



Brackish Groundwater Characterization
Southern Midland Basin Proposal
West Texas

by
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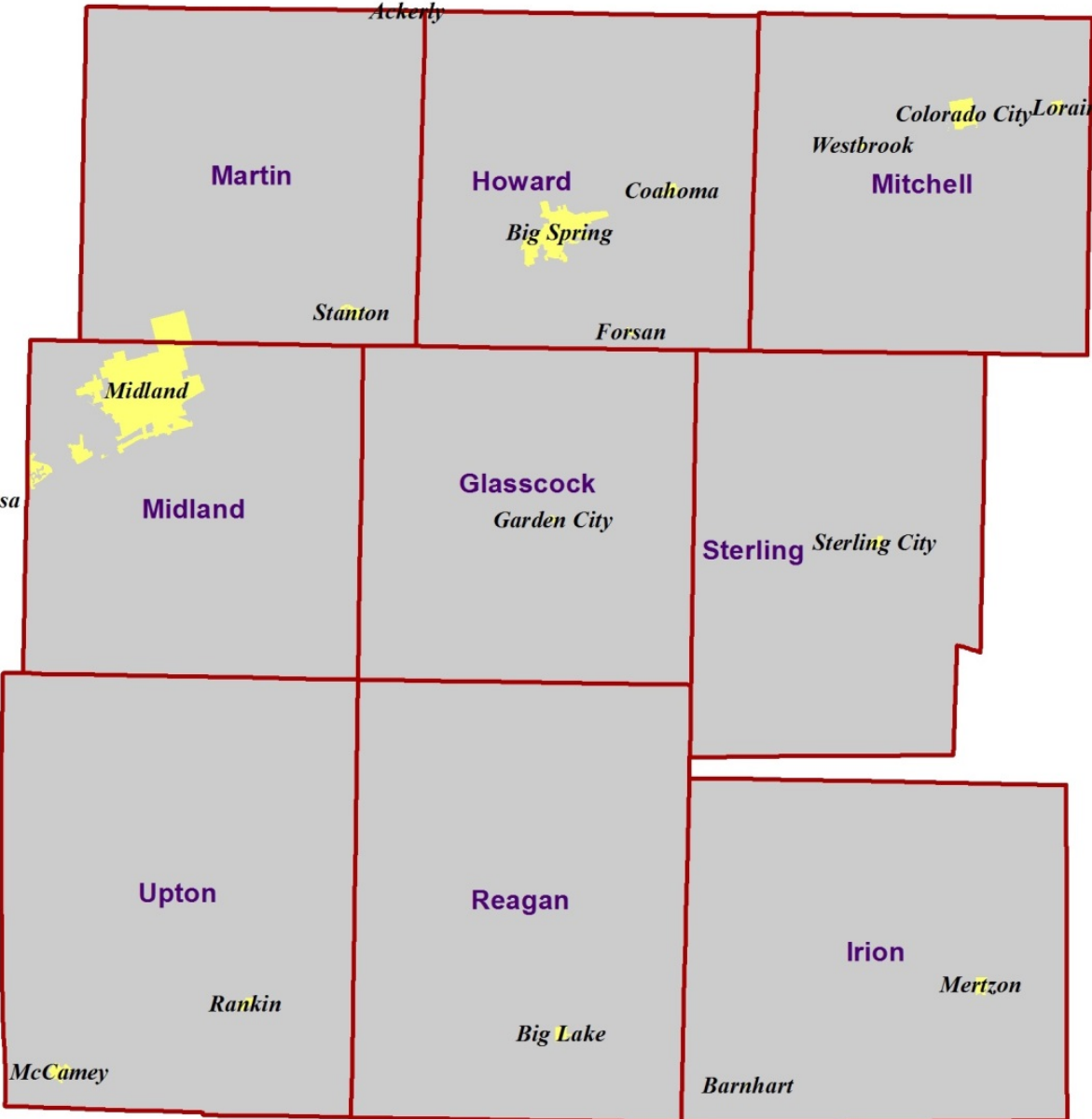
September 11, 2013

Project Objective

Estimate the volume of saline groundwater resources in a nine-county area in the southern Midland Basin using TWDB's BRACS program methodology.



Project Area



Project Description

- Project counties: Martin, Howard, Mitchell, Midland, Glasscock, Sterling, Upton, Reagan, Irion.
- Project major/minor aquifers that will be evaluated: Ogallala, Dockum, Edwards-Trinity (Plateau).
- Delineate major/minor aquifers containing saline groundwater (1,000 – 50,000 milligrams per liter of total dissolved solids).
- Chemical samples from produced water will be used to evaluate the geologic formations underlying the major/minor aquifers. A rigorous BRACS evaluation will *not* be undertaken for these formations.
- Estimate volume of saline groundwater in the major/minor aquifers.

Project Description (continued)

- Characterize groundwater quality in the major/minor aquifers including total dissolved solids, chloride, iron, silica, arsenic, sulfate, and radionuclides.
- Ogallala and Edwards-Trinity characterization will be based on existing data.
- Dockum characterization will be based on geophysical well log interpretation.
- Supplement major/minor aquifer stratigraphic control from an ongoing TWDB-funded Ogallala-Dockum Structure Project with data from the proposed project.
- Project timeline: 1 year; estimated start date January 1, 2014. Additional counties added to this proposal would add approximately 2 months/county.
- Project staff: 2 senior geologists and 2 natural resource specialists (data collection)

Project Description (continued)

- Well control consisting of water well reports and digital geophysical well logs will have a goal of 1 well per 2.5 minute grid cell
- grid cell = standard State Well Number grid system; 1 grid cell equals about 7 square miles.
- Some grid cells have no well control, and some well control will not meet project requirements.
- The well control density for each use (for example: water quality; stratigraphy; interpreted total dissolved solids calculations) will depend on the data and geologic consideration.
- We will request existing Dockum well data from project participants.
- We would like to sample water quality from Dockum wells in the project area.

Project Deliverables

- BRACS Database: all project wells and attributes. Microsoft® Access® relational database format.
- BRACS Database Data Dictionary
- Project GIS files. ArcGIS® shape files and raster grids with metadata
- Project Geophysical Well Logs in TIFF format
- Project Report, peer-reviewed and published by TWDB.

