

North American Shale Gas Plays:

More Unanswered Questions

**Prepared in Response to Comments by Concerned Citizens
of New Brunswick, Canada**

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Discussions of gas drilling in shale formations are taking place all across North America. Unsubstantiated statements are being made regarding each new play. Industry claims that shale gas is a clean fuel that will be a bridge between reliance on oil and development of renewable energy sources. Industry also claims that the technology used to extract shale gas, horizontal hydraulic fracturing, is safe. And industry claims that shale gas exploration and production will be a panacea to ailing economies. Such claims show that industry is ignoring both important facts and ongoing research.

CLEAN?

The United States Environmental Protection Agency (EPA), in a document, “Background Technical Support Document – Petroleum and Natural Gas Industry” (undated, but updated on the EPA website in November 2010) concludes that production and delivery of natural gas emits more greenhouse gases than production and delivery of oil.

Total equipment leak and vented CH₄ and CO₂ emissions from the petroleum and natural gas industry were 317 million metric tons of CO₂ equivalent (MMTCO_{2e}) in 2006. Of this total, the natural gas industry emitted 261 MMTCO_{2e} of CH₄ and 28.50 MMTCO_{2e} of CO₂ in 2006. Total CH₄ and CO₂ emissions from the petroleum industry in 2006 were 27.74 MMTCO_{2e} and 0.29 MMTCO_{2e} respectively. (page 10)

Furthermore, Professor Robert Howarth of Cornell University has concluded that “natural gas is no better than coal and may, in fact, be worse than coal in terms of its greenhouse gas footprint when evaluated over the time course of the next several decades.” Howarth’s paper, “Assessment of the Greenhouse Gas Footprint of Natural Gas from Shale Formations Obtained by High-Volume, Slick-Water Hydraulic Fracturing,” was released on November 15, 2010.

SAFE?

Supporters of hydrofracking who claim that shale gas drilling is an environmentally safe process have ignored studies and reports from non-industry sources such as a recent report by Riverkeeper, “Fractured Communities: Case Studies of the Environmental Impacts of Industrial Gas Drilling”, September 2010 (authors: Craig Michaels, James L. Simpson, William Wegner). The Riverkeeper report cites more than 100 cases across the country where federal and state regulators identified gas drilling operations as the known or suspected cause of groundwater, drinking water and surface water contamination. Horizontal drilling using high-volume hydraulic fracturing can and has caused significant adverse environmental impacts. These impacts result from changes in land use, roadbuilding, water withdrawals, improper cementing and casing of wells, over-pressurized wells, gas migration from new and abandoned wells, the inability of

wastewater treatment plants to treat flowback and produced water, underground injection of brine wastewater, improper erosion and sediment controls, truck traffic, compressor stations, as well as accidents and spills.

In Pennsylvania, state regulators have found contaminated drinking water, polluted surface waters, polluted air and contaminated soils. The Pennsylvania Department of Environmental Protection (DEP) issued a cease and desist order to Cabot Energy because they were found to have contaminated fourteen drinking water wells with methane. The Monongahela River that supplies water to one million people in West Virginia and Pennsylvania is contaminated, and gas drilling is the suspected cause as high levels of bromide were detected. Bromide is a signature component of wastewater from drilling, and it is a known carcinogen. Bubbles of methane have been appearing in the Susquehanna River. On Sept 9th, 2010, the DEP issued a notice of violation to Chesapeake Energy for failing to prevent gas migration to fresh groundwater and for allowing natural gas discharge into the state's waters, without permit.

In Pennsylvania alone, there were over 1400 industry violations in a two and one-half year period. Violations in Pennsylvania include improper construction of wastewater impoundments, faulty pollution prevention practices, discharges of industrial waste, improper well casing and construction, and improper blowout prevention. For example, in June of 2010, a gas well blowout in Clearfield County sent at least 35,000 gallons of wastewater and natural gas spewing into the air for 16 hours.

There have been multiple violations in other states as well. Here are some examples: In Ohio, inadequate well casing resulted in drinking water contamination and also the explosion of a house. In Texas, state regulators found elevated levels of benzene, formaldehyde and other toxic chemicals in neighborhoods near gas compressors. In Pavillion, Wyoming, residents have been warned not to drink their water due to contamination near gas wells. In Colorado, hundreds of spills have been reported and residents in the area have reported health impacts.

