Ambient Monitoring of Particulates, Including Crystalline Silica, Near APO Facilities, Interim Report

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Background

Aggregate production operations (APOs) refer to sites from which aggregates are being or have been removed or extracted from the earth. Aggregates are any commonly recognized construction material originating from an APO, including materials such as dimension stone, crushed and broken limestone, sand, etc. Aggregates do not include clay or shale mined for use in the manufacturing of structural clay products. APO facilities are located where material can be extracted from the earth and, in some cases, may be close to communities. APO facilities may include operations such as rock crushing. Rock crushers break larger rocks down into cobblestones, gravel, or other smaller pieces, which are sorted by size to be used for pavement, construction, and other uses. Due to their occasional close proximity to developed areas, APOs have come under scrutiny over the past few years. Specifically, citizens have become concerned about the impact of APOs in their communities due to the potential for increased emissions of particulate matter (PM), which may contain crystalline silica. Texas has approximately 1,000 registered APO facilities.

Silica, in both amorphous and crystalline forms, is the most abundant mineral in the earth's crust and is present in soil, sand, and rock formations. Crystalline silica is significantly more hazardous than amorphous silica and is recognized as an occupational inhalation hazard. Aggregates may contain silica, making APOs a potential source of crystalline silica. In the United States, approximately 2.3 million workers in 676,000 workplaces are exposed to crystalline silica; this includes approximately 2 million workers in the construction industry. Workers exposed daily for several years, up to a lifetime, to high occupational levels of fine particles of crystalline silica may develop silicosis, an irreversible, progressive, and fatal rare lung disease. The effects of inhaled crystalline silica are strictly associated with occupational exposure to particles of respirable size, that is, small enough to be inhaled and reach into the lungs (i.e., PM_4, particulate matter with an aerodynamic diameter less than or equal to 4 micrometers [µm], which can only be seen using a light microscope). Because of the natural hardness of silica, high energy is required to fracture this mineral into respirable size. Activities such as grinding, cutting, sawing, drilling, crushing, and abrasive blasting of stone, rock, concrete, mortar, or brick may generate respirable crystalline silica.

The size of the particles that cause silicosis is at least 100 times smaller than ordinary sand found on beaches and playgrounds. The risk from community exposure to crystalline silica is different from the risk associated with occupational exposure. The general public is not at risk from developing silicosis; however, some members of the general public could potentially be exposed to high levels of silica through hobbies, such as pottery making. Airborne silica is a universal mineral that is not unique to areas near APOs and is not unique to Texas. Both amorphous and crystalline forms may be found in airborne particles from various sources, including paved and unpaved roads, wind-blown soil and agricultural activities, as well as industrial sources such as construction, foundries, glass manufacturing, abrasive blasting or any industrial or commercial use of sand and quartz, and mining and rock crushing operations. Not all airborne crystalline silica is small enough to be inhaled and reach deep into the lungs.

Crystalline silica is not one of the six criteria pollutants regulated under the Federal Clean Air Act (FCAA), which requires the US Environmental Protection Agency (EPA) to establish the National Ambient Air

Quality Standards (NAAQS), and is not included on EPA's list of 188 hazardous air pollutants. Although crystalline silica is not specifically regulated in ambient air, the federal NAAQS do regulate total $PM_{2.5}$ and PM_{10} (particulate matter with an aerodynamic diameter less than or equal to 2.5 and 10 µm, respectively), which may contain crystalline silica. In Texas, certain facilities located at an APO site, like rock crushers, require an air permit prior to start of operation and must meet federal standards for $PM_{2.5}$ and PM_{10}. The Texas Commission on Environmental Quality (TCEQ) has also developed health-based air monitoring comparison values (AMCVs) specifically for crystalline silica. AMCVs are not standards, they are guidelines that are protective of human health and welfare. Health-based AMCVs are safe levels at which exposure is unlikely to result in adverse health effects.

Since crystalline silica is widely considered to be an occupational hazard and not an ambient air quality concern, the EPA does not monitor for crystalline silica, nor does EPA have an approved method for monitoring for crystalline silica in ambient air. There is no federal regulation or EPA standard for ambient crystalline silica concentrations, and there is no EPA requirement for TCEQ to monitor for crystalline silica. Crystalline silica ambient air monitoring is very difficult; however, monitoring has been conducted periodically throughout the nation in urban areas and near APOs, industrial sand mines, and sand processing plants, typically as special monitoring projects. To better assess the crystalline silica concentrations near APO facilities in Texas, the TCEQ is conducting an air monitoring project near APO facilities.

The aim of this monitoring project is to measure concentrations of crystalline silica PM_4 and total $PM_{2.5}$ at monitoring sites that are publicly accessible and downwind of APO facilities, as well as at a monitoring site that is publicly accessible but is not located near an APO facility (i.e., a background site). The goal is to monitor these constituents at existing TCEQ stationary ambient air monitoring sites to determine what contribution, if any, the APO facilities have to ambient air concentrations of crystalline silica PM_4 and $PM_{2.5}$ relative to that of background in the Central Texas area. Three of the sampling sites are located within 1 mile of an APO and are predominantly downwind of the facility. A fourth sampling site, located in the city of Austin, does not have any APOs nearby and is used as a background site.

Stationary site locations that have been chosen include:

