MARCH 2021

# AB 617 Richmond-San Pablo Air Monitoring Projects Quarterly Update, March 2021

Hello from the Richmond-San Pablo Monitoring Outreach Team! It's time for the next quarterly update on implementation of the AB 617 Richmond-San Pablo Community Air Monitoring Plan. This update includes:

- Status reports on air monitoring projects and links to data, analyses, and resources (pages 1-3), including a new web-based report from Aclima on analysis of fine particulate matter ($PM_{2.5}$) mobile monitoring data.
- Fact sheets prepared by the Air District on initial analyses of $PM_{2.5}$ and air toxics data (pages 4-10).

The Richmond-San Pablo Monitoring Outreach Team is made up of five members: Dr. Henry Clark, Oscar Garcia, Matt Holmes, Dr. Julia Walsh, and Linda Whitmore. The team meets monthly and is joined by Kevin Ruano-Hernandez, a local high school student, and Bay Area Air Quality Management District (Air District) staff to help review monitoring information and organize these updates.

## Status of Richmond-San Pablo Air Monitoring Projects

The Richmond-San Pablo Community Air Monitoring Plan is made up of several different air monitoring projects. The Monitoring Plan Steering Committee selected three projects to collect air monitoring data across the Richmond-San Pablo area, to help improve the understanding of air quality across neighborhoods, identify locations where air pollution levels are persistently or unexpectedly higher, and provide real-time air quality information. Those three projects are led by Aclima; by Groundwork Richmond in partnership with Ramboll; and by Physicians, Scientists, and Engineers for Healthy Energy (PSE) in partnership with the Asian Pacific Environmental Network (APEN). A fourth project, to be conducted by the Air District, will focus on monitoring for air toxics near community sources of concern and in neighborhoods near those sources. The next few pages contain status reports from each of these monitoring efforts.

## Aclima

Aclima has developed a newer, more accurate method to separate out higher fine particulate matter measurements from background/regional levels affecting Richmond and San Pablo -- and has created a more user-friendly grouping method to highlight areas of focus, which Aclima is proudly releasing via this link: https://rspreport.aclima.tools/.

Novel community-scale, block-level monitoring is teaching all of us about fine particulate matter compared to other pollutants that have less regional variability. And new knowledge can improve abilities to identify potentially problematic areas.

Aclima takes great care to release the most accurate possible air quality insights available and has made it a company ethos never to retroactively change released visualizations without a clear explanation about what changed and why it changed. In this case, Aclima is not changing the underlying data, and instead are updating the interpretation of that data to deliver more value to the community. Aclima identified that regional fluctuations in fine particulate matter during the fall of 2019 was appearing visually as hotspots in the version of the report that was released in February 2020.

You may note that the report presented for $PM_{2.5}$ differs from the version at https://insights.aclima.io/richmond-san-pablo. There are no changes to the other pollutants such as nitrogen dioxide. In coming weeks, Aclima will be updating https://insights.aclima.io/richmond-san-pablo with the contents of the new $PM_{2.5}$ report, accompanied by a similar explanation, as well as including an archived copy of the prior map.

## Groundwork Richmond and Ramboll

Groundwork Richmond now has 54 Clarity Node-S sensors deployed across the Richmond-San Pablo area, with about 45 nodes healthy and reading in data (see links below). The nodes are measuring $PM_{2.5}$ and $NO_2$ - current data analyses focus on $PM_{2.5}$. Gravimetric PM sampling is being conducted seasonally with Minivol samplers. Black carbon monitoring has commenced using Aethlabs monitors at five sampling locations.

**Project next steps:**

- The real-time model and sensor network will be live for another year under the second round of the CARB Community Air Grant.
- Gravimetric PM measurements will conclude in the next two months and results will be presented on a dashboard.
- Source apportionment results from the first year of operation will be investigated further and summary maps will be produced.
- Black carbon monitoring has commenced and will continue for the next 3-6 months.
- Groundwork Richmond is working with an intern based at Howard University (a former Groundwork youth team member), who is planning to do an analysis project with the black carbon data.

**Data and information links:**

- Clarity sensor data and Shair model data can be viewed on the Ramboll Shair website.
- Real-time Clarity sensor data on the Clarity Open Map: https://openmap.clarity.io/
- More info on data and analyses were presented at a webinar in February. You can watch that webinar recording here: https://americas.ramboll.com/webinar/shair-air-quality-map

## PSE Healthy Energy and APEN

**Real-time air quality data collection and visualization**

PSE, with support from APEN, is continuing to collect air quality data in Richmond-San Pablo. Currently, PSE has 52 stationary Aeroqual AQY air monitors deployed and collecting real-time air quality data in one-minute intervals. 50 monitors are measuring particulate matter ($PM_{2.5}$), nitrogen dioxide ($NO_2$), ozone ($O_3$), temperature, relative humidity, and dew point. Two prototype monitors are measuring $PM_{2.5}$, volatile organic compounds (VOC), carbon monoxide (CO), temperature, relative humidity, and dew point. In collaboration with Aeroqual, PSE has implemented ongoing calibration of air quality data collected throughout the stationary air monitoring network. In partnership with Aclima, real-time data and historical data (up to 90 days) collected through the network are visualized and available to view in real time. PSE is continuing to conduct pilot analyses to assess data quality from the Aeroqual monitors, the utility of various calibration methodologies, and the effects of regional shelter-in-place orders on air quality. Data analyses to identify location- and time-based hotspots are ongoing.

