An Overview of Groundwater Inventory Mapping

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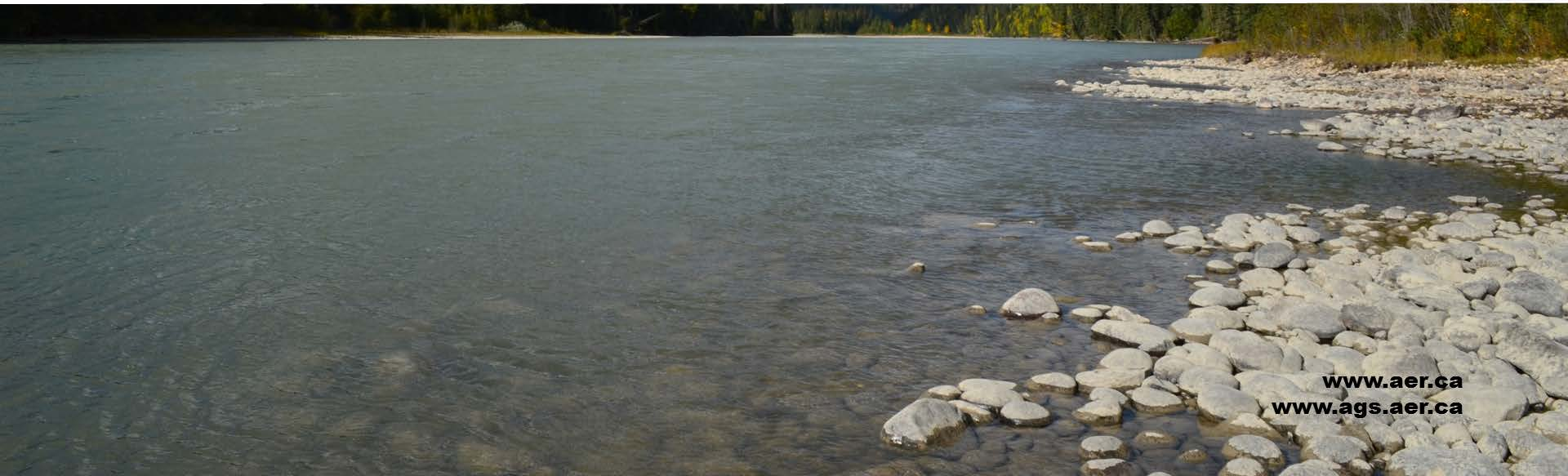
Alberta Geological Survey

NSWA Groundwater Forum, 27 February 2019



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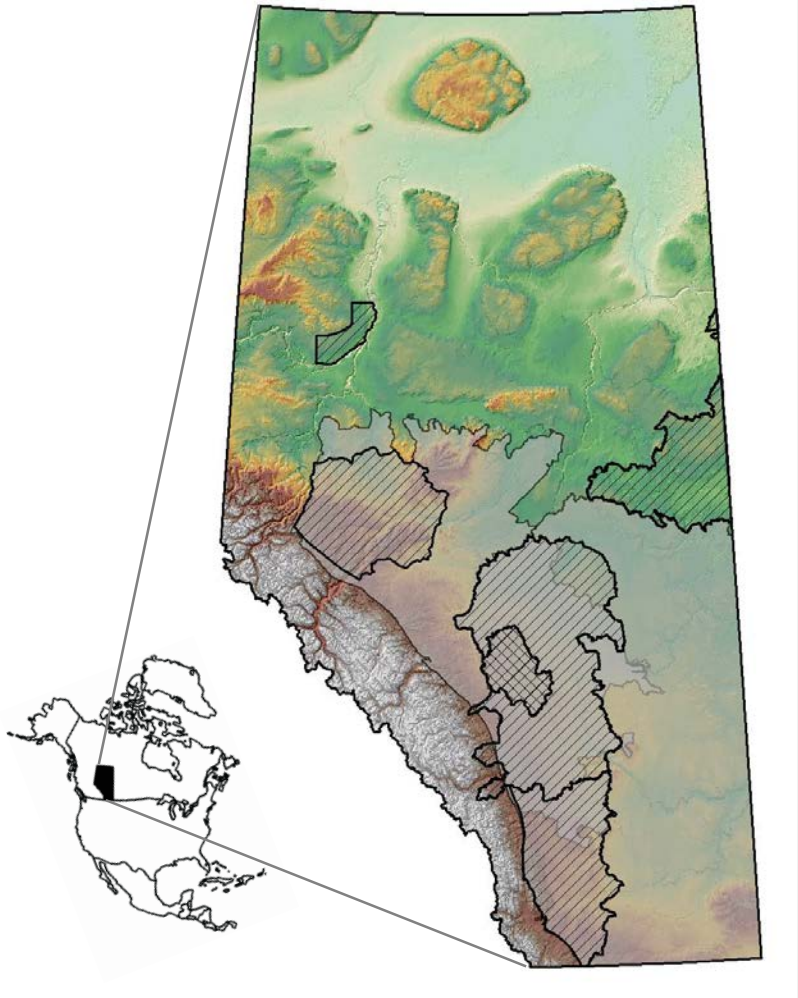
Provincial Groundwater Inventory Program



Provincial Hydrogeological Mapping

- Formation scale

Geological and Hydrogeological Characterization

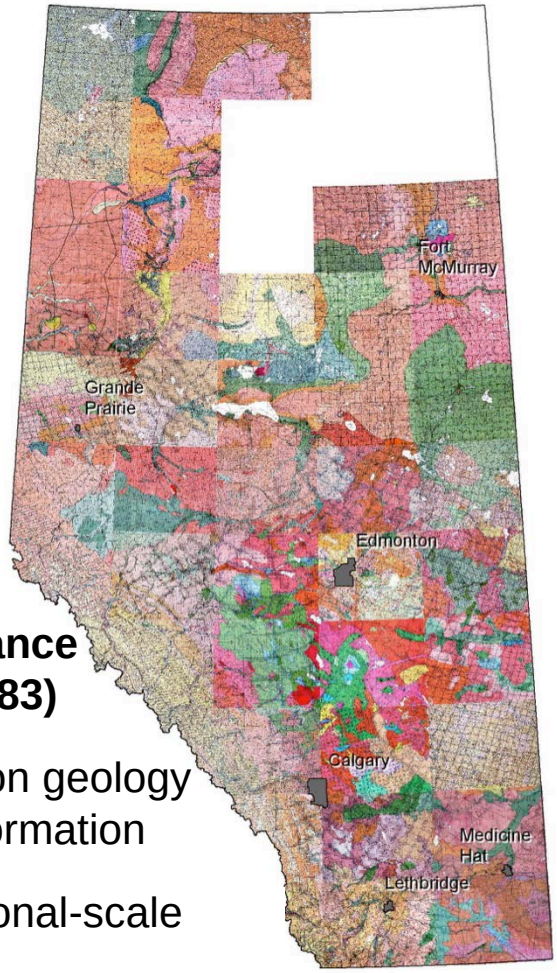
- Hydrostratigraphic units (HSUs)
- Hydrogeology (flow patterns, water quality, groundwater residence time)

Groundwater Availability Assessments

- First-order approach
- Customized to region to leverage understanding and data

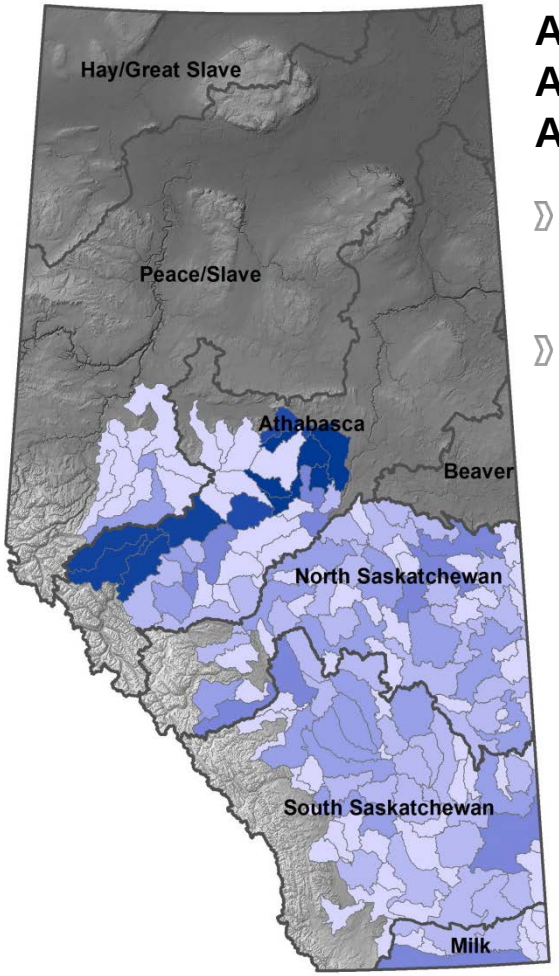
Groundwater Modelling

An Updated View



ARC Reconnaissance Program (1968-1983)

