



**WorleyParsons Komex**

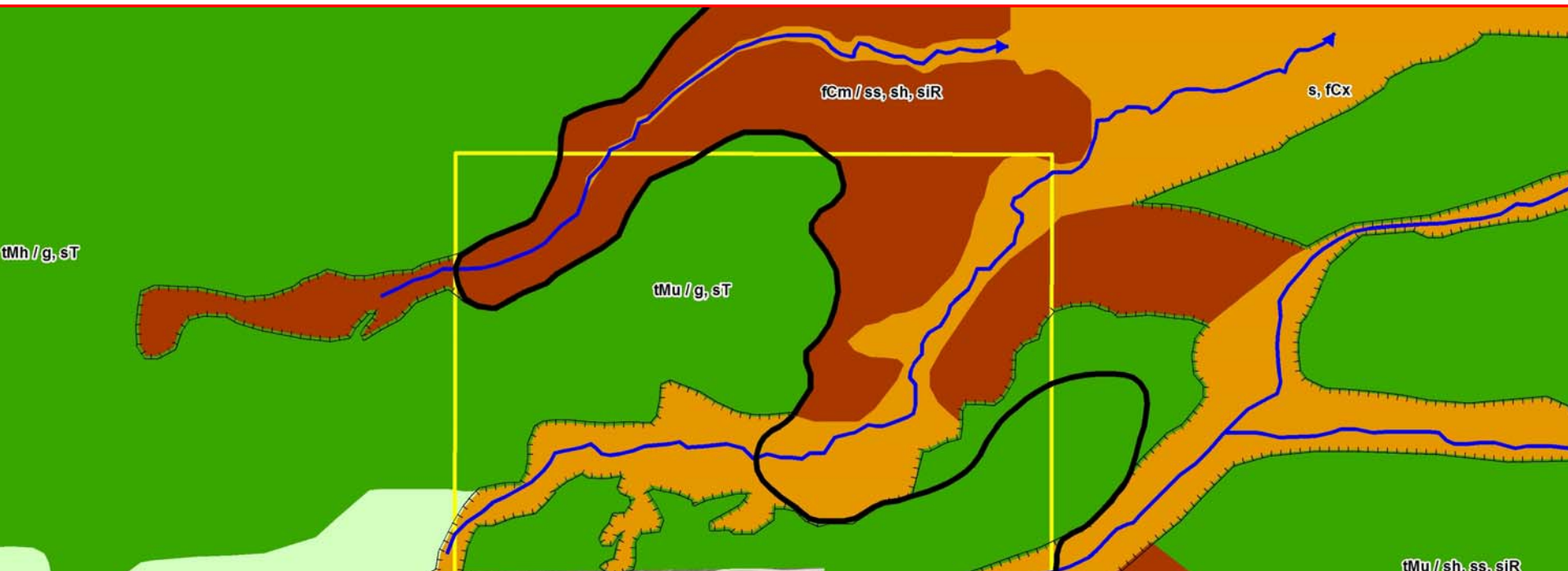
resources & energy



THE CITY OF  
**CALGARY**  
WASTE & RECYCLING SERVICES

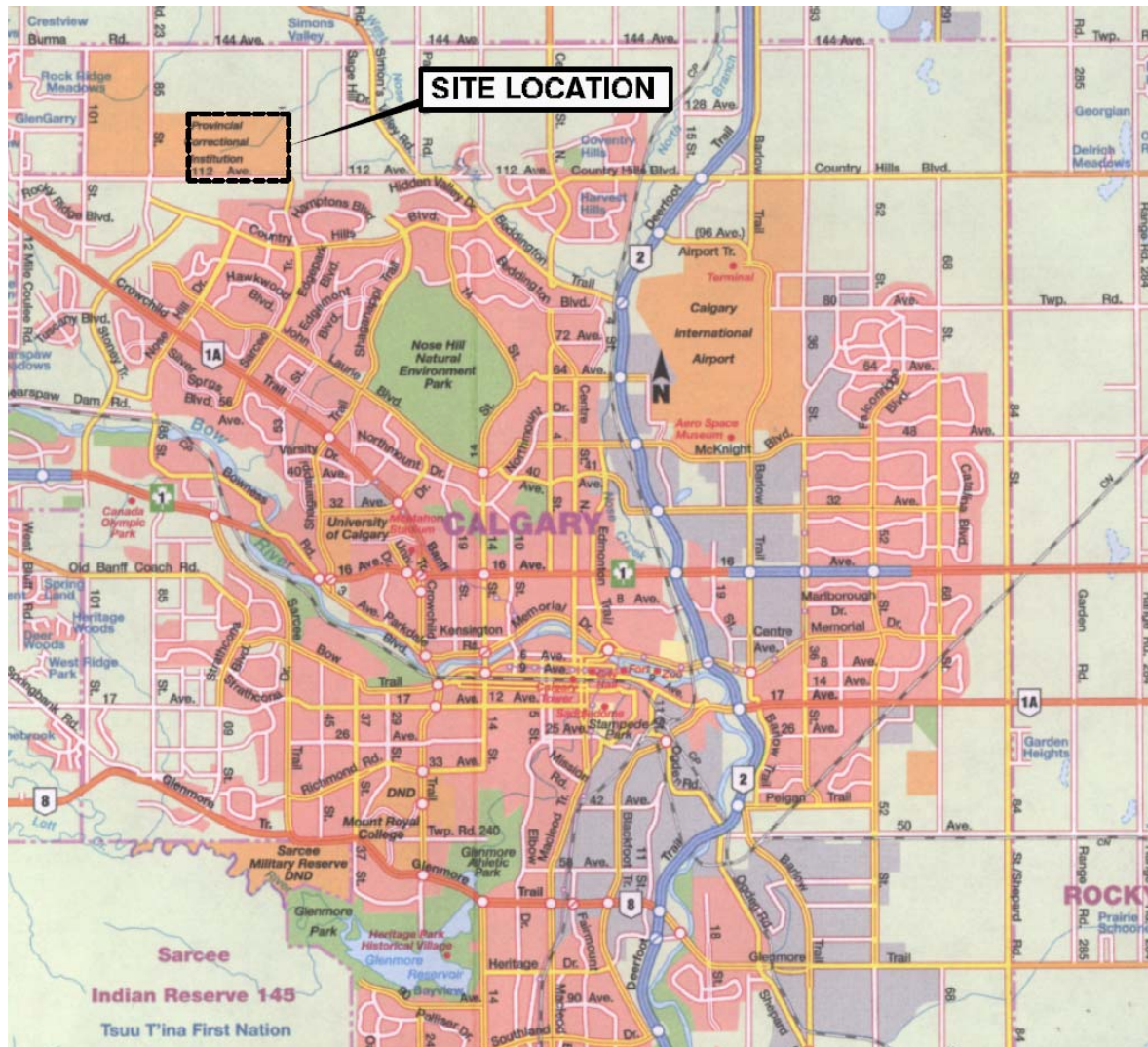
# The Geology and Hydrogeology of the Spyhill Area

