Advanced Groundwater Solutions, LLC
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Technical Memorandum

TO: Mr. Alan Day, General Manager
Brazos Valley Groundwater Conservation District

FROM: Christopher Drabek, P.G., and James Beach, P.G.

SUBJECT: Review of High Timber Resources, L.P. Simsboro Aquifer Evaluation Report

DATE: July 3, 2023

Introduction

On behalf of the Brazos Valley Groundwater Conservation District (BVGCD, District), Advanced Groundwater Solutions, LLC (AGS) has reviewed the Aquifer Evaluation Report (AER) prepared by Thornhill Group, Inc. (TGI) in support of a permit application for High Timber Resources, L.P. (High Timber) for six proposed new wells to be completed in the Simsboro Aquifer with a withdrawal amount of 11,870 acre-feet per year (ac-ft/yr). The proposed wells are located on two different tracts of land located about 3 miles northeast of the Town of Calvert and about 6 miles west-northwest of the Town of Franklin. The locations of the wells are shown on Figure 1. The first AER dated February 10, 2023 was submitted to BVGCD on May 1, 2023 as part of a High Timber Resources, L.P. application packet dated April 27, 2023. After preliminary review, AGS and BVGCD provided comments to TGI and requested some clarification on the AER on June 5, 2023. Supplemental information from TGI regarding the requested clarification was addressed in a letter dated June 13, 2023. The AER and supplemental information were submitted to address BVGCD Rule 8.4(b)(7)(B) for wells capable of producing 800 or more acre-feet per year and discusses the potential impacts of groundwater production from the Simsboro Aquifer of the proposed new wells in the northwest part of Robertson County.

AGS has evaluated the hydrogeological conditions, mapping of BVGCD permitted and registered Simsboro wells within one mile of the proposed High Timber wells and the water level drawdown estimates developed using the Texas Water Development Board (TWDB) Groundwater Availability Model (GAM) and analytical tools presented in the submitted aquifer evaluation reports. Discussion of the AER in this memorandum refers to the February 10, 2023 dated AER and supplemental letter dated June 13, 2023.

Proposed High Timber Resources, L.P. Wells

The AER identifies six proposed High Timber wells with maximum pumping rates that range from 1,400 to 1,800 gallons per minute (gpm) and an annual permit allocation of 11,870 acre-feet. Table 1 below was extracted from the TGI AER and provides the maximum pumping rate in gpm and the annual permitted allocation in acre-feet for each of the proposed High Timber Simsboro Aquifer screened wells.

Well Identification	Maximum Pumping Rate (GPM)	Annual Permit Allocation (AF)
Hightimber_1	1,400	1,806
Hightimber_2	1,400	1,806
Hightimber_3	1,700	2,323
Hightimber_4	1,800	2,323
Hightimber_5	1,400	1,806
Hightimber_6	1,400	1,806

Table 1. Proposed High Timber Resources, L.P. Well Maximum Pumping Rate and Annual Permit Allocation (from TGI AER)

The proposed locations of the six High Timber wells are shown on Figure 1 below. The faulting shown on the west part of the map will be discussed later in this memorandum.

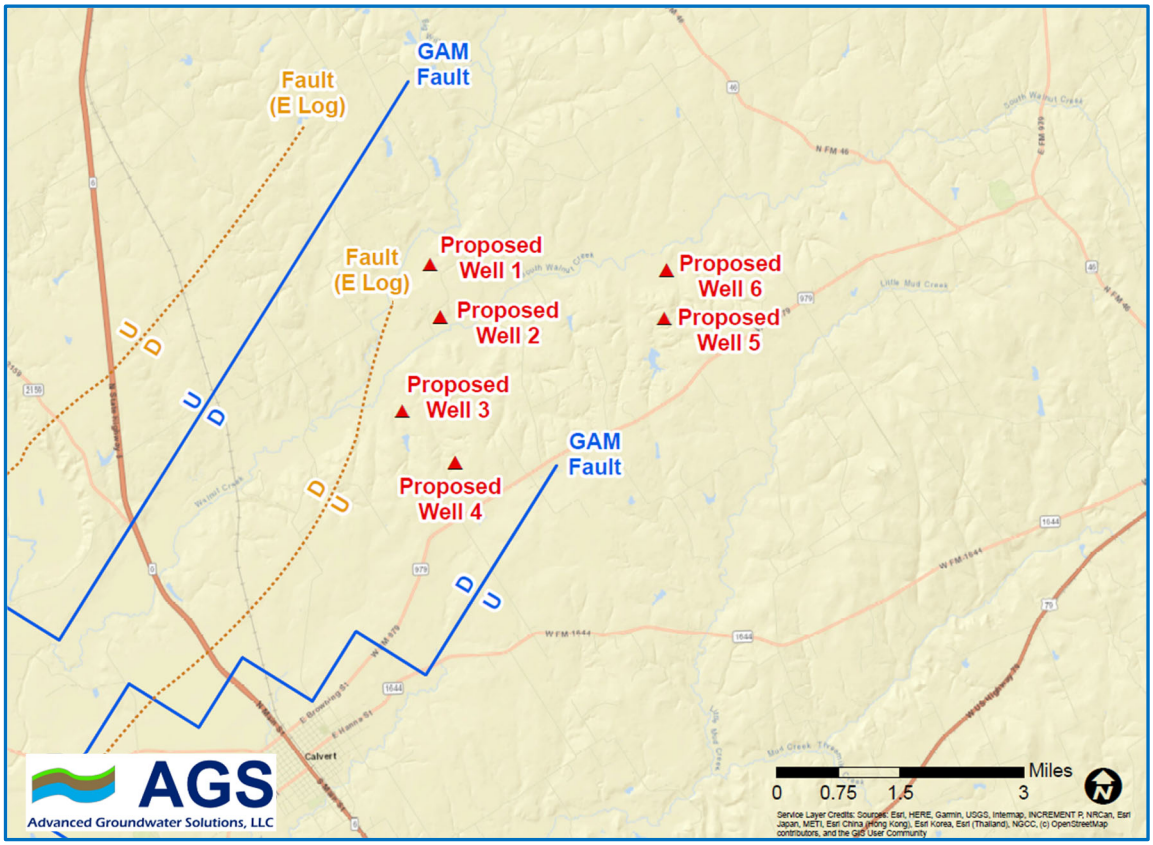


Figure 1. Proposed High Timber Resources, L.P. Well Location Map

Hydrogeologic Conditions

Rule 8.4(b)(7)(B)(1)

AGS has evaluated the hydrogeological conditions presented in the AER and generally agrees with the information presented in this section.