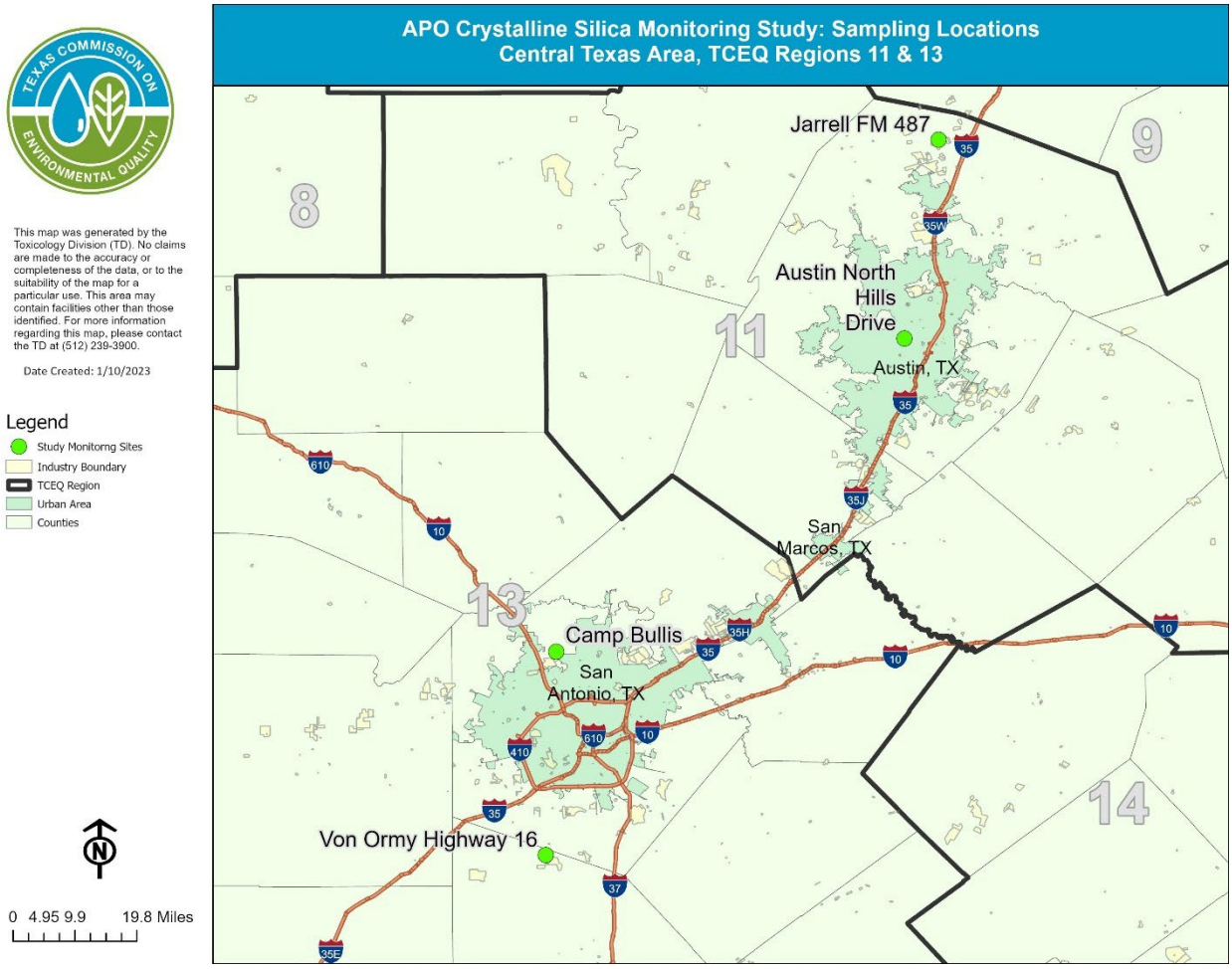
- Camp Bullis[1] (F Range [1000 yd marker off Wilderness Trail], near Wilderness Rd, San Antonio, 78257)
- Jarrell FM 487[2] (4831 Farm to Market 487, Jarrell, 76537)

[1] https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=report.view_site&formSub=1&showActiveOnly=1&showActMonOnly=1&siteID=231

[2] https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=report.view_site&formSub=1&showActiveOnly=1&showActMonOnly=1&siteID=1255

- Von Ormy Highway 16[3] (17534 North State Highway 16, Von Ormy, 78073)
- Background Site – Austin North Hills Drive[4] (3824 North Hills Drive, Austin, 78731)

Figure 1. Map showing the location of all study sampling sites in TCEQ Region 11 (Austin) and Region 13 (San Antonio).



[3] https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=report.view_site&formSub=1&showActiveOnly=1&showActMonOnly=1&siteID=1251

[4] https://www17.tceq.texas.gov/tamis/index.cfm?fuseaction=report.view_site&formSub=1&showActiveOnly=1&showActMonOnly=1&siteID=29

