

Natural Gas Compressor Stations

Addressing Community
Concerns, Assessing Emissions
and Health Impacts

SWPA-EHP Presentation

Deerfield, MA

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Southwest PA Environmental Health Project

Our mission is to respond to individuals' and communities' need for access to accurate, timely and trusted public health information and health services associated with natural gas extraction.

SWPA-EHP Services

Health evaluation and support

- Nurse Practitioner
- Health exams
- Consultations
- Referrals for health services
- Health Provider education
- Clinical toxicity profiles

Public Health Outreach

- Identification of exposure pathways
- Measurement tools
- Interpretation of air/water lab results
- Assessment of air exposures
- Evaluation of health risks
- Information assessment

Health concerns in communities exposed to natural gas from fracked shale

— David R. Brown Sc.D —

SWPA-EHP

Discussion outline

Fracking ancient shale beds releases raw natural gas and other chemicals into neighborhoods

Over 1.2 million people are living within 1/2 mile of a shale gas extraction, processing or transporting pipeline in Pennsylvania.

The Environmental Health Project has been examining persons with health concerns.

This discussion will focus on

- the health effects observed in communities,**
- the chemicals involved**
- the pathways of exposure**

Personal actions available to protect residents who are exposed will be included.

Symptoms Reported to EHP Nurse Practitioner

N=113	Individuals reporting	Percentage of total cases
Respiratory	60	53%
Dermatologic	55	49%
Eye	44	39%
Nose & throat	68	60%
Gastro-Intestinal	56	50%
Cardiac	33	29%
Neurological	65	58%
Psychiatric	64	57%
Endocrine	21	19%
Ear/hearing	19	17%

Health Issues

Category	Researcher/author
Gastrointestinal *	Earthworks (2012) Bamberger & Oswald (2012) Ferrar et al. (2013)
High Blood pressure	Subra (2010)
Muscle/joint pain	Earthworks (2012) Subra (2010) Subra (2009)
Neurological *	SWPA (on-going) Bamberger & Oswald (2012) Subra (2010) Subra (2009)
Respiratory *	SWPA (on-going) Earthworks (2012) Bamberger & Oswald (2012) Subra (2009)

Category	Researcher/author
Behavioral/ mood/stress *	SWPA (on-going) Earthworks (2012) Ferrar et al. (2013) Subra (2009) Perry (2013) Resick (2013)
Birth Outcomes	Hill (2012) McKenzie (2014)
Cancer risk	McKenzie (2012)
Dermal *	SWPA (on-going) Earthworks (2012) Subra (2009)
Ear, nose, mouth, throat *	Earthworks (2012) Subra (2010) Subra (2009)
Eye *	SWPA (on-going) Earthworks (2012) Bamberger & Oswald (2012) Subra (2010) Subra (2009)

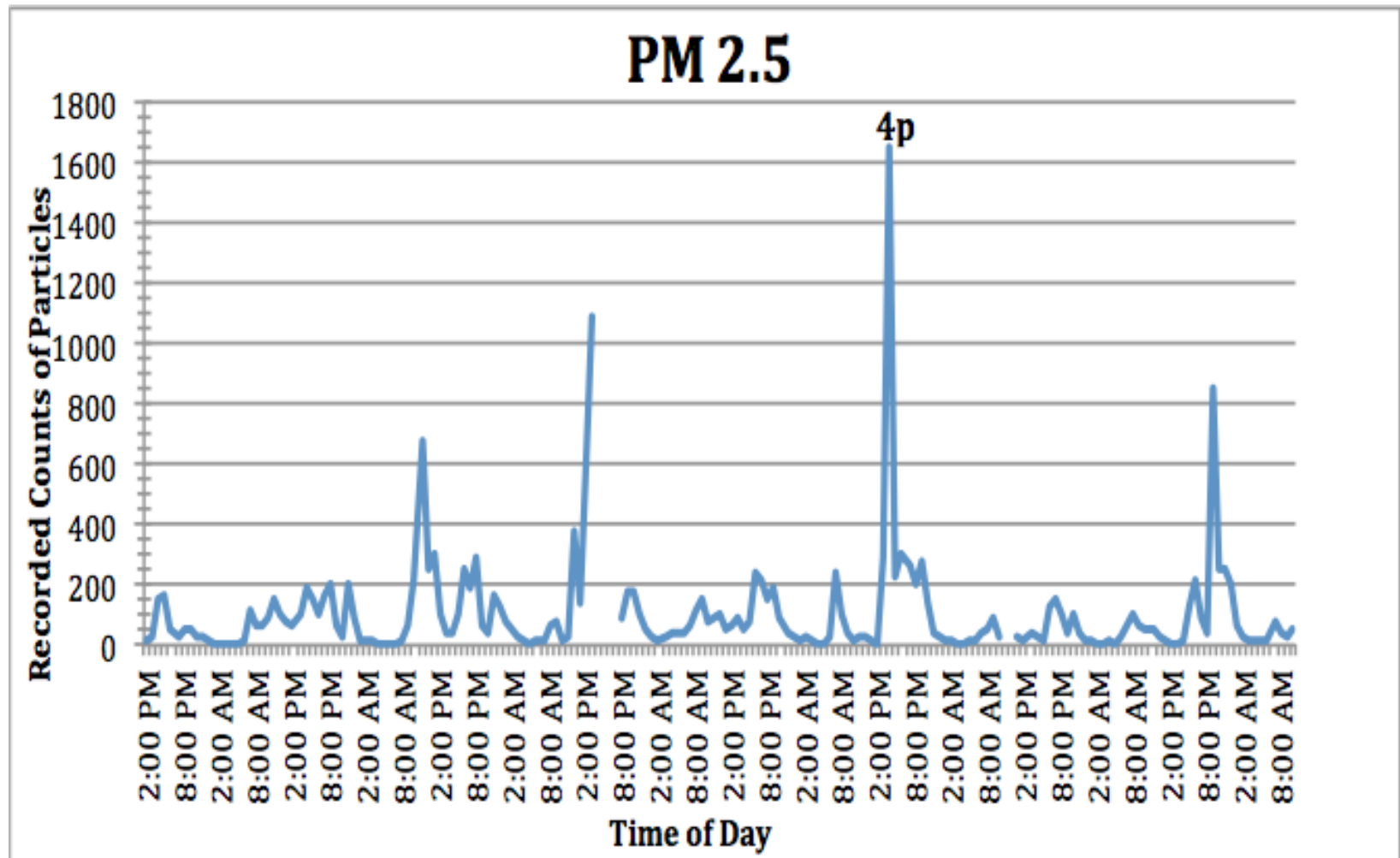
14 Emissions of Concern for Immediate Toxic Responses