- Estimate based on geology and pumping information
- Intended for regional-scale perspective



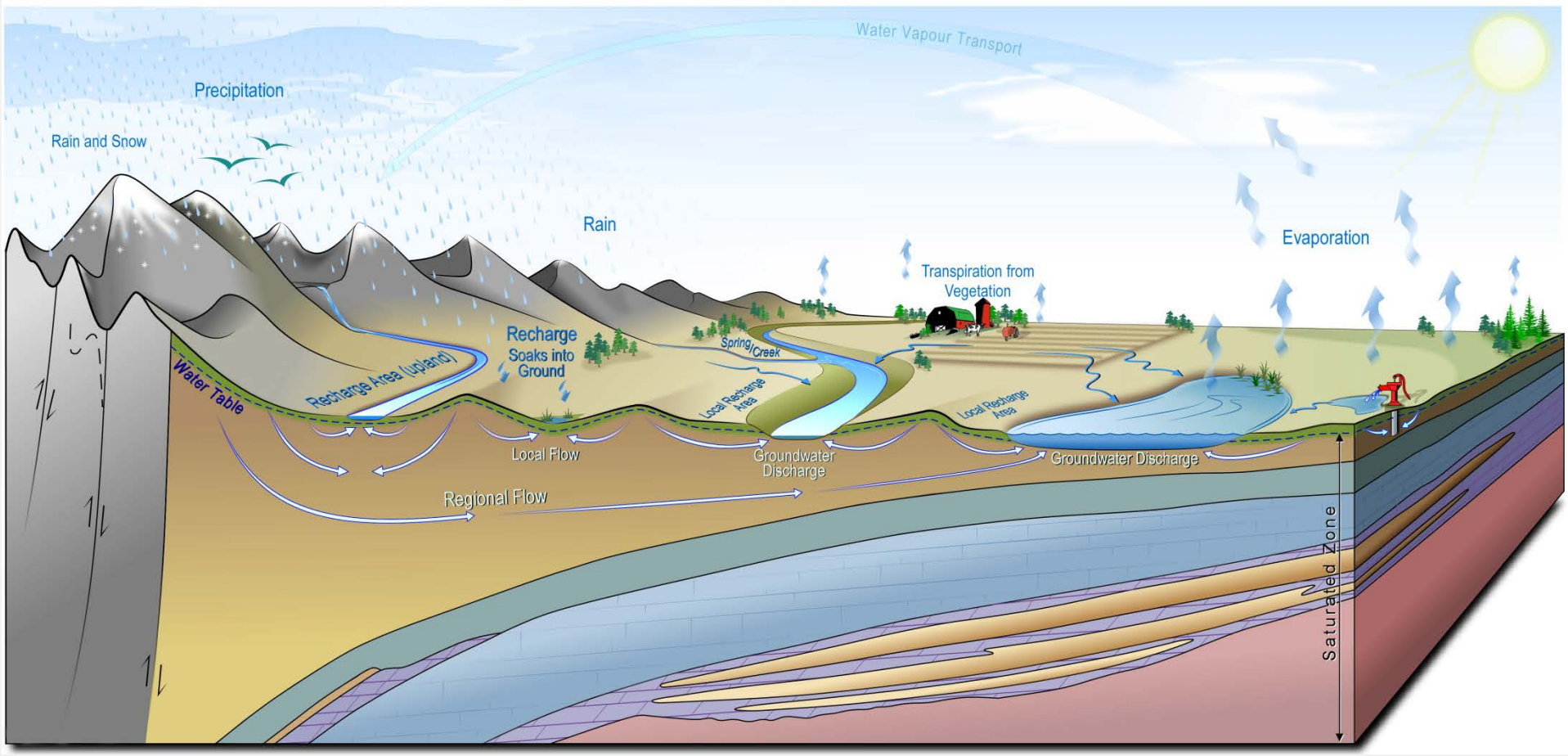
AGS Groundwater Availability Assessments

- Calculated from hydrologic data
- Watershed-scale

Aquifer Yield

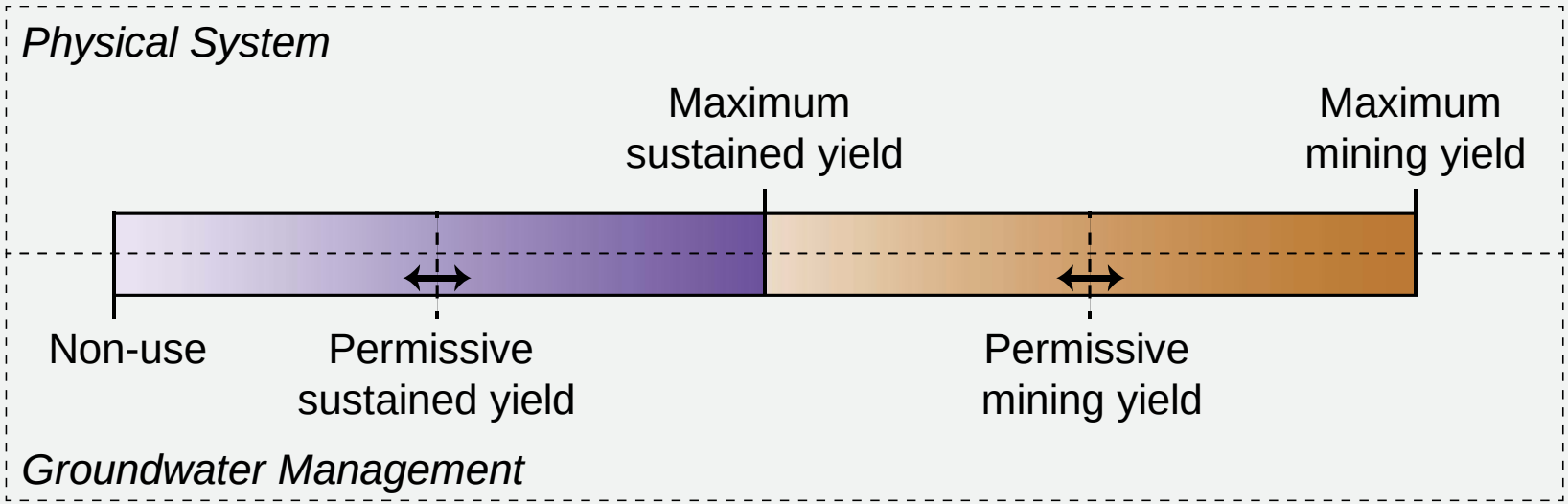
- A measure of how much groundwater can be withdrawn
- Long history of terminology and definitions
  - “Sustainable” yield
  - “Safe” yield
- Ultimately a balance between the physical hydro(geo)logical system and aquifer governance

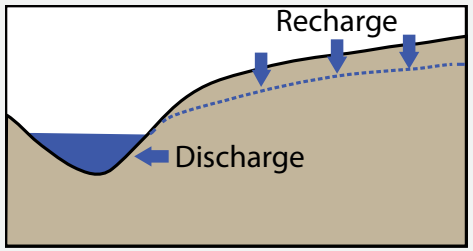
Aquifer Yield Depends on Hydrogeological System

