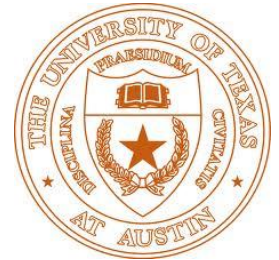


Shale Gas Development: If the Goal is Fact-Based Regulation, What Are the Facts?

Report on an Initiative of the Energy Institute
The University of Texas at Austin

Chip Groat
Associate Director
and

Professor, Jackson School of Geosciences



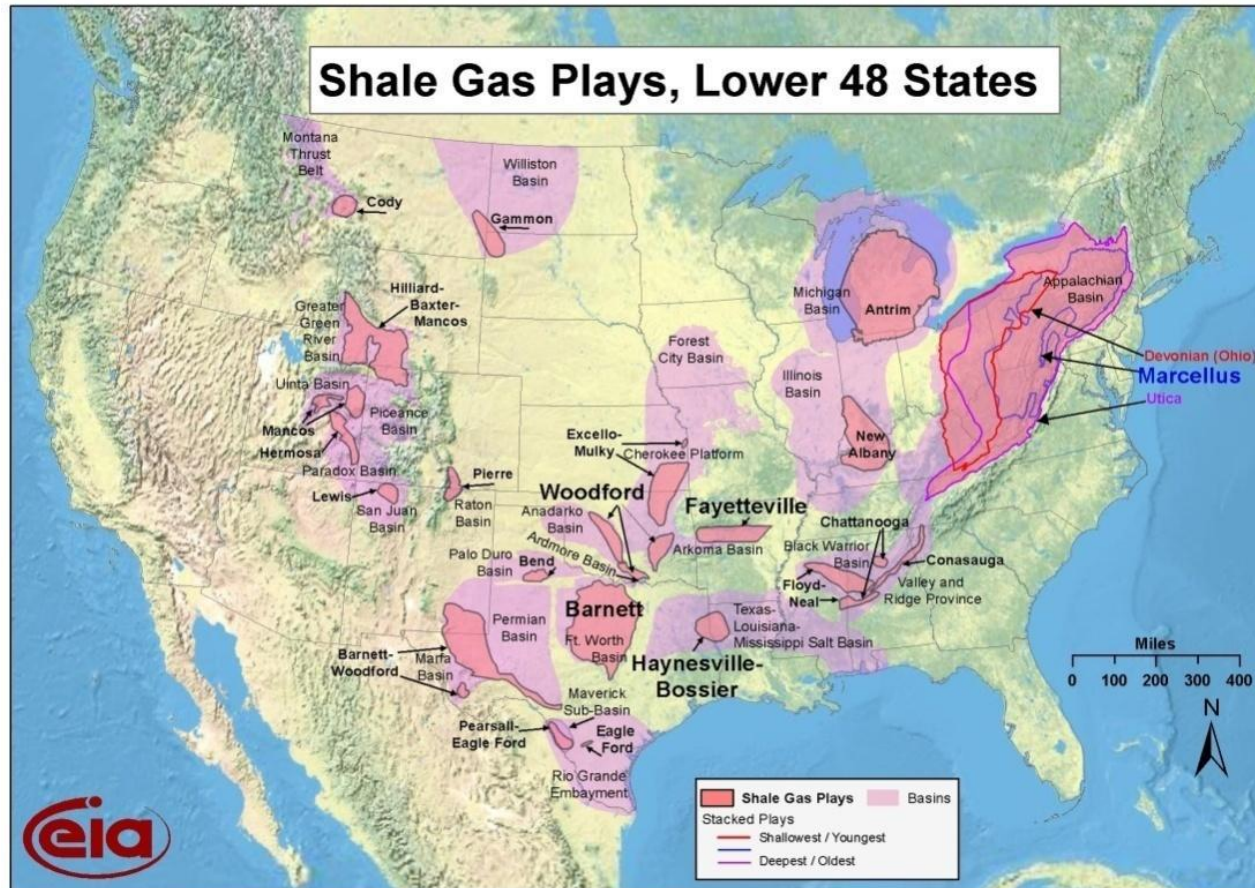
Why Shale Gas?

Why Regulation?

