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Energy Water Usage Panel

Shale Play Hydraulic Fracturing: Emerging Water Resource Conflicts

Texas Water Law Institute
December 1, 2011
Austin, Texas

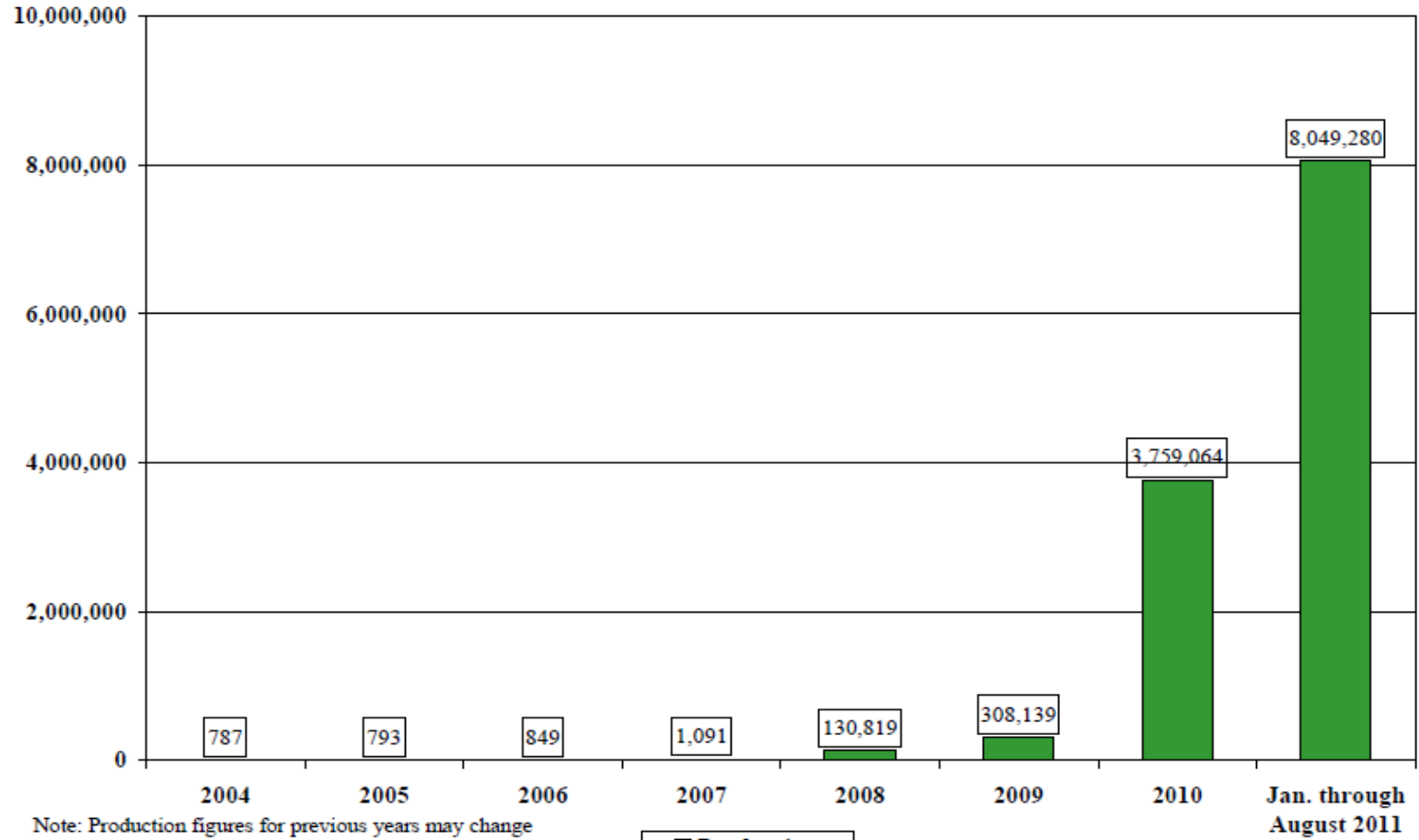


Key Statistics

- **RRC Well Data (2010)**
 - 15,466 New Drilling Permits Issued
 - **85%** were Frac'd (RRC Est.)

