

GAM Run 09-05

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Groundwater Availability Modeling Section
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EXECUTIVE SUMMARY:

Texas State Water Code, Section 36.1071, Subsection (h), states that, in developing its groundwater management plan, a groundwater conservation district shall use groundwater availability modeling information provided by the Executive Administrator of the Texas Water Development Board in conjunction with any available site-specific information provided by the district for review and comment to the Executive Administrator. Information derived from groundwater availability models that shall be included in the groundwater management plan includes:

- (1) the annual amount of recharge from precipitation to the groundwater resources within the district, if any;
- (2) for each aquifer within the district, the annual volume of water that discharges from the aquifer to springs and any surface water bodies, including lakes, streams, and rivers; and
- (3) the annual volume of flow into and out of the district within each aquifer and between aquifers in the district.

The purpose of this model run is to provide additional information to Sandy Land Underground Water Conservation District for its groundwater management plan. This modeling information, based on the newly approved groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer, is to be used in place of the results presented in Groundwater Availability Model Run 08-47 (Oliver, 2008) in development of the district's groundwater management plan. The groundwater management plan for Sandy Land Underground Water Conservation District is due for approval by the Executive Administrator of the Texas Water Development Board before February 25, 2009.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer. Table 1 summarizes the groundwater availability model data required by statute for Sandy Land Underground Water Conservation District's groundwater management plan. Figure 1 shows the area of the model from which the values in Table 1 were extracted.

METHODS:

We ran the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer and (1) extracted water budgets for each year of the 1980 through 2000 period and (2) averaged the annual water budget values for recharge, surface water outflow, inflow to the district, outflow from the district, net inter-aquifer flow (upper), and net inter-aquifer flow (lower) for the portions of the aquifers located within the district.

PARAMETERS AND ASSUMPTIONS:

- We used version 2.01 of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer. This model is an expansion on and update to the previously developed groundwater availability model for the southern portion of the Ogallala Aquifer described in Blandford and others (2003). See Blandford and others (2008) and Blandford and others (2003) for assumptions and limitations of the groundwater availability model.
- The model includes four layers representing the southern portion of the Ogallala and Edwards-Trinity (High Plains) aquifers. The units comprising the Edwards-Trinity (High Plains) Aquifer (primarily Edwards, Comanche Peak, and Antlers Sand formations) are separated from the overlying Ogallala Aquifer by a layer of Cretaceous shale, where present.
- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the Ogallala Aquifer in 2000 is 33 feet. The mean absolute error for the Edwards-Trinity (High Plains) Aquifer in 1997 is 25 feet (Blandford and others, 2008). This represents 1.8 and 3.0 percent of the hydraulic head drop across the model area for each aquifer, respectively.
- Irrigation return flow was accounted for in the groundwater availability model by a direct reduction in agricultural pumping as described in Blandford and others (2003).
- We used Groundwater Vistas version 5.30 Build 10 (Environmental Simulations, Inc., 2007) as the interface to process model output.

RESULTS:

A groundwater budget summarizes the water entering and leaving the aquifer according to the groundwater availability model. The model is based on the U.S. Geological Survey's MODFLOW 2000 groundwater modeling code (Harbaugh and others, 2000). Selected components were extracted from the groundwater budget for the aquifers located within the district and averaged over the duration of the calibrated portion of the

model run (1980 to 2000) in the district, as shown in Table 1. The components of the modified budgets shown in Table 1 include:

- Precipitation recharge—This is the areally distributed recharge sourced from precipitation falling on the outcrop areas of the aquifers (where the aquifer is exposed at land surface) within the district.
- Surface water outflow—This is the total water exiting the aquifer (outflow) to surface water features such as streams, reservoirs, and drains (springs).
- Flow into and out of district—This component describes lateral flow within the aquifer between the district and adjacent counties.
- Flow between aquifers—This describes the vertical flow, or leakage, between aquifers or confining units. This flow is controlled by the relative water levels in each aquifer or confining unit and aquifer properties of each aquifer or confining unit that define the amount of leakage that occurs.

The information needed for the district's management plan is summarized in Table 1. It is important to note that sub-regional water budgets are not exact. This is due to the size of the model cells and the approach used to extract data from the model. To avoid double accounting, a model cell that straddles a political boundary, such as a district or county boundary, is assigned to one side of the boundary based on the location of the model cell's centroid. For example, if a cell contains two counties, the cell is assigned to the county where the centroid of the cell is located.

