

Model Regulatory Framework for Hydraulic Fracturing Operations

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The Promise of Natural Gas



The Environment
The Economy
National Security

Current Regulatory Environment





Activists/Groups

Legislation



- Dial Down the Rhetoric
- Identify the Real Obstacles to Responsible Development of this Resource
- Develop Workable Solutions to Overcome these Obstacles

Regulatory Considerations





- Air Emissions
- Water Supply/Water Handling/Water Disposal
- Surface Impact
 - Drilling Locations (Pit Construction; Chemical Storage; Erosion Control)
 - Infrastructure (Roads; Compressors; Pipelines; Water Treatment Facilities)
 - Truck Traffic and Road Damage
 - Protecting Underground
 Water Resources
- Frac Fluid Disclosure

Protecting Underground Water Resources





Drinking Water From Household Wells



Well Integrity Is the Key!



Cover photo courtesy of Charlene E. Shaw, U.S. Environmental Protection Agency

Well Integrity

Southwestern Energy®





Evaluating Mechanical Integrity of Well







Evaluating Stratigraphic Confinement





Cross sectional view

Evaluating Stratigraphic Confinement

- Southwestern Energy®
- Differences in rock properties (i.e. strength and brittleness/elasticity) between the target formation (Fayetteville Shale) and surrounding formations (Morrow Shale & Hindsville Lime) act to contain hydraulic fractures within the target formation.



• Hydraulic fractures follow the path of least resistance and continue to propagate within the Fayetteville Shale.

Microseismic Evaluation of Stimulation Treatment

SWN Southwestern Energy®



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9:36:00

10:04:48

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10:33:36

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7:40:48

8:09:36

8:38:24

Evaluating Stratigraphic Confinement – Shallow Wells





Well Construction Standards





Cross sectional view



Evaluating Mechanical Integrity of Well



- Internal Mechanical Integrity
 - Verify appropriateness of proposed casing program (e.g., size, grade, minimum internal yield pressure, etc.)
 - Test casing string to ensure it can withstand maximum stimulation pressure



- External Mechanical Integrity
 - Verify quality of cement
 - Identify top of cement
 - Test cement job (FIT, CBL, etc.) when operations indicate inadequate coverage







TARGET PRODUCING ZONE



CONDUCTOR PIPE

SURFACE CASING

PRODUCTION CASING

<u>Southwestern Energy</u>

INTERMEDIATE PRODUCING ZONE

TARGET PRODUCING ZONE



Monitoring Frac Job and Producing Well



- Monitor annular pressures during and after frac job
- Terminate operations and take corrective action if abnormal pressure responses indicate mechanical integrity failure or fracture growth out of target zone



