

Shale Revolution Creates Challenge & Opportunity for Water

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An industry observer's view on Shale Gas and Water issues

- Shale extraction methods and controversies
- Current political outlook
- Scope of the resource, intensity of water usage
- Opportunities for Water enterprise

Frac: *noun*. A fracture in a rock formation.

Fracing: *verb*. Industry term for hydraulic fracturing. To pump sand, frac fluid, and water into shale at high pressure.

“Fracking”: Popularized spelling, as seen in media reporting

Horizontal Drilling + Hydraulic Fracturing = Shale Boom

- Shale: long known to hold huge natural gas resource
- Not economically viable until technological advancement
- Application of horizontal drilling and hydraulic fracturing
Pioneered by Mitchell Energy (now Devon), 1990-2004
- Shale boom begins in Barnett Shale, Ft. Worth TX, circa 2005
- Industry appeal: no dry holes with uniformly distributed resource base
- Investor appeal: predictability of return on capital
- Pretty soon... Wall Street was speaking 'shale' and doing 'shale math'
- Industry move away from conventional to shale was pronounced

Horizontal Drilling & Hydraulic Fracturing, Illustrated

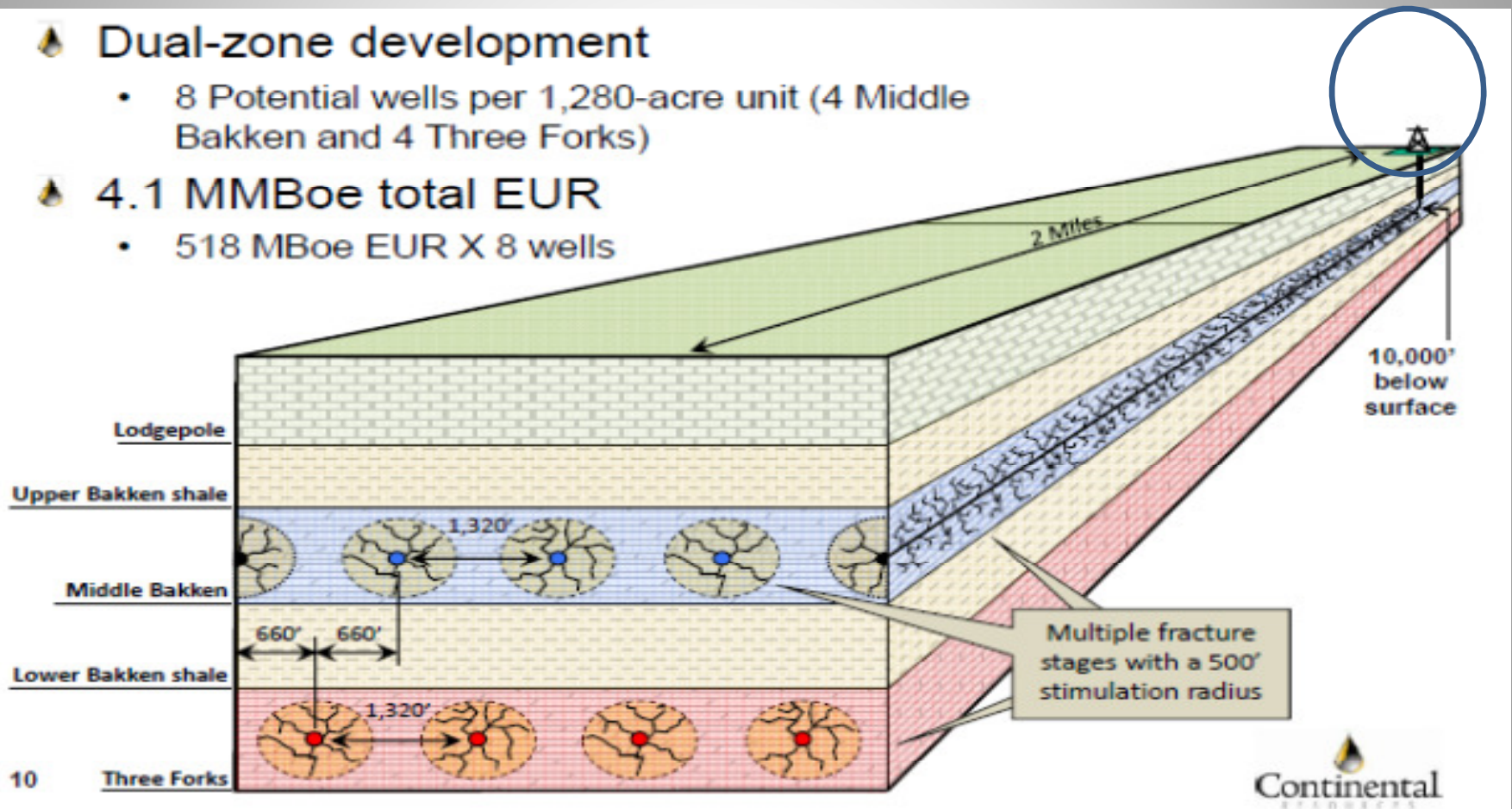
- Drilling for natural gas OR crude oil
- Wells vertically drilled to formations 6,000 -10,000 ft below surface (almost 2 miles), and then horizontally for up to 10,000 ft
- Several fracture stages, or “fracs”, along the horizontal leg
- Fractures extend for 500 to 700 ft in diameter

