

Mapping Fresh, Brackish, and Saline Groundwater
Queen City, Sparta, and Carrizo-Wilcox Aquifers
Groundwater Management Area 13

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Meeting at Evergreen Underground Water Conservation District
June 6, 2017

Relationship between current TWDB Project and House Bill 30

- Our current project contract was amended to incorporate House Bill 30 requirements for suggesting potential brackish groundwater production areas
- We will estimate **potential production areas** in the Carrizo-Wilcox Aquifer in 2016 and the **Queen City and Sparta aquifers in 2017**
- After TWDB staff evaluates the potential areas and recommends the final areas, we will calculate water volumes in those areas.

Tasks

GMA 13 Groundwater Quality Mapping

1. Project Management
2. Groundwater hydrochemistry from water samples
3. Use of geophysical log interpretation to map fresh, brackish, and saline groundwater (today's topic)
4. GIS-based application to calculate volumes of fresh, brackish, and saline groundwater
5. GIS visualization of groundwater quality

Additional Tasks

Studies to Support House Bill 30

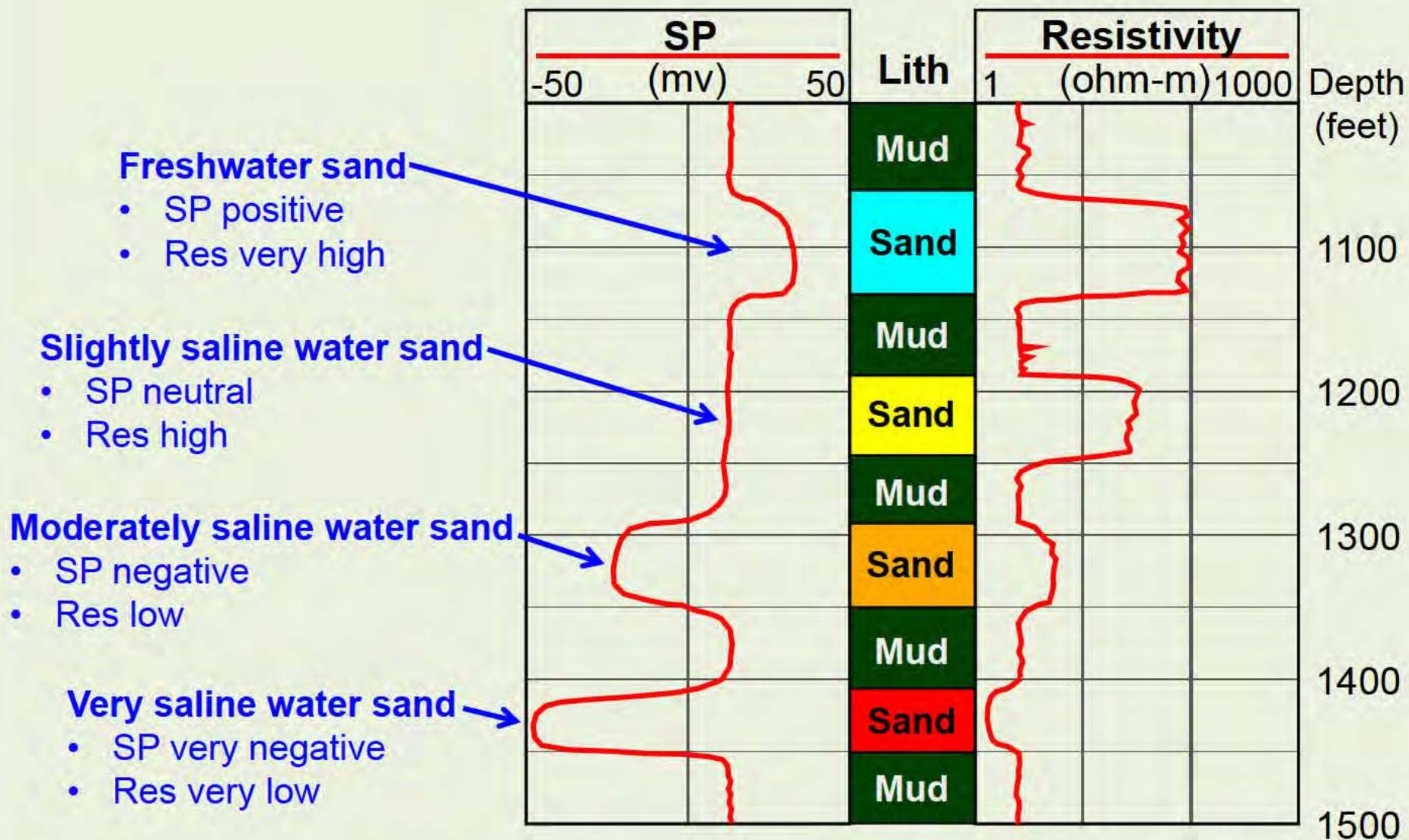
- Task 6: Aquifer hydraulic properties
- Task 7: Mapping and modeling brackish groundwater production areas

Task 3

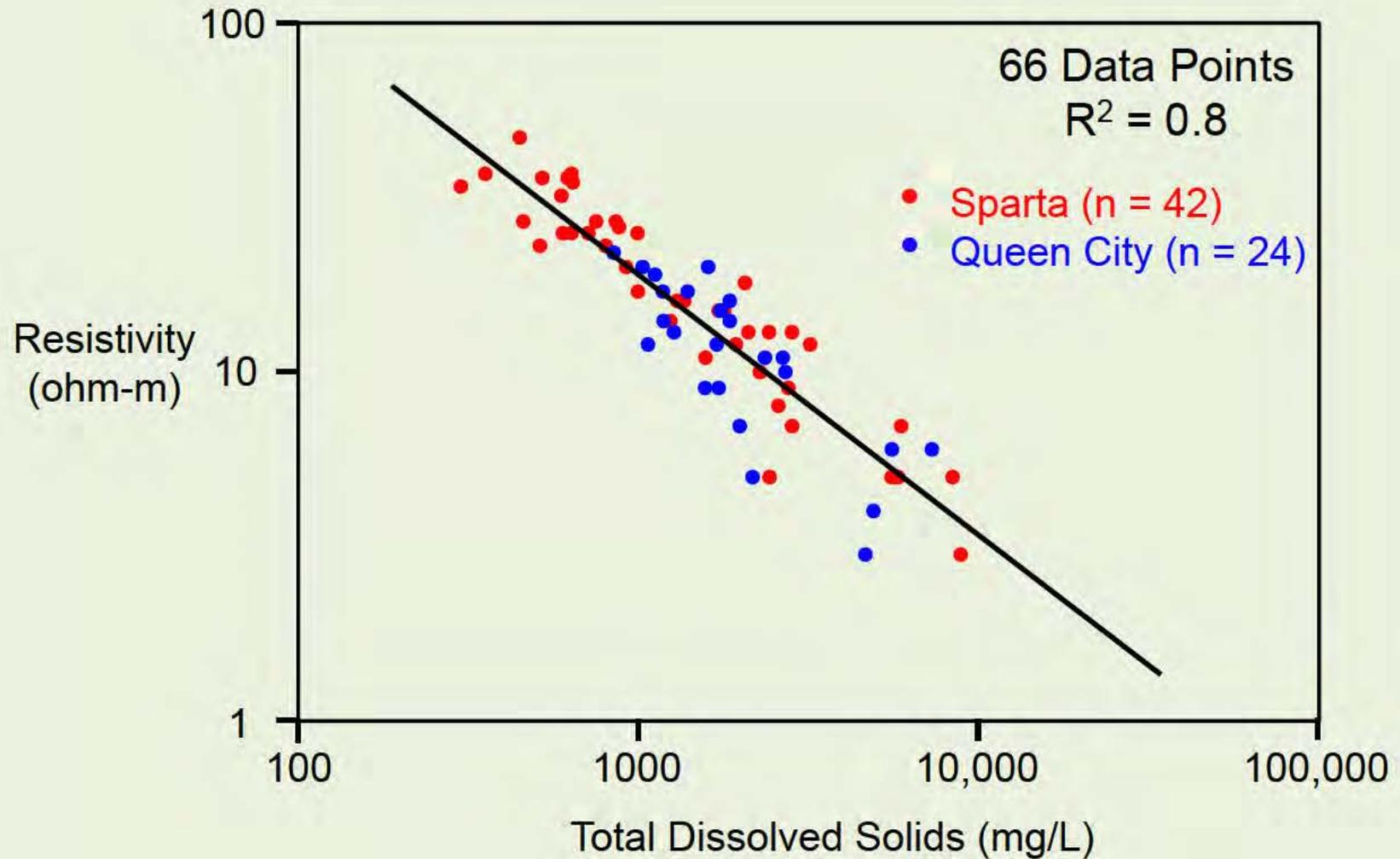
Use of Geophysical Log Interpretation to Map Fresh, Brackish, and Saline Groundwater

- 3.1. Evaluation of geophysical well logs, including availability, log quality, and data management (5,200 wells in BRACs database, 3,300 geophysical well logs)
- 3.2. Interpreting groundwater salinity from geophysical logs – 500 to 600 selected logs
- 3.3. Groundwater salinity and lithology (sand) mapping

