GWRC Meeting

Water Utility Research Needs Related to Hydraulic Fracturing

Paris, France

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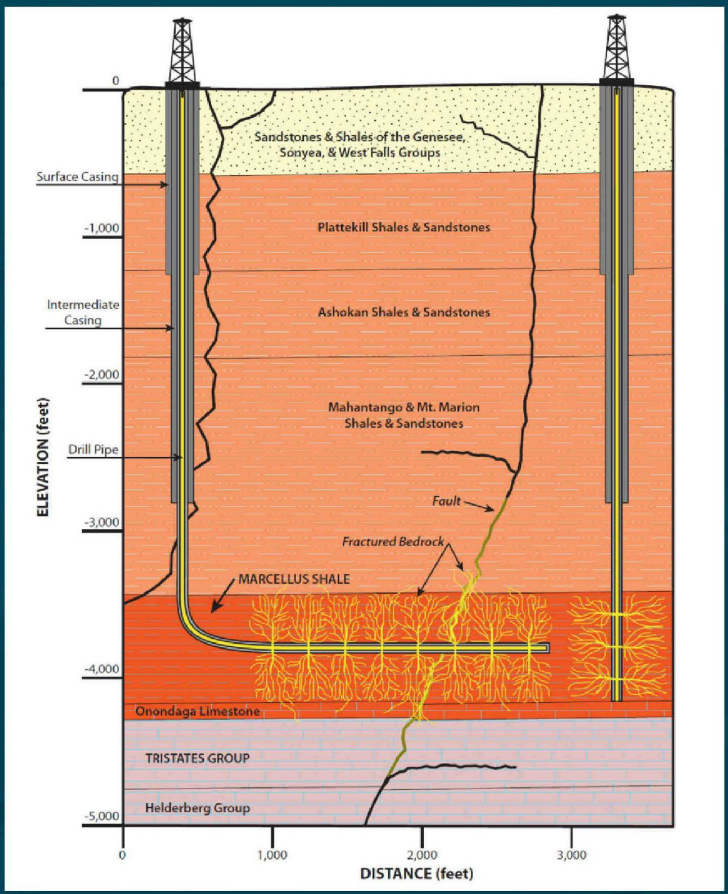
Hydraulic Fracturing

- Hydraulic fracturing is the process of injecting water at high pressure into a gas-bearing formation to induce fractures, increasing permeability
- Horizontal wells are used to increase the area of the formation fractured
- Process requires a million or more gallons per fracture operation
- Hundreds of tons of chemicals are added to control fluid properties
- Numerous potential impacts to water utilities



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US/Canadian Resource Base

- US
  - 2,500 trillion cubic feet
  - 71 trillion cubic meters
- Canada
  - 500 trillion cubic feet
  - 14 trillion cubic meters
- More than 100-year supply