- **USGS Recoverable US Reserves (March 2011)**
 - Conventional Gas **357 TCF**
 - Unconventional Gas **400 TCF**

Texas Eagle Ford Shale Oil Production 2004 through August 2011



Patchwork of Laws and Regulations

Air Emissions
EPA Proposed
New Source
Performance
Standards

**EPA Hydraulic
Fracturing Study**

**RRC Proposed
Frac Fluid
Disclosure
Rule**

Wastewater Disposal

- NPDES Permit (EPA)
- Land Application (RRC)
- Injection Well (RRC)
- MOA with TCEQ

Underground Injection

- Safe Drinking Water Act
- Underground Injection Control (UIC)

Water Supply

- Ch 210 Re-use
- TWC § 36.117 (GW permit ex)
- TWC § 11.121 (mining use)

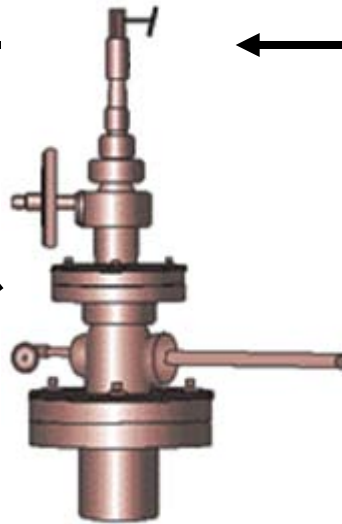
Common Law

- Subsurface Trespass
- Pollution
- Nuisance

Storm water Run-Off
NPDES Permit (EPA)