Electric Log Response (Idealized) to Groundwater Salinity

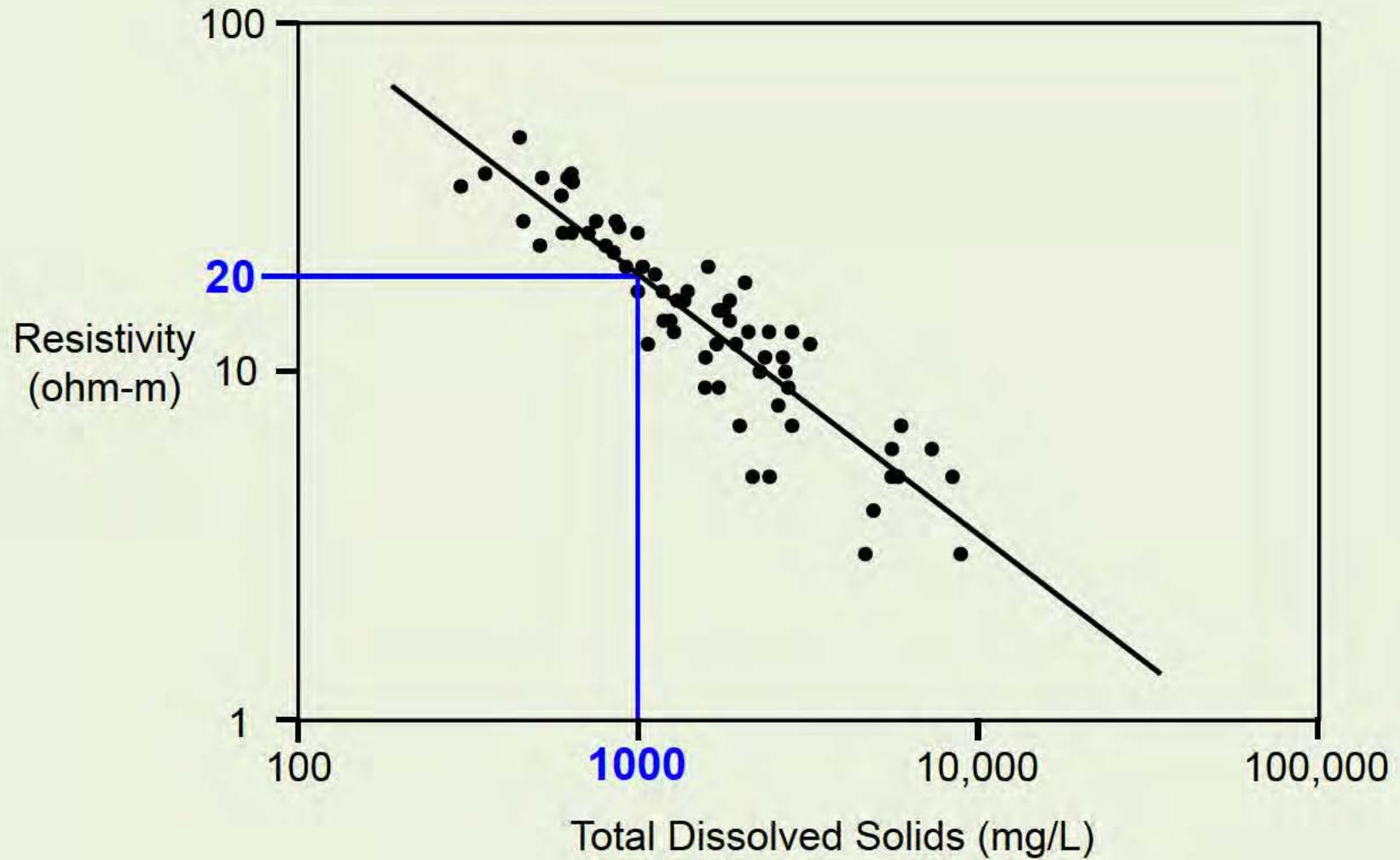


Queen City and Sparta Aquifers Correlation Between Salinity and Resistivity



Queen City and Sparta Aquifers

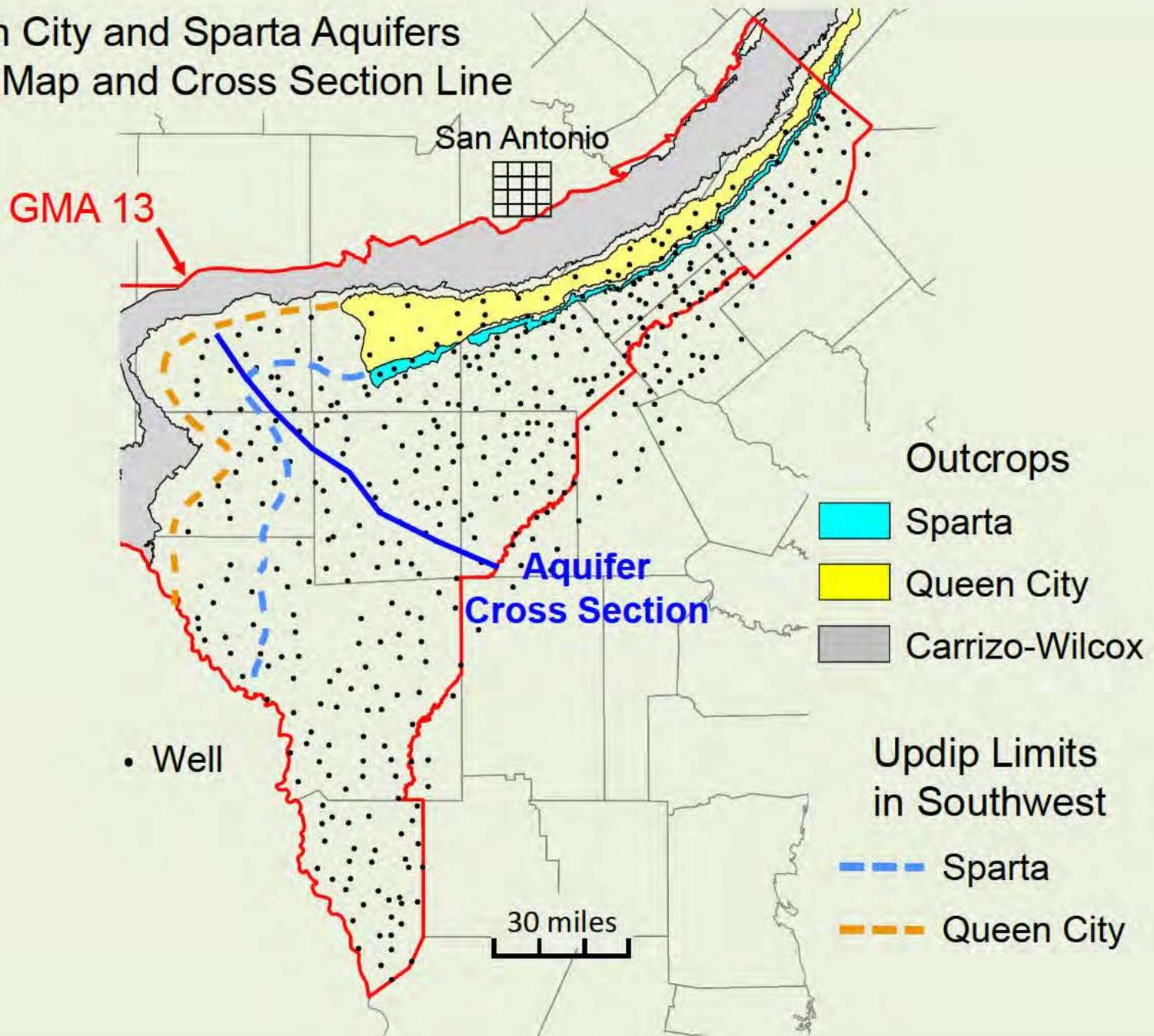
Resistivity Cut-offs



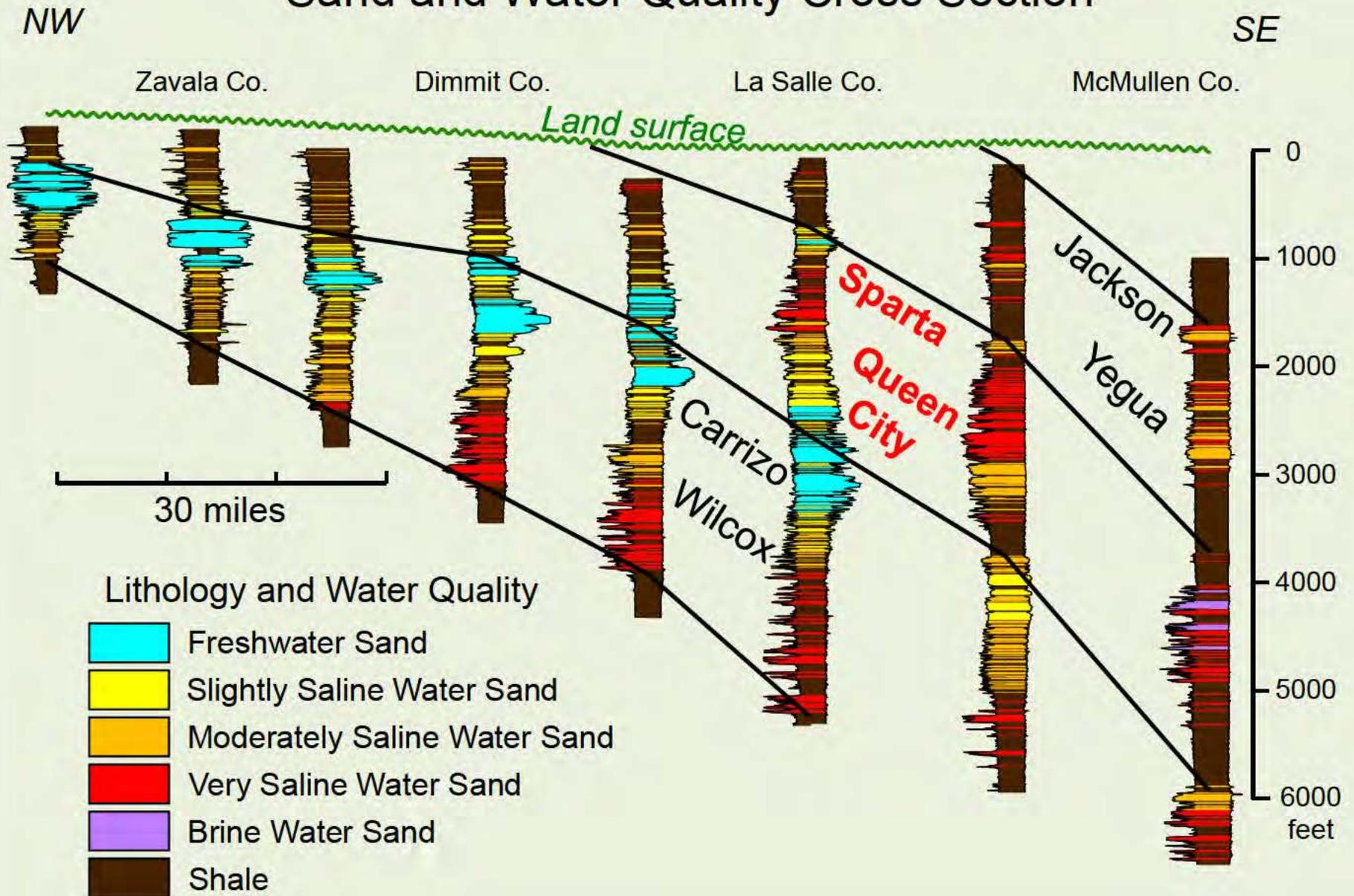
Resistivity Cut-offs for Queen City and Sparta Aquifers

Salinity Classification	Total Dissolved Solids (mg/L)	Typical Resistivity Cut-offs (ohm-m)
Freshwater	< 1,000	> 20
Slightly saline water	1,000 – 3,000	9 – 20
Moderately saline water	3,000 – 10,000	4 – 9
Very saline water	10,000 – 35,000	2 – 4
Brine	> 35,000	< 2