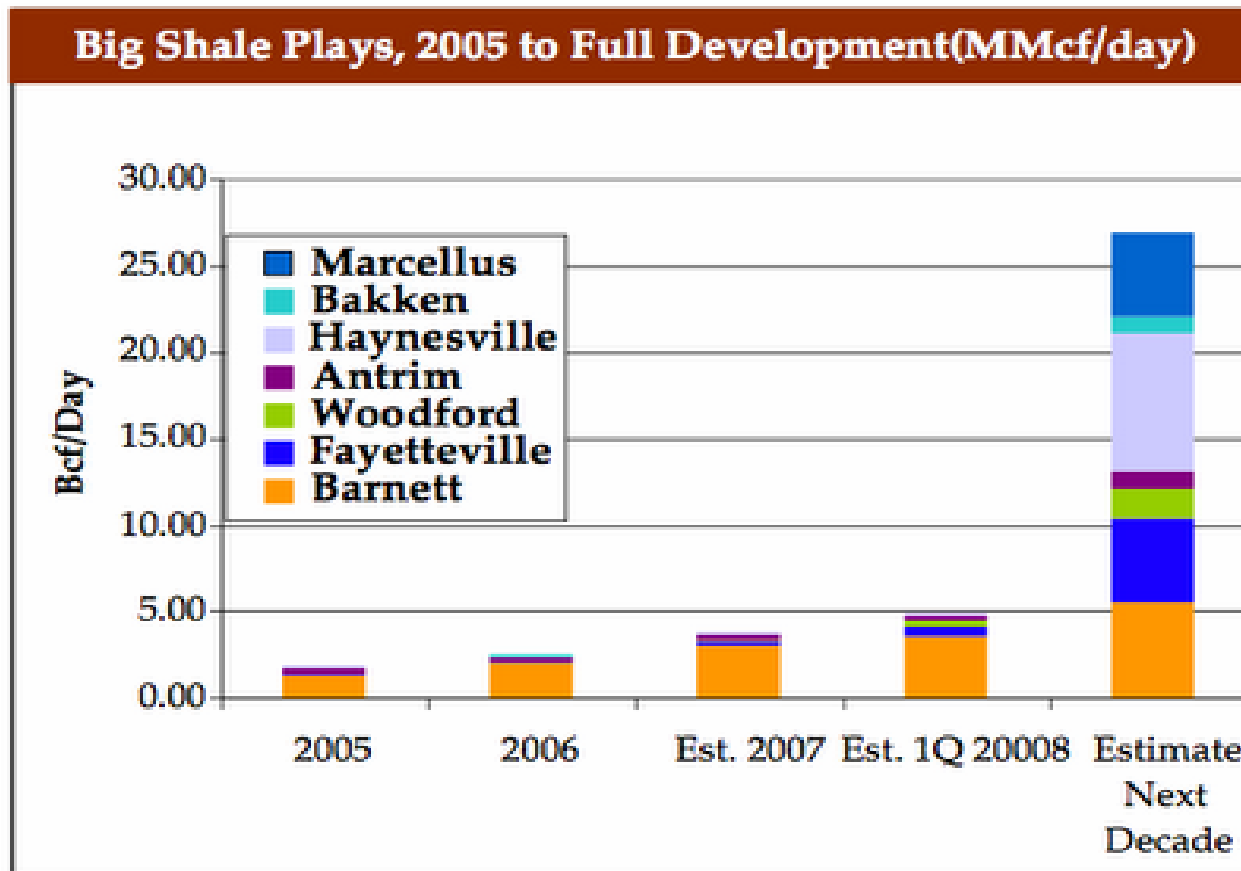
Why “Fact Based”

- Shale gas increasingly important as energy source worldwide – now 1/3 of gas resource in U.S.
- Concerns for environmental effects (hydraulic fracturing) must be addressed with effective controls.
- Some of the claims about shale gas development effects may be overstated or not based on good science.

Shale Gas Occurrences in the U.S.



