Geologic Characterization for the Corpus Christi Aquifer Storage and Recovery Conservation District

January 24, 2014

Texas Water Development Board

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Texas Water Development Board
Water Science and Conservation
Innovative Water Technologies

Texas Water Development Board

The statements contained in this presentation are my current views and opinions and are not intended to reflect the positions of, or information from, the Texas Water Development Board, nor is it an indication of any official policy position of the Board.

Statutory Authority for TWDB in ASR Studies

- TWDB shall participate in pilot projects
- Pilot projects are eligible for grants from the water loan assistance fund
- TWDB may authorize use of money from the research and planning fund for pilot projects
- TWDB shall make other studies, investigations, and surveys of the aquifers in the state as it considers necessary

Texas Water Code §11.153, 11.154, 11.155

Corpus Christi Aquifer Storage and Recovery Conservation District

- Created in 2005 by the 79th Texas Legislature
  (enactment SB 1831, Section 1, Subtitle H, Title 6)
- Prepared a groundwater management plan (2008)
- District is committed to maintaining a sustainable, adequate, reliable, cost-effective and high quality source of groundwater to promote the vitality, economy, and environment of the district.
- Prepared a five-year plan for district operation and evaluation of ASR (2009)

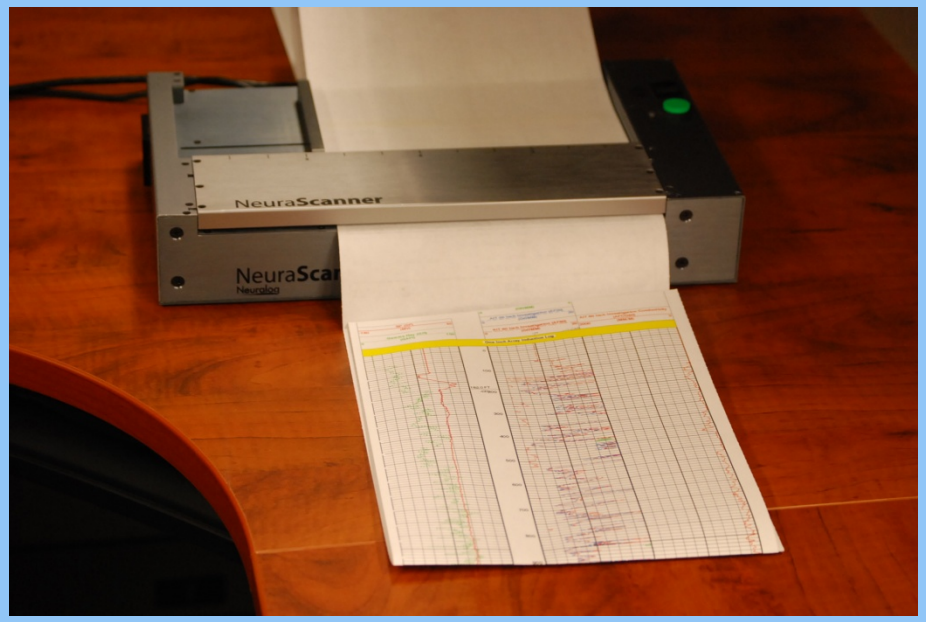
Project Objectives

Collect well data

Append data to relational database

Characterize geology within ASR District :

- sand and clay sequences
- water chemistry
- aquifer parameters
- potential problems:
  - hydrocarbons
  - high gamma ray spikes

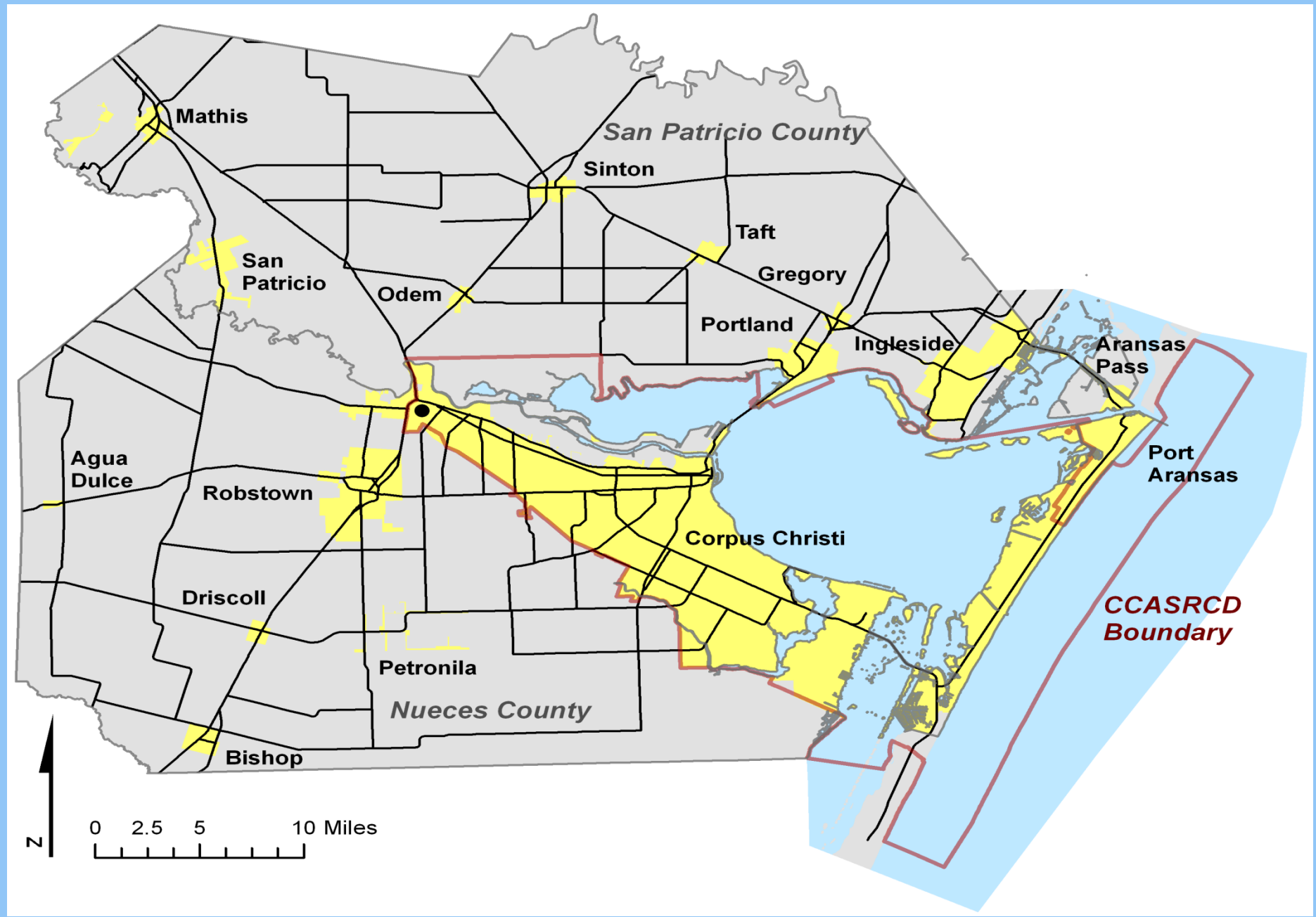


Project focus is on the Evangeline Aquifer in the area of the Stevens Water Treatment Plant at the west end of the district

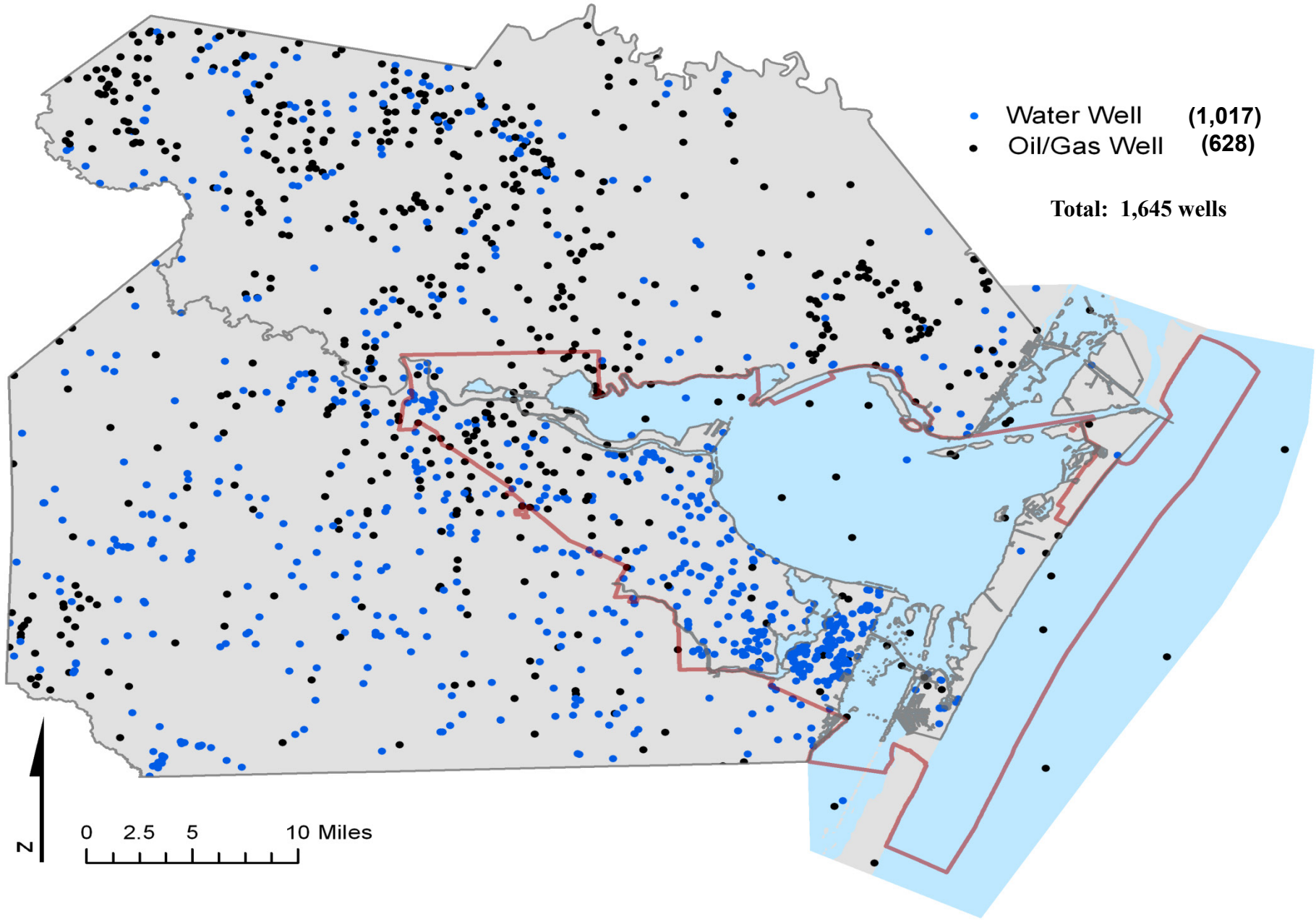
Provide database, GIS datasets, raw well data, and summary report

