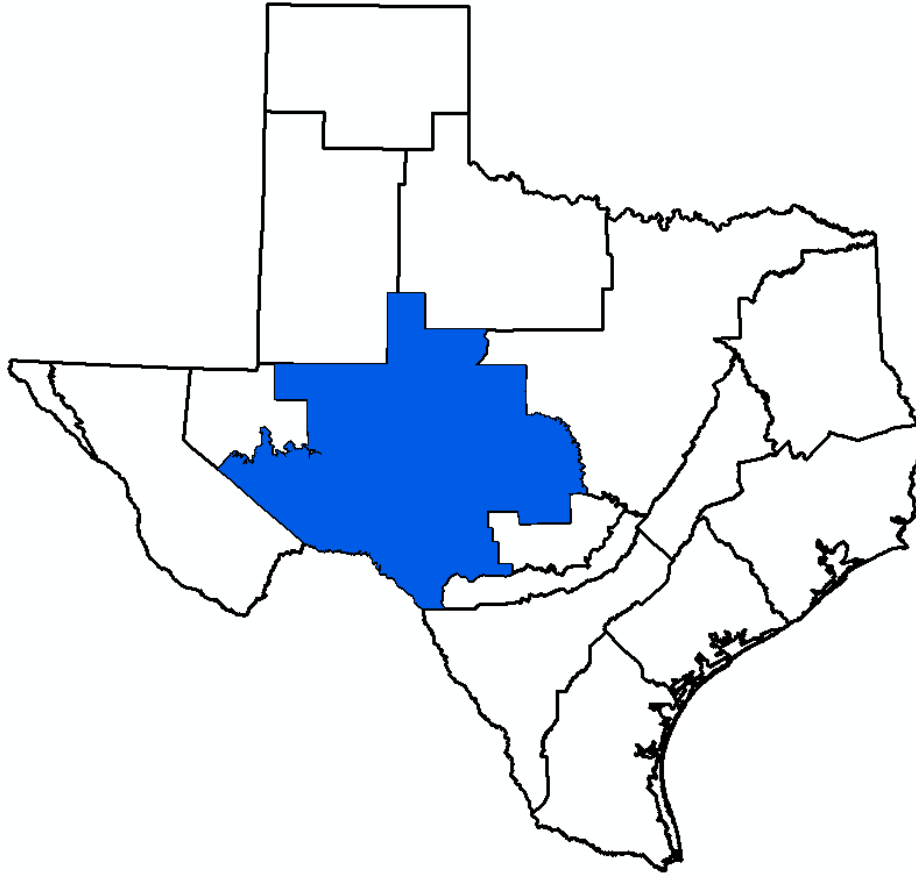


Documentation of Llano Uplift GAM Scenario 26.1



Prepared for:
Groundwater Management Area 7

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Professional Engineer and Professional Geoscientist Seals

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1.0 Introduction

On August 29, 2021, the groundwater conservation districts in Groundwater Management Area 7 adopted desired future conditions (DFCs) for the Ellenburger-San Saba and Hickory aquifers based on a simulation with the Groundwater Availability Model (GAM) of the Llano Uplift Aquifer System. The adoption of the desired future condition is documented in Hutchison (2021). The GAM simulation that was the basis for the DFCs was Scenario 3 of Hutchison (2016)

The time period of the simulation that was the basis for the DFC was 2011 to 2070. During the current round of joint planning, TWDB is requiring a planning period through the year 2080. Consequently, Scenario 3 from Hutchison (2016) needs to be extended 10 years.

In addition, the new requirements of HB 2078 led to comparisons of actual drawdown and simulated drawdown from Scenario 3 from 2011 to 2024 as documented in Hutchison (2026). Among the conclusions of Hutchison (2026) was that the actual drawdown data demonstrated that the DFC is being achieved, and there is no need to modify the DFCs during this round of joint planning.

Finally, HB 2078 included a provision to document decadal values of DFCs. In past rounds of joint planning, only the final value of the DFC was required.

Consequently, this technical memorandum documents an updated Scenario 3 from Hutchison (2016) that extends the simulation an additional 10 years (through 2080) and provides decadal output of drawdown to comply with HB 2078 requirements.

All files associated with this technical memorandum can be accessed in a Google Drive folder:

https://drive.google.com/drive/folders/1sjqEti5m5VG_E1TcVR8B7Oy_rE1k-v8A?usp=sharing

2.0 Updated Simulation (Scenario 26.1)

2.1 Simulation Files

The simulation (Scenario 26.1) is the same as Scenario 3 documented in Hutchison (2016), except for the length of the simulation. Table 1 summarizes the input files that were unchanged from Scenario 3. Table 2 summarizes the input files that were modified to add 10 years to the simulation. Table 3 summarizes the output files.

