USGS response to Board comments

Texas Water Development Board
(TWDB Contract No. 2000-483-350)
Predictive Model Review for Northern Gulf Coast GAM
"Evaluation of Ground-Water Flow and Land-Surface Subsidence Caused by Hypothetical Withdrawals in the Northern Part of the Gulf Coast Aquifer System, Texas"

General Comments:

The Groundwater Availability Model (GAM) for the northern part of the Gulf Coast aquifer is stable, converges relatively quickly, and reasonably reproduces the results cited in the draft report. However, the draft report does not adequately document how the predictive simulation was performed. For example, there is very little or no discussion on how recharge was simulated in the predictive model. Several dry cells covering an area of about eighty square miles appear near the western limits of the Chicot aquifer in southern Montgomery County. These dry cells appear in the first stress period (1840) and persist throughout the simulation to 2050. This should be discussed in the report and any implication from these dry cells should be described.

USGS: The predictive report (USGS Scientific Investigations Report [SIR] 2005–5024) describes an application of the GAM that was documented in USGS SIR 2004–5102. The reader is referred to that report for the details of how the GAM was constructed and how the simulations were done. Recharge, and all other inputs to the predictive simulations, were handled as described in SIR 2004–5102. The dry-cell problem, which primarily involved some unrealistically small general head boundary (GHB) conductance values, has been solved. The specific changes to the original GAM documented in SIR 2004–5102 to fix the dry-cell problem, and all other changes to the original GAM as a result of issues discovered during predictive simulations, are documented in appendix 1 of the predictive report.

Due to recalibration of the previously released model (Kasmarek and Robinson, 2004), we observed considerable changes in the water budget values between the previous and this model. We also noted some changes to the simulated water-levels, primarily in Wharton and Matagorda counties. Therefore, it would be pertinent to adequately discuss and document these changes in the section on modifications to the previous model (Appendix 1). Any changes to the input parameters (hydraulic conductivity, storativity) in the earlier model should also be discussed in detail and the information should be included to document the changes.

USGS: All changes to the original GAM documented as a result of issues discovered during predictive simulations are documented in appendix 1 of the predictive report. Appendix 1 now includes a table of root mean square (RMS) errors between simulated and measured 2000 water levels (potentiometric surfaces) before and after changes and a table of water-budget components before and after changes. The "considerable" water-budget changes noted (increase in water supplied by recharge and compensating decrease in water supplied by storage) primarily are the result of recalibration after moving to the Chicot aquifer some late 1990s withdrawals inadvertently assigned to the Evangeline aquifer in the Wharton-Jackson County area. It makes sense that, when withdrawals are shifted to the Chicot aquifer immediately adjacent to the GHB source, the GHB source supplies more of the water to sustain withdrawals (thus less required from storage) than when the withdrawals were in the Evangeline aquifer beneath the Chicot.

There appears to be a disconnect in the assignment of pumpage to the Jasper aquifer between the historical period and the predictive runs. For example, in the historical period there is very little or no pumping in southern part of Montgomery County while considerable pumping was assigned in the area during the predictive runs. Assignment of this additional pumping resulted in significant drawdown in this area in the predictive runs. This discrepancy in pumping assignment during the two periods should be further discussed.

USGS: This is discussed in appendix 1 of the predictive report. We acknowledge in appendix 1 that it is likely some late 1990s withdrawals from the Jasper aquifer in southern Montgomery County are missing. These withdrawals (for example, for The Woodlands) were not in the TWDB spreadsheets that were provided to the USGS. Faced with numerous changes to make and very limited time to make them, we opted not to research the issue of these withdrawals and not to change the historical Jasper aquifer withdrawals dataset. Although not stated in the report, we rationalized that any transient effects caused by missing late 1990s withdrawals would have dissipated by 2010, the first year of projected results. We state in appendix 1 that we did not change the historical Jasper aquifer withdrawals dataset.

Specific Comments

1. The report references simulated water-levels and land-surface subsidence figures from Kasmarek and Robinson (2004) for comparison of year 2000 results from calibrated model. We suggest including these figures to make this report easier to use. This can be done by expanding the section in Appendix 1 (Kasmarek and others, 2005). We also suggest including the simulated water levels and RMS plots for 1977 and 2000 calibration years in this report. We also suggest inclusion of input parameters that were changed to the previous model.

USGS: Figures of 2000 potentiometric surfaces, water-budget diagrams, and subsidence map now are included in the predictive report for ease of use and also because 2000 results have changed slightly from those of Kasmarek and Robinson (2004), the consequence of changes to the GAM described in appendix 1 of the predictive report. We have added to appendix 1 a table of RMS errors between simulated and measured 2000 potentiometric surfaces before and after model changes. No revised 1977 results or changed input parameters are included in the predictive report. We plan to document and release all changes to the GAM input parameters and subsequent results, which will include 1977 results and documentation of the changed input parameters, in a revised version of SIR 2004–5102. However, as a matter of policy, we cannot mention planned reports in any of our publications—thus we can’t state in the predictive report that an updated version of the original GAM report will be released.

2. The report does not discuss how you assigned recharge in the predictive simulation. We suggest including a brief section on how recharge was simulated in the predictive model. If the General Head Boundary was used to simulate recharge, please describe in some detail how it was varied from the transient model during the predictive simulation.

USGS: As stated in response to the first general comment, recharge, and all other inputs to the predictive simulations, were handled as described in SIR 2004–5102. Nothing was done differently regarding recharge in the predictive model.