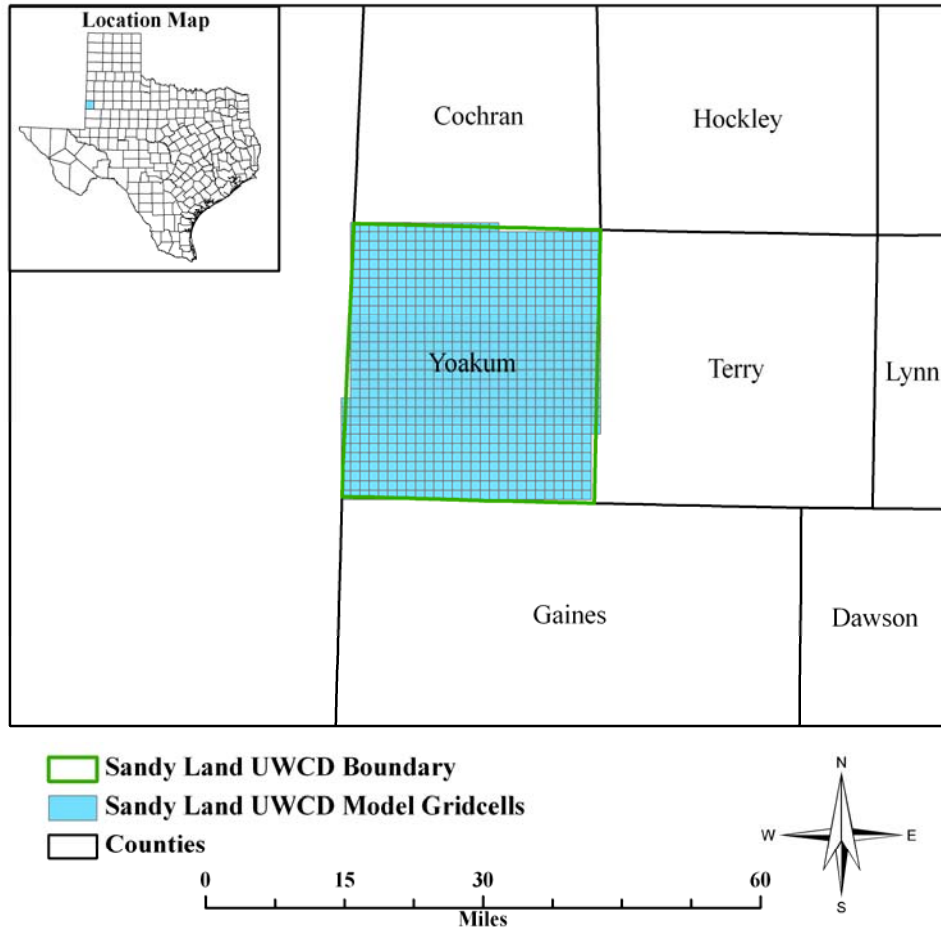
Table 1: Summarized information needed for the groundwater management plan for Sandy Land Underground Water Conservation District. All values are reported in acre-feet per year. All numbers are rounded to the nearest 1 acre-foot.

| Management Plan requirement | Aquifer or confining unit | Results |
|--|--|---------------------|
| Estimated annual amount of recharge from precipitation to the district | Ogallala Aquifer | 40,506 ^a |
| | Edwards and Comanche Peak formations | 0 |
| | Antlers Sand Formation | 0 |
| Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers | Ogallala Aquifer | 0 ^b |
| | Edwards and Comanche Peak formations | 0 ^b |
| | Antlers Sand Formation | 0 ^b |
| Estimated annual volume of flow into the district within each aquifer in the district | Ogallala Aquifer | 1,398 |
| | Edwards and Comanche Peak formations | 392 |
| | Antlers Sand Formation | 486 |
| Estimated annual volume of flow out of the district within each aquifer in the district | Ogallala Aquifer | 1,877 |
| | Edwards and Comanche Peak formations | 390 |
| | Antlers Sand Formation | 387 |
| Estimated net annual volume of flow between each aquifer in the district | From Ogallala Aquifer to underlying units | 940 |
| | From overlying Ogallala Aquifer and Cretaceous shale into Edwards and Comanche Peak formations | 1,008 |
| | From Edwards and Comanche Peak formations into Antlers Sand Formation | 1,041 |

^a Irrigation return flow was accounted for in the model by a direct reduction in agricultural pumping as described in Blandford and others (2003). This value is higher than what was reported in Groundwater Availability Model Run 08-47 (Oliver, 2008) due to the correction associated with irrigation return flow.

^b The model does not include any major springs, lakes, streams, or rivers within the district.

Figure 1: Area of the groundwater availability model for the southern portion of the Ogallala Aquifer and the Edwards-Trinity (High Plains) Aquifer from which the information in Table 1 was extracted. Note that model grid cells that straddle a political boundary were assigned to one side of the boundary based on the centroid of the model cell.



REFERENCES:

- Blandford, T.N., Blazer, D.J., Calhoun, K.C., Dutton, A.R., Naing, T., Reedy, R.C., and Scanlon, B.R., 2003, Groundwater availability of the southern Ogallala aquifer in Texas and New Mexico—Numerical simulations through 2050: Final report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 158 p.
- Blandford, T.N., Kuchanur, M., Standen, A., Ruggiero, R., Calhoun, K.C., Kirby, P., and Shah, G., 2008, Groundwater availability model of the Edwards-Trinity (High Plains) Aquifer in Texas and New Mexico: Final report prepared for the Texas Water Development Board by Daniel B. Stephens & Associates, Inc., 176 p.
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- Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model – User guide to modularization concepts and the ground-water flow process, U.S. Geological Survey Open-File Report 00-92, 121 p.
- Oliver, W., 2008, GAM run 08-47: Texas Water Development Board, GAM Run 08-47 Report, 4 p.



Cynthia K. Ridgeway is Manager of the Groundwater Availability Modeling Section and is responsible for oversight of work performed by employees under her direct supervision. The seal appearing on this document was authorized by Cynthia K. Ridgeway, P.G., on March 17, 2009.