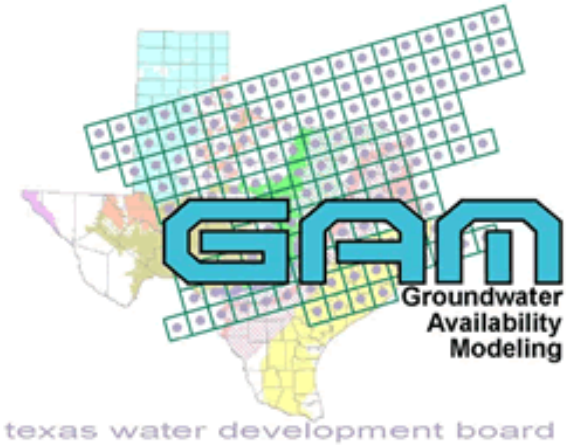
Groundwater Availability Modeling (GAM) for the Queen City and Sparta Aquifers

Stakeholder Advisory Forum No. 3

Centeq Research Plaza

College Station, Texas

January 9, 2004



Outline of Presentation

- GAM Objectives and Expectations
- Overview of Revised Model Scope
- Draft Conceptual Model
  - Implementation and integration with the Carrizo-Wilcox GAMs
- Review of Project Milestones & Schedule
- Expectations for the next SAF Meeting

GAM Objectives

- Develop realistic and scientifically accurate GW flow models representing the physical characteristics of the aquifer and incorporating the relevant processes
- GAMs are designed to be tools to help GWCDs, RWPGs, and individuals assess groundwater availability through 2050 based upon current data
- Promote stakeholder participation which is critical to the success of the GAM program

Stakeholder Advisory Forums - SAFs

- Held on 4 month schedule
  - SAF- 3 was delayed awaiting approval of the revised GAM scope and budget
- Today's meeting and future meetings will:
  - provide updates on progress
  - provide an opportunity to offer feedback
- SAF presentations and questions & responses from meetings will be posted at http://www.twdb.state.tx.us/gam/qc_sp/qc_sp.htm

Why Groundwater Flow Models?

- In contrast to surface water, groundwater flow is difficult to observe
- Aquifers are typically complex in terms of spatial extent and hydrogeological characteristics
- A groundwater model provides the best means for integrating available data for the prediction of groundwater flow at the scale of interest (measured data cannot tell the future).

Definition of a Model

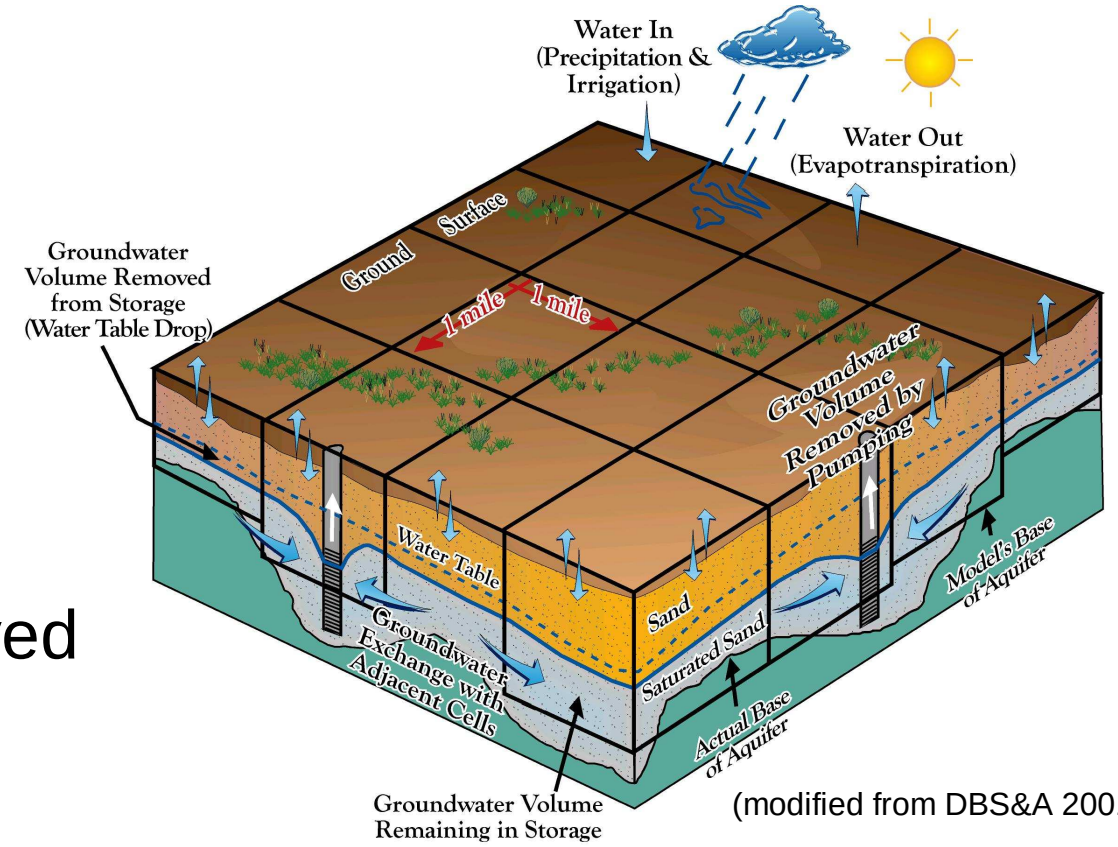
Merriam-Webster Online Dictionary: a description or analogy used to help visualize something (as an atom) that cannot be directly observed

Domenico (1972) defined a model as a representation of reality that attempts to explain the behavior of some aspect of reality and is always less complex than the real system it represents

Wang & Anderson (1982) defined a model as a tool designed to represent a simplified version of reality

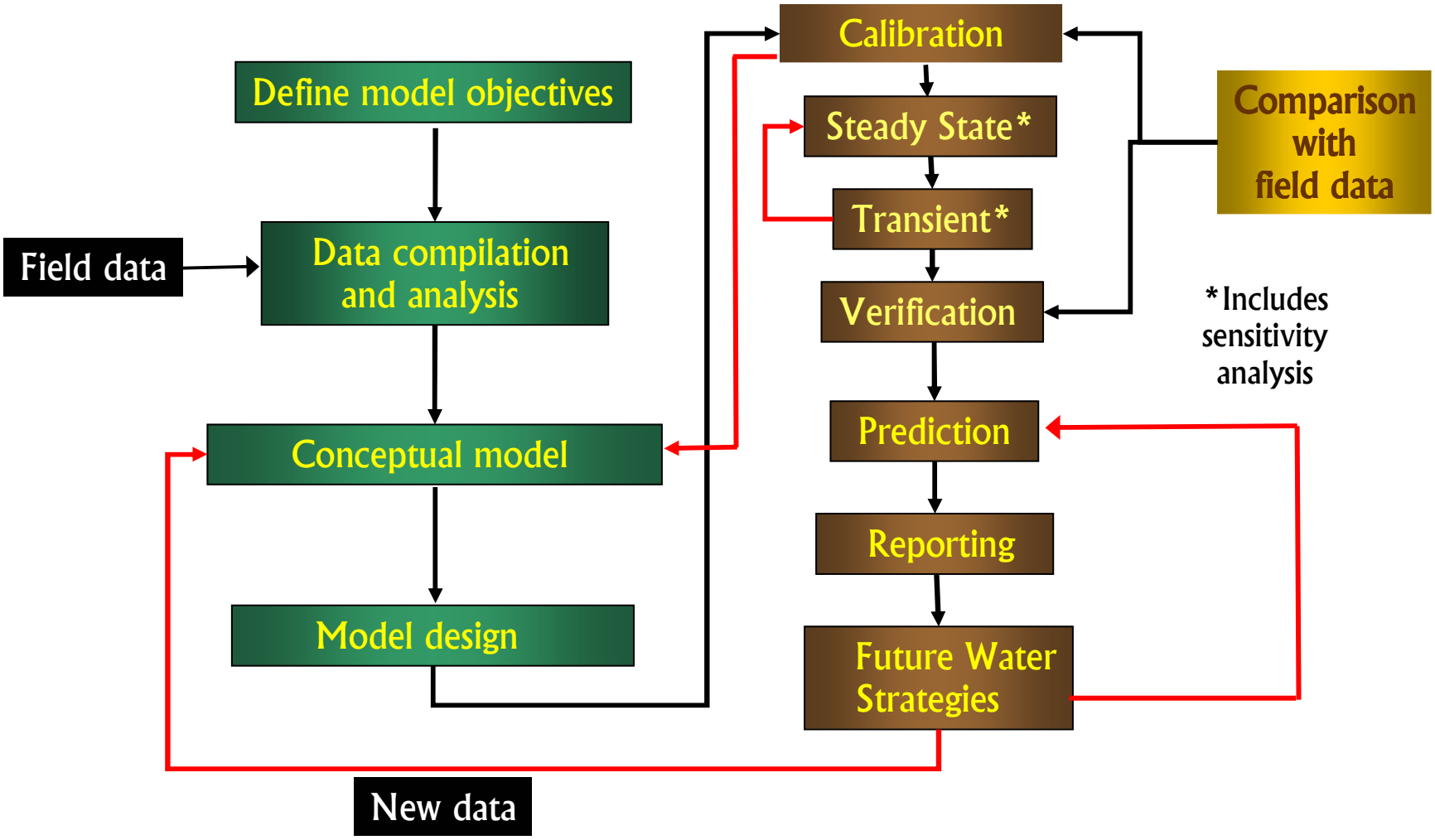
A Model is a Tool

- Model heads are calculated based upon:
  - Recharge
  - Aquifer properties
  - Pumping
  - Natural Discharge
- Model heads are compared to observed water levels
- The tool is used to predict future water levels



(modified from DBS&A 2001)

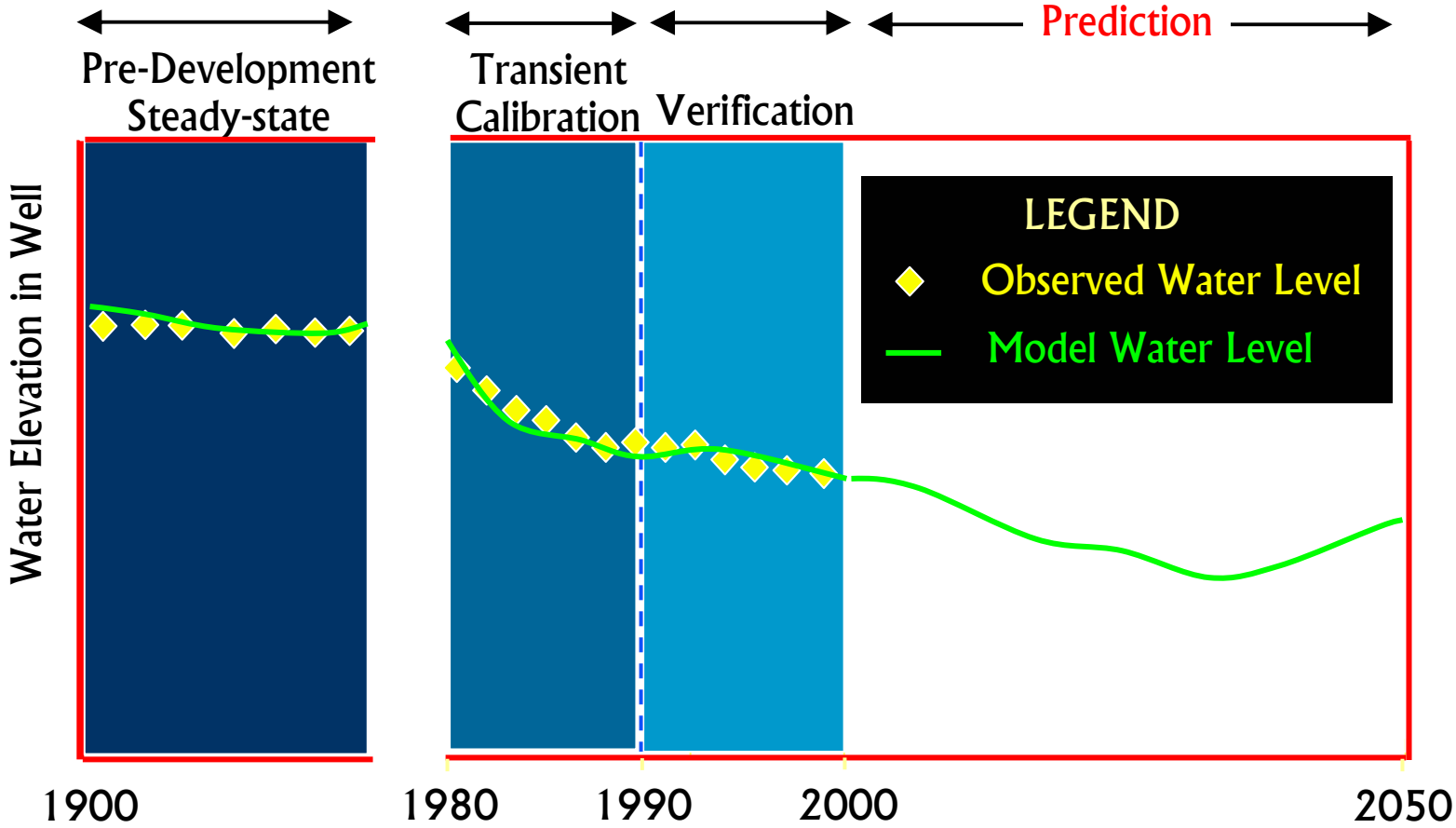
Modeling Protocol



GAM Model Specifications

- Three dimensional (MODFLOW-96)
- Regional scale (1000's of square miles)
- Grid spacing of 1 square mile
- Implement
  - recharge
  - groundwater/surface water interaction
  - pumping
- Calibration to observed water levels

GAM Model Periods



Pre-development and transient calibration periods represent different hydrologic conditions

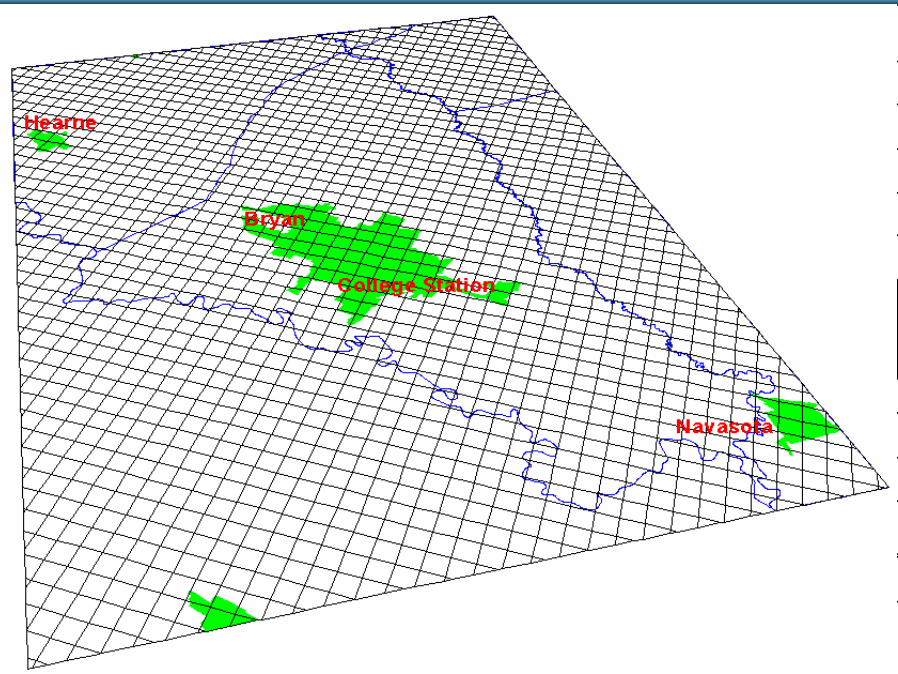
Queen City-Sparta GAM Specifications

- The Queen City and Sparta aquifer GAMs will be incorporated into the current Carrizo-Wilcox GAMs
- The product will be delivered as three models (southern, central, and northern regions)
- One modeling report will be produced

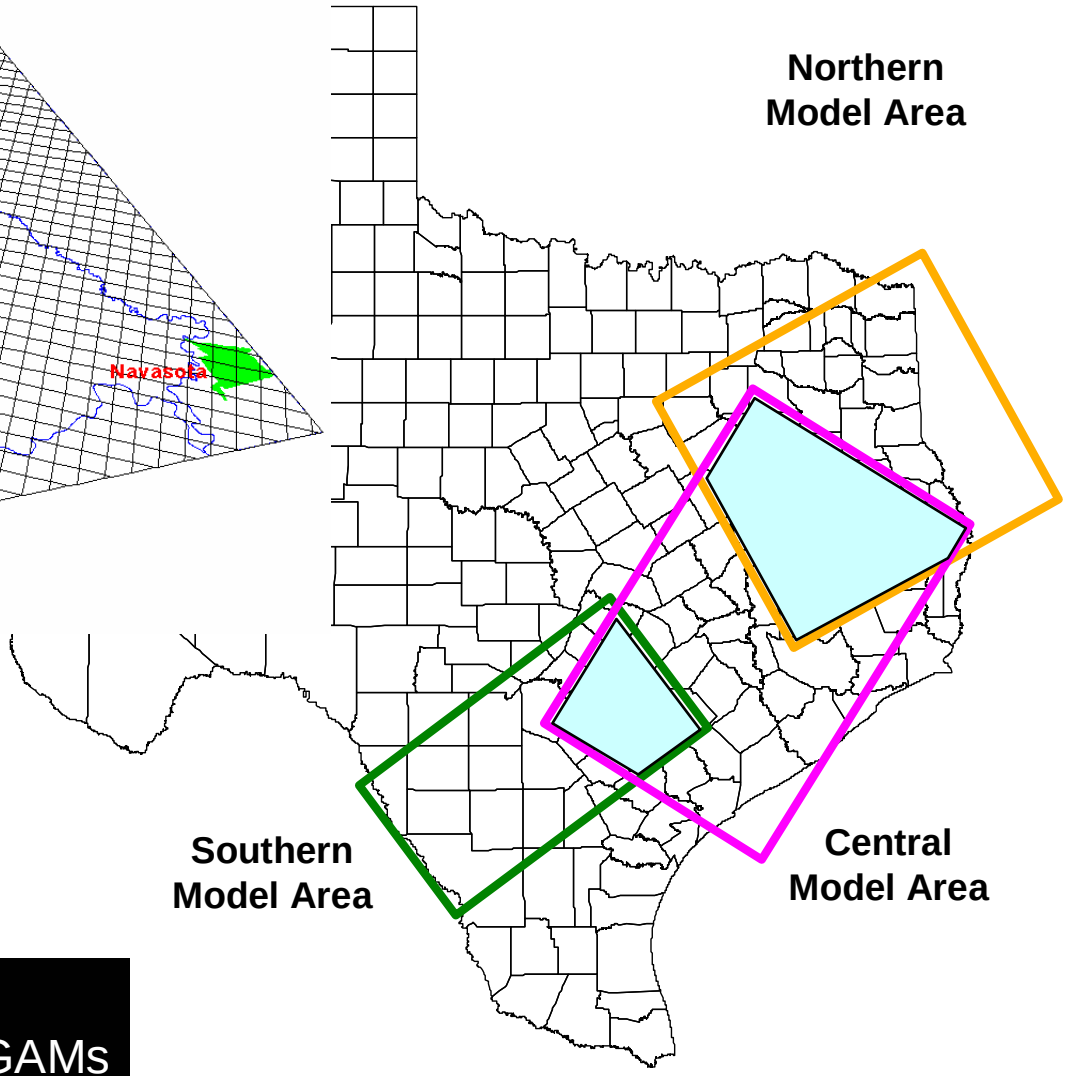
Queen City-Sparta GAM Specifications

- Original scope: Carrizo-Wilcox GAMs will be modified only as needed to properly add the Queen City and Sparta aquifers and recalibrate the entire model
- Revised scope: The Carrizo-Wilcox GAMs will be modified to be consistent in the overlap zones from the base of the Carrizo through the Sparta aquifer

Model Domains



20,000 acres represents
Approximately 5 grid blocks



Grid - 1 square mile each
Same Grid as Carrizo-Wilcox GAMs

Motivation for New Scope

- The three completed Carrizo-Wilcox GAMs have differences between them in the overlap zones
- Recent applications of these GAMs has pointed out a need to better integrate the three C/W GAMs in the overlap zones
- Integration of the C/W GAMs in the overlap zones supports proper development and calibration of the Queen City and Sparta GAMs
- Integration of the C/W GAMs in the overlap was not in the original scope

Details of New Scope

- Structure: Develop a consistent model structure from the Carrizo up through the Sparta
  - This also implies a consistent outcrop between models
- Hydraulic Properties: Develop consistent hydraulic properties from the Carrizo up through the Sparta
- Recharge: Develop consistent recharge estimates
- Pumping: Develop consistent pumping in the overlap zones for Carrizo-Wilcox aquifers
- Calibration: The Carrizo-Wilcox and the Queen City and Sparta aquifers will be consistently calibrated between the three models

Draft Conceptual Model

The Draft Conceptual Model
Report was submitted on 7/31/03

Conceptual Model

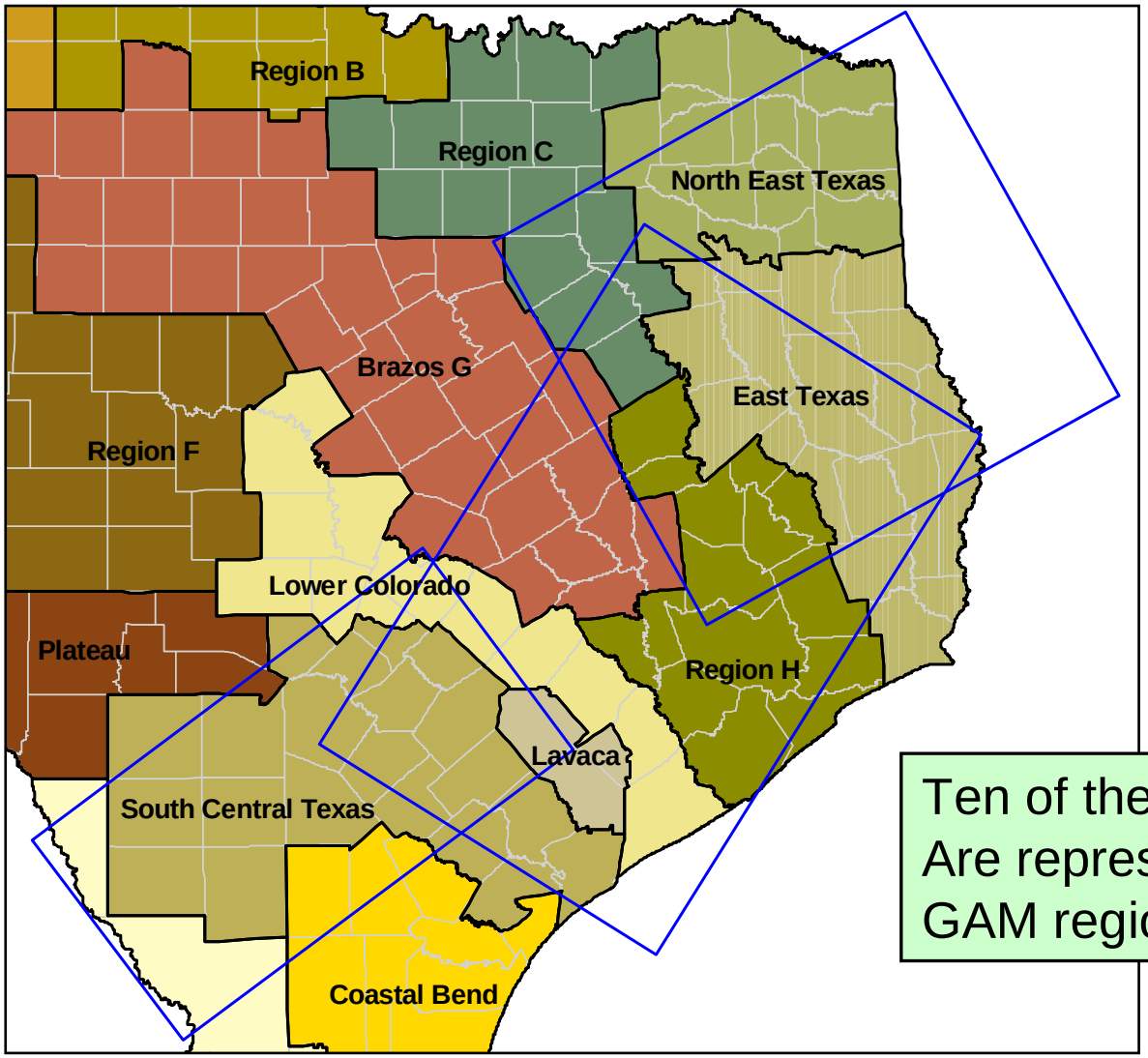
- Identify relevant processes and physical elements controlling GW flow in the aquifer:
  - Geologic Framework
  - Hydrologic Framework
  - Hydraulic Properties
  - Heads, Sources & Sinks (Water Budget)
- The conceptual model dictates how you translate the “real world” to a mathematical model

Conceptual Model Outline

- Model Setting
- Structure
- Hydraulic Properties
- Review of Water Levels and Groundwater Flow
- Groundwater Quality
- Aquifer Sinks and Sources
  - Recharge
  - Springs
  - Pumping
  - Streams

