Yukon Oil and Gas Overview:
Resources, Activities & Regulatory Framework

Presented to:

Select Committee Regarding the Risks and Benefits of Hydraulic Fracturing

By:

Energy, Mines and Resources
Whitehorse, Yukon

September 27, 2013

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Outline

- Context
  - Introduction
  - Resources
  - Devolution and Legislation
  - Activities
- Unconventional Resources and Hydraulic Fracturing
- Regulatory Framework
  - Multiple Regulators
  - Oil & Gas Process
  - Drilling and Production Regulations
  - Territorial Land Use Regulation
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- Key Messages
- Additional Information
- Contacts

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Context - Introduction

- Material presented is introductory; detailed presentations on any topic can be delivered at any time to the Select Committee.
- Yukon *Oil and Gas Act (YOGA*) - focused on developing resources in a safe and environmentally responsible manner, and ensuring optimal value for the resource.
- Unconventional oil and gas development – similar to conventional and can be effectively managed with existing legislation (*YOGA*/regulations).
- Hydraulic fracturing – considerable debate amongst Yukoners continues.

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Context - Introduction

- Yukon's land base for all oil and gas activities is limited (~17% of Yukon).
- Oil and gas activity in Yukon has been minimal to date (majority of drilling in the 1960s and 1970s).
- Yukon has received, and continues to receive, significant benefits from oil and gas activity (revenue, jobs, training and business opportunities).
- While the primary oil and gas regulator in Yukon is EMR (OGR), other Yukon regulators and assessors play key roles.
- EMR continues to work closely with other oil and gas regulators and Yukoners to ensure Yukon's oil and gas legislation is modern and robust.

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Context - Resources

Yukon's Conventional Oil & Gas Resources

Basin	Nat Gas (Tcf)	Oil (MMbbls)
Eagle Plain	6.06	437
Liard	4.11	0.1
Peel Plateau and Plain	2.92	0
Old Crow	1.15	0
Beaufort-Mackenzie	1.01	217
Bonnet Plume	0.80	0
Kandik	0.65	99
Whitehorse Trough	0.42	19
Totals	17.1	771
Offshore*	40	4.5

***Currently federal jurisdiction**

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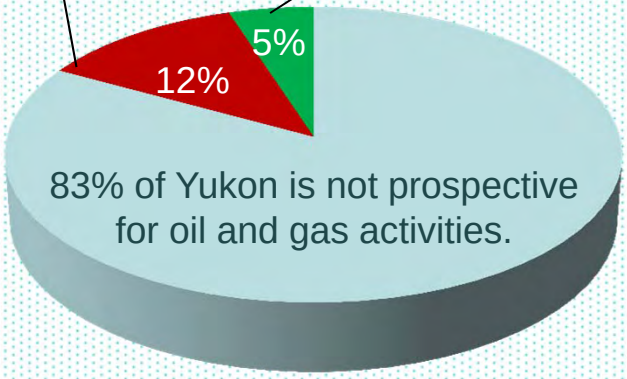
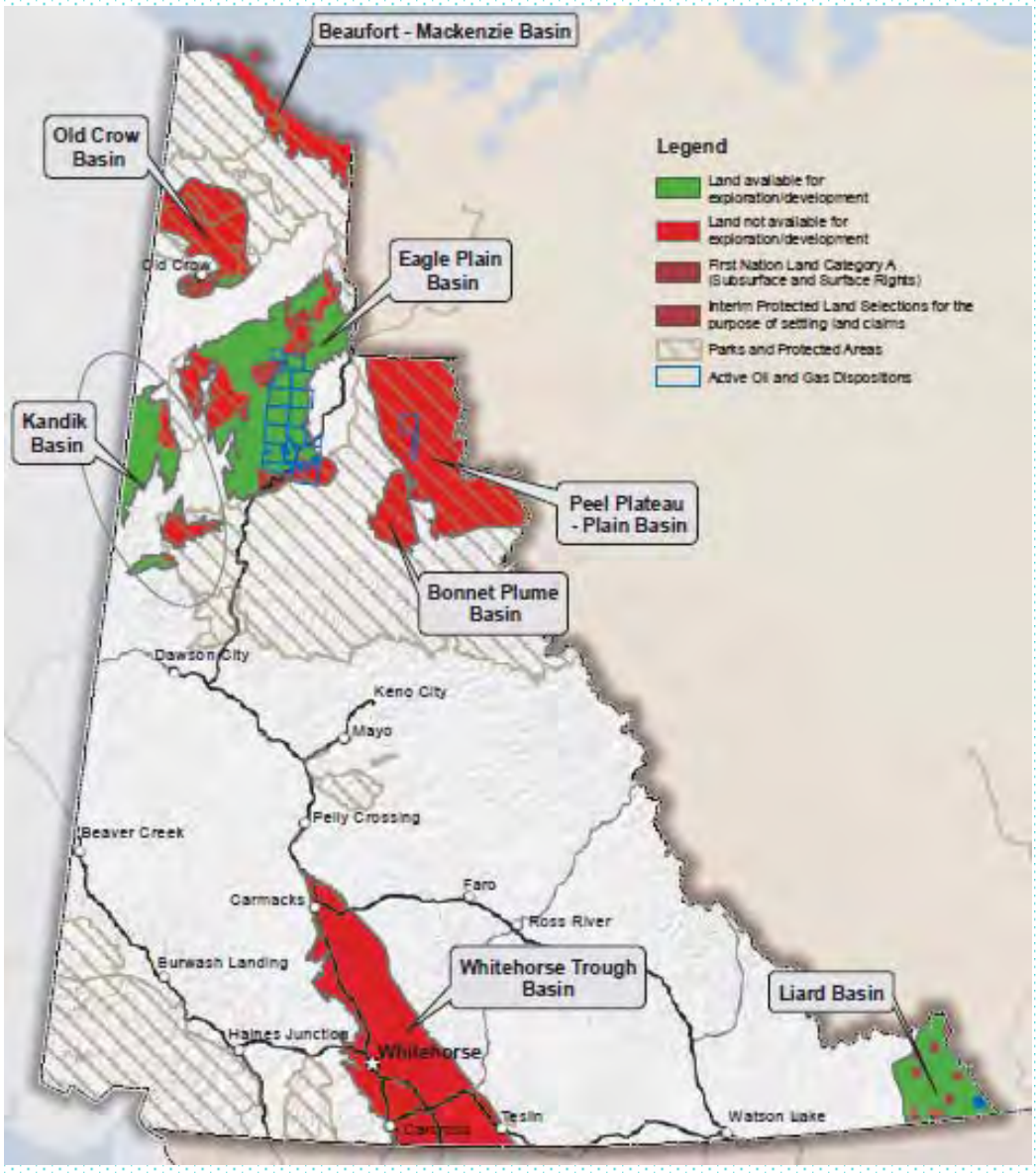
Context - Resources

17% of the Yukon is underlain by sedimentary basins; of that, 5% is currently available.



Yukon Geological Survey staff are experts on the geological characteristics of each basin



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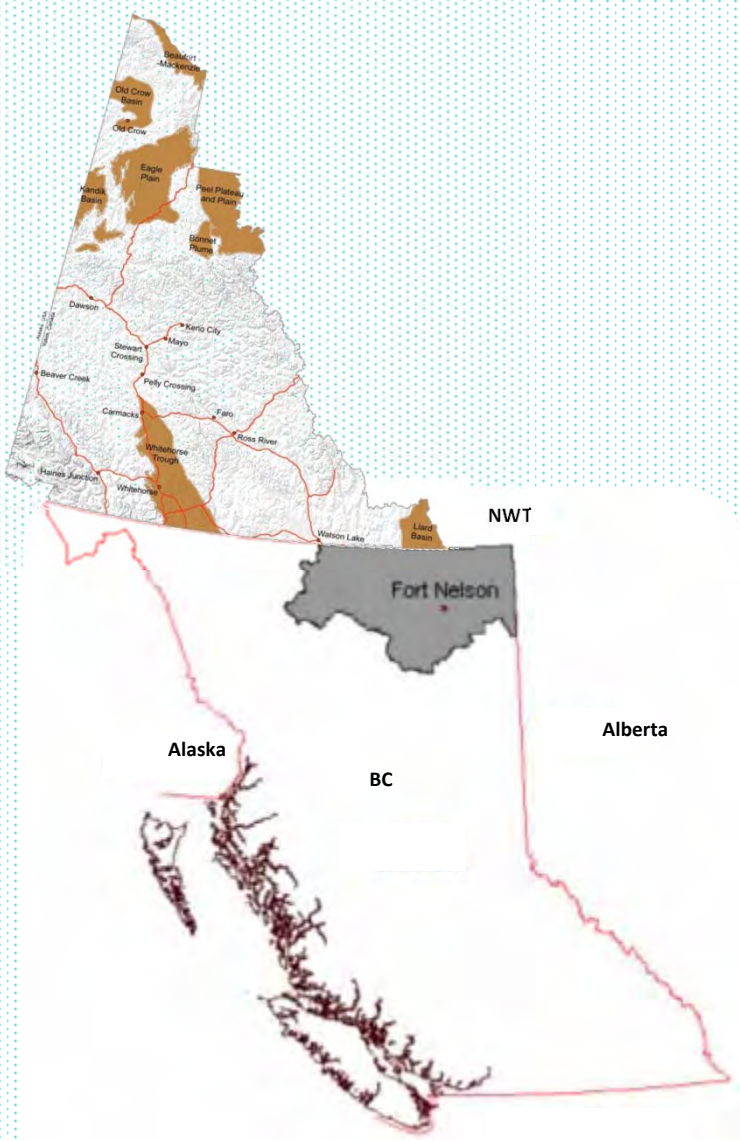
Context - Resources

The surface land available within the 5% is further reduced by:

- land use plan allowances.
- surface features such as streams, protected habitat areas, surface improvements, wetlands, etc.

Note: After 60 years of development (6400 wells drilled) in B.C.'s Fort Nelson Land and Resource Management Area, the amount of surface land utilized for oil and gas development is about 1.5% of the total area in that region.



