



**Brackish Groundwater
in the Gulf Coast Aquifer,
Lower Rio Grande Valley, Texas**

by
John Meyer, P.G.

*Region M Meeting
December 10, 2014*

Texas Water Development Board

The following presentation is based upon professional research and analysis within the scope of the Texas Water Development Board's statutory responsibilities and priorities but, unless specifically noted, does not necessarily reflect official Board positions or decisions.

Source: TWDB General Counsel



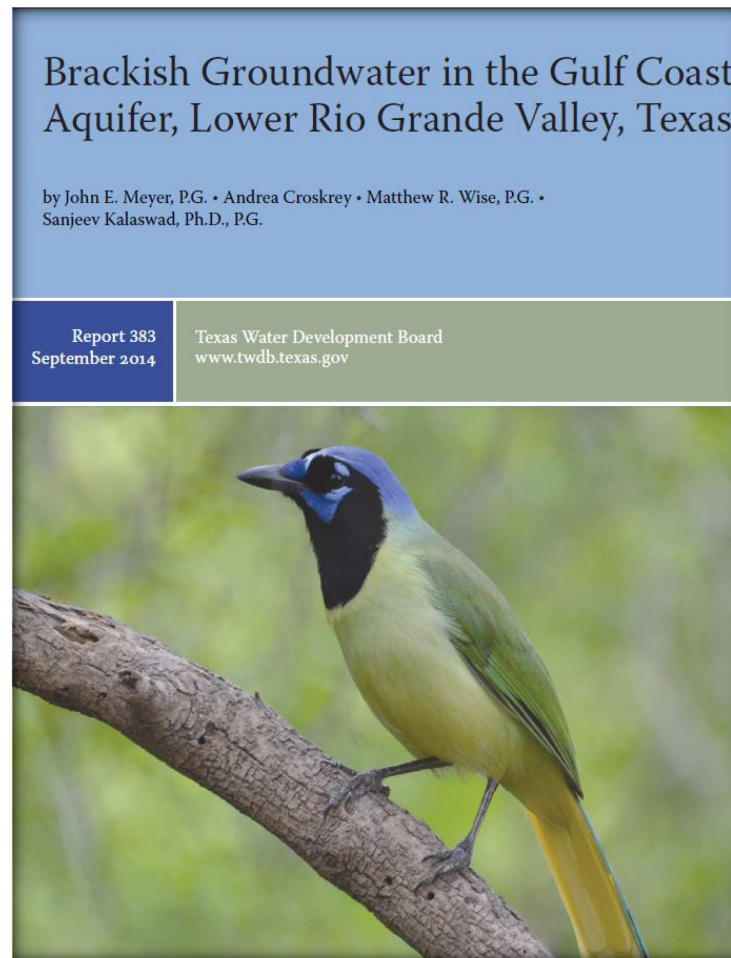
Why did we study the Lower Rio Grande Valley?

- Population will more than double in the next 50 years
1.7 to 3.9 million people
- Municipal water demand will more than double in the next 50 years
260,000 to 581,000 acre-feet per year
- Brackish groundwater use will more than quadruple in next 50 years
20,000 to 92,000 acre-feet per year
- Highest density of desalination plants in Texas
7 existing brackish groundwater desalination plants

Plans for additional 23 brackish groundwater desalination projects

What did we produce?

- Published report



- GIS Datasets
- BRACS Database
- Well logs

The real value is in the data:

Stakeholders can use this to evaluate potential groundwater exploration areas.



Sustainable and affordable water for Texas.

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Project Reports

Brackish Groundwater in the Gulf Coast Aquifer, Lower Rio Grande Valley, Texas

September 2014 | John E. Meyer, P.G., Andrea Croskrey, Matthew R. Wise, P.G., and Sanjeev Kalaswad, Ph.D., P.G.

The report presents information on the brackish groundwater resources of the Gulf Coast Aquifer in the Lower Rio Grande Valley, Texas, within Cameron, Hidalgo, Willacy, and eastern Starr counties. The study area is within the Rio Grande (Region M) Regional Water Planning Area and Groundwater Management Area 16. Water well information and geophysical well logs were used to map the three-dimensional extent of brackish groundwater salinity zones. The study area contains approximately 40 million acre feet of slightly saline groundwater (1,000 to 3,000 milligrams per liter total dissolved solids), 112 million acre-feet of moderately saline groundwater (3,000 to 10,000 milligrams per liter total dissolved solids), and 123 million acre-feet of very saline groundwater (10,000 to 35,000 milligrams per liter total dissolved solids).

The methodology used to prepare and assess this information is described in various sections of this report. The GIS datasets are described in the report appendix and are available on this website in a format that has been compressed with the WinZip utility.

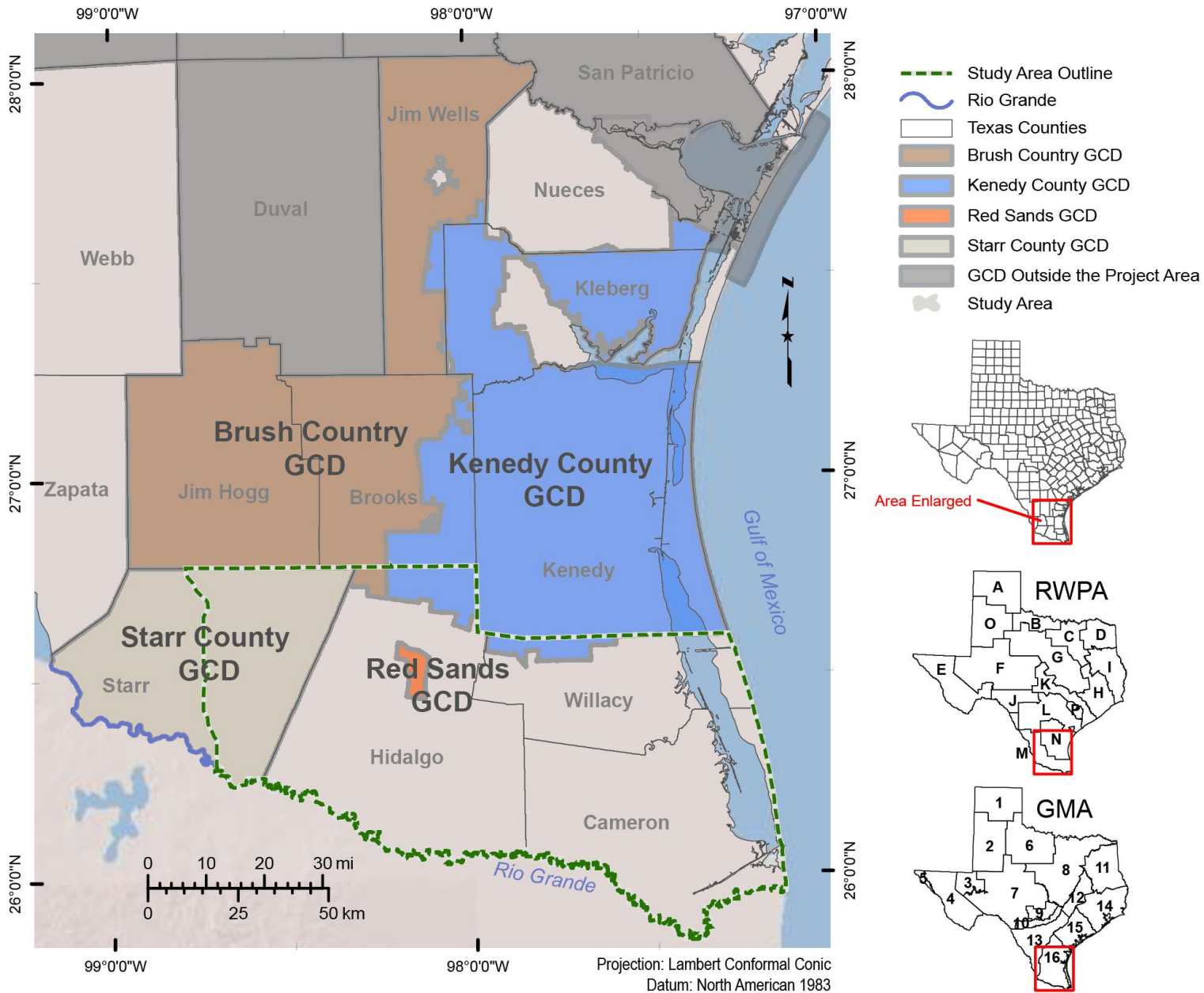
- [Brackish Groundwater in the Gulf Coast Aquifer, Lower Rio Grande Valley, Texas, September 2014](#)(36.8 MB)
- [Gulf Coast Aquifer GIS Datasets](#) (127.0 MB)

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Where is the study area?



Source: Lower Rio Grande Valley BRACS Study

What were the study objectives?

- Collect water well reports and oil/gas geophysical well logs
- Compile all data into BRACS Database
- Map salinity areas (2-dimensional) with a unique vertical salinity profile
- Create 3-dimensional salinity zone GIS datasets
- Map sand and clay layers within the Gulf Coast Aquifer
- Determine volumes of brackish groundwater
- Water quality parameter maps
- Aquifer property maps
- Study deliverables: Report, database, GIS datasets, and well logs

Groundwater Salinity Classification

Groundwater Salinity Classification	Salinity Zone Code	Total Dissolved Solids Concentration (units: milligrams per liter)
Fresh	FR	0 to 1,000
Slightly Saline	SS	1,000 to 3,000
Moderately Saline	MS	3,000 to 10,000
Very Saline	VS	10,000 to 35,000
Brine	BR	Greater than 35,000