All information will be non-confidential and available to the public on the TWDB website.

Project Budget

Category	Cost (\$)
2 Natural Resource Specialist for 12 months (wages/fringe/indirect)	118,324.80
Travel	5,175
Software (GIS and geochemical)	41,000
Computer	3,000
Digital geophysical well logs (contract to scan 1,000 logs)	10,000
Water quality samples (50 samples)	25,000
Total	\$202,500

Note: Adding counties to this proposed project will increase the timeline approximately 2 months per county and will require evaluation of additional geophysical well logs (100/county) and water quality samples (5/county plus travel) for a total of approximately \$4,125/county).

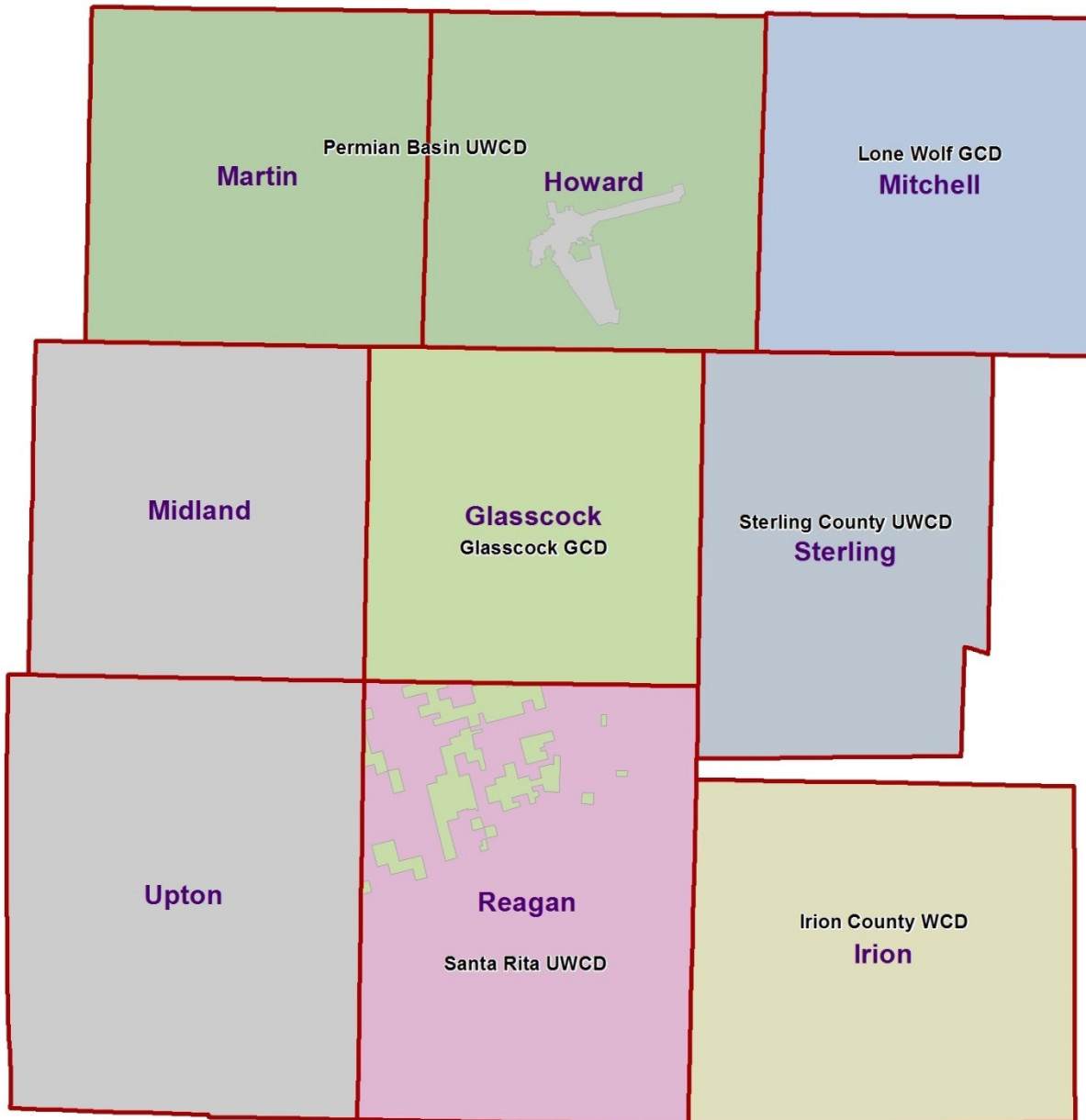
Project Data Requirements

Data will be solicited from state and federal agencies and groundwater conservation districts in the area.

