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Hydraulic Fracturing: New Developments in Water Disposal Reuse and Recycling

Environmental Impacts of Oil and Gas Production

State Bar of Texas

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San Antonio, TX



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Presentation Outline

- Water Consumption & Reuse Projections
- Regulatory Overview
 - Federal: UIC exemption/EPA Study
 - State: RRC MOU/Rule Proposals
- Property, Ownership, and Common Law Issues
- Earthquake Risk

Water Consumption & Reuse Projections

Water Demand Projection 2010 to 2060 (Texas, AcFt/Yr)

Category	2010	2020	2030	2040	2050	2060	Percent of 2060 Demand
Municipal	4,851,201	5,580,979	6,254,784	6,917,722	7,630,808	8,414,492	36.3%
Manufacturing	1,727,808	2,153,551	2,465,789	2,621,183	2,755,335	2,882,524	13.1%
Mining	296,230	313,327	296,472	285,002	284,840	292,294	1.3%
Steam-electric	733,179	1,010,555	1,160,401	1,316,577	1,460,483	1,620,411	7.4%
Livestock	322,966	336,634	344,242	352,536	361,701	371,923	1.7%
Irrigation	10,079,215	9,643,908	9,299,464	9,024,866	8,697,560	8,370,554	38.1%
Texas	18,010,599	19,038,954	19,821,152	20,517,886	21,190,527	21,952,198	

Source: TWDB, 2012 State Water Plan

UT Bureau of Economic Geology

2012 Update Mining Water Use

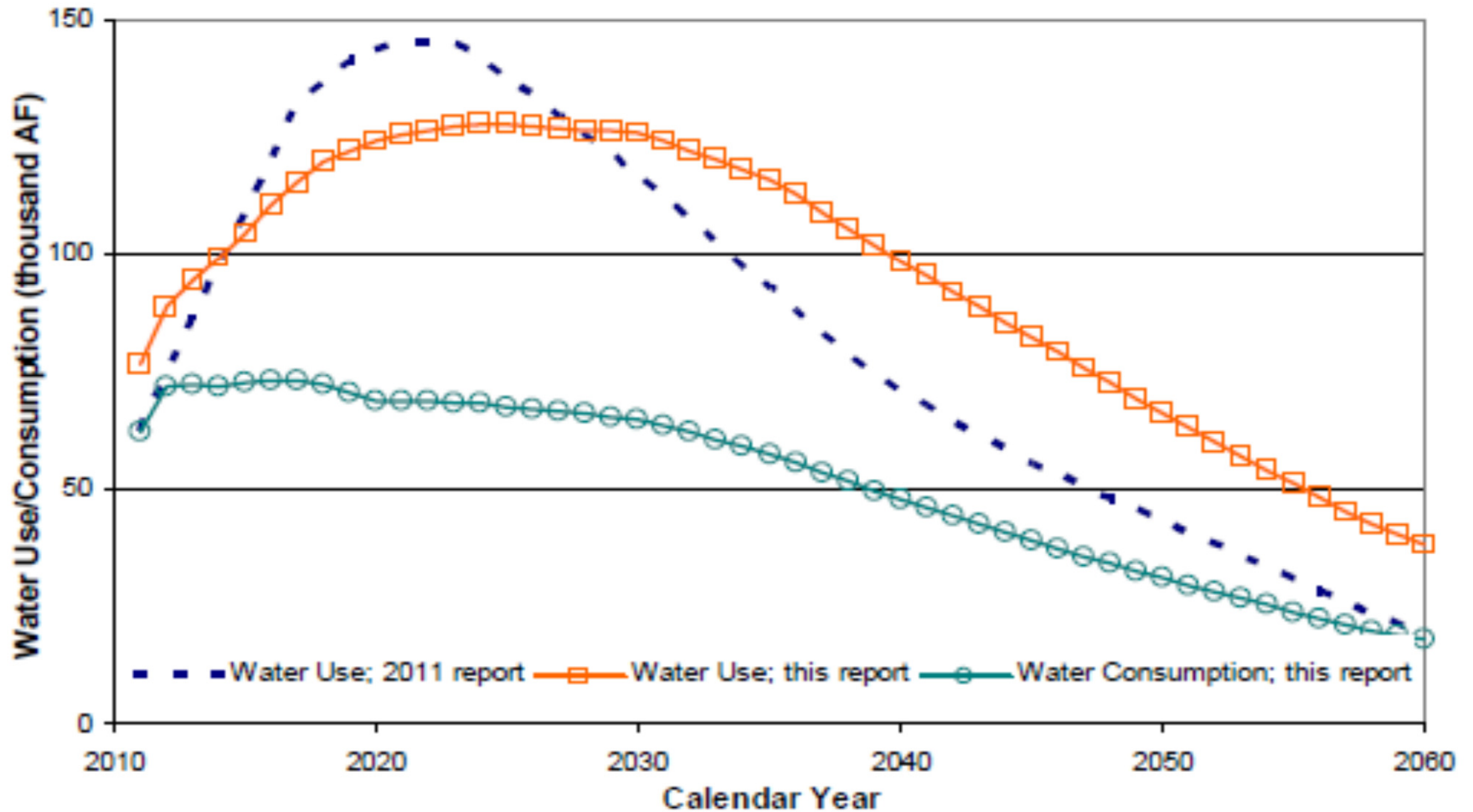
- Original Report: *Current and Projected Water Use in the Texas Mining and Oil & Gas Industry*
 - Issued June 2011
 - Based on 2008 Actual Water Uses
- Updated in Sept 2012 to Address:
 - Major shift in O&G drilling from gas to oil
 - Focus on hydraulic fracturing water use
 - New technology advances resulting in more reuse and more use of brackish groundwater
 - Update water use numbers (Actual 2011)
- Water Use v. Water Consumption
- Funded by Texas Oil & Gas Association

