

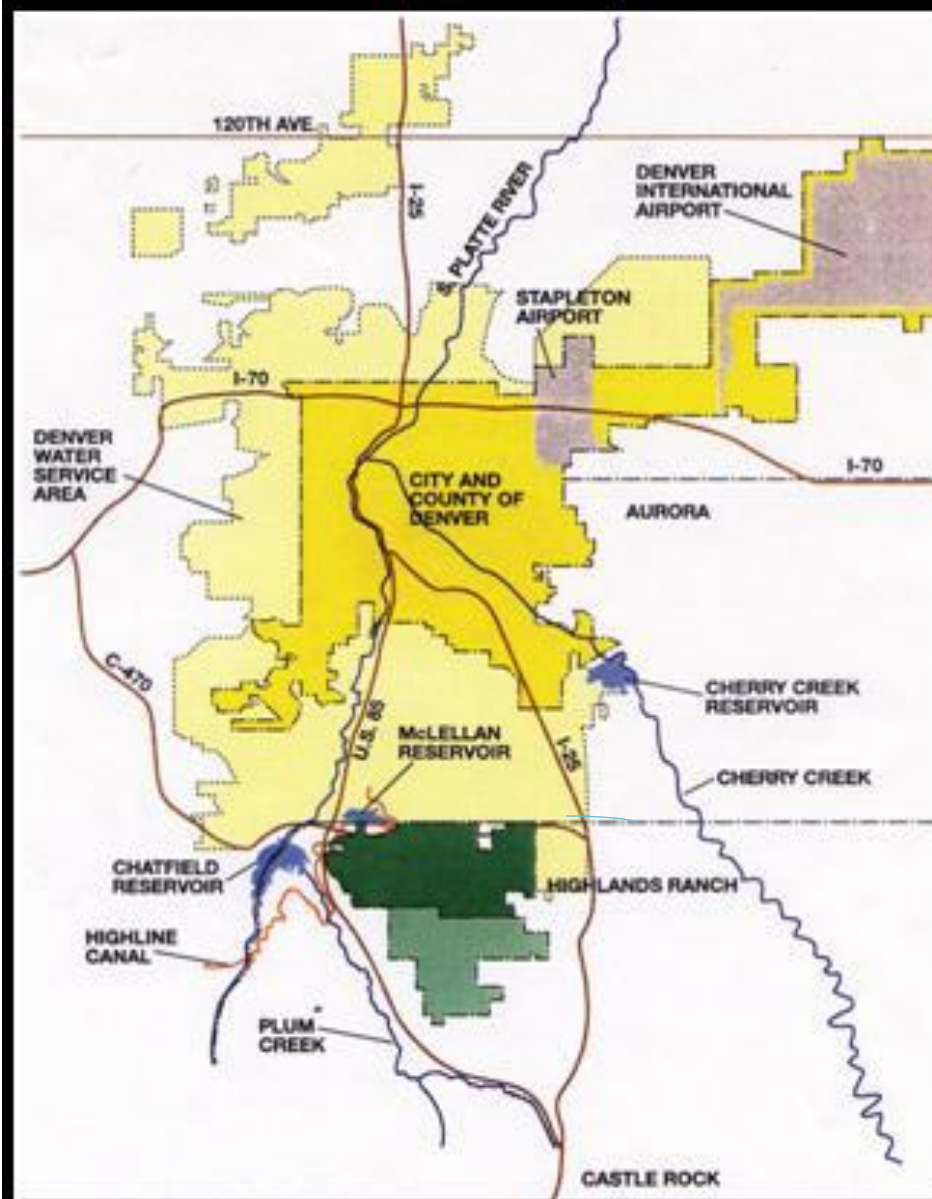
An Update on Highlands Ranch's ASR Operations