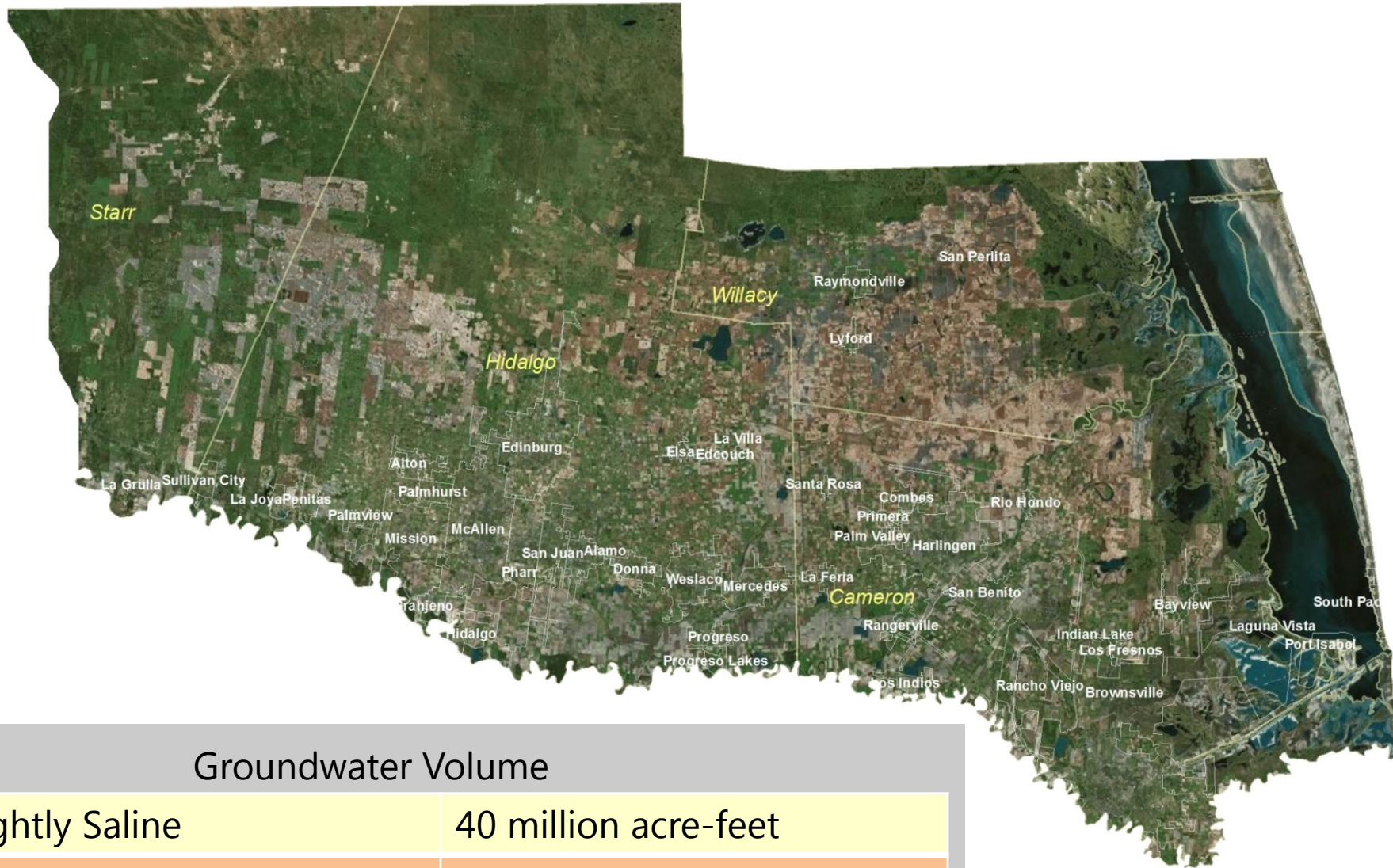
← Drinking Water Limit

← Major/Minor Aquifer Mapped Limit

← Seawater

Source: modified from Winslow and Kister, 1956

How much groundwater is there?

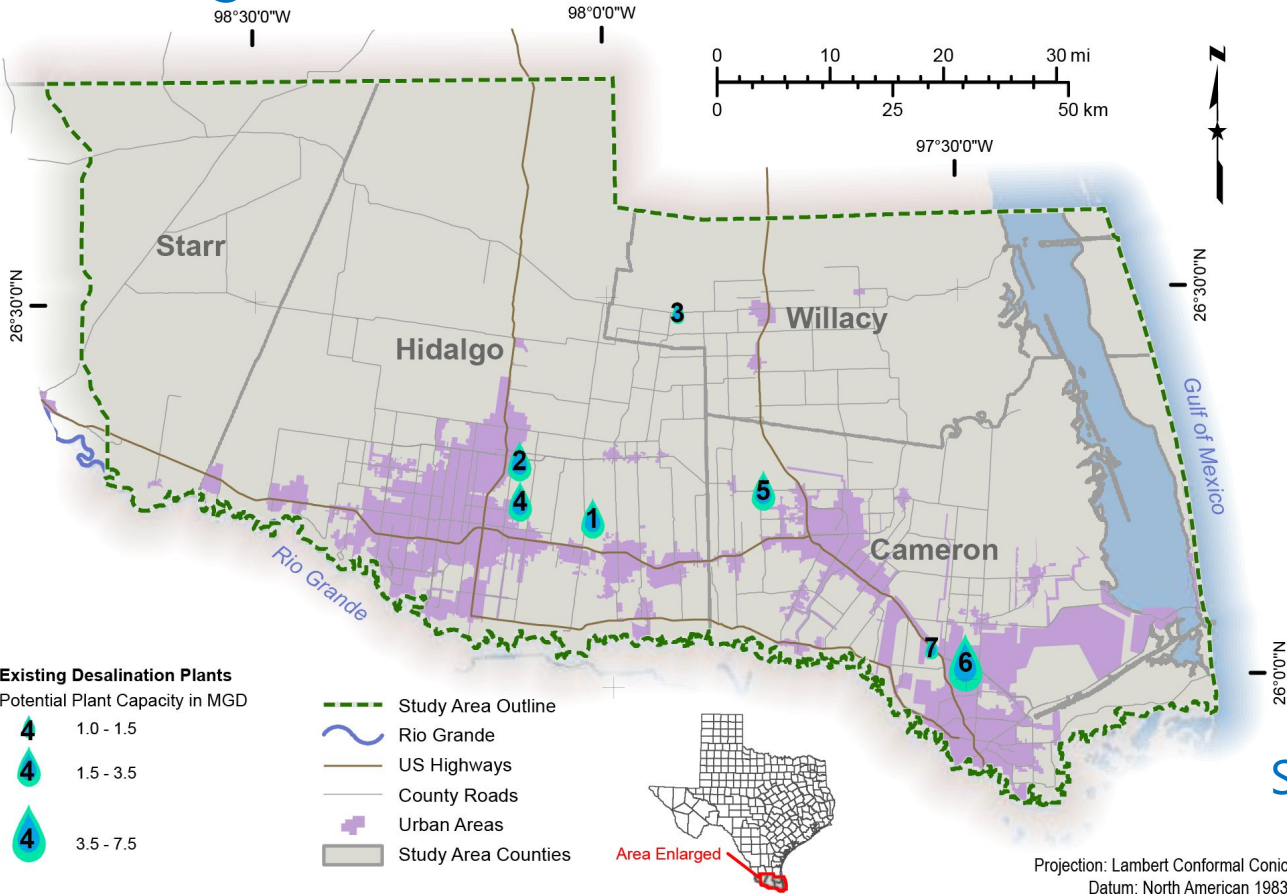


Groundwater Volume

Slightly Saline	40 million acre-feet
Moderately Saline	112 million acre-feet
Very Saline	123 million acre-feet

Source: Lower Rio Grande Valley BRACS Study

Existing Desalination Plants



Salinity zones used by plants

SS = Slightly Saline

MS = Moderately Saline

MS Deep

SS Deep and MS Deep

SS Deep

SS Deep

MS Deep

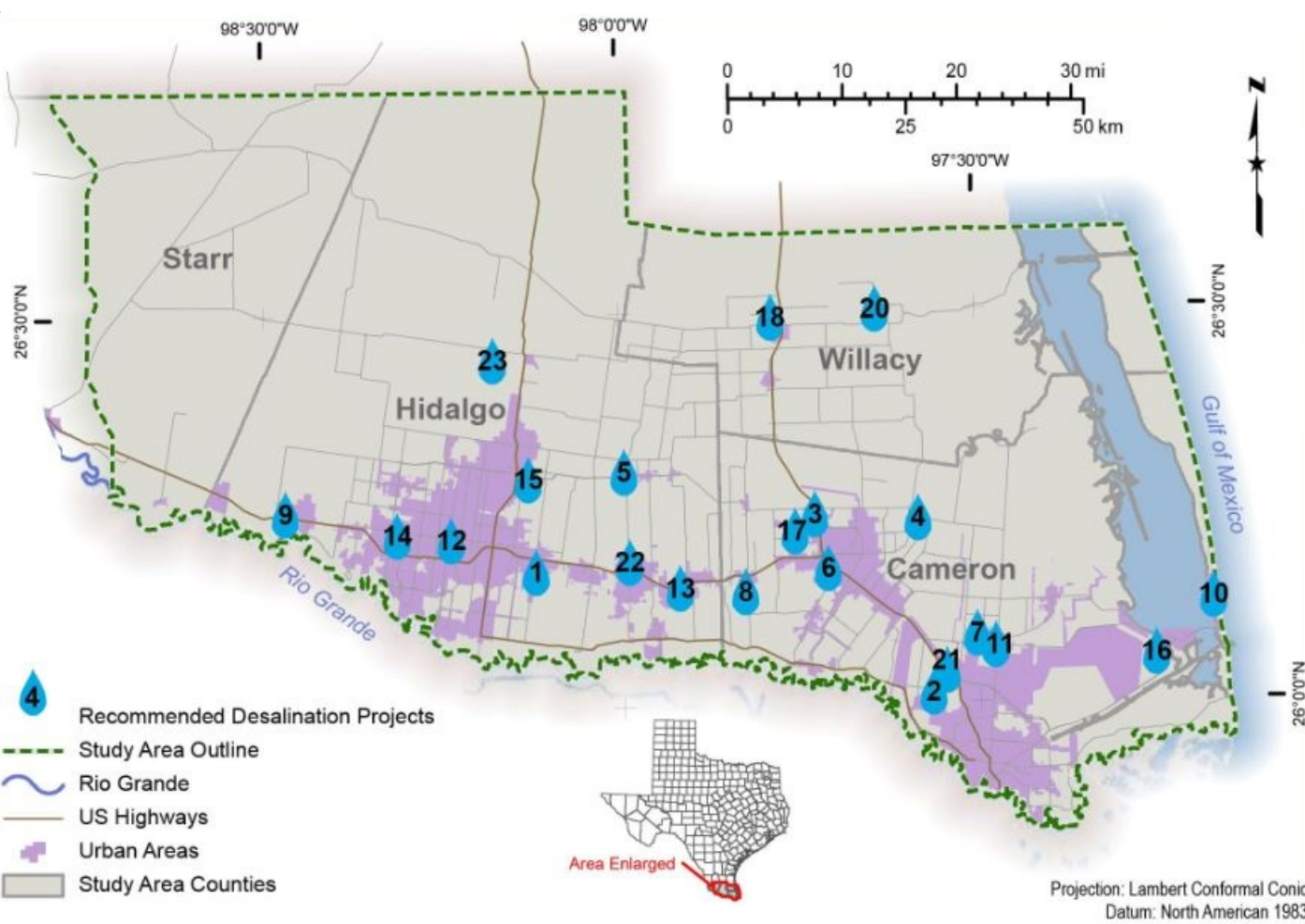
SS Deep

MS Deep

ID	Plant Name	Potential Plant Capacity (MGD)
1	North Alamo Water Supply Corporation (Donna)	2.25
2	North Alamo Water Supply Corporation (Doolittle)	3.50
3	North Alamo Water Supply Corporation (Lasara)	1.20
4	North Alamo Water Supply Corporation (Owassa)	2.00
5	North Cameron/Hidalgo WA	2.50
6	Southmost Regional Water Authority	7.50
7	Valley MUD #2	1.00

