



**Water Advisory Board
Texas Water Development Board
Lipan Aquifer Brackish
Groundwater Study**

May 24, 2017

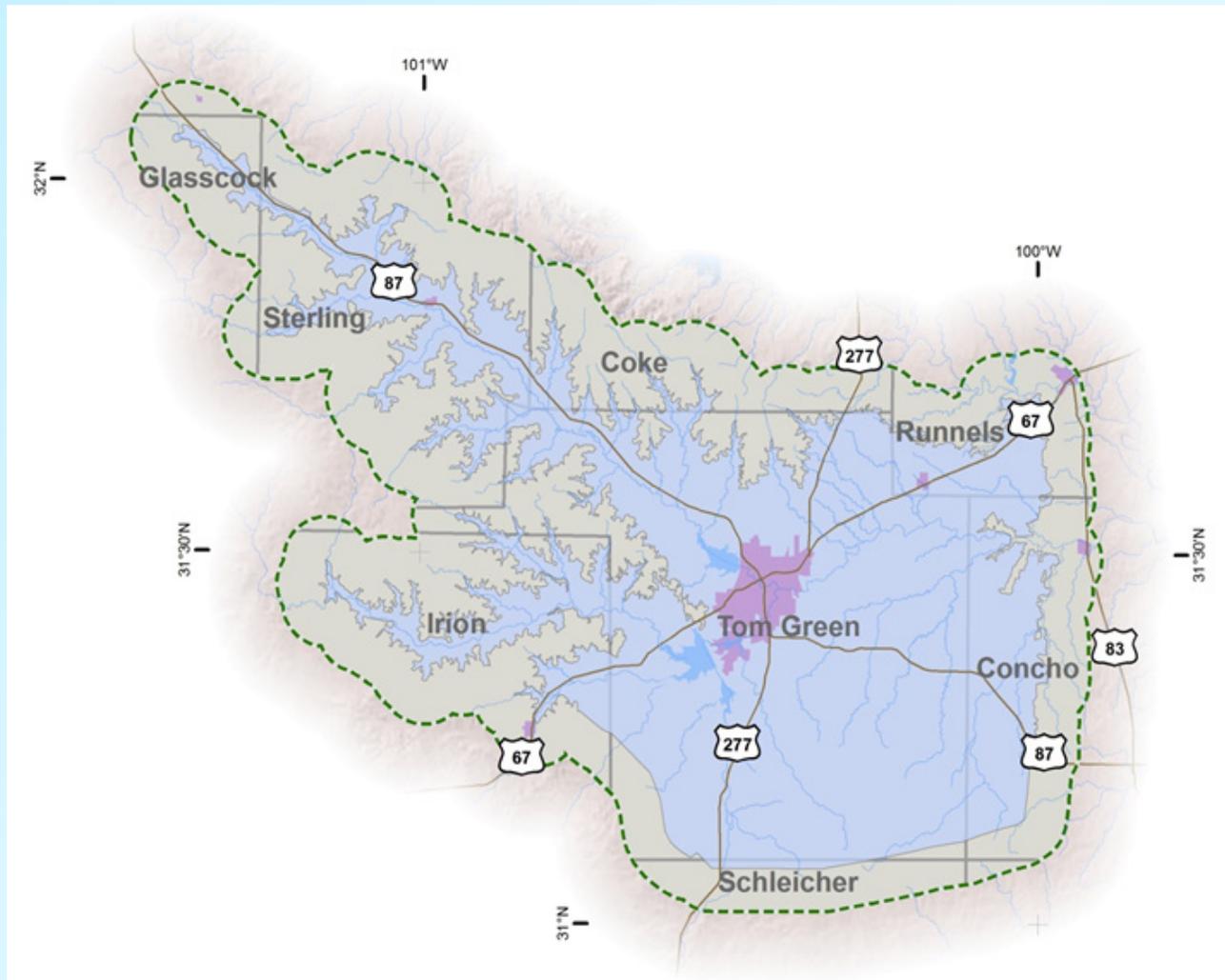


Texas Water Development Board (TWDB)

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.