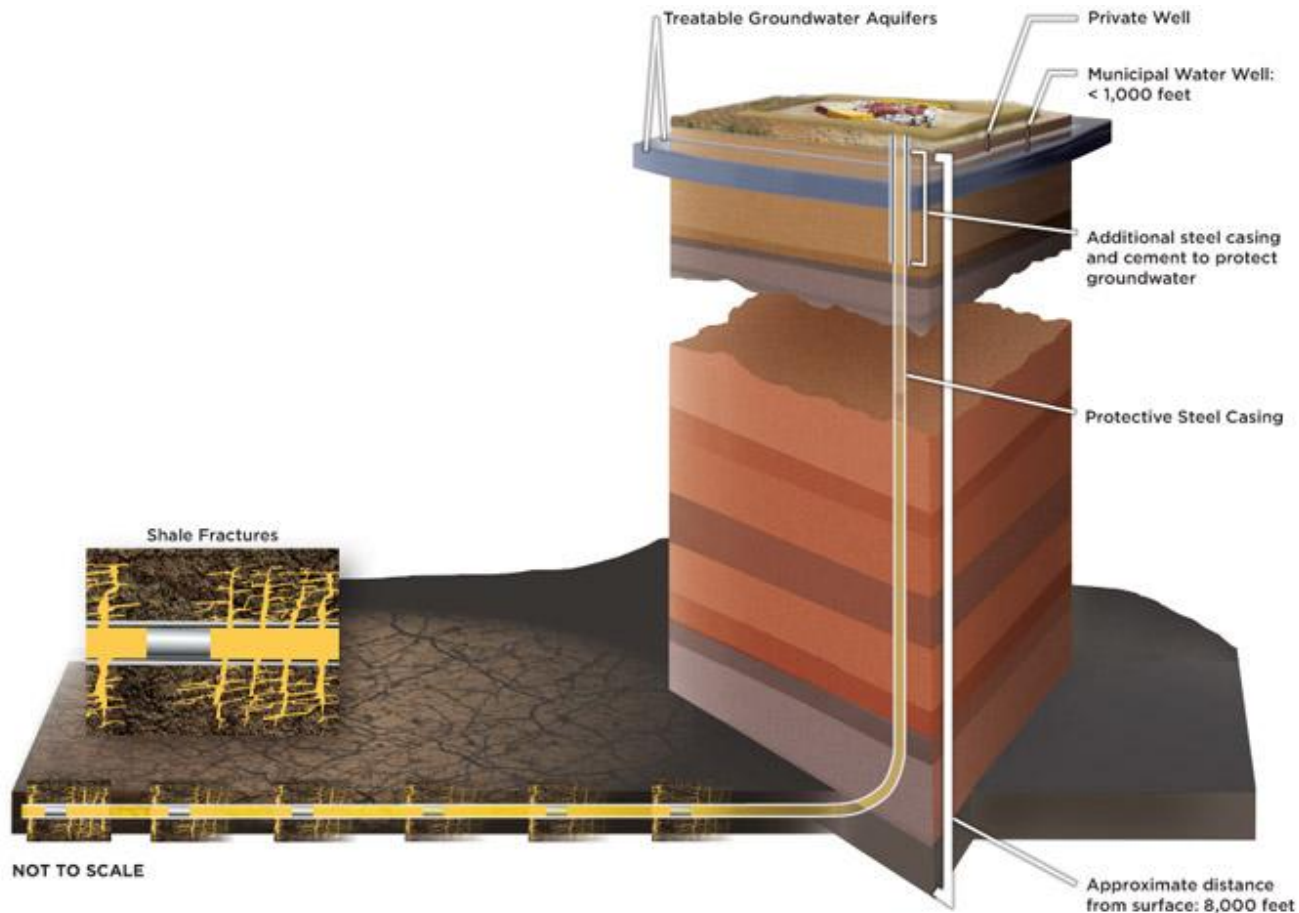
Shale Gas Production Growth Estimate



Sources: Producer interviews, analyst estimates, NCI calculations.



Shale Gas Operations



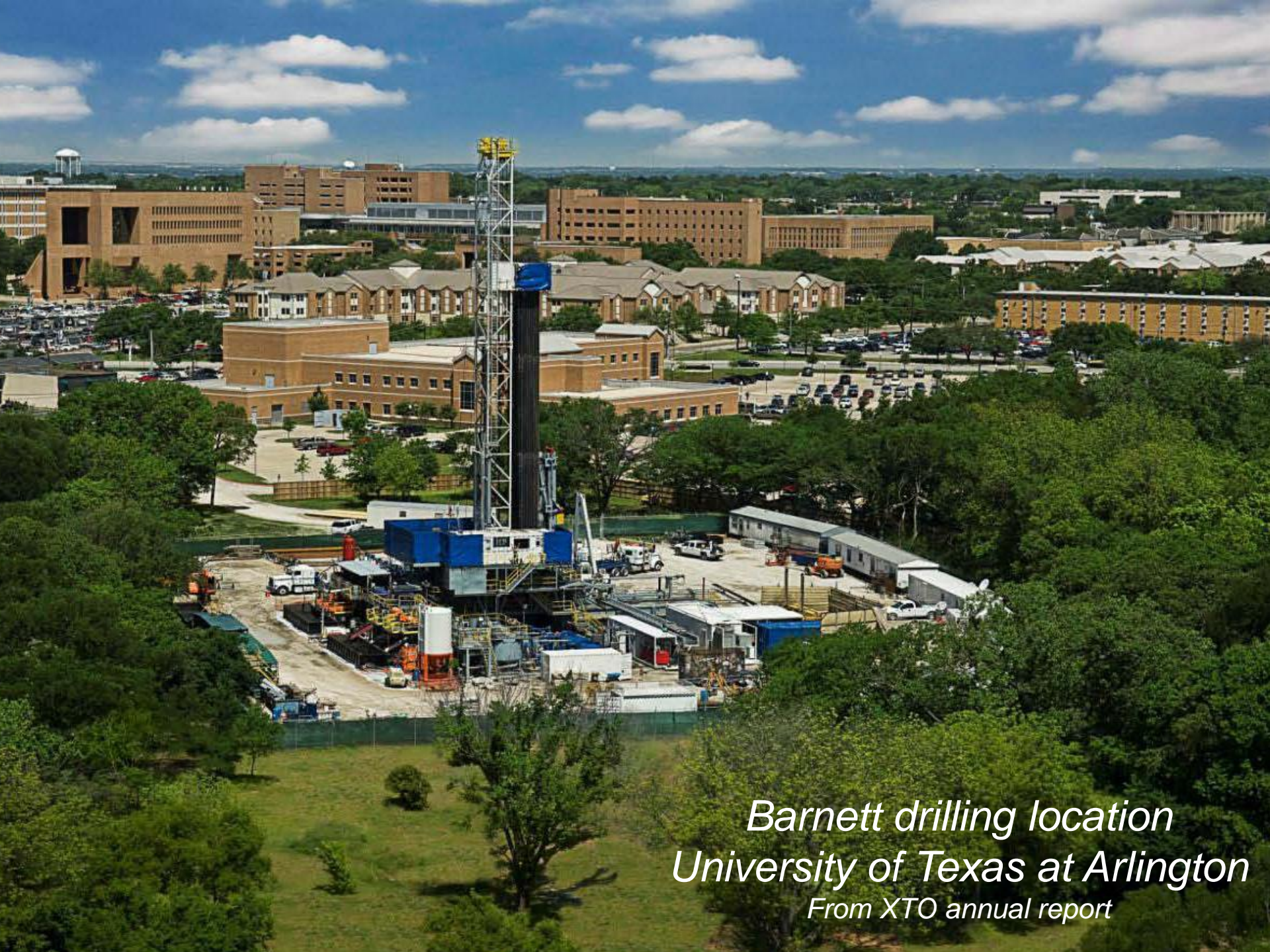
Carrizo's 22-well pad at UTA Tarrant County, Texas



