Hydrogeological and geological characterization of the Calgary-Lethbridge Corridor to support a management approach for groundwater

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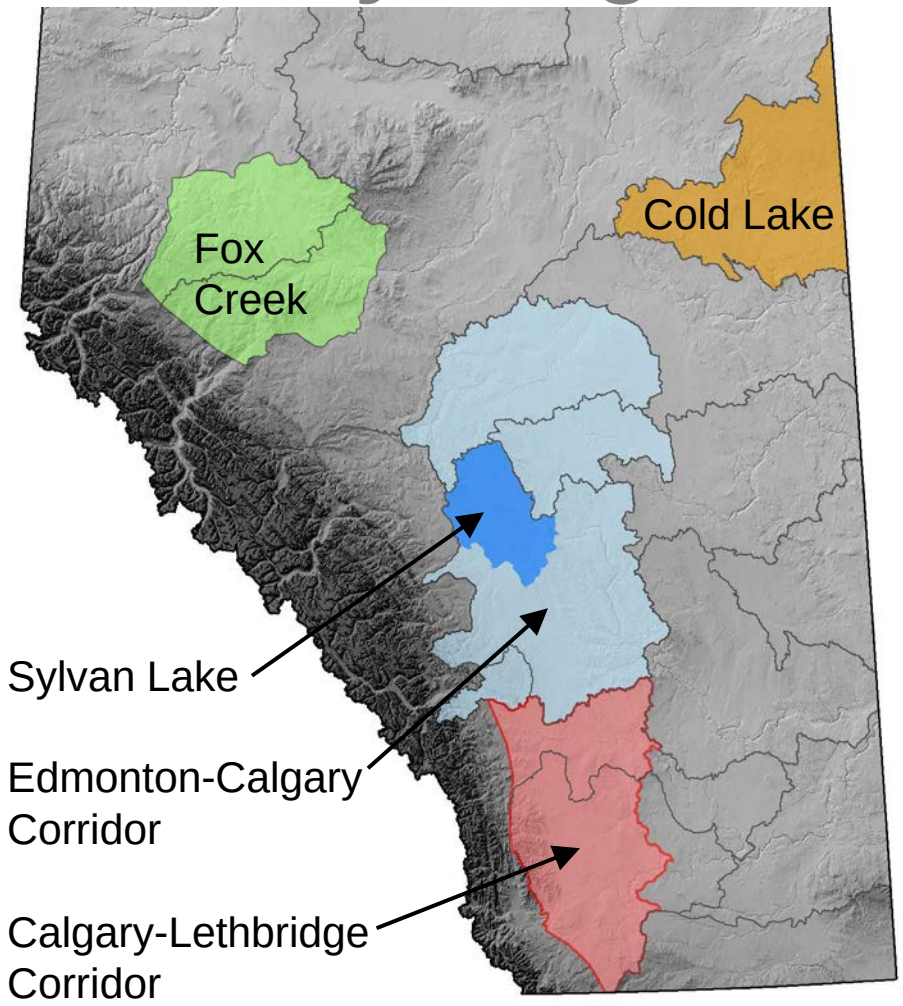
CWRA 2017 Conference, 7 June 2017

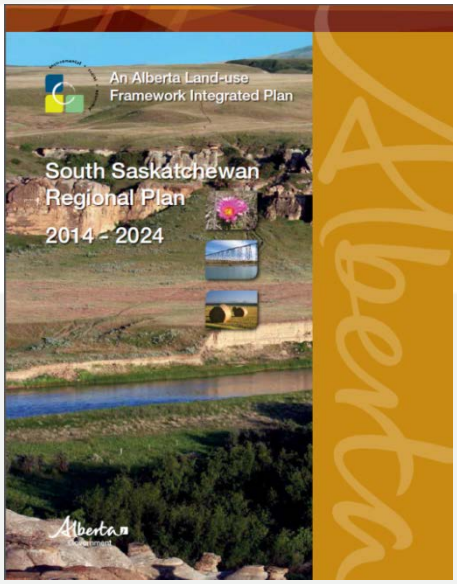
Provincial Groundwater Inventory Program

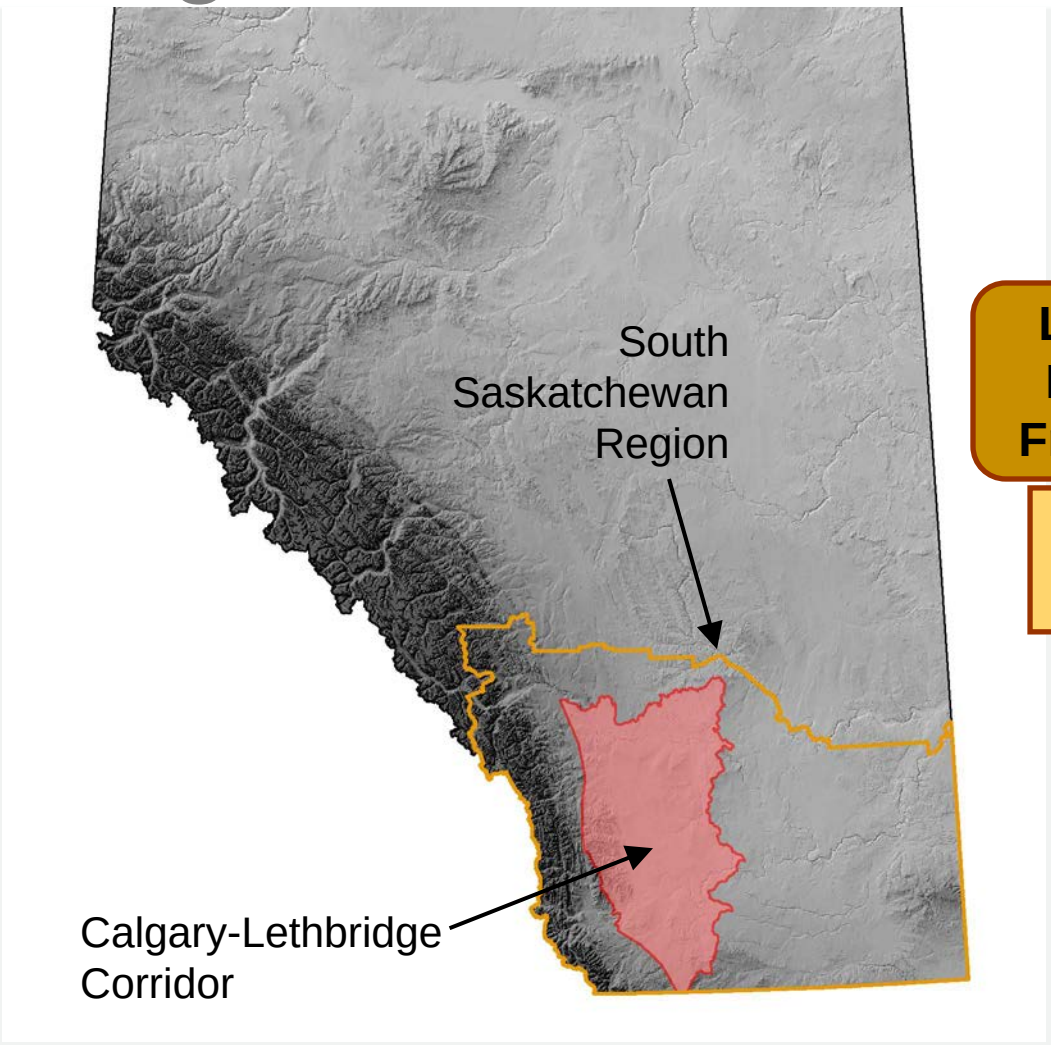


A partnership with Alberta Environment & Parks since 2008

- Characterize Alberta's groundwater resources
  - Regional-scale mapping and inventory
  - Basis for water management
- Ensure geoscience is meaningful at the 'regional' scale
  - Land-use planning regions