The AER identifies the top and bottom of the Simsboro Aquifer based on the Layer 9 (Simsboro) information found at each proposed well location from Version 3.02 of the Central Portion of the Sparta, Queen City and Carrizo-Wilcox Aquifers GAM (INTERA Incorporated and others, 2020). The GAM surfaces can often be reasonable approximations of the tops and bottoms of the aquifers, but there can be some uncertainty in the accuracy of the top/bottom of the GAM aquifer layers as the model layers are based on interpolation between a limited number of regional geophysical logs and may not include the detail of a review at the local level.

Figures 4 and 7, attached to this memorandum, show the estimated base of the Simsboro Aquifer based on the review of available local geophysical logs by AGS. The GAM estimated tops and bottoms of the Simsboro Aquifer are shown Figures 4 - 9. There are limited geophysical logs available in this area. A geophysical log shows the approximate base of the Simsboro Aquifer at a shallower depth than the GAM near proposed High Timber Well 1. A geophysical log near proposed High Timber Well 4 shows the base of the Simsboro at a depth that is similar to that shown in the GAM.

As shown on Figure 1, proposed High Timber Wells 1 through 4 are located in a down dropped area of the Simsboro Aquifer that is between two GAM estimated faults. Ground Water Consultants and AGS have mapped the Simsboro Aquifer using available electric log data in the vicinity of this geologic feature, which is known as a graben. The estimated extent of the faulting and graben mapped by GWC and AGS is shown on Figure 1 as a dashed line. Based on the electric log data reviewed, it is possible that proposed High Timber Wells 1 through 4 are not located in this geologic feature.

Site specific information will be available once the test holes are drilled and logged for each of the proposed High Timber wells.

The top of first screen and total depth for each of the six proposed High Timber wells is based on the top and bottom of the GAM Layer 9 (Simsboro) at each proposed well location as shown on Table A of the BVGCD Application for Drilling or Operating Permit included in the High Timber Resources, L.P. application packet dated April 27th.

Simsboro Aquifer Wells Within 1-mile of the Proposed Wells

Rule 8.4(b)(7)(B)(2)

AGS has confirmed that the BVGCD wells identified in revised Table 2 in the TGI supplemental letter were the only permitted or registered Simsboro wells within one mile of the proposed High Timber wells at the time of the AER. Revised Table 2 of the TGI supplemental letter includes data on each registered or permitted well screening the Simsboro Aquifer located within one mile of the proposed wells and generally includes most of the required information for the wells. Maps showing the location of the proposed High Timber wells and the BVGCD registered or permitted wells within one mile of the proposed wells are included as Exhibits 1 and 2 in the High Timber Resource Holdings, L.P. application packet dated April 27, 2023.

Interference Drawdown Estimates

Rule 8.4(b)(7)(B)(3)

BVGCD Rule 8.4(b)(7)(B)(3) requires an estimate of water level drawdown caused by the well(s) pumping at the permitted rate for 1 year and 10 years at a distance of up to five miles from the well(s) using Version 3.02 of the Central Portion of the Sparta, Queen City and Carrizo-Wilcox Aquifers GAM (INTERA Incorporated and others, 2020). An estimate of the drawdown at locations of existing registered and permitted wells in the BVGCD database that are located within one mile and screen the same aquifer as the well(s) is required to be developed using an analytical tool.

Appropriate analytical models are generally used to provide estimates of pumping effects at or near the well(s) over shorter time horizons. Regional numerical models like the TWDB GAMs are generally used to account for regional variability in the aquifer such as changes in transmissivity and faulting as well as recharge, leakage between aquifers, stream-aquifer interaction, other pumping, and other factors impacting water levels. Appropriate numerical models can provide more reliable estimates of pumping effects on a more regional scale and over longer time horizons.

Groundwater Availability Model Simulation

TGI used the TWDB Central Portion of the Sparta, Queen City and Carrizo-Wilcox Aquifer GAM to estimate drawdown that results from continuously pumping the proposed High Timber wells at a combined rate of 11,870 ac-ft/yr for 1 year and 10 years. A copy of the TGI 1-year and 10-year GAM simulated interference drawdown illustrations from the AER (TGI Figures 5 and 6) are attached to this memorandum. Table 1 in the TGI AER shows GAM simulated 1-year and 10-year drawdown estimates at BVGCD permitted and registered Simsboro wells within a five-mile radius of the proposed wells. The TGI report did not discuss the GAM simulation methodology, but the GAM model results generally appear to be reasonable based on AGS simulation verification runs.

In the AGS verification runs, two GAM simulations were completed with the first simulation (the baseline run) using the unmodified Groundwater Management Area (GMA) 12 "S-19" Desired Future Condition (DFC) run and with the second simulation (the modified run) being identical to the baseline except that the requested 11,870 ac-ft/yr of pumping was included in the MODFLOW WEL file. The simulated water levels from each simulation were compared by subtracting the simulated water level elevations of the baseline run from the modified run. This comparison isolates the pumping effects of the requested pumping. GMA 12 "S-19" includes additional regional pumping, which gradually increases through time. GMA 12 "S-19" was approved in 2021 and does not include all of the pumping from the Simsboro Aquifer that has been permitted by BVGCD in the area in the past year.

