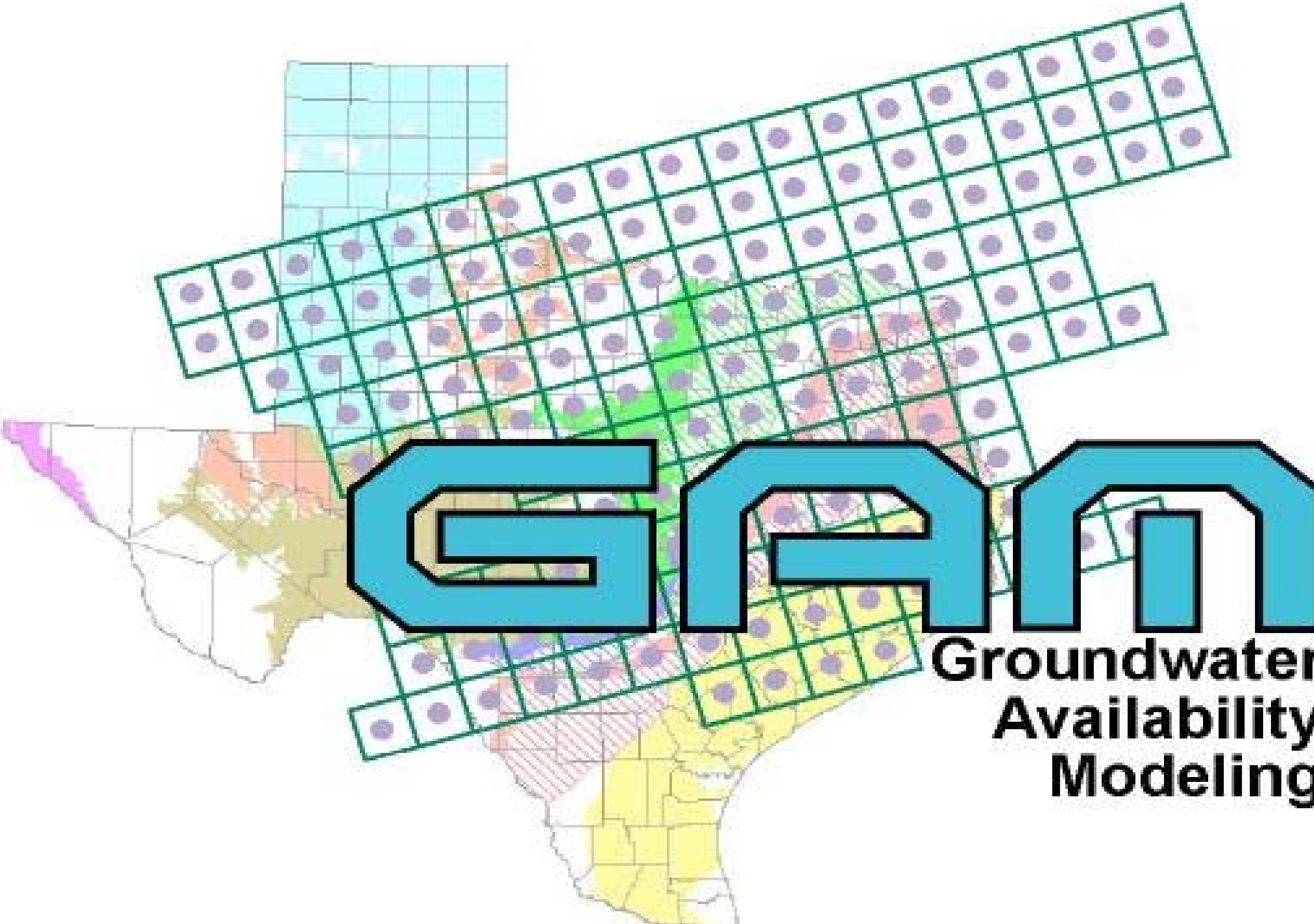

texas water development board

Agenda for Stakeholder Advisory Forum No. 6 - August 29, 2002

- Predevelopment modeling results
- Transient simulation results
- Recharge analysis
- Questions/comments/input

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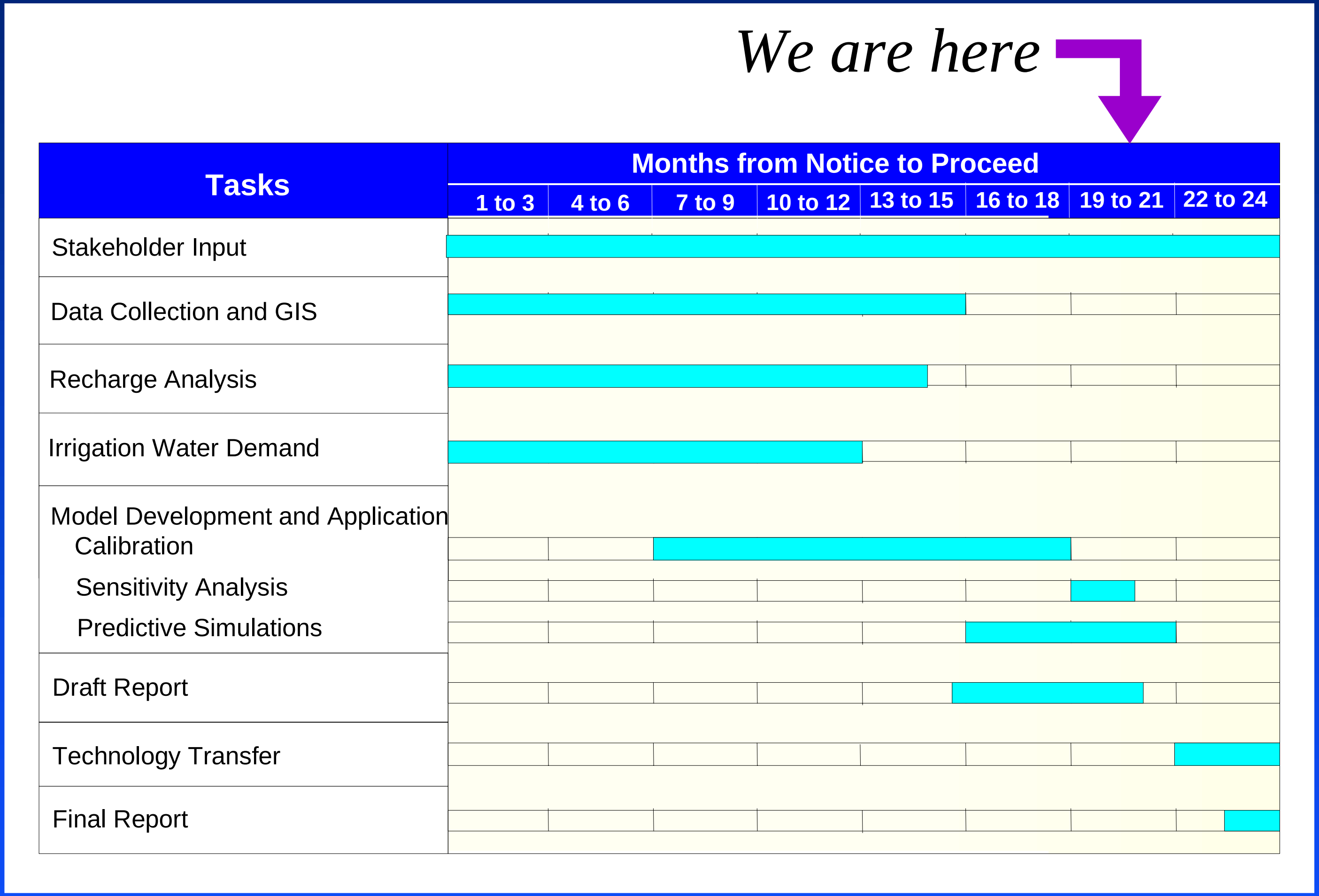
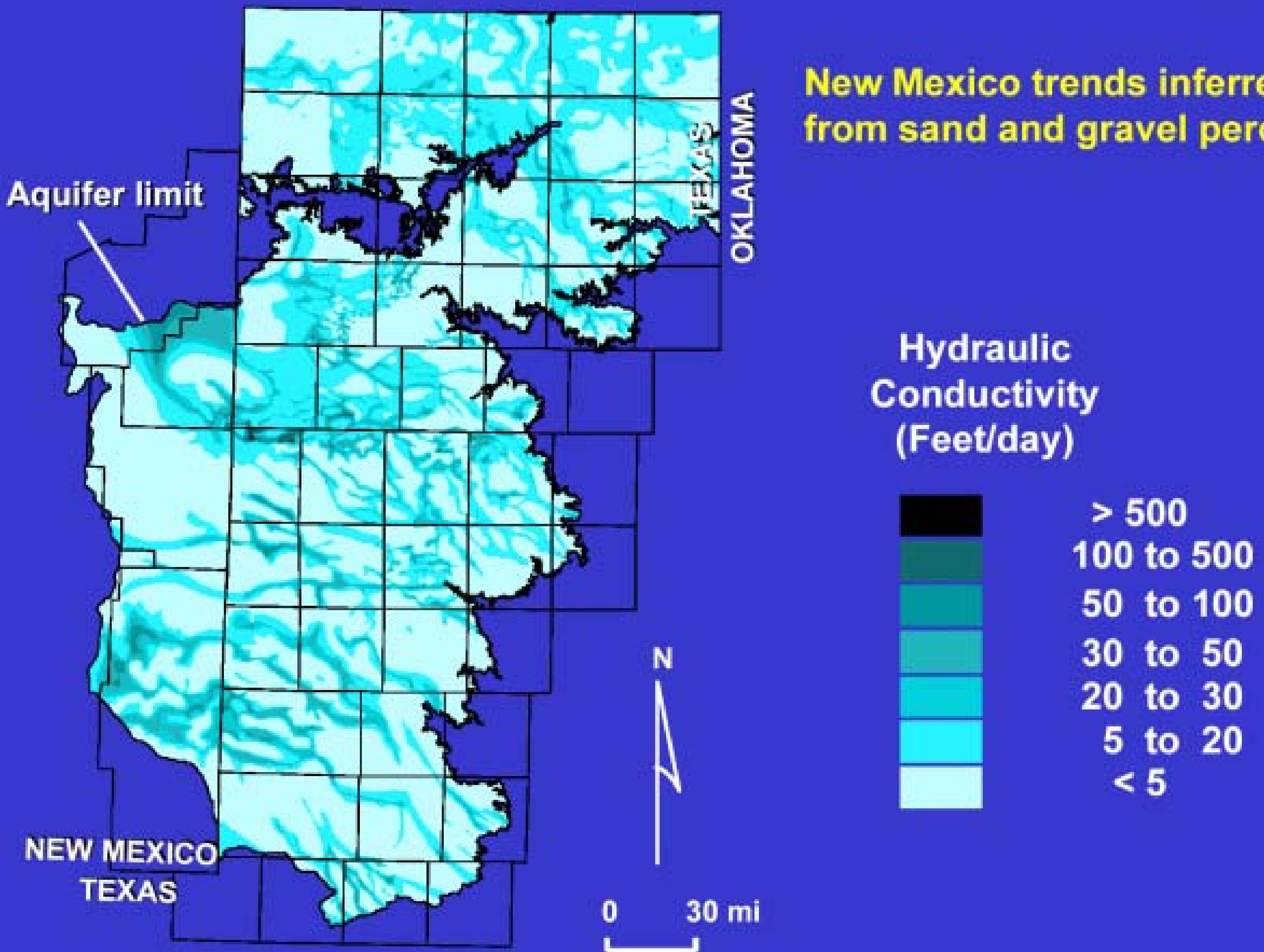
Project Schedule