🔥 Dual-zone development

- 8 Potential wells per 1,280-acre unit (4 Middle Bakken and 4 Three Forks)

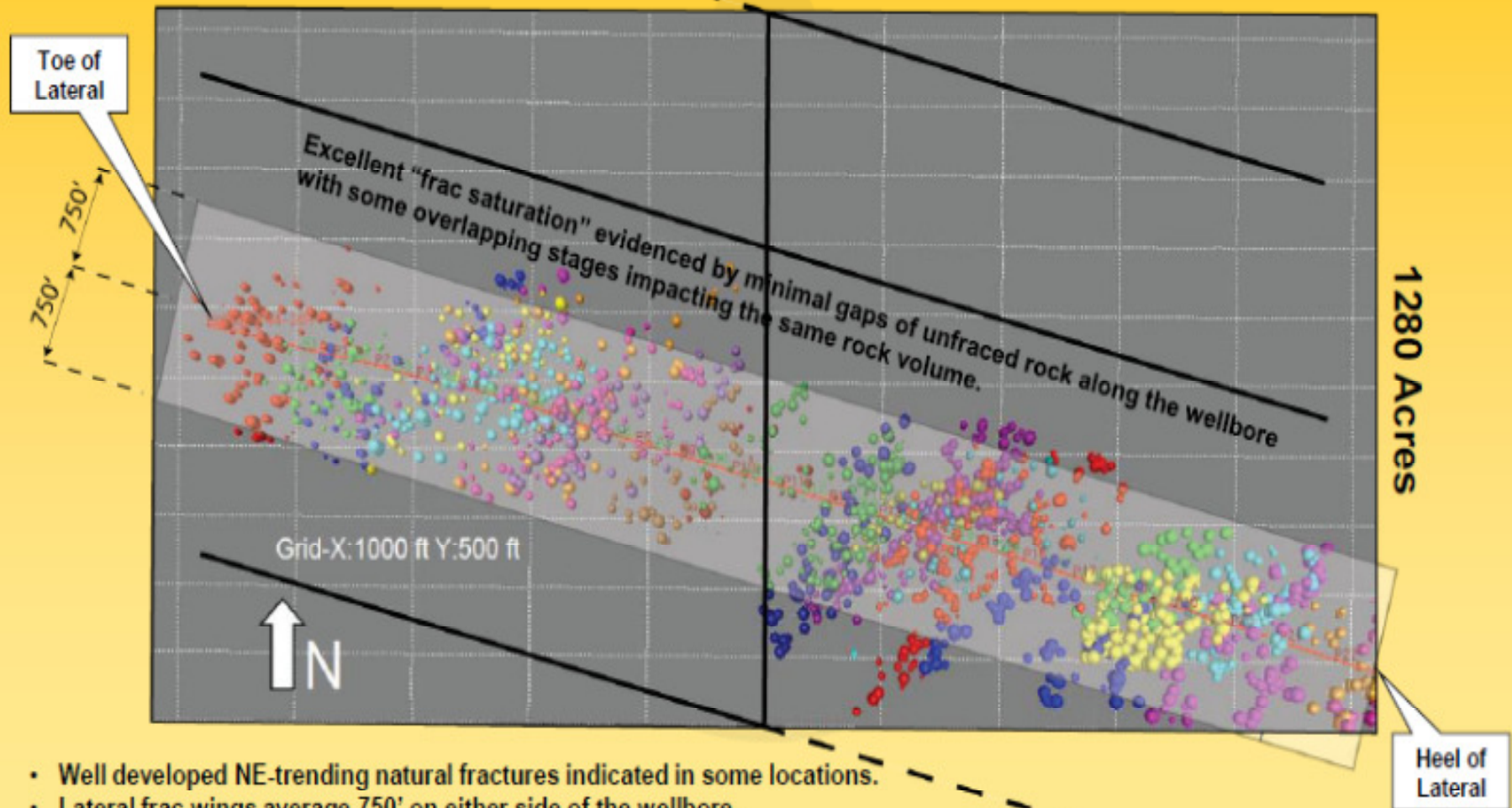
🔥 4.1 MMBoe total EUR

- 518 MBoe EUR X 8 wells



Fracs measured by Micro-seismic

Micro Seismic recorded during fracture stimulation of the Holmberg 44-24H