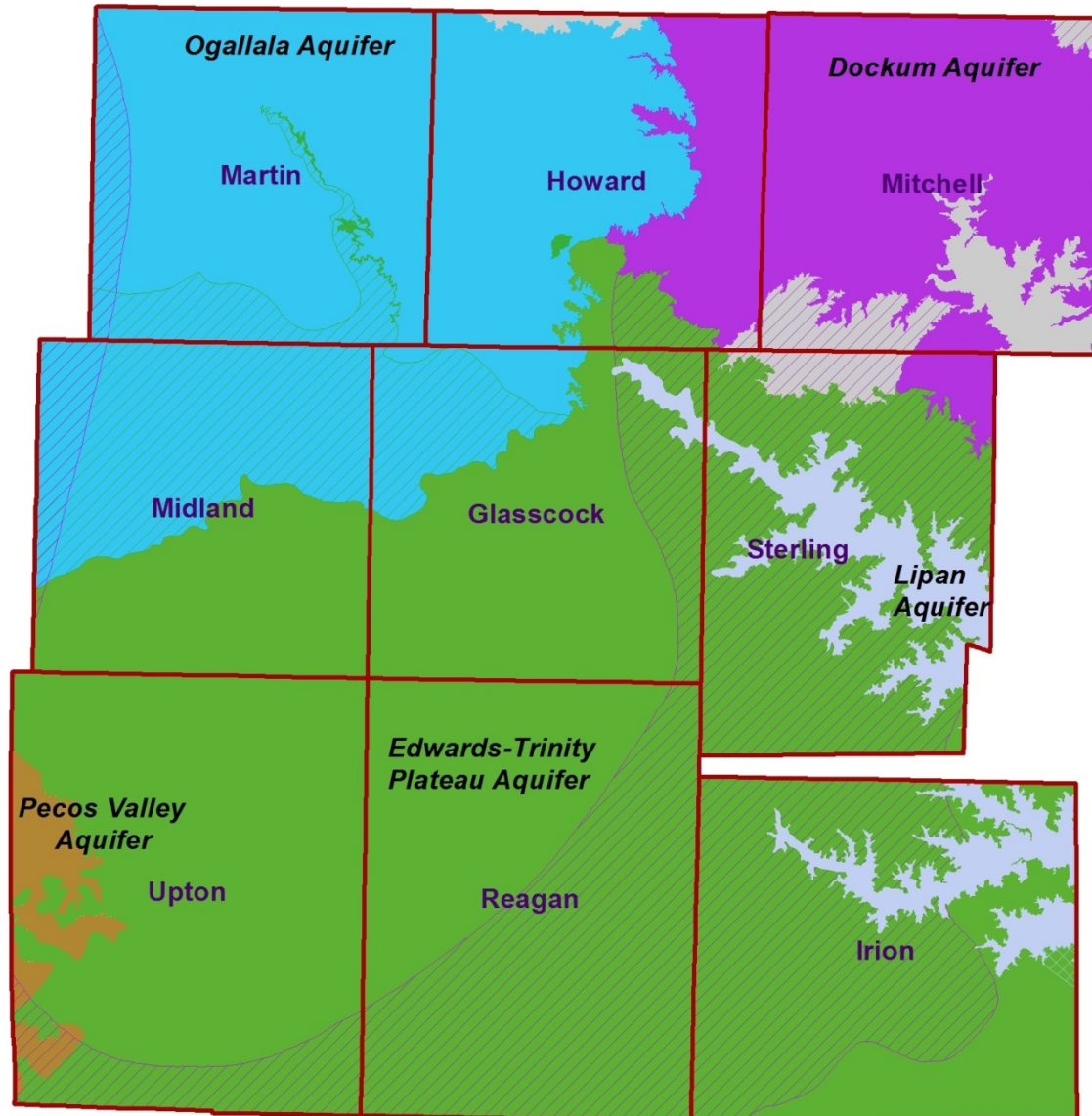
Data will be requested from project participants. For example, Dockum water well quality and well yield data are essential to calibrate results from geophysical well log interpretation.

All information will be non-confidential.

Project Area Districts



Project Area Aquifers



*solid color symbol represents aquifer outcrop
hachured symbol represents subcrop*

TWDB Database Tables

TWDB Groundwater Database

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

TWDB BRACS Database

Well Data (location, depth, owner, ...)
Water Levels
Water Chemistry (2 tables)
Casing

