

GAM

**Groundwater
Availability
Modeling**

texas water development board

STAKEHOLDER ADVISORY FORUM (SAF)

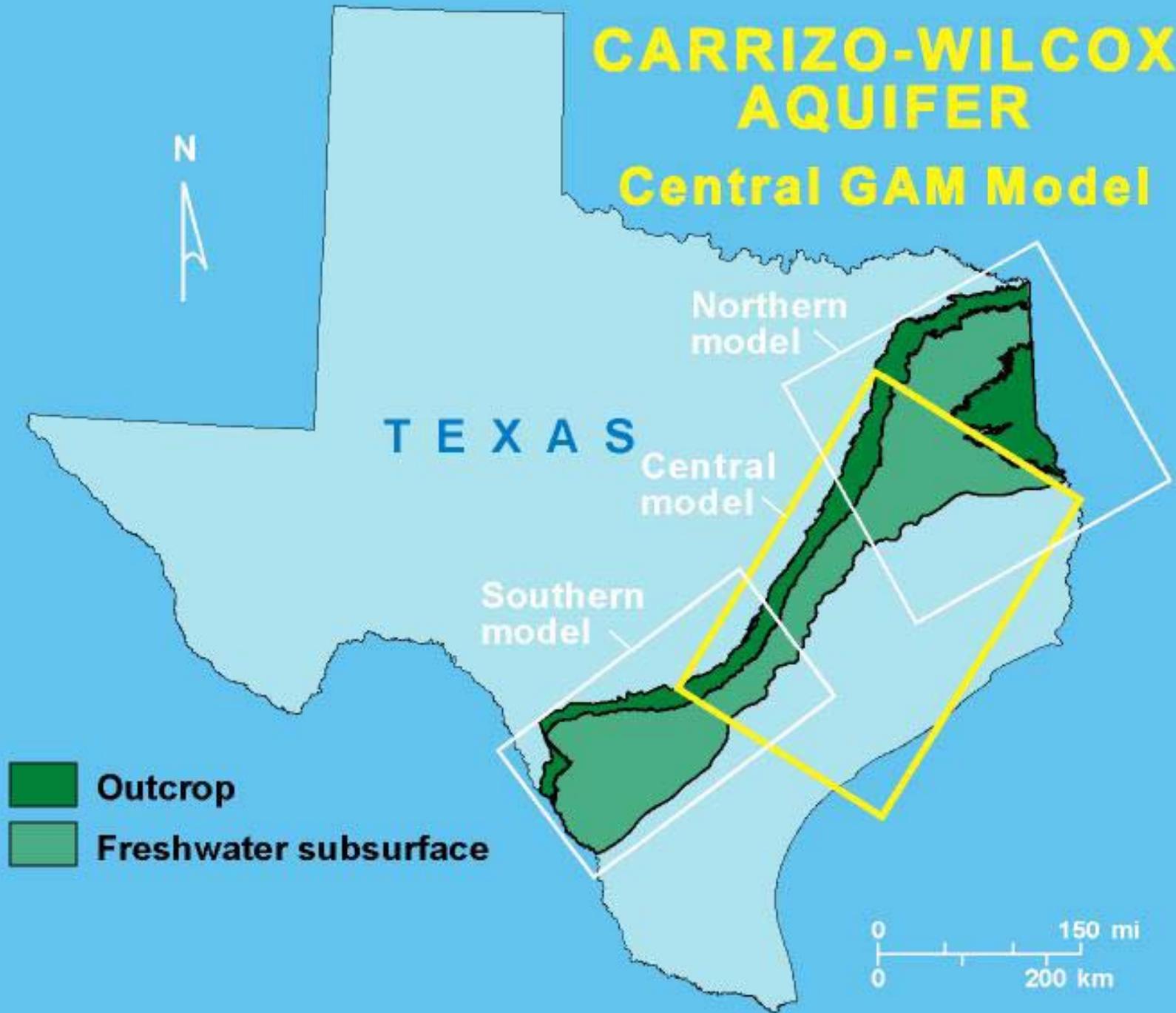
Central Carrizo-Wilcox Aquifer GAM Model

June 20, 2002

- **Welcome and introductions**
- **Recharge estimates for model**
- **Preliminary results of steady-state model calibration**
- **Status**
- **Remaining work**
- **Schedule**

