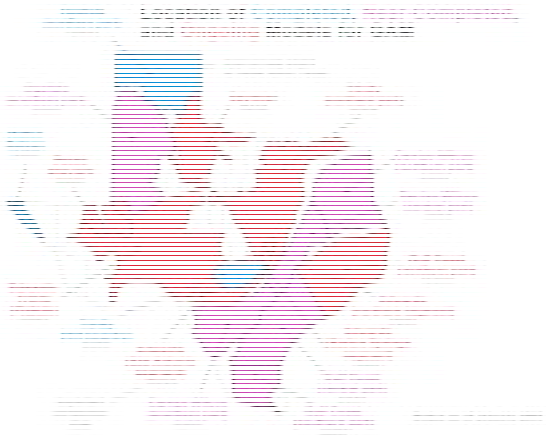
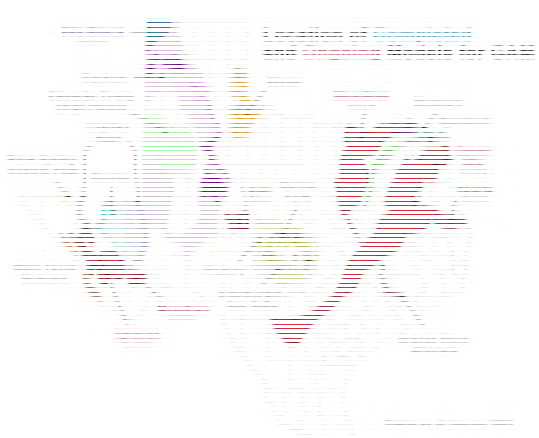
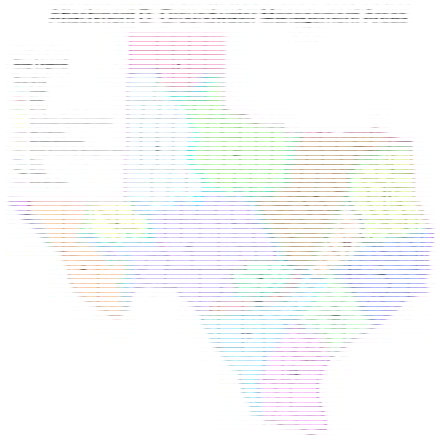
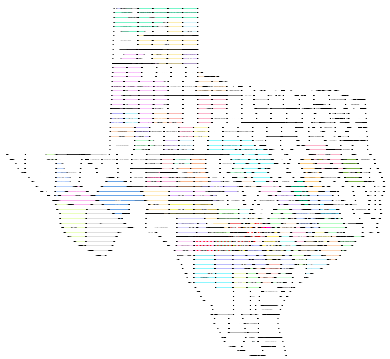
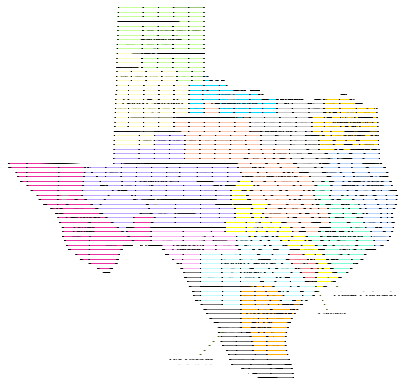
Groundwater Availability Modeling (GAM) Northern-Trinity and Woodbine Aquifer

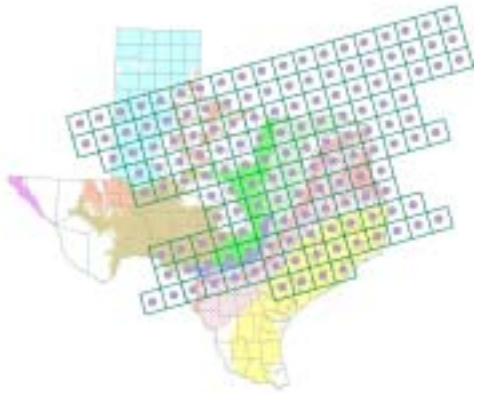




Contract Manager

Ali Chowdhury, Ph.D.

