Development and implementation of a community air monitoring project using a mobile monitoring platform in the Richmond, California area

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August 24, 2022

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BAY AREA AIR QUALITY MANAGEMENT DISTRICT

Richmond-North Richmond-San Pablo Area

- Home to over 150,000 people, located northeast of San Francisco
- This historically redlined community experiences disproportionate cumulative impacts from a high density of complex pollution sources next to and within the community
- We recommended the area for a Community Air Monitoring Plan under Assembly Bill 617

Community Co-Led Process

CARRY SUCCESS FORWARD

Co-lead team and Steering Committee will ensure an inclusive, transparent process with shared goals, creating a greater impact.

DESIGNED BY COMMUNITY

Community members designed process to build trusting relationships and authentic participation.

COMMUNITY SUMMIT

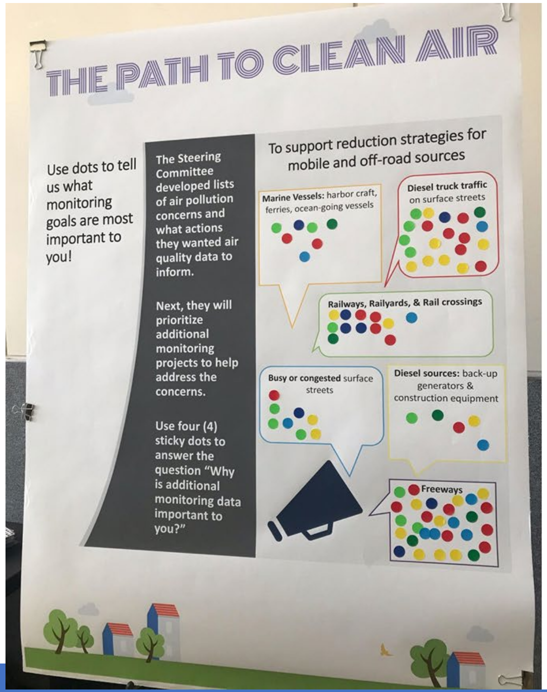
Community shaped process, including Steering Committee membership and decision-making.

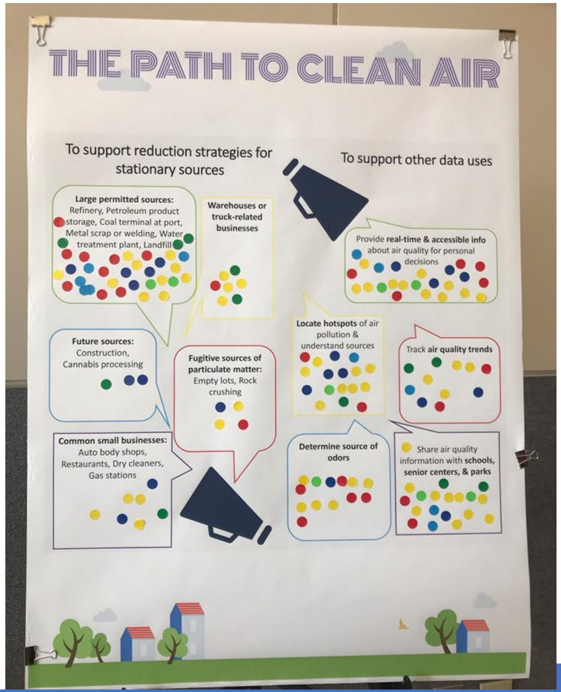
DESIGN TEAM

Community planned summit to get input on their design for Steering Committee process

Air Quality Concerns

- The Steering Committee and public identified air quality concerns and locations of interest
- The community's input was used to develop options for air monitoring projects to collect additional data where it was needed to support action
- Four monitoring projects were selected over the course of plan development, including an air toxics project using the Air District's new mobile monitoring lab

