Crystalline Silica

Ambient Air Monitoring and Evaluation of Community Health Impacts near Aggregate Production Operations (APOs)

Janet Petruska Hamilton, Ph.D., D.A.B.T.

Senior Toxicologist

Toxicology, Risk Assessment, and Research Division

Texas Commission on Environmental Quality

Overview

- Silica
- Health effects associated with inhalation of crystalline silica
- Air monitoring comparison values
- Aggregate Production Operations (APOs)
- Concentrations of crystalline silica and particulate matter near APOs
- Conclusions

What is silica?

- Silicon dioxide: SiO_2
- Most abundant mineral in earth's crust
  - Soil, sand and rock formations
- Exists in 2 forms:
  - Amorphous
  - Crystalline – occupational hazard, toxic form
- Size of particle is important
  - Respirable, aerodynamic diameter ≤ 4 µm

Amorphous silica

Synthetic amorphous silica

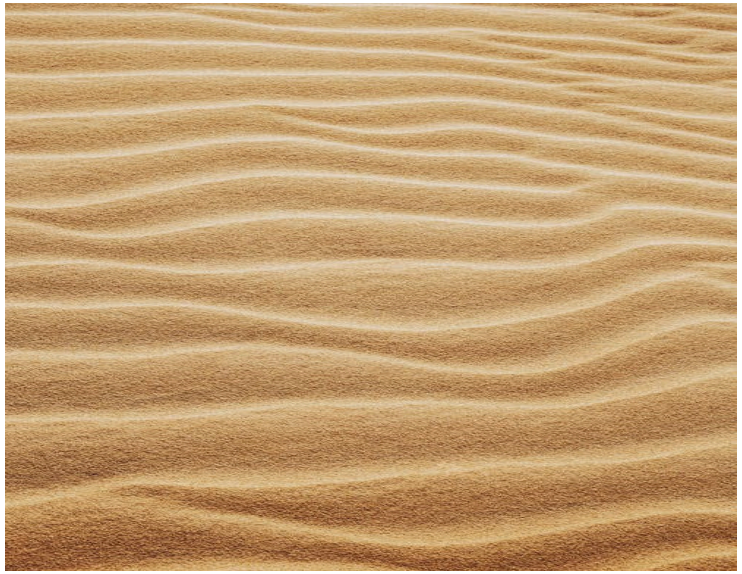
Silica gel

Diatomaceous earth
(Amazon.com)

Precipitated Silica
(ppgsilica.com)

