



Groundwater and Surface- Water Interactions within the Boulder River Valley

Montana Bureau of Mines and Geology (MBMG)
Groundwater Investigations Program (GWIP)

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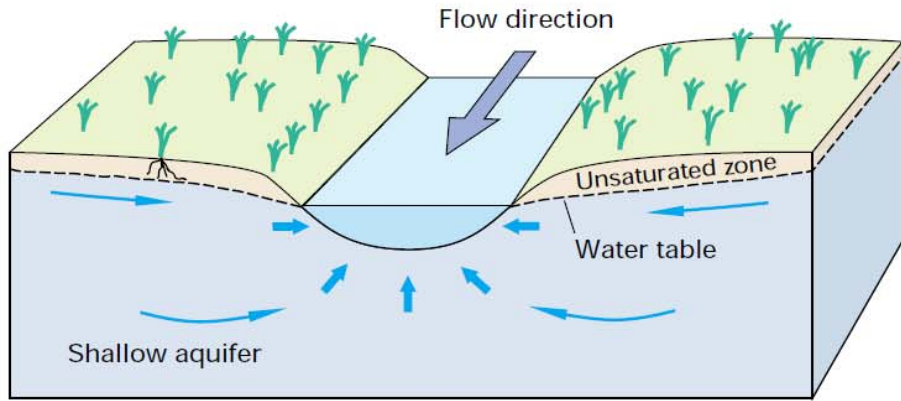


Boulder Valley Study: Major Questions

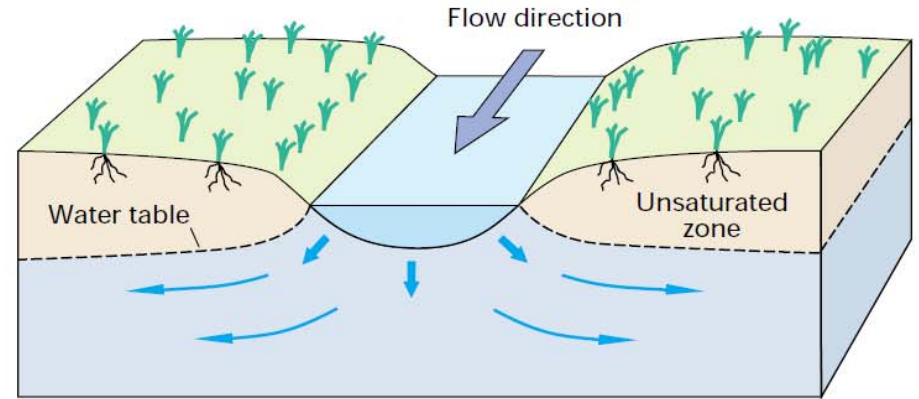
- How would increased groundwater development effect senior surface-water rights?
- Can managed recharge be used to enhance late summer stream flows?
- To answer these we need to understand the relationship between surface water and groundwater.



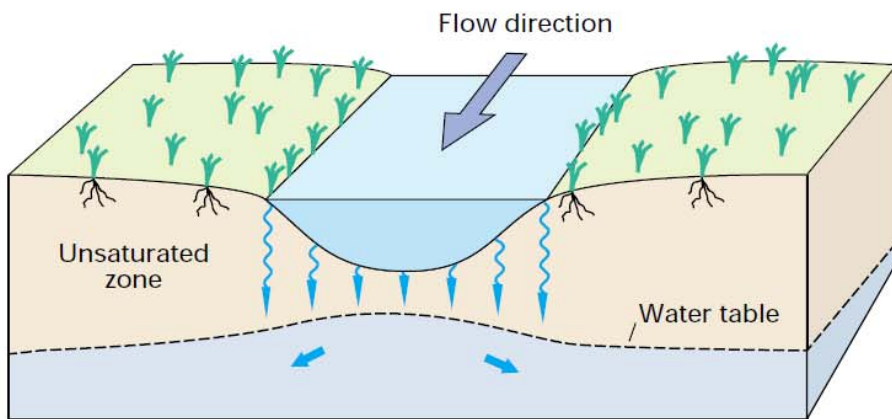
GAINING STREAM



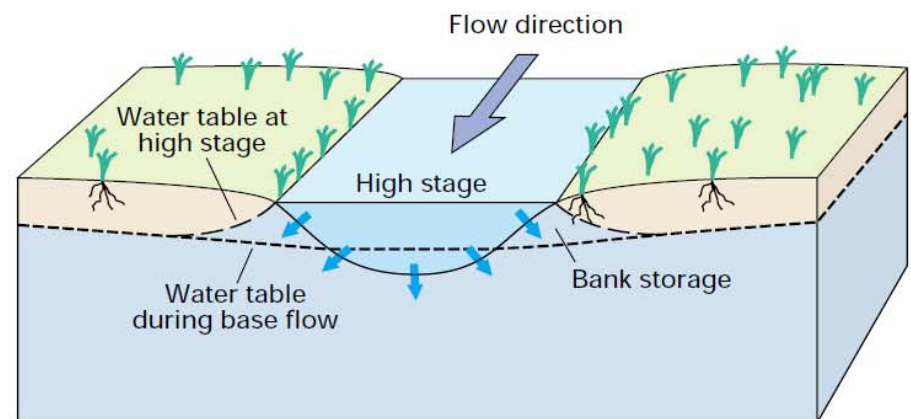
LOSING STREAM

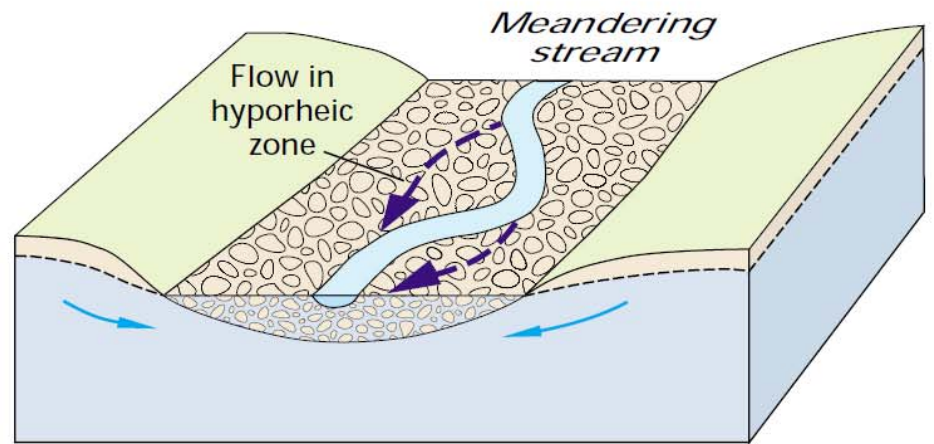
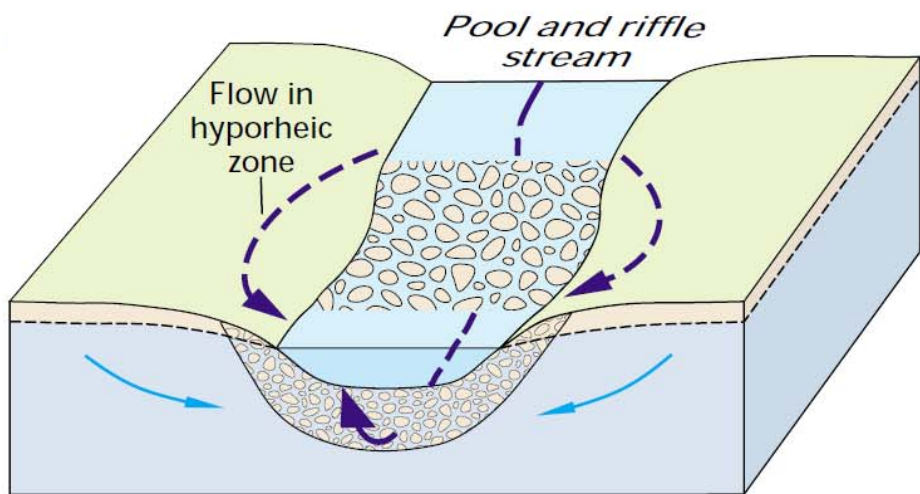