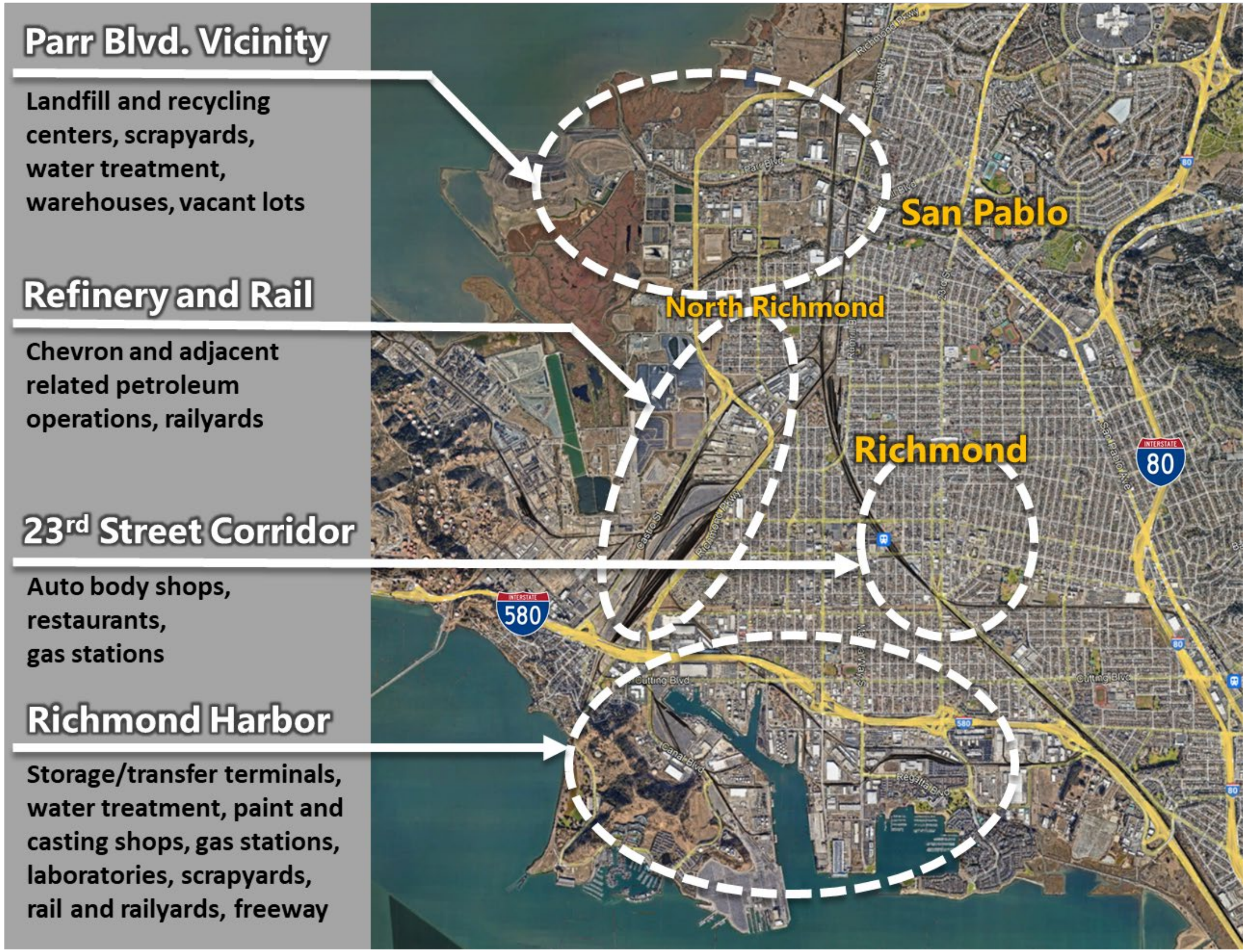




Air Toxics Monitoring Study

Project Objectives

- Identify areas of elevated gas air toxics near sources of concern
- Compare levels of gas air toxics within and nearby communities
- Use this information to identify and prioritize emission and exposure reduction strategies



Mobile Lab


Premier
TRAILER LEASING
Community Air Monitoring
¡Todos Deberían Tener Aire Limpio!
Everyone Should Have Clean Air!
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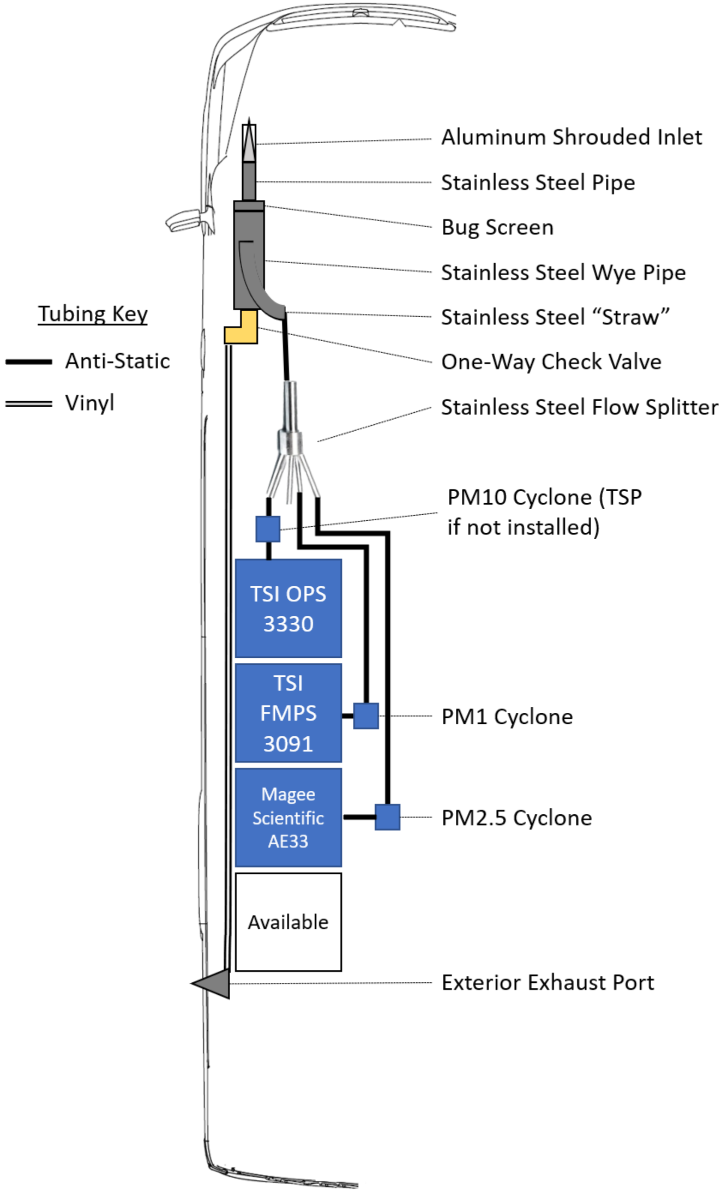
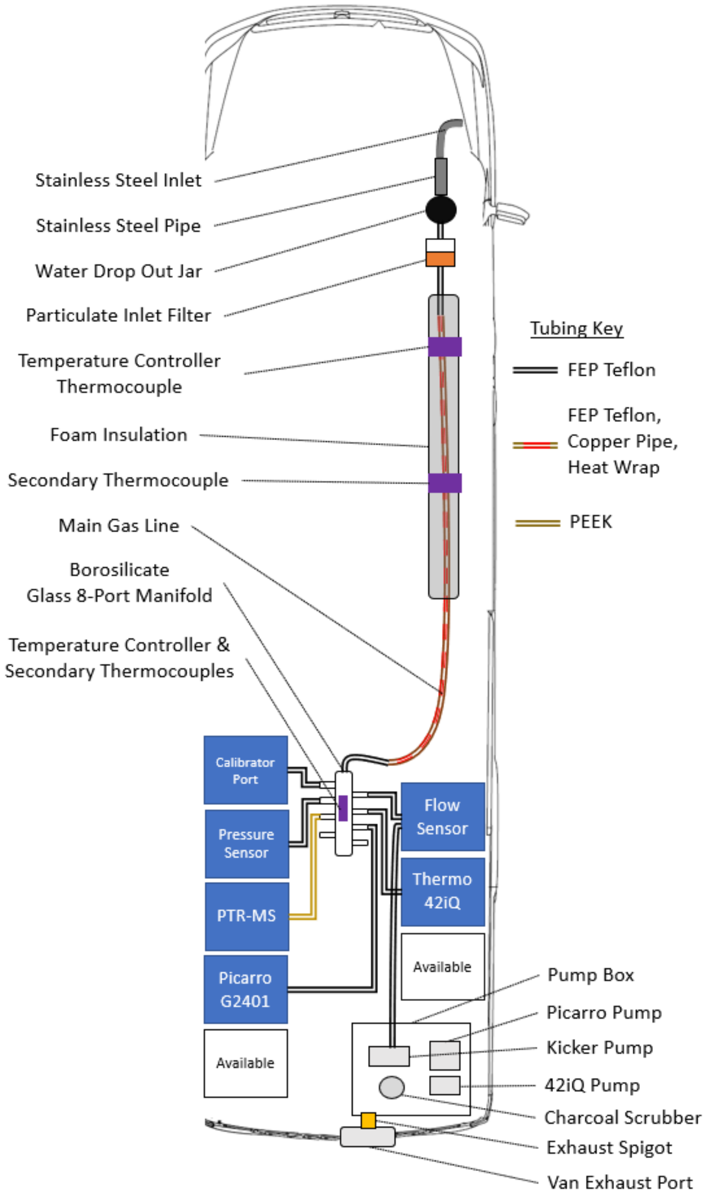
Mobile Lab

