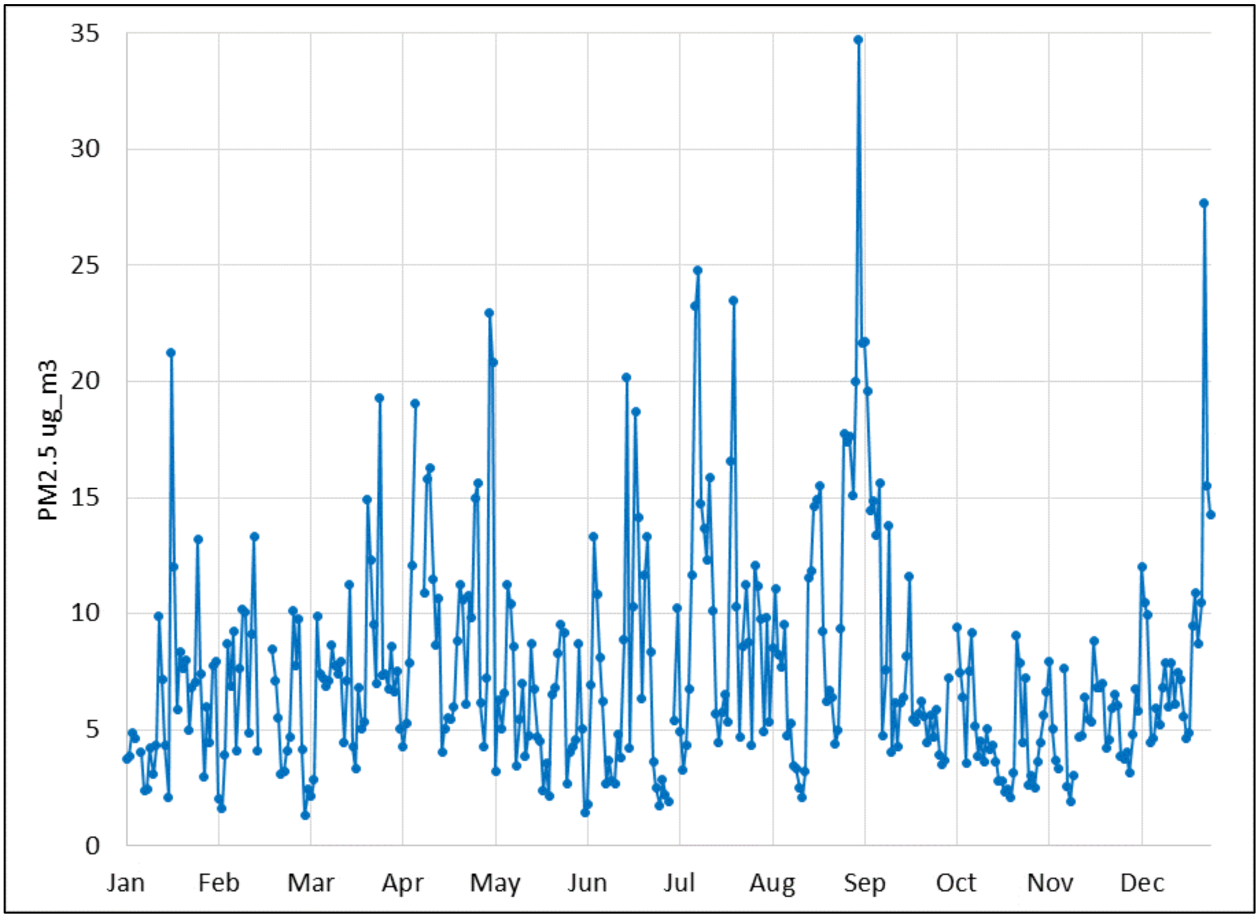

Figure 8. Averaged 24-Hour PM2.5 at GF, µg/m^3, Jan. 1 – Dec. 31, 2021

Figure 9 shows the hourly average time series graph for NO_2 at the Gregory Fresnos station from January 1 through December 31, 2021. The average NO_2 concentration at the Gregory Fresnos station during 2021 was 2.6 ppb, and the highest daily maximum, shown in Figure 9, was 24.9 ppb on January 4, 2021. The NOx instrument had been out of service in late November 2020 into late December 2020, and again had stability of performance problems beginning January 24. On March 15, 2021, a replacement instrument began operating at the station.