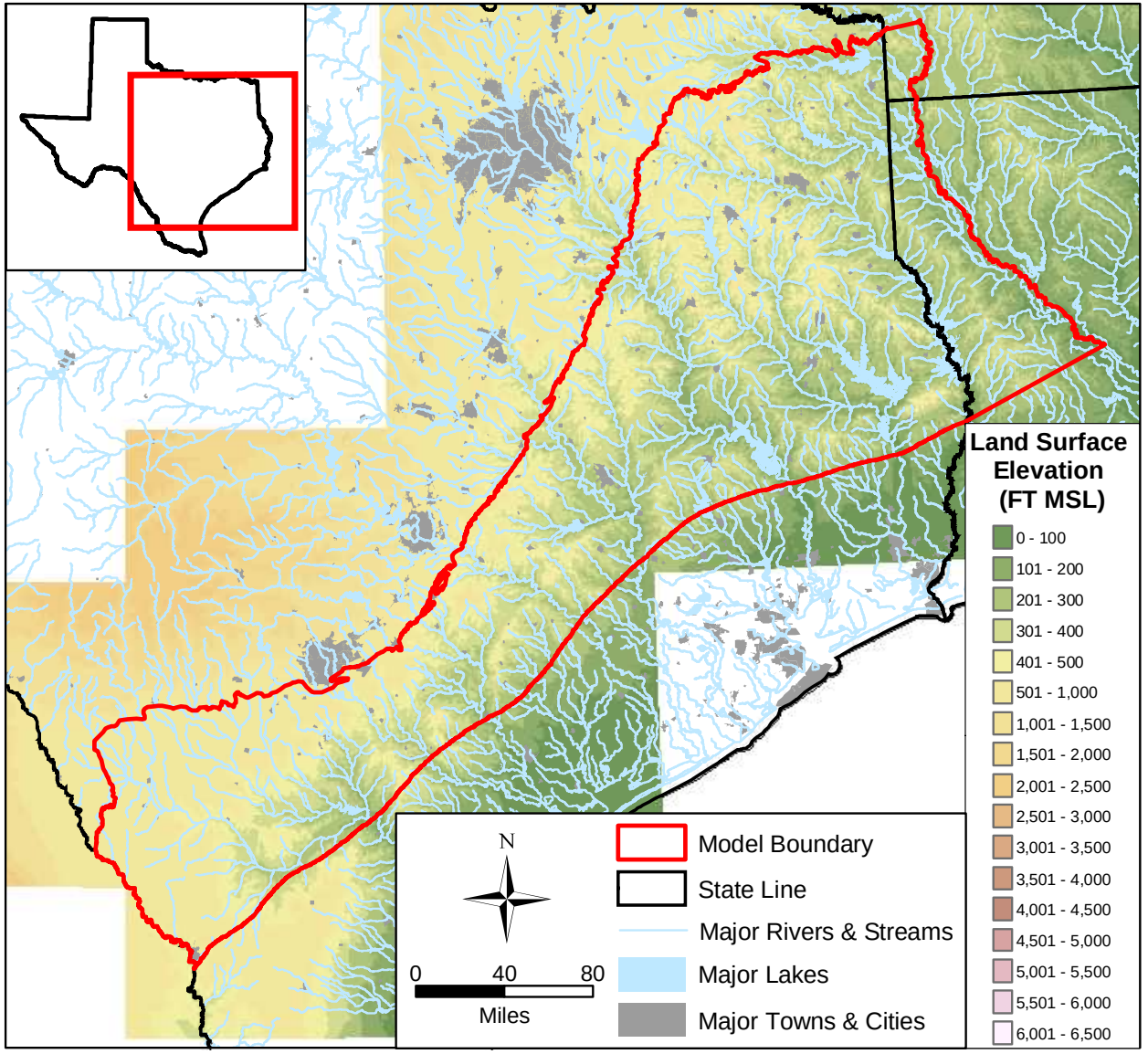
Model Setting

Regional Water Planning Groups

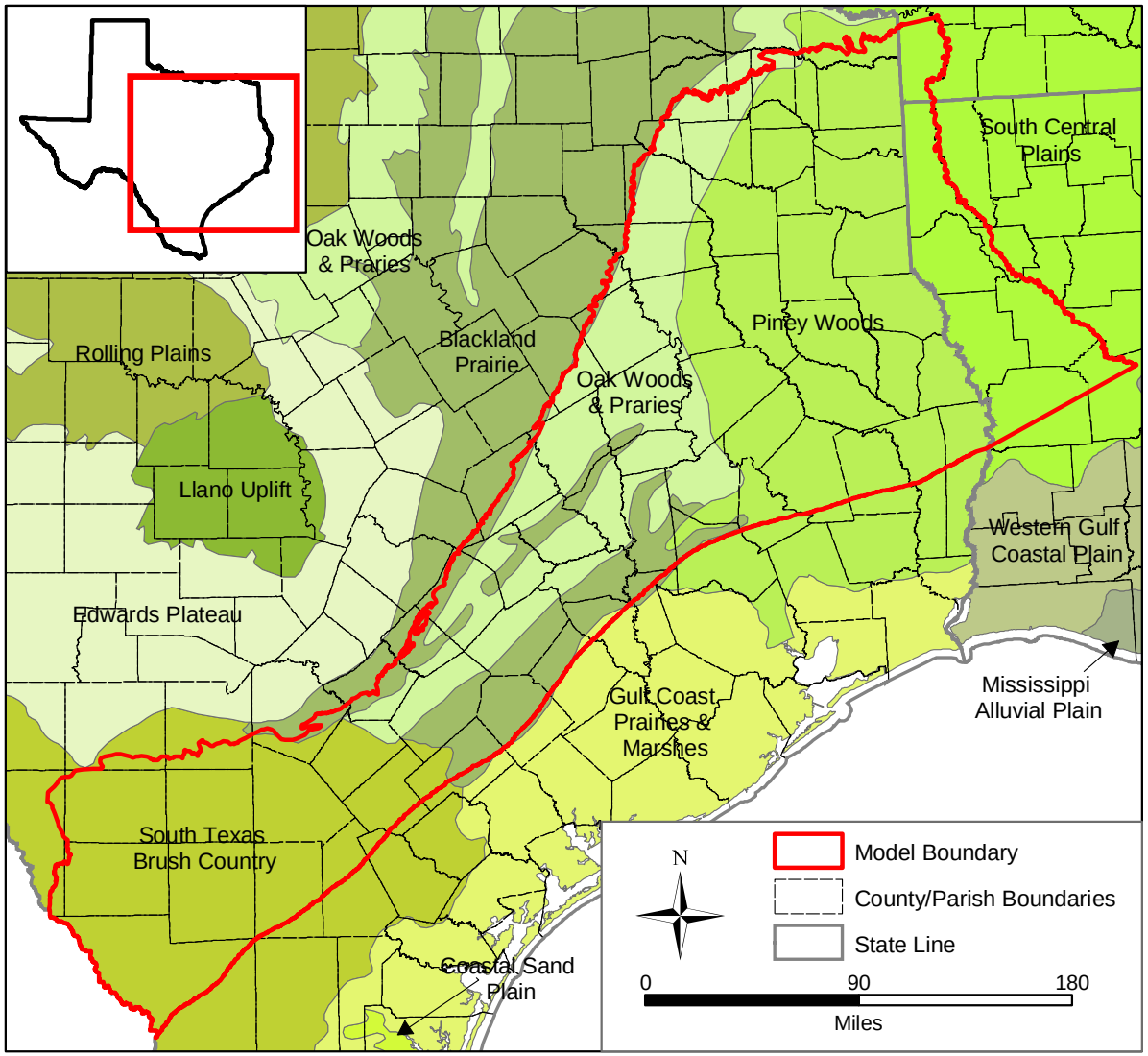


Ten of the sixteen RWPGs Are represented in the three GAM regions

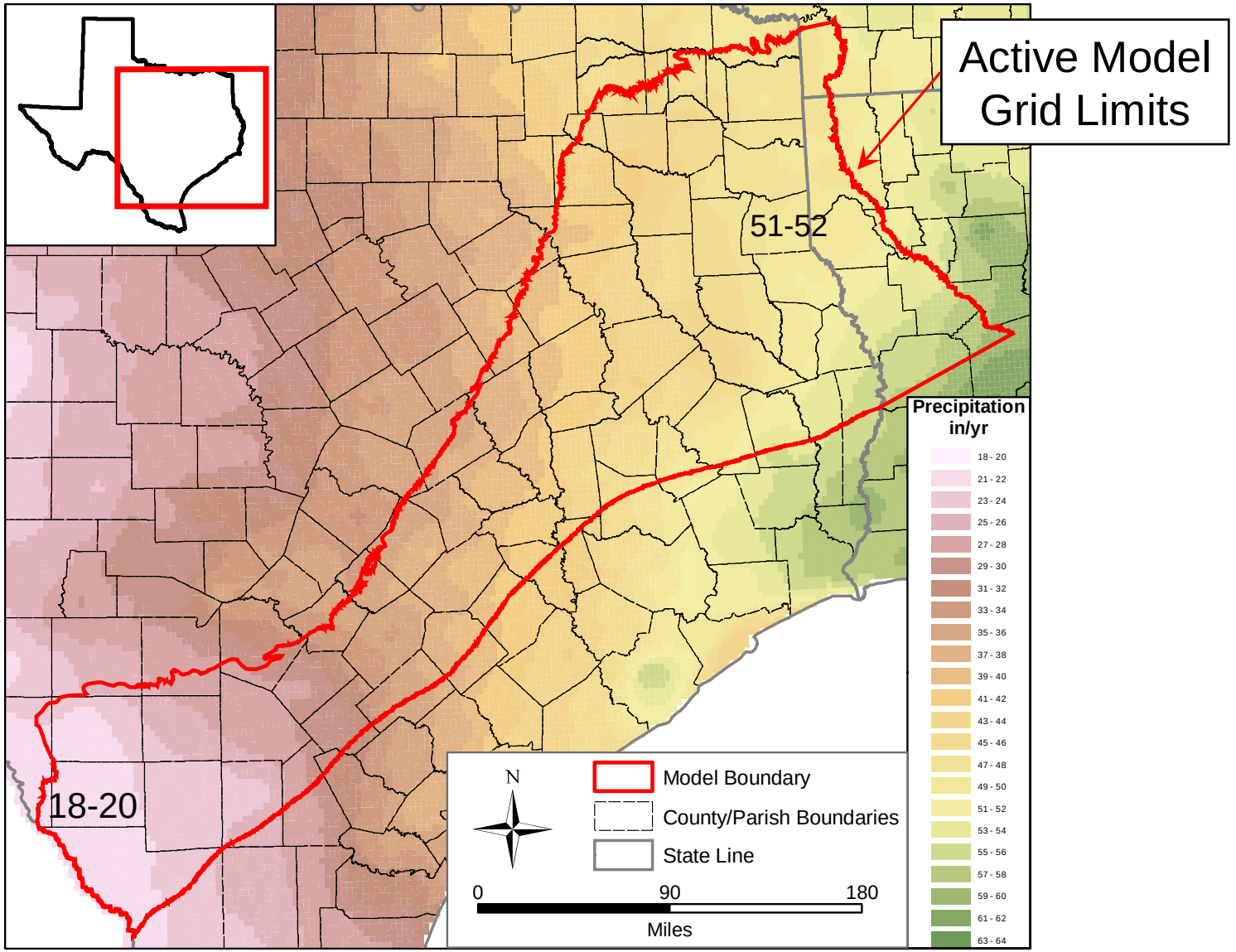
Land Surface Elevation



Eco Regions


Oak Woods & Praries
South Central Plains
Piney Woods
Rolling Plains
Blackland Prairie
Oak Woods & Praries
Llano Uplift
Western Gulf Coastal Plain
Edwards Plateau
Mississippi Alluvial Plain
Gulf Coast Prairies & Marshes
South Texas Brush Country
Coastal Sand Plain
N
Model Boundary
County/Parish Boundaries
State Line
0
90
180
Miles

Yearly Average Rainfall

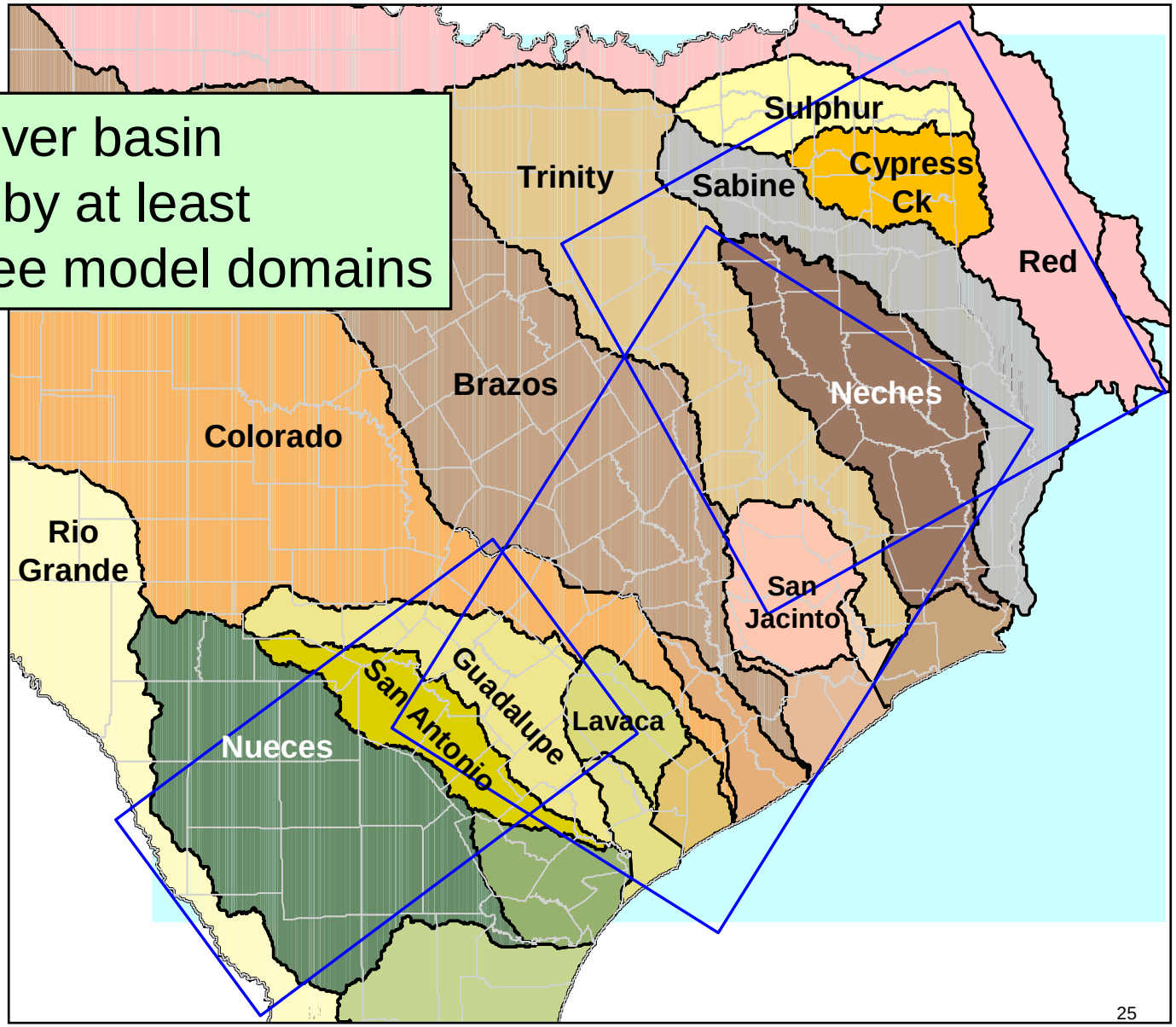


Drought of Record

- **Drought of Record in Texas is generally accepted to be in the 1950s**
  - Southern Model DOR – October 1953 through February 1957
  - Central Model DOR – 1954 through 1956
  - Northern Model DOR – June 1954 through March 1957
- **We will use the same DOR for the respective models as determined for the Carrizo-Wilcox GAMs**

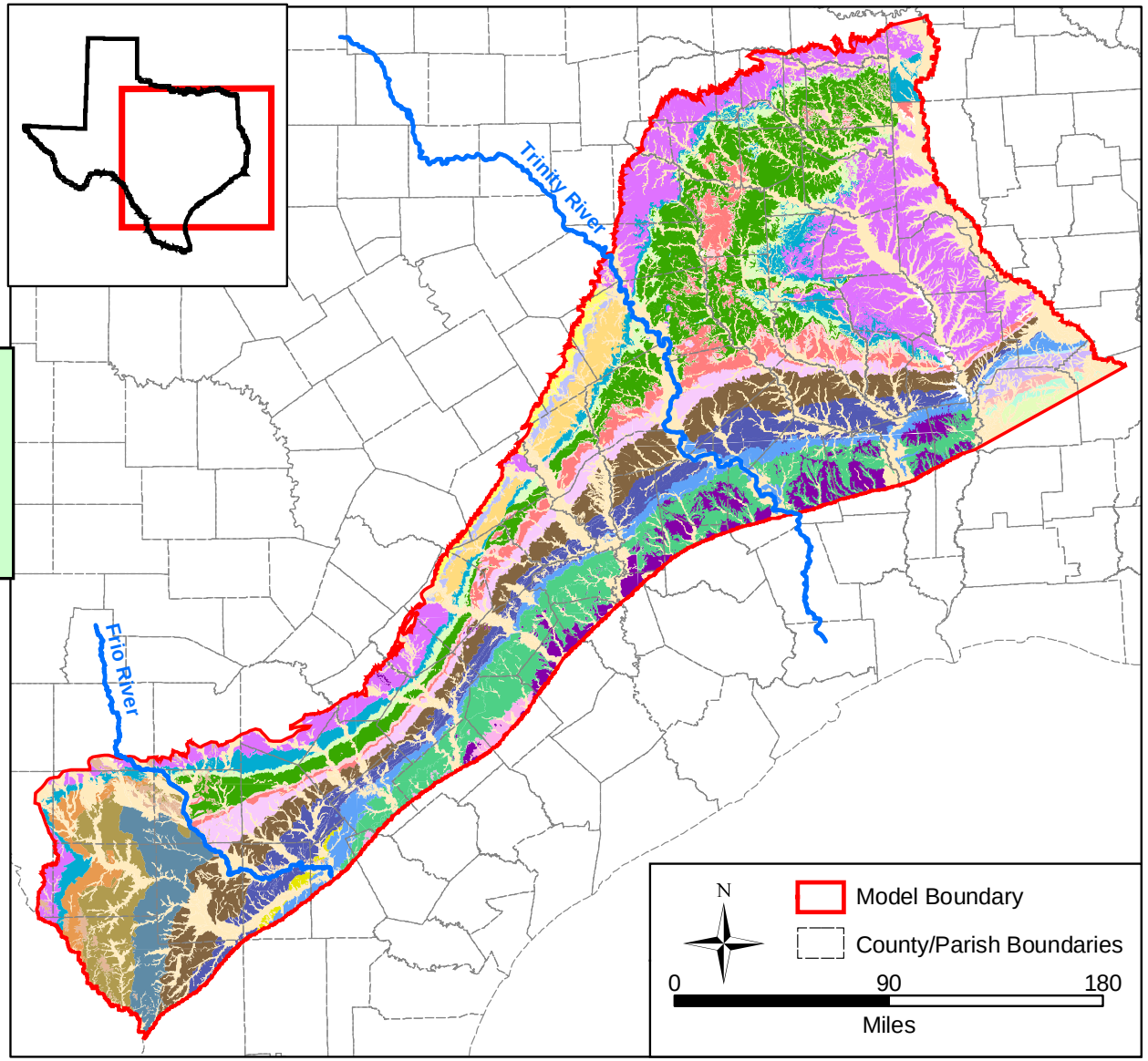
Major River Basins

Every major river basin
is intersected by at least
one of the three model domains

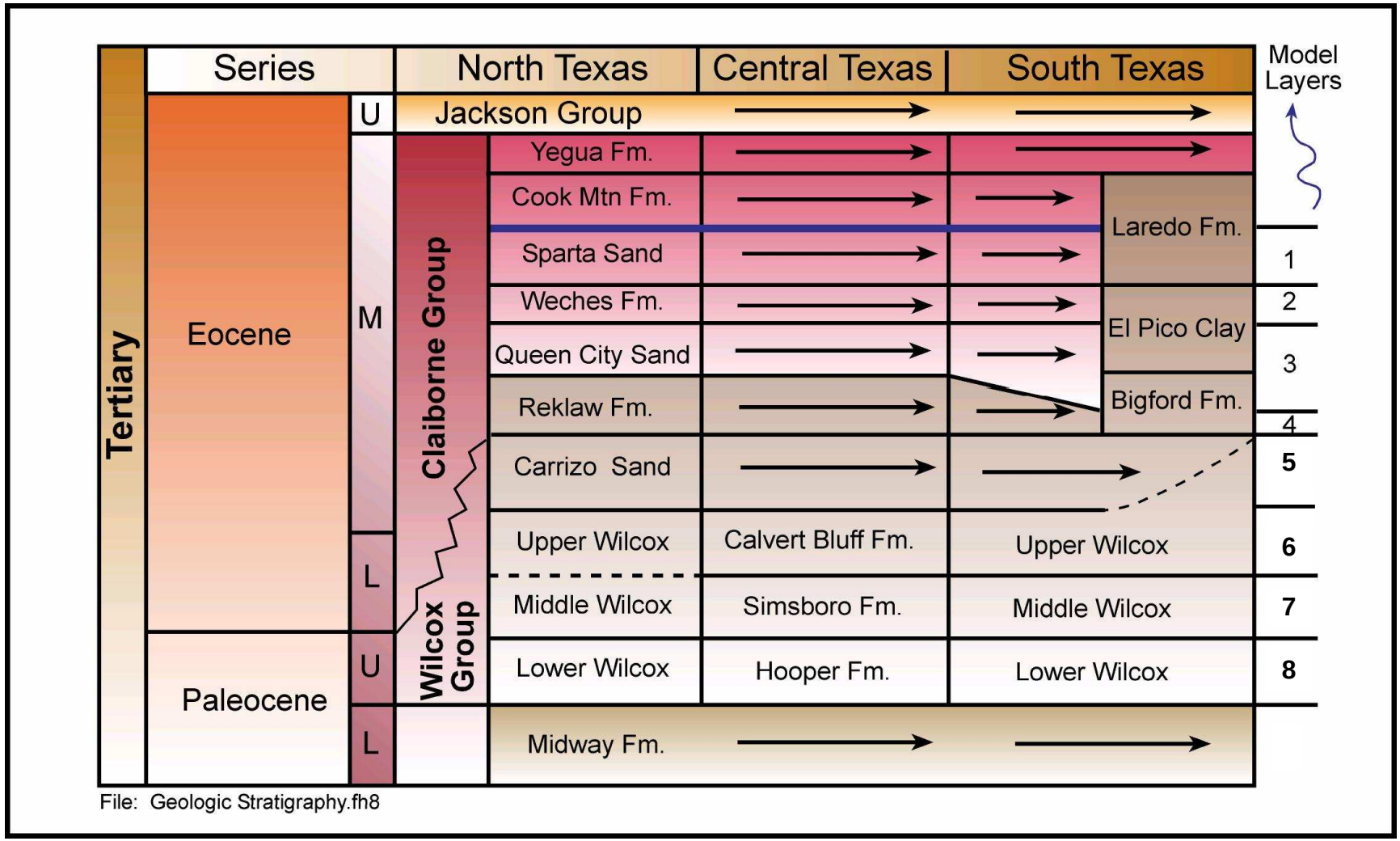


Geology

Outcrop for the active model domain

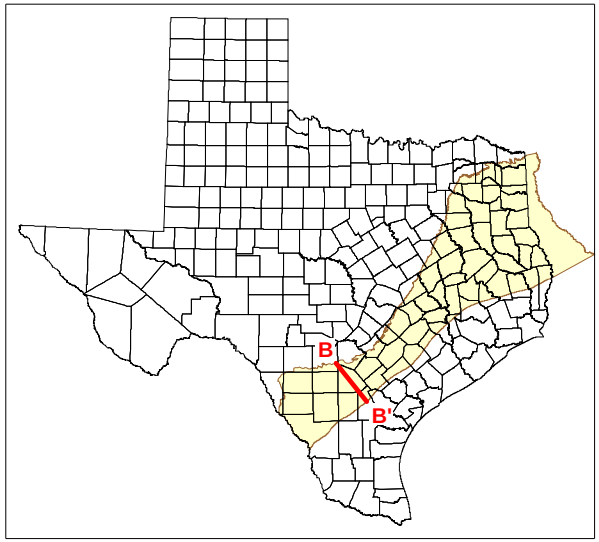


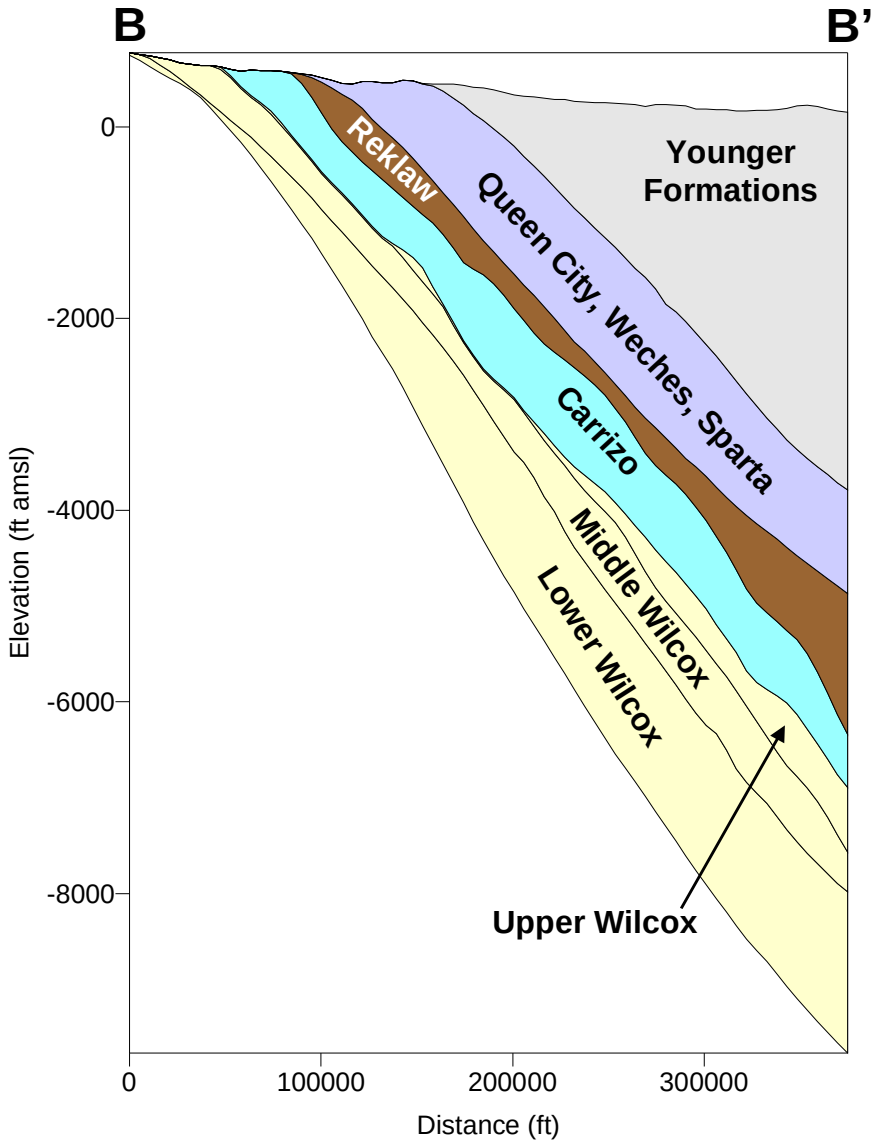
Model Stratigraphy



Hydrogeologic Cross section

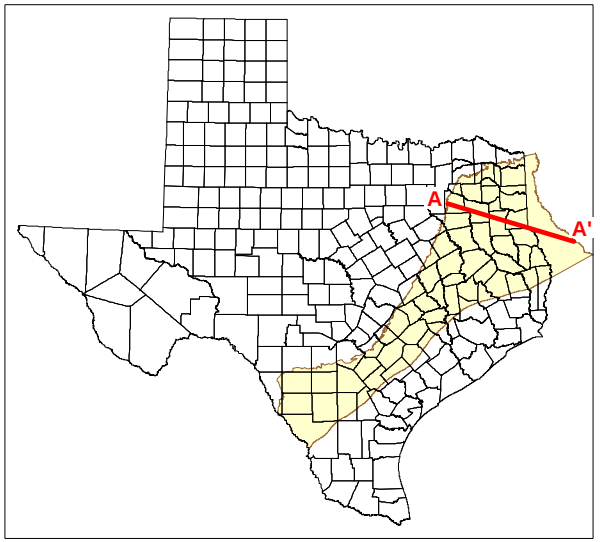
- Central and Southern Models
  - Outcrops are very narrow
  - Dips are very steep averaging 100 ft/mile or >

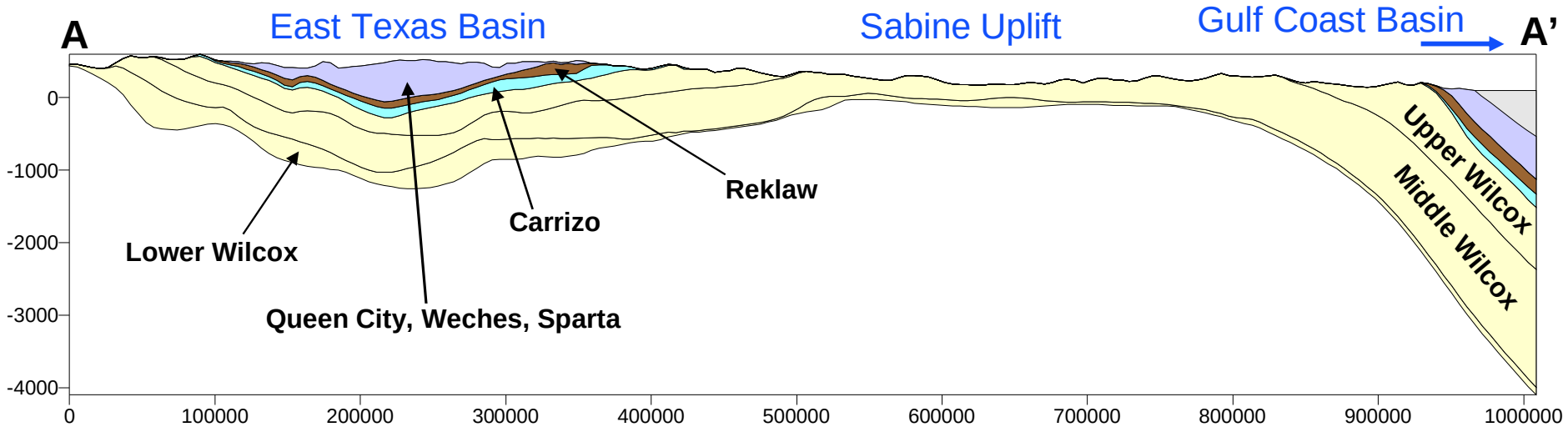




Hydrogeologic Cross Section

- Northern Model Region
  - Queen City outcrops over the majority of the East Texas Basin
  - Queen City and Sparta eroded across the Sabine Uplift
  - South of Sabine Uplift aquifers dip into the Gulf Coast Basin

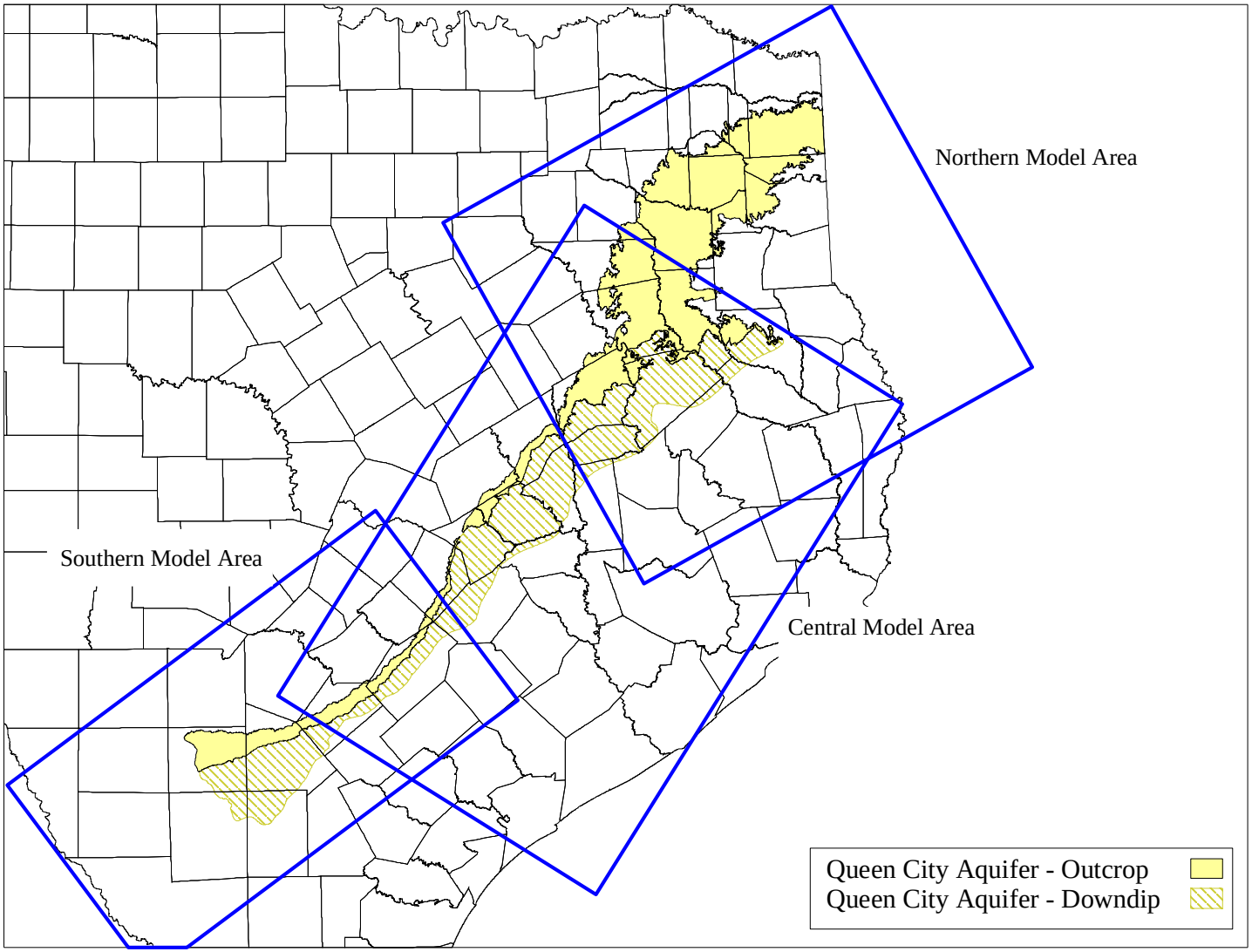




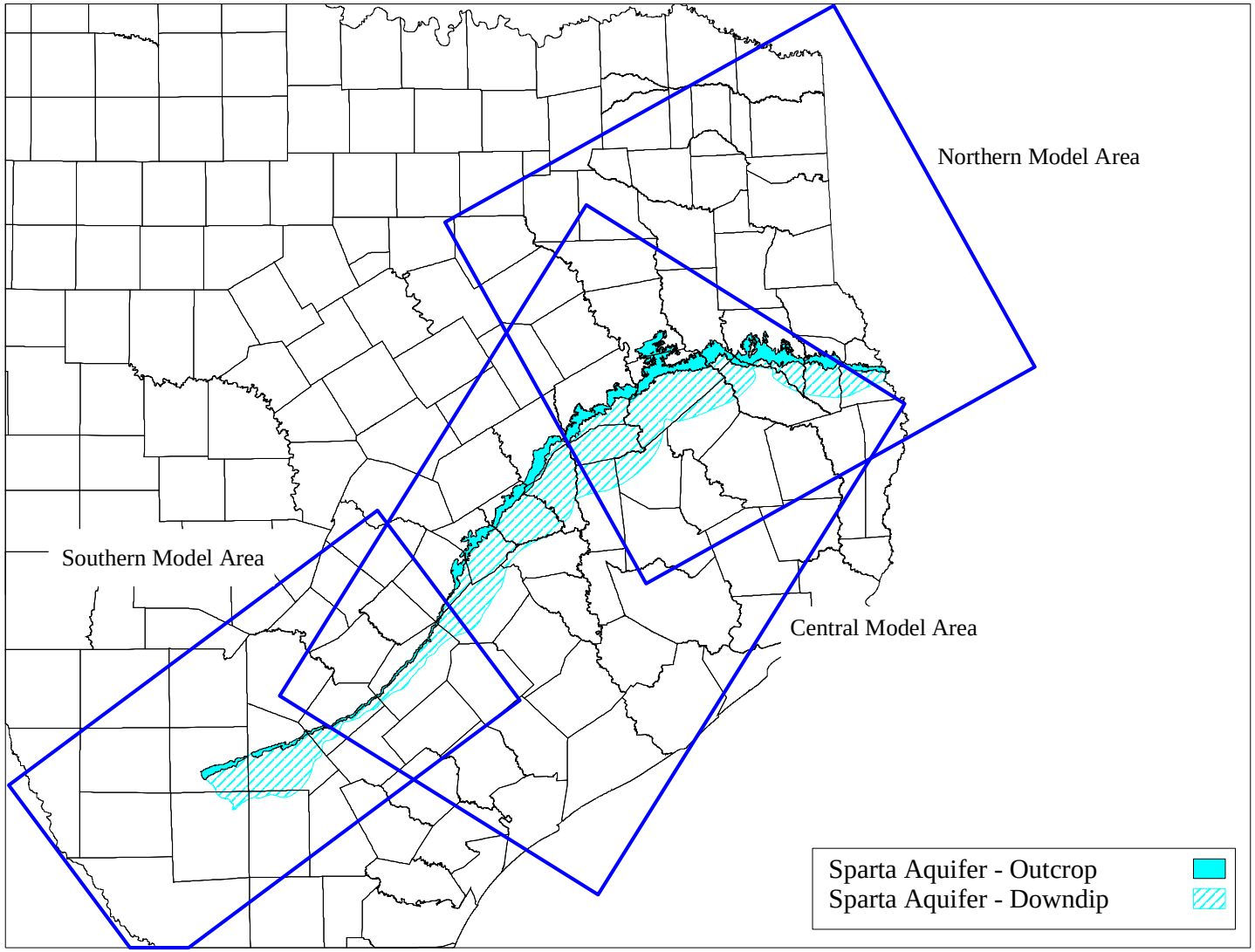
Queen City & Sparta Aquifers

- The Queen City and Sparta Aquifers extend from South Texas northeastward through East Texas into Ark. & La.
  - Sediments of the Tertiary Claiborne Group
  - Queen City aquifer consists of sand, loosely-cemented sands, and interbedded clays
  - Sparta Aquifer consists of sand and interbedded clays with massive basal sands which gently dip toward the Gulf Coast (average thickness of 400 ft.)
  - Aquifers are separated by the Weches Formation which is a marine confining unit

