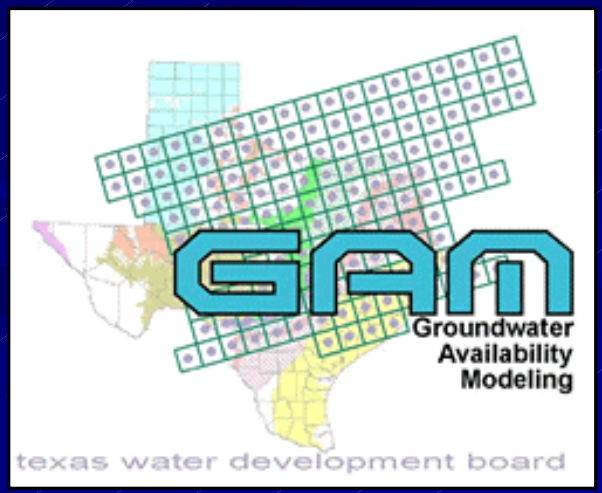
Groundwater Availability Modeling (GAM) for the Seymour Aquifer

Stakeholder Advisory Forum (SAF#1)
Seymour, Texas
January 30th, 2003



John Pickens

INTERA

Andrew Chastain-Howley

WPRC

ENPROTEC

PARSONS

Outline

- GAM team
- GAM objectives
- Basics of groundwater flow
- Concept of numerical groundwater modeling
- GAM specifications and model development
- Model limitations
- Status of data source review & data base development
- Identification of data needs
- GAM schedule

Seymour Aquifer GAM Team & Roles

- INTERA – project management, data base, SAF, modeling, & project deliverables
- Water Prospecting & Resource Consulting – data base, SAF, & modeling support
- Enprotec – data base
- Parsons – pumping & water quality data base & SAF

GAM Objectives

- Develop realistic and scientifically accurate GW flow models representing the physical characteristics of the aquifer and incorporating the relevant processes.
- Promote stakeholder participation which is critical to the success of the GAM program.

GAM Objectives (cont'd)

- Provide a thoroughly documented data base and model, available to the public.
- The models are designed as tools to help GCDs, RWPGs, and other interested parties assess groundwater availability.

GAM Deliverables

- Calibrated computer model (GAM) with predictions to 2050
- Data base (data model) to support the GAM
- Final report with presentation and discussion of the data and the GAM
- All of the above will be publicly available through the TWDB at http://www.twdb.state.tx.us/gam

SAFs

- Held on 4 month schedule
- First SAF to introduce basic information and request data for the model
- Future meetings
  - provide updates on progress
  - opportunity to obtain feedback
- SAF presentations and questions & responses from meetings will be posted at http://www.twdb.state.tx.us/gam/symr/symr.htm

Groundwater Flow - Definitions

- Aquifer – Water saturated permeable geologic unit that can transmit significant quantities of water.
- Water table – The level at which water stands in a shallow screened well.
- Hydraulic head - The water level in a well expressed as an elevation.
- Hydraulic conductivity – A physical property of the geologic media representing its ability to transmit water.

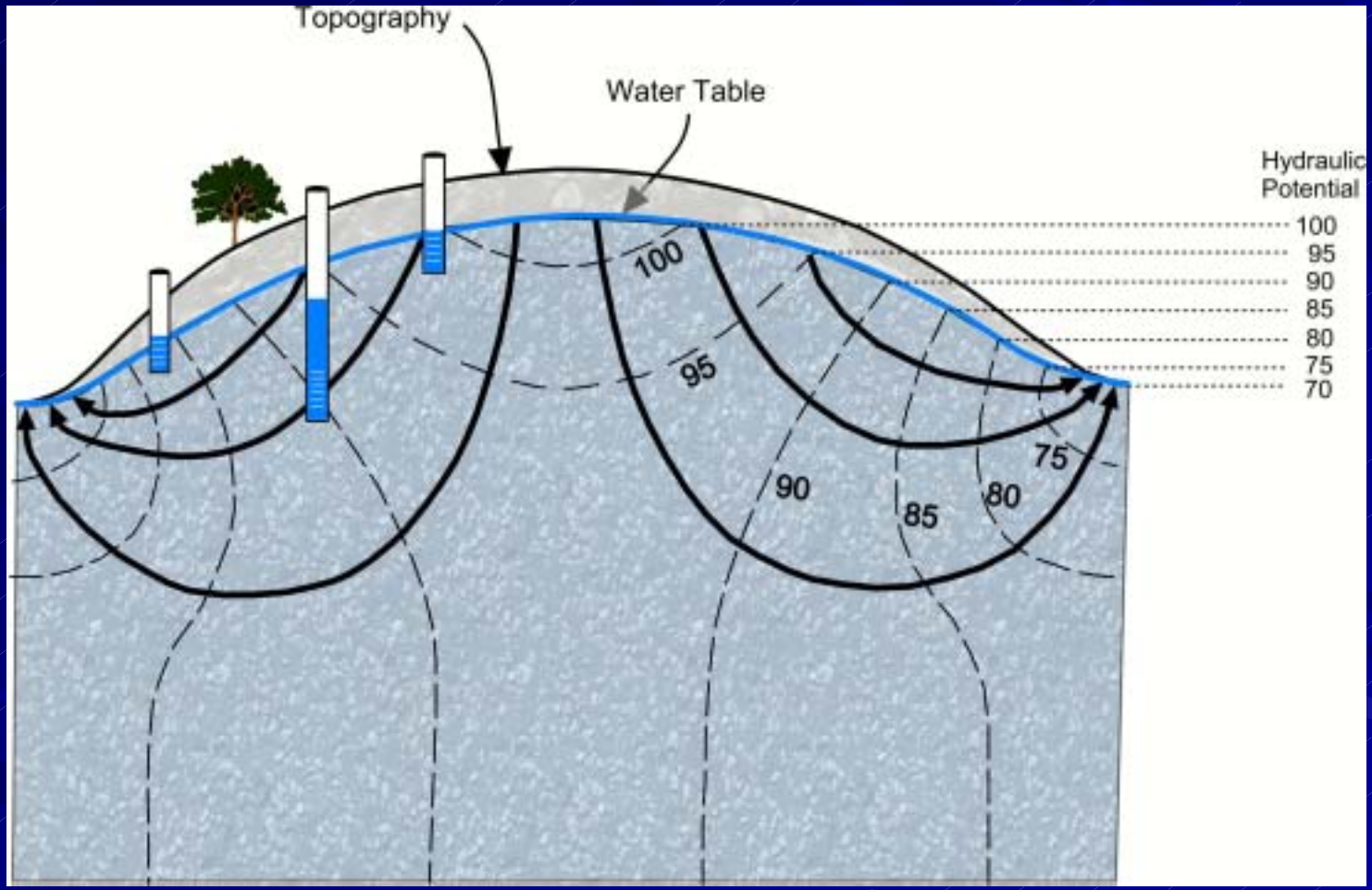
Groundwater Flow – Definitions (cont'd)

- Storativity – The volume of water that a confined aquifer releases from storage per unit surface area of aquifer per unit decline in head.
- Specific yield – The volume of water that an unconfined aquifer releases from storage per unit surface area of aquifer per unit decline in water table elevation.

Groundwater Flow – Definitions (cont'd)

- Recharge – The entry of water to the saturated zone at the water table. Recharge equals water inputs at ground surface (precipitation + irrigation) minus water losses (evapotranspiration).
- Stream losses or gains – The water that is either lost or gained through the base of the stream.