Railroad Commission

- Well spacing
- Drilling/casing
- Operation
- MOU with TCEQ

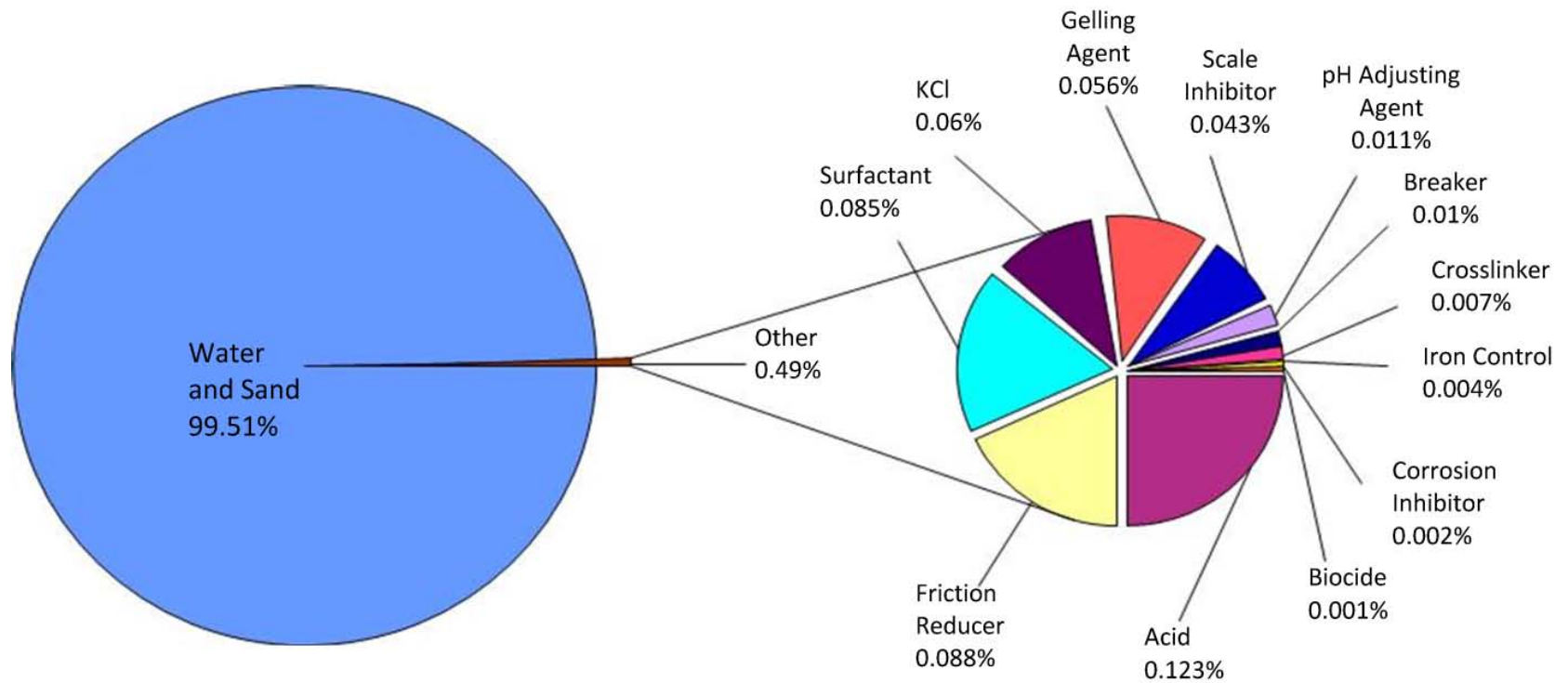


Hydraulic Fracturing Basics

- Patented in 1948; “shooting” wells dates back to 1860s.
- Method: Pump fluids at high pressure into producing formations to create fissures to allow more natural gas to escape.
- Principally takes place in horizontal wells, which may extend horizontally for thousands of feet at depth.
- Fracturing fluids are typically composed of:
 - 90% water
 - 9.5% sand
 - 0.5% other chemicals

Source: Freeing Up Energy, Hydraulic Fracturing: Unlocking America's Natural Gas Resources, API, July 19, 2010. (API, Freeing Up Energy).

Volumetric Composition of Frac Fluid



Fracing Chemical Additives

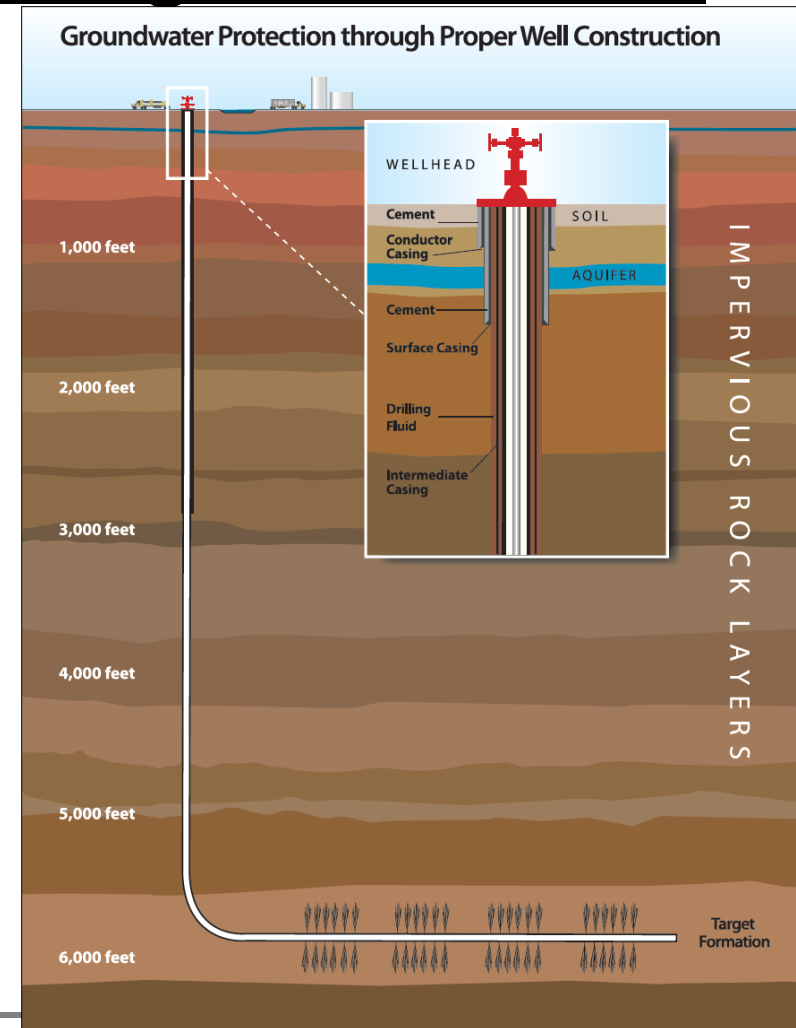
Additive Type	Main Compound(s)	Purpose	Common Use of Main Compound
Acid, Diluted (15%)	Hydrochloric acid or muriatic acid	Help dissolve minerals and initiate cracks in the rock	Swimming pool chemical and cleaner
Biocide	Glutaraldehyde	Eliminates bacteria in the water that produce corrosive byproducts	Disinfectant; sterilize medical and dental equipment
Breaker	Ammonium persulfate	Allows a delayed break down of the gel polymer chains	Bleaching agent in detergent and hair cosmetics, manufacture of household plastics
Corrosion Inhibitor	N,n-dimethyl formamide	Prevents the corrosion of the pipe	Used in pharmaceuticals, acrylic fibers, plastics
Crosslinker	Borate salts	Maintains fluid viscosity as temperature increases	Laundry detergents, hand soaps, and cosmetics
Friction Reducer	Polyacrylamide; Mineral oil	Minimizes friction between the fluid and the pipe	Water treatment, soil condition; Make-up remover, laxatives, candy
Gel	Guar gum or hydroxyethyl cellulose	Thickens the water in order to suspend the sand	Cosmetics, toothpaste, sauces, baked goods, ice cream

