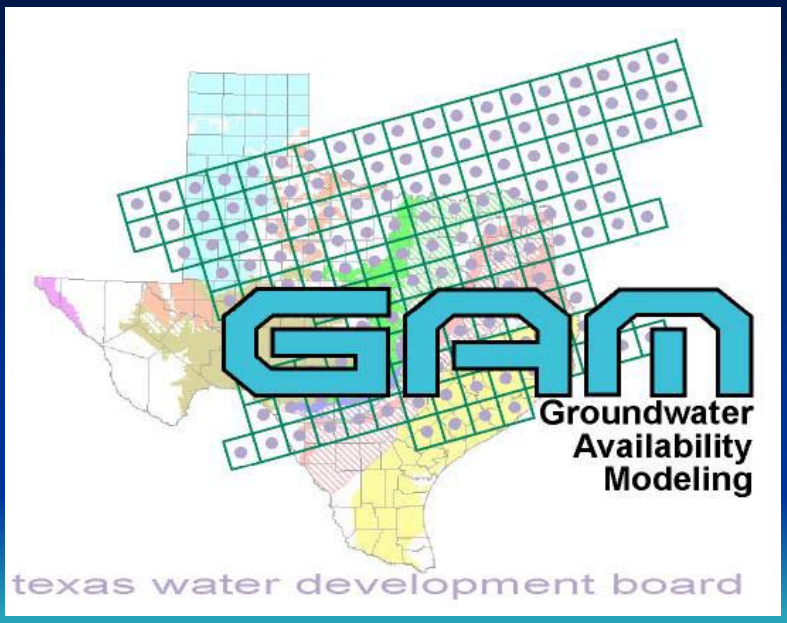
4th Stakeholder Advisory Forum
West Texas Igneous and Bolson GAM

November 20, 2003



Comments:

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West Texas Igneous and Bolson GAM Team

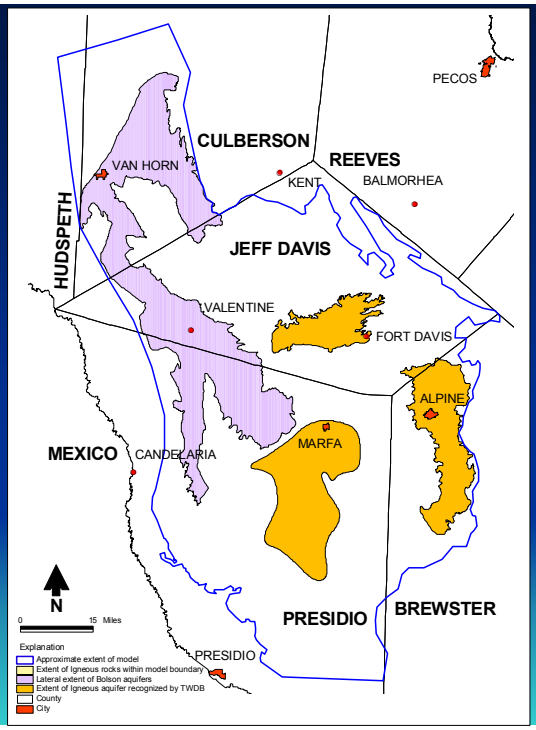
- LBG-Guyton Associates
  - Water Prospecting and Resource Consulting, LLC
  - John Shomaker & Associates, Inc.
  - Daniel B. Stephens & Associates, Inc.
  - Senior Technical Advisors
    - Kevin Urbanczyk, Ph.D., Sul Ross State University
    - Jack Sharp, Ph.D., University of Texas at Austin

SAF 4 Agenda

- Quick review of GAM conceptual model
- Model architecture
- Steady-state modeling approach
- Calibration data and targets
- Results of steady-state calibration
- Approach for transient calibration
- Questions and answers

Review of Conceptual Model

TWDB Aquifers in the Study Area



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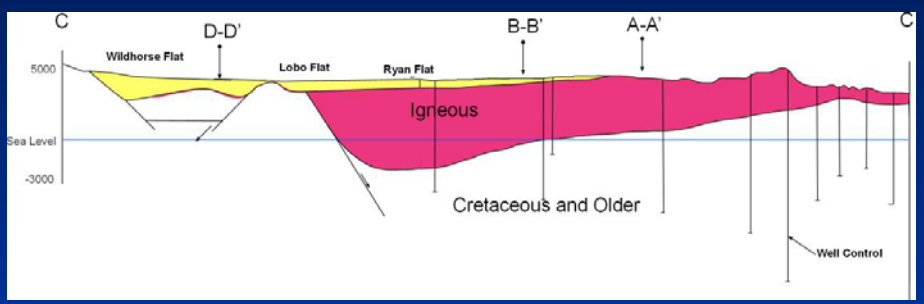
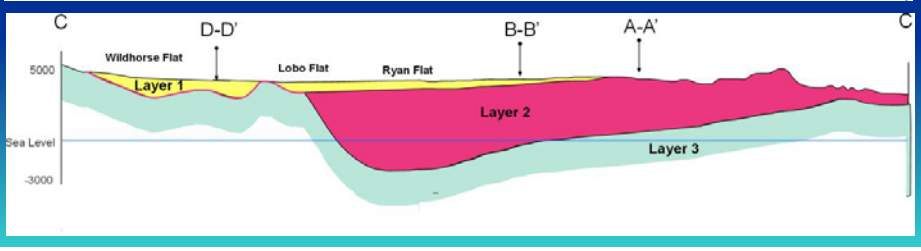
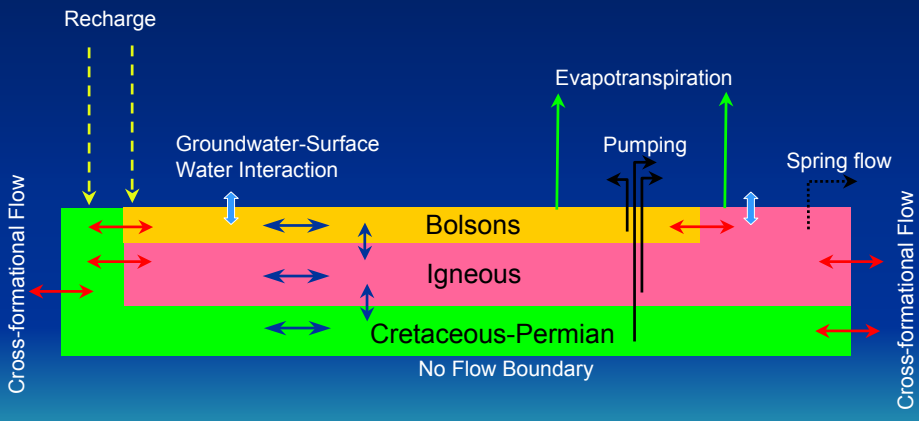
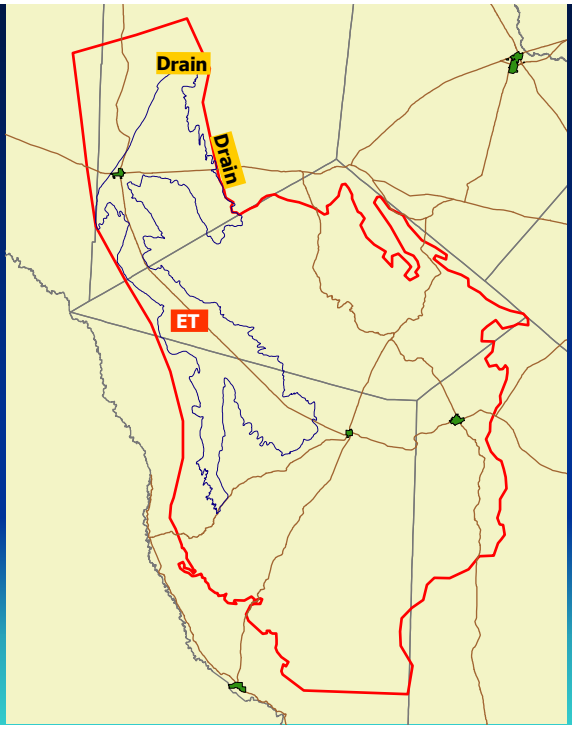