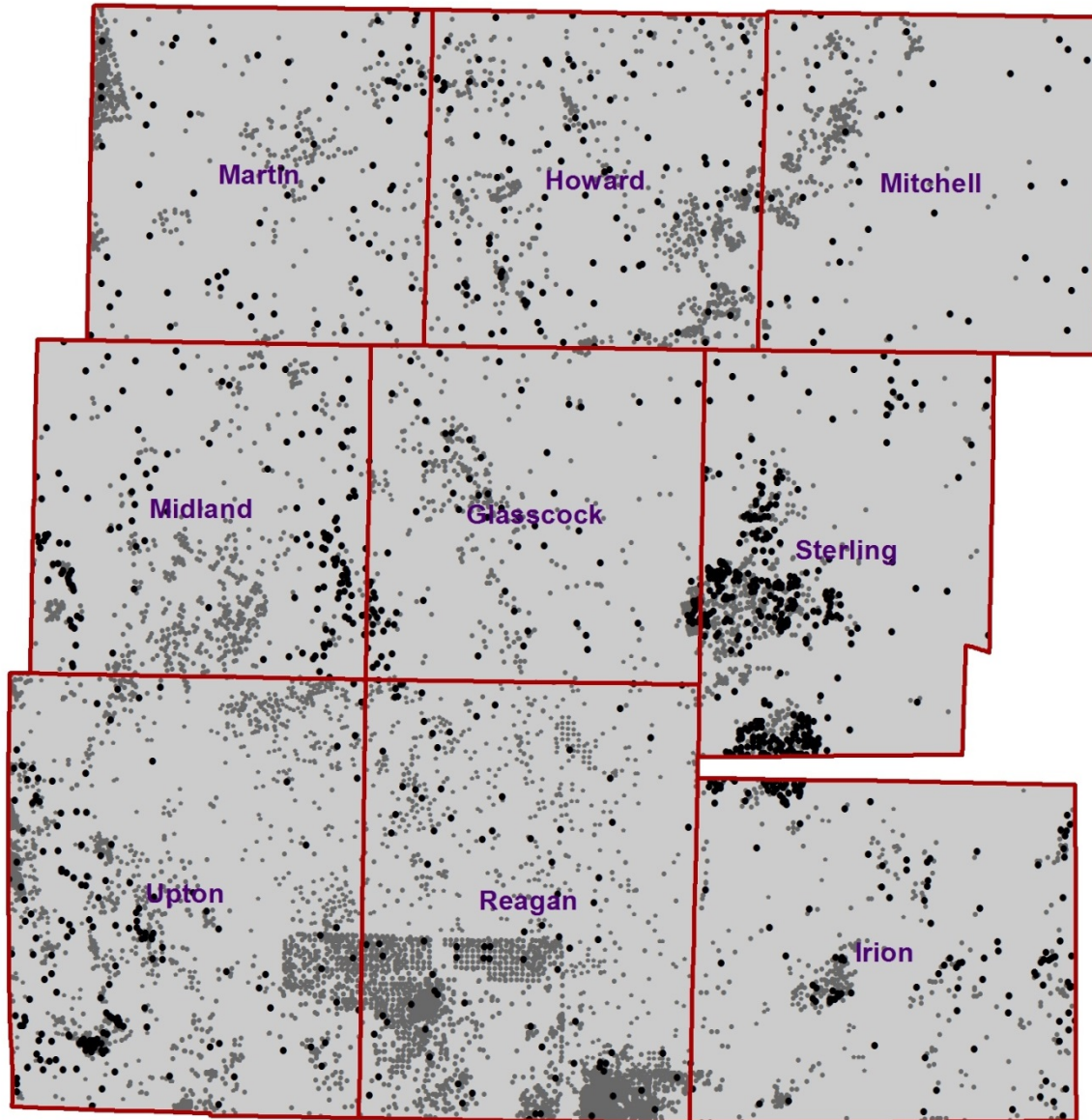
New
Tables

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 Database

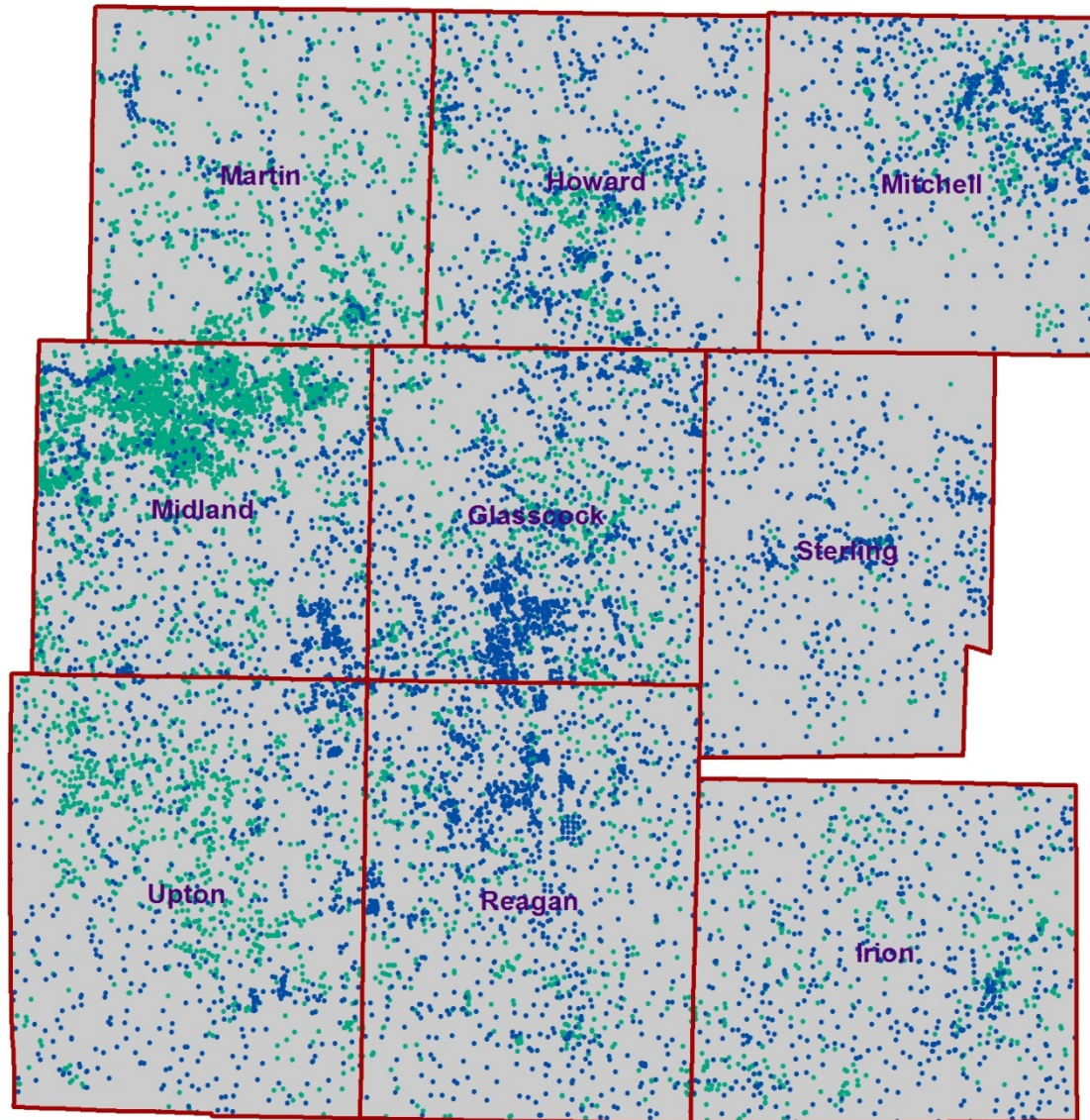
- MS Access relational design
- Contains all the new information we are collecting
- Designed to process information (Visual Basic Code)
- Link to additional databases through key fields
- Available on our website (with data dictionary)
- Will be merged with the TWDB Groundwater Database in MS SQL Server

Geophysical Well Log Control



TWDB BRACS Database (black); Available from other sources (gray)

Water Well Control



TWDB Groundwater Database (blue); TDLR Database (green)

Example of the Published Cross-section Control



Leverage work of other geologists for stratigraphic control

Lithologic and Stratigraphic Data in the BRACS Database

15658	Owner Nucorp Energy Inc.	Drill Date 06/12/1980	Remarks
	Source of Well Data RRC GAU Q Paper/Digital Geophys	Depth Total 9555	
Lithologic Description		Depth Well -99999	
	KB Height 13	Elevation 271	

Record Number	Geologic Pick	Top Depth	Lithologic Description	Initials	Last Change
		Bottom Depth	Simplified Lithologic Description		
		Thickness	Source of Data		
			Remarks		
11	Lithologic	0	No Record		
		505			
		505	GEOPHYSICAL WELL LOG	JEM	1/17/2013
12	Lithologic	505	Sand		
		512			
		7	GEOPHYSICAL WELL LOG	JEM	1/17/2013
13	Lithologic	512	Clay		
		650			
		138	GEOPHYSICAL WELL LOG	JEM	1/17/2013
14	Lithologic	650	Sand		
		660			
		10	GEOPHYSICAL WELL LOG	JEM	1/17/2013
15	Lithologic	660	Clay		
		675			
		15	GEOPHYSICAL WELL LOG	JEM	1/17/2013
16	Lithologic	675	Clay with Sand		
		700			
		25	GEOPHYSICAL WELL LOG	JEM	1/17/2013
17	Lithologic	700			

