Texas Water Development Board

Brackish Groundwater Characterization

by
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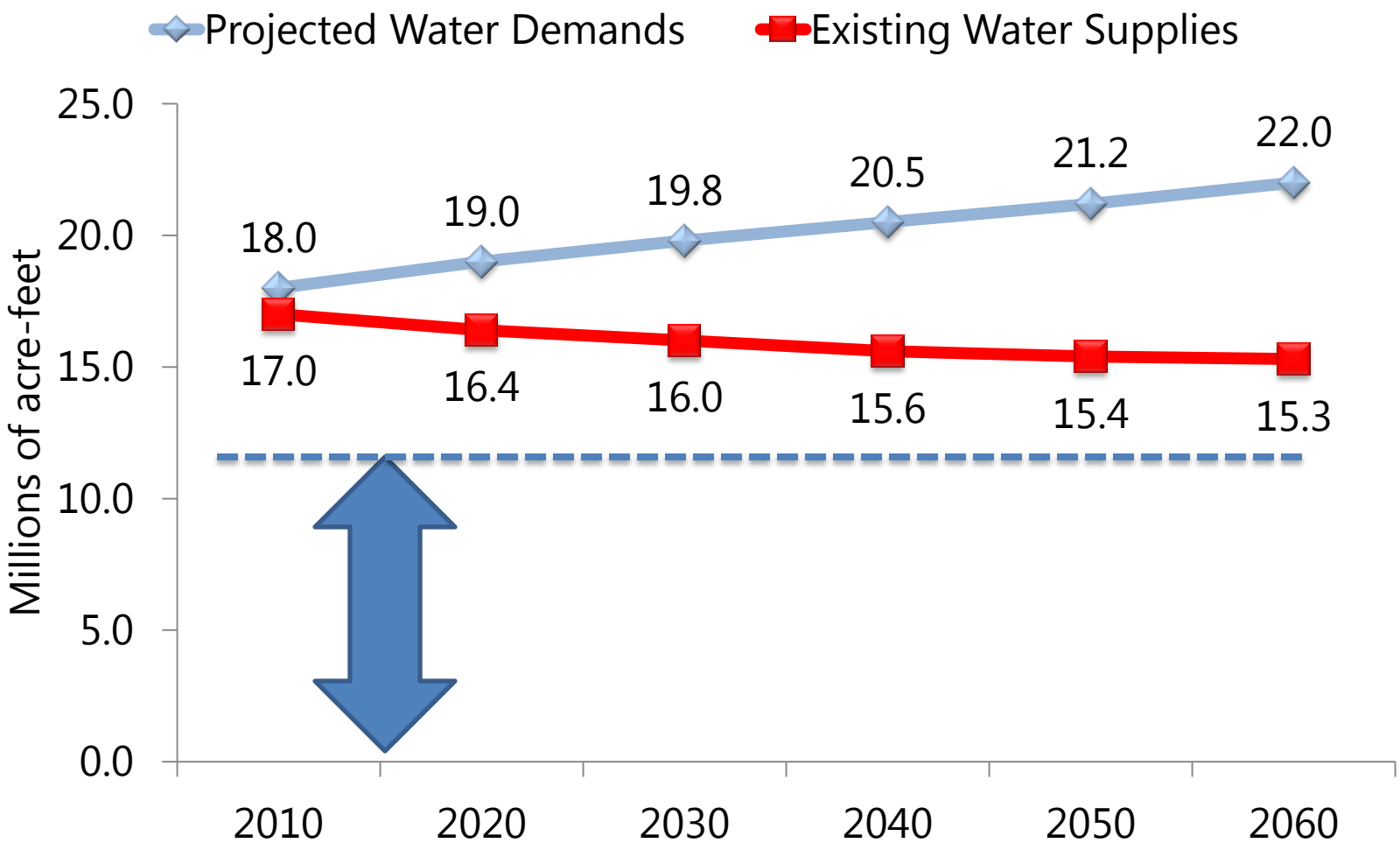
Presenting to
2012 Permian Basin Environmental Regulatory Seminar
May 31, 2012

Projected Water Demands and Existing Supplies in Texas



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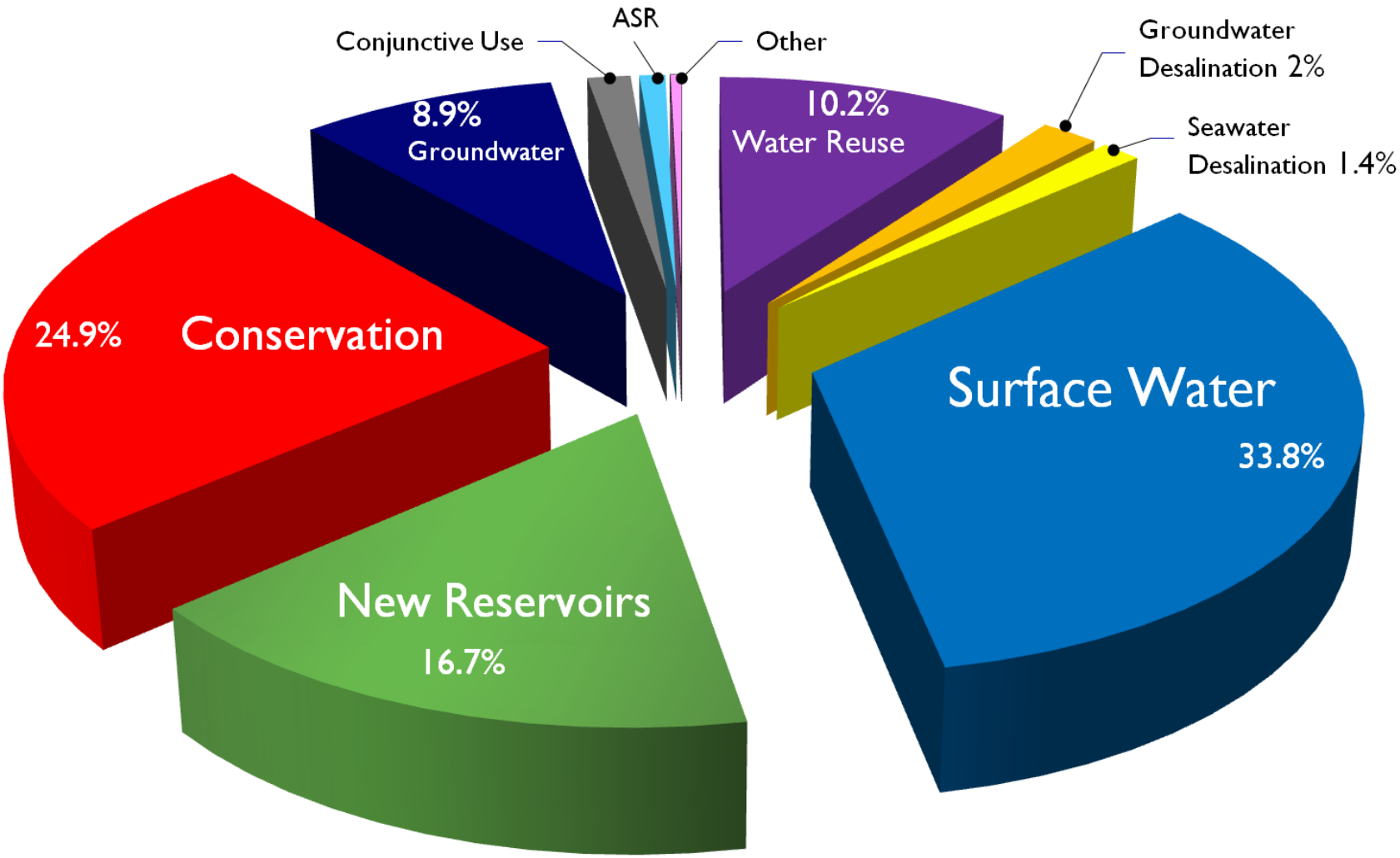
Cumulative Water Management Strategies by 2060