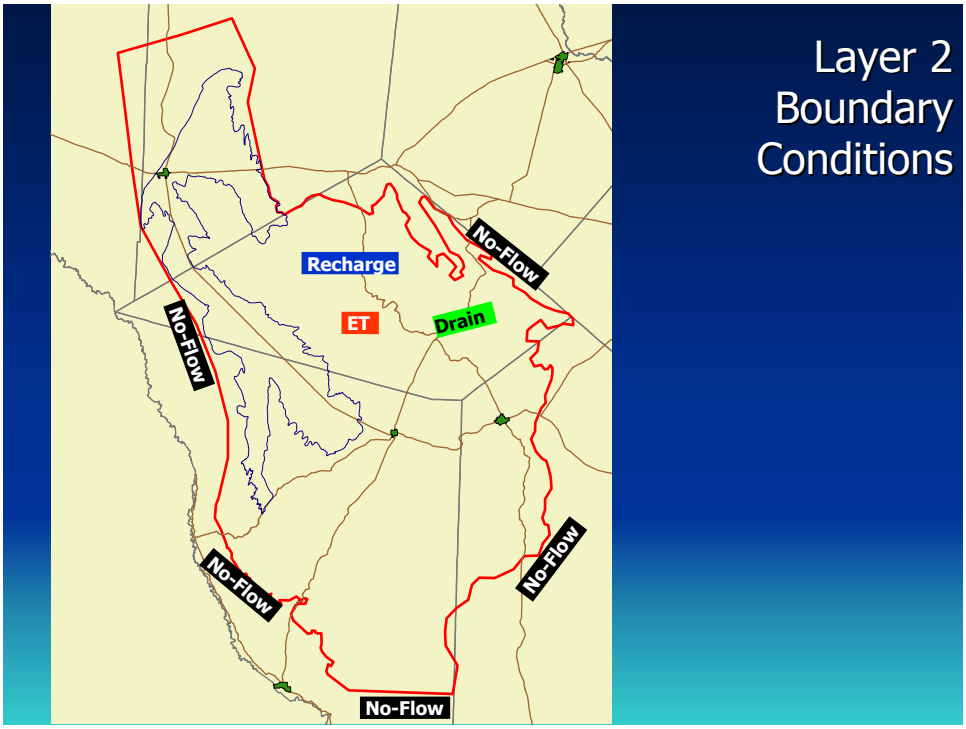


Conceptual Block Diagram

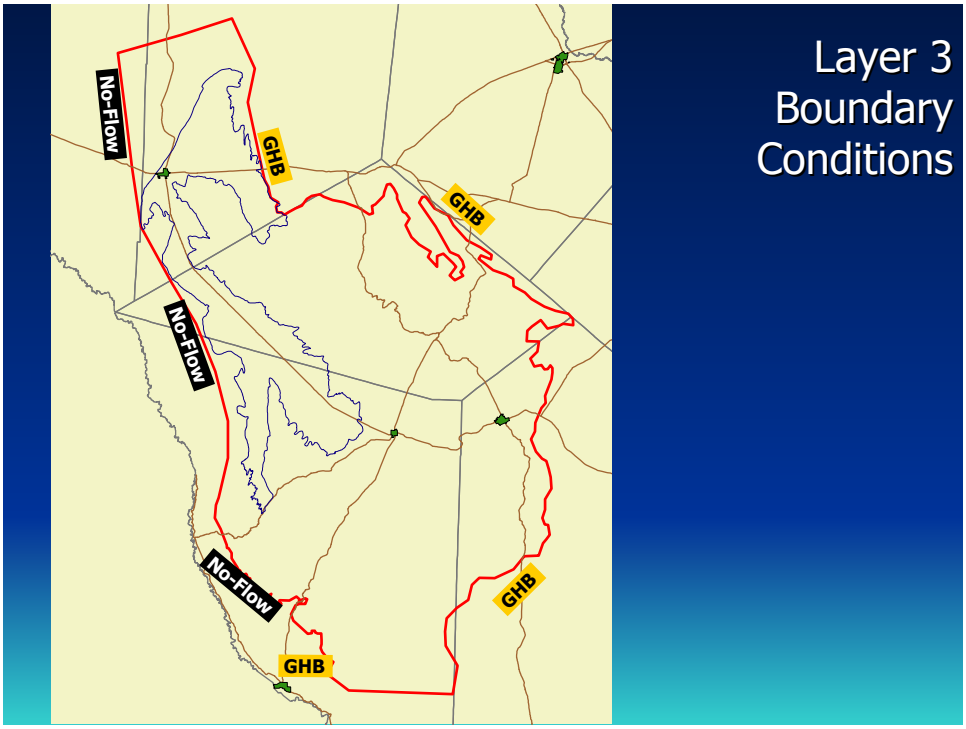


Layer 1 Boundary Conditions



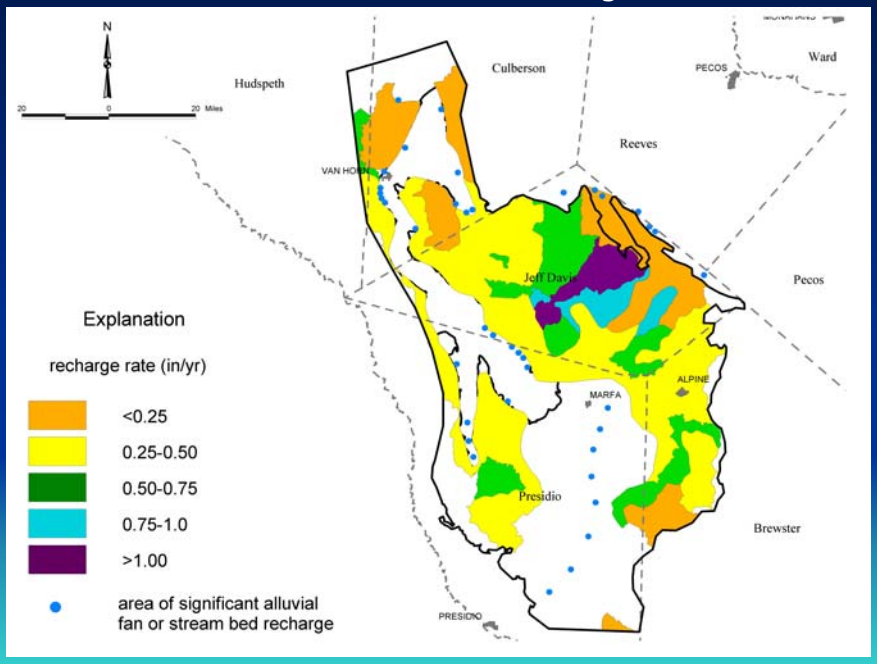


Layer 2 Boundary Conditions



Layer 3 Boundary Conditions

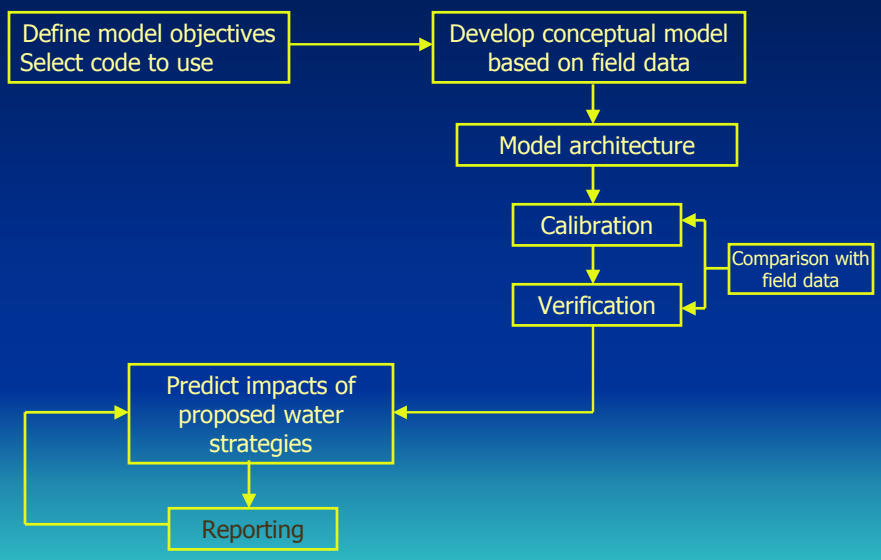
