

Health Issues Related to Unconventional Gas Drilling (UGD)

Bernard D. Goldstein, MD
University of Pittsburgh Graduate
School of Public Health
bdgold@pitt.edu

Overview of Presentation

- UGD as a potential source of human health effects
- Impediments to study of health effects specific to UGD
 - Diversity of potential sources of adverse health effects
 - Lack of willingness to study humans to determine the potential for UGD human health effects
 - Transparency issues
- Why health research on UGD is in everyone's benefit

My View: What's the Rush to Drill?

- Unfortunately, there is no reasonable scenario in which non-fossil fuels or energy conservation will completely obviate our national need for fossil fuels in the next few decades
- During this time it is certain that virtually all of the US tight shale formations will be drilled for natural gas
- In contrast to the Gulf oil deposits, which might be tapped by other countries, the shale gas deposits of natural gas are ours
 - **So what's the rush?**

Potential Health Benefits of Natural Gas Development

- Replacement of coal in power generation leading to lesser emissions of particulates, sulfur oxides, nitrogen oxides and mercury
- Probable decrease in greenhouse gas impact of fossil fuels

**Adgate, JL et al: Potential public health hazards, exposures and health effects from unconventional natural gas development.
Environ Sci Technol Feb 10, 2014**

ABSTRACT: “...occupational stressors include mortality, exposure to hazardous materials and ...industrial accidents. For communities...the major stressors are air pollutants, ground and surface water contamination, truck traffic, noise..., accidents and malfunctions, and psychosocial stress.... “

“...no comprehensive population-based studies of the public health effects of UNG operations exist. Major uncertainties are the unknown frequency and duration of human exposure..., and a paucity of baseline data to enable substantive before and after comparisons for affected populations and environmental media. “

“... research needs to address these uncertainties before we can reasonably quantify the likelihood of occurrence or magnitude of adverse health effects associated with UNG production...”

Studies from the Univ Colorado SPH

LM McKenzie et al Human health risk assessment of air emissions from development of unconventional natural gas resources Sci Total Env 2012 May 1;424:79-87.

Subchronic exposures to air pollutants during well completion activities present the greatest potential for health effects. The subchronic non-cancer hazard index (HI) of 5 for residents \leq ½ mile from wells was driven primarily by exposure to trimethylbenzenes, xylenes, and aliphatic hydrocarbons.

Studies from the Univ Colorado SPH

LM McKenzie et al, **Birth outcomes and maternal residential proximity to natural gas development in rural Colorado**; 2014 Apr;122(4):412-7. Epub 2014 Jan 28.

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. In this large cohort, we observed an association between density and proximity of natural gas wells within a 10-mile radius of maternal residence and prevalence of CHDs and possibly NTDs. Greater specificity in exposure estimates is needed to further explore these associations.



Environmental Impacts of Shale Gas Extraction in Canada

*Presentation to the Sponsor,
Environment Canada
April 23, 2014*

John Cherry, Chair

Rick Chalaturnyk, Expert Panel Member

Environmental Impacts of Shale Gas Extraction in Canada

Human Health

- Health and well-being may be adversely affected:
 - Occupational Health: silica exposure, accidents on crowded pad
 - Physical effects: related to air and water contamination
 - Psychosocial: individual quality of life, anxiety
 - Community disruption and quality of life, income inequality, health and safety, and strain on local services
 - Ethical: risks to future generations
- Aboriginal peoples' concerns: well-being, quality of life, and rights, erosion of rights through habitat destruction.
- **Overall, health Impacts are not well understood and require additional research.**

Potential Pathways for Human Health Impacts Related to UGD

- Safety Issues
- Air Pollution
 - Worker and community exposure to HF chemicals, silica, diesel exhaust and drilling compounds
 - Community exposure to air toxics, including benzene; nitrogen oxides, diesel exhaust,
 - Regional exposures: ozone
 - Global climate change health impacts – positive and negative

Potential Pathways for Human Health Impacts Related to UGD

- Water Pollution
 - HF chemicals; flowback and produced waters on site or off site, including transportation and storage; reactants
- Light and Noise
- Psychosocial Effects
 - Exacerbated by lack of transparency and trust
 - Community “boomtown” issues