DISCONNECTED STREAM



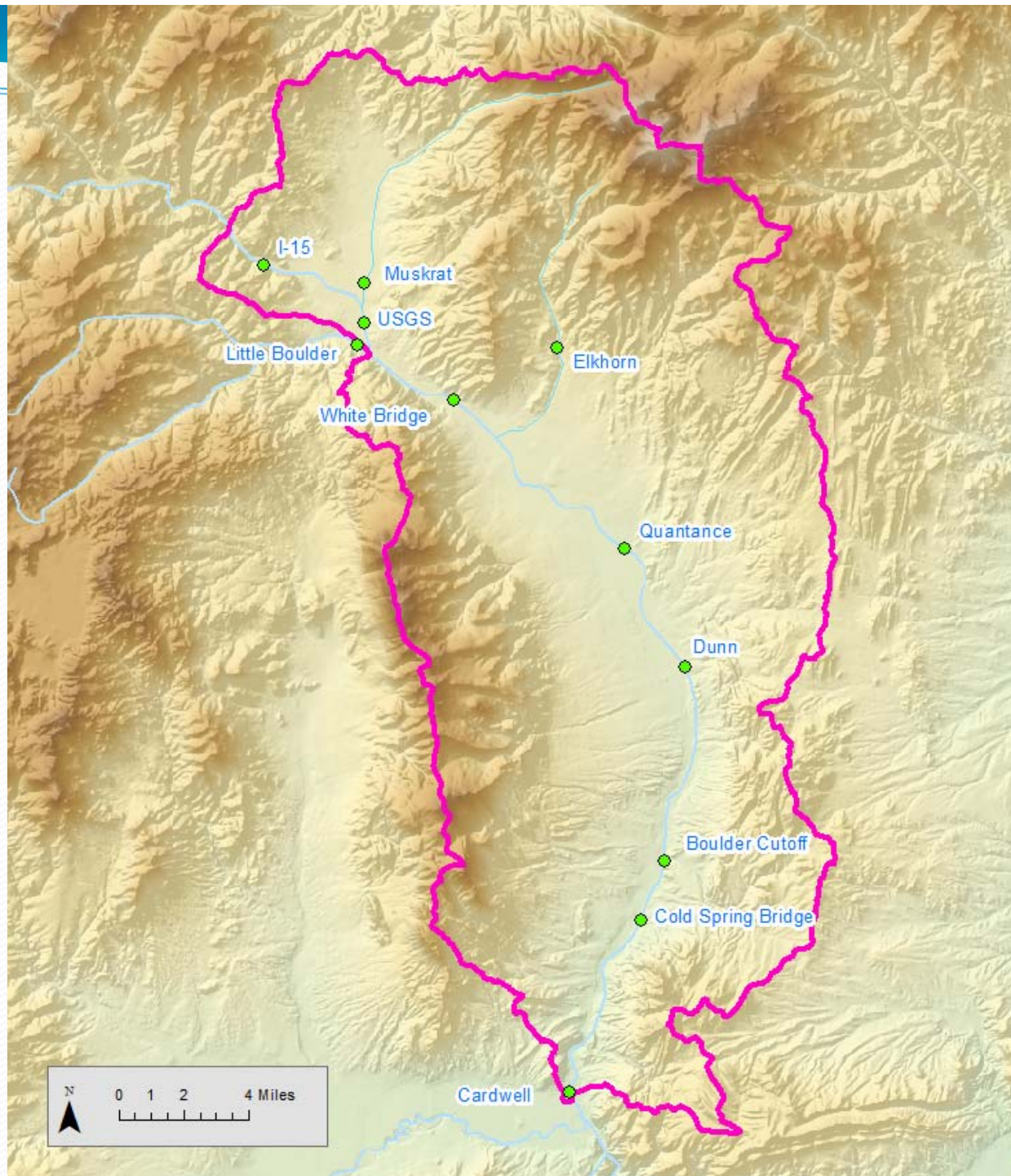
BANK STORAGE





Figures from Winter et al., 1998

Surface-Water Monitoring Stations: Boulder Valley GWIP

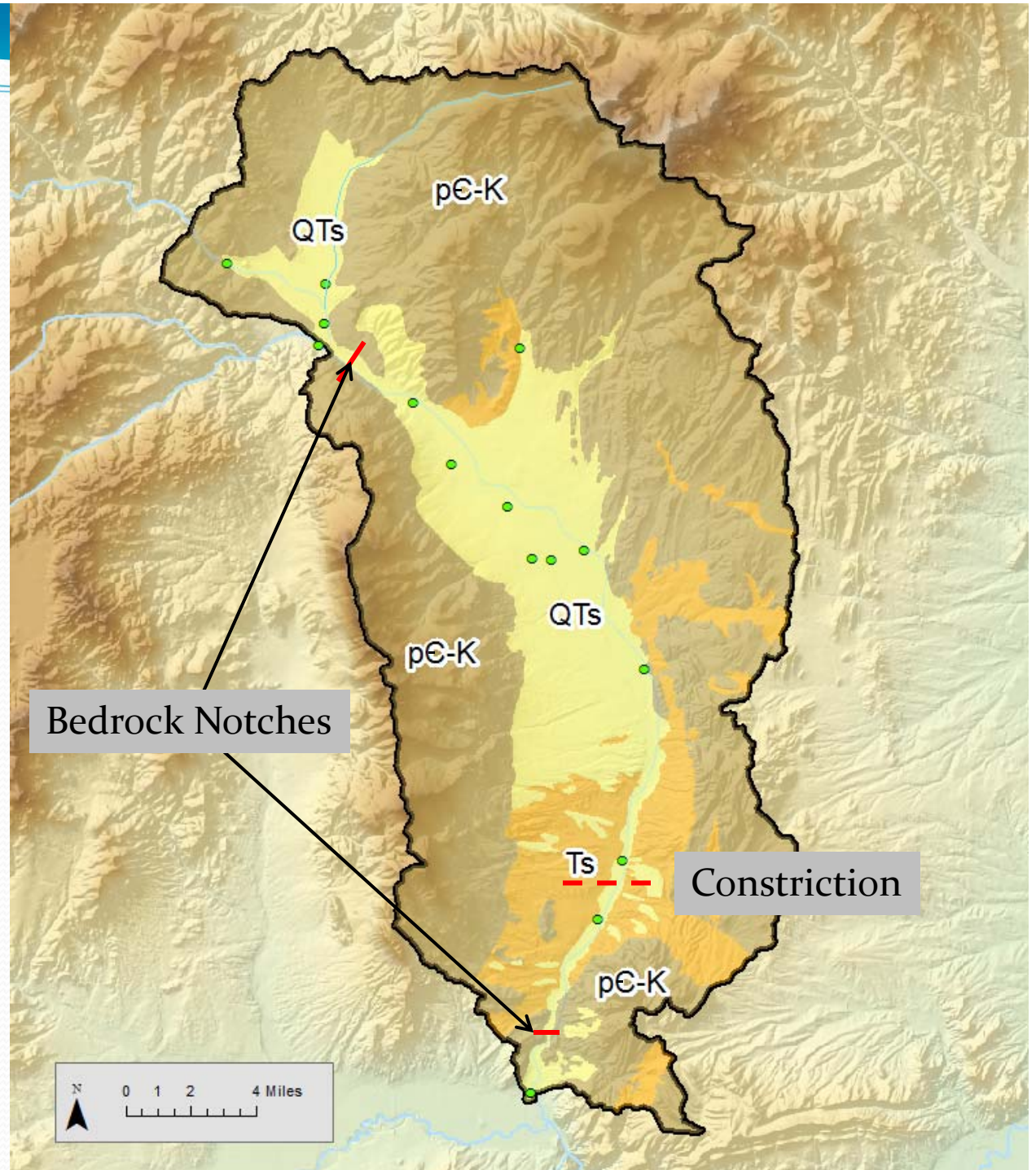


Generalized Geologic Setting

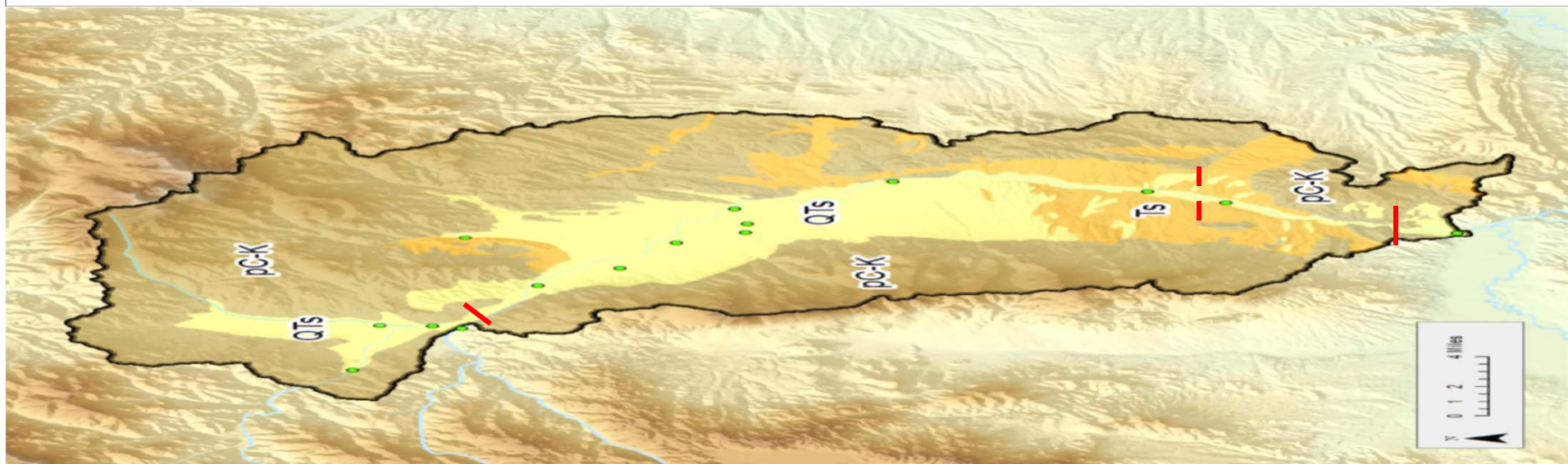