**Phase II: Black carbon measurements**

In collaboration with researchers at the Lawrence Berkeley National Laboratory, PSE is conducting three one-month-long monitoring campaigns to collect black carbon measurements using Aerosol Black Carbon Detectors (ABCDs) that are collocated with the stationary network sites. So far, two of three monitoring campaigns have been completed. The first deployment occurred during a wildfire smoke event in August 2020 and the second deployment occurred during winter months of January and February 2021. One final deployment is planned for summer 2021.

**Project next steps:**

- Data collection and analysis efforts will continue throughout 2021, and PSE plans to share updates as they continue to collect and analyze new data.
- PSE is collaborating with Aclima to update the interactive real-time air quality data visualization tool.
- PSE is collaborating with Lawrence Berkeley National Lab on black carbon data cleaning and analysis collected during a wildfire deployment (August 2020) and winter deployment (January/February 2021).
- PSE is planning another deployment of the black carbon sensors in Summer 2021.

**Data and information links:**

- Richmond Air Monitoring Network Project Landing Page
- Air Monitoring Network Interactive Air Quality Data Visualization Tool

## Air District

The Air District continues to gather and prepare existing air monitoring datasets covering Richmond-San Pablo, such as from Air District fixed-site monitoring, Chevron community monitoring stations, Aclima's quarterly mobile monitoring, and sensor network data, for initial data analysis work. There are two fact sheets included as separate documents with this quarterly update. One fact sheet describes initial analyses of $PM_{2.5}$ data and the other pertains to air toxics data. These analyses are intended to provide an overview of air quality in Richmond-San Pablo, examine variations in air quality over time, and areas and times of higher pollution levels.

While still under shelter-in-place orders, the Air District team has continued efforts to ready the air monitoring van for use in the air toxics monitoring project, detailed in Appendix G of the Community Air Monitoring Plan. These efforts include development of updated tools for data acquisition, route planning, and onboard, real-time data visualization. The collaboration between Air District and RYSE Youth Center to create artwork for the air monitoring van has continued - graphics have been finalized and decals can now be ordered and applied to the van. The Air District is also working on an informational brochure that describes the air monitoring van project and its goals in the Richmond-San Pablo area.

## Initial Analyses of Air Monitoring Data: $PM_{2.5}$

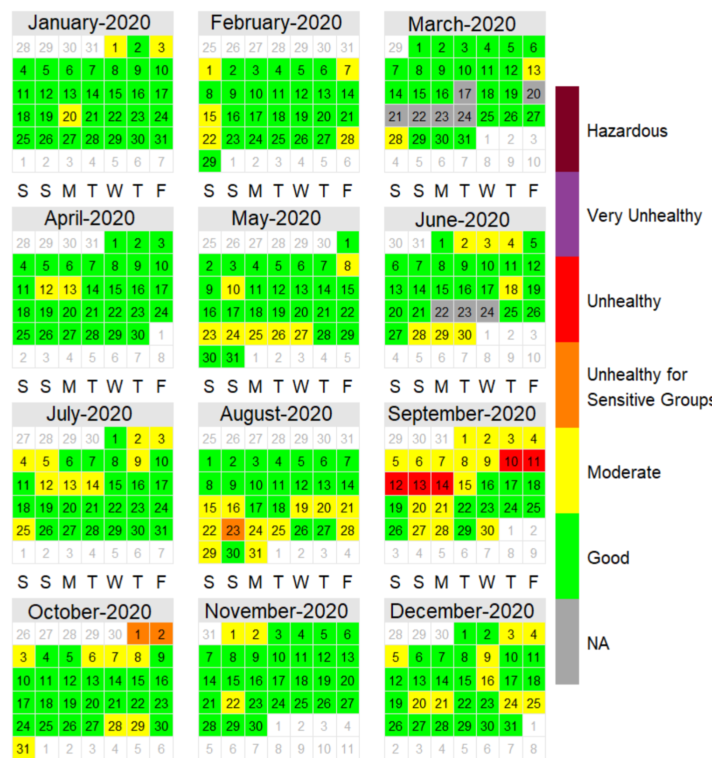
As implementation of the Richmond-San Pablo Community Air Monitoring Plan proceeds, the Air District is continuing to gather, prepare, and assess data from existing air monitoring networks. Initial analyses of $PM_{2.5}$ data are described on the next few pages. $PM_{2.5}$ stands for particulate matter with particle diameters of 2.5 micrometers and smaller, also referred to as fine particulate matter. These initial analyses aim to provide an overview of $PM_{2.5}$ levels in Richmond-San Pablo, examine variations in air quality over time, and identify locations with persistent or unexpected areas of higher pollution levels.

### A Look Back at Air Quality in 2020

The calendar on the right shows daily Air Quality Index (AQI) values for $PM_{2.5}$ in 2020, as reported at the Air District's regulatory monitoring station in San Pablo[1]. The AQI, much like an air quality "thermometer," translates daily air pollution concentrations into a number on a scale between 0 and 500. The numbers in this scale are divided into six color-coded health ranges, based on the EPA 24-hour health-based standard.

