Groundwater Resources in Mesa County

COLORADO MESA UNIVERSITY

Upper Colorado River Basin Water Forum
Grand Junction, Colorado

October 30, 2023

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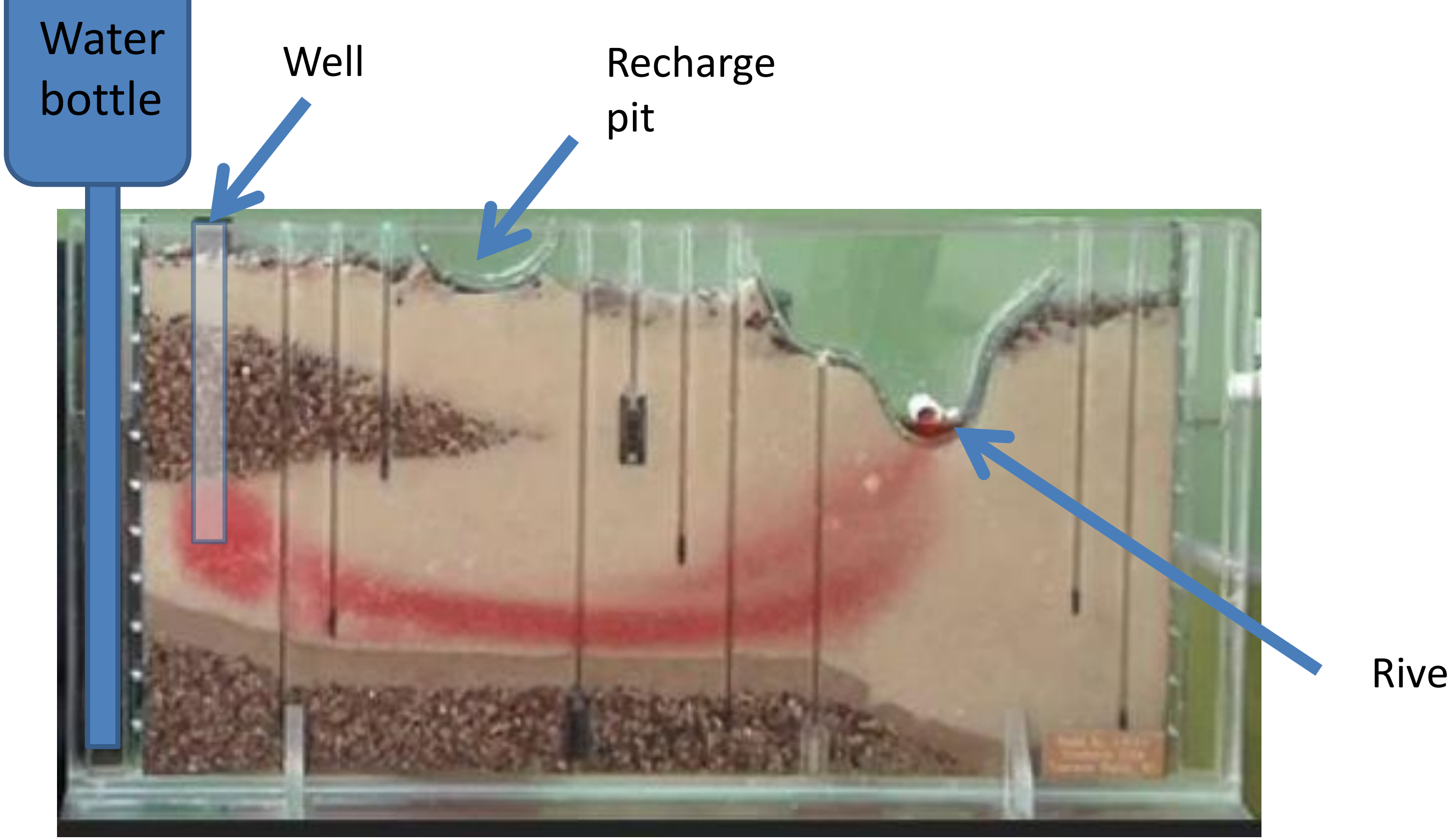
Steffan Teutsch, CMU Student, HRS Student Intern
mseitz@hrswater.com

HRS Water Consultants

Groundwater – out of sight, but should not be out of mind....



Stream depletion means either direct depletion from the stream or reduction of return flow to the stream.

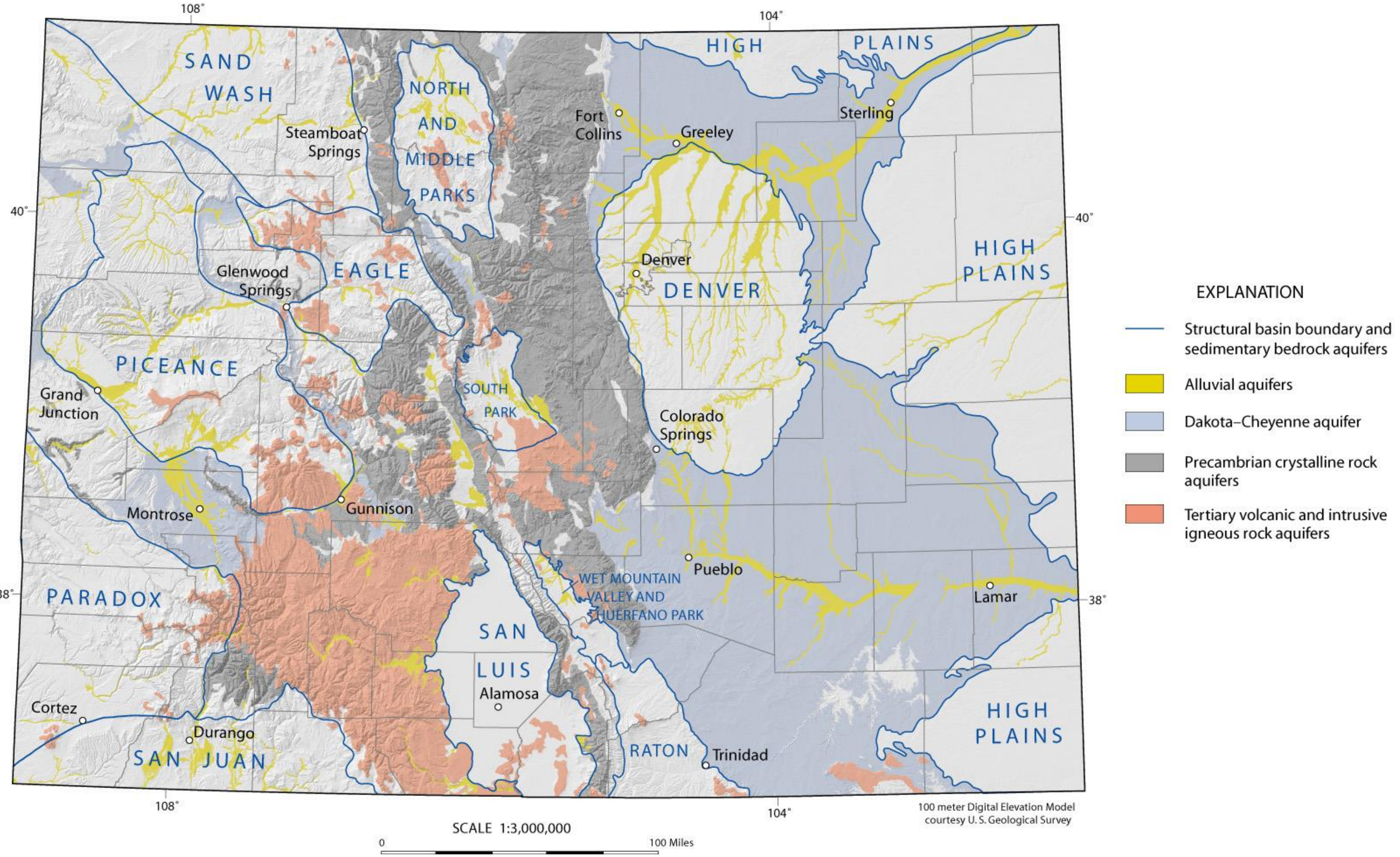
Groundwater Administration in Colorado

- 1965 – Colorado Ground Water Management Act

Topics

- Quick Overview of Area Aquifers
- Groundwater – Surface Water Interactions
- GW Highlight Topic
  - GW Recharge (in this talk)
  - Other interesting GW topics … (not in this talk)
    - Water quality (Se, U, TDS, etc.)
    - Produced Water Reuse
    - GW pumping and influence on In Stream Flow Rights
    - CO_2 sequestration
    - Geothermal

Colorado Aquifers



Source: Colorado Groundwater Atlas

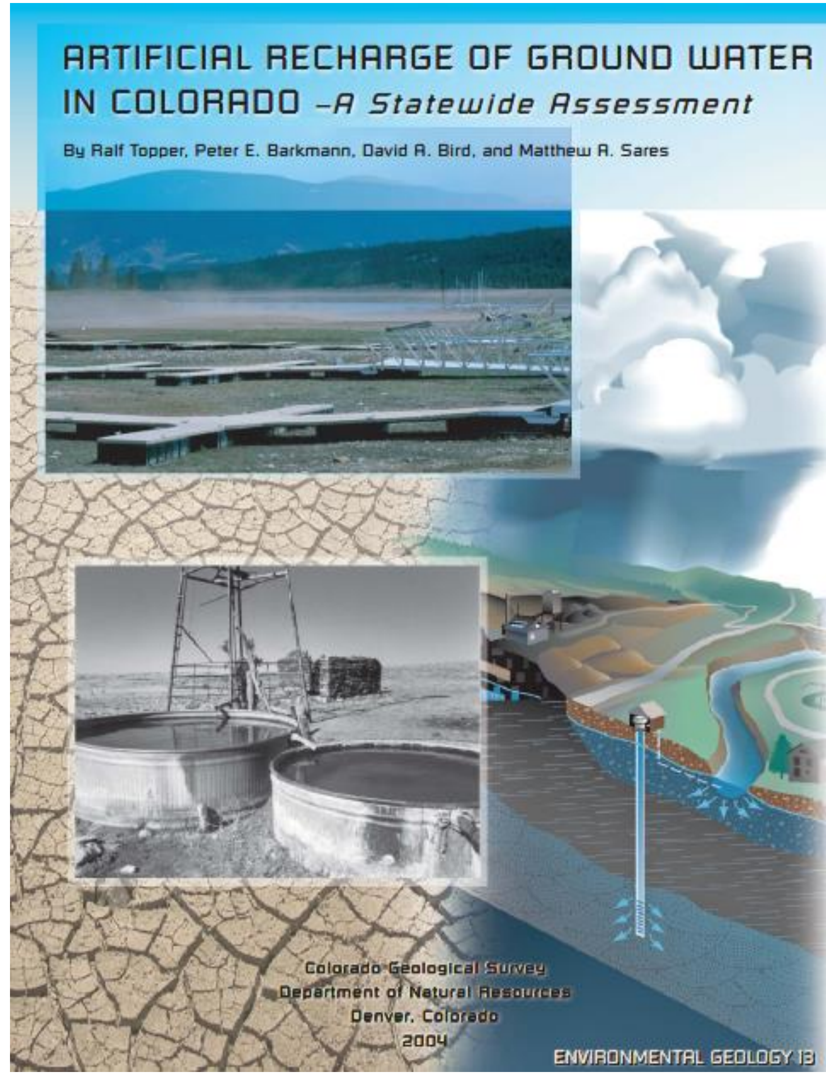
OPEN-FILE REPORT OF-17-01

Geology and Groundwater Resources of Mesa County, Colorado

By Lesley A. Sebol, Katheryne H. McGee, Erinn P. Johnson, and Peter E. Barkmann

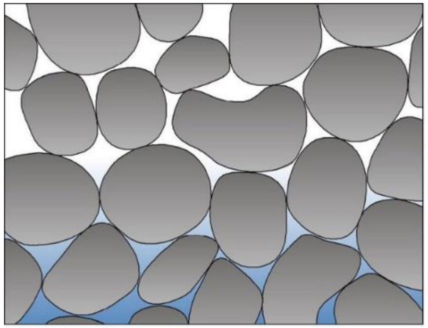
Colorado Geological Survey
Colorado School of Mines
Golden, Colorado

2017

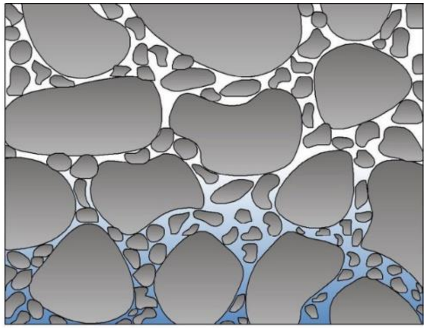


Aquifer Types

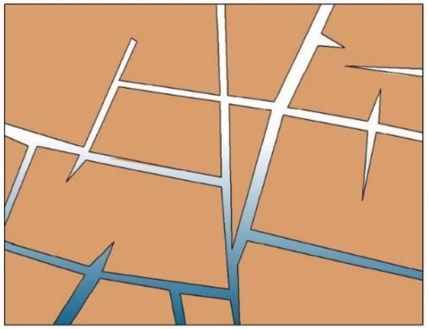
- Unconsolidated Sediments
- Sedimentary Bedrock
- Fractured Crystalline Rock & Volcanic Rock



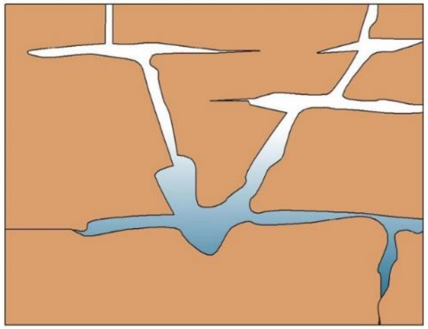
Well-sorted sedimentary material
(Alluvium of the South Platte River)



Poorly sorted sedimentary material
(Dawson, Denver, Arapahoe aquifers)