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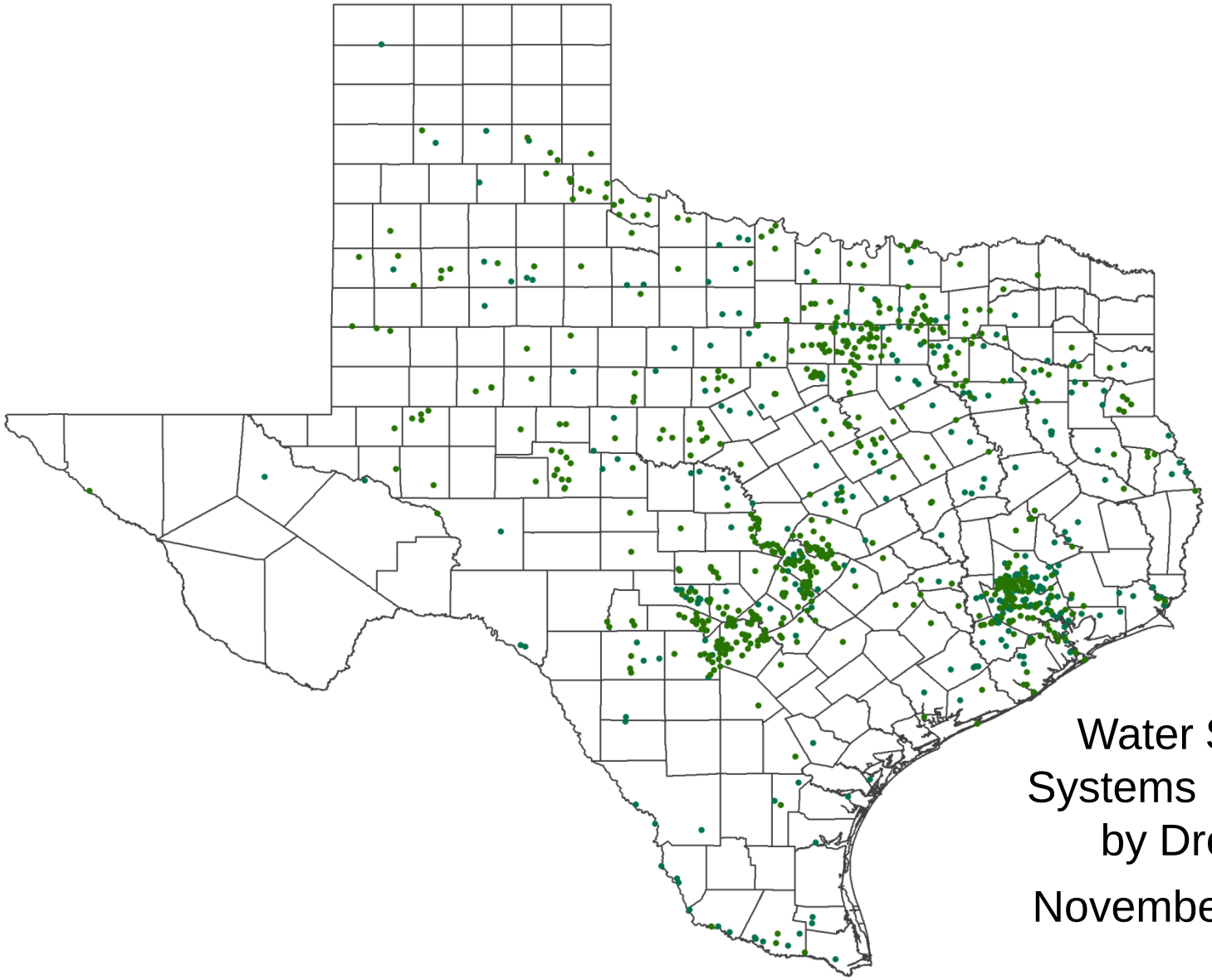
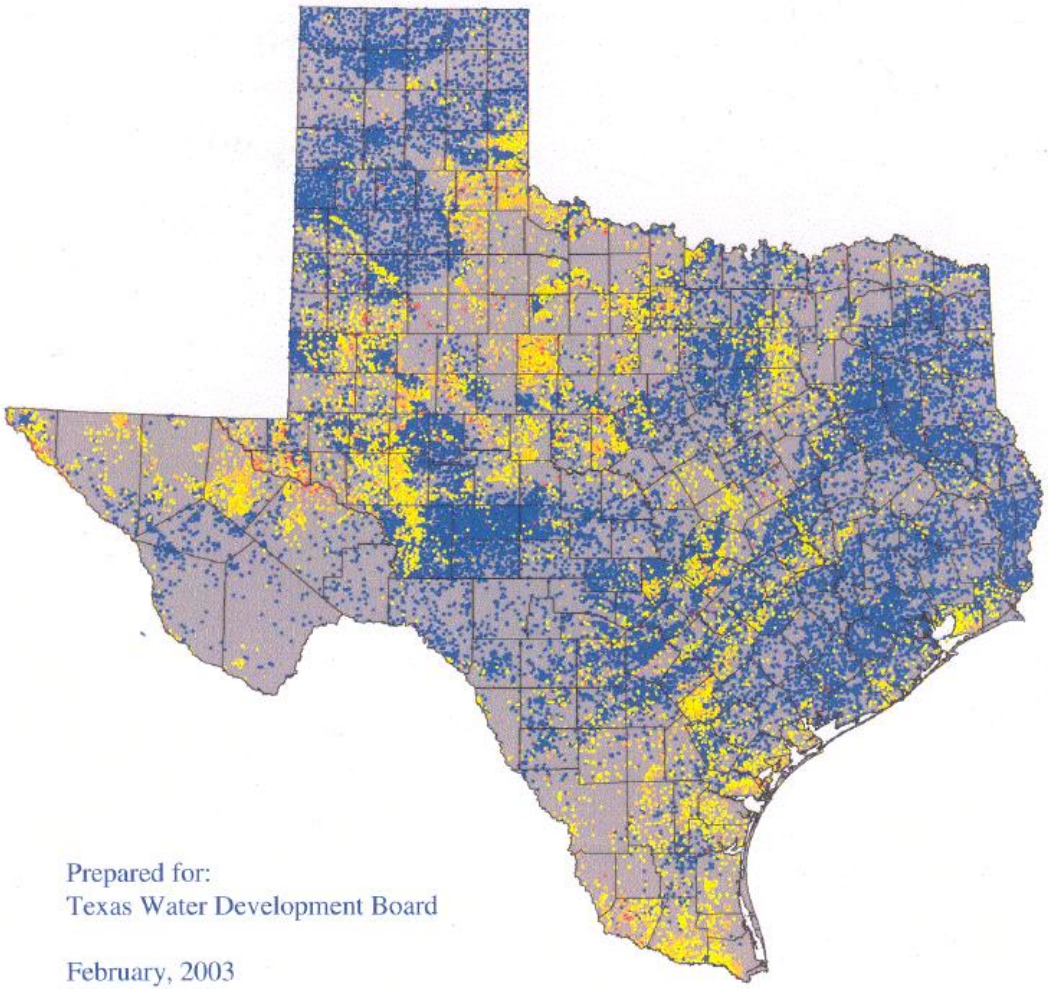
2010-2011 drought: Nearly 1,000 public water systems directly affected



Water Supply Systems Impacted by Drought

November 9, 2011

Brackish Groundwater Manual for Texas Regional Water Planning Groups



Prepared for:
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February, 2003

Texas has a LARGE volume of brackish groundwater

- 2.7 billion acre-feet
- Less than 10,000 mg/l [1.3 oz/gal]

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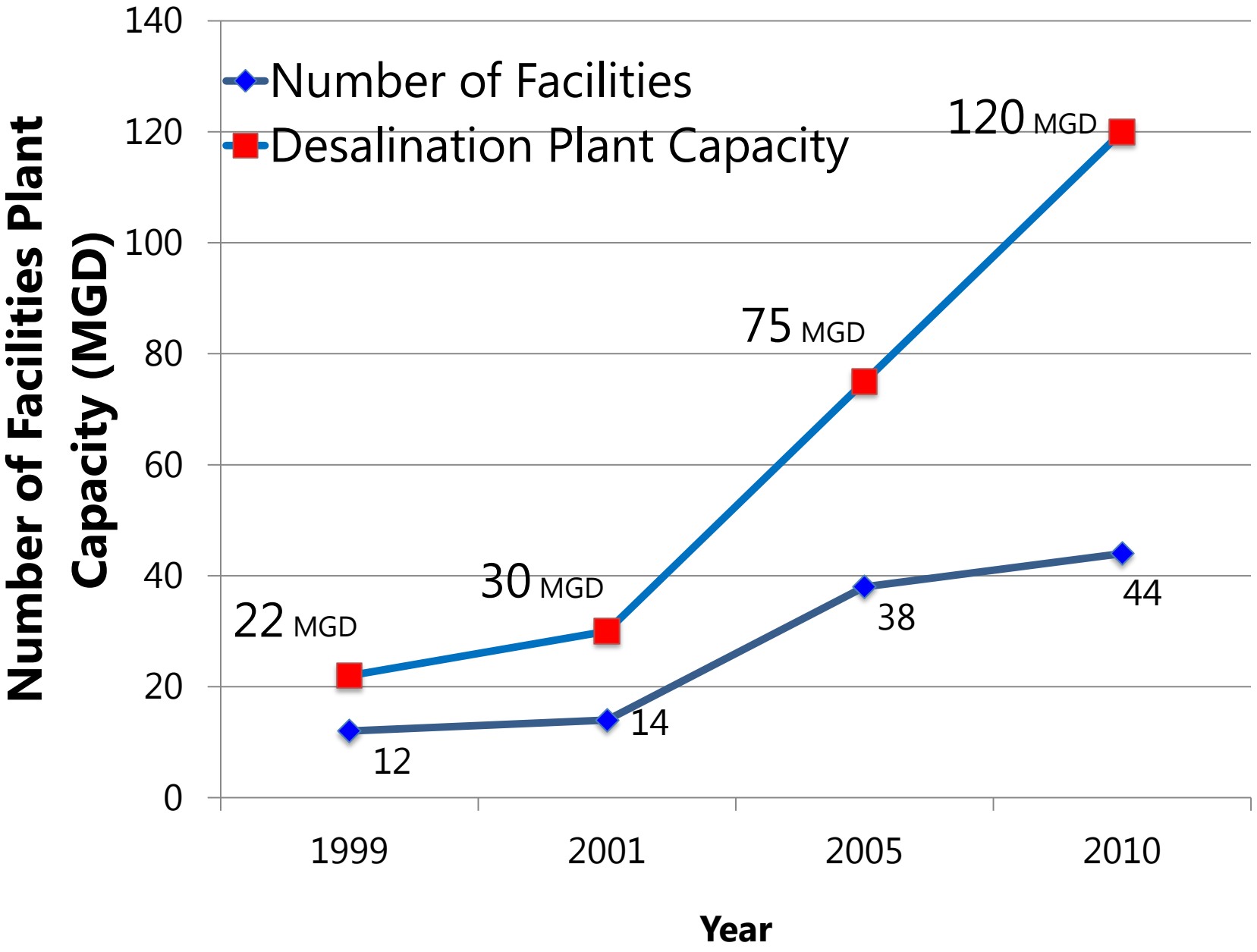

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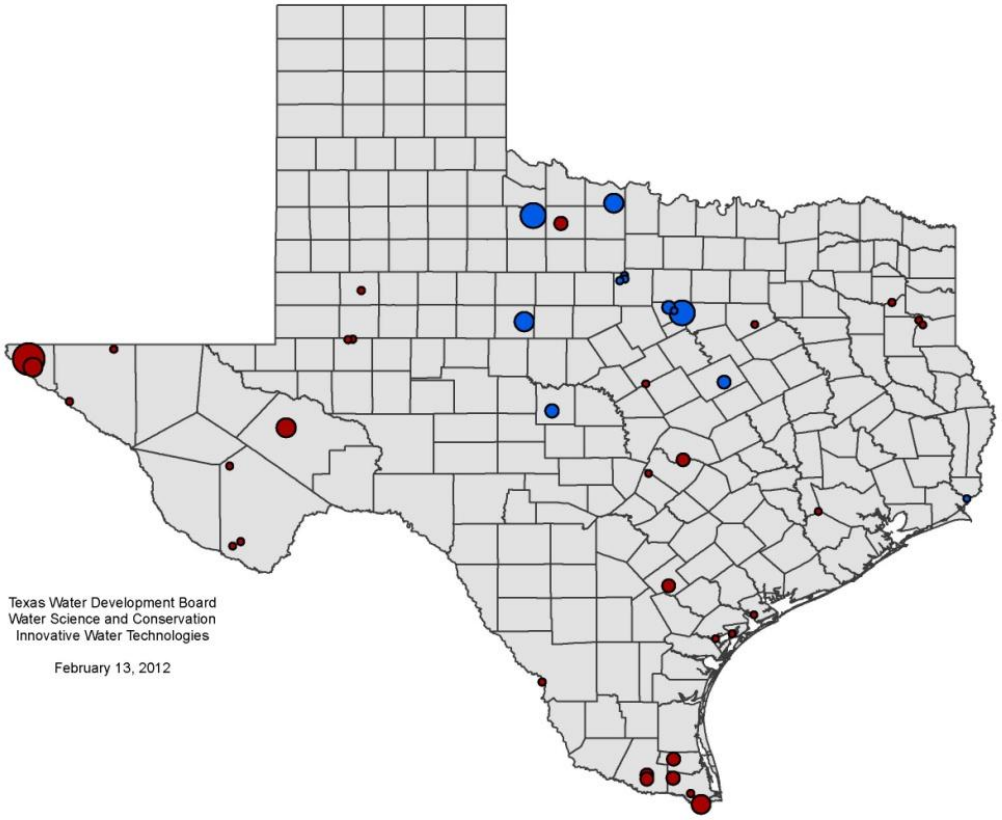
Texas Desalination Plant Capacity



