Llano Uplift Groundwater Availability Model (GAM) Stakeholder Advisory Meeting # 1

Fredericksburg, Texas

July 17, 2012

Cindy Ridgeway, P.G.

Outline

- Introduction to Groundwater Availability Model (GAM) Program
- Introduction to Project Team
- Llano Uplift Regional Overview
- Basics of Groundwater Flow
- Overview of Llano Uplift Aquifer
- Numerical Groundwater Modeling and GAMs
- Data Collection
- GAM Schedule

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GAM Program

- **Purpose:** to develop groundwater flow models to help GCDs, RWPGs, and others with managing their groundwater resources
- **Public process**: encouraged and continue to encourage stakeholder participation in model development and model improvements
- **Freely available**: standardized, thoroughly documented, with reports available over the internet
- **Living tools**: periodically updated

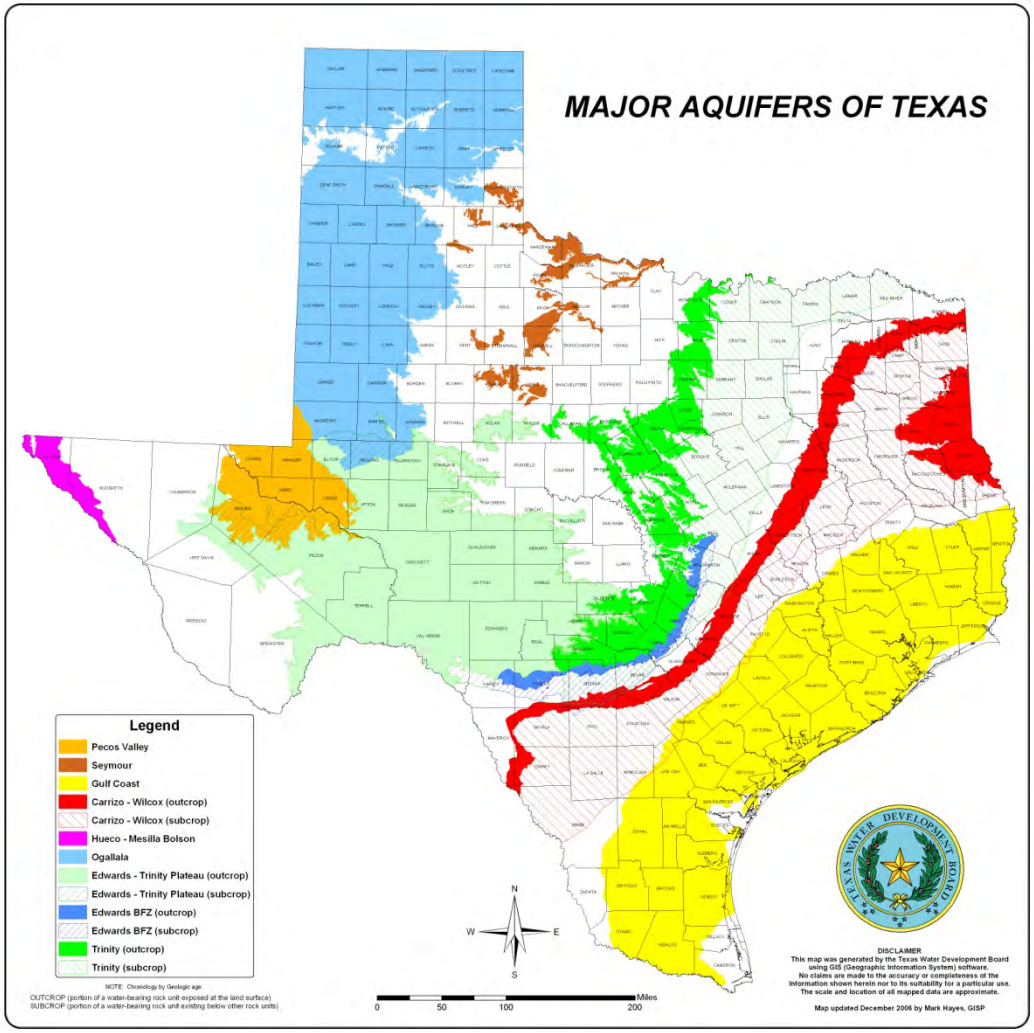
What is Groundwater Availability?