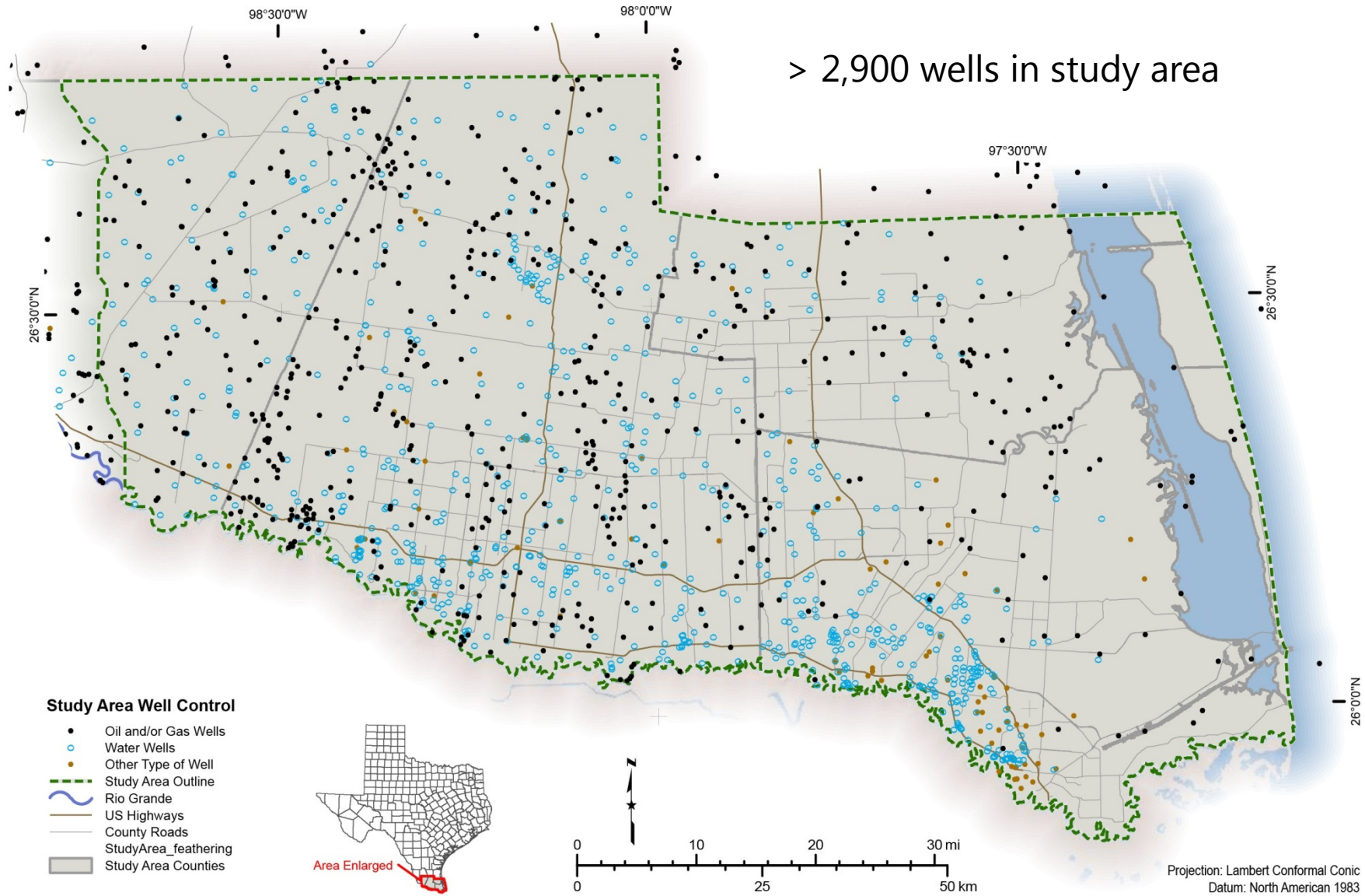
Source: Lower Rio Grande Valley BRACS Study

Recommended Desalination Plants



ID	Proposed Area or Name
1	Alamo
2	Brownsville
3	Combes
4	East Rio Honda WSC
5	Elsa
6	Harlingen
7	Indian Lake
8	La Feria
9	La Joya
10	Laguna Madre WD
11	Los Fresnos
12	McAllen
13	Mercedes
14	Mission
15	North Alamo WSC
16	Port Isabel
17	Primera
18	Raymondville
19	Rio Grande City
20	San Perlita
21	Valley MUD 2
22	Weslaco
23	County - Other

Well Control: oil/gas and water wells



Source: Lower Rio Grande Valley BRACS Study

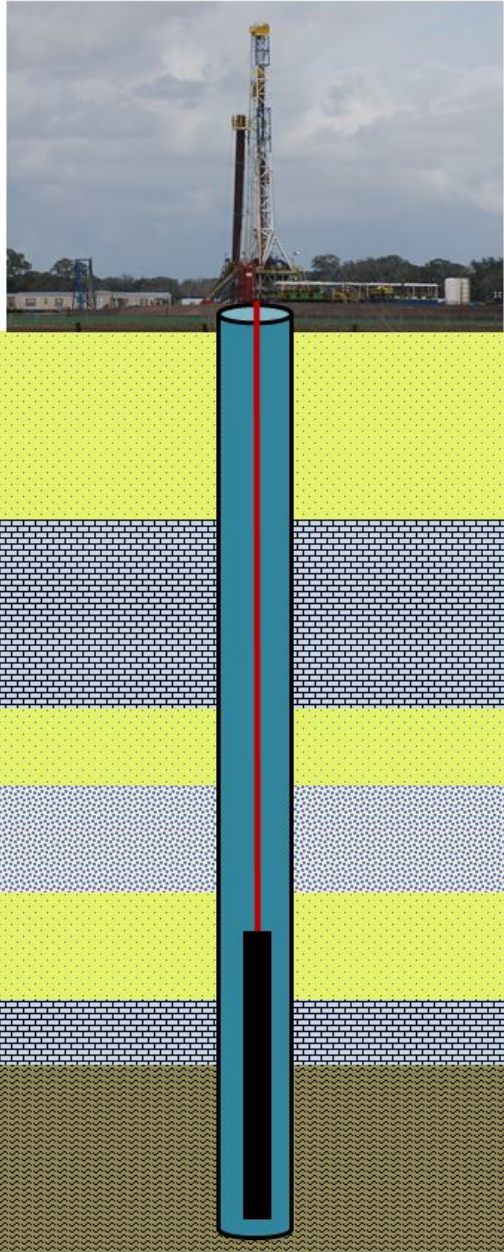
Water Well Log

ATTENTION OWNER: Confidentiality Privilege Notice on Reverse Side		STATE OF TEXAS WATER WELL REPORT	
1) OWNER: MERCEDES, CITY OF		ADDRESS: P.O. BOX 837	CITY: MERCEDES STATE: TX ZIP: 78570-
2) ADDRESS OF WELL		SEE ATTACHED MAP	GRID # 5)
3) TYPE OF WORK: NEW WELL		4) PROPOSED USE: PUBLIC SUPPLY If Public Supply well, were plans submitted to the TMRCC?	
6) WELL LOG: 28276	DIAMETER OF HOLE		7) DRILLING METHOD:
DATE DRILLING:	DIAMETER	FROM	TO
STARTED: 05/06/96	40	0	48
COMPLETED: 05/30/96	30	48	400
		8) BOREHOLE COMPLETION:	
		GRAVEL PACKED	
		IF GRAVEL... FROM 180 FT. TO 400 FT.	
		FROM FT. TO FT.	
CASING, BLANK PIPE, AND WELL SCREEN DATA: (CONTINUED ON NEXT PAGE)			
DIA	NEW/USED	DESCRIPTION	FROM TO GAGE CASING SCREEN
36	N	STEEL CASING	0 48 .375
16	N	STEEL CASING	0 215 .375
16	N	STAINLESS ST. SCREEN	215 255 .025
16	N	STEEL CASING	255 273 .0375
16	N	STAINLESS ST. SCREEN	273 335 .025
16	N	STEEL CASING	335 365 .375
9) CEMENTING DATA:			
CEMENTED FROM		No. of Sacks Used	
0 FT. TO 180 FT.		750	
FT. TO FT.			
Method used: TRIMMY LINE			
Cemented by: RICHARDSON WATER WEL			
Distance to septic field lines: ft.			
Method of verification of above distance:			
10) SURFACE COMPLETION:			
SURFACE SLAB INST.			
11) WATER LEVEL:			
STATIC LEVEL : 32 FT.		DATE: 05/30/96	
ARTESIAN FLOW: GPM.		DRILL:	
12) PACKERS:			
	TYPE	DEPTH	
	-----	---	
	-----	---	
13) TYPE PUMP:			
TURBINE			
DEPTH TO PUMP: 140			
14) WELL TEST:			
PUMP			
YIELD: 1400 GPM WITH 48 FT DRAWDOWN AFTER 36 HRS			
15) WATER QUALITY:			
TYPE OF WATER: GOOD		DEPTH OF STRATA:	
NO STRATA OF UNDESIRABLE WATER PENETRATED			
CHEMICAL ANALYSIS MADE			
COMPANY NAME: RICHARDSON WATER WELL		WATER WELL DRILLER'S LICENSE NO.: 1678 OR 1679	
ADDRESS: 808 LINCOLN		CITY: ALICE STATE: TX ZIP CODE: 78332	
		FOR TWC USE ONLY	
		WELL NO. _____	
		LOCATED ON MAP _____	
I HEREBY CERTIFY THAT THIS WELL WAS DRILLED BY ME (OR UNDER MY SUPERVISION) AND THAT EACH AND ALL OF THE STATEMENTS HEREIN ARE TRUE TO THE BEST OF MY KNOWLEDGE AND BELIEF. I UNDERSTAND THAT FAILURE TO COMPLETE ITEMS 1 THRU 15 WILL RESULT IN THE LOG(S) BEING RETURNED FOR COMPLETION AND RESUBMITTAL.			
(signed) _____		(signed) _____	
(LICENSED WATER WELL DRILLER)		(REGISTERED DRILLER TRAINEE)	

