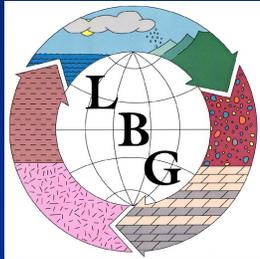
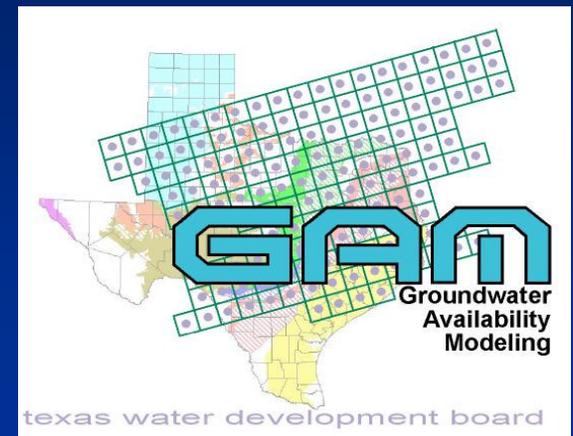


Groundwater Availability Modeling (GAM) for the Lipan Aquifer



LBG-Guyton Associates



Presented to

Stakeholder Advisory Forum

San Angelo, Texas

November 13, 2003

Comments:

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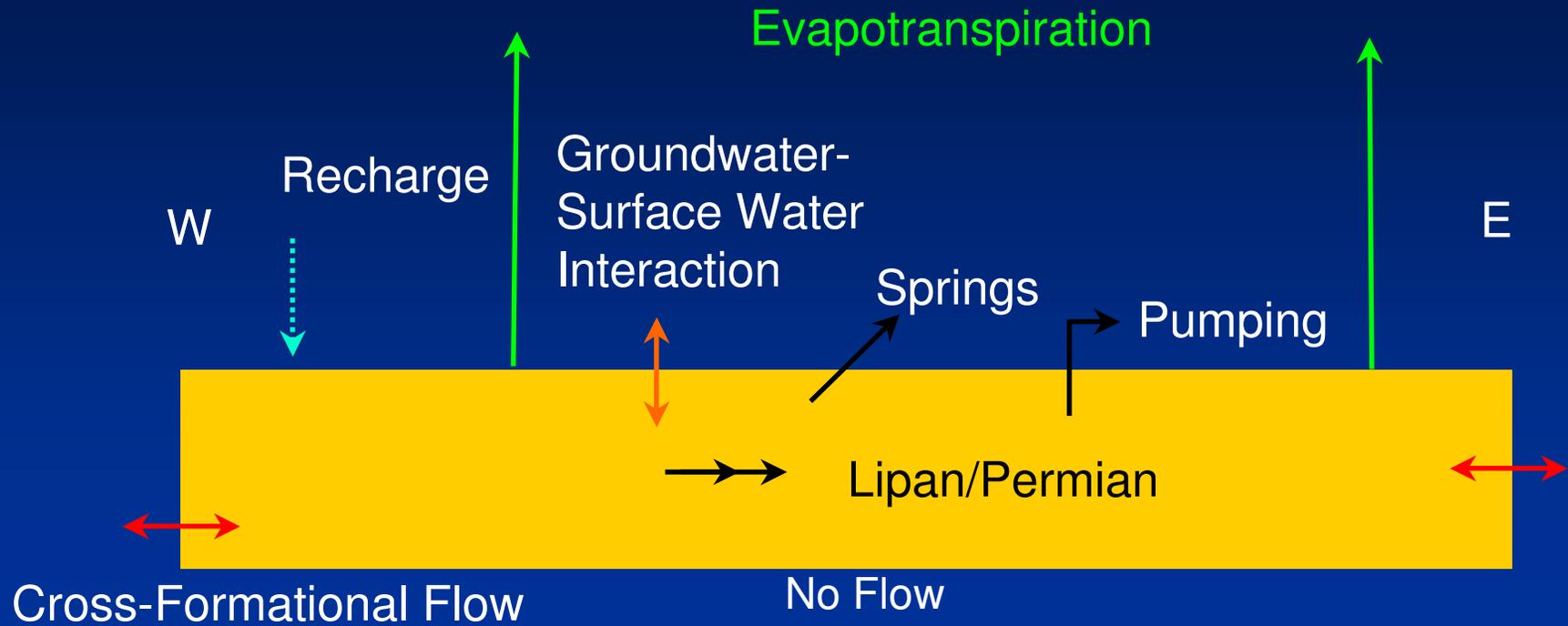
www.twdb.state.tx.us/gam



