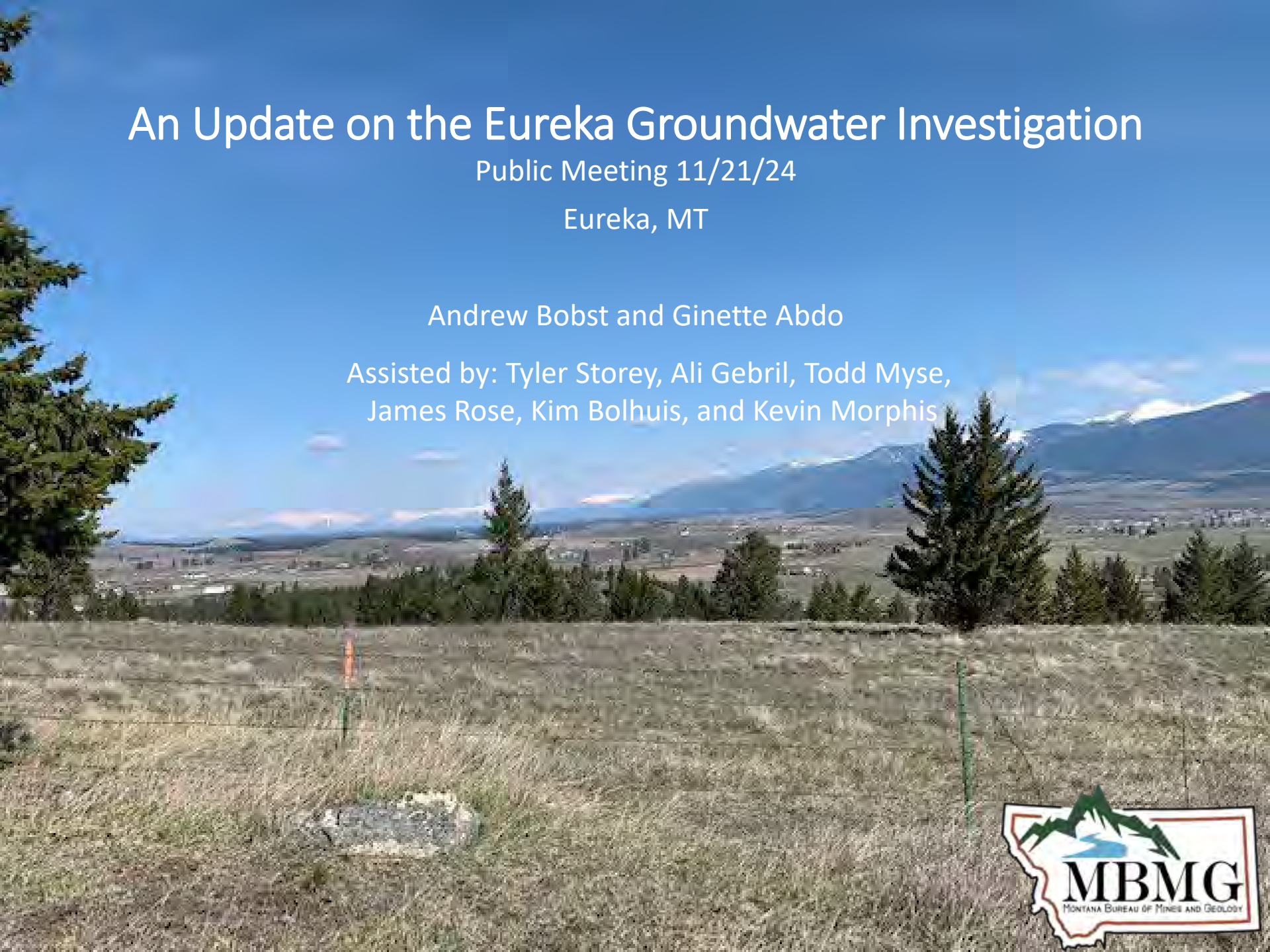
An Update on the Eureka Groundwater Investigation

Public Meeting 11/21/24

Eureka, MT

Andrew Bobst and Ginette Abdo

Assisted by: Tyler Storey, Ali Gebril, Todd Myse, James Rose, Kim Bolhuis, and Kevin Morphis



Montana Bureau of Mines and Geology

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- **Established in 1919 to provide reliable and unbiased earth science information**
- **Non regulatory, applied research**

Geology

- ✓ Geologic Mapping
- ✓ Geohazards/Earthquake Studies
- ✓ Economic Geology
- ✓ Energy Resources

Water Resources

- ✓ Ground Water Assessment Program
- ✓ Ground Water Investigation Program
- ✓ State-wide groundwater monitoring network

https://www.mbmg.mtech.edu/

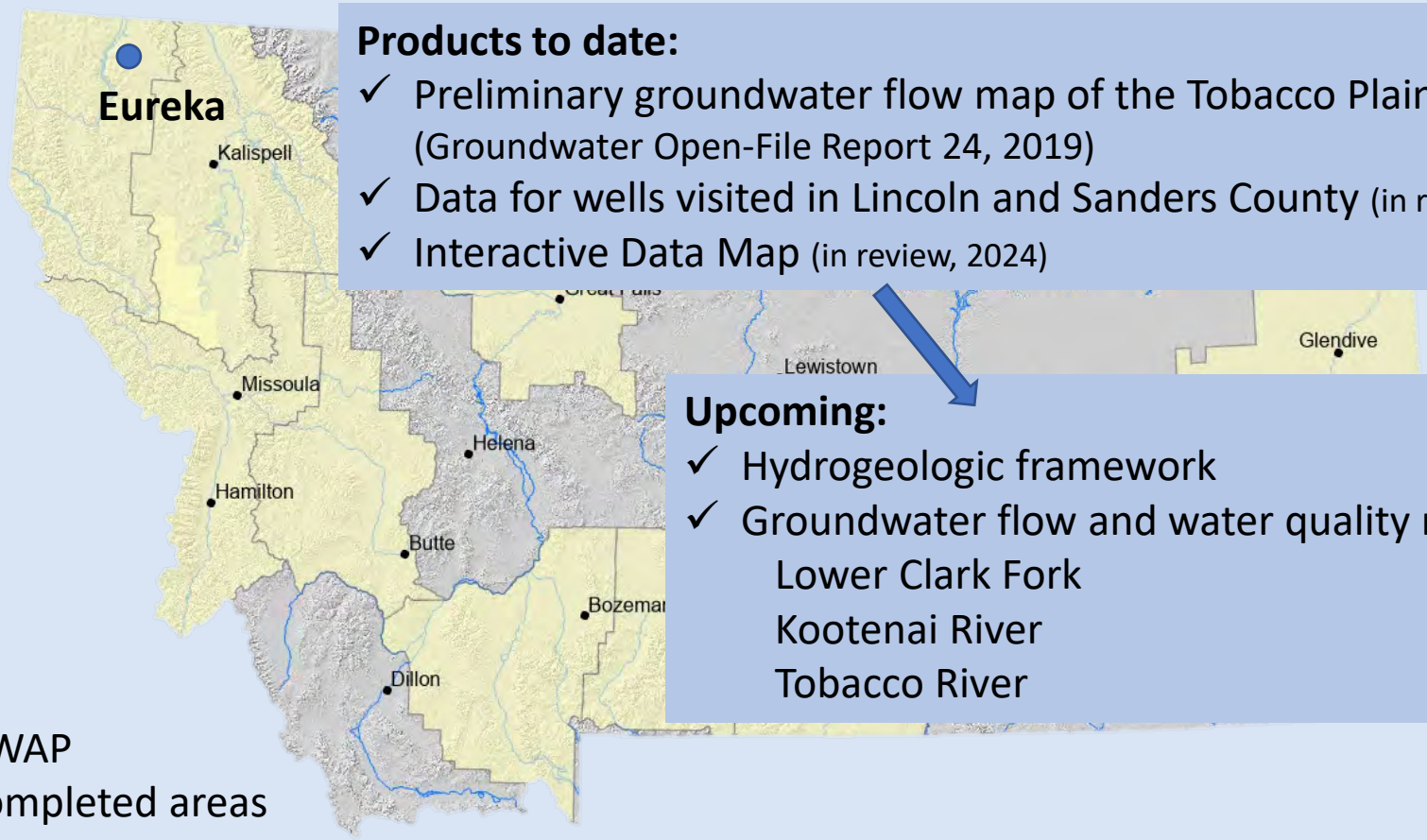



Ground Water Assessment Program (GWAP)

GWAP
Completed areas

- ✓ Provides basic information about aquifers within areas as prioritized by the Ground Water Assessment Steering Committee
- ✓ Regional scale
- ✓ Well inventories, groundwater levels and chemistry, aquifer framework
- ✓ State-wide long-term groundwater monitoring network

Ground Water Assessment Program (GWAP)



Products to date:

- ✓ Preliminary groundwater flow map of the Tobacco Plain (Groundwater Open-File Report 24, 2019)
- ✓ Data for wells visited in Lincoln and Sanders County (in review, 2024)
- ✓ Interactive Data Map (in review, 2024)

Upcoming:

- ✓ Hydrogeologic framework
- ✓ Groundwater flow and water quality map areas:
  - Lower Clark Fork
  - Kootenai River
  - Tobacco River

GWAP Completed areas

- ✓ Provides basic information about aquifers within areas as prioritized by the Ground Water Assessment Steering Committee
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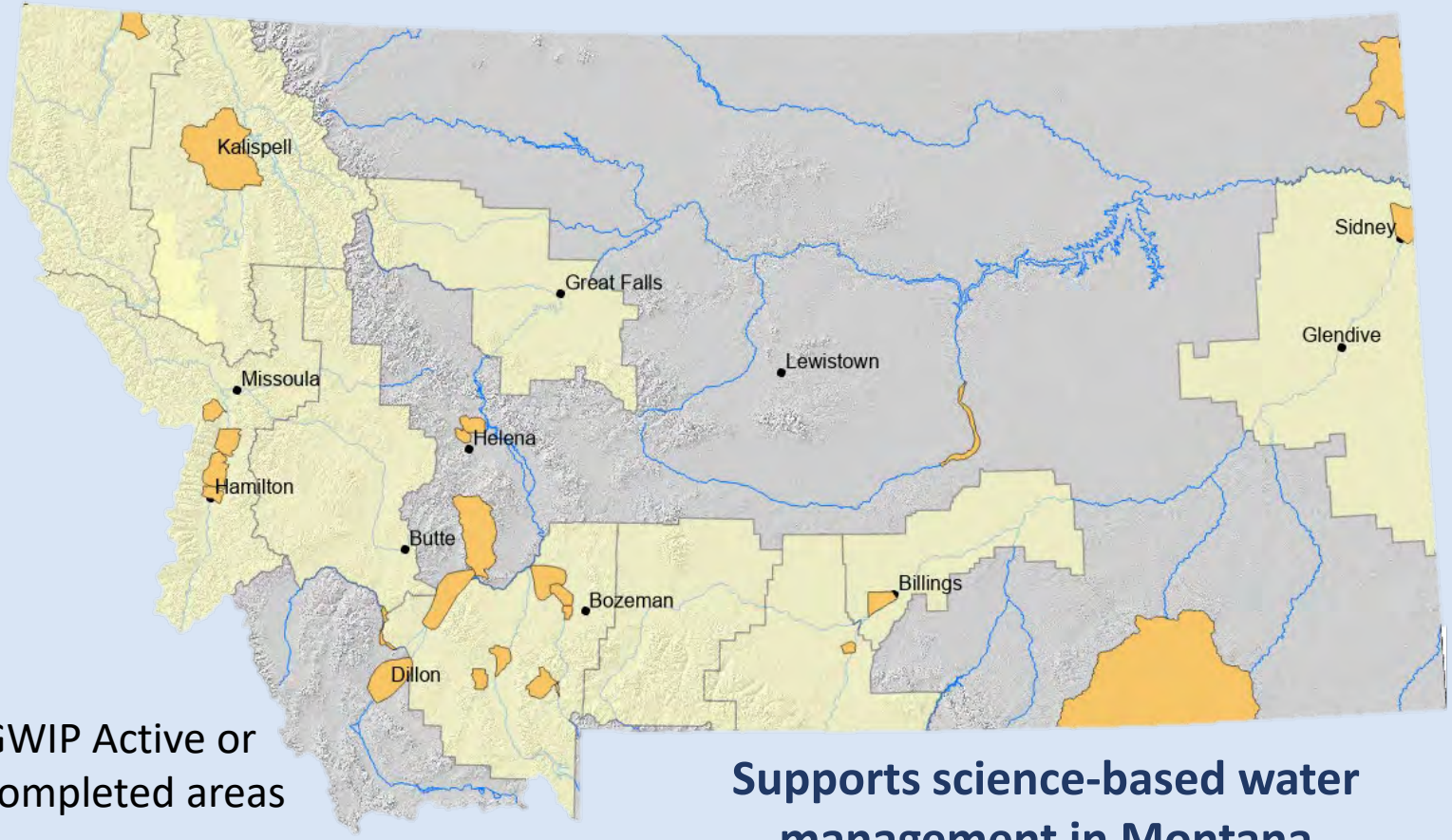
Ground Water Investigation Program (GWIP)

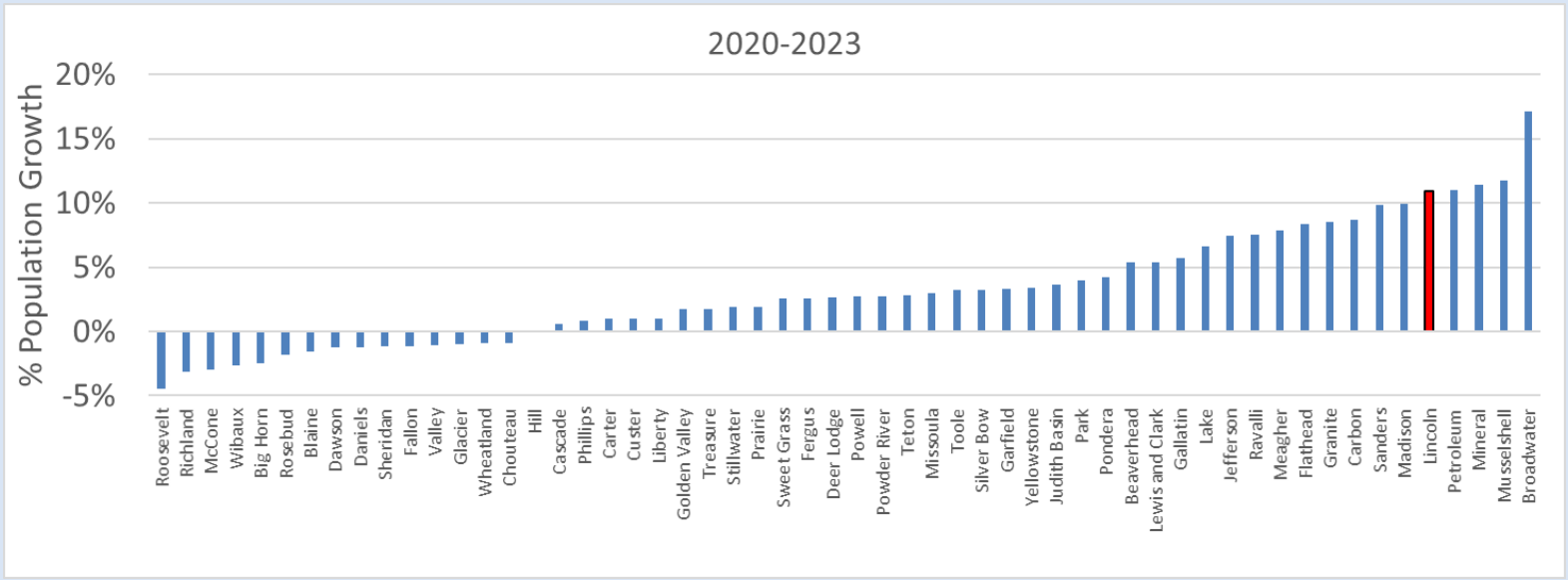


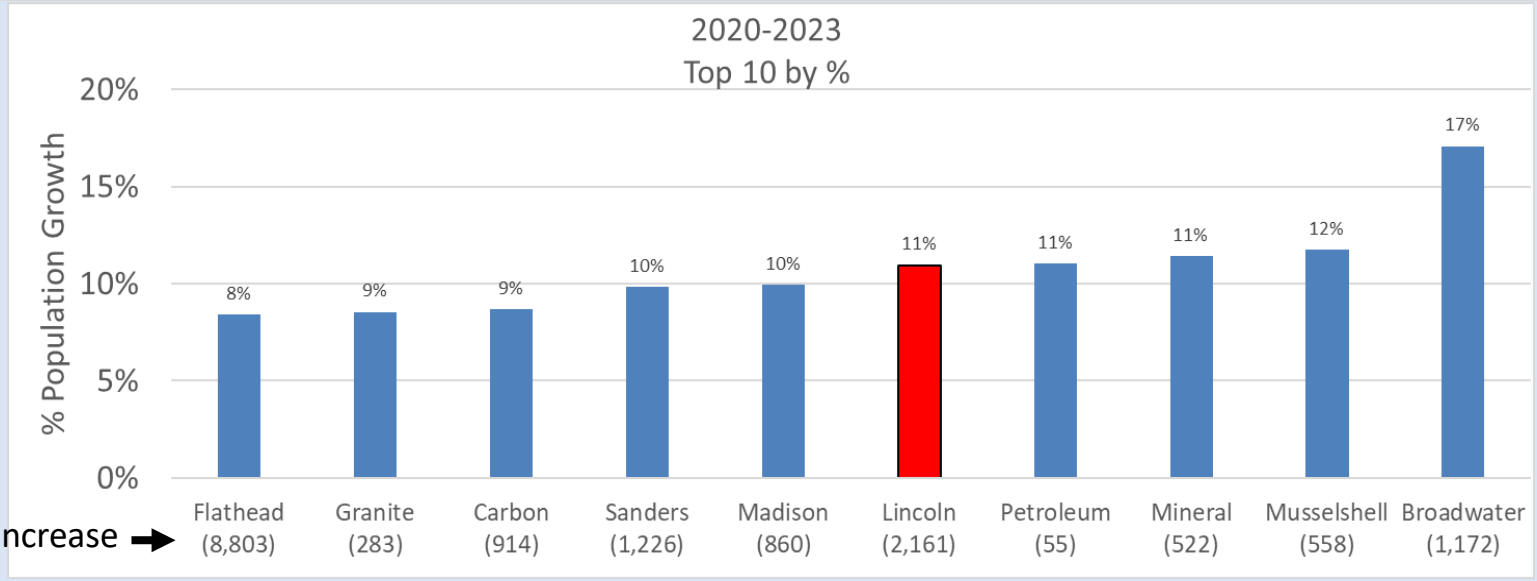
GWIP Active or completed areas

Supports science-based water management in Montana

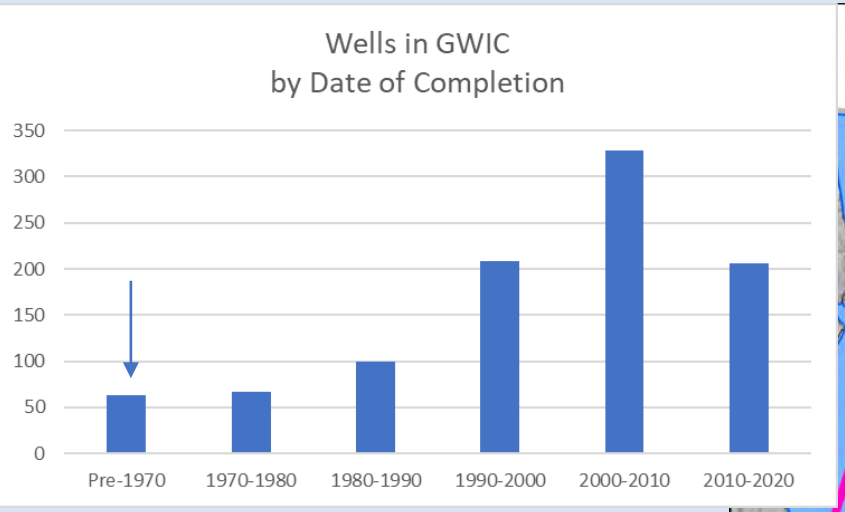
- ✓ Answers site-specific water resource questions
- ✓ Collect detail information… groundwater and surface-water monitoring, well drilling, aquifer testing, develop water budgets, water quality
- ✓ Construct groundwater flow models

