## **Examining Water Sources in NE BC in Support of Responsible Development of Unconventional Gas**



President & CEO, Geoscience BC BCWWA, Fort St John, March 2012



### Presentation Outline

- 1. Why Study Water Sources?
- 2. Montney Water Studies
- 3. Horn River Basin Studies
- 4. Northeast BC Regional Hydrology



### **About Geoscience BC**

- Geoscience BC is an industry-led, not-for-profit, nongovernment, applied geoscience organization
- Created in 2005 with \$25 million from BC Gov; received additional funding in 2008 (\$11.7 M) and 2011 (\$12 M)
- Mandate: to attract mineral and oil and gas exploration and development investment to BC



## Take-Aways from this Presentation

- Water management is vital for successful unconventional play development
- Good water management is based on good water inventories and understanding
- GBC's regional water research/inventory studies:
  - Help fill knowledge gaps
  - Provide timely delivery of public data
  - Facilitate effective partnerships and consultation among a variety of stakeholders working on water issues

## Acknowledgements

(for materials used in this presentation)

- David Molinski, OnPoint Consulting
- Brad Hayes, et al, Petrel Robertson Consulting
- David Hume, et al, Canadian Discovery Ltd
- Derek Brown, Strategic West Consulting
- Ben Kerr, Foundry Spatial
- Dave Murray et al, Kerr Wood Leidal
- Dennis Lowen, Lowen Hydrogeology Consulting
- Allan Chapman, BC Oil & Gas Commission
- Adrian Hickin, Ministry of Energy and Mines
- Kevin Ronneseth and Mike Wei, Ministry of Environment
- and numerous other BC Ministry staff



### **HRB Partners**























- HRB Producers Group: 11 companies
- BC OGC, MEM, MOE
- Fort Nelson FN, Acho Dene Koe FN
- Ducks Unlimited data sharing





## **Key Partners**

#### **Montney Water Project Partners**



















- Science and Community Environmental Knowledge Fund
- 7 producer companies
- BC Government & Regulator: OGC, MEM, MOE, FLNRO
- City of Dawson Creek UNBC (Kiskatinaw Study)



## 1. Why Study Water Sources?

#### **Multiple Interests**

#### **Policy Makers:**

- **MEM**
- MOE

# **Interests**

#### Others:

- Concerned Public
- Media
- Environmental Groups

#### **Users:**

- Landowners
- **Producers**
- **Communities**
- First Nations
- Industries

#### **Regulator/Permits:**

OGC (± FLNRO & MOE)



## 2. Overview of Montney Water Project (MWP)

- Regional inventory of water sources (not usage)
- Collaborative: industry, government, academia and community input -> research priorities & project activity
- Funding: Geoscience BC, Science Community and Environmental Knowledge Fund (SCEK), and 7 oil/gas producers, + in-kind contributions from BC Ministries and OGC
- Budget: \$1 million; Goal: deliver results within 1 year
  - Activities completed in Summer 2011, see GBC Website
  - Final Data Releases: Early 2012
- Information for policy, regulation, industry & public
- Catalyst for numerous ongoing water projects



## MWP - Water Sources Main Components for the Project

#### Surface Water (0 m)

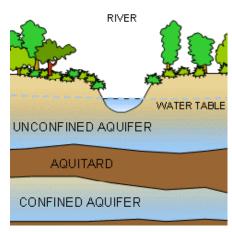
- Freshwater
- Rivers,streams, lakes



## Shallow Groundwater

(0 - 250 to 500m)

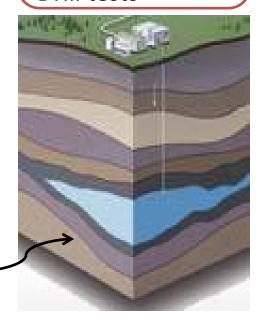
- Unconfined or confined aquifers
- Unconsolidated sediments
- Bedrock