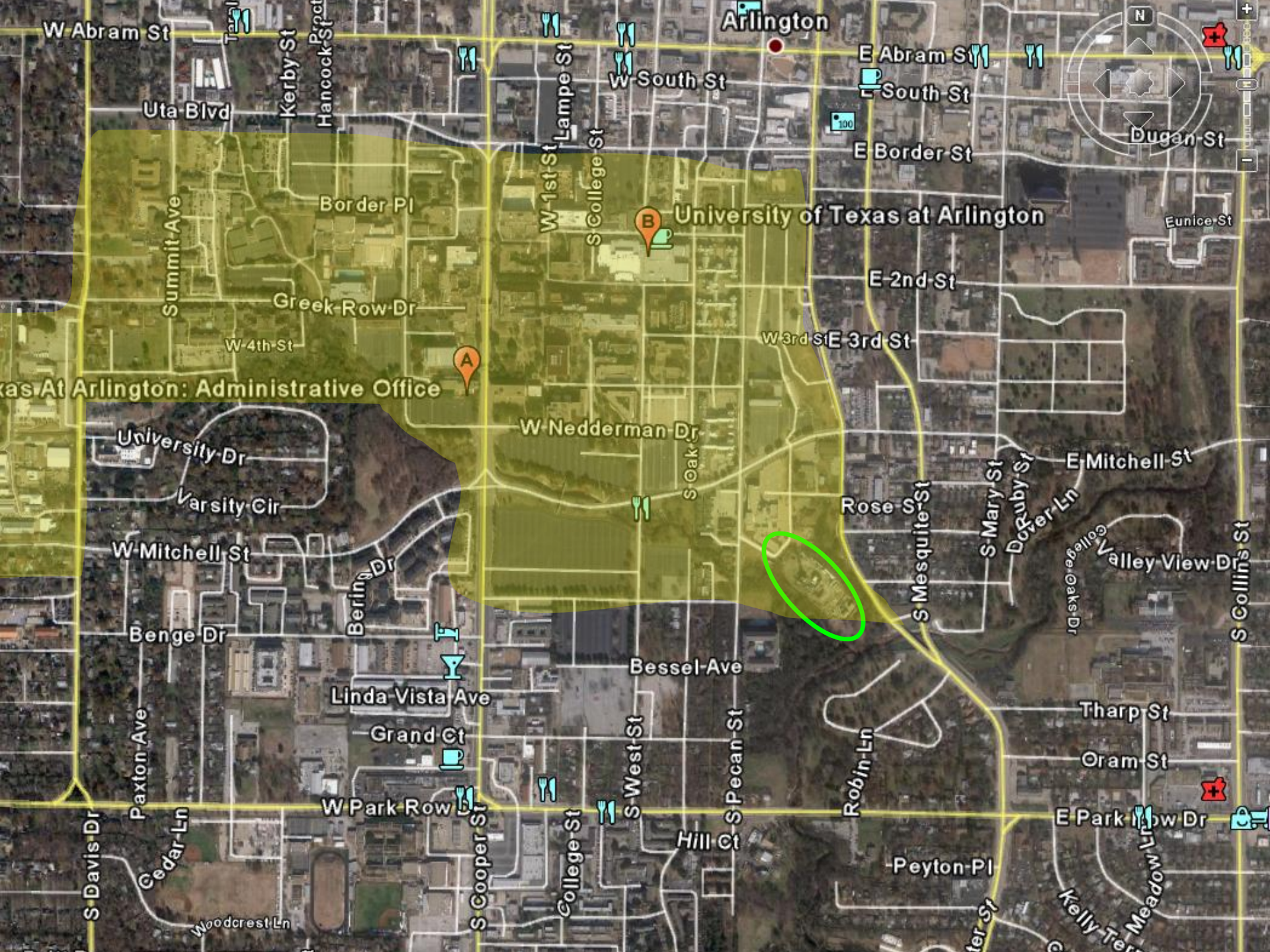
energy institute
The University of Texas at Austin

