Assessment of Groundwater Mineralization in the Upper Arkansas River Corridor

Presentation for ARCA Meeting, December 9, 2021

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SOURCE OF SALINITY, SELENIUM, AND URANIUM

Natural sources: Weathering of marine Cretaceous shales containing gypsum and sulfides.

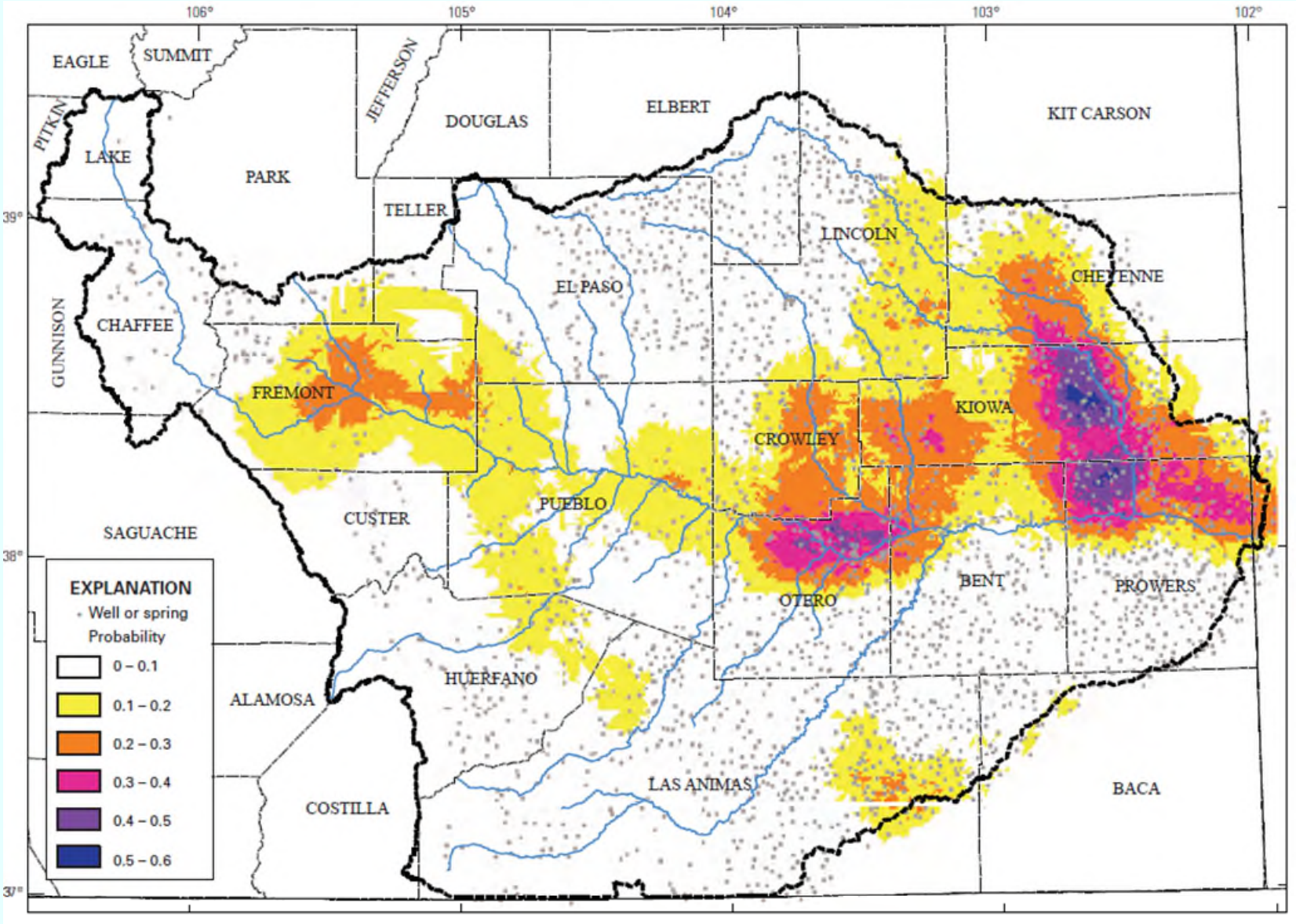
Anthropogenic sources: Insignificant.

CAUSE OF SALINITY LEVEL AT STATE LINE

Anthropogenic: Concentration of dissolved salts by consumption of water during evapotranspiration associated with extensive irrigated agriculture and shallow reservoirs.

Natural: In absence of human activities, the salinity would be three to four times less.