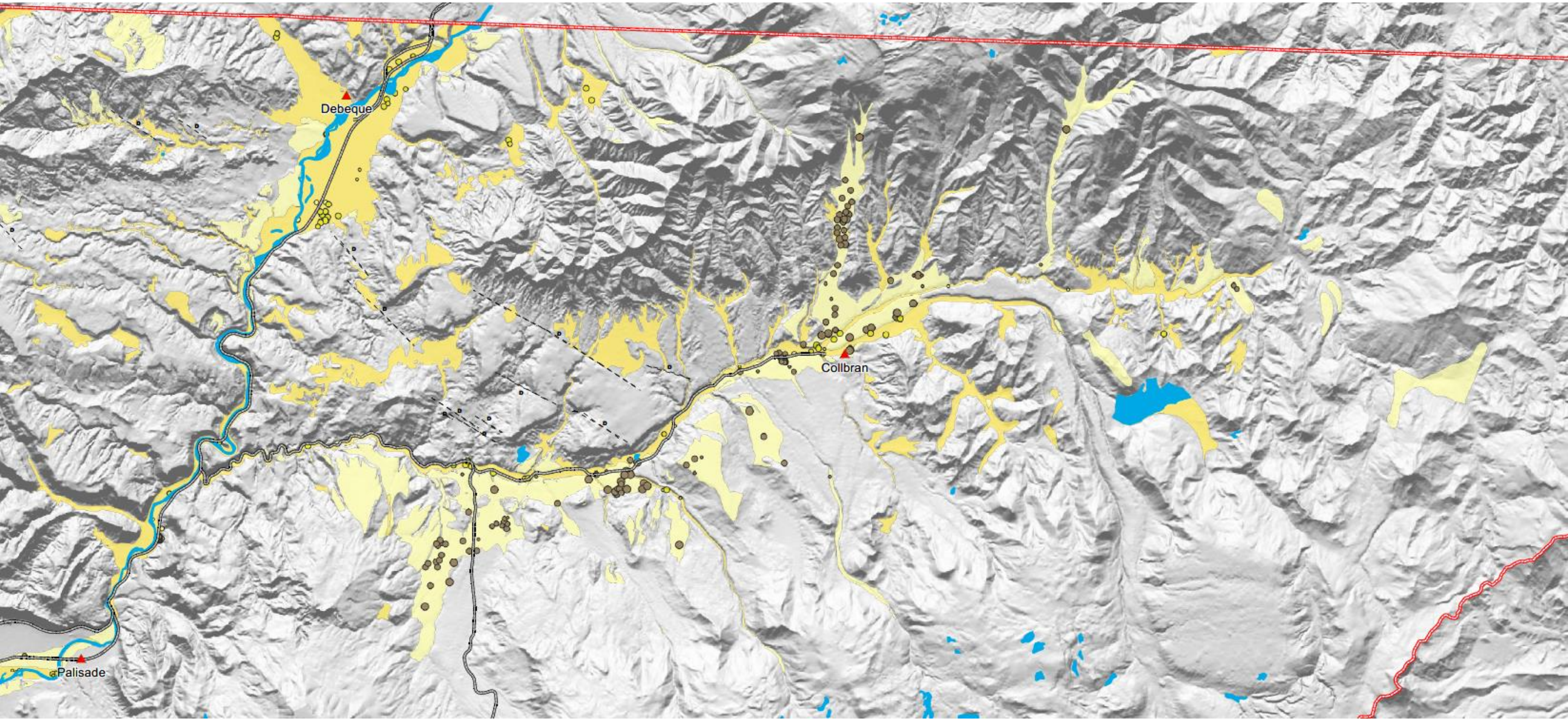


Fractured crystalline rocks
(Pikes Peak Granite)



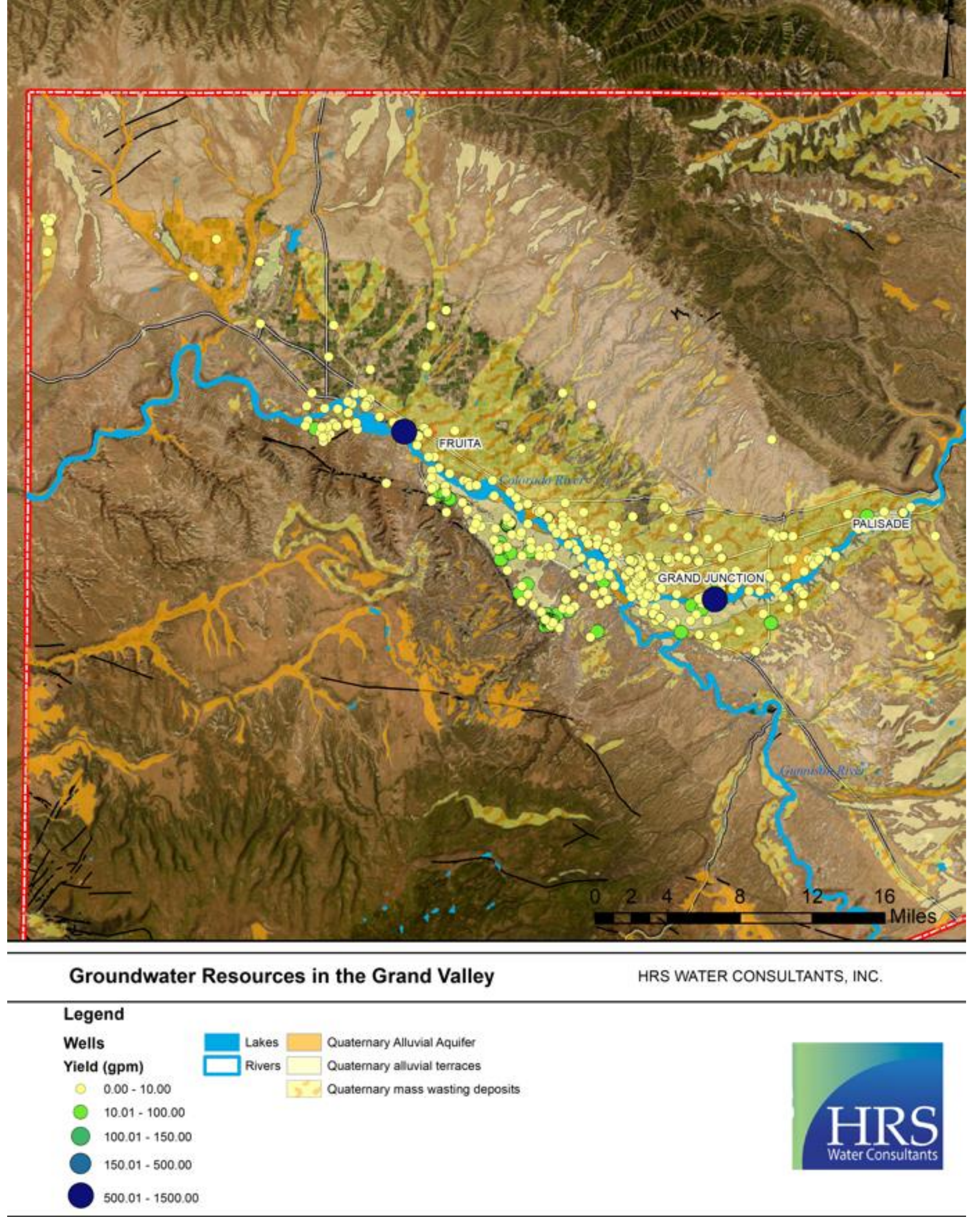
Soluble rock-forming material
(Leadville Limestone)

Unconsolidated Aquifer (CGS)



Near Debeque, Colbran, Palisade

Unconsolidated Aquifer



Palisade, Grand Junction, Fruita

Sedimentary Bedrock Aquifers

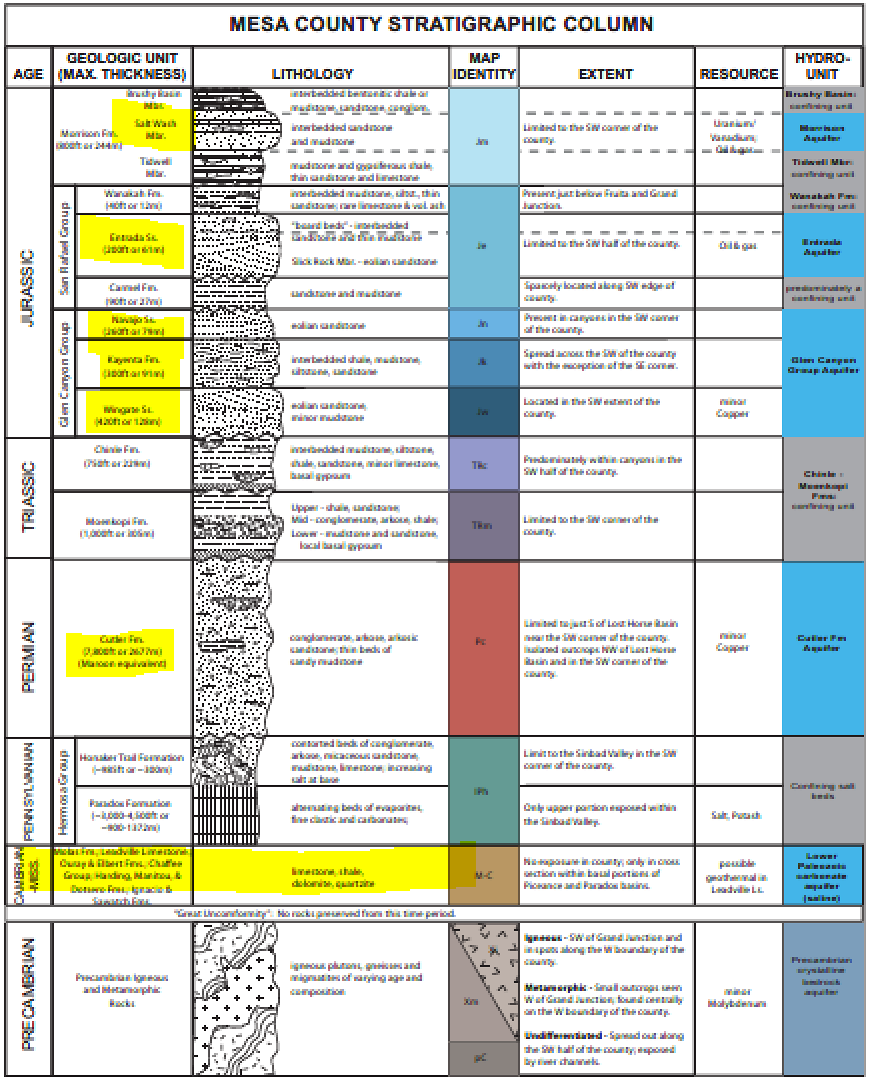


FIGURE 2B. MESA COUNTY STRATIGRAPHIC COLUMN, JURASSIC THROUGH PRECAMBRIAN UNITS.