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Context – Devolution and Legislation

- Pre-1998 Canada regulated oil and gas resources in Yukon.
- 1993 Canada-Yukon Oil & Gas Accord.
- 1998 Yukon *Oil and Gas Act* (*YOGA*).
  (came into effect 1998, amended 2012)
  - Disposition Regulations (in effect)
  - Geoscience Regulations (in effect)
  - **Drilling and Production Regulation**
    (in effect and under review)
  - Licence Administration Regulations (in effect)
  - Royalty Regulations (in effect)
  - Gas Processing Plant Regulation (in effect)
  - Pipeline Regulation (under development)

Well Drilling History

1958	1
1960s	32
1970-74	29
1977-1998	8
2005-present	6
TOTAL	**76**

Basin Activity

Eagle Plains	38
Peel Plateau	19
Liard	12
Other	7
TOTAL	**76**

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Context – Devolution and Legislation

***YOGA* objectives include:** Environmental Protection, Operational Safety, Worker Safety, Community Safety and Fair Return.

- Care for essential ecological processes and preservation of biological diversity.
  - Integrate environmental and socio-economic effects in decision making.
  - Conserve and prevent waste of resource.
  - Applies throughout Yukon.
  - Safe and efficient practices.
- Fair and equitable return to Yukon people.
- Facilitate common regime with Yukon First Nations.
- Intend to be 'Best in Class.'

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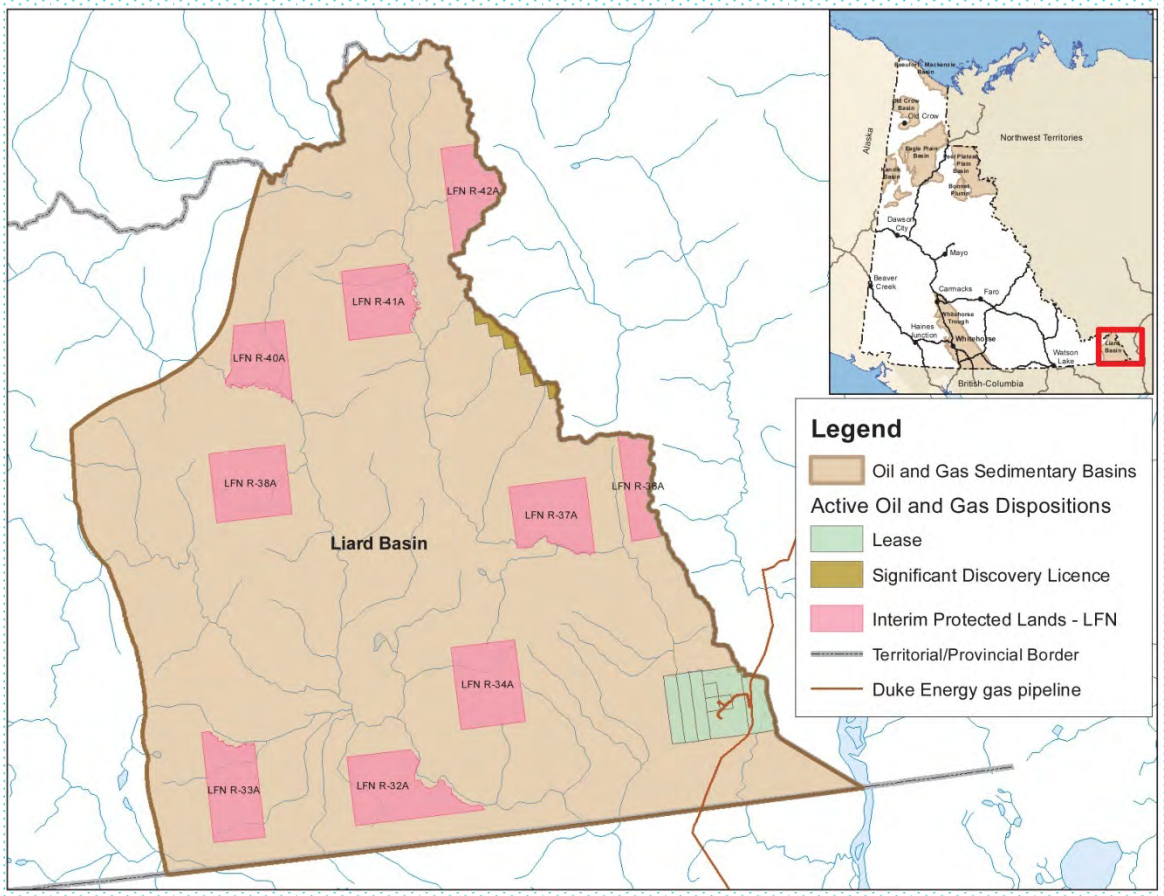
Context – Activities

Liard Basin

- Kotaneelee gas field.
- $46M in royalties from natural gas production since devolution.
- Facilities and rights recently acquired by EFLO Inc.
- New owners in planning phase.
- Shale gas potential.



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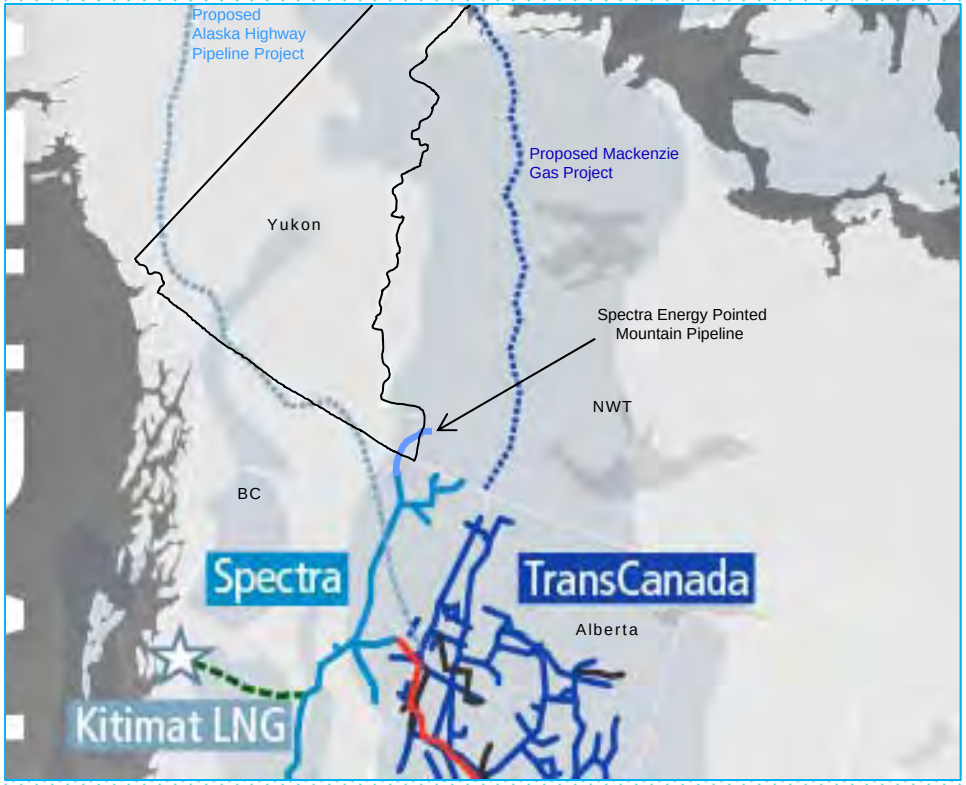
Context – Activities

Liard Basin

- Existing pipeline to NE B.C. and beyond to markets.



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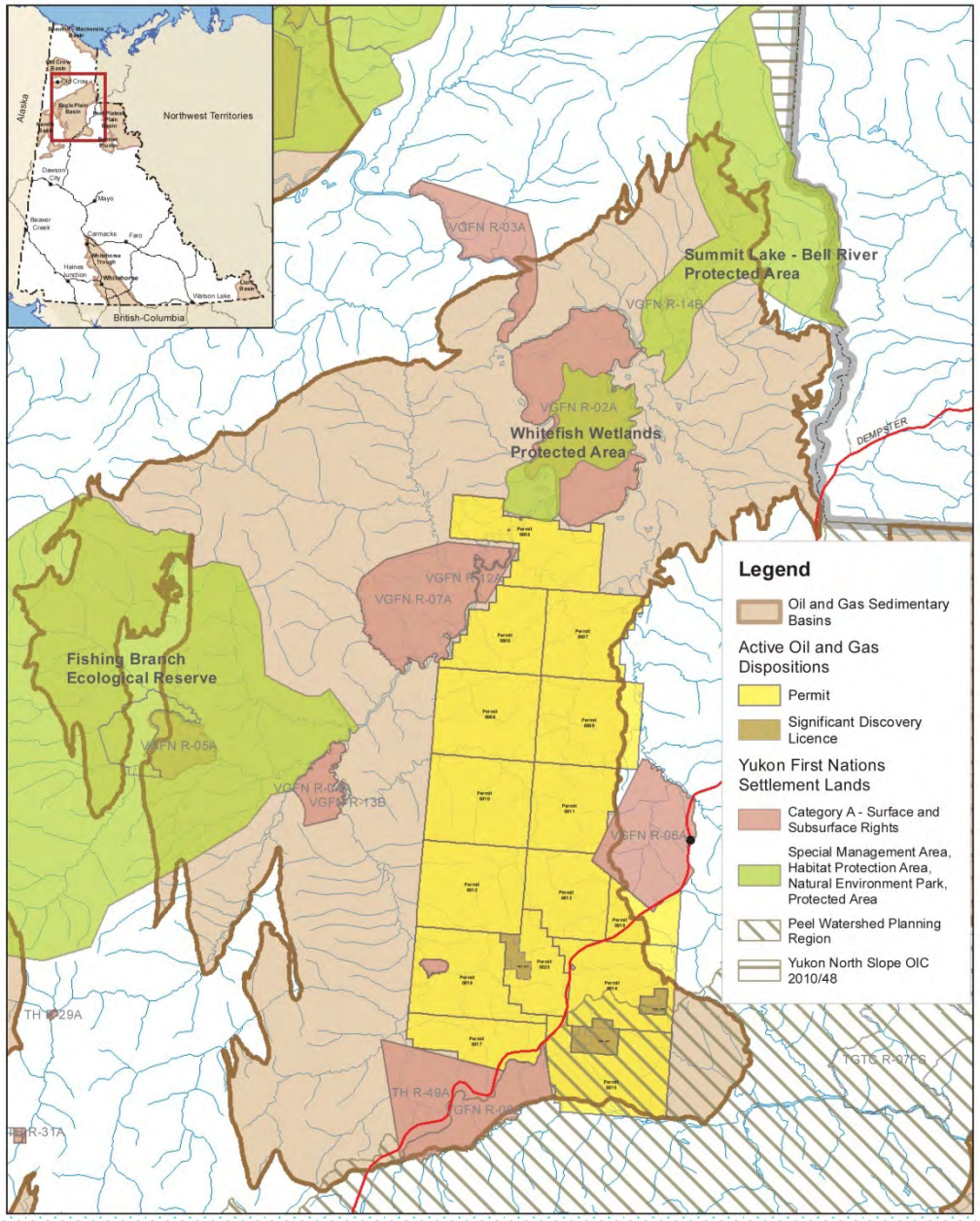
Context – Activities

Eagle Plain Basin

- $65 million in work bids since devolution.
- Northern Cross (Yukon) Ltd. continues to assess conventional and unconventional resources within its exploration permits.
- Four wells drilled in 2012/13 (vertical) with expenditure of $80 million.
- 3D seismic program proposed for 2013/14.
- Shale gas potential.



