Community Exposure to Particulate Matter and Its Impact for Schoolchildren and Residents near a Construction Asphalt Plant

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Introduction

Air is all around us, and we breathe in various air pollutants on any given day. Particulate matter (PM) pollution is the 13th leading cause of mortality worldwide. PM refers to inhalable particles comprised of dust, dirt, smoke, and soot found in the air that can be too small to be seen with the naked eye, but nonetheless pose a risk of health issues ranging from asthma to heart problems and increased respiratory symptoms. Asphalt plants are important industry, and however they emit many pollutants, including $PM_{2.5}$ and PM_{10} (PM with aerodynamic diameter < 2.5 and 10 µm, respectively) to the air during the production process, which can be dangerous to human health. Wells Cargo is an asphalt plant in Las Vegas located at the immediate north of Spring Valley High School (SVHS) and surrounded by several residential communities. SVHS students and residents near the plant have been observing dust fumes and are often forced to stay indoors. As a result air quality in the area is of concern to the community health. The objectives of this study are to: 1) examine short- and long-term community exposure to PM near Well Cargo and 2) assess how Wells Cargo contributes to the PM pollutants so that necessary actions can be taken to reduce health risks.

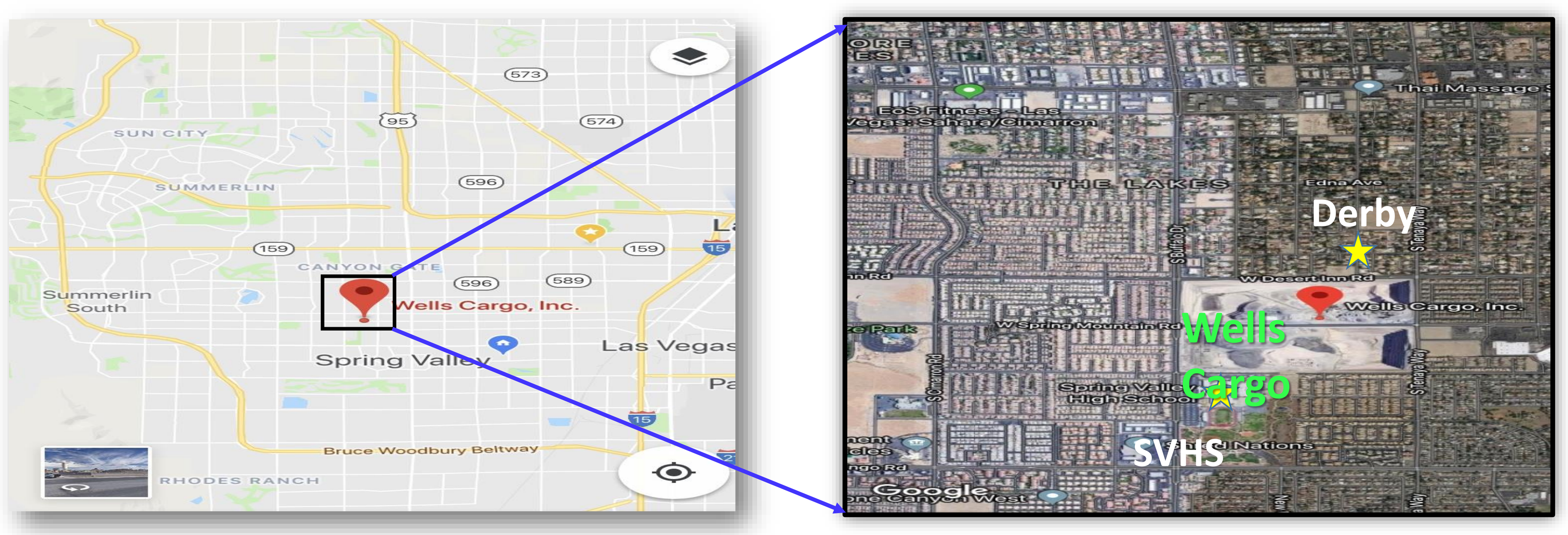

Figure 1. Sensor Location. The map indicates location of two monitoring sites, SVHS and Derby, relative to the Wells Cargo plant. Both sites are within 100 m from the Wells Cargo.

