State and regional water planning

- Consider and evaluate all potentially feasible water management strategies

- Brackish groundwater desalination
  - Develop 175,000 acre-feet/year by 2060
  - 6 regions recommended strategy
Brackish groundwater in Texas

- 1959: Texas Legislature appropriated $20,000 to study scaling problems in desalination
- 1965: The potential contribution of desalting to future water supply in Texas (TWDB and USDOI Office of Saline Studies)
- 1972: TWDB Report 157, A survey of the subsurface saline waters of Texas
BRACS Goals

- Extend the 2003 TWDB study:
  - map aquifers to 10,000 mg/L Total Dissolved Solids
  - map key desalination parameters (for example: silica, iron, ...)
  - estimate aquifer properties
  - estimate volumes of water
  - build replicable numerical groundwater flow models
  - collect well logs (water, oil/gas) for interpretation
  - build datasets (database, GIS) of project information
- Assist regional water planning groups
- Collect and disseminate information to be used for site-specific brackish groundwater projects
Tasks

- Convene a Technical Resource Panel

- Brackish Groundwater Pilot Study: Pecos Valley Aquifer, West Texas

- Contracts to support brackish groundwater analysis include:
  - Digital Geological Bibliography of Texas to focus on articles on brackish portions of aquifers in Texas
  - Compile digital geophysical well logs across Texas for resistivity / stratigraphic analysis (goal: 1 log per 2.5 minute grid cell)
  - Assessment of Groundwater Modeling Approaches to Brackish Aquifers, using Variable Density Modeling
Technical Resource Panel

- Assist TWDB staff with developing a firm technical foundation for the Brackish Resource Aquifer Characterization System
- Consists of State, Federal, Private representatives interested in Brackish Resources of Texas
- First meeting held in February, 2010 ... lots of valuable feedback.
Pilot study tasks

- Develop a project database to contain and analyze information
- Collect information: water well reports, geophysical well logs, ...
- Literature review
- Process this information into database and GIS records
- Create GIS files showing aquifer architecture
- Test techniques to interpret TDS from geophysical well logs
- Create GIS files of water quality data per aquifer
- Create GIS files of aquifer characteristics
- Quantify brackish resource in area
- Provide information: Report, raw data, database and GIS files
Pecos Valley Aquifer

Age: Cenozoic
Pecos Valley Aquifer

overlying

Edwards – Trinity Plateau Aquifer

Age: Cretaceous
Pecos Valley Aquifer

overlying

Dockum Aquifer

Age: Triassic
Pecos Valley Aquifer

overlying

Rustler Aquifer

Age: Permian
Pecos Valley Aquifer

overlying

Capitan Reef Complex

Age: Permian
Sources of Data for the Pecos Valley Study

3,354 wells in project
85% new data to TWDB
Well control

1,849 water wells
1,505 oil/gas wells
+ 2,100 TWDB wells
Relational databases were developed to manage information.
Well Attributes: location, source, log types, ...
Geophysical Well Logs and Water Well Reports Provided:

Lithologic Description

- Record Number
- Geologic Pick
- Top Depth
- Lithologic Description
- Source of Data
- Initials
- Last Change

Stratigraphic Description

- Record Number
- Geologic Pick
- Top Depth
- Stratigraphic Description
- Source of Data
- Initials
- Last Change

Charts and graphs are also present, showing various data trends and interpretations.
Cross-section showing the Salado Formation halite ridge

- Pecos Valley Aquifer
- Dockum Group and Dewey Lake
- Rustler Aquifer
- Salado Fm. (halite = yellow)
- Castile Fm.
- Rustler Aquifer: depth to aquifer top

Map showing Pecos Trough and Shallow to Deep colors.
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 across both troughs
Cross-section along length of Monument Draw Trough
Cross-section through west side solution trough, southern Winkler County

The solution troughs filled in with a complicated sequence of sediment packages.

Erosion of underlying formations occurred.

Timing of solution collapse is uncertain.

