

# GRAD592

Interdisciplinary Water Resources Seminar



**COLORADO  
WATER CENTER**  
COLORADO STATE UNIVERSITY

Tuesdays | 4:00-5:00pm | Natural Resources 109

Instructor: Karen Schlatter, Associate Director, CoWC

<https://watercenter.colostate.edu/grad592>

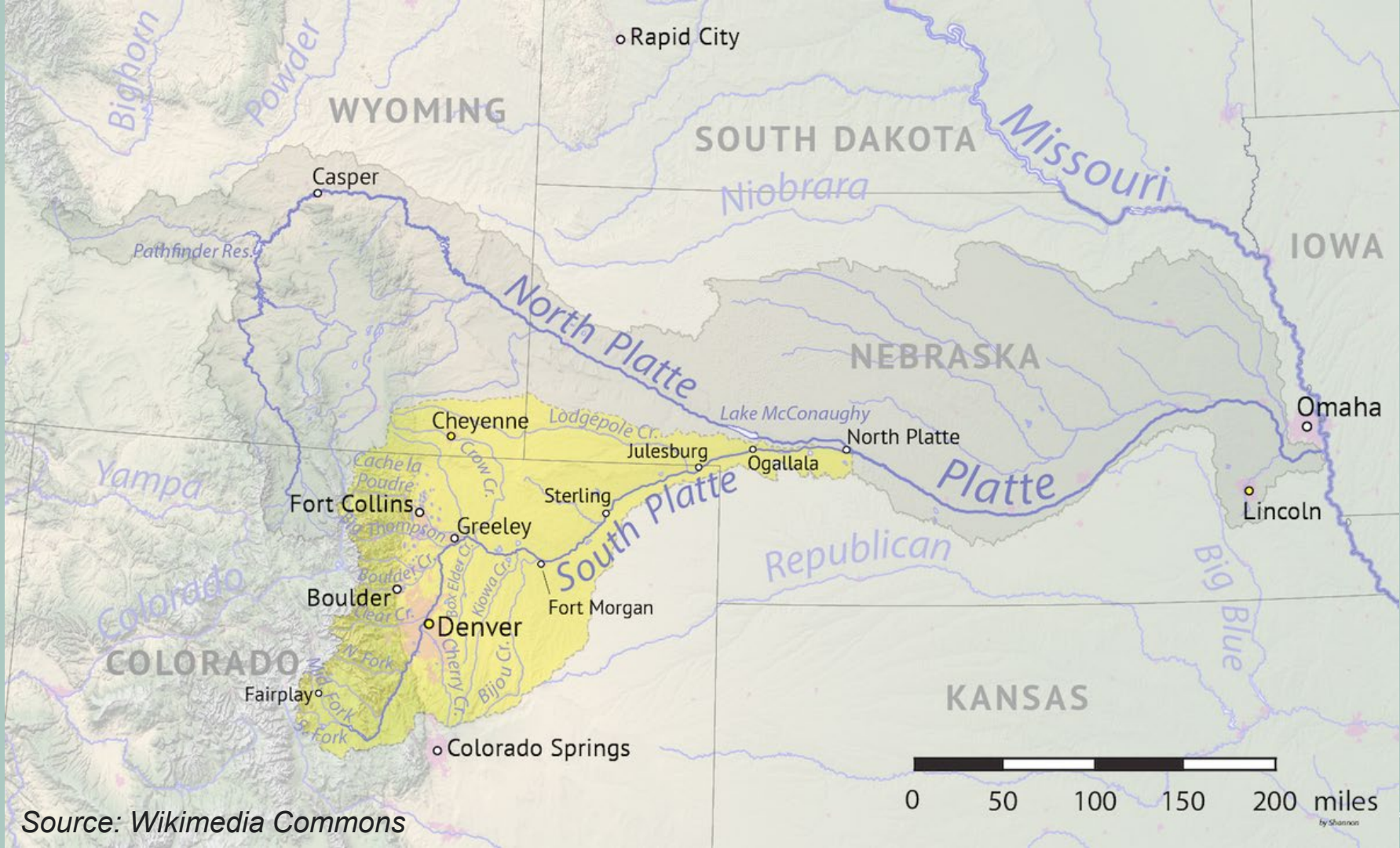
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consider your responsibility to education and inclusion, and to our lands.

[CSU Land Acknowledgment Link](#)

How many states are within the  
South Platte River Basin?





