

Overview of Groundwater Conditions in the Sturgeon River Watershed



North Saskatchewan Watershed Alliance Groundwater Forum

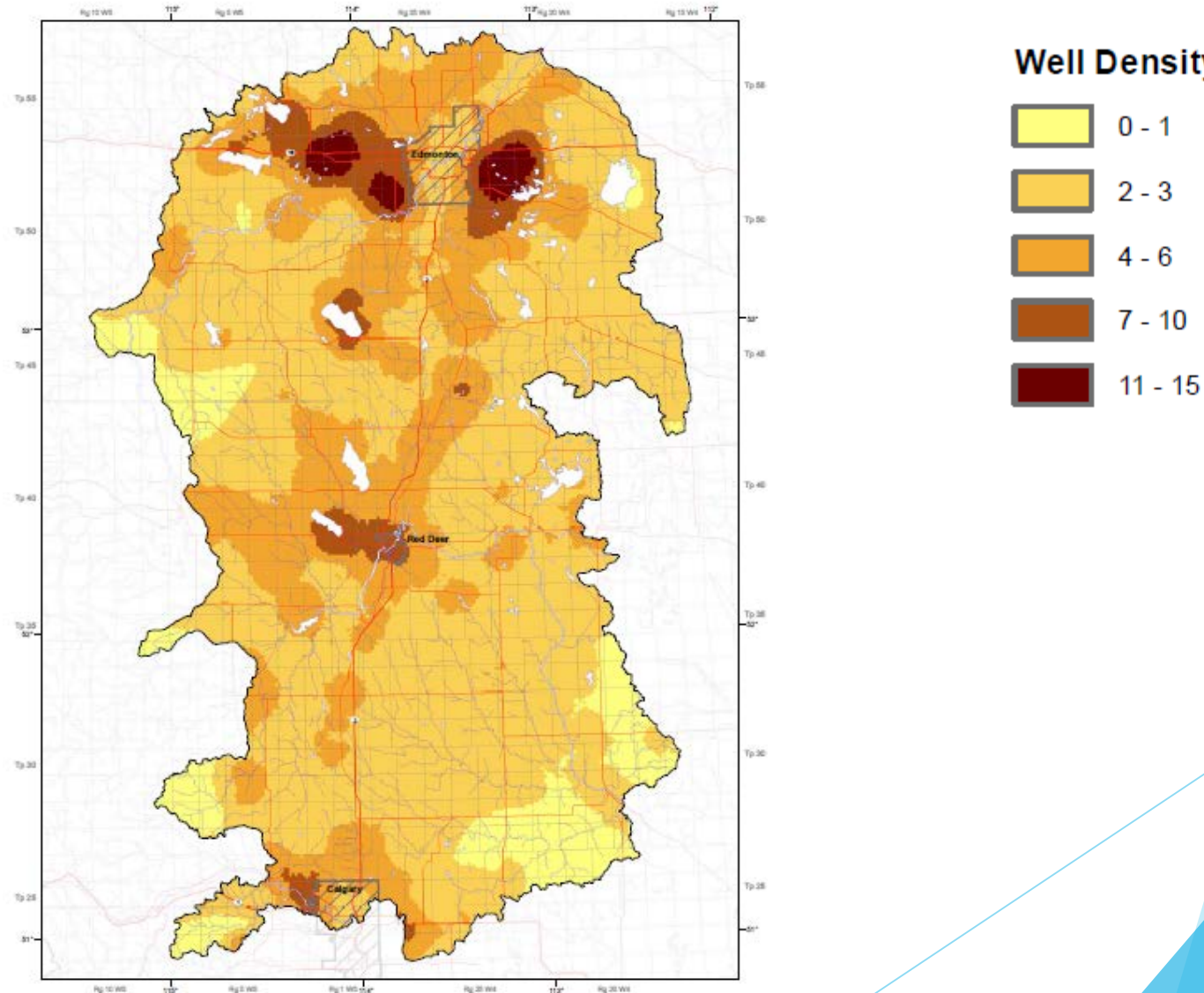
February 27, 2019

Alex Oiffer, M.Sc., P.Geol.

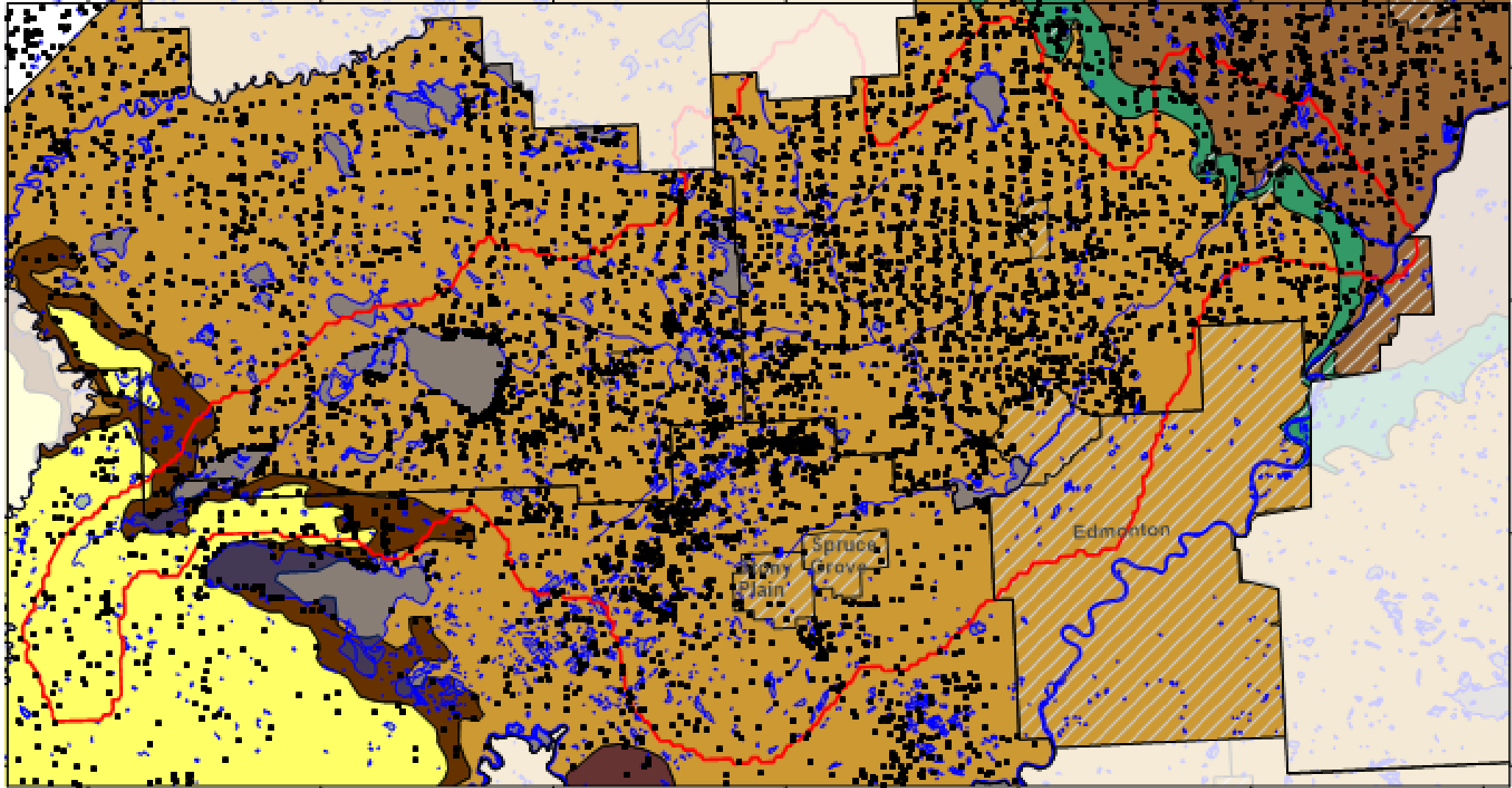
Outline

- ▶ Hydrogeologic Framework
- ▶ Local-Scale Groundwater Dynamics
- ▶ Regional-Scale Groundwater Dynamics

Water Well Density (Edmonton - Calgary Corridor)

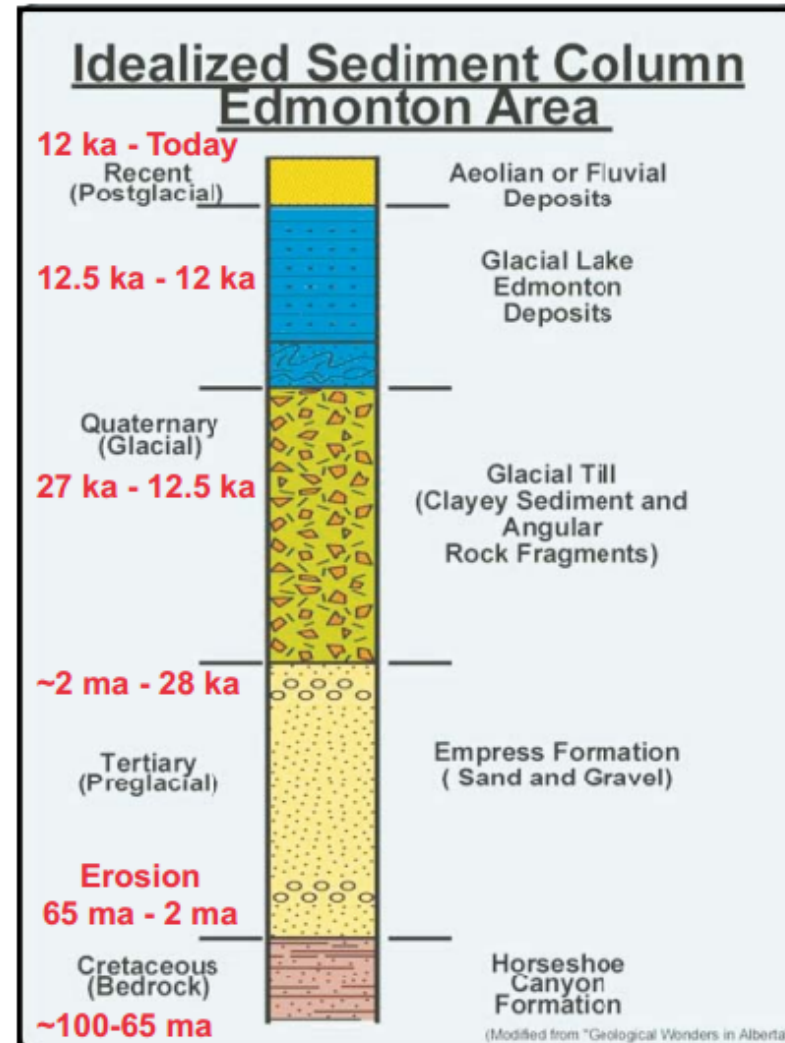


Groundwater Use from Bedrock Aquifers



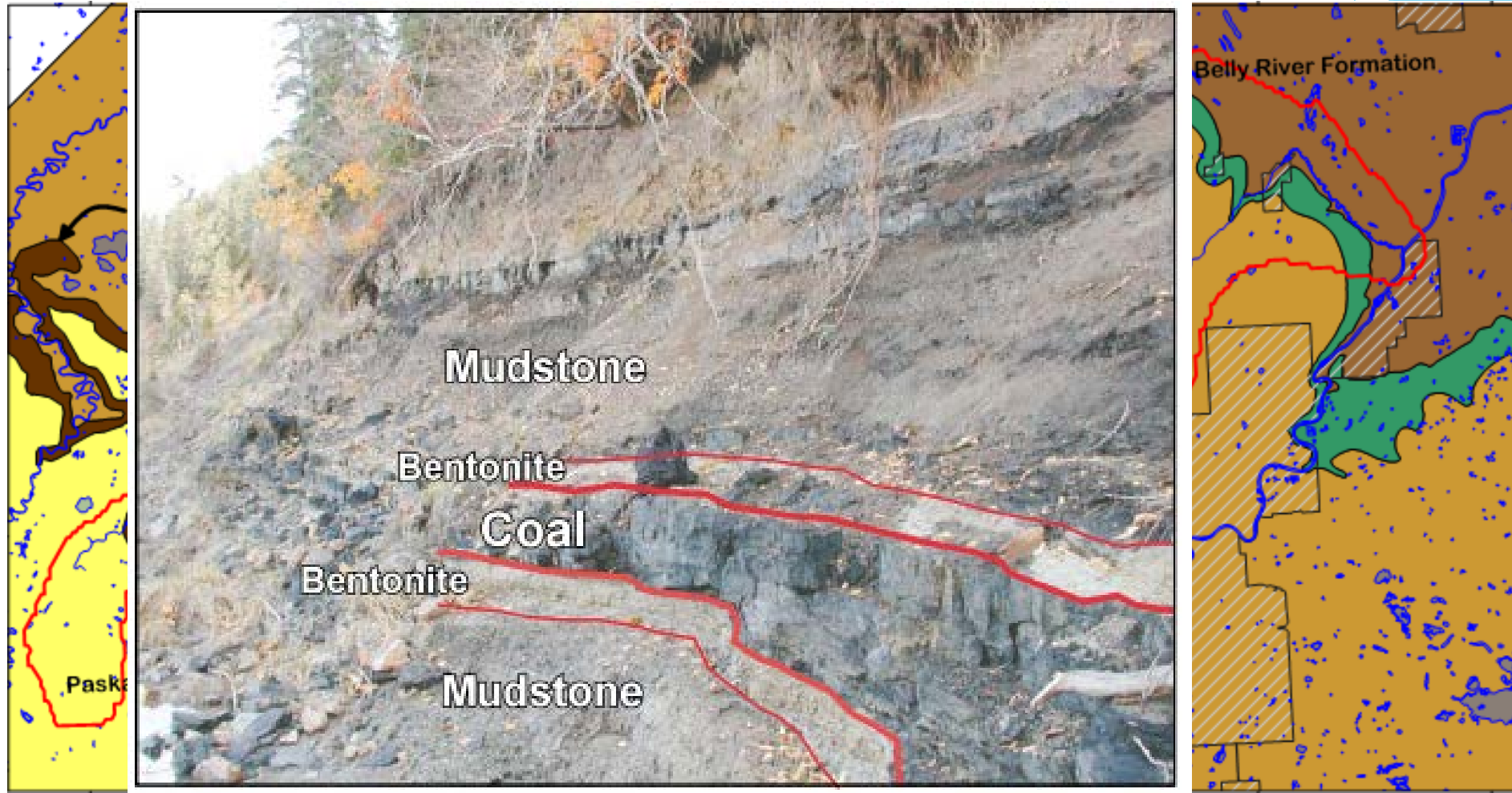
Based on digital data from HCL 1998, HCL 1999, HCL 2001