CARRIZO-WILCOX AQUIFER

Central GAM Model

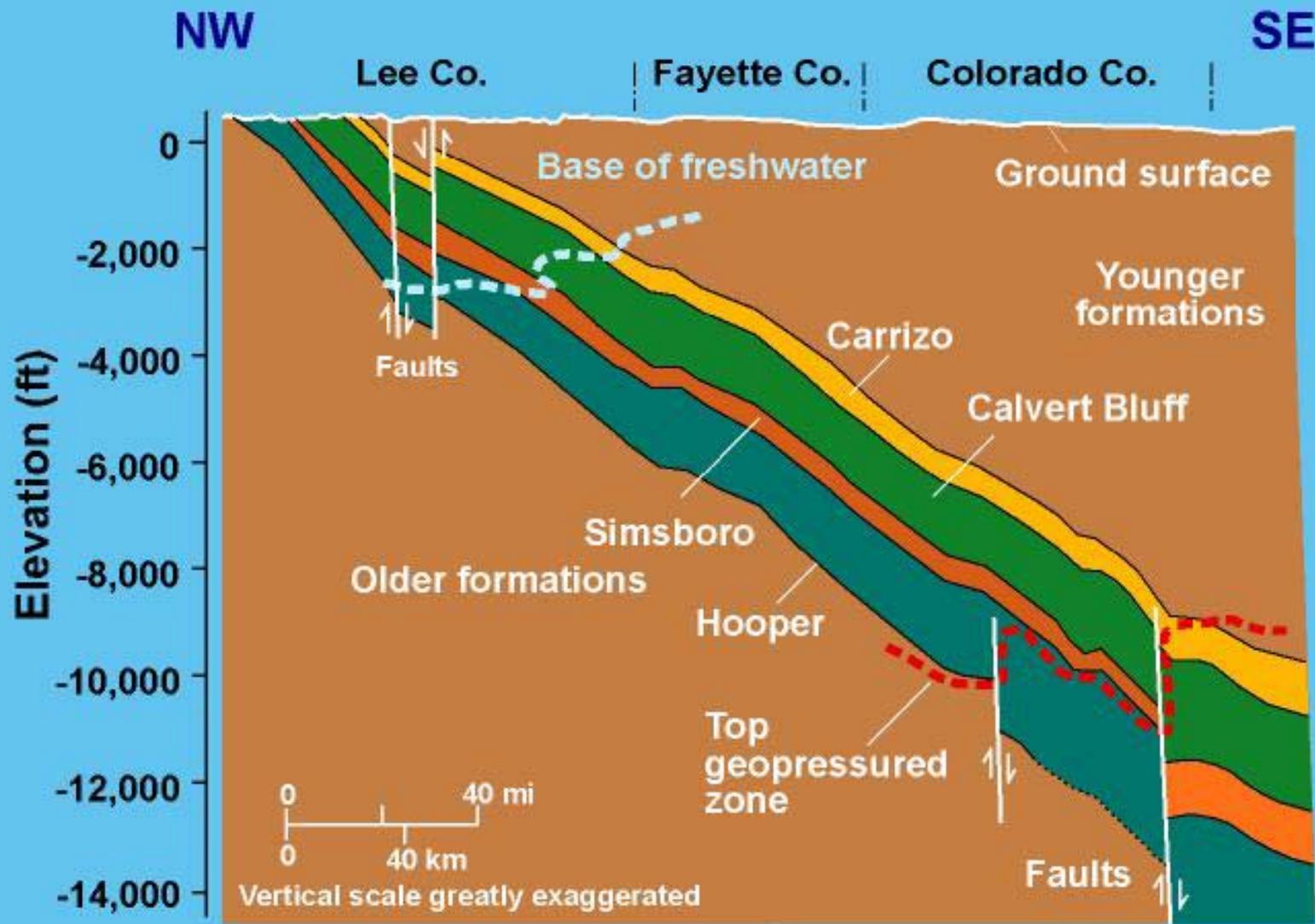


CARRIZO-WILCOX AQUIFER Central Model Area

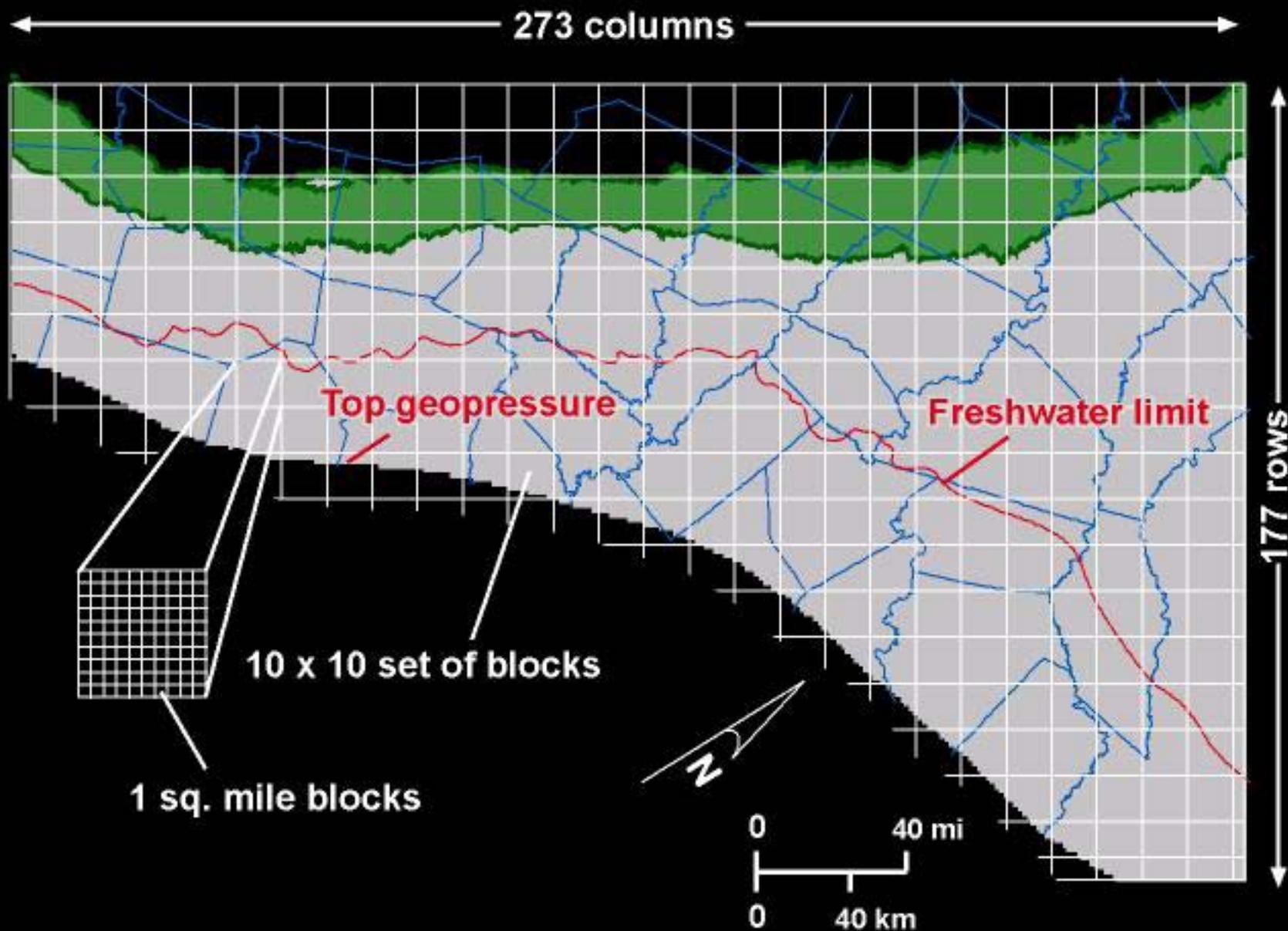


CARRIZO-WILCOX HYDROGEOLOGY

Central Part of Model Area



MODEL GRID



GAM MODEL INFORMATION REQUIREMENTS

- **Aquifer geometry**

 - Model grid

 - Model perimeter and extent

 - Top elevation of layers

 - Bottom elevation of layers

 - Calibration water levels

- **Aquifer properties**

 - Hydraulic conductivity (horizontal and vertical)

 - Storage coefficient

- **Boundary conditions and fluxes**

 - Recharge

 - Surface water (rivers, creeks, and springs)

 - Evapotranspiration

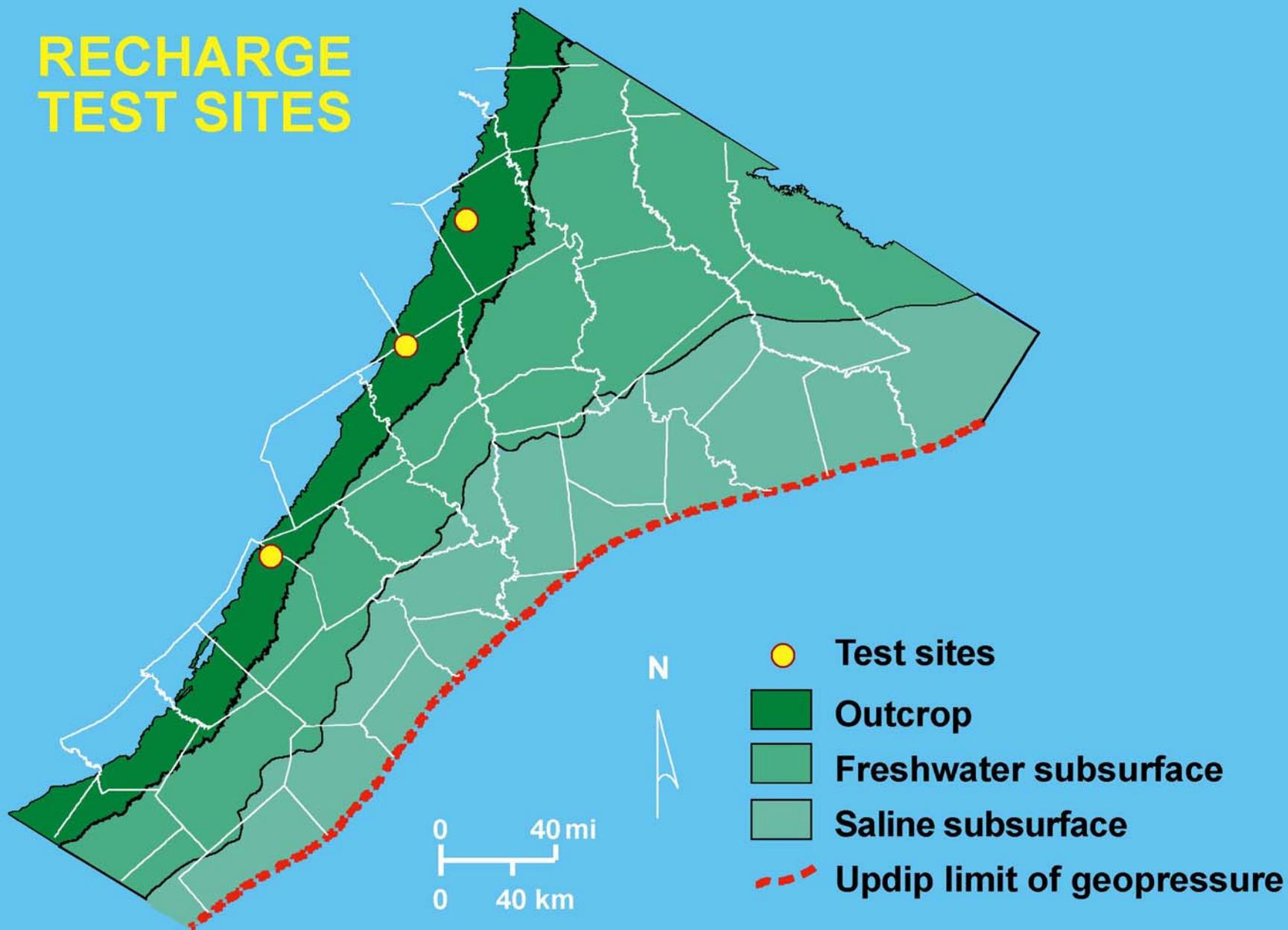
 - Pumping rates

 - Lateral boundaries—exchange with other models

 - Downdip boundary

RECHARGE ESTIMATES

RECHARGE TEST SITES

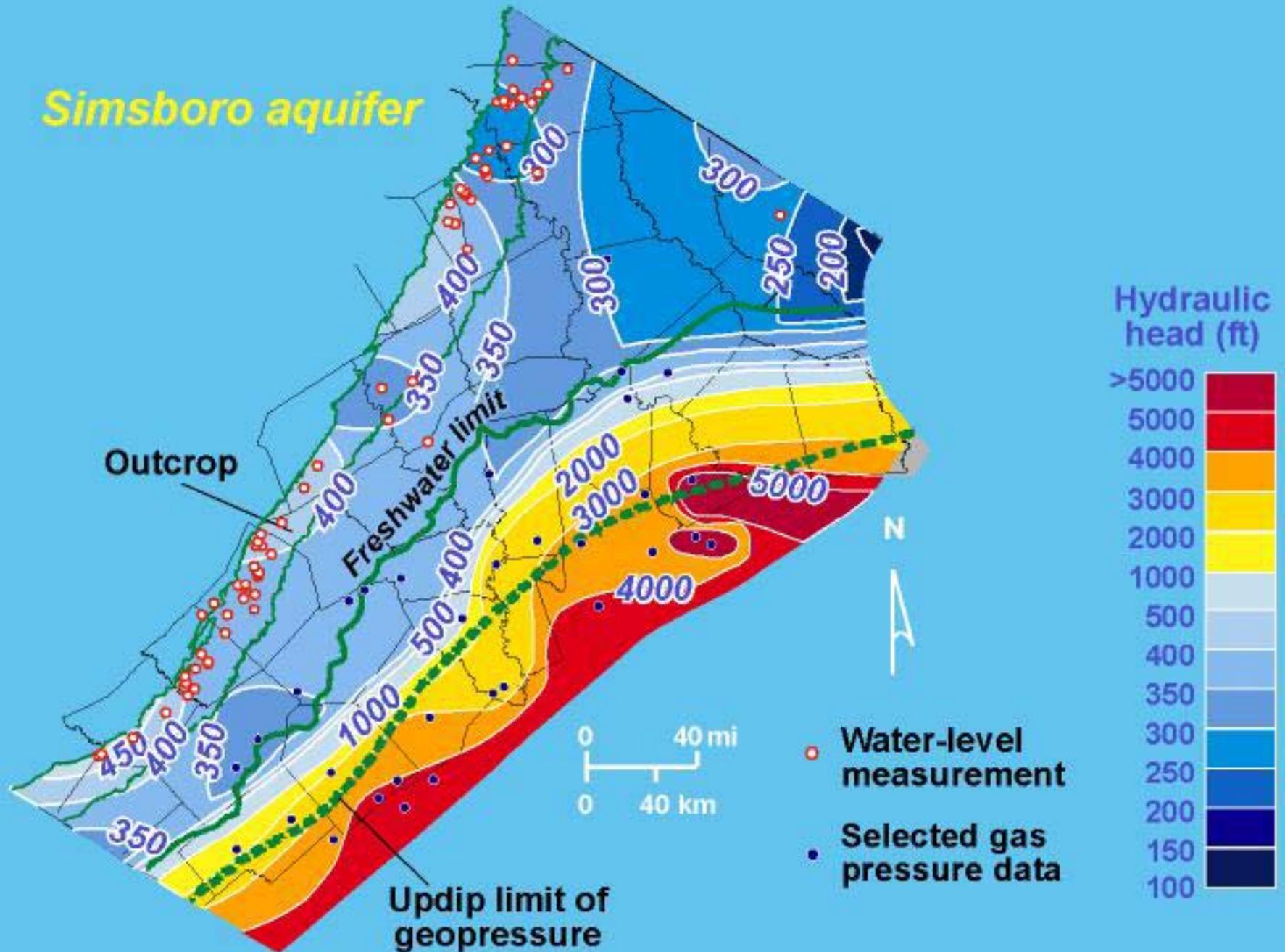


STEADY-STATE CALIBRATION

- **Maps and graphs comparing simulated and observed hydraulic heads**
- **Comparison of estimated and simulated groundwater discharge to rivers and creeks**
- **Simulated water budget**

