HORIZONTAL DRILLING AND HYDRAULIC FRACTURING CONSIDERATIONS FOR SHALE GAS WELLS

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Bureau d’audiences publiques sur l’environement (BAPE)
Saint-Hyacinthe, Québec
October 13-14, 2010
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INTRODUCTION

• Shale gas holds tremendous potential for North American energy supply.
• Environmental considerations, especially those related to horizontal drilling and water use for high volume hydraulic fracturing (HVHF), have generated spirited debate among all stakeholders.
• Many of the concerns raised by the public stem from a lack of technical awareness of how shale gas development occurs.
UNCONVENTIONAL NATURAL GAS

• Unconventional resource plays are a growing source of natural gas in North America
  – Coal Bed Methane
  – Tight Sands
  – Gas Shales
• Since 1998, Unconventional natural gas has increased by nearly 65% in the U.S.
• As of 2007, total gas from unconventional plays approached almost 50% of the total natural gas production in the U.S.

Source: John Perez, Copyright ©, 2008
SHALE GAS HISTORY

• First Commercial Gas well – Fredonia, NY (1821)  
  – Production from “Dunkirk Shale” at a depth of < 30 feet
• Ohio Shale – Big Sandy Field (1880)
• First use of HVHF in Barnett Shale (1986)
• First horizontal well drilled in Barnett Shale (1992)
• Horn River Shale, Canada (2006)
• Montney Shale, Canada (2007)
THE SHALE GAS TRIFECTA

Three factors made shale gas production economically viable:

• Advances in horizontal drilling
• Advances in hydraulic fracturing
• Increases in natural gas prices
N.A. SHALE GAS PLAYS
SHALE GAS BENEFITS

- The United States: national energy security, the economy, environment
- Individual States: the economy, tax revenues, local resources, jobs
HORIZONTAL DRILLING

- Shale gas multi-well pads typically require 2-5 acres initially:
  - Reclaimed to less than 2 acres after drilling is complete
- Multiple wells on a pad
  - 4-8 wells is typical
  - 12-16 is possible given certain conditions
- Pad preparation takes approximately one week
DRILLING THE WELLS

• Drilling operations operator 24/7 with a well taking ~90 to 120 days to drill
• Depths range from 0.8 km to over 3 km below surface
• Wells are oriented for maximum production based on geology
• Horizontal drilling allows operators to drill under homes and schools from almost a mile away
• Computer driven, state-of-the-art technology
Groundwater resources are protected by multiple casing strings and cement coupled with strict construction requirements.
HIGH VOLUME HYDRAULIC FRACTURING

• Necessary due to low matrix permeability
• Key to successful fracture treatments is to keep fractures created in the target zone
• Fracturing out of the target zone is not cost effective:
  – Adds extra cost to stimulation job
  – Could adversely affect productivity of the well
Hydraulic Fracturing Design

HVHF Operations

- Extensive up-front work with computer modeling to help design stimulation job
- Models are used to evaluate variables
  - Fluid volumes
  - Proppant size
  - Pressures during treatment
  - Fluid design
- Monitoring of fracture propagation during the stimulation job
  - Micro-seismic fracture mapping
  - Tiltmeter measurements
HVHF OPERATIONS

- Fracturing a horizontal well uses between 3 to 5 Million gallons of water
  - Delivered by truck or temporary pipeline
  - Stored in tanks, or local or centralized impoundments
- Fracturing job takes a few days to one week
- 15% to 30% of the fracture fluid is recovered as flowback
- Produced water may continue long term
Fracture Fluids

- 98-99.5% of slickwater fracturing fluid is water
- Each additive has an engineered purpose
- Proppant (sand)
HF FLUID COMPOSITION

HF Fluid with 15% Recycled Water
- Fresh Water, 71.3%
- Recycled Water, 12.6%
- Sand, 15.6%
- Other, 0.004903923

HF Fluid with 100% Fresh Water
- Fresh Water, 90.23%
- Sand, 9.11%
- Other, 0.0065186

99.4% Water and Proppant
- Fresh Water, 99.4%
- Proppant, 0.6%
- Other, 0.004903923

99.3% Water and Proppant
- Fresh Water, 99.3%
- Proppant, 0.7%
- Other, 0.0065186

Components:
- Acid, 0.40%
- Friction Reducer, 0.08%
- Biocide, 0.01%
- Surfactant, 0.10%
- Scale Inhibitor, 0.02%
- Iron Control, 0.02%
- Gelling Agent, 0.001%
- Acid Corrosion Inhibitor, 0.0008%
- Breaker, 0.00006%
GROUNDWATER RISK

• A 1989 API & DOE study determined that in basins with “reasonable” likelihood of corrosion, the risk probability of injectate reaching a USDW ranged from 1 in 200,000 to 1 in 200,000,000 for UIC wells
  – Injection is on a continuous basis

• Shale Gas Hydraulic Fracturing Differences
  – Very short in duration
  – Within multiple installed concentric casing strings and cement

• Risk is very low
WATER SOURCING

• Options available to meet water needs for drilling and fracturing
  – Surface Water
  – Groundwater
  – Municipal Water
  – Industrial Water
  – Recycled Produced Water
  – Collected Water
  – Private Water Purchases

1,000,000 gallons = ~3,785 m³
SOURCING CHALLENGES

- Options vary by location and operator
- Competing water users and availability must be considered

Groundwater Use in Barnett shale counties ranges from 1.95 percent in Somervall County to 85 percent in Cooke County.
INVITATION TO READ

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