General Geology of the Edmonton Area



(modified from R. Mussieux and M. Nelson, 1998: A Traveller's Guide to the Geological Wonders of Alberta, Provincial Museum of Alberta)

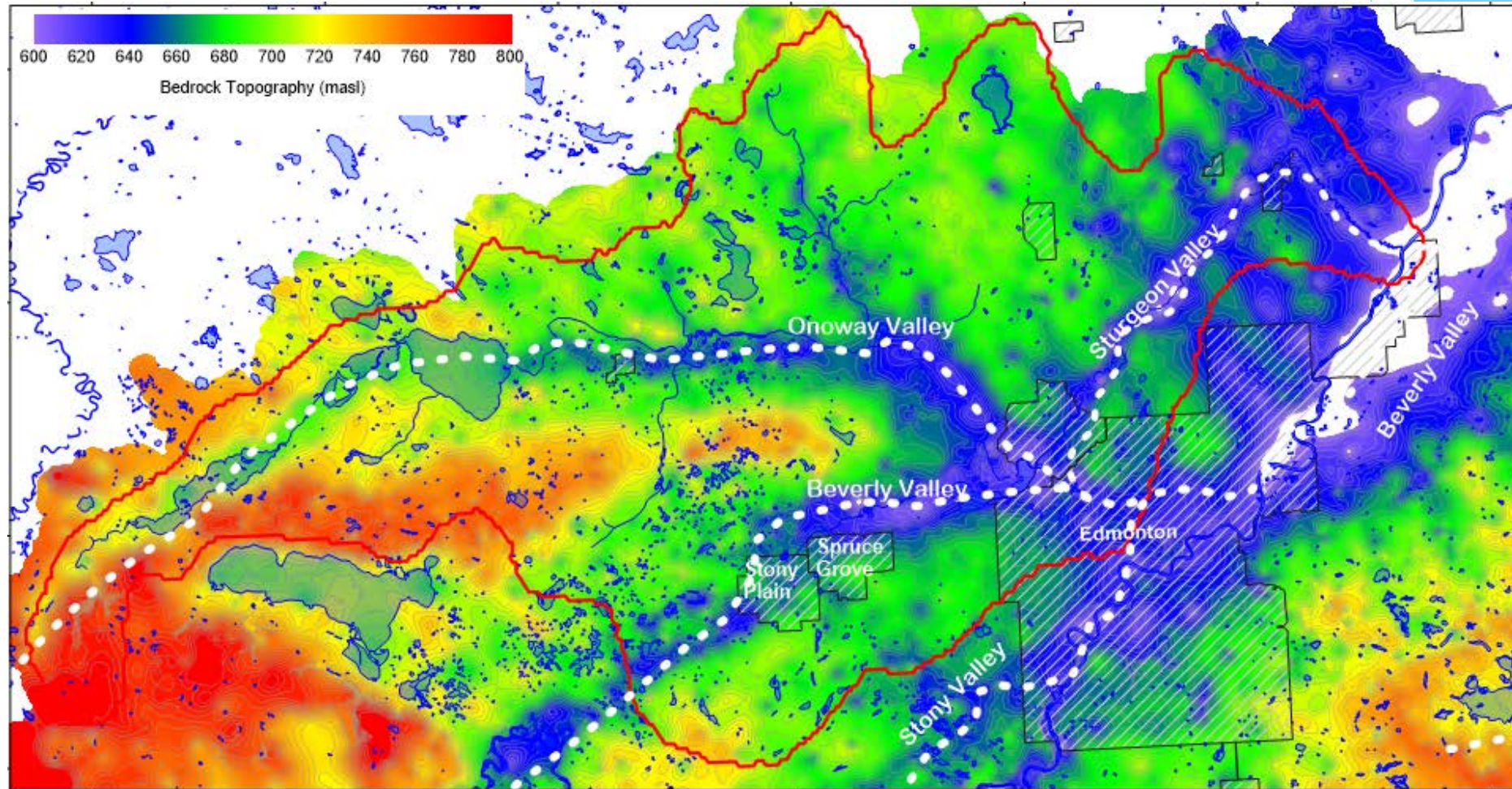
Bedrock Geology



Bedrock Geology: Prior et al. 2013

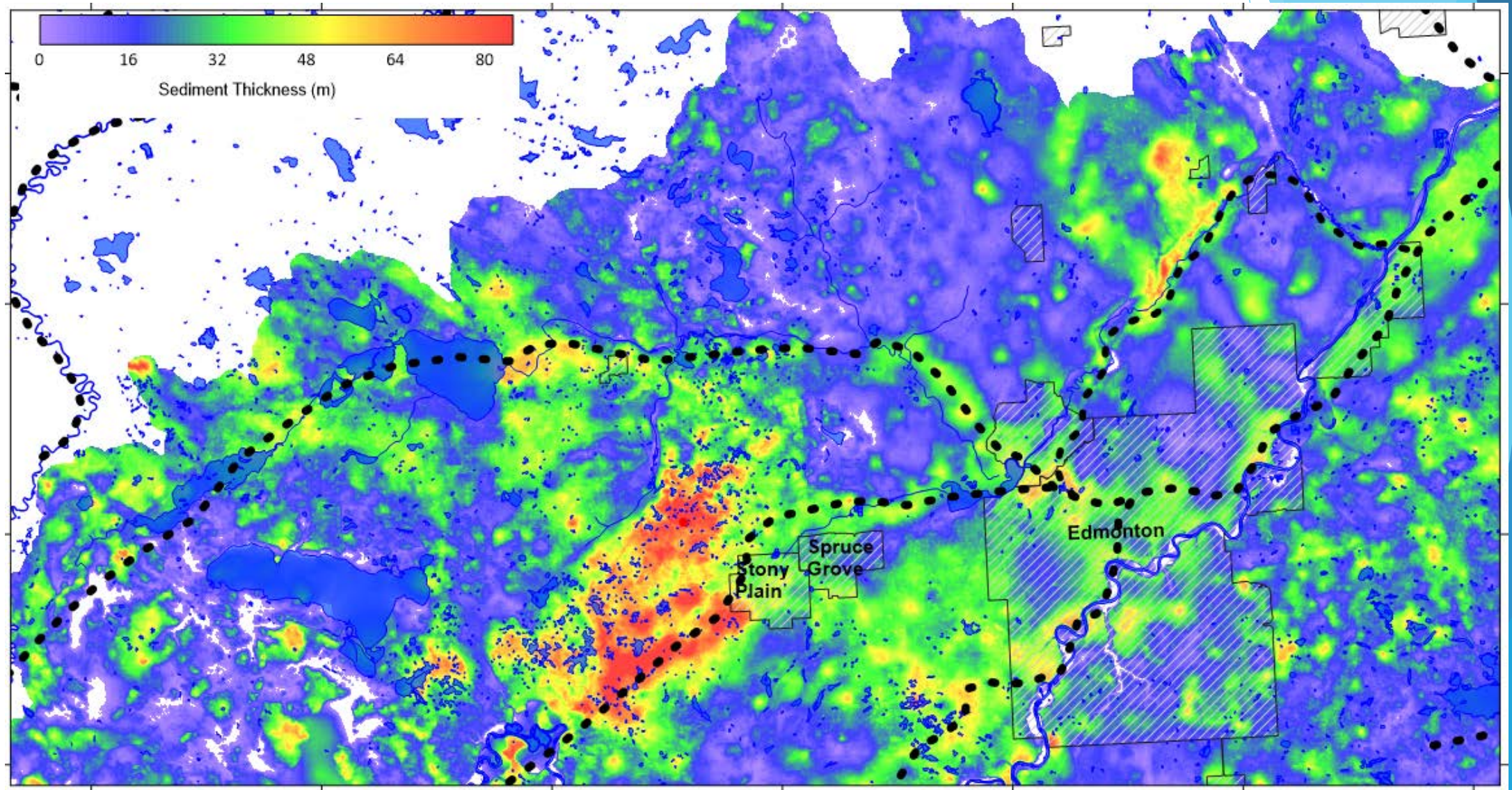
Outcrop Image: Edmonton Geological Society 2008

Bedrock Topography



Bedrock Topography: Slattery et al. 2010
Buried Valley Thalwegs: Pawlowicz et al. 2007

Thickness of Sediments



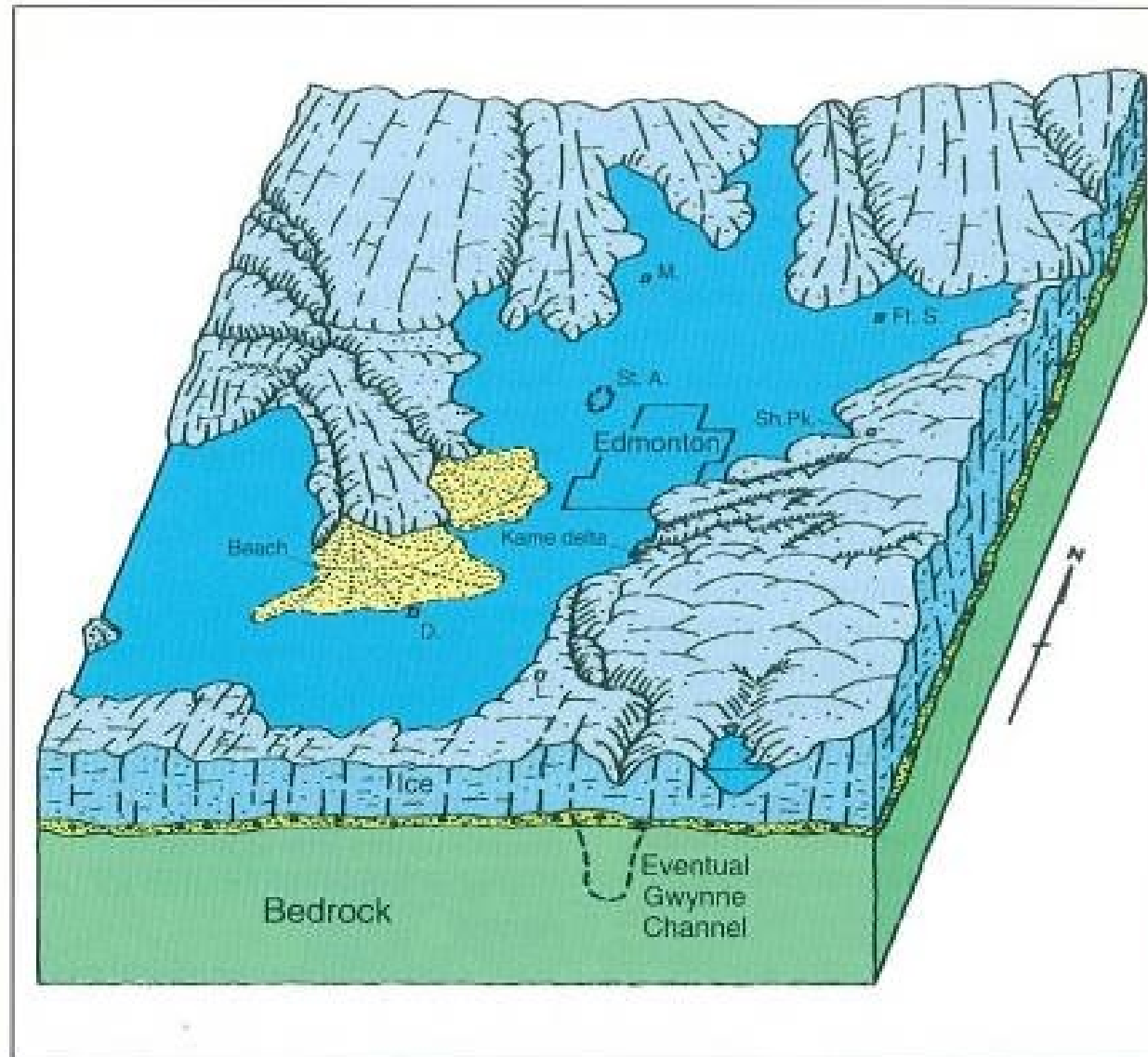
Buried Valley Thalwegs: Pawlowicz et al. 2007