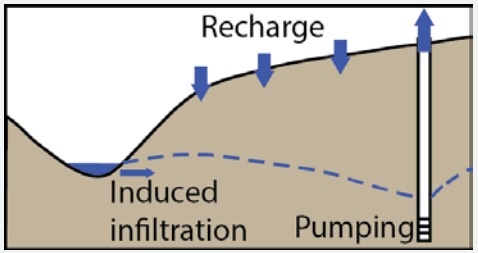


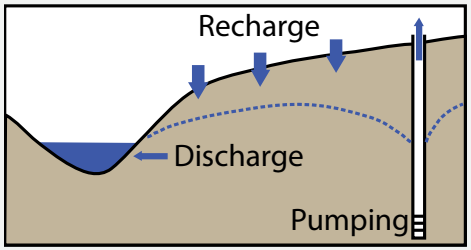
Aquifer Yield Continuum

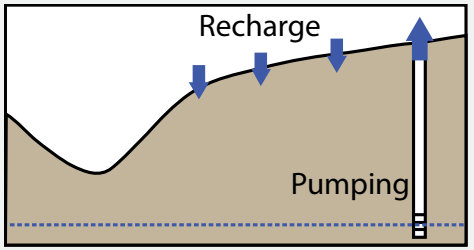
After:
Kalf and Woolley, 2005; HJ
Pierce et al., 2013; HJ











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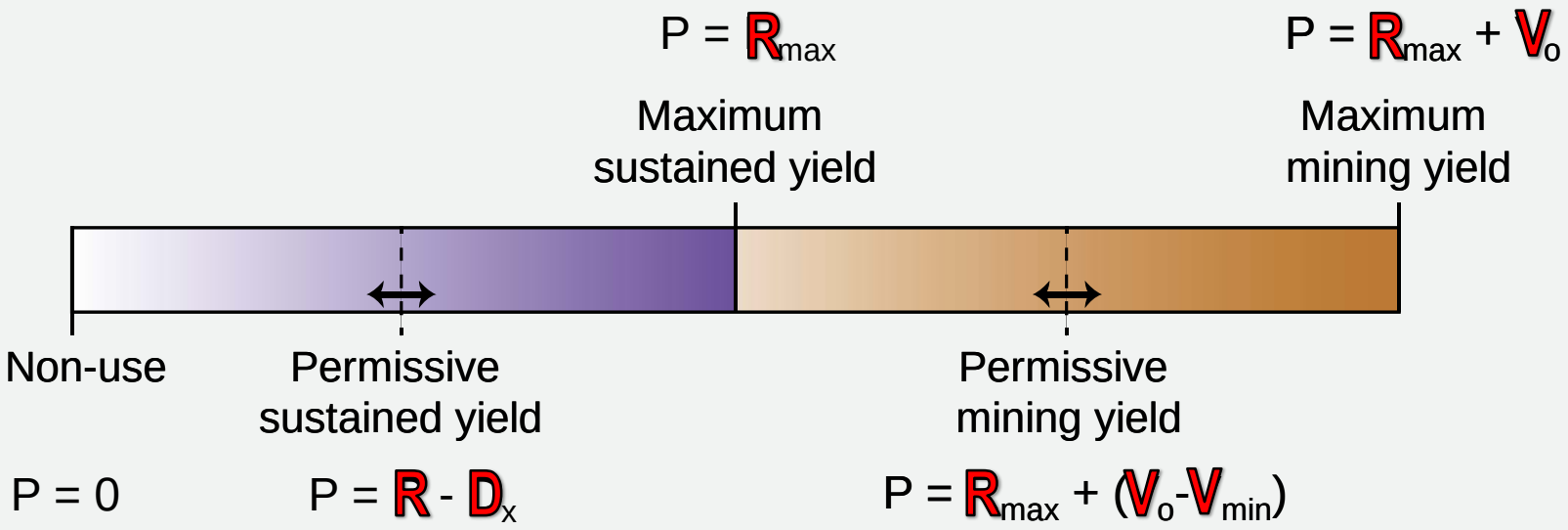
Aquifer Yield Continuum

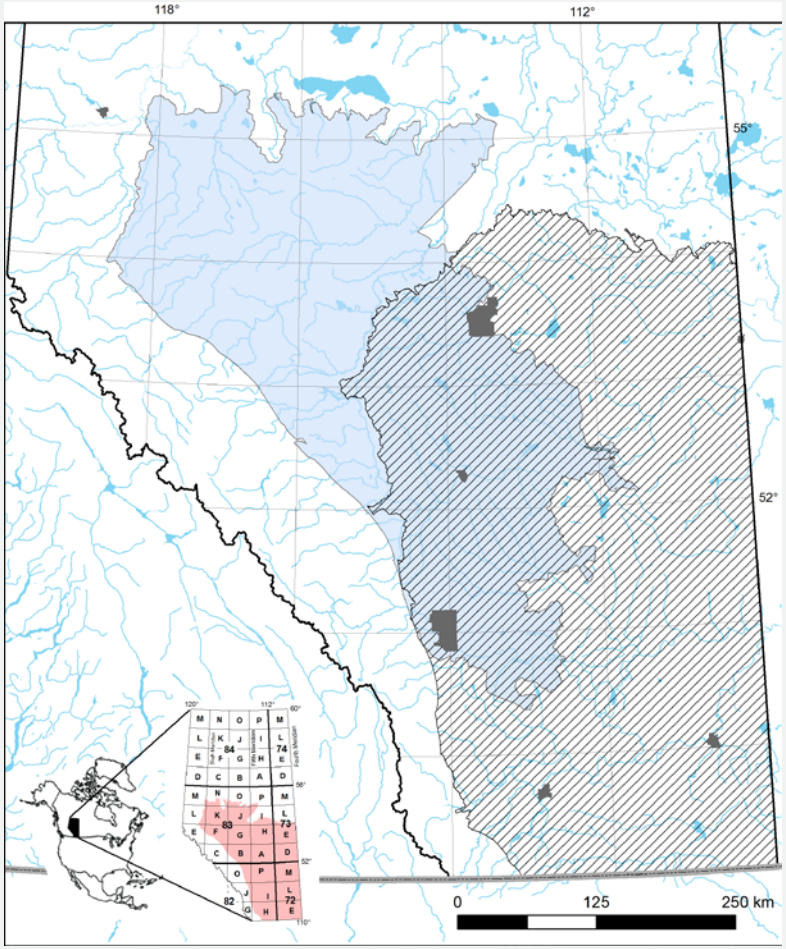


- How do we quantify this on a regional scale?

Recharge **D**ischarge **V**olume

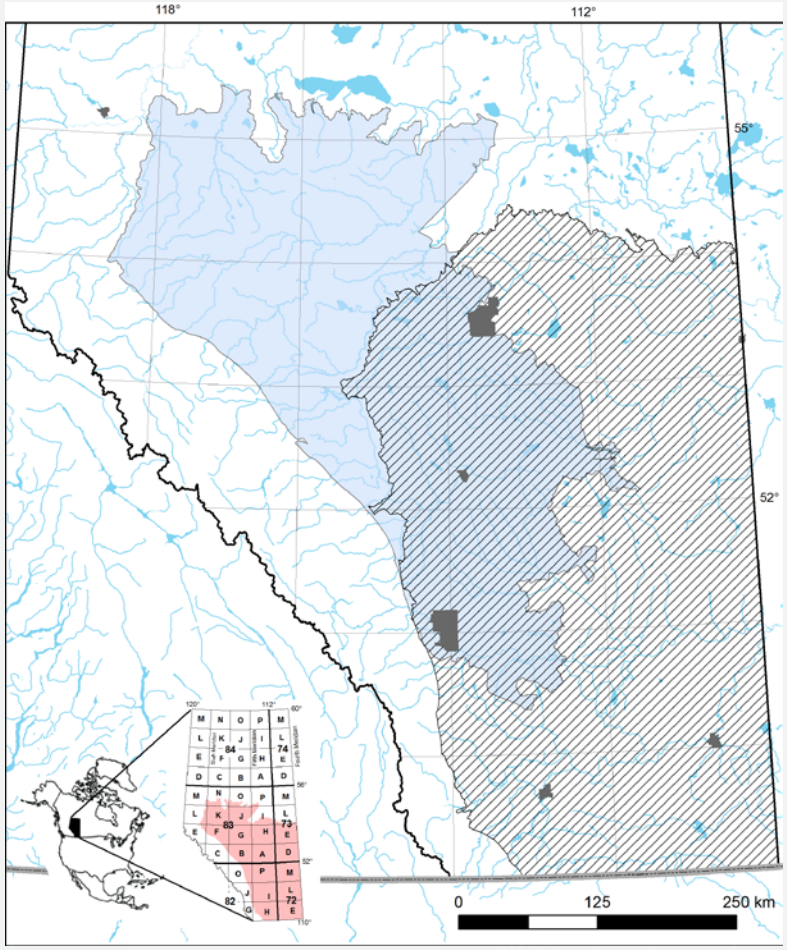
Groundwater Inventory Mapping

- Factors to consider:
  - Climate
  - Data availability
  - Hydrogeological regime
  - Landscape characteristics
- First two areas:
  - Central Alberta
  - Southern Alberta