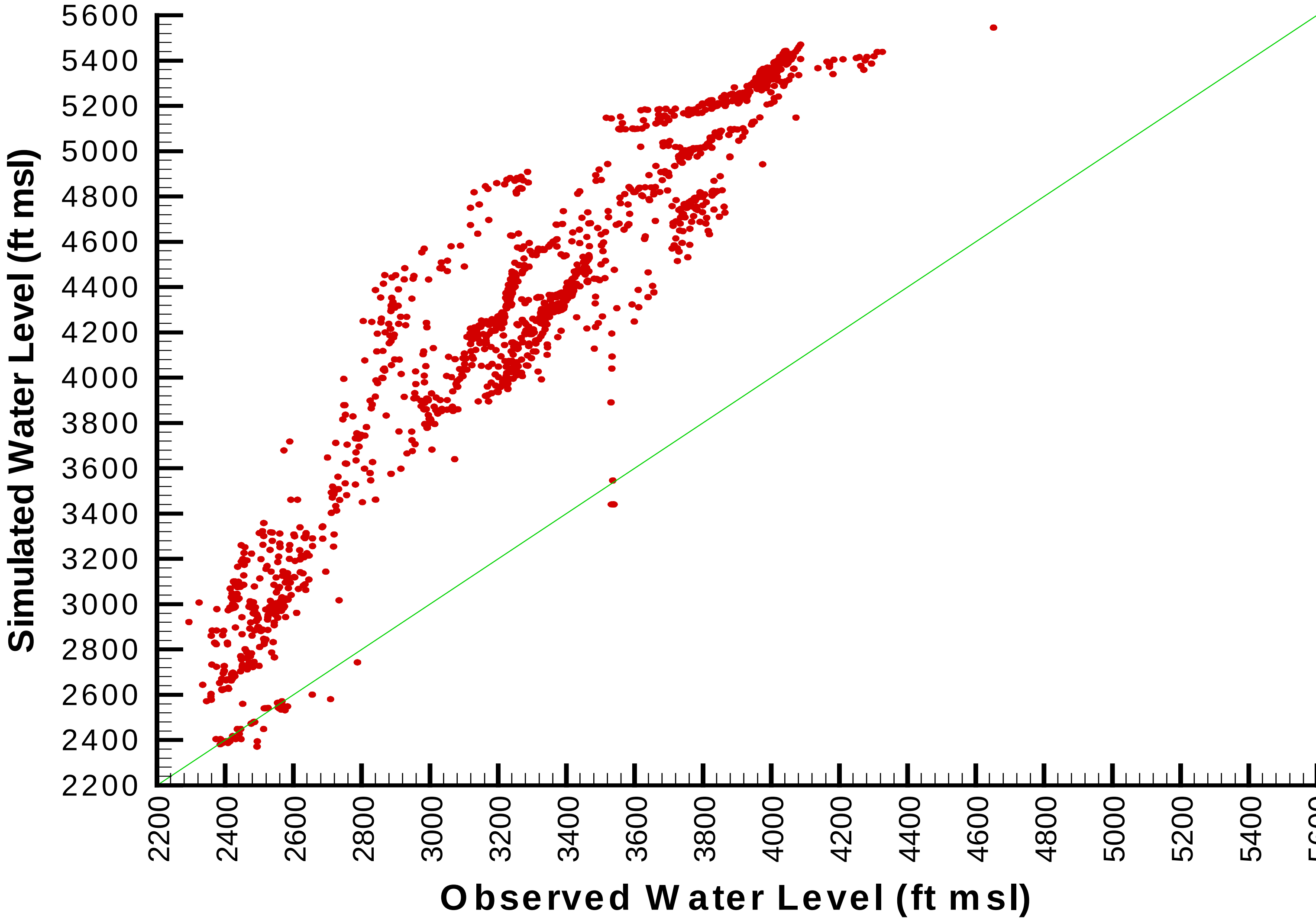


HYDRAULIC CONDUCTIVITY OF OGALLALA AQUIFER

New Mexico trends inferred from sand and gravel percentage



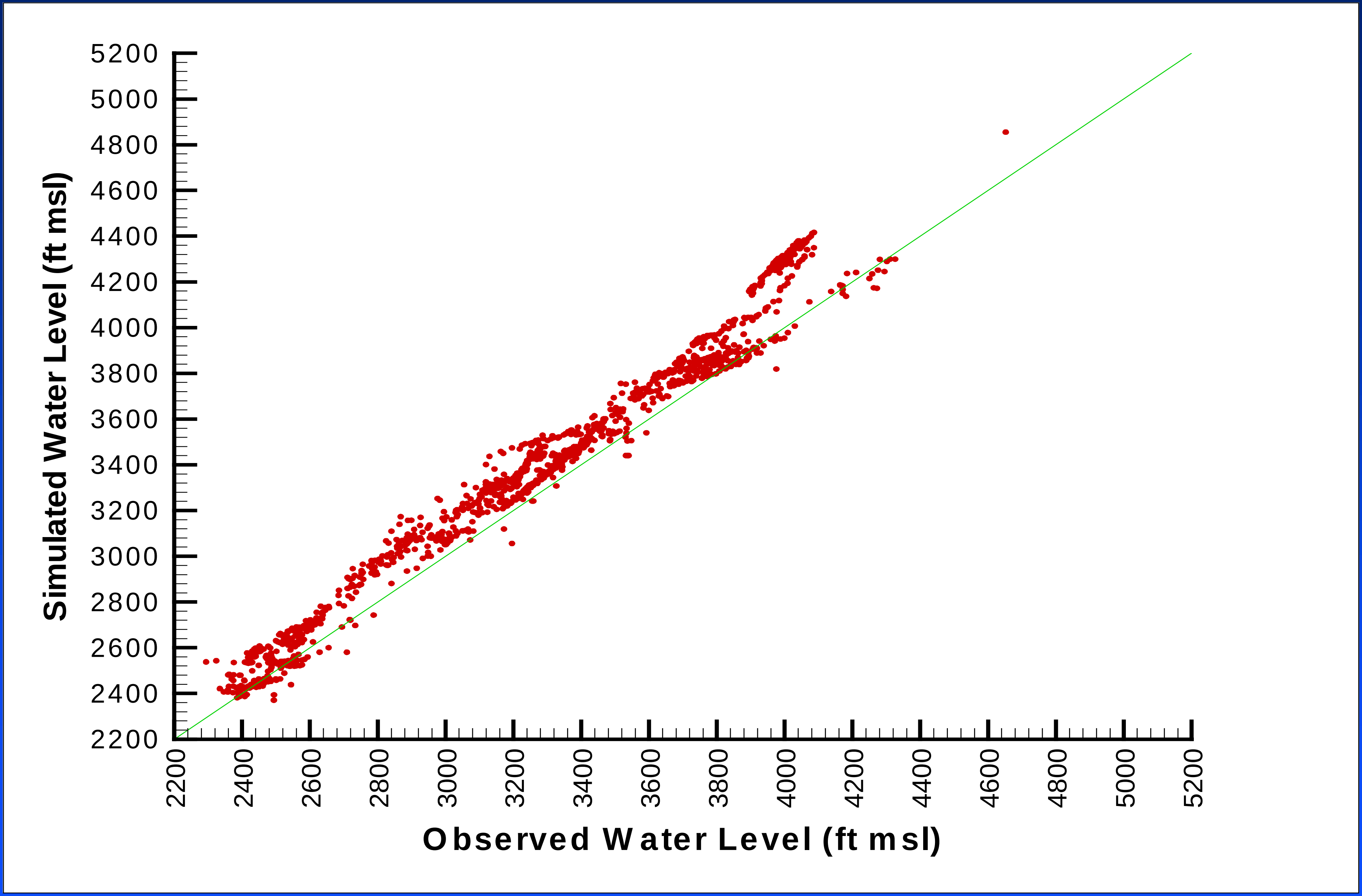
Early Calibration to Water Levels



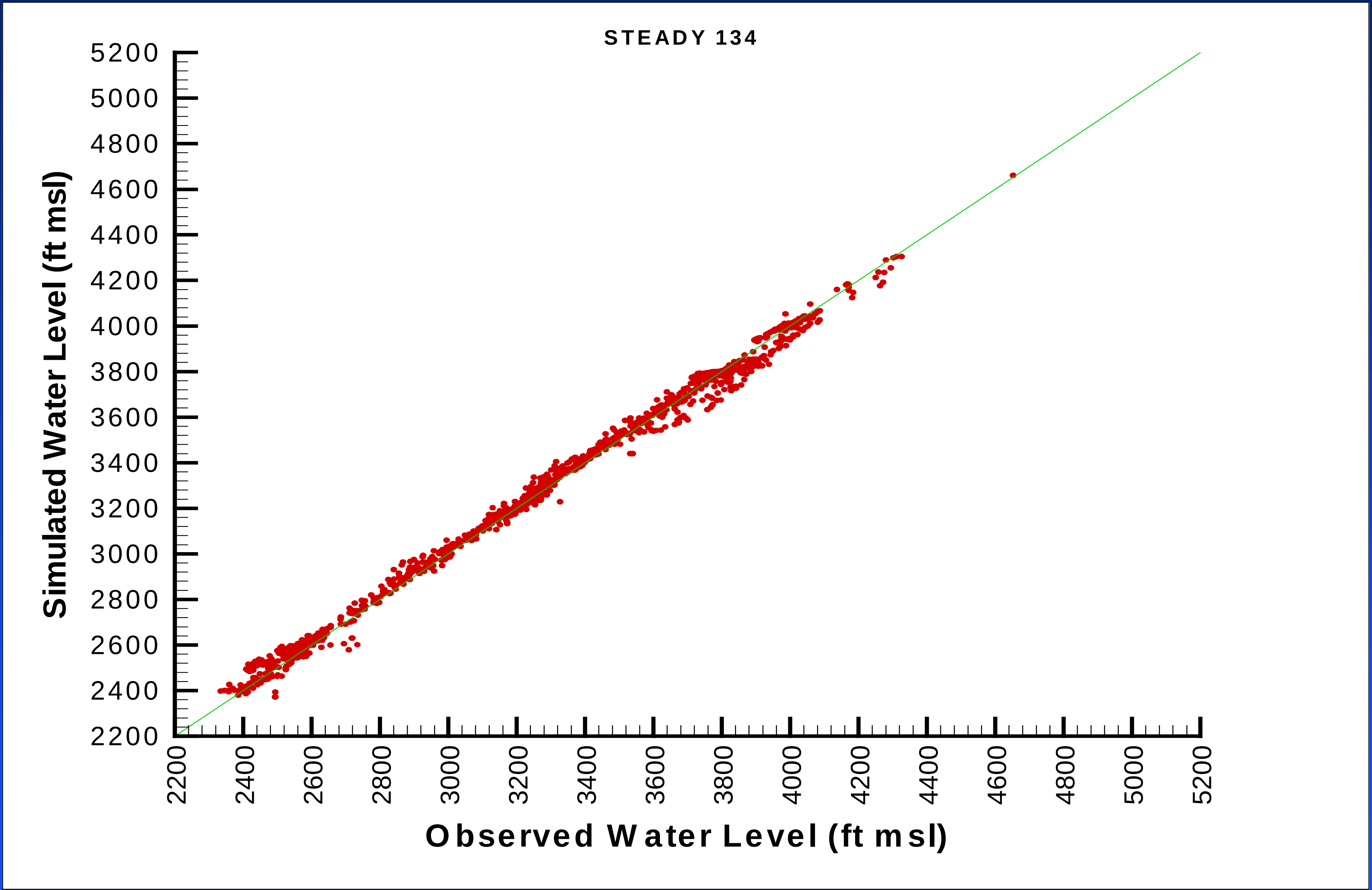
Calibration Approach

- Increase initial estimates of hydraulic conductivity (except in select regions) while maintaining geologic basis for zonation
- Decrease initial estimates of recharge, and evaluate alternative zonations
- Evaluate “interior” regions of discharge

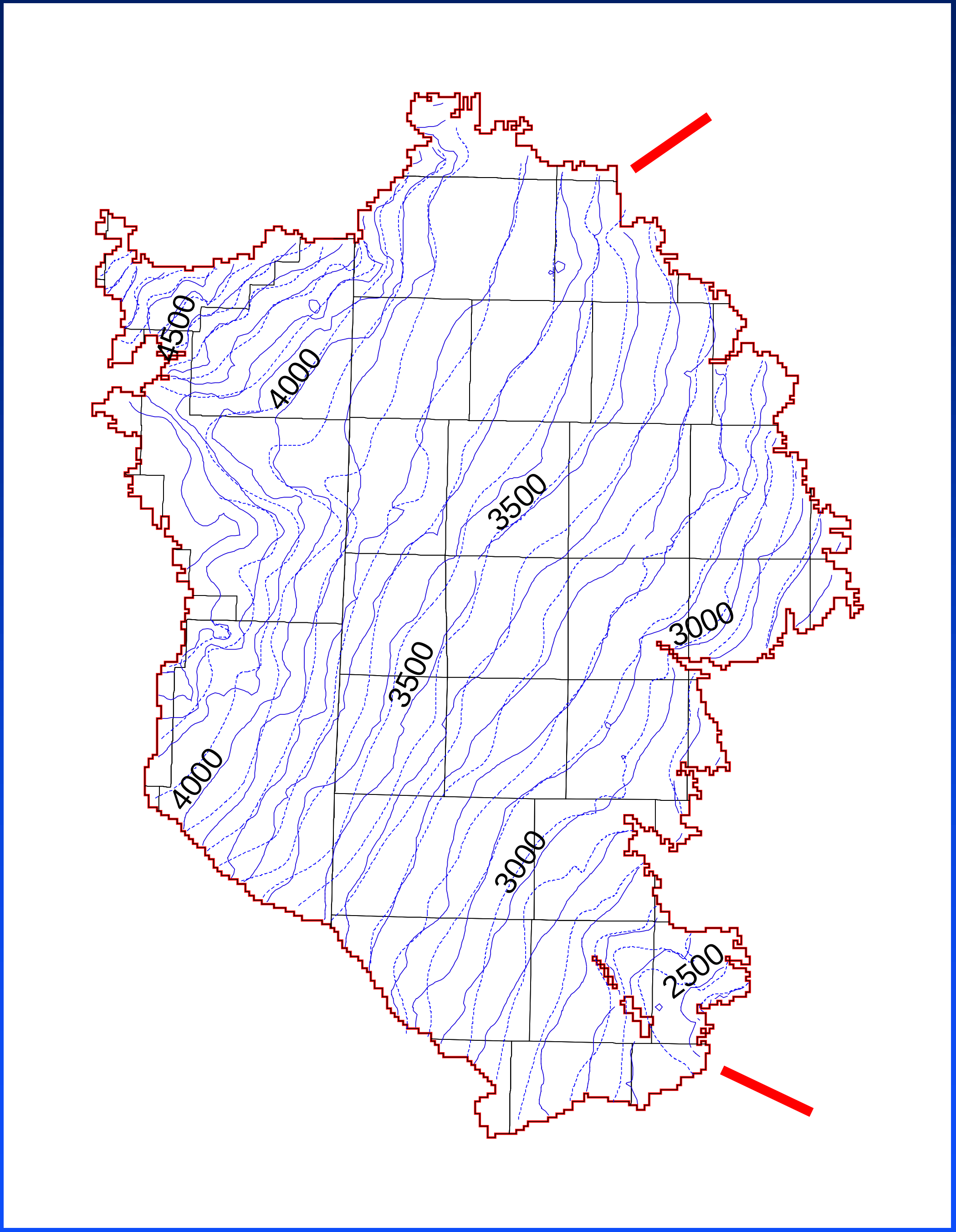
Previous Calibration to Water Levels



Final Calibration to Water Levels



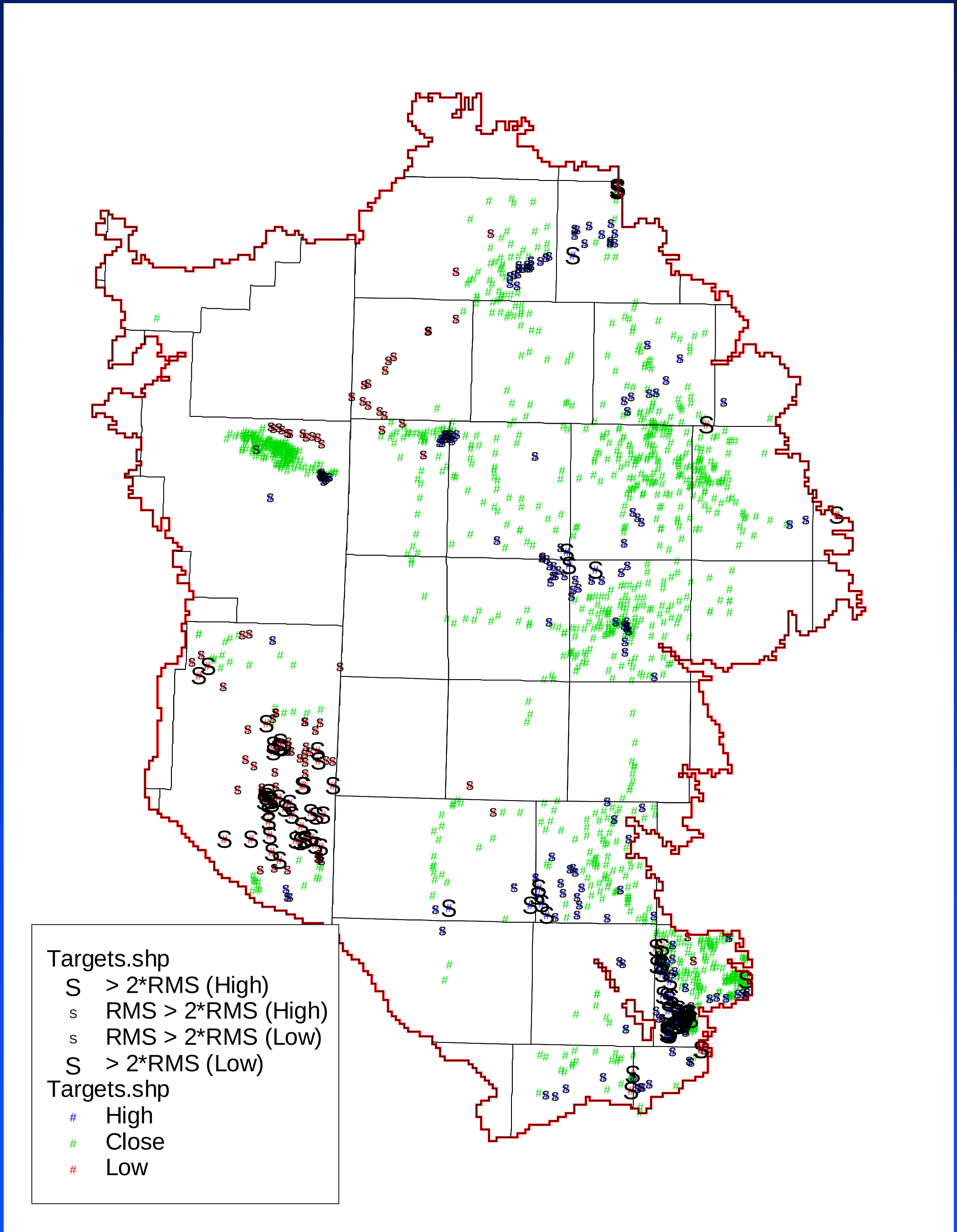
Simulated and Observed Hydraulic Heads



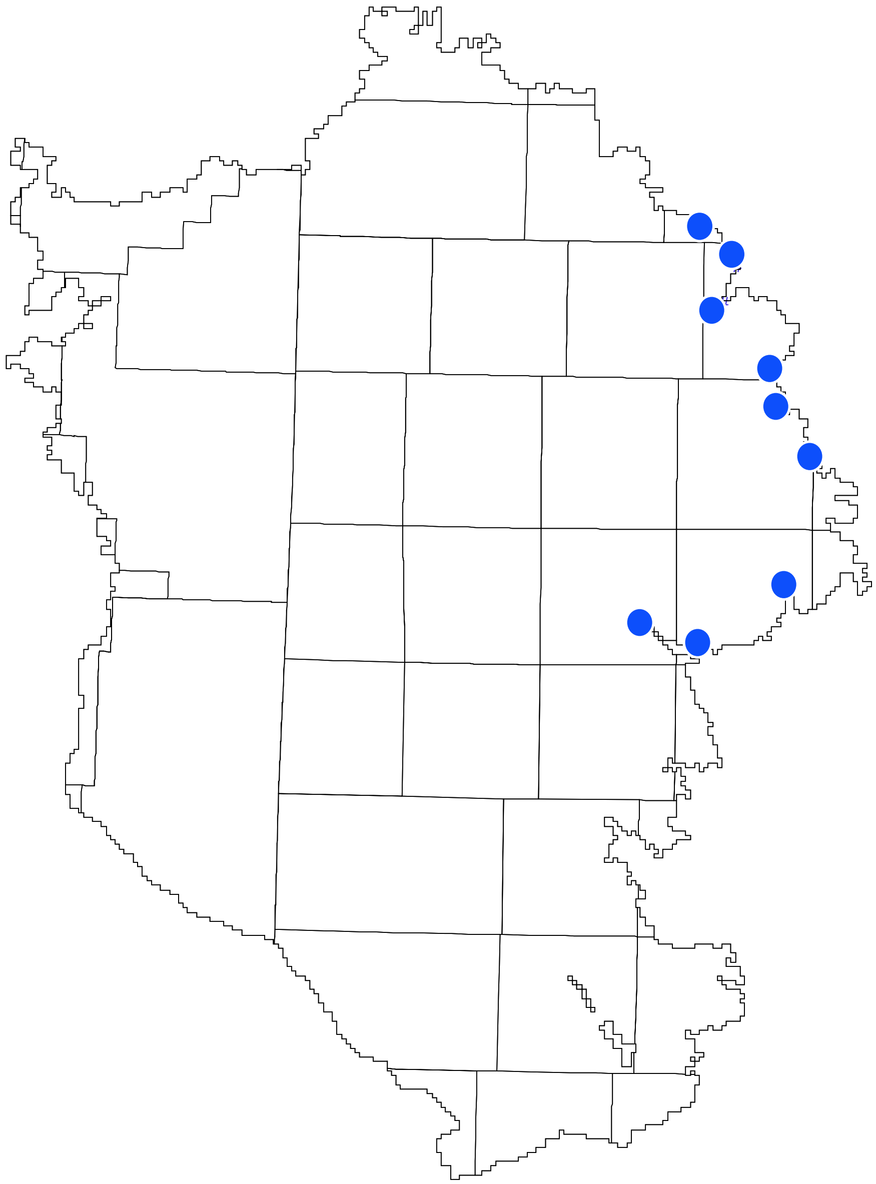
Calibration Statistics - Hydraulic Head

- RMS = 35 ft
- RMS/Range = 1%
- Residual Mean = -8 ft
- Maximum Positive Residual = 100 ft
- Maximum Negative Residual = 132 ft