Initial Distribution Of Recharge



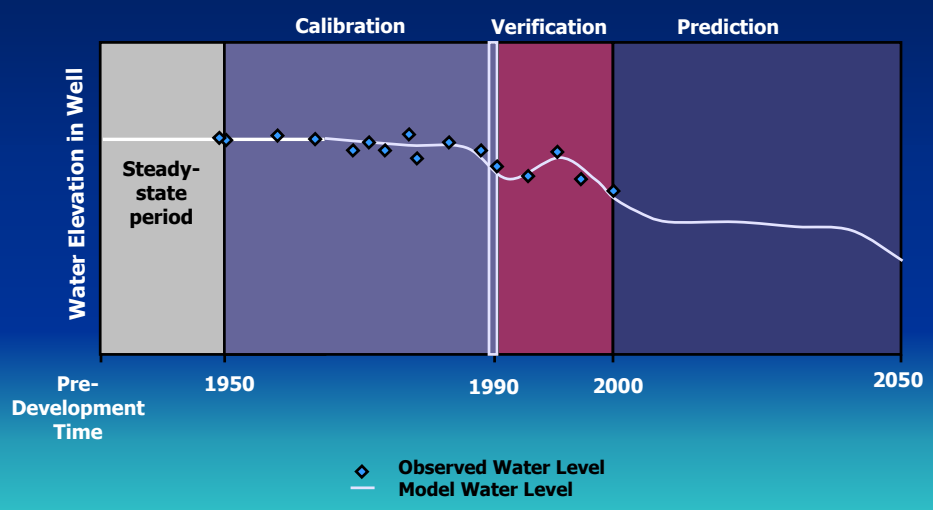
Model Specifications

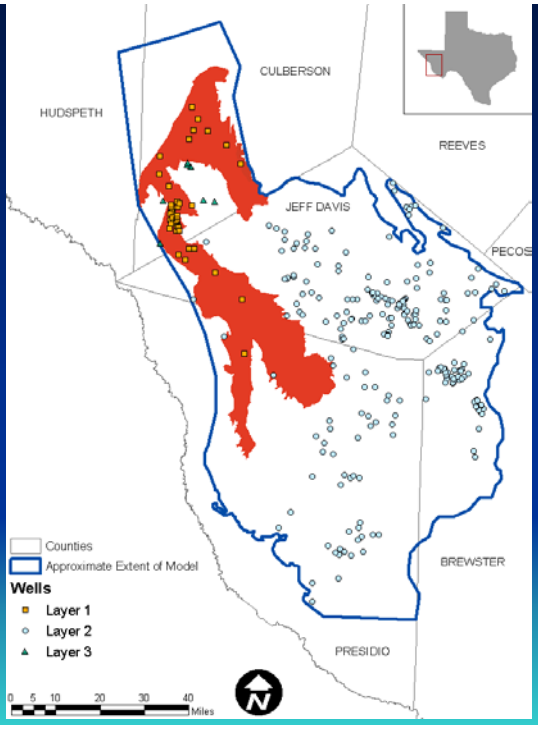
- Three dimensional (MODFLOW-96)
- Regional scale
- Includes ground/surface water interaction
- Grid spacing = ½-mile