Schematic Cross Section of Groundwater Flow



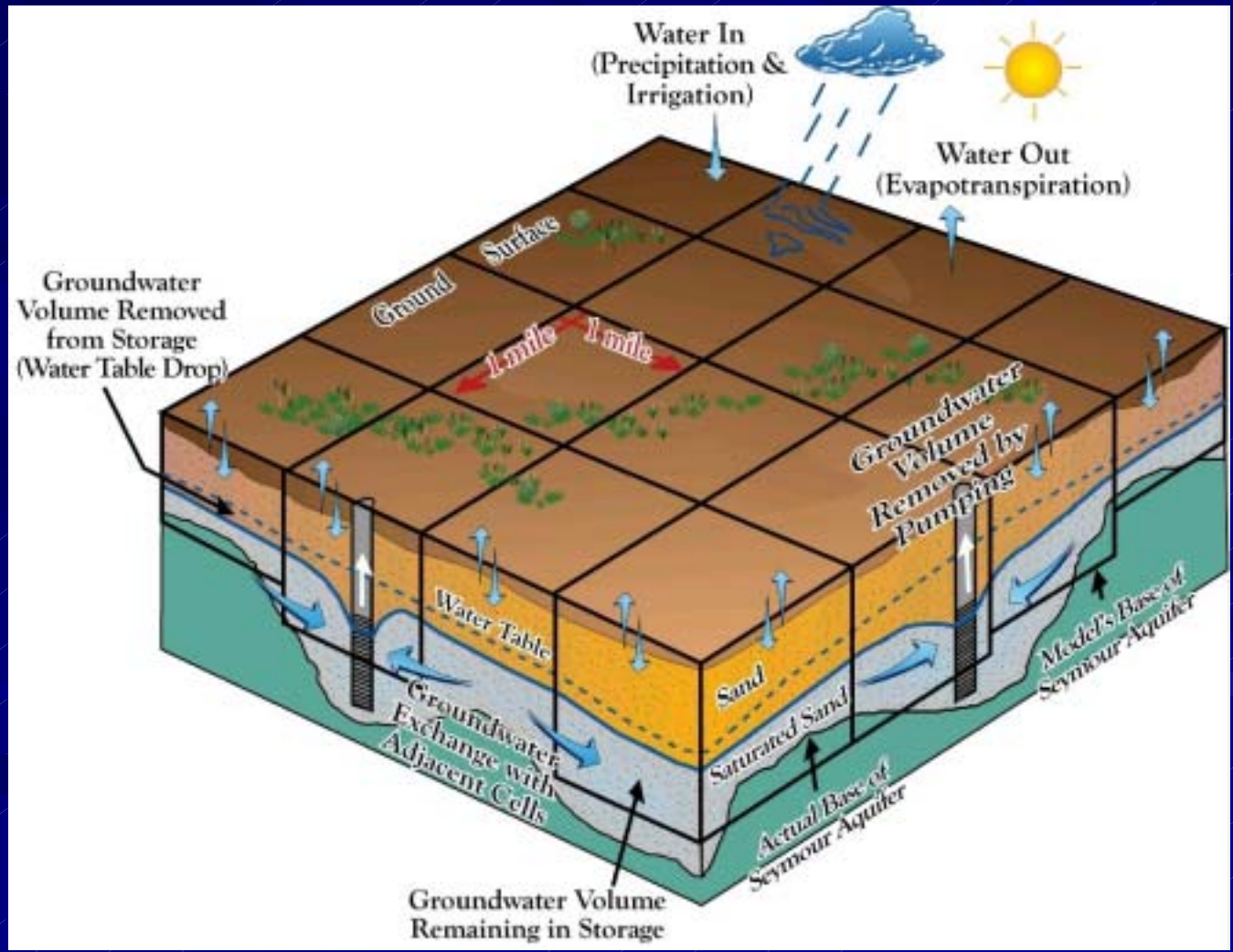
Basic Principles of GW Flow

- The primary observable quantity describing groundwater flow is the water level as measured in a well.
- The water level expressed as elevation is termed the hydraulic head.
- GW flows from high hydraulic heads to low heads.
- The water table is typically a subdued replica of the topography.

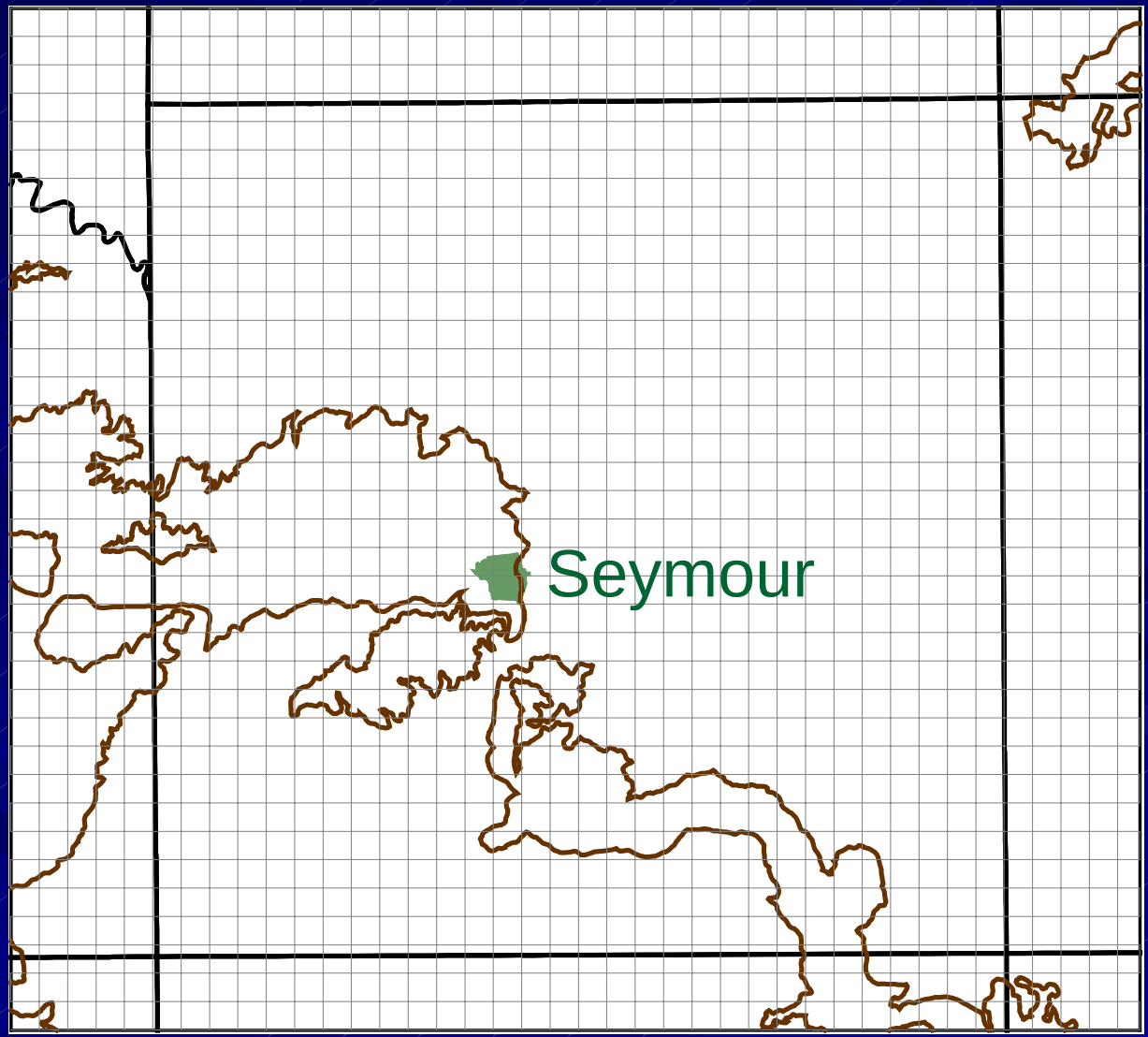
Basic Principles of GW Flow (cont'd)

- The difference in hydraulic head between adjacent wells describes the direction of GW flow.
- The thickness and hydraulic conductivity of the aquifer material define volumetric flow rates (e.g., pumping).