Surface water Desalination Plant Capacity (units: millions of gallons per day)

- 0.02300 - 1.00000
- 1.00001 - 5.00000
- 5.00001 - 10.00000
- 10.00001 - 20.00000
- 20.00001 - 30.00000

Groundwater Desalination Plant Capacity (units: millions of gallons per day)

- 0.02300 - 1.00000
- 1.00001 - 5.00000
- 5.00001 - 10.00000
- 10.00001 - 20.00000
- 20.00001 - 30.00000

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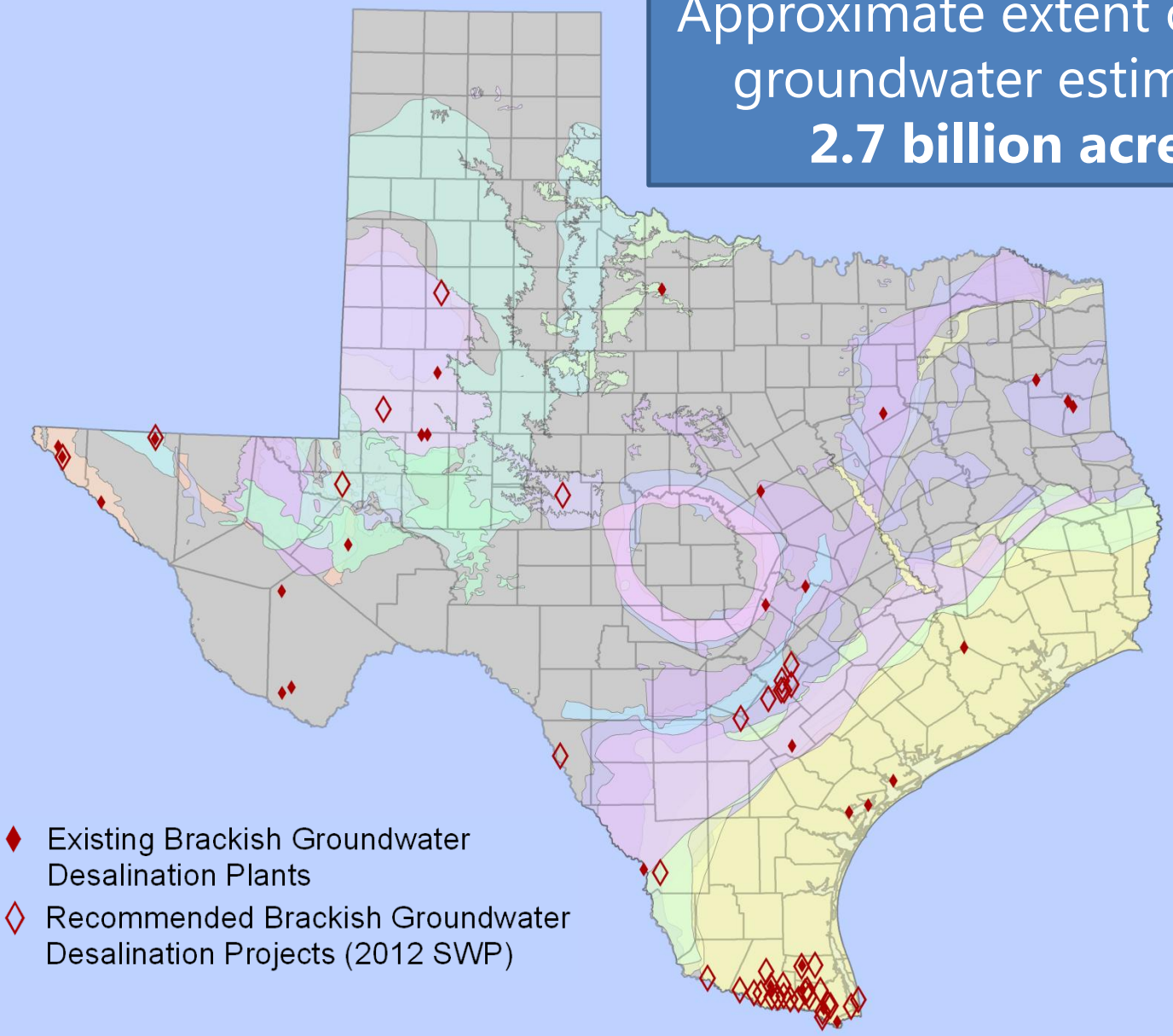
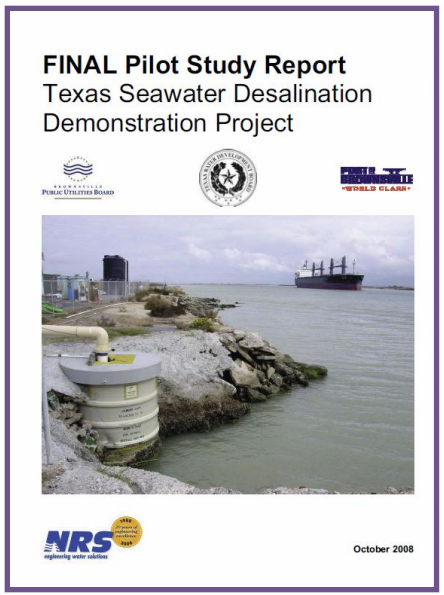
Approximate extent of brackish groundwater estimated at **2.7 billion acre-feet**

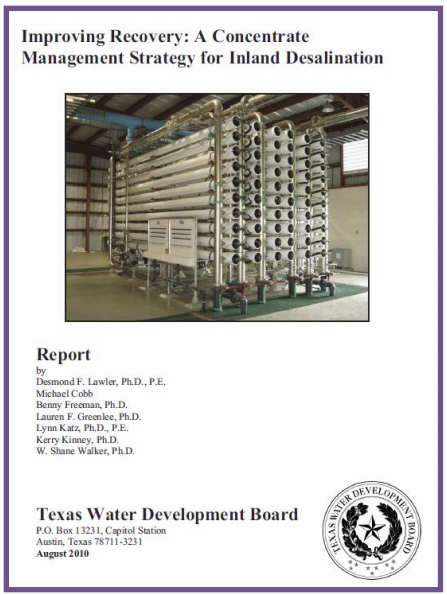


Investment in Desalination Studies and Demonstration Projects

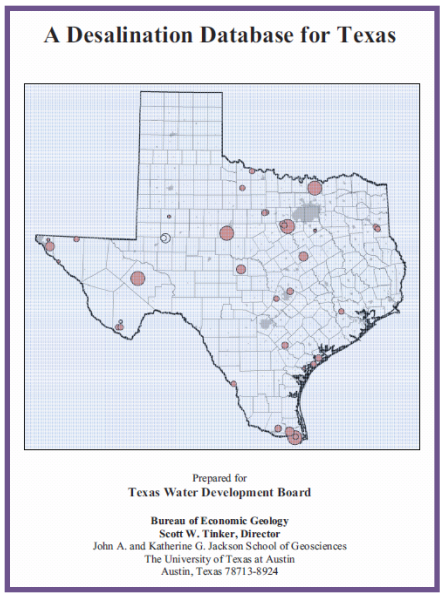
Seawater pilot



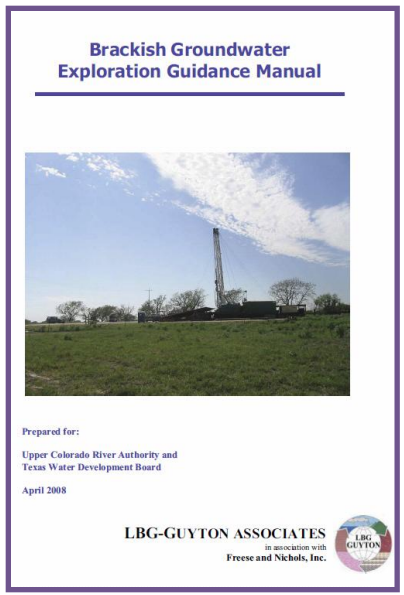
Concentrate Management



Information



Source Characterization



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Concentrate disposal methods in use

- Surface water
  - Direct
  - Sewer system
- Evaporation ponds
- Zero liquid discharge
- Land application
- Underground injection

Brackish Resource Aquifer Characterization System (BRACS)

- 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
- provide ***all*** information to interested stakeholders

  (well logs; database; GIS files; reports)

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BRACS Projects

- Pecos Valley Aquifer, West Texas *(completed August 2011)*
- Gulf Coast Aquifer, Corpus Christi ASR District *(completed March 2012)*
- Queen City – Sparta Aquifer, Atascosa and McMullen Counties
- Carrizo – Wilcox Aquifer, Central Texas
- Gulf Coast Aquifer, Lower Rio Grande Valley

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BRACS Database

- MS Access relational design
- Required to hold all the new information we are collecting
- Designed to process information (Visual Basic Code)
- Related to other agency databases through key fields
- Updated copy available on our website
- Will be merged with the TWDB Groundwater Database in MS SQL Server

