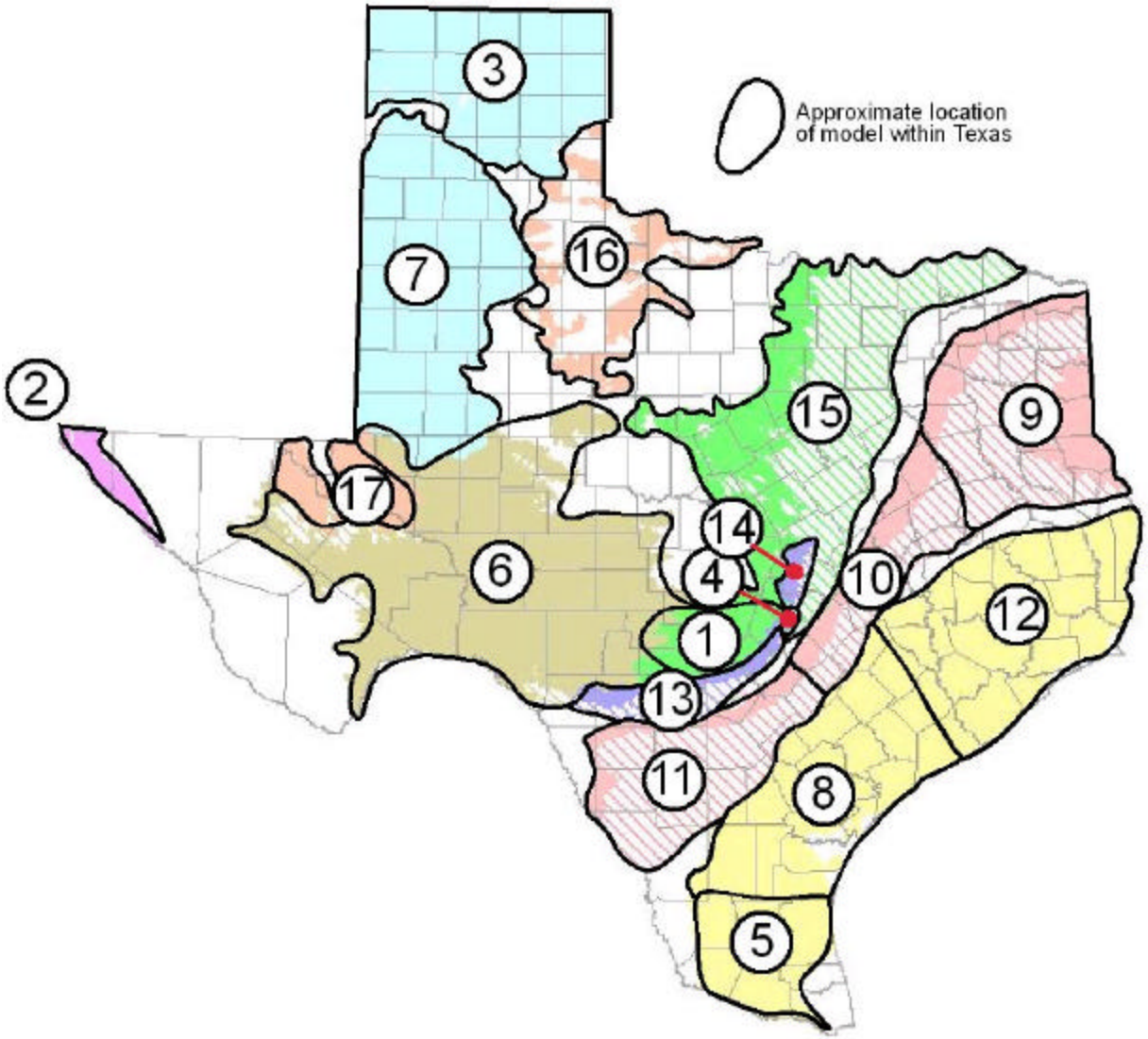

texas water development board

# Location of Completed, Ongoing, and Proposed Models for GAM




c = completed
o = ongoing
p = proposed

1. Trinity (Hill Country) c
2. Hueco Bolson c
3. Ogallala (northern part) c
4. Edwards (Barton Springs segment) c
5. Lower Rio Grande Valley o
6. Edwards-Trinity Plateau o
7. Ogallala (southern part) o
8. Gulf Coast (central part) o
9. Carrizo-Wilcox (northern part) o
10. Carrizo-Wilcox (central part) o
11. Carrizo-Wilcox (southern part) o
12. Gulf Coast (northern part) o
13. Edwards (San Antonio segment) o
14. Edwards (northern segment) p
15. Trinity (northern part) p
16. Seymour p
17. Pecos Alluvium p

October 2000

# AGENDA
# STAKEHOLDER ADVISORY FORUM (SAF) MEETING
# April 16, 2000

- Role of GAM models and the SAF
- Groundwater modeling
- Approach for the Central Carrizo-Wilcox GAM Model
- Modeling team and project schedule

# ROLE OF GAM MODEL

- Goal of GAM project is to develop a realistic and scientifically accurate computer model that represents the aquifer, its water budget, and its groundwater processes, such as recharge, discharge, and pumping
- Model will be used by groundwater conservation districts (GWCD), regional water-planning groups (RWPG), TWDB, and individuals to evaluate the hydrologic effects of various water-use alternatives
- Stakeholder participation is important to ensure that the model is accepted as a valid representation of the aquifer
- Once the model is developed, it can be used to assess availability of groundwater

# STAKEHOLDER ADVISORY FORUM (SAF)

- Stakeholder participation is critical to the success of the GAM program!!!
- SAF is intended to be widely inclusive of interested participants
- Quarterly SAF meetings
  - —Updates on progress of model development
  - —Opportunity for issues to be raised that are related to modeling the aquifer
  - —Identification of information to help build a better model
- SAF memo reports and presentation materials will be posted on the TWDB Web site (http://www.twdb.state.tx.us)

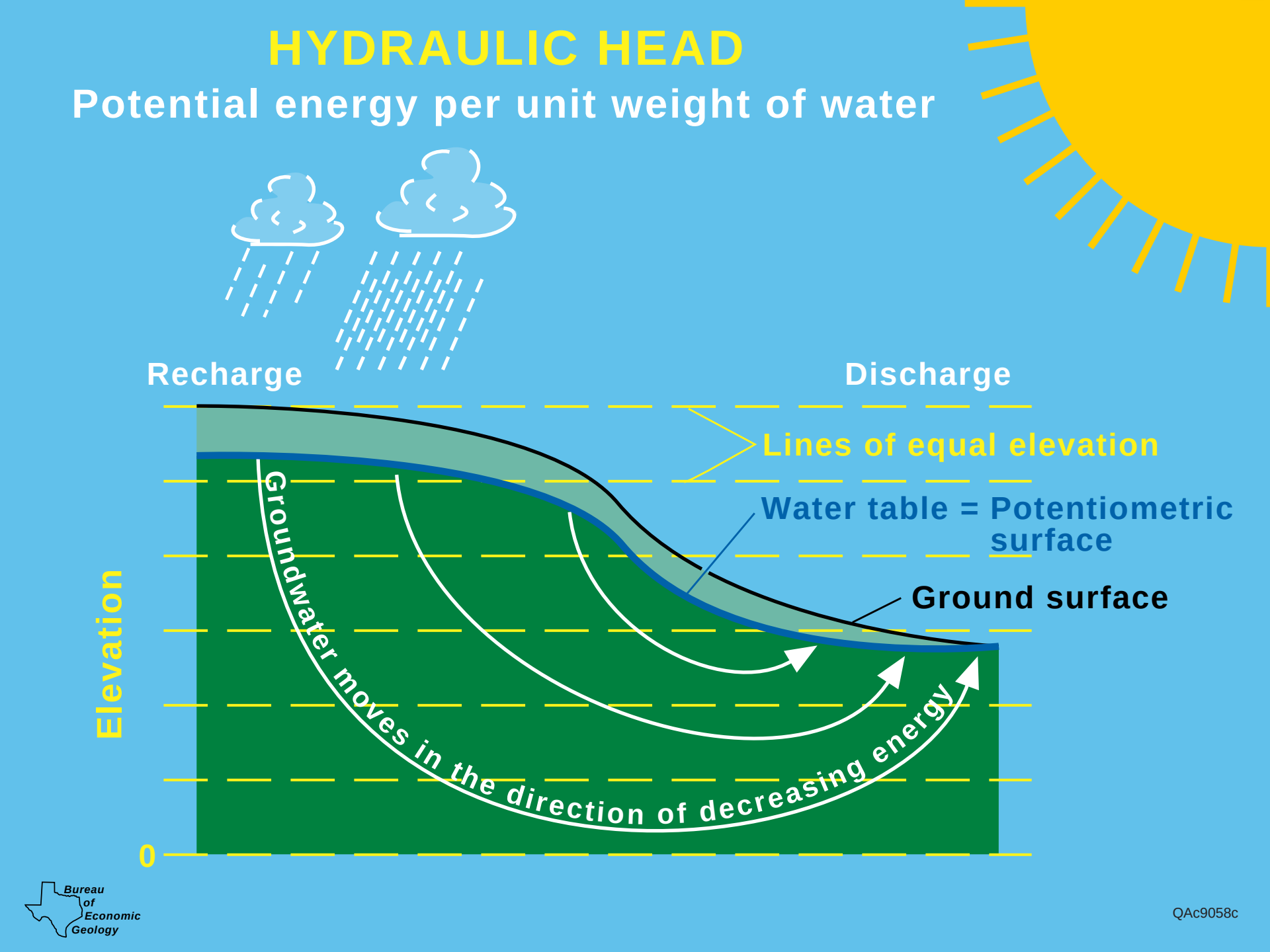
# GOALS OF THE GAM MODEL OF THE CENTRAL CARRIZO-WILCOX AQUIFER

- The model of the central Carrizo-Wilcox aquifer is to be
  - Realistic
  - Scientifically accurate
  - Capable of addressing important technical and policy issues
  - Acceptable as a valid representation of the aquifer
  - Well documented by a report and data
- Model to be used to predict effects of groundwater use
  - 2000 through 2050 period as projected by RWPG
  - Projected pumping under normal and drought-of-record conditions
- Model and data to be available to public