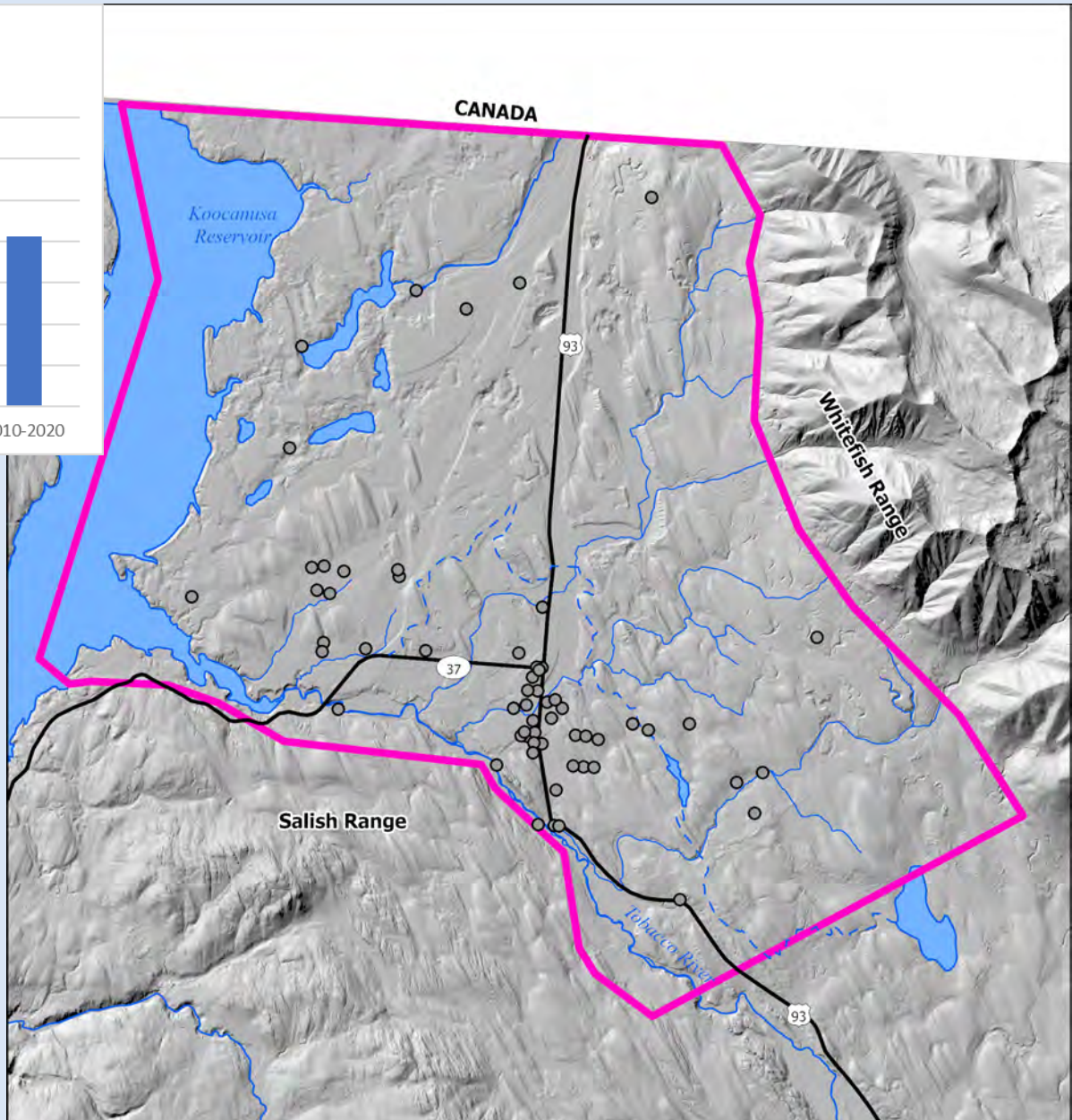
Background – Population Growth



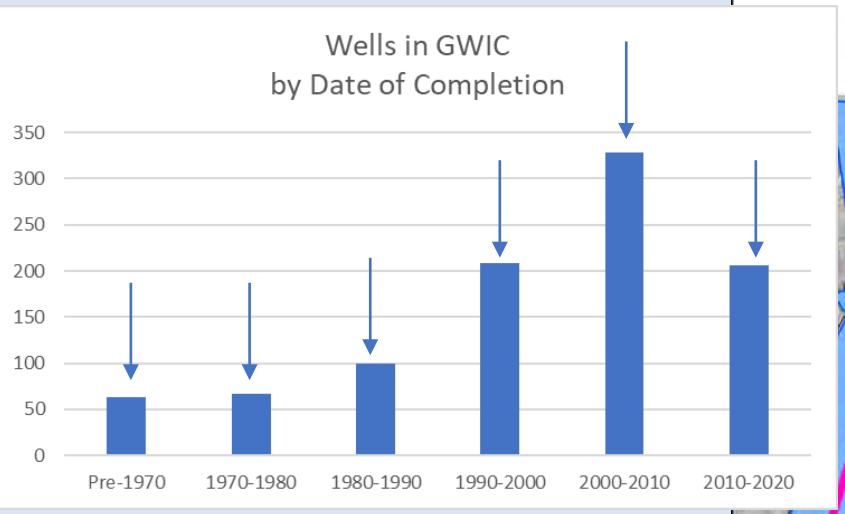


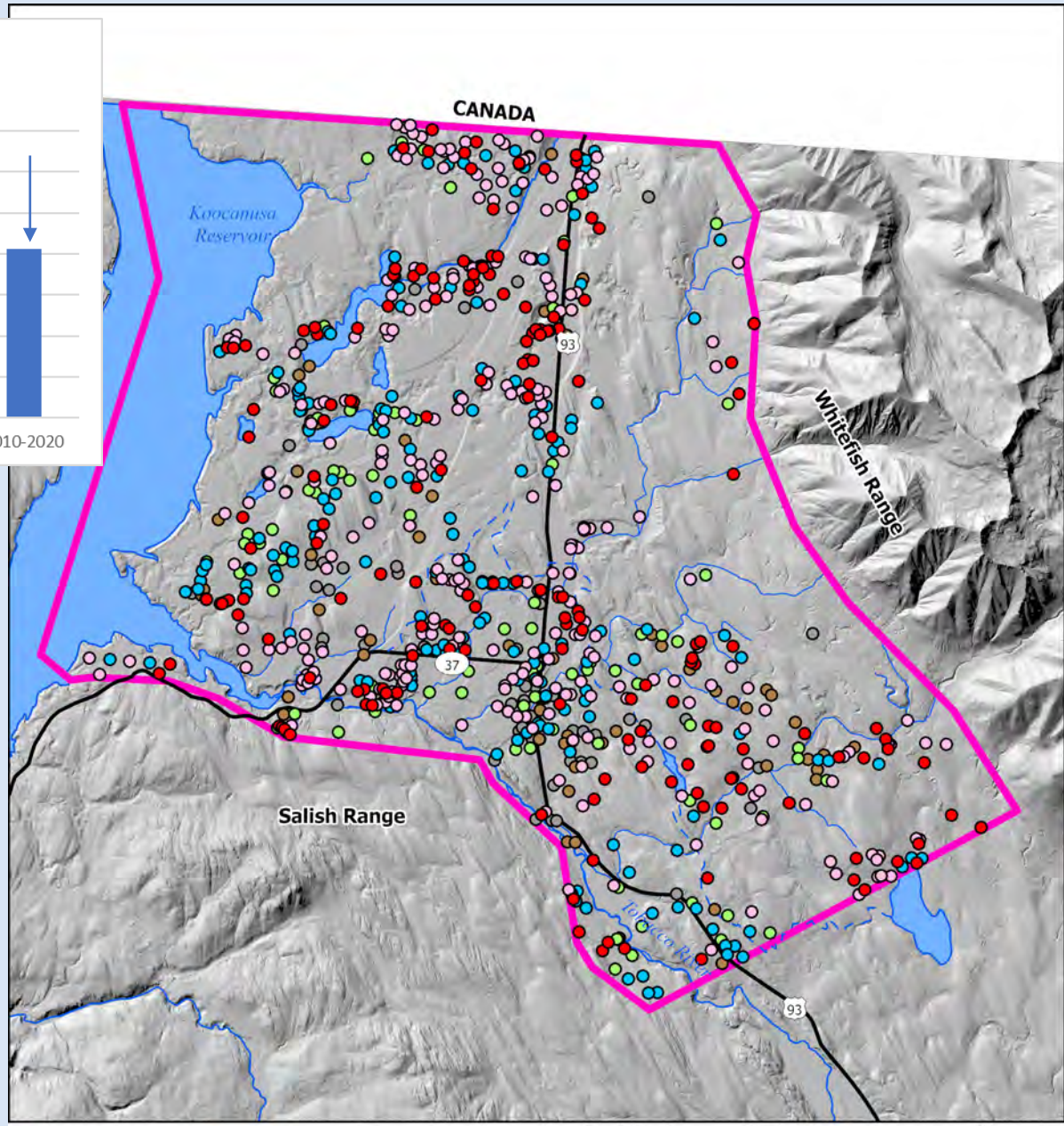
Background – Groundwater Development





Background – Groundwater Development





Background – Water-Rights Administration

Tobacco River	Kootenai River (Koocanusa Reservoir)
Existing legal demands (water rights) exceed physical supply in the months of January, February, June, July, September and December.	Physical supply exceeds existing legal demands in all months.
Water right applications resulting in new or altered net depletions/return flows to the Tobacco River may require a mitigation or aquifer recharge plan.	Water right applications do not require a mitigation or aquifer recharge plan.

Study Purpose

- Provide an understanding of the area's hydrogeology
  - Complex Glacial Geology

- Understand effects of groundwater development in different areas on groundwater and surface-water availability

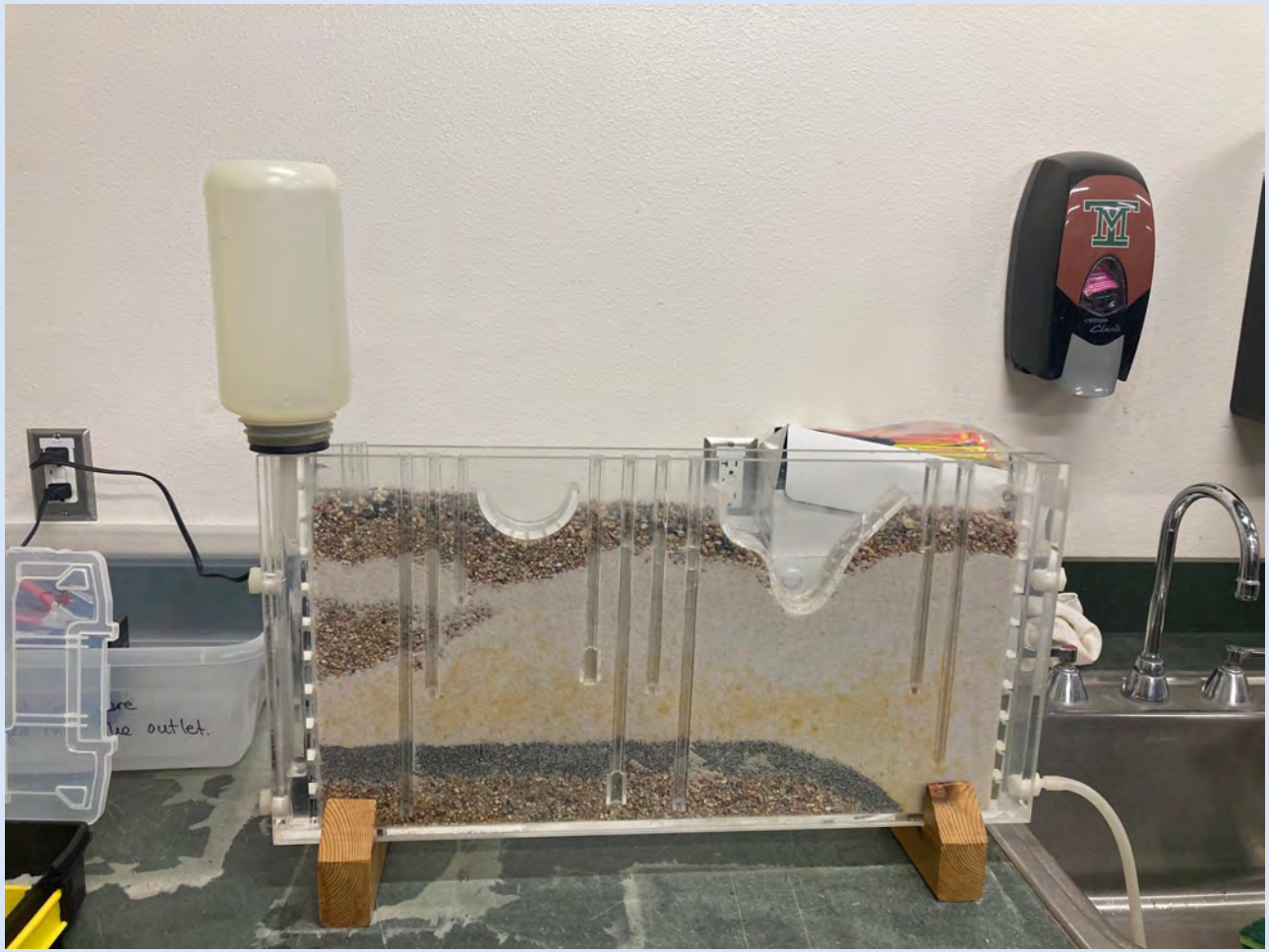
- Develop a water management tool to allow screening the likely location and timing of surface-water depletions from a new groundwater development.

Objective – Develop Groundwater Model

- Understand the 3D distribution of Geologic Units and their aquifer properties (static properties)

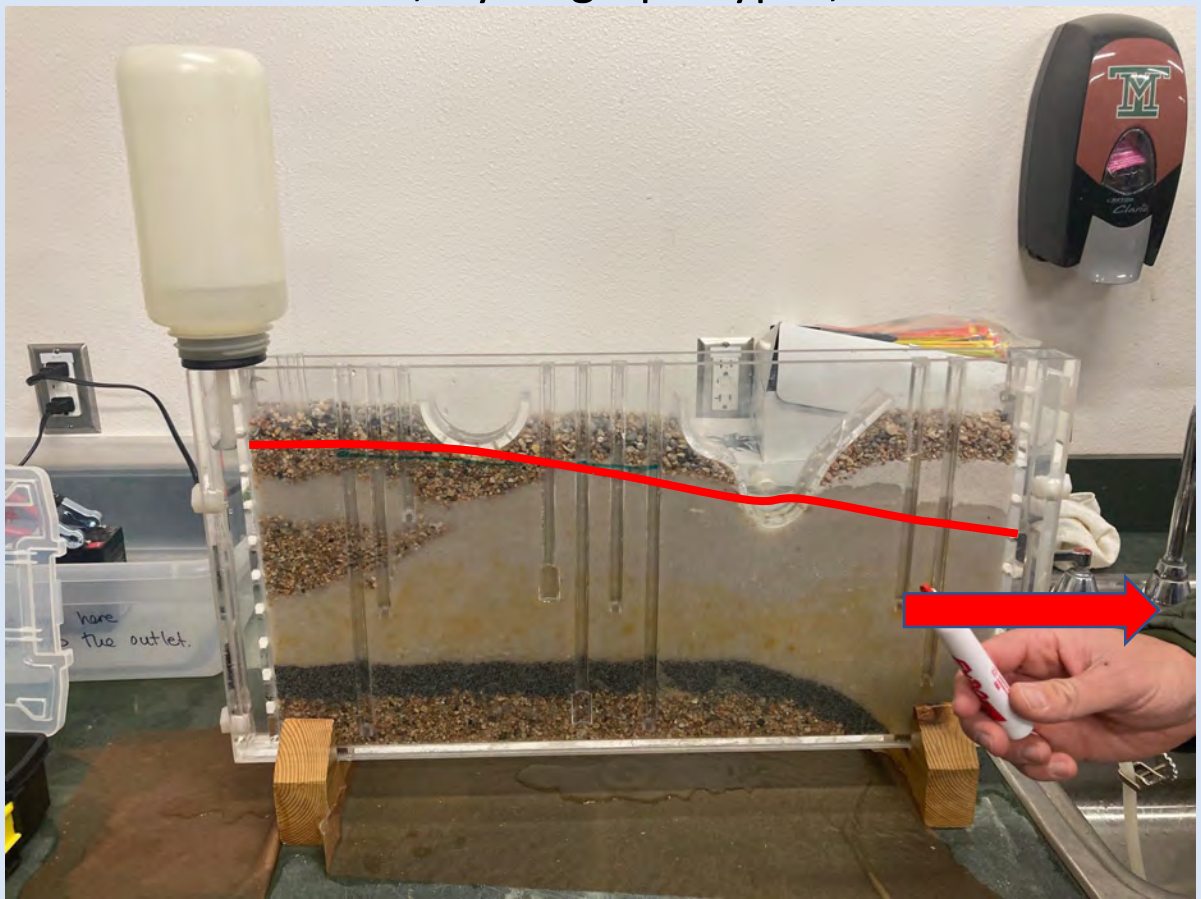
Objective – Develop Groundwater Model

- Develop a Dynamic Groundwater Budget
  - Where the water is coming from and going to, how much, and what is the timing



Objective – Develop Groundwater Model

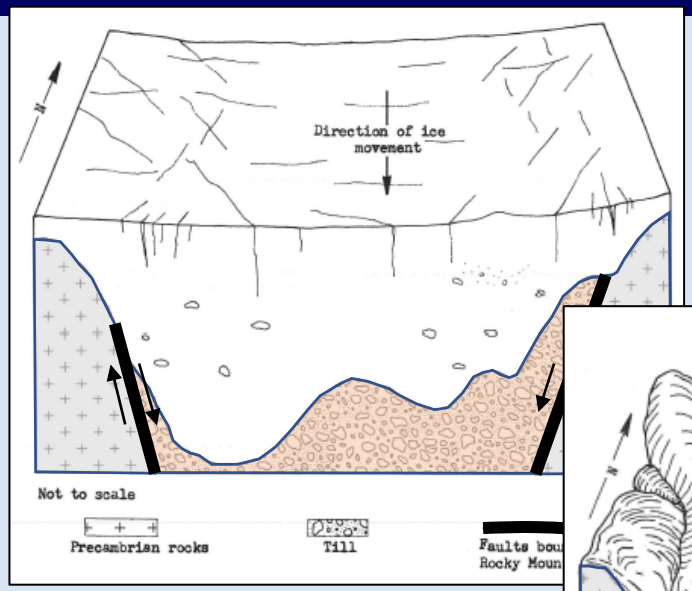
- Use Monitoring Data to Calibrate
  - The combination of static aquifer properties and the dynamic water budget determine groundwater levels and fluxes over time
  - Numerically adjust model properties to simulate observations
    - Groundwater Elevations, Hydrograph Types, Stream Gains and Losses, etc.