Science + **Policy** = **Groundwater Availability**

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

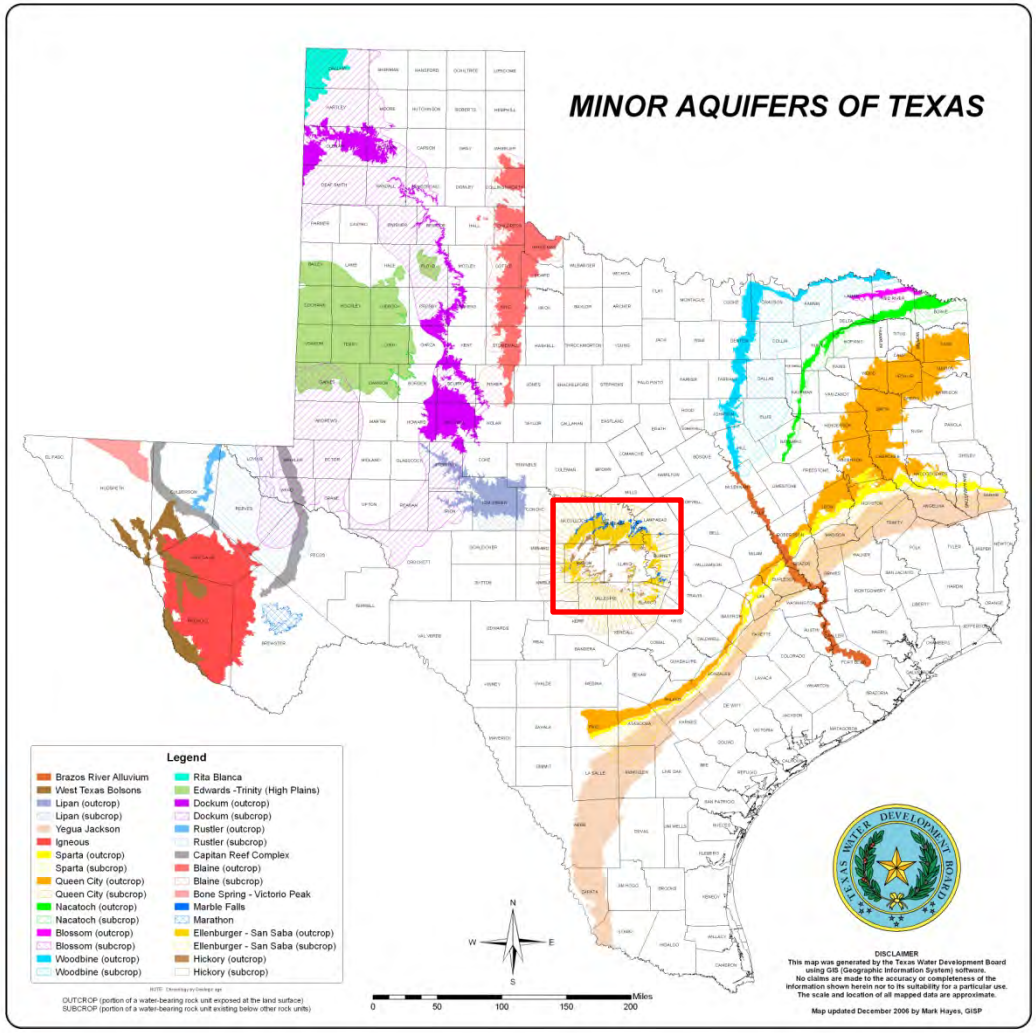
Goal: informed decision-making

Major Aquifers

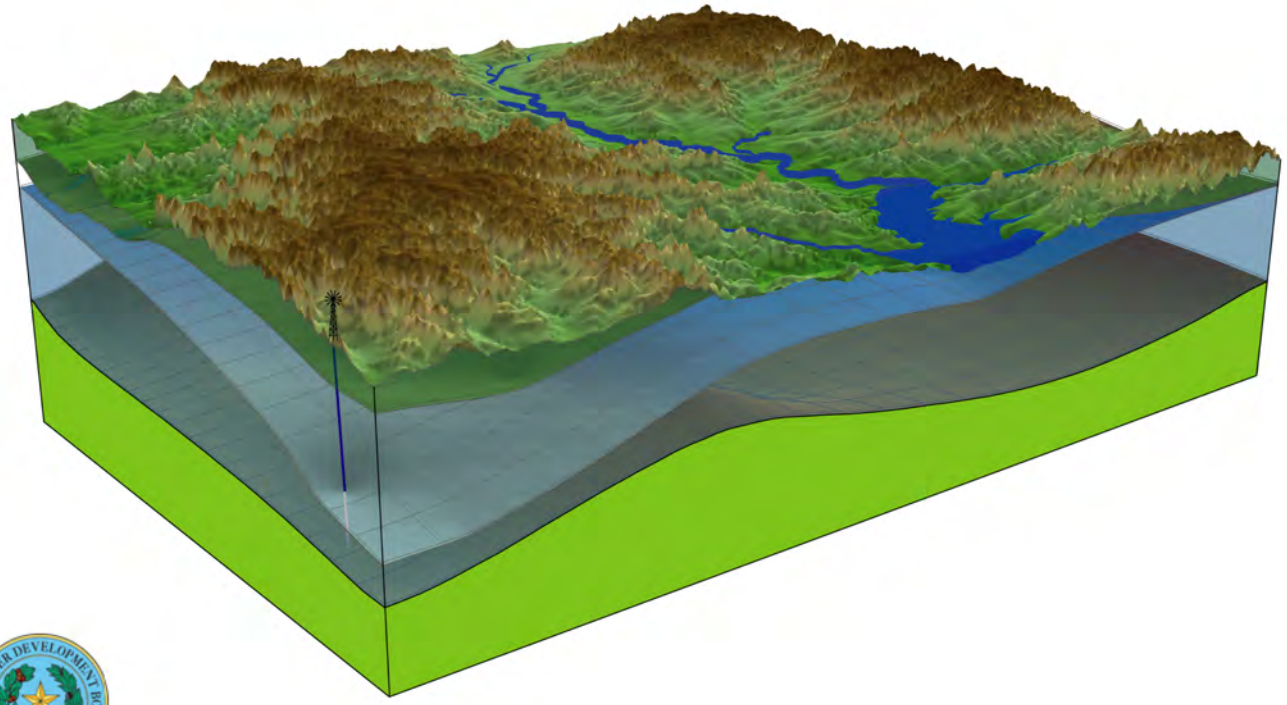


TEXAS WATER DEVELOPMENT BOARD

Minor Aquifers



Groundwater Model



How we use Groundwater Models

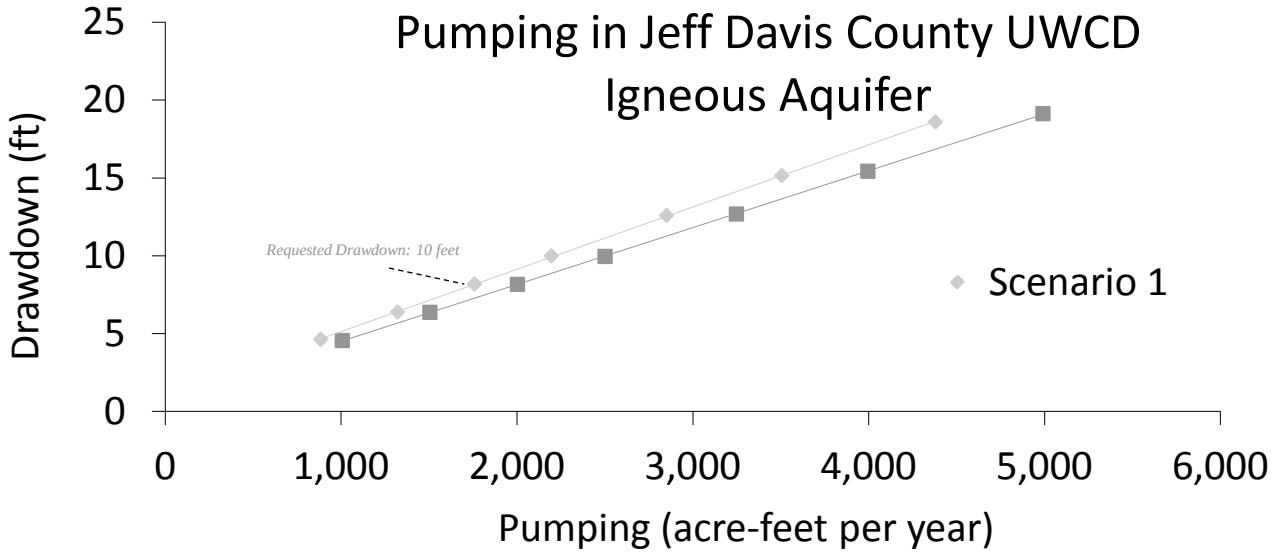
- Inform groundwater districts about historical conditions in the aquifer

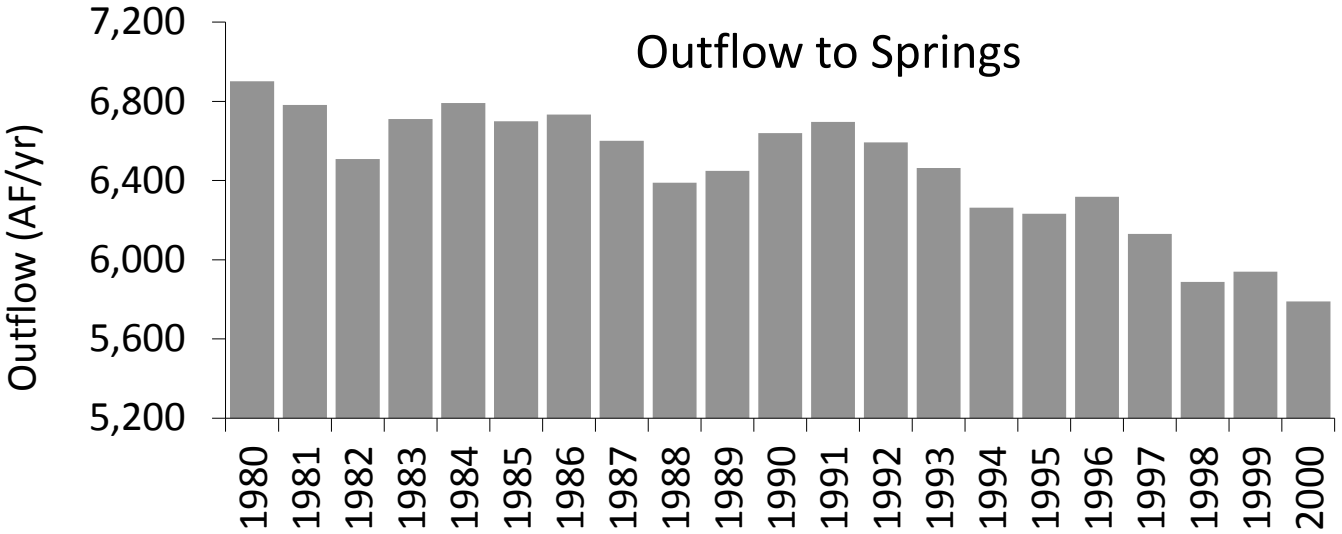
Management Plan requirement	Aquifer or confining unit	Results
Estimated annual amount of recharge from precipitation to the district	Edwards-Trinity (Plateau) Aquifer	140,509
	Pecos Valley Aquifer	14,115
	Dockum Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and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

How you use Groundwater Models

- Determine desired future conditions (DFCs)

DFC: Desired, quantified condition of groundwater resources (such as water levels, water quality, spring flows, or volumes) for a specified aquifer within a management area at a specified time or times in the future.





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

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Project Team

- Cindy Ridgeway, M.Sc., P.G.: GAM manager
  - Oversee GAM operation
  - Flow modeling
  - Water resources management
  - Database
  - GIS

Project Team

- *Jerry Shi, Ph.D., P.G.: modeler
  - flow and transport modeling
  - water resources management
  - hydraulic testing
  - soil boring/rock coring
  - soil/groundwater remediation

* project manager Llano Uplift

Project Team

- Radu Boghici, M.Sc., P.G.
  - Flow modeling
  - Structure geology and hydrogeology
  - Regional groundwater flow and water quality
  - Database
  - GIS

Project Team

- William Kohlrenken, B.A., Pursuing MAG
  - Flow modeling
  - Geo-database
  - GIS

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Jerry Shi, Ph.D., P.G.