Discerning Pecos Valley from underlying Dockum sediments can be extremely complicated.
## Desalination parameters of interest

<table>
<thead>
<tr>
<th>Physical Parameters</th>
<th>Cations (mg/L)</th>
<th>Anions (mg/L)</th>
<th>Other Chemical Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductivity (mS/cm)</td>
<td>As$^{3+}$</td>
<td>Cl$^{-}$</td>
<td>Alkalinity (mg/L as CaCO$_3$)</td>
</tr>
<tr>
<td>pH</td>
<td>As$^{5+}$</td>
<td>F$^{-}$</td>
<td>Boron (mg/L)</td>
</tr>
<tr>
<td>Silt density index</td>
<td>Ba$^{2+}$</td>
<td>HCO$_3^-$</td>
<td>Dissolved oxygen concentration (mg/L)</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>Ca$^{2+}$</td>
<td>NO$_2^-$ -N</td>
<td>H$_2$S (mg/L)</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>Cu$^{2+}$</td>
<td>NO$_3^-$ -N</td>
<td>Hardness (mg/L as CaCO$_3$)</td>
</tr>
<tr>
<td></td>
<td>Fe$_{3}^{+}$</td>
<td>SO$_4^{2-}$</td>
<td>Pesticides(mg/L)</td>
</tr>
<tr>
<td></td>
<td>K$^+$</td>
<td></td>
<td>Radionuclides (pCi/L)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Uranium (μg/L)</td>
</tr>
<tr>
<td></td>
<td>Mg$^{2+}$</td>
<td></td>
<td>Silica (mg/L)</td>
</tr>
<tr>
<td></td>
<td>Mn$^{2+}$</td>
<td></td>
<td>TDS (mg/L)</td>
</tr>
<tr>
<td></td>
<td>Na$^+$</td>
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</tr>
<tr>
<td></td>
<td>NH$_4^+$ -N</td>
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</tr>
<tr>
<td></td>
<td>Ni$^{2+}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zn$^{2+}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Pecos Valley Aquifer Total Dissolved Solids (mg/L)

- **Blue**: 0 – 1,000
- **Yellow**: 1,000 – 3,000
- **Orange**: 3,000 – 10,000
- **Red**: > 10,000

Range: 116 to 312,487 mg/L
628 wells
Pecos Valley Aquifer Geochemistry

- **Silica**
  - Range: 1 to 83 mg/L
  - 493 wells

- **Sulfate**
  - Range: 3 to 3,260 mg/L
  - 717 wells

- **Chloride**
  - Range: 3 to 86,200 mg/L
  - 739 wells

**Base map: Pecos Valley Aquifer Depth Below Ground Surface**

**Chemical Content:** Low 🟠 Medium 🟢 High 🟥

Shallow 🟣 Deep 🟥
Determining resistivity values for calculating TDS

Can use:

SP Log  
(Spontaneous Potential)

Resistivity Tools  
Induction  
Laterolog  
Resistivity  
Electric  
Lateral
Calculation of TDS from geophysical well logs

Load method-specific log values and correction factors; automate the analysis
Brackish Groundwater Database well locations in WIID

WIID: Water Information Integration & Dissemination
Summary


- 44 water treatment plants in Texas use Reverse Osmosis to treat brackish water.

- The Texas Innovative Water 2010 Seminar held in San Antonio in October, 2010, showed a tremendous interest in brackish groundwater resources.

- The TWDB, through the BRACS project and external contracts, is well-poised to provide the information Texas needs to continue development of this resource.

- Each aquifer is different and techniques of analysis will need to fit data available.

- August 31, 2011 is the deadline for the Pecos Valley aquifer pilot study.

- August 31, 2011 is the deadline for the three contracts: Geophysical well logs, Geological Bibliography, and Groundwater Modeling and Variable Density applicability.
Innovative Water Technologies

The mission of the Innovative Water Technologies is to educate the water community on the use of nontraditional water supplies. This mission is accomplished by participating in research needed to advance technology demonstration projects, developing publications and educational materials, and making presentations to the public, and actively participating in key water organizations.

To promote and advance the use of nontraditional water supply development and management technologies such as desalination, rainwater and stormwater harvesting, water reuse, and aquifer storage and recovery in Texas, Innovative Water Technologies:

- funds and participates in research and demonstration projects; and,
- disseminates information through outreach activities.

Innovative Water Technologies (IWT) is primarily involved in the areas of nontraditional water supply and management activities including desalination, rainwater and stormwater harvesting, water reuse, and aquifer storage recovery.

Through our desalination program, we administer grants for brackish groundwater desalination projects and seawater desalination pilot studies. To date, TWDB has funded eight brackish groundwater desalination demonstration projects worth a total of about $2.2 million, and two seawater desalination pilot plant studies worth approximately $3.13 million.

We promote rainwater and stormwater harvesting and water reuse through grants for research and demonstration projects and outreach activities.

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