# GROUNDWATER MODELING

# HYDRAULIC HEAD

## Potential energy per unit weight of water

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# WHAT IS A GROUNDWATER MODEL?

- A groundwater model is an aquifer in a computer
- Computer codes represent the movement of groundwater in an aquifer as a set of mathematical equations
  - —MODFLOW
- Models are useful tools for looking at “What if?” questions
  - —Predictive models require calibration and verification
- Models are approximations and representations of what goes on in an aquifer
  - —Assumptions and simplifications

# MODEL CAPABILITY AND EXPECTATIONS

- Given projected future pumping rates, all else being unchanged, the water-resource model will predict for 1-mi$^2$ areas
  - —Depth to water
  - —Water levels
  - —Base-flow discharge to streams
  - —Change in evapotranspiration
  - —Water budget of inflows and outflows
- Calibration error is to be unbiased and less than 30 ft
- Regional scale model will not handle local features fully
- Model will not estimate soil moisture or other ecosystem attributes

# CARRIZO-WILCOX AQUIFER IN TEXAS


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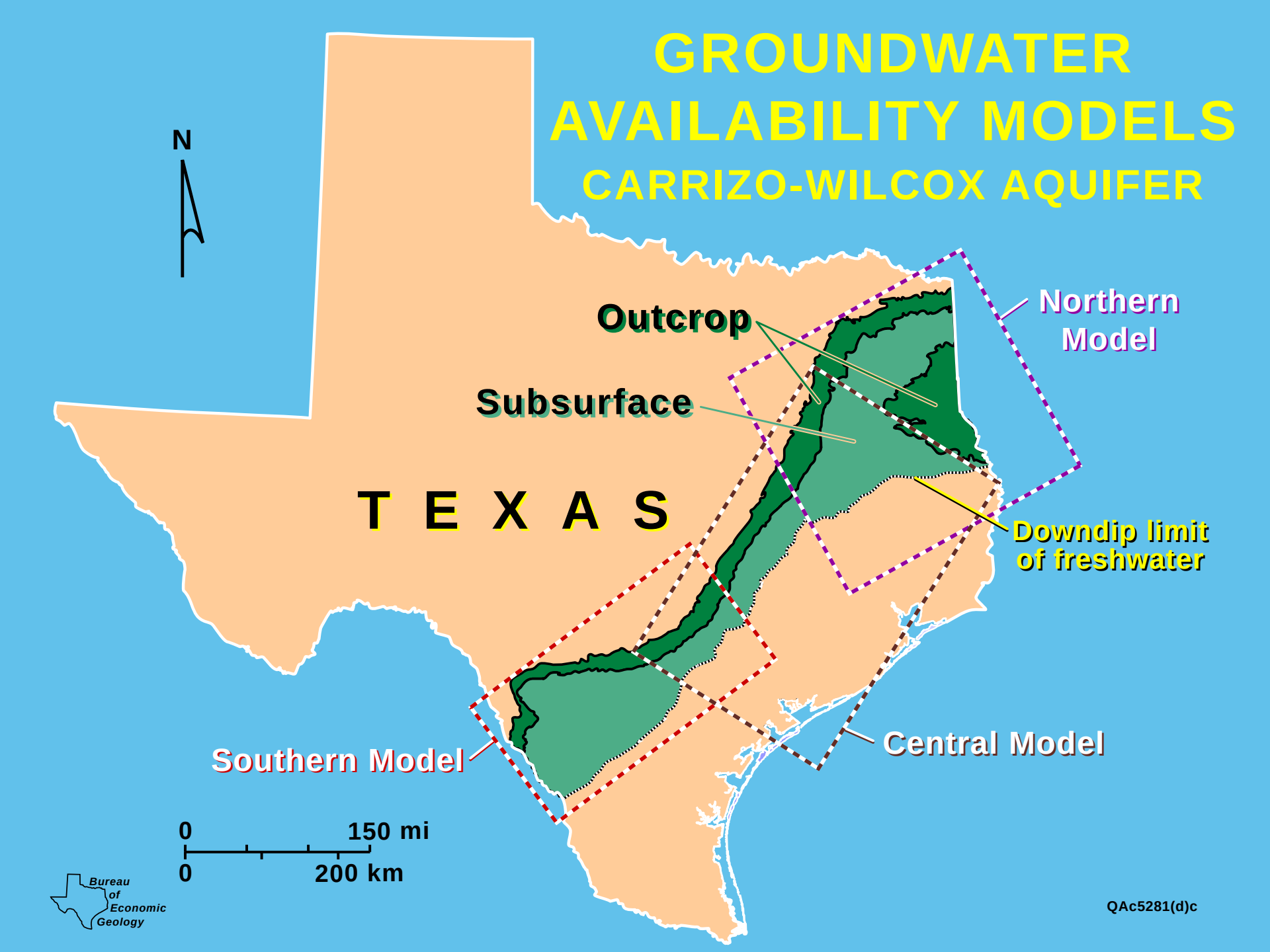
GROUNDWATER
AVAILABILITY MODELS
CARRIZO-WILCOX AQUIFER
N
Outcrop
Subsurface
Northern
Model
T E X A S
Downdip limit
of freshwater
Central Model
Southern Model
0
150 mi
0
200 km
Bureau
of
Economic
Geology
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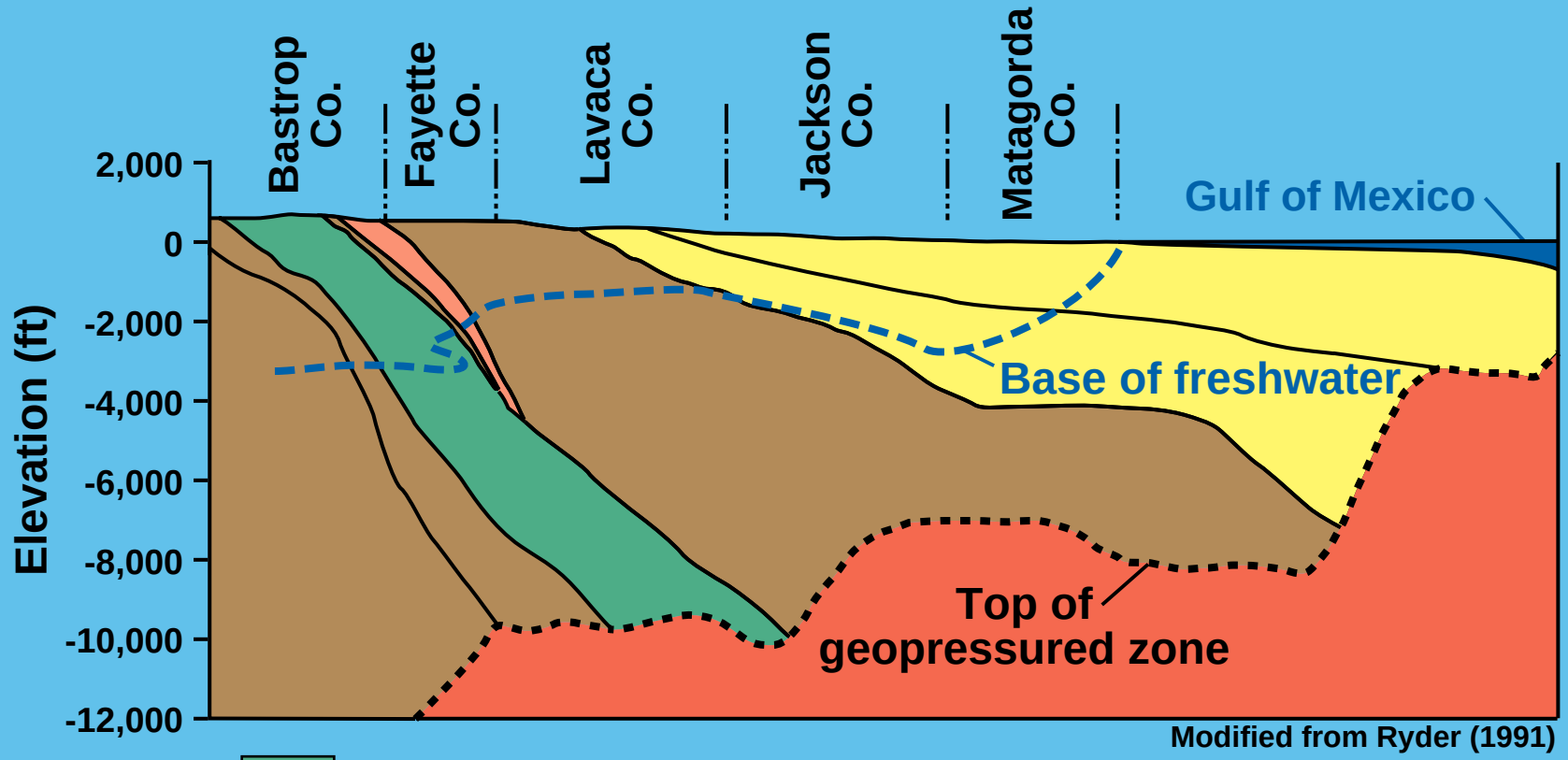
# GROUNDWATER MODELING OF CENTRAL PART OF CARRIZO-WILCOX AQUIFER