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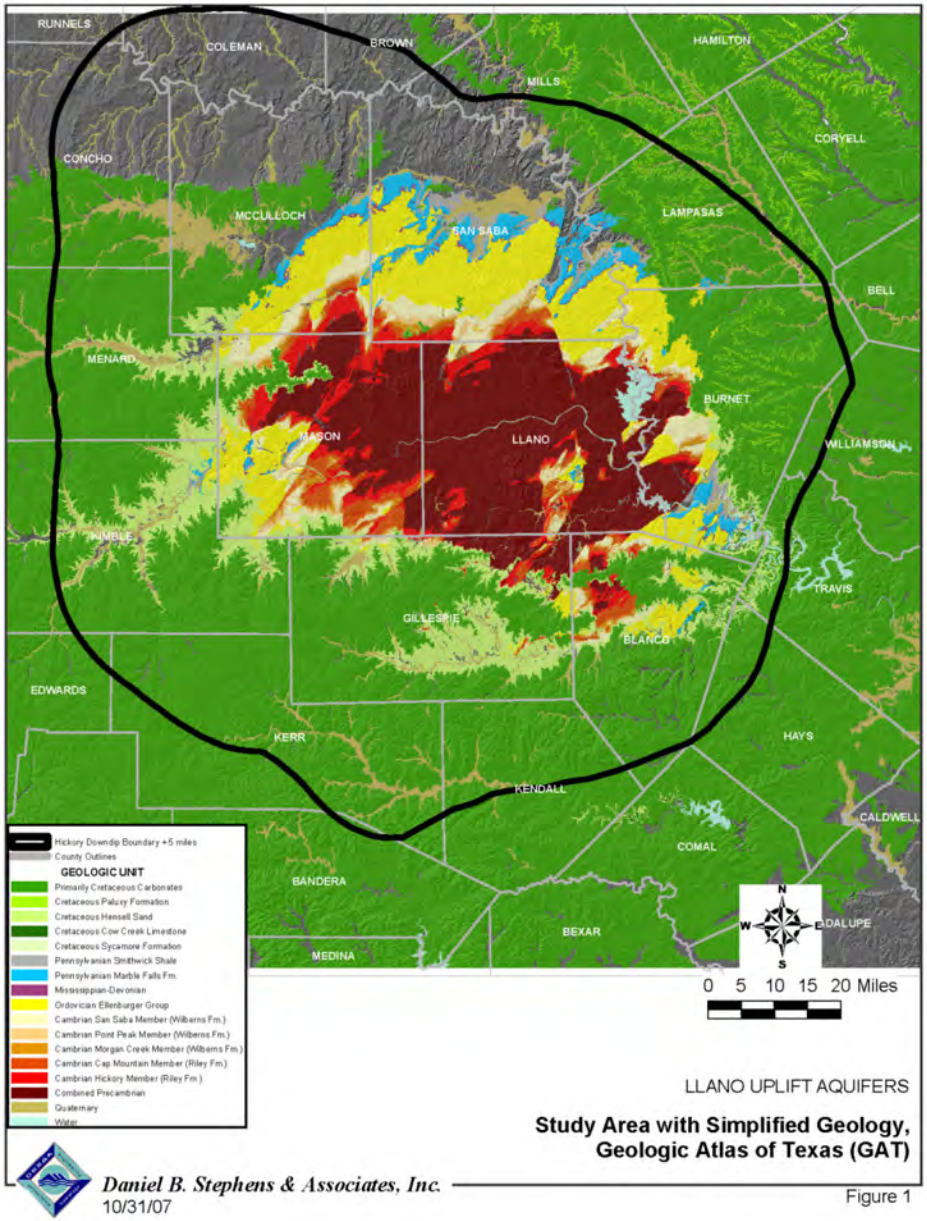
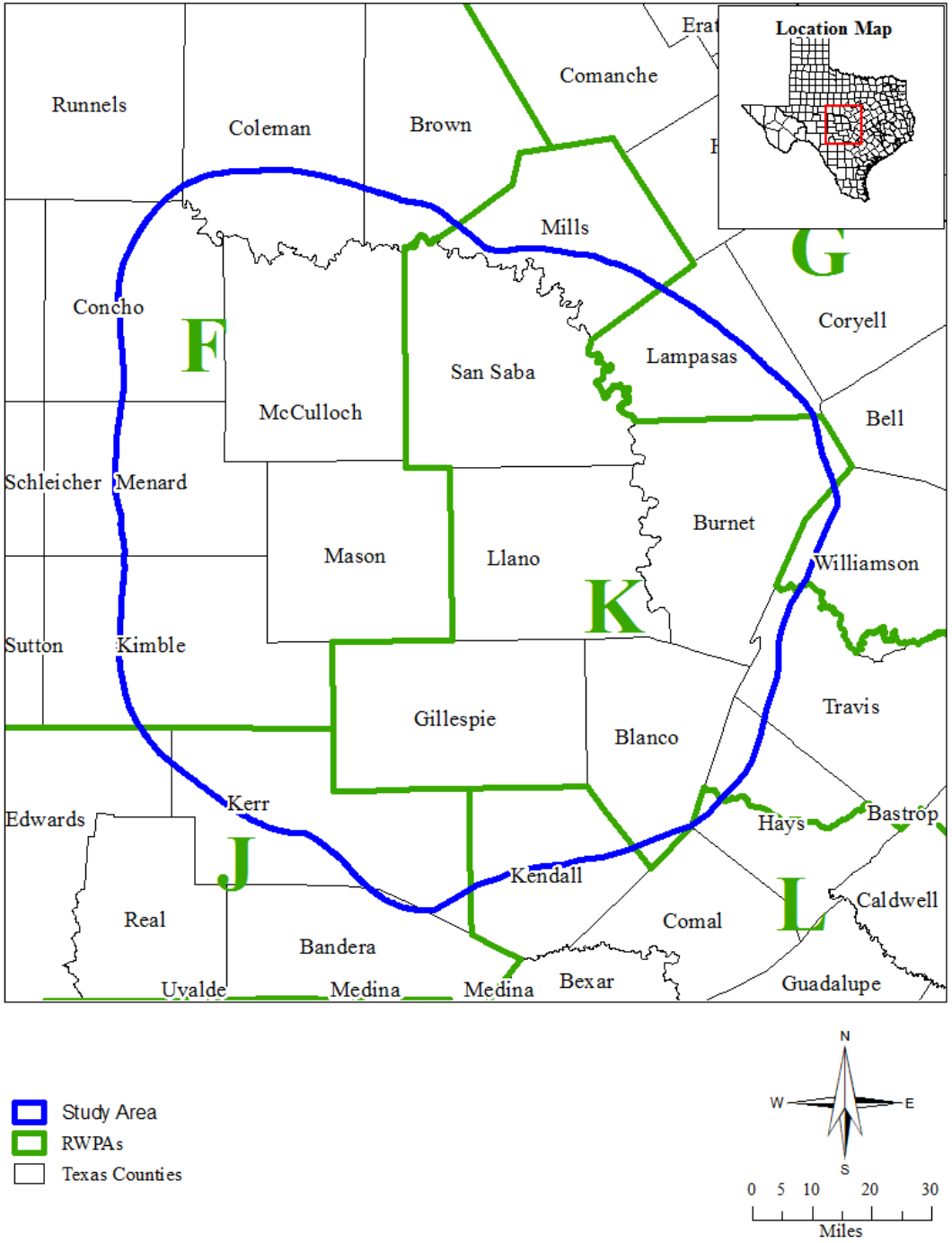
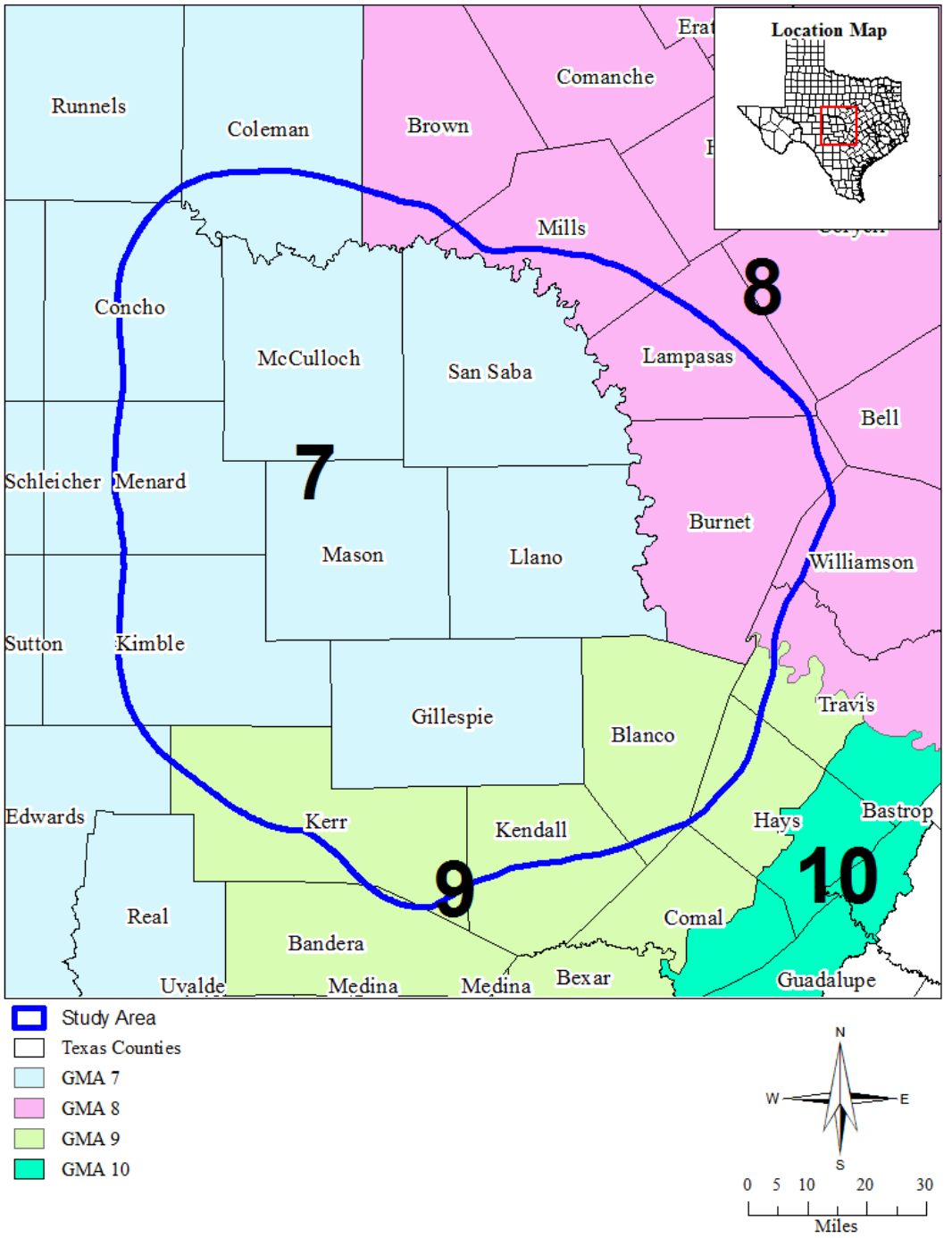
Llano Uplift Aquifers Boundaries