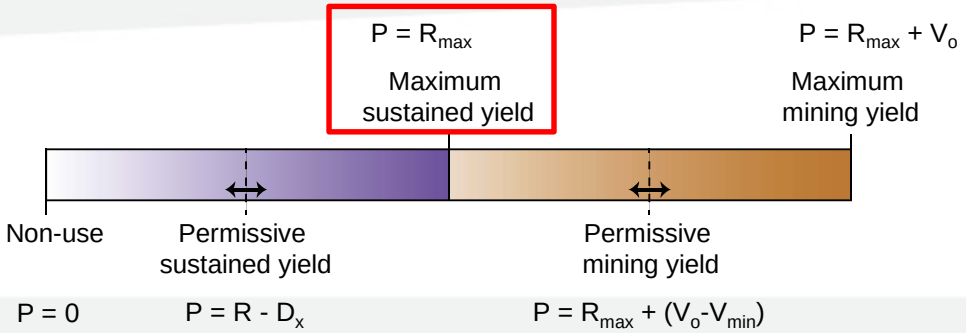


Study Areas

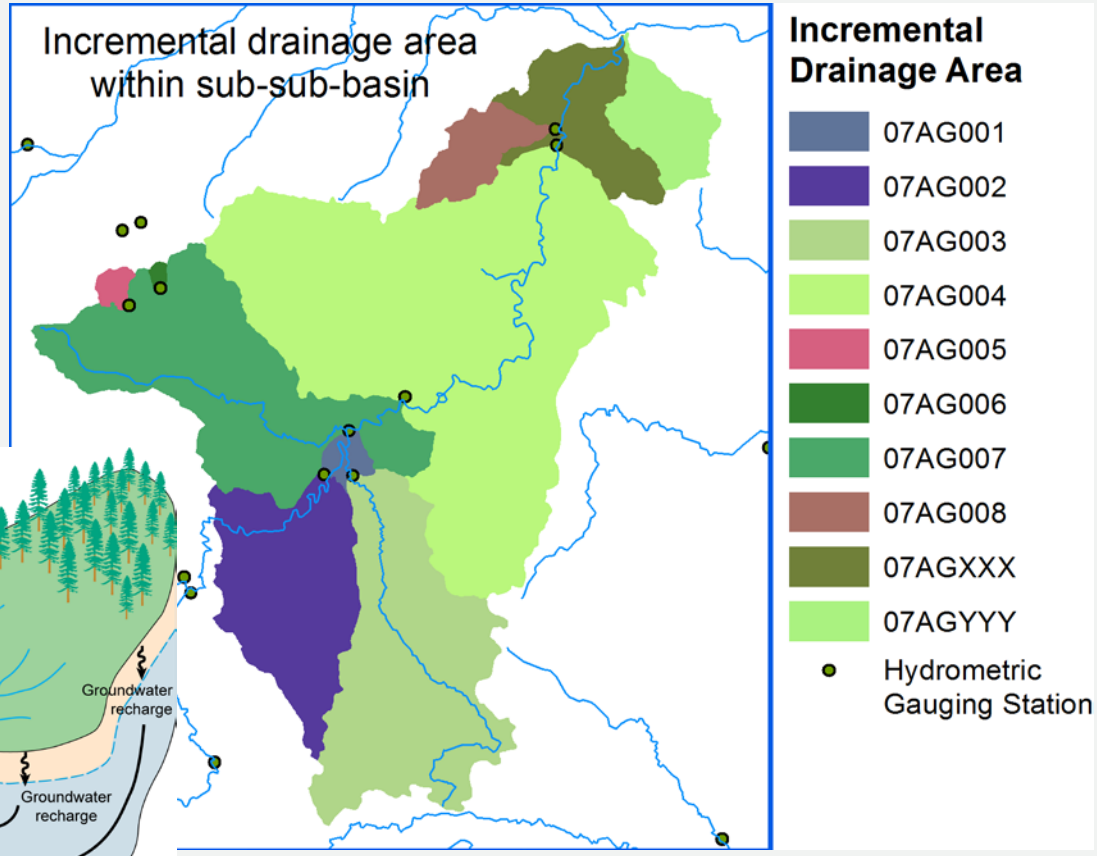
- Central Alberta
  - Near-surface bedrock aquifers
  - Thin overlying sediment
  - Generally unregulated rivers and abundance of river gauging data
  - ❖ **Baseflow approach**
- Southern Alberta
  - Canadian prairies
  - Thicker sediment compared to central Alberta
  - Regulated rivers and data variable
  - ❖ **Recharge modelling approach**

