Hydraulic Fracturing Principles and Operating Practices

Select Committee on Hydraulic Fracturing

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CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

Hydraulic Fracturing is not new

First commercial hydraulic fracturing job was at Velma, Oklahoma in 1949
(Courtesy of Halliburton, 2010)

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Natural gas and emissions

- **Natural gas burns about 50% cleaner than coal when used in power generation and has far fewer emissions**
  - CO2 emissions from energy use lowest in 20 years, partially because of increased natural gas use in power generation (U.S. EIA 2012)

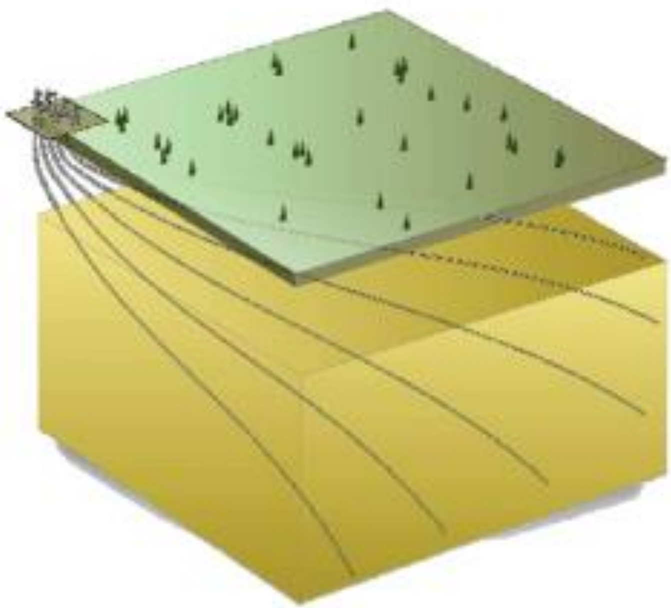
- **Scientific research indicates little difference between shale gas and conventional gas in terms of GHG emissions:**
  - "life-cycle GHG emissions of natural gas produced from shale resources are only slightly higher(3.8%) than those of natural gas produced from more conventional sources" (**NRCan 2012**)
  - "relatively little difference between conventional and shale gas in life-cycle GHG emissions" (**ICF Consulting Canada 2012**)
  - "it is also clear is that the production of shale gas and specifically, the associated hydraulic fracturing operations have not materially altered the total GHG emissions from the natural gas sector" (**MIT, Nov 2012**)

Water Use: The Facts

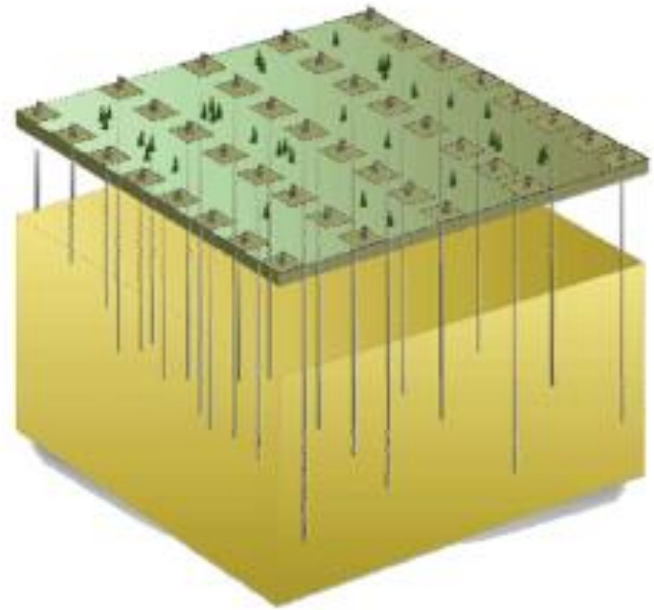
- In BC, of all surface water authorized (excluding waterpower), the oil and gas industry accounted for less than 1% (0.6) of the total
  - Source: BC Oil & Gas Commission, 2010
- Commonly 50 to 90% of fracturing fluid is recovered
- Fracturing fluid is 98.5% water and sand
- Disclosure of fracturing fluid additives is mandatory in AB & BC on Fracfocus.ca

Reducing Surface Footprint

Multi-well pads have significantly reduced the amount of disturbed area versus a comparable vertical well development



6 Horizontal wells (8 fracs/well) = 48 total fracs per section



Same development would require 48 vertical wells each on a separate wellsite

Adapted from www.encana.com

Opportunities for the Yukon

- Territorial Government revenues
  - Royalties
  - Taxes

- Social Benefits: individual & societal
  - Jobs & increased standard of living & income
  - Strengthened social programs via bolstered government revenues