Project Completed: February 29, 2012

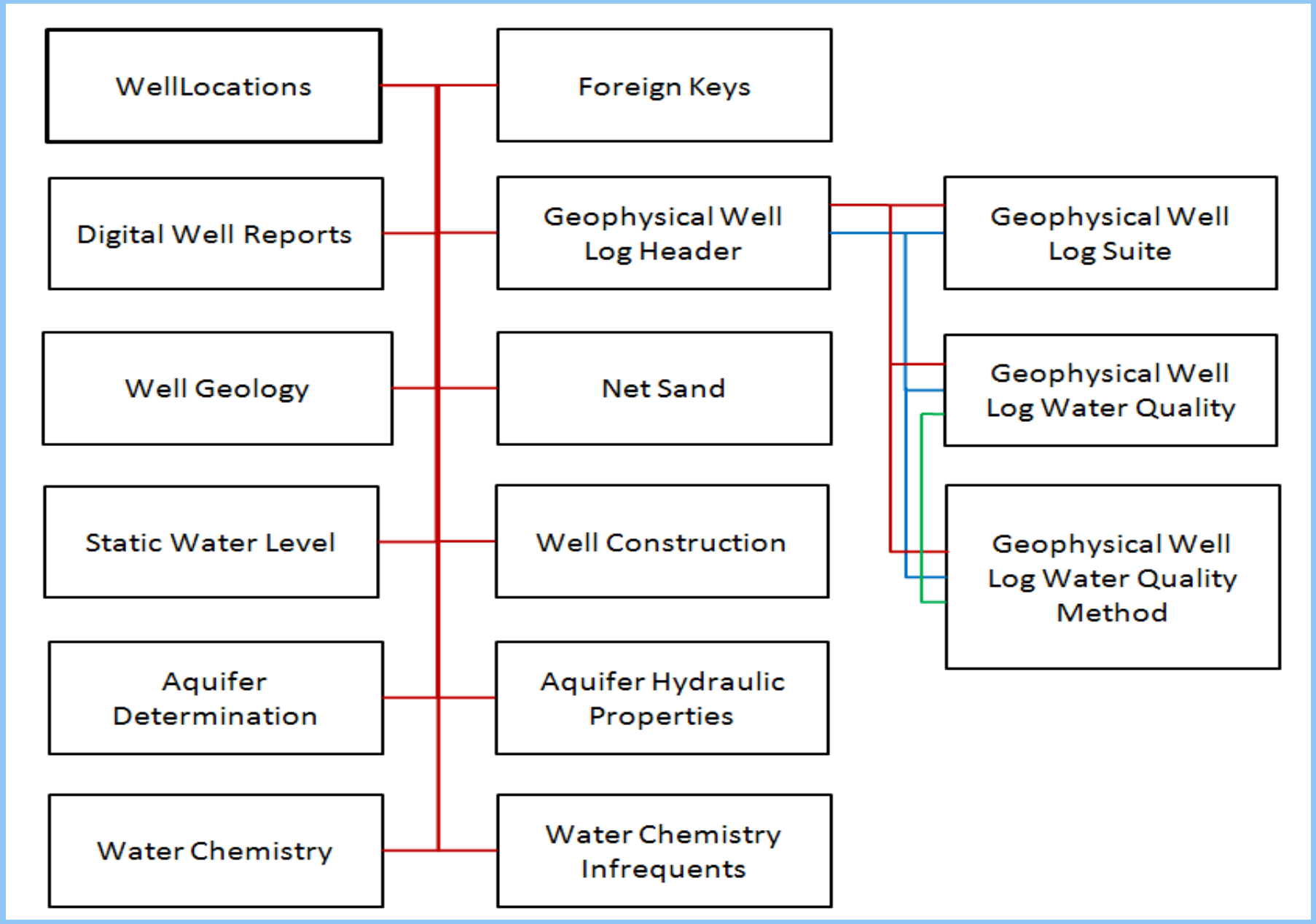
Project Area



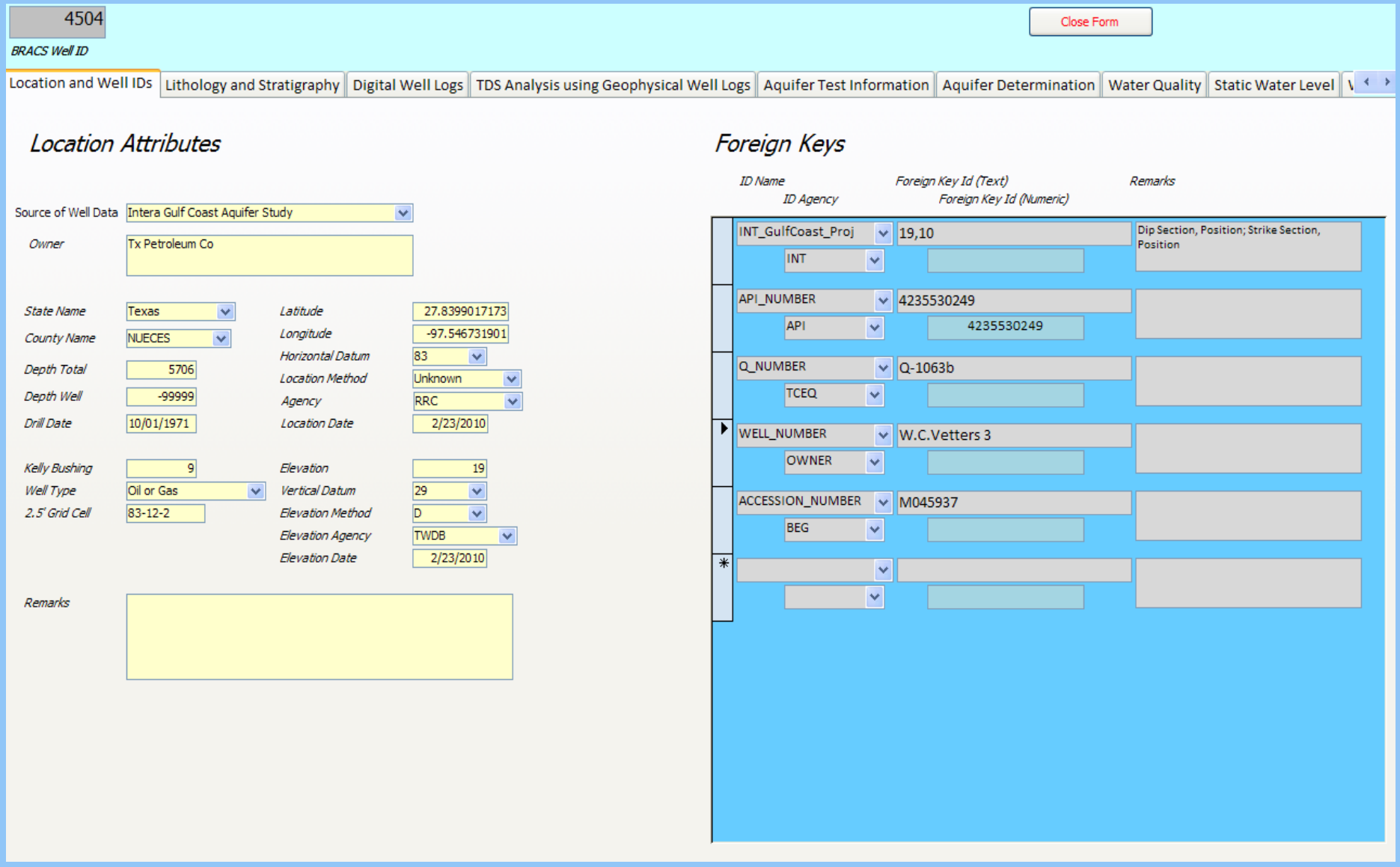
Project Area Well Control



BRACS Database Table Relationships



Location and Foreign Key Tables



Geophysical Log Header and Well Report Tables

13330

BRACS Well ID

Close Form

Location and Well IDs | Lithology and Stratigraphy | Digital Well Logs | TDS Analysis using Geophysical Well Logs | Aquifer Test Information | Aquifer Determination | Water Quality | Static Wate

Digital Geophysical Well Logs

9619

Log File Type: TIF IMAGE

GL Folder Name: 42_355

REMARKS: Negative Image, 4 parts

File Name: Q1306_355_Part_1

GL_HYPERLINK: B:\GeophysicalWellLogs\42_355\Q1306_355_Part_1.tif

Geophysical Log	*Top Depth*	*Bottom Depth*	*Remarks*
RESISTIVITY	1000	2280	N/A
SPONTANEOUS POTENTIAL	1000	2280	N/A
	0	0	N/A

Record: 1 of 4 | No Filter | Search

Digital Water Well Logs

(New)

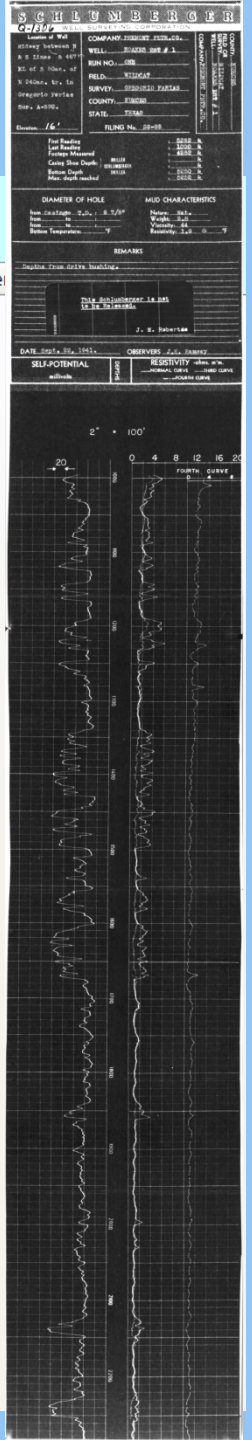
Log File Type: N/A

WW folder:

Remarks:

File Name:

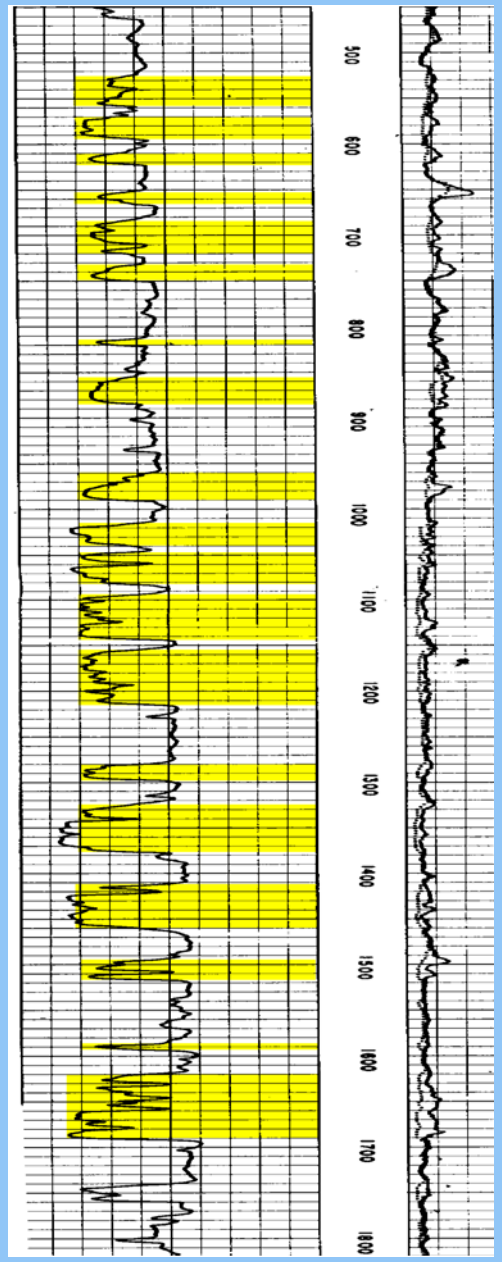
Record: 1 of 1 | No Filter | Search



District Geology

Age (millions of years before present)	Geologic Formation	Hydrogeologic Unit	
Pleistocene (1.8 - present)	Beaumont	Chicot Aquifer	Coast Aquifer
	Lissie		
Pliocene (5.6 – 1.8)	Willis		
Miocene (23.8 – 5.6)	Upper Goliad	Evangeline Aquifer	
	Lower Goliad		
	Upper Lagarto		
	Middle Lagarto	Burkeville Confining Unit	
	Lower Lagarto	Jasper Aquifer	Gulf
	Oakville		
Oligocene	(upper) Catahoula		
	(lower) Catahoula	Catahoula Confining Unit	

Used hydrostratigraphy of the Gulf Coast Aquifer developed for the TWDB groundwater availability model program (Young and others, 2010).



Upper Goliad Sands (yellow; SP response)
in the upper Evangeline Aquifer

Simplified lithology from geophysical well logs was interpreted from base of surface casing to several hundred feet below the Oakville Formation (base of Jasper Aquifer).

This information was loaded into the database . Water well driller formation descriptions was also loaded.

Elevated gamma ray “spikes” and potential hydrocarbon zones were noted in the database.

Geology Table

4504

BRACS Well ID

Close Form

Location and Well IDs | Lithology and Stratigraphy | Digital Well Logs | TDS Analysis using Geophysical Well Logs | Aquifer Test Information | Aquifer Determination | Water Quality | Static Water Level

Lithologic Description

Record Number	*Geologic Pick*	*Top Depth* / *Bottom Depth* / *Thickness*	*Lithologic Description* / *Simplified Lithologic Description* / *Source of Data* / *Remarks*	*Last Change*
1	Lithologic	0		
		90	No Record	
		90	GEOPHYSICAL WELL LOG	
				11/18/2011
2	Lithologic	90		
		122	Sand	
		32	GEOPHYSICAL WELL LOG	
				11/18/2011
3	Lithologic	122		
		207	CLAY	
		85	GEOPHYSICAL WELL LOG	
				11/18/2011
4	Lithologic	207		
		314	Clay with Sand	
		107	GEOPHYSICAL WELL LOG	
				11/18/2011
5	Lithologic	314		
		393	Sand with Clay	
		79	GEOPHYSICAL WELL LOG	
				11/18/2011
10	Lithologic	393		
		437	Clay	
		44	GEOPHYSICAL WELL LOG	
				11/8/2011

Stratigraphic Description

Record Number	*Geologic Pick*	*Top Depth* / *Bottom Depth* / *GT Flag* / *Thickness*	*Stratigraphic Description* / *Source of Data*	*Last Change*
130	Stratigraphic	0	Beaumont Formation	
Unit > Well Depth ?		166	PUBLISHED REPORT	
		166		9/12/2011
131	Stratigraphic	166	Lissie Formation	
Unit > Well Depth ?		356	PUBLISHED REPORT	
		190		9/12/2011
132	Stratigraphic	356	Willis Formation	
Unit > Well Depth ?		573	PUBLISHED REPORT	
		217		9/12/2011
133	Stratigraphic	573	Upper Goliad Formation	
Unit > Well Depth ?		1702	PUBLISHED REPORT	
		1129		9/12/2011
134	Stratigraphic	1702	Lower Goliad Formation	
Unit > Well Depth ?		2205	PUBLISHED REPORT	
		503		9/12/2011
135	Stratigraphic	2205	Upper Lagarto Formation	
Unit > Well Depth ?		2731	PUBLISHED REPORT	
		526		9/12/2011
136	Stratigraphic	2731	Middle Lagarto Formation	
Unit > Well Depth ?		3249	PUBLISHED REPORT	
		518		9/12/2011
137	Stratigraphic	3249	Lower Lagarto Formation	
Unit > Well Depth ?		3813	PUBLISHED REPORT	
		564		9/12/2011
138	Stratigraphic	3813	Oakville Formation	
Unit > Well Depth ?		4774	PUBLISHED REPORT	
		961		9/12/2011

Net Sand Analysis Form

BRACS Well ID: 4504

BRACS Net Sand Determination Code
Gulf Coast Aquifer Project

Close Form

Step 1. The aquifer determination process must be complete before determining Net Sand, Sand Percent, and Maximum Sand values for the formations in the Gulf Coast Aquifer.