Numerical Groundwater Model - Model Grid Cells & Their Interactions



Model Grid Scale



GAM Model Specifications

- Three dimensional (MODFLOW-96)
- Regional scale (1000's of square miles)
- Grid spacing of 1 square mile
- Implement
  - recharge
  - groundwater/surface water interaction
  - pumping
- Calibration to observed water levels

Modeling Overview

- Modeling Protocol & Practice
- MODFLOW
- PMWIN – Processing MODFLOW

Modeling Protocol

- Define model objectives & tools
- Data compilation & analysis *****
- Conceptual model development *****
- Model design *****
- Model calibration (predevelopment & 1980 – 1990)
- Model verification (1990 – 2000)
- Model prediction (2000 – 2050)
- Reporting
- Future use – evaluate water management strategies

*** current steps today**

MODFLOW

- Computer based model developed by the U.S. Geological Survey
- Selected by TWDB for all GAMs
- Handles the relevant processes
- Comprehensive documentation
- Public domain – non-proprietary
- Most widely used groundwater model
  - USGS had 12,261 downloads of MODFLOW computer code in 2000
- Supporting interface programs available

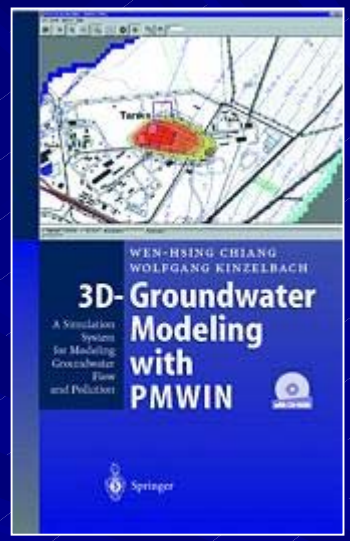
MODFLOW Interfaces

- PMWIN
  - Academic, commercially available
  - Selected by TWDB for the GAMs
- Groundwater Modeling System (GMS)
  - DOD, commercially available
- GWVistas
  - Private, commercially available
- Visual MODFLOW
  - Private, commercially available

PMWIN – Processing MODFLOW

- Developed at the Institute of Hydromechanics and Water Resources Management, Swiss Federal Institute of Technology in Zurich
- Authors:

  Wen-Hsing Chiang and Wolfgang Kinzelbach



http://www.ihw.ethz.ch/soft/PMWIN.html

Model Inputs

- Top & bottom elevation surfaces for each layer
- Aquifer Properties:
  - Thickness
  - Hydraulic Conductivity (K)
  - Storativity or specific yield (transient)
- Initial water table elevations
- Recharge
- Stream characteristics
- Pumping

Model Limitations

- The Seymour aquifer is heterogeneous vertically (sand, gravel, silt, clay), but is represented as one layer with average properties.
- Data available (e.g., geology, wells, pumping) is limited in some regions.
- The GAM is a tool for making groundwater availability assessments on a regional basis only.
- The GAM is not capable of predicting aquifer responses at small scales (e.g., individual wells). Such evaluations would require a refined model.

Seymour Aquifer

- Composed of clay, silt, sand, and gravel. Sands & gravels occur primarily at base.
- For some of the model areas, it includes alluvial deposits in the river valleys.
- Model will represent the Seymour and alluvium as a single layer.
- Thickness of Seymour aquifer is up to 100 feet, with a saturated thickness typically less than 60 feet.

Key Data Sources

- TWDB data at their website: http://www.twdb.state.tx.us/data/data.htm
  - Seymour/alluvium (approx. 5000 wells)
- County reports by TWDB & predecessors
- U.S. Geological Survey reports
- UT Bureau of Economic Geology reports
- Oklahoma WR Board & GS reports
- TCEQ drillers logs
- Brune (1975) spring locations & flows

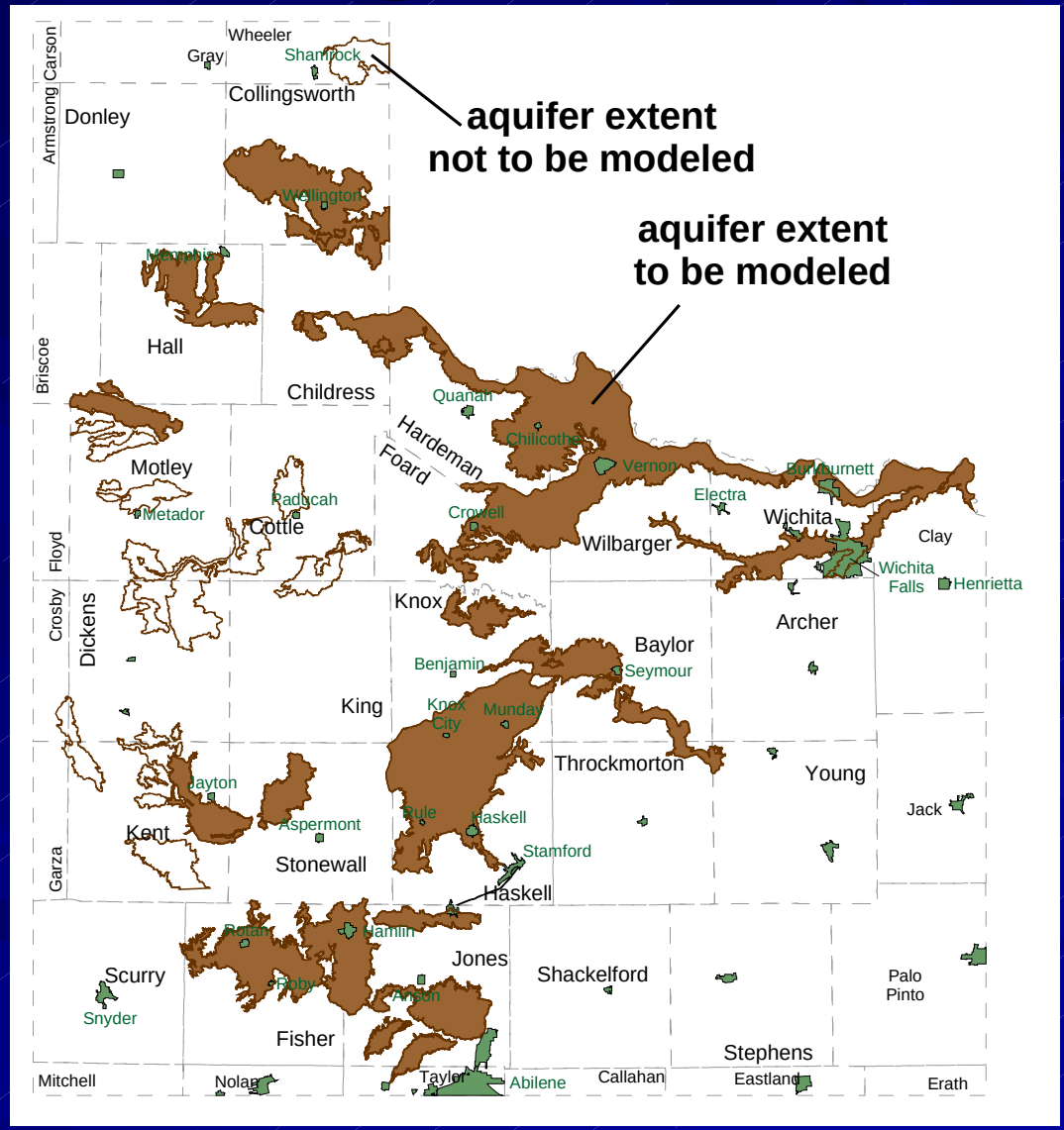
Key Data Sources (cont'd)

- Websites:
  - U.S. Geological Survey
    - topography
    - stream flows
    - stream gain/loss studies
  - U.S. EPA
    - stream characteristics
    - land use / land cover
    - soil type
  - National Climatic Data Center - precipitation