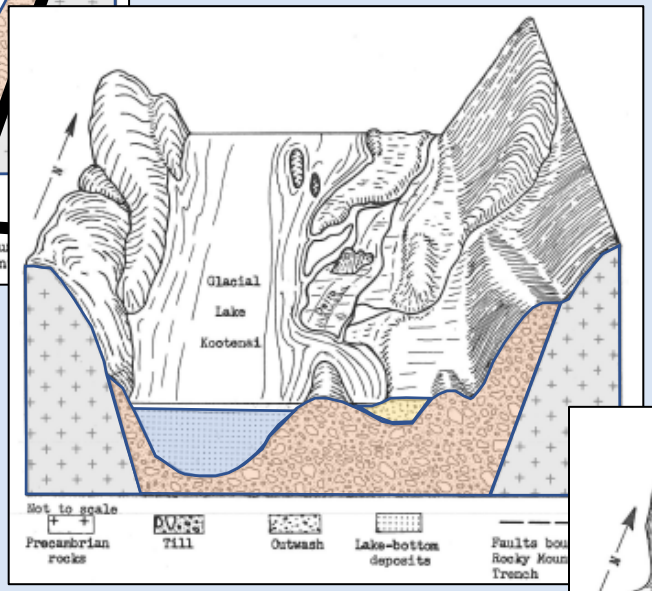
Objective – Develop Groundwater Model

A single solution using dissimilar types of information.

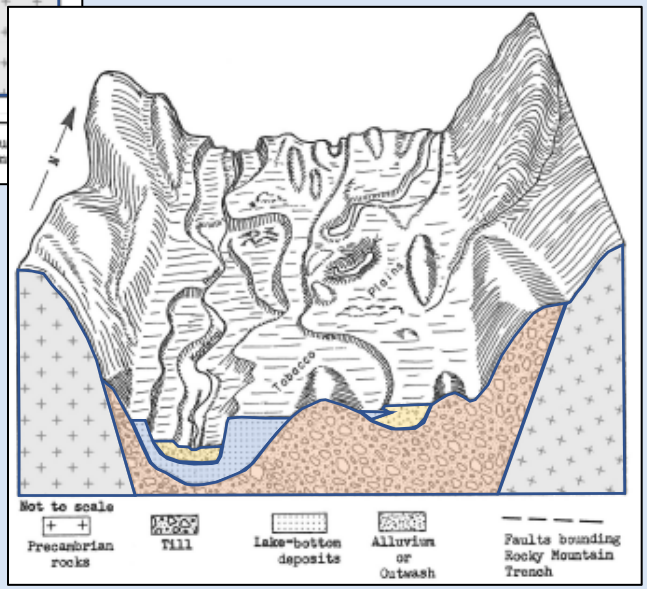
Distribution of Geologic Units



Ice advance and Drift deposition in the Rocky Mountain Trench



Glacial retreat
Outwash and Lake deposition



Modern Processes
Stream alluvium
and alluvial fans

Coffin and others, 1971

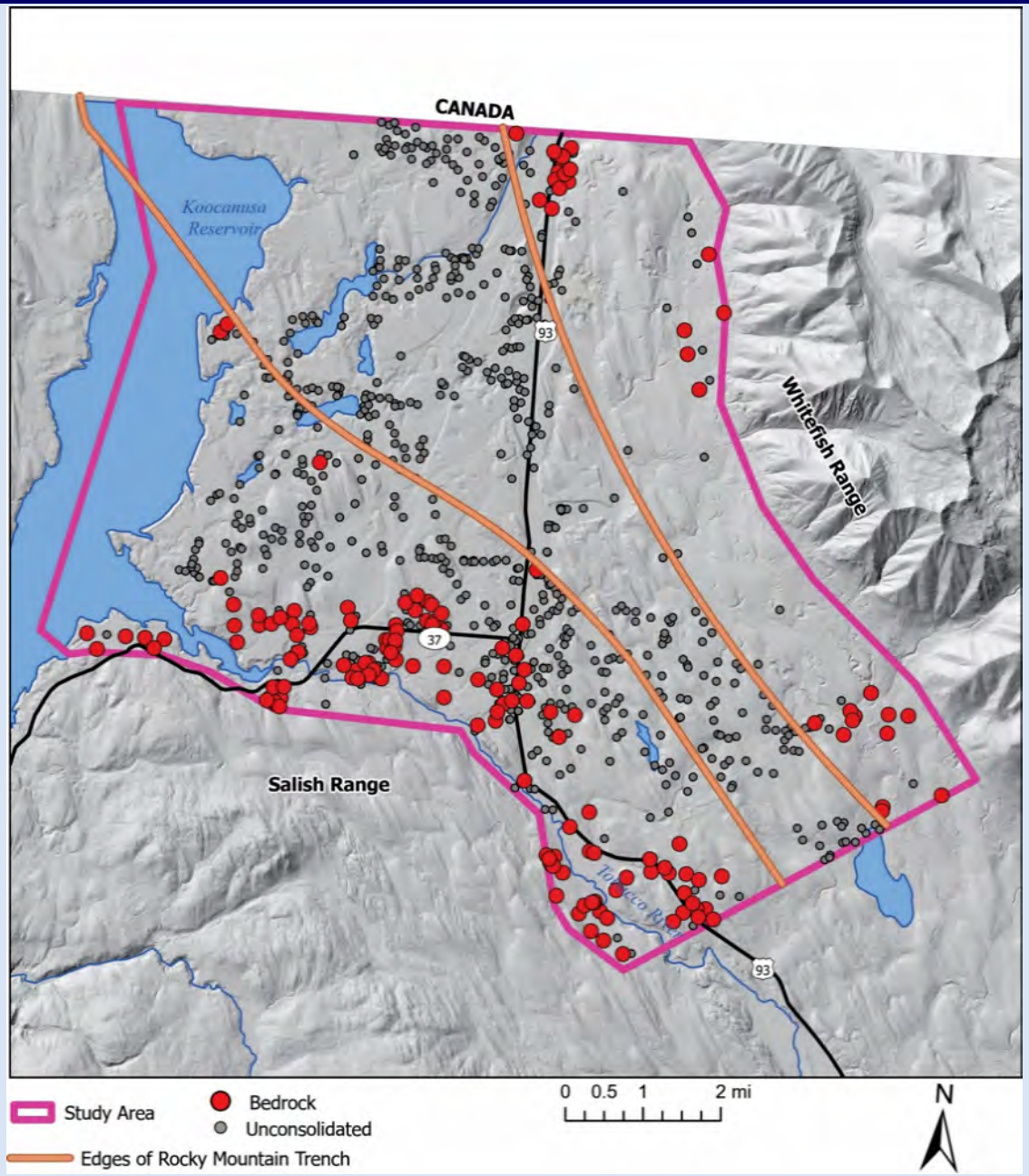
Distribution of Geologic Units

Hydrostratigraphic units

- **Bedrock**
  - Bedrock highs in some areas
- **Drift**
  - Basal Till
  - Sand and Gravel lenses
- **Fluvial Outwash**
  - Sand and Gravel
  - Ancestral Phillips Creek, Ancestral Tobacco River, and other tributaries
- **Lake** (glacial Lake Kootenai)
  - Gravel and sand near shore deposits
  - Sandy to silty deeper lake deposits
- **Modern sediments**
  - Stream alluvium/ alluvial fans

Concurrent Deposition, with interfingering/ gradational contacts

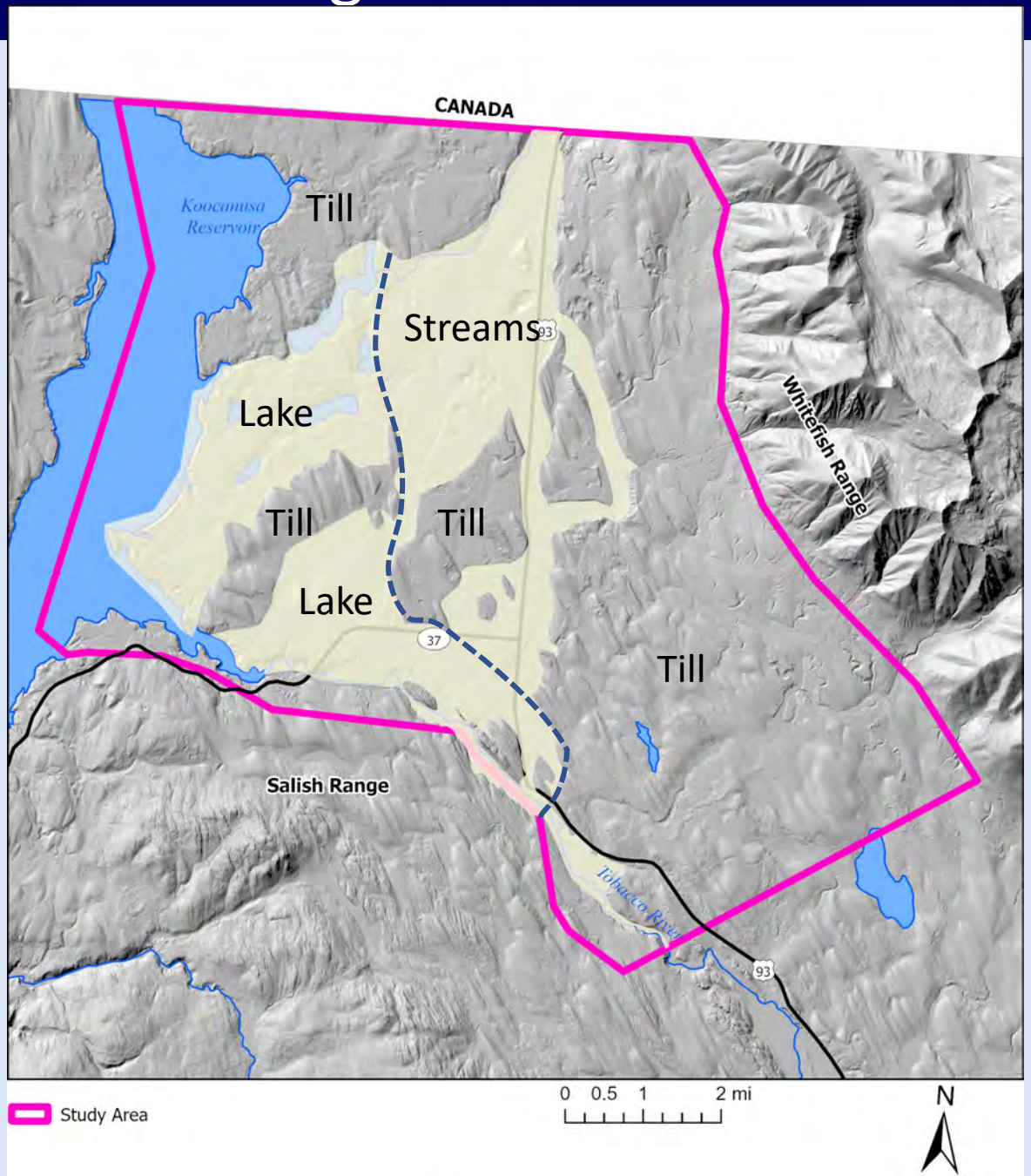
Distribution of Geologic Units - Bedrock



Rocky Mountain Trench Based on Gravity data from Coffin and others, 1971

Preliminary

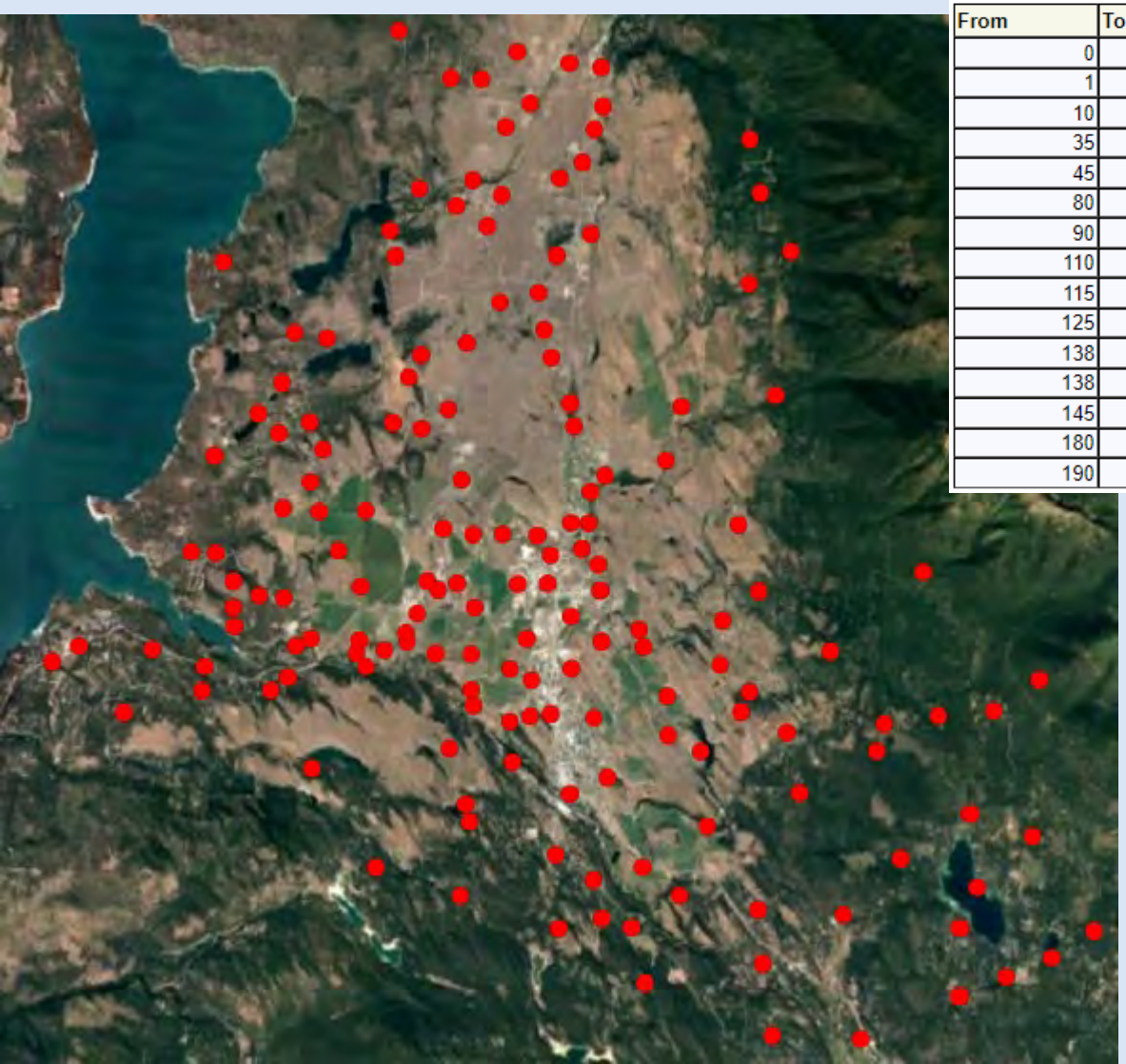
Distribution of Geologic Units



Preliminary

Refining the Geologic Model

164 Well Logs



112ALVM - ALLUVIUM (PLEISTOCENE)

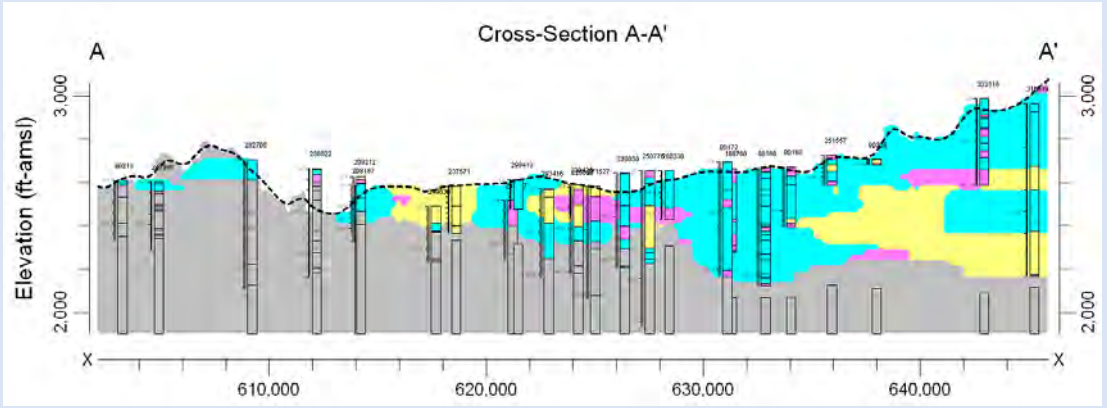
From	To	Description
0	1	TOP SOIL
1	10	REDDISH BROWN SILTY FINE SAND
10	35	REDDISH BROWN SILTY SAND
35	45	SANDY CLAY
45	80	SILTY CLAY
80	90	SAND AND CLAY
90	110	SILTY CLAY
110	115	CLAY AND GRAVEL
115	125	GRAVEL
125	138	CLAY
138	280	GRAVEL
138	145	COARSE GRAVEL AND SAND
145	180	COARSE GRAVEL AND SAND WITH FEW COBBLES
180	190	SAND AND GRAVEL
190	240	GRAVEL AND SAND WITH FEW COBBLES

