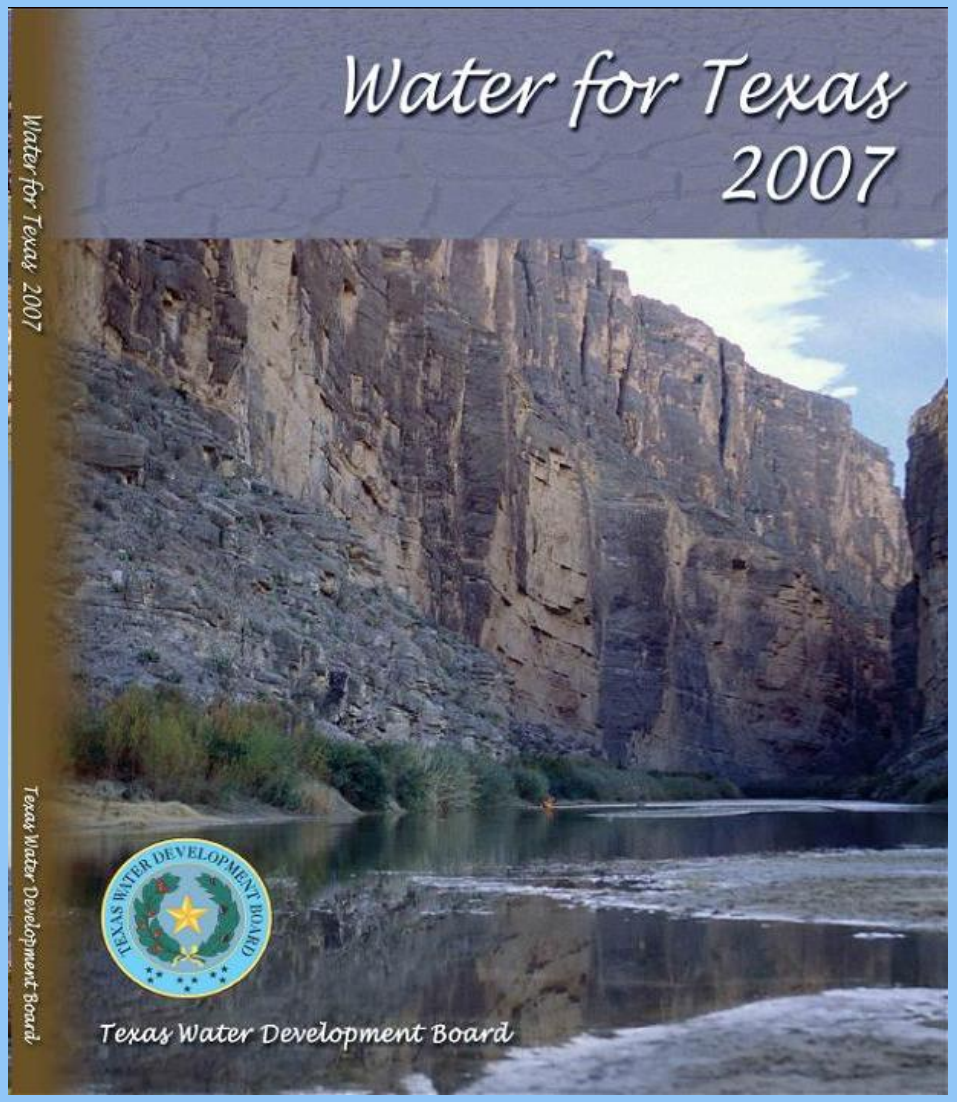
Brackish Resources Aquifer Characterization System (BRACS)

August 2, 2011

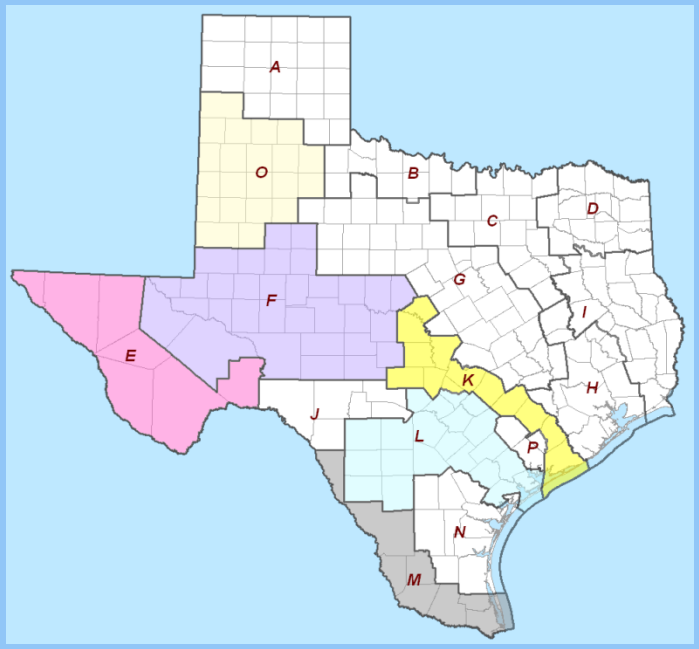
John E. Meyer P.G.

Texas Water Development Board
Water Science and Conservation
Innovative Water Technologies

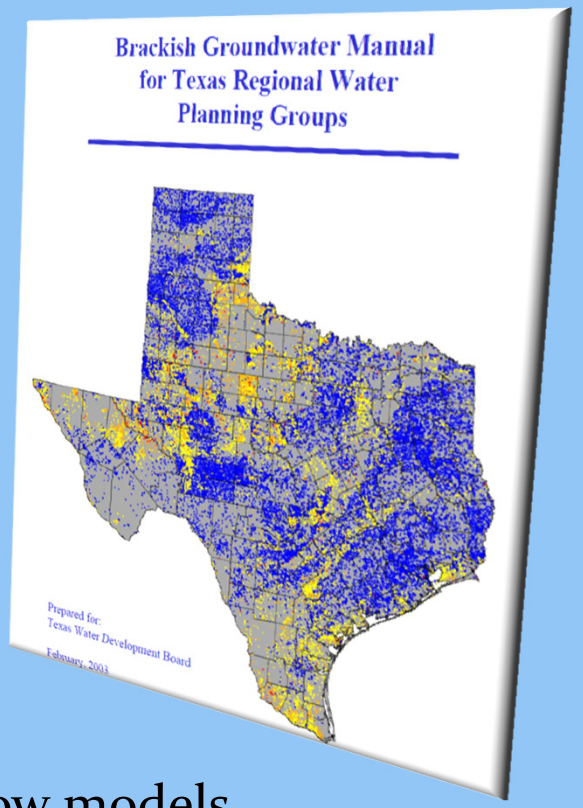
State and regional water planning



- Consider and evaluate all potentially feasible water management strategies
- Brackish groundwater desalination
  - Develop 175,000 acre-feet/year by 2060
  - 6 regions recommended strategy



BRACS Goals:



- Extend the TWDB statewide brackish groundwater study (2003):
  - map aquifers to 10,000 mg/L TDS
  - map key desalination parameters
  - estimate aquifer properties
  - estimate volumes of water
  - prepare data for numerical groundwater flow models
  - collect well logs (water, oil/gas) for interpretation
  - build datasets (database, GIS) of project information
- Assist regional water planning groups
- Collect and disseminate information to be used for site-specific brackish groundwater projects

Tasks:

- Convene a Technical Resource Panel
- Pilot Study: Pecos Valley Aquifer, West Texas
- Contracts to support brackish groundwater analysis include:
  - Digital Geological Bibliography of Texas to focus on articles on brackish portions of aquifers in Texas
  - Compile digital geophysical well logs across Texas for resistivity / stratigraphic analysis (goal: 1 log per 2.5 minute grid cell)
  - Assessment of Groundwater Modeling Approaches to Brackish Aquifers, using Variable Density Modeling

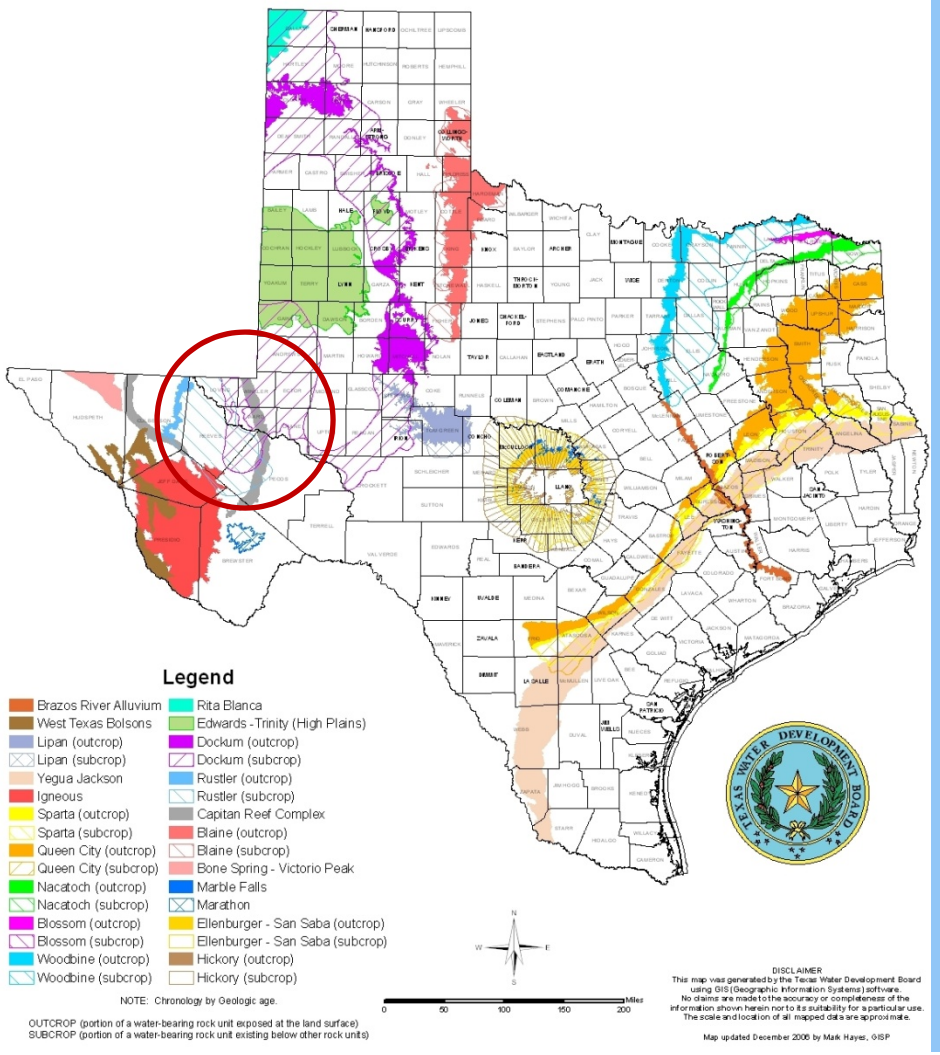
Pilot study tasks

- Develop a project database to contain and analyze information
- Collect information: water well reports, geophysical well logs, …
- Literature review
- Process this information into database and GIS records
- Create GIS files showing aquifer architecture
- Test techniques to interpret TDS from geophysical well logs
- Create GIS files of water quality data per aquifer
- Create GIS files of aquifer characteristics
- Quantify brackish resource in area
- Provide information: Report, raw data, database and GIS files