- According Carrizo estimates:
 - Total drainage area of 1100 acres
 - EUR of 110 bcf over 25 years
 - 5 bcf per well
 - At \$5/mcf gas, \$550 million in production revenue
 - Roughly \$140 million to 1500 royalty owners
- UTA has 391 acres, worth tens of millions in future royalties

Article by Jack Smith, Fort Worth Star Telegram, 10/1/2010



*Barnett drilling location
University of Texas at Arlington
From XTO annual report*



University of Texas at Arlington

University of Texas at Arlington: Administrative Office

W Nedderman Dr

S Mesquite St

E Mitchell St

Bessel Ave

Linda Vista Ave

W Park Row

Robbin Ln

E Park Row Dr

Peyton Pl

Kelly Ter



Arlington

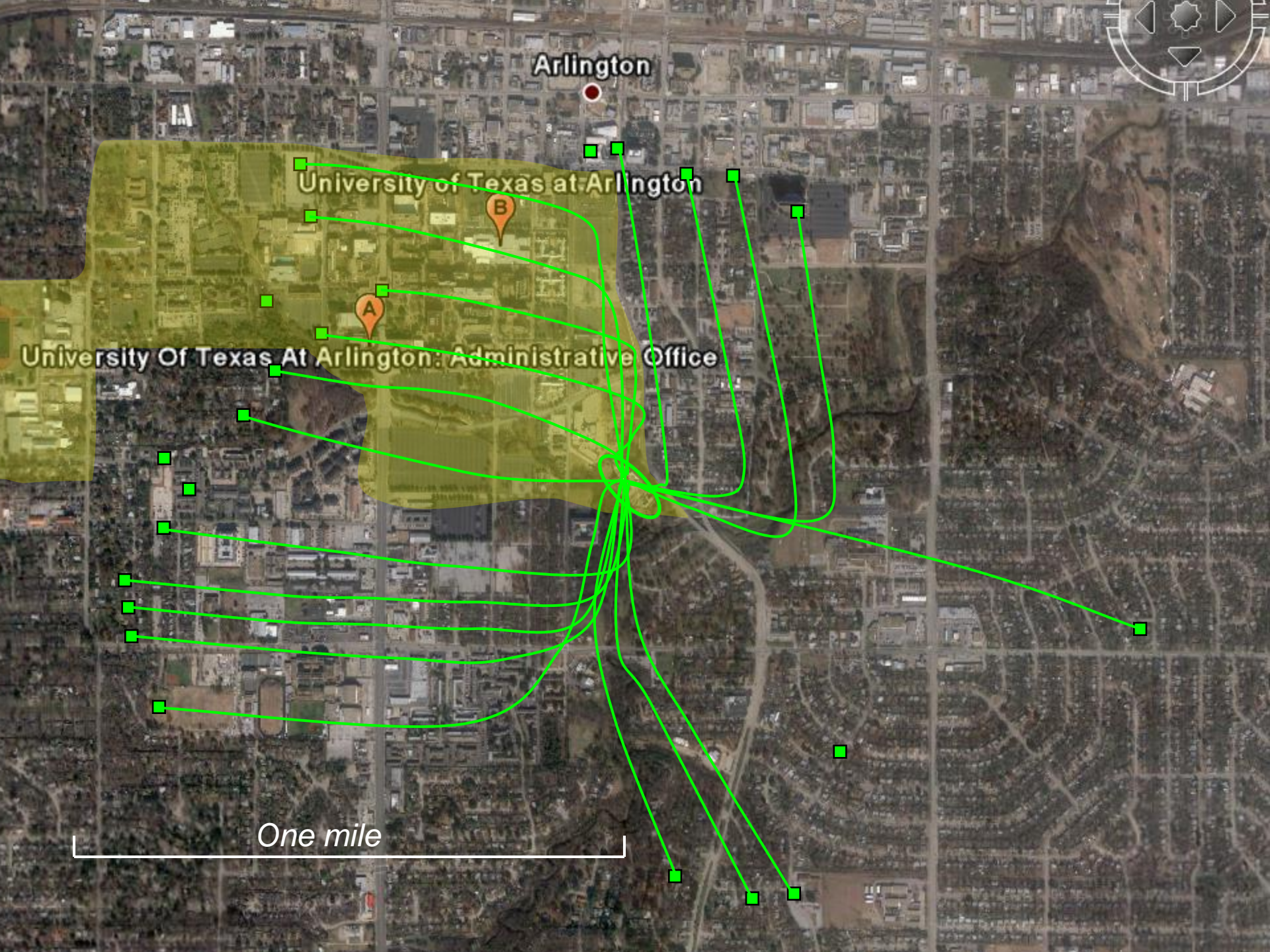
University of Texas at Arlington

University Of Texas At Arlington: Administrative Office

A

B

One mile





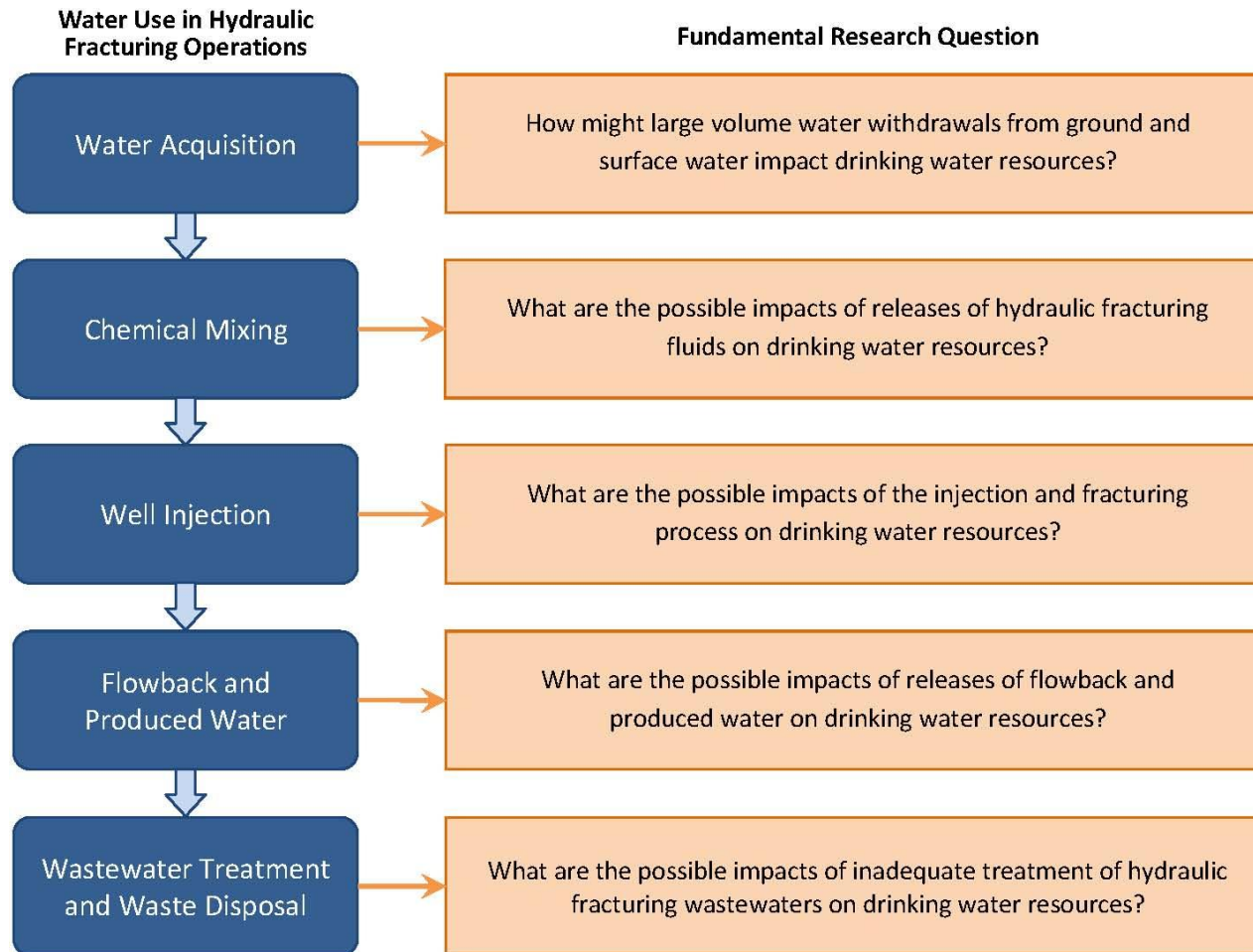
Challenges of Shale Gas Development

- Water Quality Impacts
- Water Consumption Impacts
- Seismic Events
- Air Quality Impacts
- Landscape Effects
 - Drill pads
 - Truck traffic
 - Production and transportation infrastructure