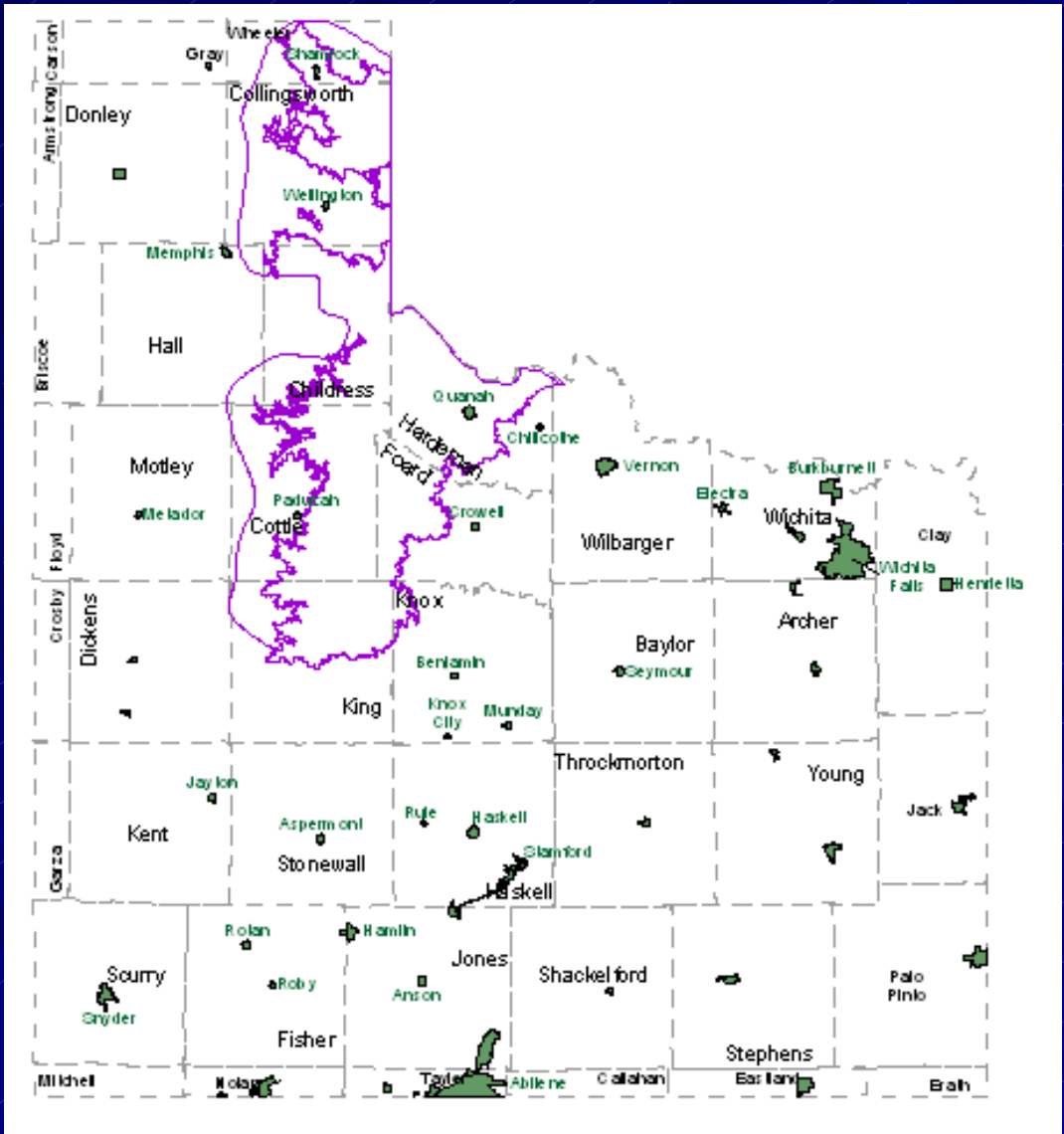
Data Model (Data Base) for GAM

- Provides consistent methodology for storage of the data base for each GAM
- Facilitates future improvements to or modifications of the current work
- Available to the general public as an addition to the model and final report