Probability of Uranium >30 µg/L in Groundwater in Arkansas River Basin, Colorado



From Miller et al. (2010) – a USGS study

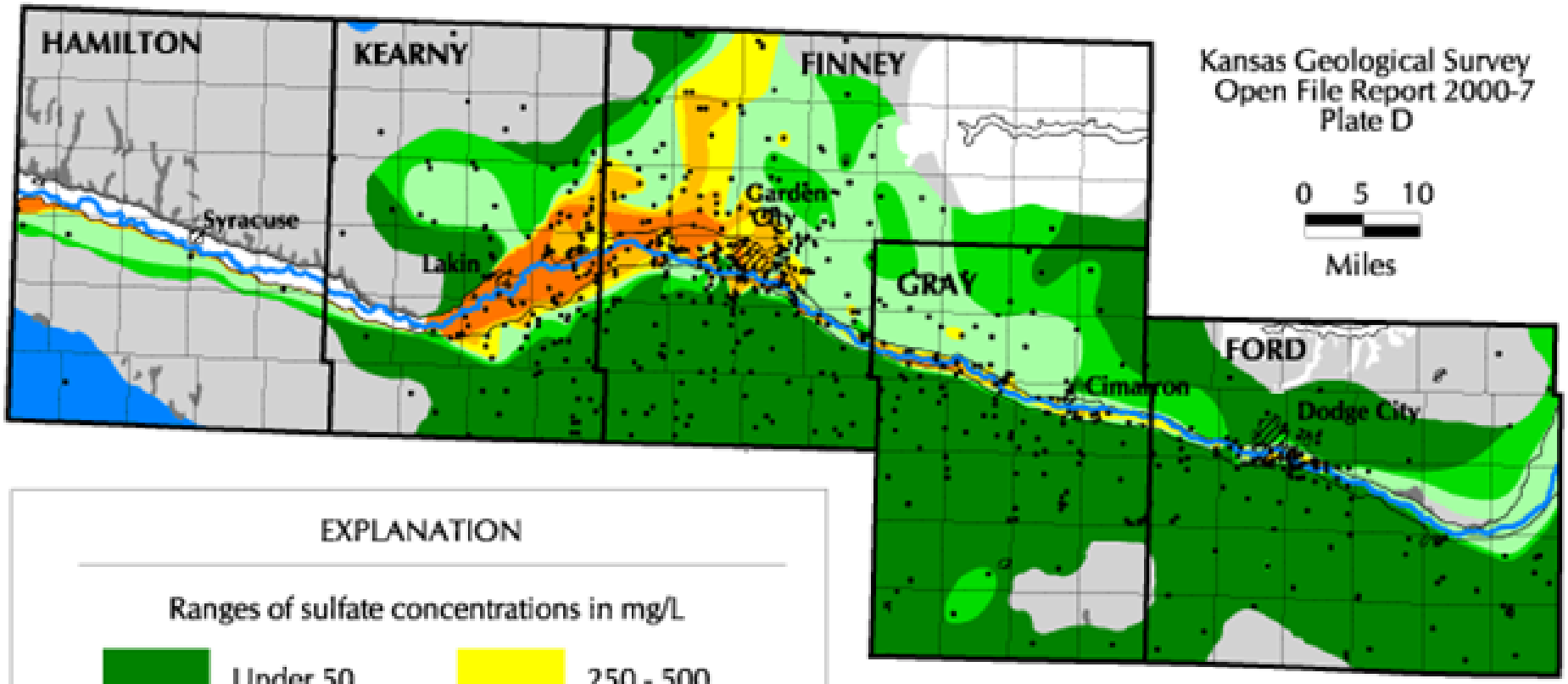
Arkansas River near Colorado-Kansas Line

1963-2010 for all data except 2009-2010 for U

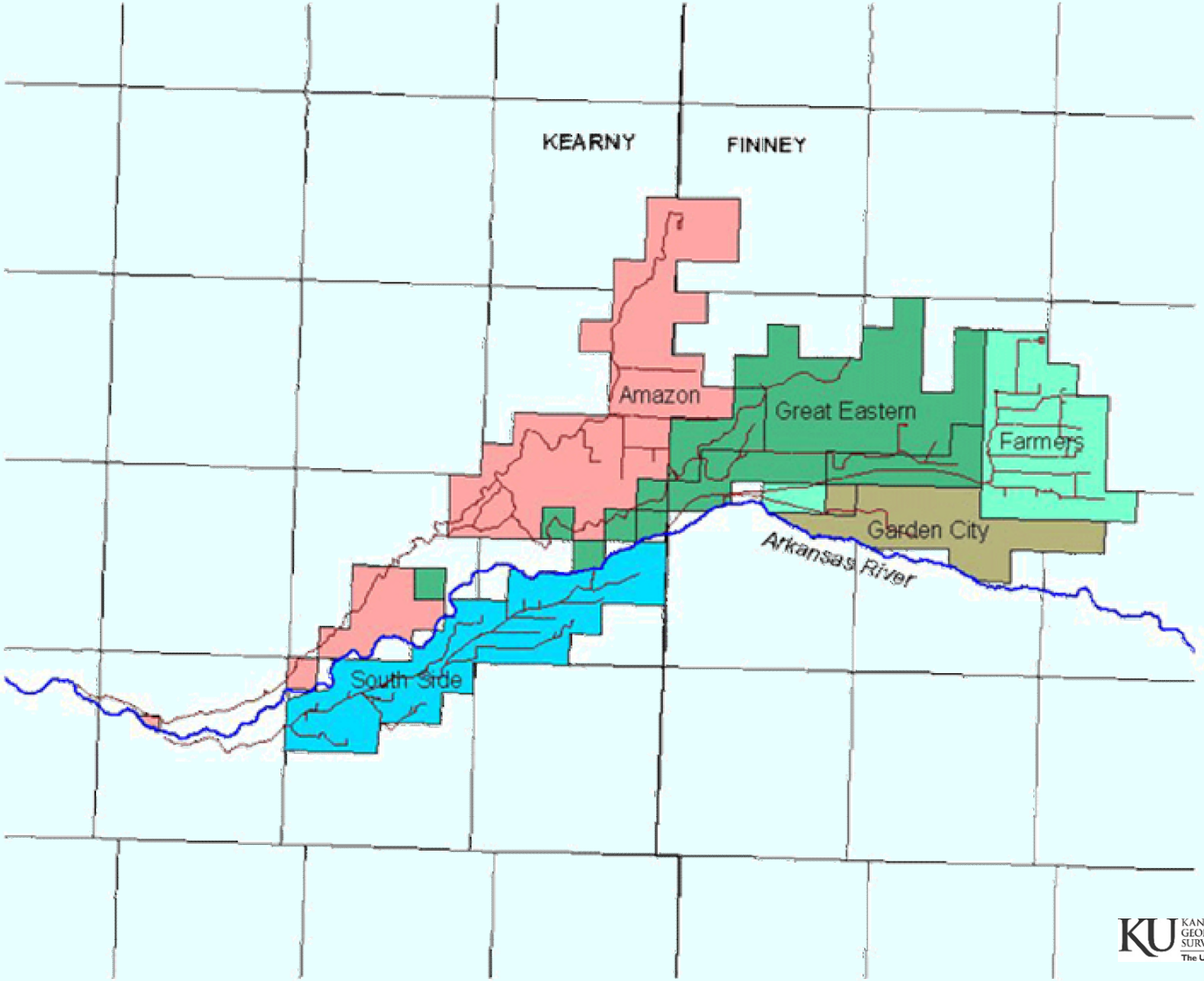
	Flow ft^3/sec	TDS mg/L	SO4 mg/L	Cl mg/L	U µg/L
Average	244	3,260	1,960	137	63.5
Number of samples	554	486	553	551	27
Drinking water standard, MCL or (recommended)	-	(500)	(250)	(250)	30

2000 Map

Sulfate Concentration for the High Plains Aquifer in the Upper Arkansas River Corridor in Southwest Kansas