24-Stage Frac / IP: 2,558 BOE/D on April 13, 2010



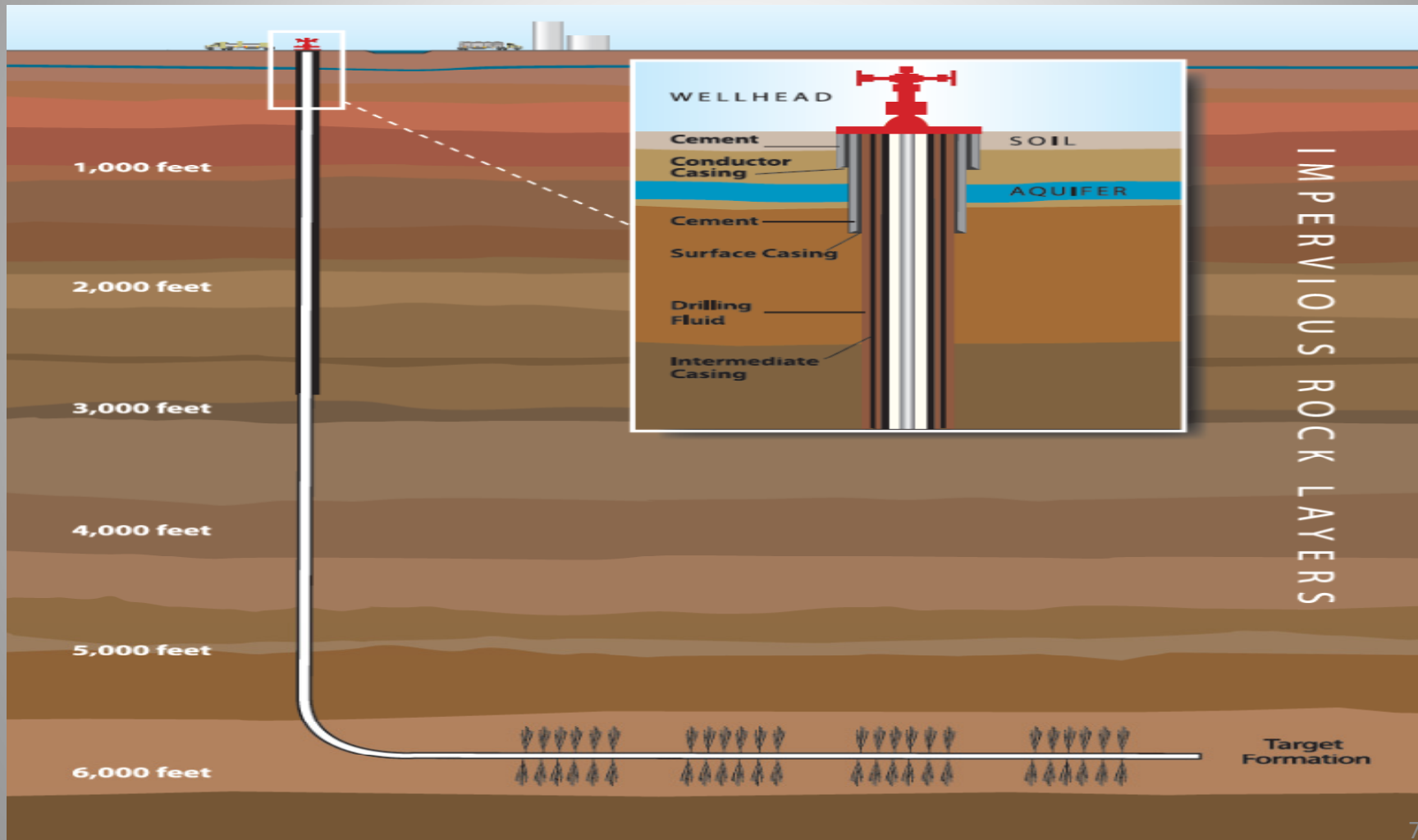
- Well developed NE-trending natural fractures indicated in some locations.
- Lateral frac wings average 750' on either side of the wellbore.
- This is consistent with our other fracs and planned spacing pattern for full field development.

