From Wellhead to Ethane Cracker:

Shale Gas, Petrochemicals, and Health

Ned Ketyer, M.D., F.A.A.P.
SWPA Environmental Health Project
ecketyer@gmail.com

Community College of Beaver County
May 25, 2019

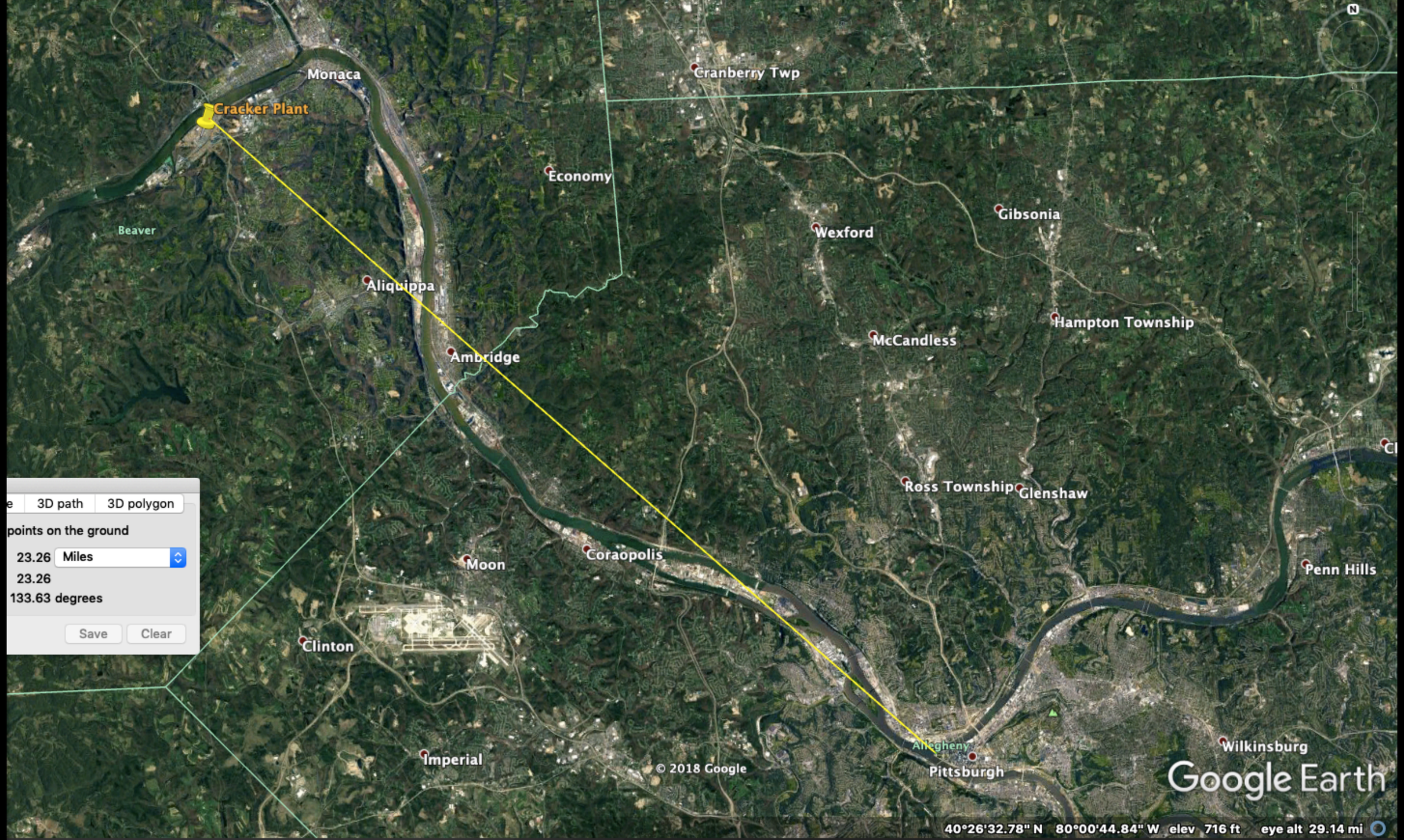
Pennsylvania Constitution
Article I Section 27

"The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment.

Pennsylvania's public natural resources are the common property of all the people, including generations yet to come.

As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people."

Ratified by PA voters on May 18, 1971


Monaca
Cranberry Twp
Cracker Plant
Economy
Beaver
Gibsonia
Wexford
Aliquippa
Hampton Township
McCandless
Ambridge
Ross Township
Glenshaw
Moon
Coraopolis
Penn Hills
Clinton
Imperial
Allegheny
Pittsburgh
Wilkinsburg
© 2018 Google
Google Earth
3D path
3D polygon
points on the ground
23.26 Miles
23.26
133.63 degrees
Save
Clear
40°26'32.78" N 80°00'44.84" W elev 716 ft eye alt 29.14 mi

