Action: Mobile monitoring to identify pollution hotspots and assess the impact of warehouse-related emissions on community exposure

Background & Objective

San Bernardino, Muscoy (SBM) community has a large number of warehouses, which is a critical component of the goods movement chain and as of early 2019, already includes 43 warehouses greater than 100,000 ft^2. The majority of the ocean-going freight containers arriving at the ports are transported through communities in the Inland Empire to clusters of warehouse distribution centers before distribution to the rest of the country. Emissions from warehouses was one of the major air quality concerns identified by the SBM community steering committee (CSC). This includes, but is not limited to, exposure to emissions from new warehouse construction and development, diesel particulate matter emissions from truck traffic associated with warehouses, and truck idling on warehouse properties and on nearby streets, particularly in proximity to residential premises and sensitive receptors.

The air monitoring strategy to characterize emissions from this source category includes mobile measurements near warehouses and in nearby residential areas to determine pollution gradients, identify air pollution hotspots, and assess the air quality impacts of warehouse activities on the surrounding neighborhoods. This will also help track the progress of the potential mitigation measures that were developed in the Community Emissions Reduction Plan (CERP).

Method

Air monitoring was conducted near areas identified by the CSC, using a mobile platform capable of measuring a wide range of particulate and gaseous pollutants, including particulate matter (PM), black carbon (BC), ultrafine particles (UFP), and nitrogen dioxide (NO_2). Figure 1 shows the location of warehouses within SBM. The locations of warehouses were obtained from Southern California Association of Governments' (SCAG) 2016 land use dataset. South Coast AQMD is working with SCAG to obtain a more up to date map of warehouses, considering their rapid development in this community. Figure 1 also shows the locations of the air quality concerns related to warehousing identified by the CSC through a prioritization activity.

Results

- As of August 2020, a total of 8 days of mobile monitoring was conducted near the warehouses within the SBM community
- Mobile monitoring results indicated elevated concentrations of NO_2, UFP, and BC near some of the warehouses in SBM, while no significant elevations were observed near others (see Attachment A for details)
- Ambient levels of NO_2, UFP, and BC near warehouses were not as elevated as those measured on major freeways and streets (Attachment A)
- Ambient levels of NO_2, UFP and BC in residential areas were comparable or lower than those measured near the warehouses, with generally lower levels in areas that are further away from the warehouses (Attachment A)

Next steps
• Work with SCAG to obtain a more up to date map of warehouses, considering the rapid development of warehouses in this community • Continue additional mobile measurements surveys targeting areas with high warehouse-related activity • Analyze mobile monitoring data to inform or provide input to implementation of emission reduction strategies and track their progress