Crystalline silica

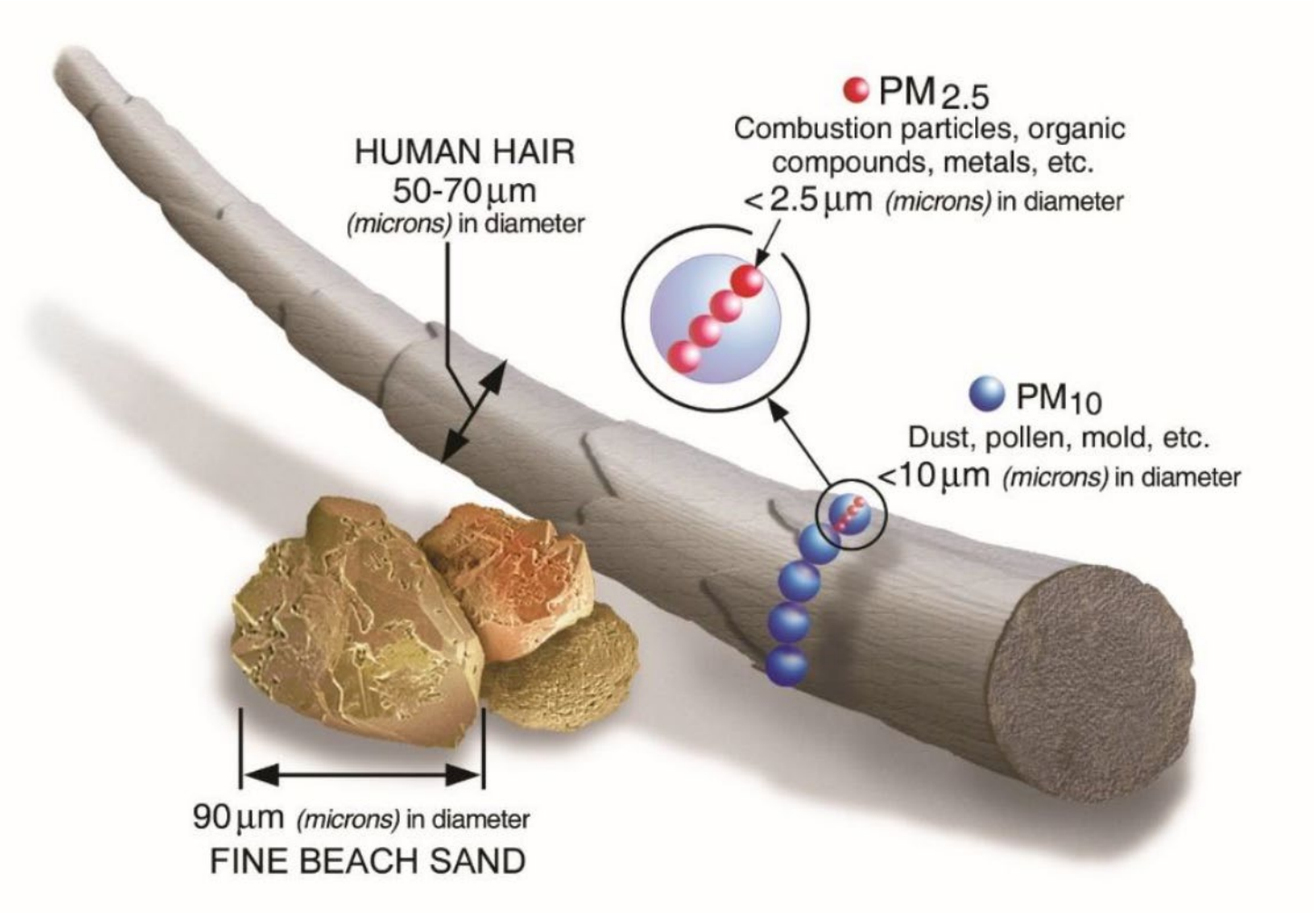
Quartz



Sand

Shale

Granite

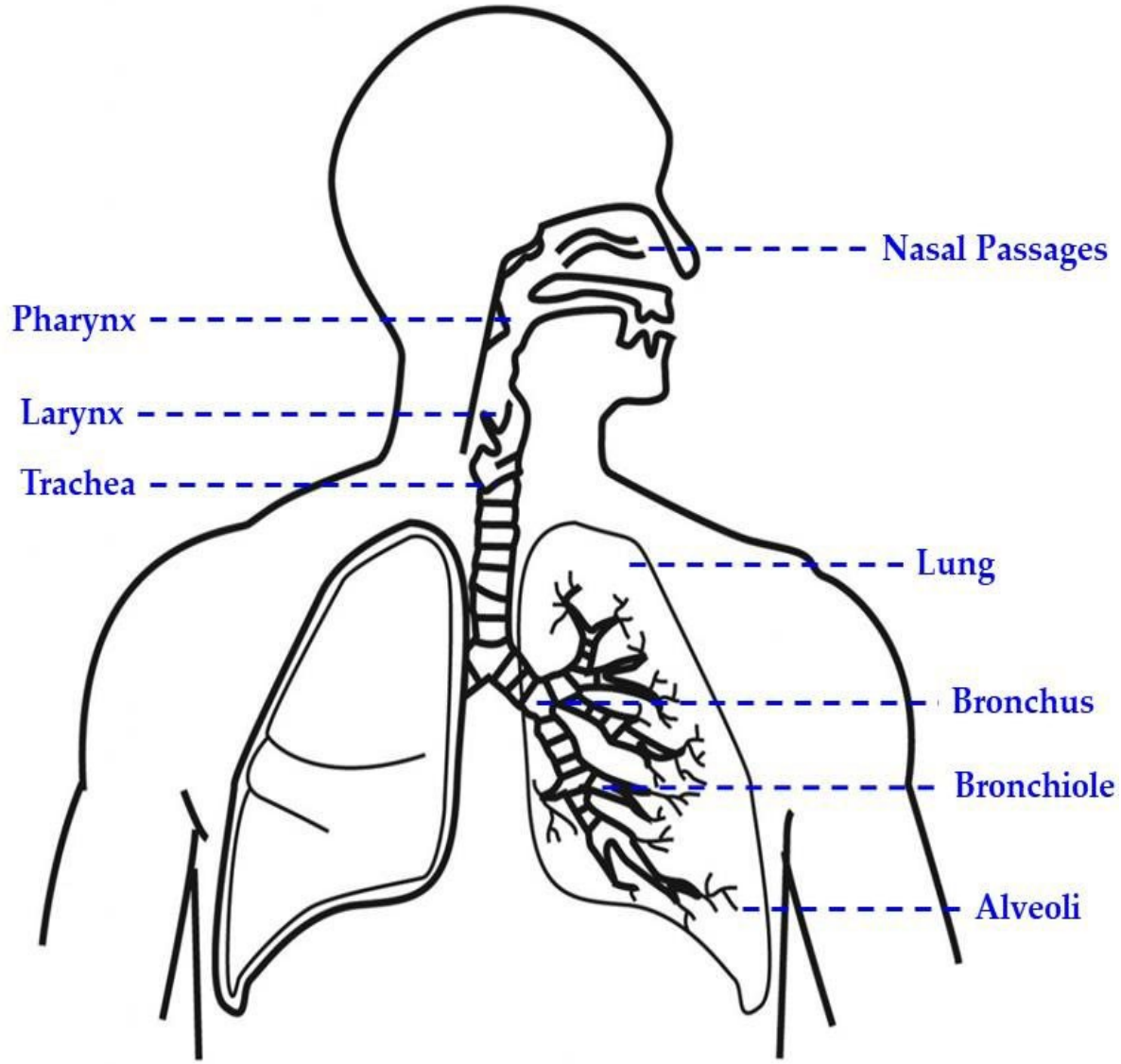


Comparison of particulate matter (PM) sizes

Source: US Environmental Protection Agency

Inhalation of PM

Size	Location of Deposition
≥ 10 µm to 100 µm	Nose, mouth, pharynx, larynx
≤ 10 µm	Trachea, bronchi, bronchioles
≤ 4 µm	Alveoli



From MI Guzman. Int. J. Health Plann. Mgmt. 2021;36:257-66.

Silicosis

- Rare occupational disease associated with high exposures to crystalline silica – diagnosis relies on history of occupational exposure
- Cumulative dose of respirable crystalline silica - most important factor in development of silicosis
- Long latency period
- Fibrotic lung disease
- Incurable, irreversible, progressive and fatal disease
- Preventable – exposure in workplace regulated by the Occupational Safety and Health Administration (OSHA)

Air monitoring comparison values

AMCVs

- Not standards
- Protective of human health and welfare effects
- Safe levels, unlikely to result in adverse health effects

Crystalline Silica

Duration	AMCV (µg/m³) PM_4
Short-term (1-hr)	47
Short-term (24-hr)	24
Long term	0.27