Clare North (WorleyParsons Komex) and Martin Ortiz (The City of Calgary)

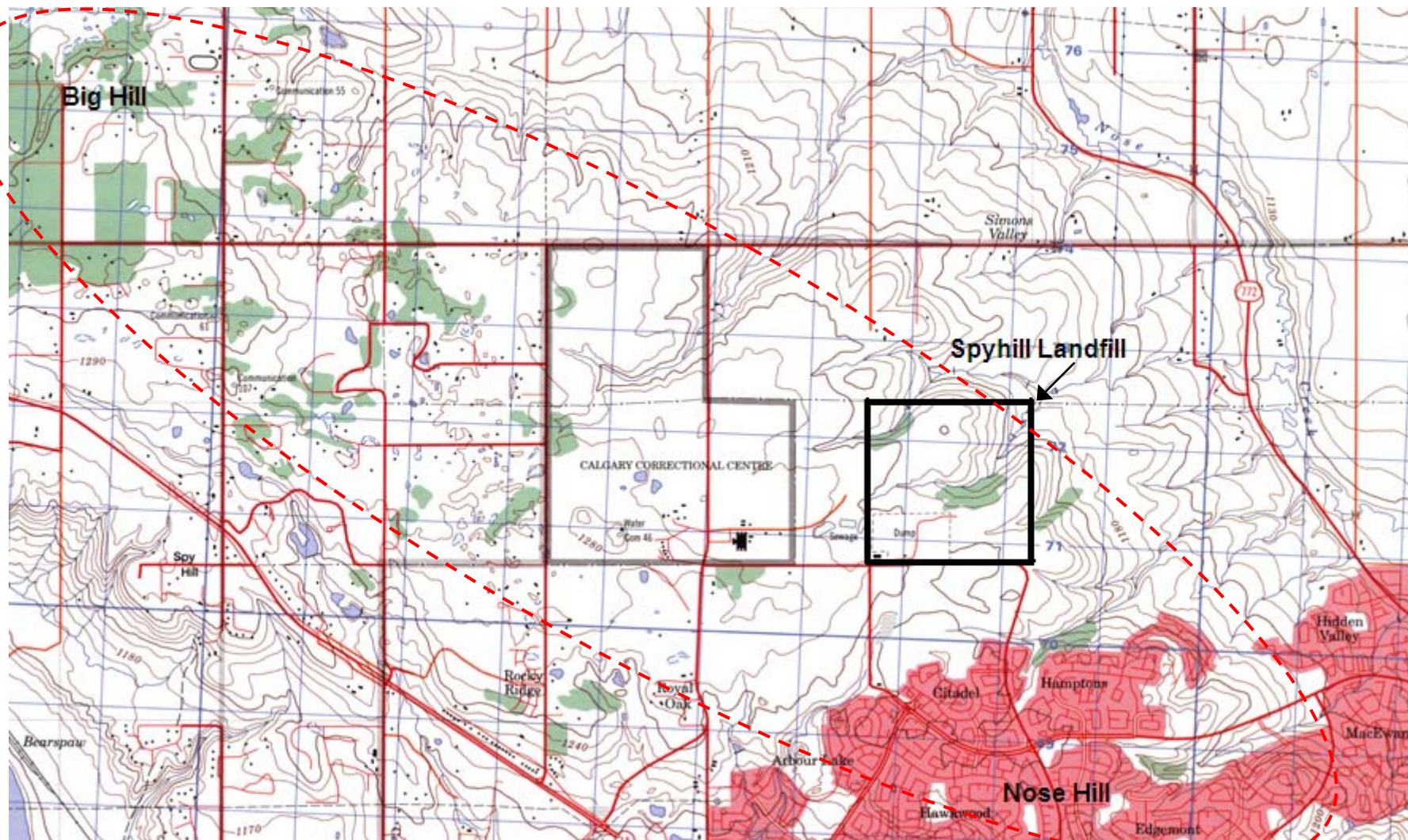




- ▶ Background
- ▶ Site Location
- ▶ Existing Information
- ▶ New Work
- ▶ Geology
- ▶ Hydrogeology
- ▶ Summary









### ► Published Information

- Moran (1986) identified 3 geologic units in the area:
  - Till (Quaternary Lochend and Upper Spyhill Formations)
  - Gravel (Tertiary Undivided layer)
  - Bedrock (Tertiary Porcupine Hills Formation)
- Distribution was approximate based on limited borehole data