In 2020, the AQI was in the Good or Moderate categories on most days. **Wildfire smoke** contributed to unhealthy air quality at times, notably from late August to early October. In general, daily fluctuations in air quality are driven by **changes in weather patterns and emissions**. The pandemic also affected pollution emission patterns in 2020.

Air Quality Index for $PM_{2.5}$ at San Pablo, 2020

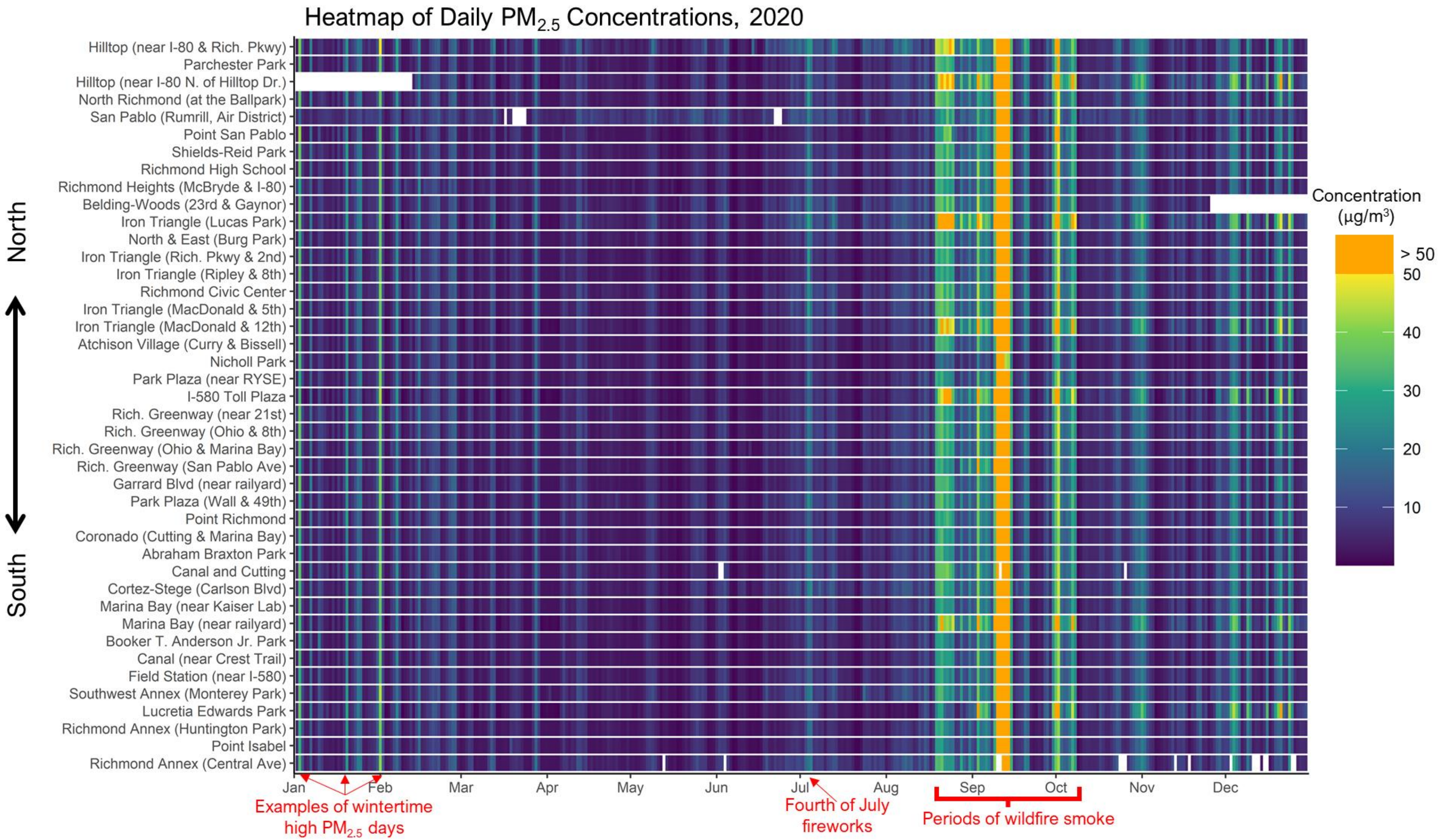



### Exploring $PM_{2.5}$ Levels in Richmond-San Pablo

In addition to data from the Air District's regulatory monitor in San Pablo, $PM_{2.5}$ data are also available from lower-cost sensors that are now in place in many locations across the Richmond-San Pablo area. Data from sensor networks can provide real-time air quality information and help qualitatively track changes in air quality over time in different neighborhoods[2]. Data from the network of Clarity air quality sensors installed as part of the Groundwork Richmond Air Rangers project are the focus of the next few pages. A "heatmap" like the one shown on the next page is one way to visualize data at many locations over time and identify **pollution events and patterns**.

[1] $PM_{2.5}$ data at San Pablo were not available during periods of instrument maintenance or calibration. Completeness of daily data was over 97% and was well above data completeness requirements established by EPA.

[2] The Air District's Air Quality Data FAQ contains more information on air quality data sources and data uses. Accuracy of data from lower-cost sensors can vary greatly across manufacturers and from sensor to sensor, and can change over time.



