GAM run 04-06

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REQUESTOR:

Middle Trinity Groundwater Conservation District

DESCRIPTION OF REQUEST:

The Middle Trinity Groundwater Conservation District (GCD) requested that analytical groundwater modeling be performed to calculate the water-level drawdown imposed by production from aquifers in the district. The district encompasses Erath and Comanche counties. The modeling is designed to provide insight into the variation of drawdown with distance from a single water well.

PARAMETERS AND ASSUMPTIONS:

The following parameters and assumptions were used to answer the request:

- Transmissivity derived from several well tests was provided by the GCD for the City of Stephenville. Transmissivity and storativity data were also obtained from Klempt and others (1975). The geometric mean of the available data was then calculated to determine the model inputs. Both confined (artesian) and unconfined (water table) aquifer conditions were found to exist in the GCD. The transmissivity and storativity used for confined conditions was 8,616 gallons per day per foot (gpd/ft) and 2.3×10^{-4} respectively. The transmissivity and storativity used for unconfined conditions was 8,616 gallons per day per foot and 0.019 respectively.
- Drawdown was calculated for a single well using the maximum rate, 275 gpm, from the City of Stephenville well data provided by the GCD.
- The groundwater drawdowns were calculated using a verified analytical model, THWELLS (van der Hiejde, 1990). THWELLS is a Theis equation based solver for drawdown from single or multiple wells.
- The Theis equation assumes that:
    - The aquifer is confined and of infinite extent;
    - The aquifer is homogenous and isotropic with respect to hydrogeologic properties;
    - The aquifer is bounded on the top and bottom by impervious strata;
    - Flow is radial through a porous medium;
    - The aquifer is horizontal with a constant thickness.

METHODS:

- Two model runs were performed using parameters for confined and unconfined conditions.
- Unconfined conditions were simulated by applying a drawdown (dd) correction to the confined aquifer drawdown as follows (Walton, 1970).
  - unconfined dd = confined dd – (confined dd)^2/(2*initial saturated thickness)
- The models were run for a 30 year time frame with continuous pumping. This was designed to provide a conservative estimate of the long term effects of pumping.

RESULTS:

Aquifer Conditions

From a review of information provided in Klempt and others (1975) and from the TWDB water well database, it was determined that both confined (artesian) and unconfined (water table) aquifer conditions exist within the GCD. Drawdown will tend to be lower in unconfined aquifers because of the much larger coefficient of storage (specific yield).

Wells that are completed in the outcrop portions of the Travis Peak Formation (including the Hosston and Hensell sands) and the Paluxy Formation have reported storage coefficients that are indicative of unconfined conditions. Unconfined storage coefficients, or specific yields, are generally on the order of 0.01. Wells completed deeper than the outcropping formation have smaller storage coefficients, reflecting confined aquifer conditions.

Transmissivity and Storativity Values

The transmissivity appears to be similar for unconfined and confined aquifers in the GCD. Therefore one value was used to model both confined and unconfined conditions. The geometric mean of values provided by the GCD for Stephenville and values given in Klempt and others for Erath and Comanche counties was 8,616 gpd/ft.

The geometric mean of five reported storage coefficients from unconfined wells in Comanche county was 0.019. This value was used to calculate the drawdown for the unconfined aquifer case. The geometric mean of three reported storage coefficients from confined wells in Comanche and Erath counties was 2.3×10^{-4}. This value was used to calculate the drawdown for the confined aquifer case.

Model Calculated Drawdown

Because of the bimodality in the reported storage coefficients, two model runs were performed to calculate end member results for possible artesian and water table conditions within the GCD. The model pumping rate, 275 gpm, is the highest reported value for the Stephenville wells. That rate was chosen by the GCD to provide a conservative estimate of the possible drawdown. The drawdown calculated by the models for 30 years of continuous pumping at 275 gallons per minute is graphed in Figures 1 and 2. The drawdown versus distance is greater for the confined aquifer case because of the smaller storativity.

Discussion
The model calculates the theoretical drawdown imposed by the pumping scenarios. The model does not reflect current water levels or simulate current water-level drawdown in district aquifers.