1. Barium, Arsenic
2. Fluoride salts*
3. VOCs *
4. PAHS
5. BTX*
6. Methylene chloride, (halogenated alkanes)*
7. Acetaldehyde/Formaldehyde
8. Fine particulate matter*
9. Carbon monoxide
10. Glycols*
11. Silica dust*
12. Radium and radioactive decay products*
13. Nitrogen oxides
14. Hydrogen sulfide

Chemicals and Pathways of Exposure

- **Chemicals come from both fracking fluids and the actual shale deposits.**
- **Exposure pathways are:**
 - **Air emissions from flaring, fugitive emissions and blow downs.**
 - **Water emissions are from waste ponds, disposal, spills and long term storage.**
 - **Soil and food exposures from fallout and other undetermined factors.**

A one-week sample of Dylos results for a house monitored in March 2013



Summary of peak PM2.5 count values for each house, given in number of hours, % total hours, times of day, and maximum peak value.

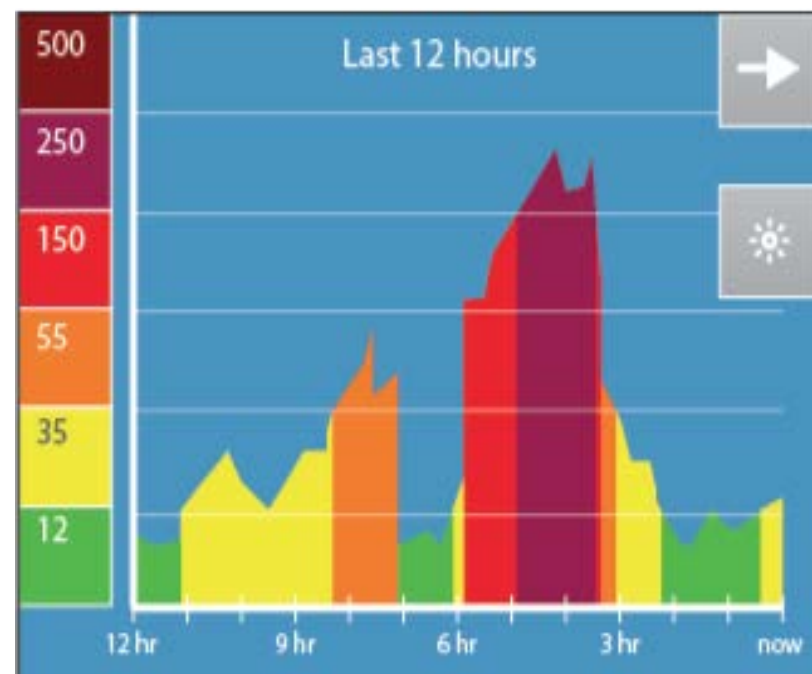
(Median 50 Cts/0.01ft³)

6 hour average: night, morning, afternoon, evening

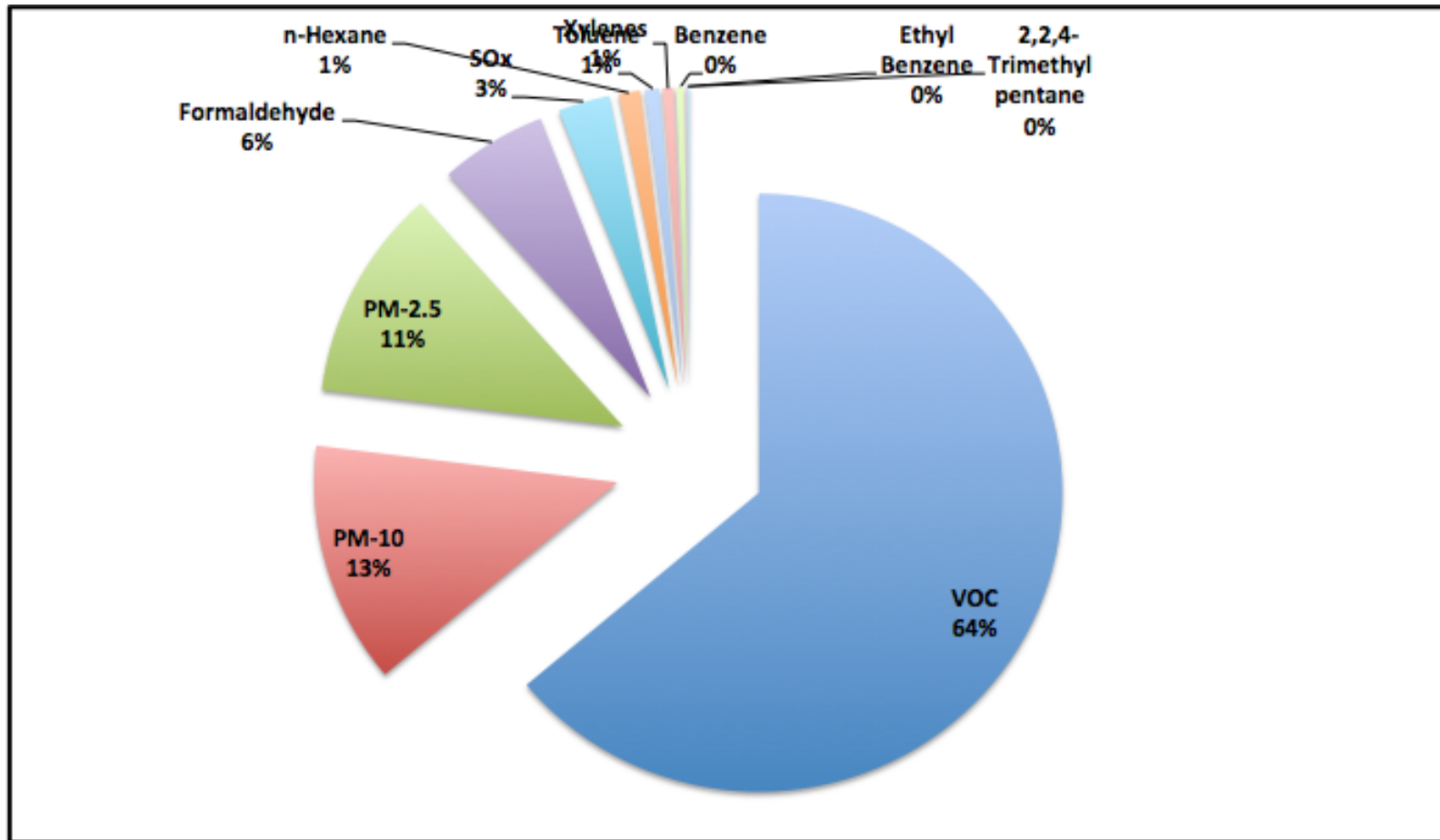
House	Number of hours with peaks	% of total hours with peaks	Times of day of peaks*	Maximum Peak Value
1	12	8.5	N	2711
2	11	5	M, N	756
3	3	2.5	M	171
4	1	0.5	N	201
5	8	2.5	A, E	556
6	11	7.7	A, E, N	576
7	31	8.7	M, A, E	1654
8	29	15	M, A, E	991
9	9	12.6	M, E, N	1057
10	23	32	M, A, E, N	844
11	7	16	M, E	3846
12	2	1.4	E	203
13	3	4.3	M	164
14	57	34.3	M, A, E, N	1761