Queen City Aquifer



Sparta Aquifer

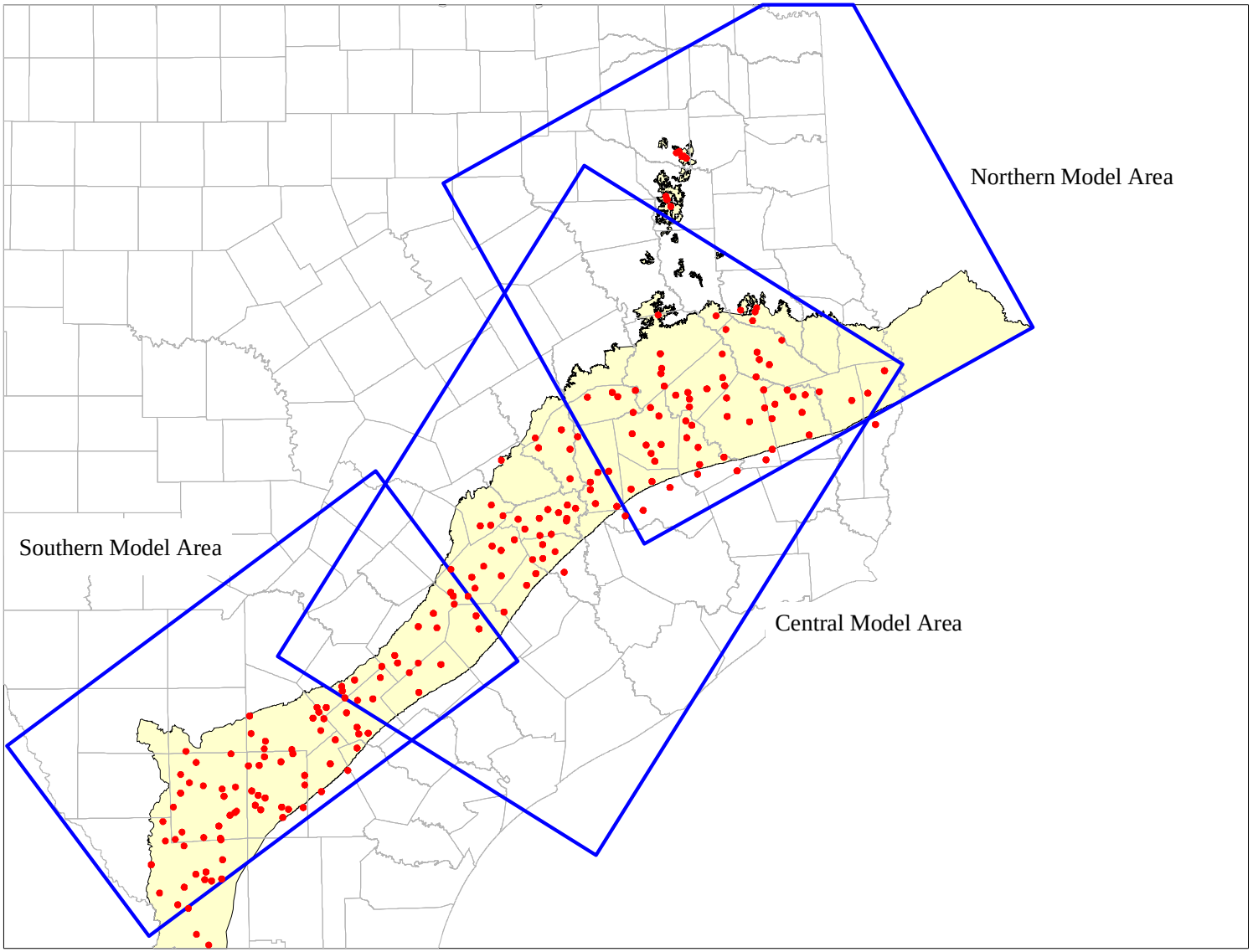


Aquifer Structure

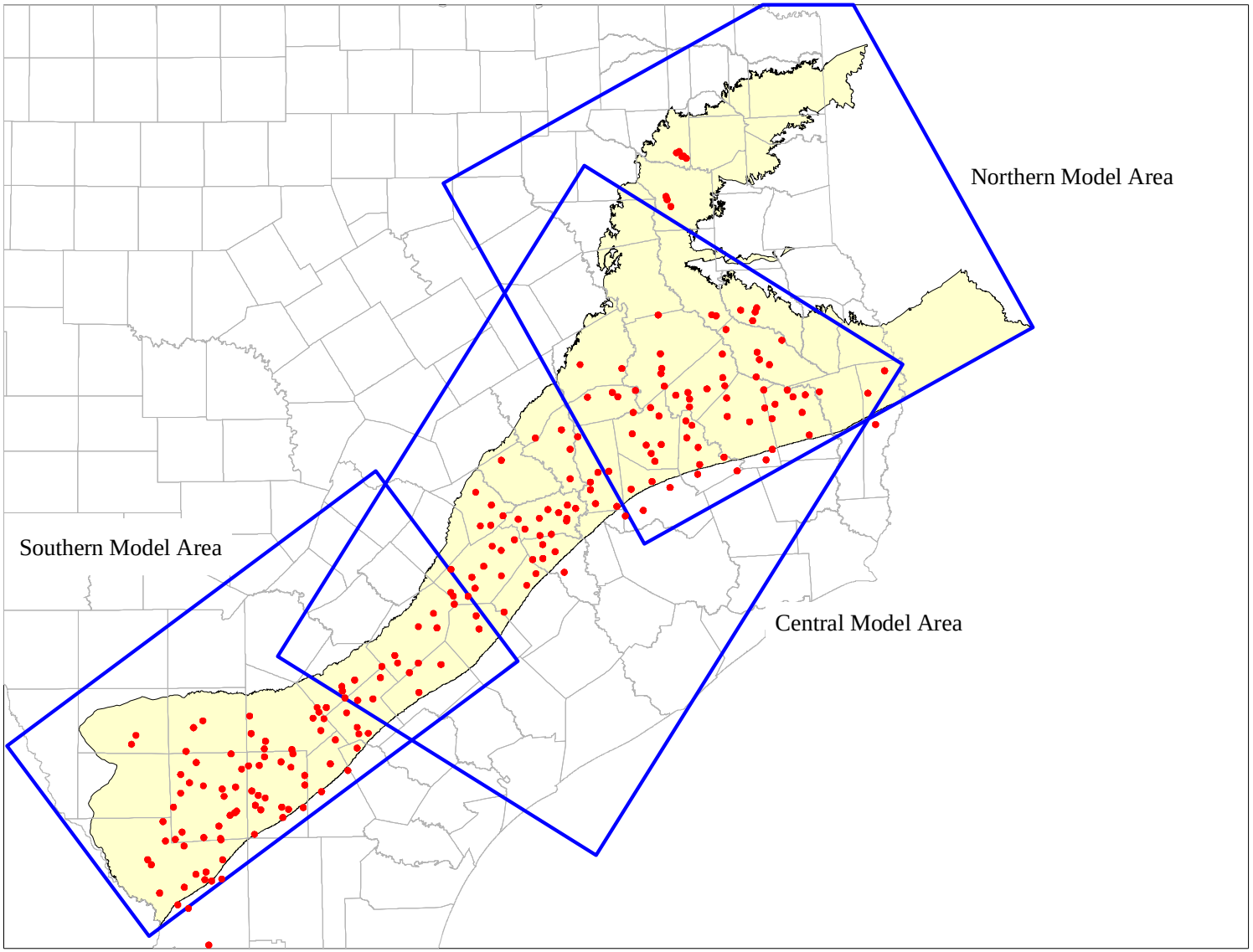
Geologic Structure Data Sources

- Structure – Refers to the elevation of the tops of the Queen City, the Weches, and the Sparta formations
- MS Thesis – TCEQ well log database
  - Guevara (1972) & Garcia (1972) – Queen City
  - Ricoy (1976) - Sparta
    - Approximately 250 logs used across the 3 model areas
  - Payne (1968)
  - East Texas Model
- Sand thickness maps:
  - Guevara (1972) & Garcia (1972) – Queen City
  - Ricoy (1976) and Payne (1968) - Sparta

Sparta Aquifer – Structure Control

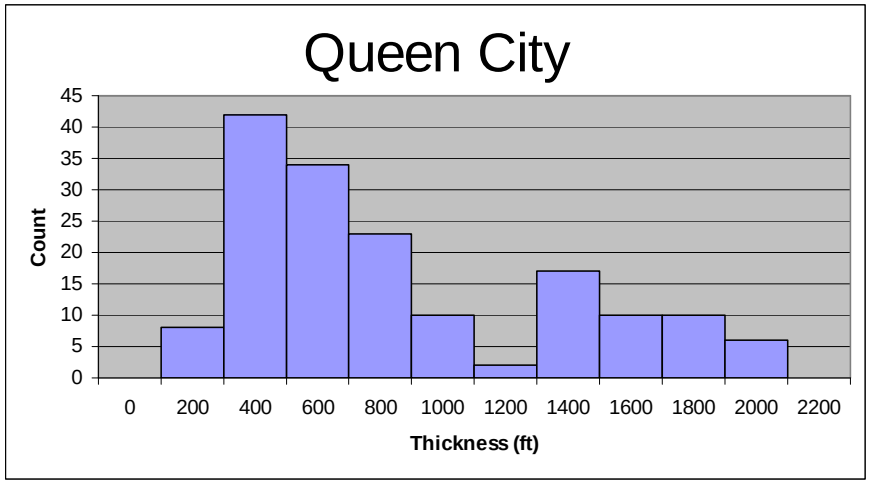


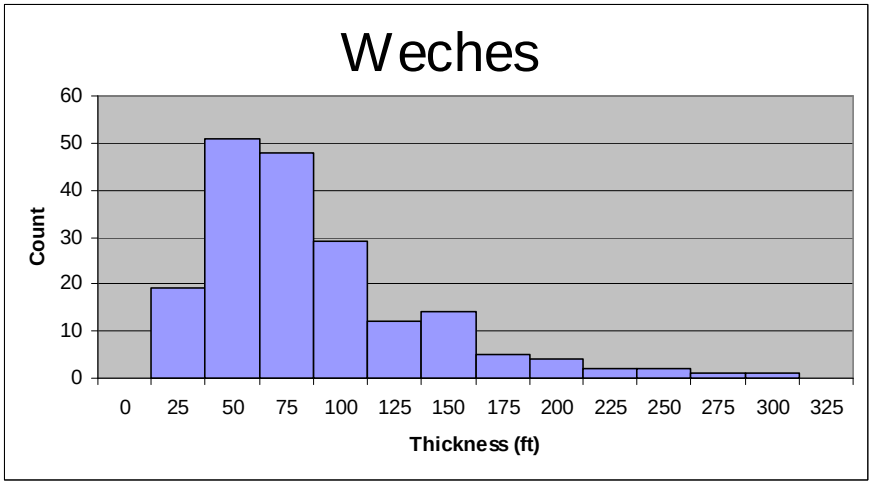
Queen City Aquifer – Structure Control

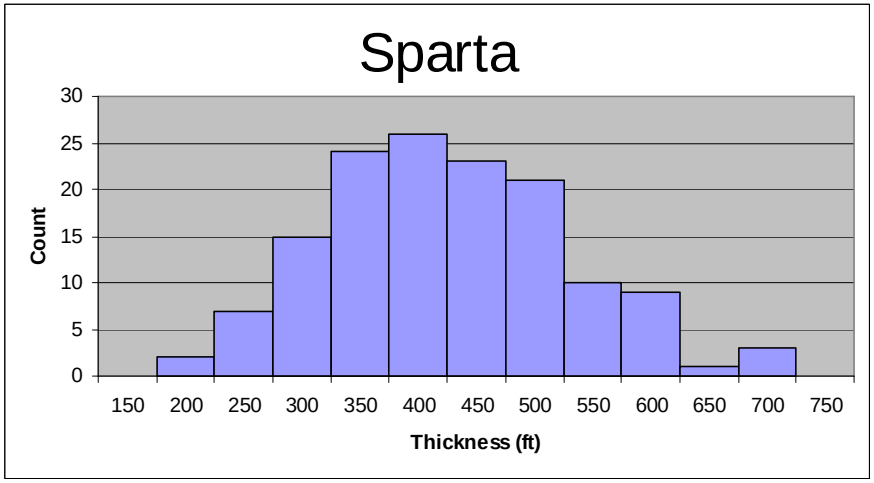


Aquifer Thickness - Draft

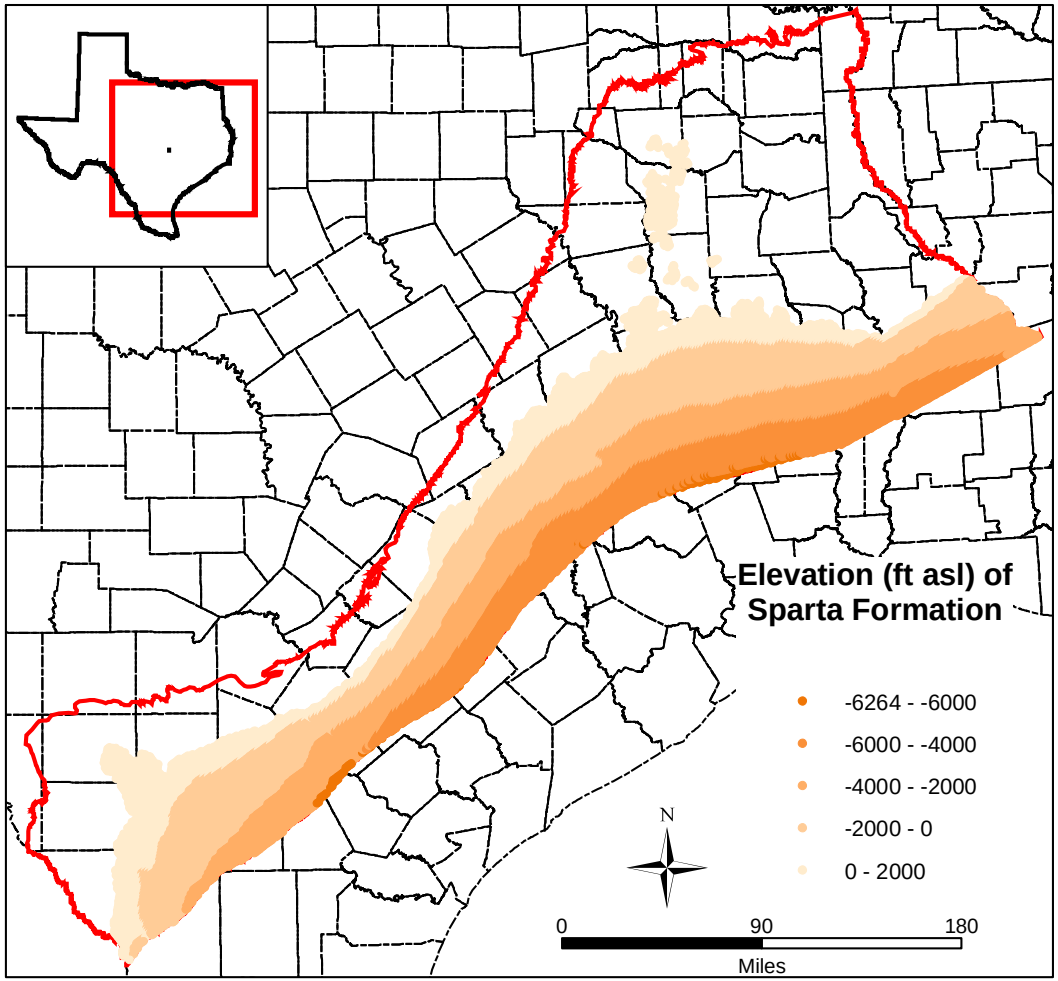
Total Thickness



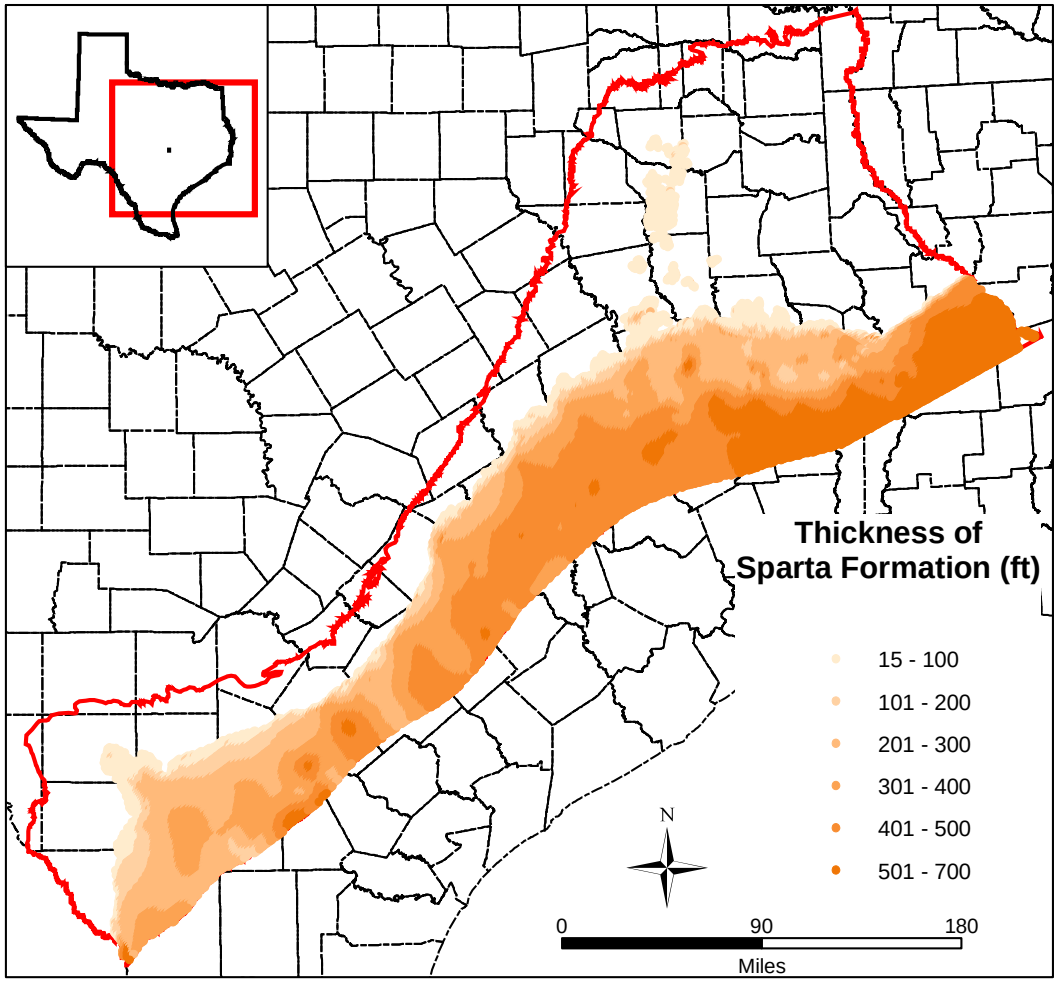




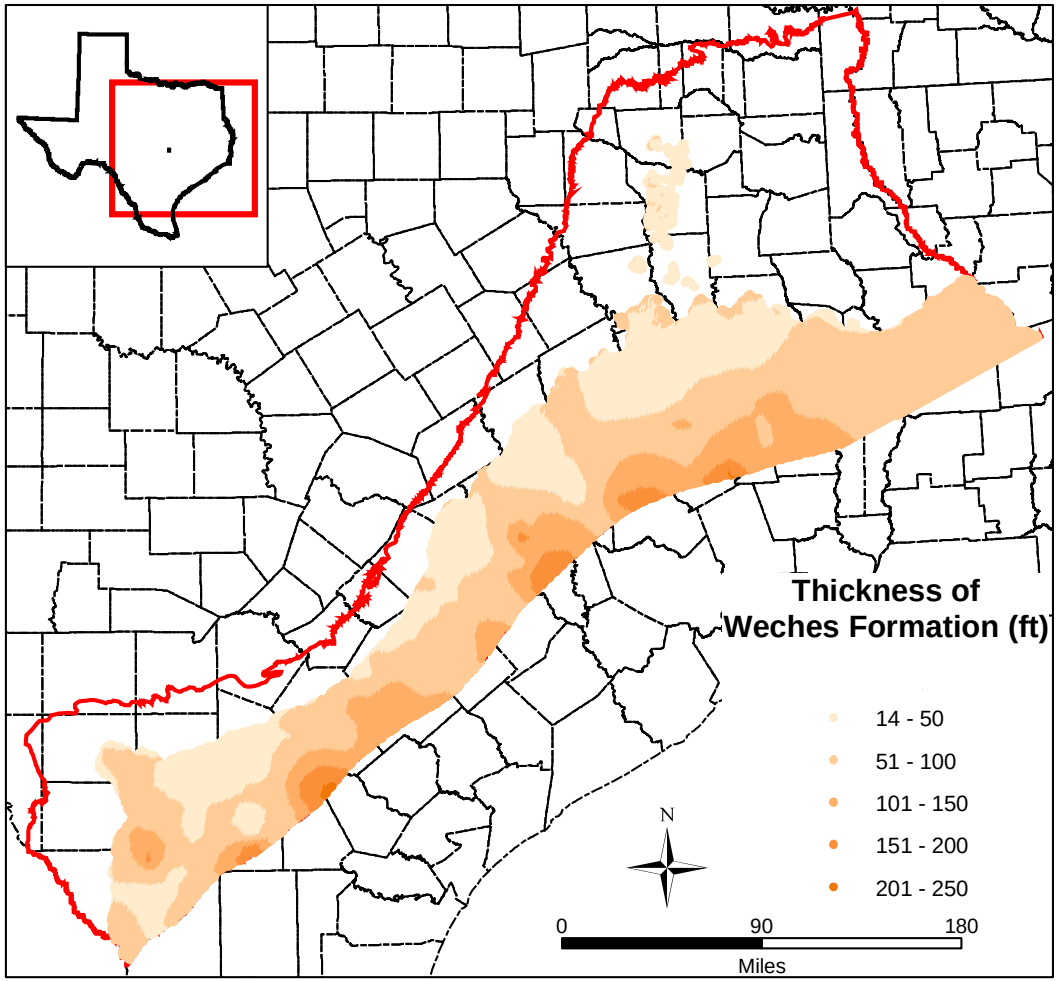
Structure Contour – Sparta Formation



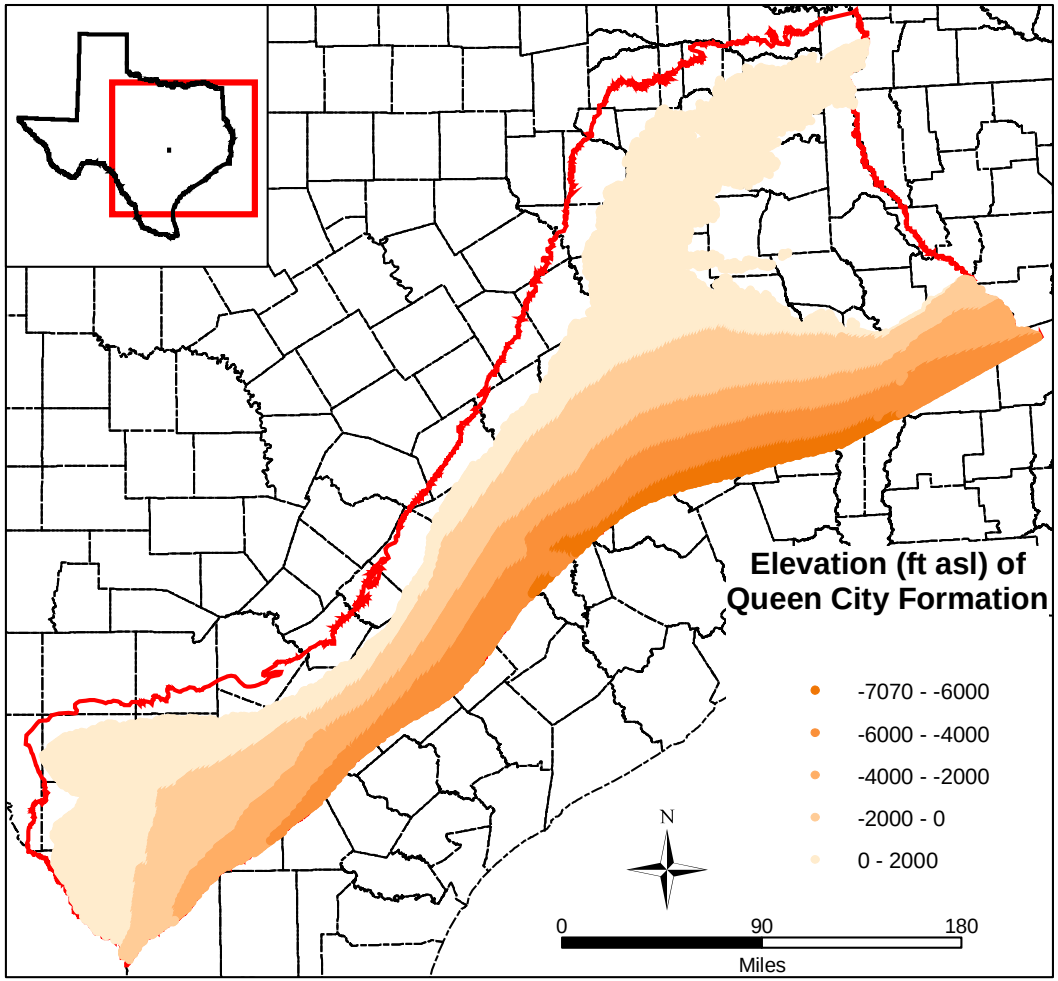
Isopach of the Sparta Formation



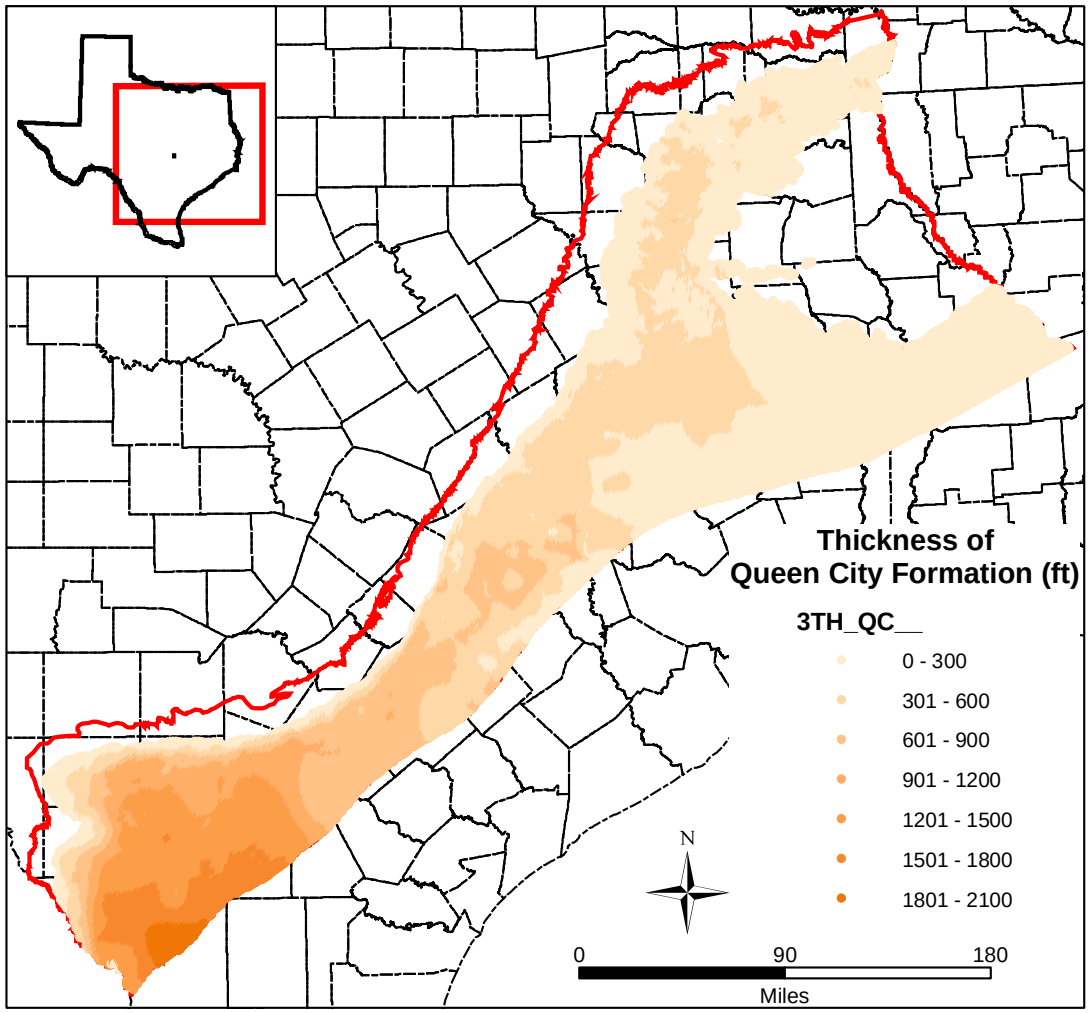
Isopach of the Weches Formation



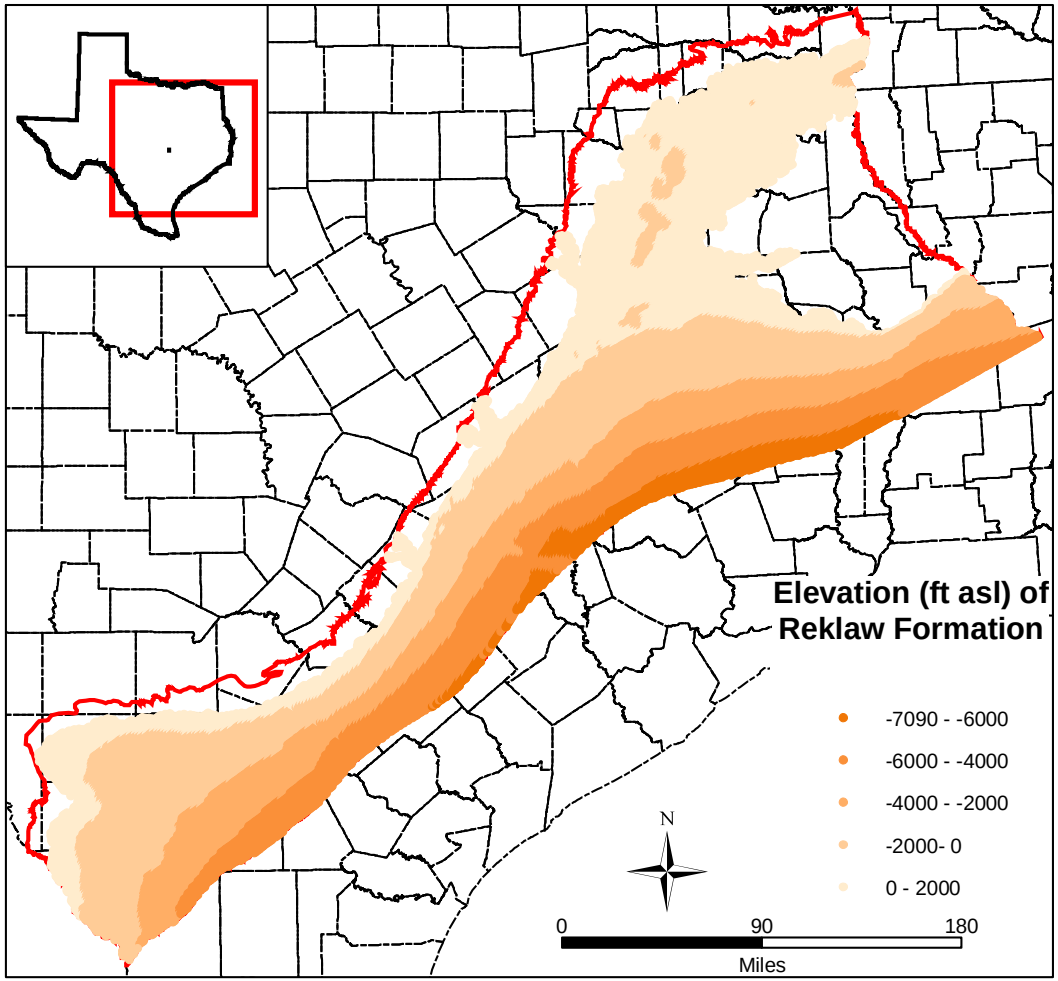
Structure Contour – Queen City Formation