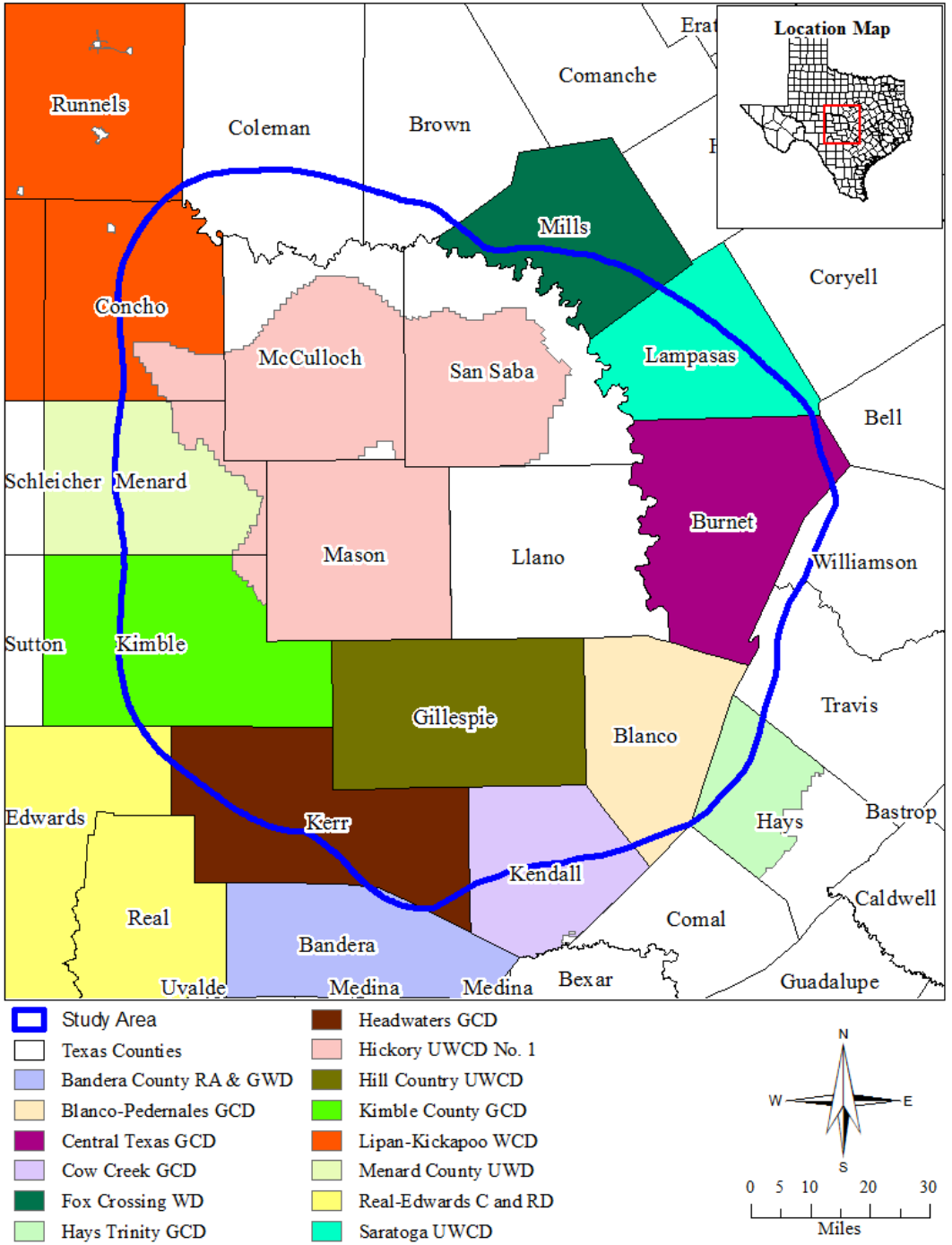
Regional Planning Groups: F, G, J, K, & L



Groundwater Management Areas: 7, 8, and 9



Groundwater Conservation Districts



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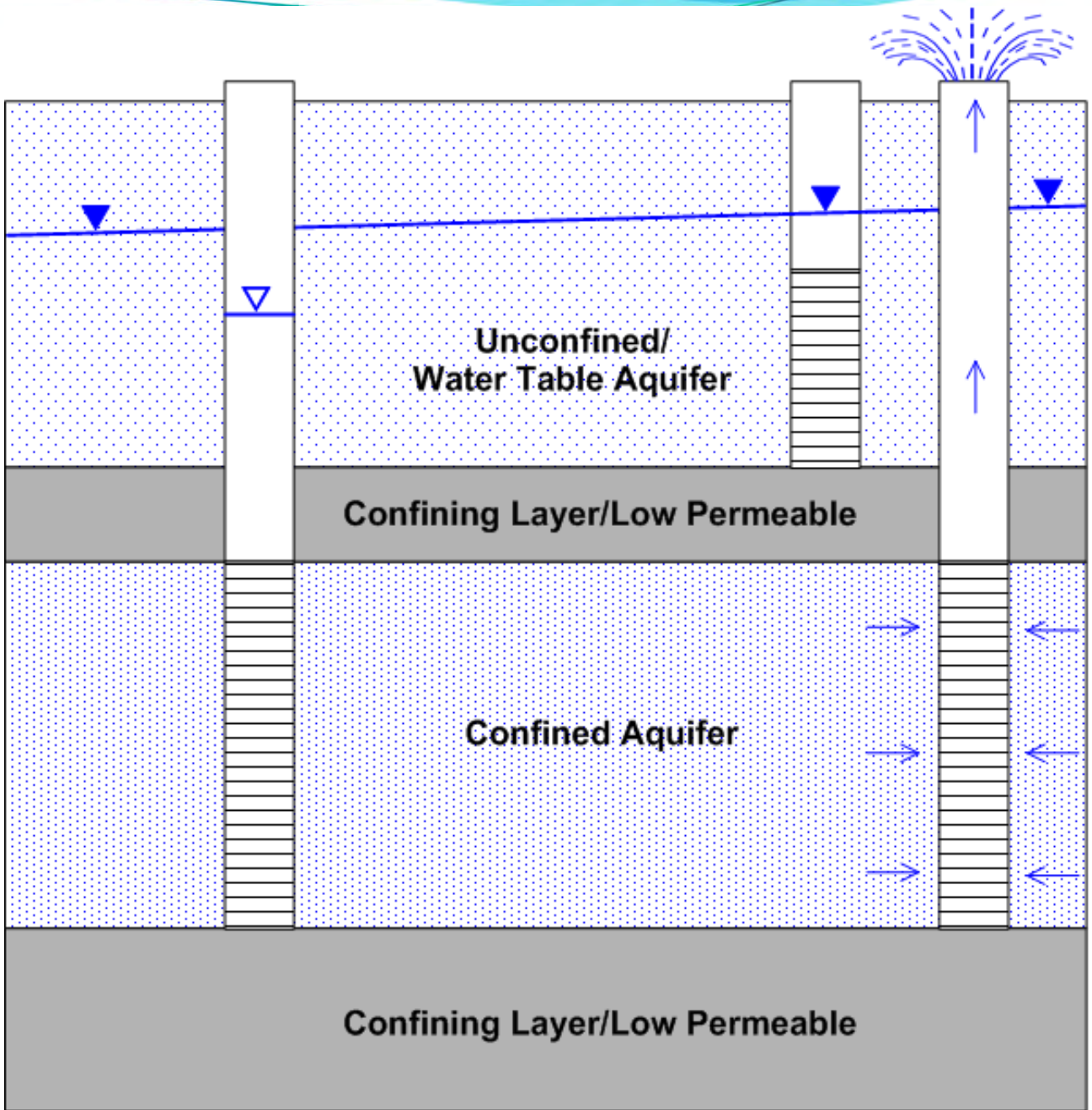
Basic Principles of GW Flow

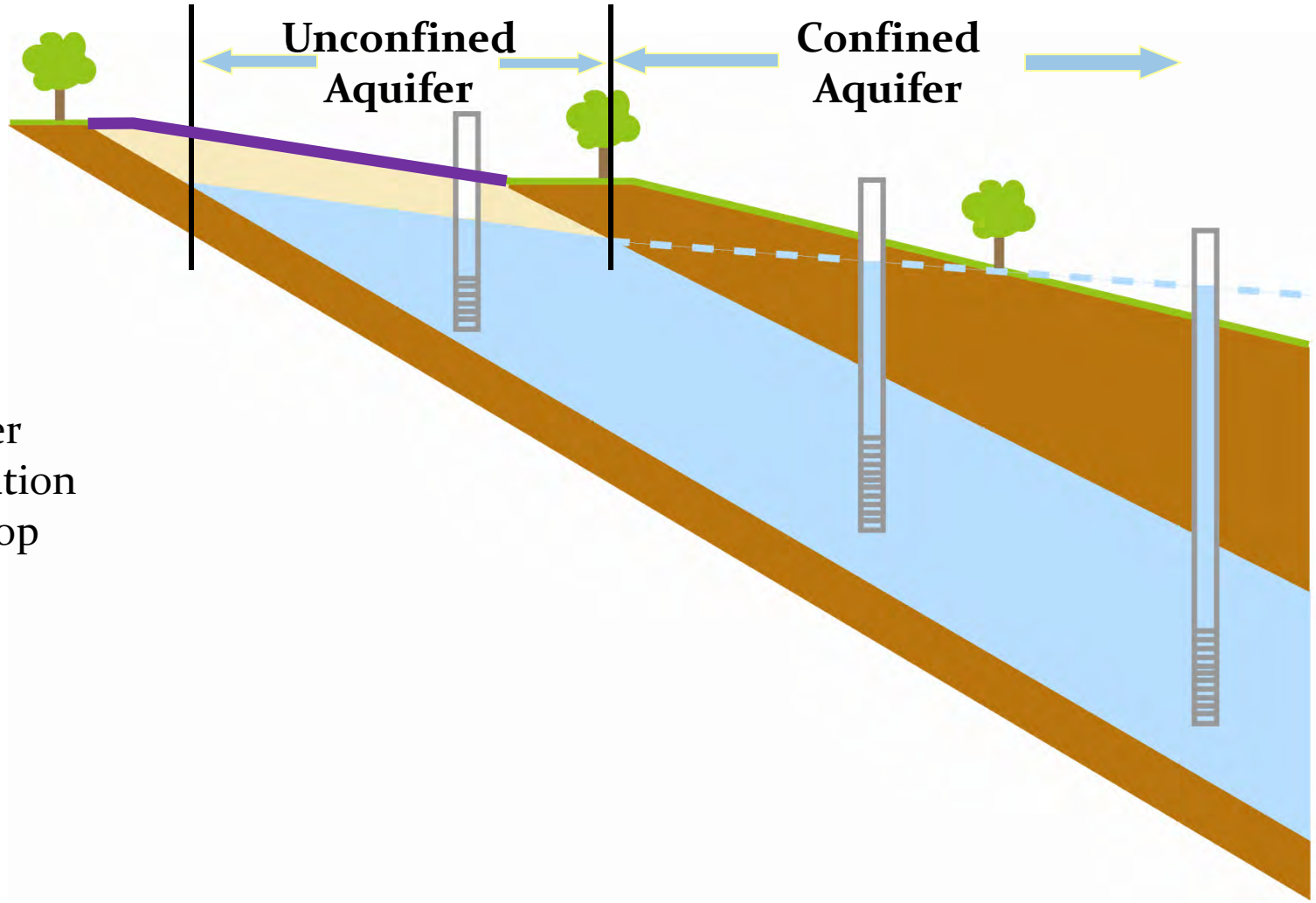
- We use water level measurements from wells
- Groundwater flows from higher water elevations (heads) towards lower water elevations (heads)
- Water table is typically a subdued replica of the land surface (topography)