South Saskatchewan Regional Plan

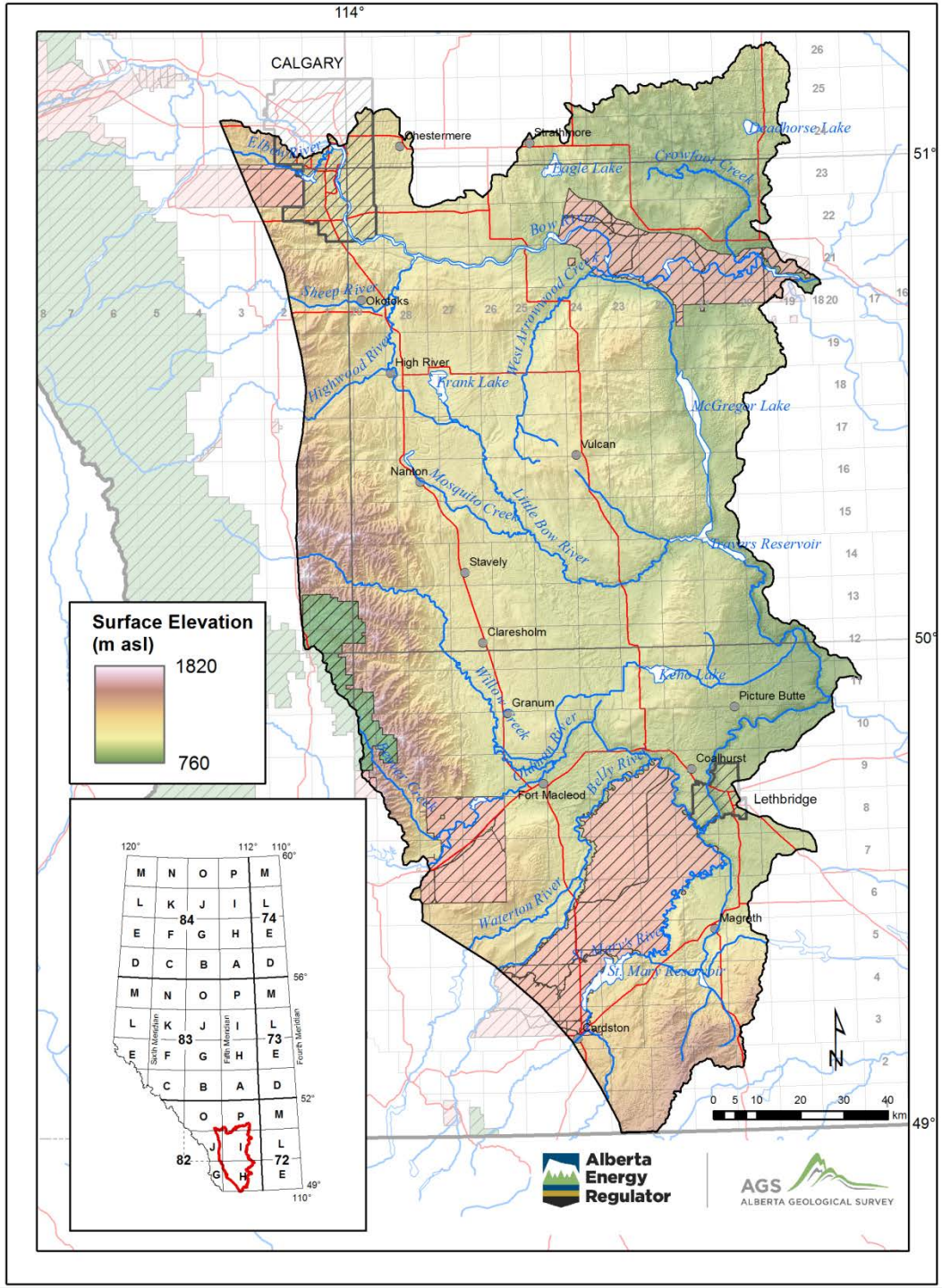




Land Use Planning Framework

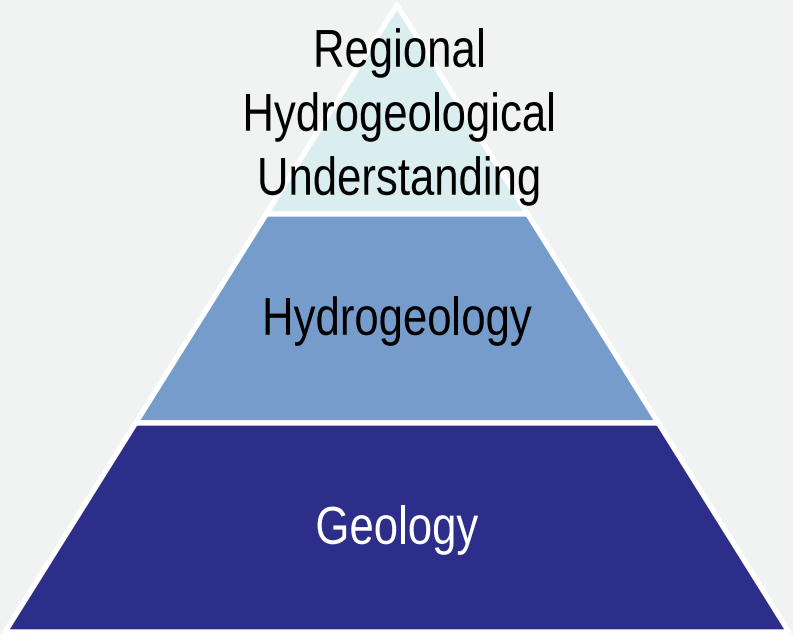
South Saskatchewan Regional Plan

Groundwater Management Framework



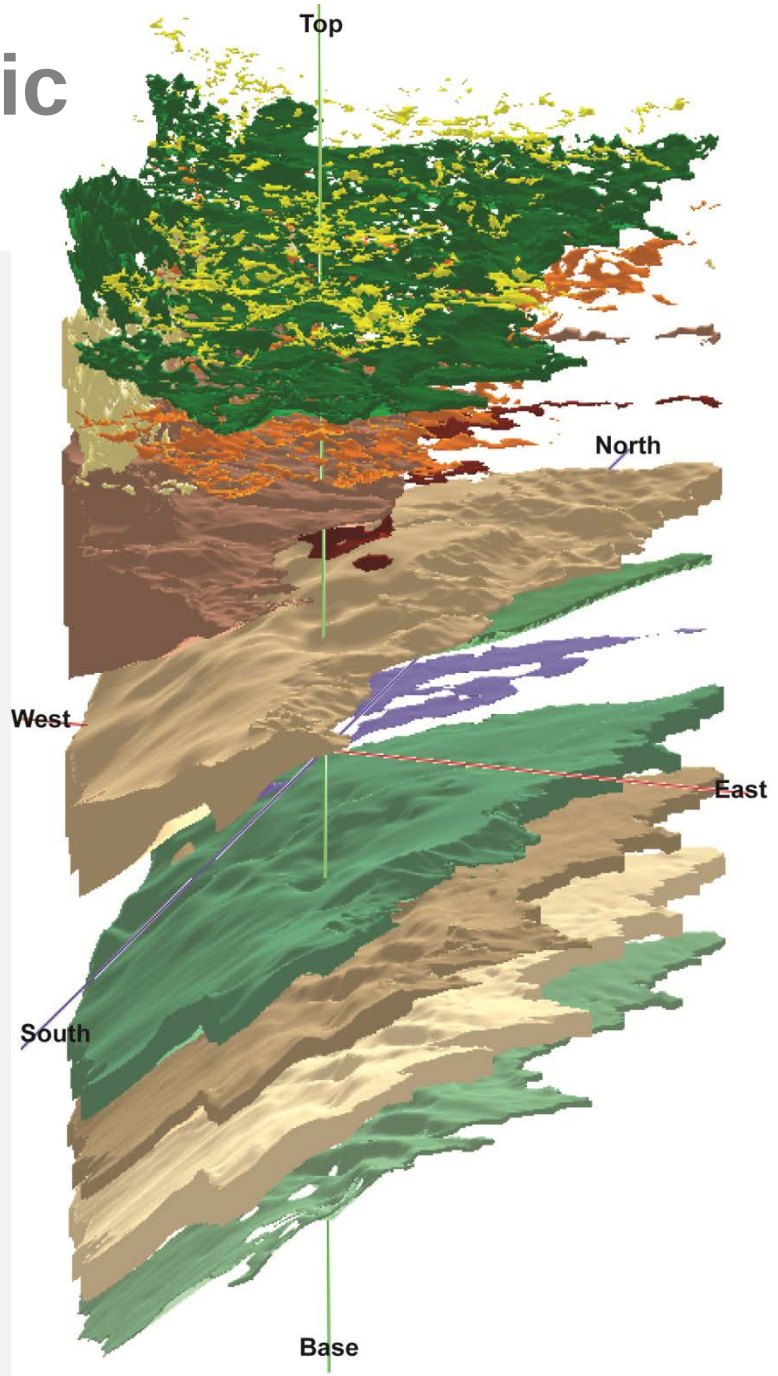
Calgary-Lethbridge Corridor

- Develop a digital hydrostratigraphic framework
- Defined by 8 sub-basins and deformation belt to the west
- 21,159 km^2



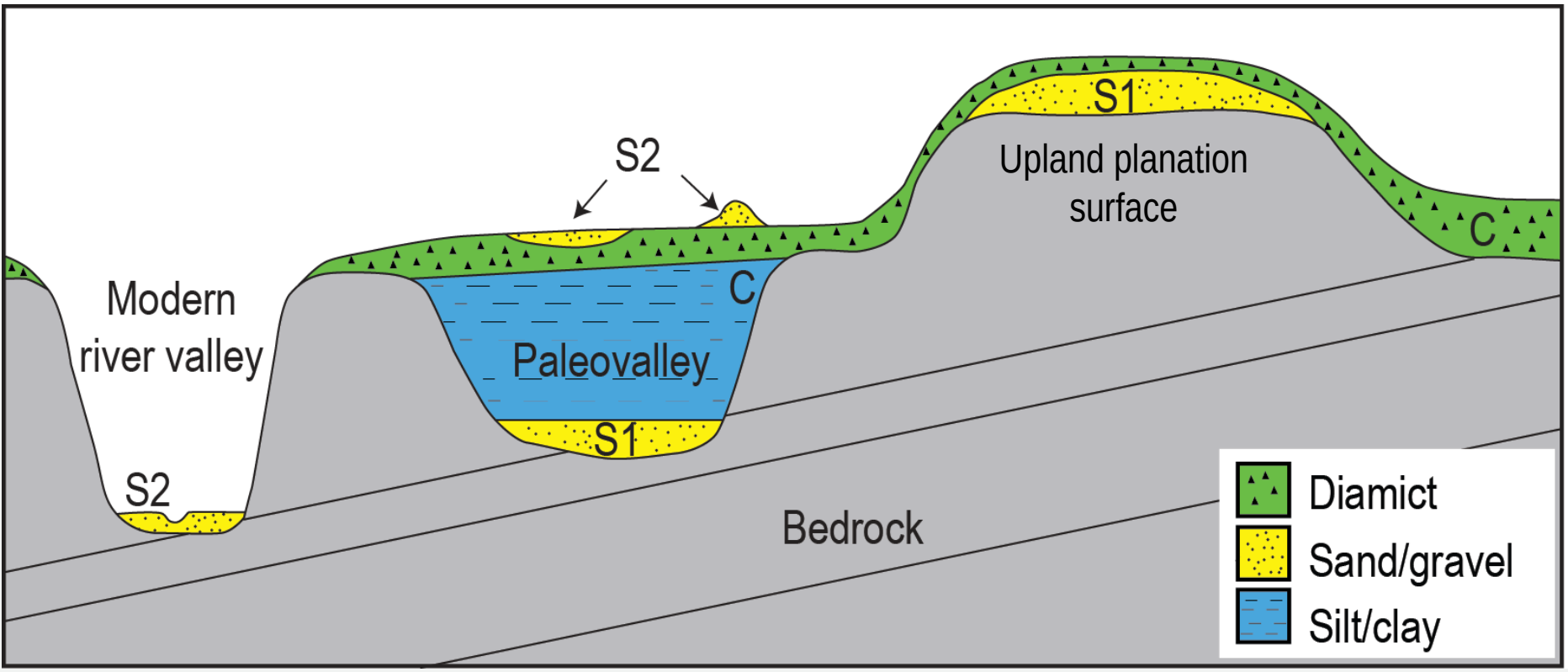
Hydrostratigraphic Model

- 3 HSU's developed for unconsolidated sediments
- Each bedrock formation defined as an HSU
- Updated bedrock topography and paleovalleys



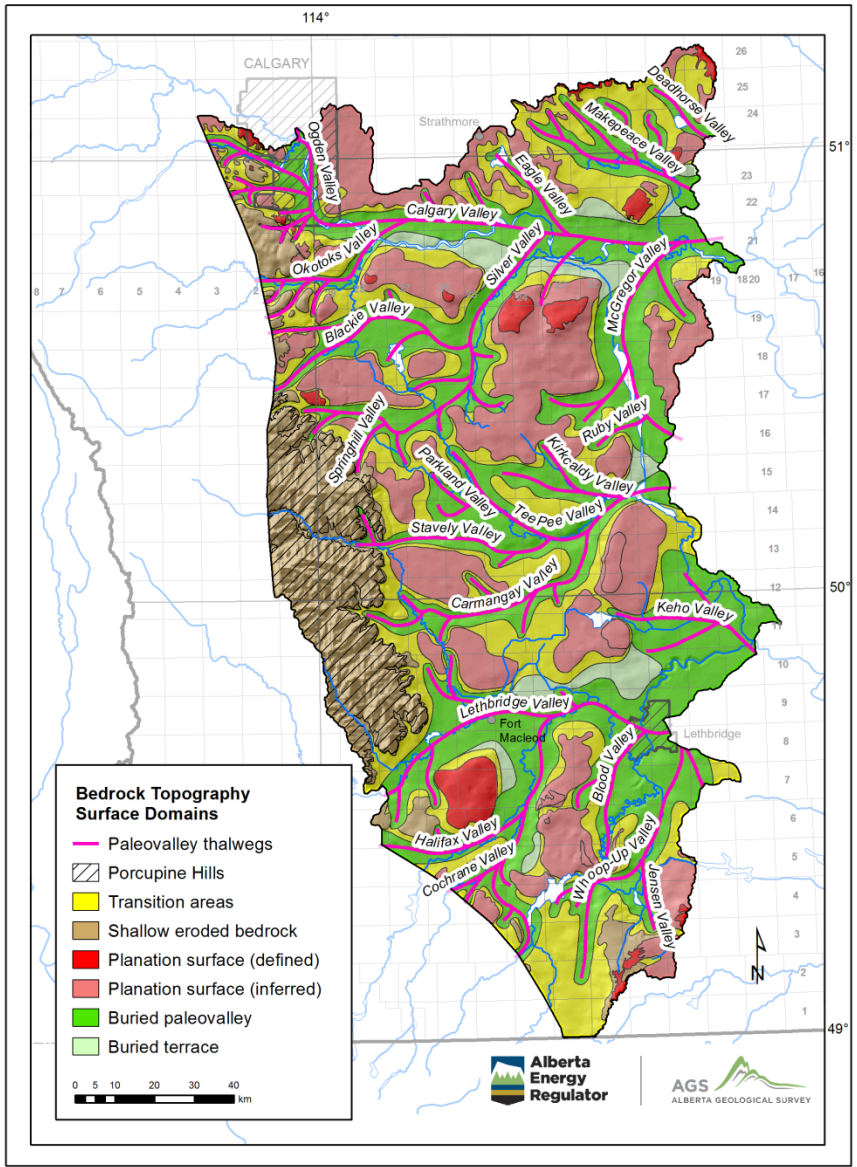
AGS

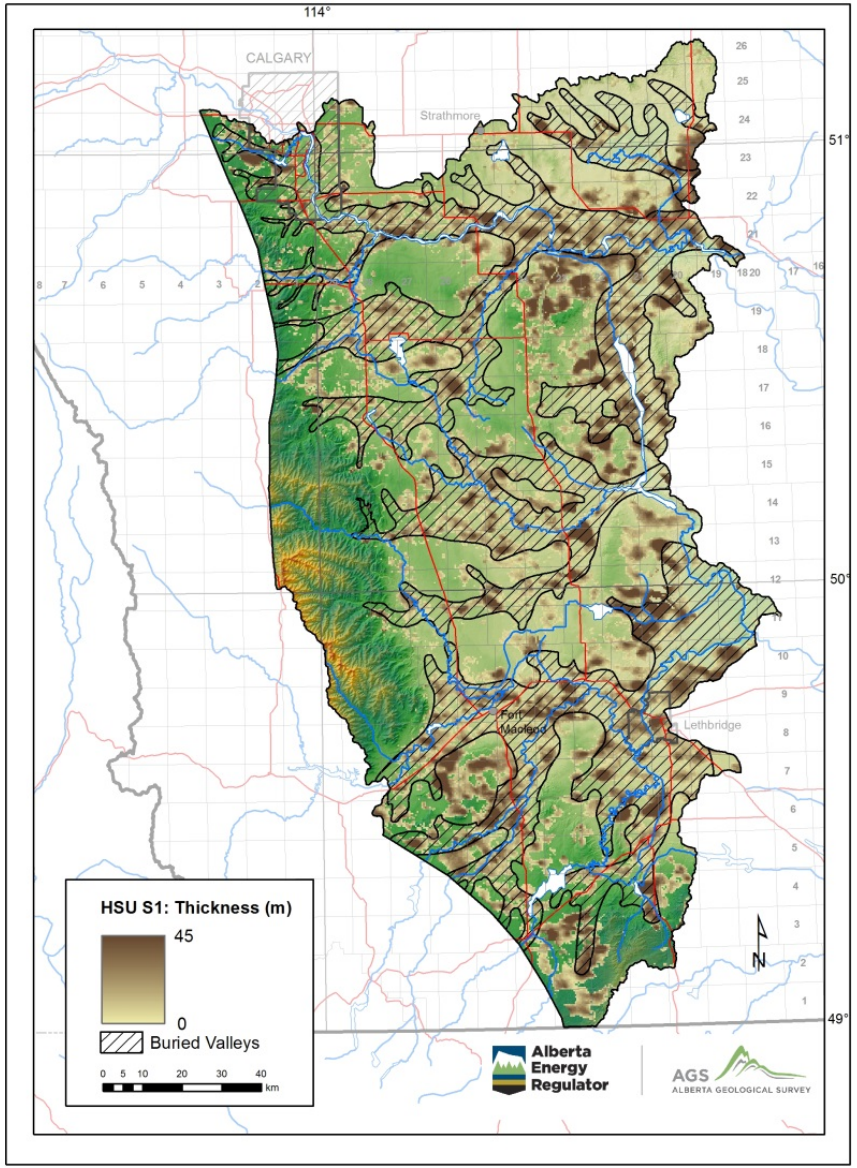
Unconsolidated HSUs



- Delineate groupings of unconsolidated sediments with common texture
  - Laterally-connected fine- or coarse-grained units
  - Can be recognized at a regional scale (> 1 km)

