GAM Run 09-021

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July 31, 2009

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 Neches and Trinity Valleys Groundwater Conservation District for its groundwater management plan. This modeling information, which includes the newly approved groundwater availability model for the Nacatoch Aquifer, is to be used in place of the results presented in Groundwater Availability Model Run 08-71 (Oliver, 2008) in development of the district's groundwater management plan. The groundwater management plan for Neches and Trinity Valleys Groundwater Conservation District is due for approval by the executive administrator of the Texas Water Development Board on September 10, 2009.

This report discusses the methods, assumptions, and results from model runs using the groundwater availability models for the northern sections of the Carrizo-Wilcox, Queen City, and Sparta aquifers, the northern section of the Trinity Aquifer, and the Nacatoch Aquifer. Table 1 summarizes the groundwater availability model data required by statute for Neches and Trinity Valleys Groundwater 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 models and (1) extracted water budgets for each year of the 1980 through 1999 period (Carrizo-Wilcox, Queen City, and Sparta and northern portion of the Trinity Aquifer groundwater availability models) or the 1980 through 1997 period (Nacatoch Aquifer groundwater availability model) 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:

Northern Sections of the Carrizo-Wilcox, Queen City, and Sparta Aquifers

- We used Version 2.01 of the groundwater availability model for the northern sections of the Carrizo-Wilcox, Queen City and Sparta aquifers. See Fryar and others (2003) and Kelley and others (2004) for assumptions and limitations of the groundwater availability model for these aquifers.

- The groundwater availability model includes eight layers, representing:

  1. the Sparta Aquifer (Layer 1),
  2. the Weches Confining Unit (Layer 2),
  3. the Queen City Aquifer (Layer 3),
  4. the Reklaw Confining Unit (Layer 4),
  5. the Carrizo Aquifer (Layer 5),
  6. the Upper Wilcox Aquifer (Calvert Bluff Formation—Layer 6),
  7. the Middle Wilcox Aquifer (Simsboro Formation—Layer 7), and
  8. the Lower Wilcox Aquifer (Hooper Formation—Layer 8).

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the aquifers in the model (Carrizo-Wilcox, Queen-City, and Sparta) for the calibration and verification time periods (1980 to 1999) ranged from 15 to 29 feet (Kelley and others, 2004).

- We used Processing Modflow for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 2001) as the interface to process model output.

Northern Section of the Trinity Aquifer

- We used version 1.01 of the groundwater availability model for the northern section of the Trinity Aquifer. See Bené and others (2004) for assumptions and limitations of the model.

- The northern section of the Trinity Aquifer model includes seven layers representing:

1. the Woodbine Aquifer (Layer 1),
2. the Washita and Fredericksburg Confining Unit (Layer 2),
3. the Paluxy Aquifer (Layer 3),
4. the Glen Rose Confining Unit (Layer 4),
5. the Hensell Aquifer (Layer 5),
6. the Pearsall/Cow Creek/Hammett/Sligo Confining Unit (Layer 6), and
7. the Hosston Aquifer (Layer 7).

- As shown in Figure 1, only a very small portion of the northern section of the Trinity Aquifer is located within the district. The water budget values for this confined portion of the aquifer are, therefore, very small or zero.

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the four main aquifers in the model (Woodbine, Paluxy, Hensell, and Hosston) for the calibration and verification time periods (1980 to 1999) ranged from approximately 37 to 75 feet.

- We used Processing Modflow for Windows (PMWIN) version 5.3 (Chiang and Kinzelbach, 2001) as the interface to process model output.

Nacatoch Aquifer

- We used version 1.01 of the groundwater availability model for the Nacatoch Aquifer. See Beach and others (2009) for assumptions and limitations of the model.

- The groundwater availability model for the Nacatoch Aquifer includes two layers representing:

1. the Kemp Clay and Midway Units (Layer 1)
2. the Nacatoch Aquifer (Layer 2)

- The mean absolute error (a measure of the difference between simulated and measured water levels during model calibration) for the Kemp Clay and Midway units and the Nacatoch Aquifer are 4 feet and 30 feet, respectively.

- 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. 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 runs (1980 to 1999 or 1980 to 1997) 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. “Inflow” to an aquifer from an overlying or underlying aquifer will always equal the “Outflow” from the other aquifer.

