

STUDIES AND REPORTS ON THE DANGERS OF FRACKING AND THE NEED FOR
MORE HEALTH DATA THAT SUPPORT A 5 YEAR MORATORIUM

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On the risks to public health and welfare not being comprehensively assessed

- In October 2012, the American Public Health Association (APHA) issued a policy statement saying “[high-volume horizontal hydraulic fracturing (HVHF)] poses potential risks to public health and the environment, including groundwater and surface water contamination, climate change, air pollution, and worker health.... The public health perspective has been inadequately represented in policy processes related to HVHF.” The APHA statement added: “[H]ydraulic fracturing workers are potentially exposed to inhalation health hazards from dust containing silica. There may also be impacts on workers and communities affected by the vastly increased production and transport of sand for HVHF. Inhalation of fine dusts of respirable crystalline silica can cause silicosis. Crystalline silica has also been determined to be an occupational lung carcinogen.”¹
- A September 2012 U.S. Government Accountability Office report adds that “Oil and gas development, whether conventional or shale oil and gas, pose inherent environmental and public health risks, but the extent of these risks associated with shale oil and gas development is unknown, in part, because the studies GAO reviewed do not generally take into account the potential long-term, cumulative effects.”²
- In January 2012, Christopher Portier, Director of the National Center for Environmental Health and Agency for Toxic Substances and Disease Registry at the U.S. Centers for Disease Control and Prevention in Atlanta, stated to the *Associated Press* that “more research is needed for us to understand public health impacts from natural gas drilling and new gas drilling technologies.”³
- In September 2010, researchers at the Colorado School of Public Health conducted a prospective Health Impacts Assessment of proposed natural gas development in Garfield County and found that it “has the potential to create a variety of stressors that can impact health.” The researchers reported “These stressors include air emissions, water and soil contamination, traffic, noise/vibration/light, community wellness, economic/employment changes, health infrastructure stress, and industrial accidents/malfunctions.”⁴

¹ American Public Health Association. [Policy Statement]. “The Environmental and Occupational Health Impacts of High-Volume Hydraulic Fracturing of Unconventional Gas Reserves.” October 30, 2012.

² U.S. Government Accountability Office. “Oil and Gas: Information on Shale Resources, Development, and Environmental and Public Health Risks.” September 5, 2012.

³ “CDC scientist: tests needed on drilling impact.” *Associated Press*. January 4, 2012.

⁴ Witter, Roxanne et al. [For the Garfield County Board of County Commissioners]. “Health Impacts Assessment for Battlement Mesa, Garfield County Colorado.” September 2010.

On Colorado-specific risks and harms:

Colborn, T. et al. “An exploratory study of air quality near natural gas operations.” *Human and Ecological Risk Assessment: An International Journal*. To appear, accepted for publication November 8, 2012 at 1039 to 1056.

“This exploratory study was designed to assess air quality in a rural western Colorado area where residences and gas wells co-exist. Sampling was conducted before, during, and after drilling and hydraulic fracturing of a new natural gas well pad. Weekly air sampling for 1 year revealed that the number of non-methane hydrocarbons (NMHCs) and their concentrations were highest during the initial drilling phase and did not increase during hydraulic fracturing in this closed-loop system. Methylene chloride, a toxic solvent not reported in products used in drilling or hydraulic fracturing, was detected 73% of the time; several times in high concentrations. A literature search of the health effects of the NMHCs revealed that many had multiple health effects, including 30 that affect the endocrine system, which is susceptible to chemical impacts at very low concentrations, far less than government safety standards. Selected polycyclic aromatic hydrocarbons (PAHs) were at concentrations greater than those at which prenatally exposed children in urban studies had lower developmental and IQ scores. The human and environmental health impacts of the NMHCs, which are ozone precursors, should be examined further given that the natural gas industry is now operating in close proximity to human residences and public lands.” (Abstract)

Gilman, J.B. et al. “Source signature of volatile organic compounds from oil and natural gas operations in Northeastern Colorado.” *Environmental Science & Technology*, vol. 47. iss. 3. January 2013 at 1.