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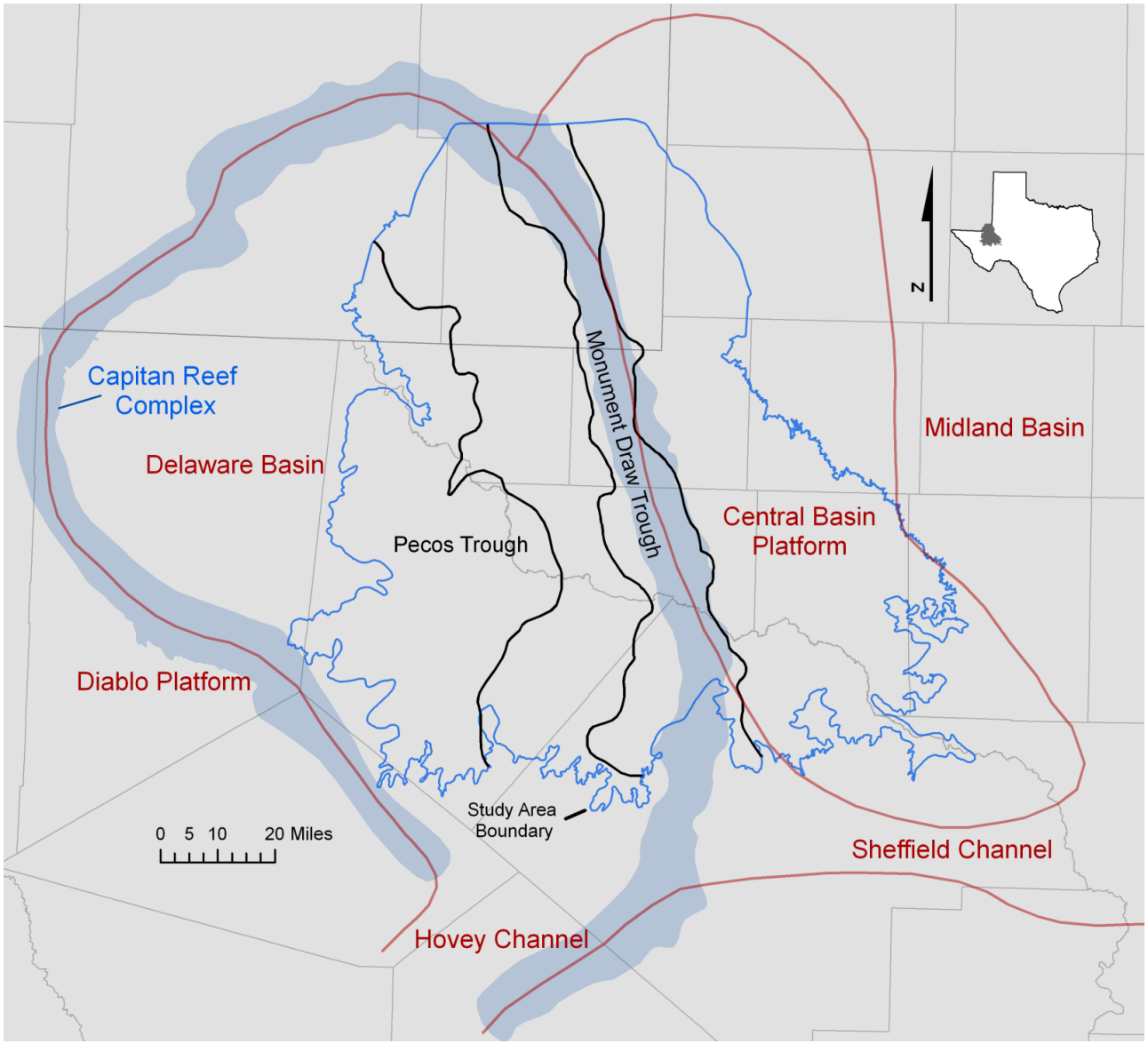
Pecos Valley Aquifer Pilot Study Area and Permian Structural Elements



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Mapping the Pecos Valley Alluvium and underlying formations in greater detail than what has been done in previous studies was imperative.

System	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Region 7
Quaternary	Pecos Valley Alluvium ? ?	Pecos Valley Alluvium ? ?	Pecos Valley Alluvium ? ?	Pecos Valley Alluvium ? ?	Ogallala Formation ? ?		
Tertiary							
Cretaceous			Cretaceous Undivided	Cretaceous Undivided			Cretaceous Undivided
Jurassic							
Triassic	Dockum Group		Dockum Group		Dockum Group	Dockum Group	Dockum Group
Permian	Dewey Lake Formation	Dewey Lake Formation	Dewey Lake Formation	Dewey Lake Formation	Dewey Lake Formation	Dewey Lake Formation	Dewey Lake Formation
	Rustler Formation	Rustler Formation	Rustler Formation	Rustler Formation	Rustler Formation	Rustler Formation	Rustler Formation
	Salado Formation	Salado Formation	Salado Formation	Salado Formation	Salado Formation	Salado Formation	Salado Formation
	Capitan Reef Complex / Castile	Castile	Capitan Reef Complex / Castile	Castile	Capitan Reef Complex / Castile	Capitan Reef Complex / Castile	Capitan Reef Complex / Castile

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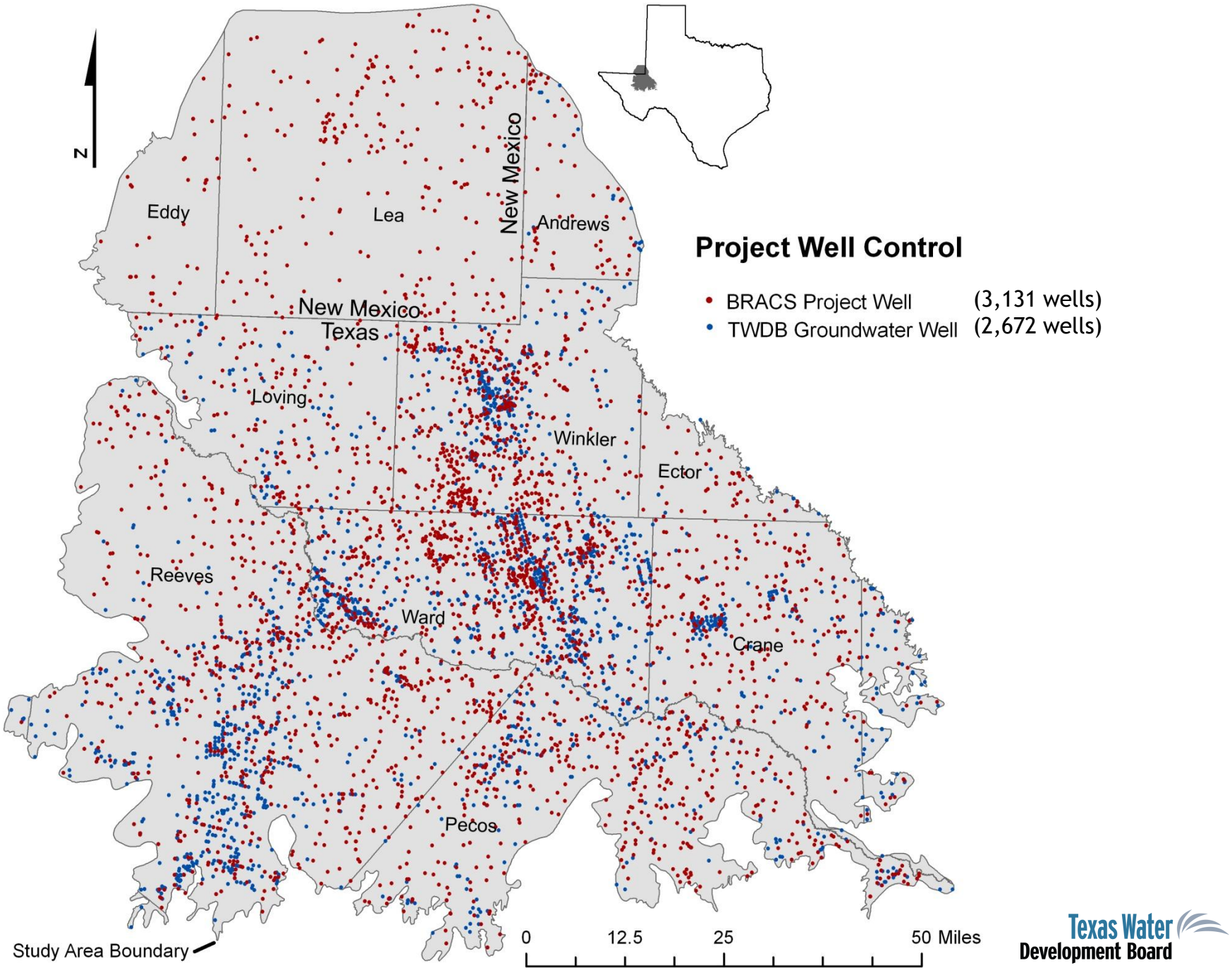
N
Eddy
Lea
New Mexico
Andrews
New Mexico
Texas
Loving
Winkler
Ector
Reeves
Ward
Crane
Pecos
Project Well Control
BRACS Project Well (3,131 wells)
TWDB Groundwater Well (2,672 wells)
Study Area Boundary
0
12.5
25
50 Miles
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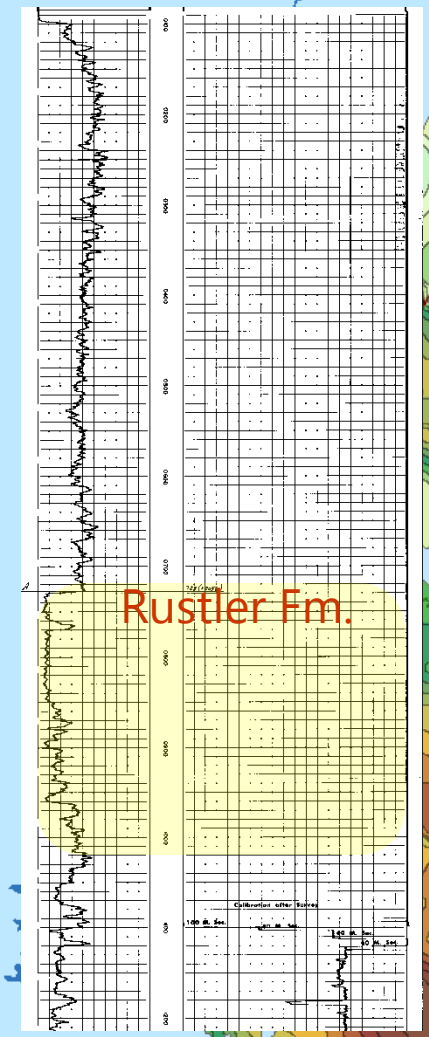
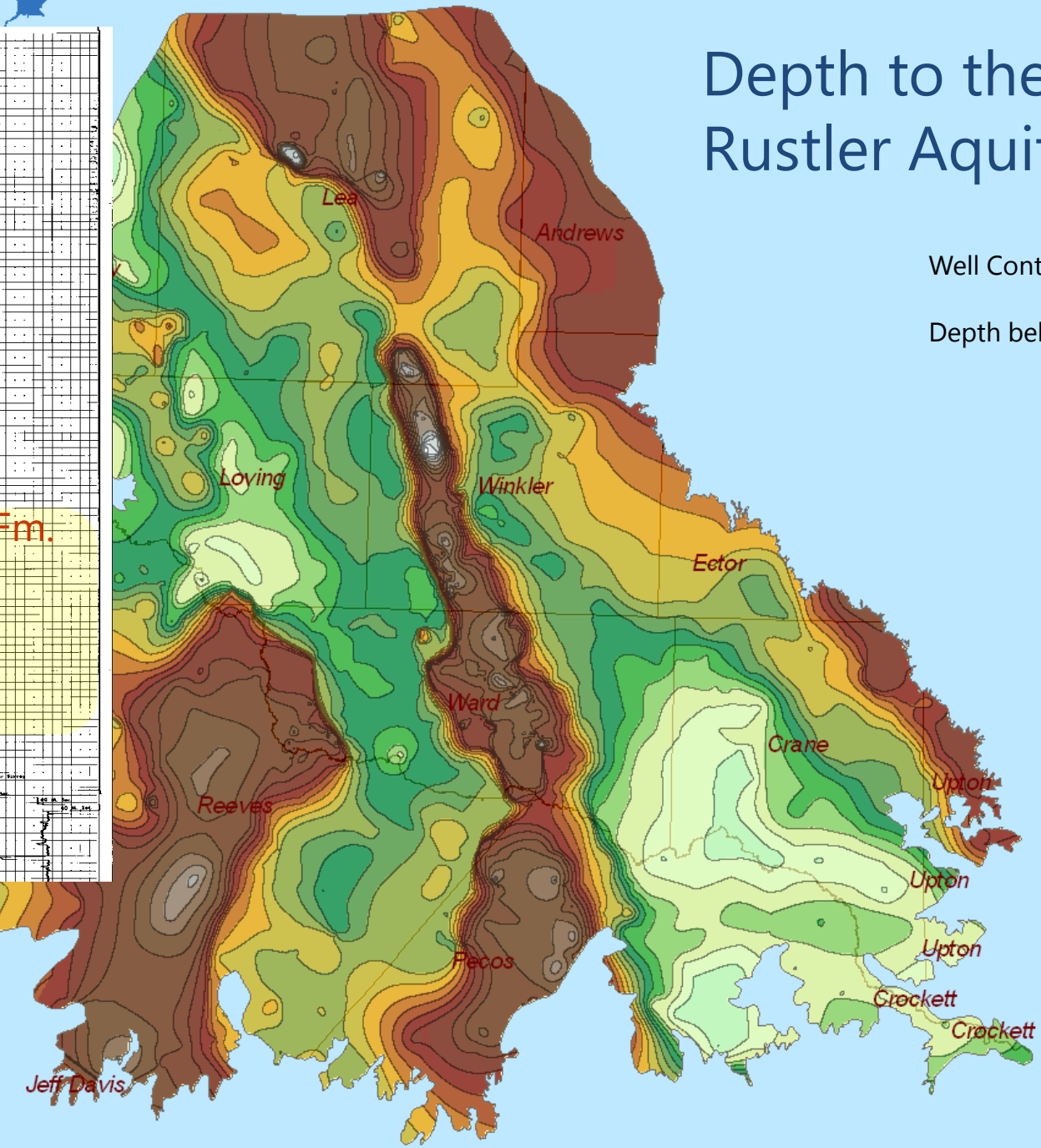
Depth to the Rustler Aquifer Top