Source: BEG Update to 2011 Mining Water Use Report, Sept. 2012

UT BEG 2012 Update

- Total actual water use for hydraulic fracturing has increased from 36,000 AF in 2008 to ~81,500 AF in 2011.
- Annual peak water use previously estimated at 145,000 AF in the early 2020's; now estimated to be a broad peak plateauing at ~125,000 AF/yr during the 2020's.
- Fresh water consumption is estimated to stay at the general level of ~70,000 AF/yr and to decrease in future decades.
- Adding other uses (e.g. waterflooding and drilling), brings projected max O&G water use up to ~180,000 AF/yr during 2020-2030.

Projected Fracing Water Use (Texas)



Source: BEG Update to 2011 Mining Water Use Report, Sept. 2012 (Fig. 48)

Competing Water Uses: Eagle Ford Fracing v. Agriculture

“Mr. Brownlow, who has a Ph.D. in geochemistry, says it takes 407 million gallons to irrigate 640 acres and grow about \$200,000 worth of corn on the arid land.

The same amount of water, he says, could be used to frack enough wells to generate \$2.5 billion worth of oil.

‘No water, no frack, no wealth,’ says Mr. Brownlow, who has leased his cattle ranch for oil exploration.”

- WSJ, Dec. 6, 2011

Quoting Darrell Brownlow, Ph.D.

Fracing Water Use

Actual 2011 v. Projected

Play / Region Unit: kAF	2011 Actual Water Use	Fraction Non-R/R Non-brackish	2011 Actual Water Consumption	2011 Projected Water Use
Barnett Shale	25.75	0.92	23.69	33.08
Eagle Ford Shale	23.76	0.8	18.81	10.07
East Texas Basin	7.54	0.95	7.06	8.46
Anadarko Basin	6.52	0.5	3.21	2.26
Permian Basin	14.44	0.68 / 0.2	8.55	7.26
Gulf Coast Basin	3.49	0.95 / 0.8	3.31	1.00
Statewide	81.51	0.79*	64.63	62.13

Source: BEG Update to 2011 Mining Water Use Report, Sept. 2012 (Table 9)

Reuse and Brackish Water Use Estimates

Play / Region	Type	Current (2011) %
Permian Far West	Recycled/reused	0%
	Brackish	80%
	Fresh	20%
Permian Midland	Recycled/reused	2%
	Brackish	30%
	Fresh	68%
Anadarko Basin	Recycled/reused	20%
	Brackish	30%
	Fresh	50%
Barnett Shale	Recycled/reused	5%
	Brackish	3%
	Fresh	92%
Eagle Ford Shale	Recycled/reused	0%
	Brackish	20%
	Fresh	80%
East Texas Basin	Recycled/reused	5%
	Brackish	0%
	Fresh	95%