Relatively recently, shale gas exploration activities have begun in New Brunswick, Canada, and reports indicate that unsubstantiated claims are being made there by industry representatives. It was reported in the Telegraph-Journal on November 5, 2010, that Tom Alexander, general manager of SWN Resources Canada Inc., a wholly owned subsidiary of Southwestern Energy Company, stated "The lifeblood and food of a resource play is sand and water." Mr. Alexander didn't mention the fact that as many as 500 different chemicals, many toxic, may be added to the water and sand. Research by scientists, such as Dr. Theo Colburn and Wilma Subra, show that certain chemicals used in fracking are carcinogens and endocrine disruptors.

ECONOMIC BOON?

Mr. Alexander of SWN Resources was reported, again in the Telegraph-Journal, to have said that shale gas drilling will be a boon to New Brunswick's economy, "bringing jobs and lining government coffers".

It is far from clear that shale gas drilling would benefit the regional economy of New Brunswick. An earlier report, “Unanswered Questions About the Economic Impact of Natural Gas in the Marcellus Shale: Don’t Jump to Conclusions” by Jannette M. Barth, dated March 27, 2010, summarized serious flaws in multiple economic impact studies. Studies reviewed in that report include the following:

A study produced at Penn State University and funded by the Marcellus Shale Coalition, an industry trade group

- “An Emerging Giant: Prospects and Economic Impacts of Developing the Marcellus Shale Natural Gas Play”, Timothy Considine, Robert Watson, Rebecca Entler, Jeffrey Sparks, July 24, 2009; and

A study commissioned by the Broome County, NY Legislature

- “Potential Economic and Fiscal Impacts from Natural Gas Production in Broome County, New York”, Bernard L. Weinstein and Terry L. Clower, September 2009.

A study of the Barnett Shale in Texas

- “An Enduring Resource: A Perspective on the Past, Present, and Future Contribution of the Barnett Shale to the Economy of Fort Worth and the Surrounding Area”, The Perryman Group, March, 2009.

Since the writing of the initial “Unanswered Questions” report of March 27th, the following studies were released and they suffer the same shortcomings as the above studies.

Another study produced at Penn State and funded by the Marcellus Shale Coalition

- “The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play: An Update”, Timothy Considine, Robert Watson, Seth Blumsack, May 24, 2010.

A study funded by the American Petroleum Institute

- “The Economic Impacts of the Marcellus Shale: Implications for New York, Pennsylvania, and West Virginia: A Report to the American Petroleum Institute”, Timothy J. Considine, July 14, 2010.

Mr. Alexander referenced an industry-funded study by the University of Arkansas School of Business on the Fayetteville Shale that concludes that one billion cubic feet of gas per day could create 9,500 jobs. There were two study reports released by the University of Arkansas, in 2006 and in 2008, and they also share the flaws of the other economic impact studies.

Two studies produced at the Sam M. Walton College of Business, University of Arkansas

- “Projecting the Economic Impact of the Fayetteville Shale Play for 2005-2008,” May, 2006, sponsored by SEECO, Inc., a wholly-owned subsidiary of Southwestern Energy Company.
- “Projecting the Economic Impact of the Fayetteville Shale Play for 2008-2012,” March, 2008, sponsored by Arkansas Land and Exploration LLC, Chesapeake

Energy Corporation, Petrohawk Energy Corporation, and Southwestern Energy Company.

Each of the studies listed above ignores significant economic costs such as the following:

- The enormous cost to repair roads and bridges that will be damaged by heavy equipment and the hundreds of tanker trucks that are required to haul water and waste water to and from every well site.
- The high cost of mitigating environmental damage, such as drinking water contamination and fish kill. There is evidence of both in Pennsylvania and in western states.
- Increased spending by communities on emergency medical care, first responders and law enforcement. Local hospitals and fire departments may be ill-equipped to handle industrial accidents involving heavy machinery and toxic chemicals. Drilling operations typically involve large numbers of transient workers, who may not have proper regard for the protection or betterment of the community.
- High economic costs associated with the potentially severe health impacts such as cancer, brain damage, respiratory disease and endocrine disruption that have been connected to chemicals used in the hydraulic fracturing process.
- Declines in other industries that are likely to take place. The negative effect on natural beauty and the environment will be sure to hurt the tourism industry. As in upstate New York, fishermen and hunters will be much less likely to visit New Brunswick, and the impact on agriculture and organic farming could be devastating.

