Exhibit C1 - Scope of Work

1 Scope of Work

Air Rangers III is designed as a community monitoring project to fulfill the goals of AB617 with an emphasis on community engagement and benefit. The anticipated benefits, outcomes, and community improvements of this project include:

- A work plan that will ensure that the project is detailed, achievable, and in line with community air grant priorities as described in the CARB request for applications.
- Equitable public participation, local partnership building, collaboration, workforce development, and advancements in environmental justice through using broad-scale efforts and an app to gather information on community siting recommendations to ensure fair representation of monitoring in the low-income, disadvantaged areas
- Knowledge on community scale air pollution, associated source drivers, health recommendations, and education on air quality related topics that will:
    - Assist community members to understand their air pollution exposures to make informed decisions surrounding daily activities
    - Provide multi-lingual air dashboard and community-based screens provide health education, social, and economic benefits to the community
    - Provide the community with the data and tools to understand emissions sources in the community and the locations of their biggest impact to support emissions reductions strategy
    - Build community capacity through training, and educational opportunities to better understand air pollution within the community and gain transferable skills to future professional opportunities
    - Provide young people with future workforce training and opportunities that can lead to jobs in environmental science, data science, advocacy, and research; Groundwork Richmond youth will be engaged in the PurpleAir monitor deployment.
    - Highlight career opportunities in the environmental sector
    - Develop community capacity through air quality education, real-time data, and analyses.
    - Develop youth capacity through involvement with PurpleAir sensor deployment
- PurpleAir monitors will stay in the community, even after the grant program has ended; Air Rangers III will contribute to a long-term monitoring network in an environmental justice community.

The **potential challenges** of this project include:

- Monitor siting
    - Access to electricity and Wi-Fi for PurpleAir Monitors. Cellular hotspots will be purchased to mitigate this challenge for up to 10 monitors
    - Security for PurpleAir monitors

- Sensor performance
    - Environmental interferences (e.g., overheating on excessively hot days, and signal overload from wildfire smoke episodes)
    - Sensor drifts, biases, etc., which may require monitor replacement
- Modeling and model integration to display real-time information
    - Limitations in access to data such as latest emission inventories, real-time traffic and congestion, building topography, etc., which are crucial inputs to the Shair model.
    - Availability of real-time flaring information (although retrospective impact analysis will be possible via data already collected)
    - Community access to the digital environment which is mitigated by working with the community to access community screens
- Community capacity
    - Insufficient participation by community members in various aspects of community engagement such as providing suggestions for sensor locations, following and/or subscribing to social media alerts, providing feedback for improvements of Shair platform.
    - Sustainability of staff – limited resources and re-training staff
    - Community member contributions
- Reporting – language barriers
    - Deliverables will be prepared in at least English and Spanish

Awareness of these challenges will allow for conscious mitigation and a successful implementation of the project. By attaining these goals, Air Rangers III directly addresses the following **Community Air Grant priorities**:

Projects that propose/achieve equitable public participation and demonstrate local partnership building and coordination, resource leveraging, in-kind support, or other forms of collaboration.

Groundwork Richmond, Inc. is a community-based nonprofit dedicated to working with partners to train Richmond youth to understand, work to remediate and alleviate the historically disproportionate environmental burdens experienced by Richmond residents through transformative projects. Groundwork will serve as the face of Air Rangers III; act as liaison to the Richmond-San Pablo Community Air Monitoring Steering Committee; act as point of contact for community and resident inquiries and will deploy & maintain the remote sensor network in partnership with the City of Richmond.

GWR calls on community participation and donated time, in-kind contributions, and resource leveraging from a variety of partners, such as Ramboll, and the City of Richmond. Air Rangers III will solicit sensor location suggestions from the Richmond community. Community outreach for sensor siting will ensure that Richmond's new sensor network is representative of community concerns and disadvantaged neighborhoods. In addition, GWR's youth will be involved with the deployment of

sensors, guided by Ramboll and GWR's Program Manager, to facilitate community capacity building and empowerment.

The City will also facilitate the siting and permitting of air monitoring equipment on city infrastructure and facilities as necessary and assist in the coordination of both monitoring equipment installations and placement of air quality information screens with hosting sites.

In addition, GWR will leverage resources from Air Rangers I and Air Rangers II, including: the existing siting app, and Shair's existing deployment in Richmond. Air Rangers III would extend and enhance that deployment; the extension requires additional computational and cloud storage costs.

In-kind support has been offered from partners who believe in the mission and who seek to support the data analysis and consolidate all available real-time air quality data in one place to help the Richmond community mitigate exposure and better understand emissions source drivers in the community. Ramboll has offered **$40,000** in time and materials, including the incorporation of the Wildfire Smoke Module within Shair, which would estimate the $PM_{2.5}$ impact of wildfires in the community and provide historical contributions of wildfire on $PM_{2.5}$. Ramboll will also identify major sources of air pollution in the community, which includes the analysis of large amounts of data generated from the monitoring network and Shair modeling during the first 24 months of the project, and a derivation of insights related to source contributions and each and every location within the disadvantaged and low-income parts of Richmond.

In addition, the collaboration between Ramboll and GWR offers local partnership building through training and capacity building opportunities from the following project aspects:

- Air Monitoring Siting Support
- PurpleAir Monitor Deployment
- Training and Mentoring GWR's Green Team
- Air Quality (Shair) Display on Community Screens

Projects that foster workforce development (job creation and/or job training)

Air Rangers III includes several project aspects that foster training in environmental science, data science, air quality data analysis, and technical air quality expertise, science communication, science education, and community empowerment. As a direct result of the mentorship in Air Rangers I, Ramboll has hired a former member of Groundwork Richmond's Air Rangers as a Junior Engineer, concurrent with his attendance at a local community college where is studying pre-engineering with the goal of attending a University of California campus. This opportunity will increase the likelihood of his success in this field.

In addition, GWR's Green Team (youth) will support the deployment of PurpleAir sensors, under supervision by the Program Manager.

Projects that advance environmental justice within the context of California's air quality policies.

Air Rangers III will use broad-based community input, via an app, and community outreach for those without digital access, to ensure community input into siting monitors. This community outreach will result in monitoring sites that fairly represent the low-income, disadvantaged areas. Used as described below, these monitors will advance environmental justice within the context of California's air quality policies.

Air Rangers III will equip the community of Richmond with new information to better understand Richmond's air quality issues and the source of the community's environmental burden. This knowledge can help the community advocate for emissions control policies that can have a meaningful impact on air pollution, and assess the impact of CERP strategies. This information will be disseminated through social media and canvassing. Air Rangers III supports this environmental justice community's understanding of source specific pollutant emissions:

- Real time air quality data and source contribution insight in Shair
- Real time refinery emissions evaluation module in Shair, focused on flaring events, which occur within and adjacent to disadvantaged and low income neighborhoods
- Multi-lingual analysis dashboard, which will summarize spatial and temporal patterns and major influential sources ascertained from two years of monitoring and Shair modeling, so that socioeconomic disparities in exposure to pollution across Richmond's various census blocks can be clearly inferred.
- Identifying major sources of air pollution in the community, with a particular emphasis on the Chevron Refinery, which will empower the disadvantaged community to advocate for effective pollution emissions regulations.

Projects that focus on transferability of emission reduction strategies from AB 617 communities to other communities with similar sources of air pollution.

While the Richmond community has complex air quality related issues, there are other AB 617 and environmental justice communities that share the same air quality concerns as the Richmond community, such as the Wilmington, Carson, West Long Beach community (Year 1 – South Coast AQMD). The project aspects will provide insight into temporal and spatial air pollution patterns over a two-year time scale, which would likely apply to other communities with similar sources of pollution, particularly refinery flaring. The following project aspects are transferable to other communities looking to better understand their air quality issues and source information:

- A web tool to allow the community to select air quality monitor locations
- PurpleAir installation guidelines
- Wildfire smoke assessment

- Refinery flare assessment
- Air quality analysis dashboard to enhance community decision making
- Community mentorship program to build capacity in under-represented communities

CARB recommends a specific structure for this section, as described on pages 11-12 of the request for applications document. **Table 1** summarizes this structure, and where different pieces of the scope of work can be found.