# CARRIZO-WILCOX AQUIFER IN THE GULF BASIN GROUNDWATER SYSTEM

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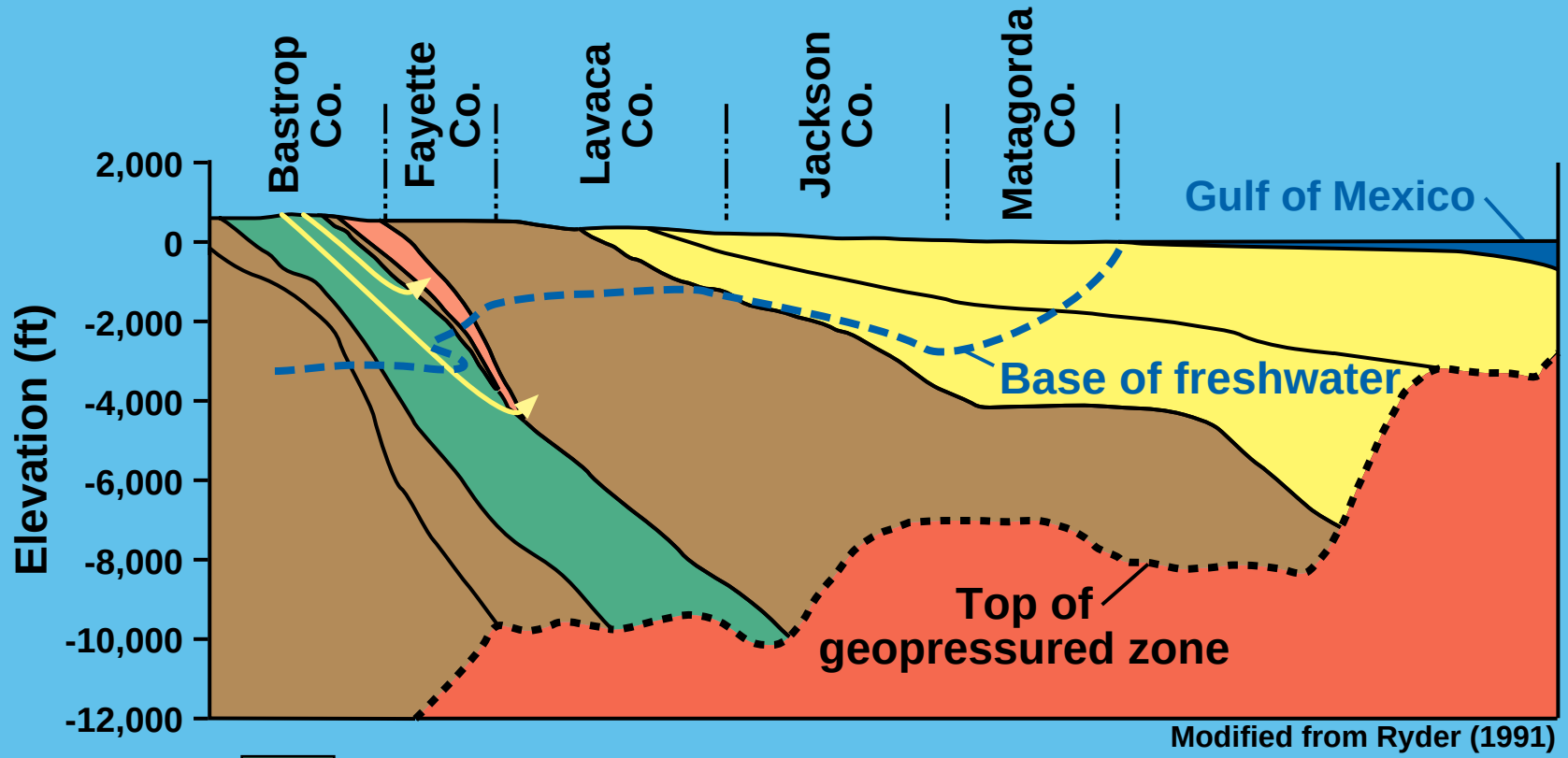
# CARRIZO-WILCOX AQUIFER IN THE GULF BASIN GROUNDWATER SYSTEM




Modified from Ryder (1991)

Carrizo-Wilcox

Other Aquifers and Aquitards

Sparta-Queen City

Gulf Coast

Flow line

0 30 mi

0 40 km

Vertical scale greatly exaggerated

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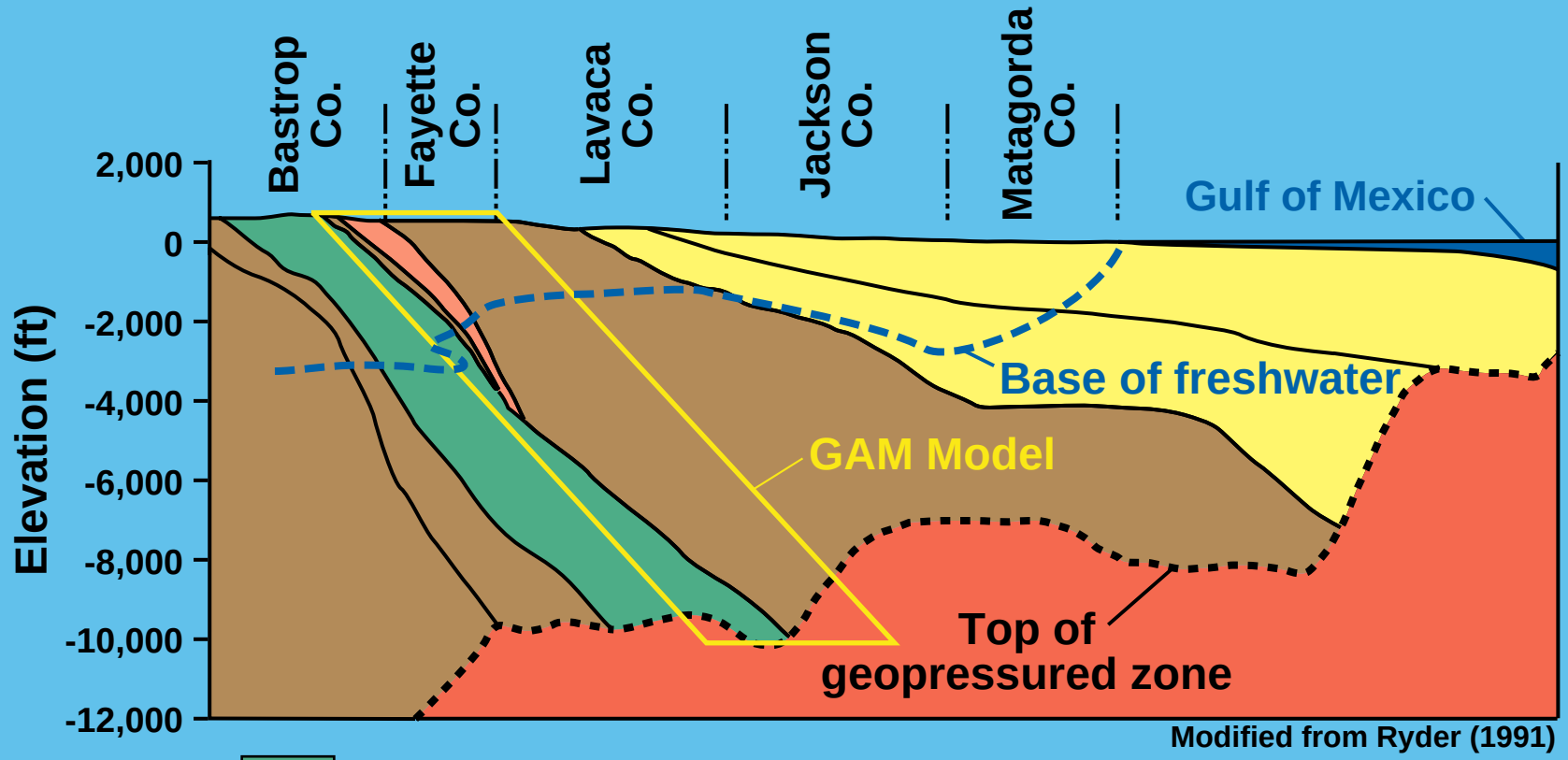
# CARRIZO-WILCOX AQUIFER IN THE GULF BASIN GROUNDWATER SYSTEM