EHP Air Model

Highest Chemical Emissions

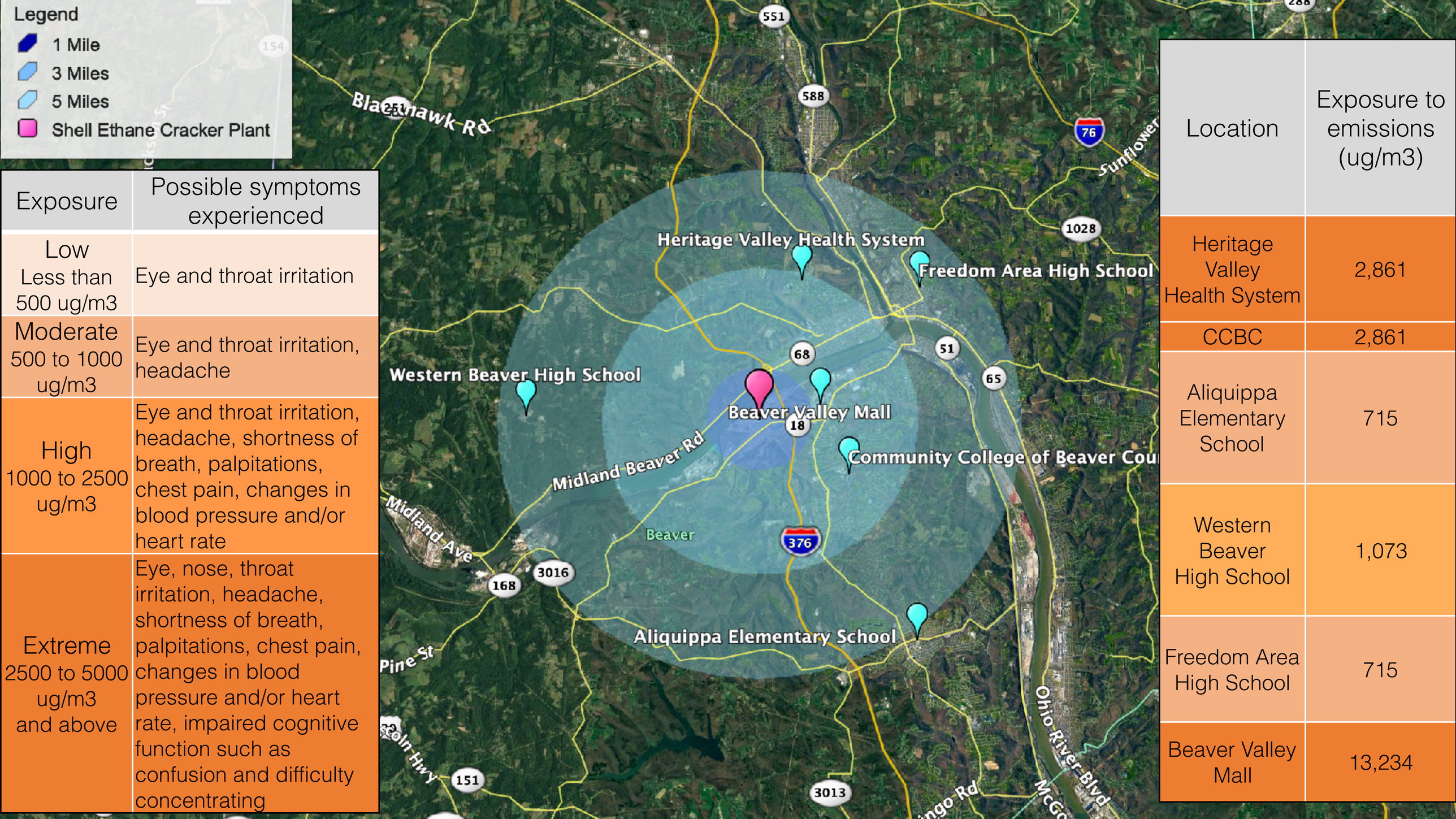
- Nitrogen oxides (NOx)
- Carbon monoxide (CO)
- Volatile Organic Compounds (VOCs)
- PM2.5
- HAPs

Emissions data: 50% of permitted emissions (PA-DEP)

Weather data: NOAA

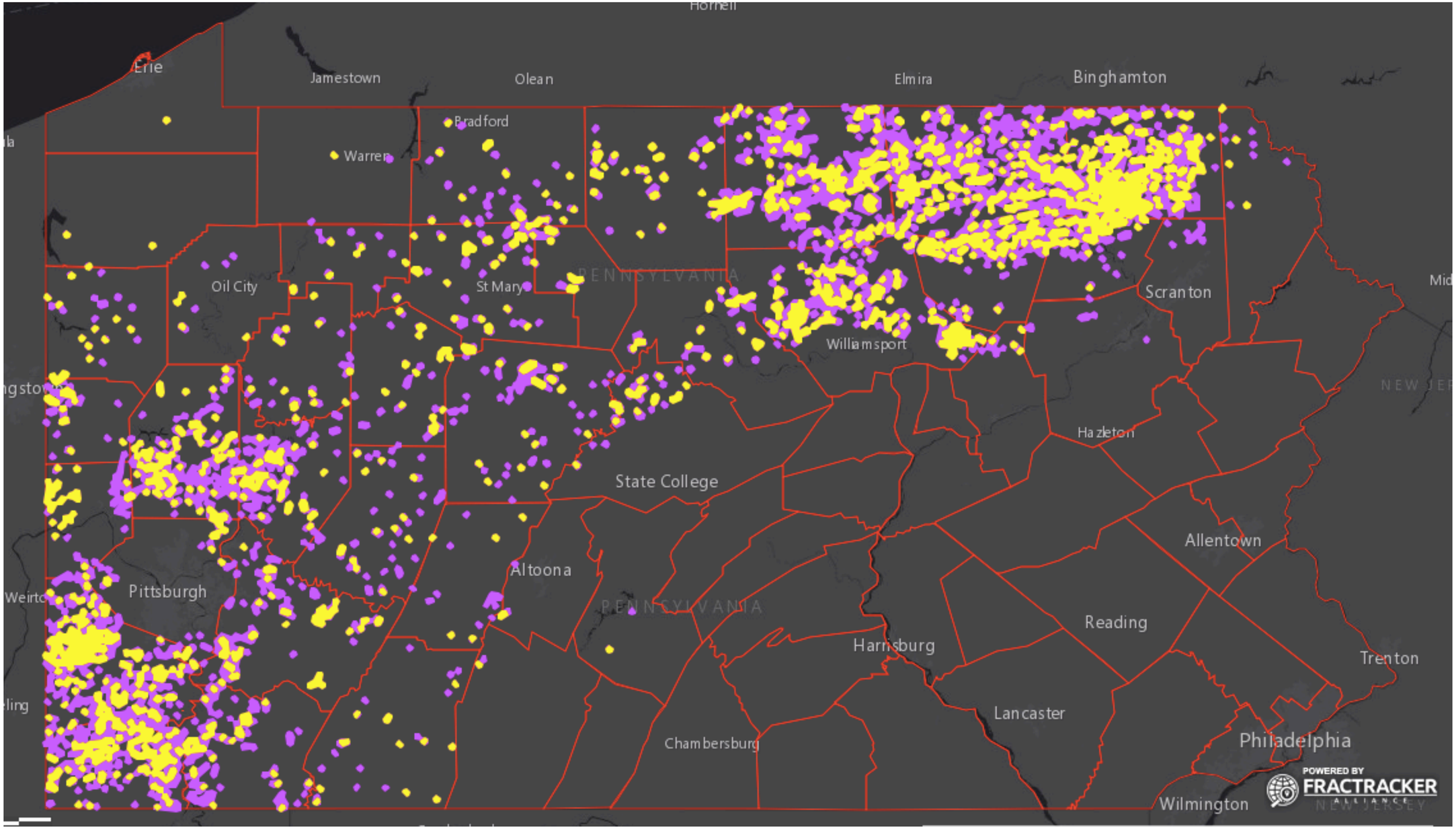
Royal Dutch Shell Ethane Cracker Plant
Permitted Emissions

Air Contaminant	Emission Rates (tons)
NOx	348
CO	1,012
VOCs	620
PM 2.5	159
HAPs	30.5
Ammonia	152
CO2	2,248,293