Controversy: Do Fracs Cause Water Pollution?

Conventional Wisdom: "Fracking" causes water pollution

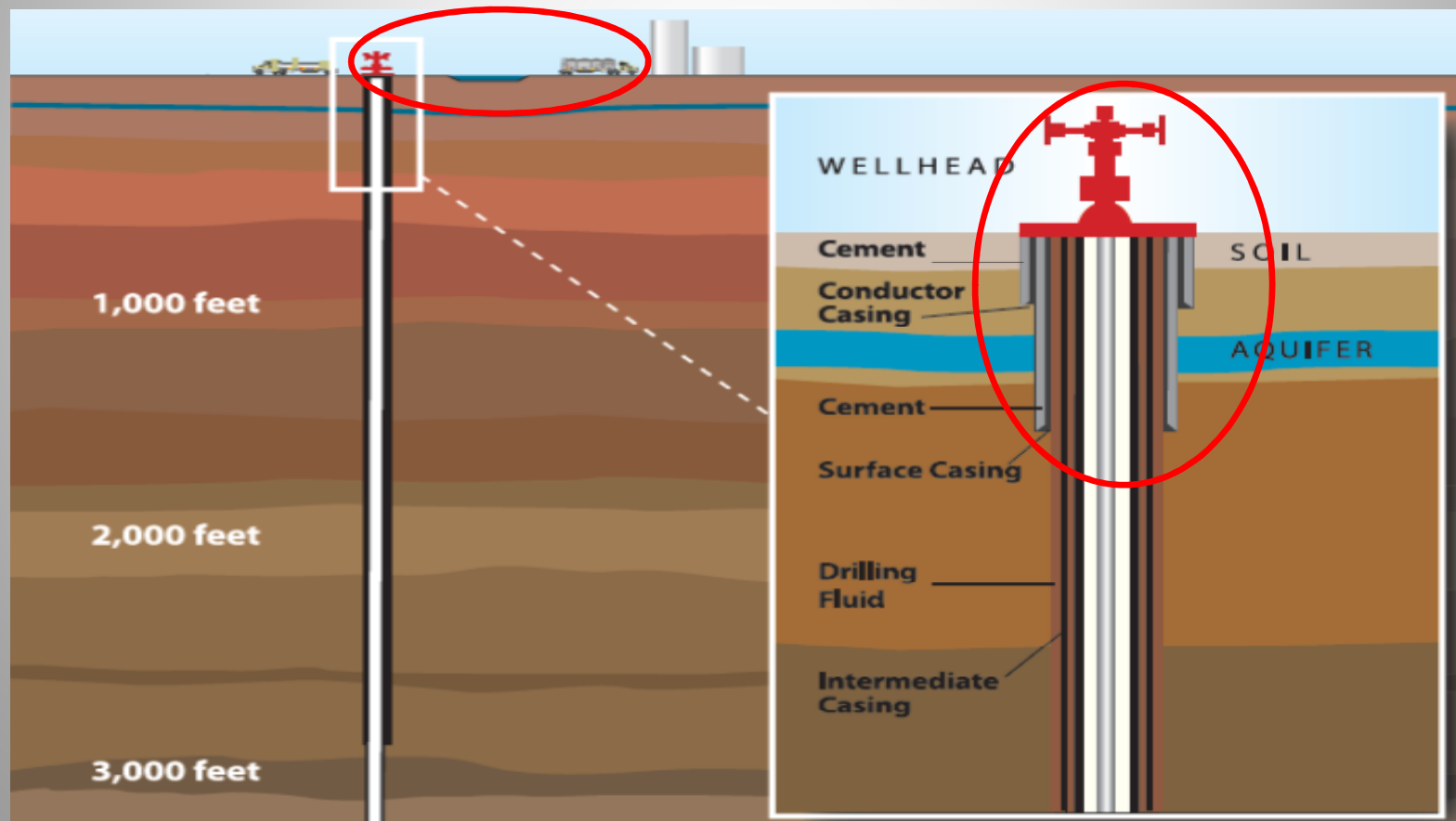
Observer's View: the frac itself is not to blame. Mitigating factors include:

- Distance from aquifer
- Low permeability of the surrounding rock



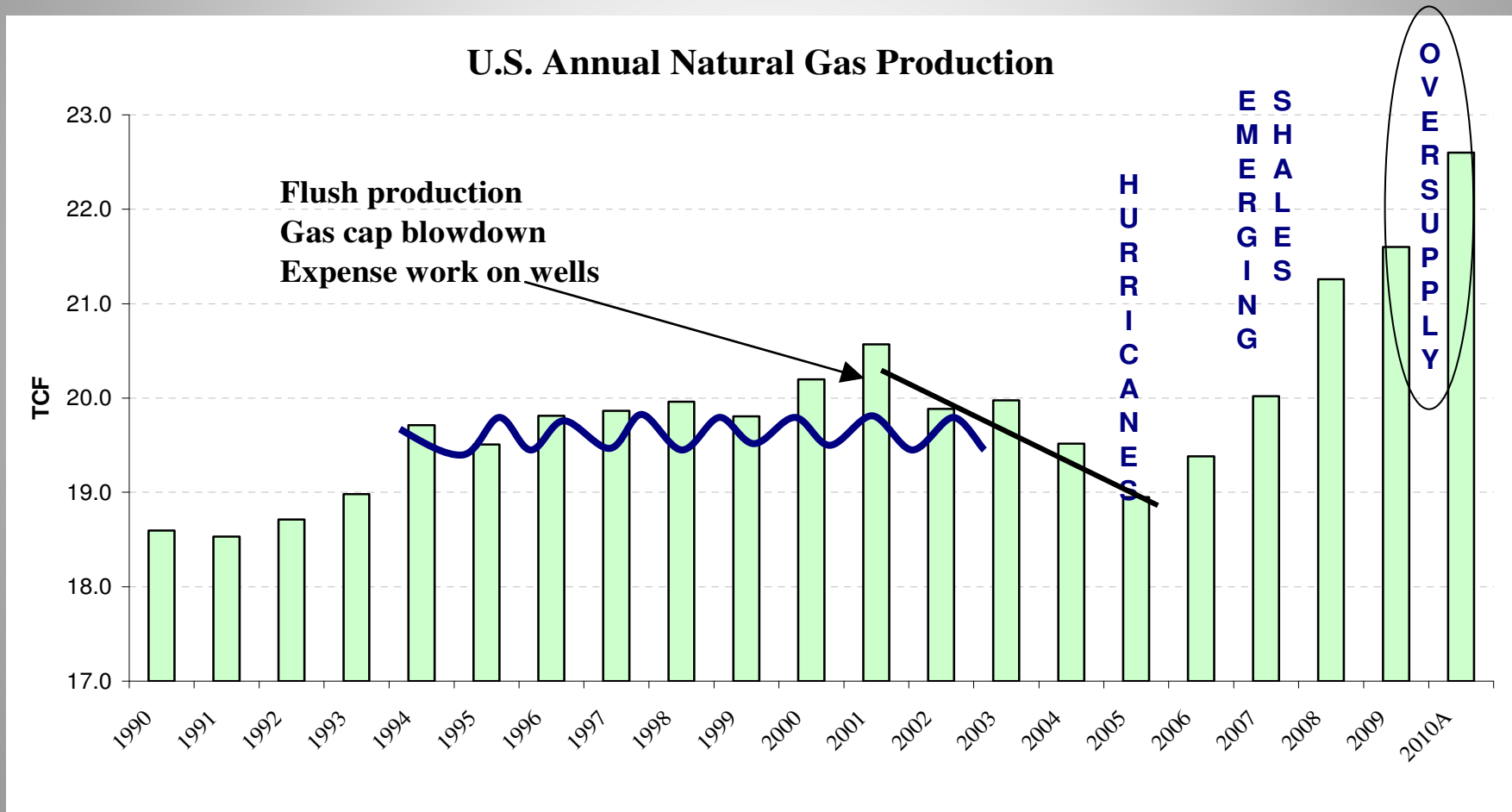
Most Likely Causes of Groundwater Contamination

- Sloppy surface practices (spilling frac fluid, wastewater, etc). Best practices not employed
- Frac fluid recipe can be toxic (benzene, etc), but mostly includes water and sand (95%), and surfactants (similar to shampoo)
- Poor or inadequate cement casing jobs to protect near-surface aquifer