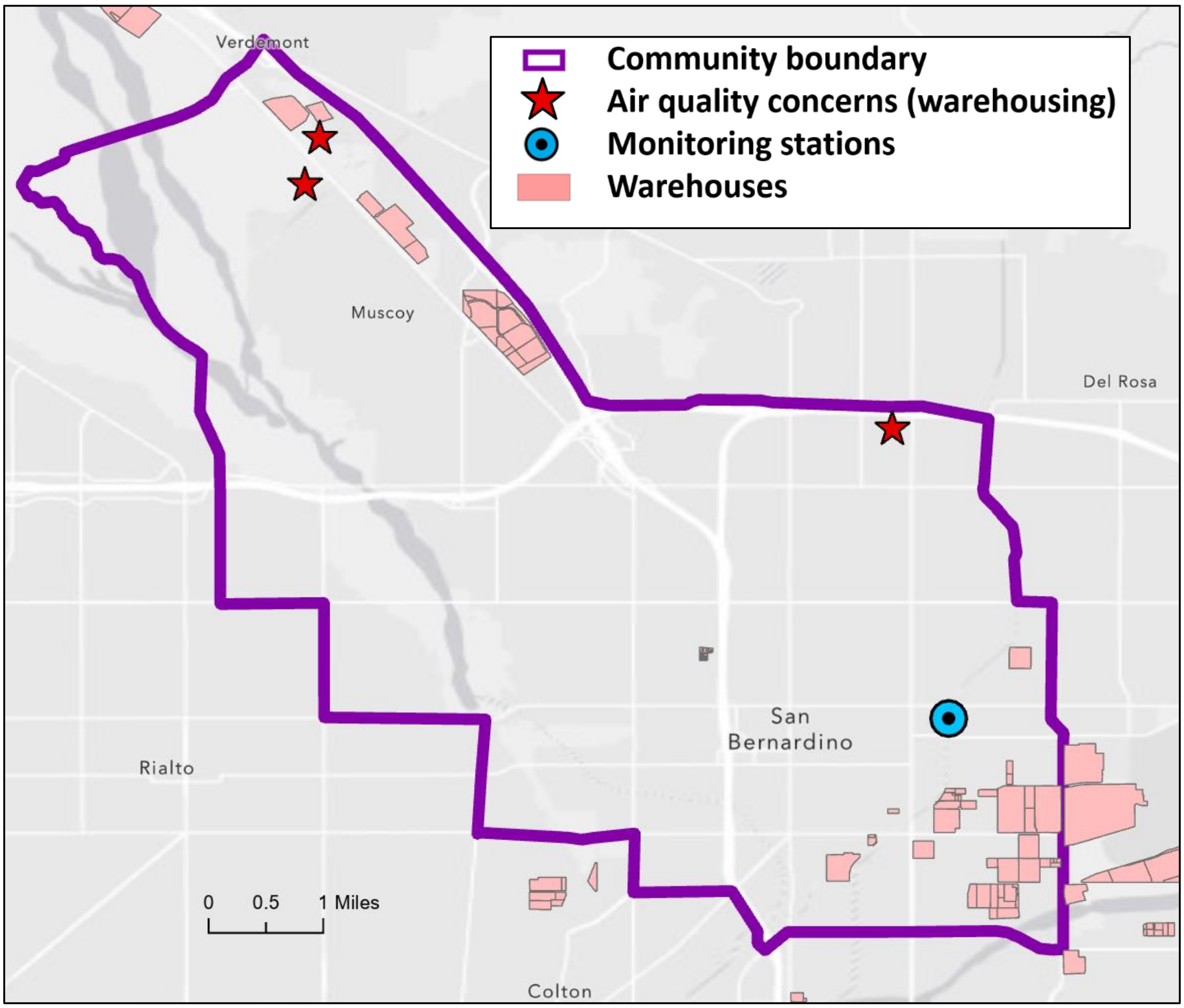

Figure 1. Map showing the locations of the warehouse distributions centers in SBM (based on SCAG's land use dataset from 2016) and of the air quality concerns related to warehousing identified by the CSC. The location of the air monitoring station for baseline measurements operated by the South Coast AQMD is also included

Attachment A

As of August 2020, a total of 8 mobile monitoring surveys have been conducted in the San Bernardino Muscoy (SBM) community. A major part of the warehouse related air pollution results from diesel powered trucks that transport goods to and from the warehouses and other diesel equipment that is operated on-site. These engines emit a complex mixture of air pollutants, including both gaseous and solid material. The solid material in diesel exhaust is known as diesel particulate matter (DPM), which is a component of fine particulate matter ($PM_{2.5}$). There is no technique to directly measure DPM (a major contributor to health risk); therefore, indirect measurements for surrogates of diesel exhaust are used, specifically black carbon (BC). DPM is typically composed of carbon particles ("soot", also called BC) and numerous organic compounds. Diesel exhaust also contains gaseous pollutants, including volatile organic compounds (VOC) and nitrogen oxides (NOx).