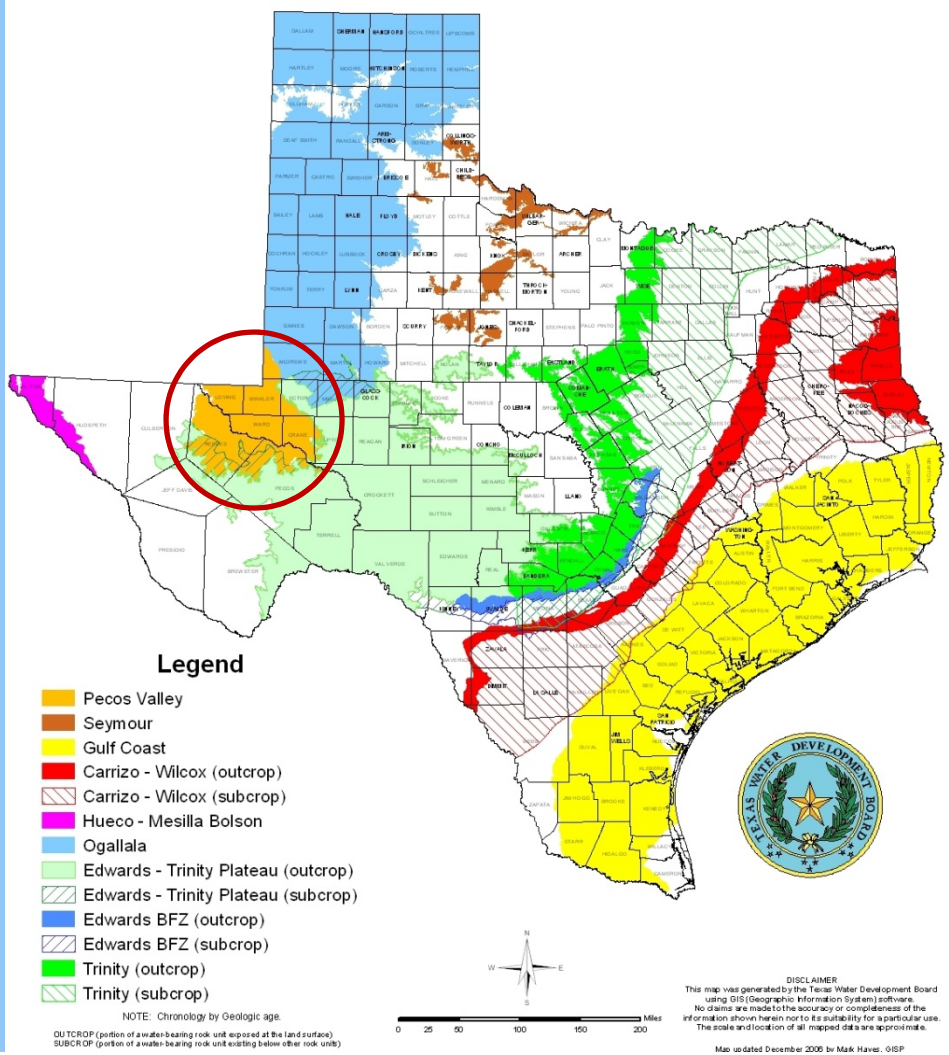
Pecos Valley Aquifer Pilot Study Area

Major and Minor Aquifers

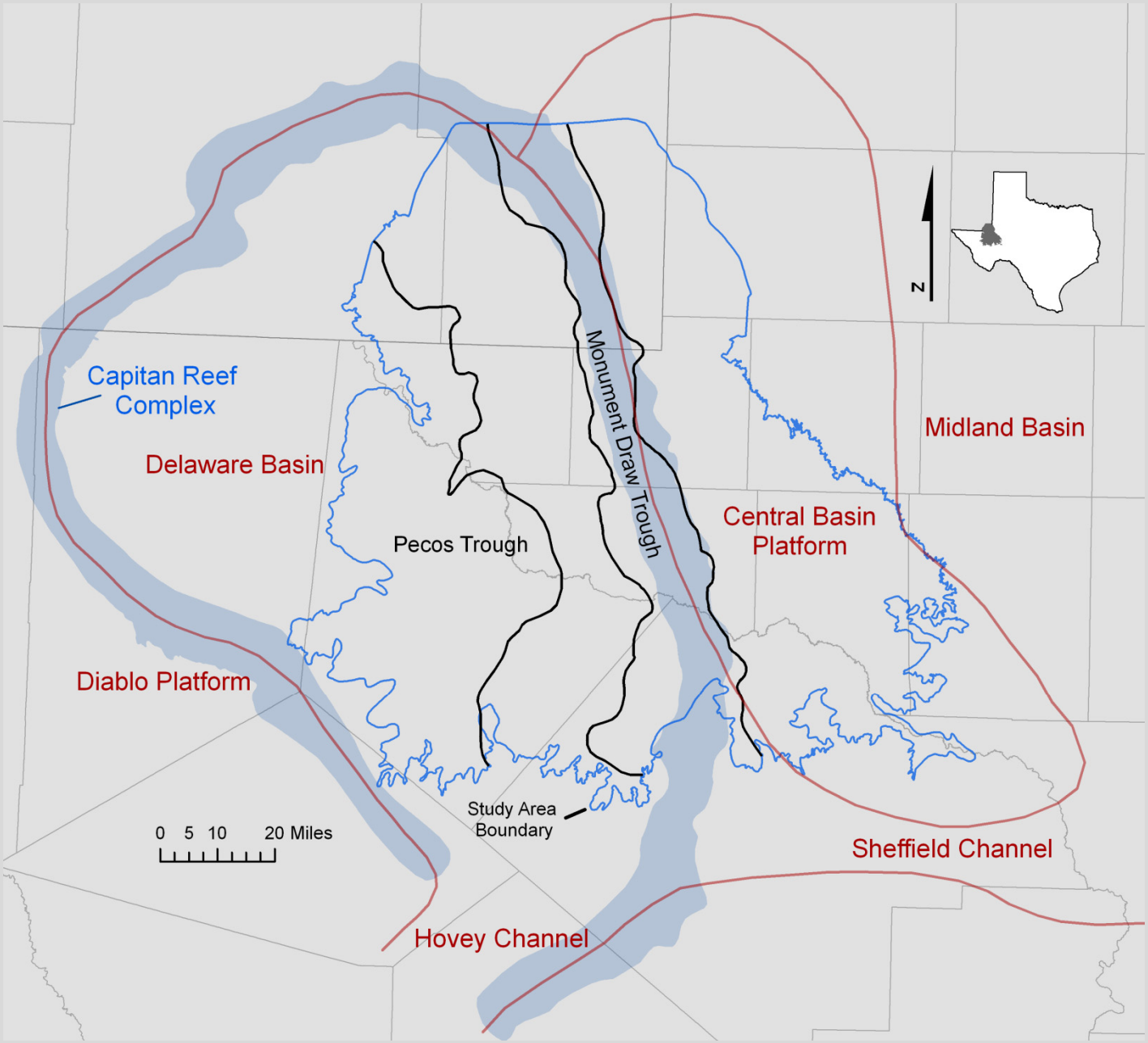
Minor Aquifers of Texas

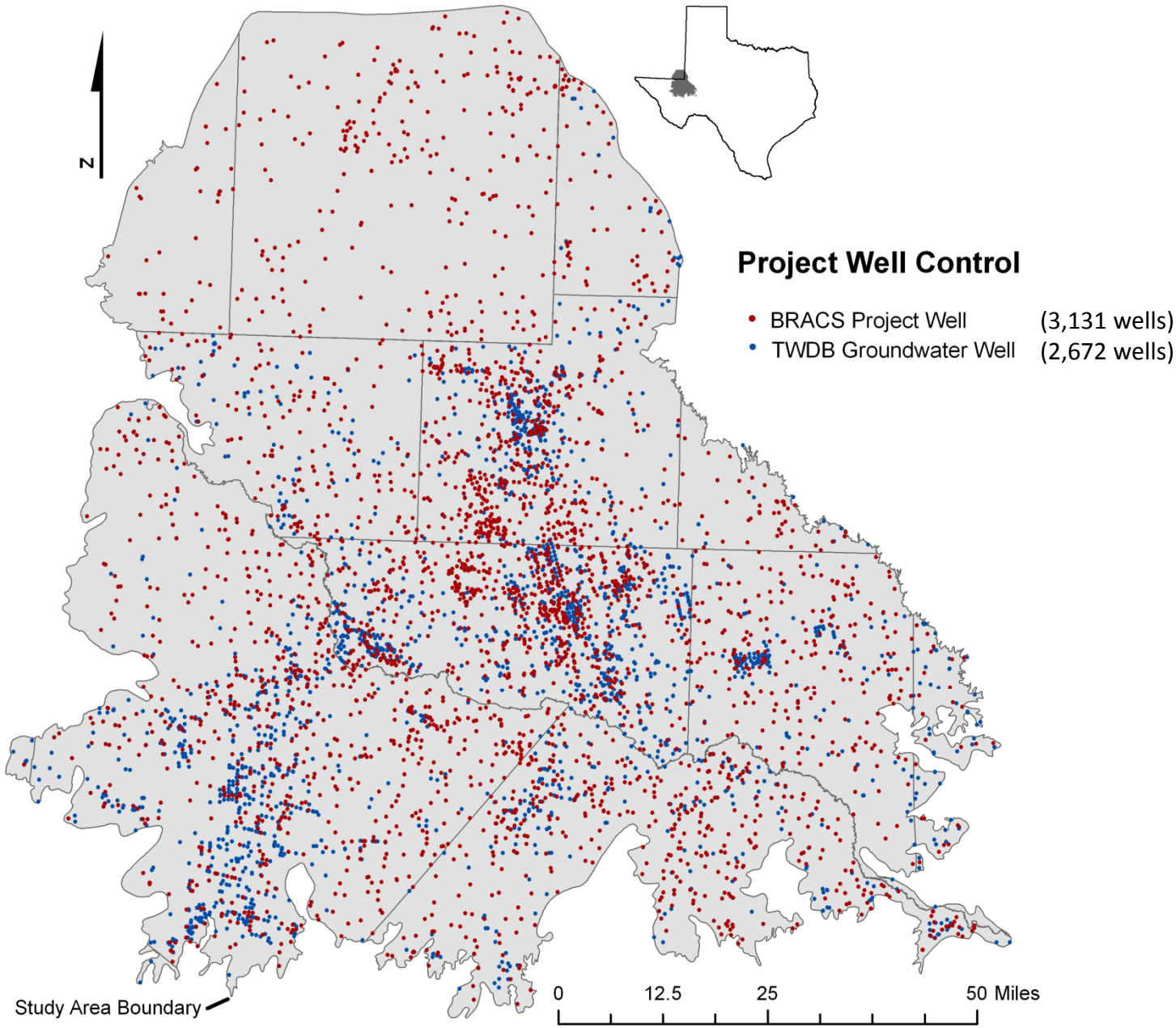


Major Aquifers of Texas

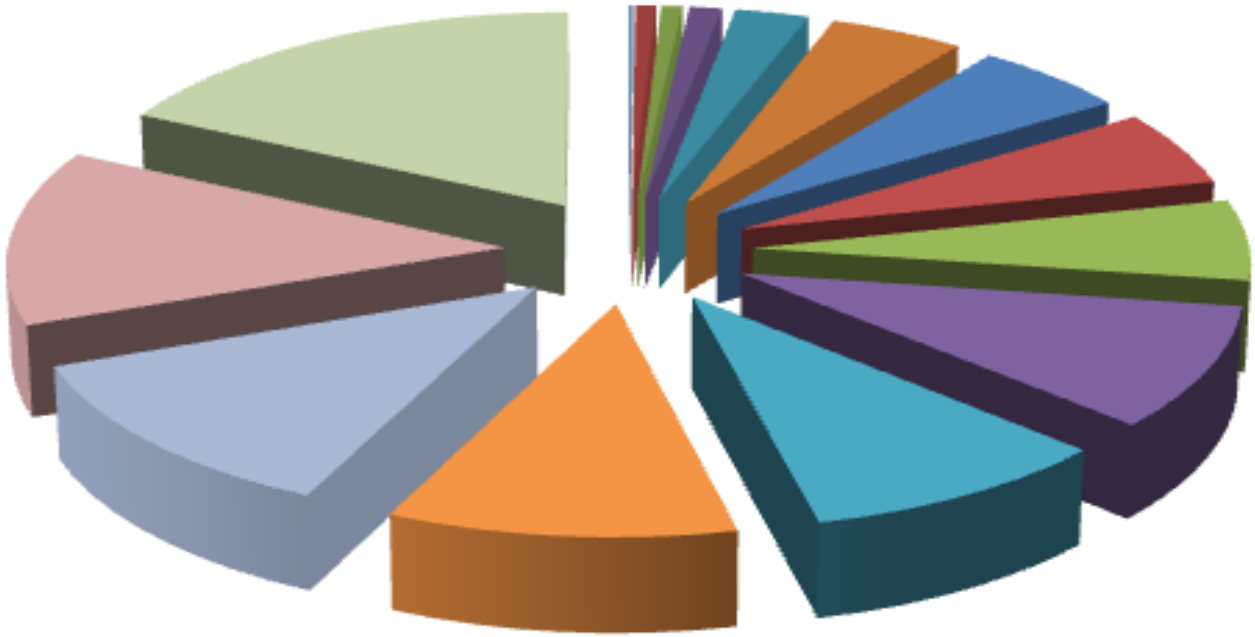


Pecos Valley Aquifer Pilot Study Area and Permian Structural Elements




N
Project Well Control
BRACS Project Well (3,131 wells)
TWDB Groundwater Well (2,672 wells)
Study Area Boundary
0
12.5
25
50 Miles

Sources of Data for the Pecos Valley Study



- NM OSE Aquifer Test Information
- NM OSE Digital Water Well Reports
- TCEQ PWS Water Wells
- TWDB Geophysical Logs
- NM OSE Paper Water Well Reports
- DBSA Capitan Reef Study
- NM EMNRD Geophysical Logs
- ULUTS Digital Geophysical Logs
- TCEQ SC Q Paper/Digital Geophysical Logs