The simplified lithology data entry for water wells and geophysical well logs must be complete, since this information is used to determine Net Sand, etc. One can update the SLD with more well points and re-run this process to add more data and correct errors.

Step 2. Process Net Sand

Net Sand Processing Table

Record Number	Simplified Lithologic Description	Top	Bottom	Thickness	Sand %
15	Sand	533	549	16	1
17	Sand	560	585	25	1
19	Sand	595	614	19	1
21	Sand	640	659	19	1
23	Sand	669	700	31	1
25	Sand	704	710	6	1

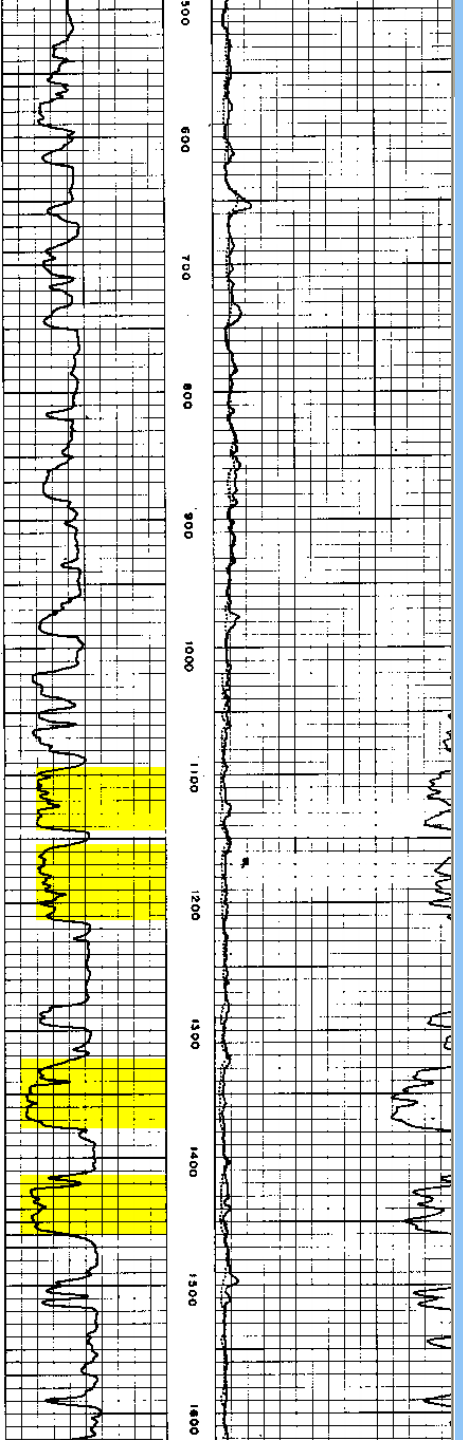
	Formation Net Sand Sand %	*Formation Present* Well Partial Penetration	*Partial Geology Desc*	*Aquifer Net Sand* Sand %	*Aquifer Present* Well Partial Penetration
Beaumont Fm	32	Yes		*Chicot Aquifer*	
	-99999	No	Yes		
Lissie Fm	44	Yes		161	Yes
	23	No	No	30	No
Willis Fm	85	Yes			
	39	No	No		
Upper Goliad Fm	601	Yes		*Evangeline Aquifer*	
	53	No	No		
Lower Goliad Fm	179	Yes		888	Yes
	35	No	No	41	No
Upper Lagarto Fm	108	Yes			
	20	No	No		
Middle Lagarto Fm	208	Yes		*Burkeville Confining Unit*	
	40	No	No		
Lower Lagarto Fm	202	Yes		*Jasper Aquifer*	
	36	No	No	577	Yes
Oakville Fm	375	Yes		38	No
	39	No	No		

Aquifer Determination Table

Depth Well	-99999	B_T_D:	0
Depth Hole	5706	B_B_D:	124
Screen Top	-99999	L_T_D:	124
Screen Bottom	-99999	L_B_D:	316
		W_T_D:	316
		W_B_D:	535
		UG_T_D:	535
		UG_B_D:	1669
		LG_T_D:	1669
		LG_B_D:	2175
		UL_T_D:	2175
		UL_B_D:	2702
		ML_T_D:	2702
		ML_B_D:	3218
		LL_T_D:	3218
		LL_B_D:	3779
		OK_T_D:	3779
		OK_B_D:	4740

Net Sand Analysis and Map Creation

- Geophysical well log net sand analysis used the same technical approach used by Young and others (2010).
- The data was collected in much finer detail than Young and others (2010) … with bed thicknesses of down to 10 feet.
- The formation top/bottom data from Young and others (2010) was used to group the sands.
- Well net sand data can be queried (from MS Access) and viewed (in GIS) in a number of ways, depending on what questions you are trying to answer.
- We did not prepare an exhaustive collection of net sand maps across the study area for the nine Gulf Coast Aquifer formations.
- We did prepare an example of how this data can be presented.
- Once ASR parameters are established on the ideal sand thickness, depth, bounding clay unit thicknesses, and potential well field location then custom maps can be prepared by a future contractor.



Upper Goliad Formation

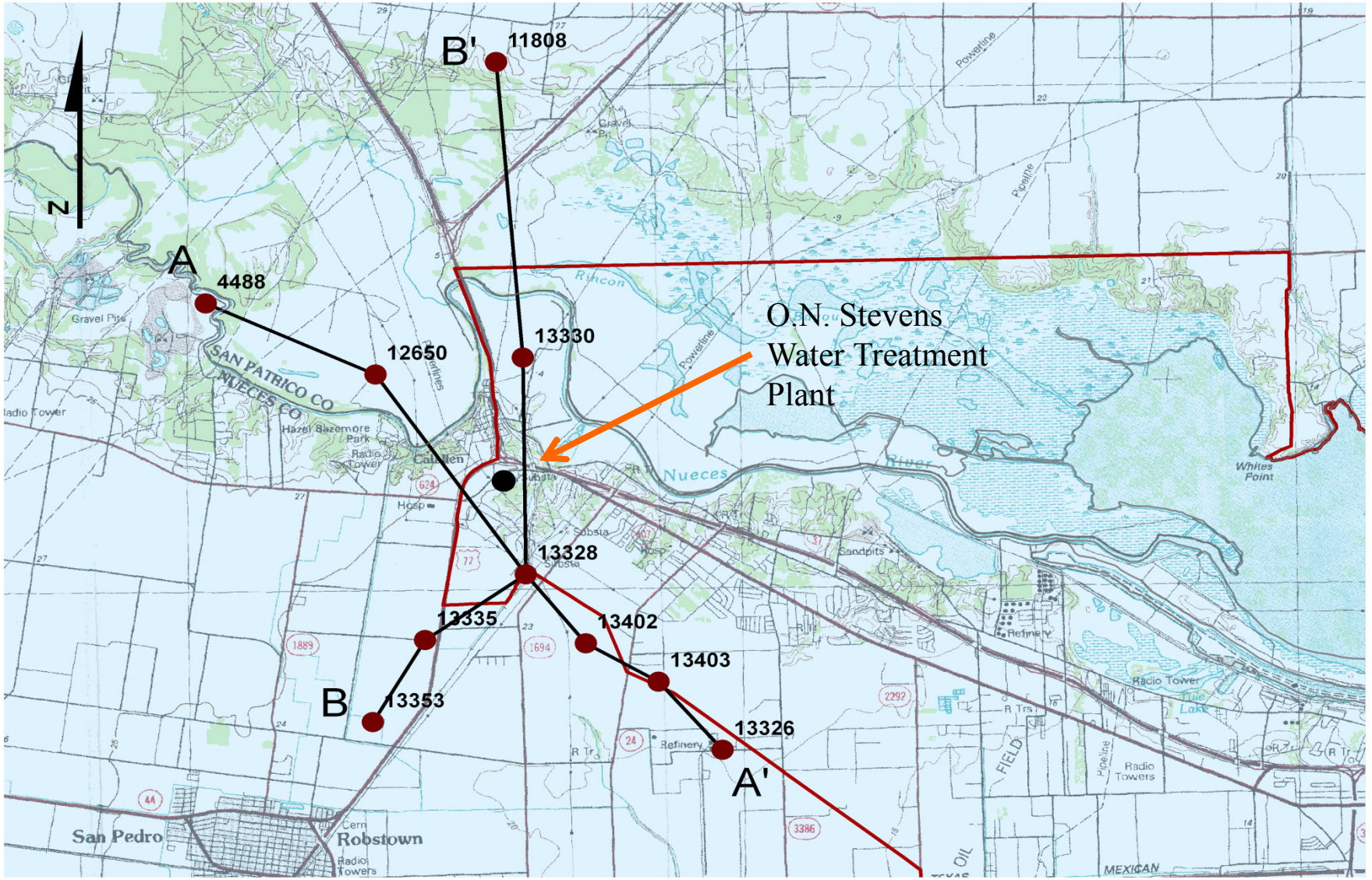
Well 4504 Sand Analysis

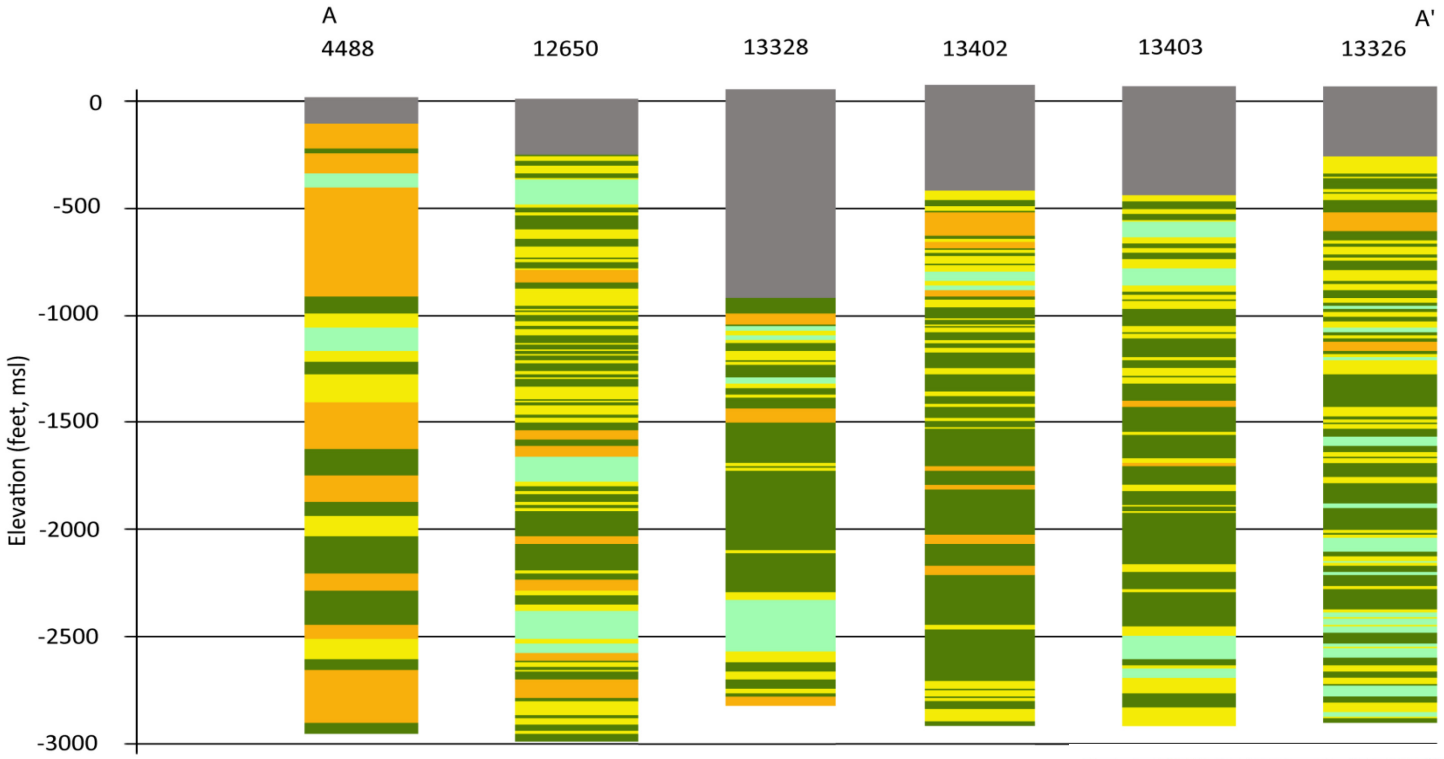
Net Sand	601 ft
Upper Goliad Thickness	1,134 ft
Sand Percent	53%