Mobile measurements were conducted using a mobile platform capable of monitoring a wide range of particulate and gaseous pollutants, including particulate matter (PM), black carbon (BC), ultrafine particles (UFP), and nitrogen dioxide (NO_2), as part of the area-wide surveys. The routes traversed by the mobile platform were selected to perform monitoring in areas with warehouses. The locations of warehouses were obtained from Southern California Association of Governments' (SCAG) 2016 land use dataset. South Coast AQMD is working with SCAG to obtain a more up to date map of warehouses, considering the rapid development of warehouses in this community.

Typically, measurements from a mobile platform at a given location are relatively short, ranging from seconds to a few minutes when the platform is moving. Therefore, given the high temporal variability of most air pollutants, mobile survey measurements do not necessarily capture the typical air quality conditions of a specific location. One way to address this limitation is by increasing the number of measurements runs (passes or transects) to obtain a more representative and consistent map of the spatial and temporal variability of the measured air pollutants. Figure A-1 shows the routes traversed by the mobile monitoring in and around warehouses and major roadways and freeways within the SBM community. In this figure, the number of passes, that is a measure of representativeness of the measured concentrations, is shown as a white-to-green color gradient, with darker green representing areas where more passes/measurement were taken/conducted. The warehouses which are identified by the community steering committee (CSC) as air quality concerns are also shown in this figure.