“An extensive set of volatile organic compounds (VOCs) was measured at the Boulder Atmospheric Observatory (BAO) in winter 2011 in order to investigate the composition and influence of VOC emissions from oil and natural gas (O&NG) operations in northeastern Colorado. BAO is 30 km north of Denver and is in the southwestern section of Wattenberg Field, one of Colorado’s most productive O&NG fields. We compare VOC concentrations at BAO to other U.S. cities; summertime measurements at two additional sites in northeastern Colorado; as well as the composition of raw natural gas from Wattenberg Field. These comparisons show that (i) the VOC source signature associated with O&NG operations can be clearly differentiated from urban sources dominated by vehicular exhaust, and (ii) VOCs emitted from O&NG operations are evident at all three measurement sites in northeastern Colorado. At BAO, the reactivity of VOCs with the hydroxyl radical (OH) was dominated by C₂-C₆ alkanes due to their remarkably large abundances (e.g., mean propane = 27.2 ppbv). Through statistical regression analysis, we estimate that on average $55 \pm 18\%$ of the VOC-OH reactivity was attributable to emissions from O&NG operations indicating that these emissions are a significant source of ozone precursors.” (Abstract)

Pétron, Gabrielle et al. “Hydrocarbon emissions characterization in the Colorado Front Range: A pilot study.” *Journal of Geophysical Research, Atmospheres*, vol. 117. February 21, 2012.

“This study provides a regional overview of the processes impacting ambient alkane and benzene levels in northeastern Colorado in the late 2000s. We report atmospheric observations collected by two sampling platforms: a 300-m tall tower located in the SW corner of Weld County (samples from 2007 to 2010), and road surveys by a Mobile Lab equipped with a continuous methane analyzer and 931 discrete canister sampling (June–July 2008). The analysis of the tower data filtered by wind sector reveals a strong alkane and benzene signature in air masses coming from northeastern Colorado, where the main activity producing these compounds is related to oil and gas operations over the Denver–Julesburg Fossil Fuel Basin [DJB].” (p. 41, preprint)

“The emissions profiles for flashing and venting losses are in good agreement with the atmospheric alkane enhancement ratios observed during this study and by Goldan et al. [1995] in Boulder in 1991. This is consistent with the hypothesis that the observed alkane atmospheric signature is due to oil and gas operations in the DJB.” (p. 42-43)

“The C₆H₆ [benzene] source we derived based on flashing and venting VOC emissions in the WRAP inventory (143 Mg/yr) most likely underestimates the actual total source of C₆H₆ from oil and gas operations. Our top-down source estimates for C₆H₆ from oil and gas operations in Weld County cover a large range: 385-2056 Mg/yr. Again, the lowest figure is much higher than reported in the 2008 CDPHE inventory for Weld County oil and gas total point sources (61.8 Mg/yr).” (p. 43-44)

On General Public Health:

McKenzie, L.M. et al. “Human health risk assessment of air emissions from development of unconventional natural gas resources.” *Science of the Total Environment*, vol. 424. May 1, 2012 at 79 to 87.

“Our results show that the non-cancer [hazard index] from air emissions due to natural gas development is greater for residents living closer to wells. Our greatest [hazard index] corresponds to the relatively short-term (i.e., subchronic), but high emission, well completion period. This [hazard index] is driven principally by exposure to trimethylbenzenes, aliphatic hydrocarbons, and xylenes, all of which have neurological and/or respiratory effects. We also calculated higher cancer risks for residents living nearer to wells as compared to residents residing further from wells. Benzene is the major

contributor to lifetime excess cancer risk for both scenarios. It also is notable that these increased risk metrics are seen in an air shed that has elevated ambient levels of several measured air toxics, such as benzene.” (p. 83)“Further studies are warranted, in order to reduce the uncertainties in the health effects of exposures to [natural gas development] NGD air emissions, to better direct efforts to prevent exposures, and thus address the limitations of this risk assessment.” (p. 86)

Perry, Simona L. “Using ethnography to monitor the community health implications of onshore unconventional oil and gas developments: examples from Pennsylvania’s Marcellus Shale.” *New Solutions*, vol. 23 iss. 1. 2013 at 33 to 53.