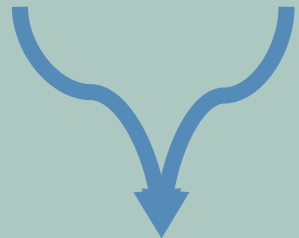


Source: Wikimedia Commons





South Platte North Platte



Platte



Missouri



Mississippi



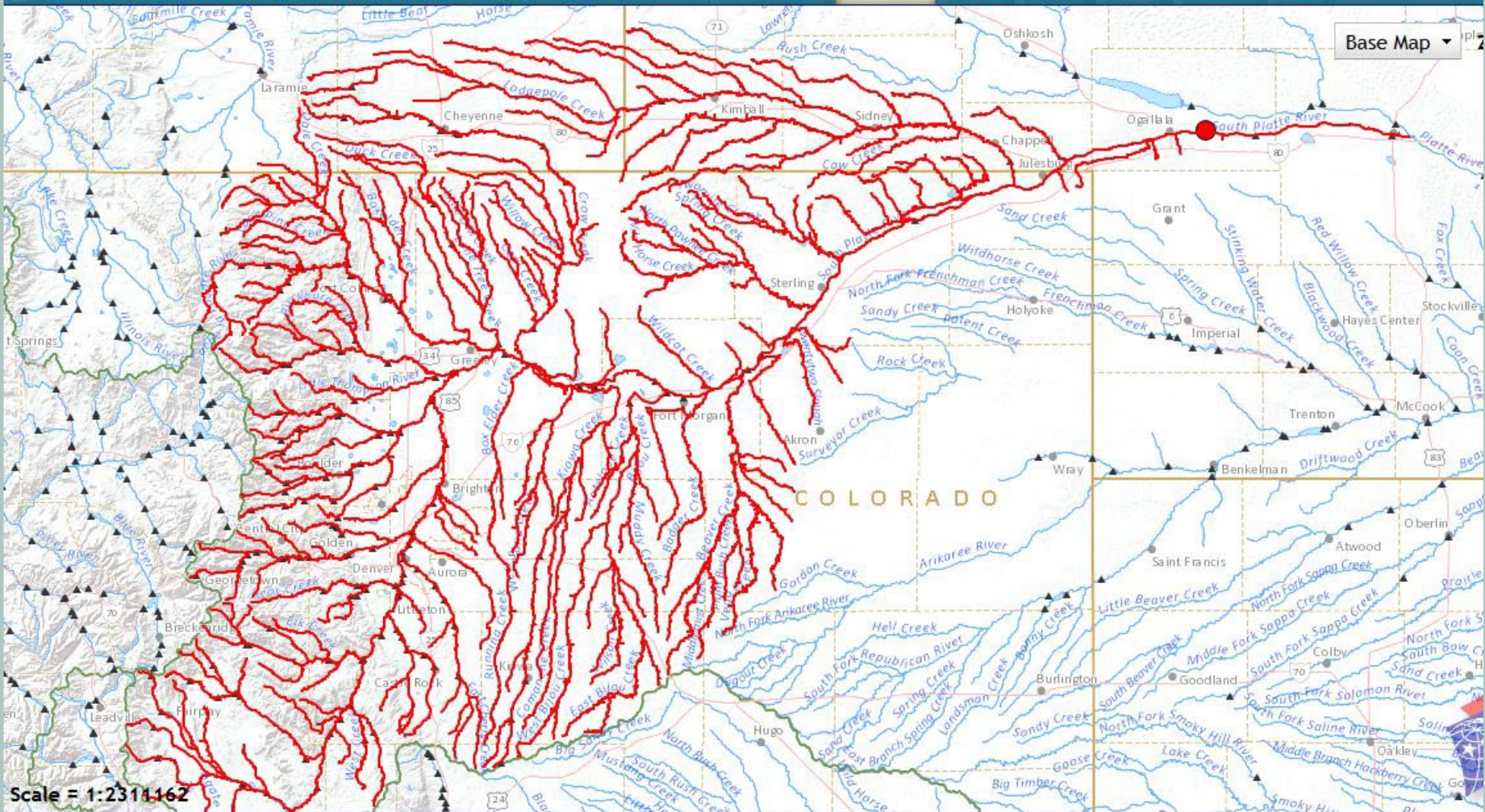
Gulf of Mexico

Source: American Rivers





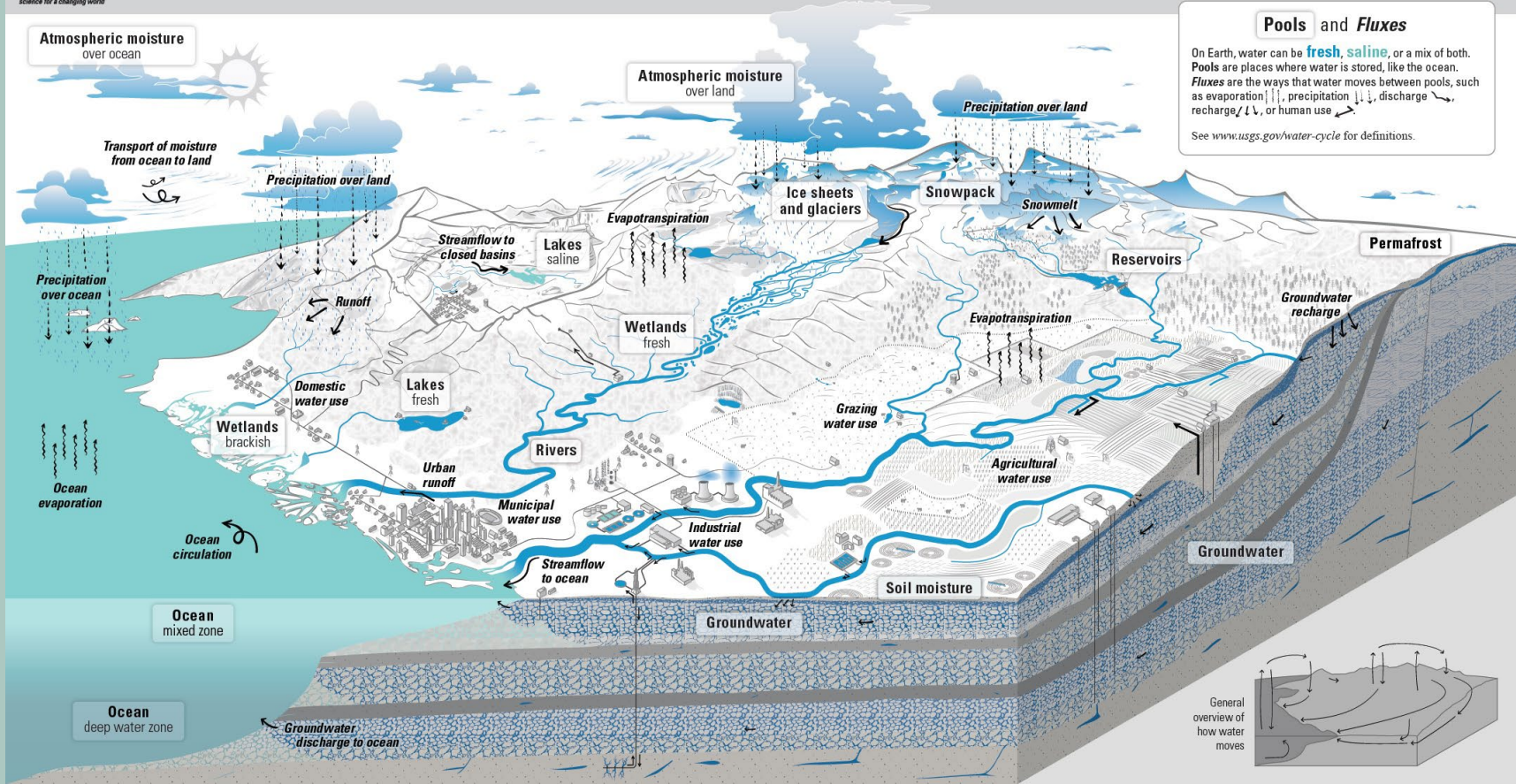
Base Map



Scale = 1:2311162



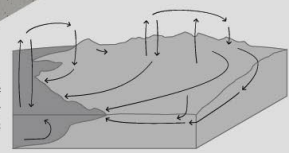
# The Hydrologic Cycle



**Pools and Fluxes**

On Earth, water can be **fresh, saline**, or a mix of both. **Pools** are places where water is stored, like the ocean. **Fluxes** are the ways that water moves between pools, such as evaporation, precipitation, recharge, or human use.

See [www.usgs.gov/water-cycle](http://www.usgs.gov/water-cycle) for definitions.