- RRC Digital Geophysical Logs
- TWDB Groundwater Database
- TCEQ Water Well Images
- TDLR Digital Water Well Reports
- BEG Paper/Digital Geophysical Logs
- TWDB Published Reports

3,131 wells in project

85% new data to TWDB

Relational Database Primary Tables

TWDB Groundwater Database

Well Data
Remarks
Water Levels
Water Chemistry (2 tables)
Casing

TWDB BRACS Database

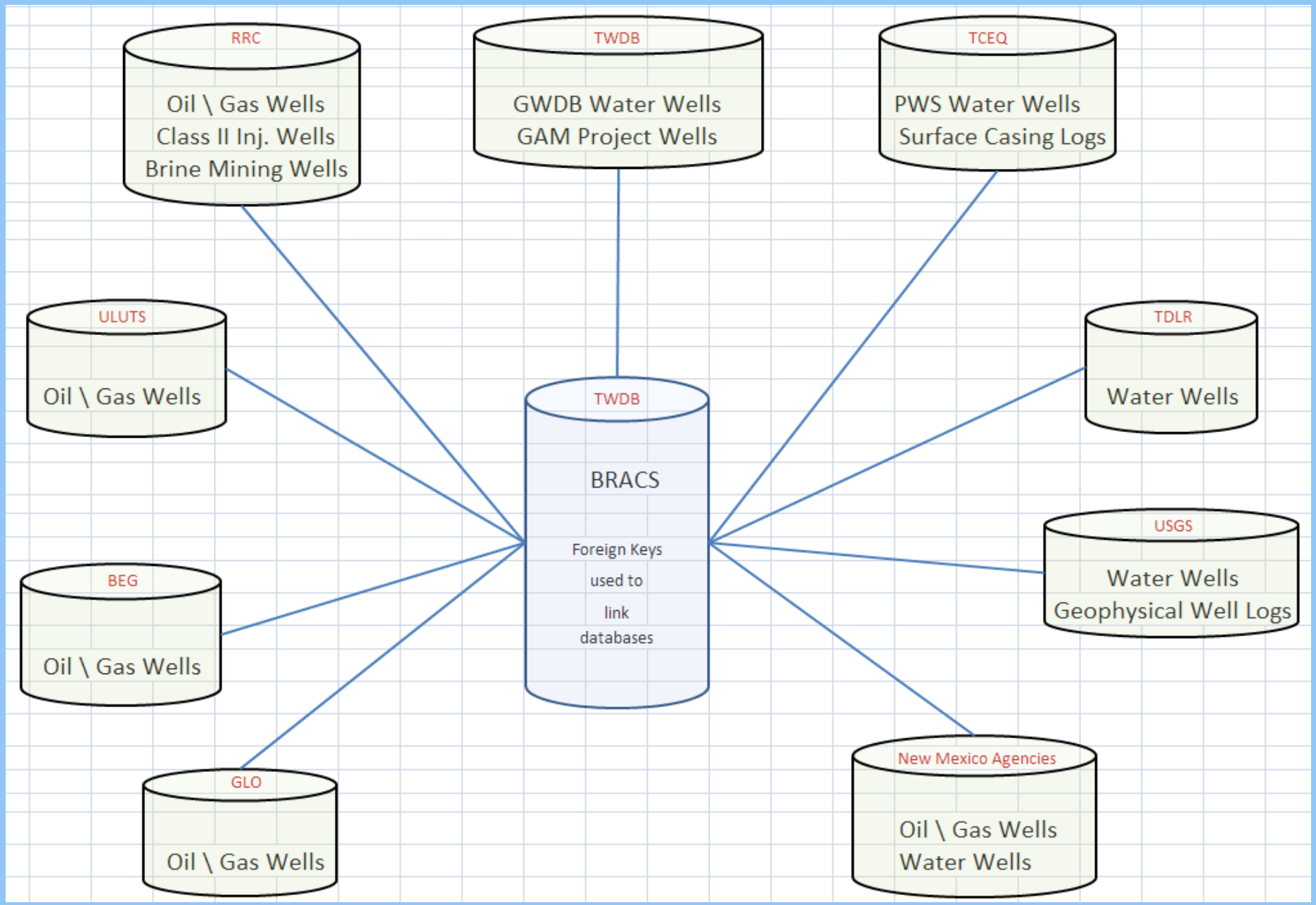
Well Data

Water Levels
Water Chemistry (2 tables)
Casing

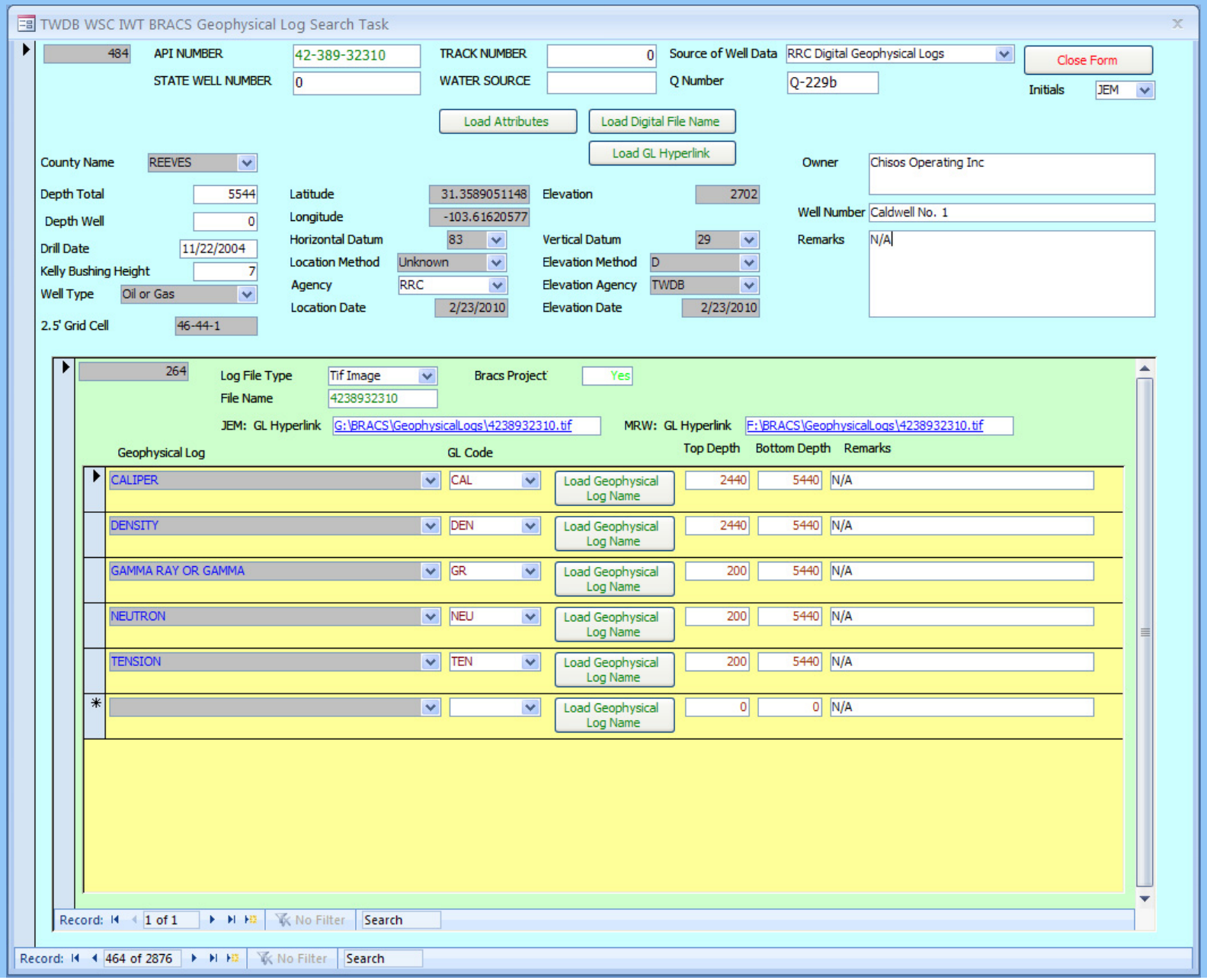
New Tables

Foreign Keys (well ids)
Well Geology (lithology\stratigraphy)
Net Sand and Sand Percent
Interpreted TDS from Geophysical W.L.
Aquifer Determination Analysis
Digital Water Well Reports
Digital Geophysical Well Logs
Geophysical Well Log Suites
Aquifer Test Information