Historic Ditch Irrigation Service Areas



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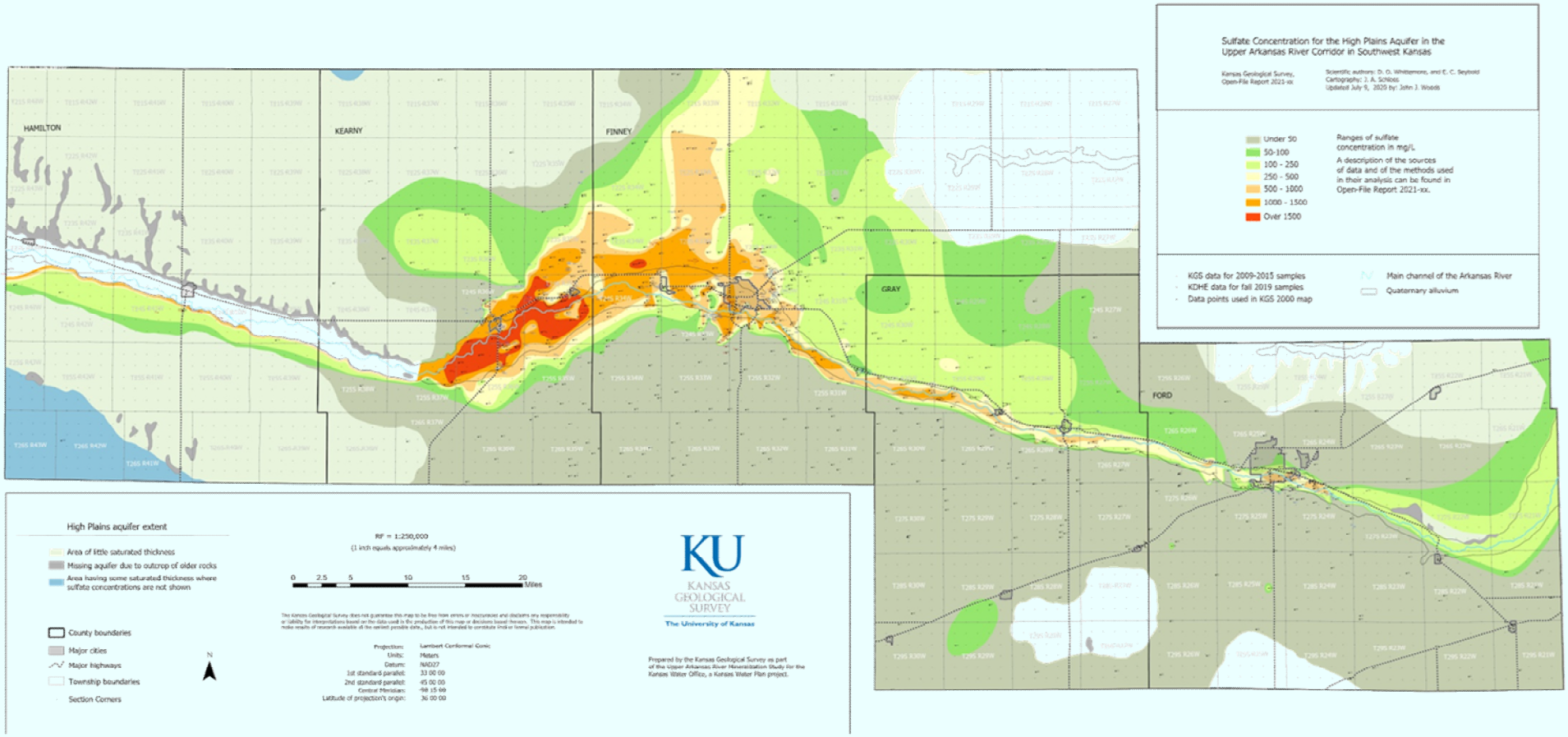
CURRENT STUDY OF MINERALIZATION AND URANIUM IN ARKANSAS RIVER CORRIDOR

- KDHE voluntary sampling and analysis of private wells (fall 2019)
- KGS, KDHE, GMD3 collaborative study for KWO on salinity and uranium distribution in the aquifer, including factors controlling the distribution, and river loads and their impact on the area.

CURRENT STUDY OBJECTIVES:

1. Determine distributions of salinity, uranium, and other constituents in the High Plains aquifer in the upper Arkansas River corridor.
2. Determine changes between current and past chemical distributions.
3. Determine chemical loads of Arkansas River water into study area.
4. Assess geographic factors controlling chemical distributions.
5. Assess vertical lithologic controls on distributions.
6. Assess hydrogeochemical factors controlling chemical distributions.

Groundwater Sulfate Concentration in High Plains Aquifer Based on Recent KDHE Domestic Well and KGS Well Data