Record Number	Geologic Pick	Top Depth	Stratigraphic Description	Initials	Last Change
		Bottom Depth	Source of Data		
		Thickness	Remarks		
1	Stratigraphic	0	Jackson Group		
		646	Geophysical Well Log		
		646	cased to 505	JEM	10/4/2012
2	Stratigraphic	646	Yegua Formation		
		1614	Geophysical Well Log		
		968		JEM	10/4/2012
3	Stratigraphic	1614	Cook Mountain Formation		
		2070	Geophysical Well Log		
		456		JEM	3/11/2013
4	Stratigraphic	2070	Sparta Formation		
		2287	Geophysical Well Log		
		217		JEM	3/11/2013
5	Stratigraphic	2287	Weches Formation		
		2365	Geophysical Well Log		
		78		JEM	3/11/2013
6	Stratigraphic	2365	Queen City Formation		
		3010	Geophysical Well Log		
		645		JEM	3/11/2013
7	Stratigraphic	3010	Reklaw Formation		
		3321	Geophysical Well Log		
		311		JEM	10/4/2012
8	Stratigraphic	3321	Carrizo Formation		
		4150	Geophysical Well Log		
		829		JEM	2/11/2013
9	Stratigraphic	4150	Wilcox Group		
		7345	Geophysical Well Log		
		3195		JEM	2/11/2013

Add First Record
Add Next Record
Complete Last Record

Calculate Strat Thickness
Add First Record
Add Next Record
Complete Last Record
Add BLANK Record

