# GAM Run 06-02

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Texas Water Development Board
Groundwater Availability Modeling Section
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## REQUESTOR:

Mr. John Jones on behalf of the Culberson County Groundwater Conservation District (GCD).

## DESCRIPTION OF REQUEST:

Mr. Jones requested a Groundwater Availability Model (GAM) run using the GAM for the Igneous and parts of the West Texas Bolsons aquifers. Mr. Jones requested that we determine water budgets in both the Igneous and parts of West Texas Bolsons aquifer.

## METHODS:

To determine the water budgets in the Culberson County GCD area, we used the GAM for the Igneous and parts of the West Texas Bolsons aquifers and ran a standard transient calibration-verification model run, which includes the years 1980 to 1999. The portions of the West Texas Bolsons aquifer included in the GAM are Wildhorse Flat, Michigan Flat, Ryan Flat, and Lobo Flat and are locally referred to as being part of the Salt Basin Bolson aquifer. In this report, to avoid confusion with other parts of the West Texas Bolsons aquifer, we refer to the West Texas Bolsons aquifer modeled in this GAM as the Salt Basin Bolson aquifer.

The pumpage that we used in the model run was that which was developed for the transient calibration/verification run, which represents the best estimate of historic pumpage.

## PARAMETERS AND ASSUMPTIONS:

- See Beach and others (2004) for assumptions and limitations of the GAM for the Igneous and West Texas Bolsons aquifers.

- The mean absolute error (a measure of the difference between simulated and actual water levels during model calibration) in the entire GAM for the period of 1990 to 2000 is 64 feet, or four percent of the range of measured water levels (Beach and others, 2004).

- The model includes three layers, representing the Salt Basin Bolson aquifer (Layer 1), the Igneous aquifer (Layer 2), and the underlying Cretaceous and Permian units (Layer 3).

- We simulated a 51-year time period for the model run, representing 1950 to 2000.

- We used all of the input parameters for the model, including pumpage and recharge, determined through the calibration of the transient model covering the years 1950 to 2000.

- The GAM uses drains to simulate discharge to streams. Drains are included in both the Salt Basin Bolson aquifer and Igneous aquifer layers of the model.

- The GAM uses general-head boundaries (GHB) to simulate cross-formational flow into and out of layer 3, which represents the Cretaceous and Permian units underlying the Igneous aquifer.

- The GAM uses the MODFLOW evapotranspiration package (ET) to simulate discharge of water to evaporation and transpiration.

- The GAM includes pumpage representing rural domestic, municipal, industrial, irrigation, and livestock uses.

## RESULTS:

Water budgets for the district area for the Salt Basin Bolson and Igneous aquifers are presented in Tables 1 and 2, respectively. This table shows the average annual flow, in acre-feet, of water into (Inflow) and out of (Outflow) each aquifer in the Culberson County GCD area for the years 1980 to 1999. The components of the budgets shown in Table 1 include:

- Storage—This component is water stored in the aquifer. The storage component that is included in "Inflow" is water that is removed from storage in the aquifer (that is, water levels decline). The storage component that is included in "Outflow" is water that is added back into storage in the aquifer (that is, water levels increase). This component of the budget is often seen as water both going into and out of the aquifer because this is a county-wide budget, and water levels will decline in some areas (water is being removed from storage) and will rise in others (water is being added to storage).

- Wells—This is water produced from wells in each aquifer. In the GAM for the Igneous and parts of the West Texas Bolsons aquifers, this component is always shown as "Outflow" from an aquifer, because all wells included in the GAM produce (rather than inject) water. Wells are modeled in the GAM for the Igneous and parts of the West Texas Bolsons aquifers using the MODFLOW Well package.

- Streams and springs—This is water that drains from an aquifer if water levels are above the elevation of the spring or seep. This component is always shown as "Outflow", or discharge, from an aquifer. The loss of groundwater to streams and

springs is modeled in the GAM for the Igneous and parts of the West Texas Bolsons aquifers using the MODFLOW Drain package.

- Recharge—This component normally simulates areally distributed recharge due to precipitation falling on the outcrop areas of aquifers. However, in the GAM for the Igneous and parts of the West Texas Bolsons aquifers, the recharge package also includes recharge from alluvial fans and stream beds which occurs along the mountain fronts in discrete locations. Recharge is always shown as "Inflow" into an aquifer and is modeled in the GAM for the Igneous and parts of the West Texas Bolsons aquifer using the MODFLOW Recharge package. The GAM assumes that precipitation recharge to the Salt Basin Bolson aquifer is zero.