Sediment Thickness: Lyster et al. 2010

Glacial Sediments

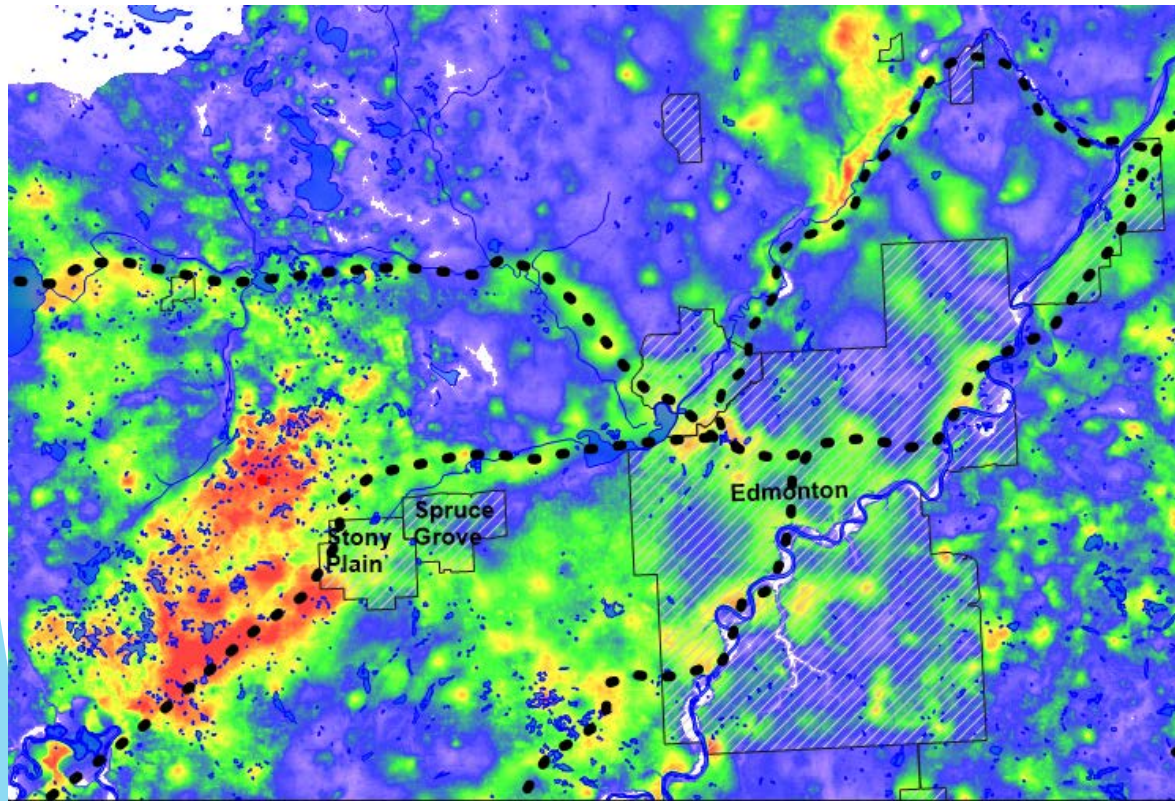
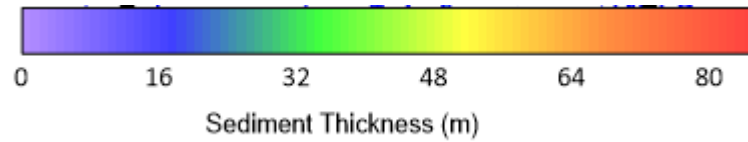


Glacial Sediments

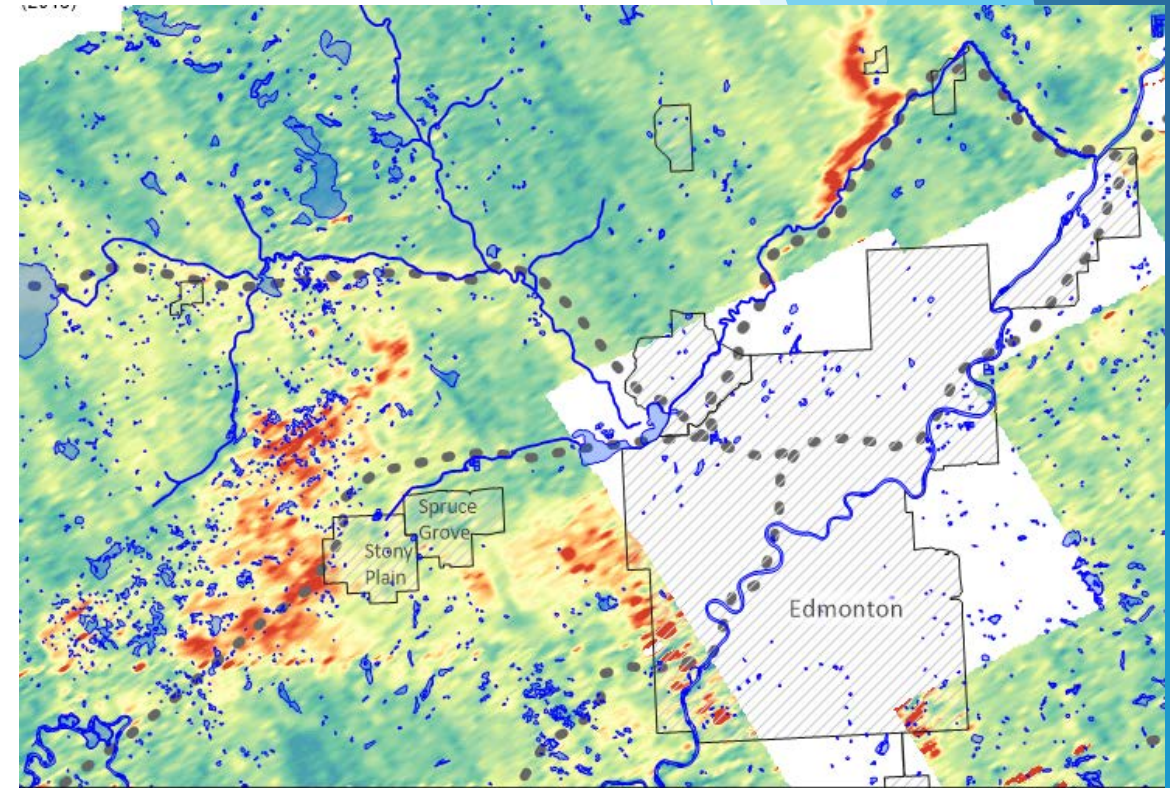


J.D. Godfrey

Sediment Thickness



Electrical Resistivity at 0 m depth (Ohm - m)
Source: Fugro Airborne Surveys and Larch Consulting Ltd. (2015)

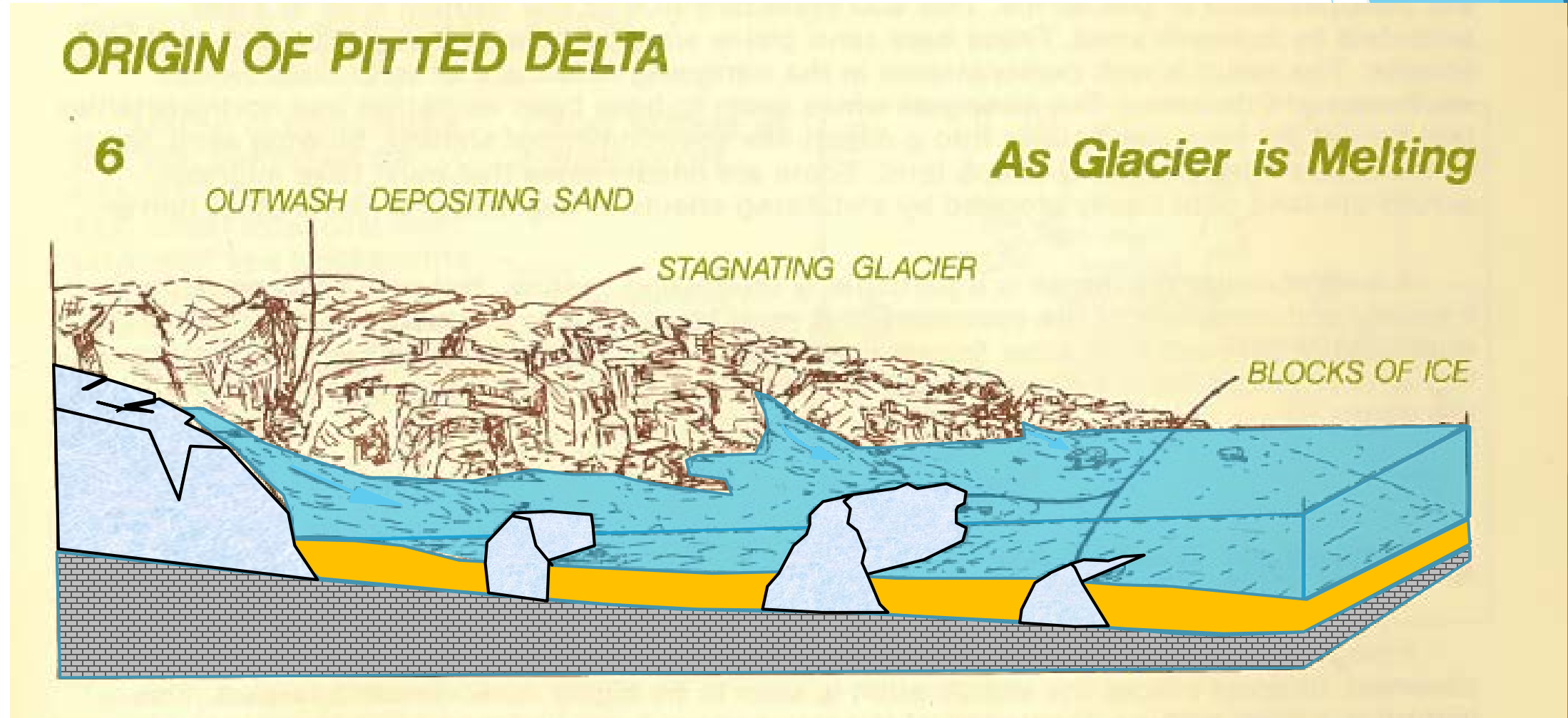


EM Survey: Fugro Airborne Surveys and Larch Consulting 2015

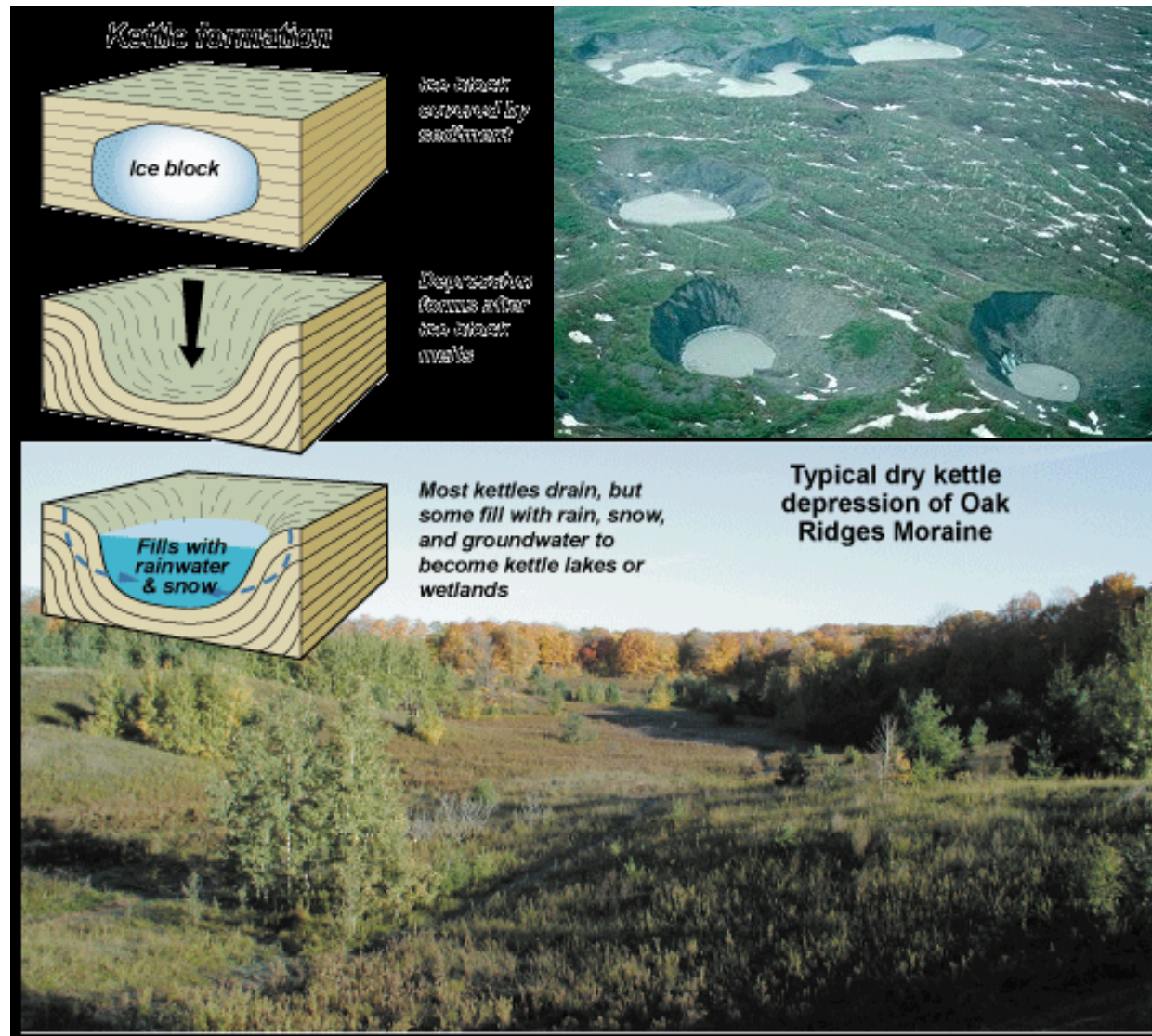
Buried Valley Thalwegs: Pawlowicz et al. 2007

