Written Remarks of Peter DeCarlo Regarding the Assessment of Air Quality Monitoring during PES Fire
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Honorable Chair, Vice Chair, Minority Chair, and members of the committee. My name is Peter DeCarlo, and I am an Associate Professor in the Departments of Civil, Architectural and Environmental Engineering and Chemistry at Drexel University. I am also a resident of South Philadelphia. My expertise is in the measurement of airborne pollutants with a focus on particulate matter. My written remarks are on my personal behalf.

During the massive explosion and subsequent fire at PES many area residents were concerned about the potential air quality impacts of the fire. At the time city officials consistently reassured people that there was no adverse air quality impact, even though clear smoke plumes were visible from the fire. Air quality measurements were made at fixed sites as part of the regulatory network of the city, several air samples were taken and assessed for volatile organic compounds by the city, and some handheld monitoring was done. The below discussion indicates where issues with air quality monitoring for each of these methods arise, and suggests that much of the city's messaging on air quality surrounding the fire was based on false negatives. Simply put, air quality was not measured in the right place, or with the right equipment and thus led to an erroneous assessment of air quality impact.

Fixed site monitoring

Philadelphia Air Management measurement sites were not situated in appropriate locations for monitoring during the fire due to the prevailing wind direction. Camden was potentially downwind, but only briefly as wind turned south early in the morning and remained steady blowing to the East-south-east. The Figures below show where $PM_{2.5}$ is monitored in the immediate region, and the expected plume travel and dilution downwind based on a National Oceanic and Atmospheric Plume Dispersion model.

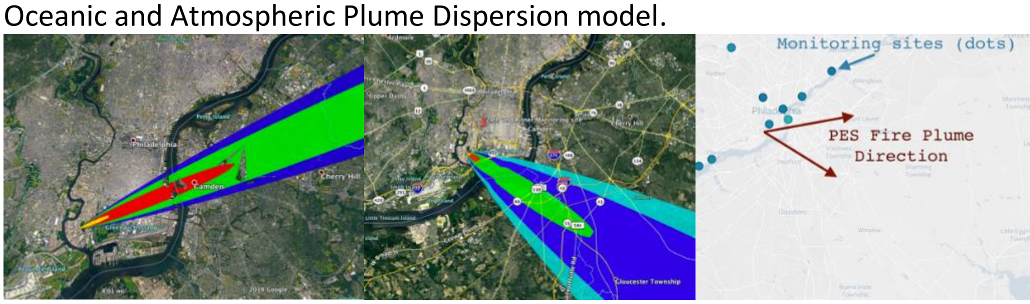


Figure 1: Calculated plume trajectory at ~6AM and at 2 PM based on measured meteorology. Locations of PM monitoring sites in the PA/NJ area and the direction of the fire plume. Plume colors represent a factor of 10 decrease in estimated pollutant concentration from yellow (highest) to red, to green, to dark blue, to light blue.

As part of a consent decree with the City of Philadelphia, State of Pennsylvania, and the EPA PES monitors various pollutants at 2 sites on the property. The so-called "downwind" site on

PES property showed a significant spike of $PM_{2.5}$ and PM_{10} for 2+ hours (data is only given in hourly intervals) with concentrations exceeding 60 $\mu g\ m^{-3}$ and 80 $\mu g\ m^{-3}$ for $PM_{2.5}$ and PM_{10} respectively. While the 24-hour concentrations are unlikely to exceed the 35 $\mu g\ m^{-3}$ standard, they demonstrate that the plume was detectable if monitoring was done in appropriate locations and for the appropriate air pollutants. Figure 2 below shows the $PM_{2.5}$ concentrations at two Philadelphia Air Management measurement sites as well as the monitoring done by PES as part of the consent decree.