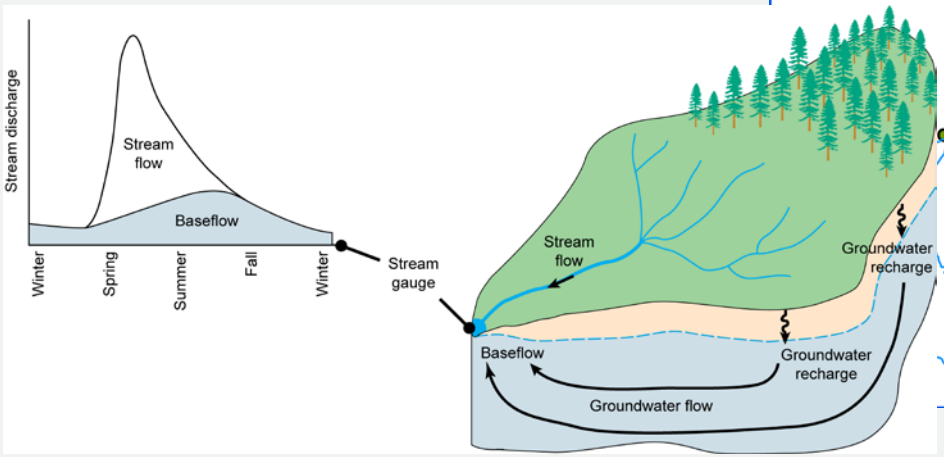


Recharge



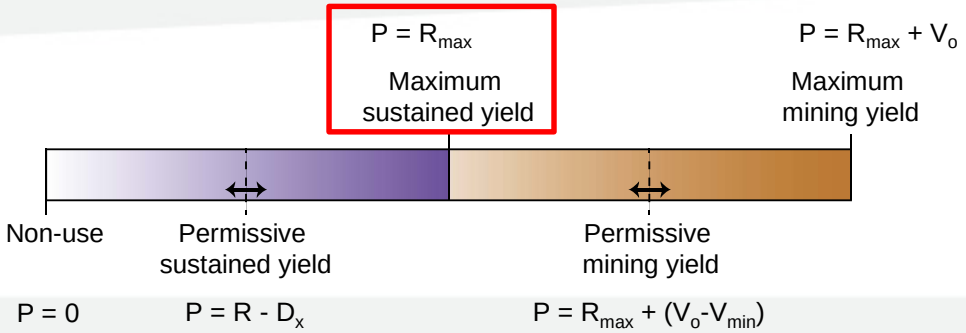
- Central Alberta



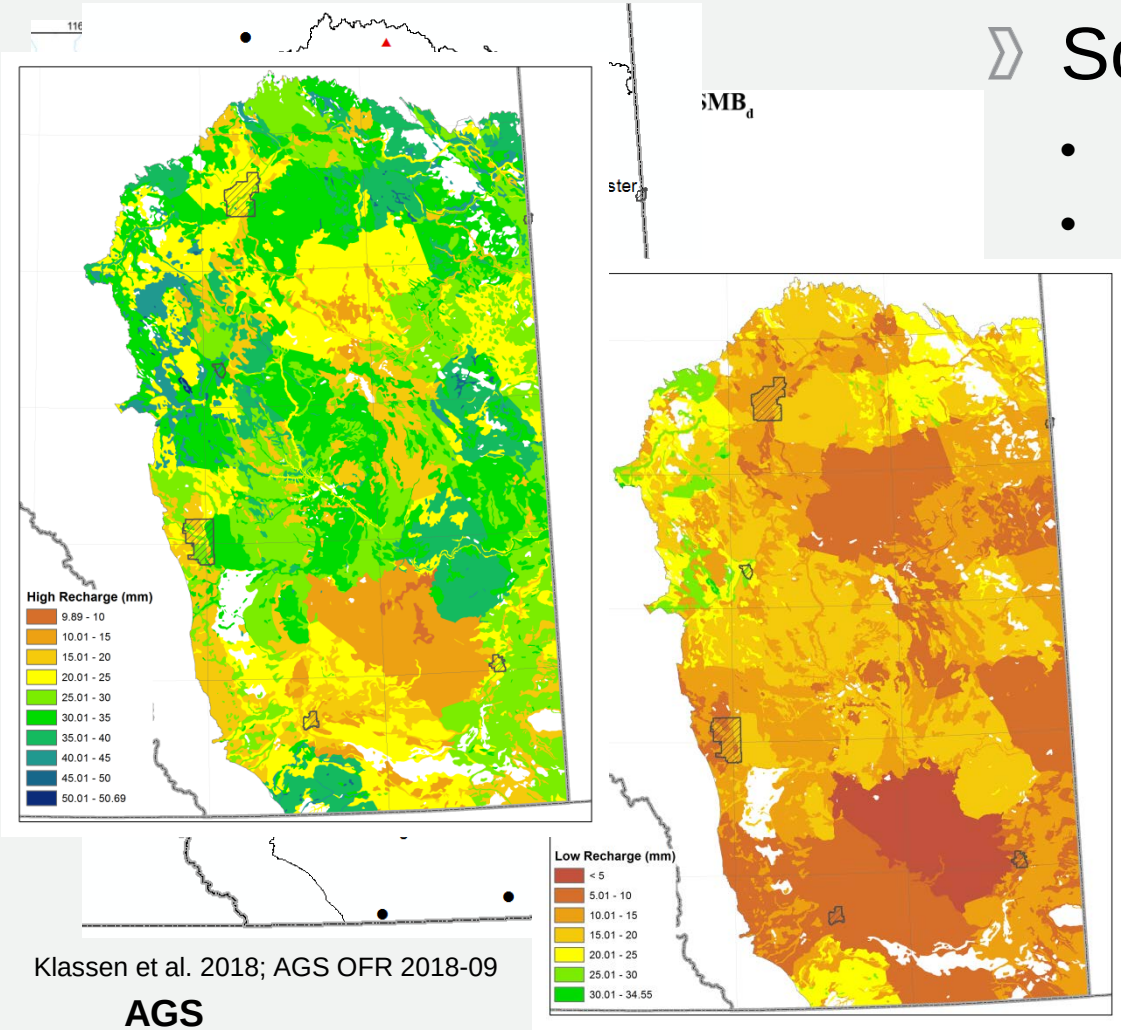


Klassen and Smerdon 2018; AGS OFR 2017-07

Recharge



37 weather stations



Klassen et al. 2018; AGS OFR 2018-09

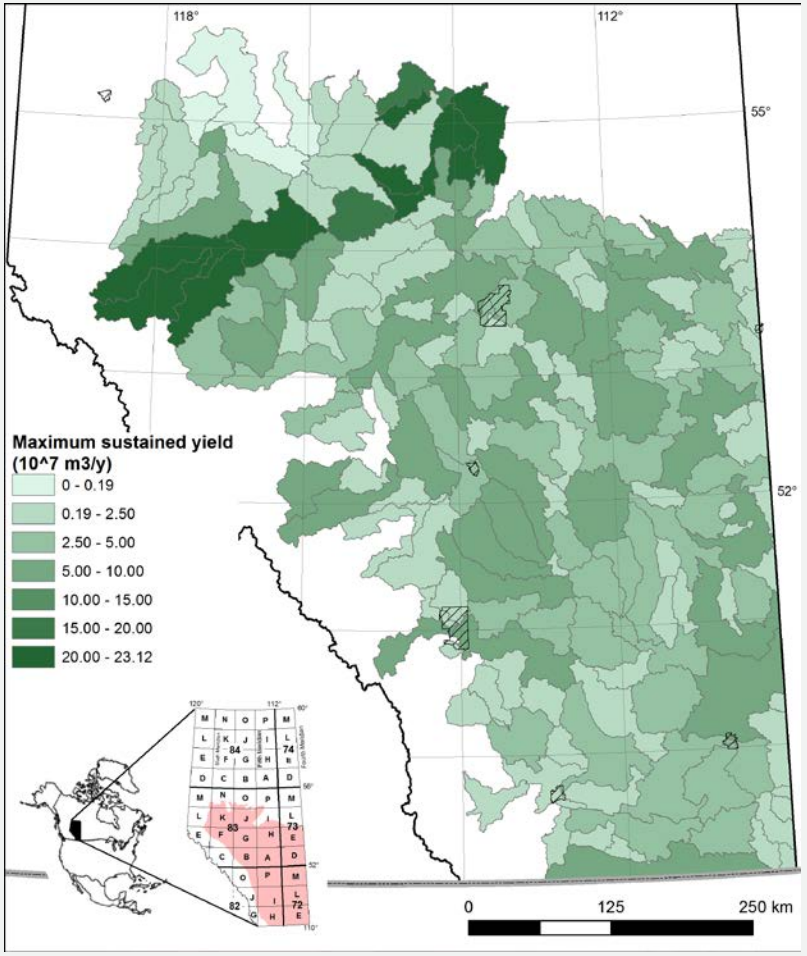
Southern Alberta

- Extension of UofC research
- Prairie potholes → depression focused recharge

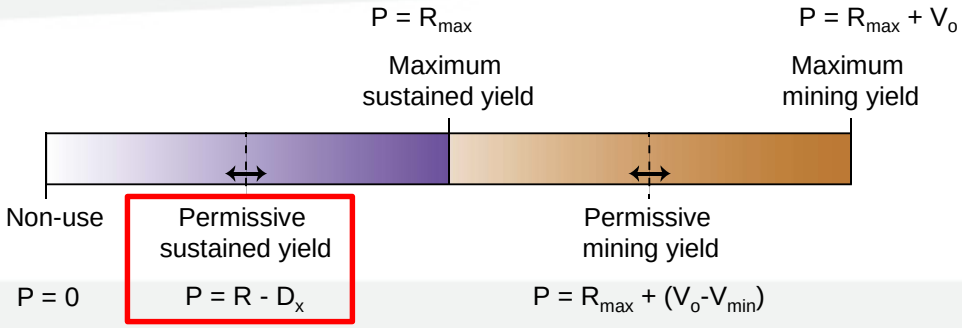
1. Terrain analysis
2. 1D recharge modelling
3. Spatial distribution of recharge

Recharge Results

- Central Alberta
  - Recharge aggregated from incremental drainage basins to HUC8
- Southern Alberta
  - Recharge aggregated from surficial geology to HUC8