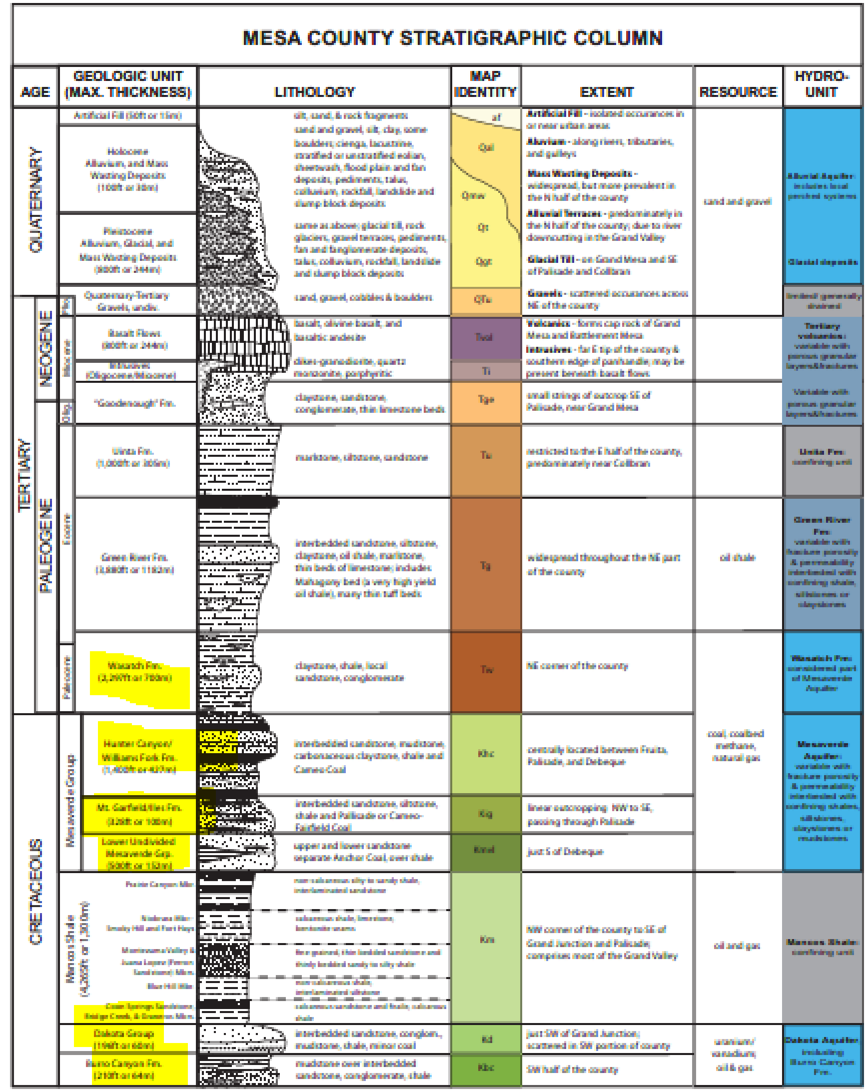
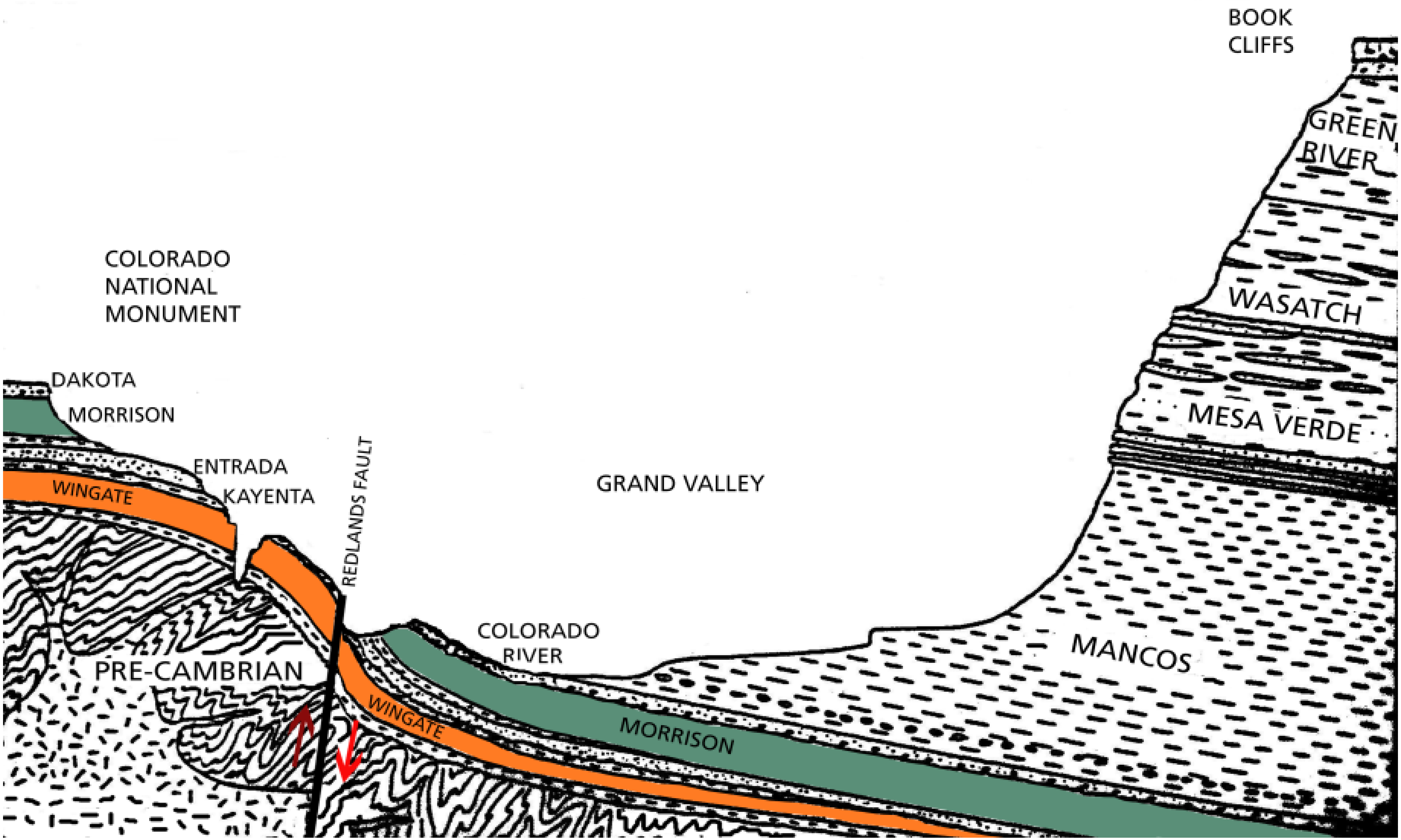
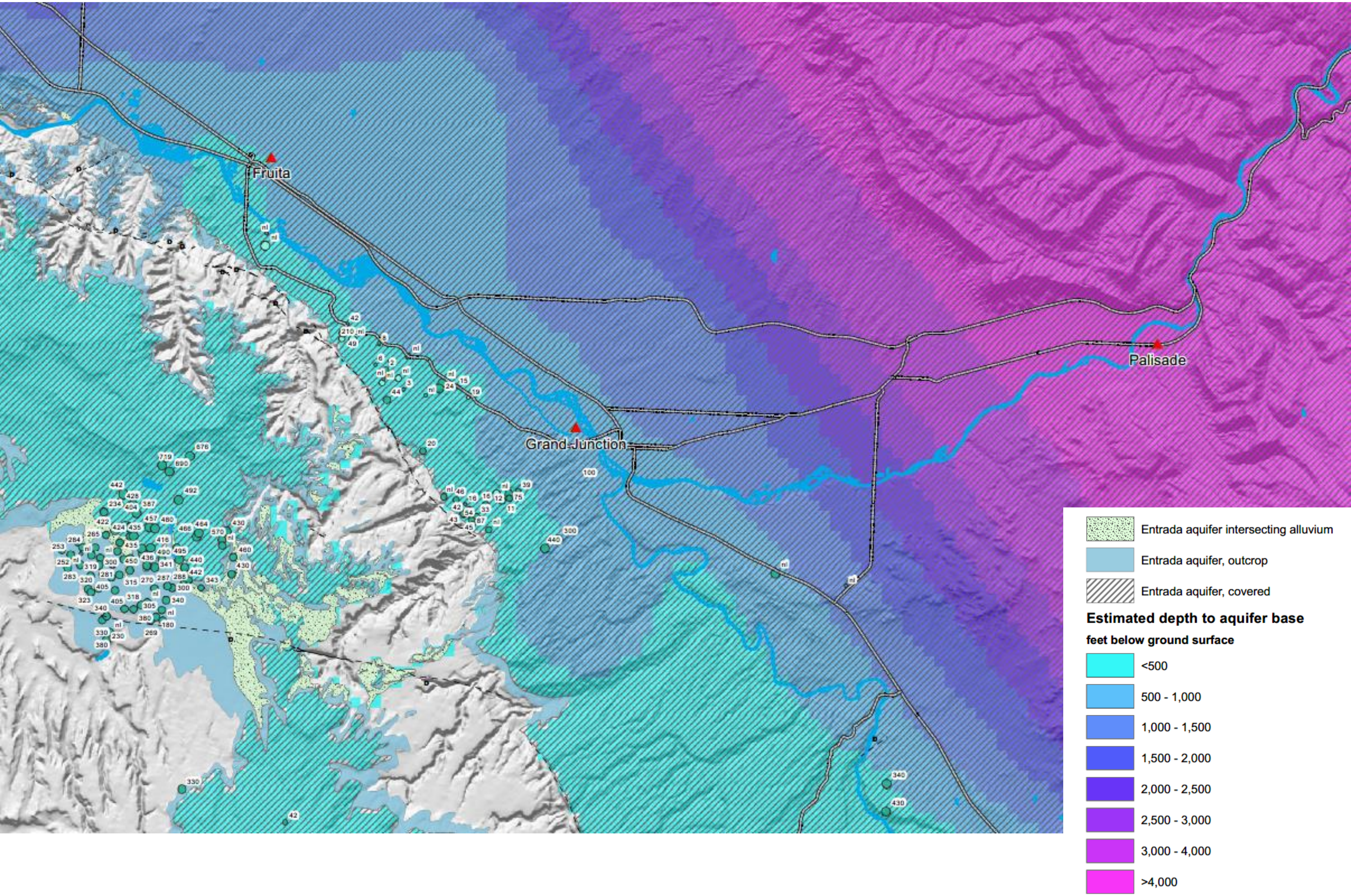


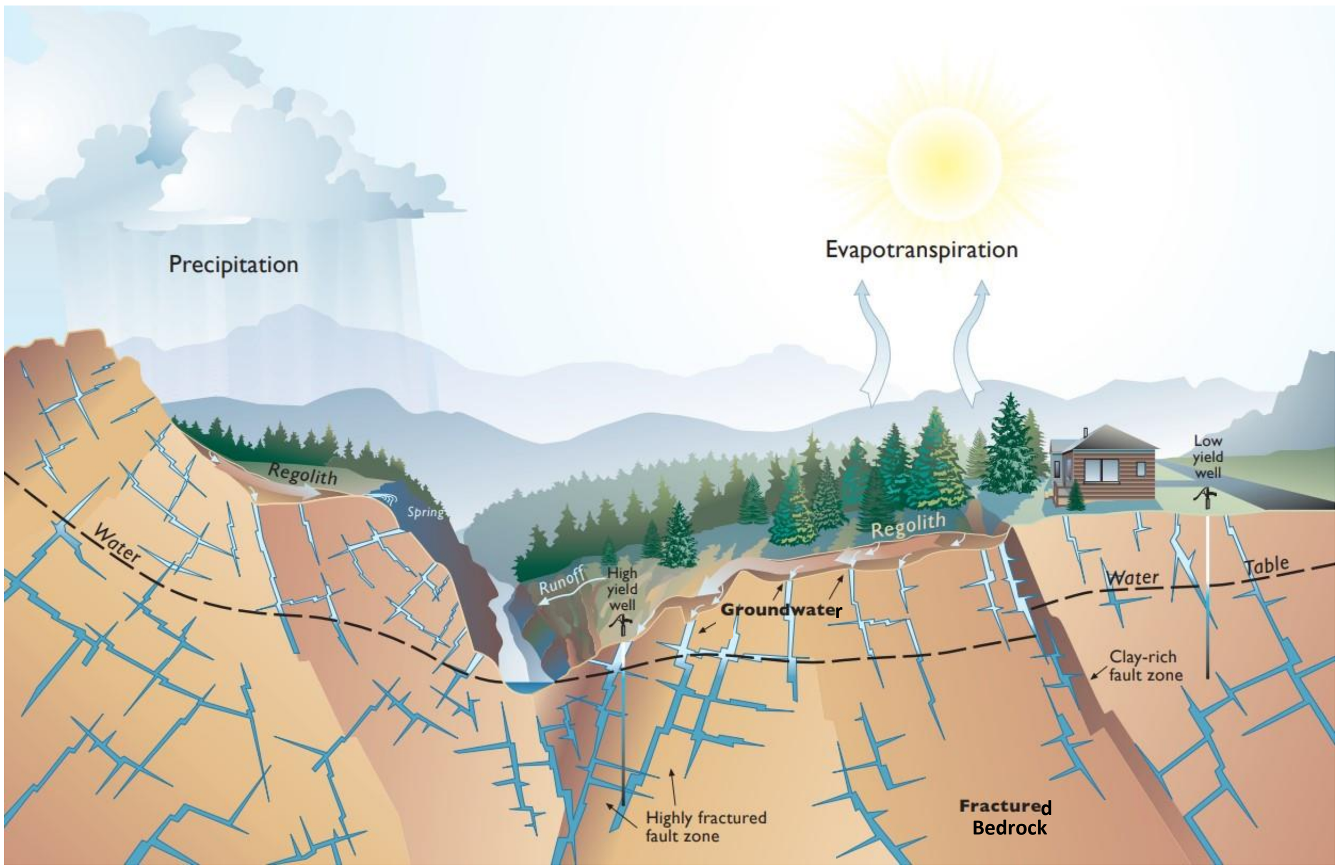
FIGURE 2A. MESA COUNTY STRATIGRAPHIC COLUMN, QUATERNARY THROUGH CRETACEOUS UNITS.


BOOK CLIFFS
GREEN RIVER
WASATCH
MESA VERDE
COLORADO NATIONAL MONUMENT
DAKOTA
MORRISON
ENTRADA
KAYENTA
WINGATE
REDLANDS FAULT
GRAND VALLEY
COLORADO RIVER
PRE-CAMBRIAN
WINGATE
MORRISON
MANCOS

Example CGS Map - Entrada Aquifer



Fractured Crystalline Bedrock Aquifers

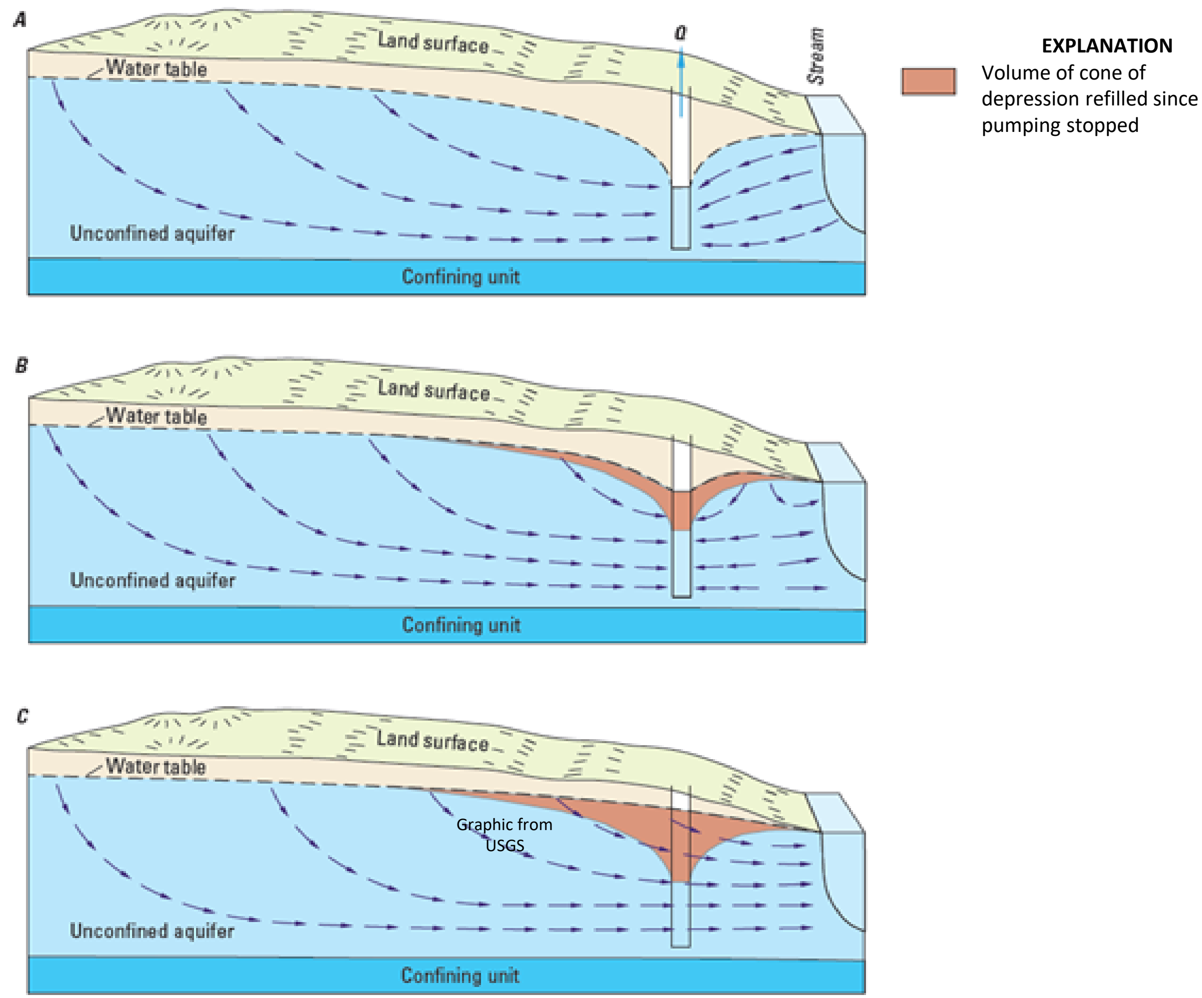


Non-injury

Quantify and replace impacts to surface water rights holders in location, time, and amount of depletions

Well flow meter

Unconsolidated Aquifer Cross Section Demonstrating Stream Depletion



Stream Depletion and Accretion

- Stream depletion is most commonly caused by well pumping.
- Stream accretion is most commonly the result of recharge projects, ditch leakage, lawn or farm irrigation return flow.
- For both stream depletion and accretion there must be a hydraulic connection between the aquifer and the stream in order for stream depletion or accretion to occur.
- Direction and velocity of groundwater flow do not affect results.