Sediment Thickness: Lyster et al. 2010

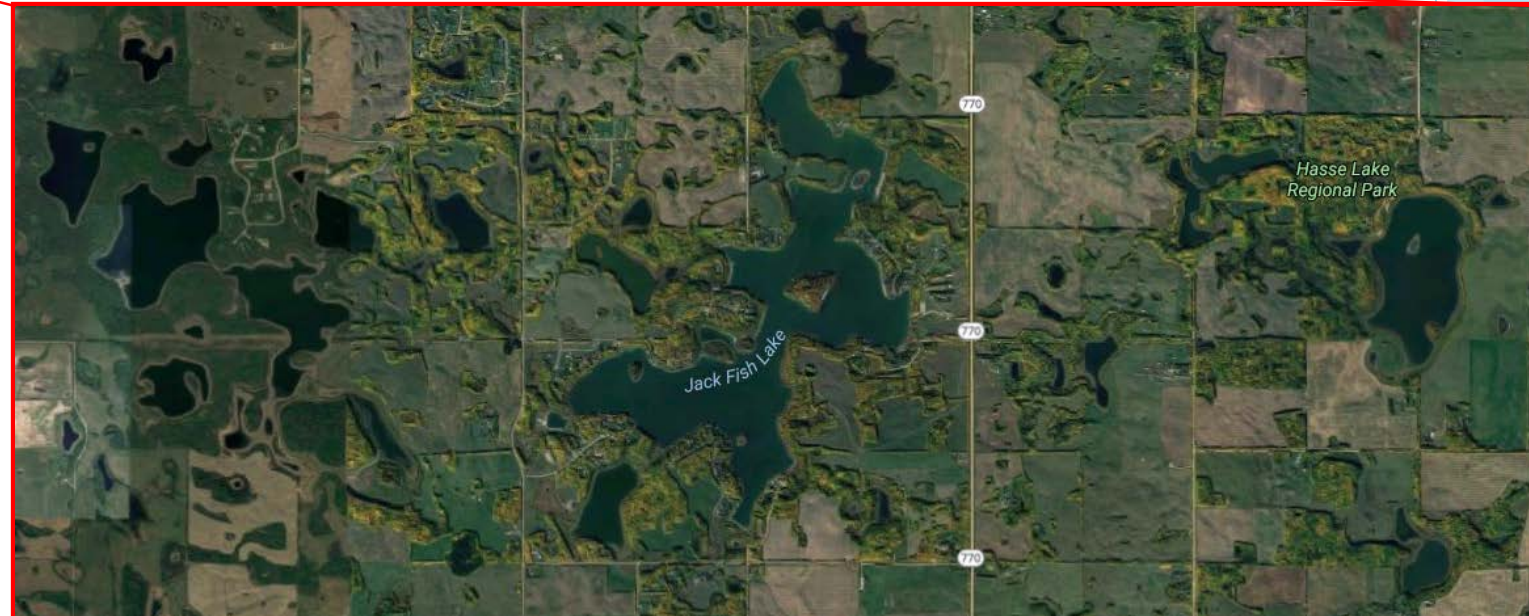
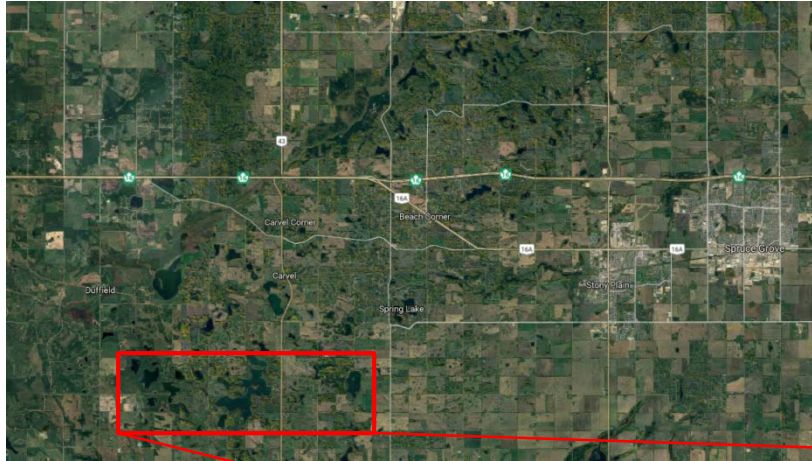
Formation of Pitted Delta