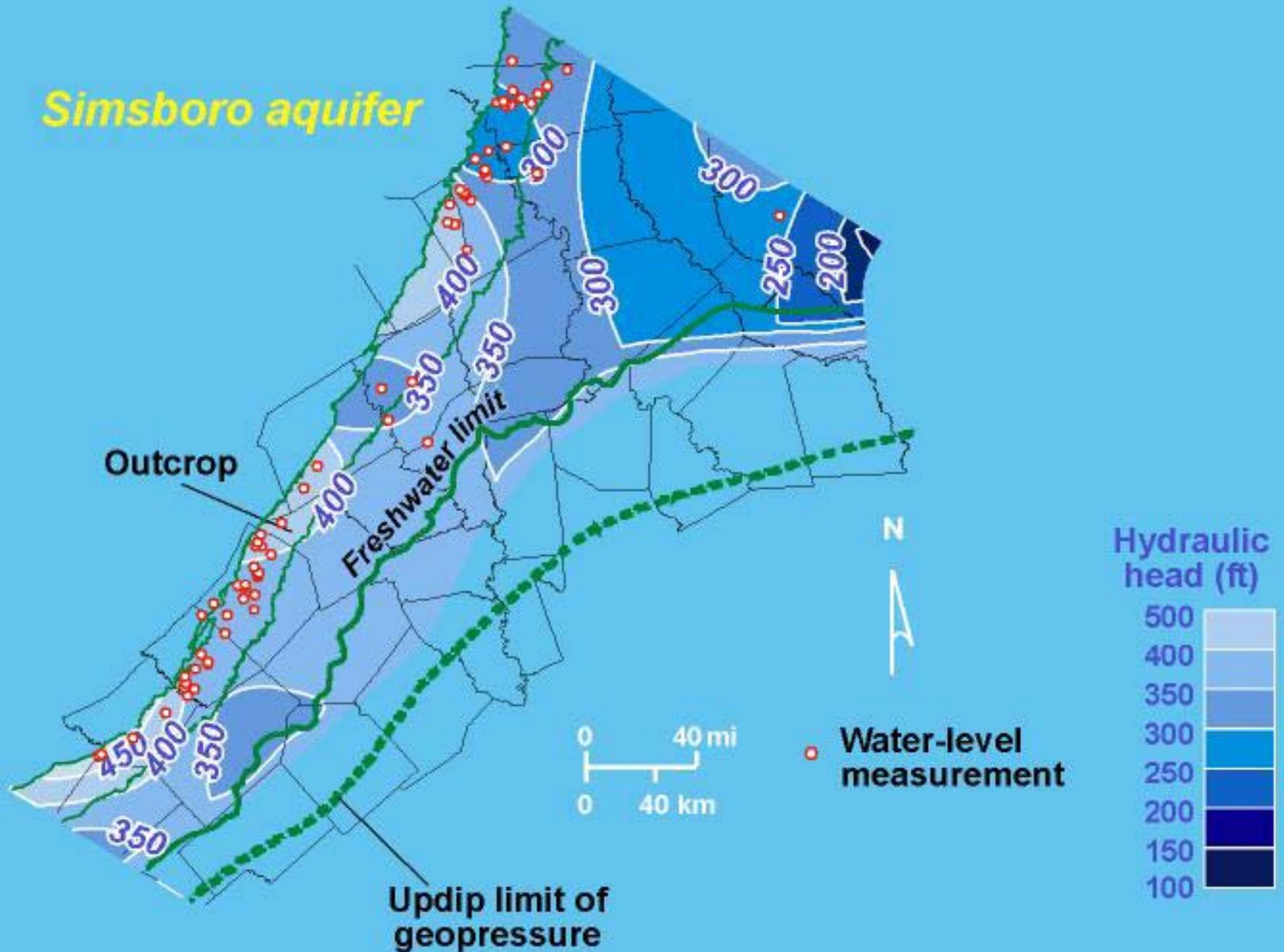
PREDEVELOPMENT POTENTIOMETRIC SURFACE

Simsboro aquifer



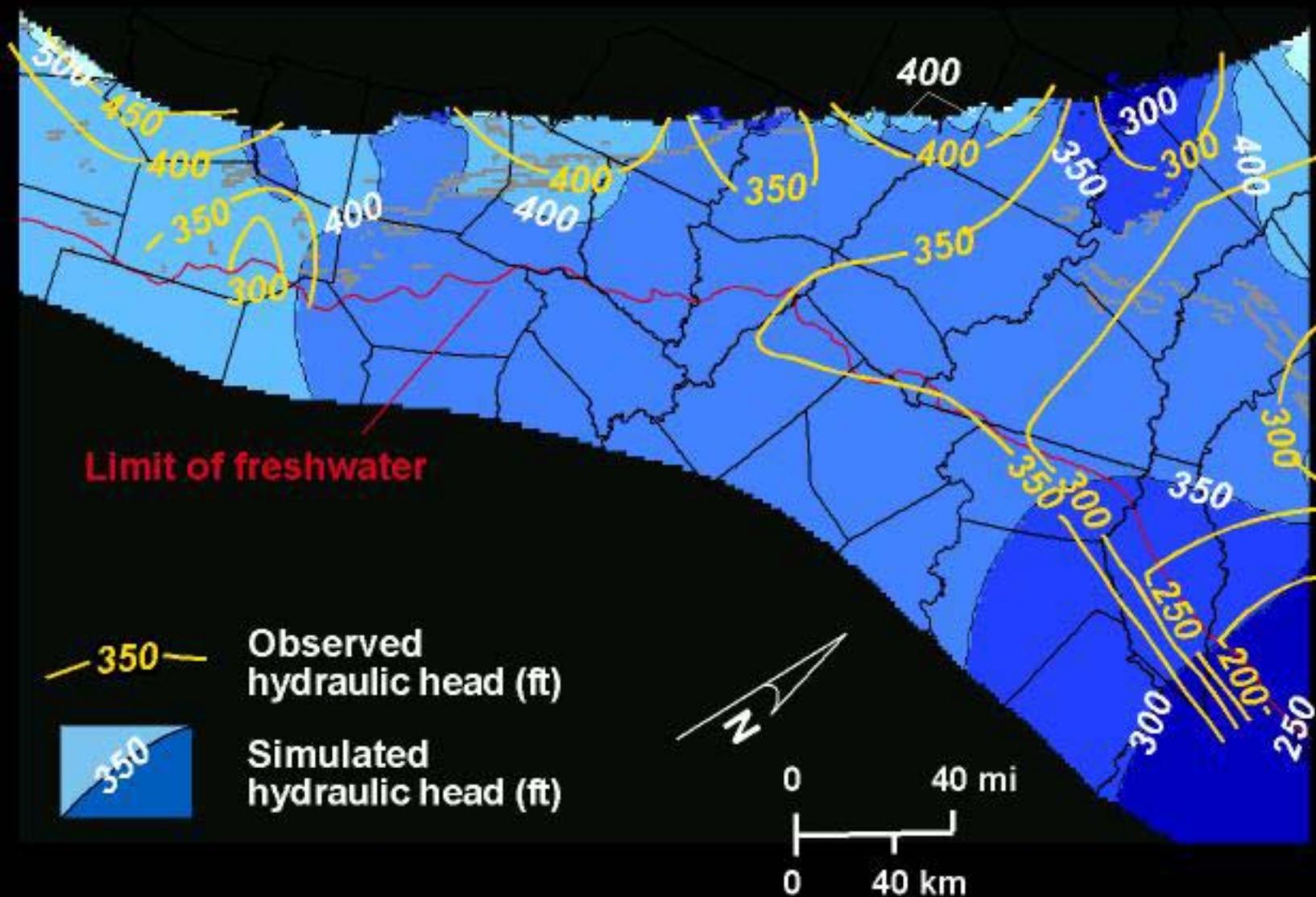
PREDEVELOPMENT POTENTIOMETRIC SURFACE

Simsboro aquifer



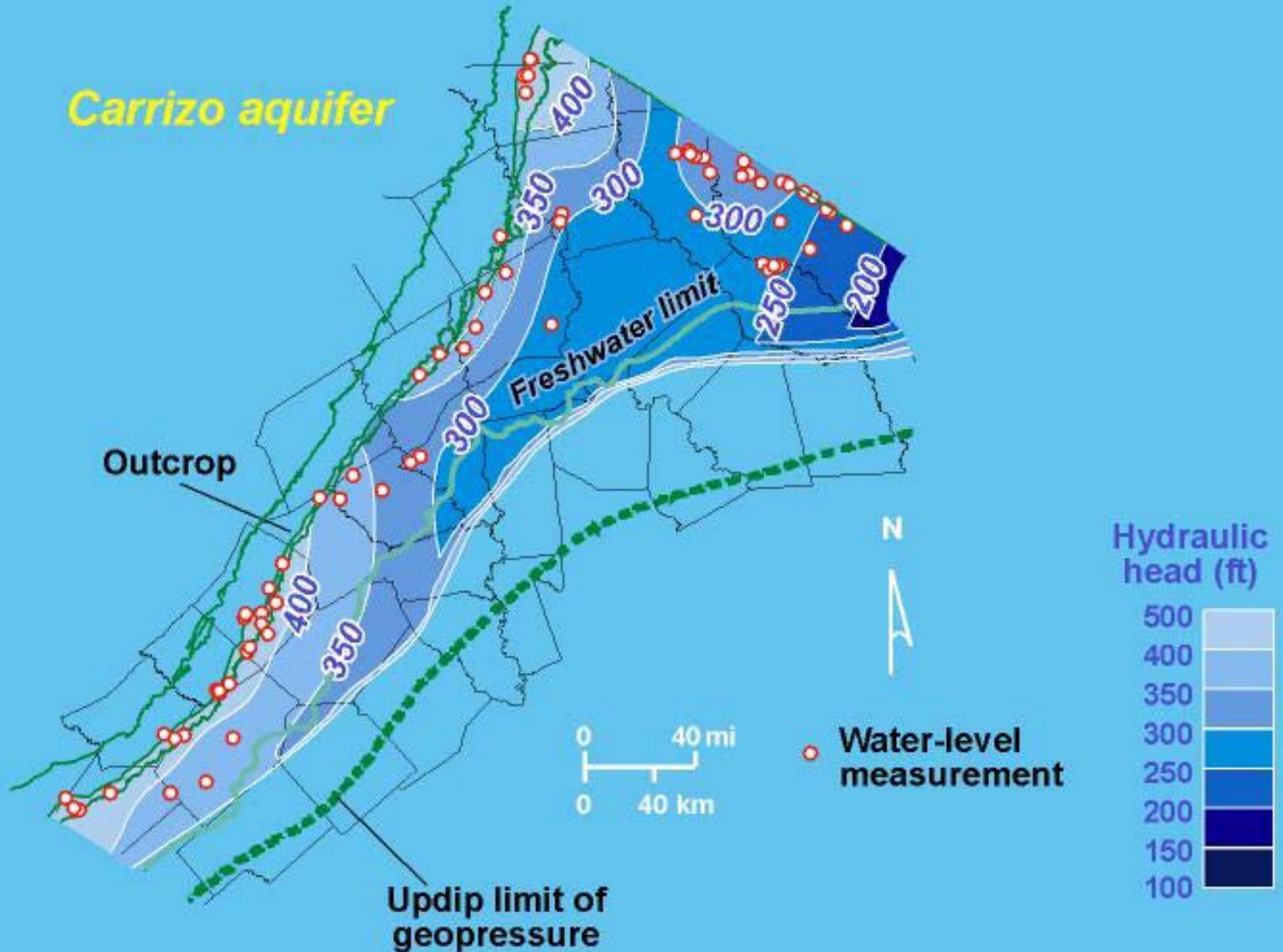
STEADY-STATE CALIBRATION

Simsboro Potentiometric Surface



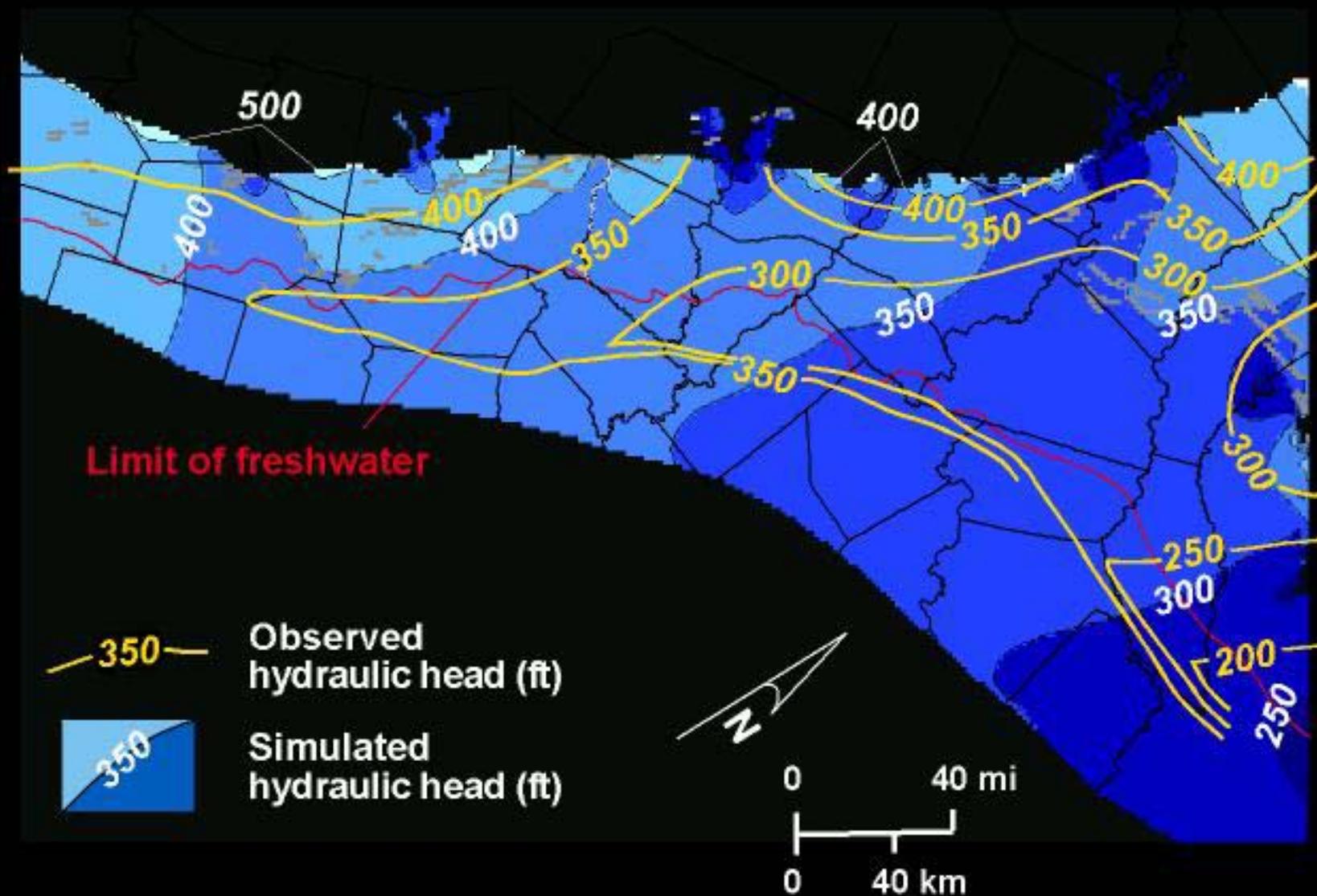
PREDEVELOPMENT POTENTIOMETRIC SURFACE

Carrizo aquifer



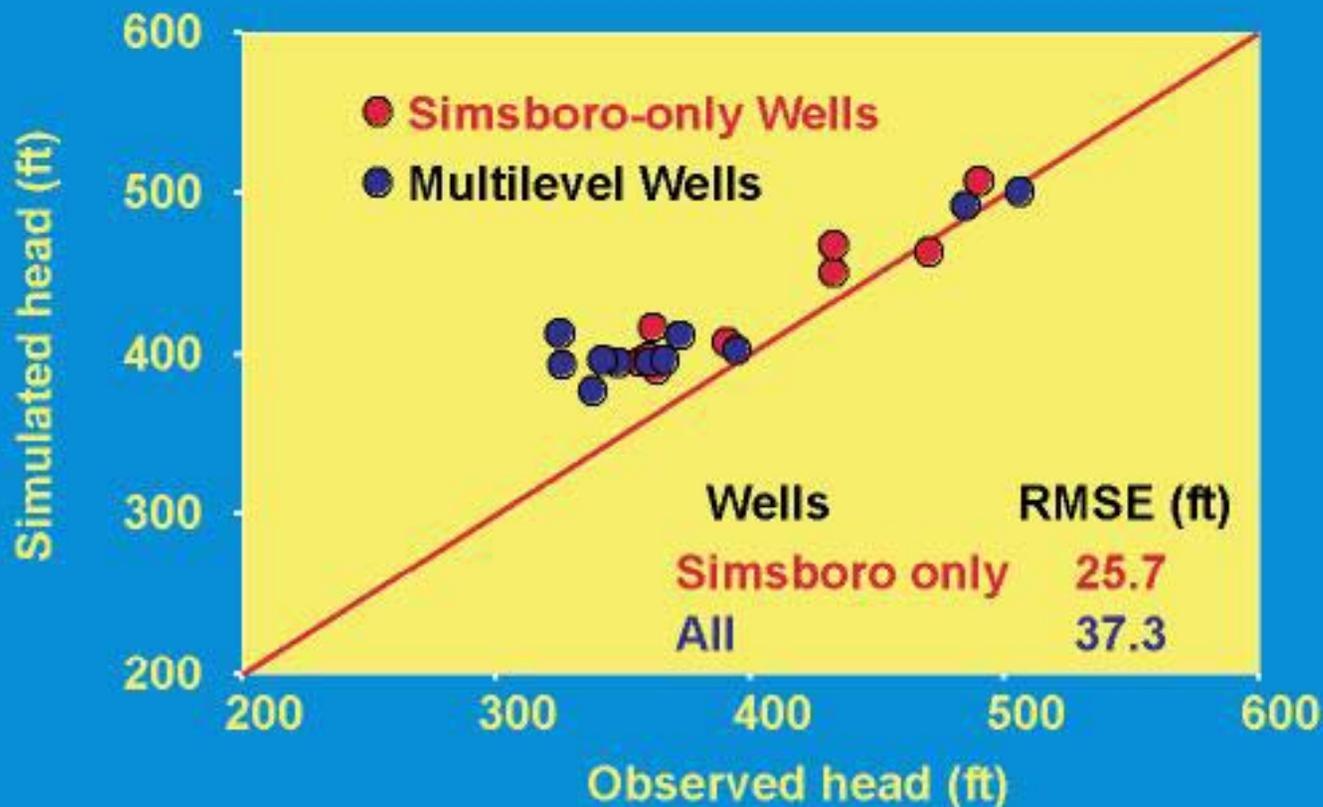
STEADY-STATE CALIBRATION

Carrizo Potentiometric Surface