### ► Landfill Reports

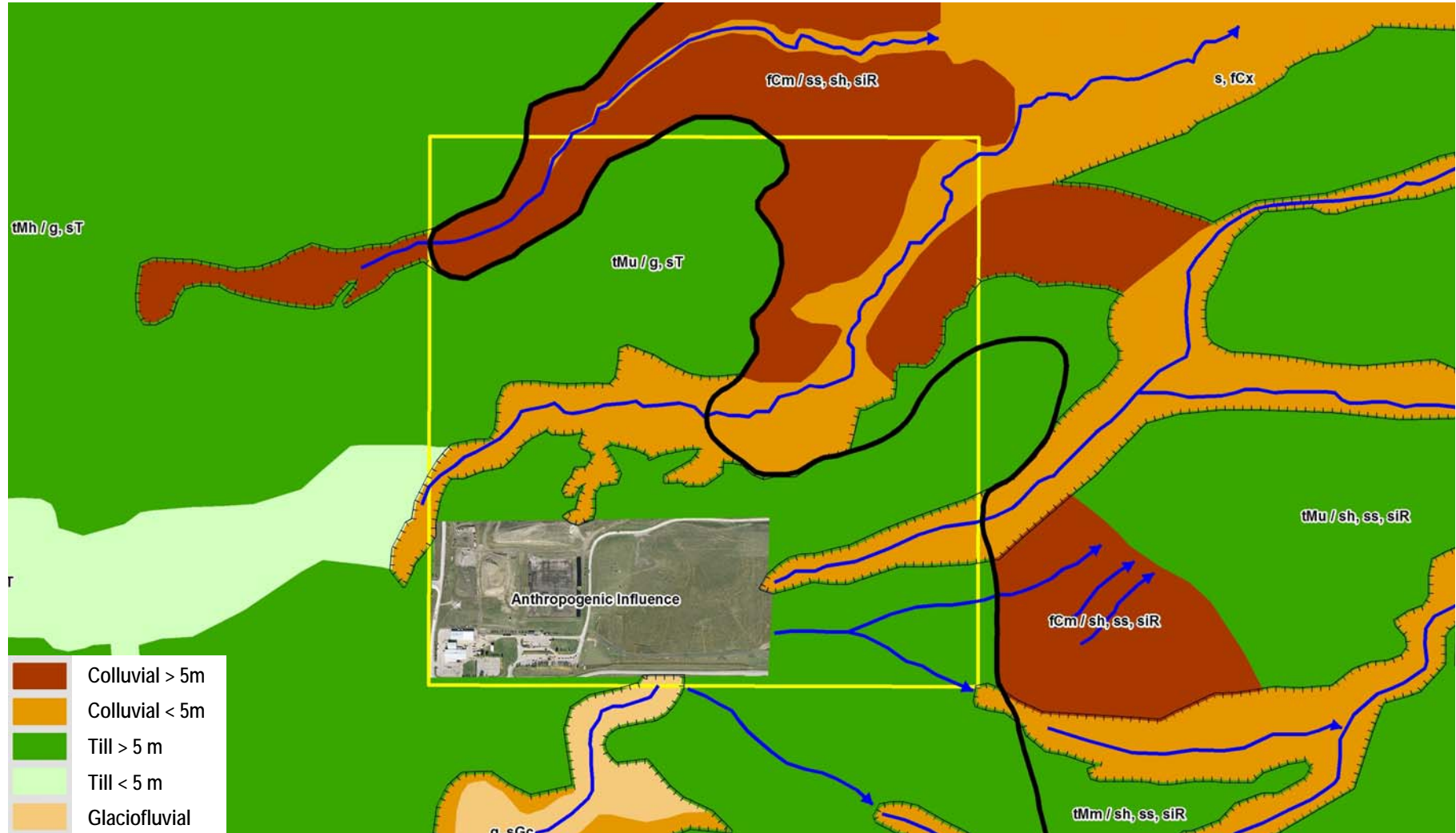
- Gravel mining feasibility reports
- Annual approval reports