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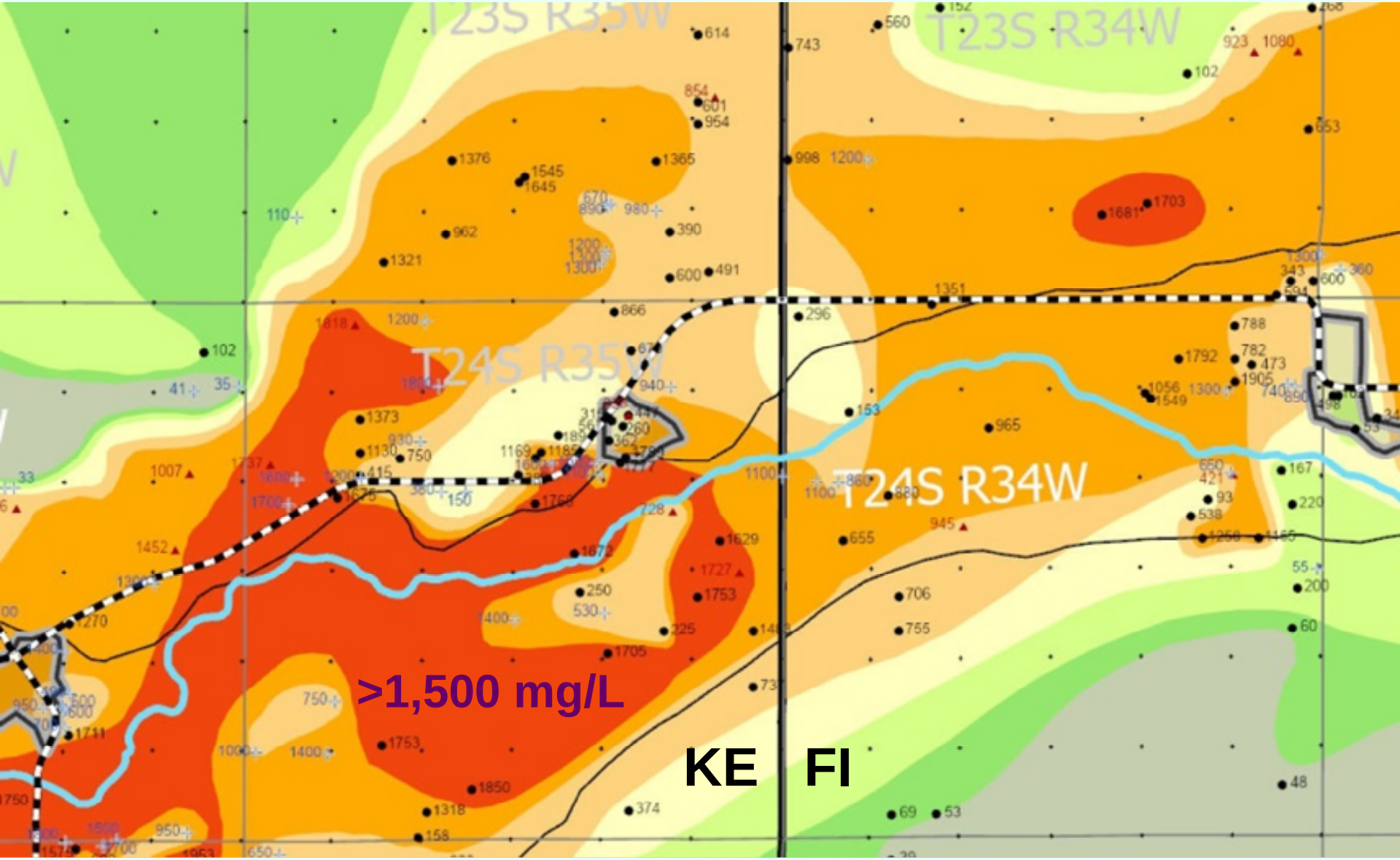
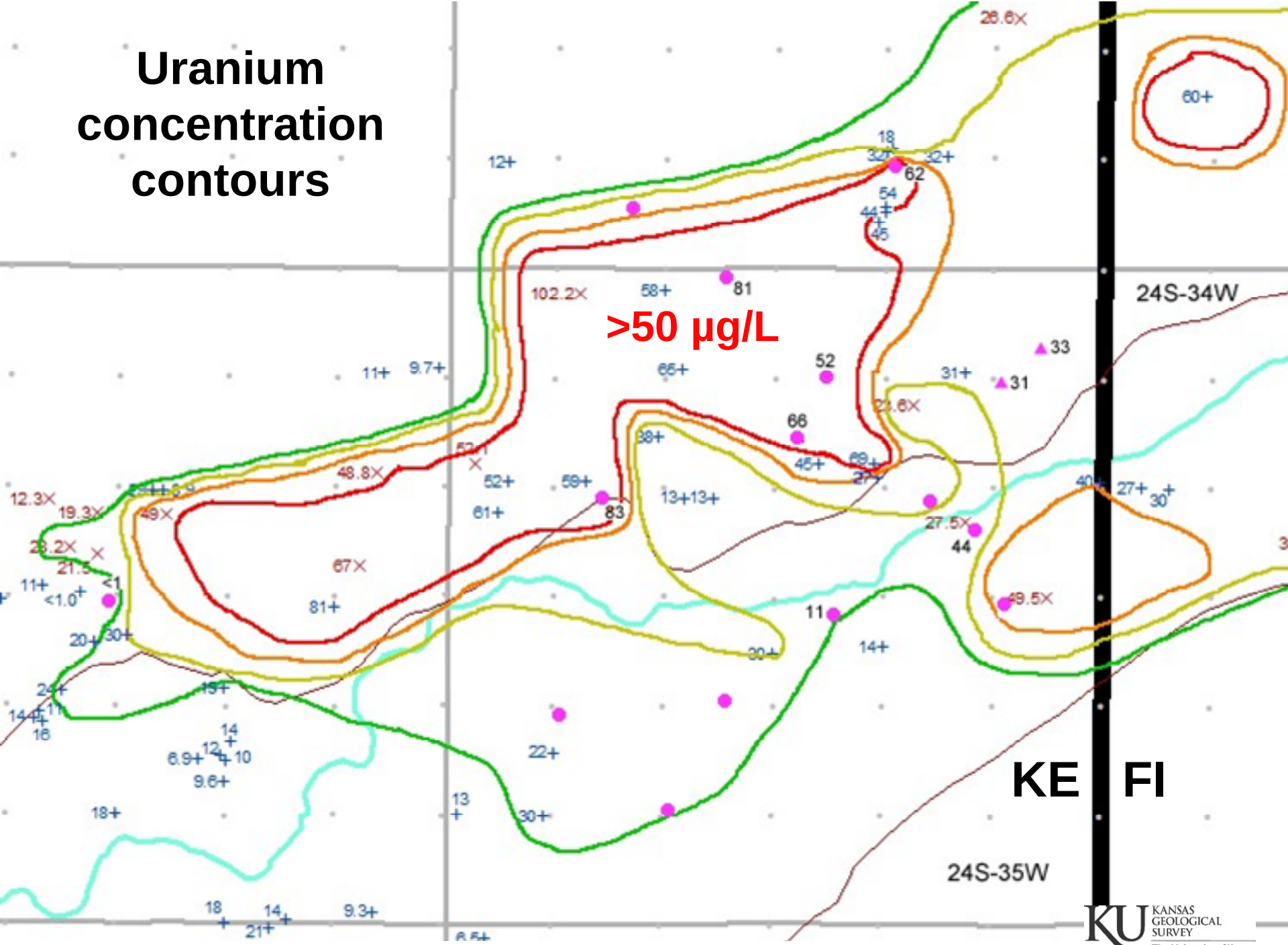
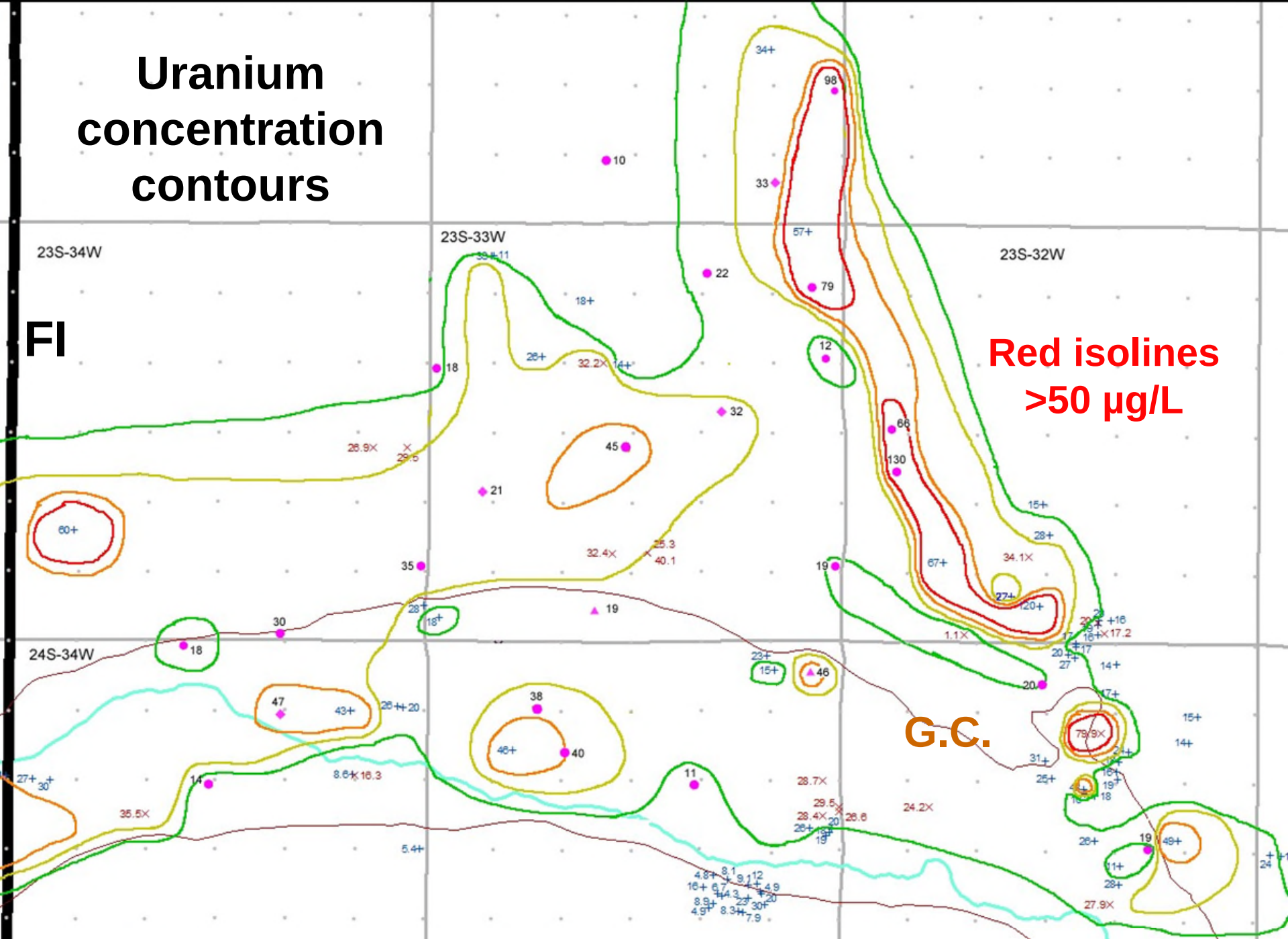
Sulfate Concentration in Lakin to Holcomb Area