Review of Conceptual Model



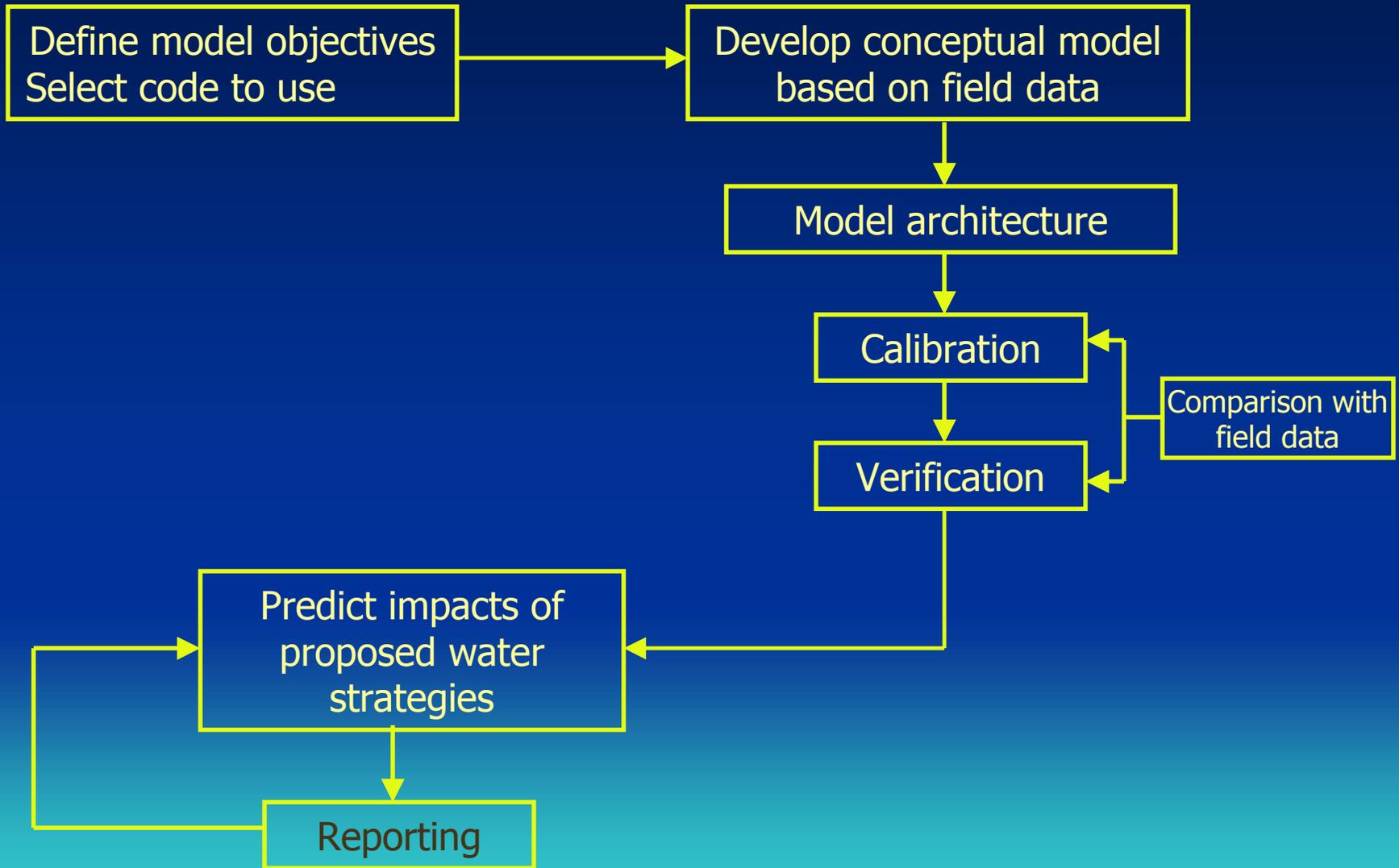
Numerical Model Block Diagram



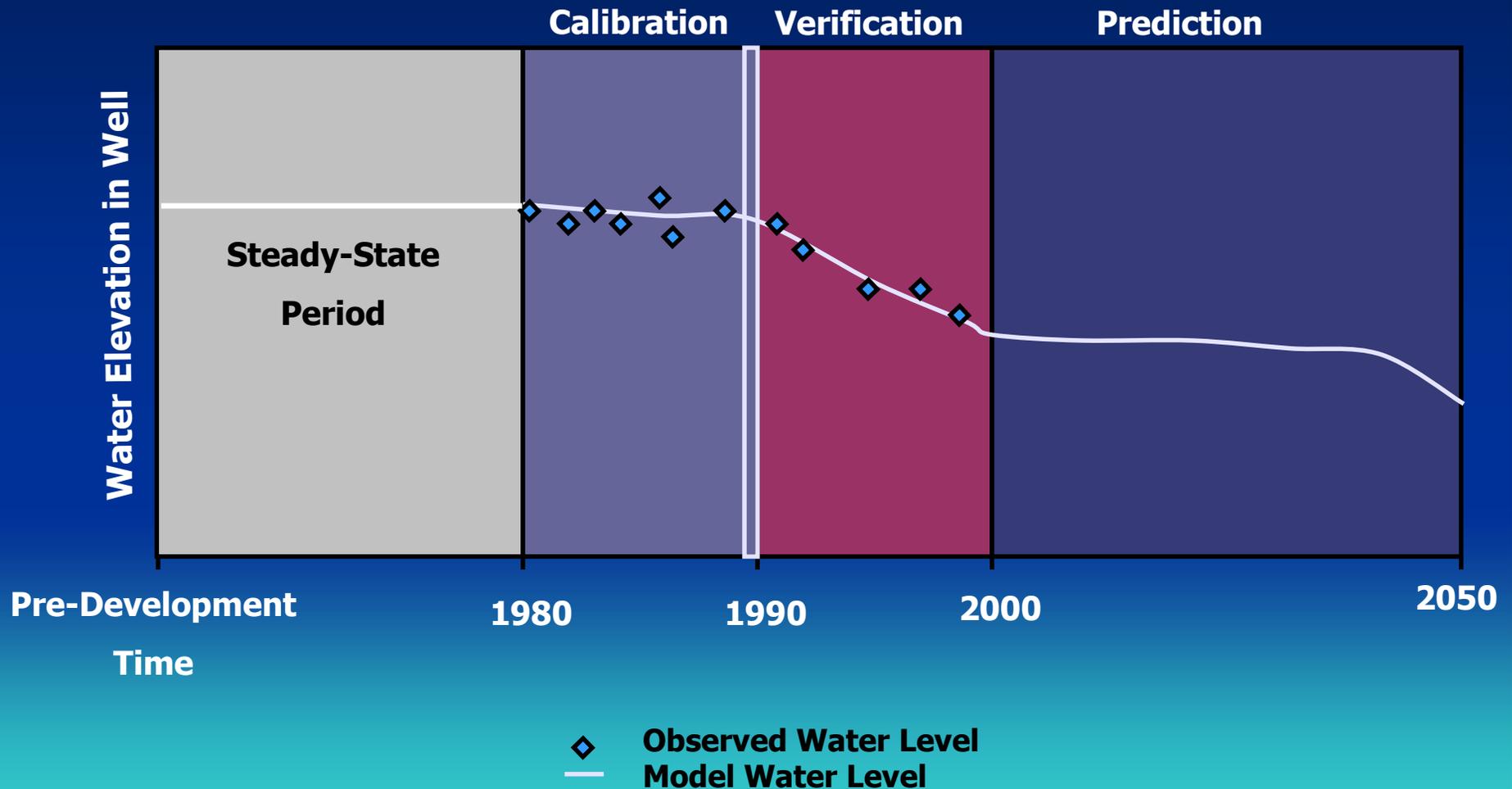
Model Specifications

- Three dimensional (MODFLOW-96)
- Regional scale
- Includes ground/surface water interaction
- Grid spacing = 1/2-mile
- Calibration to within 10% of head drop

GAM Modeling Protocol



Lipan GAM Modeling Periods



Steady-State Time Frame

- Modeled 1980 as Steady-State
- Incorporated 1980 Pumping Stresses
- Prior to 1980 – Very limited water level and pumping data available

Time Frame	Stress Periods	Days
Pre-1980 Steady-State	1	10,000,000 (27,358 years)