### ► Anecdotal Information

- Several gravel pits in the area





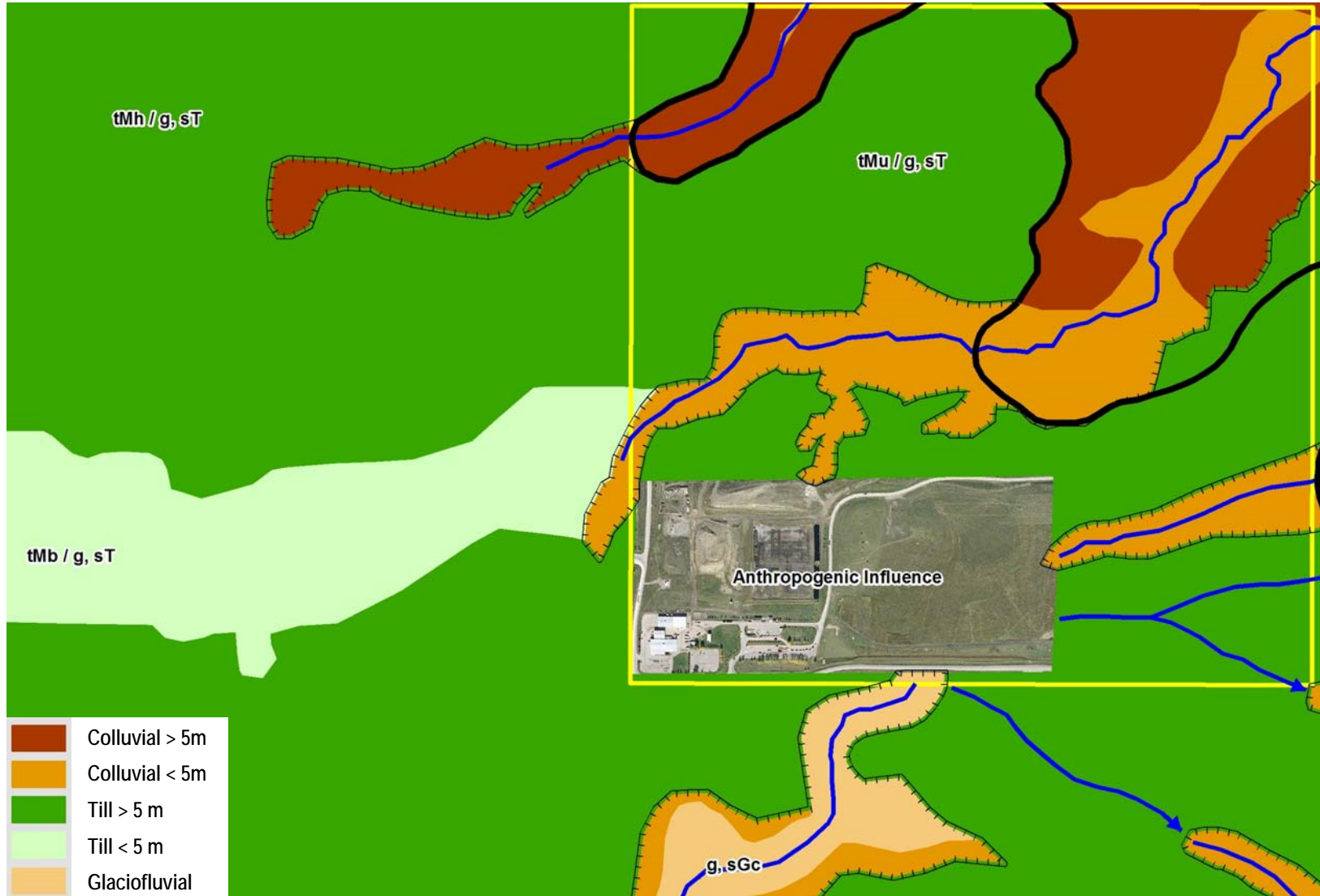


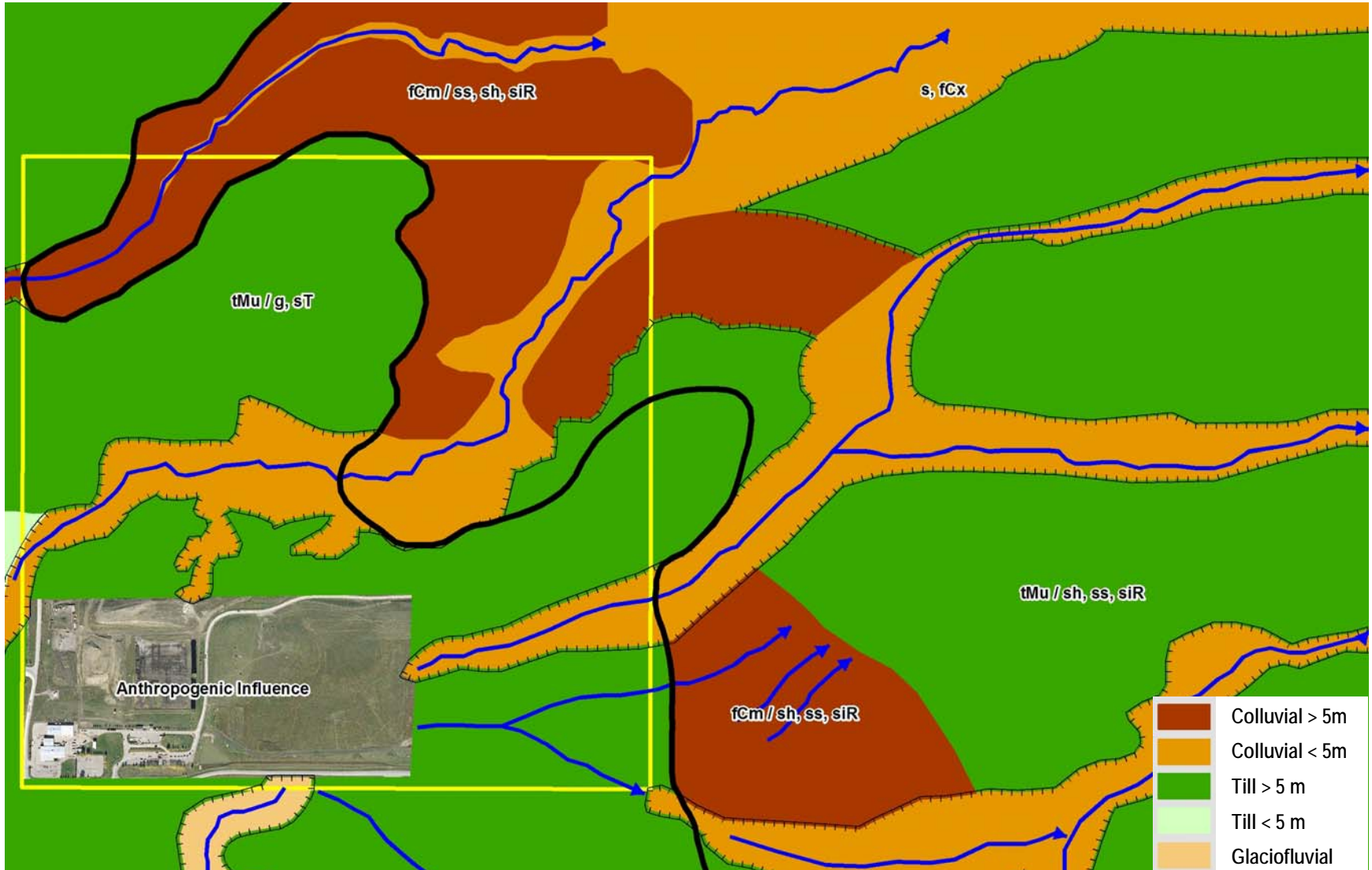