- Local & Reliable Energy Supply
  - Natural gas is cleaner
  - Reduce local energy costs via reduced imports

Social License:
Earning Confidence & Trust

- Effective & efficient government oversight of industry operations
    - world class regulatory frameworks

- Industry commitment to continued social and environmental performance
    - Transparency in operations, outcomes

- Leadership in technology & innovation investments

- International recognition & reputation for leadership

CAPP Guiding Principles for Hydraulic Fracturing

CAPP Guiding Principles for Hydraulic Fracturing

1. We will safeguard the quality and quantity of regional surface and groundwater resources, through sound wellbore construction practices, sourcing fresh water alternatives where appropriate, and recycling water for reuse as much as practical.
2. We will measure and disclose our water use with the goal of continuing to reduce our effect on the environment.
3. We will support the development of fracturing fluid additives with the least environmental risks.
4. We will support the disclosure of fracturing fluid additives.
5. We will continue to advance, collaborate on and communicate technologies and best practices that reduce the potential environmental risks of hydraulic fracturing.

CAPP Hydraulic Fracturing Operating Practices

Hydraulic Fracturing Regulations

- **Well Casing & Cementing**
  - Casing design and cementing requirements isolate and protect usable groundwater
  - Surface casing must be cemented to surface
- **Protecting Water Wells & Groundwater**
  - Fracturing at shallow depths (<600 m) requires risk assessment
  - Fracturing restrictions in proximity to water wells
  - Only non-toxic fracturing fluids can be used above usable groundwater
  - Baseline water well testing prior to hydraulic fracturing:
    - Not currently required in AB, but requirements are expected in 2014
    - In BC, water well testing may be a condition of well approval if concerns arise
    - Most companies voluntarily test nearby water wells prior to drilling
- **Chemical Disclosure**
  - Mandatory to publicly disclose fracturing fluid composition; mandatory in BC & AB

Hydraulic Fracturing Regulations

- **Water Use**
  - Water licences/permits required for fresh water withdrawals
  - Licences/permits have withdrawal limits and reporting requirements
- **Fluid Handling & Management**
  - Requirements for proper containment of fluids used or generated
  - Fluids that cannot be recycled or reused must be injected into deep disposal wells
    - Disposal wells must meet design and construction requirements
- **Seismicity**
  - Seismic monitoring, reporting and mitigation (BC)
- **Inter-wellbore Communication**
  - Risk assessment and well control plan required (AB)
  - Recommended notification of and coordination with other operators prior to hydraulic fracturing within 1000 m of a well (BC)

Appendices

CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

RESPONSIBLE CANADIAN ENERGY™

1 Fracturing Fluid Additive Disclosure

- **Publicly disclose, on a well-by-well basis, the chemical ingredients in additives used**
- **Supports action by provincial governments to make disclosure mandatory**


Frac Focus
Chemical Disclosure Registry
HYDRAULIC FRACTURING THE PROCESS
WATER USAGE & PROTECTION
FIND A WELL IN YOUR AREA
REGULATION PROVINCES & TERRITORI

Canada's first hydraulic fracturing registry now online

British Columbia is the first province in Canada to enforce the public disclosure of ingredients used for hydraulic fracturing.

FracFocus.ca - the registry which provides a transparent accounting of B.C. hydraulic fracturing operations - includes a database of the ingredients used to suppor extensive content about the regulations and safety procedures governing industry activity.

As of Jan. 1, 2012, public disclosure for hydraulic fracturing fluid is mandatory. By law, a list of ingredients used must be uploaded to the registry within 30 days of the point in time when a well is able to produce gas.

Hydraulic fracturing is subject to strict regulations in British Columbia. The Province has instituted laws to ensure the process protects groundwater and the environ incident of harm to groundwater from hydraulic fracturing within British Columbia.

The Province of B.C. built FracFocus.ca to accommodate future participation by other jurisdictions so there can be one national site for disclosure information.

The FracFocus.ca website delivers on a commitment made by Premier Christy Clark during the B.C. Oil and Gas Conference in Fort Nelson last September, where sh increase the transparency of hydraulic fracturing in B.C.