Unconsolidated HSUs





Unconsolidated HSUs

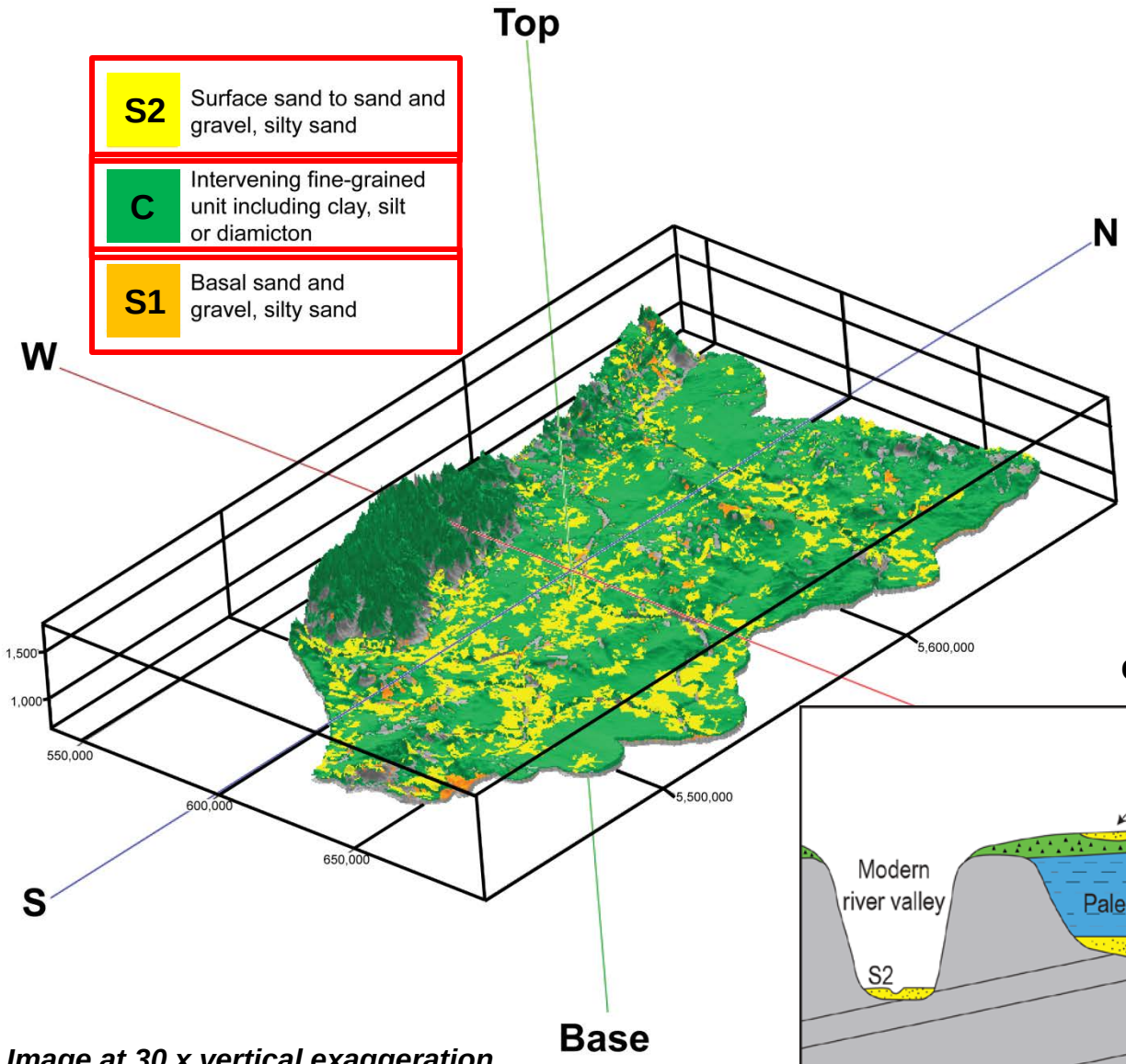
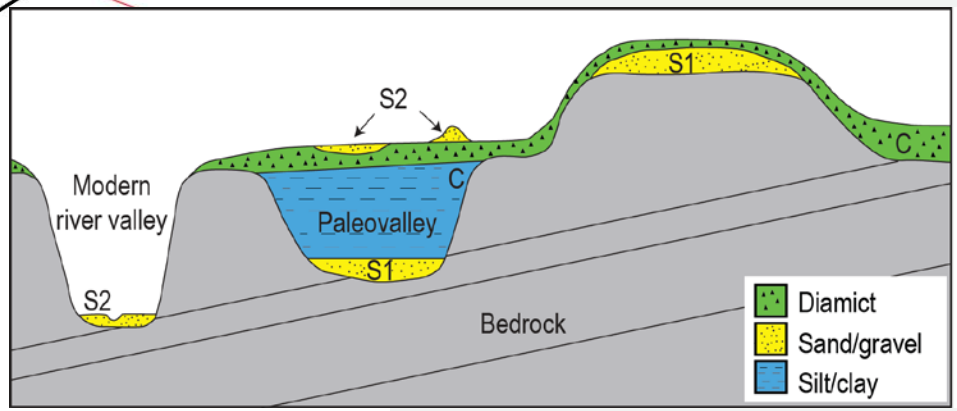