Queen City and Sparta Aquifers Location Map and Cross Section Line



South Texas Aquifers Sand and Water Quality Cross Section

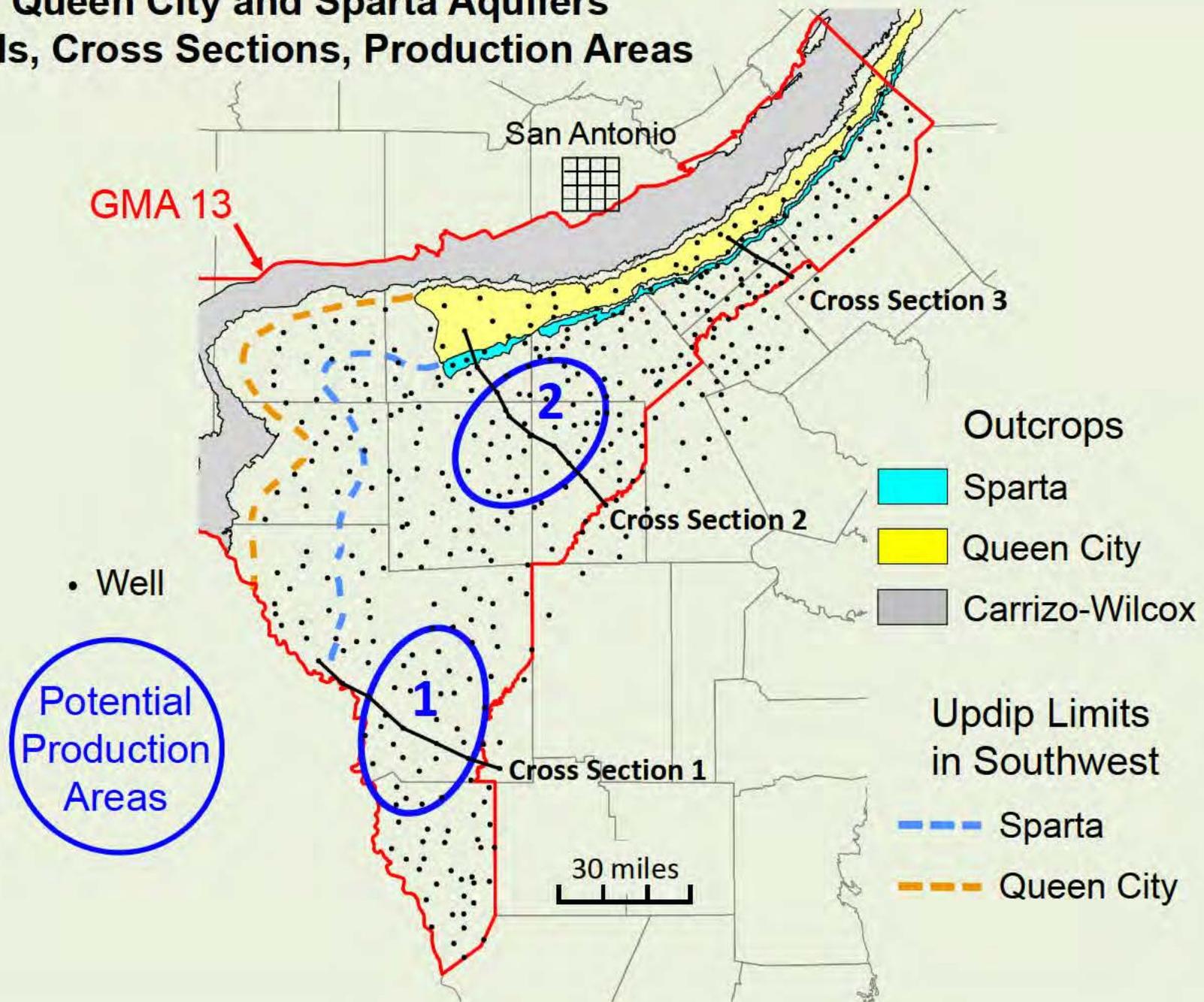


Geologic Formation Name Changes South Texas Outcrop

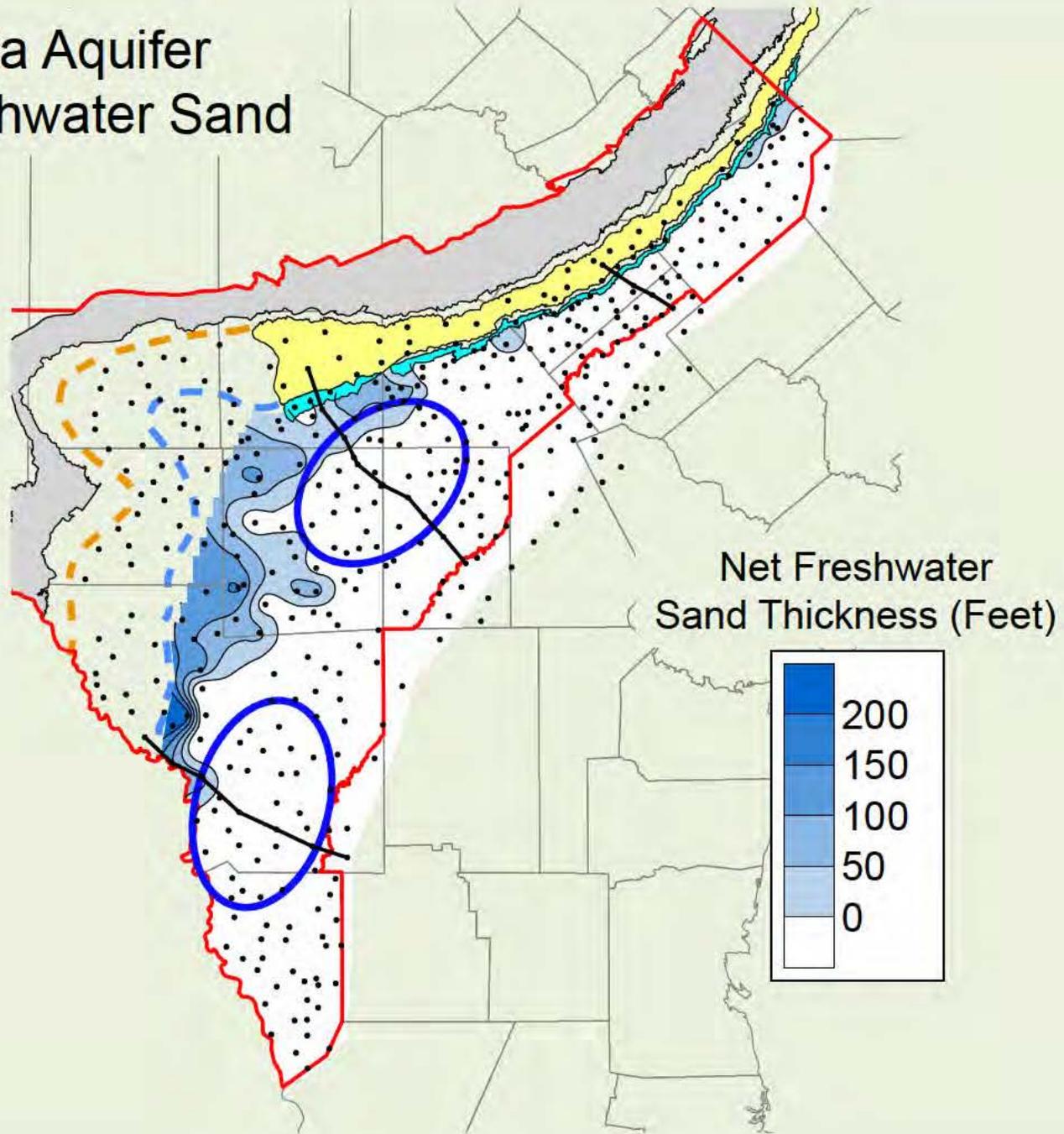
Northeast of the Frio River	Southwest of the Frio River
Yegua	Yegua
Cook Mountain	Laredo
Sparta*	
Weches*	El Pico Clay
Queen City*	Bigford
Reklaw*	
Carrizo	Carrizo

*Names used throughout GMA 13 in this study

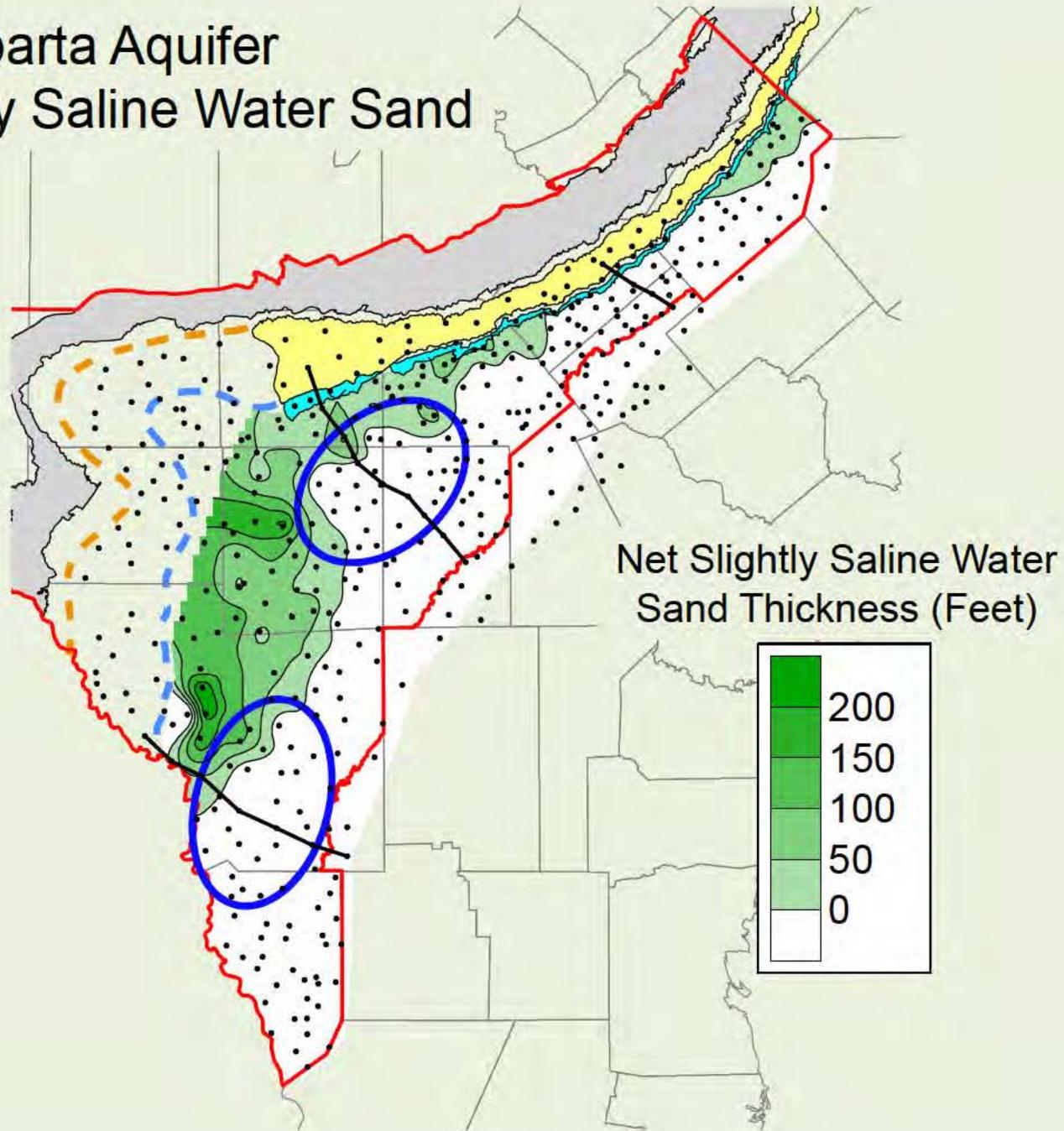
Queen City and Sparta Aquifers Wells, Cross Sections, Production Areas