The AGS GAM simulation results after 1 and 10 years of pumping 11,870 ac-ft/yr generally show drawdown estimates to be slightly less than the TGI drawdown estimates at all of the proposed High Timber well locations. The slight drawdown differences between the AGS and TGI runs

could potentially be attributed to background pumping in the TGI simulations if TGI did not use the approach described above to isolate the drawdown.

The GAM estimated drawdown contours near proposed High Timber Wells 1 through 4 appear to be influenced by faults included in the GAM, which are in the same general area as faults that have been mapped by GWC and AGS using local geophysical logs and other hydrogeologic data.

AGS has reviewed this AER based on the hydrogeologic information available today, the information provided by the applicant, and the models and tools available at this time. New scientific or hydrogeologic information or updated models may change the findings of this review.

Analytical Model Simulation

TGI used an analytical model based on the Theis non-equilibrium equation to estimate theoretical potentiometric head declines at and surrounding the proposed wells. TGI updated the analytical simulations as part of the June 13, 2023 supplemental response using a transmissivity value of 50,000 gallons per day per foot (gpd/ft) and storativity value of 0.0001 for the 1-year simulation and 0.001 for the 10-year simulation. TGI states that these parameters are based on a 45-day pumping test previously performed at the Walnut Creek mine. A copy of the updated TGI 1-year and 10-year analytical simulated interference drawdown illustrations from the June 13th supplemental letter (TGI Revised Figures 7 and 8) are attached to this memorandum. Table 1 provided in the AER was not updated by TGI in conjunction with the updated proposed High Timber Well analytical drawdown estimates developed by TGI as part of the June 13th supplemental response. TGI personnel indicated that they used the same method in the analytical approach that has been used in BVGCD in the past. That approach has historically included estimating analytical drawdown values at the proposed well locations by averaging the estimated drawdown at the well over the grid cell within the analytical tool.

AGS estimated the drawdown at the pumping wells using the Theis analytical model and calculating the drawdown at one foot from the well. Table 1 below provides a summary of the AGS simulated drawdown estimates at each of the proposed High Timber wells. The different storage values used by TGI in the analytical simulations (0.0001 for the 1-year simulation and 0.001 for the 10-year simulation) have yielded the same drawdown estimated after 1 year and 10 years of pumping. AGS performed a 10-year simulation assuming that the storage value is 0.0001 to show the difference between that simulation and the 10-year simulation using a storage value of 0.001. If the actual storage coefficient is 0.0001 the drawdown at 10 years is estimated to be as shown in the table below.

Proposed High Timber Well	AGS Simulated Drawdown After 1-Year of Pumping	AGS Simulated Drawdown After 10-Years of Pumping	AGS Simulated Drawdown After 10-Years of Pumping with Storage Vaule of 0.0001
Well 1	190	190	238
Well 2	197	197	245
Well 3	205	205	253
Well 4	205	205	253
Well 5	185	185	233
Well 6	183	183	231

Table 1. AGS Theis Analytical Simulated Drawdown at the Proposed High Timber Wells After 1-Year and 10-Years of Pumping 11,870 ac-ft/yr Using TGI Hydraulic Properties and Also Using a Storage Coefficient of 0.0001 for the 10-year Simulation

There is an increased density of contours near the proposed High Timber wells using the AGS approach and we think these are more appropriate estimates of "near well" drawdown. However, there are many factors that will determine the actual drawdown near the well during pumping, and therefore, these differences are assumed to be minor for the purposes of the AER. Figures 2 and 3 below show the estimated AGS analytical modeling drawdown contours that result from pumping 11,870 ac-ft/yr for 1-year and 10-years, respectively.