Table 1. Summary of section 3

Task / Subsection	Aspect	Section within Proposal
Work plan development	**General Project Information**	**3**
	Contribution to Community Air Grant priorities	**3**
	Goals and Objective, Specific Tasks, Measures of success, Milestones, expected benefits and outcomes, and Reporting of results	**3.1**
Monitoring	**Goals and objectives**	**3.2**
	Specific tasks	**3.2**
	Measures of success	**3.2**
	Milestones, Expected Benefits and Outcomes	**3.2**
	Contribution to Community Air Grant priorities	**3**
	Reporting of results	**3.5**
	***Element 1*: Forming community partnerships**	**3.2.1**
	***Element 2*: Community-specific purpose for air monitoring**	**3.2.2**
	***Element 3*: Scope of actions**	**3.2.3**
	***Element 4*: Air monitoring objectives**	**3.2.4**
	***Element 5*: Roles and responsibilities**	**3.2.5**
	Element 6*: Analyze and interpret data *(optional)	**3.2.4**
Community engagement	**Goals and objectives**	**3.3**
	Specific tasks	**3.3**
	Measures of success	**3.3**
	Milestones, expected outcomes and benefits	**3.3**
	Contribution to Community Air Grant priorities	**3**
	Reporting of results	**3.5**
Workforce development	**Goals and objectives**	**3.4**
	Specific tasks	**3.4**
	Measures of success	**3.4**
	Milestones, expected outcomes and benefits	**3.4**
	Contribution to Community Air Grant priorities	**3**
	Reporting of results	**3.5**
Reporting	**Goals and objectives**	**3.5**
	Specific tasks	**3.5**

	Measures of success	**3.5**
	Milestones, expected outcomes and benefits	**3.5**
	Contribution to Community Air Grant priorities	**3**
Anticipated Benefits, potential challenges, and community improvement		**3**
How will the project contribute to the Community Air Grant Project Priorities?		**3**

1.1 Task 1: Work Plan Development

This proposal is for a Technical Community Air Grant. Consistent with that, **the goal** of this task is to develop a work plan with **the objective** of having a workable flexible plan that provides value to the community and contributes to the Community Air Grant Priorities. There are **two milestones** for the work plan development. A draft work plan for community and, if desired, CARB review, and a final work plan from which to build the project. **Success** will be measured on timely submission and community acceptance of the final work plan.

GWR will develop and submit a Work Plan before beginning work on the Project. We are proposing a community-led air-monitoring component and this technical Work Plan will describe how the Project will address community air pollution concerns.

The Work Plan will have the following five elements of Table E-2 from CARB's Community Air Protection Blueprint:

1. Community support and participation.
2. State the community-specific purpose for monitoring.
3. Identify scope of actions.
4. Define air monitoring objectives.
5. Establish roles and responsibilities.

1.2 Task 2: Monitoring

Air Rangers III will build upon the work accomplished in both Air Rangers I and Air Rangers II. The subscription for the existing Clarity node sensors has expired, so Air Rangers III will cost-effectively expand the existing PurpleAir network to create a long-term sensor network, available after the expiration of the grant, by purchasing and deploying 35 PurpleAir Sensors to continue to fill in air quality data gaps. The Shair model will be updated to reflect the community's most pressing concerns: wildfires and emissions from the Chevron Refinery, and the flaring in particular. Both issues have gained heightened community interest in the past two years. This will allow Air Rangers III, if granted, to provide targeted objectives to monitor wildfire smoke and Chevron refinery source variations and their impact on the Richmond, CA community. Further, new PurpleAir Air Sensor monitoring sites will increase the long-term monitoring in Richmond, and will improve resolution in the long term for the community. **Table 2**

summarizes goals and objectives, measures of Success and milestones, and benefits and outcomes for monitoring efforts.

Table 2. Monitoring Goals and Objectives, Measures of Success and Milestones, and Benefits and outcomes.

Tasks	
Air Monitoring Support	
Objectives	• **Expand the existing PurpleAir sensor network for two years, and beyond, by deploying 35 PurpleAir sensors to monitor $PM_{2.5}$**
Goals	• **Ensure that the monitors are distributed in a manner that fairly represents the low-income, disadvantaged areas using community insights and input, as described in Element 4.**
Measures of Success	• **Receiving 100 responses for request/feedback and recommendations in Community Monitor Locator Web App to placement of air monitoring sites. This will indicate the success of community outreach, with representation from a range of demographics and locations.** • **Engaging at least 30 community members during outreach activities** • **Engaging 5 GWR Green Team youth for deployment**
Milestones	• **Prepare and deploy a webpage-based tool to solicit suggestions from the community on sensor locations** • **Acquiring 35 additional PurpleAir monitors incorporated into Shair.** • **Leveraging existing PurpleAir monitors to strengthen Shair model.** • **Arrangement for co-location of sensors for performance evaluation, if possible.** • **In-situ deployment of sensors**
Benefits	• **Increase density of local scale air pollution measurements and analysis** • **Equitable public participation, local partnership building, collaboration, workforce development, and advancements in environmental justice.** • **Equitable implementation of long-term sensor network.**
Outcomes	• **Expand community air quality monitoring to better understand local scale air pollution.** • **Placing sensors at locations representative of population density, low-income areas and the demographic mix of the domain** • **Improve understanding of local scale air pollution.**
Shair Model	
Objectives	• **Use Shair's 20-meter spatial resolution data to allow community members to look at real-time hyperlocal air quality and associated source drivers for 24 months.** • **Contribute to emission reduction strategies**
Goals	• **Provide insight on source specific contributions identified at a 20-meter resolution to community members to inform their efforts at targeting specific sources for air quality improvement policies.**
Measures of Success	• **100 daily average Shair users, with representation from various demographics and locations** • **98% up-time of Shair model** • **Shair model operational within 3 months of sensor deployment**
Milestones	• **Deploy Shair** • **Demonstrate to the community how to use Shair and include the features in newsletters and social media platforms.**
Benefits	• **Overall health education, social, and economic improvements to the community.** • **Reduce daily exposure to air pollution**

	• **Better understand local air pollution impacts and their sources** • **Expand air quality knowledge in disadvantaged communities** • **Support and evaluate emissions reductions strategies** • **Assess the impact of Community Emission Reduction Plan (CERP) strategies**
Outcomes	• **Real-time monitoring will allow community members to make informed decisions about their air quality daily**
Wildfire Smoke Module	
Objectives	• **Deploy a wildfire smoke module within Shair.**
Goals	• **Estimate the impact of wildfires in the community for $PM_{2.5}$, protect community health, and plan their daily activities.**
Measures of Success	• **Presentation of Shair platform wildfire smoke module with new wildfire episodes and agency data.**
Milestones	• **Deploy the wildfire module in Shair**
Benefits	• **Better understanding of particulate matter concentrations during wildfire events.**
Outcomes	• **Continued monitoring will allow the community to explore trends more thoroughly for hotspots, and source attribution**
Refinery Source Allocation Module	
Objectives	• **Isolate the Chevron refinery source, estimate the contribution of the Chevron refinery on air quality in the community and incorporate this information into Shair.** • **Provide the community information on flaring impacts**
Goals	• **Better understand the impact of the Chevron Refinery in the community by implementing the hourly Shair model for 24-months over a 20-meter resolution and support emissions reductions programs and policy decisions associated with refineries.** • **Provide real-time or retrospective modeling or Chevron flare emissions**
Measures of Success	• **Accuracy of source allocation from the refinery – incorporate the real-time flaring emissions, if available, in Shair as a unique emission source within the refinery source**
Milestones	• **Deploy Shair refinery source module**
Benefits	• **Better understanding the impact of the refinery, in general, and flaring activity, in particular, on the community.**
Outcomes	• **Continued monitoring will allow the community to explore trends more thoroughly for hotspots, source attribution, and the effect of source control**
Shair Analysis Dashboard	
Objectives	• **Use Shair's 20-meter spatial resolution data to allow community members to look at air quality and source attribution from specific times, sources, and locations across the year in a public-facing, multi-lingual map format over a 24-month period.** • **Empower community to advocate for their own pollution reduction measures by aiding in identification of influential sources**

Goals	• **Provide insight on source specific contributions identified at each sensor location to look at air quality patterns over space, time, seasons, and locations with a multilingual dashboard**
Measures of Success	• **Use of Shair platform data for community presentation** • **Presentation of data in additional language(s) identified by the community** • **At least 100 dashboard users in the community**
Milestones	• **Development of multilingual dashboard** • **Disseminate into the community**
Benefits	• **Overall health education, social, and economic improvements to the community.** • **Benefit from the knowledge on community scale air pollution, health recommendations, and education on air quality related topics and assist community members in making informed decisions surrounding daily activities** • **Community members will become active partners with the government to identify, evaluate, and ultimately reduce air pollution and harmful exposures within their community.**
Outcomes	• **Analysis dashboard will allow the community to better understand local scale air pollution and source drivers**

1.2.1 *Element 1: Forming Community Partnerships*

Air Rangers III monitoring efforts will closely rely on Community members' first-hand knowledge that is vital for understanding and addressing local air quality challenges in their community. As exemplified by Air Rangers I and II, community involvement with the program led to an effective and reliable community-focused monitoring program, adoption of the program by the BAAQMD Monitoring Outreach Team (MOT), and mentorship of Groundwork Richmond Youth. One example of our success in this with past Air Ranger grants involves a Groundwork Richmond Air Ranger who joined the MOT and CERP Steering Committees as a high school senior. His involvement and passion for community air quality stemmed from the previous grant, and this mentorship and support will continue to be a goal of Air Rangers III.