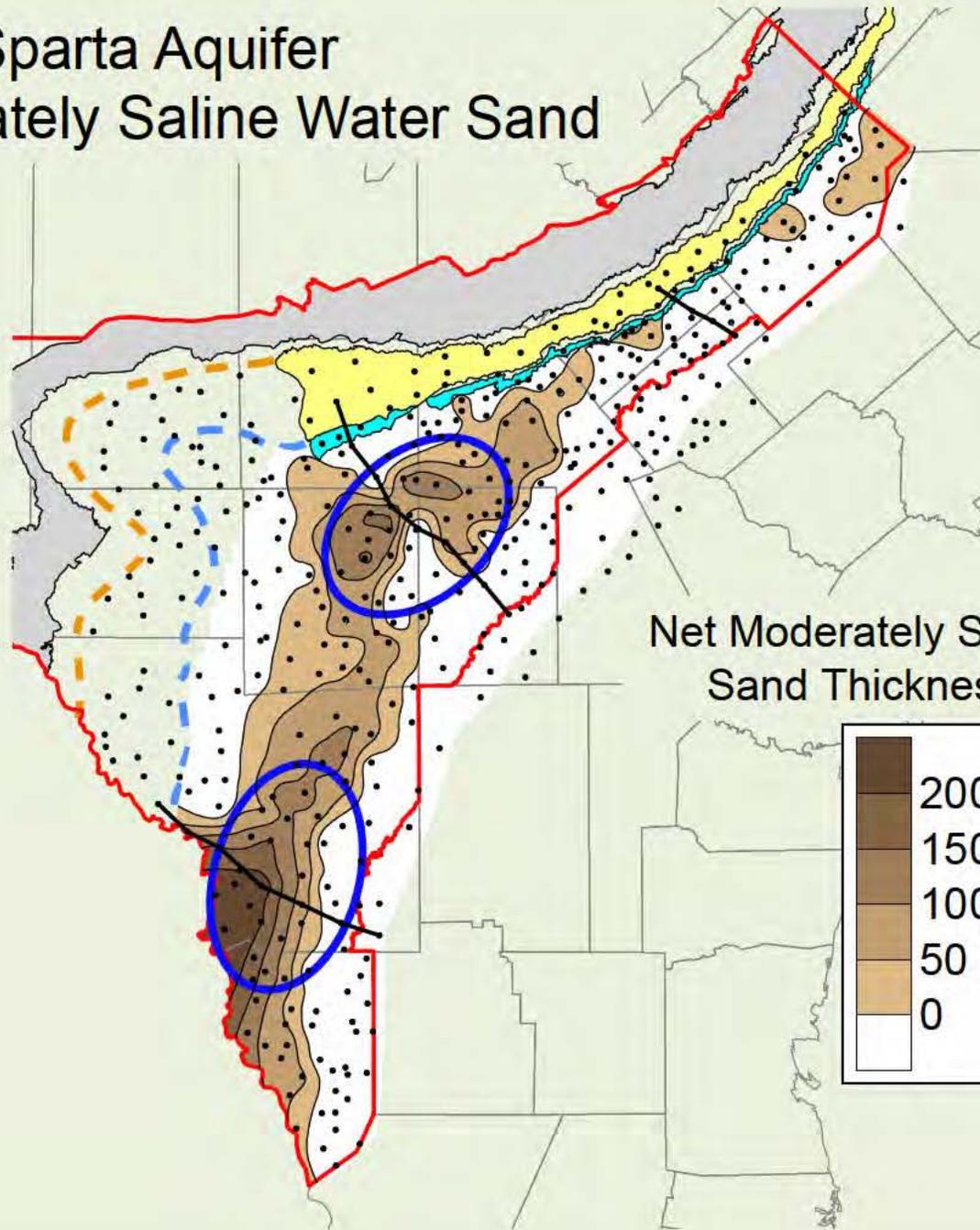
Sparta Aquifer Net Freshwater Sand



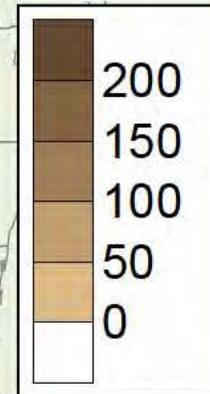
Sparta Aquifer Net Slightly Saline Water Sand



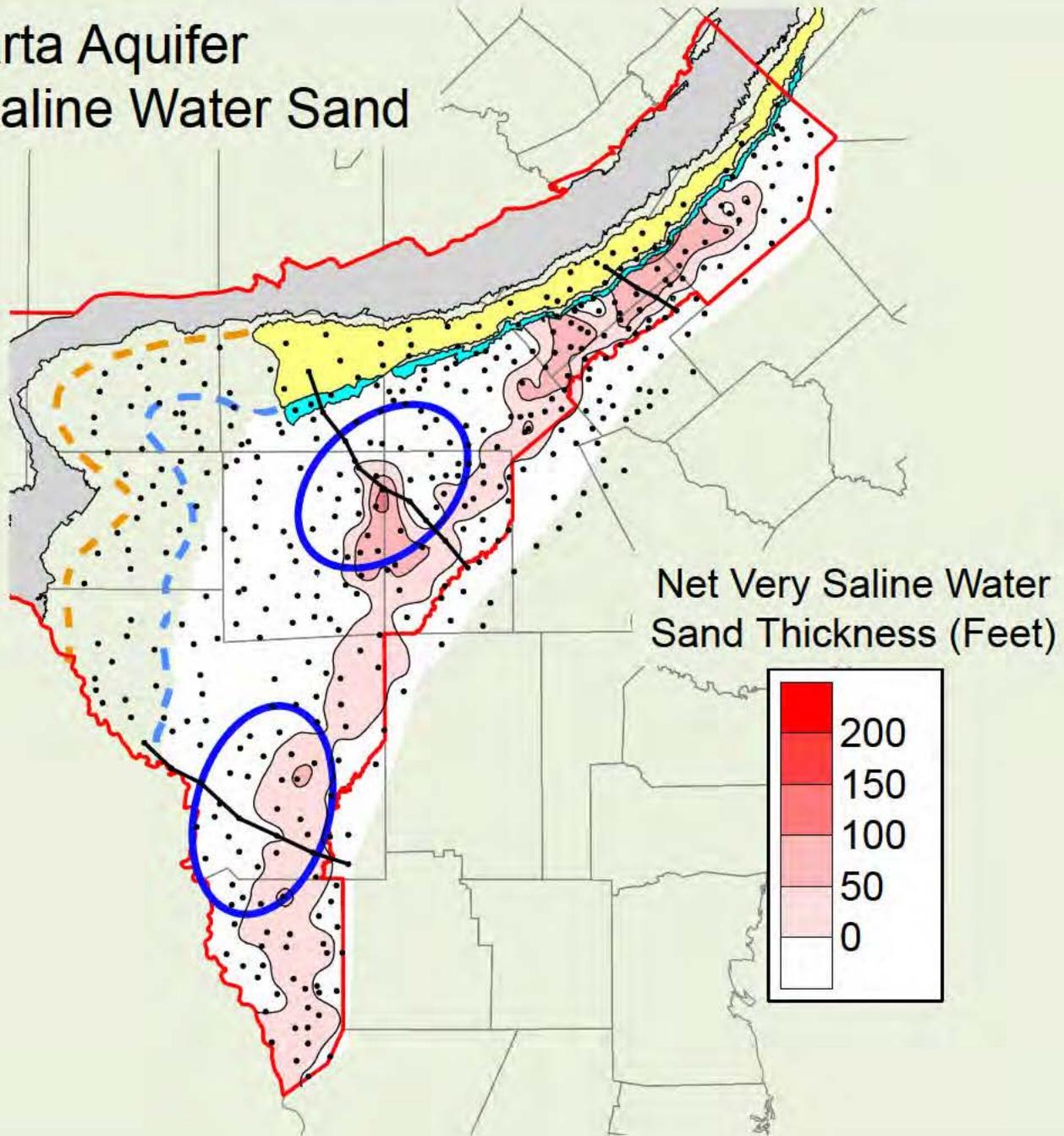
Sparta Aquifer Net Moderately Saline Water Sand



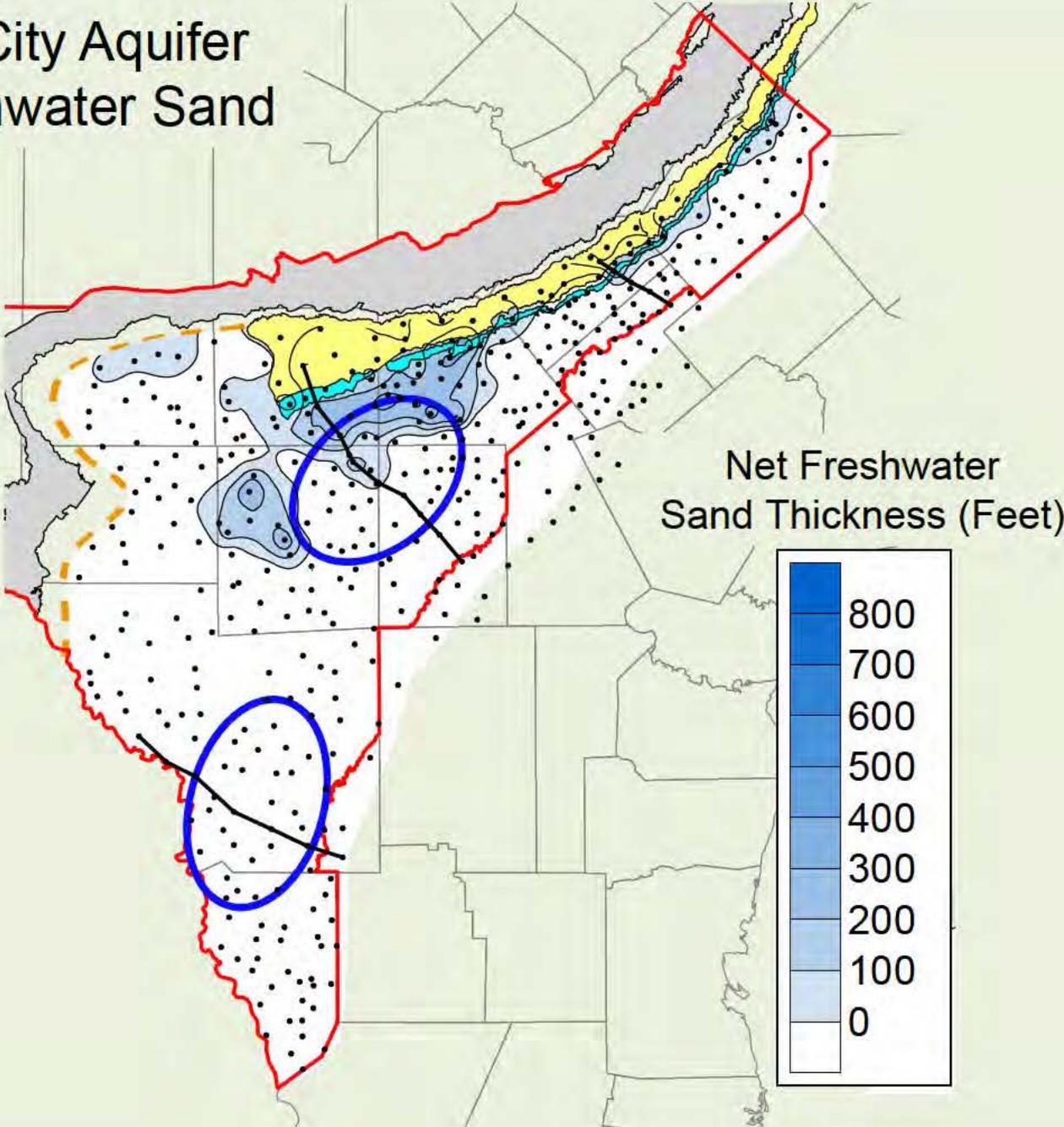
Net Moderately Saline Water
Sand Thickness (Feet)



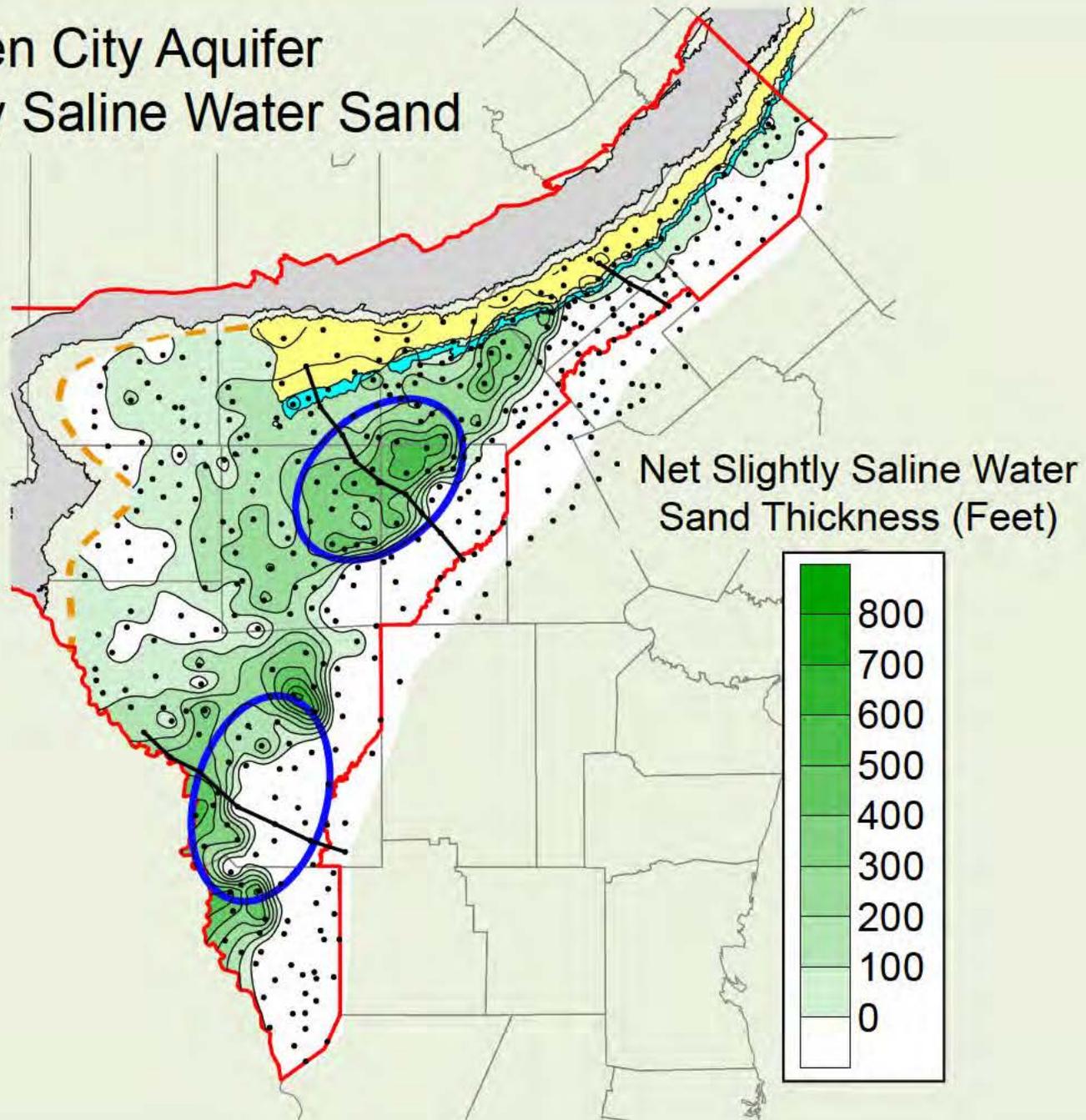
Sparta Aquifer Net Very Saline Water Sand