Environmental exposure to crystalline silica

Study	Location/Year(s) of sampling	Sampling schedule	PM measured	Crystalline silica (µg/m³)
Davis et al. 1984	22 US cities [a] 1980	24 hr every 6 d for 1 year	**$PM_{2.5}$** $PM_{2.5-15}$	**0 – 1.9** 0.9 – 8.0
US EPA 1996	17 US cities [a] 1987 - 1993	24 hr every 6 d for 7 years	PM_{10}	0.3 – 5.0 (mean 1.9)
Pennsylvania Dept. of Environmental Protection	Tunkhannock, PA 2015	24 hr every d for 30 d	**PM_4**	**Most < LOD** **3 samples:** **0.69 – 0.75**

a: Includes Dallas and El Paso.
LOD: limit of detection; PA: Pennsylvania

- There are no regulations requiring ambient air monitoring for crystalline silica.
- Regardless of source, particles >10 µm contain a greater percentage of crystalline silica than particles <10 µm

Aggregate production operations (APOs)

- Defined in the Texas Administrative Code (30 TAC, Chapter 342)
- Aggregates: gravel, sand, dirt, soil, caliche, dimension stone, crushed or broken lime, granite, or other stone
- APOs: rock quarries, gravel pit, borrow pit
- Operations: rock crushers, concrete crushers
- Air permit required before facility can operate

Crush stone, move earth: generate dust which contains some crystalline silica

Rock quarry

Source: pixabay.com

Air monitoring near APOs: crystalline silica

- 8 Published studies (2002 to 2018) in US of crystalline silica concentrations measured at fenceline or residential locations
  - Sand and gravel facilities
  - Sand mining facilities
  - Fracking sand mines
- Samples collected for 24 or 48 hr for up to 3 years
- Concentrations of respirable crystalline silica (PM_4): 0 to 2.8 µg/m^3
  - Many samples were below the limit of detection
- Measured concentrations unlikely to cause acute or chronic health effects and are not associated with silicosis