Aquifers

- Water Table/ Hydraulic Head
- Hydraulic Head

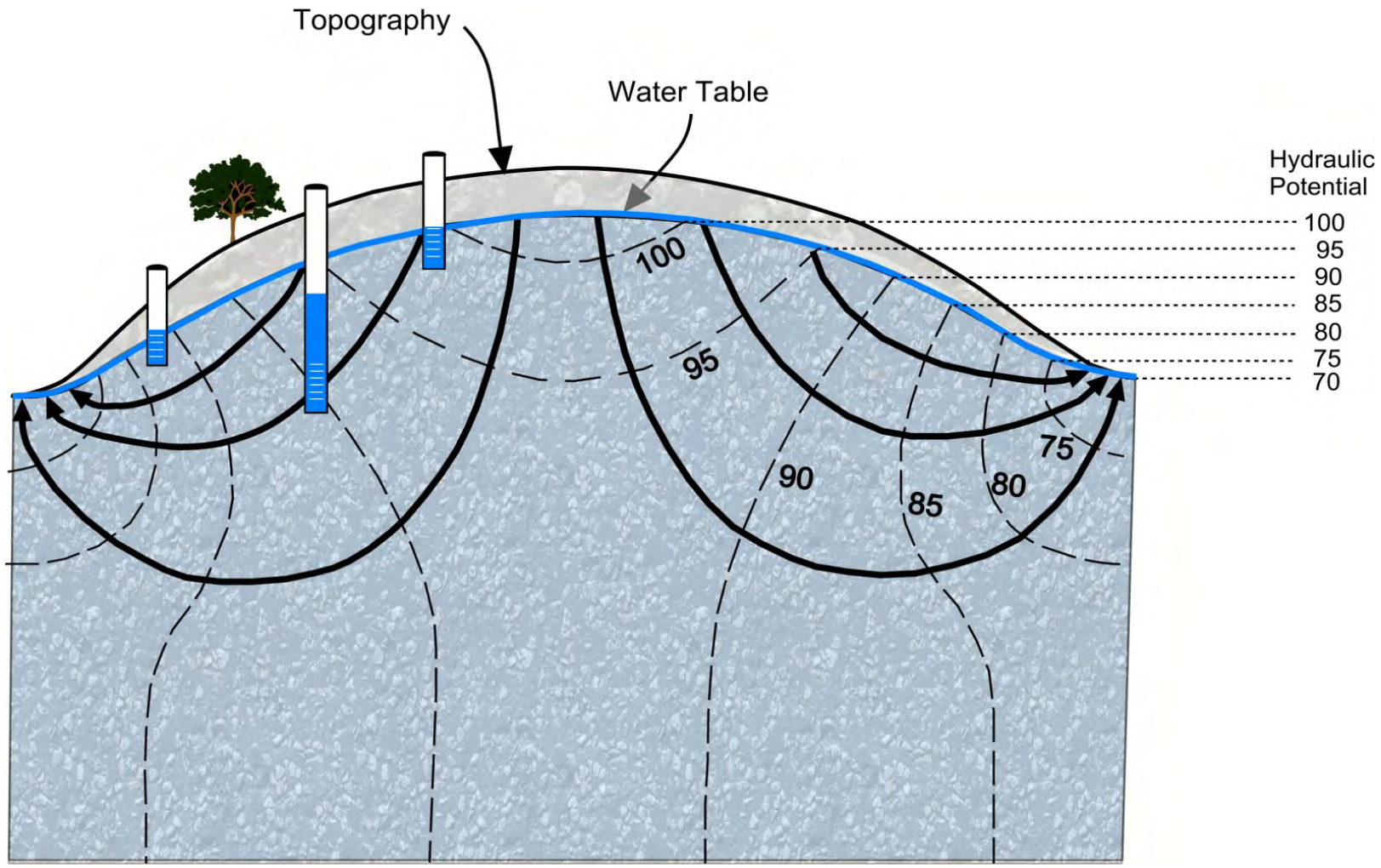


Confined/Unconfined Aquifer



Aquifer Formation Outcrop

Schematic Cross Section of Groundwater Flow