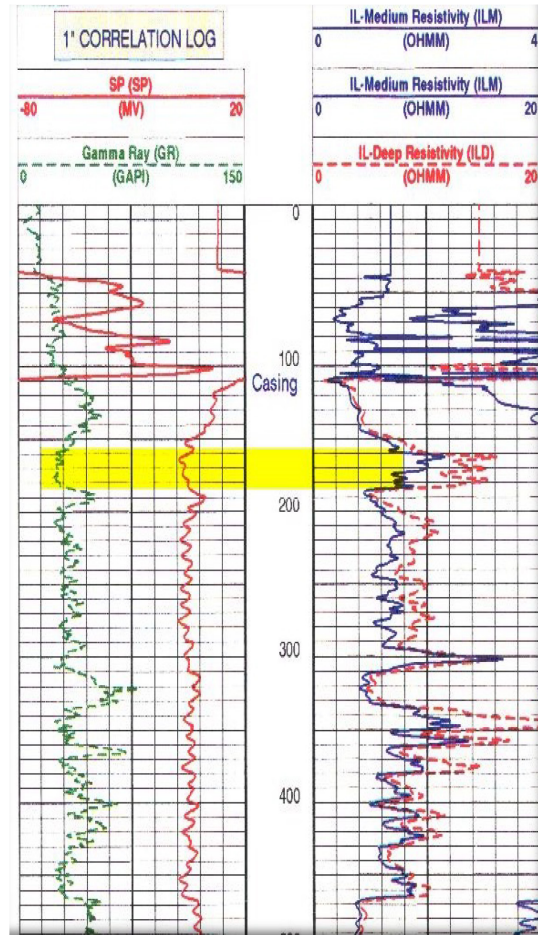
- Geology (sand, clay, ... depositional environment)
- Well screen
- Aquifer productivity
- Water quality
- Static water level

Geophysical Well Log.

A tool or combination of tools lowered into a borehole on a wireline and retrieved to the surface.

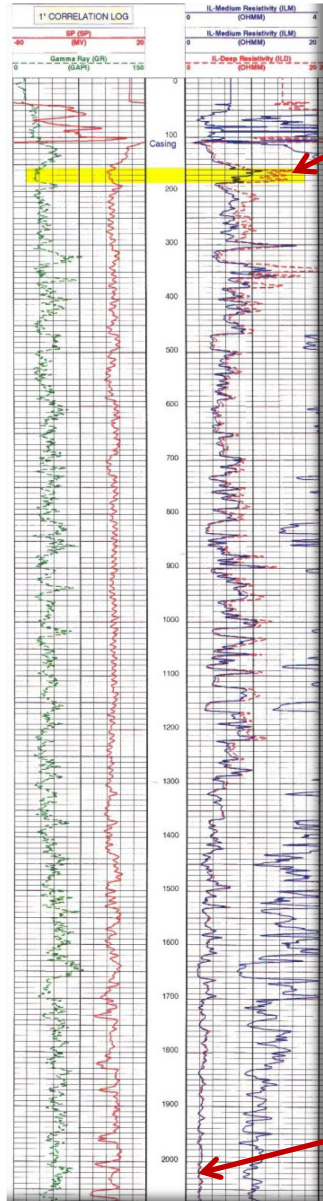


Example log



How do you interpret the log to estimate salinity?

Resistivity



High resistivity

low resistivity

Resistivity is measured by a variety of tools. (shallow and deep investigation).

Resistivity is a function of the:

- geologic formation
- groundwater
 - ✓ fresh = high resistivity
 - ✓ saline = low resistivity

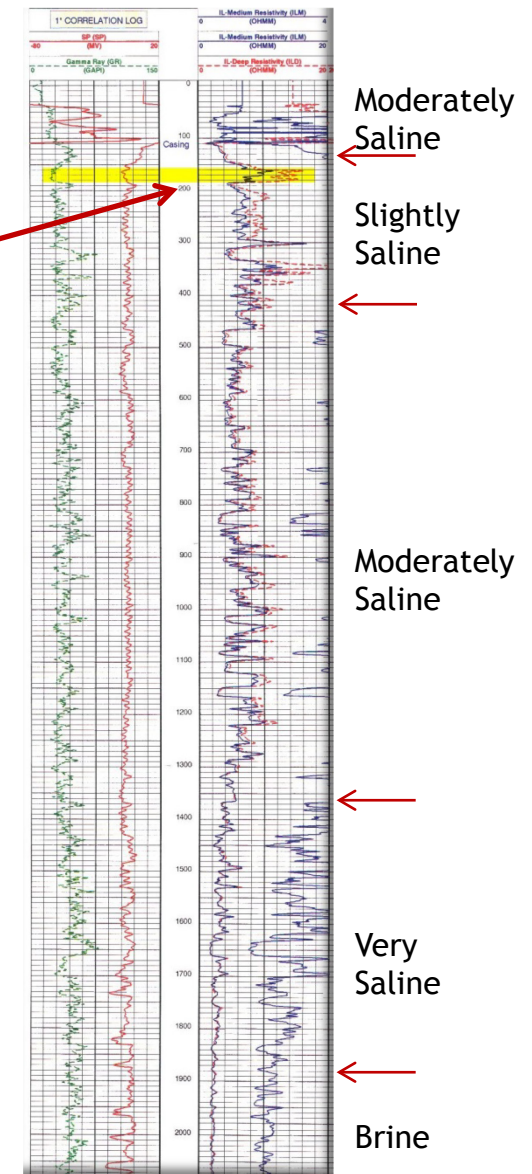
Correction factors are used to calculate the resistivity of the groundwater component and convert this to estimated total dissolved solids.

Log Analysis



We calibrate log resistivity interpretations with nearby water quality data.

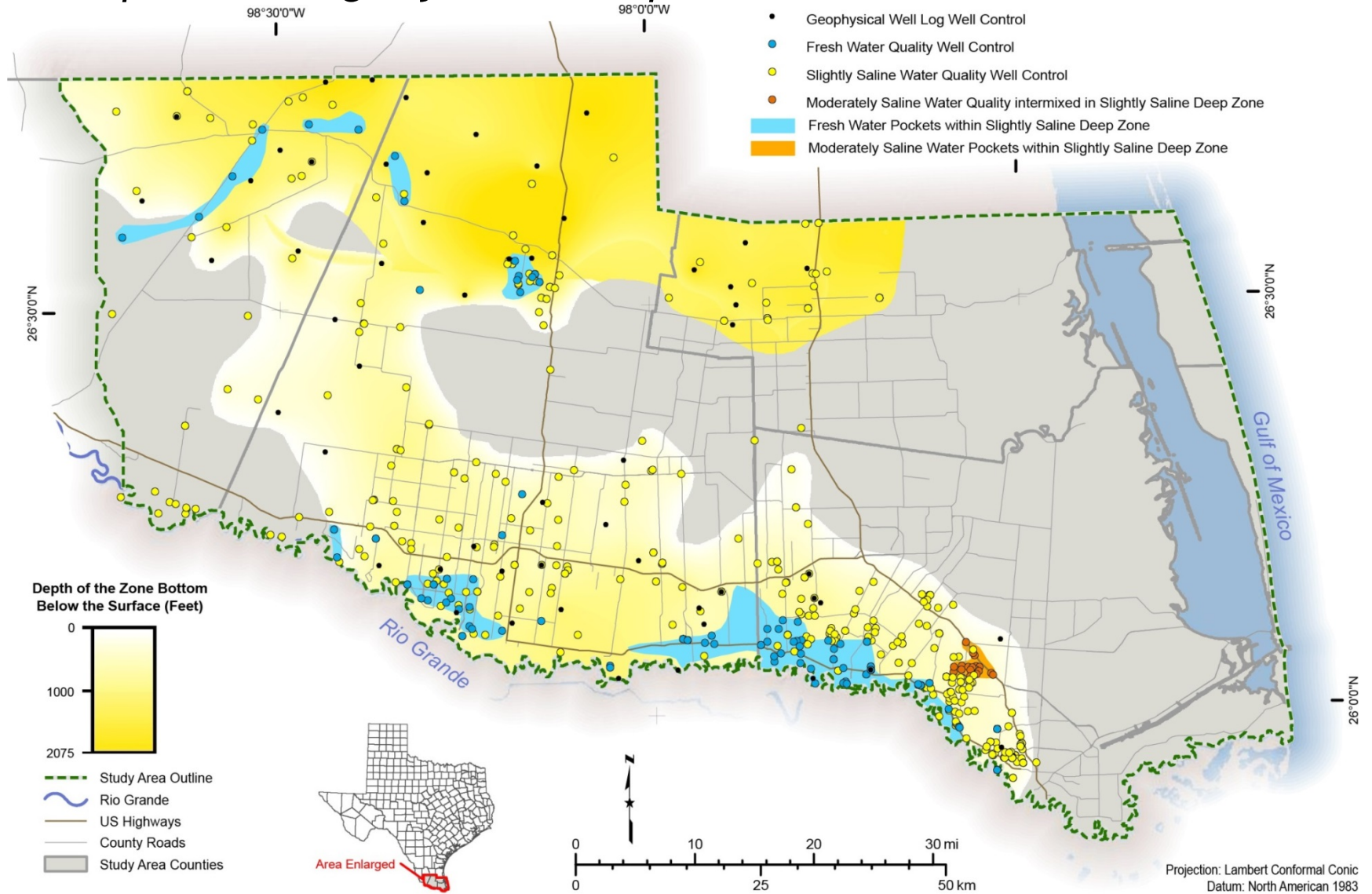
We continue to interpret the log to the base of the Gulf Coast Aquifer.