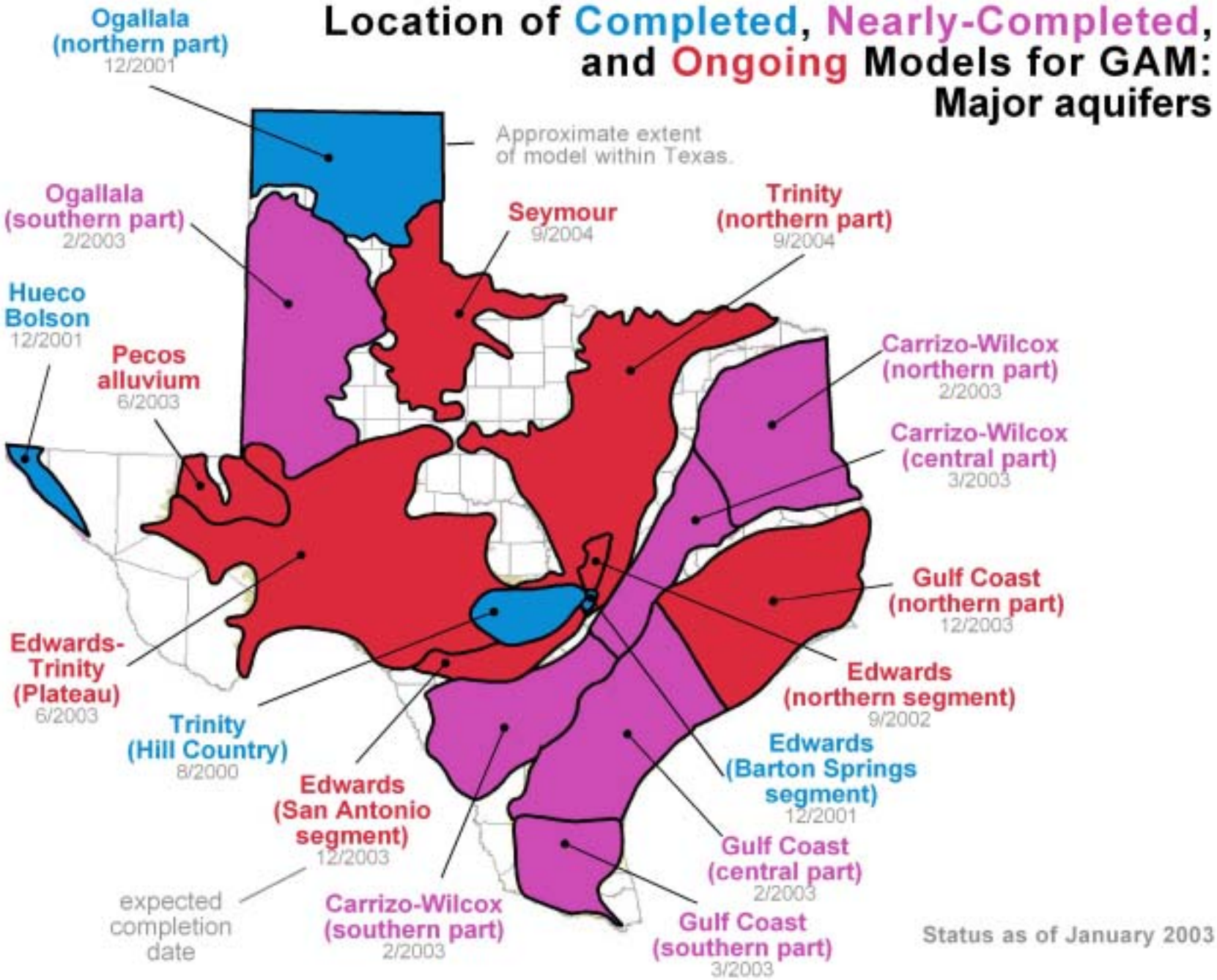



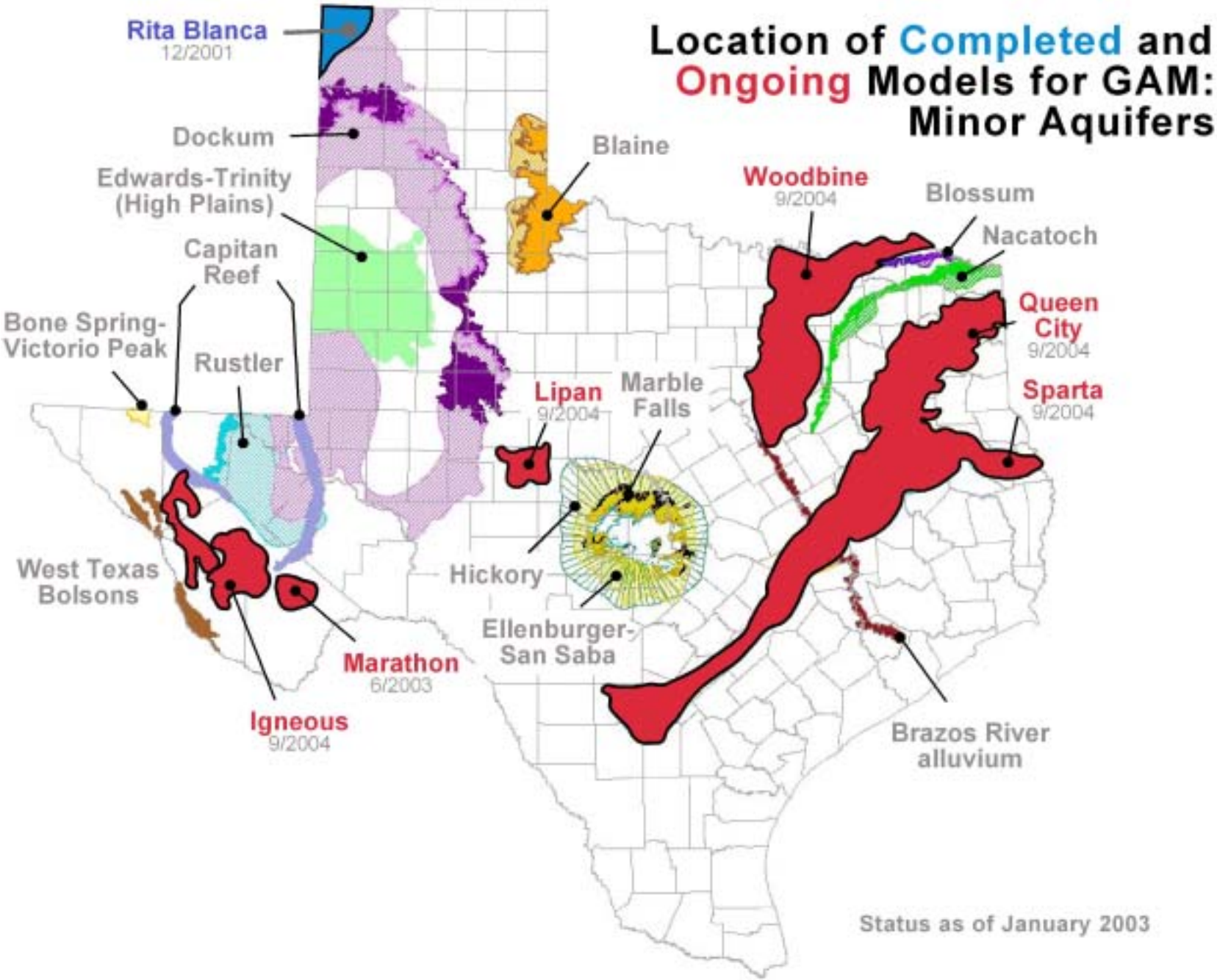
Texas Water Development Board

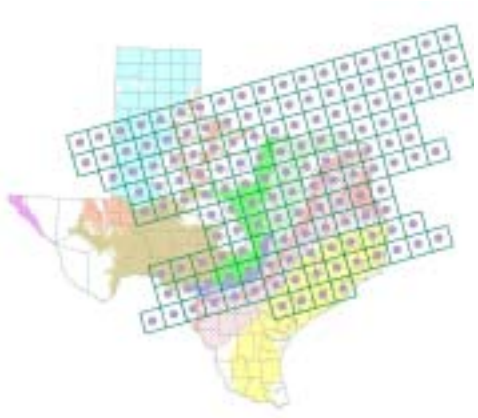


GAM

- Purpose: to develop the best possible groundwater availability model with the available time and money.
- Public process: you get to see how the model is put together.
- Freely available: standardized, thoroughly documented, and available over the internet.
- Living tools: periodically updated.

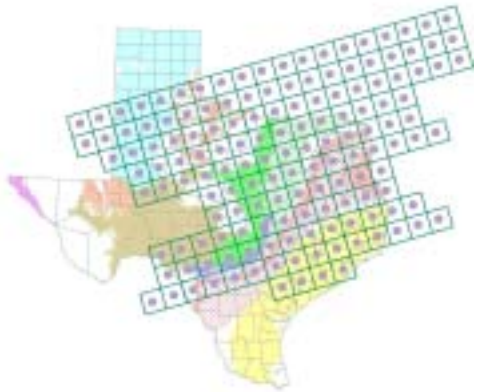

Location of Completed, Nearly-Completed, and Ongoing Models for GAM: Major aquifers
Ogallala (northern part) 12/2001
Approximate extent of model within Texas.
Ogallala (southern part) 2/2003
Seymour 9/2004
Trinity (northern part) 9/2004
Hueco Bolson 12/2001
Pecos alluvium 6/2003
Carrizo-Wilcox (northern part) 2/2003
Carrizo-Wilcox (central part) 3/2003
Gulf Coast (northern part) 12/2003
Edwards-Trinity (Plateau) 6/2003
Edwards (northern segment) 9/2002
Trinity (Hill Country) 8/2000
Edwards (Barton Springs segment) 12/2001
Edwards (San Antonio segment) 12/2003
Gulf Coast (central part) 2/2003
expected completion date
Carrizo-Wilcox (southern part) 2/2003
Gulf Coast (southern part) 3/2003
Status as of January 2003


Location of Completed and Ongoing Models for GAM: Minor Aquifers
Rita Blanca
12/2001
Dockum
Edwards-Trinity (High Plains)
Capitan Reef
Bone Spring-Victorio Peak
Rustler
Blaine
Woodbine
9/2004
Blossum
Nacatoch
Queen City
9/2004
Sparta
9/2004
Lipan
9/2004
Marble Falls
Hickory
Ellenburger-San Saba
West Texas Bolsons
Marathon
6/2003
Igneous
9/2004
Brazos River alluvium
Status as of January 2003



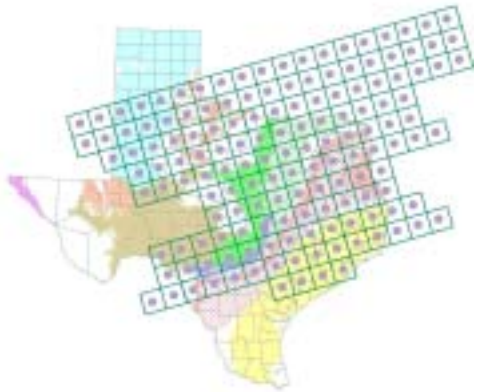
What is groundwater availability?