Model Architecture



Boundary Conditions and Properties

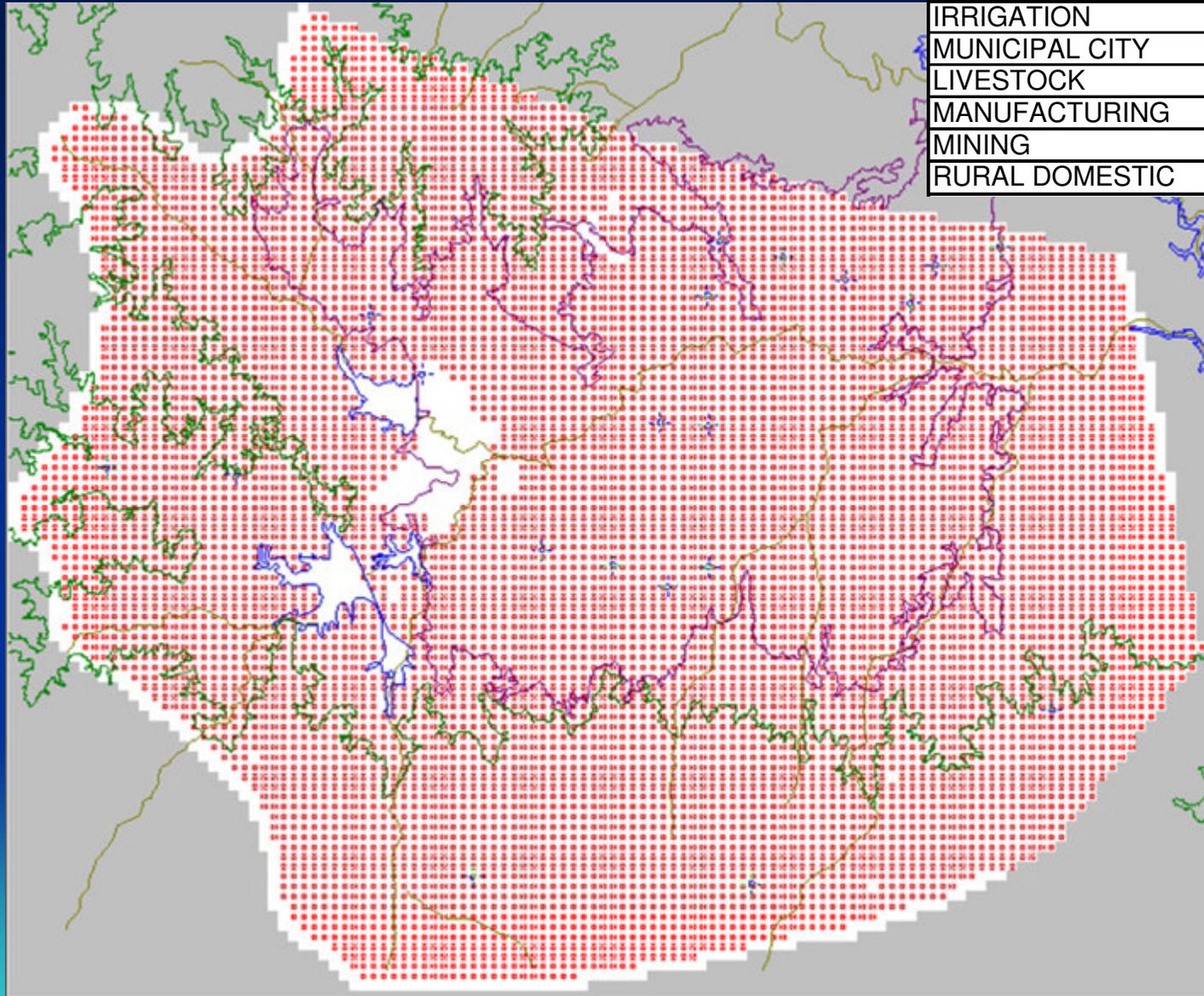
Boundary Conditions

1. Wells
2. Streams
3. Lakes
4. General Head Boundaries
5. Drains

Parameters

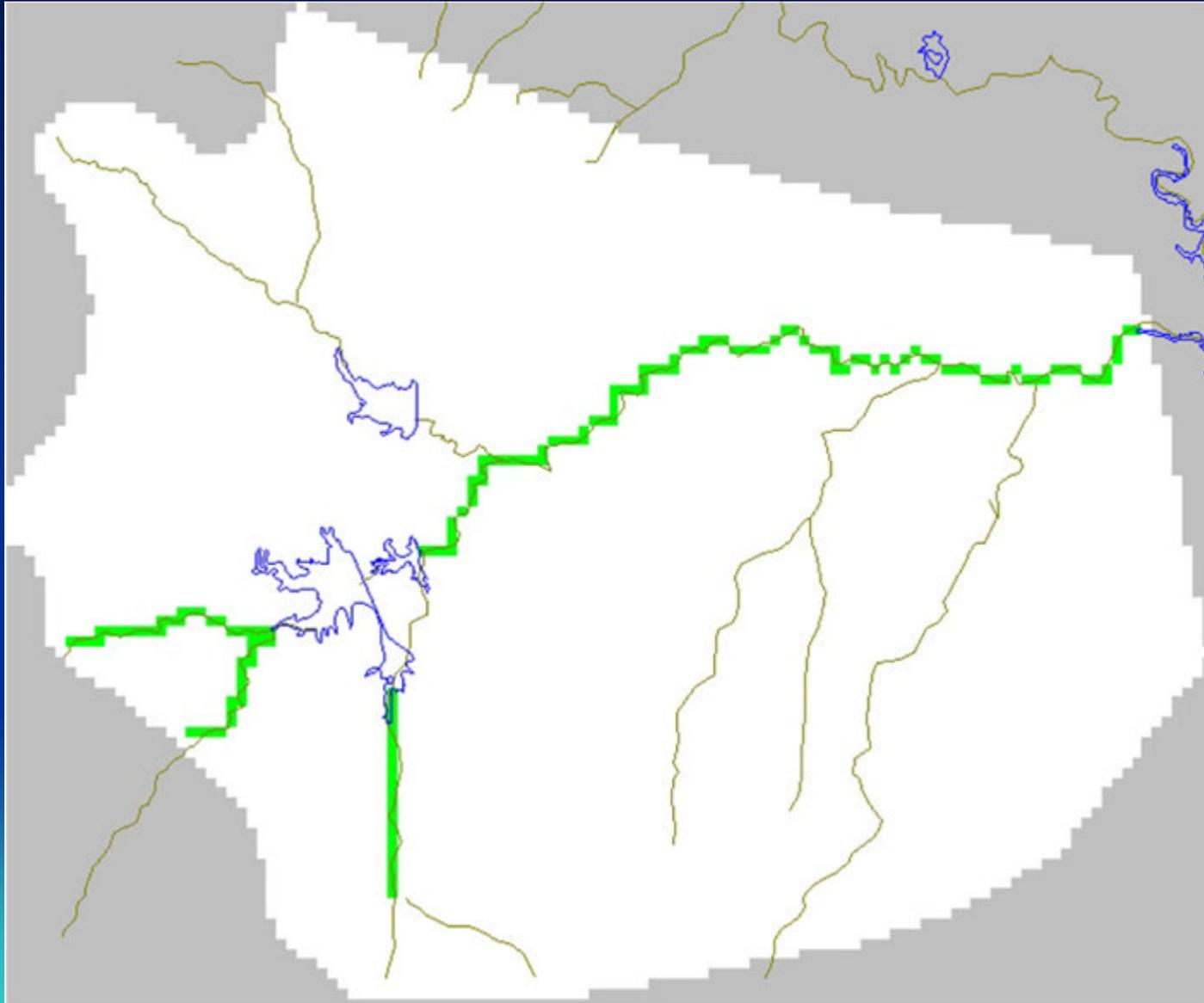
1. Hydraulic Conductivity
2. Recharge
3. Evapotranspiration

Wells

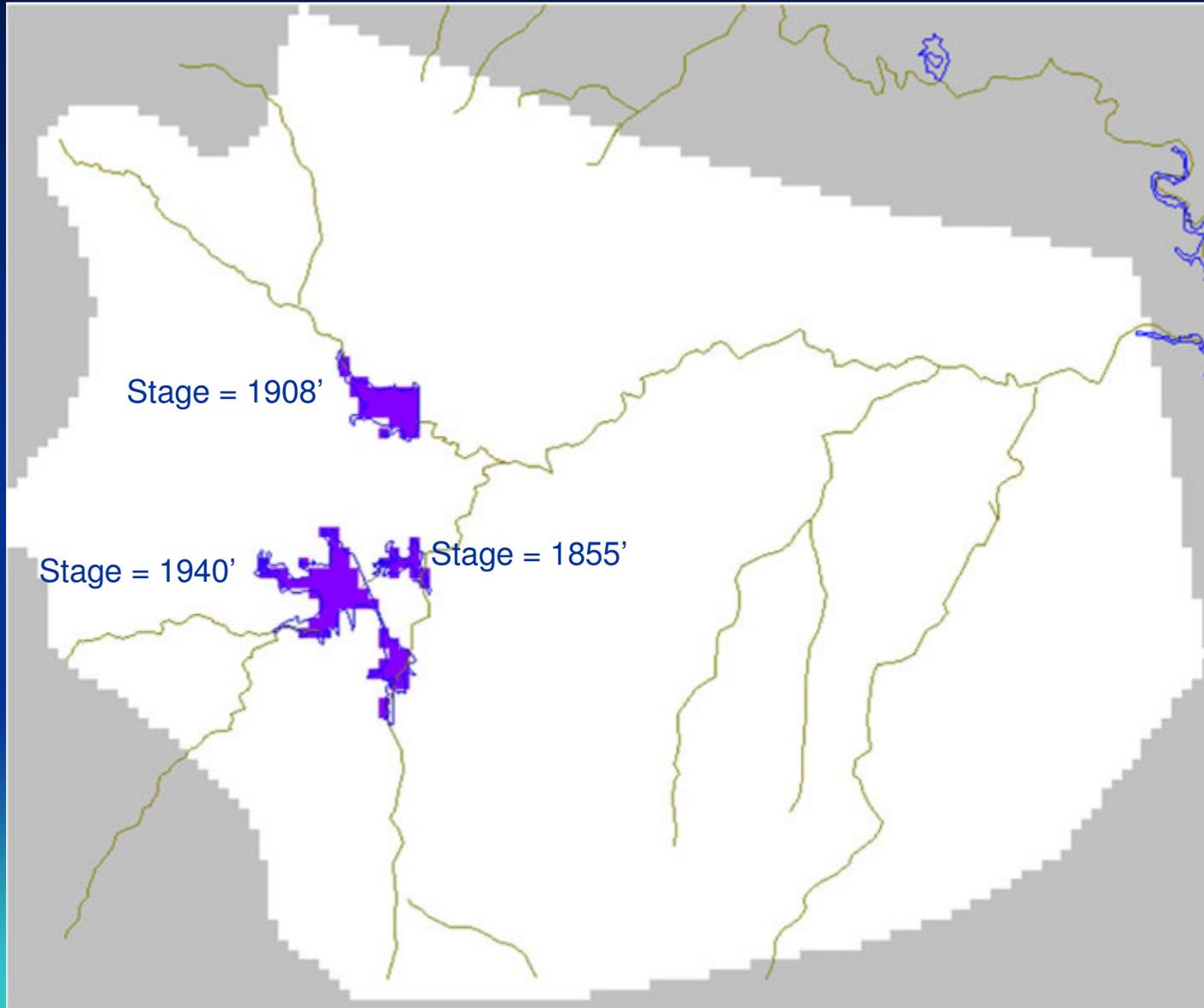


Type	Acre-Feet/yr
IRRIGATION	8990.00
MUNICIPAL CITY	0.12
LIVESTOCK	27.00
MANUFACTURING	44.73
MINING	0.007
RURAL DOMESTIC	1364.36