Residual Map



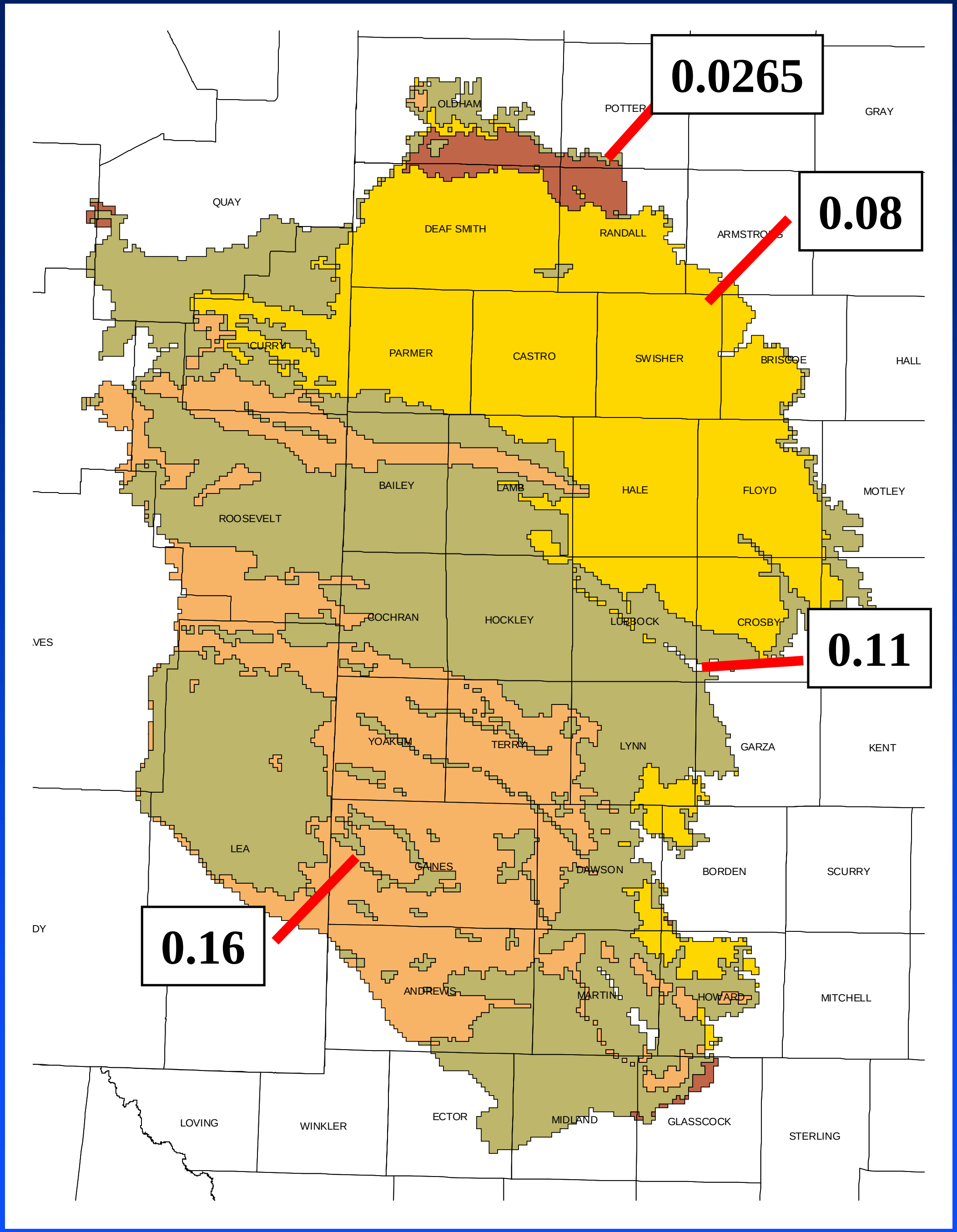
Major Escarpment Springs



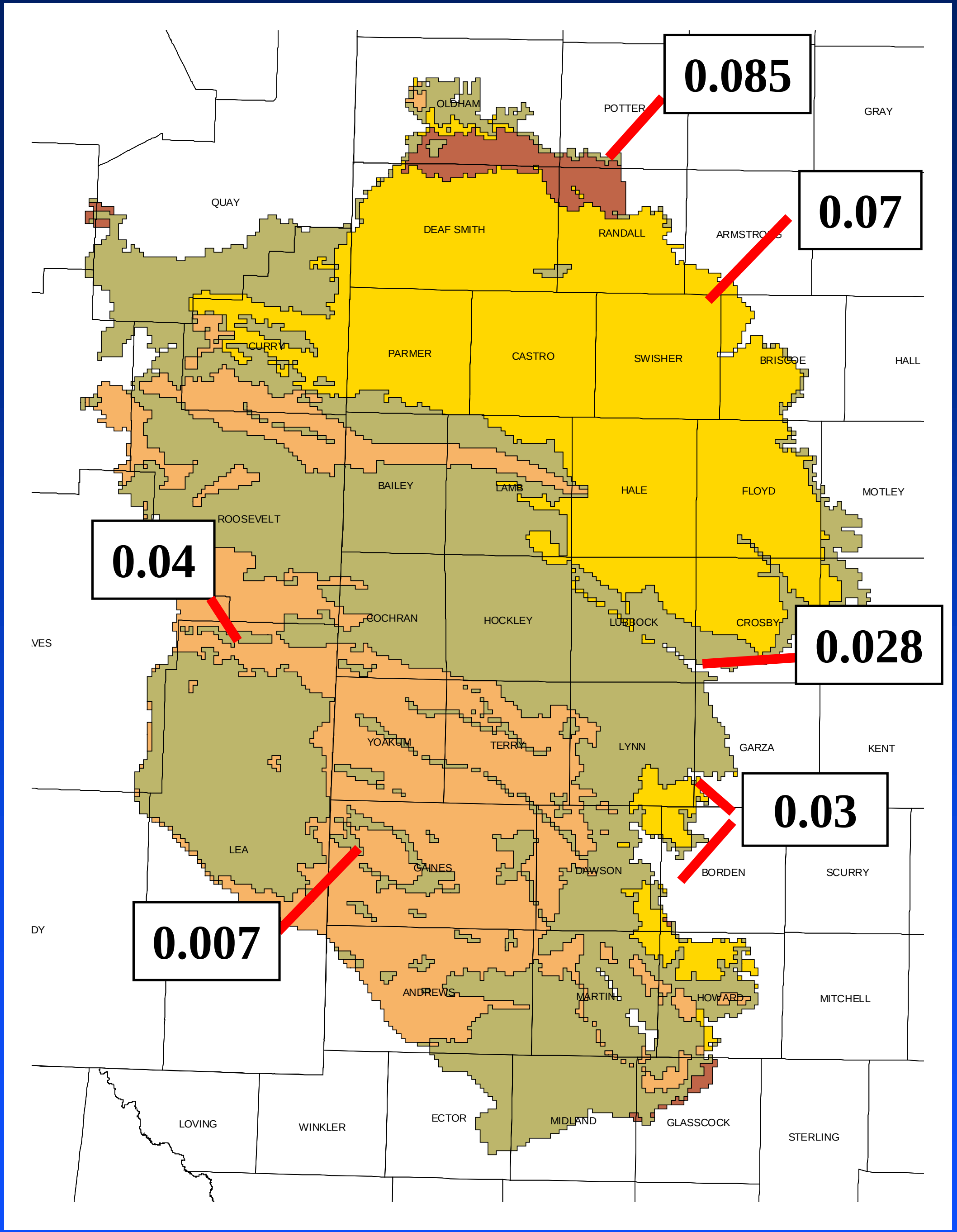
Calibration Statistics - Major Springs on Escarpment

- "Observed" Predevelopment Flow = 3,115 gpm
- Simulated Predevelopment Flow = 2,450 gpm
- Discrepancy = -21%

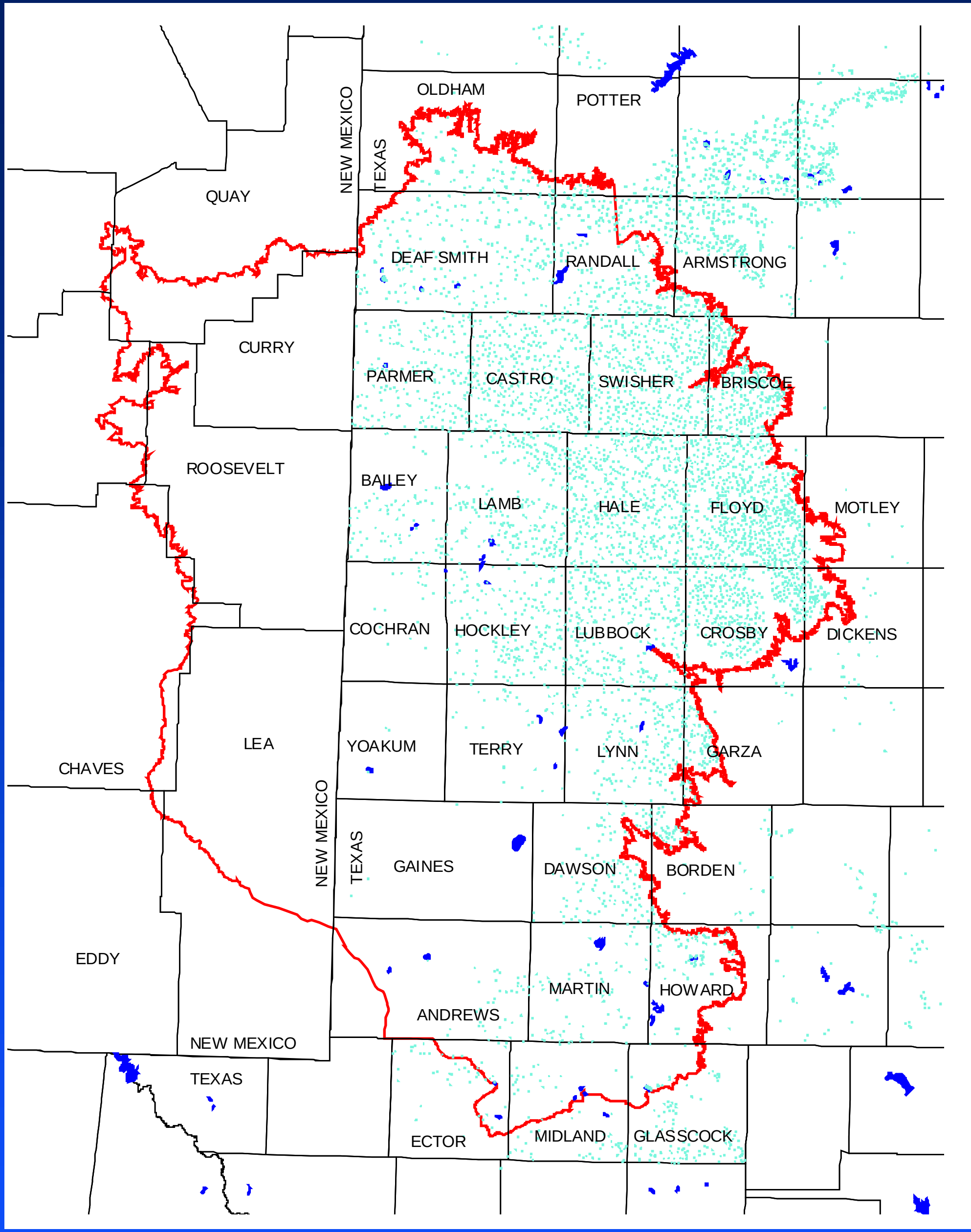
Previous Recharge Zones Used in the Model (inches/yr)



Final Recharge Zones Used in the Model (inches/yr)



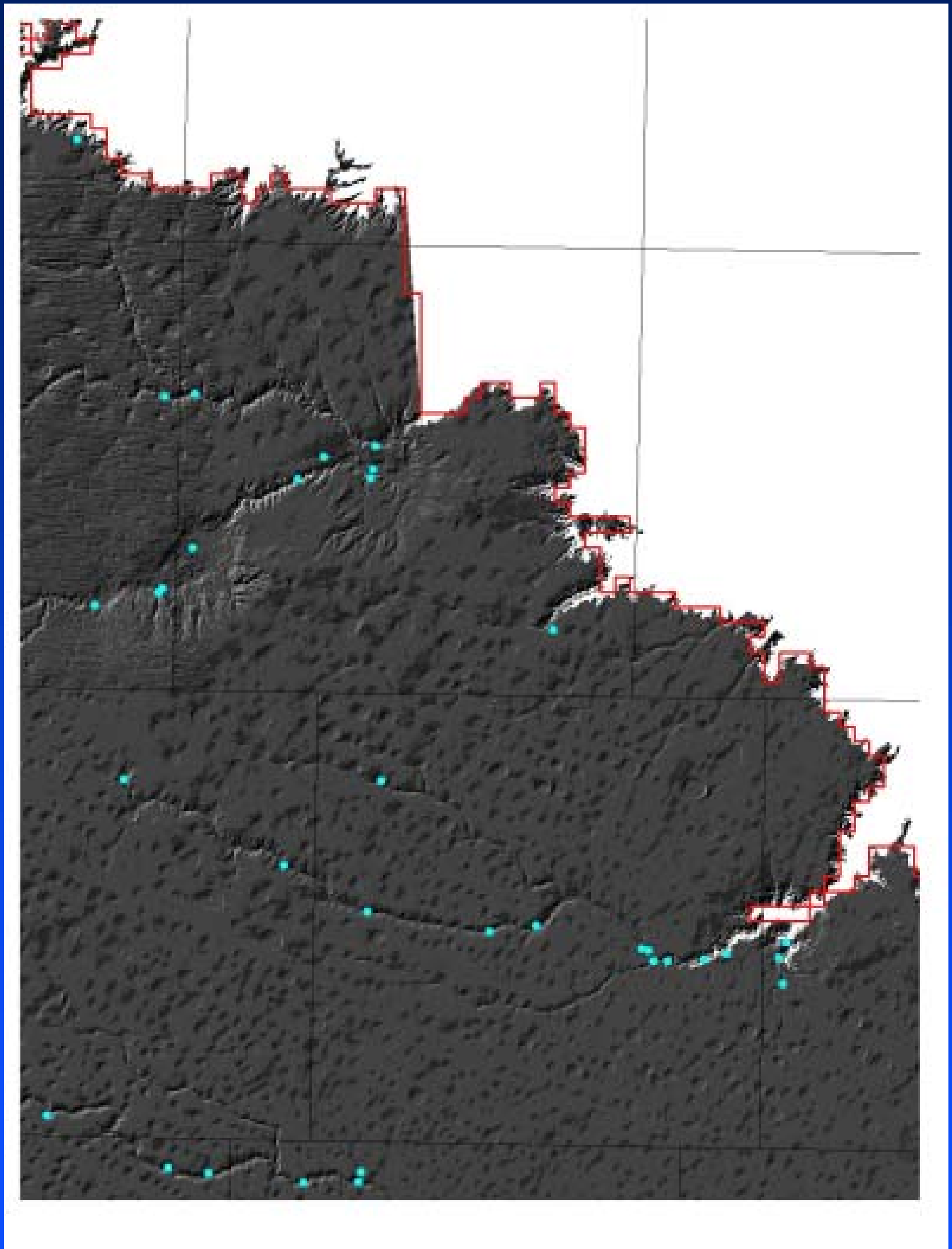
Lakes and Playas



Regional Recharge Comparison With Other Models

- GAM Predevelopment - 0.037 inch/yr
- USGS RASA Predevelopment - 0.13 inch/yr, w/ majority of area 0.086 inch/yr
- TWDB Report 288 (begins 1960) - 0.2 inch/yr

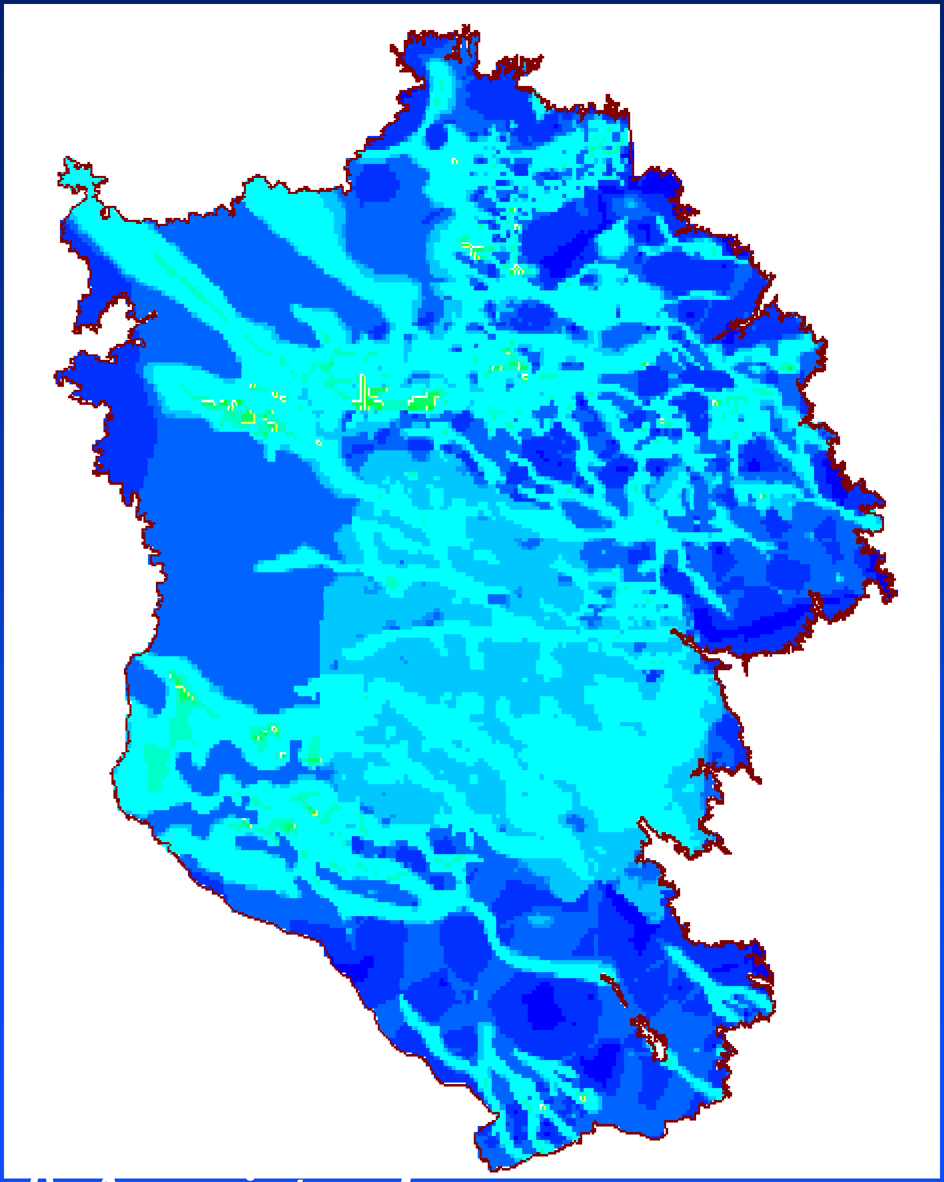
Spring Locations



Average Hydraulic Conductivity - Comparison With Other Models

- GAM Predevelopment - 17 ft/day
- USGS RASA - 10 - 150 ft/day
- TWDB Report 288 (begins 1960) - 68 ft/day