Ramboll has prepared quarterly updates for the MOT (found on the BAAQMD Community Air Monitoring Work and Materials site here), which have been invaluable to support their monitoring strategy. This information has been passed to the CERP Steering Committee and results are used to inform effective emissions reduction strategy. Ramboll and Groundwork Richmond have worked closely with the following steering committee members: Kevin Ruano Hernandez, Kevin Olp, Daniel Alrick. Air Rangers III will continue this spirit to assess the impact of these strategies on emissions, in addition to providing the community with a long-term sensor network and improving the understanding of major sources, such as the Chevron Refinery and Wildfires. Specific tasks that foster community partnerships are described below:

1. Air Monitoring Planning and Siting Support

   First and foremost, Air Rangers III will facilitate synergies in monitoring, exposure assessment, and community engagement with the original Air Rangers project. Air Rangers III leverages a skilled staff and trained group of local youth who will have

had more than a year of trial-and-error in engaging the community in air quality measurement in the Richmond community. Input on air monitoring locations will be received from concerned residents through the web-tool. Resident input will be vetted by a team of air quality experts from Ramboll and Groundwork Richmond staff. Community feedback will be reviewed, and a thorough assessment of potential major and minor challenges and problems will be considered prior to selection of the potential monitoring sites. This will enhance siting the monitors so that they fairly represent the low-income, disadvantaged areas.

2. Professional Partnerships and In-Kind Support

   In-kind support has already been offered from partners who believe in the mission and who seek to support the data analysis and consolidate all available real-time air quality data in one place to help the Richmond community mitigate exposure and better understand emissions source drivers in the community. Ramboll has offered upwards of $40,000 in time, expertise and materials leading to specific benefits such as the development of the Wildfire Smoke Module and Identifying Sources of Air Pollution within Ramboll's Shair Platform.

3. Community Steering Committee

   Ramboll will continue to engage with the CERP Steering Committee to assess the impact of emissions reductions strategy. This analysis will be supported with the analysis dashboard, summarizing 24 months of air quality and source contribution. The MOT made a unanimous decision to adopt the Ramboll Shair monitoring network in the Richmond-San Pablo Community Air Monitoring Plan in 2019. Air Rangers III will continue to facilitate synergies with the CERP Steering Committee.

4. Contact Personnel

   The project contact persons for any questions on the planned technical work will be:

   - [redacted]

1.2.2 *Element 2: Community-Specific Purpose for Air Monitoring*

The city of Richmond is home to a unique and complex set of air pollution emissions sources, including Chevron refinery, the state's largest oil refinery, two major interstate highways, metals processing, a commercial port, and considerable wintertime residential heating, among others. There have also been numerous fires affecting the community over the past few years, particularly the Sims Metal Fire and the junk yard fire. Concerns from the community regarding the wildfire smoke has been rising due to increasing wildfire impacts over recent years in Northern California. The City of Richmond does not host a BAAQMD-sponsored regulatory PM monitor --the closest is in neighboring San Pablo. The City does have three high-grade community air monitors near the perimeter of the refinery, but these monitors leave considerable areas of the city's most vulnerable neighborhoods unmonitored, especially those to the east near

Richmond's major freeways. Below is a summary of the five specific purposes for the proposed air monitoring plan:

1. Increasing the number of monitors in disadvantaged areas that will continue to gather data after Air Rangers III is completed.
2. Provide community members with highly localized air quality information in near-real time by developing:
   a. Wildfire Smoke Module: to protect public health by helping the community understand the impact of wildfires in the community.
   b. Refinery Source Allocation Module: Help the community understand the impact of the refinery, in general, and flaring from the refinery, specifically, on the community to ultimately support emission reductions.
3. Shair Analysis Dashboard: provide community members with analyzed data and insights in multiple languages with long- and short-term data available throughout the disadvantaged and low-income communities
   a. Identifying major sources of air pollution in the community: to provide insights on source specific contributions to community air quality.
   b. Air quality assessment of the air monitoring data: analyze large amounts of data collected during the project and provide meaningful results.

In order to increase monitoring coverage across the Richmond neighborhoods, Air Rangers III is planning to install 35 additional PurpleAir sensors in these areas to continuously estimate concentrations of particulate matter smaller than 10, 2.5, and 1.0 microns in diameter (PM10, $PM_{2.5}$, and PM1, respectively). Measurements from these PurpleAir units, and the existing PurpleAir sensor network are used to anchor the results of a 20m x 20m resolution air quality model, the results of which are and will be visualized and provided to the community.

1.2.3 *Element 3: Scope of Actions*

Air Rangers III aims to support air quality monitoring directly relevant to the needs of concerned and disadvantaged community members. We propose a meaningful expansion and extension of both Air Rangers and Air Rangers II in the following ways:

- Distribute a Community Monitor Locator Web App to community to gather updated feedback on sensor installation and empower GWR staff to further outreach to those on the other side of the digital divide and ensure that the monitors fairly represent the low-income, disadvantaged areas.
- Substantially increase the PurpleAir sensor network by deploying up to 35 additional PurpleAir sensors and leveraging existing PurpleAir sensors to monitor $PM_{2.5}$.
- Train community members to site and install PurpleAir monitors according to the locations recommended by the Community Monitor Locator App and confirmed by the air quality and community experts at Groundwork Richmond and Ramboll
- Use Shair's 20-meter spatial resolution data to allow community members to look at near real-time air quality, and historical air quality in a multilingual public-facing intuitive map format over a 24-month period.

- Help the community understand the impact of wildfires in the community for $PM_{2.5}$, protect community health, and plan their daily activities.
- Help the community understand the overall impact of the Chevron Refinery, and refinery flaring, (ideally in real-time) in the community and support emissions reductions programs and policy decisions associated with refineries.
- Determine the average percent composition of contributing sources on an annual, daily, and hourly basis for inspection by the community at a 20-meter resolution to inform community efforts at targeting specific sources for air quality improvement policies.
- Provide community outreach to disseminate this information both for those with access to digital devices and those without access to digital devices.

1.2.4 *Element 4: Air Monitoring Objectives*

Air Ranges III is designed to provide the community with air quality data, when and where they want it in an intuitive, user-friendly, and language inclusive dashboard plus alternatives for those across the digital divide. It is also designed to better inform them about Chevron events that can impact air quality to respond to concerns raised at community steering committee meetings. Finally, it will provide the community with better information on the impacts of wildfires, and how to respond to the increasing impacts of climate change on air quality.

This grant combines monitoring with a powerful model that allows the community to really use the monitoring data to effectively reduce air pollution impacts by identifying the sources of pollution in the community. Measurements serve the purpose of providing air quality estimates at specific points in space and time. Models, when anchored in measurement, as this program proposes, serve to fill in the gaps between where those measurements were taken and, importantly, can provide information on why the air quality is the way it is. This creates insights on exposure-critical emissions sources which is especially important for communities like Richmond that are affected by many varied emitters. After two years of measurement and model production, we will have an incredibly rich dataset with which to help diagnose highly impacted areas and likely contributors.

Keeping in line with the objectives above, the tasks and methods of our monitoring plan are outlined below:

Monitoring Siting

Sites will be chosen from those proposed by the community combining information on potential sources of $PM_{2.5}$ and related community exposures, locations of disadvantaged and sensitive communities, potential for identifying and characterizing areas experiencing disproportionate air pollution impacts, and the ability to provide real-time data useful to the community. Once general sites are chosen, the suitability of these sites will be critically reviewed during physical field visits by GWR and moved slightly as needed. Technicians will be coached and training in selecting scientifically valid mounting points, utilizing siting methods influenced by the Imperial County

Community Air Monitoring Project[1,2], and US Federal Siting protocols[3]. **Figure 7** shows a map of the CalEnviroScreen 3.0[4] results of census tracts that are disproportionately affected by air pollution, overlaid with the locations of current online PurpleAir sensors. The census tracts that are most adversely affected by air pollution, >90% level in Richmond (red) have no PurpleAir sensors when they are the communities that would benefit the most from having real-time measurements. Monitor locations will attempt to fill in the gaps of the PurpleAir sensors already available and target the communities that have higher relative burdens of air pollution and are lower income. GWR will also communicate with multiple entities to provide reference monitoring data for sensor data quality check and post processing process described later in this section.

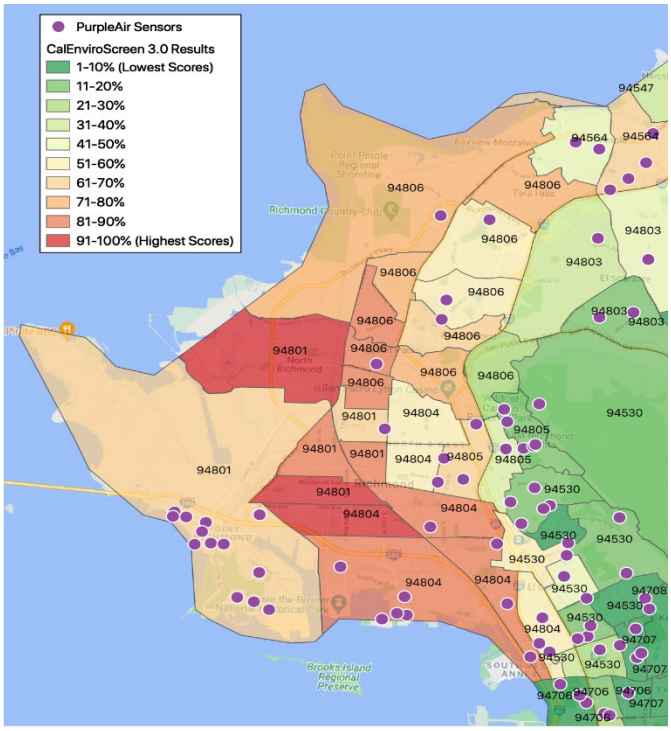

Figure 7. Outdoor PurpleAir sensors online as of 2021-09-23 in the Shair modeling domain, overlayed with the CalEnviroScreen 3.0 results with ZIP codes labels.