Air monitoring near APOs: $PM_{2.5}$

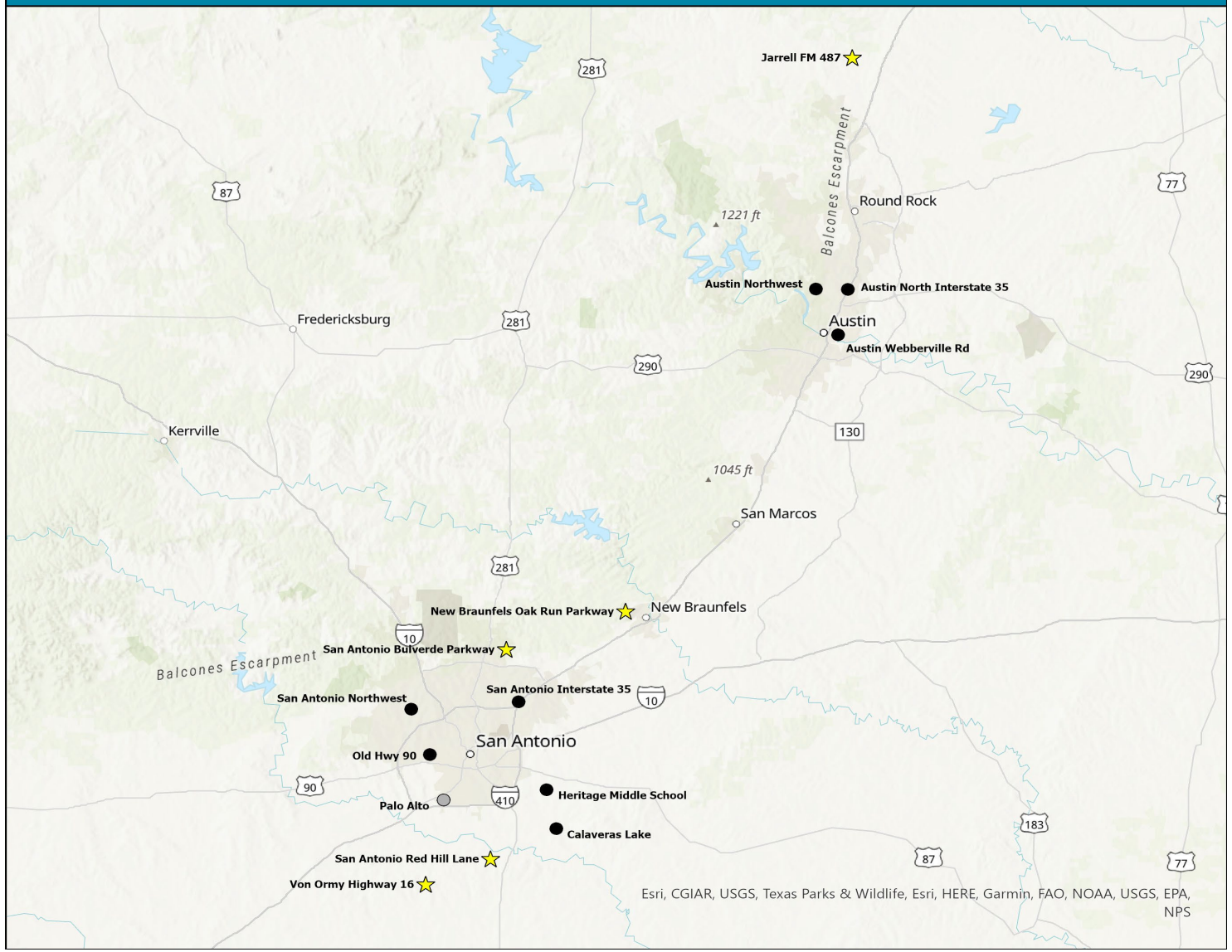
- Beginning October 2019 through July 2020, TCEQ began installation of 5 new ambient air $PM_{2.5}$ monitors near APOs
  - Located within 1 mile downwind of APO
  - 4 monitors in San Antonio area
  - 1 monitor in Austin area
- Data from new monitors compared to regional average $PM_{2.5}$ concentrations

PM2.5 Ambient Air Monitoring Site Locations in Central Texas
TCEQ Region 11 - Austin & Region 13 - San Antonio

This map was generated by the Toxicology Division (TD). No claims are made to the accuracy or completeness of the data, or to the suitability of the map for a particular use. This area may contain facilities other than those identified. For more information regarding this map, please contact the TD at (512) 239-3900.