Starting Hydraulic Conductivity - 15 Zones



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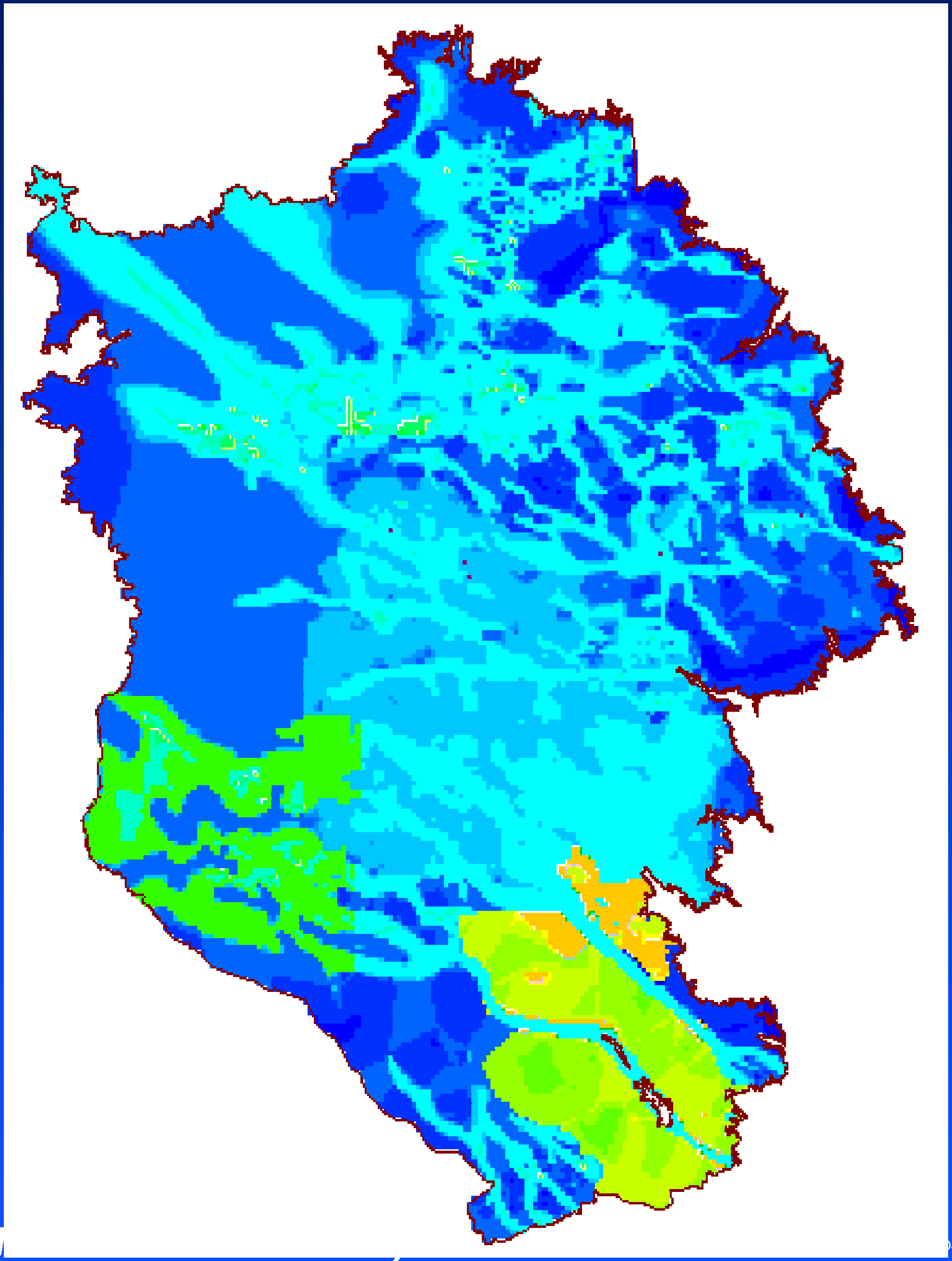
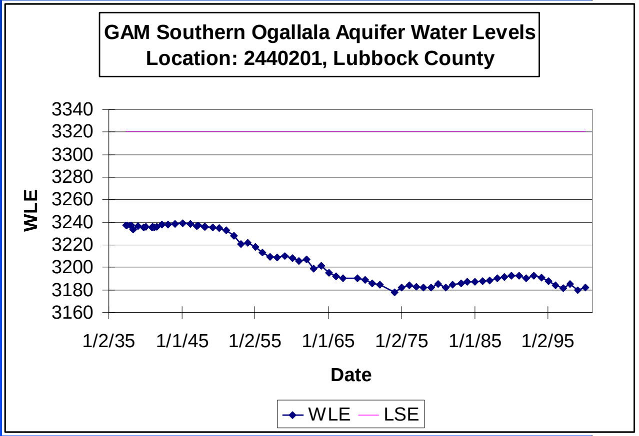
Adjusted Hydraulic Conductivity - 17 Zones

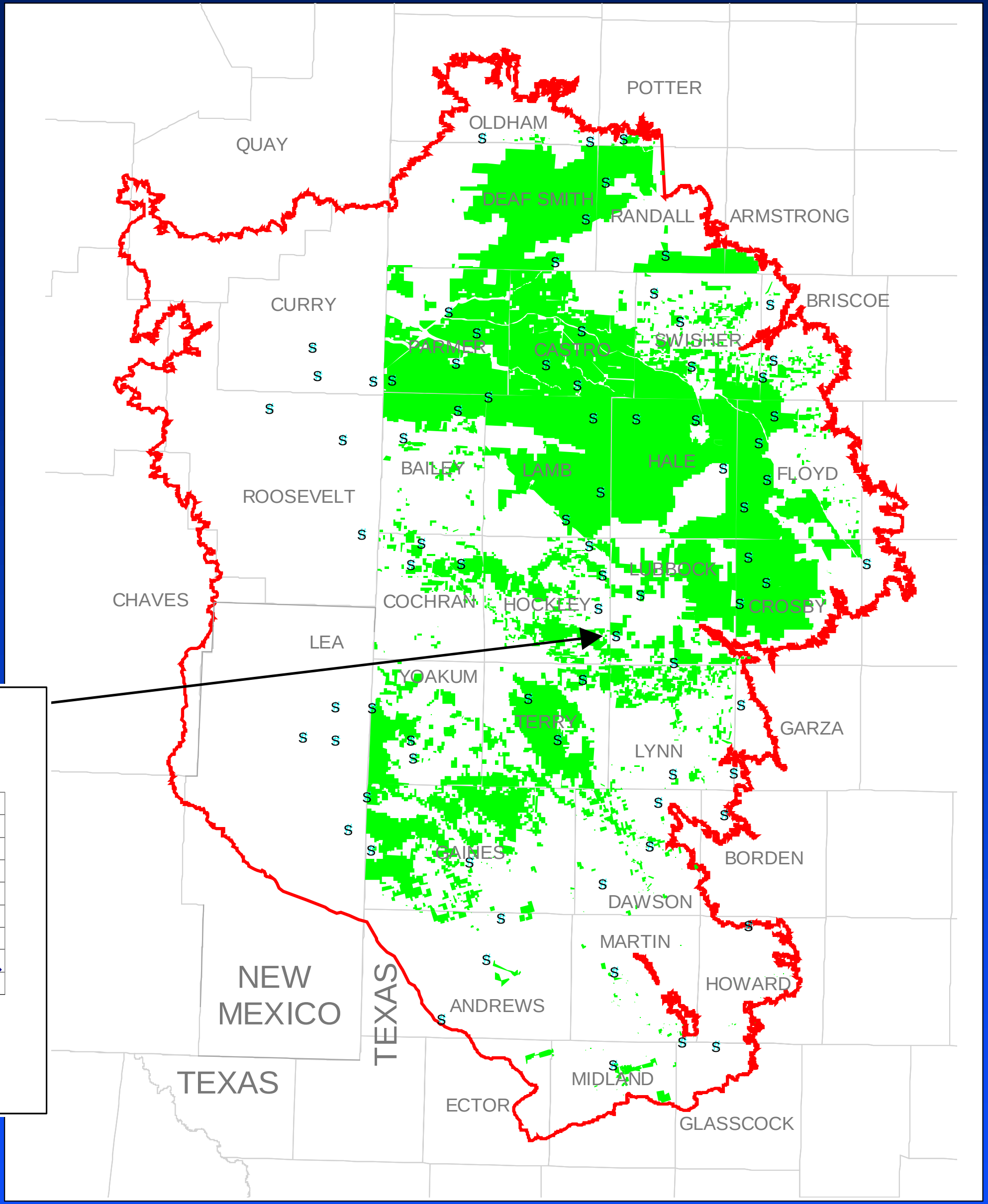


Conclusions - Predevelopment

- Calibration statistics are good and match to observed heads and discharge is reasonable
- Simulation results are not biased over large regions (excluding Lea County, New Mexico)
- Calibrated model input parameters are within valid ranges and follow reasonable conceptual models

1994 Irrigated Lands with Hydrograph Locations





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Transient Calibration Approach

- Calibration period is 1940 - 1990, with emphasis on 1980 -1990
- 1991 - 2000 is model verification period
- Calibration parameters are specific yield and recharge (irrigation return flow and additional, post-development recharge)

Transient Calibration Approach

- Used TWDB survey numbers for 1958, 1964, 1969, 1974, and 1979
- Used Amosson et al. numbers for 1982, 1983, 1984, 1987, 1992, 1993, 1994, 1997
- Linear interpolation between years
- Applied to 1994 irrigated acreage coverage for TX and NM

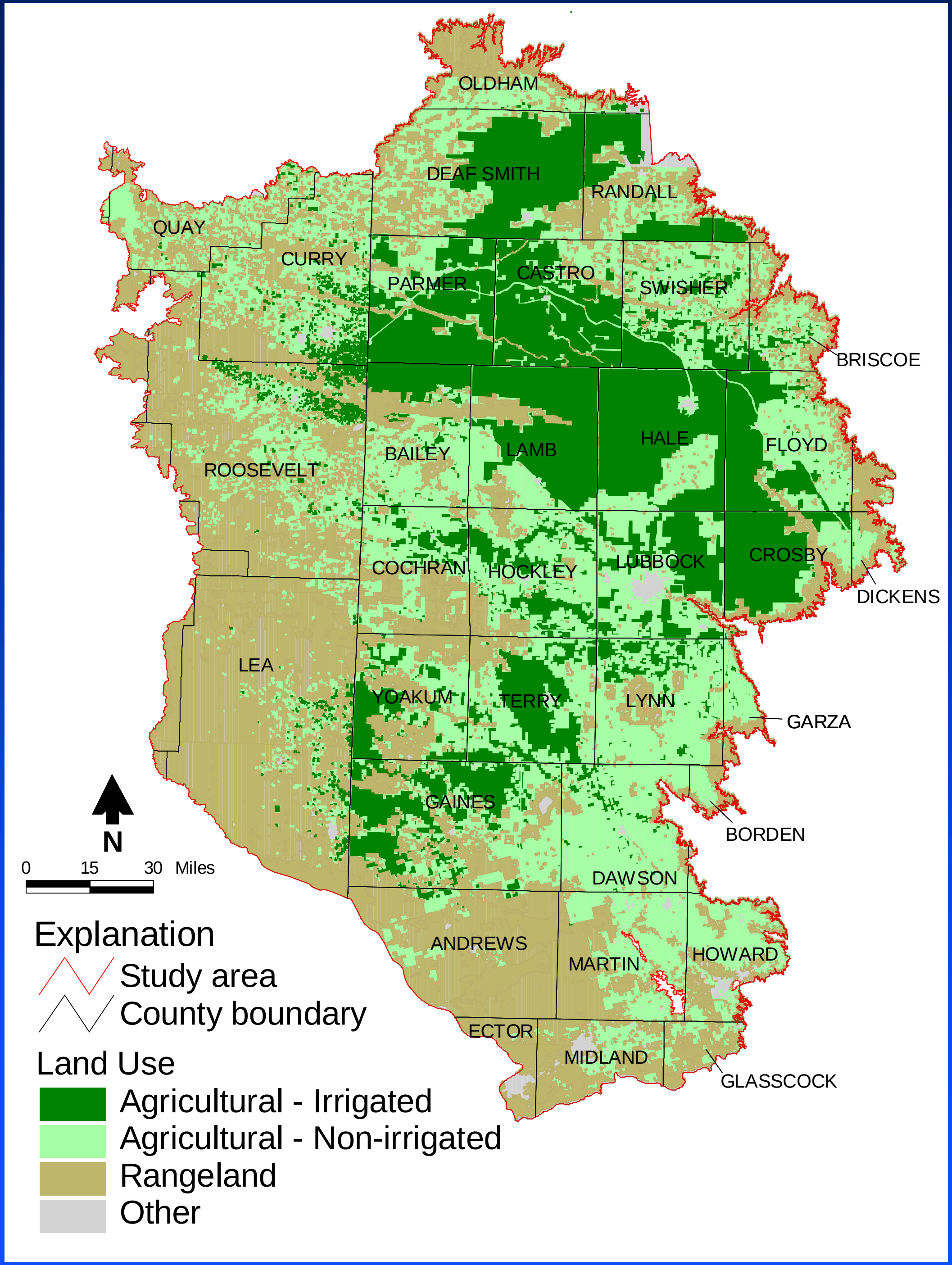
Return Flow Estimates

1940 - 1960	55%	1981 - 1985	25%
1961 - 1965	50%	1986 - 1990	20%
1966 - 1970	45%	1991 - 1995	15%
1971 - 1975	40%	1996 - 2000	10%
1976 - 1980	35%		