- 2019 Mercedes-Benz Sprinter Van
- 8.0 kW mobile electric power supply
- 400 Ah battery bank and inverter/charger
- Separate particle and gas sampling systems
- Gas sampling system temperature controlled
- 1 second data resolution with geotagging

Particle Sampling System



Gas Sampling System



Mobile Lab Pollution Instrumentation

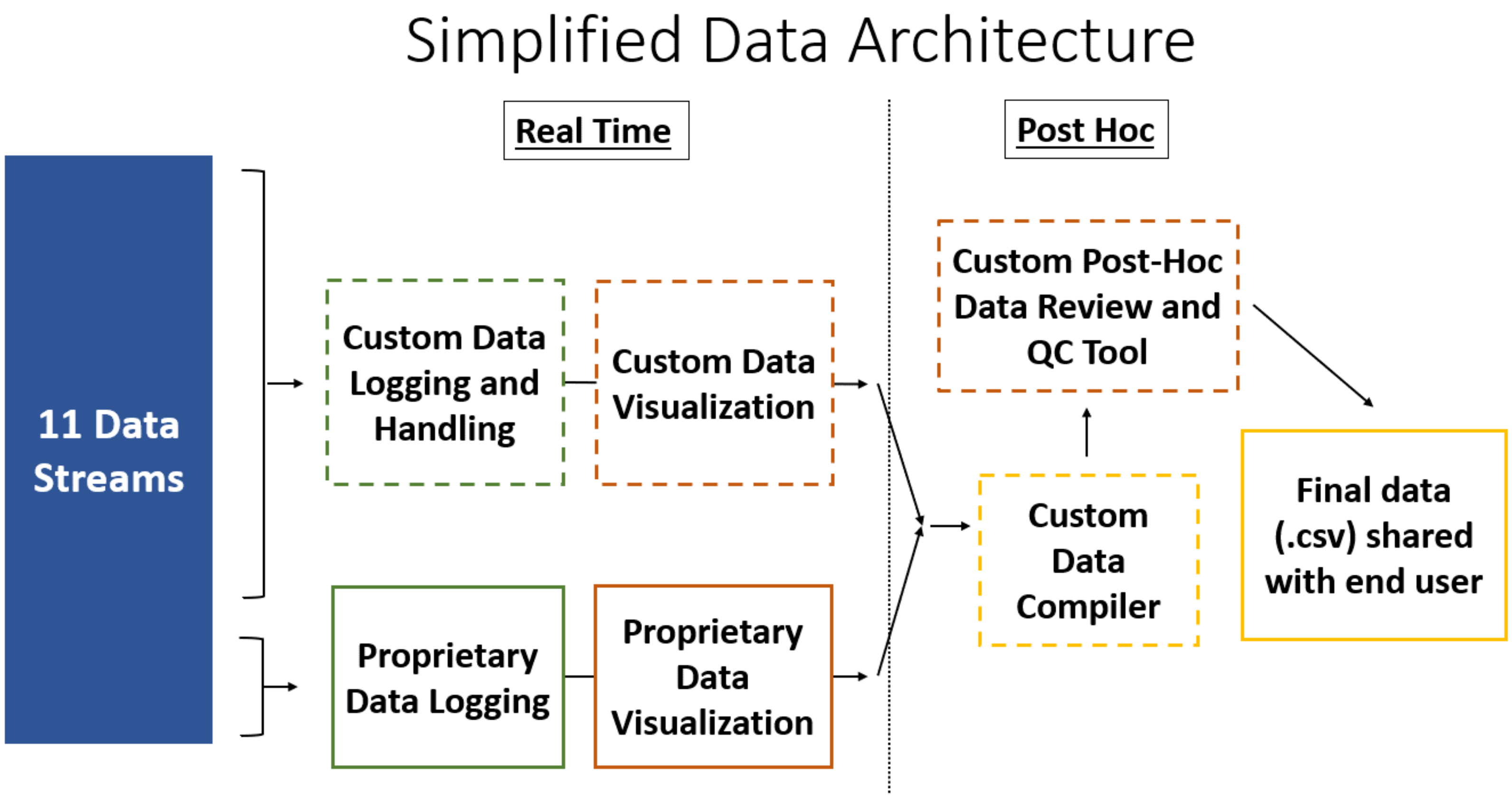
Instrument Model	Van System	Measurements
Ionicon PTR-ToF-MS	Gas	Speciated VOCs
Picarro G2401	Gas	CO, CH4, CO2
Thermo 42iQ	Gas	NOx
Magee AE33	Particulate Matter	Black Carbon, UVPM Particle Mass Concentration
TSI FMPS 3091	Particulate Matter	Size: 5.6 to 560 nm
TSI OPS 3330	Particulate Matter	Size: 0.3 to 10 µm, Mass: PM1, PM2.5, PM10, Counts/Number Concentration