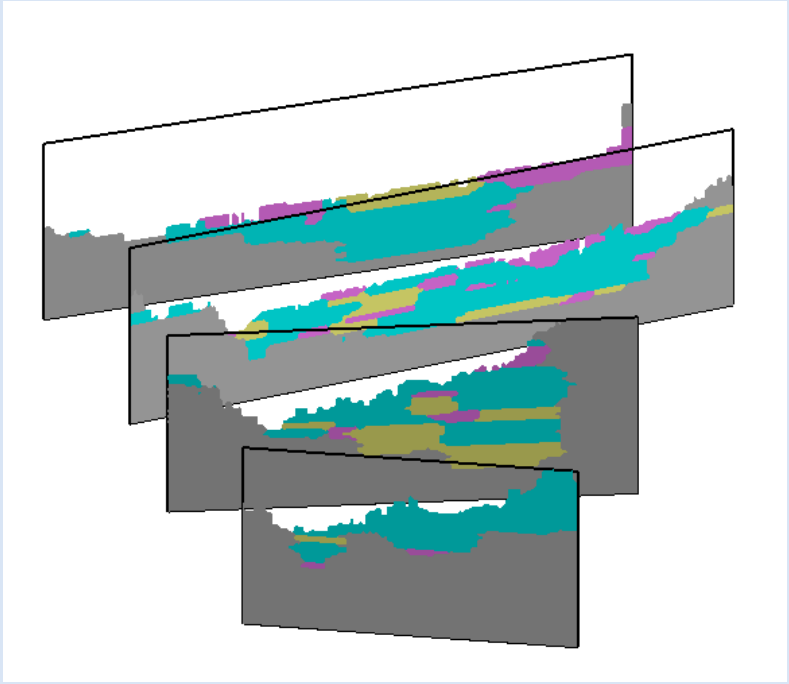
Lithologic Log

Refining the Geologic Model

164 Well Logs

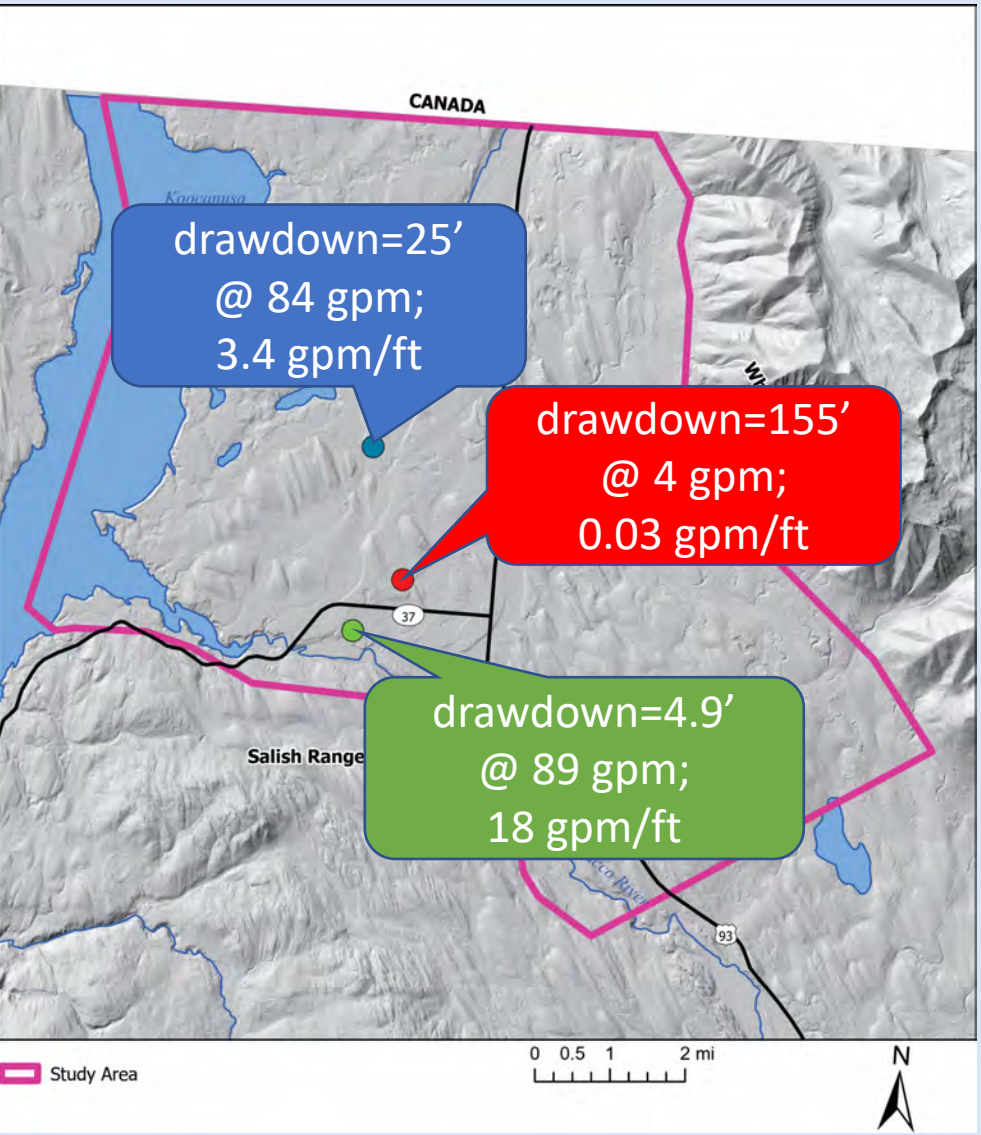
RockWorks – Create 3D Geologic Model





Example of Rockworks Cross Section and Fence Diagrams

Aquifer Properties of Geologic Units



Defining Aquifer Properties

- Permeability (hydraulic conductivity)
- Water Storage (storativity)

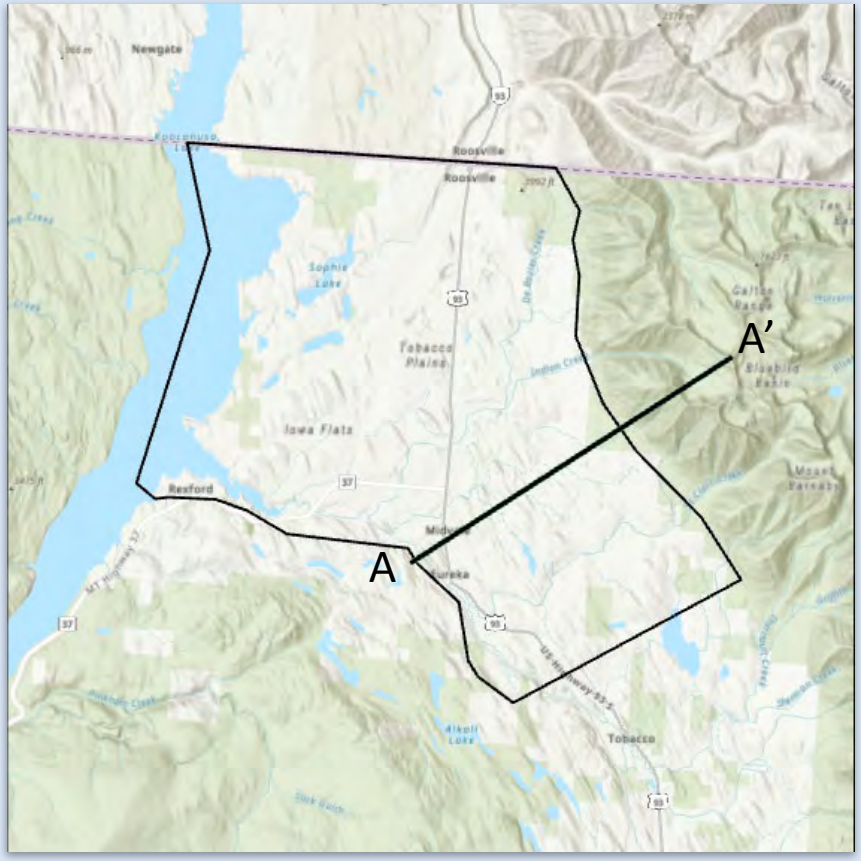
Existing Aquifer Tests

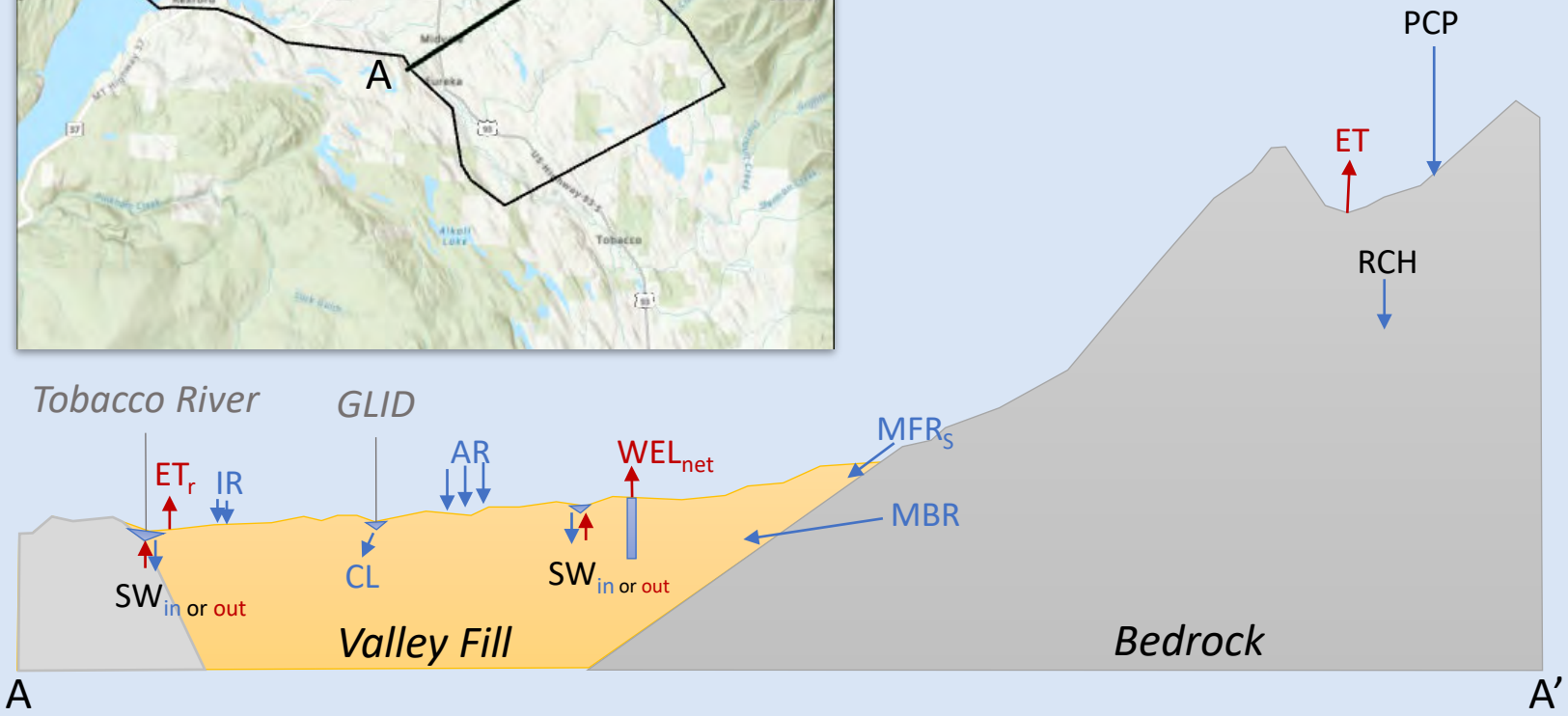
GWIP Aquifer Test Sites (72 hr tests)

- Deep Outwash Gravel (K=46 ft/d)
- Bedrock (K=0.01 ft/d)
- Deltaic Gravel (K=1,890 ft/d)

(see Bobst, 2024)

Dynamic Groundwater Budget





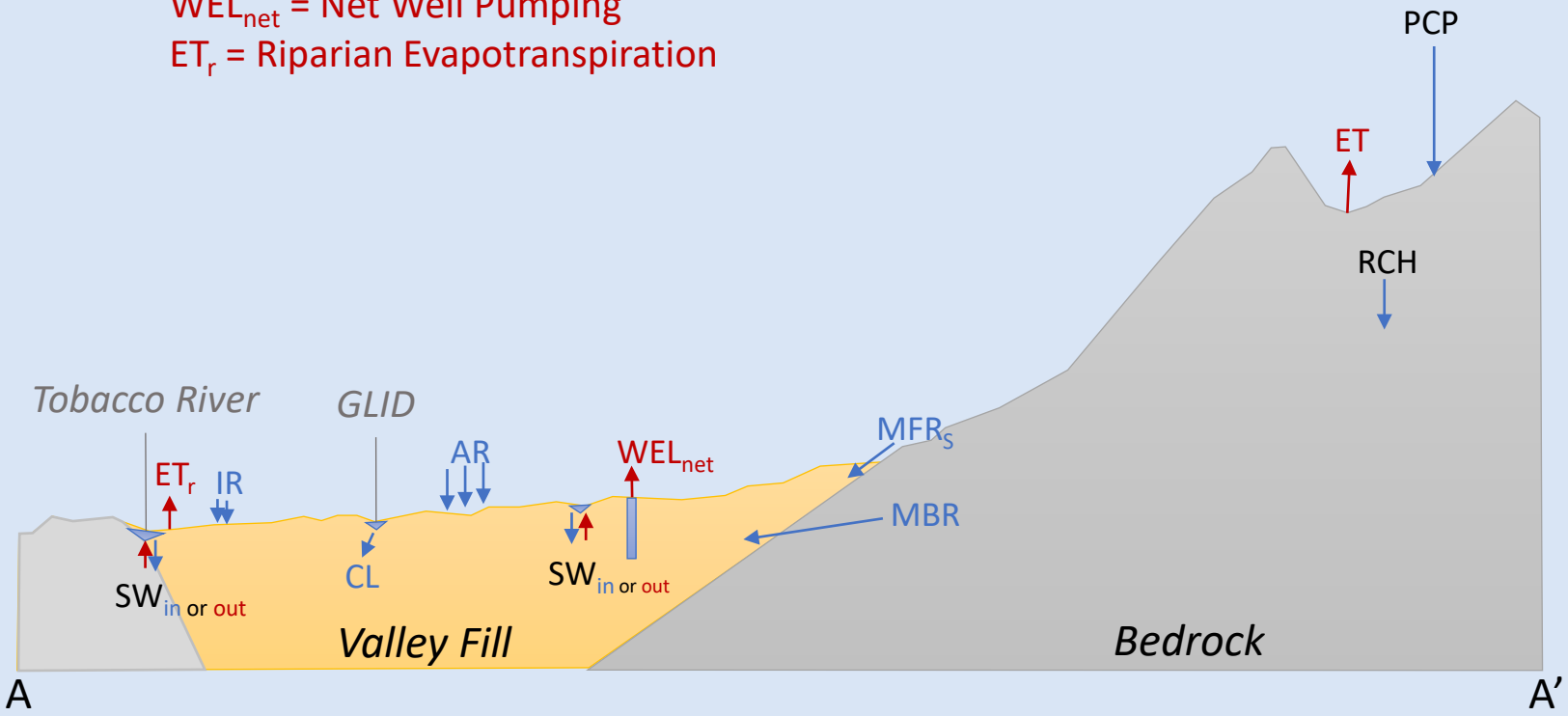
Dynamic Groundwater Budget

Inflows

MBR = Mountain Block Recharge
MFR_S = Mountain Front Recharge Stream Infiltration
SW_{in}= Surface Water In
LI = Lake Infiltration (not shown on schematic); e.g. Sophie Lake
AR = Areal Recharge
CL = Canal Leakage
IR = Irrigation Recharge

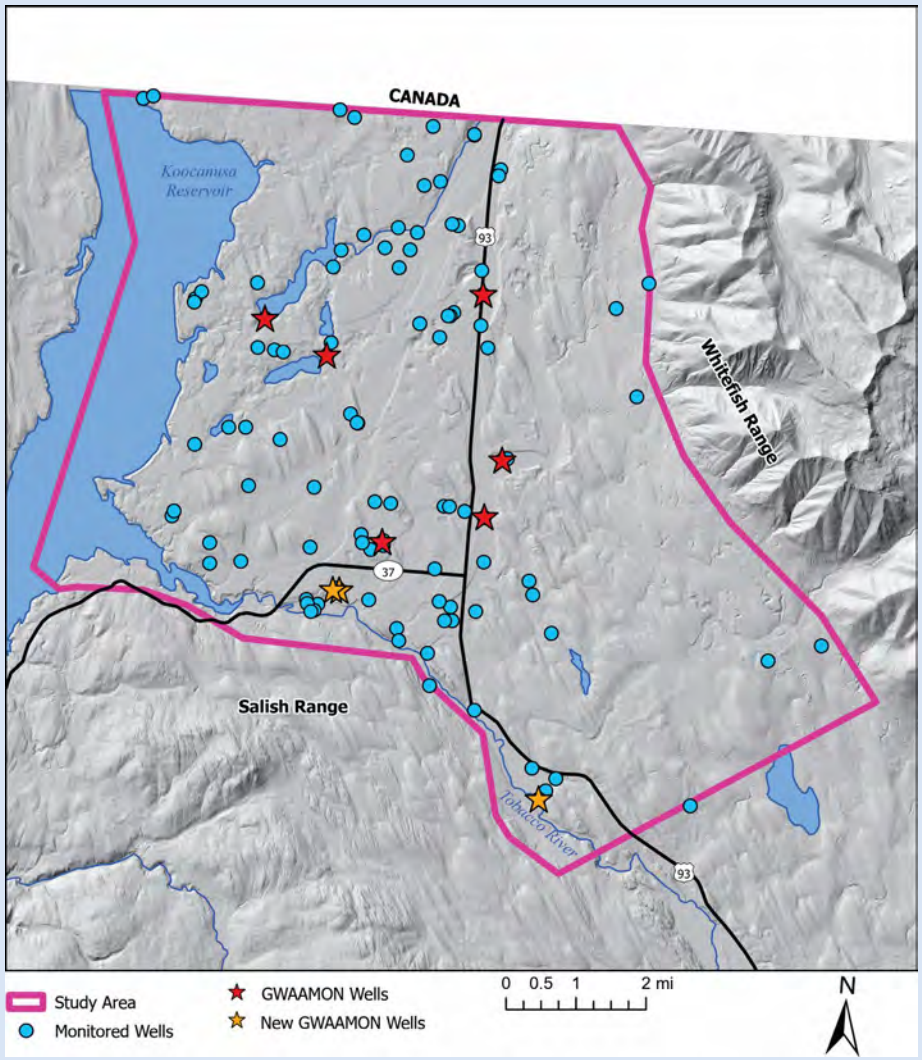
Outflows

SW_{out} = Surface Water Out – Tobacco River, Lake Koocanusa, Tributaries
WEL_{net} = Net Well Pumping
ET_r = Riparian Evapotranspiration