- …the amount of groundwater available for use.
- The State does not decide how much groundwater is available for use: GCDs and RWPGs decide.
- A GAM is a tool that can be used to assess groundwater availability once GCDs and RWPGs decide how to define groundwater availability.



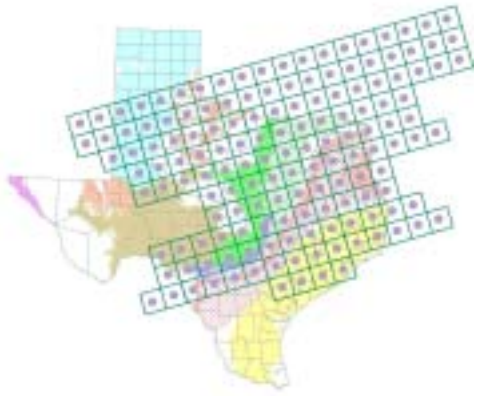
Do we have to use GAM?

- Water Code & TWDB rules require that GCDs use GAM information. Other information can be used in conjunction with GAM information.
- TWDB rules require that RWPGs use GAM information unless there is better site specific information available



How do we use GAM?

- The model
  - predict water levels and flows in response to pumping and drought
  - effects of well fields
- Data in the model
  - water in storage
  - recharge estimates
  - hydraulic properties
- GCDs and RWPGs can request runs



Living tools

- GCDs, RWPGs, TWDB, and others collect new information on aquifer.
- This information can enhance the current GAMs.
- TWDB plans to update GAMs every five years with new information.
- Please share information and ideas with TWDB on aquifers and GAMs.

Participating in the GAM process

- SAF meetings
  - hear about progress on the model
  - comment on model assumptions
  - offer information (timing is important!)
- Report review
  - at end of project
- Contact TWDB
  - Dr. Robert Mace
  - contract manager

Comments:

Contract Manager

Ali.Chowdhury@twdb.state.tx.us

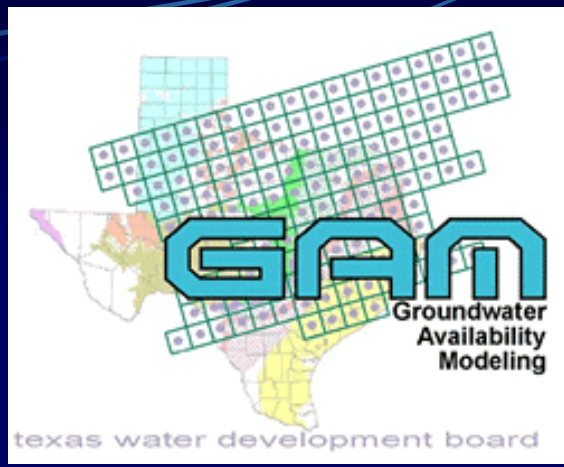
(512)936-0834

www.twdb.state.tx.us/gam

Northern Trinity / Woodbine Groundwater Availability Model

Stakeholder Advisory Forum (SAF)

March 19, 2003



SAF Meeting Outline

- GAM Program Overview
- General Geology/Hydrology
- Historical Use Perspective
- Groundwater Flow Model
- Open Discussion

Northern Trinity / Woodbine Groundwater Availability Model

GAM Program Overview

Goals of the GAM Program

- Include substantial stakeholder input
- Provide reliable groundwater availability information
- Predict groundwater conditions over a 50-year planning period
- Produce publicly available groundwater models and supporting data

GAM Project Team

- R.W. Harden & Associates, Inc.
  - Project lead, geology, hydrology, modeling, and reporting
- LBG-Guyton Associates
  - Aquifer characteristics and water levels
- HDR, Inc.
  - Groundwater – surface water interaction
- Freese & Nichols, Inc.
  - Climatic data and stakeholder/RWPG interfacing

Project Team – (continued)

- United States Geological Survey
  - Aquifer data and modeling expertise
- Dr. Joe Yelderman, Jr.
  - Conceptualization of aquifer
- TWDB Staff
  - Technical oversight and assistance
- Stakeholders
  - Real world experience and Project needs/Interests

Why is a Groundwater Flow Model Needed?

- Numerical model allows for more complex analysis than is possible with analytical methods
- Can be used to assess and interpret certain types of groundwater availability issues and/or concepts
- Allows for comparative analysis and testing and understanding of ‘what-if’ scenarios

Stakeholder Advisory Forum

- Stakeholder participation is important
- SAF Meetings
  - Held about once every four months
- Contact with Project Team encouraged
- SAF presentation materials and GAM information to be posted on TWDB website: http://www.twdb.state.tx.us/gam/trnt_n/trnt_n.htm

SAF Input

- Your Experiences
  - Historical use
  - Pumping tests
  - Water levels
- Your Interests
  - Identify needs of the model
  - Recognize uses of the model