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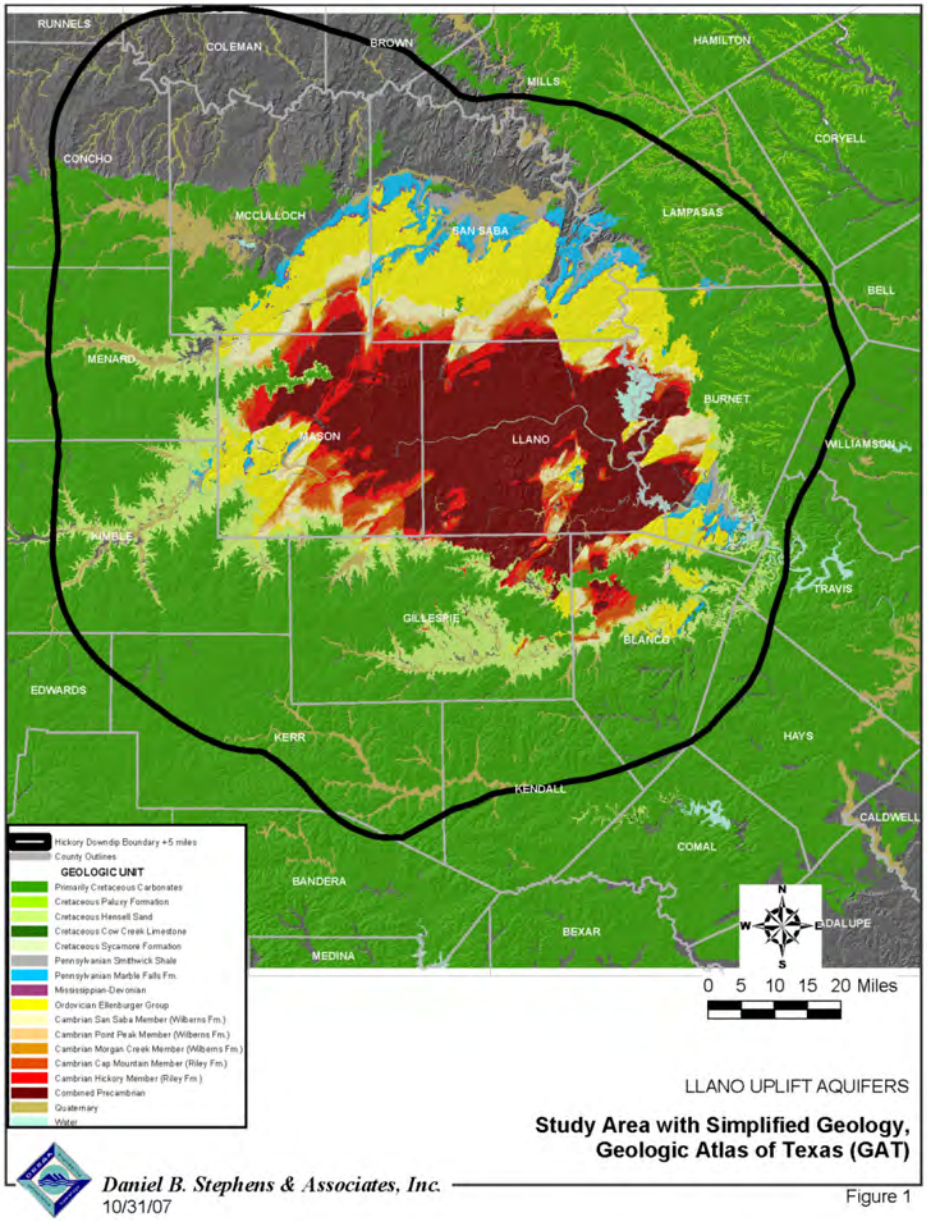
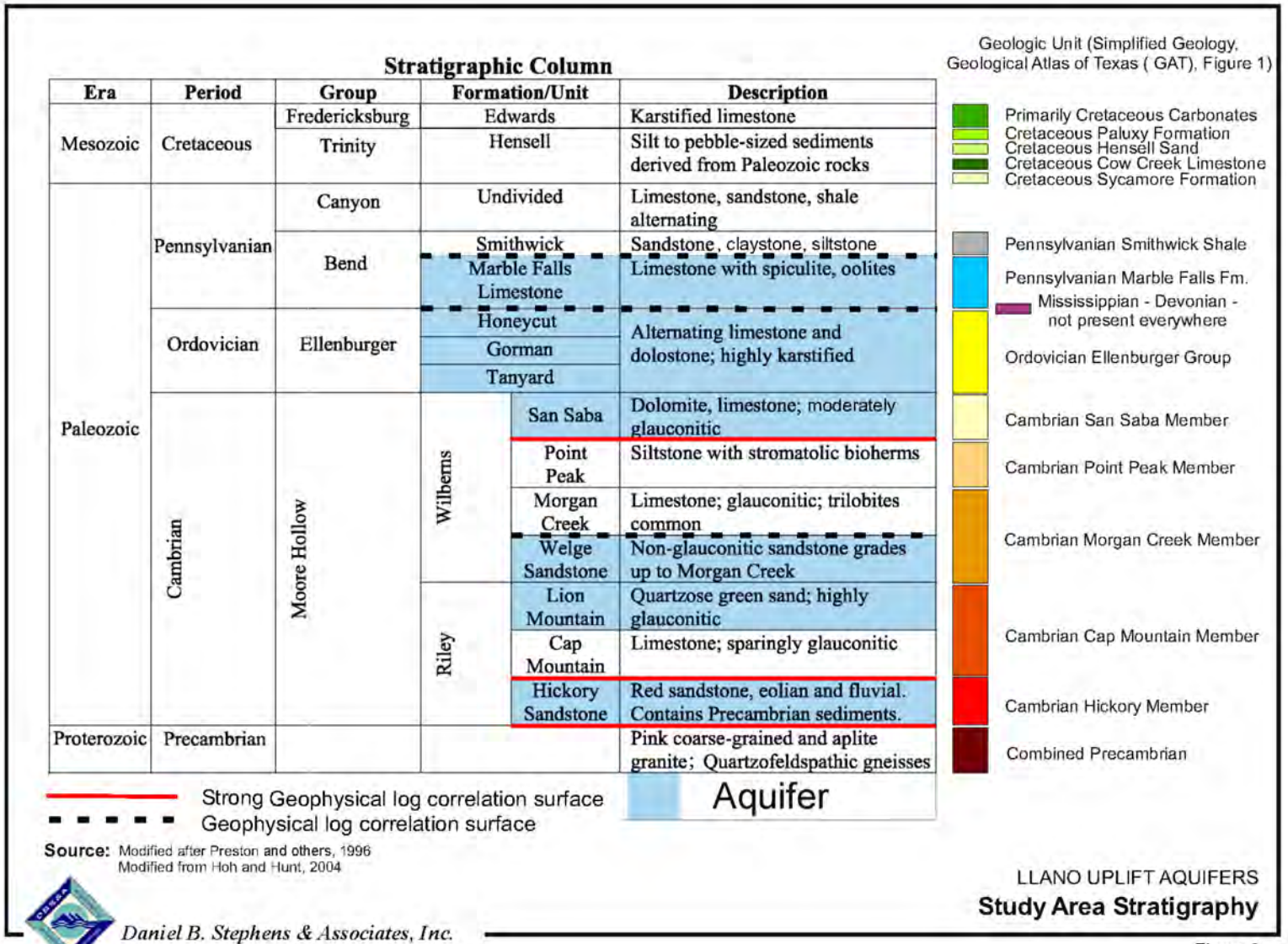
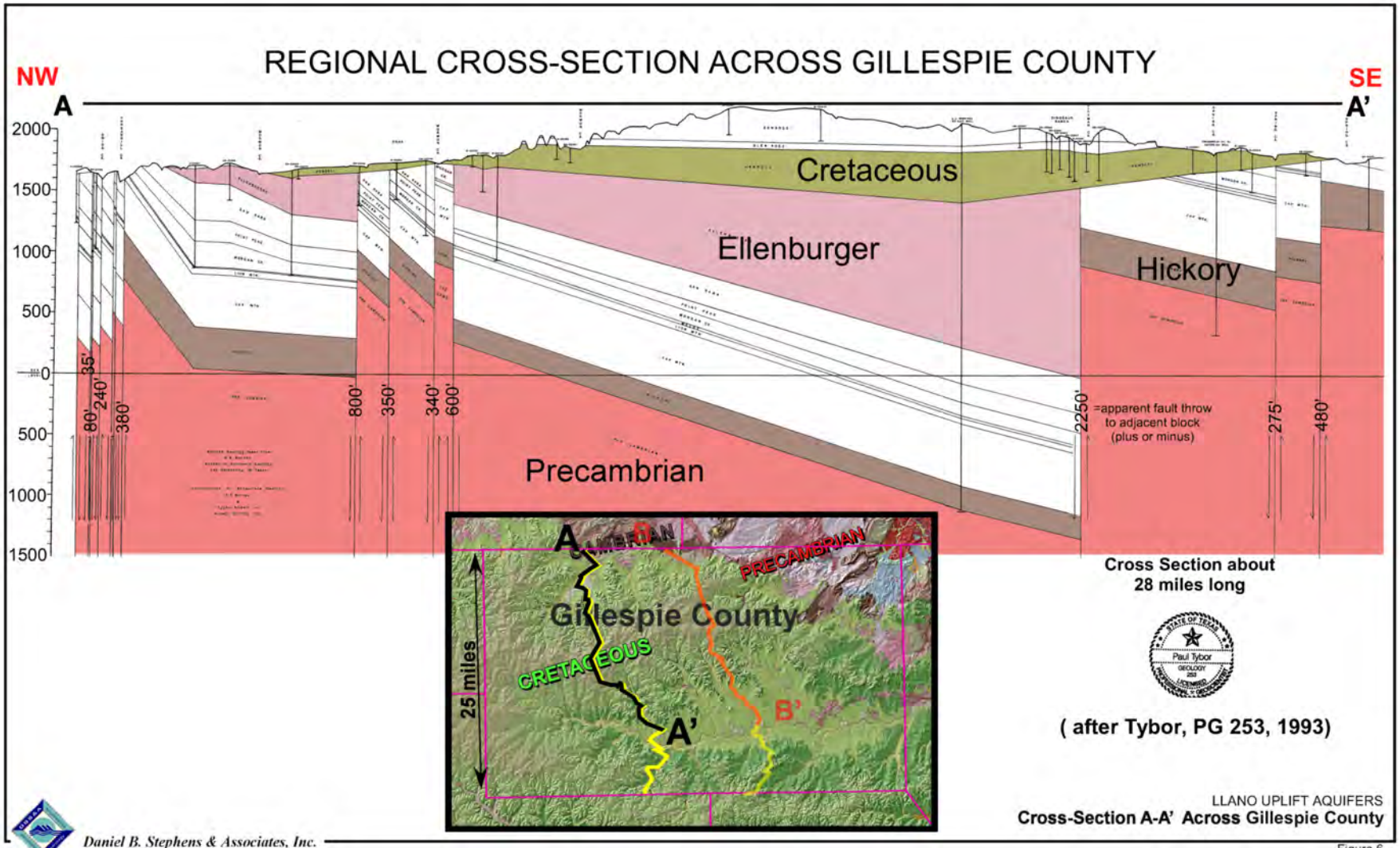
Study Area of Llano Uplift Aquifers