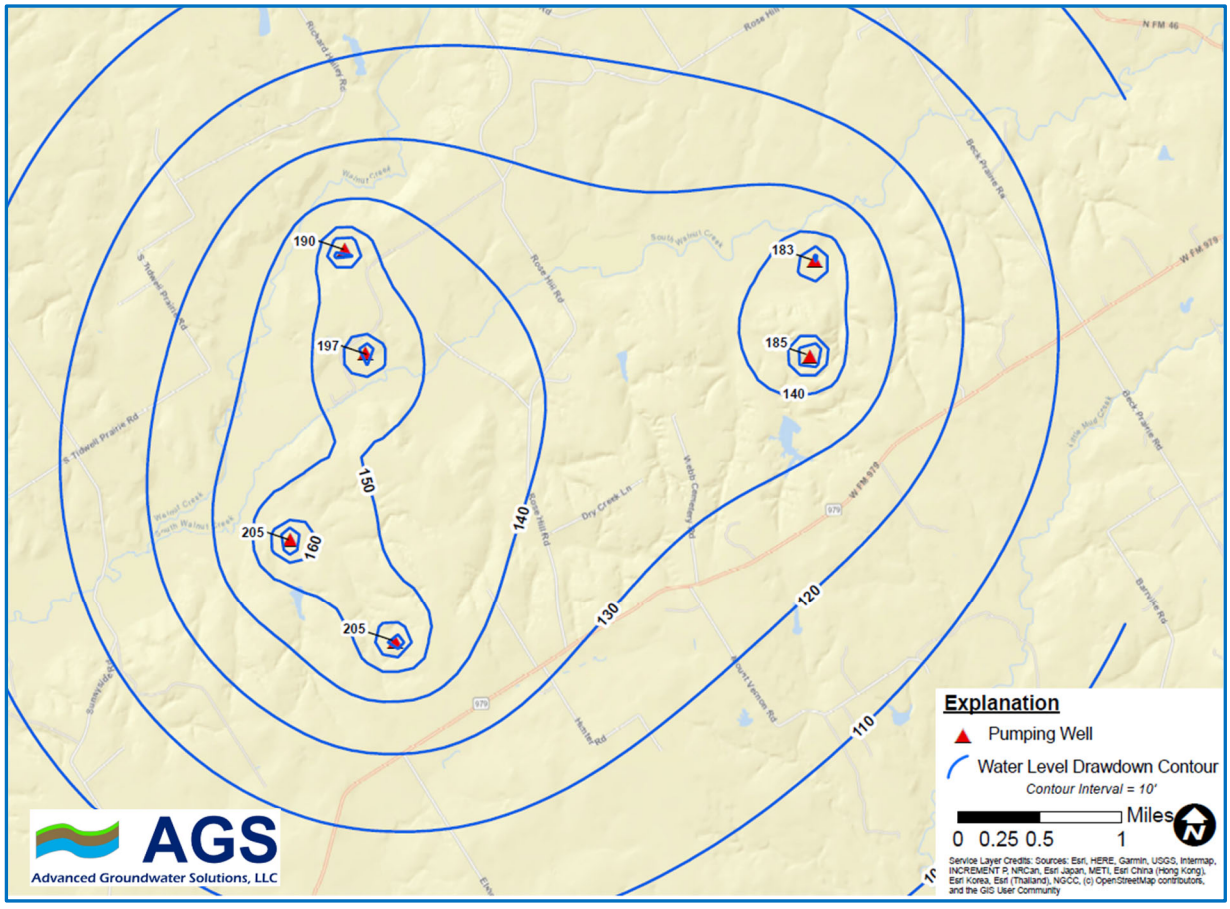


Figure 2. AGS Theis Analytical Simulated Drawdown After Proposed High Timber Pumping of 11,870 ac-ft/yr for 1-Year (TGI Hydraulic Properties)

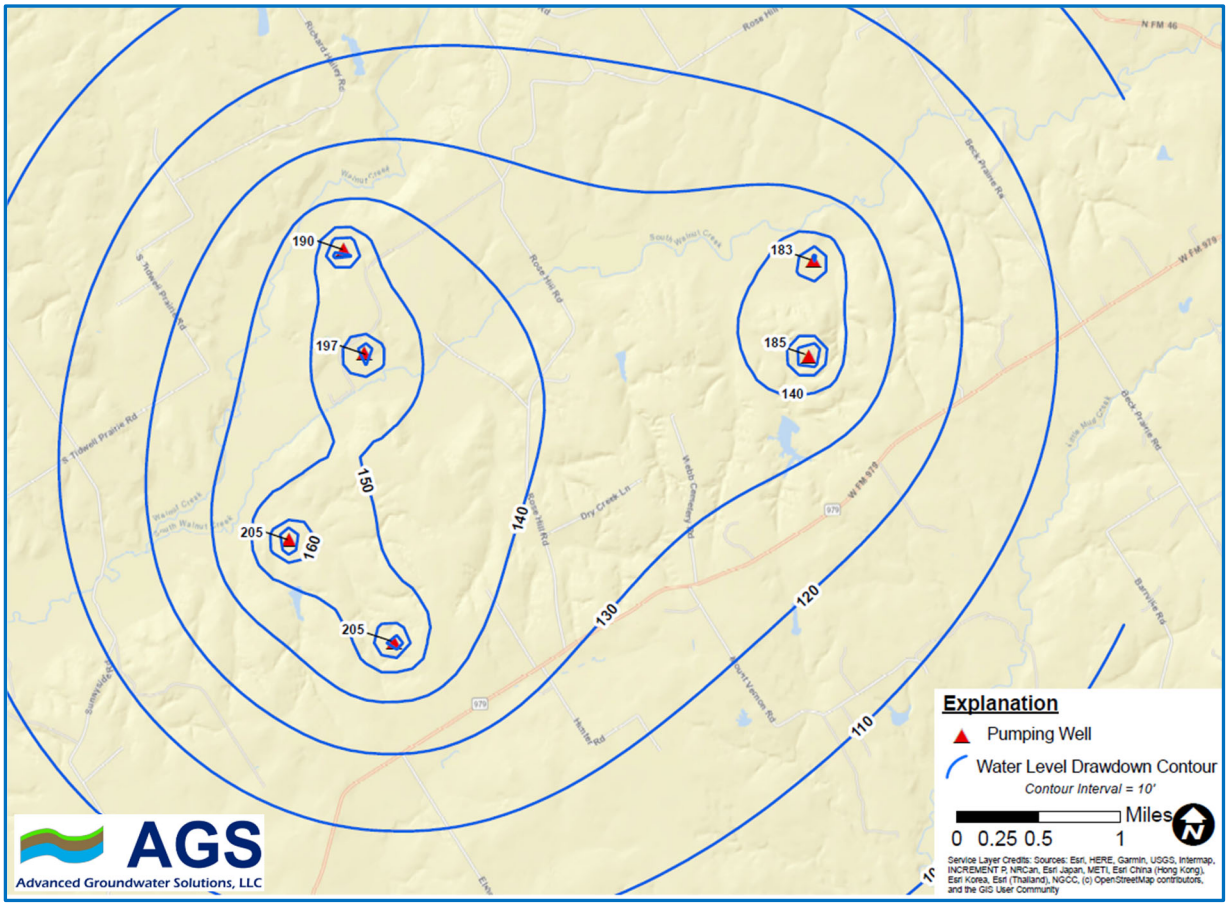


Figure 3. AGS Theis Analytical Simulated Drawdown After Proposed High Timber Pumping of 11,870 ac-ft/yr for 10-Years (TGI Hydraulic Properties)

A Level of Local Uncertainty

The proposed High Timber Wells are located in an area where there is a limited number of geophysical logs and existing water well data available for the Simsboro Aquifer. BVGCD has recently sought to acquire new logs and has reviewed the complex subsurface geology and area faulting using the available data. The limited amount of existing geophysical logs leads to uncertainty as to the local extent of the faulting and graben. The proposed High Timber Wells are also in an area that has not experienced pumping at the magnitude of the proposed High Timber wells. The amount of available drawdown in the Simsboro Aquifer in this area will depend on the actual top and bottom extent of the Simsboro Aquifer, but the structure and hydraulic properties in this area can only be refined as new data are made available. Available tools such as the Central Portion of the TWDB Sparta, Queen City and Carrizo-Wilcox Aquifers GAM and analytical models are based on the best available science and data and have been used to estimate future pumping impacts. However, the actual pumping effects related to the proposed High Timber wells may be different that what was estimated in the TGI AER and supplemental letter based on the site specific Simsboro Aquifer characteristics in the vicinity of High Timber well locations.