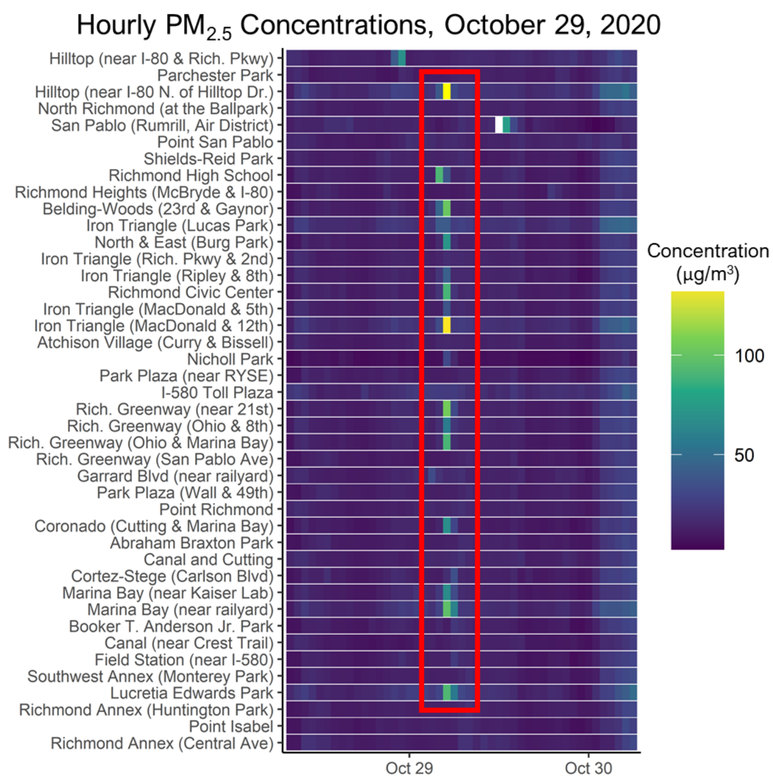

The heatmap above shows $PM_{2.5}$ data for 2020 from the Clarity sensors and the Air District's San Pablo monitor[3]. Sensor locations are listed from north (top) to south (bottom). Brighter colors indicate higher $PM_{2.5}$ levels[4]. Overall, $PM_{2.5}$ levels across the sensor network follow very **similar day-to-day variations**, driven by regional emissions and weather patterns. The notes in red at the bottom of the heatmap indicate some notable days or events with higher $PM_{2.5}$ levels.

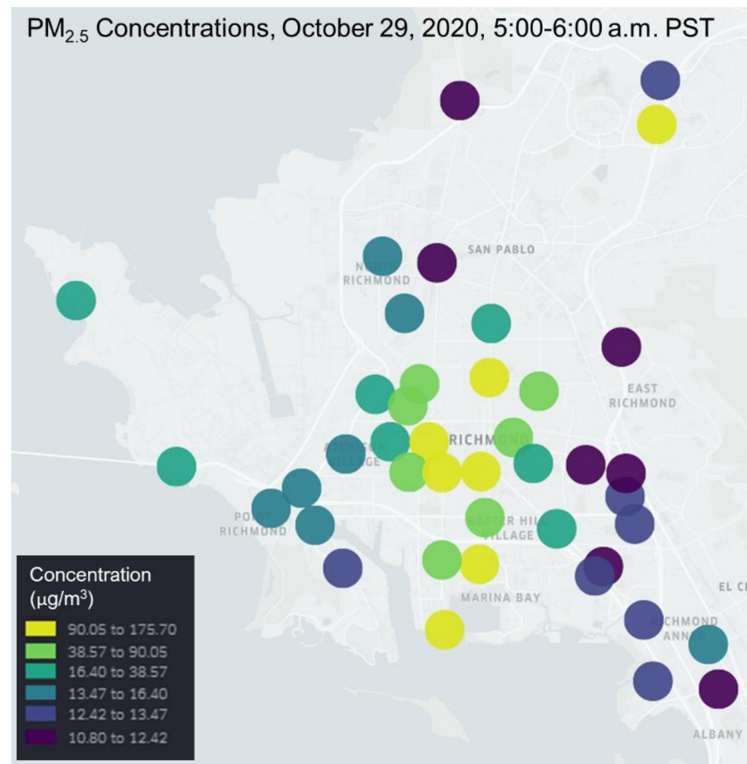
[3] Air District monitors and lower-cost sensors report data at different time frequencies and durations, resulting in differences in how averages are calculated. Compared to sensors, Air District monitors are required to have more minutes of data available in an hour in order to calculate an hourly average.

[4] Note that on the $PM_{2.5}$ scale on the right, the highest $PM_{2.5}$ days are grouped together. This is because extremely high $PM_{2.5}$ levels during the wildfire smoke events (at times well over 100 µg/m$^3$) would otherwise make it difficult to discern day-to-day variability in $PM_{2.5}$ during the rest of the year.