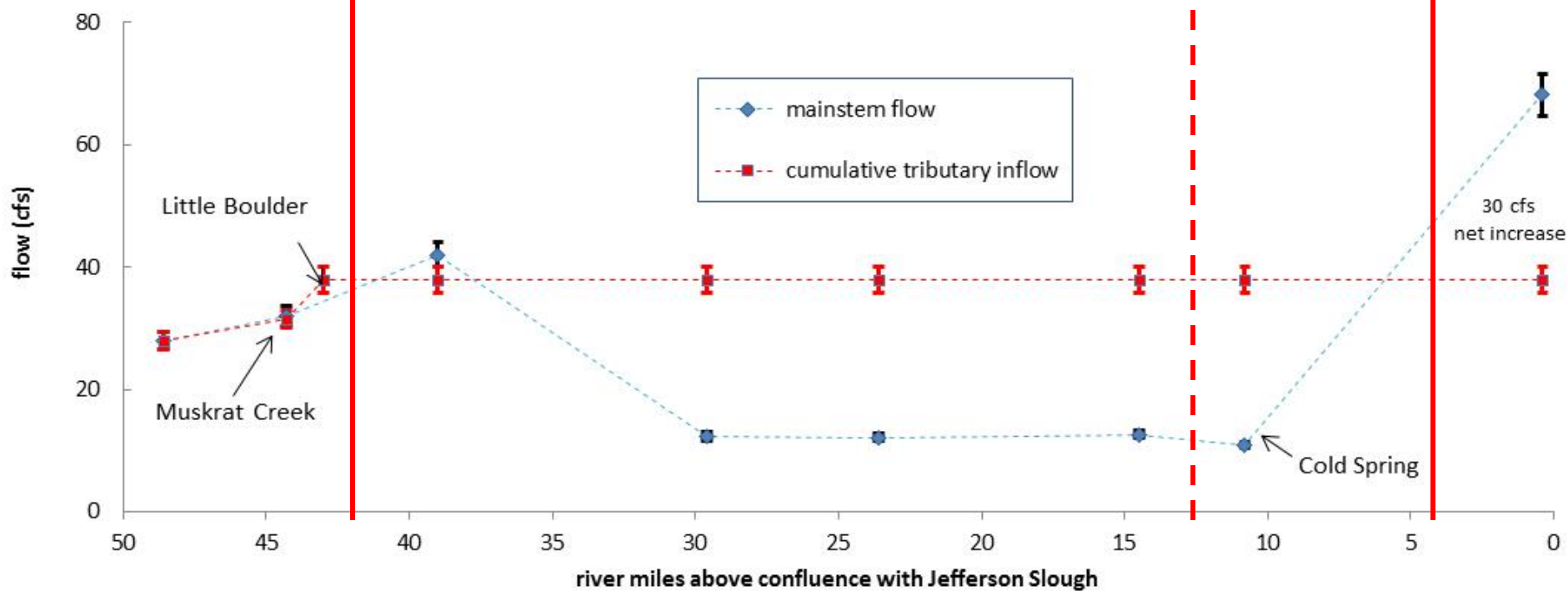
Qal = Quaternary Alluvium

QTs = Quaternary and Tertiary Sediments

pЄ-K = Bedrock



Boulder River; October 22, 2012



A. Gaining reach of stream

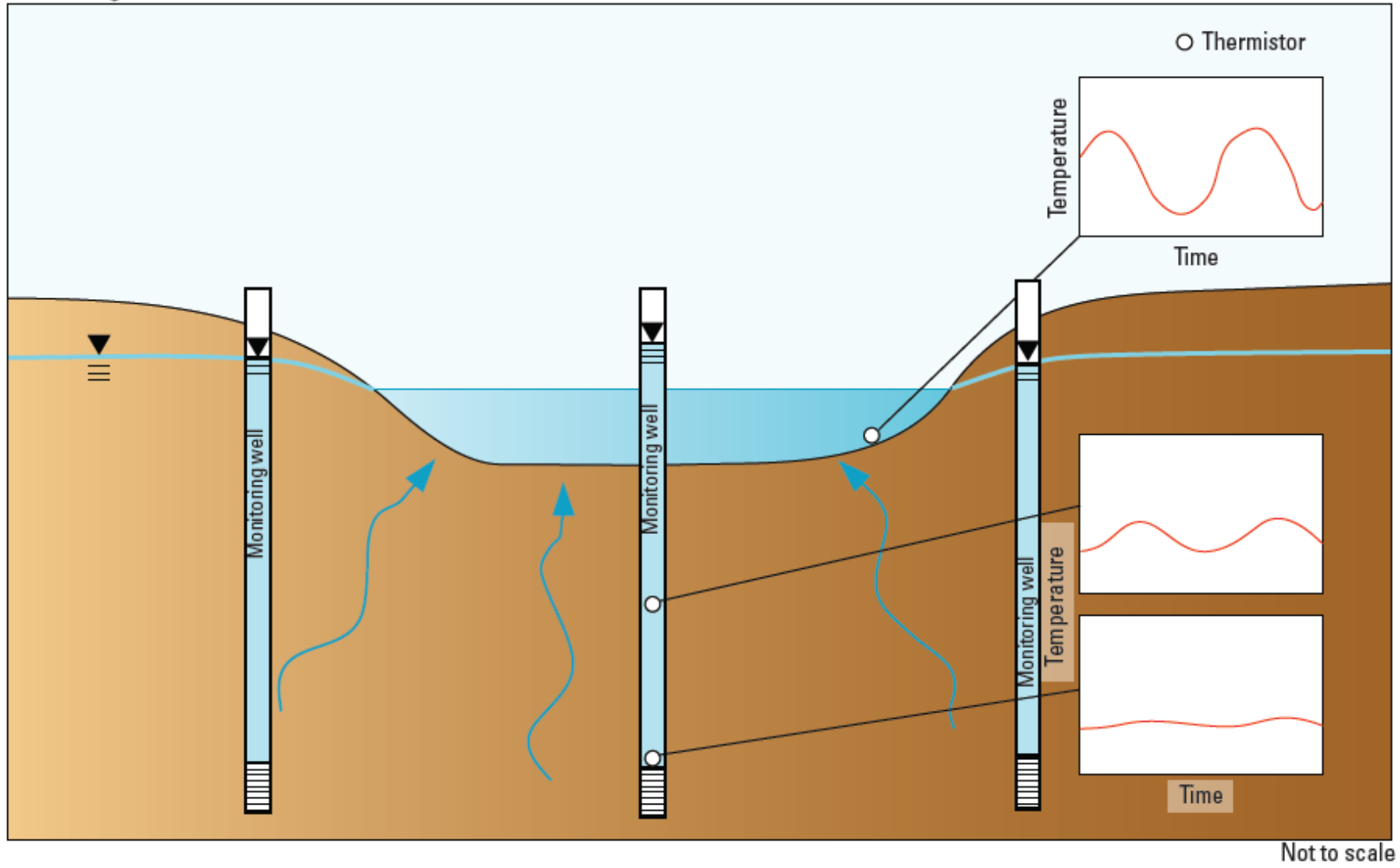
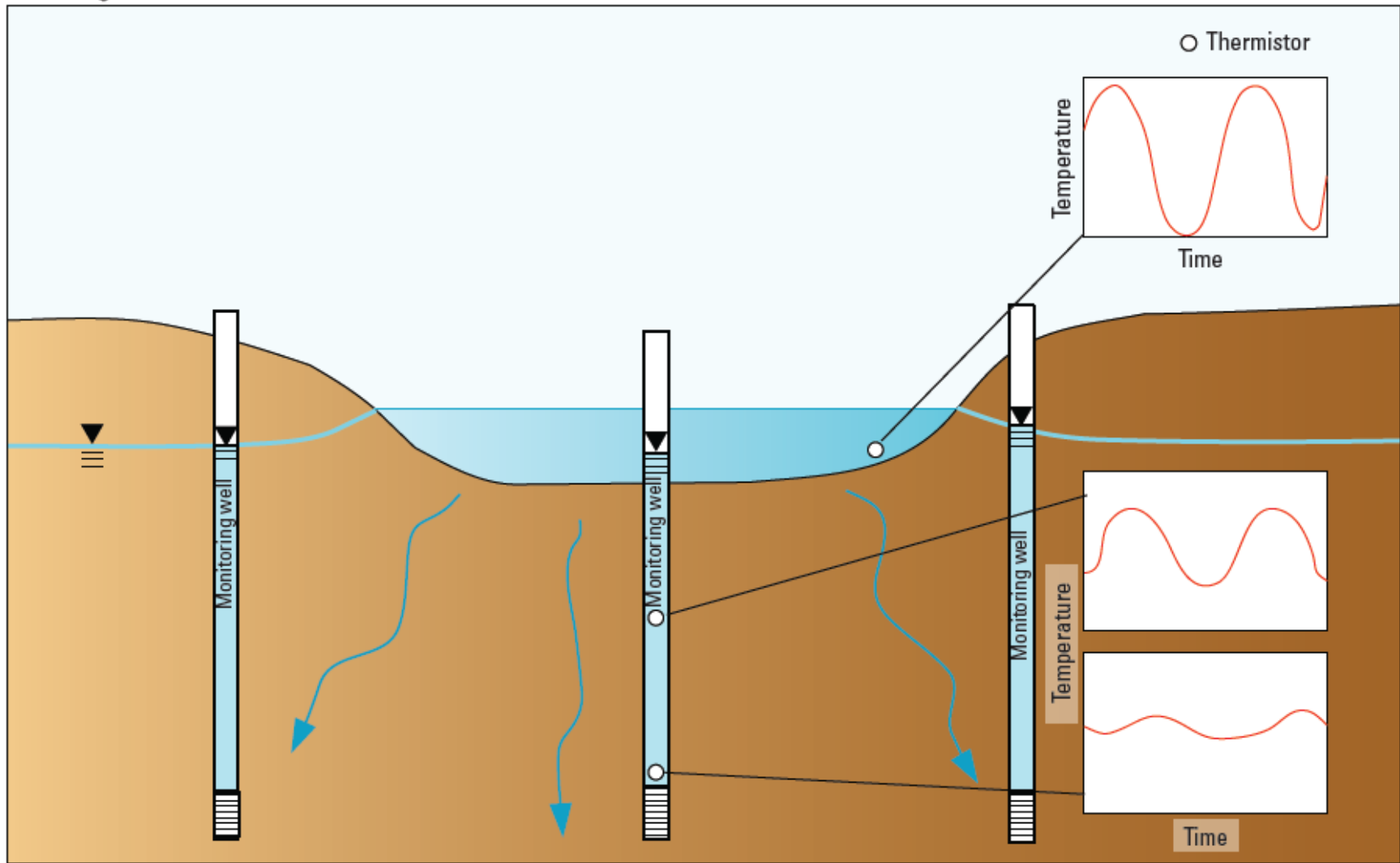