Impediments to study of health effects specific to UGD

Diversity of potential sources of
adverse health effects

12 Types of Additives for Fracking (0.5% of fluid)

Additive	Example Chemical	Purpose
Acid	Hydrochloric acid or muriatic acid	Helps dissolve minerals and initiate cracks in the rock
Antibacterial agent	Glutaraldehyde	Eliminates bacteria in the water that produces corrosive by-products
Iron control	Citric acid	Prevents precipitation of metal oxides
Breaker	Ammonium persulfate	Allows a delayed break down of the frac gel
Corrosion inhibitor	n,n-dimethyl formamide	Prevents corrosion of pipe
Crosslinker	Borate salts	Maintains fluid viscosity
Surfactant	Isopropanol	Increases viscosity of the frac fluid
Friction reducer	Petroleum distillate	Minimizes friction
Gel Guar gum	Hydroxyethyl cellulose	Helps suspend the sand in water
Clay stabilizer	Potassium chloride	Brine carrier fluid
pH adjusting agent	Sodium or potassium carbonate	Adjusts and controls pH of the fluid
Scale Inhibitor	Ethylene glycol	Reduces scale deposits in pipe

Sources: Earthworks. (2011). *Hydraulic Fracturing 101*. Retrieved Jan 11, 2012, from http://www.earthworksaction.org/issues/detail/hydraulic_fracturing_101#CHEMICALS;
EnergyIndustryPhotos. (2008). *What is Hydraulic Fracturing and What is it Used for?* Retrieved Jan 11, 2012, from http://www.energyindustryphotos.com/what_is_hydraulic_fracturing.htm

Many Agents of Potential Concern

- Three sources of toxicologically relevant agents
 - Hydrofracturing agents
 - Hydrocarbons and gases present in shale; methane, ethane, propane, benzene, toluene, ethyl benzene, xylenes, hydrogen sulfide
 - Natural constituents: brine components; barium, bromide, calcium, chloride, iron, magnesium, strontium; arsenic; radionuclides
 - ***Mixtures of any or all of above***

(Goldstein et al. The role of toxicological sciences in meeting the challenges and opportunities of hydraulic fracturing. Tox Sci, epub ahead of print April 4, 2014)

Many Agents of Potential Concern (2)

- Chemical reactions favored by higher temperatures and affected by other local conditions
 - Temperature in shale that favors natural gas production is ~480F
 - High pressure and salinity

(Goldstein et al. The role of toxicological sciences in meeting the challenges and opportunities of hydraulic fracturing. Tox Sci, epub ahead of print April 4, 2014)

Why Exposure Can Vary Greatly From Site to Site

- Different safety culture
- Different geology
- Different site-specific issues
- Different drilling technology
- Different hydraulic fracturing chemicals
- Different shale gas collection and distribution techniques
- Different flowback constituents and disposal techniques