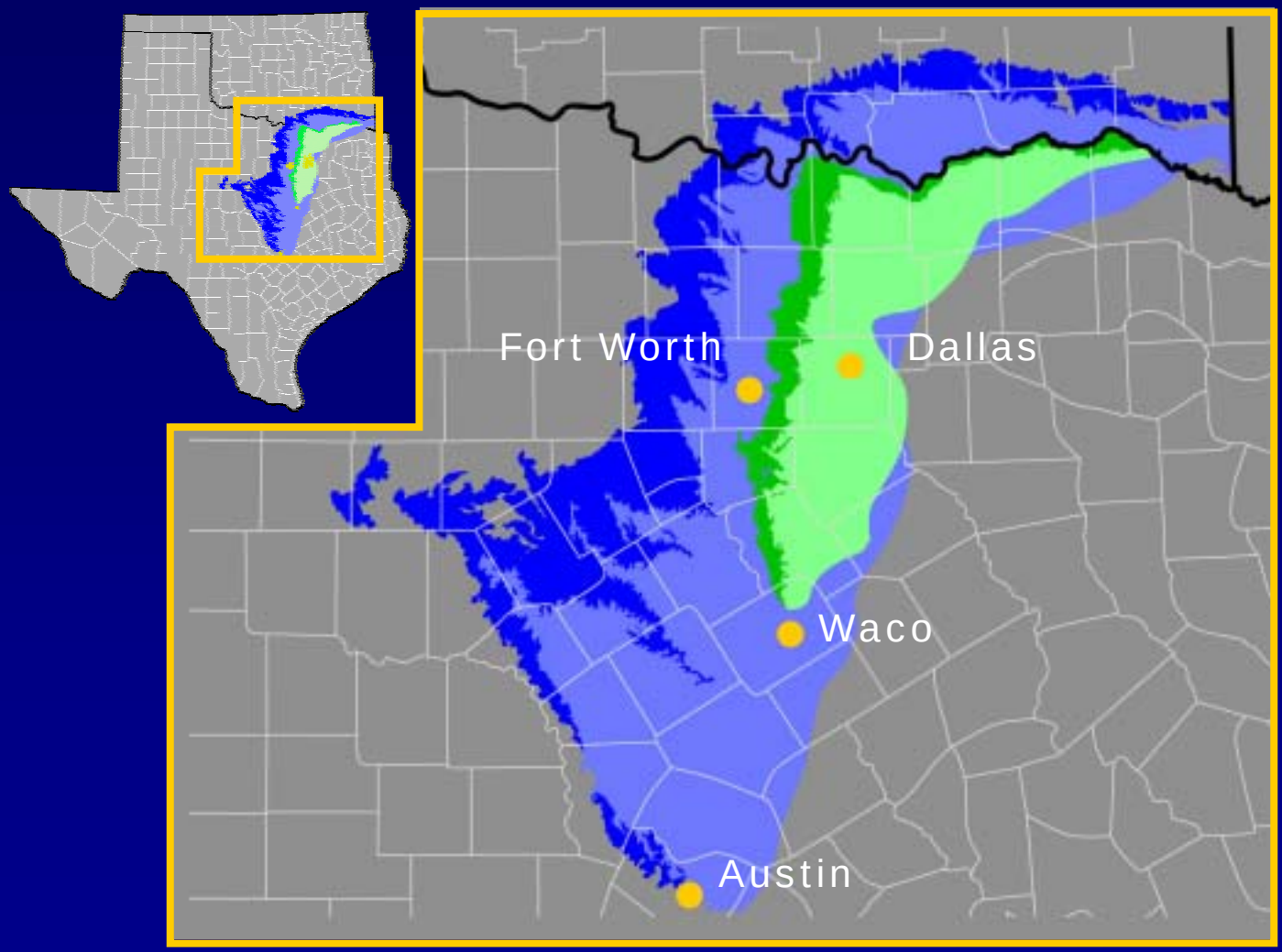
Project Work Steps

- Aquifer characterization
  - Data components of hydrologic cycle
  - Aquifer geometry and hydraulic characteristics
  - Historical pumpage and water levels
- Computer model development, calibration, and prediction
- Report and data presentation