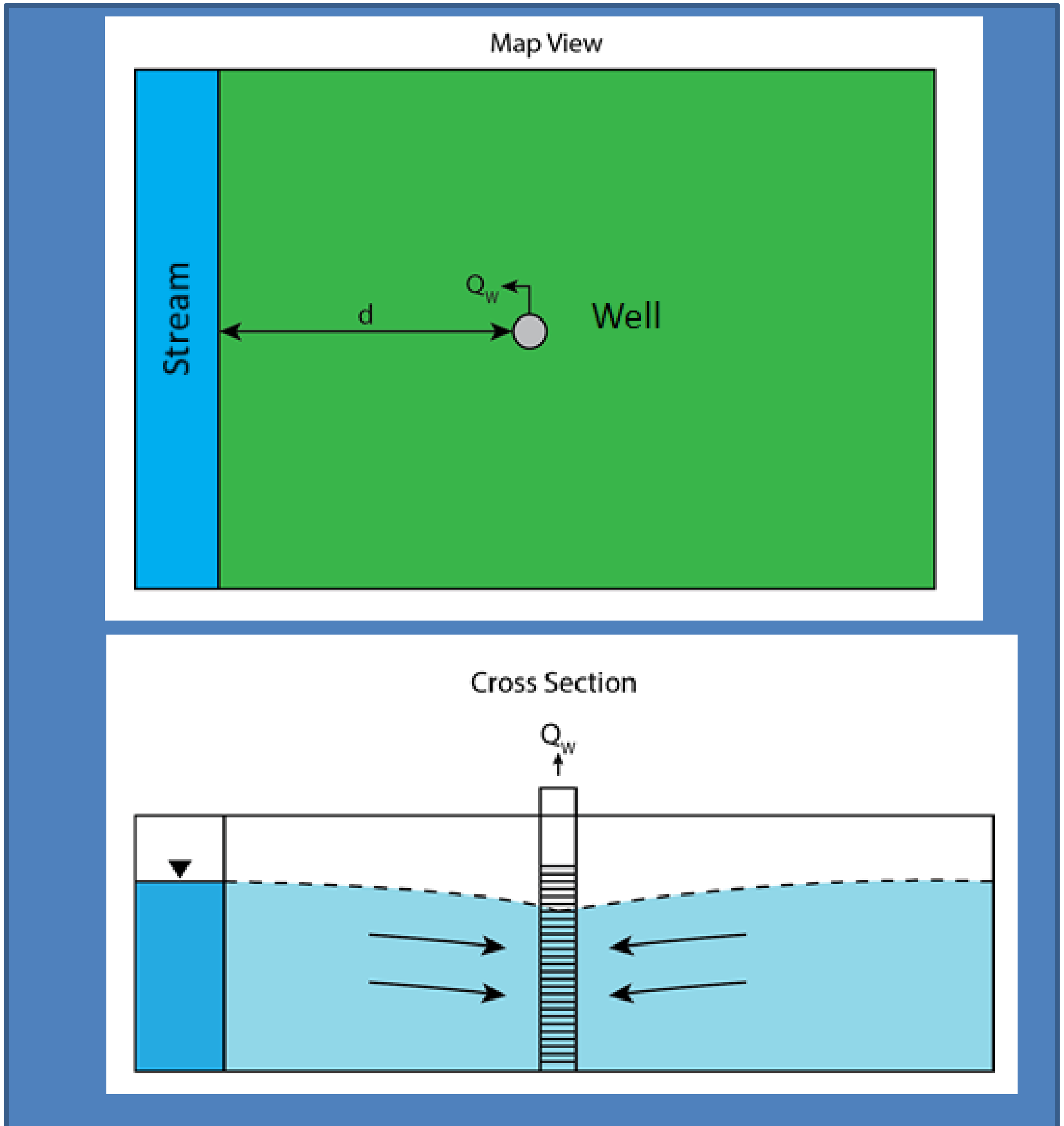
- More accurate estimate -> More conjunctive use w/o injury!

Data Needed to use Glover Equation (1954)

Glover Equation

$$\frac{q}{Q} = \operatorname{erfc}\left(\frac{a}{\sqrt{\frac{4tT}{S}}}\right)$$

Transmissivity (ft^2/day)
Specific Yield or Storativity (Sy or S)
Distance from well to river