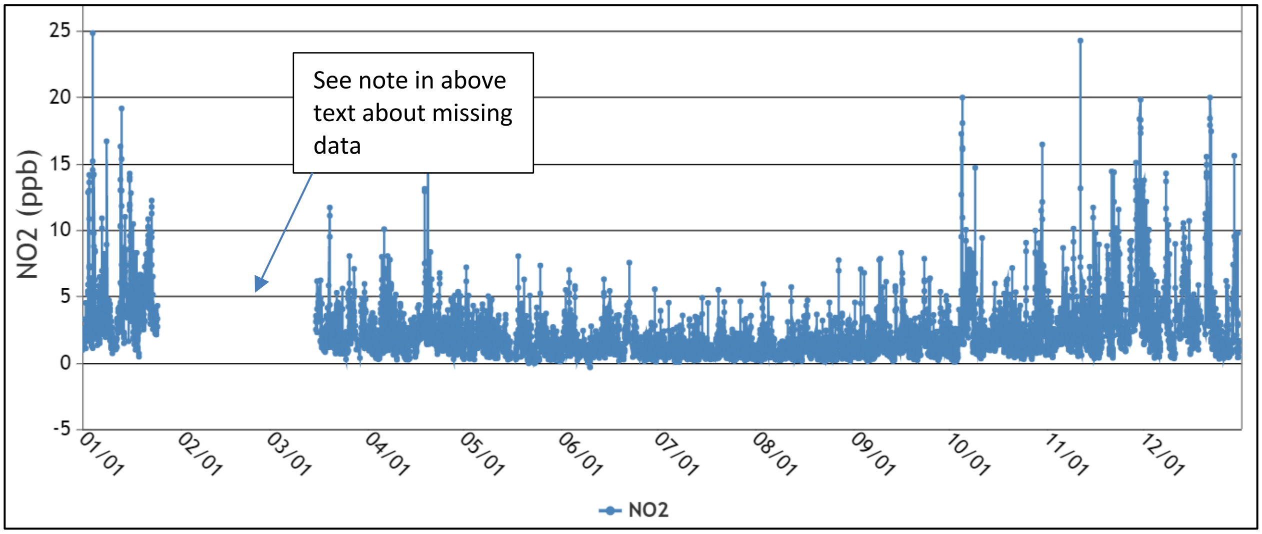

Figure 9. Hourly NO_2 at GF, ppb units, Jan. 1 – Dec. 31, 2021

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 SO_2 at the GF station is shown in Figure 10. The graph is scaled to illustrate how low the concentrations have been compared to the 75-ppb level of the NAAQS. Figure 11 shows the 2021 time series for SO_2 reflecting the range of observed concentrations. Some attention is paid to the higher SO_2 concentrations later in this report in Section 5.0.

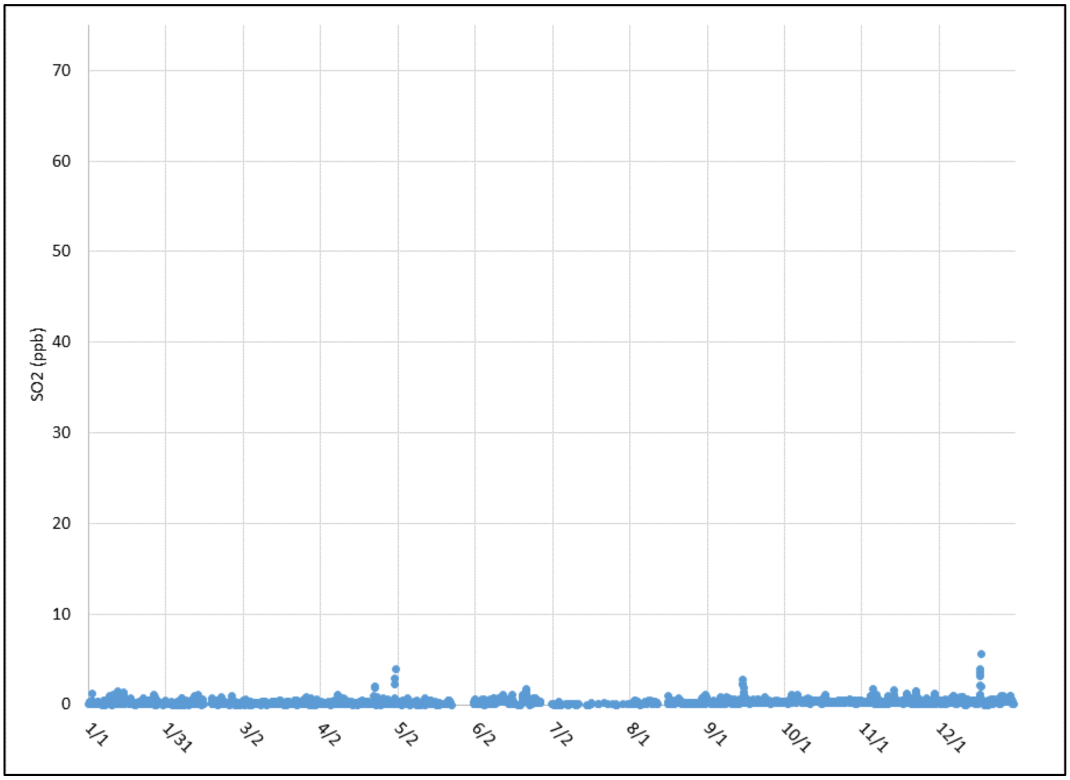

Figure 10. Hourly average SO_2 at GF, ppb units, Jan. 1 – Dec. 31, 2021, NAAQS scale