Uranium concentration contours




Uranium concentration contours
23S-34W
23S-33W
23S-32W
24S-34W
FI
Red isolines >50 µg/L
G.C.

Uranium Loads in the Arkansas River 2012–2020

Based on daily specific conductance, estimated daily uranium concentration, daily flow, and sum of daily loads for each year

Year	Mean annual flow, ft^3/sec	Mean annual uranium concentration, µg/L	Annual uranium load, ton/yr
2012	29	73	1.98
2013	27	76	1.78
2014	92	63	4.15
2015	196	50	6.63
2016	202	51	8.23
2017	235	52	10.03
2018	207	54	9.28
2019	186	54	8.20
2020	147	56	5.33

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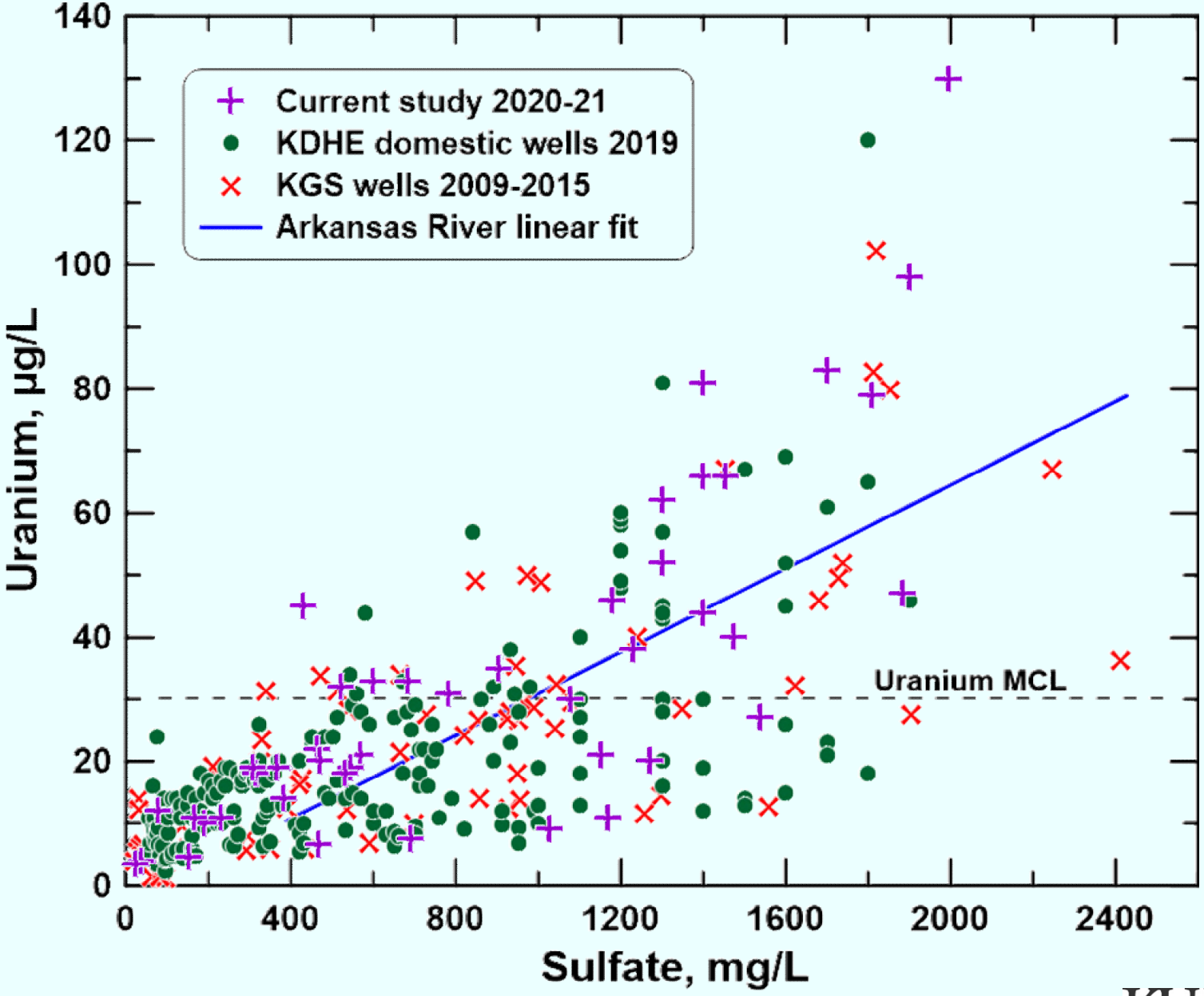
High Plains Aquifer Groundwater 2009-2021