Source: BEG Update to 2011 Mining Water Use Report, Sept. 2012 (Table 7)

Reuse and Brackish Water Use Estimate Summary

- **Barnett Shale:** Operators primarily use fresh surface water (estimated at 80% of “new” water). Overall, little recycling/reuse and brackish water use is currently occurring in this play as compared to other plays further west or south.
- **Eagle Ford Shale:** Operators rely mostly on groundwater (estimated at 90% of “new” water) and significant amount of brackish water being used (currently estimated at 20%); no recycling.
- **Haynesville Shale and East Texas Basin:** No significant recycling/reuse and/or use of brackish water. 70% of “new water” is groundwater.
- **Permian Basin:** 30% or more of fracing water used is brackish. Nearly all of the “new” water used is groundwater. There is currently little recycling/reuse, although several companies use produced water from conventional oil and gas operations.
- **Anadarko Basin:** Estimated 20% is recycled/reused; brackish water use is estimated at 30%. Most of the “new” water is groundwater (estimated at 80%).

Source: BEG Update to 2011 Mining Water Use Report, Sept. 2012

Future of Recycling/Reuse

- Recycling frac water saves about 20% of water used in the process
 - Means that 6 billion gallons of water could have been saved in 2011 (conservatively assuming just a single use of frac water).
- Recycling is currently 50% – 75% more expensive than the current practice of deep well disposal.*
- New technologies being developed to further reduce water consumption
- As the cost of water increases, these more expensive technologies become more attractive.

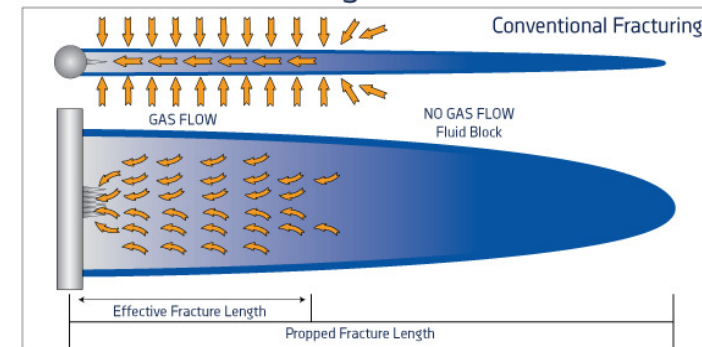
* Source: Oral and Written Testimony of Luke Metzger, Environment Texas, Texas House of Representatives Committee on Natural Resources, Austin, Texas, June 27, 2012 & Oral and Written Testimony of Jay Ewing, Devon Energy, Texas House of Representatives Committee on Natural Resources, Austin, Texas, June 27, 2012.

Beyond Recycling: LPG Based “Water-Less” Fracing

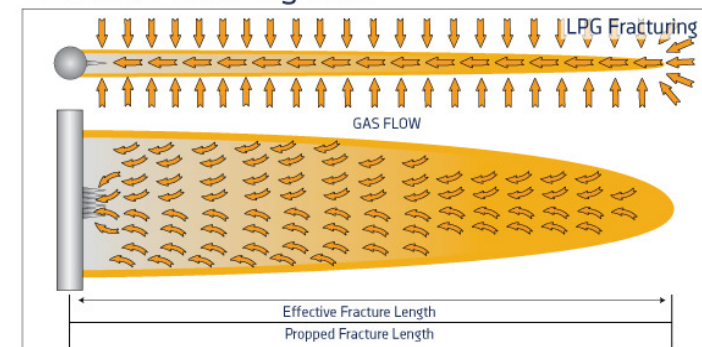
- GASFRAC Liquid Petroleum Gas Gel Fracturing Process
- Advantages:
 - No Water Use or Disposal
 - Longer Effective Frac Lengths
 - “100%” of LPG Recovered
- Implementation Issues
 - Proprietary Process
 - Limited Field Trials
 - Company Financial/Management Issues
 - GasFrac Energy Services, Inc., Recent Stock Price Decline to \$2

Effective Frac lengths- GASFRAC vs. Water:

Conventional Fracturing Fluids



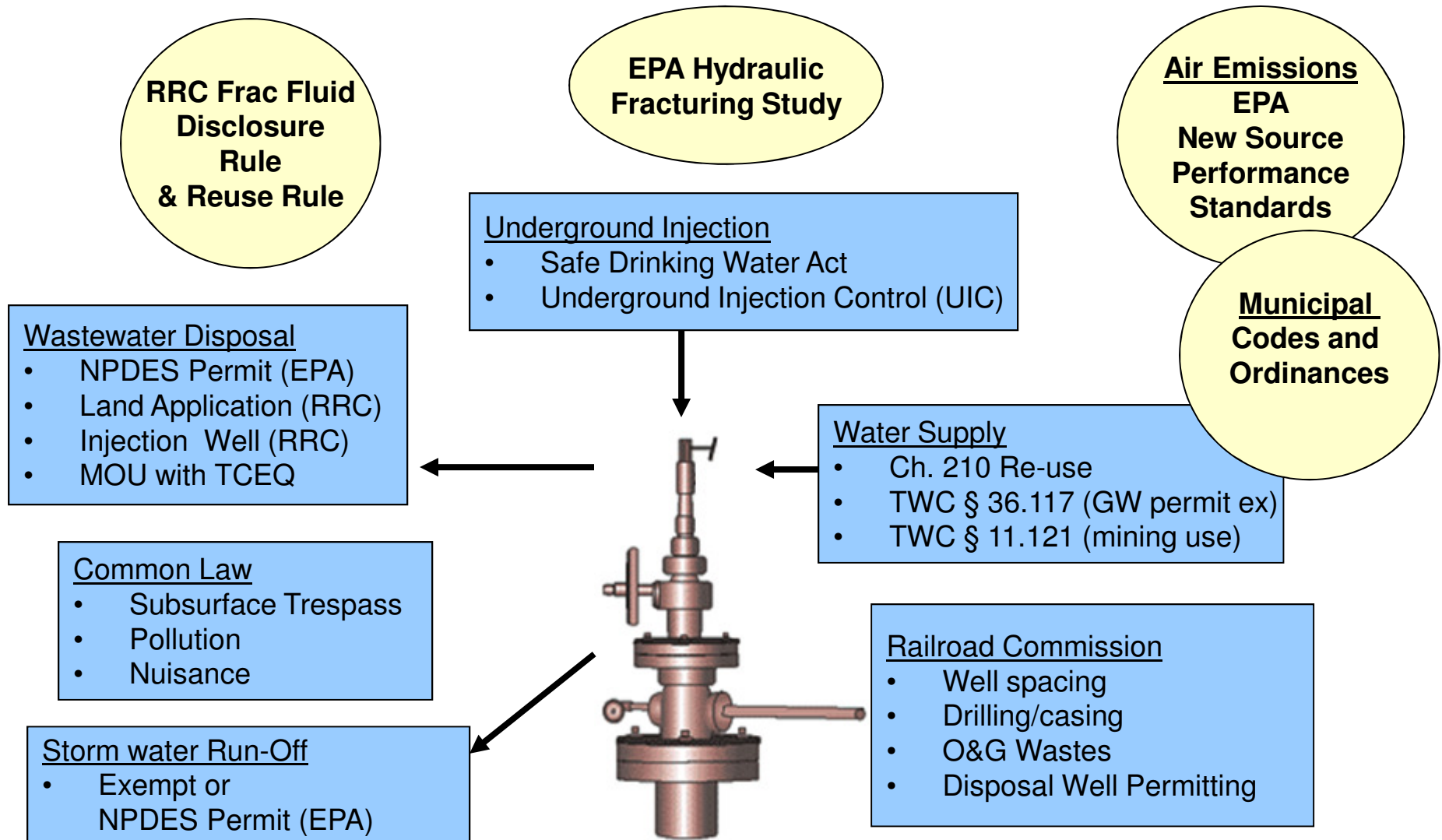
LPG as a Fracturing Fluid



Source: GasFrac Energy Services, Inc. Company Website

Regulatory Issues

Patchwork of Laws and Regulations



Post-Fracing Flowback

- After fracing, pressure decreases in the wellbore and frac fluid flows back to the surface and must be separated from O&G and collected for reuse or disposal.
- Amount of frac fluid recovered as flowback varies from 25% to 75%.
- Flowback can have frac fluids and high TDS values, concentrations of major ions (e.g. barium, bromide, calcium, iron), radionuclides, VOCs, and other natural occurring elements.