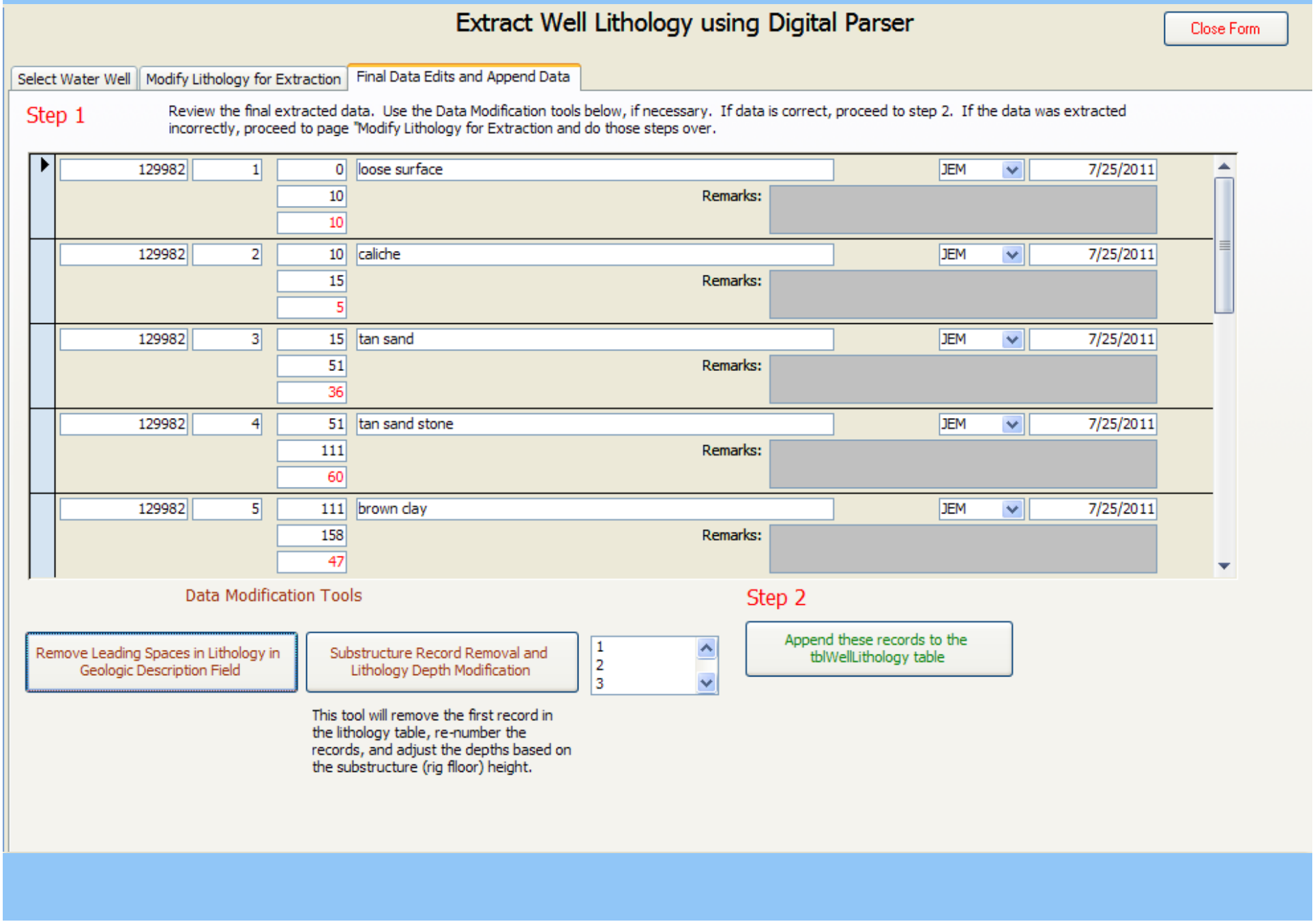
BRACS Supporting Databases



Well Attributes: location, source, log types, …



Digital Lithology from TDLR Submitted Driller Reports



Geology Table

frmWell_Lithology_DE

2509 | API Number 4249532576 | State Well Number 0 | Owner ENERGEN RESOURCES CORPORATION | Drill Date 10/20/1996
Track Number 0 | Water Source | Well Number UNIVERSITY 47-21 3 | Depth Total 7300
Q Number | Source of Well Data ULUTS Digital Geophysical Logs

Lithologic Description

Record Number	Geologic Pick	Top Depth / Bottom Depth / Thickness	Lithologic Description	Source of Data	Initials	Last Change
5	Lithologic	0				
		80	No Record			
		80	GEOPHYSICAL WELL LOG	JEM		3/7/2011
6	Lithologic	80				
		170	Sand			
		90	GEOPHYSICAL WELL LOG	JEM		3/7/2011
7	Lithologic	170				
		297	Clay			
		127	GEOPHYSICAL WELL LOG	JEM		3/7/2011
8	Lithologic	297				
		532	Sand			
		235	GEOPHYSICAL WELL LOG	JEM		3/7/2011
9	Lithologic	532				
		752	Sand and Clay			
		220	GEOPHYSICAL WELL LOG	JEM		3/7/2011
10	Lithologic	752				
		810	SAND			
		58	GEOPHYSICAL WELL LOG	JEM		3/7/2011
11	Lithologic	810				

Add First Record | Add Next Record | Complete Last Record

NMOSE POD HYP

Stratigraphic Description

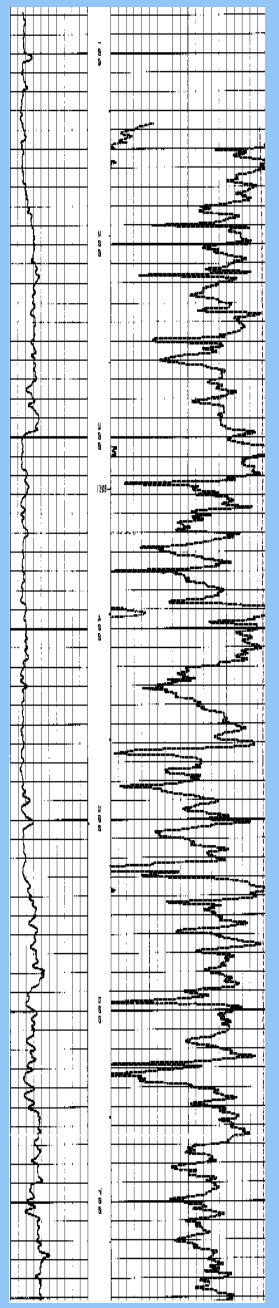
Record Number	Geologic Pick	Top Depth / Bottom Depth / Thickness	Stratigraphic Description	Source of Data	Initials	Last Change
1	Stratigraphic	0	Pecos Valley Alluvium			
Unit > Well Depth ?		1330		GEOPHYSICAL WELL LOG		
		1330		JEM		3/7/2011
2	Stratigraphic	1330	Dockum Group			
Unit > Well Depth ?				GEOPHYSICAL WELL LOG		
				JEM		3/7/2011
3	Stratigraphic		Dewey Lake Redbeds			
Unit > Well Depth ?		1792		GEOPHYSICAL WELL LOG		
				JEM		10/22/2010
4	Stratigraphic	1792	Rustler Formation			
Unit > Well Depth ?				GEOPHYSICAL WELL LOG		
				JEM		8/30/2010
*						
Unit > Well Depth ?						

Add First Record | Add Next Record | Complete Last Record | Add BLANK Record

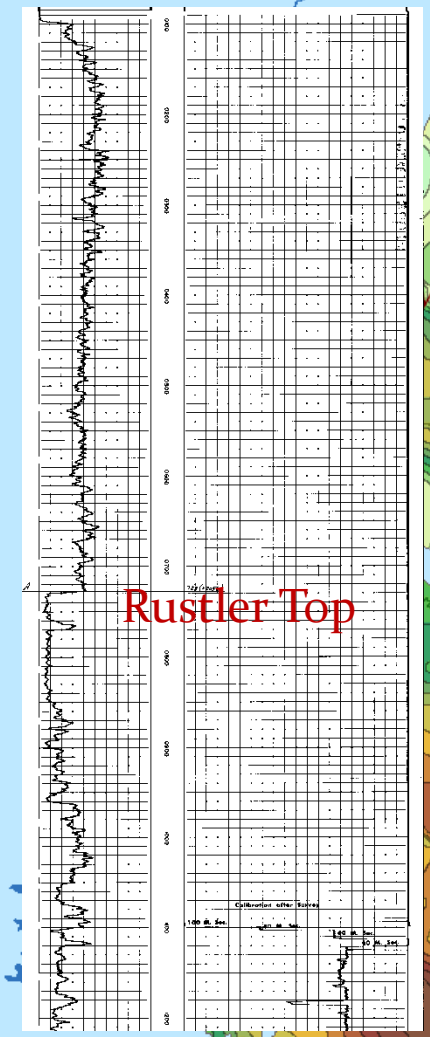
Geophysical Well Log Hyperlinks

JEM G:\BRACS\GeophysicalLogs\4249532576.tif
MRW F:\BRACS\GeophysicalLogs\4249532576.tif

Record: 1 of 1 | No Filter | Search



Depth to the Rustler Aquifer Top



Well Control: 1,479 wells

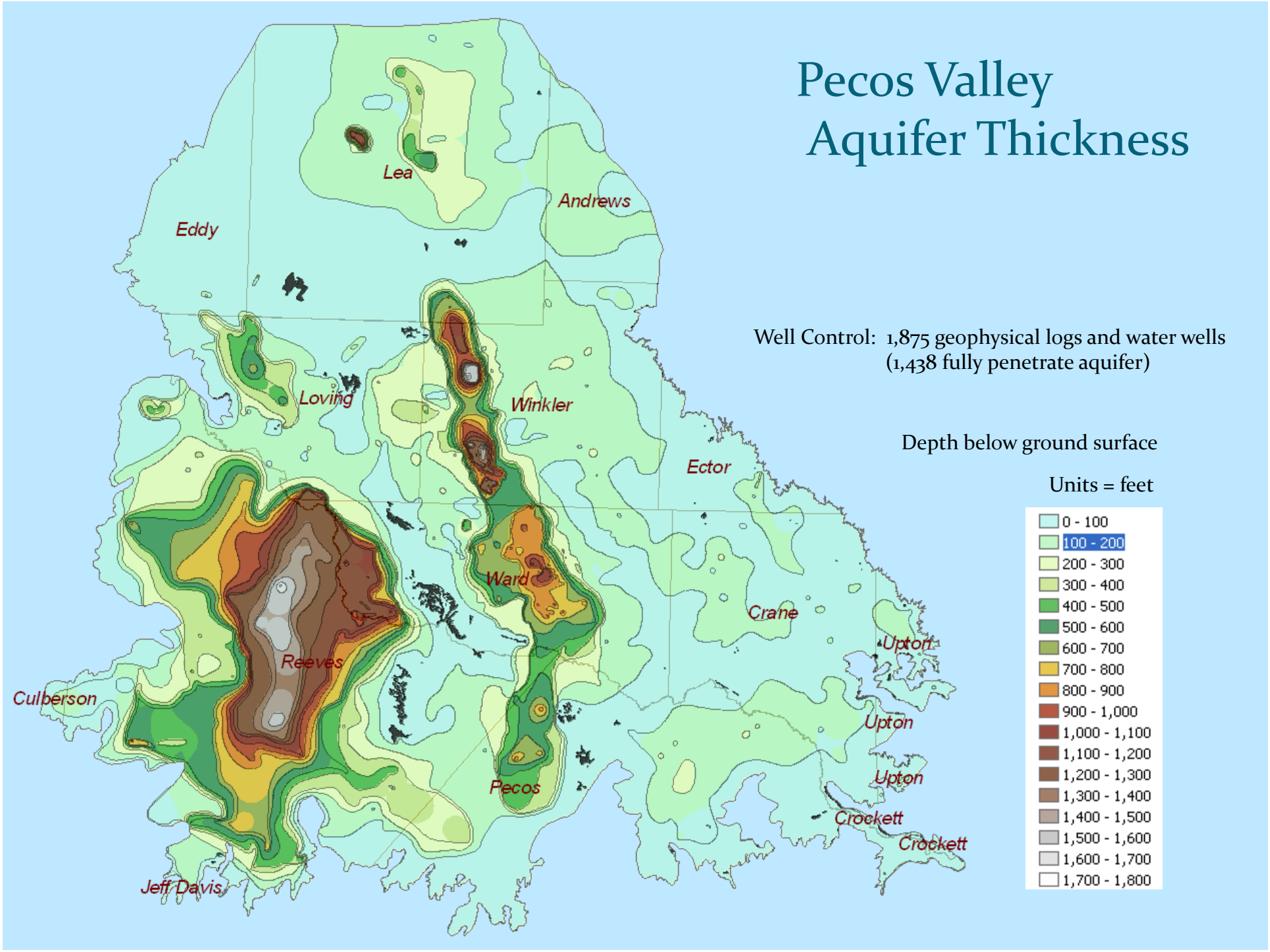
Depth below ground surface

Units = feet

- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1,000
- 1,000 - 1,100
- 1,100 - 1,200
- 1,200 - 1,300
- 1,300 - 1,400
- 1,400 - 1,500
- 1,500 - 1,600
- 1,600 - 1,700
- 1,700 - 1,800
- 1,800 - 1,900
- 1,900 - 2,000
- 2,000 - 2,100
- 2,100 - 2,200
- 2,200 - 2,300
- 2,300 - 2,400
- 2,400 - 2,500
- 2,500 - 2,600