Mobile Lab Auxiliary Instrumentation

Instrument Model	Van System	Measurements
Airmar 200WX	Meteorology and GPS	Ambient Temperature, Barometric Pressure, Wind Speed, Wind Direction, Latitude, Longitude, Vehicle Speed
Garmin GPS 18xUSB	GPS	Latitude, Longitude, Vehicle Speed, Altitude
AMSP Sensor Box	Environmental	Gas System Flow and Pressure
AMSP Temperature Controller	Environmental	Gas System Temperature
AMSP Van Env Box	Environmental	Internal Van Temperature

Mobile Lab Data System

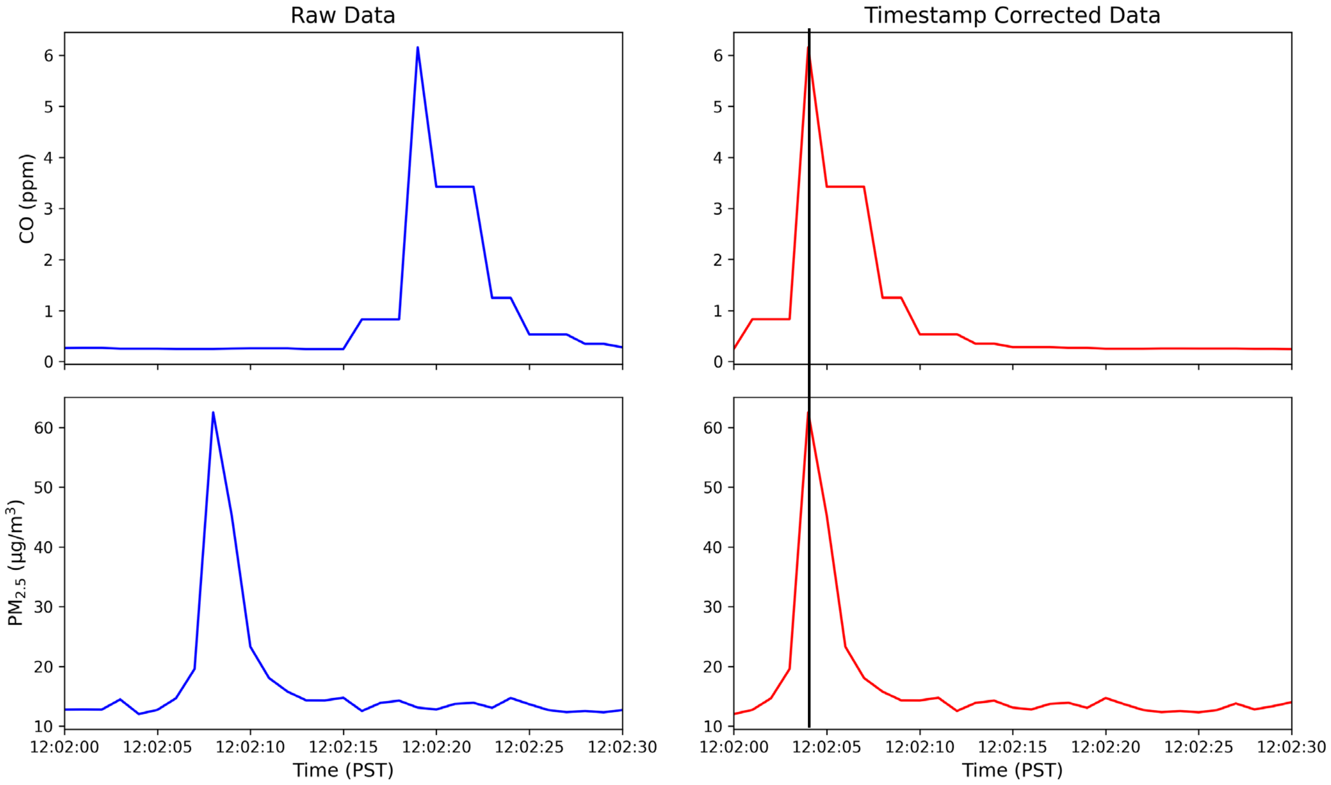
- Python Logger
- Proprietary software for other instruments
- C# Parser
- R Shiny Mobile Viewer
- QC protocols using standardized R tools



Mobile Data Synchronization

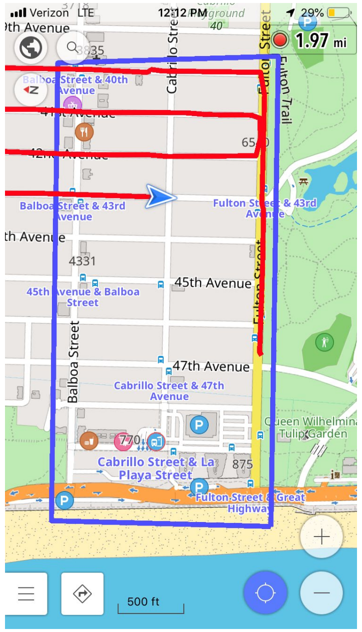
- Unknown instrument response times confound geotagging of data.
- A method was developed to determine instrument response times.
- Identified response times used to correct instrument timestamps and accurately geotag instrument data.
- Manuscript on methodology forthcoming.

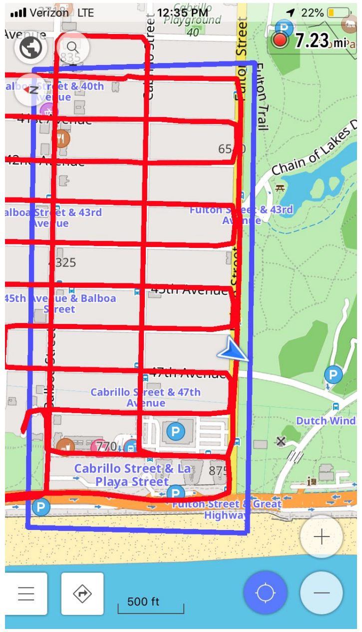
Applying Timestamp Corrections to two Data Streams