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Highlands Ranch's Location



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



Background on Highlands Ranch

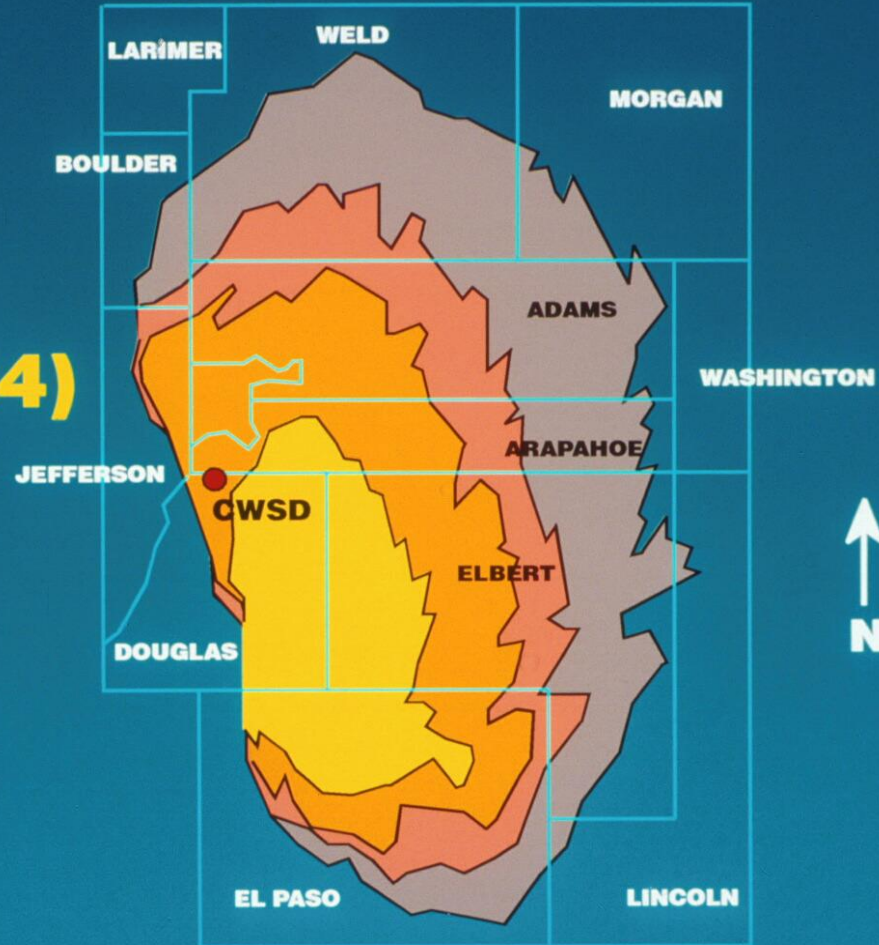
- First home built in 1981
- Current population 105,000; 98% built out
- Conjunctive use system of surface water and non-tributary groundwater
- Use groundwater from Denver, Arapahoe and LFH aquifers
- Total wells drilled: 51; currently available wells: 35
- History of water use: 87% surface / 13% groundwater
- Annual water demand: 18,000 AF/yr

Deep Groundwater Resources

CWSD is located on the Western edge of the aquifers

Area Extent of Denver Groundwater Basin Formations (after Robson, 1984)

-  Dawson Aquifer
-  Denver Aquifer
-  Arapahoe Aquifer
-  Laramie-Fox Hills Aquifer