Lipan Aquifer Study Area



Study area

- Study area boundary
- Lipan Aquifer
- ~ Study area streams
- Study area reservoirs
- ✚ Urban areas
- U.S. highways
- ▭ Study area counties



Projection: Albers
Datum: North American 1983



Brackish Resources Aquifer Characterization System (BRACS)

- Total of 6,995 wells evaluated
 - All from public sources
 - 2,314 from TWDB Groundwater Database (GWDB)
 - 4,287 unique to BRACS Database
 - 394 shared between BRACS and GWDB
- BRACS well sample sources
 - Abilene Geological Society published report
 - BEG paper/digital geophysical logs
 - BEG Report of Investigations 191
 - LBG Brackish GW for San Angelo study
 - LBG Lipan GAM study well data
 - RRC digital geophysical logs
 - RRC GAU Q-log paper/digital geophysical logs
 - TCEQ PWS water wells
 - TCEQ water well images
 - TDLR digital water well reports
 - TWDB aquifer test information
 - TWDB geophysical logs
 - TWDB Groundwater Database
 - TWDB published reports
 - USGS geophysical logs

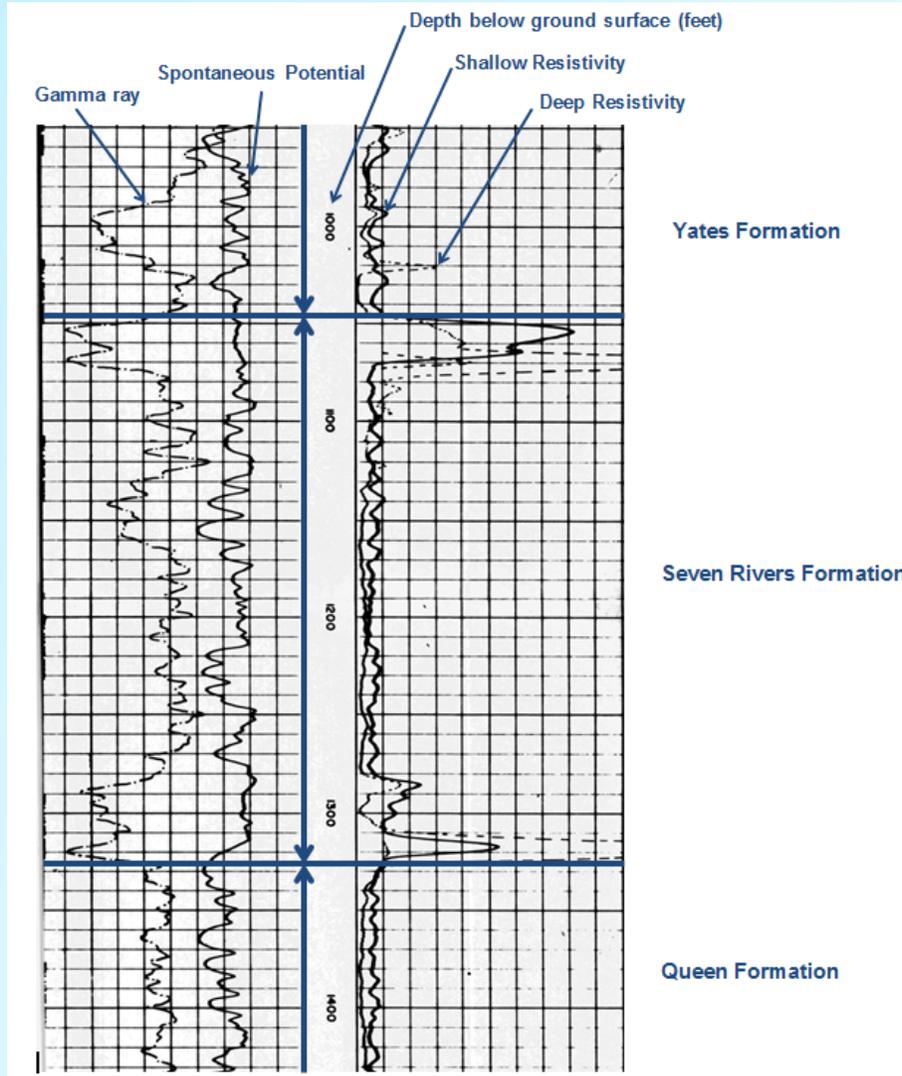


Stratigraphy (mapping the subsurface)