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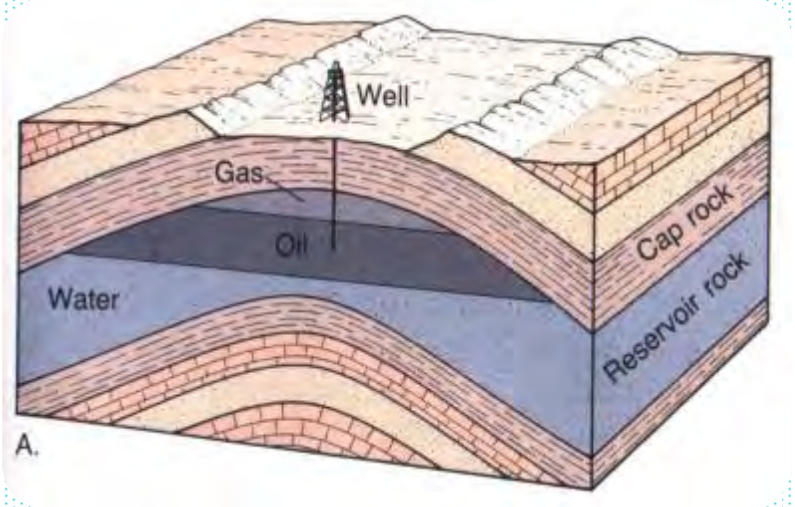
Unconventional Resources and Hydraulic Fracturing

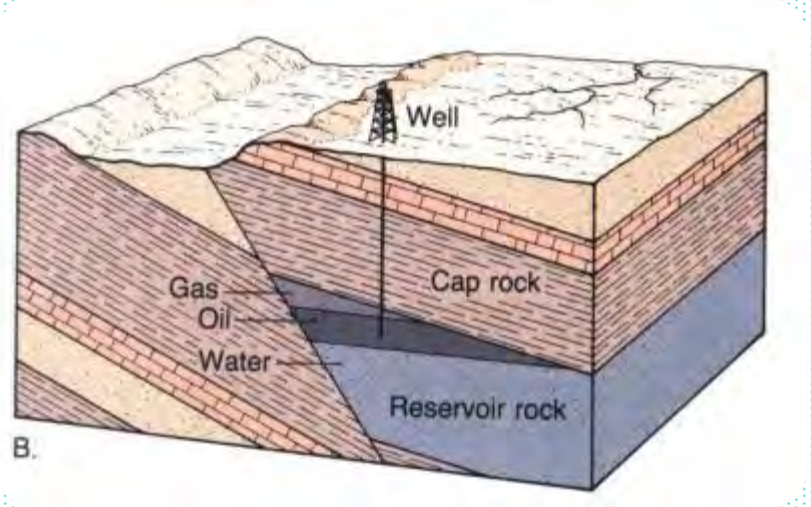
Conventional Resources

- Conventional oil or gas accumulations are trapped in structures in the rock.
  - Requires: (1) Source, (2) Migration, (3) Trap, and (4) Reservoir.
- Majority of historic production has come from conventional deposits.
- These deposits were typically accessed by vertical wells.

Traps/Seals



Fold



Fault

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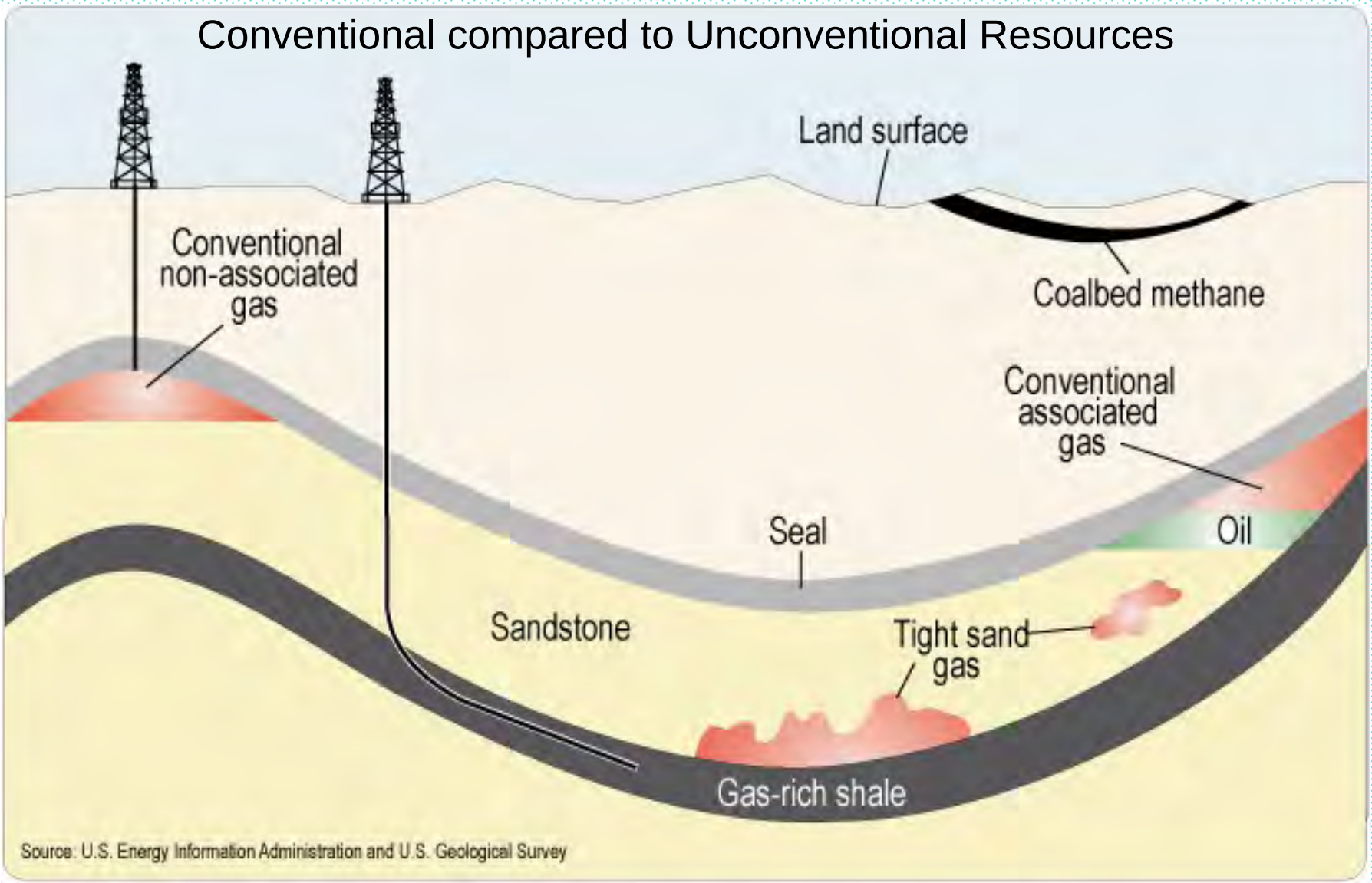

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Unconventional Resources and Hydraulic Fracturing

The Transition to Unconventional Resources

Enabled by three key innovations:

- Horizontal wells.
- Multi-stage hydraulic fracturing.
- Multi-well pads.

The supply of North American natural gas and oil is now largely dependent on unconventional resources.

- Decline in conventional resources in Western Canadian Sedimentary Basin and elsewhere in North America.

NOTE: to extract these resources currently requires hydraulic fracturing

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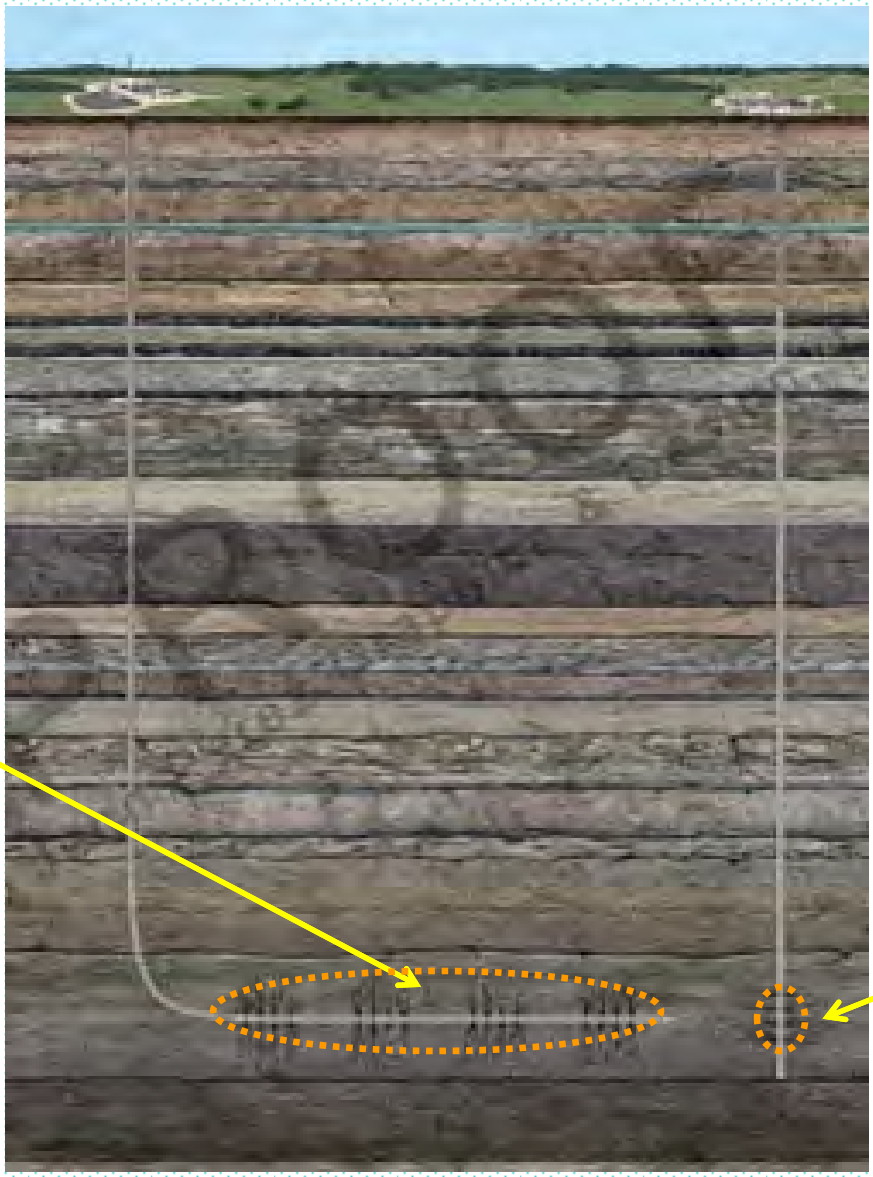
Unconventional Resources and Hydraulic Fracturing

What is hydraulic fracturing?

