In cooperation with Llano Estacado Underground Water Conservation District, Sandy Land Underground Water Conservation District, and South Plains Underground Water Conservation District.

Geophysics Used for the Hydrogeologic Framework of the Ogallala and Edwards-Trinity (High Plains) Aquifers in Gaines, Yoakum, and Terry Counties, Texas.

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Location Maps
Hydrogeologic Setting

• Ogallala Formation
  – Quaternary- to Tertiary-age unit

• Edwards-Trinity (High Plains)
  – Cretaceous-age unit
    • Fredericksburg Group (upper part)
      – Clay and shale
      – Limestone
    • Trinity Group (lower part)
      – Antlers Formation

• Dockum Group
  – Triassic-age unit

*Local name

Modified from Blandford and others, 2008
Requests from Cooperators

• Request 1
  – Determine total formation thickness and estimate saturated thickness of the Ogallala and Edwards-Trinity (High Plains) aquifer system.

• Request 2
  – Develop values of specific yield for the aquifers on results of Request 1.

• Request 3
  – Collect and analyze geochemical samples from selected wells of the Ogallala and Edwards-Trinity (High Plains) aquifer system.

• Provide associated databases, geographic information system (GIS) layers, and report.
Components of the Hydrogeologic Framework

• Hydrogeology
  – Geophysical and lithologic logs
  – Determine tops and bases of aquifer units (“picks”)

• Structure
  – Delineate geologic structure
  – Interpolate picks to create surfaces of the tops and bases
  – Calculate unit thicknesses

• Aquifer properties
  – Update historical pump-test data
  – Aquifer specific yield and/or transmissivity
Early Framework Analysis

Compilation of data – GAM, RRC, BRACS, and Underground Water Conservation Districts

Overall Data Gap Analysis

Average Standard Deviation of Geologic Grids

USGS

Science for a Changing World
- Stratigraphic picks confirmed with multiple log types.
- Data collection effort to obtain the following log types:
  - Long/Short Normal Resistivity
  - Spontaneous Potential
  - Single Point Resistance
  - Natural Gamma
  - Caliper
  - Fluid Resistivity
  - Fluid Temperature

Source: Stanton and others, 2004

- Base of Ogallala
- Top of Cretaceous
Time-Domain Electromagnetic Technique

• Measures electrical resistivity in the subsurface based on the decay of voltage over time.
Geophysical Data Collection

Data Collection with Overall Data Gap Analysis

Overall Data Gap Analysis

Average Standard Deviation of Geologic Grids (feet)

5 10 15 20 25
Hydrogeologic Framework

• Developed contact layers
  – Compiled geophysical logs and driller’s descriptions
  – Collected surface and borehole geophysics to develop contact layers

• Estimated thickness based on contact layers

• Saturated thickness estimated from most recent water table and the base of Ogallala.
Aquifer Hydraulic Properties

- Transmissivity
- Hydraulic Conductivity
- Porosity
- Specific Yield
- Storativity
- Saturated thickness
- Estimated storage retention

Correlation estimation

Unconfined aquifer
Aquifer Hydraulic Properties Testing

- Historical pump-test data
- Aquifer specific yield and/or transmissivity
- Flowmeter surveys can be used to evaluate the hydraulic conductivity and transmissivity of the aquifer
- Nuclear magnetic resonance
Aquifer Hydraulic Properties

- Transmissivity
- Hydraulic Conductivity
- Porosity
- Specific Yield
- Storativity
- Saturated thickness
- Estimated storage retention
- Calculated
- Historical Drawdown; Flowmeter
- TDEM
- NMR
- Total water volume
- Estimated from resistivity
- Correlation estimation

Unconfined aquifer

Calculated/modeled

Incorporates technologies such as TDEM, Flowmeter, and NMR.
Nuclear Magnetic Resonance

- Magnetic resonance directly measures the response from hydrogen atoms
- Great tool to measure direct response from water molecule
Collected Aquifer Hydraulic Properties

Borehole Flowmeter Transmissivity

Borehole NMR Transmissivity
All Aquifer Hydraulic Properties

Borehole Flowmeter and NMR Transmissivity

Historical Pump Test Transmissivity
https://webapps.usgs.gov/HDE/southernhighplains/

Web Application
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QUESTIONS?