Sand Alyers thicker

Top Depth	Bottom Depth	Thickness
560	585	25
595	614	19
640	659	19
669	700	31
704	710	6
722	741	19
803	812	9
846	877	31
950	982	32
1005	1032	27
1038	1049	11
1053	1074	21
1084	1135	51
1145	1206	61
1269	1289	20
1313	1368	55
1402	1452	50
1484	1497	13
1501	1508	7
1576	1585	9

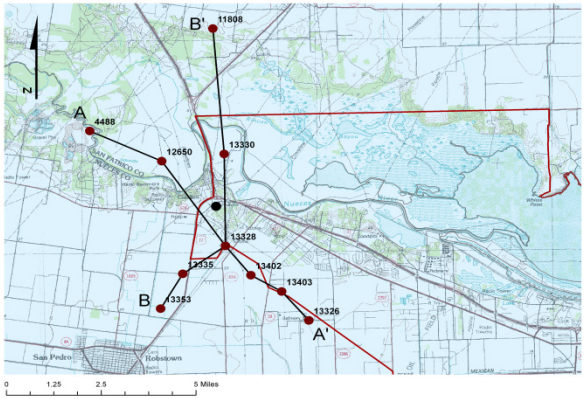
Cross-Section Location

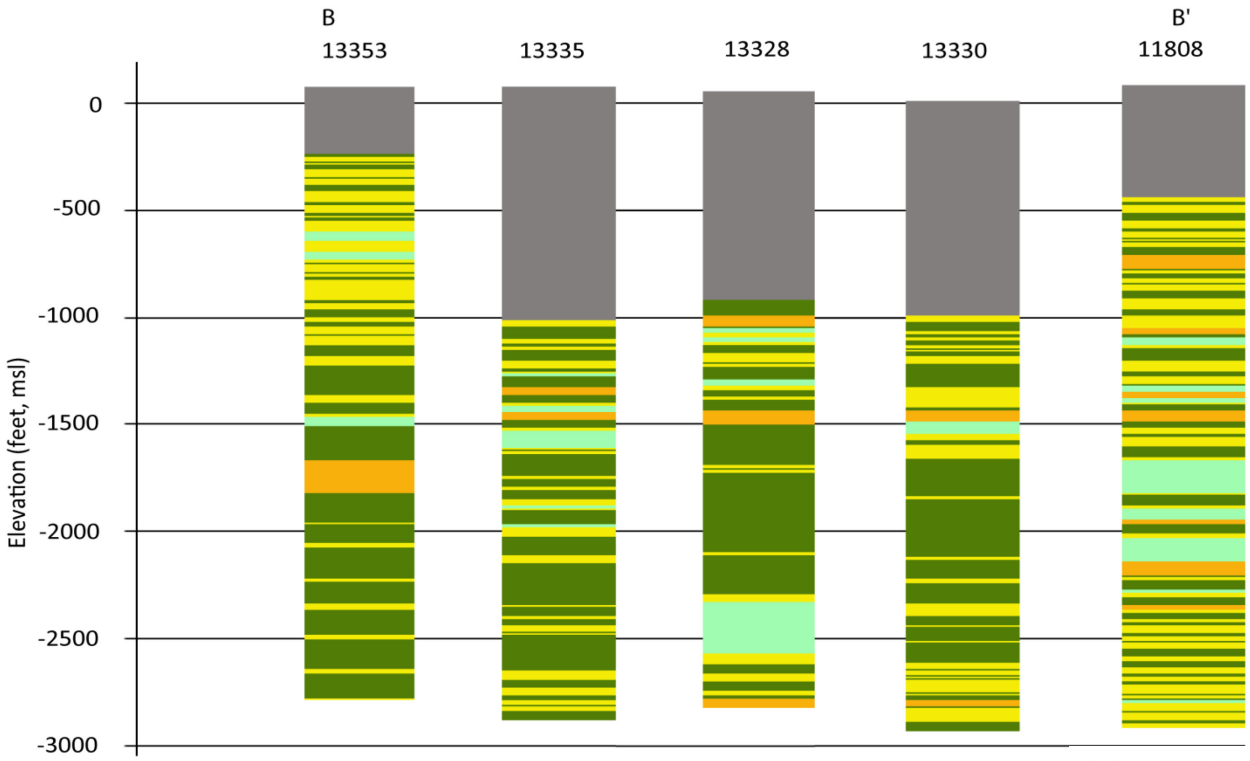




Lithology

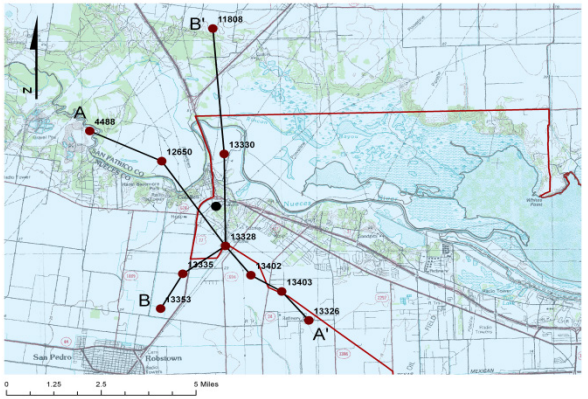
- No Record
- Sand
- Clay
- Sand with Clay
- Clay with Sand