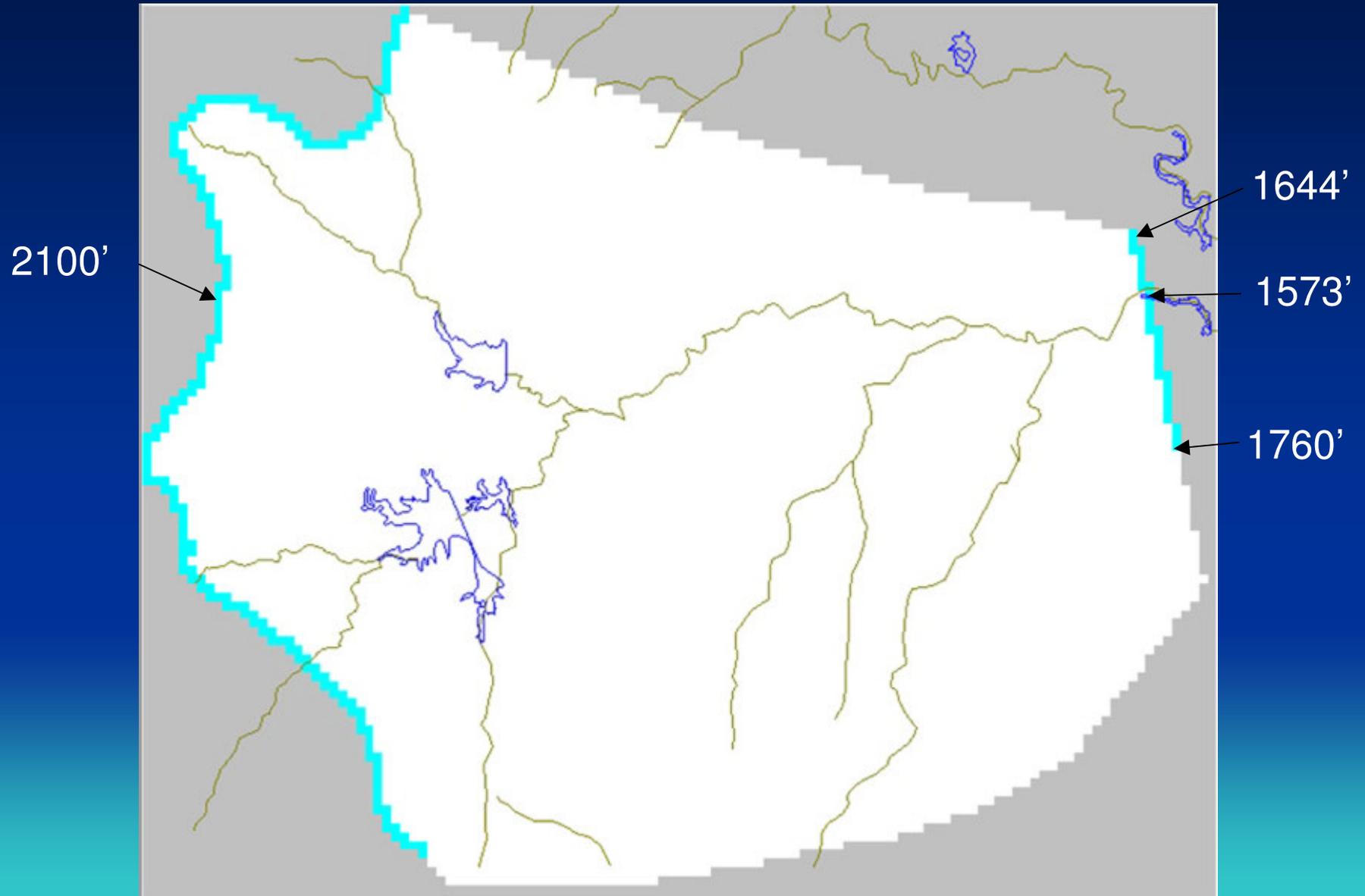
Streams



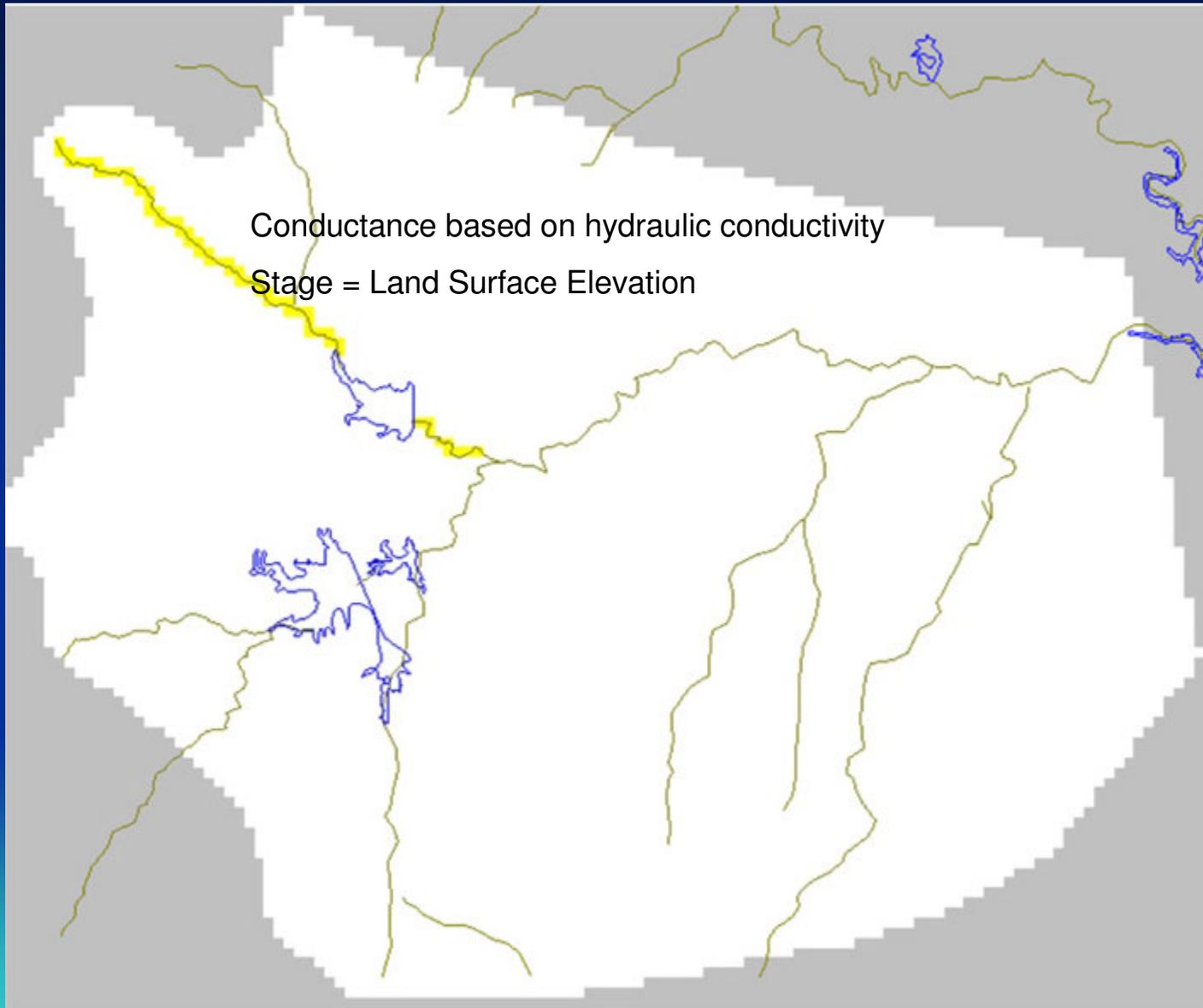
Lakes



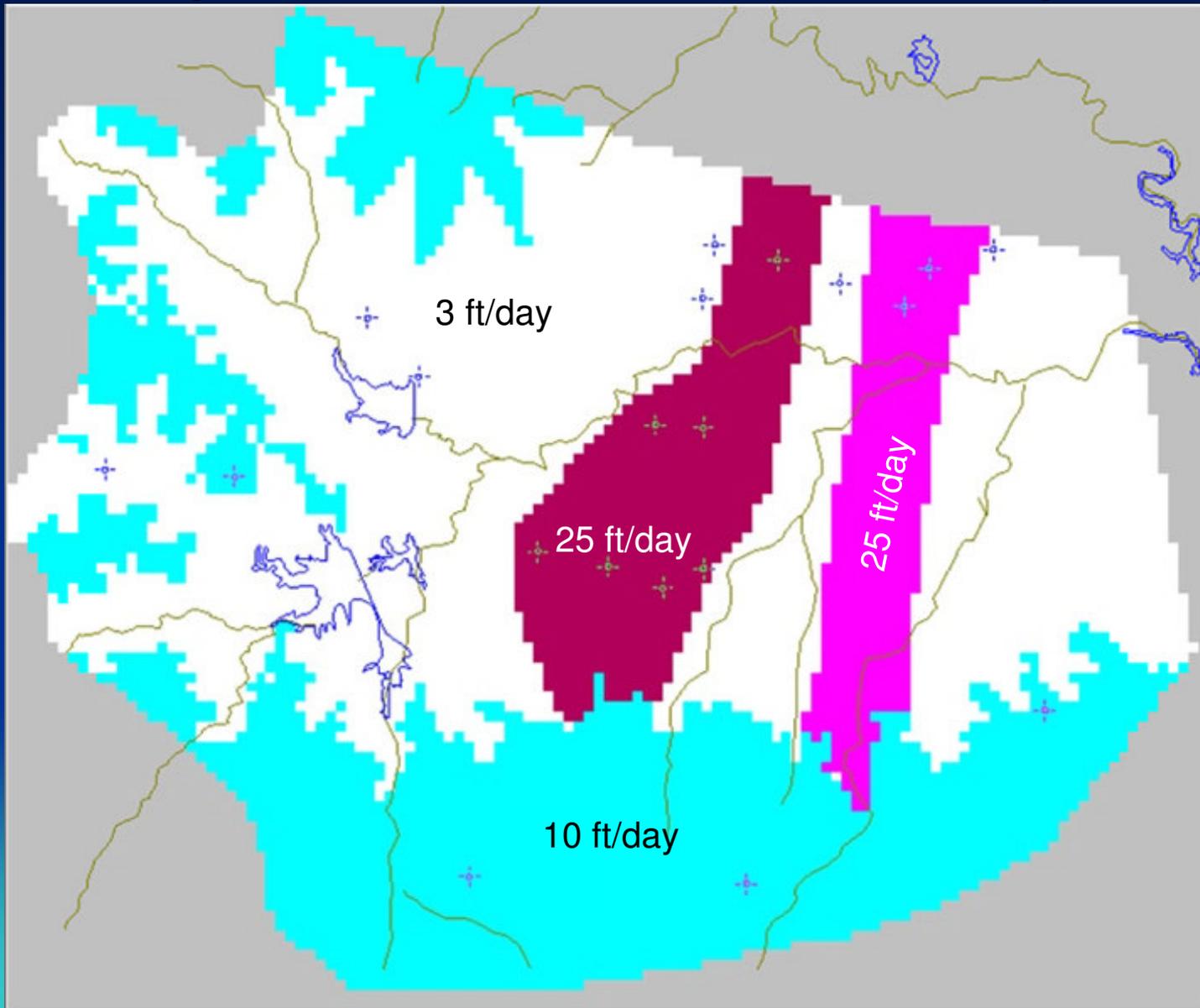
General Head Boundaries



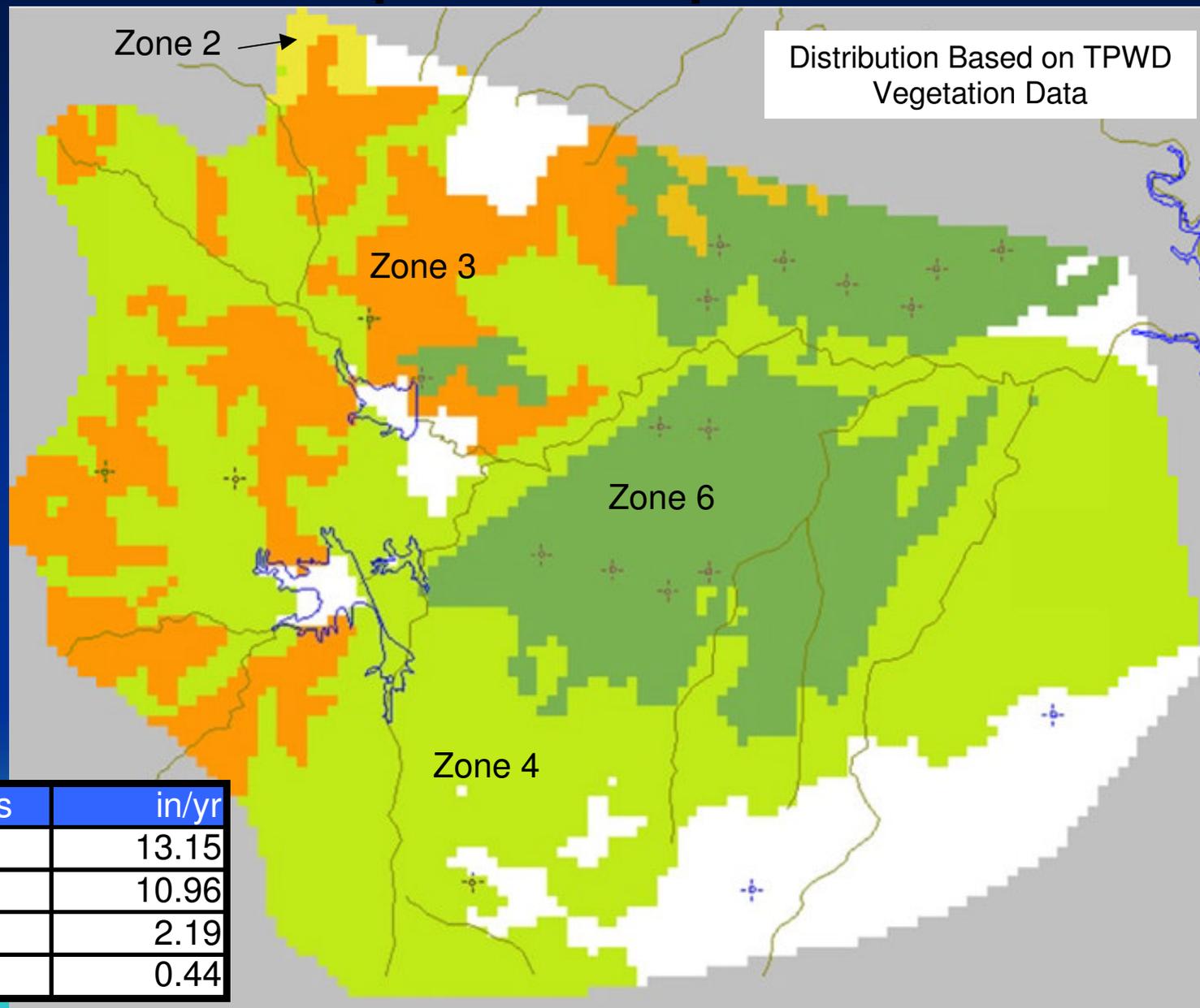
Drains



Hydraulic Conductivity