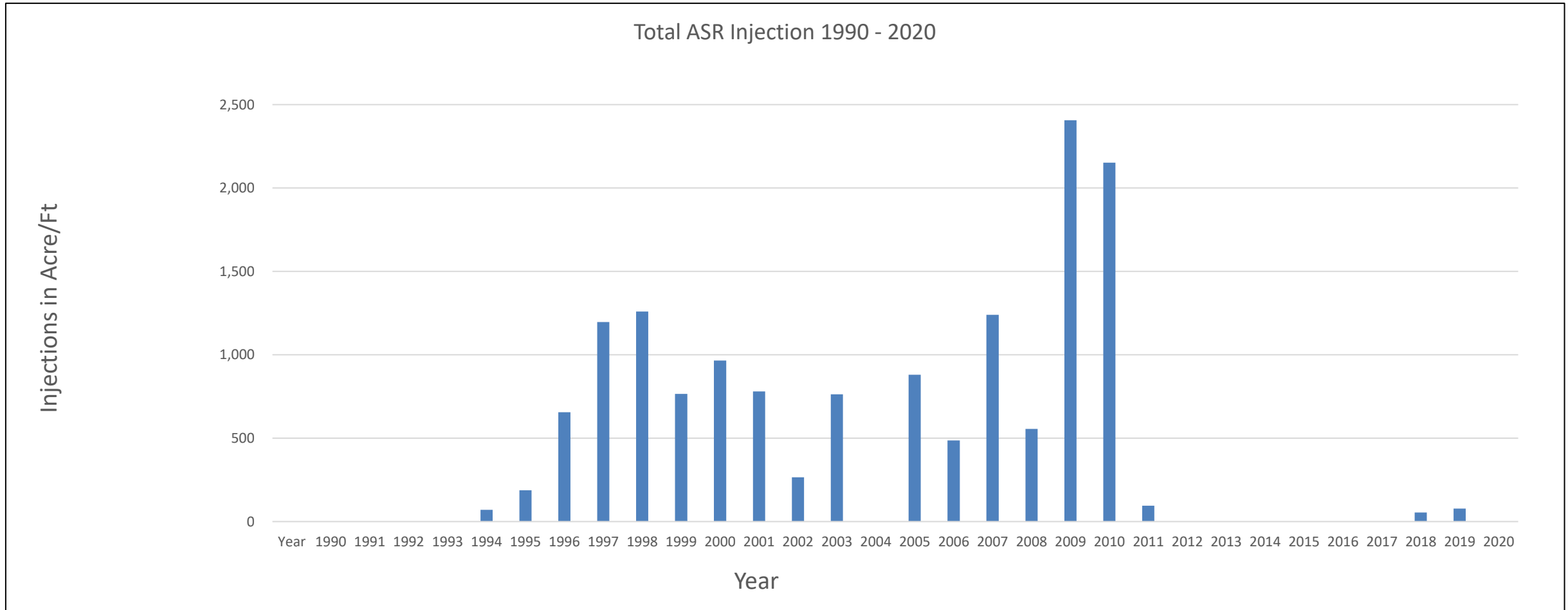
When is nontributary groundwater used?

- The goal is to maximize the use of surface water.
- Groundwater is used when:
 - Surface water is not available (ex: during droughts)
 - The surface water treatment plant (WTP) has insufficient capacity to meet demands.
 - When the WTP is under construction
 - For periodic maintenance of the wells

