

## The Southwest Pennsylvania Environmental Health Project Procedure for air quality monitoring and analysis using Speck PM<sub>2.5</sub> monitors

In an effort to answer the question of public health effects brought on by poor air quality around shale gas activities, The Southwest Pennsylvania Environmental Health Project (EHP) has developed protocols for monitoring the air quality (indoor and outdoor) of residents' homes. EHP is specifically concerned about the direct toxicity of fine particulate matter (PM<sub>2.5</sub>) and potential synergistic actions resulting from the simultaneous transport of other emitted toxic chemicals. EHP also conducts health assessments and a national health survey (the SF-36) which measures quality-of-life and health status, in conjunction with environmental monitoring.

EHP serves communities and individuals as a resource for information on potential exposures to hazardous substances from shale gas development (SGD), as well as offering strategies for limiting the risk of associated health effects. EHP understands that the shortage of objective, reliable data on the health effects of gas extraction activities leaves open many questions about the origins of residents' health problems and the scope of public health risks in communities.

In late 2013 Carnegie Mellon University's CREATE Lab provided 150 Speck air quality monitors to EHP. The Speck monitors collect particulate matter (PM<sub>2.5</sub>) data in real-time. Minute-by-minute data is measured and recorded on the monitor. EHP places monitors in residences near SGD, collects the data for analysis and prepares interpretive reports for residents.

In 2014 EHP placed the monitors inside and outside residences throughout Southwestern Pennsylvania and parts of Ohio, West Virginia and New York. The devices gathered data on PM<sub>2.5</sub> levels at homes in proximity to gas activity sites such as drilling sites, compressor stations, metering stations and processing stations. By analyzing the Speck data in association with medical health assessments of the residents performed by EHP's nurse practitioner, we have gained a better understanding of the effects of SGD on public health.

**Purpose:** Develop a protocol for monitoring air quality with Speck (PM<sub>2.5</sub>) monitors that is appropriate for public health assessment.

**Goal:** Define a standard protocol for Speck air quality monitoring that can be used by other community groups or individuals interested in assessing air pollution in residential areas. The protocol can also shared with local and state level agencies in order to show the validity of EHP's air monitoring program.

"

**Objective:** Outline EHP's current best practices for PM monitoring using the Speck monitor.

### **Particulate matter and monitoring device**

Particulate matter (PM) is an irritant that affects the respiratory and cardiovascular system. It has many sources and is found at most industrial sites. PM<sub>2.5</sub> can carry other pollutants into the deep lung that may additionally impact health. For these reasons, EHP chooses to measure PM<sub>2.5</sub> at residences to develop estimates of background levels of airborne particles and to identify the frequency, duration and intensity of peaks. PM<sub>2.5</sub> is used as a surrogate for estimating levels of associated SGD chemicals.

There are a variety of particulate monitors on the market. EHP provides the Speck monitor, which is now commercially available for \$200.00. The Speck displays measurements in ug/m<sup>3</sup>, stores continuous readings of PM<sub>2.5</sub> for several months, and stored data is downloadable.

### **Initial contact with residents**

EHP receives calls from residents who believe their health has been affected by natural gas activities in their community. Often, these residents are unfamiliar with natural gas development activities, specifically the length of time the process can take and the potential health effects they may experience, both short and long term.

EHP educates residents about common at-home practices to make their living space healthier while SGD is ongoing. Although residents may not be able to stop the gas activities in their neighborhood, EHP works with them to monitor and potentially limit the possible routes of exposure. Materials on how to improve indoor air quality and recommendations on air purifiers are available on EHP's website [www.environmentalhealthproject.org](http://www.environmentalhealthproject.org).

### **Qualification for Speck monitoring**

In general, for residents living within 1 mile of natural gas activity, EHP recommends monitoring their homes for PM<sub>2.5</sub> exposures. Due to the limited number of monitors EHP can offer, we typically provide monitoring to residences within 3 miles of natural gas activity. The services of EHP's Nurse practitioner are available regardless of a resident's location, via either phone or office visits if outside the SWPA region.

Upon request from a resident to monitor their environment (water, air and health) EHP initiates a conversation via telephone or e-mail. This conversation covers the monitoring process, health assessment and collection of necessary information such as their home and mailing address and their current health concerns related to the natural gas activities. When possible, if a nearby site has yet to be constructed, baseline monitoring is recommended. This allows for comparisons before and after construction and natural gas operations.

With the consent of the resident, EHP enters their home address into FracTracker's mapping software to measure the distance from the residence to the nearby natural gas activity sites (such as compressor stations, well pads, processing stations and impoundment ponds).

### **EHP's system of Speck calibration**

To calibrate a particulate matter monitor, it must be placed into a chamber that has a previously determined level of PM. Another option is to run monitors next to a previously calibrated piece of equipment and compare results. Due to the rate at which EHP moves monitors in and out of the office, and the cost of equipment, EHP has developed another simplified system of calibration that uses the EPA's recorded PM levels for comparison with the speck monitors.