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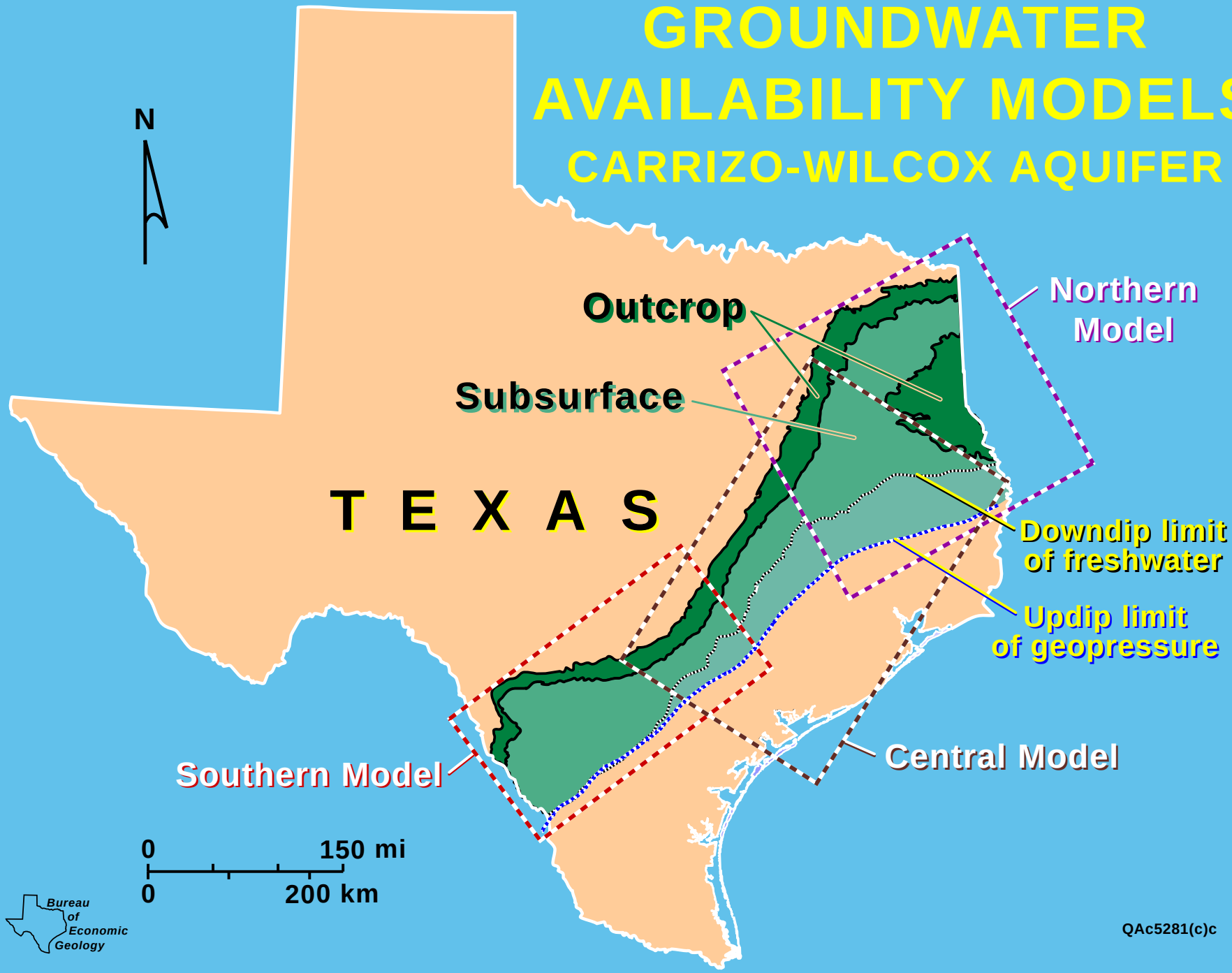
# GROUNDWATER AVAILABILITY MODELS