Review of Reported Symptoms

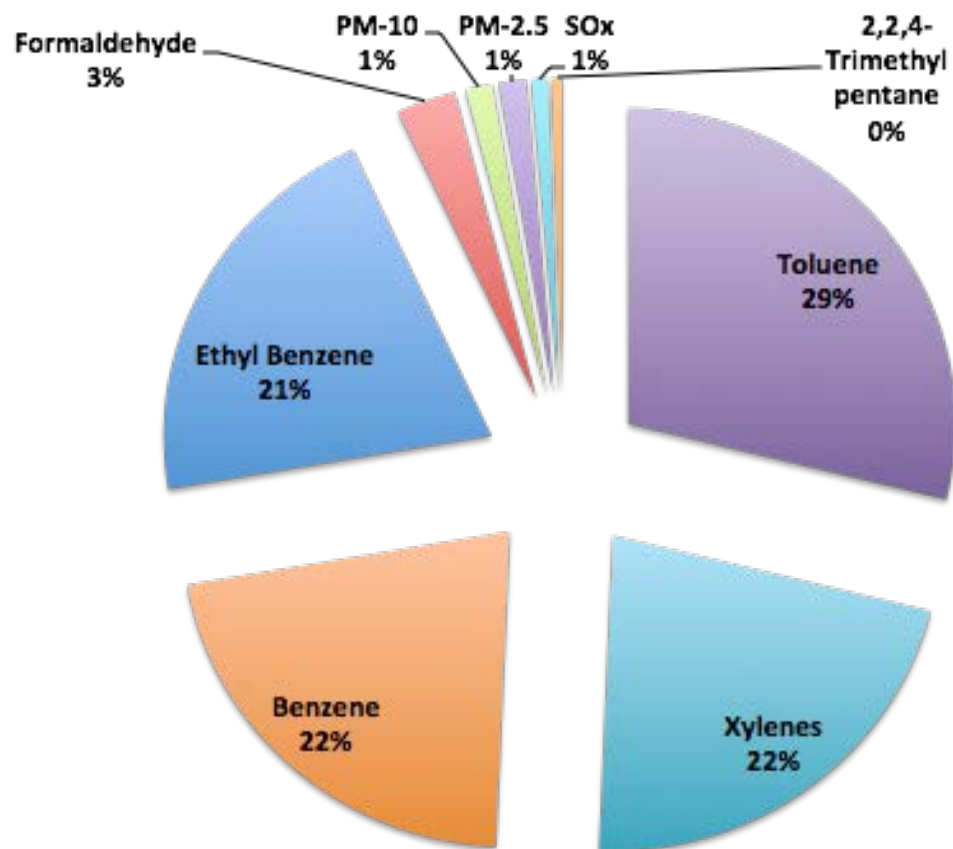
Symptoms might be persistent, transient, or intermittent. These variations in symptom presentation are consistent with the changing and episodic nature of exposures.