Well Control: 1,479 wells

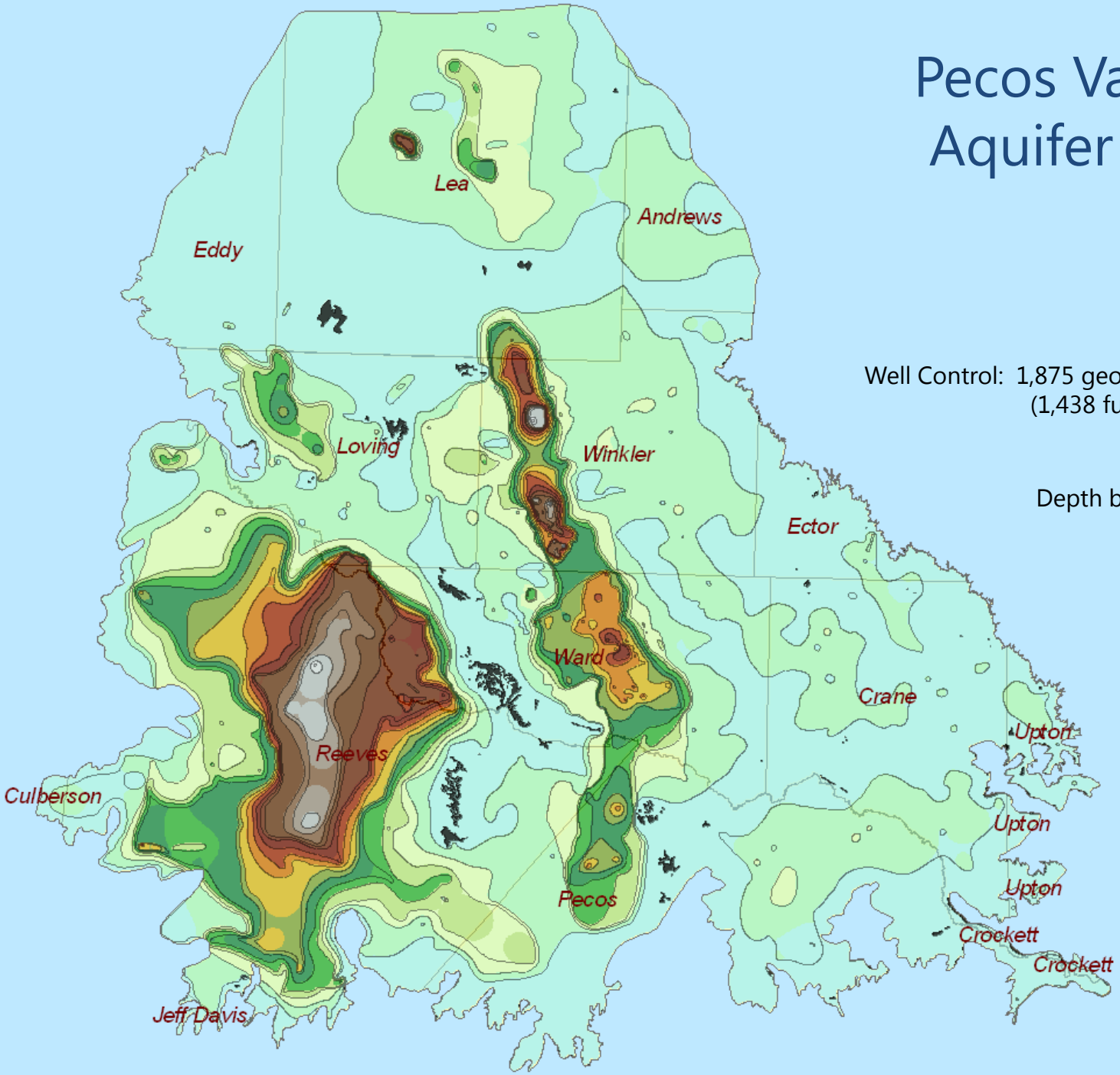
Depth below ground surface

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

Pecos Valley Aquifer Thickness



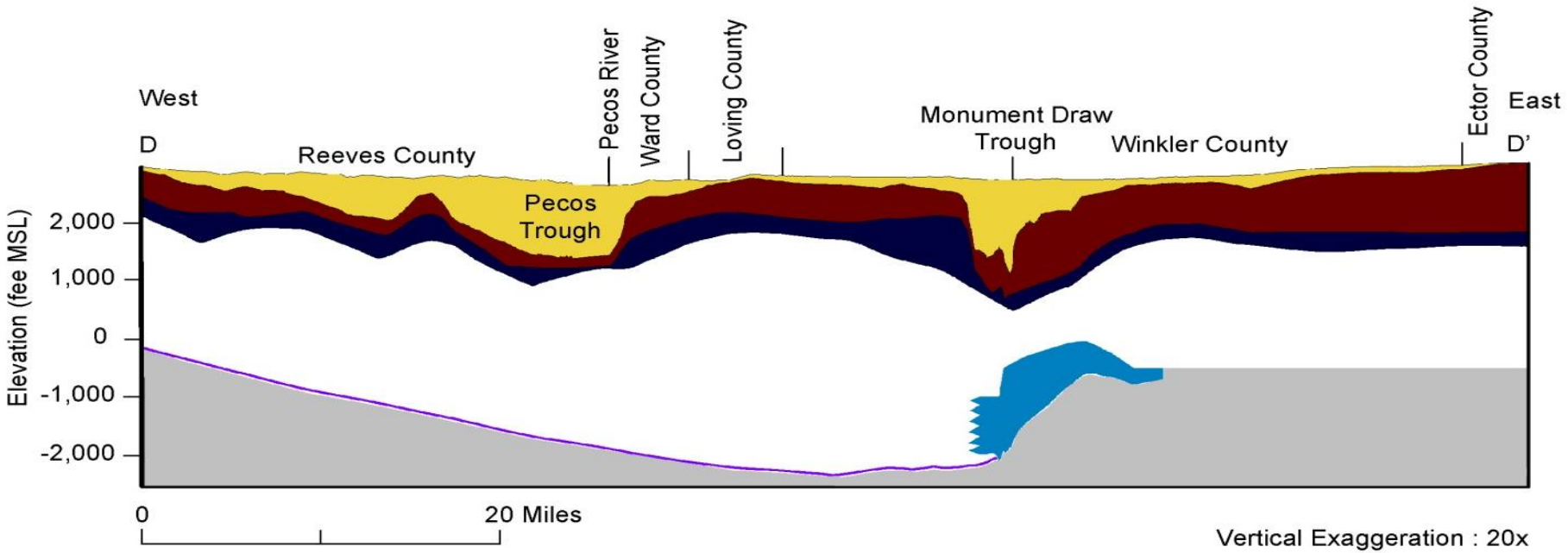
Well Control: 1,875 geophysical logs and water wells
(1,438 fully penetrate aquifer)

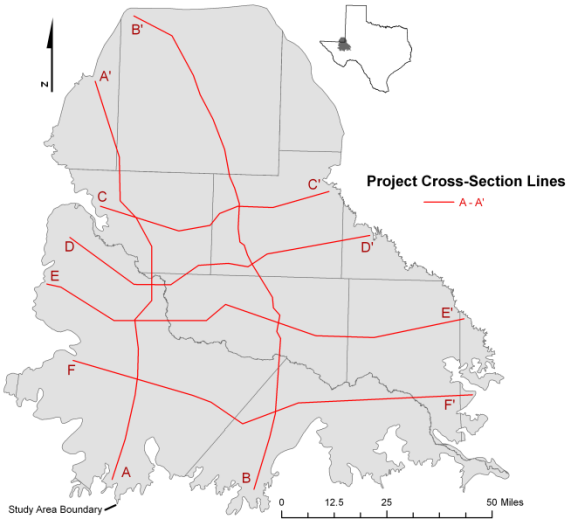
Depth below ground surface

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

Cross-section D – D’