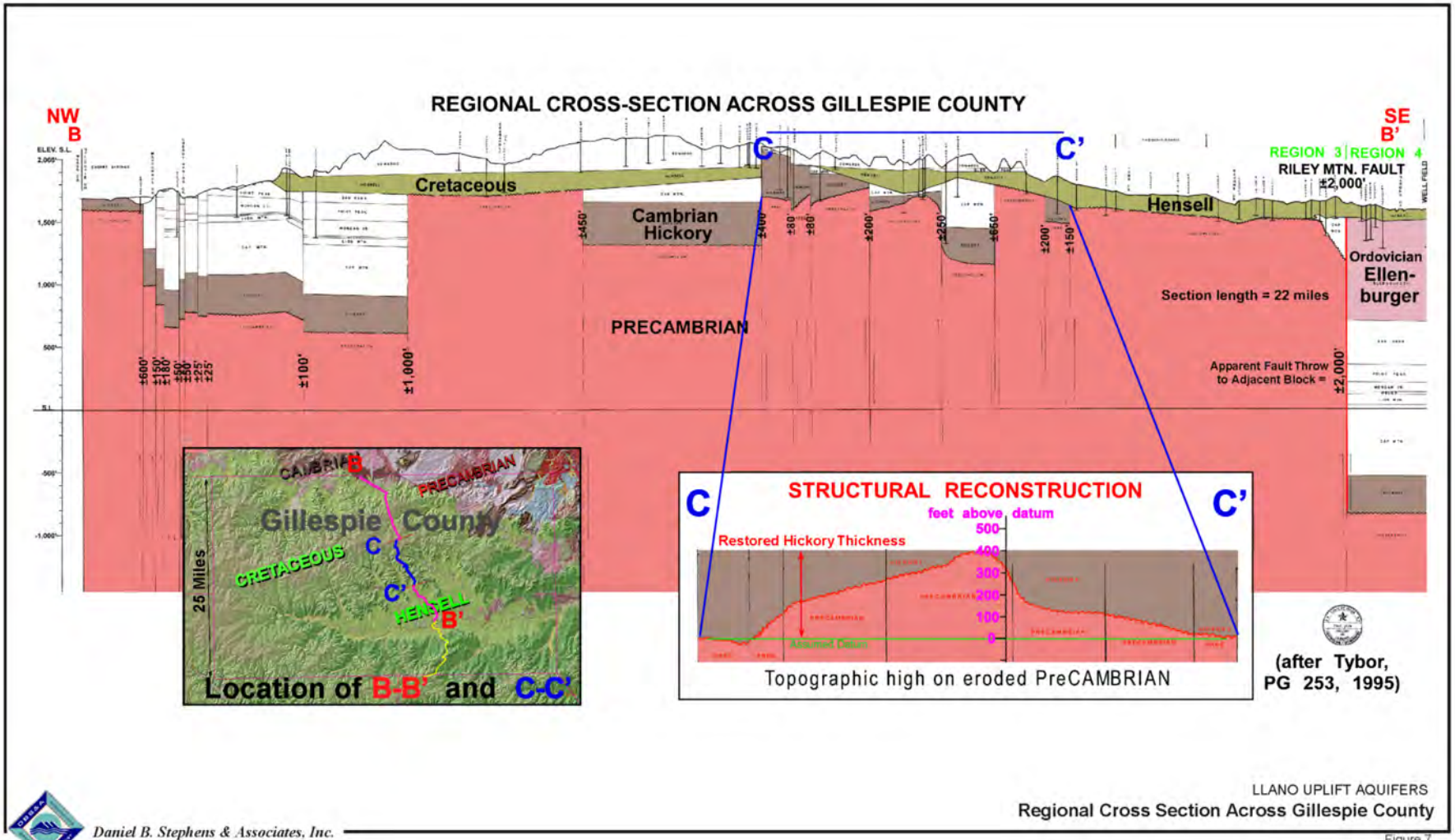
Stratigraphy



Structural Cross-Section



Structural Cross-Section



LLANO UPLIFT AQUIFERS
Regional Cross Section Across Gillespie County

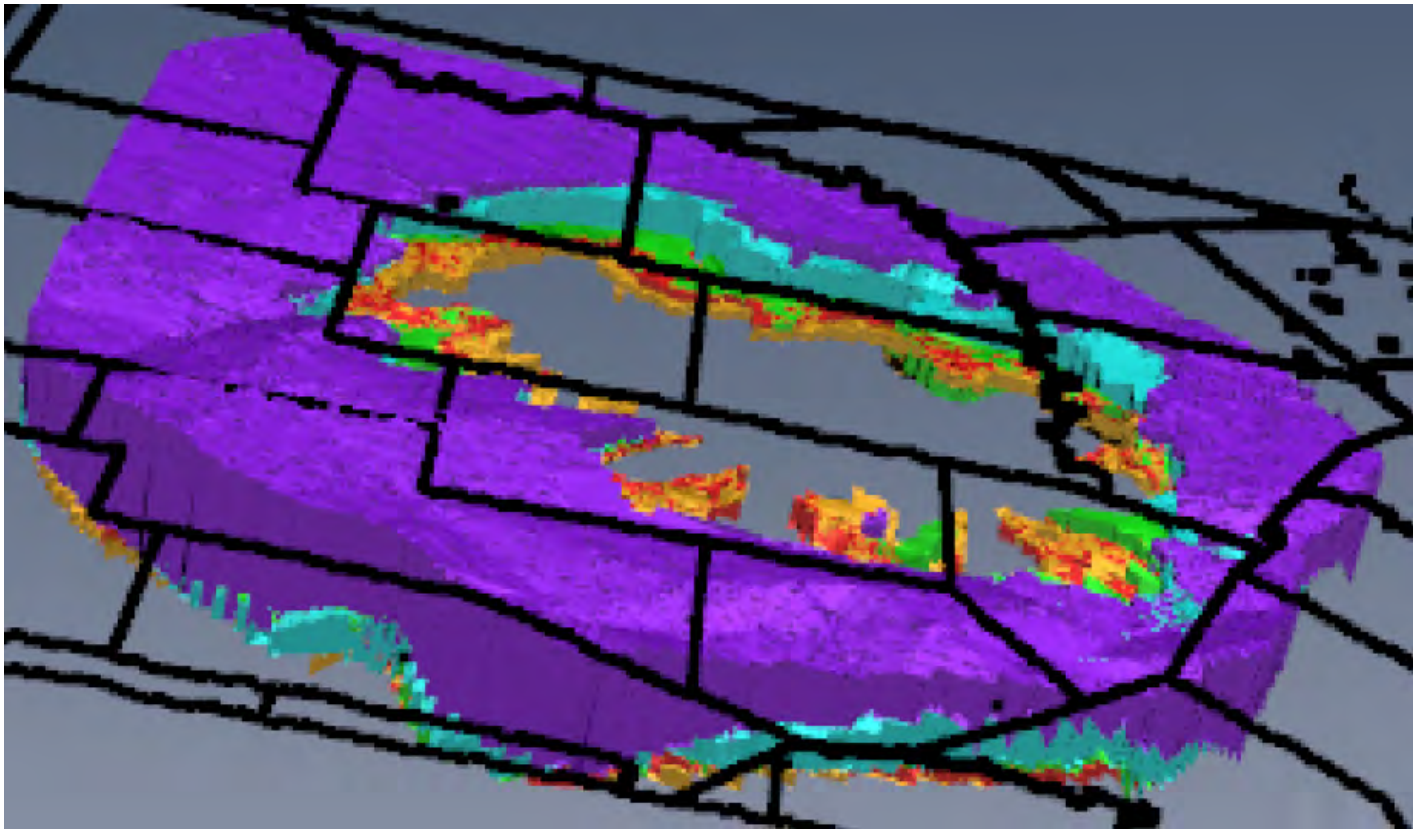
Daniel B. Stephens & Associates, Inc.
10-31-07

Figure 7

Model Framework

- The tops, bottoms, and sides of the aquifers
- Challenges:
  - It's complicated… the aquifers are:
    - Tilted (dip),
    - Sliced (faults),
    - Diced (broken into smaller compartments), and
    - Have a hole in the middle of everything
- Study by Daniel B. Stephens & Associates (2007) framework will form the foundation
  - Finish defining areas not covered by Daniel B. Stephens & Associates (2007)

3-Dimensional Framework



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Definition of a Model

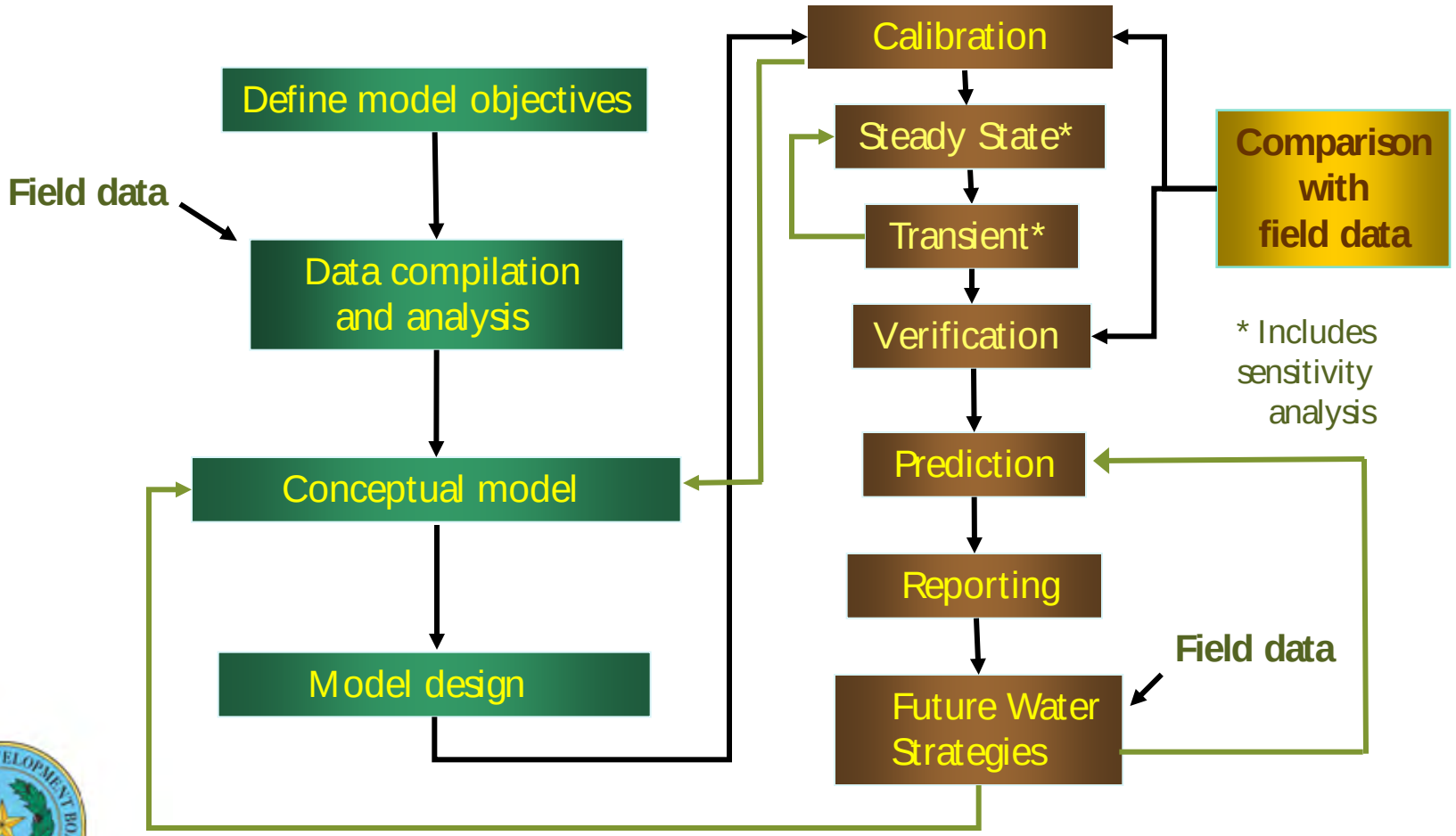
Wang & Anderson (1982) defined a model as a tool designed to represent a **simplified** version of reality

Why A Numerical Groundwater Flow Model?

- Given the scale and complexity, a numerical groundwater model is the **BEST** tool to understand regional groundwater flow

- Llano Uplift model will be a 3-dimensional numerical flow model

Modeling Protocol



GAM Model Specifications

- Three dimensional (MODFLOW-2000/2005/NWT/USG)
- Regional scale (16,000 +/- square miles)
- Grid spacing
  - Uniform grid – ¼ or ½ miles
- Implement
  - recharge
  - groundwater/surface water interaction
  - pumping
  - springs
- Calibration to observed water level/flow

Why MODFLOW?

- Code developed by the U.S. Geological Survey
- Three dimensional
- Selected by TWDB for all GAMs
- Handles the relevant processes
- Comprehensive documentation
- Public domain – free
- Most widely used groundwater flow model

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Data Collection

- Llano Uplift framework study by Daniel B. Stephens & Associates (2007) => DONE
- Additional well logs from Brackish Resources Aquifer Characterization System (BRACS)
- Aquifer properties, water levels, surface water flows, spring discharges, precipitation, recharge, evapotranspiration, and other data
  - Data at TWDB/other agencies
  - Data from stakeholders
  - Data from others

Data Request

- Any documented data to support the model
  - Rock cores/well logs
  - structural picks
  - Water level measurements (location, date, reference)
  - Flow measurements: stream, spring, etc. (location, units of measure)
  - Pumping tests => aquifer properties
  - Aquifer use: pumping volumes, metered data (location)
  - Other studies
- **Date request by December 31, 2012**

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Project Tasks and Proposed Schedule

- Conceptual Model Development (June 2012 – December 2013)
  - Stakeholder Meeting #1 (July 17, 2012)
  - Data collection due December 2012
  - Review, analyze, and compile data (Summer of 2013)
  - Develop Conceptual Model Report (End of 2013)
  - Schedule second Stakeholder meeting

Project Tasks and Proposed Schedule

- Numerical Model Development (January 2014 – December 2015)
  - Construction
  - Calibration
  - Sensitivity Analysis
  - Model Report
  - Schedule Stakeholder Meeting

Thank You
Questions?

