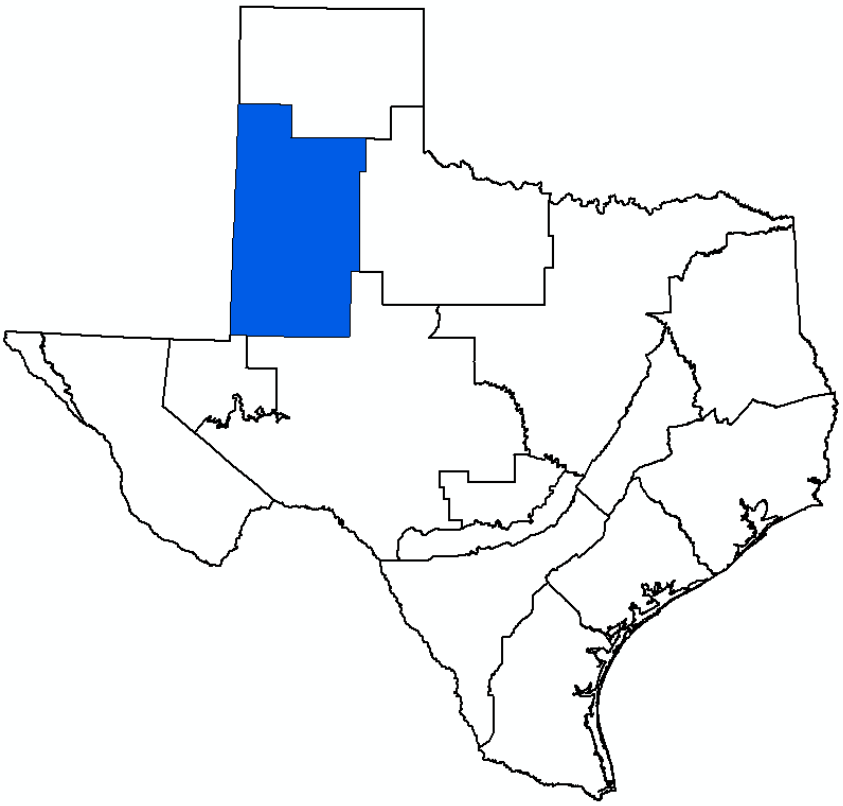
GMA 2 Technical Memorandum 15-01
Draft 1

Ogallala Aquifer:
Initial Predictive Simulations



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1.0 Introduction and Objective

This technical memorandum documents initial simulations using the recently released High Plains Aquifer System Groundwater Availability Model (Deeds and Jigmond, 2015). The model is also known as the HPAS GAM, or simply the GAM. The GAM includes the Ogallala, Edwards-Trinity (High Plains), and Dockum aquifers. This technical memorandum covers the results of the Ogallala Aquifer. Other memoranda cover the other aquifers.

The objective of these simulations was to take advantage of a feature in the recently released model that differs from the previous version of the GAM. Earlier versions of the GAM required external adjustment of input groundwater pumping rates to avoid dry cells. The new version of the GAM uses the Newton Formulation and the upstream weighting package which automatically reduces pumping as heads drop in a particular cell as defined by the user (Niswonger and others, 2011). This feature provides a means to simulate the declining production of a well as saturated thickness decreases.

Deeds and Jigmond (2015) further enhanced the utility of this new feature by changing the threshold specification of saturated thickness when pumping reductions occur during a simulation. Niswonger and others (2011) used a fraction of cell thickness. As explained by Deeds and Jigmond (2015, pg. 2-27), a disadvantage of this approach is that cells that have an initially high saturated thickness, pumping reduction would occur to rapidly as compared to cells with less saturated thickness. Deeds and Jigmond (2015) modified the code to include a specification of an absolute value of saturated thickness at which pumping would be reduced. During development and calibration of the GAM, Deeds and Jigmond (2015) used a value of 30 feet as the threshold value of saturated thickness.

The simulations described in this technical memorandum considered two sets of basic alternatives: 1) varying the value of saturated thickness threshold, and 2) varying the initial pumping for each cell.