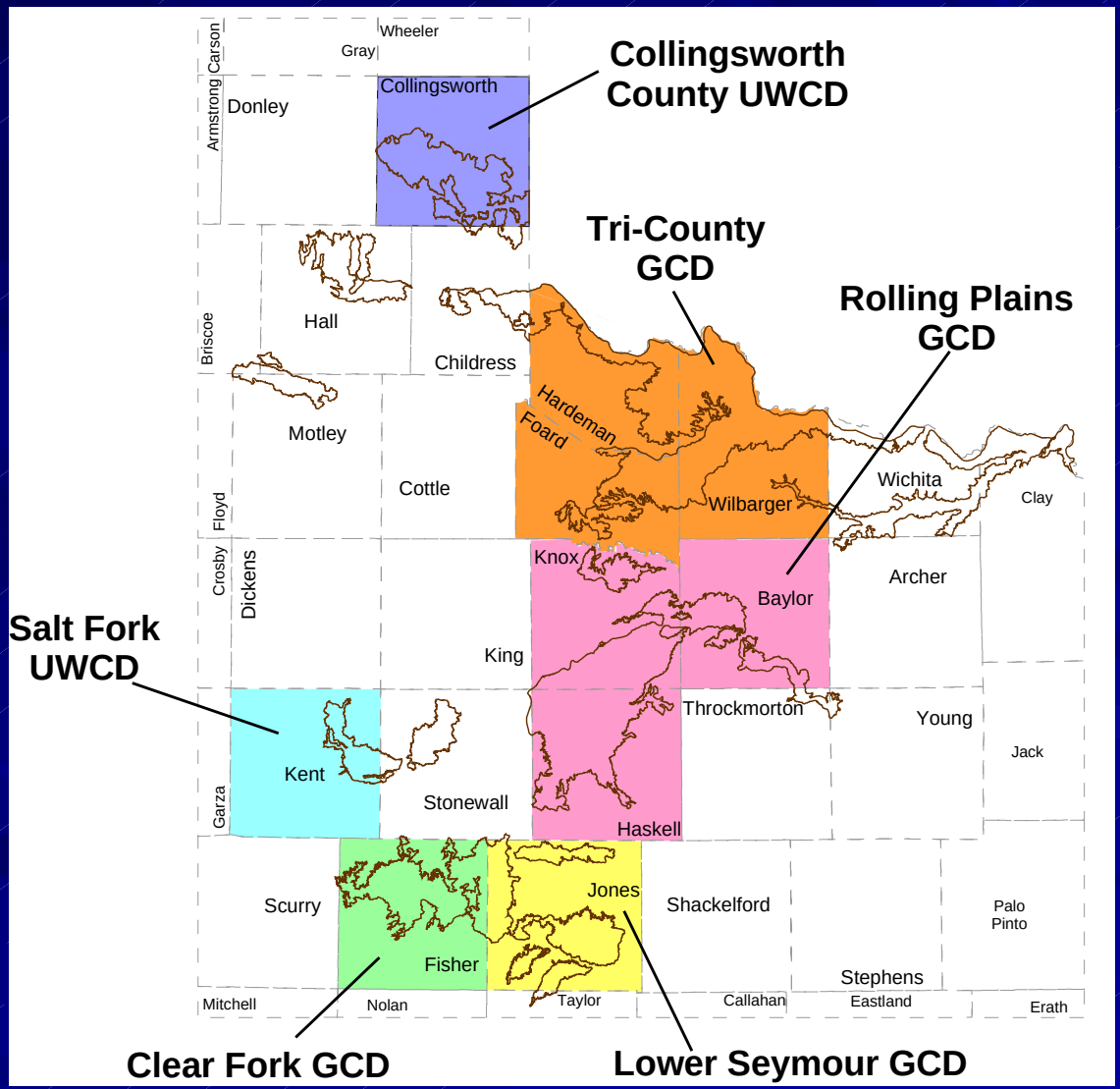
Seymour Aquifer Boundaries



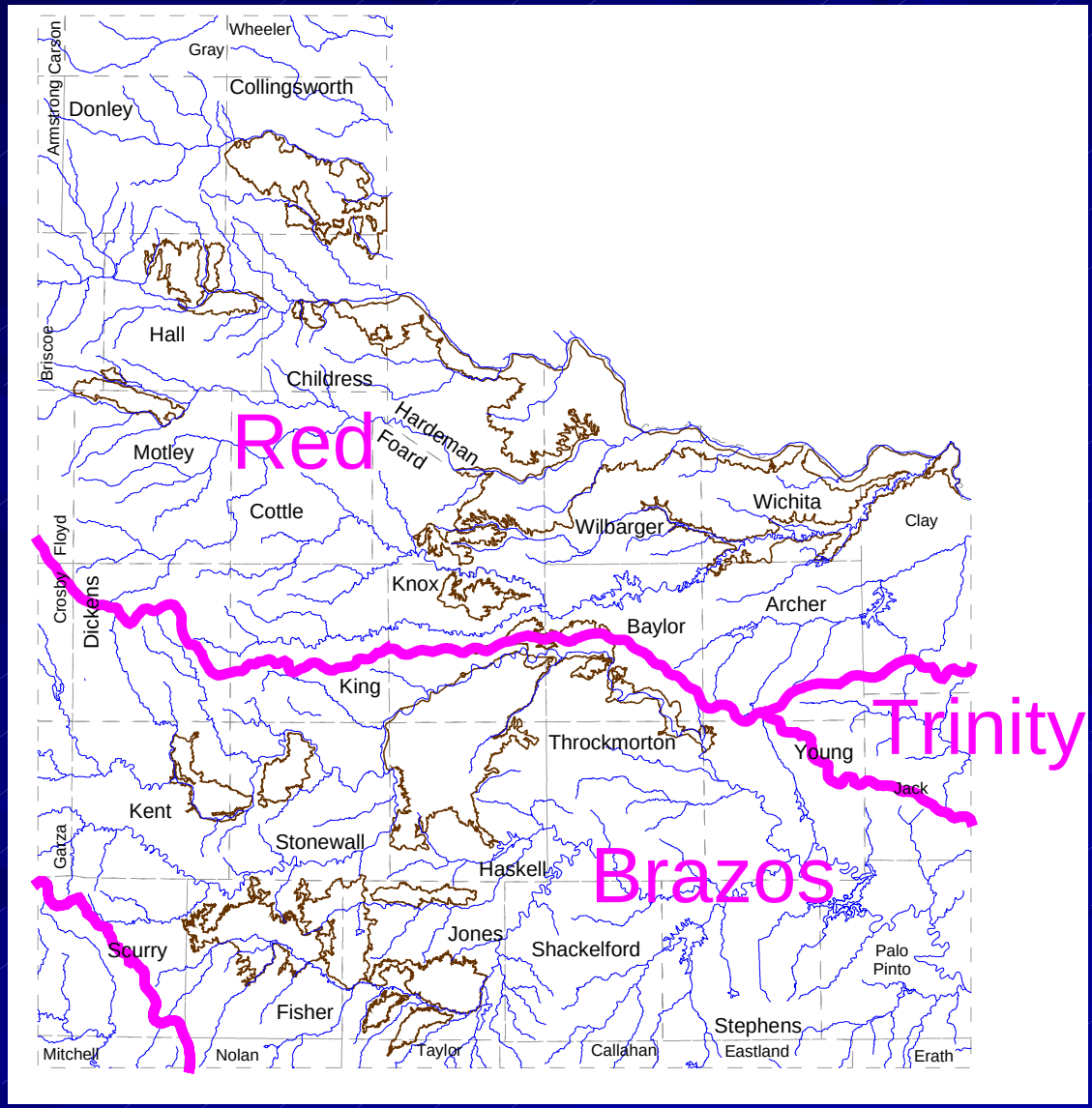
Blaine Aquifer Boundaries



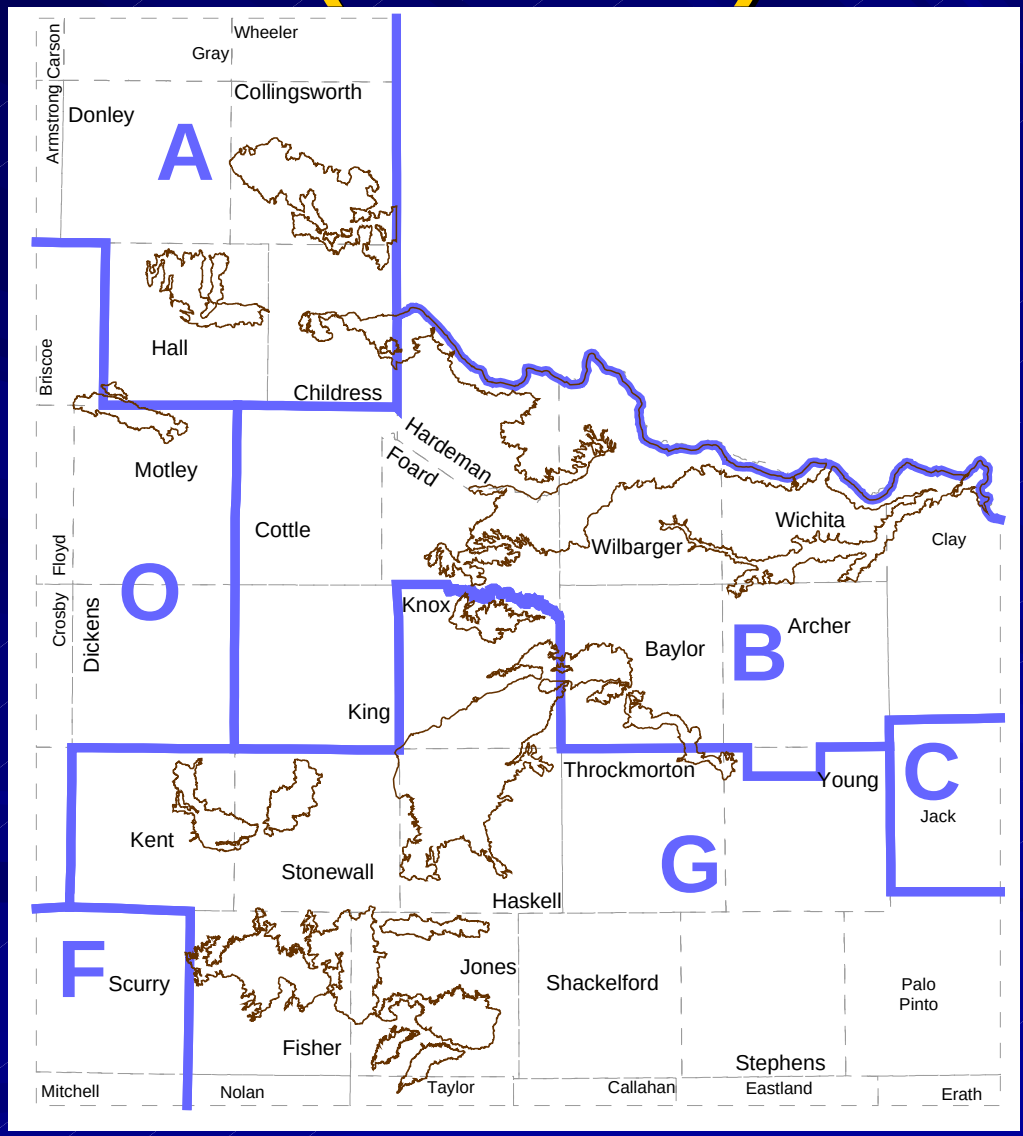
Groundwater Conservation Districts (GCDs)