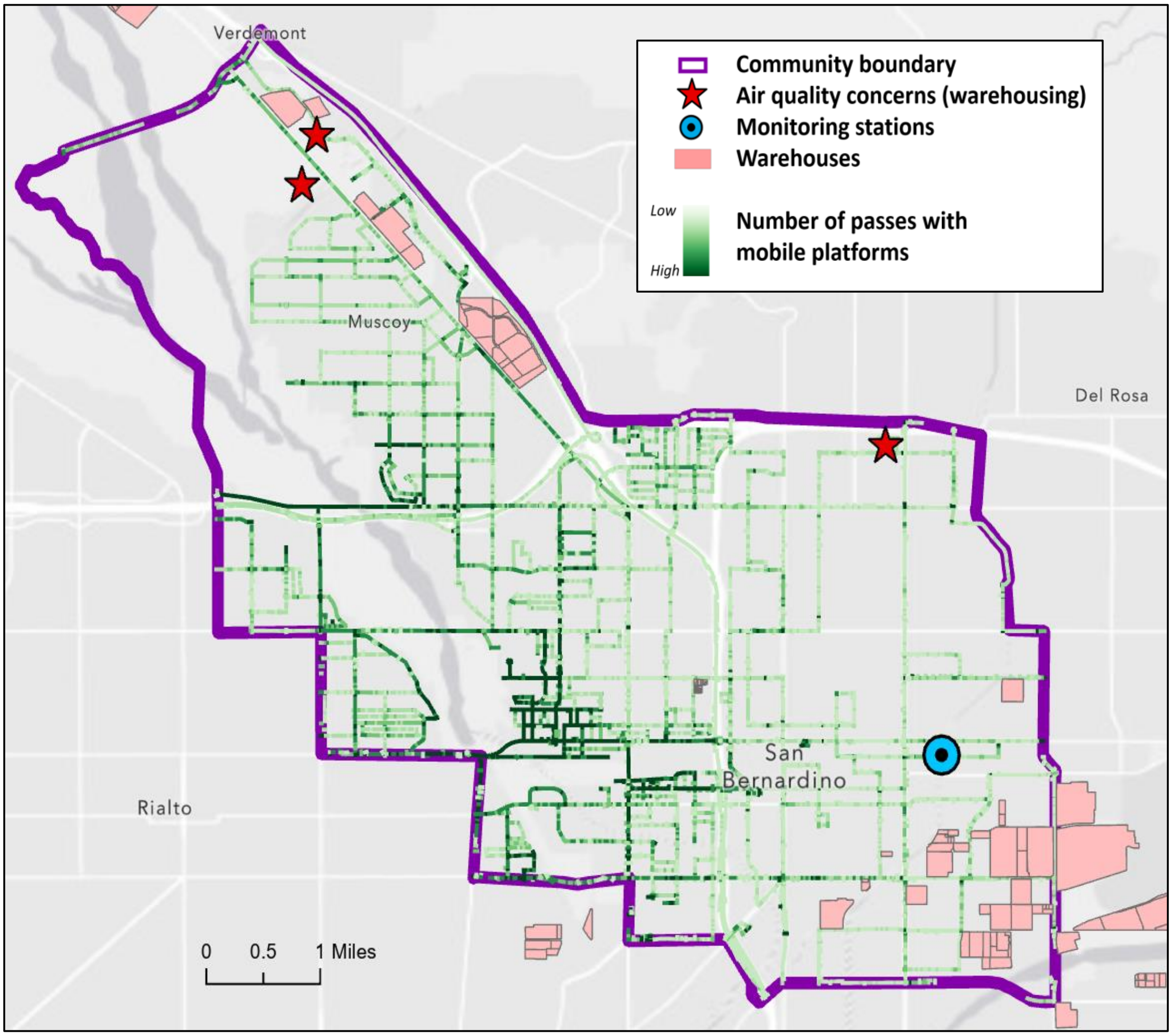

Figure A-1. Map of the SBM community showing the routes traversed by the mobile monitoring in and around warehouses and major roadways and freeways within the SBM community

Figure A-2 shows the dates and time periods of the area-wide mobile measurements performed within the SBM community. As shown in this figure, mobile monitoring was performed at different times of day during the eight weekdays.

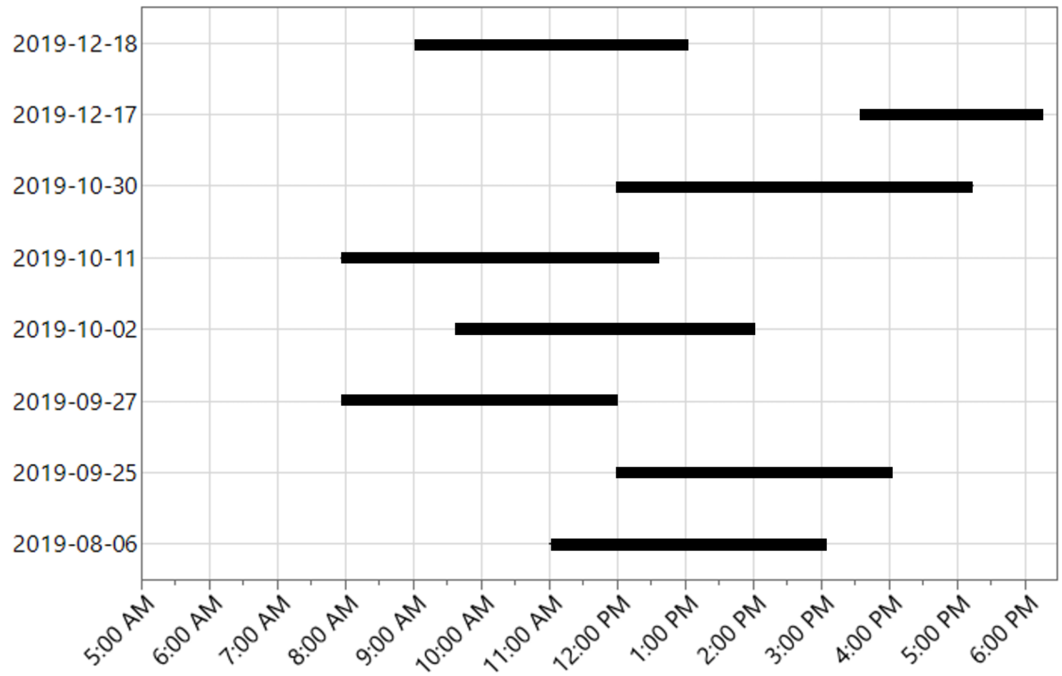

Figure A-2. The duration and time window for the area-wide mobile measurements performed in the SBM community. The time windows only include hours of active mobile measurements within the community, excluding the commute time between South Coast AQMD Headquarters and SBM

Upon extensive screening and pre-processing of the data, UFP and NO_2 measurements were found to be the most robust and reliable set of diesel exhaust markers measured, with 8 and 7 (out of 8) valid days of measurements, respectively, and minimum instrument down time, followed by BC measurements, with 6 days of measurements.