The first set of simulations provides a means to understand the sensitivity of increasing and decreasing the saturated thickness threshold value used in the development and calibration of the model (30 feet). For these simulations, the three threshold values were used: 20 feet, 30 feet, and 40 feet.

The second set of simulations provides a means to understand the effect of increasing current pumping and, alternatively, reducing current amounts of pumping on long term well production and groundwater level declines. Because the groundwater levels in the Ogallala Aquifer have been declining over recent decades, and because it is recognized that current levels of pumping are likely to decline in future decades due to decreased saturated thickness, these simulations are useful as part of understanding the balance of groundwater conservation and development over a long period of time (58 years). This new version of the GAM represents the first time that a modeling tool that can simulate the declining production rates associated with decreasing saturated thickness without user intervention and multiple iterations to avoid dry cells.

2.0 Description of Simulations

Simulations were run for 58 years (2013 to 2070). Model files for the scenarios were taken from INTERA's deliverable to the TWDB for predictive runs in GMA 1. The only modification to these files for these simulations were the WEL file (input pumping amounts) as described below.

A base case was developed using a saturated thickness threshold of 30 feet (as was used during the development and calibration of the GAM), and pumping equal to 2012 amounts (the last year of model calibration). Other threshold values for saturated thickness (PHIRAMP) that would result in decreased pumping were 20 feet and 40 feet. Other values of initial pumping were 50 percent of 2012 pumping (on a cell by cell basis), 75 percent of 2012 pumping, 125 percent of 2012 pumping and 150 percent of 2012 pumping.

As a result, 15 simulations were run as shown in Table 1.

Table 1. Summary of Simulations

Scenario	Initial Pumping Rate (as a percentage of 2012 pumping)	Saturated Thickness Threshold (PHIRAMP)
1	0.50	20
2	0.75	20
3	1.00	20
4	1.25	20
5	1.50	20
6	0.50	30
7	0.75	30
8 (Base Case)	1.00	30
9	1.25	30
10	1.50	30
11	0.50	40
12	0.75	40
13	1.00	40
14	1.25	40
15	1.50	40

3.0 Predictive Simulation Results

Results for the 15 simulations are summarized by county in two appendices and two summary tables.

3.1 Summary of Pumping and Drawdown Results

Table 2 summarizes the drawdown in 2070 for all 15 simulations. Please note that the choice of saturated thickness threshold resulted in only minor differences in results.

Appendix A presents graphs of pumping and drawdown, and is organized as follows:

- The first page is a map of GMA 2 counties for reference purposes.
- Each subsequent page summarizes results for a particular county.
- The upper graph shows the pumping from 1930 to 2012 (from the calibrated GAM), the pumping from Scenarios 6 to 10 (the pumping simulations associated with a saturated thickness threshold of 30 feet) for the years 2013 to 2070. The current modeled available groundwater (MAG) is also shown for reference purposes for the years 2010 to 2060.
- The lower graph shows the county-average drawdown from 2013 to 2070 of Scenarios 5 to 9 (the pumping simulations associated with a saturated thickness threshold of 30 feet). The current DFC in terms of drawdown from 2010 to 2060 is also shown for reference purposes.

3.2 Summary of Pumping and Storage Volumes

Table 3 summarizes the drawdown in 2070 for all 15 simulations. Please note that the choice of saturated thickness threshold resulted in only minor differences in results.

Appendix B presents graphs of pumping and storage volume remaining as a percentage of initial storage, and is organized as follows:

- The first page is a map of GMA 2 counties for reference purposes.
- Each subsequent page summarizes results for a particular county.
- The upper graph shows the pumping from 1930 to 2012 (from the calibrated GAM), the pumping from Scenarios 6 to 10 (the pumping simulations associated with a saturated thickness threshold of 30 feet) for the years 2013 to 2070. The current modeled available groundwater (MAG) is also shown for reference purposes for the years 2010 to 2060.
- The lower graph shows the storage remaining in each year (2013 to 2070) as a percentage of the initial storage (2012) for Scenarios 5 to 9 (the pumping simulations associated with a saturated thickness threshold of 30 feet). The current DFC in terms of storage remaining from 2010 to 2060 is also shown for reference purposes.