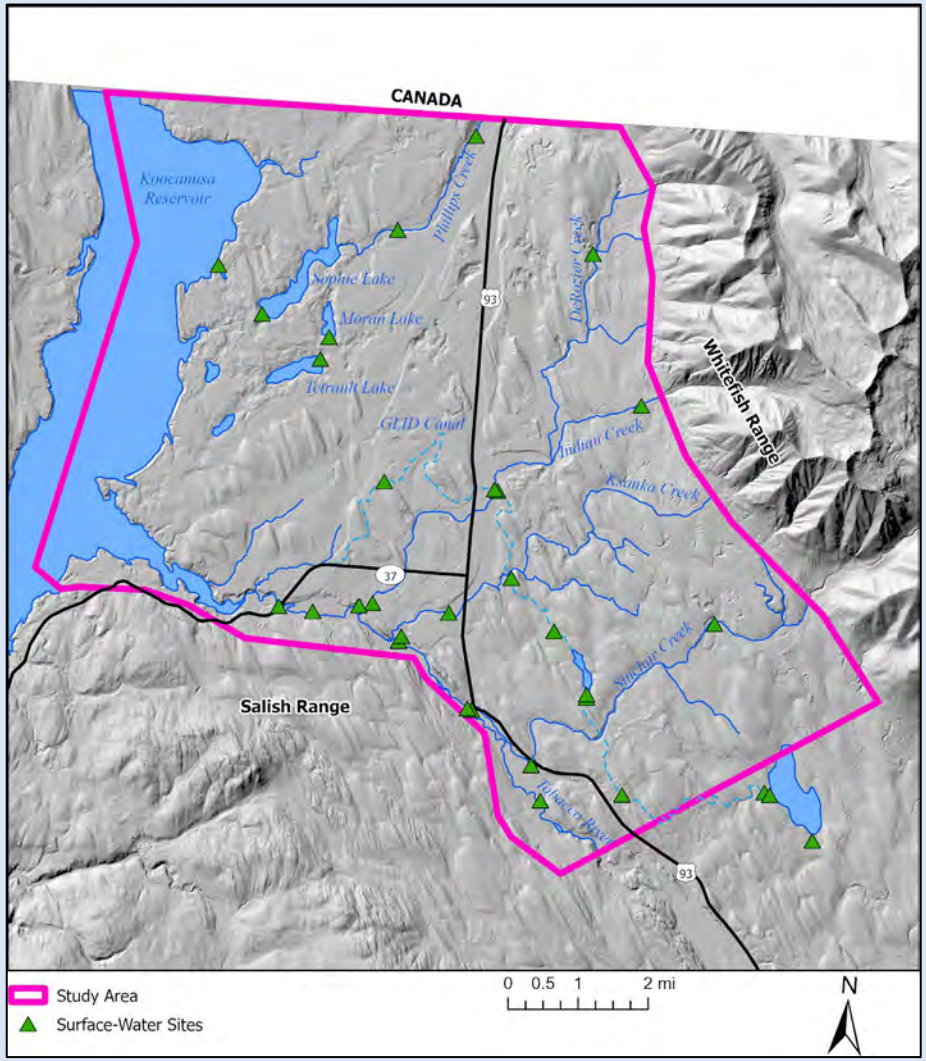


Monitoring (2022-2024)

Groundwater Network (104 wells)



Surface-Water Network (31 sites)

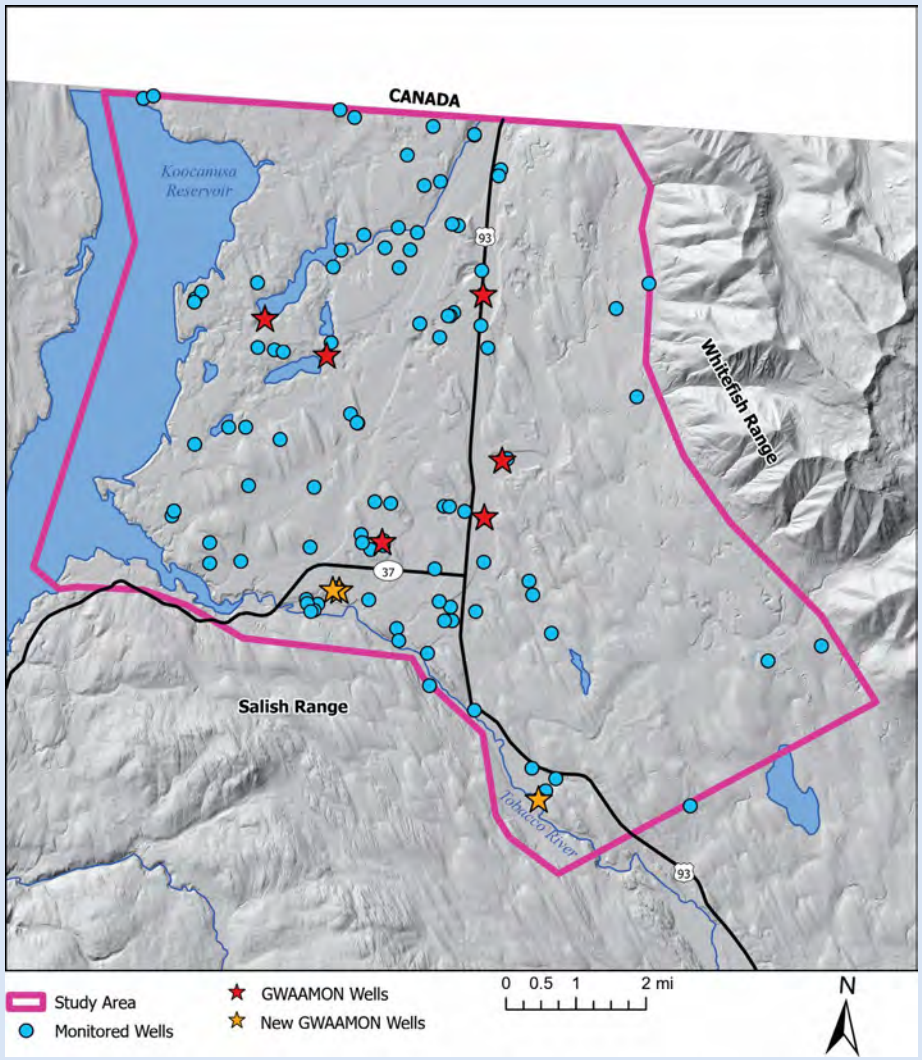


Primary Monitoring Period: October 2022 to October 2023 (Water Year 2023+)

Extended Monitoring (fewer sites, with automated transducers): July 2022 to July 2024

Monitoring (2022-2024)

Groundwater Network (104 wells)



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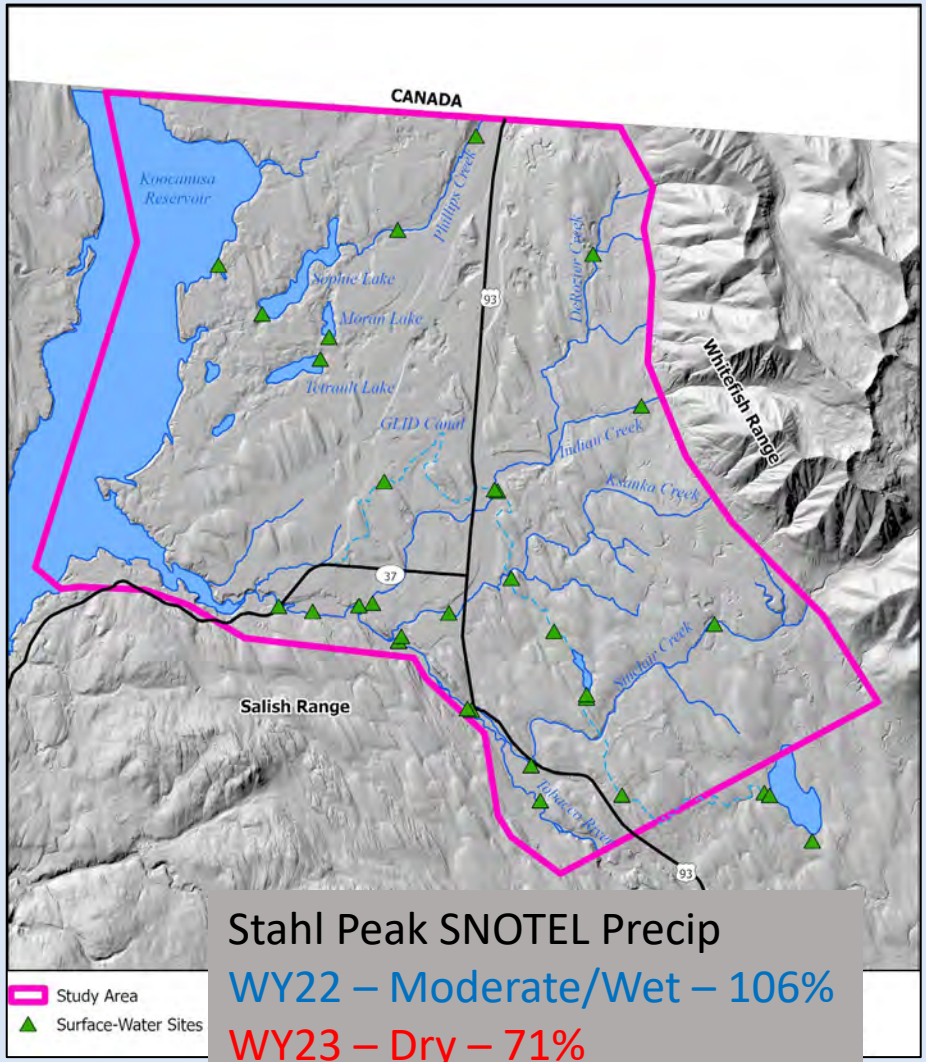


Stahl Peak SNOTEL Precip
WY22 – Moderate/Wet – 106%
WY23 – Dry – 71%
WY24 – Moderate/Dry – 90%

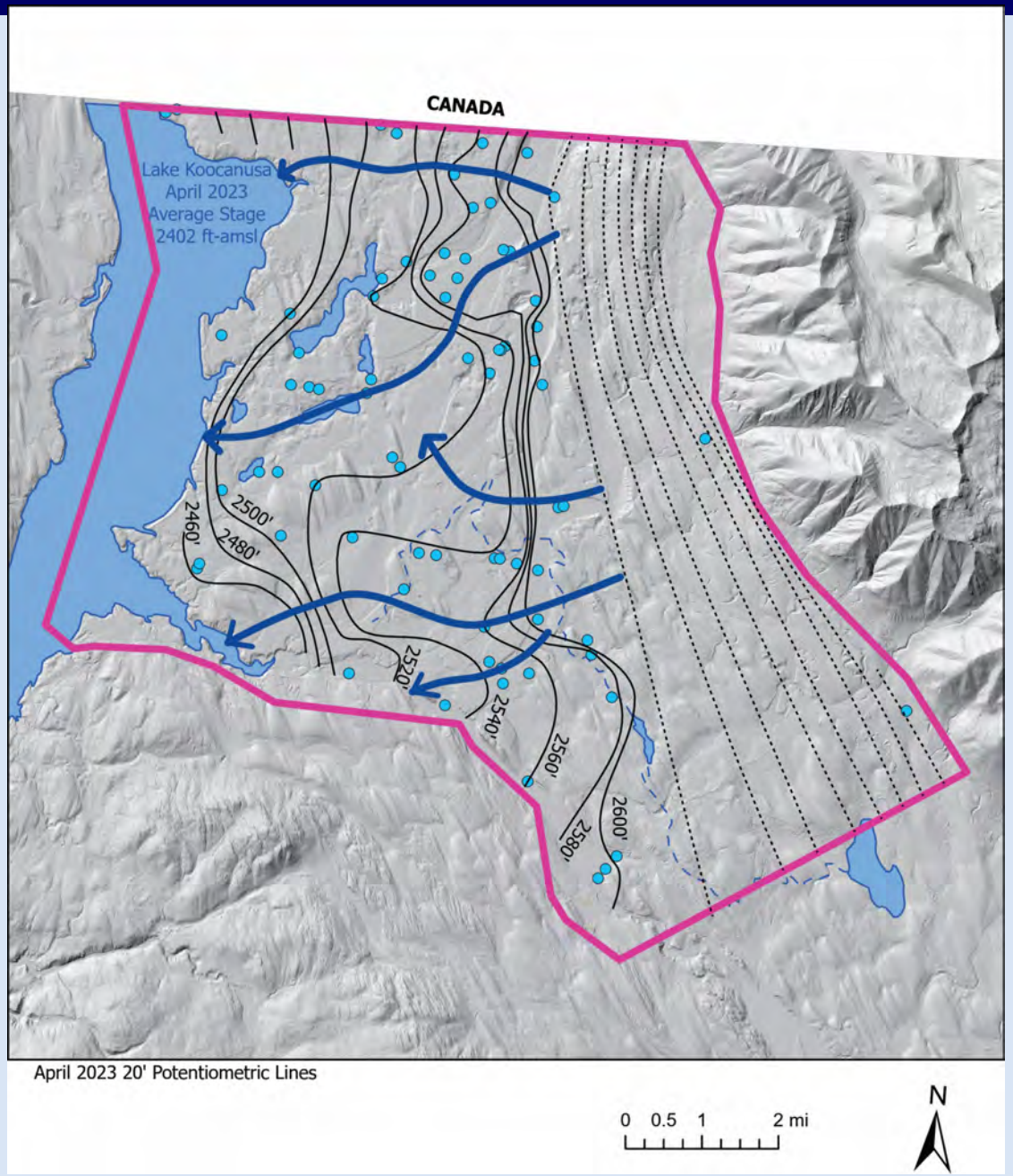
Primary Monitoring Period: October 2022 to October 2023

Extended Monitoring (fewer sites, with automated transducers): July 2022 to July 2024