Estimated Long-term impacts at the Proposed High Timber Resources, L.P. Wells based on the GMA 12 2021 DFC Run

As a way of evaluating potential long-term estimated water level decline at the proposed High Timber wells, AGS plotted the simulated water level decline at each well location based on the 2021 GMA 12 DFC/Modeled Available Groundwater (MAG) projections for the Simsboro Aquifer as shown on the attached Figures 4 through 9. The water level projections shown in the attached figures are from the TWDB approved DFC/MAG run known as GMA 12 "S-19", but do not include the local impacts from the proposed High Timber wells included in the AER, nor do they include all of the pumping from the Simsboro Aquifer that has been permitted in the area in the past year. The DFC run includes pumping estimates from the Groundwater Conservation Districts in GMA 12 as of about December 2021 that yield DFCs so that the TWDB can estimate the MAG. The detailed assumptions for the DFC simulation can be found in the GMA 12 Explanatory Report (Daniel B. Stephens & Associates and others, 2022) and documentation of the TWDB MAG run can be found in GAM Run 21-017 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 12 (Shi and Harding, 2022).

The graphs illustrate the relationship between the land surface, estimated static water level through time, the GAM estimated top and bottom of the Simsboro Aquifer (GAM Layer 9) and the estimated base of the Simsboro Aquifer based on review of available local electric logs near the locations of the proposed High Timber wells.

Available static water level measurements from wells located near the proposed High Timber wells are also shown on the attached figures. A private irrigation well (BVGCD Permit BVOP-0018) is completed in the Simsboro Aquifer and has a total depth of about 600 below land surface. The BVOP-0018 static water level is shown on Figures 4, 5 and 6 and the well is located about 1 mile south-southwest of proposed High Timber Well 1, about 0.5 miles southwest of proposed High Timber Well 2 and about 0.8 miles north-northeast of proposed High Timber Well 3. The water level history for a private domestic well (BVGCD Permit BVR-0644) is shown on Figure 7 and the well screen sands of the Simsboro Aquifer in the depth interval of about 460 to 480 feet below land surface. BVR-0644 is located about 0.8 miles to the southeast of proposed High Timber Well 4. Water levels from an unused well (BVGCD Permit BVGO-0188) are shown on Figures 8 and 9 and the well screen sands of the Simsboro Aquifer in the depth interval of about 280 to 380 feet below land surface. BVGO-0188 is located about 1.3 miles east-northeast of proposed High Timber Well 5 and about 1.3 miles to the east-southeast of proposed High Timber Well 6.

Available drawdown in wells in the Simsboro Aquifer will decline over time based on the DFC simulation. In other words, the line with green dots does not include the impact of the proposed High Timber wells. Although not evaluated or discussed in detail herein, these levels of water level decline in wells and artesian head decline in the aquifer will have some impact on vertical leakage, intercepted discharge, reduction in confined and unconfined storage, and potential flow directions in the aquifer. Pumping by the proposed wells will have some of the same type effects on the aquifer.

Conclusions

The submitted AER generally addresses the requirements defined by BVGCD Rule 8.4(b)(7)(B) for wells capable of producing 800 or more acre-feet per year.

Overall, the TGI GAM simulations look reasonable and AGS was able to generally recreate the TGI simulation results. There are minor differences in the simulated drawdown estimated by TGI and AGS near the proposed High Timber well locations, but these can most likely be attributed to differences in the approach to the GAM simulation(s).

The TGI analytical modeling results show less drawdown as a result of pumping the requested permitted amount of 11,870 ac-ft/yr at the proposed High Timber well locations than calculated by AGS. This may be due to the difference in application of the Theis analytical approach. To provide a drawdown at the well, AGS calculates the drawdown at the pumping wells at one foot from the well.

AGS is documenting the differences but does not consider them to be major for the purposes of this report.

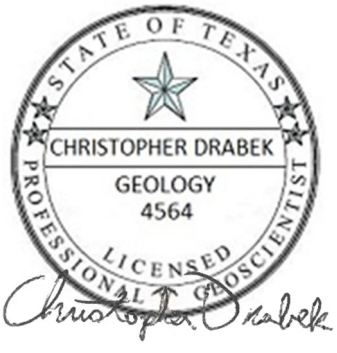
References

Daniel B. Stephens & Associates, INTERA Incorporated, and Ground Water Consultants, LLC, 2022, Desired Future Condition Explanatory Report for Groundwater Management Area 12, 859 p.

INTERA Incorporated, D.B. Stephens & Associates, and Ground Water Consultants, LLC, 2020, GMA 12 Update to the Groundwater Availability Model for the Central Portion of the Sparta, Queen City, Carrizo-Wilcox Aquifers: Update to Improve Representation of the Transmissive Properties of the Simsboro Aquifer in the Vicinity of the Vista Ridge Well Field, 30 p.

Shi, J. and Harding, J., 2022, GAM RUN 21-017 MAG: Modeled Available Groundwater for the Aquifers in Groundwater Management Area 12, 36 p.