Northern Trinity / Woodbine Groundwater Availability Model

General Aquifer Geology / Hydrology

Location Map



Trinity

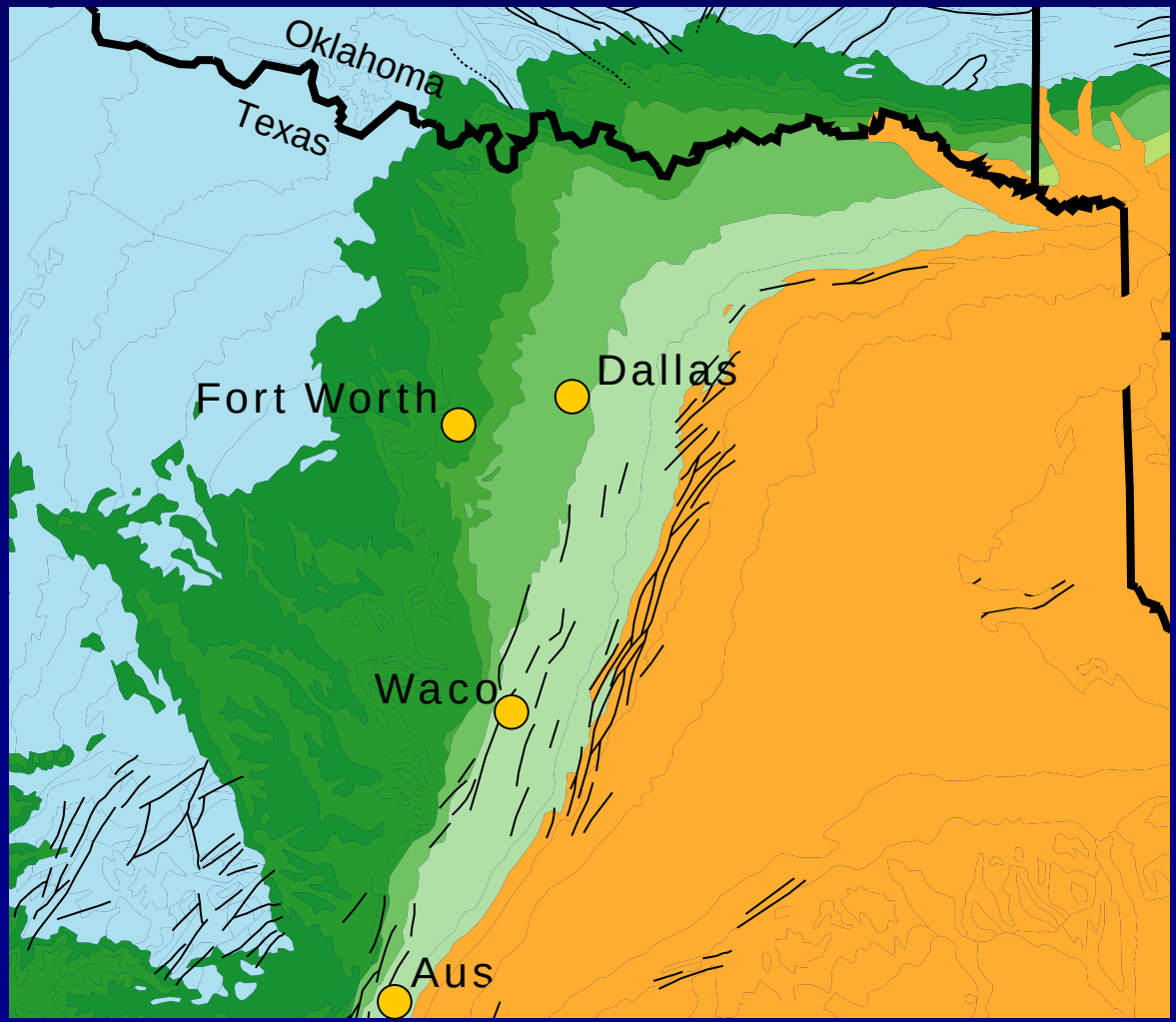
- Outcrop
- Downdip Zone

Woodbine

- Outcrop
- Downdip Zone

Source: TWDB 1990

Surface Geology



Tertiary and Quaternary Formations

Navarro and Taylor Groups

Austin and Eagle Ford Groups

Woodbine Group

Washita and Fredericksburg Groups

Trinity Group

Paleozoic Formations

Major Fault

Source: USGS 1974

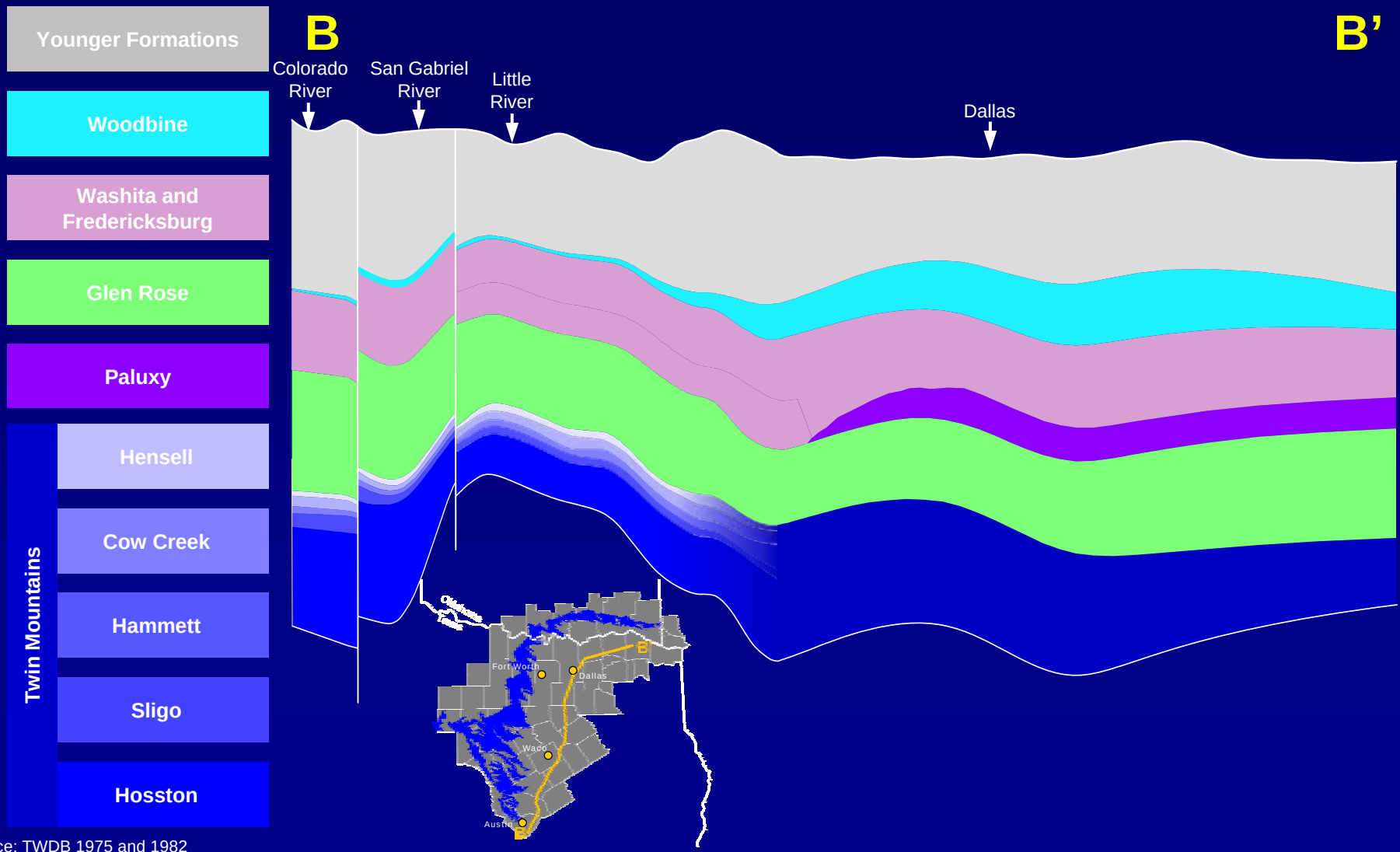
Hydrostratigraphic Column

System	Series	Group	Formation					Approximate Maximum Thickness	
			North		South			North	South
Tertiary	Undifferentiated								
Cretaceous	Gulfian	Navarro	Undifferentiated		Undifferentiated			800	550
		Taylor						1,500	1,100
		Austin						700	600
		Eagle Ford						650	300
		Woodbine						700	200
	Comanchian	Washita	Grayson Marl		Buda, Del Rio			1,000	150
			Mainstreet, Pawpaw, Weno, Denton, Fort Worth, Duck Creek		Georgetown				150
			Kiamichi		Kiamichi				50
		Fredericksburg	Goodland		Edwards			250	175
					Comanche Peak				150
			Walnut Clay		Walnut Clay				200
		Trinity	Antlers	Paluxy	Paluxy			400	200
				Glen Rose	Glen Rose			1,500	1,500
				Twin Mountains	Travis Peak	Hensell	Hensell	1,000	1,800
						Pearsall	Cow Creek		
							Hammett		
							Sligo		
						Hosston	Hosston		
Paleozoic	Undifferentiated								