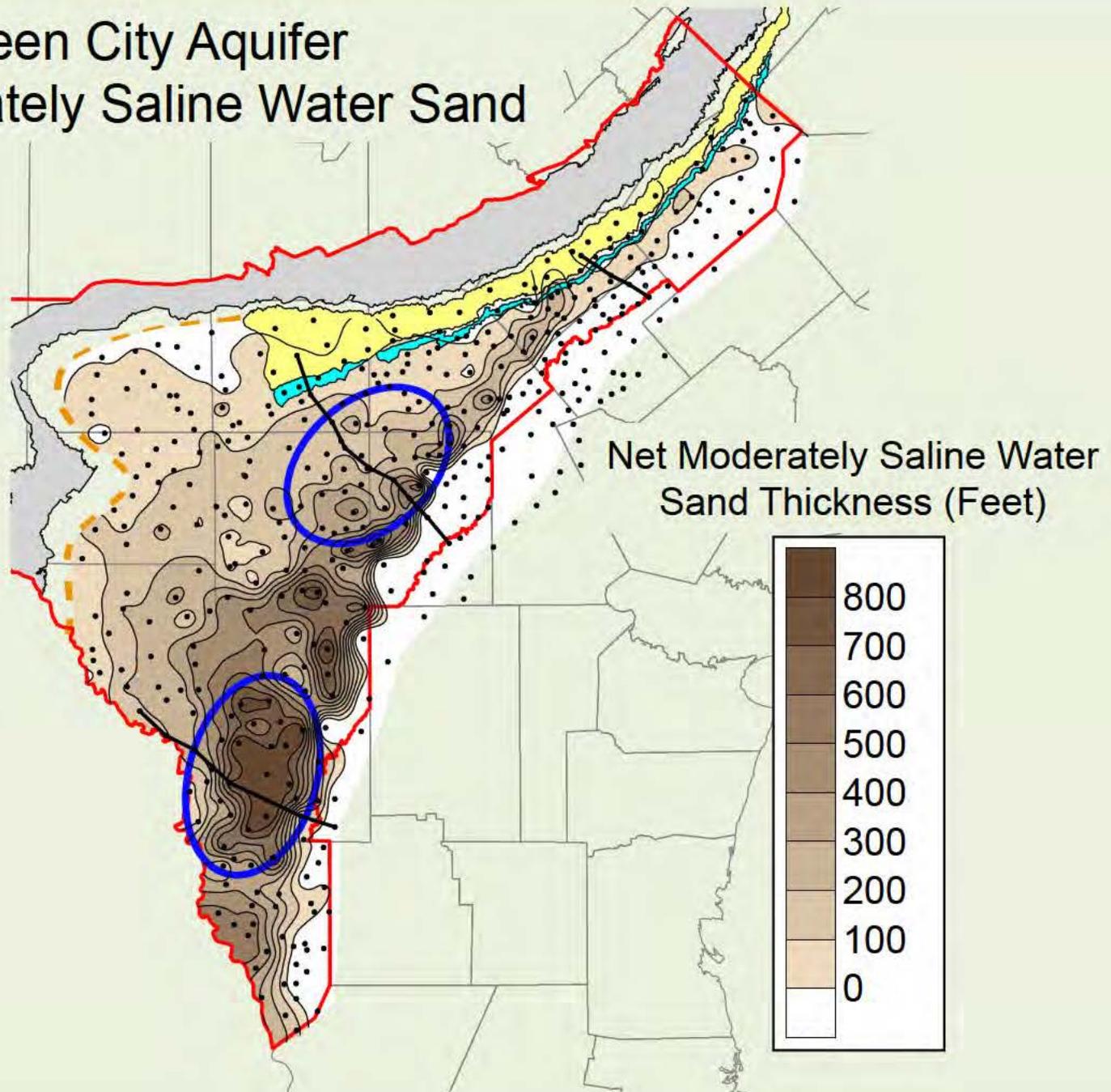
Queen City Aquifer Net Freshwater Sand



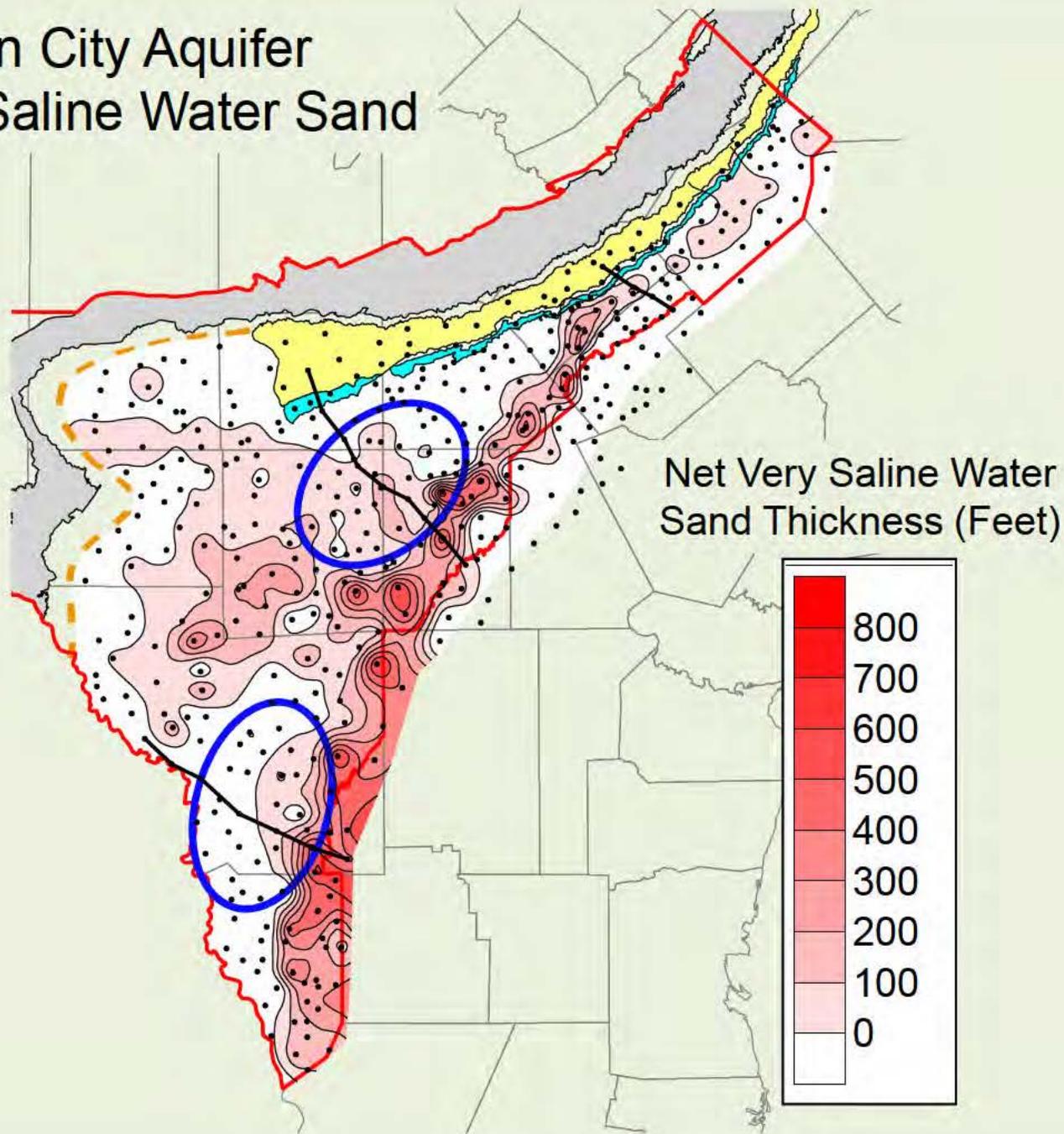
Queen City Aquifer Net Slightly Saline Water Sand



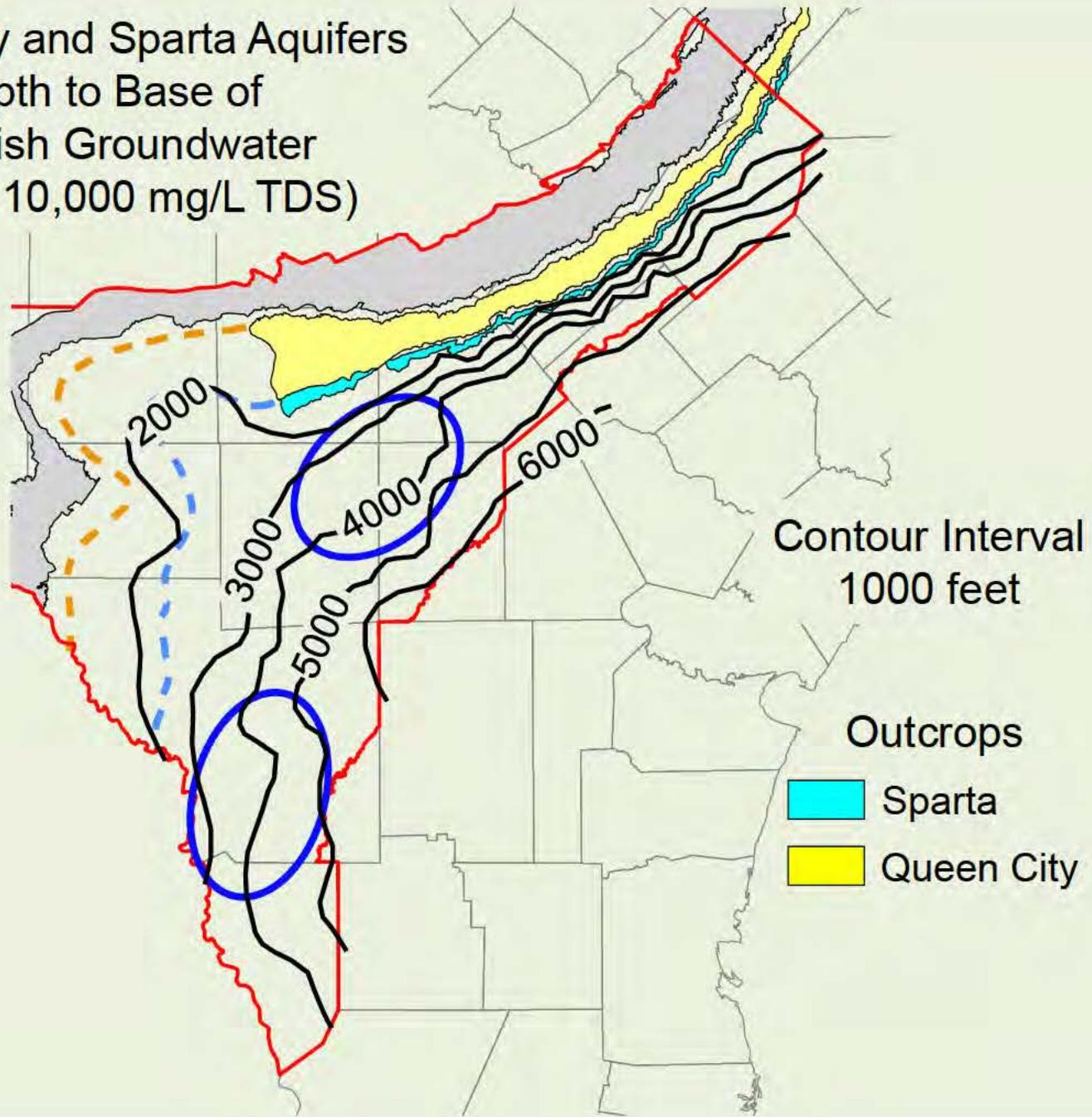
Queen City Aquifer Net Moderately Saline Water Sand