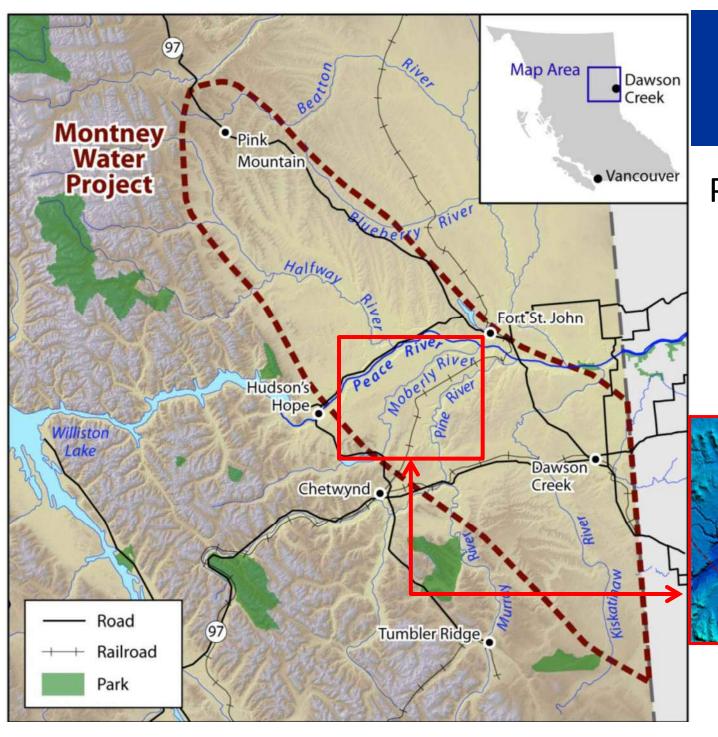


+ disposal zones

#### Deep Groundwater (>500m)

- Bedrock
- Well logs
- Seismic
- Drill tests

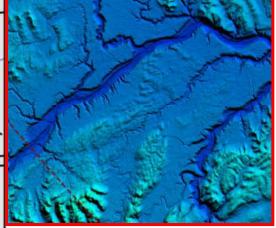




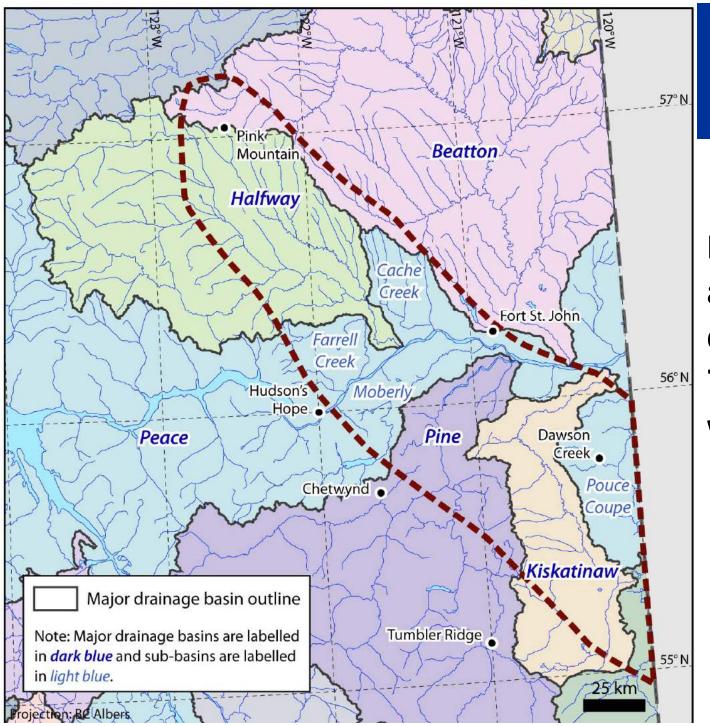
## Surface Water

Project Area = 16,800 km<sup>2</sup>

Main rivers & topography







## Project Outline and Major Watersheds

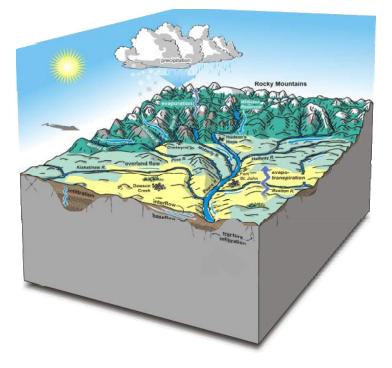
Data compiled and database developed for 7 major watersheds

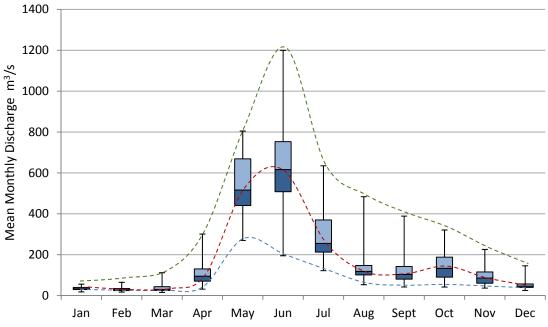


## Surface Water Key Findings

- Profound seasonal and yearly flow variations
   Highest = May to July; Lowest = September to March
- High-flow rate times are likely best for water withdrawals

07FB001 Pine River at East Pine Low, Average and Maximum Monthly Flow

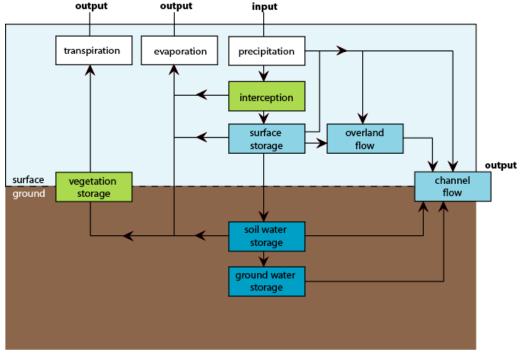




### Surface Water – Model and Analysis

GOAL: to define regional characteristics of hydrologic

cycle in watersheds



Storage and transfer in the hydrologic cycle

#### **DATA USED**

- Streamflow
- Surficial geology and vegetation
- Climate: precipitation, evaporationtranspiration