History of ASR use at Highlands Ranch

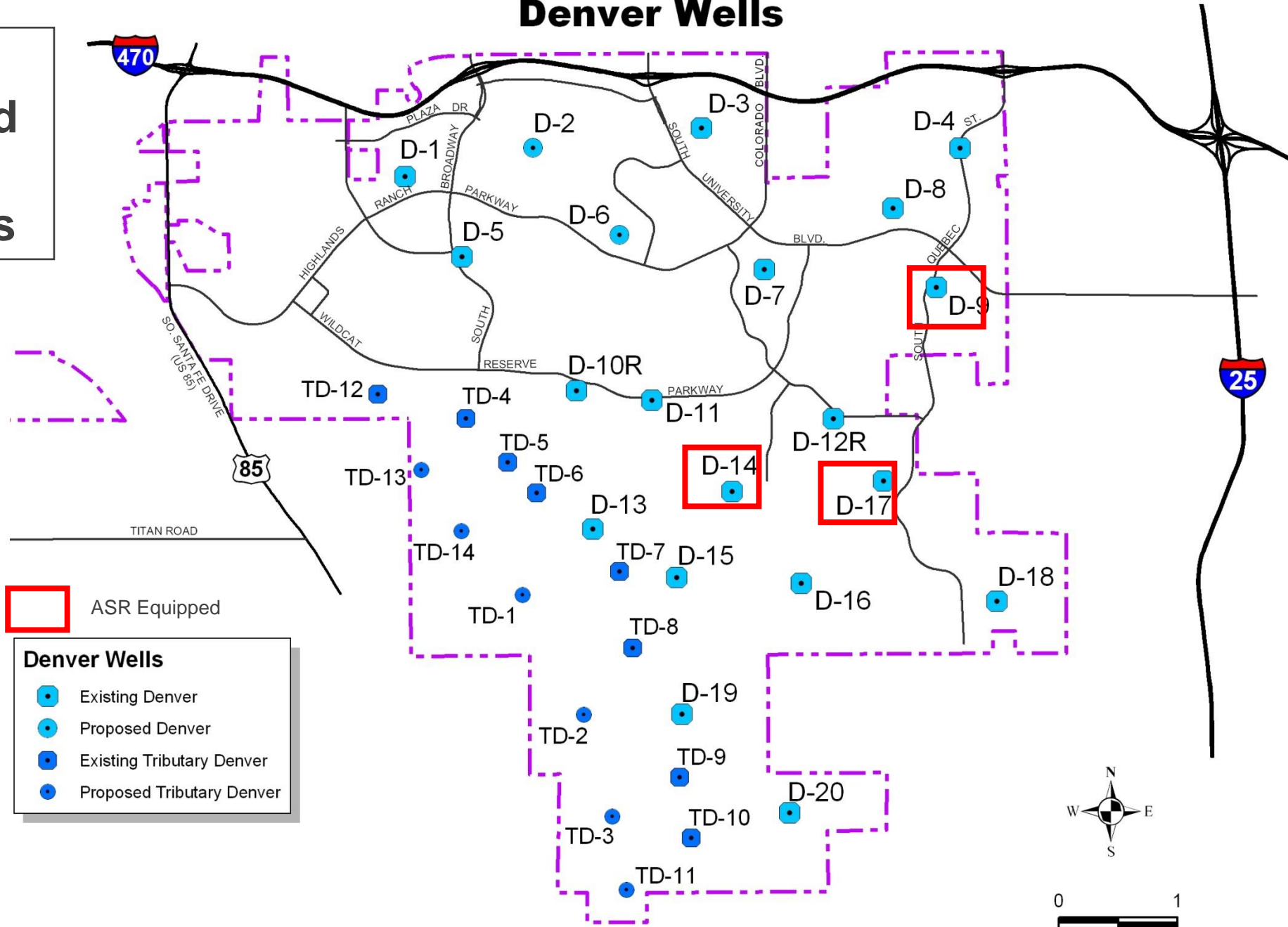
- Conducted a one year study of ASR in 1992
- From 1993 to 2023, have injected 15,357 AF using 25 different wells, as follows:
 - Arapahoe: 10,592 AF using 11 wells
 - Denver: 2,130 AF using 4 wells
 - LFH: 2,635 AF using 10 wells
- In 2023 injected 361 AF over 3 months using 5 Arapahoe wells, 7 LFH wells and one Denver well

