Hydraulic Fracturing Issues and Research Needs for the Water Community

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advancing the science of water
About the Foundation

• **Drinking Water Research Program**
  – Centralized coordinated research program
  – Compliments local, regional, and legislative efforts through credible science
  – ~ 1000 Subscribers underwrite research (~900 water utilities)
  – > $500 million dollars worth of research

• **Collaboration**
  – Utility Community plans research
  – Project Advisory Committees & Foundation
  – ~ 1000 Volunteers provide input to projects and programs

• **Knowledge Base**
  – Reports & Projects (~900 published, ~300 ongoing)
The Promise of Natural Gas

— Positive Regional Economic Impacts
— Energy Independence
— Billions in taxable revenues
— Hundreds of thousands of jobs
— Less carbon-intensive energy source
Awww….that is nice…..
But WAIT - that can't be good....

Drillers Face Methane Concern

Contamination of Water Supply Near Gas-Drilling Operations Prompts Industry Focus on Design of Wells

By Susan Tracy

GRANVILLE SUMMIT, Pa.—Sherry Vargason has cooked with water from a five-gallon jug for the past year. It's inconvenient, but preferable to using tap water containing enough methane gas that she can light a match and see an orange flame flare out of the faucet.

Many water supplies in northern Pennsylvania have long contained detectable levels of methane, because of poorly constructed water wells and the unusual geologic features here. But the contamination in Ms. Vargason's existing well is among the first cases that state regulators have attributed to natural-gas drilling, prompting a normally competitive group of drilling companies to work together to fix the problem.

Cases like Ms. Vargason's are gaining more attention amid a boom in U.S. natural gas production. But methane-leakage problems in water wells are distinct from problems that some environmentalists attribute to hydraulic fracturing or fracking, a drilling technique that involves injecting

Sherry Vargason ignites methane at the kitchen sink in her Granville Summit, Pa., home, where natural-gas drilling was linked to well contamination.
So many ways to look at it…

Source: Energy Tomorrow
Energy Development
Well Density in Representative Counties of Major Shale Gas Plays (2001-2009)

- **Barnett** (Newark East formation)
- **Fayetteville** (Cleburne, Conway, Faulkner, Van Buren, White counties)
- **Haynesville** (Bossier, Caddo, DeSoto, Red River counties)
- **Marcellus** (Bradford, Lycoming, Susquehanna, Tioga counties)

![Well completions/1,000 sq mi graph]

Well completions data for the years 1993-2009, with data for 2009 (partial) also shown.
Areas of Concern

• Water quantity impacts

• Use of chemicals and associated contamination risks

• Industrial activity in source water locations

• Generation of large volumes of industrial wastewater
Water and Chemical Usage

- Highly water intensive (2-9 million gallons per well)
  - US EPA - 35,000 wells would consume the water needed by 5 million people
  - Approx 1% to 2% of total fracture fluid volume are chemicals

http://www.toxiclitigationblog.com/tags/fracking/
Surface Activities

http://www.hydraulicfracturing.com/Process/Pages/information.aspx
Subsurface Activities

- Activities include: drilling, casing, fracturing, completion, maintenance, rehabilitation, etc.

- Risk of subsurface migration of contaminants from unexpected subsurface conditions or operator error

- Specific to local geology and individual operators
Wastewater Disposal

- Wastewater produced varies per well, ~30-90% of injected fluids

- 1.3 BG produced in last 3 years in PA
  - ~500,000 gallons produced per well
  - ~1.2 mgd of drilling wastewater

- Water quality concerns
  - TDS ~100,000 ppm
  - Radionuclides
  - Residual drilling chemicals
Regional Drilling Wastewater Disposal Capacity

- Underground injection is most typical in other regions, limited in NY and PA

- Current Capacities
  - Commercial injection wells
    - PA: ~0.03 mgd
    - NY: 0 mgd
  - Industrial treatment: ~0.57 mgd (PA, WV)
  - Municipal treatment capacity: unknown

- Future Capacity Needed
  - Estimated at 6 to 28 mgd
Needed Research

- Improved Methods for Predicting Chemical Characteristics of Flowback Water and Produced Water (Brine)

- Water Supply Monitoring Protocols/Methods and Best Management Practices

- Perception and Communication of Hydraulic Fracturing Risks

- Identifying the Subsurface Risks, Risk Mitigation Measures and Appropriate Areas of Concern for Utilities to consider from Natural Gas Production Activities
Improved Analytical Chemistry Methods

- Identify, adopt, adapt analytical methods for flowback water and produced water
  - High TDS (> 100,000 mg/L) interferes with traditional analytical techniques especially when target substances are dilute (e.g. EDCs)

- Characterize fate of chemicals during the fracturing process (dilution, degradation and degradation byproducts).