### Surface Water – Watershed Compilations

#### Eight posters:

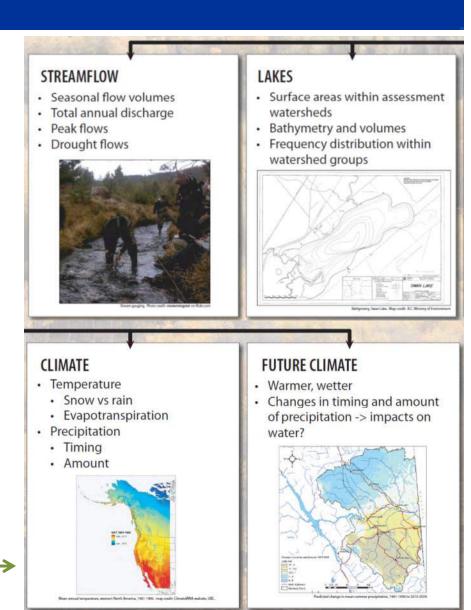
1 overview and 7 watersheds

#### Components:

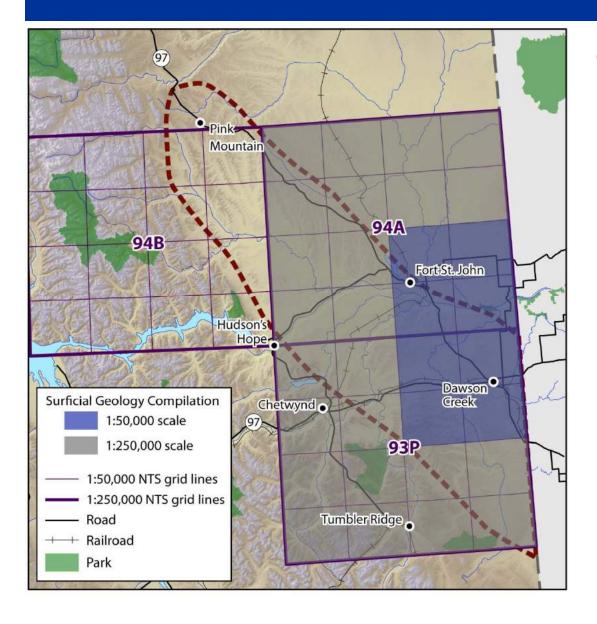
- Streamflow
- Lakes
- Water balance
- Ungauged watersheds
- Groundwater & paleovalleys
- Surficial materials, land use and vegetation
- Climate
- Future Climate

Geoscience BC Report 2011-12

(See Geoscience BC website)



## **Surficial Geology Compilation**

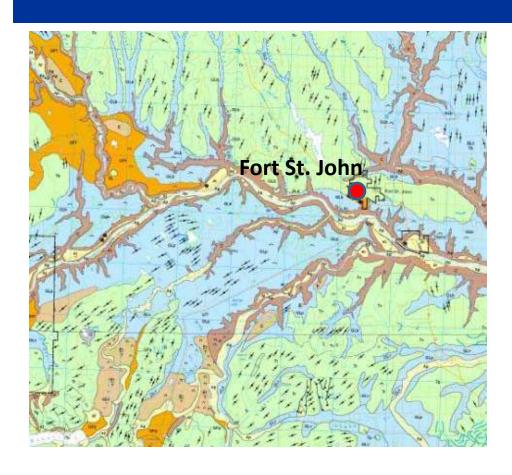


#### **Objective:**

- Compile, digitize and integrate existing mapping with a common legend
- Provide GIS data for integration into surface water models



