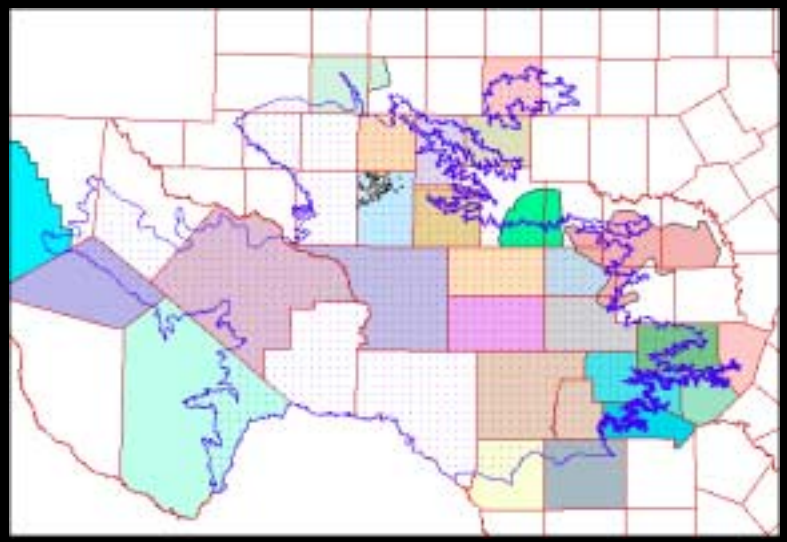
Welcome To The Third Quarterly Edwards-Trinity Aquifer Model Stakeholders Advisory Forum



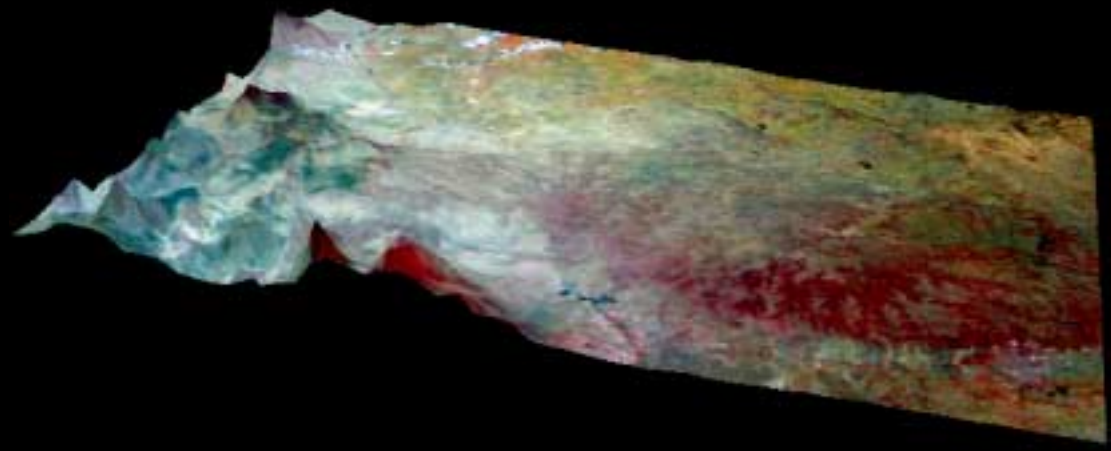
ET SAF 3

February 11, 2002

Texas Water Development Board

Groundwater Availability Modeling

A Groundwater Flow Model for the Edwards-Trinity Aquifer of West-Central, Texas



Roberto Anaya

Texas Water Development Board

Edwards-Trinity Stakeholders Advisory Forum Objectives

- Provide Public Awareness of GAM
- Update Interested Participants
- Solicit Data and Information
- Encourage Comments and Criticism

Evolving Investigation of the Hydrogeology of the Edwards-Trinity aquifer system, Edwards Plateau, Texas

Separate Over-head Slide Presentation

Presented by

Seay Nance

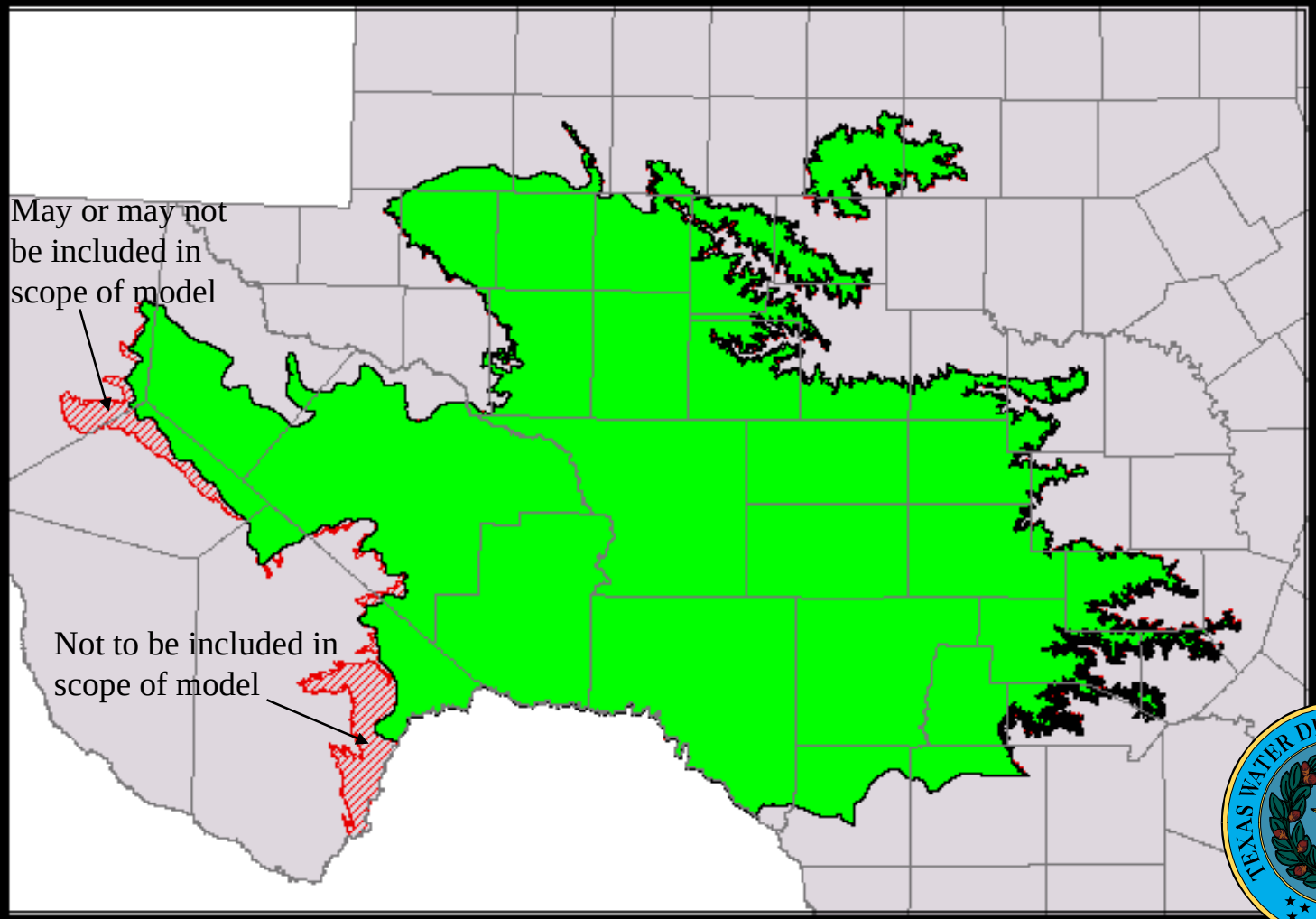
Department of Geosciences

University of Texas at Austin

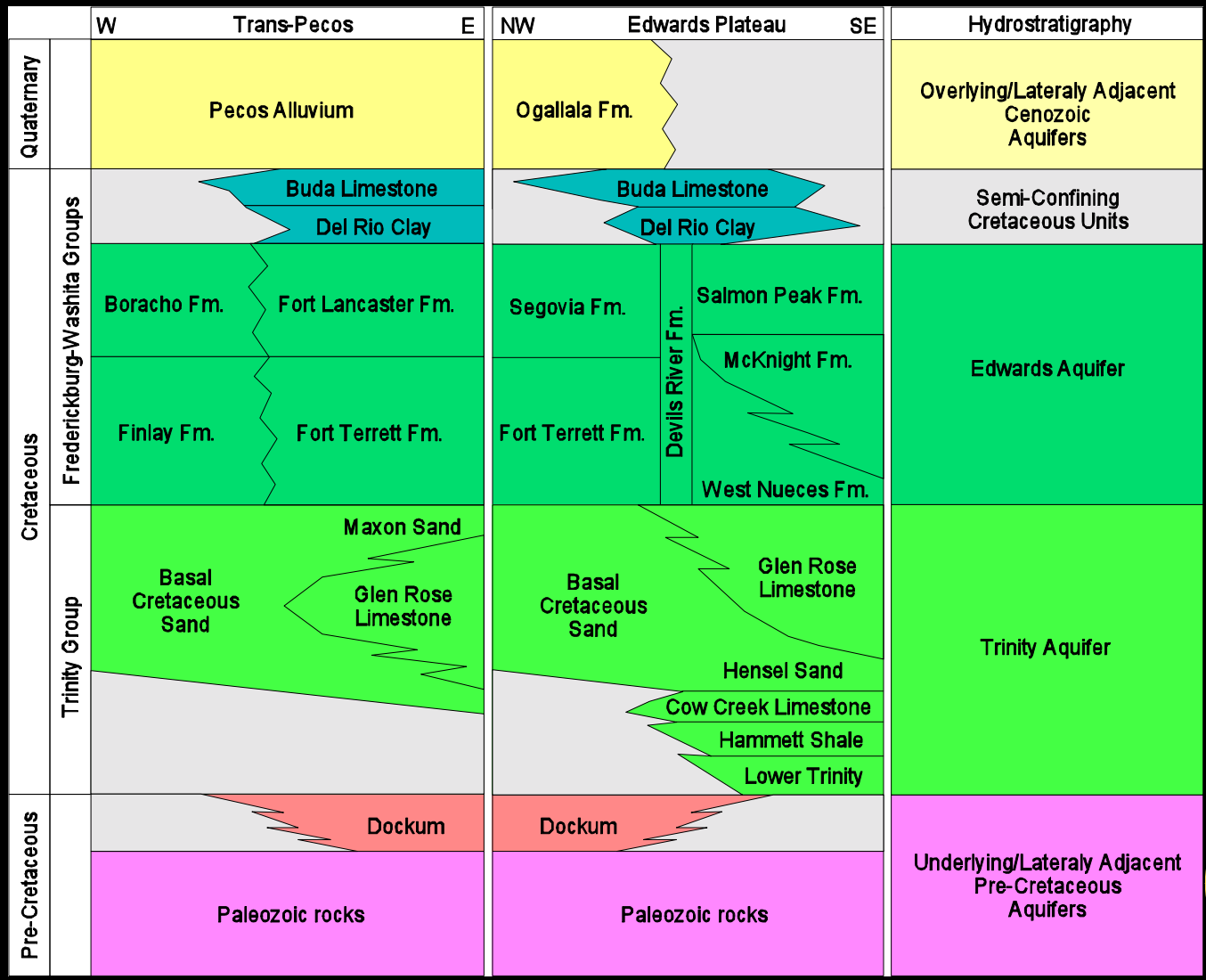
Model Layers and Boundary Conditions

- 3 layers proposed for the model
- Top layer number 1 will be used to model Edwards-Trinity cap rocks
- Emphasis will be placed on bottom 2 layers
- General-head boundary will be used for layer 3 cells to represent the hydraulic connection with underlying and lateral aquifers

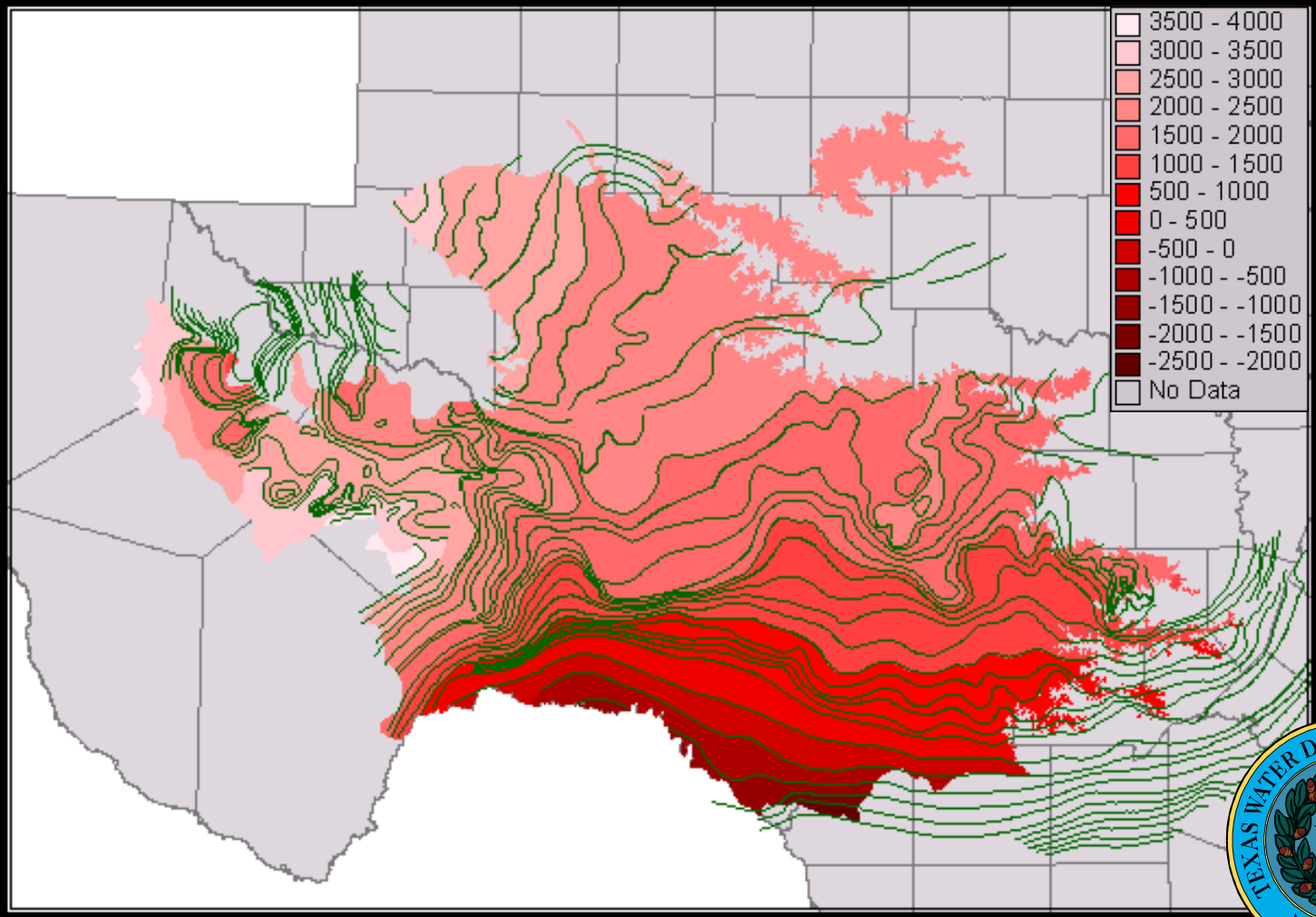
New Spatial Extent For The Edwards-Trinity Model



Hydrostratigraphic Units

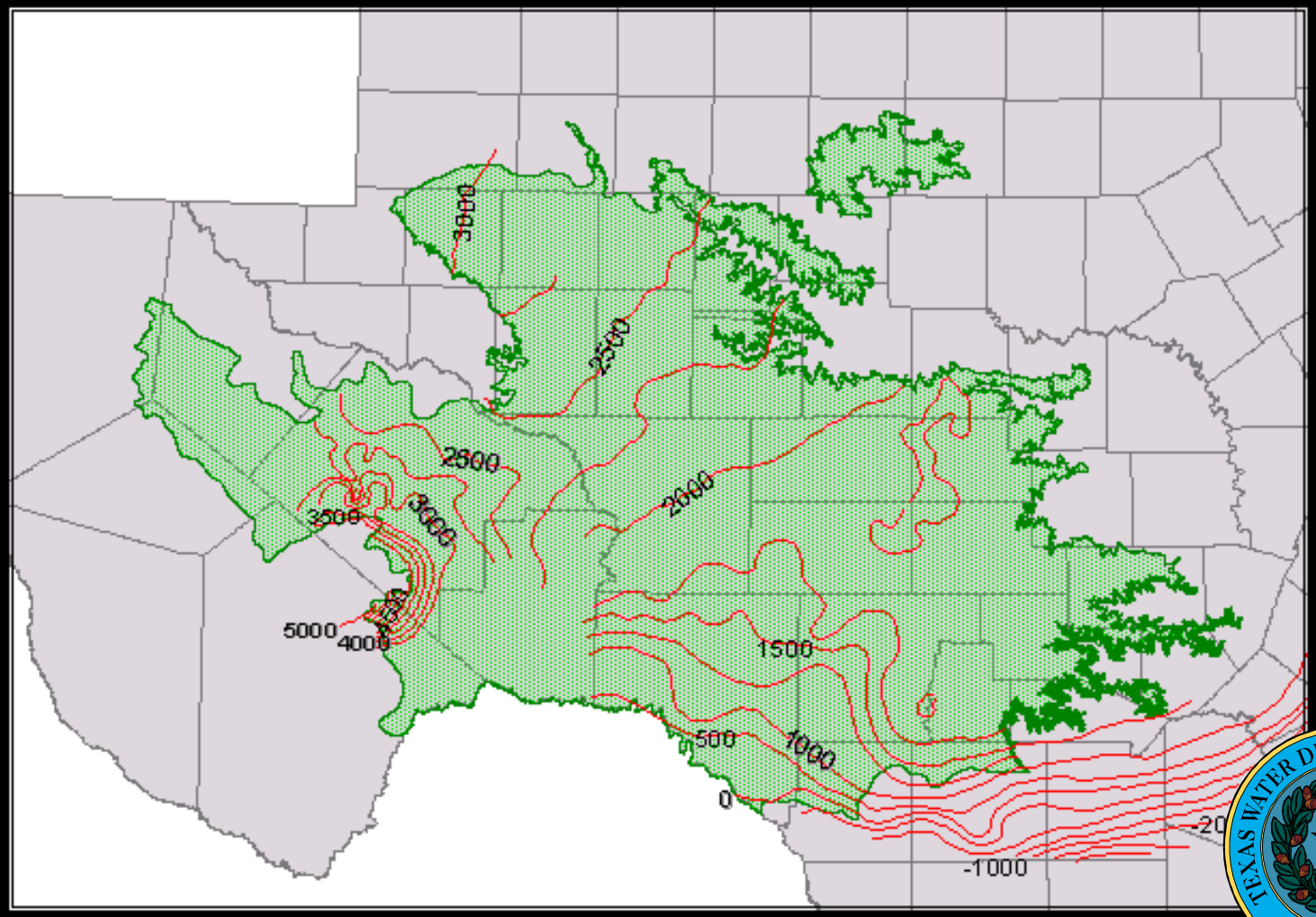


Structural Base of Edwards-Trinity Sediments



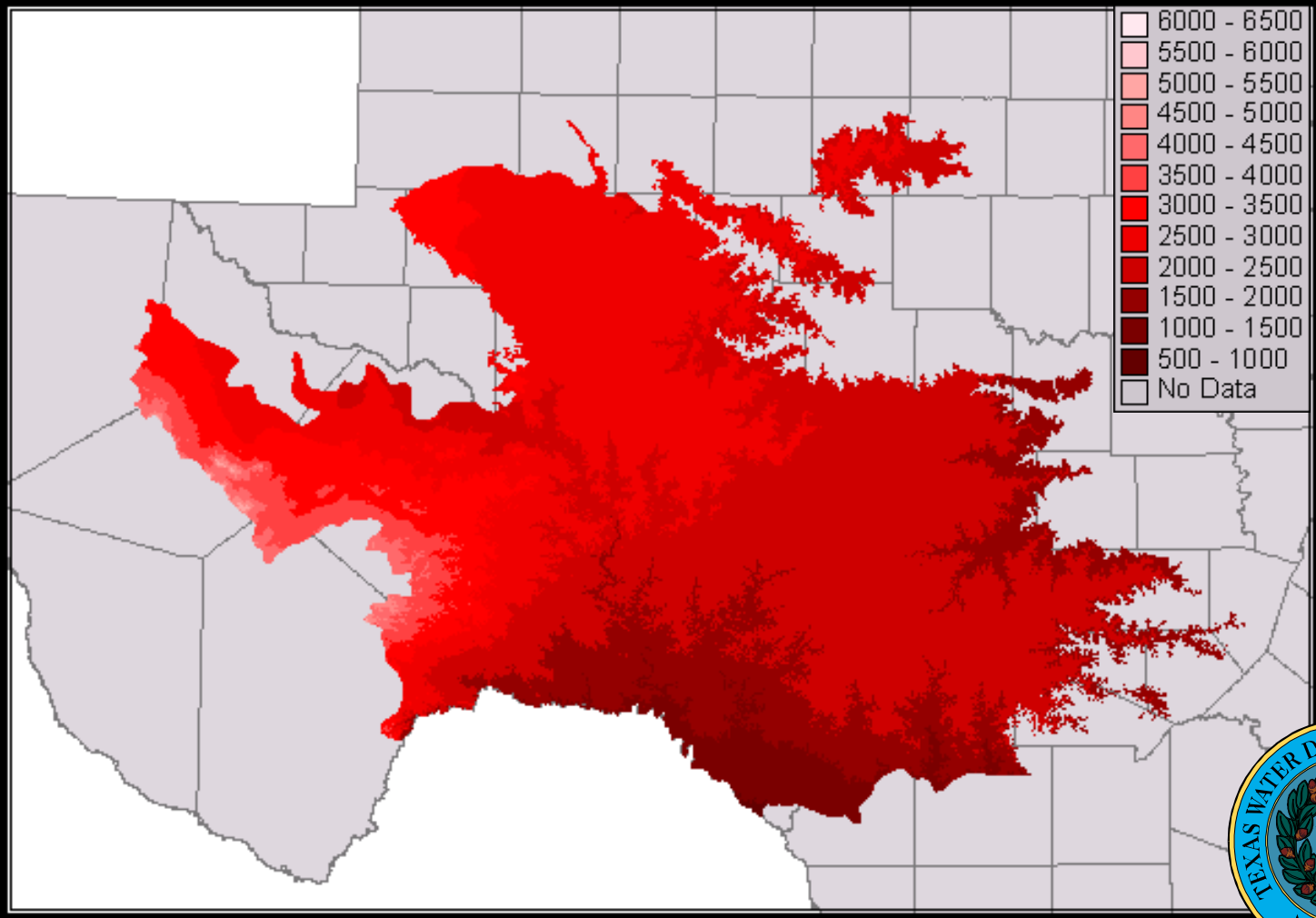
From - USGS unpublished data, 2001

Structural Base of Edwards Sediments



Adapted From - Barker and Ardis, 1996

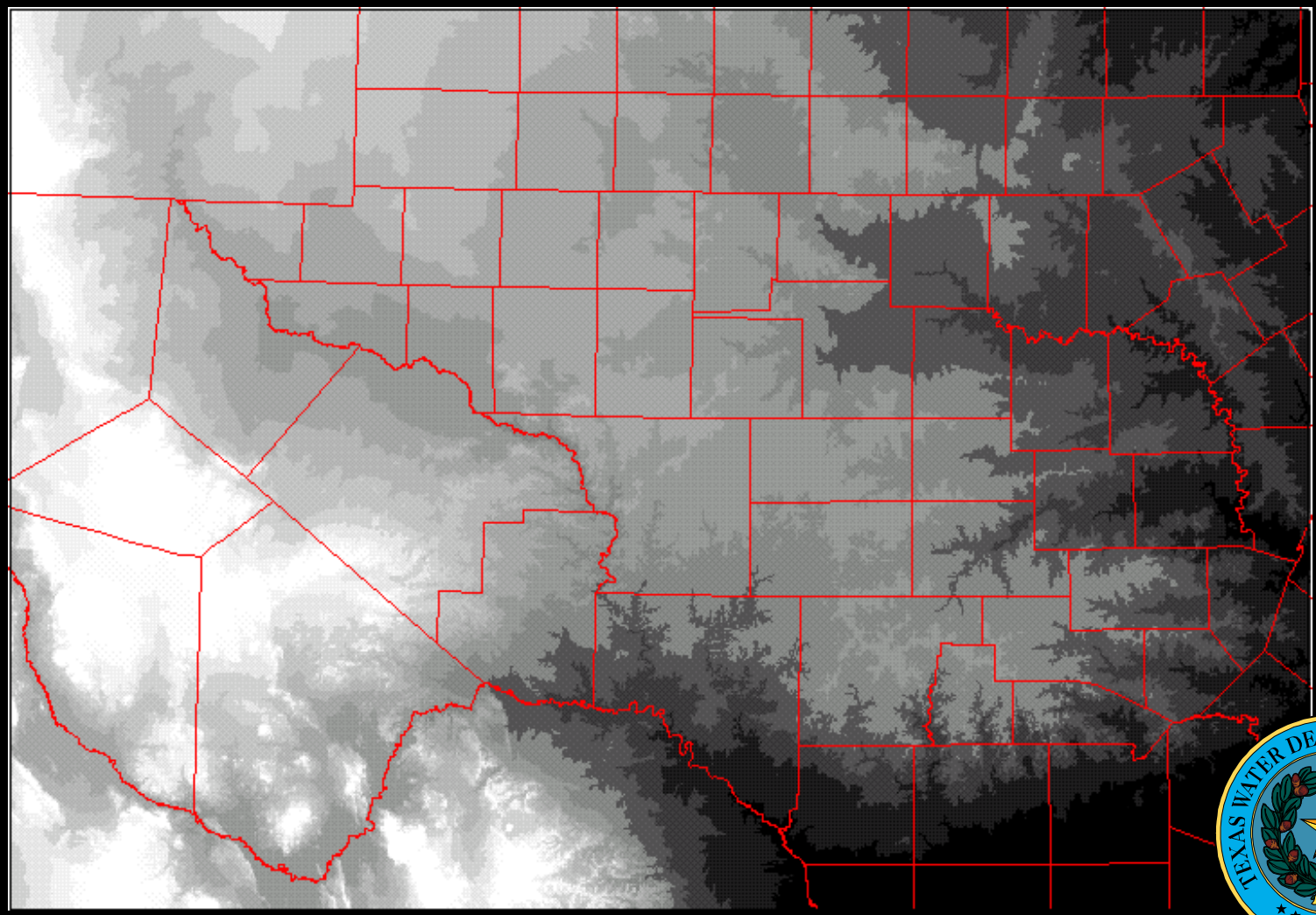
Structural Top of Edwards-Trinity Sediments