Monitoring – April 2023 Groundwater Flow

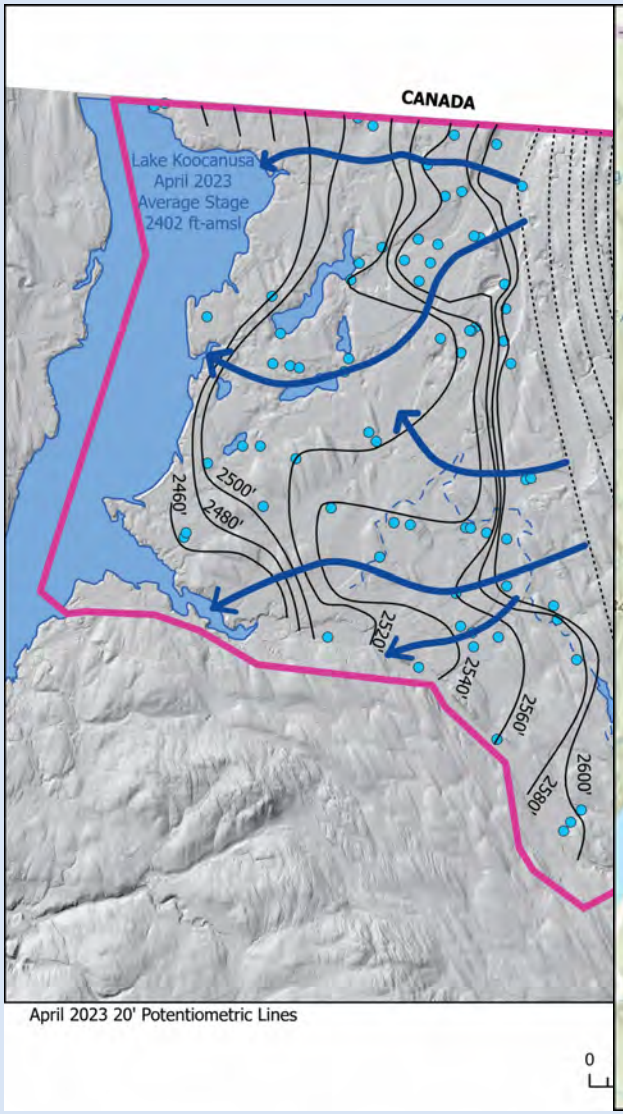
April 2023

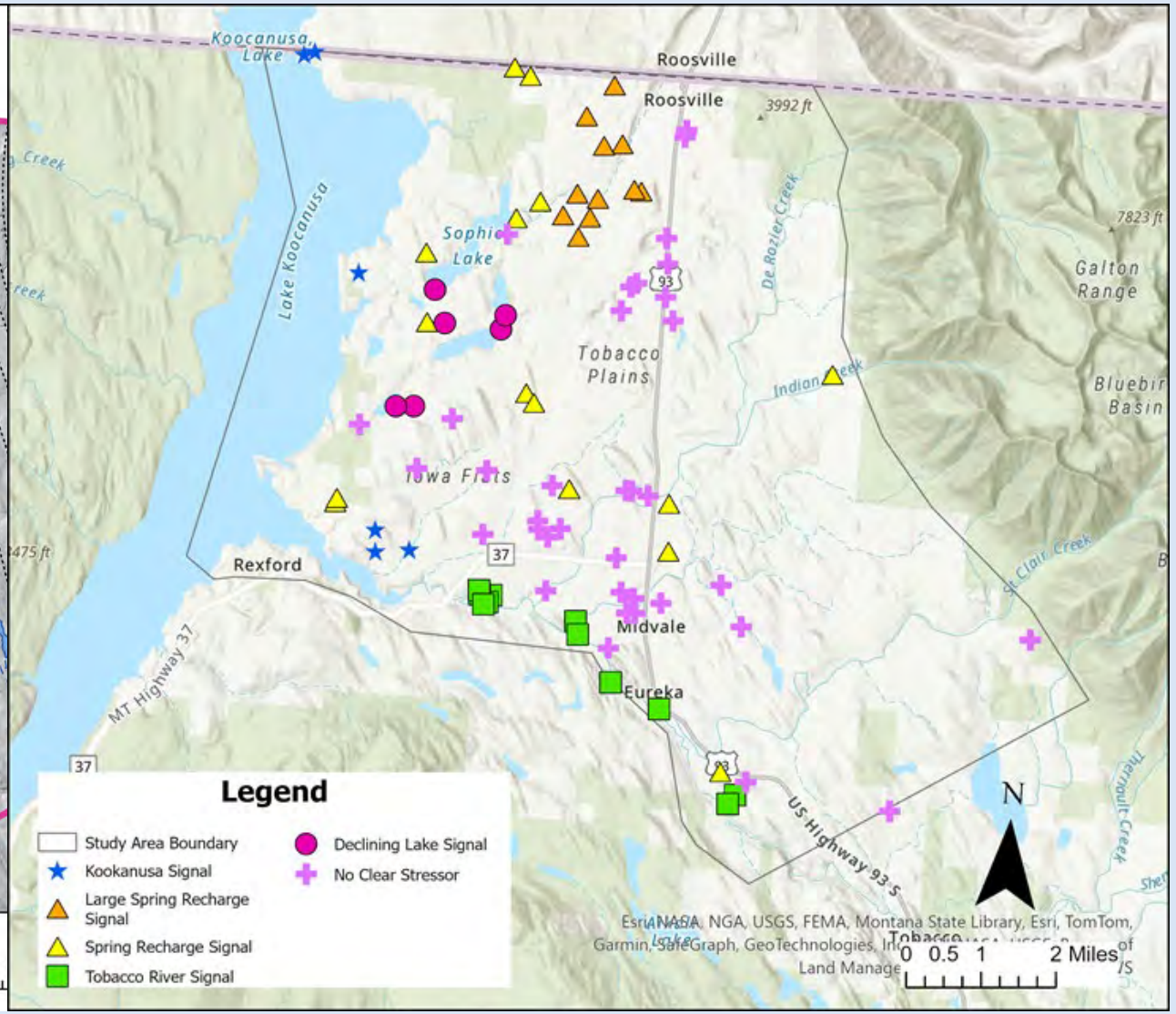
20’ Contours



Preliminary

Monitoring – Hydrograph Types



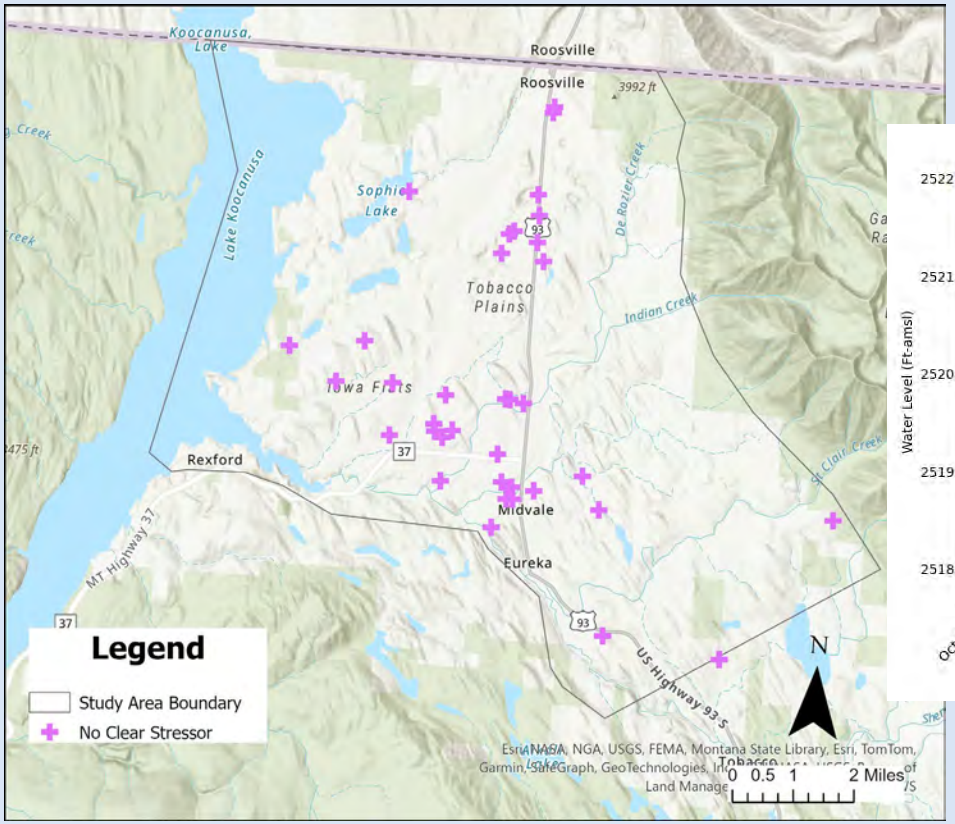


April 2023 Potentiometric Surface

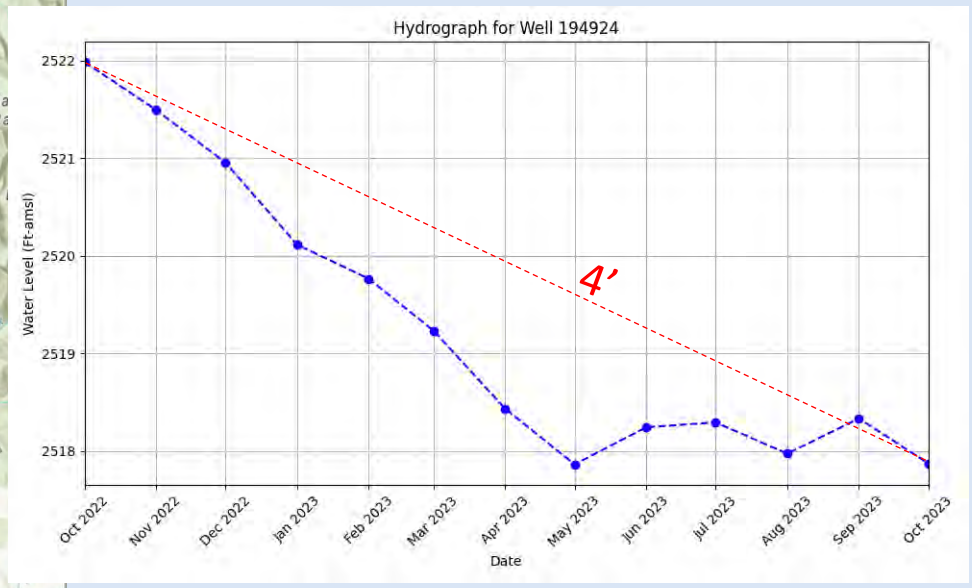
Distribution of Hydrograph Types

Preliminary

Monitoring – Hydrograph Types



No Clear Stressor



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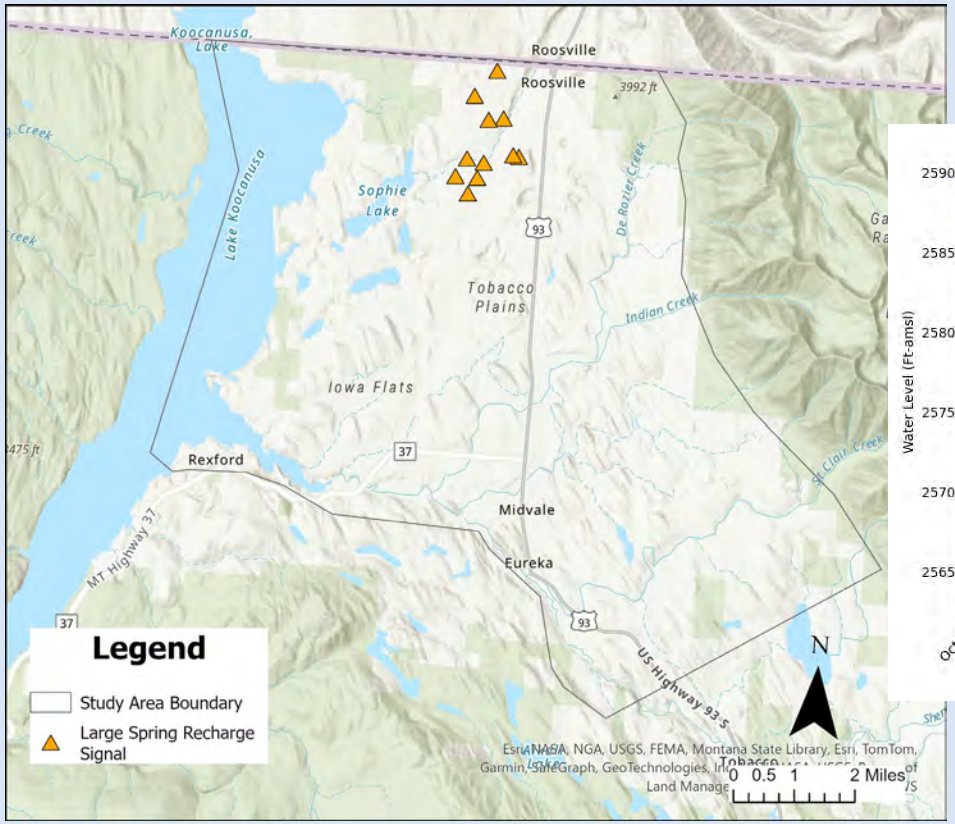
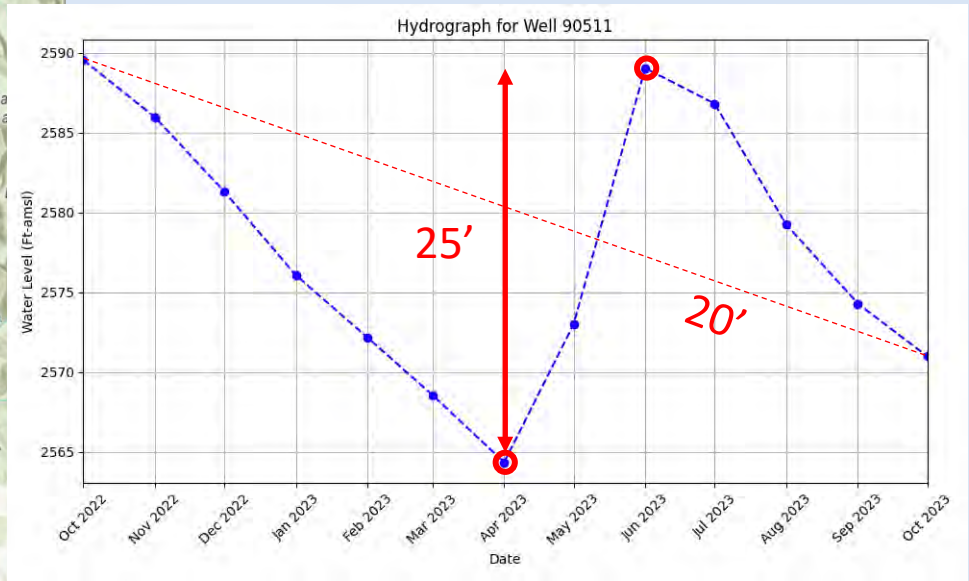


Large Spring Recharge Signal



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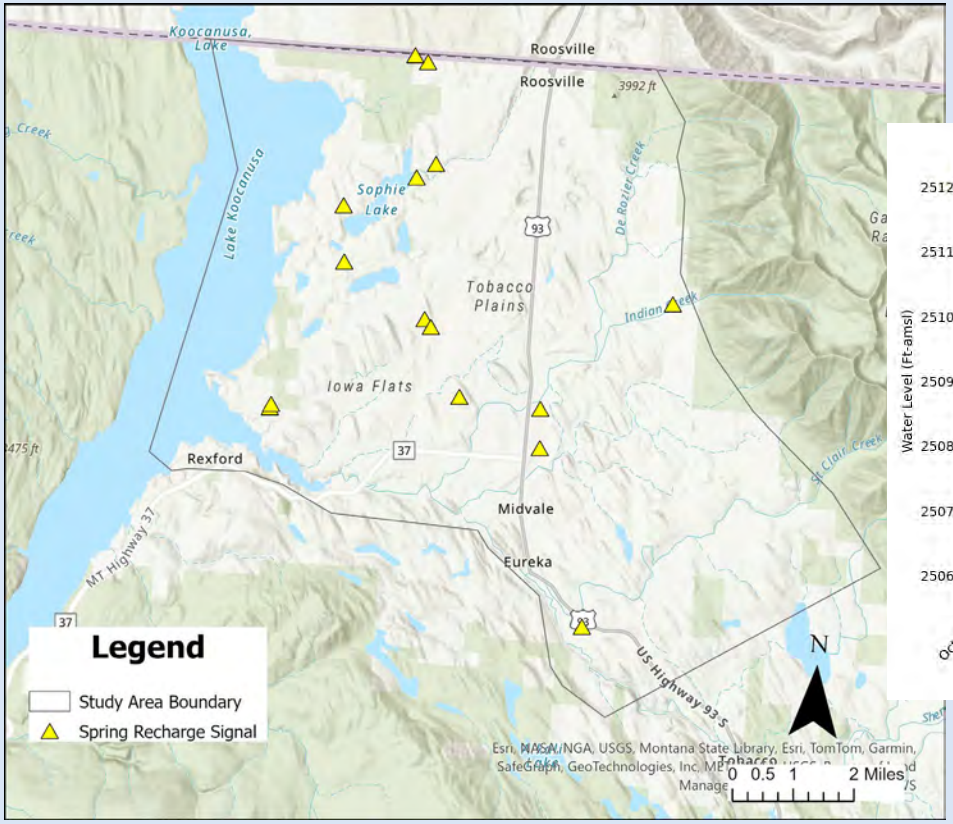
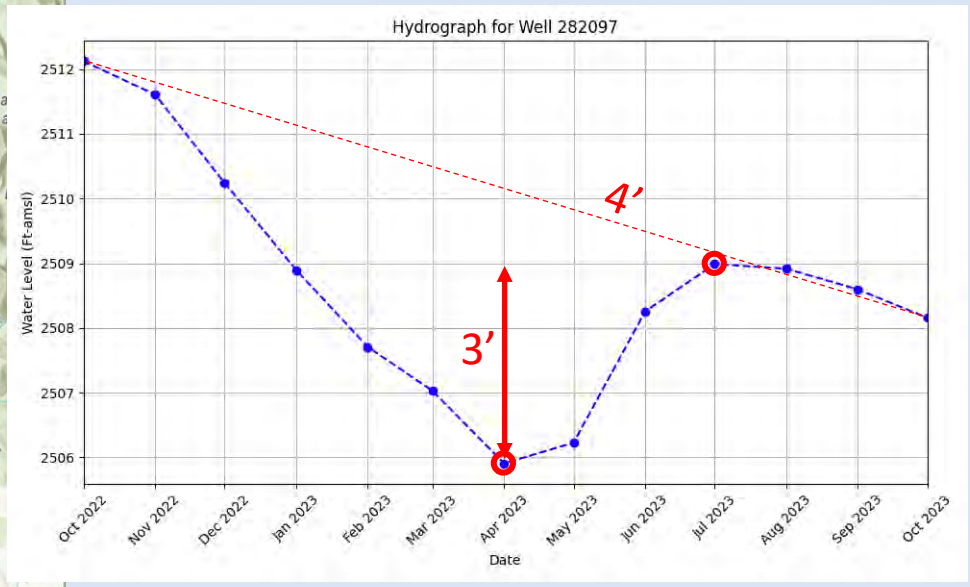


Small Spring Recharge Signal



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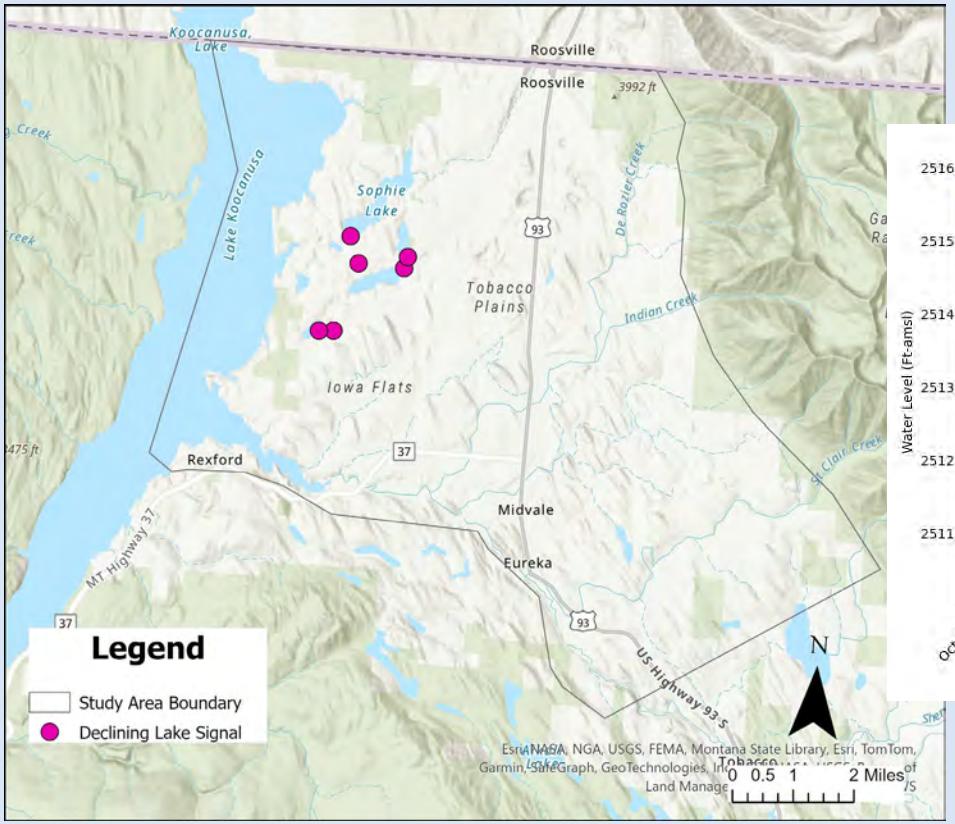
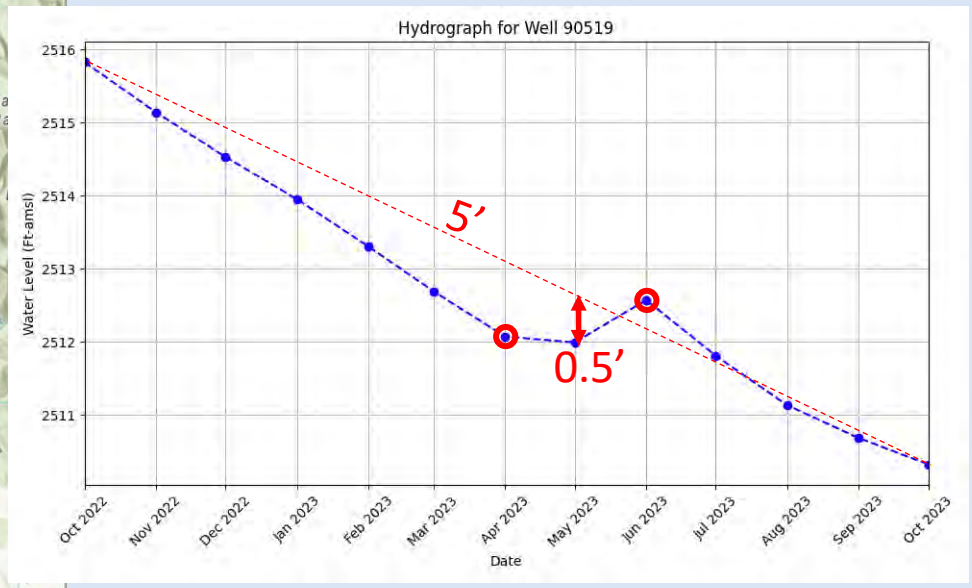