Timing of ASR use at Highlands Ranch



Denver Wells

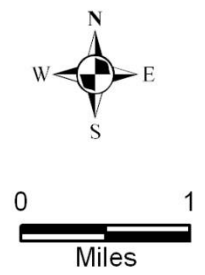
ASR
equipped
well
locations



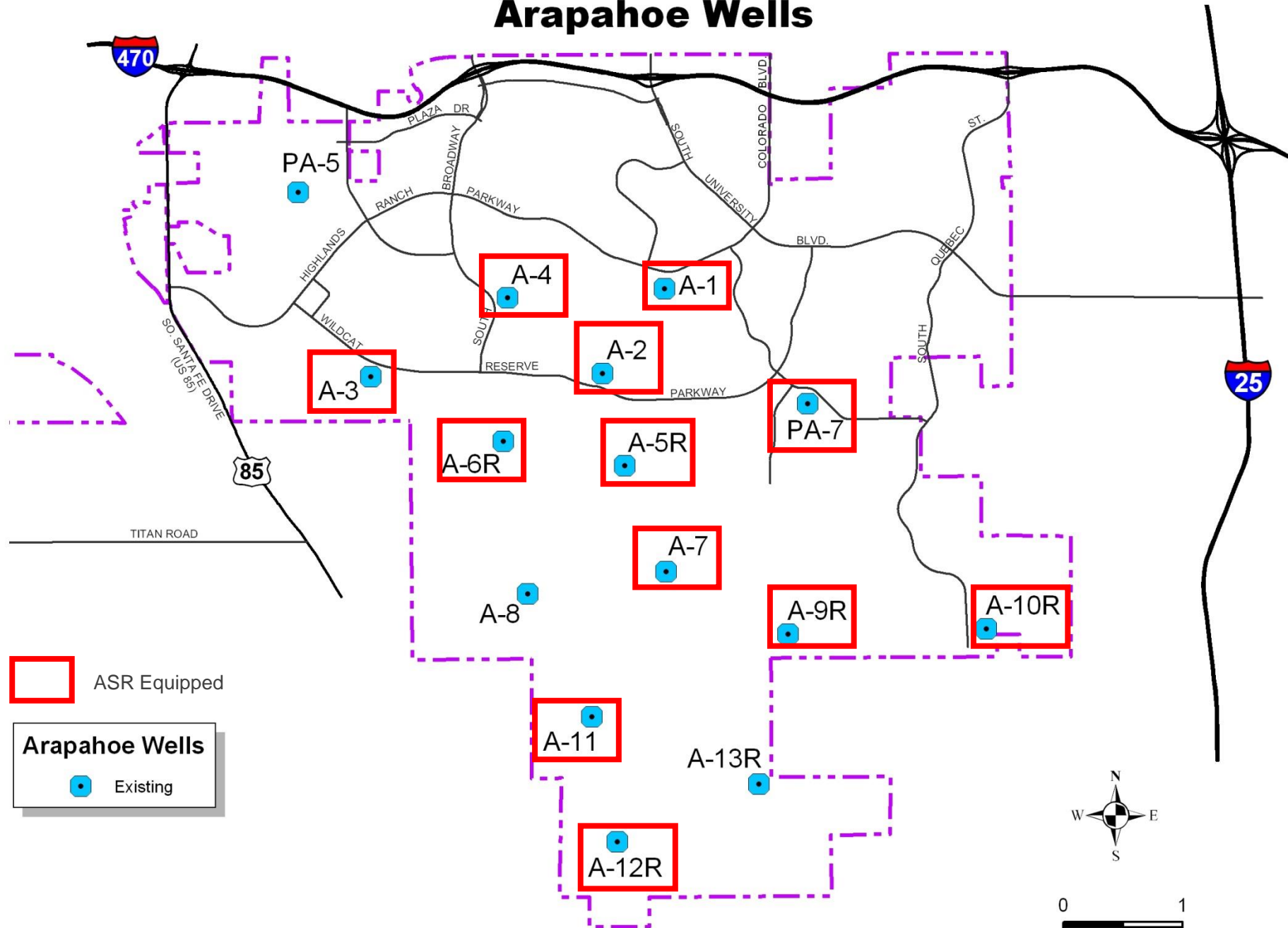
ASR Equipped

Denver Wells

- Existing Denver
- Proposed Denver
- Existing Tributary Denver
- Proposed Tributary Denver