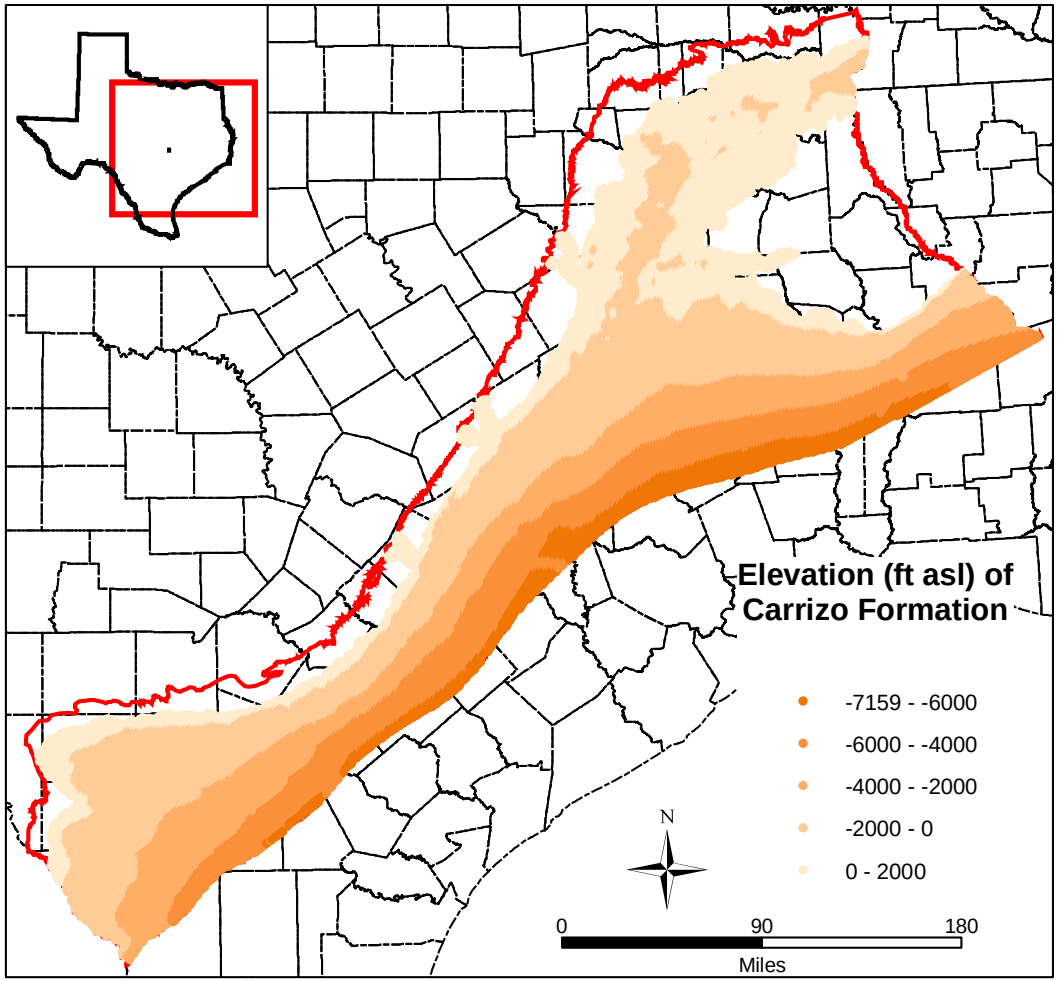
Isopach of the Queen City Formation



Structure Contour – Reklaw Formation



Structure Contour – Carrizo Formation



Aquifer Properties

Hydraulic Properties

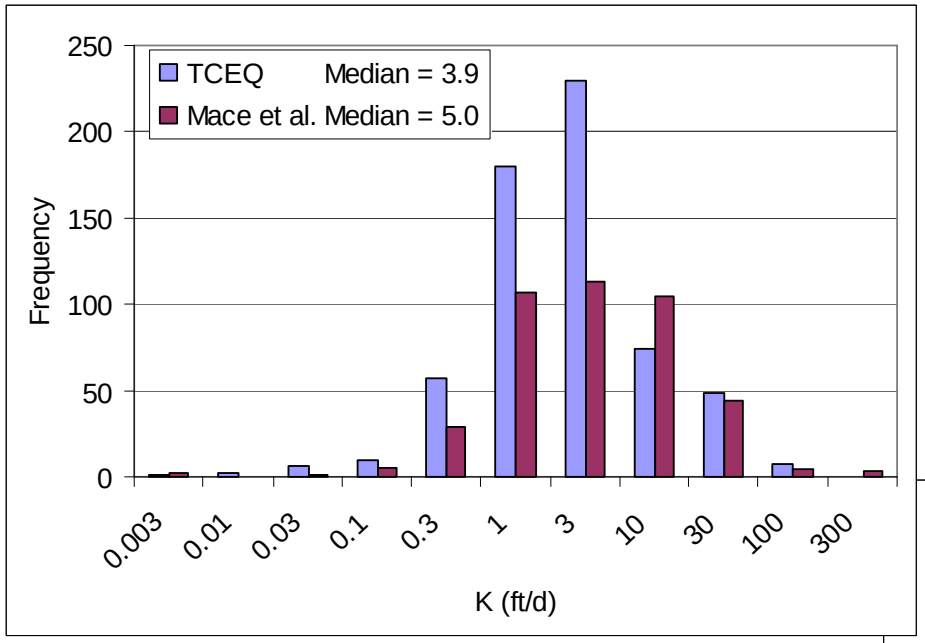
Soft Data:

- USGS
  - Payne (1968)
  - McWreath et al (1991)
  - RASA – Prudic (1991)
- BEG
  - Guevara & Garcia (1972)
  - Ricoy (1977)
- TWDB
  - Myers (1969)
  - County Reports

Hard Data:

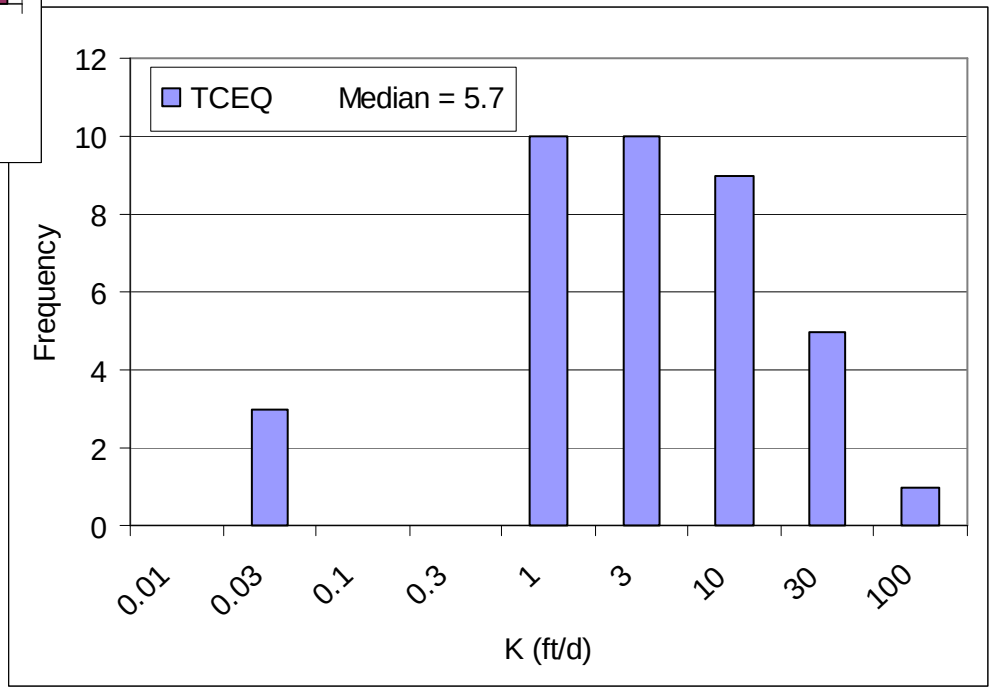
- TCEQ file search of the drillers logs
  - Estimates of specific capacity will be used to augment published values
- Mace et al. (2000) database
- Stakeholder provided data

Hydraulic Conductivity Distributions

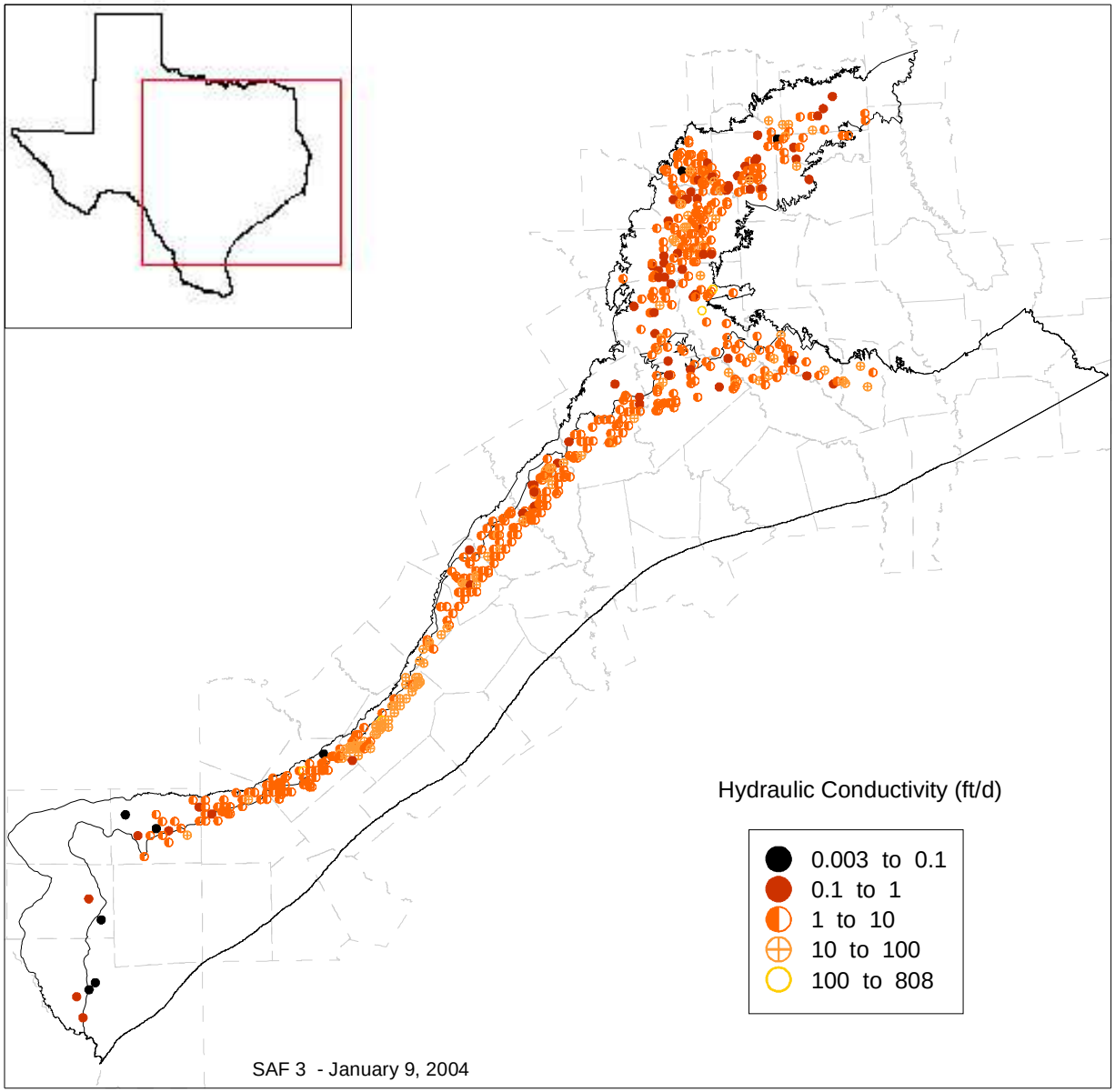


Queen City

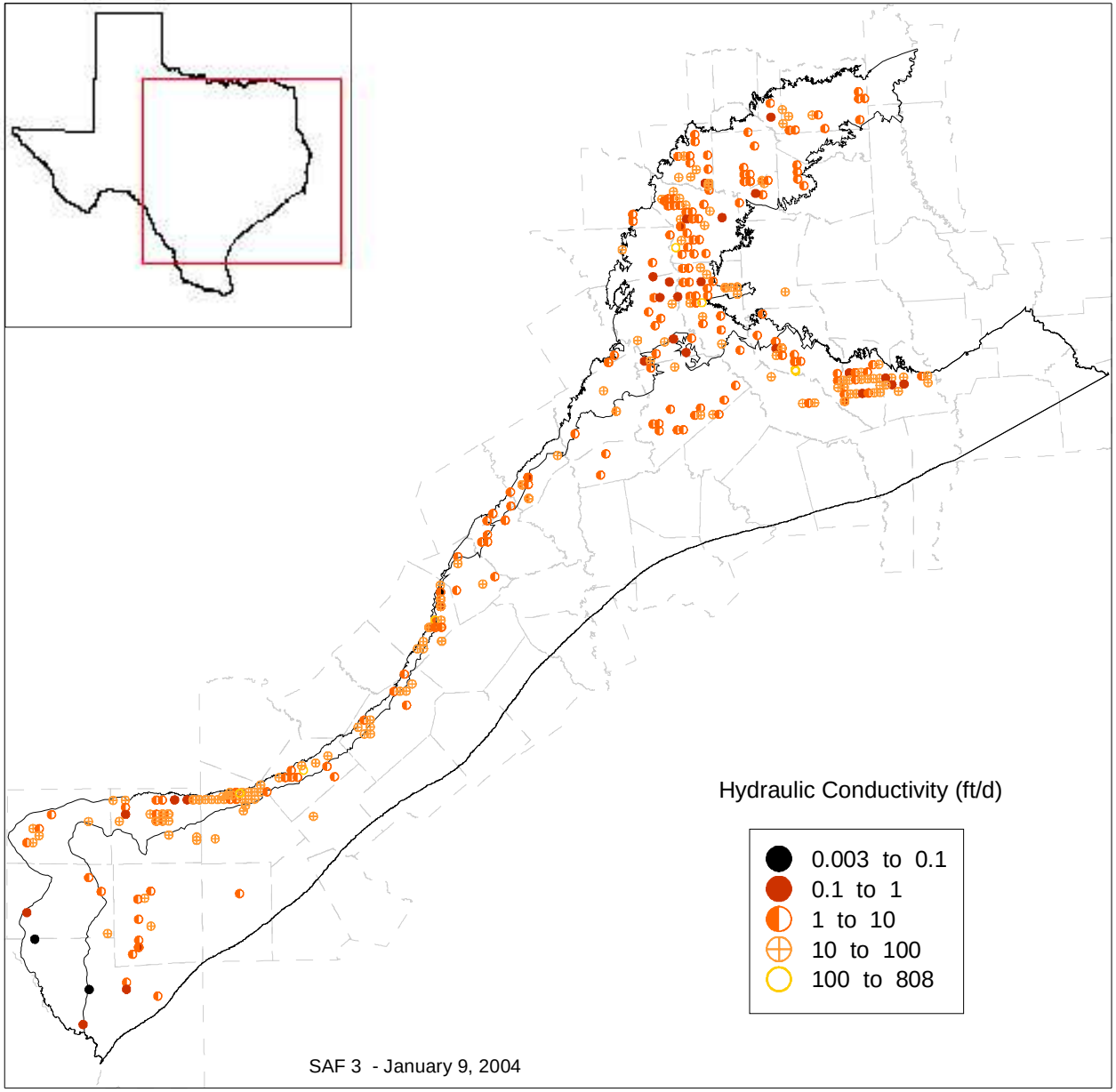
Sparta



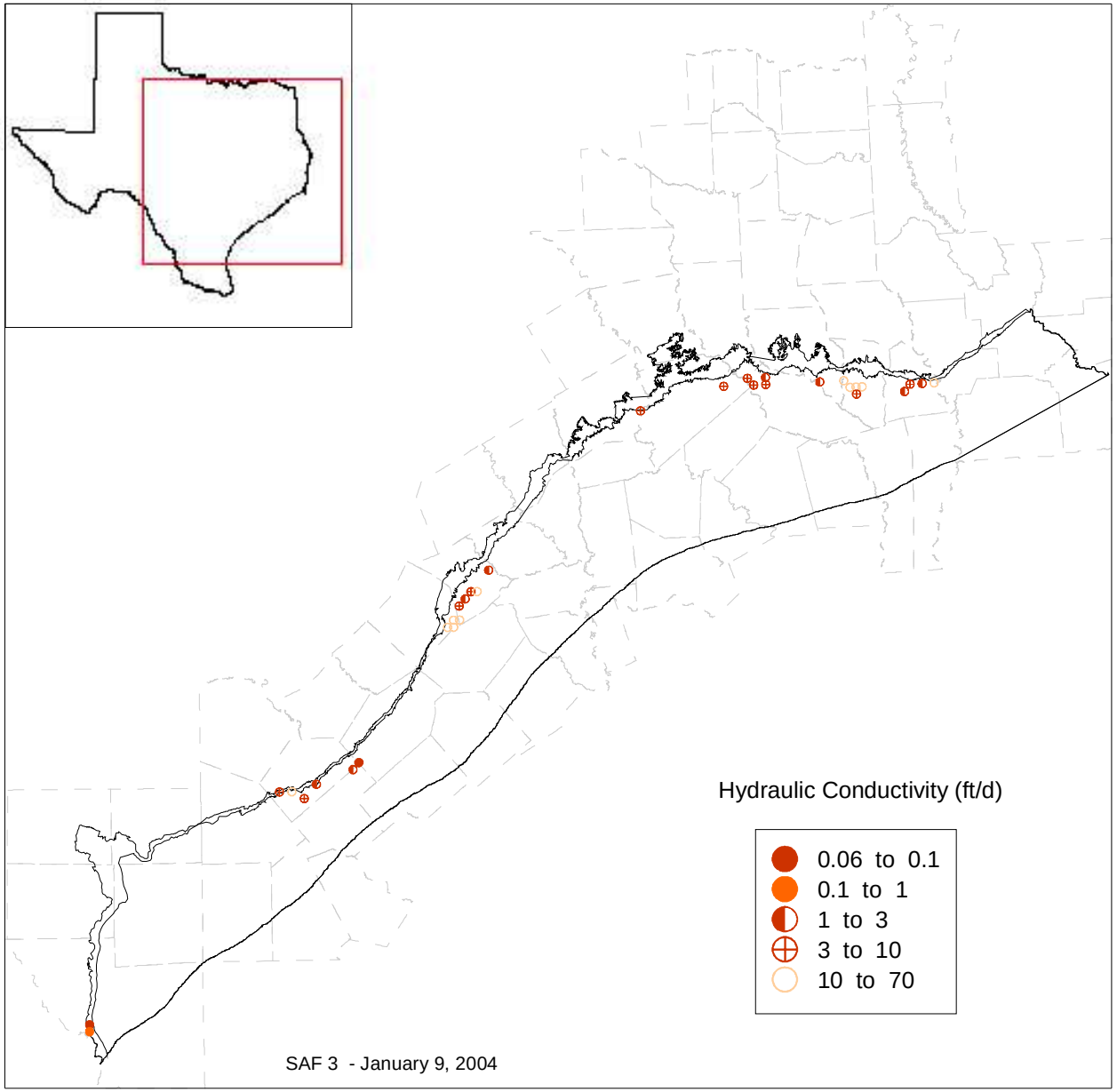
Queen City Hyd. Cond. - TCEQ



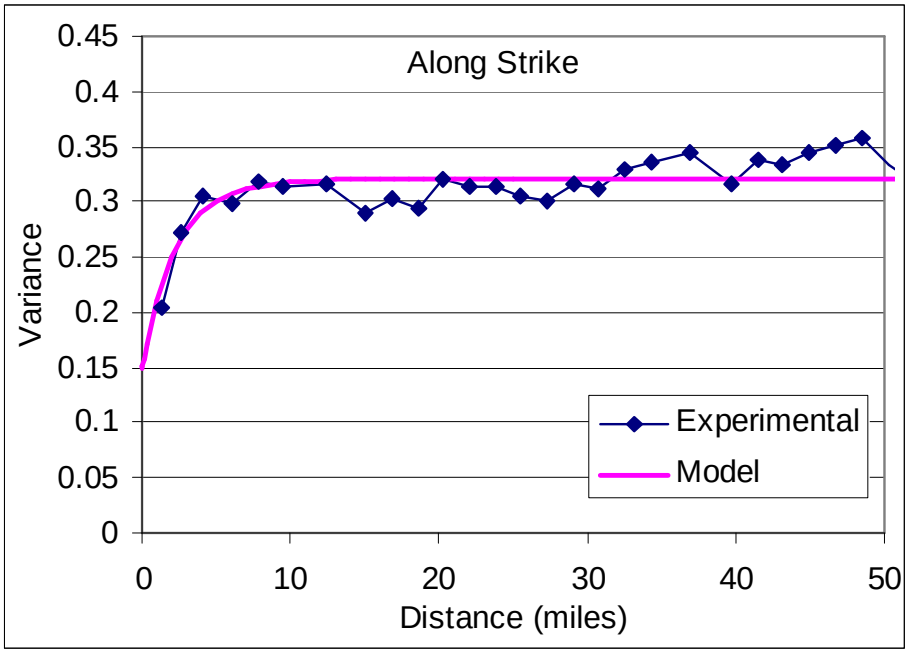
Queen City Hyd. Cond. – Mace data

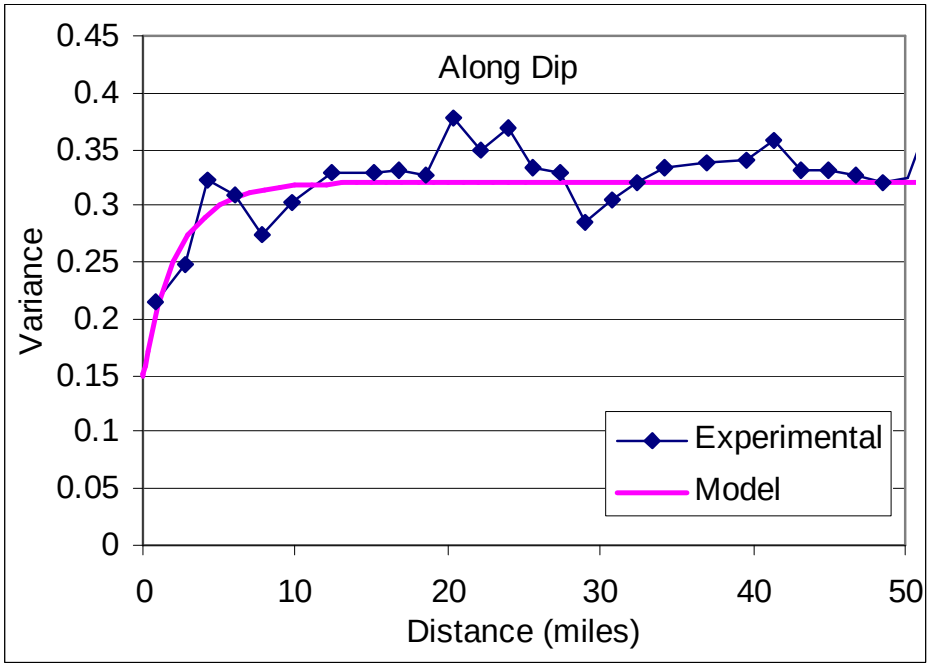


Sparta Hyd. Cond. - TCEQ

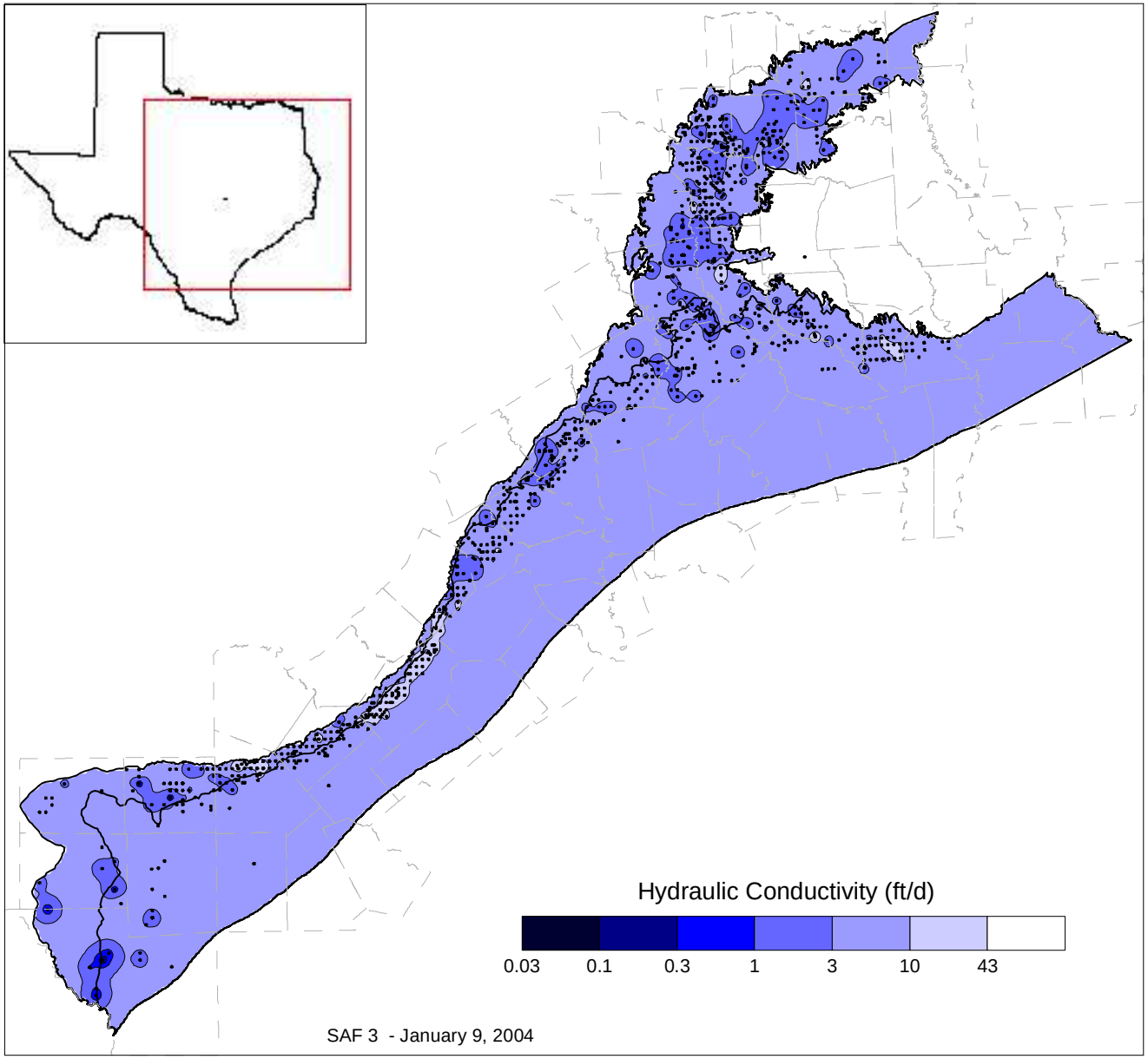


Queen City Variograms - Combined



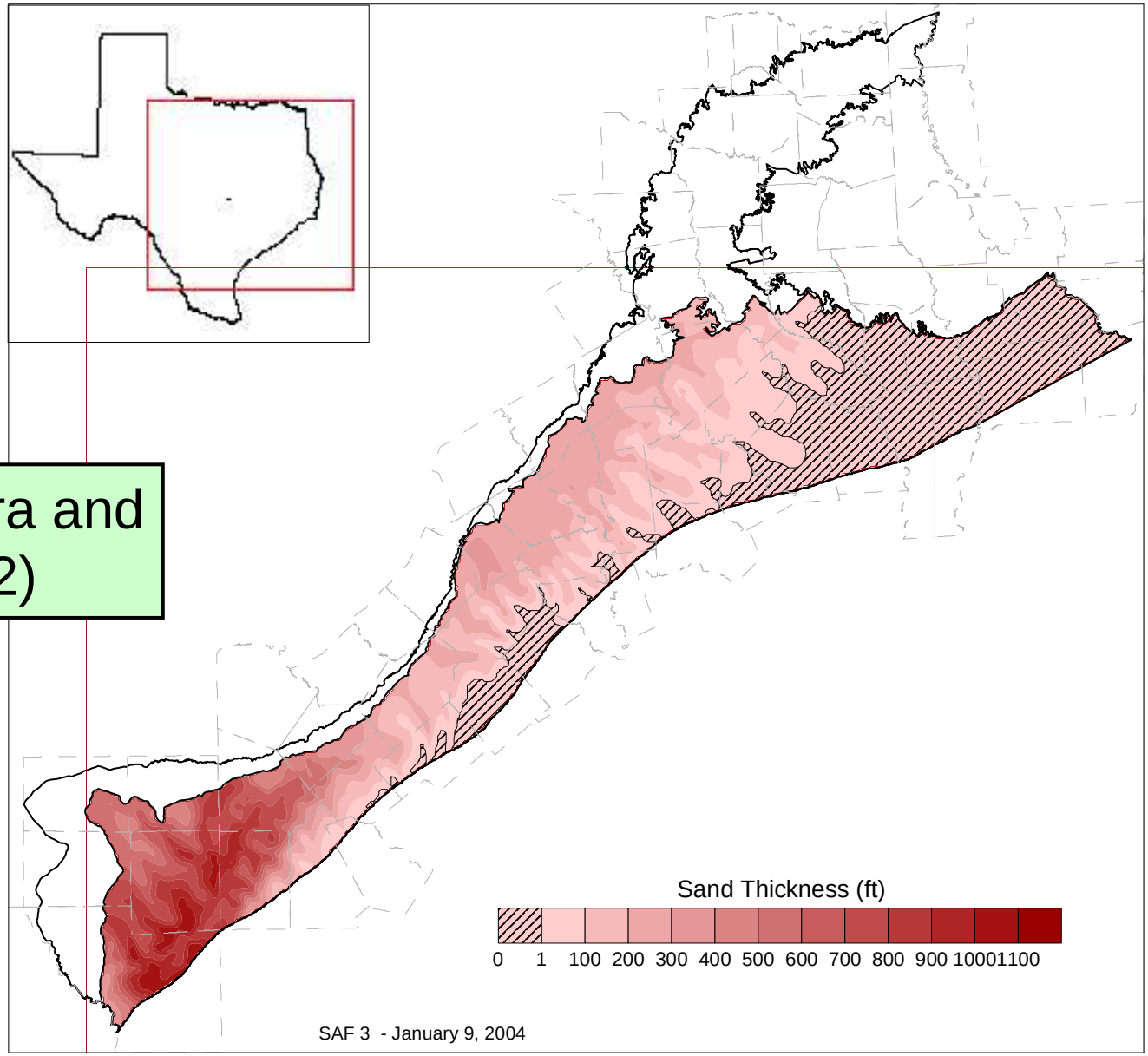


Queen City Kriged Hyd. Cond.