“Data collected from interviews, focus groups, and participant observations in 2009, 2010, and 2011 confirm that rapid environmental and social changes were happening in the county as a result of Marcellus Shale developments. A total of 31 landowners and 68 other residents of the county were interviewed during this time period, and most spoke about experiencing what was later classified during data analysis as psychosocial stress.” (p. 34)

“In many of the rural and urban communities across North America where onshore unconventional oil and gas developments are being considered or already taking place there is a lack of scientific and clinical information on the local psychological and sociocultural factors that may directly influence community health outcomes [9]. Without such baseline information on the determinants of community health with particular emphasis on psychosocial stress factors, practitioners and policy makers have a difficult time determining the potential for harm to public health associated with these relatively new development projects and then enacting appropriate preventive measures.” (p. 46)

Steinzor, Nadia et al. “Investigating links between shale gas development and health impacts through a community survey project in Pennsylvania.” *New Solutions*, vol. 23 iss. 1. 2013 at 55 to 83.

“While the toxic and polluting qualities of substances used and produced in shale gas development and the general health effects of exposure are well established, scientific evidence of causal links has been limited, creating an urgent need to understand health impacts.” (p. 55)

“While the survey and testing results, and their related findings, do not constitute definitive proof of cause and effect, we believe they do indicate the strong likelihood that the health of people living in proximity to gas facilities is being affected by exposure to pollutants from those facilities. Most participants report a high number of health symptoms; similar patterns of symptoms were identified across project locations and distances from facilities; and consistency in symptoms reported exists regardless of age group or smoking history. In addition, contaminants that result from oil and gas development were detected in air and water samples in areas where residents are experiencing health symptoms that are established in the literature as consistent with such exposures.” (p. 76)

Bamberger, M. and R.E. Oswald. "Impacts of gas drilling on human on animal health." *New Solutions*, vol. 22, iss. 1. 2012 at 51 to 77.

"Animals, especially livestock, are sensitive to the contaminants released into the environment by drilling and by its cumulative impacts. Documentation of cases in six states strongly implicates exposure to gas drilling operations in serious health effects on humans, companion animals, livestock, horses, and wildlife. Although the lack of complete testing of water, air, soil, and animal tissues hampers thorough analysis of the connection between gas drilling and health, policy changes could assist in the collection of more complete data sets and also partially mitigate the risk to humans and animals. Without complete studies, given the many apparent adverse impacts on human and animal health, a ban on shale gas drilling is essential for the protection of public health." (p. 72)

Colborn, T. et al. "Natural gas operations from a public health perspective." *Human and Ecological Risk Assessment: An International Journal*, vol. 17, iss. 5. September 20, 2011 at 1039 to 1056.

"In addition to the land and water contamination issues, at each stage of production and delivery tons of toxic volatile compounds (VOCs), including BETX, other hydrocarbons, and fugitive natural gas (methane), can escape and mix with nitrogen oxides (NO_x) from the exhaust of diesel-fueled, mobile, and stationary equipment, to produce ground-level ozone." (p. 1042)

"A list of 944 products containing 632 chemicals used during natural gas operations was compiled.... More than 75% of the chemicals could affect the skin, eyes, and other sensory organs, and the respiratory and gastrointestinal systems. Approximately 40–50% could affect the brain/nervous system, immune and cardiovascular systems, and the kidneys; 37% could affect the endocrine system; and 25% could cause cancer and mutations." (p. 1039)

Goldstein, B. et al. "Missing from the table: role of the environmental public health community in governmental advisory commissions related to Marcellus Shale drilling." *Environmental Health Perspectives*, vol. 120, iss. 4. April 2012 at 483 to 486.

"At a public hearing held by the SEAB Natural Gas Subcommittee 62.7% of those not in favor of drilling mentioned health issues. Although public health is specified to be a concern in the executive orders forming these three advisory committees, we could identify no individuals with health expertise among the 52 members of the Pennsylvania Governor's Marcellus Shale Advisory Commission, the Maryland Marcellus Shale Safe Drilling Initiative Advisory Commission, or the SEAB Natural Gas Subcommittee." (p. 483)

“Environmental public health is not yet at the table in governmental advisory processes related to drilling in the Marcellus Shale.” (p. 486)

Representative Health Studies during Moratorium:

There are several studies underway regarding the health impacts of fracking and related surface activities, including:

1) U.S. Environmental Protection Agency: At Congress’s request, the EPA is currently engaged in a study on the potential impacts of hydraulic fracturing on drinking and ground water.ⁱ December 2014 is the date given for the release of the final draft report.ⁱⁱ This should be followed by peer review and a public comment period preceding the final report.