Figure from Caldwell and Eddy-Miller, 2013

B. Losing reach of stream



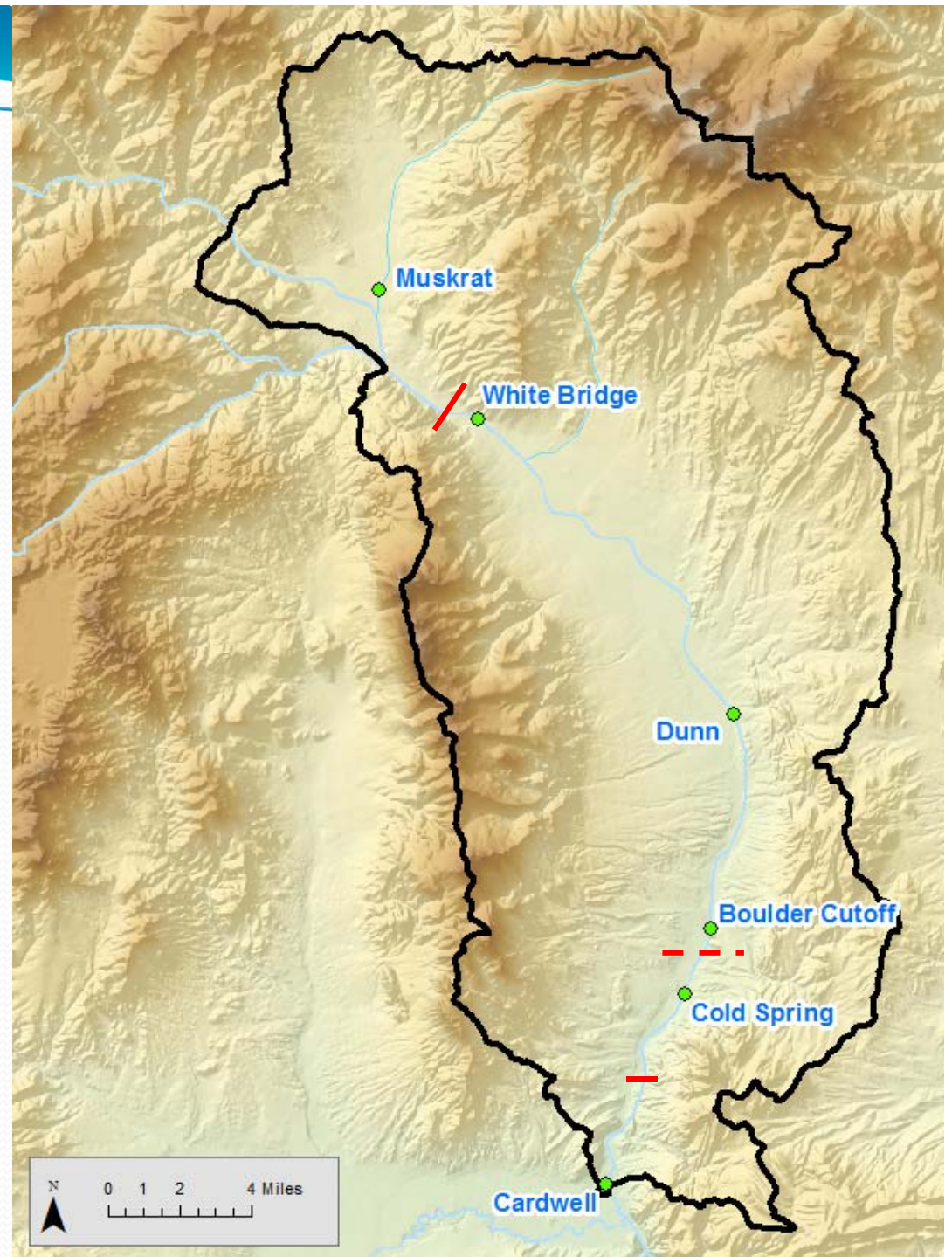
Not to scale

Figure from Caldwell and Eddy-Miller, 2013

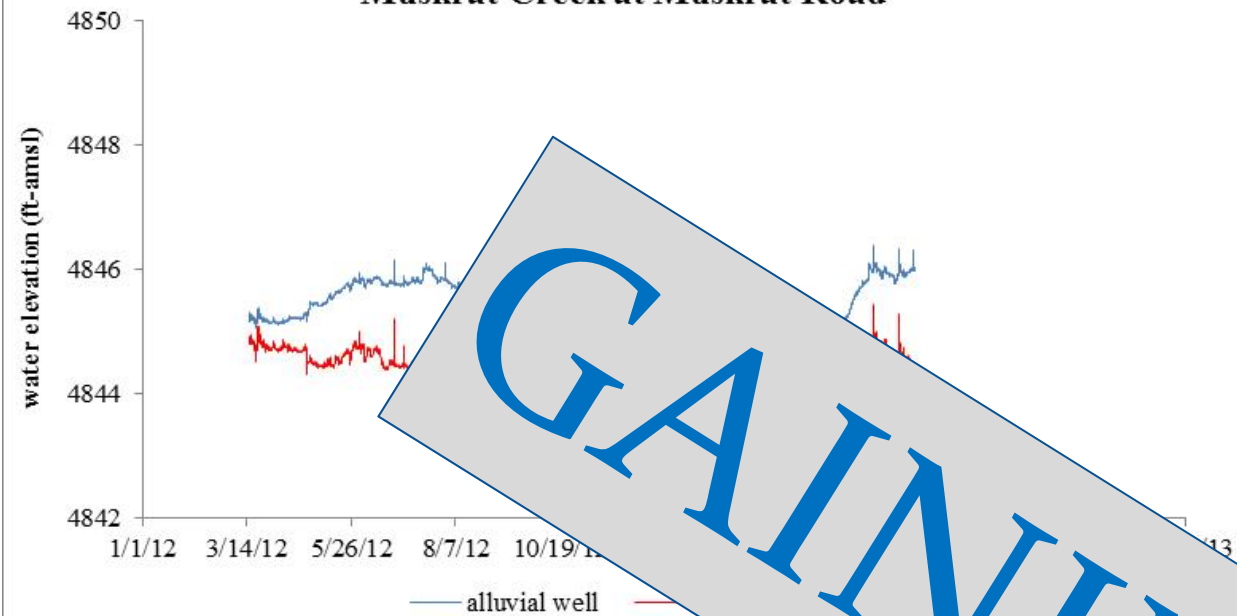
6 Wells installed adjacent to Boulder River and Muskrat Creek