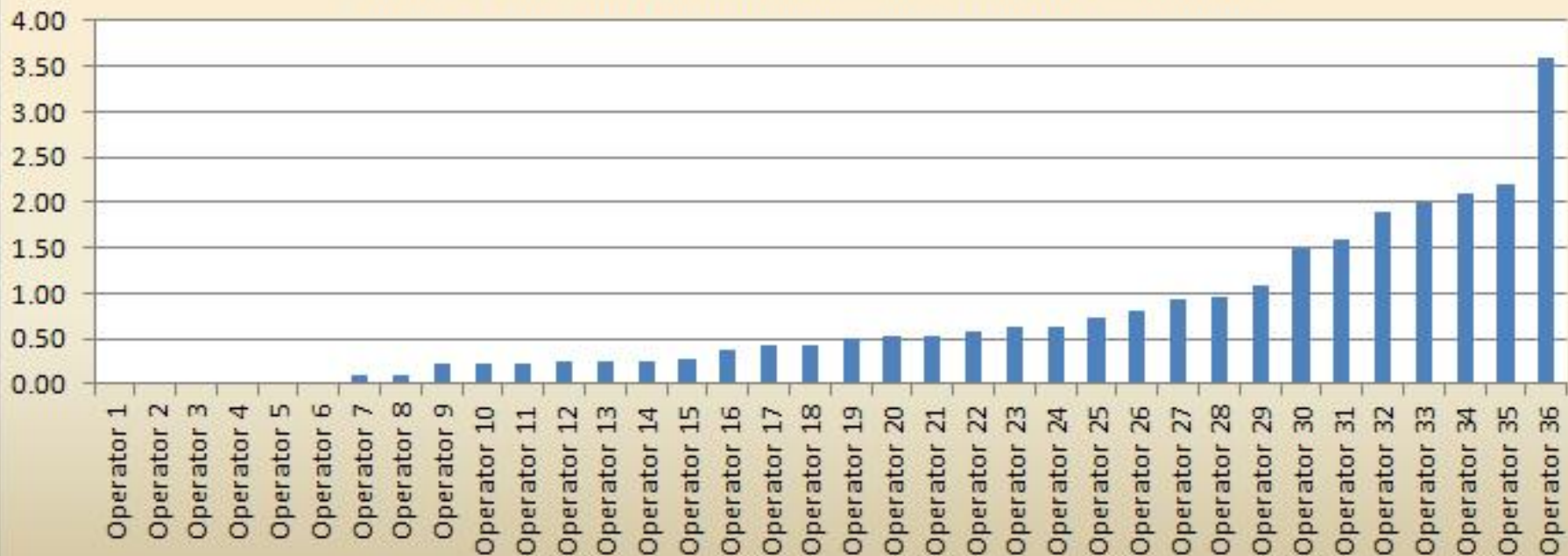




PA Marcellus Shale Violations per Well

Wells Drilled from 3/6/2006 to 10/31/11. Violations from 1/1/2010 to 9/30/2011.

Operators with 10 or more Marcellus Shale wells in Pennsylvania



Measurements of methane emissions at natural gas production sites in the United States

David T. Allen, Vincent M. Torres, James Thomas, David W. Sullivan, Matthew Harrison, Al Hendler, Scott C. Herndon, Charles E. Kolb, Matthew P. Fraser, A. Daniel Hill, Brian K. Lamb, Jennifer Miskimins, Robert F. Sawyer, and John H. Seinfeld.

PNAS 110:17768–17773, 2013

Sponsors

- Environmental Defense Fund
- Anadarko Petroleum Corporation
- BG Group plc
- Chevron
- Encana Oil & Gas (USA) Inc.
- Pioneer Natural Resources
- SWEPI LP (Shell)
- Southwestern Energy
- Talisman Energy USA
- XTO Energy, an ExxonMobil subsidiary
- Allen, D. T., Torres, V. M., Thomas, J., Sullivan, D. W., Harrison, M., Hendler, A., . . . Seinfeld, J. H. (2013). Measurements of methane emissions at natural gas production sites in the United States. Proceedings of the National Academy of Sciences. doi: 10.1073/pnas.1304880110

Measurements of methane emissions at natural gas production sites in the United States

- Measurements were made of methane emissions during 27 completion flowback events.
- The duration of the completions ranged from 5 to 339 h (2 wk). Measured methane emissions over an entire completion flowback event ranged from less than 0.01 Mg to more than 17 Mg with an average of 1.7 Mg and a 95% confidence interval of 0.67-3.3 Mg.
- Potential emissions for the wells in this work ranged from 0.2 Mg to more than 1 Gg methane, with an average of 124 Mg.

Measurements of methane emissions at natural gas production sites in the United States

- The nine unloading events reported in this work were varied in their characteristics. **Methane emissions ranged from less than 0.02 Mg to 3.7 Mg.** Some unloadings were as short as 10-15 min with uninterrupted flow for short periods and periods of no flow for much of unloading period. **Some of the wells sampled only unloaded once over the current life of the well, whereas others were unloaded monthly.**
- The sampled population reflected a wide range of emission rates, with a population of high emitting wells and a population of low emitting wells.

Measurements of methane emissions at natural gas production sites in the United States

- Average methane emission rates for a single unloading ranged from roughly 100 g/min to in excess of 30,000 g/min. These rates are much larger than emission rates for production sites (typically tens of grams of methane per minute per well) or from completions (typically a few hundred grams per event per minute). At these emission rates, a single unloading event could, during the short period that it is occurring, result in emissions that are the equivalent of up to several thousand wells in routine production.

