

# Numerical Modeling of Deep-Aquifer Wastewater Disposal in the Paddy-Cadotte Formation of Northeast BC



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Matthew Simons, Diana Allen, Dirk Kirste (SFU)

Laurie Welch (BCOGC)



# Presentation Outline

## Introduction

- Disposal Wells
- Wastewater Characteristics

## Knowledge Gaps

## Study Area

## Modeling

- Axisymmetric Box Models
  - Design
  - Results

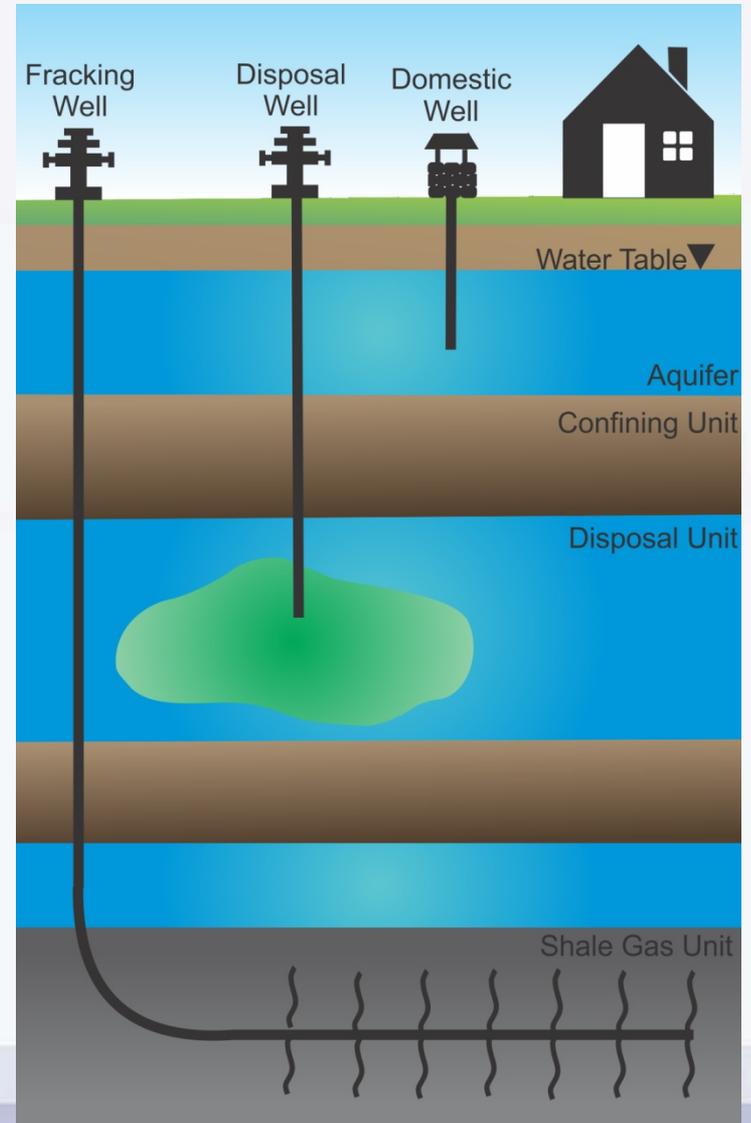
## Conclusions and Future Work

# Disposal Wells in BC

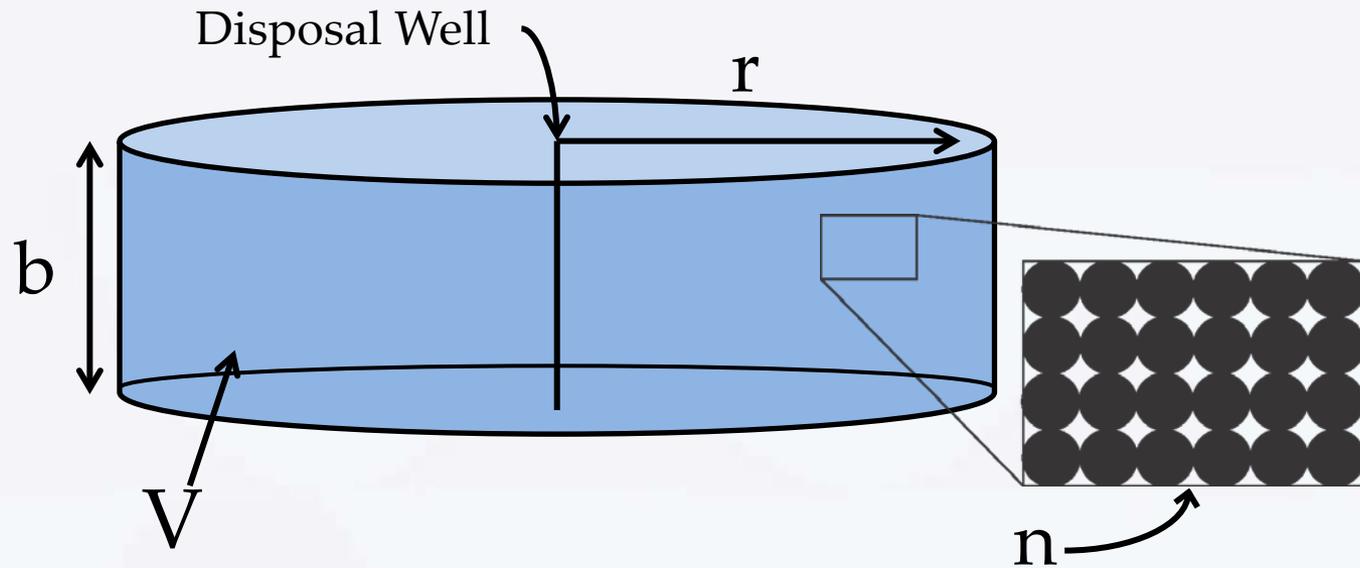
Regulated by the British Columbia Oil and Gas Commission. Regulations include:

- Disposal formations must be properly confined
- Disposal formations must be located at a minimum depth determined by local geology, typically ~600 m below ground surface
- Pressure limitations are imposed on pumping to prevent overpressuring the formation

Wastewater is composed of a mixture of flowback and produced water, and can reach salinity values of  $>300,000$  mg/L, more than 8x saltier than ocean water.



# Volumetric Calculation



$$r = \sqrt{\frac{V}{\pi b n}}$$

Does not account for:

- Regional groundwater flow
- Mass transport processes
- Buoyancy effects due to fluid density differences arising from variations in temperature and salinity

# Wastewater Monitoring

“There has been little monitoring of formation pressures . . . and almost no effort dedicated to tracking injected brine in the subsurface.”