EHP's office is situated in an urban area, 3 miles away from any natural gas activities. Monitors are set up in the office, and readings are compared to the local EPA Air Quality Index (AQI). If the Speck monitors match the AQI, we consider the Specks to be working correctly and available for distribution.

For EHP's residential monitoring efforts, the AQI provides accurate regional data on background levels of PM<sub>2.5</sub>. The Speck monitors used at residences, in general, show background levels similar to the AQI, punctuated by episodic spikes.

### **Recommended particle (PM<sub>2.5</sub>) monitoring procedure**

EHP recommends that during all stages of natural gas construction residents keep a record of relevant events. The checklist of relevant information includes:

- A health journal to record any new or sudden health complications they experience, such as frequent headaches, nosebleeds, etc.
- Any changes happening in their community due to the new natural gas infrastructure.
- Information on events that may cause spikes in PM inside or outside the home such as cooking, vacuuming, truck traffic, lawn mowing, nearby fields plowed, etc.
- Health symptoms and weather conditions can also be recorded (see EHP's diary guidelines at <http://www.environmentalhealthproject.org/health/health-diary/>).

To begin monitoring, ideally a period of baseline data would be collected for a minimum of 2-4 weeks of indoor and outdoor readings from each residence. However, EHP usually does not come in contact with a resident until after the natural gas facility has been built.

Following a baseline period, the construction of the natural gas site (compressor station, well pad, etc.) should be monitored. Again we recommend a minimum of 2-4 weeks, up to three months, for indoor and outdoor monitoring to give adequate time to capture air quality levels during various stages of construction.

Post-construction monitoring follows. This is the time when the facility is 'up and running'. EHP recommends that 2-3 months of indoor and outdoor data be collected. Lastly, events such as a blow-down at a compressor station, venting, accidents, a large flare or a release of chemicals giving off a strong odor should be sampled in conjunction with Summa canisters to collect volatile organic compounds (VOCs) if possible. See recommendations for VOC monitoring below.

### **Placement of the monitors**

By locating a pair of Speck monitors both inside and outside of a resident's home, EHP is able to compare data on PM<sub>2.5</sub> exposure during the course of SGD activity. EHP personnel will typically assist residents in determining a good place to put monitors both inside and outside the house.

Indoors, we suggest that monitors be placed in a room that does not get a lot of traffic and where it is less likely to be affected by children playing or kitchen activity, which can generate PM through cooking. Rooms that are closest to the natural gas site(s) are preferable. To monitor outside, the resident will need a sheltered area but within reach of an electrical outlet, such as on a porch. If possible, the outside monitor should also be on the side of the house that faces the site.

Each resident receiving a Speck monitor from EHP will speak with an EHP employee who can educate them on the monitoring process. The resident will also receive the following:

- A Speck consent form
- An written introduction to the Speck monitor: how it works
- An educational handout on EPA's Air Quality Index (AQI)
- An incident recording sheet

The Speck consent form confirms that EHP is temporarily loaning the monitors to the resident and that all data recorded will be held confidential. EHP also informs the resident that this data would not be useful in a court of law.

A Speck monitor displays the PM<sub>2.5</sub> levels on a screen and ties those readings to the Environmental Protection Agency's AQI by using the AQI health-based color scheme. In order for residents to fully understand what the different levels of the AQI mean, EHP provides an educational handout that shows the relation between colors, concentration of PM<sub>2.5</sub> and health statements. This information is also available at [www.airnow.gov](http://www.airnow.gov).

Along with the use of a Speck monitor, residents are able to consult with EHP's nurse practitioner at home or in the EHP office. The nurse practitioner will perform a health physical, as well as go over the following:

- Authorization and consent form
- EHP organization privacy and security policy of client health information
- Home exposure assessment related to oil & gas development activities
- Individual health exposure assessment

### **VOC monitoring**

Periodic sampling with Summa canisters under appropriate weather conditions can provide qualitative information on what chemicals may be present in association with PM<sub>2.5</sub>. Canisters sample for a wide variety of VOCs and hydrocarbons that have been associated with shale gas related activity. Depending on resources, sampling can take place during different phases of development, including pre- and post-construction. Weather conditions must always be considered when sampling occurs (see below). At a minimum, samples

should be taken when winds are calm or light. Recommended sampling times, in order of priority are:

1. Event-based sampling such as during venting, blowdowns, accidents or cleaning
2. Post-construction during normal operations
3. During the construction phase
4. Pre-construction for baseline monitoring (this is the least important because levels of chemicals may be below the detection level needed for analysis)

1. Events: Capturing “events” is particularly important for understanding potential risks from emissions. Peak exposures (i.e. events) rather than the everyday lower levels are likely to adversely affect human health in the short term, such as causing an asthma attack, as well as contributing to long-term effects. It is most useful to use the canister in conjunction with a particulate monitor since PM<sub>2.5</sub> and VOCs can travel together from compressor station emissions, for example. Thus, for “event” sampling at a nearby home, both Summa canisters and PM monitors should be readily available. If sampling near the fenceline of a compressor station site this may not be feasible. It should be noted that long-term low exposures can also have health effects.

2. Post-construction: Periodic sampling during normal operations should occur near the site during appropriate weather conditions to provide information on longterm emissions.