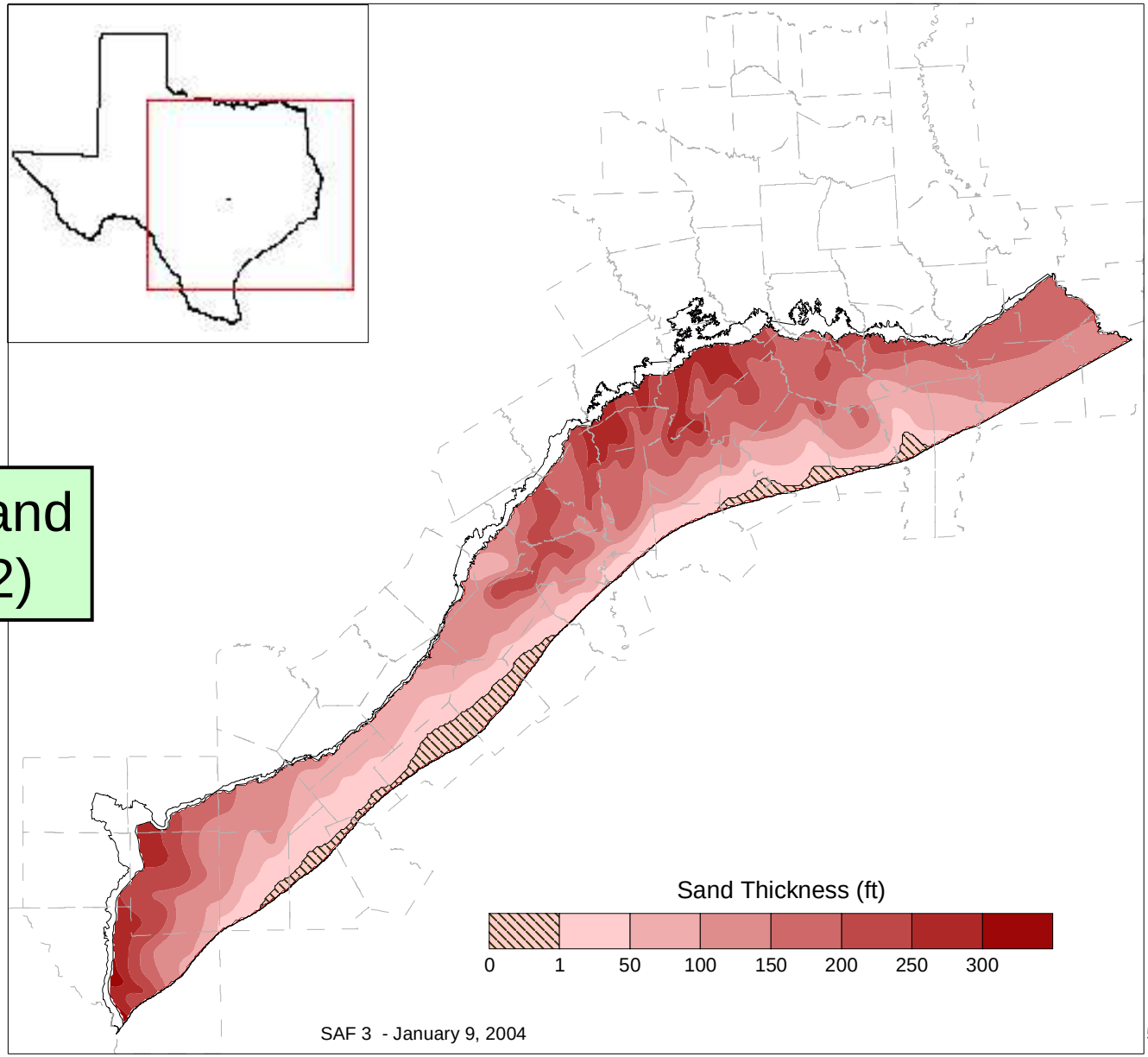
Queen City Net Sand Thickness (ft)

after Guevara and Garcia (1972)



Sparta Net Sand Thickness (ft)

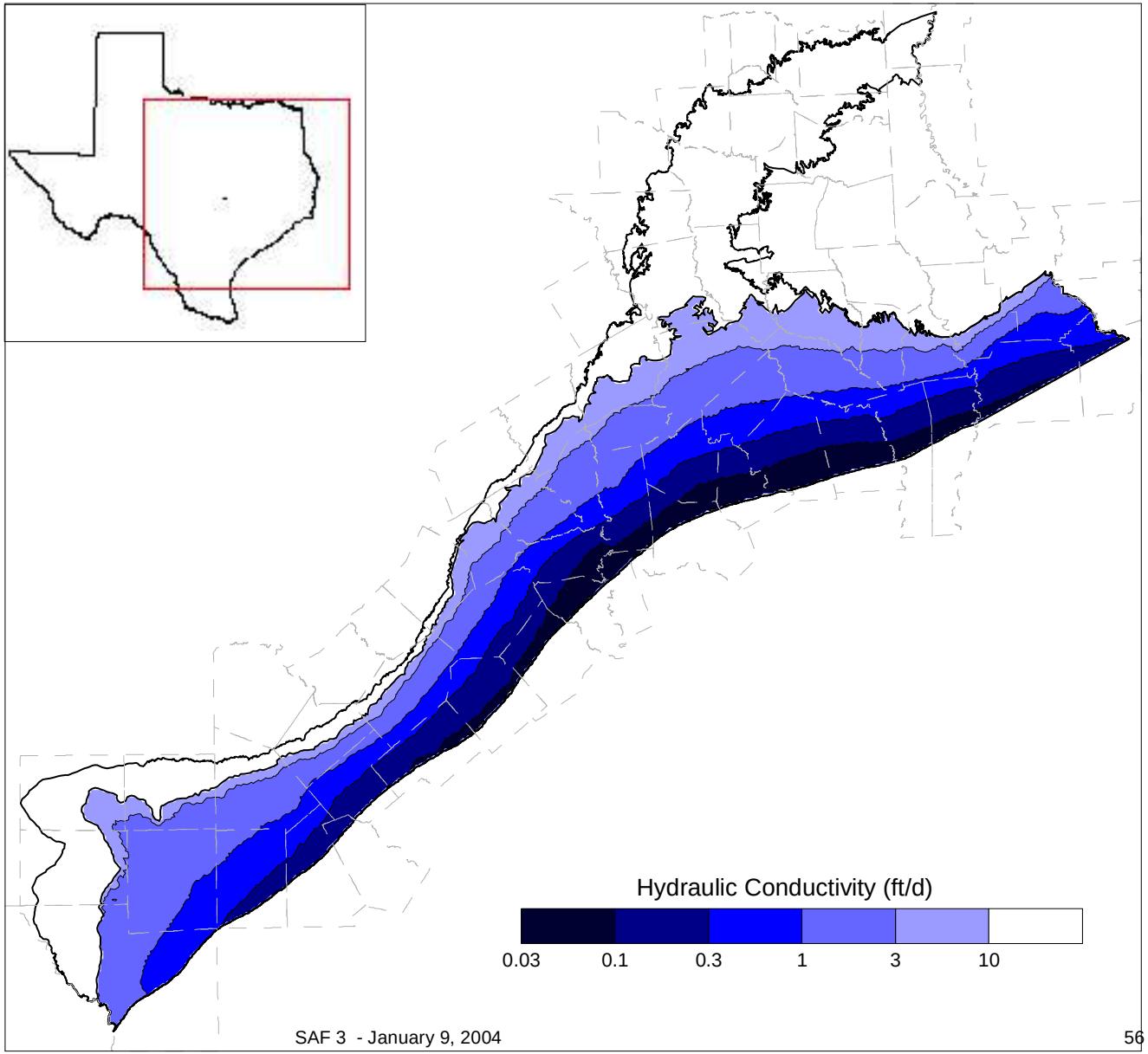
after Ricoy and Brown (1972)



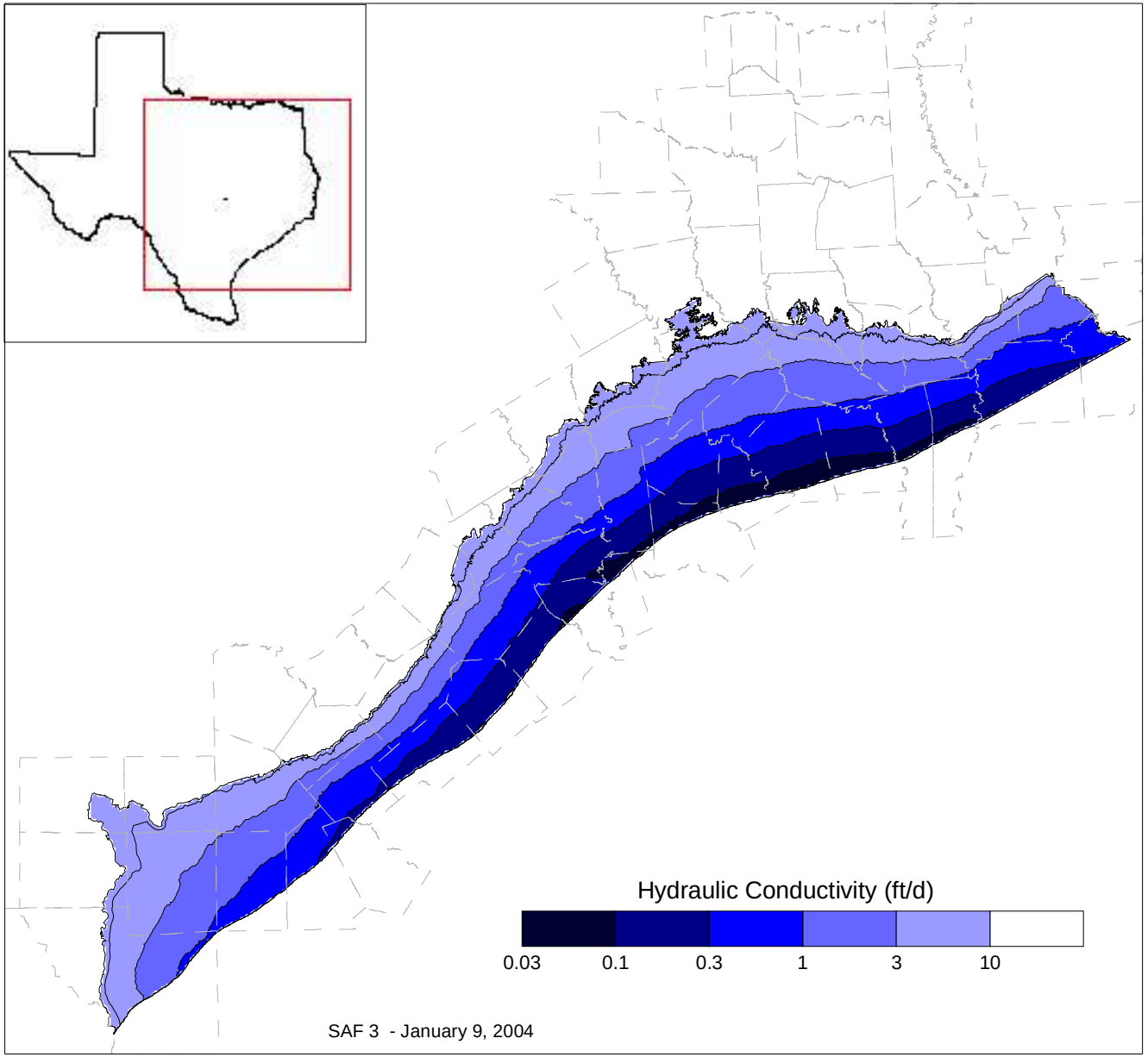
Data Analysis

- Correlations between hydraulic conductivity and net sand or depth of burial were indeterminate based on observed data
- Prudic (1991) found correlation between hydraulic conductivity and depth in Texas Coastal Plain aquifers
  - We used Prudic's depth correlation for the middle Claiborne to estimate downdip hydraulic conductivity

Queen City Hyd. K. Depth Trend

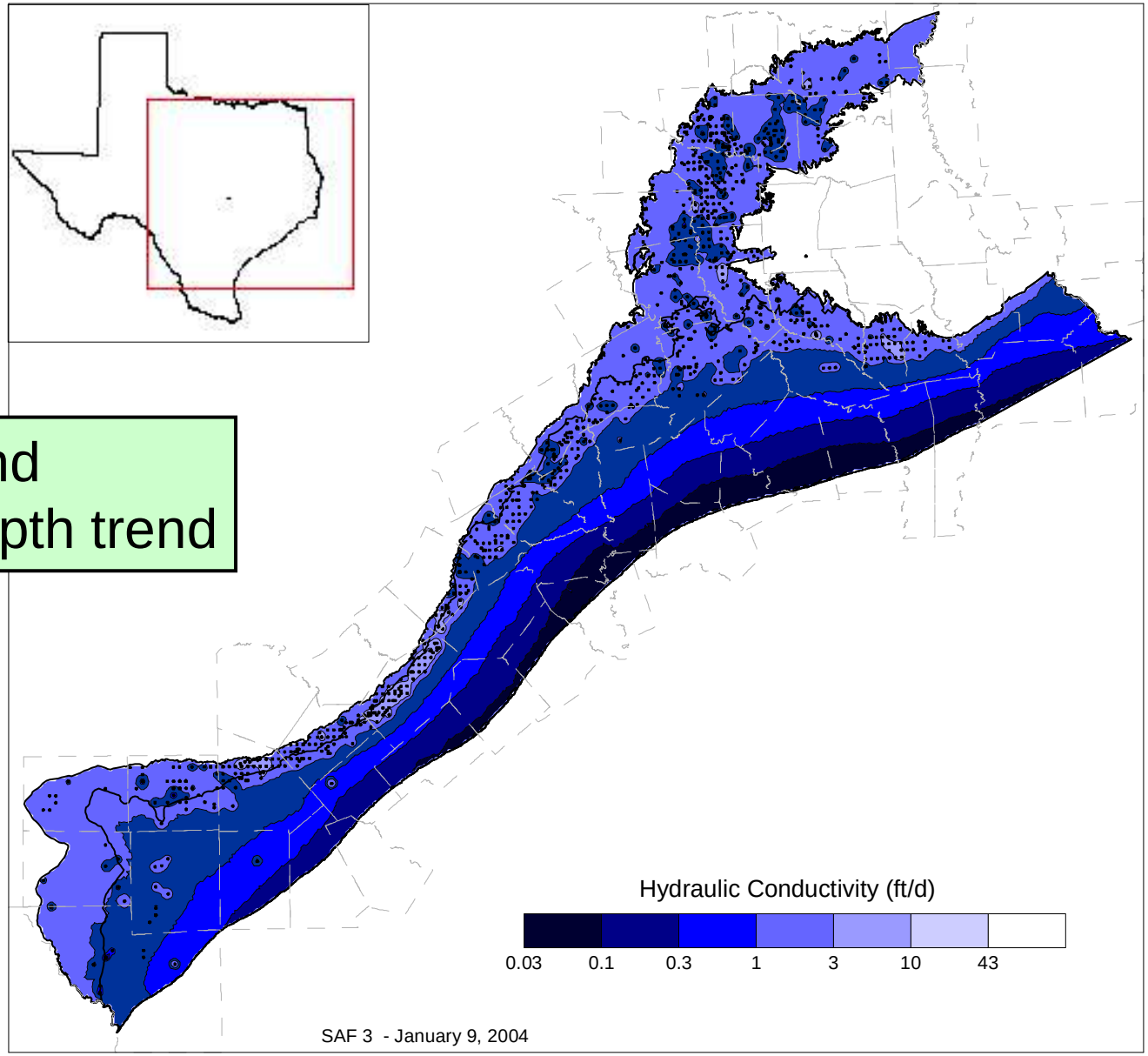


Sparta Hyd. K. Depth Trend



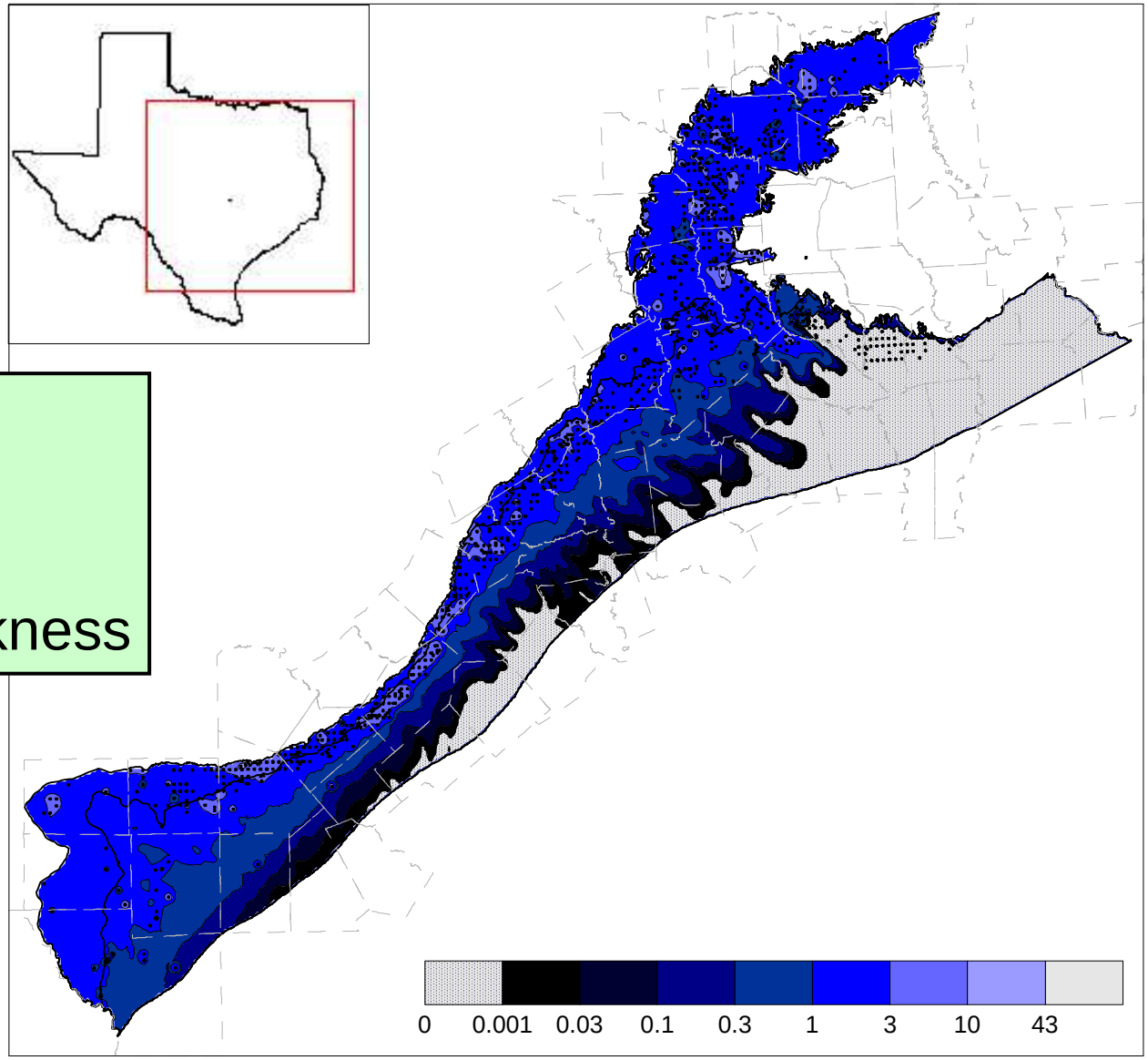
Merged Queen City Hyd. Cond.

Test data and
Weighted depth trend

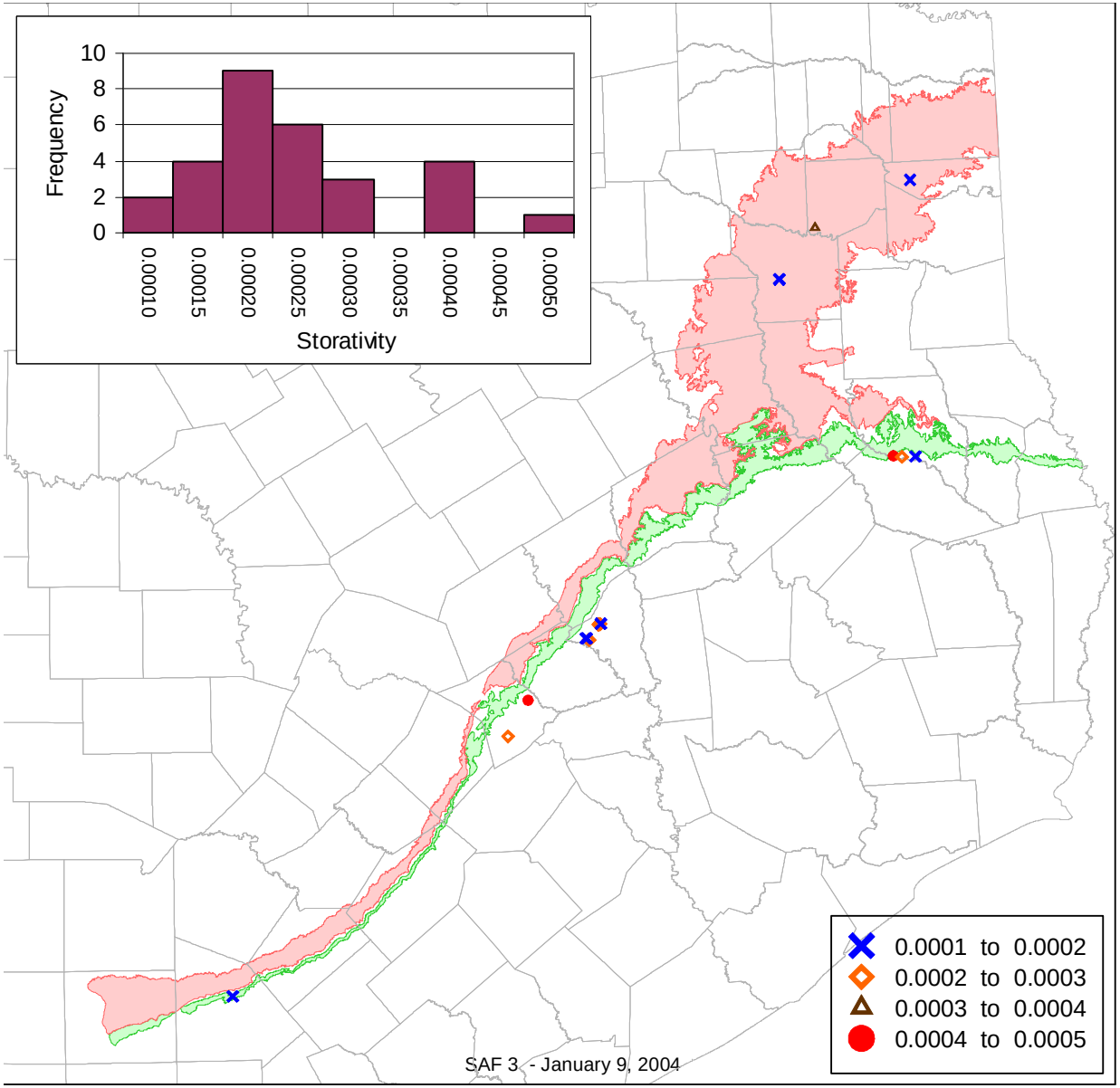


Queen City Effective Hyd. Conductivity

Combines:
* Test data
* Depth trend
* Net sand thickness



Queen City Storage Measurements



Kv – Implementation

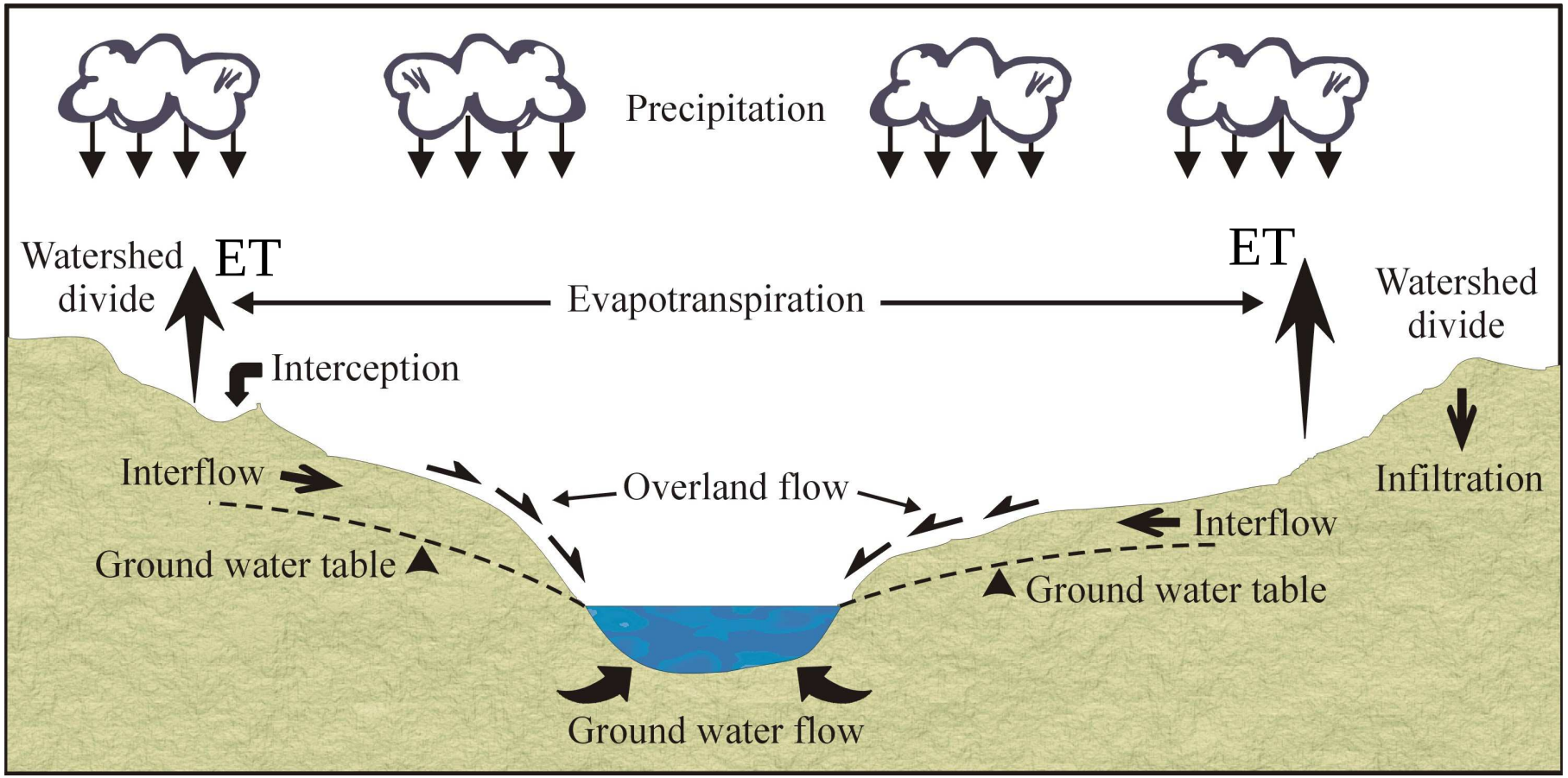
- Use clay fraction and an assumed clay conductivity to define Kv zones which will then be varied within limits during calibration.
  - We will limit Kv on the low end with the harmonic mean
- Kv will be altered at the Carrizo-Wilcox contact and the Reklaw-Carrizo and Reklaw-Queen City contacts to make the C/W GAMs consistent in the overlap zones.