## CARRIZO-WILCOX AQUIFER

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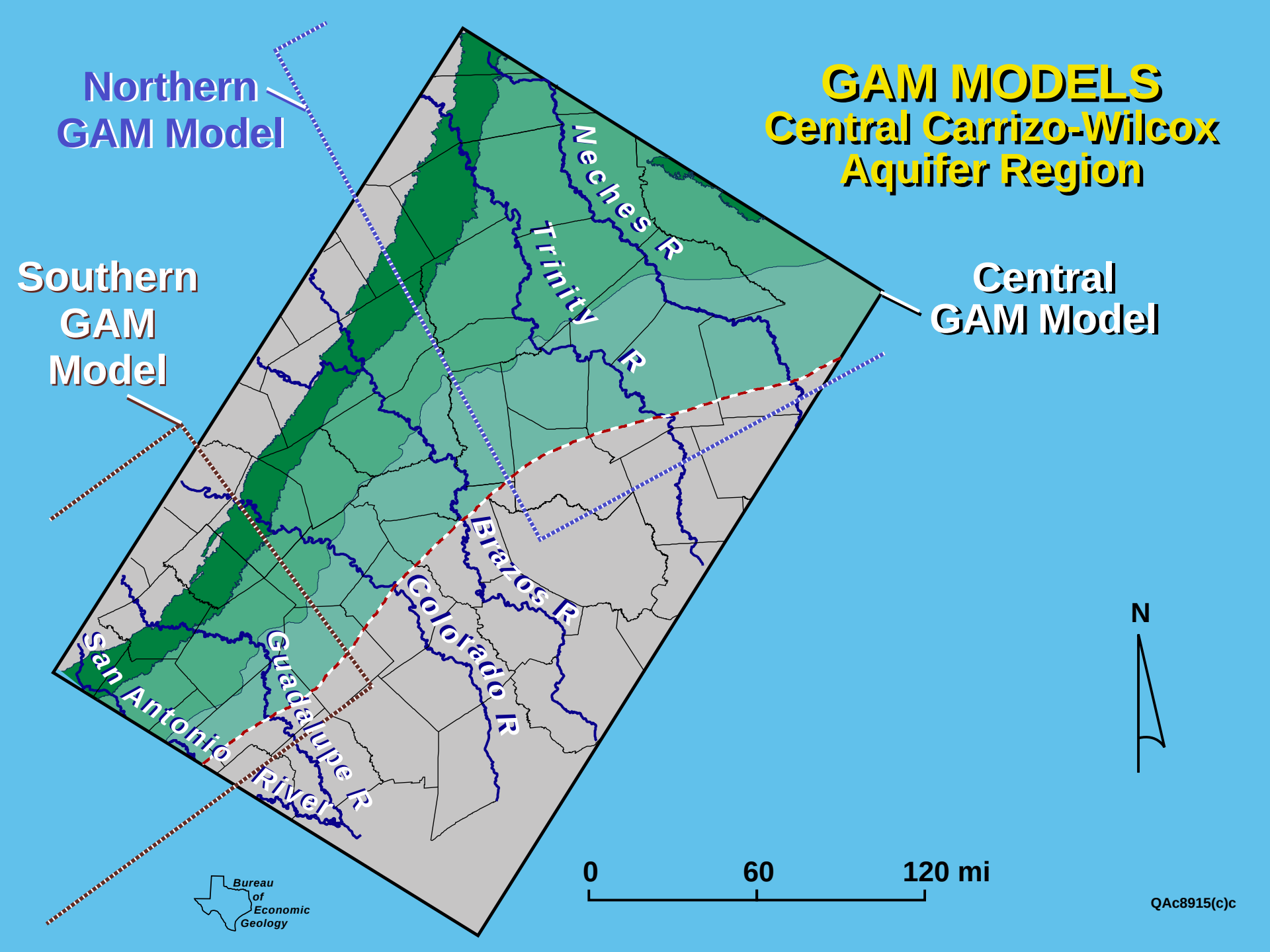
GAM MODELS
Central Carrizo-Wilcox
Aquifer Region
Northern
GAM Model
Southern
GAM
Model
Central
GAM Model
Neches R
Trinity R
Brazos R
Colorado R
Guadalupe R
San Antonio River
N
0
60
120 mi
Bureau
of
Economic
Geology
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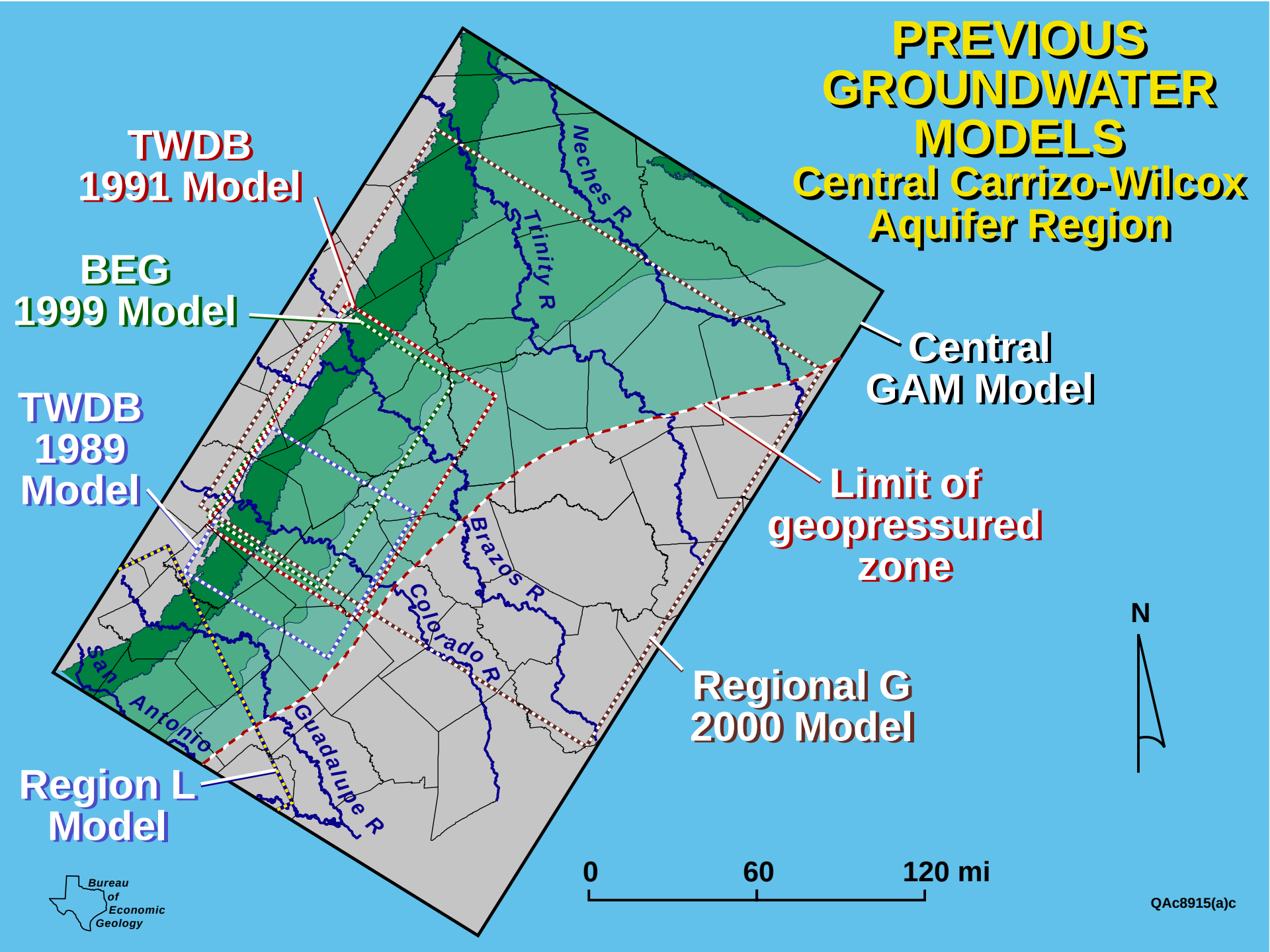
PREVIOUS GROUNDWATER MODELS
Central Carrizo-Wilcox Aquifer Region
TWDB 1991 Model
BEG 1999 Model
TWDB 1989 Model
Region L Model
Central GAM Model
Limit of geopressured zone
Regional G 2000 Model
Neches R
Trinity R
Brazos R
Colorado R
Guadalupe R
San Antonio
N
0
60
120 mi
Bureau of Economic Geology
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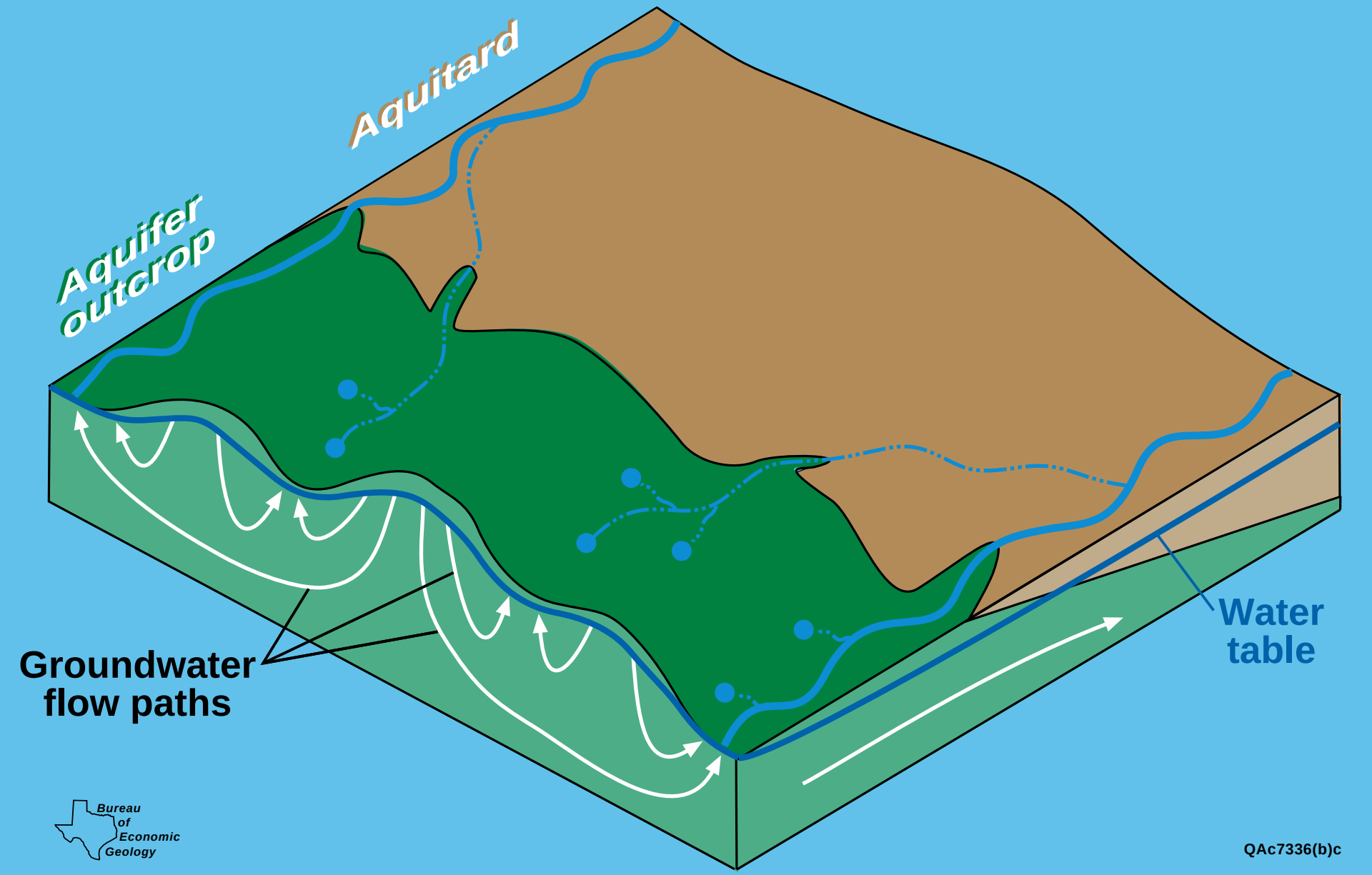
# CONCEPTUAL HYDROLOGICAL MODEL
## Central Carrizo-Wilcox Aquifer