BRACS Well ID 42889

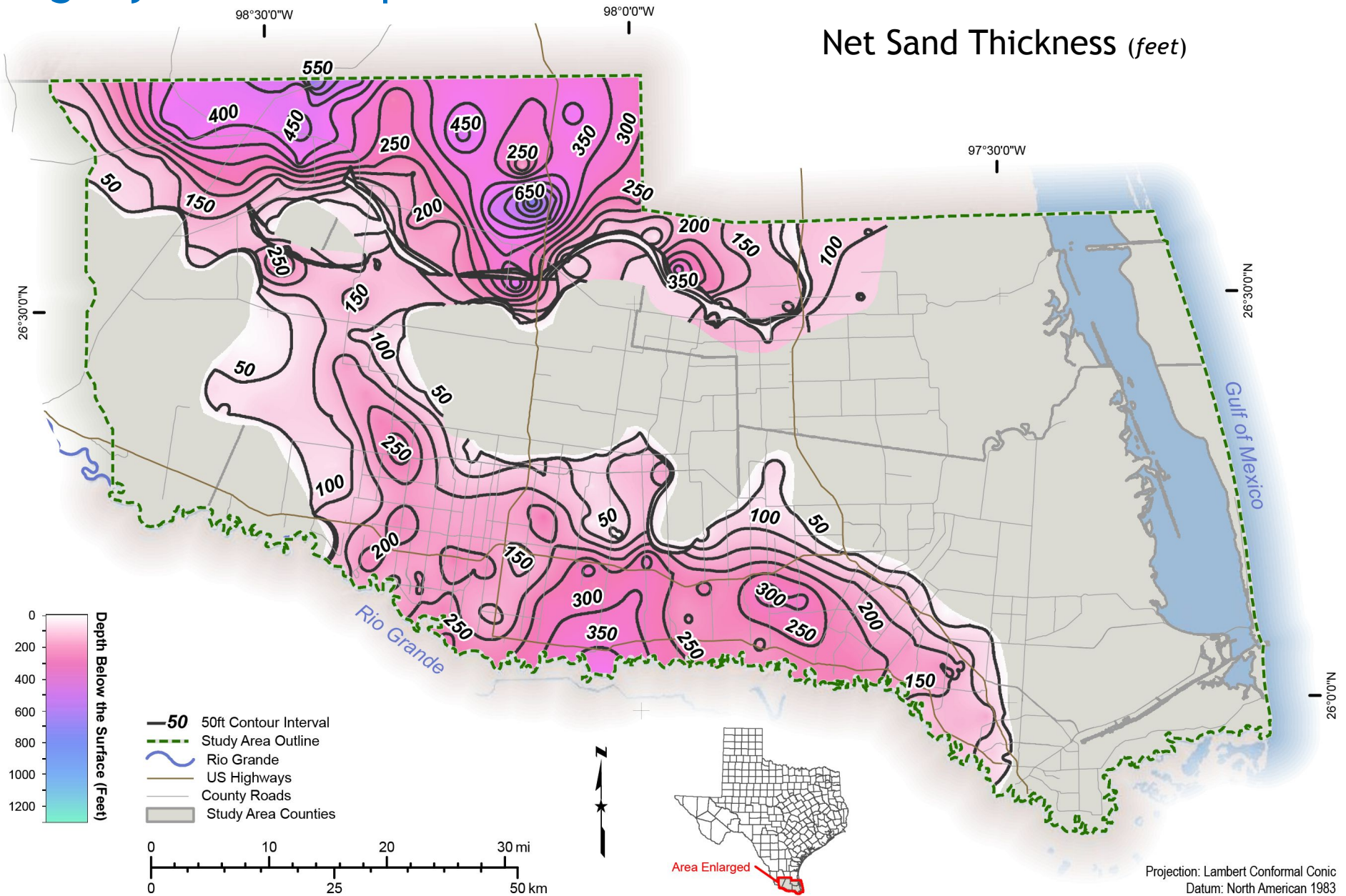
Map TDS data and log interpretations in 3-dimensions.

Example: the Slightly Saline Deep Zone



Source: Lower Rio Grande Valley BRACS Study

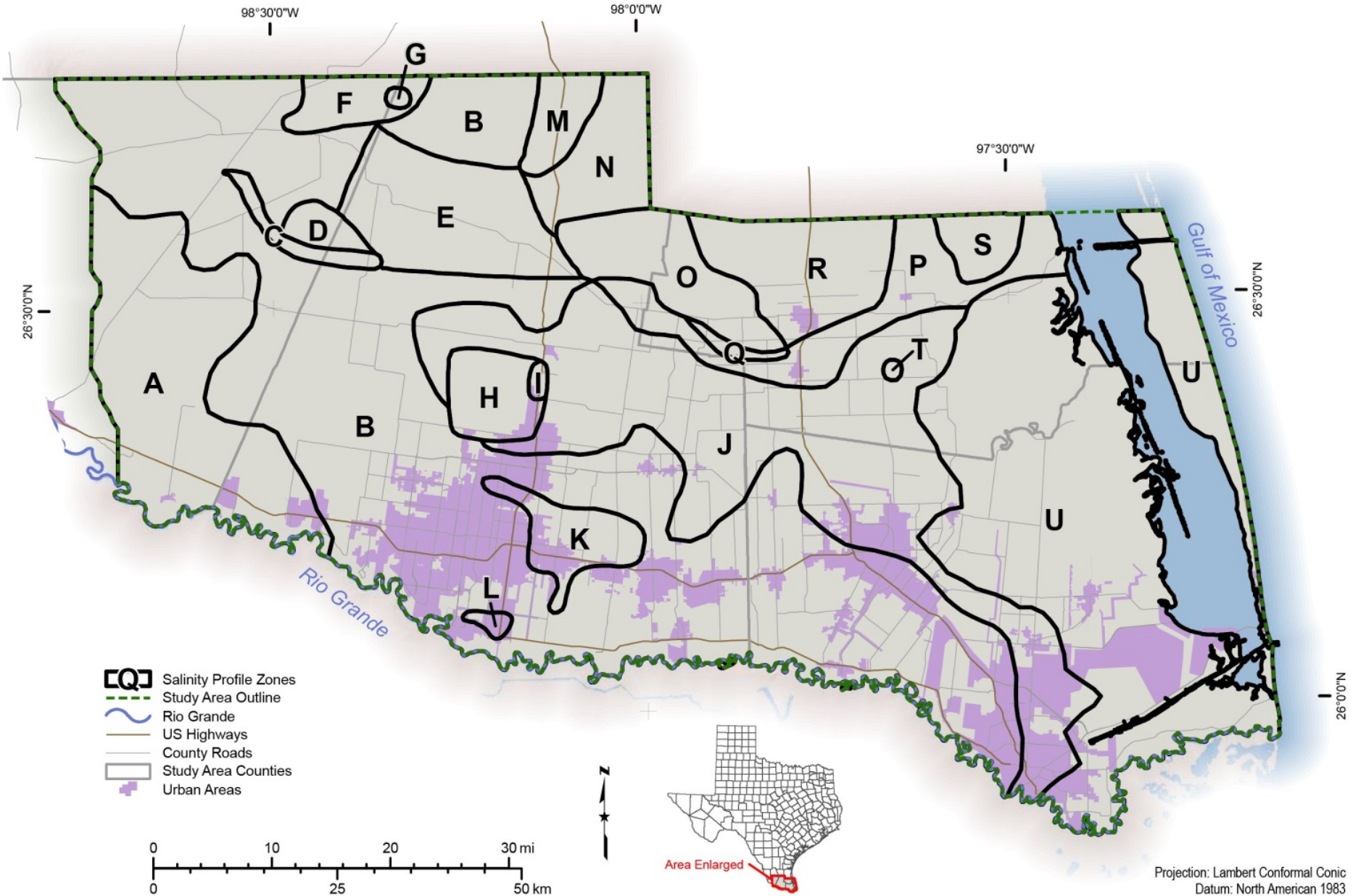
Slightly Saline Deep Zone



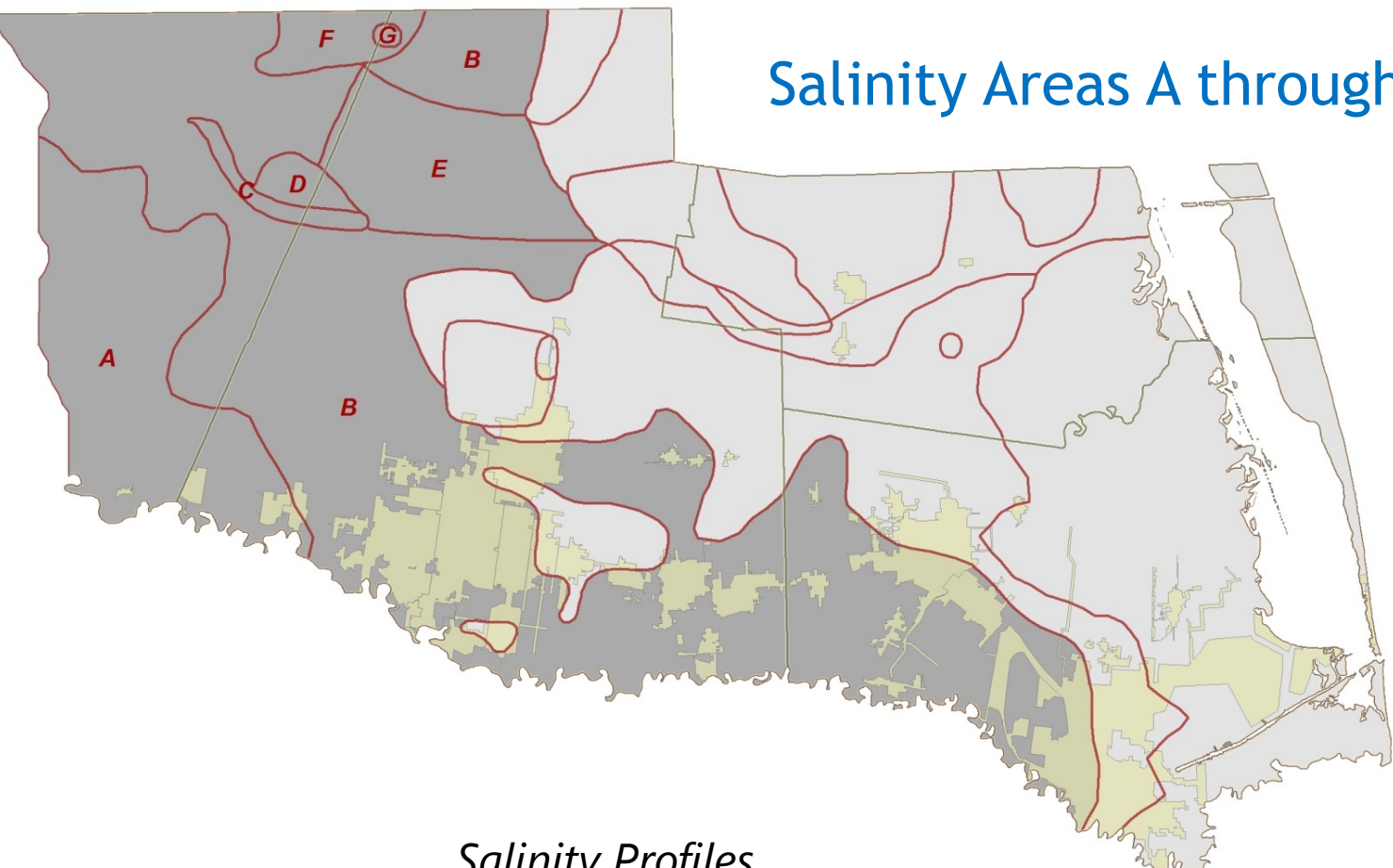
Source: Lower Rio Grande Valley BRACS Study