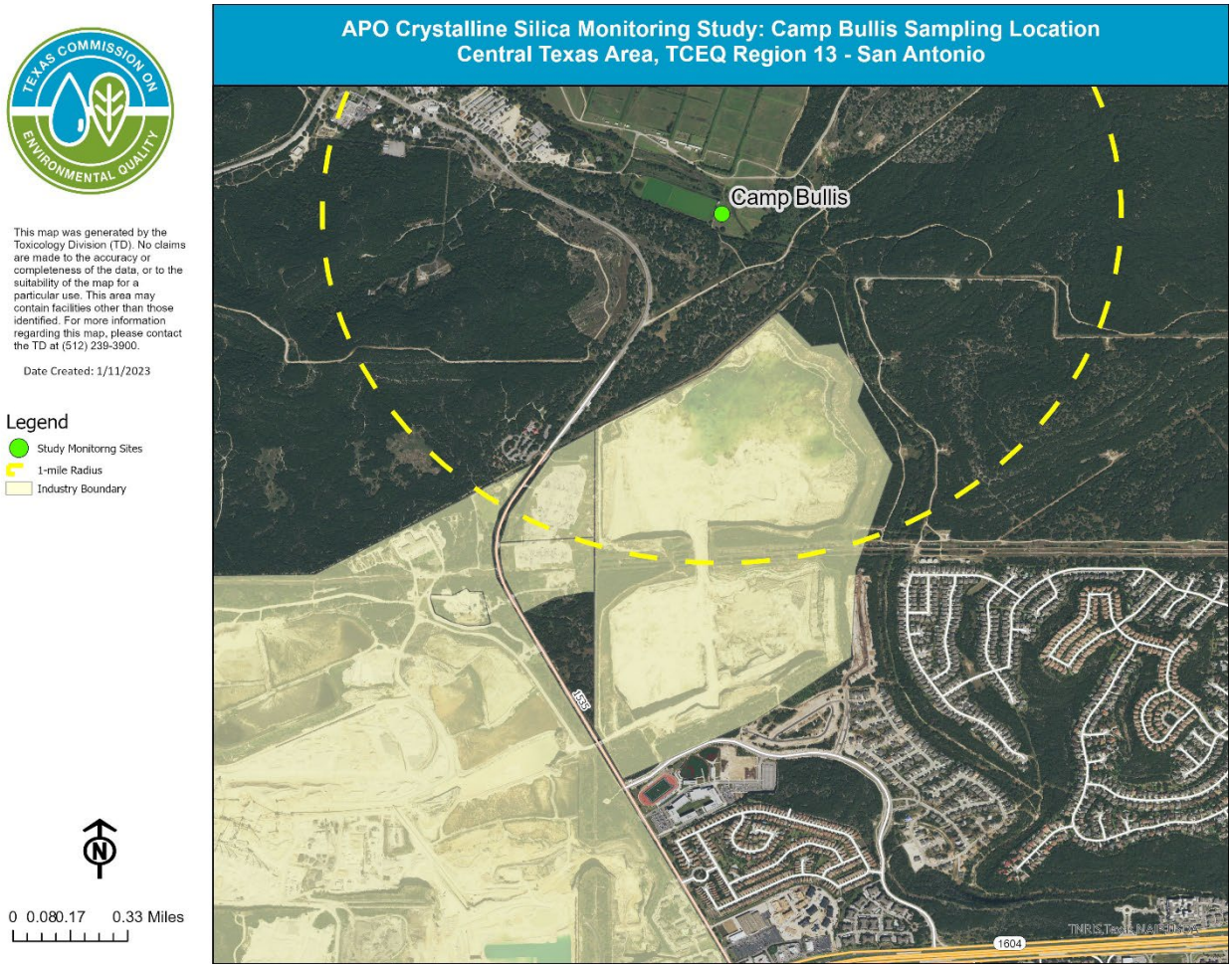
Sampling Information

Sampling Sites

Camp Bullis

The Camp Bullis site is located in TCEQ Region 13 – San Antonio. It is just outside the city of San Antonio's outer loop, to the North of city center. This site was chosen based on its close proximity to a large APO facility that has several different APO operations present, such as limestone quarry, rock crushing, cement mixing, and asphalt mixing.

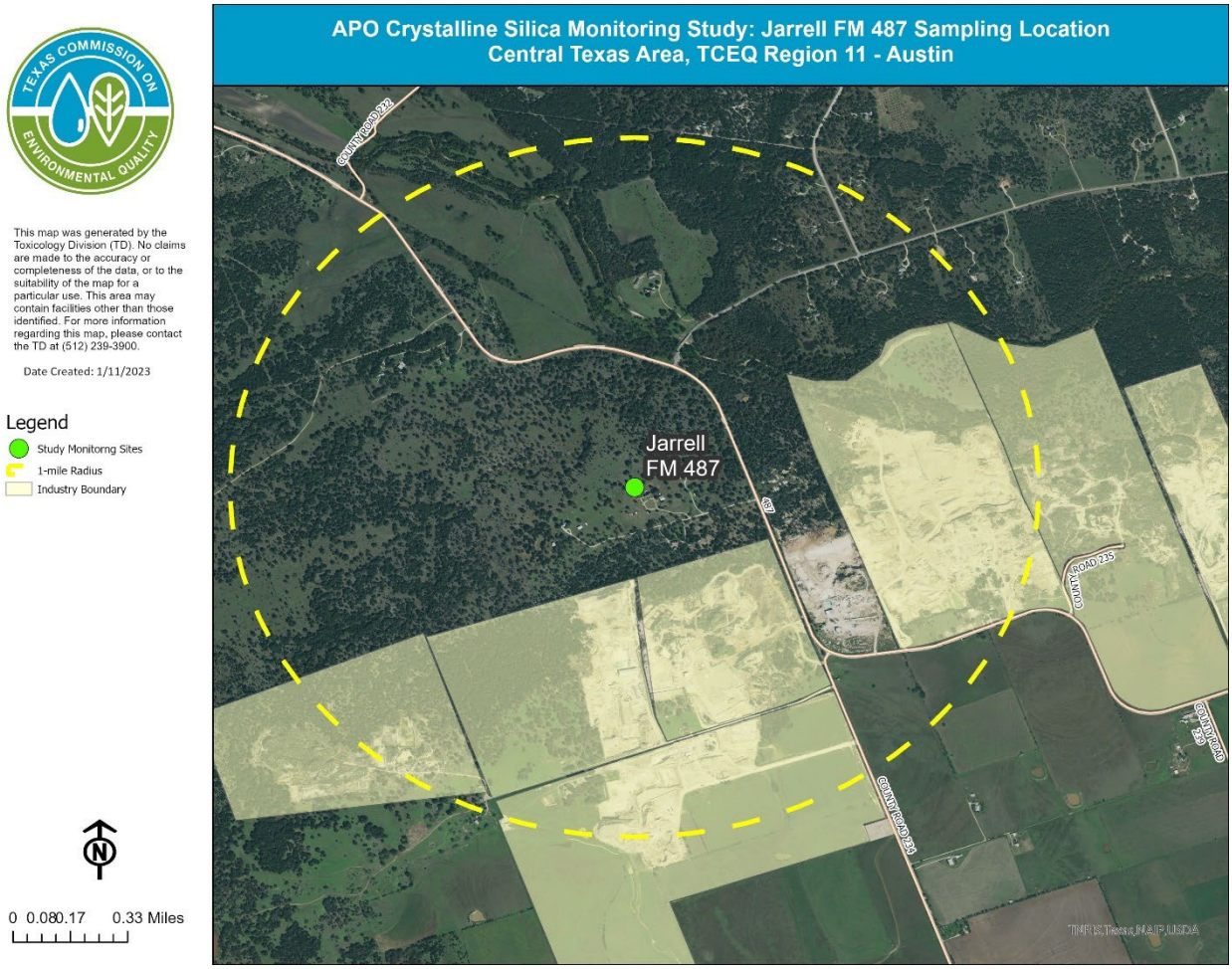
Figure 2. Map showing the location of Camp Bullis and the surrounding area.



Jarrell FM 487

The Jarrell FM 487 site is located in TCEQ Region 11 – Austin, to the West of Jarrell. This site was chosen based on its close proximity to a quarry that includes several rock crusher and stone cutter facilities.