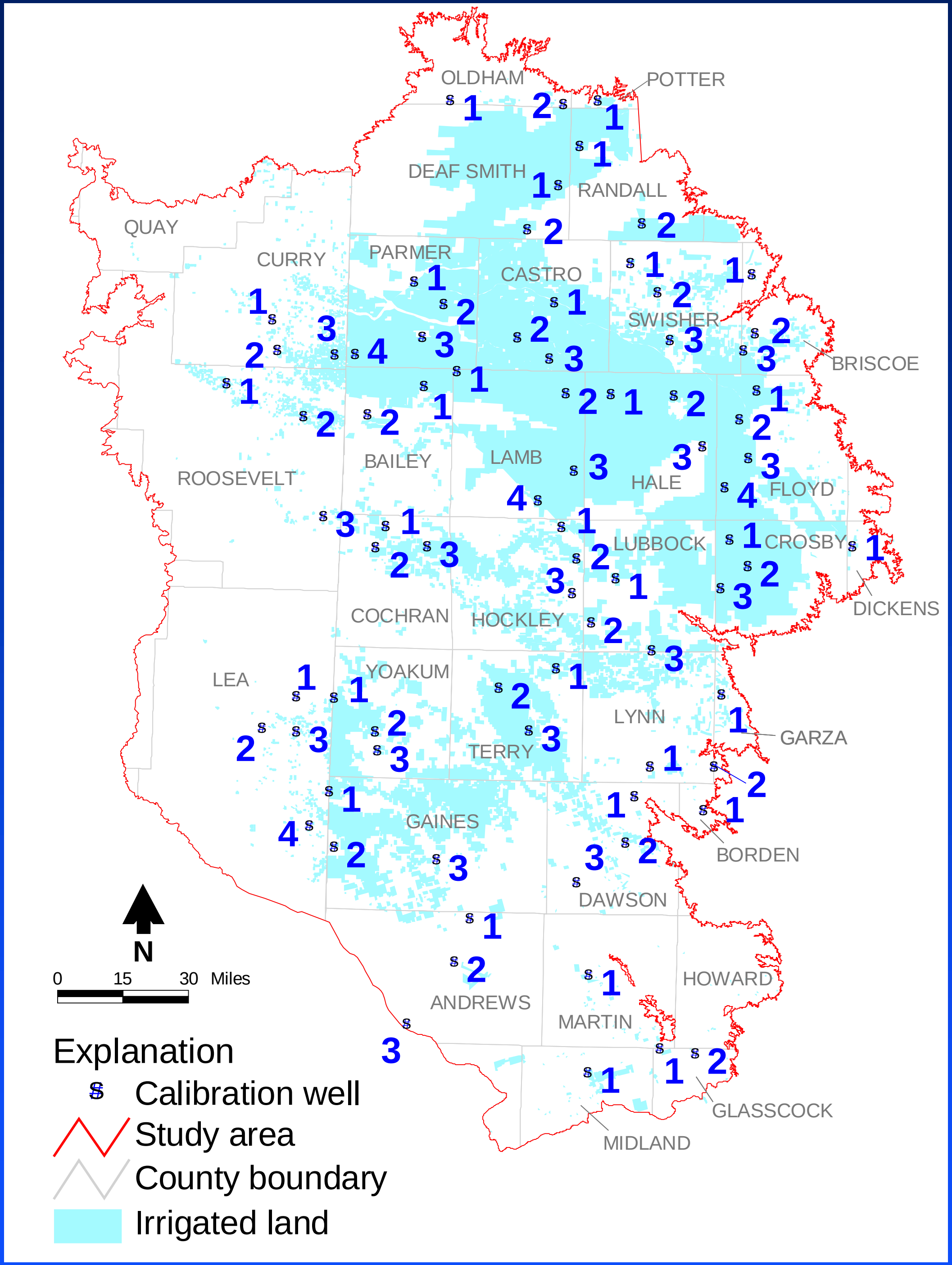
Transient Calibration Approach

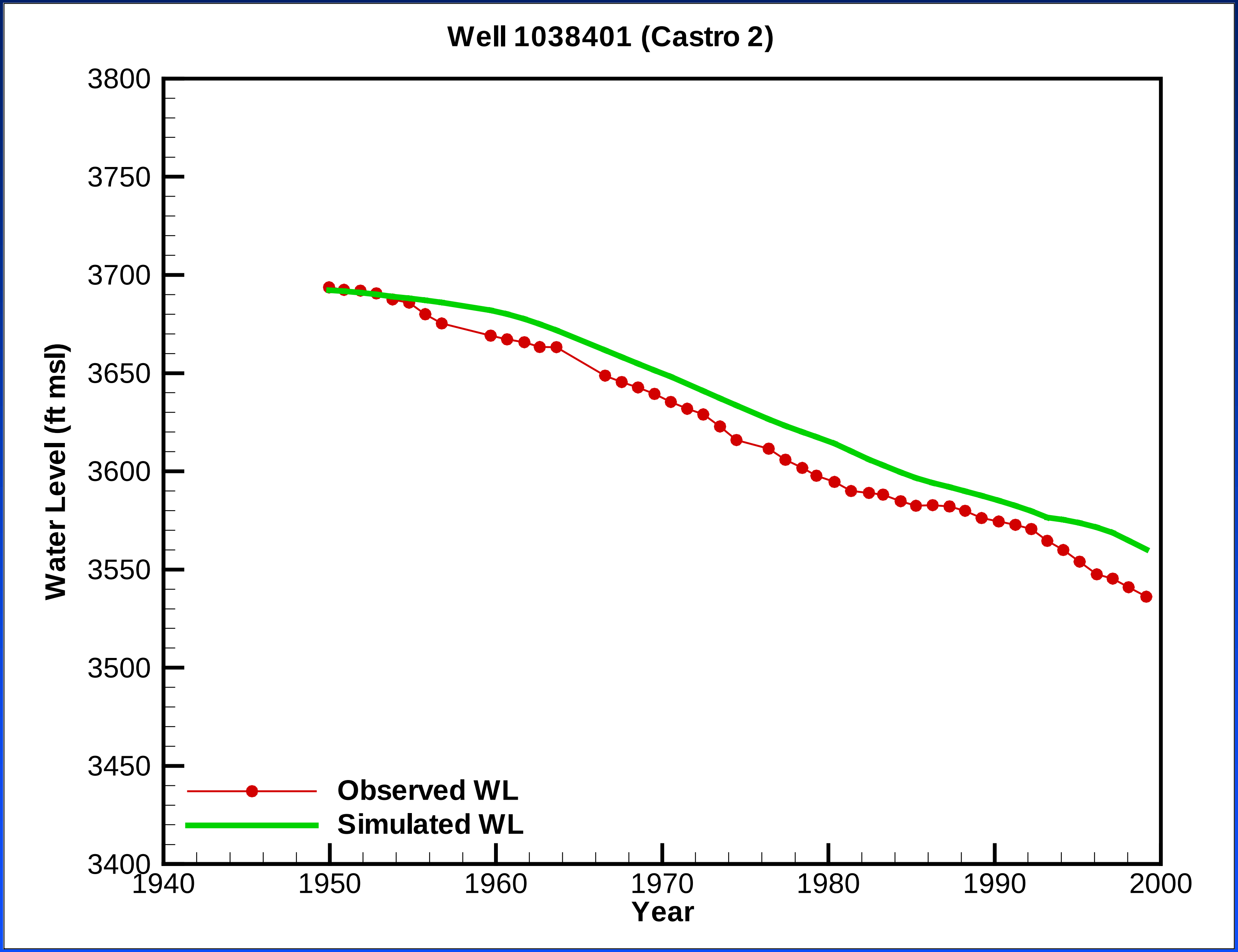
- Specific yield assigned by hydraulic conductivity zone - ranges from 0.12 to 0.22
- Increase in recharge over agricultural lands (irrigated and non-irrigated) to ~ 2 inches per year, except in New Mexico
- Some adjustments to hydraulic conductivity evaluated, but not used

Land Use

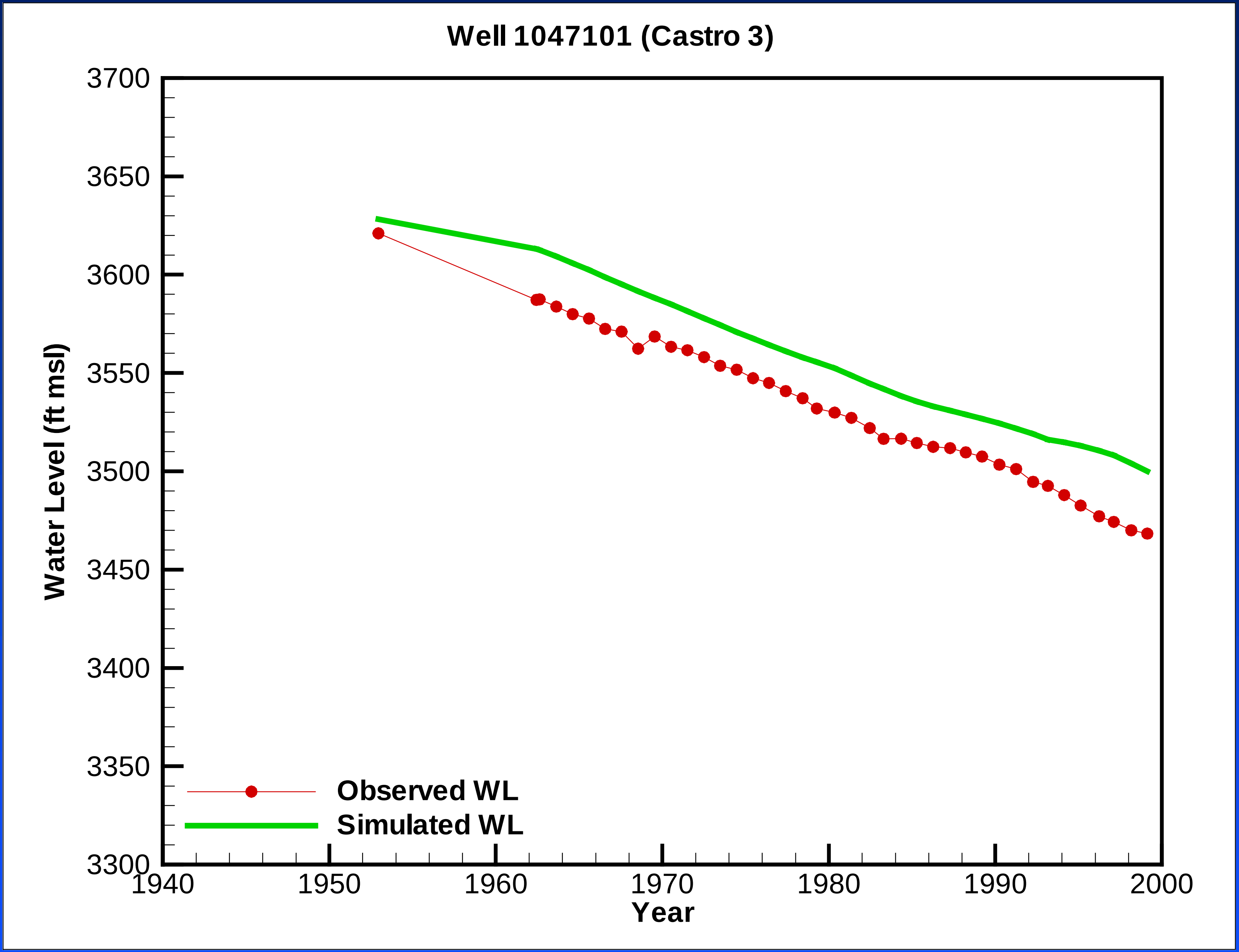

OLDHAM
DEAF SMITH
RANDALL
QUAY
CURRY
PARMER
CASTRO
SWISHER
BRISCOE
BAILEY
LAMB
HALE
FLOYD
ROOSEVELT
COCHRAN
HOCKLEY
LUBBOCK
CROSBY
DICKENS
LEA
YOAKUM
TERRY
LYNN
GARZA
GAINES
BORDEN
DAWSON
ANDREWS
MARTIN
HOWARD
ECTOR
MIDLAND
GLASSCOCK
N
0 15 30 Miles
Explanation
Study area
County boundary
Land Use
Agricultural - Irrigated
Agricultural - Non-irrigated
Rangeland
Other

Transient Calibration Points

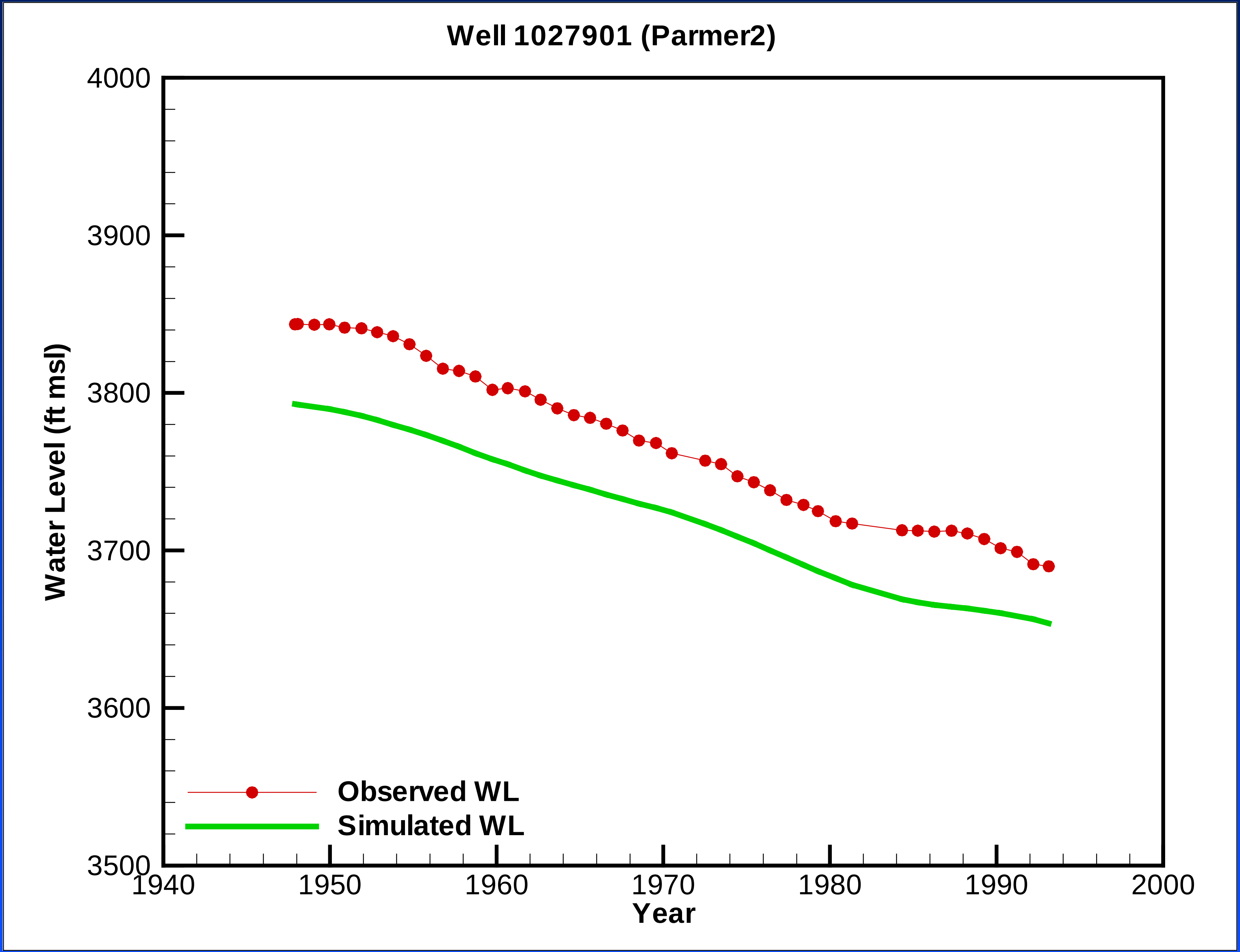




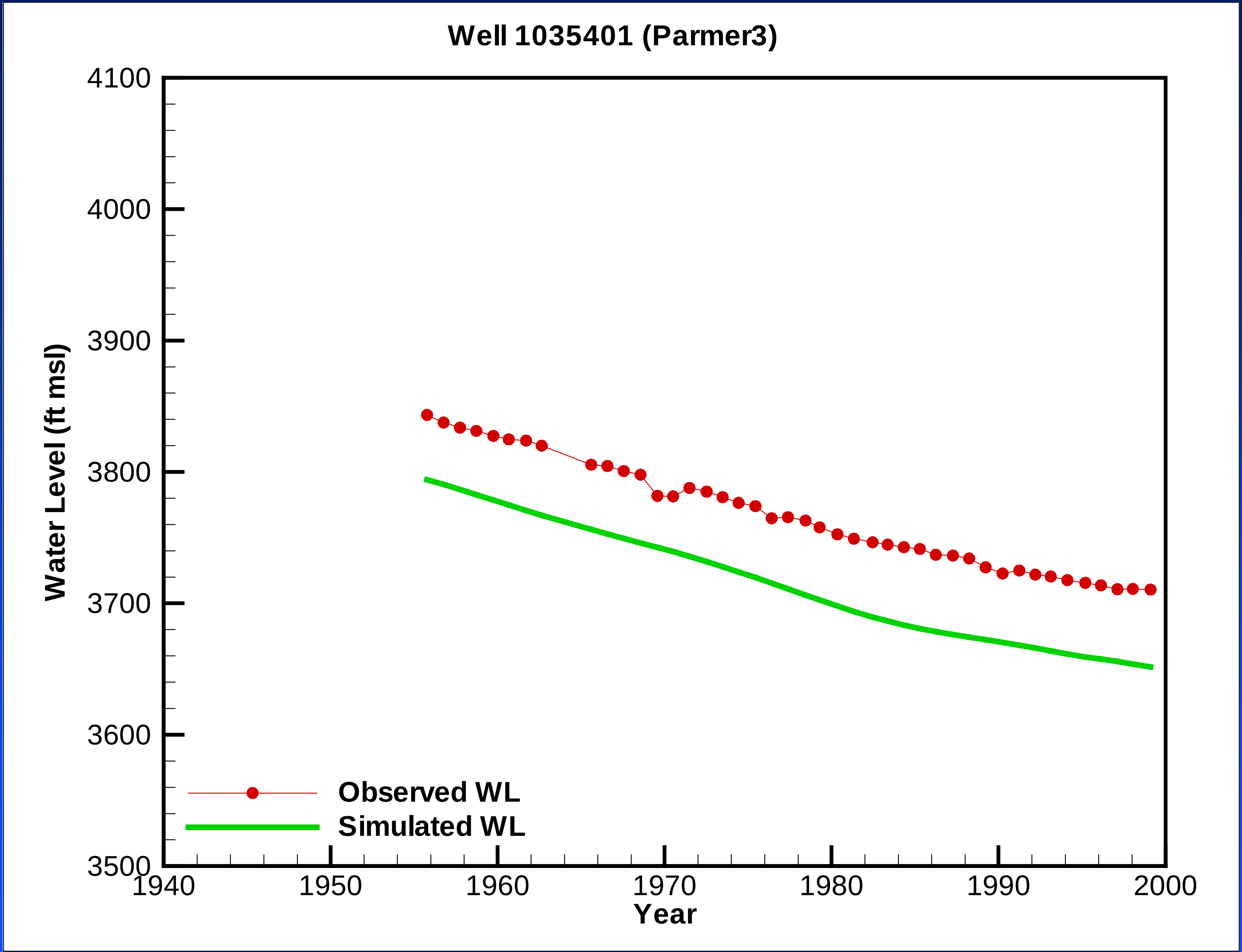
Well 1038401 (Castro 2)
Water Level (ft msl)
3800
3750
3700
3650
3600
3550
3500
3450
3400
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Simulated WL



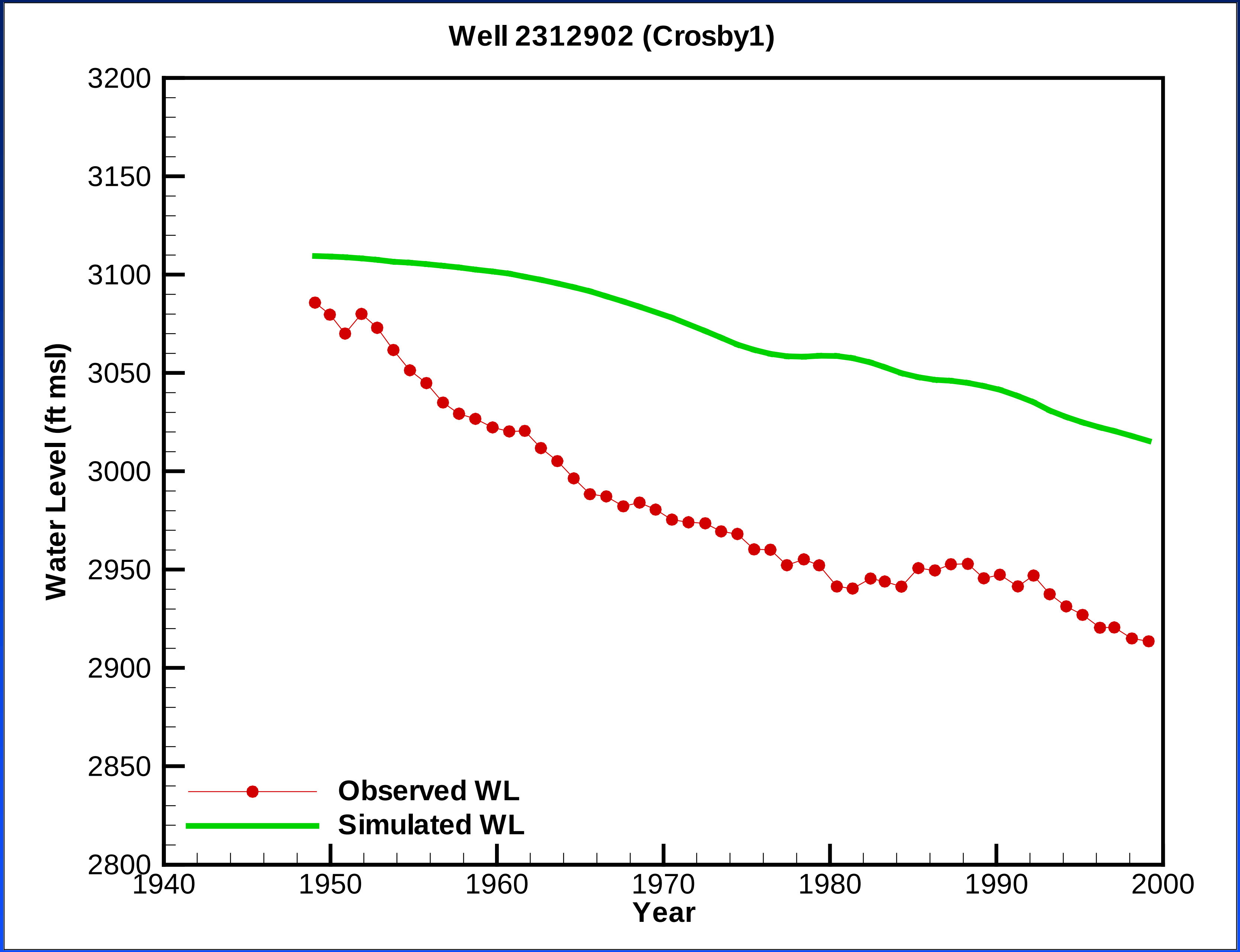
Well 1047101 (Castro 3)
Water Level (ft msl)
3700
3650
3600
3550
3500
3450
3400
3350
3300
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Simulated WL