Review of Water Levels and Groundwater Flow

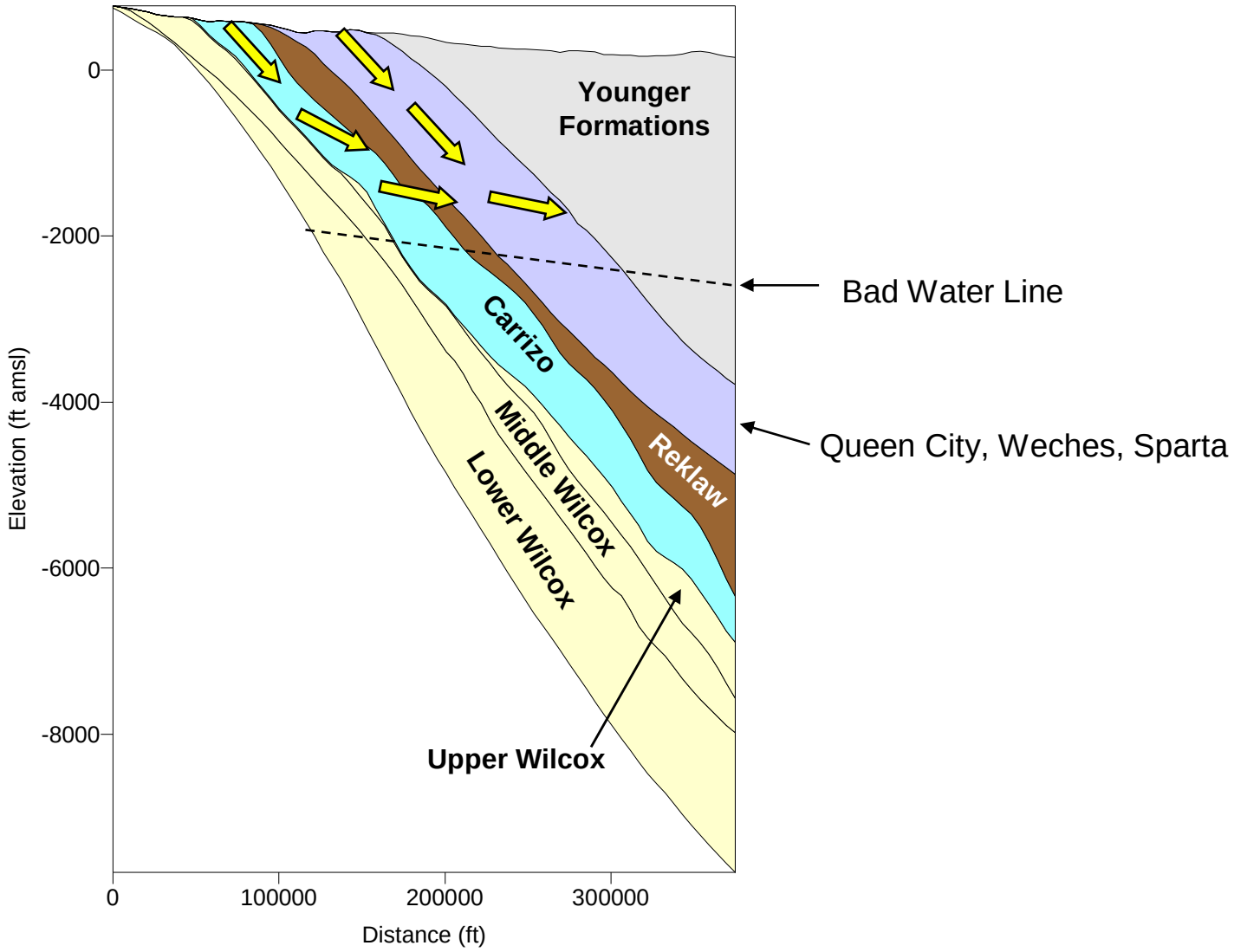
Regional Groundwater Flow

- In the northern portion of the study area, groundwater flows locally in the Queen City aquifer rather than regionally due to topographic controls (Fogg and Kreitler, 1982)
- In the central and southern portions of the study area, groundwater flows regionally in the Queen City and Sparta aquifers from topographic highs in the outcrop areas to topographic lows down dip of the outcrop

Shallow Aquifer Flow Conceptualization



Deep Aquifer Flow Conceptualization

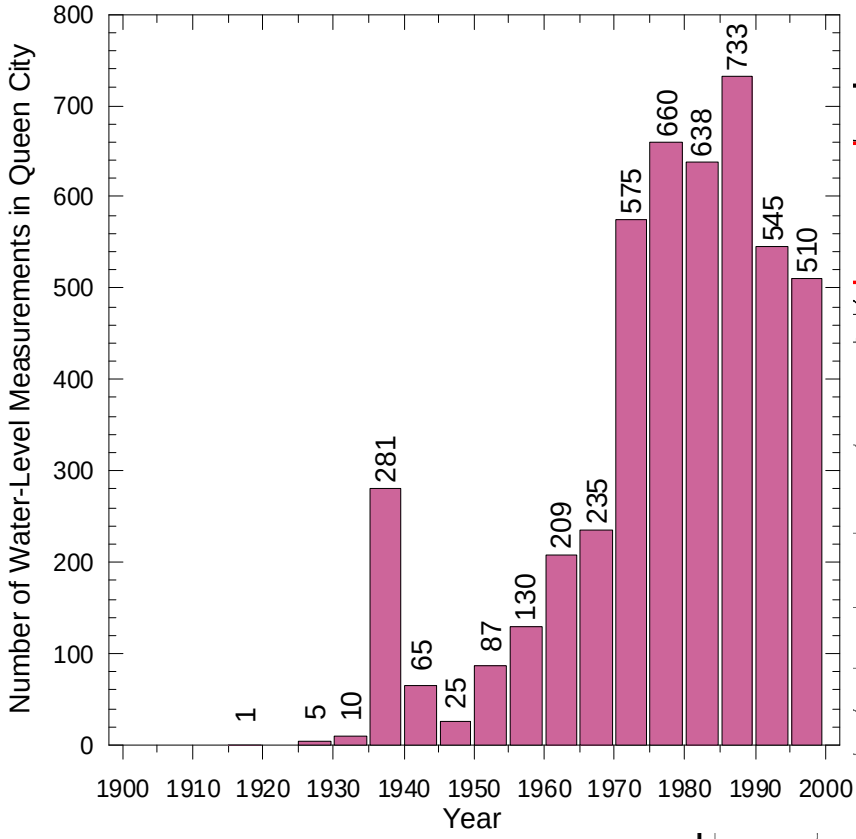


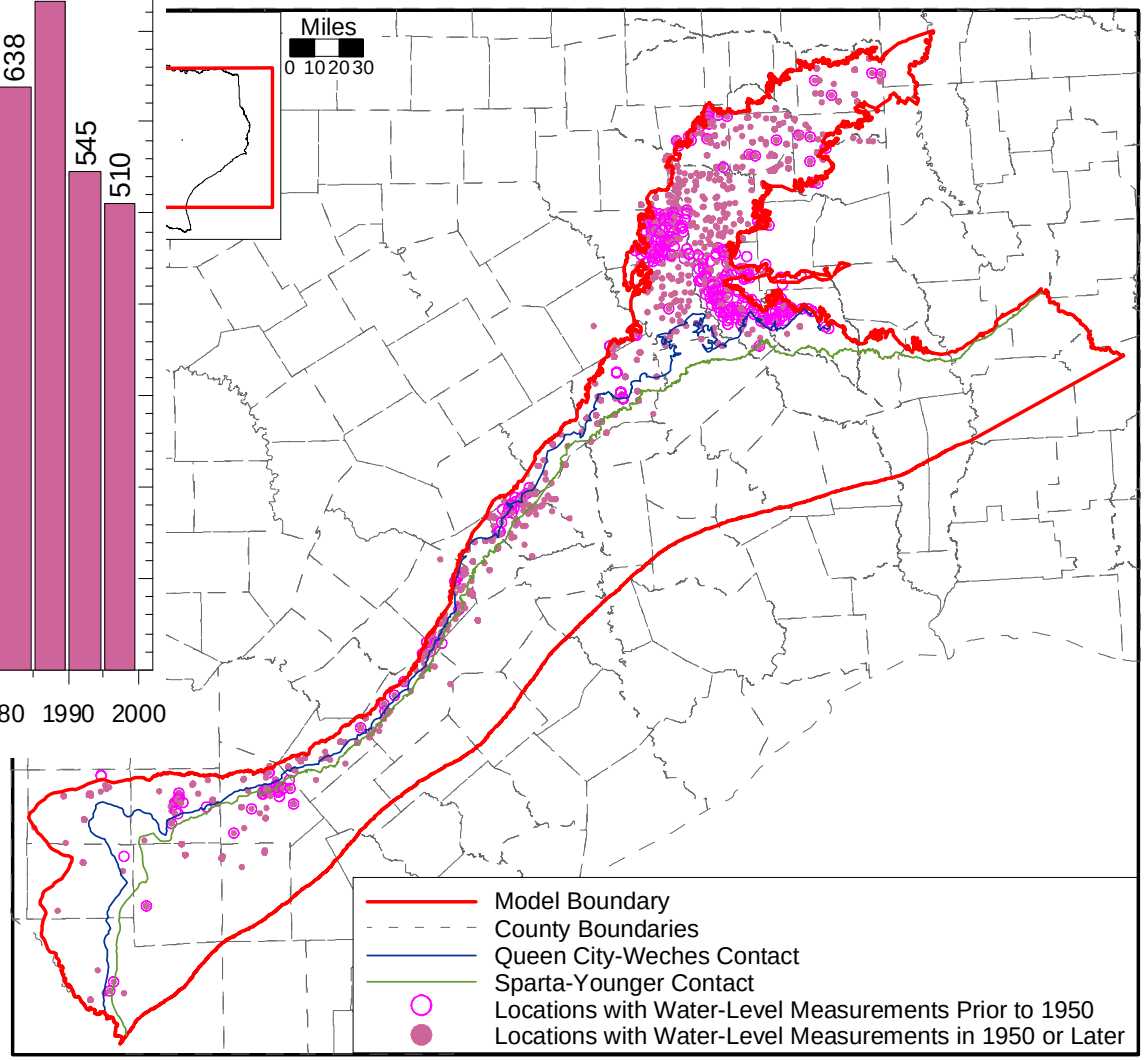
Water Levels

Requirements

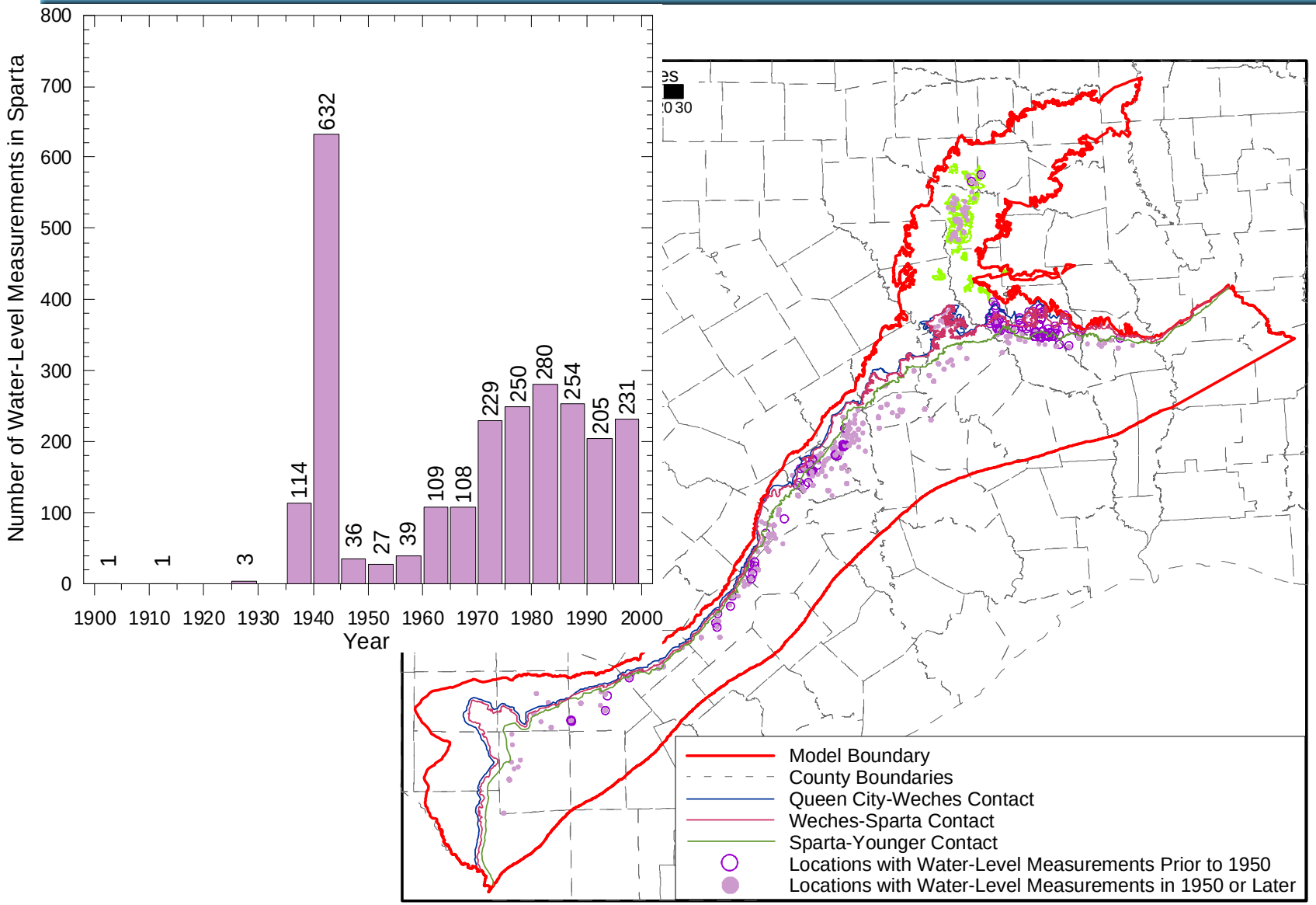
- Develop water-level elevation contours of predevelopment conditions, QC and Sparta.
- Develop QC and Sparta water-level elevation contours for
  - The start of model calibration (1980)
  - The end of model calibration (1990)
  - The end of model verification (1999)
- Evaluate transient water-level conditions and select hydrographs for use as calibration targets in both QC and Sparta
- Evaluate cross-formational flow