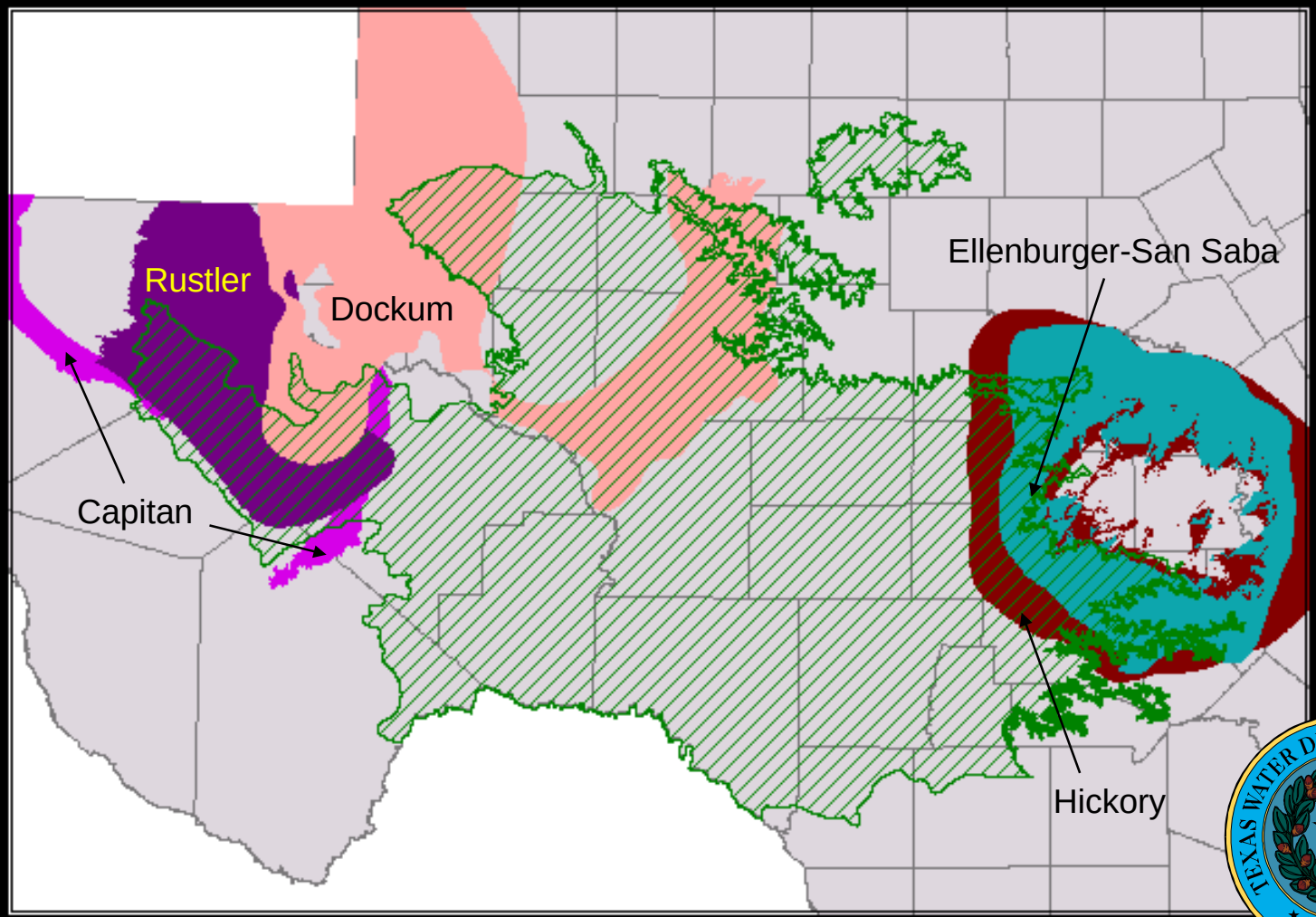
From - USGS unpublished data, 2001

TEXAS WATER DEVELOPMENT BOARD

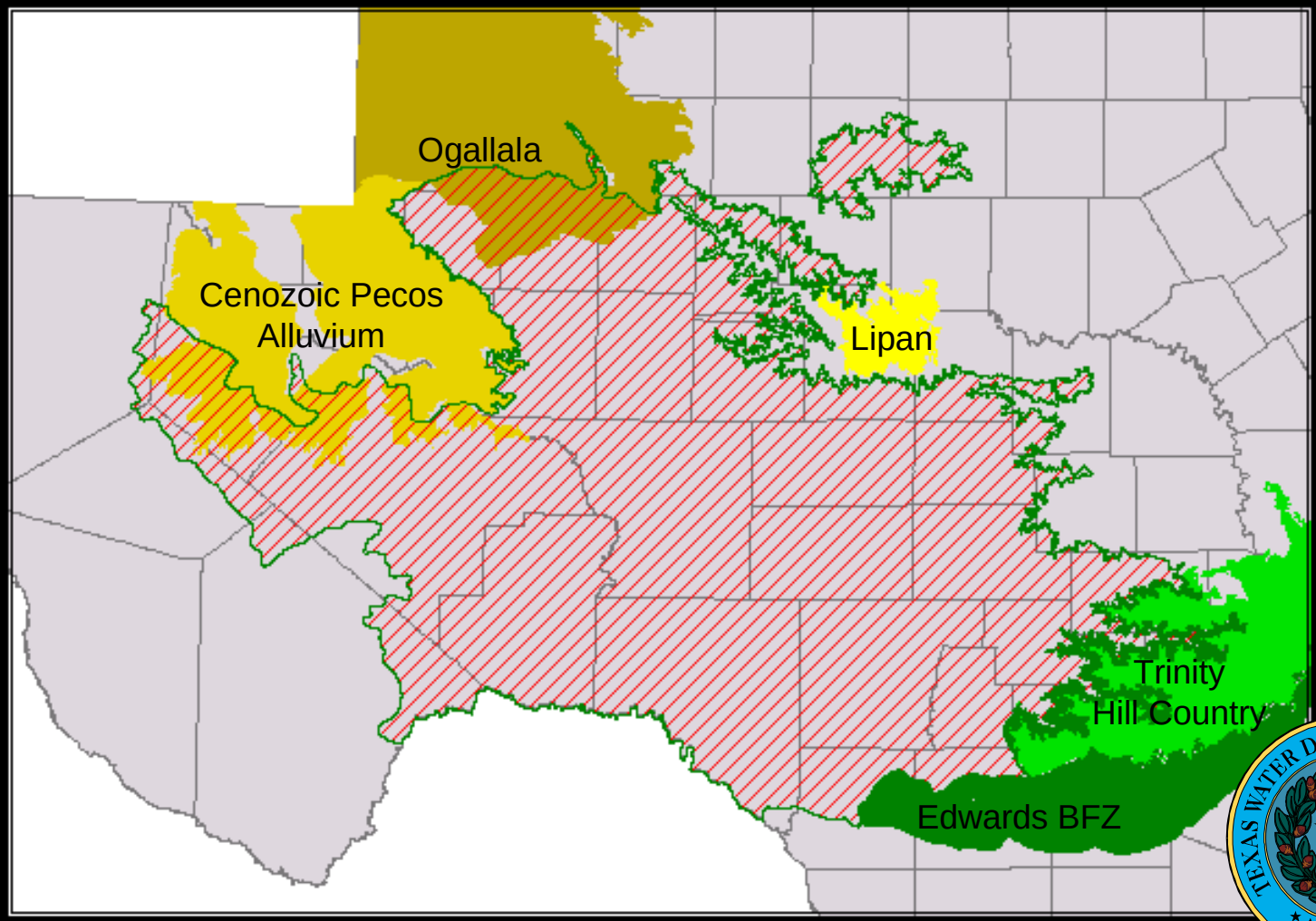
Digital Elevation Model



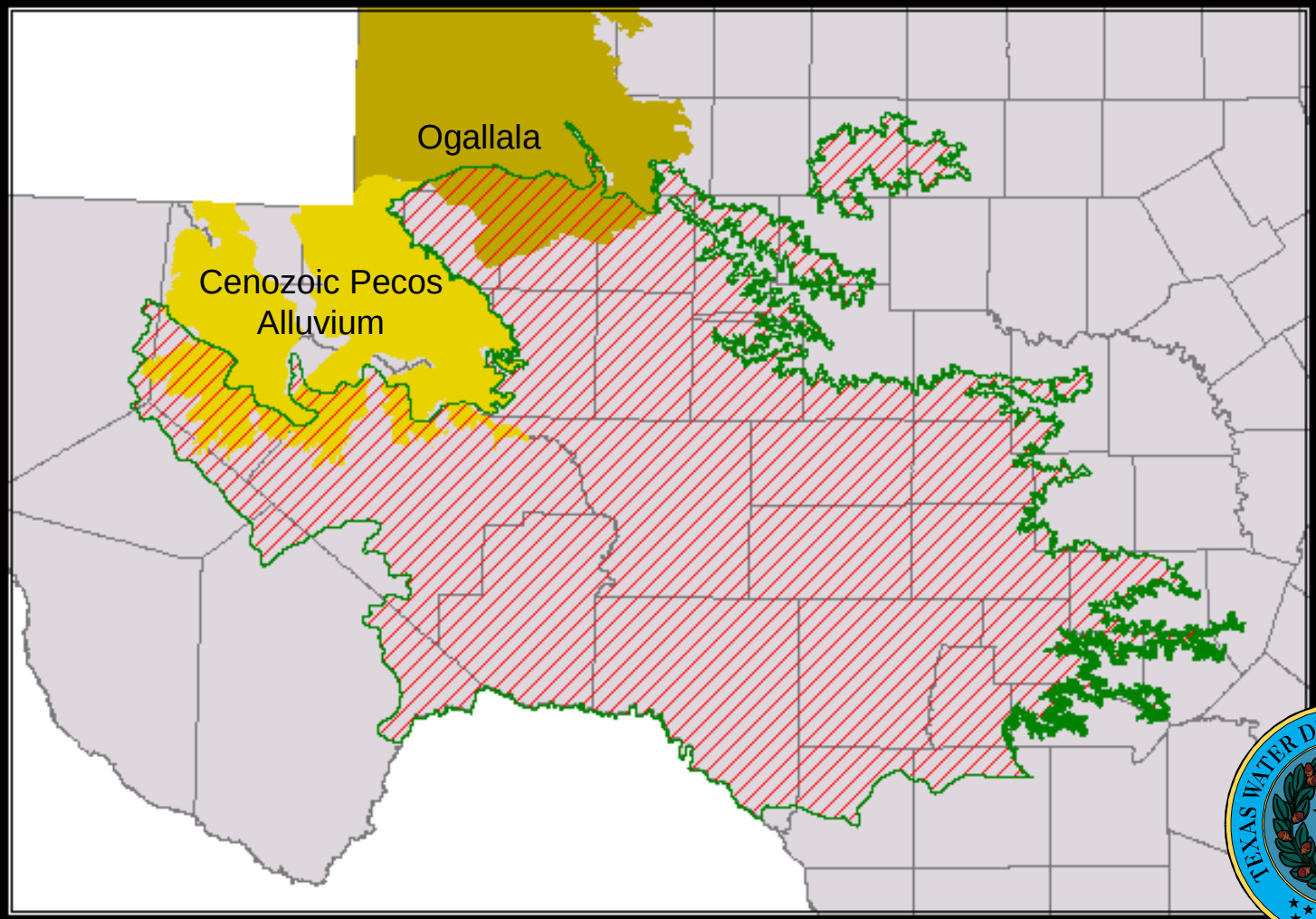
Underlying Geology at Base of Edwards-Trinity Aquifer



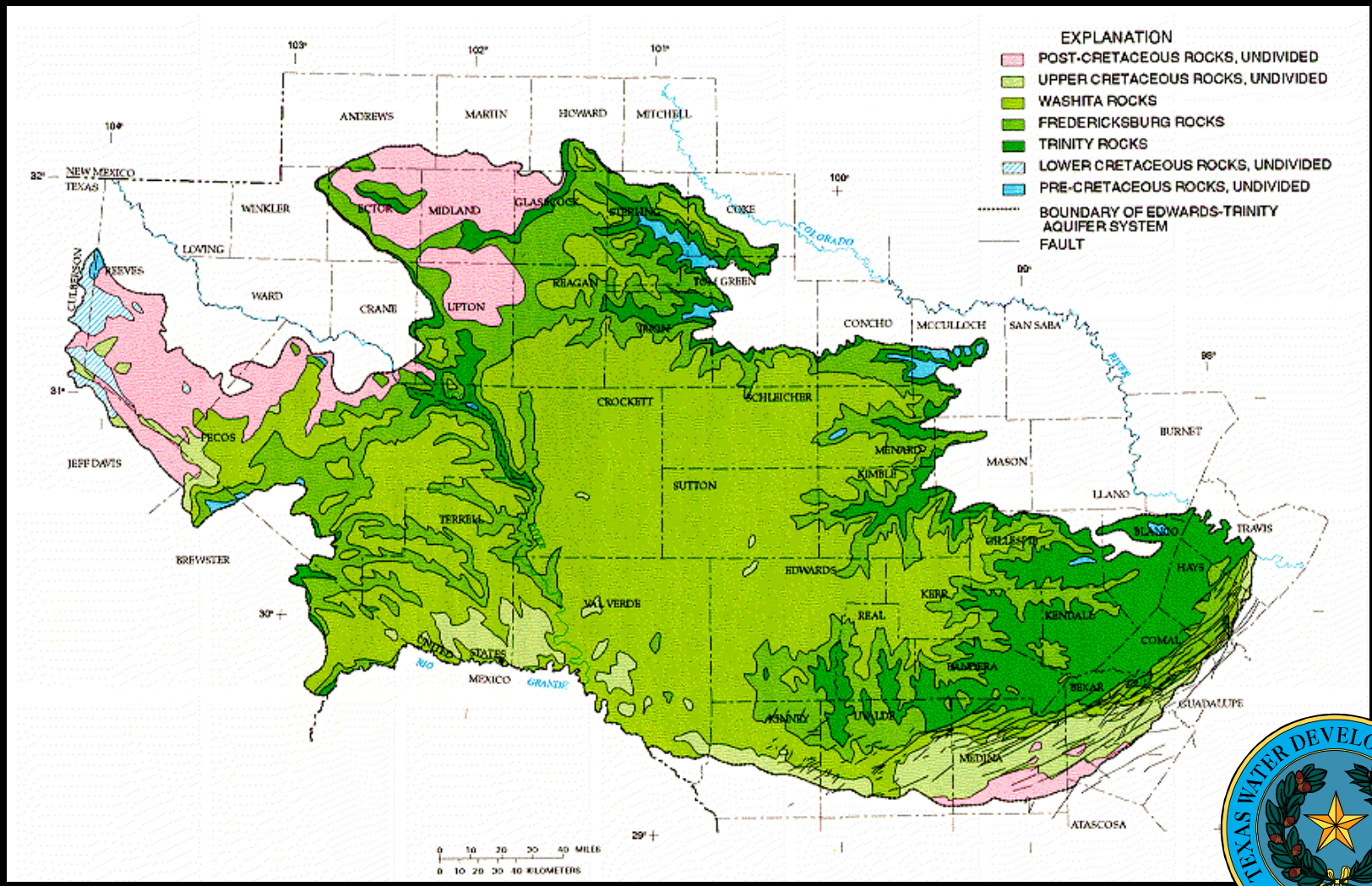
Lateral Geology at Edges of Edwards-Trinity



Overlying Geology of Edwards-Trinity Aquifer

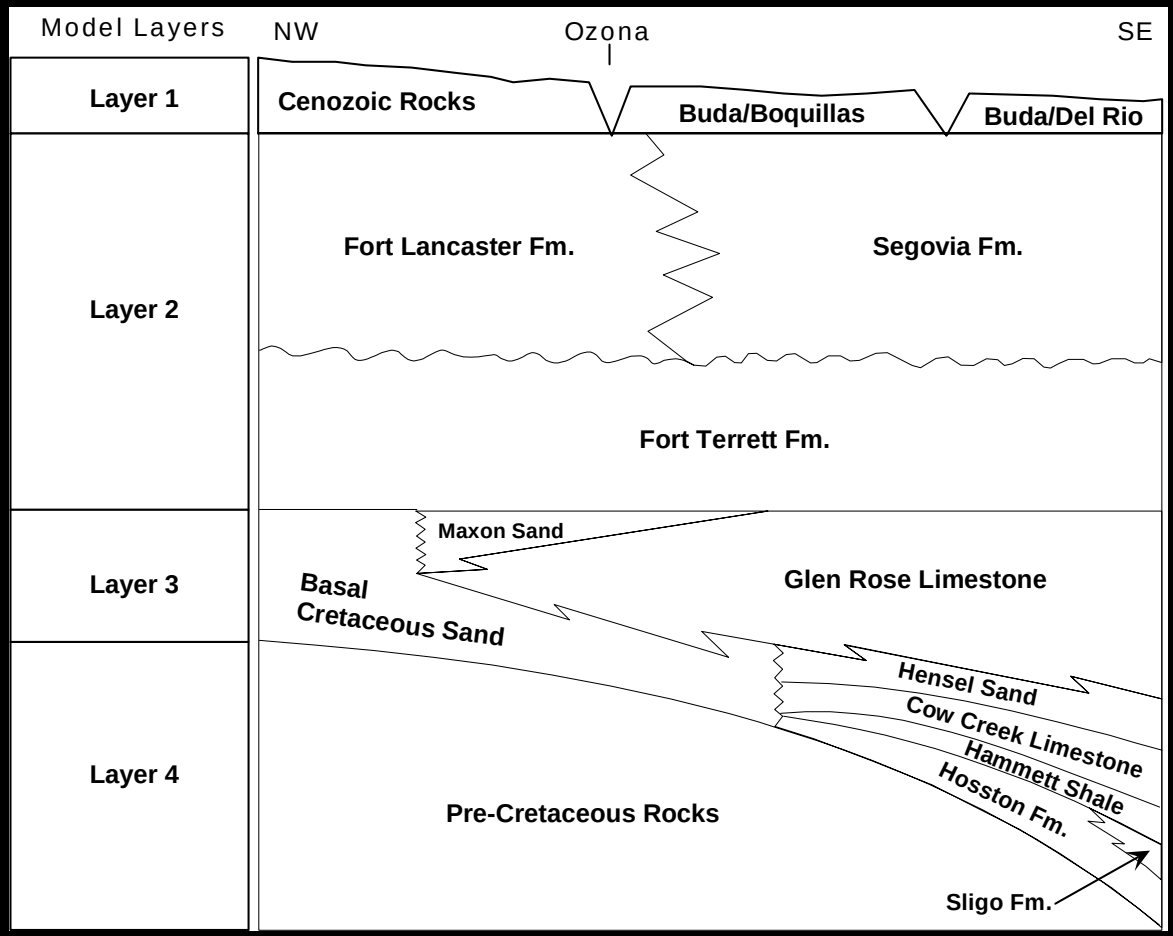


Surface Geology



From - Barker and Ardis, 1996

Proposed Model Layers For The Edwards-Trinity Aquifer Sediments



Questions or Comments?

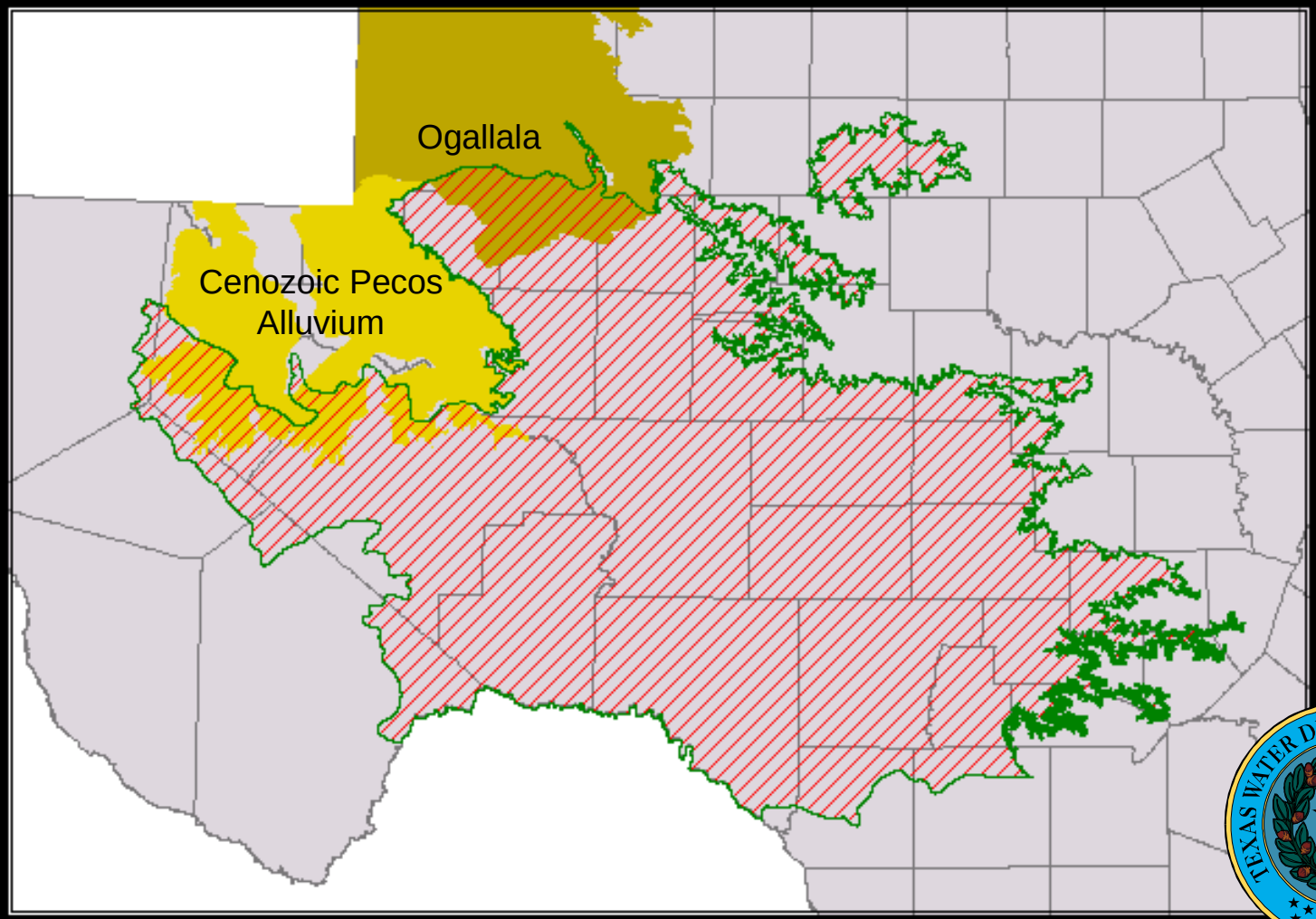
15 Minute Break!

We will reconvene for a few more minutes
to finish discussion on boundary conditions

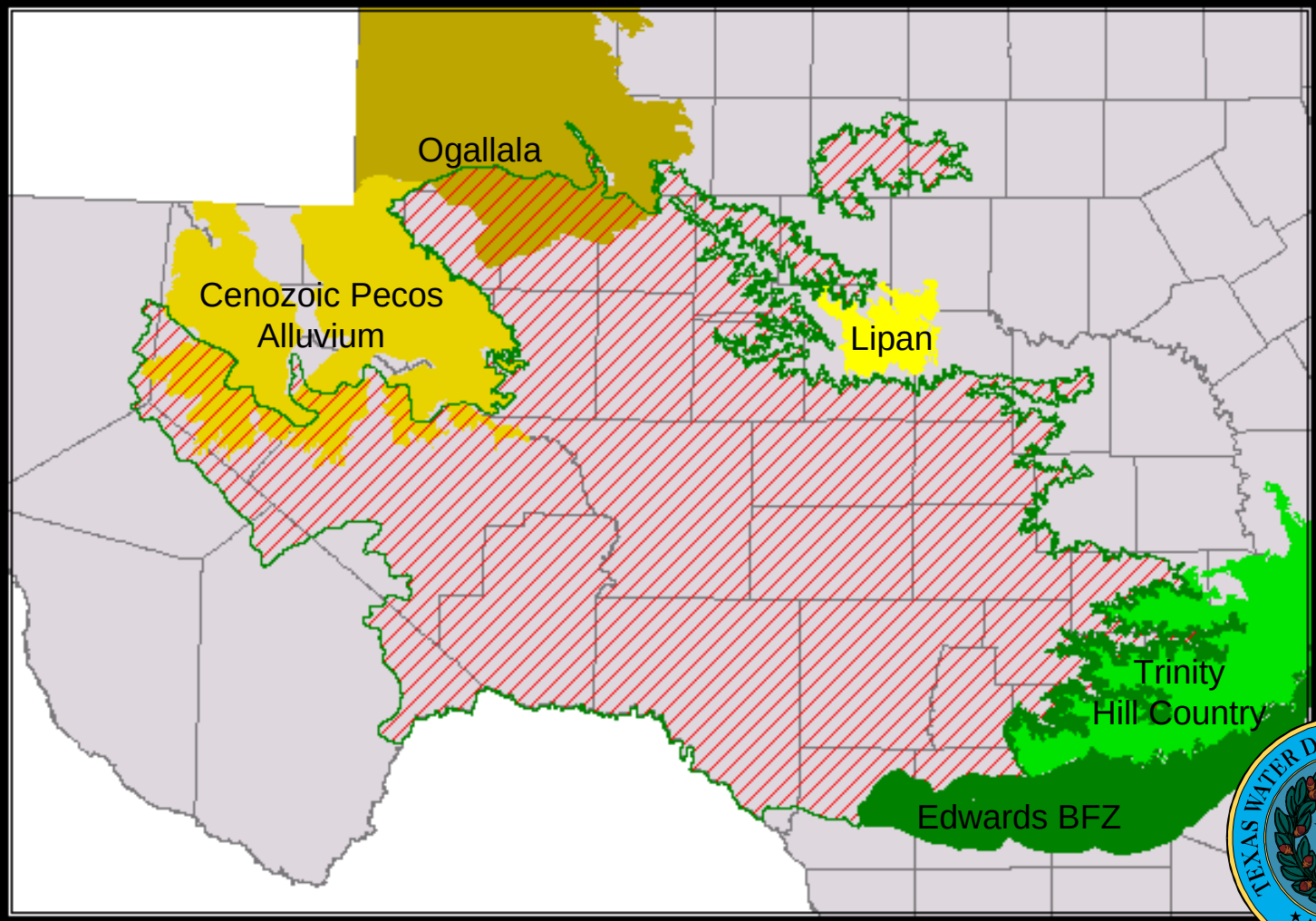
FOR MORE INFO VISIT...