- 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

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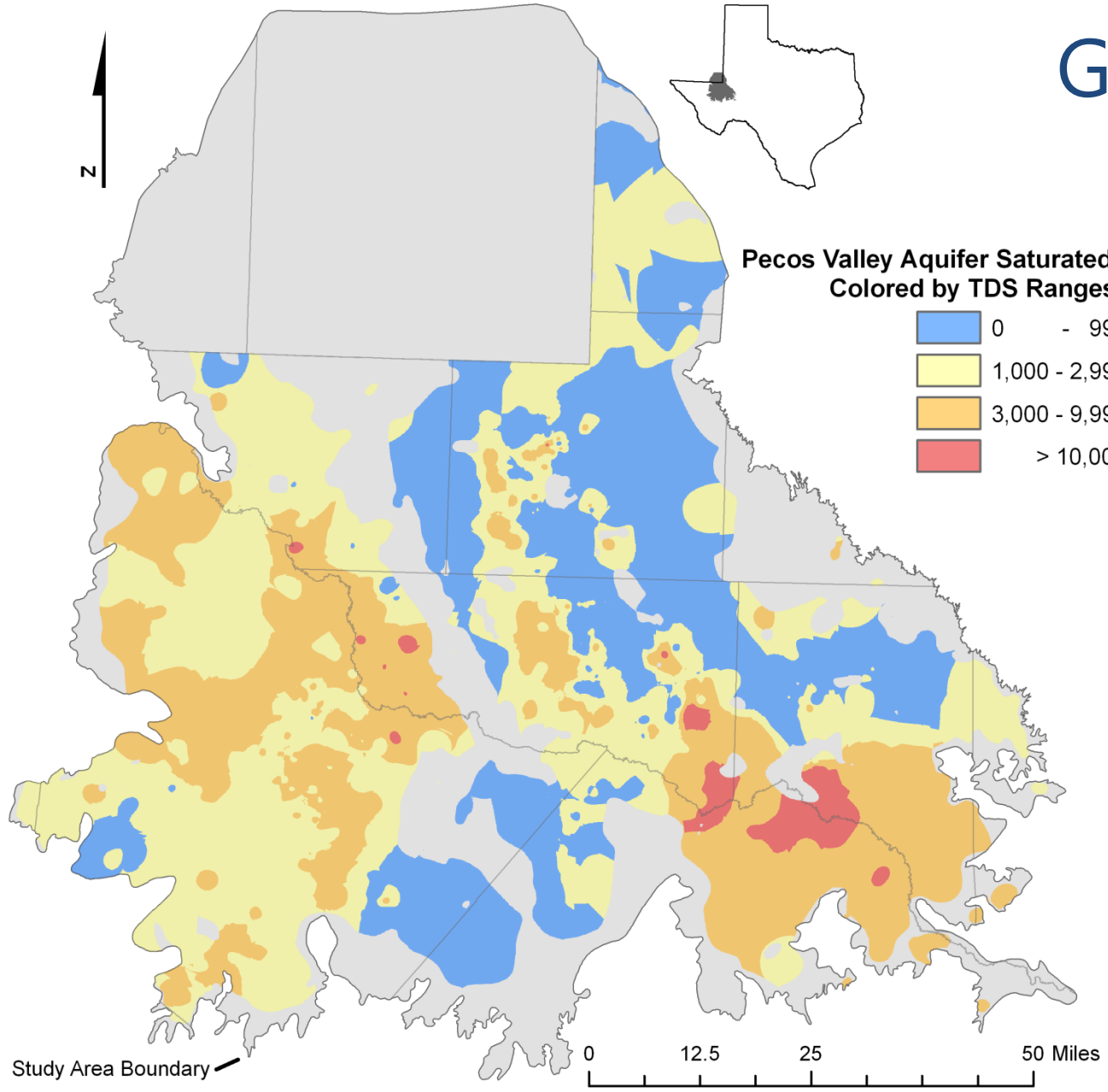
Groundwater Volumes



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

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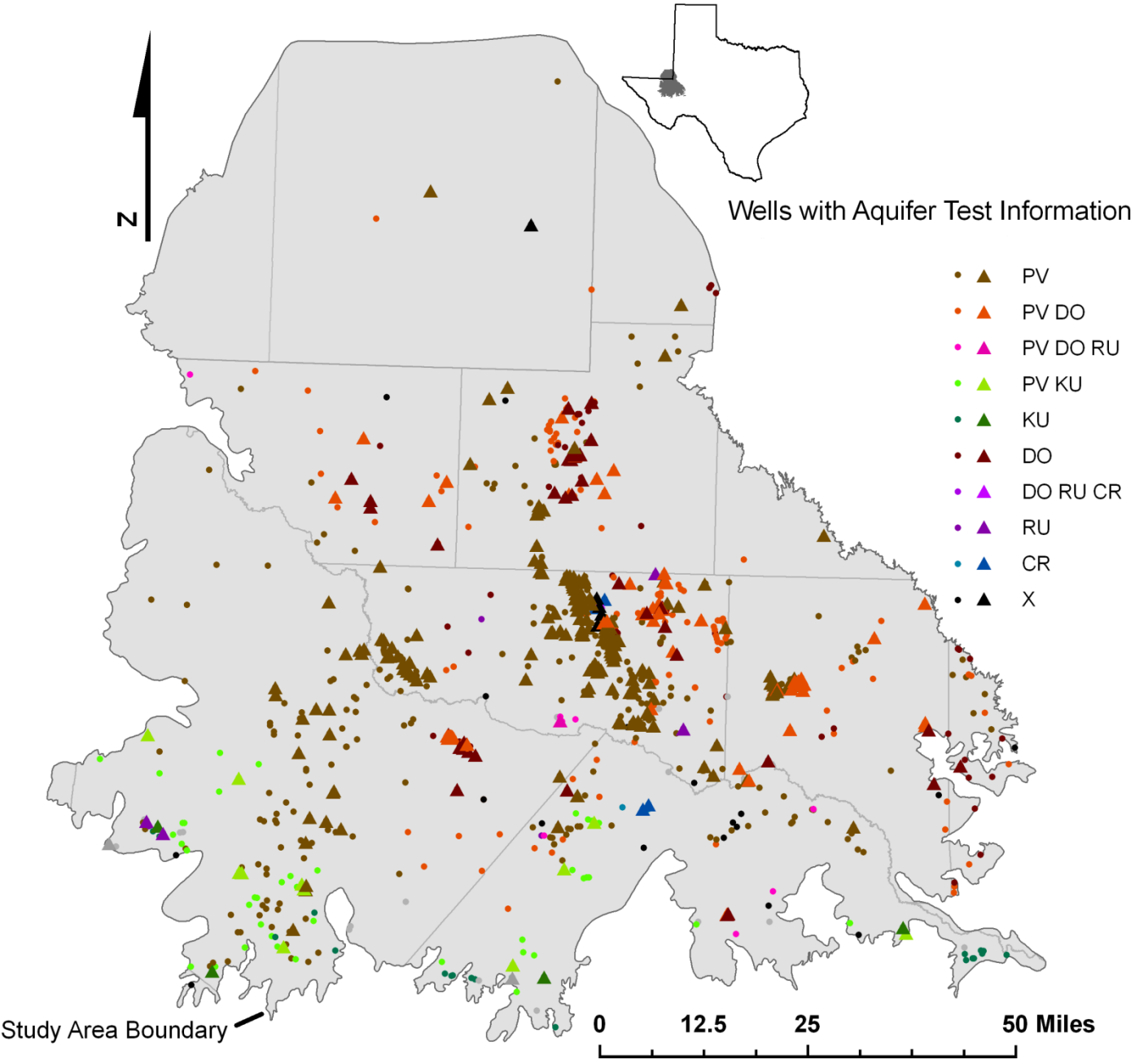
Aquifer Properties



Triangle = Aquifer Test Results

Dot = Well Yield Data

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

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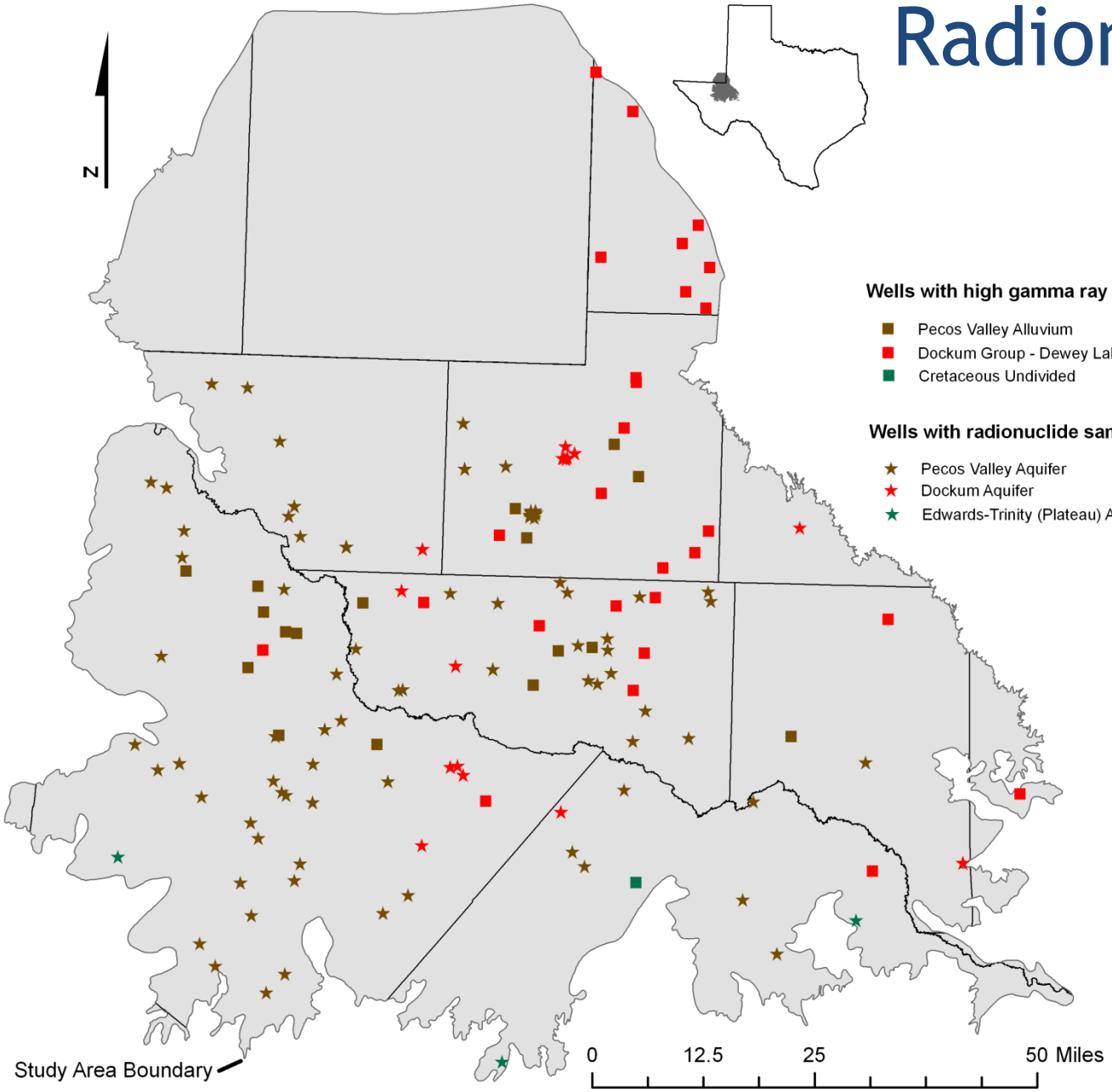
Desalination parameters of interest