Fracing Chemicals Additives

Additive Type	Main Compound(s)	Purpose	Common Use of Main Compound
Iron Control	Citric acid	Prevents precipitation of metal oxides	Food additive, flavoring in food and beverages; Lemon Juice ~7% Citric Acid
KCl	Potassium chloride	Creates a brine carrier fluid	Low sodium table salt substitute
Oxygen Scavenger	Ammonium bisulfite	Removes oxygen from the water to protect the pipe from corrosion	Cosmetics, food and beverage processing, water treatment
pH Adjusting Agent	Sodium or potassium carbonate	Maintains the effectiveness of other components, such as crosslinkers	Washing soda, detergents, soap, water softener, glass and ceramics
Proppant	Silica, quartz sand	Allows the fractures to remain open so the gas can escape	Drinking water filtration, play sand, concrete, brick mortar
Scale Inhibitor	Ethylene glycol	Prevents scale deposits in the pipe	Automotive antifreeze, household cleansers, and deicing agent
Surfactant	Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, and hair color

Examples of Vertical Separation Freshwater to Producing Formation

- Barnett
 - Freshwater Depth: 1,200
 - Formation Depth: 6,500-8,500 ft.
- Haynesville
 - Freshwater Depth: 400
 - Formation Depth: 10,500-13,500
- Marcellus (PA)
 - Freshwater Depth: 850
 - Formation Depth: 4,000-8,500



Reported Average Frac Water Use (gallons/well)

- Barnett 2,300,000
- Haynesville 2,700,000
- Marcellus (PA) 3,800,000
- Eagle Ford 6,000,000

Projected Fracing Water Use (Texas)