Figures A-3, A-4, and A-5 illustrate "aggregated" maps of the spatial patterns (or concentration gradients) of NO_2, UFP, and BC concentrations around the warehouses within the SBM community, as well as in the residential areas, as was measured by the mobile monitoring platform during those eight days.

To ensure that the concentration gradient map is representative of the variations in the pollutant concentrations, individual measurements taken within each 30-meter street segment in different passes and on different days were "aggregated", by calculating their arithmetic average, and shown as colored bins on the map. Therefore, each segment on the map represents multiple measurements taken at different passes. In addition, it should be noted that mobile measurements taken on different days and hours cannot be directly compared, mainly because of the day-by-day and diurnal (i.e., hour-of-the-day) variability in pollutant concentrations as a result of changes in meteorology and source emission strengths. Therefore, in order to account for the day-by-day as well as diurnal variability in the pollutant concentrations, the mobile monitoring data need to be normalized with stationary data from a fixed air monitoring station, according to a commonly used method in the literature. To achieve this, hourly data from the San Bernardino air monitoring station (which is part of the South Coast AQMD air monitoring network) was collected for the time period when mobile monitoring was conducted (Figure A-2). For example, on August 6th, 2019, mobile monitoring was performed from 11 am PST to 3 pm PST; therefore, a total of 4 hourly averages were calculated for each pollutant from the San Bernardino air monitoring station. Subsequently, the mobile monitoring data with 1- and 3-second time resolution were divided by the hourly averaged stationary data that corresponded to the hour in which that measurement was taken.

The air pollutants related to warehouses are emitted by multiple sources that are operated by diesel trucks and off-road equipment. Therefore, inference on how much of the levels measured using the mobile platform is attributed to each source cannot be made with high level of certainty. Nonetheless, near-source measurements (e.g. measurements while driving around the warehouse clusters) is likely to be most impacted by the source in their vicinity. Thus, it provides a qualitative measure to compare potential contributions of each emission source to the ambient levels. The more accurate quantitative evaluation of source contributions would require proper source apportionment studies.

As shown in Figure A-3, the NO_2 levels that were measured near some of the warehouses were relatively elevated, while levels measured near many other warehouses did not exhibit substantial elevations. On the other hand, the measured levels in residential areas away from the warehouses were generally lower. The concentration levels of NO_2 in residential areas that were away from the warehouses, as well as from major roads and freeways showed significantly lower levels of NO_2.