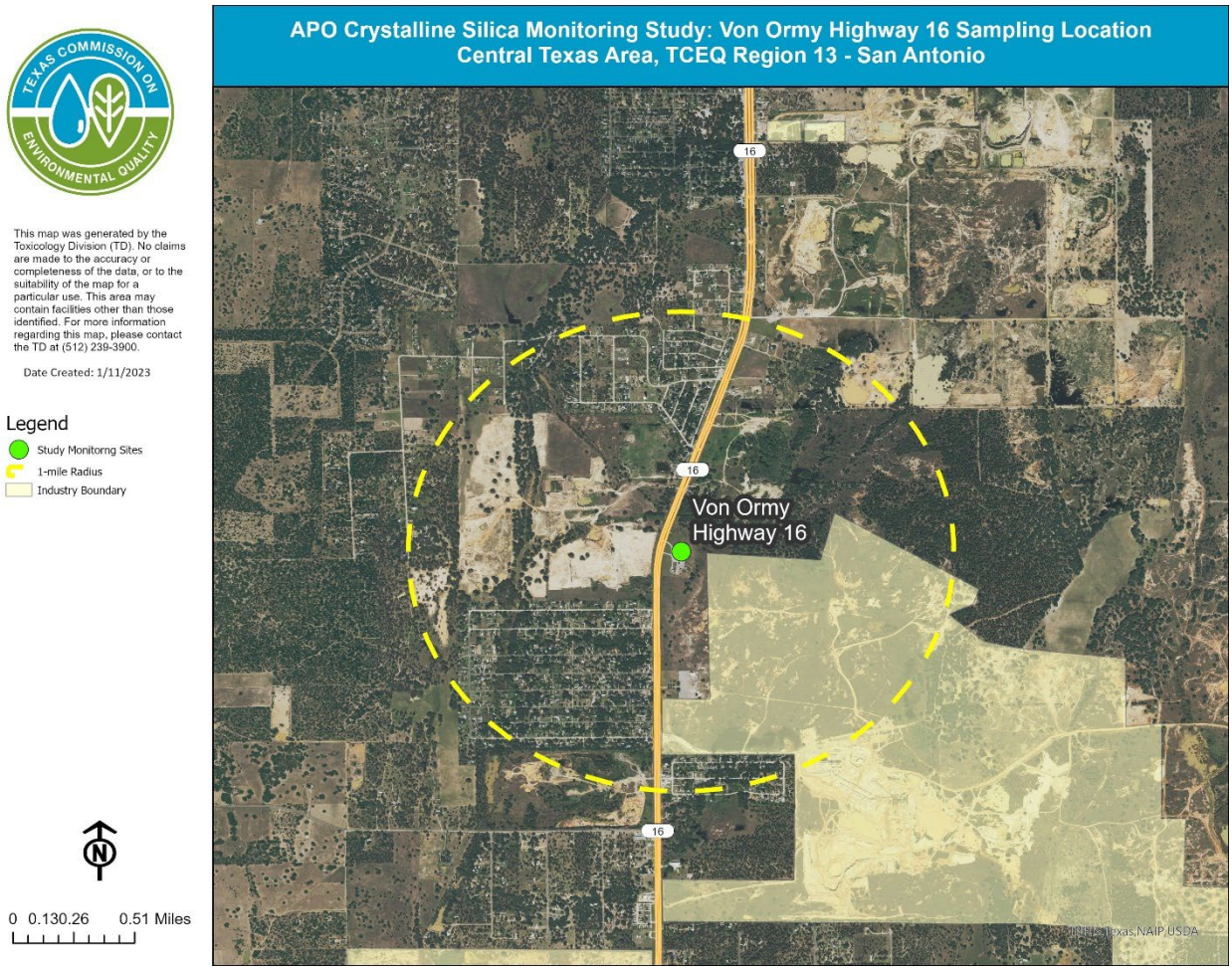
Figure 3. Map showing the location of Jarrell FM 487 and the surrounding area.



Von Ormy Highway 16

The Von Ormy Highway 16 site is located in TCEQ Region 13 – San Antonio. It is outside the city of San Antonio's outer loop, to the South of city center. This site was chosen due to its close proximity to several sand mining pits.

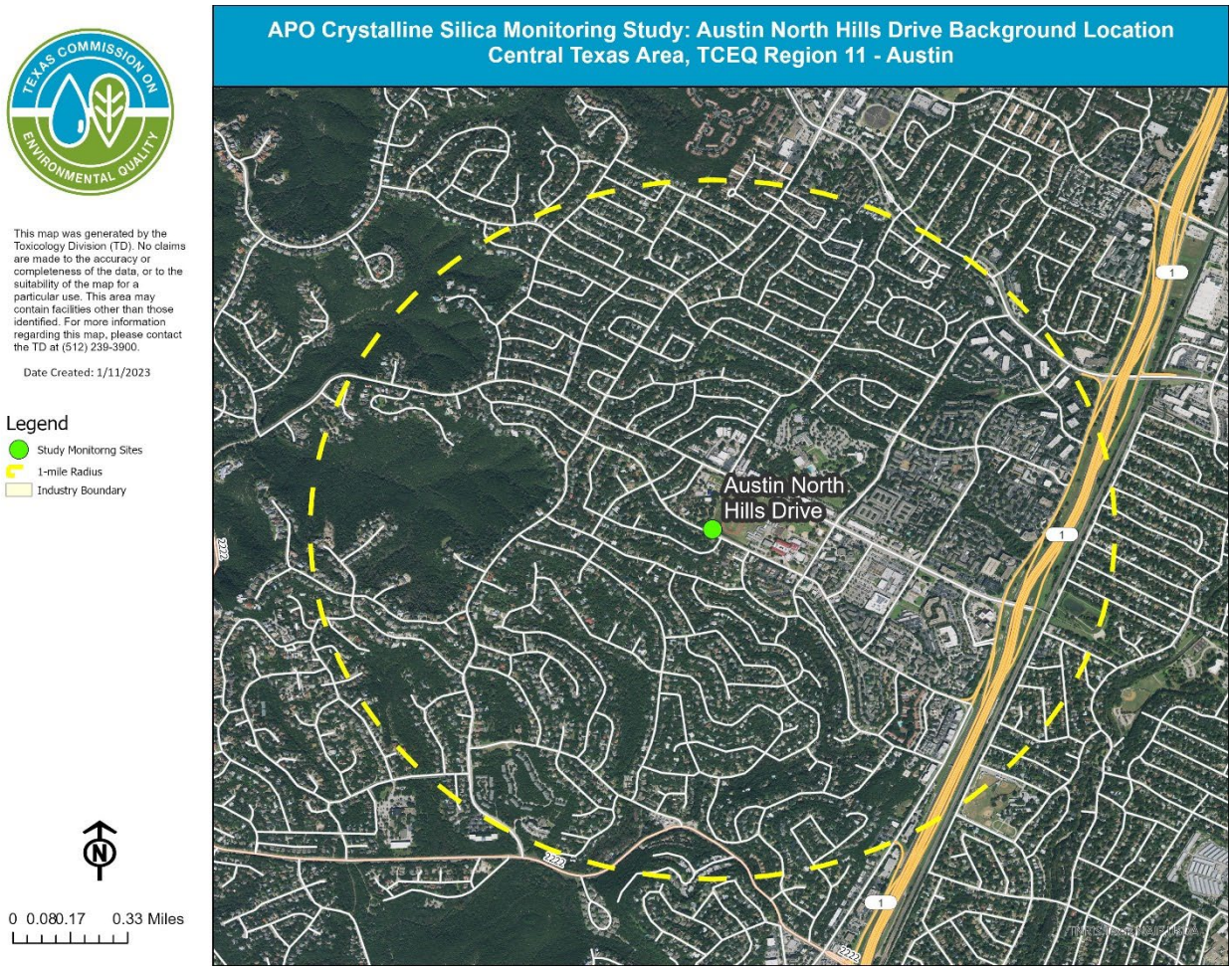
Figure 4. Map showing the location of Von Ormy Highway 16 and the surrounding area.



