Public Health Evaluation of Ambient Air Nearby to a Shale Gas Well Site

Results from Long-term Air Monitoring at the Augustine Well Site in Washington County, Pennsylvania

Summary

- **2.5 Years of continuous air monitoring during development and production**

  Monitored and measured from July 2019 - December 2021

- **The Augustine well site did not contribute to elevated increases in potential health concern for either PM2.5 or VOCs**

Key Findings

- This air quality and public health evaluation showed that measured daily average **PM2.5 concentrations at the two site monitors were frequently** (81% and 64% of measurement days for Monitors 1 and 2, respectively) **below the corresponding PM2.5 concentrations** measured at the rural Pennsylvania Department of Environmental Protection (PADEP) Florence monitoring site in Washington County that is classified as a regional background monitor.
  - **The majority of the days when the average daily concentrations of PM2.5 exceeded background** (72% and 62% of measurement days for Monitors 1 and 2, respectively) **occurred during pre-construction, construction, or intermittent periods with limited or no activity on the well site**.
  - **Measured 24-hour PM2.5 concentrations were generally well below the US Environmental Protection Agency (US EPA) daily PM2.5 National Ambient Air Quality Standard** (NAAQS), and annual average PM2.5 concentrations were well below the US EPA annual average PM2.5 NAAQS (see Figure 2).
- **Long-term average concentrations for measured BTEX species** (benzene, toluene, ethylbenzene, and xylenes) that have been raised as concerns for natural gas well sites, **were all below health-based air comparison values, indicating an absence of chronic health concerns, including elevated risk of cancer** (see Figure 3).
- **Overall, the air monitoring data for the monitoring sites nearby to the well pad perimeter do not indicate that Augustine well pad air emissions contributed to elevated increases in long-term average concentrations of potential health concern for either PM2.5 or the measured VOC species at nearby residences.**

Novel Aspects of This Study

- Over two years of air monitoring collected during all phases of well pad development and well production, including approximately six (6) months of monitoring during the production phase.
- Downwind and upwind ambient PM2.5 measurements using regulatory-quality monitors and methodologies, and ambient VOC monitoring sites in each cardinal wind direction around the well pad perimeter.
- Laboratory analysis for 62 VOC species using sensitive US EPA method.
- Continuous monitoring of hourly PM2.5 concentrations for characterizing both short-term peak and long-term average PM2.5 concentrations, and continuous collection of 6-day air samples for VOC analysis for characterizing long-term average concentrations.