- Total of 1,046 wells with 5,424 picks used for formation mapping
- Fifteen Permian units mapped
 - 250 millions years old and older
- Ten potential water-bearing formations identified
 - One younger Quaternary and Neogene sediments
 - Nine Permian units
- Other formations mapped
 - One Triassic formation (Dockum Group)
 - One Cretaceous formation (Trinity Group, Edwards-Trinity (Plateau) Aquifer)
 - To be studied in future reports



Stratigraphic Picks

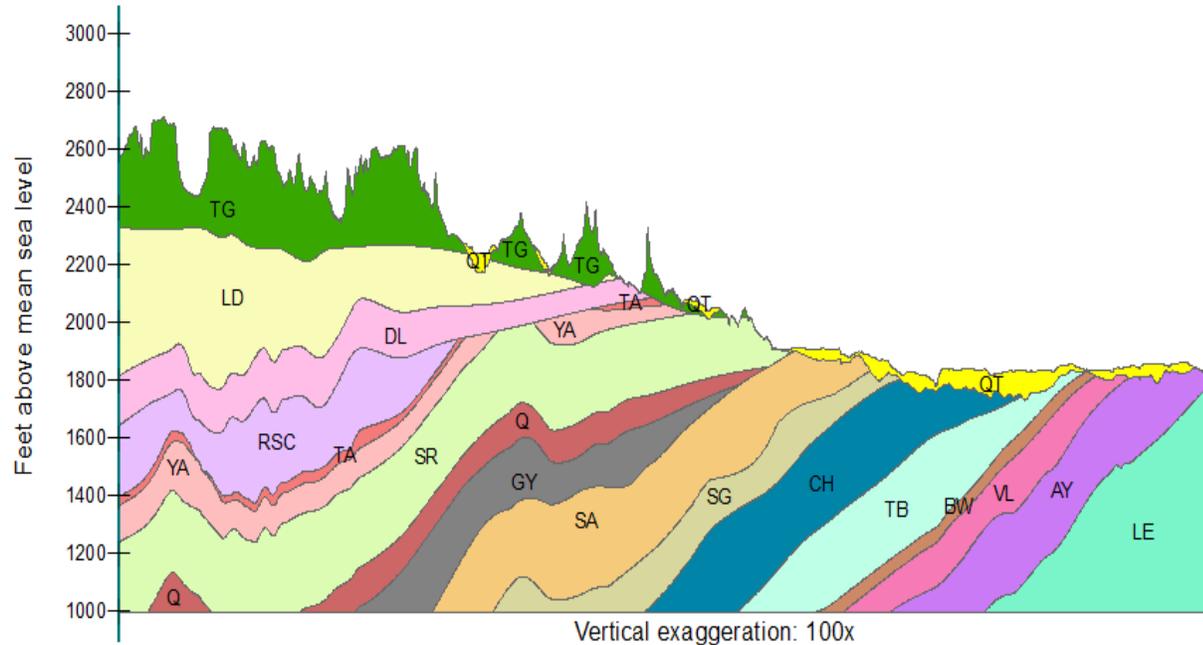


- Formations picked based on geophysical well log interpretation
- One example of many shown at left
 - BRACS well ID 37978