3. We suggest including a water budget for calibration year 1977 in addition to a water budget for calibration year 2000 given the large variation between the current water budget and the water budget in the previously released model.

USGS: See response to specific comment 1. We believe the better place for the revised 1977 water budget is in the planned revised version of SIR 2004–5102.

4. Considerable drawdown has been observed in the Jasper aquifer in southern Montgomery County during the predictive simulation. However, there was little or no pumping assigned or drawdown observed in the Jasper aquifer during calibration with the historical data sets. We suggest some description on why pumping was assigned in the Jasper aquifer in that area when there were no historical pumping.

USGS: See response to general comment 3.

5. We suggest including a description on how pumping was developed for 1998 to 2000. We observe that the pumping is relatively similar for these time periods. For example, for Montgomery County, the pumpage stays identical at 32,000 ac-ft/yr from 1998 to 2000. Was pumping assigned based on historical or predictive data for the calibration year 2000?

USGS: With the exception of withdrawals for Harris, Galveston, and Fort Bend Counties, 1998–2000 withdrawals in the GAM were held constant at 1997 levels. Annual withdrawals for Harris, Galveston, and Fort Bend Counties for 1998–2000, which account for 45 percent of total GAM withdrawals for each of those years, were varied on the basis of data obtained from the Harris-Galveston Coastal Subsidence District. During much of the development of the original GAM, we mistakenly believed 1997 was the end of the historical period and 1998 was the beginning of the predictive period. By the time we realized the historical period was through 2000, not 1997, it was too late to do all that would have been required to distribute 1998–2000 withdrawals (except for the three counties noted) to cells and still meet the (then) deadline for the original GAM. Thus the decision was made to use 1997 withdrawal data for 1998–2000 for all counties except the three noted. This should have been documented in SIR 2004–5102 and will be in the planned revision of that report.

6. Numerous dry cells appear in the Chicot aquifer in southern Montgomery County and persist throughout the simulation. If this is a limitation of the model due to model architecture, list under section on limitation and its implications for the local area.

USGS: Dry-cell problem fixed. See response to general comment 1.

7. Please show location names (that is, Evandale, Beaumont) on the map that were cited in the text.

USGS: Done.

8. Abstract (paragraph 1) and Summary (paragraph 2): Please state that the basis of data was regional water planning group estimates not TWDB (that is, "…based on estimated groundwater demands provided by regional water planning groups (RWPG) and compiled and analyzed by TWDB").

USGS: Done.

9. Page 17 states, "Simulated storage increases about 10 percent during 2000-10 from 333 to 369 ft^3/s…". The sum of ∆SS and ∆SC from figure 19 is 383 not 333. Please review and correct so figure and text agrees. Also please update references to year 2000 storage on page 54, Summary section, if needed.

USGS: Water-budget components revised on the basis of GAM changes.

10. Page 32 states, "…simulated net recharge increases from 967 ft^3/s in 1965 to 1,086 ft^3/s in 2010, 1,197 ft^3/s in 2020, and 1,321 ft^3/s in 2030". The sum of net recharge in figure 38 is 1,261 ft^3/s not 1,321 ft^3/s. Please review and correct so figure and text agree. Also please update references to year 2030 net recharge on page 55, Summary section, if needed.

USGS: Water-budget components revised on the basis of GAM changes.

11. Appendix 2 (page 60), please clarify if withdrawals were divided evenly both vertically and spatially among all the point sources in an assemblage for municipal, manufacturing, mining, and power generation categories.

USGS: Point sources were assigned to hydrogeologic units (vertically distributed) on the basis of percentage of screened interval open to a unit, or well depth, or both. Withdrawals within each assemblage of wells were divided (laterally distributed) evenly among the wells in that assemblage. Text has been clarified and an example given to illustrate vertical and lateral distribution of withdrawals.

12. Appendix 2 (page 61), please elaborate on reference to additional information to indicate other hydrogeologic unit(s) were available for vertical distribution of nonpoint source withdrawals. If nonpoint source withdrawals were determined to come from a unit other than or in addition to the outcrop, what methodology was used for distributing pumpage vertically? Total pumpage for a county/basin use category, for example irrigation, was evenly split between the Chicot and Evangeline? Or as was discussed on page 58, was all pumpage assigned to the lower layer instead of the outcrop layer? Were all inventoried wells in that county/basin analyzed and the percent screened in each layer used to weight vertical distribution?

USGS: Text clarified to state that nonpoint-source withdrawals were simulated as artificial point sources, one per model cell per category (livestock [per rangeland category], irrigation [per crop category], and county-other), on the basis of information in the State well database. Withdrawals were assigned to hydrogeologic units (vertically distributed) by joining attributes from the database to the artificial points using GIS techniques. If information in the database was not available to assign hydrogeologic units, nonpoint-source withdrawals were assigned to the respective outcropping hydrogeologic unit.

References:

Kasmarek, M. C. and Robinson, J. L., 2004, Hydrogeology and simulation of groundwater flow and land-surface subsidence in the northern part of the Gulf Coast aquifer system, U.S. Geological Survey Scientific Investigations Report 2004-5102, 103p.

Kasmarek, M. C., Reece, B. D., and Houston, N. A., 2005, Evaluation of groundwater flow and land subsidence caused by hypothetical withdrawals in the northern part of the Gulf Coast aquifer system, U.S. Geological Survey Scientific Investigations Report 2005-5, 62p.