Wells completed with open bottom in first permeable zone

- Good for water quality and groundwater elevations
- Don't expect to see diurnal temperature variations



Groundwater/Surface-Water Interactions Muskrat Creek at Muskrat Road

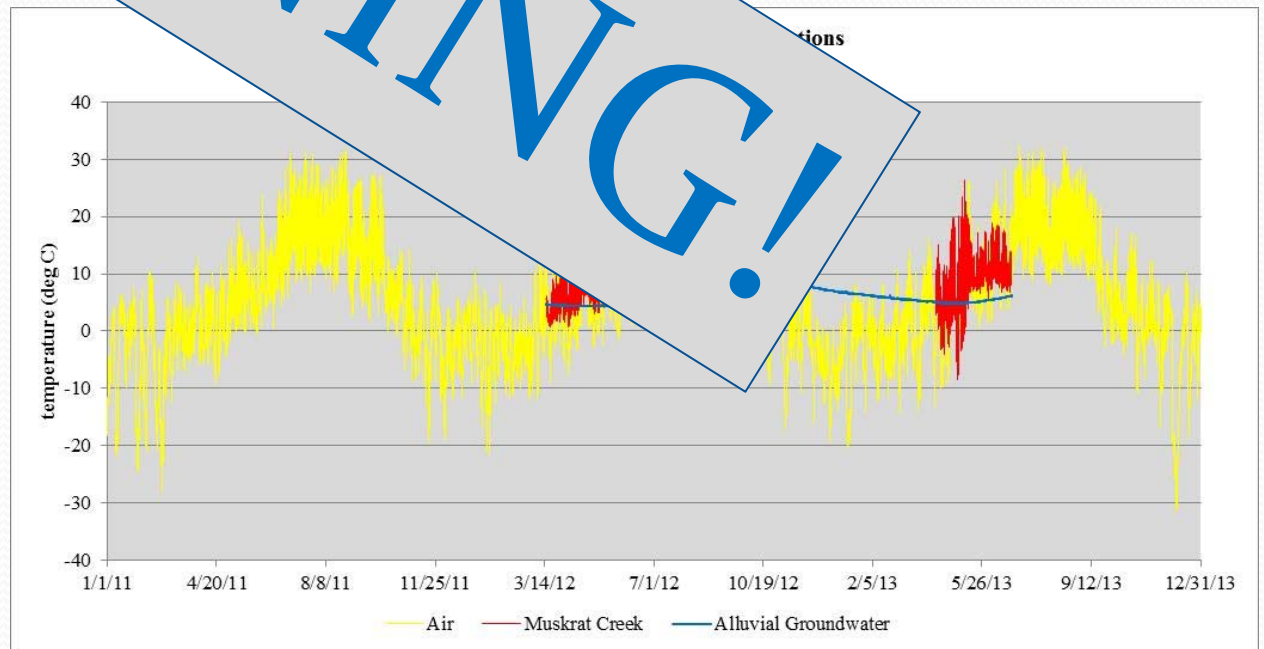


Groundwater levels are always higher than surface-water levels

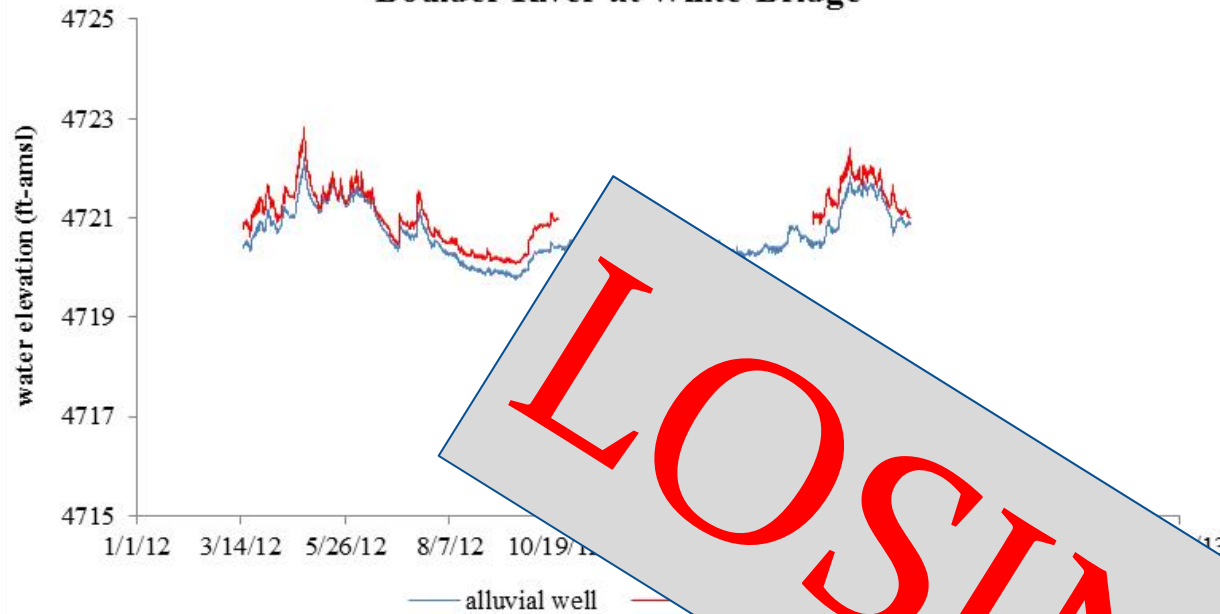
GAINING!

Surface-water temperatures are similar to, but somewhat less variable than air temperature

Groundwater temperatures are much less variable than surface-water or air temperatures. Minimum and Maximum temperatures are also offset. Do not approach 0 °C.



Groundwater/Surface-Water Interactions Boulder River at White Bridge



Groundwater levels are always lower than surface-water levels

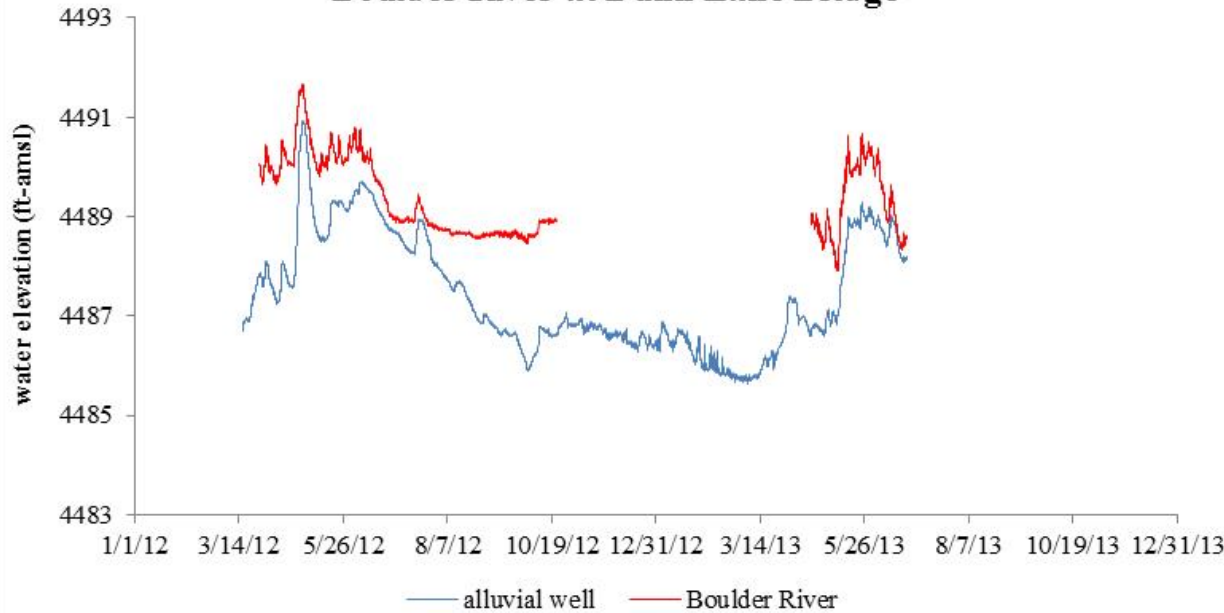
LOSING!