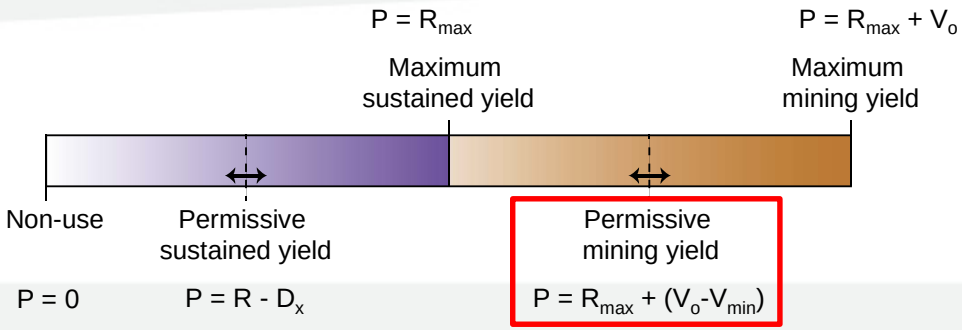


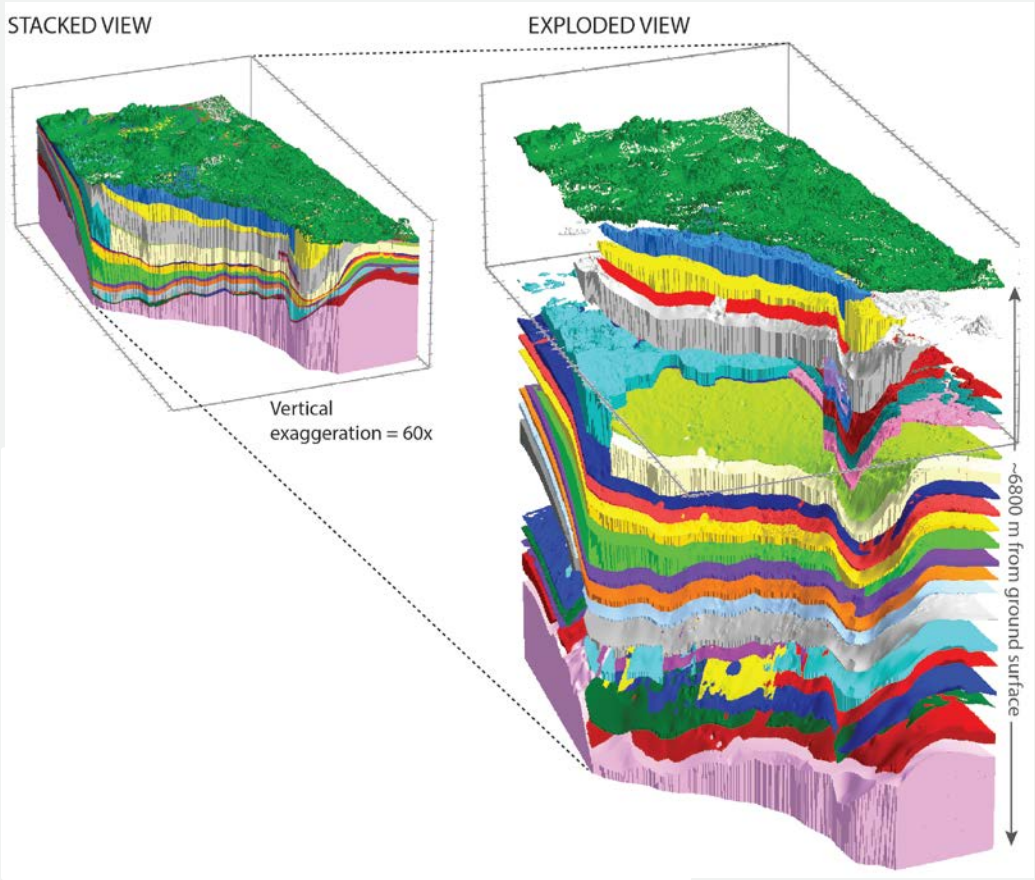
Discharge



- Governance boundary
- Assumed recharge (baseflow/modelled) was equal to discharge
- As a demonstration → assume 10% and 50% of discharge as pumping

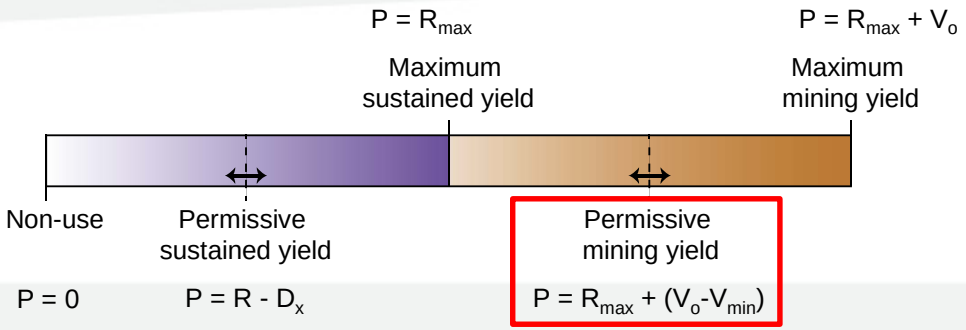
Aquifer Volume



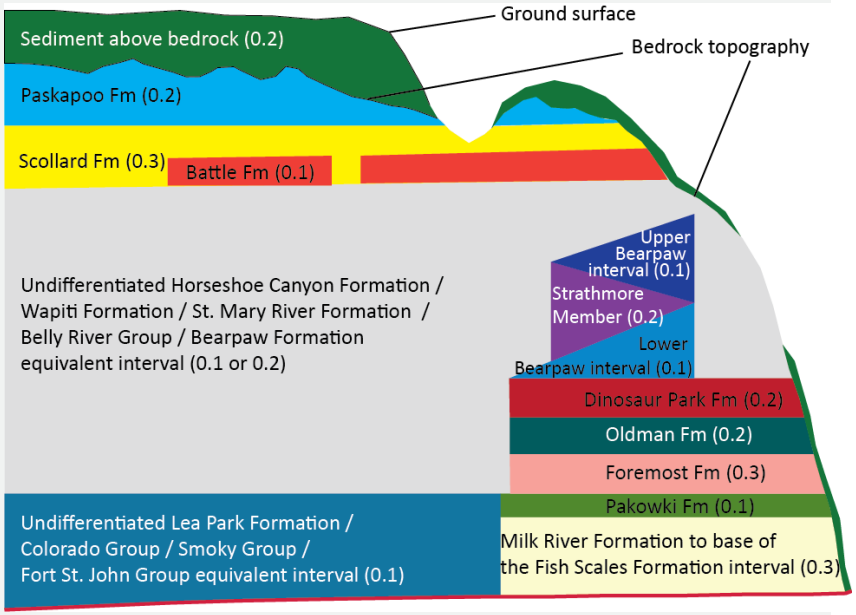


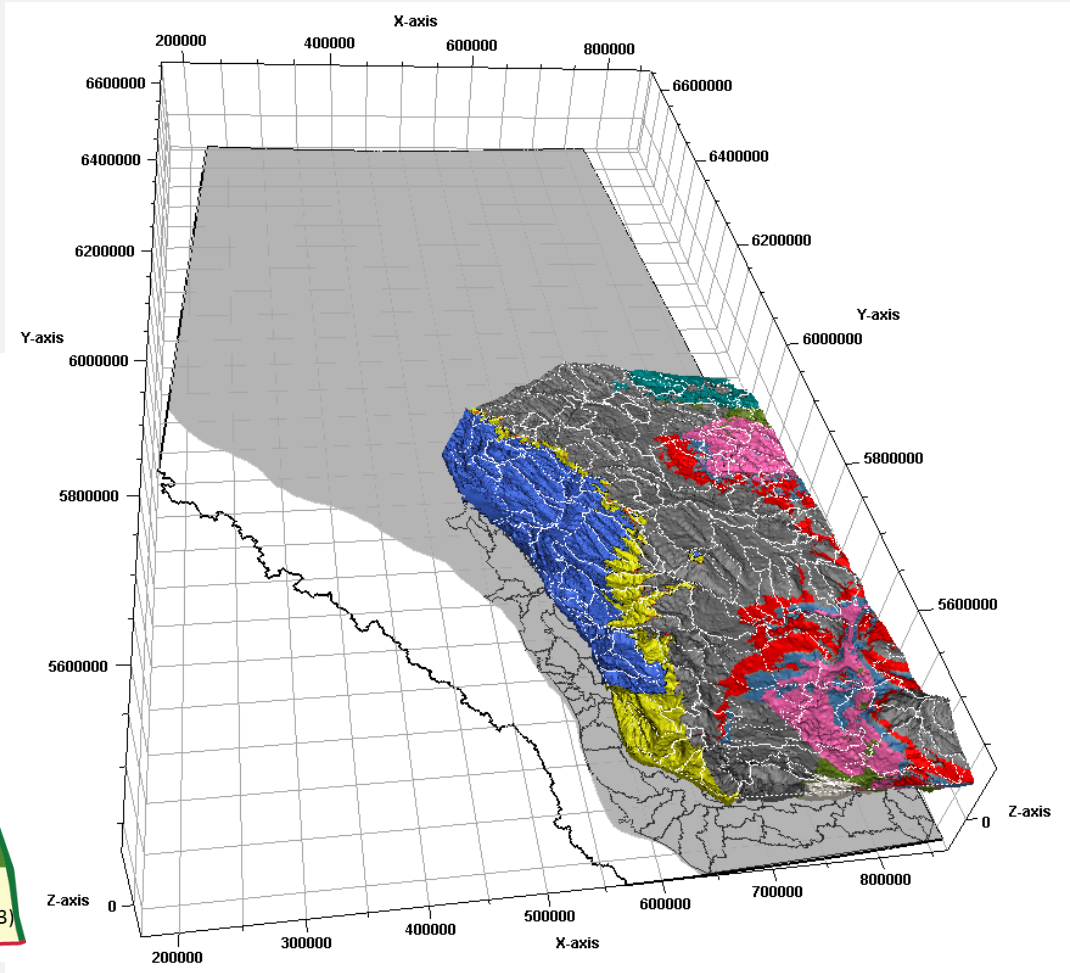
3D Provincial Geological Framework Model of Alberta