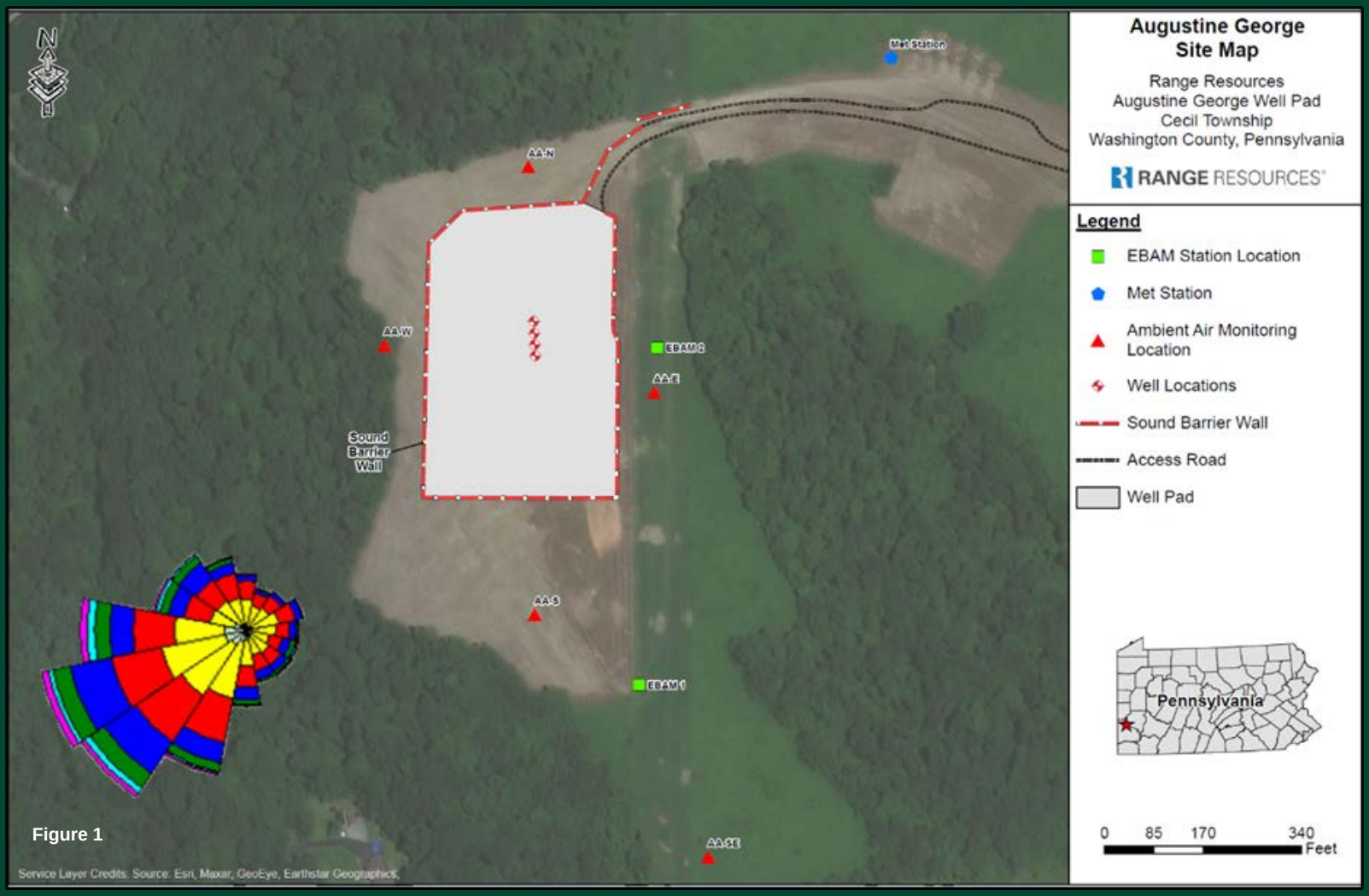

Figure 1

Figure 1.Locations of PM2.5 (green squares) and VOC (red triangles) air monitoring sites relative to the well pad. The overall wind rose for the entire study period is shown in the lower left corner of the map.

Study Methods

- An air monitoring network was designed to measure PM2.5, VOCs, and meteorological parameters during the development and operation of the Augustine well site (June 2019 – December 2021).
- Two PM2.5 and five VOC air monitoring sites ranging from about 204 to 940 feet from the nearest wells at the well site were established, including monitoring sites both upwind and downwind of the well site.
- A public health evaluation of this air monitoring dataset was conducted by comparing measured air concentrations to: (1) conservative (i.e., health-protective) health-based air comparison values, and (2) air concentrations measured at a PADEP monitoring site in Washington County that is representative of regional background air quality.

Augustine well site during hydraulic fracturing phase

About the data

- Health-based air comparison values developed by US EPA and the Agency for Toxic Substances and Disease Registry (ATSDR) are not bright lines above which health effects are expected; instead, due to the use of conservative assumptions and safety/uncertainty factors, they typically specify exposure levels that are from several-hundred-fold to several-thousand-fold lower than the exposure level at which an actual adverse effect was observed in people or laboratory animals.
- Measured air concentrations are not specific to just air emissions from the Augustine well site, as there is other local and regional Marcellus Shale development; moreover, the majority of the measured species have a large number of common anthropogenic and natural sources and are commonly measured in ambient air.