- Hydraulic fracturing is a technique (a 'completion process' following the drilling of the well) used to crack tight formations to allow hydrocarbons (gas or oil) to flow to the wellhead and be recovered. It typically includes a well-stimulation process in which fluids, proppant and additives are pumped under high pressure into the hydrocarbon-bearing formation.
- First used in 1947 and has evolved from conventional targets. It's use increased after the 1970s energy shortages, and with US Gov't research and incentives.
- Today it is widely used across resource plays throughout North America and elsewhere.
- Currently, approximately 90% of BC wells, 60% of Saskatchewan wells and 75% of Alberta wells are horizontal and hydraulically fractured.

Unconventional Resources and Hydraulic Fracturing



Vertical vs. Horizontal Fracturing

Horizontal Fracturing
- More reservoir 'access'

Vertical Fracturing
- Limited reservoir 'access'

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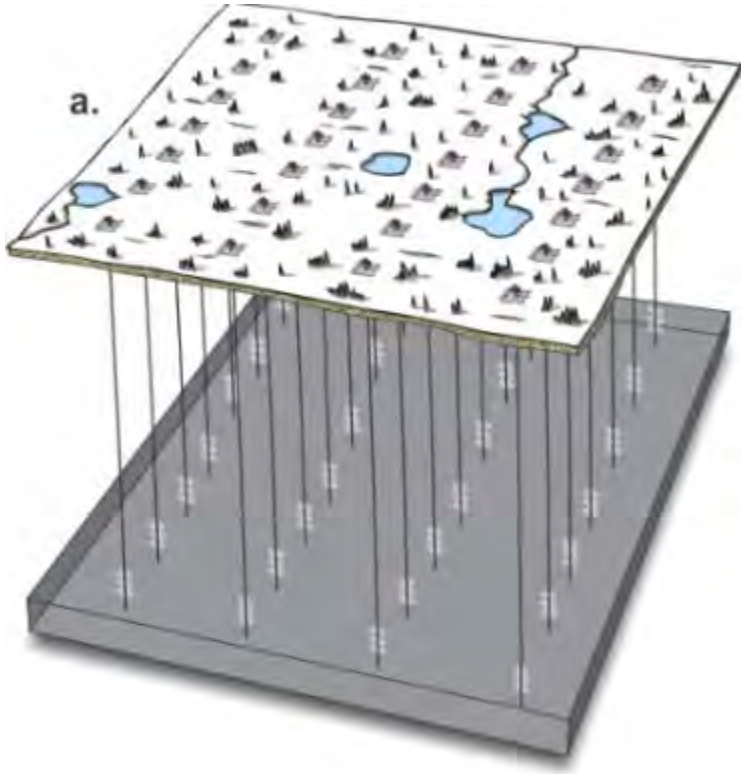
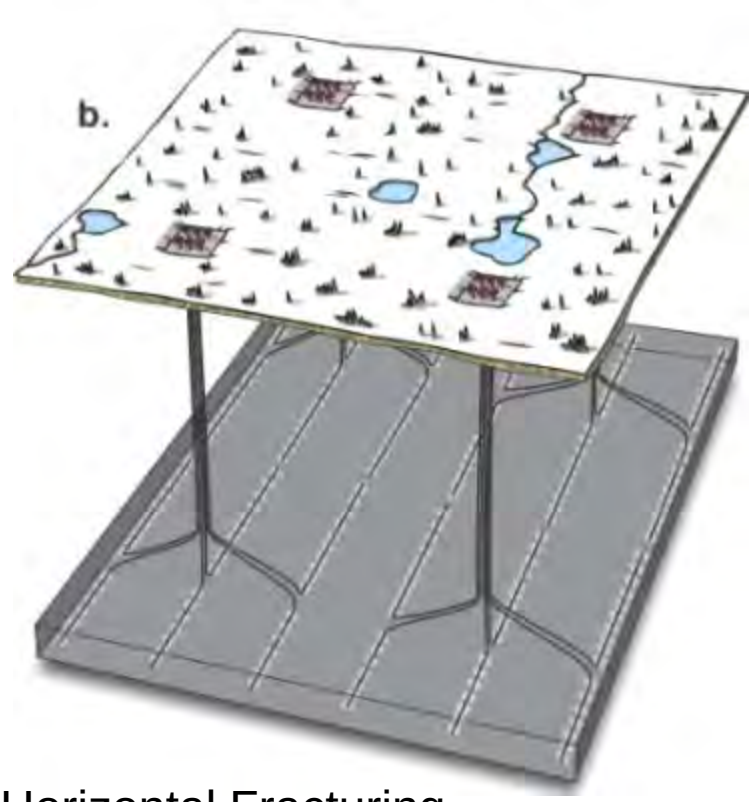
Unconventional Resources and Hydraulic Fracturing

Surface Impacts - Vertical vs. Multi-Well Pads



Vertical Fracturing
- Requires numerous well sites



Horizontal Fracturing
- Reduces surface footprint
- Ability to plan
- Efficient infrastructure

Play Video

OGC video if available via internet

http://www.bcogc.ca/horizontal-drilling-video

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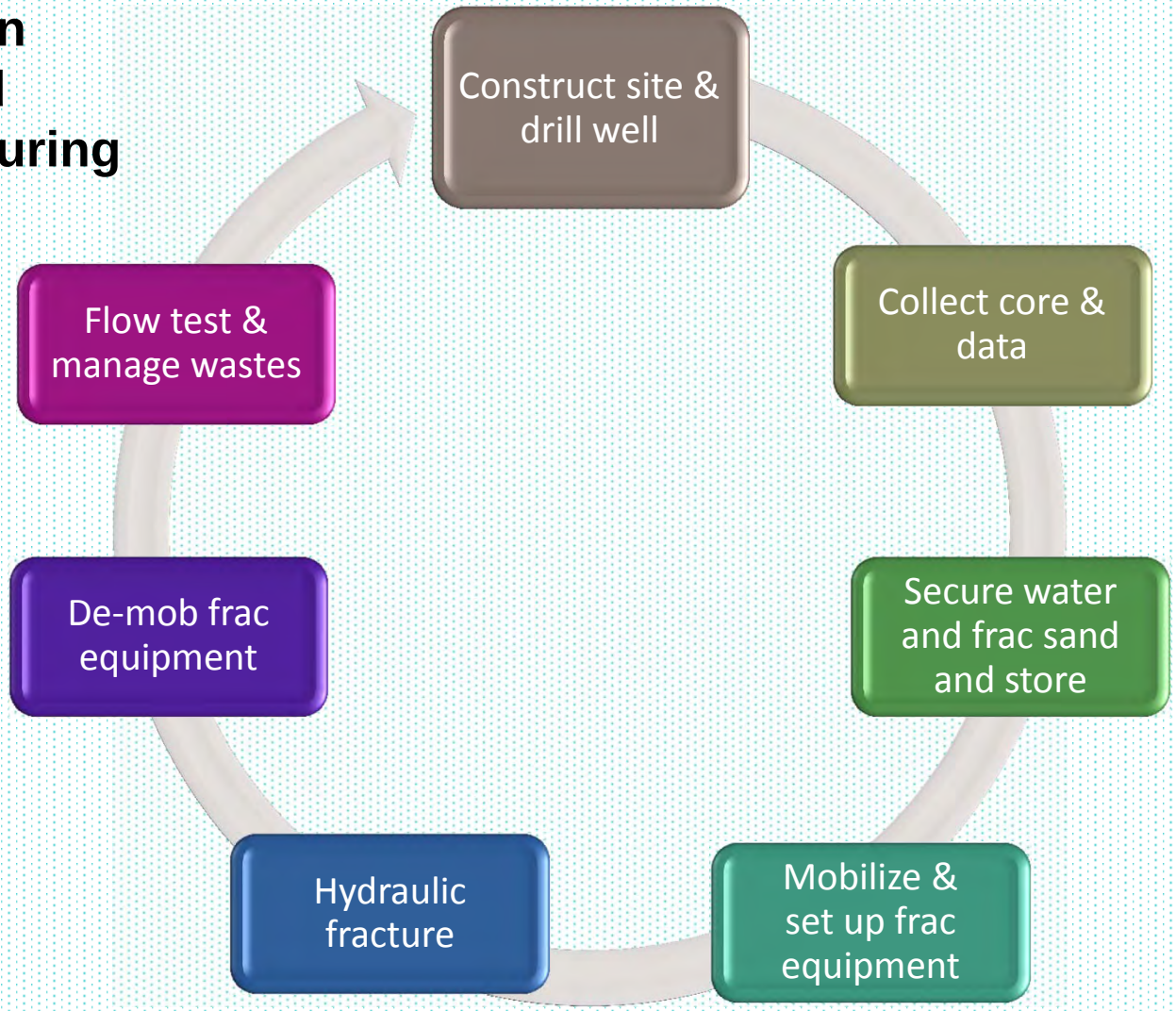
Unconventional Resources and Hydraulic Fracturing

Key Steps in Drilling and Hydraulic Fracturing Processes



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Unconventional Resources and Hydraulic Fracturing

Construct site and drill well

- Prepare surface for equipment and supplies (access may be required).
- Set up drilling and related equipment and drill well.