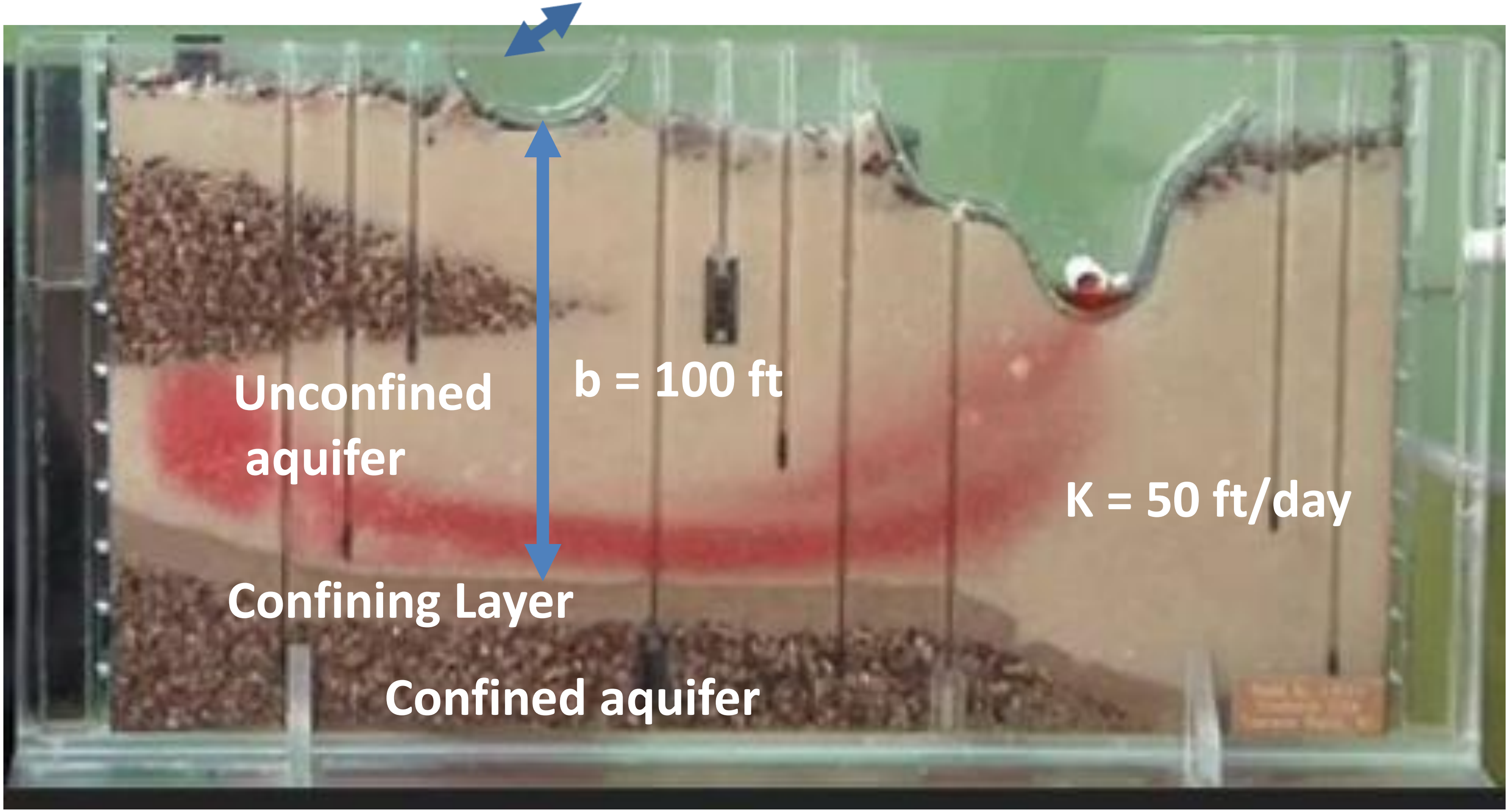


T = K * b

b = aquifer thickness

T = 50 ft/day * 100 feet

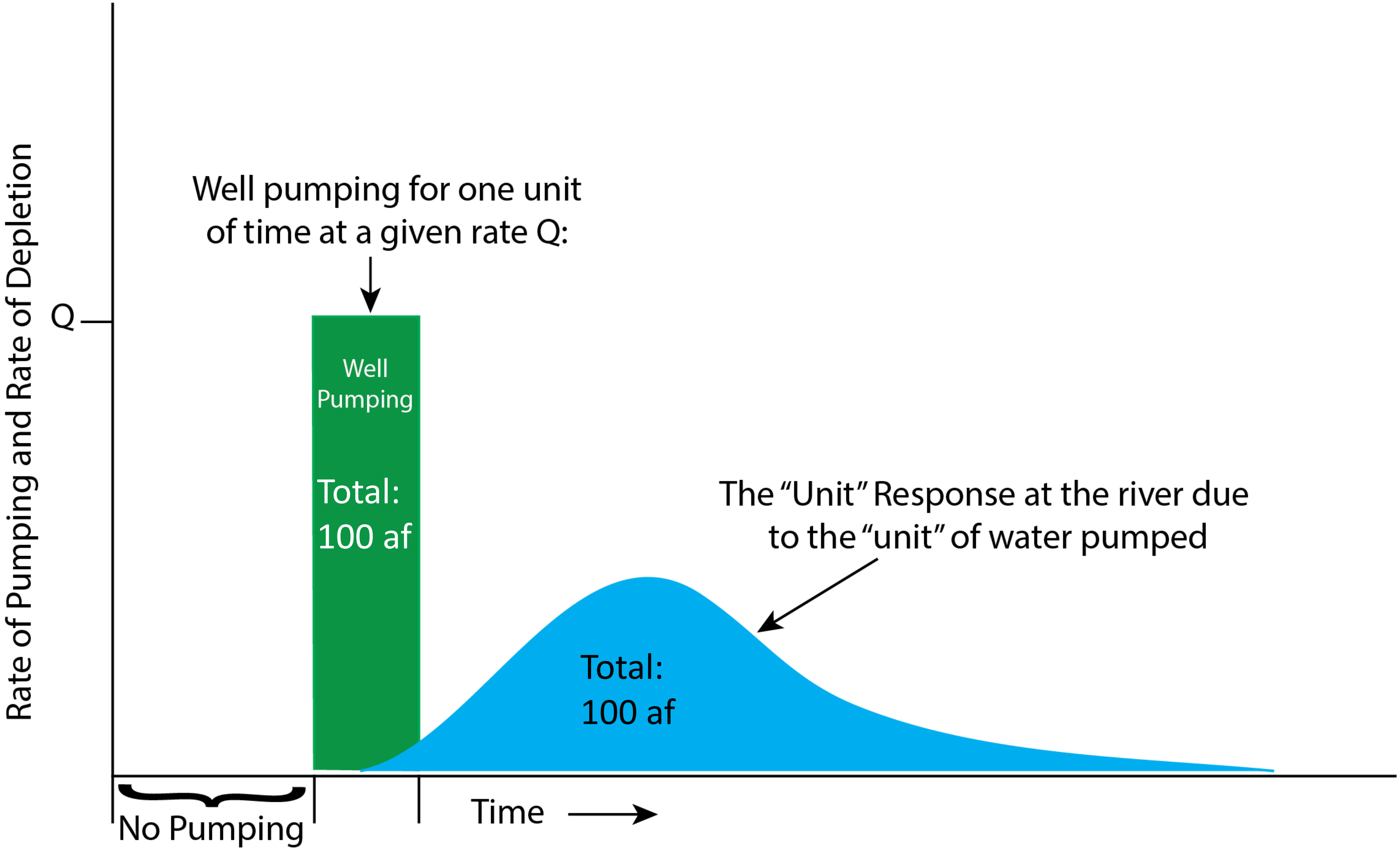
T = 5,000 FT^2/Day



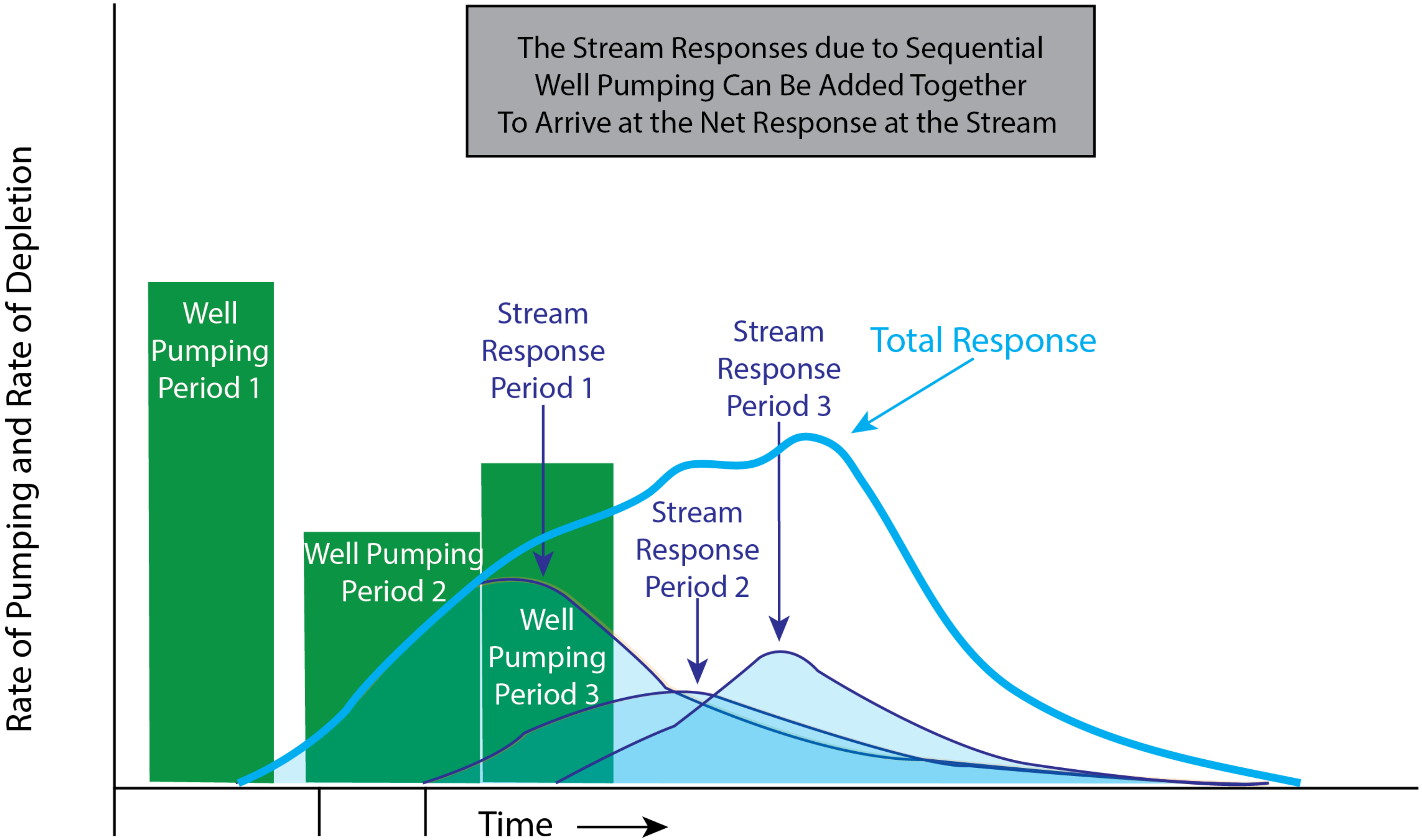
5,000 FT^2/DY*7.48

= 37,000 gpd/ft

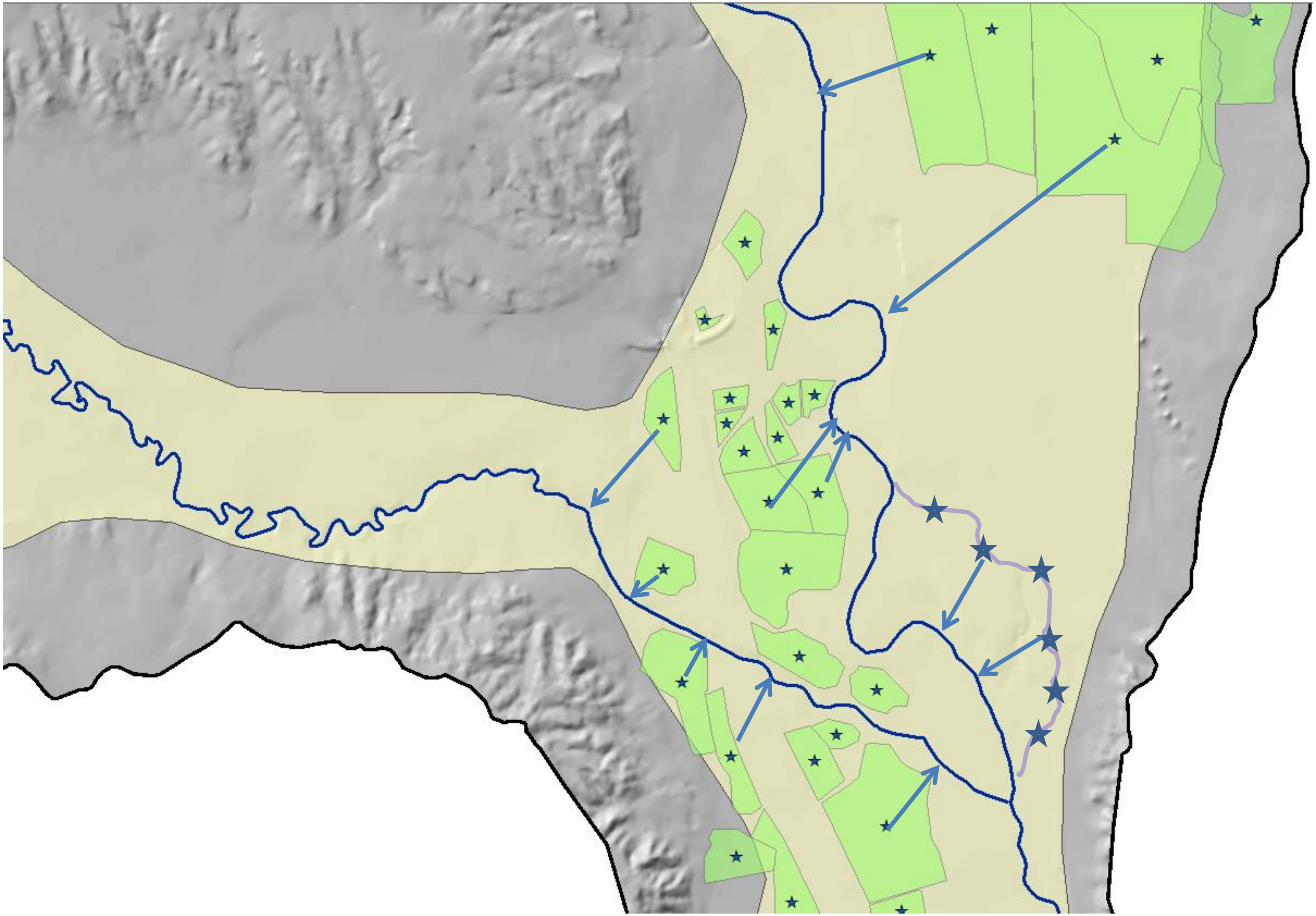
Depletion Response at a Stream Due to a "Unit" of Well Pumping: Generic Case



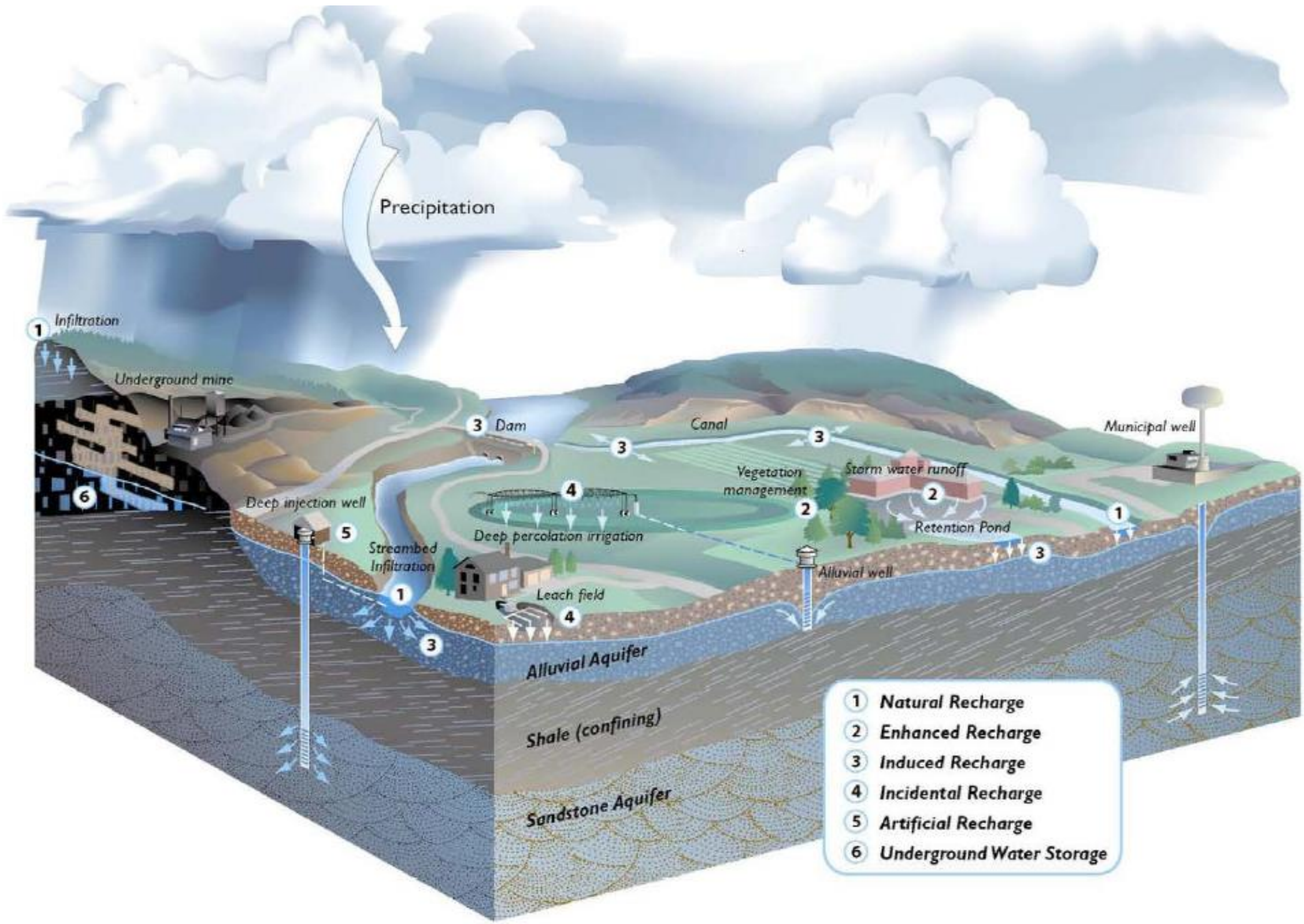
Depletion Response at a Stream Due to a Sequential Pumping at One Well



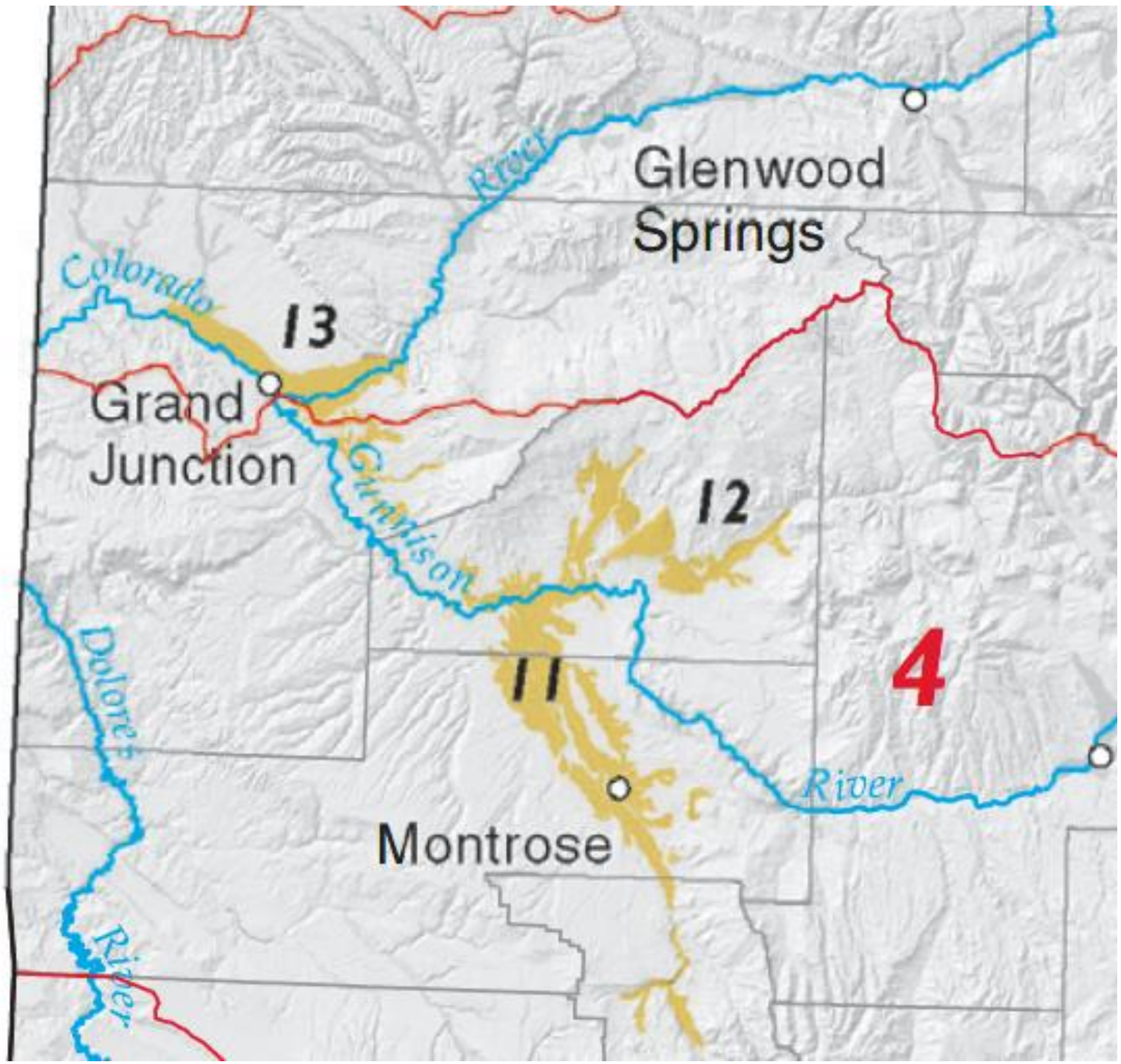
Example of Farm Return Flow with Glover Eq.