Geophysical Well Log Hyperlinks

Build Hyperlink

Link: B:\GeophysicalWellLogs\42_177\Q562_177.tif

Log File Type: TIF IMAGE GL folder: 42_177

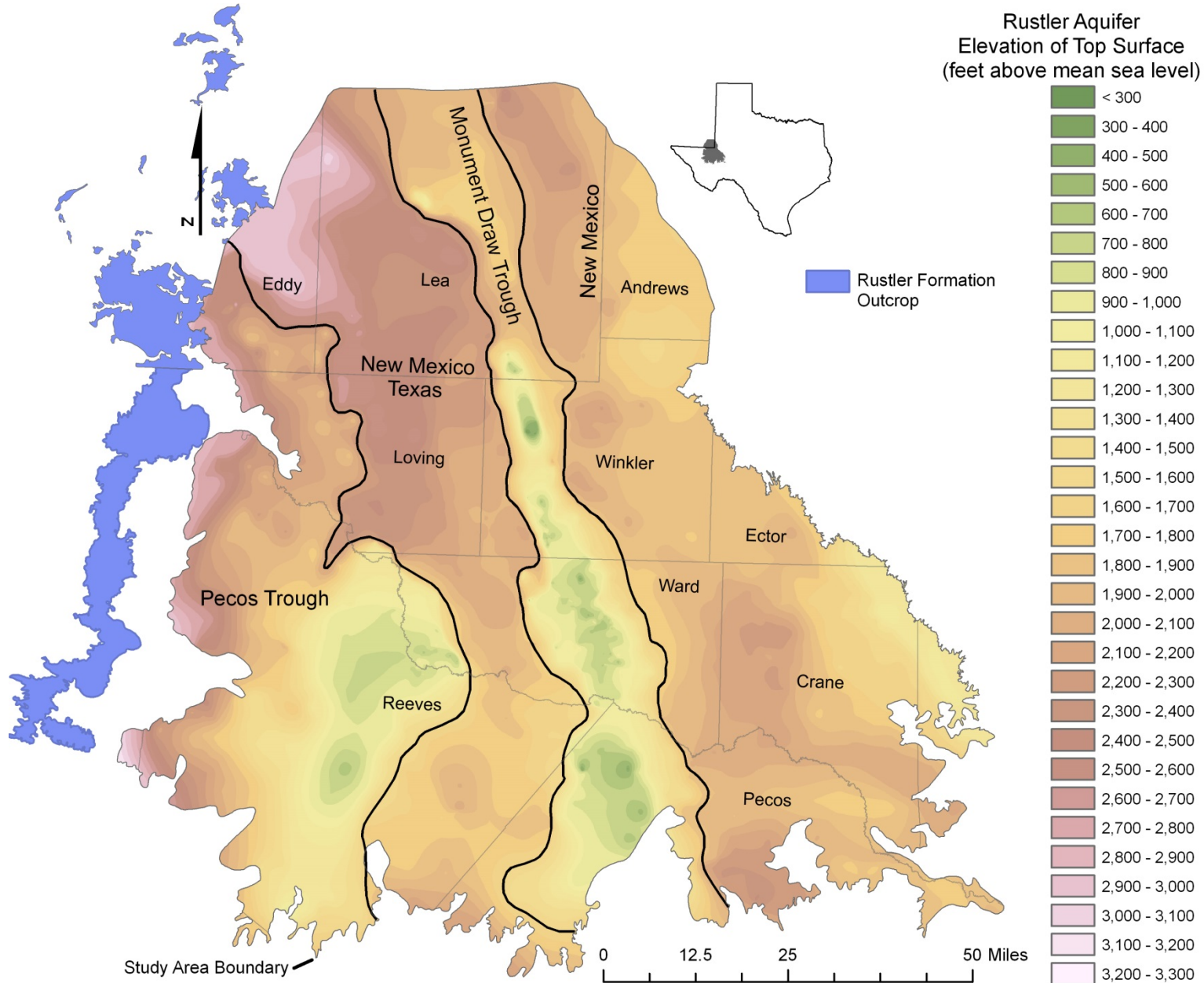
File Name: Q562_177

Record: 1 of 1 No Filter Search

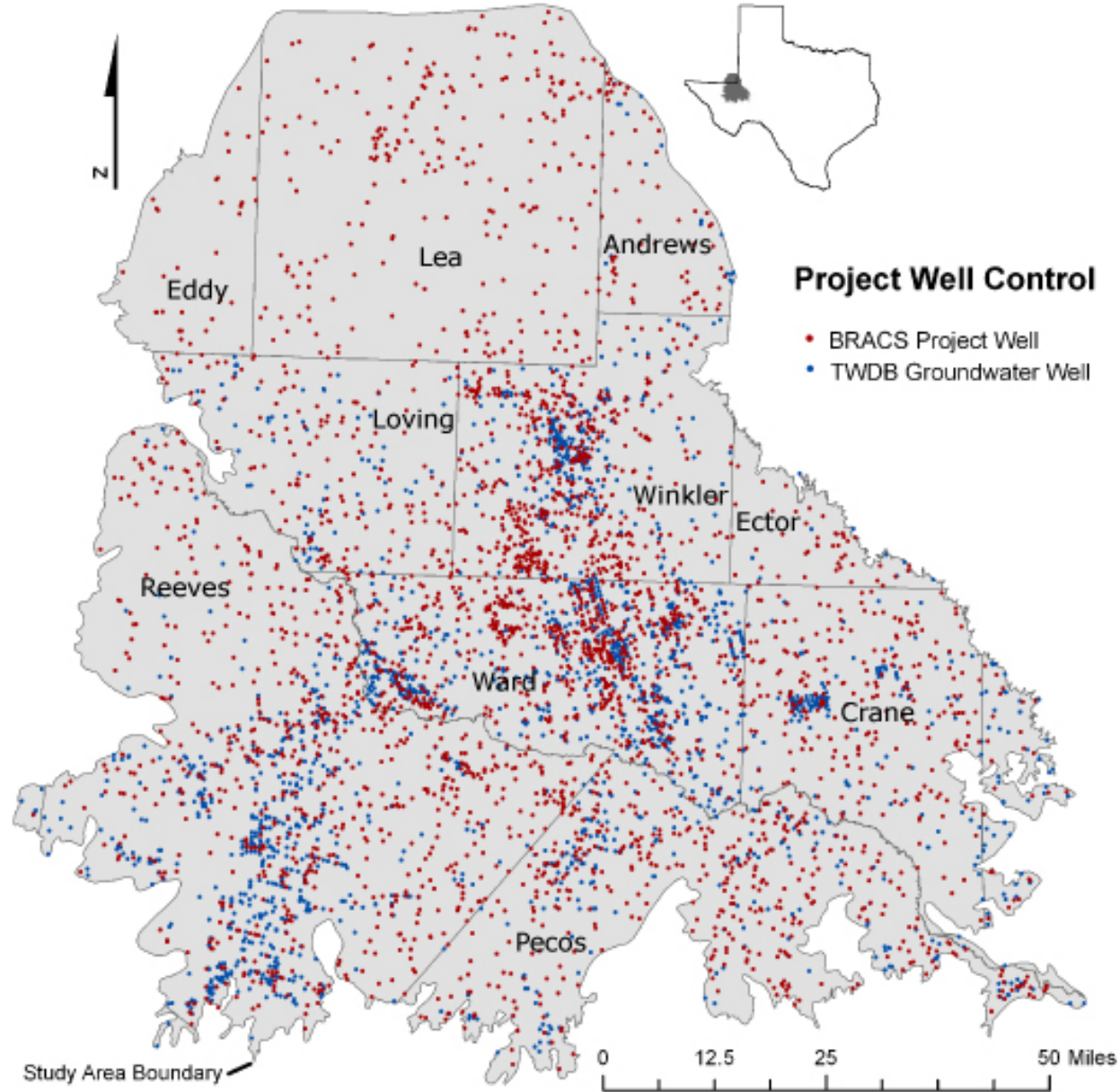
Insert New Strat Record

Request

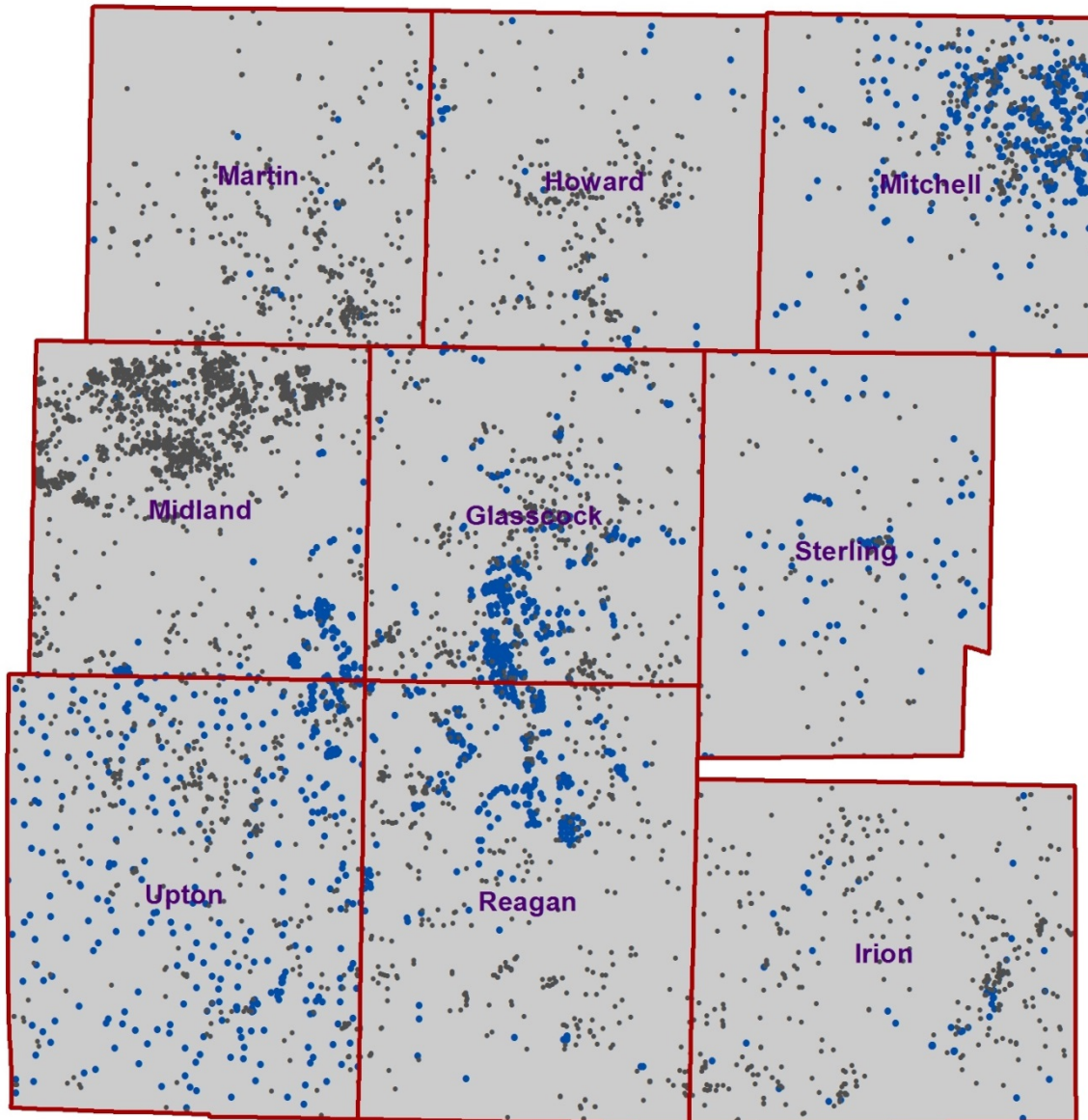
Example of formation raster surfaces, Pecos Valley Aquifer Project