PurpleAir Specifications

The PurpleAir monitoring network consists of low-cost air pollution monitoring devices deployed in the U.S. and worldwide beginning in 2017. Overall, PurpleAir PA-II sensors

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1 Wong et al. 2018. Combining community engagement and scientific approaches in next-generation monitor siting: the case of the Imperial County Community Air Network. International Journal of Environmental Research and Public Health. 15:523.

2 For example, priority regions of Richmond were selected after viewing maps and considering various local demographics, the community was engaged in site identification, and monitor deployment is occurring slowly and steadily, which allows for the team to observe increasingly local trends and identify any potential gaps in the proposed siting before all sensors have been deployed. This gives an effect similar to the 2-phase monitor siting used in Imperial County.

3 For example, consideration and quantification of the amount of restricted flow around each monitor and consideration of distance to the nearest obstruction.

4 CalEnviroScreen 3 0 https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30

show excellent accuracy compared to reference $PM_{2.5}$ measurements (i.e., R^2 ~ 0.93–0.97) over a concentration range of 0 to 250 $\mu g \cdot m^{-3}$. Sensor specifications are outlined in **Table 3**. Further lab evaluation of the PurpleAir sensors were conducted by the South Coast Air Quality Management District (AQ-SPEC team) and other research groups[5].

Table 3. PurpleAir Sensor Specifications

Sensor	Resolution	Range	Precision	Accuracy
PurpleAir PA-II (PMS5003)	**1 µg/m³**	**0 - 500 ug/m³**	**Correlation (R^2) between PurpleAir sensors > 0.9**	**Correlation (R^2) with regulatory monitor > 0.9**

$PM_{2.5}$ Measurement Methods

In keeping with these objectives, the pollutant of interest for this proposal is $PM_{2.5}$. Measurements will be conducted over the course of at least two years to account for seasonal trends and variability that may exist in emissions sources and meteorology. The primary method used for assessing $PM_{2.5}$ concentrations will be the 35 newly deployed PurpleAir Monitors that will be placed throughout the City, combined with leveraging the existing network of PurpleAir sensors around the community. PurpleAir Monitors are AC powered and require stable Wi-Fi connection to stream information on the PM concentrations continuously about every 10 minutes. $PM_{2.5}$ concentration estimates from these sensors will be treated signal adjustments that account for calibration factors using co-located reference monitor data if available, local atmospheric changes (i.e., Temperature (T) and Relative Humidity (RH)) in aerosol properties, if co-location data is available. PurpleAir sensors are optical particle counters and house laser-based particle counters that detect and resolve particles into different size bins (e.g., 0.3, 0.5, 1.0, 2.5, and 10 μm). Data report frequency for $PM_{2.5}$ measurements is about every 10 minutes. Spatially dense installation of PurpleAir sensors, combined with high temporal reporting resolution, will aid in capturing spatial and temporal patterns of $PM_{2.5}$. Further, deploying the sensors for a 24-month period will inform long-term representative patterns such as seasonal variations and meteorological influences. PurpleAir sensors will be stationary in order to track seasonal variations of pollutant concentrations. Information on seasonal variations is critical to building actionable insights for mitigating pollution hotspots particularly those that are variable. PurpleAir's high measurement frequency is able to capture the periodic features of pollution concentration change in time, resulting in up to 1.7 million data points per year.

Sensor Performance Data

Below are results of collocated measurements between multiple Clarity Nodes previously deployed in the Richmond city under Air Rangers II grant objective, PurpleAir, and BAM 1020, and eBAMs at the CARB 1309 T Street regulatory monitoring

[5] AQ-SPEC. Evaluation Summary Purple Air PM Sensor; Air Quality Management District: Diamond Bar, CA, USA, 2017.

site in Sacramento, CA. Over this period, PurpleAir sensors show good agreement with the BAM 1020, and appear to have more stability than the eBAM (**Figure 8**). From this month-long collocation, the mean R^2 between PurpleAir and the BAM was 0.65 (corresponding R^2=0.52 for Clarity nodes) (**Figure 9**), with root mean squared error of 1.8 ug/m^3.

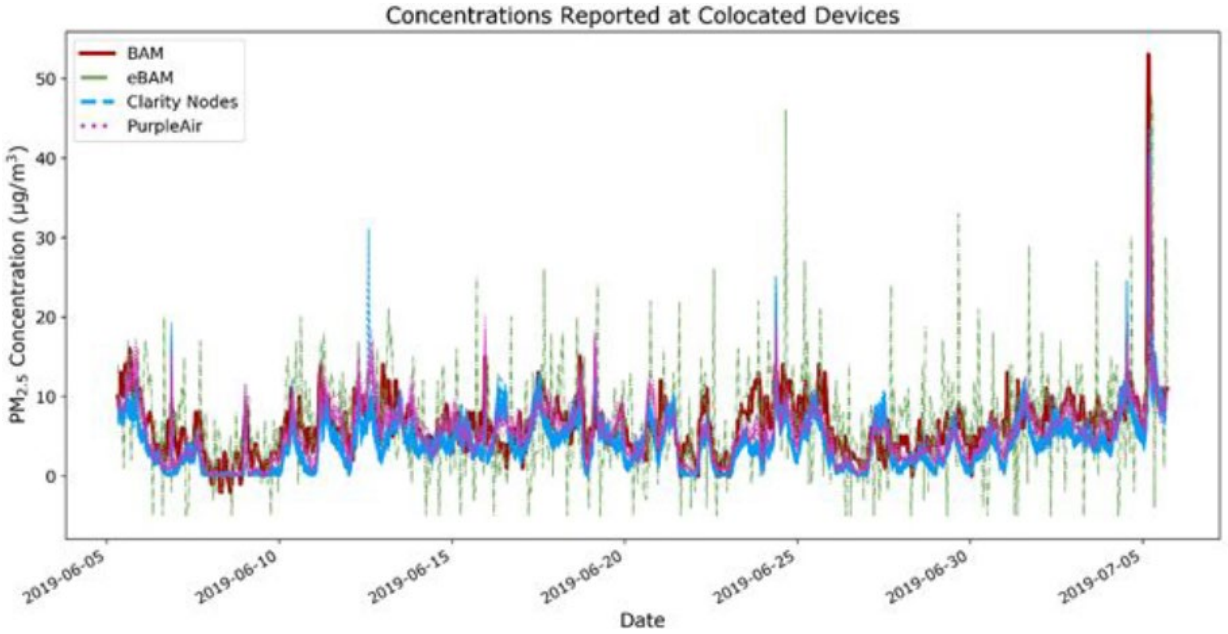

Figure 8. Time series of a month-long collocation between multiple PurpleAir sensors, Clarity sensors BAM 1020, and eBAMs at the CARB regulatory monitoring site in Sacramento, CA.

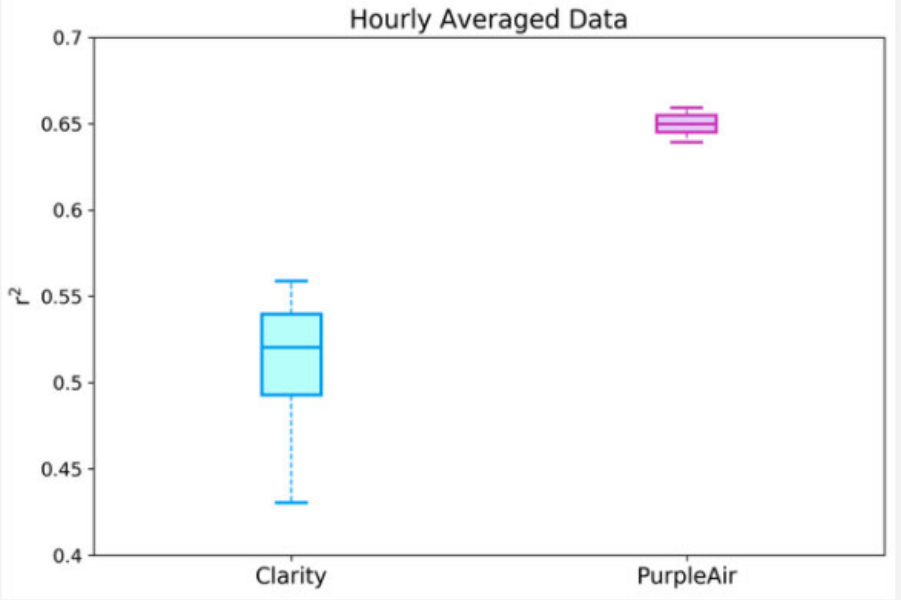

Figure 9. The distribution of correlations (r^2 values) between hourly average estimates produced from individual monitors as compared to BAM output.