Figure 2

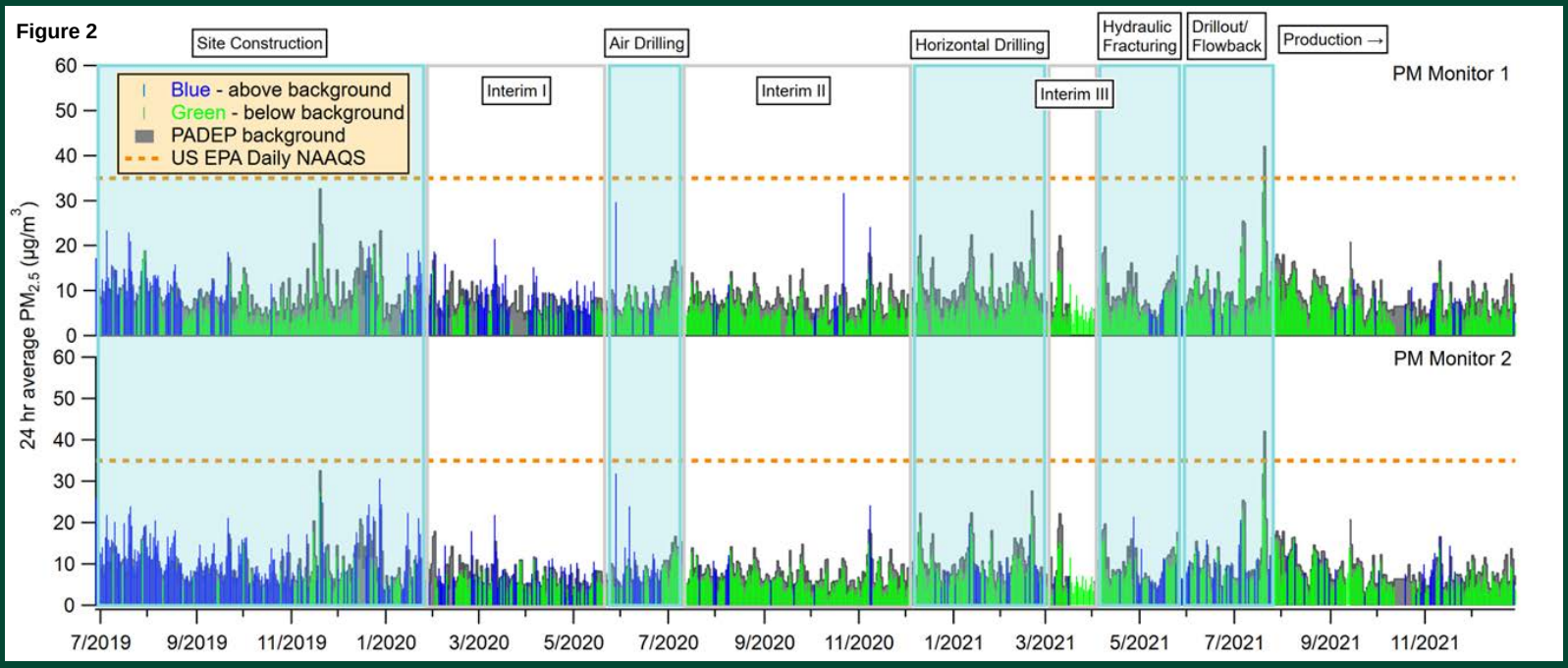

Figure 2. Times series of daily average PM2.5 concentrations over the entire monitoring period (June 2019 through December 2021) for PM Monitor 1 (top graph) and PM Monitor 2 (bottom graph) versus for the PADEP background Florence monitor. Blue days are measurements above background PM and green days are measurements below background PM. The US EPA daily PM2.5 NAAQS of 35 µg/m3 is shown in the dashed orange line.