## Two Main Types of Groundwater Aquifers

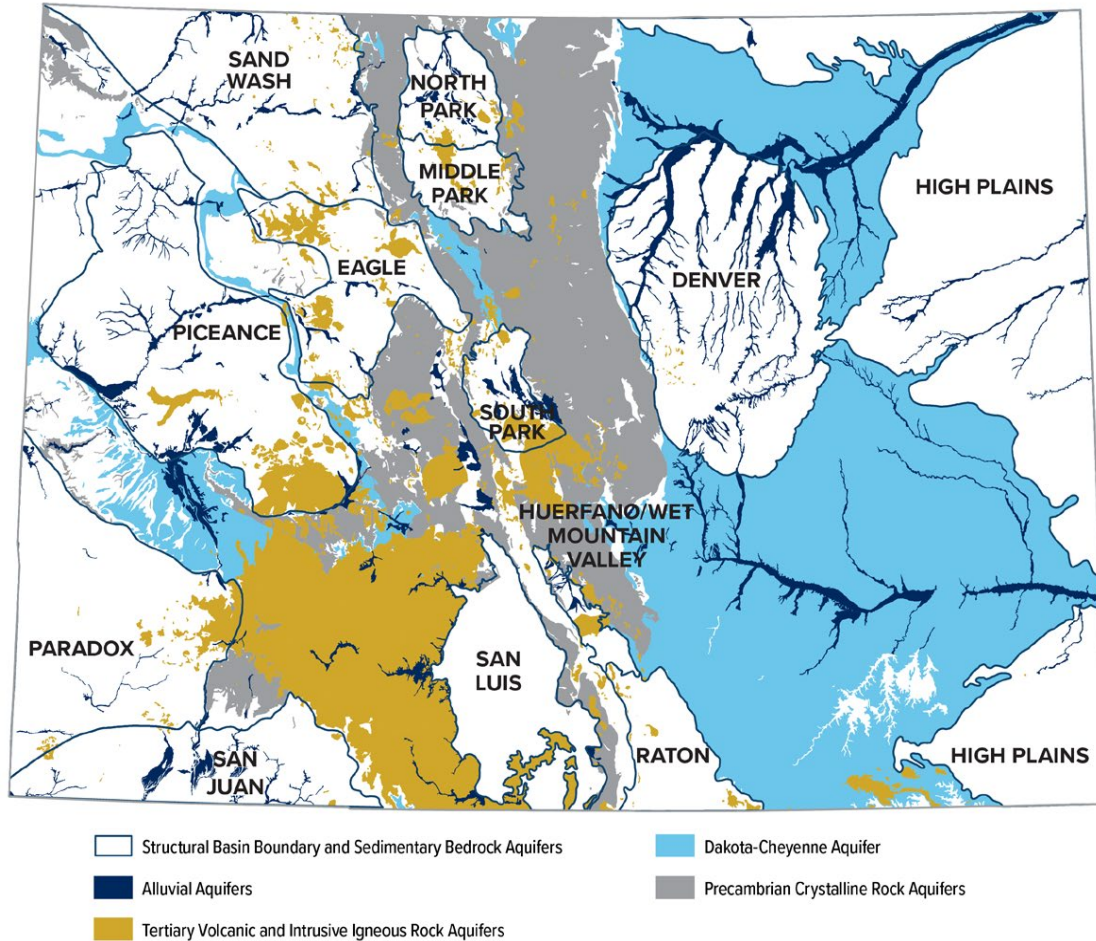
### Alluvial Aquifers –

Tend to be near the ground surface and act as extensions of nearby streams

### Bedrock Aquifers –

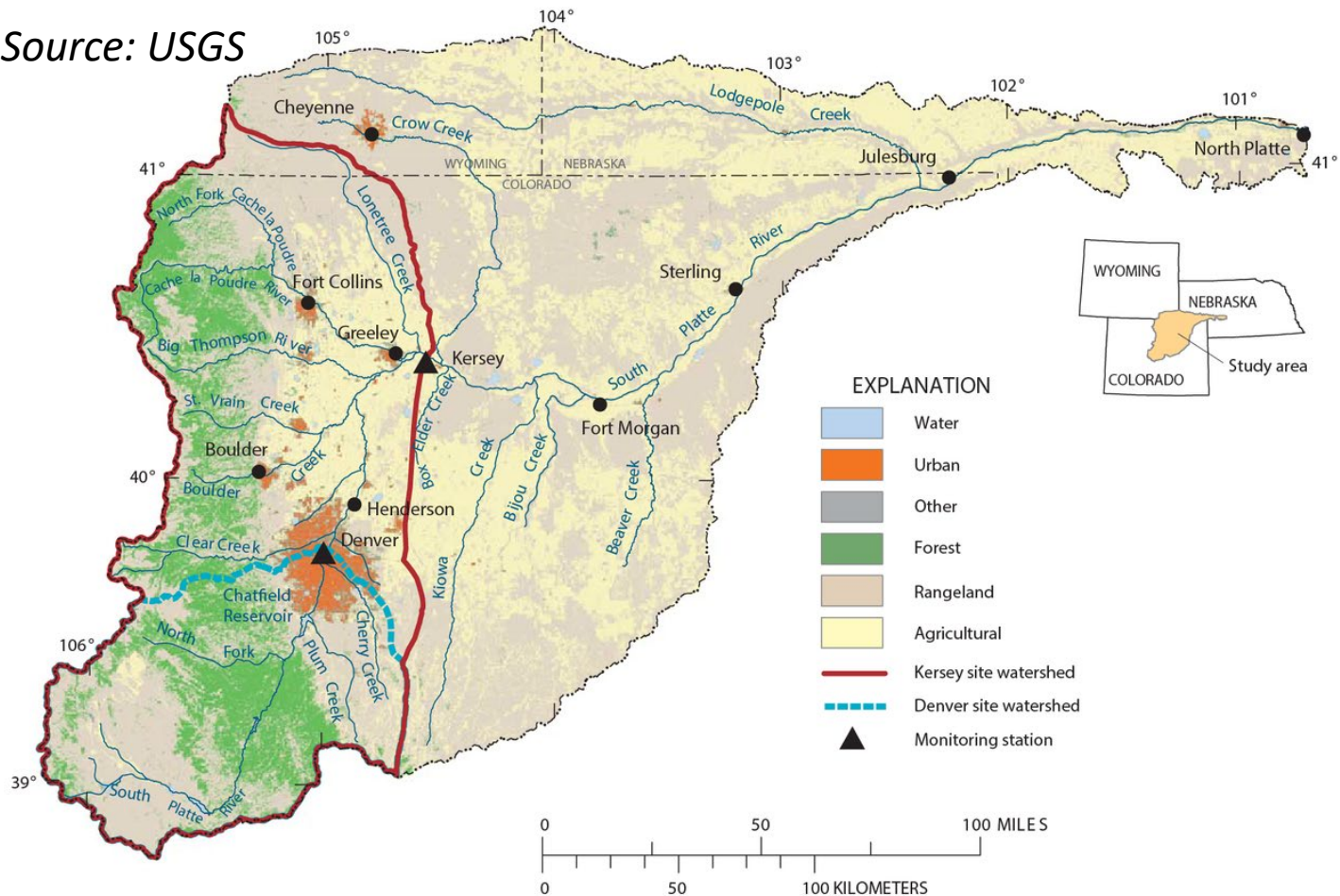
Tend to be well below the ground surface, are not well connected to streams, and are often non-renewable

- 85% of Colorado's groundwater is used for irrigated agriculture
- 60% of groundwater use is from non-renewable sources