Geoscientist's Seal:



The seal appearing on this document was authorized by Christopher Drabek, P.G. 4564 on 7/3/2023.
Advanced Groundwater Solutions, LLC (TBPG Firm Registration No. 50639)

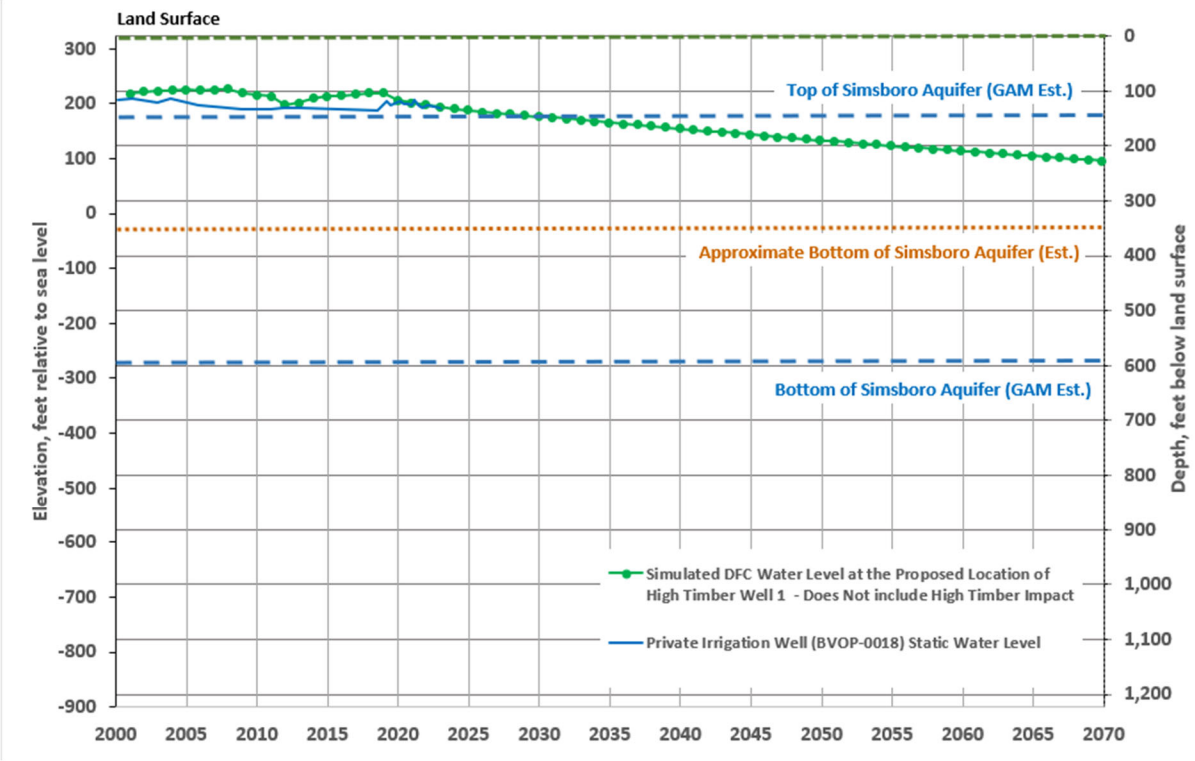


Figure 4. Projected DFC Water Level Change at Proposed High Timber Resources, L.P. Well 1

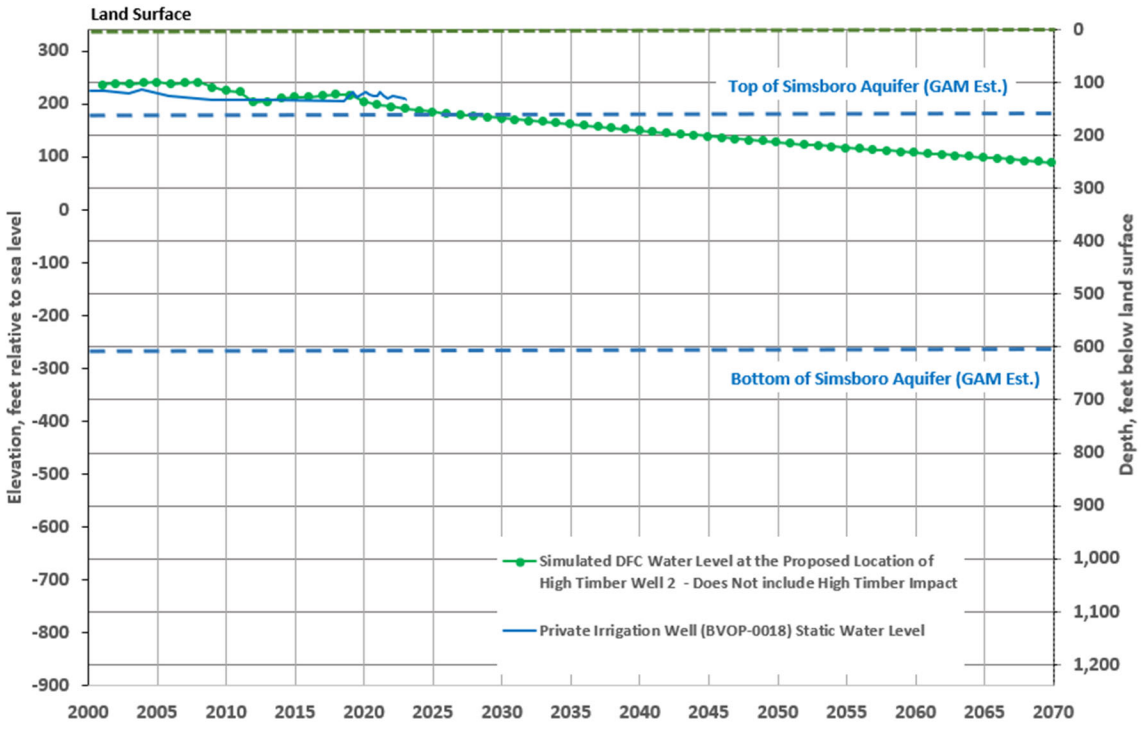


Figure 5. Projected DFC Water Level Change at Proposed High Timber Resources, L.P. Well 2