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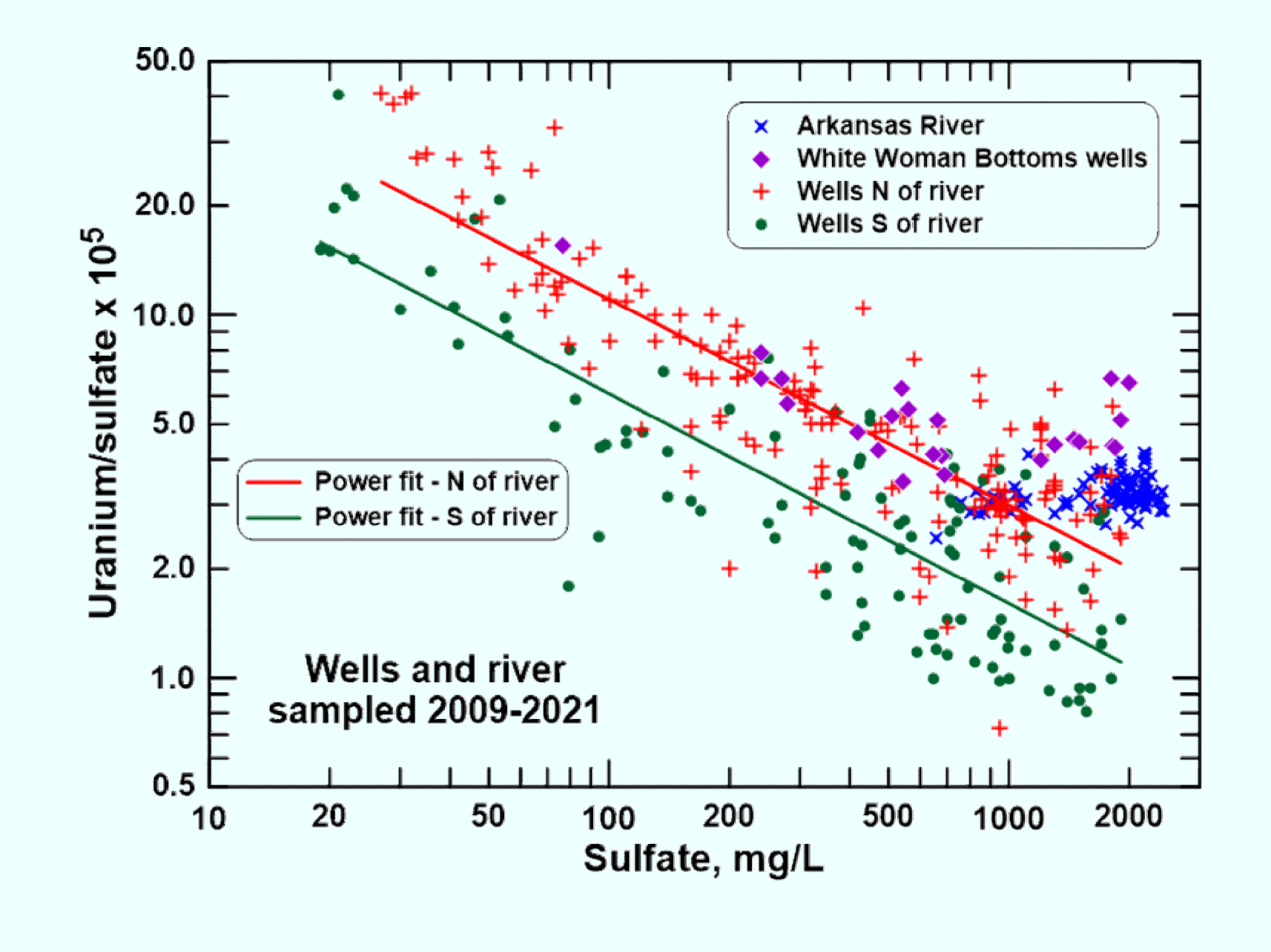
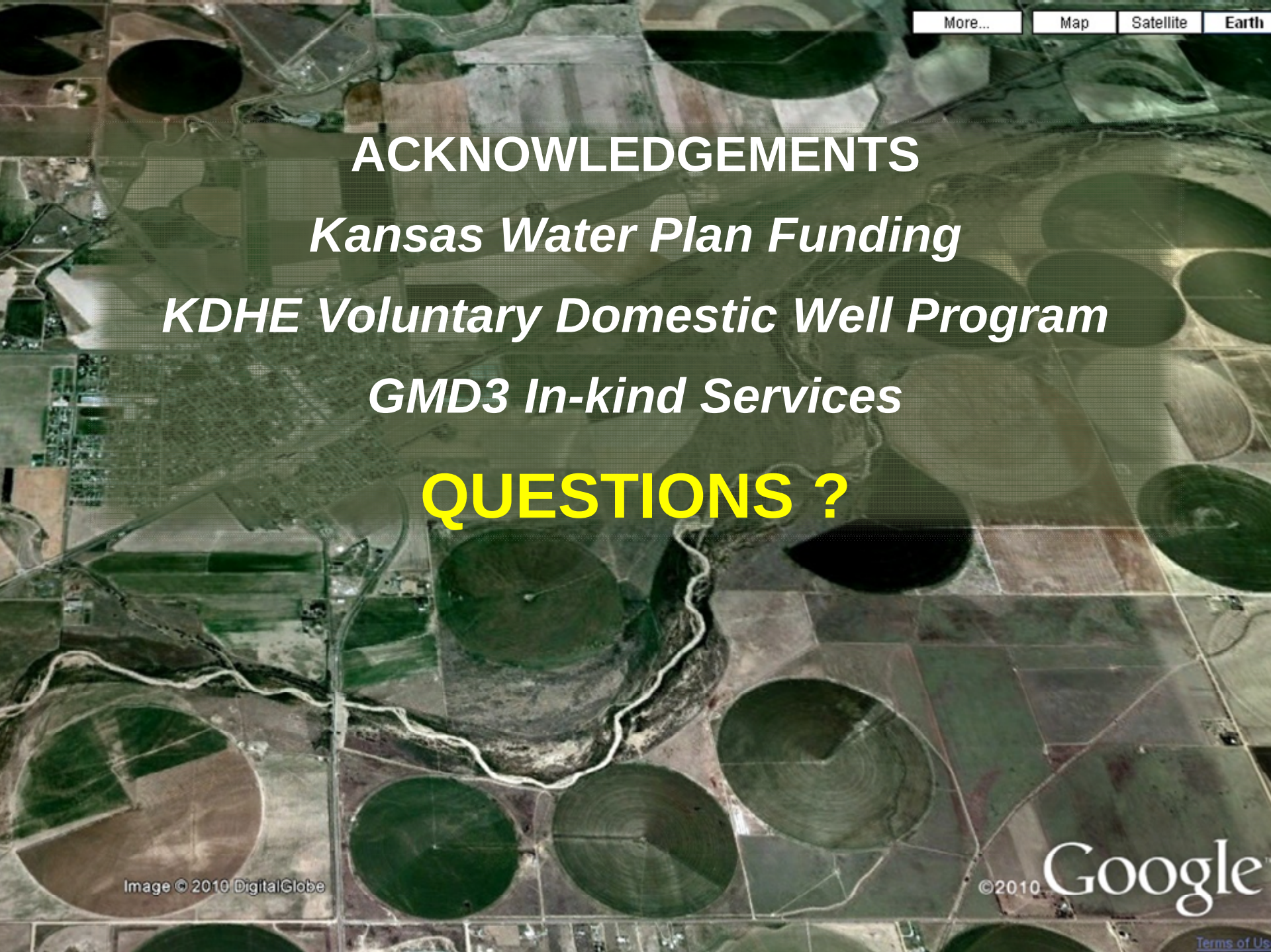