Aquifer Volume



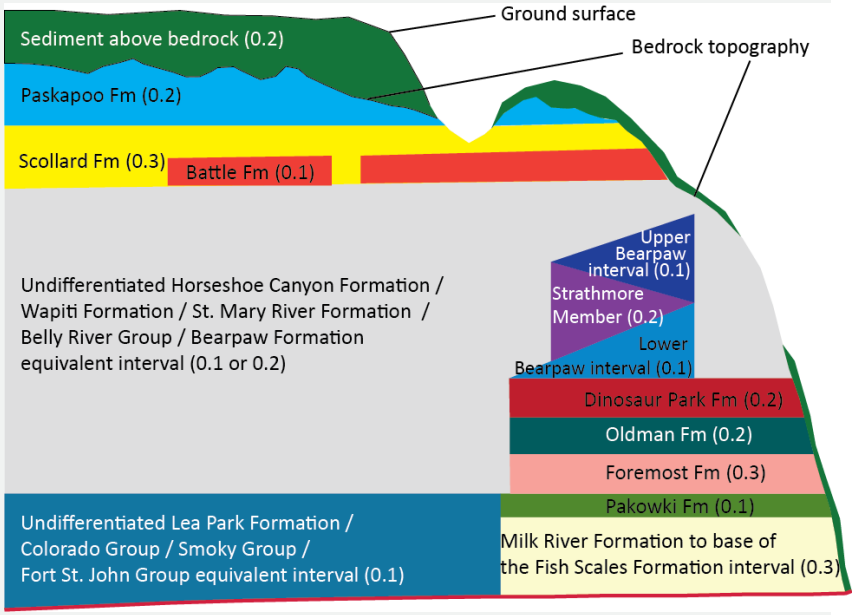
- Focus on upper 150m

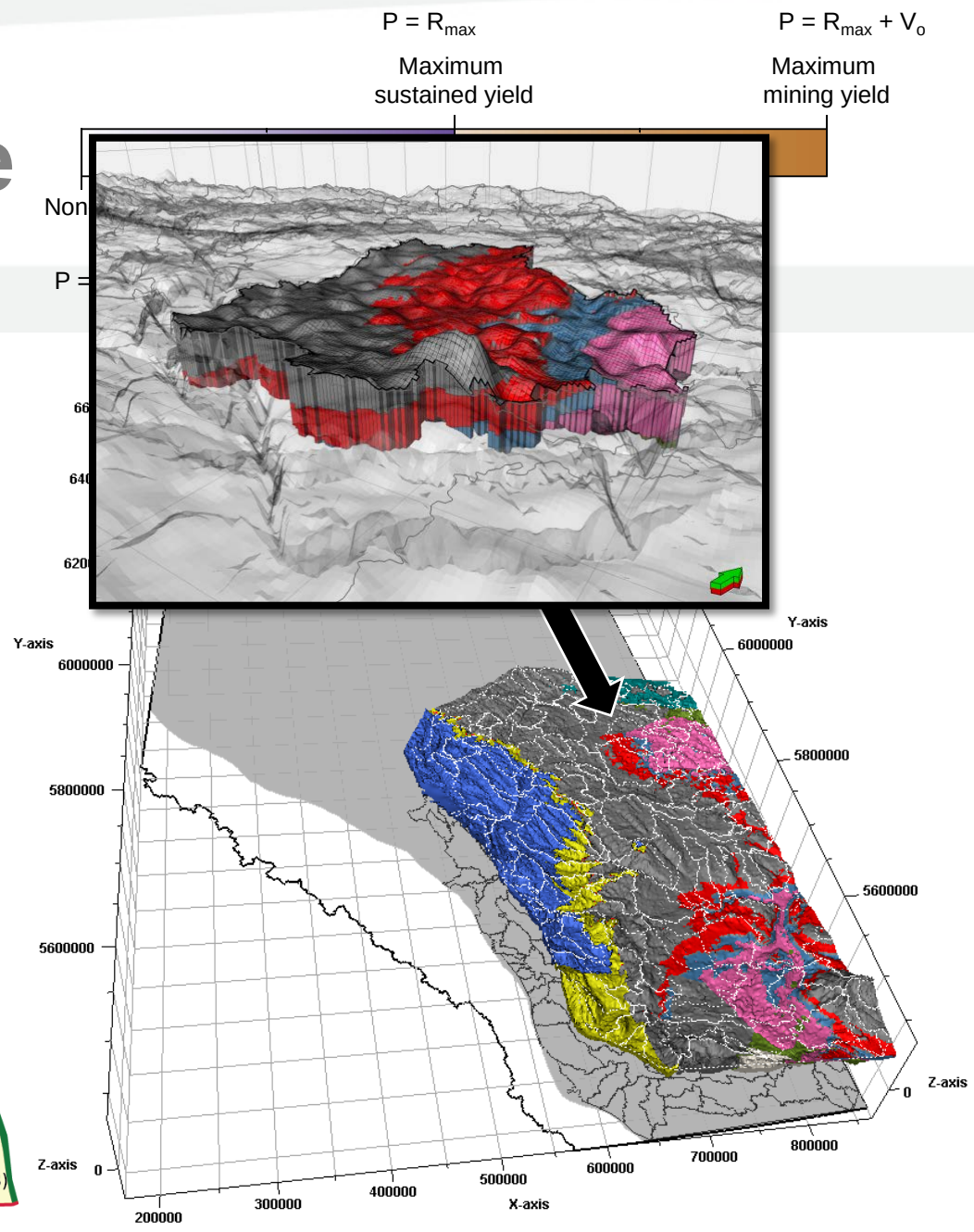




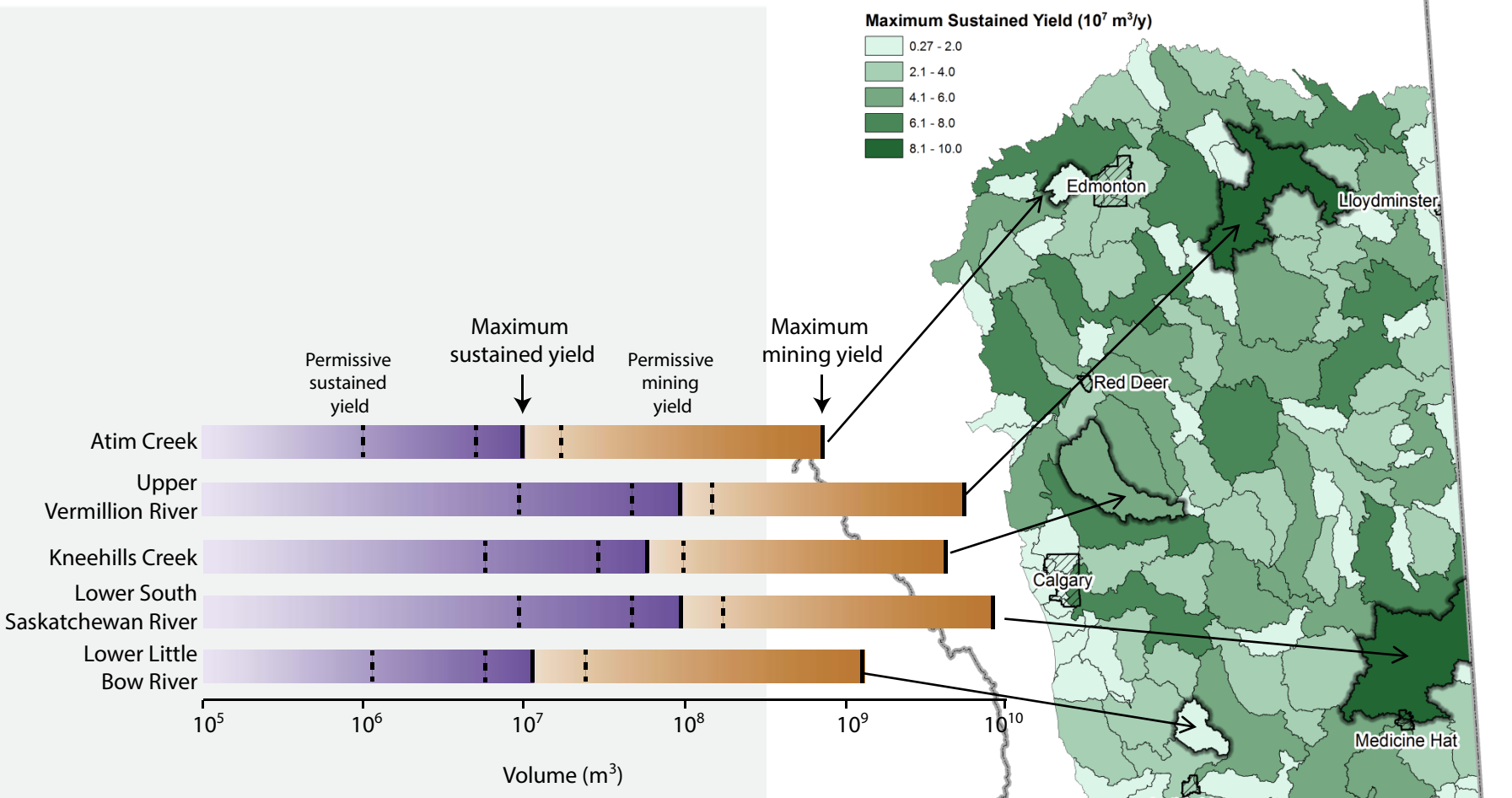
Aquifer Volume

- V_{min} = 99%





Aquifer Yield Continuum



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Water Use Reporting

Groundwater Availability and Allocation

Groundwater availability has been quantified by the Alberta Geological Survey for watersheds coloured gold/blue/etc. Work is ongoing to quantify availability in other parts of the province.

Reported groundwater availability is equivalent to average annual regional groundwater recharge. This value represents the average volume of water replenished by rainfall and snowmelt into the groundwater system within a watershed boundary. After moving through the groundwater system, recharge is often discharged into surface water bodies such as lakes, rivers, and wetlands.

Therefore, as groundwater withdrawals become closer to the value of groundwater

AER Local Groundwater Allocation to Availability: 0.00%

HUC8: **11040201**

Local

Local Groundwater Availability (m³): **93,219,541**

All Local Groundwater Allocation (m³): **2,528,942**

AER Local Groundwater Allocation (m³): **200**

All Local Groundwater Allocation: **2.71%**

AER Local Groundwater Allocation

0.00% 35.00%


Disclaimer | Water Summary | Nonsaline Water Use Summary | Notes on Data | Glossary

Alberta Energy Regulator

Alberta Water Use Report

2017 Water Summary

Overall in Alberta, AER experts have estimated that over 140 billion cubic metres of nonsaline water are available. Of this, about 10 billion cubic metres (or 7 per cent) are allocated for use through *Water Act* licences for municipal, agricultural, forestry, industrial, and other uses. Of this 10 billion cubic metres of water that is licensed for use, approximately 1 billion cubic metres is allocated for use in the energy development industry (10 per cent of the total licensed for use, or 0.7 per cent of all the water available in Alberta). The remaining 9 billion cubic metres (90 per cent) was allocated to other users such as agriculture, forestry, commercial (e.g., golf courses and gravel pit operations), and municipalities.

The maps below display the proportion of available water that is licensed for energy development. The boundaries represent Hydrological Unit Code 8 (HUC8) areas, as set by Alberta Environment and Parks (AEP). While data on groundwater allocation is available across the entire province, information on availability exists only for areas in south and central Alberta. Where availability information does not yet exist, the proportion that is allocated is represented as zero. Work is being conducted by the Alberta Geological Survey to develop groundwater availability information for more areas of the province.