Managed Aquifer Recharge (image: CGS)



Colorado Geological Survey Recharge Study – Grand Valley Results



EXPLANATION

Priority quaternary alluvial aquifers

Modern quaternary alluvium

TABLE VIII-1.
SUMMARY RANKING OF UNCONSOLIDATED ALLUVIAL AQUIFERS

Basin or Area	Aquifer	Ranking Value	Quality Value	Storage (ac-ft) Per Acre	Total (thousands)	Available (thousands)
Lower South Platte River	South Platte River Alluvium	132	20	6.0	4,650	2,320
Lower South Platte River	Bijou Creek Alluvium	128	17	5.3	2,790	810
Lower Arkansas River	Arkansas River Alluvium	118	18	2.3	4,010	500
San Luis Valley	Quaternary Alluvium	113	18	2.3	15,550	3,890
Uncompahgre River	Uncompahgre River Alluvium	96	17	3.0	1,530	305
Lower South Platte River	Kiowa Creek Alluvium	92	16	5.3	920	405
North Park	North Platte River Alluvium	91	17	4.5	1,530	380
Gunnison River	Gunnison River Alluvium	88	18	2.3	1,175	220
Lower Arkansas River	Big Sandy Creek Alluvium	87	17	4.5	1,130	425
White River	White River Alluvium	81	18	1.5	805	110
Wet Mountain Valley	Quaternary Alluvium	77	16	1.5	1,240	125
Upper Arkansas River	Buena Vista/Salida Alluvium	77	15	2.3	660	125
Yampa River	Yampa River Alluvium	73	17	1.5	685	115
Lower South Platte River	Box Elder Alluvium	71	17	1.5	310	80
South Park	Upper South Platte River Alluvium	59	16	1.2	270	90
Colorado River	Grand Valley Alluvium	48	16	1.5	395	80

TABLE VIII-2.
SUMMARY RANKING OF CONSOLIDATED BEDROCK AQUIFERS

Basin or Area	Aquifer	Ranking Value	Quality Value	Storage (ac-ft) *	
				Per Acre	Available (thousands)
High Plains Aquifer	High Plains – East	169	19	15.0	95,290
High Plains Aquifer	High Plains – Southeast	162	20	15.0	28,530
High Plains Aquifer	High Plains – North	143	19	4.0	4,570
Denver Basin	Dawson	109	19	6.0	5,010
SE Colorado	Dakota-Cheyenne Group	105	19	0.3	1,280
Sand Wash Basin	Wasatch-Fort Union	94	15	0.3	320
Denver Basin	Laramie-Fox Hills	92	20	0.3	1,285
Denver Basin	Arapahoe	92	19	0.2	590
Middle Park	Troublesome Formation	91	16	7.5	1,025
Raton Basin	Cuchara-Poison Canyon	77	18	1.0	465
Sand Wash Basin	Mesa Verde	70	16	2.0	1,885
Greater Denver Basin	Laramie-Fox Hills	67	15	4.5	5,045
Piceance Basin	Mesa Verde	66	14	2.0	2,865
Eagle Basin & Vicinity	Weber-Maroon-Minturn	62	14	1.0	730
Piceance Basin	Uinta Formation	60	14	7.5	5,015
Denver Basin	Denver	55	19	0.1	155
SW Colorado	Morrison-Summerville-Entrada	55	14	0.8	735
Raton Basin	Raton-Vermejo-Trinidad	54	18	5.0	4,035
South Park	Antero-Wagontongue	51	13	3.8	370
SW Colorado	Wingate	50	12	3.8	1,810

Example Alluvial Recharge Operation on Alluvial Terrace

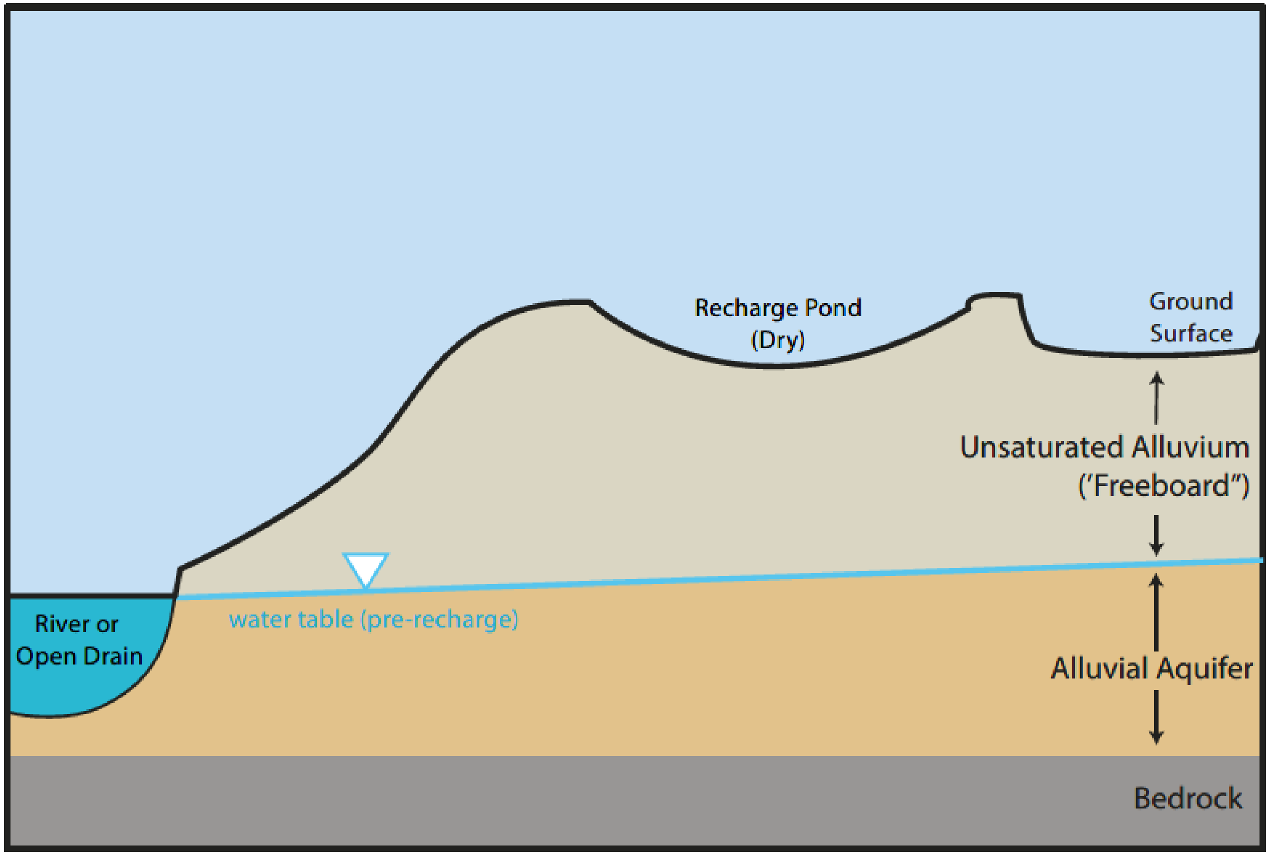


Figure 3. Example MAR Site Prior to Recharge

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Example Alluvial Recharge Operation on Alluvial Terrace

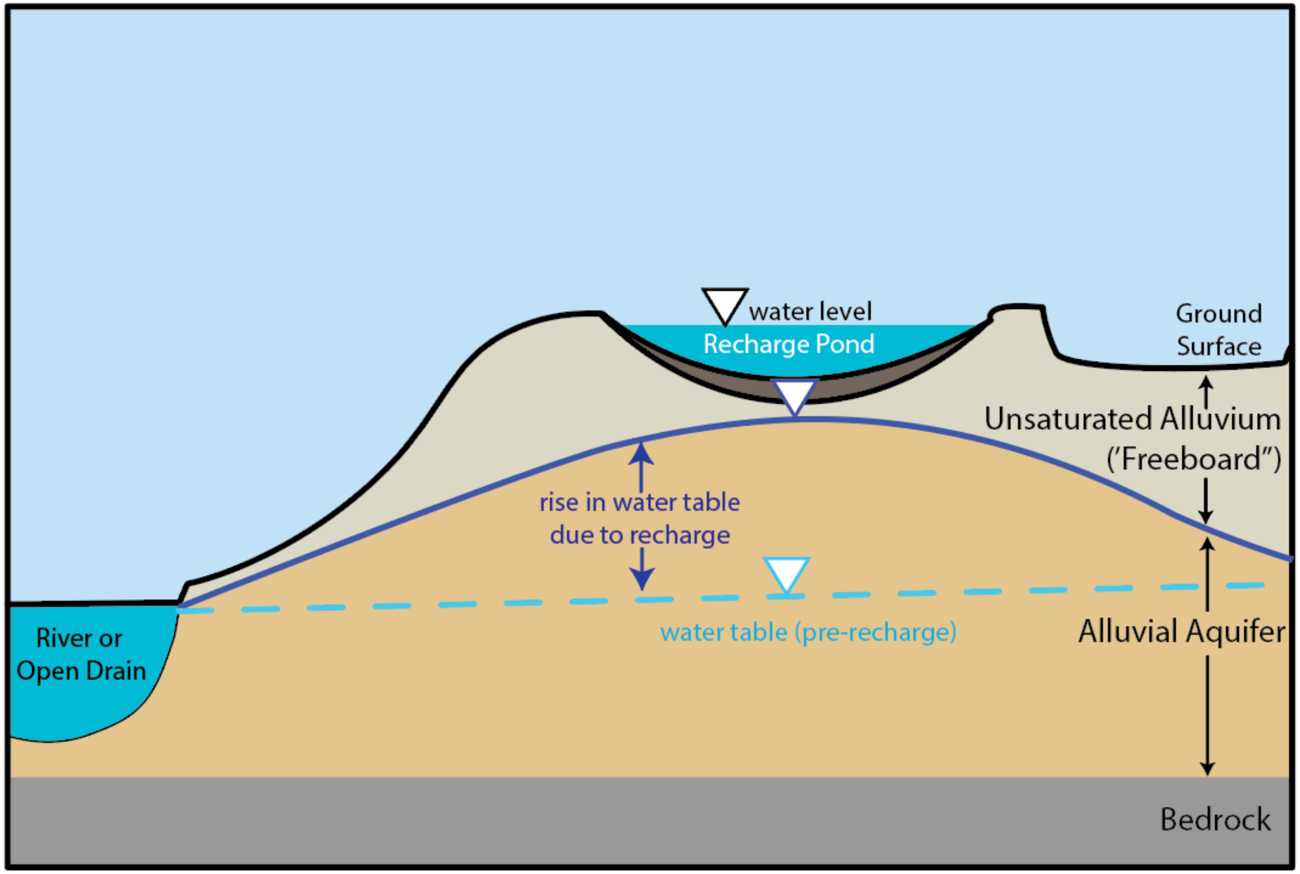

Figure 4. Example MAR Site During Recharge

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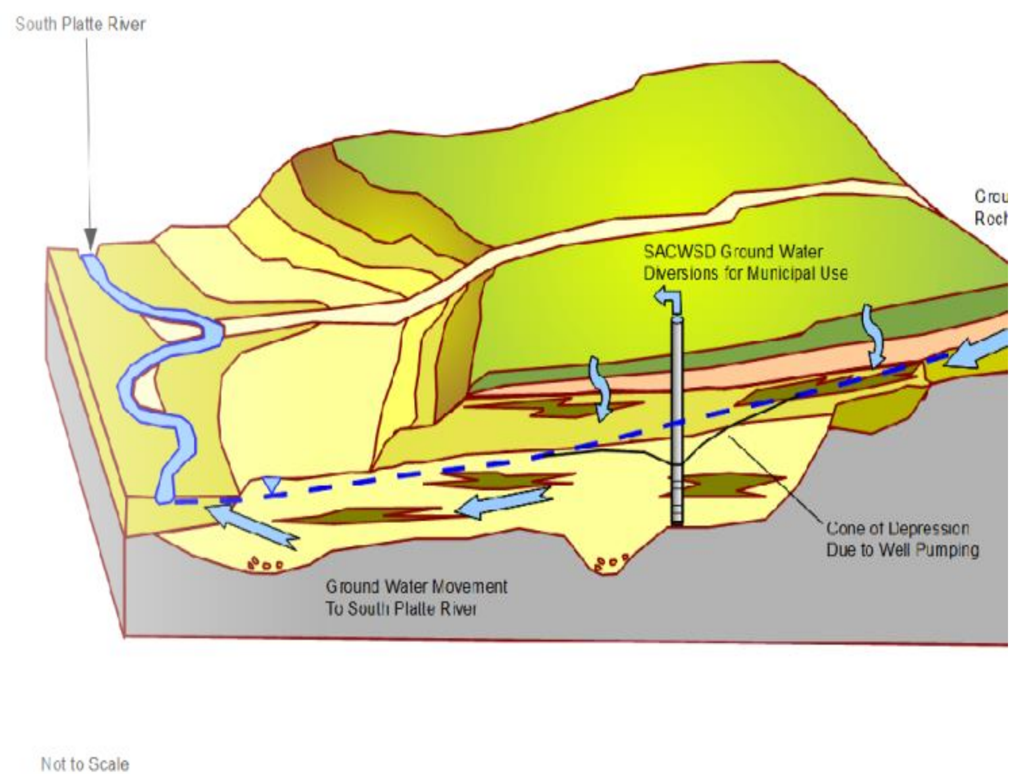
Questions

Aquifer recharge and water banking possible in Mesa Co.?

Any benefits to conjunctive use?

E.g., Capture early season runoff and re-time to when needed?

Any potentially NT sedimentary bedrock aquifers?