Allen, D. T., Torres, V. M., Thomas, J., Sullivan, D. W., Harrison, M., Hendler, A., . . . Seinfeld, J. H. (2013). Measurements of methane emissions at natural gas production sites in the United States. *Proceedings of the National Academy of Sciences*. doi: 10.1073/pnas.1304880110

DIVERSITY OF SOURCES

SUTTON'S LAW AS A JUSTIFICATION
FOR STUDYING HUMANS IN RELATION
TO THE POTENTIAL HEALTH EFFECTS
OF UGD

Willie Sutton



US Steel: Clairton, PA



Impediments to study of health effects specific to UGD

Lack of willingness to study humans to
determine the potential for UGD
human health effects

Language of the Executive Orders Creating Unconventional Natural Gas Drilling Advisory Committees

(Goldstein et al, Env Hlth Persp 120:483-486, 2012)

“...task the Secretary of Energy Advisory Board (SEAB) with establishing a subcommittee...to develop, within six months, consensus recommended advice to the agencies on practices for shale extraction **to ensure the protection of public health and the environment**” (emphasis added)

-President Barak Obama in
Blueprint for a Secure Energy Future (March 2011)

The Marcellus Shale Safe Drilling Initiative will assist State policymakers and regulators in determining how gas production from the Marcellus shale in Maryland can be accomplished **without unacceptable risks of adverse impacts to public health, safety, the environment and natural resources**” (emphasis added)

-Maryland Governor Martin O’Malley in
Executive Order 01.01.2011.11: The Marcellus Shale Safe Drilling Initiative (June 2011)

“WHEREAS, the Commonwealth takes seriously its responsibility to ensure the development of natural gas in a manner that **protects the environment and safeguards the health and welfare of its citizens**” (emphasis added)

-Pennsylvania Governor Tom Corbett in
Executive Order 2011-011: Creation of Governor’s Marcellus Shale Advisory Commission (March 2011)

Role of the Pennsylvania Department of Health in Responding to Concerns about Shale Gas

- Recommendations from the Governor's Marcellus Shale Advisory Commission for registry, epidemiological studies, health care provider and public education, etc –almost completely ignored
- PADOH not one of the 17 state agencies, commissions, etc funded by the ~\$200 million annual impact fee
- PADOH's long-term federally funded Environmental Health Indicator Project not involved

(Goldstein, B. D. The importance of public health agency independence: Marcellus shale gas drilling in Pennsylvania. *Amer J Publ Hlth* 104:e13-15, 2014)

Impediments to study of health effects specific to UGD

Transparency issues

A Typology of Transparency Failures

- Information is kept secret
- Information is obtained but availability is hindered or obfuscated
- Information could be available but is not obtained

Congressional Testimony of Michael L. Krancer, Secretary of the Department of Environmental Protection, Commonwealth of Pennsylvania

“There has been a misconception that the hydraulic fracturing of wells can or has caused contamination of water wells. This is false.

...hydraulic fracturing is only a temporary feature of natural gas development, which only lasts a few weeks.

“Hydraulic fracturing of wells is not new in Pennsylvania, it has been going on here since about the 1950s and has been standard practice since about the 1980s

”
.

Childhood Cancer Incidence in Pennsylvania Counties in Relation to Living in Counties With Hydraulic Fracturing Sites.

Fryzek et al JOEM 55:796-801, Jul 2013

(Response: Goldstein & Malone JOEM 55:1376-1378 Nov 2013)

Abstract

–“CONCLUSIONS: This study offers comfort concerning health effects of HF on childhood cancers”.