Focus of the Energy Institute Initiative

- Three major shale gas plays
 - Barnett
 - Haynesville
 - Marcellus
- Water quality issues
- Topics of greatest interest to local governments will be considered in Barnett Case Study
 - Issues to be identified with their input

Life Cycle of Water in Hydraulic Fracturing





Energy Institute Initiative Goals

- Achieve effective communication leading to fact-based regulation and public understanding
- Promote policies and regulations that are grounded in science
 - Provide products that effectively communicate with policy makers and regulators

How Is the Initiative Being Performed?

1. Funding provided by Energy Institute
2. Engage multi-disciplinary team members
3. Develop team member contributions – white papers. Outside review of papers.
4. Integrate individual contributions into a policy-maker -oriented final report and other products



Scope and Methods

1. Review claims in media
2. Evaluate claims and impacts geographically (Informatics)
3. Review technical literature on shale gas impacts
4. Review current regulations and records of violations

The University of Texas at Austin: Campus-wide Participation



energy institute
The University of Texas at Austin

- Jackson School of Geosciences
- UT Bureau of Economic Geology
- UT and Tulsa Schools of Law
- UT School of Communication
- Energy Institute
- Environmental Defense Fund



Investigation Team

- Leadership
 - Charles G Groat
 - El Associate Director
 - Thomas W Grimshaw
 - El Research Fellow
- Primary Contributors
 - Scott Anderson
 - Environmental Defense Fund (Austin)
- Primary Contributors
 - Ian Duncan
 - UT Bureau of Economic Geology
 - Matt Eastin
 - UT School of Communications
 - Suzanne Pierce
 - Jackson School of Geosciences
 - Hannah Wiseman
 - Tulsa University School of Law



Assessment of Hydraulic Fracturing News: Coverage

- Newspapers
- Television
- Radio
- Online News

News Coverage Preliminary Results

- Newspaper coverage: 66% negative
- Broadcast (TV & radio): 70% negative
- Online news: 63% negative

Assessment of Public Perception



- Online research method
- 1473 respondents
- 26 counties in Barnett Shale area
- About 75 questions
- Three areas surveyed
 - Attitude toward hydraulic fracturing
 - Knowledge of hydraulic fracturing
 - Media habits

Public Perception Preliminary Findings: Hydraulic Fracturing Attitudes

- Survey questions indicate that hydraulic fracturing is...
 - Valuable
 - Productive
 - Not foolish
 - Good
 - Beneficial
 - Positive
 - Somewhat helpful
 - Somewhat effective
 - Good for the economy
 - Important to the US economy
 - Important overall
- Questions also indicate that hydraulic fracturing is...
 - Bad for the environment
 - Unsafe



Public Perception Preliminary Findings: Hydraulic Fracturing Knowledge

- Many living in the Barnett Shale area have some hydraulic fracturing knowledge
- Tend to lack understanding of regulation and cost-benefit of shale gas production
- Most overestimate the level of hydraulic fracturing regulation
- Many overestimate annual water consumption for shale gas operations
- Many underestimate the amount of electricity generated from natural gas