Austin North Hills Drive (Background Site)

The Austin North Hills Drive site is located in TCEQ Region 11 – Austin. It is in the Northwest Hills area of the city of Austin, to the Northwest of city center. This site was chosen as the background sampling site. It does not have any active APO facilities within a 1-mile radius.

Figure 5. Map showing the location of Austin North Hills Drive and the surrounding area.



Sampling Details

Four PM_4 crystalline silica samplers were deployed for this project; three at sites near APO facilities and one at a background site. Because there are no specific PM_4 samplers required by regulation, the samplers used are Federal Reference Method (FRM) $PM_{2.5}$ samplers that have a modified flow rate to capture the PM_4 fraction. The modified flow rate of 11.11 liters per minute (lpm) was determined by a study conducted outside of TCEQ. The FRM flow rate is 16.67 lpm for collection of $PM_{2.5}$. Modification of FRM $PM_{2.5}$ samplers for use as PM_4 samplers has been used for determination of crystalline silica PM_4 by others in published studies[5] of ambient air monitoring near facilities that potentially emit crystalline silica PM_4 (e.g., sand mining, fracking-sand, and sand and gravel facilities in various states). Each stationary site contains a PM_4 crystalline silica sampler and a $PM_{2.5}$ sampler. Meteorological data are also being collected at each sampling site.

All four PM_4 crystalline silica samplers have a sample duration of 24-hours. Samples are collected at the three samplers that are located near APO sites once every three days and at the background sampler once every sixth day. The initial duration of the project is to be a minimum of 1 year, in particular with the intention of sample collection during the summer when the area is dry.

Sampling frequencies of 1-in-6 days and 1-in-3 days are common practice in ambient air collection. These sampling frequencies are designed to provide a representative average for the area sampled. The days chosen for sampling are aligned with the EPA's published annual sampling schedule for ambient air monitoring, which includes 1-in-3, 1-in-6, and 1-in-12-day sampling for consistency in national sampling schedules.

Analytical instruments can reliably measure down to a specific chemical concentration when samples are analyzed; below that level, the instrument is no longer able to see, or detect, a concentration. This level is called the detection limit (DL) and can vary based on analytical method and chemical. When data are not detected, zero may be provided in the dataset for that sample. For evaluation purposes, when a sample was not detected, rather than including a zero for the sample, the zero was replaced with one-half the detection limit. This is a common practice in human health evaluation of ambient air monitoring data. While the concentration is unknown when it is below the detection limit, by giving it a value of ½ the detection limit, the measurement is included in the assessment. The following provides the DLs and ½ DLs for these data:

Chemical	*DL (µg/m³)*	*½ DL (µg/m³)*
Crystalline Silica PM_4	0.3	0.15
Total PM_4	3.1	1.55
Total $PM_{2.5}$	5.0	2.5

[5] Richards J and T Brozell. 2021. Compilation and evaluation of ambient respirable crystalline silica air quality data near sand quarries and processing facilities. Atmosphere. 12:903. https://www.mdpi.com/2073-4433/12/7/903

Preliminary Data

Sample collection began at the beginning of June 2022. Several sampling days in June, July, and August coincided with the seasonal arrival of Saharan dust in Central Texas. Overlapping Saharan dust event/sample collection dates in 2022 were as follows:

- June 13, 16, and 22
- July 16, 19, 22, and 31
- August 3 and 6

These sampling days show a marked increase in particulate matter concentrations at all sampling locations, including the background site (Figure 6). Crystalline silica contribution from Saharan dust events cannot be differentiated from potential APO site contributions.

There is a measurable level of crystalline silica present at all sampling sites, including the background site. This is expected since silica is the most abundant mineral in the earth's crust. Figures 7, 8, 9, and 10 provide the available measurements of crystalline silica PM_4, total PM_4, and total $PM_{2.5}$ for each sampling site, along with the 24-hr AMCV for crystalline silica. These figures also provide monthly wind roses to show the predominant wind directions associated with the data. The predominant wind directions are typically from the south and southeast, which puts the monitors predominantly downwind of the nearby facilities. All crystalline silica measurements thus far are well below the health-based 24-hr crystalline silica AMCV (24 $\mu g/m^3$). For 3 of the 4 sites, the percentage of the total PM_4 measurement that comprises crystalline silica is fairly consistent (in the range of 2 to 10%). The Von Ormy Highway 16 site is the exception, having higher percent crystalline silica than the other sites (in the range of 2 to >20%) (Figure 11). This site is located in close proximity to sand mining pits, which likely explains why the crystalline silica content would be higher at this site.

Total PM_4 levels measure all particulates that have an aerodynamic diameter of 4 micrometers or less, which includes all particles in $PM_{2.5}$ measurements as well as some larger sized particles. Therefore, it is not unexpected that the PM_4 and $PM_{2.5}$ data patterns are very similar (Figure 7, Figure 8, Figure 9, and Figure 10).

Once sufficient data have been collected, analyses will be conducted to determine if $PM_{2.5}$ measurements may be used as a potential surrogate for PM_4 crystalline silica levels, dependent on the type of nearby facility.

Conclusions

Based on the data that have been collected near APO facilities and at a background site to date, all 24-hr PM_4 crystalline silica measurements are well below the health-based 24-hr AMCV. Therefore, exposure to these monitored concentrations would not be expected to cause short-term adverse health effects. In addition, to date the measured crystalline silica levels at the background site are very similar to the levels measured downwind of two of the three APO facilities, with only the measurements near a sand mine being consistently higher than the background site concentrations (although still below levels of

short-term health concern). A minimum of one year's worth of measurements is needed to evaluate these data from a long-term health perspective.

Figure 6. Crystalline silica PM_4 concentrations measured at all project sites with Saharan dust event days noted.