Figure 2. Asphalt Plant and community protest against its dust emissions

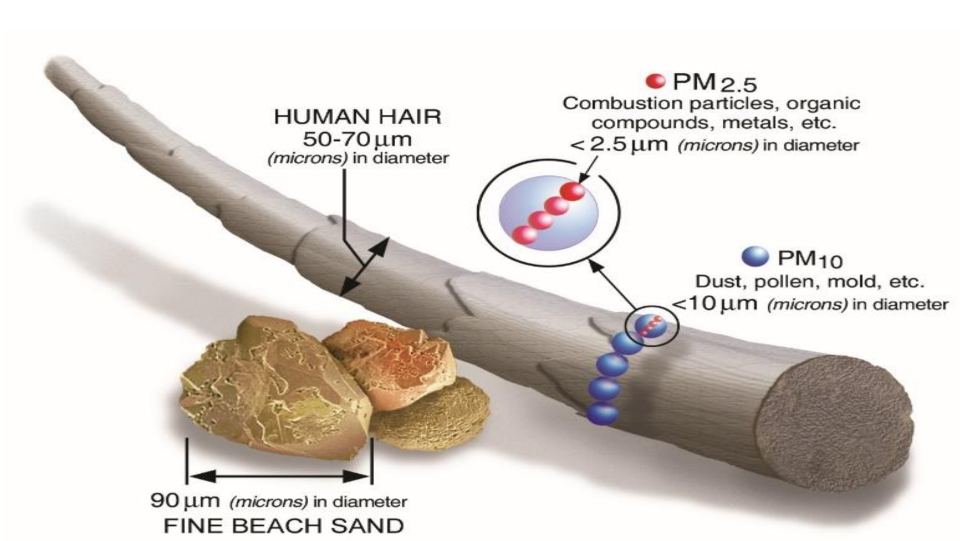

Figure 3. Size of Particulate Matter (PM). www.epa.gov/pm-pollution

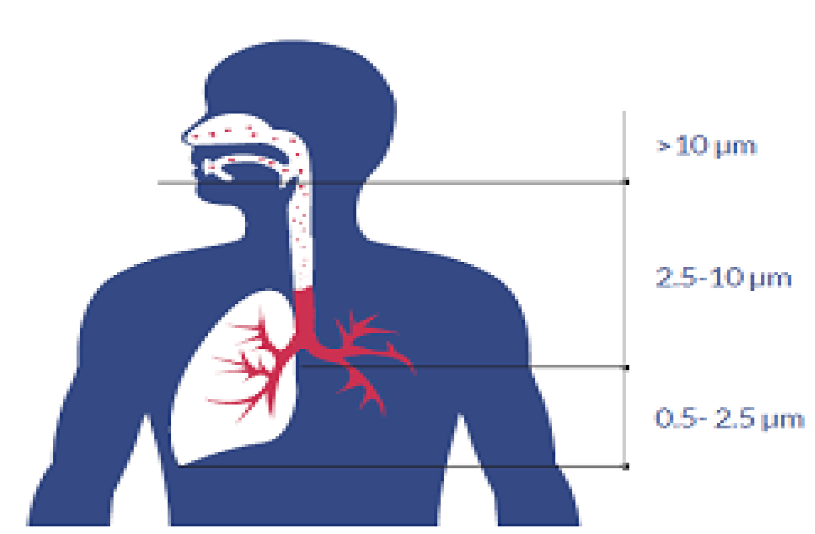

Figure 4. Depth of PM penetration by its size. www.health.ny.gov

Methods and Materials

Figure 5. The NFRM Air Quality Monitor at the Spring Valley High School

Figure 6. The SCI 608 Criteria Pollutant Sensor at the Derby site

We installed three air quality monitors (NFRM, ARA Instrument, Eugene, OR) to measure PM concentrations at the Spring Valley High School in October 2018. NFRMs (Figure 5) report both $PM_{2.5}$ and PM_{10} concentrations, as well as temperature, pressure, wind speed, and wind direction, in real-time at a 5-minute interval. Two NFRMs also collect $PM_{2.5}$ or PM_{10} on Teflon-membrane filters for subsequent analysis of particle mass and elemental/metal composition, while the other NFRM collect PM_{10} on quartz-fiber filters for analysis of organic carcinogens such as polycyclic aromatic hydrocarbons (PAHs). The intended sampling period is one year from October 2018 to October 2019. This poster presents 6-month results between December 2018 and May 2019.
In addition, Criteria Pollutant Sensors (SCI 608, Sailbri Cooper Inc., Beaverton OR) were installed at both the SVHS and Darby sites in January 2019. The sensors (Figure 6) were calibrated for consistency before deployment. They serve as a validation to the NFRM measurements. The differences in $PM_{2.5}$ and PM_{10} between Darby and SVHS indicate contributions from the Wells Cargo plant.