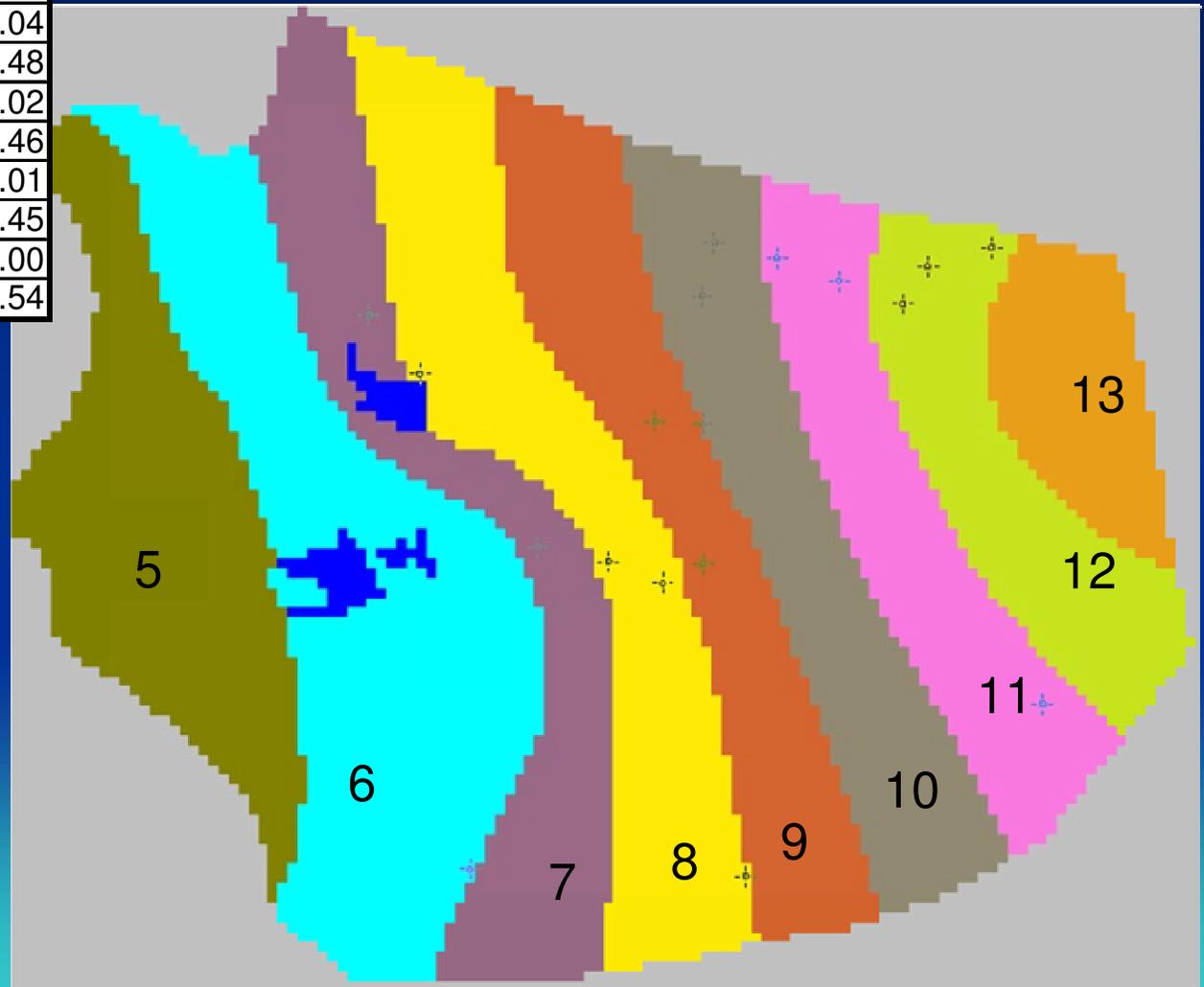
Evapotranspiration



Recharge

Zone	Recharge in/yr	Rainfall in/yr
5	0.41	20.49
6	0.42	21.04
7	0.43	21.48
8	0.44	22.02
9	0.45	22.46
10	0.46	23.01
11	0.47	23.45
12	0.48	24.00
13	0.49	24.54