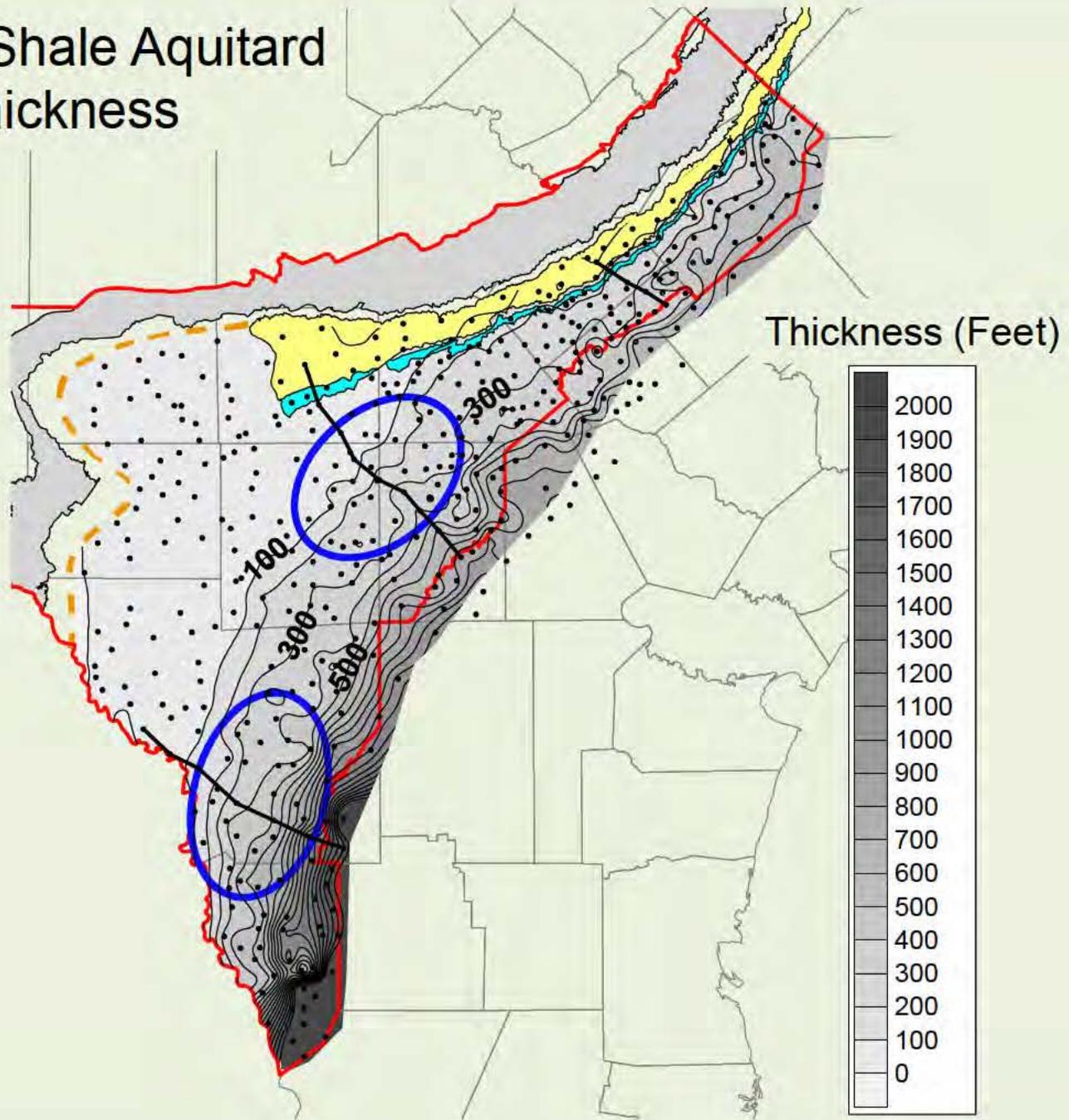
Queen City Aquifer Net Very Saline Water Sand



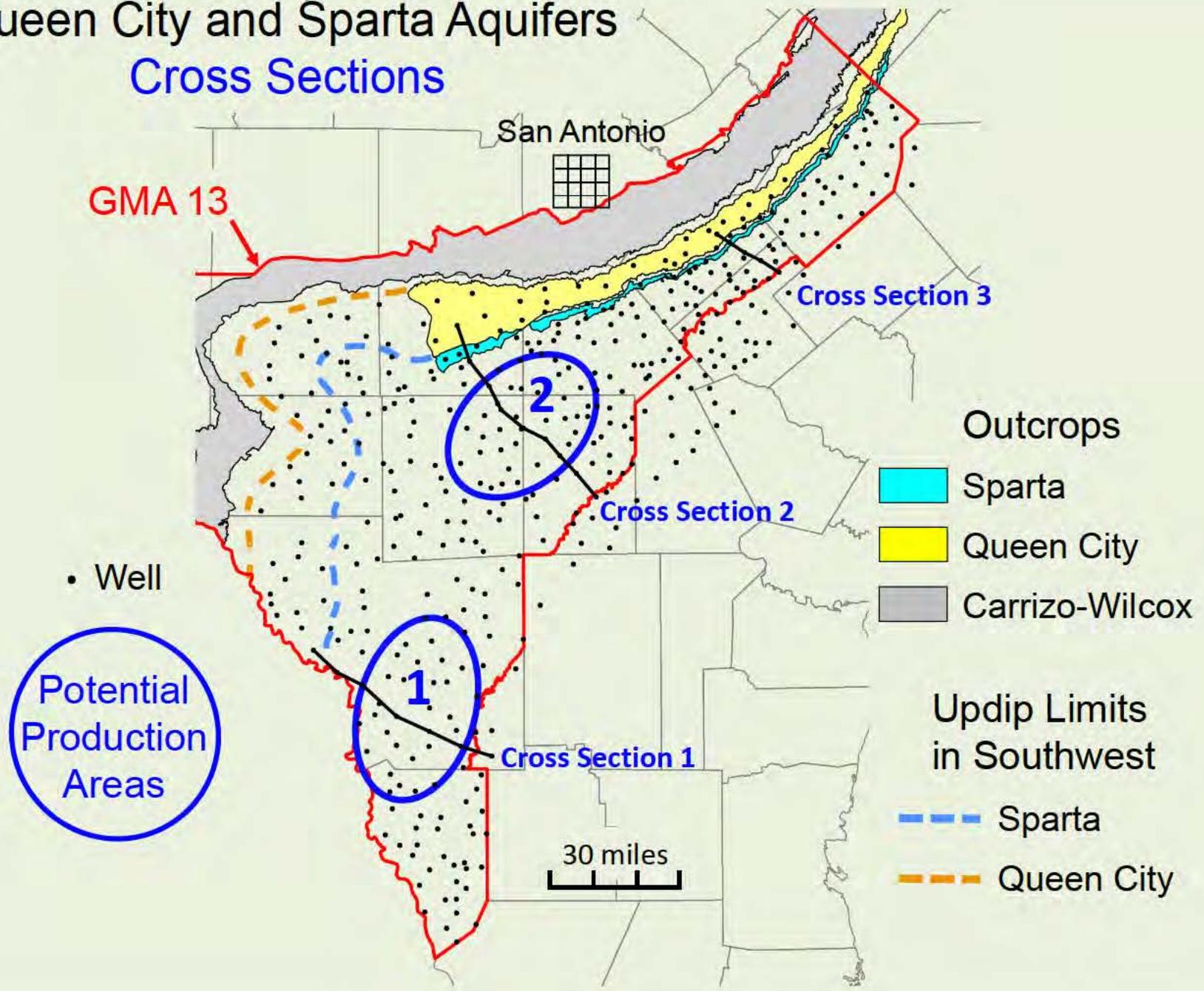
Queen City and Sparta Aquifers
Depth to Base of
Brackish Groundwater
(1000 – 10,000 mg/L TDS)