In addition to the omission of significant economic costs, most of the above studies, including the two University of Arkansas studies, use a modeling technique which, when used alone in this case, is likely to lead to inaccurate, and often exaggerated, results. Input/Output analysis is useful in many situations, but with all economic models, it must be used carefully and adjustments frequently must be made to achieve accurate results. Problems with the Input/Output approach include the following:

- Input/Output analysis does not capture the types of costs that are listed above such as the costs of environmental damage and declines in public health.
- It assumes that all populations have identical spending patterns. This exaggerates the estimated economic impact if new workers are transient. Such workers send their wages to their families living elsewhere, improving the economies in those distant locations, not in the shale region.
- Input/Output analysis assumes “constant returns to scale.” This means that the gas industry would get no volume discounts on supplies. This is an unrealistic assumption.
- Input/Output models are static in time, implying that there are no changes in coefficients over time and no allowance for price changes.
- Input/Output models are aspatial, implying that transportation costs are not fully reflected.
- True input/output coefficients are unknown. One cannot know what the true

coefficient values are in a case where the industry does not already exist in a region, such as horizontal drilling and hydrofracking in New Brunswick, Canada.

- In an input/output analysis, the production function is constant. This does not allow for input substitution or changes in the proportions of inputs as technology and/or prices change over time.

Long-term economic costs are not reflected in any of the studies. Large amounts of chemically laden fracking fluid remain underground following gas extraction, and the economic costs to our environment and public health that may be caused by chemical reactions and water movement underground over the next fifty or so years are unknown.

The industry-funded economic impact studies are based on data provided by the oil & gas industry. The University of Arkansas study attaches a copy of the gas company survey that was used to collect data. Natural gas production assumptions that are fed into the models are based on industry numbers. There is much controversy regarding the amount of recoverable reserves in the shale formations. It is possible that industry may be exaggerating gas production estimates. Alan Berman, a petroleum geologist and consultant to the energy sector, has conducted independent analyses of production numbers in the Barnett Shale and the Fayetteville Shale, and he has shown that the actual decline curves are much steeper than industry has claimed. Mr. Berman also shows that the years of production are significantly fewer than those claimed by industry. If gas production is significantly less and the number of years of gas production are fewer than the assumptions used for the economic impact analysis, then the output, employment, income and tax revenue numbers produced by the analyses are overly optimistic.

The oil and gas industry is highly capital-intensive, approximately ten times more capital-intensive than the average American industry. It, therefore, has a low employment multiplier compared to the relatively more labor-intensive industries that may be in danger of declining if gas drilling is encouraged. While economic multipliers for particular industries vary for a variety of reasons, some generalizations about multipliers can be made. Capital-intensive industries have lower employment multipliers than labor-intensive industries. A geographic area with relatively vast industrial diversity will have higher economic multipliers than a region with only a few industries. An industry that uses materials and labor primarily from within the region will have a relatively higher multiplier than an industry that buys its services and supplies from outside the region. The region could be defined as a state, county, multi-state area or sub-county area, and these differences in multipliers still apply. If an industry is in a large urban area, its multipliers are generally higher as greater amounts of industry spending remains in the area. Small and/or rural areas tend to have lower multipliers, since an industry must use services and supplies from firms outside the area. So, when applying a multiplier to estimate economic impact, much care should be taken to reflect the economic character and industry diversity of the region being analyzed. Economic development decision makers should consider such factors prior to encouraging a new industry into a region.

It is not clear that jobs associated with shale gas drilling will go to residents of New

Brunswick. Reports from Pennsylvania indicate that 70% of gas rig jobs in the Marcellus Shale are going to people from out of state who are often non-permanent workers, sending their earnings to their families to spend in their home states.