Well 1027901 (Parmer2)
Water Level (ft msl)
4000
3900
3800
3700
3600
3500
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Simulated WL

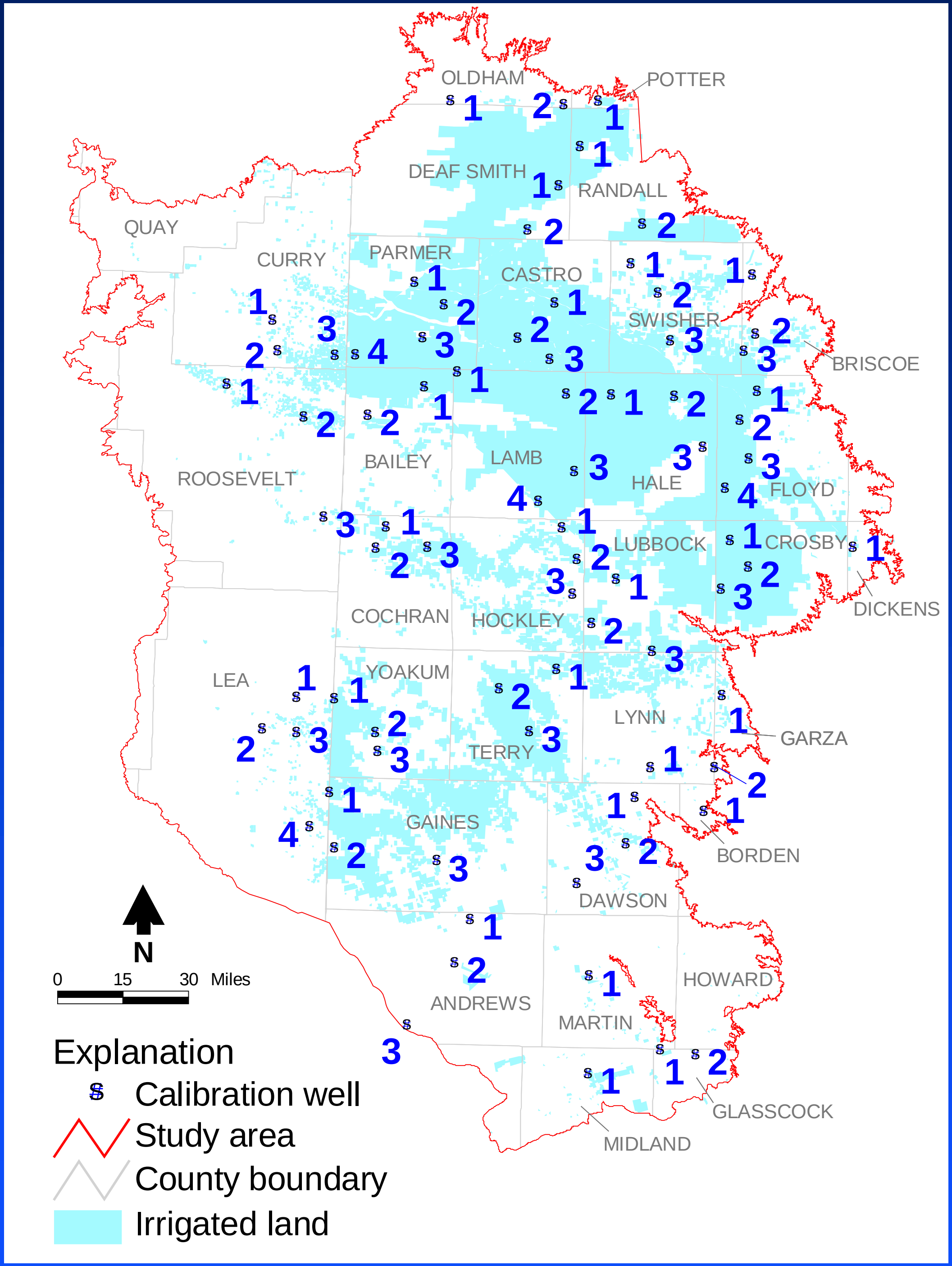


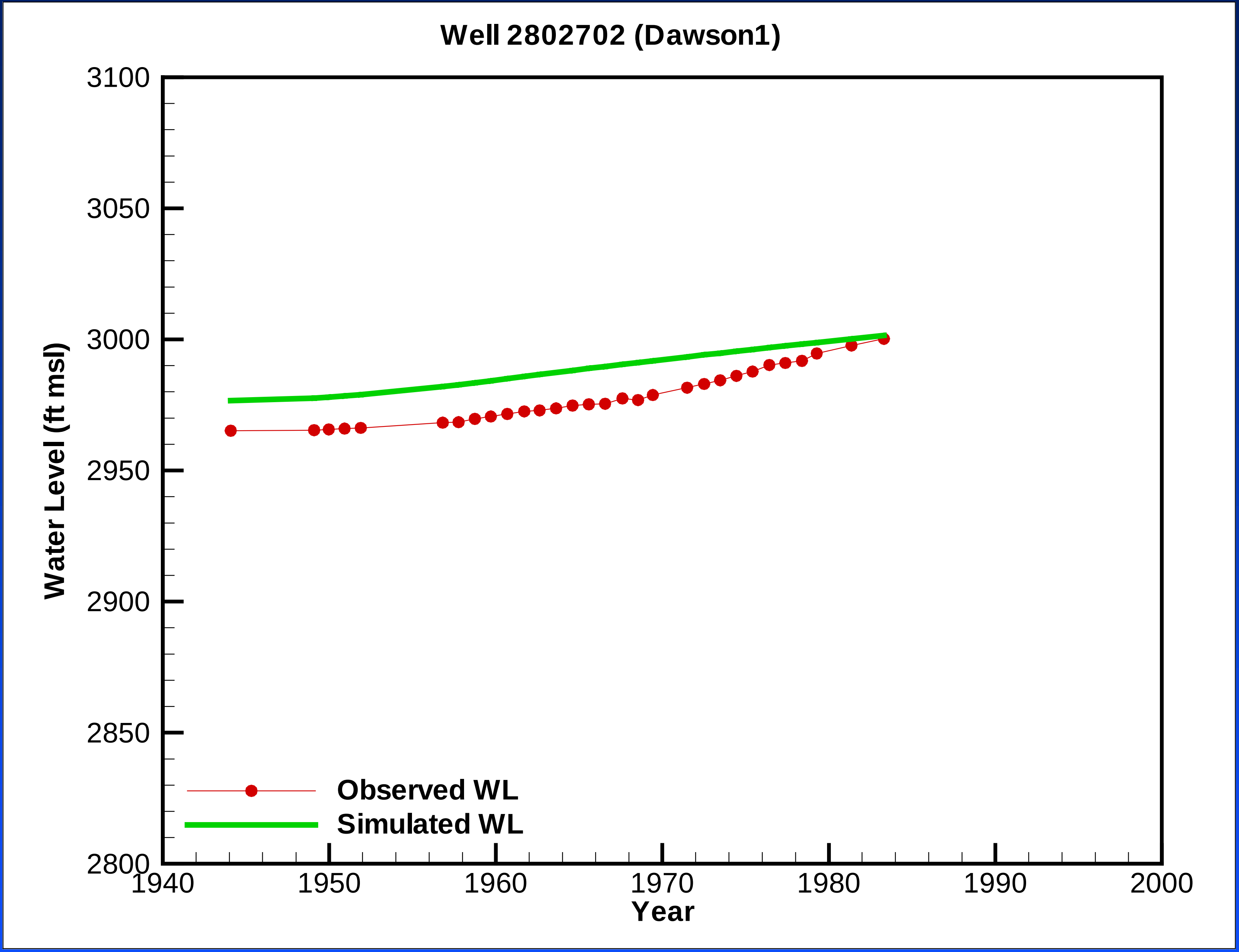
Well 1035401 (Parmer3)
4100
4000
3900
3800
3700
3600
3500
Water Level (ft msl)
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Simulated WL



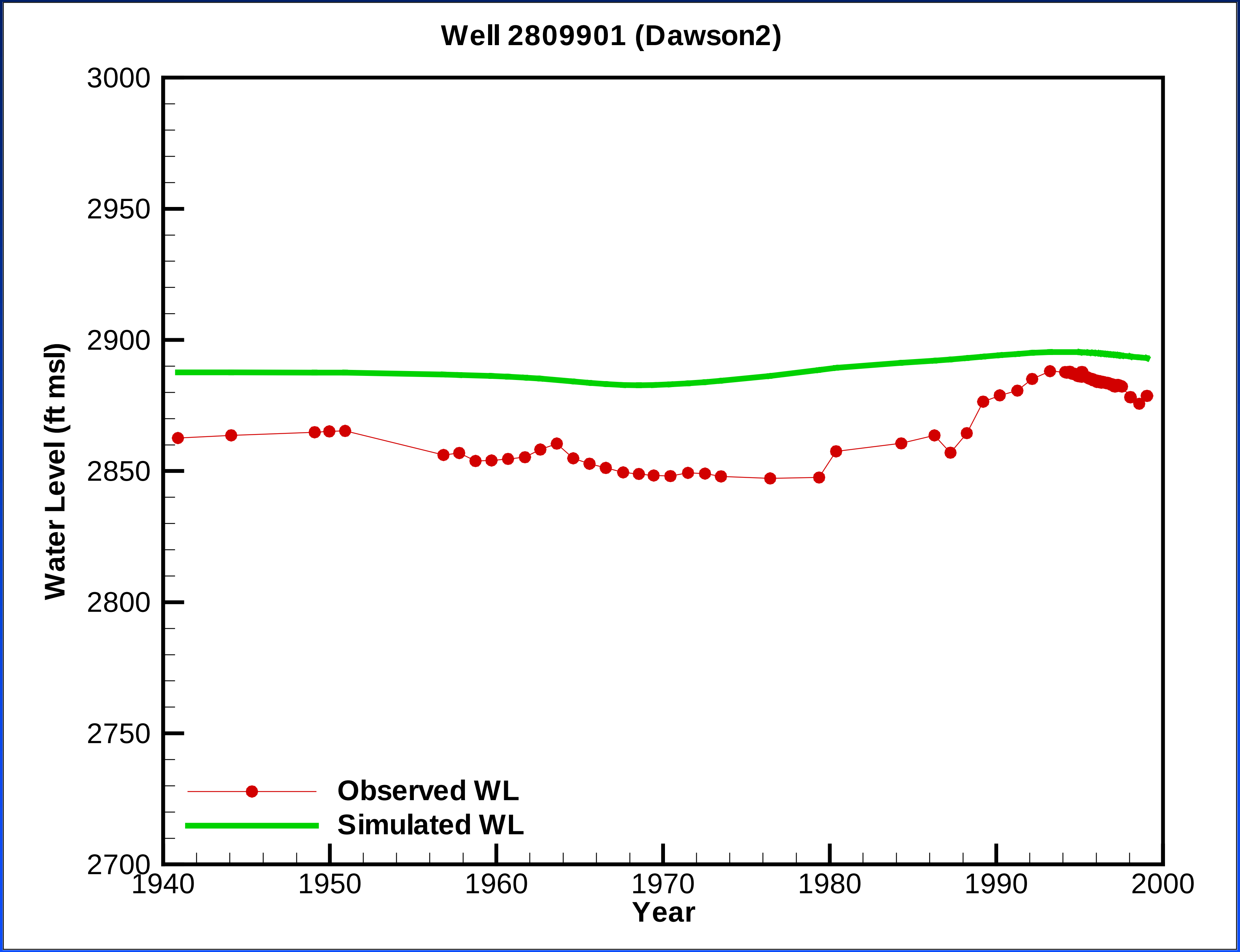
Well 2312902 (Crosby1)
3200
3150
3100
3050
3000
2950
2900
2850
2800
Water Level (ft msl)
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Simulated WL

Transient Calibration Points



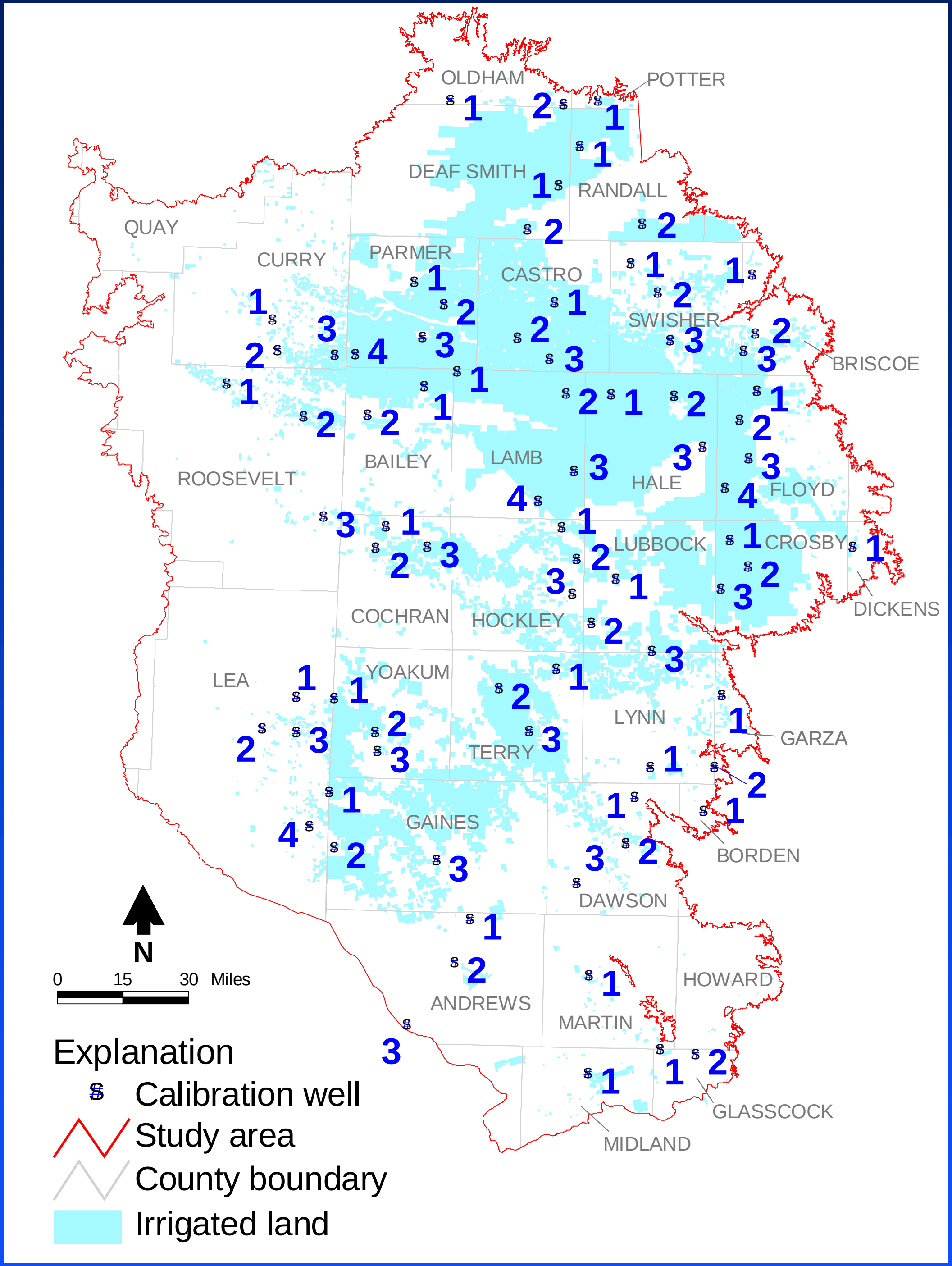


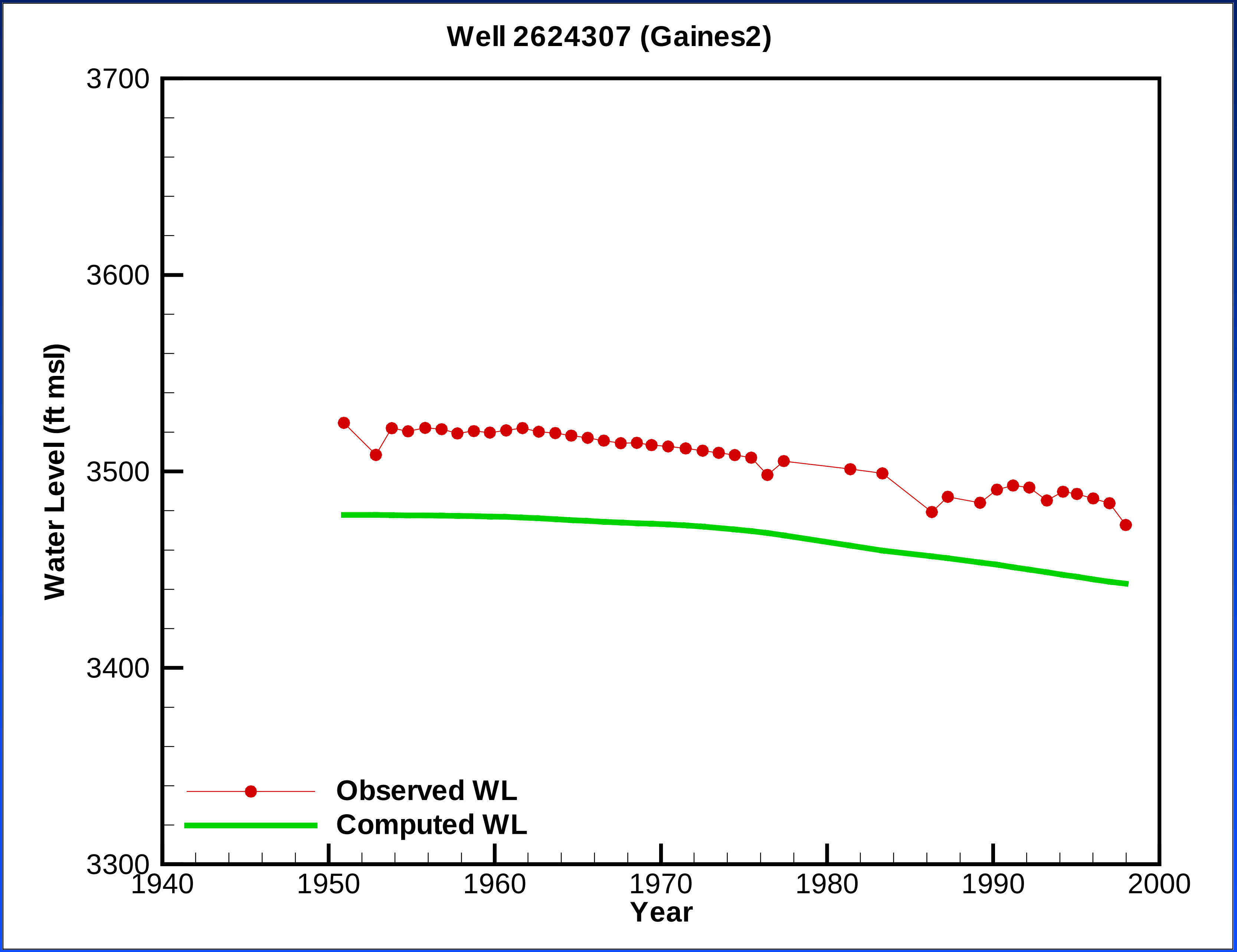
Well 2802702 (Dawson1)
3100
3050
3000
2950
2900
2850
2800
Water Level (ft msl)
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Simulated WL