- Inadequate wastewater treatment and disposal facilities. Volume and nature of contaminants overwhelm facilities meant to handle sewage.



Today's Realities

- Onshore conventional natural gas supplies are limited
- Natural gas resource of 2450 tcf supports 100 yrs of consumption at current rates
- Gas from shale (about 860 tcf) accounts for about 35 years of the total consumption



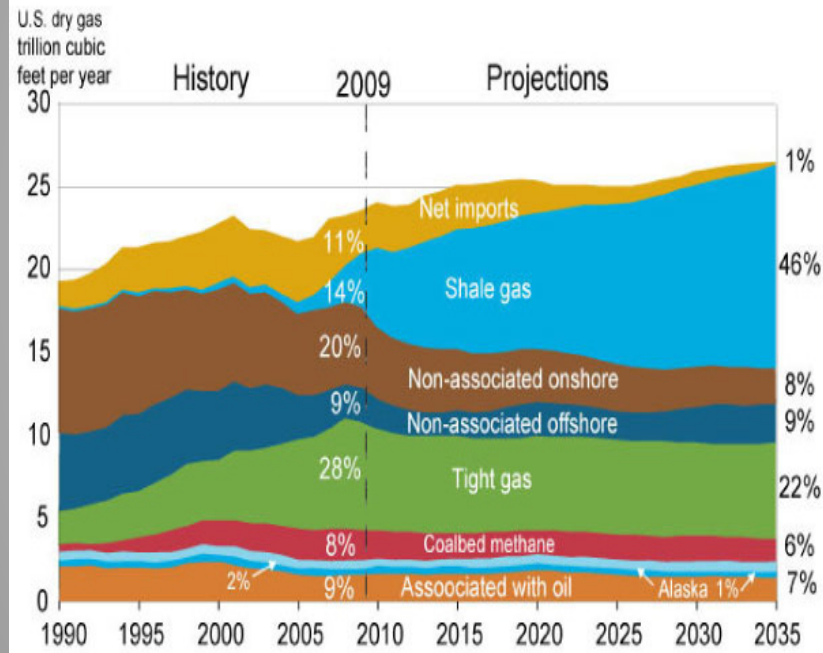
Source:

Susquehanna International Group

Tomorrow's Needs

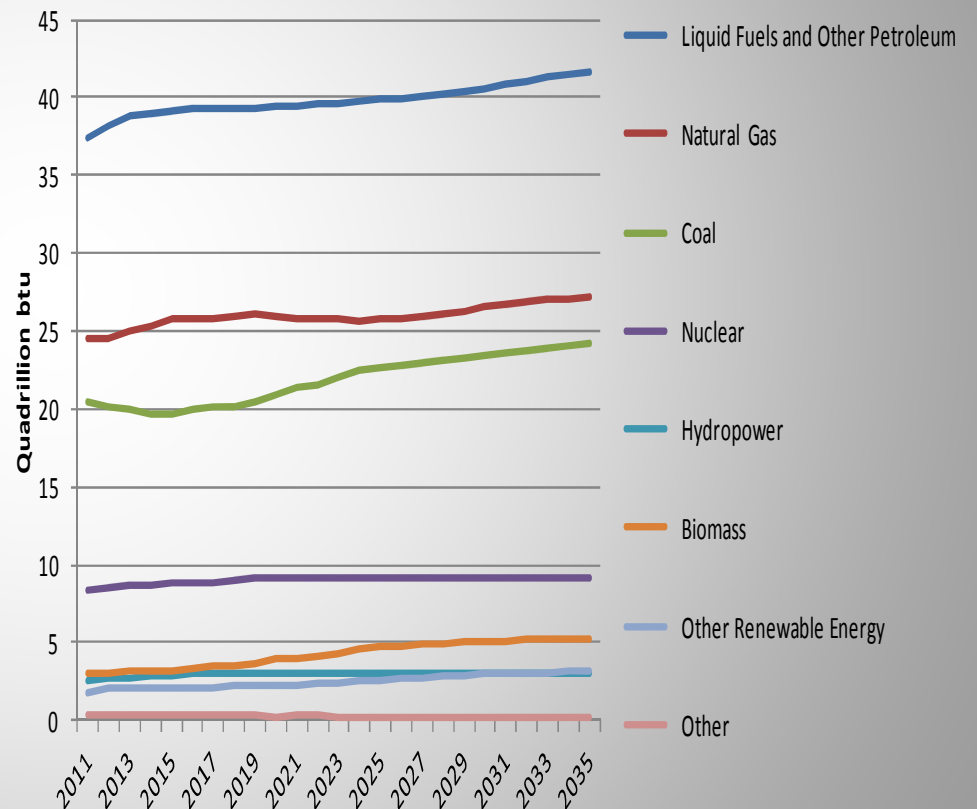
- Shale and tight gas comprise majority of future gas supply
- EIA forecasts show natural gas consumption continues to rise
- Could increase at expense of coal depending on coal legislation

U.S. Natural Gas Supply, 1990-2035



Source: EIA, Annual Energy Outlook 2011

Forecasted U.S. Energy Consumption



Political Reality

- Security of Supply, Domestic Job Creation, Trade Balance arguments are politically difficult to ignore
- Recent State of the Union: President Obama now a natural gas supporter. Nuclear, the darling of the 2009 State of the Union, goes quiet post-Fukushima
- US Oil production is up markedly (3.2% y-y). Horizontal drilling and “fracking” are the reason.