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+}		

Radionuclides



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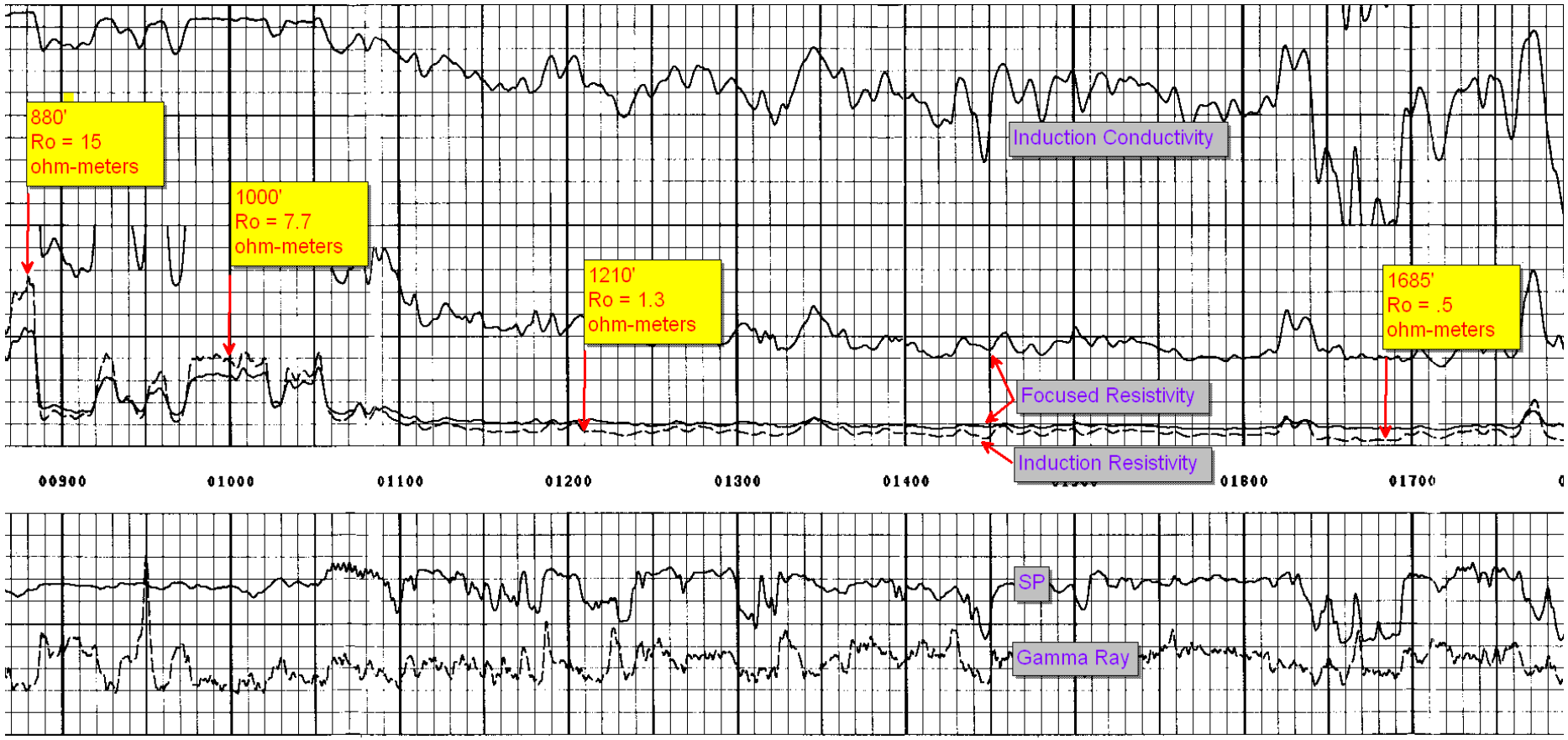
Geophysical Well Log Resistivity or SP used for Interpreting Formation Water TDS



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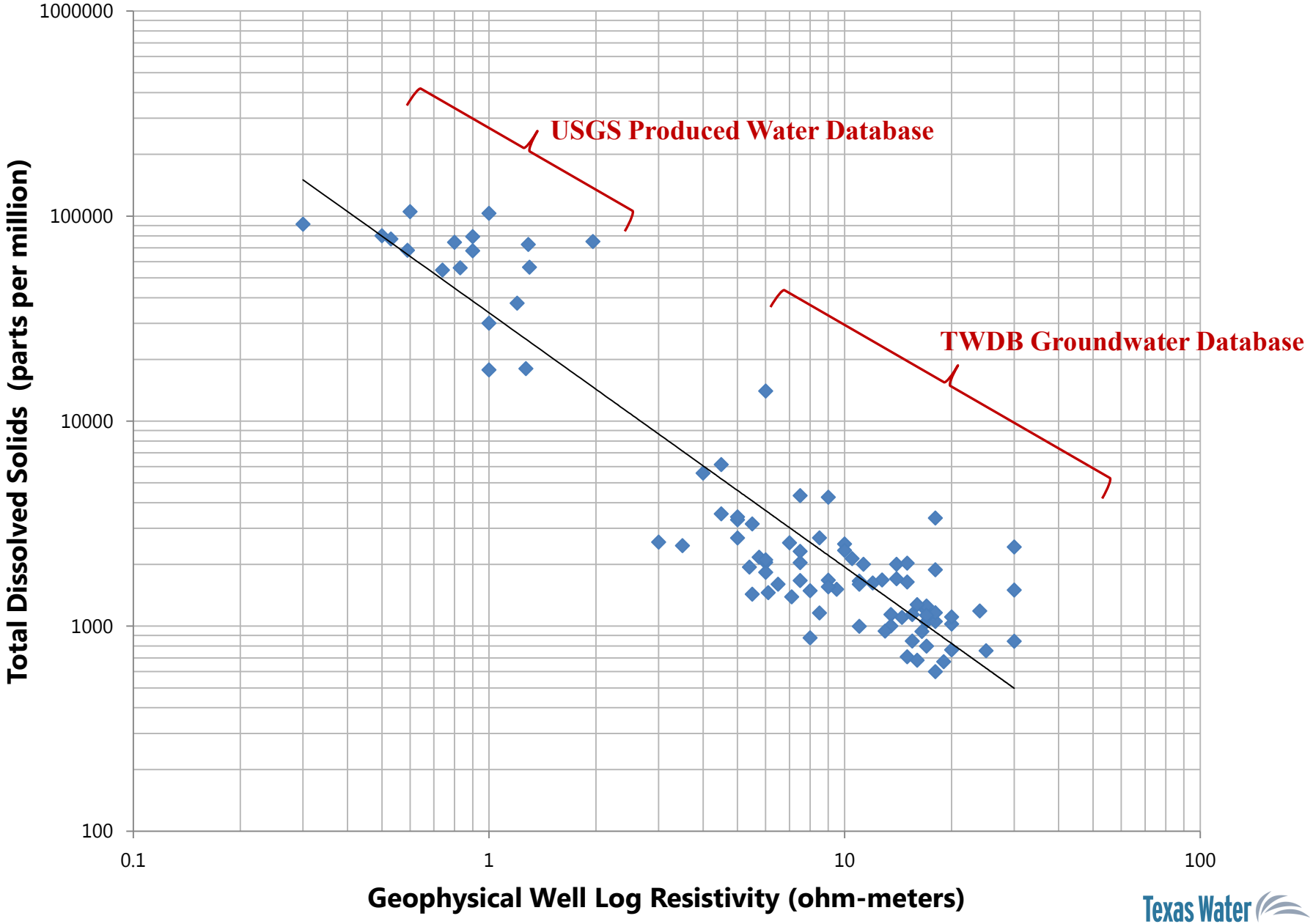
Mean Ro TDS Method



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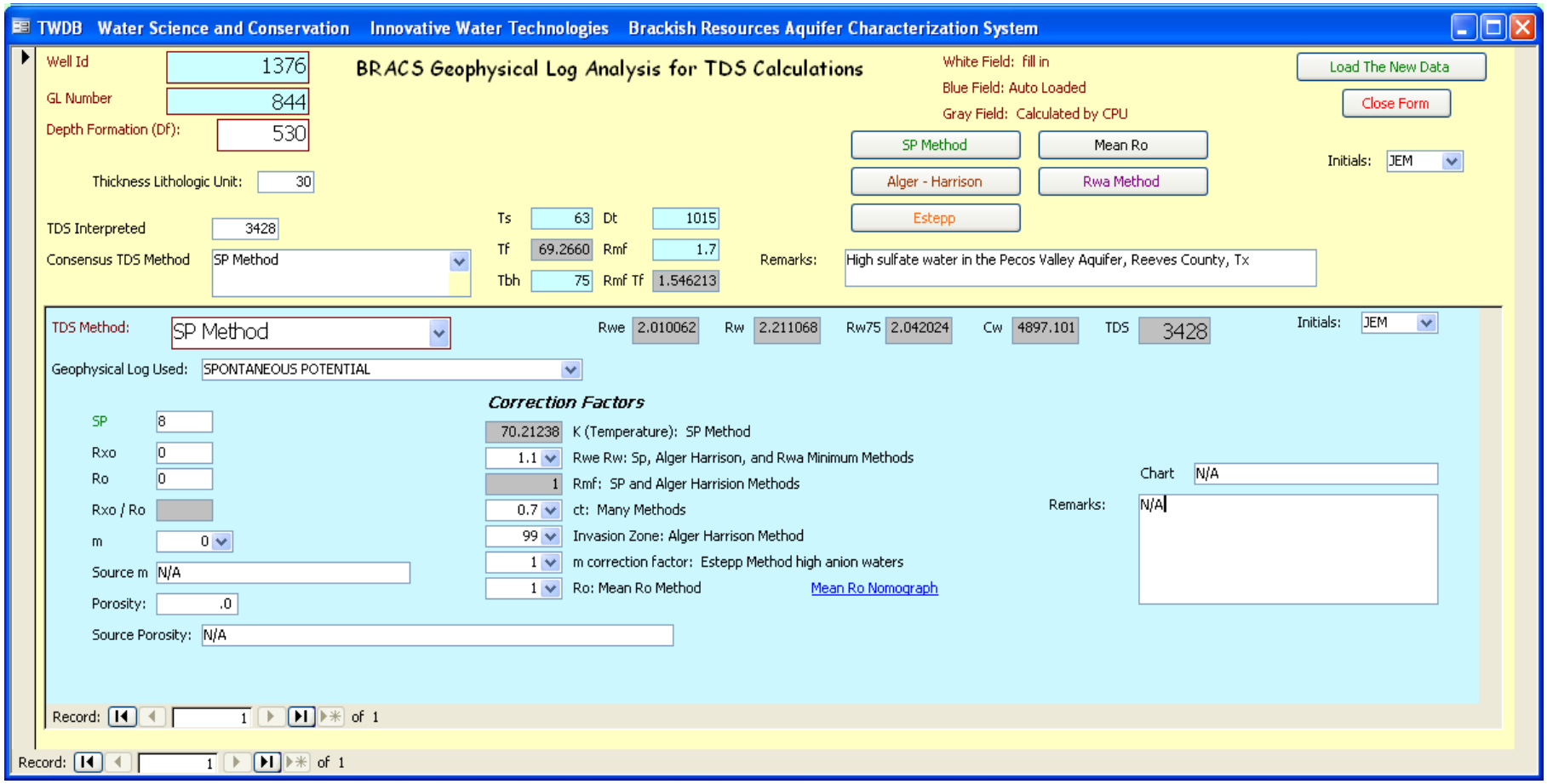
Calculation of TDS from geophysical well logs