## Surficial Geology Compilation



Geoscience BC Report 2011-8
MEM Energy Open File 2011-2

An illustration of output

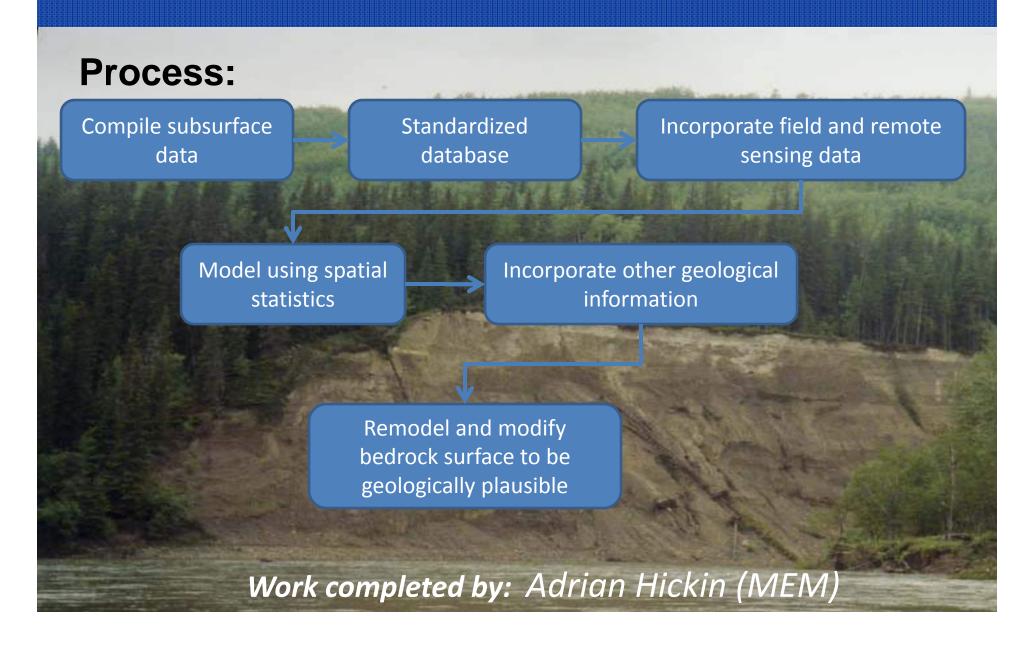
 Two 1:250,000 Surficial Geology Maps NTS 93P & 94A

#### Work completed by:

- Adrian Hickin (MEM)
- MAF Geographix



## Bedrock Topography & Drift Thickness

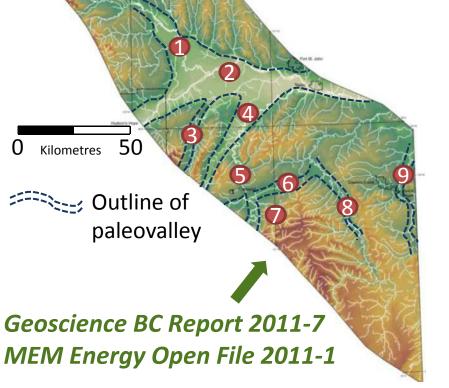


## Bedrock Topography, Drift Thickness and Paleovalleys



Identify areas of thick unconsolidated drift

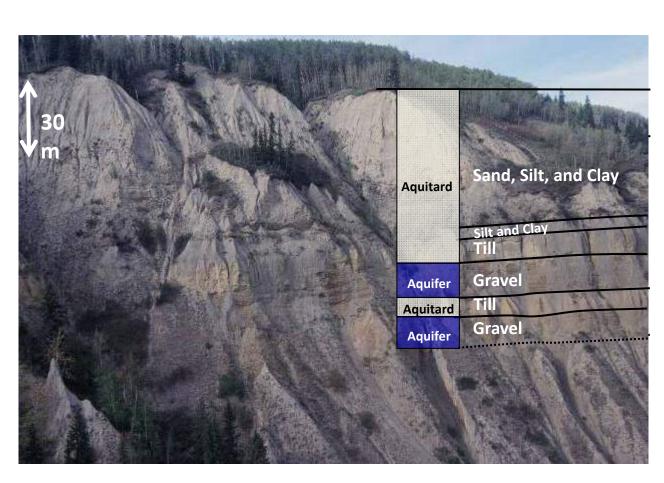
Paleovalleys potentially host aquifers





## Quaternary Geology Section

Sand and gravel units = main aquifers in unconsolidated materials



Source: Adrian Hickin, Ministry of Energy and Mines



#### New Water Well Data

- Collected new groundwater data from sources in Fort St. John, Dawson Creek and Prince George
  - Drilling reports
  - Groundwater studies
  - Drinking water supply wells
- 780 water wells collected and input into WELLS database; 200 wells with new water quality data
- Overseen by Lindsay MacFarlane, Ministry of Environment

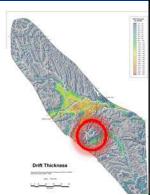


### Water Well Yield

#### **Bedrock Well Yield**

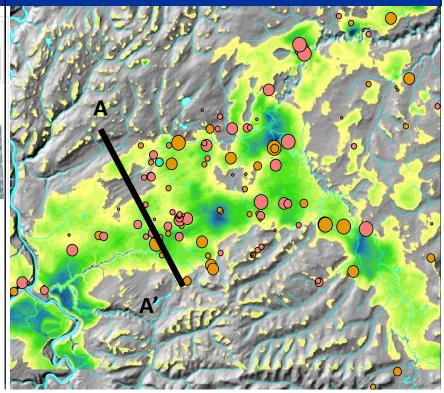
•	0 - 3  gpm	0 – 20 m3/d
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- $\circ$  3 7 gpm 20 46 m3/d
- $\circ$  7 12 gpm 46 78 m3/d
- O 12 − 25 gpm 78 − 164 m3/d
- 25 75 gpm 164 511 m3/d