One of the research questions the EPA study seeks to answer is: “What are the chemical, physical, and toxicological properties of hydraulic fracturing chemical additives and wastewater constituents?” According to the Progress Report released in December 2012, the EPA is compiling existing data regarding toxicity and potential human health effects associated with the chemicals reported to be in fracturing fluids and found in wastewater. There are currently over 1,000 chemicals identified.ⁱⁱⁱ

2) State of Colorado: The state is set to perform a significant study of emissions tied to oil and gas development. The project will provide information about how oil and gas emissions behave, how they travel and their characteristics in areas along the northern Front Range. A second phase would assess possible health effects using information collected in the first phase. CDPHE will contract with Colorado State University to conduct the study. The first phase of the study is projected to cover a three-year period from July 2013 through June 2016. The second phase to develop a health risk assessment would begin in January of 2016.^{iv}

3) National Science Foundation: There is a pending NSF study entitled: “Routes to Sustainability for Natural Gas Development and Water and Air Resources in the Rocky Mountain Region.”

The length of this study is 5-years, with a first working meeting having taken place on Jan. 18, 2013, and now underway. It is funded for \$12 million (\$11,999,328). There are five primary investigators, led by Principal Investigator Joseph Ryan, Professor of CU-Boulder’s Civil, Environmental, and Architectural Engineering Department. The NSF team studying the health risk assessments of unconventional drilling will include medical researchers John L. Adgate, Roxana Z. Witter, and Lisa M. McKenzie of the Colorado School of Public Health, University of Colorado and Anschutz Medical Campus in Aurora (also authors of a published peer-reviewed study,

“Human health risk assessment of air emissions from development of unconventional natural gas sources”^v).

Patty Limerick is a co-principal investigator, also at CU-Boulder and the Director of the Center for the American West. Based on conversations between Sierra Club and Ms. Limerick, the researchers anticipate a mid-point report at 2.5 years, or by June, 2015.

Among the study's stated goals is the: "quantitative and qualitative assessment of the health risks, both chemical and non-chemical, associated with water and air exposure."^{vi}

4) Geisinger Health System: This is a Pennsylvania physician-led health care system that is currently undertaking a study of the health impacts of hydraulic fracturing, based on the health histories of two million people who live near the Marcellus Shale.^{vii} In August 2012, a press release by Geisinger states that preliminary results of data analysis may be released within the next year while other aspects of the research will unfold over 5, 10, or 15 years.^{viii}

ⁱ <http://www.epa.gov/hfstudy/>.

ⁱⁱ <http://www.epa.gov/hfstudy/pdfs/summary-of-technical-roundtables.pdf>

ⁱⁱⁱ EPA, *Study of the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources Progress Report* (December 2012) available at <http://www2.epa.gov/sites/production/files/documents/hf-report20121214.pdf>.

^{iv} See CDPHE Press Release, January 9, 2013 at:

<http://dnr.state.co.us/SiteCollectionDocuments/News/Statetoundertakemajorstudyonoilandgasemissions.pdf>

^v Science of the Total Environment, March 22, 2012, available at http://abrahampaiss.com/frackfreeboulder/wp-content/uploads/2013/01/Health_risk_assessment_natural_gas_mckenzie2012study.pdf.

^{vi} The University of Colorado Boulder is the lead institution for a [Sustainability Research Network](#) (SRN) funded by the [National Science Foundation](#). The Network will engage [twenty-seven researchers](#) at nine institutions, including Colorado School of Mines, Colorado School of Public Health (University of Colorado Denver), Colorado State University, NOAA and University of Colorado Boulder.

^{vii} *Geisinger Leads Marcellus Shale Initiative* (2013), available at <http://www.geisinger.org/research/cx/73809-1-ResearchCnxWinter2013WEB.pdf>; see also Jon Hamilton, *Medical Records Could Yield Answers on Fracking*, NPR (May 16, 2012), available at <http://www.npr.org/2012/05/16/151762133/medical-records-could-yield-answers-on-fracking>;

<https://webapps.geisinger.org/ghsnews/articles/GuthrieHealthandGeisingerc8464.html>. A March 2013 AP article says Geisinger envisions the study as a 20-year project divided into 5-year phases, with the

first five years spent building a data-collection

system. <http://www.usatoday.com/story/news/nation/2013/03/09/fracking-study-years-off/1975261/>