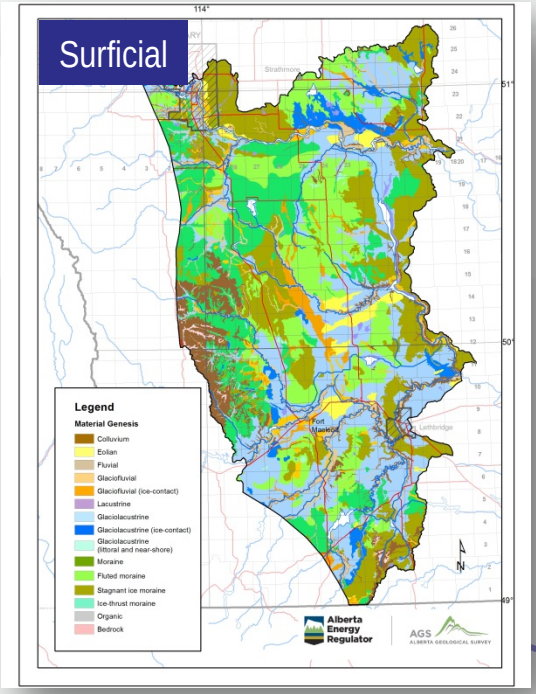
Image at 30 x vertical exaggeration

Conceptual Model

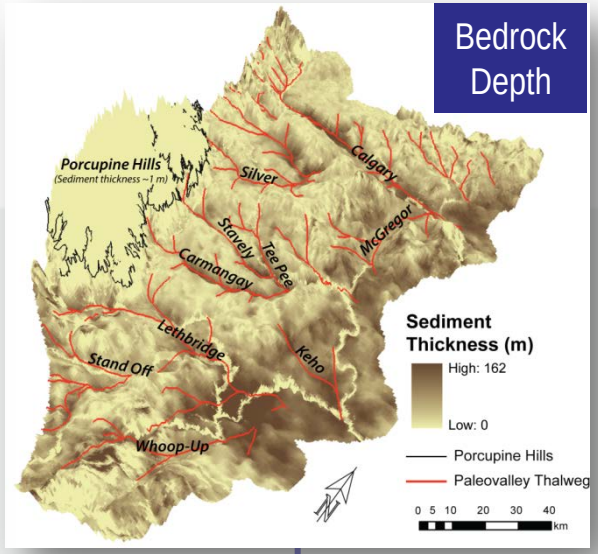


Geology

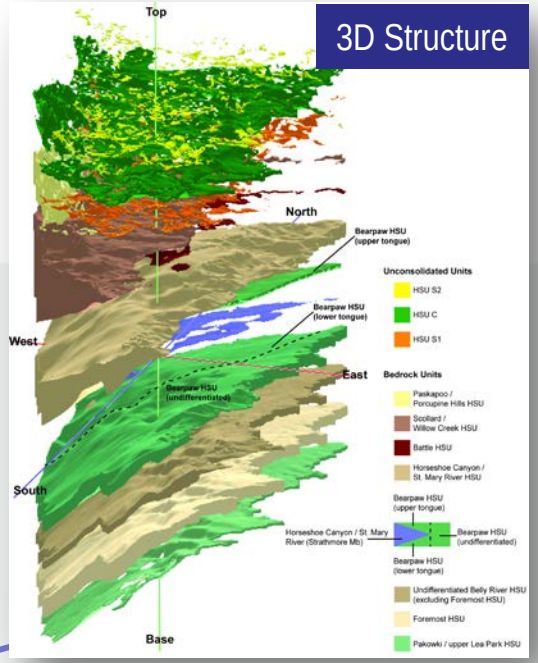
Surficial



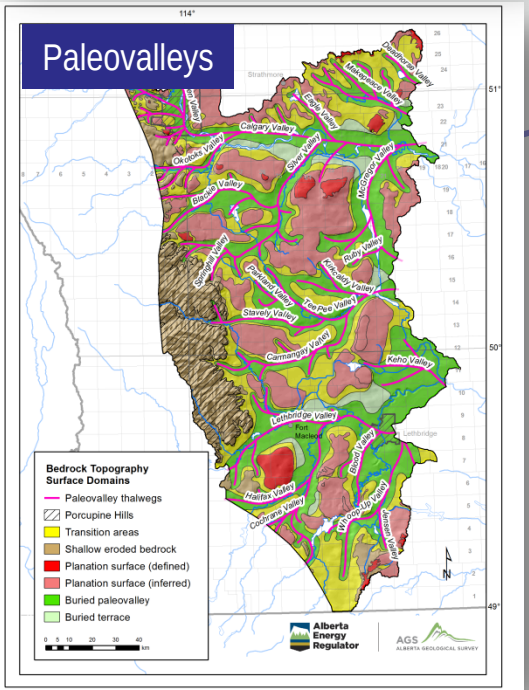
Bedrock Depth



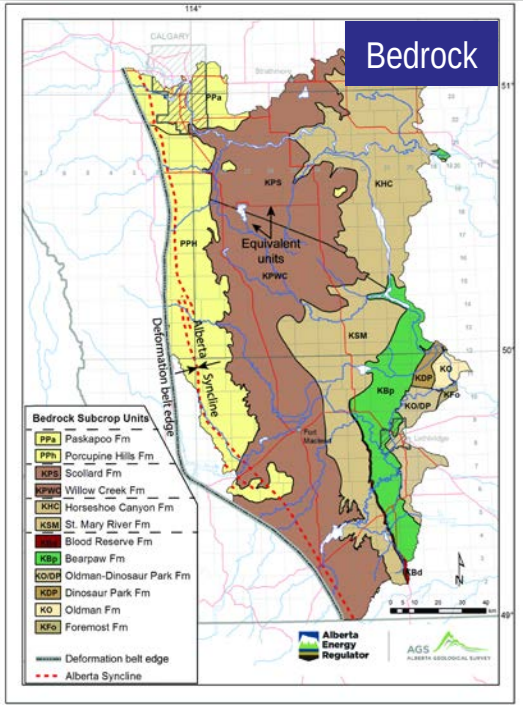
3D Structure

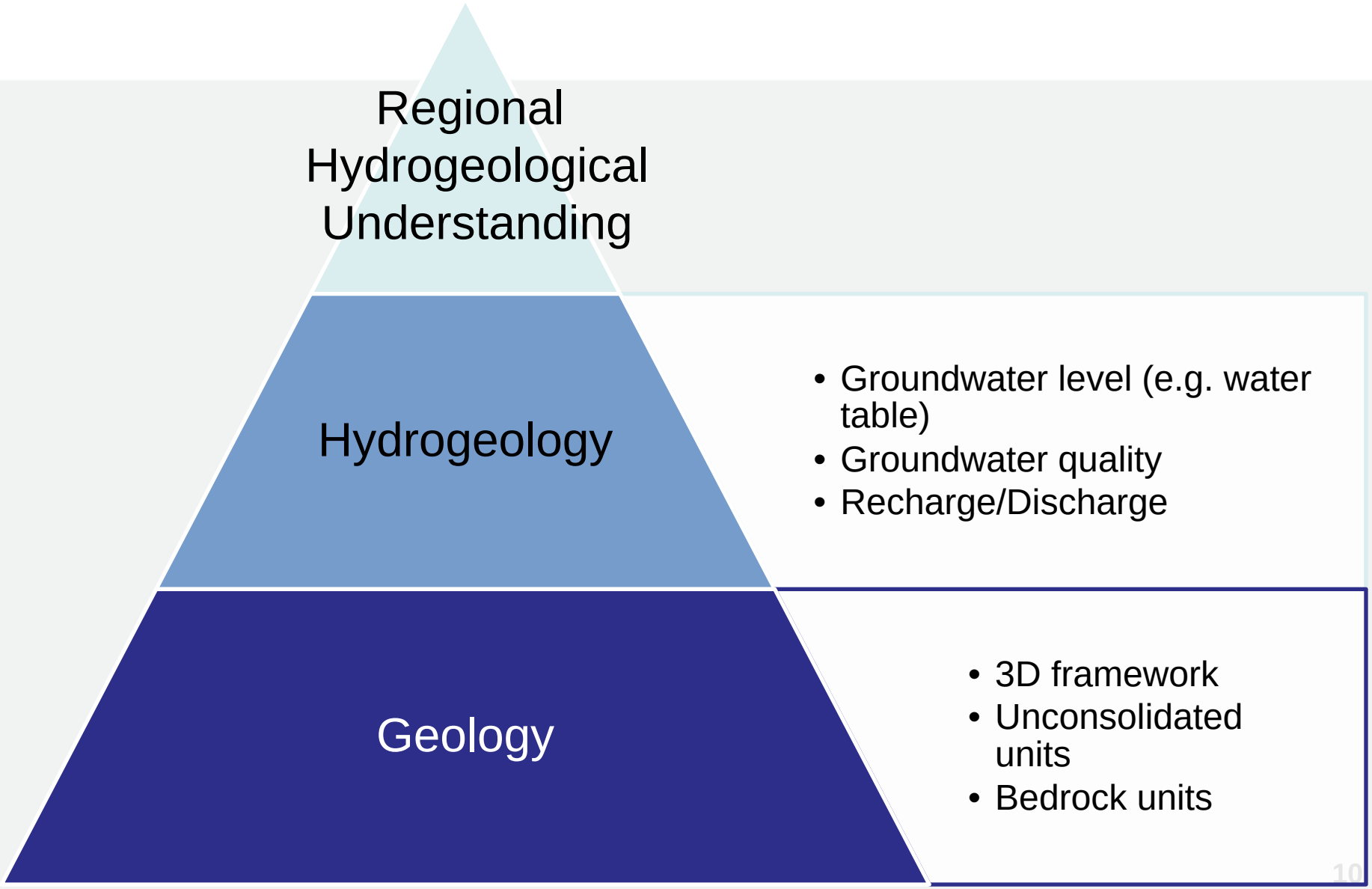


Paleovalleys



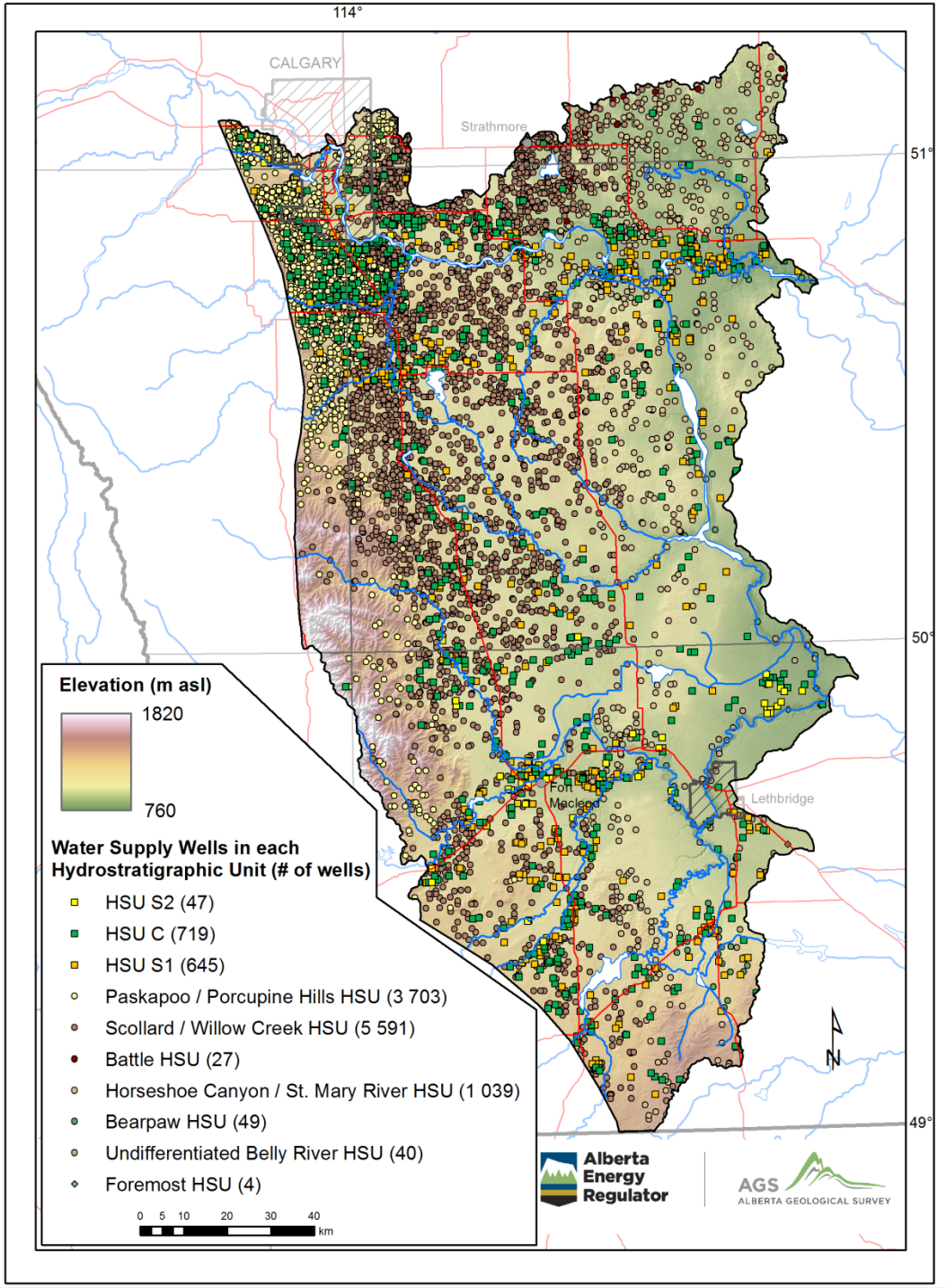
Bedrock



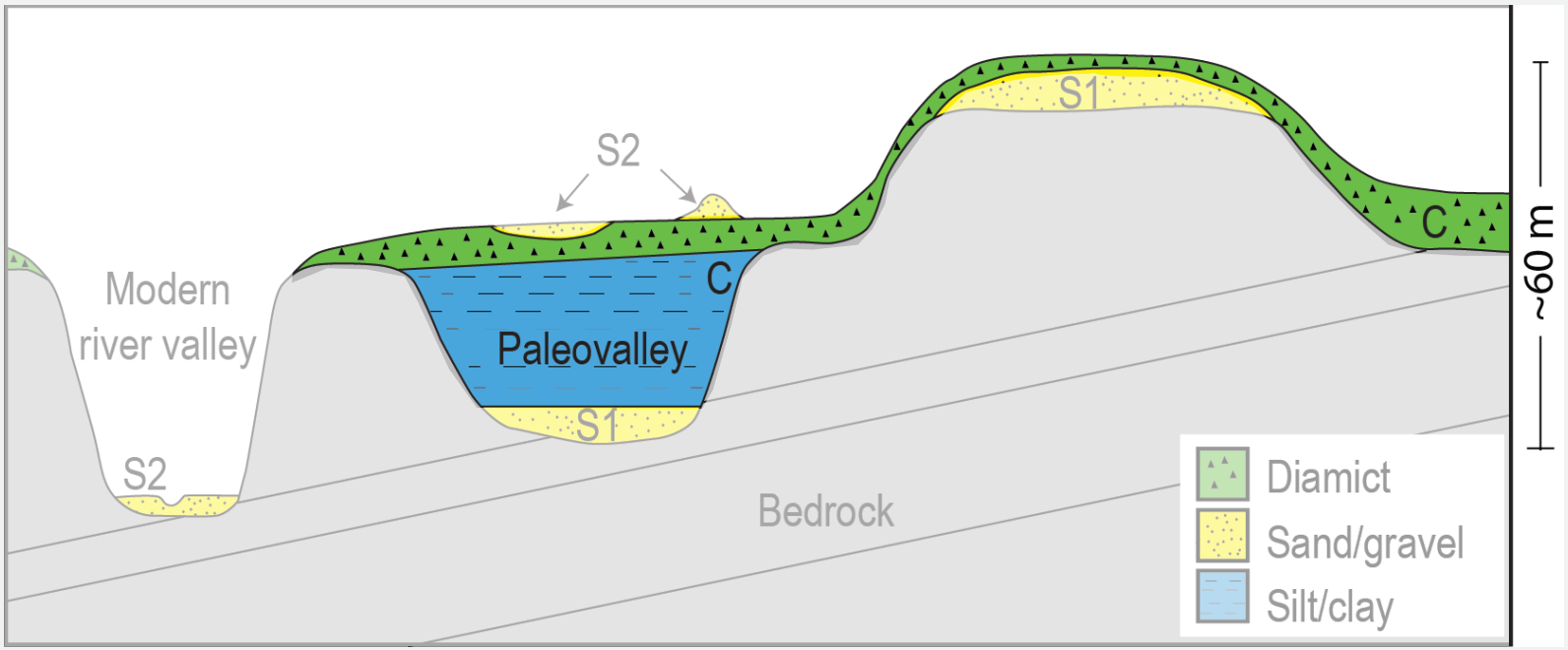

Regional Hydrogeological Understanding
Hydrogeology
Geology
• Groundwater level (e.g. water table)
• Groundwater quality
• Recharge/Discharge
• 3D framework
• Unconsolidated units
• Bedrock units

Water Supply Wells

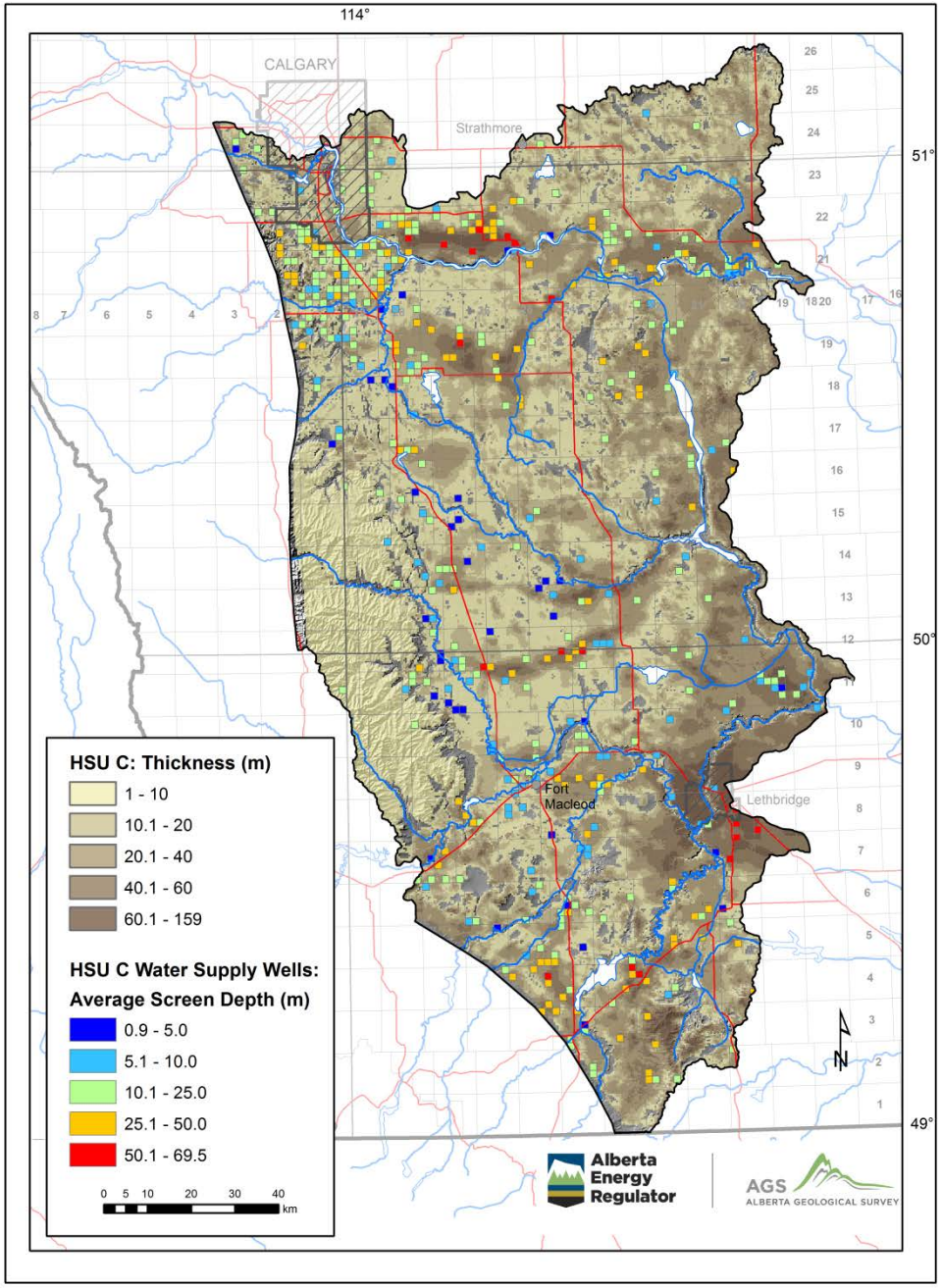
- E.g. Domestic, stock, municipal, etc.
- NOT observation, test holes, dewatering, etc.
- Allocation to several different geological units
- Useful to see water sources