Exposure	Possible symptoms experienced
Low Less than 500 ug/m3	Eye and throat irritation
Moderate 500 to 1000 ug/m3	Eye and throat irritation, headache
High 1000 to 2500 ug/m3	Eye and throat irritation, headache, shortness of breath, palpitations, chest pain, changes in blood pressure and/or heart rate
Extreme 2500 to 5000 ug/m3 and above	Eye, nose, throat irritation, headache, shortness of breath, palpitations, chest pain, changes in blood pressure and/or heart rate, impaired cognitive function such as confusion and difficulty concentrating

Location	Exposure to emissions (ug/m3)
Heritage Valley Health System	2,861
CCBC	2,861
Aliquippa Elementary School	715
Western Beaver High School	1,073
Freedom Area High School	715
Beaver Valley Mall	13,234



Pennsylvania

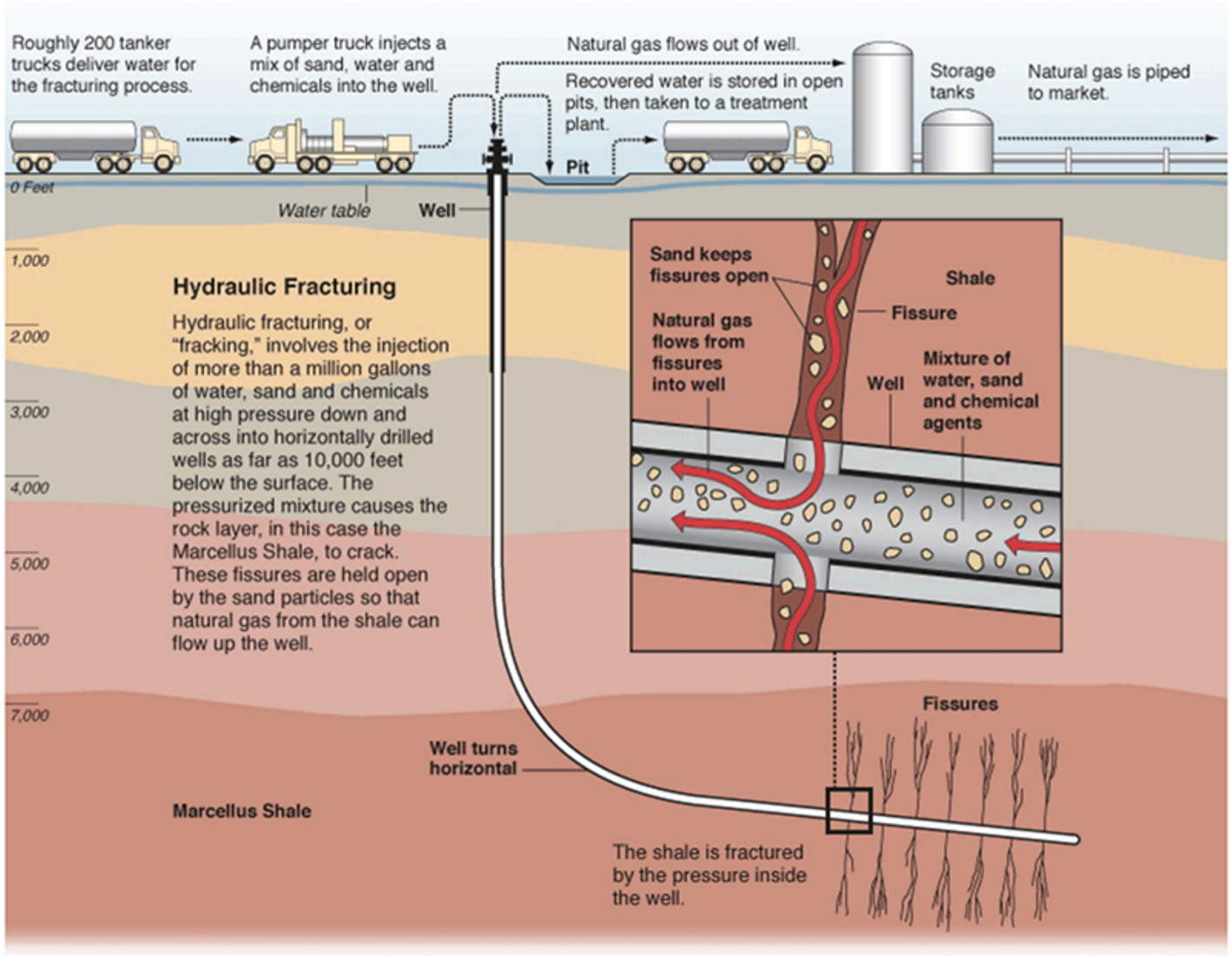
(Updated 3/27/2019)

- **11,885 Active Unconventional Gas Wells**
- **12,342 Violations**

(Google Images/wikipedia.org)

Flowback: What Comes Back Up

- Drill Cuttings (solid waste)
- Contaminated Water
  - > Fracking chemicals
  - > Salt (Brine)
  - > Natural elements (lead, arsenic)
  - > Naturally-occurring radioactive materials (NORMs) — radium 226)
- Non-fuel Gases (VOCs, PAHs, hydrogen sulfide, radon)
- Methane
- Liquid Fuels (propane, butane, ethane)



Important points about UNG development

1. Emissions of toxics occur at every stage of the process.
2. Emissions don't stay in one place.

> trucks travel

> winds blow

> rivers and streams flow

> what goes up comes down

> climate, weather patterns, topography help determine exposure

Important points about UNG development

3. Gases leak accidentally and are vented on purpose.

4. Airborne emissions are often invisible.

5. Liquids leak & spill, on well pads and off well pads.

6. Chemicals that leak, spill, or are aerosolized remain a mystery.

7. Earth is a closed system. What happens here stays here.

Airborne Emissions — Exposure & Health Effects

> Emissions occur at every stage of UNG development and are typically invisible.

> Symptoms from exposure are well-known from decades of occupational research.

> Exposure to toxics based on several factors:

— proximity to emissions
— duration of exposure
— individual susceptibility (age, gender, genetics, pre-existing conditions)
— use of personal protective equipment

> Exposure may be continuous or episodic.