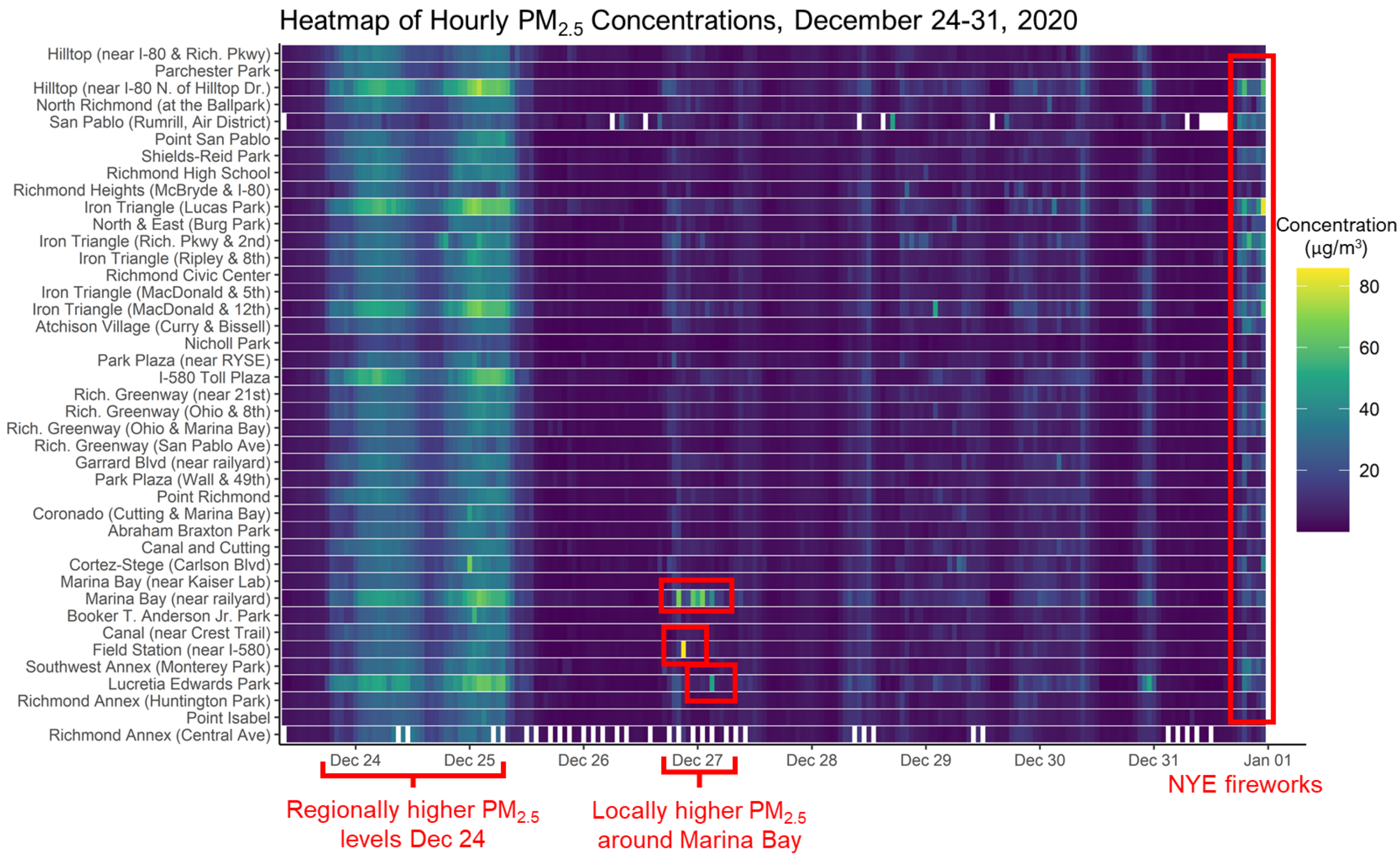
There are also some differences between locations that could be investigated further. **Many factors influence particulate matter measurements at a specific location**, including instrumentation (regulatory monitor vs. sensor), proximity to emissions sources, sensor installation considerations (such as airflow obstructions), sensor calibration, meteorology, and topography. Sometimes, transport of pollution from other areas or events like wildfires are large contributors on the worst $PM_{2.5}$ days. However, it's also important to note that many common in-community sources, such as industrial facilities, smaller businesses, trains, and vehicles on roads **contribute to $PM_{2.5}$ levels year-round** and can be responsible for shorter-duration elevated levels of $PM_{2.5}$ in specific places.

While health-based standards for $PM_{2.5}$ are based on daily or annual averages, shorter-term periods of high $PM_{2.5}$ can also be impactful. Hourly data illustrate how $PM_{2.5}$ levels vary throughout the day due as emissions or meteorological conditions change, revealing different patterns than can be seen in daily or annual averages. An example is shown below, when during the early hours of October 29, 2020, several sensors reported a short period of **much higher $PM_{2.5}$ levels**, particularly in the Hilltop, North & East, Belding/Woods, Iron Triangle, Richmore Village, Coronado, Cortez-Stege, and Marina Bay neighborhoods. Further analysis is needed to better understand what contributed to these higher $PM_{2.5}$ levels.



Another example heatmap is shown below for late December 2020. It shows higher $PM_{2.5}$ levels throughout the area on December 24 associated with a typical **wintertime area-wide event** where meteorological conditions allow for pollutants, including wood smoke, to build up. Often during these events, temperature inversions trap pollutants near ground-level, and offshore winds can bring additional pollutants into the Bay Area from the Central Valley. Air quality improved on December 25 as a storm system moved into the Bay Area. Then, higher $PM_{2.5}$ levels were reported at a much more **localized subset of sensors** around Marina Bay starting late on December 26. Higher $PM_{2.5}$ levels also appear late on December 31 with New Year's Eve fireworks.