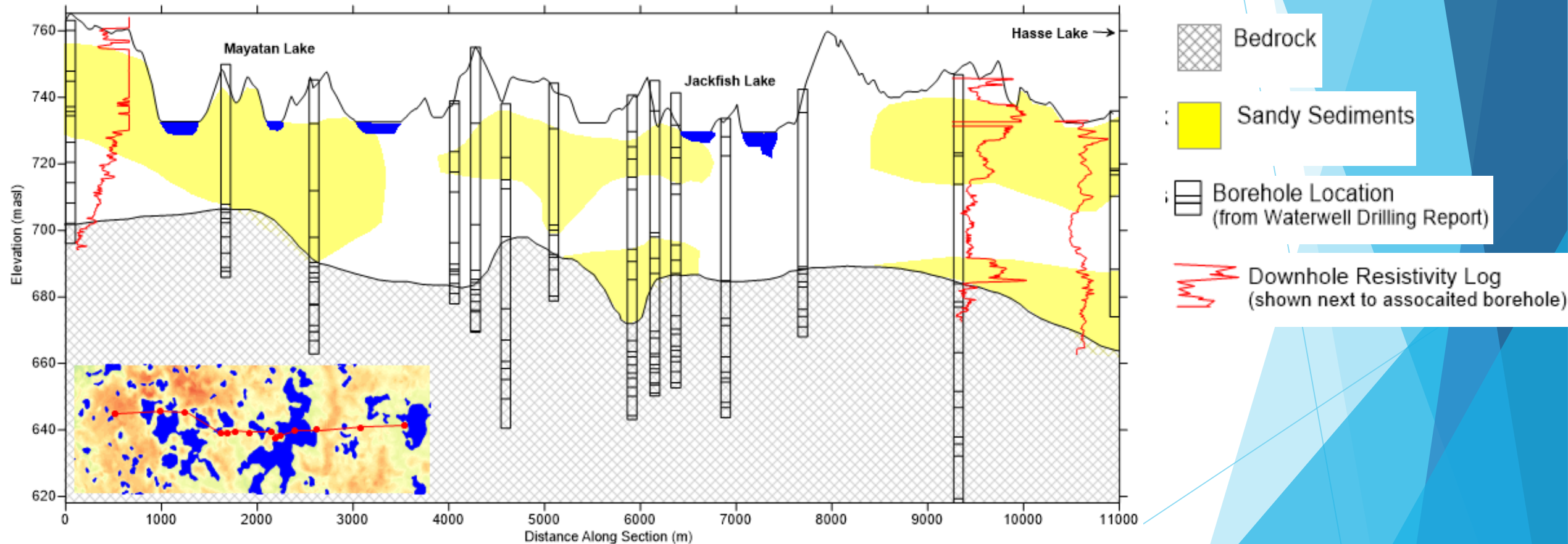
Formation of Kettle Lakes



Kettle Lakes in Carvel Pitted Delta

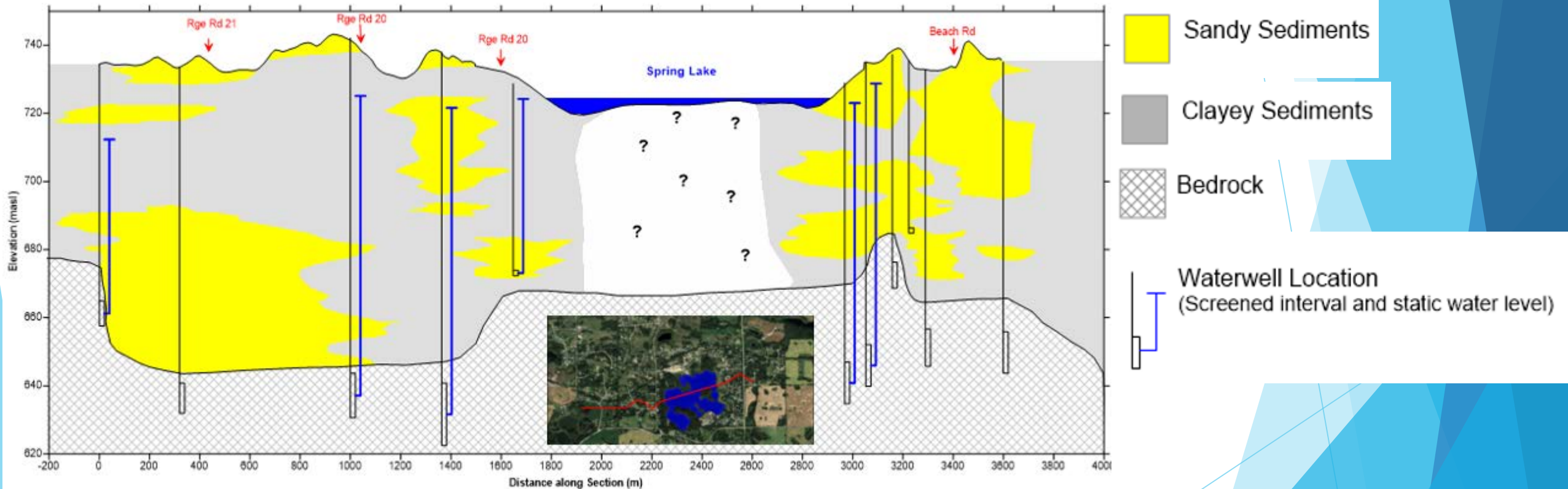


Connection between Groundwater and Surface Water



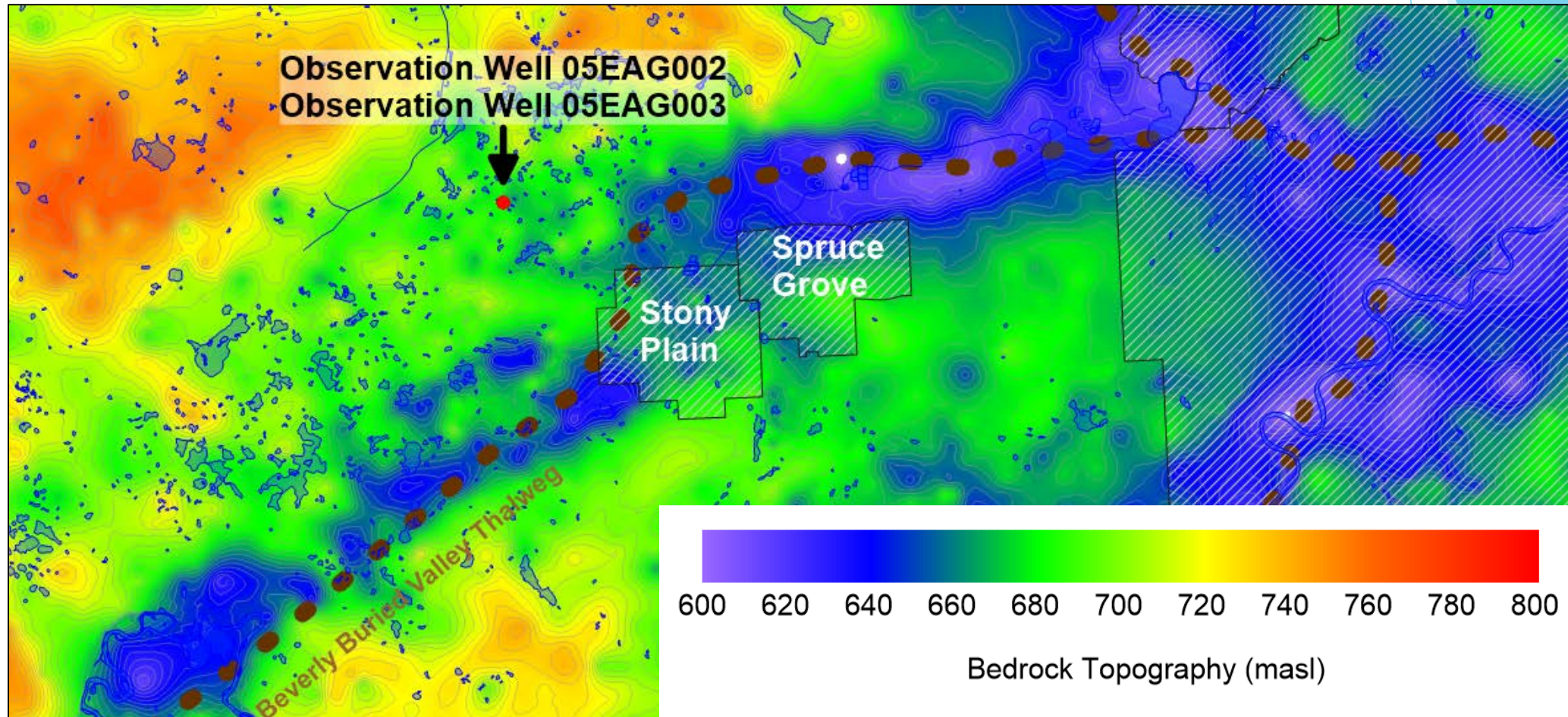
Geology: Dupuy et al. 1979, Tokarsky 1976b, Matichuk 1976, Slattery et al. 2010, Fugro Airborne Surveys and Larch Consulting 2015, Alberta Environment and Parks Water Well Database
Bathymetry: Alberta Environment 2008

Connection between Groundwater and Surface Water



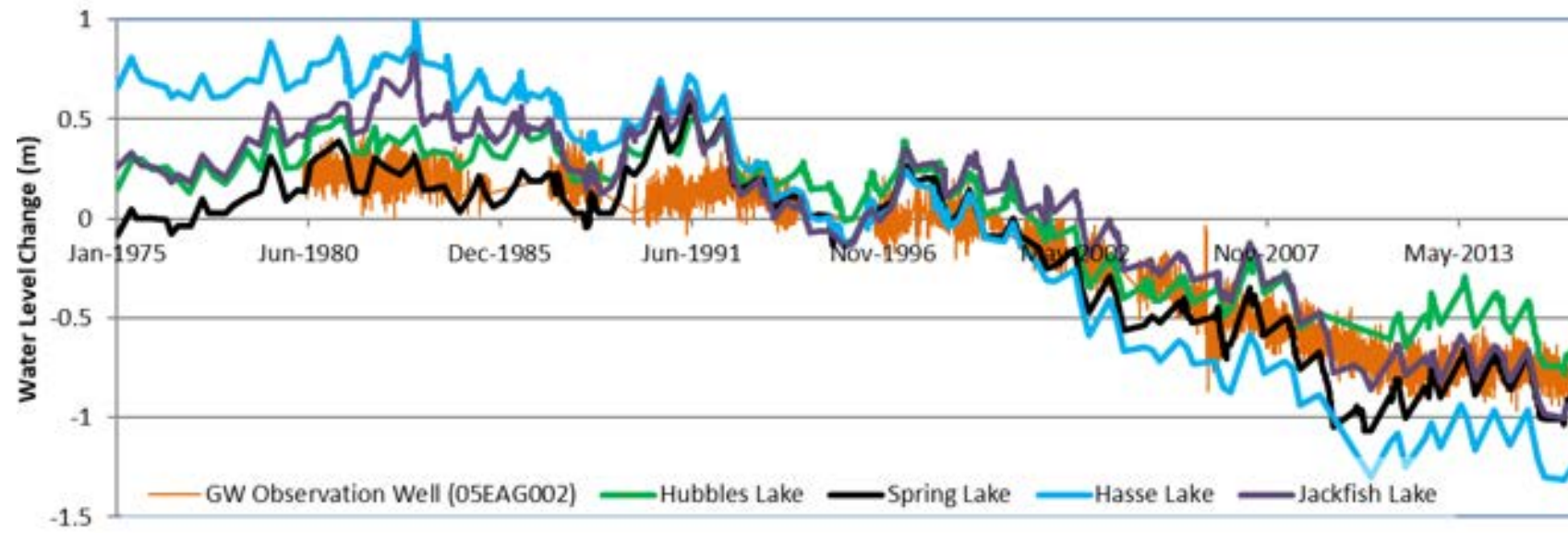
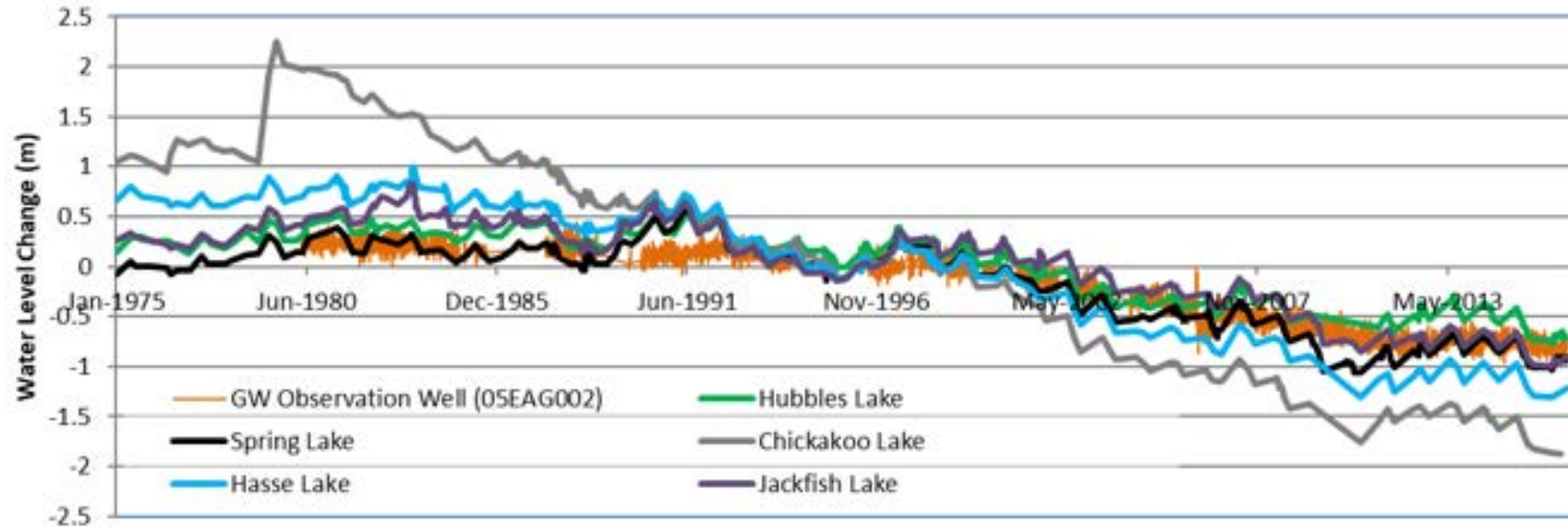
Geology: Tokarsky 1975, Slattery et al. 2010, Alberta Environment and Parks Water Well Database
Bathymetry: Alberta Environment 2008

Evidence of Hydraulic Connection between Groundwater and Surface Water

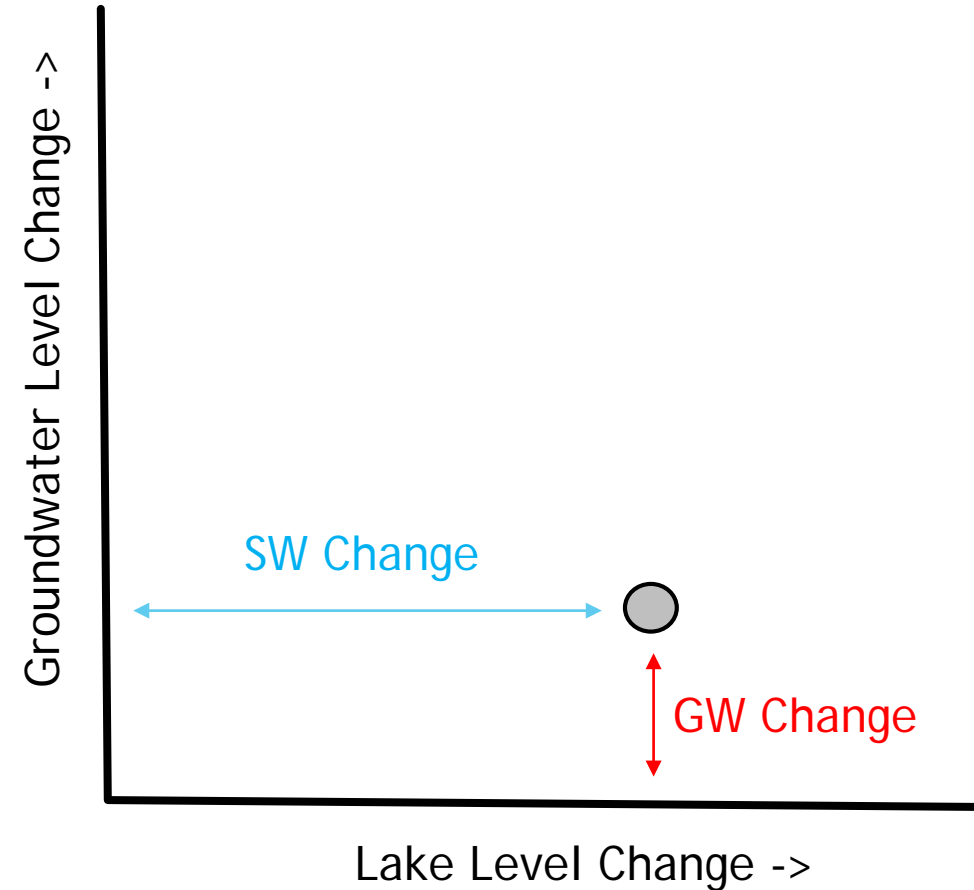
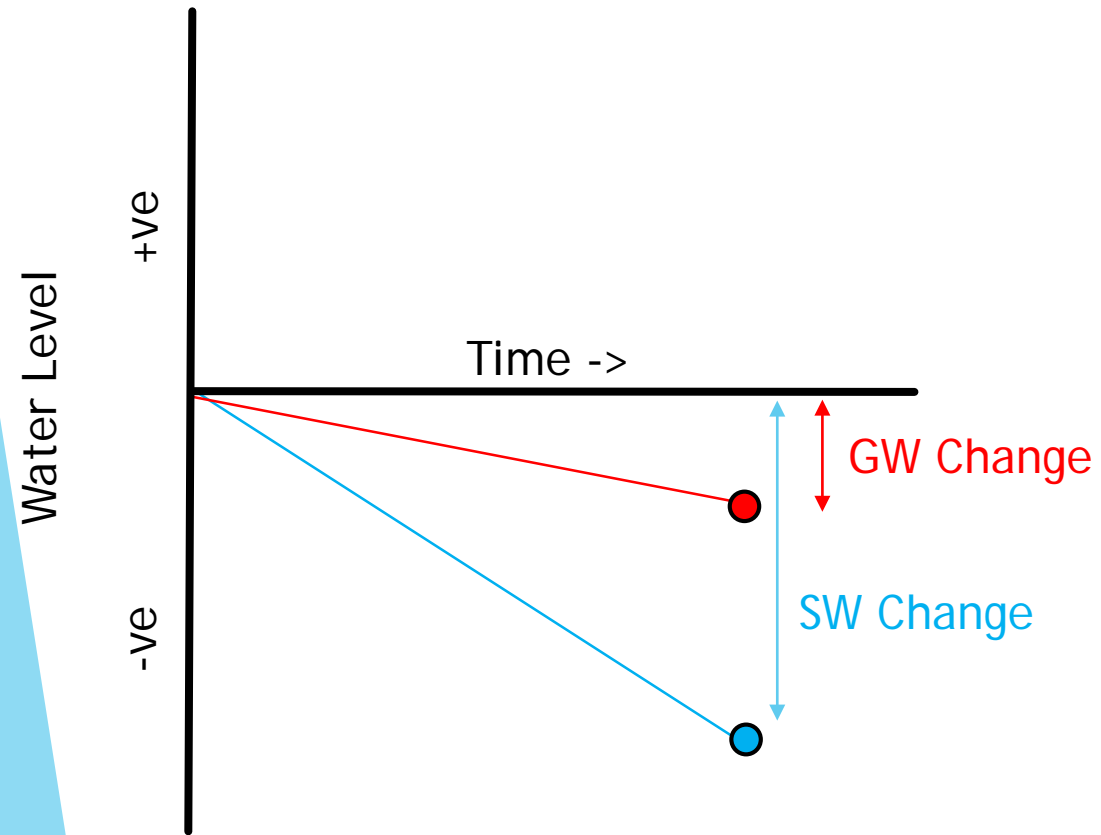