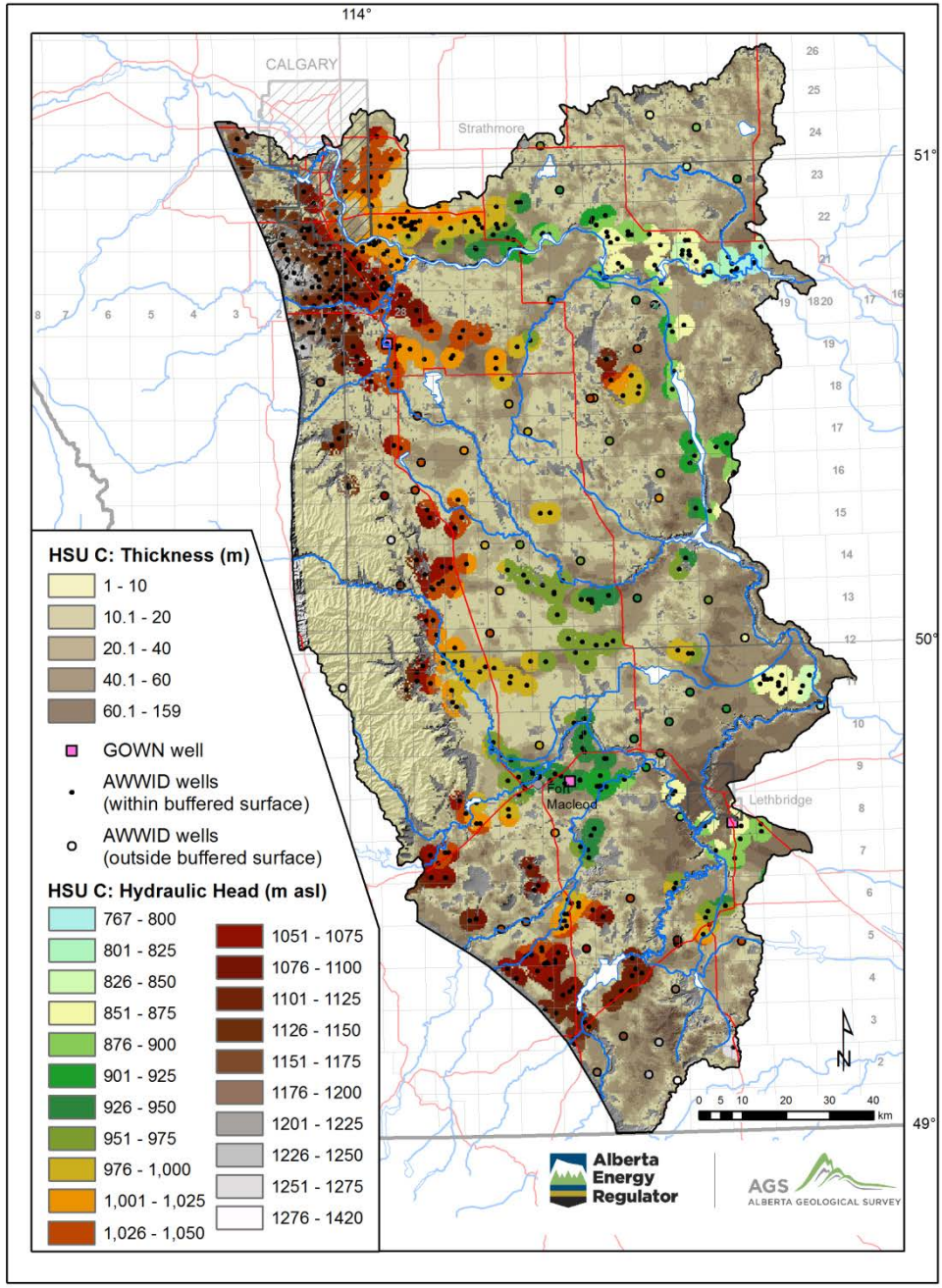


HSU C

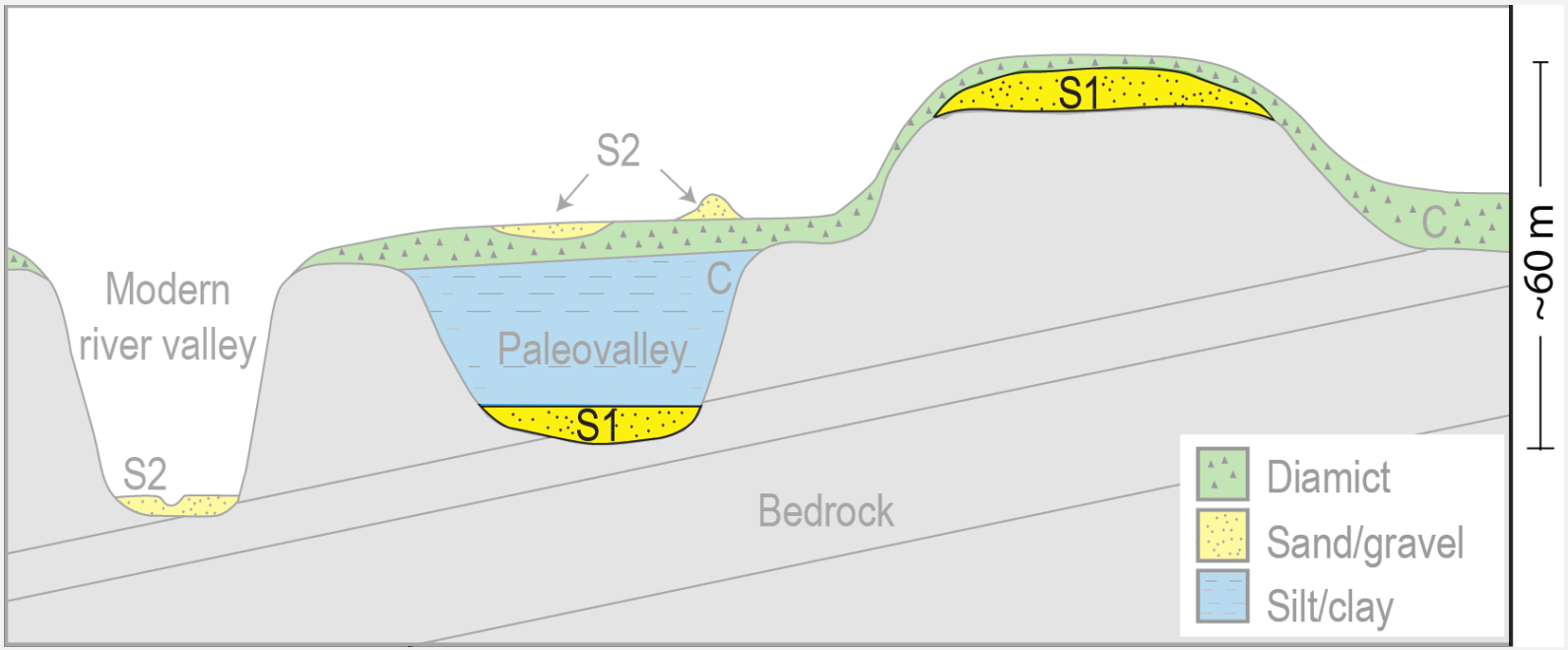


- Regional confining layer but also local aquifer
- Can be > 50 m thick in paleovalleys

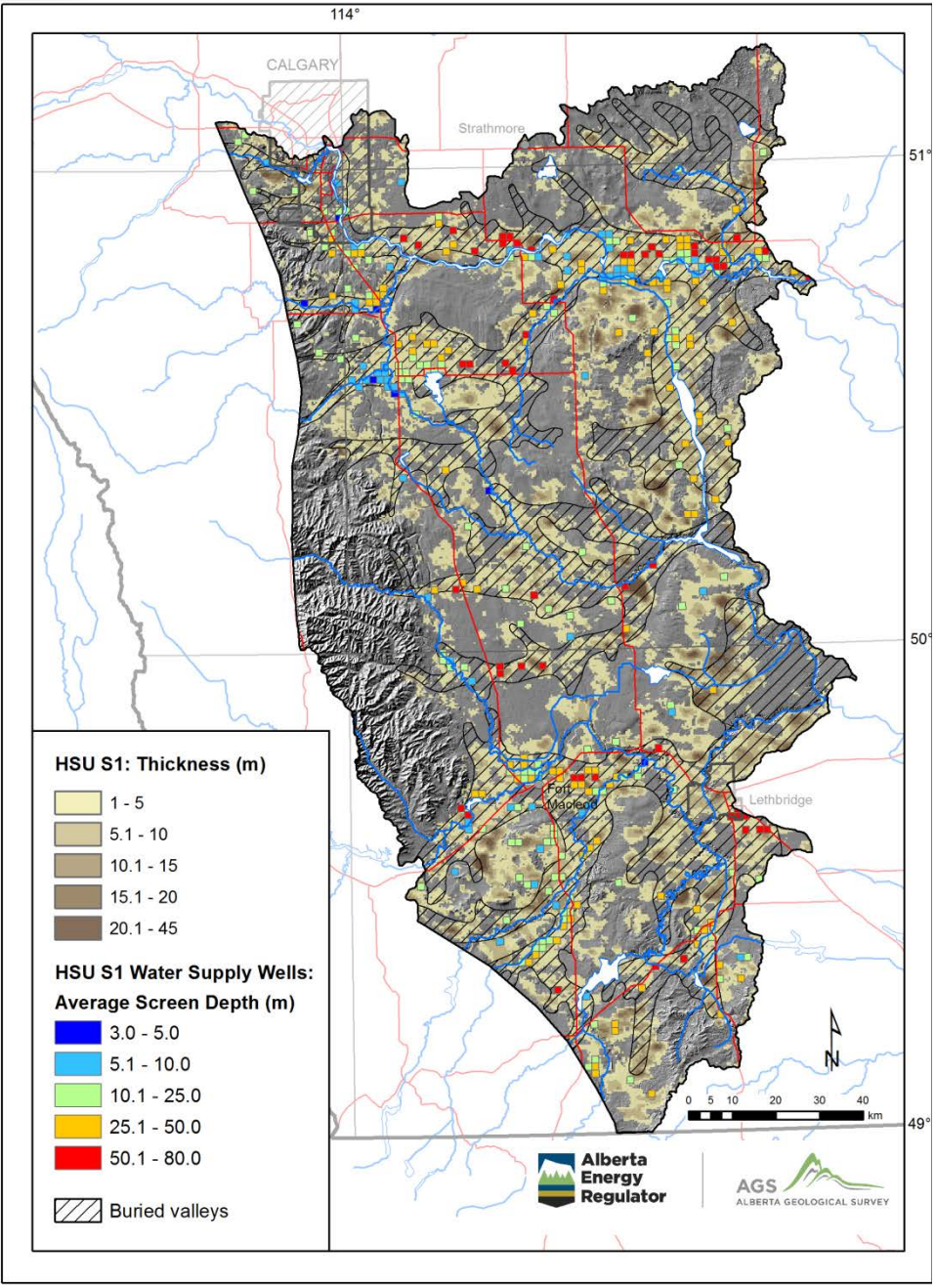

114°
CALGARY
Strathmore
51°
50°
49°
Fort Macleod
Lethbridge
HSU C: Thickness (m)
1 - 10
10.1 - 20
20.1 - 40
40.1 - 60
60.1 - 159
HSU C Water Supply Wells:
Average Screen Depth (m)
0.9 - 5.0
5.1 - 10.0
10.1 - 25.0
25.1 - 50.0
50.1 - 69.5
0 5 10 20 30 40 km
N
Alberta Energy Regulator
AGS
ALBERTA GEOLOGICAL SURVEY

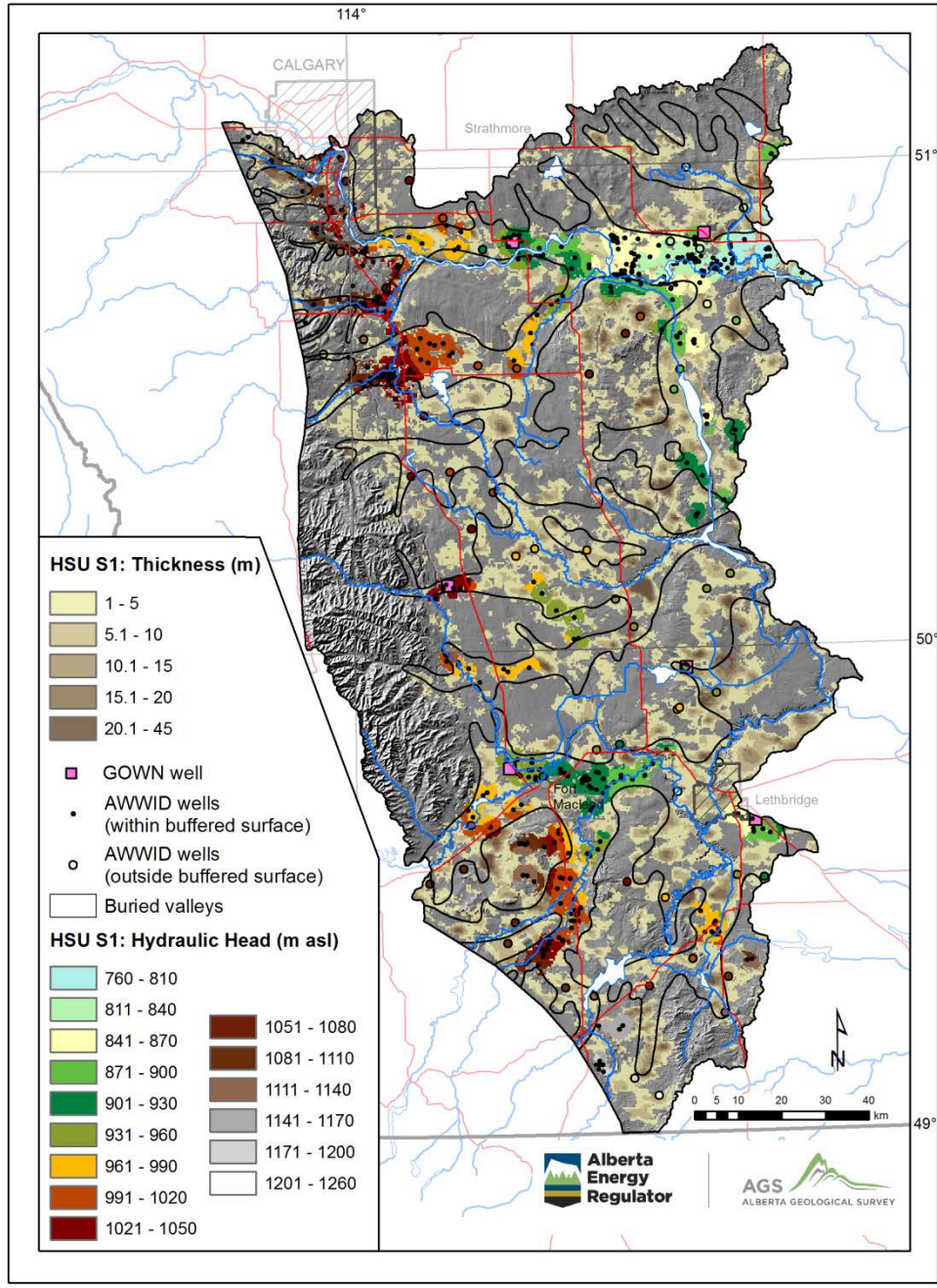

114°
CALGARY
Strathmore
51°
50°
49°
Fort Macleod
Lethbridge
HSU C: Thickness (m)
1 - 10
10.1 - 20
20.1 - 40
40.1 - 60
60.1 - 159
GOWN well
AWWID wells
(within buffered surface)
AWWID wells
(outside buffered surface)
HSU C: Hydraulic Head (m asl)
767 - 800
801 - 825
826 - 850
851 - 875
876 - 900
901 - 925
926 - 950
951 - 975
976 - 1,000
1,001 - 1,025
1,026 - 1,050
1051 - 1075
1076 - 1100
1101 - 1125
1126 - 1150
1151 - 1175
1176 - 1200
1201 - 1225
1226 - 1250
1251 - 1275
1276 - 1420
0 5 10 20 30 40 km
N
Alberta Energy Regulator
AGS
ALBERTA GEOLOGICAL SURVEY

HSU S1



- Recognized as aquifers in the region
- Can be shallow or deep


114°
CALGARY
Strathmore
51°
50°
49°
Fort Macleod
Lethbridge
HSU S1: Thickness (m)
1 - 5
5.1 - 10
10.1 - 15
15.1 - 20
20.1 - 45
HSU S1 Water Supply Wells:
Average Screen Depth (m)
3.0 - 5.0
5.1 - 10.0
10.1 - 25.0
25.1 - 50.0
50.1 - 80.0
Buried valleys
0 5 10 20 30 40
km
Alberta Energy Regulator
AGS
ALBERTA GEOLOGICAL SURVEY