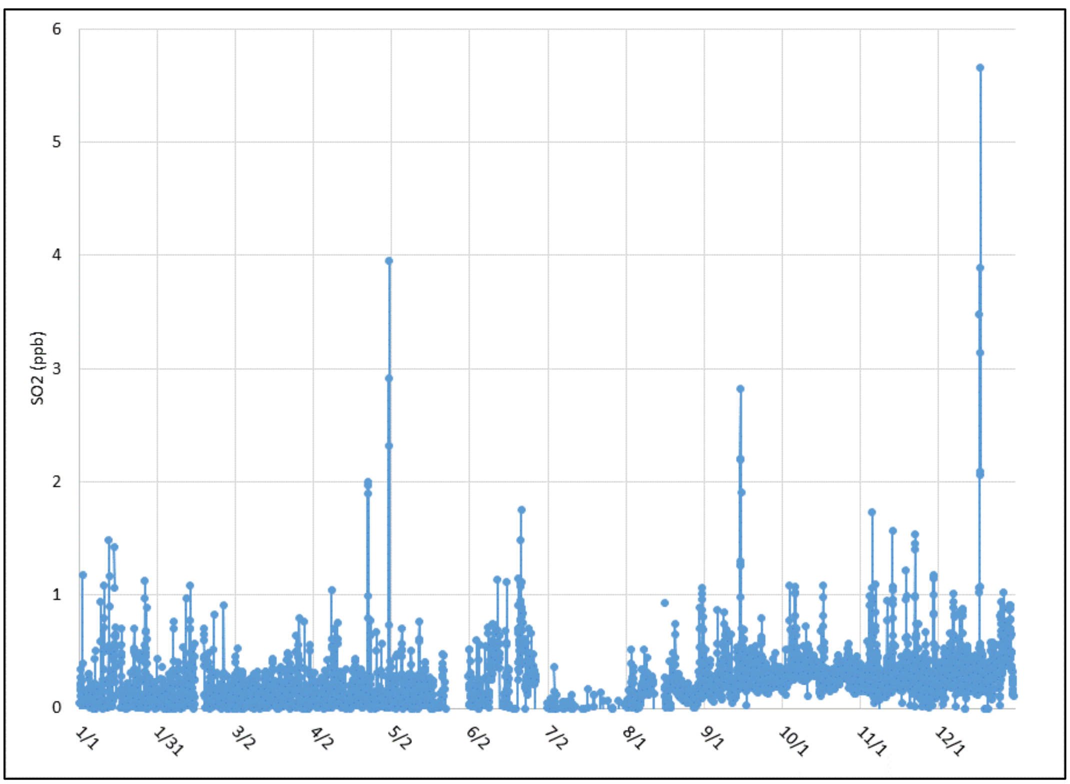

Figure 11. Hourly average SO_2 at GF, ppb units, Jan. 1 – Dec. 31, 2021

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. Hourly concentrations that exceed the NAAQS 24-hour average value have been seen at the two stations, but no violations of the standard have occurred. Figure 12 shows the 2021 hourly concentrations time series graph of PM2.5 and Figure 13 shows the 24-hour average concentrations at the PBG site, and Figure 14 and Figure 15 show the same time series for the PBway site. The average concentration in 2021 at PBG was 7.2 $\mu g/m^3$ and was 8.2 $\mu g/m^3$ at PBway.

In examining the graphs for PM2.5 at the three monitoring stations, one may be struck by the similarity in the time series, particularly the 24-hour average time series graphs in Figure 8, Figure 13, and Figure 15. The stations are highly correlated:

- between GF and PBG, correlation=0.89,
- between GF and PBway, correlation =0.94, and
- between PBG and PBway, correlation =0.95.

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.