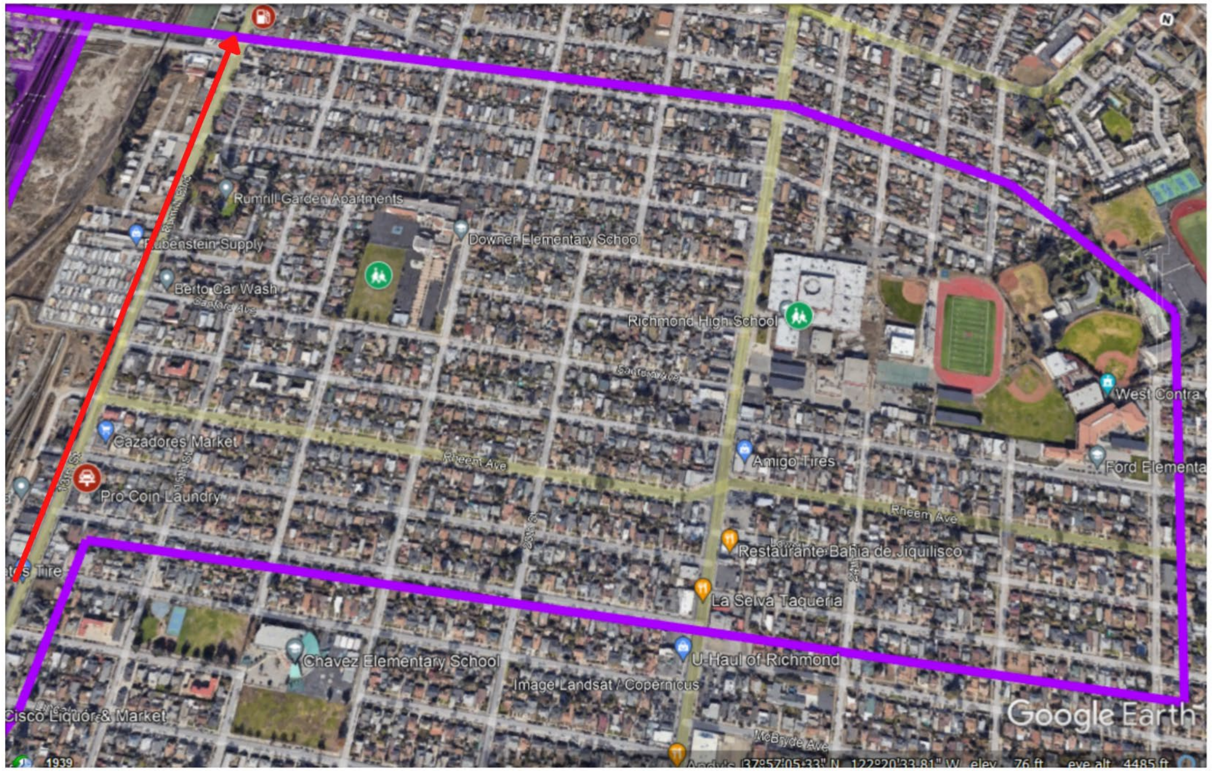
Driving Methodology

Navigating Study Area using OsmAnd Maps





Right-Handed Box Driving Method



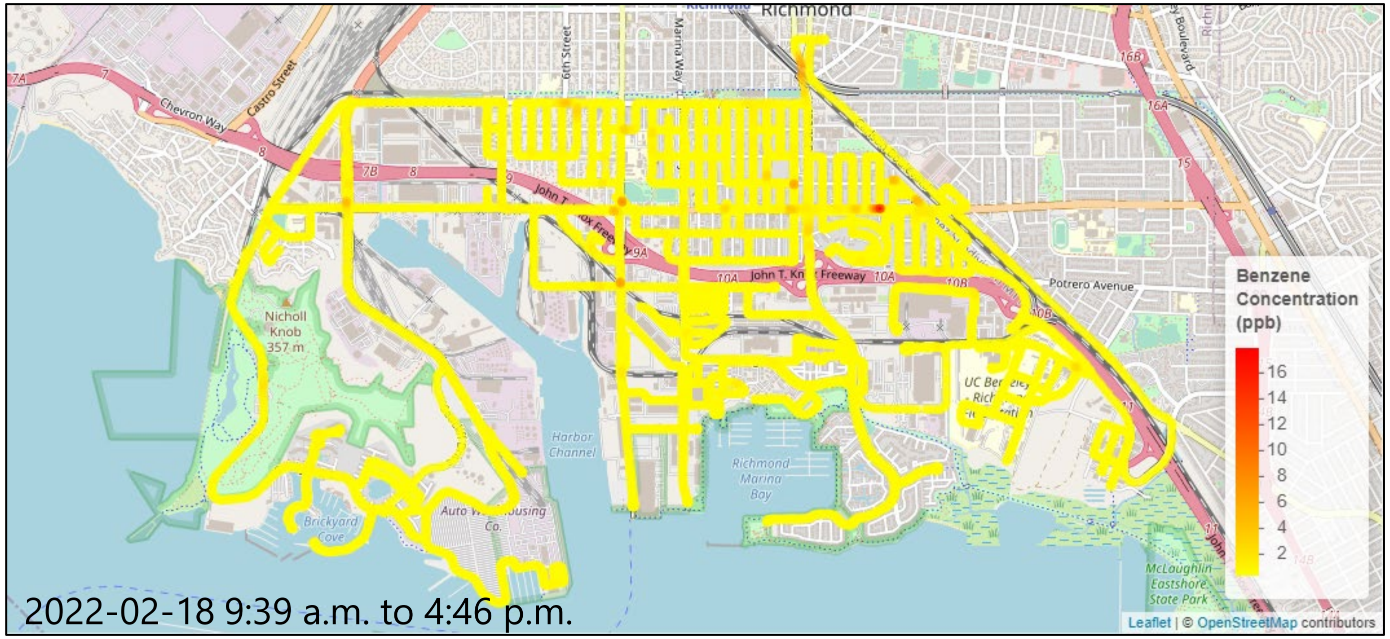
- “OsmAnd Maps” app on iPhone or iPad.
- GPX file of study area perimeter uploaded into app.
- GPS data recorded and driven route visualized in context of study area polygon.