Shale gas drilling supporters assume that property values will increase. In fact they may decrease. Rental rates will probably increase due to the influx of transient workers, hotel occupancy rates may increase, and some parts of Pennsylvania have experienced this in the Marcellus play. The value of large tracts of land may increase if they are desirable for gas leases. However, single-family homes and small lots may decline in value. There have been reports that banks are reluctant to give mortgages for properties with a gas lease or even for properties nearby leased land. It would be very difficult to find a buyer for a home if mortgages are unavailable or if the home's drinking water is contaminated. In Wise County, Texas, in the Barnett Shale region, it has been reported that real estate appraisers have discounted valuations by as much as 75% if a property has a gas well.

Supporters seem to ignore studies that have not been funded by industry. Independent and academic studies conclude that regions that have encouraged extractive industries do not experience long-term economic benefits. An academic study published in 2002 reviewed 301 quantitative analyses in order to determine the economic implications of mining for non-metropolitan regions. The author concluded that unemployment and poverty worsened in mining counties in non-metropolitan regions. It found that the highest levels of long-term poverty are in places where there was once a thriving extractive industry. ("Mining the Data: Analyzing the Economic Implications of Mining for Non-metropolitan Regions" Freudenburg, Sociological Inquiry, 2002)

Headwaters Economics, an independent, non-profit research group in Montana, has been studying the economic impact of gas drilling. In one analysis, Headwaters analyzed 23 counties in western states to compare the economic health of counties that focused on fossil fuel extraction as a strategy for economic development to neighboring counties that did not. It concluded that counties that were not focused on fossil fuel extraction experienced higher growth rates, more diverse economies, better-educated populations, a smaller gap between high and low income households, and more retirement and investment income. Julia Haggerty, policy analyst at Headwaters Economics, states "the majority of new jobs and businesses in gas-field services will leave when the buildup phase ends, and the bulk of profits will accrue to multinational corporations and their shareholders." ("How to Get Through the Gas Boom", Julia Haggerty, Philadelphia Inquirer, January 6, 2011.)

Experience shows that gas drilling creates a short economic boom followed by a long economic bust. An economic impact study funded jointly by the Park Foundation in New York and the Heinz Foundation in Pennsylvania is being conducted under the leadership of Cornell Professor Susan Christopherson. In her recent initial public briefing in Albany, Dr. Christopherson shared preliminary findings and stated that at least 50% of total gas in a shale well is produced the first year, production beyond five years is uncertain, and that long-term economic development from shale gas is uncertain.

What happens after a few years of gas production? Will all the gas and the gas money be gone? Will our land, water and air be left polluted? Will the population be ill?

These questions must be answered fairly and thoroughly prior to taking any risks with drinking water, public health and the economy.

Jannette M. Barth, Ph.D., president of J.M. Barth & Associates, Inc., an economic research and consulting firm, has worked in the fields of economic analysis and econometric modeling and forecasting for over 35 years. She received her B.A. from Johns Hopkins University and her M.A. and Ph.D. from the University of Maryland. Several of her former positions include Chief Economist, New York Metropolitan Transportation Authority and Consultant and Account Manager, Chase Econometrics/Interactive Data Corporation.

Dr. Barth's areas of concentration in graduate school and beyond have been econometrics, public finance and industrial organization. Dr. Barth has evaluated economic decisions using various techniques including econometric modeling, input-output analysis and cost-benefit analysis. She has applied these techniques in various industries and has experience in both the development and evaluation of a wide variety of economic models and analyses.

Dr. Barth has taught economics at both the graduate and undergraduate levels.

In recent years, Dr. Barth has been able to combine two of her greatest interests, economics and fine art, by becoming a consultant to attorneys and appraisers in art valuation and serving as an expert witness.

A supporter of sustainable economic development, Dr. Barth volunteers much of her time applying her knowledge and experience to environmental and economic development issues.

As a landowner in Delaware County, New York, in the Marcellus Shale region, Dr. Barth became interested in the economic and environmental impacts of gas drilling using hydraulic fracturing techniques. After reviewing the existing studies of economic impacts of gas drilling in New York, including the treatment in the draft Supplemental Generic Environmental Impact Statement produced by the Department of Environmental Conservation, Dr. Barth authored a summary report, "Unanswered Questions About the Economic Impact of Gas Drilling in the Marcellus Shale: Don't Jump to Conclusions". Her work in this area is entirely self-funded.