www.twdb.state.tx.us/gam

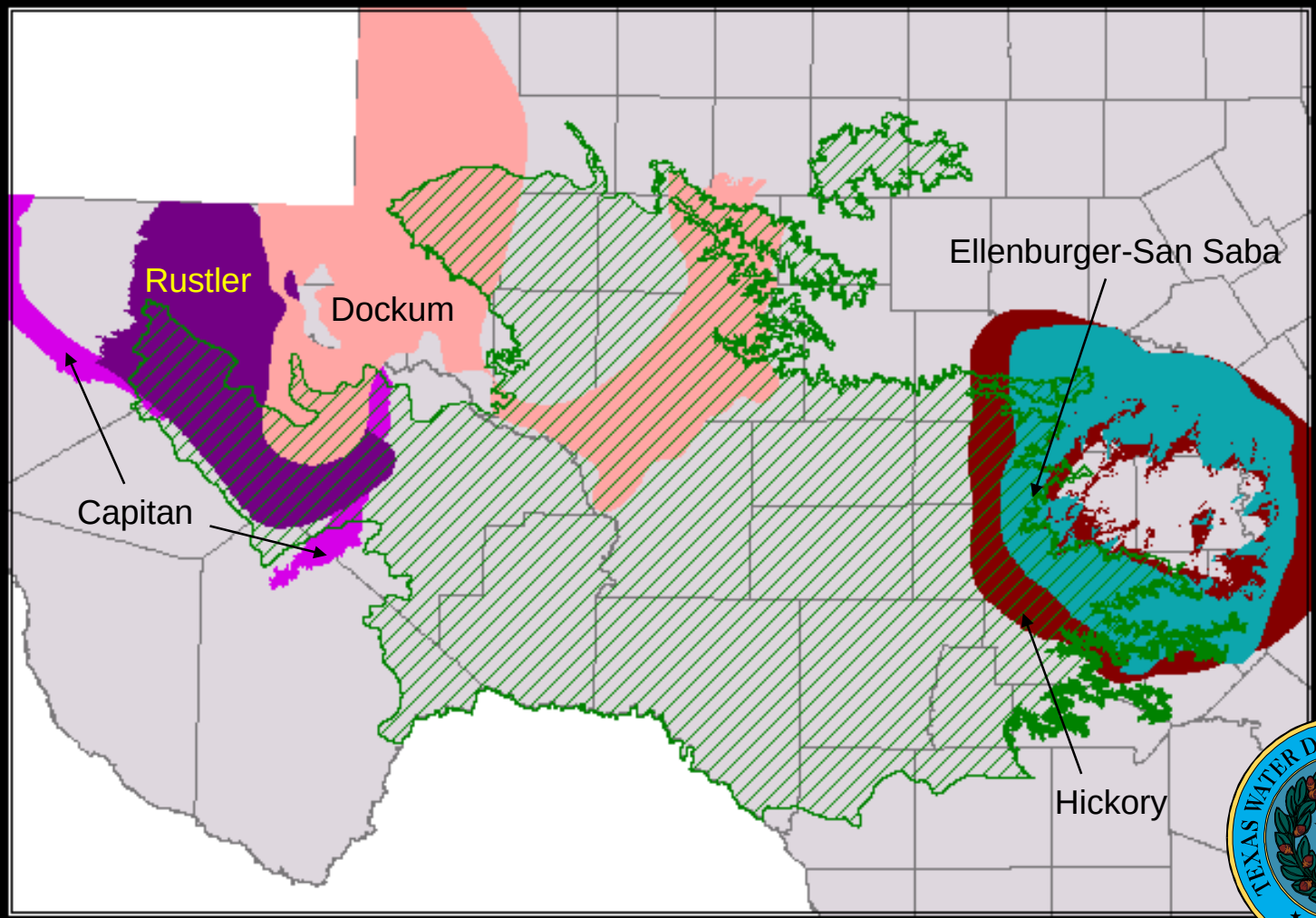
Overlying Units Hydraulically Connected to Edwards-Trinity



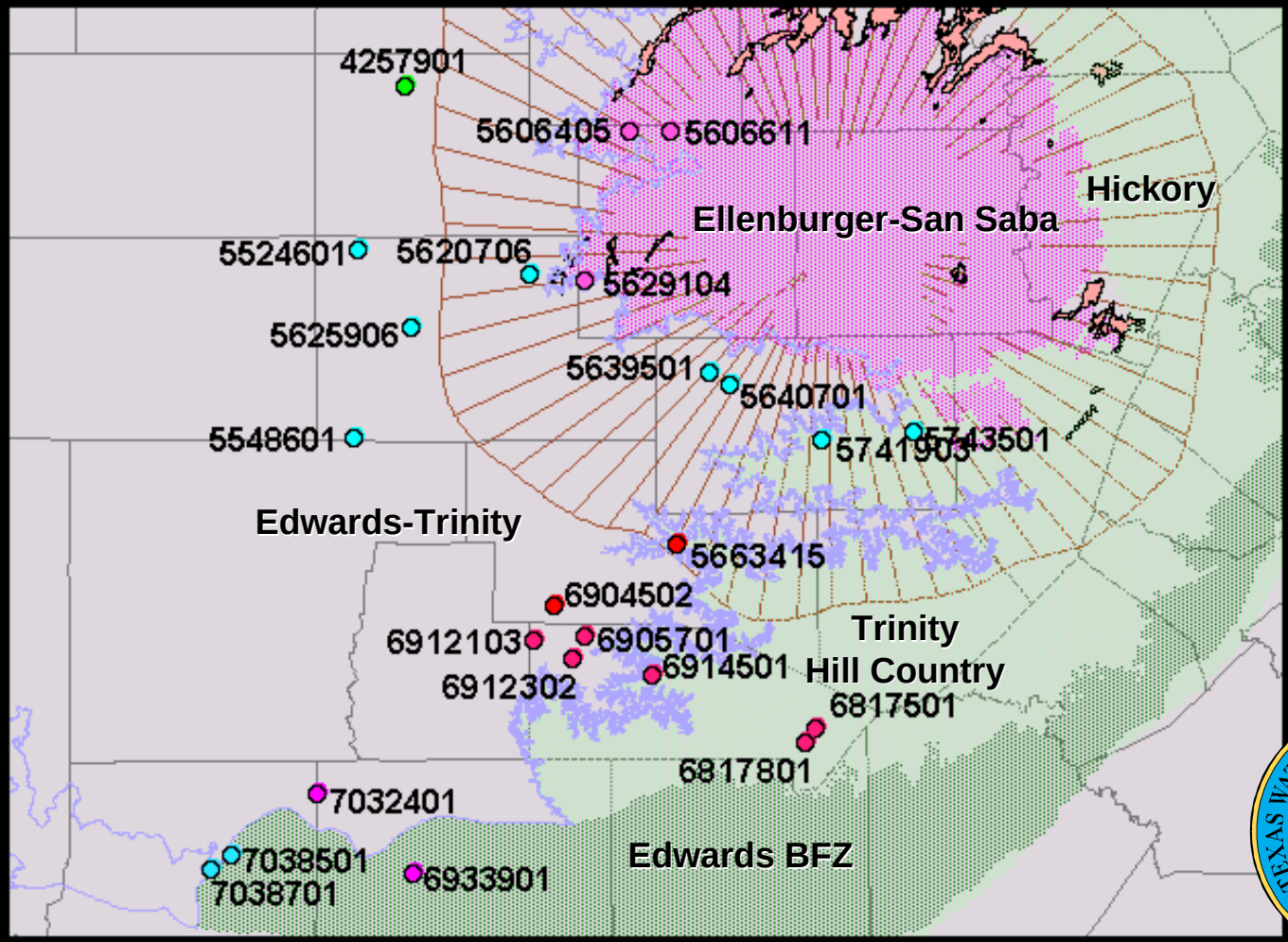
Lateral Units Hydraulically Connected to Edwards-Trinity



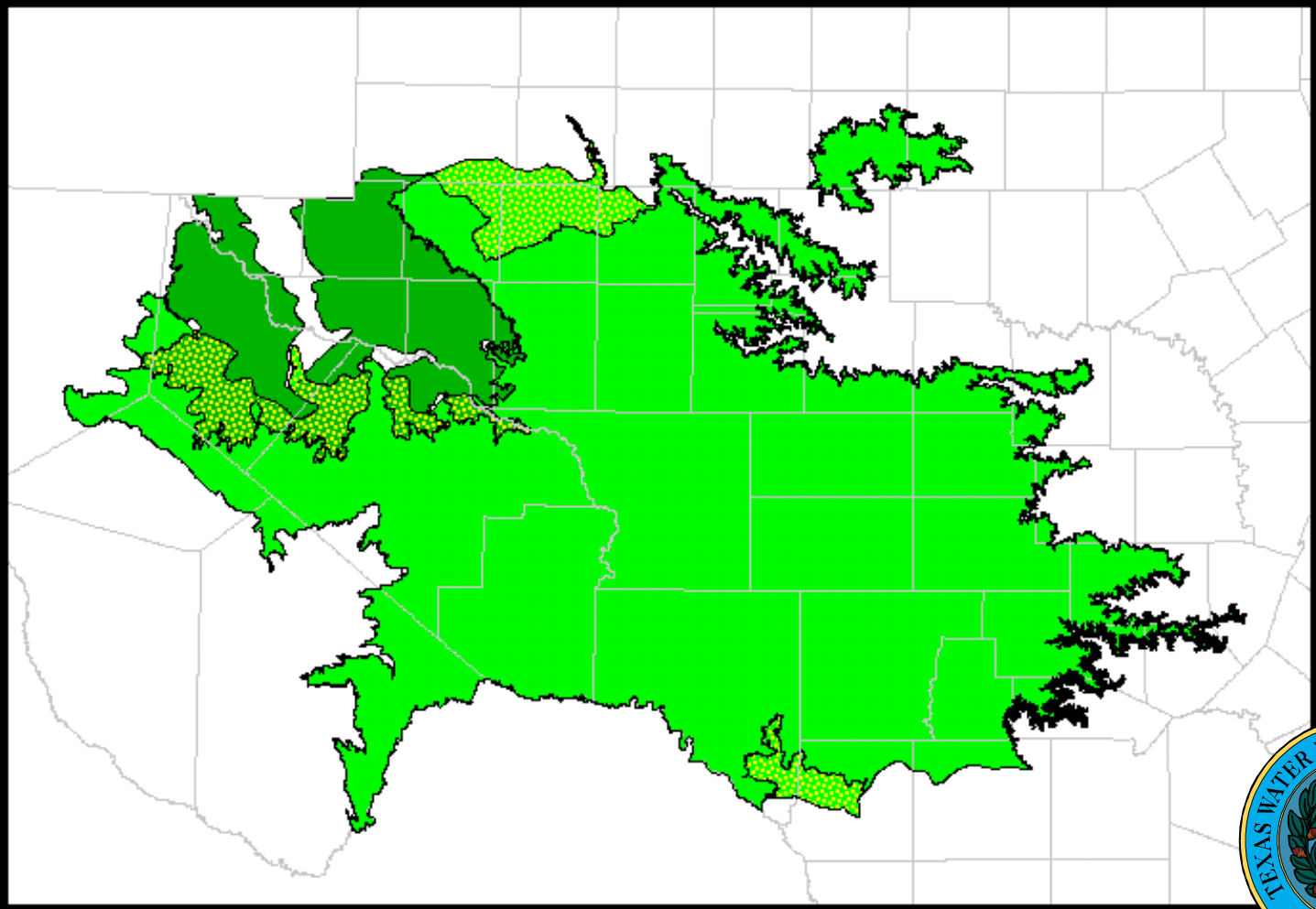
Underlying Units Hydraulically Connected to Edwards-Trinity



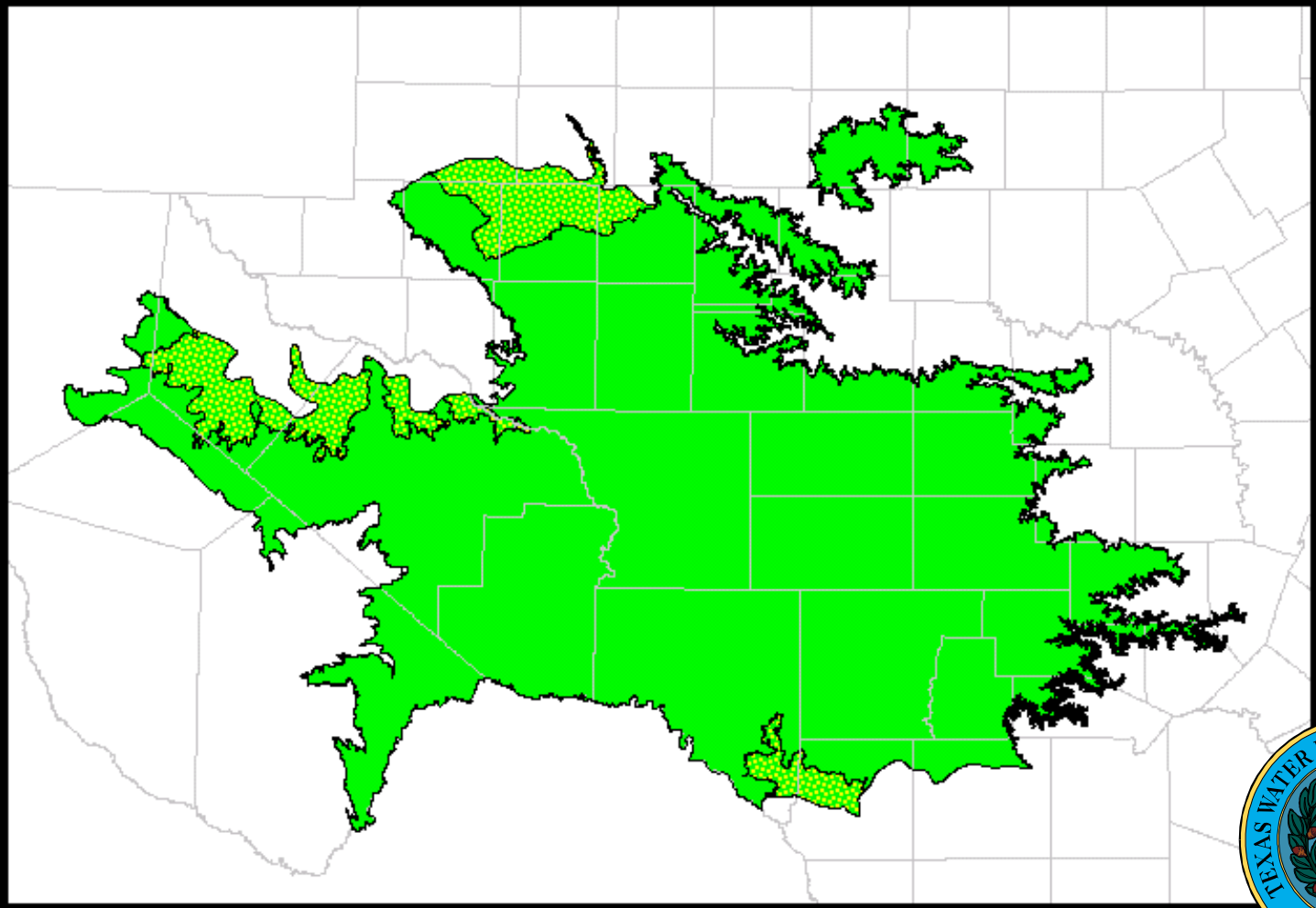
A Partial Comparison of Water Levels



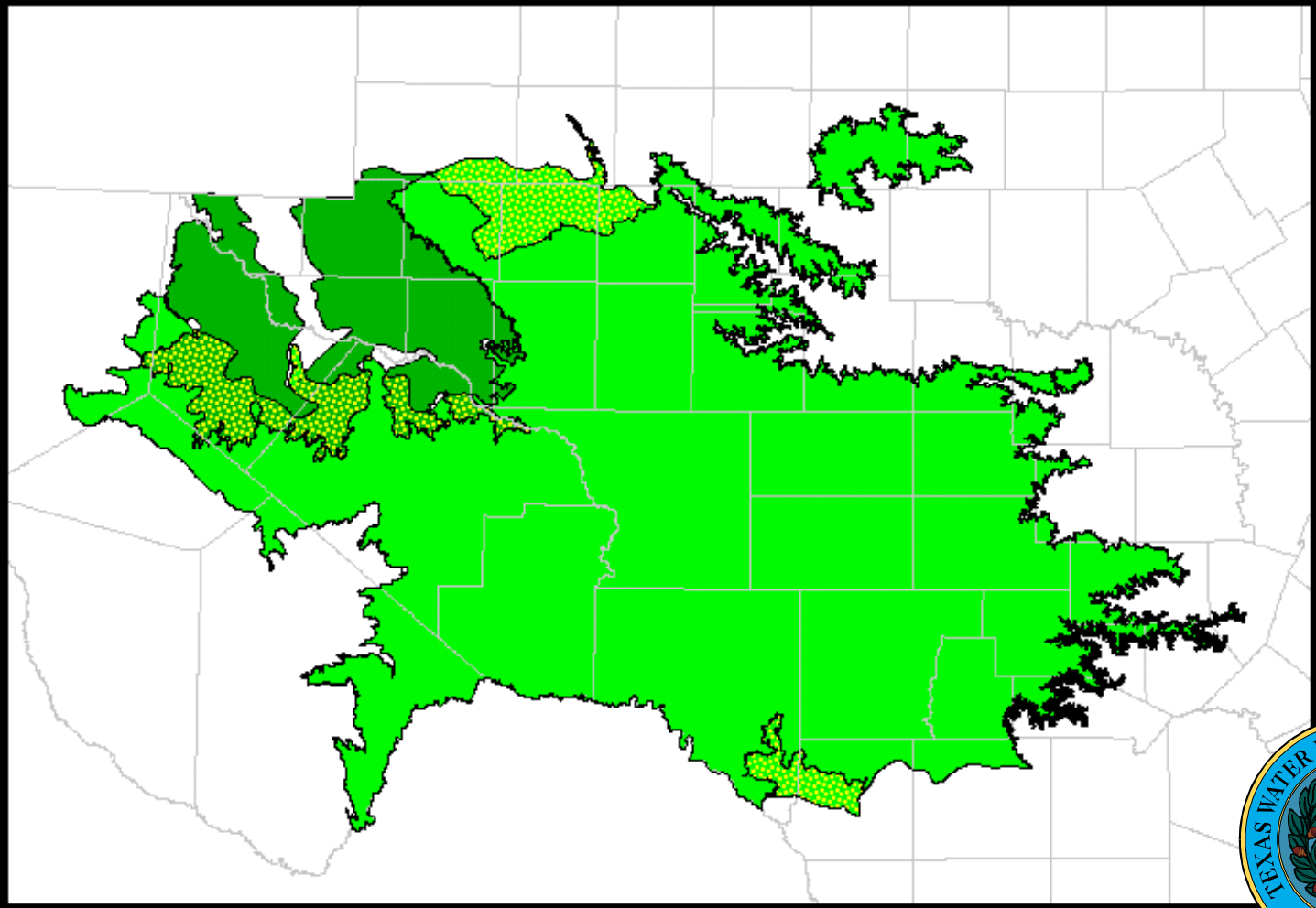
To Model the Pecos Alluvium or ...



...Not to Model the Pecos Alluvium?



The Pecos Alluvium Will Be Modeled With Edwards-Trinity



Lunch Time!

90 Minute Break

We will reconvene after lunch for a presentation of the Cenozoic Pecos Alluvium by Ian Jones

FOR MORE INFO VISIT...

www.twdb.state.tx.us/gam

CENOZOIC PECOS ALLUVIUM AQUIFER

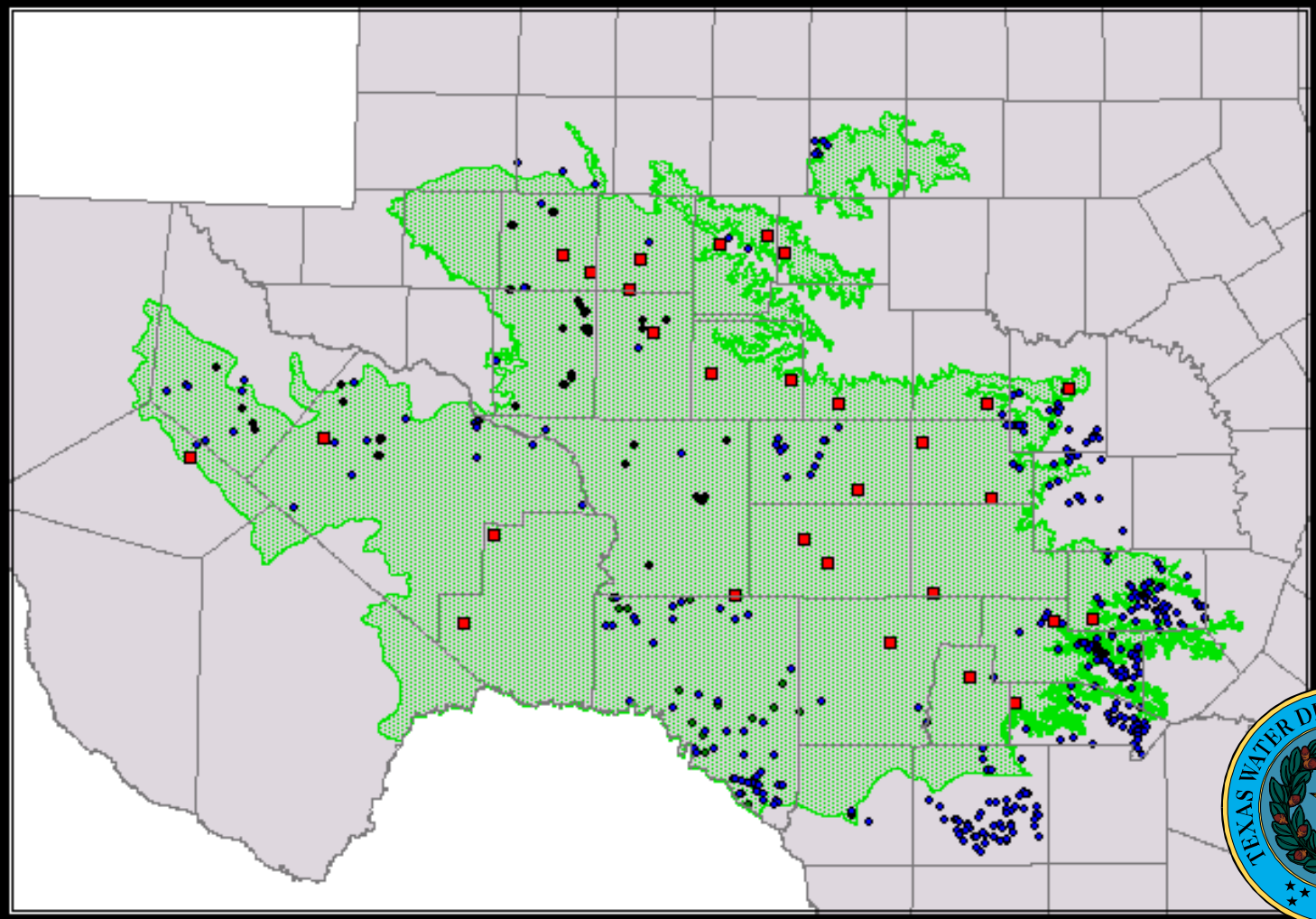
Separate Power Point Presentation

Presented by

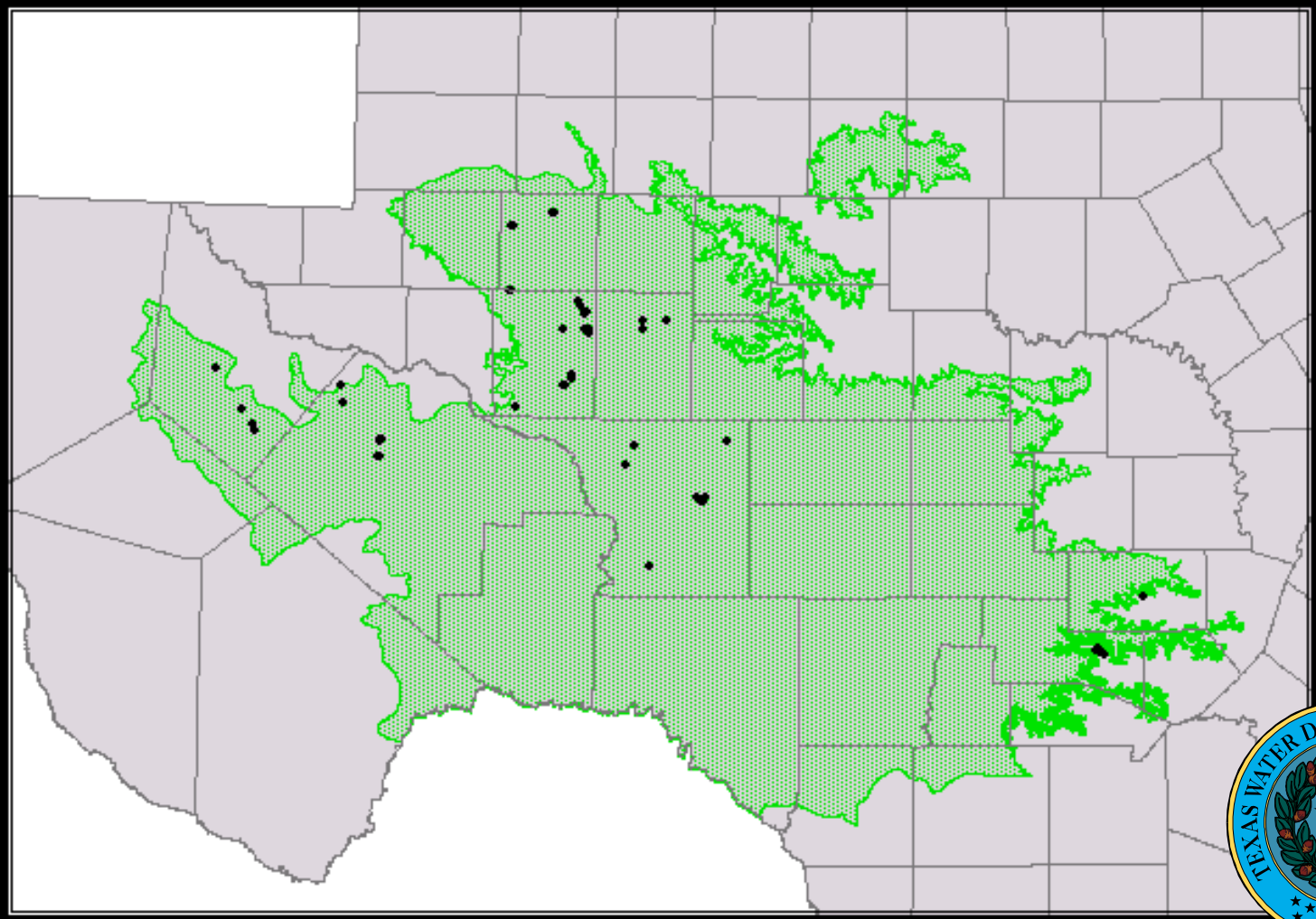
Ian Jones

Texas Water Development Board

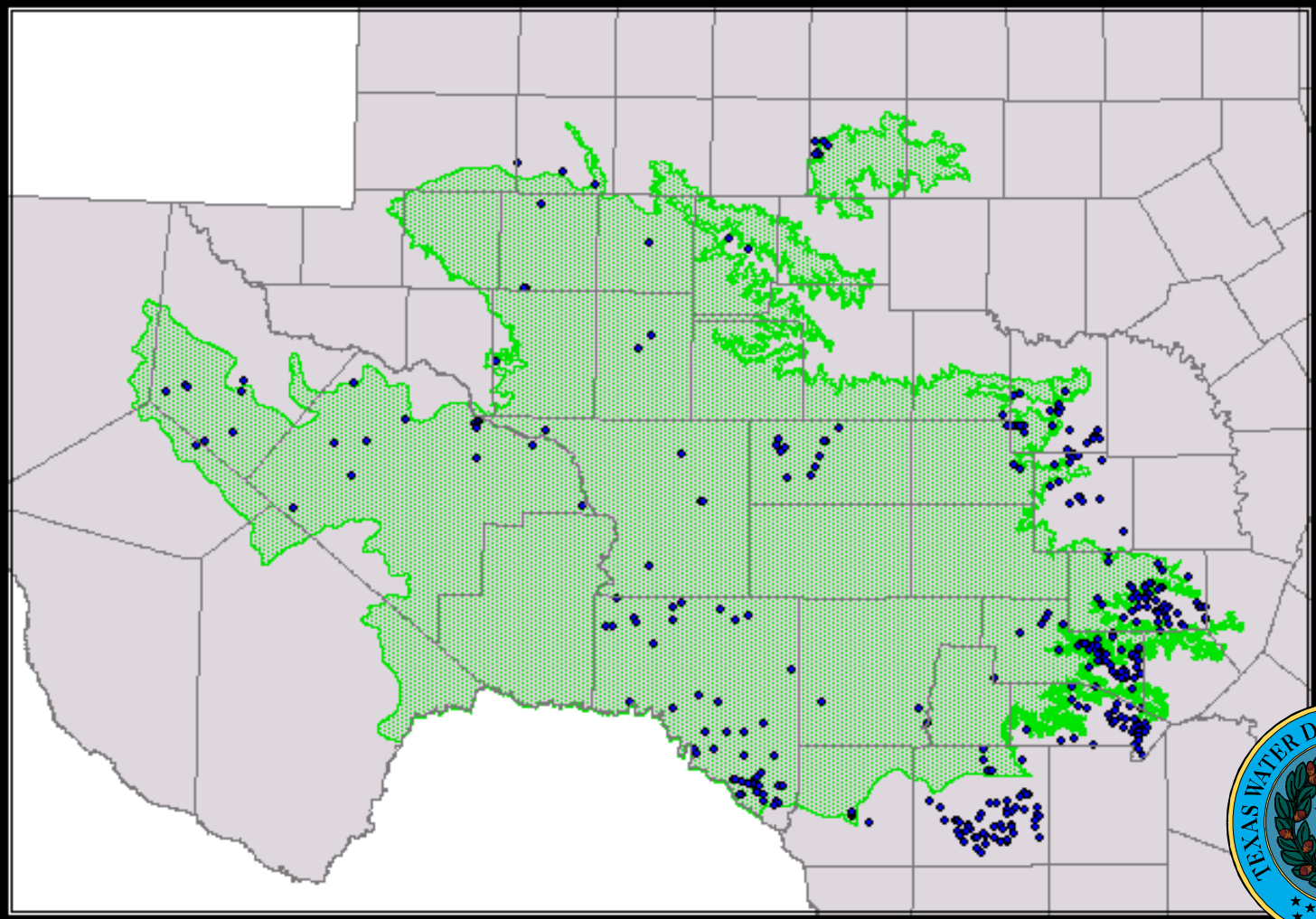
Update on Pumping Tests for the Edwards-Trinity Aquifer