Table 1. Simulation Input Files (Unmodified from Scenario 3)

MODFLOW Package	Unit Number	File Name	Description
BAS6	1	lupred01.bas	Basic Input
SMS	19	llano-uplift.sms	Solver
LPF	11	llano-uplift.lpf	Aquifer Parameters
DATA	61	ib1.dat	Active/Non Active Cell Specification by Layer
DATA	62	ib2.dat	Active/Non Active Cell Specification by Layer
DATA	63	ib3.dat	Active/Non Active Cell Specification by Layer
DATA	64	ib4.dat	Active/Non Active Cell Specification by Layer
DATA	65	ib5.dat	Active/Non Active Cell Specification by Layer
DATA	66	ib6.dat	Active/Non Active Cell Specification by Layer
DATA	67	ib7.dat	Active/Non Active Cell Specification by Layer
DATA	68	ib8.dat	Active/Non Active Cell Specification by Layer
DATA	71	2010hed1.dat	Initial Heads by Layer
DATA	72	2010hed2.dat	Initial Heads by Layer
DATA	73	2010hed3.dat	Initial Heads by Layer
DATA	74	2010hed4.dat	Initial Heads by Layer
DATA	75	2010hed5.dat	Initial Heads by Layer
DATA	76	2010hed6.dat	Initial Heads by Layer
DATA	77	2010hed7.dat	Initial Heads by Layer
DATA	78	2010hed8.dat	Initial Heads by Layer

Table 2. Simulation Input Files (Modified from Scenario 3)

MODFLOW Package	Unit Number	File Name	Description
DISU	29	lupred-2080.dis	Cell discretization
OC	22	lupred-2080.oc	Output control
GHB	17	lupred-2080.ghb	General head boundaries
RCH	18	luavgrch-2080.rch	Recharge
WEL	12	scen03-2080.wel	Well (Pumping)
RIV	14	lu2010riv-2080.riv	River
DRN	13	lu2010drn-2080.drn	Drains (springs)

Table 3. Simulation Output Files

MODFLOW Package	Unit Number	File Name	Description
LIST	7	luscen03-2080.lst	Standard Output
DATA(BINARY)	50	luscen03-2080.cbb	Cell-by-cell flows
DATA(BINARY)	30	luscen03-2080.hds	Heads
DATA(BINARY)	31	luscen03-2080.ddn	Drawdown

2.2 Post-Processing of Model Output

Output from the simulation was processed with two Fortran programs. The groundwater elevation data was processed and drawdowns were calculated with the program *getdd.exe*. Output pumping was processed with the program *getpump.exe*.

For both programs, the current version of the model grid file was used (updated October 12, 2023). This file was downloaded from the TWDB website. To facilitate reading of the grid file, it was edited for use in these programs by eliminating some of the columns that were not pertinent for these analyses (*lnup_grid_poly101223 rev.csv*).

The drawdown postprocessor:

- Reads the grid file
- Reads a list of county names, county codes, and output file names
- Sums the cell count for each county-model layer unit
- Writes the cell count for each count-model layer unit (one for total count, one for active model cell count)
- Reads the initial heads for each model layer
- Reads the simulation output file for heads (groundwater elevations)
- Calculates drawdown in each cell using 2010 (initial heads) as the baseline
- Sums the drawdowns for each county-model layer unit
- Calculates the average drawdown for each county-model layer unit as the sum of the drawdowns divided by the active cell count
- Writes annual drawdown for each county-model layer unit in individual files
- Writes county decadal drawdown from 2030 to 2080 for each model layer

The pumping postprocessor:

- Reads a list of output file names
- Reads the grid file
- Assigns a county code to each cell using the convention used in the cbb file
- Reads the cbb file
- Sums the pumping by county-aquifer units
- Writes annual pumping for each county-aquifer unit
- Writes county decadal pumping from 2030 to 2080 for each aquifer

3.0 Drawdown Results

Decadal drawdowns from 2030 to 2080 for the Ellenburger-San Saba Aquifer are presented in Table 4. The current DFC (drawdown from 2010 to 2070) is also included for comparison purposes.