Results & Discussion

Preliminary data show a 6-month average of 6.21 µg/m^3 for $PM_{2.5}$ and 11.60 µg/m^3 for PM_{10}, with the maximum 24-hour average of 14.9 and 47.2 µg/m^3, respectively. These are all below the U.S. EPA ambient air quality standards (Figure 7 and 8). PM concentrations appear to be minimum with wind speeds between 0.6 and 2 ms^{-1} and increase toward lower or higher wind speeds (Figure 9). The highest PM concentrations are associated with northeasterly and southwesterly transport (Figure 10)

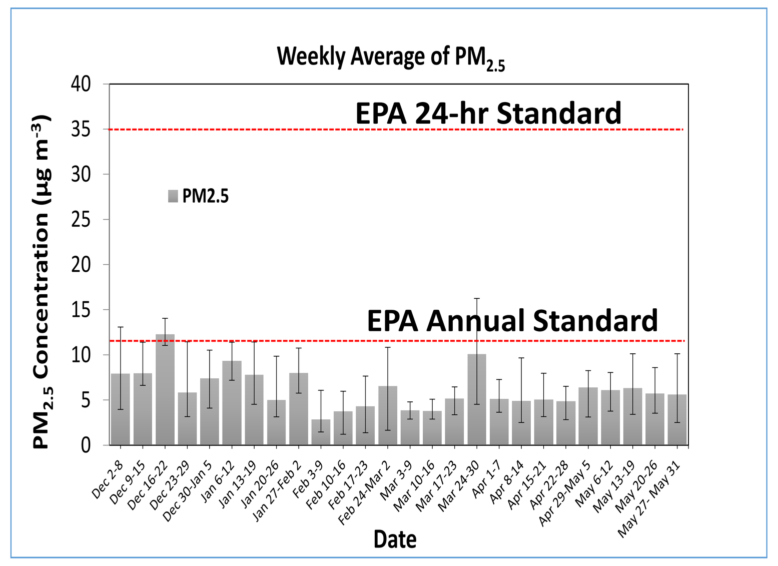

Figure 7. Weekly average of $PM_{2.5}$ with error bars indicating lowest and highest 24-hour average concentrations during the week.

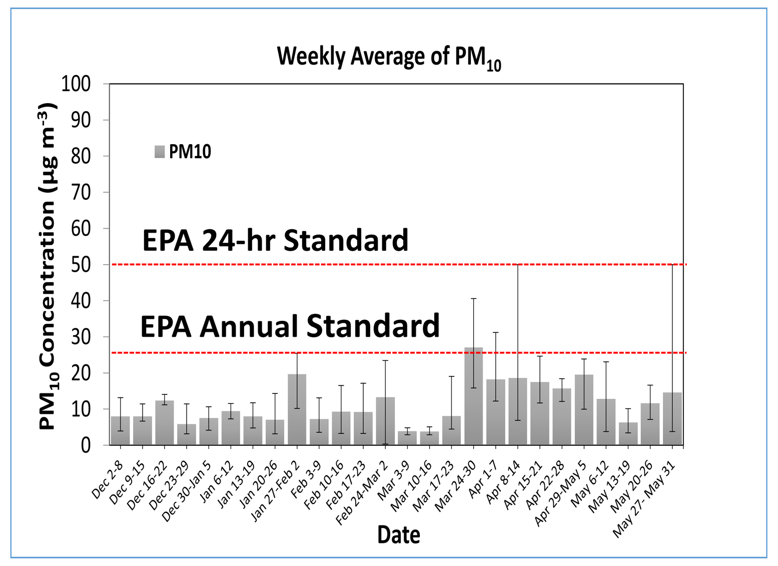

Figure 8. Weekly average of PM_{10} with error bars indicating lowest and highest 24-hour average concentrations during the week.

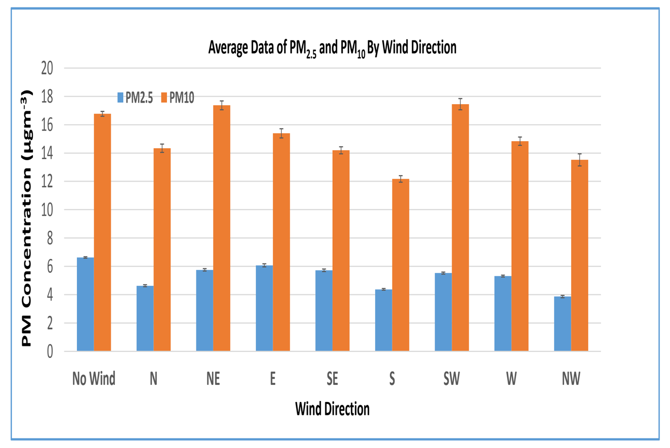

Figure 9. Both $PM_{2.5}$ and PM_{10} concentrations decrease with wind speed when 0 < WS < 2 ms^{-1}, and then they start to rise with wind speed when WS > 2 ms^{-1}.