-Ferguson, 2014

# Questions to answer:

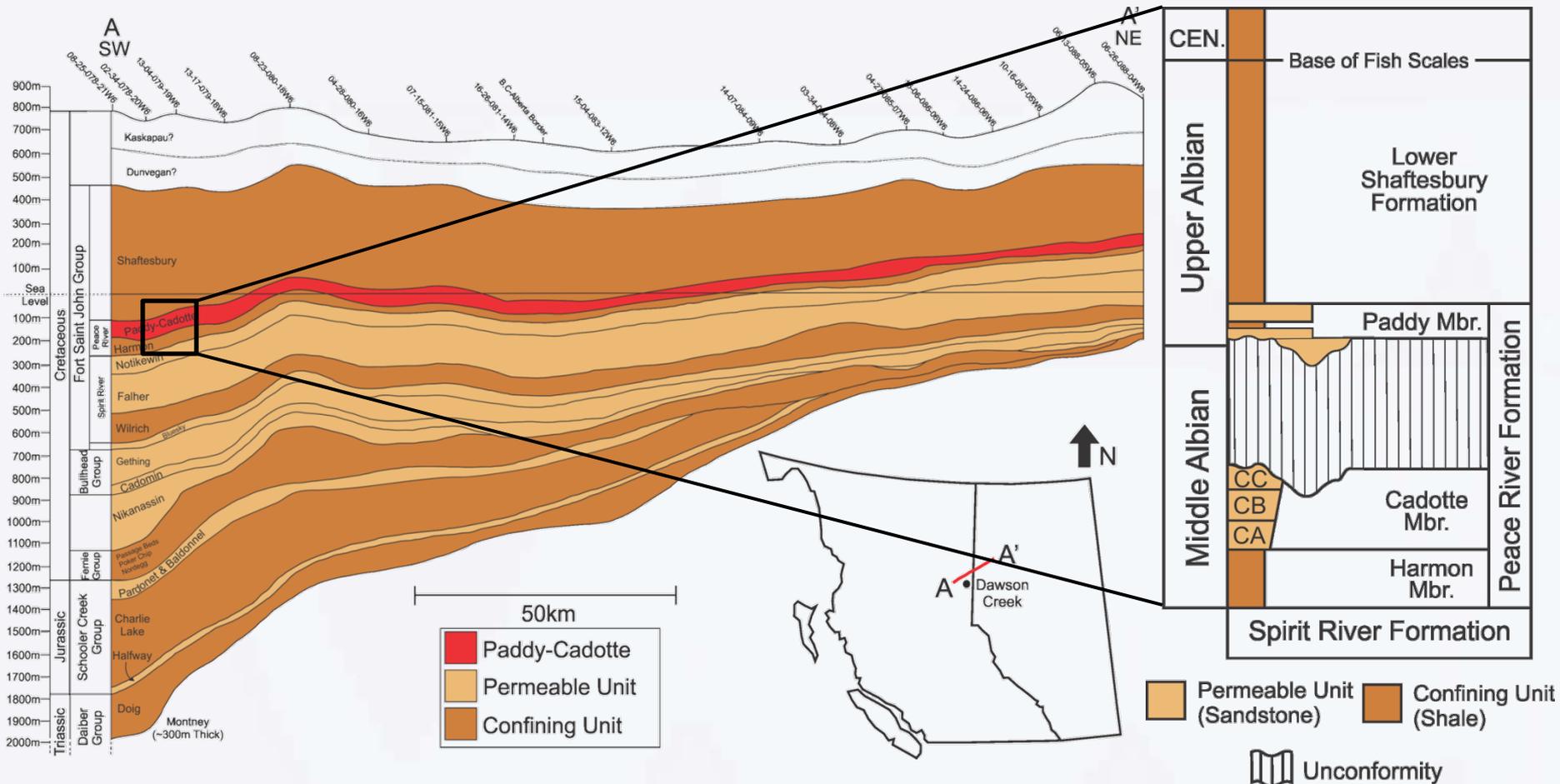
How does wastewater behave on the regional scale?

- Will be answered using a regional model of the Paddy-Cadotte. This model will incorporate source water wells targeting the same formation and assess their influence on wastewater migration.

How does wastewater behave on the local scale?

- Will be answered using small-scale box models, the results of which will be presented in this talk.

# Study Area



Modified from Leckie and Reinson (1993)