Tanker Trucks
Source: DOE, Fracing Primer



Lined Fresh Water Supply Pit from
Marcellus Shale
Source: DOE, Fracing Primer

Federal 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 March 15, 2011 to remove exemption (HR 1084).
 - Similar bills introduced in Senate (S 587) and in past (2009 – HR 2766).
- On May 10, 2012, EPA released its proposed permitting guidance concerning the use of diesel fuel in fracking operations.
 - The proposal clarifies what petroleum substances are covered.
 - While many in the industry no longer use diesel fuel, some believe that this guidance could become the basis for future regulations if the SWDA exemption is ever legislatively removed.



EPA/600/R-11/122/November 2011/www.epa.gov/research

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

United States Environmental Protection Agency
Office of Research and Development

EPA Hydraulic Fracturing Study Status

- *EPA Plan to Study the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources*; Released Nov. 2011
- Intended to examine “life cycle” of fracing, specific focus on potential impact to drinking water resources.
- Study analyzing and researching questions involving:
 - Water Acquisition; Chemical Mixing; Well Injection; Flowback and Produced Water; and Wastewater Treatment and Waste Disposal.
- Progress report published in December 2012 detailing status of 18 research projects
- Final report expected in 2014.

Note: In 2004, EPA conducted study finding that hydraulic fracturing in coal-bed methane wells posed little to no threat to underground drinking water.

State Regulation O&G Wastes: RRC/TCEQ MOU

- Railroad Commission and TCEQ first adopted a memorandum of understanding (MOU) in 1981 following command of the legislature.
- MOU sets forth the agencies' jurisdiction over various matters, including wastes associated with oil and gas exploration, production and refining operations.
- The RRC is specifically charged with the regulation of wastes and discharges “resulting from activities associated with the exploration, development, or production of oil or gas or geothermal resources...”
See 16 TAC § 3.30(b)(2)(A-B).

Amendments to the MOU

- The MOU was amended eff. May 1, 2012; In response to Article 2 of House Bill (HB) 2694, passed by the 82nd Texas Legislature(2011).
- Modifications required transfer from the TCEQ to the RRC the responsibility of preparing and issuing groundwater protection/recommendation letters (sometimes referred to as “water board letters”).
- In modifying the MOU, the RRC removed the reference to TCEQ regulations for the definition of underground source of drinking water (USDW) and explicitly defined the USDW in the MOU.
- HB 2694 triggered other rule changes at the RRC, including:
 - 16 TAC Section 3.13 (Casing, Cementing, Drilling and Completion Requirements)
 - Section 3.99 (Cathodic Protection Wells)
 - Section 3.100 (Seismic Holes and Core Holes)

Disposal Rules Proposal

- Railroad Commission has jurisdiction over injection wells used to dispose of oil and gas waste. *See* 16 TAC §§ 3.30(b)(1)(C) & 3.30(b)(2)(C).
- Staff of the Railroad Commission initiated changes to disposal well regulations at 16 TAC § 3.9.
 - Staff have released an informal rule proposal.
- Informal rule expands protection of groundwater to include USDW and proposes significant additional requirements.
- New rules propose to codify surface water protection requirements that the Staff typically requests to be added as permit conditions.

Recycling Rules Proposal

- Railroad Commission in September 2012 proposed a significant expansion of oil and gas waste recycling rules, citing an increase number of applications that don't fit existing categories.
- Original recycling rules passed in 2006 only established requirements for two categories of facilities: mobile or stationary.
- Proposes repeal of existing two categories and replacement with new commercial recycling rules establishing five commercial recycling categories.
- Railroad Commission also proposes creating non-commercial and on-lease recycling criteria for produced water and/or hydraulic fracturing flowback.

Recycling Rules Proposal: Five Commercial Categories

- On-lease commercial solid oil and gas waste recycling;
- Off-lease or centralized commercial solid oil and gas waste recycling;
- Stationary commercial solid oil and gas waste recycling facilities;
- Off-Lease or centralized commercial recycling of produced water and/or hydraulic fracturing flowback fluid; and
- Stationary commercial recycling of produced water and/or hydraulic fracturing fluid.