- Evapotranspiration—This is water that flows out of an aquifer due to direct evaporation and plant transpiration. This component of the budget will always be shown as "Outflow". Evapotranspiration is modeled in the GAM for the Igneous and parts of the West Texas Bolsons aquifers using the MODFLOW Evapotranspiration (EVT) package.

- Vertical flow between aquifers—This describes the vertical flow, or leakage, between two aquifers. This flow is controlled by the water levels in each aquifer and aquifer properties of each aquifer that define the amount of leakage that can occur. "Inflow" to an aquifer from an overlying or underlying aquifer will always equal the "Outflow" from the other aquifer.

- Lateral flow between counties—This component describes lateral flow within the aquifer between Culberson and adjacent counties.

It is important to note that sub-regional water budgets for individual areas, such as the Culberson County GCD area, are not exact. This is due to the one-half mile spacing of the model grid and because we assumed each model cell is assigned to a single county. The water budgets for an individual cell containing a county boundary are assigned to either one county or the other and therefore very minor variations in the county-wide budgets may be observed.

Overall average annual water budgets for precipitation recharge, average surface water inflow, average surface water outflow, average inflow into the district, average outflow from the district, average net interaquifer flow (upper), and average interaquifer flow (lower) are presented in Table 3. This is a summary of the budgets provided in Tables 1 and 2. Please note that in Table 3, negative values indicate a net outflow from that aquifer. Therefore, there is a net outflow from the Igneous aquifer to the aquifer above it of 5,267 acre-feet per year, and a corresponding net inflow of 5,267 acre-feet per year in the Salt Basin Bolson aquifer from the Igneous aquifer below it.

**Table 1. Summary of water budgets for the Culberson County GCD area in the Salt Basin Bolson aquifer for 1980 to 1999. Flows reported in acre-feet per year.**

| | Inflow | Outflow |
|---|---|---|
| Storage | 5,040 | 3,090 |
| Wells | 0 | 15,749 |
| Springs and Streams* | 0 | 494 |
| Recharge** | 2,109 | 0 |
| Evapotranspiration | 0 | 0 |
| Vertical flow between Igneous Aquifer | 12,979 | 7,712 |
| Lateral flow into District | 6,900 | 0 |

*Springs and streams were modeled using the MODFLOW drain package
**Recharge for the Salt Basin Bolson aquifer represents alluvial fan and stream bed recharge only.

**Table 2. Summary of water budgets for the Culberson County GCD area in the Igneous aquifer for 1980 to 1999. Flows reported in acre-feet per year.**

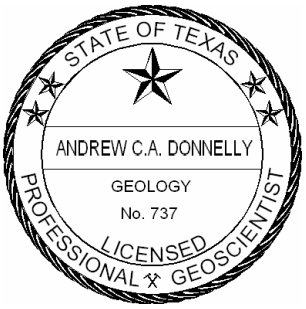
| | Inflow | Outflow |
|---|---|---|
| Storage | 489 | 14 |
| Wells | 0 | 0 |
| Springs and Streams | 0 | 0 |
| Recharge | 903 | 0 |
| Evapotranspiration | 0 | 449 |
| Vertical flow between Salt Basin Bolson Aquifer | 7,712 | 12,979 |
| Vertical flow between Cretaceous and Permian Aquifers | 12,978 | 9,499 |
| Lateral flow into District | 857 | 0 |

**Table 3. Summary of overall water budgets for the Culberson County GCD area for 1980 to 1999. Flows reported in acre-feet per year.**

| | Precipitation Recharge | Average Surface Water Inflow | Average Surface Water Outflow | Average Inflow into District | Average Outflow from District | Average Net Interaquifer Flow (upper) | Average net Interaquifer Flow (lower) |
|---|---|---|---|---|---|---|---|
| Salt Basin Bolson Aquifer | 0 | 2,109 | 0 | 6,900 | 0 | -- | 5,267 |
| Igneous Aquifer | 903 | 0 | 0 | 857 | 0 | -5,267 | 3,479 |

## REFERENCES:

Beach, J. A., Ashworth, J. B., Finch, Jr., S. T., Chastain-Howley, A., Calhoun, K., Urbanczyk, K. M., Sharp, J. M., and Olson, J., 2004, Groundwater availability model for the Igneous and parts of the West Texas Bolsons (Wild Horse Flat, Michigan Flat, Ryan Flat and Lobo Flat) aquifers: contract report to the Texas Water Development Board, 208 p.

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