Groundwater Availability Model (GAM) for the Blossom Aquifer
Stakeholder Advisory Forum Number 1
Daingerfield, Texas
June 25, 2014
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Shirley C. Wade
Groundwater Resources Division
Texas Water Development Board
The statements contained in this presentation are my current views and opinions and are not intended to reflect the positions of, or information from, the Texas Water Development Board, nor is it an indication of any official policy position of the Board.
Thank you

• To Daingerfield State Park for use of their beautiful facilities for our stakeholder meeting
Outline

• Introduction
  – Study Objectives
  – TWDB Groundwater Availability Modeling Program

• Background
  – Aquifers and Groundwater Flow
  – Groundwater Models

• Blossom Aquifer Overview
  – Study Area - maps
  – Climate – average rainfall map, annual rainfall at select stations
  – Geology – stratigraphy, geologic map
  – Historical Water Use - pumping
  – Historical Water Levels – hydrographs

• Request for Data
• Project Schedule
Study Objectives

• To better understand the Blossom Aquifer; the inflows and outflows and aquifer properties and
• To develop a tool to help local and regional water planners make decisions about future water planning
Groundwater Availability Modeling
GAM Program

- **Purpose:** to develop groundwater flow models to help Groundwater Conservation Districts (GCD), Groundwater Management Areas (GMA), Regional Water Planning Groups (RWPG), and others with managing their groundwater resources

- **Public process:** encourage stakeholder participation in model development and model improvements

- **Freely available:** standardized, thoroughly documented, with reports available over the internet

- **Living tools:** periodically updated
What is Groundwater Availability?

Policy + Science = Groundwater Availability

Desired Future Conditions + GAM or other tool = Modeled Available Groundwater

Goal: informed decision-making
Modeled Available Groundwater in statute

Texas Water Code, §36.1084 (b) states that, the Executive Administrator of the TWDB shall provide each district and regional water planning group located wholly or partly in the management area with the modeled available groundwater in the management area based upon the desired future conditions adopted by the districts.
Modeled Available Groundwater

- Desired future conditions are determined through joint planning of groundwater conservation districts in groundwater management areas
- Modeled available groundwater is then estimated by groundwater availability models where they are available
Groundwater Management Areas of Texas

Groundwater Management Areas were created "in order to provide for the conservation, preservation, protection, recharging, and prevention of waste of the groundwater, and of groundwater reserves or their subdivisions, and to control subsidence caused by withdrawal of water from those groundwater reserves or their subdivisions, consistent with the objectives of Section 156, Article XV, Texas Constitution, groundwater management areas may be created..." (Texas Water Code §35.051) Added by Acts 1985, 74th Leg., ch. 933, §2, eff. Sept. 1, 1995.

The responsibility for Groundwater Management Area delineation was delegated to the Texas Water Development Board (Section 35.08A, Chapter 35, Title 3, Texas Water Code). The initial Groundwater Management Area delineations were adopted on December 15, 2002 (356.23, TWDB Rules).

MISSION: The Texas Water Development Board’s (TWDB) mission is to provide leadership, planning, financial assistance, information, and education for the conservation and responsible development of water for Texas.
Major Aquifers

Note:
The Edwards-Trinity (Plateau) and Pecos Valley aquifers are included in the same model.
These boundaries are approximate and do not show overlaps between models.
Minor Aquifers

(Updated 4/1/2013)
How we use Groundwater Models

• Texas Water Code, § 36.1071 (h) Inform groundwater districts about historical conditions in the aquifer

<table>
<thead>
<tr>
<th>Management Plan requirement</th>
<th>Aquifer or confining unit</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated annual amount of recharge from precipitation to the district</td>
<td>Edwards-Trinity (Plateau) Aquifer</td>
<td>140,509</td>
</tr>
<tr>
<td></td>
<td>Pecos Valley Aquifer</td>
<td>14,115</td>
</tr>
<tr>
<td></td>
<td>Dockum Aquifer</td>
<td>0</td>
</tr>
<tr>
<td>Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers</td>
<td>Edwards-Trinity (Plateau) Aquifer</td>
<td>31,222</td>
</tr>
<tr>
<td></td>
<td>Pecos Valley Aquifer</td>
<td>9,804</td>
</tr>
<tr>
<td></td>
<td>Dockum Aquifer</td>
<td>0</td>
</tr>
<tr>
<td>Estimated annual volume of flow into the district within each aquifer in the district</td>
<td>Edwards-Trinity (Plateau) Aquifer</td>
<td>32,993</td>
</tr>
<tr>
<td></td>
<td>Pecos Valley Aquifer</td>
<td>3,441</td>
</tr>
<tr>
<td></td>
<td>Dockum Aquifer</td>
<td>554</td>
</tr>
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</table>
How we use Groundwater Models