An example of a horizontal well:

- 2000m vertical depth to target horizon.
- 1500 to 3500m lateral portion.
- About 20 days to drill.

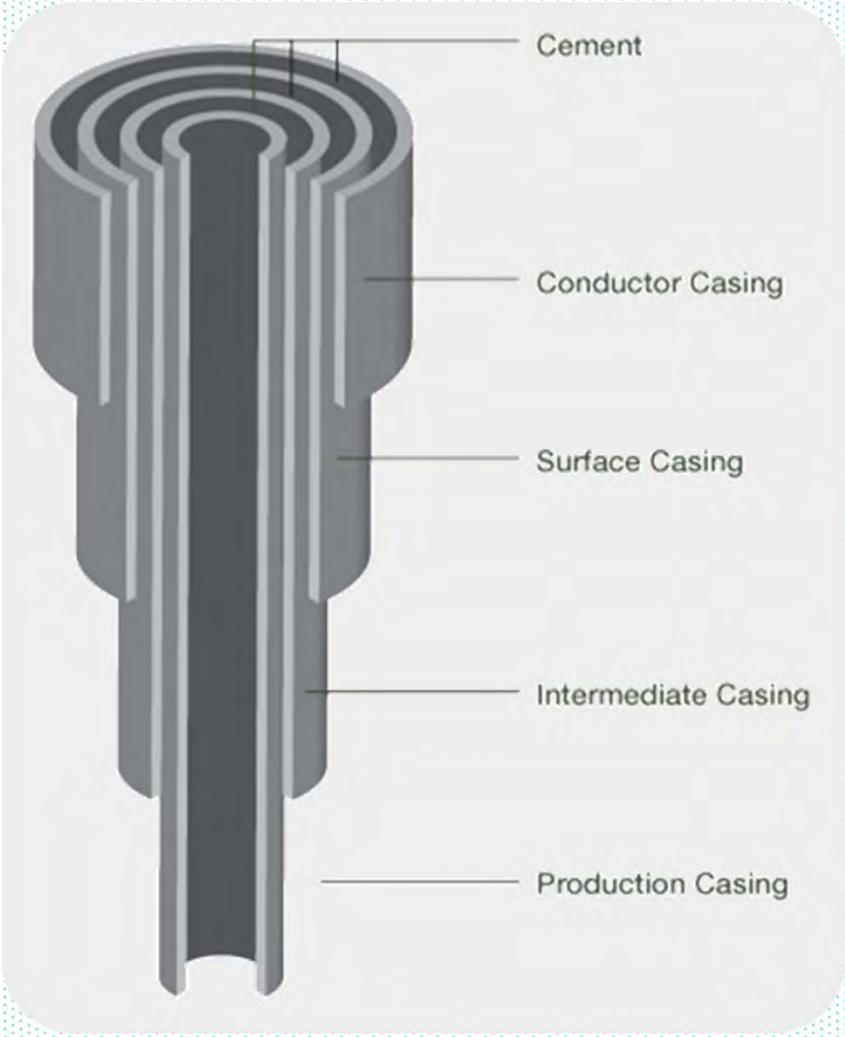
Unconventional Resources and Hydraulic Fracturing

Key Aspects of Well Drilling

- Industry is required to abide by strict well casing regulations.
- Specially designed cement is placed along the entire length of the surface casing, which extends below the lower limit of non-saline groundwater.
- A second steel casing is fully cemented.
- Casing and cement provide impenetrable barriers between fluids in the casing and any fresh/non-saline groundwater.

Typical Well Casing

(not to scale)



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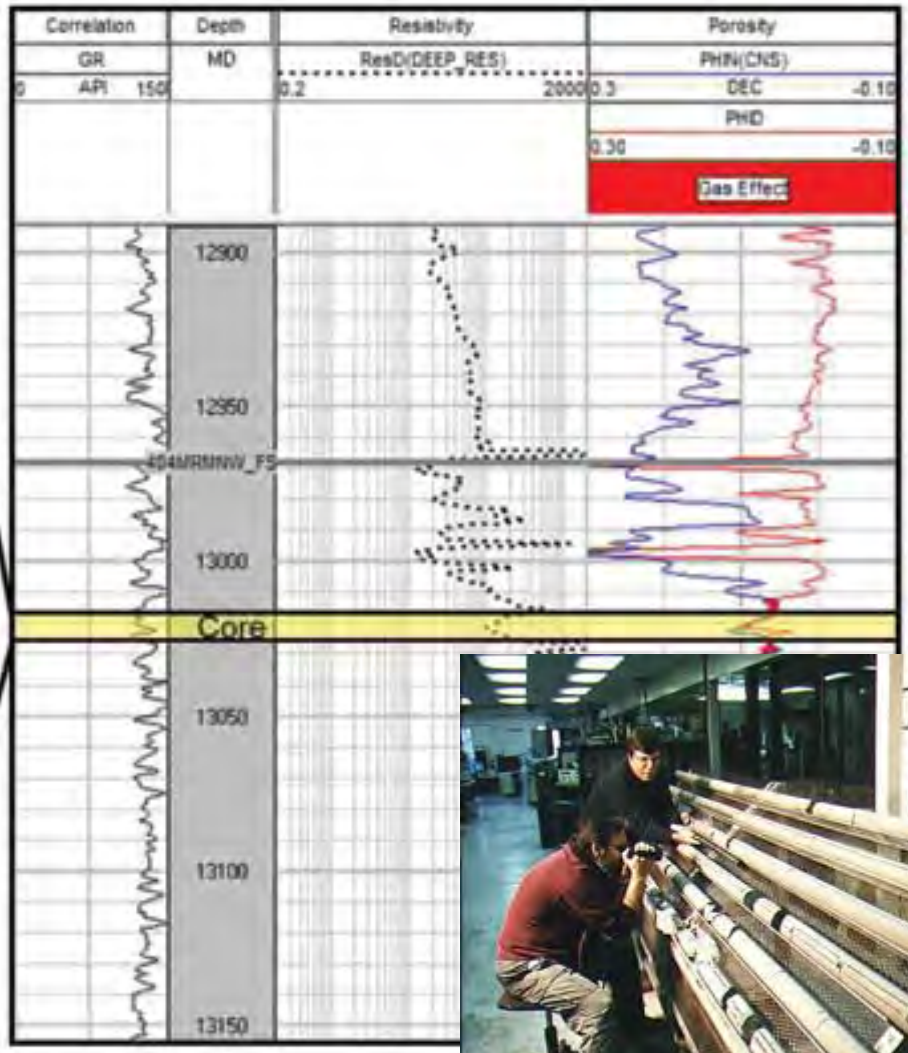
Unconventional Resources and Hydraulic Fracturing

Collect Core and Data



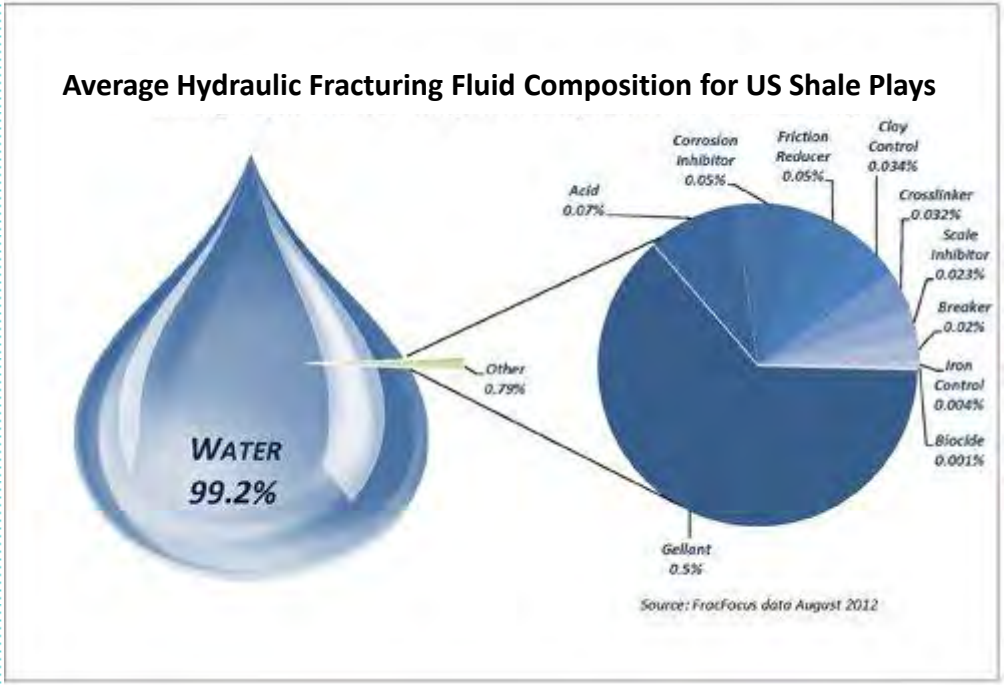
Unconventional Resources and Hydraulic Fracturing

Secure water and frac sand and store

A moderate size hydraulic fracture = 15,000 m^3 of water

Sand pumped down hole = “frac sand”

- Keeps fractures “propped” open
- Grain size varies
- A moderate size frac job = 1000 T of frac sand (40 truck loads)



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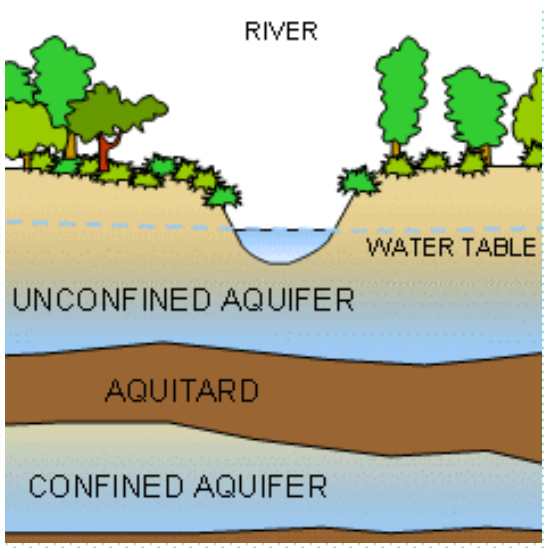
Unconventional Resources and Hydraulic Fracturing