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 centroid of the model cell. 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 Neches and Trinity Valleys Groundwater Conservation District's groundwater management plan. 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[a]
Estimated annual amount of recharge from precipitation to the district	Sparta Aquifer	22,771
	Weches Confining Unit	2,420
	Queen City Aquifer	74,954
	Reklaw Confining Unit	4,395
	Carrizo Aquifer	7,206
	Upper Wilcox Aquifer	6,639
	Middle Wilcox Aquifer	3,584
	Lower Wilcox Aquifer	1,329
	Nacatoch Aquifer	56
	Woodbine Aquifer	0
	Washita and Fredericksburg Confining Unit	0
	Paluxy Aquifer	0
	Glen Rose Confining Unit	0
	Hensell Aquifer	0
	Pearsall/Cow Creek/Hammett/Sligo Confining Unit	0
	Hosston Aquifer	0
Estimated annual volume of water that discharges from the aquifer to springs and any surface water body including lakes, streams, and rivers[b]	Sparta Aquifer	5,985
	Weches Confining Unit	395
	Queen City Aquifer	43,978
	Reklaw Confining Unit	3,899
	Carrizo Aquifer	3,669
	Upper Wilcox Aquifer	2,167
	Middle Wilcox Aquifer	3,296
	Lower Wilcox Aquifer	1,221
	Nacatoch Aquifer	357
	Woodbine Aquifer	0
	Washita and Fredericksburg Confining Unit	0
	Paluxy Aquifer	0
	Glen Rose Confining Unit	0
	Hensell Aquifer	0
	Pearsall/Cow Creek/Hammett/Sligo Confining Unit	0
	Hosston Aquifer	0

Table 1: Continued

Management Plan requirement	Aquifer or confining unit	Results[a]
Estimated annual volume of flow into the district within each aquifer in the district	Sparta Aquifer	510
	Weches Confining Unit	61
	Queen City Aquifer	5,249
	Reklaw Confining Unit	994
	Carrizo Aquifer	7,998
	Upper Wilcox Aquifer	5,867
	Middle Wilcox Aquifer	4,227
	Lower Wilcox Aquifer	4,465
	Nacatoch Aquifer	1,092
	Woodbine Aquifer	40
	Washita and Fredericksburg Confining Unit	6
	Paluxy Aquifer	18
	Glen Rose Confining Unit	12
	Hensell Aquifer	31
	Pearsall/Cow Creek/Hammett/Sligo Confining Unit	0
	Hosston Aquifer	148
Estimated annual volume of flow out of the district within each aquifer in the district	Sparta Aquifer	2,063
	Weches Confining Unit	148
	Queen City Aquifer	3,718
	Reklaw Confining Unit	785
	Carrizo Aquifer	5,820
	Upper Wilcox Aquifer	5,654
	Middle Wilcox Aquifer	3,652
	Lower Wilcox Aquifer	2,269
	Nacatoch Aquifer	260
	Woodbine Aquifer	42
	Washita and Fredericksburg Confining Unit	6
	Paluxy Aquifer	19
	Glen Rose Confining Unit	12
	Hensell Aquifer	32
	Pearsall/Cow Creek/Hammett/Sligo Confining Unit	0
	Hosston Aquifer	152

Table 1: Continued

Management Plan requirement	Aquifer or confining unit	Results[a]
Estimated net annual volume of flow between each aquifer in the district	Sparta Aquifer to the Weches Confining Unit	6,876
	Weches Confining Unit to the Queen City Aquifer	7,916
	Queen City Aquifer to the Reklaw Confining Unit	7,113
	Reklaw Confining Unit to the Carrizo Aquifer	8,776
	Carrizo Aquifer to the Upper Wilcox Aquifer	7,496
	Upper Wilcox Aquifer to the Middle Wilcox Aquifer	3,392
	Middle Wilcox Aquifer to the Lower Wilcox Aquifer	4,053
	Kemp Clay and Midway Units to the Nacatoch Aquifer	223
	Washita and Fredericksburg Confining Unit to the Woodbine Aquifer	1
	Washita and Fredericksburg Confining Unit in/out of the Paluxy Aquifer	0
	Paluxy Aquifer in/out of the Glen Rose Confining Unit	0
	Glen Rose Confining Unit to the Hensell Aquifer	1
	Hensell Aquifer to the Pearsall/Cow Creek/Hammett/Sligo Confining Unit	1
	Pearsall/Cow Creek/Hammett/Sligo Confining Unit to the Hosston Aquifer	3

[a]As shown in Figure 1, only a very small portion of the northern section of the Trinity Aquifer is located within the district. The water budget values for this aquifer are, therefore, very small or zero.

[b]The evapotranspiration package of the groundwater availability model for the northern section of the Trinity Aquifer includes evaporation, transpiration, springs, seeps, and discharge to streams not modeled by the streamflow-routing package as described in Bené and others (2004). However, since only the confined portion of the Trinity Aquifer is located within the district, surface water outflow values using both the evapotranspiration and streamflow-routing packages were zero in Table 1 for this aquifer.

