Deep Saline Groundwater Extraction in the Horn River Basin – Guidance for Groundwater Information for an Environmental Assessment

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Presentation Outline

- Unconventional Natural Gas
- Horn River Basin – Overview
- BC Groundwater Regulation Triggers
- Reviewable Projects - EA Process
- Saline GW - Exemption Requirements
- New Guidance Document (BC MOE, December 2012) - Explained
- Summary
- Questions?
Unconventional Natural Gas
NE BC – Unconventional (Shale) Gas

- 3rd largest natural gas deposit in North America
- Estimates of 250-500 tcf
- 10-20% recoverable
Shale Gas and Hydrofraccturing

- Gas deposits stored in deep shale-bearing formations
- To produce natural gas from these formations, hydraulic fracture stimulation (hydrofracturing) methods are used
- Fluid injected at high pressure to fracture the shale formation
- Hydrofracturing = large water needs
Shale Gas and Hydrofracturing
Horn River Basin - Location
Horn River Basin...

- 1.3 million hectares
- ~20 companies currently operating
- **HUGE WATER NEEDS**
- **Camps**
  - 200-400 people per camp @ 1,200 L/person/d
- **Drilling and Fracturing**
  - 40,000 m³ per well for frac’ing over several days
- Current water use = SW, shallow non-saline GW, deep saline GW
...Horn River Basin

- 2012: >500 horizontal gas/experimental wells drilled to date
- Up to 50,000 gas wells may be developed in the Horn River Basin
- Shallow non-saline and deep saline GW needs will be increasing
Horn River Basin - Saline GW...

- Mattson sandstones
  - Isolated to the west
- Basal Cretaceous sandstones
  - Thin and isolated
- Debolt-Rundle platform
  - Regionally extensive
  - Debolt Fm – karstic limestone aquifer
Debolt Formation Aquifer

- 600-900 mbgl
- Regionally isolated from surficial aquifers (thick Cretaceous shale deposits)
- TDS >15,000 to <40,000 mg/L
- H₂S concentrations (may be >100 mg/L)
- Estimated up to 10 billion m³ GW in Debolt Fm
- Variable yield (may be >20,000 m³/d)
Horn River Basin - Lease Location Map and Debolt Isopach Map
Environmental Assessment Act (BC EAO)
- Reviewable Project Regulation
- Groundwater extraction >75 L/s (6,500 m³/d)
- Does not distinguish between saline and non-saline GW
- Currently the only Regulation in BC that relates to groundwater diversion volumes or licensing

Water Act Modernization Process (2014?)
- Groundwater Licensing Component release
- (currently in public consultation process)
Large GW Extraction Projects (>75 L/s) = “Reviewable Project”

- Environmental Assessment (EA) certificate may be required prior to construction
- EA = lengthy process including assessment of all GW users, potential cumulative effects, etc.
- Non-saline GW (<4,000 mg/L TDS)
- Saline GW (>4,000 mg/L TDS)
"Exemption from EA Certificate"

IF:

"the Executive Director considers that a reviewable project will not have a significant adverse environmental, economic, social, heritage or health effect, taking into account practical means of preventing or reducing to an acceptable level any potential adverse effects of the project"
EA Required...?

1) Application for an EA Certificate Exemption

2) Project Description
   - Basis for EAO’s decision on whether an EA required
     *(Section 10(1)(b) of EA Act)*
   - Sufficient information w.r.t. potential adverse environmental, heritage, health, economic, social effects
   - Details available in *Guideline for Preparing a Project Description for an EA in BC* (and in consult with EAO)

3) Supporting Documentation
   - Groundwater-specific
GW-related information requirements:
- Hydrogeological data to demonstrate hydraulic separation of target saline Fm from:
  - Shallow groundwater
  - Surface water
- Potential effects on other saline GW users
- Potential effects to aquifer (quality)
- Proposed monitoring plan
- Mitigative/adaptive management measures
Deep Saline Aquifers (e.g., Debolt Fm or deeper)