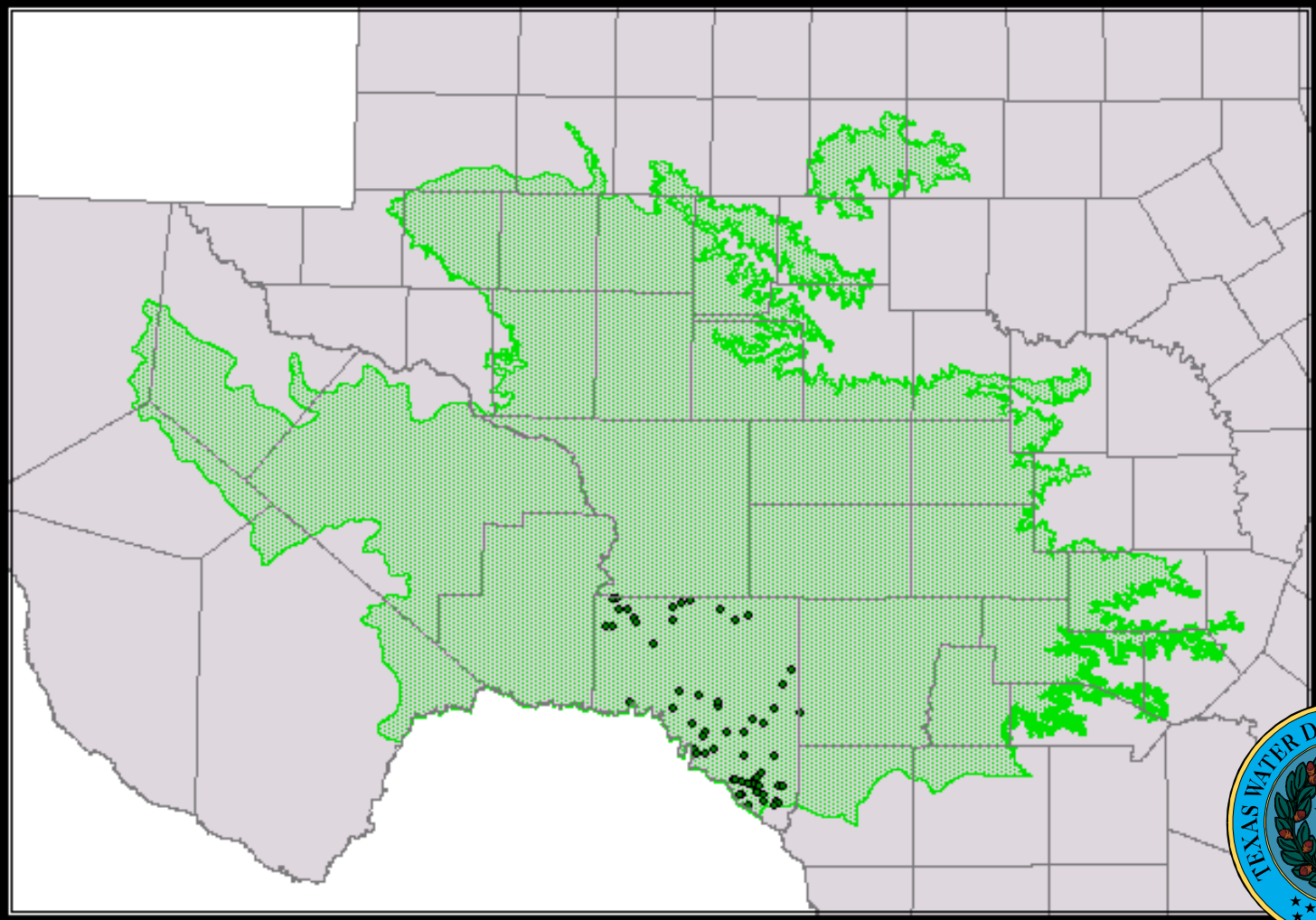
Existing Pumping Tests From TWDB GW Database



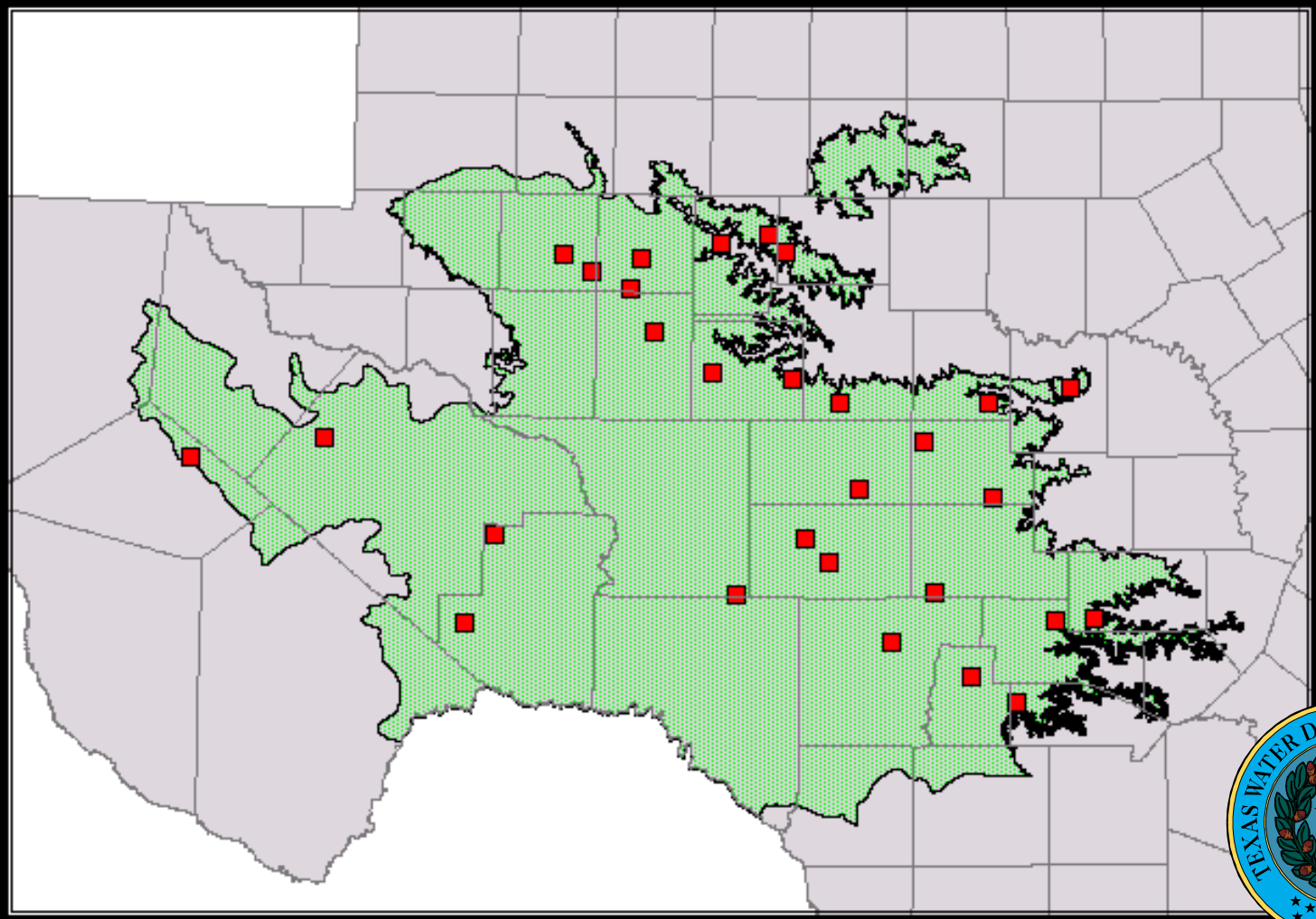
Specific Capacity Tests Digitized From TNRCC Source Data



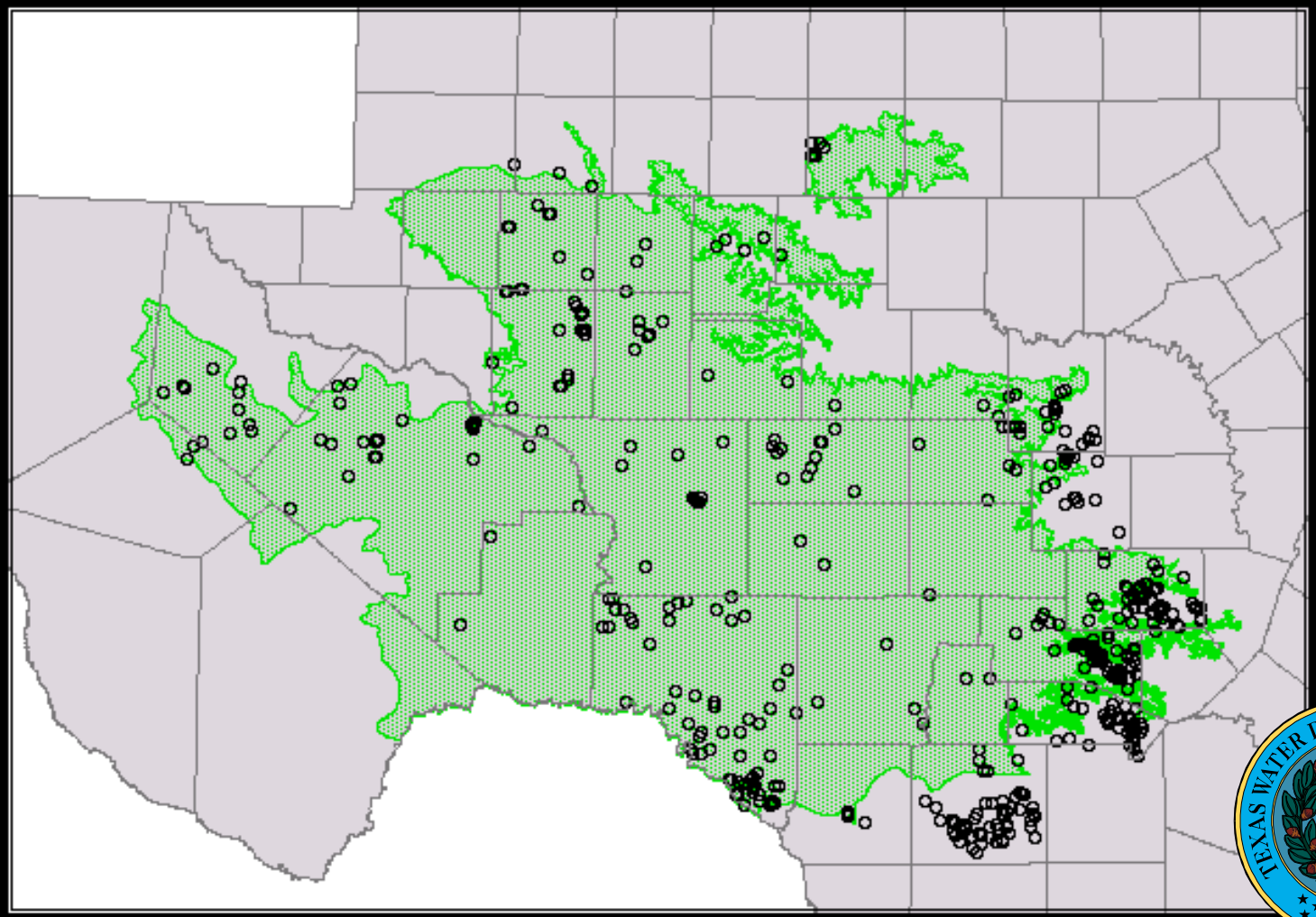
Hydraulic Data Digitized For Val Verde TWDB Project



29 of 39 TWDB Pumping Tests Completed Since ET SAF 1



Current Spatial Data Density for Hydraulic Properties



Current Project Status

- Completed Literature Review
- Continued Collection of Hydrogeologic Data
- Continued Data Processing and Analysis
- Completed 29 of 39 New Pumping Tests
- Project Still 3 to 4 Months Behind Schedule

Topics For ET SAF 4

- Final Structural Geometry
- Development of 3D Model Grid
- Hydraulic Property Distributions
- Discuss Pumpage Distributions
- Reservoir, Stream, and Spring Boundaries
- Introduce Methods for Recharge and Evapotranspiration Estimates

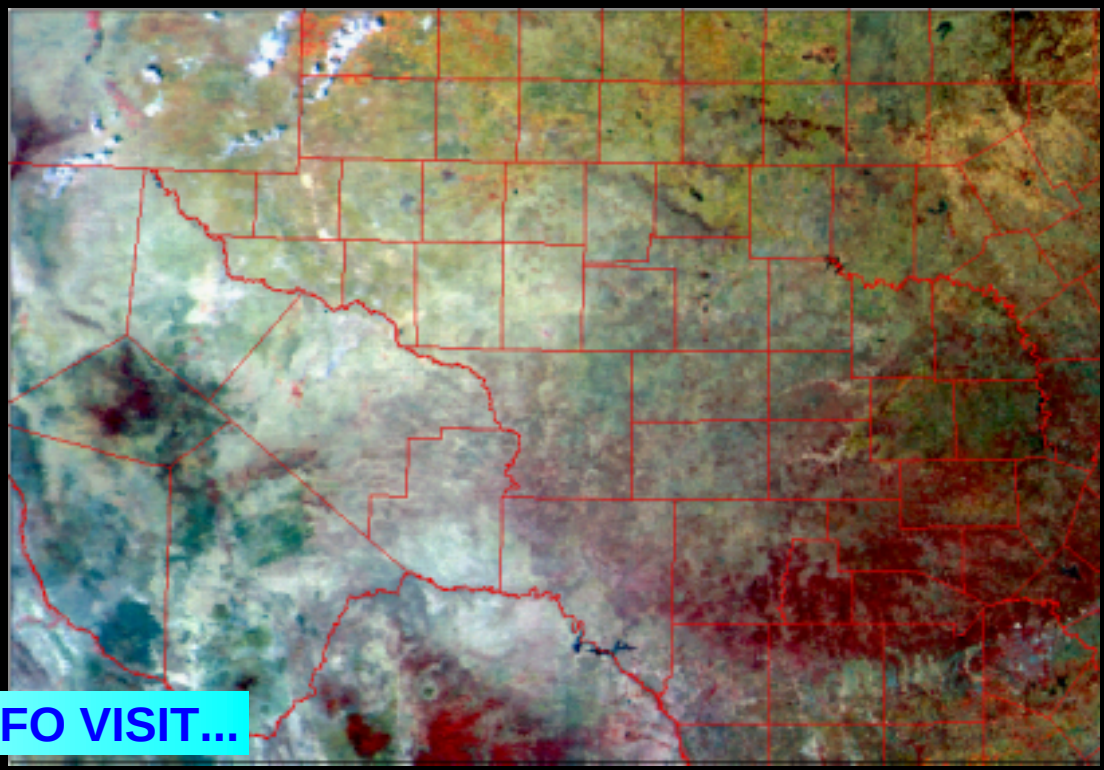
Primary Literature Sources

- R. A. Barker and A. F. Ardis, ***Hydrogeologic Framework of the Edwards-Trinity Aquifer System, West-Central Texas***, USGS Professional Paper 1421-B, 1996.
- L. E. Walker, ***Occurrence, Availability, and Chemical Quality of Groundwater In The Edwards Plateau Region of Texas***, Texas Department of Water Resources Report 235, 1979.
- R. Rees and A. W. Buckner, ***Occurrence and Quality of Groundwater In The Edwards-Trinity (Plateau) Aquifer in the Trans-Pecos Region of Texas***, Texas Department of Water Resources Report 255, 1980.
- E. L. Kuniansky and K. Q. Holligan, ***Simulation of Flow in the Edwards-Trinity Aquifer System and Contiguous Hydraulically Connected Units, West-Central Texas***, USGS Water-Resources Investigation Report 93-4039, 1994.

Questions or Comments?

End of ET SAF 3!

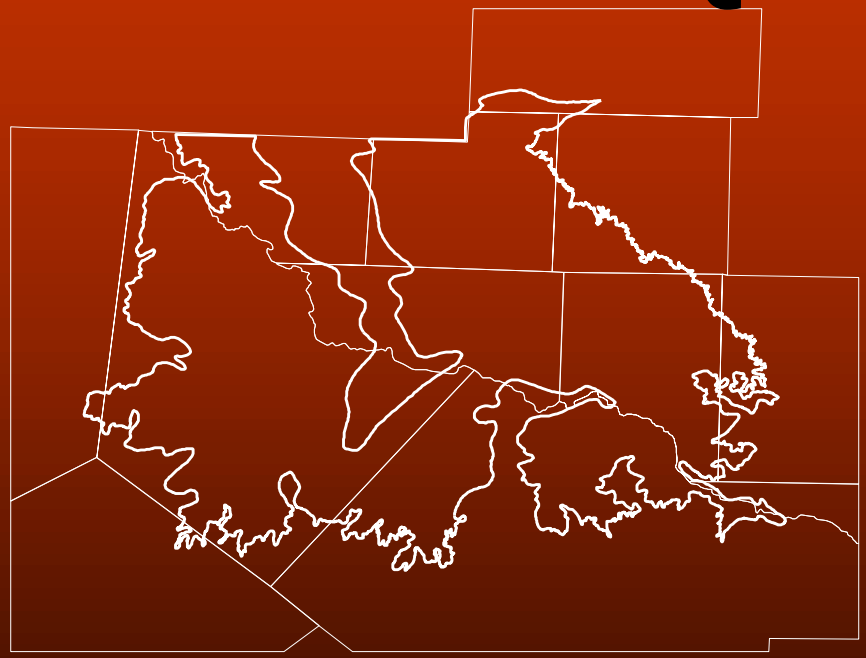
Have a safe drive home ...



FOR MORE INFO VISIT...