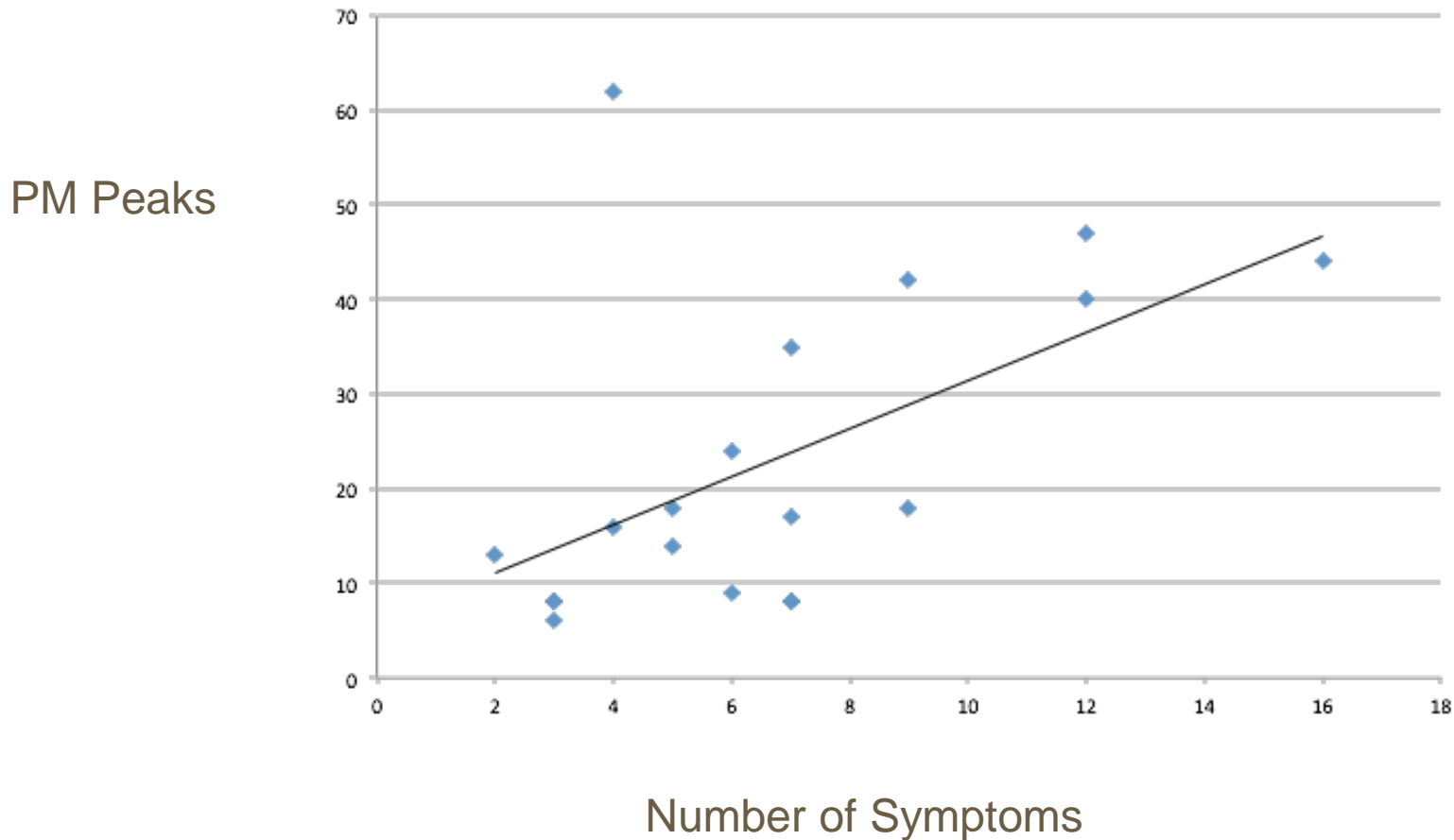
DEP Summary of the Inventory Data Reported Emissions



Compressor Blowdowns



PM 2.5 Peaks vs Number of Symptoms



Health Findings and Air Monitoring Reports are in Conflict

Health Findings

Reports of acute onset sequale in humans :

- respiratory,
- neurologic,
- dermal,
- vascular bleeding,
- abdominal pain,
- nausea, and vomiting

Monitoring Reports

Assurances from air monitoring data that untoward exposures are not occurring.

- Barnett Shale Texas (Bunch et al- 2013)
- Marcellus Shale Ambient Air sampling (Pennsylvania DEP 2010)
- City of Fort Worth gas Air Quality Study (ERG 2011)

Central Questions

What are the health issues associated with UNGD of shale and implications for health care providers?

What is the evidence that would indicate a clinical problem for providers?

What characteristics define the health issues of immediate concern, and what is needed to mitigate the damage?

Summary of the Evaluation

- **The analysis shows that protocols used for assessing compliance with ambient air standards do not adequately determine**
 - the intensity, frequency or durations of the actual human exposures to the mixtures of toxic materials released at UNGD sites.
 - Typically used periodic 24-hour average measures underestimate actual acute exposures by an order of magnitude.
 - NAAQs and other available reference standards for ambient air are set in ‘forms’ that prevent determination of acute health risk.
 - Standards do not consider the most likely synergistic potential of the mixture-combinations of toxic air emissions.
 - Standards needed for acute toxics are not available for most compounds
 - Measures are incomplete (Only 6 of 11 primary chemicals identified by BSSI measured by TCEQ)
- **Application of basic, air dispersion modeling shows that local weather conditions and time of release are strong determinants of the timing and intensity of individual exposures.**

Westtown, New York (Minisink)

— Summary of air monitoring and
health assessment at 8
residences —

Minisink: Pilot Project

- **Community coordinator**
- **Health assessments of 8 families**
- **PM2.5 monitoring with Speck monitors**
- **VOC sampling with summa canisters**

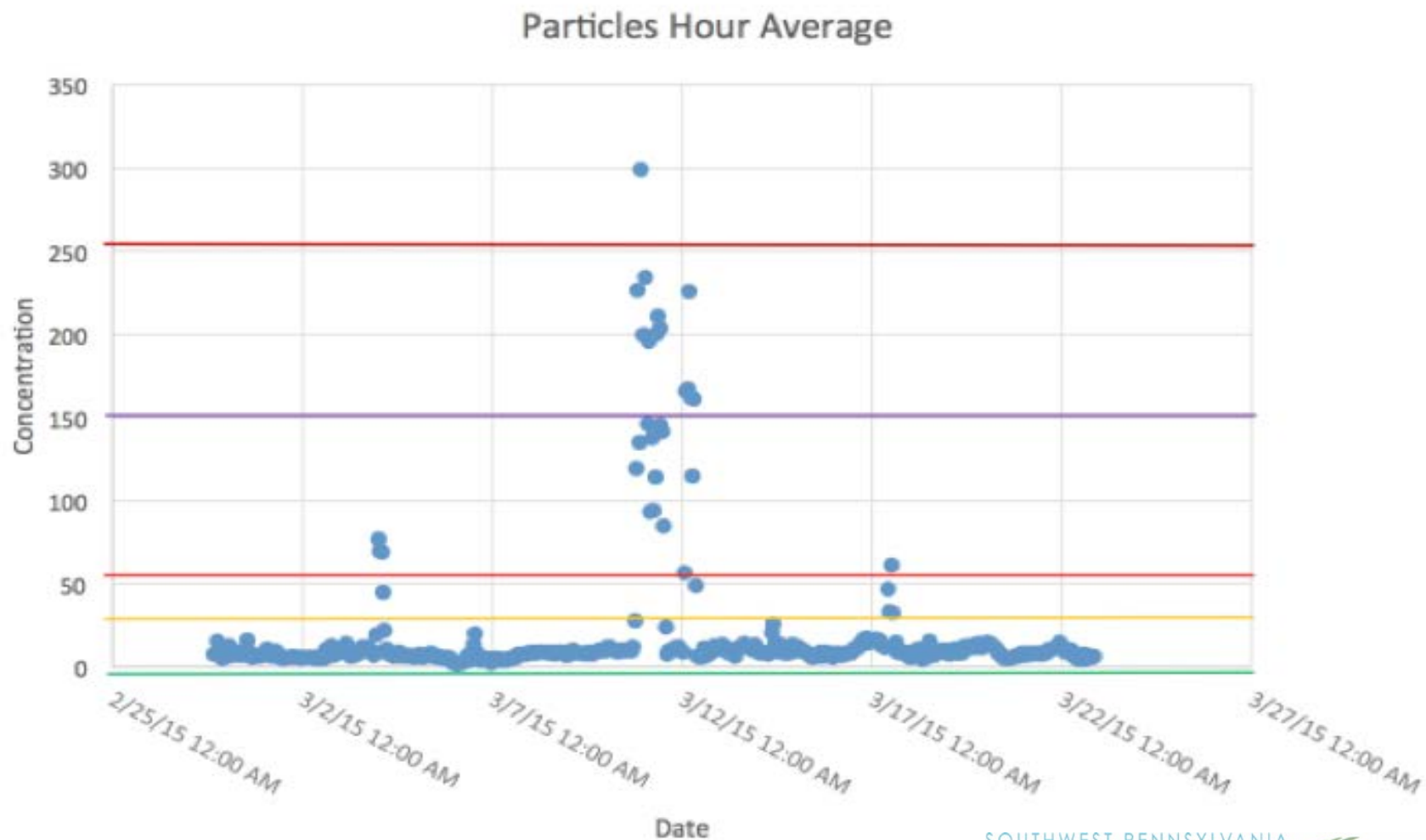
Minisink:

The predominant health impacts reported were:

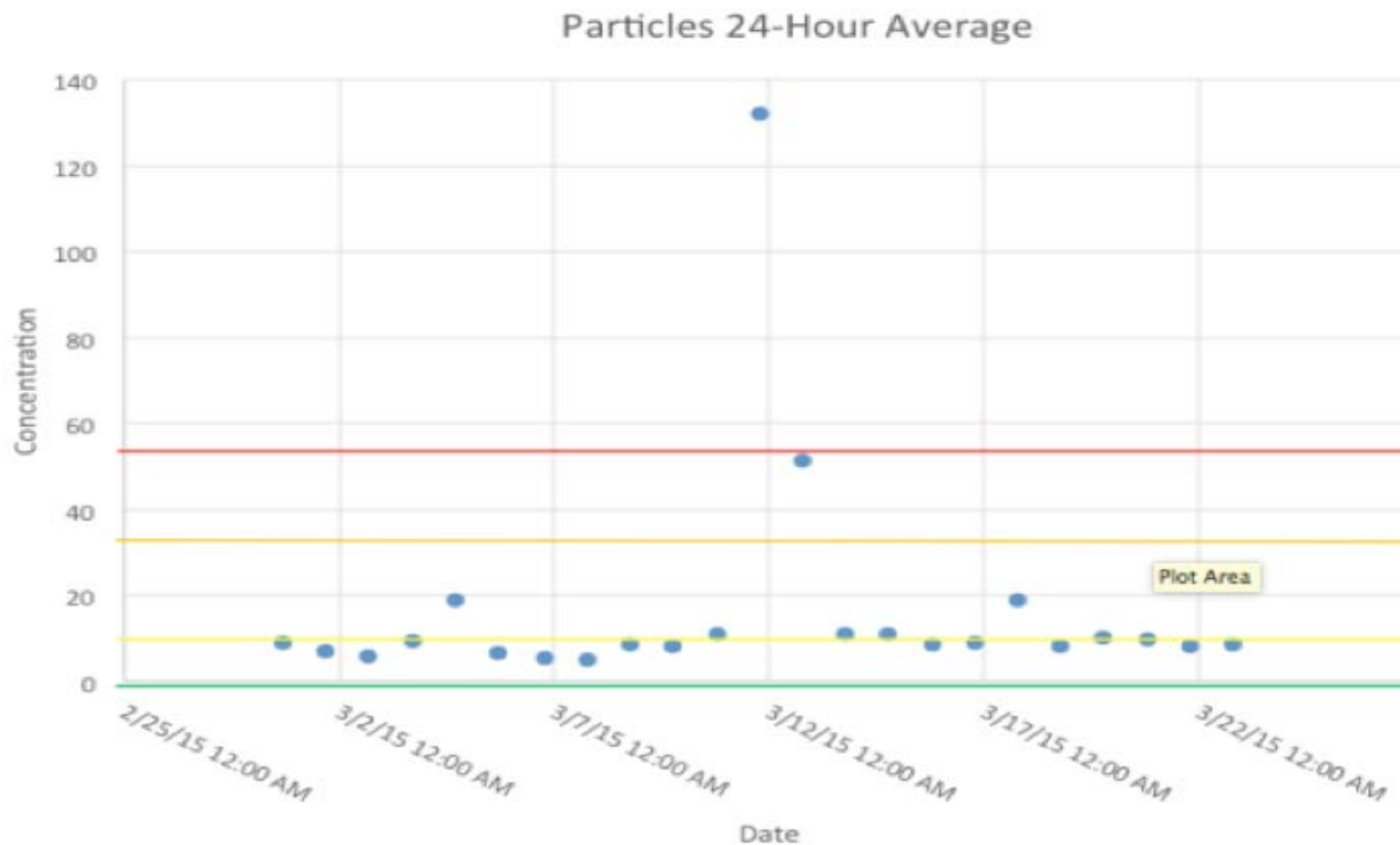
- Respiratory problems
- Neurological problems
- Dermatological problems

- Overall “quality of life” levels were below normal for half of the respondents when compared to a national standard (SF36).

Example of Speck Results (ug/m³)



Example of Speck Results



Episodic high levels of PM2.5 outside multiple homes occurred within similar time frames seven times over 59 days. These results are based on hourly averages of ug/m3 values.