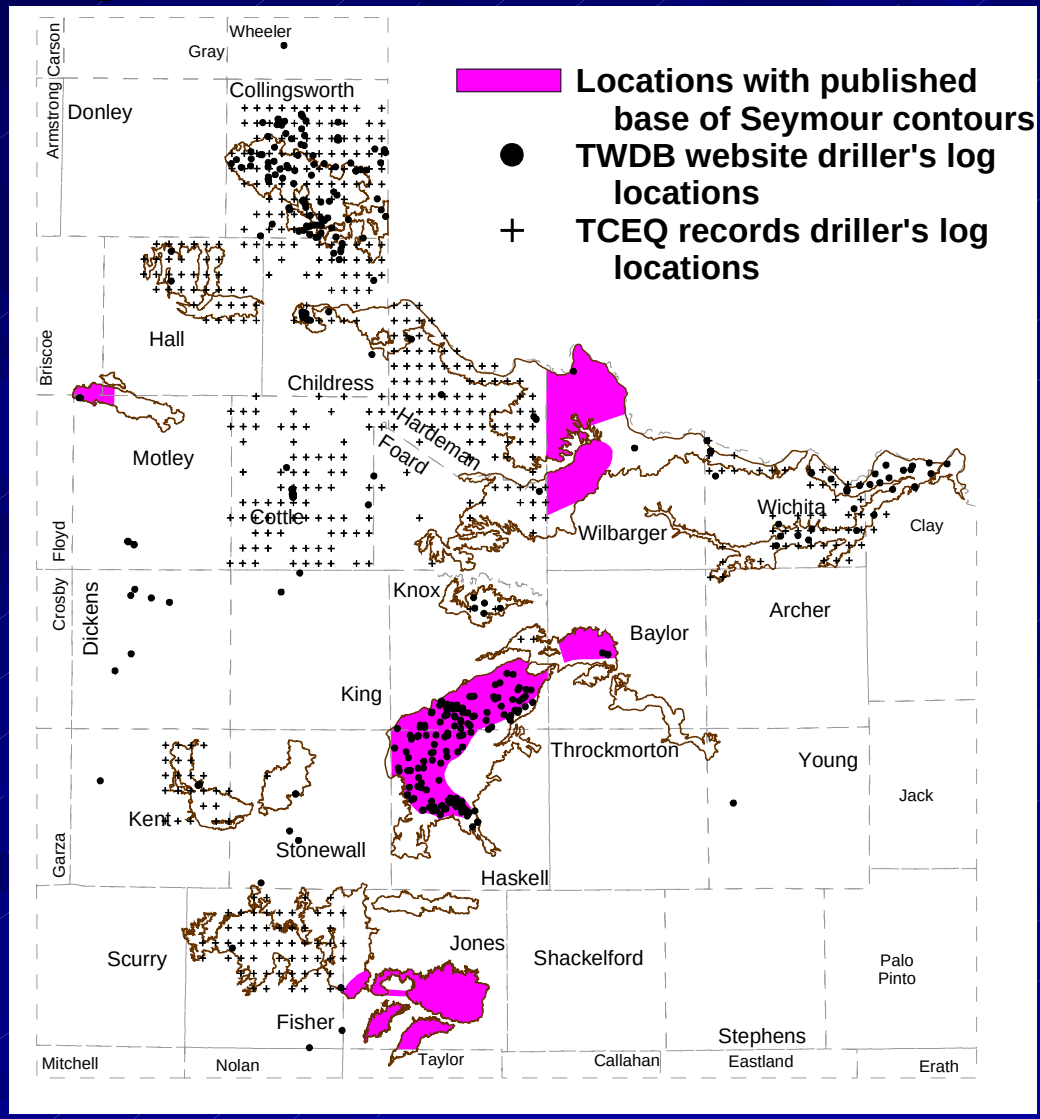
River Basins



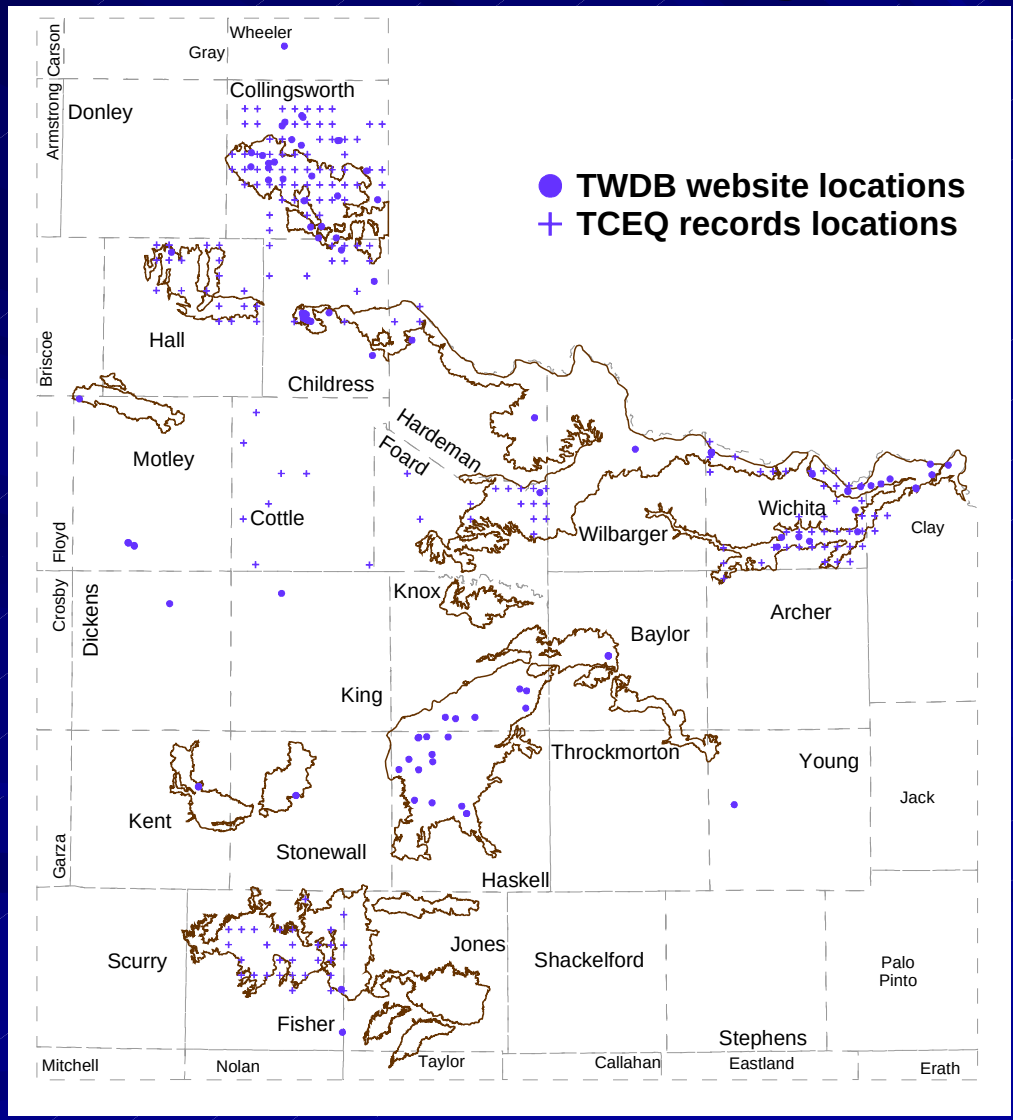
Regional Water Planning Groups (RWPGs)



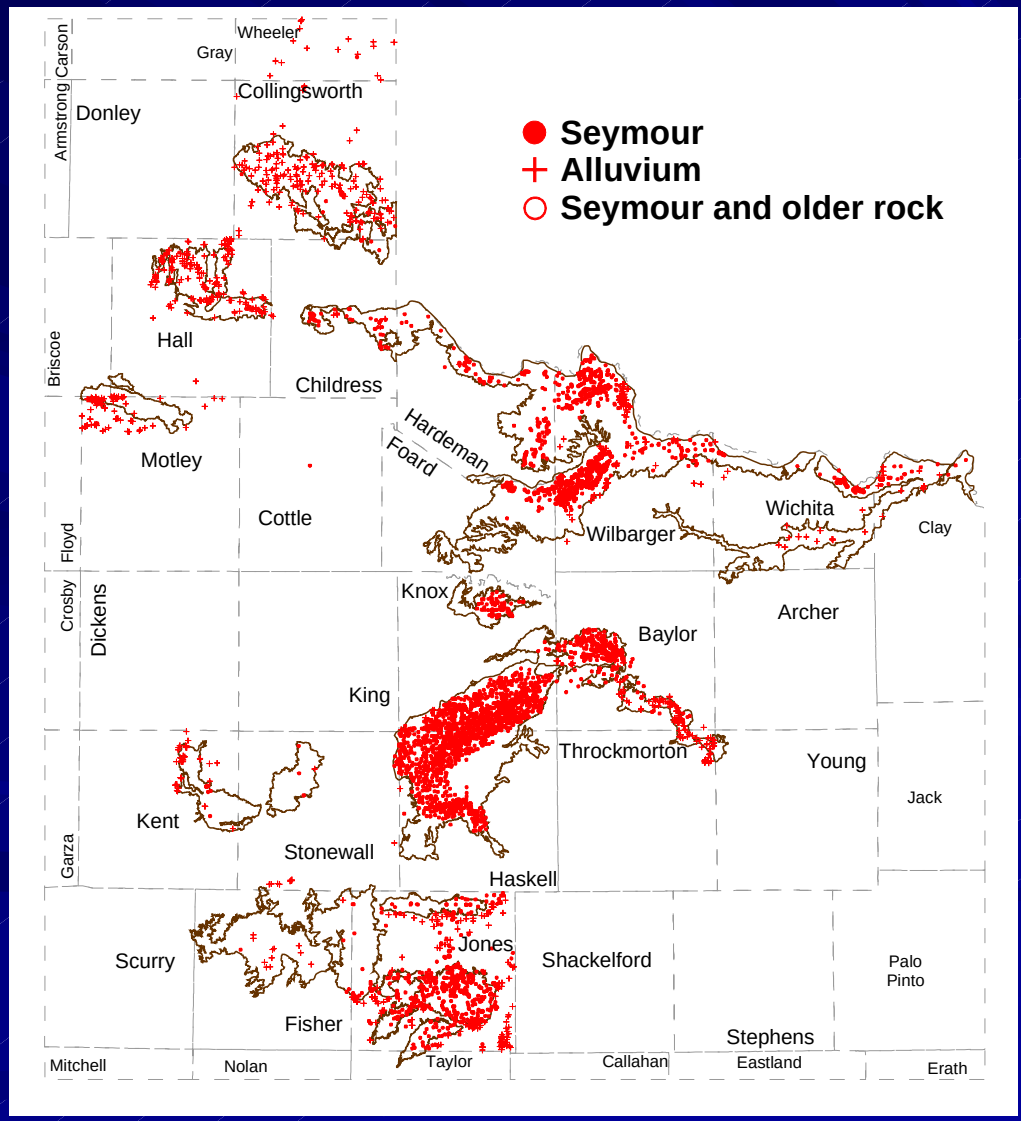
Seymour/Blaine – Prelim. Geologic Structure Locations