> Exposure may involve multiple chemicals from one or from multiple sources in the vicinity of the exposed person. (AGGREGATE EMISSIONS)

OCTOBER 2016

Pennsylvania Medical Society

Resolution Supporting a Moratorium on Fracking

Adopted as amended

RESOLUTION 16-206

(Referred to Reference Committee B)

Subject: Pennsylvania Medical Society Support for a Moratorium on Fracking
Introduced by: Michael DellaVecchia, MD, on behalf of the Philadelphia County Medical Society
Author: Walter Tsou, MD, Philadelphia County Medical Society

WHEREAS, As physicians of Pennsylvania, we care first and foremost about the health of our community and believe that when an activity raises potential harm to human health, precautionary measures should be taken until cause and effect relationships are fully established scientifically; and

WHEREAS, Act 13 (Impact Fee) of 2012 includes a provision that allows disclosure of proprietary chemicals after a physician places a request in writing, but prohibits further disclosure of the chemicals to other doctors or written into medical records, even if needed to properly care for a patient[1]; and

WHEREAS, Hydraulic fracturing, or fracking, is a method of oil and gas removal that involves blasting between 4-6 million gallons of water, sand and chemicals under high pressure deep into the earth to break up the Marcellus Shale to allow oil and gas extraction; and

WHEREAS, The Marcellus Shale covers about 60% of Pennsylvania and much of the mineral rights have been leased to gas drilling companies; and

WHEREAS, The gas drilling industry has identified around 60 chemicals regularly used in fracking and hundreds that could potentially be used[2]; and

WHEREAS, The gas drilling industry has many "proprietary" chemicals which are trade secrets so there is no way to ascertain their toxicity, but fracking routinely employs numerous toxic chemicals, including benzene and other volatile organic compounds[3] and can also expose humans to harm from lead, arsenic, and radioactivity brought back to the surface with fracking flowback fluid; and

WHEREAS, The gas industry has lobbied to exempt their industry from federal regulations of many important environmental laws, including the Safe Drinking Act, the Clean Air Act, the Clean Water Act, National Environmental Policy Act, Resource Conservation and Recovery Act, and CERCLA (the Superfund Act) hampering any federal oversight of the industry[4]; and

WHEREAS, Many fracking chemicals and the radioactive isotopes of flowback fluid are known carcinogens and evidence is mounting throughout the country that these chemicals are making their way into aquifers and drinking water[5], and

RESOLVED, That the Pennsylvania Medical Society urge and support a moratorium on new natural gas extraction using high-volume hydraulic fracturing in Pennsylvania; and be it further

RESOLVED, That the Pennsylvania Medical Society urge the ~~state legislature~~Commonwealth of Pennsylvania to fund an independent health registry and commission research studies on the health effects of fracking.

Concerned Health Professionals of NY

PSR PHYSICIANS FOR SOCIAL RESPONSIBILITY

Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking (Unconventional Gas and Oil Extraction)

Fifth Edition

March 2018

Fracking industry site near Greers Ferry Lake in Quitman, Arkansas in the Fayetteville Shale region. ©2014 Julie Dermansky

> 1,300 peer-reviewed studies & investigative reports.

- **90% published since 2013**
- **25% published in 2017**

"There is no evidence that fracking can operate without threatening public health directly or without imperiling climate stability upon which public health depends."

http://www.psr.org/assets/pdfs/fracking-compendium-5.pdf

(Southwest PA - Environmental Health Project)

Vulnerable Community Members

- Pregnant women and fetuses
- Infants and children
- Elderly
- Poor
- People and communities of color
- Pre-existing medical conditions
- Outdoor workers
- First Responders

THE EVIDENCE IS IN:

AIR POLLUTION FOLLOWS FRACKING

©Julie Dermansky

(See footnotes 50-135, 333, 444-45)

Petro-Frack Operations

— Airborne Emissions —

> Fracking Chemicals

> Sand (silica dust)

> Volatile Organic Compounds (VOC)

> Polycyclic Aromatic Hydrocarbons (PAH)

> Particulate Matter (PM 2.5)

> Carbon monoxide (CO)

> Carbon dioxide (CO2)

> Nitrogen dioxide (NO2)

> Sulfur dioxide (SO2)

> Methane (CH4)

VOCs + NO2 + SUNLIGHT = OZONE

OZONE + PARTICULATE MATTER = SMOG

THE EVIDENCE IS IN:

LIVING NEAR FRACKING SITES RAISES the RISKS FOR PREGNANT WOMEN

©Julie Dermansky

(See footnotes 434, 436, 450, 472, 1075, 1080, 1081)

PLoS One. 2015; 10(6): e0126425.
PMCID: PMC4454655
Published online 2015 Jun 3. doi: 10.1371/journal.pone.0126425

Perinatal Outcomes and Unconventional Natural Gas Operations in Southwest Pennsylvania

Shaina L. Stacy,[1] LuAnn L. Brink,[2] Jacob C. Larkin,[3] Yoel Sadovsky,[3] Bernard D. Goldstein,[1] Bruce R. Pitt,[1,*] and Evelyn O. Talbott[2]

Jaymie Meliker, Academic Editor

[1] Department of Environmental and Occupational Health, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania, United States of America
[2] Department of Epidemiology, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania, United States of America
[3] Magee-Womens Research Institute and Department of Obstetrics, Gynecology and Reproductive Sciences, School of Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania, United States of America
Stony Brook University, Graduate Program in Public Health, UNITED STATES

Competing Interests: The authors have declared that no competing interests exist.

Conceived and designed the experiments: LLB SLS. Performed the experiments: SLS LLB. Analyzed the data: SLS LLB JCL YS BDG BRP EOT. Contributed reagents/materials/analysis tools: SLS LLB JCL YS BDG BRP EOT. Wrote the paper: SLS LLB JCL YS BDG BRP EOT.

* E-mail: brucep@pitt.edu

Received 2015 Jan 24; Accepted 2015 Apr 2.

Abstract

Go to: Go to:

Unconventional gas drilling (UGD) has enabled extraordinarily rapid growth in the extraction of natural gas. Despite frequently expressed public concern, human health studies have not kept pace. We investigated the association of proximity to UGD in the Marcellus Shale formation and perinatal outcomes in a retrospective cohort study of 15,451 live births in Southwest Pennsylvania from 2007–2010. Mothers were categorized into exposure quartiles based on inverse distance weighted (IDW) well count; least exposed mothers (first quartile) had an IDW well count less than 0.87 wells per mile, while the most exposed (fourth quartile) had 6.00 wells or greater per mile. Multivariate linear (birth weight) or logistical (small for gestational age (SGA) and prematurity) regression analyses, accounting for differences in maternal and child risk factors, were performed. There was no significant association of proximity and density of UGD with prematurity. Comparison of the most to least exposed, however, revealed lower birth weight (3323 ± 558 vs 3344 ± 544 g) and a higher incidence of SGA (6.5 vs

"Comparison of the most to least exposed, however, revealed lower birth weight… and higher incidence of SGA."

Unconventional Natural Gas Development and Birth Outcomes in Pennsylvania, USA

Casey, Joan A.; Savitz, David A.; Rasmussen, Sara G.; Ogburn, Elizabeth L.; Pollak, Jonathan; Mercer, Dione G.; Schwartz, Brian S.

Epidemiology: March 2016 - Volume 27 - Issue 2 - p 163–172
doi: 10.1097/EDE.0000000000000387
Perinatal Epidemiology

Abstract | In Brief | Author Information

Background: Unconventional natural gas development has expanded rapidly. In Pennsylvania, the number of producing wells increased from 0 in 2005 to 3,689 in 2013. Few publications have focused on unconventional natural gas development and birth outcomes.