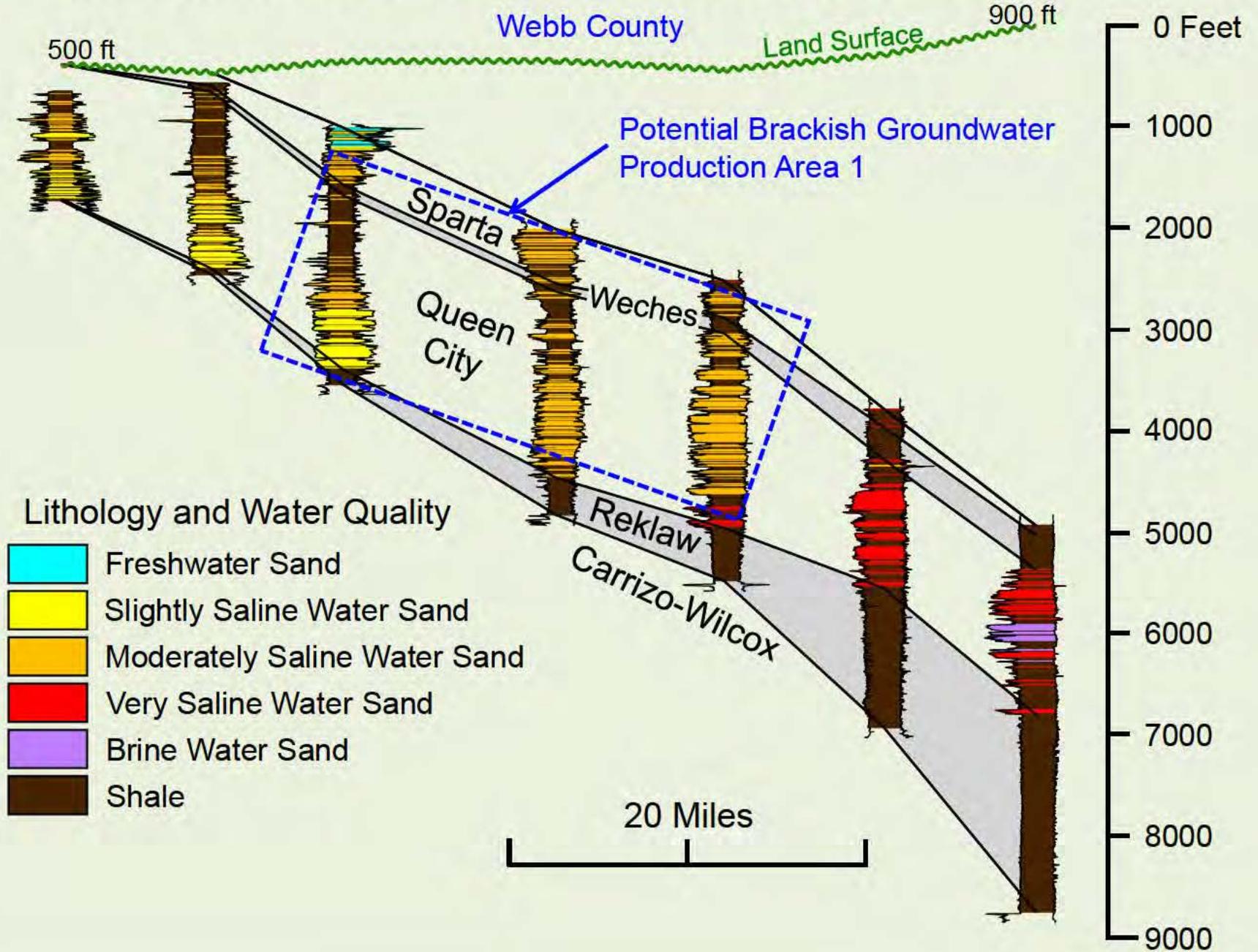
Reklaw Shale Aquitard Thickness



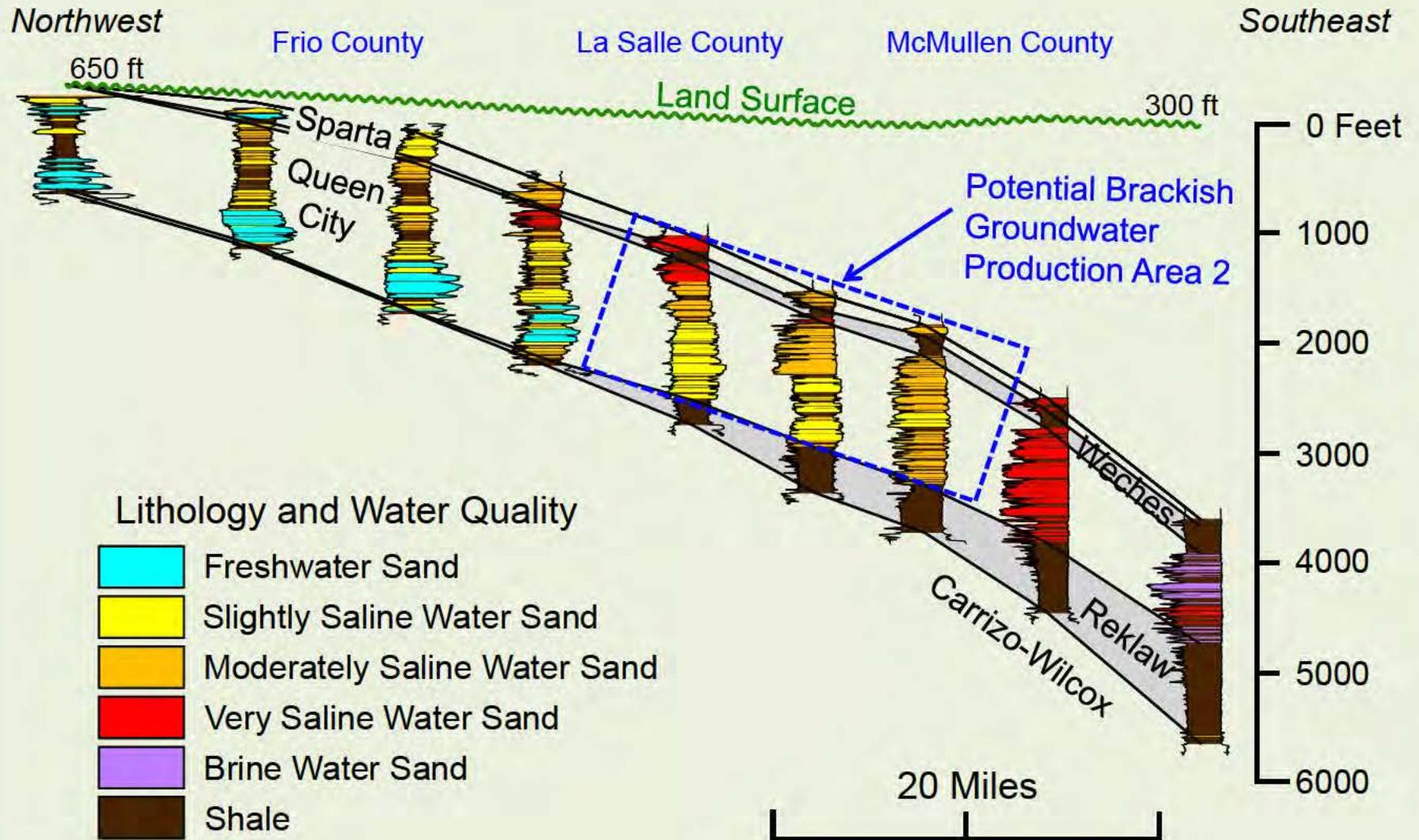
Queen City and Sparta Aquifers Cross Sections



QUEEN CITY AND SPARTA AQUIFERS CROSS SECTION 1



QUEEN CITY AND SPARTA AQUIFERS CROSS SECTION 2

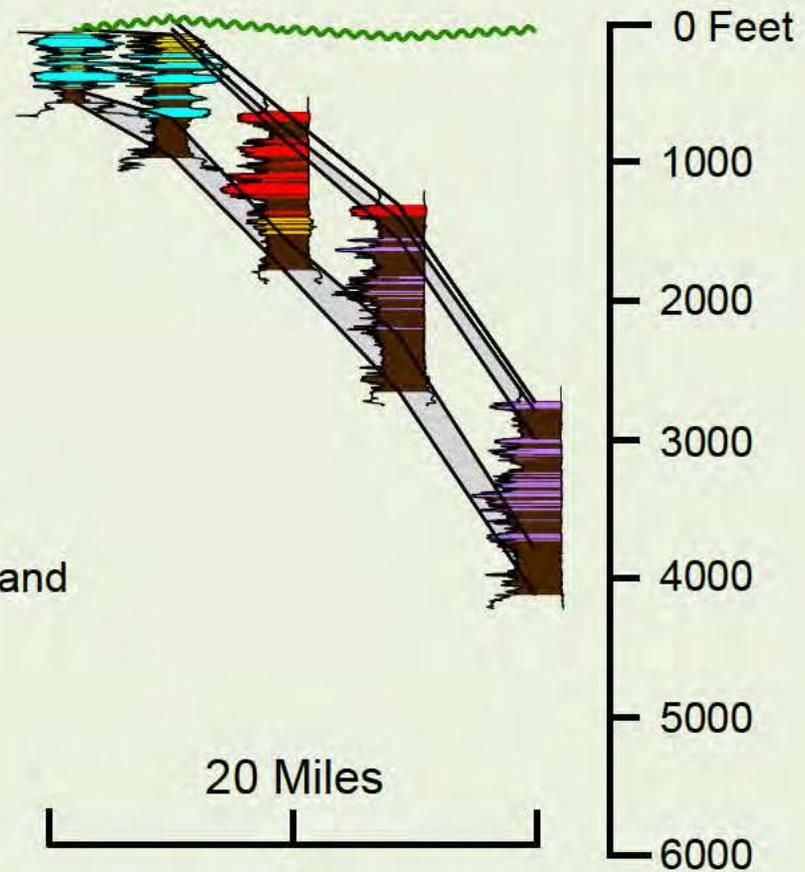


QUEEN CITY AND SPARTA AQUIFERS CROSS SECTION 3

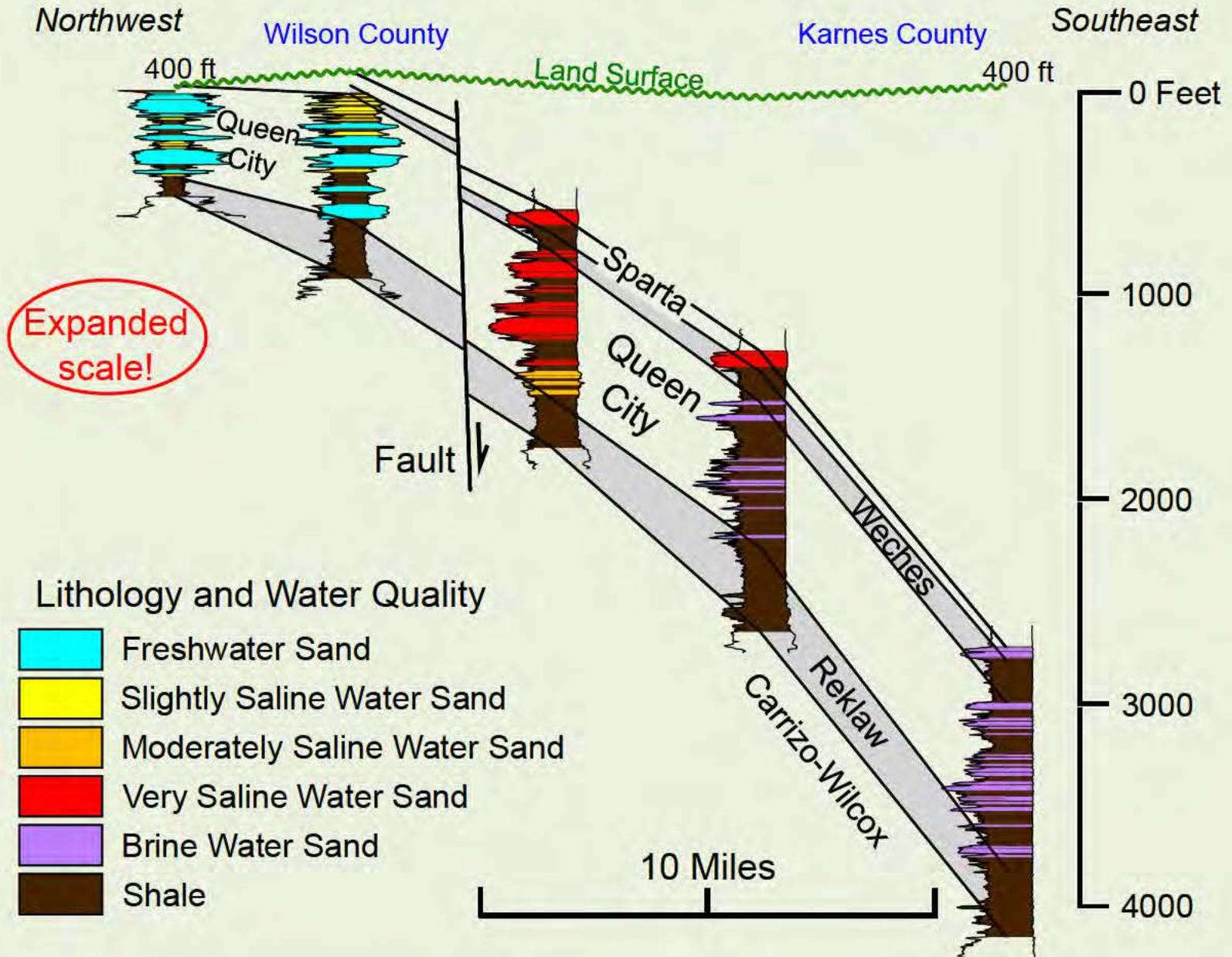
Wilson and Karnes Counties

Same scale as the other cross sections!