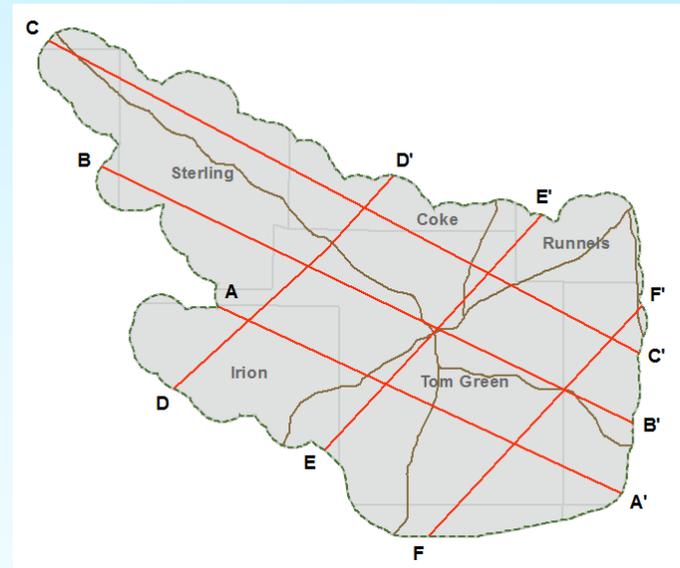
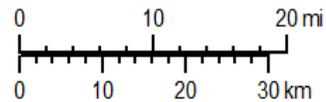
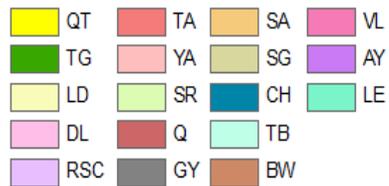