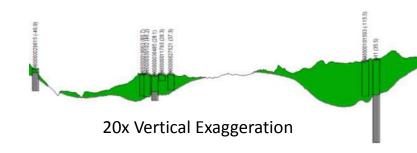
## **Unconsolidated Well Yield**

- $^{\circ}$  0 3 gpm 0 20 m3/d
- $^{\circ}$  3 7 gpm 20 46 m3/d
- 7 12 gpm 46 78 m3/d
- 12 25 gpm 78 164 m3/d
- 25 75 gpm 164 511 m3/d



#### Analysis and image by:

Adrian Hickin (MEM)





## Groundwater Data to Map and Classify Aquifers

#### **Data Used:**

- Water Well Records
- Observation Wells
- Pump Tests
- Water Quality Analysis
- Geology Maps
- Topographic Maps
- Air Photos
- Hydrogeology Reports
- Info from Stakeholders

#### Results:

- Identified ~20+ new aquifers
- Revised ~35+ previously defined aquifers
- Results on MoE websites

#### Work completed by:

Lowen Hydrogeology

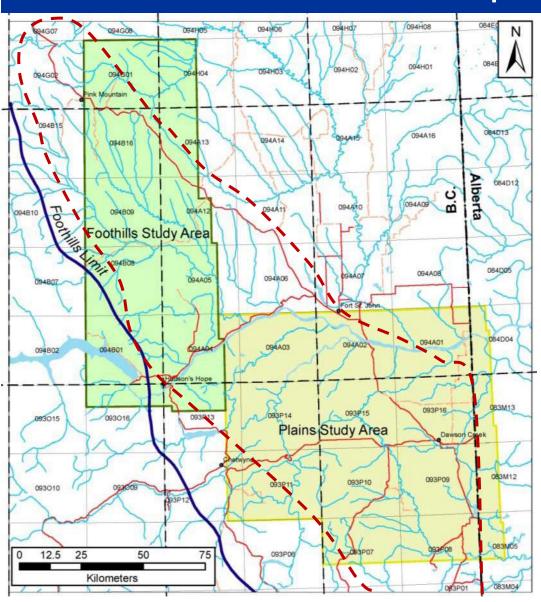
Consulting

#### Work Overseen by:

Kevin Ronneseth (MoE)



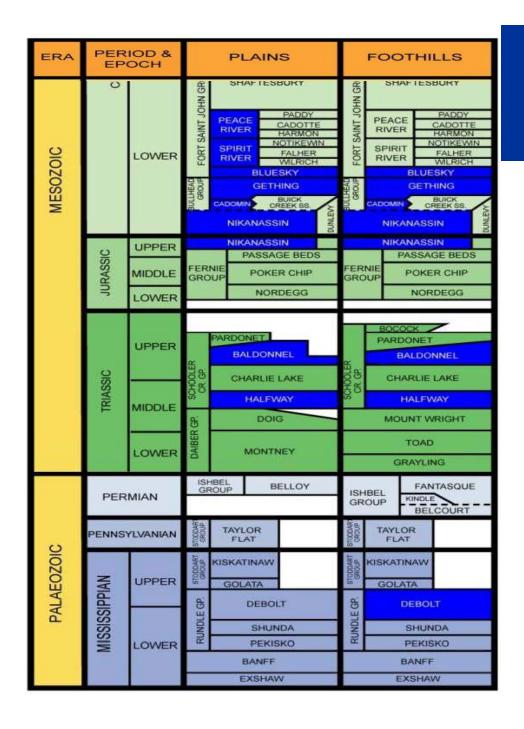
## Deep Subsurface Aquifers and Potential Disposal Zones



- Subdivided into Plains and Foothills study areas
- Aquifer characteristics distinct in each area
- Work undertaken by:
   Petrel Robertson Consulting
   Ltd. (stratigraphy and reservoir characterization)

Canadian Discovery Ltd. (hydrogeology)





### Montney Deep Subsurface Aquifer Stratigraphy

- Plains several
   potential aquifer zones
   in Lower Cretaceous
   and Triassic
- Foothills less
   Cretaceous potential,
   possible Debolt
   carbonate aquifer?



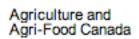


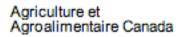
## Dawson Creek UNBC - Kiskatinaw Study













## 3. Horn River Basin Projects

- Project developed in 2008 in collaboration with HRB Producers Group
- Phase 1 Deep Subsurface Aquifer Study
  - HRBPG wanted to reduce their use of surface water and identify potential sites for local fluid disposal, to reduce environmental footprint
  - HRBPG provided technical data/project guidance
  - Project results available from GBC website (Spring 2010)
- Phase 2 HRB Water Studies: spring 2011 ongoing