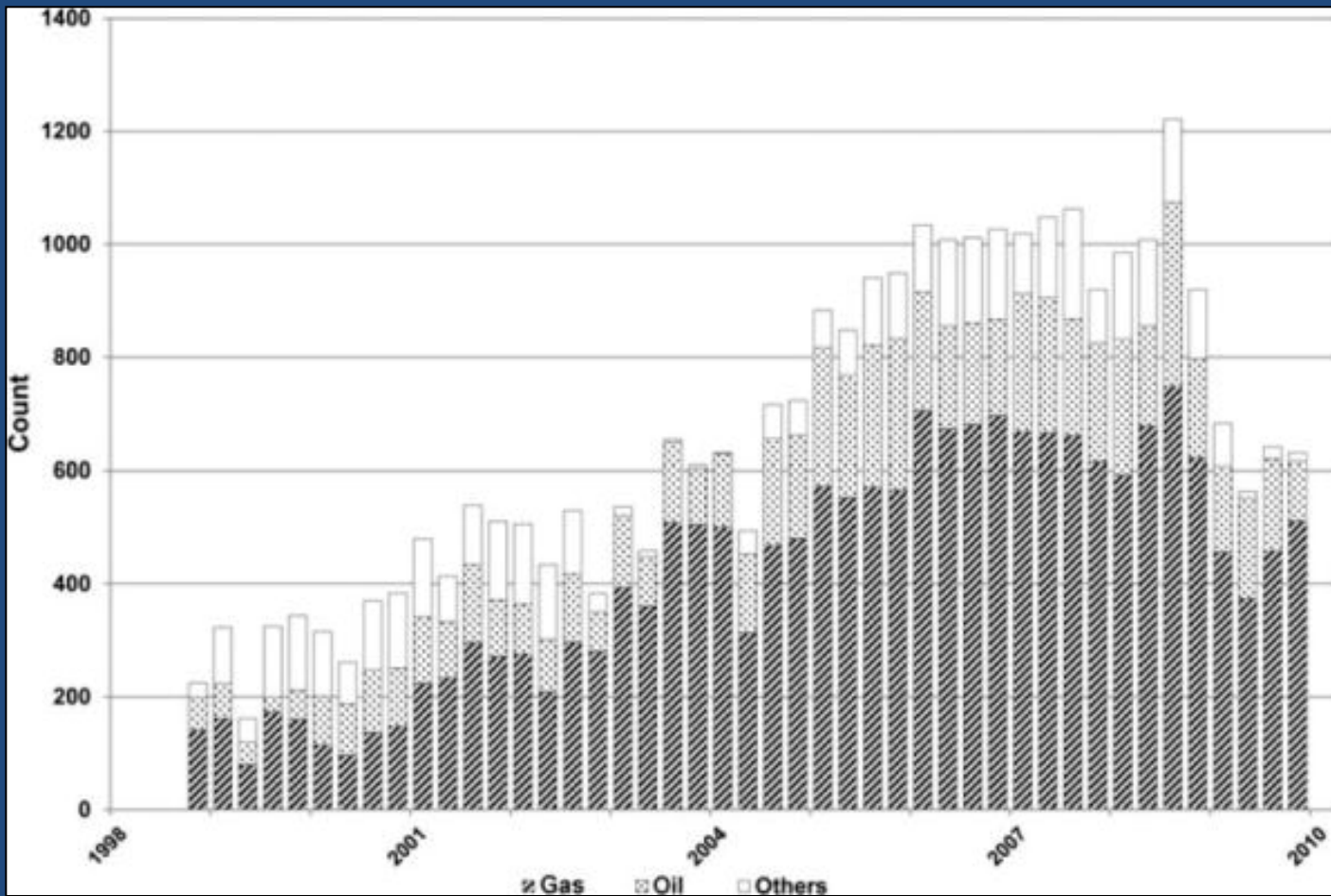


FIGURE 1 . Gas, oil, and other types of well drilling in Pennsylvania from January 1, 1998, to December 31, 2009.