Water Sources

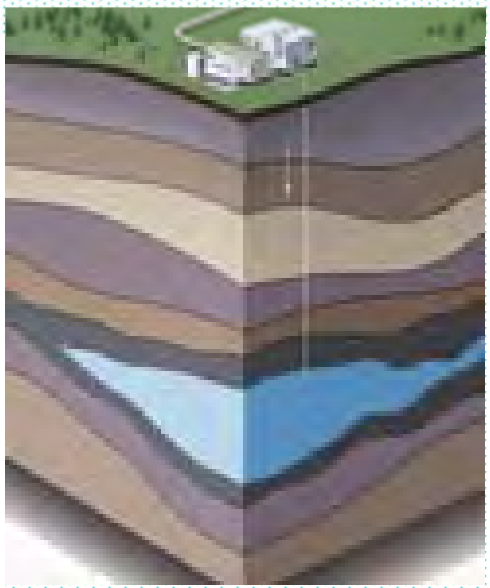
Surface Water
(0 m)

- rivers
- streams
- lakes
- oceans

Shallow Groundwater
(0 – 250 m)



Deep Groundwater
(>500 m)



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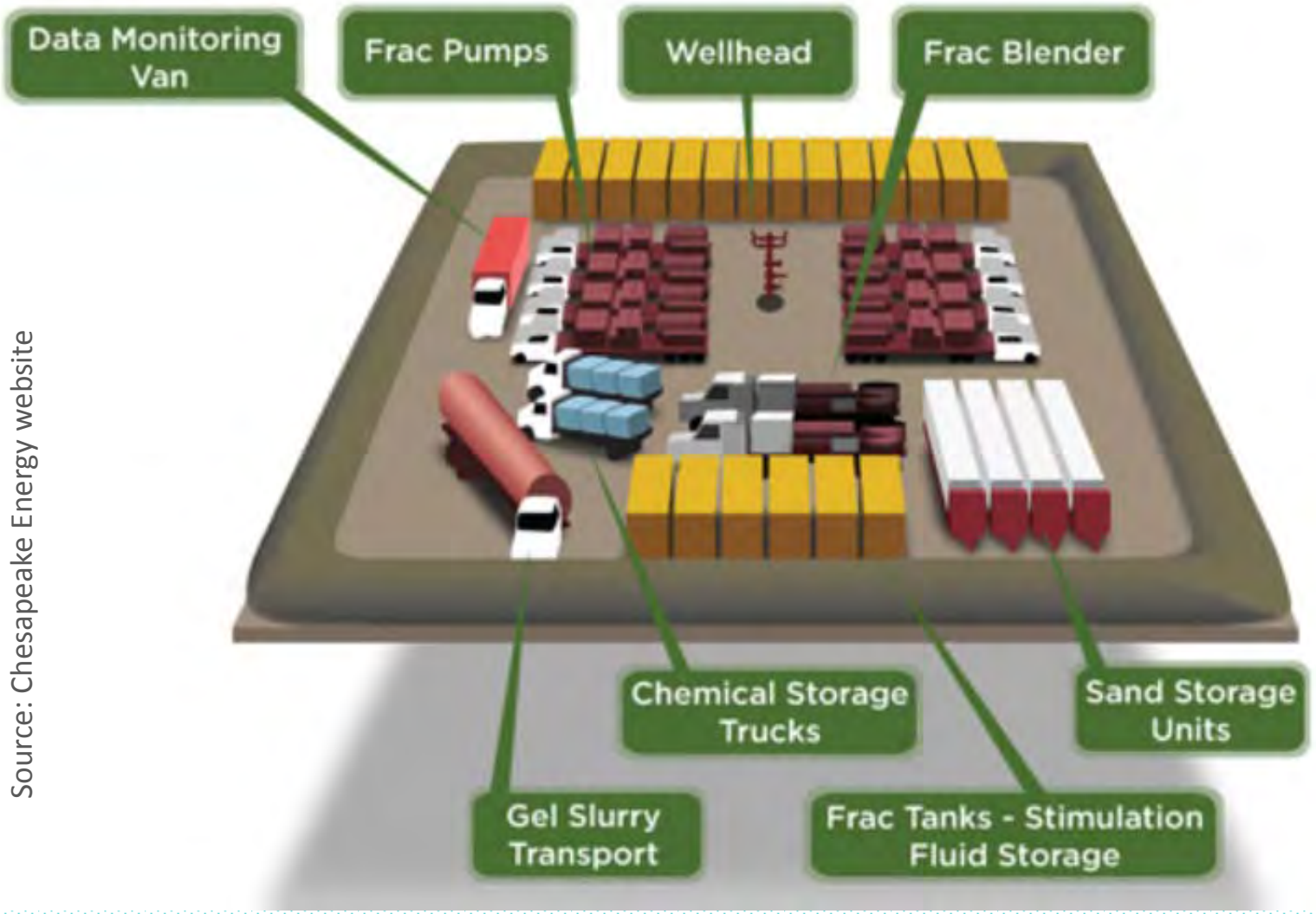
Unconventional Resources and Hydraulic Fracturing

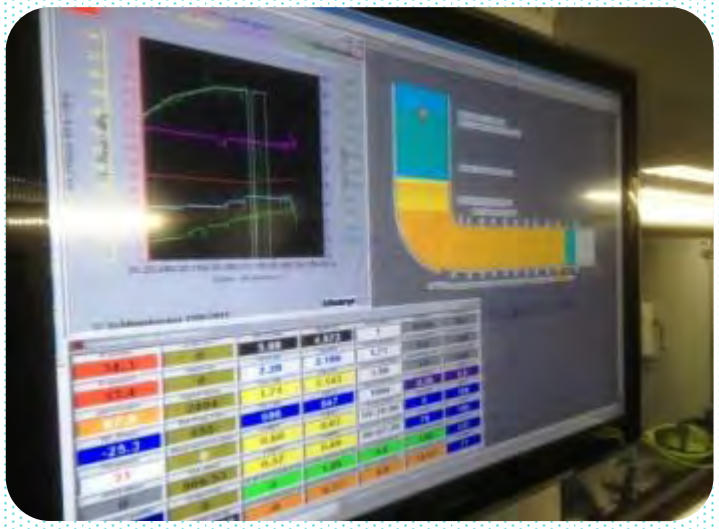
Mobilize and Set up Frac Equipment

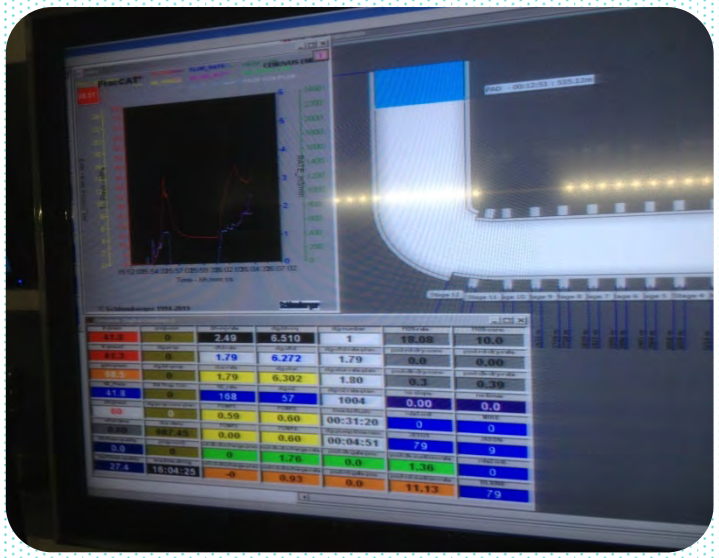


Source: Chesapeake Energy website

Unconventional Resources and Hydraulic Fracturing

Hydraulic Fracture





- Technical experts monitor frac job operations in real-time, onsite and in corporate offices.
- Yukon's Chief Operations Officer (COO) also monitors the operation.
- Many parameters including volumes, pressures, fluid components, etc.

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Unconventional Resources and Hydraulic Fracturing

De-mobilization of equipment

- Frac equipment is removed as soon as HF operation is complete.
- Some storage tanks remain to hold flow back and produced fluids.
- Flow testing equipment is installed to allow testing well (or production).

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Unconventional Resources and Hydraulic Fracturing

Flow test and manage flow back fluid

- Flowback fluid is put into tanks on the lease for temporary storage.

Fluid waste disposal facility, Taylor, B.C.

- These fluids may be re-used in another frac operation, or they are trucked to a regulated deep disposal well.

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Unconventional Resources and Hydraulic Fracturing

Rapid Evolution of Best Practices, Guidelines and Requirements

- CAPP - Hydraulic Fracturing Operating Practices
- FracFocus.ca - Reporting of chemical use
- B.C. Oil & Gas Commission - Water use reporting requirements and Northeast Water Tool
- New Brunswick - Responsible Environmental Management of Oil and Natural Gas Activities
- Petroleum Technology Alliance Canada projects:
  - Groundwater monitoring. A screening-level system for categorizing hydraulic fracturing fluid additives according to potential health and environmental risks – Intrinsik
  - Reuse of Flow back and Produced Water for Hydraulic Fracture
- Inter-wellbore communication notices to operators from regulators
- National Energy Board – New 'Filing Requirements for Onshore Drilling Operations Involving Hydraulic Fracturing'
- Alberta Energy Regulator – Hydraulic Fracturing Operations in Alberta