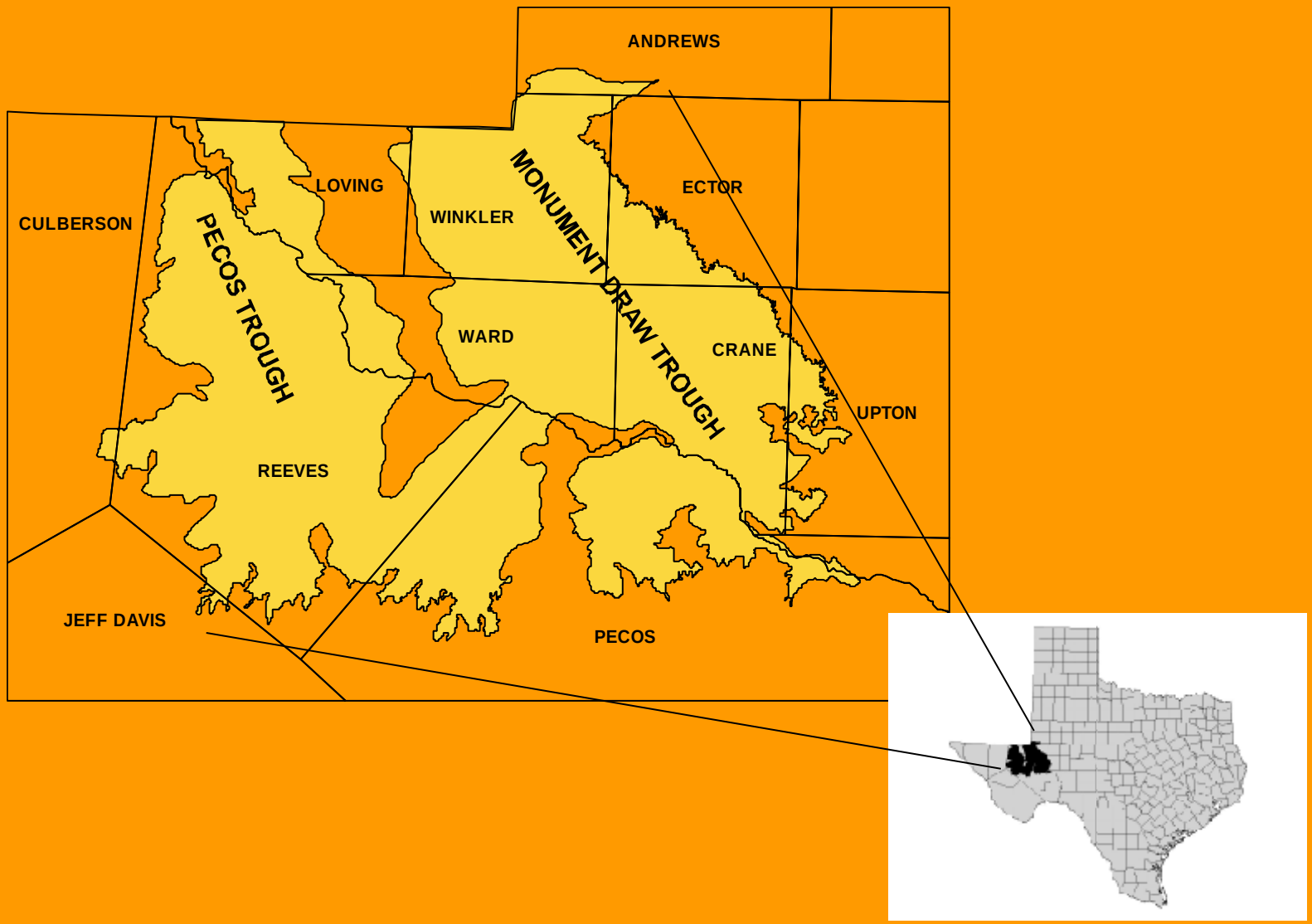
www.twdb.state.tx.us/gam

CENOZOIC PECOS ALLUVIUM AQUIFER

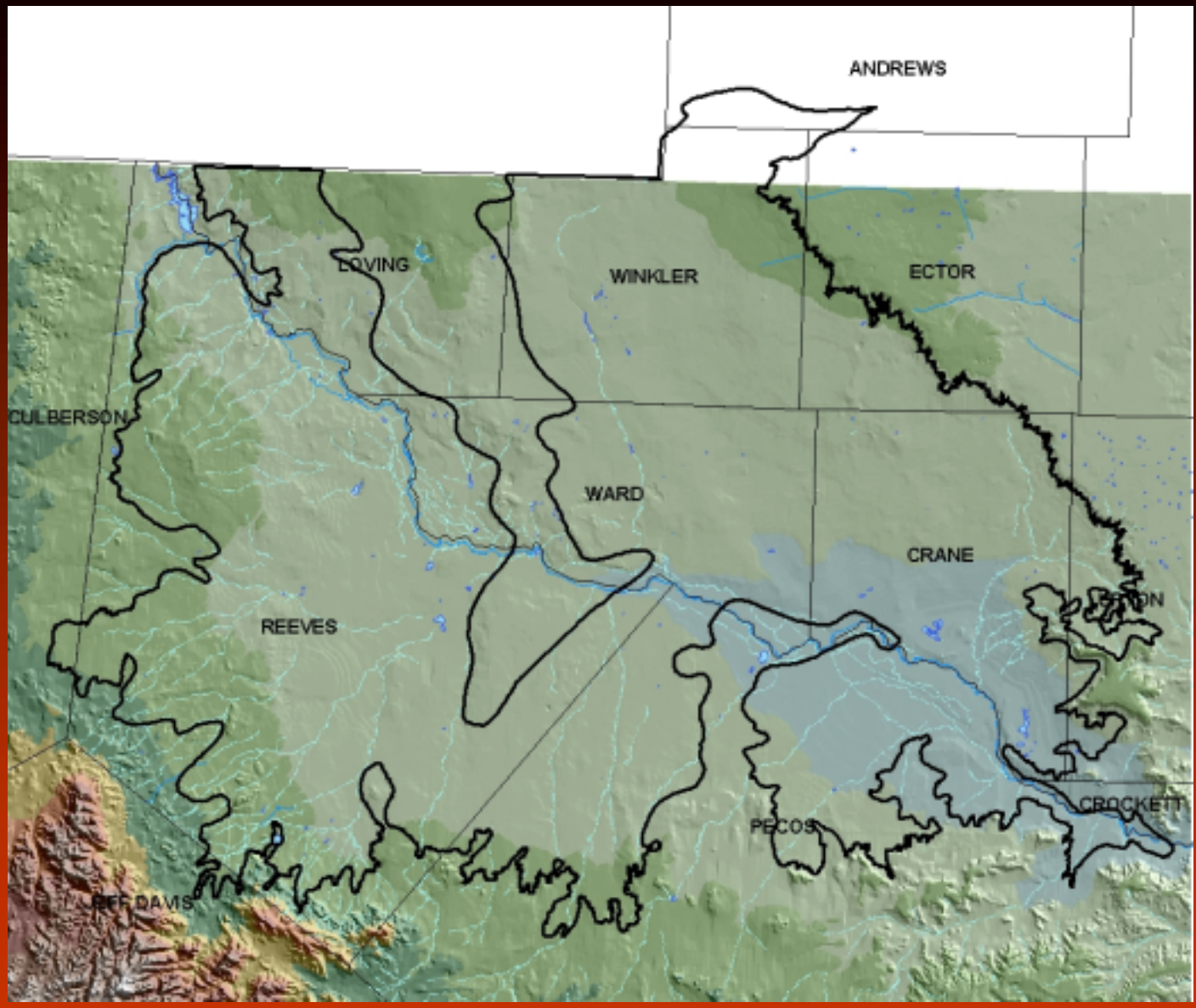


Ian C. Jones

Texas Water Development Board



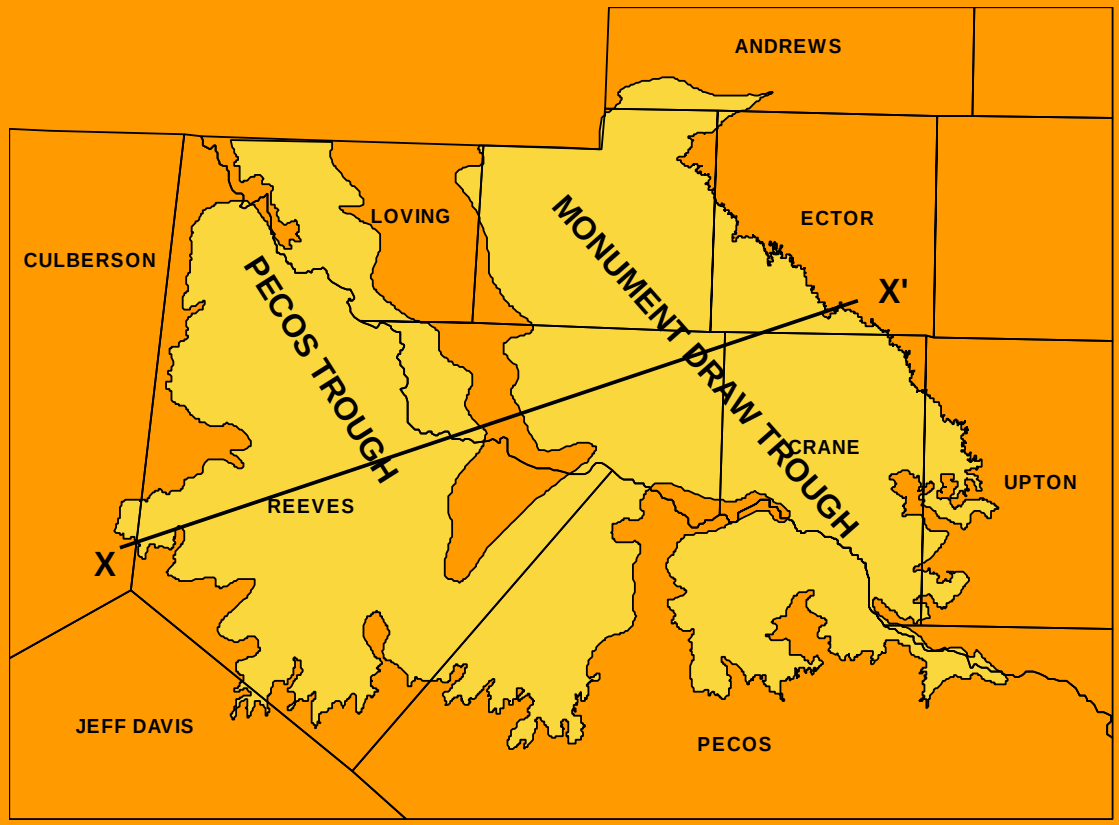
LOCATION MAP

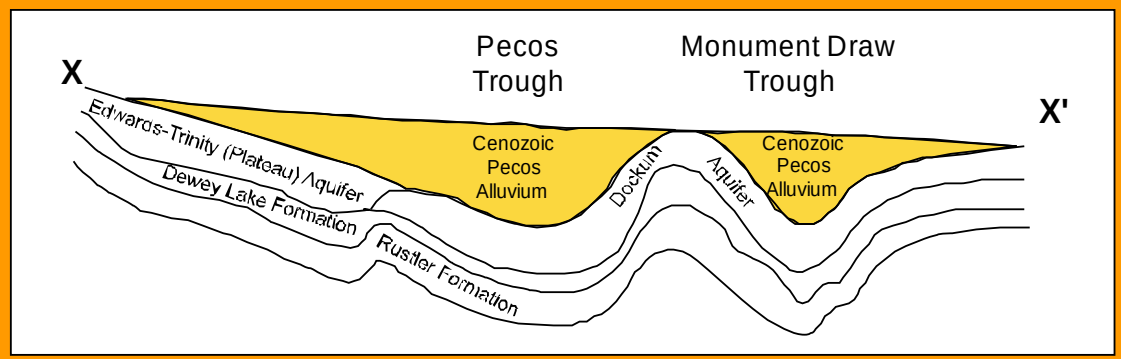

ANDREWS
LOVING
WINKLER
ECTOR
CULBERSON
WARD
CRANE
REEVES
CROCKETT
PECOS
JEFF DAVIS

TOPOGRAPHY

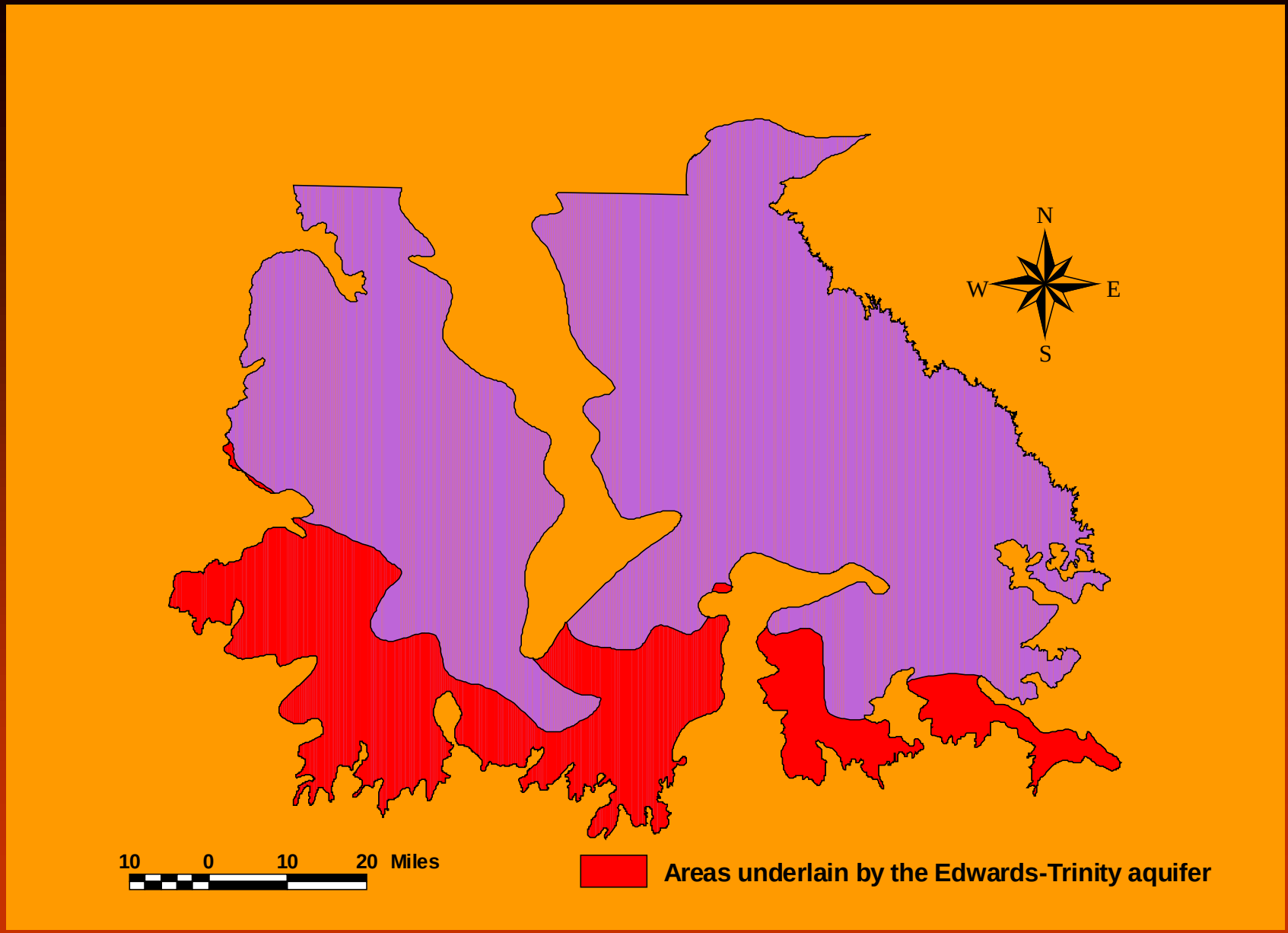
Era	System	Series/Group		Stratigraphic Unit
Cenozoic	Quaternary			Cenozoic Pecos Alluvium
Mesozoic	Tertiary			Volcanic Rocks
	Cretaceous	Gulf		undifferentiated
		Comanche	Washita	undifferentiated
			Fredericksburg	
			Trinity	undifferentiated
	Triassic	Dockum		undifferentiated
Paleozoic	Permian	Ochoan		Dewey Lake Red Beds
				Rustler Formation
				Salado Formation
				Castile Formation
		Guadalupian		Capitan Reef Complex