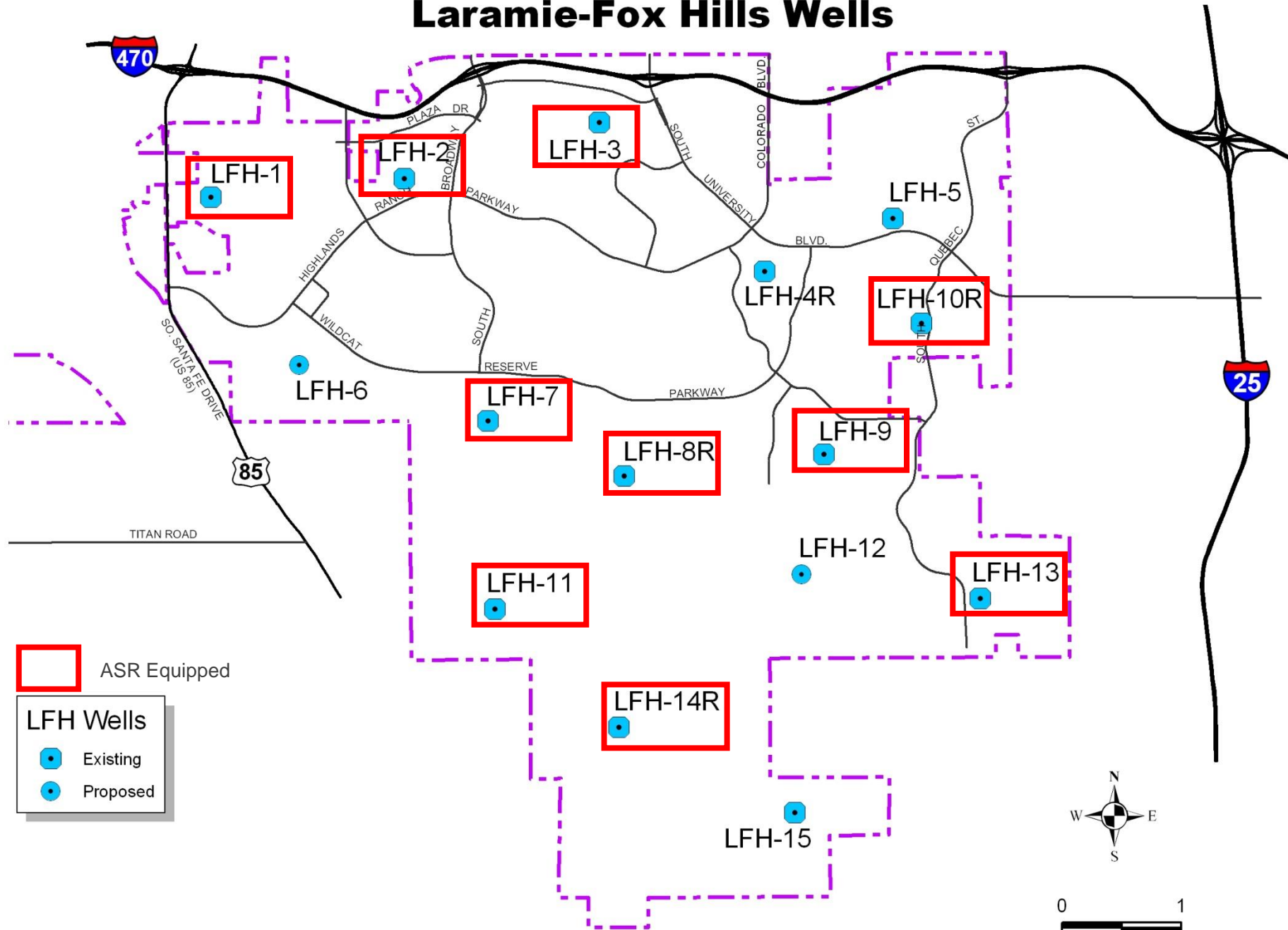


Arapahoe Wells



**Arapahoe aquifer:
Highest
flow rates
and good
water
quality**

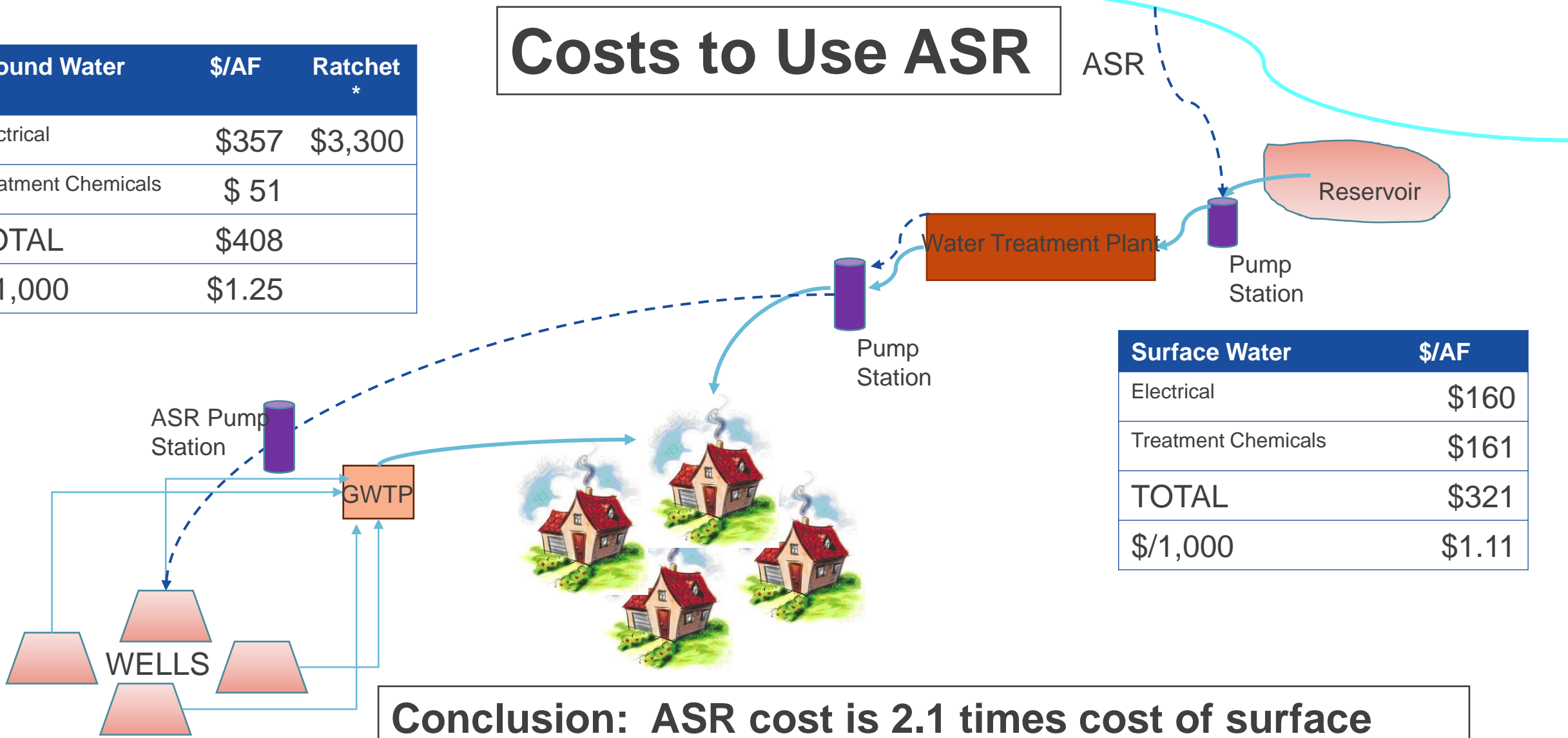
Laramie-Fox Hills Wells



LFH aquifer:
Good flow rates,
poor water quality

Costs to Use ASR

Ground Water	\$/AF	Ratchet *
Electrical	\$357	\$3,300
Treatment Chemicals	\$ 51	
TOTAL	\$408	
\$/1,000	\$1.25	