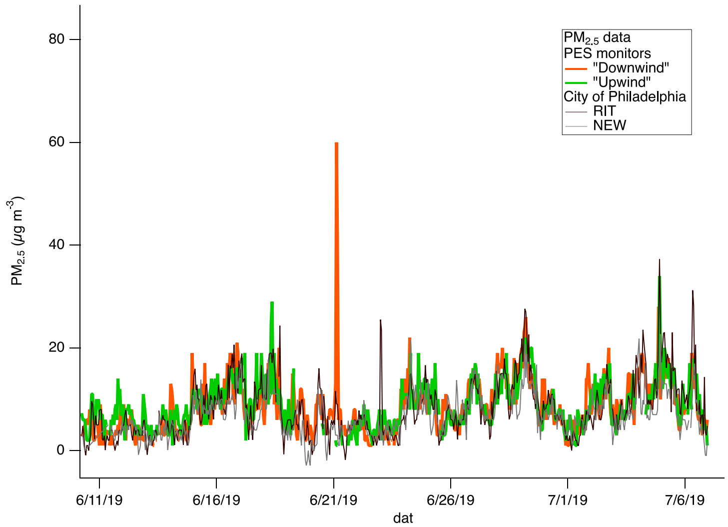


Figure 2: PM2.5 concentrations measured by the City of Philadelphia and PES on site. The spike in PM2.5 on 6/21 is due to the fire, and shows elevated concentrations for several hours.

Handheld monitoring

HF monitoring by Philadelphia Air Management Services measured elevated HF at a location near PES. There was concern this was a false positive, and PES personnel later measured at the same location without HF detected. This is concerning since HF if released as a "puff" would not remain in the same location for an extended period of time. The positive measurement should have been cause for proactive measures to protect residents. A negative reading hours later in no way confirms a false positive.

Additional handheld sampling was conducted with multiRAE instruments (https://www.raesystems.com/products/multi-gas-detection/multirae-family-multi-gas-monitors). These instruments while convenient to use and available to borrow are not suitable for outdoor air quality monitoring, nor are they advertised as being appropriate for this application. They are not approved Federal Reference Methods nor are they Federal Equivalent Methods for assessment of air quality. The measurement detection limits and sensitivity are not sufficient for detecting elevated levels of pollutants from the fire. These instruments were also only set to monitor for a few select species, and not typical air quality pollutants (e.g. criteria pollutants or HAPS which are regulated species). Species monitored with the multiRAE systems included: Gamma radiation, Lower Explosive Limit, Carbon Monoxide, Hydrogen Sulfide, VOCs (unspecified), and Oxygen. Of these species only Hydrogen Sulfide and CO are considered pollutants related to air quality, but the sensors in the MultiRAE instruments are too coarse resolution to have meaningful input into AQ levels. Typical H_2S concentrations monitored at the refinery are less than 1 part per billion. The detection limit for the H2S in the multiRAE detector is 100 parts per billion, this detection limit is inadequate to assess whether there was an exceedance of H_2S due to the fire at PES. For Carbon Monoxide, the detection limit of the MultiRAE instrument is 1 part per million or 1000 parts per billion. Typical concentrations in Philadelphia are 250 parts per billion, and seldom exceed 1 part per million. Again the MultiRAE instruments are not suitable for an assessment of outdoor air quality impact from the fire if the measurements are not sensitive enough. Fundamentally, these handheld instruments provided false negative readings which were then used in messaging to residents about how there was no adverse AQ impact from the fire.