Sensor Deployment

The PurpleAir sensors require electric power and Wi-Fi connections. We will first solicit suggestions from the community members for locations of these sensors, and from the suggestions received, we will select sites that are representative of the socio-economic characteristics of the community, while also considering sources (e.g., freeways, stationary sources, etc.), sensitive receptor locations (e.g., schools, hospitals, old age homes), reference monitors and existing sensor locations. In addition, Wi-Fi, power and security will be considered. Ten hotspots will be purchased to expand the potential deployment locations. While the co-location study with reference monitor(s) prior to field deployment is not critical for the network, there would be additional quality assurance if a performance evaluation could be completed. Data from the CMS is available on-line and we would work to use that data with the goal of conducting a co-location study, which will be further developed in the work plan.

Real-time Quality Assurance of PurpleAir Data

Given the importance of sensor data calibration and quality control, we will use a two-step approach to post-process hourly PurpleAir $PM_{2.5}$ data to minimize the impact of sensor malfunction, intra-sensor bias, and environmental and operational parameter impact. This approach will apply systematic quality control for the sensor readings.

A comprehensive description of the quality control method used in this study can be found in Lu et al.[6] More details including various statistical indicators can be found in the methods section of the mentioned study, but in summary, the systematic quality control consists of five steps:

a. remove malfunctioning sensor data based on a low frequency of change (i.e., 5 h moving standard deviation of zero) in their readings across time.
b. discard apparent $PM_{2.5}$ outliers with extreme hourly values that exceed the sensor's effective measurement range in both channels;
c. identify periods of prolonged interruption or data loss due to power outages or data communication loss using a 75% completeness criterion (four or more 10 min measures per hour and 18 h or more in a day);
d. evaluate the degree of agreement from dual-channel readings for each sensor within a given month of operation based on calculated statistical anomaly detection indicators as the coefficient of determination $R^2 > 0.8$ and mean absolute error < 4 ug/m^3. Given the reported saturation issues of PurpleAir sensors at high particle mass loadings (>50 µg/m^3), leading to higher measurement bias and uncertainty in the mean absolute error indicator, mean absolute percentage error > 0.3 is adopted as an additional criterion to handle the sensor's measurement limit at high particle mass loading;
e. in case of sensor data reported only from one channel, a linear regression of hourly readings for each sensor with its neighboring sensors within 3 km is performed and data from sensors with $R^2 < 0.6$ or having no neighboring sensors within 3 km is discarded from the analysis.

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[6] Lu Y, Giuliano G, Habre R. Estimating hourly PM2.5 concentrations at the neighborhood scale using a low-cost air sensor network: A Los Angeles case study. Environ Res. 2021 Apr; 195:110653. doi: 10.1016/j.envres 2020.110653. Epub 2021 Jan 18. PM D: 33476665.

f. correction for wildfire smoke impacts using the U.S EPA U.S. wide correction equation for PurpleAir sensor data[7].

Using the above-mentioned process for PurpleAir sensor data quality control, multiple field studies have shown that the regression between post-processed PurpleAir data against U.S. EPA's air quality system (AQS) data was improved significantly with fewer spikes detected in original sensor data against AQS data. Further, the quality-controlled data had a more robust dual channel agreement with the AQS data.

Post-processing of PurpleAir Data

In addition to the real-time corrections and quality checks described above, we will also work to perform the following additional data corrections after the end of the monitoring phase. Additional corrections and insights achieved from this post-processing will be used in reporting results via the Shair Analysis Dashboard (Section 3.3), and the final report submitted to CARB.

Based on reference monitor data, if available for the full year, we could derive dynamic correction factors as functions of environmental conditions such as relative humidity and temperature for each PurpleAir sensor[8]. These factors would then be calculated and applied retrospectively to the entire multi-year monitoring dataset generated from the sensor network. This added quality check would enable us to exclude environmental influences on sensors that may have resulted in apparent spatial and/or temporal variations.

Shair Dispersion Model Specifications

Ramboll's air quality model (simply called "Shair" for 'share the air') adds value to sensor network data by uncovering actionable insights into contributing emission sources and adds value to traditional models by anchoring model output in measurement and other real-time data (such as sensor data, reference data, meteorology, and traffic data) and incorporating a high-resolution street canyon model. The model is sensor-agnostic and can ingest information from air quality monitors, as well as real-time data that help characterize local emissions inventories, such as traffic. Shair operates in the cloud to translate large and unwieldy quantities of air quality data into the information needed to influence action and mitigation efforts by the city and air pollution control agencies. Shair is built on a backbone of the Comprehensive Air Quality Model with extensions (CAMx: www.camx.com), an EPA accepted regional air quality model with an in-house street-level urban pollution model called "Shairstreet."All of this is performed on Google Cloud Platform in the cloud for increased speed and reliability. The technical details about the underlying models used in Shair are accessible in the openly accessible Shair whitepaper.

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7 Johnson, K., A. Holder, AND A. Clements. Development and Performance Validation of U.S. Wide Correction Equation for PurpleAir Sensor Data. AirNow Sensor Data Pilot Webinar, Research Triangle Park, NC, September 16, 2020. Avaialbe at https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=350075&Lab=CEMM

8 Incorporating Low-Cost Sensor Measurements into High-Resolution PM2.5 Modeling at a Large Spatial Scale Jianzhao Bi, Avani Wildani, Howard H. Chang, and Yang Liu Environmental Science & Technology 2020 54 (4), 2152-2162 DOI: 10.1021/acs est.9b06046

Information from the PurpleAir deployed sensors and existing sensor network will be fed as inputs to the Shair model for uniform spatial enrichment and source apportionment. As described in detail above, Shair uses a mixture of validated scientific models such CAMx (for regional chemistry), Weather Research and Forecasting (WRF; for meteorology and weather), Shairstreet (pollutant dispersion around the built environment), and real-time traffic congestion data to produce a real-time map of pollution concentrations at high spatial resolution (20 meters), with source apportionment analysis showing major sources influencing the air quality at each location. The final output of Shair model is a nearly real-time look at $PM_{2.5}$ concentrations estimated at 20m x 20m spatial resolution, and these estimates are tethered to the actual measurements produced by any and all sensors within the domain (PurpleAir and reference-grade instrument(s)). The performance of the Shair model is thus greatly strengthened by the presence of sensors in the domain. **Figure 10** demonstrates the capability of the Shair model applied in Richmond, CA, where nearly 50 Clarity sensors are used as inputs to the model.

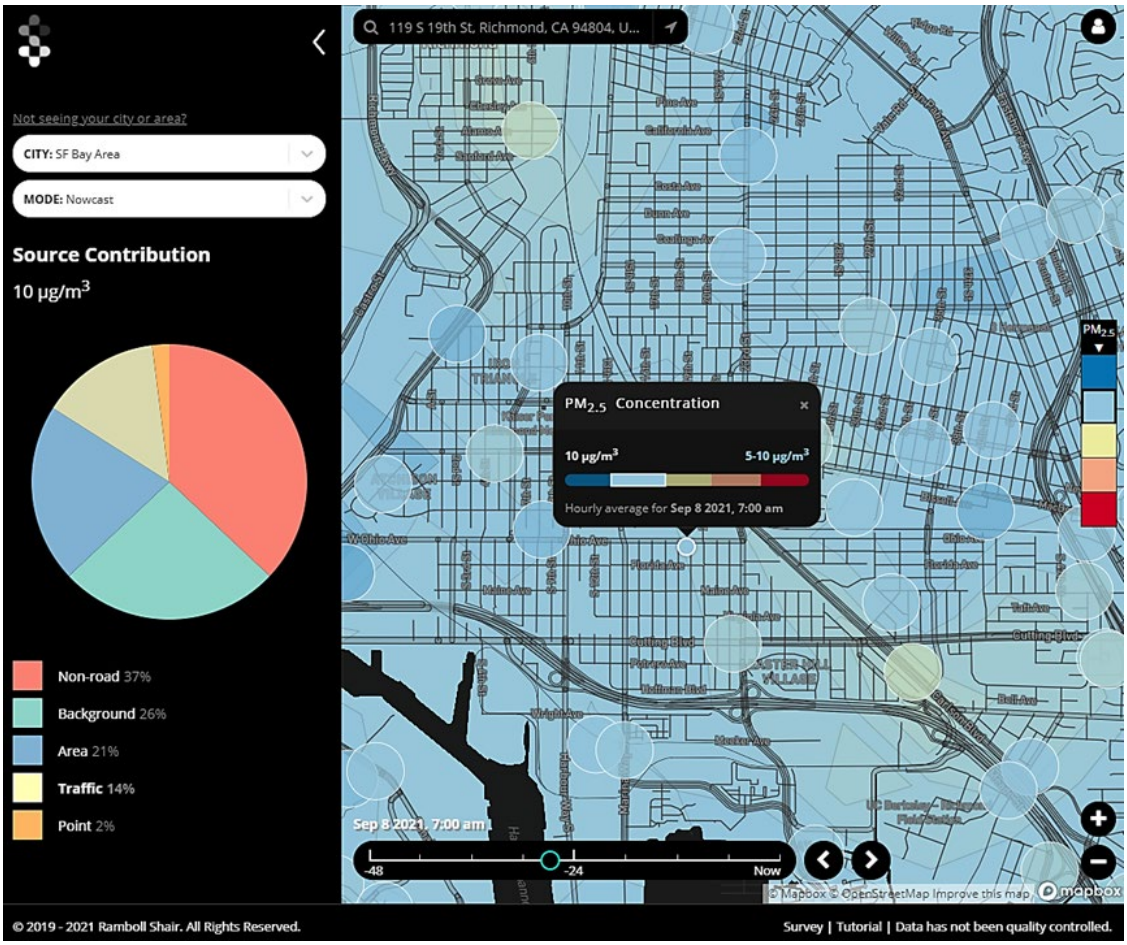

Figure 10. A demonstration of the interactive Shair module, showing real-time $PM_{2.5}$ concentrations in Richmond, CA monitored by a network of Clarity sensors, as well as real-time source contribution analyses at any user-specified location.