STRATIGRAPHIC UNITS

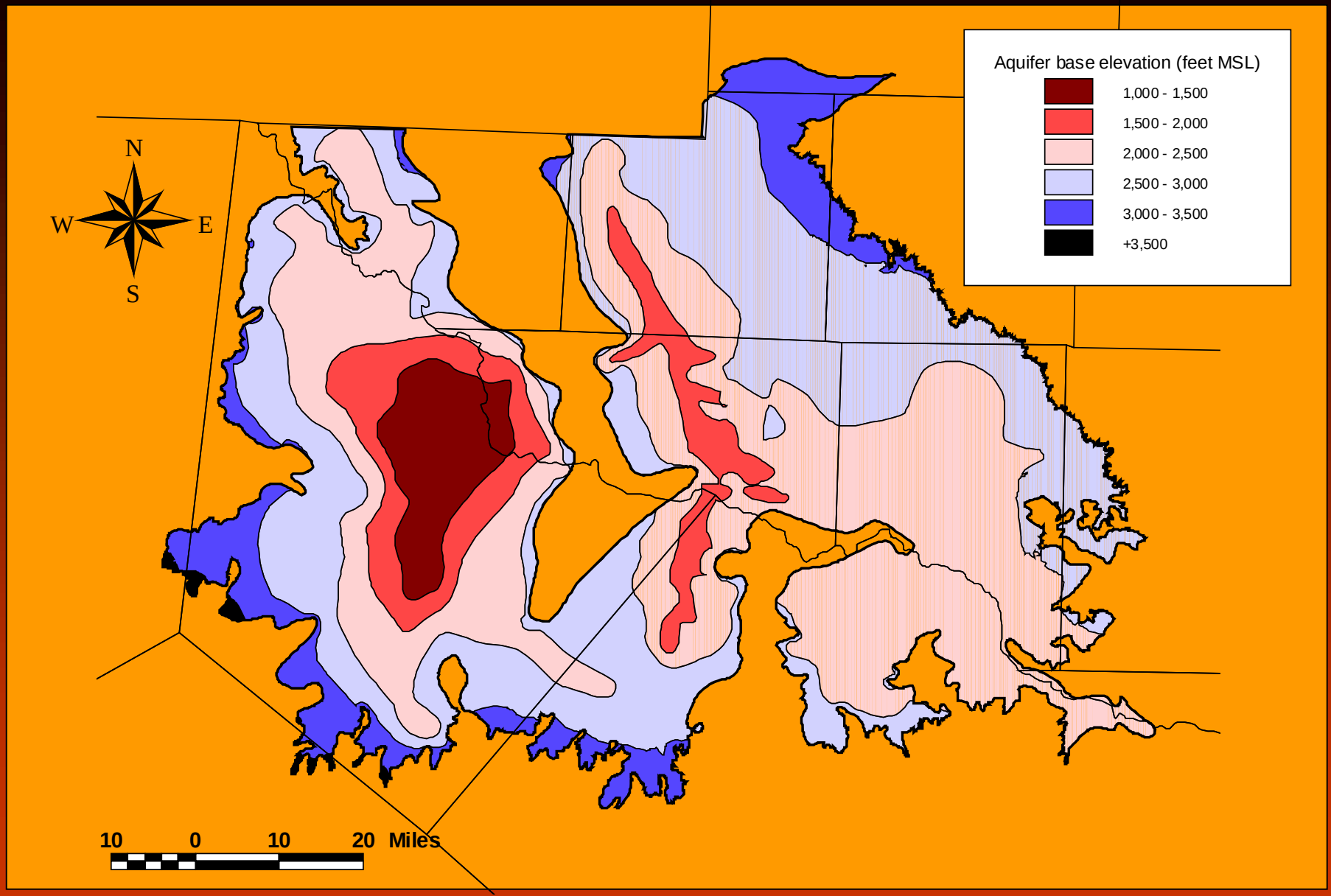




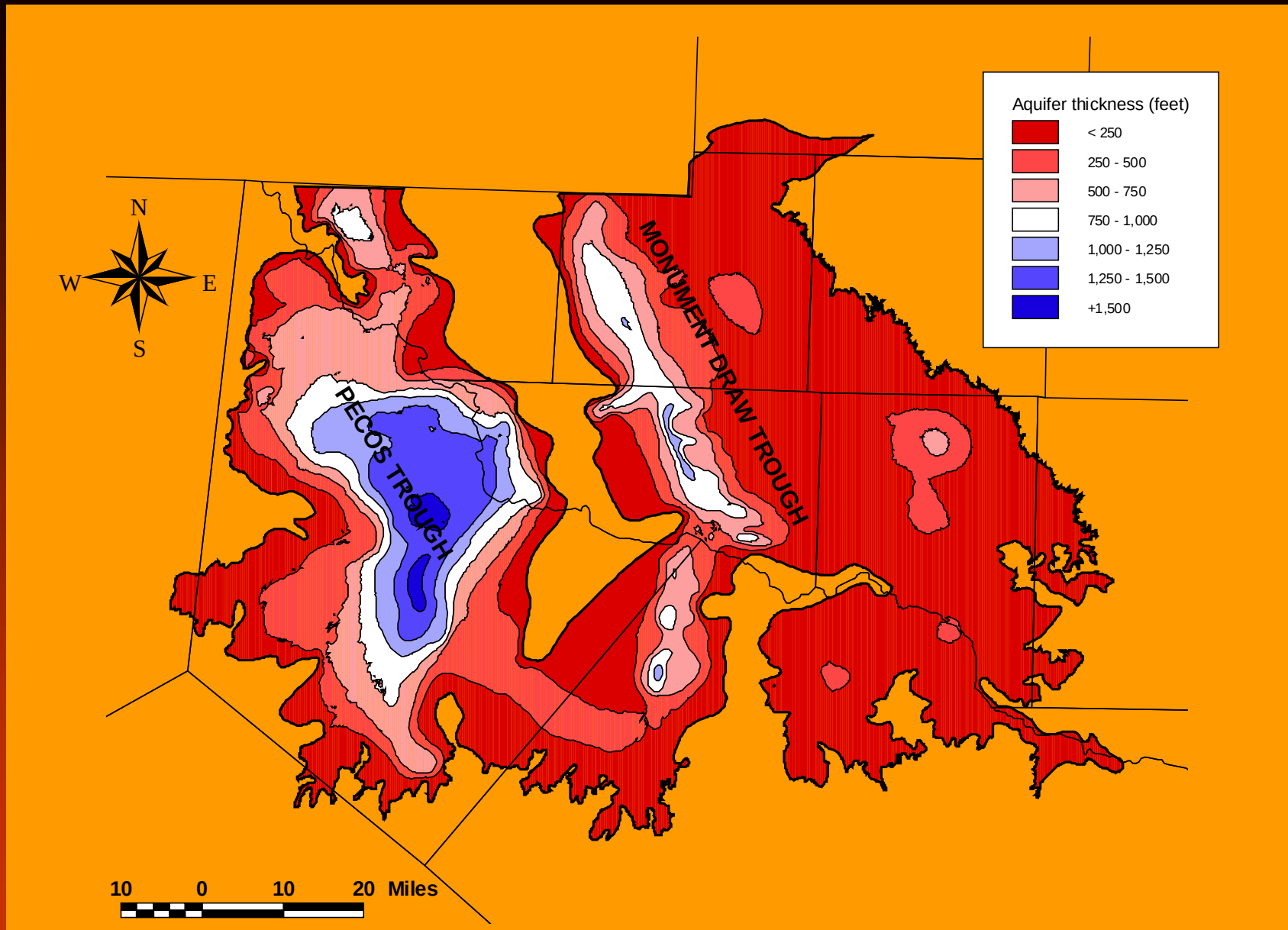
CENOZOIC PECOS ALLUVIUM AQUIFER


N
W
E
S
10 0 10 20 Miles
Areas underlain by the Edwards-Trinity aquifer

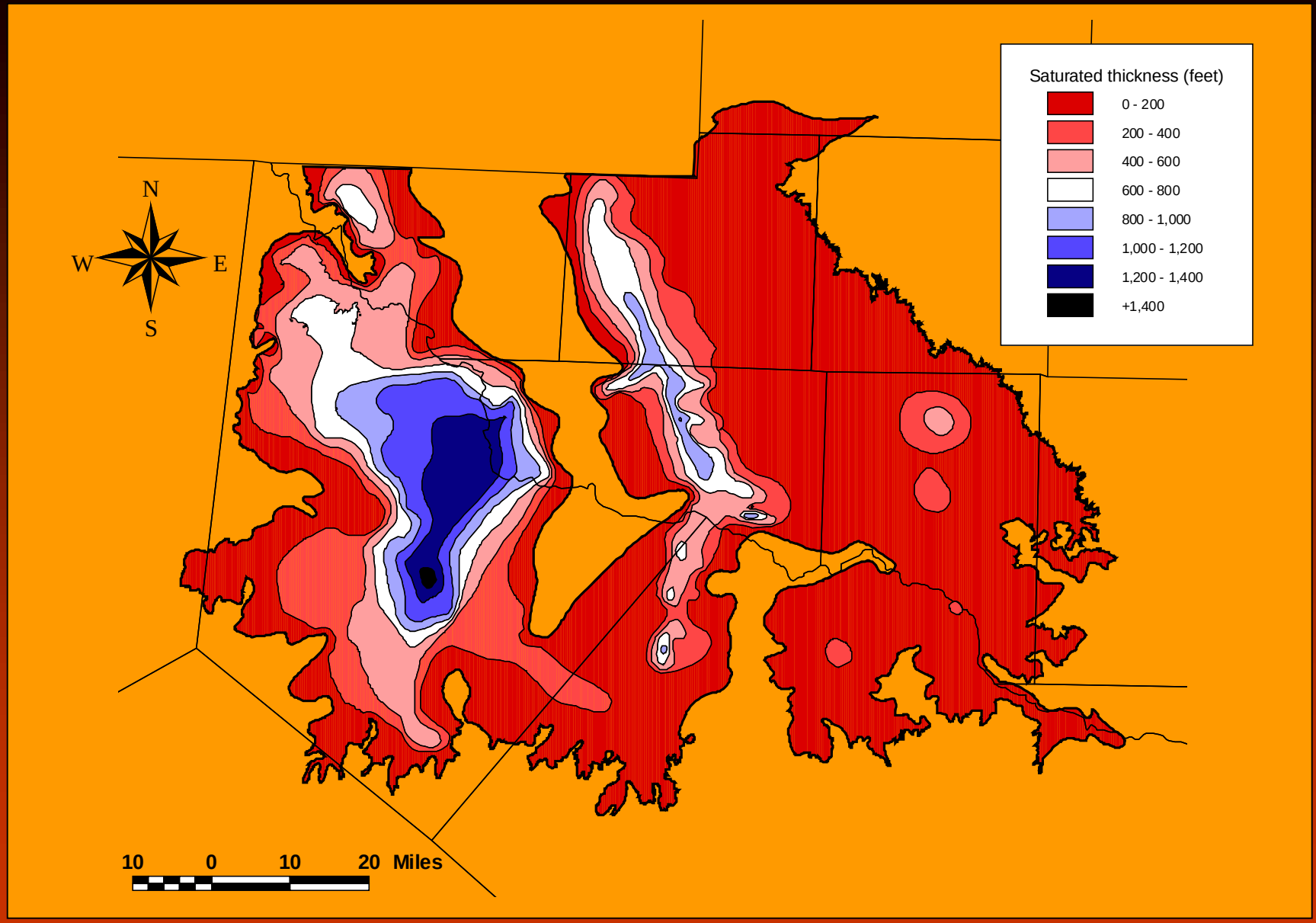
AQUIFER



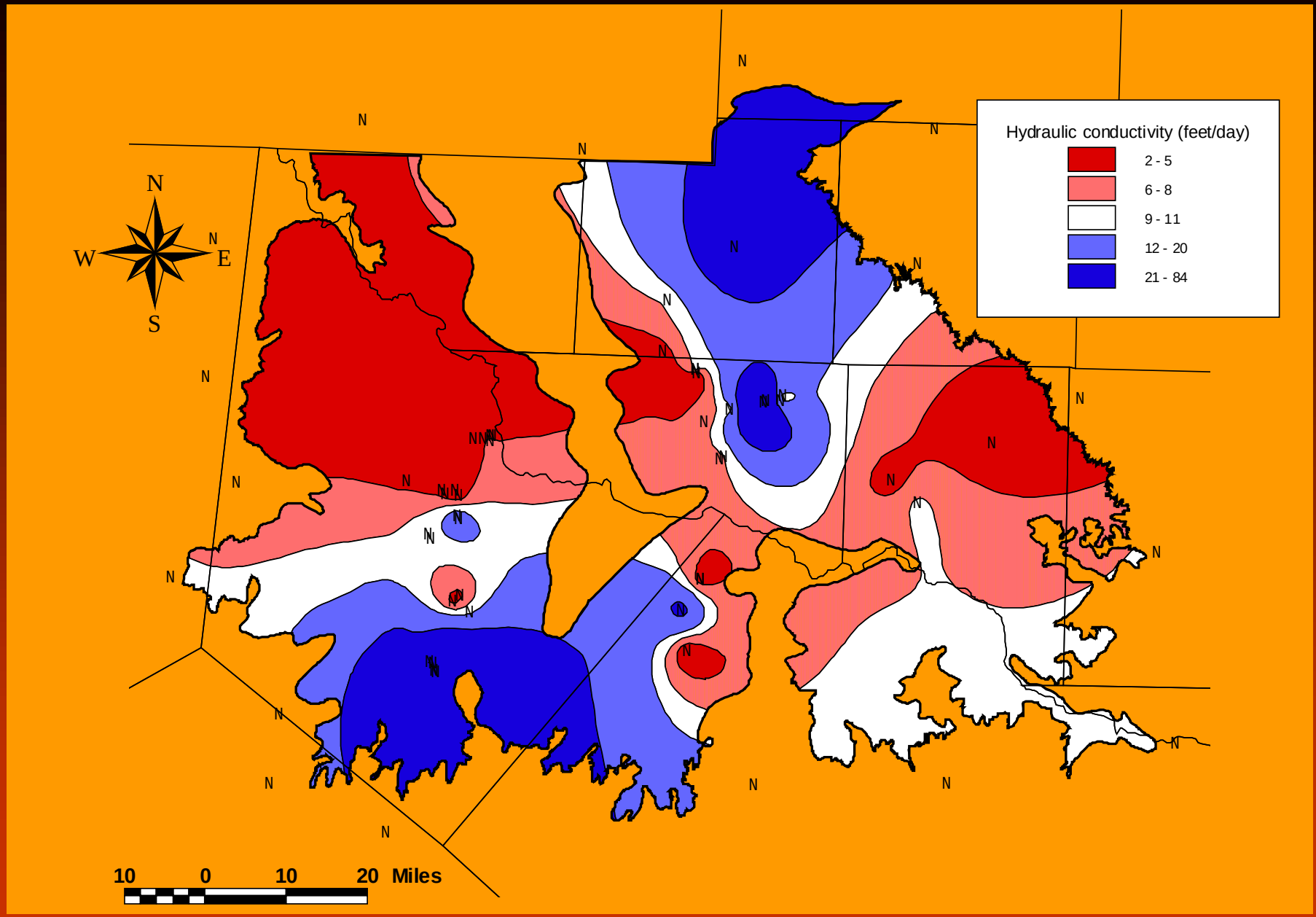
AQUIFER BASE



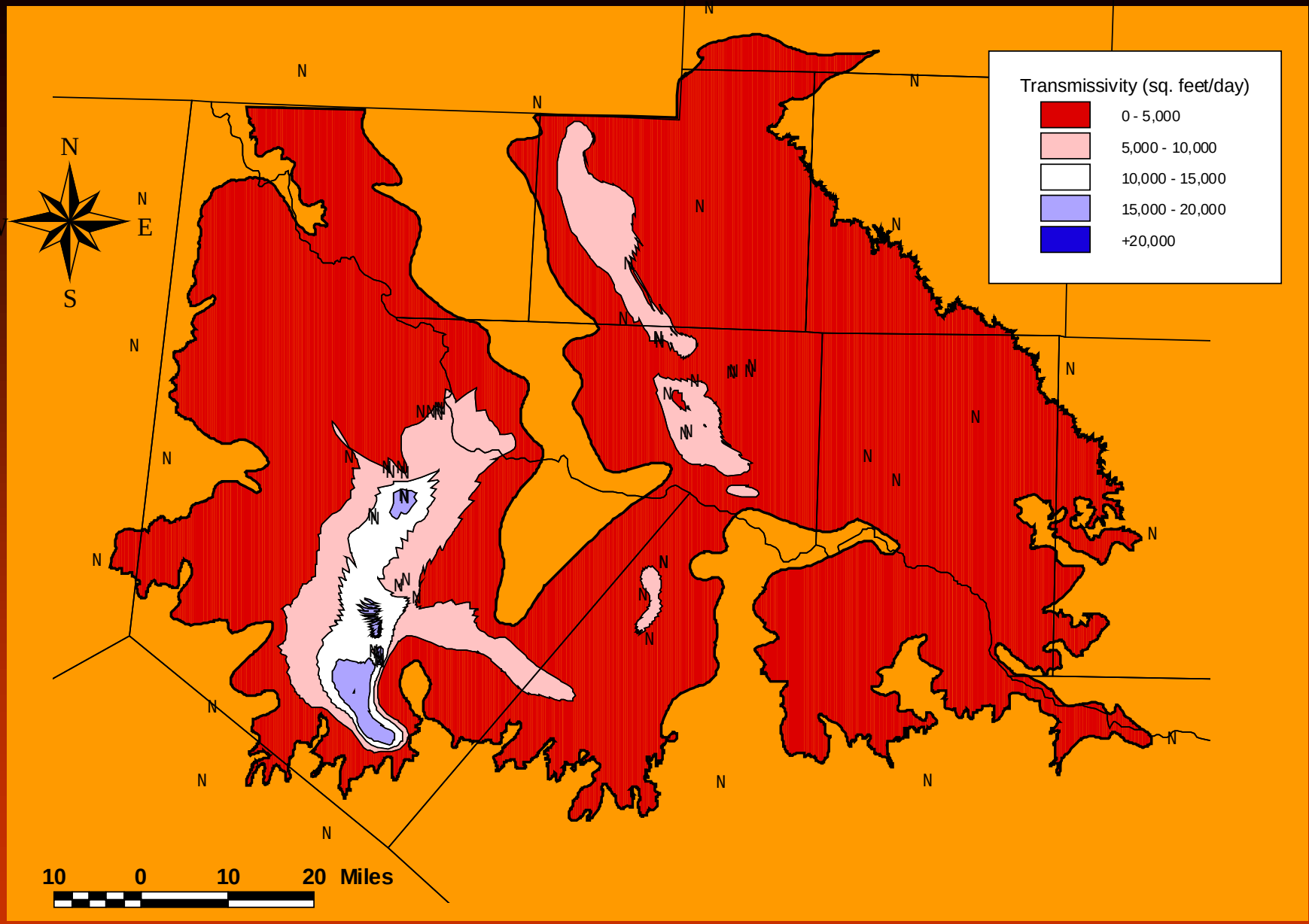
AQUIFER THICKNESS



SATURATED THICKNESS



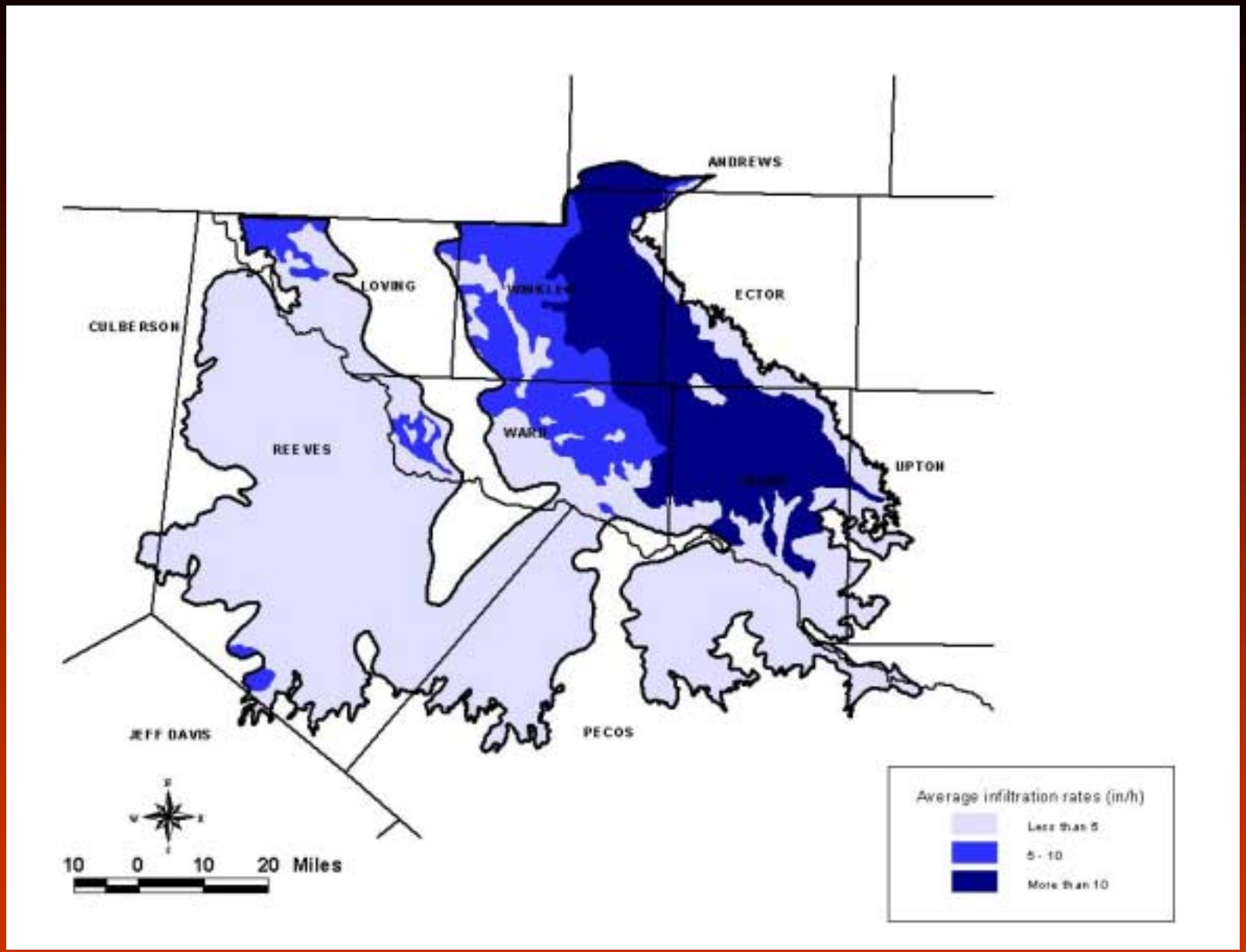
HYDRAULIC CONDUCTIVITY



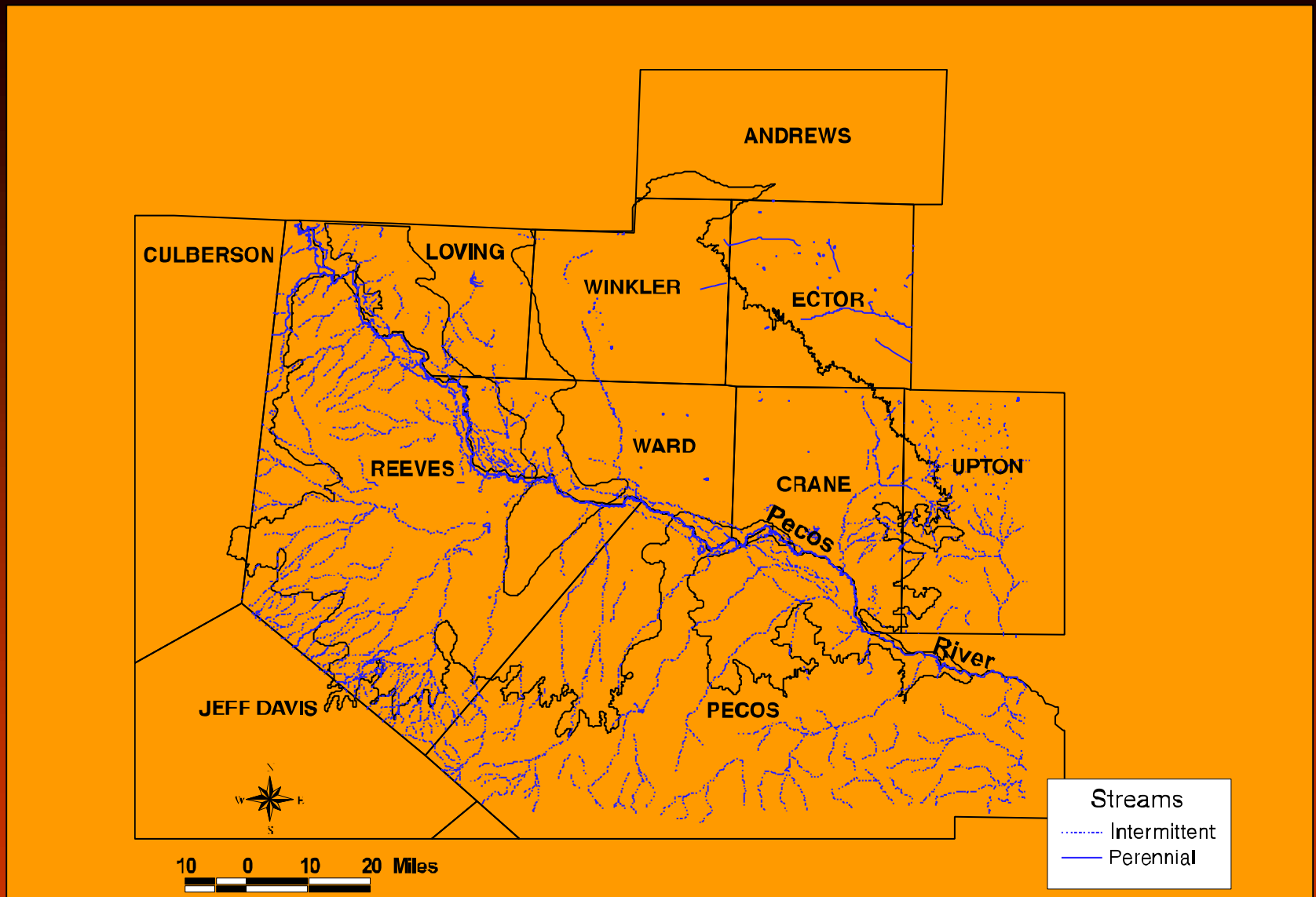
TRANSMISSIVITY

RECHARGE

- Infiltration of precipitation
- Seepage from ephemeral streams
- Inter-aquifer flow
- Irrigation return-flow



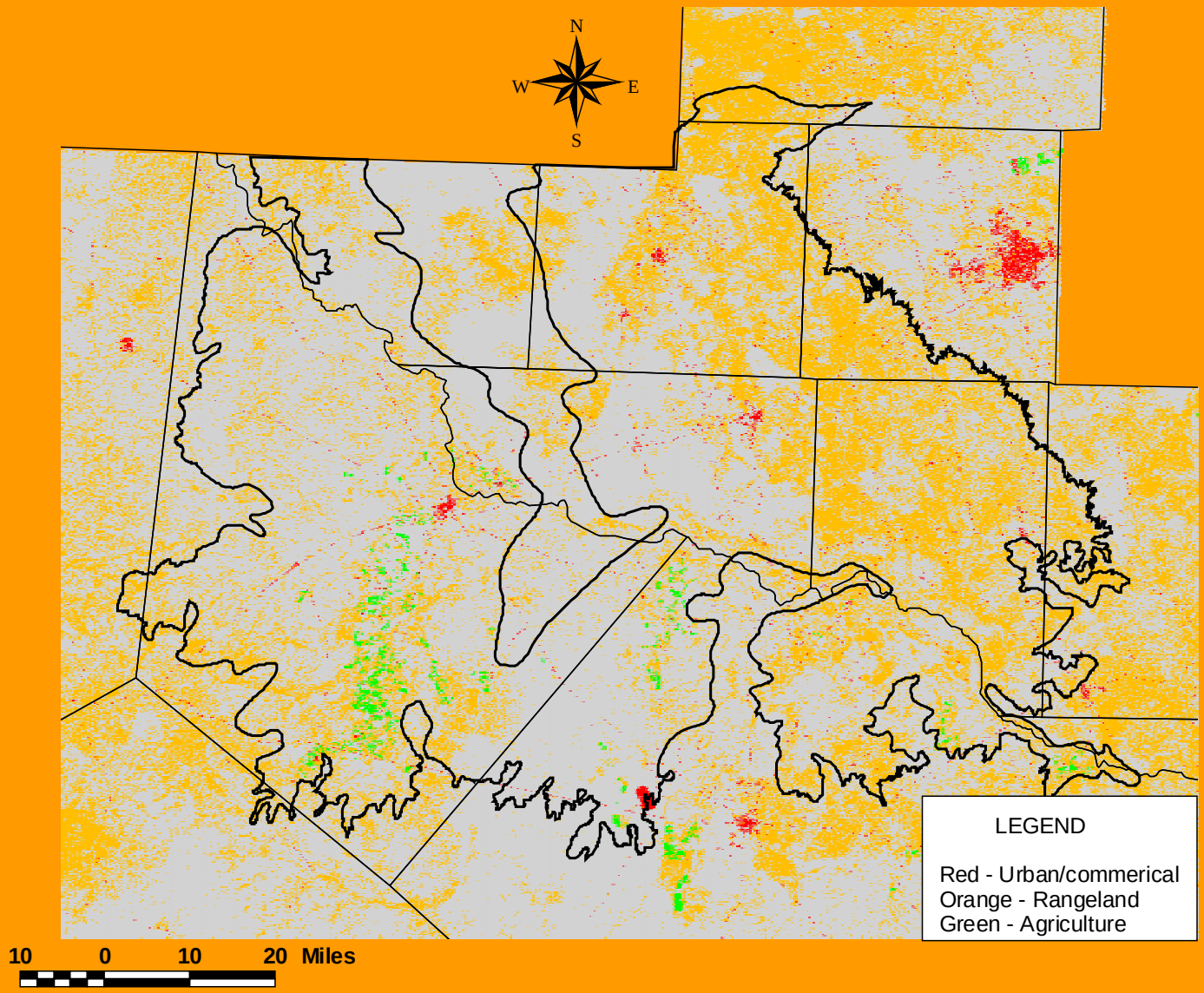
SOIL INFILTRATION RATES



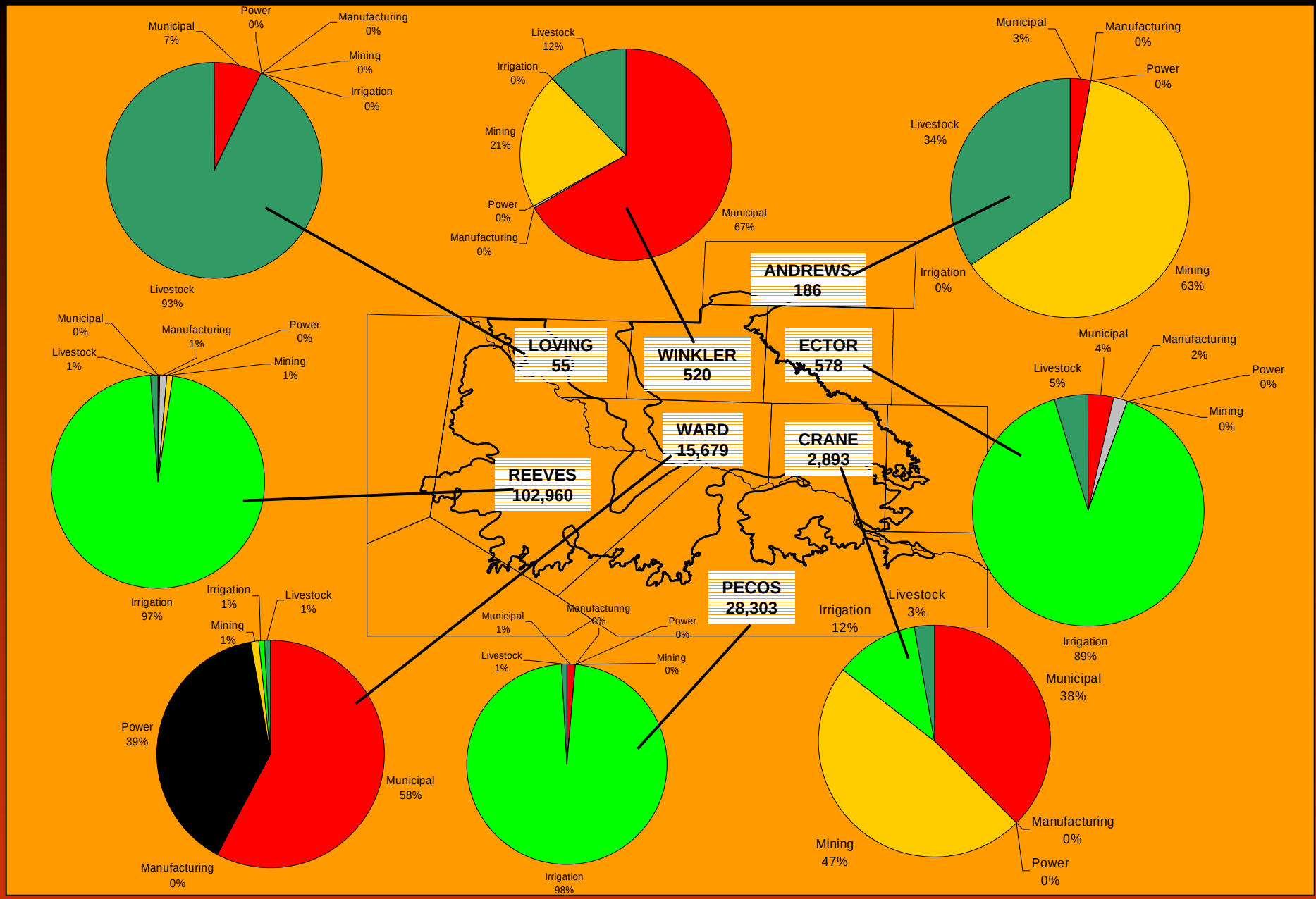
SURFACE WATER HYDROLOGY

DISCHARGE

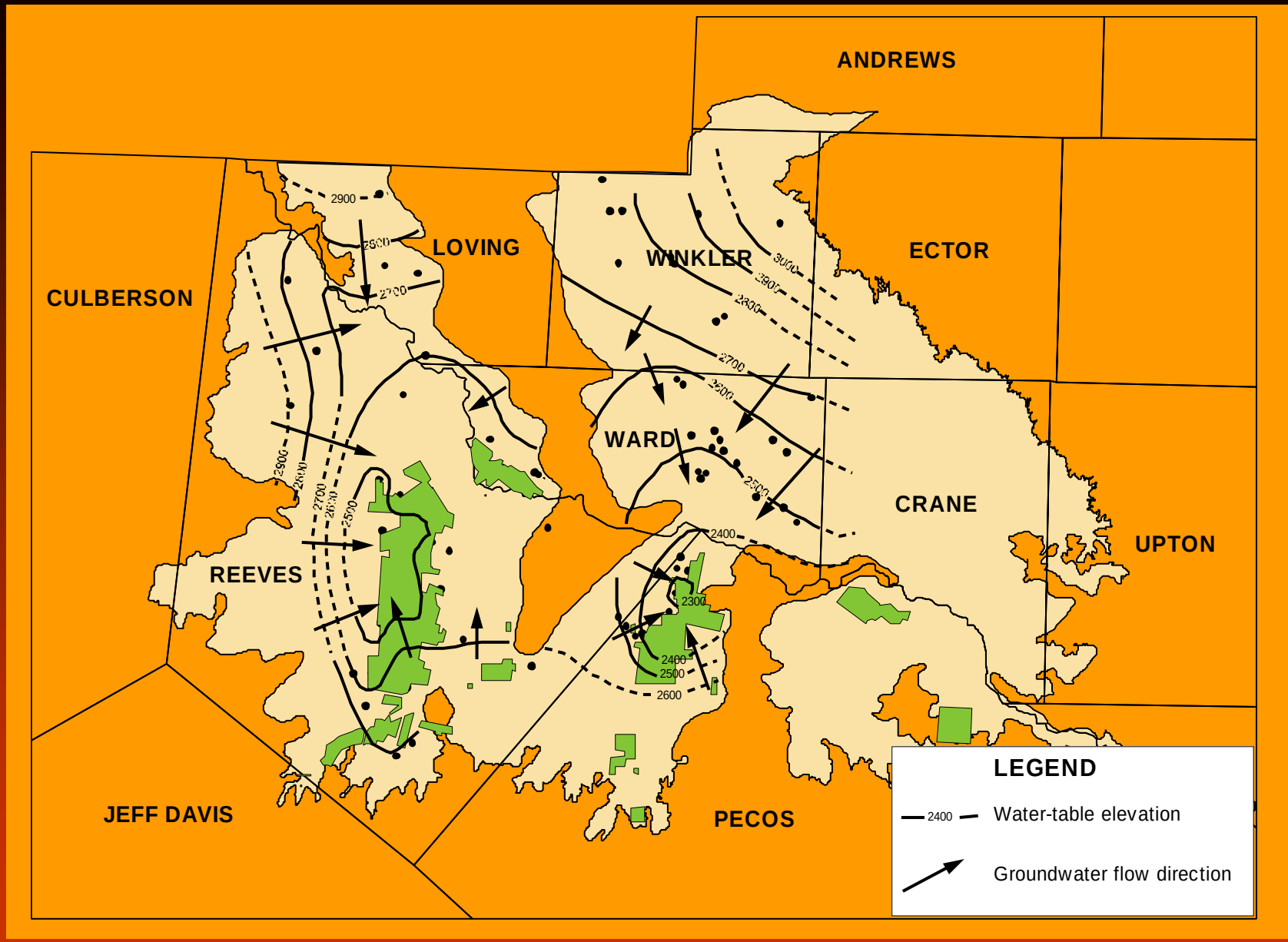
- Evapotranspiration
- Baseflow in Pecos River
- Pumpage


N
W
E
S
LEGEND
Red - Urban/commerical
Orange - Rangeland
Green - Agriculture
10 0 10 20 Miles

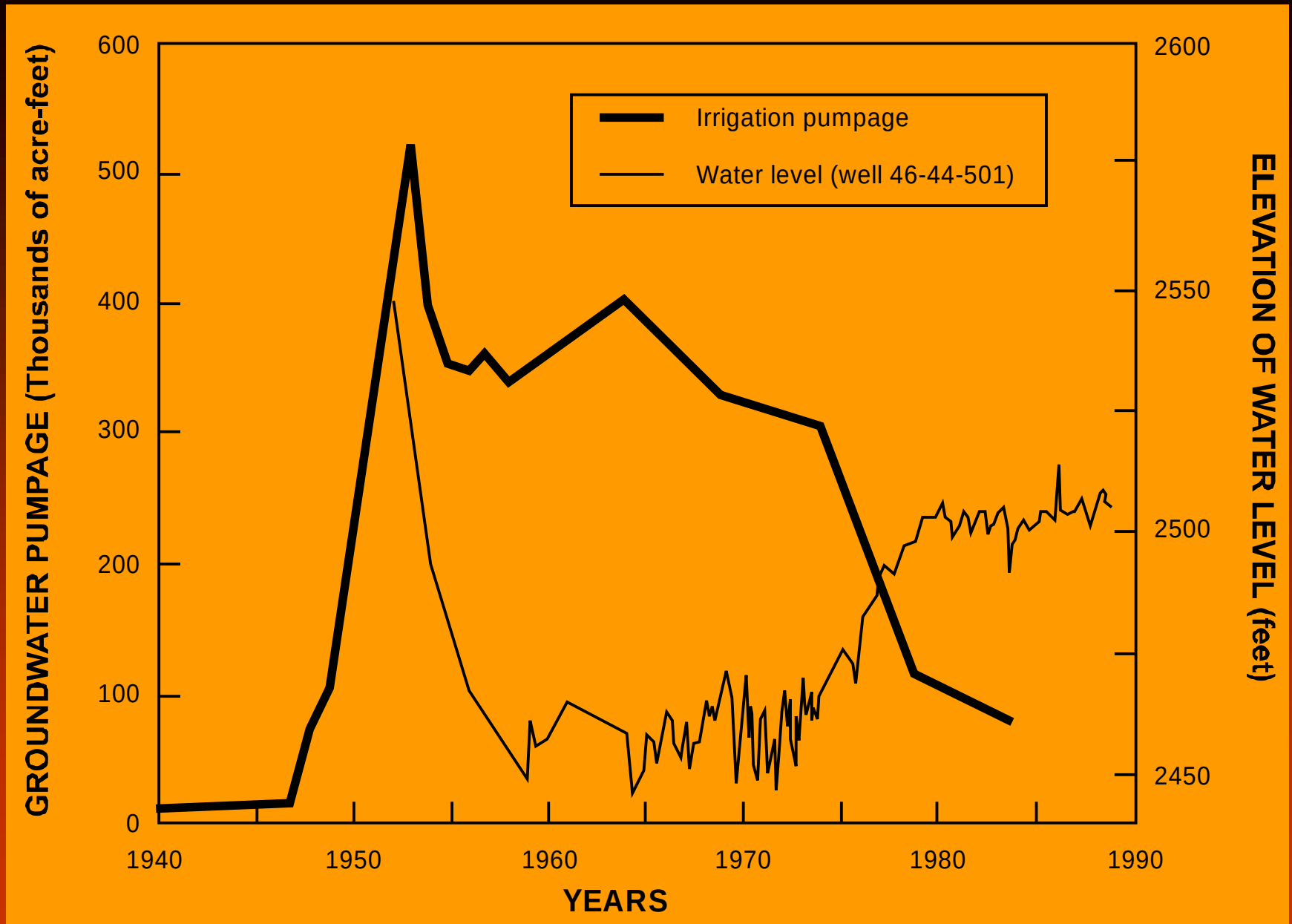
LAND USE


ANDREWS
186
LOVING
55
WINKLER
520
ECTOR
578
WARD
15,679
CRANE
2,893
REEVES
102,960
PECOS
28,303
Municipal 7%
Power 0%
Manufacturing 0%
Mining 0%
Irrigation 0%
Livestock 93%
Livestock 12%
Irrigation 0%
Mining 21%
Power 0%
Manufacturing 0%
Municipal 67%
Municipal 3%
Manufacturing 0%
Power 0%
Livestock 34%
Irrigation 0%
Mining 63%
Municipal 0%
Manufacturing 1%
Power 0%
Livestock 1%
Mining 1%
Irrigation 97%
Municipal 4%
Manufacturing 2%
Livestock 5%
Power 0%
Mining 0%
Irrigation 89%
Irrigation 1%
Livestock 1%
Mining 1%
Power 39%
Municipal 58%
Manufacturing 0%
Municipal 1%
Manufacturing 0%
Power 0%
Livestock 1%
Mining 0%
Irrigation 98%
Livestock 3%
Irrigation 12%
Municipal 38%
Manufacturing 0%
Mining 47%
Power 0%

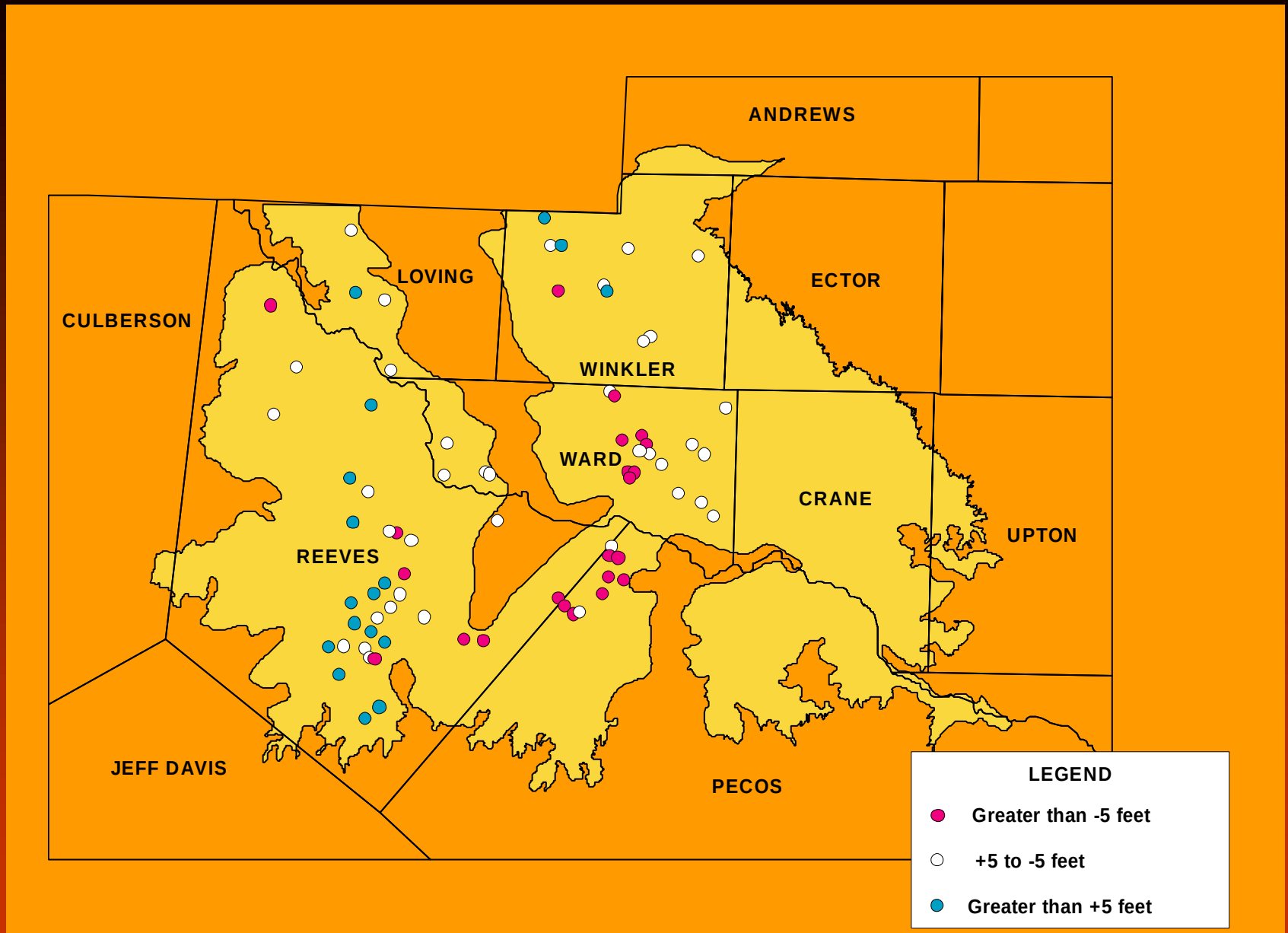
PUMPAGE



POTENTIOMETRIC SURFACE (1998)



IRRIGATION PUMPAGE



WATER-LEVEL CHANGE (1989-1998)

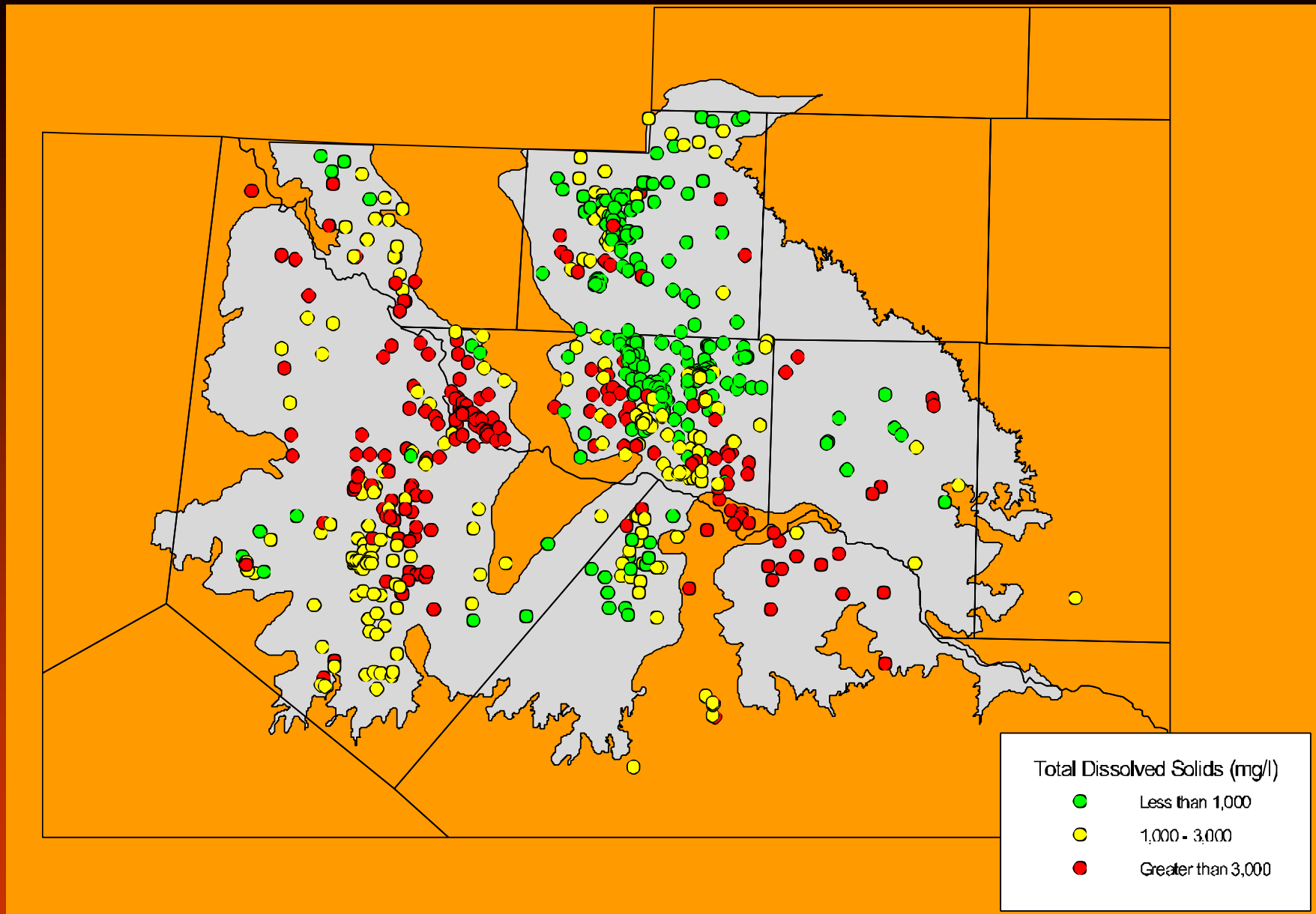
SUMMARY

- Unconfined alluvial aquifer
- Trough axes
  - Greatest saturated thickness
  - Highest transmissivity
- Natural recharge
  - Infiltration of precipitation
  - Seepage from losing streams
  - Interaquifer flow

SUMMARY (cont.)