Example of project well control, Pecos Valley Aquifer Project



Aquifer and Well Test Data

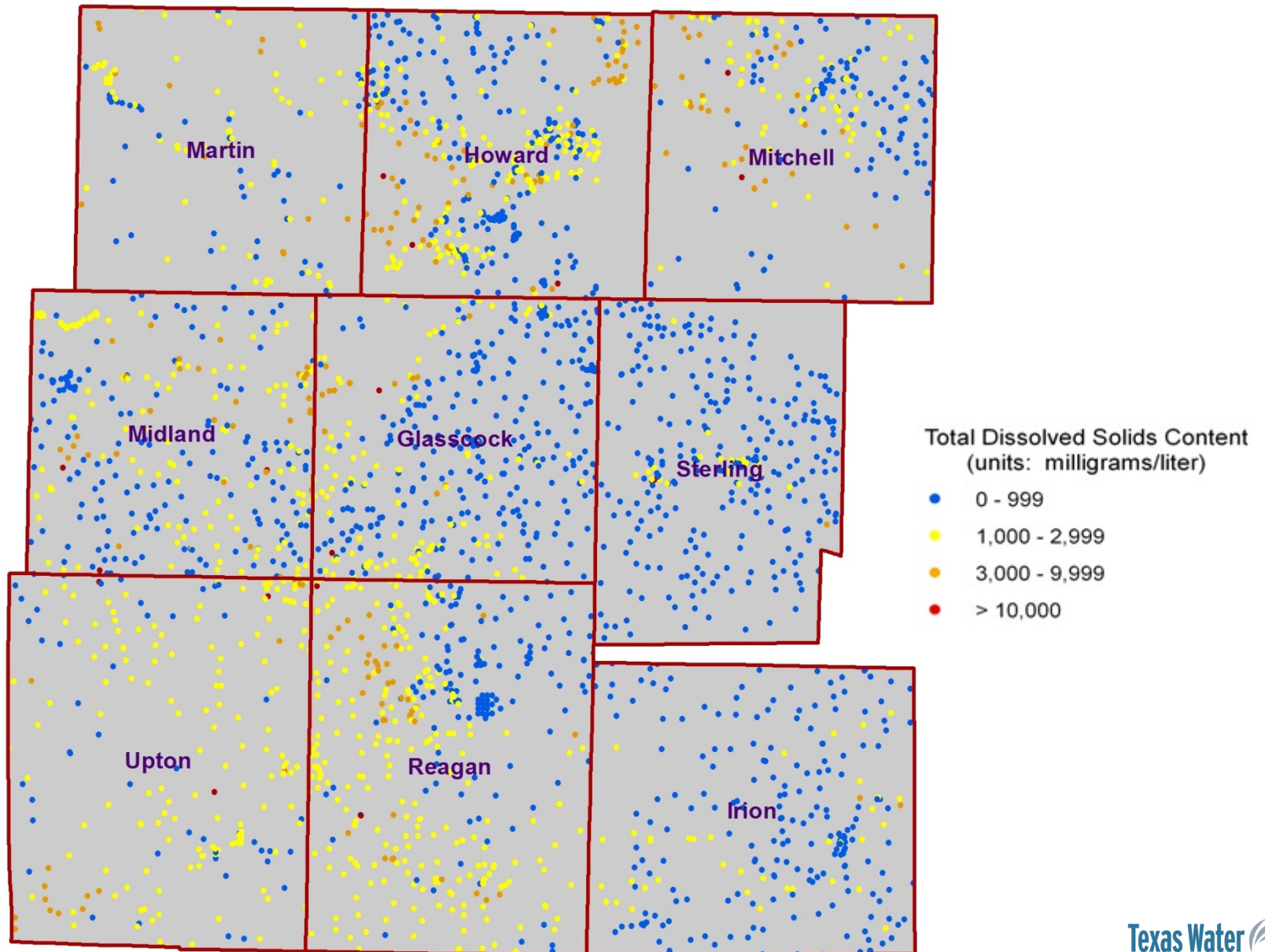


May include:

- Well yield
- Specific capacity
- Hydraulic conductivity
- Transmissivity
- Storativity
- Specific yield
- Test length
- Drawdown
- Report Reference (Myers, R 98)

TWDB Groundwater Database (blue); TDLR Database (gray)

Existing Water Quality Data



Interpreting Total Dissolved Solids using Geophysical Well Logs

- Log interpretation methods provide *estimates* of water quality and are based on parameters *which are often estimated*.
- Interpretation methods are based on Estep, 1998.
- Evaluation and modification of these methods is an ongoing task at the TWDB.
- Parameter estimates are based on best available data or reasonable assumptions.
- Geophysical well log interpretation is “calibrated” with nearby water quality data, then extrapolated into areas lacking water quality data.
- The degree of uncertainty using these techniques increases in areas with insufficient well control and increased distance from locations with good water quality data that serve to calibrate the logs.
- Obtaining logs with appropriate tools and range of depth will be a challenge in this project area.