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Cindy.ridgeway@twdb.texas.gov

Meeting Minutes for the First Llano Uplift Aquifers Groundwater Availability Model (GAM) Stakeholder Advisory Forum (SAF) Meeting

July 17, 2012

Hill Country University Center, Fredericksburg, Texas

The first Stakeholder Advisory Forum (SAF) Meeting for the Llano Uplift Aquifers Groundwater Availability Model (GAM) was held on Tuesday, July 17, 2012 at 1:30 PM at the Hill Country University Center located at 2818 E. US Highway 290 in Fredericksburg, 78624. A list of meeting participants is provided at the end of this meeting note.

The purpose of the first SAF meeting was to provide an introduction to the Llano Uplift aquifers, the GAM Team, and to solicit input from stakeholders including any available data that could be made public in support of this modeling project. The meeting also provided a forum for discussing the project schedule and provided an opportunity for feedback from stakeholders.

Meeting Introduction: Cindy Ridgeway, TWDB

The meeting was initiated by Ms. Cindy Ridgeway of the Texas Water Development Board (TWDB). She gave a brief introduction to the GAM Program and discussed how GAMs are used in Texas water resources planning. She then discussed GAMs and how they related to modeled available groundwater (MAG) as well as the importance of the stakeholder process. She closed by introducing the Llano Uplift Aquifers GAM Team and introduced the project manager Dr. Jerry Shi.

SAF Presentation: Jerry Shi, Ph.D., P.G., TWDB

Dr. Shi presented a prepared presentation structured according to the following outline:

1. Llano Uplift Regional Overview;
2. Basics of Groundwater Flow;
3. Overview of Llano Uplift Aquifers;
4. Numerical Groundwater Modeling and GAMs;
5. Data Collection; and
6. GAM Schedule.

Questions and Answers:

Question: Are you going to simulate one model from Marble Falls to Hickory?

Answer: There are no assumptions at this point; that is only one of the options being explored. We don't yet know if it is better to have a single model or to have three to four separate models based on the faults. We need your input on which way you want to go.

Follow-up Question: What were other scenarios you were thinking about?

Follow-up Answer: Based on structure, there are two major faults from south to north parallel, and another two major faults east to west. Those faults divide the region into four big blocks. Based on data, some wells that are very close to each other but on opposite sides of a fault have very little connection between wells. It might be an option to divide the region into sub-regions and the different sub-regions can have a separate model.

Question: What format do you want the water levels in?

Answer: You can send in any format you feel comfortable with. We need the well ID, location, what reference you used, and water level.

Follow-up comment: The format keeps changing.

Follow-up comment answer: The database is being taken apart and reconstructed. TWDB is in the process of updating the databases and a final format has not been finalized. If you send data to us (the GAM group) we will take anything to help develop the model.

Follow-up comment: Sending data is great, but if you need us to come and get it we'll be able to, on occasion, send a staff member to go collect it.

Comment: The groundwater conservation districts (GCD's) want to pick the wells they send us data for because of experiences they have with the quality of the drillers.

Comment Response: This will be a very challenging model with all the faulting, we will take any data, maybe send us two sets and distinguish what you are confident in and what you are not. Any data, even "bad" data is something that we'll look at. Our suggestion is to mark them to show which ones you're confident in and which ones you are not. Even bad data in a zone with no data is better than nothing at all.

Comment: You may need to do a search of all exploratory oil and gas wells. They go down 2,500 to 5,000 feet. You may be able to work with the Railroad Commission (RRC) for that.

Comment Response: BRACS database includes RRC data, Texas Commission on Environmental Quality (TCEQ) data, and Bureau of Economic Geology (BEG) data all compiled into one database. It's just the geophysical logs and nobody has done picks.

Follow-up Response: The picks may be wrong; also the logs are hard to read. The GCD's ask themselves, "Where in the Ellenburger are we?" You are free to come to our office and look through our geophysical logs.

Response to follow-up: What we are trying to model is where the water is. May not be exact on where one geologic formation ends and one begins.

Comment: Blanco has plenty of aquifer tests that are available and nine in Blanco County are coming in.

Comment Response: We will take everything and anything. The model might be 20 little models stuck in to one big one. This will be the most challenging model to date.

Question (TWDB): Is there a preferred time and date to get together to discuss methods for picks?

Response (GCDs): In the next few weeks, it would be good to have consensus on what's being picked.

Question: Are you using water chemistry, is it important?

Answer: We look at it, and we will write it up. The chemistry can help us understand a little bit on what's going on. Issues with the Hickory Aquifer might be of water quality concern in some areas. We will go through all the data to understand what's going on in connections between different aquifers and different outflows, and we may use it in estimating recharge, and surface-groundwater interaction.

Comment: We have spring flow studies on the Pedernales River.

Response: We will calibrate to one flow measurement if necessary, so we aren't constricting ourselves. The more data we have the better the model.

Question: Is there a way to find out what data has already been sent to you?

Answer: We can query the database, or you can.

Question: Should we assume you have access to stream gain and loss studies that have been done in the past?

Answer: Don't assume anything; please let us know about any data or studies you are aware of. We became aware of a few of these studies when we contracted the structure study and tried to get copies of those studies as well. Even general observations will help as well; like areas that never have water or areas that tend to flood. We will compare the data that we have and what you give us and disregard duplicates.

Comment: City of Johnson City has a good record of their pumping and drawdown of the Hickory and Ellenburger aquifers. Municipalities and cities are a good data source.

Response: We have a contract for scanning in pump tests required by public water supply to TCEQ . We just got it in and need to go through it. Also, we will try to go through districts first to get data.

Question: To whom should we address data format in.

Answer: Jerry.

Question: We have stream flow data; what format do you want it in? Do you want the raw data?

Answer: Paired data, flow and cross section. If you want to calculate it – go ahead. We will take anything you have.

Question: I'm going to guess this doesn't involve field research, is that correct?

Answer: No money, but staff can come out to help out on occasion. When times were different,

Doug Coker went out and took measurement so we have about a year of that. We can't dedicate Janie's group anymore.

Comment: Because of limited budget, the model may be more academic, we may try to find ways to add additional data (well logs, geophysical, aquifer test); can't commit but might be a possibility. I'm interested to add a little more data over the coming months.

Comment Response: You may have some study that we aren't aware of, or data you know of that we don't. Whatever you can do additionally is great. The GAMs are living tools, and will always be improved upon.

Comment (TWDB): Maybe there are creative ways to work on data; we will call, and you can call us.

Comment Response: No deadline to get it done, we have more flexibility because it's in house. If some money shows up, we might be able to funds some more studies, no promises.

Question: Is the extent of the model area set?

Answer: No, it's not set. We can change it. For statute we have to develop a model for each or all combination of aquifers. The data may lead up to move the model area, shift it, make it bigger, or smaller. We are not going to commit that the outline in the presentation [recommended during the development of the model framework] to being the final shape of the model.

Question: What was the boundary based on?

Answer: The total dissolved solids of the Hickory Aquifer. D. B. Stevens report is located online. Presentation is also online and you are free to contact us http://www.twdb.texas.gov/RWPG/rpgm_rpts/0604830614_LlanoUpliftAquifers.pdf .

Question: How will you estimate recharge?

Answer: Some preliminary studies have been done through contract(s). We have to use what we have to study, soil, precipitation, previous studies and come up with a number. We will do our part but at the same time we want your input on a reasonable recharge.

Question: Didn't you have (recharge) estimate from the last planning cycle?

Answer: We did base flow calculations, they represent the low end of groundwater recharge. This is a basin wide estimate, but is still an estimate.

Comment: I'm not aware of this study that has been done (for recharge).

Response: Contract with a consulting firm for whole GMA 8 area. Not delivered yet so not online yet. We should get something from them in the next month.

Question: When all this comes out, will we have a breakdown of what is usable? Might it be a factor of what shrinks the boundary?

Answer: The bad quality line was the boundary, but getting a push to model brackish water for

desalinization. Making assumptions with MODFLOW not using density flow. Who is going to drill a mile down to get it? Maybe one day.

Comment: If you are using the model to turn DFCs into MAGs, there should be a way to differentiate between usable fresh water and brackish.

Response: We want to make sure the boundary goes out past the zone. It needs to be further away from the pumping centers. If you put the boundary too close, the boundary will affect the model. We can make sure we are all in agreement on what areas are fresh. We have to make sure we have a tool that is capable of a lot of things. Policy may change. Marriage between the two.

Llano Uplift Aquifers GAM Stakeholder Advisory Forum 1

July 17, 2012

Attendance

Name	Affiliation
Cindy Ridgeway	Texas Water Development Board
Larry French	Texas Water Development Board
Jerry Shi	Texas Water Development Board
Radu Boghici	Texas Water Development Board
Will Kohlrenken	Texas Water Development Board
Charles Shell	Central Texas GCD
Mitchell Sodek	Central Texas GCD
Natalie Houston	U.S.G.S.
Jennifer Wilson	U.S.G.S.
Angelina Deans	Hickory UWCD
David Huie	Hickory UWCD
David Mauk	Bandera County River Authority & Groundwater District
David Jeffery	Bandera County River Authority & Groundwater District
Caroline Runge	Menard Underground Water District
Ron Fieseler	Blanco-Pedernales Groundwater Conservation District
Yun Huang	Bureau of Economic Geology/University of Texas at Austin
Rob Roggiero	Professional Geoscientist/Consulting Hydrogeologist
Tim Lehmberg	Gillespie County Economic Development
Paul Tybor	Hill County UWCD