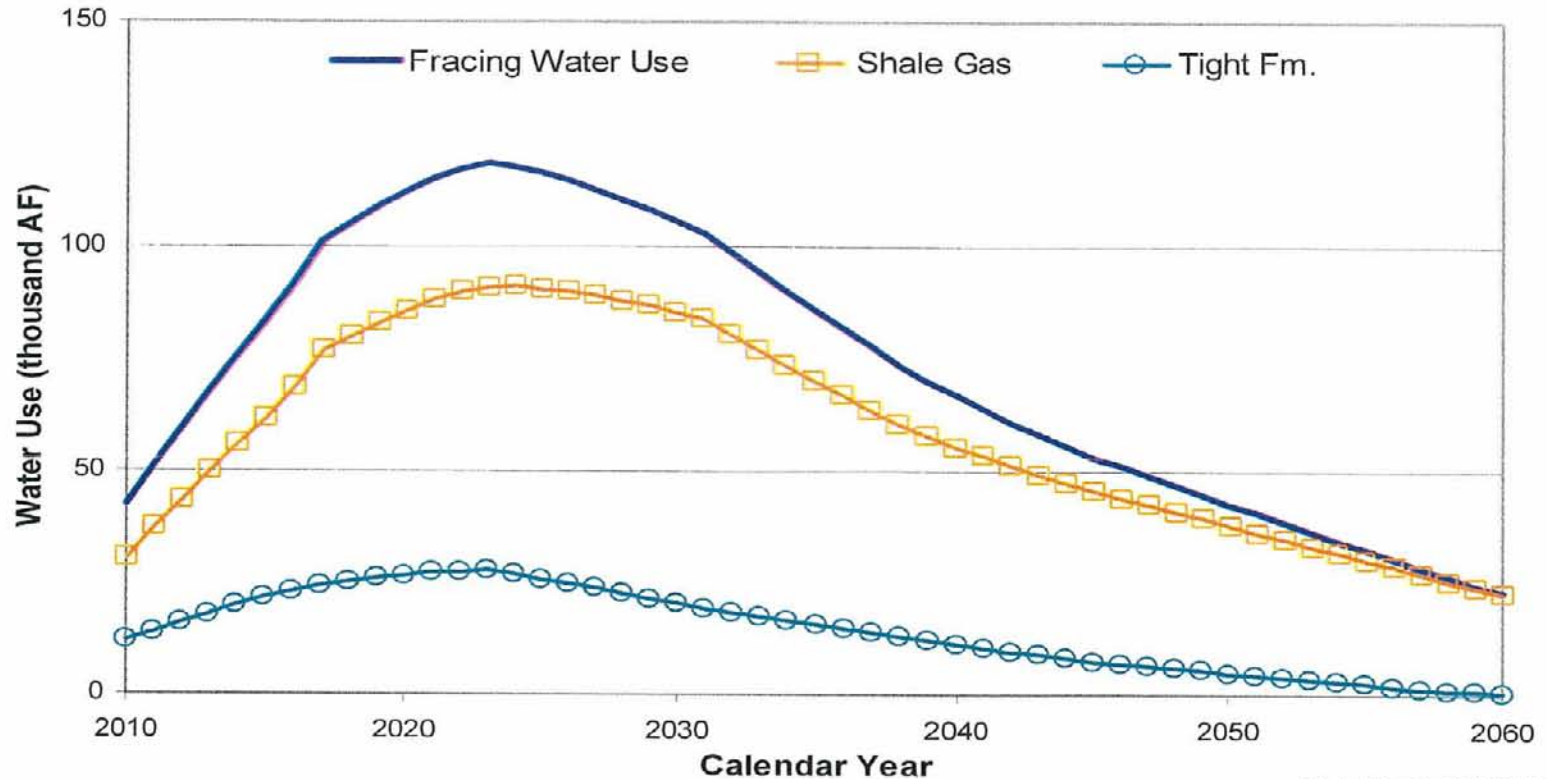


Figure 119. Projected state fracing water use

MiningWaterUse2010-2060_2.xls

Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources

United States Environmental Protection Agency
Office of Research and Development

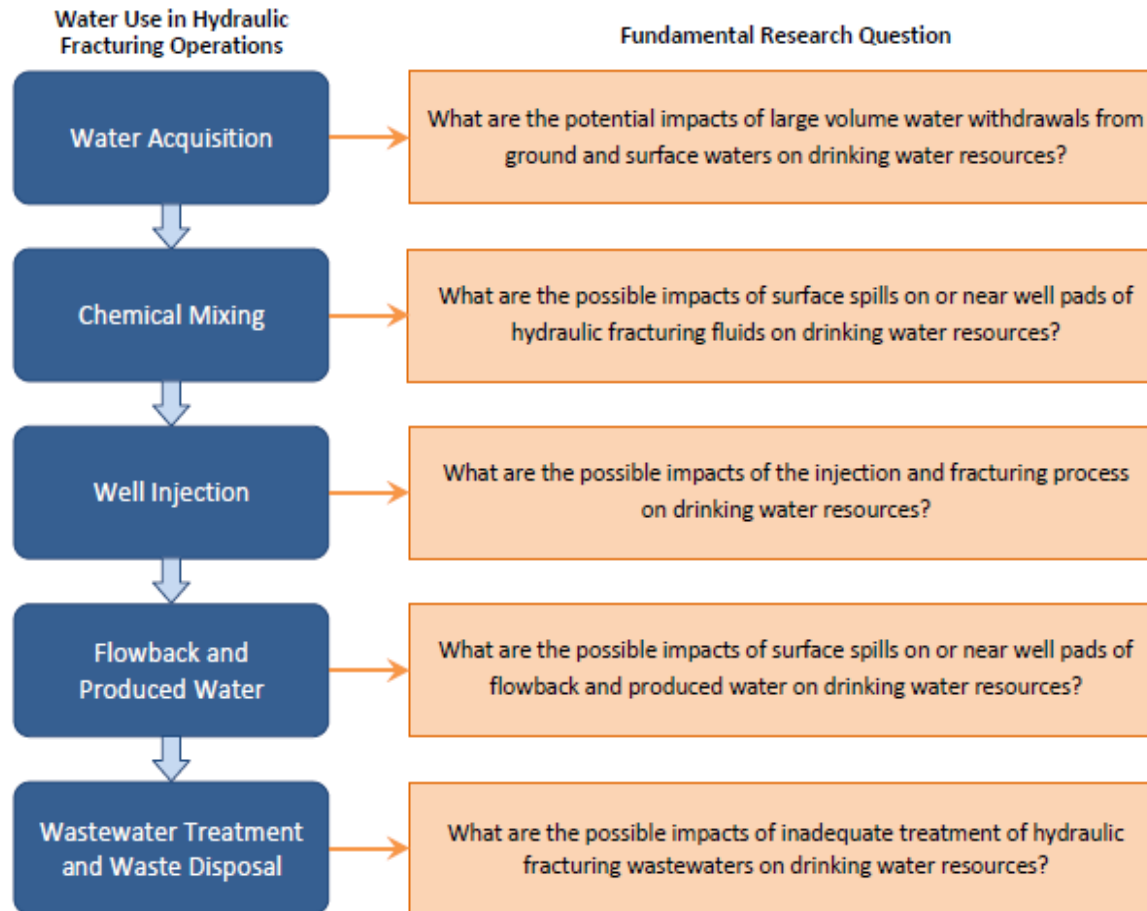


FIGURE 1. FUNDAMENTAL RESEARCH QUESTIONS POSED FOR EACH IDENTIFIED STAGE

EPA Hydraulic Fracturing Study Plan

- November 3, 2011: EPA Final Hydraulic Fracturing Study Plan
- Will examine “life cycle” of fracing, specific focus on potential impact to drinking water resources.
- Study will analyze and research questions involving:
 - Water Acquisition; Chemical Mixing; Well Injection; Flowback and Produced Water; and Wastewater Treatment and Waste Disposal.
- Study will include:
 - Five retrospective case study locations: Bakken Shale, ND; Marcellus Shale, PA (2 locations); Raton Basin, CO; and Barnett Shale, TX
 - Two prospective cases study locations: Marcellus Shale, PA; Haynesville Shale, LA.
- Initial results expected in 2012, with 2014 report.
- In 2004, EPA conducted study finding that hydraulic fracturing in coal-bed methane wells pose little to no threat to underground drinking water.

Federal SDWA Regulation

- Safe Drinking Water Act exempts fracking (except w/ diesel fuel) from regulation as “underground injection” by the Energy Policy Act of 2005. (42 U.S.C. 300h(d)(1)(B)(ii)).
 - Bills introduced in March 2011 to remove exemption and explicitly include fracking in SWDA (HR 1084, S 587).
 - Similar bills introduced in past (2009 – HR 2766).
- April 12, 2011: EPA Deputy Administrator Bob Perciasepe testified before Congress that using diesel in fracking requires an SDWA permit or is a violation.
- August 11, 2011: EPA sent letters to nine O&G companies requesting data on 350 wells that were frac’d, as part of its study of potential impacts on drinking water resources.