U.S. F-15s & F-16s over Kuwait, 1991. *Wikipedia*

Crude Oil Production 2010

Rank	Country	barrels/day
1	Russian Federation	10270
2	Saudi Arabia	10007
3	US	7513
4	Iran	4245
5	China	4071
6	Canada	3336
7	Mexico	2958
8	United Arab Emirates	2849
9	Kuwait	2508
10	Venezuela	2471

BP Statistical Review, 2011

The State of Regulatory Discourse on Fracs

Current frac regulations are a patchwork of State and Federal regulations, with several exemptions.

- EPA and states have power to regulate discharge water under the Clean Water Act, however
- Oil & Gas wastes are exempt from Federal Hazardous Waste Regulations, making the proof of a link between fracs and water pollution a critical component in the future ability to regulate
- Hydraulic fracturing fluids are currently exempt from Safe Drinking Water Act, but the move by States and Industry groups is towards disclosure

DOE

- DOE panel focuses on poor surface practices, water disposal
- Recommends manifest trucking system (like nuclear or other hazmat), and better cement jobs for well casing (increased oversight such as Gulf of Mexico post-BP Macondo)

EPA

- Potentially more punitive if direct links found to water pollution
- Again, likely focus on water treatment, frac fluids, cement casing
- Preliminary findings in 2012; Full study results in 2014



Most Likely Outcomes

In our view, end result will be:

Fracs continue, albeit with:

- Increased regulation and supervision of surface practices (manifest trucking for wastewater)
- Regulation of frac fluid content
- Strict regulations for, and monitoring of, well casing
- Tighter standards for wastewater treatment, both for municipalities that accept wastewater, and for private enterprise that treats & disposes

Resulting in:

- Added cost to industry (higher capex per well for casing, higher SG&A for increased oversight and monitoring)
- Frac fluid recipe changes, but industry adapts to new, more inert formulas

By the Numbers - Water Intensity of the Industry is Sizeable

- We estimate about 15,000 horizontal wells were drilled in 2011. Could be conservative.
- About 4.5 million gallons of water per frac job
- 67.5 billion gallons of water pumped into wells
- About 70% of which is recovered from the well and must be treated or disposed of
- Sizeable footprint of Oil & Gas industry for water usage



Susquehanna River, Bradford County, PA. *Wikipedia*

Continued Challenges and Opportunity for the Water Sector

Go Get It!

- Oil & Gas Industry historically struggles to implement Best Practices until it is forced by Regulators
- An industry waiting for solutions

Opportunity Set

- Wastewater treatment & reclamation
- Wastewater disposal
- Water quality monitoring
- Localized water supply to oil & gas industry for frac jobs
- Many others



Susquehanna River, Bradford County, PA. *Wikipedia*

Thank You!

Questions?

Gray Peckham has more than 10 years experience covering oil and gas and is equally comfortable providing insights on international and domestic energy issues. Peckham has covered domestic E&Ps extensively and visited foreign oil companies in Brazil, Austria and Hungary. He began his career at oil & gas research firm John S. Herold, where he spent approximately six years, eventually developing the firm's strategic/political risk and national oil company coverage. Peckham joined the sell side in 2006 as an equity analyst at a boutique firm, where he covered a number of small-cap domestic and international E&Ps. In 2008, he moved to CRT Capital to cover domestic E&Ps from both credit and equity perspectives. In 2010, Peckham joined Susquehanna Financial Group to cover E&P, and was responsible for primary coverage, focusing on valuation and strategy. In 2012, Peckham founded **Coastal Consulting Concepts**, providing strategic, financial, and policy advisement to the energy sector. Peckham holds a master's degree in history (U.S. foreign policy) from Yale University, a B.A. from Boston College and is an officer in the U.S. Navy Reserve (currently Individual Ready Reserve).

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