Acrolein

Acrolein, which is a VOC present in all combustion emissions (e.g., automobile exhaust, wood smoke), was the only measured VOC species detected in at least 10% of samples over the two year monitoring period to have average concentrations exceeding chronic health-based air comparison values. However, due to acrolein's high reactivity, there are known challenges to making accurate measurements of airborne acrolein, including for the US EPA air sampling method used for the VOC samples (Method TO-15). Given the uncertainty in the acrolein measurement results from the methodological limitations, as well as the low frequency of detection for acrolein at each of the monitoring sites (from 5 to 12% detection frequencies), the exceedances of the chronic health-based air comparison values for acrolein at each of the monitoring sites should not be intepreted as indicating potential health risks from well pad acrolein emissions.

Figure 3

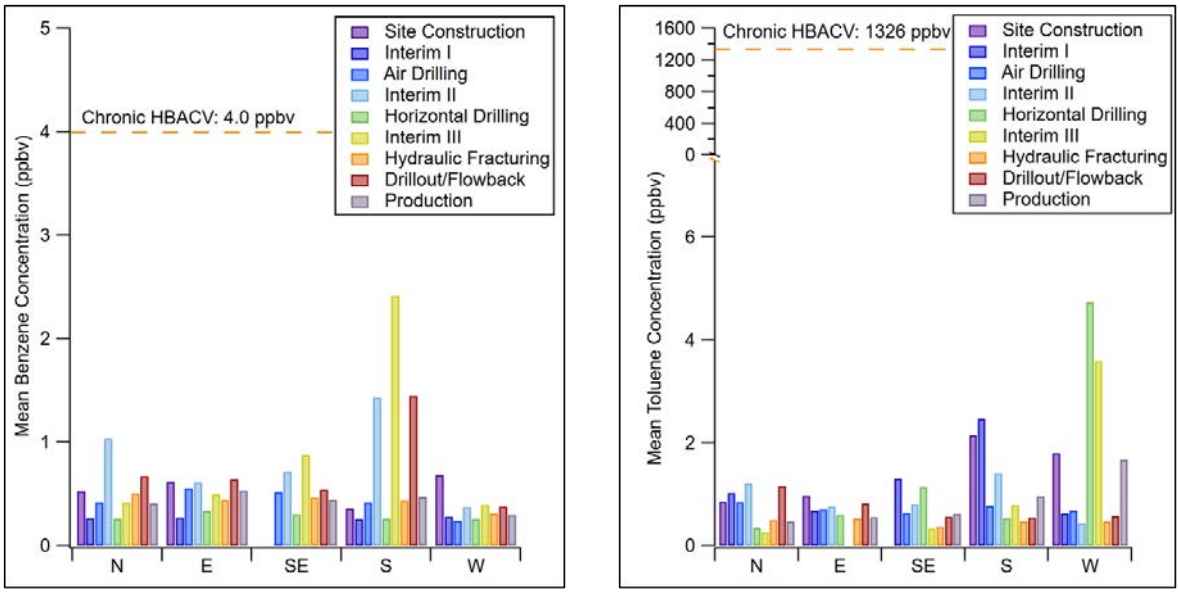

Figure 3. Comparison of mean detected concentrations above the method detection limit by monitoring site and well pad development phase with chronic health-based air comparison values (HBACVs) for benzene and toluene, two of the four BTEX (benzene, toluene, ethylbenzene, and xylenes) species. The graphs show that all mean detected benzene and toluene concentrations by monitoring site and well pad development phase are less than chronic HBACVs. The mean detected benzene and toluene concentrations represent overestimates of long-term average concentrations due to the intermittent occurrence of concentrations below the method detection limit (detection frequencies ranged from 50.3 to 90.1% for benzene across the monitoring sites, and 44.4 to 60.0% for toluene across the monitoring sites). The other two BTEX species- ethylbenzene and xylenes- were detected very infrequently (3.0 and 4.4% of samples, respectively) such that there was insufficient data to compute mean detected concentrations.