Lea
Andrews
Loving
Winkler
Ector
Ward
Crane
Upton
Reeves
Upton
Pecos
Upton
Crockett
Crockett
Jeff Davis

Pecos Valley Aquifer Thickness



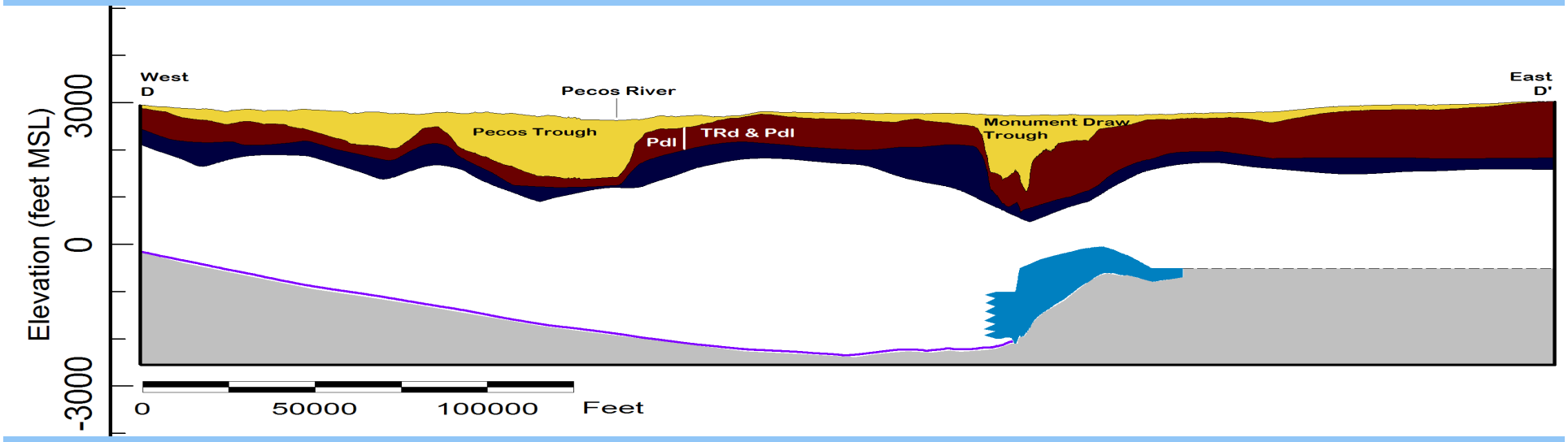
Well Control: 1,875 geophysical logs and water wells
(1,438 fully penetrate aquifer)

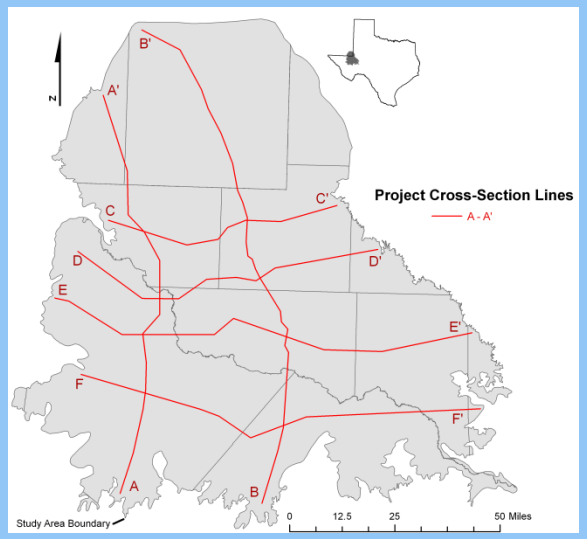
Depth below ground surface

Units = feet

- 0 - 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1,000
- 1,000 - 1,100
- 1,100 - 1,200
- 1,200 - 1,300
- 1,300 - 1,400
- 1,400 - 1,500
- 1,500 - 1,600
- 1,600 - 1,700
- 1,700 - 1,800

West to east cross-section D – D' across both troughs

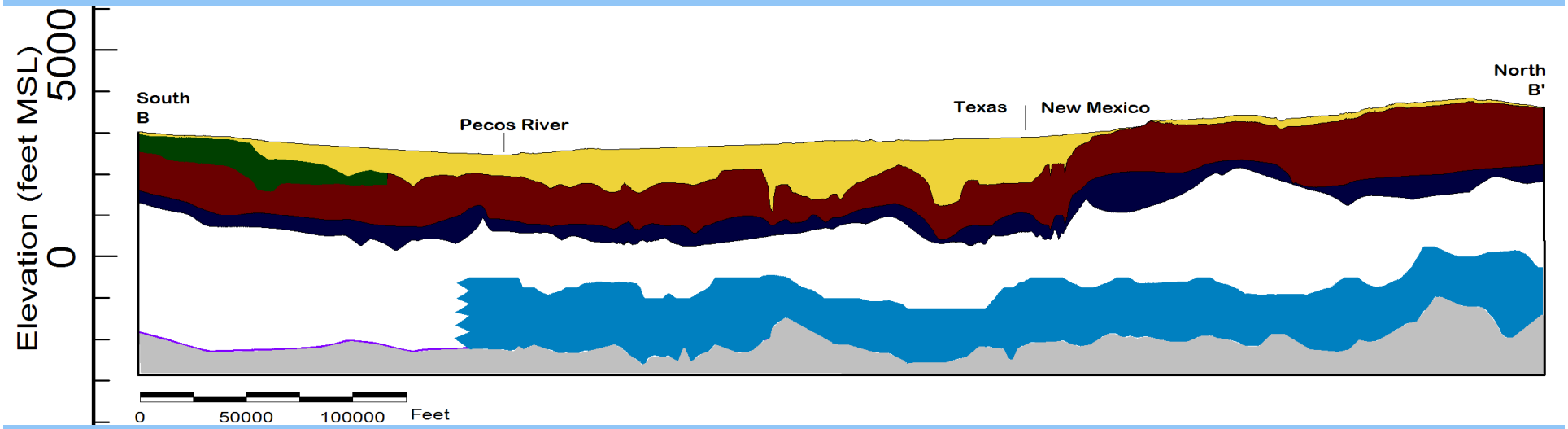


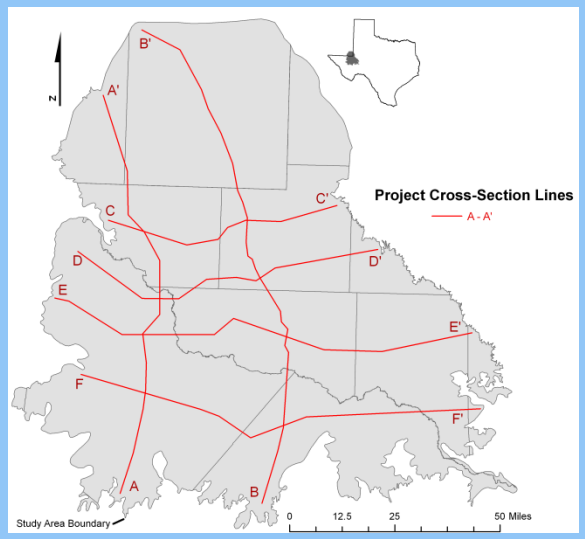


- Pecos Valley Alluvium
- Cretaceous Undivided
- Dockum Group (TRd) & Dewey Lake Formation (Pdl)
- Rustler Formation
- Salado and Castile Formations
- Capitan Reef Complex
- Pre-Castile beds west of Capitan Reef Complex & Pre-Salado beds east of Capitan Reef Complex

Vertical exaggeration = x20

South to north cross-section B – B’
Monument Draw Trough





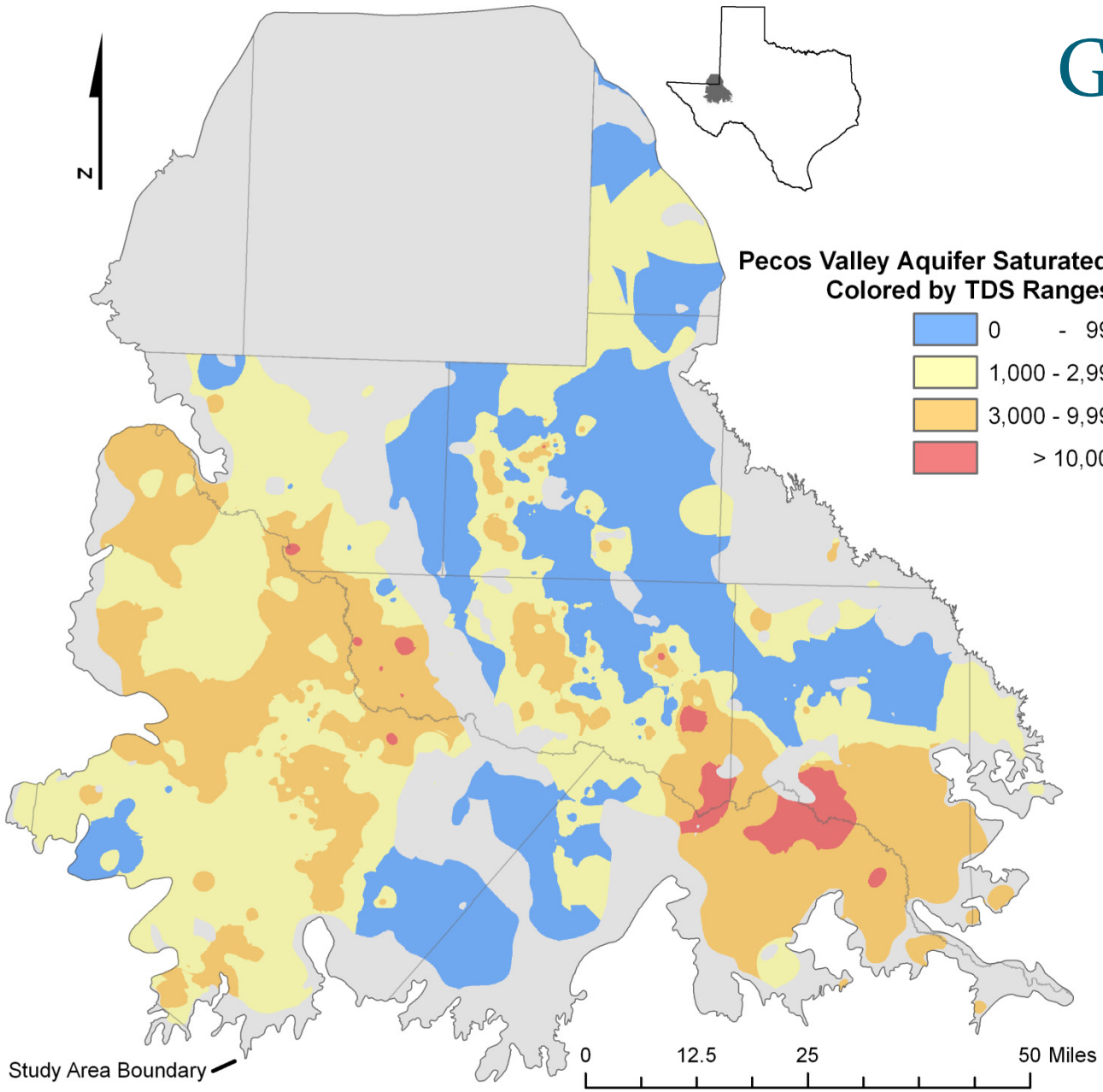
Pecos Valley Alluvium
Cretaceous Undivided
Dockum Group (TRd) & Dewey Lake Formation (Pdl)
Rustler Formation
Salado and Castile Formations
Capitan Reef Complex
Pre-Castile beds west of Capitan Reef Complex
& Pre-Salado beds east of Capitan Reef Complex