Surface-water temperatures are similar to, but somewhat less variable than air temperature

Groundwater temperatures are similar to but less variable than surface-water or air temperatures. Minimum and Maximum temperatures are coincident. Approach 0 °C during the winter.



Groundwater/Surface-Water Interactions Boulder River at Dunn Lane Bridge

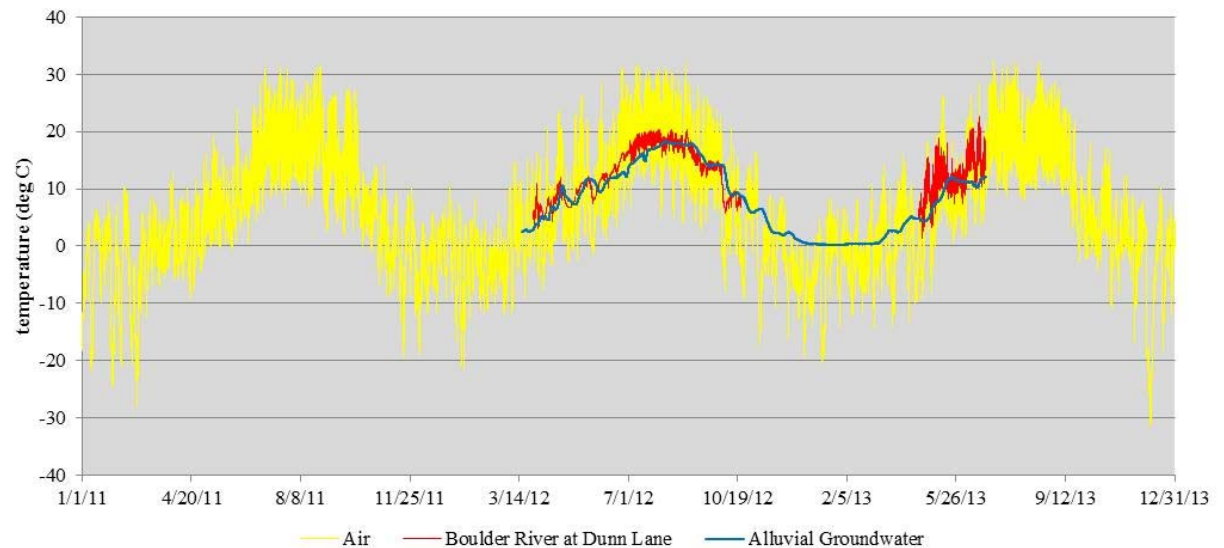


Groundwater levels are always lower than surface-water levels

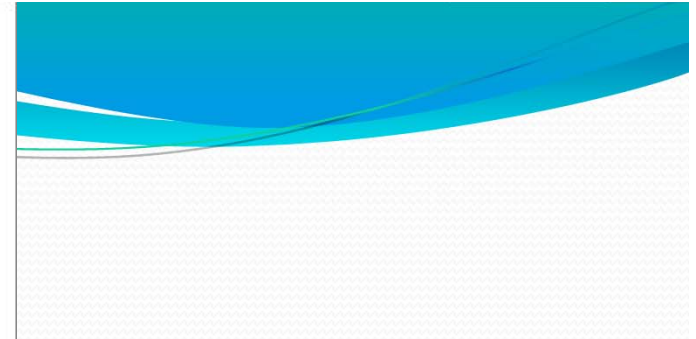
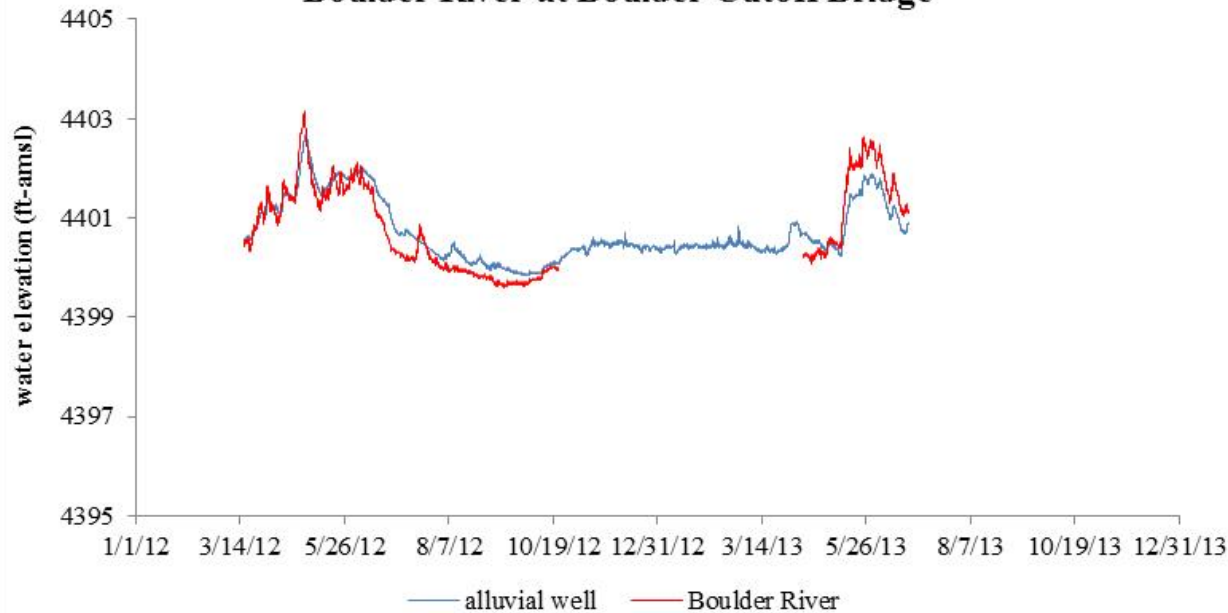
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Groundwater/Surface-Water Interactions Boulder River at Dunn Lane



Groundwater/Surface-Water Interactions Boulder River at Boulder Cutoff Bridge

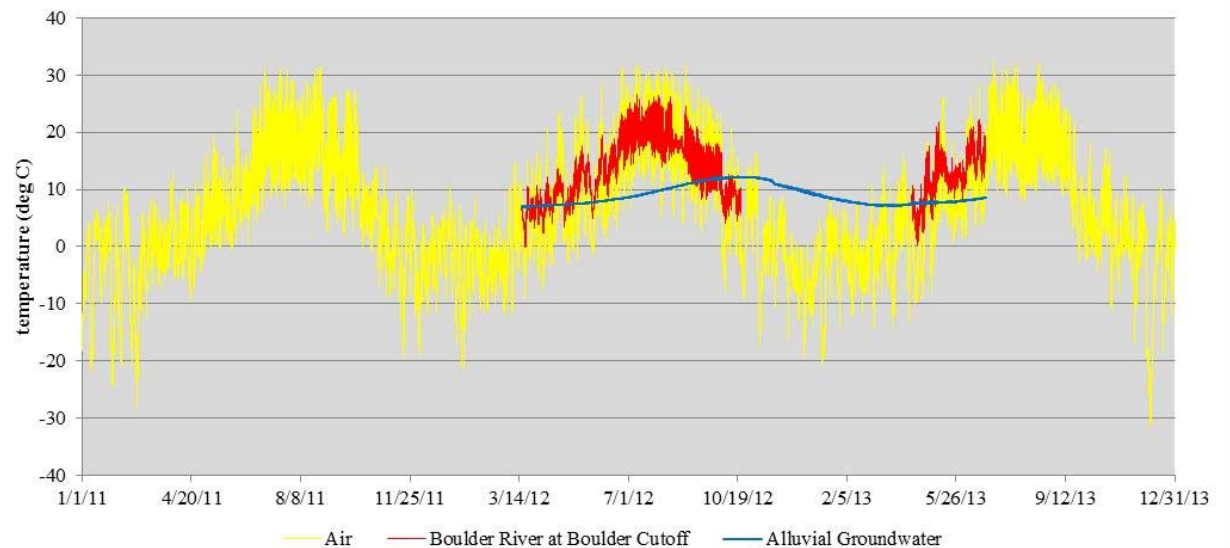


Groundwater levels are higher than surface-water levels, except for during spring runoff.