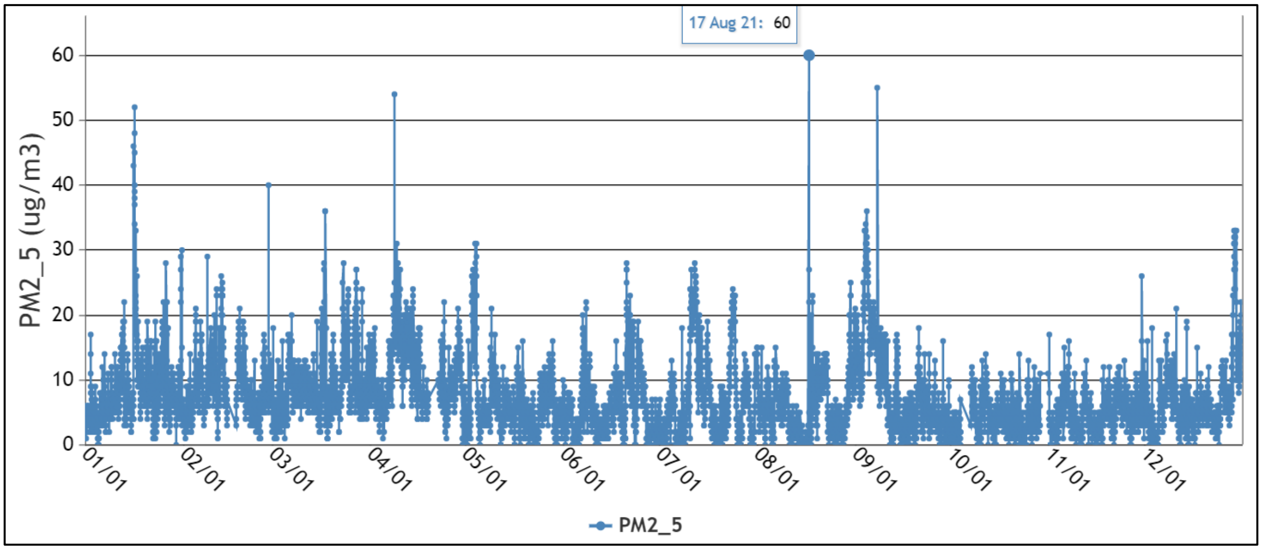

Figure 12. Hourly average PM2.5 at PBG, µg/m^3, Jan. 1 – Dec. 31, 2021

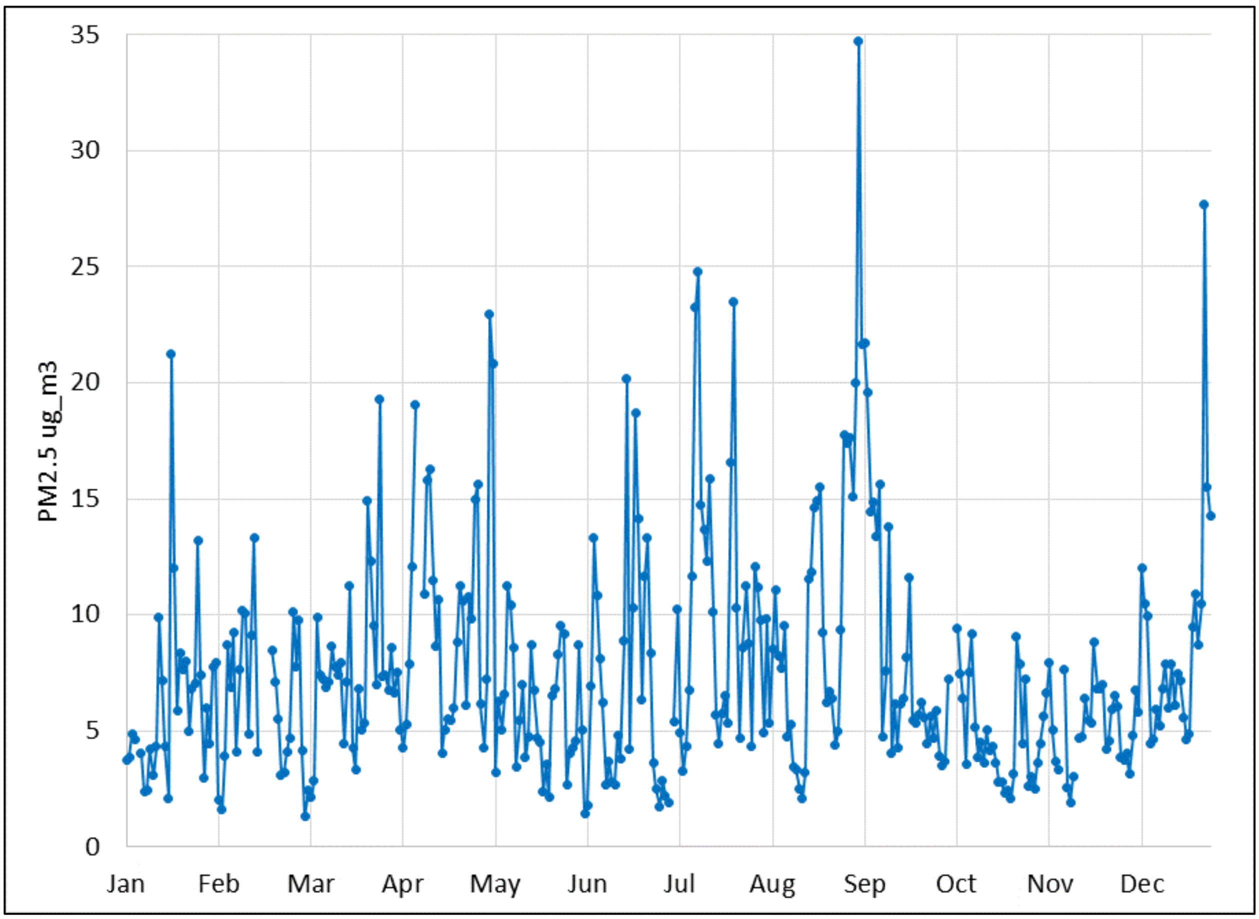

Figure 13. Averaged 24-Hour PM2.5 at PBG, µg/m^3, Jan. 1 – Dec. 31, 2021

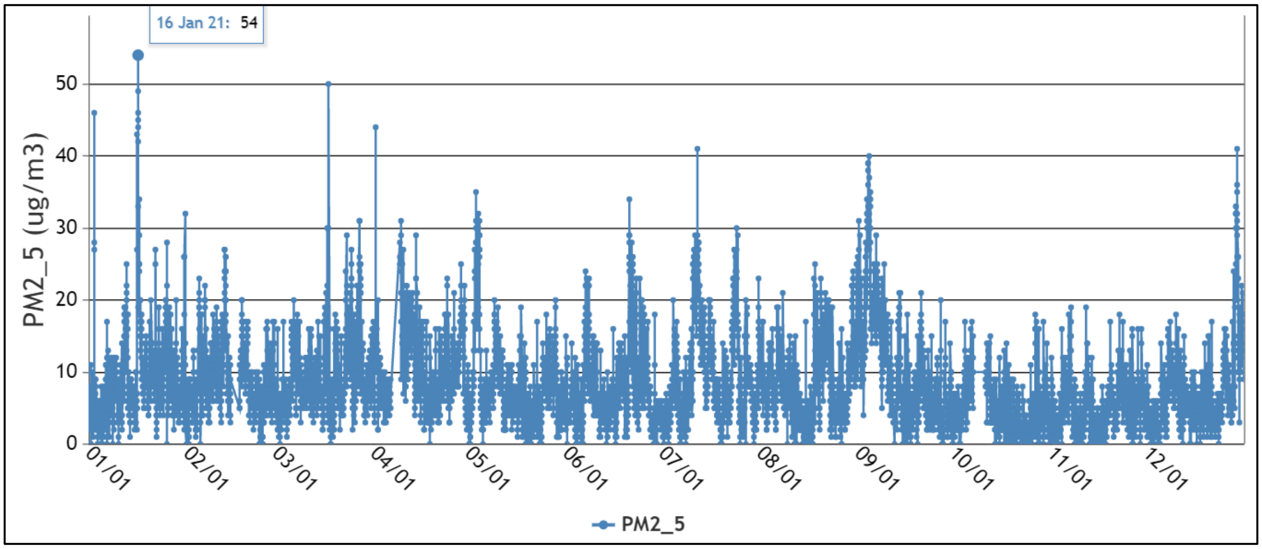

Figure 14. Hourly average PM2.5 at PBway, μg/m^3, Jan. 1 – Dec. 31, 2021

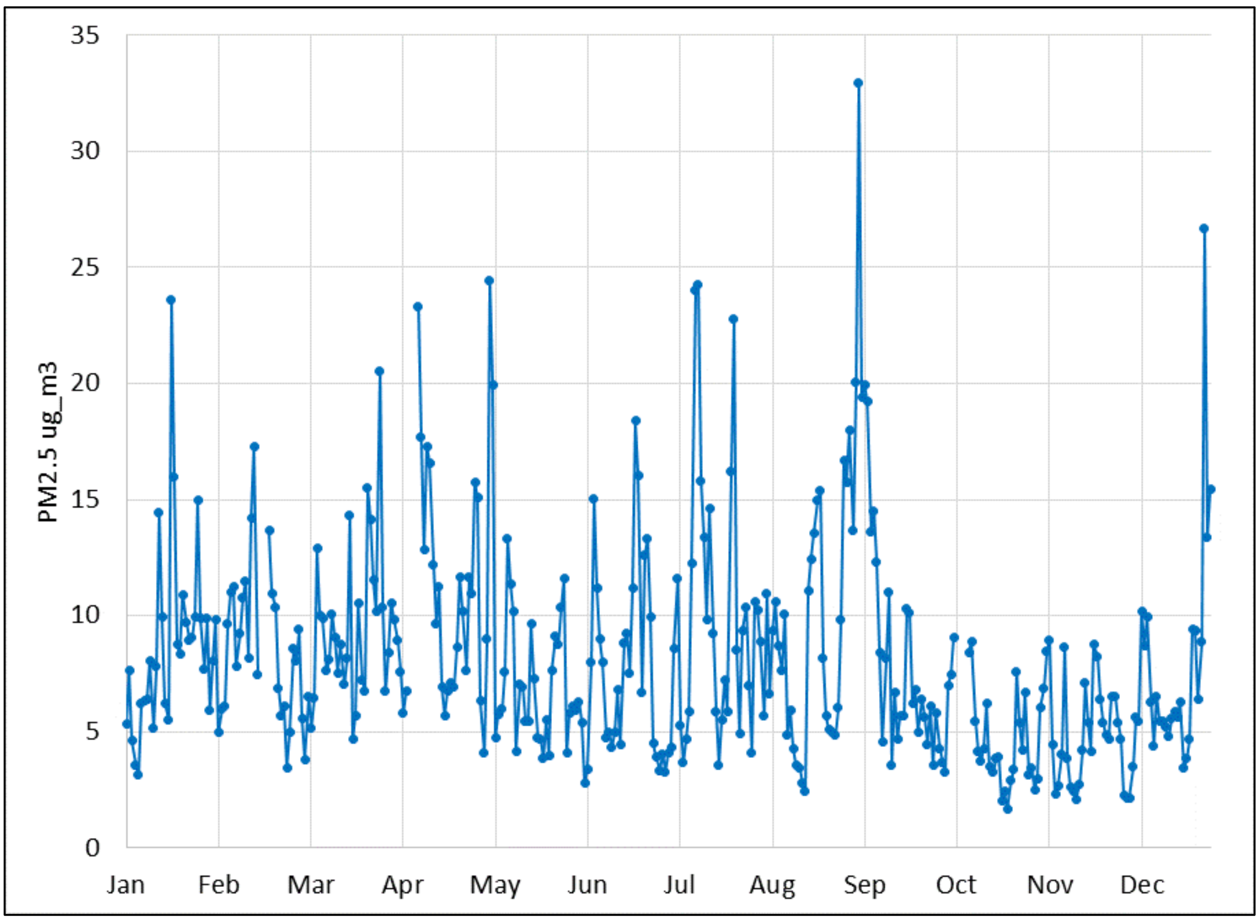

Figure 15. Averaged 24-Hour PM2.5 at PBway, μg/m^3, Jan. 1 – Dec. 31, 2021

5.0 Data Analysis

Sulfur Dioxide at Gregory Fresnos

As was mentioned earlier, the GF station SO_2 analyzer was replaced in August 2021. Since then, the data have been more stable, but all of the data are useable for air quality assessment. Although measured concentrations of SO_2 at the GF station since the beginning of monitoring have been low in comparison to the NAAQS, on several occasions in 2021 concentration above the general background – which is close to 0 ppb – have been measured. A total of 6,966 one hour values of SO_2 were measured at the GF station in 2021, and 99 percent of all values were below 0.94 ppb. The top 1 percent (70 largest concentration values) were selected for examination of the associated wind data. Figure 16 shows a bar chart histogram of the frequency of SO_2 values in the top 1% concentrations by 10 degree wind bins. A few obvious peaks in the graph appear at 150 to 160 degrees (southeast) and 10 to 20 and 20 to 30 degrees (northeast).