Contact:

Sandra Steilo

- **Disclosure on FracFocus.ca is mandatory in BC and Alberta**
- **Advocating for FracFocus.ca as disclosure vehicle across Canada**

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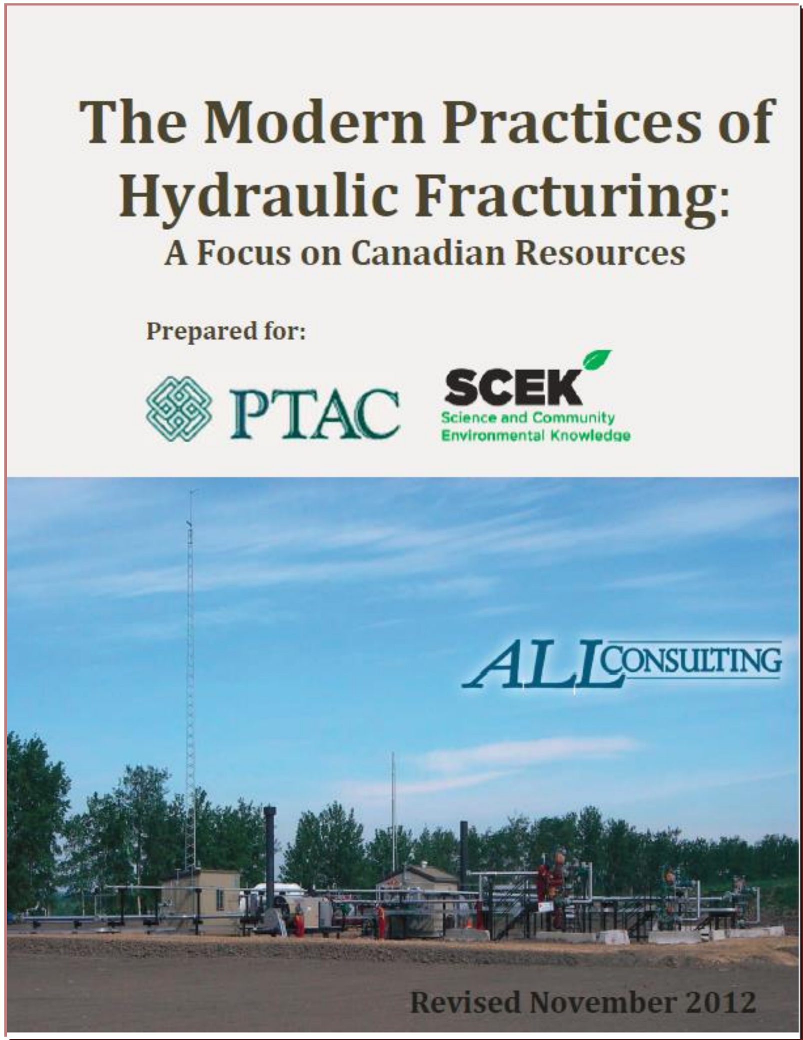
Fracturing Fluid Additive Risk Assessment and Management

- **Identify and manage potential health and environmental risks associated with these additives**
- **Develop risk management plans for each well fractured**

CAPP sponsored the development of a screening tool for its members to classify fracturing fluid additives according to potential health and environmental risks