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U.S. Shale Gas Use

- 2000: 1 % of US supply
- 2011: 20% of US supply
- 2030: 50% of US supply

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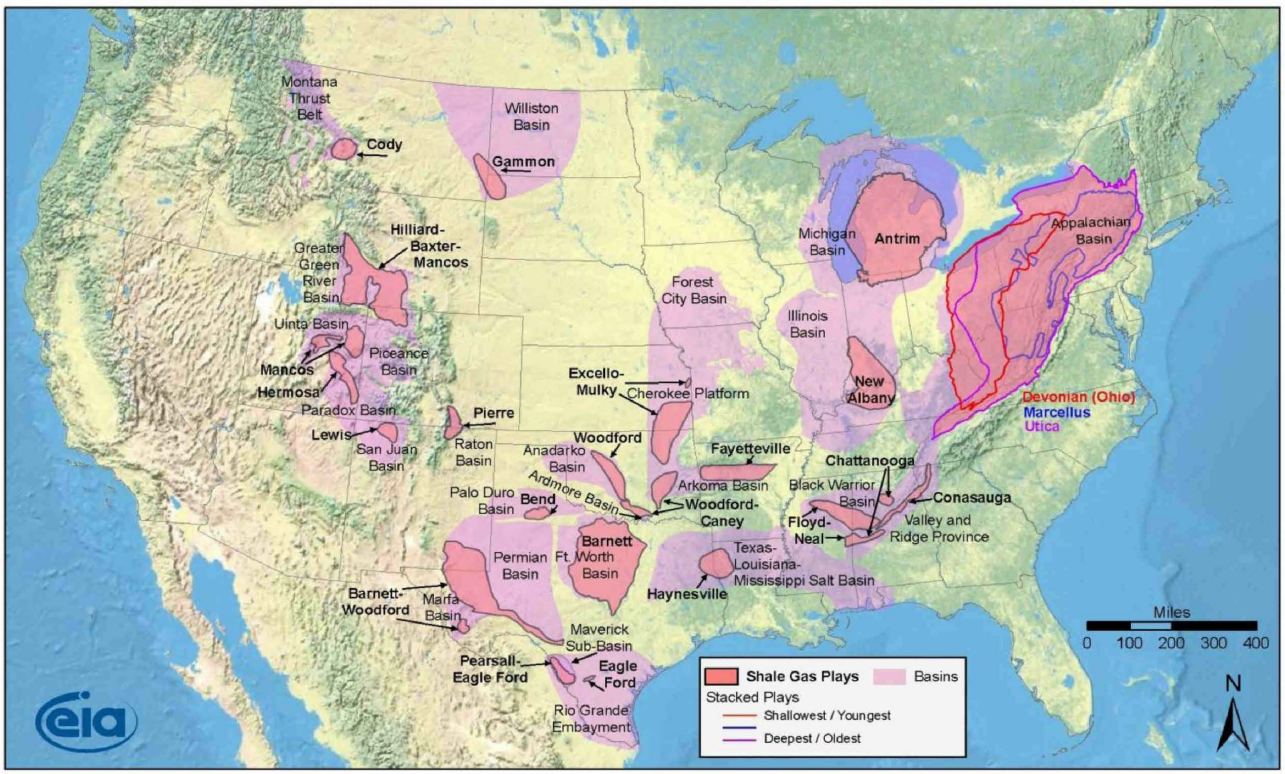
U.S. Hydrofracturing Locations



Source: Energy Information Administration based on data from various published studies
Updated: May 28, 2009

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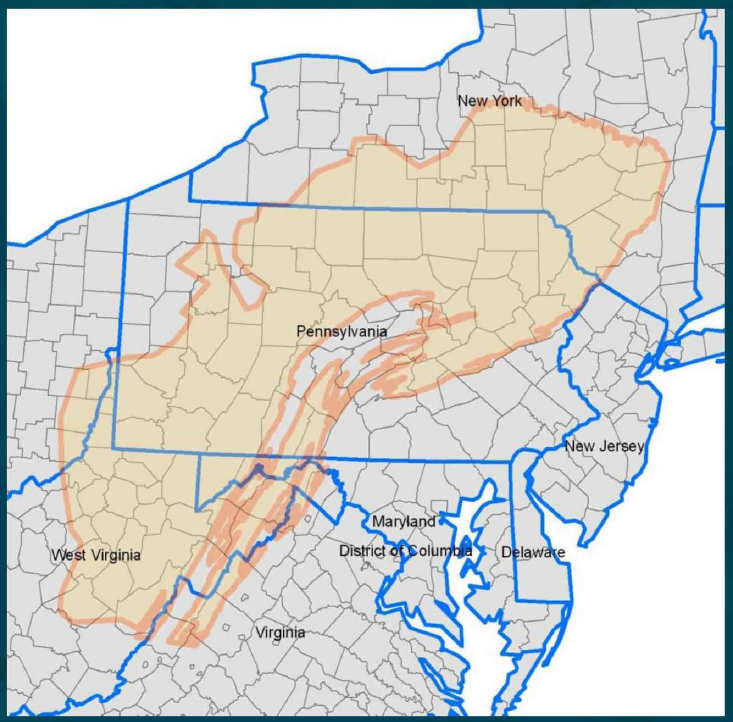
Natural Gas and the Marcellus Shale

- The Marcellus Shale is approx 95,000 sq mi (246,000 sq km); underlies parts of six states
- Potentially more than 500 trillion ft^3 (14 trillion m^3) of gas reserves
- Moratorium on high-volume hydraulic fracturing in NY and the Delaware River Basin as regulations are developed
- Drilling is active in PA, with 1,368 Marcellus wells drilled in 2010, compared with only 196 in 2008