However, it is well known that southeasterly winds are the most common in this area, and thus, all else held equal, one should expect more high concentrations from that direction. Figure 17 shows a bar chart histogram of the distribution of wind directions in 2021 for the GF station. As has also been pointed out earlier in this report, the wind speed has an effect on concentrations so one should generally expect higher concentrations downwind of a source under light winds and lower concentrations under high speed winds. The standard Gaussian dispersion formula for relating emissions from a source to downwind concentrations suggests that a simple correction of adjust for wind speed effects is to multiply the concentration by the wind speed and divide by the average wind speed. This report labels this as the *SO_2-adjusted* value. To account for the directionality and speed behavior of the wind, Figure 18 shows the distribution by wind direction bin for two variables:

- *Ratio SO_2* is the ratio of the count of top 1% SO_2 values in a wind bin to the number of hours wind direction was in that bin. All else being equal, each bin would have same ratio. The figure shows they do not.
- *Ratio SO_2-adj* is the ratio of the count of top 1% *SO_2-adjusted* values in a wind bin to the number of hours wind direction was in that bin. All else being equal, each bin would have same ratio. The figure shows they do not.

Overall, there appears to be evidence that SO_2 sources exist to the northeast between 10 and 20 degrees and to the southeast between 150 and 160 degrees. Other possible upwind directions are southerly between 180 to 190 degrees and northwest between 310 and 330 degrees, although Figure 17 suggests fewer winds come from this northwest direction.

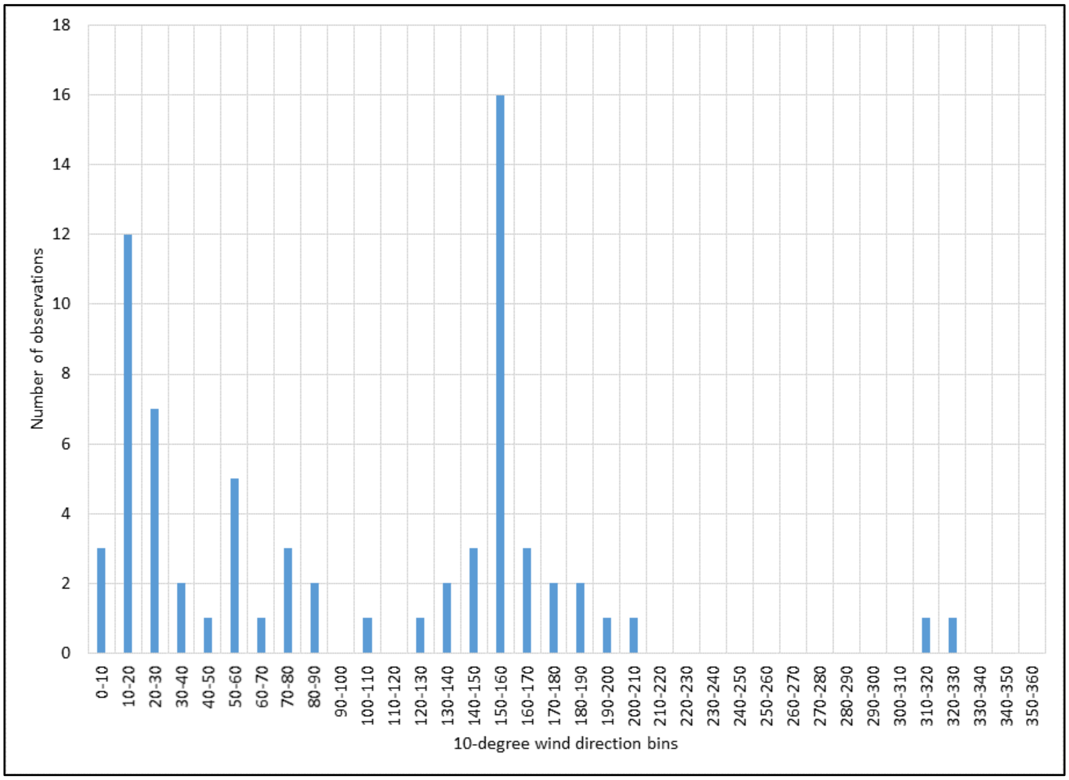

Figure 16. Bar chart of frequency of SO2 values in the top 1% concentrations by 10 degree wind bins at the GF station.