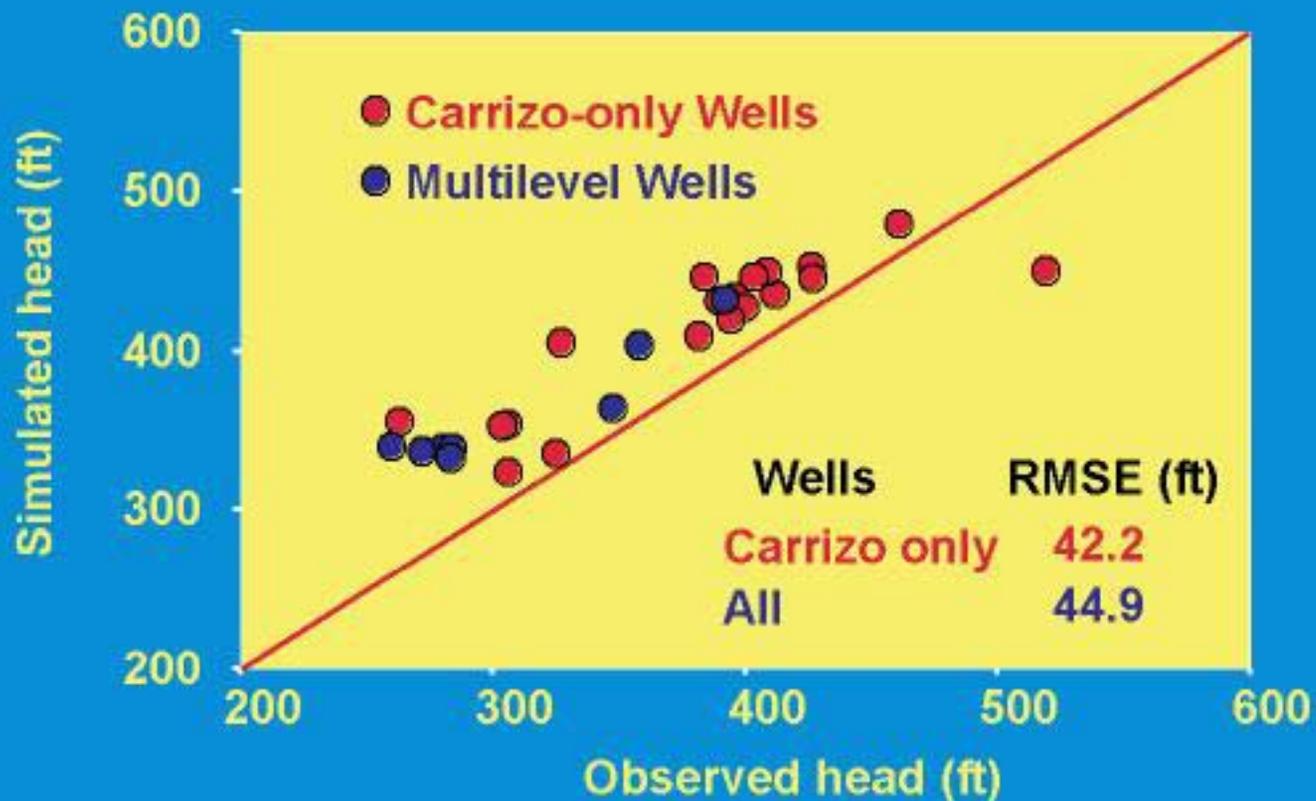
SIMULATED VS. OBSERVED WATER LEVELS

Simsboro Layer 5



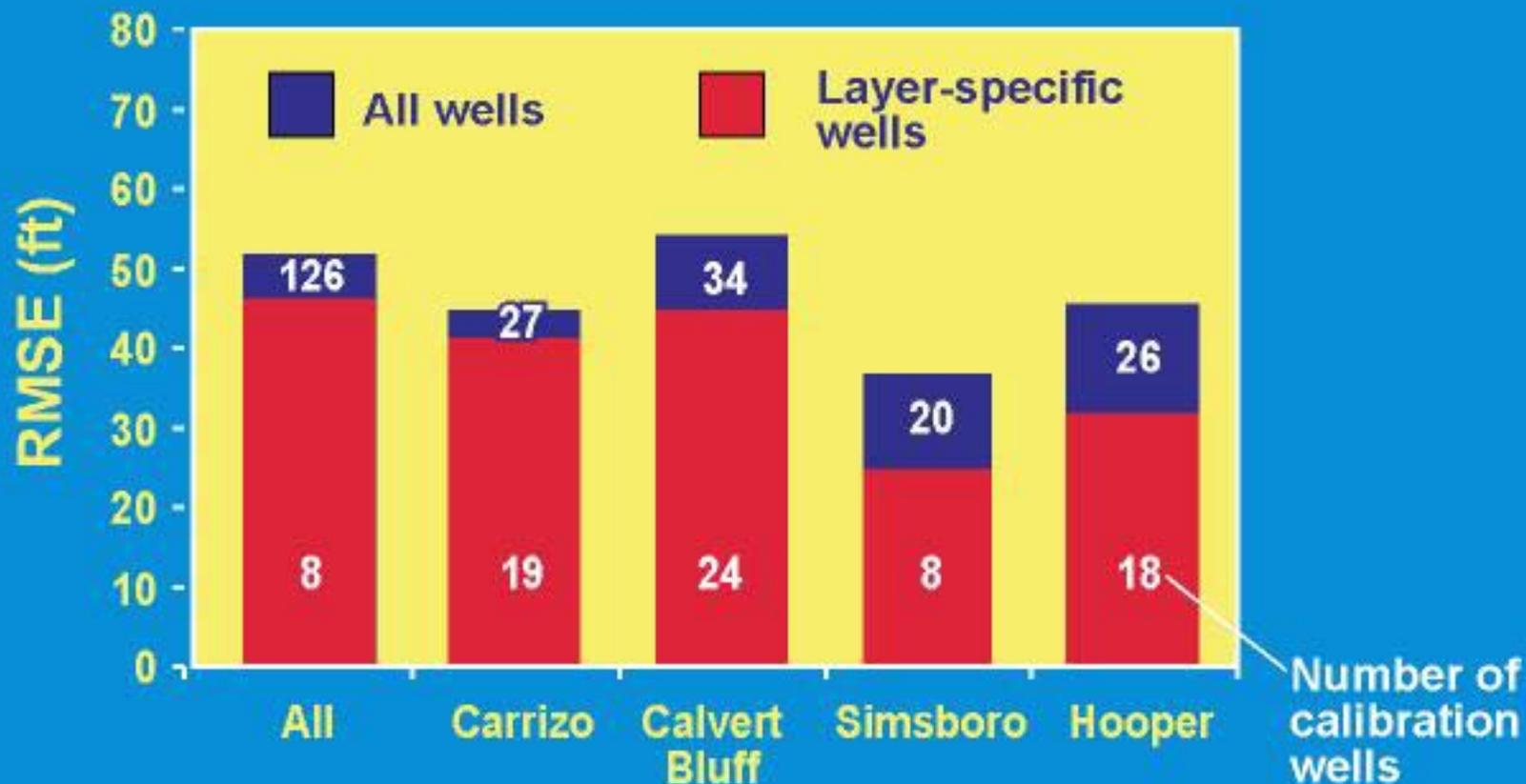
SIMULATED VS. OBSERVED WATER LEVELS

Carrizo Layer 3



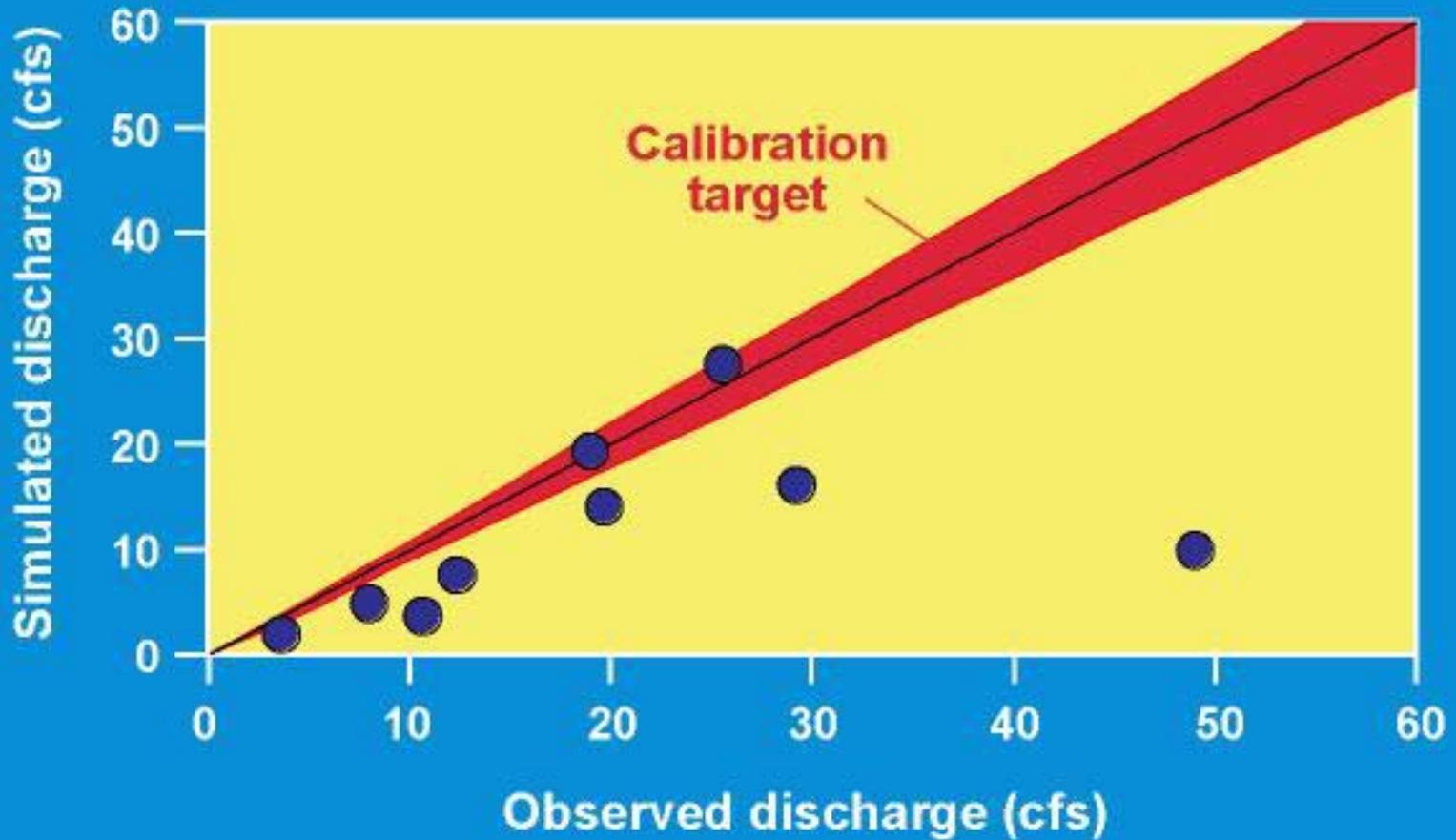
STEADY-STATE CALIBRATION

Root Mean Square Error (RMSE) as of June 17, 2002



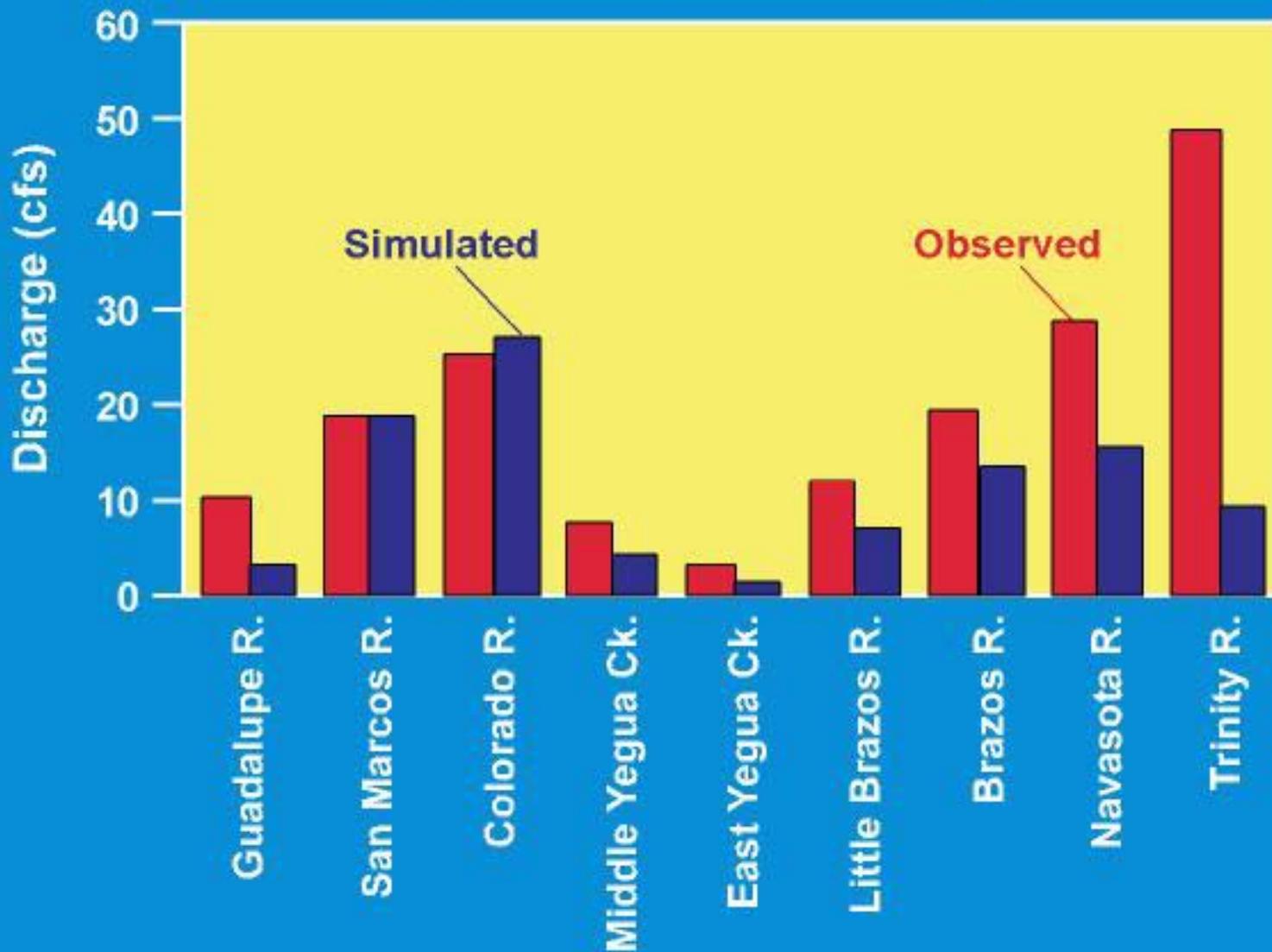
RIVER CALIBRATION

Groundwater Discharge



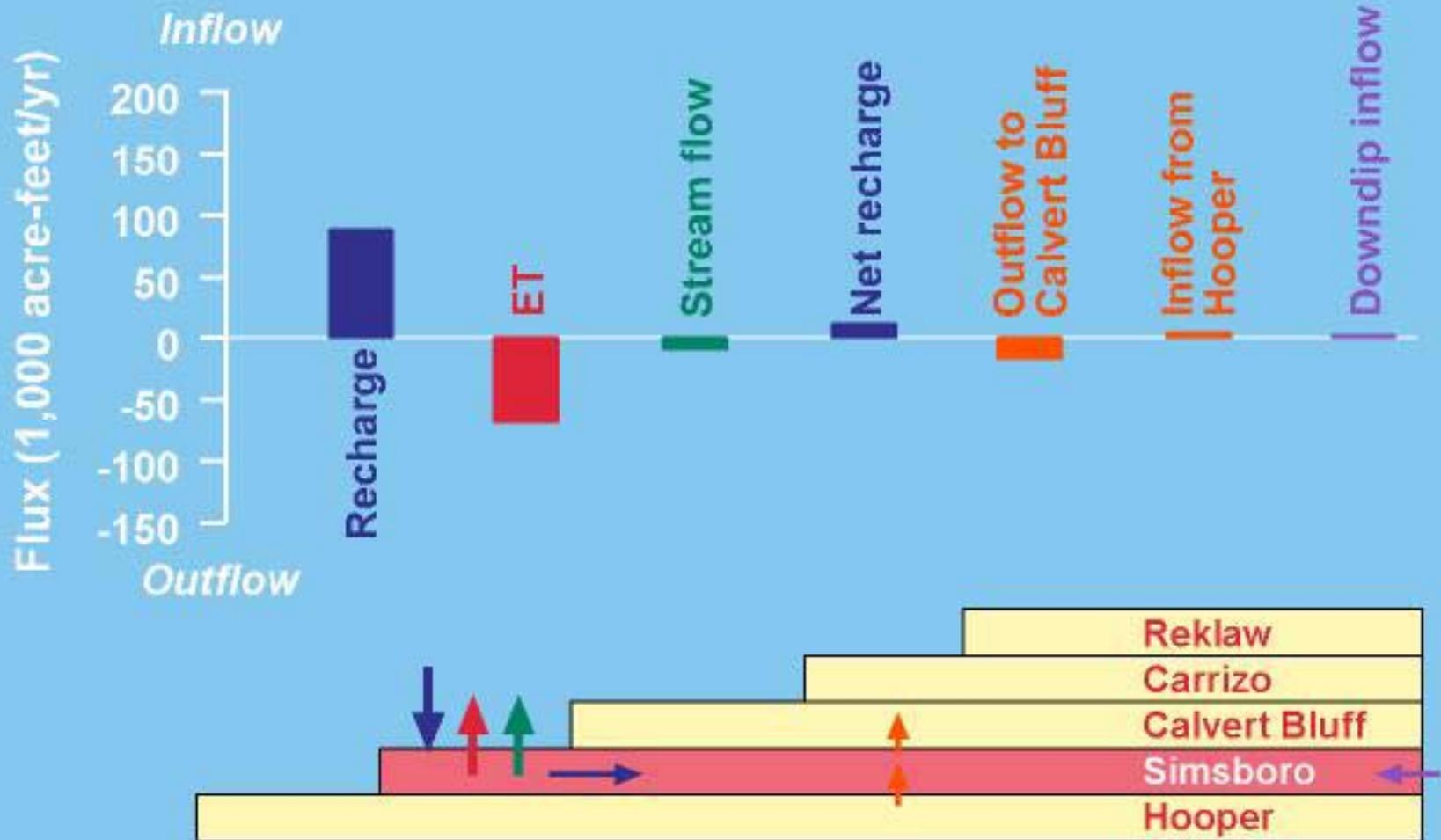
RIVER CALIBRATION

Groundwater Discharge



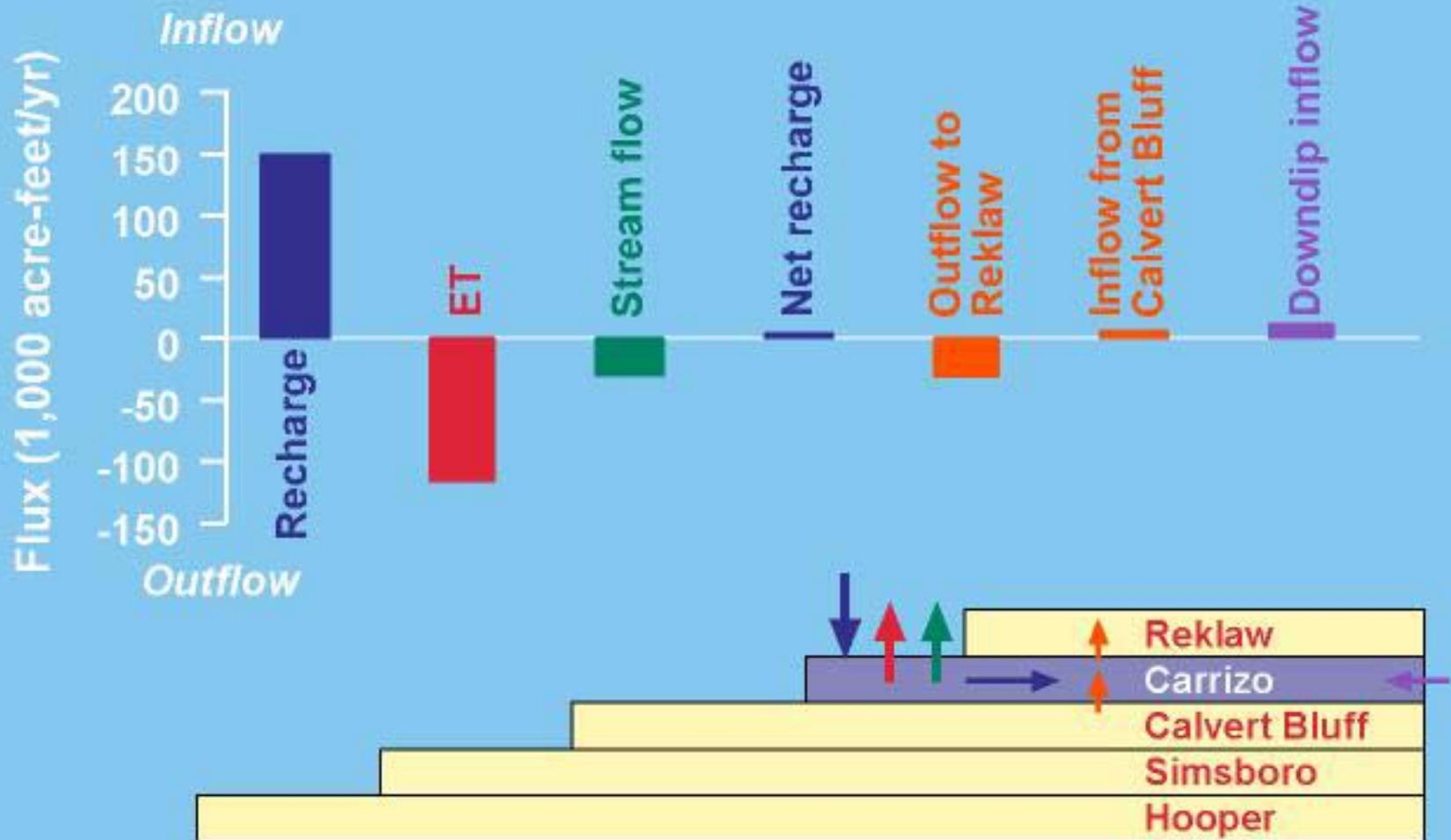
MODEL WATER BUDGET