"… an association between UNGD and preterm birth… and high risk pregnancy."

RESEARCH ARTICLE | ENVIRONMENTAL STUDIES

Hydraulic fracturing and infant health: New evidence from Pennsylvania

Janet Currie[1,2,*], Michael Greenstone[2,3] and Katherine Meckel[4]
+ See all authors and affiliations

Science Advances 13 Dec 2017:
Vol. 3, no. 12, e1603021
DOI: 10.1126/sciadv.1603021

Abstract

The development of hydraulic fracturing ("fracking") is considered the biggest change to the global energy production system in the last half-century. However, several communities have banned fracking because of unresolved concerns about the impact of this process on human health. To evaluate the potential health impacts of fracking, we analyzed records of more than 1.1 million births in Pennsylvania from 2004 to 2013, comparing infants born to mothers living at different distances from active fracking sites and those born both before and after fracking was initiated at each site. We adjusted for fixed maternal determinants of infant health by comparing siblings who were and were not exposed to fracking sites in utero. We found evidence for negative health effects of in utero exposure to fracking sites within 3 km of a mother's residence, with the largest health impacts seen for in utero exposure within 1 km of fracking sites. Negative health impacts include a greater incidence of low–birth weight babies as well as significant declines in average birth weight and in several other measures of infant health. There is little evidence for health effects at distances beyond 3 km, suggesting that health impacts of fracking are highly local. Informal estimates suggest that about 29,000 of the nearly 4 million annual U.S. births occur within 1 km of an active fracking site and that these births therefore may be at higher risk of poor birth outcomes.

1.1 million births in Pennsylvania between 2004-2013

Increased incidence of LBW within 3 km of active fracking site, with highest incidence within 1 km

29,000 births in U.S. per year within 1 km of active fracking site

ehp ENVIRONMENTAL HEALTH PERSPECTIVES

RESEARCH VOLUME 122 | 2014

CHILDREN'S HEALTH

Environ Health Perspect; DOI:10.1289/ehp.1306722

Birth Outcomes and Maternal Residential Proximity to Natural Gas Development in Rural Colorado

Lisa M. McKenzie,[1] *Ruixin Guo,*[2] *Roxana Z. Witter,*[1] *David A. Savitz,*[3] *Lee S. Newman,*[1] *and John L. Adgate*[1]

Author Affiliations OPEN

PDF Version (258 KB)

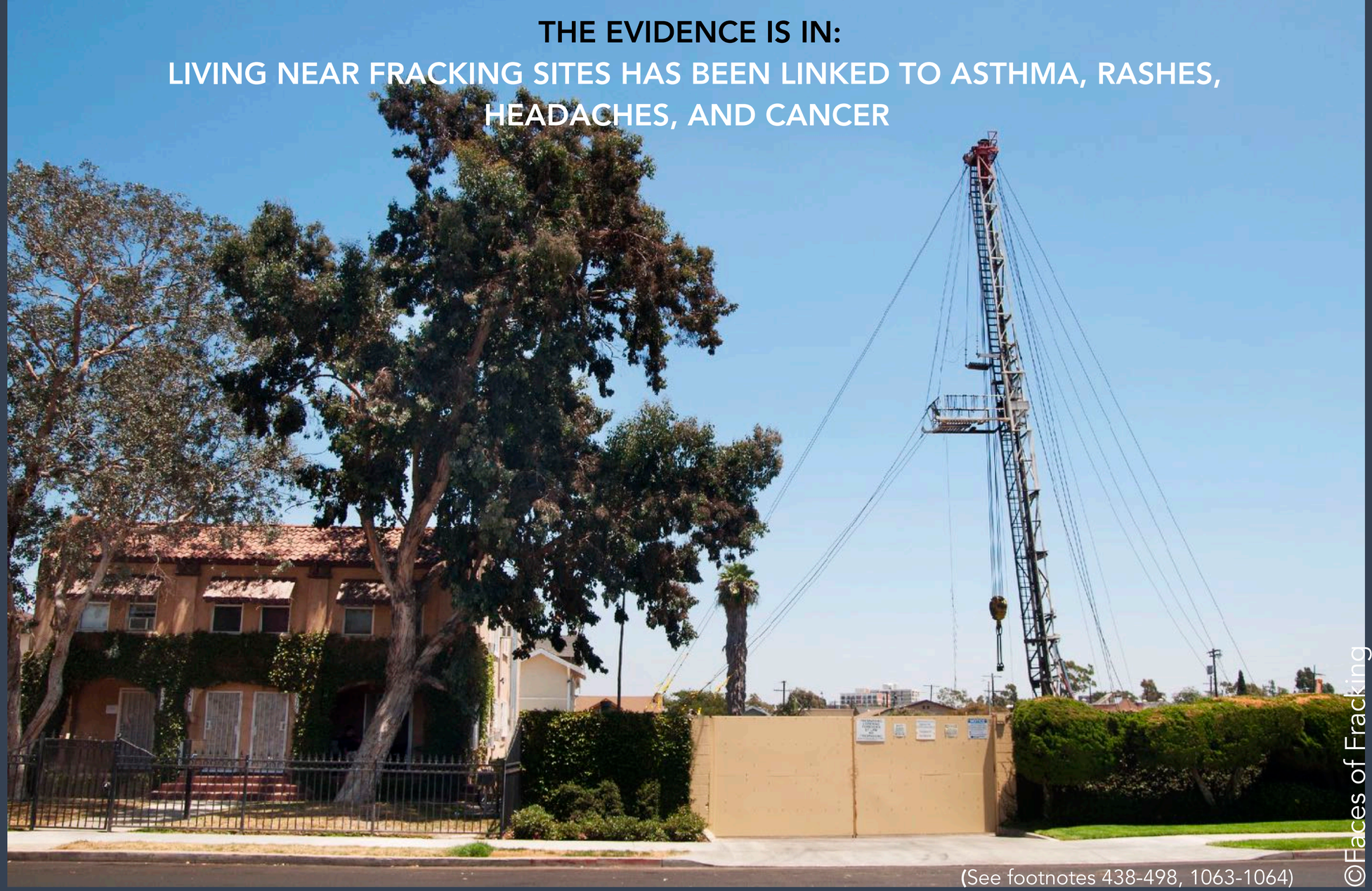
ABSTRACT | ABOUT THIS ARTICLE | SUPPLEMENTAL MATERIAL

Background: Birth defects are a leading cause of neonatal mortality. Natural gas development (NGD) emits several potential teratogens, and U.S. production of natural gas is expanding.