Cross-sections

- Six cross-sections generated
- Cross-section B-B' shown



Aquifer codes

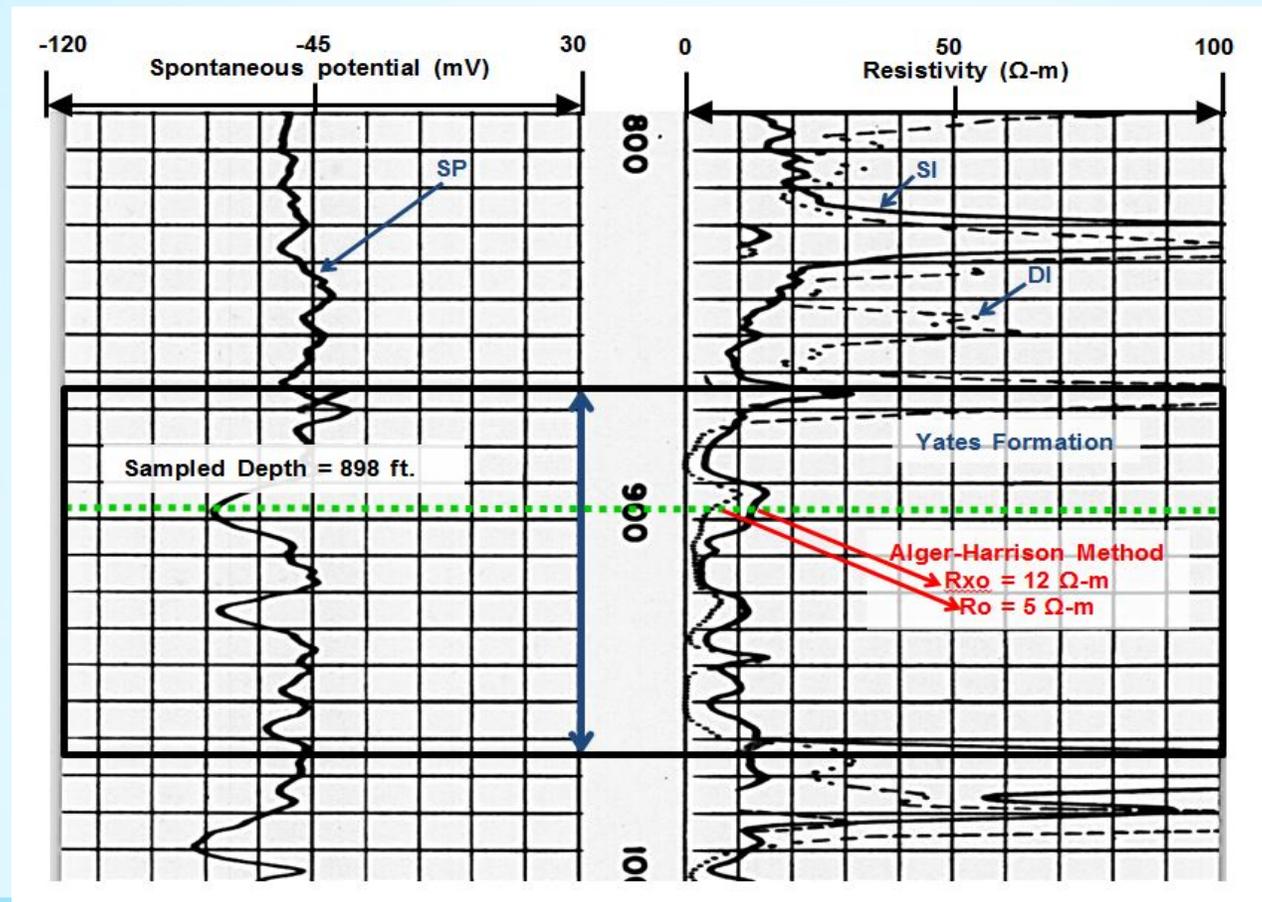


Aquifer code	Stratigraphic unit
QT	Quaternary and Neogene sediment
TG	Trinity Group
LD	Dockum Group
DL	Dewey Lake Formation
RSC	Rustler-Salado formations
TA	Tansill Formation
YA	Yates Formation
SR	Seven Rivers Formation
Q	Queen Formation
GY	Grayburg Formation
SA	San Andres Formation
SG	San Angelo Formation
CH	Upper Choza member
TB	Tubb member
BW	Bullwagon Dolomite
VL	Vale Shale member
AY	Arroyo Formation
LE	Lueders Formation and older formations