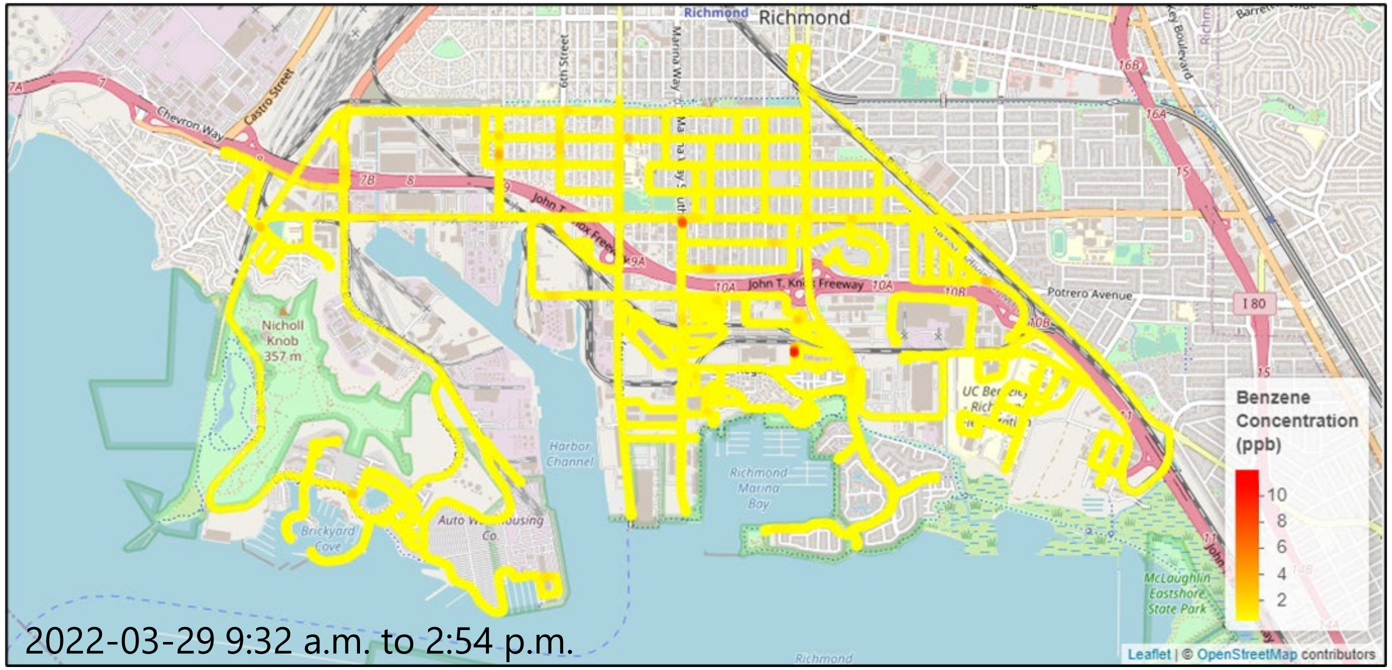
Mobile Lab Challenges

- Handling a variety of data streams from different types of instruments is challenging.
- Data review is time consuming and tedious, but critical.
- Developing QC practices for non-regulatory instrumentation is novel and takes time and consideration.
- Instrument requirements and deficiencies become more salient in mobile setting.
- Driving area selection requires thoughtfulness and must balance study goals with logistical and operator limitations.

Data Analysis

- Data analysis is ongoing
- Primary analysis tool is R
- Comparing pollutant levels within and across drive missions
- Examining spatial variability in different pollutants relative to known pollution sources, community locations of interest, vulnerable populations