Objectives: We examined associations between maternal residential proximity to NGD and birth outcomes in a retrospective cohort study of 124,842 births between 1996 and 2009 in rural Colorado.

"…we observed an association between density and proximity of natural gas wells within a 10-mile radius of maternal residence and prevalence of congenital heart defects and possibly neural tube defects."

THE EVIDENCE IS IN:
LIVING NEAR FRACKING SITES HAS BEEN LINKED TO ASTHMA, RASHES, HEADACHES, AND CANCER



(See footnotes 438-498, 1063-1064)

©Faces of Fracking

FRACKING SCIENCE COMPENDIUM 5TH EDITION

DOWNLOAD at: concernedhealthny.org/compendium/

Concerned Health Professionals of NY

PSR

Health symptoms in residents living near shale gas activity: A retrospective record review from the Environmental Health Project

Preventive Medicine Reports

Beth Weinberger [a], Lydia H. Greiner [b], Leslie Walleigh [c], David Brown [a]

Show more

https://doi.org/10.1016/j.pmedr.2017.09.002

Highlights

- This is a retrospective symptom review of adults exposed to unconventional natural gas wells.
- We attributed symptoms to exposure only if no other cause could be identified.
- Most commonly reported symptoms: sleep disruption, headache, throat irritation.
- Our findings are consistent with other studies using self-reported symptoms.

Top 10 Symptoms Associated with Proximity to UNGD

1. Sleep disruption
2. Headache
3. Throat irritation
4. Stress/anxiety
5. Cough
6. Shortness of breath
7. Sinus problems
8. Fatigue
9. Nausea
10. Wheezing

Weinberger, B. et al, Health symptoms in residents living near shale gas activity/ A retrospective record review from the Environmental Health Project

Preventive Medicine Reports, 14 September 2017 (online)
http://www.sciencedirect.com/science/article/pii/S2211335517301353

Association Between Unconventional Natural Gas Development in the Marcellus Shale and Asthma Exacerbations ONLINE FIRST

Sara G. Rasmussen, MHS[1]; Elizabeth L. Ogburn, PhD[2]; Meredith McCormack, MD[3]; Joan A. Casey, PhD[4]; Karen Bandeen-Roche, PhD[2]; Dione G. Mercer, BS[5]; Brian S. Schwartz, MD, MS[1,3,5]

[+] Author Affiliations

JAMA Intern Med. Published online July 18, 2016. doi:10.1001/jamainternmed.2016.2436 Text Size: A A A

Article | Figures | Tables | Supplemental Content | References | Comments

ABSTRACT

ABSTRACT | INTRODUCTION | METHODS | RESULTS | DISCUSSION | CONCLUSIONS | ARTICLE INFORMATION | REFERENCES

Importance Asthma is common and can be exacerbated by air pollution and stress. Unconventional natural gas development (UNGD) has community and environmental impacts. In Pennsylvania, UNGD began in 2005, and by 2012, 6253 wells had been drilled. There are no prior studies of UNGD and objective respiratory outcomes.

Objective To evaluate associations between UNGD and asthma exacerbations.

Design A nested case-control study comparing patients with asthma with and without exacerbations from 2005 through 2012 treated at the Geisinger Clinic, which provides primary care services to over 400 000 patients in Pennsylvania. Patients with asthma aged 5 to 90 years (n = 35 508) were identified in electronic health records; those with exacerbations were frequency matched on age, sex, and year of event to those without.

"UNGD activity metrics were statistically associated with increased risk of mild, moderate, and severe asthma exacerbations."

Environ Health Perspect; DOI:10.1289/EHP281

Associations between Unconventional Natural Gas Development and Nasal and Sinus, Migraine Headache, and Fatigue Symptoms in Pennsylvania

Aaron W. Tustin,[1] Annemarie G. Hirsch,[2] Sara G. Rasmussen,[1] Joan A. Casey,[3] Karen Bandeen-Roche,[4] and Brian S. Schwartz[1,2,5]

Author Affiliations open

PDF Version (1.6 MB)

Abstract | About This Article | Supplemental Material

Background: Unconventional natural gas development (UNGD) produces environmental contaminants and psychosocial stressors. Despite these concerns, few studies have evaluated the health effects of UNGD.

Objectives: We investigated associations between UNGD activity and symptoms in a cross-sectional study in Pennsylvania.

Methods: We mailed a self-administered questionnaire to 23,700 adult patients of the Geisinger Clinic. Using standardized and validated questionnaire items, we identified respondents with chronic rhinosinusitis (CRS), migraine headache, and fatigue symptoms. We created a summary UNGD activity metric that incorporated well phase, location, total depth, daily gas production and inverse distance–squared to patient residences. We used logistic regression, weighted for sampling and response rates, to assess associations between quartiles of UNGD activity and outcomes, both alone and in combination.

Results: The response rate was 33%. Of 7,785 study participants, 1,850 (24%) had current CRS symptoms, 1,765 (23%) had migraine headache, and 1,930 (25%) had higher levels of fatigue. Among individuals who met criteria for two or more outcomes, adjusted odds ratios for the highest quartile of UNGD activity compared with the lowest were [OR (95% CI)] 1.49 (0.78, 2.85) for CRS plus migraine, 1.88 (1.08, 3.25) for CRS plus fatigue, 1.95 (1.18, 3.21) for migraine plus fatigue, and 1.84 (1.08, 3.14) for all three outcomes together. Significant associations were also present in some models of single outcomes.

Conclusions: This study provides evidence that UNGD is associated with nasal and sinus, migraine headache, and fatigue symptoms in a general population representative sample.

PLOS | ONE

Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates

Thomas Jemielita, George L. Gerton, Matthew Neidell, Steven Chillrud, Beizhan Yan, Martin Stute, Marilyn Howarth, Pouné Saberi, Nicholas Fausti, Trevor M. Penning, Jason Roy, Kathleen J. Propert, Reynold A. Panettieri Jr.