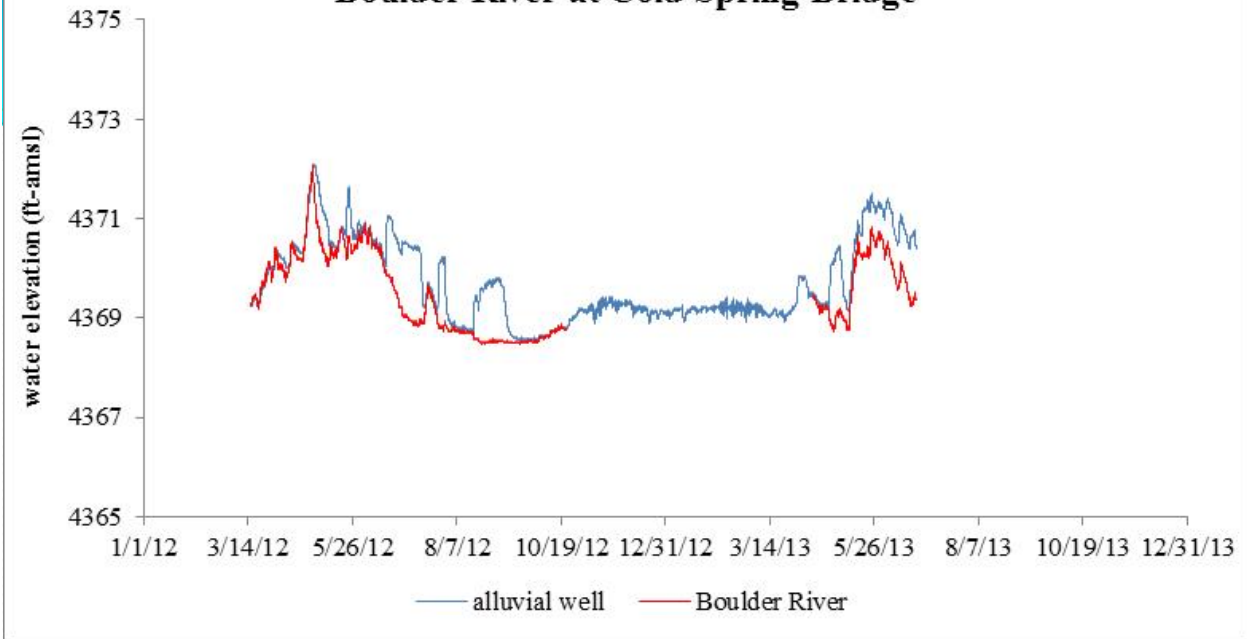
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Groundwater/Surface-Water Interactions Boulder River at Boulder Cutoff



Groundwater/Surface-Water Interactions Boulder River at Cold Spring Bridge



Groundwater levels are never lower than surface-water levels.

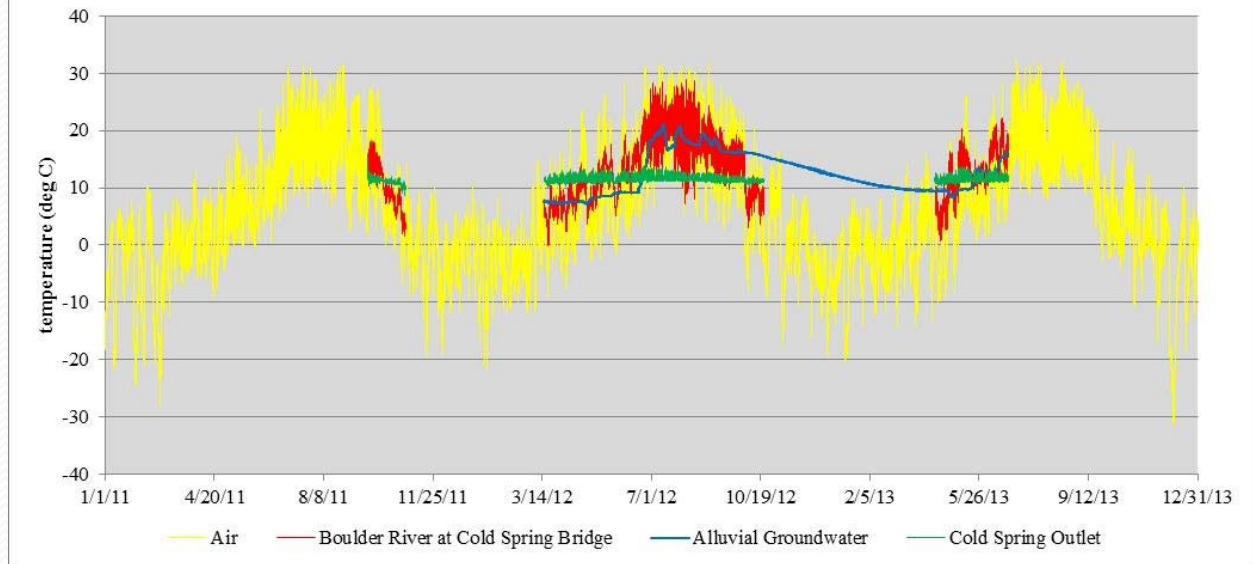
Pulses are much higher.

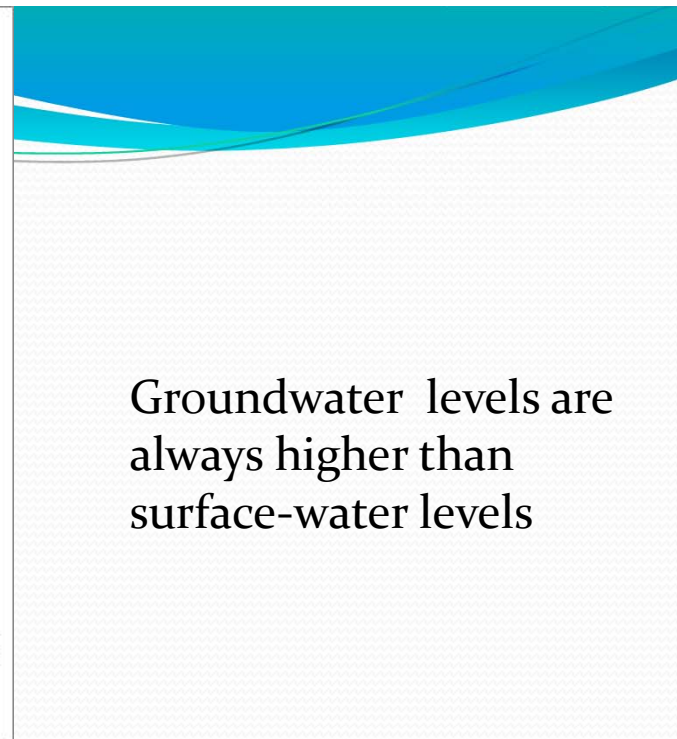
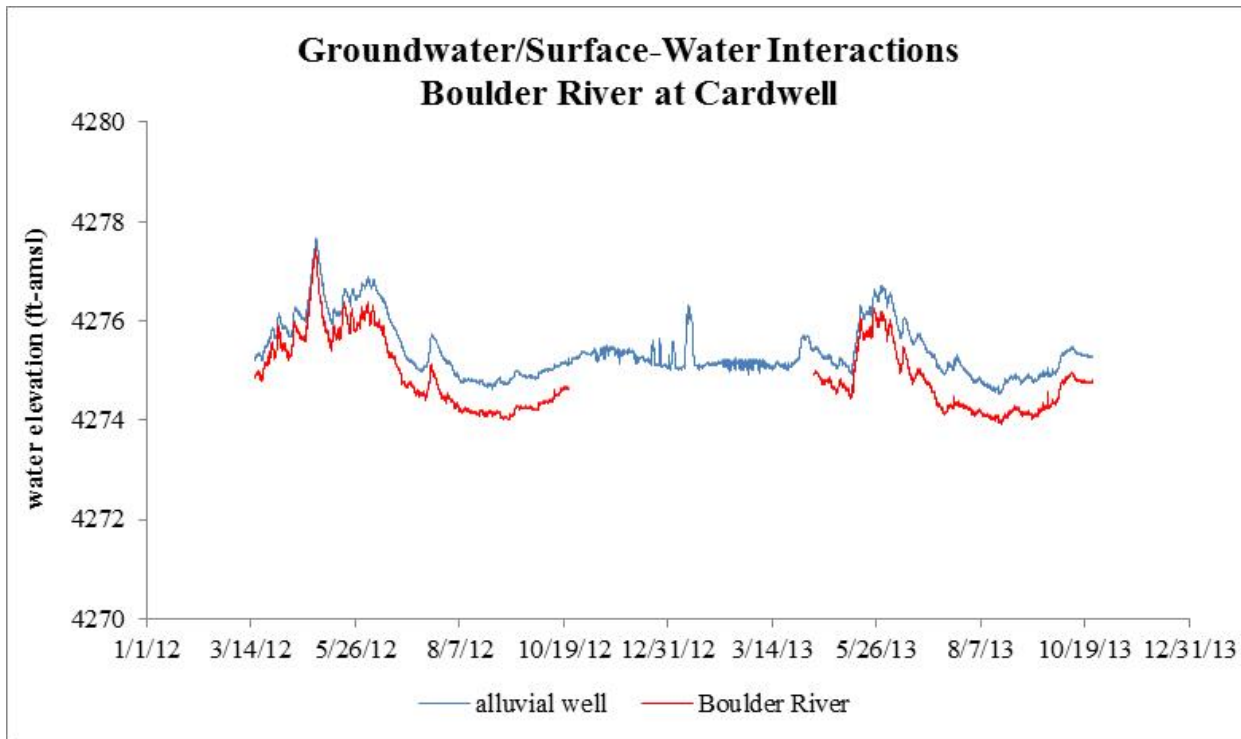
Site is next to a flood irrigated field.