# Study Area

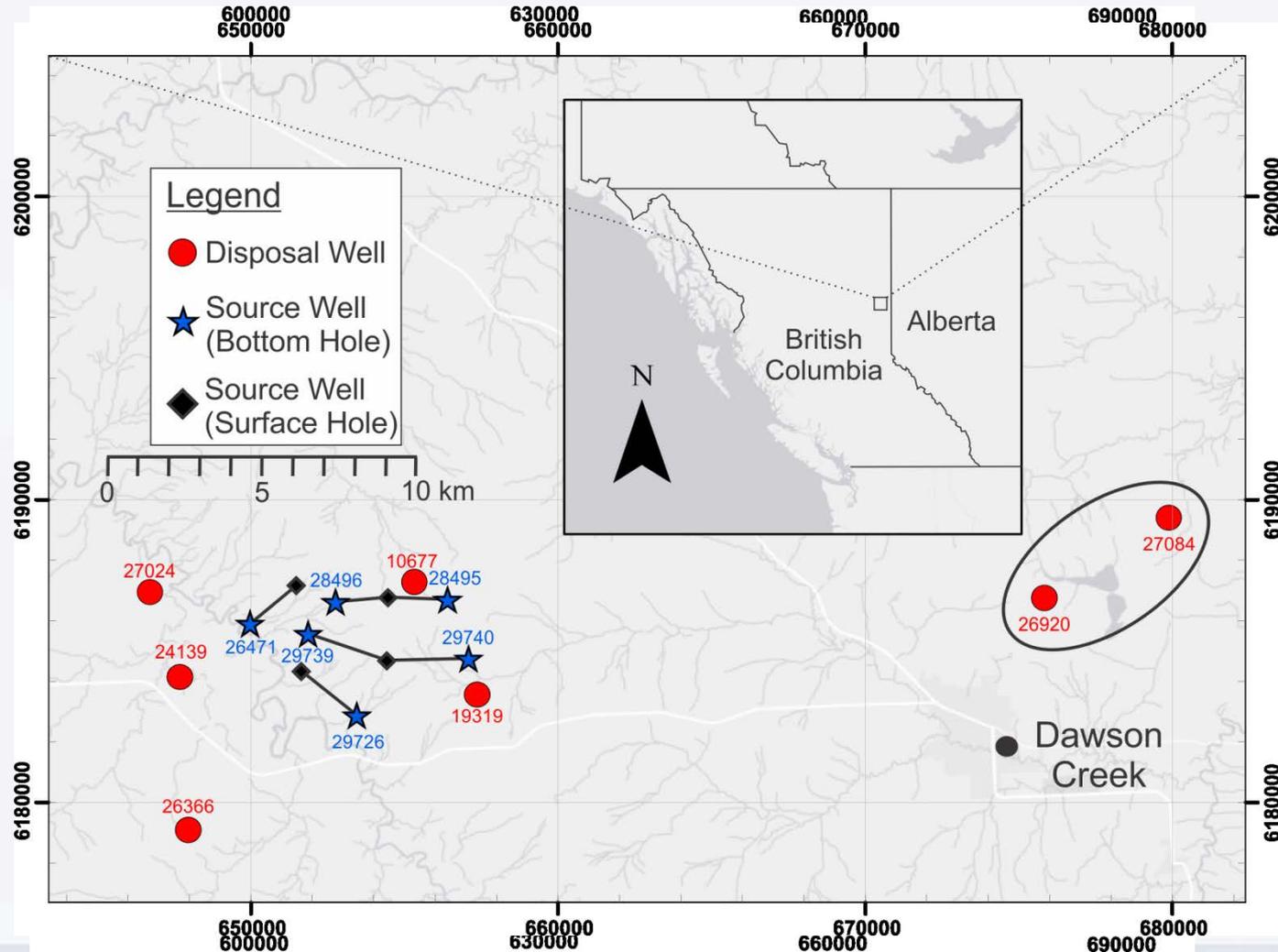
Well field ~20 km west of Dawson Creek

5 Disposal Wells