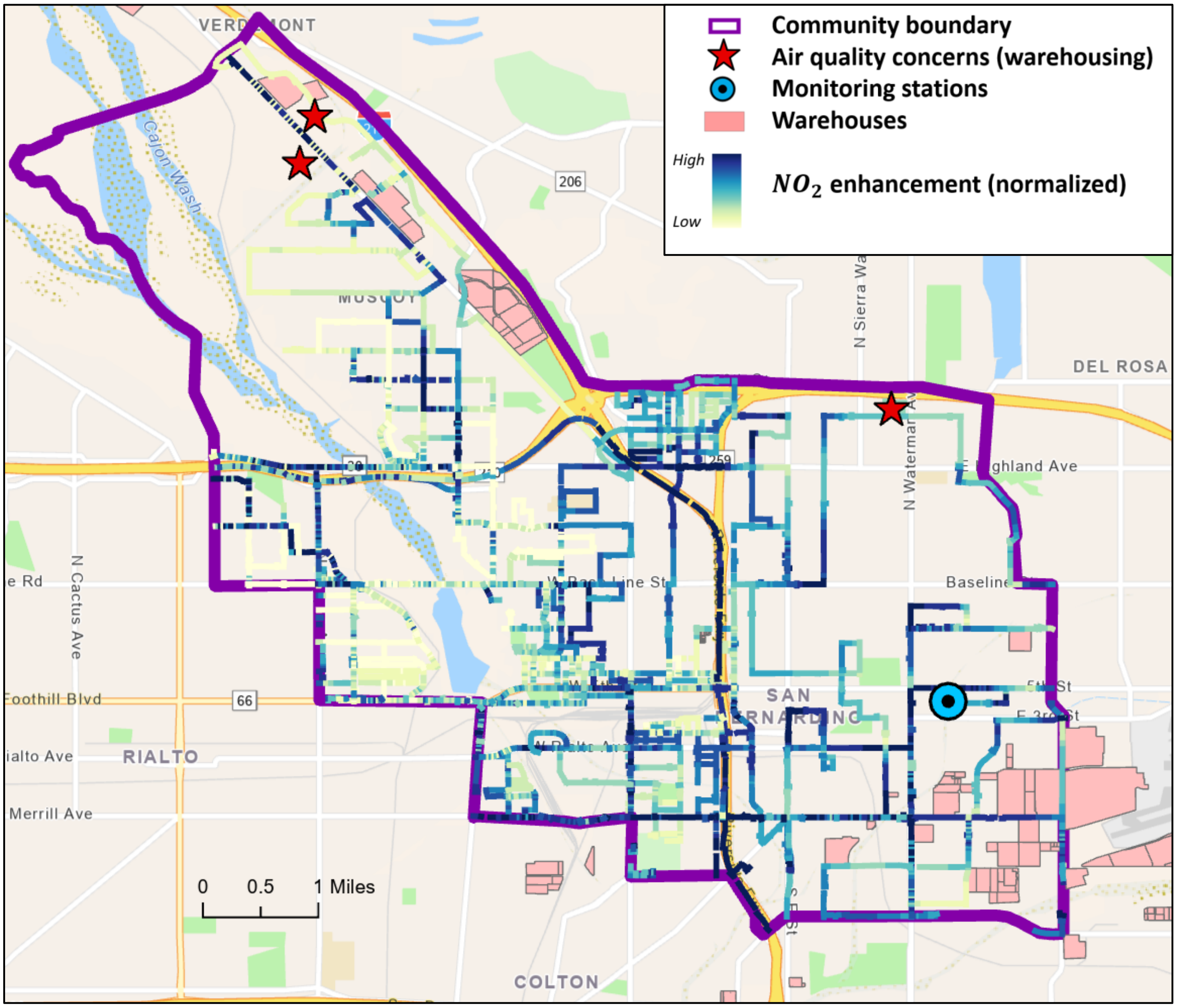

Figure A-3: Aggregated map showing the spatial variability of NO_2 concentrations near warehouses, around freeways, and the residential areas within SBM

UFP concentrations were elevated near the warehouses within the SBM community (Figure A-4). However, these elevated levels were lower than concentrations observed on the freeways or on some of the major roadways. Similar to NO_2 observations, UFP concentrations were generally lower in residential communities around Cajun Wash as compared to those measured near warehouses and on major streets and freeways within SBM.