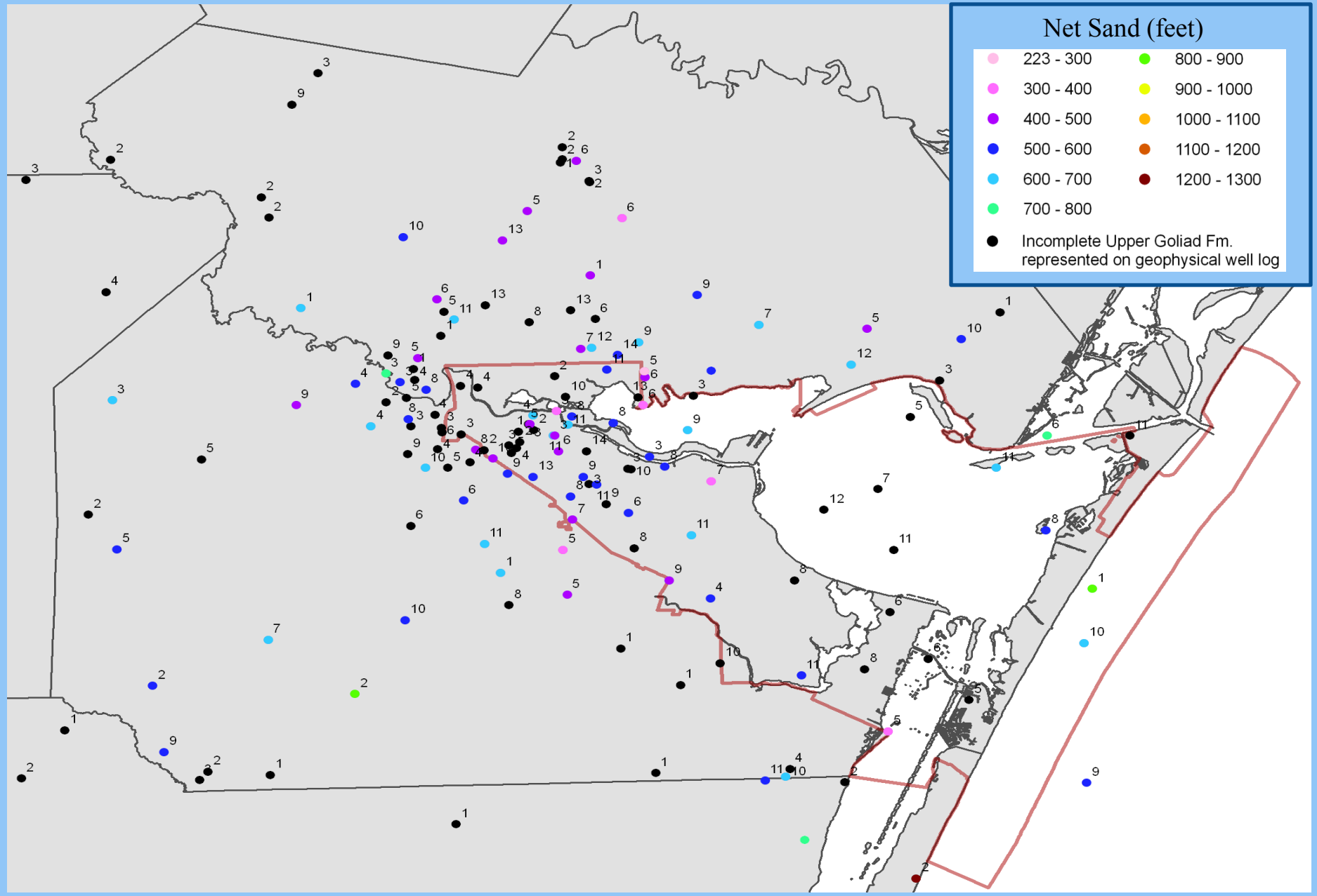
Lithology

- No Record
- Sand
- Clay
- Sand with Clay
- Clay with Sand

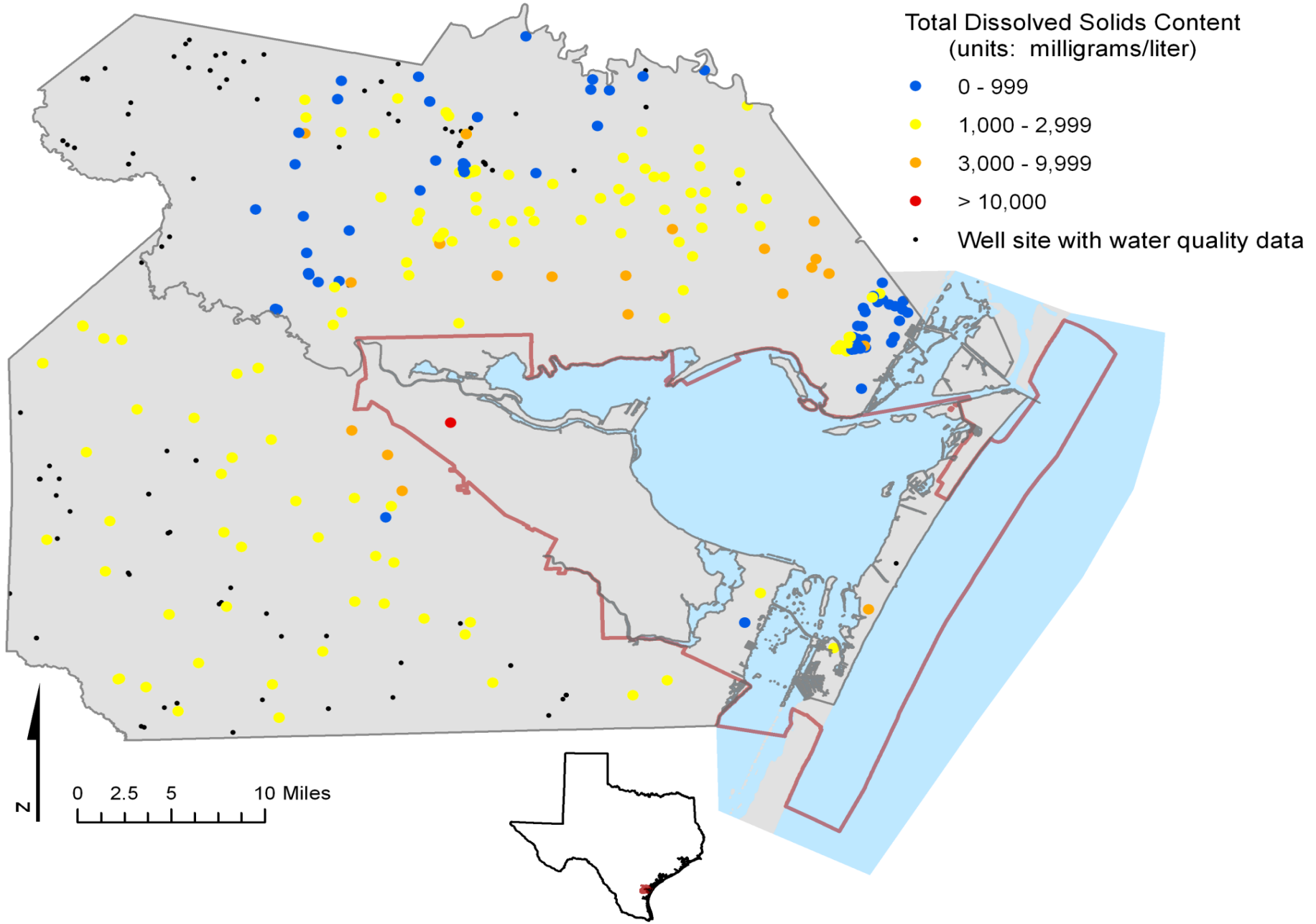


Example: Upper Goliad Fm. Net Sand Map

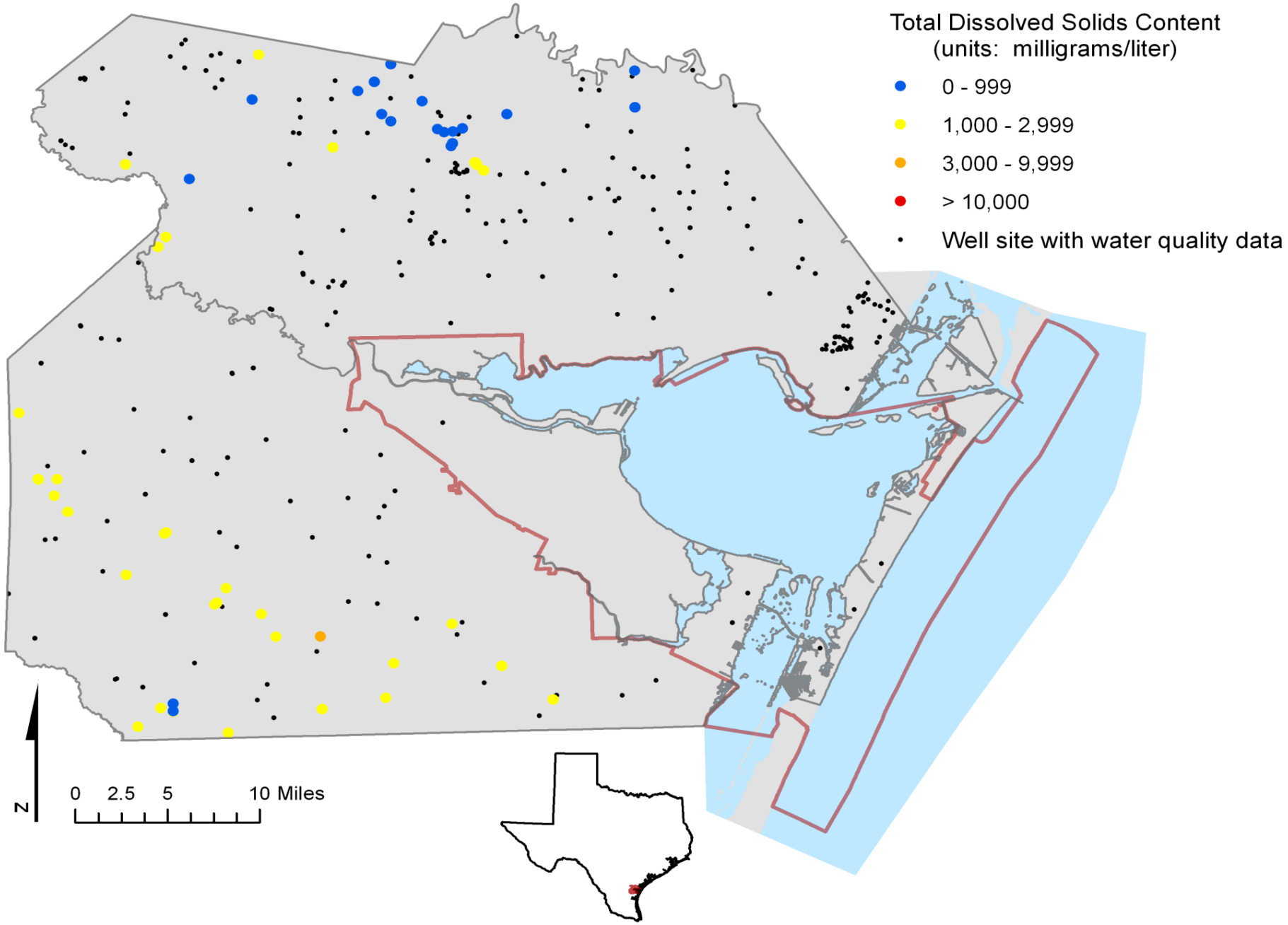
(integers refer to number of sands > 20 feet thick)



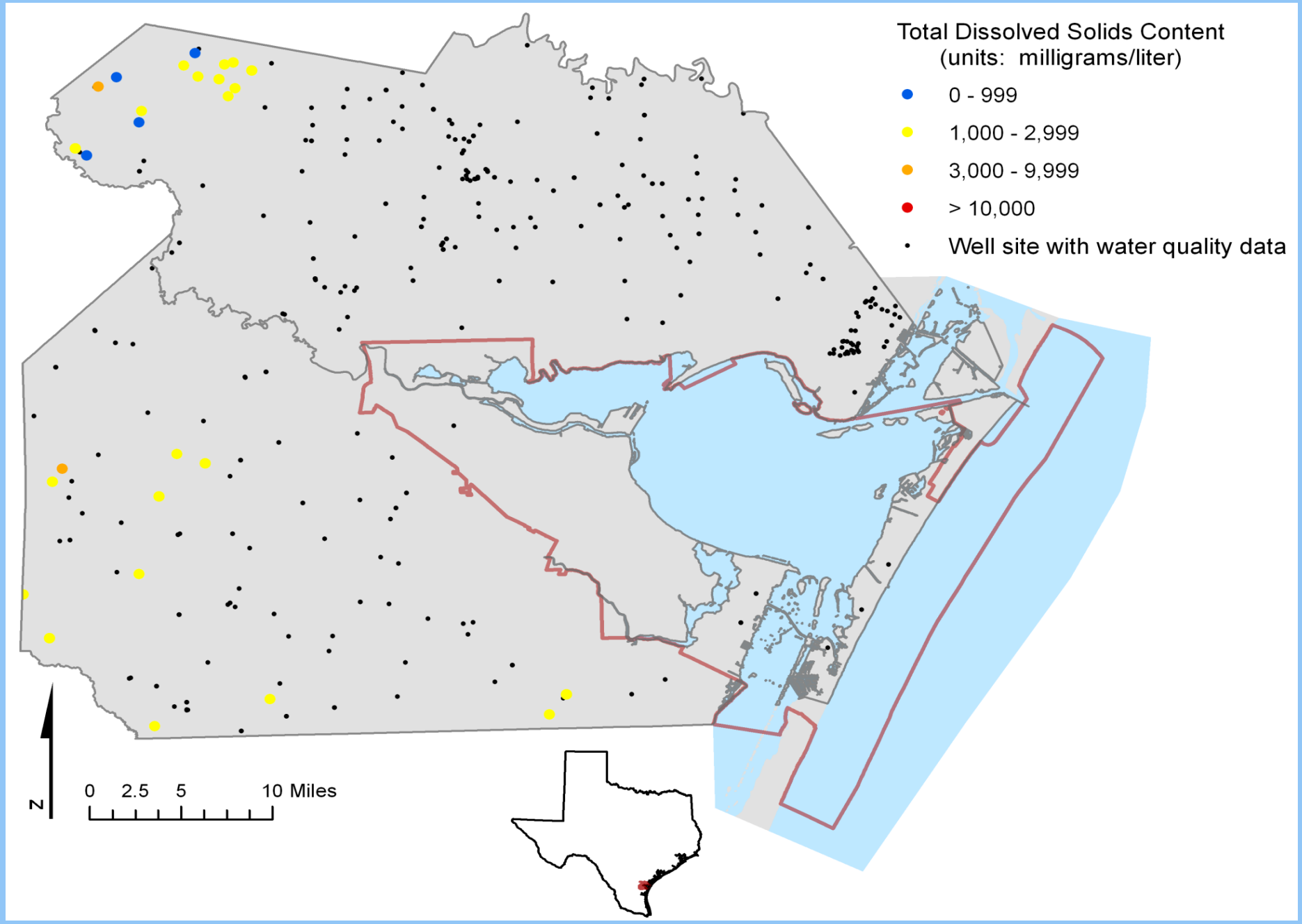
Chicot Aquifer Total Dissolved Solids



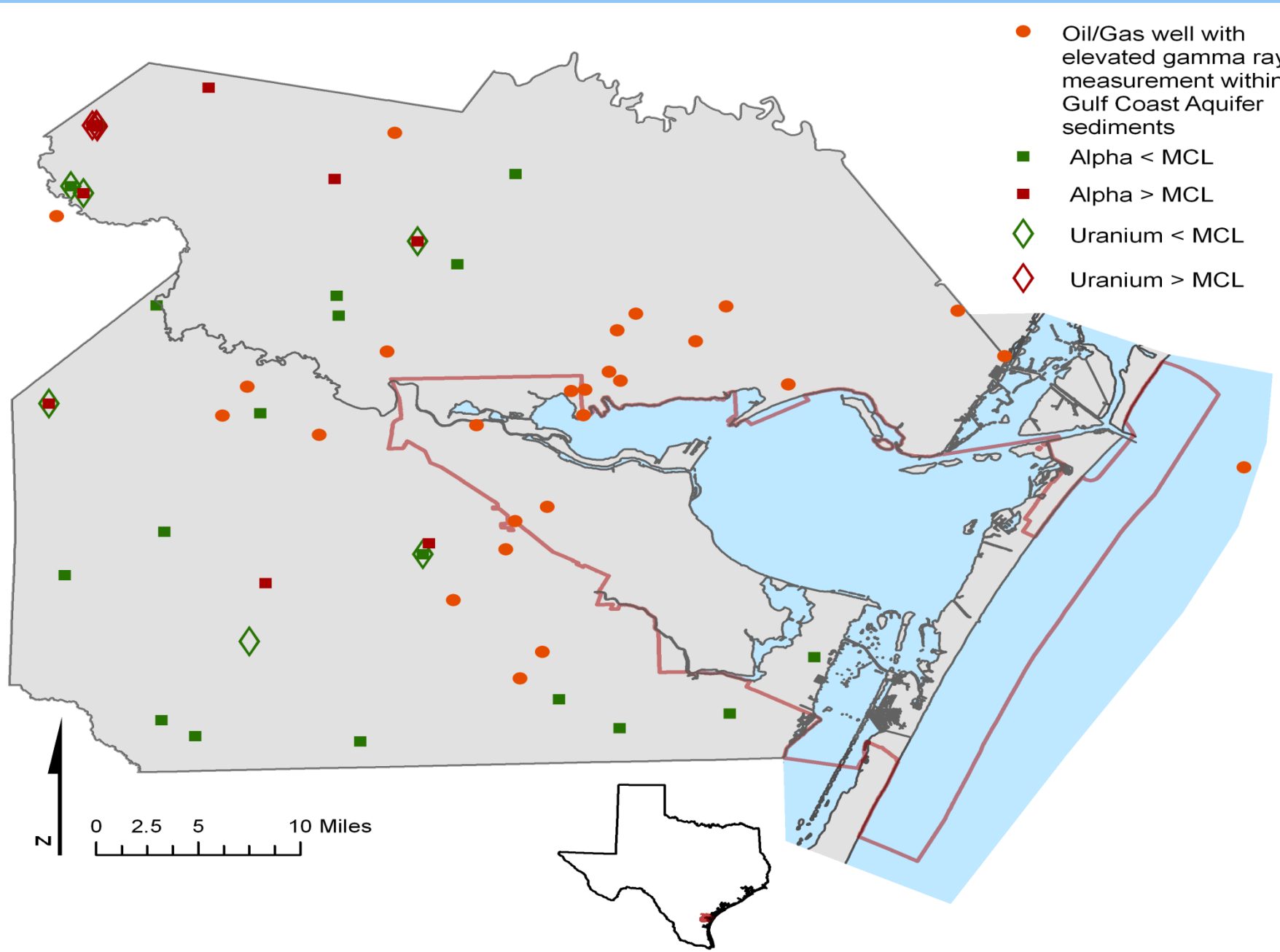
Chicot-Evangeline Aquifer Total Dissolved Solids