- Texas Water Code, § 36.108 (d): the districts shall consider groundwater availability models and other data or information [when developing desired future conditions]
How we use Groundwater Models

- **Texas Water Code, § 36.1084 (b):** Estimate modeled available groundwater based on desired future conditions

<table>
<thead>
<tr>
<th>County</th>
<th>Regional Water Planning Area</th>
<th>Basin</th>
<th>Year</th>
</tr>
</thead>
</table>

*Modeled available groundwater is in acre-feet per year*
How we use Groundwater Models

- Texas Water Code, § 36.108 (d) (3)
  Estimating total recoverable storage for explanatory reports
Stakeholder Advisory Forums

- Keep updated about progress of the model development
- Understand how the groundwater model can, should, and should not be used
- Provide input and data to assist with model development
An aquifer consists of subsurface layers of rock or dirt that can produce economically usable amounts of water.
Groundwater flows from higher potential energy (head) to lower potential energy.
Groundwater Flow

• Hydraulic Conductivity or $K$ is a measure of how easily water flows through the aquifer
Water levels can indicate confined or unconfined conditions

Hydraulic Head: Water level as measured in a well

Water levels can indicate confined or unconfined conditions.
Aquifer Storage Properties

• Storage coefficient and specific yield are measures of the volume of water an aquifer can hold (measured from aquifer tests)

• Storage coefficient is much smaller than specific yield. A unit drop in the water table produces much more water than a unit decline in confined water level.
Groundwater models are simplified representations of underground water systems (aquifers)
Groundwater Models

• They can be physical models such as sand tank models or they can be mathematical models

• We are using a mathematical modeling computer program called MODFLOW for the Blossom Aquifer groundwater availability model

• MODFLOW is a publicly available computer program developed by the United States Geological Survey
Groundwater Models

- Aquifer data is used by the computer model to predict water levels and groundwater discharge
- History matching also known as model calibration is used to estimate some aquifer properties that are not well known
Building a Groundwater Model
To build a groundwater model we:

1. Characterize aquifer properties
2. Overlay grid
3. Assign aquifer properties to the grid cells
4. Adjust aquifer properties (within limits) to match historical data (water levels and groundwater discharge)

Last step is known as calibration
Characterize Aquifer Geometry and Properties
Assign Aquifer Properties

- Recharge
- Pumping
- Hydraulic Conductivity
- Initial water level
- Storage properties
Calibration Example 1: GAM for the Presidio Bolson
Calibration Example 2: Houston Area Groundwater Model (from Kasmarek, 2013)

Estimated downdip limit of freshwater in the Chicot aquifer

EXPLANATION
- **Simulated potentiometric contour**: Shows altitude at which water would have stood in tightly cased well. Interval 50 feet. Datum is NAVD 88.
- **Measured potentiometric contour**: Shows altitude at which water would have stood in tightly cased well. Interval 50 feet. Datum is NAVD 88.
- **Data point**: Well in which water-level measurement was made.
- **Data point and well number**: Well in which water-level measurement was made and for which hydrograph is shown on figure 26.

Acknowledgement:
Base modified from U.S. Geological Survey digital data
Scale 1:240,000 (except Louisiana hydrography 1:100,000)
Albers equal-area projection
North American Datum of 1988
Standard parallels 34°56’ and 27°25’, central meridian 100°
1981 – 2010 Average Rainfall

(PRISM Climate Group, Oregon State University, http://prism.oregonstate.edu, created 10 July 2012)
source: National Climate Data Center, online data accessed September 2013
CLARKSVILLE 2 NE TX US

Source: National Climate Data Center, online data accessed September 2013
NEW BOSTON TX US