GAM Modeling Protocol



GAM Modeling Periods



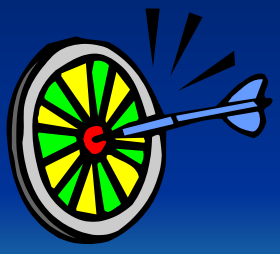


Location of Target Wells for Steady-State Calibration

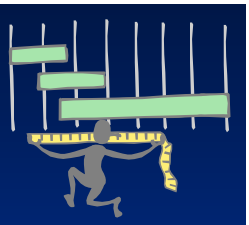
Igneous water level Measurements from recent years utilized for steady-state

Types of Calibration Targets

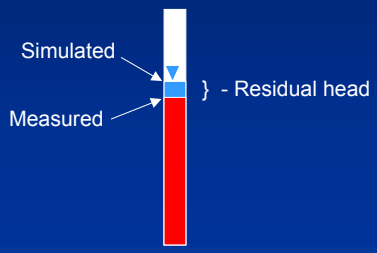
- Hard Targets
  - Water level measurements in wells
  - Streamflow measurements
  - Water level gradients
- Soft Targets
  - Overall water budget
  - Water budget components



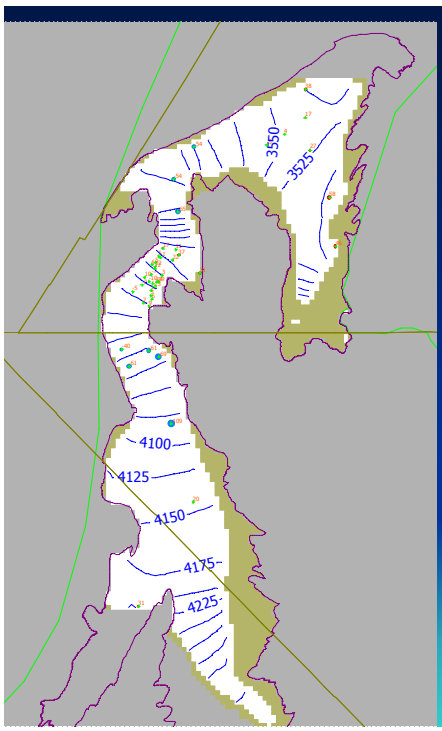
Calibration Measures



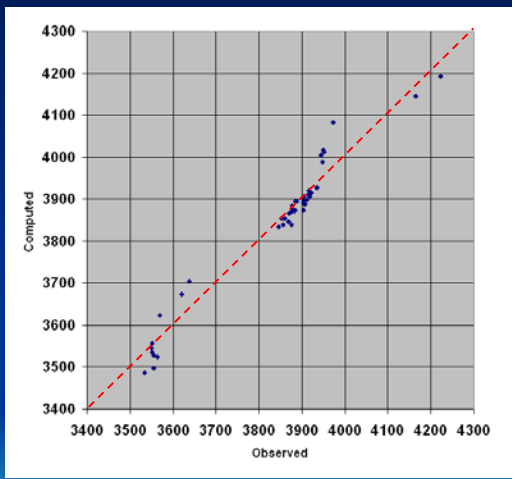
- Residuals
  - Measured heads minus simulated heads



  - Measured streamflow minus simulated streamflow

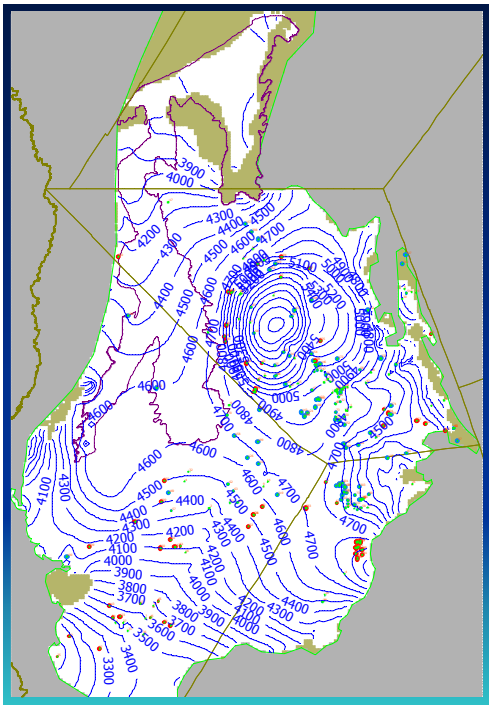


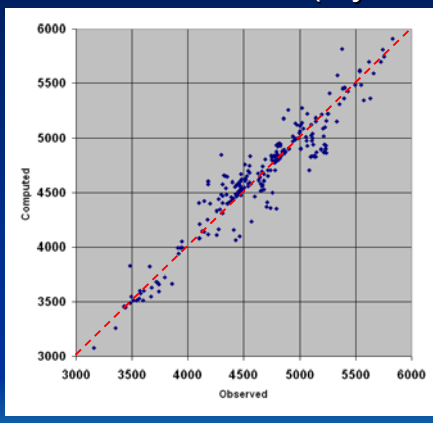
Steady-State Simulated Heads (layer 1)