- October 20, 2011: EPA announces that in 2014 it will propose technology-based water pretreatment standards for water going from shale gas (frac) wells to publicly owned treatment plants.

Federal Air Regulation

- EPA proposed revised New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) for the oil and gas industry on August 23, 2011.
- The proposal broadens the list of operations subject to NSPS to include hydraulic fracturing of gas wells.
- The rule proposes new operational standards for completing frac gas wells, requiring the use of reduced emissions completions (RECs).
 - RECs use special equipment to separate gas and liquid hydrocarbons from the flowback that comes from the well and captures those gases before they may escape to the air.
 - If RECs cannot be used, EPA has proposed requiring pit flaring to control VOCs from fracing flowback.
- EPA estimates that the rule would reduce VOC emissions from fraced wells by 95 percent.
- Fracing is not subject to new NESHAP requirements, but numerous other parts of the oil and gas industry are affected by both the NSPS and NESHAP proposed revisions.

Other Federal Developments

- April 16, 2011:
 - Congressional report prepared by Waxman, Markey, and DeGette outlining chemicals used in fracking, including benzene, lead, and methanol.
 - Alleged use of 29 chemicals that are known or possible carcinogens.
- August 11, 2011:
 - Shale Gas Subcommittee of the Secretary of Energy Advisory Board releases 90-day report with preliminary recommendations for increasing fracking environmental safety while lauding importance of natural gas.
- October 31, 2011:
 - Interior Department announces it expects to issue new regulations for fracking on public lands in “a couple of months.”
- November 10, 2011:
 - Shale Gas Subcommittee releases second 90-day report on progress of implementing initial recommendations.