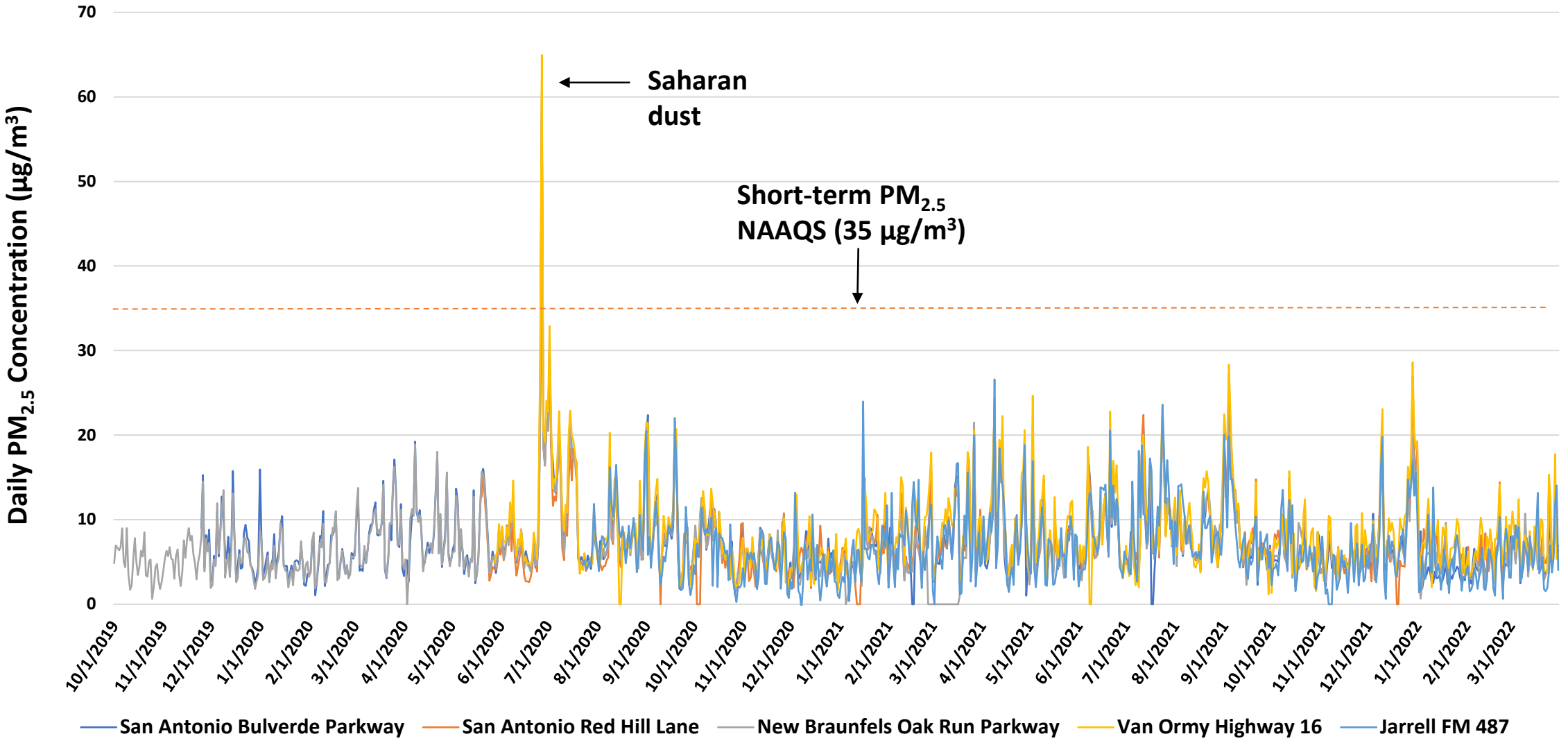
Date Created: 12/8/2020

Legend
- Active PM2.5 Monitoring Site
- Inactive PM2.5 Monitoring Site
- PM2.5 Monitoring Site Near APO Facility