## Next Steps for $PM_{2.5}$ Data Analysis

Upcoming analyses will incorporate additional datasets and types of information, such as meteorological data, air quality from other networks and for other pollutants, and sensor siting information. These analyses will focus on:

- Comparisons of sensor network data to regulatory monitoring data
- Providing information on air pollution near roadways
- Better understanding areas where $PM_{2.5}$ levels may be persistently higher than others
- Identifying possible contributors to short-duration events with high $PM_{2.5}$ levels

## Initial Analyses of Air Monitoring Data: Air Toxics

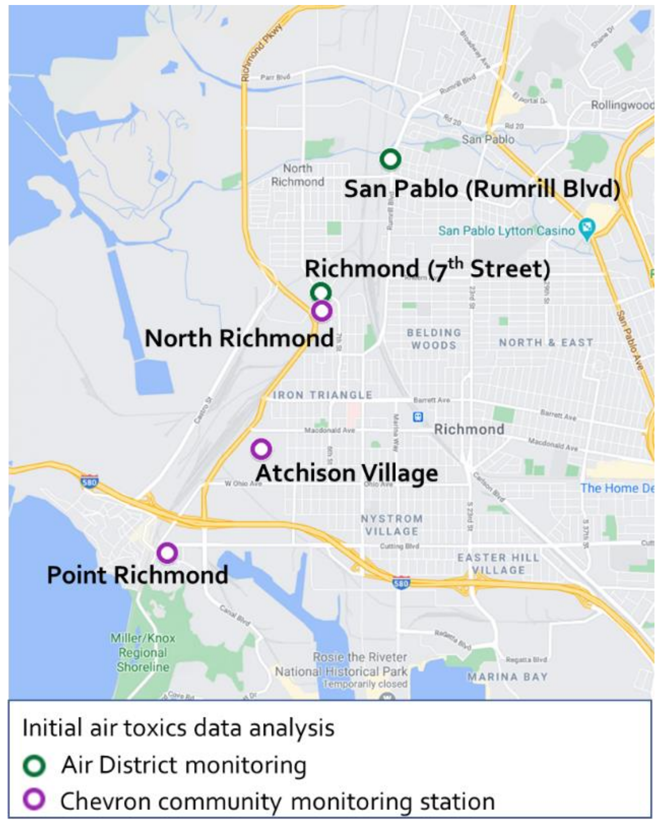
As part of implementing the Richmond-San Pablo Community Air Monitoring Plan, the Air District is gathering and analyzing available air monitoring data. Initial analyses of selected air toxics data are described on the next three pages.

Air toxics, also known as Hazardous Air Pollutants, are pollutants that are known or suspected to cause cancer or other serious health problems, including Volatile Organic Compounds (VOCs) and particulate metals. EPA's Hazardous Air Pollutants website contains examples of these kinds of pollutants.

### Air Toxics Monitoring

There are several air toxics monitoring systems in the Richmond-San Pablo area, including Air District monitoring stations, Chevron community monitoring stations, Chevron fenceline monitoring, and Chevron ground-level monitoring. The specific pollutants measured, instrumentation, locations, and purpose(s) for monitoring vary across these systems[5].

This analysis uses data from **Air District monitoring stations** and **Chevron community monitoring stations**, shown on the map to the right. With data available over several years, these fixed-site stations can provide useful information on how levels of certain air toxics change in a place over time, how levels compare with health-based guidelines, and possible sources of certain air toxics. However, their coverage is limited in terms of geography and the types of air toxics they measure. Air quality modeling or other air monitoring methods can provide more information over larger areas and/or for other types of air toxics.