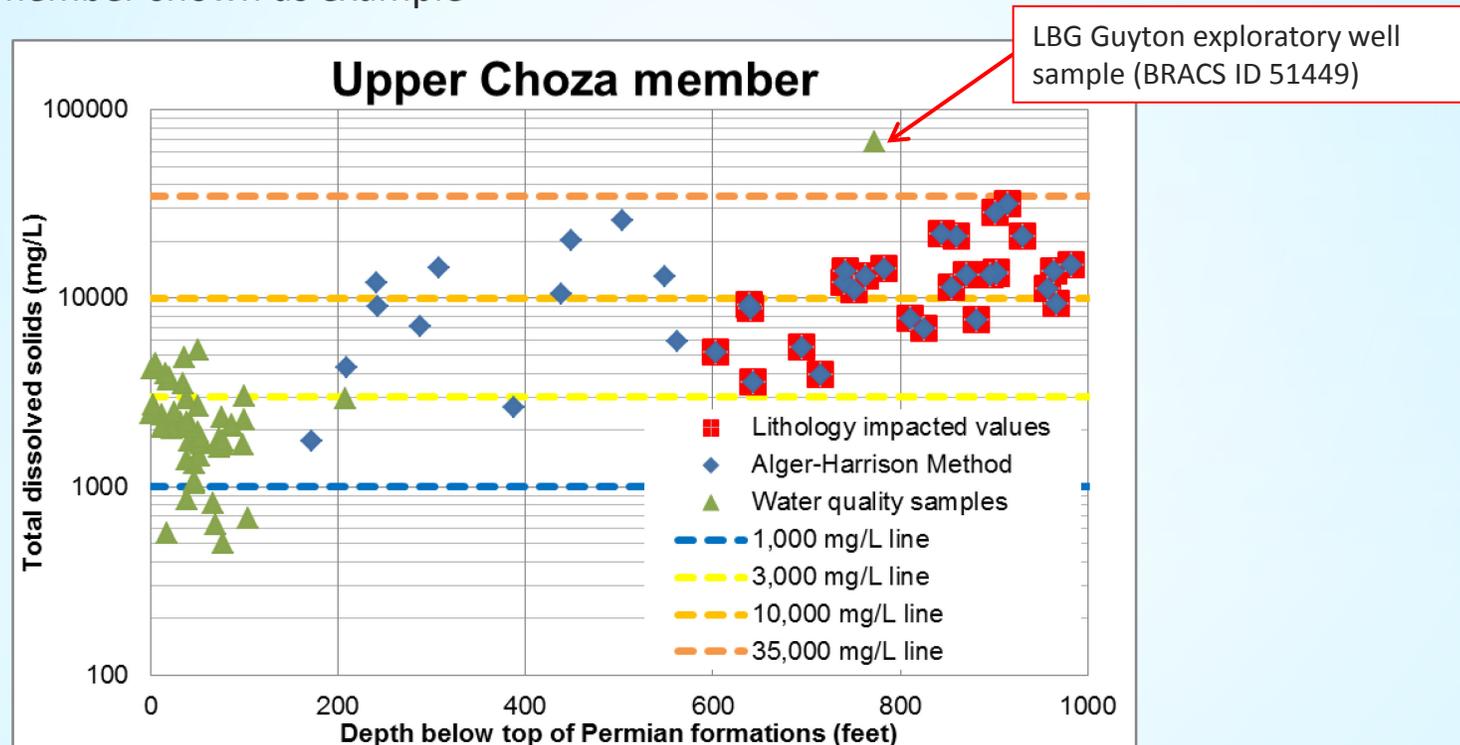
Salinity determination

- Calculate when you don't have samples
- Alger Harrison Method, best for local geology
 - 179 wells evaluated, 771 calculated TDS values



Salinity vs. depth plots

- Performed for nine Permian potential water-bearing formations
 - Combination of water quality samples and calculated values
 - Lithology impacted calculations at greater depths (red squares below)
 - Depth below Permian top used rather than depth below surface
 - Upper Choza member shown as example



Salinity zone determination

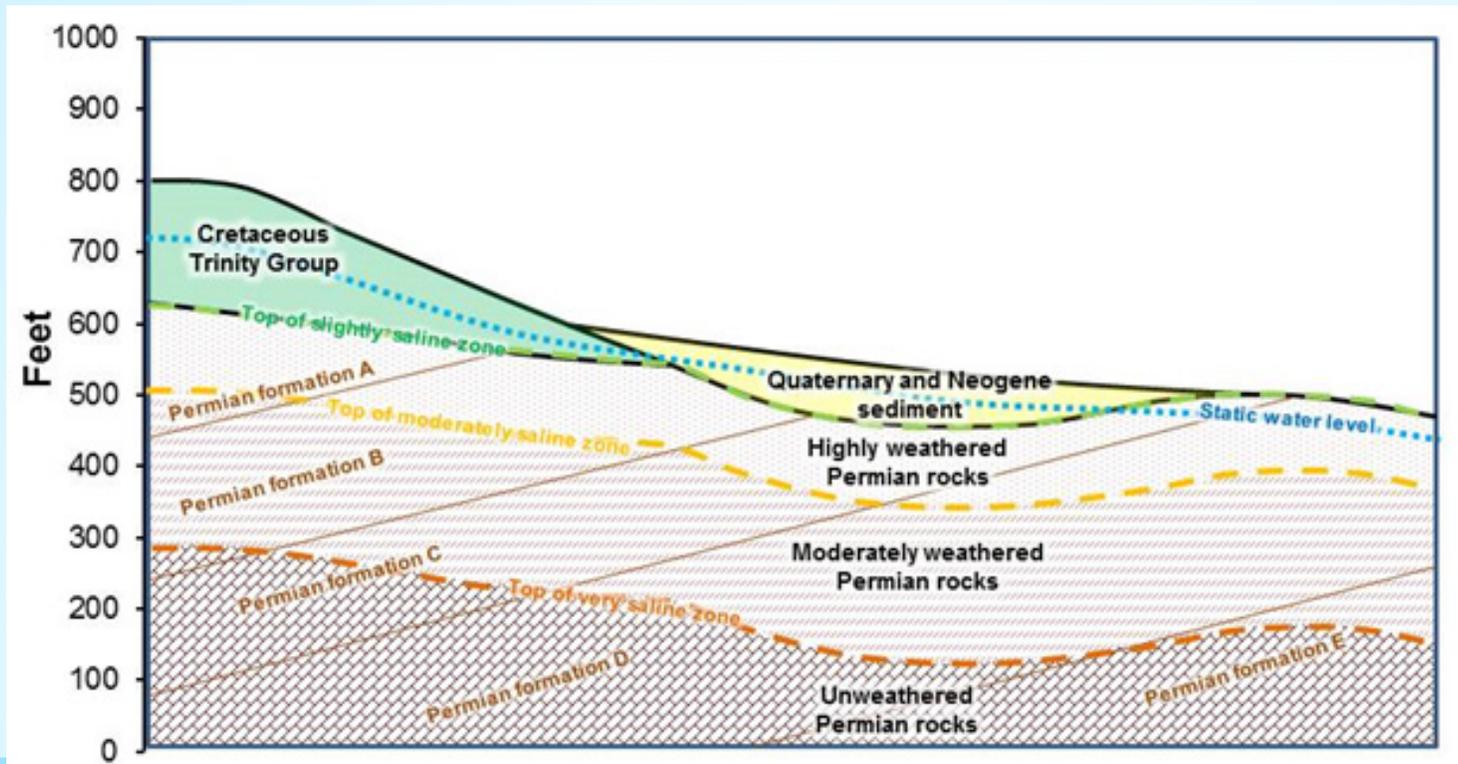
- Performed for nine Permian potential water-bearing formations
 - Significant data scatter within each zone
 - Salinity values per formation averaged with depth intervals within a zone
- Values averaged across formations to determine regional relationship
- Resulting surfaces mapped and used for groundwater volume calculation