Thank you!
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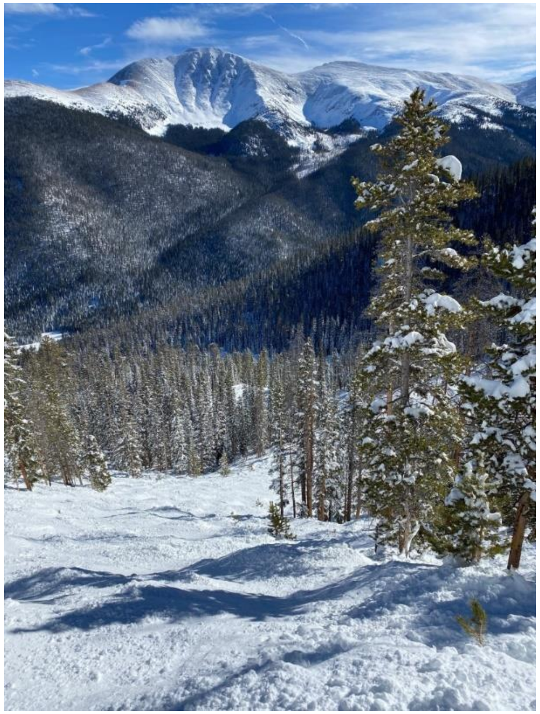
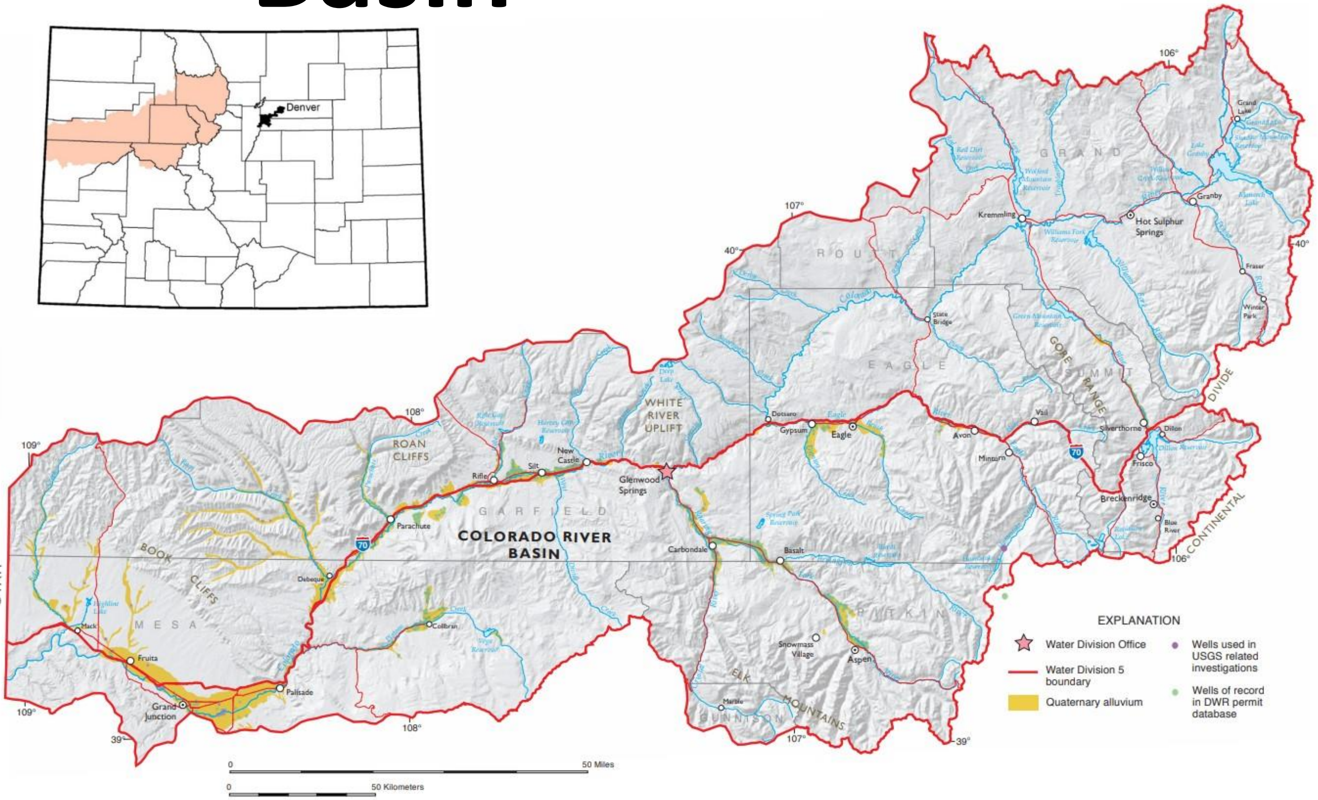
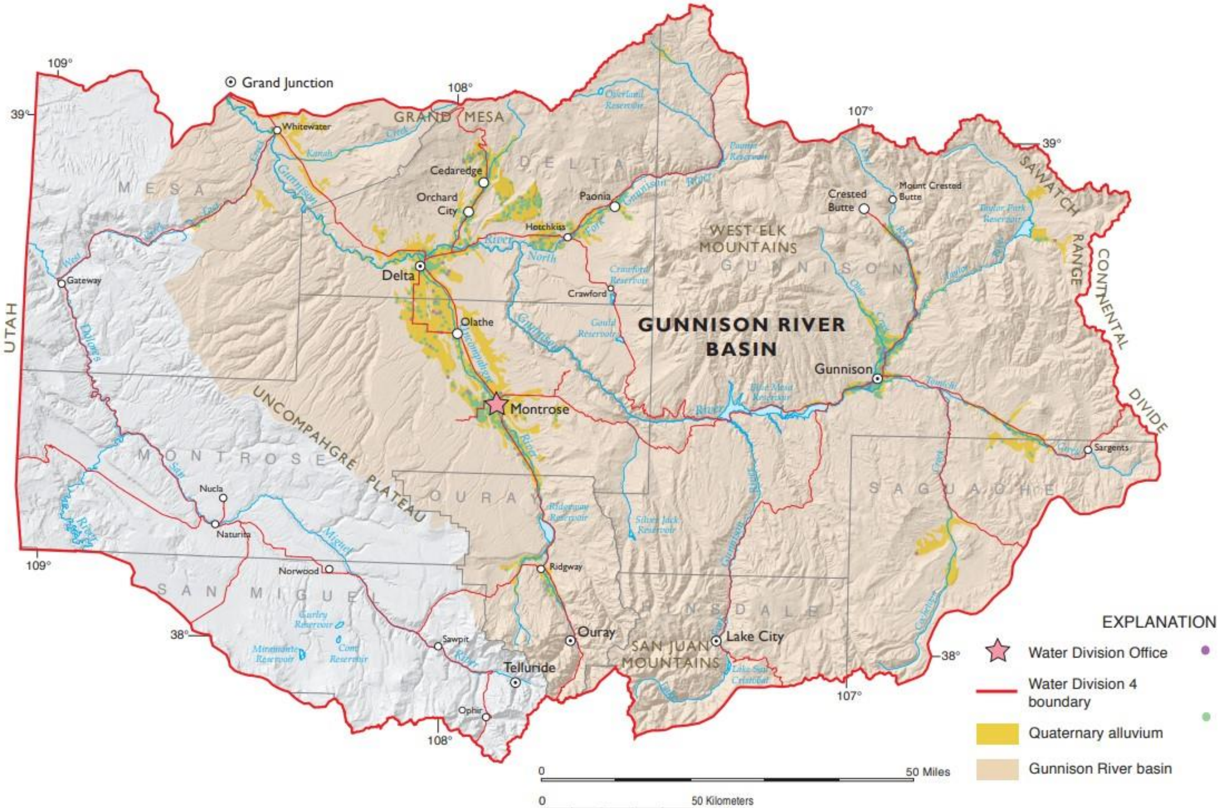
Additional Slides

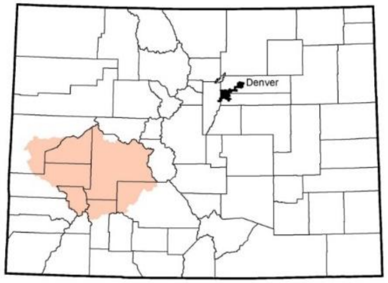
Colorado River Basin

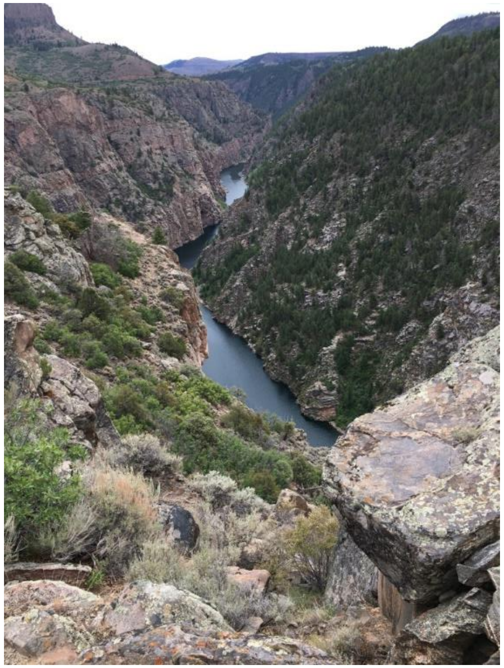




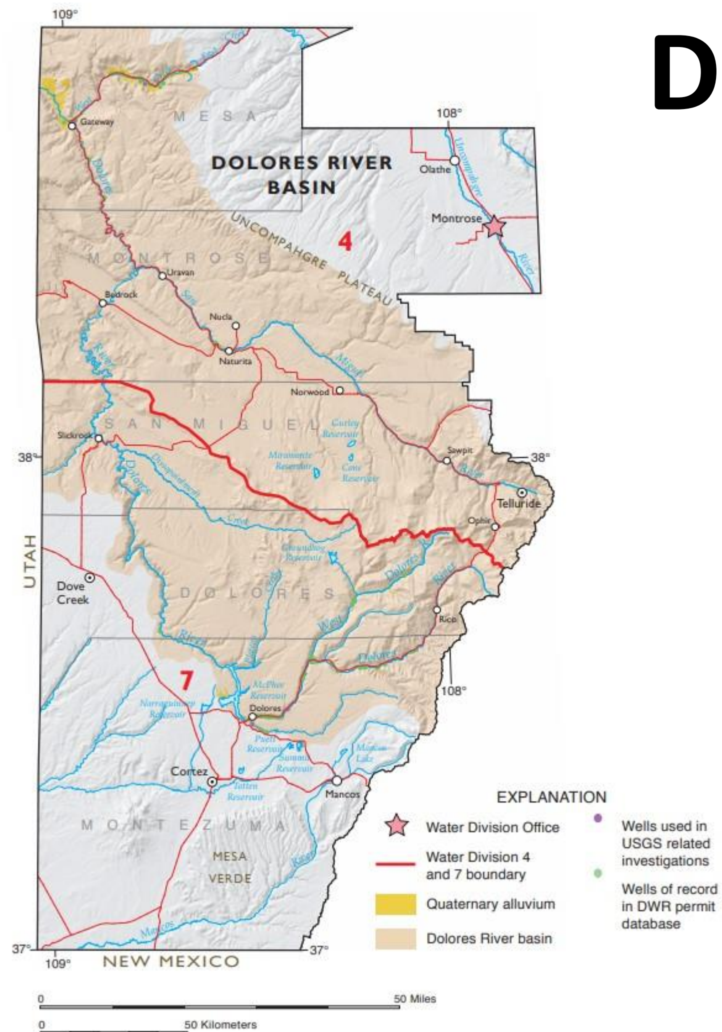
Gunnison River Basin

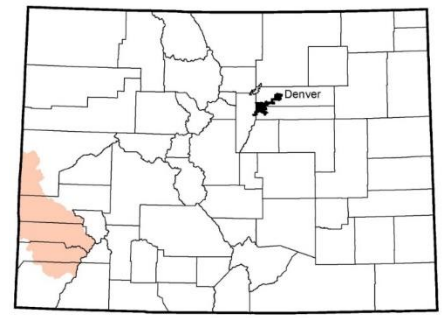






Dolores River Basin





Groundwater Administration in Colorado

- Water Right Determination and Administration Act of 1969
  - Integration of GW into SW prior appropriation system
  - “Revolutionary” concept: allowing out-of priority diversions per an approved augmentation plan
  - Creation of Water Courts

“Recogizing that previous and existing laws have given inadequate attention to the development and use of underground waters of the state, that **the use of underground water as an independent source or in conjunction with surface waters is necessary to the present and future welfare of the people of this state**, and that the future welfare of the state depends upon a **sound and flexible integrated use** of all water of the state.” – 1969 Act (CRS 37-92-102(2).

“Glover Equation” has become the de-facto method in Colorado Groundwater cases…..

Groundwater 101 – Understanding the inputs to the Glover Equation

Key references:

Basic Ground-Water Hydrology

By RALPH C. HEATH

Prepared in cooperation with the
North Carolina Department of
Natural Resources and Community
Development

USGS
science for a changing world

Streamflow Depletion by Wells—Understanding and Managing the Effects of Groundwater Pumping on Streamflow

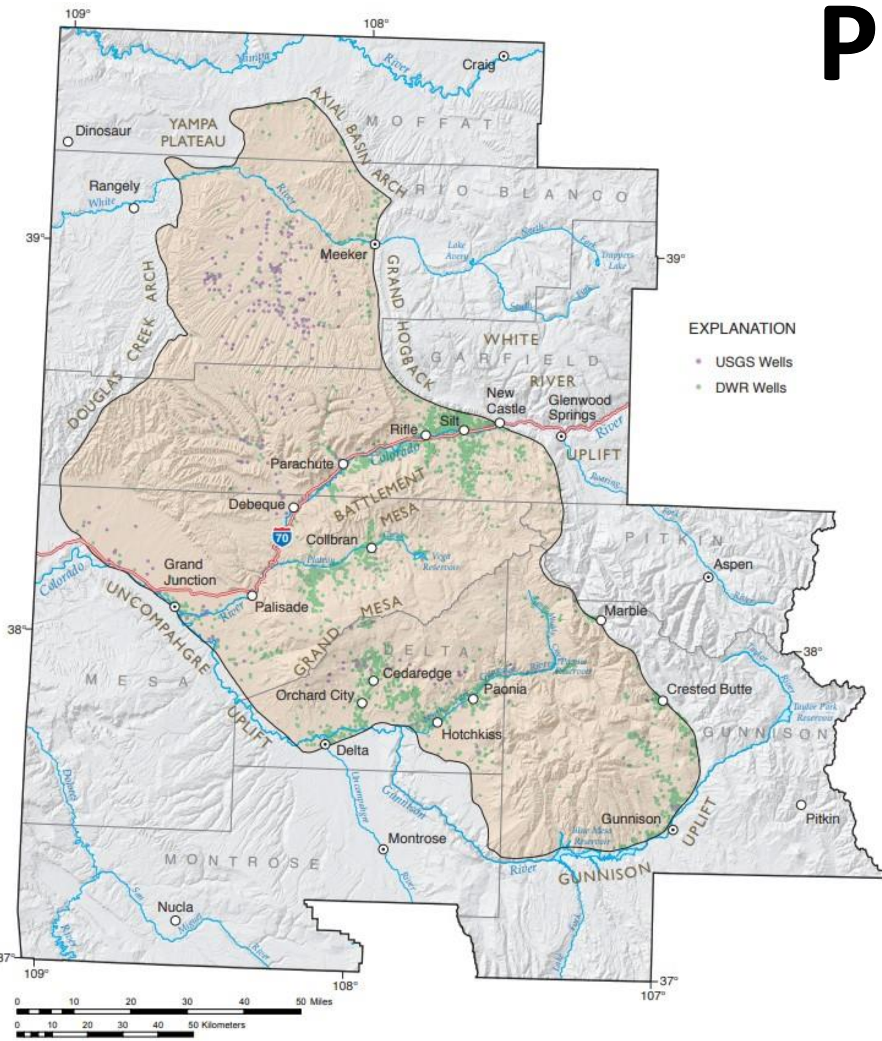
By Paul M. Barlow and Stanley A. Leake

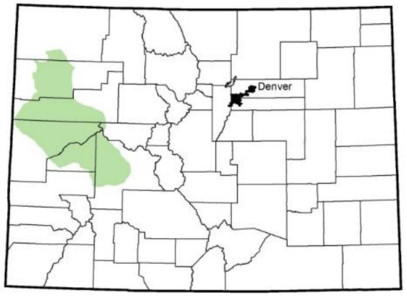
Photograph by Robert F. Breault, U.S. Geological Survey

Wyoming Pond on the Wood River, Pawcatuck River Basin, Rhode Island.