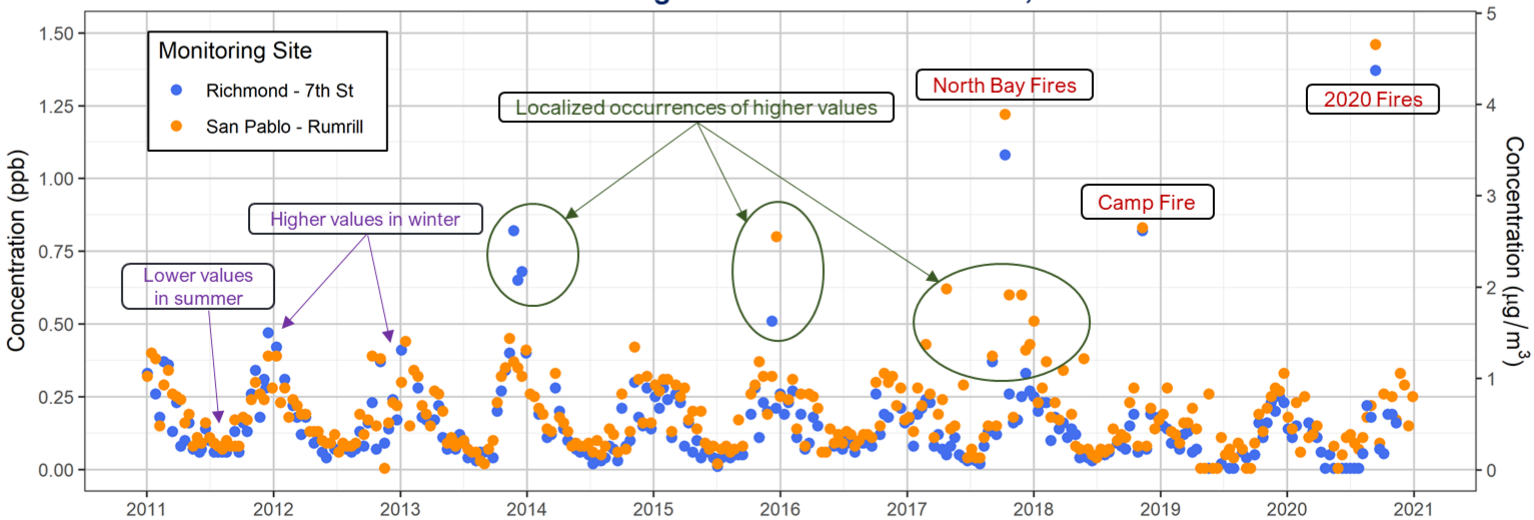

### The BTEX Compounds

BTEX compounds, one subset of air toxics, are described in the table below. In general, more air monitoring data are available for the BTEX compounds compared to many other air toxics, and these data are the focus of this document.

| | |
|---|---|
| **What are the BTEX compounds?** | BTEX is an acronym for **B**enzene, **T**oluene, **E**thylbenzene, and **X**ylenes |
| **What produces these kinds of pollutants?** | The BTEX compounds have many common sources, including:<br>• Fossil fuel burning (gasoline, oil, coal)<br>• Wildfires/biomass burning<br>• Mainstream and secondhand cigarette smoke<br>• Oil and gas processing and refining<br>• Evaporation of gasoline, solvents, paints, and refrigerants |
| **Why are BTEX compounds of concern?** | These compounds can cause acute or chronic health impacts. Benzene is the most toxic of these compounds and is carcinogenic. Sources that emit BTEX often emit other pollutants — some of these are known to damage health, while many others have not been adequately assessed. |

[5] The Richmond-San Pablo Air Monitoring Data Inventory contains more information about the different air monitoring systems currently in operation in the Richmond-San Pablo area.

**24-hour Average Benzene Measurements, 2011-2020**

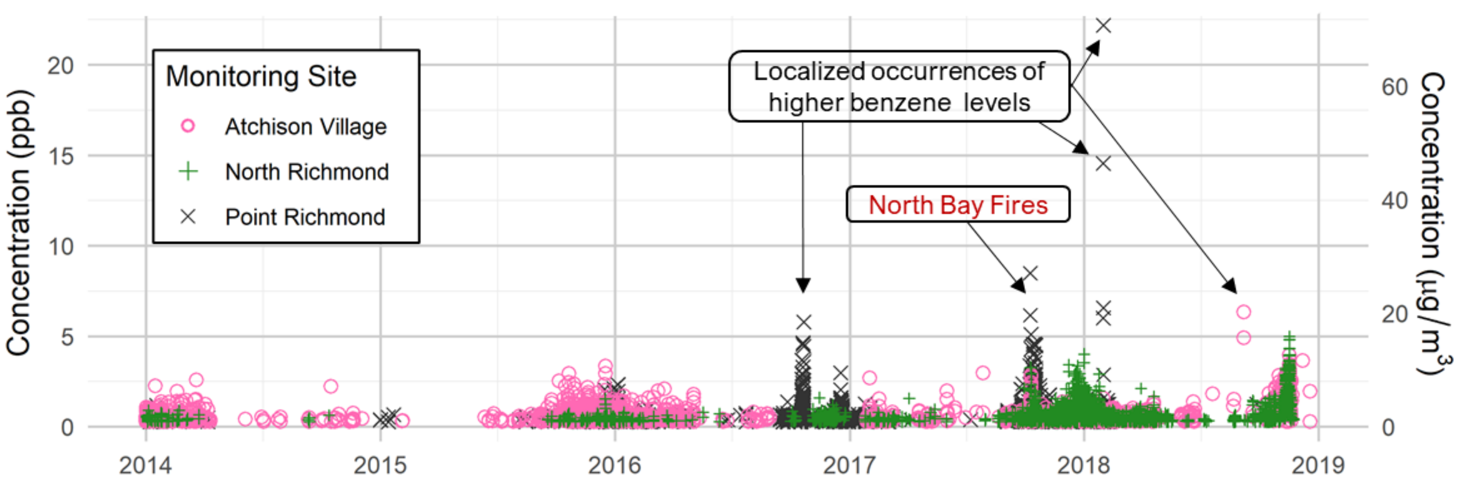



The graph above shows measurements of benzene over the last ten years at the Air District's monitoring stations in Richmond and San Pablo. These measurements are taken every 12 days and the collected samples are analyzed in the Air District's laboratory. Some initial findings are annotated in the graph:

- **Seasonal cycle** with higher benzene levels in winter and lower levels in summer. This cycle is due to:
  - Photochemistry: Benzene is removed from the atmosphere by chemical reactions that take place in sunlight. Weaker sunlight in the winter limits these reactions.
  - Meteorology: Strong temperature inversions, common in the winter, can trap pollution near the ground.
  - Emissions: The type and amount of fuels burned vary over time. Some examples include seasonal changes in gasoline blends, residential wood burning in the winter, wildland fires in the summer and fall. Evaporative emissions from fuels and other products also increase with warmer temperatures.
- Some of the highest benzene levels occurred on days that **wildfire smoke** affected the entire area.
- Other occurrences of higher levels appear at only one site, possibly associated with **localized emissions**.