Shairstreet is the roadway component of Shair. It is composed of three main modules: a) an urban street canyon model, b) a reduced complexity NOx chemistry model, and c) a dispersion model for pollutant concentrations away from the roadways. The urban street canyon model accounts for the effects of the built environment on traffic pollution dispersion, which is especially of importance for commercial city centers where adjacent tall buildings can trap polluted air between them, and/or cause recirculation. Capturing the complexity of wind flow patterns in street canyons is thus essential to understanding how pollutant concentrations change on streets and sidewalks - where exposure is potentially high - and how they move through the built environment. The default Shairstreet street canyon model was developed at Ramboll and is based on the operational street pollution model (OSPM), a semi-empirical model developed by researchers at the National Environmental Research Institute of Denmark. OSPM has been updated and used widely over the last 20 years or so. It operates under the assumption that pollutant levels in a street canyon have three major contributors: direct contributions from vehicle tailpipes as affected by ground-level wind, contributions from pollution in air that is recirculated by a well-mixed vortex generated inside of the canyon, and background concentrations above the street canopy.

Shairstreet's default street canyon model assumes that vertical dispersion is governed primarily by mechanical turbulence with thermal stratification ignored, and that street-level mechanical turbulence is created by street level wind and traffic in the street. Real-time vehicle counts and average vehicle speeds for all roads - which are based on speed and congestion data - are used as inputs for calculating street level vertical turbulence. The traffic induced turbulence is especially important on windless days, when the ambient turbulence is small, in determining pollutant concentrations. The street level wind speed is derived from canopy-level wind speeds from WRF, and is calculated assuming a logarithmic reduction of wind speed over vertical distance. Traffic-induced turbulence is characterized in the same approach as OSPM, which accounts for flow distortion and related turbulence produced by vehicles moving on the street. For roads without adjacent buildings, street level concentrations are assumed to be affected by only the surface level wind and traffic-induced turbulence.

Atmospheric dispersion of a point source can be well-modeled using Gaussian dispersion principles. Estimated dispersion from line sources (e.g. roadways) is only appropriate when wind flow is perpendicular to the line source, which is not always a reality. Some models, like AERMOD, use a high number of point and area sources to approximate line source dispersion, but this is computationally expensive when the road network being modeled is large. Instead, Shairstreet employs a computationally efficient method for approximating Gaussian line source dispersion based on work published by researchers at the University of California, Riverside and National Center for Atmospheric Research[9]. This method has been shown to produce small, acceptable errors when compared to an exact solution. The resulting dispersed concentration values are then used to inform the concentrations of pollutants in nearby grid cells of the Shair model.

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[9] Venkatram A, Horst TW. Approximating dispersion from a finite line source. Atmospheric Environment. 2006 Apr 1;40(13) 2401-8.

Supporting Measurements

A major innovation of the Shair model is its integration of near-realtime measurement data from both regulatory and sensor-based monitors to reduce model bias. All pollutant concentrations modeled by Shair are compared to measurements taken across the modeled domain. Biases discovered in Shair output are then adjusted for. The most recent measurements available (typically during the hour of estimation or shortly before) are automatically called via API from all available sensors and regulatory monitors within the modeling domain. Values at locations between these measurements are interpolated using objective analysis methods like Voronoi nearest neighbor interpolation to produce an estimate of air quality at every point throughout the modeled domain. The difference between the values rooted in measurements and the Shair modeled values are compared at each point to produce an estimate of Shair bias. Shair output is then adjusted for that bias prior to production of the final Shair model output. As a result, Shair's model output is anchored in near-real time measurement data.

One issue faced by community members and policy makers relying on data in near-realtime information is that scientists have not had a chance to manually verify values or to check for false peaks and troughs. The result can be misinformed decision making, especially when folks are worried about acute exposure events. Our team has developed an automated process for flagging and removing values with a high likelihood of being outliers. The default parameters of this process are robust but can be easily adjusted according to concerns of the grantor agency. Once flagged, measurement data will be excluded from immediate integration with Shair but could be manually examined.

Analyze and Interpret Data

We will use a variety of data analysis procedures to ingest the raw data produced by the network of sensors, including but not limited to the following examples:

- Time series analyses of deployed sensors to ascertain general temporal patterns such as diurnal, weekly, seasonal patterns.
- Geospatial analyses of deployed sensors to ascertain spatial patterns, near-source dispersion extents, and influential sources.
- Real-time Shair modeling to increase the spatial resolution of the $PM_{2.5}$ map produced by the sensor network, as well as source apportionment:
    - For the Chevron refinery, in general, and flaring events, in particular
    - For the impact of wildfires

For data analysis after the data has been gathered, we will use open-source data analysis tools such as R and Python to make our methods fully transparent and create a freely accessible resource for community members aspiring to learn environmental data analysis skills.

Shair Wildfire Module

Air Rangers III proposes to include a wildfire smoke module within the Shair model. This feature would estimate the impact of wildfires in the community for the $PM_{2.5}$ map and provide the user historical contributions from wildfire smoke. This can help the community better understand the need for "clean air centers" during wildfire season. The Wildfire Module would estimate the impact of wildfires in the community for the $PM_{2.5}$ map and provide historical contributions from wildfire smoke that the user can select. For example, a community member could toggle to show the current impact of wildfires on PM concentrations and view the previous hour, day, week etc. This insight would be used to protect community health. Users would be able to plan their daily activities based on the Shair map. Because Shair is near-real time, users can use historical patterns of smoke to predict where the smoke is likely to be in the future.

Wildfire smoke forecasts will be integrated from the High Resolution Rapid Refresh for smoke (HRRR Smoke) model for near-surface $PM_{2.5}$ concentrations [10]. HRRR Smoke simulates PM from wildland fires in real time on a 3-km resolution grid over the entire contiguous United States and is initialized four times per day to forecast smoke concentrations for the next 36 hours. The Shair model will process the most recent available HRRR Smoke forecast and will be included as a separate source contribution viewable on the web app.

Refinery Source Allocation Module

In order to better understand the impact of the Chevron refinery in the community, Ramboll will isolate the Chevron refinery from other sources in the community and show the estimated real-time contribution of the Chevron refinery on air quality in the community. The Ramboll Shair model can calculate source contribution at any location in real-time. In addition, Air Rangers III will investigate the availability of real-time flaring data from the Chevron refinery. If real-time data can be made available, we propose to model flaring in real-time to allow users to see flaring impact on a real-time basis. If the data cannot be made available on a real-time basis, alternative methods to obtain the data will be investigated, including community reporting.

Real-time flaring information may be available through the Contra Costa County Health Services (CCHS) Department. The CCHS's policy[11] "promotes prompt and accurate reporting of releases or threatened releases of hazardous material that may result in injury or damage to the community or environment." This notification is conducted through the Community Warning System (CWS). The same policy states that immediate notification is required for any "event may cause general public concern, such as in cases of fire, explosion, smoke, or flaring". According to this policy, alerts may be found at www.cococws.us. GWR will work with CCHS to find the most reliable, complete information on flaring to determine whether a real-time flaring model will be possible.

[10] https://rapidrefresh.noaa.gov/hrrr

[11] https://cchealth.org/hazmat/hmc/pdf/2021-0225-attachment4.pdf

At a minimum, we will conduct a retrospective analysis of the data to evaluate the impact of flaring based on data currently available on flaring events from the Bay Area Air Quality Management District. This module can be used to support emissions reduction programs and policy decisions associated with refineries in general.

Shair Analysis Dashboard

The dashboard will be a product of this grant that is specifically intended to promote emissions reductions programs. The high spatial resolution of Shair's data allows for community members to look at air quality from specific times and locations across the year. We will build a dashboard for intuitive visualization of the 24 months of air quality data. For example, an individual could use the dashboard to view the average $PM_{2.5}$ concentration between 8-9 a.m. Monday through Friday when their child walks to school. Additionally, they could view the average percent composition of contributing sources (traffic, area, point, background, and non-road). This visualization will be presented in additional languages, designed for ease of use for community members. Data would also be available at all monitoring stations, showing the estimated and observed concentrations. We will then distill and disseminate this information for distribution to the community to better inform their efforts at targeting specific sources for air quality improvement.

1.2.5 *Element 5: Roles and Responsibilities*

Groundwork Richmond

Groundwork Richmond, Inc. is a community-based nonprofit dedicated to working with partners to train Richmond youth to understand, work to remediate and alleviate the historically disproportionate environmental burdens experienced by Richmond residents through transformative projects. Groundwork will serve as the face of Air Rangers III; act as liaison with ARB; prepare semi-annual reports for ARB; oversee subcontractors; invoice ARB; pay contractors; act as liaison to the Richmond-San Pablo Community Air Monitoring Steering Committee; act as point of contact for community and resident inquiries and will deploy & maintain the remote sensor network in partnership with the City of Richmond.