114°
CALGARY
Strathmore
51°
50°
49°
Fort Macleod
Lethbridge
HSU S1: Thickness (m)
1 - 5
5.1 - 10
10.1 - 15
15.1 - 20
20.1 - 45
GOWN well
AWWID wells
(within buffered surface)
AWWID wells
(outside buffered surface)
Buried valleys
HSU S1: Hydraulic Head (m asl)
760 - 810
811 - 840
841 - 870
871 - 900
901 - 930
931 - 960
961 - 990
991 - 1020
1021 - 1050
1051 - 1080
1081 - 1110
1111 - 1140
1141 - 1170
1171 - 1200
1201 - 1260
0 5 10 20 30 40
km
Alberta Energy Regulator
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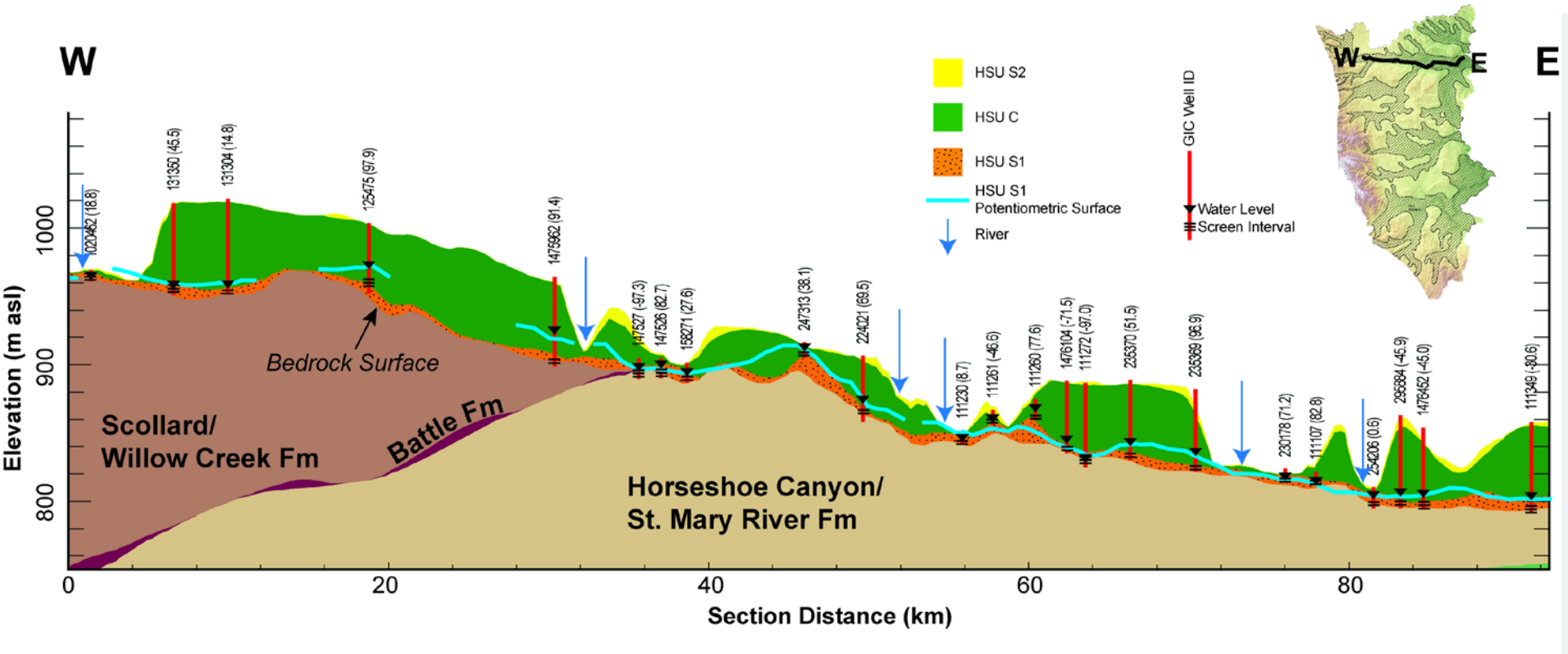
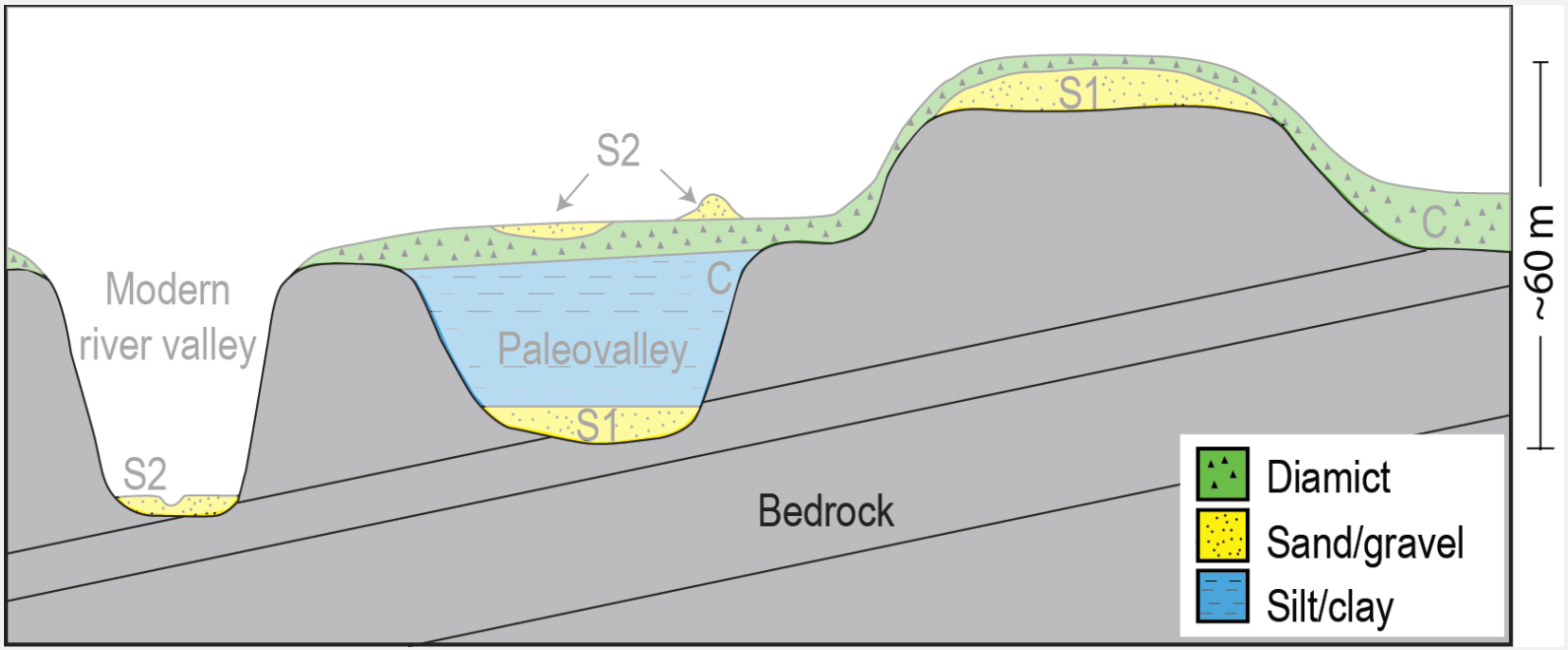
ALBERTA GEOLOGICAL SURVEY

HSU S1 Cross Section

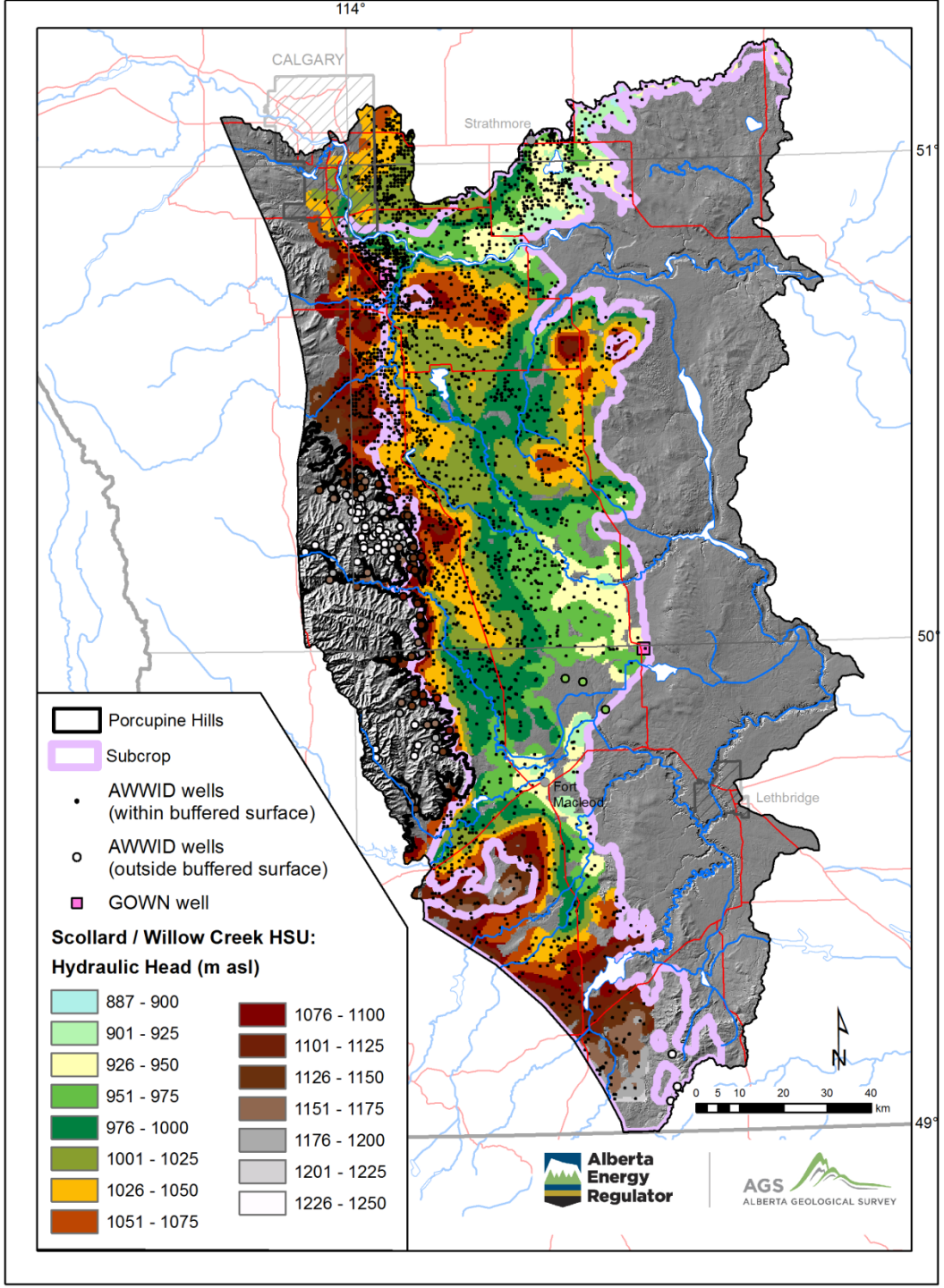


- Some intersection with modern Bow River valley
- Spatially variable connection of paleochannel and river
- HSU's provide a framework for mapping gaining/losing reaches

Bedrock Units

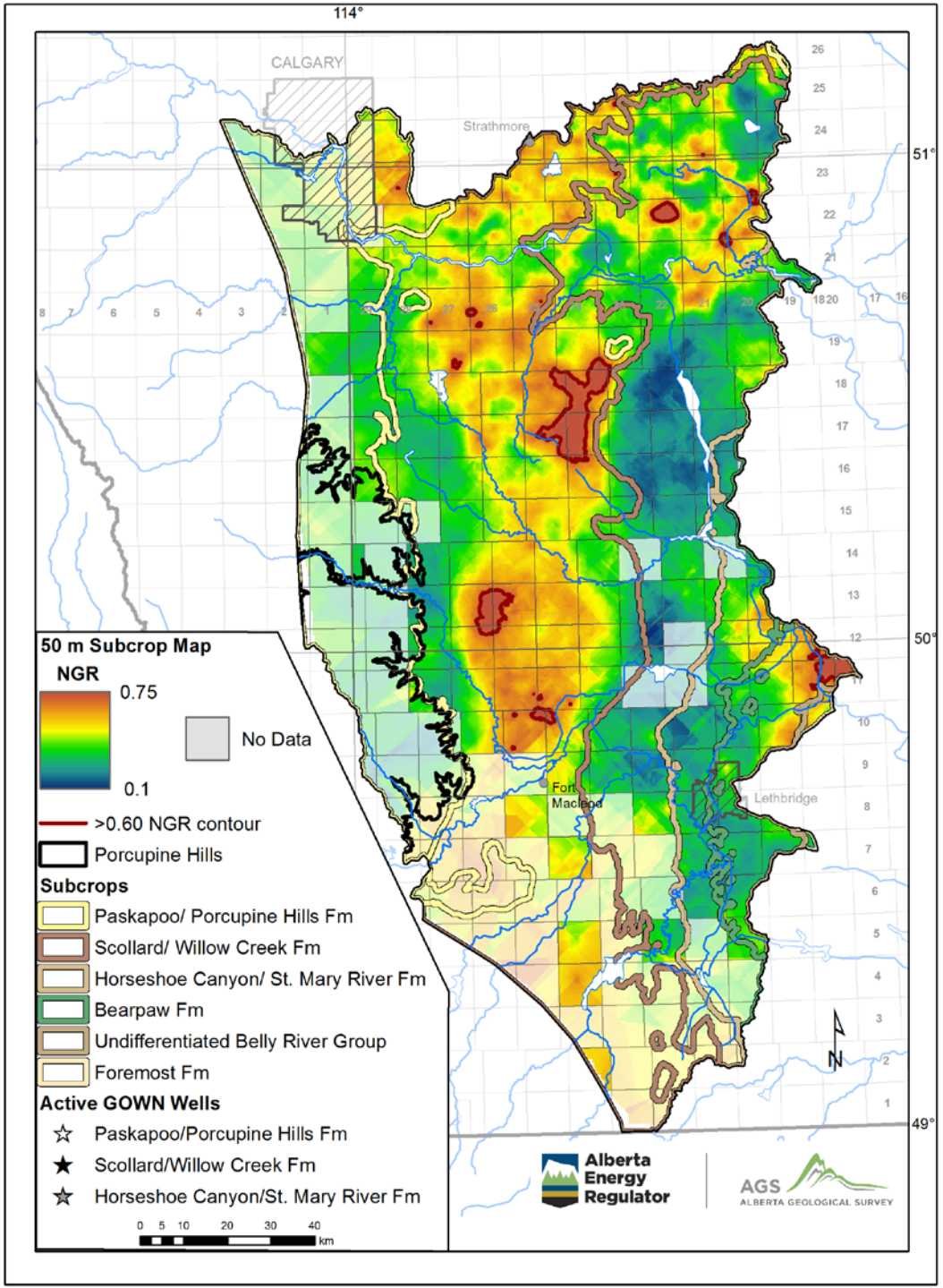


- More widespread aquifer potential across region
- Spatially variable hydraulic properties


114°
CALGARY
Strathmore
51°
50°
49°
Fort Macleod
Lethbridge
Porcupine Hills
Subcrop
AWWID wells (within buffered surface)
AWWID wells (outside buffered surface)
GOWN well
Scollard / Willow Creek HSU:
Hydraulic Head (m asl)
887 - 900
901 - 925
926 - 950
951 - 975
976 - 1000
1001 - 1025
1026 - 1050
1051 - 1075
1076 - 1100
1101 - 1125
1126 - 1150
1151 - 1175
1176 - 1200
1201 - 1225
1226 - 1250
N
0 5 10 20 30 40
km
Alberta Energy Regulator
AGS
ALBERTA GEOLOGICAL SURVEY