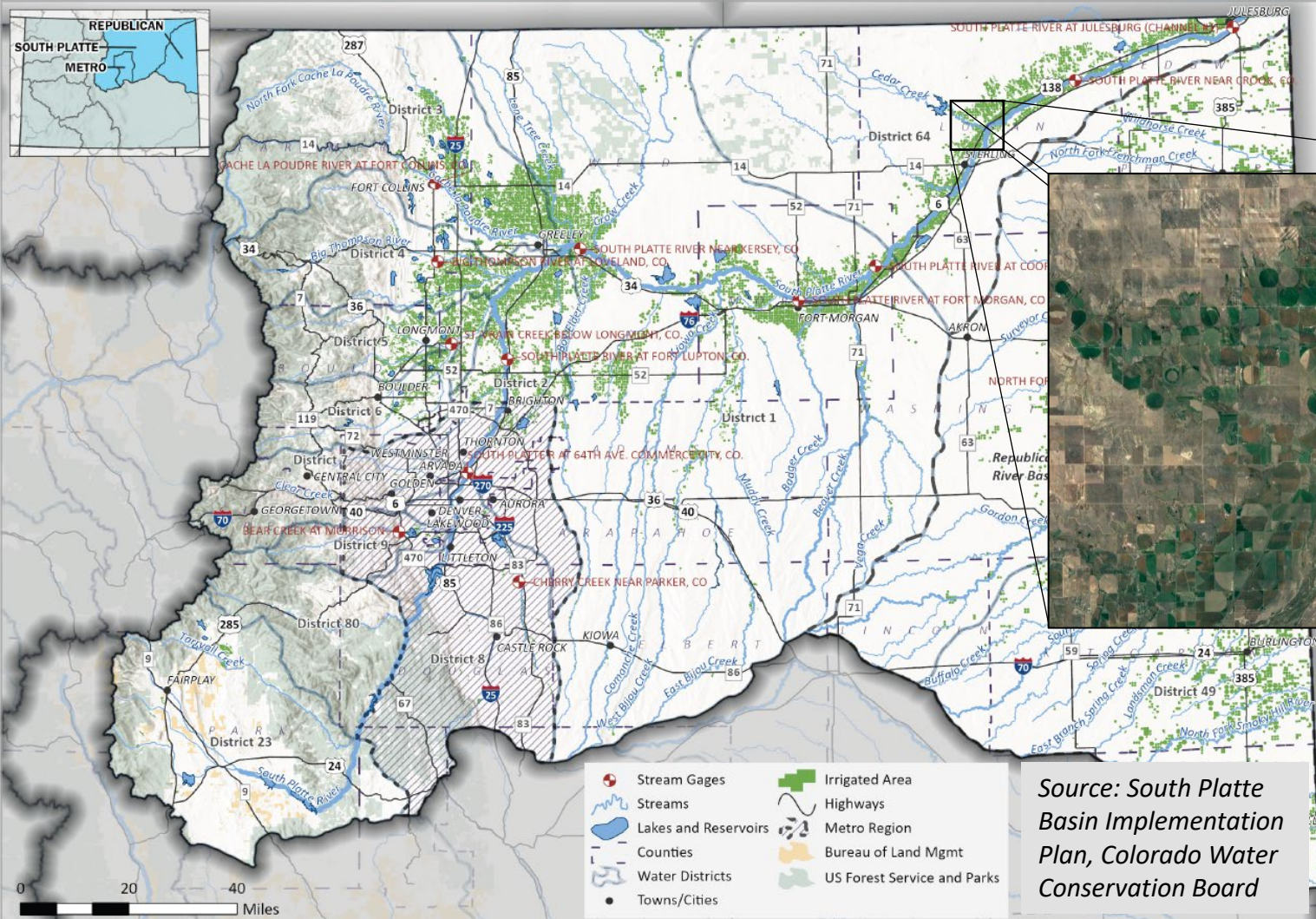
Source: 2023 Colorado Water Plan

Source: USGS



Base from the U.S. Geological Survey,  
 U.S. Census Bureau digital data, 1974 to 1992,  
 1:100,000 to 1:500,000 Albers Equal Area projection  
 Standard parallels 29 °30N and 49 °30N,  
 Central meridian 104 °W  
 Latitude of projection origin 23°W





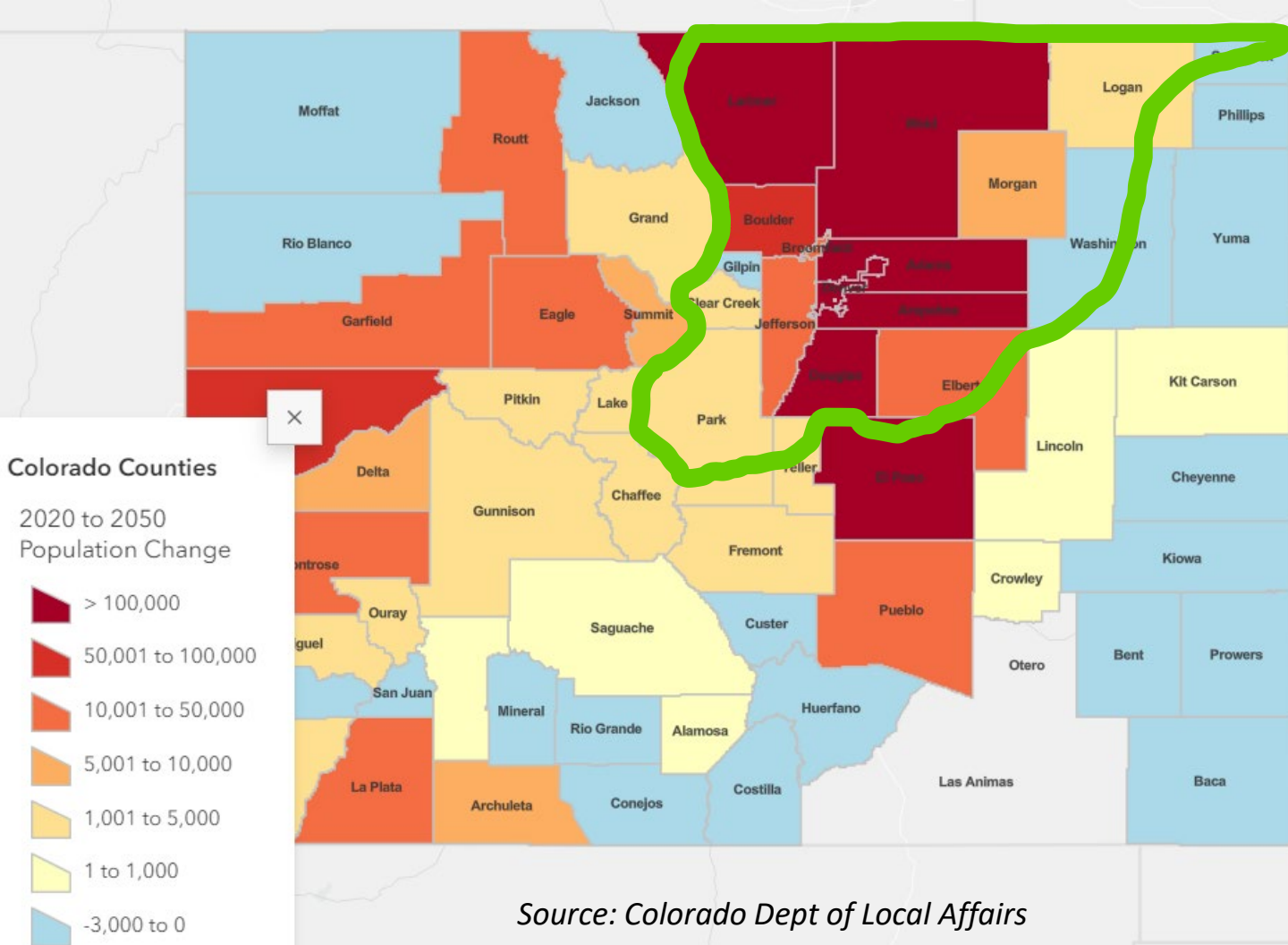
~854,000 acres of irrigated land



Ag lands account for 85% of water diversions in SPRB

Source: South Platte Basin Implementation Plan, Colorado Water Conservation Board





- 70% of Colorado's population is within SPRB
- Projected growth rate at nearly twice the national rate