# of Wells	43	
Mean Error	-1	feet
Absolute Mean Error	24	feet
Range in Head	690	feet
Std/Range	4.9	%

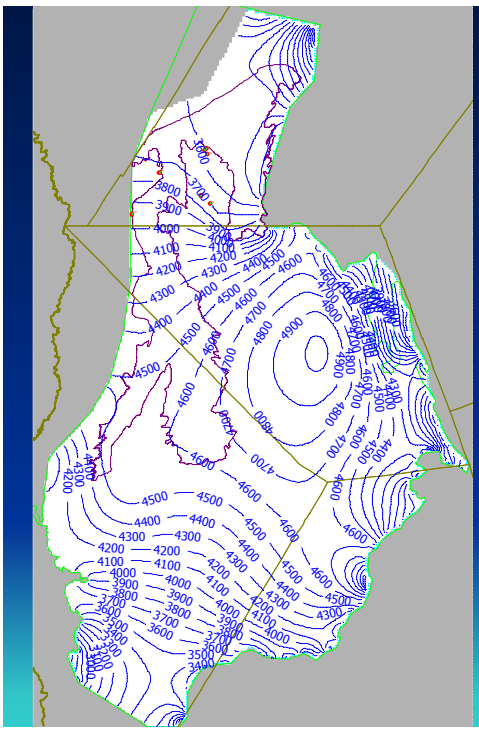
Steady-State Simulated Heads (layer 2)



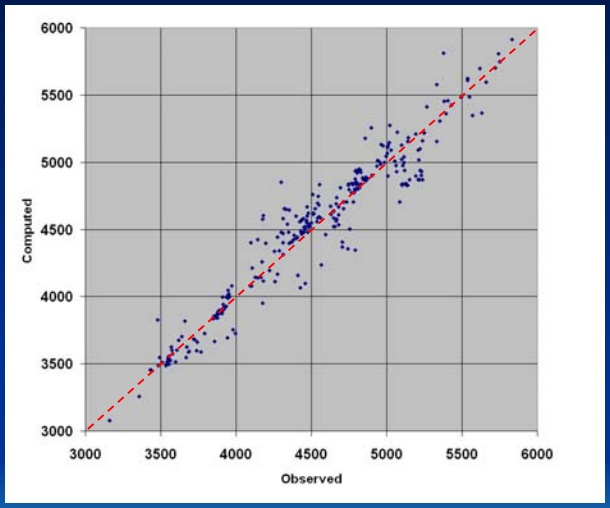


# of Wells	245	
Mean Error	-7	feet
Absolute Mean Error	119	feet
Range in Head	2833	feet
Std/Range	5.7	%

Steady-State Simulated Heads (layer 3)

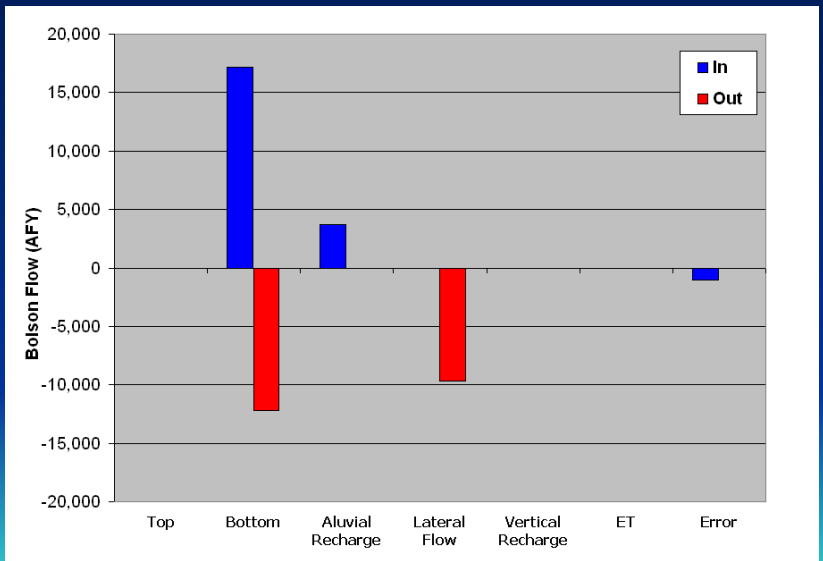


Steady-State Heads (all layers)