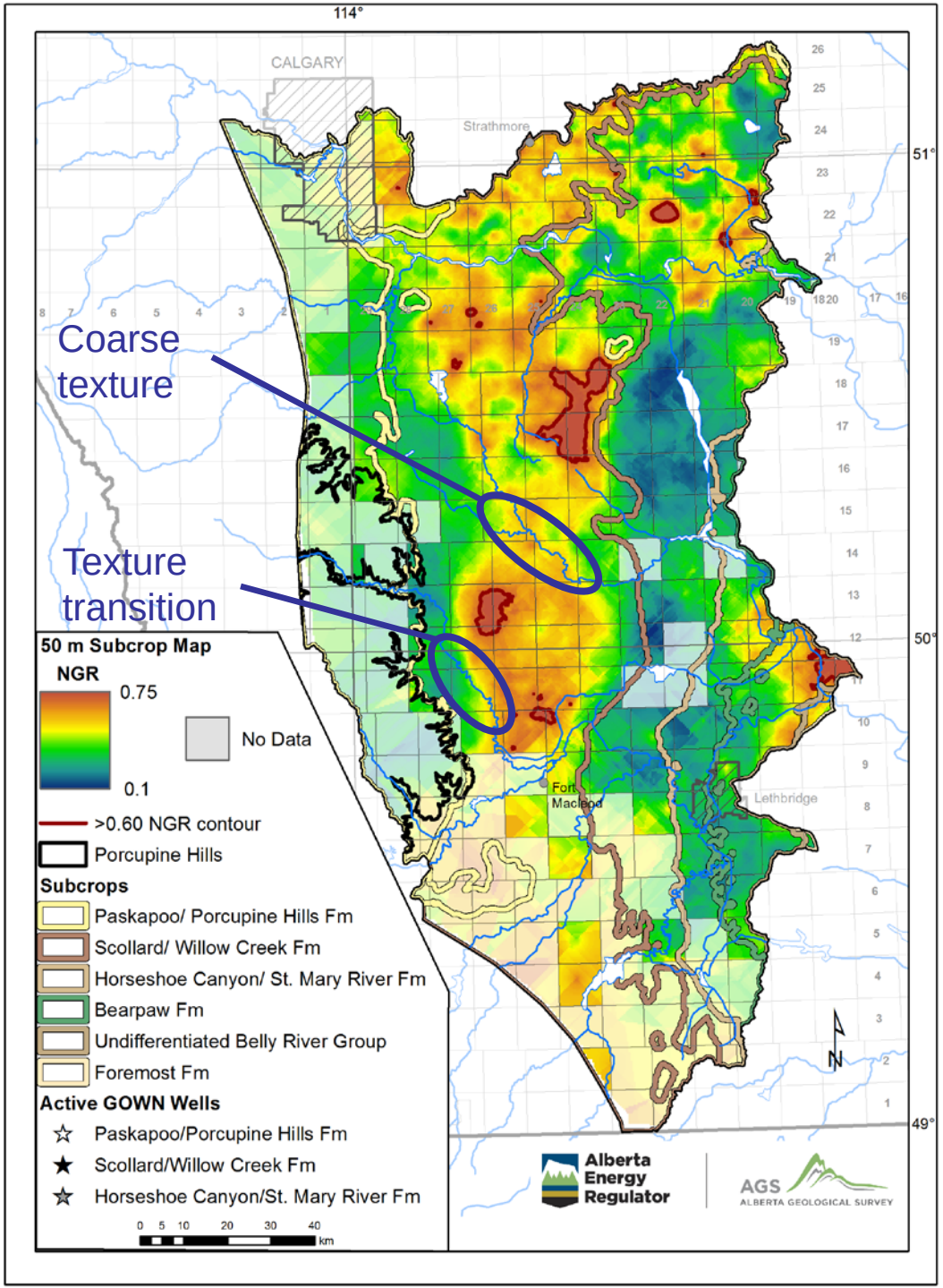
Distribution of Permeable Bedrock

- Identify major sandstone trends → *aquifer potential*



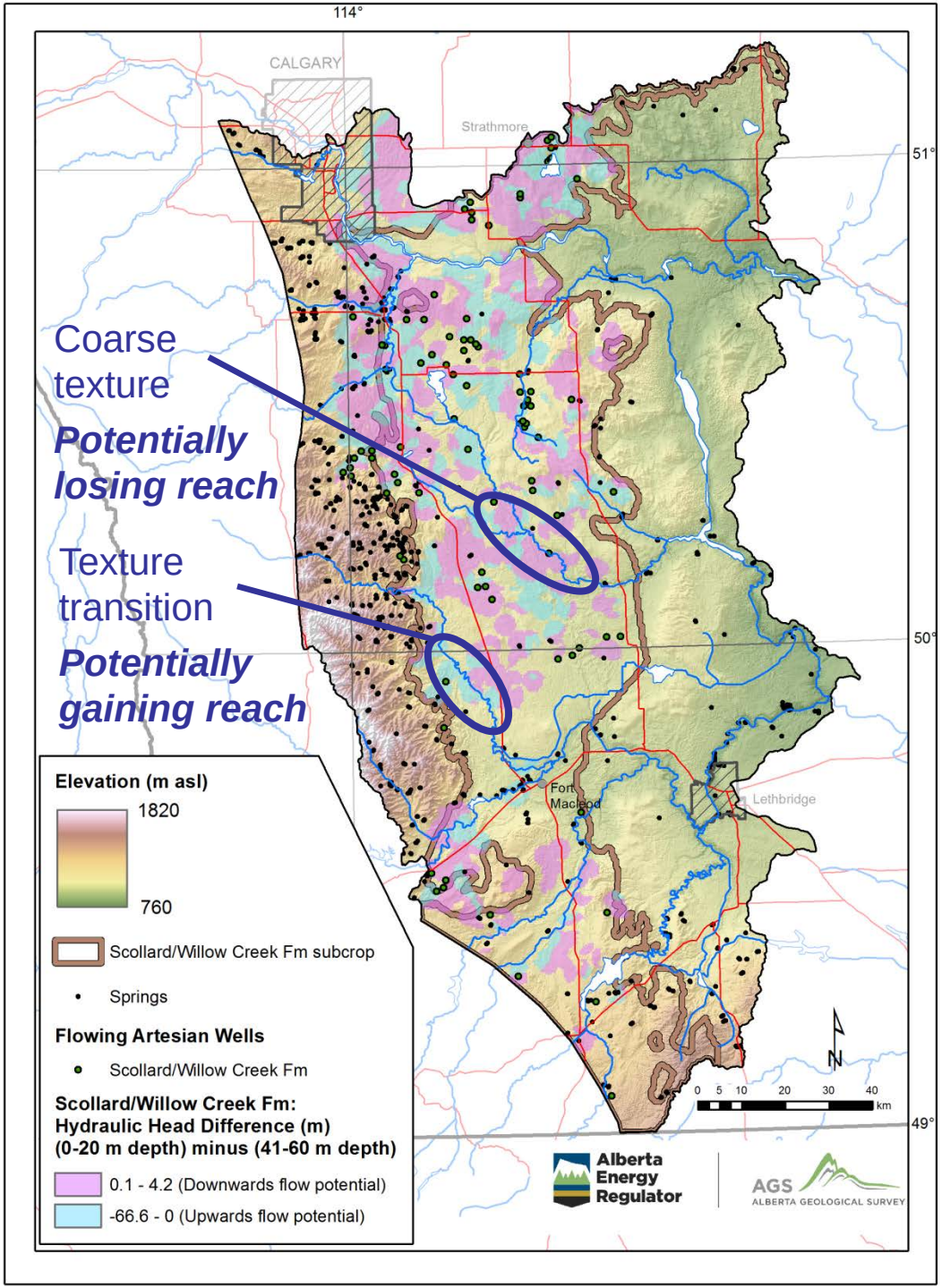
Distribution of Permeable Bedrock

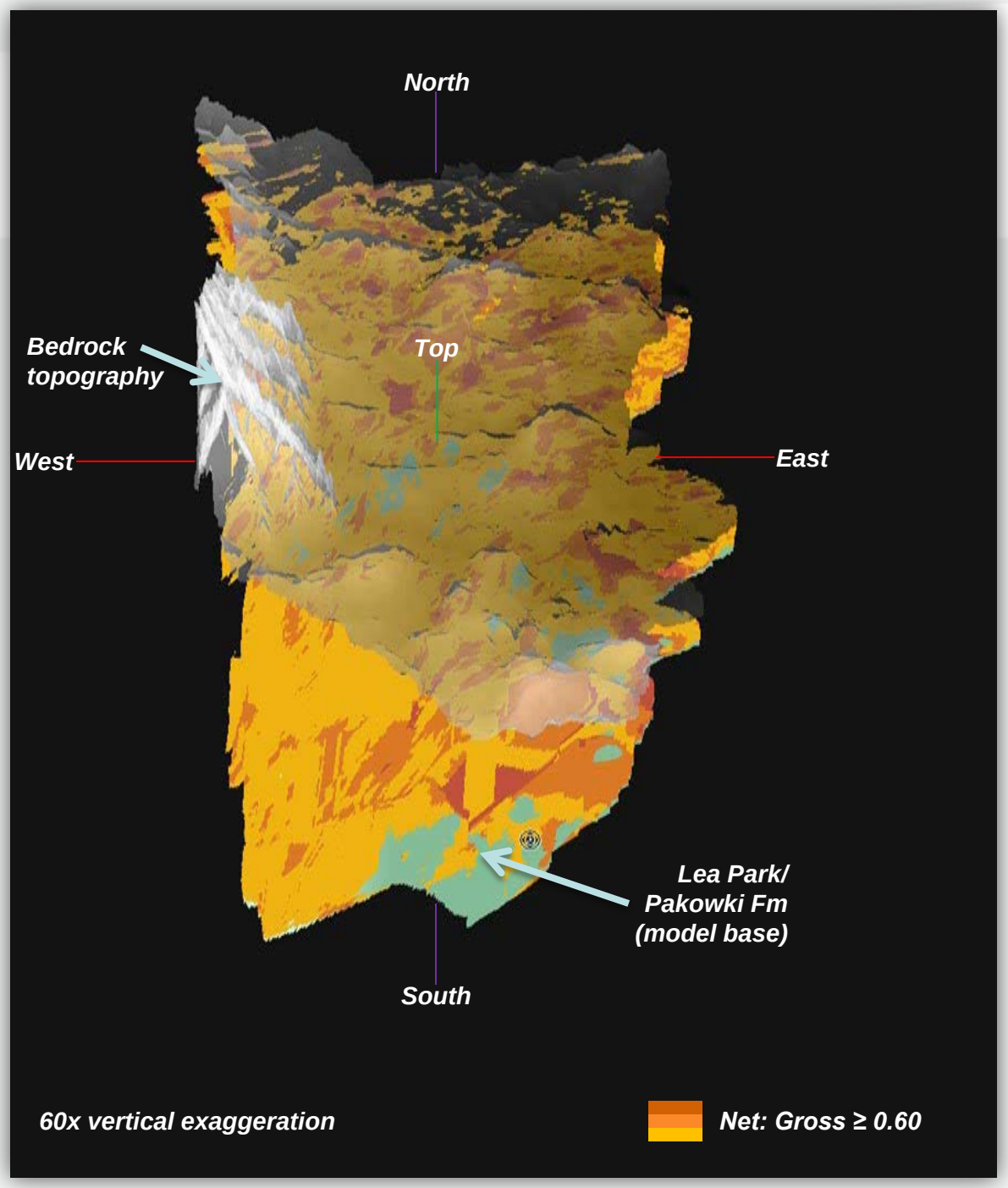
- Identify major sandstone trends → *aquifer potential*
- Locate where permeable bedrock could intersect rivers
- Framework for mapping gaining/losing reaches at regional scale



Potential Recharge Discharge Areas

- Potentiometric surfaces developed from water well database
- Analysis of hydraulic head difference
- First-order mapping of groundwater and surface water interaction

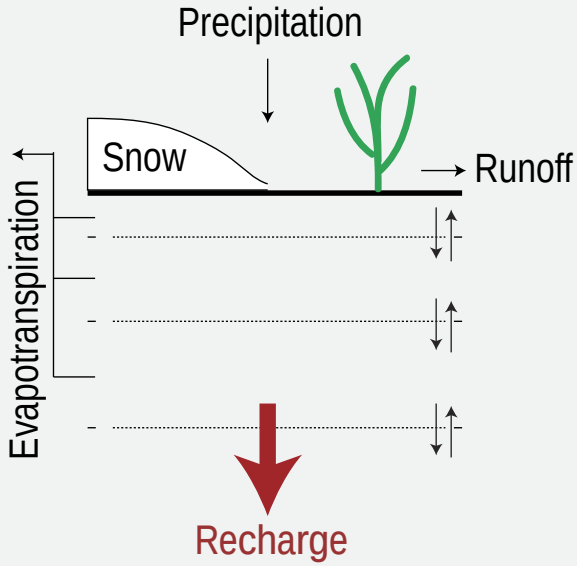




- Shallow depths (<150 m): sandstone mapping complements existing water well data
- Deeper depths (>150 m): sandstone mapping provides info where data may be lacking

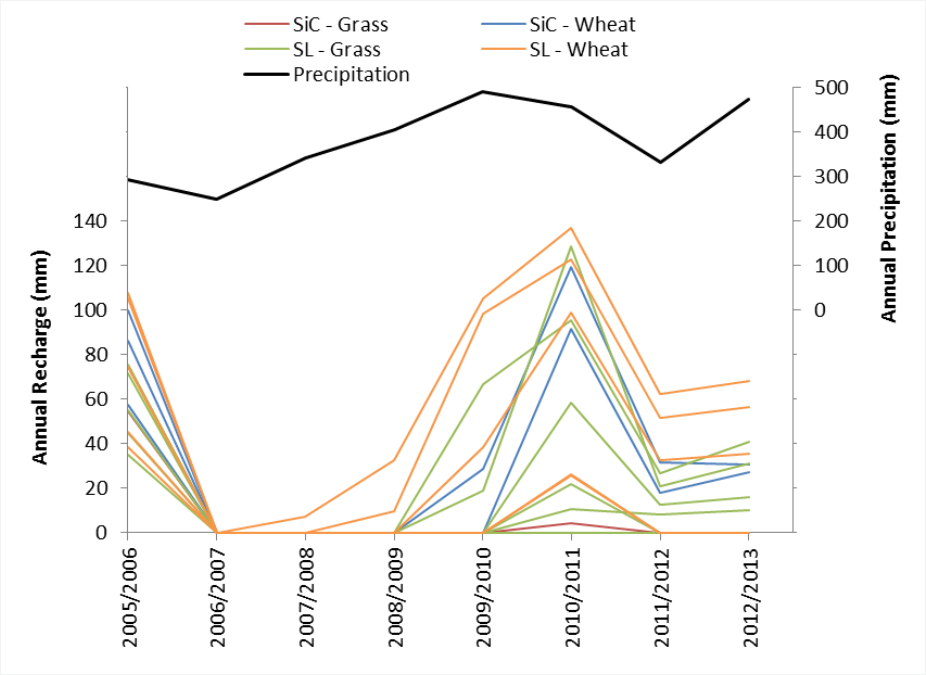
Versatile Soil Moisture Budget Model (VSMB)