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Water and Chemical Usage

- Two to nine MG (7,560 m^3 to 34,000 m^3) of stimulation water per well
- Hundreds of tons of chemicals per well
  - Approximately 1% to 2% of total fracture fluid volume are chemicals
  - Many chemicals exhibit acute and chronic toxicity
  - Limited understanding due to lack of disclosure

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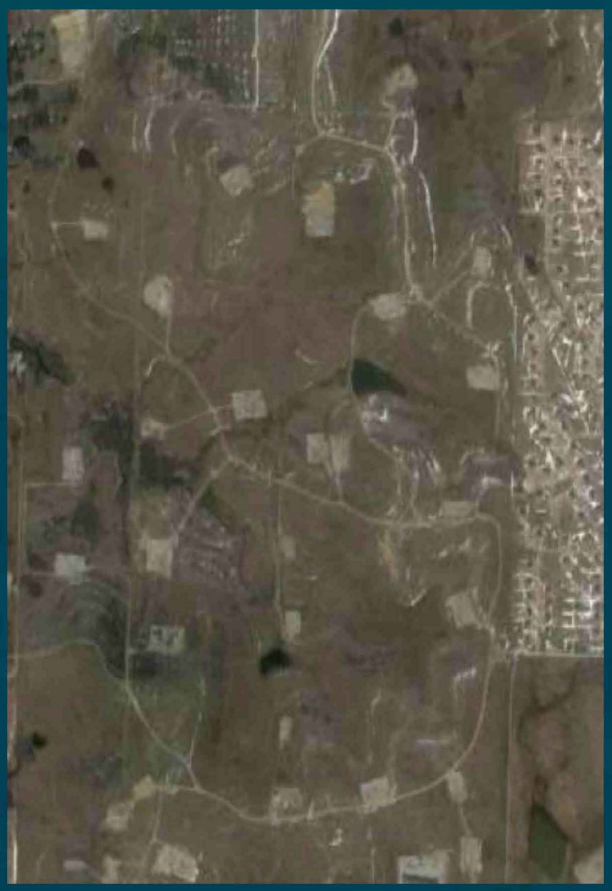
Surface Activities

- Activities: seismic testing, site access, drill pad construction, and truck traffic
- Typical concerns: land disturbance and erosion (hilly terrain and wetland crossings particularly vulnerable), accidents and spills, vibration impacts on structures, and shallow infrastructure
- Effectiveness of spill control measures a major concern



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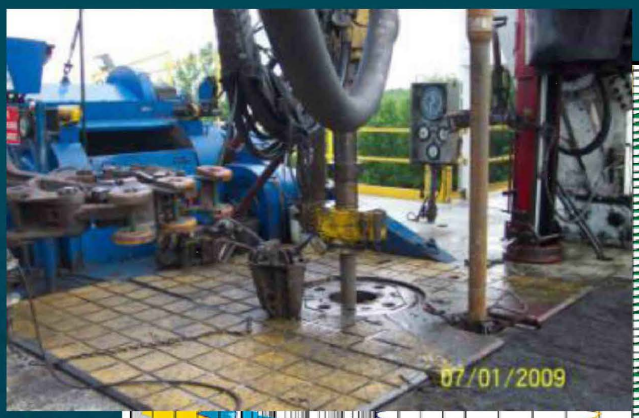
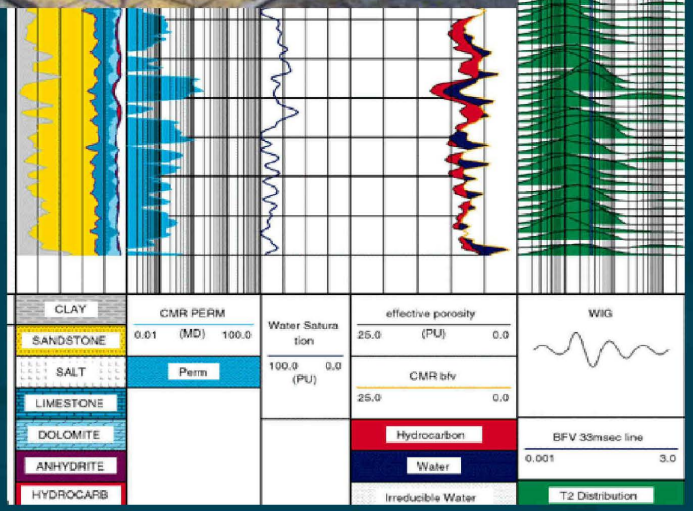
Subsurface Processes