Recharge =
2% of Rainfall

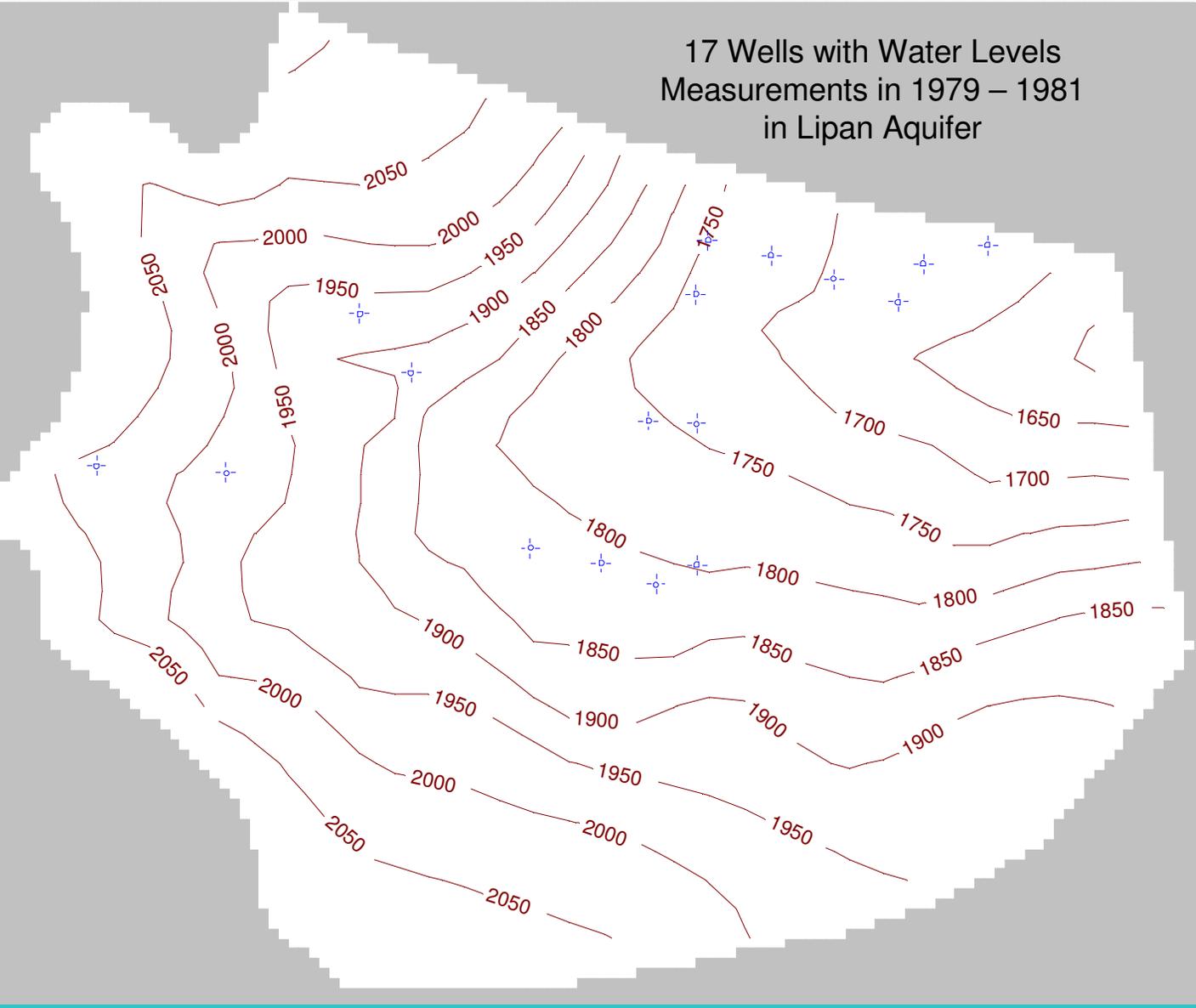


Model Results

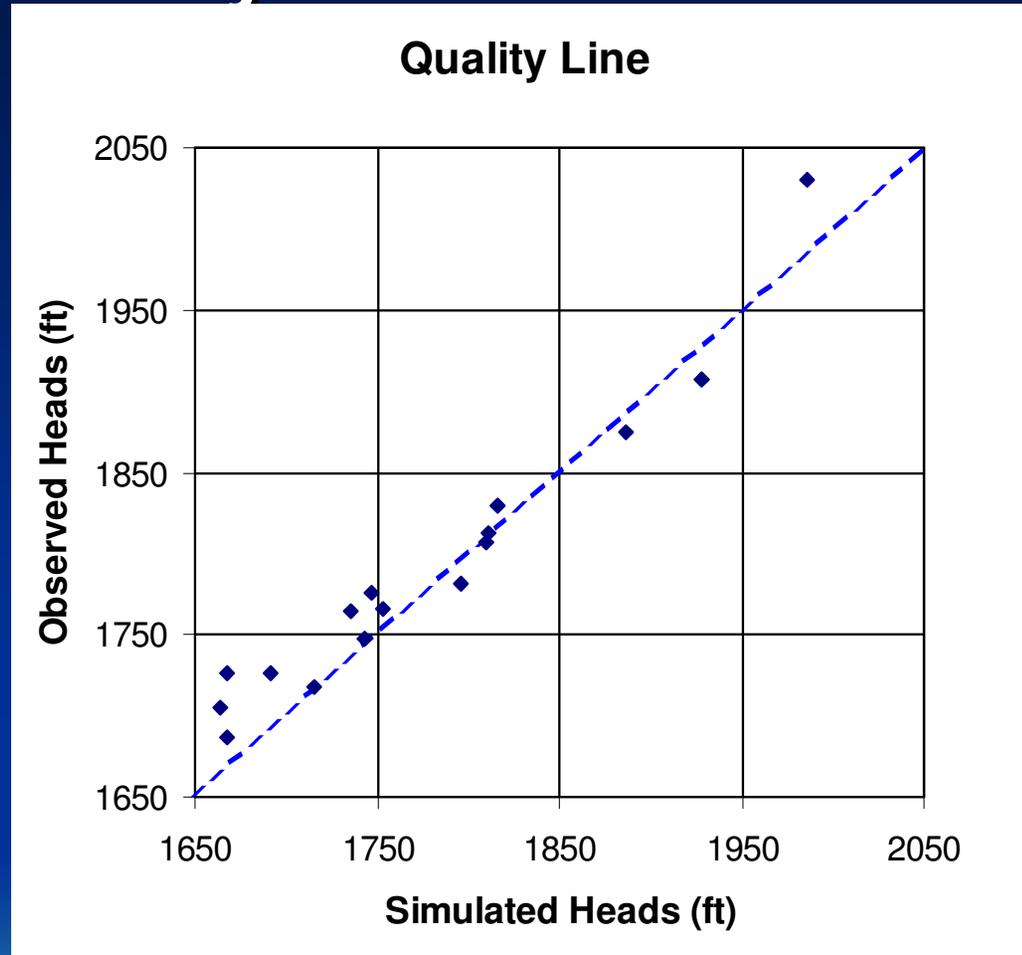


Steady-State Calibration Target Locations

17 Wells with Water Levels Measurements in 1979 – 1981 in Lipan Aquifer