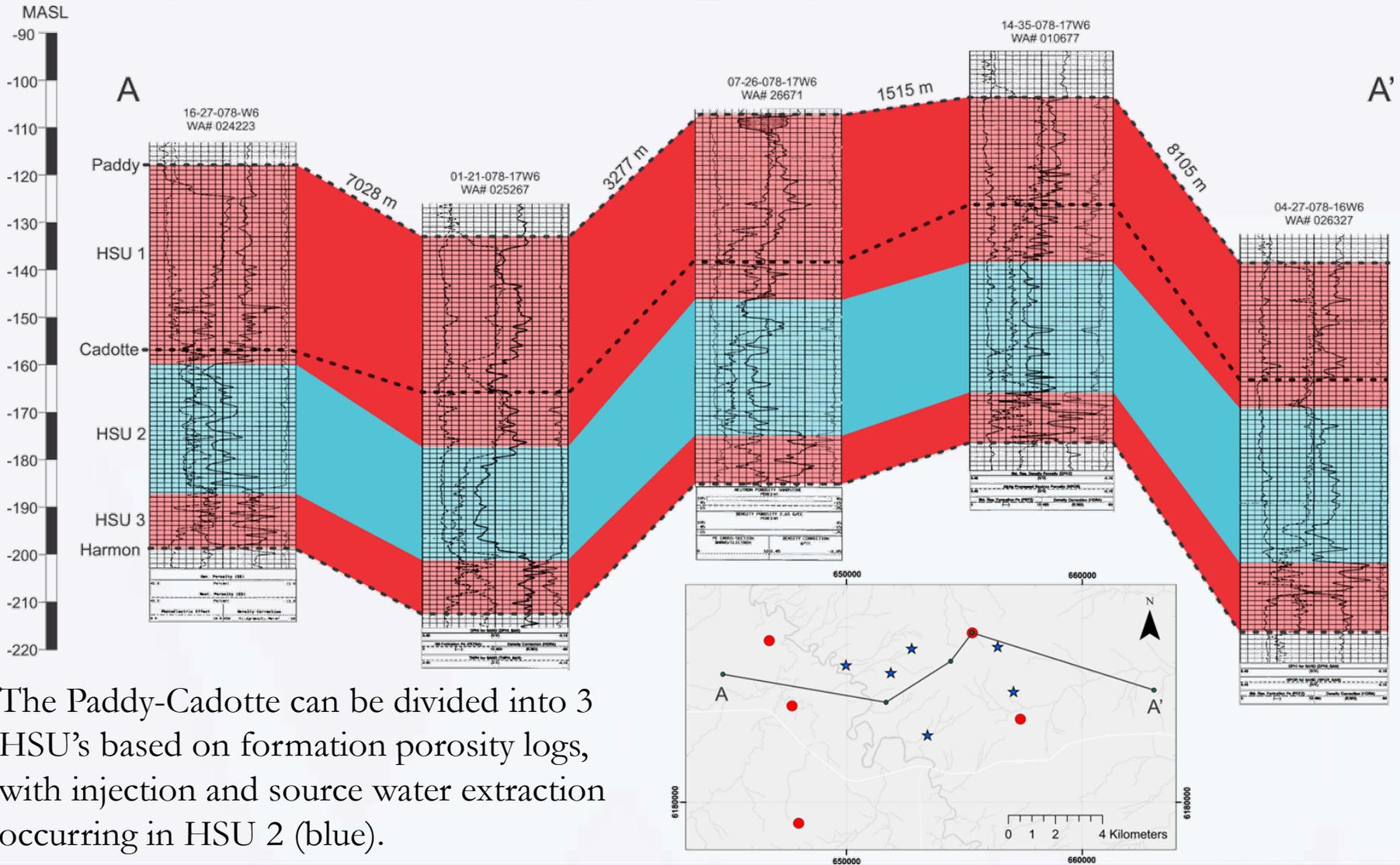
- Average injection rate of 100-150 m<sup>3</sup>/day