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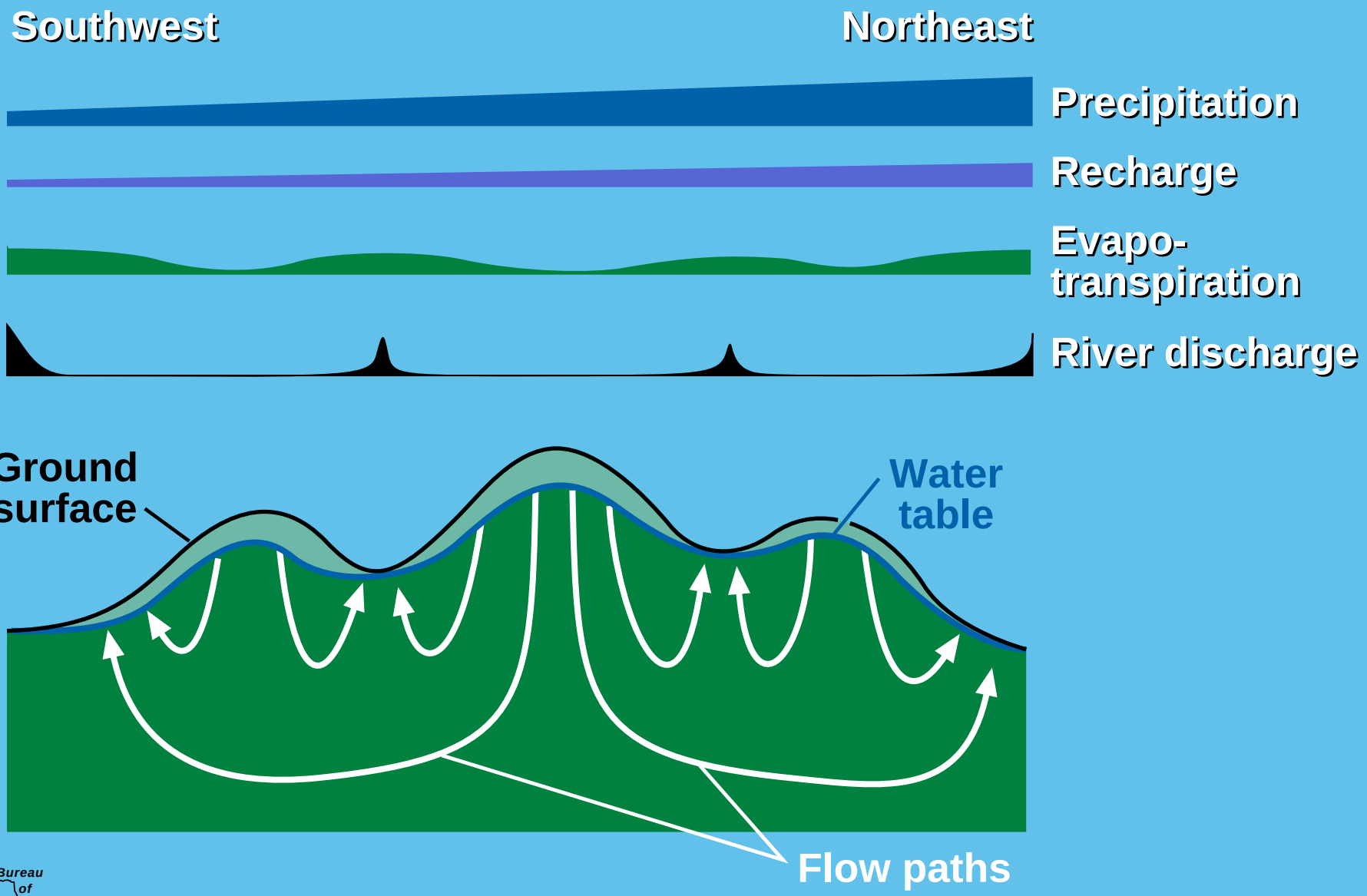
# APPROACH FOR MODELING RECHARGE

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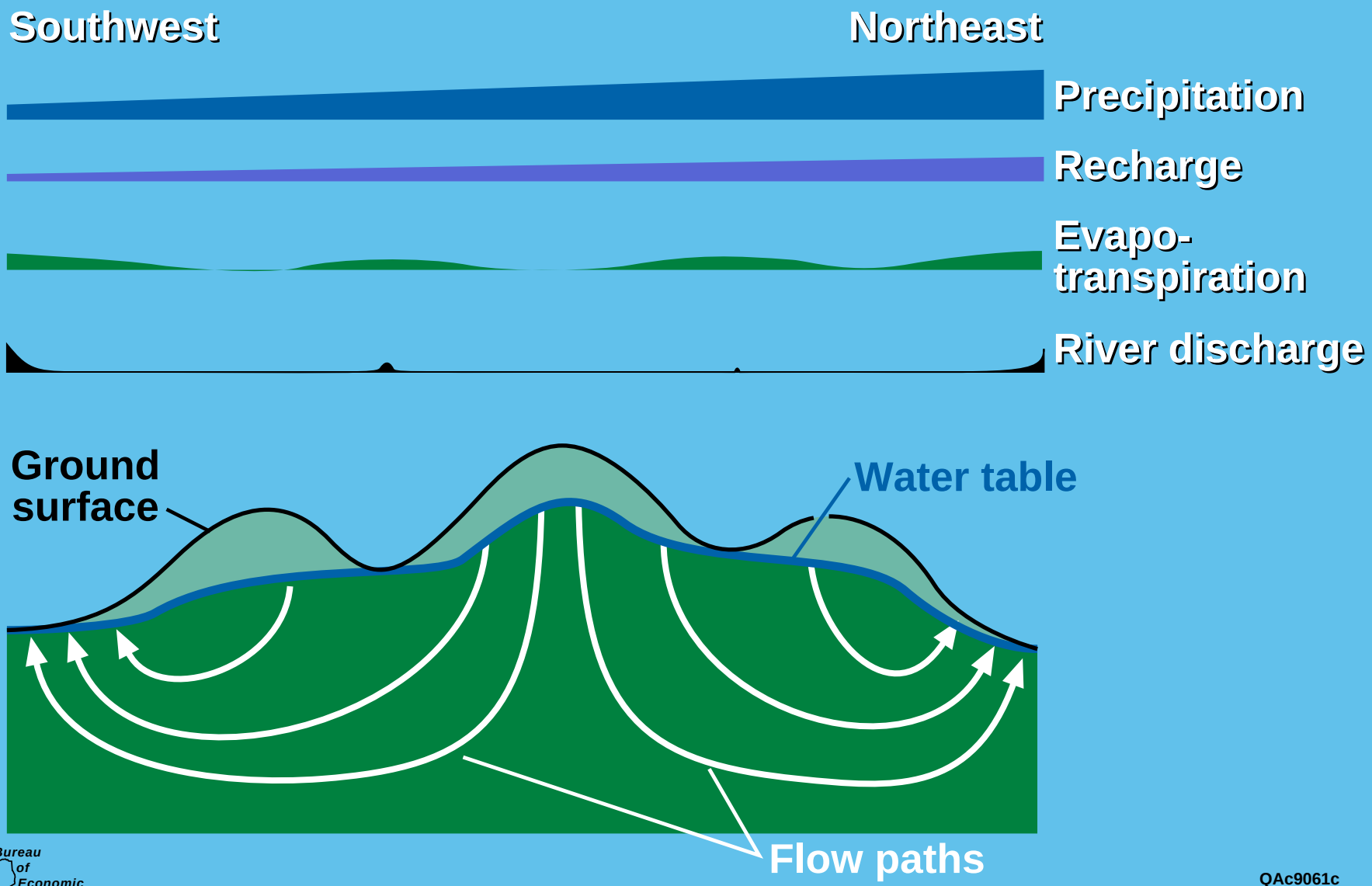
# APPROACH FOR MODELING RECHARGE
## Captured Recharge Model