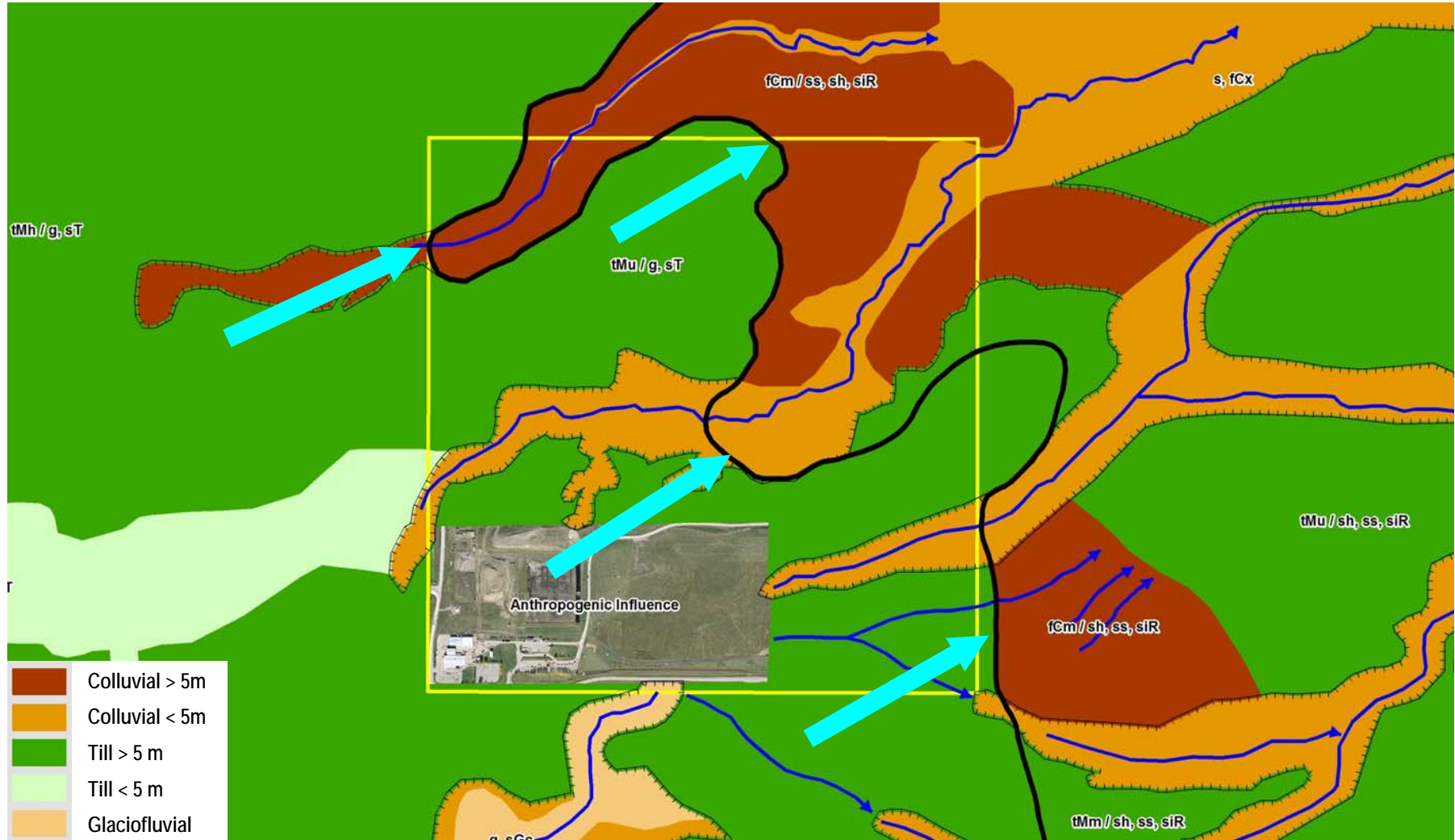
### ► Drilling

- Ground truth aerial photograph interpretation
- Challenging drilling due to highly variable geology
- Coring of three boreholes