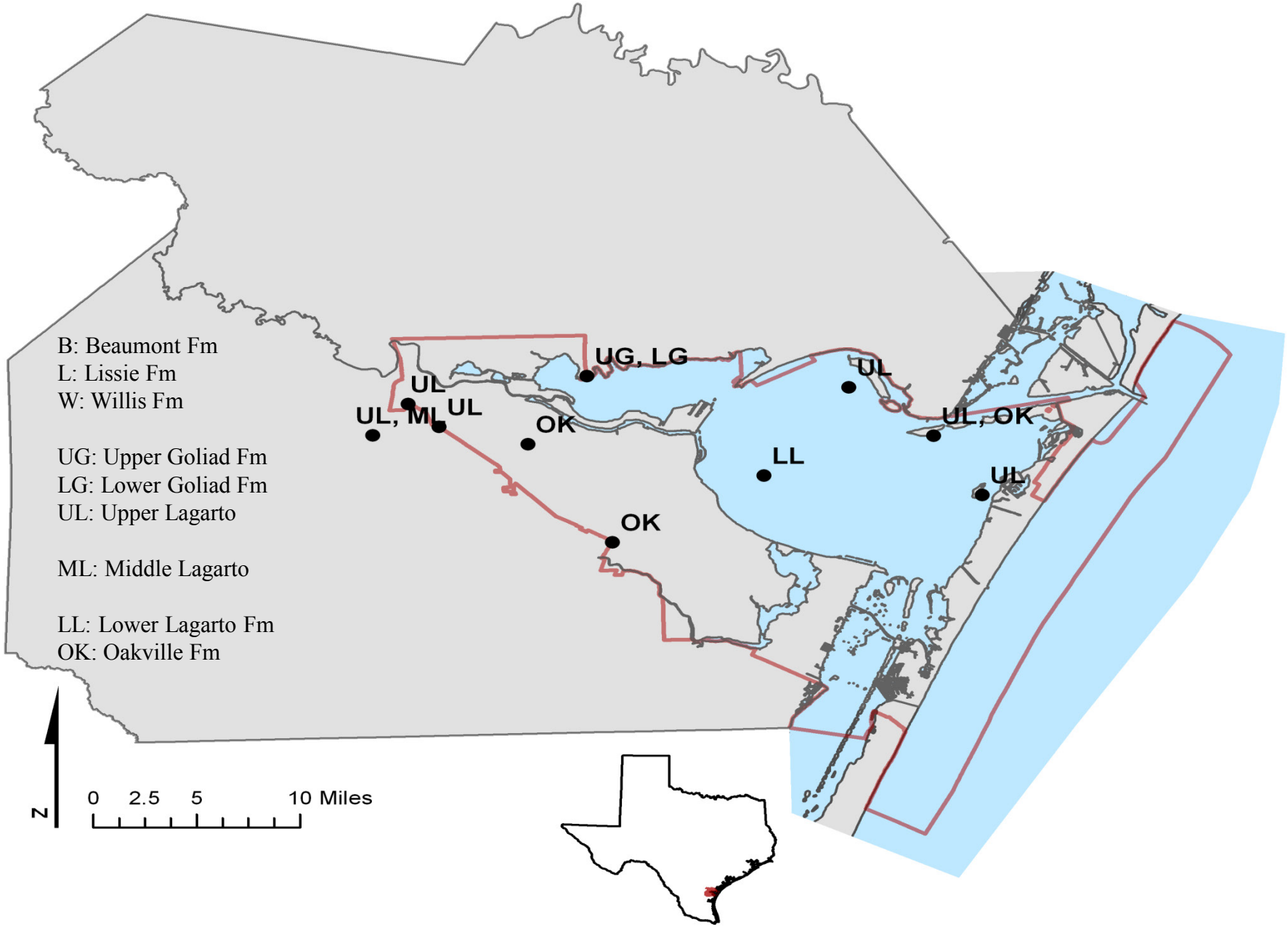
Evangeline Aquifer Total Dissolved Solids



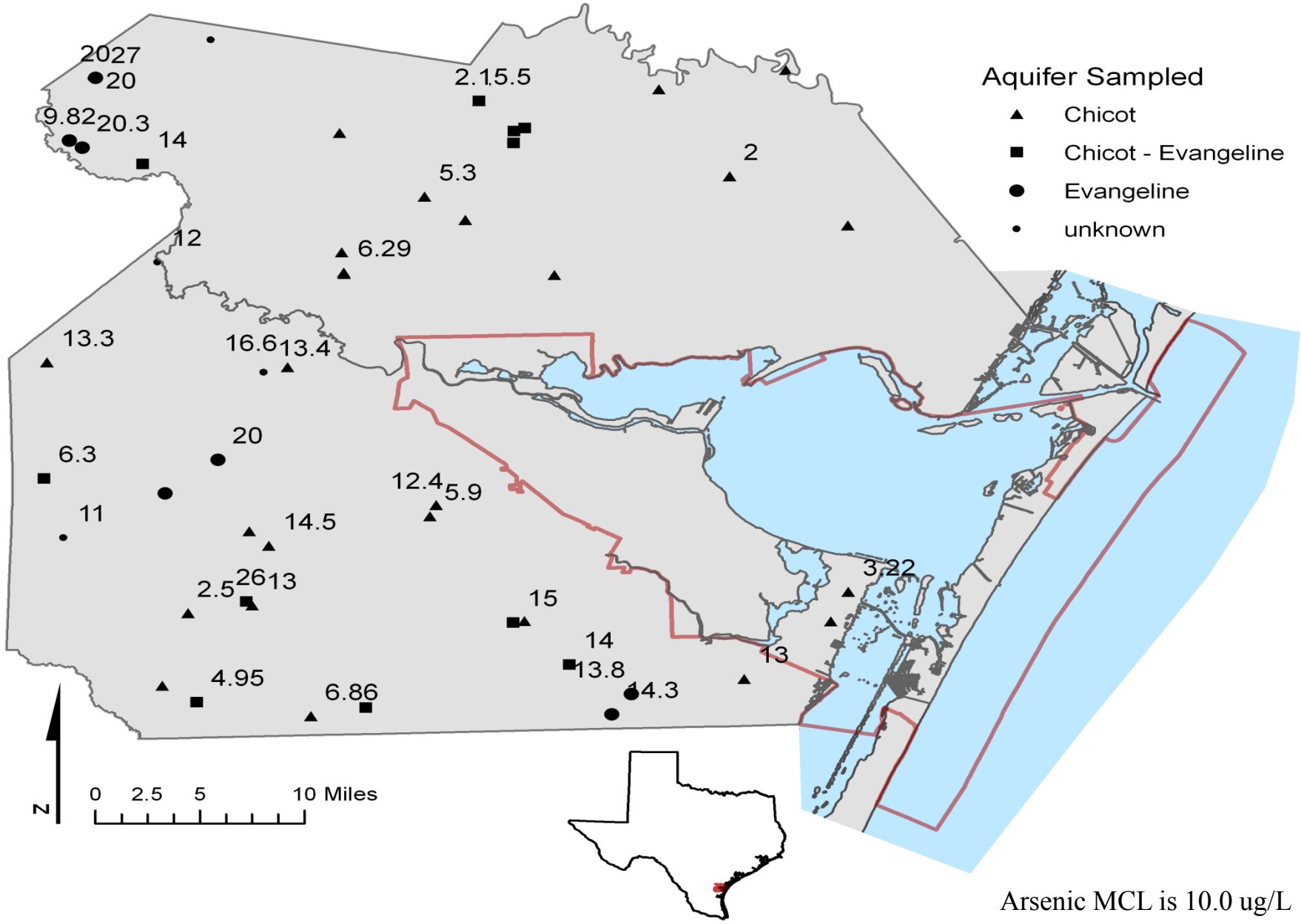
Radioactivity within the Gulf Coast Aquifer