Arkansas River
White Woman Bottoms wells
Wells N of river
Wells S of river
Power fit - N of river
Power fit - S of river
Wells and river
sampled 2009-2021
Uranium/sulfate x 10^5
Sulfate, mg/L
50.0
20.0
10.0
5.0
2.0
1.0
0.5
10
20
50
100
200
500
1000
2000

CURRENT FINDINGS

- Sulfate concentration has increased in the High Plains aquifer compared to the 2000 map.
- High uranium areas are within high sulfate areas.
- The largest areas of high uranium (>50 µg/L) and sulfate are in east-central Kearny County. The highest uranium area is north of the river whereas the high sulfate area occurs both north and south of the river.
- Uranium >50 µg/L also occurs along the White Woman Bottoms depression in Finney County.
- Controls on uranium in groundwater include: 1) proximity to river channel, ditch, and ditch irrigated area, 2) background concentration, 3) adsorption on sediments dependent on depth to water table, aquifer travel distance, and aquifer lithology, 4) well construction.


More...
Map
Satellite
Earth
ACKNOWLEDGEMENTS
Kansas Water Plan Funding
KDHE Voluntary Domestic Well Program
GMD3 In-kind Services
QUESTIONS ?
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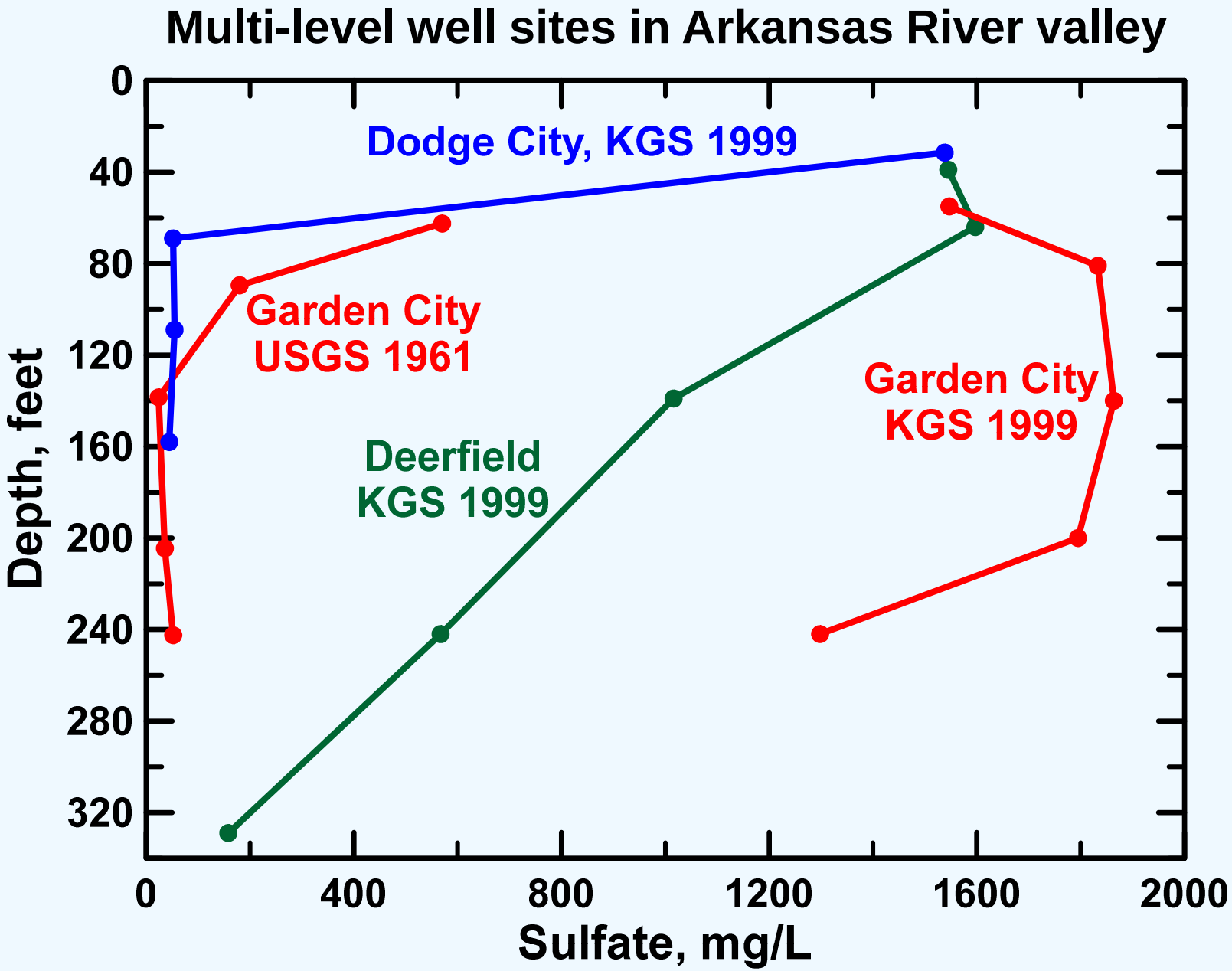