Placing your mouse cursor over a specific HUC8 area will provide additional information on surface and groundwater availability and allocation, the proportion of the available water allocated (as a percentage) to all sectors of Alberta, and the proportion of the availability that is specifically allocated for energy development. Information is provided for the "local" area and as a "cumulative" total for surface water. (More information on the definition of local and cumulative is provided in the glossary.) Groundwater information is shown as "local" only.

Surface Water Availability and Allocation

When companies apply to use water, they must state the maximum annual amount of water they need over the entire life cycle of their project. Companies estimate their maximum water use based on their project's needs, a general understanding of the geology in the area, as well as a contingency to ensure they have enough water for their energy development project.

Due to the need for large volumes of nonsaline water, oil sands mining is allocated the most nonsaline water in the industry (66 per cent), followed by enhanced oil recovery (EOR) (10 per cent), in situ (6 per cent), and hydraulic fracturing (9 per cent). "Other" (9 per cent), accounts for other water that is allocated to other energy development activities including pipeline integrity testing and hydrocarbon processing.

Groundwater Availability and Allocation

Groundwater availability has been quantified by the Alberta Geological Survey for watersheds coloured gold/blue/etc. Work is ongoing to quantify availability in other parts of the province.

Reported groundwater availability is equivalent to average annual regional groundwater recharge. This value represents the average volume of water replenished by rainfall and snowmelt into the groundwater system within a watershed boundary. After moving through the groundwater system, recharge is often discharged into surface water bodies such as lakes, rivers, and wetlands.

Therefore, as groundwater withdrawals become closer to the value of groundwater availability, the less water is available for groundwater discharge. Less groundwater discharge could affect groundwater dependent

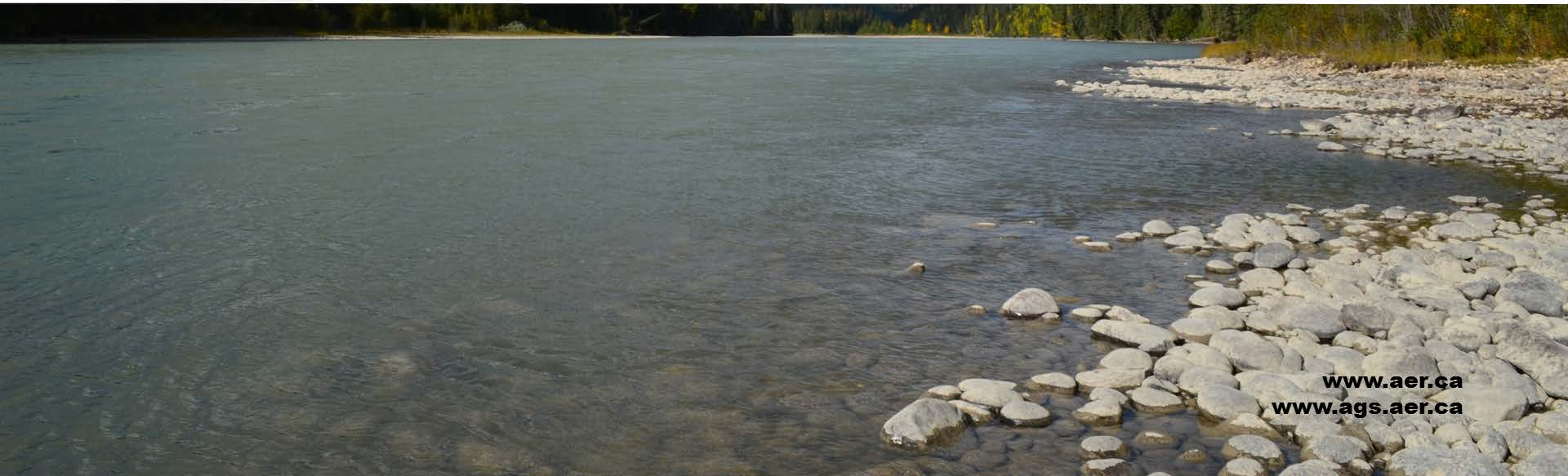
https://www.aer.ca/

Groundwater Availability

Conclusions

- Aquifer yield is dependent both on the physical system and aquifer governance
- AGS developed a regional method to establish bounds on aquifer yield
  - Screening tool to inform decisions
- Yield continuum approach can be:
  - Adapted for unique regions
  - Modified further for local scale applications

Thank You



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