(BC MOE, December 18, 2012)

Authored/technical guidance – Waterline Resources Inc. and Gordon Groundwater Consulting
BC MOE Guidance Document - Why

- Provide clarity on information that can be used to assess hydraulic separation between target saline formation and shallow GW and SW
- Confusion between reservoir and hydrogeological terminology
- Bridge the gap between reservoir engineering data and hydrogeological data
- Current review process is inefficient and cumbersome
- Streamline review process (for both proponent and reviewer)
- Currently aimed at deep saline aquifer in HRB, and can be carried over for similar projects in other areas of BC
What is it?
- Outline of components related to groundwater that are to be included
- Types of information that can be used as supporting data

Intent:
- To focus on available information that the energy company would already have on hand, while recognizing that some data sources may not be available for all project sites
1. Project Description Overview

- Shale Gas Development Plan
  - High-level
- Water Development Plan
  - Project water use and disposal needs
  - Proposed source wells
  - Proposed disposal wells
  - GW extraction/injection volumes
  - Proposed saline GW storage, treatment, transport, reuse, recycling, disposal
2. Regional Hydrogeologic Setting

- Geologic, hydrogeologic, hydrologic overview
  - Regional information available
  - Aquifer characteristics
  - Hydrogeologic interpretation
  - SW bodies and shallow aquifers within 5km radius of Debolt wells

- Existing users (saline and non-saline GW)
  - 5km radial search
  - OGC, Accumap, GeoScout, BC Water Resources Atlas website, BC MOE WELLS database, EAO
3. Local Description Setting...

- Interpreted Site Geology
  - Drilling records, logs, maps...
- Source/disposal well completion/integrity testing
  - Loss of circulation incidents
  - Cement returns
  - Cement bond logs
  - Pressure integrity/leakoff testing
  - Casing vent monitoring
3. Local Setting Description

- Hydrogeological Testing
  - Drill stem or swab tests
  - Injection tests
  - Pumping tests
  - Other data (temperature, tracer...)
  - Aquifer/reservoir monitoring data
  - GW flow/reservoir modeling (Guidance document, BC MOE)
- GW quality assessment
4. Potential Adverse Effects Assessment from GW Extraction

- Potential hydraulic connection with shallow water resources – assessment and interpretation
  - Geological evidence (aquifer/aquiclude)
  - Pressure head/water levels
  - Water quality
  - Well integrity and isolation
  - Monitoring/operational data
- Water source well/aquifer capacity assessment
  - Long-term well capacity predictions
- Potential impact analysis
  - Predicted drawdown effects to users within 5km
  - Effects of mixing on water quality
5. Proposed Monitoring Program

“...to obtain additional data to verify performance of aquifer and confirm lack of hydraulic connection with overlying shallow aquifers and lack of impacts to other users.”

- Monitoring wells
- Water extraction and levels
- Water quality
- Proposed Monitoring Reporting
6. Adaptive Management/Mitigation Plan

- Monitoring data to set baseline GW data
- Threshold based triggers developed in discussion with EAO
- Review and revision of approach as more data collected
- Mitigation plan – recommend operational changes of mitigative actions that could be undertaken based on anticipated risks for an adverse effect that was not predicted
Confined karstic limestone aquifer
600-900 mbgl
Regionally isolated from surficial aquifers by thick Cretaceous shale deposits
TDS >15,000-<40,000 mg/L
H2S may be >100 mg/L
In Summary

- If you want to use saline Debolt Water for shale gas:
  - $<6,500 \text{ m}^3/\text{d}$ – Well permit, OGC
  - $>6,500 \text{ m}^3/\text{d}$ – Reviewable Project, BC EAO
  - Follow steps from this presentation to apply for an EA exemption to show no adverse effects expected

- New BC GW Regulations expected in 2014 and beyond to manage groundwater in BC and take the confusion out of needs
Questions?

Thank You!!