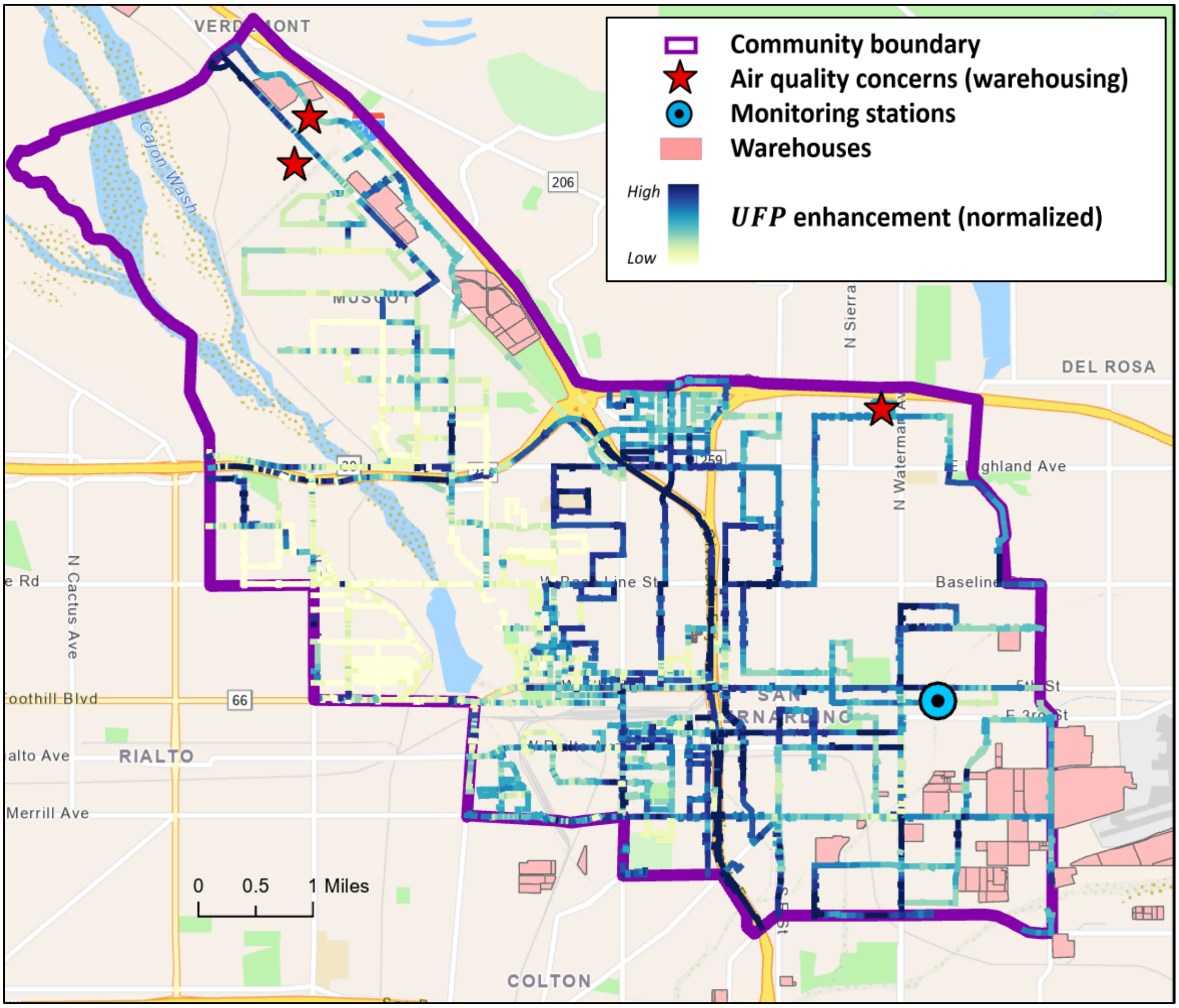

Figure A-4: Aggregated map showing the spatial variability of UFP concentrations near warehouses, around freeways, and the residential areas within SBM

As shown in Figure A-5, the measured levels of BC near warehouses were slightly more elevated in comparison to the levels measured in the residential areas. Similar to UFP and NO_2 observations, BC concentrations were generally lower in residential areas away from warehouses and major roads and freeways.