Table 4. Decadal Drawdown - Ellenburger-San Saba Aquifer

County	Current DFC (ft in 2010 to 2070, adopted in 2021)	Draw down (ft, 2010 to Year Listed)					
		2030	2040	2050	2060	2070	2080
Gillespie	8	5	6	7	7	8	8
Kimble	18	11	14	15	17	18	19
Mason	14	9	11	12	13	14	14
McCulloch	29	28	28	28	28	29	29
Menard	46	40	42	44	45	46	47
SanSaba	5	5	5	5	5	5	5

Decadal drawdowns from 2030 to 2080 for the Hickory Aquifer are presented in Table 5. The current DFC (drawdown from 2010 to 2070) is also included for comparison purposes.

Table 5. Decadal Drawdown - Hickory Aquifer

County	Current DFC (ft in 2010 to 2070, adopted in 2021)	Draw down (ft, 2010 to Year Listed)					
		2030	2040	2050	2060	2070	2080
Concho	53	51	52	52	53	53	53
Gillespie	9	5	7	7	8	9	9
Kimble	18	11	14	15	17	18	19
Mason	17	11	13	14	16	17	18
McCulloch	29	28	28	28	29	29	29
Menard	46	41	42	44	45	46	47
SanSaba	6	5	5	6	6	6	6

Please note that in most counties, the current DFC (2070, adopted in 2021) is the same as the drawdown in 2070 from the updated simulation. This is because the only change was the addition of 10 years to the simulation. However, the 2080 drawdown (the basis for the “new” DFC) is slightly higher than the 2070 in some counties (by about 1 ft) as the system has not reach an equilibrium level.

In summary, the updated DFC would be the drawdown in 2080 by county, and the decadal values are presented for compliance with the new requirements of HB 2078.

4.0 Pumping Results

The modeled available groundwater (MAG) is the average pumping to achieve the DFC based on the GAM simulation and is calculated by TWDB. The pumping values presented in this technical memorandum are included to provide an initial estimate of the MAGs. Small differences between these values and the MAGs are generally due to differences in calculation methods. This technical memorandum provides documentation for use by TWDB in calculating the MAG, if they choose to adopt this method.

Decadal pumping values from 2030 to 2080 for the Ellenburger-San Saba Aquifer are presented in Table 6. The current MAG for 2070 is also included for comparison purposes.

Table 6. Decadal Pumping - Ellenburger-San Saba Aquifer

County	Current MAG (AF/yr in 2070, adopted in 2021)	Pumping (AF/yr by Decade)					
		2030	2040	2050	2060	2070	2080
Gillespie	6,294	6,470	6,470	6,470	6,470	6,470	6,470
Kimble	521	535	535	535	535	535	535
Mason	3,237	3,861	3,861	3,861	3,861	3,861	3,861
McCulloch	4,364	4,485	4,485	4,485	4,485	4,485	4,485
Menard	309	310	310	310	310	310	310
SanSaba	7,890	8,395	8,395	8,395	8,395	8,395	8,395

Decadal pumping values from 2030 to 2080 for the Hickory Aquifer are presented in Table 7. The current MAG for 2070 is also included for comparison purposes.

Table 7. Decadal Pumping - Hickory Aquifer

County	Current MAG (AF/yr in 2070, adopted in 2021)	Pumping (AF/yr by Decade)					
		2030	2040	2050	2060	2070	2080
Concho	27	44	44	44	44	44	44
Gillespie	1,751	1,841	1,841	1,841	1,841	1,841	1,841
Kimble	165	165	165	165	165	165	165
Mason	13,212	15,039	15,039	15,039	15,039	15,039	15,039
McCulloch	24,377	24,450	24,450	24,450	24,450	24,450	24,450
Menard	2,725	2,725	2,725	2,725	2,725	2,725	2,725
SanSaba	7,680	7,751	7,751	7,751	7,751	7,751	7,751

Please note that the pumping in each decade is constant, and, in many counties, is slightly higher than the current MAG. This may be due to recent changes to the grid file. The differences are not considered significant.

5.0 References

Hutchison, W.R., 2016. Llano Uplift Aquifers: Initial Predictive Simulations with Draft Llano Uplift GAM. GMA 7 Technical Memorandum 16-02. November 18, 2016, 25p.

Hutchison, W.R., 2021. GMA 7 Explanatory Report: Aquifers of the Llano Uplift Region (Ellenburger-San Saba, Hickory, Marble Falls). Prepared for Groundwater Management Area 7, August 28, 2021. 60p.

Hutchison, W.R., 2026. Comparison of Measured Drawdown with Simulated Drawdowns from the Desired Future Conditions Adopted in 2021 in Groundwater Management Area 7. GMA 7 Technical Memorandum 26-01 (Draft 1). April 16, 2026, 45p.