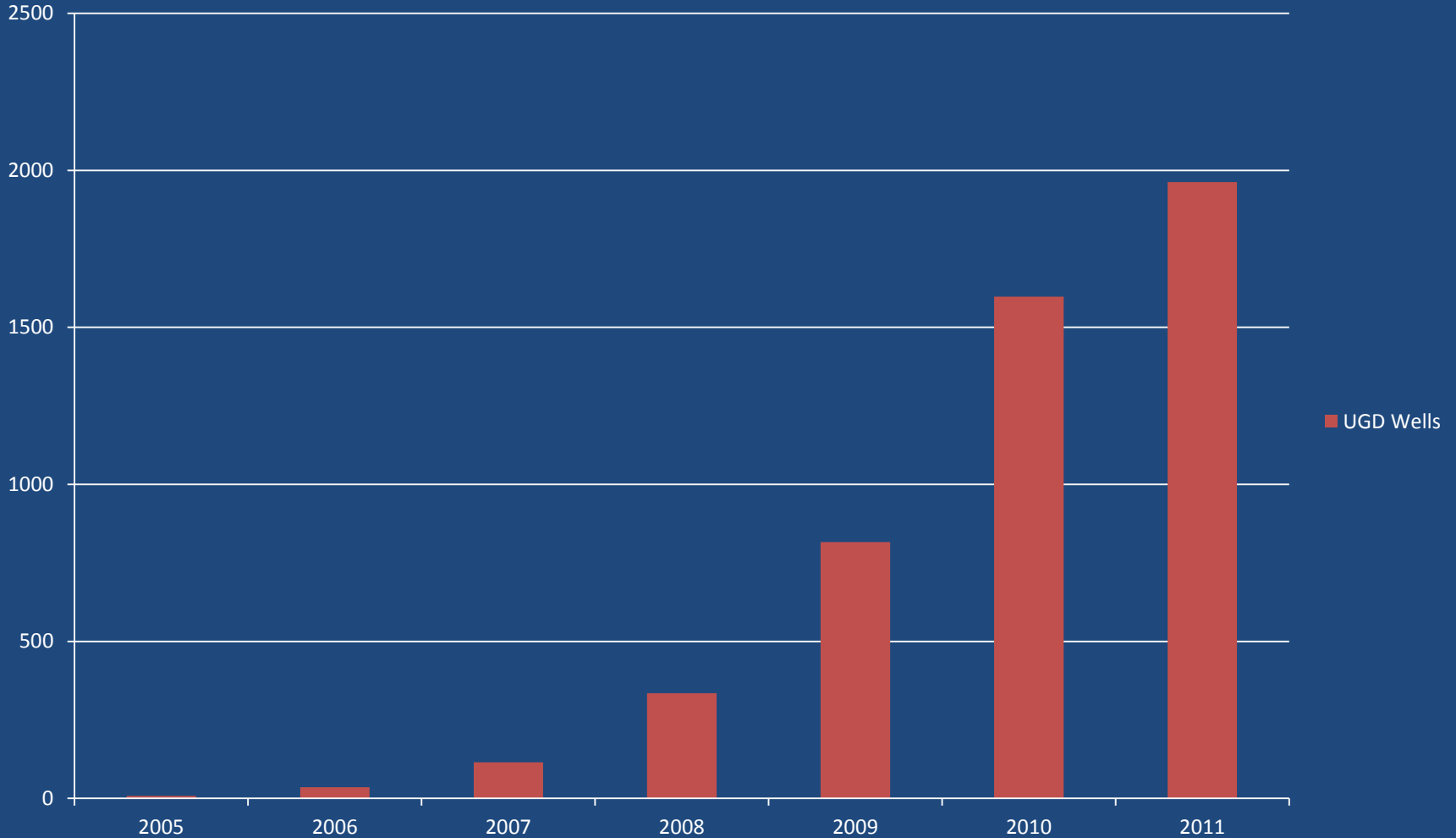
Childhood Cancer Incidence in Pennsylvania Counties in Relation to Living in Counties With Hydraulic Fracturing Sites.

Fryzek, Jon; Pastula, Susan; Jiang, Xiaohui; Garabrant, David:

Journal of Occupational & Environmental Medicine. 55(7):796-801, July 2013.

- Pennsylvania's ACT 13 requires that industry provide more information about the hydrofracturing chemicals used on site

UGD Wells in Pennsylvania



PA Department of Environmental Protection (DEP). (2013) Online Spud Data Report Database. Accessed 7-17-13
http://www.depreportingservices.state.pa.us/ReportServer/Pages/ReportViewer.aspx?/Oil_Gas/Spud_External_Data

What his/her lawyer should tell a doctor who might want CBI

- Once you sign the document allowing you to obtain confidential business information (CBI):
 - If you release the information you are legally liable for any business loss sustained by the company. (Halliburton is said to value their hydrofracturing secrets at upwards of \$200 million)
 - It is highly unlikely that any such law suit will be covered by your malpractice insurance.
 - If you think the CBI chemical could be causing health problems, state law probably requires you to divulge this secret information to public health authorities. It is not clear whether you are liable if the public health authorities then release the secret information

It would take an exceptionally brave (or foolhardy) health care provider to request CBI

Environmental Recidivism: Disclosures Not Required Under PA Act 13

Notwithstanding any other provision of this chapter, a vendor, service provider or operator **shall not be required** to do any of the following:

- (1) Disclose chemicals that are not disclosed to it by the manufacturer, vendor or service provider.
- (2) Disclose chemicals that were not intentionally added to the stimulation fluid.
- (3) Disclose chemicals that occur incidentally or are otherwise unintentionally present in trace amounts, may be the incidental result of a chemical reaction or chemical process or may be constituents of naturally occurring materials that become part of a stimulation fluid.

Emphases added

Court reveals how shale drillers, Pittsburgh-area family agreed

August 12, 2013 1:54 pm

By Don Hopey / Pittsburgh Post-Gazette

The previously confidential agreement to settle a Washington County family's claims that its health and property value were damaged by nearby shale gas development contains lifetime bans on what they can say and do, and also places restrictions on where they may live. ...