Source: Colorado Dept of Local Affairs

# SPRB Water Uses & Values

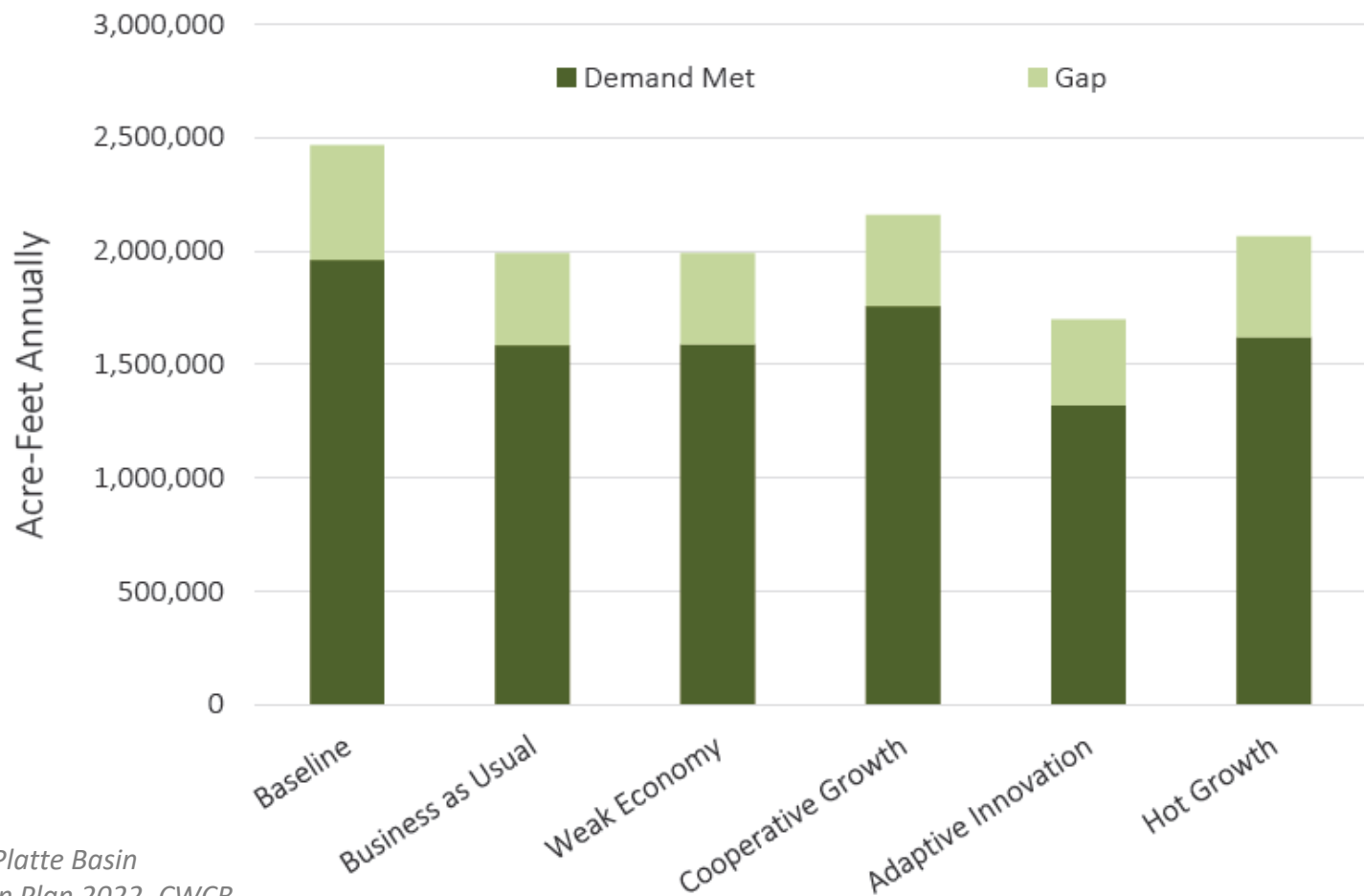
- 85% of water diversions are for agriculture; agricultural sales (2017) in SPRB and Republican River Basin totaled \$5.6 billion (75% of statewide total)
- 70% of state's population is in SPRB (3.8 million people); includes many of the most rapidly growing counties in the state
- SPRB includes ~40% of total statewide industrial water demand
- Estimated supply gap of 540,700 af annually to meet M & I demand by 2050
- Water-related recreation in SPRB is estimated at \$8.9 billion (2020)
- Endangered species act requirements to improve and maintain habitat on Platte River for: Piping Plover, Least Tern, Whooping Crane, and Pallid Sturgeon

Source: South Platte Basin  
Implementation Plan 2022, CWCB



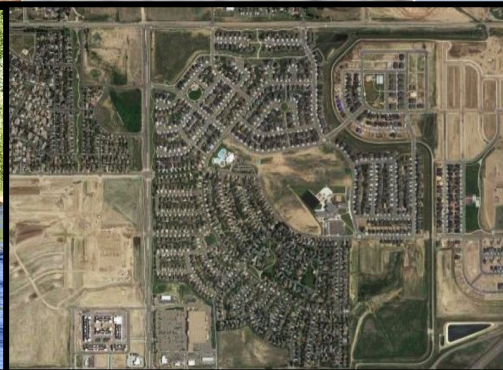
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# SOUTH PLATTE



Source: South Platte Basin  
Implementation Plan 2022, CWCB





How did we get here?



# Indigenous Cultures

- Human presence in region  
~13,000 years ago
- Ute (1000s) – Rocky Mountains
- Arapaho, Kiowa – plains,  
foothills, Rocky Mountains
- Cheyenne, Apache, Comanche,  
Lakota, Shoshone, and Pawnee  
peoples – plains





# Violence, Disease, and Forced Relocation

- 1851 Fort Laramie Treaty - broken
- 1864 Sand Creek Massacre - 230 Cheyenne & Arapaho people killed, mostly women, children, & elderly
- Forced relocation of tribes - Northern Arapaho to Wind River reservation
- No reservations exist today in South Platte River Basin

Source: CPR News, History Colorado

Cheyenne and Arapaho people are today part of these tribal nations:

- Cheyenne & Arapaho Tribes of Oklahoma
- Northern Arapaho Tribe, Wind River, Wyoming
- Northern Cheyenne Tribe, Montana

Descendants of tribes closely connected to the Northeastern plains of Colorado are today part of these tribal nations:

- Cheyenne River Sioux Tribe, South Dakota
- Crow Creek Sioux Tribe, South Dakota
- Oglala Sioux Tribe, South Dakota
- Rosebud Sioux Tribe, South Dakota
- Standing Rock Sioux Tribe, North Dakota
- Three Affiliated Tribes Mandan, Hidatsa and Arikara Nation, North Dakota
- Crow Tribe, Montana
- Eastern Shoshone Tribe, Wind River Reservation, Wyoming
- Shoshone-Bannock Tribes, Idaho

*Yufna Soldier Wolf, member of Northern Arapaho Tribe, Wind River, Wyoming*  
Image credit: PBS.org

Source: CPR News,  
History Colorado





Today, the Utes are three tribes:

- Southern Ute Indian Tribe, Colorado
- Ute Mountain Ute Tribe, Colorado and Utah
- Ute Indian Tribe of the Uintah & Ouray Reservation, Utah

Descendants of tribes closely connected to the Southeastern plains of Colorado are today part of these tribal nations:

- Apache Tribe of Oklahoma
- Fort Sill Apache Tribe, Oklahoma
- Jicarilla Apache Nation, New Mexico
- Mescalero Apache Tribe, New Mexico
- Comanche Nation, Oklahoma
- Kiowa Tribe of Oklahoma
- Pawnee Nation of Oklahoma
- Osage Nation, Oklahoma
- Wichita & Affiliated Tribes, Oklahoma

*Source: CPR News,  
History Colorado*

*Ernest House Jr., a member of the Ute Mountain Ute Tribe and former executive director of the Colorado Commission Indian Affairs, at the confluence of the South Platte River and Cherry Creek in Denver.*