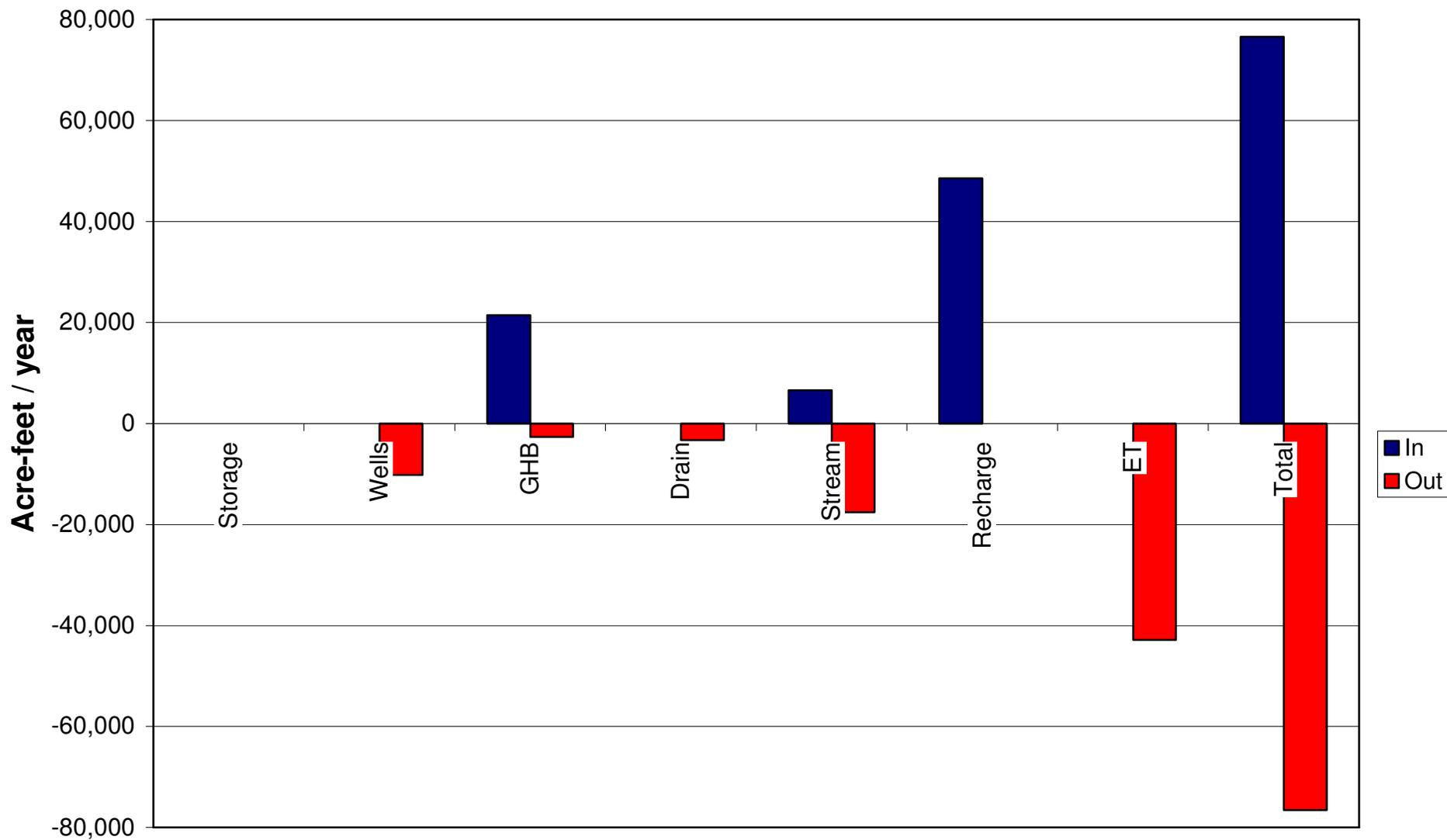


Analysis of Calibration

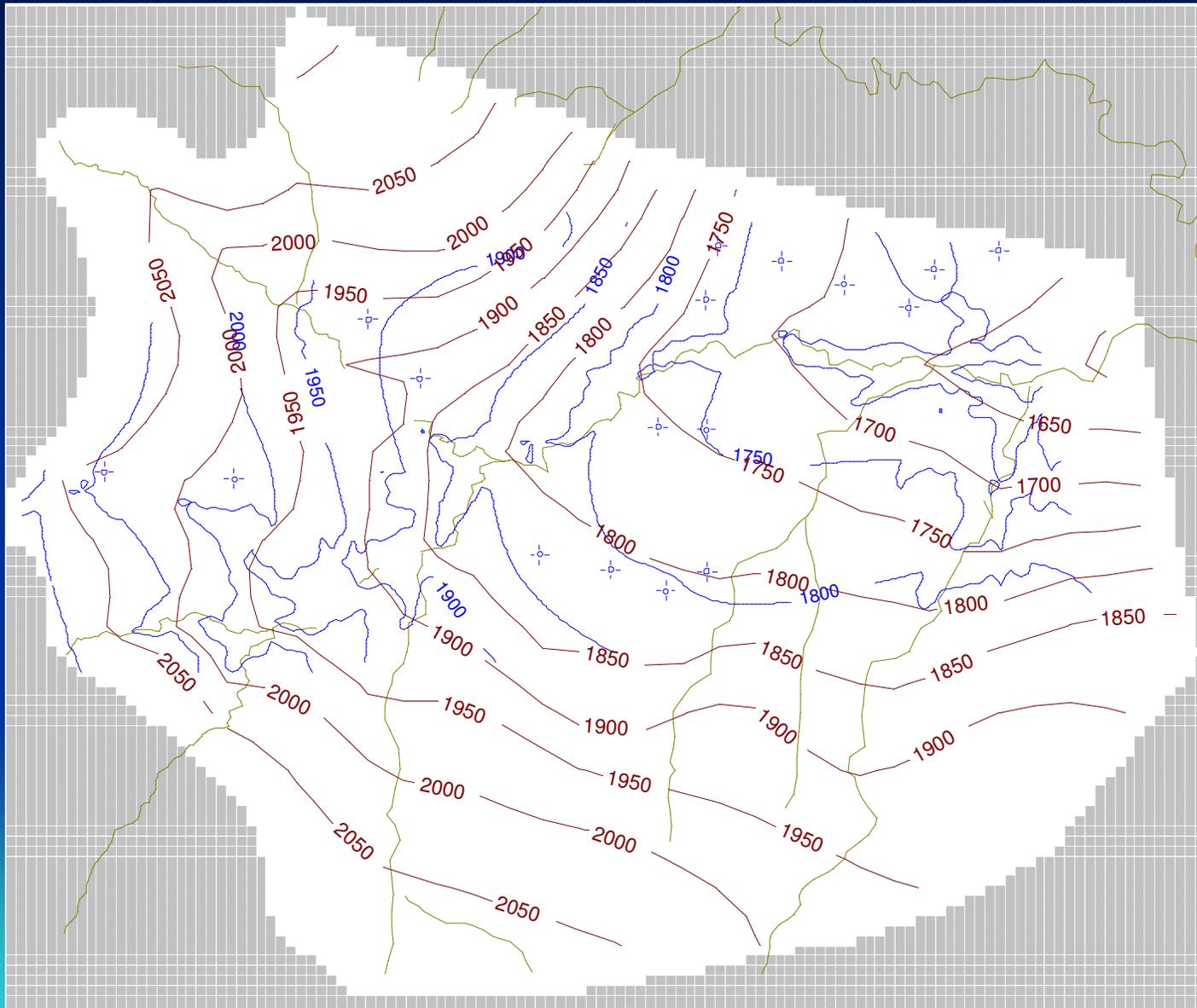


Mean Residual	12.80 ft
Mean Absolute Error	21.17 ft
RMS Error	26.33 ft
Range	343.03 ft
RMSE /Range	7.68 %