The 17-page settlement agreement also includes the Hallowiches' previously reported payoff of **\$750,000**, and notes they will continue to receive oil and gas royalties under the terms of a lease agreement entered into by the previous owners of their farm. It prohibits them from objecting to any drilling under any new property or residence they may own, and details the lifetime nondisclosure and nondisparagement **clauses preventing them from speaking publicly about the settlement** or protesting or challenging any gas development activity or lease by the operators.

Why health research on UGD is to
everyone's benefit

Top 6 stressors

Stressor	Session 1 (n=33)
Denied or provided false information	79%
Corruption	61%
Concerns/complaints ignored	58%
Being taken advantage of	52%
Financial damages	45%
Noise pollution	45%

Ferrar, K. J., Kriesky, J. K., Christen, C. L., Marshall, L. P., Malone, S. L., Sharma, R. K., Michanowicz, D. R., Goldstein, B. D., (2013). Assessment and longitudinal analysis of health impacts and stressors perceived to result from unconventional shale gas development in the Marcellus Shale region. **International Journal of Occupational Environmental Health. 19:104-112, 2013**

ROLE OF ANECDOTAL EVIDENCE IN OVERTURNING ACT 13

- Timothy Merrill, a retired executive with long-term oil and gas industry experience, wrote that the PA Supreme Court's decision to overturn parts of ACT 13:
“... is not supported by any evidence, data or facts in the court's 162-page opinion. Rather, he (Chief Justice Castille) seems to accept the plaintiffs' stories and anecdotal evidence as the whole truth...”

A pernicious ruling on gas: The Pennsylvania Supreme Court misread our rights at the expense of progress; January 11, 2014

<http://www.post-gazette.com/opinion/Op-Ed/2014/01/12/A-pernicious-ruling-on-gas/stories/201401120007#ixzz33mHJRxqv>

Anecdotal Data from Justice Castille's Decision Overturning PA ACT 13

“the homeowner abandoned her family home because the exposure to the toxic water and air caused her and her children severe health problems such as constant and debilitating headaches, nosebleeds, nausea, difficulty and shortness of breath, skin rashes and lesions, bone and muscle pain, inability to concentrate, and severe fatigue.”

Robinson Township v. Commonwealth of Pennsylvania, ___ A.3d ___, 2013 WL 6687290 at *23. (Pa. 2013)

Corbett administration asks justices to reconsider Act 13

January 2, 2014 11:32 PM

By Don Hopey / Pittsburgh Post-Gazette



Pa. files for reconsideration of Act 13 decision

Story

Comments

Share Print Font Size:

Posted: Friday, January 3, 2014 10:55 am

Rachel Morgan, Shalereporter.com | 0 comments

HARRISBURG -- The state has officially responded to last month's Pennsylvania Supreme Court Act 13 decision.

Attorneys for Gov. Tom Corbett announced Thursday they had filed an appeal of the Supreme Court's Dec. 19 ruling on Act 13, asking the courts to reconsider.



AP photo by Keith Srakocic

A crew works on a drilling rig at a well site for shale-based natural gas in Zelienople, Pa.

The Role of the Lack of Independent Scientific Study in Overturning ACT 13

The Environmental Quality Board is to articulate criteria for granting permits premised on consideration of the impact on public natural resources, including ... sources used for public drinking supplies. *It is worth noting that the Commonwealth does not specify whether any independent scientific study has been commissioned* or what data will be used to assess the impact on any or all of the public natural resources that the Board is to consider in promulgating regulations.

In addition to strengthening the citizens' claims that the statutory scheme offers no clear standards for determining permit applications, *the absence of data also suggests that the Commonwealth has failed to discharge its trustee duty of gathering and making available to the beneficiaries complete and accurate information* as to the nature and amount of the trust property. (emphases added)

Justice Ronald D. Castille, Robinson Township, etc. v. Commonwealth (Supreme Court of Pennsylvania Middle District ed., 2013). Footnote 60.

TWO MAJOR RECOMMENDATIONS

- To the HEI Committee: Focus your recommendations on the study of humans to determine if human health effects of UGD are occurring
- To the rest of us: Proactively ensure that the data are made available which would allow a fair estimation of whether UGD is directly producing adverse human health effects