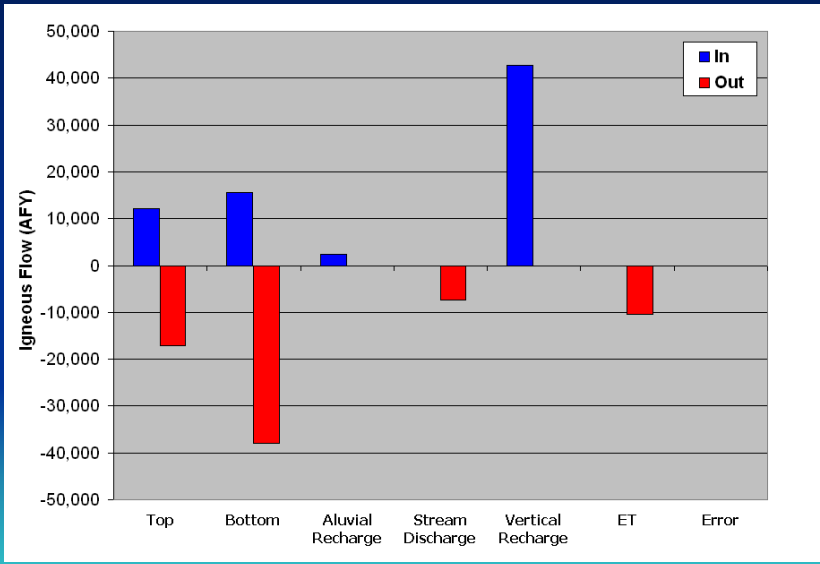


# of Wells	295	
Mean Error	-1	feet
Absolute Mean Error	107	feet
Range in Head	2833	feet
Std/Range	5.4	%

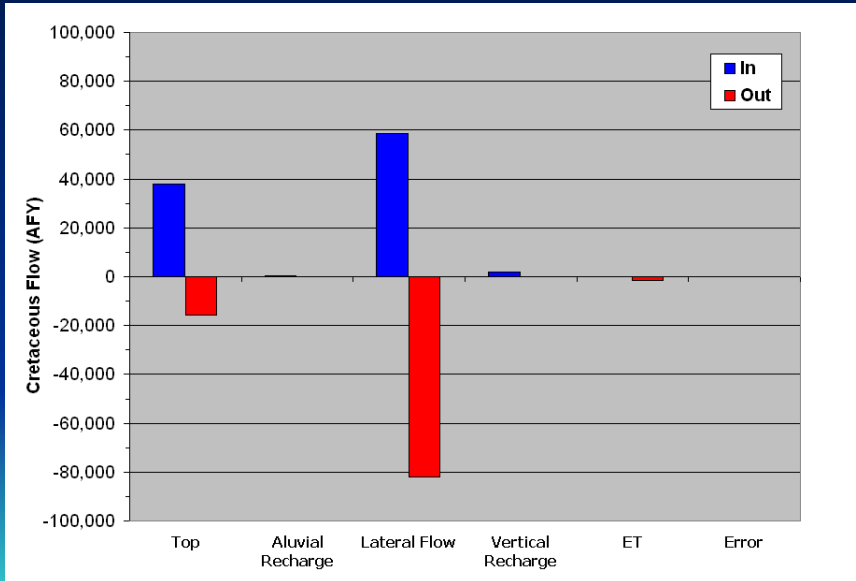
Steady-State Budget (layer 1)



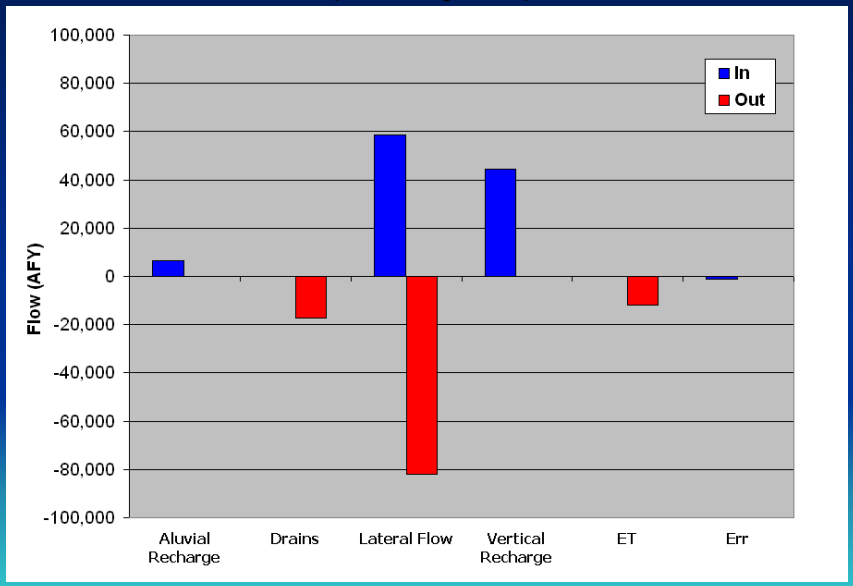
Steady-State Budget (layer 2)

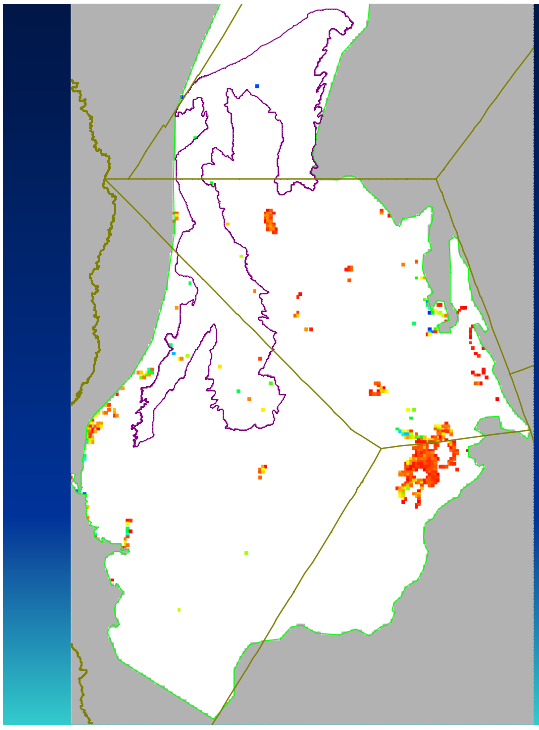


Steady-State Budget (layer 3)



Steady-State Budget (all Layers)





Steady-State Evapotranspiration

Extinction Depth = 10 ft
ET Max Rate = 0.00228 ft/day or 10 in/year

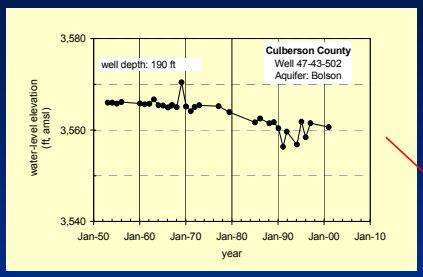
Transient Calibration Process

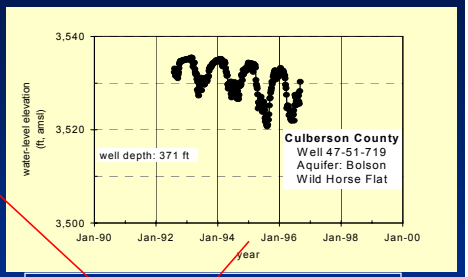
- Hard Targets
  - Transient water level measurements in wells
  - Streamflow measurements
  - Drawdown in pumping areas
- Soft Targets
  - Overall water budget
  - Water budget components

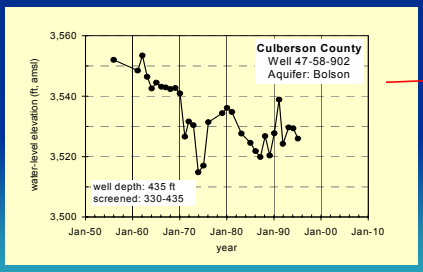
Simulation Periods

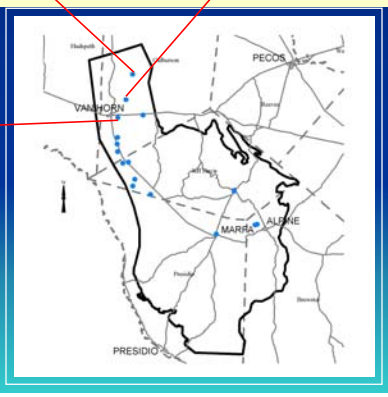
Time Period	# Stress Periods	Length (years)
pre-1950: steady state period prior to major pumping	1	-
1950 – 1990: calibration period Focus on 1970-1990 Most significant irrigation pumping	40	1
1990 – 2000: verification period Relatively dry period	10	1