Date of Peak event	# of monitors showing a peak out of # in use	Recorded peak levels	Daily AQI average
10/30	3/4	31, 90, 426	5.0
11/5	2/5	33, 57	5.5
11/7	3/5	36.5, 114, 133	5.3
11/12	4/5	53.7, 131, 269, 325	9.0
12/3	3/5	40, 235, 399	5.0
12/6	2/5	76, 160	10.8
12/17	3/5	99, 162, 229	9.9



Health Assessment

Project: Assessing Gas
Compressor Station Health
Impacts

SWPA-EHP
Madison County, NY DOH
IHE University at Albany

Assessment Goals & Objectives

- **Assess** health status of residents before the compressor station is built, during construction, and during operations and blow down events within 1 mile of the site.
- **Monitor** and measure environmental factors before the compressor station is built, during construction, and during operations and blow down events.
- **Evaluate/analyze results to determine possible health effects.**

* Madison County site - the most comprehensive assessment

Assessment Parameters ^{*} Madison County only

Environmental

- Air Quality
 - PM,
 - VOCs, Formaldehyde
 - Radon*
- Home Env. Assess.
- Water Quality*
 - Surface & Well*
 - *EPA Drinking Water Standards
- Noise*
- Traffic counts*

Health

- Residents
 - Health Questionnaires
 - Health Diary
 - Lung Function Test*
- Community Health* Assessment
 - Target health data (cancer, respiratory, cardio, birth)
 - School nurse reports
 - EMS/Police/ER logs
- DOH Complaint log*

Monitoring Events/Timeline

Residents within 1 mile of station participate in baseline monitoring and follow-up assessments for a period of 2 years.

4 main monitoring events

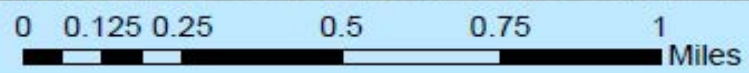
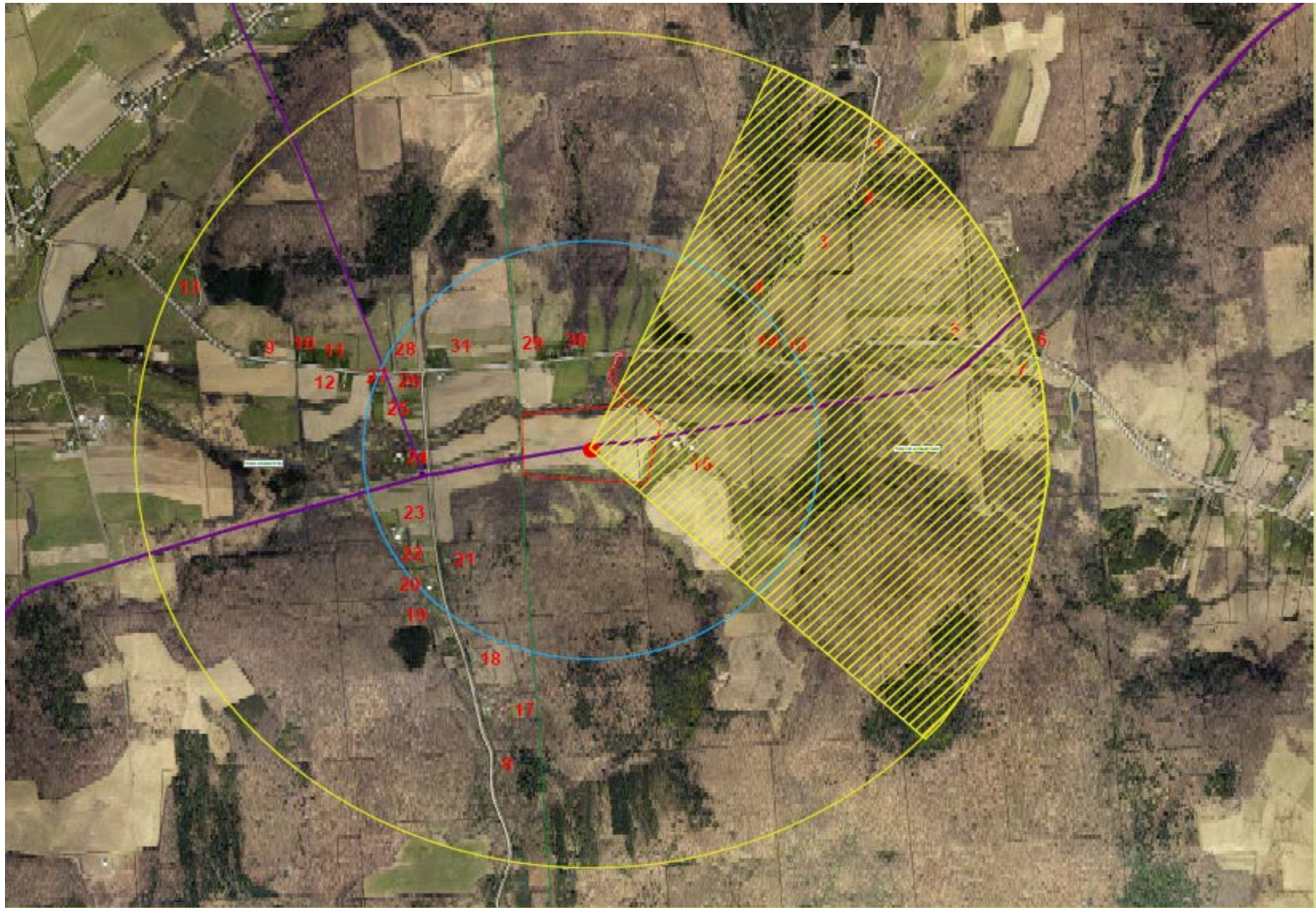
- Baseline – Pre-Construction* - MOST IMPORTANT
- Construction*
- Post Construction
 - 1 yr
 - 2 yrs

Monitoring Levels/Locations

- Individuals (surveys, diaries, Lung Function Test*)
- Residences within 1 mile (air, noise, water)
 - Indoor air
 - Outdoor air
- Select Community Sites (water, noise, air)
Schools? Daycares?

Collaboration:

- EHP, Albany IHE, Madison County
- Cornell University/Oregon State Univ. Animal Study
- West Virginia University Consortium – environmental air study



All parcel data was compiled from Madison County Real Property Tax Parcel Information, 8th Edition, on August 5, 2008. This data is as only as accurate and up-to-date as the Town Assessor's records.