- Discharge
  - Evaporation-transpiration
  - Base-flow to Pecos River
  - Pumpage
- Irrigation effects
  - Started in 1940s
  - Water-level recovery starting in 1970s

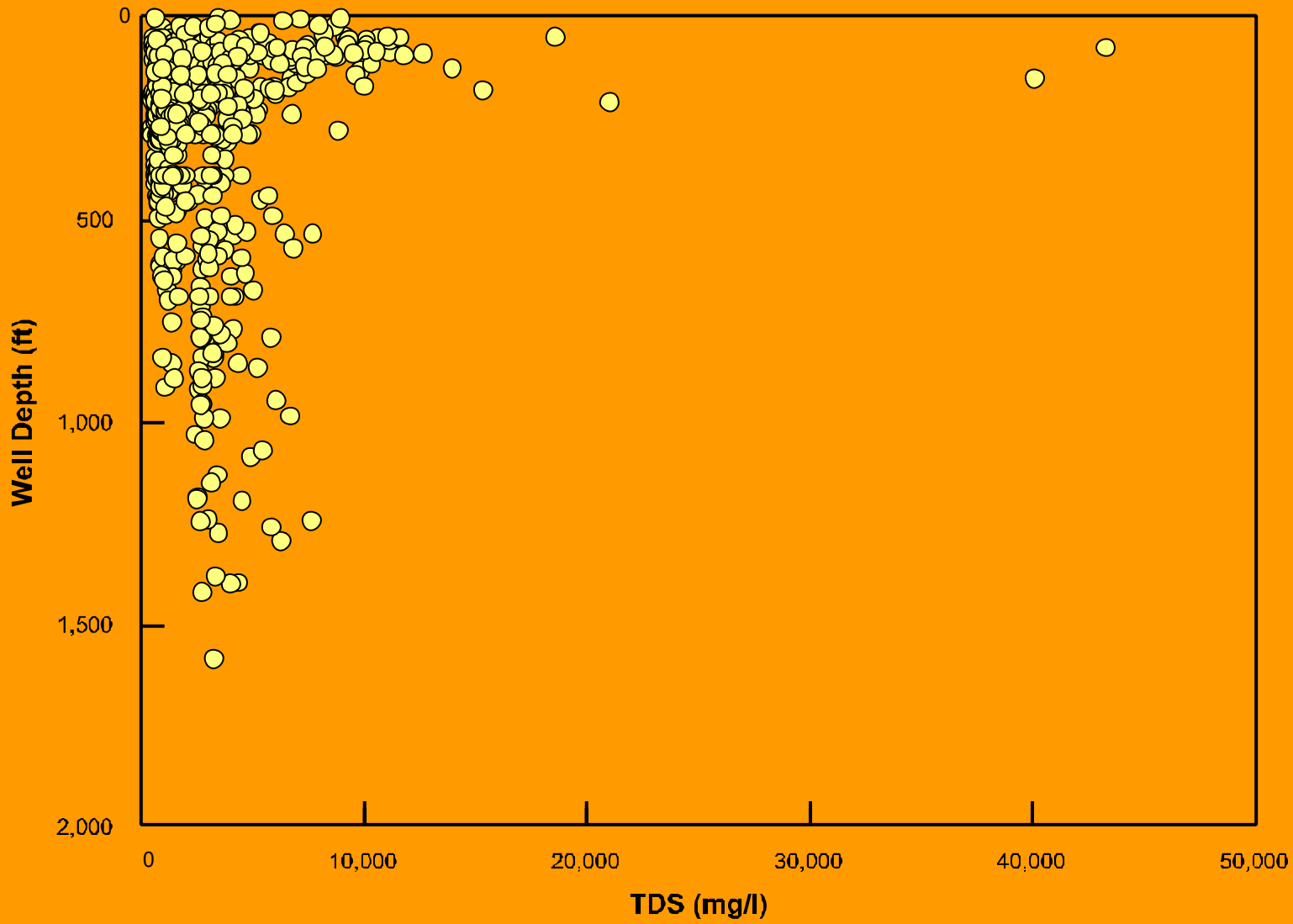
TEXAS WATER DEVELOPMENT BOARD



GROUNDWATER QUALITY

GROUNDWATER SALINITY

- Natural
  - Presence of evaporites
  - Evaporation
- Anthropogenic
  - Irrigation return-flow
  - Pumpage
  - Oil-fields



TOTAL DISSOLVED SOLIDS vs. DEPTH

SUMMARY (cont.)

- **Salinity**
  - Dissolved solids less than 5,000 mg/l
  - Lower east of Pecos River
  - High salinity related to:
    - Natural or pumpage-related inflow
    - Evaporation
    - Saline irrigation return-flow
    - Local oil-field brine contamination
  - Low salinity related to:
    - Rapid recharge of precipitation

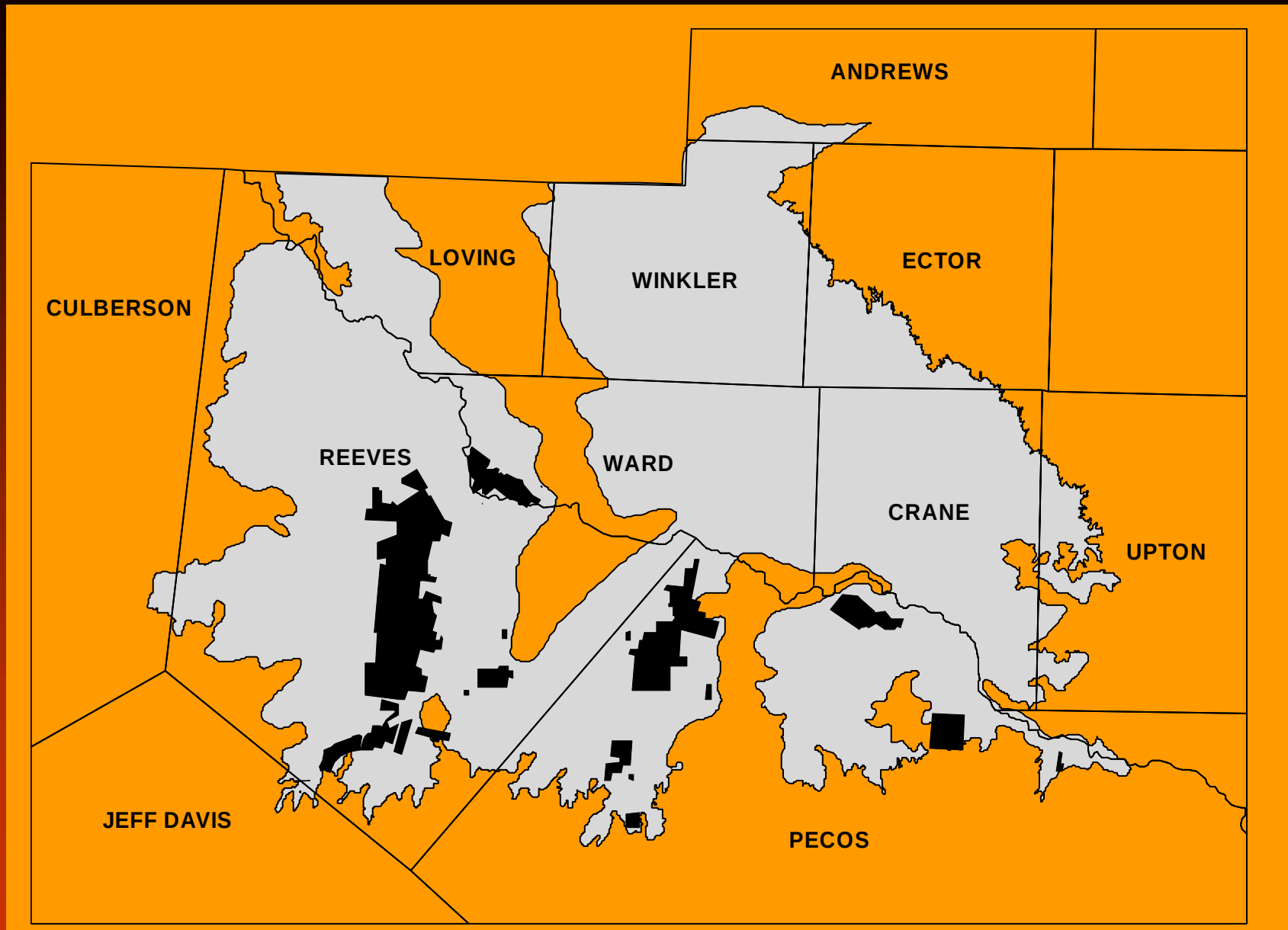
SUMMARY

Pecos Trough

- Lower infiltration rates
- Higher dissolved solids
- More water-level decline

Monument Draw Trough

- Higher infiltration rates
- Lower dissolved solids
- Less water-level decline

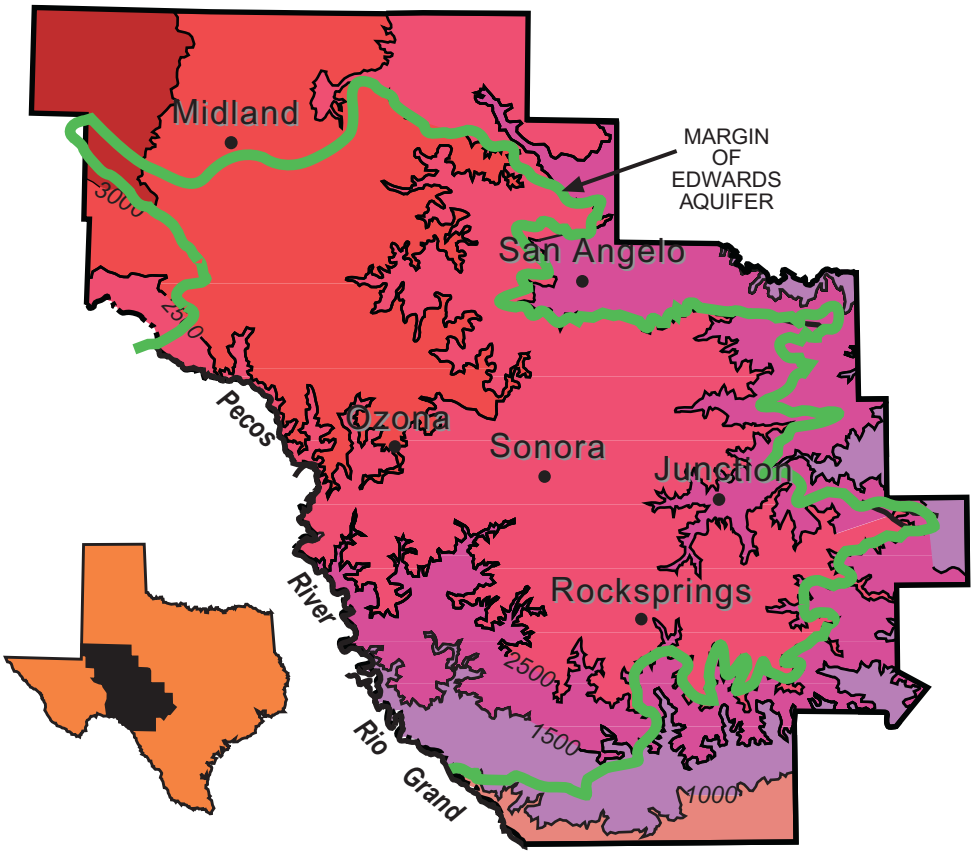


IRRIGATED FARMLAND

Hydrogeological Patterns
in the
Edwards-Trinity Aquifer System, Edwards Plateau, Texas