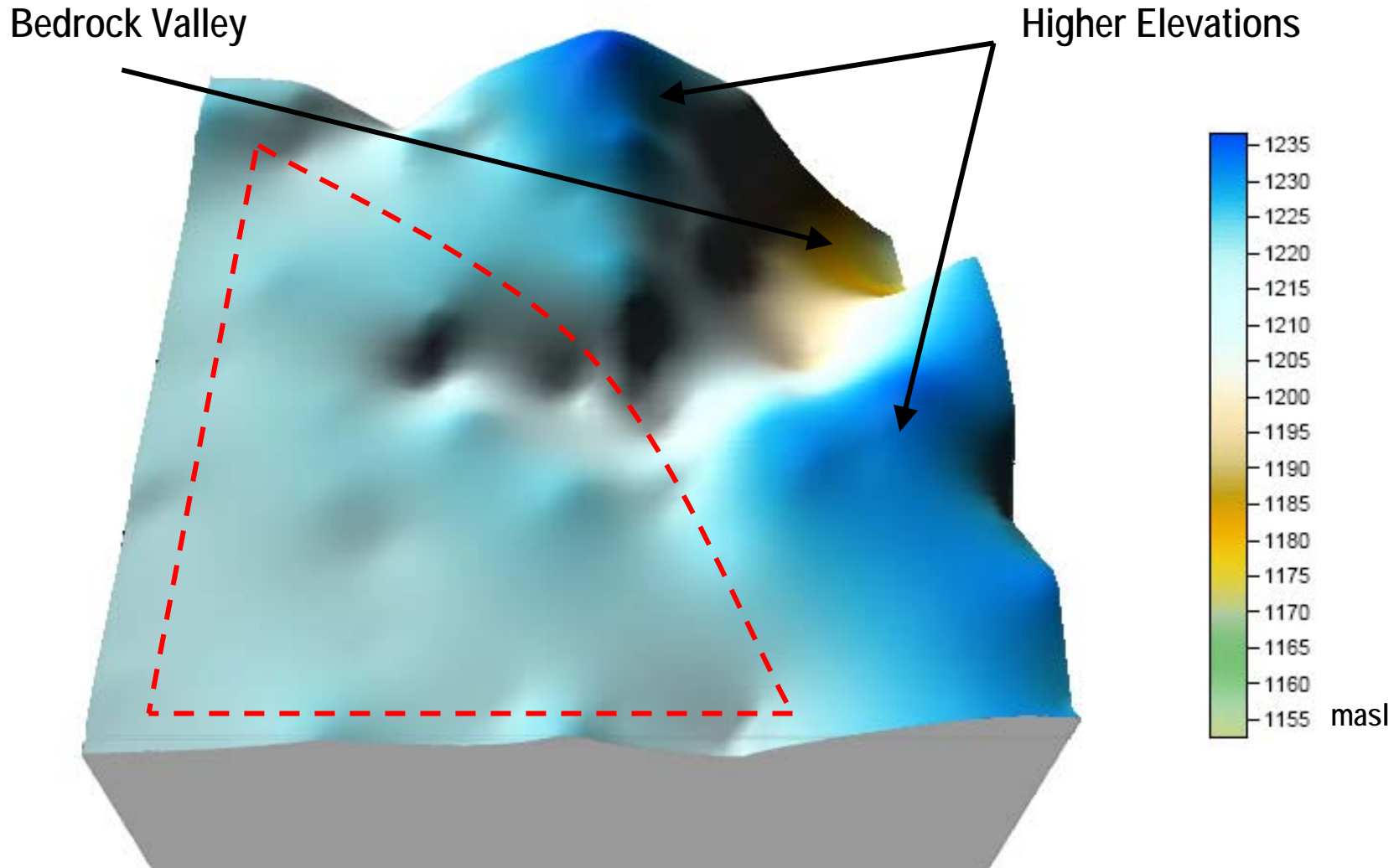








- ▶ Gravel Deposits - several cemented horizons identified
  - Cemented horizons tend to be thin ( $<0.5$  m) and discontinuous
  - One thicker ( $\sim 2$  m) and apparently continuous cemented horizon located 1225 - 1228 masl
  - Origin of cementation is unknown





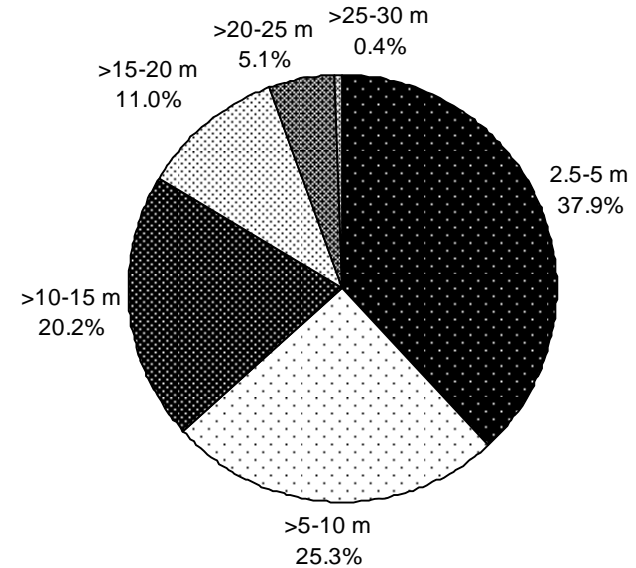
- ▶ Interbedded mudstones, siltstones and sandstones
- ▶ Sandstone units rare and typically thin (< 2 m)