Surface-water temperatures are similar to, but somewhat less variable than air temperature

Groundwater temperatures show much less short term variability, but they pulse up with flood irrigation. Do not approach 0 °C.

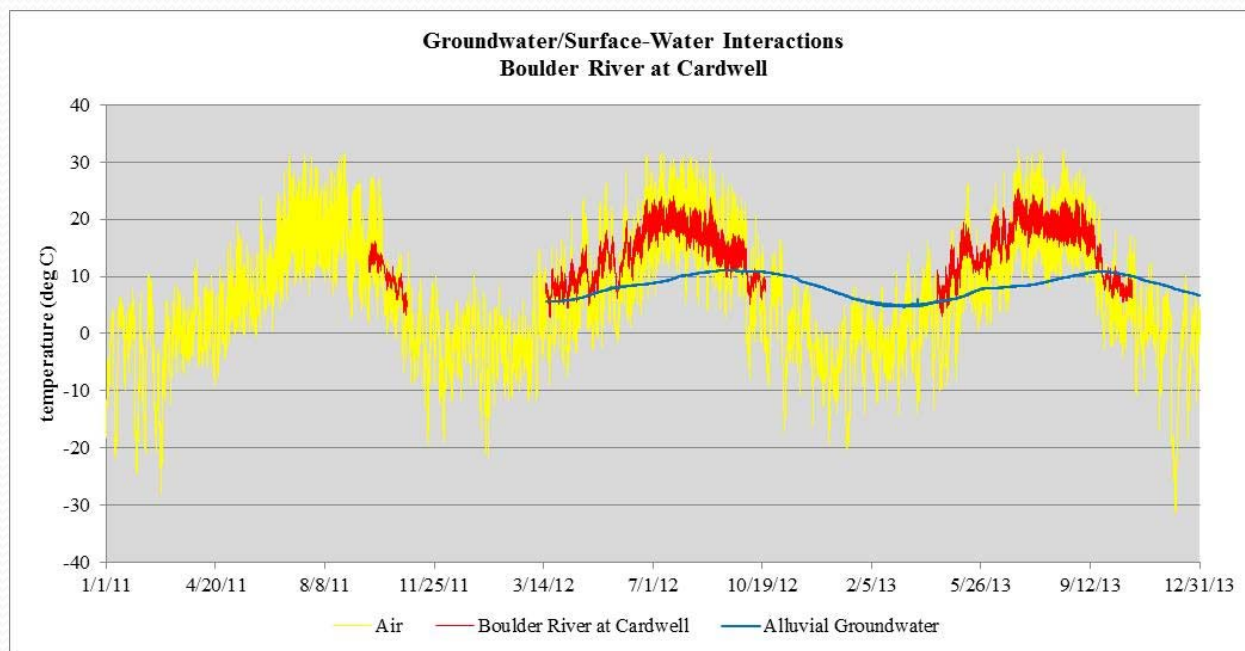
Groundwater/Surface-Water Interactions Boulder River at Cold Spring Bridge





Surface-water temperatures are similar to, but somewhat less variable than air temperature

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Result Summary

	Net Flow	SW/GW Site	Notes
BR I-15 to Red Bridge	Gain		
Lower End of Muskrat Creek		Gain	
Red Bridge to White Bridge	Gain		
White Bridge		Loss	
White Bridge to Quantance	Loss		
Quantance to Dunn	---		
Dunn Lane		Loss	
Dunn to Boulder Cutoff	---		
Boulder Cutoff		Gain - Variable	Loss during Spring runoff
Cutoff to Cold Spring	---		
Cold Spring		Gain	Strong irrigation signal
Cold Spring to Cardwell	Gain		
Cardwell		Gain	

Summary:

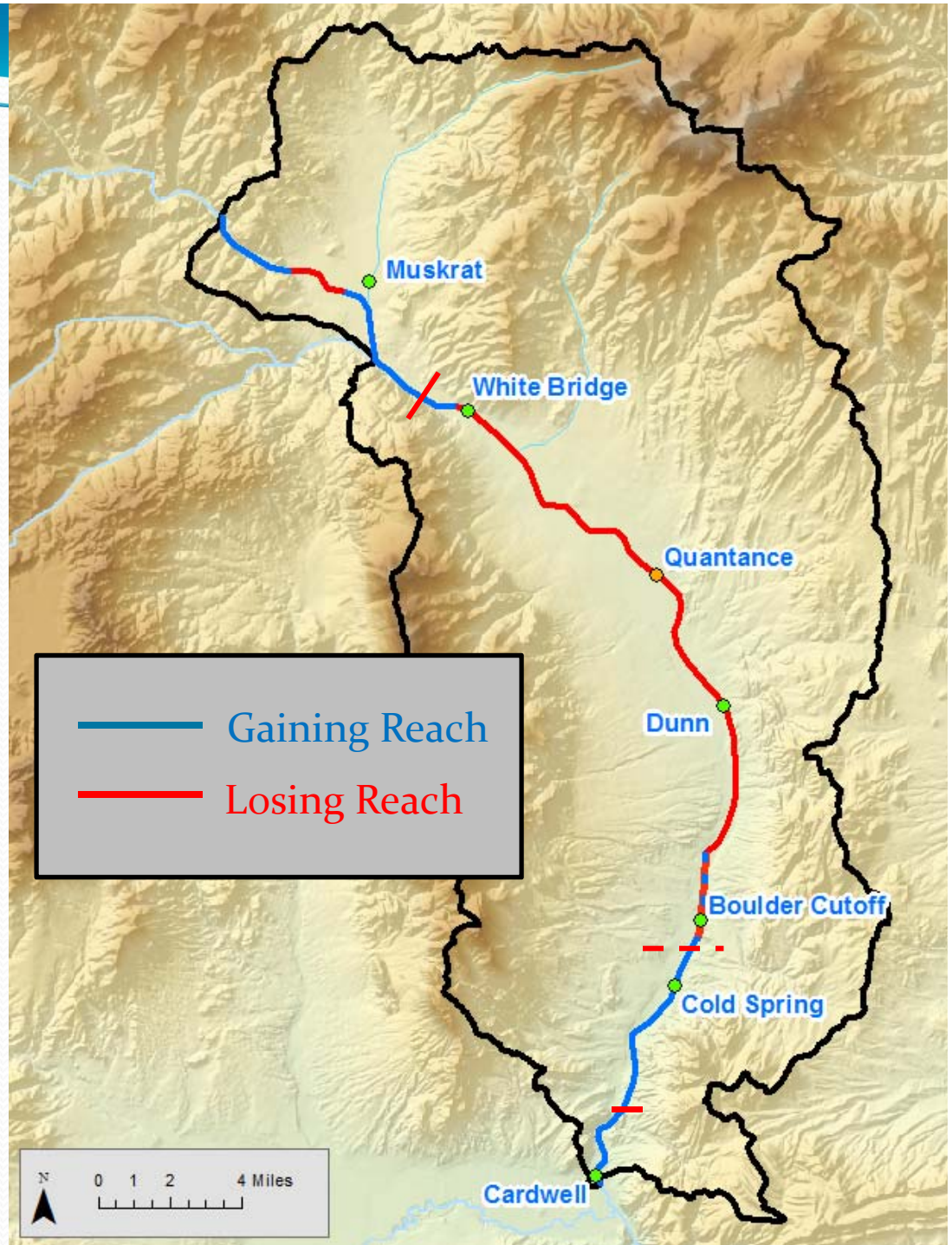
The Boulder River transitions from gaining to losing.

As unconsolidated units thin and narrow through bedrock notches groundwater flows into the river.

Below notches river water recharges groundwater.

Techniques to better define the geographic distribution of gains and losses would be useful.

-Thermal Imaging?





Questions?

If you have groundwater issues that you would like GWIP to consider, please talk to me, or go to our website at:

<http://www.mbmng.mtech.edu/gwip/gwip.asp>