Simsboro



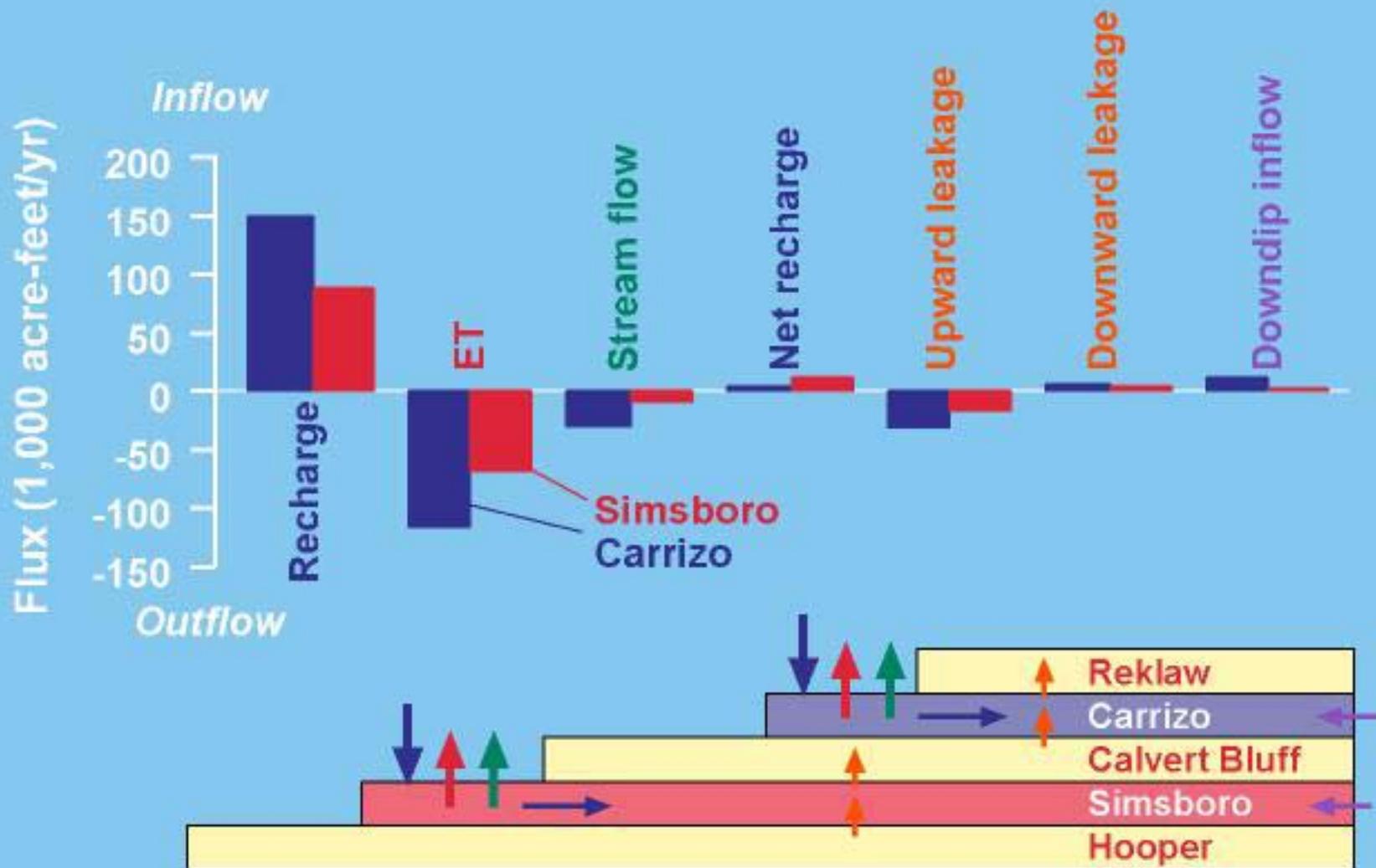
MODEL WATER BUDGET

Carrizo



MODEL WATER BUDGET

Steady State Calibration



STATUS OF WORK

- **Steady-state calibration in progress**
- **Trial-and-error adjustment continues pending TWDB approval**
- **Transient calibration data sets nearly ready**
- **Preparation of first part of draft report underway**

REMAINING WORK

- **Steady state calibration**
 - **Select “best” version**
 - **Sensitivity analyses**
- **Transient history calibration**
 - **Finish pumping history input files**
 - **Model adjustments to “best” match hydrographs and baseflow**
- **Verification runs**
- **Predictive models**
- **Report preparation**

SCHEDULE

- **June**
 - Complete steady state model calibration
- **July-August**
 - Complete transient model calibration
- **August**
 - Complete sensitivity analyses, verification runs, and predictive models
- **August-September**
 - Report preparation

**Minutes of Stakeholder Advisory Forum (SAF)
Central Carrizo-Wilcox Aquifer Groundwater Availability Model**

**Forum No. 5
Thursday, June 20, 2002, at 10 a.m.
LCRA Riverside Campus
Bastrop, Texas**

The fifth Stakeholder Advisory Forum (SAF) for the Central Carrizo-Wilcox Aquifer Groundwater Availability Model (GAM) was held on June 20, 2002, from 10:00 to 12:00 a.m. at the LCRA Riverside Campus in Bastrop, Texas. Thanks go to Dr. Jobaid Kabir of LCRA in arranging for the SAF to meet at the LCRA Riverside Campus. Appendix A of these forum minutes lists participants who signed the attendance sheet.