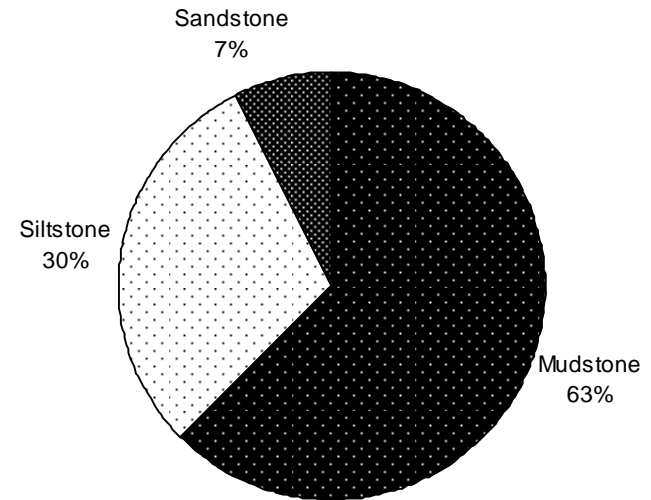




### Proportional Distribution of Fractures with Depth below Bedrock Surface



### Proportional Distribution of Fractures by Lithology

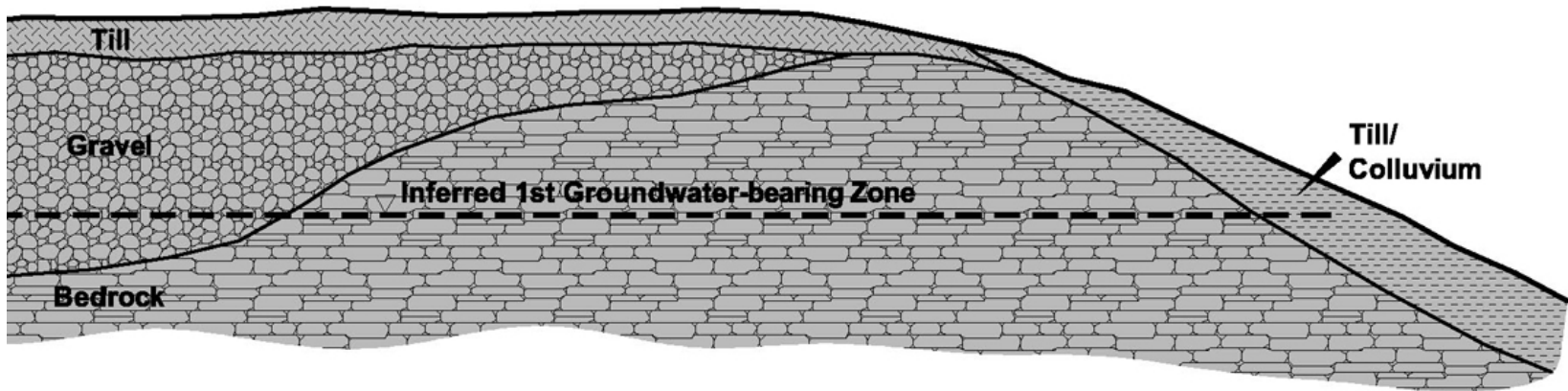




### ► Groundwater bearing zones

- 3 main groundwater bearing zones identified based on:
  - Elevation of installation
  - Groundwater levels
  - Hydrochemistry
- Perched groundwater in some areas