- 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





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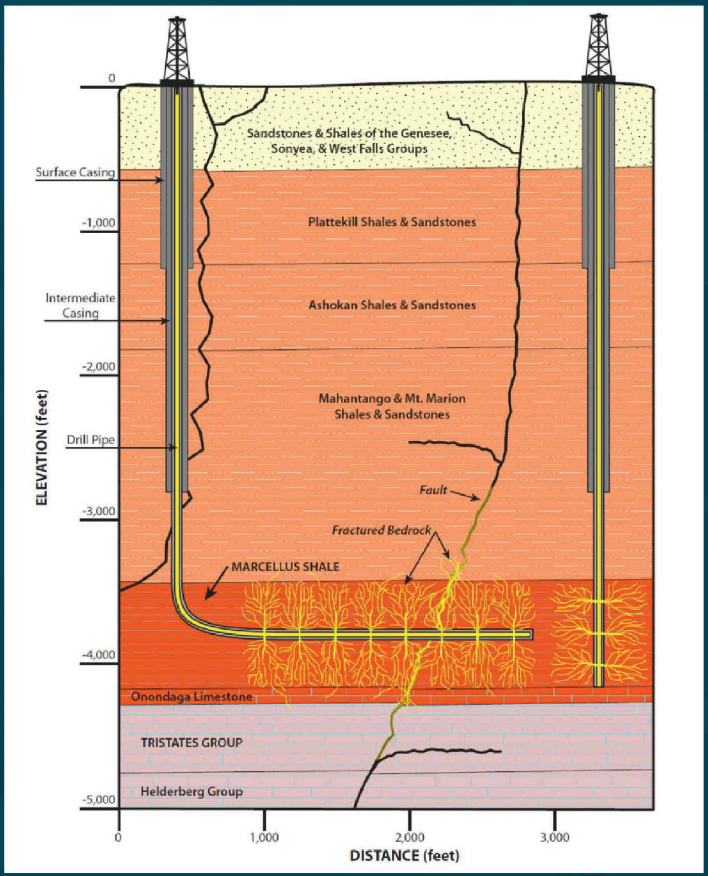
Subsurface Migration

- Very controversial
- Recorded incidents are due only to failures in the vertical casings
- Is there enough data to differentiate potential risks of subsurface migration from ***drilling*** vs. ***fracturing***?



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Subsurface Migration, cont'd

- Is subsurface migration possible? Yes
  - Punxautawney Hunting Club 36H - Clearfield County, PA
  - Schwartz 2-15B Well - Garfield County, CO
  - Multiple wells - Dimock, PA
- Are these incidents common? No
- Do we understand all the factors that increase risk of subsurface migration? Maybe
  - Human error and failure to take proper precautions or use proper equipment cited in most documented incidents