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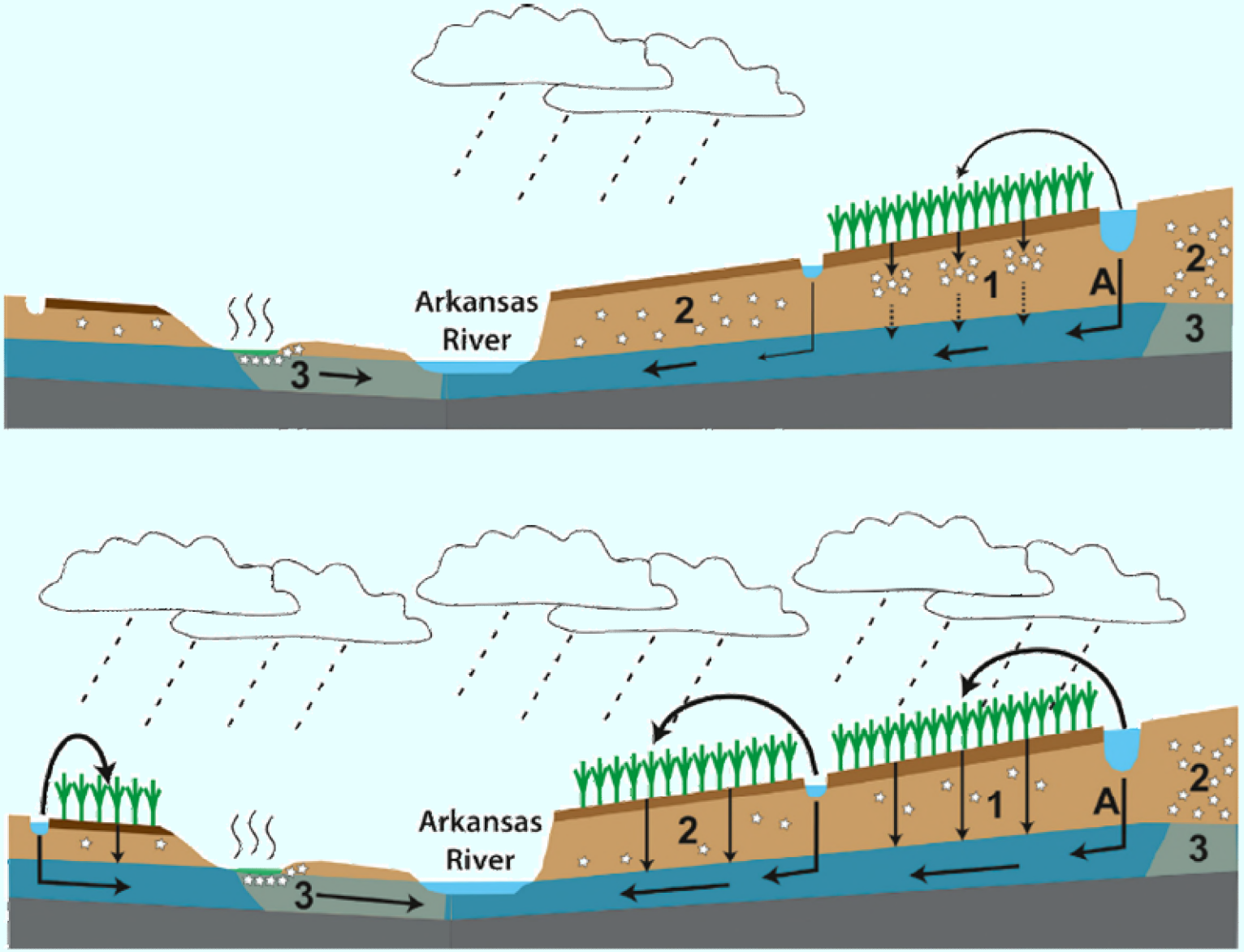
CURRENT FINDINGS (continued)

- Only four of the domestic wells exceed the selenium MCL of 50 µg/L, and three of these exceed it by less than 5 µg/L.
- Only one of the domestic wells exceeds the arsenic MCL of 10 µg/L.
- The selenium and arsenic concentrations for a given sulfate level generally exceed those of the Arkansas River, suggesting that the aquifer is the main source of these constituents.
- Many wells exceed the nitrate-N MCL of 10 mg/L. Nearly all nitrate concentrations for a given sulfate level exceed those of the Arkansas River, indicating that local contamination is the source.

Salt Storage and Flushing in Arkansas River Valley in Colorado



From Bern et al. (2020) – a USGS study