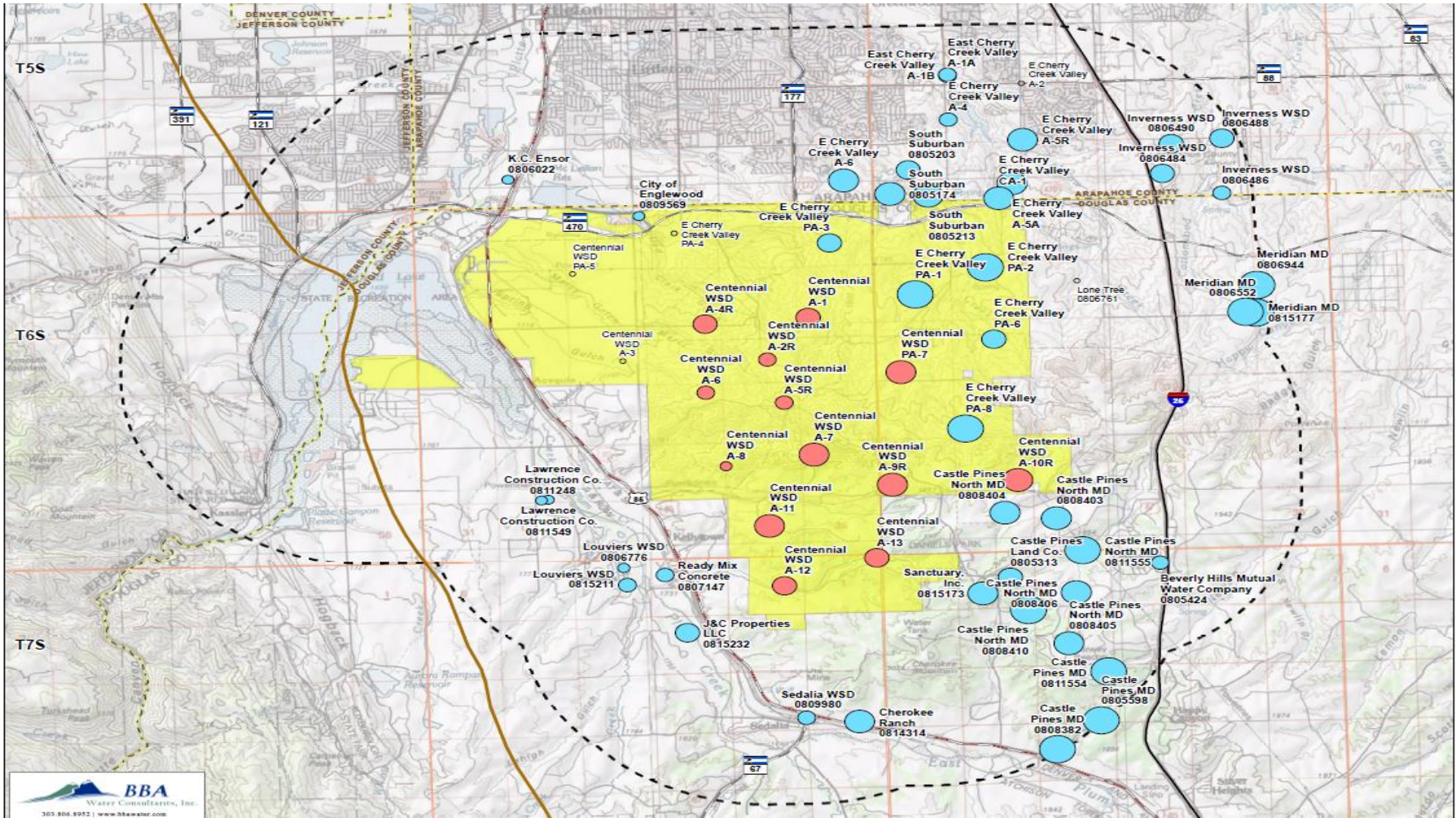
Surface Water	\$/AF
Electrical	\$160
Treatment Chemicals	\$161
TOTAL	\$321
\$/1,000	\$1.11

Conclusion: ASR cost is 2.1 times cost of surface water only

Groundwater longevity challenge

- Water level sensors operating in all wells for 20 or more years
- Static water levels in Arapahoe average 30% into formation; some are 50% into the formation
- Decreed “paper” groundwater: 18,254 AF/yr; Actually available groundwater: 8,000 AF/yr
- Pumping rates on average have declined 50%
- 10 wells now unusable
- Trends show production declines sooner than expected

There is heavy GW use by our neighbors; CWSD use is 20% of total



Centennial Denver Basin Arapahoe Aquifer Wells
Water Year 2018-2022

Date: 8/15/2023 | Job No. 1622.13

Legend

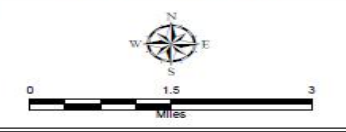
Well Pumping, Acre-Feet (Owner, Well Name) selection

Water Years 2018-2022

- 0.0
- 0.1 - 100.0
- 100.1 - 250.0
- 250.1 - 500.0
- 500.1 - 1000.0
- 1000.1 - 2134.3
- Centennial Well (shown in red), Non-Centennial Well (shown in blue)
- District Boundary
- 3-mile Buffer
- ▭ Arapahoe Boundary

Note: Bold labels are wells with reported pumping, smaller non-bold labels are wells with no reported pumping.

Data Source: CDSS, CDOT, USGS, BLM



Can ASR improve the groundwater longevity problem? (Answer: it's unclear)

- ASR is proven to be physically feasible.
- The problem is having excess surface water to inject.
- When have surface water available:
 - First, provide only surface water to customers
 - Second, fill as soon as possible all surface reservoirs
 - Third, then can consider injecting water into aquifers
- Problem: current groundwater entities have limited surface water assets, and infrequently have excess surface water.

Thank you for your attention; Are there any questions?