Vertical exaggeration = x20

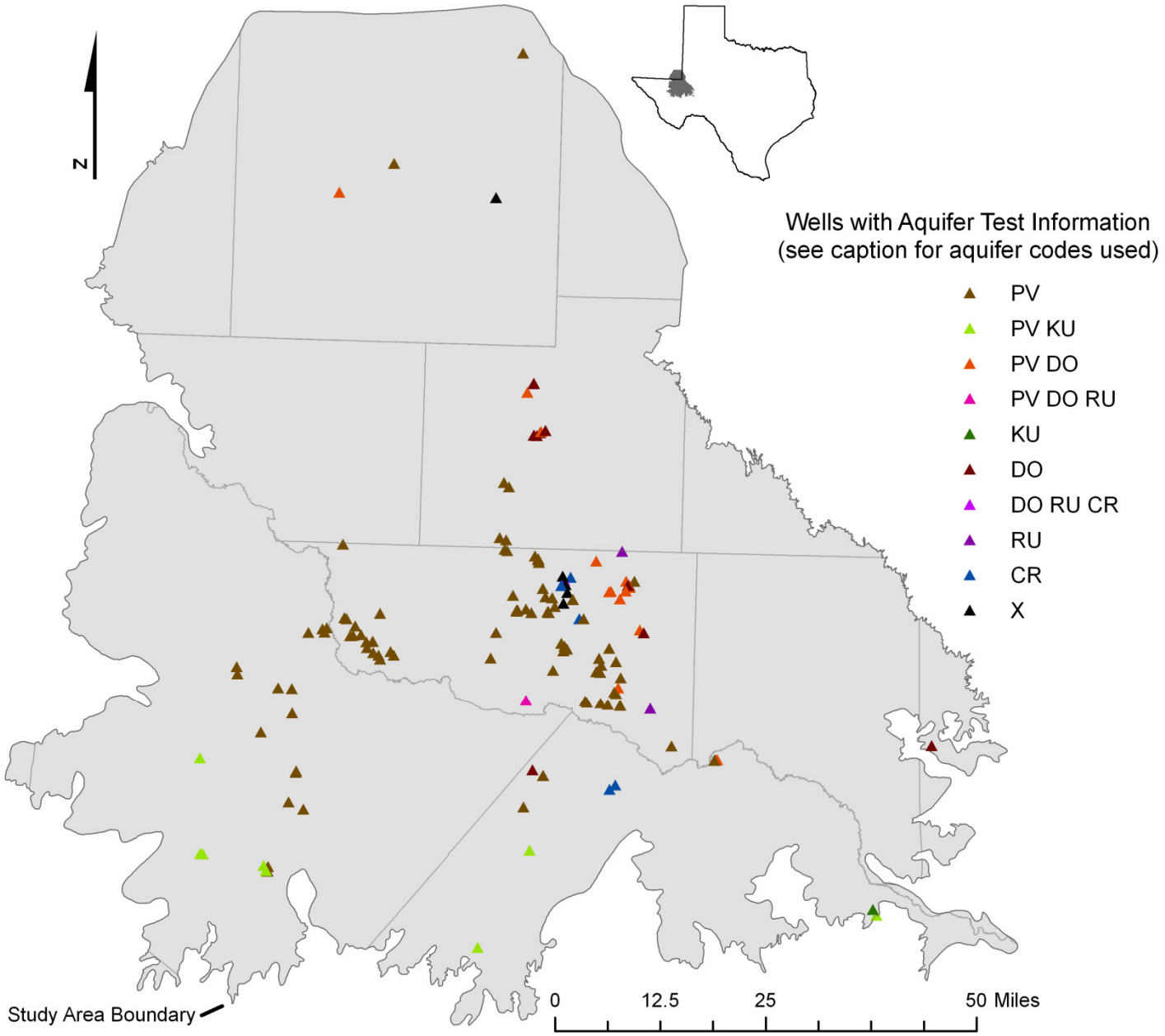
Aquifer Determination Process

- Formation top\bottom surfaces created in ArcGis
  - Pecos Valley Alluvium
  - Cretaceous Undivided
  - Dockum Group – Dewey Lake Formation
  - Rustler Formation (top)
- Project area sub-divided into 7 areas with different stratigraphic relationships
- Every well in project area assigned formation top\bottom surface depths
- Well screens (or well depth if no screen) compared with formation depths
- Aquifer(s) assigned to each water well
- Well information (chemistry, aquifer tests, water levels, net sand, production) can now be compared with other wells using same aquifer

Groundwater Volumes



14.7 million acre-feet
46.2 million acre-feet
38.9 million acre-feet
.9 million acre-feet

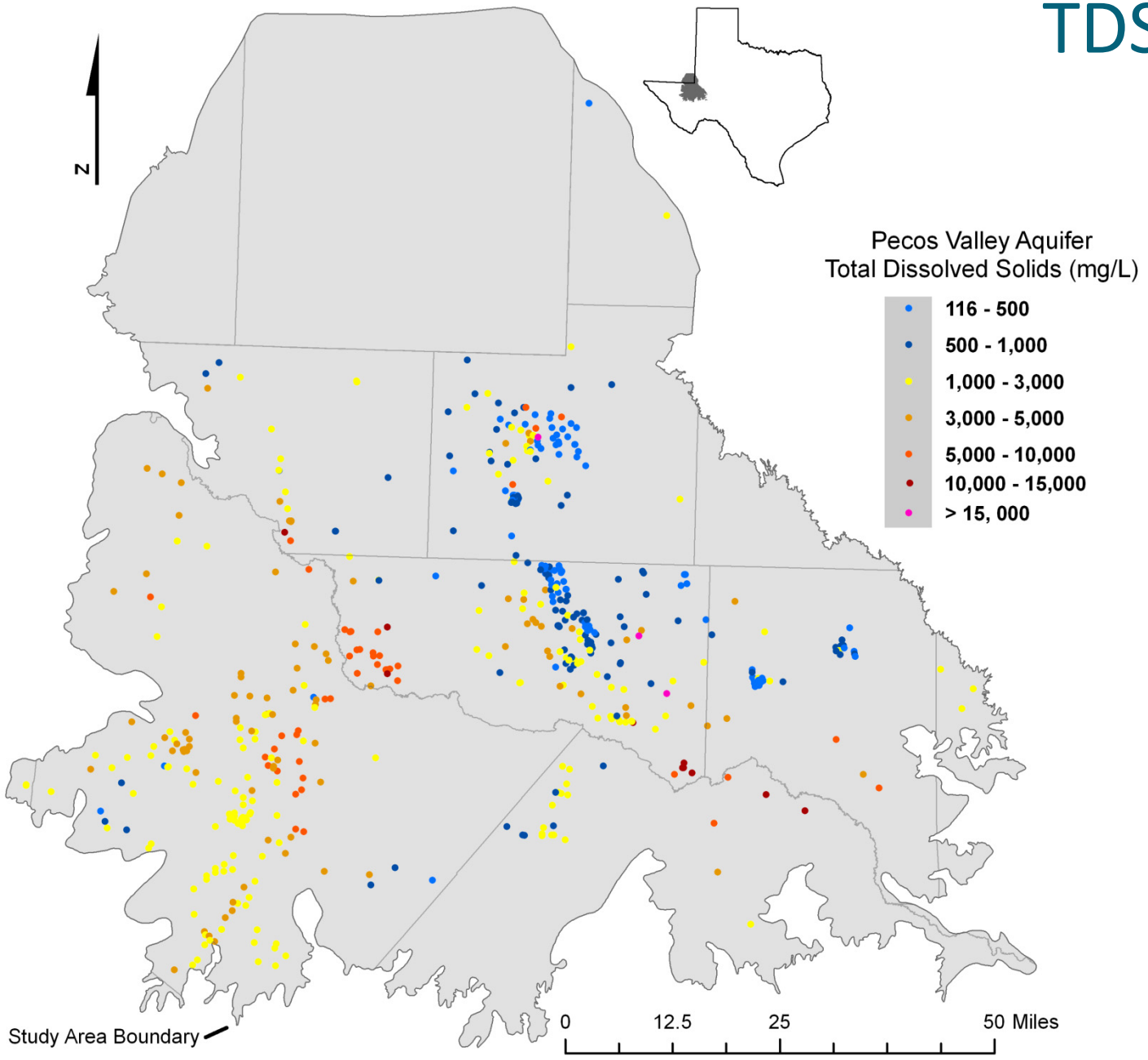


PV: Pecos Valley; KU: Cretaceous Undivided; DO: Dockum; RU: Rustler; CR: Capitan Reef Complex; X: not applicable

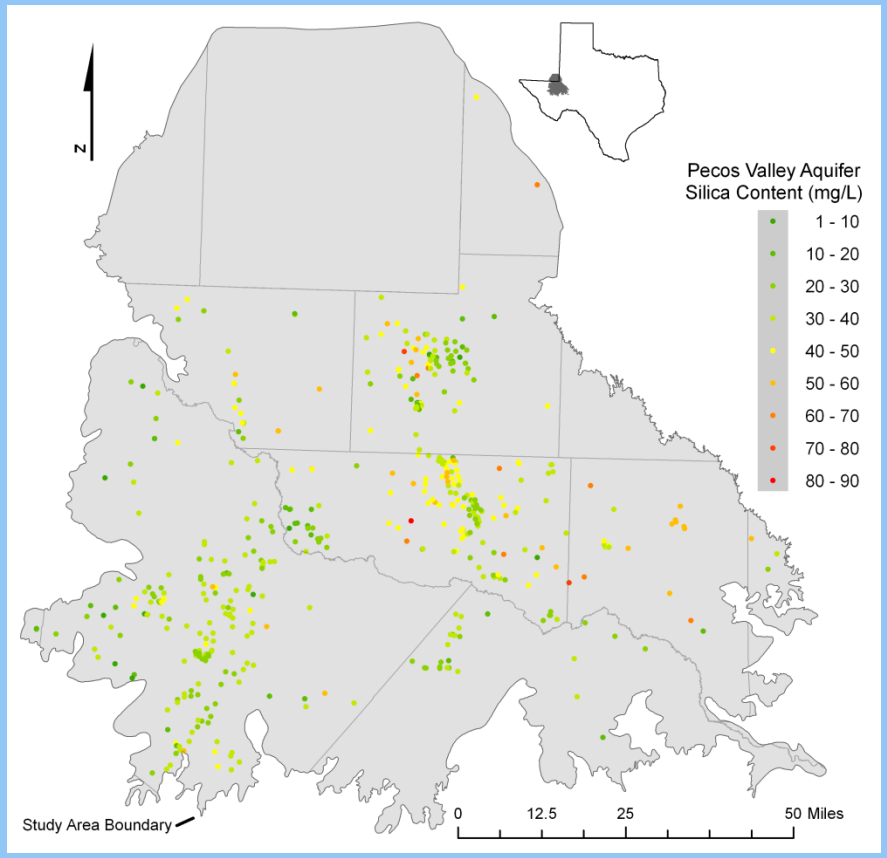
Desalination parameters of interest

Physical Parameters	Chemical Parameters		
	Cations (mg/L)	Anions (mg/L)	Other Chemical Parameters
Conductivity (mS/cm)	As^{3+}	Cl^-	Alkalinity (mg/L as $CaCO_3$)
pH	As^{5+}	F^-	Boron (mg/L)
Silt density index	Ba^{2+}	HCO_3^-	Dissolved oxygen concentration (mg/L)
Temperature (°C)	Ca^{2+}	NO_2^- -N	H_2S (mg/L)
Turbidity (NTU)	Cu^{2+}	NO_3^- -N	Hardness (mg/L as $CaCO_3$)
	Fe_3^+	SO_4^{2-}	Pesticides(mg/L)
	K^+		Radionuclides (pCi/L) Uranium (µg/L)
	Mg^{2+}		Silica (mg/L)
	Mn^{2+}		TDS (mg/L)
	Na^+		
	NH_4^+ -N		
	Ni^{2+}		
	Zn^{2+}		