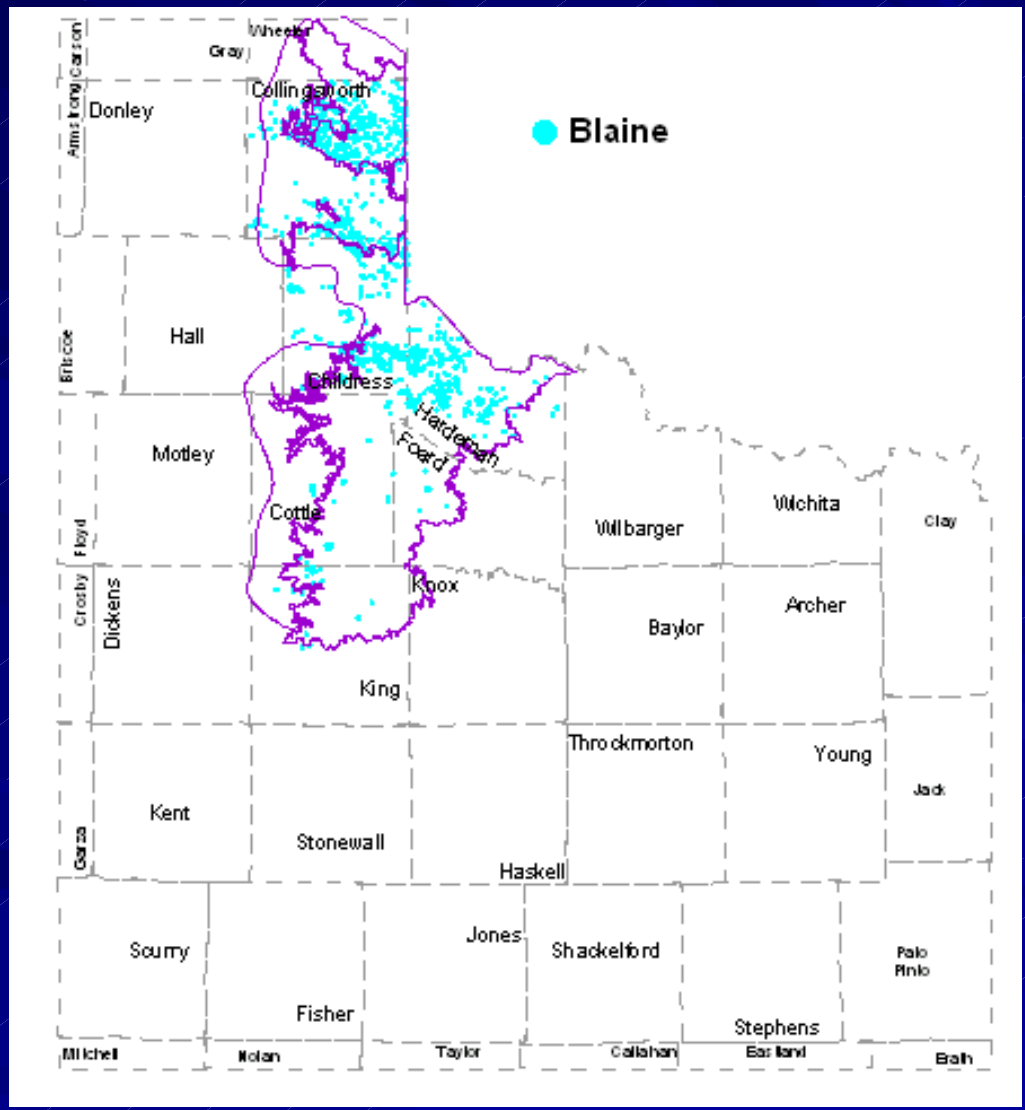
Seymour/Blaine – Prelim. Hydraulic Conductivity Locations



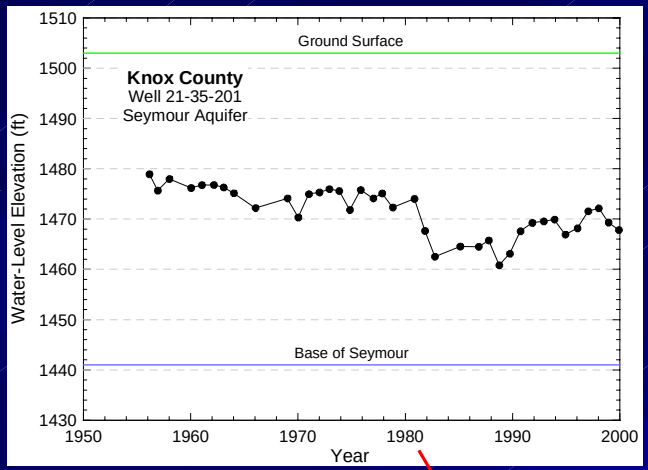
Seymour – Water-Level Locations

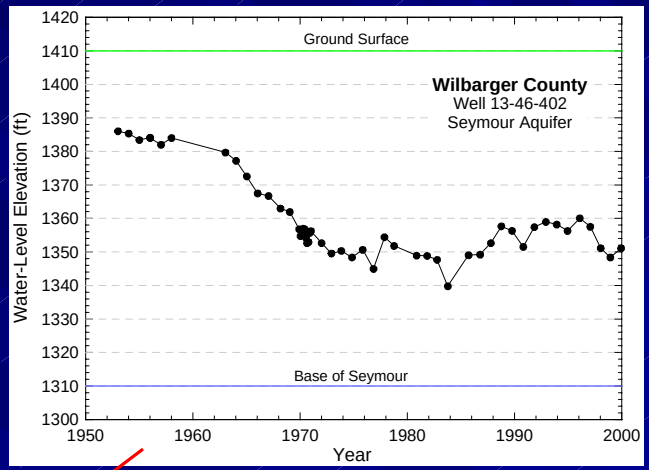


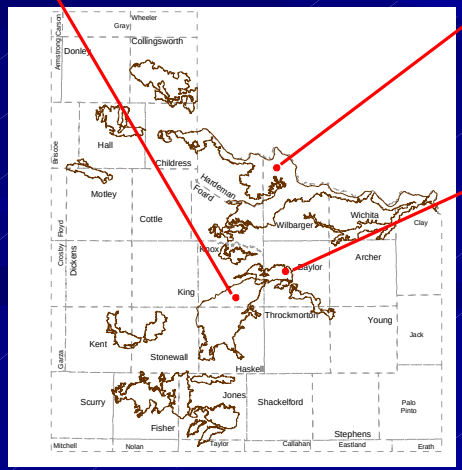
Blaine – Water-Level Locations

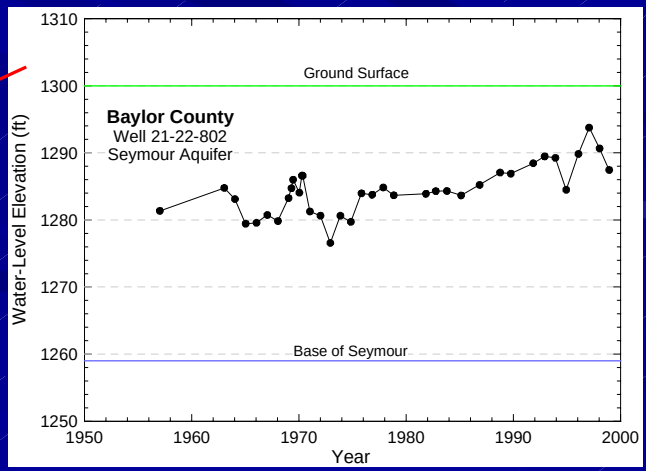


Seymour Wells – Hydrograph Examples









Current Data Needs

- Seymour & Blaine data for areas with sparse information
  - Geologic logs
  - Water levels (elevations)
  - Aquifer properties
- Relevant data not in the TWDB data base. Data provided must be documented and publicly available.
- Data needed by March 3, 2003.

Current Data Needs (cont'd) – Who to Contact?