Map prepared by the Madison County Health Department

Basic Community Monitoring and Health Assessment Model

Primary Community Contact person/organizer

PRE- and POST-CONSTRUCTION Monitoring

4 residences within about ½ mile for placement of continuous air monitors - one inside, one outside

VOC and formaldehyde sampling at closest residences (1 or more 12-hour sample under appropriate weather conditions)

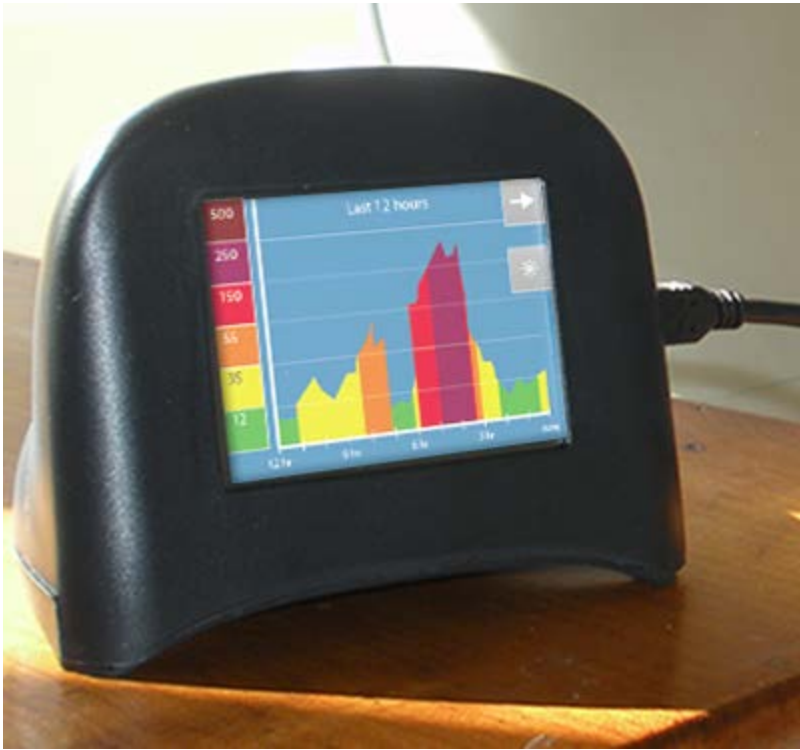
PRE- and POST-CONSTRUCTION Health assessments

Individual health assessment, **SF36** and home environment assessment surveys on as many residents as possible within 1 mile

Medically trained personnel review health assessments with residents

PM Monitors

Continuous air monitoring



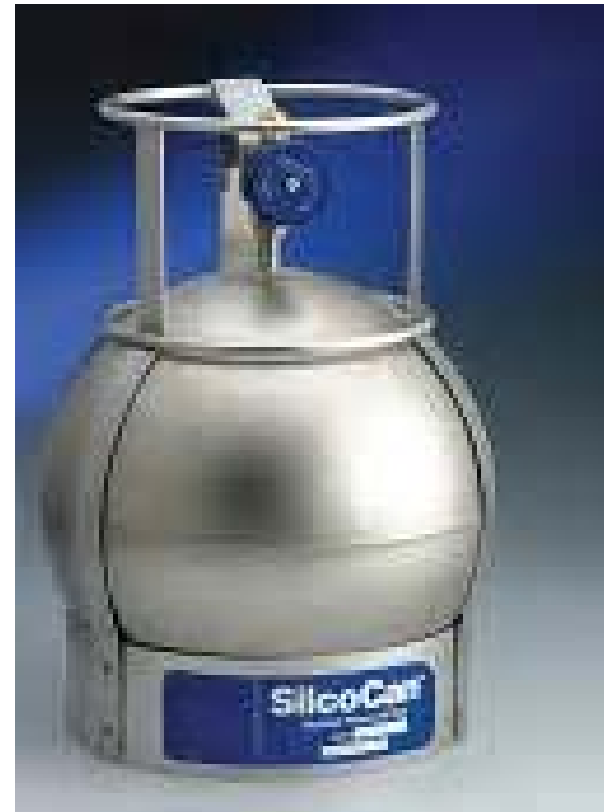
Noise Monitor Casella cel264

- Indoor/outdoor
- 1 hour



Summa Canister

12-hour samples
calm conditions and overnight



EHP Air Model

1. Determine source terms- PM, VOCs, formaldehyde

derived from monitoring studies and public data

2. Measure distance from source to residence

Google Earth

3. Gather weather data from nearest airport or weather station

wind direction, wind speed, cloud cover, day or night (6-hour time periods)

4. Consult EHP air model charts

estimates of exposure at the residence based on source term, weather, distance

Exposure Profile Based on Local Weather Pattern

Wind speed	Day	Day	Day	Day	Night	Night
	Clear or just a few clouds	Scattered cloud cover. Sky less than half filled with clouds	Broken cloud cover. Sky more than >50% cloud cover	Overcast >80% cloud cover	> 50% cloud cover	< 50% cloud cover
<5 mph	low	low	low	extreme	extreme	extreme
5 to 7mph	low	low	average	very high	extreme	extreme
7 to 11 mph	very low	low	low	average	average	high
11 to 13 mph	low	low	average	average	average	average
>13 mph	very low	low	low	low	low	low