Geophysical Well Log Analysis

aaaQry_GWDB_Casing | tbiTwdb_WellData | frmBracsDataWebsites

BRACS Geophysical Log Analysis for TDS Calculations

Well Id:
 GL NUMBER:

GL FILE TYPE:
 GL FILE NAME:
 GL HYPERLINK: B:\GeophysicalWellLogs\42_329\42329_MII

Perform Geophysical Log Analysis

Edit an Existing Record
 Add a New Record

GL Co:
 Remarks: Rmf not on header; use Schl. Gen 7 salt mud correction. No SP units on log header (Assume 20 mv, see BRACS 17755)

Well Location table

OWNER	SINCLAIR OIL AND GAS COMPANY	DEPTH TOTAL	7044
SOURCE WELL DATA	BEG Paper/Digital Geophysical Logs	K B HEIGHT	0
		DRILL_DATE	11/19/1951

Depth Total:
 Temperature Surface:
 Temperature Bottom Hole:
 Rmf:
 Rmf Temperature:
 Rm:
 Rm Temperature:
 Mud Type:

Geophysical Log Suite

	Depth Top Logged Interval	Depth Bottom Logged Interval	Remarks
GAMMA RAY OR GAMMA	0	1333	
RESISTIVITY	293	1334	10", 32" limestone, and 19' (scale cut off; see o
SPONTANEOUS POTENTIAL	293	1333	SP assume 20 mv, see BRACS 17755
*	0	0	N/A

Depth Formation (DF):
 Thickness Lithologic Unit:
 TDS Interpreted:
 Consensus TDS Method:
 Tf:
 Formation:
 Rmf Tf:
 Remarks: test using NaCl cf and SP invasion correction
 Initials:

TDS Method:
 Rwe:
 Rw:
 Rw75:
 Cw:
 TDS:
 Initials:

Geophysical Log Used:

Correction Factors

SP	<input type="text" value="71.8"/>	<input type="text" value="70.69653"/>	K (Temperature): SP Method
Rxo	<input type="text" value="2"/>	<input type="text" value="1.17"/>	Rwe Rw: Sp, Alger Harrison, and Rwa Minimum Methods
Ro	<input type="text" value="10"/>	<input type="text" value="1"/>	Rmf: SP and Alger Harrison Methods
Rxo / Ro	<input type="text" value="0.2"/>	<input type="text" value="0.7"/>	ct: Many Methods
m	<input type="text" value="0"/>	<input type="text" value="99"/>	Invasion Zone: Alger Harrison Method
Source m	<input type="text" value="N/A"/>	<input type="text" value="1"/>	m correction factor: Estep Method high anion waters
Porosity	<input type="text" value="0"/>	<input type="text" value="1"/>	Ro: Mean Ro Method
Source Porosity	<input type="text" value="N/A"/>		

Chart:
 Remarks: WQ: 4418801 (1961) TDS: 9140; ct .7, Rwe NaCl cf: 1.17; SP @ 950 = +56, Spcor = .78, E_Spcorr = 71.8

Record: 1 of 1 | No Filter | Search

Record: 3 of 3 | No Filter | Search

Requery Form

BRACS Database designed to perform calculations and retain initial, intermediate, and finished results. Multiple methods at multiple depth intervals can be performed.

Determining Saline Water Quality Zones:

Evaluate:

- stratigraphy
- water quality data
- well log interpretation

Record Number	Geologic Pick	Top Depth Bottom Depth Thickness	Stratigraphic Description Hydrochemical TDS Zone Remarks	Initials	Last Change
11	Hydrochemical	0 120 120	Edwards Limestone Fresh GWDB WQ: 4418702	JEM	9/9/2013
12	Hydrochemical	120 328 208	Antlers Formation Slightly Saline GWDB WQ: 4418832	JEM	9/9/2013
13	Hydrochemical	328 658 330	Chinle Formation Unknown	JEM	9/9/2013
14	Hydrochemical	658 910 252	Santa Rosa Sandstone Very Saline GL analysis	JEM	9/9/2013
15	Hydrochemical	910 1100 190	Santa Rosa Sandstone Moderately Saline GL analysis	JEM	9/9/2013
17	Hydrochemical	1100 1380 280	Tecovas Formation Unknown	JEM	9/9/2013
18	Hydrochemical	328 1380 1052	Dockum Group	JEM	9/9/2013
19	Hydrochemical	1380 1525	Dewey Lake Redbeds Unknown		

Estimated Groundwater Volumes

Three TDS Ranges:

- Fresh (0-999 mg/L)
- Brackish (1,000 -2,999 mg/L)
(3,000 – 9,999 mg/L)
- Very Saline (> 10,000mg/L)

Organized by:

- Aquifer
- County
- Estimated Confined Availability
- Estimated Total Recoverable Storage

Use similar volume methods as:

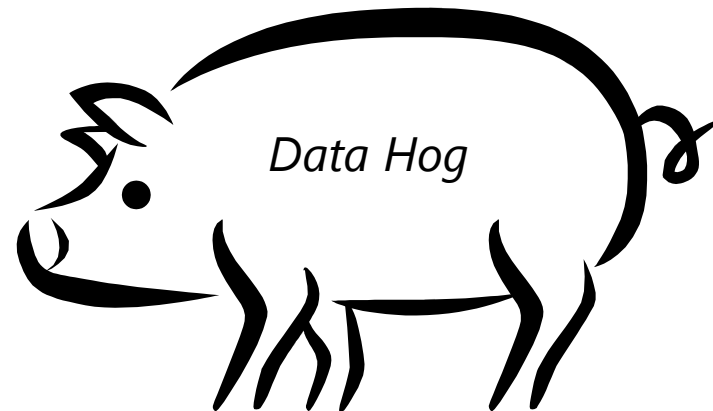
“Brackish Groundwater Manual for Texas Regional Water Planning Groups”

TWDB Groundwater Resources Division

Request for Information

Non-confidential data:

- Geology/hydrogeology reports and data
- Water quality data (water well; produced water)
- Well testing and aquifer parameters
- Geophysical well logs



Summary

- Project schedule: January 1 - December 31, 2014
- All project information will be available on TWDB website
- All geophysical well log files available upon request
- Clients, Groundwater Districts, public water systems, and other interested parties will be contacted by email when project is completed
- The TWDB website has many links to reports on desalination, concentrate management, existing desalination facilities, and groundwater data and studies.

www.twdb.texas.gov

Discussion ?

Texas Water Development Board



www.twdb.texas.gov

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