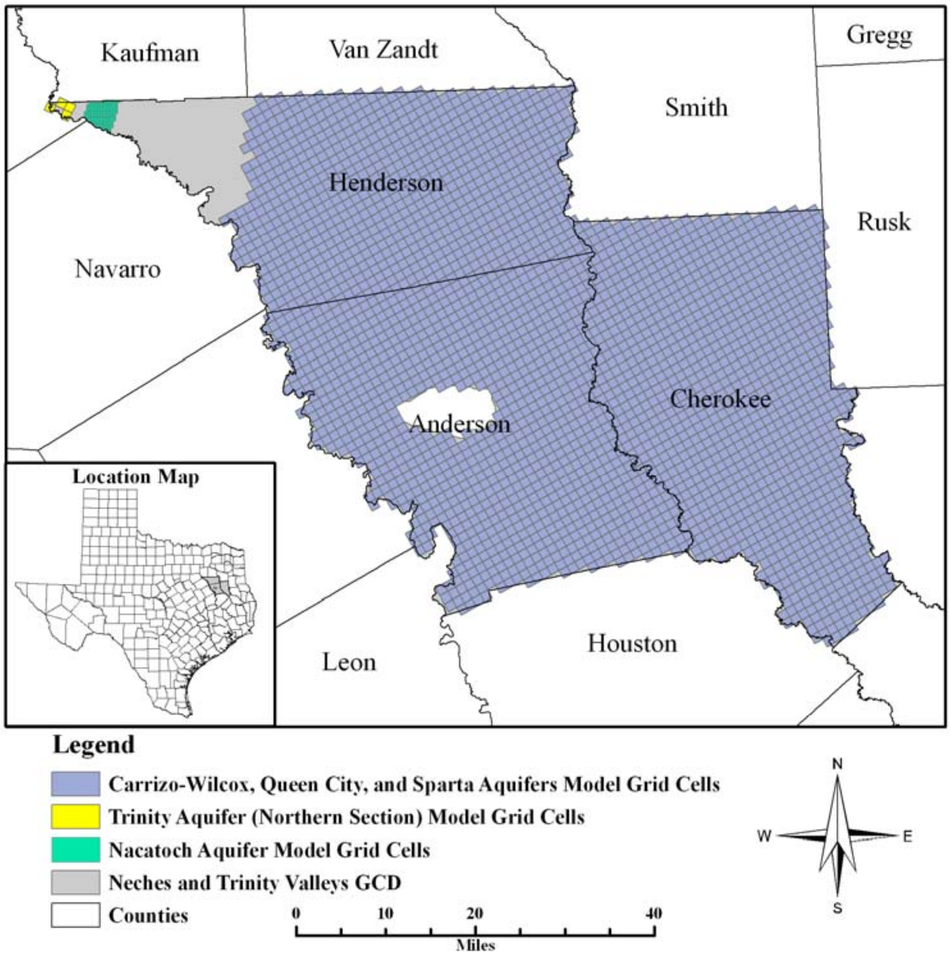

Figure 1: Area of the groundwater availability model for the northern sections of the Carrizo-Wilcox, Queen City, and Sparta aquifers, the northern section of the Trinity Aquifer, and the Nacatoch Aquifer from which the information in Table 1 was extracted. Note that model grid cells that straddle a political boundary were assigned to one side of the boundary based on the centroid of the model cell as described above.

REFERENCES:

Beach, J.A., Huang, Y., Symank, L., Ashworth, J.B., Davidson, T., Vreugdenhil, A.M., and Deeds, N.E., 2009, Nacatoch Aquifer Groundwater Availability Model: contract report to the Texas Water Development Board, 304 p.

Bené, J., Harden, B., O'Rourke, D., Donnelly, A., and Yelderman, J., 2004, Northern Trinity/Woodbine Groundwater Availability Model: contract report to the Texas Water Development Board by R.W. Harden and Associates, 391 p.

Chiang, W., and Kinzelbach, W., 2001, Groundwater Modeling with PMWIN, 346 p.

Environmental Simulations, Inc., 2007, Guide to using Groundwater Vistas Version 5, 381 p.

Fryar, D., Senger, R., Deeds, N., Pickens, J., Jones, T., Whallon, A.J., and Dean, K.E., 2003, Groundwater availability model for the northern Carrizo-Wilcox aquifer: Contract report to the Texas Water Development Board, 529 p.

Kelley, V.A., Deeds, N.E., Fryar, D.G., and Nicot, J.P., 2004, Groundwater availability models for the Queen City and Sparta aquifers: Contract report to the Texas Water Development Board, 867 p.

Oliver, W., 2008, GAM run 08-71: Texas Water Development Board, GAM Run 08-71 Report, 7 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 July 31, 2009.