## Horn River Basin Deep Subsurface Aquifer Characterization Project (Phase 1)

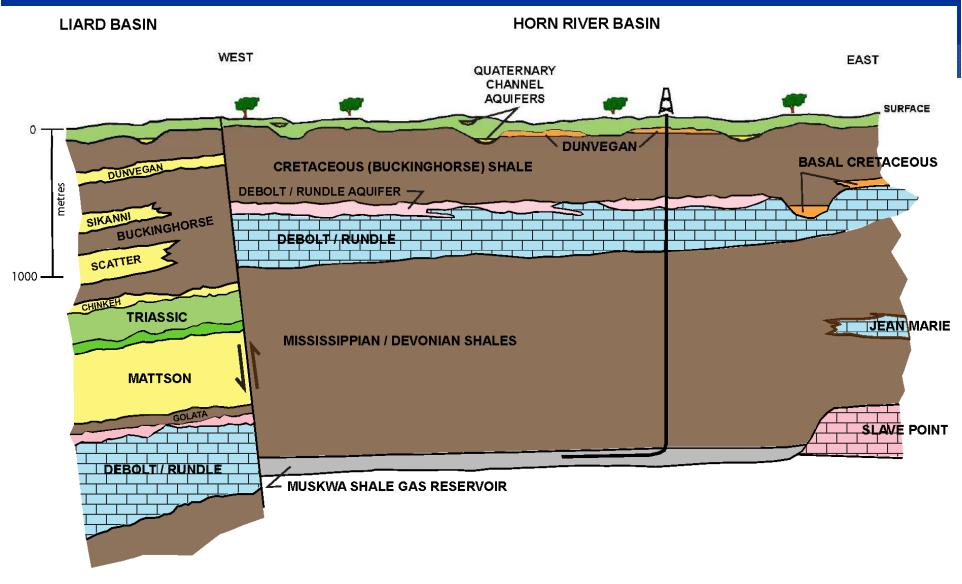
#### **Phase 1 Objectives:**

Determine distribution and capacity of deep subsurface, non-potable aquifers in HRB as:

- Potential sources of water for shale gas completions
- Potential disposal sites for flowback and produced water



#### Debolt/Rundle Carbonate Aquifer



Sketch by Brad Hayes, Petrel Roberston Consulting Ltd

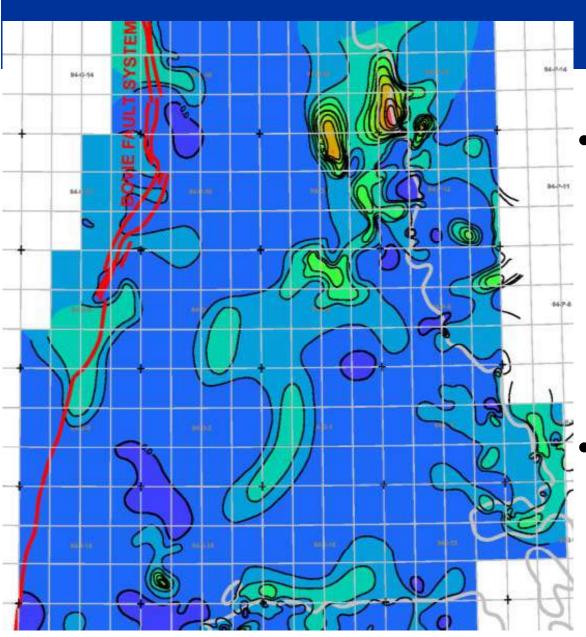


## Porosity-Thickness Debolt / Rundle Aquifer

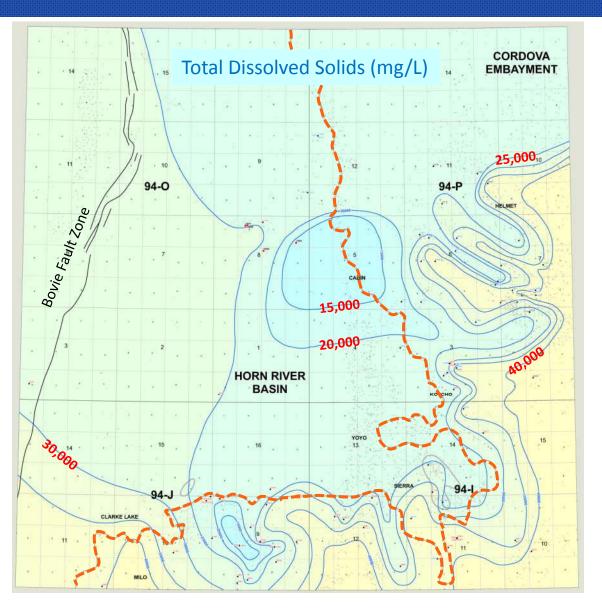
 Aquifer thickness and quality controlled by depositional aspects of Debolt / Rundle carbonates, and by erosion beneath overlying unconformity

Uneven distribution across basin





## Debolt / Rundle Aquifer – Water Salinity



Formation water TDS 15,000 – 40,000 mg/l

- Much too saline to be potable, but may be acceptable for use as completion fluid
- Values similar across entire vertical section



## HRB Aquifer Characterization Project Phase 1 Conclusions

- Debolt / Rundle carbonate platform has best aquifer potential
  - Limited well control in west half of HRB is good aquifer quality more widespread?
  - Semi-quantitative reservoir quality assessment
- Waters are saline, but suitable for use as completion fluid
  - Low concentrations of sour gas in Mississippian waters requires some treatment
- Extremely high permeabilities occur in Debolt / Rundle
  - Flow/injectivity tests, DST's, cuttings samples, well logs
- Aquifer opportunities are not evenly distributed across the basin