Published: July 15, 2015 • http://dx.doi.org/10.1371/journal.pone.0131093

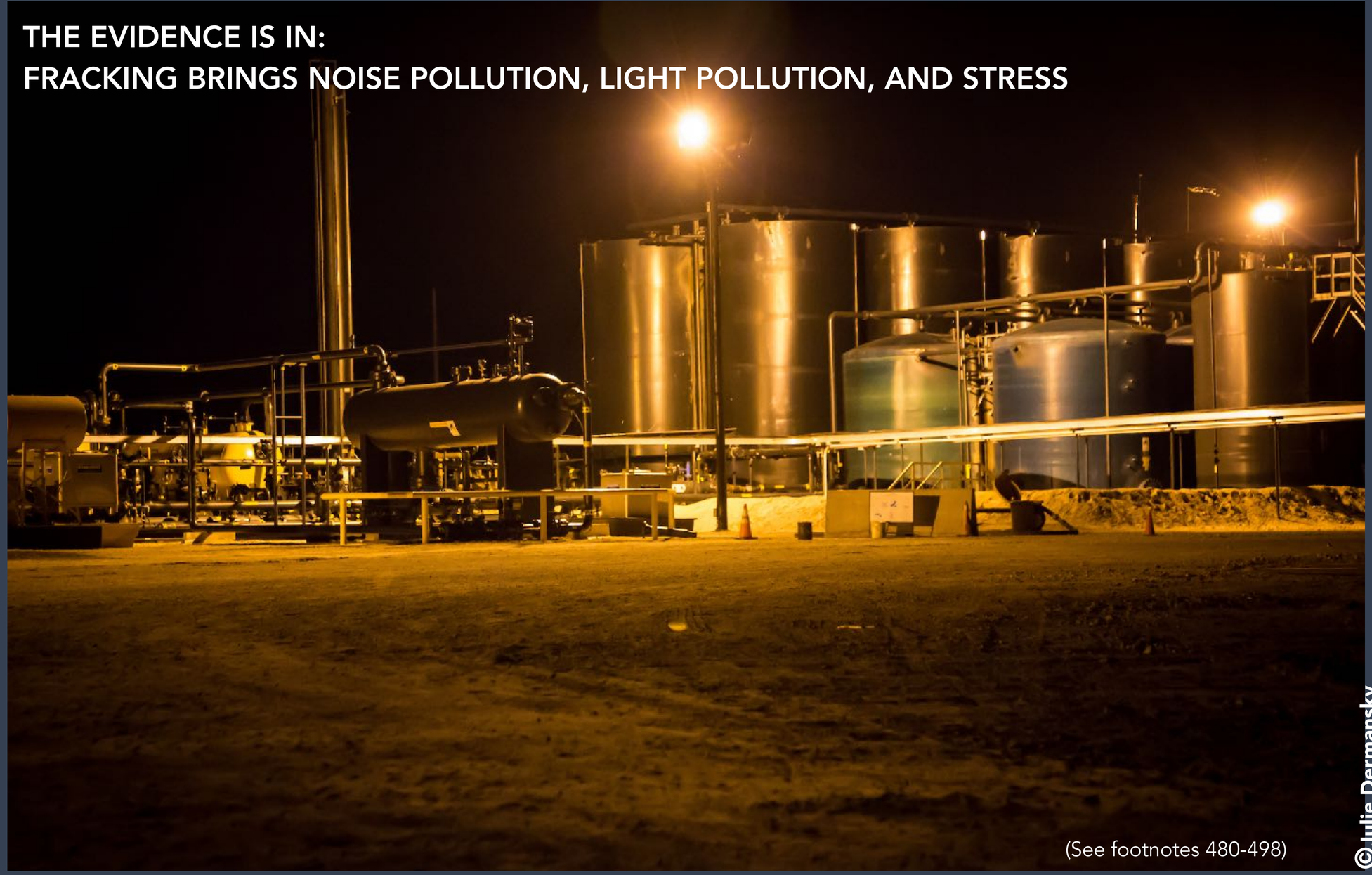
Correction

28 Aug 2015: Jemielita T, Gerton GL, Neidell M, Chillrud S, Yan B, et al. (2015) Correction: Unconventional Gas and Oil Drilling Is Associated with Increased Hospital Utilization Rates. doi: info:doi/10.1371/journal.pone.0137371 | **View correction**

Abstract

Over the past ten years, unconventional gas and oil drilling (UGOD) has markedly expanded in the United States. Despite substantial increases in well drilling, the health consequences of UGOD toxicant exposure remain unclear. This study examines an association between wells and healthcare use by zip code from 2007 to 2011 in Pennsylvania. Inpatient discharge databases from the Pennsylvania Healthcare Cost Containment Council were correlated with active wells by zip code in three counties in Pennsylvania. For overall inpatient prevalence rates and 25 specific medical categories, the association of inpatient prevalence rates with number of wells per zip code and, separately, with wells per km^2 (separated into quantiles and defined as well density) were estimated using fixed-effects Poisson models. To account for multiple comparisons, a Bonferroni correction with associations of $p<0.00096$ was considered statistically significant. Cardiology inpatient prevalence rates were significantly associated with number of wells per zip code ($p<0.00096$) and wells per km^2 ($p<0.00096$) while neurology inpatient prevalence rates were significantly associated with wells per km^2 ($p<0.00096$). Furthermore, evidence also supported an association between well density and inpatient prevalence rates for the medical categories of dermatology, neurology, oncology, and urology. These data suggest that UGOD wells, which dramatically increased in the past decade, were associated with increased inpatient prevalence rates within specific medical categories in Pennsylvania. Further studies are necessary to address healthcare costs of UGOD and determine whether specific toxicants or combinations are associated with organ-specific responses.

THE EVIDENCE IS IN:
FRACKING BRINGS NOISE POLLUTION, LIGHT POLLUTION, AND STRESS



(See footnotes 480-498)

©Julie Dermansky

Research article

Assessment and longitudinal analysis of health impacts and stressors perceived to result from unconventional shale gas development in the Marcellus Shale region

Kyle J Ferrar ✉, Jill Kriesky, Charles L Christen, Lynne P Marshall, Samantha L Malone, Ravi K Sharma, Drew R Michanowicz & Bernard D Goldstein