source: National Climate Data Center, online data accessed September 2013
<table>
<thead>
<tr>
<th>Era</th>
<th>System</th>
<th>Series</th>
<th>Group</th>
<th>Formation</th>
<th>Approximate maximum thickness (ft)</th>
<th>Lithology¹</th>
<th>Water-bearing characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cenozoic</td>
<td>Quaternary</td>
<td>Recent</td>
<td></td>
<td>Alluvium</td>
<td>75</td>
<td>Sand, silt, clay, and gravel</td>
<td>Yields small² to moderate³ quantities of water to wells along the Red River</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pleistocene</td>
<td></td>
<td>Fluvialite, terrace deposits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Taylor</td>
<td>Marbrook Marl</td>
<td>Marbrook Marl</td>
<td>1,500</td>
<td>Clay, marl, shale, chalk, mudstone, and sandstone, very fine-grained</td>
<td>Yields small quantities of water to shallow wells</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pecan Gap Chalk</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Wolfe City-Ozan Formation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Austin</td>
<td>Gober Chalk</td>
<td>Gober Chalk</td>
<td>226</td>
<td>Chalk, discontinuous</td>
<td>Not known to yield water to wells</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Brownstown</td>
<td>Brownstown</td>
<td></td>
<td>Clay or shale</td>
<td>Not known to yield water to wells</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blossom Sand</td>
<td>Blossom Sand</td>
<td>400</td>
<td>Fine to medium sand inter-bedded with light to dark marl and chalky marl</td>
<td>Yields small to moderate quantities of water to municipal, domestic, and livestock wells</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Bonham</td>
<td>Bonham</td>
<td>700</td>
<td>Clay or shale</td>
<td>Not known to yield water to wells</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Ector</td>
<td>Ector</td>
<td></td>
<td>Chalk</td>
<td>Not known to yield water to wells</td>
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<tr>
<td></td>
<td></td>
<td>Eagle Ford</td>
<td></td>
<td>Eagle Ford</td>
<td>650</td>
<td>Shale with thin beds of sandstone and limestone</td>
<td>Yields small quantities of water to shallow wells</td>
</tr>
</tbody>
</table>

¹ Lithology from Wood and Guevara (1981) and Nordstrom (1982).
² Small quantities of water are generally less than 100 gallons per minute
³ Moderate quantities of water are generally 100 to 1,000 gallons per minute
West-East Cross Section (after McLaurin, 1988)

- Lamar County
- Red River County
- Red River County
- Bowie County

- Land Surface
- Blossom Sand
- Eagle Ford Group

Latitude, in feet

Sea Level

0 2 4 6 8 Miles

Texas Water Development Board
North-South Cross Section
(after McLaurin, 1988)
Water Use
Water Levels
Data Request

• Any un-published data to support the model
  – Geophysical logs
  – Pump tests
  – Water levels
  – Interpreted aquifer properties
  – Structural picks
  – Pumping information

• Data request by January 31, 2015
Tentative Schedule

2014
• June – SAF1

2015
• January – deadline for receiving stakeholder data
• May – draft conceptual model report
• June – SAF2
• July – Deadline for stakeholder comments on conceptual model

2016
• August – draft model report
• September – SAF3
• October – deadline for comments on draft model report
• December – final model report posted
Contact Information

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Austin, Texas 78711-3231

Web information:
http://www.twdb.texas.gov/groundwater/
Questions
First Stakeholder Advisory Forum for the Blossom Aquifer Groundwater Availability Model held at Daingerfield State Park Group Recreation Hall on June 25, 2014.

Attendance

<table>
<thead>
<tr>
<th>Name</th>
<th>Affiliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wendell Davis</td>
<td>Red River WSC</td>
</tr>
<tr>
<td>Shirley Wade</td>
<td>Texas Water Development Board</td>
</tr>
<tr>
<td>Cindy Ridgeway</td>
<td>Texas Water Development Board</td>
</tr>
<tr>
<td>Radu Boghici</td>
<td>Texas Water Development Board</td>
</tr>
</tbody>
</table>

Questions and Answers

**Question 1: Is the Blossom Aquifer confined or unconfined?**

Response 1: Both, depending on the location.

**Question 2: Are these three wells showing on your slide the only ones you'll use in the model?**

Response 2: These are the wells that have a good amount of water level data. They (The TWDB Water Sciences and Conservation Groundwater Monitoring Group) definitely monitor more wells, but I wanted to show what the aquifer is doing over a long period of time.

**Question 3: Is any of the Red River water getting into the Blossom Sands?**

Response 3: We don't know. We're trying to answer this with the model. The geologist who has been working on the model layers believes the Red River Alluvium rests on top of a different geologic unit.

**Question 4: Are there other aquifers below the Blossom?**

Response 4: There are other geologic layers that could contain groundwater, but are not designated as aquifers due to lower formation productivity and/or salinity problems.

**Question 4: Is the high rainfall (shown on the precipitation charts) right after the drought of record?**

Response 5: The high rainfall occurred in 1957.

Comment: (Noting water use charts) A lot of the irrigation in the area comes from surface water impoundments.