Ramboll

Ramboll (www.ramboll.com) is an international company based in Denmark, with a strong California contingent. Ramboll includes over 16,000 scientists and engineers in 300 offices around the world. Ramboll excels at combining local experience with a global knowledgebase and has previously worked with both Groundwork Richmond and the City of Richmond, as well as many key stakeholders associated with the project, including CARB, BAAQMD, and the CAM Steering Committee.

Ramboll's world-wide air quality group has extensive experience in air quality monitoring, management, and modelling. Multiple team members and advisors are internationally recognized air quality experts with over 25 years of experience in air quality modeling and monitoring work. The Ramboll air quality group has experience in a wide range of air quality topics such as regional air quality planning (under state,

federal, and international cross-border frameworks), photochemical model development (Ramboll developed CAMx), local air dispersion modeling (Ramboll modelled pollutant concentrations across the city of San Francisco using AERMOD and developed the street pollution model Shairstreet), cloud-based air quality modelling (Ramboll developed Shair), air quality data analytics, atmospheric chemistry, emissions inventories, air quality monitoring and management (designing and managing monitoring programs with real-time health metric outputs), land use entitlement (Ramboll developed the widely used software package CalEEMod for estimating emissions for land-use development projects), and regulatory/policy development.

Ramboll will work with Groundwork Richmond and the City of Richmond to deploy the new PurpleAir sensors and develop public information for Groundwork's outreach material. Ramboll will refresh Green Corps members on the use and maintenance of PurpleAir sensors, develop a wildfire module to estimate PM impacts from wildfires, develop a refinery flaring source attribution module within Shair to better understand the impact of the Chevron refinery in general and flaring, in particular, present Air Rangers III data to Groundwork for the CERP Steering Committee, implement improved source attribution in the Richmond application of the Shair model, and mentorship in data science career awareness. Ramboll will maintain the Richmond implementation of the Shair model for two years including cloud storage and compute costs, deliver model output to the Community via the Shair app on an hourly basis, and lead the analysis of data collected during the Air Rangers III project for presentation to various community meetings.

City of Richmond

The City of Richmond will be a subcontractor for this project to facilitate monitor deployment on City-owned infrastructure. The City budget will cover costs related to facilitation of the siting and permitting of air monitoring equipment on city infrastructure and facilities as necessary and assist in the coordination of the monitoring equipment installations with hosting sites and will work with Groundwork Richmond to explore opportunities for long-term maintenance of the network and the open data stream. The City will work with Groundwork to identify City-owned Displays to display real-time air quality data via Shair.

1.3 Task 3: Community Engagement

GWR has a close connection with City Departments and City Leadership and will disseminate information about our programs via various communication platforms. In addition, GWR maintains a comprehensive database of key community partners, boards, committees and commissions to motivate existing decision-making bodies in the most effective way and to build support among key stakeholders. GWR also utilizes a comprehensive digital outreach strategy that spans generations by relying on email, newsletters, Facebook, Instagram, Snapchat and TikTok – where many individuals are usually at – their mobile devices. A sample Instagram post, prepared under the Air Rangers II, is shown in **Figure 11.** Still, we recognize that not all residents are readily available on social media. Accordingly, GWR staff, our Green Corps Job Training

Program and our Green Team Education Program conduct door-to-door canvassing to disseminate information about our urban forestry, or green infrastructure projects & environmental justice organization programs.

Figure 11. Sample Instagram post, prepared under the Air Rangers II

Previous Air Rangers outreach has and will continue to be integrated into these efforts and will further promote utilization of our air monitoring data for residents to make informed choices about outdoor activity. Canvassing efforts will also share opportunities for residents to participate in the community events we lead, the service projects we facilitate and to pursue our paid education and training opportunities. We make every effort to ensure that the broadest possible sample of Richmond residents have access to our programs.

Air Rangers III will also include elements of community engagement within the monitoring tasks. New monitoring locations will be determined with the successful community-based multi-step process employed for the initial deployment. Input on locations will be received from engaged residents through a web-tool. Community outreach will extend the visibility and availability of the web-tool to those in the community without digital access. Community feedback will be reviewed by a team of air quality experts from Ramboll and Groundwork Richmond staff. This will include a thorough assessment of potential major and minor $PM_{2.5}$ sources, related exposures, and the locations of disadvantaged and sensitive communities prior to selection of the potential monitoring sites. The sites identified during these processes will be scrutinized during physical field visits by Green Corps technicians and shifted if needed. Technicians will be trained by Ramboll to select scientifically valid, secure mounting points within the general predetermined monitoring location and will implement site verification and PurpleAir sensor installation field forms (see Attachment C) which document installation requirements and create a record of deployment location. Decisions on final siting are influenced by the Imperial County Community air monitoring Project[12], and US Federal siting protocols[13].

Table 4 summarizes community engagement tasks, goals and objectives, measures of success and milestones, and benefits and outcomes. Specific tasks are described below.

Shair Engagement

The visual appeal, layperson-friendliness, and ease of access of the Shair platform will provide the community with real-time information on their local air quality conditions, both current and forecasts for the near future, as well as information on major influential sources. Further, Shair will regularly communicate via social media platforms (Facebook, Instagram, Twitter).

Shair Analysis Dashboard

The high spatial resolution of Shair's data allows for community members to look at air quality from specific times and locations across the year. Ramboll will build a multi-lingual dashboard that clearly visualizes 24 months of air quality data in any time period or slice of time. For example, an individual could use the dashboard to view the average $PM_{2.5}$ concentration between 8-9 a.m. Monday through Friday when their child walks to school. Additionally, they could view the average percent composition of contributing pollution sources.

12 Wong et al. 2018. Combining community engagement and scientific approaches in next generation monitor siting: the case of the Imperial County Community Air Network. International Journal of Environmental Research and Public Health. 15 523.

13 For example, priority regions of Richmond were selected after viewing maps and considering various local demographics, the community was engaged in site identification, and monitor deployment is occurring slowly and steadily, which allows for the team to observe increasingly local trends and identify any potential gaps in the proposed siting before all sensors have been deployed. This gives an effect similar to the 2-phase monitor siting used in Imperial County.

Multilingual Community Center Air Quality Displays

Ramboll will work with the City of Richmond to provide air quality related information for up to five screens to improve community engagement. The screens will display live maps of community-level air quality in different parts of Richmond, and crucial information on neighborhoods with particularly bad air quality and the sources responsible for the pollution. The screens will also include health protection recommendations for vulnerable populations, such as the elderly and those with pre-existing health conditions.

Training GWR's Green Team

To support community engagement in air quality, Ramboll will host community PurpleAir monitor training sessions. Trainings will include learning how to perform monthly quality assurance checks, data interpretation, monitor siting, deployment, operation, maintenance, and limitation of low-cost sensors. This task will assist GWR in building capacity to maintain the PurpleAir sensors and promote community engagement with the monitoring and data collection process.

AQ Education and Engagement

We will present our findings from the air monitoring, modeling, and source allocation at steering committee meetings, as requested by the community. Via these presentations, we will educate and train the community on air quality fundamentals, air pollution health effects, and how mitigation measures can be designed to target major influential sources. Groundwork Richmond will regularly communicate via social media platforms and newsletters to keep the community informed and up to date on latest air quality news, "spare the air" alerts, and protective guidelines. Communications will be prepared in Spanish and English. We will also create social media posts on Twitter, Facebook and Instagram, on air quality topics, including creating awareness of the Shair app, and current air quality issues.

Shair Analysis Dashboard

The Shair Analysis Dashboard will occur in the third year, following continuous Shair monitoring for the prior two years. GWR will work with Ramboll to ensure community engagement throughout the two years prior to demonstrate how to use Shair, and to provide air quality information at up to five screens in the City. Over the two years, Ramboll will work to collect, analyze, and interpret the air quality data. During the third year, GWR will work with Ramboll to focus community engagement on the source apportionment results that will lead to community recommendations on controls and pollution reduction measures.