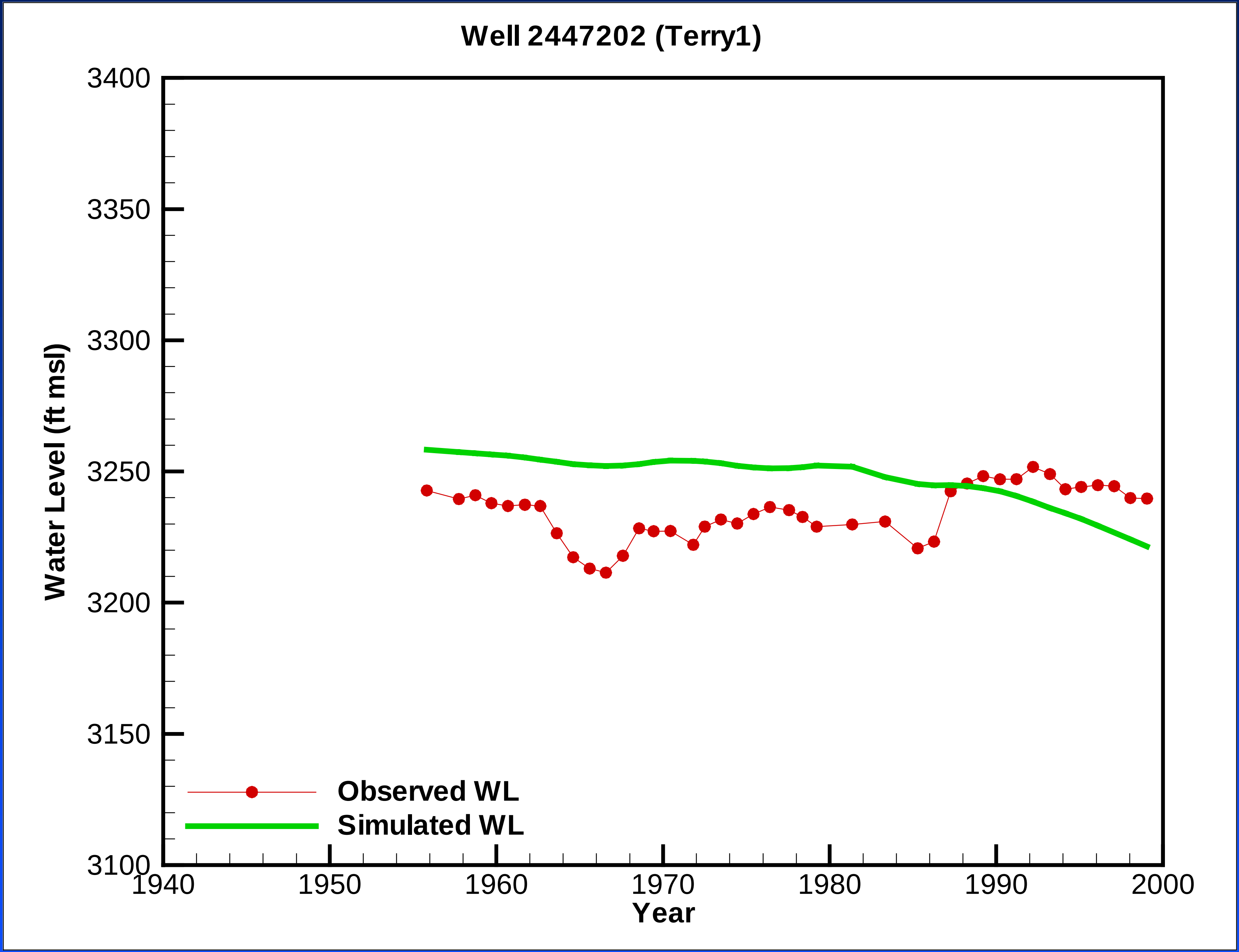
Well 2809901 (Dawson2)
Water Level (ft msl)
3000
2950
2900
2850
2800
2750
2700
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Simulated WL

Transient Calibration Points

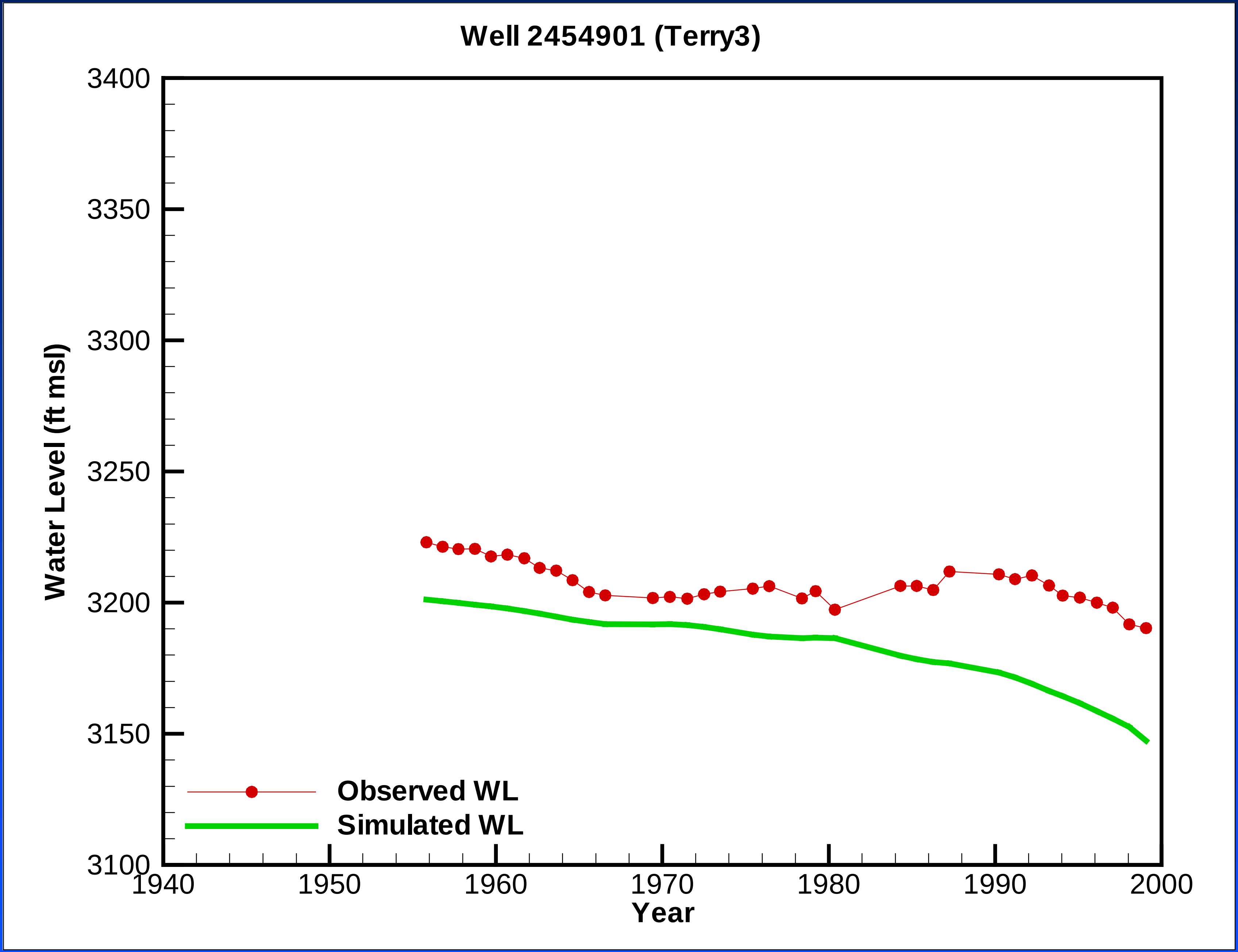




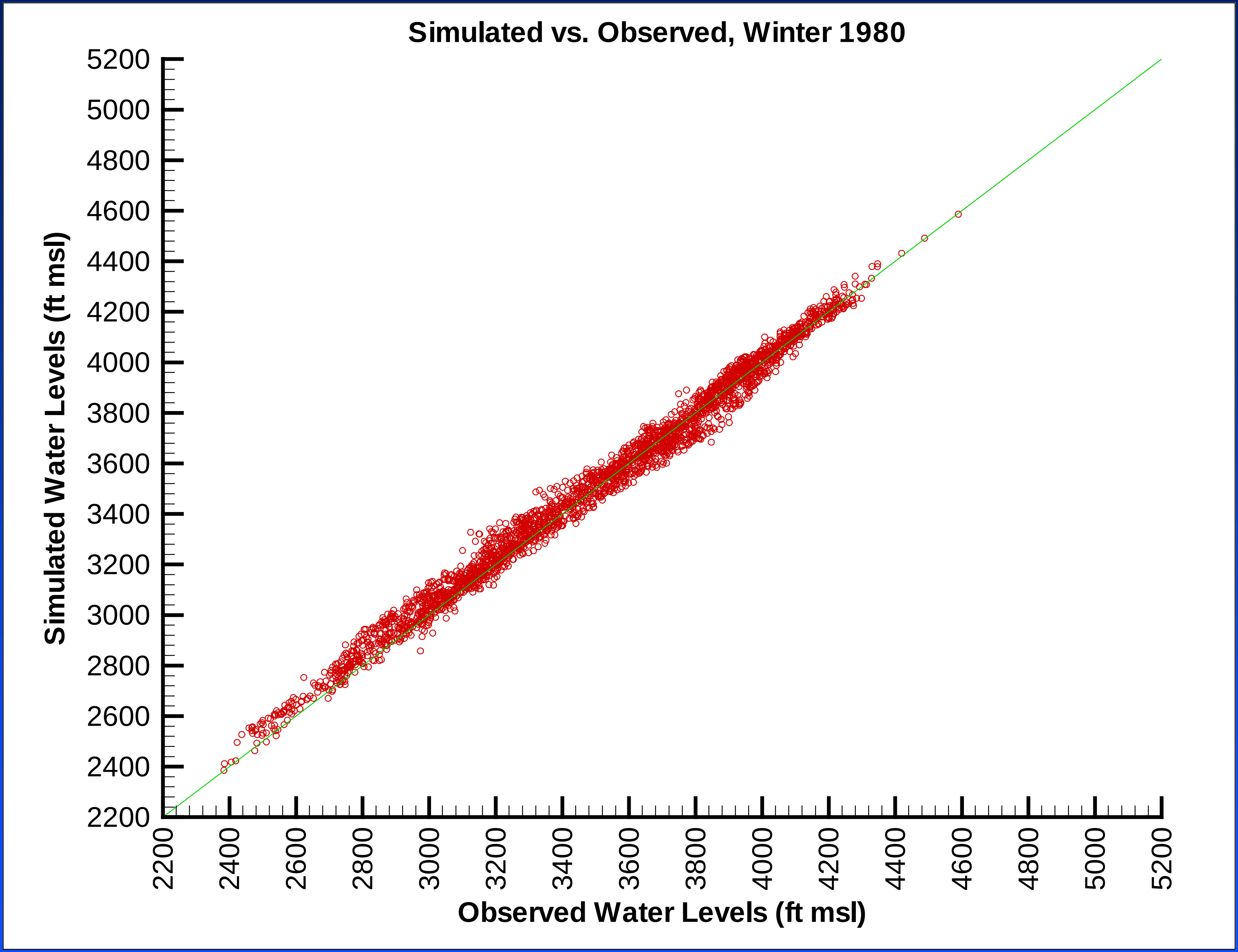
Well 2624307 (Gaines2)
3700
3600
3500
3400
3300
Water Level (ft msl)
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Computed WL

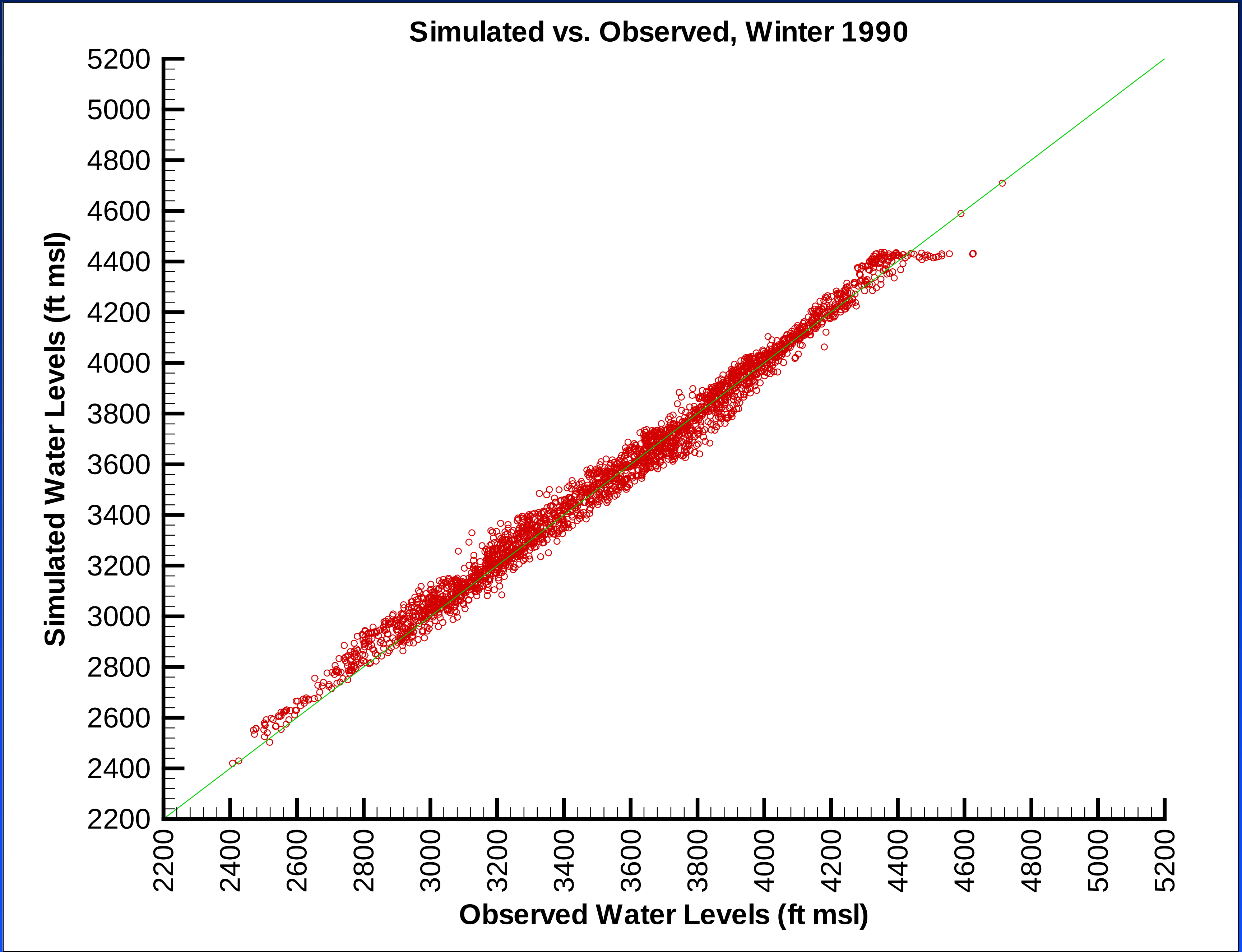


Well 2447202 (Terry1)
Water Level (ft msl)
3400
3350
3300
3250
3200
3150
3100
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Simulated WL