REFERENCES:

Klempt, W. B., R. D. Perkins, and H. J. Alvarez, 1975, Ground-Water Resources of Part of Central Texas with Emphasis on the Antlers and Travis Peak Formations, R195 v. 1 and 2, Texas Water Development Board, Austin, Texas.

van der Heijde, P., 1990, THWELLS, International Ground Water Modeling Center, Colorado School of Mines, Golden, CO.

Walton, W. C., 1970, Groundwater Resource Evaluation, McGraw Hill, N.Y., 664 p.

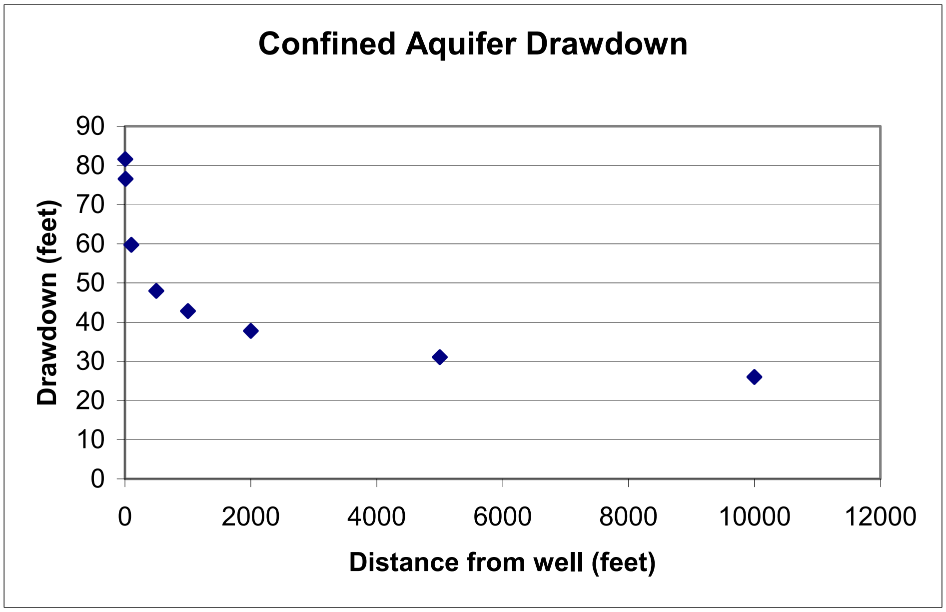

Figure 1. Drawdown versus distance calculated for the confined aquifer case.

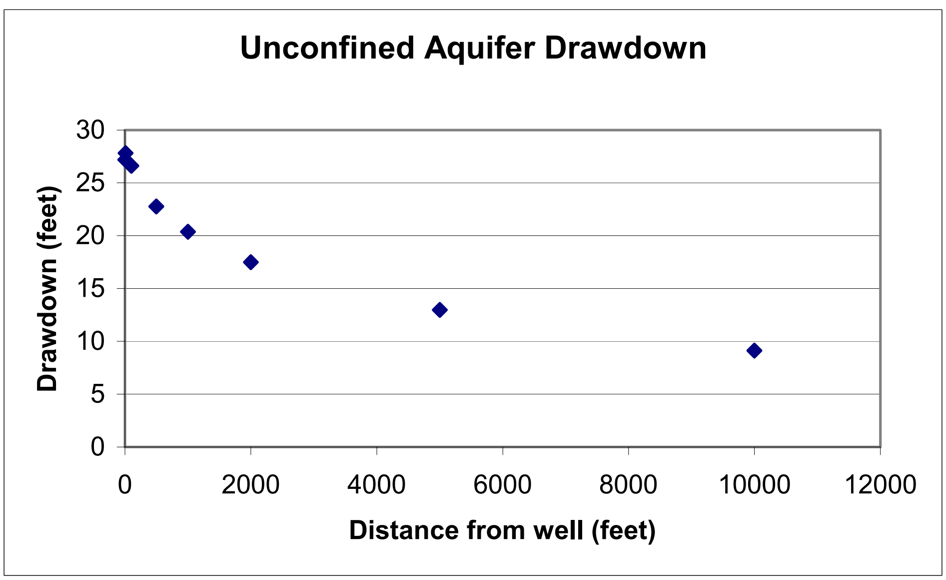

Figure 2. Drawdown versus distance calculated for the unconfined aquifer case.