Geological formation	Depth below top of Permian (feet)	
	3,000 mg/L (base of slightly saline)	10,000 mg/L (base of moderately saline)
Yates Formation	110	215
Seven Rivers Formation	60	315
Queen Formation	0	390
San Angelo Formation	205	445
Upper Choza member	185	385
Tubb member	150	425
Bullwagon Dolomite	115	290
Arroyo Formation	80	260
Lueders Formation	40	225
Average	105	328



Salinity zone schematic

- Water storage top is historical static water level
- Fresh water in formations younger than Permian
- Slightly saline water in the highly weathered Permian units
- Moderately saline water in moderately weathered Permian units
- Very saline water at greater depths



Groundwater volume

- Top of saturated volumetric calculation is historic static water level
 - Derived from 167 wells with 14,755 records taken since January 2001
- Specific yield (volume water per bulk volume) applied
 - 0.05 applied to fresh and slightly saline volumes (young/heavily weathered Permian)
 - 0.005 applied to moderately saline volumes (moderately weathered Permian)
- Groundwater volumes in acre-feet
 - Comparison – 2016 Region F water plan reported 28,242 acre-feet pumpage in 2010

Formation	Fresh	Slightly saline	Moderately saline
Lueders Formation	0	1,084,079	467,616
Arroyo Formation	0	516,069	225,232
Bullwagon Dolomite	0	239,435	50,578
Tubb member	0	604,992	159,680
Upper Choza member	0	491,044	153,991
San Angelo Formation	0	180,245	95,627
Queen Formation	0	140,381	83,563
Seven Rivers Formation	0	778,661	251,652
Yates Formation	0	406,499	117,804
Quaternary and Neogene sediments	171,707	0	0
Total volume	171,707	4,441,405	1,605,743



Conclusions

- Calculated salinity values vary significantly
 - Groundwater volumes are based on regional average depths
- Volumes of groundwater by salinity zones
 - Not all can be economically or technically recovered
 - 0.17 million acre-feet of fresh groundwater
 - 4.44 million acre-feet of slightly saline groundwater
 - 1.61 million acre-feet of moderately saline groundwater
- All data to be made public once report is published
 - Collected well data and geophysical logs
 - Calculated parameters
 - GIS files
 - Supporting database (Microsoft Access 2007 format)





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