Page 104-112 | Published online: 12 Nov 2013

Page 104-112 | Published online: 12 Nov 2013

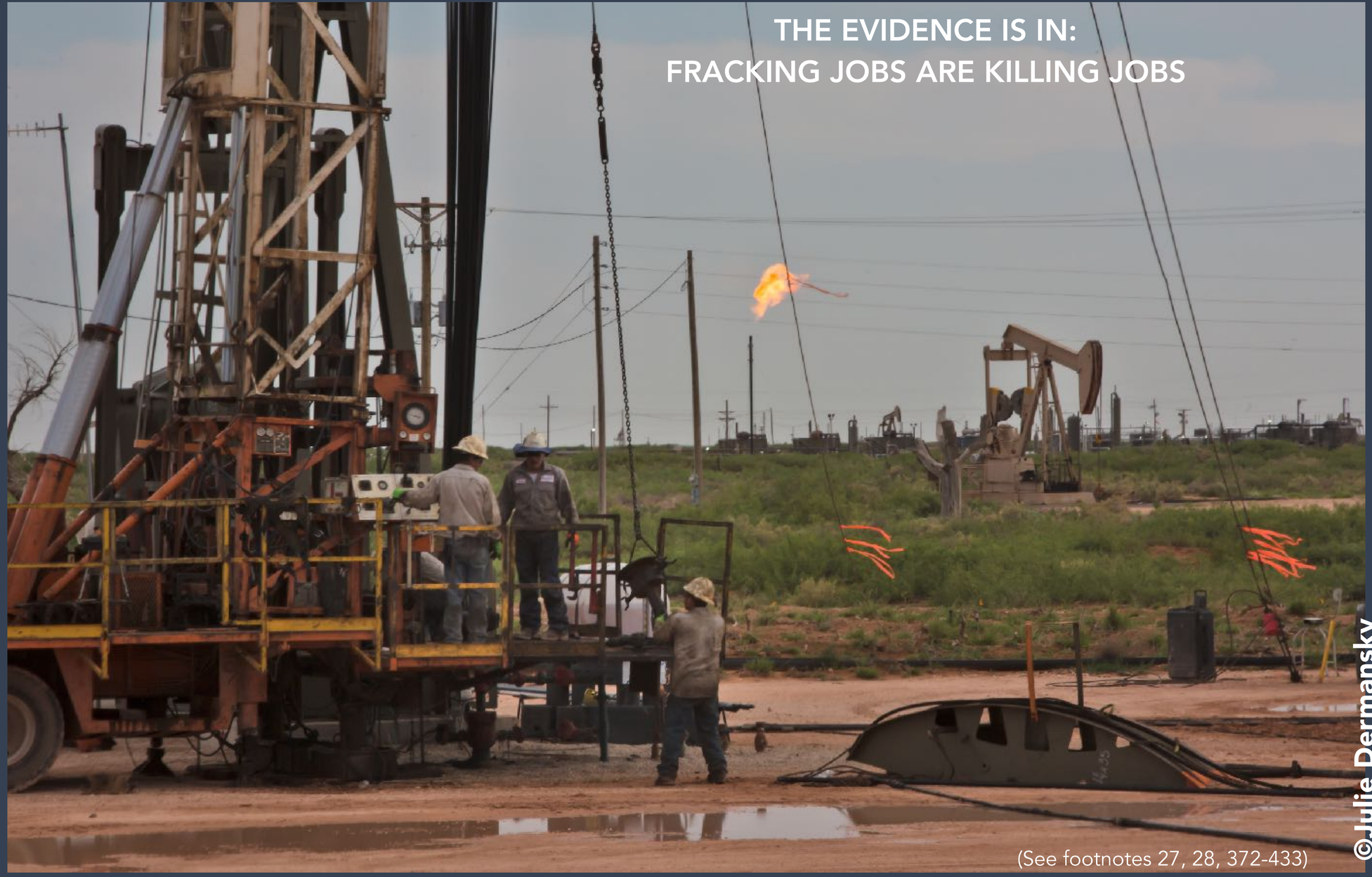
Download citation http://dx.doi.org/10.1179/2049396713Y.0000000024 *International Journal of Occupational and Environmental Health*

"Stress" is one of the most frequently reported symptom by residents living in the Marcellus Shale region.

Psychosocial Impacts of UNGD

SOURCES OF STRESS

- Noise (drilling, fracking, flaring, pig-launcher venting, compressor blowdowns, truck traffic)
- Odors (diesel, hydrocarbon emissions, hydrogen sulfide)
- Light (sleep deprivation)
- Traffic (increased truck-related fatalities)
- Crime (violent crime, property crime, drug and alcohol abuse, STD's)


THE EVIDENCE IS IN:
FRACKING JOBS ARE KILLING JOBS
(See footnotes 27, 28, 372-433)
©Julie Dermansky

(See footnotes 30, 816-868)

FRACKING SCIENCE COMPENDIUM 5TH EDITION

DOWNLOAD at: concernedhealthny.org/compendium/

Concerned Health Professionals of NY

PSR

THE EVIDENCE IS IN:

EMISSIONS FROM COMPRESSOR STATIONS ARE HIGHLY TOXIC

©Julie Dermansky

(See footnotes 816-17, 823, 826-28, 830-31, 838, 857)

FRACKING SCIENCE COMPENDIUM 5TH EDITION

DOWNLOAD at: concernedhealthny.org/compendium/

Concerned Health Professionals of NY

PSR

Health Effects Associated with Stack Chemical Emissions from NYS Natural Gas Compressor Stations: 2008-2014

A Technical Report Prepared for the Southwest Pennsylvania Environmental Health Project underwritten by the Park Foundation

12 October 2017

"This report shows that every compressor station routinely releases large volumes of chemicals associated with a variety of diseases and disorders."

— Raina Rippel, Director SWPA EHP

P.N. Russo & D.O. Carpenter

Institute for Health and the Environment
A Pan American Health Organization / World Health Organization
Collaborating Centre in Environmental Health
University at Albany

THE EVIDENCE IS IN:

FRACKING ACCELERATES CLIMATE CHANGE

©Julie Dermansky

(See footnotes 29, 699-796, 848-850)

FRACKING SCIENCE COMPENDIUM 5TH EDITION

DOWNLOAD at: concernedhealthny.org/compendium/

Concerned Health Professionals of NY

PSR

"The health impacts of climate change demand immediate action."

Declaration on Climate Change and Health

2017

For More Information

> **Breathe Project** www.breatheproject.org

> **Children's Environmental Health Network** www.cehn.org

> **Climate Reality Project** www.climaterealityproject.org

> **Pediatric Alliance** www.pediatricalliance.com

> **Physicians for Social Responsibility - PA** www.psrphila.org

> **SWPA Environmental Health Project**
www.environmentalhealthproject.org

Additional Reading

- Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking — 5th Edition
  Physicians for Social Responsibility/Concerned Health Professionals of New York (2018)
  http://www.psr.org/assets/pdfs/fracking-compendium-5.pdf

- The ROGER Citation Database
  PSE's Repository for Oil and Gas Energy Research (ROGER)
  https://www.psehealthyenergy.org/our-work/shale-gas-research-library/

- Pittsburgh Regional Environmental Threats Analysis (PRETA)
  University of Pittsburgh Graduate School of Public Health
  Particulate Matter (2012): http://www.chec.pitt.edu/documents/PRETA/PRETA_PM.pdf
  Hazardous Air Pollutants (2013): http://www.chec.pitt.edu/documents/PRETA/CHEC%20PRETA%20HAPs%20Report.pdf

- Schraufnagel, D.E. et al, "Air Pollution and Noncommunicable Diseases — Part 1: The Damaging Effects of Air Pollution" (*Chest Journal*, February 2019)
  https://journal.chestnet.org/article/S0012-3692(18)32723-5/fulltext

- 5th Intergovernmental Report on Climate Change (IPCC) - 2014 (AR5), 2018 (SR5)
  https://www.ipcc.ch

- 4th National Climate Assessment (NCA4) — Volume 1: 2017; Volume 2: 2018
  https://nca2018.globalchange.gov