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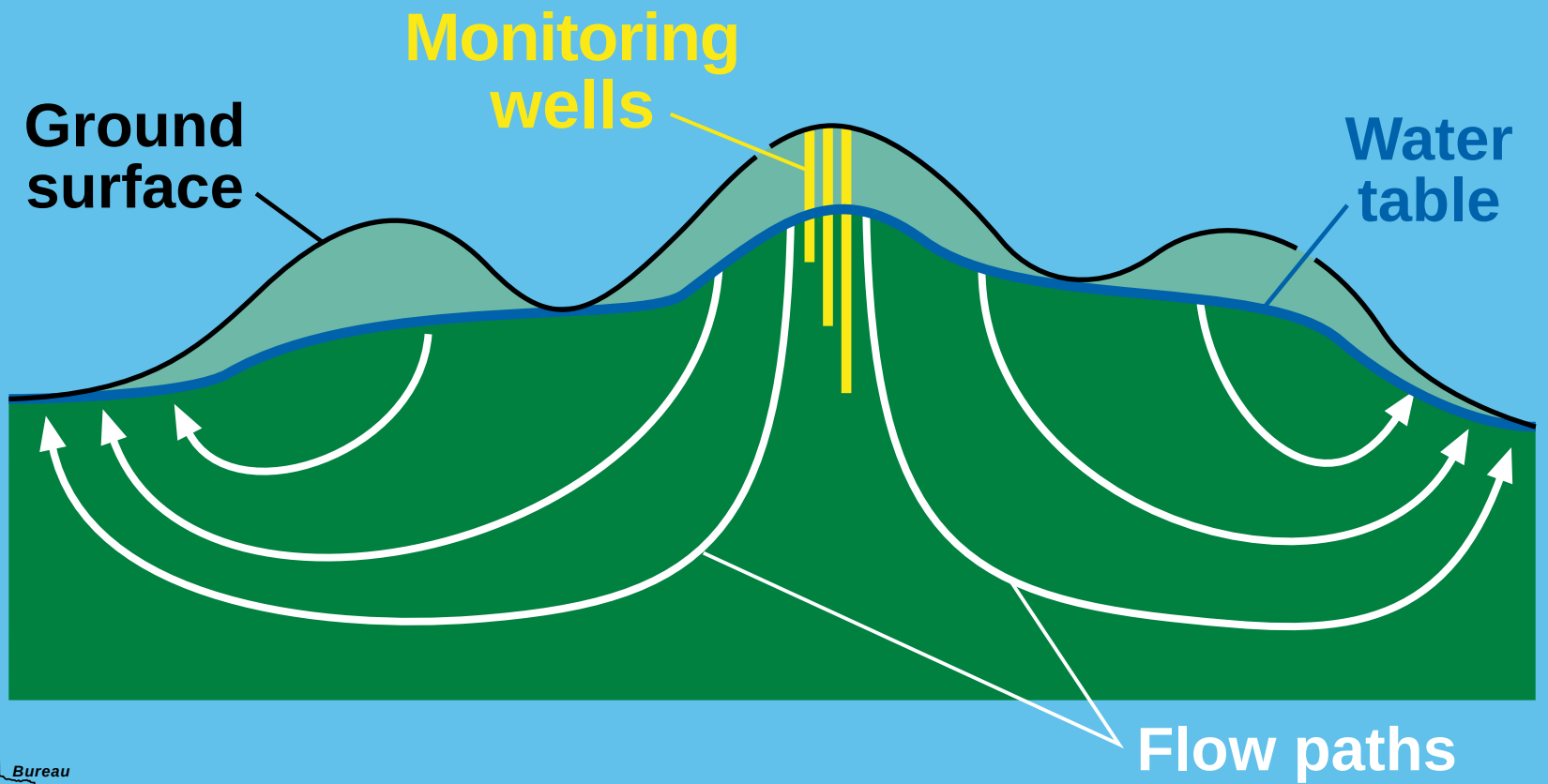
# RECHARGE MEASUREMENTS

## Data on recharge rates using environmental tracers

## Chlorofluorocarbons (CFCs)
## Tritium/Helium ($^3$H/He)

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# MODELING TEAM AND PROJECT SCHEDULE

# MODELING TEAM

**Bureau of Economic Geology**

- Project leader
- Model development
- Predictive simulations
- Report preparation

**R. W. Harden & Associates, Inc.**

- Model development
- Predictive simulations
- Contributions to report

**HDR Engineering, Inc.**

- Interaction of surface water and groundwater for model calibration
- Consultation on conceptual model
- Contributions to report

Bureau of Economic Geology

# PROJECT SCHEDULE

| | | | |
|---|---|---|---|
| Model construction | Jan 2001 | through | July 2001 |
| Steady-state calibration | Aug 2001 | through | Oct 2001 |
| Transient calibration & verification | Nov 2001 | through | Mar 2002 |
| Predictive simulations | Mar 2002 | through | April 2002 |
| Report preparation | May 2002 | through | Sept 2002 |
| Draft report due | Sept 2002 | | |
| Final report due | Jan 2003 | | |

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# PROJECT SCHEDULE

| | | | |
|---|---|---|---|
| **MODEL constuction** | **Jan 2001** | **through** | **July 2001** |
| First SAF meeting | April 2001 | | |
| Second SAF meeting | July 2001 | | |
| – Conceptual model | | | |
| – Model update | | | |
| **Steady-state calibration** | **Aug 2001** | **through** | **Oct 2001** |
| Third SAF meeting | Oct 2001 | | |
| **Transient calibration & verification** | **Nov 2001** | **through** | **Mar 2002** |
| Fourth SAF meeting | Jan 2002 | | |
| **Predictive simulations** | **Mar 2002** | **through** | **April 2002** |
| Fifth SAF meeting | April 2002 | | |
| **Report preparation** | **May 2002** | **through** | **Sept 2002** |
| Sixth SAF meeting | July 2002 | | |
| **Draft report due** | **Sept 2002** | | |
| Seventh SAF meeting | Oct 2002 | | |
| – Comments on draft report | | | |
| **Final report due** | **Jan 2003** | | |

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

**Forum Meeting No. 1**
**Monday, April 16, 2001, at 1:30 p.m., Commons Bldg.**
**J.J. Jake Pickle Research Campus**
**The University of Texas at Austin**
**10100 Burnet Rd., Austin, TX**

**List of Attendees**

| Name | Affiliation |
|---|---|
| Angie Alaniz | Brazos Valley COG |
| Ted Angle | Texas Water Development Board |
| James Beach | LBG-Guyton Associates |
| J.D. Beffort | Texas Water Development Board |
| James Bene | R. W. Harden and Associates, Inc |
| Russell Bostic | Farmer/ Rancher |
| Mark Bryson | Brazos GRWPG/ Alcoa |
| John Burke | Aqua Water |
| Richard L. Burns | Alcoa |
| Susan Butler | San Antonio Water System |
| Andrew Chastain-Howley | Water Prospecting, LLC- Consultant |
| Sigrid Clift | Bureau of Economic Geology |
| Rick Conner | City of Bryan |
| Bob Doonan | Burleson Co. |
| Dr. Alan Dutton | Bureau of Economic Geology |
| Larry French | URS Corporation |
| Michele G. Gangnes | Neighbors for Neighbors |
| Gerry Grisak | Duke Engineering |
| Dr. Tom Gustavson | Bastrop County |
| Keith Hansberger | Lost Pines Groundwater Conservation District |
| Bob Harden | R. W. Harden and Associates, Inc |
| Thomas D. Hill | Guadalupe-Blanco River Authority |
| Jobaid Kabir | LCRA |
| Sanjeev Kalaswad | Texas Water Development Board |
| Van Kelly | Duke Engineering |
| Bob Kier | Robert S. Kier Consulting |
| James Kowis | ALCOA |
| Cindy Leoffler | TPWD |
| R. Brent Locke | Bistone M.W.S.D. Mexia |
| Dr. Robert Mace | Texas Water Development Board |
| David Meesey | Texas Water Development Board |
| Ann Mesrobian | Lost Pines GCD |
| Barry Miller | Gonzales Co. UWCD |
| Kevin Morrison | San Antonio Water System |

| | |
|---|---|
| Steve Musick | Texas Natural Resources Conservation Commission |
| Ronald Naumann | Guadalupe Co. GCD/Spring Hill W.S.C. |
| Dave O'Rourke | HDR Engineering |
| Denis Qualls | Brazos River Authority |
| Jay Raney | Bureau of Economic Geology |
| George Rice | NFN |
| Cindy Ridgeway | Texas Water Development Board |
| Gloria Rivera | SCTRWPG and Schertz-Seguin Local Govt. Corp |
| Rainer Senger | Duke Engineering |
| Dr. Jack Sharp | UT |
| Sheril Smith | Bastrop County Resident – Water Resource Chair Sierra Club |
| Grant Snyder | URS Corporation |
| Connie Standridge | Region C, Winkler Water Supply |
| Don Strickland | City of Somerville |
| Todd Votteler | Guadalupe-Blanco River Authority |
| John Waugh | San Antonio Water System |
| Ted Way | Texas Water Development Board |
| Sherry D. Webb | Vineyard owner, Loe County |
| Jamie Wilson | R. W. Hardey & Assoc. |
| Billie Woods | Neighbors for Neighbors |

# GROUNDWATER AVAILABILITY MODELING OF THE CENTRAL PART OF THE CARRIZO-WILCOX AQUIFER IN TEXAS

## Stakeholder Advisory Forum

**Presenters:** **Alan R. Dutton, UT Bureau of Economic Geology**
**Robert Mace, Texas Water Development Board**

**Monday, April 16, 2001**
**J.J. Pickle Research Campus**

### Questions and Answers

Note: Questions and Answers have been paraphrased for clarity.

**Questioner 1:**
What's the tie-in between the model and the pumping projections of the regional planning groups? It seems to me that the model should stand alone. Does the use of specific pumping rates determine how the model is built and run or does the model stand alone?

**Alan Dutton:**
The GAM program can be seen as Step 2 of the statewide water planning process that began in 1997, where Step 1 included formation of the regional planning groups and their development of water-demand forecasts for the next 50 years. Step 2 is the TWDB's GAM modeling program with its focus on groundwater. Stakeholders of the GAM models being developed include members of the regional water planning groups.

The groundwater models being developed as part of GAM are tools to be used for predicting future water levels and stream-aquifer exchanges given assumed rates of pumping from the aquifers. The TWDB has stipulated for the GAM process that contractors will use the RWPG projections but with the addition of a drought of record. Once the GAM model is completed, it will be posted on the TWDB web site and available to the RWPGs, groundwater conservation districts, and the public, who can load whatever future pumping rates they think are more accurate forecasts.