3. Construction: During this phase, PM and diesel-related VOCs may be present. Sampling at a nearby home that has a PM monitor, downwind and during daytime operations is recommended. Because this phase is of limited duration it is of lower priority, though health impacts may occur for sensitive individuals during this time.

4. Pre-construction: If funding allows, establishing baseline VOCs at nearby homes or at the fenceline can be helpful, particularly if the data may be used to provide evidence that air contamination occurred after site development. In a rural environment it is unlikely that VOCs will be detected above the recording limit for VOC analysis.

Sampling times: Summa canisters can sample for a range of time periods. Each sampling time period may serve a particular purpose:

- “Grab” samples for as short as 30 seconds are best for times when odors are present and/or the air may rapidly dissipate
- 3-hour samples can be used for short-term events
- 12-hour samples can be used for overnight or daytime sampling
- 24-hour samples are commonly used and thus can be compared with other sites. The drawback with 24-hour samples is that any “peak” in VOC concentrations during that time will be averaged out over the 24- hour period.
- 

Chemicals sampled: A common suite of chemicals sampled for near compressor stations and other shale gas sites is found in the EPA TO-15 sampler. We recommend that methane also be added to the lab analysis since it is a large component of the releases from compressor stations and other SGD facilities.

Sampling for formaldehyde is also recommended but requires a separate sampling method. A formaldehyde badge is a passive sampler that can be hung outside or inside. Formaldehyde is a VOC that has been found near compressor stations. Formaldehyde badges are best used for a 24-hour sampling period. Like the Summa canister, formaldehyde badges will provide the greatest information if used when emissions are high or conditions are such that they are concentrated near homes.

As more is learned about the types of chemical emitted from SGD sites, there may be additional chemicals to sample for with different methods.

### **Impact of weather on sampling periods**

EHP's document, "How's the Weather"

(<http://www.environmentalhealthproject.org/health/air/>), discusses the effects of weather and time of day on how pollutants travel from the site to nearby homes. In general, Summa canisters are best used when pollutants are most likely to be concentrated in the air surrounding the residence. Days that are cloudy with calm or light winds and nights with calm or light winds are most suitable.

### **Post-monitoring Speck data analysis**

After the monitoring period has ended, EHP collects the Speck monitors, or residents return them to the office. EHP's environmental health educator then downloads the data and generates a report of the readings.

The data is analyzed for several key factors. The first examines the minute-by-minute data and identifies the maximum recorded PM<sub>2.5</sub> values, which show the peak exposure levels. The times of peak exposures are also identified for further examination of patterns of peak exposures. EHP then averages the data into different time-averages (i.e. 15-minutes, 30-minutes, 60-minutes, 3-hours, 6-hours, 12-hours and 24-hours) to assess potential health impacts over time.

Another factor of EHP's data analysis is the comparison of Speck results to the EPA's Air Quality Index (AQI). The EPA has created health-based levels of PM<sub>2.5</sub> exposure. The health levels given by EPA are color-coded (green, yellow, orange, red, purple and maroon); green denotes a safe level and maroon a hazardous level. More information on the EPA AQI is available on the website [www.airnow.gov](http://www.airnow.gov).

After analysis, EHP creates tables and charts and interprets the results in a several page report, which is mailed to the resident.

### **Post-monitoring report**

In the Speck report residents will find a cover page thanking them for their cooperation in the monitoring process. They can also find information on PM<sub>2.5</sub>, an explanation of 'what's in the report' and lastly, general recommendations of actions to take now that their air quality levels have been recorded.

---

#### **SW Pennsylvania Office**

4223"Y cvgtf co "Rrr| c'F tlgx."%#23.'O eO wtc{.'RC"37539  
Office: 724.260.5504 • Cell: 724.249.7501

#### **Connecticut Office**

760 Chapel Street, New Haven, CT 06510  
Cell: 203.823.6642

The second page shows their data analyzed on an hourly basis (60-minute time average). EHP finds that the hour average is more relevant than minute by minute data or 24 hour averages for health assessments. It can also be easily modeled with recorded meteorological data. EHP also reports the highest reading recorded on an hourly basis and explains the health correlation based on EPA's AQI.

Following the chart is a list of additional information on the AQI and monitoring results. Lastly, EHP summarizes the report with two pages of recommendations concerning health and air quality.

### **Resident follow-up**

Typically, within 6 months of mailing the Speck report to a resident, EHP will follow up with a phone call to ask about his or her current state of health, and inquire about further monitoring possibilities. EHP often receives calls from residents prior to the 6 month date with requests to continue monitoring due to an increase in natural gas activities.

Once a resident has placed a call to EHP for another round of monitoring, the process will start over again with a new health assessment, and another placement of the monitors.

---

#### **SW Pennsylvania Office**

4223"Y cvgtf co "Rr| c'F tkg."%423.'O eO wtc{.'RC"37539  
Office: 724.260.5504 • Cell: 724.249.7501

#### **Connecticut Office**

760 Chapel Street, New Haven, CT 06510  
Cell: 203.823.6642