Lakes Area Signal



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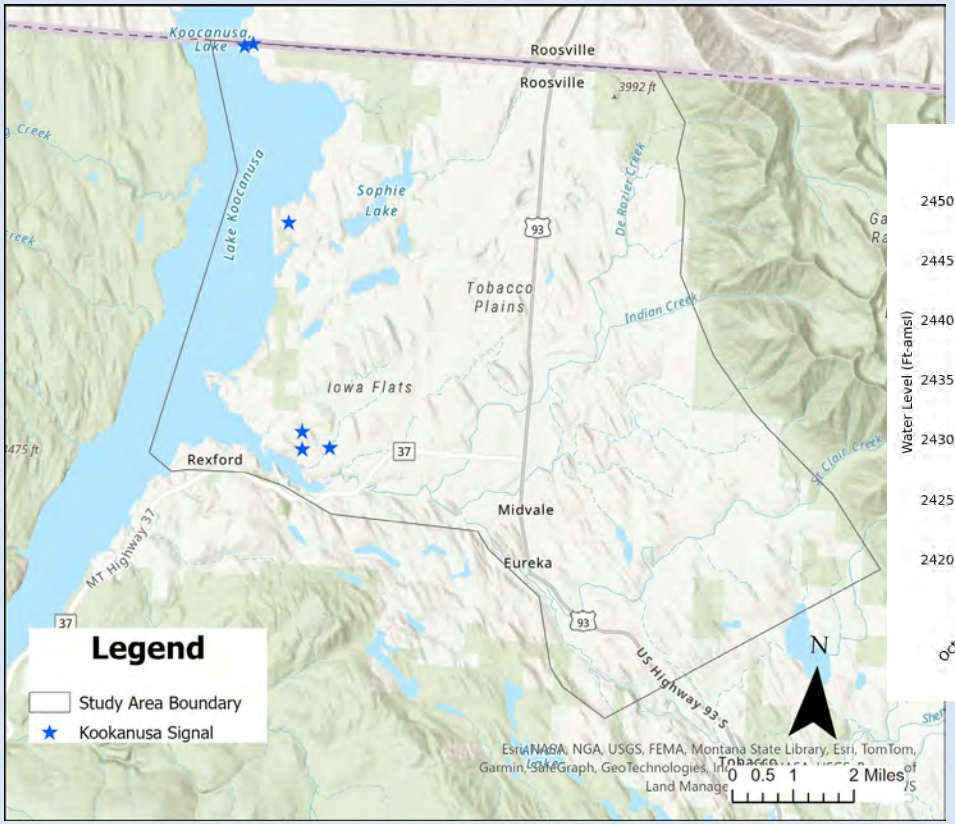
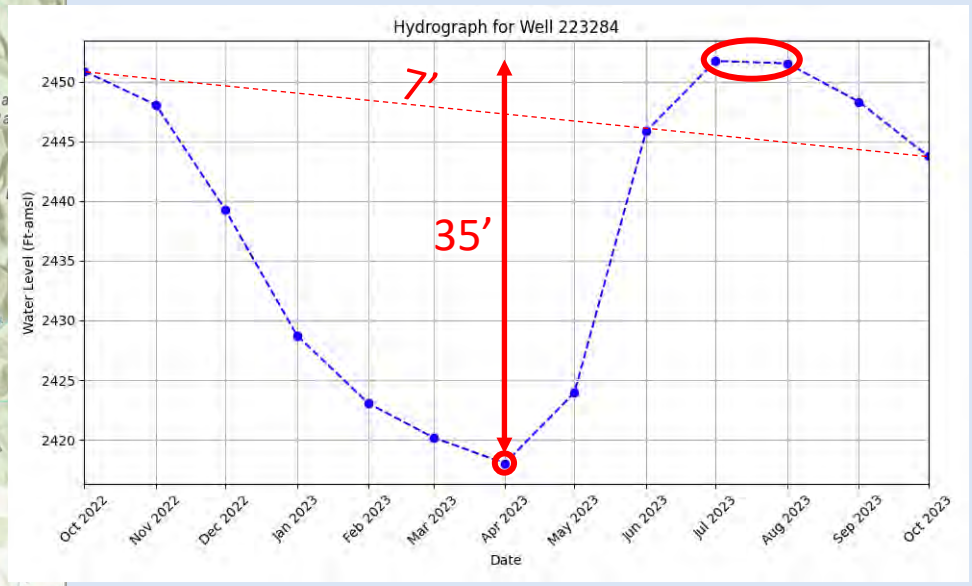


Lake Koocanusa Signal



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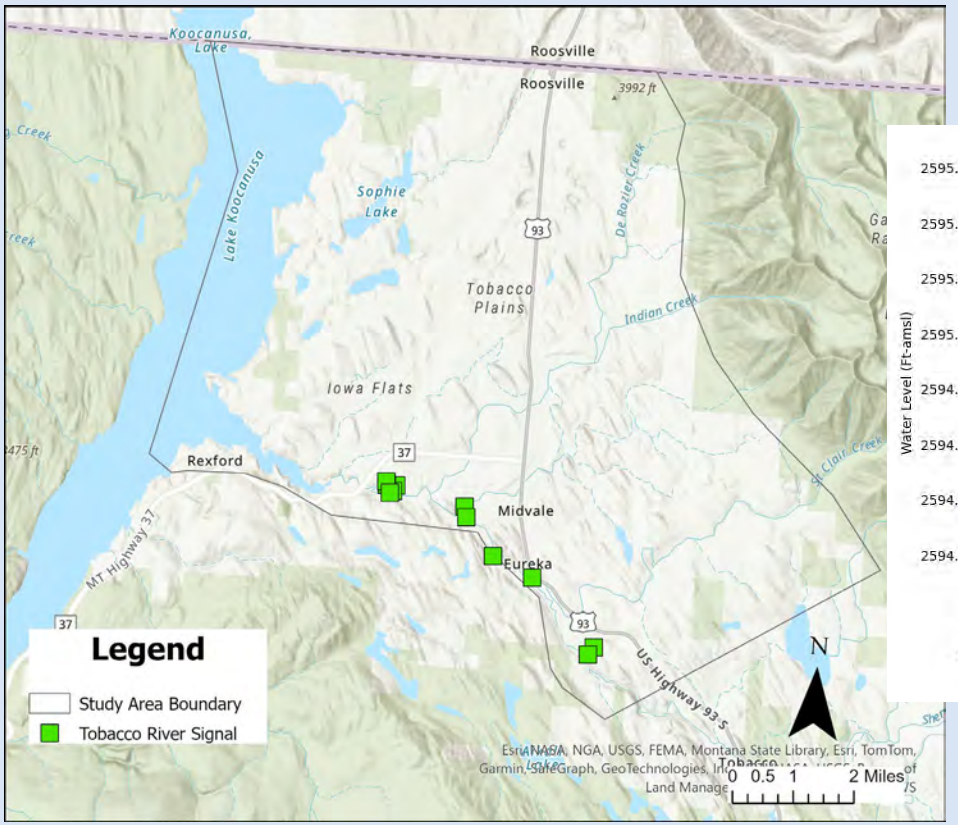
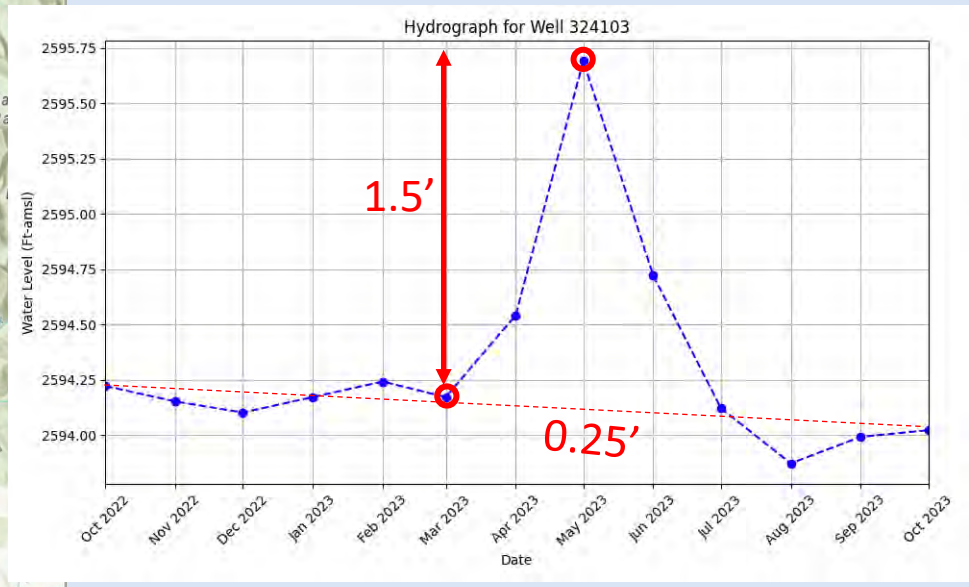


Tobacco River Signal



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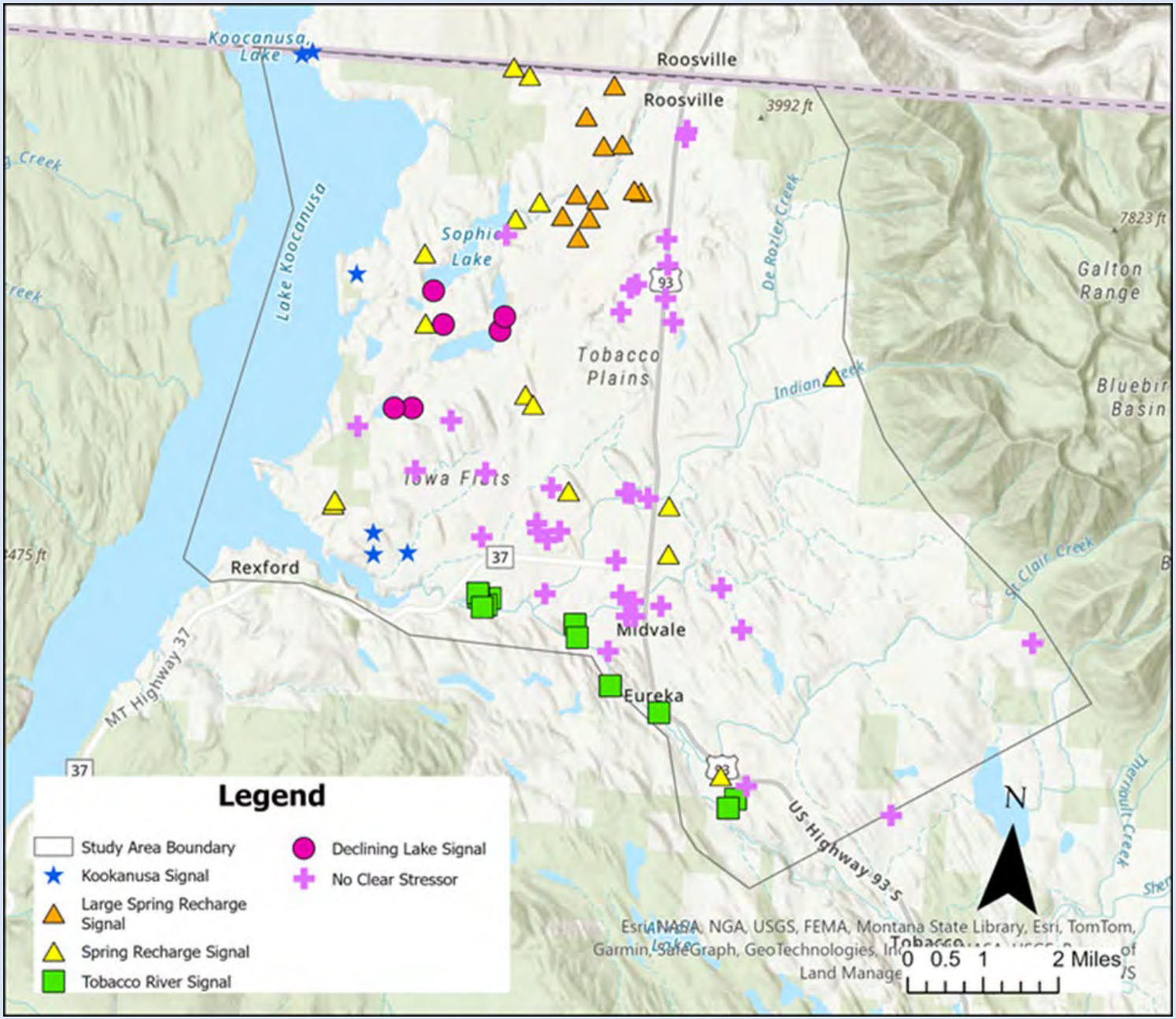
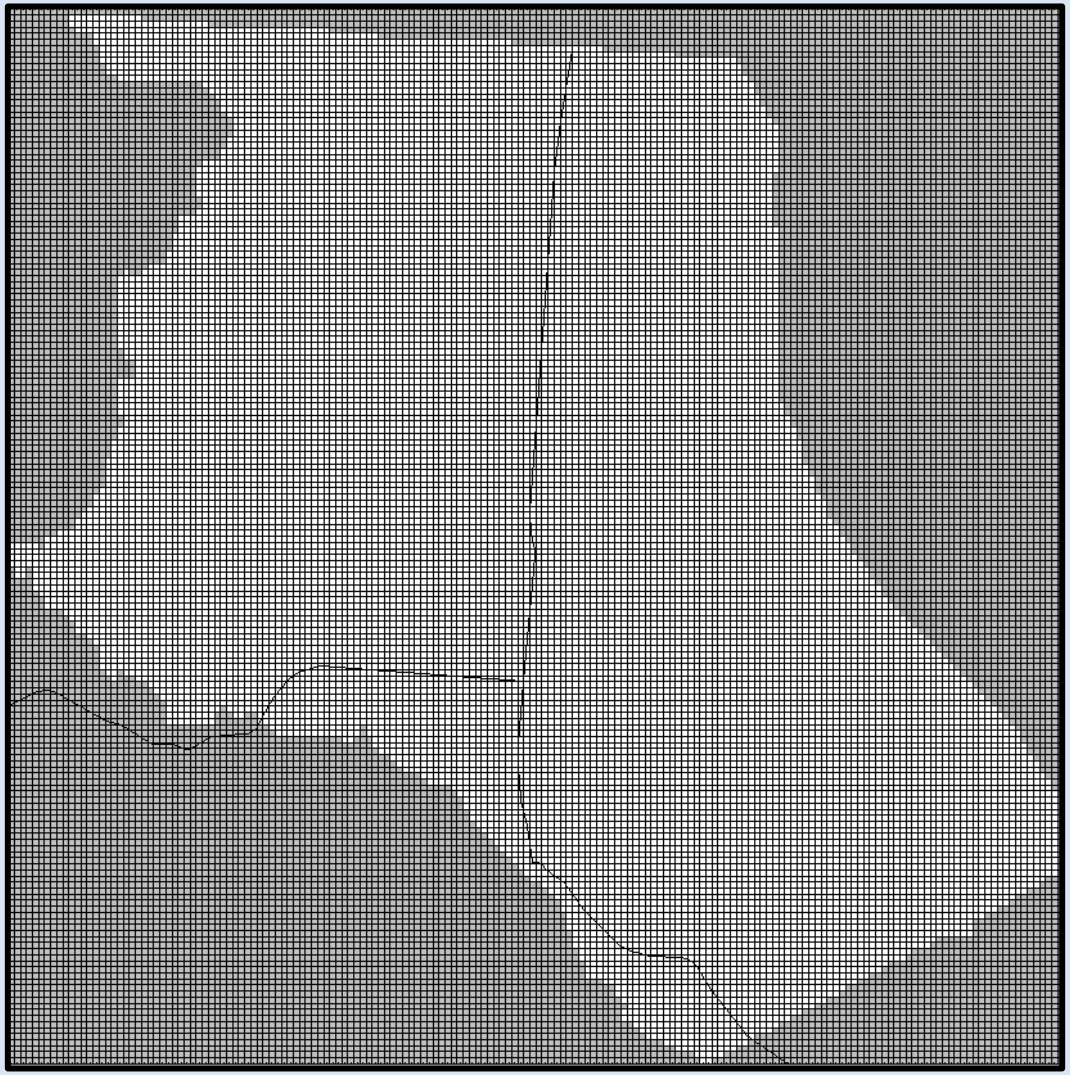