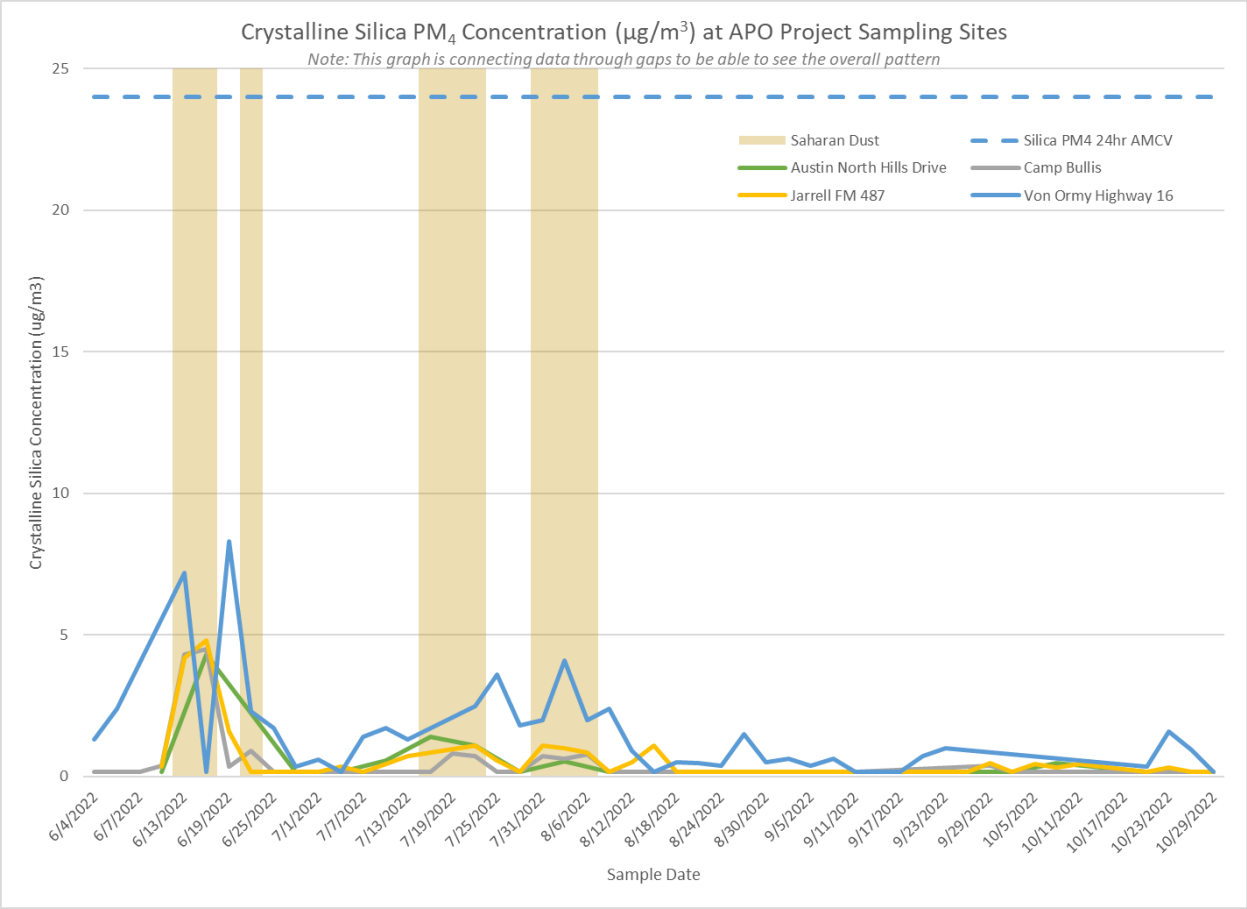


Figure 7. Crystalline silica PM_4, total PM_4, and total $PM_{2.5}$ 24-hr average concentrations measured at the background site (Austin North Hills Drive) with Saharan dust event days noted. Monthly wind roses are provided along with a map of the site.