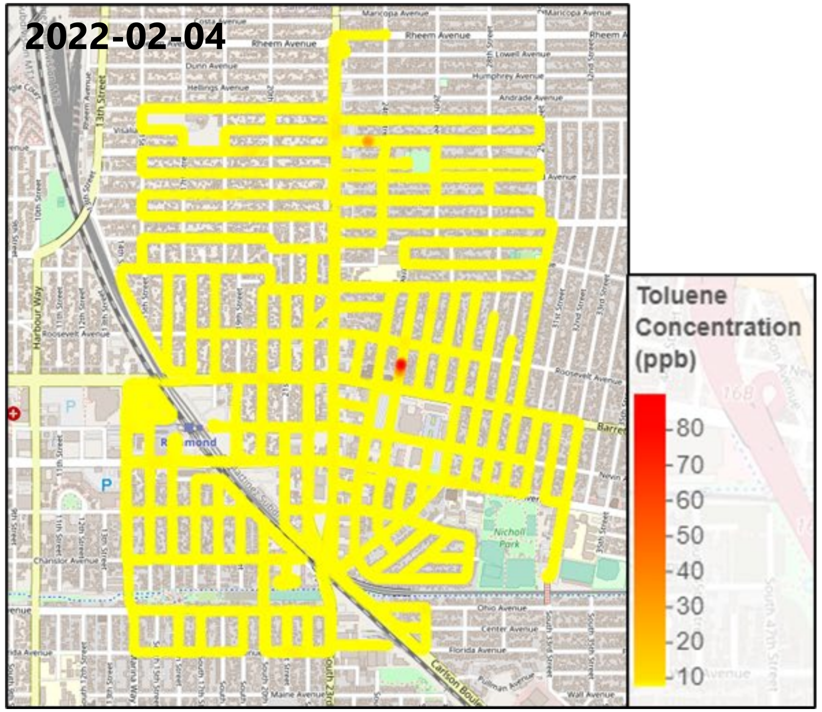


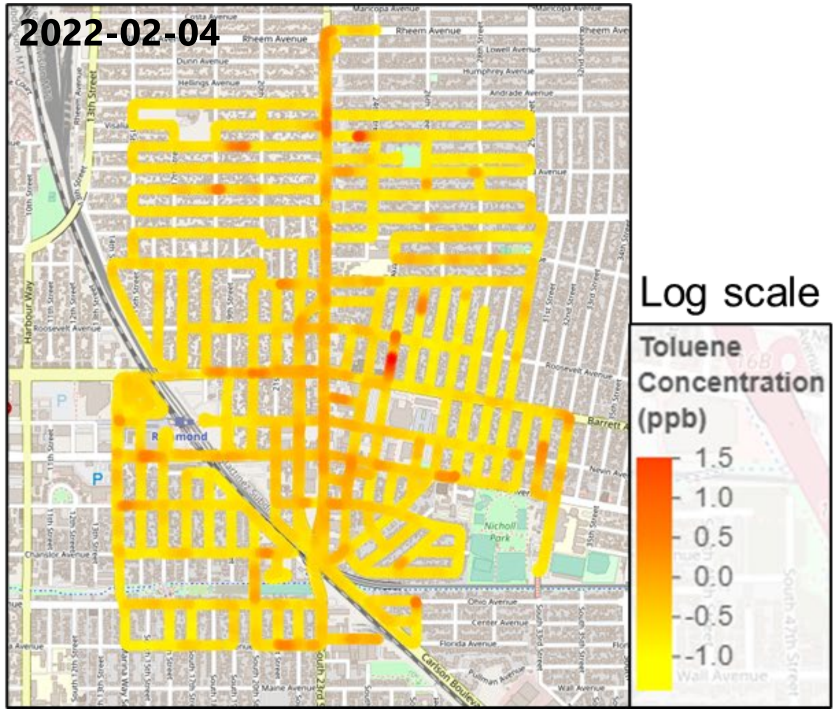


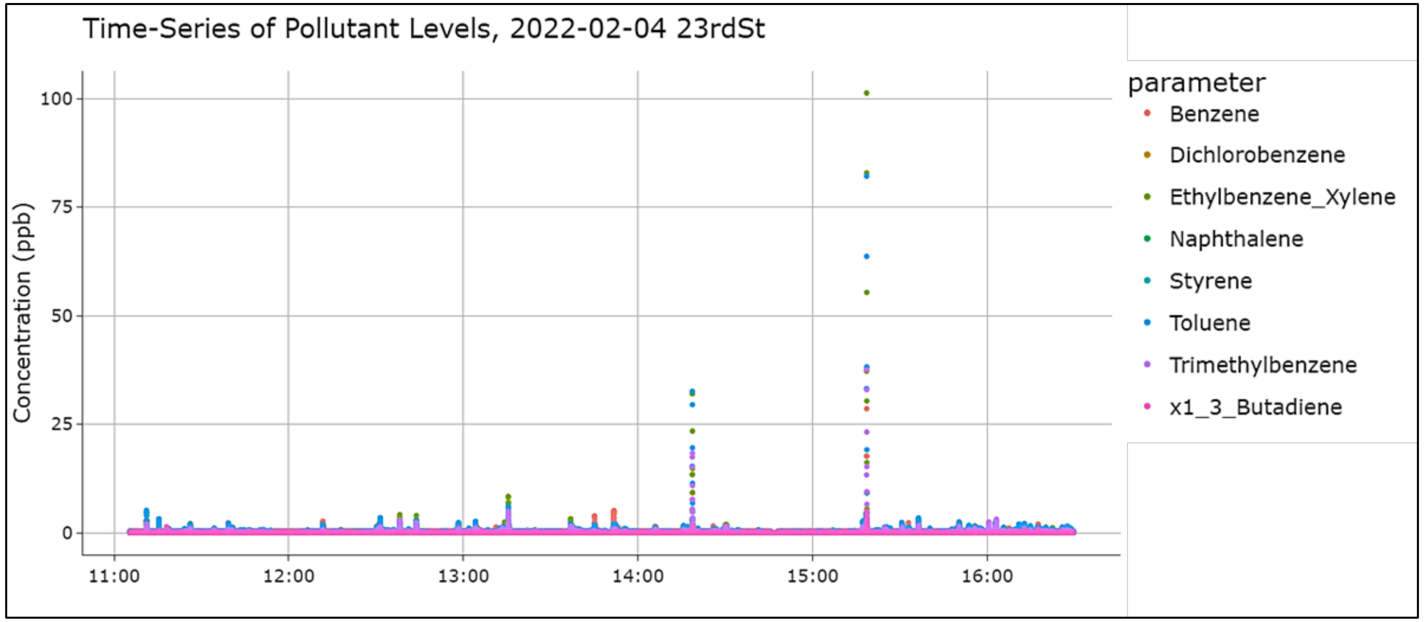
Example plots of benzene concentrations from two drive missions

Data Analysis

- Numerous short-duration, transient spikes in concentrations
- Using additional pollutants (CO, NO_x, BC, size-resolved PM counts) to help differentiate combustion vs. evaporative emissions
- Considering additional approaches to reveal local source-related impacts relative to changes in background concentrations