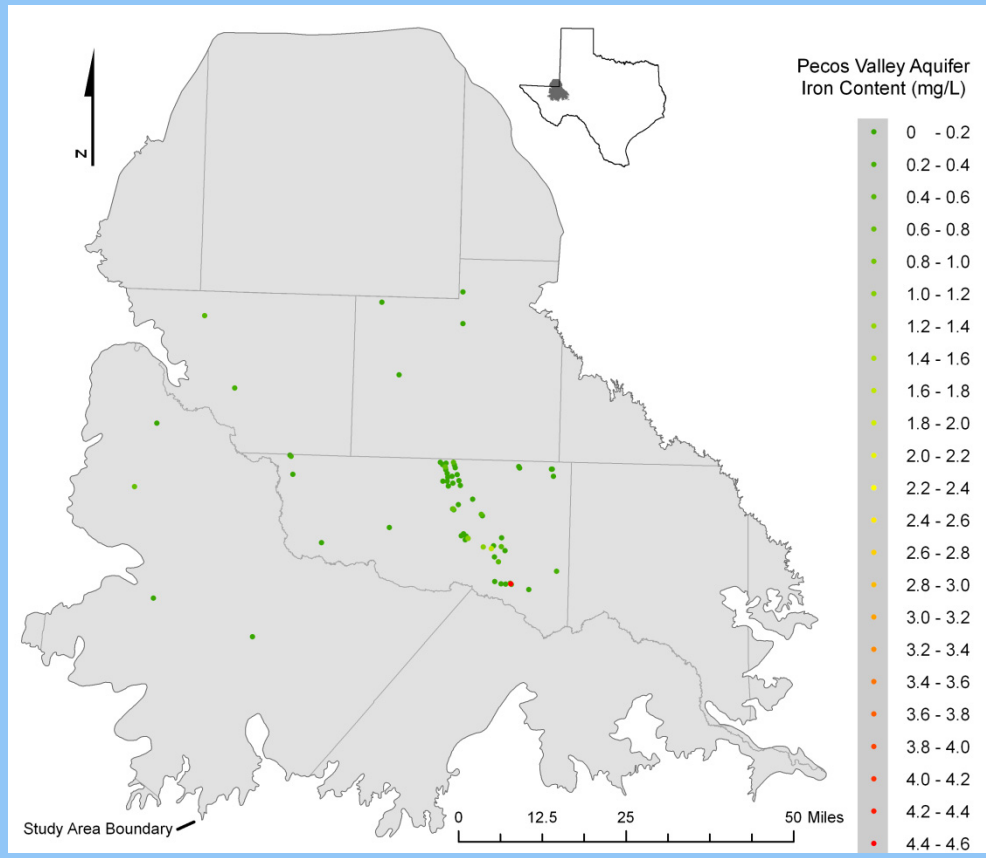
TDS


N
Pecos Valley Aquifer
Total Dissolved Solids (mg/L)
116 - 500
500 - 1,000
1,000 - 3,000
3,000 - 5,000
5,000 - 10,000
10,000 - 15,000
> 15, 000
Study Area Boundary
0
12.5
25
50 Miles

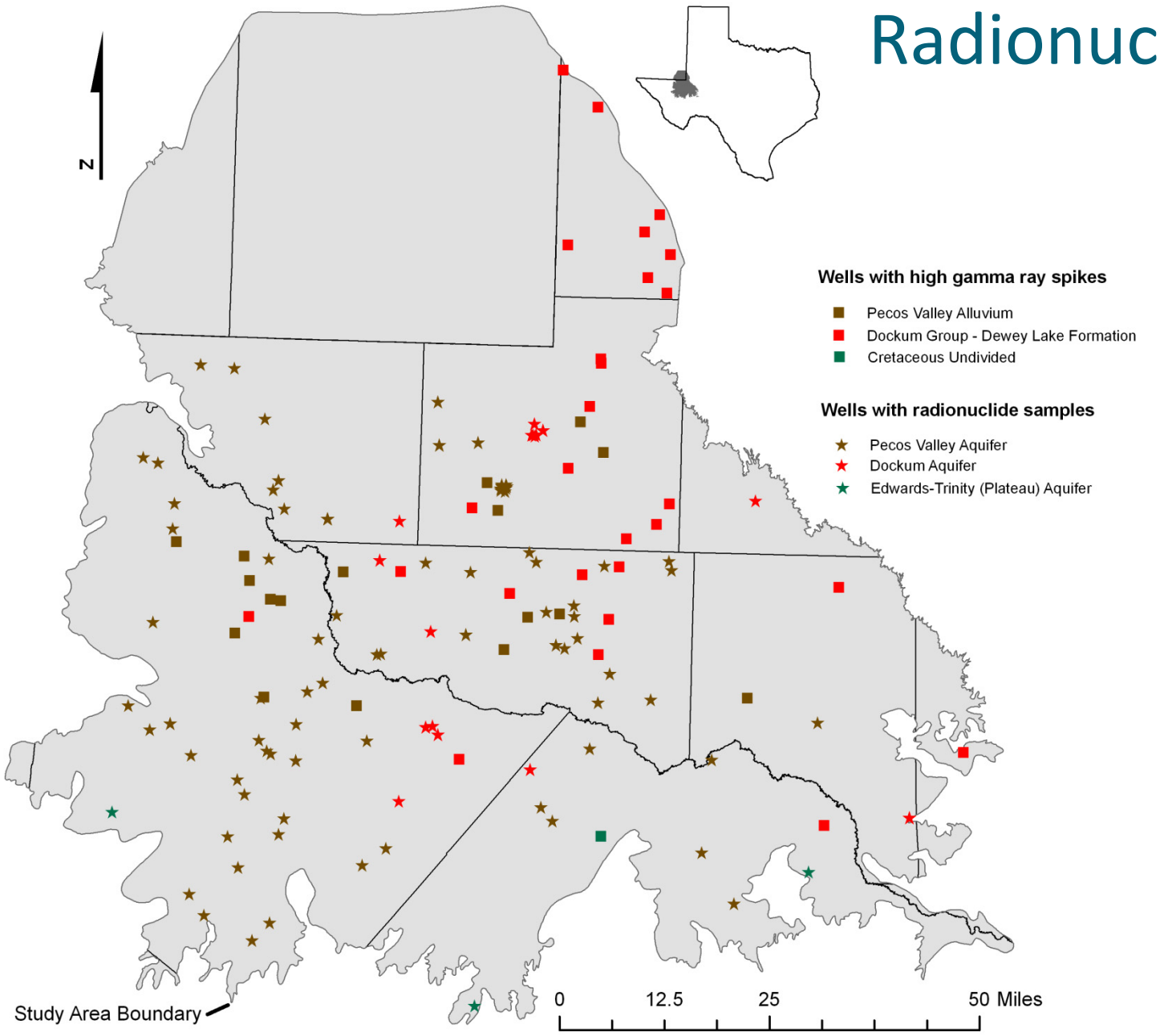
Silica


N
Pecos Valley Aquifer
Silica Content (mg/L)
1 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
Study Area Boundary
0
12.5
25
50 Miles

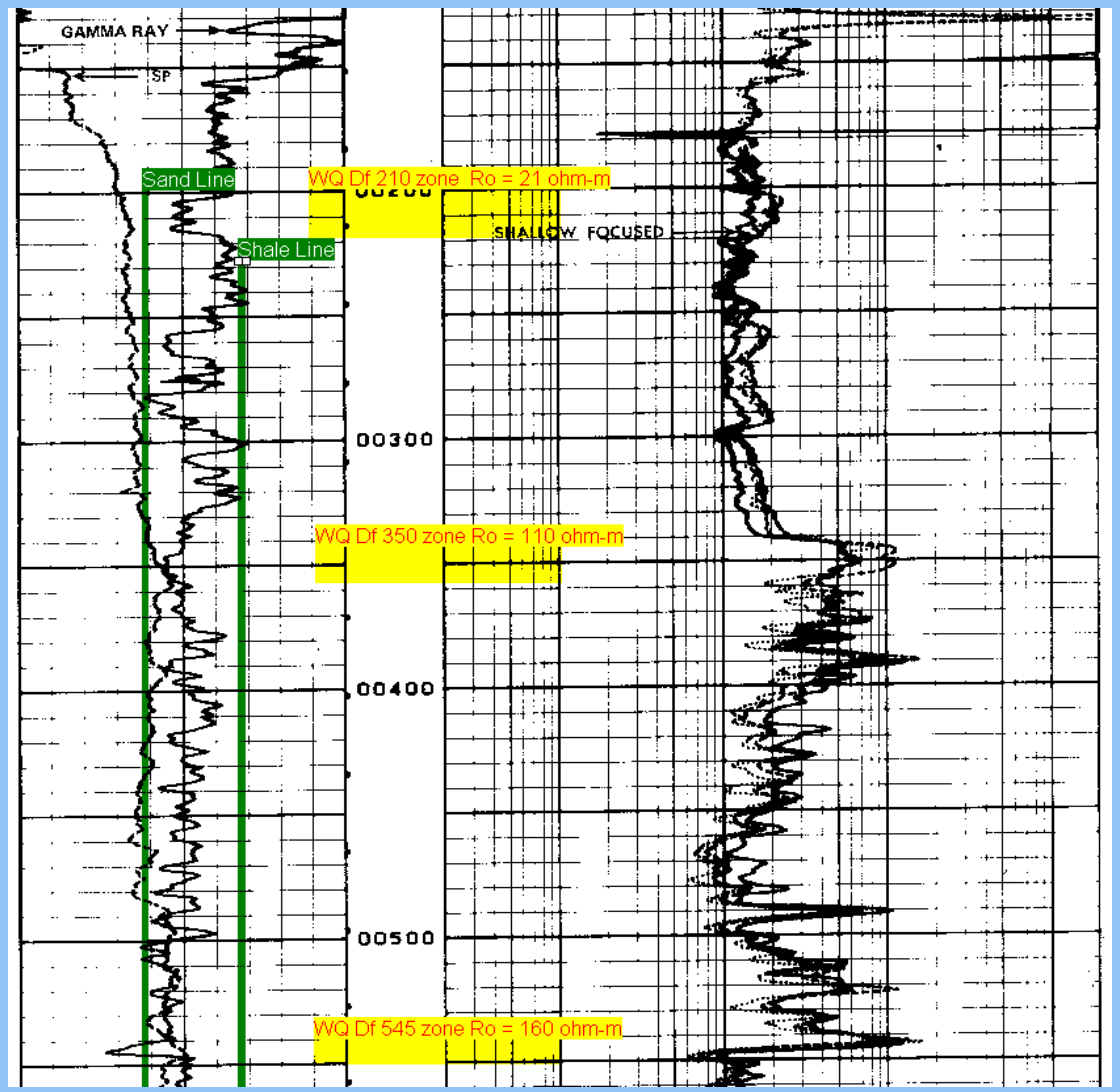
Iron


N
Pecos Valley Aquifer
Iron Content (mg/L)
0 - 0.2
0.2 - 0.4
0.4 - 0.6
0.6 - 0.8
0.8 - 1.0
1.0 - 1.2
1.2 - 1.4
1.4 - 1.6
1.6 - 1.8
1.8 - 2.0
2.0 - 2.2
2.2 - 2.4
2.4 - 2.6
2.6 - 2.8
2.8 - 3.0
3.0 - 3.2
3.2 - 3.4
3.4 - 3.6
3.6 - 3.8
3.8 - 4.0
4.0 - 4.2
4.2 - 4.4
4.4 - 4.6
Study Area Boundary
0
12.5
25
50 Miles