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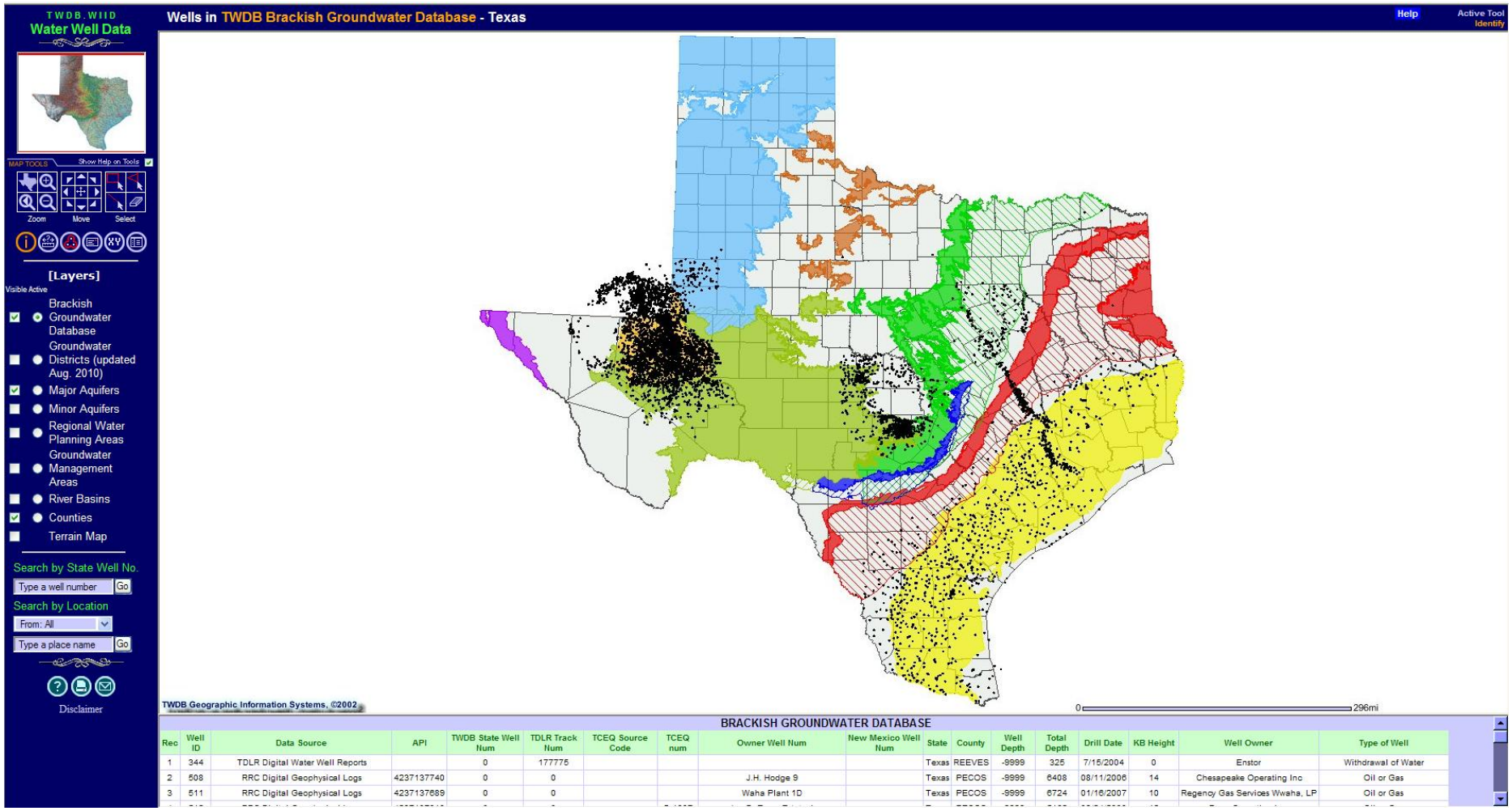
BRACS Database well locations in WIID(*)



Rec	Well ID	Data Source	API	TWDB State Well Num	TDLR Track Num	TCEQ Source Code	TCEQ num	Owner Well Num	New Mexico Well Num	State	County	Well Depth	Total Depth	Drill Date	KB Height	Well Owner	Type of Well
1	344	TDLR Digital Water Well Reports		0	177775					Texas	REEVES	-9999	325	7/15/2004	0	Enstor	Withdrawal of Water
2	508	RRC Digital Geophysical Logs	4237137740	0	0			J.H. Hodge 9		Texas	PECOS	-9999	6408	08/11/2006	14	Chesapeake Operating Inc	Oil or Gas
3	511	RRC Digital Geophysical Logs	4237137689	0	0			Waha Plant 1D		Texas	PECOS	-9999	6724	01/16/2007	10	Regency Gas Services Wwaha, LP	Oil or Gas

(*) WIID: Water Information Integration & Dissemination

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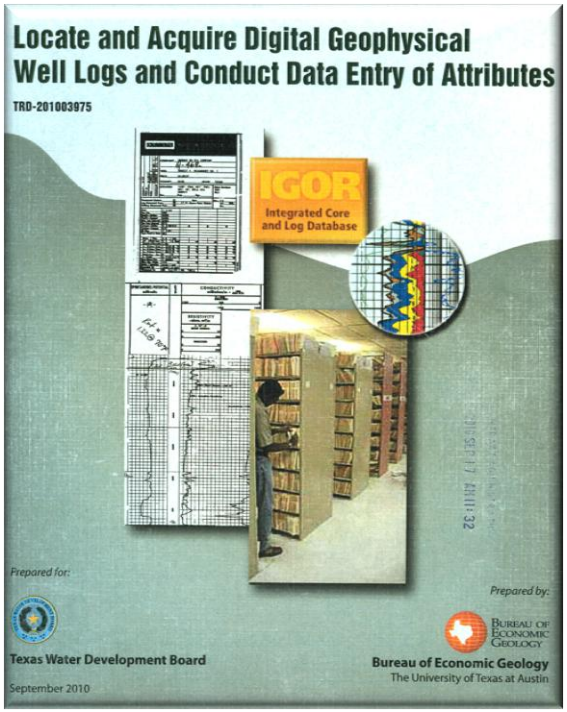
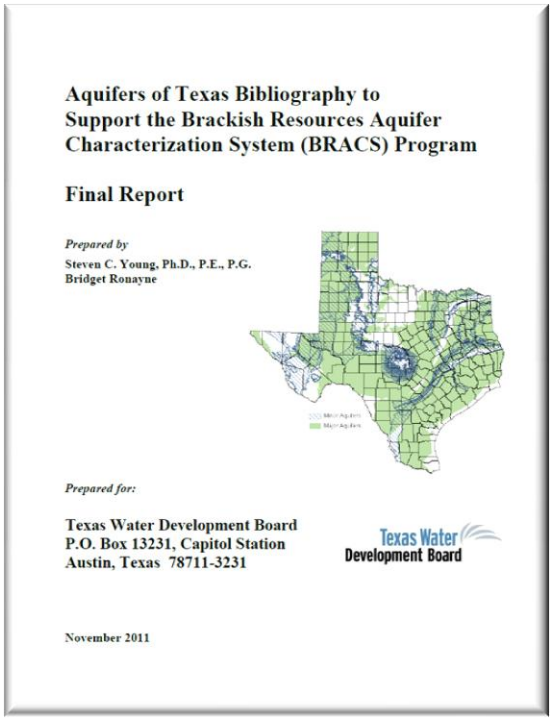
Contracted Studies

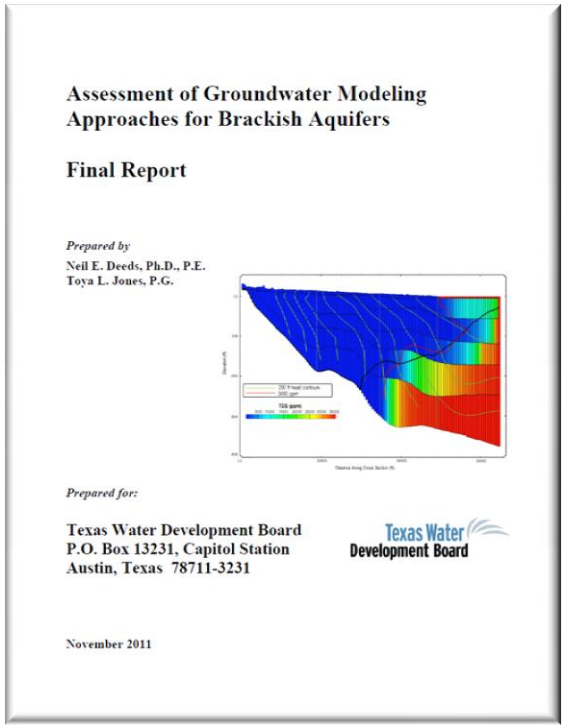
Well Log Collection



Geologic Bibliography



Variable Density Modeling



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Summary

- The 2003 Brackish Groundwater Manual estimated total volume of brackish groundwater in: Texas : > 2.7 billion acre-feet.
- Pecos Valley Aquifer: > 85 million acre-feet.
- 44 desalination water treatment plants
- Interest in brackish groundwater resources increasing
- TWDB's key role: provide the information to develop this resource.
- Each aquifer is different and techniques of analysis will need to fit data available.
- The BRACS data is an intermediate data set between the statewide approaches used in the past and site-specific resource development drilling and evaluation.

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