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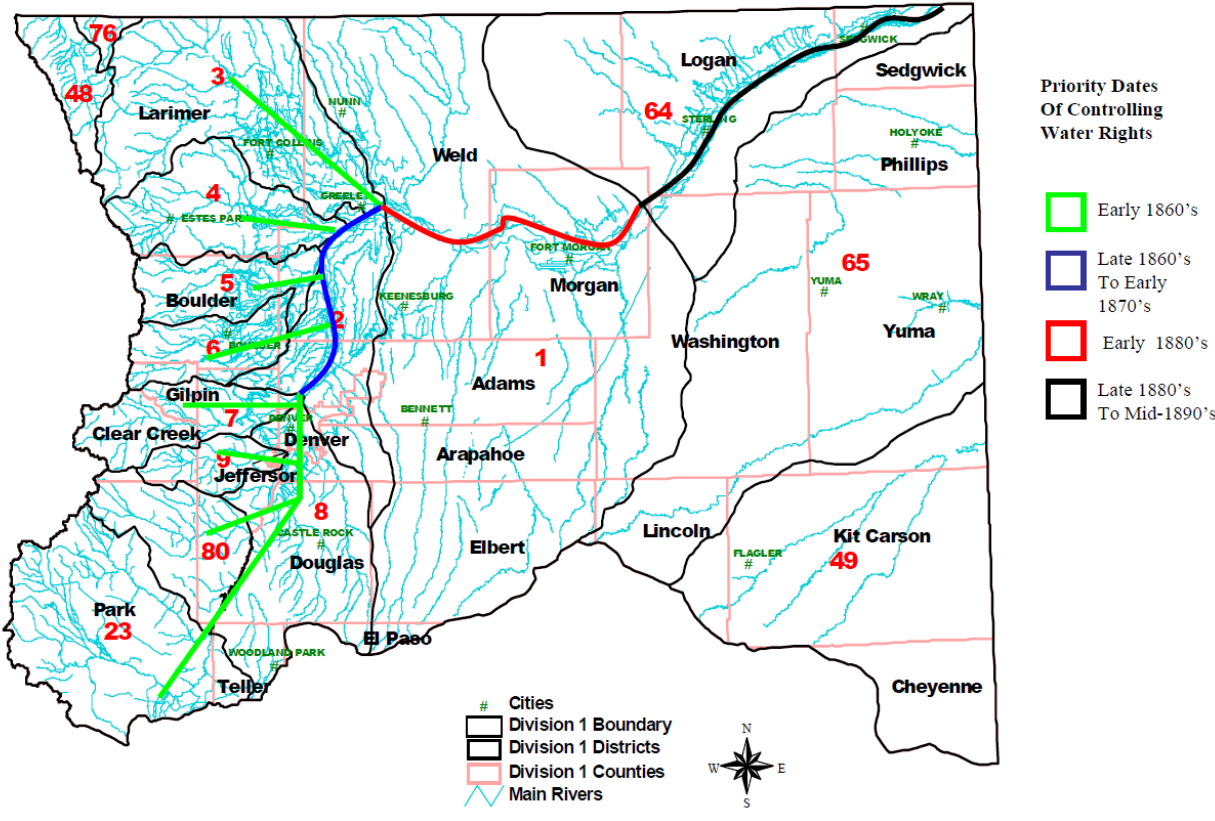
# SPRB Settlers & Water Development

- 1820: Major Stephen Long expedition along South Platte → “the Great American Desert”
- Fur trappers and trading posts along river and tributaries
- 1859 Colorado gold rush; mining settlement along SP = Denver
- 1862: Homestead Act
- 1860s: Colorado Doctrine
- 1870: Union Colony (Greeley) – agricultural development
- 1860-1890: Construction of small and large-scale irrigation ditches
- 1876: Colorado becomes a state; adoption of Prior Appropriation Doctrine in Colorado Constitution (first state to do so)
- 1880s: Storage structures constructed to capture spring runoff
- 1882: First transmountain ditches constructed to divert water for irrigation



# Water Development in SPRB (Direct Flow Water Rights)

State of Colorado, Division of Water Resources, Division 1, South Platte River Drainage.



## Prior Appropriations Doctrine

- Earliest uses of water have highest priority for use (first in time, first in right)
- Water must be used for beneficial purpose (no waste, no speculation)

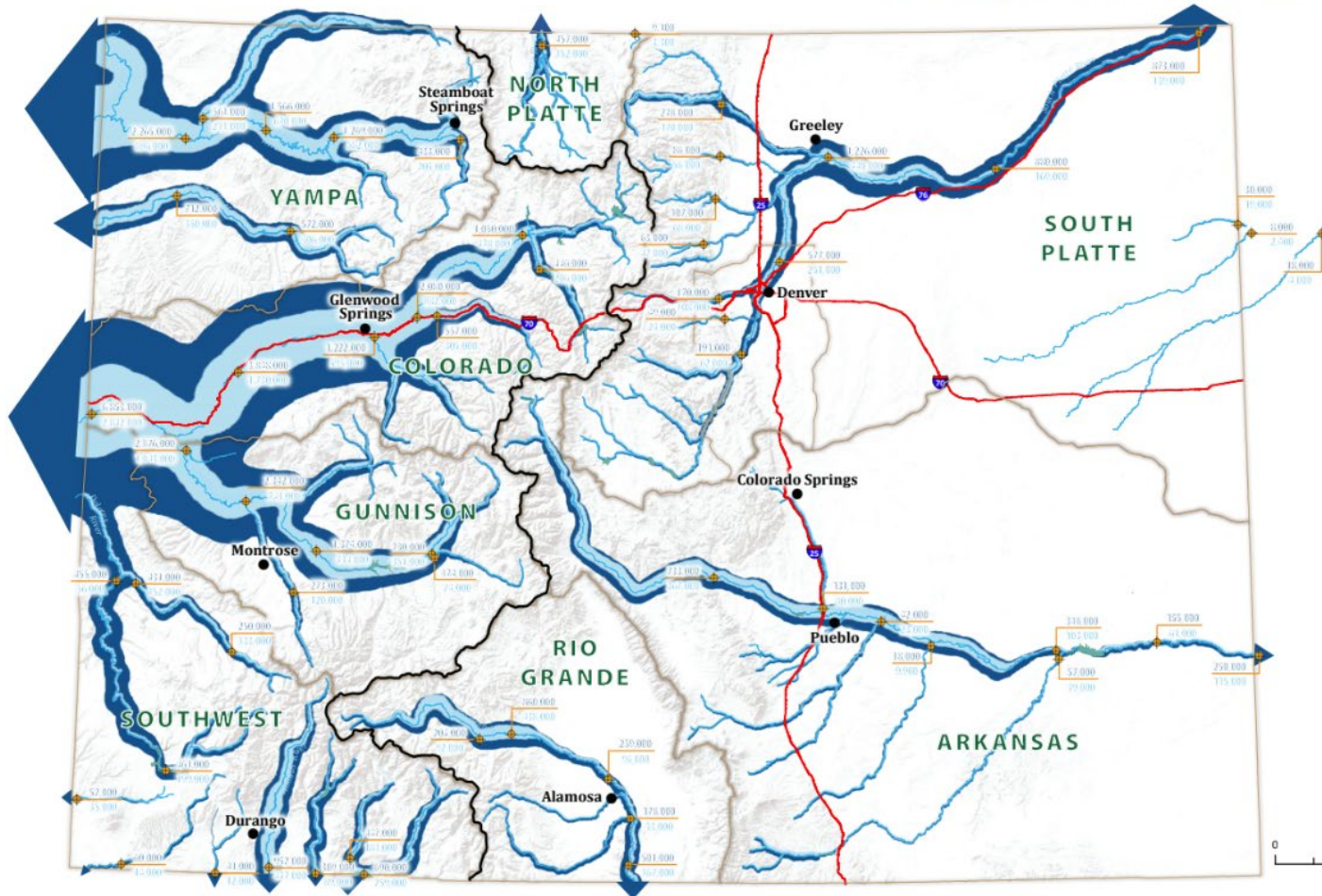




# STATEWIDE

## Summary of Observed Wet-and-Dry Surface Water Hydrology

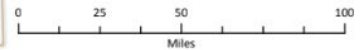
SPRB mean annual flow:  
 1.4 million acre-feet (af)