Canister sampling for VOCs using the TO-15 protocol

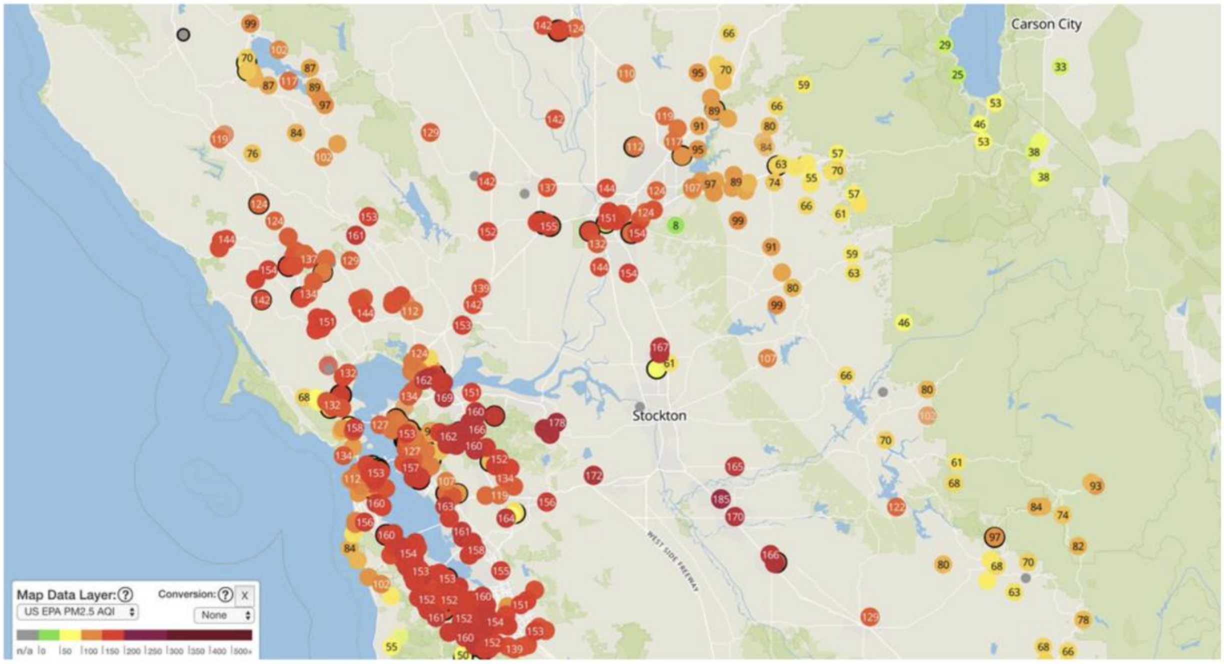
Two hours after the explosion, two canister samples were taken. One canister was upwind of the fire, the other downwind. Exact locations are not clear from the data, but the downwind sample mentions a parking lot. Ultimately the results of these 2 samples did not indicate significant concern for the measured species. This sampling, unfortunately, was inadequate. Only two samples taken, and only 1 of them in a "downwind" location is insufficient for assessing the impact of the fire over a larger spatial area. With many reports of residents complaining of smells during the fire and after, it is concerning that more measurements were not taken, and especially measurements in the neighborhoods downwind of the fire. Under-sampling of the air quality in the wake of the fire is not protective of the resident health, and it is not clear why more aggressive sampling was not done during the fire.

Lack of $PM_{2.5}$ sampling

One of the main pollutants emitted from a fire is particulate matter. This is often called soot and is the product of incomplete combustion. The visible smoke plumes are clear indication of this pollutant, and the photos and video of the fire throughout the day indicated that this was a consistent emission, however there was no attempt to measure this pollutant by Philadelphia Air Management services. Perhaps this is due to the lack of portable $PM_{2.5}$monitoring instruments, but it remains a large oversight in the assessment of air quality during and in the wake of the fire.

Looking forward

Lessons can be learned from other areas which deal with fire emissions. Two important examples of fire monitoring can be suggested as a way to be more prepared for other incidents in the future. In Montana where forest fires are common in the summer time, monitoring agencies have portable E-BAM measurements ($PM_{2.5}$) that can be deployed rapidly in downwind areas to assess the impact of the fire on local air quality. These devices provide a flexible multipoint measurement using a federal reference measurement standard. Investment in these monitors is expensive, but invaluable when accidents such as PES (or other industrial accidents) occur. A non-FRM/FEM measurement standard is to use low cost sensors. During the forest fires in California last year, low-cost sensors by purple air helped show where the air quality was most impacted see: https://www.cnet.com/news/california-fires-boost-interest-in-purpleair-air-pollution-sensors/



PurpleAir's air quality sensors feed data into a map anyone can see. This screenshot shows bad air quality in the San Francisco Bay Area and the number of people who've installed the sensors.

Screenshot by Stephen Shankland/CNET

Figure 3: Purple Air map of air quality index from sensors measuring in Northern California during the wildfires from summer of 2018.

While the accuracy of the monitors is poor, they were approximately twice as high as the federal reference methods measuring $PM_{2.5}$ simultaneously, the density of the sensors helped residents have an idea of where the plumes were and where air quality was affected. Unfortunately, South Philadelphia had no low-cost sensor network, and we were therefore not able to leverage the measurement capabilities of such a sensor network.

Retrospective

Air quality monitoring during the PES fire was not done effectively. This is in part due to the regulatory network of fixed site monitoring being poorly situated in relation to the fire plume. Additionally, however, use of handheld monitors that are not suitable for outdoor air quality monitoring contributed to messaging by city officials that relied on false negatives. At the same time a positive (perhaps false positive) reading of HF was not discussed by city officials. In the future better and more flexible air quality network design and improved monitoring should be in place so that the city can appropriately respond to air quality issues in the future.