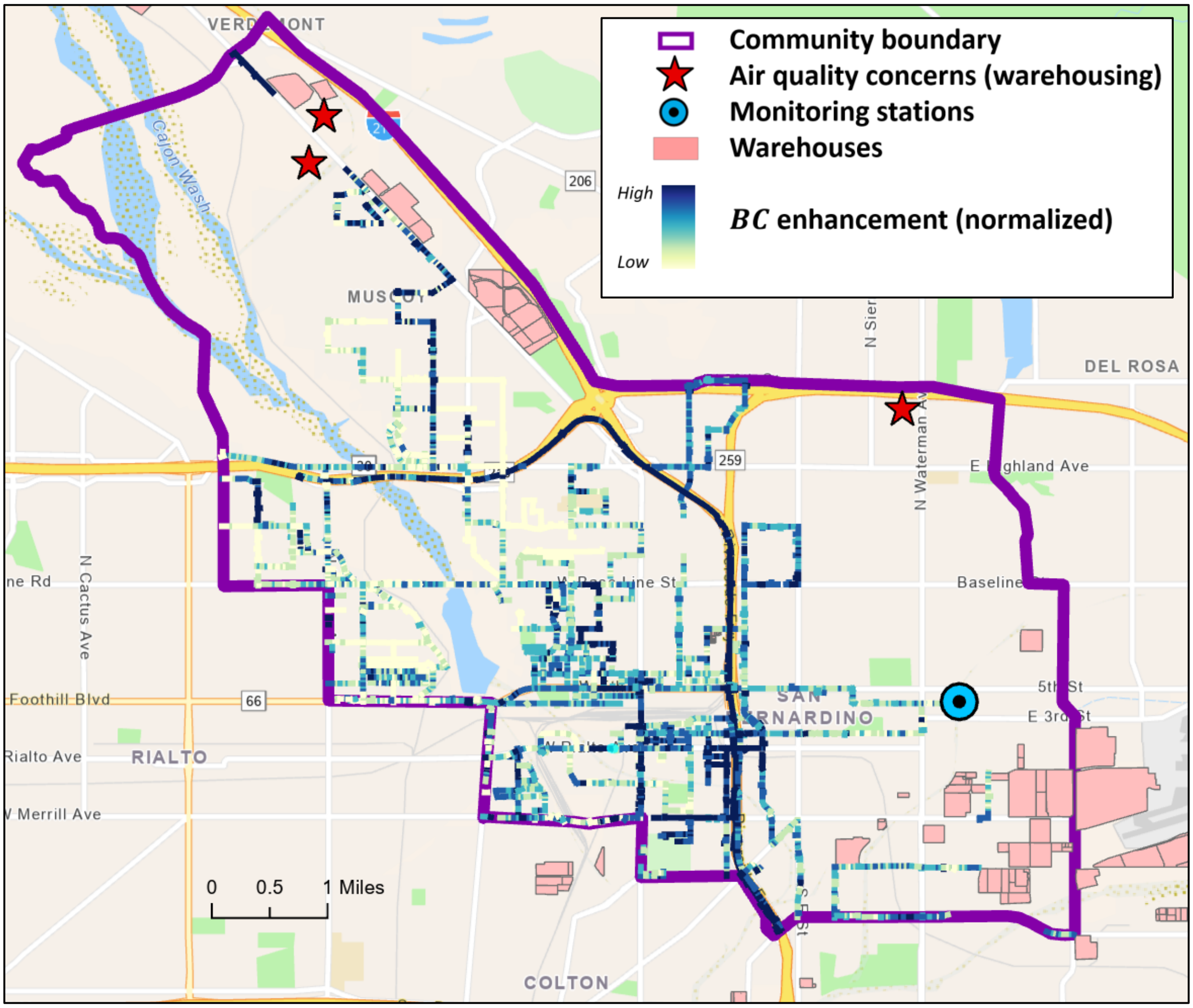

Figure A-5: Aggregated map showing the spatial variability of BC concentrations near warehouses, around freeways, and the residential areas within SBM