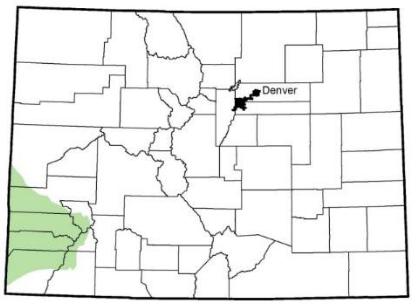
USGS Circular 1376

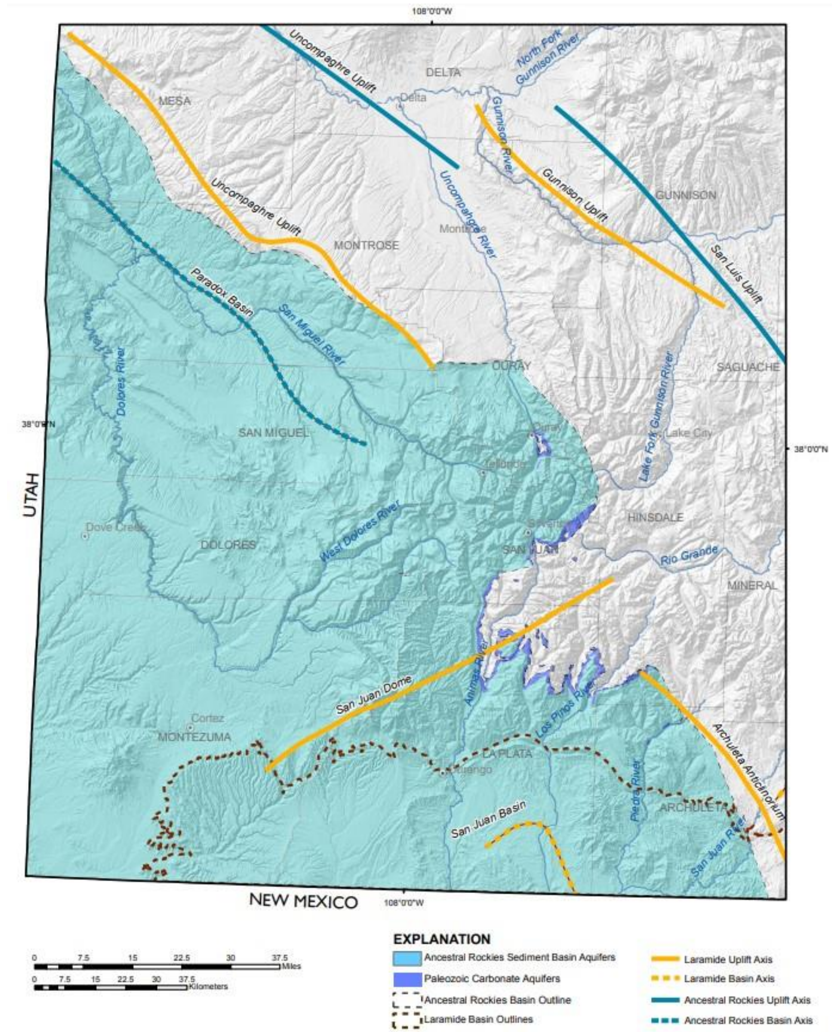
Piceance Basin



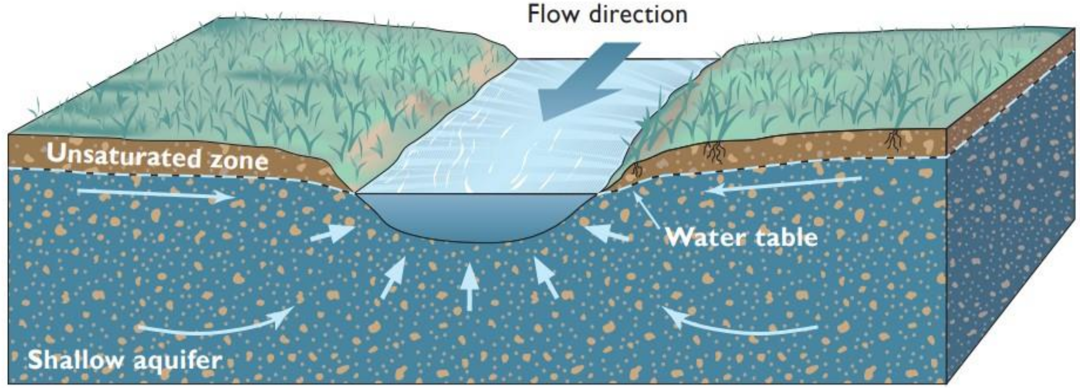


Paradox Basin

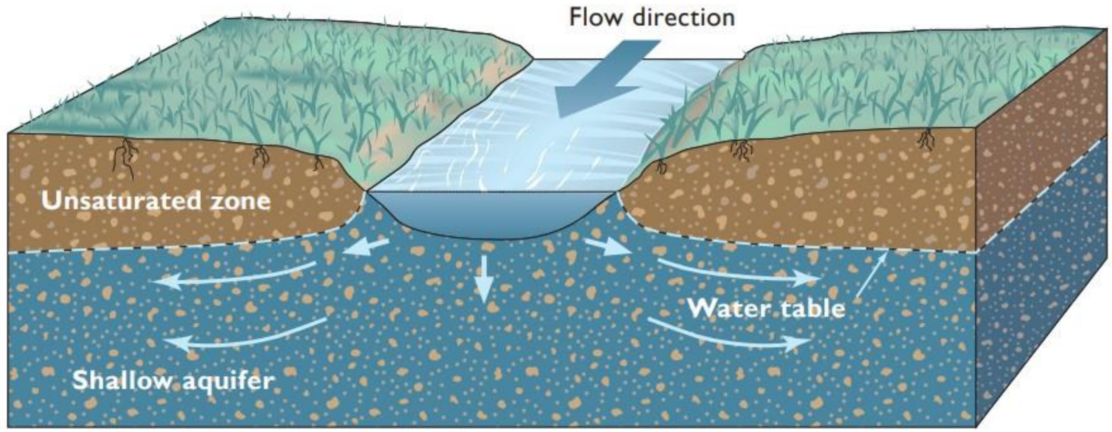




Gaining Stream:



Losing Stream:



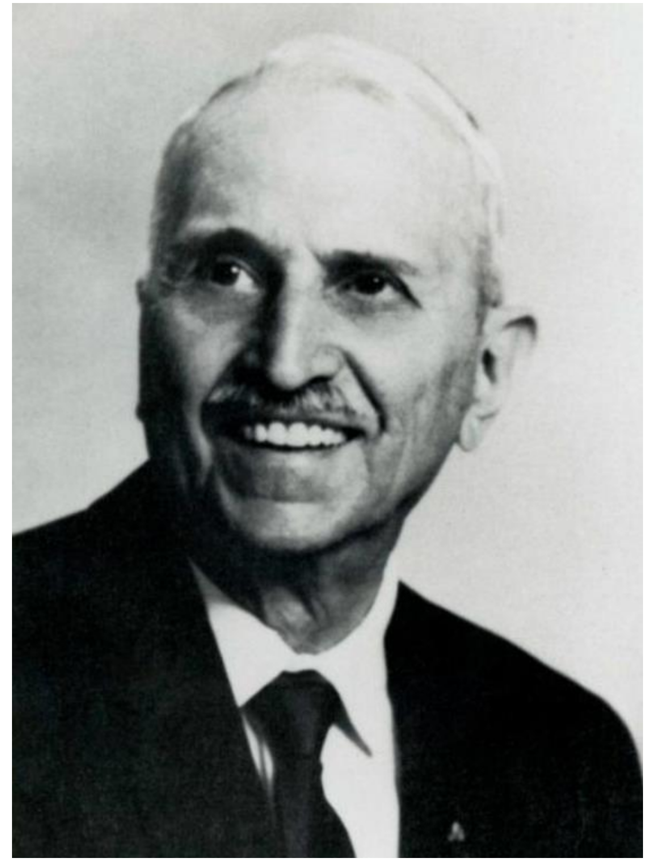
Robert Glover

United States Reclamation Service (later USBR) – 1920 through 1954

Boeing aircraft

United States Geological Survey

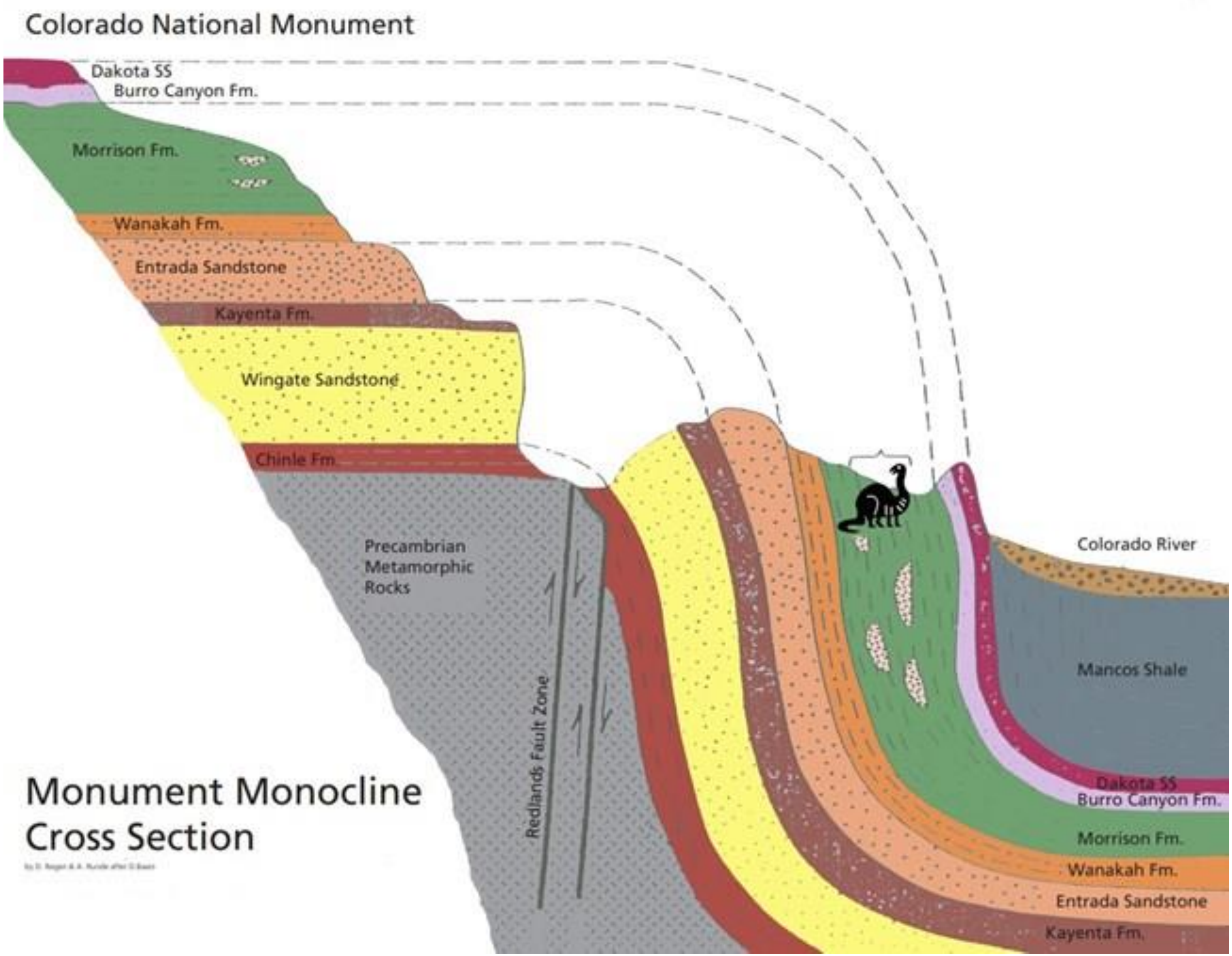
Developed and taught groundwater course at CSU.



Robert Ellsworth Glover (1896 – 1984)

River Depletion Resulting from Pumping a well Near a River (1954)

Textbook: Transient Ground Water Hydraulics (1974)


Colorado National Monument
Dakota SS
Burro Canyon Fm.
Morrison Fm.
Wanakah Fm.
Entrada Sandstone
Kayenta Fm.
Wingate Sandstone
Chinle Fm.
Precambrian Metamorphic Rocks
Redlands Fault Zone
Colorado River
Mancos Shale
Dakota SS
Burro Canyon Fm.
Morrison Fm.
Wanakah Fm.
Entrada Sandstone
Kayenta Fm.
Monument Monocline Cross Section