Property, Ownership, and Common Law Issues

Subsurface Water

Disposal Complications

- In a Memorandum Opinion by the Texas Appellate Court, the Court observed that some measure of actual harm must accompany the migration of subsurface fluids in order for there to be an impairment of the existing rights in the subsurface of an adjacent land owner.*
- However, a permit granted by an agency does not shield the permit holder from tort liability for actions arising out of the use of the permit. This is consistent with the language of the Injection Well Act and Texas Administrative Code governing the TCEQ.**
- 9th Court of Appeals (Beaumont) on September 13, 2012, found that burden of proving consent in trespass is placed on the alleged trespasser, trespass is a viable cause of action for invasions of the briny water at the subsurface level even without damage at the surface level, and that it is possible the jury could find trespass damages caused by an injection well.***

* *FPL Farming, Ltd. v. Texas Natural Resource Conservation Commission*, 2003 WL 247183 (Tex. App.-Austin 2003).

** *FPL v. Environmental Processing Systems*, 351 S.W.3d 306 (Tex. 2011).

*** *FPL Farming Ltd. v. Env'tl. Processing Sys., L.C.*, No. 09-08-00083-CV, 2012 WL 4017388, at *1 (Tex. App. — Beaumont Sept. 13, 2012, no. pet. h.).

Subsurface Trespass in Texas

- The most well know case on the matter is *Coastal Oil v. Garza Energy Trust*,* where adjacent landowners sought a trespass actions against a gas well operator for hydraulic fracturing operations where fractures from the operation extended across lease lines causing drainage from underneath the adjoining property.
 - Held: Damages arising from such drainage did not support a claim for subsurface trespass because the rule of capture effectively barred the recovery.
- 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.

Sources: *Coastal Oil v. Garza Energy Trust*, 268 S.W.3d 1 (Tex. 2008); and *Geo Viking, Inc. v. Tex-Lee Operating Company*, 839 S.W.2d 797 (Tex. 1992) (per curiam op withdrawn on reh'g).

Groundwater Ownership and Reuse

- Absent an express conveyance or reservation to the contrary, the courts have consistently held water is a part of the surface estate.*
- However, a mineral lessee has the right to take as much water as is reasonably necessary to enable lessee to carry out the development and production operations under the lease.**
- The *Sun Oil* Court observed that the leasehold estate is the dominant estate and has an implied grant of free use of such part and so much of the premises as is reasonably necessary to effectuate the purposes of the lease.**
- To date, there is little guidance regarding the sale of fracing flowback to third-parties or for off-lease use. It is advisable to obtain the consent of the surface owner, as part of a *surface use agreement*.

* *Edwards Aquifer Authority v. Day*, 369 S.W.3d 814 (Tex. 2012) ; SB 332; *Sun Oil Co. v. Whitaker*, 483 S.W.2d 808 (Tex. 1972); *Fleming Foundation v. Texaco, Inc.*, 337 S.W.2d 846 (Tex.Civ.App.1960).

** *Sun Oil Co.*, 483 S.W.2d 808.

Earthquake Risk

Looming Issue: Earthquakes

- Numerous allegations have been made that fracking operations may result in “minor” earthquakes.
- Reports of earthquakes include operations in Texas, Arkansas, Oklahoma, and even England.
- A recent Oklahoma study found strong correlation between fracking activities and a series of small January, 2011 Oklahoma earthquakes.
- Arkansas has implemented a moratorium on fracking water disposal wells in an earthquake prone area of Arkansas.
- British fracking company (Cuadrilla Resources) on November 2, 2011, announced the conclusions of a report that it was highly likely their fracking activities caused small earthquakes in April and May 2011.

New UT Earthquake Report

- Two-year survey deployed seismographs to compare earthquake activity and injection-well locations in the Barnett Shale area (Author: Cliff Frohlich, July 2012).
- Study found more small quakes, nearly all less than magnitude 3.0, than were previously known.
- “I didn't find any higher risks from disposal of hydraulic fracturing fluids than was thought before,” says Frohlich. “The risk is all from big quakes, which don't seem to occur here.”
- Plausible Hypothesis: Injection only triggers earthquakes if injected fluids reach and relieve friction on suitably oriented, nearby fault under stress.

QUESTIONS?

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