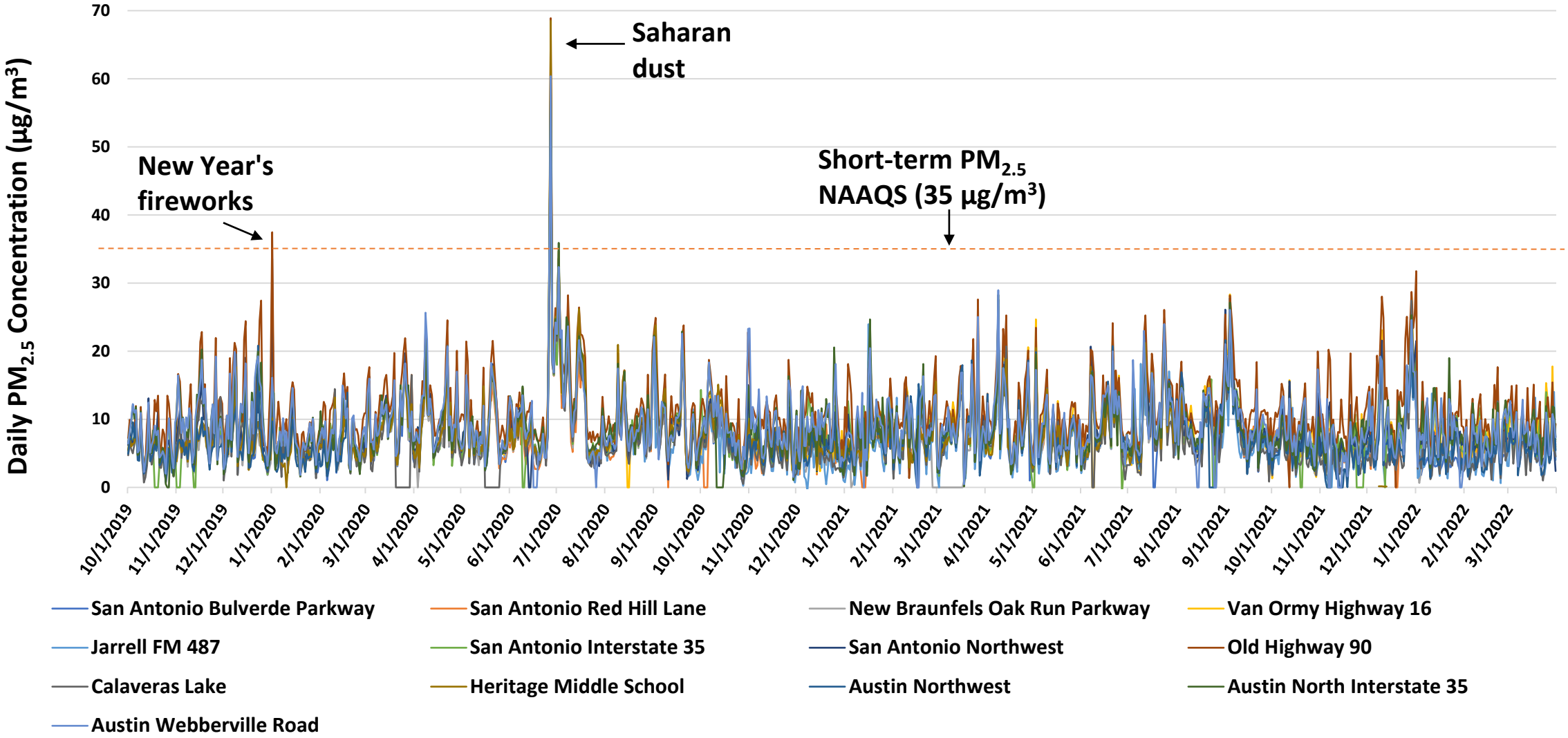


0 5 10 20 Miles

Daily $PM_{2.5}$ Concentrations - APO-related Monitors



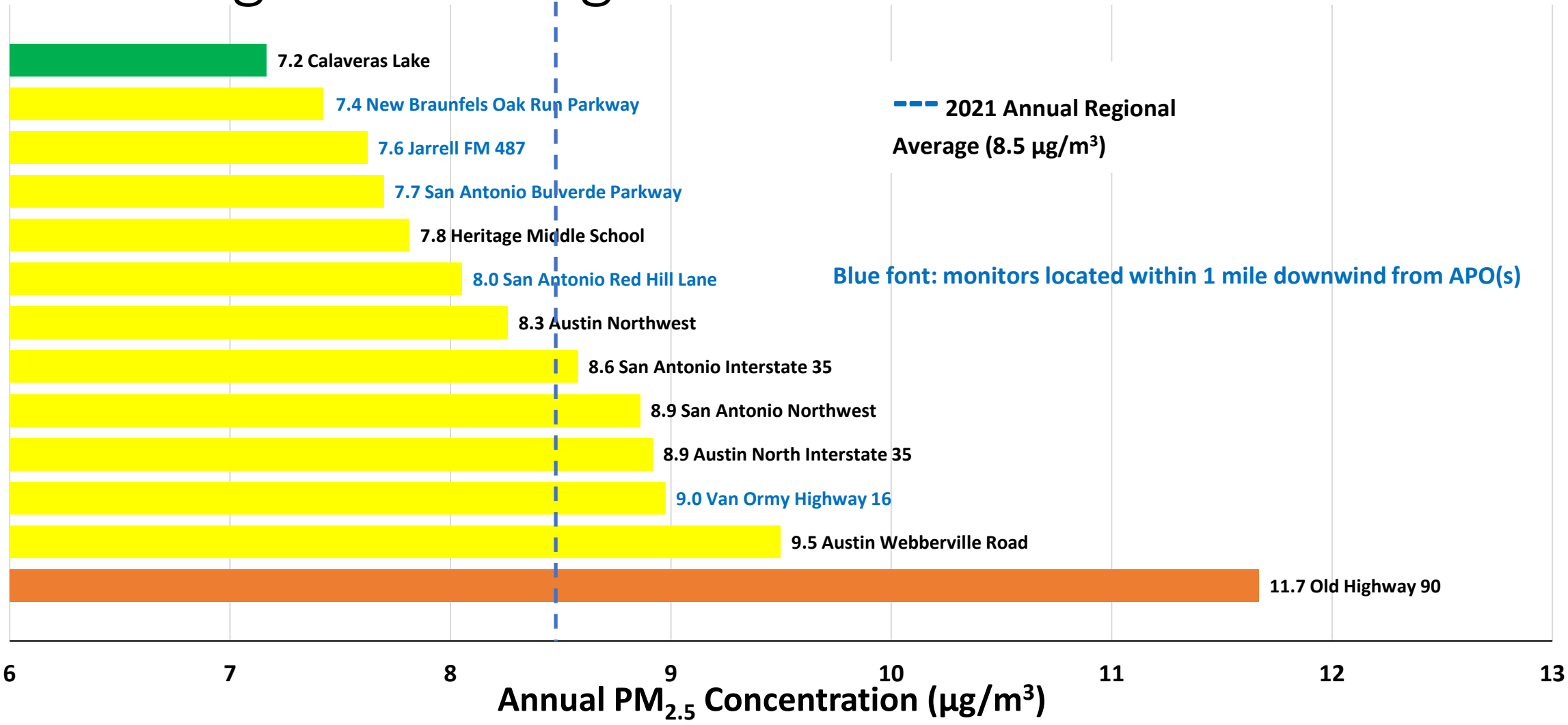
Daily $PM_{2.5}$ Concentrations - San Antonio and Austin



$PM_{2.5}$ concentrations in central Texas

- For all monitors, a measured exceedance of the 24-hour standard (35 µg/m^3) occurred on only two days.
- January 1, 2020
  - Old Highway 90 site due to New Year's fireworks activities in the adjacent parking lot.
  - Measured 24-hour average $PM_{2.5}$ concentration of 37.4 µg/m^3.
- June 27, 2020
  - All sites impacted by Saharan dust event spanning from 6/26/2020 through 7/9/2020.
  - Regional 24-hour average $PM_{2.5}$ concentration of 62.3 µg/m^3.

Average Annual $PM_{2.5}$ Concentration Compared to Regional Average - 2021



$PM_{2.5}$ monitoring near APOs: conclusions

- Measured values at new APO-related monitors follow the general regional $PM_{2.5}$ trend.
- Data do not indicate any significant influence from nearby sources on $PM_{2.5}$ concentrations measured at APO-related monitors.
  - Monitors tend to measure concentrations consistent with area background levels.

Summary

- Crystalline silica is not an environmental hazard
  - Concentrations of crystalline silica measured near APOs are unlikely to cause acute or chronic health effects and are not associated with silicosis

- Concentrations of $PM_{2.5}$ measured near APOs follow the regional trend
  - No significant influence from nearby sources on $PM_{2.5}$ concentrations measured at APO-related monitors

Acknowledgments

- Allison Jenkins, MPH
- Tracie Phillips, Ph.D.