What did we find?

21 Salinity Areas Labeled A - U



Salinity Areas A through G



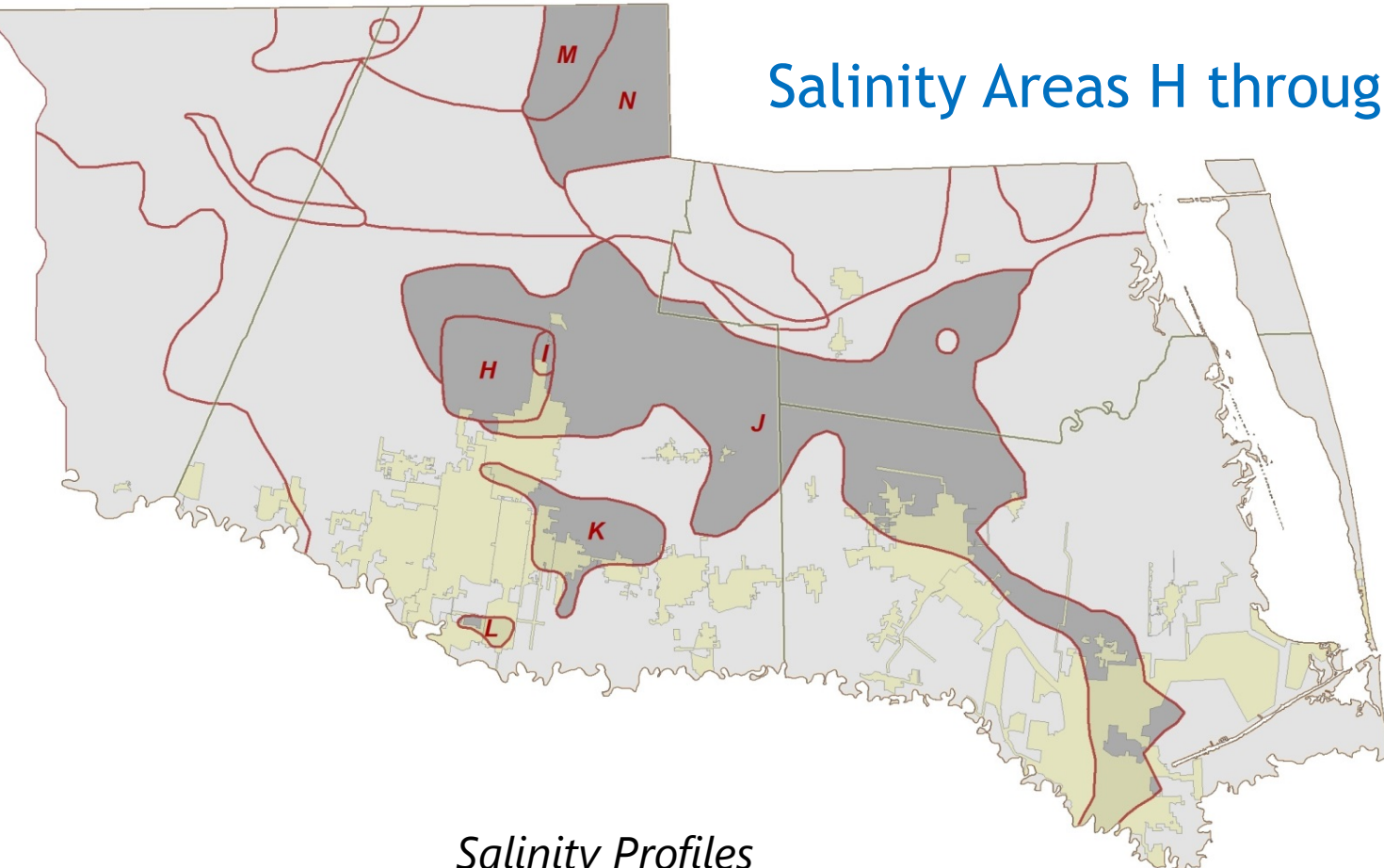
Salinity Profiles

A	B	C	D	E	F	G
				SS Shallow 2		VS Shallow 1
		MS Shallow 5		MS Intermediate 1	MS Shallow 4	MS Shallow 4
	SS Deep	SS Deep		SS Deep	SS Deep	SS Deep
MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep
VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep
BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep

Groundwater Salinity Classification	Total Dissolved Solids Concentration (units: milligrams per liter)
Fresh	0 to 1,000
Slightly Saline	1,000 to 3,000
Moderately Saline	3,000 to 10,000
Very Saline	10,000 to 35,000
Brine	Greater than 35,000

Source: Lower Rio Grande Valley BRACS Study

Salinity Areas H through N



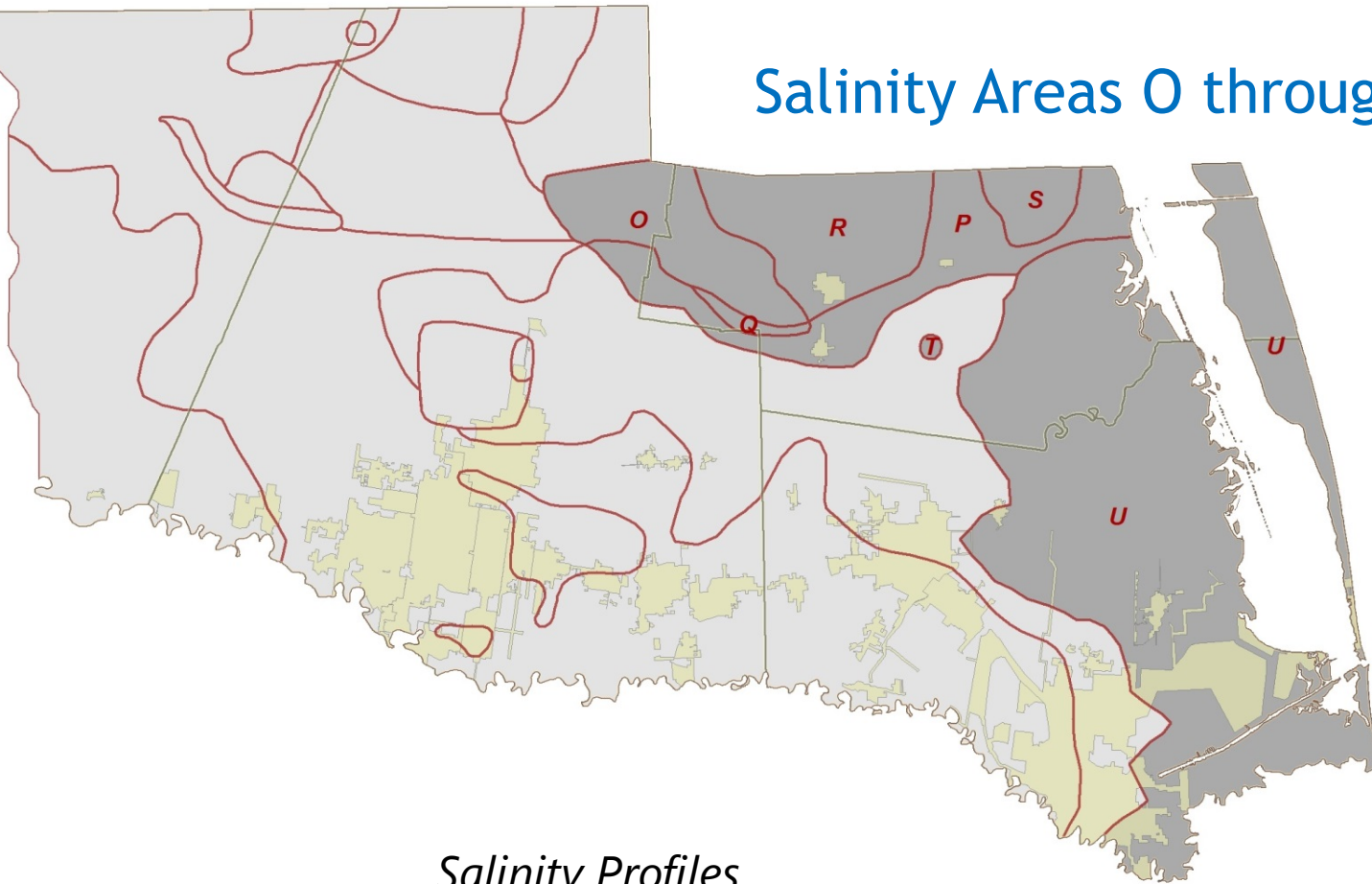
Salinity Profiles

H	I	J	K	L	M	N
	VS Shallow 3			SS Shallow 1	VS Shallow 2	
MS Shallow 2	MS Shallow 2		MS Shallow 1	MS Intermediate 2	MS Intermediate 1	MS Intermediate 1
SS Intermediate	SS Intermediate		SS Deep	SS Deep	SS Deep	SS Deep
MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep
VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep
BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep

Groundwater Salinity Classification	Total Dissolved Solids Concentration (units: milligrams per liter)
Fresh	0 to 1,000
Slightly Saline	1,000 to 3,000
Moderately Saline	3,000 to 10,000
Very Saline	10,000 to 35,000
Brine	Greater than 35,000

Source: Lower Rio Grande Valley BRACS Study

Salinity Areas O through U

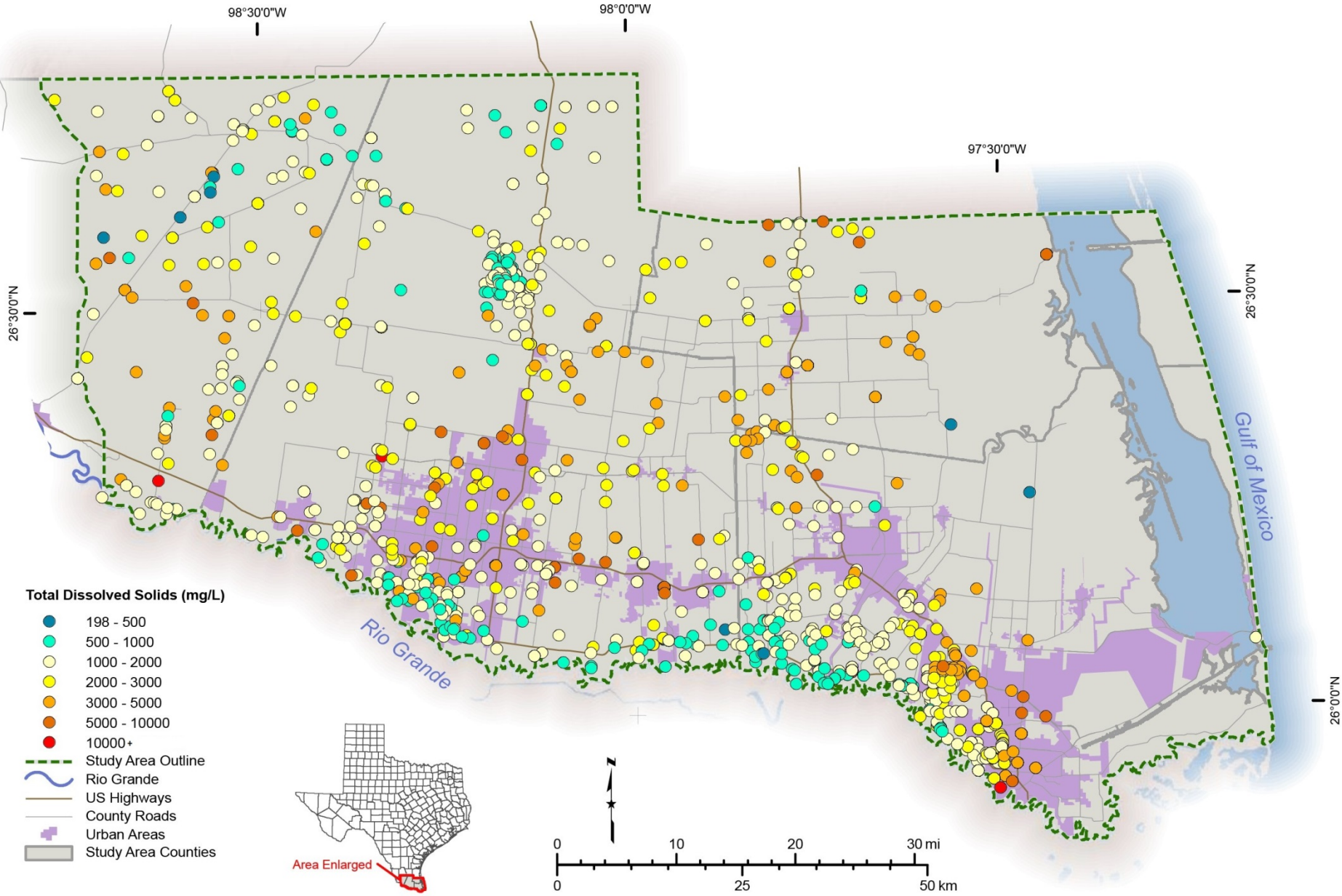


Salinity Profiles

O	P	Q	R	S	T	U
VS Shallow 4			VS Shallow 4			
MS Intermediate 1			MS Intermediate 1	MS Shallow 3	Brine Shallow	
SS Deep	VS Shallow 4		SS Deep	VS Shallow 4	VS Intermediate	
MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	MS Deep	
VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep	VS Deep
BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep	BR Deep

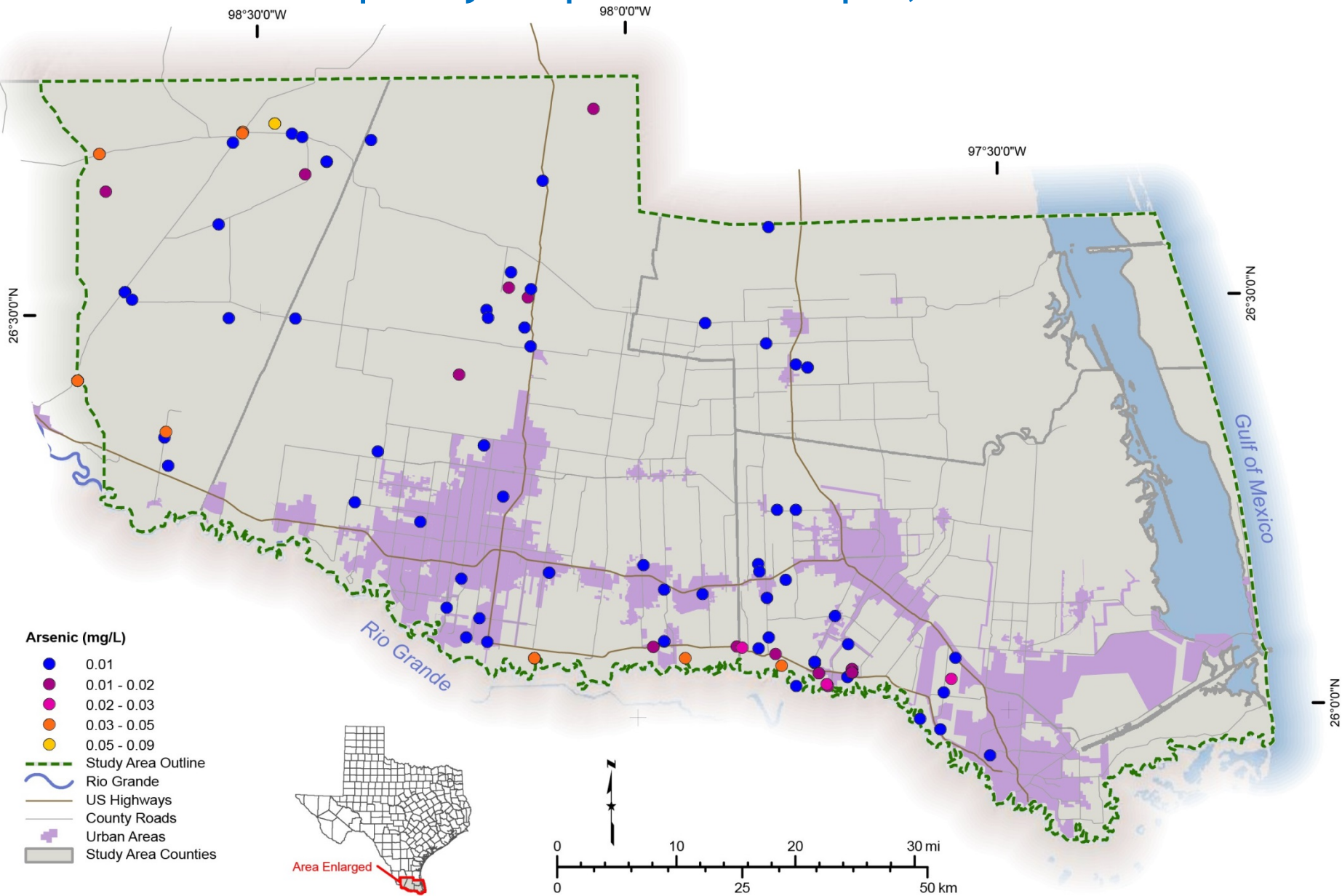
Groundwater Salinity Classification	Total Dissolved Solids Concentration (units: milligrams per liter)
Fresh	0 to 1,000
Slightly Saline	1,000 to 3,000
Moderately Saline	3,000 to 10,000
Very Saline	10,000 to 35,000
Brine	Greater than 35,000