Table 4. Community Engagement Tasks, Goals and Objectives, Measures of Success and Milestones, and Benefits and Outcomes

Tasks	
Shair Analysis Dashboard	
Objectives	• **Build a dashboard for clear visualization of 24 months of air quality data, aggregated by sensor location, to show spatial and temporal insights on source attribution and average air quality** • **Empower community to advocate for their own pollution reduction measures by aiding in identification of influential sources**
Goals	• **Provide insight on source specific contributions identified at each sensor location to look at air quality patterns over space, time, seasons, and locations**
Measures of Success	• **Presentation of Shair platform data to community** • **Presentation of data in additional language(s) identified by the community** • **At least 100 dashboard users in the community**
Milestones	• **Development of multilingual dashboard** • **Disseminate into the community**
Benefits	• **Overall health education, social, and economic improvements to the community.** • **Benefit from the knowledge on community scale air pollution, health recommendations, and education on air quality related topics and assist community members in making informed decisions surrounding daily activities**
Outcomes	• **Analysis dashboard will allow the community to better understand local scale air pollution**
Multi-Lingual Community Center Air Quality Displays	
Objectives	• **Provide live air quality data for air quality screen displays in different locations in Richmond** • **Identify locations for screens and data sharing**
Goals	• **Improve community engagement, providing health guidance and recommendations to vulnerable populations.** • **Provide health protective recommendations for vulnerable populations.** • **Assist community members in making informed decisions about air quality.**
Measures of Success	• **Number of Community AQ Displays** • **Operation status of the Community AQ Displays**
Milestones	• **Identifying community screens for data sharing** • **Implementing air quality displays on community screens**
Benefits	• **Increased access to air quality information and education**
Outcomes	• **Encourage community capacity building** • **Provide residents with real time information about the air they are breathing.**
Training GWR's Green Team	
Objectives	• **Host trainings that will teach siting, deployment, maintenance, and limitation of low-cost sensors** • **To support community engagement in air quality**
Goals	• **Promote community engagement with the monitoring and data collection process.** • **Build capacity to maintain the PurpleAir monitors Quality Assurance**

	• **Demonstrate to the community how to use Shair.** • **Maintain an active air quality presence on social media**
Measures of Success	• **Number of GWR Green Team trainings** • **Number of attendees to GWR Green Team trainings**
Milestones	• **Community member success in applying skills learned in trainings to maintain and upkeep low-cost sensors** • **Create social media posts to engage with the Richmond community on local air quality news, alerts, and guidelines.**
Benefits	• **Builds leadership and air quality expertise within the community** • **Encourage local volunteer efforts** • **Help address gaps in underrepresented minorities, contributing to a skilled work force** • **Build capacity between active partners and government to identify, evaluate, and ultimately reduce air pollution and harmful exposures within their community.**
Outcomes	• **Increased engagement between community and steering committees**

1.4 Task 4: Workforce Development

Air Rangers III includes several project aspects that foster training in environmental science, data science, air quality data analysis, technical air quality expertise, science communication, science education, and community empowerment. Mentorship and training provide new opportunities for diverse career needs for younger individuals within the Richmond community.

Table 5 briefly summarizes workforce development tasks, goals and objectives, measures of success and milestones, and benefits and outcomes. A detailed description of each task is included below:

Training GWR's Green Team

To support workforce development, Ramboll lead one-day of PurpleAir monitor deployment. In addition, Ramboll will host up to four PurpleAir Monitor training sessions. Training will include monitor siting, deployment, operation, data interpretation, and limitation of low-cost sensors. This task will assist GWR and engaged youth community members in building capacity to analyse and understand PurpleAir data and quality assurance.

Mentorship Opportunities

To address the diverse career needs of our focus population of 18- to 28-year-old Richmond residents, one project aspect focuses on mentorship for Richmond's youth. GWR plans to deploy PurpleAir sensors, which can be cited lower to the ground, reducing deployment risks, and ultimately allowing more youth to be involved with deployment. The purpose of this project aspect is to highlight career opportunities in the environmental sector. GWR will partner with Ramboll for exposure to real-world applications of environmental data science, outreach, and policy opportunities for data communication.

GWR has previously hosted the Air Rangers and Air Rangers II projects. GWR Air Rangers are volunteers that are interested in learning more about air quality, environmental policy, data science and analysis. By exposing GWR staff to Ramboll, Air Rangers III will provide both direct and indirect mentorship to young students interested in air quality. GWR is pleased to report that a previous Air Ranger has been hired at Ramboll as a part time junior engineer while he attends community college. This career trajectory was a direct result of the previous work with the CARB Community Air Grants.

The Air Rangers III program will continue to provide workforce opportunities for members from the Richmond community. For example, the Project Manager role will supervise all Green Corps operations, act as a liaison between community and Education and Community Coordinator Position and Green Corps position to communicate sensor locations for deployment, and ultimately facilitate employment opportunities in environmental monitoring. Another position that will be allocated to support Air Rangers III is a Project Manager, who will be responsible for supervising teams to install PurpleAir sensors and perform maintenance during the grant period.

Table 5. Workforce Development Tasks, Goals and Objectives, Measures of Success and Milestones, and Benefits and Outcomes

Task	
Training GWR's Green Team	
Objectives	• **Host trainings that will teach siting, deployment, maintenance, and limitation of low-cost sensors** • **To support community engagement in air quality**
Goals	• **Promote community engagement with the monitoring and data collection process.** • **Build capacity to maintain the PurpleAir monitors Quality Assurance** • **Demonstrate to the community how to use Shair.** • **Maintain an active air quality presence on social media**
Measures of Success	• **Number of GWR Green Team trainings** • **Number of attendees to GWR Green Team trainings**
Milestones	• **Community member success in applying skills learned in trainings to maintain and upkeep low-cost sensors** • **Create social media posts to engage with the Richmond community on local air quality news, alerts, and guidelines.**
Benefits	• **Builds leadership and air quality expertise within the community** • **Encourage local volunteer efforts** • **Help address gaps in underrepresented minorities, contributing to a skilled workforce** • **Build capacity between active partners and government to identify, evaluate, and ultimately reduce air pollution and harmful exposures within their community.**
Outcomes	• **Increased engagement between community and steering committees**
Mentorship Opportunities	
Objectives	• **Provide exposure to real-world applications of environmental data science** • **Empowering members of the Green Team to assist with quality data collection**
Goals	• **Support local workforce development** • **Build community capacity** • **Develop transferable skills in community**
Measures of Success	• **Number of technical, outreach, and policy training delivered to local youth.** • **Hosting PurpleAir Monitoring training.**
Milestones	• **Reaching a greater number of youth through training and mentorship** • **Receive mentorship from GWR and Ramboll**
Benefits	• **Further workforce development opportunities** • **Broaden career horizons among Richmond's most underemployed demographic, young men and women of color between the ages of 18-28.** • **Build capacity between community partners and government to evaluate, and ultimately reduce air pollution and harmful exposures within their community.**
Outcomes	• **Highlight career opportunities in the environmental sector.** • **Receive mentorship from GWR and Ramboll.**

1.5 Task 5: Reporting

GWR will provide biannual reports, outlining which tasks in the timeline have been completed and progress of uncompleted tasks for a total of six reports over the span of the grant period. The reports will outline project-to-date expenditures, as well as progress on the project goals described in Section 3. A summary of data collected will also be included in the mid-project report. **Table 6** summarizes reporting task goals and objectives, measures of success and milestones, and benefits and outcomes. The final report submitted to CARB will follow the structure of the biannual reports Administrative Reports requested in the Community Air Grants Program Grant Guidelines, as outlined in the Air Grants Reporting Template form:

- Task name or number, brief description, percentage completed during current reporting period and percentage of task that remains to be completed
- Estimate of the funds spent on the task this Reporting Period and estimate of the funds remaining for completion of the task
- Name of sub-contractor assigned to the task (if applicable)
- Quantify the amount of work completed on the task during the quarter (e.g., number of sensors purchased, number of meetings held, number of staff hired, number of community members engaged, etc.) to the extent feasible
- Identify any challenges or barriers encountered in the implementation of this task
- Summarize any changes to the project by ask and seek advanced approved from ARB (if applicable)
- Describe the work planned for the next reporting period, including mention of long-range plans, as relevant to the project.

The final report submitted to CARB will follow the requested format provided in the Community Air Grants Program Grant Guidelines (Air Grants Reporting Template form) including project title, report number, grantee organization, date progress report submitted, grant number, name of CARB Grant Liaison, project Contact or Administrator, report Preparer, reporting period, beginning and end dates covered by the Progress Report Period will be embedded in the project reports.

The Project Overview will include: a brief of the project, percentage of the project completed during the reporting period, percentage of the project that remains to be completed and estimate of the funds already spent on Project up until reporting period and estimate of funds remaining for completion will be included in each report.

Finally, the report will cover how the grant is being utilized to meet the goals of AB 617 as well as a narrative of how the project is benefitting disadvantaged and low-income communities or low-income households during the reporting period. Challenges or barriers encountered in the implementation of the project will also be implemented in the project report. The Air Grant Reporting Template Form requires the Administrative Reports to include information related to project tasks.

Table 6. Reporting Task Goals and Objectives, Measures of Success and Milestones, and Benefits and Outcomes

Tasks	
Reporting	
Objectives	• **Report and presentation of data collection process and challenges** • **Preparation of biannual progress reports** • **Timely preparation and submittal of final report**
Goals	• **Provide sustainable resources for the community members and air district for future efforts through proper transfer of knowledge and experience for data collection** • **Update CARB on grant progress**
Measures of Success	• **Timely submission of biannual reports** • **Proper allocation of funding within reporting periods** • **Preparing an effective work plan prior to commencing air grant activities**
Milestones	• **Submission of a detailed work plan prior to implementation of Air Rangers III.** • **Submission of regular progress reports every 6 months after commencing project. We understand the first two biannual reports are due on 15 June 2022, and 15 December, 2022.** • **Submission of a final report at the end of the 3-year project.**
Benefits	• **On-time progress report submissions will keep the project on- track and facilitate specific task achievement.** • **Transferability to other CARB grant applicants** • **Transferability to other AB 617 or Environmental Justice communities who may be interested in following the same methods within Air Rangers III.**
Outcomes	• **Air District and CARB tracking purposes of successful project outcomes**