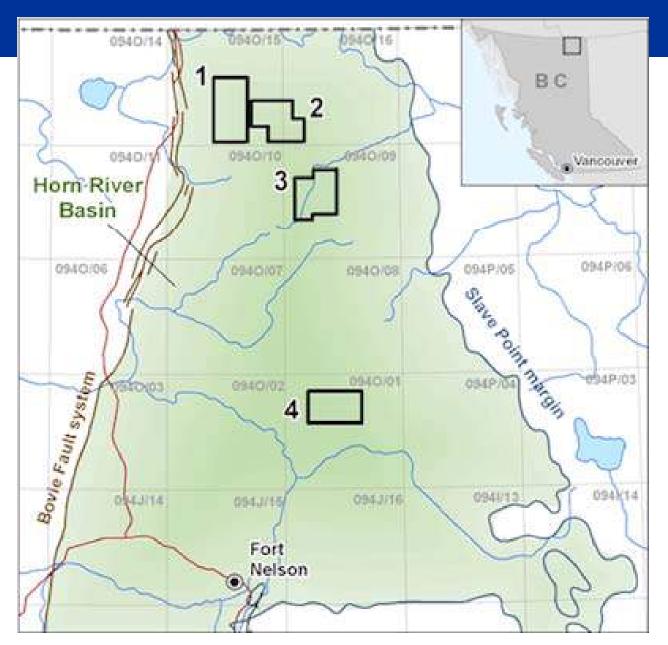


## HRB Aquifer Characterization Project Phase 2 Studies (In Progress)

- Pilot project to evaluate airborne geophysical survey (time-domain electromagnetic) to delineate shallow channel aquifers and try to identify water-filled channels
  - Pilot study flown by SkyTEM, Spring 2011
  - Data publicly released, March 5, 2012
- Update subsurface aquifer mapping with new well data
  - Particularly: additional test and flow / injectivity results
  - Completed by Petrel Robertson Consulting Ltd.
  - Data to be released next Friday, March 30, 2012
- Three-year water study collecting data on quantity and quality of surface water sources
  - Started in Summer 2011
  - Project manager = Kerr Wood Leidal



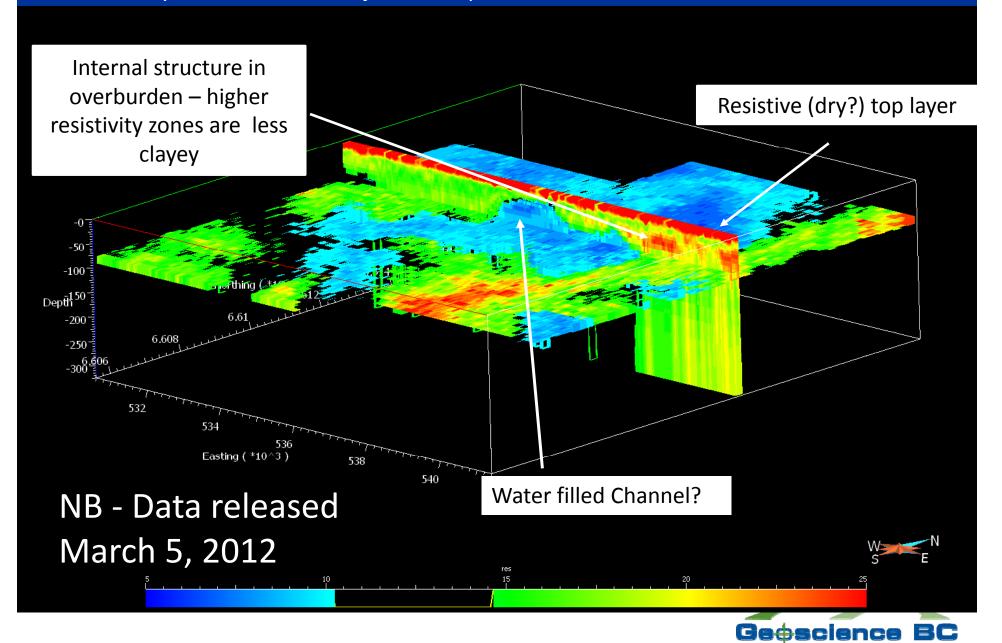
## HRB – Pilot Airborne EM Survey



- 4 test blocks(EOG, Imperial,Quicksilver,Stone Mountain)
- approx 10 x 10 km each
- 2400 line-km of data collected
- 200m line spacing
- survey flownby SkyTEM



SkyTEM inversion data has been mapped into a 3D voxel in Gocad, with one layer for each inversion layer. Colours were adjusted to optimize visualization of the inverted data.