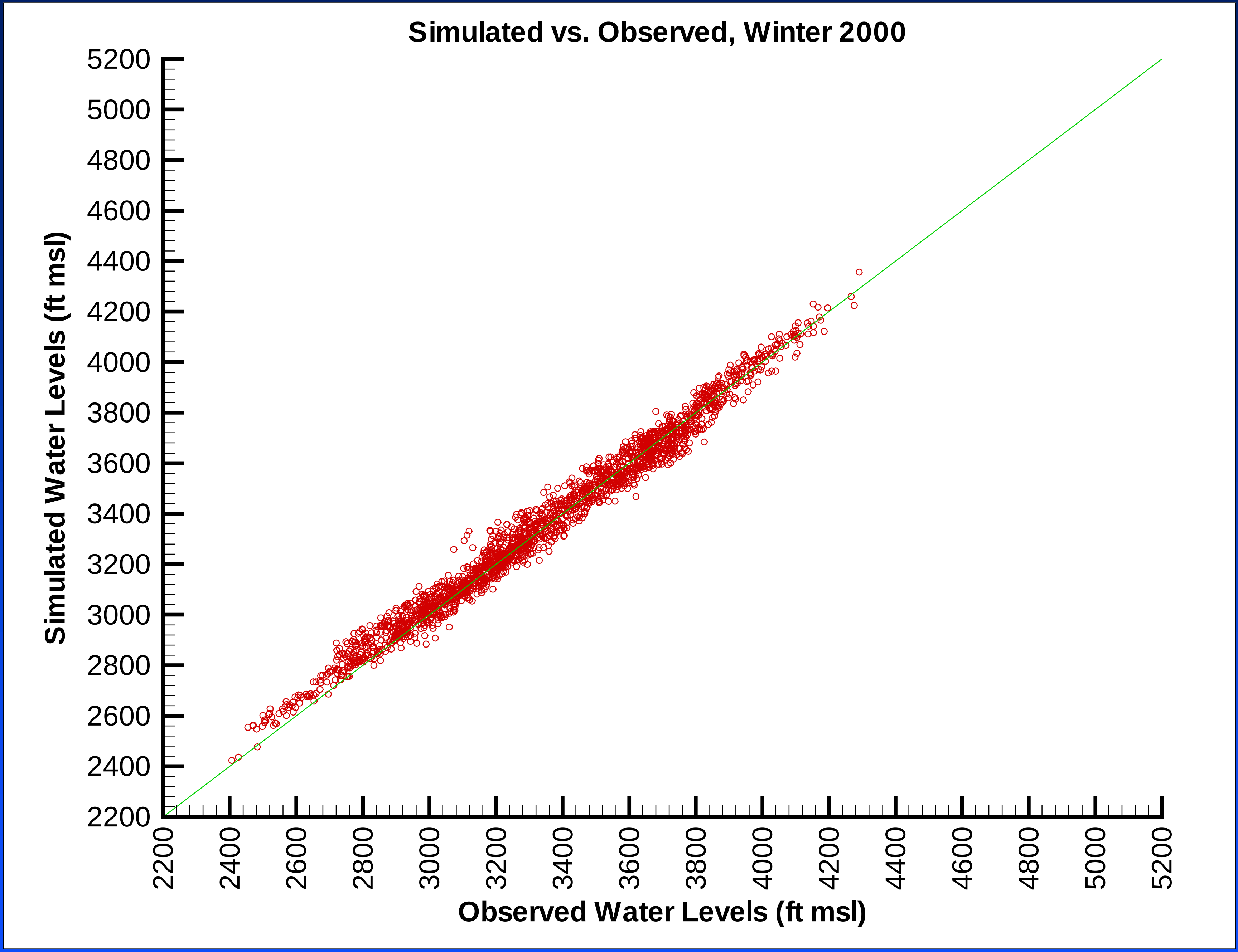


Well 2454901 (Terry3)
3400
3350
3300
3250
3200
3150
3100
Water Level (ft msl)
1940
1950
1960
1970
1980
1990
2000
Year
Observed WL
Simulated WL


Simulated vs. Observed, Winter 1980
Simulated Water Levels (ft msl)
Observed Water Levels (ft msl)
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
5200

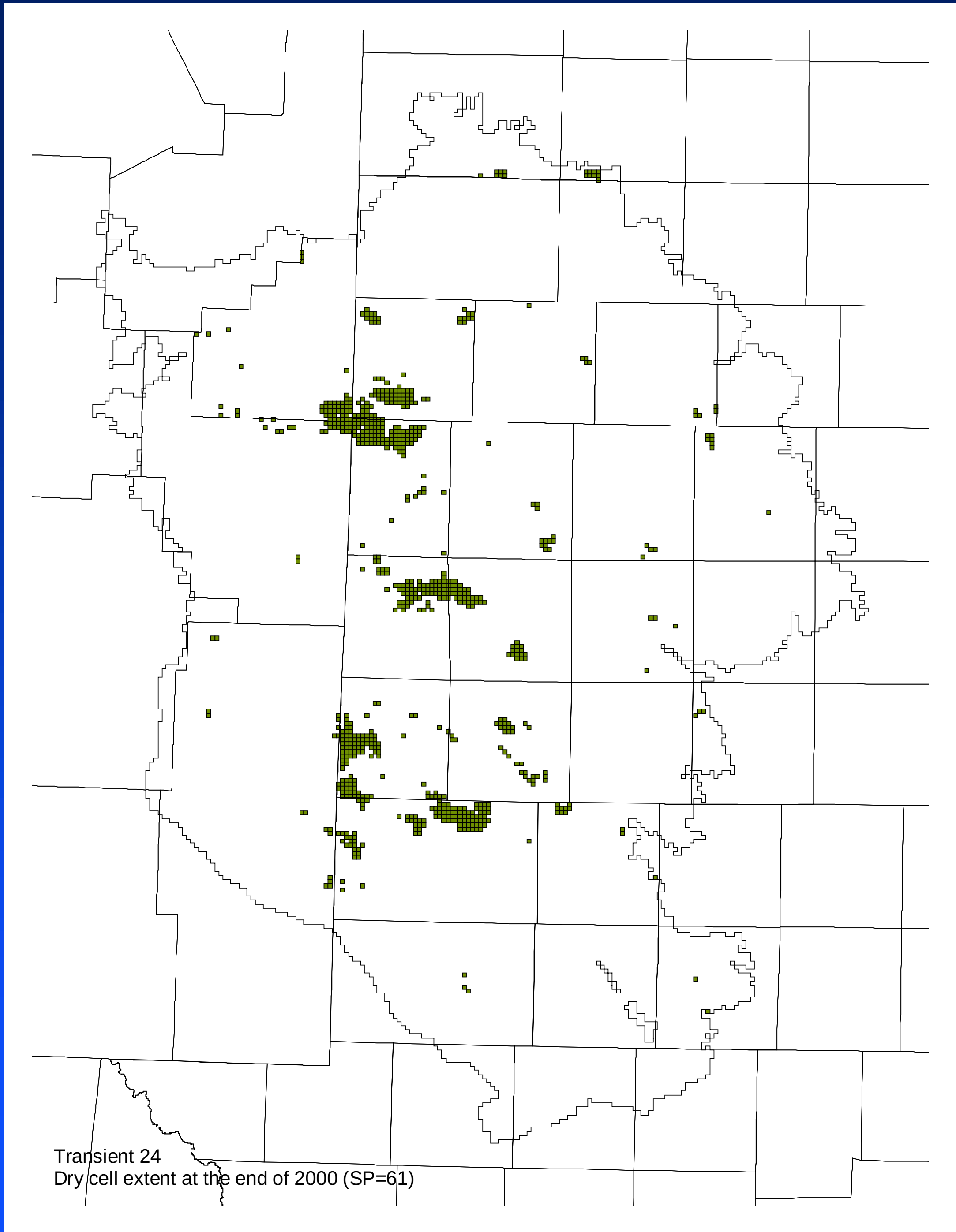


Simulated vs. Observed, Winter 1990
Simulated Water Levels (ft msl)
5200
5000
4800
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
5200
Observed Water Levels (ft msl)

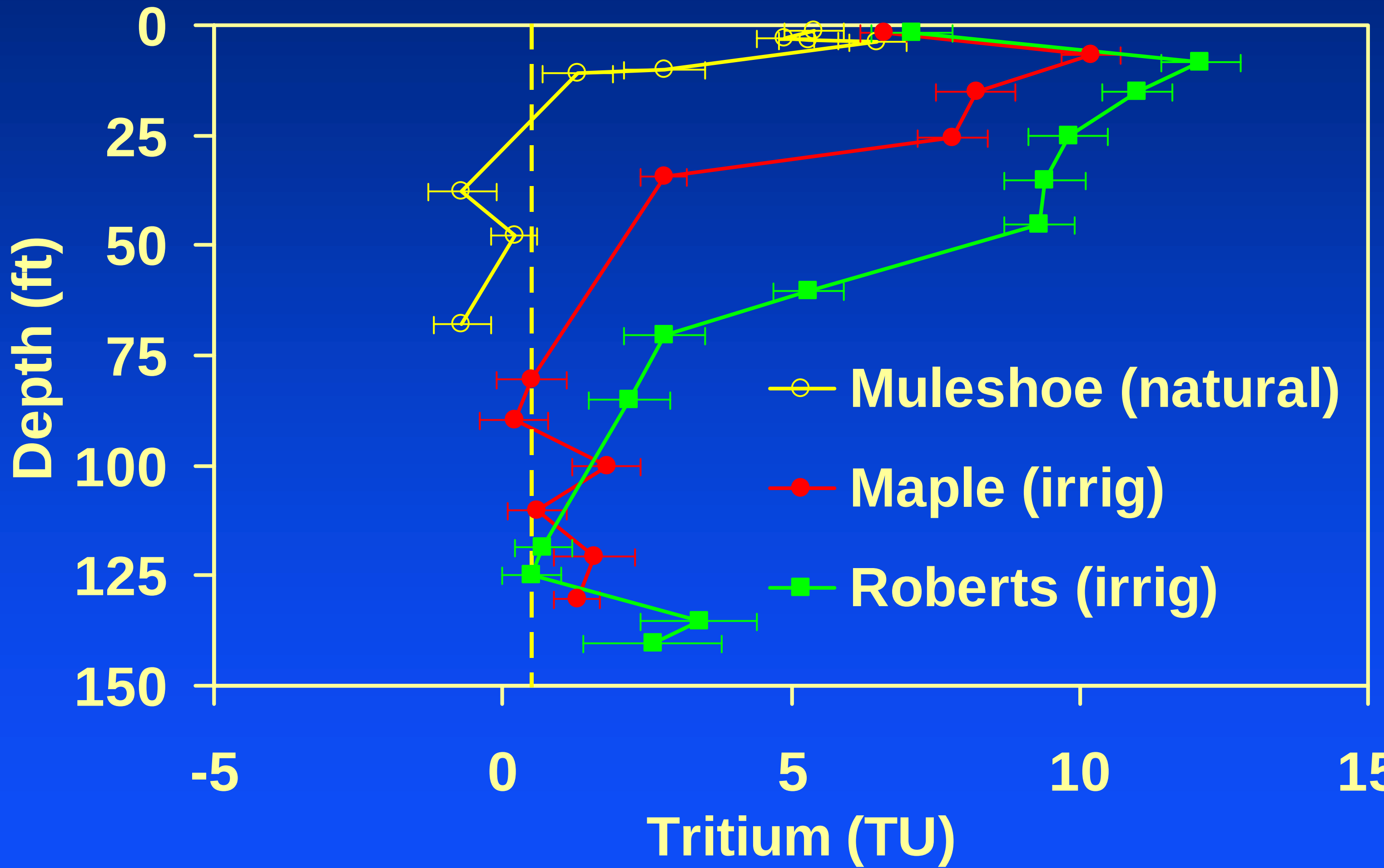


Simulated vs. Observed, Winter 2000
Simulated Water Levels (ft msl)
Observed Water Levels (ft msl)
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
5200

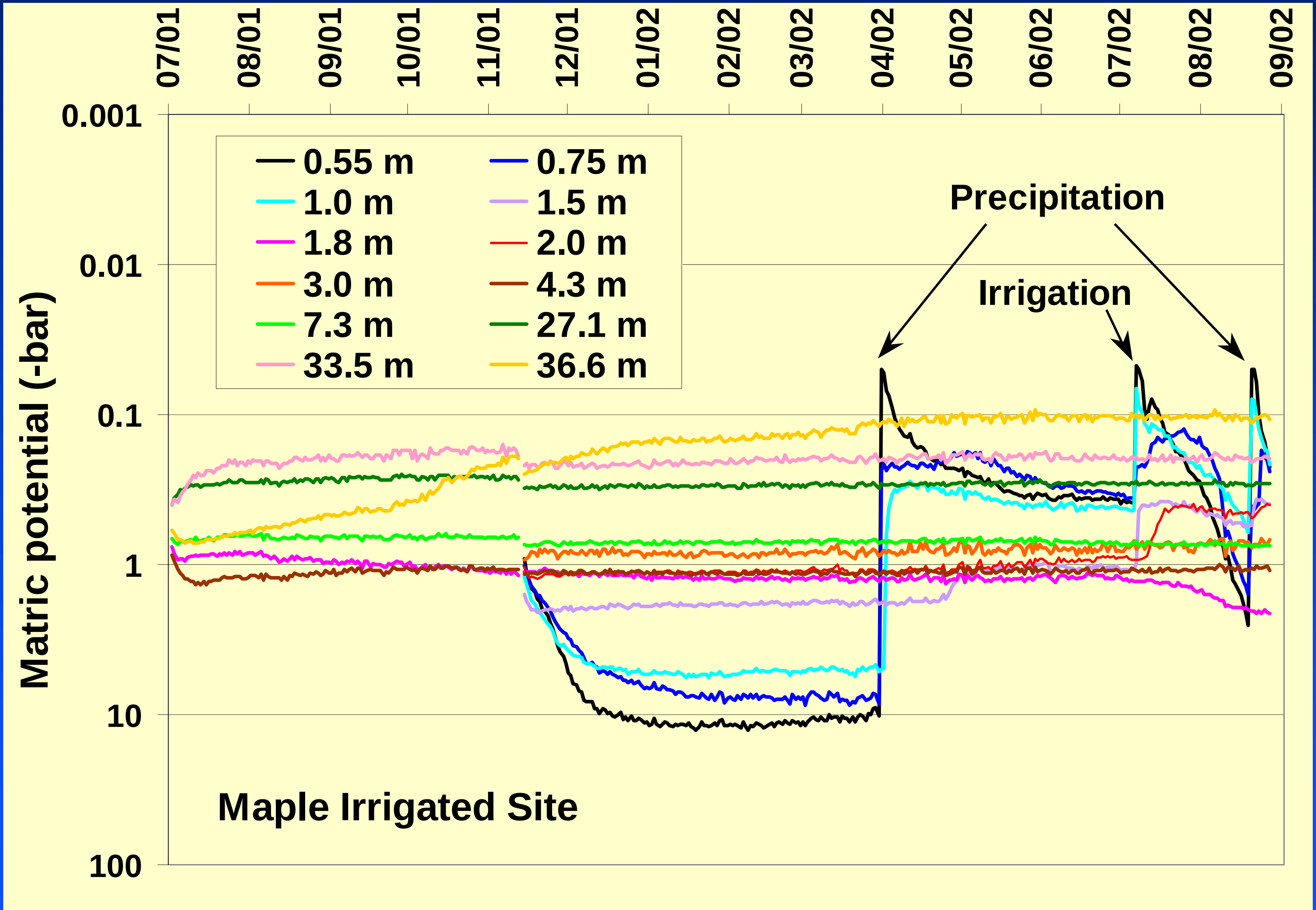
“Dry” Cells



Tritium Profiles in the Unsaturated Zone



Water pressure monitoring at an irrigated site



Average Recharge in Irrigated Plots

Site	$^3H_{gw}$ (TU)	$^3H_{CM}$ (m)	$^3H_{deep}$ (m)	ave WC	R CM (in/yr)	R deep (in/yr)
Roberts	14.5	11.1	45.1	0.12	1.4	4.5
Maple	0.1	5.2	41.5	0.14	0.7	4.6

gw = groundwater
CM = Center of mass
deep = deepest occurrence of tritium
WC = water content
R = recharge

Where Next?

- Finishing touches on transient calibration - meeting with TWDB September 6
- Input non-irrigation pumping and do 2 three-year periods of monthly pumping
- Predictive simulations
- Draft report September 30

Southern Ogallala Stakeholder Advisory Forum No. 6
August 29, 2002

List of Attendees

Name	Affiliation
Richard Smith	TWDB
Stefan Schuster	TWDB
Jason Coleman	South Plains UWCD
Don McReynolds	High Plains UWCD No. 1
Carmon McCain	High Plains UWCD No. 1
Clyde R. Crumley	LEUWCD
Jim Conkwright	High Plains UWCD No. 1
Harvey Everheart	Mesa UWCD
Larry Sanders	Region F
Ferrel Wheeler	Garza County Underground and Fresh Water Conservation District
Ches Carthel	City of Lubbock
Ron Brady	Panhandle Ground Water Conservation District
Ben Weinheimer	TCFA
Gale Henslee	Xcel Energy
Herb Grubb	HDR Engineering
Cary L. Betz	TNRCC
Neil Blandford	Daniel B. Stephens & Associates, Inc. (presenter)

Stakeholder Advisory Forum No. 6
August 29, 2002
High Plains Underground Water Conservation District No. 1
Lubbock, Texas

Questions & Answers Concerning Groundwater Availability Modeling (GAM) of the Southern Ogallala

1. When will the final model be available?

Response: *January 31, 2003.*

2. At some locations your simulated water level is below the observed water level in the aquifer. Wouldn't that cause the model to show less water available?

Response: *Yes, it would. I would recommend that at the local level, the changes in water level simulated by the model (i.e. the drawdown) be used in conjunction with observed water levels to determine remaining saturated thickness for a given time.*

3. So you are saying that this is not a predictive model?

Response: *No, it is a predictive model. I am simply saying that at some locations it may be more appropriate to use the predicted drawdown, or change in water levels, as opposed to the hydraulic head that is simulated.*

4. At some locations in our county (Terry County) the aquifer is nearly dry now. Some farmers have only about 20 ft of water in their wells.

Response: *No formal response to comment. The comment was made because this is one of the regions that experienced problems with dry model cells.*

5. Why wouldn't you change the water level in the model to match the measured water levels before doing the predictive simulations?

Response: *It is not good procedure to do this and it would introduce mass balance errors and numerical predictive uncertainties into the model. Basically, if the initial heads were changed to observed values for the predictive runs, the simulated changes in water levels would occur because of 1) internal numerical "readjustments" in the model, and 2) future pumping. We want to estimate changes due to future pumping only, and to change* *the starting heads would confuse the issue and produce ambiguous and unreliable results.*