Generalized Cross Section

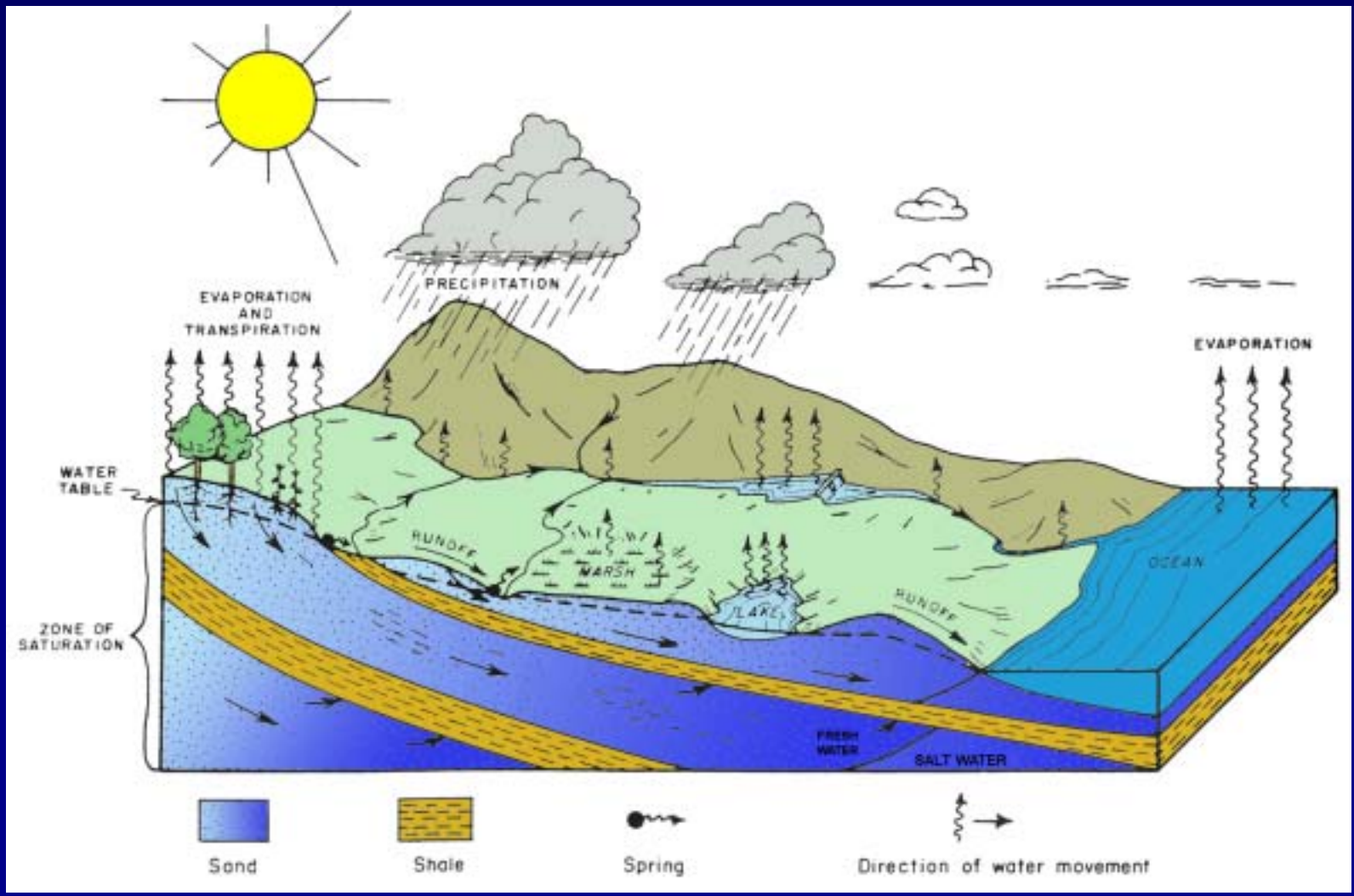
Source: TWDB 1975

Generalized Cross Section



Source: TWDB 1975 and 1982

Hydrologic Cycle



Northern Trinity / Woodbine Groundwater Availability Model

Historical Aquifer Perspective

Early Water Use

"The water supply in Dallas was in large part not considered clean enough to do laundry, and many of the well-to-do families sent their laundry to Shreveport for washing."

Circa 1890 when the water supply was spring water (from Bowder Springs) and river water from the Trinity River watershed.

Bolding and Bolding, 1981,
Origin and Growth of the Dallas Water Utilities

Seagoville Like Dallas

"Seagoville is like Dallas in one respect and that is we need artesian wells"

Dallas Daily Times Herald, June 26, 1891

Eureka!

"Ring the bells and sound the tom-tom. Waco leads the rest of the state in artesian wells--a well that will supply the city with pure freestone water."

"At two o'clock, in the afternoon, while the auger, which has been drilling for two months on Bell's Hill, in J. D. Bell's artesian well struck a white sand strata and **a great subterranean ocean of water** at the same time."

"From a 5 and 5/8 in. pipe this morning **a river** is running over Bell's Hill, with an estimated flow of four hundred thousand gallons daily. The contractors estimated that the force of water is sufficient to raise the water in a stand pipe to a height [sic] of one hundred, and perhaps, one hundred and twenty-five feet."

Waco Evening News, March 12, 1889

Pure and Infinite Water!

"boundless flow“

"a value inestimable“

"immense body of water“

"incalculable“

"inexhaustible quantities"

Waco Evening News, March 12, 1889

Free Water!

"What shall we do with it?“

"Make it as free as the air we breathe.“

"Flush our streets daily and make Waco the healthiest city in the world.“

"Make Waco the great sanitarium of the Southwest.“

"Erect stand-pipes and give water power to every manufacturing concern that wants it."

Waco Evening News, March 16, 1889

Mineral Water

103 degrees F
1,000 ppm [mg/l]

"Mr. Bill Harris says that the artesian water from Captain Bell's well has valuable curative powers. He has bathed his lame foot, ...and says he has experienced great relief...."

"It is thought by eminent judges that the new artesian water is a sovereign anti-fat remedy.“

Waco Evening News, March 19, 1889

Artesian Wells

Men drinking from hot artesian spring in Marlin

circa 1920

Old postcard

Example Public Water Supplies

- City of Morgan
  - First well drilled in 1902 – flowed when drilled
  - Static water level was reported to be 70 feet deep in 1943
- City of Rogers
  - Well drilled in 1940
  - Flowed 835 gallons per minute in 1940
  - Static water level of 166 feet above land surface

Geyser City

Scenes in and near Waco - 1890

…Waco advertised itself as a "Geyser City" and built several natatoriums urging visitors to drink and bathe in its 104 degree [F] water in order to cure "dyspepsia, rheumatism, syphilis, eczema, many other chronic problems."

[Walker, 1983]

OOPS!

"The people of Waco thought the supply of artesian water was certainly inexhaustible, but in 1894 the wells began to produce less water and even go dry*."

Walker [1983]

*(cease to flow at the surface)

Era of Development

From 1910 – 1950:

- Rural Supply and Fire Protection
- 90 % of Communities on ground water
- 2/3 of total water used was groundwater

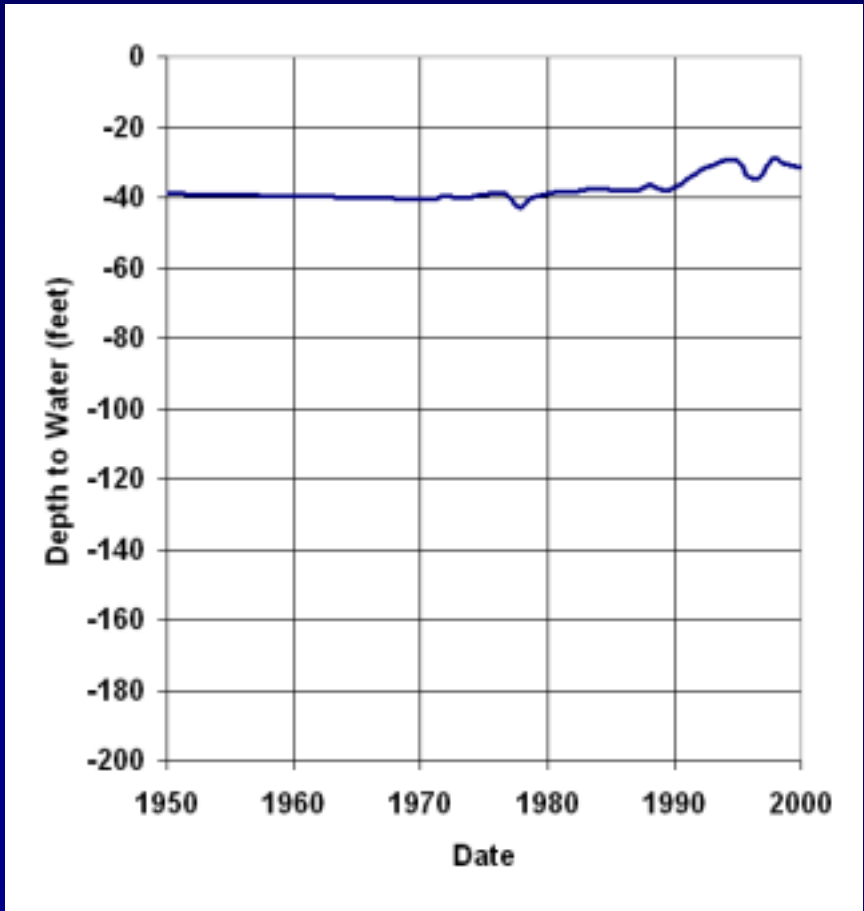
City of Penelope

"The City of Penelope tried several times to drill a deep artesian well and while a well was being drilled in 1916 the local hotel burned to the ground. Two other large fires destroyed much of the town, discouraging the people.