### ► Occurrence

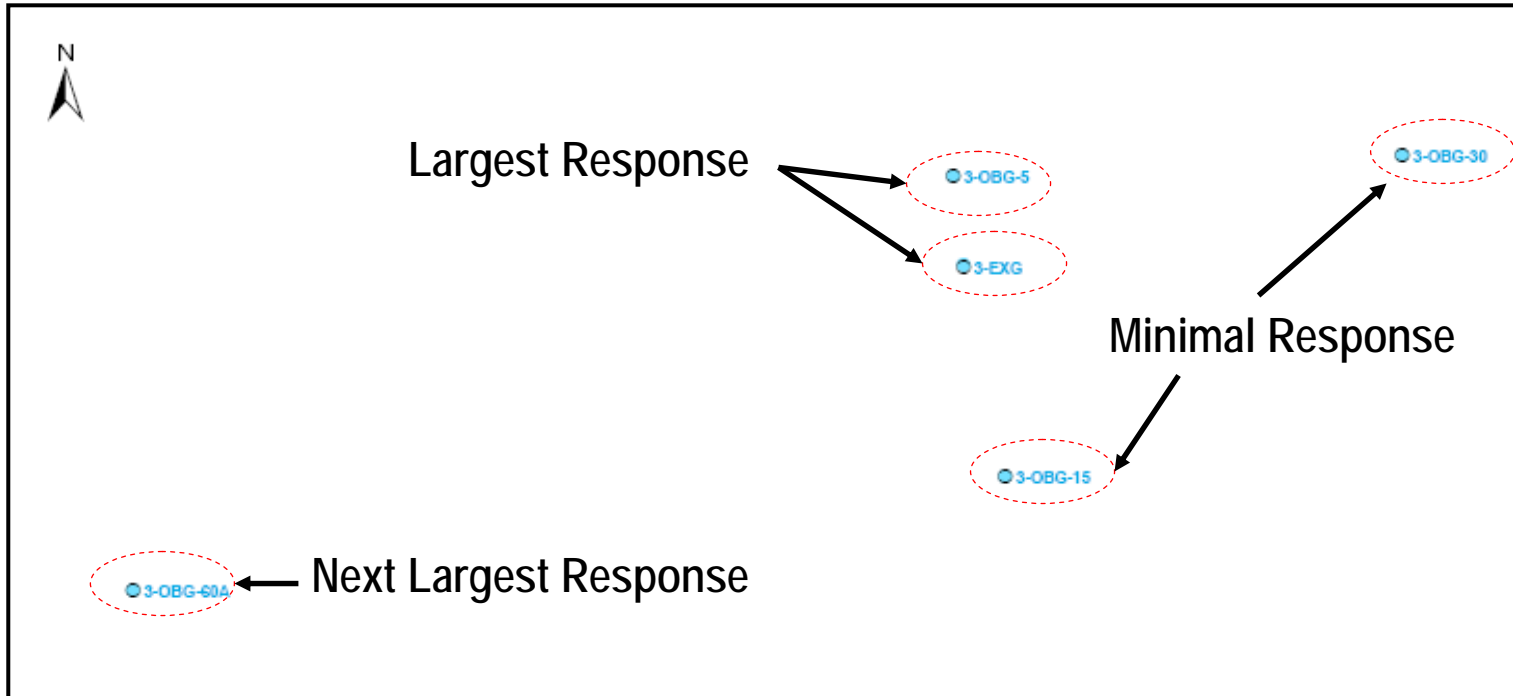


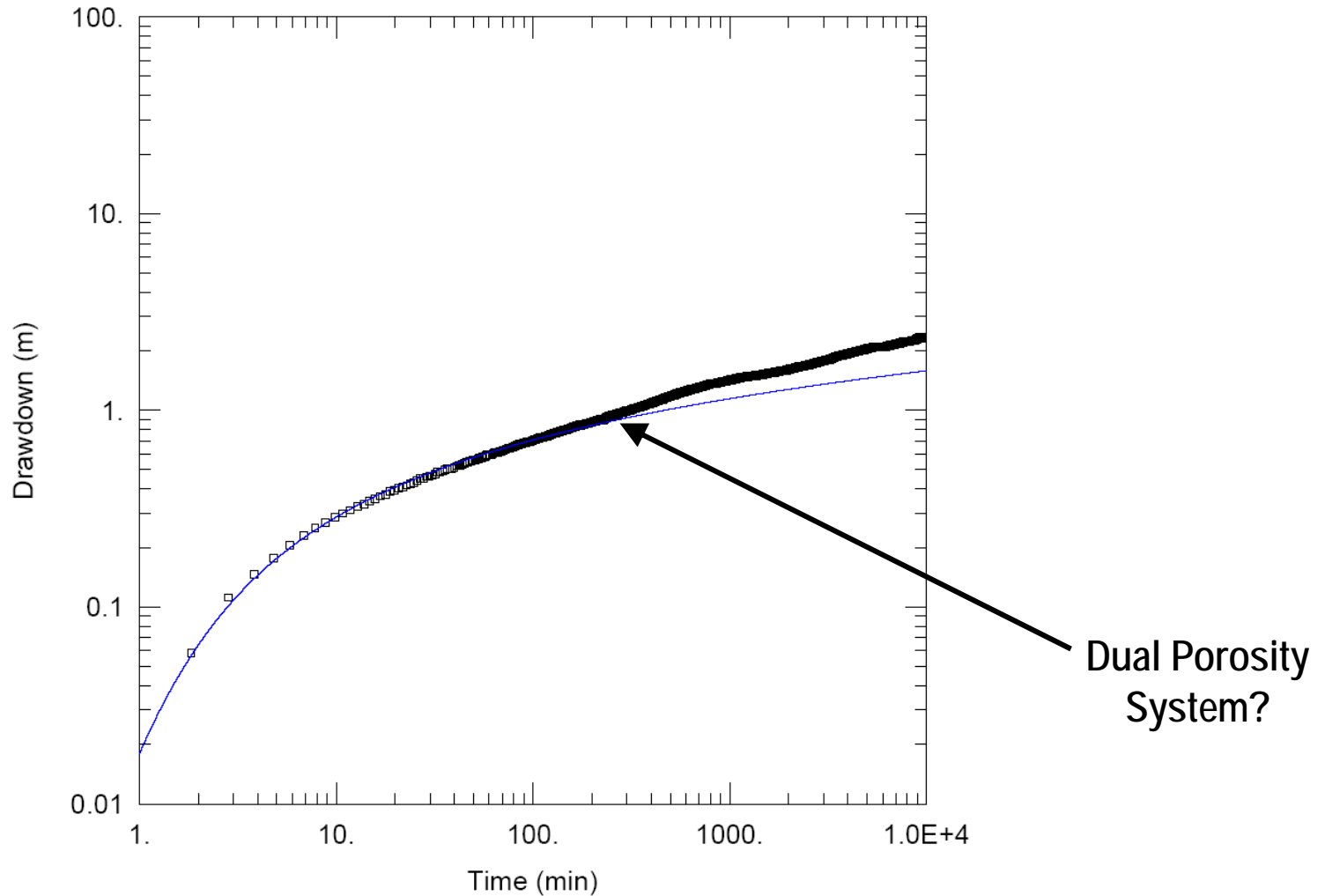
- ▶ Potential for groundwater/surface water interaction
- ▶ Highly variable aquifer properties
- ▶ Groundwater flow generally toward the northeast
- ▶ Calcium bicarbonate hydrochemical water type





- ▶ Exclusively in bedrock
- ▶ Calcium magnesium bicarbonate and sodium bicarbonate hydrochemical water types
- ▶ Generally some degree of hydraulic connection with 1<sup>st</sup> GWBZ based on vertical gradients ~ 0 to 0.5
- ▶ Groundwater flow toward the northeast
- ▶ Aquifer test was undertaken to evaluate hydrogeologic properties









- ▶ Found deeper in bedrock (~50 mbgs)
- ▶ Groundwater flow toward east or northeast
- ▶ Sodium bicarbonate hydrochemical water type
- ▶ Single well hydraulic conductivities < 2<sup>nd</sup> GWBZ
- ▶ Generally hydraulically isolated from 2<sup>nd</sup> GWBZ based on vertical gradients > 1 at nested locations



- ▶ Identified based on anomalous groundwater levels and vertical gradients  $>1$  at nested locations
- ▶ Perched water identified above cemented layer in gravel at some locations



- ▶ Large area with variable topography and geology
- ▶ Aerial photograph interpretation was a useful tool
- ▶ Distribution of surficial deposits partially dictated by topography
- ▶ Drilling confirmed much of the aerial photograph interpretation
- ▶ Drilling was challenging



- ▶ 3 main GWBZs identified
  - ▶ Complex 1<sup>st</sup> GWBZ
  - ▶ 2<sup>nd</sup> GWBZ flow influenced by fractures
  - ▶ Flow generally toward northeast in all 3 zones
  - ▶ Perched water above cemented layer
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- ▶ Development of a reliable conceptual model required compilation of data from several parts of the investigation