- John Pickens
  INTERA Inc.
  9111A Research Blvd
  Austin, TX 78758
  (512) 425-2030
  jpickens@intera.com
- Cindy Ridgeway
  Texas Water Development Board
  P.O. Box 13231
  Austin, TX 78711
  (512) 936-2386
  cindy.ridgeway@twdb.state.tx.us

GAM Schedule

- Project start – Nov. 2002
- Complete data base assembly/evaluation – Mar. 2003
- Draft conceptual model report – Aug. 2003
- Steady-state model calibration – Nov. 2003
- Transient calibration & verification – Jan. 2004
- Predictions – Feb. 2004
- Draft Model Report to TWDB – Mar. 1, 2004
- Model Training Seminar – Apr. 2004
- Final Model Report to TWDB – Jun. 30, 2004
- Note: SAFs are scheduled at 4 month intervals

Meeting Wrap-Up

- Discussion / comments / questions
- Next meeting – scope & schedule

SEYMOUR GAM STAKEHOLDERS ATTENDANCE LIST
Stakeholders Advisory Forum
Held
January 30, 2003 in Seymour, Texas

Name	Affiliation
Cindy Ridgeway	TWDB
Joe Shephard	City of Seymour
Mike McGuire	Rolling Plains GCD
Elaine Simpson	City of Seymour
Dan Henard	Collingsworth UWD
Thomas Powell	Collingsworth UWD
David Meesey	TWDB
Dan Craighead	Public
Pat Craighead	Public
John Pickens	Intera
Andrew Chastain-Howley	WPRC
Don A. Butler	NRCS Boardmember

Summary Memorandum Report
Seymour Aquifer GAM
SAF Meeting #1, Seymour, Texas
January 30, 2003

PRESENTATION

The first Stakeholder Advisory Forum was held on Thursday, January 30, 2003 at 1:30 p.m. at the Portwood Arts and Civic Center, 800 East Morris St., Seymour, Texas.

The presentation topics for this forum included:
(1) GAM objectives, expectations, and schedule
(2) basics of groundwater flow in aquifer
(3) concept of numerical groundwater modeling
(4) approach for development of the Seymour aquifer model
(5) summary of data sources reviewed and data base that has been developed over past two months to support the model, and
(6) identification of data needs

A summary of questions, answers, and other discussion is listed below.

QUESTIONS AND ANSWERS.

Q: Dan Craighead: What is the timeline for the GAM project?
A: John Pickens: The Seymour Aquifer GAM will be completed in June 2004.

Q&A: David Meesey: On completion of the GAM project, the Groundwater Conservation Districts (GCD's) may want to take the regional GAM and reduce it more to fit at a local level.

Q&A: John Pickens: Theoretically it will be possible to give regional answers. This GAM is a good starting point, but will not answer all the local questions; further refinement would be necessary for this.

Info: Mike McGuire: The Tri-County GCD is on the ballot for approval this Saturday.

Info: Thomas Powell: Collingsworth UWD is starting water-level monitoring next month

Q: John Pickens: Are the Collingsworth monitoring sites in the TWDB database?
A: Thomas Powell: Some yes and some no. The TWDB have 15 to 20 regular monitoring wells within the GCD boundaries.

Info: Cindy Ridgeway: The most important data (water levels) are between 1980 and 2000, as these are dates where the model will be calibrated against the actual water-level measurements. We are also mainly looking for data in areas where it is currently sparse, such as in Stonewall County for example.

Info: Cindy Ridgeway: The data base can be enhanced at a later date with new modeling if relevant new data (such as monitored data from Collingsworth) becomes available.

Info: Thomas Powell: There is not much historical data at the moment.

Info: Offers to visit Collingsworth UWD and Rolling Plains GCD to review and evaluate their available data were made. Andrew Chastain-Howley will organize and conduct the visits.

Q&A: Mike McGuire: In reference to specific well hydrographs (21-35-201) in the presentation. This one is monitored by the USGS; a new monitoring well has also recently been drilled to reduce the interference with pumping at this well. This well is used for drought monitoring purposes by the TWDB.

Q: Joe Shephard: Are the hydrographs showing yearly data?
A: Mike McGuire: Yearly, up until 2000 on the presentation graphic. In 2001 and 2002, the water levels have dropped to near historic lows.

Q: John Pickens: Was there much rainfall in this area last year?
A: Mike McGuire: The area is still in a 5 year drought, surface water did recover a little bit, but no recharge appears to have reached the aquifer. If 2003 is a low rainfall year, this is likely to become the drought of record in this area. A concern expressed here by Mr. McGuire was that the region G (Brazos) Water Plan stated that there was no significant drop in water level in this region. The area needs sustained rainfall for any recharge to occur.
Info: John Pickens: We will use a technique called the standardized precipitation index to evaluate the drought of record. It looks at both the rainfall deficit and the time period in defining very dry periods.

Q: Don Butler: How do the GCD's and RWPG's interact?
A: Cindy Ridgeway: In response to legislative bill SB1, 16 planning regions were formed. Each of these entities was asked to report on how they would meet a drought of record within the next 50 years. They should look at all the available data and resources, including the GCD's.
A2: David Meesey: David stated that he is the TWDB project manager for Region G. Each region's management plan is reviewed and certified by the TWDB. Each GCD should get to review the RWPG plan and the RWPG should get to review the management plans for each of the GCD's in their area. Both at the RWPG and TWDB levels there is facility for review and comment to avoid inconsistencies between plans. The goal for this is to be pro-active so that any discrepancies can be ironed out at an early stage.

Q: Don Butler: The groups are planning for emergencies?
A: David Meesey: The planning is drought-based over a 50 year planning horizon.
A2: Mike McGuire: Within the Rolling Plains management plan they are aiming to manage the aquifer to be sustainable. This means that given normal rainfall and average recharge a sustainable availability should be the goal. Mike also mentioned that he is involved in both planning regions B and G, so he will keep up to date with what is happening at that level. This GAM will help assess the availability of groundwater resources and will facilitate more groundwater information to be added into the regional plans.

Q: Dan Craighead: How much information is available on recharge?
A: John Pickens: To estimate recharge on an areal basis for the Seymour aquifer, we will use the Soil and Water Assessment Tool code. It utilizes precipitation, antecedent moisture conditions, soil type, and land use / land cover to estimate recharge. The project team has not yet researched this task extensively. The BEG is planning a recharge study at one site in the Seymour. A2: Mike McGuire: There are some recharge studies in the area. In the vicinity of Seymour the recharge sands are west of town. In Knox and Haskell Counties, Rule to Rochester appears to be the main recharge zone.

Q: Dan Craighead: Would it be wise to dam up the flood flow to enhance recharge? Areas to the North and West of Seymour would appear to be good candidates.
A: Andrew Chastain-Howley: The stream systems of any magnitude in this area are generally below the base of the Seymour aquifer. Only in the western areas such as Collingsworth County, are the aquifer units below the streams.
A2: Mike McGuire: Erica at TNRIS in Austin is working on plotting stream segments into GIS. This should be useful.

Q: John Pickens: What will be developed from this work?
A: Cindy Ridgeway: Erica is working on the StratMap program. This will include GIS stream coverages and should include elevation data associated with the streams. The data is numbered slightly differently than other data, such as those in the Water Availability Models.

Q: Dan Craighead: From the presentation, it suggests that the Seymour overlies the Blaine?
A: Andrew Chastain-Howley: The Seymour does overly the Blaine in the western part of the model area. There is no Blaine underlying the Seymour in the nearby vicinity (near the City of Seymour).

Q: Don Butler: Is there much movement of water within and between the aquifer pools?
A: Mike McGuire: There is not much movement between the pools as the connections between them are generally very small and constrained. Within the Knox-Haskell pool, the flow is generally to the northwest or southeast, out from the center.
A2: Andrew Chastain-Howley: The flow within the pools will vary greatly depending on the properties of the aquifer. In the Knox-Haskell area one report suggested that recharge to discharge would occur (under steady conditions) within a 30-year period. This suggests reasonably rapid movement of water through the aquifer.

Q: John Pickens: Seymour (city) is centrally located within the model area, where should we have other SAF meetings?
A: A number of attendees suggested that Seymour was a good location.

Other Information:

- Fisher Counties GCD confirmation election was completed in November 2002.
- Jones County GCD has not organized its election yet.
- The SAF presentation is posted on the TWDB GAM website.
- Lots of maps of the area are already included on this website.
- Suggestions for improvements to the SAF meetings and presentation were requested.

Prepared by: Andrew Chastain-Howley
Date: February 2, 2003