Presence of Hydrocarbons in the Gulf Coast Aquifer

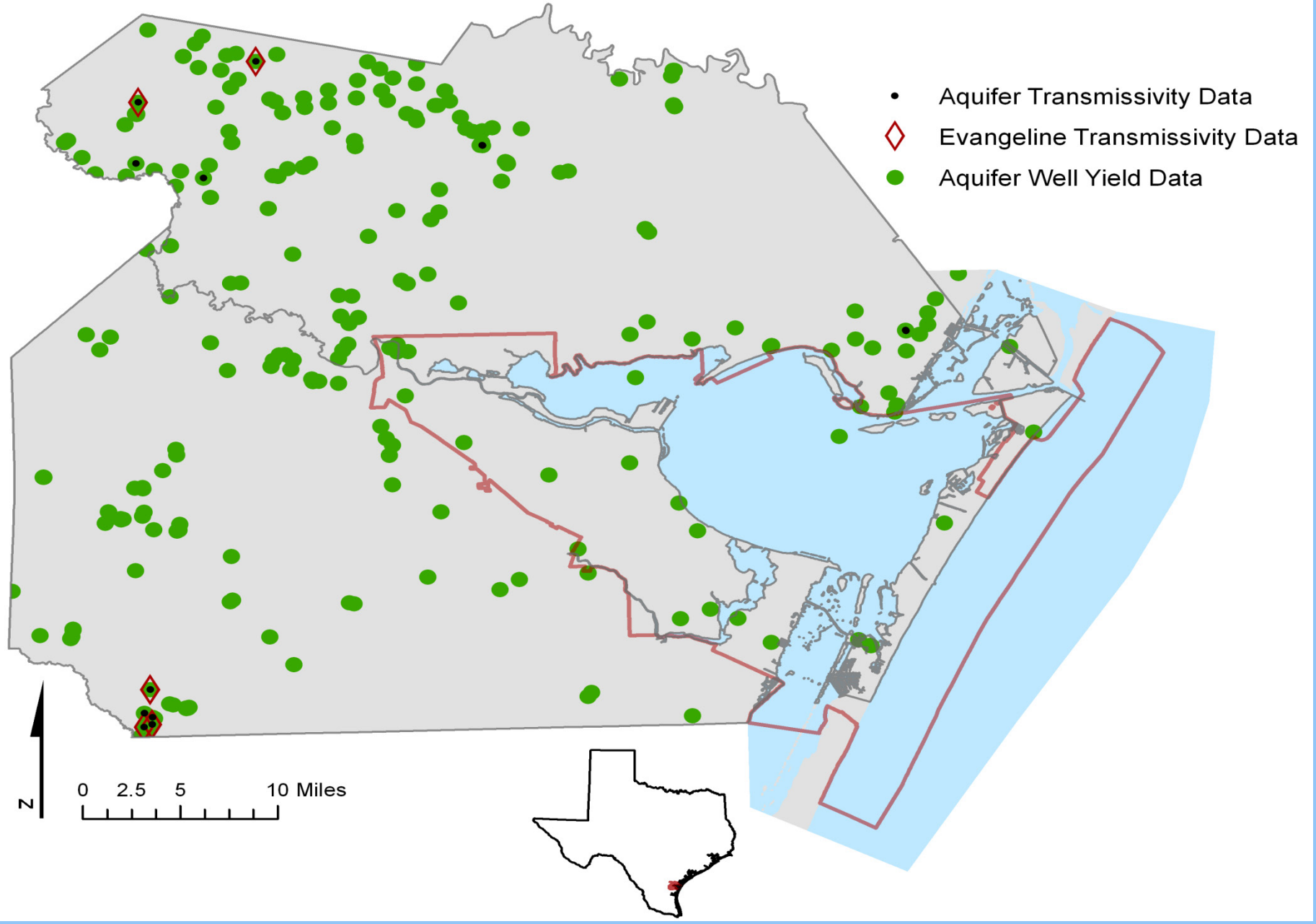


Concentration of Arsenic within the Gulf Coast Aquifer

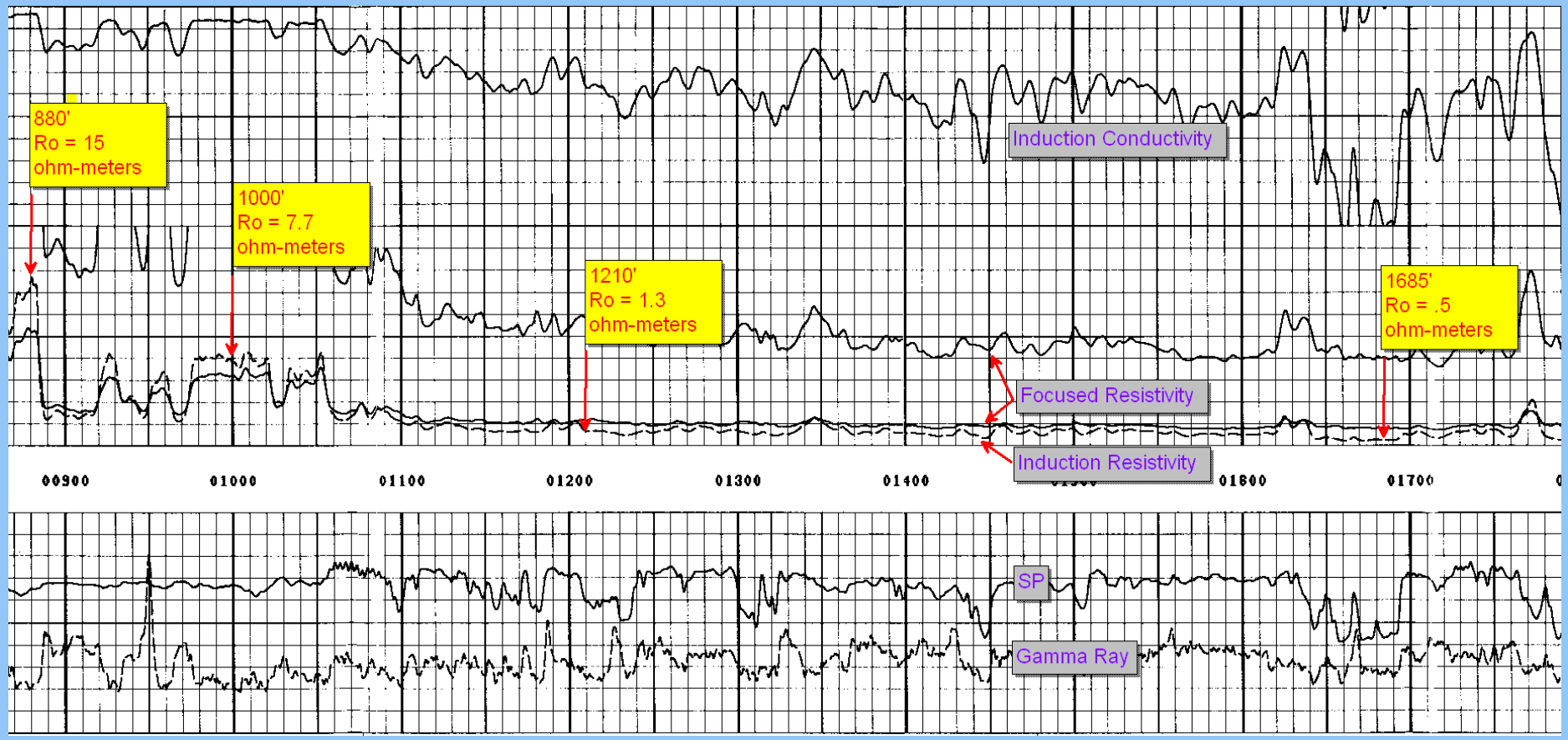


Arsenic MCL is 10.0 ug/L

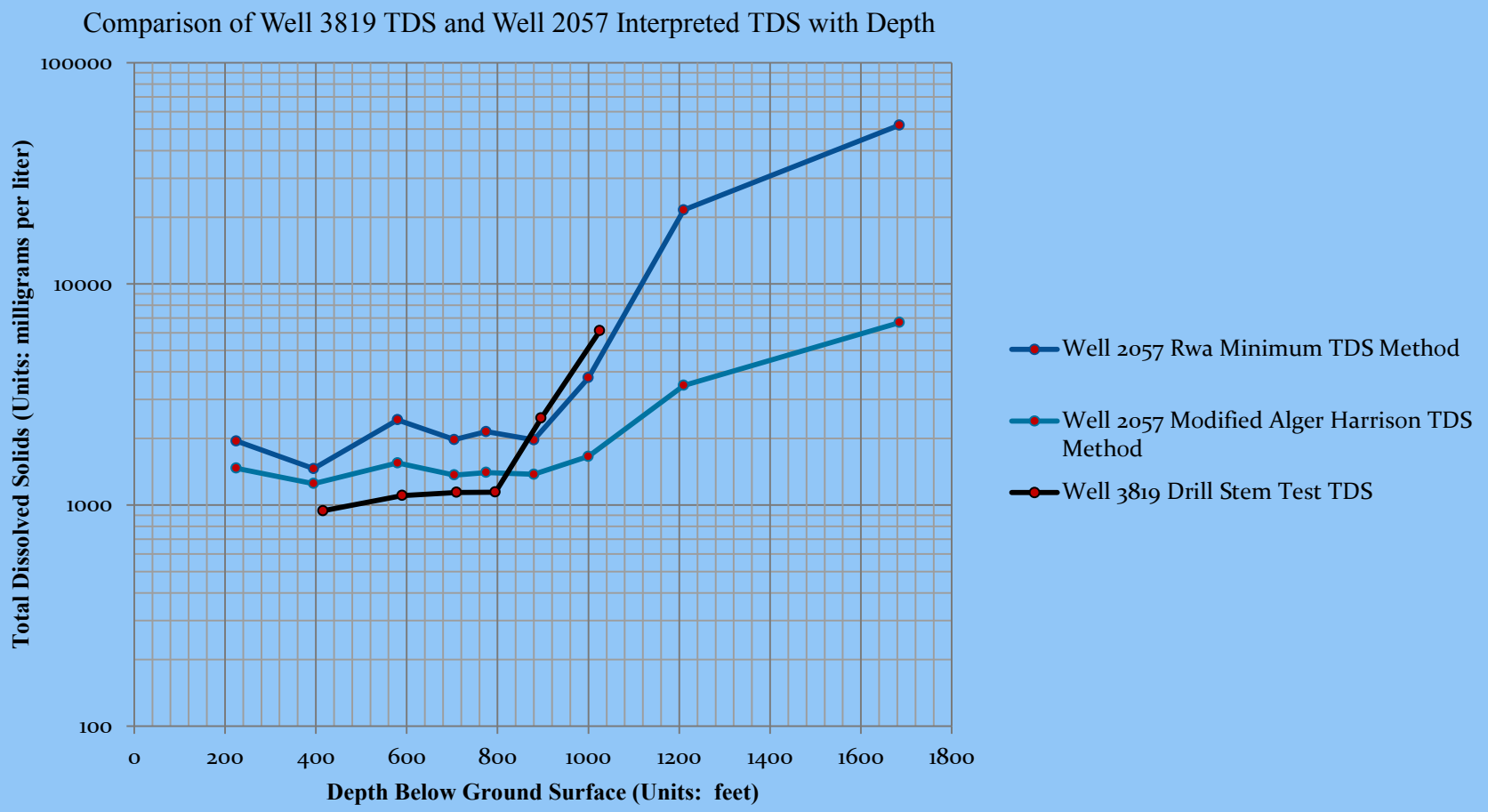
Hydraulic Properties Information within the Gulf Coast Aquifer



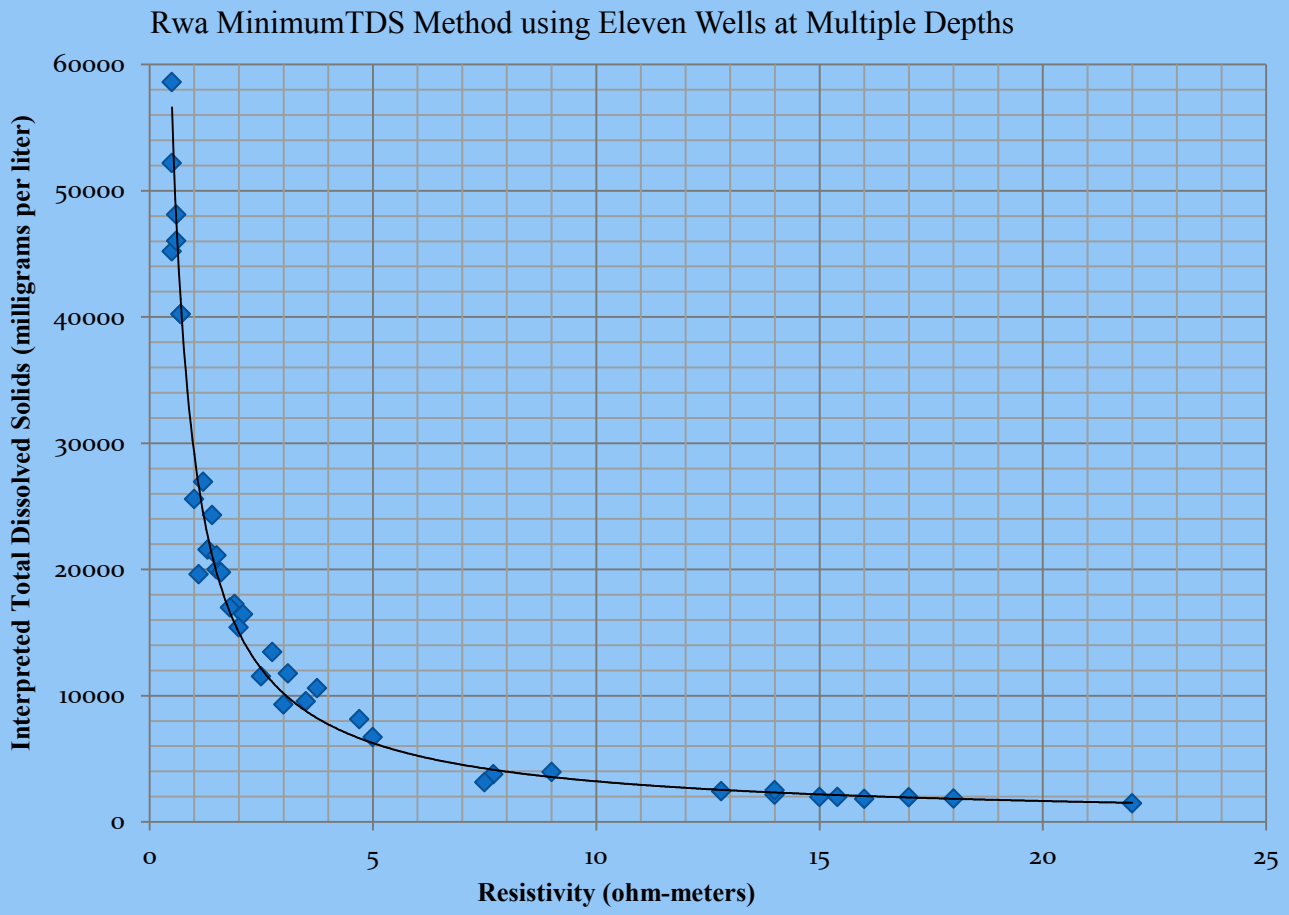
Geophysical Well Log Resistivity or SP used for Interpreting Formation Water TDS

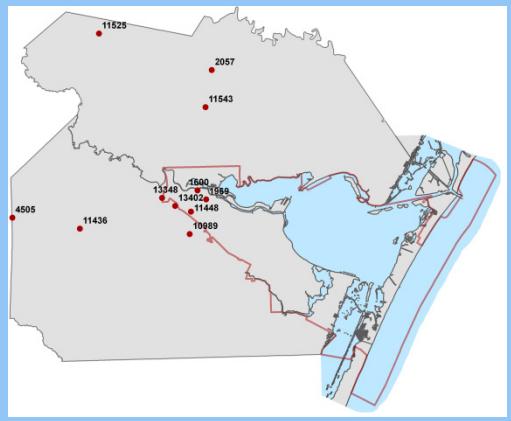


Comparison of Oil Well DST Sample Data and Two Geophysical Well Log TDS Interpretation Methods