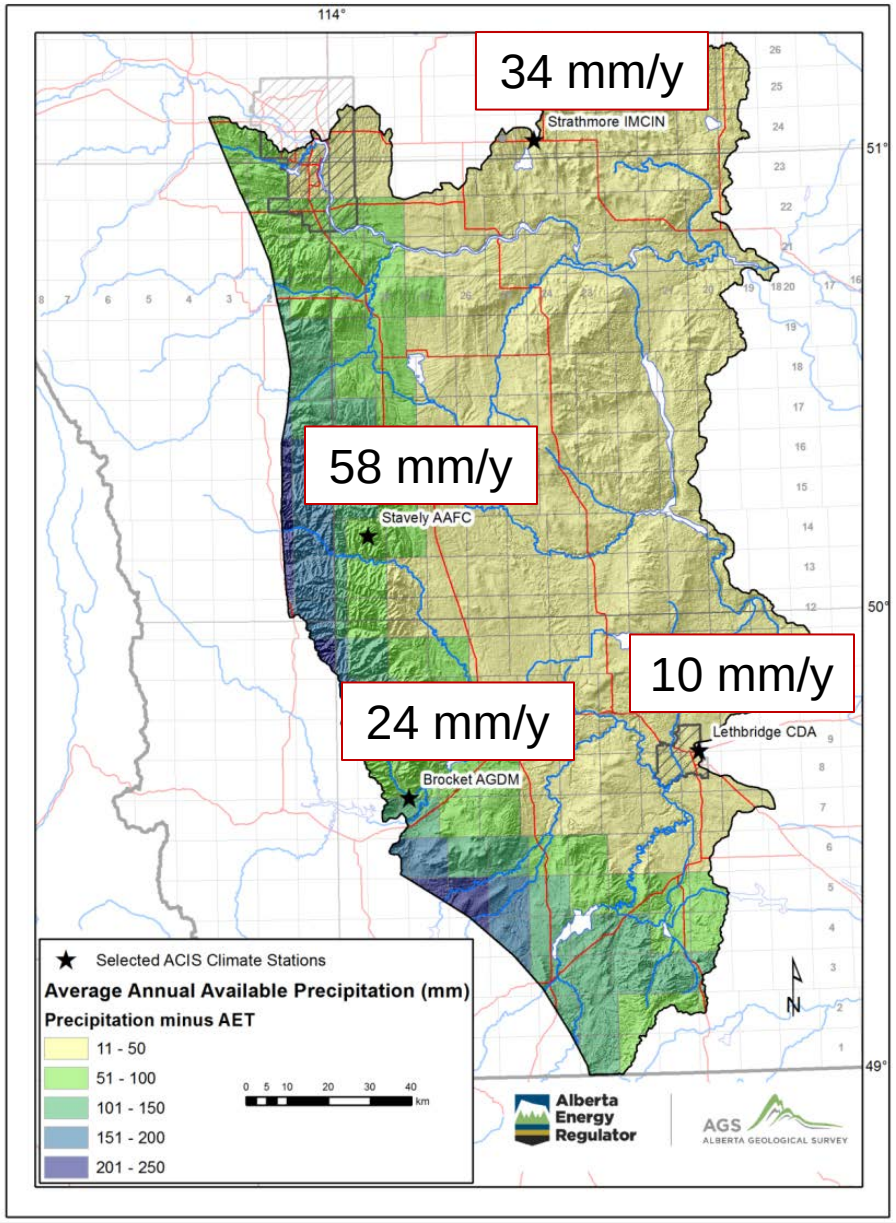
- 1D simulation of recharge
- Used in Canadian Prairies by ARD/ACIS and UofC
- Different simulations for different conditions
  - 2 soils (sandy loam/silty clay)
  - 2 vegetation (grass/wheat)
  - 3 ET routines
  - 4 weather stations



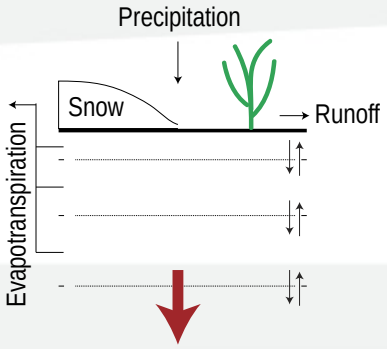
CLC Recharge

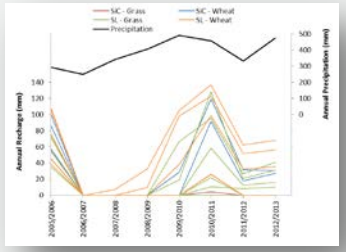
- Strong seasonal and annual variation
- Depression focused recharge important (UofC)

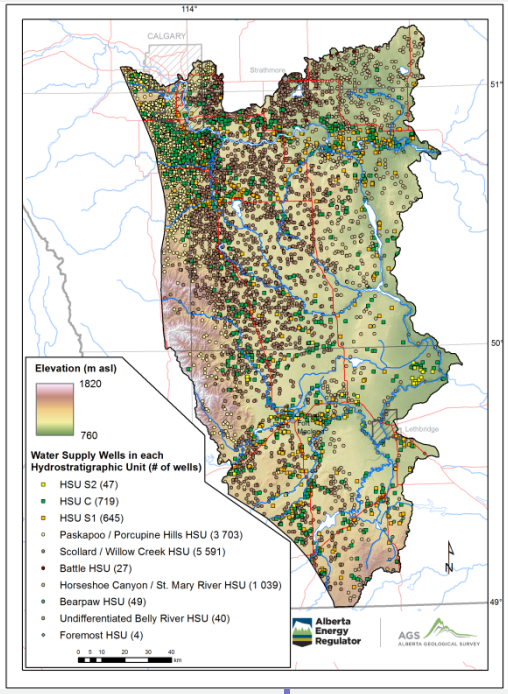


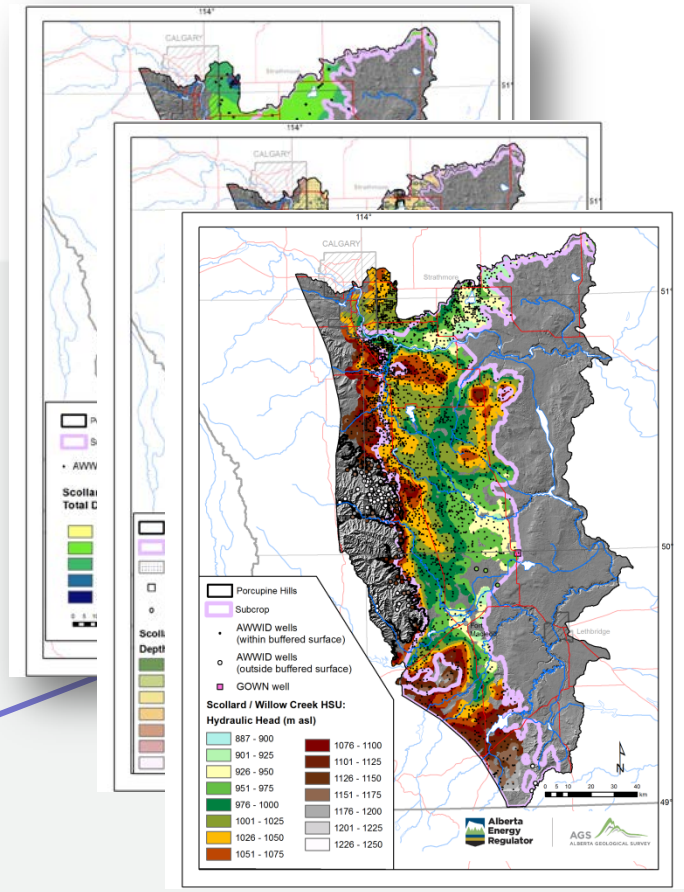


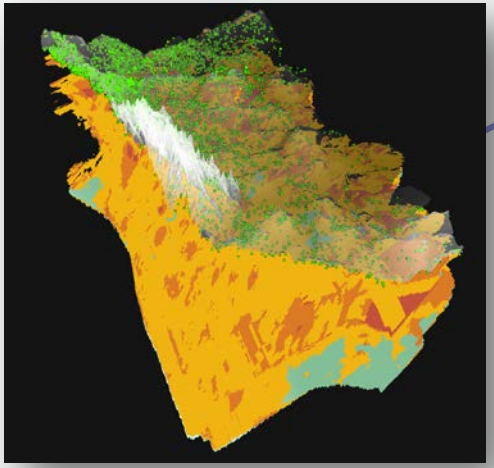
Hydrogeology

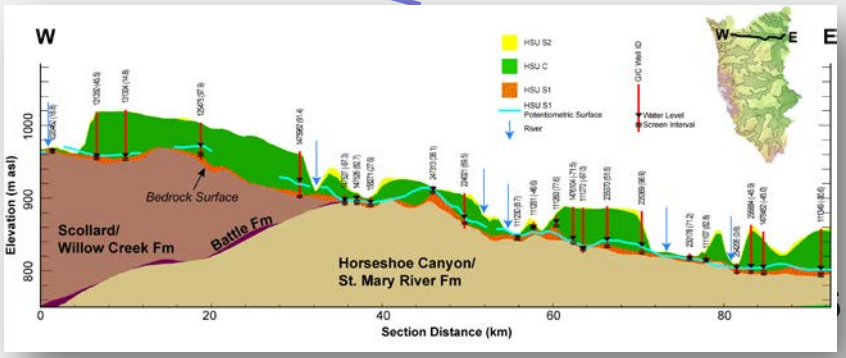




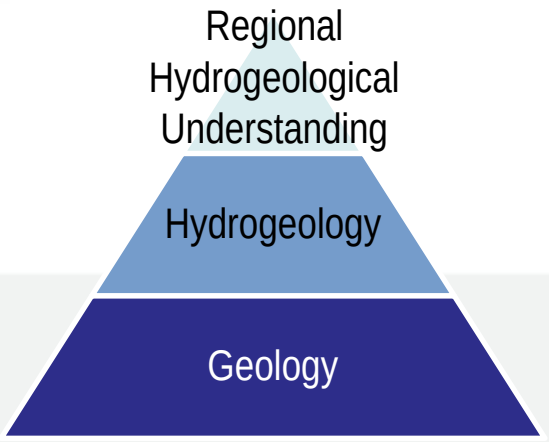




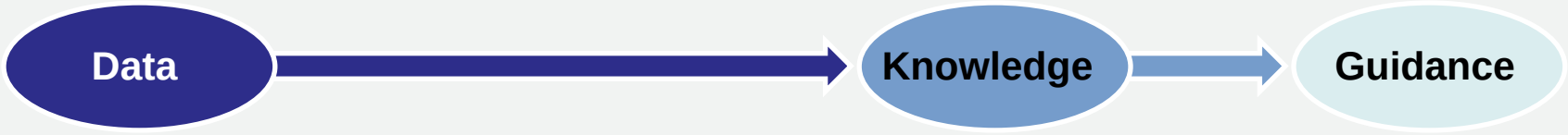




Summary



- Better understanding of regional hydrogeology
  - Helpful in defining formal aquifers and groundwater management units
  - Useful in mapping groundwater-surface water interaction
  - Identify gaps in groundwater monitoring network



- Geoscience supports groundwater management approach in the SSRP

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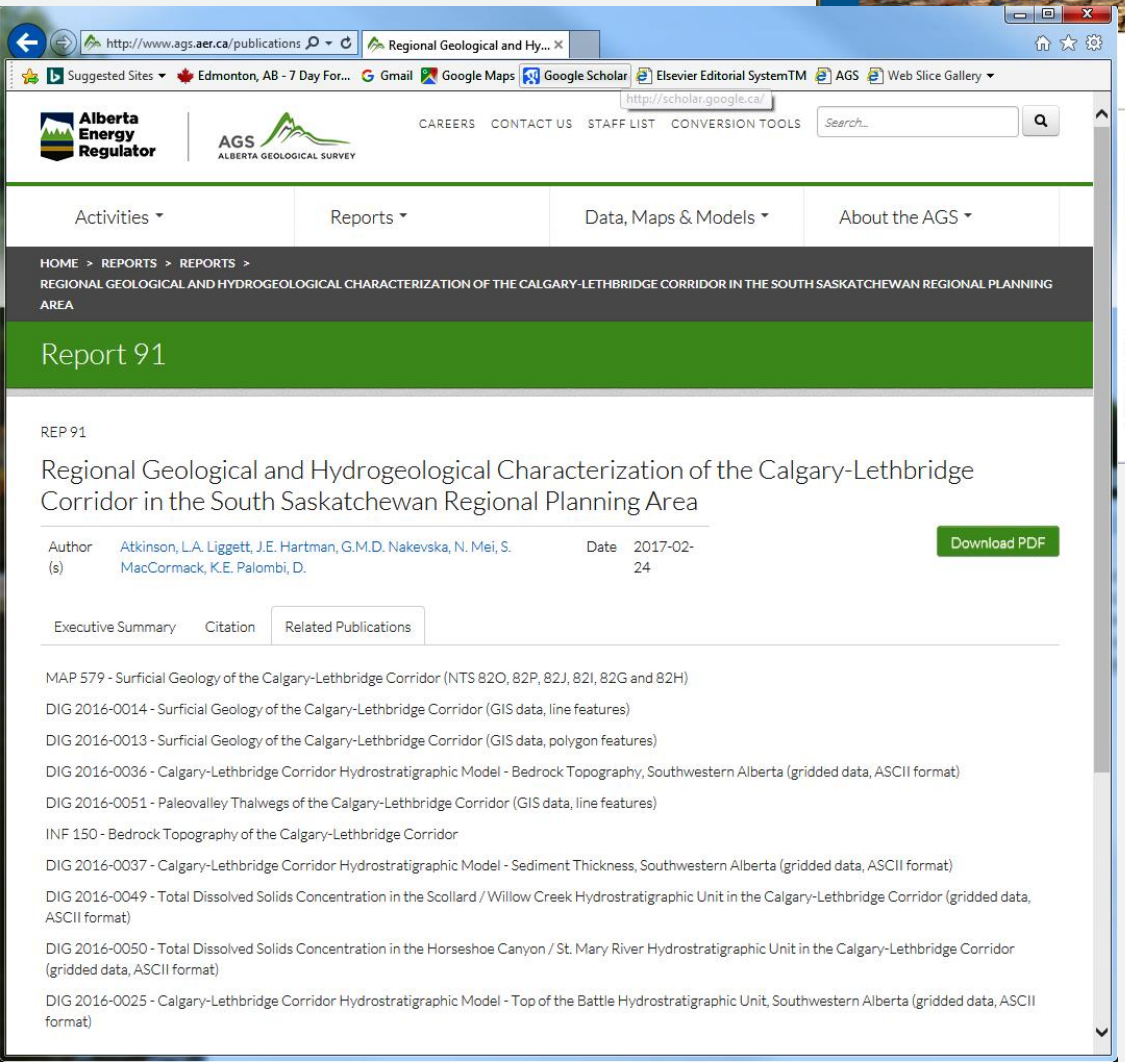

http://ags.aer.ca/

Report and digital data

- Geological surface
- Groundwater information

Questions?