Hourly-average benzene data from the Chevron community monitoring stations[6], shown in the graph below, show a similar seasonal cycle with higher values in the winter. A few occurrences of higher levels also appear, some coincident with fires while others appear at only one monitoring site.

**Hourly Average Benzene at Chevron community monitoring stations**




[6] BTEX data from the Chevron community monitoring stations are measured using automated systems that provide data continuously and at 5-minute time resolution. However, they also have a higher detection limit, such that only 5-minute levels above 0.50 ppb are detected. For readability on the graph, hourly average values of less than half the MDL, or 0.25 ppb, are not shown on this plot.

## Benzene and Health

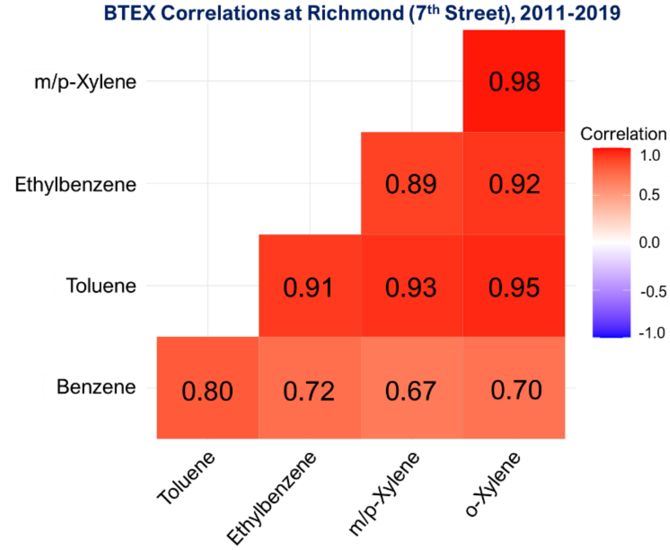
The table below provides information on benzene and established health guidance. It is important to note that benzene is only one air toxics pollutant, and that **other air toxics may have different health impacts and be larger drivers behind cumulative health impacts**. Air quality modeling, as opposed to air monitoring, is often better suited for assessing those cumulative impacts.

| | |
|---|---|
| **Lifetime cancer risk** | Sustained exposure to average benzene concentrations of 1.3 to 4.5 micrograms per meter cubed (μg/m$^3$) over a lifetime would result in an estimated increase in cancer risk of no greater than 10 in a million[7]. Measured benzene levels have been largely below 1.3 μg/m$^3$. |
| **Non-cancer health impacts from long-term exposure** | The reference exposure level (REL)[8] for **chronic** inhalation of benzene is 1.0 ppb. This is based on the risk of health outcomes other than cancer for sustained exposures over a lifetime. Recent annual and multi-year averages of measured benzene in Richmond and San Pablo have been generally between 0.15 and 0.30 ppb. |
| **Non-cancer health impacts from shorter-term exposure** | The REL for acute (infrequent, 1-hour) inhalation of benzene is 8.0 ppb. Hourly average benzene measurements at the Chevron community monitoring stations were mostly well below 8.0 ppb. Values over 8.0 ppb were measured at the Point Richmond monitor in October 2017 during the North Bay Fires and in January 2018. |

## BTEX and Pollution Sources

The measurements of the different BTEX compounds have **strong positive correlations** with each other at the Richmond and San Pablo air monitoring stations, meaning that when one compound is higher, the others are typically higher as well. When this happens, it is usually because all four compounds are being **emitted from the same sources**, or from a group of closely related sources. Correlations are similarly strong at other Bay Area monitoring stations, indicating that the BTEX compounds have **similar sources that are found throughout the region**. Emissions from burning fossil fuels, such as vehicle exhaust and residential wood smoke, are examples of these common, similar sources.

**BTEX Correlations at Richmond (7th Street), 2011-2019**




## Next Steps for Air Toxics Analysis

Additional analysis will focus on possible sources for air toxics and on intermittent occurrences of higher air toxics levels by comparing with data for other pollutants and with meteorological data.

Efforts under Assembly Bill 617, such as the Air District's planned air toxics monitoring project[9], are intended to provide additional information on air quality in Richmond-San Pablo. This air toxics monitoring project will use mobile monitoring to screen for common gas-phase air toxics to help better understand the geographic variability in air toxics levels and identify areas where levels of these pollutants are unusually high.

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[7] Cancer risk information for benzene from the U.S. EPA: https://www.epa.gov/sites/production/files/2016-09/documents/benzene.pdf

[8] Reference exposure levels for benzene from California OEHHA: https://oehha.ca.gov/air/chemicals/benzene

[9] The air toxics mobile monitoring project is described in Appendix G of the Richmond-San Pablo Community Air Monitoring Plan.