Wild Horse Flat Hydrographs

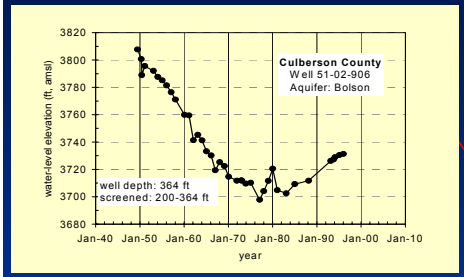


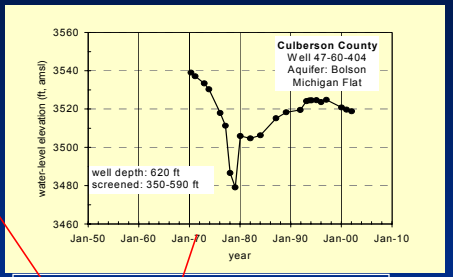


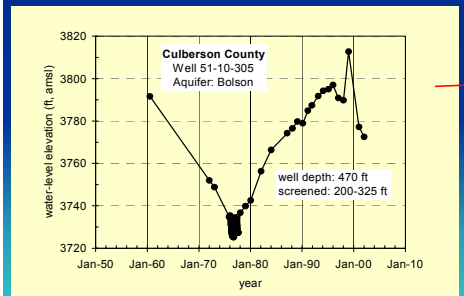


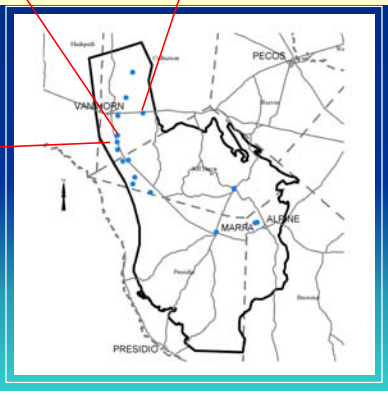


Michigan And Lobo Flat Hydrographs

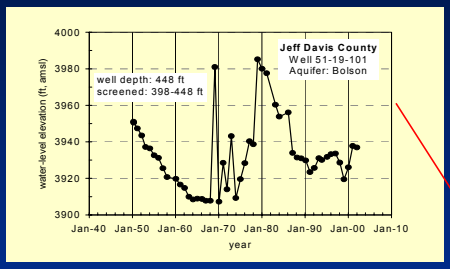


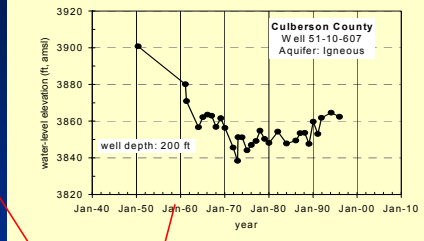


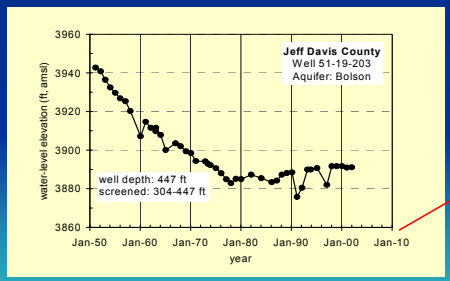


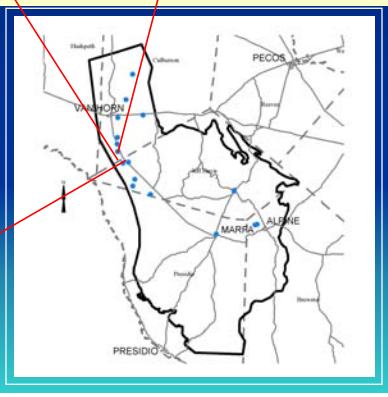


Lobo Flat Hydrographs

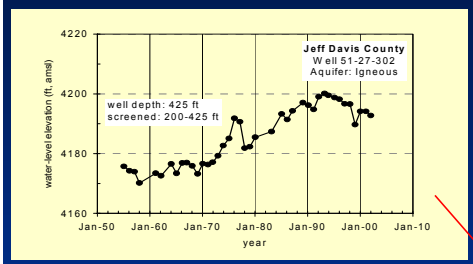


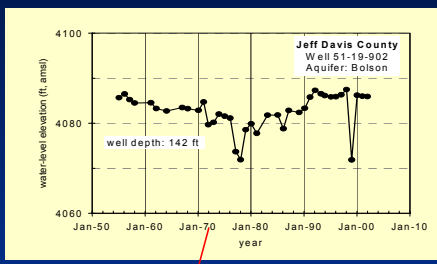


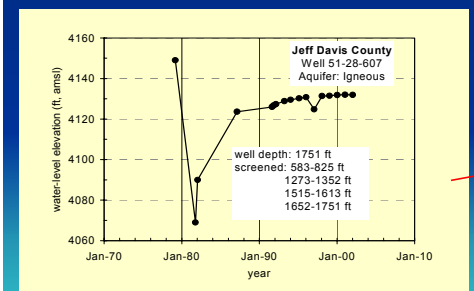


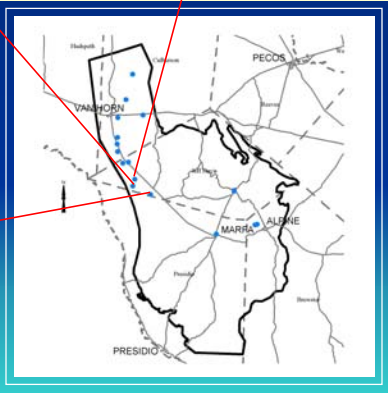


Lobo And Ryan Flat Hydrographs

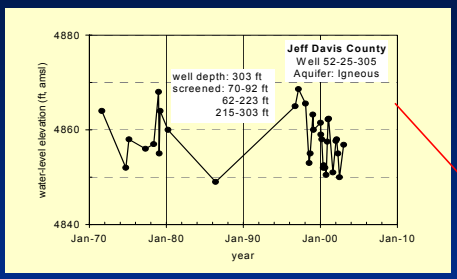


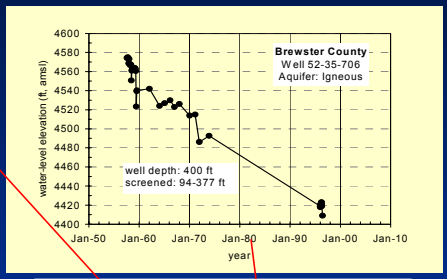


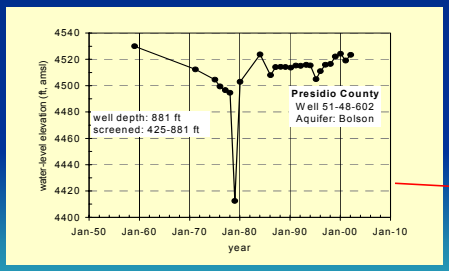


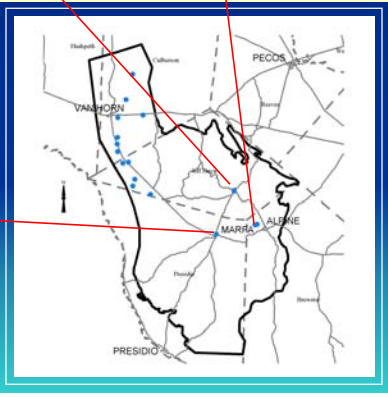


Igneous Aquifer Hydrographs









Project Schedule

Task	Sep-02 1	Oct-02 2	Nov-02 3	Dec-02 4	Jan-03 5	Feb-03 6	Mar-03 7	Apr-03 8	May-03 9	Jun-03 10	Jul-03 11	Aug-03 12	Sep-03 13	Oct-03 14	Nov-03 15	Dec-03 16	Jan-04 17	Feb-04 18	Mar-04 19	Apr-04 20	May-04 21	Jun-04 22
Stakeholder Input																						
TWDB Review Meetings				√			√			√				√				√		√		
SAF Meetings					√			√			√				√				√			
Conceptual Model Development																						
Data Collection																						
a) Physiography			Contract Signed November 13																			
b) Geology																						
c) Water Levels																						
d) Recharge																						
e) Surface Water																						
f) Aquifer Characteristics																						
g) Discharge																						
Model Development																						
a) Architecture																						
b) Steady-State Calibration																						
c) Transient Calibration																						
d) Verification																						
e) Sensitivity Analysis																						
Predictions																						
Documentation												Draft							Draft			Final

Date and Project Month

QUESTIONS AND ANSWERS
West Texas Igneous and Bolson GAM
SAF Meeting 4 – November 20, 2003
Van Horn, Texas

Q: Which hydrologic parameters are being tweaked in order to reach calibration?
A: For the steady-state calibration, the calibration parameters are hydraulic conductivity, recharge, boundary heads and conductance (for general head and drain boundaries).

Q: How has recharge been modified since its initial input?
A: Sensitivity analysis is being performed on recharge. For the steady-state calibration, it appears that approximately 60% of original recharge estimate (that shown in the draft conceptual model report) is reasonable. This is consistent with the findings of other groundwater modeling studies that have been performed in the southwest U.S. that have incorporated this method of recharge estimation. The value may be further modified further during the transient calibration.

Q: Why have you set no-flow boundaries in layer 2 in areas where flow is known to occur?
A: The thickness of the igneous aquifer generally decreases near the boundaries. Many of the grid blocks "dry out" and become inactive for the steady-state and transient simulations, which causes the general head boundaries at the edges of the model to become inactive in those areas also. To ensure that flow can continue to move out of the model (as is indicated by measured water levels), general head boundaries have also been incorporated in layer 3 to ensure that water can actually move out through layer 3 if layer 2 dries out.