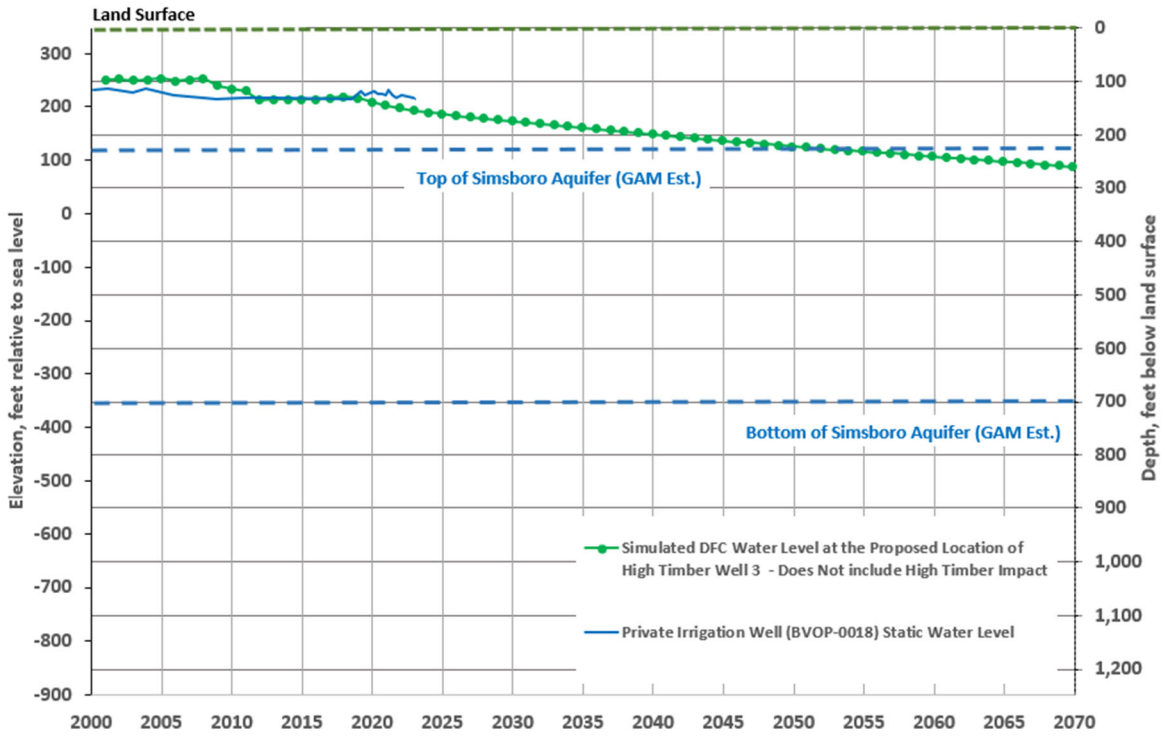


Figure 6. Projected DFC Water Level Change at Proposed High Timber Resources, L.P. Well 3

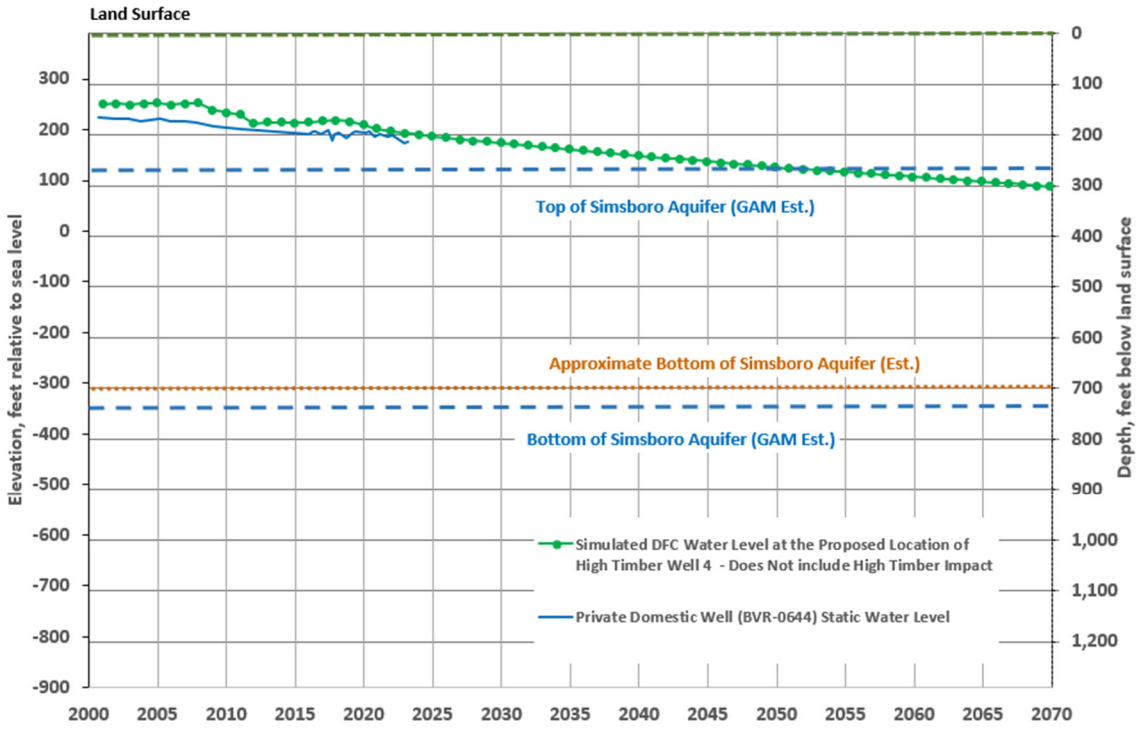


Figure 7. Projected DFC Water Level Change at Proposed High Timber Resources, L.P. Well 4