Additives



Available on SCEK and PTAC websites

The Modern Practices of Hydraulic Fracturing: A Focus on Canadian Resources

Table 4: Fracturing Fluid Additives, Main Compounds and Common Uses

Additive Type	Main Compound	Use in Hydraulic Fracturing Fluids	Common Use of Main Compound
Acid	Hydrochloric acid or muriatic acid	Acids are used to clean cement from casing perforations and drilling mud clogging natural formation porosity, if any, prior to fracturing fluid injection (dilute acids concentrations are typically about 15% acid)	Swimming pool chemical and cleaner
Biocide	Glutaraldehyde	Fracture fluids typically contain gels that are organic and provide a medium for bacterial growth. Bacteria can break down the gelling agent reducing its viscosity and ability to carry proppant. Biocides are added to the mixing tanks with the gelling agents to kill these bacteria.	Cold sterilant in health care industry
Breaker	Sodium Chloride	Breakers are chemicals that are typically introduced toward the later sequences of a fracturing job to "break down" the viscosity of the gelling agent to better release the proppant from the fluid enhance the recovery or "flowback" of the fracturing fluid.	Food Preservative
Corrosion Inhibitor	N,n-dimethyl formamide	Corrosion inhibitors are used in fracture fluids that contain acids; they inhibit the corrosion of steel tubing, well casings, tools, and tanks.	Crystallization medium in Pharmaceuticals
Crosslinker	Borate Salts	There are two basic types of gels used in fracturing fluids: linear and cross-linked. Cross-linked gels have the advantage of higher viscosities that do not break down quickly.	Non-CCA wood preservatives and fungicides
Friction Reducer	Petroleum distillate or Mineral oil	Friction reducers minimize friction, allowing fracture fluids to be injected at optimum rates and pressures.	Cosmetics, nail and skin products
Gel	Guar gum or hydroxyethyl cellulose	Gels are used in fracturing fluids to increase fluid viscosity, allowing them to carry more proppant than straight water solutions. In general, gelling agents are biodegradable.	Food-grade product used to increase viscosity and elasticity of ice cream, sauces and salad dressings.
Iron Control	Citric acid	Iron controls are sequestering agents that prevent precipitation of metal oxides.	Used to remove lime deposits. Lemon Juice is ~ 7% Citric Acid
KCl	Potassium Chloride	KCl is added to water to create a brine carrier fluid.	Table salt substitute
Oxygen Scavenger	Ammonium bisulfate	Oxygen present in fracturing fluids through dissolution of air causes the premature degradation of the fracturing fluid; oxygen scavengers are commonly used to bind the oxygen.	Used in cosmetics
Proppant	Silica, quartz sand	Proppants consist of granular material, such as sand, mixed with the fracture fluid. They are used to hold open the hydraulic fractures, allowing the gas or oil to flow to the production well.	Play box sand, concrete or mortar sand
Scale Inhibitor	Ethylene glycol	Scale inhibitors are added to fracturing fluid to prevent precipitation of scale (calcium carbonate precipitate).	Automotive antifreeze and de-icing agent
Surfactant	Naphthalene	Surfactants are used to reduce interfacial tension and promote more efficient clean-up or flow-back of injected fluids.	Household fumigant (found in mothballs)

Source: GWPC and ALL Consulting, *Modern Shale Gas Development in the United States: A Primer*, prepared for the U.S. Department of Energy Office of Fossil Energy and National Energy Technology Laboratory (April 2009).

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3 Baseline Groundwater Testing

- **Enable assessment of potential changes in groundwater over time**
- **Test existing domestic water wells within 250 m of wellhead prior to drilling**
- **Participate in regional groundwater monitoring programs**

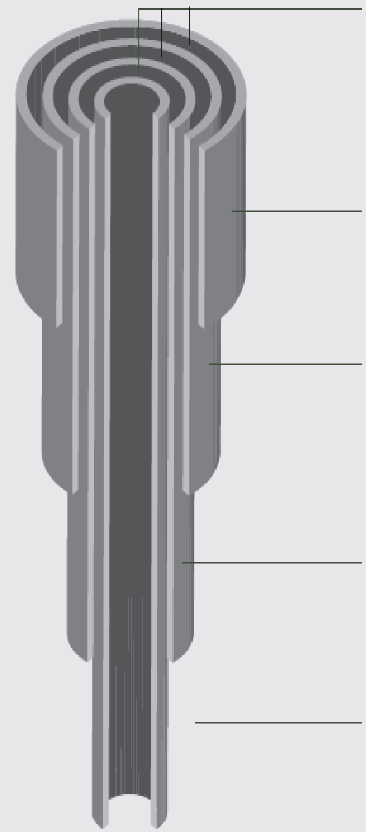
The BC Government has committed to establishing a collaborative groundwater monitoring system for northeastern BC

4 Wellbore Construction and Quality Assurance

- **Critical to protecting groundwater resources**
- **Compliance with regulations and good engineering practice**
- **Confirm wellbore integrity prior to fracturing**

Typical Well Casing Diagram

(Not to Scale)



5 Water Sourcing, Measurement & Reuse

- **Evaluate available water sources**
- **Measure and report water withdrawals**
- **Reuse water as much as practical**

Industry-funded supporting studies:

- Fracturing Fluid Flowback Reuse Feasibility Study & Design Tool
- Determination of Water Monitoring Standards for Oil & Gas Operators
- Integrated Assessment of Water Resources for Unconventional Oil & Gas Plays in West-Central AB

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Fluid Transport, Handling, Storage & Disposal

- Identify, evaluate and mitigate potential risks of fluid transport, handling, storage and disposal
- Enable quick and effective response to spills

7 Anomalous Induced Seismicity

- New practice introduced in late 2012
- Assess the potential for anomalous induced seismicity
- Where assessment indicates potential for anomalous induced seismicity exists, implement practices for:
  - Wellbore placement and drilling design
  - Personnel preparedness
  - Monitoring
  - Mitigation and response

Six new seismic monitors will be added in NEBC for a total of eight - paid for by industry and government