Sources: U.S. House Committee on Energy and Commerce, Chemical Used in Hydraulic Fracturing (April 2011) and Robert Howard, et al, Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations (2011).

Range Resources Case

EPA Emergency Order

- December 7, 2010: EPA issues emergency order under Section 1431 of SDWA alleging contamination of two domestic wells.
 - No notice, no opportunity for Range Resources to comment, and no presentation evidence.
 - Failing to comply with Emergency Order could lead to \$16,500 per violation per day penalty.
- Order requires Range Resources to:
 - Provide drinking water within 48 hours to affected residents;
 - Install explosivity meters within 48 hours; and
 - Identify gas flow, eliminate gas flow if possible, and remediate areas of aquifer that have been impacted.
- Alleges methane contamination, not fracking fluid specifically.
- Alleges that state and local authorities had not taken sufficient action to address endangerment.

Range Resources Litigation

- January 18, 2011: U.S. DOJ files complaint in Federal Court against Range Resources for not complying with EPA's emergency order.
- January 20, 2011: Range Appeals EPA order to 5th Cir.
- March 22, 2011: Following investigation, RRC Commissioners unanimously vote to clear Range Resources of EPA allegations. EPA did not testify at hearing.
- October 3, 2011: Oral argument held in Range's 5th Cir. Appeal.

Texas Regulation

- Railroad Commission of Texas (RRC) has primary oversight authority for O&G wells, not Texas Commission on Environmental Quality (TCEQ).
- May 2009 RRC Chairman letter: “not...a single documented contamination case associated with hydraulic fracturing.”
- No specific regulation of Frac methods, but generally covered by RRC oil and gas rules.
- Bills filed in 2011 to increase fracing regulation died. (Except HB 3328)

Existing RRC Regulations

- Groundwater protection regulations include:
 - Rule 5** - Permit required for drilling and deepening of wells (does not specifically cover fracing operations).
 - Rule 8** - Groundwater protection and regulates storage and disposal of oil and gas wastes.
 - Rule 9** - Disposal wells for oil and gas waste.
 - Rule 13** - Establishes casing, cementing, drilling, and completion of well requirements.
 - Rule 46** - Requires permit for fluid injection for enhanced oil recovery but does NOT regulate fracing.
- Rules are at 16 TAC Section 3.1, et seq.*

Fracing Disclosure

RRC Proposed Rule 3.29

- **HB 3328:** Mandates Disclosure of Frac Fluids
- **RRC Proposal** (September 9, 2011)
 - Total volume of water used
 - Each chemical ingredient intentionally added
 - Trade name, description of function
 - Concentration of each chemical
 - Filed w/ RRC and posted on Internet
 - Trade Secret Protection per Public Information Act

FracFocus.Org

Hydraulic Fracturing Fluid Product Component Information Disclosure

Fracture Date:	02/28/11
State:	Louisiana
County:	De Soto
API Number:	1181329178
Operator Name:	Shell Western E&P
Well Name and Number:	Advanced LBT 11-1H
Longitude:	-93.8754244
Latitude:	32.8509228
Long/Lat Projection:	NAD83
Production Type:	Gas
True Vertical Depth (TVD):	12,130
Total Water Volume (gal):	7,966,938

Hydraulic Fracturing Fluid Composition

Trade Name	Supplier	Purpose	Ingredients	Chemical Abstract Service Number (CAS #)	Maximum Ingredient Concentration in Additive (% by mass)**	Maximum Ingredient Concentration in HF Fluid (% by mass)**	Comments
Fresh Water	Operator				100.0%	92.62978%	Density = 8.330
SAND - COMMON WHITE	Halliburton	Proppant	Crystalline silica, quartz	14808-80-7	100.0%	3.31730%	
SAND - PREMIUM WHITE	Halliburton	Proppant	Crystalline silica, quartz	14808-00-7	100.0%	4.48342%	
PROPSANT (SAND) PREMIUM	Halliburton	Proppant	Crystalline silica, quartz	14808-00-7	100.0%	1.05155%	
			Hexamethylenetetramine	1000-7-0	5.0%	0.02105%	
			Phenol / formaldehyde resin	900303-35-4	5.0%	0.02521%	
FR-88	Halliburton	Friction Reducer	Hydrotreated light petroleum distillate	84742-47-8	10.0%	0.03993%	
BE-9	Halliburton	Bioocide	Tributyl tetraethyl phosphonium chloride	81741-28-8	10.0%	0.03528%	
Claytex 3	Halliburton	Clay Control	Sodium chloride	7947-84-6	10.0%	0.03855%	
VICON NF DRCA/ER	Halliburton	Breaker	Chlorous acid, sodium salt	7759-18-2	10.0%	0.03089%	
			Sodium chloride	7647-14-5	10.0%	0.03358%	
LOC-30 UC	Halliburton	Oiling Agent	Diur gum	9000-00-0	40.0%	0.03264%	
			Diaphtha, hydrotreated heavy	94147-48-4	40.0%	0.03264%	
OP DRCA/ER	Halliburton	Breaker	Sodium persulfate	7775-27-1	100.0%	0.03084%	
Optimasec-100™	Halliburton	Surfactant	Sodium percarbonate tetrahydrate	13445-33-7	100.0%	0.03782%	