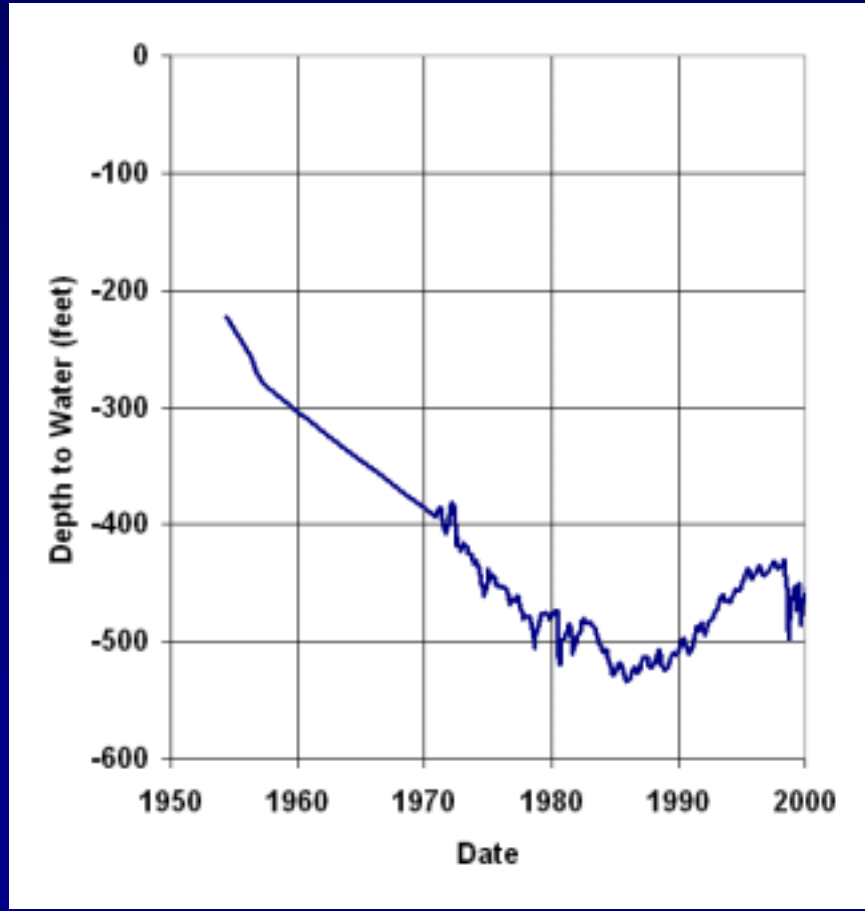
Penelope did not complete a successful well until 1959."

Bruegger, 1990, 5D, in Sharpless and Yelderman, 1993

Historical Water Levels



Outcrop Well in Parker County



Confined Aquifer Well in Dallas County

Previous TWDB Aquifer Studies

- Central Texas - TWDB Report 195
  Klempt, Perkins & Alvarez (1975)
- North Texas - TWDB Report 269
  Nordstrom (1982)
- North Central Texas – TWDB Report 349
  Langley (1999)
- Central Texas - TWDB Report 350
  Ridgeway & Petrini (1999)