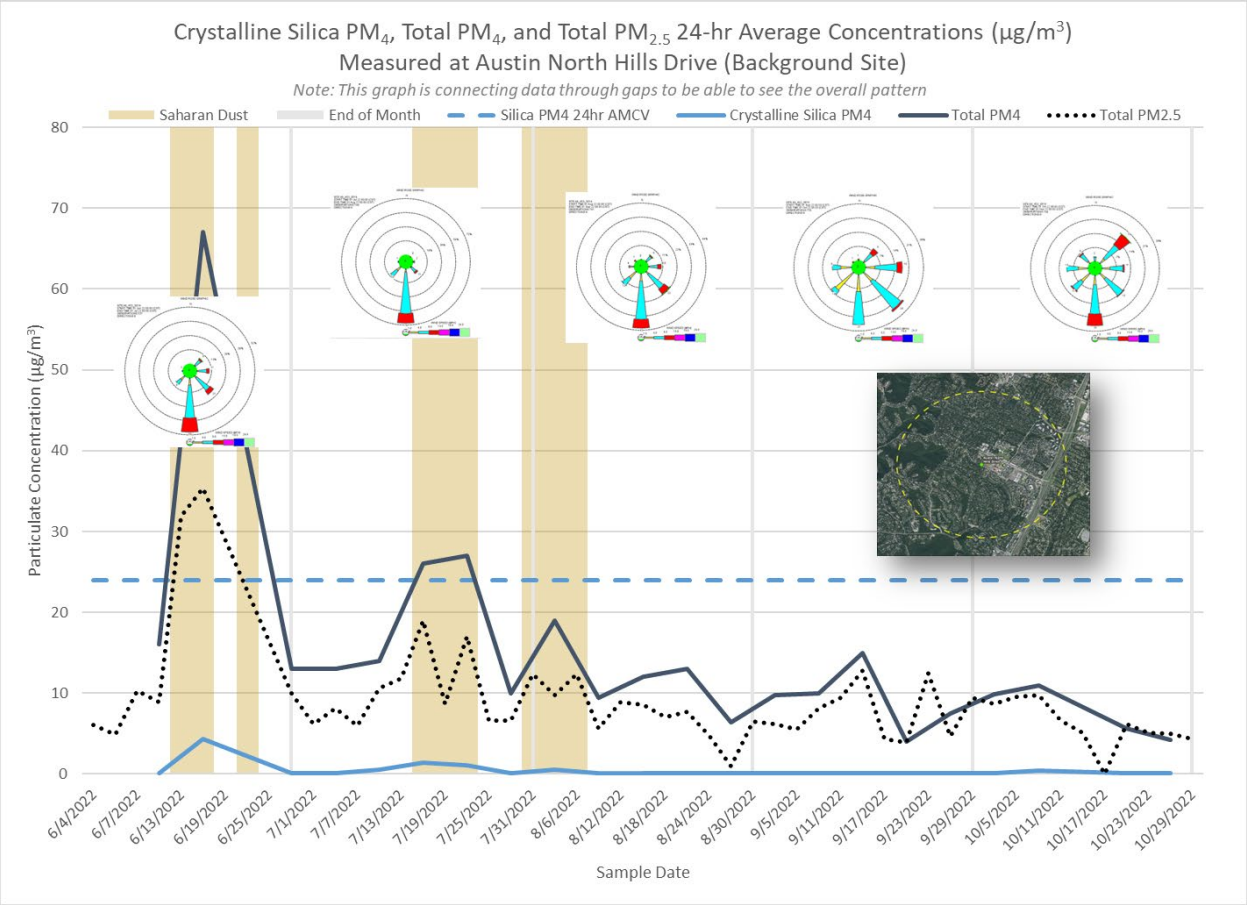


Figure 8. Crystalline silica PM_4, total PM_4, and total $PM_{2.5}$ 24-hr average concentrations measured at Camp Bullis (located near a large APO facility that has a quarry and rock crushers) with Saharan dust event days noted. Monthly wind roses are provided along with a map of the site.

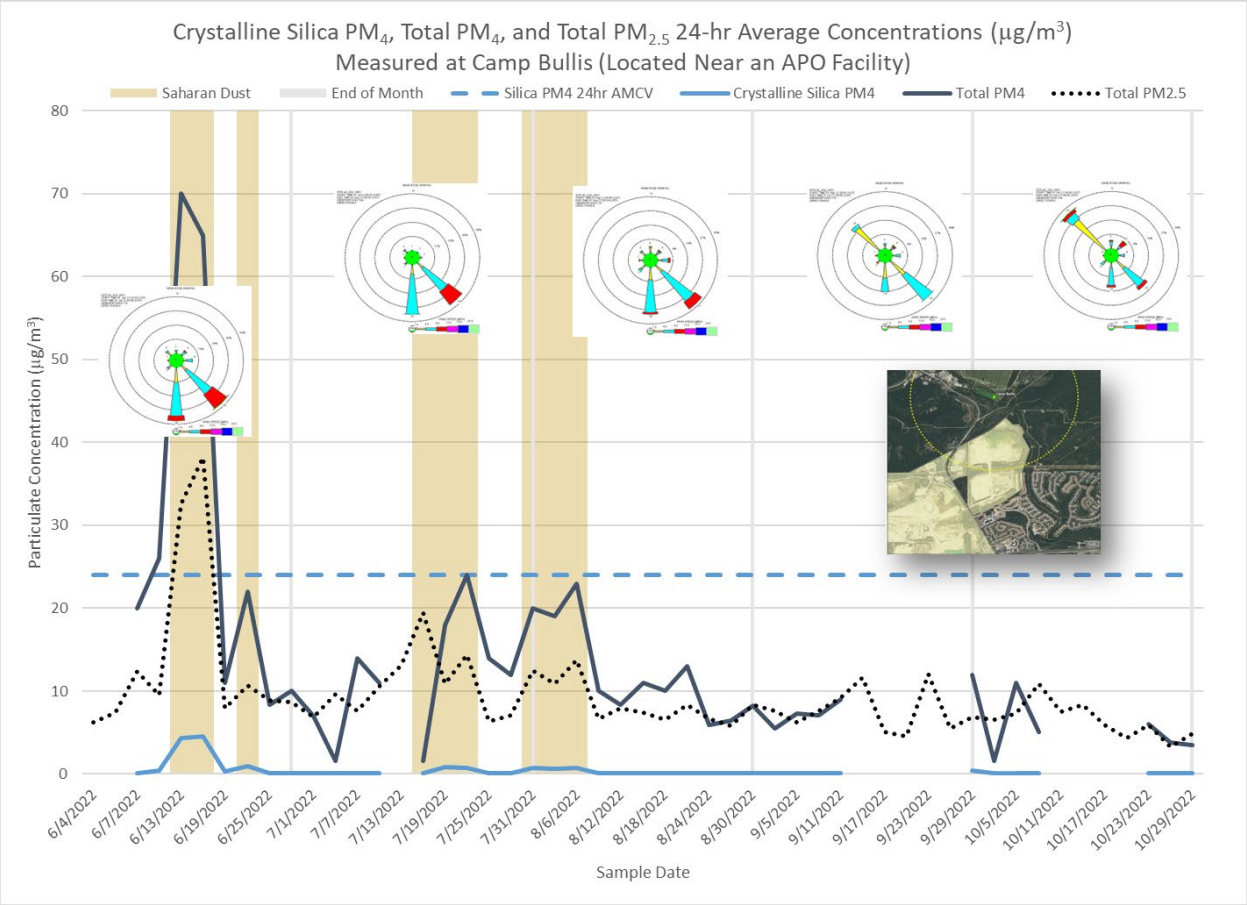


Figure 9. Crystalline silica PM_4, total PM_4, and total $PM_{2.5}$ 24-hr average concentrations measured at Jarrell FM 487 (located near a quarry that has rock crushers and stone cutters) with Saharan dust event days noted. Monthly wind roses are provided along with a map of the site.