6 Source Wells:

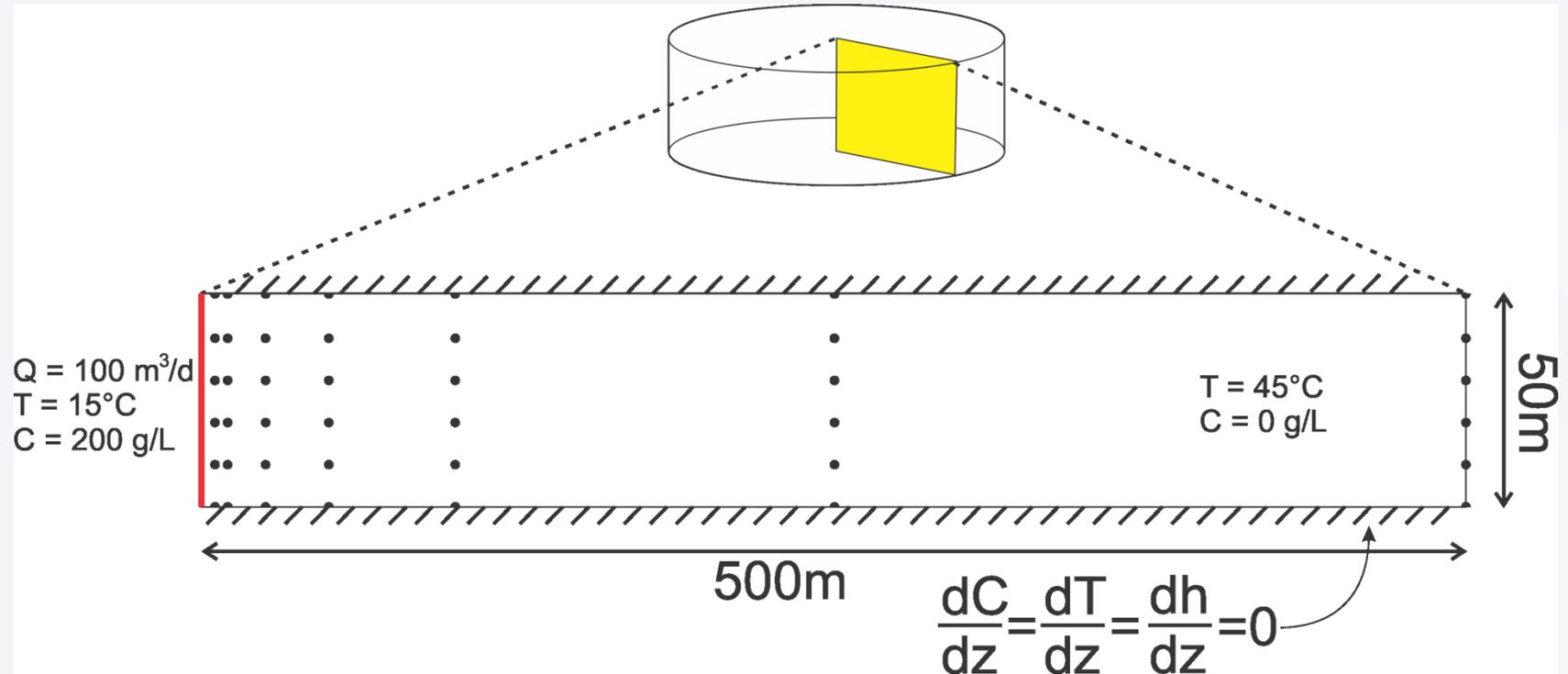
- Average extraction rate of 200 m<sup>3</sup>/day