* Total Water Volume sources may include fresh water, produced water, and/or recycled water

** Information is based on the maximum potential for concentration and thus the total may be over 100%

All component information listed was obtained from the supplier's Material Safety Data Sheets (MSDS). As such, the Operator is not responsible for inaccurate and/or incomplete information. Any questions regarding the content of the MSDS should be directed to the supplier who provided it. The Occupational Safety and Health Administration's (OSHA) regulations govern the criteria for the disclosure of this information. Please note that Federal Law protects 'proprietary', 'trade secret', and 'confidential business information' and the criteria for how this information is reported on an MSDS is subject to 29 CFR 1910.1200(i) and Appendix D.

Risks to Surface Water: Flowback

- After fracing, a portion of frac fluids are produced back to the surface.
 - Amount of frac fluid recovered as flowback varies from 25% to 75%.
 - Flowback rate in first few days can exceed 100,000 gallons per day.
 - Will drop to ~ 50 gallons per day over time.
- Flowback fluids may include high TDS values, concentrations of major ions (e.g. barium, bromide, calcium, iron), radionuclides, VOCs, and other natural occurring elements.

Handling/Disposal of Flowback

- Flowback and produced water are held in storage tanks and water impoundment pits prior to and during treatment, recycling, and disposal.
- Underground injection is primary method for disposal for flowback and produced water.
 - Concerns regarding injection capacity and cost of trucking wastewater to injection site.
- Potential for use of publicly owned treatment works (POTW) or commercial treatment facilities if in populated areas.
 - POTWs often not designed to treat fracking wastewaters.
- Releases, leaks, and/or spills involving storage and transportation of flowback and produced water could contaminate shallow drinking water aquifers and surface water.
- Reuse is possible, with treatment.

Groundwater Use Permit Exemption

Texas Water Code 36.117

- (b) A district may not require any permit issued by the district for:
- (2) the drilling of a water well used solely to supply water for a rig that is actively engaged in drilling or exploration operations for an oil or gas well permitted by the [RRC] . . . and the well is located on the same lease or field associated with the drilling rig . . .

* * *

- (d) Notwithstanding Subsection (b), a district may require a well to be permitted by the district and to comply with all district rules if:
- (2) the purpose of a well exempted under Subsection (b)(2) is no longer solely to supply water for a rig that is actively engaged in drilling or exploration operations for an oil or gas well . . .

Common Law:

Subsurface Trespass

- In *Coastal Oil v. Garza Energy Trust*, the Texas Supreme Court held that the rule of capture prevented a neighbor from recovering damages when subsurface hydraulic fracturing extended into the neighbor's land.
 - Court held that since the only claim of damage from trespass was damages from drainage resulting from fracing, the claim was precluded by rule of capture.
- Texas Supreme Court intentionally avoided question of whether fracing extending beneath another's land was itself a subsurface trespass.
 - Long history of case law where Texas Supreme Court has decided not to address question.
 - In 1992, Texas Supreme Court in *Geo Viking, Inc. v. Tex-Lee Operating Company* said fracing constituted a trespass when it extended onto neighboring property but withdrew the opinion 6 months later.

Regulatory Forecast

- Broad disclosure of fracking fluids and chemical additives
- Narrowing of UIC exemptions
- Ban on use of certain additives
- Restrictions on disposal of flowback fluids
- Enhanced enforcement, site inspections
- Challenges to obtaining water during drought



QUESTIONS

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