Radionuclides



Determining resistivity values for calculating TDS



Can use:

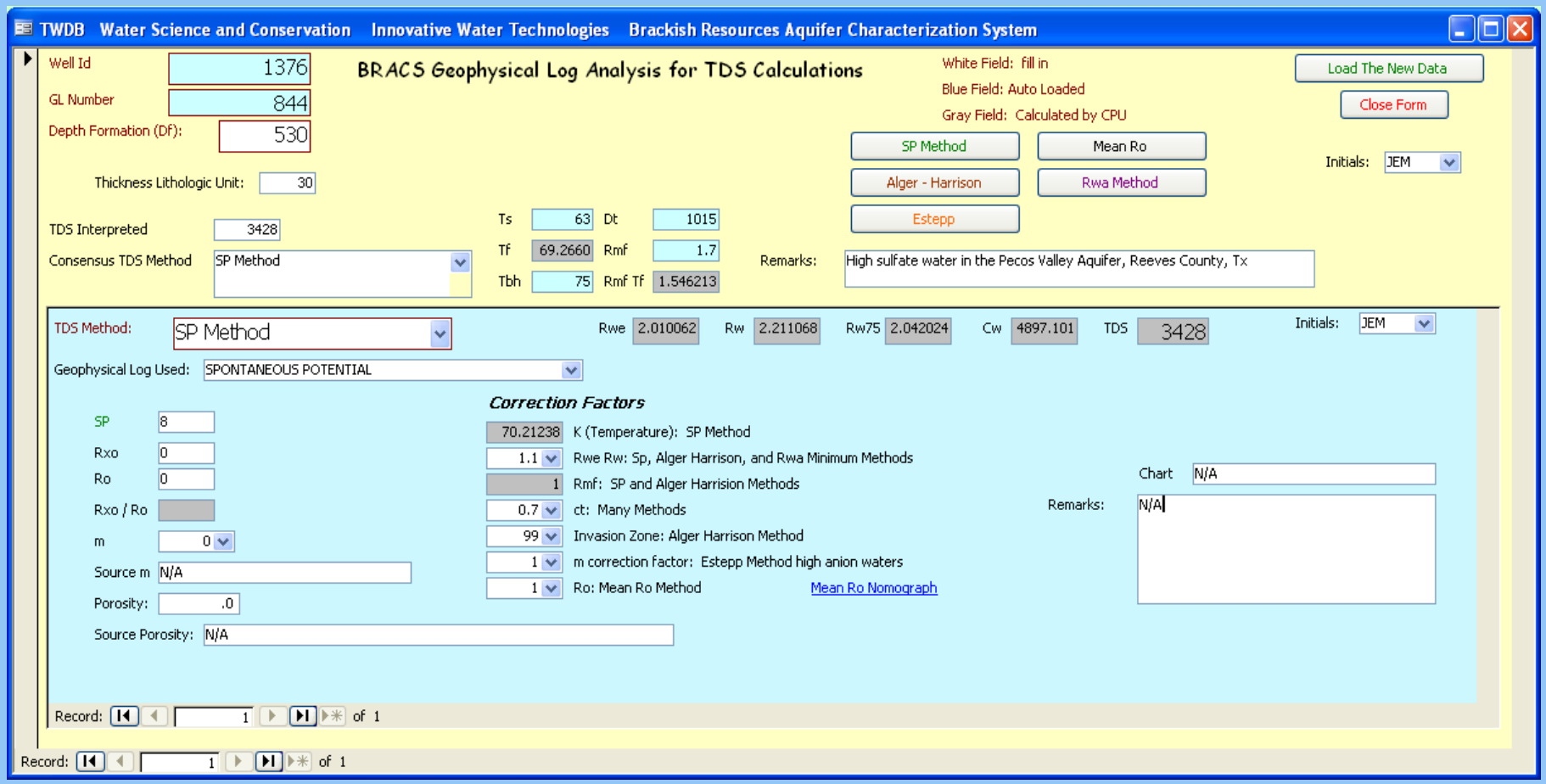
SP Log
(Spontaneous Potential)

Resistivity Tools
- Induction
- Laterolog
- Resistivity
- Electric
- Lateral

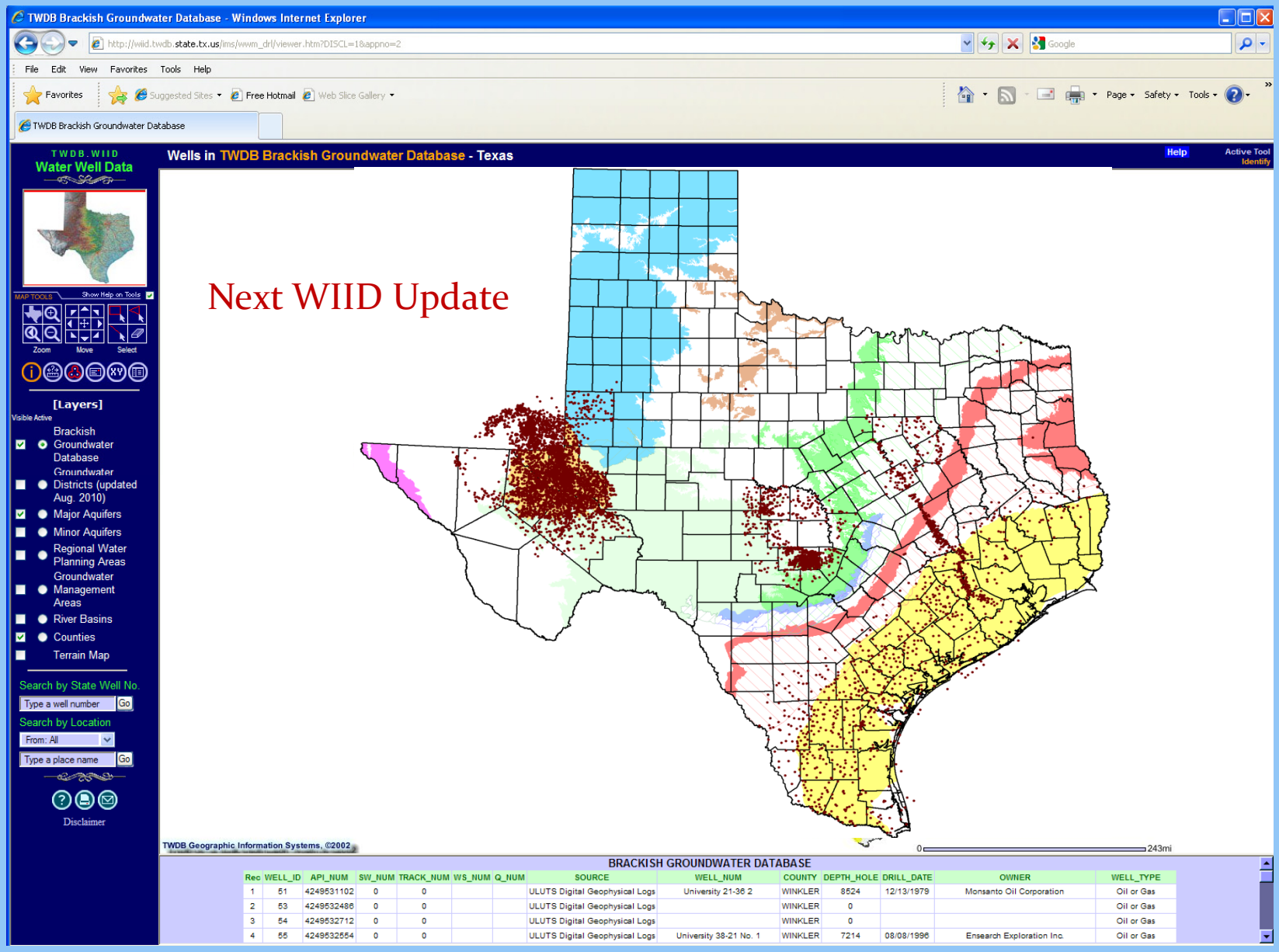
Calculation of TDS from geophysical well logs

Staff load method-specific log values and correction factors

and the analysis is performed by the software



Brackish Groundwater Database well locations in WIID



WIID: Water Information Integration & Dissemination

Summary

- The 2003 Brackish Groundwater Manual indicated the estimated total volume of brackish groundwater in: Texas : > 2.7 billion acre-feet.
- Pecos Valley Aquifer: > 85 million acre-feet.
- 44 water treatment plants in Texas use Reverse Osmosis to treat brackish water.
- The Texas Innovative Water 2010 Seminar held in San Antonio in October, 2010, showed a tremendous interest in brackish groundwater resources.
- The TWDB, through the BRACS project and external contracts, is well-poised to provide the information Texas needs to continue development of this resource.
- Each aquifer is different and techniques of analysis will need to fit data available.
- August 31, 2011 is the deadline for the Pecos Valley aquifer pilot study.
- August 31, 2011 is the deadline for the three contracts: Geophysical well logs, Geological Bibliography, and Groundwater Modeling and Variable Density applicability.

Texas Water Development Board

Sustainable, affordable, quality water for Texans, our economy, and our environment.

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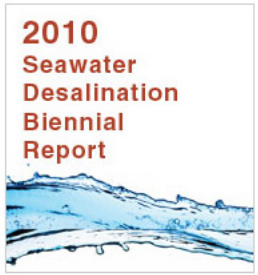

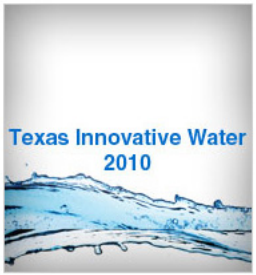

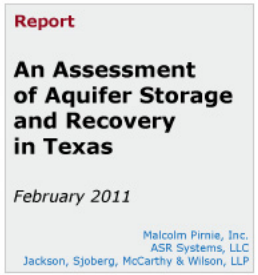

Innovative Water Technologies

- 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?

TWDB: (512) 463-7847

http://www.twdb.state.tx.us

Contact: john.meyer@twdb.state.tx.us