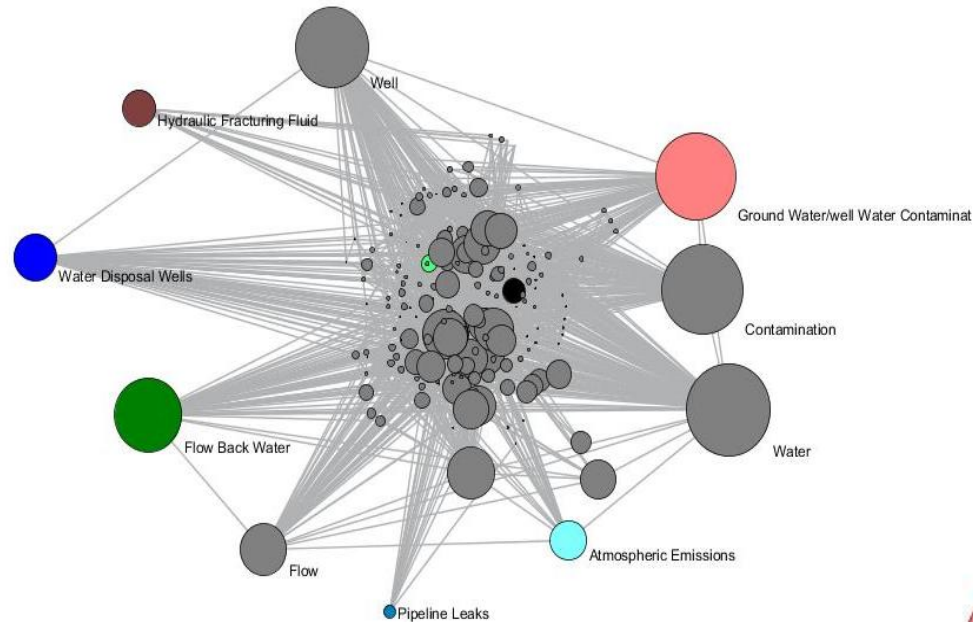
Informatics Research Questions

1) **What are the primary topics and concerns present in sources of information about shale gas and hydraulic fracturing?**



2) **How do media reports align topics of concern with scientific knowledge and how do presentations vary across geographic regions?**

Scientific Literature



Data source:

Scientific Publications from peer-reviewed literature (Web of Science database)

Timeframe:

10 years from July 2001 to July 2011

Topical Search:

Subject Matter Experts List of Keywords
Combinatorial Search with Keywords





Regulation of Shale Gas Development: Coverage

- Federal and State Regulations addressed
- Full cycle of shale gas well construction included
- Sixteen states with current or pending shale gas production

Shale Gas Development Cycle for Regulation



1. Exploration/testing
2. Locating of well pad
3. Constructing well pad and facilities
4. Transporting equipment, fluids
5. Drilling and casing
6. Controlling air emissions
7. Withdrawing water
8. Fracturing the well
9. Preventing spills
10. Testing and replacing water supplies
11. Storing waste
12. Disposing of waste
13. Remediating the site

Preliminary Findings: Shale Gas Regulation

- Most regulatory authority lies with states
- Majority of state regulations were written before shale gas development
- Recent regulatory focus on three concerns
 - Proper casing of shale gas wells
 - Disclosure of content of fracturing solution
 - Proper management of flowback and produced water
- Local regulation of shale gas development activities should be considered and assessed

Preliminary Findings: Shale Gas Regulation

- Regulatory updates have been done by many states
- But gaps remain in some states in dealing with
 - Risks of surface spills
 - Well casing and cementing
 - Water withdrawal and use
 - Wastewater disposal

Enforcement Capacity

Findings



- Most states have capacity to address a variety of complaints
- Also to conduct independent inspections and enforcement actions
- Michigan has relatively higher capacity (e.g. 17,000 oil & gas inspections in 2010)
- Pennsylvania also quite active (e.g. 1400 shale gas wells inspected in 2010)

General Observations

- Many of the violations are procedural and:
 - represent no environmental effects, or
 - are minor with no environmental effects
 - represent minor effects, such as small releases
- Many of the effects noted occur in all types of oil and gas well development – not unique to shale gas
- Fractured wells may experience more incidents because of additional equipment on the site

Enforcement Actions: Preliminary Findings



- Four states assessed so far: LA, MI, NM, WY
- Types of violations
 - Well pad and access road construction
 - Site maintenance
 - Drilling (and potentially fracturing)
 - Fracturing-specific violations
 - Waste storage and disposal
 - Plugging and remediation
 - Procedural violations

Enforcement Actions: Types of Violations



	LA	MI	NM
Total Violations	135	498	82
Major (%)	0.6	0	11.4
Substantial (%)	7.1	14.8	40.5
Minor (%)	1.9	24.4	20.3
No Effect (%)	30.8	28.0	20.3
Procedural (%)	60.0	33.0	25.4

Enforcement Actions: Preliminary Findings



- Shale gas regulations should address all stages of shale gas development
- Regulatory emphasis needs to focus more on surface events (e.g. spills) and less on hydraulic fracturing risks. Emphasis on groundwater detracts from potentially higher risk of surface incidents
- Surface effects easier to identify – less likely to detect subsurface effects without sampling which is not common. Need more baseline information on surface and groundwater quality

Environmental Impacts: Preliminary Findings

- Leakage associated with hydraulic fracturing of shale formations at depth has not been observed
- Long-term, cumulative risks associated with hydraulic fracturing after gas production has ceased cannot be fully evaluated with existing information
- Blowouts are rare and their impacts can be remediated with standard approaches
- Water quality problems widely ascribed to shale gas well drilling are more apparent than real

Work in Progress

- Compiling the enforcement data from Texas, Pennsylvania, New York
- Completing the scientific review of environmental issues: water and air quality, seismic events
- Completing the informatics work – visual portrayal of claims and actual effects