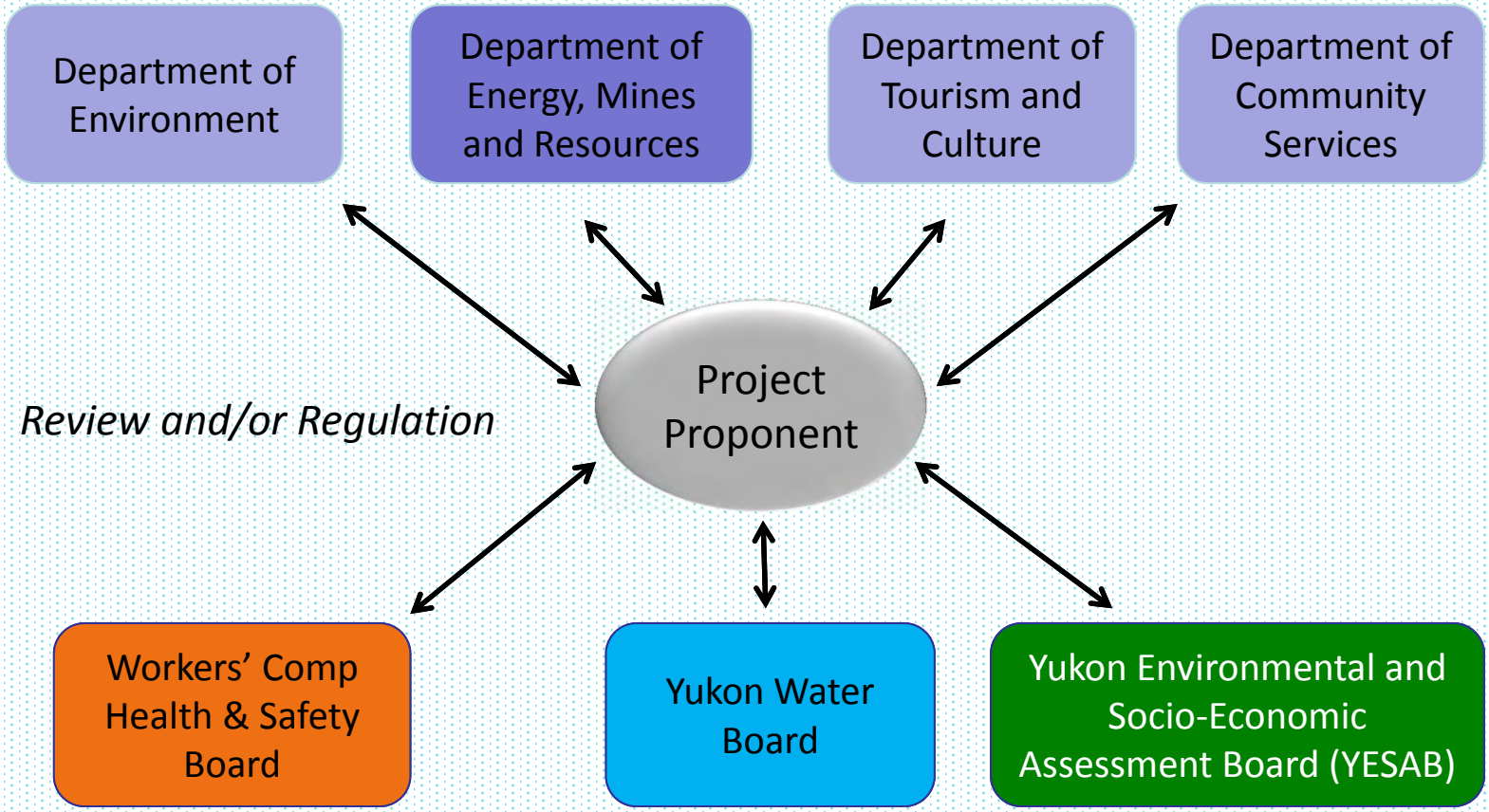
Unconventional Resources and Hydraulic Fracturing

Hydraulic Fracturing Issues and Lessons Learned

- Surface or groundwater protection measures.
- Water use with some hydraulic fracturing operations.
- Fracture chemical use and disclosure.
- Inter-wellbore communication incidents.
- Induced seismic event incidents.
- Emissions – during extraction and processing.
- Activity level-related items – noise, light, dust, traffic, infrastructure wear.
- Cumulative effects planning and efficient development.

Regulatory Framework – Multiple Regulators

Regulators and Agencies for Review of O&G Activities



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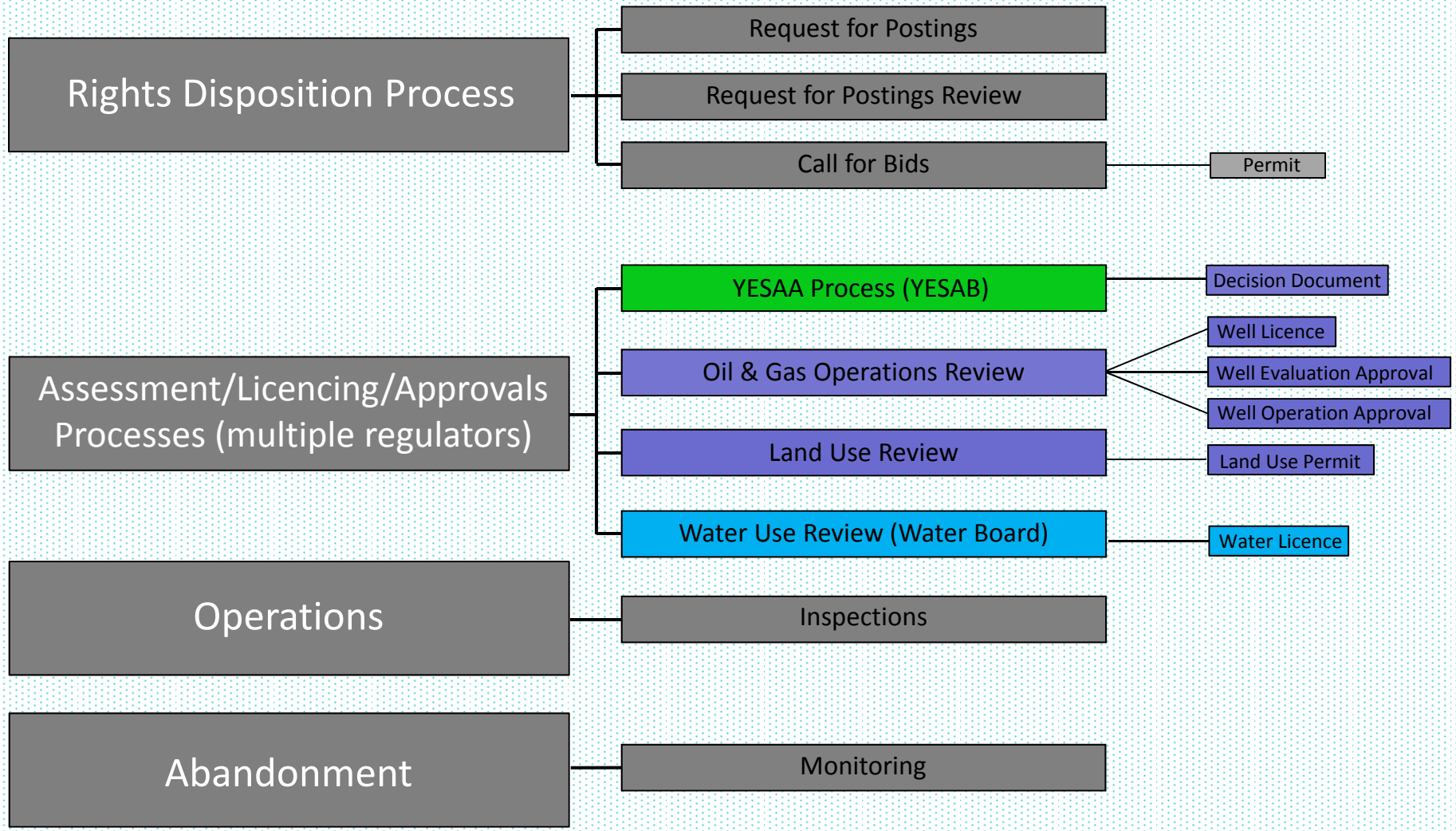
Regulatory Framework – Oil & Gas Process



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Regulatory Framework – Oil & Gas Process

Drilling and well operations approvals

Pre-application

- Consultation and notifications
- Proponents registered with Yukon Corp Registry
- Insurance
- Security
- Rights where required
- Land status check
- Other triggered reviews (YESAA)

Application

- Identification provisions (well location, type, applicant designate, etc)
- Drilling Program
- Safety Plan
- Environmental Protection Plan
- Consultation and Notification
- Well Deposit
- Proof of Financial Assurance
- Consideration of YESAB recommendations

Post-Approval

- Operations ensue
- Field inspection
  - Construction, drilling, operating wells, pipelines, facilities, restoration and incidents
- Compliance monitoring
- Mandatory reporting
- Site reclamation

DECISION

- **approve as submitted;**
- **deny;**
- **approve with conditions.**

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Regulatory Framework – Drilling and Production Regulation

- Yukon's Drilling and Production Regulation employs a combination of prescribed and goal based measures.
- The powers of the regulator are broad, including the power to impose requirements drawn from other jurisdictions.

Drilling and Production Regulation

6, 9 – 11	Conditions imposed
50 – 64	Casing, cementing, testing, drilling
73	Completions; formation intervals isolated; stimulation done in a manner that is safe
153	Safety and environmental protection plans
169	Bodies of water

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Regulatory Framework – Drilling and Production Regulation

Casing and Cementing Integrity

- Yukon's Drilling and Production Regulation prescribes strict casing design requirements.
- Integrity of casing and cement provide zonal isolation.
- Vital component for surface and groundwater protection.

Drilling and Production Regulation

Casing Design & Requirements

- Burst pressure
- Collapse loading
- Tensile strength
- Bending, buckling or other stresses

Casing Program Requirements

- Minimum depth
- Permafrost protection
- Cementing requirements and test

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Regulatory Framework – Drilling and Production Regulation

Fluids During Drilling

- Plans provide the maximum flexibility to require provisions with regard to hydraulic fracturing operations and practices.
- Operator is required to submit plans for review by the COO.
- Operator is responsible to operate as per the approved plan.
- Plans have enforceable conditions to adhere to.
- COO has ability to require disclosure of fracking fluid additives as a condition of the Well Operation Approval.

Drilling and Production Regulation

6, 9 – 11 Conditions imposed

31 – 32 Approved drilling fluids

153 Safety and environmental protection plans

Safety Plan:
ALL matters related to health and safety of public and integrity of well site.

Environmental Protection Plan:
ALL matters related to the licensees oil and gas activities.

Contingency Plan:
To cope with any foreseeable emergency situation.

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Regulatory Framework – Drilling and Production Regulation

Handling of Waste/Fluids

- As per modern best practices Yukon forbids the use of unlined storage pits as a means to store fluids at the surface.
- Fluids not recycled or reused must be re-injected and stored in deep rock formations, far below groundwater sources.
- Another key component with respect to managing hydraulic fracturing fluids.