#### HRB Phase 2 – Surface Water Study Objectives 36

- Project design developed in partnership with HRBPG, BC OGC, MEM, MOE, Fort Nelson First Nation (Fort Nelson, BC) and Acho Dene Koe First Nation (Fort Liard, NWT)
- Study Goals:
  - Collect accurate water flow, quality and climate data for key watersheds in the HRB
  - Train First Nations in project management, design and data collection
  - Collect data in support of sustainable planning for use of water for shale gas development in HRB



## **Program Components**

- 7 hydrometric (flow) stations (4 with telemetry)
- 3 climate stations with telemetry
- Water quality sampling
- Biological (Benthic sampling)
- Web-based data handling and reporting



## Schedule

- 3 Year Program
- Planning and training Aug 2011-Mar 2012
- Year one setup:
  - Hydrometric May 2012
  - Climate stations June 2012
- Year 2 and 3 monitoring
- Annual reporting
- Building First Nations Skills and Capacity

## First Nations Engagement

- Project Management
  - Project management skills
  - Mentoring and experience
- Environmental Planning
  - Monitoring station design and location
  - Traditional use final site selection
- Research and Field Monitoring
  - Classroom training
  - Field crew experience



### **Horn Basin Watershed Stats**

- Vast area (over 11,000 km<sup>2</sup>)
- 42 major watersheds
- 2 existing WSC hydrometric sites
- Climate station at Fort Nelson airport
- BC Forests seasonal Fire/weather stations
- Various seasonal producer stations

## **Network Selection Criteria**

- 1. Watershed characteristics
- Operational considerations (industry and First Nations)
- 3. Logistical considerations
- 4. (location, stable sites etc.)

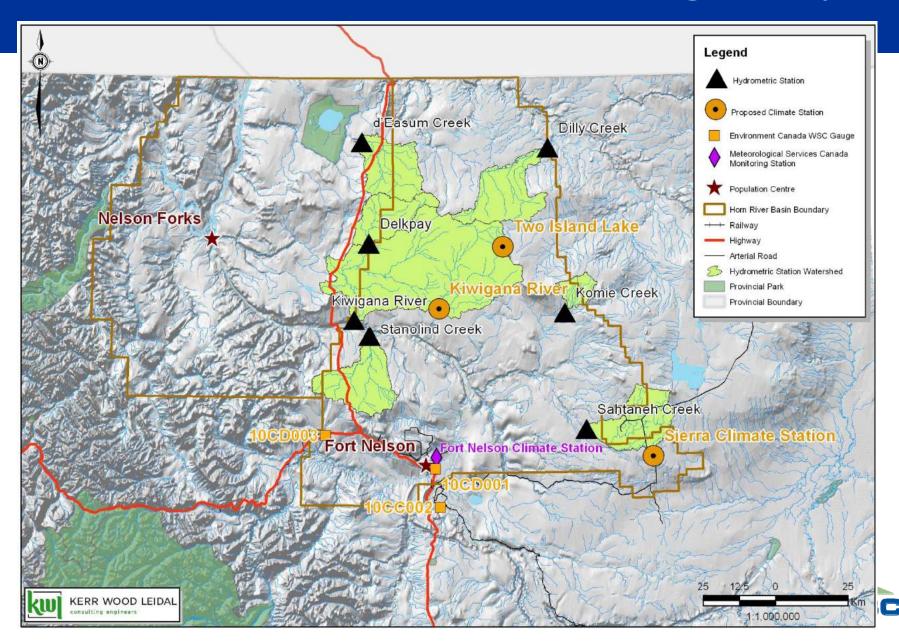


### Watershed Characteristics

- Geographic zone (Estho Escarpment)
- Watershed size (300-900 km²)
- Aspect
- Elevation
- Stream order
- Land cover
- Receiving watershed



## **HRB Surface Water Monitoring Study**



## 4. NE BC Regional Hydrologic Modelling

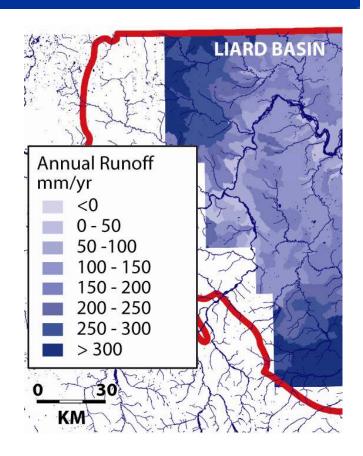
#### **Objectives**

- 1. Define natural surface water supply
- 2. Guide decisions on water licensing & withdrawal
- 3. Provide information to interested parties

#### **Approach**

- 1. Climate, topography and land cover information for all of NE BC
- 2. GIS based format for analysis and query

Partnership with OGC and Forests, Lands, and Natural Resource Operations: Allan Chapman, Project Leader





### Conclusions

- Geoscience BC's regional multi-disciplinary partnership projects, such as Horn River Basin and Montney Water projects, contribute to a broad understanding of water availability and issues
- Geoscience BC's water projects provide valuable information to industry, government, First Nations, local communities and other interests

www.geosciencebc.com

THANK YOU