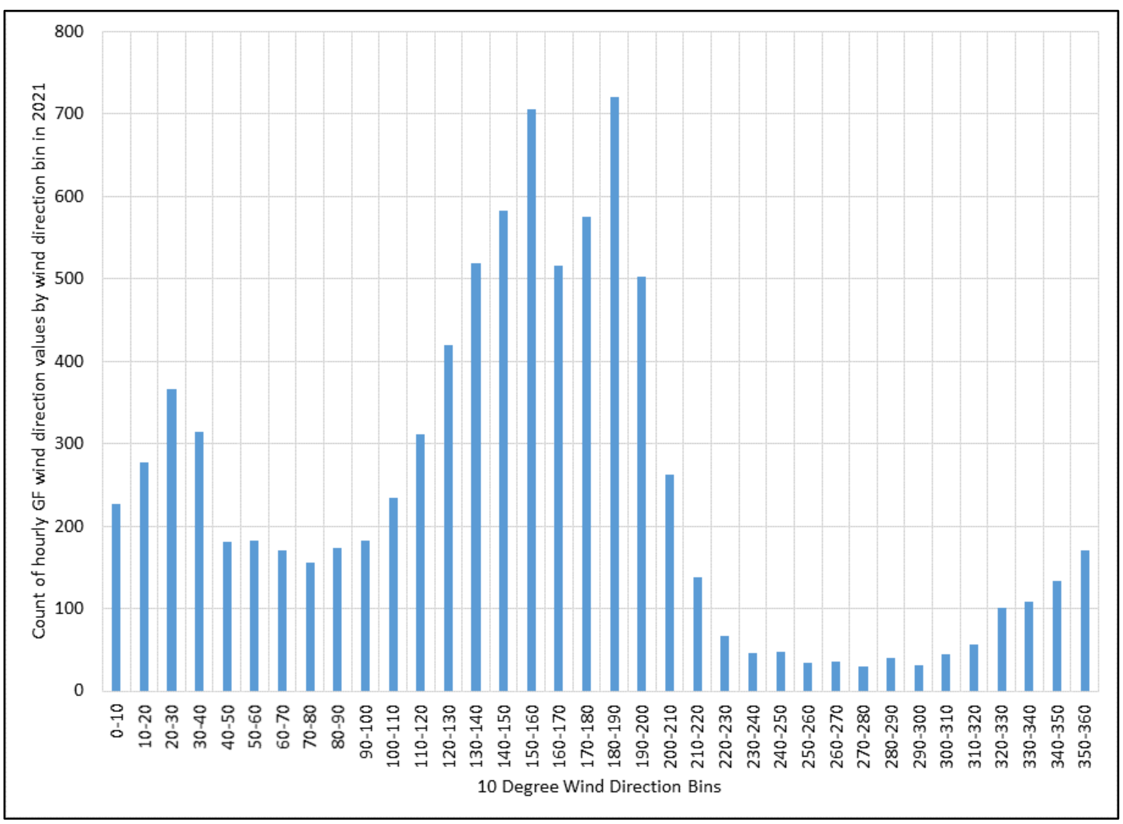

Figure 17. Distribution of hourly wind directions at the GF station in 2021.