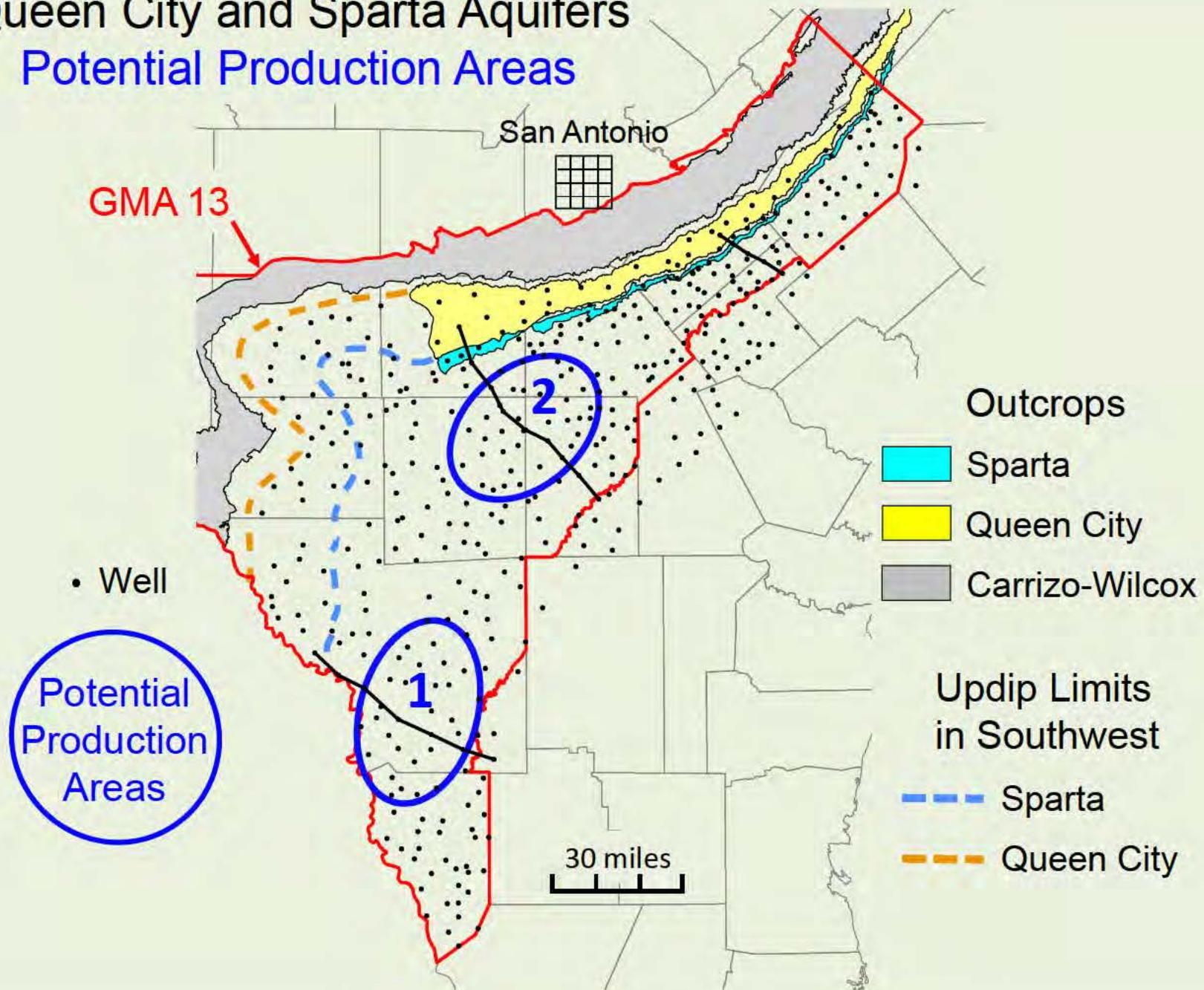
- Lithology and Water Quality
- Freshwater Sand
 - Slightly Saline Water Sand
 - Moderately Saline Water Sand
 - Very Saline Water Sand
 - Brine Water Sand
 - Shale



QUEEN CITY AND SPARTA AQUIFERS CROSS SECTION 3



Queen City and Sparta Aquifers Potential Production Areas



Brackish Groundwater Potential Production Areas

1. Sparta and Queen City in Webb County and Northern Zapata County

- a) Mostly moderately saline groundwater (MSW = 3000 – 10,000 TDS)
- b) Sparta: up to 200 feet of MSW sand
- c) Queen City: up to 800 feet of MSW sand
- d) Queen City: up to 300 feet of slightly saline groundwater (SSW = 1000 – 3000 TDS) sand
- e) No Carrizo-Wilcox fresh groundwater in this area

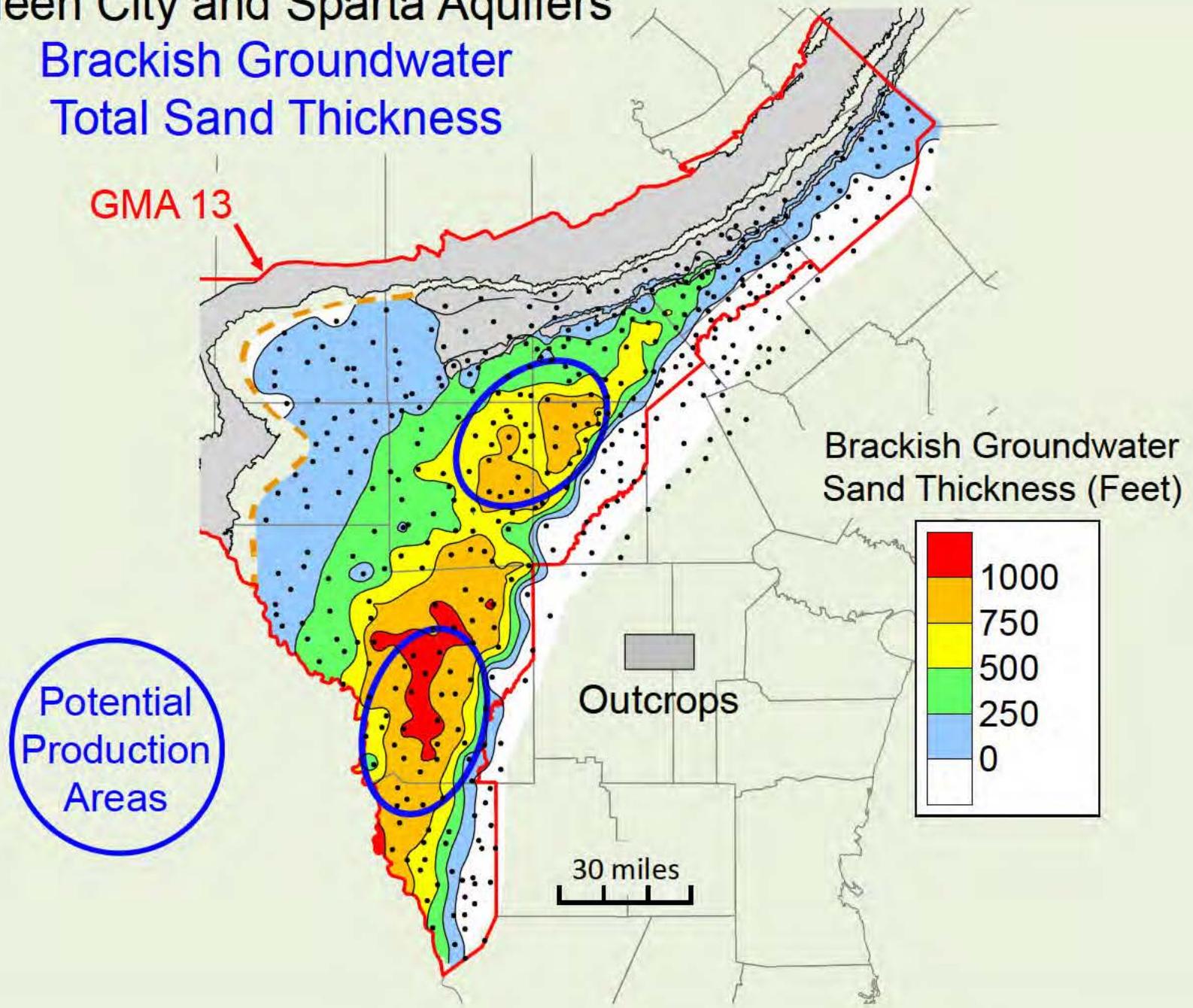
2. Sparta and Queen City in Atascosa, Frio, La Salle, and McMullen Counties

- a) Mixed moderately and slightly saline groundwaters
- b) Sparta: up to 150 feet of MSW sand
- c) Queen City: up to 600 feet of MSW sand
- d) Queen City: up to 500 feet of SSW sand
- e) Deep Carrizo-Wilcox fresh groundwater separated by 50 to 400 feet of Reklaw Shale aquitard

Task 3. Geophysical Log Interpretation Conclusions

- Electric logs record both **lithology (sand/shale)** and **groundwater salinity** for continuous vertical sections through the aquifer (not just point source measurements)
- Empirical data (groundwater chemical analyses) are used to calibrate resistivity logs (**resistivity vs TDS graph**)
- Electric logs are analyzed spatially to **map aquifer thickness** and to estimate **volumes of fresh and brackish groundwater**
- Electric-log-based stratigraphic analysis used to distinguish connected versus separated flow systems – **shale barriers**
- **Queen City and Sparta aquifers contain abundant brackish groundwater in GMA 13!**

Queen City and Sparta Aquifers Brackish Groundwater Total Sand Thickness



Queen City and Sparta Aquifers in GMA 13 Remaining Tasks

1. Model Potential Production Areas (PPAs) – forecast production volumes and impacts (House Bill 30)
2. Map existing water wells and injection wells in PPAs
3. Characterization of groundwater quality – suitability for desalination or hydraulic fracturing
4. Calculate fresh, brackish and saline groundwater volumes
5. Draft contract report and TWDB technical comments
6. Final report and data posted on TWDB website

Stakeholder Advisory Forum for the GMA 13 Brackish Groundwater Mapping Project

June 6, 2017; Pleasanton, TX

Q&A Summary & Comments:

Q1: What criteria is used for assessing suitability of water for hydraulic fracturing?

A1: (Scott Hamlin, Bob Reedy)

Water chemistry (S, Cl, HCO₃, etc. content).

Produced water recycling is common.

Industry is moving towards using brackish water for fracking.

Q2: On cross-section #2 in the presentation, will the freshwater at the base of the Queen City Aquifer in Frio County need to be dealt with differently during modeling?

A2: (Scott Hamlin, Bob Reedy)

Freshwater in Frio County will definitely be considered for modeling.

Potential Production Area boundaries will be set using an iterative process to limit impacts to freshwater zones over time.

Comments: HB30 – TWDB recommends monitoring well location.

HB2377 (pending) – Adjustments will be made based on impact of monitoring wells on freshwater resources.

Will this be part of GMA process?

(Did not catch the answer, maybe John Meyer can help?)

Q3: Were any Railroad Commission water well logs used?

A3: (Scott Hamlin)

Most well logs used were from the BRACS database.

Q4: Top of Carrizo looks deeper on PPT than seen on a well close by (~ 4500 ft vs 6000 ft)

A4: (Scott Hamlin)

Possibly an area of faulting. Top of Carrizo deepens quickly.

Q5: Is injection being considered in the Sparta sands in Fayette County oil wells?

A5: (John Meyer)

Not being currently considered. Lateral and vertical fluid migration not fully understood yet.

SIGN-IN SHEET

Stakeholder Advisory Forum for the GMA-13 Brackish Groundwater Mapping Project

6 June 2017; Pleasanton, TX

Name	Affiliation
Ian Jones	TWDB
John Waugh	SAWS
Ken Brooks	SAWS
Chris Ashcraft	STEER
Lonnie Stewart	McMullen GCD
Pete George	Collier Consulting
Diana Nichols	Kelly Hart
Greg Sengelmann	GCUWCD
John Meyer	TWDB
Jay Troell	EUWCD
Chris McFarlane	EUWCD
Russell Labus	EUWCD
Scott Hamlin	BEG, UT-Austin
Bob Reedy	BEG, UT-Austin
Amy Banerji	BEG, UT-Austin