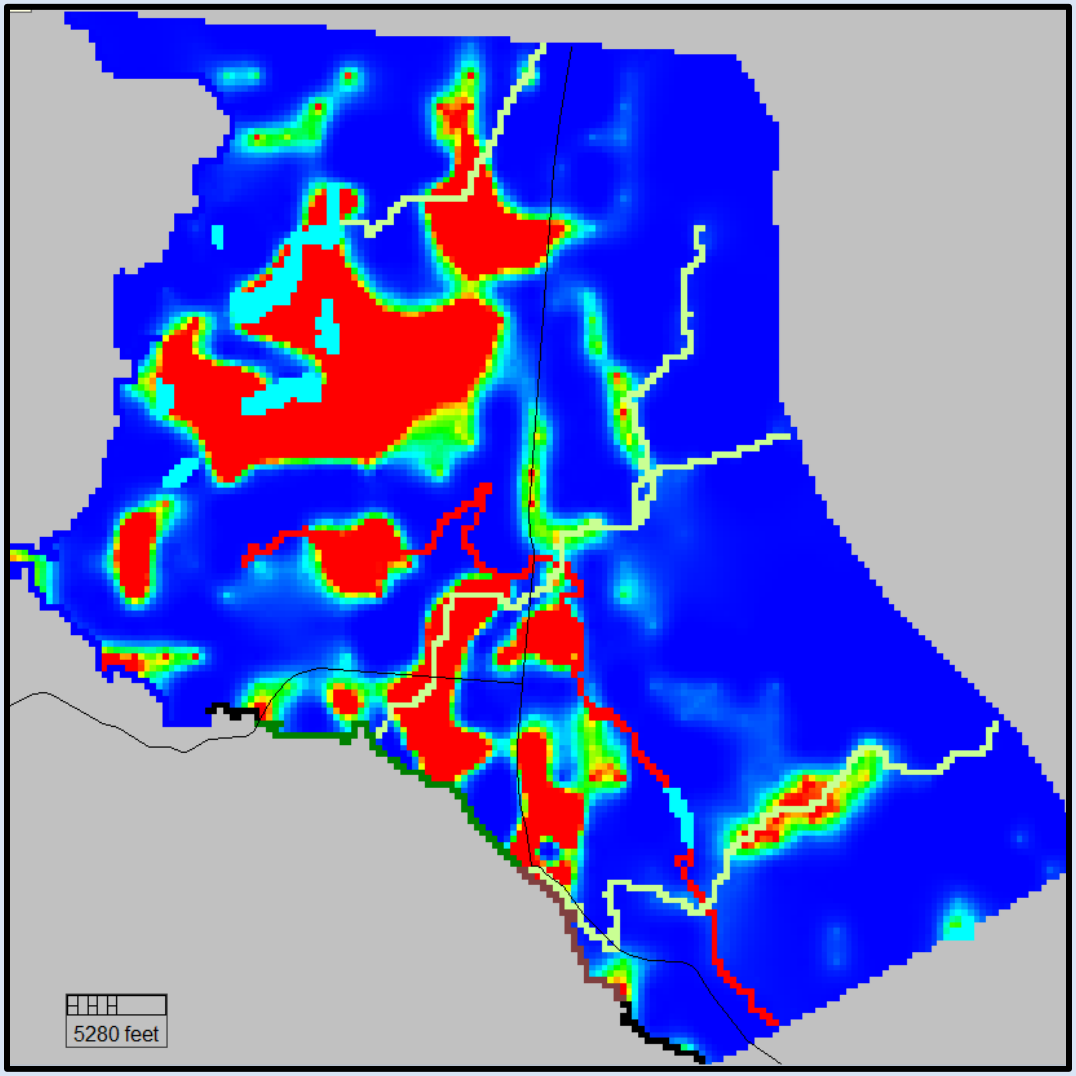
Preliminary

Underway – Steady State Model



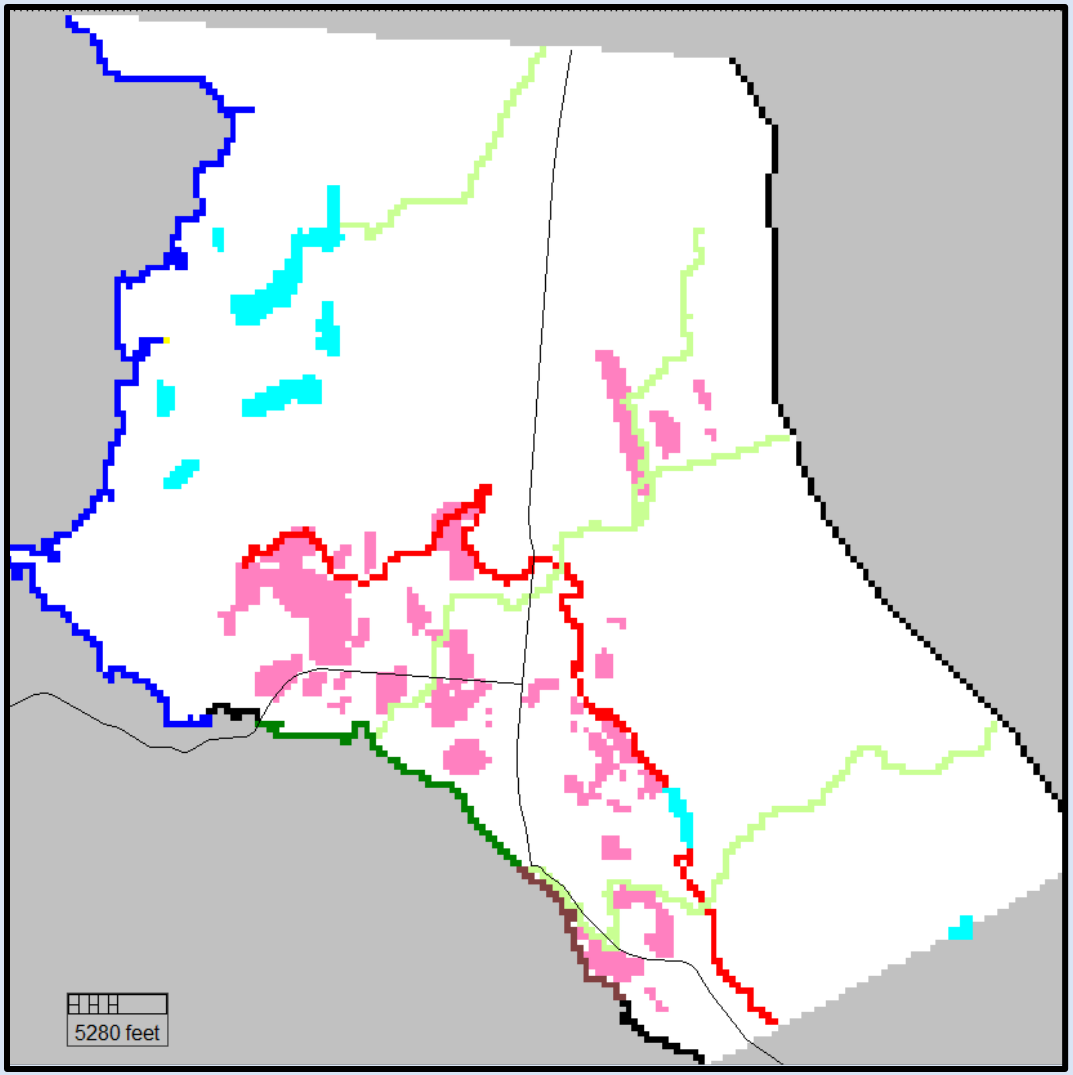
Model Grid

Underway – Steady State Model



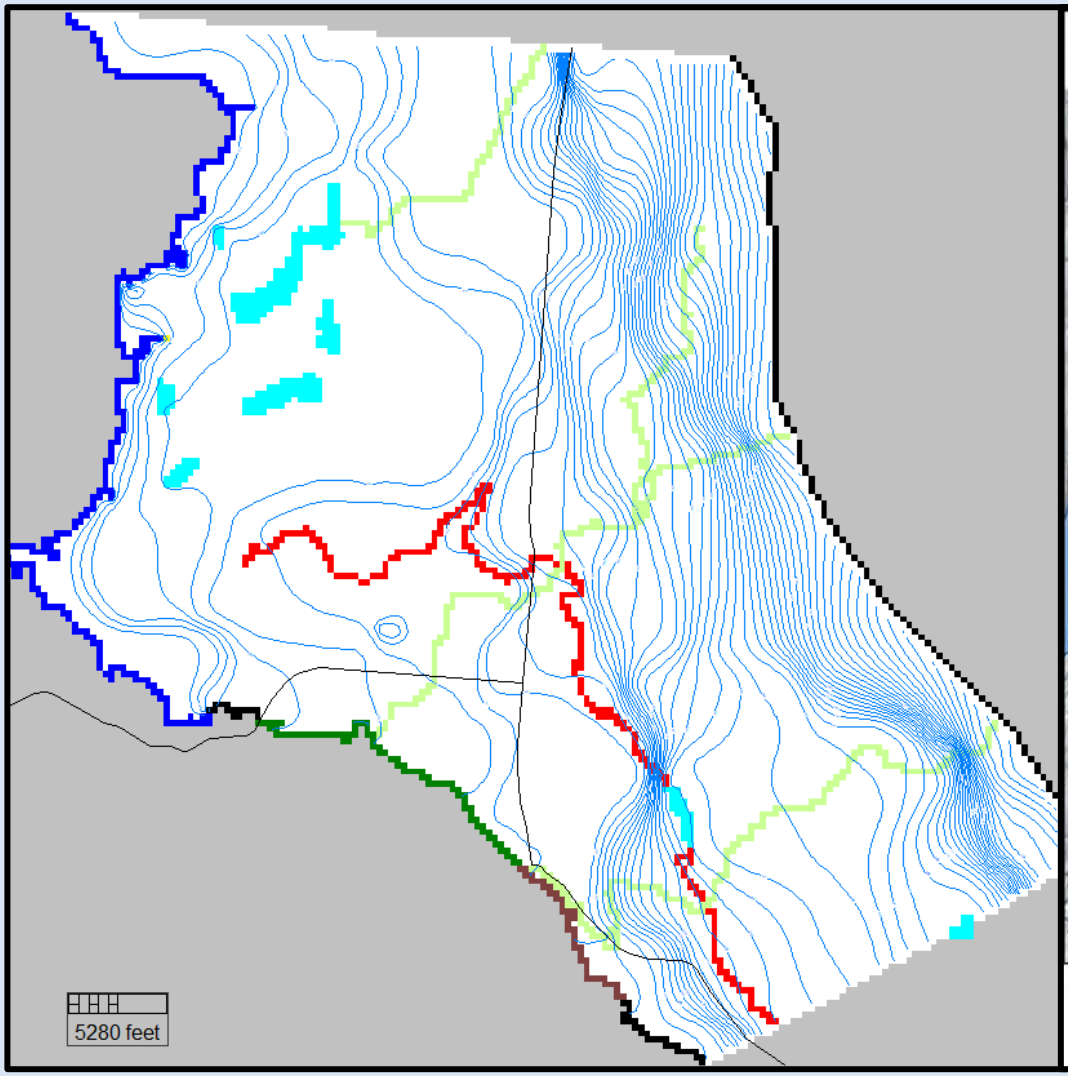
Distribution of Aquifer Properties based on Geologic Model

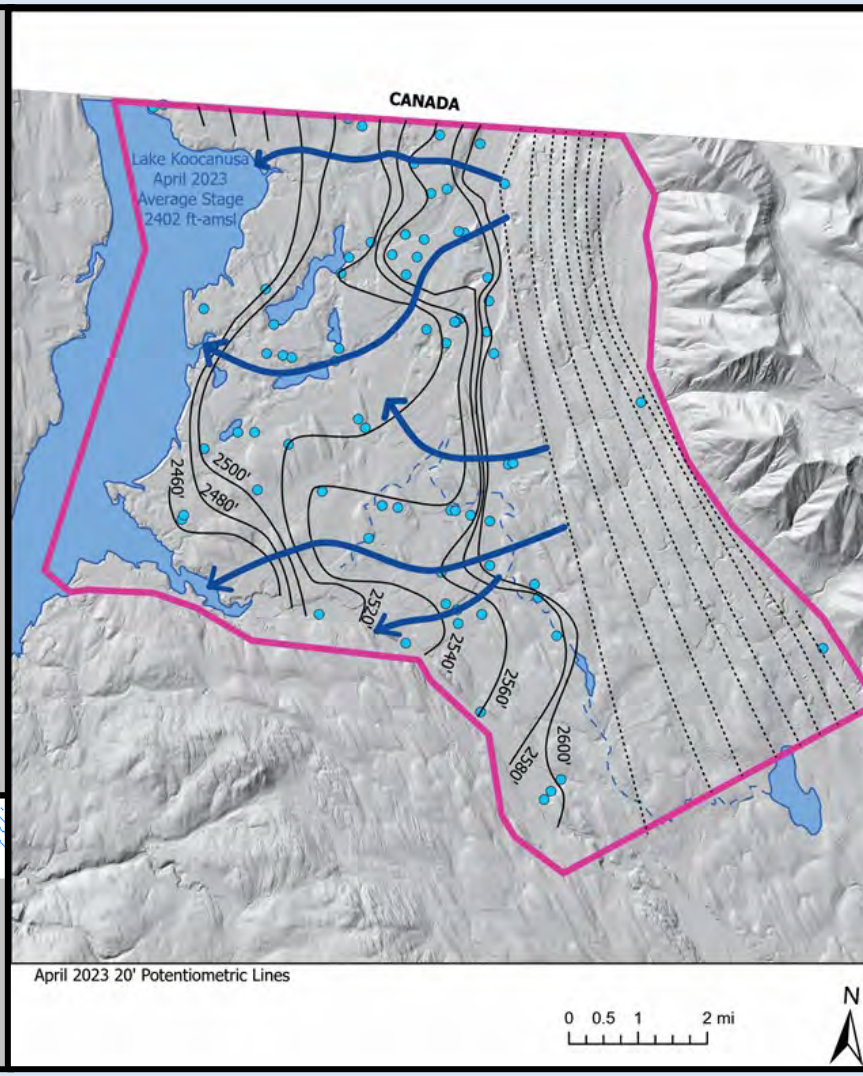
Underway – Steady State Model



Boundary Conditions/Sources and Sinks

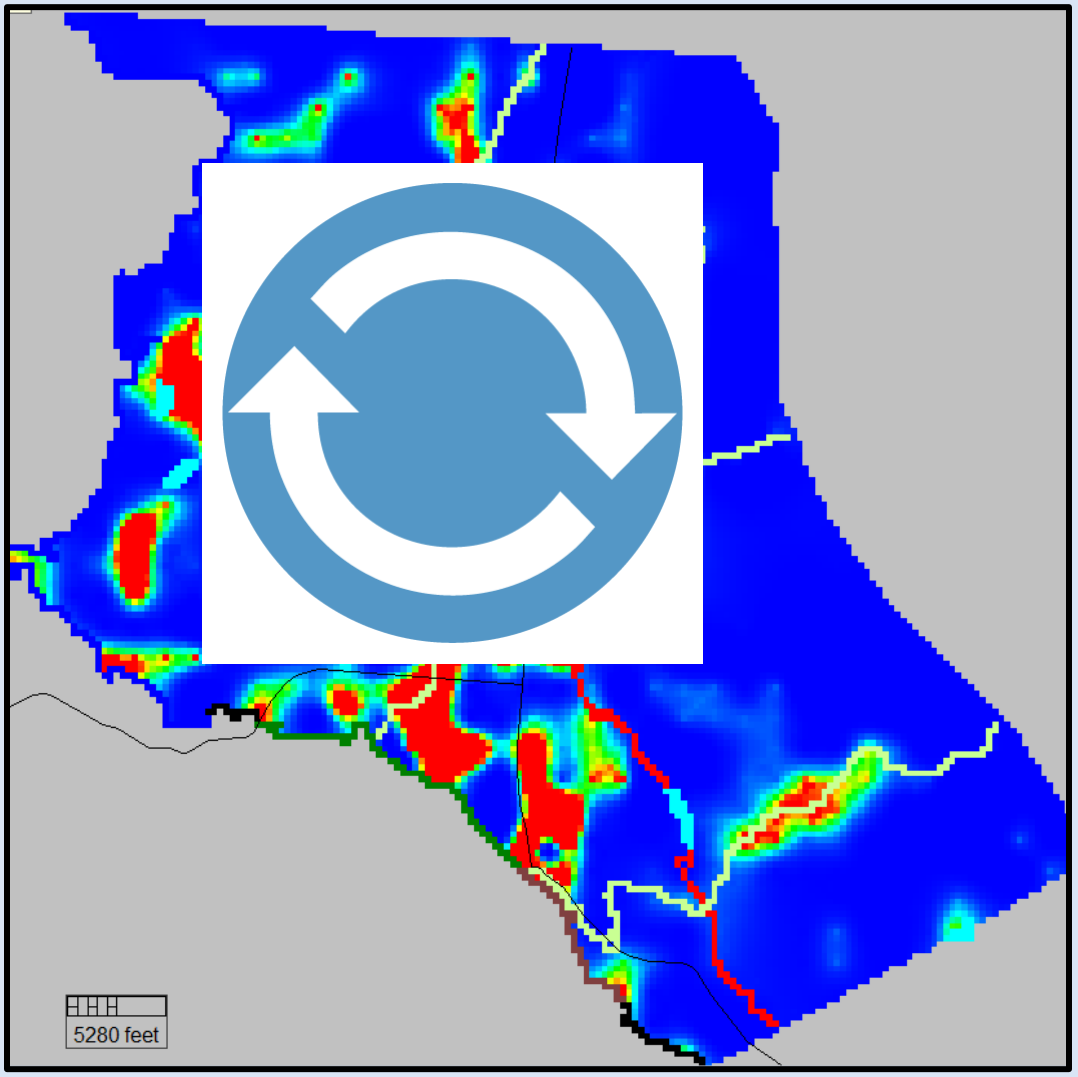
Underway – Steady State Model





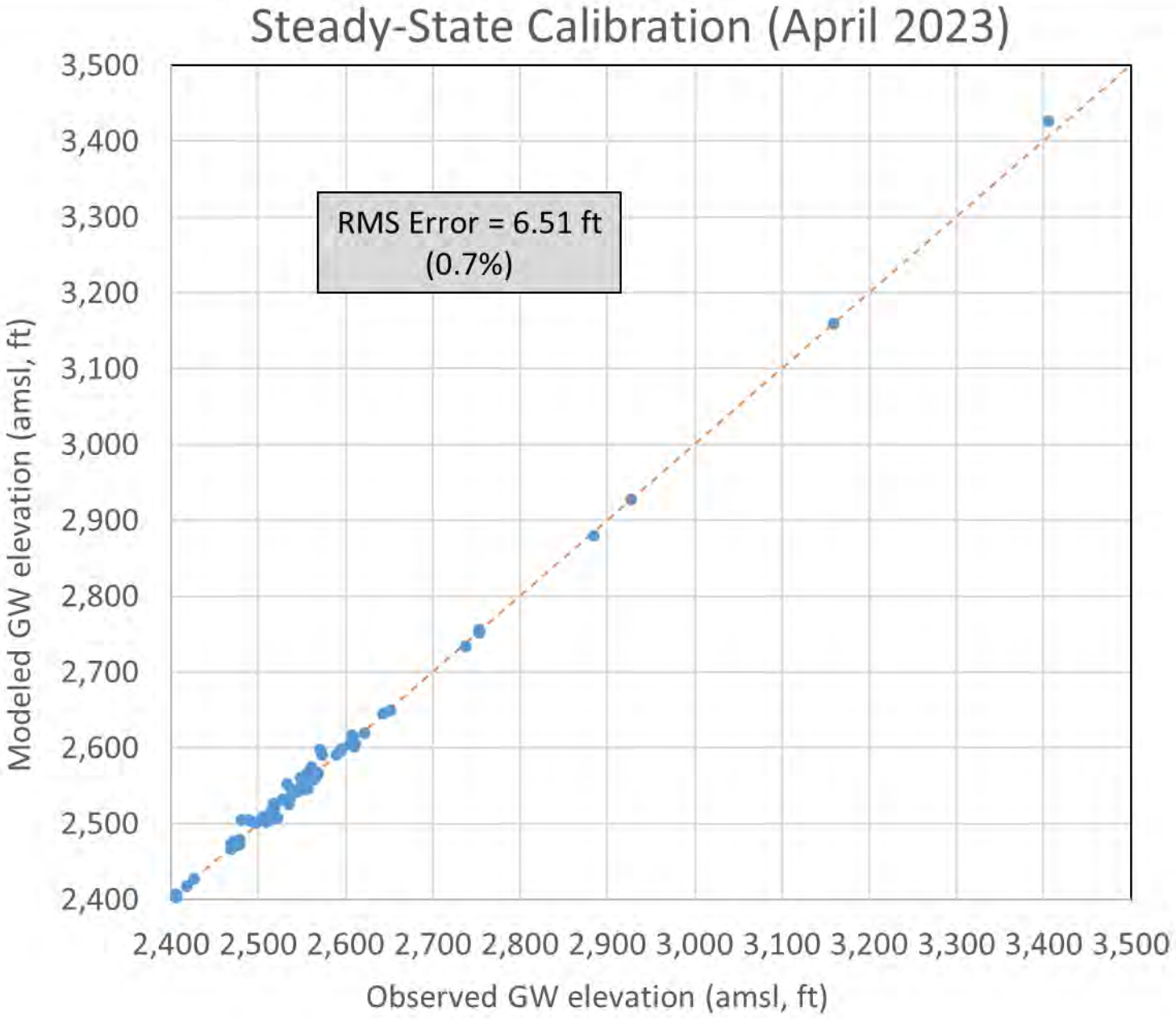
Simulate Groundwater Levels, and Compare to Observations

Underway – Steady State Model



Modify aquifer properties, and sources and sinks, within reasonable ranges to improve model fit with observations

Underway – Steady State Model



Underway – Steady State Model

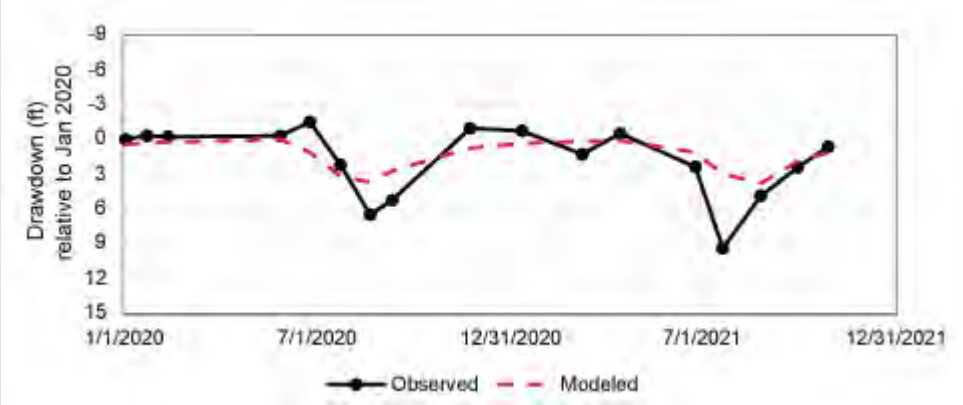
A single solution using dissimilar types of information.

Next Steps – Convert to Transient Model

- Dynamic Boundary Conditions
  - Changes over time

- Add Storativity term
  - Aquifer property that defines how water is stored and released over time

- Calibrate to hydrograph types



Example

Next Steps – Questions and Scenarios

- Delineate the area where groundwater development will likely require mitigation due to depletion of the Tobacco River
- Provide the model as a water management tool
- Evaluate the effects of decreased inflow from Phillips Creek
- Evaluate the different effects from the same amount of pumping in different hydrogeologic units
  - Change the shape of the potentiometric surface
- Others?

Questions