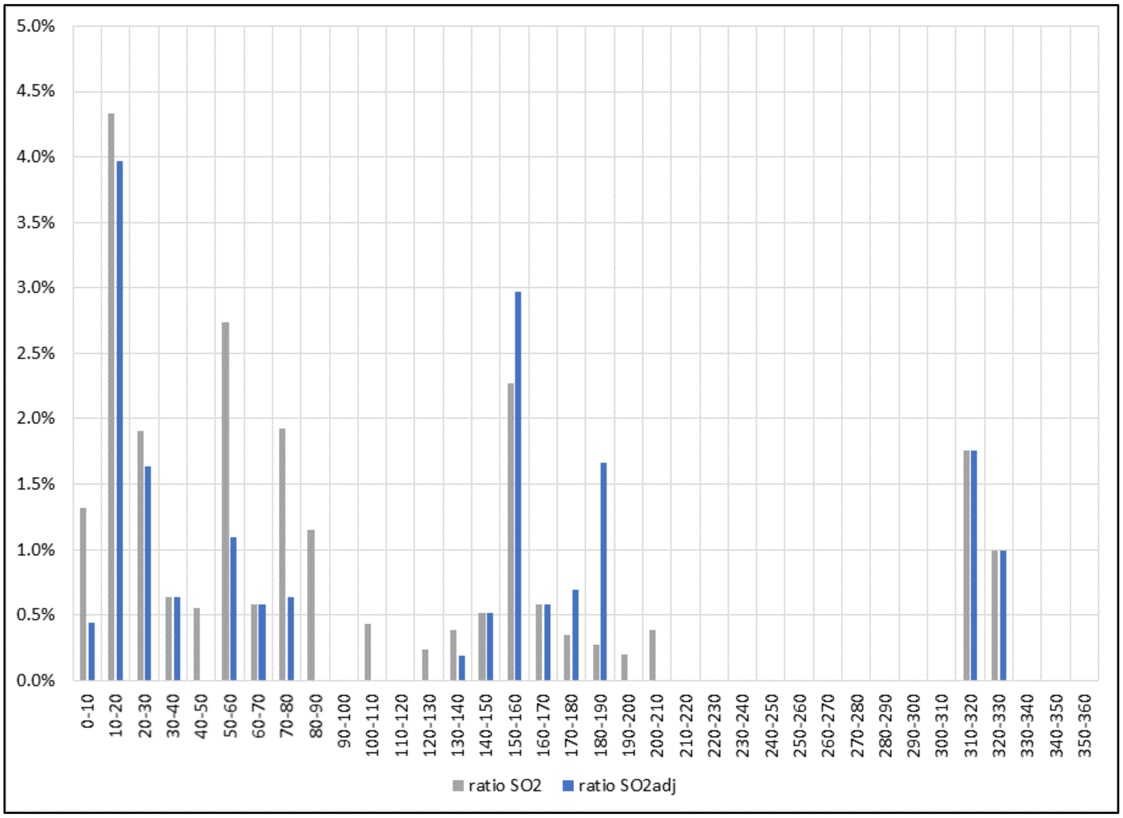

Figure 18. Bar chart of ratio of count of top 1% SO2 values and top 1% SO2 wind speed adjusted values to the count of wind directions by 10 degree wind bins at the GF station.

High Ethylene Measurement at Gregory Fresnos

In examining the 2021 VOC data from the auto-GCs, an unusually high value for the highly reactive compound ethylene at the Gregory Fresnos station on July 5, 2021. Reactive hydrocarbons often participate in ozone formation; however, weather on that day was not conducive to ozone formation, and the peak ozone concentrations in Corpus Christi that day was only 27 ppb. Winds were generally easterly and southeasterly mid-day as the elevated concentrations were measured. Figure 19 shows the hourly ethylene along with the total nonmethane hydrocarbon and total target compound concentrations. The graph shows that ethylene comprised the large majority of the total nonmethane hydrocarbon mass from 9 CST through 14 CST. Figure 20 shows several individual hydrocarbons on that day, most of them alkane species, with ethylene concentrations on the right-hand y-axis and the other species on the left-hand y-axis. It is clear in this graph that two other compounds – methylcyclopentane and 2,4-dimethylpentane – were also elevated coincident with ethylene, and the auto-GC also had a surge of ethane at 11 CST.

Cursory back-trajectory estimates suggest the source was to the east of the monitoring station, but no other conclusions are available.

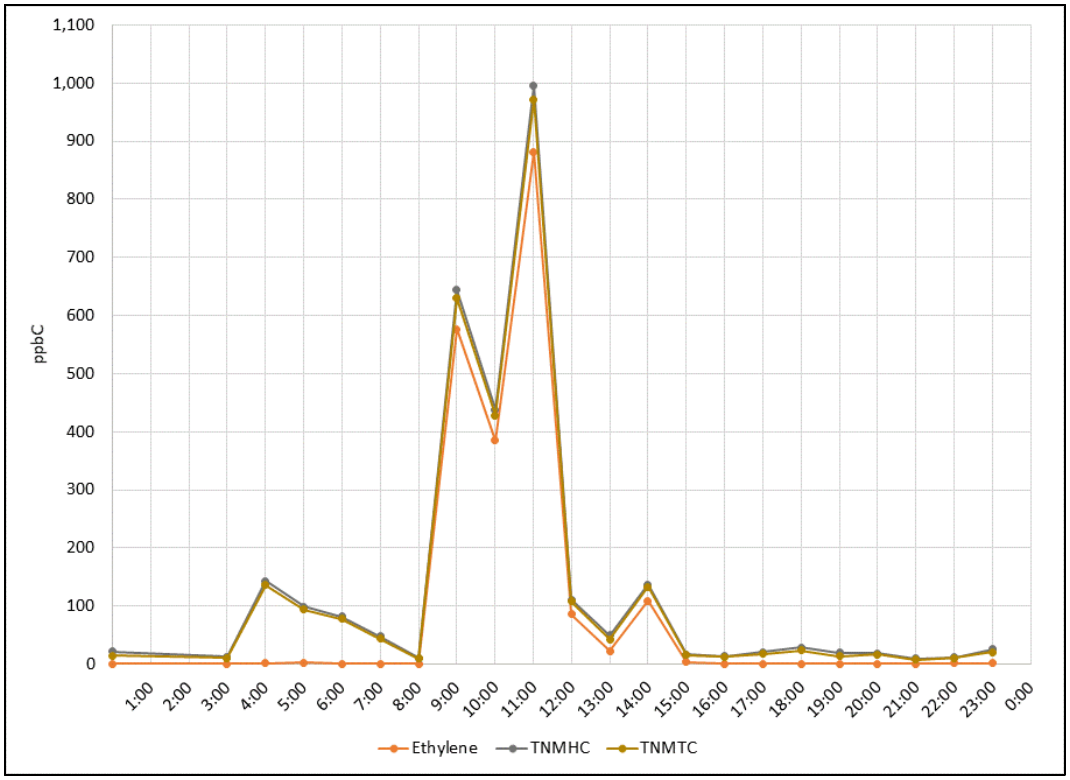

Figure 19. July 5, 2021 ethylene, total nonmethane hydrocarbon and target compound hourly concentrations, with ethylene accounted for nearly all HC mass on several hours.