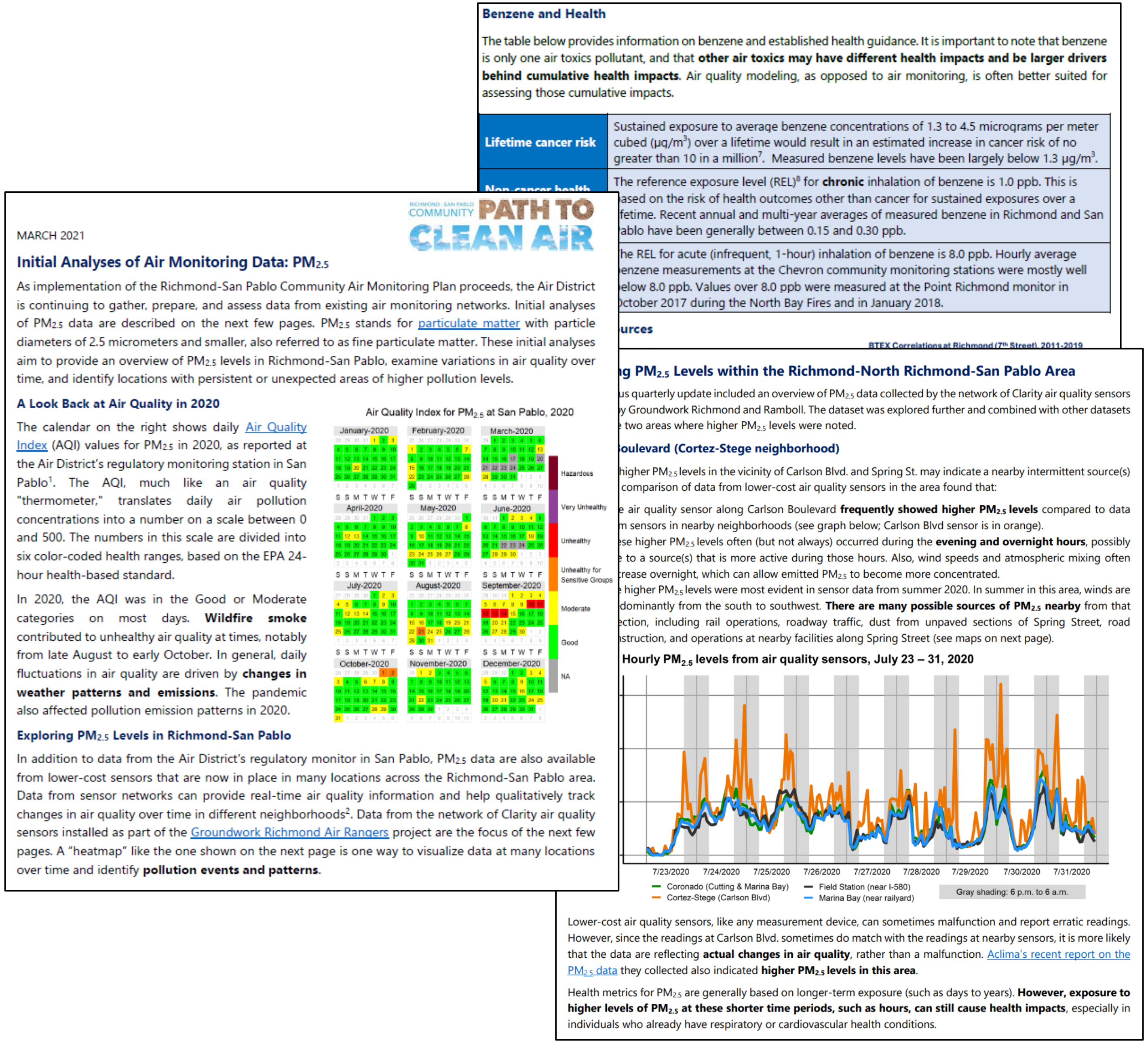






Public Reporting

- The Steering Committee selected a Monitoring Outreach Team to help design and review public-facing materials with insights from all four CAMP monitoring projects
- This team developed quarterly monitoring updates on implementation of the air monitoring plan and will create a final public-facing report on the air toxics study



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/m³) 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/m³.
Non-cancer health	The reference exposure level (REL)[8] for **chronic** inhalation of benzene is 1.0 ppb. This is ased on the risk of health outcomes other than cancer for sustained exposures over a fetime. Recent annual and multi-year averages of measured benzene in Richmond and San ablo have been generally between 0.15 and 0.30 ppb.
	he REL for acute (infrequent, 1-hour) inhalation of benzene is 8.0 ppb. Hourly average enzene measurements at the Chevron community monitoring stations were mostly well elow 8.0 ppb. Values over 8.0 ppb were measured at the Point Richmond monitor in ctober 2017 during the North Bay Fires and in January 2018.

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

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MARCH 2021

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

January-2020, February-2020, March-2020, April-2020, May-2020, June-2020, July-2020, August-2020, September-2020, October-2020, November-2020, December-2020

Hazardous, Very Unhealthy, Unhealthy, Unhealthy for Sensitive Groups, Moderate, Good, NA

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**.

g $PM_{2.5}$ Levels within the Richmond-North Richmond-San Pablo Area

us quarterly update included an overview of $PM_{2.5}$ data collected by the network of Clarity air quality sensors y Groundwork Richmond and Ramboll. The dataset was explored further and combined with other datasets two areas where higher $PM_{2.5}$ levels were noted.

oulevard (Cortez-Stege neighborhood)

higher $PM_{2.5}$ levels in the vicinity of Carlson Blvd. and Spring St. may indicate a nearby intermittent source(s) comparison of data from lower-cost air quality sensors in the area found that:

e air quality sensor along Carlson Boulevard **frequently showed higher $PM_{2.5}$ levels** compared to data n sensors in nearby neighborhoods (see graph below; Carlson Blvd sensor is in orange).
se higher $PM_{2.5}$ levels often (but not always) occurred during the **evening and overnight hours**, possibly to a source(s) that is more active during those hours. Also, wind speeds and atmospheric mixing often rease overnight, which can allow emitted $PM_{2.5}$ to become more concentrated.
higher $PM_{2.5}$ levels were most evident in sensor data from summer 2020. In summer in this area, winds are dominantly from the south to southwest. **There are many possible sources of $PM_{2.5}$ nearby** from that ection, including rail operations, roadway traffic, dust from unpaved sections of Spring Street, road nstruction, and operations at nearby facilities along Spring Street (see maps on next page).

Hourly $PM_{2.5}$ levels from air quality sensors, July 23 – 31, 2020

7/23/2020, 7/24/2020, 7/25/2020, 7/26/2020, 7/27/2020, 7/28/2020, 7/29/2020, 7/30/2020, 7/31/2020

Coronado (Cutting & Marina Bay) — Field Station (near I-580) — Cortez-Stege (Carlson Blvd) — Marina Bay (near railyard) — Gray shading: 6 p.m. to 6 a.m.

Lower-cost air quality sensors, like any measurement device, can sometimes malfunction and report erratic readings. However, since the readings at Carlson Blvd. sometimes do match with the readings at nearby sensors, it is more likely that the data are reflecting **actual changes in air quality**, rather than a malfunction. Aclima's recent report on the $PM_{2.5}$ data they collected also indicated **higher $PM_{2.5}$ levels in this area**.

Health metrics for $PM_{2.5}$ are generally based on longer-term exposure (such as days to years). **However, exposure to higher levels of $PM_{2.5}$ at these shorter time periods, such as hours, can still cause health impacts**, especially in individuals who already have respiratory or cardiovascular health conditions.

Questions?

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