Q: How much of the aquifer characterization is based on previous studies and how much on actual current measurements?
A: The goal of the conceptual model development was to take into account all the data and research that was available. The draft conceptual model report provides some details of previous work and the available data that is being used in the study. With regard to water level information, very little data was collected prior to the 1950s. Therefore, for the Igneous aquifer, we assume that more recent data collected in the Davis Mountains is indicative of steady-state conditions in some areas.

Q: Does the model show the interaction between the Igneous and Bolson aquifers in Antelope Valley Farms area during the 1980s pumping period?
A: There is hydraulic connection between the Igneous and Bolson aquifers in Antelope Valley Farms area in the model. The degree of interaction between the two aquifers will be simulated during the transient calibration. However, there are no wells that are screened only in the Igneous aquifer in that area. Therefore, the degree of connection has not been directly measured by water level changes in the different aquifers during pumping periods.

Q: Is there a concern for the perched water in the Igneous. Is the small percent error indicative of the difficulty of incorporating perched water?
A: In the Davis Mountains (Igneous aquifer), it is recognized that the model will be "interpretive" and will simulate the radial flow away from the topographically highest region of the mountains. Perched water at higher elevations that is structurally controlled will not be simulated. A major goal of incorporating the Igneous aquifer into the model is to simulate the regional groundwater flow and recharge components that impact the Bolsons.

Q: Is the Balmorhea spring system outflow a component of the lateral movement out of the model area?
A: Yes, but Balmorhea is outside the model area and is not simulated directly.

Q: Is there a problem with assuming a 1950s water level in the Igneous aquifer when there is only 20 to 30 years of historical record?
A: We feel that this assumption is valid and appropriate so that we can use the more recent (and geographically distributed) water levels to gain insight into regional flow patterns, which have not changed significantly since 1950.

Q: Is there a rap-around movement of water in the Wild Horse – Michigan flats area?
A: Groundwater movement in the Salt Basin primarily moves from south to north; however, primarily in Wild Horse Flat, movement has been altered such that it appears to rap-around and flow toward the pumping center.

Q: What is the level of complexity of pumping test data used and from where does the money come to perform these tests?
A: Some pumping tests of mostly municipal wells were performed with observation wells. However, recent pumping tests performed for this project were of shorter duration and produced a specific capacity measurement, which was compared to transmissivity estimates developed from the longer tests.

Q: Is the percent error evenly distributed throughout the model area?
A: For the most part, yes.

Q: Is oil well data integrated into the project?
A: Interpretations of oil well geophysical logs, primarily by John Olson, were used in developing the conceptual model and stratigraphy for the model.