Drilling and Production Regulation

6, 9 – 11	Conditions imposed
31 – 32	Approved drilling fluids
164	Handling of oilfield waste
	In accordance with EPP; *Does not* create a hazard to safety, health or environment
165	Produced water… handled such that contamination of groundwater is prevented

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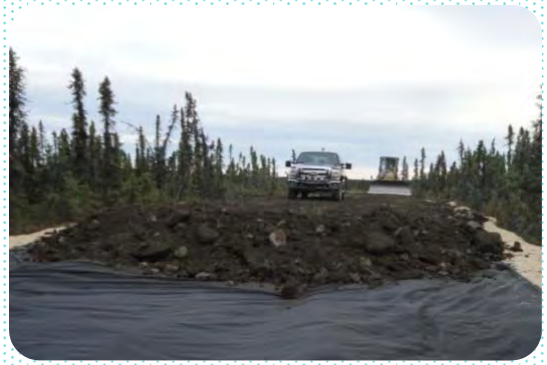
Regulatory Framework – Territorial Land Use Regulation

Land Use Permits

- Examples of land use relevant to oil and gas activities that require permits:
  - Access road right-of-ways
  - Drill sites
  - Worker campsites

Legislation - *Territorial Lands Act*

- Land Use Regulation (key clauses)
  - Sections 7, 8, 9 – Prohibitions (outlines when a land use permit is required)
  - Section 30 – Terms and Conditions of Permits
  - Section 35 – Security Deposit
  - Sections 37, 38, 39 – Duties and Powers of Inspectors



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Regulatory Framework – Collaboration

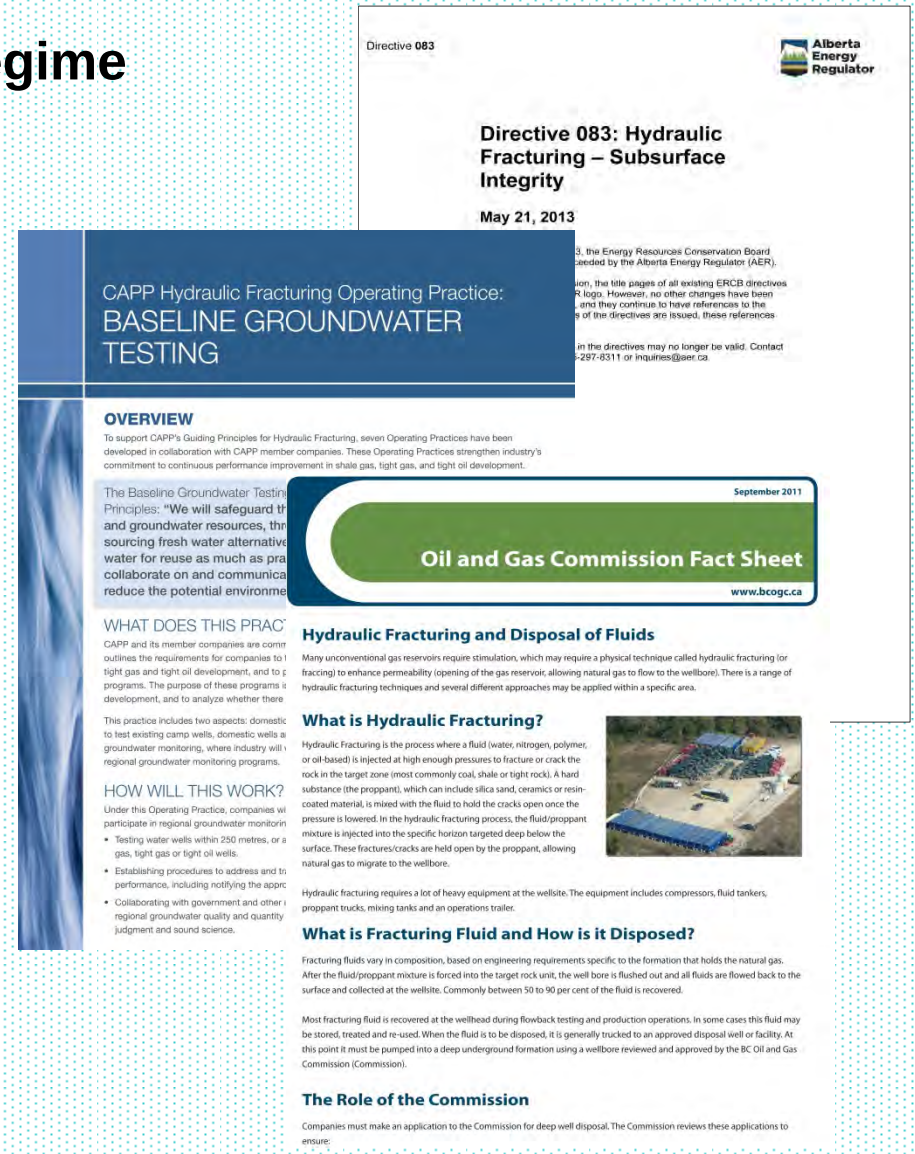
Yukon 'Best in Class' Adaptive Regime

Lever the Best in Other Regimes

- Reviewed BC, AB, NB, others.
- Service agreement with National Energy Board.
- Service agreement in development with BC Oil and Gas Commission
- Share best practice with Interstate Oil & Gas Compact Commission.

Flexible and Adaptive Regime

- Apply others' (BC, AB) directives.
- Yukon published best practices.
- Water Workshop.
- CAPP guidance documents.
- Canadian Standards Association.
- FracFocus.



Directive 083

Alberta Energy Regulator

Directive 083: Hydraulic Fracturing – Subsurface Integrity

May 21, 2013

CAPP Hydraulic Fracturing Operating Practice:
BASELINE GROUNDWATER TESTING

OVERVIEW

To support CAPP's Guiding Principles for Hydraulic Fracturing, seven Operating Practices have been developed in collaboration with CAPP member companies. These Operating Practices strengthen industry's commitment to continuous performance improvement in shale gas, tight gas, and tight oil development.

September 2011

Oil and Gas Commission Fact Sheet

www.bcogc.ca

Hydraulic Fracturing and Disposal of Fluids

Many unconventional gas reservoirs require stimulation, which may require a physical technique called hydraulic fracturing (or fraccing) to enhance permeability (opening of the gas reservoir, allowing natural gas to flow to the wellbore). There is a range of hydraulic fracturing techniques and several different approaches may be applied within a specific area.

What is Hydraulic Fracturing?

Hydraulic Fracturing is the process where a fluid (water, nitrogen, polymer, or oil-based) is injected at high enough pressures to fracture or crack the rock in the target zone (most commonly coal, shale or tight rock). A hard substance (the proppant), which can include silica sand, ceramics or resin-coated material, is mixed with the fluid to hold the cracks open once the pressure is lowered. In the hydraulic fracturing process, the fluid/proppant mixture is injected into the specific horizon targeted deep below the surface. These fractures/cracks are held open by the proppant, allowing natural gas to migrate to the wellbore.

Hydraulic fracturing requires a lot of heavy equipment at the wellsite. The equipment includes compressors, fluid tankers, proppant trucks, mixing tanks and an operations trailer.

What is Fracturing Fluid and How is it Disposed?

Fracturing fluids vary in composition, based on engineering requirements specific to the formation that holds the natural gas. After the fluid/proppant mixture is forced into the target rock unit, the well bore is flushed out and all fluids are flowed back to the surface and collected at the wellsite. Commonly between 50 to 90 per cent of the fluid is recovered.

Most fracturing fluid is recovered at the wellhead during flowback testing and production operations. In some cases this fluid may be stored, treated and re-used. When the fluid is to be disposed, it is generally trucked to an approved disposal well or facility. At this point it must be pumped into a deep underground formation using a wellbore reviewed and approved by the BC Oil and Gas Commission (Commission).

The Role of the Commission

Companies must make an application to the Commission for deep well disposal. The Commission reviews these applications to ensure:

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Regulatory Framework – Modernizing

Continuously Modernize

- Current regime enables achievement of *YOGA* objectives – environment, worker, community, operational protection, economic.
- Yukon applies 'continuous improvement' approach to *YOGA* and regulations.
- The DPR review is underway and will be finalized following the Standing Committee's review of the risks and benefits of hydraulic fracturing.
- OGR will continue to work with other YG departments, regulators and Yukoners to ensure the regulation is up to date.

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Key Messages

- While Yukon's land base for oil and gas activity is relatively small, it has the potential to continue to provide significant benefits to Yukon.
- Developing unconventional oil and gas resources by utilizing the technique of hydraulic fracturing is the trend throughout North America, and is a key interest for Yukon's current oil and gas rights holders.
- The issues that have arisen regarding hydraulic fracturing have and continue to be addressed by both regulators and industry. Considerable advancements in best practices have recently occurred.
- Yukon's DPR can regulate hydraulic fracturing, however, we are currently reviewing the regulation and working with other oil and gas regulators to ensure lessons learned are incorporated into a modern regulation.
- Since devolution of onshore oil and gas management to Yukon in 1998, Yukon has developed state-of-the-art legislation to properly regulate all oil and gas activities, including hydraulic fracturing.

Additional Information

- Yukon Oil and Gas Legislation (YOGA and DPR)
- Directive 083: Hydraulic Fracturing – Subsurface Integrity - Alberta Energy Regulator
- Hydraulic Fracturing and Disposal of Fluids– B.C. Oil and Gas Commission
- Understanding Hydraulic Fracturing – Canadian Society for Unconventional Resources
- Golden Rules for a Golden Age of Gas – World Energy Outlook
- The Next Frontier in United States Shale Gas and Tight Oil Extraction – Energy Technology Innovation Policy Research Group
- Shale Gas: Summary of Selected Environmental Research – Government of New Brunswick
- Responsible Shale Development: Enhancing the Knowledge Base on Shale Oil and Gas in Canada – Energy and Mines Ministers' Conference 2013
- The Modern Practices of Hydraulic Fracturing: A Focus on Canadian Resources – Petroleum Technology Alliance Canada
- The Potential Impacts of Hydraulic Fracturing on Drinking Water Resources – U.S. Environmental Protection Agency
- Addressing the Environmental Risks from Shale Gas Development – Worldwatch Institute
- National Human Health Risk Evaluation for Hydraulic Fracturing Fluid Additives – Gradient Corp.

Contacts

- BC Oil and Gas Commission (OGC) – Ken Paulson
- Alberta Energy Regulator (AER) – Bob Willard
- National Energy Board (NEB) – Bharat Dixit
- Canadian Association of Petroleum Producers (CAPP) – Alex Ferguson
- Canadian Society of Unconventional Resources (CSUR) – Kevin Heffernen and Wally Kozak
- Pembina Institute
- Interstate Oil and Gas Compact Commission – Lynn Helms
- Academia
  - University of Alberta - Dr. Rick Chalaturnyk
  - University of Texas – Dr. Scott Tinker
  - Stanford University of Earth Sciences – Dr. Mark Zobak