Compressor station Estimated air exposure values of VOCs in $\mu\text{g}/\text{m}^3$ (average hourly emission per day 300 grams/minute)							
Weather and Stability Class	100 yds 0.1 km	360 yds 0.5 km	1/2 mile 1 km	1.2 miles 2 km	1.8 miles 3 km	3.1 miles 5 km	6.2 miles 10 km
Sky: clear day Wind: <5 mph A1	525	17	4	1	<1	<1	0
Sky: clear day Wind: 5-7 mph A-B2	400	26	7	1	<1	<1	<1
Sky: clear day Wind: 7-11 mph B3	275	25	8	1	<1	<1	<1
Sky: clear day Wind: 11-13 mph C4	400	67	23	6	3	<1	<1
Sky: clear day Wind: >13 mph C5	350	58	20	5	2	1	<1
Sky: scattered clouds, day Wind: <5 mph A-B6	375	37	11	2	1	<1	<1
Sky: scattered clouds, day Wind: 5-7 mph B7	450	40	12	2	1	<1	<1
Sky: scattered clouds, day Wind: 7-11 mph B-C8	375	52	18	4	2	<1	<1
Sky: scattered clouds, day Wind: 11-13 mph C-D9	550	84	30	10	5	2	<1
Sky: scattered clouds, day Wind: >13 mph D-10	625	87	32	12	6	2	<1
Sky: broken clouds, >50%, day Wind: <5 mph B11	630	56	18	3	1	<1	<1
Sky: broken clouds, >50%, day Wind: 5-7 mph C12	750	125	44	12	5	2	<1
Sky: broken clouds, >50%, day Wind: 7-11 mph C13	475	79	28	7	3	1	<1
Sky: broken clouds, >50%, day Wind: 11-13 mph D14	725	100	37	14	7	2	<1
Sky: broken clouds, >50%, day Wind: >13 mph D15	630	87	32	12	6	2	<1

Sky: overcast > 80%, day Wind: <5 mph D16	1850	250	96	37	18	7	1
Sky: overcast > 80%, day Wind: 5-7 mph D17	1350	175	69	26	13	5	1
Sky: overcast > 80%, day Wind: 7-11 mph D18	850	100	44	17	8	3	<1
Sky: overcast > 80%, day Wind: 11-13 mph D19	725	100	37	14	7	2	<1
Sky: overcast > 80%, day Wind: >13 mph D20	625	87	32	12	6	2	<1
Sky: clouds > 50%, night Wind: <5 mph E21	2600	500	200	100	65	31	9
Sky: clouds > 50%, night day 5-7 mph E22	1850	350	150	75	46	22	7
Sky: clouds > 50%, night Wind: 7-11 mph D23	850	100	44	17	8	3	<1
Sky: clouds > 50%, night Wind: 11-13 mph D24	725	100	37	14	7	2	<1
Sky: clouds > 50%, night Wind: >13 mph D25	625	87	32	12	6	2	<1
Sky: clouds < 50%, night Wind: <5 mph F26	4200	725	350	150	99	46	17
Sky: clouds < 50%, night day 5-7 mph F27	3000	500	250	100	71	33	12
Sky: clouds < 50%, night Wind: 7-11 mph E28	1100	225	99	48	29	14	4
Sky: clouds < 50%, night Wind: 11-13 mph D29	725	100	37	14	7	2	<1
Sky: clouds < 50%, night Wind: >13 mph D30	625	87	32	12	6	2	<1

Guide to Air Quality Near Shale Gas Sites



Sunny Day

any wind or no wind



Cloudy Day

no wind or light wind



Cloudy Day

windy



Calm Night

scattered to no clouds



Night

scattered to no clouds,
windy



Cloudy Night

no wind



Cloudy Night

light wind to windy

Healthy:
No associated
health risks/concerns.

Moderate to Healthy:
Unusually sensitive
people, older adults
and children
should avoid exertion
and outdoor work.

Unhealthy:
Avoid extended or
heavy exertion,
close windows,
go somewhere else,
turn on air filter.

Very Unhealthy:
Avoid extended or
heavy exertion,
close windows,
go somewhere else,
turn on air filter.

SOUTHWEST PENNSYLVANIA ENVIRONMENTAL HEALTH PROJECT

WWW.ENVIRONMENTALHEALTHPROJECT.ORG

FOR DETAILED INFORMATION, CONTACT 724-260-5504

How to protect against health impacts from unconventional natural gas development (UNGD)

Cut off contamination from air

Clean your house often, especially areas where your children play. Use a vacuum that can fit a HEPA filter. Don't sweep with a broom.

Vent the air in places where you use water. Open windows or run an exhaust fan in the bathroom, kitchen and laundry room. If you have a stove fan, always use it while cooking.

Let fresh air in your home when it is breezy outside, usually in the middle of the day. Unhealthy air can collect closer to ground level when the air is still, usually in the morning and evening.

Take off your shoes and wipe off pets' paws and fur before going inside. This will help to keep contamination from soil out of your home.

Cut off contamination from water

Don't rely on one-time water tests to tell you if your water is safe to drink and use. Accidents and contamination can happen at any time.

Consider using bottle water for drinking, cooking and making drinks like baby formula, coffee, juice.

If you must drink or cook with your tap water, leave it uncovered in a pitcher or bottle in the refrigerator overnight before using it.

Stop drinking your water if you or someone in your family has stomach pain or discomfort, confusion, nosebleeds, muscle pains or other unusual symptoms.

If your water burns your skin or causes a rash, take showers and baths somewhere else. Go see your doctor and call our office to see our nurse practitioner.

Monitor changes in your health and environment

Keep a health diary. Write down changes in your health and changes you notice in your water or air. Share this information with your health care provider.

Remember that children, senior citizens or people with chronic health conditions are more sensitive. Pay special attention to changes in their health.

Check the conductivity of your water. This can tell you if your water changes and if there may be a problem with your water. EHP offers the CATTfish, to monitor conductivity, to individuals on well or spring water.*

Monitor particulate matter (PM) in the air. EHP offers the Speck air monitor to help individuals identify times when particulate matter concentrations are high within their home, and other times when exposures may not be occurring.*

Find ways to cope with the changes in your environment. EHP offers a free program, *Take Steps to Health*, to help individuals improve their health and manage some of life's stressors.

*The Speck and CATTfish cannot identify specific chemicals in your air or water. They warn you that changes that may warrant extra testing are occurring.



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Conclusions

- People are exposed to toxics through air, water and soil.
- The exposures are periodic and intense for several hours.
- Regulatory air and water screening will not detect the hazard.

- Most likely acute physical symptoms headache, wheezing, ear/nose/throat (including nosebleeds), skin rash and fatigue.
- Biomonitoring methods need to be developed.

- Interventions and support at the patient level help coping.
- Individuals must monitor their health and exposure status.
- Sense of community trust and social capital is destroyed.
- Federal, State and Local public health and environmental agencies are not able to effectively respond. **The Public Health Process has become rule bound, restricted to standard environmental tests of air and water and research health protocols.**
- **Regulatory agencies do not have the flexibility to monitor health and environment appropriately.**

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