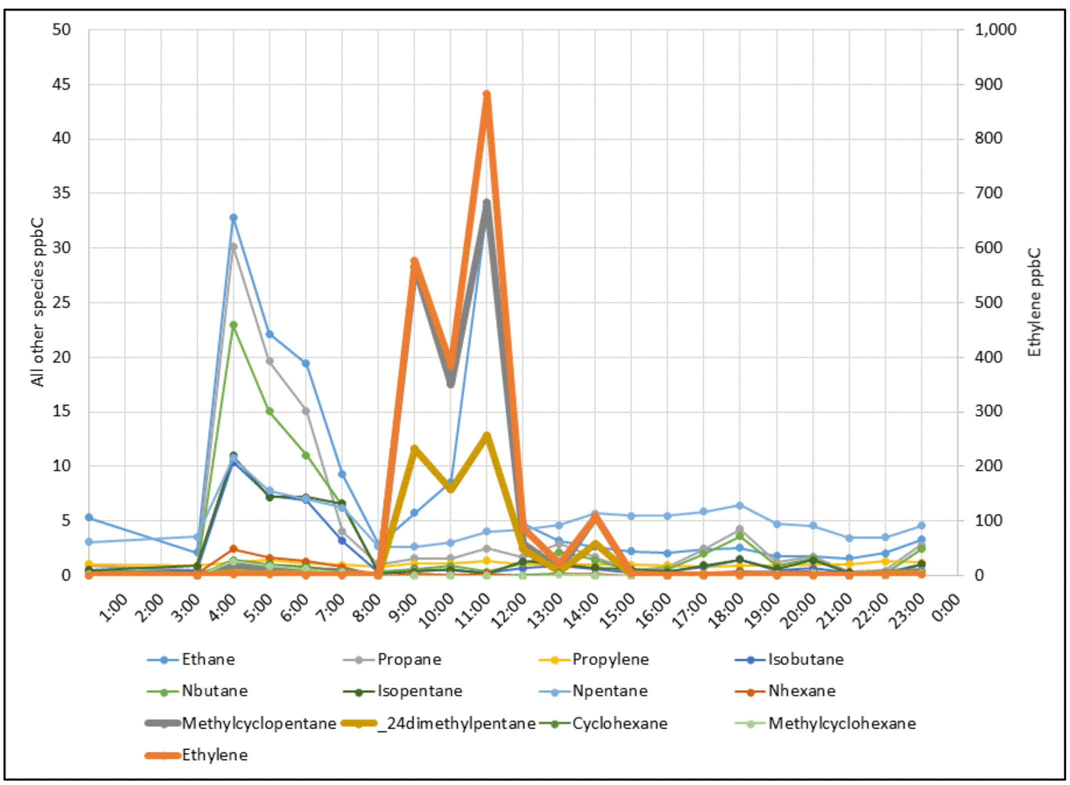

Figure 20. July 5, 2021 Ethylene with two other correlated species, and other compounds.

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

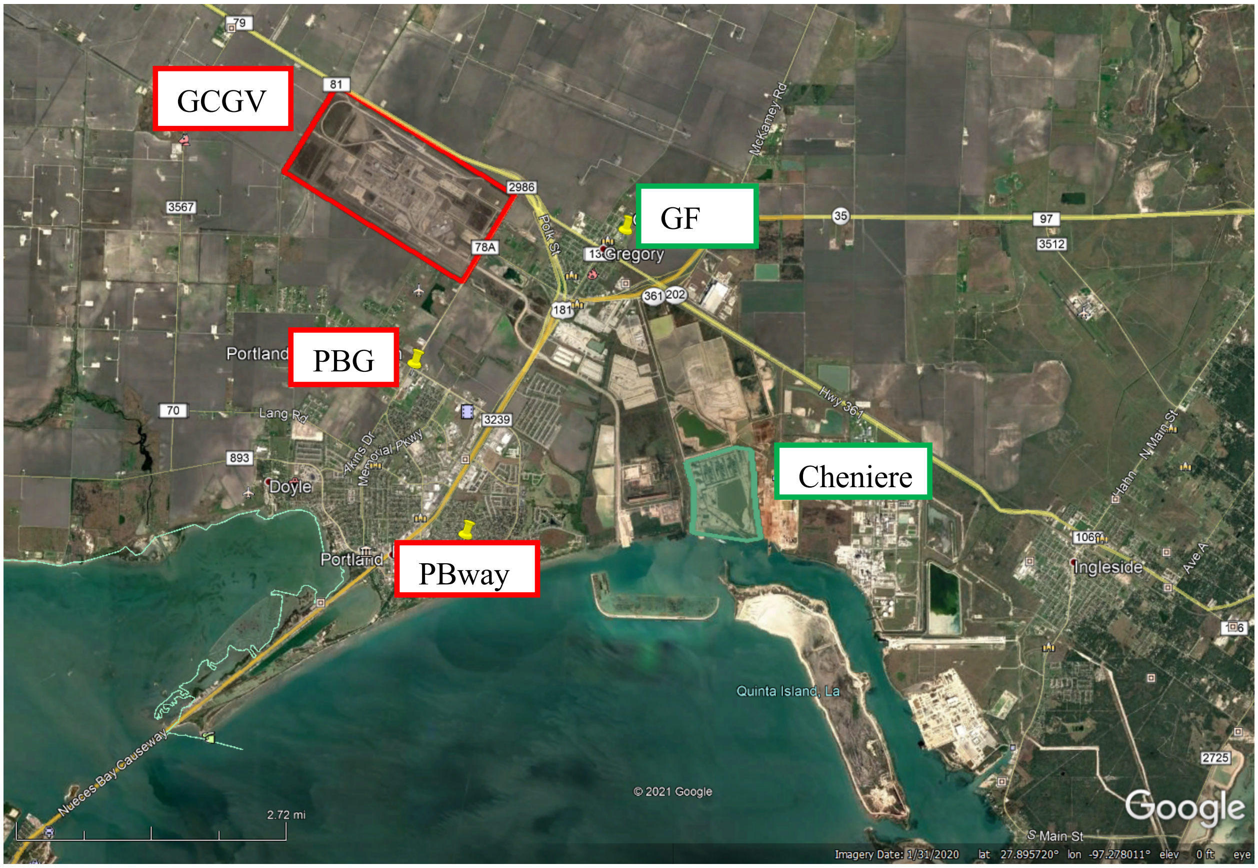

Figure 21. Location of Gregory-Fresnos Community Air Monitoring Station (GF), and two Portland community stations on GPISD campuses on Buddy Ganem (PBG) and on Broadway (PBway) and the Cheniere Energy and GCGV industrial facilities

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 air samples when an independent sensor detects that *elevated* (see below) levels of hydrocarbons (TNMHC) are present. 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 http://www.tceq.texas.gov/toxicology/AirToxics.html (accessed October 2021). 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 ($PM_{2.5}$) 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 October 2021)

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.