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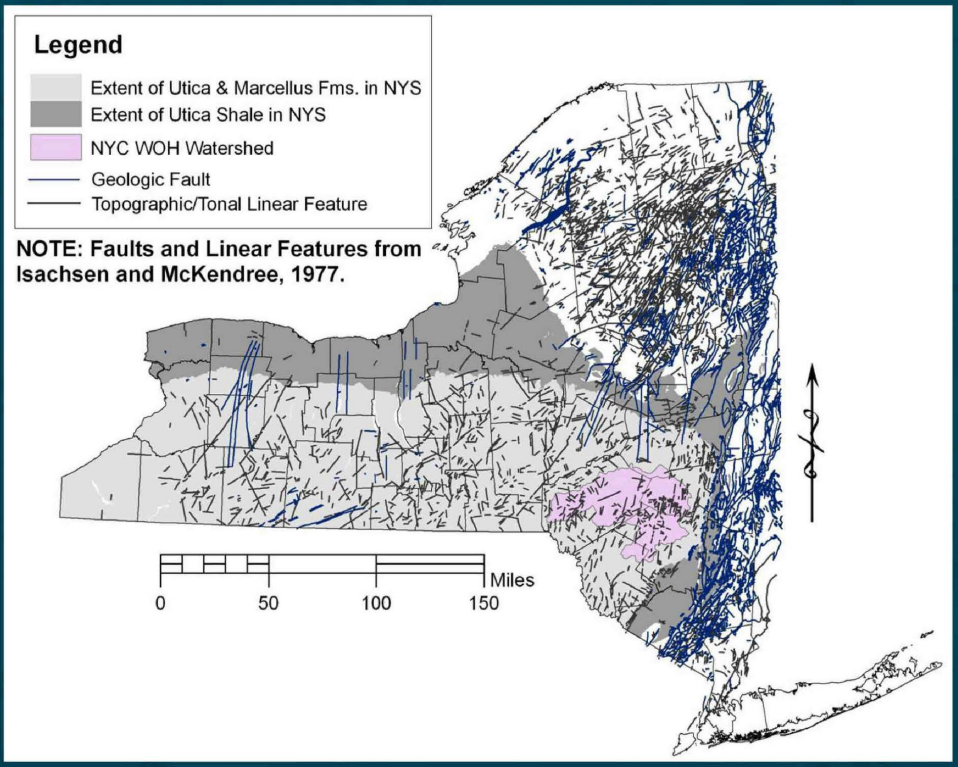
Geologic Features in NY That Could Affect Subsurface Migration

- Brittle structures (i.e., faults and fractures) are distributed throughout the state
  - Lateral lengths up to 7 miles (11 km)
  - Vertical depths up to 6,000 feet (1,800 m)
  - Many unmapped features may exist



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Wastewater Disposal

- Wastewater produced varies per well, ~30-90% of injected fluids
- 1.3 BG (4.9 million m^3) produced in last 3 years in PA
  - ~500,000 gallons (1,890 m^3) per well
  - ~1.2 mgd (4,500 m^3/d) of drilling wastewater
- Water quality concerns
  - TDS ~100,000 mg/L
  - Radionuclides
  - Residual drilling chemicals
  - Many others

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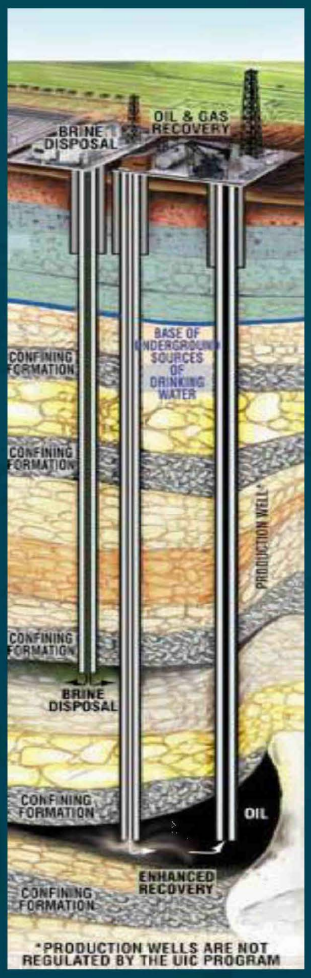
Regional Drilling Wastewater Disposal Capacity

- 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



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Risks to Utilities Are Uncertain

- Need to more concretely define the risks to drinking water utilities from natural gas drilling that uses hydraulic fracturing
- How do HF risks compare to other risks currently faced by utilities? How should utilities allocate resources?
- Summarize federal and state regulations for those states with unconventional natural gas resources
- Analyze how various regulations may affect risk for water utilities (comparison of spill/incident reports along with state regulations)

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Communications and Outreach Between Utilities, Industry, and Public

- Expanding natural gas development and increased water demands are increasing the overlap of water and energy resources
- 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
- Need to develop methods or guidance for improved communication between utilities, energy companies, and the public in order to limit conflict

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

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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.

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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?

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Impacts to POTWs and Downstream Impacts to Water Utilities

- Impacts to POTWs accepting fracking 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

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Summary

- "Fracking" has been practiced for years –

  "With over 20,000 shale wells drilled over the last 10 years, the environmental record of shale-gas development is a good one. Nevertheless, one must recognize the damage that can be caused by just one poor operator". *MIT Energy Institute*

- Produced water must be treated
- Casing integrity must be maintained
- Subsurface migration
- Development will continue: too much money is at stake.

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