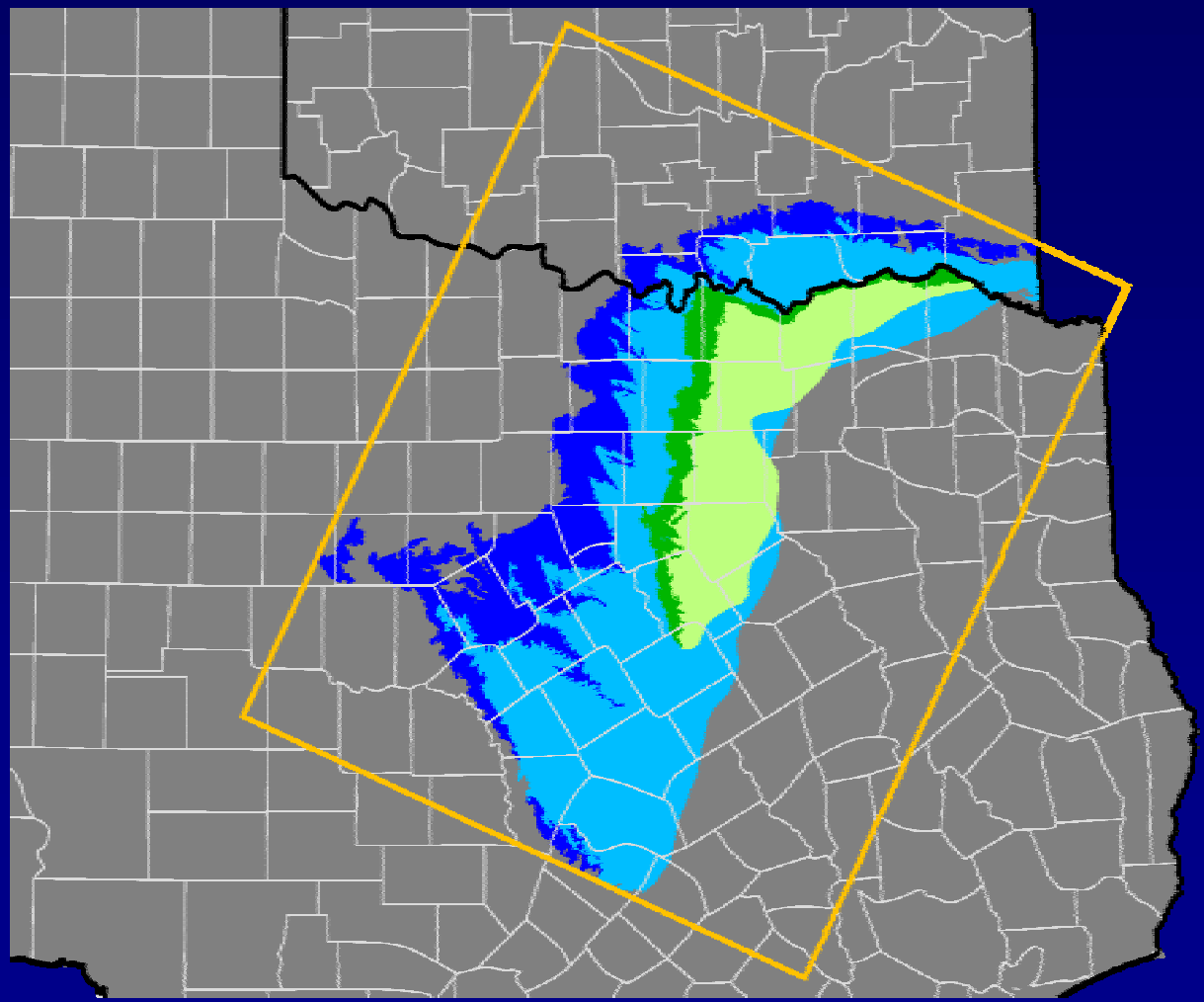
Modern Time

- Aquifer data
- Aquifer analysis including modeling

Northern Trinity / Woodbine Groundwater Availability Model

Groundwater Flow Model

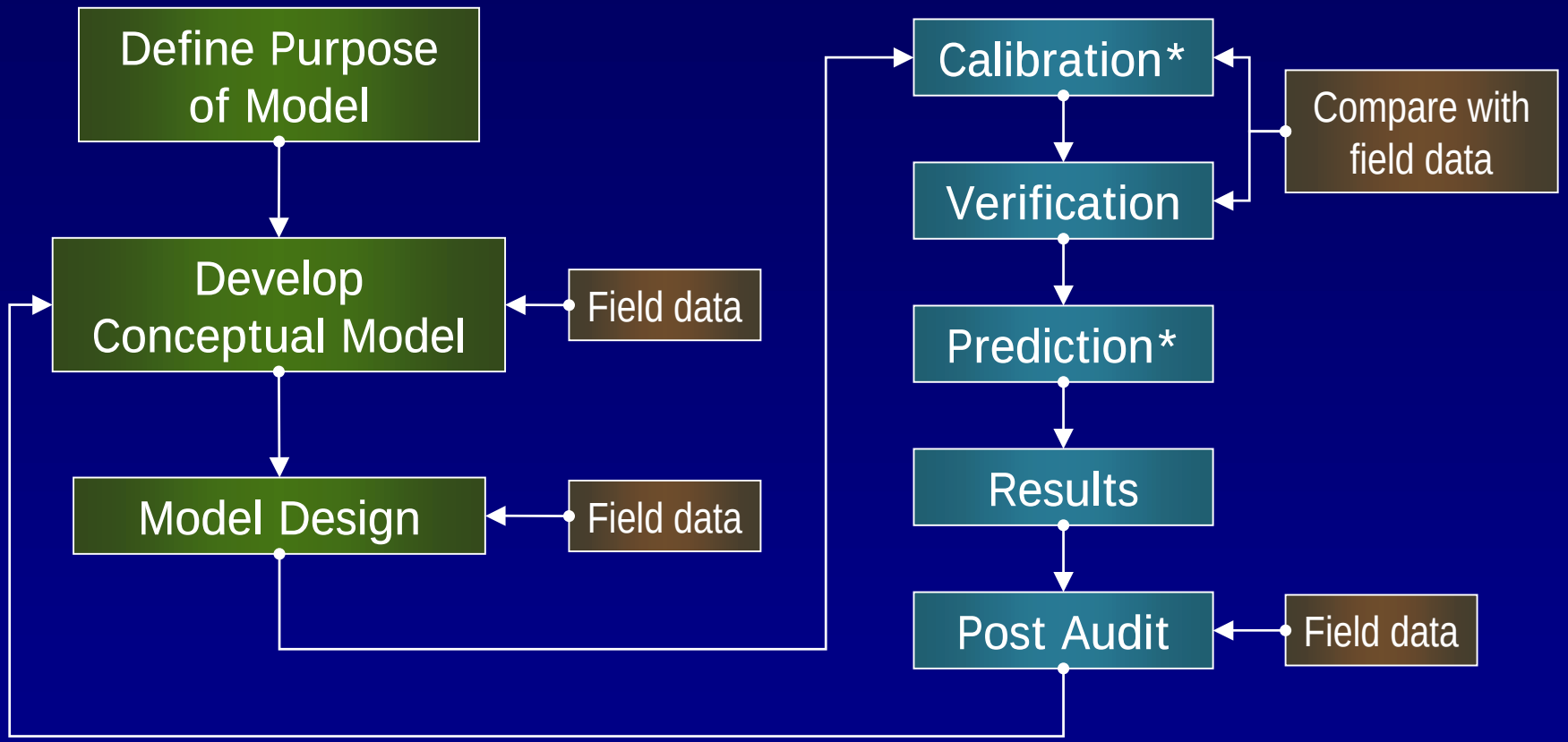
Model Domain



Model Input Data

- Aquifer Geohydrology
  - Structure
  - Hydraulic properties
  - Water levels
- Surface Water Interaction
  - Recharge
  - Discharge
- Historical Aquifer Use
  - Location and amount through time

Modeling Process



*includes sensitivity analysis

Model Strengths & Limitations

- Regional Model
  - Should allow for reasonable regional evaluations
  - May be inapplicable at a local scale
- Calibration/Prediction
  - Calibration/Verification periods – 10 years
  - Prediction period – up to 50 years
  - Available calibration data and detail

What a Regional GAM Can and Can't Do

- CAN DO
  - Provide estimates of regional water level changes under different use scenarios (amounts and distributions)
  - Provide estimates of the relative importance of different aquifer flow components (recharge, leakage, etc.) under different aquifer stages
  - Provide estimates of the aquifer's response to different groundwater management scenarios
- CAN'T DO
  - Determine the amount of water that should be produced
  - Determine policy or an appropriate management strategy

Project Schedule Milestones

- Project Initiation - January 2003
- Draft Conceptual Model Complete – August 2003
- Model Development Begins – Sept. 2003
- Study Completion Date – March 2004
- Final Report - August 2004

Northern Trinity / Woodbine Groundwater Availability Model

SAF Open Discussion

Trinity and Woodbine aquifers GAM
Stakeholder Attendance List
March 19, 2003

Name	**Representing**
Steven McKay	City of Howe
David Woreham	City of Howe
Eric Strom	USGS
Ali Chowdhury	TWDB
Lou Fleischhauer	Trinity Engineering
Dean Conner	City of Woodway
Warren Williams	Luella USC
Paul Phillips	City of Weatherford
Tim Jahn	Brazos River Authority
Sue Thompson	City of Highland Village
Alice James	BW2 Engineers
H.C. Clark	Enviornmental
V. Ratliff	Historical
Kevin Spencer	R.W. Harden & Associates, Inc.
Stephanie Griffin	Freese & Nichols, Inc.
Bob Harden	R.W. Harden & Associates, Inc.
Joe Yelderman	Dept of Geology, Baylor University
Tracy Relinski	R.W. Harden & Associates, Inc.

Summary of Questions/Answers
SAF No. 1 Trinity (north) and Woodbine aquifers GAM
Harris Education Center
Hillsboro, Texas
March 19th, 2003

1. Q: Will the model show water quality on a regional basis?
   A: The final report will address water quality conditions that exist in the Northern Trinity/Woodbine aquifer. The model will not have water quality input. If desired, in the future the flow model developed for this program could be used in conjunction with a water quality transport model to simulate water quality.

2. Q: Will the model indicate deep circulation on fault zones?
   A: Yes, the model will include appropriate input to simulate the regional effects of faulting.

3. Q: Are you going to include water temperature as one of the constraints on the model?
   A: The model will not include water temperature as a specific input. The effects of temperature are relatively small compare to other model input parameters.