Steady-State Volume Budget



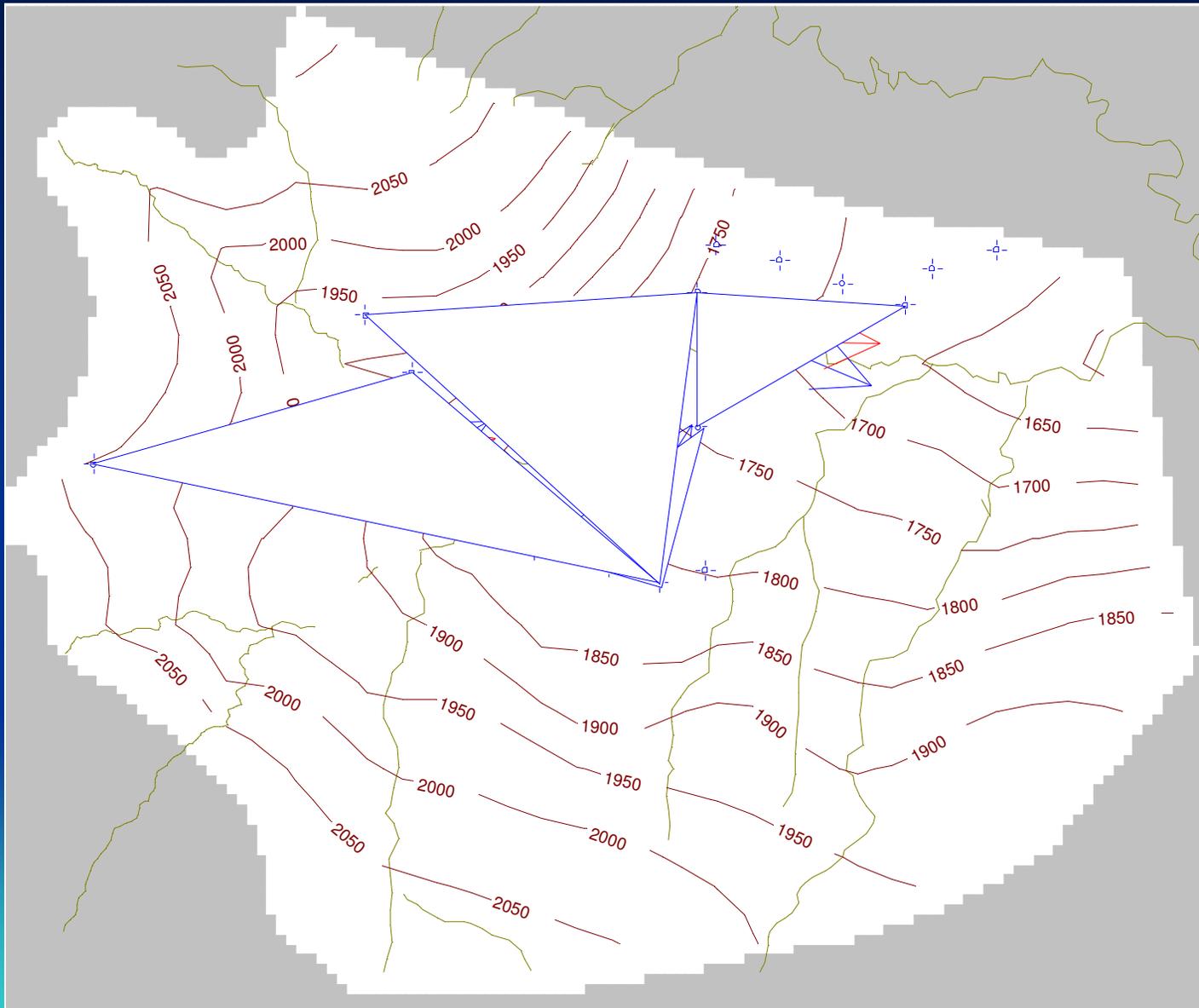
Simulated Water Levels



Observed

Simulated

Gradients



— Observed

— Simulated

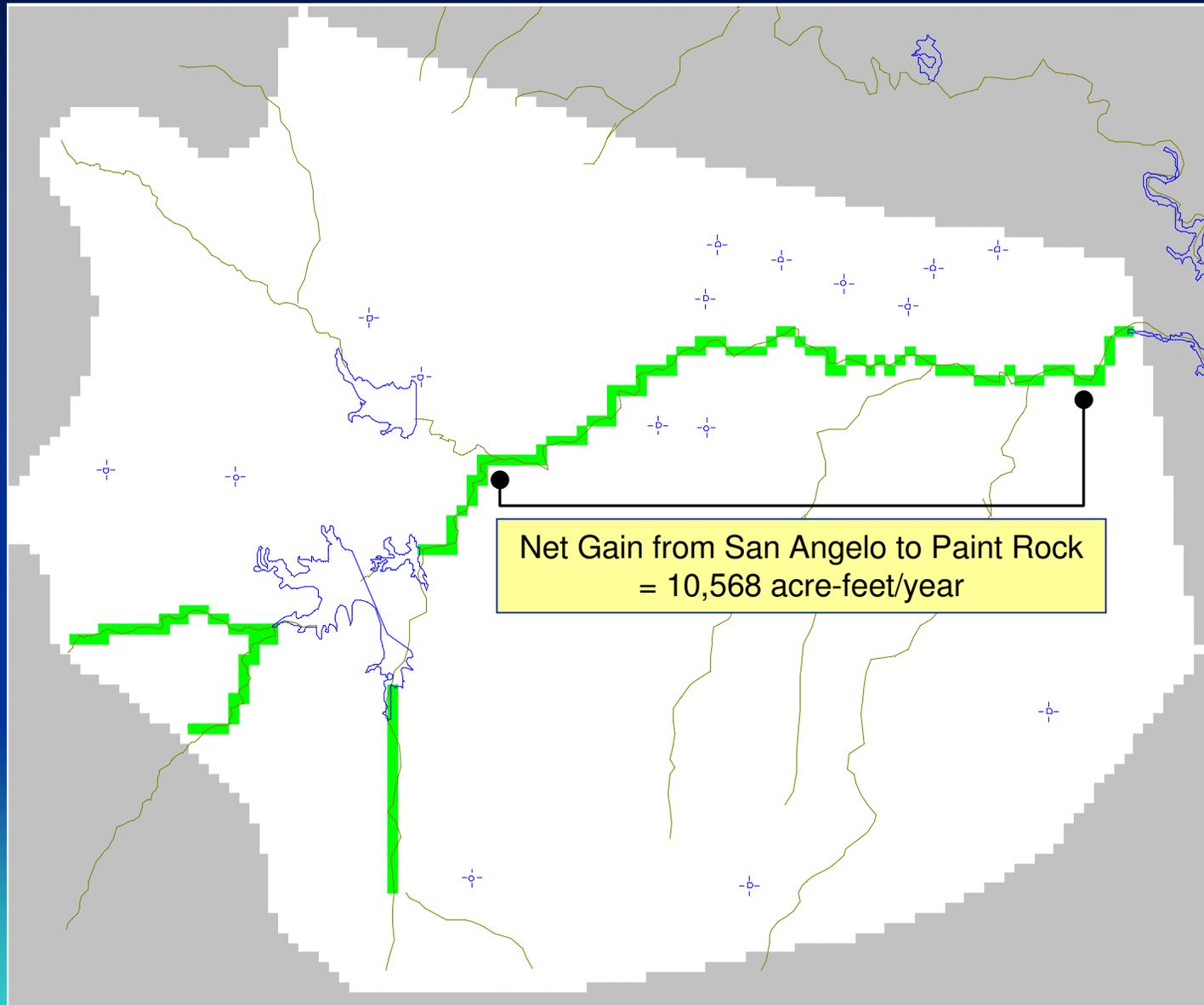
Concho River Low Flow Analysis 1979 - 1981

Average Minimum Flows 1979 - 1981		
Gage Location		
San Angelo	8.19	cfs
Paint Rock	25.00	cfs
Gain (+) / Loss (-)	16.81	cfs
Ft3/day	1,452,035.08	
Acre-ft/Year	12,175.29	

Stream Flow Responses

- For different Calibration simulations, river gains from San Angelo to Paint Rock varied from 1,000 acre-feet per year to over 15,000 acre-feet per year.
- Amount of gain or loss in the river is sensitive to ET Depth, ET Rate and Recharge.

Simulated Concho River Gain



Area of Active ET Steady-State Model