This fifth SAF meeting continued on discussions held at previous meetings and focused on recharge estimates and preliminary results of steady-state model calibration. The presentation materials are available in a file named "SAF5_CW-c.pdf" at the project web site at http://www.twdb.state.tx.us/GAM/czwx_c/czwx_c.htm.

Meeting Introduction:

Alan Dutton of the Bureau of Economic Geology (BEG) opened the meeting and introduced other participants present for the BEG modeling team, including Bob Harden from R. W. Harden and Associates, Inc., and Jean-Philippe Nicot and Katherine Kier from BEG. Robert Mace, the Program Manager at the Texas Water Development Board (TWDB)

SAF Presentation:

The following summarizes the discussion of questions, answers, comments, and expressed concerns. Discussion focused on recharge rates, comparison of the central model to the northern and southern models, and the results of the model-calibration effort.

Recharge

The Bureau summarized field estimates of recharge (slide 9). Of seven tests, half came out very low whereas the others suggested rates of approximately 1 inch/year. There was no apparent match with the south-to-north increase in precipitation. Additional analysis is needed to evaluate and confirm these estimates. Questions remain regarding how representative are these estimates for the whole Simsboro outcrop and how to scale the estimates for the 1-mi² model cells. Also, recharge rate applied in the calibrated model may end up being different from these preliminary field estimates.

QUESTION: Could recharge estimates in the northern part of the aquifer's study area be low because of clay hardpans, which might be especially developed in the higher rainfall areas?

ANSWER: Variations in soil permeability, as mapped using STATSGO data and including the properties of the hardpan layer (B-soil horizon), do not appear to be great enough to compensate for the greater precipitation. So, while soil properties undoubtedly have an influence on recharge rate, they cannot be the sole explanation for the estimated recharge rate.

QUESTION: Could vegetation be a factor in the low recharge rates reported at the three boreholes in the northern part of the aquifer?

ANSWER: Vegetation have a major effect on the soil-water budget and may help explain why there is no an apparent change in recharge rate from south to north across the Simsboro outcrop. However, similar sites in grassland settings were selected. Most sites had been cleared of trees for several decades.

QUESTION: Could rejection of recharge be a factor as to why the three boreholes in the northern part of the aquifer study area showed no recharge?

ANSWER: The recharge estimates are based on measurements taken above the water table. Recharge is the rate at which water enters the water table. Rejected recharge is the amount of recharge that ends up being discharged to springs and seeps and to rivers and creeks in the outcrop, or discharged by evapotranspiration (ET) in river bottomlands, and so does not make it into the confined part of the aquifer down dip of the outcrop. So the estimates of recharge from these field tests are estimates of the original input into the aquifer, not of rejected recharge.

QUESTION: How representative are the recharge estimates for the whole aquifer?

ANSWER: The sites were in open fields several (4 or 5) acres in extent. There is variation within and between each site that make it risky to state that these estimates perfectly describe the expected recharge rate across the entire outcrop of the Simsboro. Seven measurements were taken so far. Three have been discounted for reporting no recharge. So that leaves four that are being used, but statistically that's not really a good representation for the entire study area. It would be a long-term goal to have more field-based estimates in the study area. Also, other methods for estimating recharge should be further explored.

QUESTION: How much does the recharge rate vary through time?

ANSWER: The estimate of approximately 1 inch per year averages recharge rate over the last 40 to 50 years. We so far have not tried to interpret variations in recharge rate within those 40 to 50 yr.

QUESTION: Since you're using chloride levels to calculate recharge in the soils, have the chloride levels changed significantly within the last 40-50 years to affect comparisons?

ANSWER: These preliminary estimates of recharge are based on reported chloride concentration in precipitation in 2000. Data were from the National Atmospheric

Deposition Program web site. Chloride concentrations were calculated using conventional methods. There are some variations in chloride in precipitation over the years, but part of that variation may be an artifact of the monitoring network having changed. In making the recharge calculation we assumed changes in chloride in precipitation were negligible.

QUESTION: Is tritium testing not to be conducted on samples now?

ANSWER: We have not yet received results from three groundwater samples taken at the water table. Three of the test holes went to the water table and temporary well casing were installed to allow samples to be pumped.

QUESTION: How good are the available recharge rates?

ANSWER: There are very few field measurements of recharge in any Texas aquifer. Those recharge rates are summarized in an 84-page document labeled "RechRept.pdf" and found at the TWDB's website (<http://www.twdb.state.tx.us/gam/resources/resources.htm>). Our estimates are consistent with or in the same ballpark as previous estimates of recharge in the Carrizo-Wilcox aquifer, most of which were estimates from modeling. There are questions of whether these few measurements are representative of the whole aquifer. As previously stated, it is better to start collecting data on this important rate than to continue to solely rely on model calibration.

QUESTION: Is recharge to be equally distributed over the entire outcrop area?

ANSWER: Recharge is assumed to be greater in the sandy Simsboro and Carrizo Formations than in the more clay-rich Calvert Bluff and Hooper Formations.

Comparison of the central (BEG) model to the northern and southern models (by Intera)

QUESTION: In terms of the recharge rate and water budget, how does BEG's model compare to Intera's?

ANSWER: BEG has not reviewed the modeled water budgets for the northern and southern models. BEG is using the approximate 1 inch/yr as an estimate in model calibration, subject to change. Other previous models (TWDB, USGS) used recharge rates of 1 to 4 inches per year in upland areas. We expect Intera's estimates would be about the same.

QUESTION: Is Intera's approach to estimating recharge similar to BEG's?

ANSWER: Intera used a GIS-based approach that considered slope, vegetation, soils, and other factors. This method worked well for the southern model but not so well for the northern area. There has been quite coordination between BEG and Intera especially in setting up the models and defining the elevations of layers. We are still comparing other data sets.

QUESTION: How well does the BEG's central Carrizo-Wilcox model correlate with Intera's northern and southern models?

ANSWER: We have not yet made a formal comparison of all three models in their overlap areas. We need to complete the calibration of the central model.

QUESTION: Will what happens in the northern and southern parts of the aquifer, especially in Mexico and Louisiana, have a big influence on the central Carrizo-Wilcox?

ANSWER: What happens as far away as Mexico and Louisiana will probably not affect the central model very much. However, what happens in the aquifer in the counties adjacent to the central model area would be of interest. BEG and Intera will have to look at the model overlap areas and ensure the model boundaries are being treated appropriately.

Results of the model-calibration effort

QUESTION: Are interested parties going to be able to predict what the water levels will be in the aquifer in the next 30 to 40 years?

ANSWER: That ability is the goal of the GAM program in general and of the Central Carrizo-Wilcox GAM study. That is, to provide a quantitative, scientific model that Stakeholders will have confidence in using to predict water levels.

QUESTION: Are we on schedule for the model? When will there be a draft available?

ANSWER: Right now we are calibrating the model representing predevelopment conditions; we will soon move to calibrating the model against historical changes in the aquifer. Then we will use the model to predict water-level changes through 2050 as an example of applying the model. We are about two months behind schedule right now because of a delay in the steady-state calibration. We have less than three months to finish the steady-state and transient simulations. We are committed to having a draft of the final report out by late September in accordance with our contract with TWDB.

QUESTION: How fast of a turnaround rate is expected for model runs by TWDB?

ANSWER: TWDB is expecting to both (1) distribute copies of the model to groundwater conservation districts, regional water planning groups, and others, and (2) run model simulations on a first come, first serve basis for the groundwater conservation districts, regional water planning groups. Plans are being developed for how TWDB will handle requests for simulations and reporting of results.

QUESTION: When will the model training workshop be?

ANSWER: The model training workshop will be the last scheduled SAF meeting and will be held after the draft report is completed. The workshop will most likely be in November or early December.

**Stakeholder Advisory Forum (SAF)
Central Carrizo-Wilcox Aquifer Groundwater Availability Model**

**Forum Meeting No. 5
Thursday, June 20, at 10 a.m.
LCRA Riverside Campus
Bastrop County, TX**

List of Attendees

<u>Name</u>	<u>Affiliation</u>
Greg Barker	
Russell Bostic	
Pete Brien	Brazos Valley GCD
Alan Dutton	BEG
Larry French	URS
Michele Gangnes	
Bob Harden	RW Harden & Assoc
Bob Kier	Robert S. Kier Consulting
Katie Kier	BEG
Dan Kowalski	Walnut Creek Mining Co.
R. Brent Locke	Bistone MUSD
Cliff Lowe	EVWCD
Robert Mace	TWDB
Travis McPhaul	Lost Pines GCD
Ann Mesrobian	Lost Pines GCD
Barry Miller	GCUWCD
Kevin Morrison	SAWS
Jean-Philippe Nicot	BEG
Rodney O'Connor	
Tom Smith	SAWS
Cathy Snider	Neighbors for Neighbors
Shirley Wade	TWDB