Total Dissolved Solids



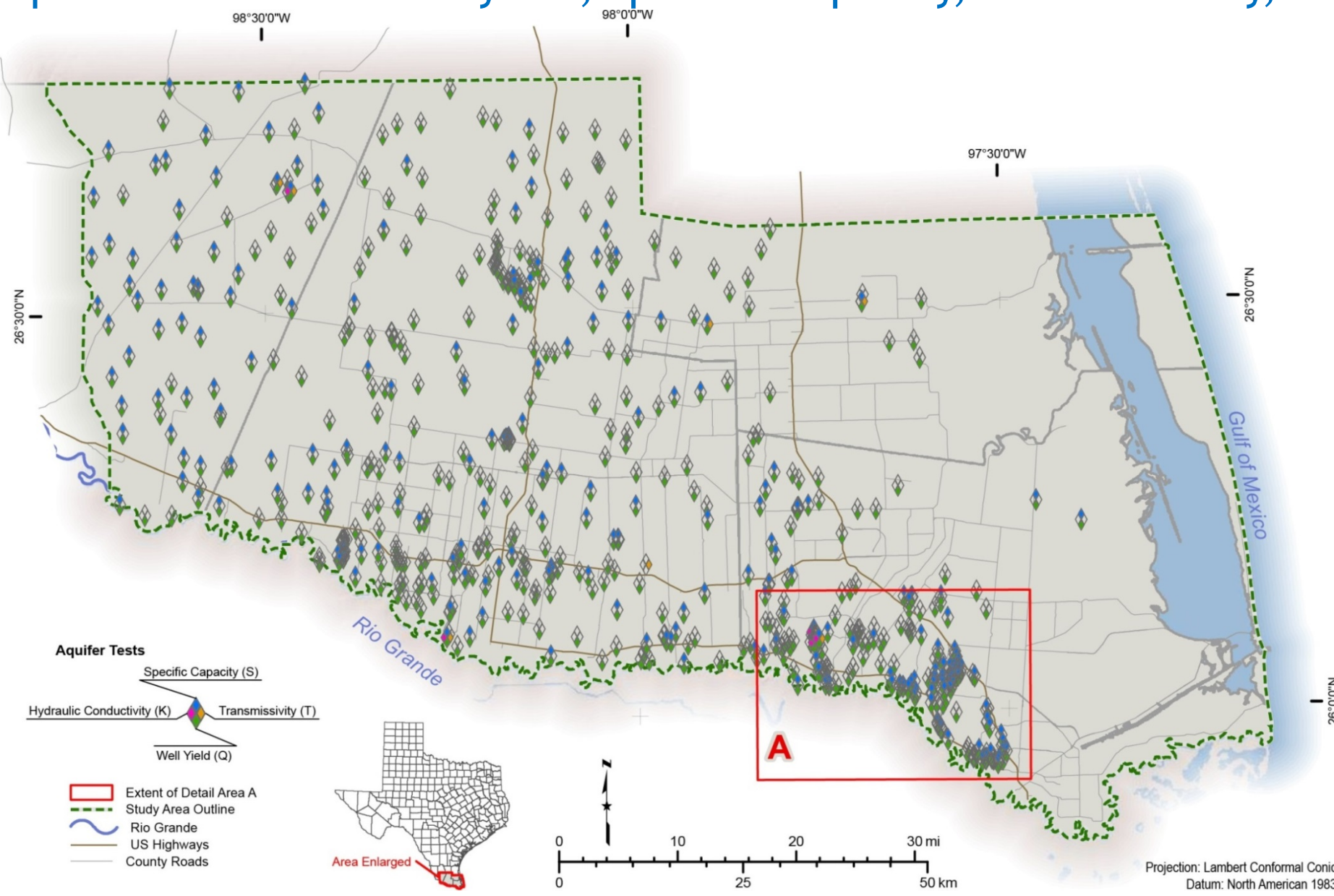
Source: Lower Rio Grande Valley BRACS Study

Additional water quality maps: for example, arsenic



Source: Lower Rio Grande Valley BRACS Study

Aquifer Test Data: well yield, specific capacity, transmissivity, ...



Source: Lower Rio Grande Valley BRACS Study

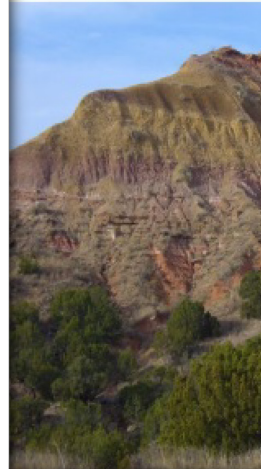
BRACS Database and Data Dictionary

Brackish Resources Aquifer Characterization System Database Data Dictionary

Open File Report 12-02, Second Edition

September 2014

John E. Meyer, P.G.



2. Well location table: tblWell_Location

The well location table contains one record per well. When a new well record is appended into the BRACS Database, the record is first added to this table, which assigns its unique identification number using an autonumber data type in the field [WELL_ID]. The table contains attributes about the well, such as owner, location, source of well information, and well depth information (Table 2-1).

Table 2-1. Table tblWell_Location field names, data type and size, and lookup table references.

Field Name	Data Type	Size	Lookup Table
WELL_ID	Long Integer	4	
SOURCE_WELL_DATA	Text	250	tblLkSourceWellData
STATE_NAME	Text	50	tblLkState
COUNTY_NAME	Text	13	tblLkCounty
DEPTH_TOTAL	Long Integer	2	
DEPTH_WELL	Long Integer	2	
ELEVATION_BOTTOM_WELL	Long Integer	2	
ELEVATION_BOTTOM_HOLE	Long Integer	2	
DRILL_DATE	Text	10	
KELLY_BUSHING_HEIGHT	Integer	2	
OWNER	Text	100	
WELL_TYPE	Text	50	tblLkWellType
LATDD	Double	8	
LONGDD	Double	8	
HORIZONTAL_DATUM	Text	2	tblLkHorizontalDatum
LOCATION_METHOD	Text	10	tblLkLocationMethod
LOCATION_DATE	Date/Time	8	
AGENCY	Text	5	tblLkAgency
GRID_25MIN	Text	15	
ELEVATION	Long Integer	4	
VERTICAL_DATUM	Text	2	tblLkVerticalDatum
ELEVATION_METHOD	Text	1	tblLkElevationMethod
ELEVATION_AGENCY	Text	5	tblLkAgency
ELEVATION_DATE	Date/Time	8	
REMARKS	Text	250	
INITIALS	Text	3	tblLkInitial
ADDRESS	Text	100	
CITY	Text	50	
SITE DIRECTIONS	Text	255	

Field Descriptions

WELL_ID Each well record in the database is assigned a unique well ID in this table using the Microsoft® Access® autonumber data type, which is a long integer. This is the key field in the table and serves as the primary key field linking every BRACS Database table.

SOURCE_WELL_DATA Each well record is assigned the source of the well information. In some cases multiple sources exist; in this case, the source of the geophysical well log or water well driller report takes precedence. These field values are listed in the lookup table

tblLkSourceWellData (Table 2-2). This lookup table also contains a description of the data source, a web address if applicable, and a published report reference if applicable. The table will continue to grow with time as new sources of information are acquired, and Table 2-2 contains only a partial list of these values.

Table 2-2. Lookup table tblLkSourceWellData. A partial list of these values is presented in this table.

SOURCE_WELL_DATA	AGENCY
BAER Yegua Jackson Study	Baer Engineering and Environmental Consulting, Inc., with Intera, Inc.
BEG Paper/Digital Geophysical Logs	Bureau of Economic Geology, University of Texas at Austin
DBSA Capitan Reef Study	Daniel B. Stephens Assoc. et al
DBSA Llano Aquifers Study	Daniel B. Stephens Assoc. et al
GLO Paper/Digital Geophysical Logs	General Land Office
Intera Gulf Coast Aquifer Study	Intera, Inc.
Intera Rustler Aquifer Study	Intera, Inc.
NM EMNRD Geophysical Logs	New Mexico Energy, Minerals and Natural Resources Department
NM OSE Aquifer Test Information	New Mexico Office of State Engineers
NM OSE Digital Water Well Reports	New Mexico Office of State Engineers
NM OSE Paper Water Well Reports	New Mexico Office of State Engineers
RRC Digital Geophysical Logs	Railroad Commission of Texas
SL Digital Geophysical Logs	Subsurface Library
TCEQ PWS Water Wells	Texas Commission on Environmental Quality
TCEQ SC Q Paper/Digital Geophysical Logs	Texas Commission on Environmental Quality
TCEQ Water Well Images	Texas Commission on Environmental Quality
TDLR Digital Water Well Reports	Texas Department of Licensing and Regulation
TDLR Paper Water Well Reports	Texas Department of Licensing and Regulation
TWDB Aquifer Test Information	Texas Water Development Board
TWDB Geophysical Logs	Texas Water Development Board
TWDB Groundwater Database	Texas Water Development Board
TWDB Published Reports	Texas Water Development Board (and all predecessor agency names)
ULUTS Digital Geophysical Logs	University Lands, University of Texas System
USGS Brazos River Alluvium Study	U.S. Geological Survey
USGS Edwards-Trinity (Plateau) Study, Pecos Co.	U.S. Geological Survey
USGS Geophysical Logs	U.S. Geological Survey

STATE_NAME The state name based on the well location. This lookup table contains state and codes for Texas and adjacent states. These field values are listed in the lookup table tblLkState.

COUNTY_NAME The county name based on the well location. This lookup table contains state and county names for Texas and adjacent states. These field values are listed in the lookup table tblLkCounty.

DEPTH_TOTAL The total depth of the hole in units of feet below ground surface. This is reported on the water well driller report or header page on a geophysical well log. A value of -999999 is used if the value is not known.

BRACS Database: for example, the salinity zone form

frmSalinityZone_GulfCoast

BRACS Well ID: State Well Number:

OWNER:

Project Salinity Zone:

Lower Rio Grande Valley BRACS Study
Salinity Zone Profile Form Close Form

Salinity Zone Profile at Well Site

DEPTH_WELL:
 Depth Total:
 SCREEN_TOP:
 SCREEN_BOTTOM:
 MULTIPLE_SCREEN:

Moderately Saline	Top Depth	<input type="text" value="0"/>
	Bottom Depth	<input type="text" value="851"/>
Very Saline	Top Depth	<input type="text" value="851"/>
	Bottom Depth	<input type="text" value="1351"/>
Brine	Top Depth	<input type="text" value="1351"/>

Salinity Zone Legend

- Slightly Saline (1,000 - 3,000 milligrams per liter Total Dissolved Solids)
- Moderately Saline (3,000 - 10,000 milligrams per liter Total Dissolved Solids)
- Very Saline (10,000 - 35,000 milligrams per liter Total Dissolved Solids)
- Brine (> 35,000 milligrams per liter Total Dissolved Solids)

Month	Day	Year	Sample Number	Silica	Calcium	Magnesium	Sodium	Potassium	Bicarb	Carb	Sulfate	Chloride	Nitrate	TDS	Spec. C.
9	16	2005	1	13.7	155	81	1070	17.9	250	-99999	1120	1230	< 0.05	3818	6000
7	16	2013	1	26.5	138	74	855	10.3	333.15	0	976	1120	< 0.02	3371	4130
				-99999	-99999	-99999	-99999	-99999	-99999	-99999	-99999	-99999	-99999	-99999	-99999

Source: BRACS program

Summary

- Substantial brackish groundwater for development
- Study can support the location of favorable exploration sites
- Well field drilling and testing is required to provide site-specific details that this study cannot provide
- BRACS study deliverables available on TWDB website
- Future efforts:

TWDB will contract a Lower Rio Grande Valley groundwater salinity model. A tool to estimate subsidence will also be developed.

Collect new well data as brackish groundwater is developed

Texas Water Development Board



www.twdb.texas.gov

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