### MAP KEY

- Gages
- AFY (typical wet year)
- AFY (typical dry year)
- Streams
- Typical Wet Year Flow
- Typical Dry Year Flow
- Reservoirs (>10,000 AF)
- Major Hydrologic Basins in Colorado

*NOTE: Wet and dry typical hydrology years determined separately for each basin.*



# Watershed Diversions

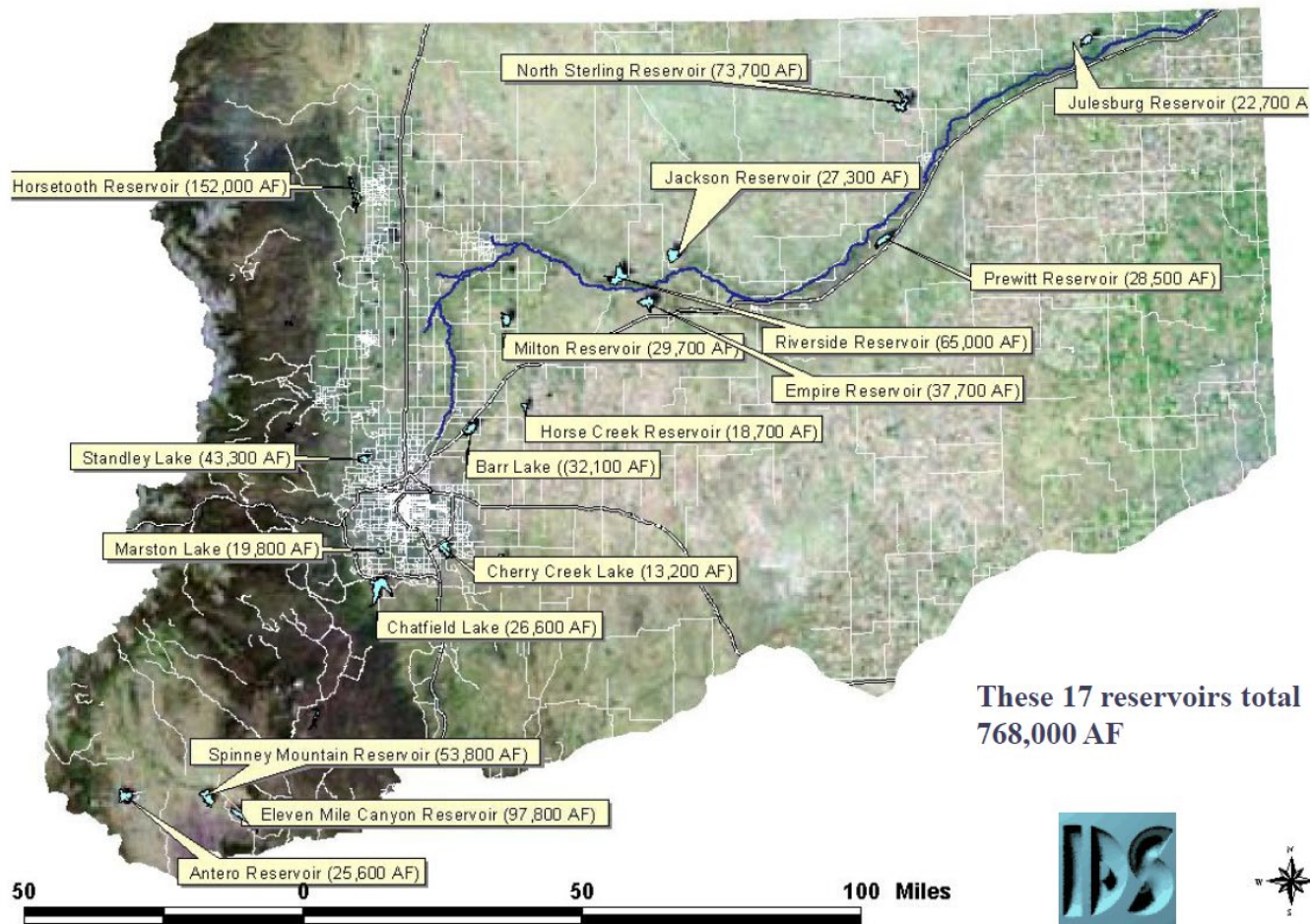


- 44 structures in Colorado that divert water from one watershed to another
- Majority divert water from west of the Continental Divide to east
- Largest diversions into SPRB:
  - Adams Tunnel – 216,570 af
  - Roberts Tunnel – 58,426 af
  - Moffat Tunnel – 52,390 af

*Source: Citizen's Guide to Colorado's Transbasin Diversions, Water Education Colorado*



# South Platte Major Storage Projects



**These 17 reservoirs total  
768,000 AF**

*Source: Interim Water Resources Review  
Committee Presentation by Jim Yahn and  
Joe Frank, August 2012*







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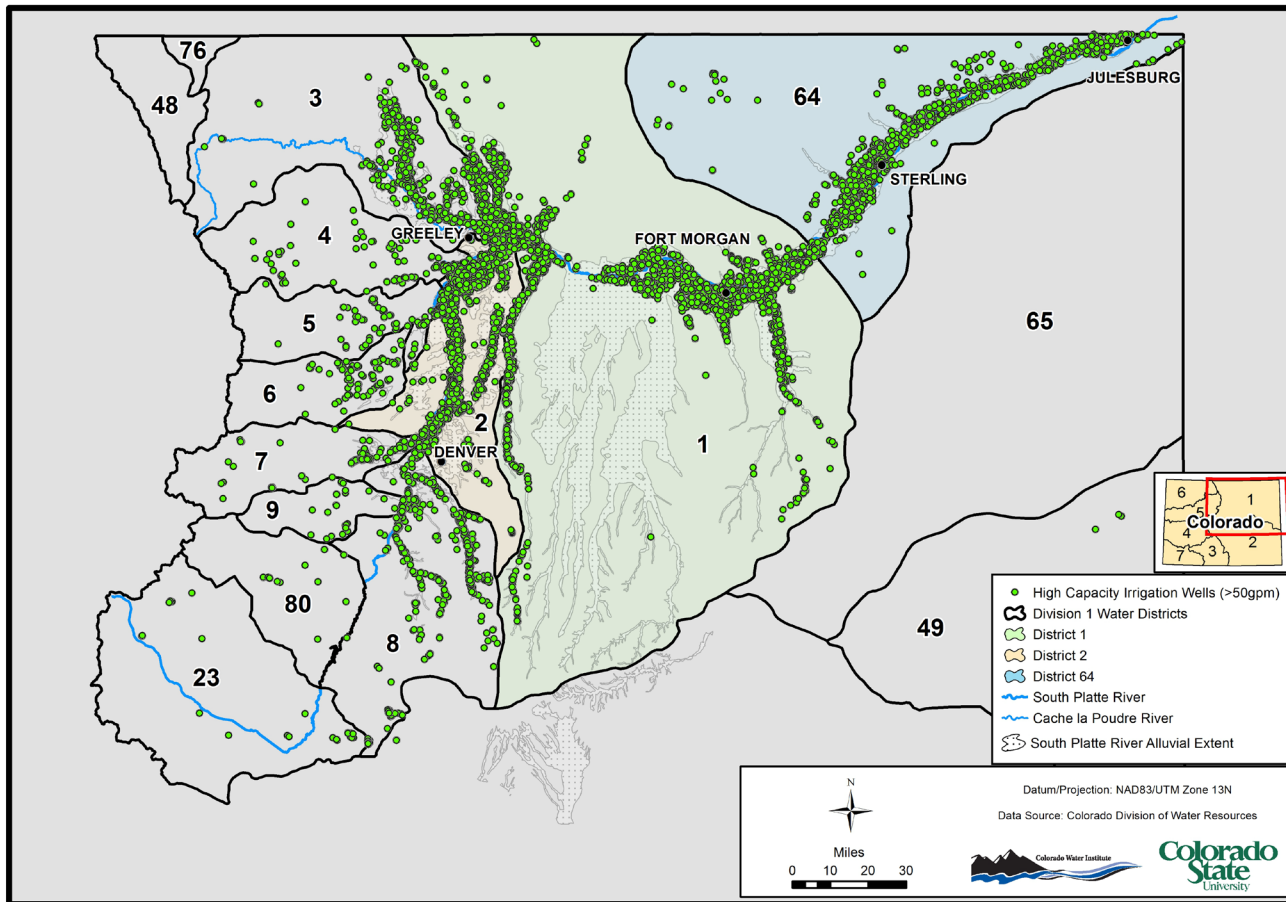