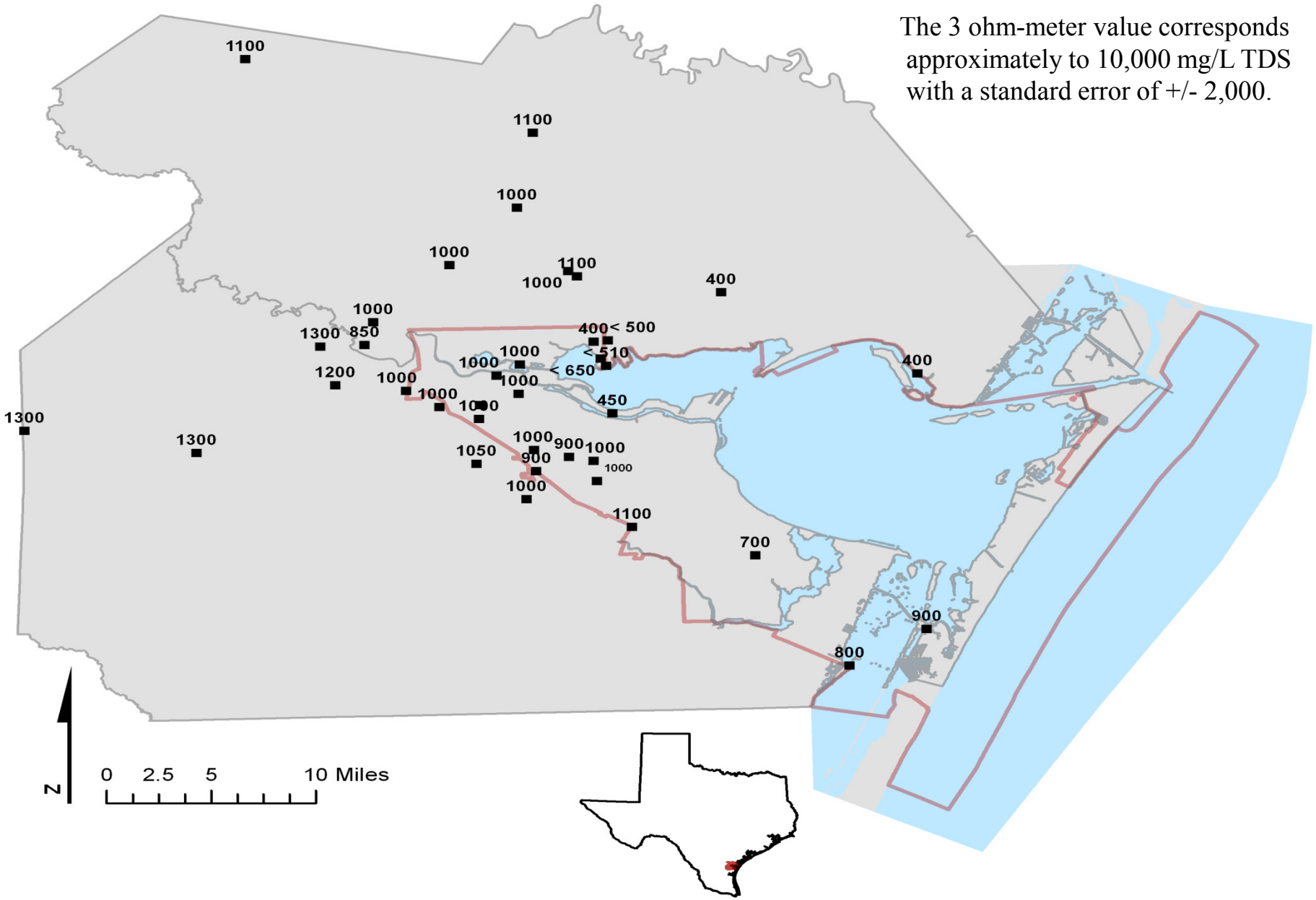


Interpreted total dissolved solids (TDS) and deep resistivity from geophysical well logs using the Rwa Minimum TDS Method.

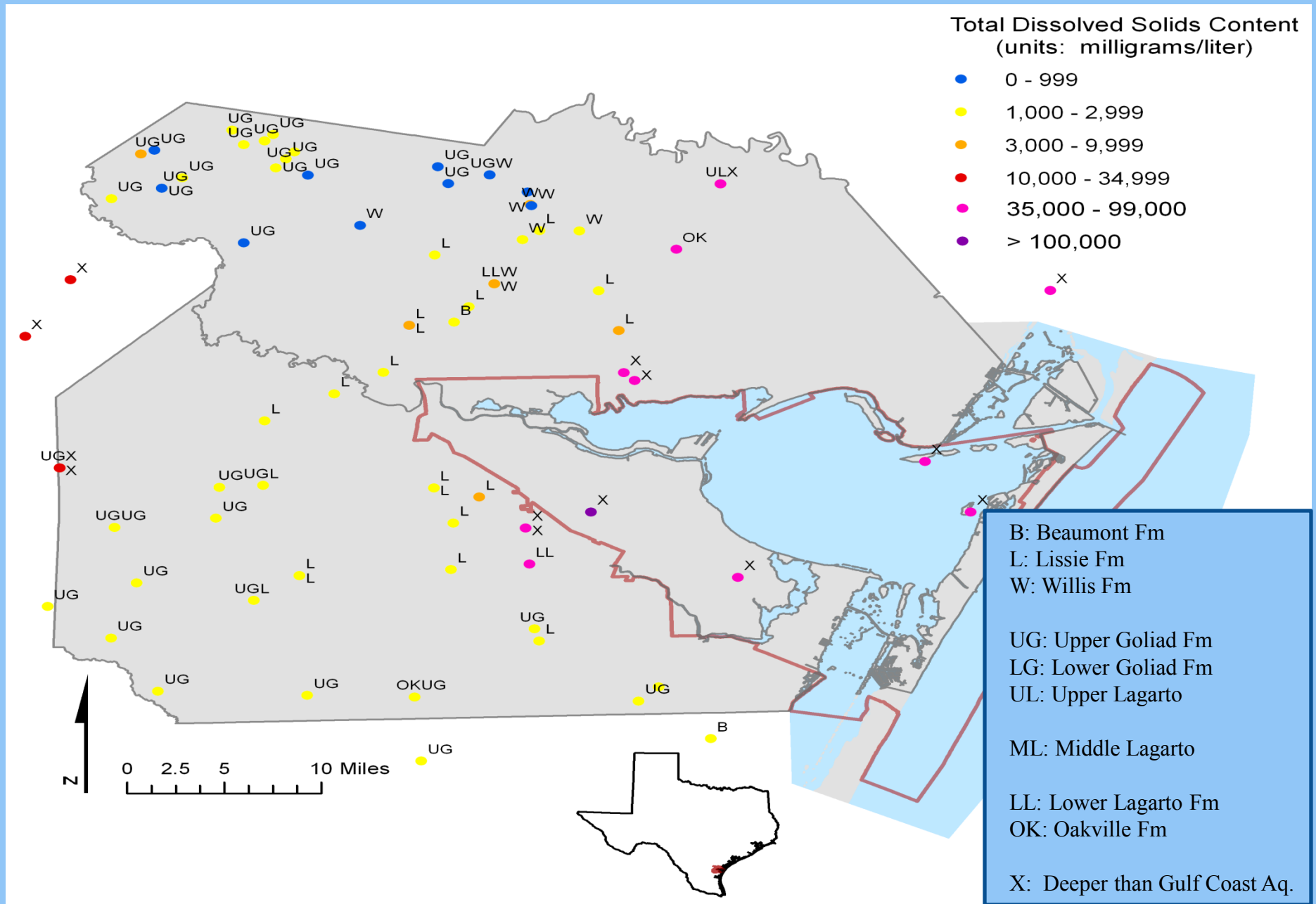




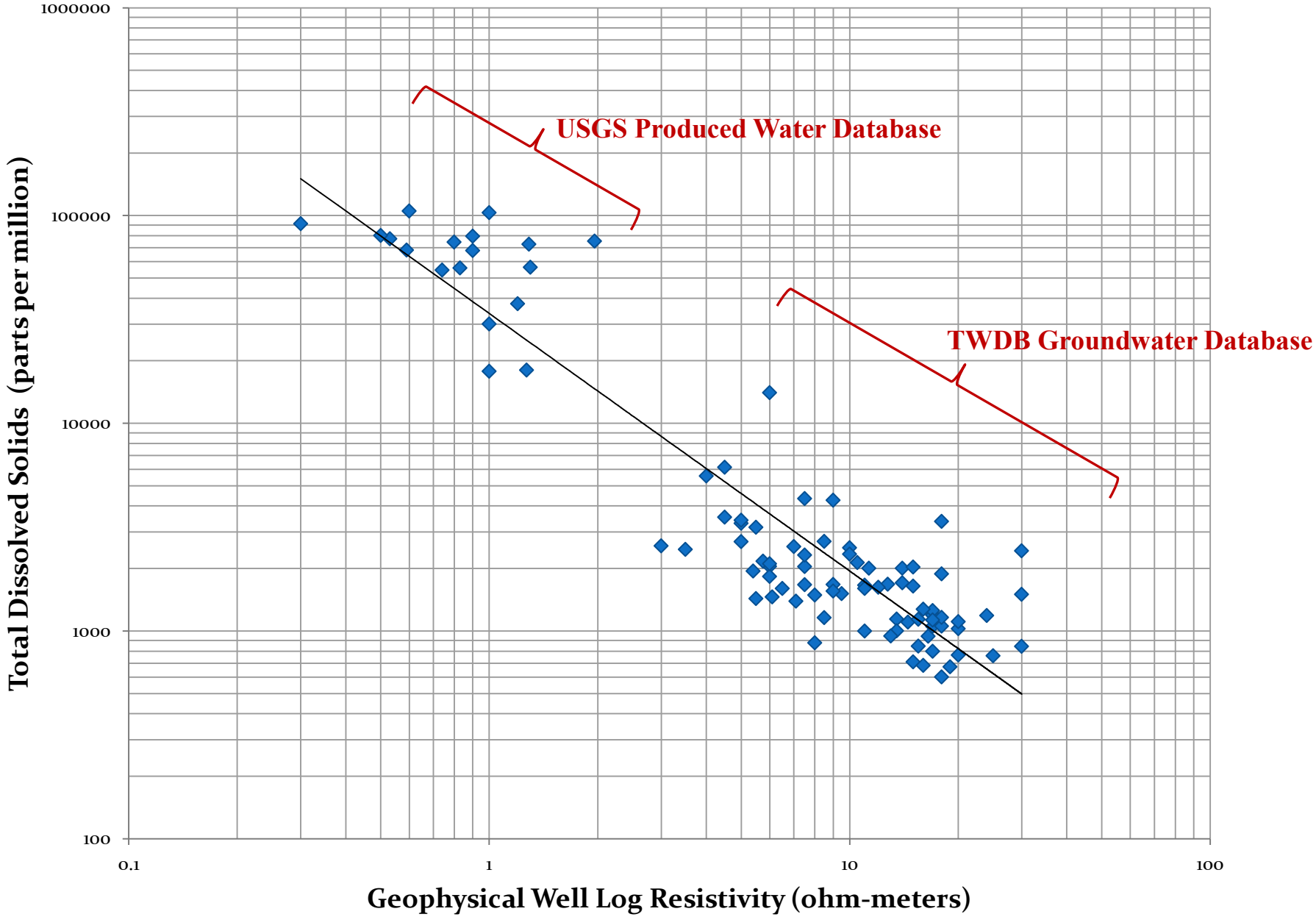
Approximate Depth to the 10,000 mg/L TDS in Gulf Coast Sands



Wells used to compare geophysical log resistivity and well TDS values



Mean Ro TDS Method



Summary: Methodology

- The project was structured to collect as much data as possible in the region, and evaluate the entire Gulf Coast Aquifer sequence to offer the District flexibility on site and target depth selection.
- Additional well data can be loaded into the database to evaluated additional areas in more detail, including test well drilling information.
- All information collected was non-confidential. Additional confidential data is available in the project area if needed.
- The variability of geophysical log quality, age, and completeness precluded automated analysis of net sand using LAS files.
- Techniques of geophysical well log resistivity analysis are under evaluation and results have limited application.

Summary: Geology

- The project area contains numerous sands within the entire Gulf Coast sequence of varying thicknesses,
- Formation water quality ranges from brackish to saline based on resistivity data.
- Extreme caution should be used if extrapolating the limited water quality data to the District area.
- Limited aquifer hydraulic property information must be extrapolated to the District area.
- Test well drilling and comprehensive evaluation of formation geology and water quality will be essential.
- Radioactivity, arsenic, hydrocarbons are known project area groundwater contaminants that must be thoroughly evaluated during test drilling.

Texas Water Development Board

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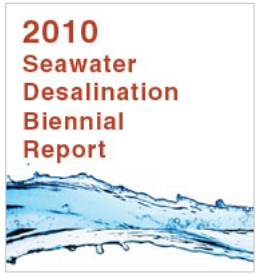

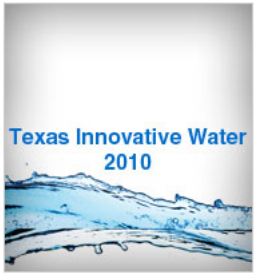

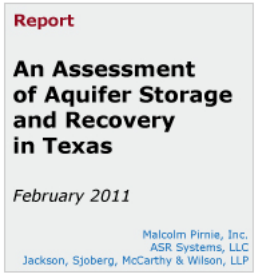

Innovative Water Technologies

- Aquifer Storage and Recovery
- BRACS
- Desalination
- Rainwater Harvesting
- Water Reuse

Innovative Water Technologies

The mission of the Innovative Water Technologies is to educate the water community on the use of nontraditional water supplies. This mission is accomplished by participating in research needed to advance technology demonstration projects; developing publications and educational materials; making presentations to the public; and, actively participating in key water organizations.

To promote and advance the use of non-traditional water supply development and management technologies such as desalination; rainwater and stormwater harvesting; water reuse; and aquifer storage and recovery in Texas, Innovative Water Technologies:

- funds and participates in research and demonstration projects; and,
- disseminates information through outreach activities.

Innovative Water Technologies (IWT) is primarily involved in the areas of nontraditional water supply and management activities including: desalination, rainwater and stormwater harvesting, water reuse, and aquifer storage recovery.

Through our desalination program, we administer grants for brackish groundwater desalination projects and seawater desalination pilot studies. To date, TWDB has funded eight brackish groundwater desalination demonstration projects worth a total of about $2.2 million, and two seawater desalination pilot plant studies worth approximately $3.13 million.

We promote rainwater and stormwater harvesting and water reuse through grants for research and demonstration projects and outreach activities.

Texas Water Development Board, 1700 North Congress Avenue, Austin, TX 78711 | TEL: 512-463-7847

Questions?

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