Bedrock Topography: Slattery et al. 2010
Buried Valley Thalwegs: Pawlowicz et al. 2007

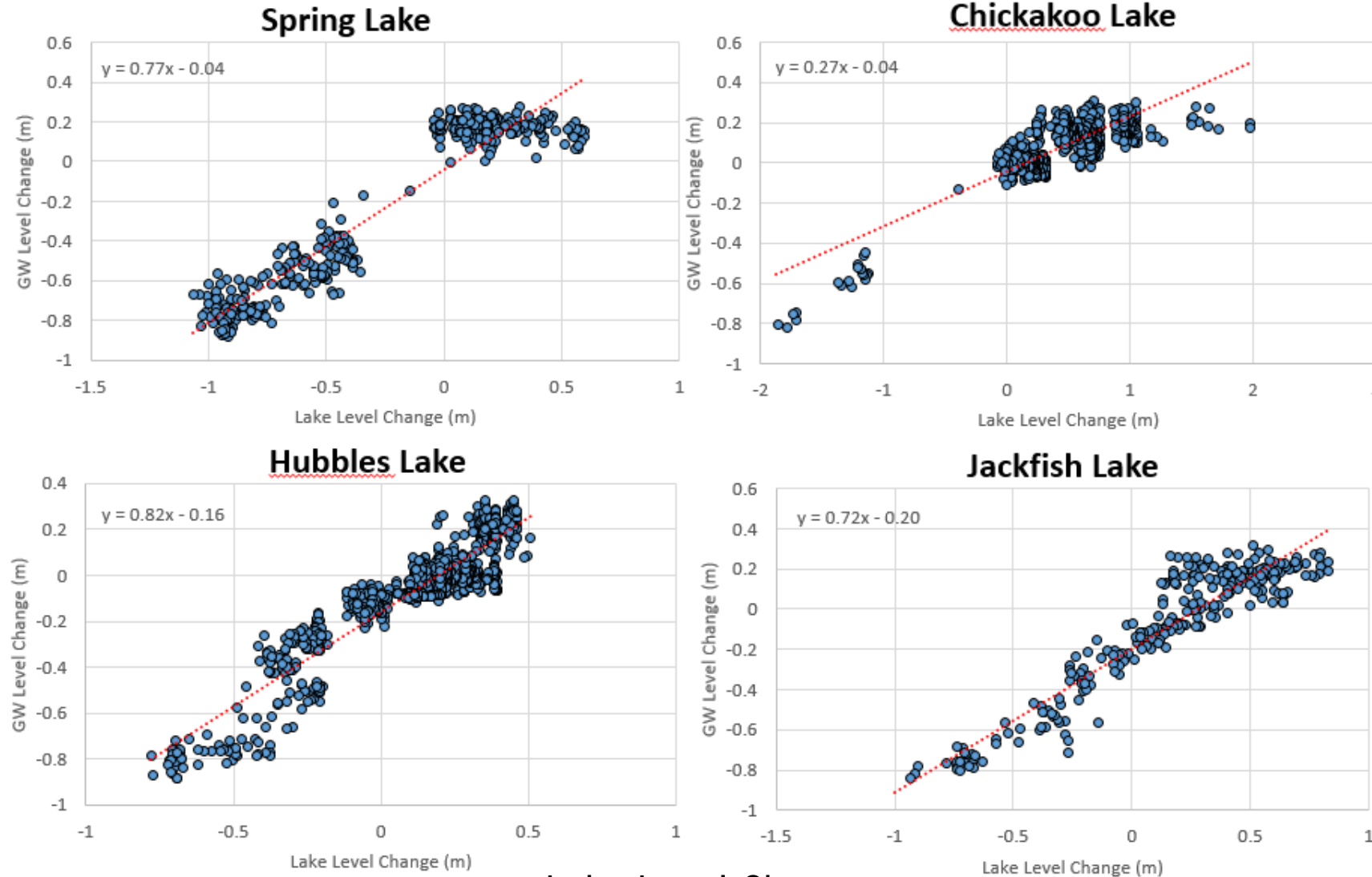
Evidence of a Hydraulic Connection



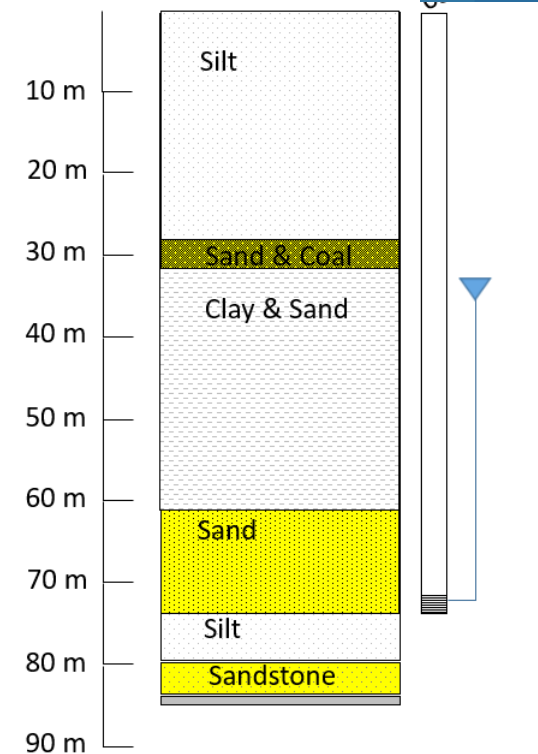
Evidence of a Hydraulic Connection



Evidence of a Hydraulic Connection



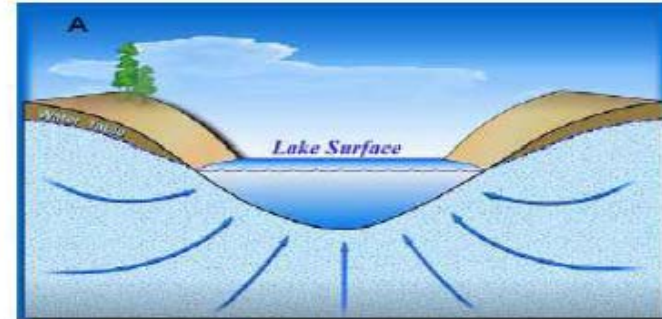
Lake Level Change ->



Groundwater – Lake Interactions

Gaining Lake

- gains water from groundwater system



Losing Lake

- Loses water to groundwater system



Flow-through

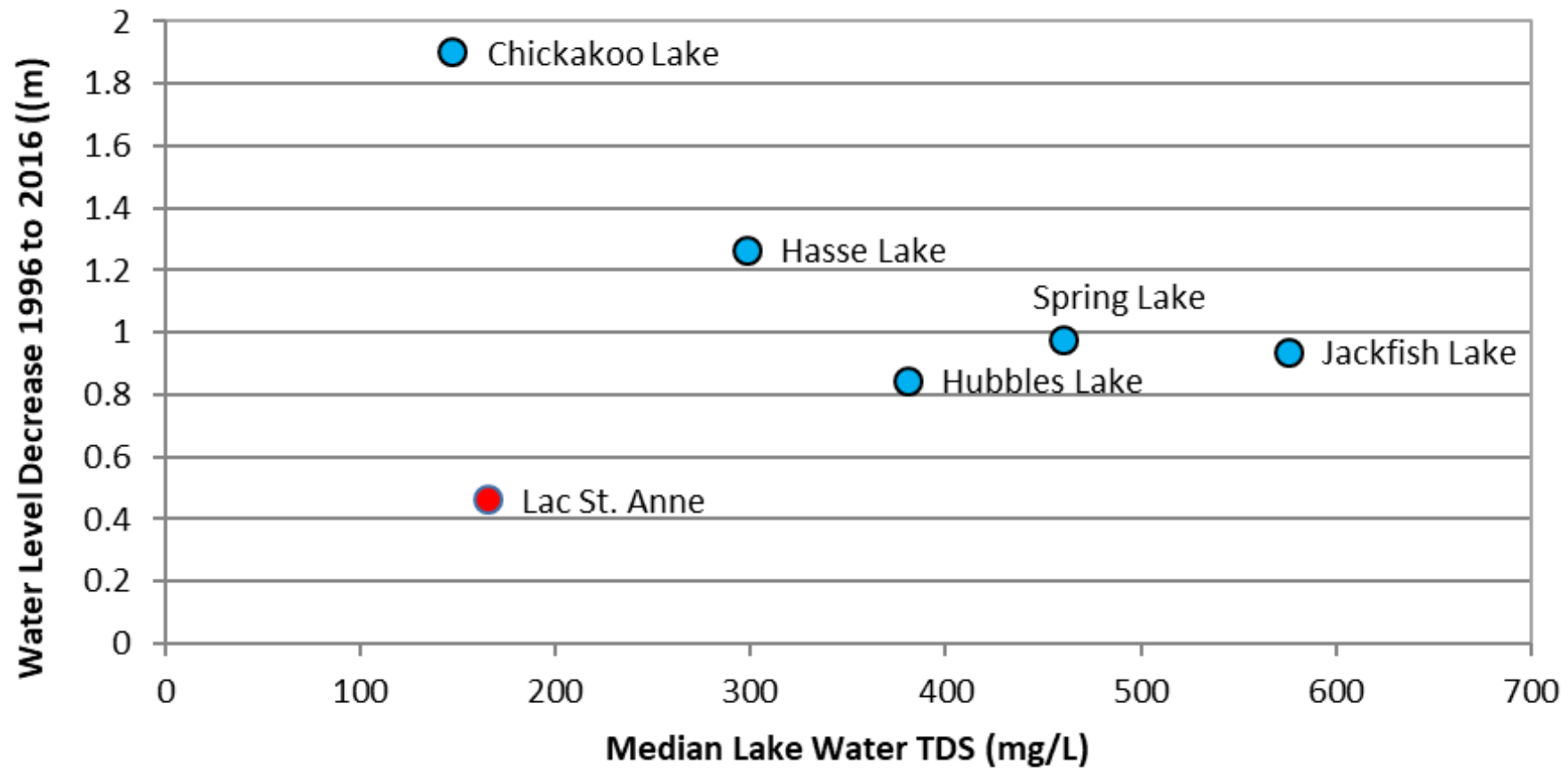
- Groundwater In \approx Groundwater Out