# Return Flow Hydrology

- “Return of Seepage Water to the Lower South Platte River in Colorado,” Ralph Parshall, 1922 (Colorado Ag. College, aka Colorado State University)
- Surface water irrigation led to gradual rise in groundwater table “...as much as 100 feet in some areas”
- Historically, South Platte River would frequently run dry in summer (following peak flow from snowmelt in May/June)
- Surface water irrigation led to more constant flows along lower South Platte in summer months



# High Capacity Irrigation Wells in DWR Division 1



Alluvial ground-  
water well  
development  
1930-70s

*South Platte Groundwater Study,  
Colorado Water Center, 2013*



## Alluvial well development 1930-70s

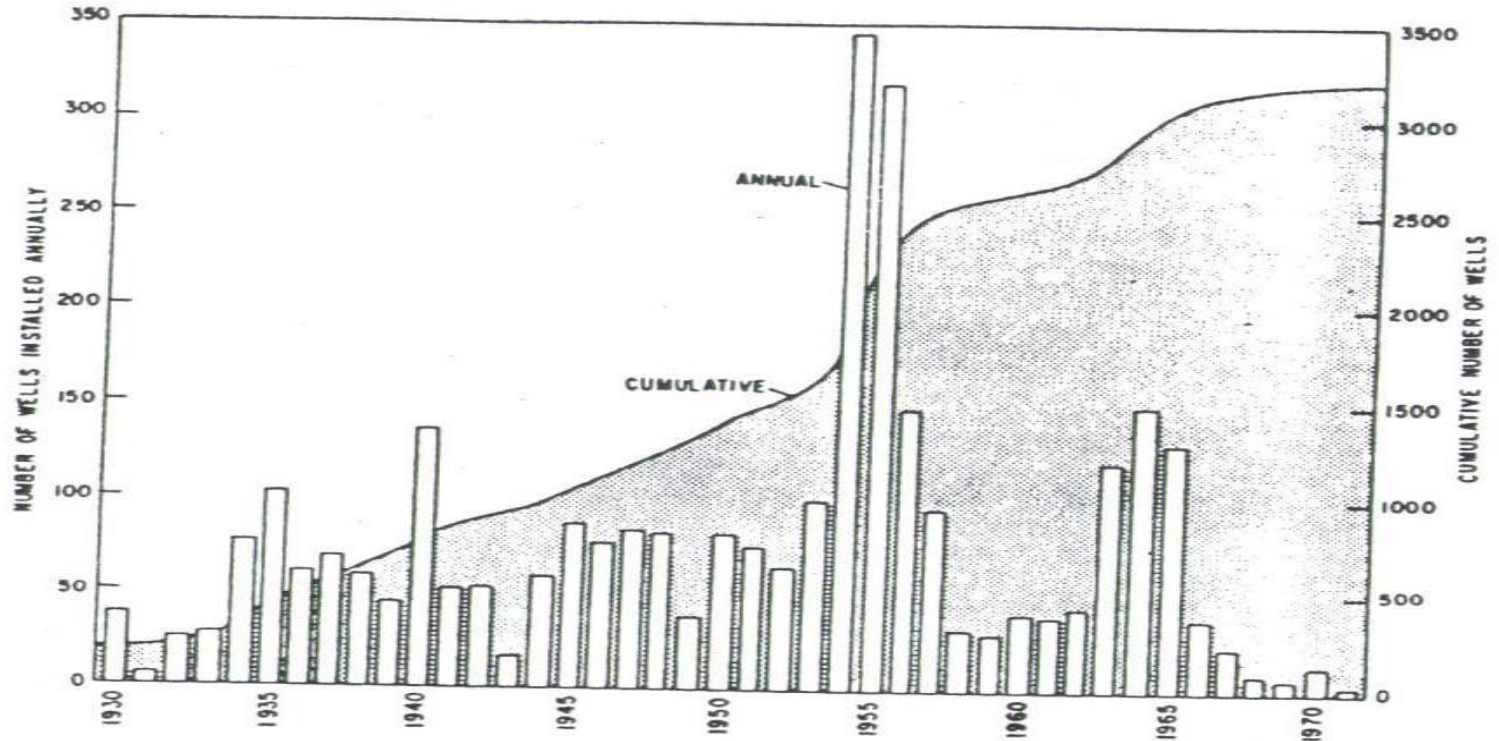


Fig. 2. Annual installation and cumulative number of irrigation wells in the South Platte River valley study area

# Dwindling South Platte River in 1950s

- In 1955, >4000 irrigation wells pumped enough water to fill Horsetooth Reservoir four times (584,000 af)
- 1950s-60s: laws passed and court rulings to regulate groundwater pumping in state and resolve conflicts between surface water and groundwater use
- 1970s-today: well augmentation plans

*Source: South Platte Groundwater Study,  
Colorado Water Center, 2013*



# Summary of SBRB Hydrology

- Average annual native flows volume: 1.4 million af
- Transbasin water into SPRB: ~400,000 af per year
- Nontributary groundwater aquifers: ~30,000 af per year
- Total annual surface water diversions: **~4 million af**, groundwater withdrawals: 500,000 af

# Challenges in the SPRB

- Significant amount of SPRB supply originates in the Colorado Basin - subject to compact compliance
- Meeting future municipal, industrial, and agricultural water needs while protecting and enhancing the environmental and recreation opportunities
- Continued decrease in amount of irrigated agricultural land – impacts on communities, economy, environment
- Climate change impacts: likely reduction of streamflows and shifting snowmelt runoff patterns to earlier in the year
- Efficiency improvements, reuse, and watershed health projects involving recharge can reduce or change the timing of return flows that supply downstream water users of all sectors
- Water quality issues (salinity, others)

Source: 2023 Colorado Water Plan



# Questions?

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