**Questioner 1:**
Is the model independent of those forecasts?

**Alan Dutton:**
Yes. The calibrated model will be our best effort in describing how the aquifer works with rates and locations of recharge and flowpaths of groundwater. The calibrated model will run through the year 2000. Any forecasted pumping rate should start with a consistent set of year-2000 pumping rates, but might differ through the next 50 yr. So the forecast pumping rates are independent of model calibration.

**Questioner 2:**
I am sort of concerned that there doesn't seem to be much interest or focus addressing water quality in these studies. I don't think it's only this study but all of the GAM studies. It seems to me that water quality needs to be addressed. Otherwise models might predict we have a lot of available groundwater but which actually has poor quality, perhaps requiring expensive treatment. Is water quality going to be addressed at some point in these models or is that something that happens later? How can we make sure that model users will not be mislead into thinking water is available when water quality has not been taken into account, that is, available water isn't necessarily usable water?

**Alan Dutton**:
Part of the scope of work involves mapping the total dissolved solids (TDS) distribution in the different aquifers. We will map TDS or salinity from the outcrop down through the freshwater section of the aquifers and quite a way into the deeper subsurface where the salinity exceeds 3,000 mg/L, which is traditionally been defined as the base of the freshwater aquifer.

It is not part of the scope of work to model future changes in water quality. We will plan to look at historical data to document any appreciable changes in water quality that have occurred in the past that might be associated with water withdrawal. Future model development could build on the results of this physical model to predict water quality changes.

**Questioner 3:**
Could we use Region L's definition of sustainability in this study for the development of this GAM model for the central Carrizo-Wilcox area?

**Alan Dutton:**
The scope and goal of this study is to develop a well-calibrated model of how this aquifer works. Then various forecasted pumping rates can be simulated and people can consider what they think of the consequences of such pumping rates. The GAM-model development requirements specify our using the RWPG forecasts. Since the Central Carrizo-Wilcox Aquifer GAM model area crosses multiple regional water planning areas, we will have to find a way of making different forecasts for different parts of the model. Once the model is developed, RWPGs and groundwater conservation districts and the public can use the model to look at any forecast pumping rate to determine, for example, what level of pumping is sustainable. This would involve specifying a set of pumping rates, looking to see what future changes are predicted in water levels and stream flow, determining if those changes are sustainable, then changing the set of pumping rates for another set of runs, repeatedly, looking at results to evaluate what level is sustainable.

**Questioner 3:**
But the model can be used to look at that?

**Alan Dutton:**
Yes. The model we're developing is intended to be used to look at questions just like that. What level is sustainable. First, one defines availability, for example in terms of sustainability, and then one uses the model to evaluate what level of pumping is sustainable. Other definitions of availability also can be simulated as a basis for looking at policy implications. But these additional simulations are not within the scope of this model development.

**Questioner 4:**
Will you be able to model droughts and rainy conditions?

**Alan Dutton:**
Part of the scope of work includes simulating a future drought comparable to the drought of record for the past 100 years. Also, we are to pay particular attention to droughts that occurred during the period being used for model calibration and verification.

**Questioner 5:**
How are the results of the recharge study to be used and when are they expected?

**Alan Dutton**:
We plan on two locations for making recharge measurements in the Simsboro outcrop. First we will sample existing nearby water wells to confirm what environmental tracers might be successfully used. Then if we find favorable results we will install the nested set of monitoring wells and collect samples. We are presently checking our equipment and reviewing our techniques. We have to get monitor wells installed soon. We are hopeful of getting analytic results back during Summer 2001 in time for them to be taken into account and help constrain the model. But we do need to go pretty fast on securing access to locations for installing the monitor wells.

**Questioner 6:**
It would be very helpful to get information to the Stakeholders in advance of the meeting so Stakeholders will be better prepared to review and comment on information we're presenting. Communication needs to be improved about what's going on with the model development and this would be one way. The SAF meetings also should address work that's coming up not just work you've already completed.

**Alan Dutton:**
It will continue to be part of our meeting agenda to talk about where we're headed and how we'll be addressing modeling issues. I'm open to suggestions as to ways to get more communication. You're welcome to send me e-mails, phone me, contact me at the Bureau if you see things that you have a problem with. You're also certainly welcome to contact Dr. Mace at the TWDB and share your concerns with them. We really want to find a way to foster communication. Your suggestion about posting presentation materials in advance will be considered. It would require us to stop work and prepare illustrations farther in advance of each meeting, but we could then update with new information at the meeting.

**Questioner 7:**
What will set the agenda for the upcoming meetings and how can we get more input into the model development?

**Alan Dutton:**
The agenda will be set according to logical topics. The last slide shown (frame no. 27/27 of the document "SAF1_CW-c.pdf" [http://www.twdb.state.tx.us/GAM/czwx_c/czwx_c.htm]) lists the project schedule. For example, the July meeting will focus on the conceptual model, model

development status, and a look ahead at model calibration. By the third meeting, in October, we should be into the steady-state calibration and that is the obvious subject for that meeting. So I believe these SAF meetings will be forward looking and I am hopeful that as we proceed that there is enough communication. If not, we'll try to find a way of doing things differently.

**Questioner 8:**
Do you have something for us to read or look at to better understand your scope of work?

**Alan Dutton:**
The project's scope of work ("CW-c_SOW.pdf") is posted on the TWDB Web site at http://www.twdb.state.tx.us/GAM/czwx_c/czwx_c.htm. You might also look at "GAM_RFP_attach.pdf" (http://www.twdb.state.tx.us/GAM/GAM_documents/documents.htm), which states basic requirements of the GAM models.

**Questioner 9:**
Do you have a way to post information a few weeks in advance for people to download, to look at it?

**Alan Dutton:**
We will E-mail or alert you to material to let you know there's material on the TWDB web site.

**Questioner 10**:
Is there a technical committee planned? There are a number of technical experts here. Was a technical committee already convened? That will give you input from experts? Are they part of this?

**Alan Dutton:**
All interested parties are invited to be in these SAF Forums–for example, the public, cities, industries, state agencies. We also have periodic TWDB reviews of our technical progress to sign-off on work-to-date. There's no plan for a subcommittee of this group to act as a technical advisory group.

**Questioner 11:**
I would like to request to see this contract in detail. Is there a process where we can see the water technology input you're getting from others, to know where you're starting from, in the time you're working on developing and testing the model?

**Robert Mace:**
The TWDB convened a technical advisory group from different fields of hydrogeology, modeling, groundwater conservation districts, and groundwater planning, to help plan out the overall GAM program. We meet a few times to discuss what these models had to have, what things should be standardized, what things should not be standardized, what things should be included to do these models, addressed on the scientific side. There is information on this technical group at the TWDB Web site at http://www.twdb.state.tx.us/GAM/SAFs.htm. The TWDB then took the results from the team and drafted the Request for Proposal. That Request for Proposal is posted on the TWDB Web site (http://www.twdb.state.tx.us/GAM/GAM_documents/documents.htm).

**Questioner 12:**
Do you have everything on the web page?

**Questioner 13:**
You might give folks the Internet address for that page for those of us who don't know it.

**Robert Mace:**
It's on the back of that TWDB handout. For those of you who don't have the TWDB handout, it's www.twdb.state.tx.us/GAM. The handout is available at http://www.twdb.state.tx.us/publications/newsletters/waterfortexas/wftwinter00/article4.htm.

**Questioner 14:**
Since HDR's model was used for the Region L water planning group, why did you not show that as one of the models here? Will you be using recharge information from that study as background in this study?

**Alan Dutton:**
The HDR Region L model referred to does overlap the southern end of the Central Carrizo-Wilcox Model area. The revised illustration is frame no. 19/27 of the document "SAF1_CW-c.pdf" http://www.twdb.state.tx.us/GAM/czwx_c/czwx_c.htm).

In terms of looking at recharge rates, we want to build this study on all available and relevant information. Recharge is something that is not well known everywhere, so we need to look at the HDR Region L model and see if we can find a way on how to take those values into account in our study.

**Questioner 15:**
How much does this project cost?

**Robert Mace:**
Approximately $550,000.

**Questioner 16:**
Does that include the recharge study?

**Alan Dutton:**
Yes.

**Questioner 17:**
You might check how the formation contacts are drawn on the block diagram; it looks like they Vee-upstream?

**Alan Dutton:**
The revised block diagram is frame no. 20/27 of "SAF1_CW-c.pdf" (http://www.twdb.state.tx.us/GAM/czwx_c/czwx_c.htm). The version shown at the SAF meeting was drawn in an attempt to render a three-dimensional block diagram with ground-

surface relief. The formation contact in the valley did appear opposite to how it would appear on a geologic map. The revised block diagram attempts again to show the three-dimensional surface relief but with correct depiction of formation contacts in the valleys.

**END**