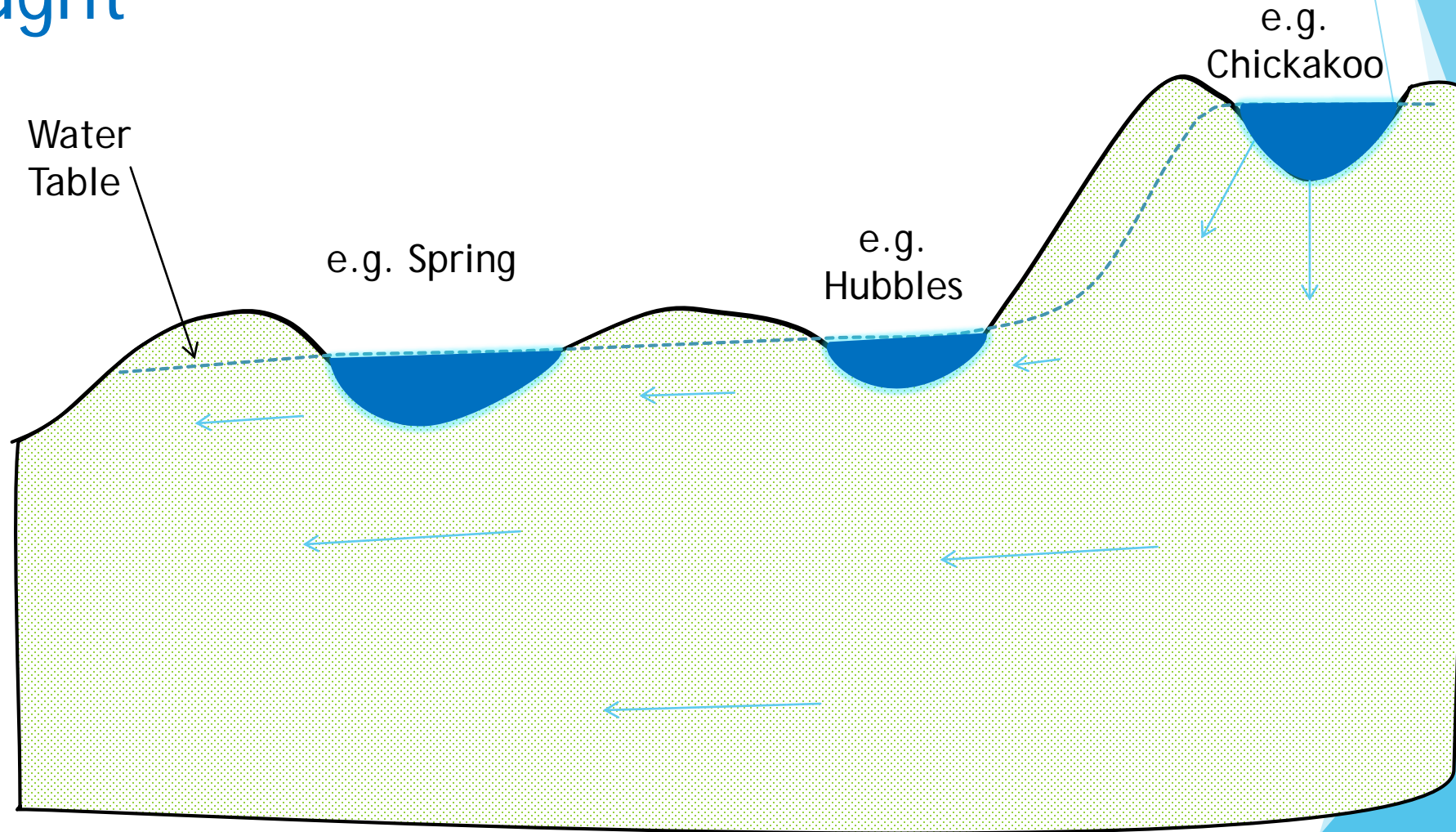
Groundwater and Lake Level Buffering



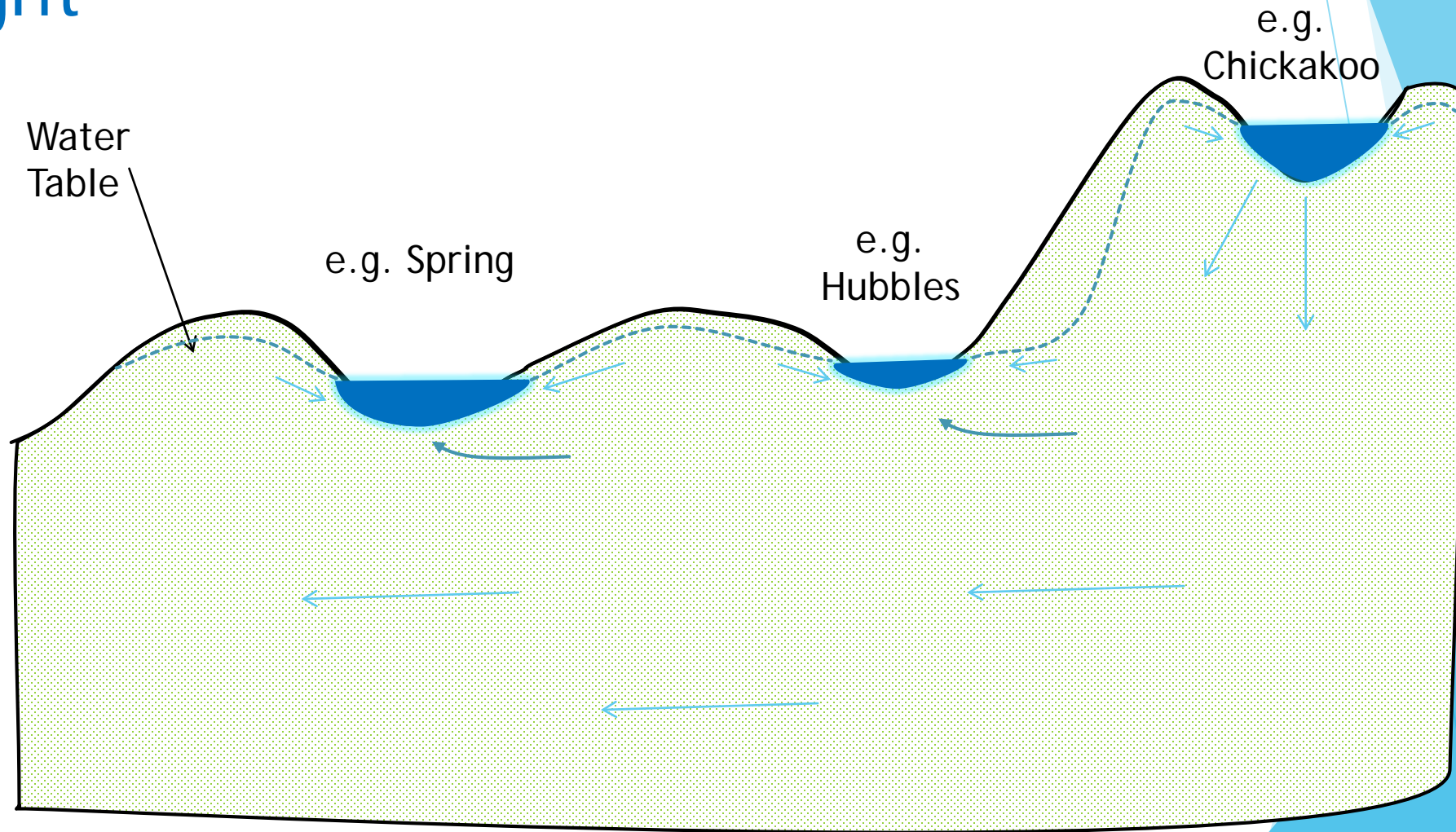
Evidence of Groundwater Buffering of Lake Levels



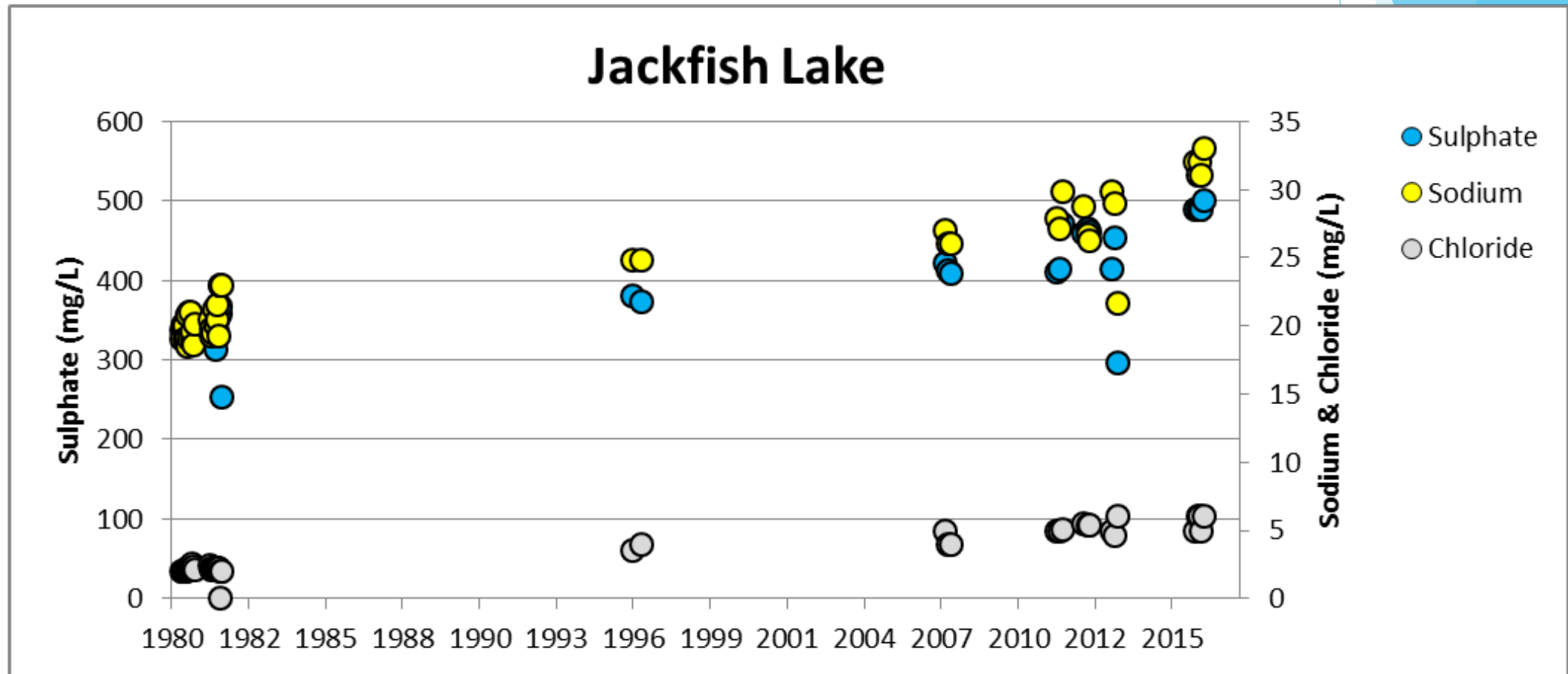
Landscape Position and Resilience to Drought



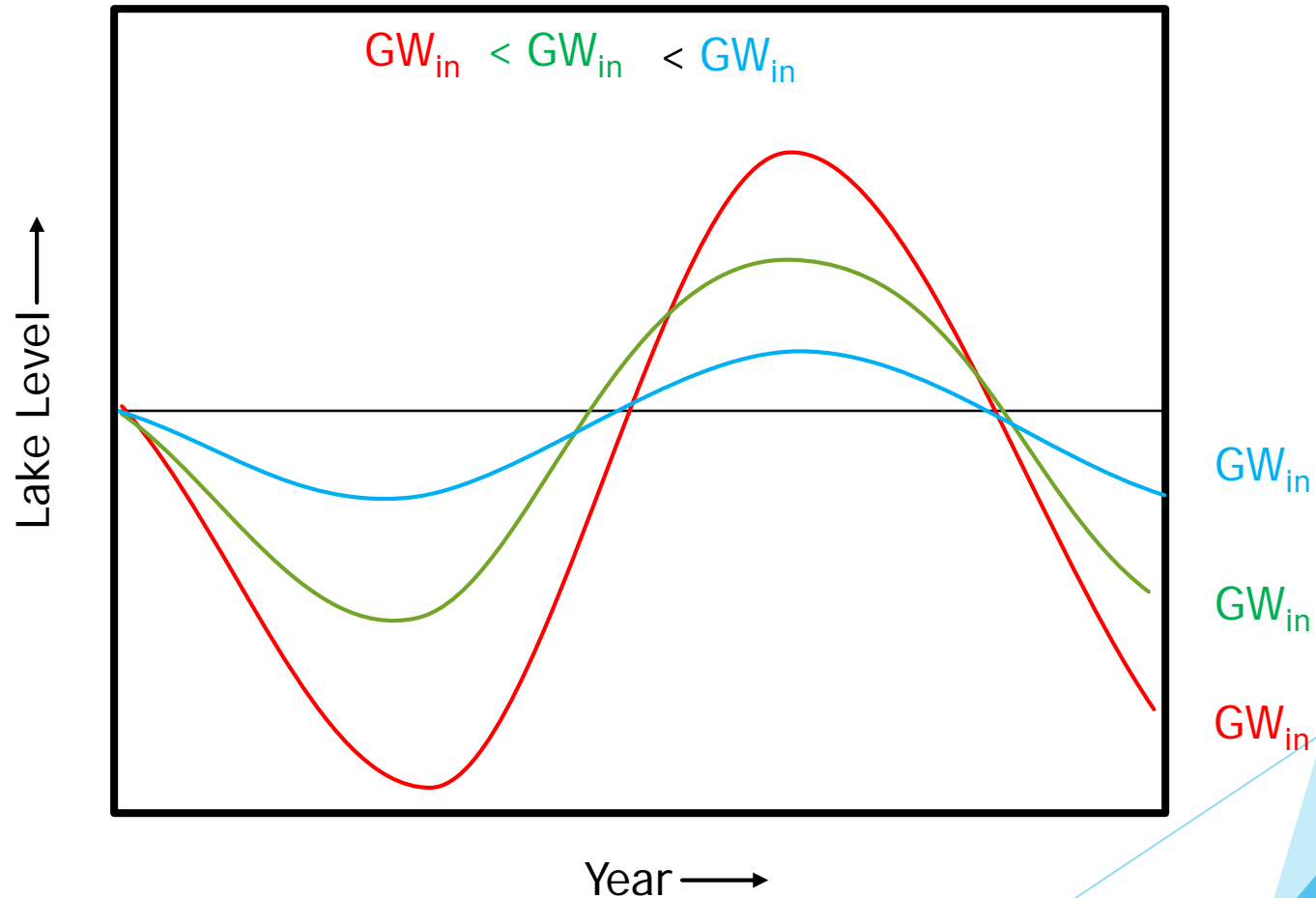
Landscape Position and Resilience to Drought