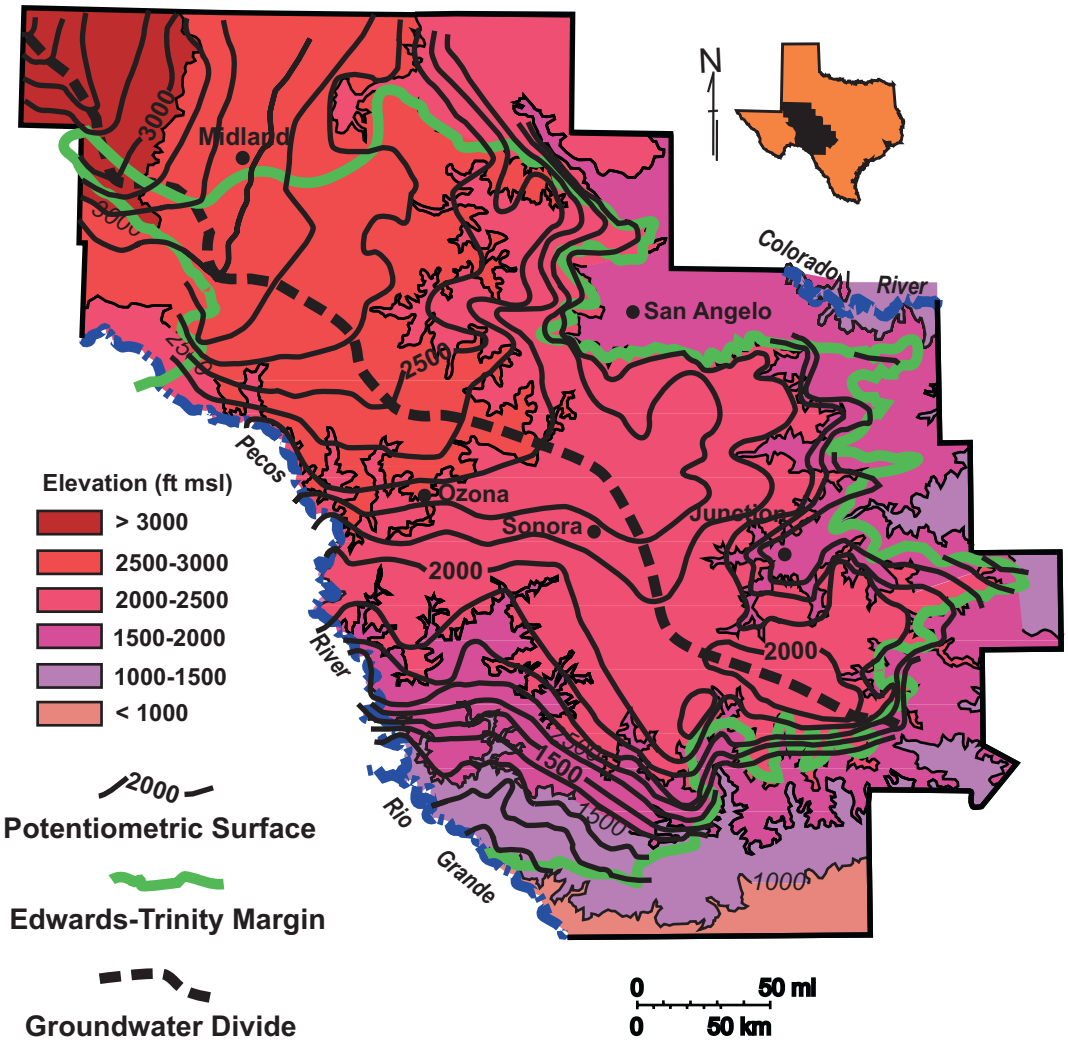
H. S. Nance
John M. Sharp

Department of Geological Sciences
The University of Texas at Austin



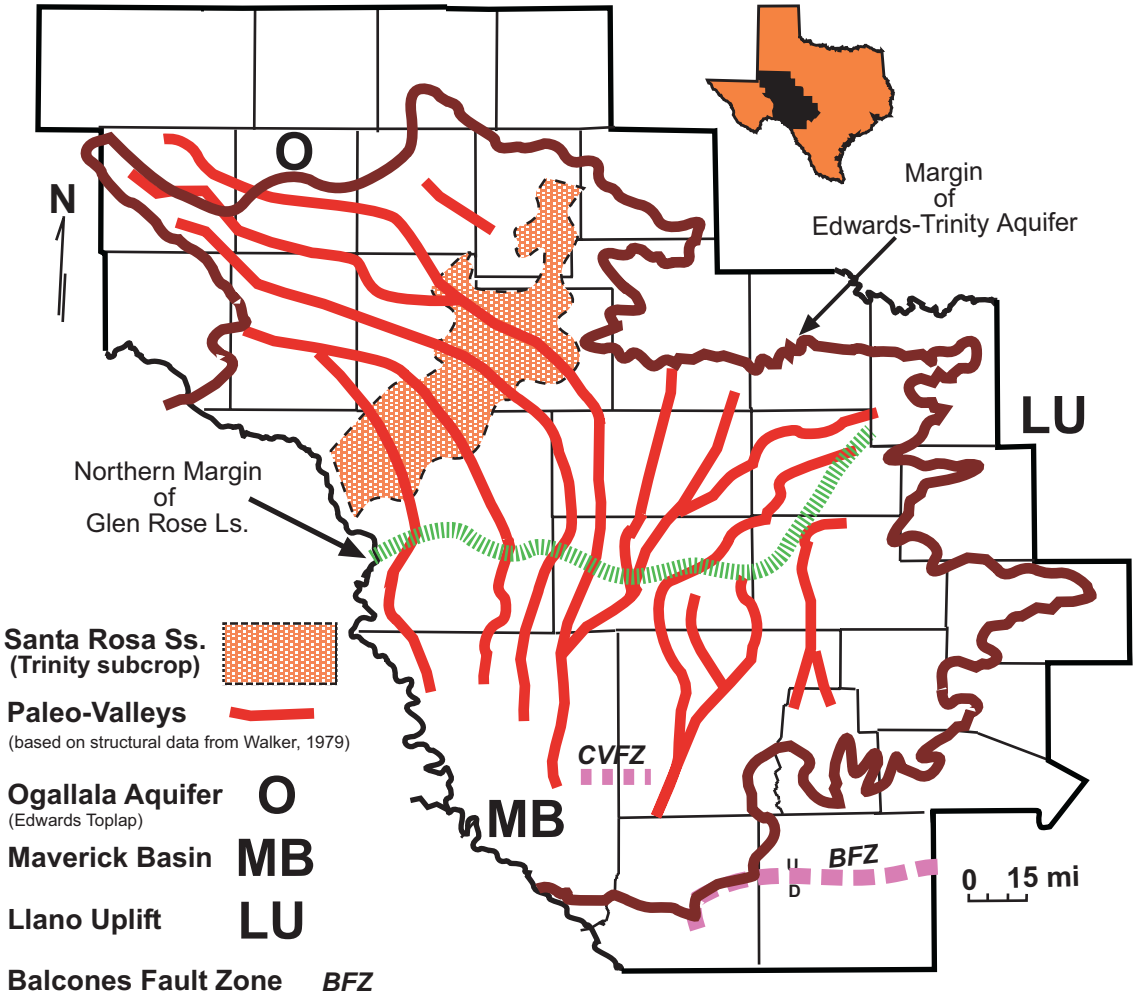
Topography
&
Potentiometric Surface

Edwards-Trinity Aquifer System



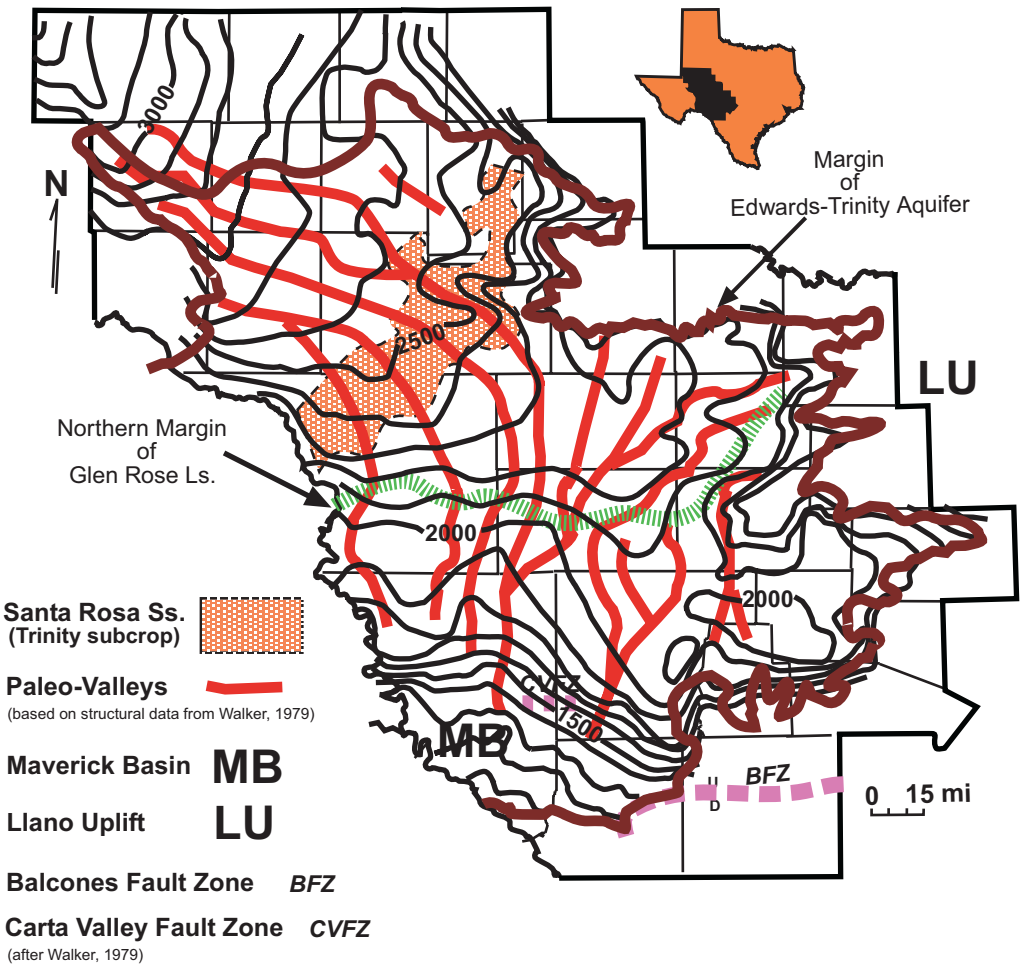
Selected Hydrogeological Elements

Edwards-Trinity Aquifer System

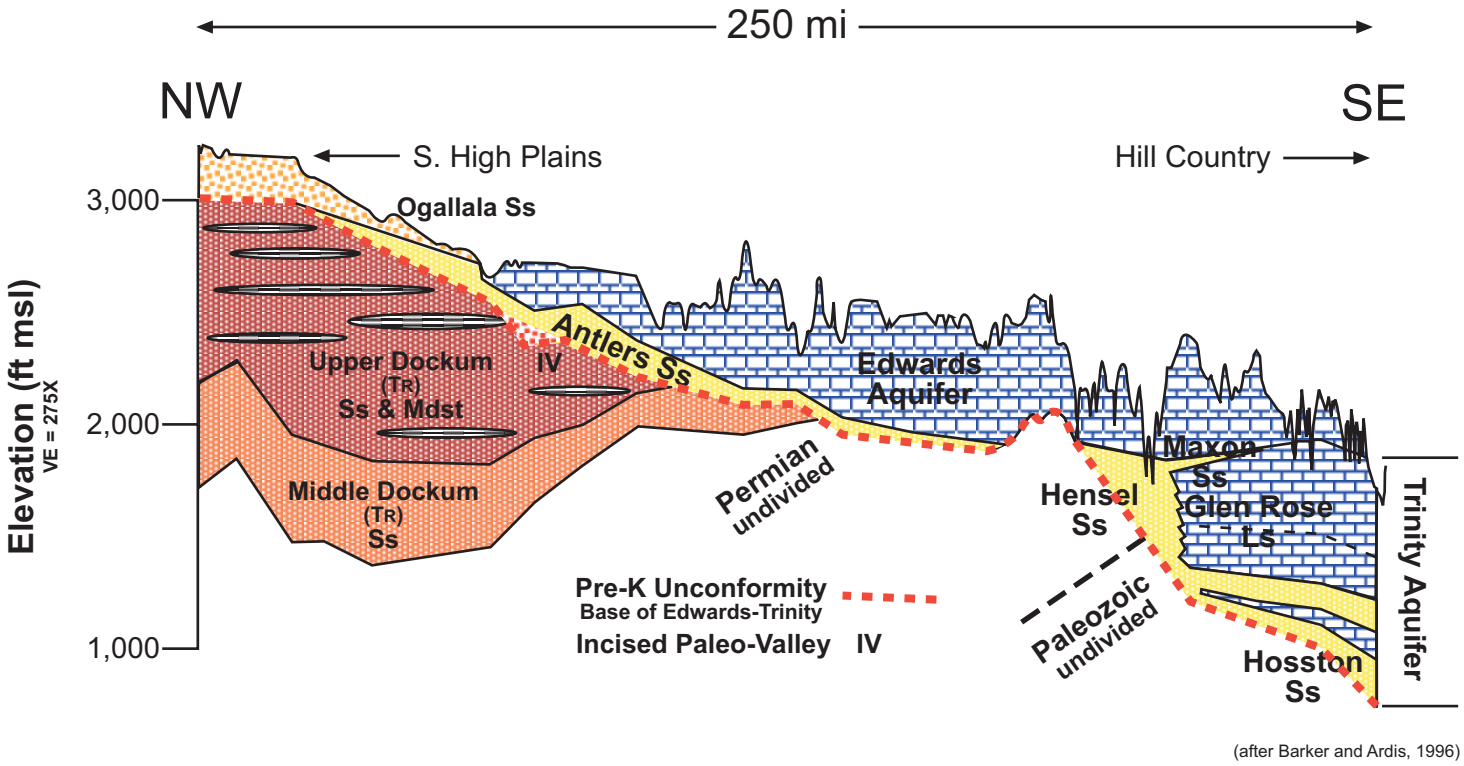


Geological Elements and Potentiometric Surface

Edwards-Trinity Aquifer System

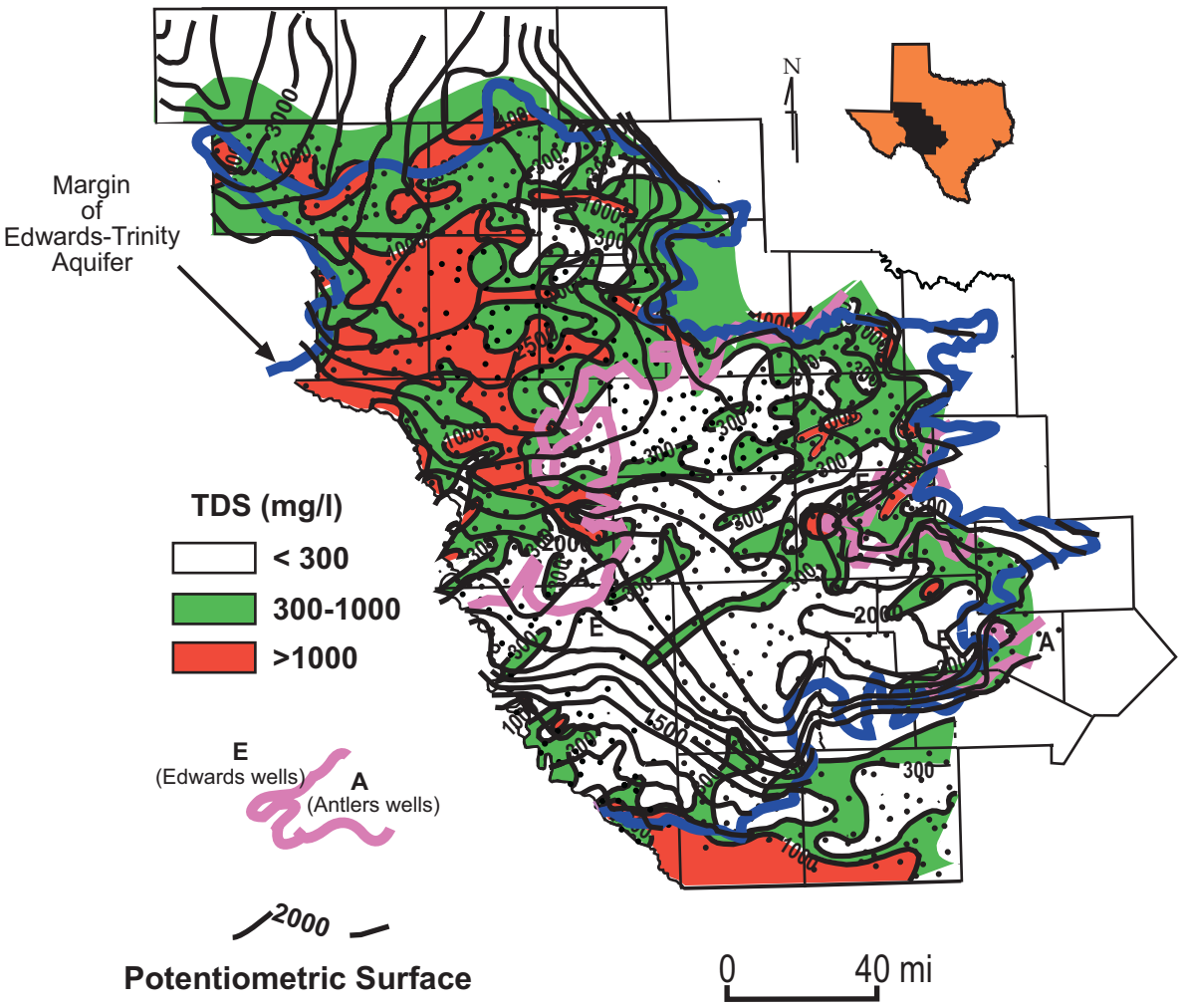


Structure Cross Section
Edwards Plateau



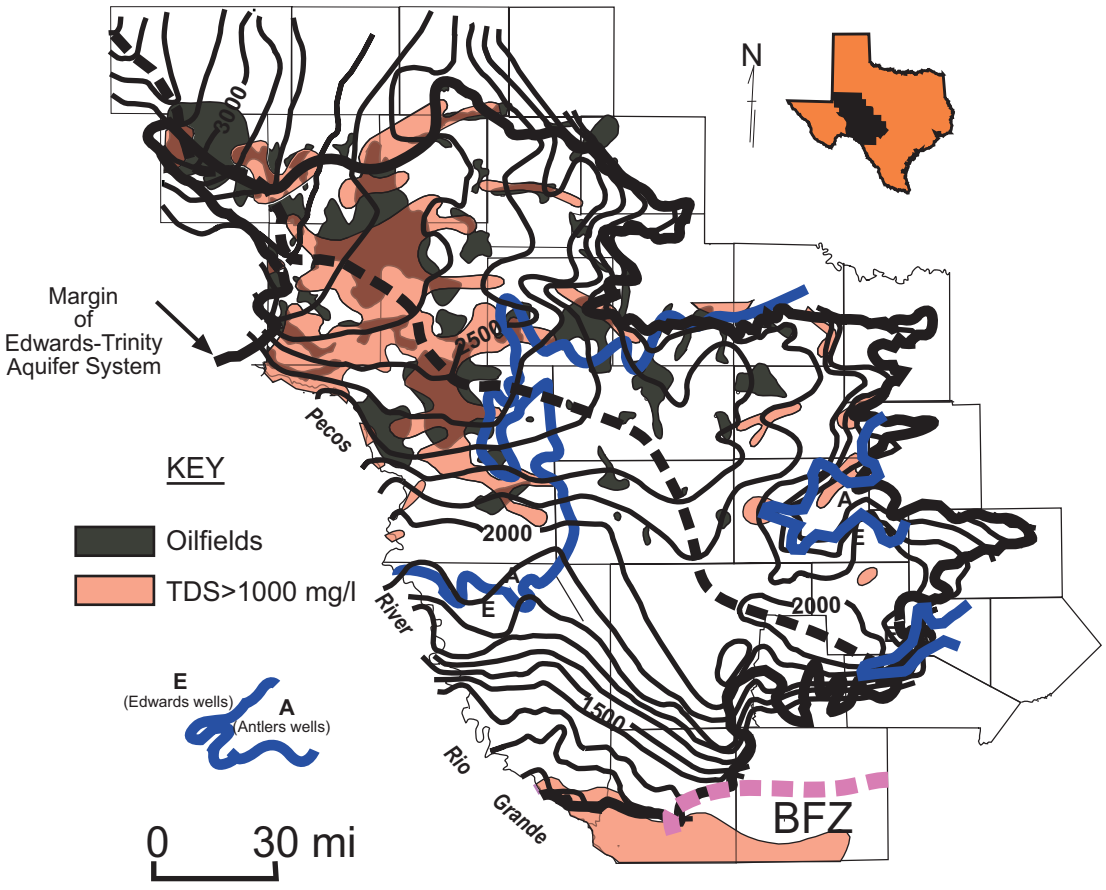
(after Barker and Ardis, 1996)

Total Dissolved Solids
Edwards-Trinity Aquifer System

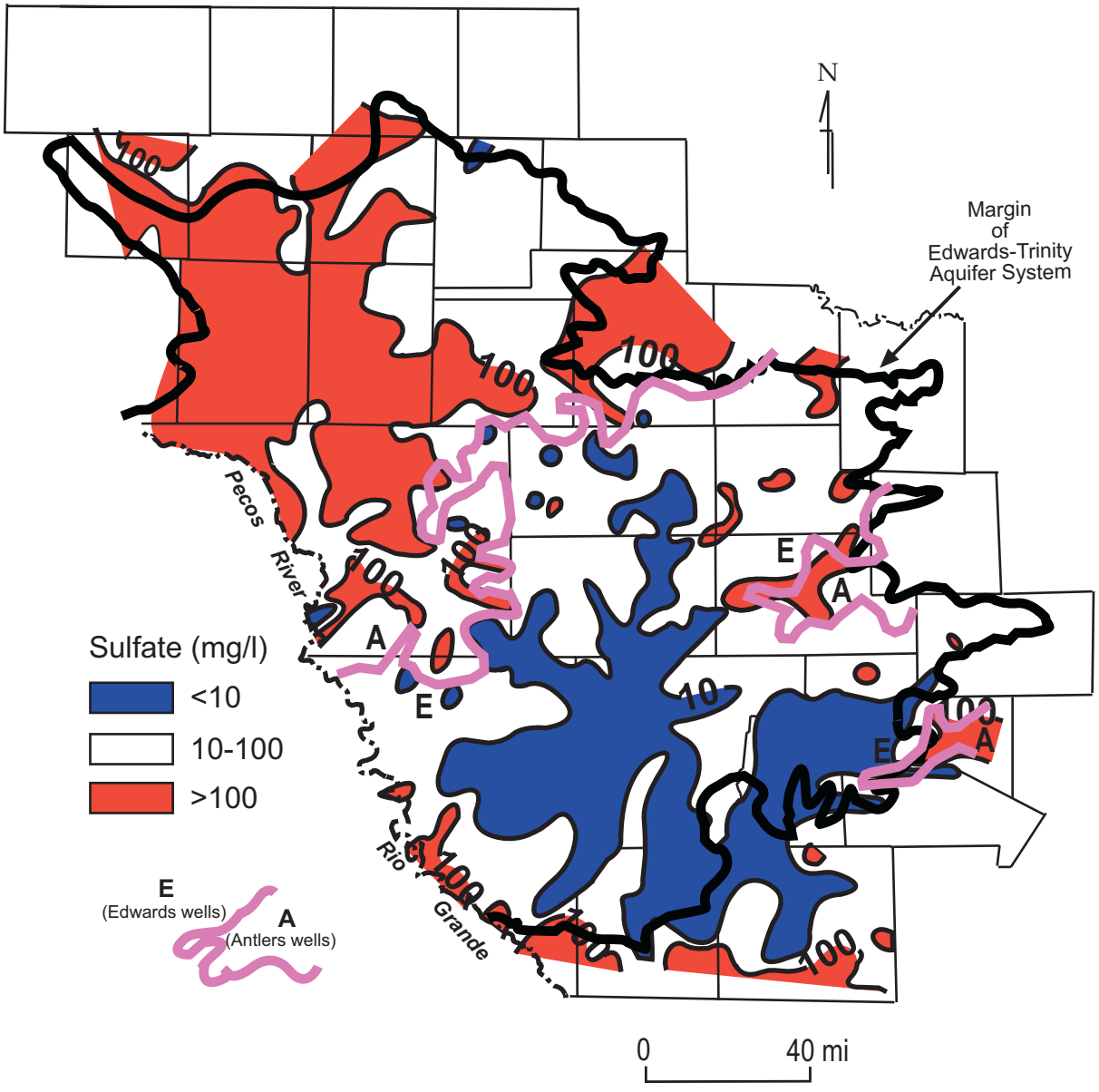


Total Dissolved Solids and Oilfields

Edwards-Trinity Aquifer System

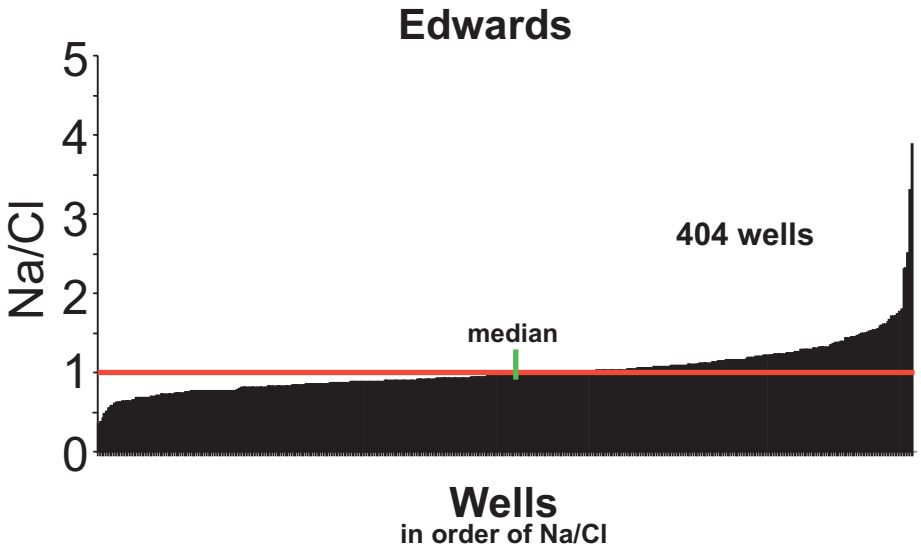


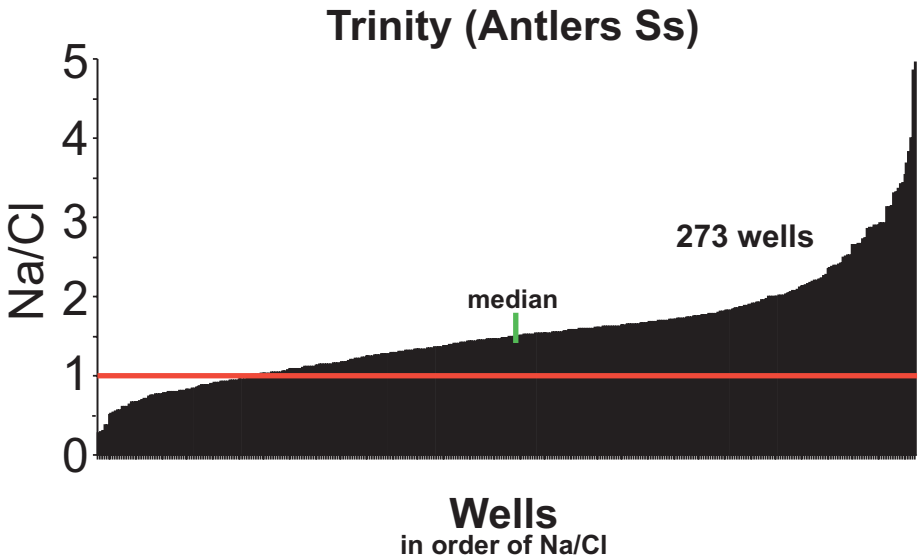
Sulfate in Groundwater
Edwards-Trinity Aquifer System



Na/Cl
(Molar Basis)

Edwards-Trinity Aquifer System

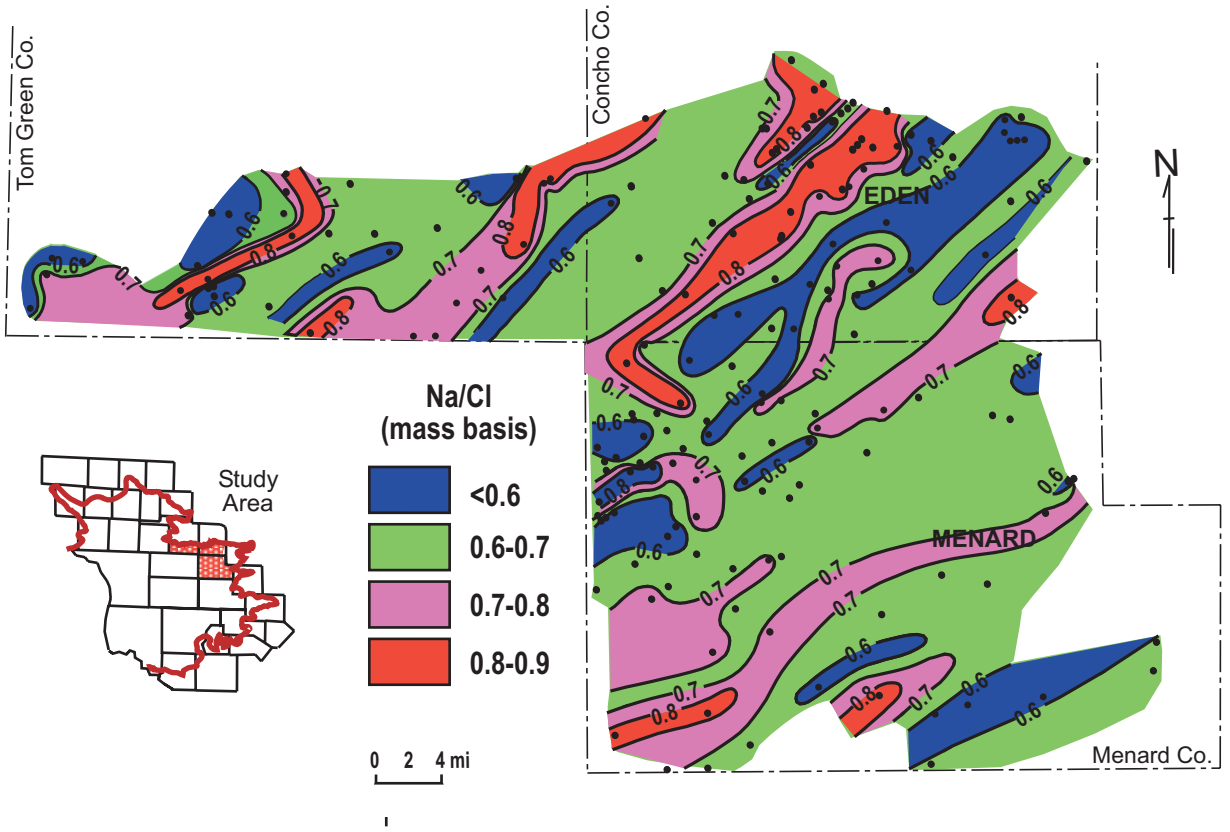




(data from Walker, 1979)

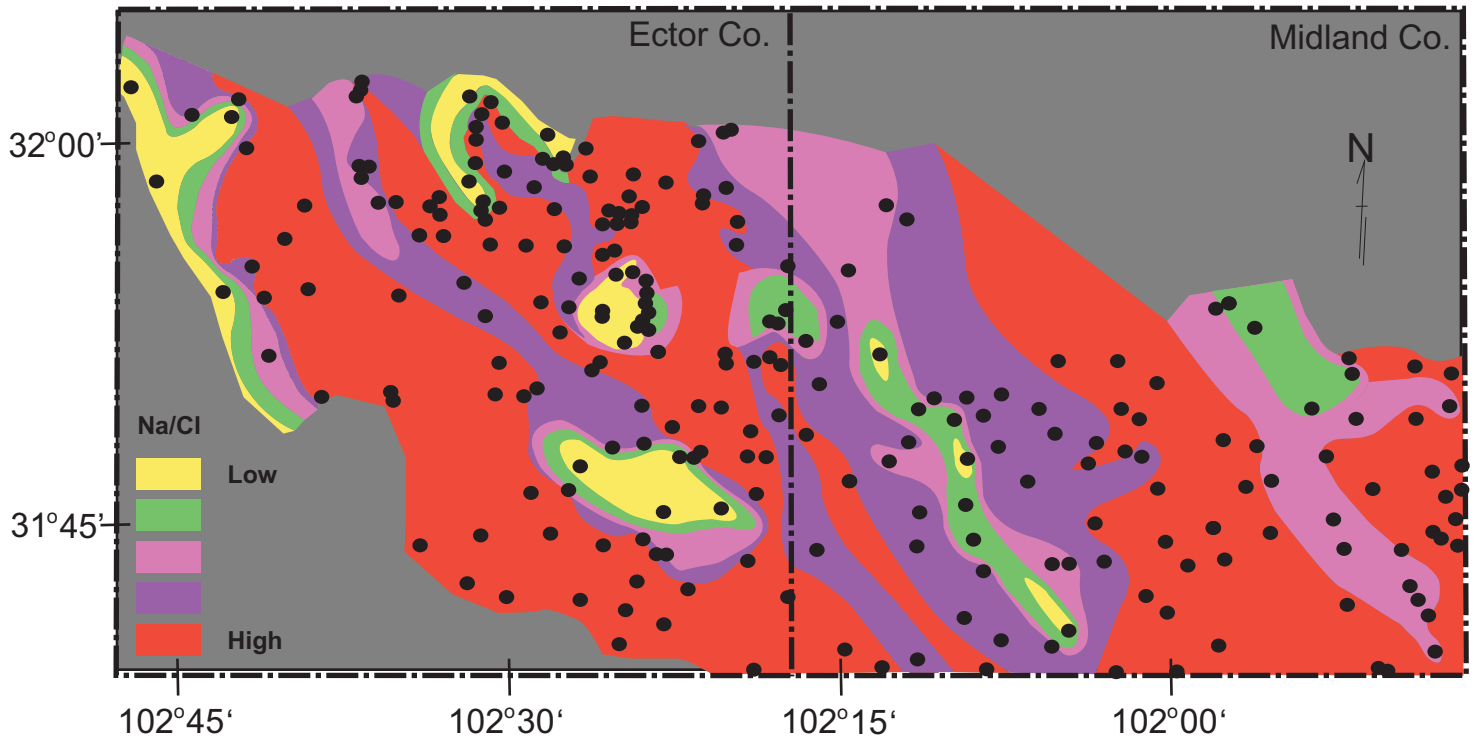
Na/Cl in Groundwater
Edwards Aquifer

Edwards-Trinity Aquifer System



Na/Cl in Groundwater
Trinity (Antlers) Sandstone

Edwards-Trinity Aquifer System



data from Walker (1979)

Hydrogeological Patterns
in the
Edwards-Trinity Aquifer System

Conclusions and Future Work

1. Divergent hydrochemical signatures and Antlers storativities suggest that Trinity sandstones and Edwards carbonates compose separate aquifers and Trinity sandstones are hydraulically confined.

2. Correspondence of hydrochemical and depositional trends suggest that siliciclastic facies control flow in Trinity sandstones.

3. Correspondence of oilfield operations with highest salinity groundwater and divergence of salinity and potentiometric gradients suggest that density-driven perculation of saline fluids from oilfield operations are a major source of salinity in the Antlers.

4. Parallelism of chloride trends with fracture and cavern trends suggest that significant recharge to the Edwards is focused through regional fracture sets.

5. Parallelism of Na/Cl trends with fracture and cavern trends suggest that Trinity groundwaters ascend into the Edwards through regional fracture sets.

6. Increased salinities in the Edwards along the Edwards-Trinity perimeter suggest that Trinity groundwater discharges to the Edwards along the down-gradient margin of the aquifer system.

7. Environmental isotope and temperature surveys may indicate sources of salinity, preferred areas of recharge, and cross-formational flow.

Edwards-Trinity GAM Stakeholders Advisory Forum 3
February 11, 2002 – Ozona, Texas
List of Attendees

Name	Affiliation
Wendell Moody	Private Citizen
Scott Holland	Sterling County UWCD / Irion County Water Conservation District
Larry Sanders	Phillips Petroleum Company
Winton Milliff	Coke County UWCD
Stan Reinhard	Hickory UWCD NO. 1
Virgil Poloeek	Sutton County UWCD
Janet Adams	Jeff Davis County UWCD
Marvin Shurley	Private Citizen
James D. Wearver	Private Citizen
Perry Bushong	Real-Edwards Conservation and Reclamation District
Allan Lange	Lipan-Kickapoo Water Conservation District
Vic Hilderbran	Uvalde County UWCD
Caroline Runge	Menard County Underground Water District
Dennis Clark	Emerald UWCD
Joe David Ross	Private Citizen
Larry Hoffmann	Private Citizen
Seay Nance	University of Texas - Austin
Roberto Anaya	Texas Water Development Board
Ian Jones	Texas Water Development Board
Rick Harston	Glasscock County UWCD
Cindy Weatherby	Santa Rita UWCD
Dick Luebke	Texas Parks and Wildlife
Bert Striegler	Private Citizen
Cameron Cornett	Headwaters UWCD

Edwards-Trinity GAM Stakeholders Advisory Forum 3
February 11, 2002 – Ozona, Texas
Meeting Summary

About 24 people attended the third quarterly Edwards-Trinity Aquifer Groundwater Availability Modeling Stakeholders Advisory Forum, held in Ozona, Texas. The stakeholders present were representing Texas Parks and Wildlife, 13 local groundwater conservation districts, and local landowners.

As a guest speaker, Seay Nance of the University of Texas at Austin presented his dissertation topic and his initial findings with regard to the evolution of water quality in the Edwards-Trinity aquifer and an improved understanding of the groundwater flow system. Roberto Anaya presented an update on the geologic structure, a brief discussion about the hydraulically connected aquifers, and the implications for selecting boundary conditions and the number of model layers for the Edwards-Trinity model. Ian Jones presented an extended summary discussion on the Cenozoic Pecos Alluvium aquifer, which will be modeled with the Edwards-Trinity aquifer. Roberto Anaya ended the session with an update on the pumping tests being done by TWDB staff. The stakeholders were notified that the modeling project was behind schedule and that additional staff has been assigned to help bring the project back on schedule.

The next SAF meeting was tentatively scheduled for late-May 2002 in Ozona, Texas. Topics for the next forum include 1) final structure and 3D model grid with associated boundary conditions; 2) a preliminary distribution of hydraulic properties; and 3) a discussion on methods to be used for distributing recharge, evapotranspiration, and pumpage.

Primary Stakeholder Issues Follow:

1) A stakeholder is still concerned about the accuracy of information going into the model stating that he has Glen Rose limestone on his property in Concho County where BEG has mapped it as Antlers sand.

ANSWER: The BEG maps being used for the model generalize geologic information at a 1:250,000 scale which may not accurately represent the actual geology on anyone's specific property. The exact locations of where the Glen Rose pinches out cannot be mapped at such a detailed scale and it is not uncommon for stringers of Glen Rose to extend out beyond the mapped boundary of the Glen Rose extent.

2) A stakeholder had concerns that the model does not include faults that may allow for degradation of Edwards-Trinity water quality from adjacent aquifers as discussed by John Ashworth at the Aquifers of West Texas Conference held in Alpine December of 2001.

ANSWER: Unable to reply with a satisfactory comment due to unfamiliarity with John Ashworth's discussion. However, as a follow-up, John Ashworth was contacted and he could not recall any major faults that could allow such water quality degradation and that his statements may have been taken out of context or misunderstood. He did say that it might be possible for Edwards-Trinity wells to become contaminated with poorer water quality from adjacent aquifers as a result of increased pumpage.

3) A stakeholder believes that state money is not being spent efficiently by rehashing old and existing TWDB data when instead it should be spent acquiring new data. He said, "I would like to see less talk and more data!"

ANSWER: Agreeably and unfortunately the data density for the Edwards-Trinity aquifer is limited in comparison to other major aquifers but we must do the best we can with what we have to work with. A suggestion was made to place more pressure on their state representatives and the regional water planning group members to fund additional data collection activities for the Edwards-Trinity.

-Roberto Anaya, 02/13/02