# Hydrostratigraphy



# Axisymmetric Box Model

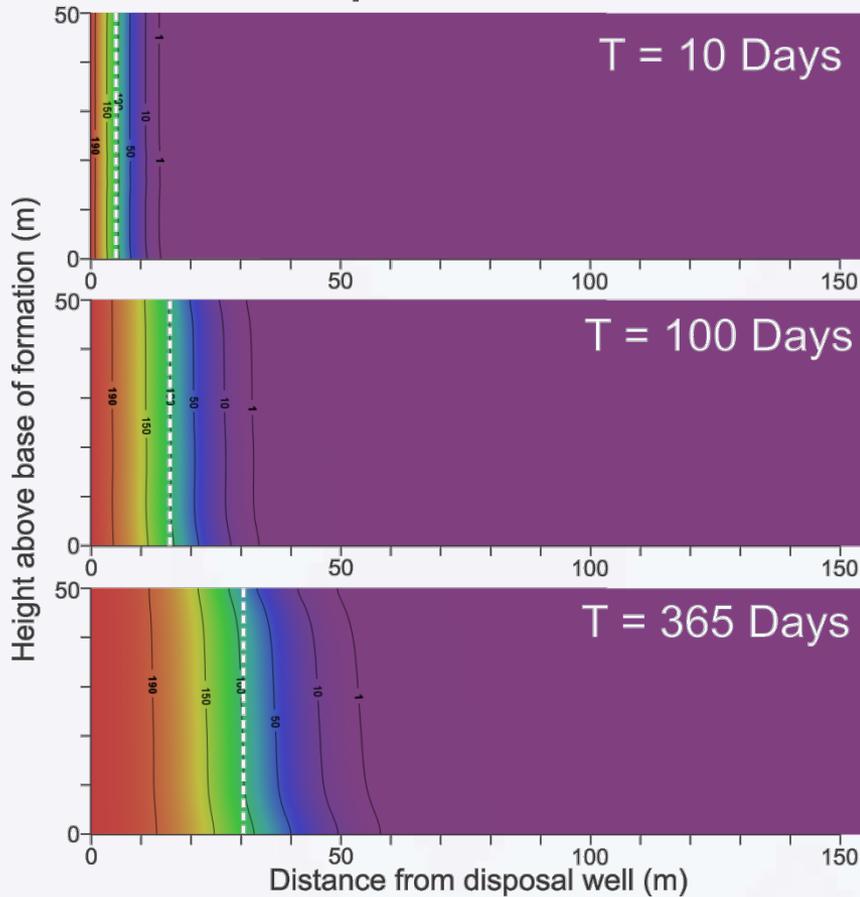


Pro: Significantly reduced simulation time compared to equivalent 3D model

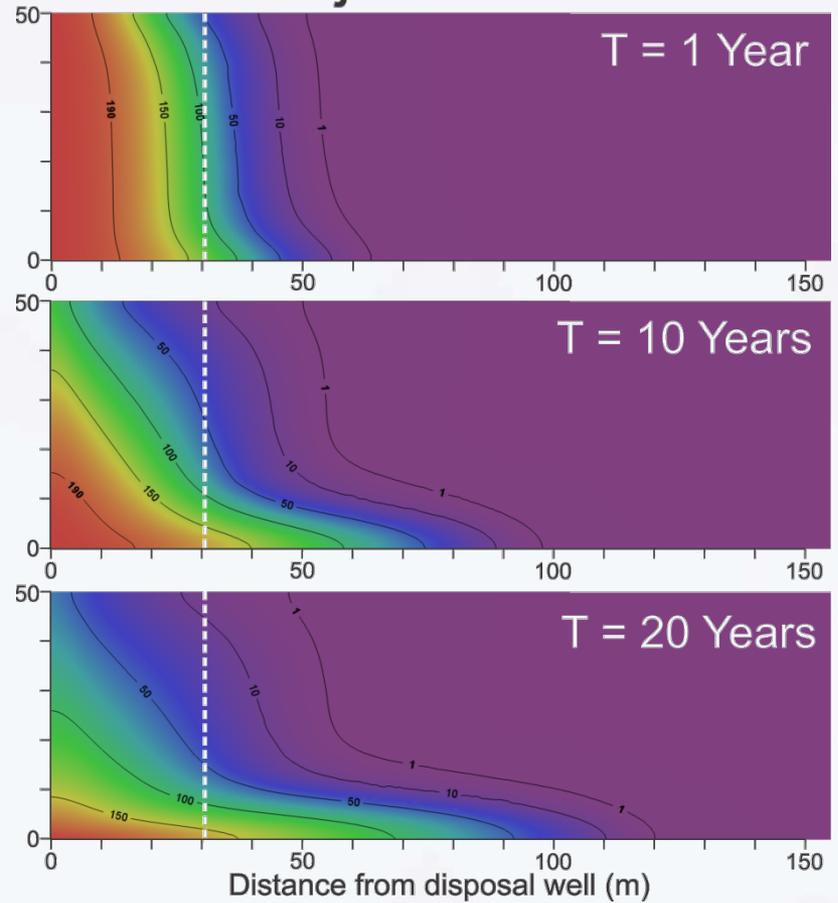
Con: Unable to simulate features that are not radially symmetric about the well

# Base Case Results

## Disposal Period



## Post-Injection Period



# Conclusions and Future Work

Box models allowed for :

- Understanding of plume structure and extent
- Evaluation of the volumetric calculation

Volumetric calculation was inaccurate due to not incorporating mass transport processes and density-related effects

These results, in addition to results from a sensitivity analysis, will help guide construction of a regional model of the Paddy-Cadotte.

# Acknowledgements



Pacific Institute  
for Climate Solutions  
*Knowledge. Insight. Action.*



# References

Leckie, D.A. and Reinson, G.E. (1993) Effects of Middle to Late Albian sea level fluctuations in the Cretaceous interior seaway, Western Canada. In: Evolution of the Western Interior Basin (Eds W.G.E. Caldwell and E.G. Kauffman), Geol. Assoc. Can. Spec. Paper, 39, 151-176

Petrel Robertson Consulting Ltd. and Canadian Discovery Ltd. 2011. Deep Subsurface Aquifer Characterization in support of Montney Tight Gas Development: Geological Report; Geoscience BC, Report 2011-11, 386 p.