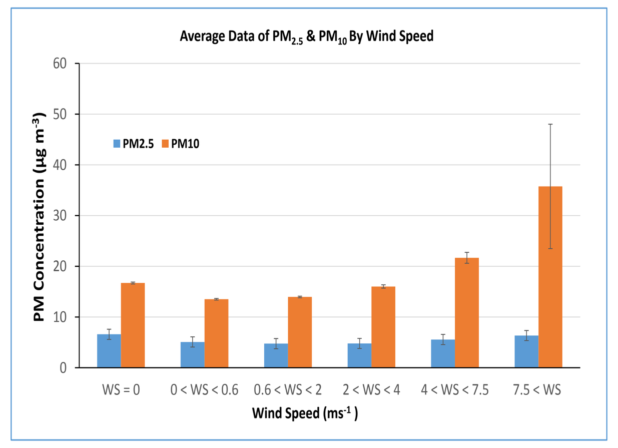

Figure 10. Both $PM_{2.5}$ and PM_{10} concentrations vary with wind direction. The NE and SW transport as well as no-wind conditions produce higher PM levels.

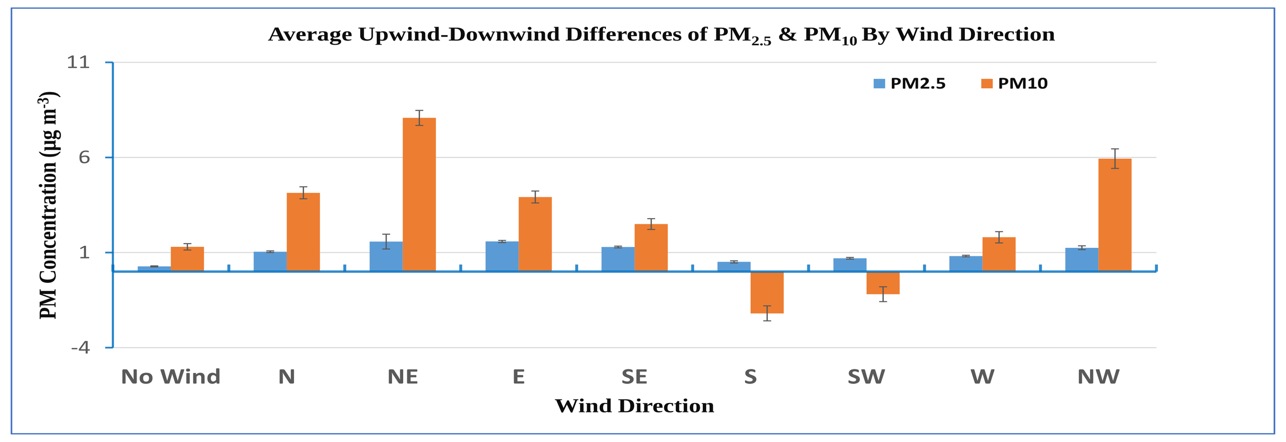

Figure 11. Differences of $PM_{2.5}$ or PM_{10} between SVHS and Darby (SVHS - Darby) by wind direction.

PM concentrations were generally higher at SVHS, which may reflect that SVHS is closer to Wells Cargo emitters. However, the differences between SVHS and Darby vary dramatically with wind direction (Figure 11). With northeasterly winds when SVHS is downwind of Wells Cargo, PM_{10} at SVHS is ~8 µg/m^3 higher than at Darby. With southwesterly winds, however, Darby is downwind of Wells Cargo and experiences higher PM_{10} concentrations than SVHS.

Conclusions

The asphalt plant can potentially increase the short-term and long-term exposure of schoolchildren and community to PM air pollution, especially during windy conditions. Although preliminary data show no violation to the U.S. EPA air quality standards, actions should be taken to reduce PM emissions from the plant to reduce health risks for the most sensitive populations.

Reference

http://www.epa.gov/pm-pollution
http://www.health.ny.gov