Queen City Water Level Control

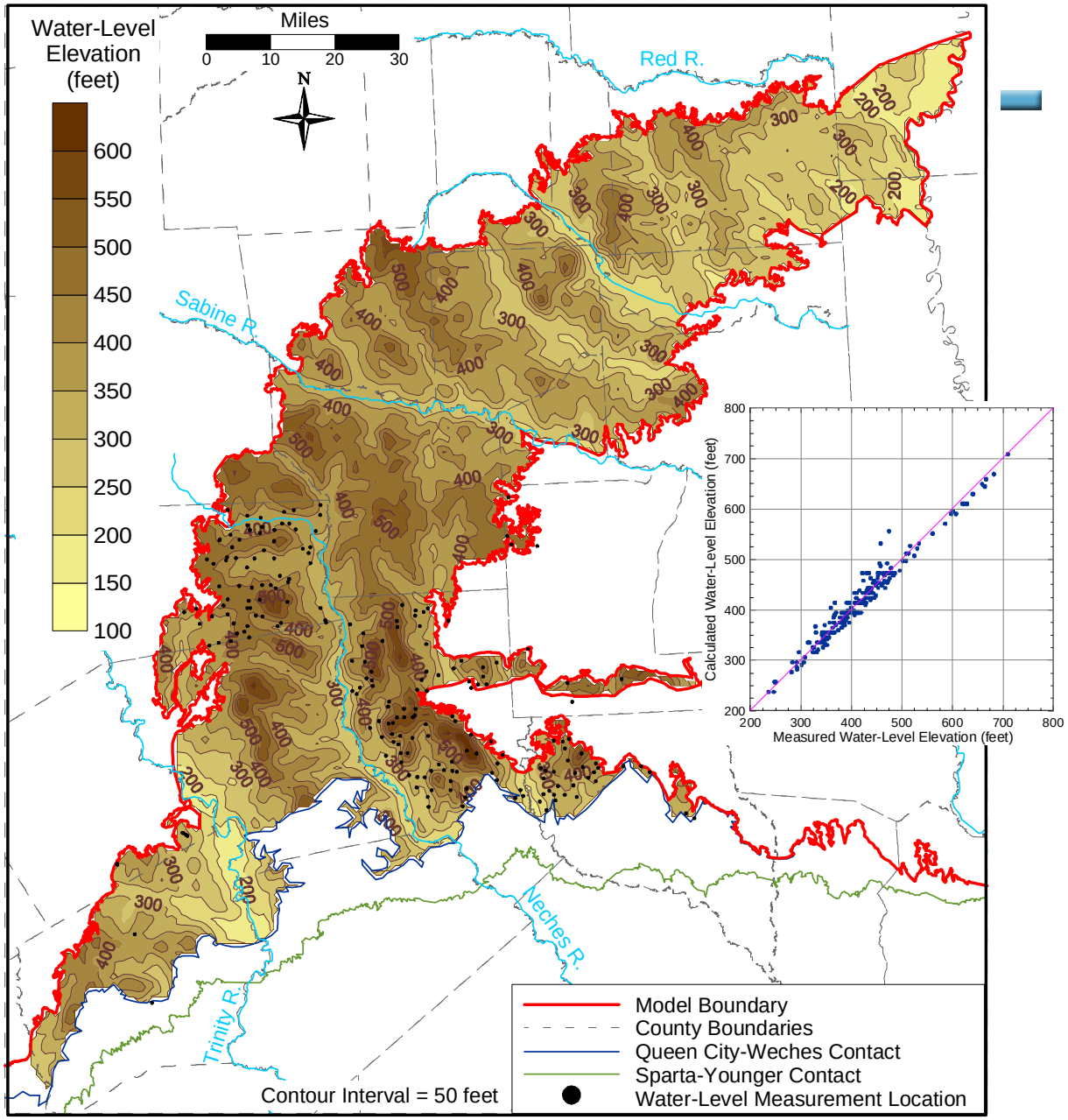




Water Level Control – Sparta aquifer

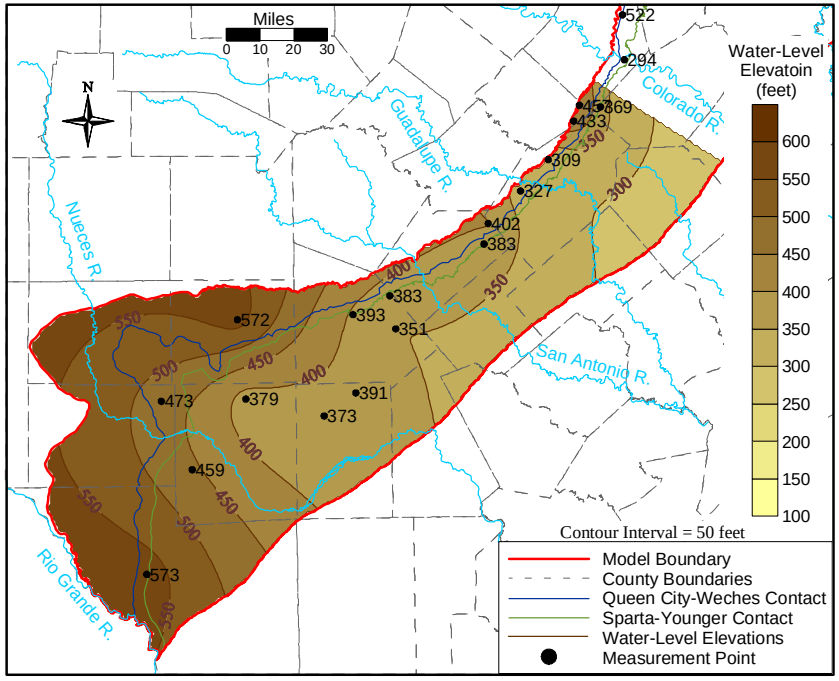


Queen City Predevelopment Water Levels Northern Area

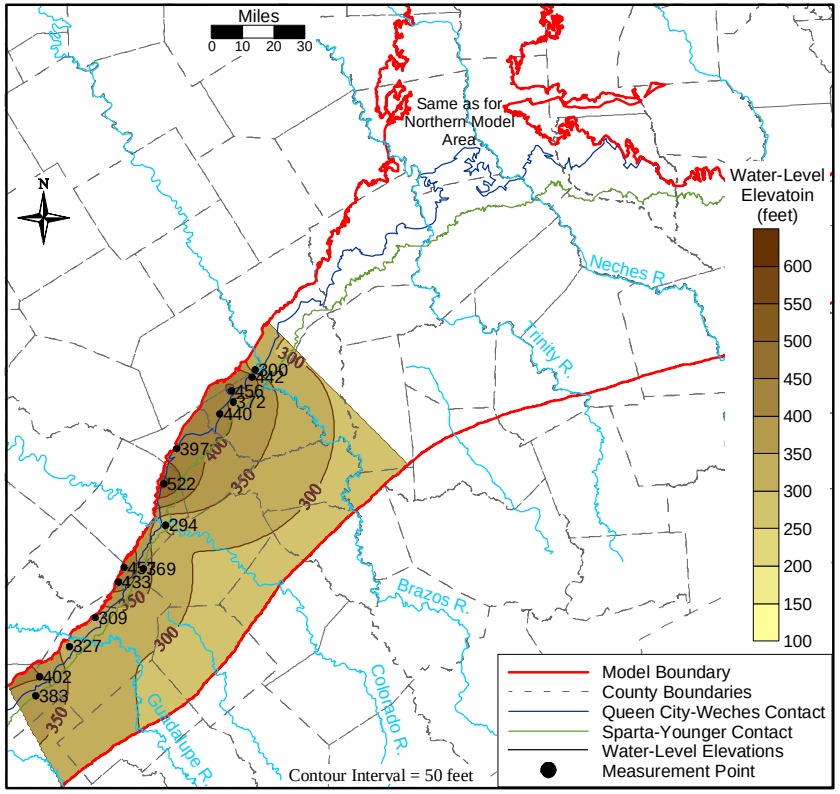


Queen City Predevelopment

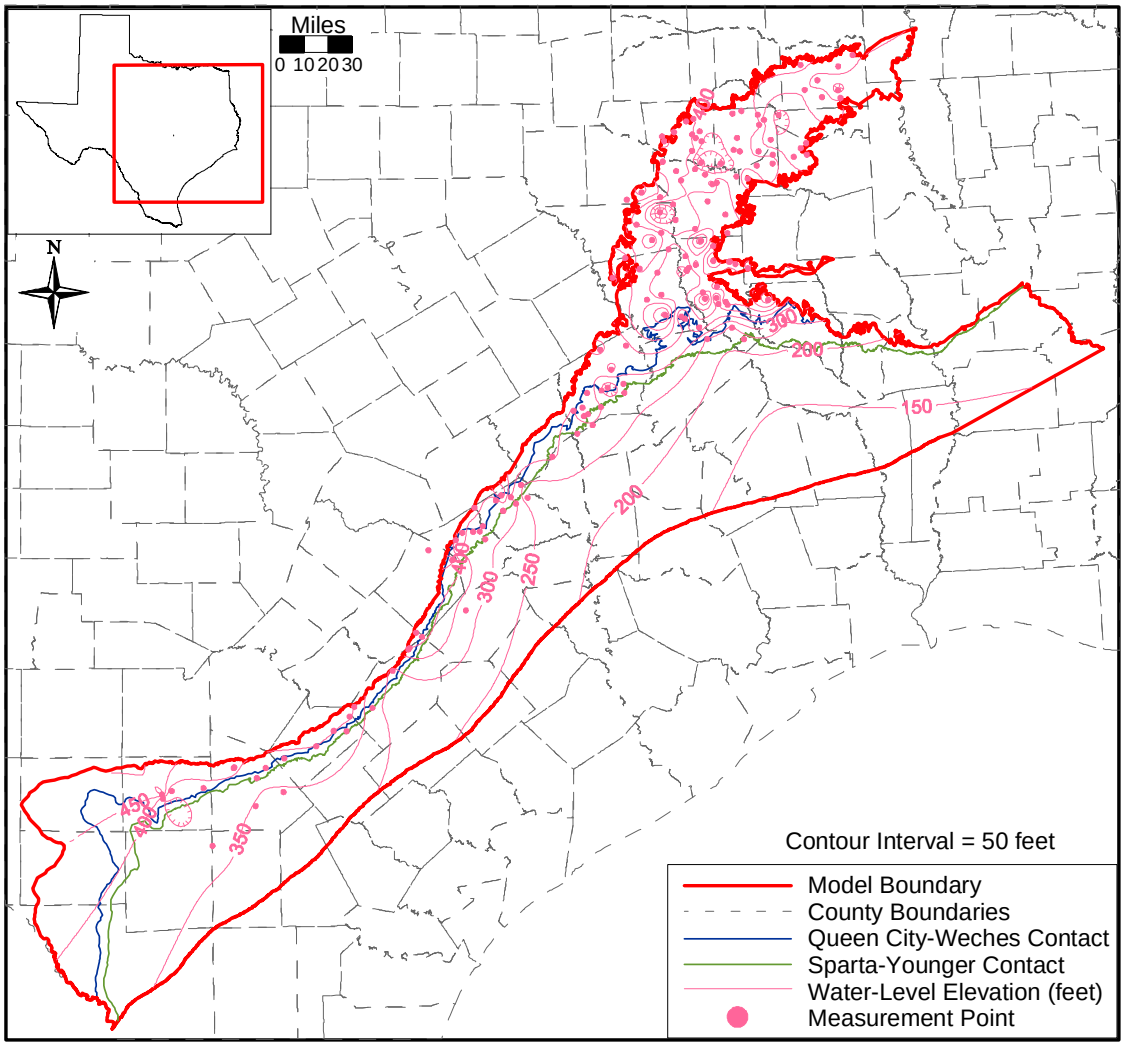
Southern Area



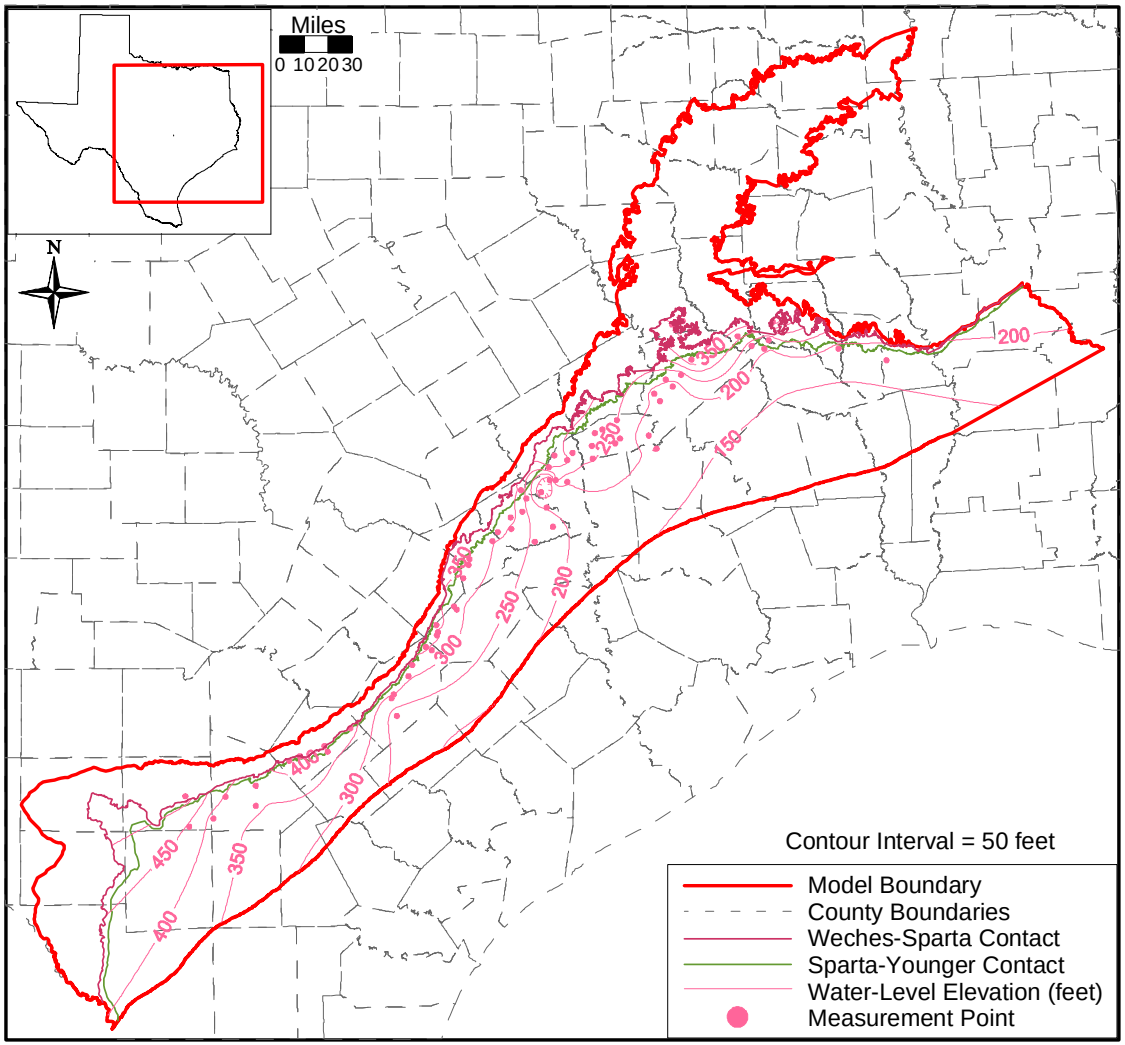
Central Area



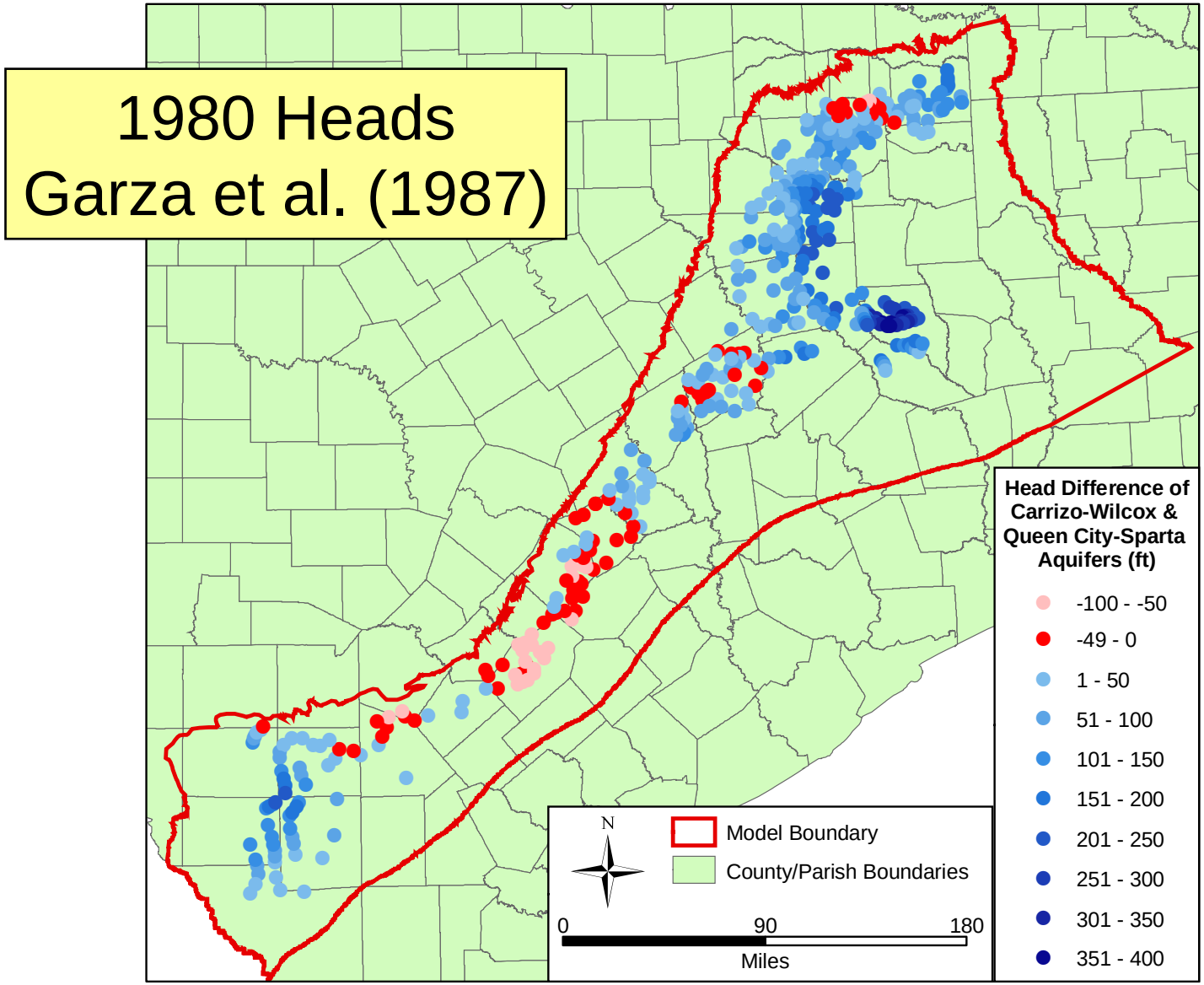
Queen City 1980 Water Level Elevation



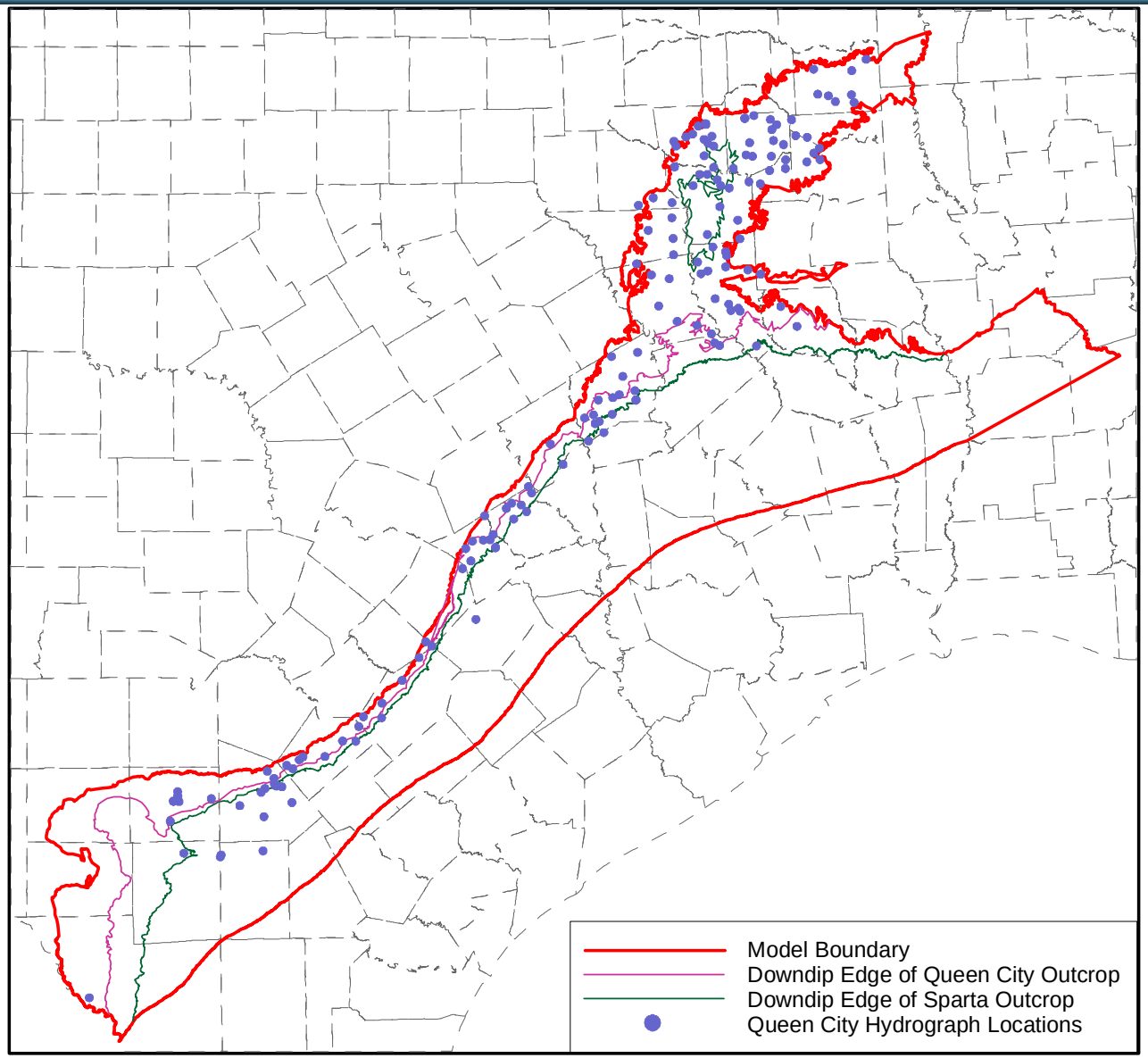
Sparta 1980 Water Level Elevation

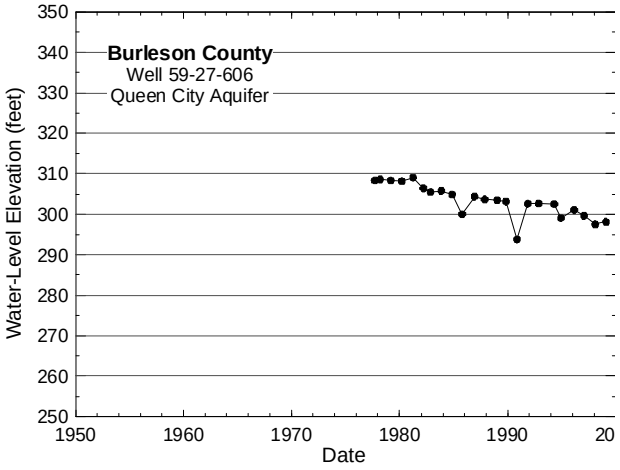


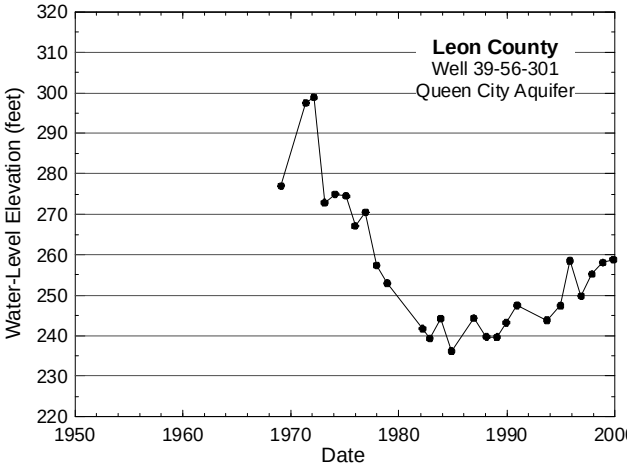
Head Difference QC/Sparta - CWilcox

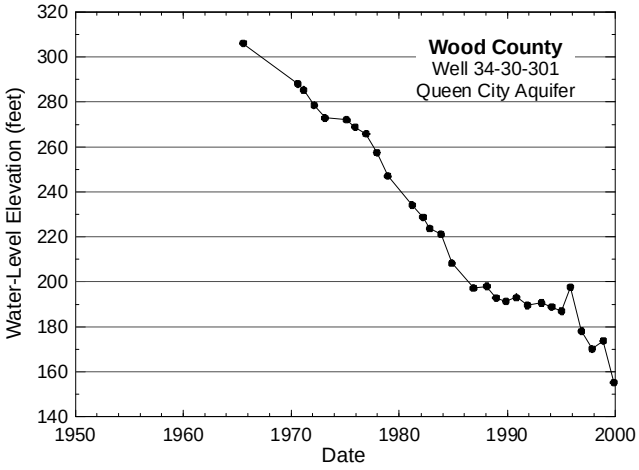


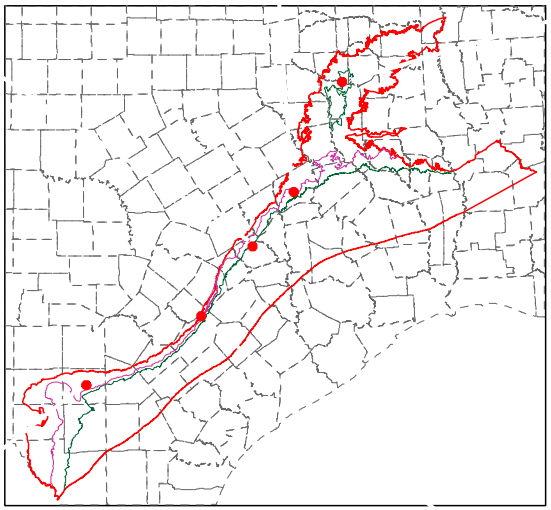
Queen City Hydrograph Locations

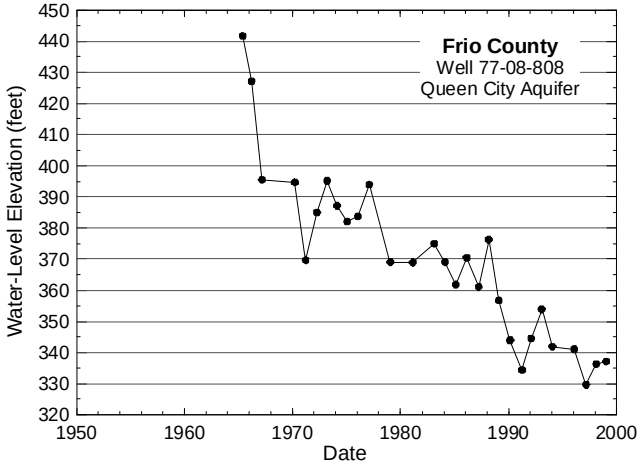


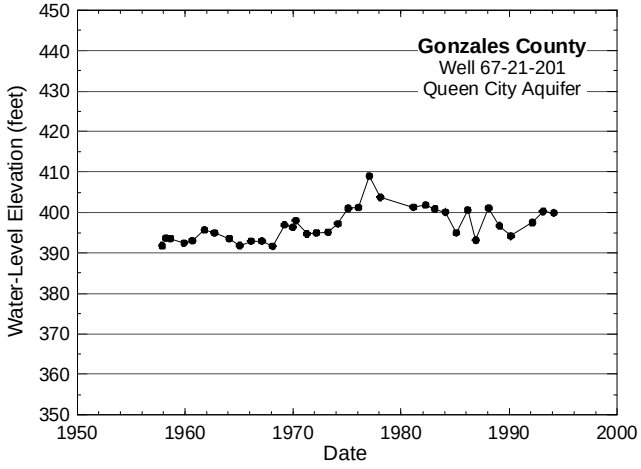

Burleson County
Well 59-27-606
Queen City Aquifer
Water-Level Elevation (feet)
Date


Leon County
Well 39-56-301
Queen City Aquifer
Water-Level Elevation (feet)
Date

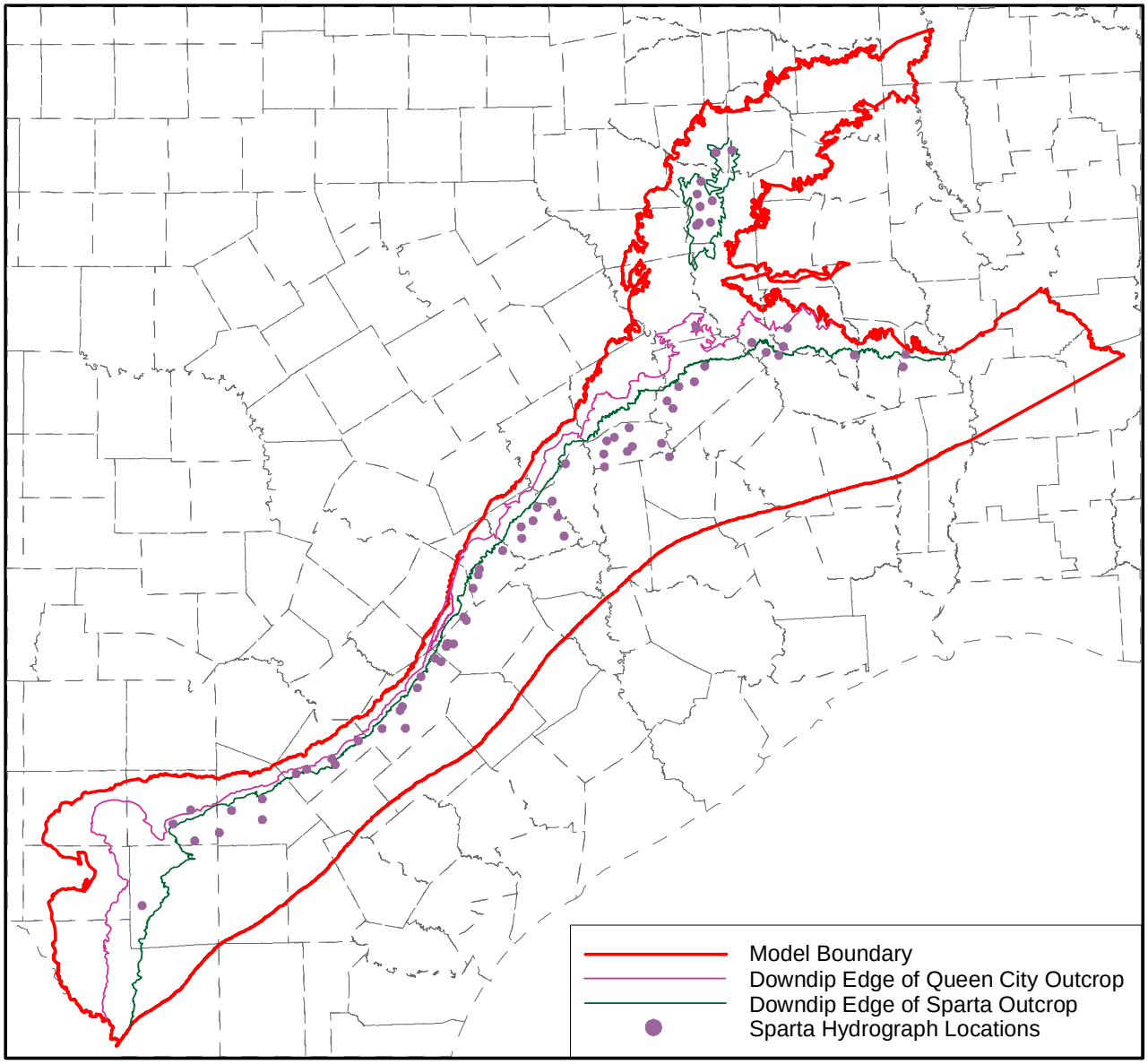

Wood County
Well 34-30-301
Queen City Aquifer
Water-Level Elevation (feet)
Date

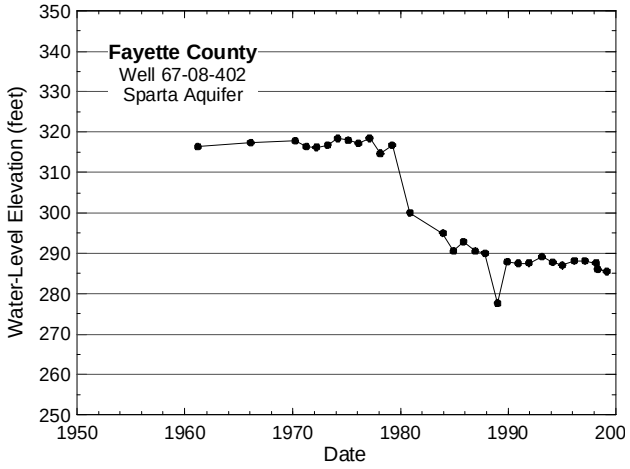


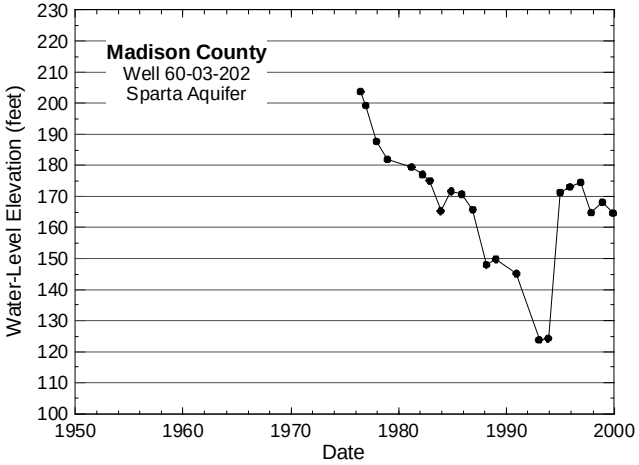

Frio County
Well 77-08-808
Queen City Aquifer
Water-Level Elevation (feet)
Date

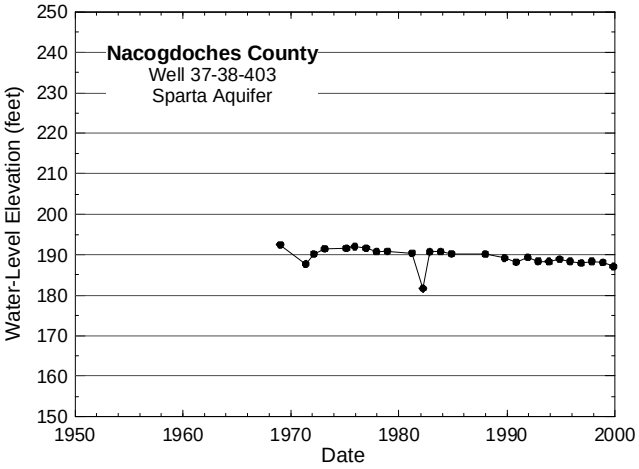

Gonzales County
Well 67-21-201
Queen City Aquifer
Water-Level Elevation (feet)
Date

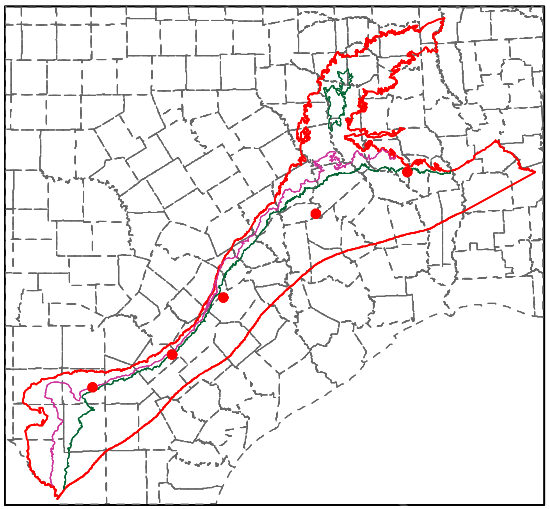
Sparta Hydrograph Locations

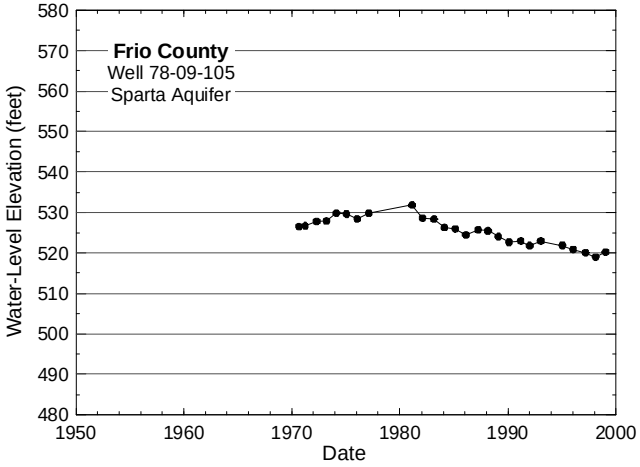


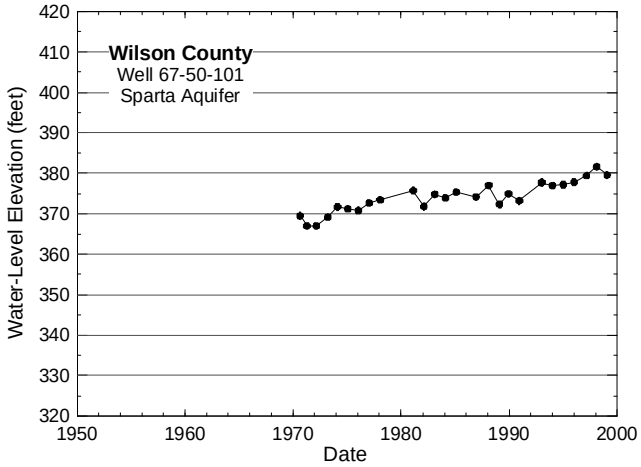

Fayette County
Well 67-08-402
Sparta Aquifer
Water-Level Elevation (feet)
Date


Madison County
Well 60-03-202
Sparta Aquifer
Water-Level Elevation (feet)
Date


Nacogdoches County
Well 37-38-403
Sparta Aquifer
Water-Level Elevation (feet)
Date




Frio County
Well 78-09-105
Sparta Aquifer
Water-Level Elevation (feet)
Date

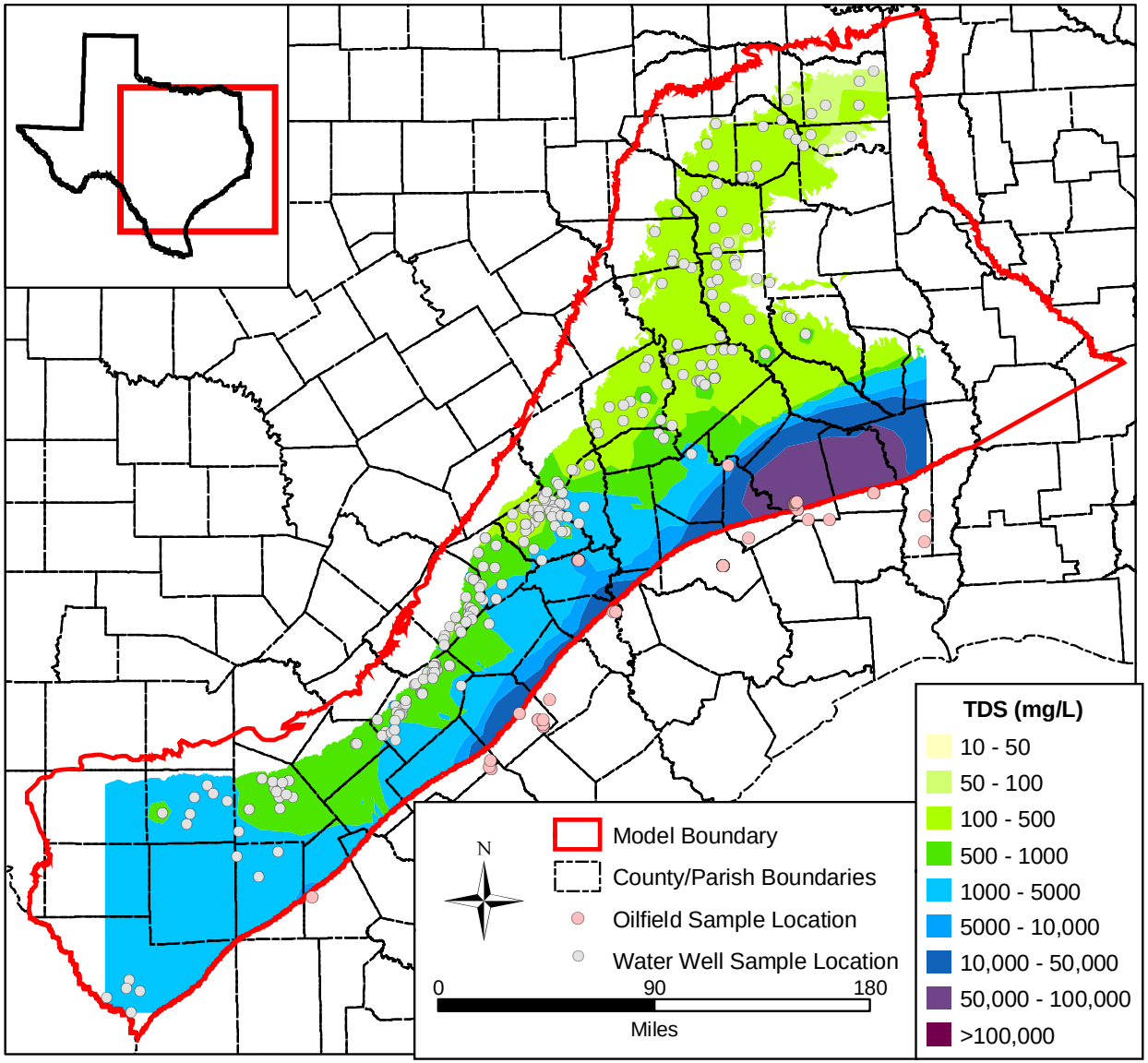

Wilson County
Well 67-50-101
Sparta Aquifer
Water-Level Elevation (feet)
Date

Water Quality

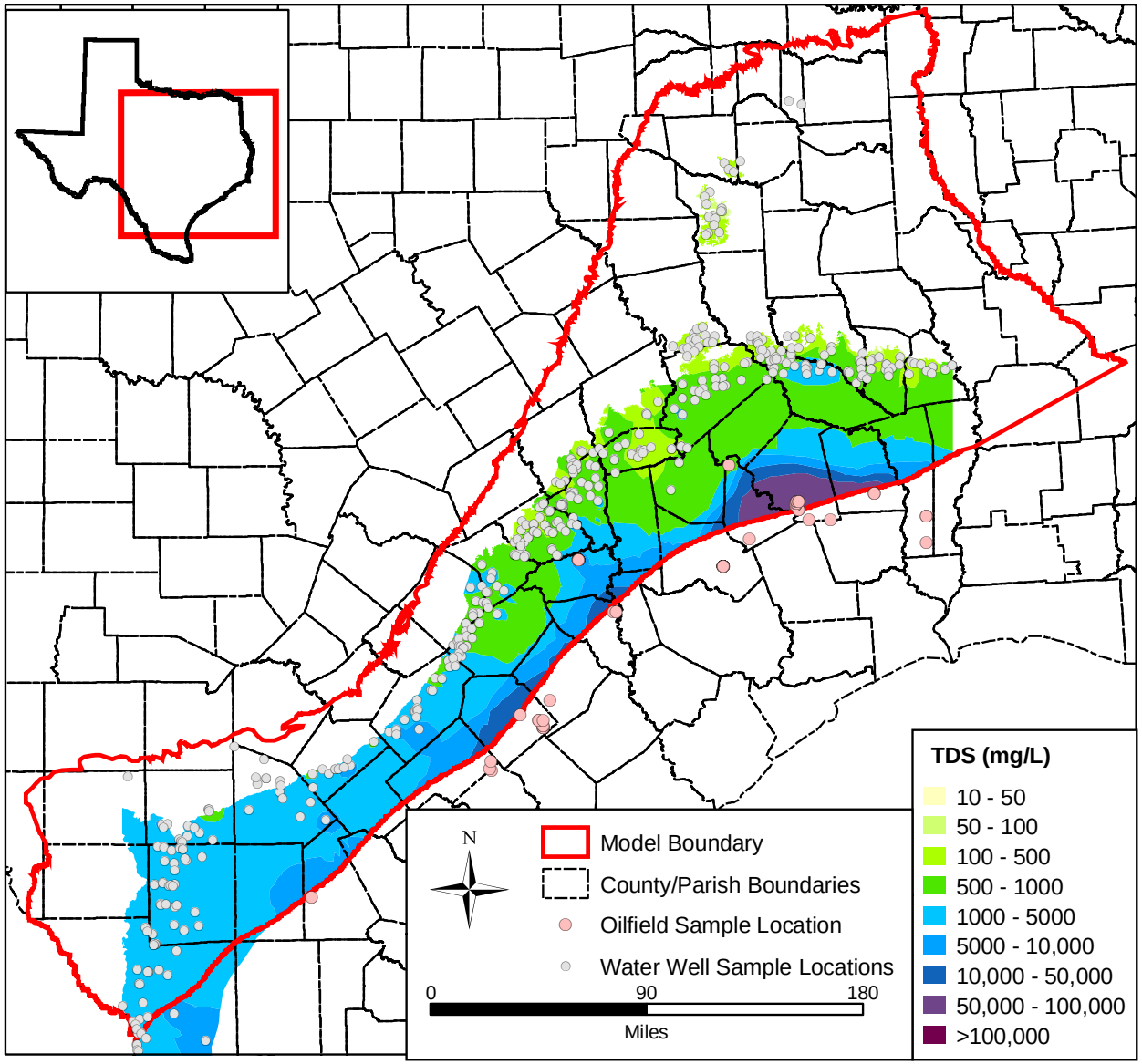
Groundwater Quality

- Data on water quality were obtained from TWDB internet files and USGS internet file on saltwater in downdip section
- Water-quality data from TWDB included:
  - 270 wells with information for the Queen City and El Pico Formations
  - 405 wells with data for the Sparta and Laredo Formations
- Average TDS is greater south of Lee County than to the north, as previously reported in TWDB Hydrologic Atlases:
- Average total dissolved solids (TDS) increases down dip in the aquifers