- Comparison of what is injected with what is brought back to the surface or what remains in the formation

Source: NYCDEP
Water Supply Monitoring and Emergency Response

- Water Supply Monitoring Protocols
  - Define appropriate screening parameters, location, and frequency for both surface water and ground water
  - Develop relative cost-value analysis of monitoring protocols
  - Evaluate the affects of hydrogeological variations and hydrologic variability (e.g., drought) on monitoring programs

- Existing emergency response programs may lack critical elements that are necessary for utilities to effectively respond to incidents unique to natural gas development and hydraulic fracturing.

Source: NYCDEP
Communications and Outreach between Utilities, Industry, and Public

- There is a need to understand and quantify perceptions of the risk associated with hydraulic fracturing and the factors that drive this perception for both the public and water utilities.

Source: Arlington Water
Subsurface Processes

• What factors contribute to movement of fluids away from the well bore and target formation?

• What mitigation measures are available in the event of contamination due to subsurface incidents?

• What is the potential for cumulative impacts to confining layers from intensive drilling and hydraulic fracturing?

• How should well casing integrity be evaluated during construction and over the life of the well?
Impacts to POTWs and Downstream Impacts to Water Utilities

• Impacts to POTWs accepting fracturing wastewater
  – Concentration of toxics in biosolids (radium, heavy metals, etc.)
  – Disruption of biological processes from salts, metals, biocides, etc.

• Downstream impacts to water utilities
  – Many constituents pass through POTWs; treatment by dilution only (TDS, hydrocarbons, radionuclides)
  – Increased disinfection byproduct forming material (specifically bromine)
  – Unknown toxicity of many fracturing chemicals and their degradation byproducts
Other Recommended Research

• Duke University  
  (Jackson, R., Pearson, B., Osborn, S., Warner, N., Vengosh, A.)
  - Health effects of methane
  - National database of Methane, Ethane, and Propane concentrations and other chemical attributes in drinking water.
  - Mechanisms of methane contamination in drinking Water
  - Development of more extensive baseline data for drinking water wells and deep formation waters.
  - Disposal of waste water from hydraulic fracturing and shale gas extraction - fate of contaminates
Funding for Research

• Much of the funding for research is paid for by Oil and Gas Companies
• Concern that funding research could appear to indicate opposition to drilling.
• Politics - water agencies lack clout and money.
Federal R&D Budgets

Energy’s shrinking share of the research and development pie

Federal outlays for R&D by budget function (constant 2006 dollars, millions)\textsuperscript{22}

- National defense
- General science, space, and technology
- Health
- Energy

- Source - Big Oil Goes to College; Center for American Progress
Examples of Research

- **Potential Impacts of Hydraulic Fracturing on Drinking Water Resources**
  USEPA
- **An Integrated Framework for Treatment and Management of Produced Water**
  - Research Partnership to Secure Energy for America
- **Multiple DOE Studies**
  - Focused on wastewater management and treatment.
- **Energy Institute - University of Texas at Austin**
  - Separating Fact from Fiction in Shale Gas Development (complete)
  - Evaluation of groundwater contamination claims in the N. Texas Barnett Shale and assessment of fresh groundwater used in shale gas development (Under Development).
  - Assessment of hydrological connectivity between water in the units above and below shale units being fractured (Under Development).
  - Public perception of hydraulic fracturing (complete)
Lets just talk about it...
TRUST ME, I'M A SCIENTIST
Resources

- STRONGER (strongerinc.org)
- U.S. EPA Hydraulic Fracturing Research Study
- Research Partnership to Secure Energy for America An Integrated Framework for Treatment and Management of Produced Water
- U.S. DOE Sustainable Management of Flowback Water during Hydraulic Fracturing of Marcellus Shale for Natural Gas Production
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