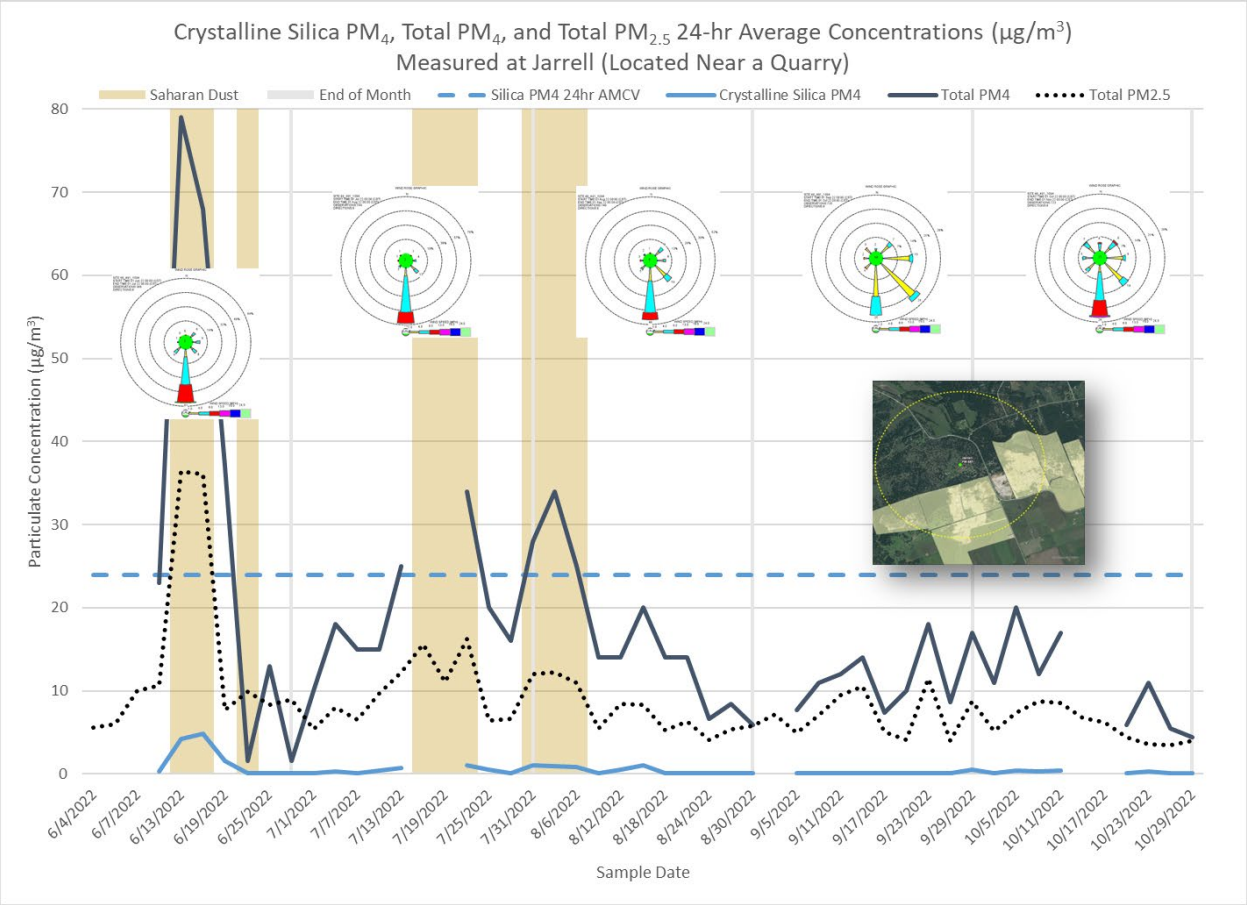


Figure 10. Crystalline silica PM_4, total PM_4, and total $PM_{2.5}$ 24-hr average concentrations measured at Von Ormy Highway 16 (located near sand mining pits) with Saharan dust event days noted. Monthly wind roses are provided along with a map of the site.

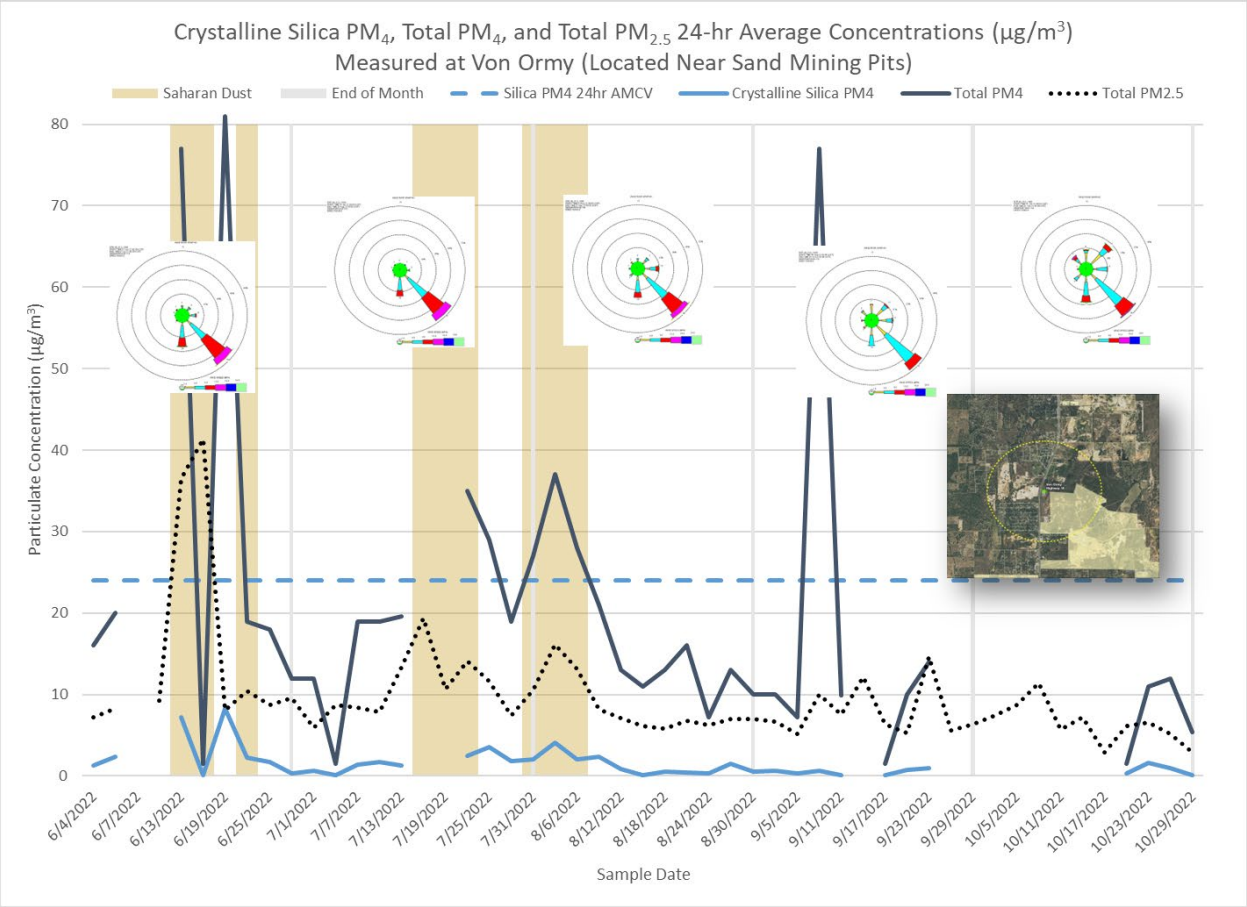


Figure 11. Percent crystalline silica measured in the total PM_4 concentration with Saharan dust event days noted.