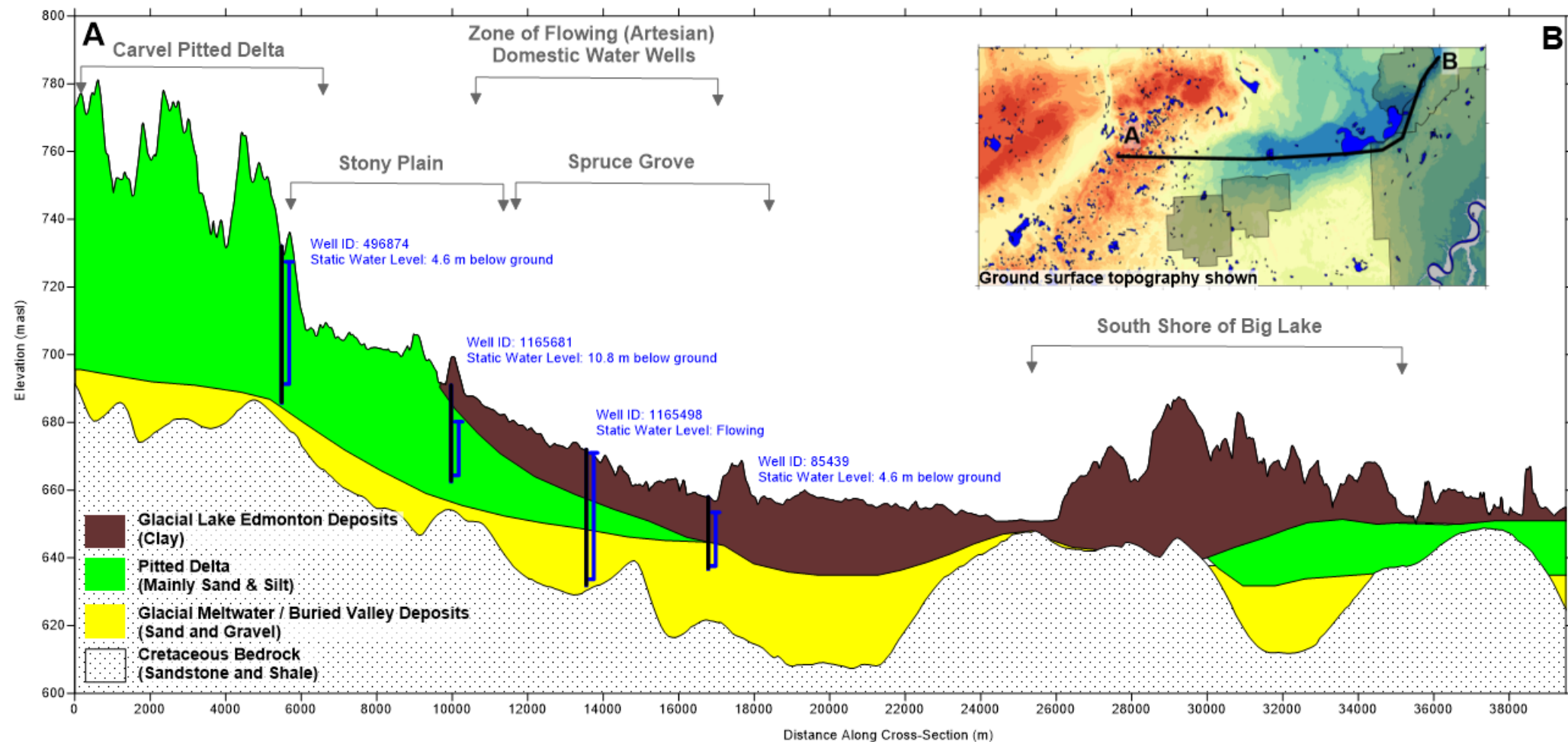
Chemistry as Evidence of Groundwater Buffering of Lake Levels



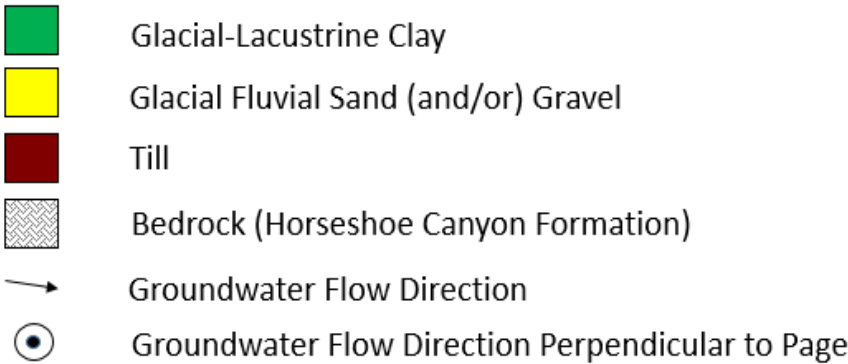
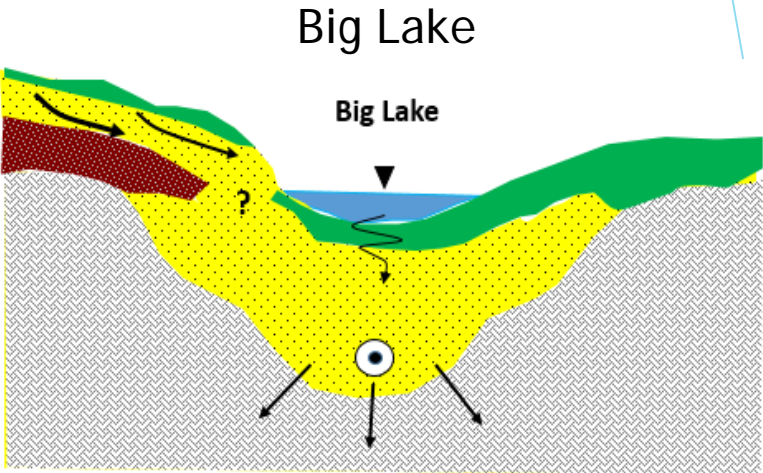
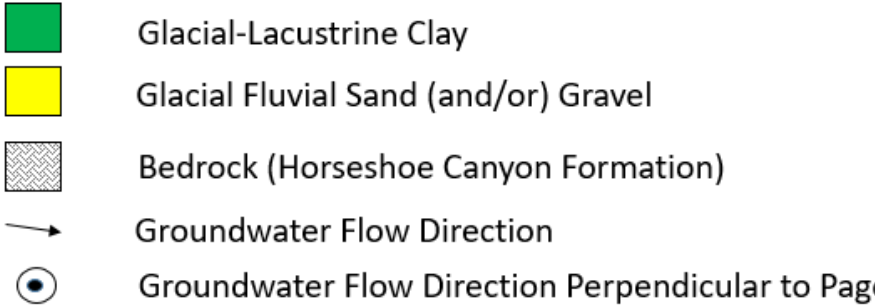
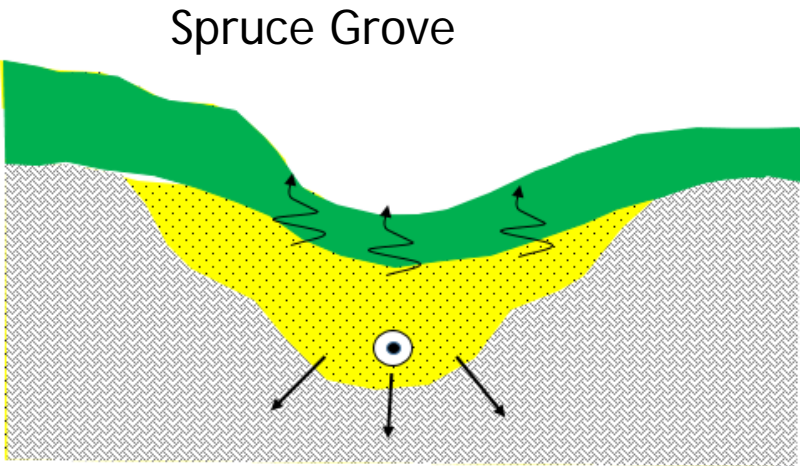
Buffering Effect of Groundwater Inflows



Role of Carvel Pitted Delta as a Groundwater Recharge Zone



Local Hydrogeology



Conclusions

- ▶ Human Users of Groundwater
 - ▶ Mostly from deeper bedrock aquifers (and buried channel aquifers)
- ▶ Natural Users of Groundwater
 - ▶ Mostly from unconsolidated surficial sediments
- ▶ Carvel Pitted Delta
 - ▶ Sandy upland feature is likely to represent key groundwater recharge zone for sub-region.
- ▶ Carvel Lakes
 - ▶ Groundwater appears subordinate to climatic effects, but still has role.
- ▶ Sturgeon River
 - ▶ Immediately downstream of Big Lake the likely prevalence of clayey sediments inhibits GW - SW interactions.
 - ▶ Farther downstream, GW-SW interaction may be more significant in more deeply incised portions of Sturgeon River.

Acknowledgements

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- ▶ Brent Welsh (Alberta Energy Regulator)
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- ▶ Dr. Brian Smerdon (Alberta Geological Survey)
- ▶ Dr. Clement Agboma (Alberta Environment and Parks)
- ▶ Staff of the North Saskatchewan Watershed Alliance

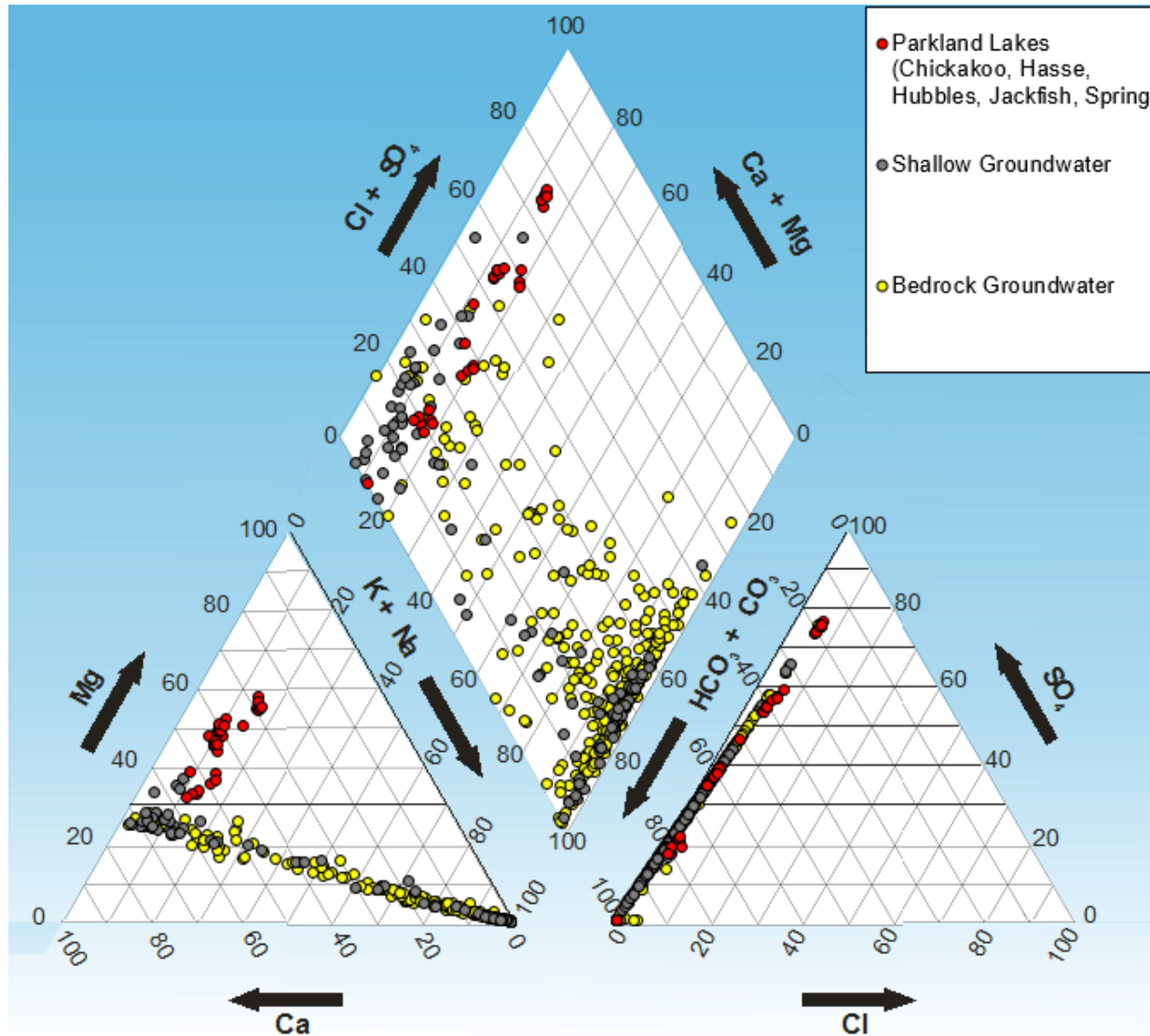
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Groundwater Chemistry and Closed-Basin Lake Chemistry



Shallow Groundwater Flow (Simulated)