TDS - Queen City Aquifer



TDS - Sparta Aquifer

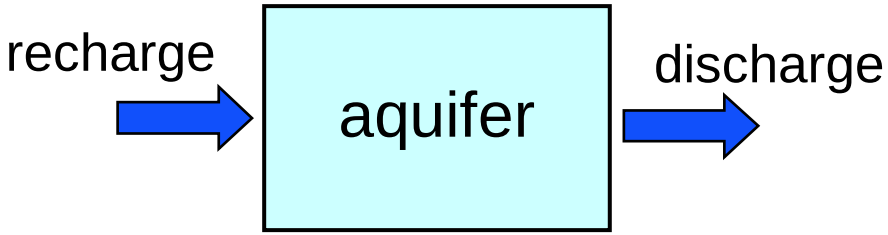


Aquifer Sinks and Sources

Recharge, Springs, Pumping,
& Aquifer-Stream Interactions

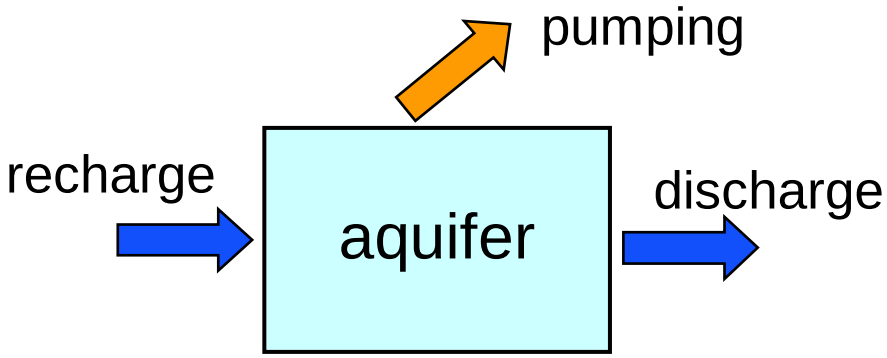
Aquifer Dynamics - Sustainability

Pre-development



Dynamic equilibrium:
Aquifer recharge is balanced by aquifer discharge

Post-development



Dynamic equilibrium:
Pumping is balanced by a reduction in discharge and in some cases an increase in recharge – sometimes termed “capture”

After Alley et al, (1999) and Bredehoeft (2002)

Aquifer Dynamics – Post-Development

- Development is balanced by:
  - Decrease in storage
  - Reduction in discharge
    - Stream gains
    - Spring flows
    - Groundwater ET
  - Increase in recharge (generally small in comparison to discharge reduction)
    - Stream losses
  - Cross-formational flow (entering or leaving the aquifer)
- Therefore, models have to be able to handle these processes correctly for use in predictions of availability and sustainability

Recharge

- Recharge – The addition of water to the water table. Recharge equals water inputs at ground surface (precipitation + irrigation + stream loss) minus water losses (runoff + evapotranspiration)
- Recharge is a complex function of
  - Precipitation (rate, volume, distribution),
  - Evapotranspiration (ET)
  - Runoff
  - Soil moisture, soil type
  - Depth to water
- Recharge is not directly measurable on a model scale
- Recharge varies as a function of time and space

Recharge

- Northern and Southern Carrizo-Wilcox GAMs
  - SWAT models used to predict recharge variation both temporally and spatially
  - Recharge based primarily on daily precipitation data, MRLC land use data, and STATSGO soil parameters.
  - SWAT recharge results in the Northern Carrizo-Wilcox model & northern part of the Southern model were decreased during calibration.
- Limitations to Method as applied
  - Rates too high in high precipitation regions
  - Error in estimated ET swamps the recharge calculation
  - Method is decoupled from underlying aquifer properties

Recharge

- Central Carrizo Wilcox Model
  - A priori estimation of minimum and maximum temporal recharge rates (corresponding to minimum and maximum precipitation) for each formation.
  - Scaled the recharge spatially based on soil hydraulic conductivity, with maximum recharge occurring for a soil column vertical hydraulic conductivity greater than or equal to 1.75 ft/day.
- Limitations to Method as applied
  - Subjective specification of formation minimum and maximums
  - Limits recharge areally which may tend to limit total recharge volumes

Recharge Estimates – Muller and Price (79)

Basin	Zone	Carrizo Wilcox	Queen City	Sparta
Sulphur	1	4000	7000	
Cypress	1	15000	234500	
Sabine	1	40000	137800	
Sabine	2	4000		7400
Neches	1	124600	253200	30700
Neches	2	25400	8100	23700
Trinity	1	13400	500	
Trinity	2	65300	14500	34800
Trinity	3	300		200
Brazos	4	11100		
Brazos	5	118200	2700	7000
Colorado	3	49200	3700	10000
Guadalupe	2	38600	8000	20000
San Antonio	2	33200	3600	10000
Nueces	1	78700	8500	20000
Rio Grande	2	13700		
		634700	682100	163800

Steady-state results

Region	M&P 79	Model
South	186,340	141,578
Central	479,700	80,800
North	327,460	310,582

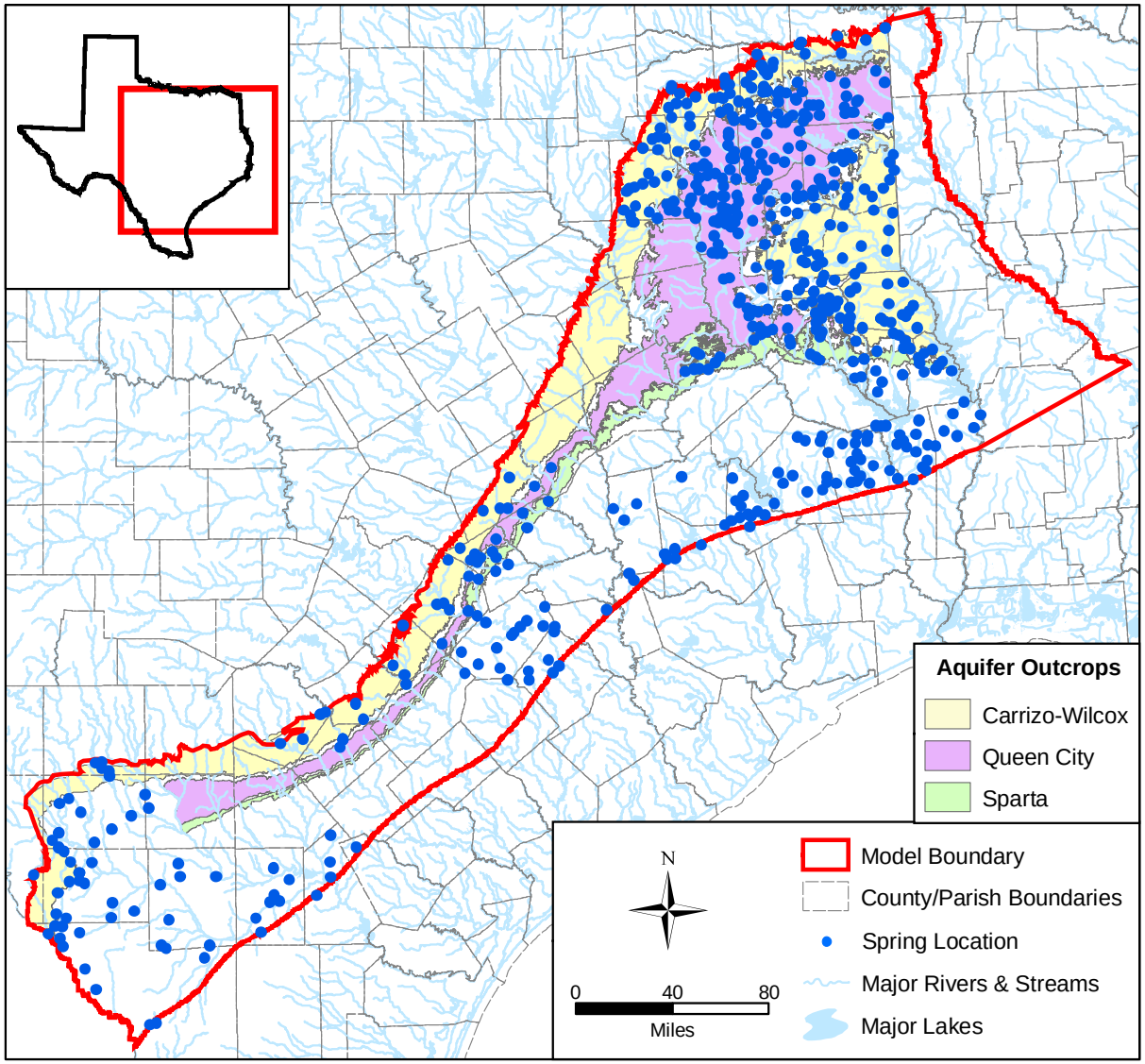
	Area (Acre)	1 inch/yr	2 in/yr	3 in/yr
C/W	7203119.038	600,260	1,200,520	1,800,780
QC	4947597.494	412,300	824,600	1,236,899
Sparta	991344.4605	82,612	165,224	247,836

Recharge Implementation

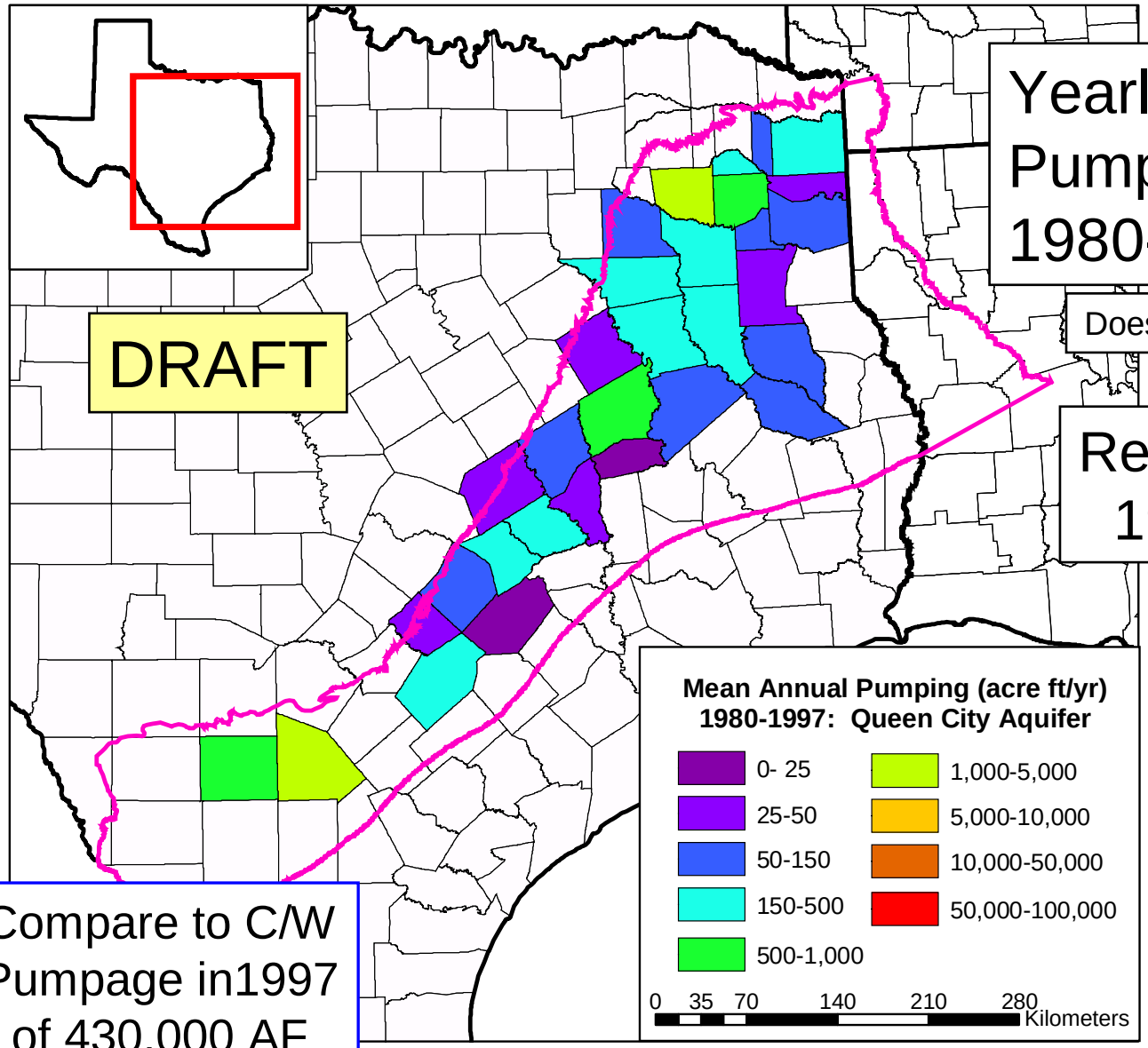
- Endpoint: Recharge approach will be the same between Carrizo-Wilcox and Queen City
- We will use a method based upon precipitation, soil clay content, and underlying aquifer properties
- This method will be developed based upon the recently published recharge report by Scanlon (BEG).
- The recharge estimates will be constrained based upon previous estimates
- Consistency between the Carrizo-Wilcox models in the overlap areas implies a change in recharge from the current models

Springs in model domain

- Data Sources
  - Brune (1975)
  - Brune (1981)
  - TWDB County Reports
  - TWDB Wells database
- Significant springs will be modeled as drain boundary conditions



Queen City Pumping (AFY)



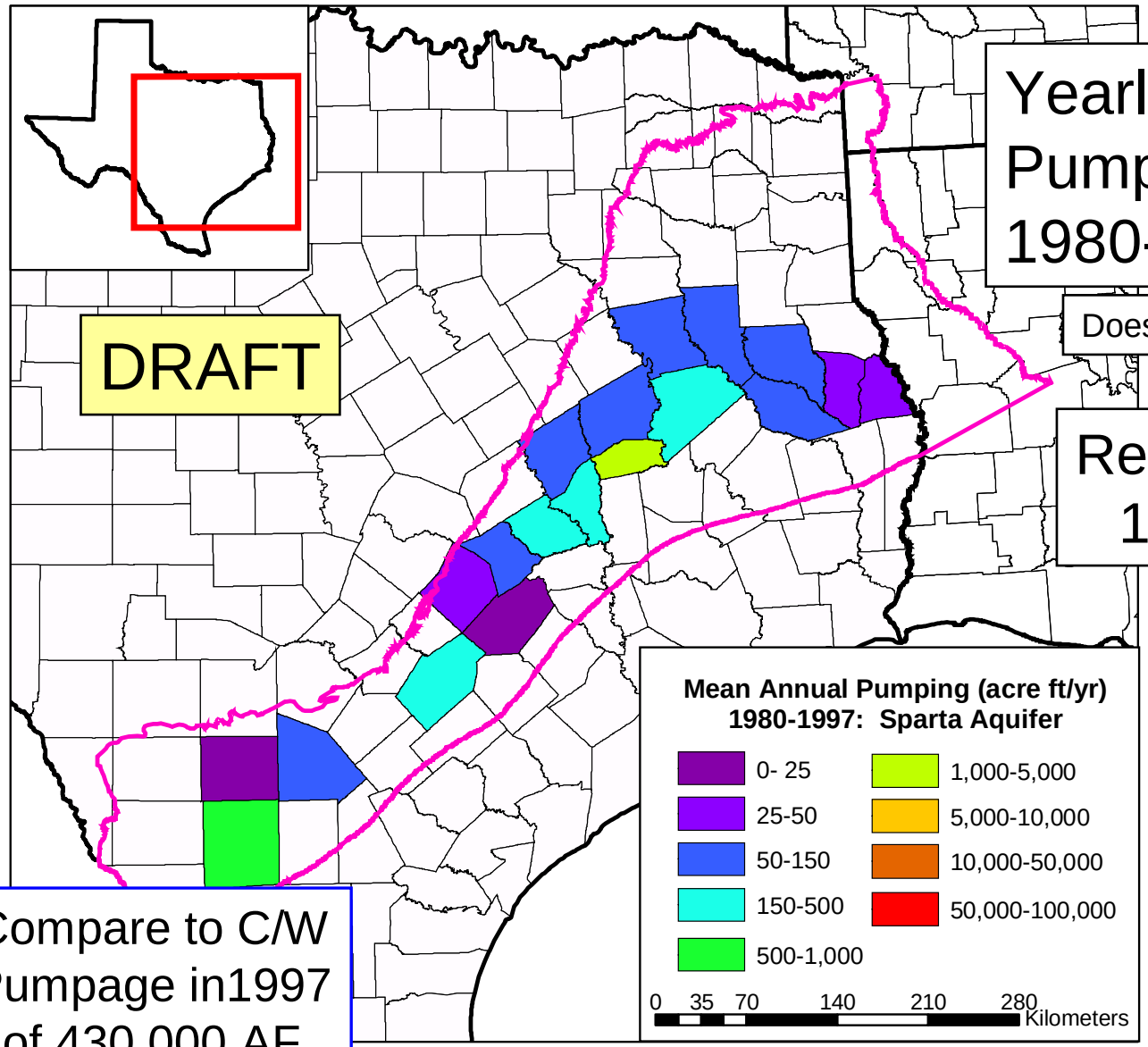
Yearly Average Pumping Rate (AFY) 1980-1997

Does not include rural/domestic

Reported Pumpage 1997 -14,000 AF

Compare to C/W Pumpage in1997 of 430,000 AF

Sparta Aquifer Pumping (AFY)



DRAFT

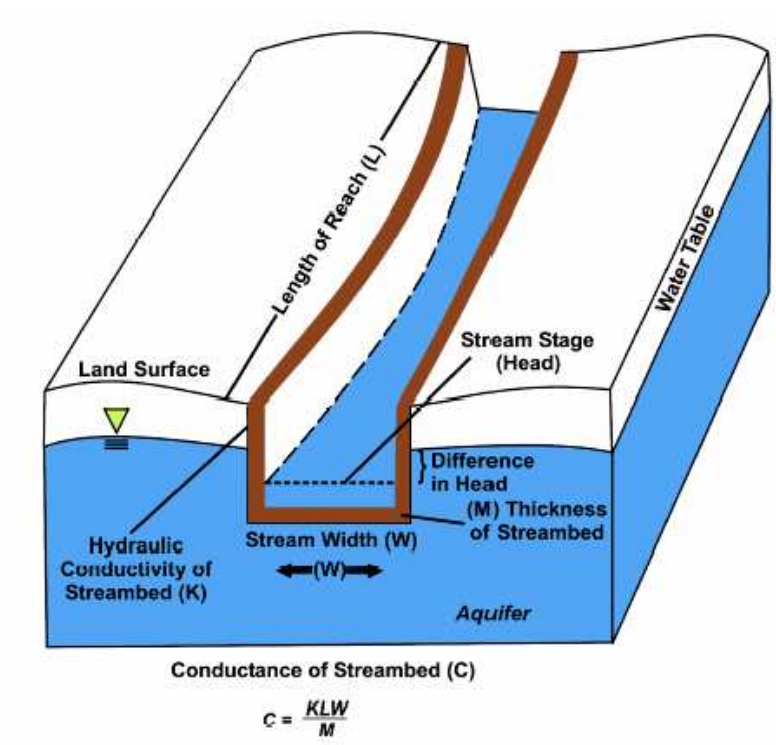
Yearly Average Pumping Rate (AFY) 1980-1997

Does not include rural/domestic

Reported Pumpage 1997 - 6,800 AF

Compare to C/W Pumpage in1997 of 430,000 AF

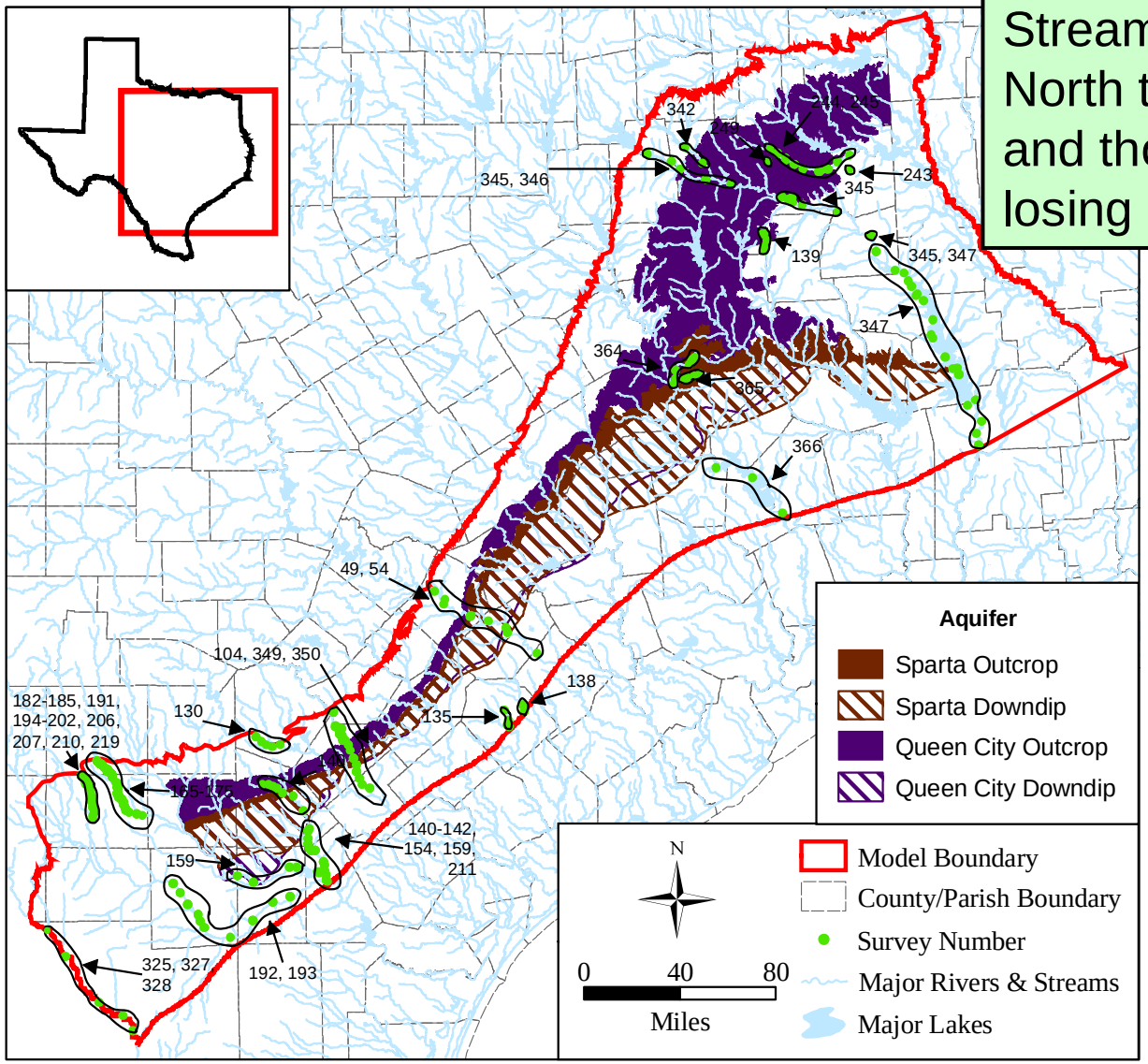
Streams – Prudic (1991)



- Stream length (1 mile)
- Stream width
- Streambed thickness
- Streambed hyd. K
- Streambed elevation
- Streambed slope
- Manning's roughness
- Headwater reach Q for every stress period
- Segment connections

Most of this data is available From the C/W GAMs

Gain-Loss Studies (Slade et al. 2002)



Streams from the Guadalupe North tend to be gaining and those South tend to be losing on average

Streams – Calibration

- **Calibrate streambed conductivities to match losses/gains**
- **Calibration targets:**
  - USGS low flow data (Slade et al. 2002) – 366 studies on 249 stream reaches
  - Stream Gage Analysis
    - Augment HDR analysis in the Central region
    - Priority of analysis: Trinity, Guadalupe, Brazos, Nueces, Neches, Rio Grande, Navasota, San Antonio, Colorado
  - WAM loss coefficients
  - Published estimates from other models (Limited)
  - Stream gage data – upper bound

Model Implementation

- We will begin with the same values in overlap areas for the Carrizo through the Sparta
  - Structure
  - Hydraulic Conductivity
  - Storage
  - Pumping
  - Recharge
  - Boundaries
- We will monitor parameter changes between models during calibration to insure consistency between models at the end of the day

GAM Revised Schedule

2003

SAF 1 — Feb 28

Jan 23 — Kickoff Meeting

- ☒ Complete database
- ☒ Evaluate data
- ☒ Preliminary model design

Stakeholder - Apr 31 Data

SAF 2 — June 12

July 31 — Draft Conceptual Model Report

2004

SAF 3 — Jan 9

March — Steady-state model review

SAF 4 — April

May — Transient model review

SAF 5 — June

June — Predictions review

Stakeholder Comments

July1 — Draft report review

SAF 6 — Sep

Oct 30 — Final Report & Model

Meeting Wrap-Up

- Next meeting – April
  - Draft steady-state model calibration
  - Pumping distribution
  - Transient model Progress
- Discussion / comments / questions

Who to Contact?

- Van Kelley

  INTERA Inc.
  9111A Research Blvd
  Austin, TX 78758
  (512) 425-2047
  vkelley@intera.com

- Dr. Shirley Wade

  Texas Water Development Board
  P.O. Box 13231
  Austin, TX 78711
  (512) 936-0883
  shirley.wade@twdb.state.tx.us

Thank You

Name	Affiliation
Bob Kier	Robert S. Kier Consulting
J.P Nicot	Bureau of Economic Geology
Neil Deeds	INTERA Inc.
Dennis Fryar	INTERA Inc.
Gary Westbrook	Post Oak Savannah GCD
Nathan Ausley	Post Oak Savannah GCD
Larry French	URS
Barry Miller	Gonzales County UWCD
Robert Gresham	Mid-East Texas GCD
Madmu Jamallamudi	TAMU
Fred Boadu	TAMU
Ric Jensen	TAMU/TWRI
Val Silvy	TAMU/TWRI
Shirley Wade	TWDB

Meeting Minutes for the

Third Queen City/Sparta Groundwater Availability Model (GAM) Stakeholder Advisory Forum (SAF) Meeting

January 9, 2004

Centeq Research Plaza

College Station, Texas

The third Stakeholder Advisory Forum (SAF) Meeting for the Queen City/Sparta Groundwater Availability Model (GAM) was held on January 9th, 2004 from 1:30 until 3:00 PM in Room 120 of the Centeq Research Plaza, Building A located at 1500 Research Parkway in College Station. Attachment A of these meeting minutes provides a list of all participants who signed up as attending the meeting.

The purpose of the third SAF meeting was to provide an update on the progress for the Queen City/Sparta Aquifers GAM and provide an opportunity for feedback from stakeholders.

Meeting Introduction: Dr. Shirley Wade, TWDB

The meeting was initiated by Dr. Shirley Wade of the Texas Water Development Board (TWDB). She gave a brief introduction to the GAMs and discussed the current status of the GAM program. She then discussed groundwater availability and use of the GAMs, followed by a look at the future of the GAMs and opportunities for public involvement in GAM development.

SAF Presentation: Neil Deeds and Dennis Fryar, INTERA

Neil Deeds and Dennis Fryar, scientists on the INTERA Queen City/Sparta team, presented a prepared presentation. The presentation was structured according to the following outline:

1. GAM objectives and expectations
2. Overview of Revised Model Scope
3. Draft Conceptual Model (including implementation and integration with Carrizo-Wilcox GAMs
4. Review of Project Milestones and Schedule
5. Expectations for the next SAF Meeting

The presentation is available on the GAM website (*www.twdb.state.tx.us/gam)*.

Questions and Answers: Open Forum:

Q: Will the current GAMS be extended to 2060 since 2007 planning will soon be available?

A: No. The predictive period will be from 2000 to 2050 and pumping will be based on the Regional Water Planning Group predictions from the 2002 State Water Plan.

Q: Does data go back to year 1900?

A: Only a few of the precipitation hydrographs go back to approximately the 1930's. The well hydrographs typically have more modern records than the precipitation hydrographs.

Q: Why did the revised scope not include the Wilcox.

A: The Carrizo is the primary aquifer in the South-Central overlap area, where stakeholder concerns about discrepancies were most pronounced.

Q: How accurate is the bad water line shown in the presentation (based on the kriged data)?

A: Some of the anomalous-looking trends are due to kriging artifacts. Uncertainty will increase where data support is lacking.

Q: Can you explain the drawdown/rebound [shown on an example well hydrograph]?

A: These hydrographs are examples. We do not know the specifics regarding that particular well.

Q: The bad water line south of Gonzales County appears to trend in the wrong direction.

A: Observation noted.

Q: Does pumping cause a TDS increase downdip?

A: We are not aware of any specific occurrences of this phenomenon in the current aquifer. However, pumping can certainly change TDS levels in an aquifer.

Q: What does the "zone" mean [on a particular slide which discusses recharge]?

A: The zone refers to spatial delineation within a river basin as used in TWDB Muller and Price (1979) report on groundwater availability in Texas.

Q: Do we differentiate between flowing springs and springs that have gone dry?

A: We have much more spring location data than flow. We have some flow estimates from the Brune survey. As a result, we implement springs in the model to allow for surface discharge in the model. However, in many cases we have no flow estimates to quantify model discharge.

Q: Will this slide show be available electronically?

A: Yes, it will be posted on the TWDB website.

Q: How soon will estimated future pumping data be available from the GAMs?

A: The predicted pumping data is based on estimates made by the planning groups.

Q: Will there be a final conceptual model report?

A: No, but the project final report will include the bulk of the draft conceptual model report.

Q: Is the GAM data available for all of the aquifers?

A: The data becomes available as each GAM is finalized. See the TWDB website for the status of the GAMs.

Q: What is the cost of the model data?

A: The cost is $16.21 per CD.

Q: How do we project pumping into the future?

A: Predicted pumping in the model is based on estimates made by the RWPGs.

Q: Was SWAT used for only part of the Queen City/Sparta model?

A: Actually, SWAT was used for the Northern and Southern Carrizo-Wilcox GAMs. We do not currently intend to use SWAT recharge results in the Queen City/Sparta model.

Q: What are the overlap areas [referred to in the "revised scope" section].

A: [Shown on slide] The overlap regions are areas where the model areas coincide.

Q: If you had it to do over again, would you make the model grid orientation consistent between the three Carrizo-Wilcox models?

A: A consistent grid orientation would simplify some of the integration of the Queen City/Sparta models with the Carrizo-Wilcox models, especially in the overlap areas. However, re-orienting the grid would require a disproportionate amount of labor at this point.

ATTACHMENT A: SIGN-UP SHEET

Name	Affiliation
Bob Kier	Robert S. Kier Consulting
J.P Nicot	Bureau of Economic Geology
Neil Deeds	INTERA Inc.
Dennis Fryar	INTERA Inc.
Gary Westbrook	Post Oak Savannah GCD
Nathan Ausley	Post Oak Savannah GCD
Larry French	URS
Barry Miller	Gonzales County UWCD
Robert Gresham	Mid-East Texas GCD
Madmu Jamallamudi	TAMU
Fred Boadu	TAMU
Ric Jensen	TAMU/TWRI
Val Silvy	TAMU/TWRI
Shirley Wade	TWDB