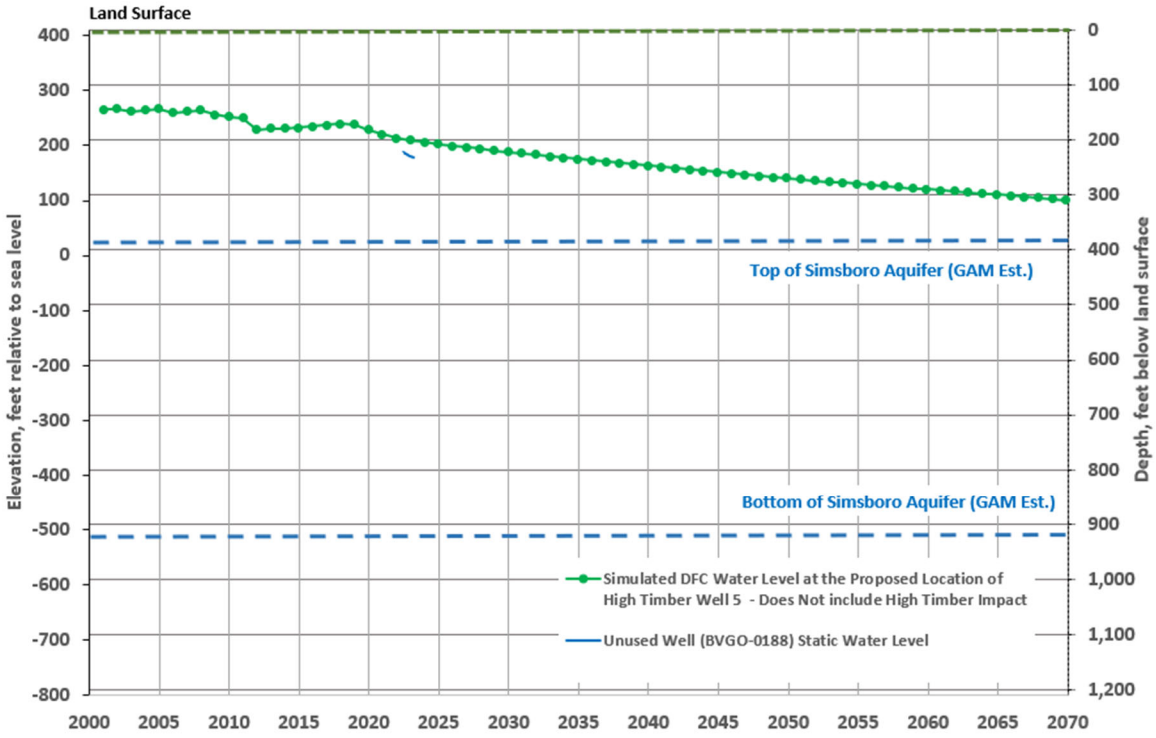


Figure 8. Projected DFC Water Level Change at Proposed High Timber Resources, L.P. Well 5

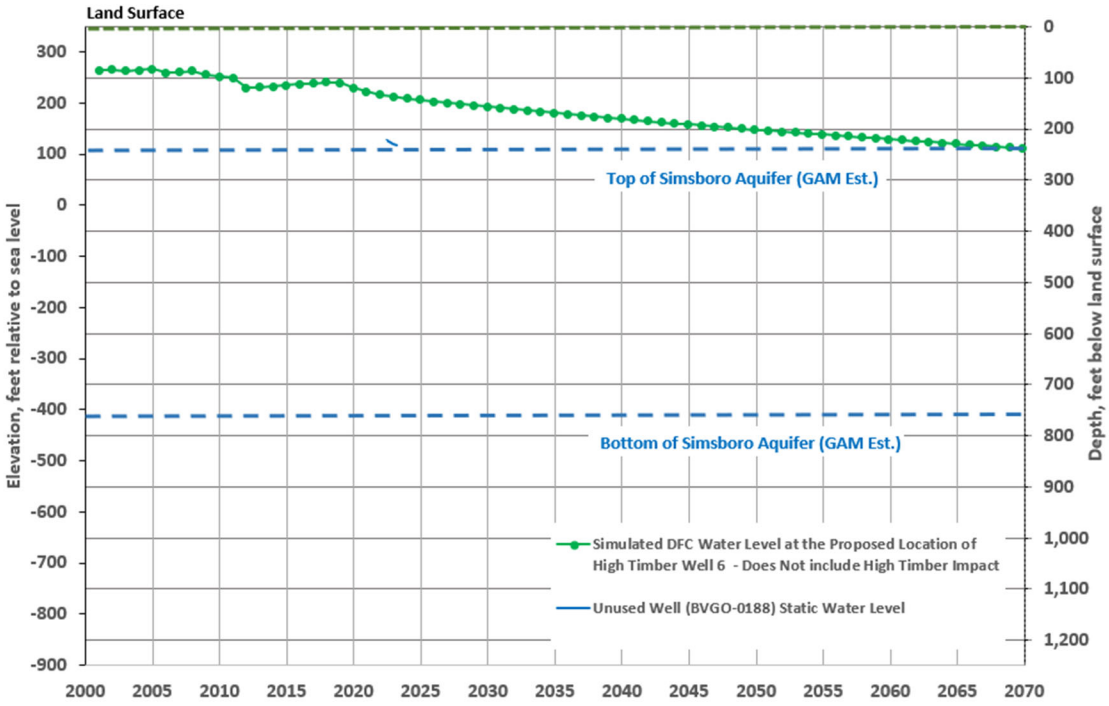


Figure 9. Projected DFC Water Level Change at Proposed High Timber Resources, L.P. Well 6

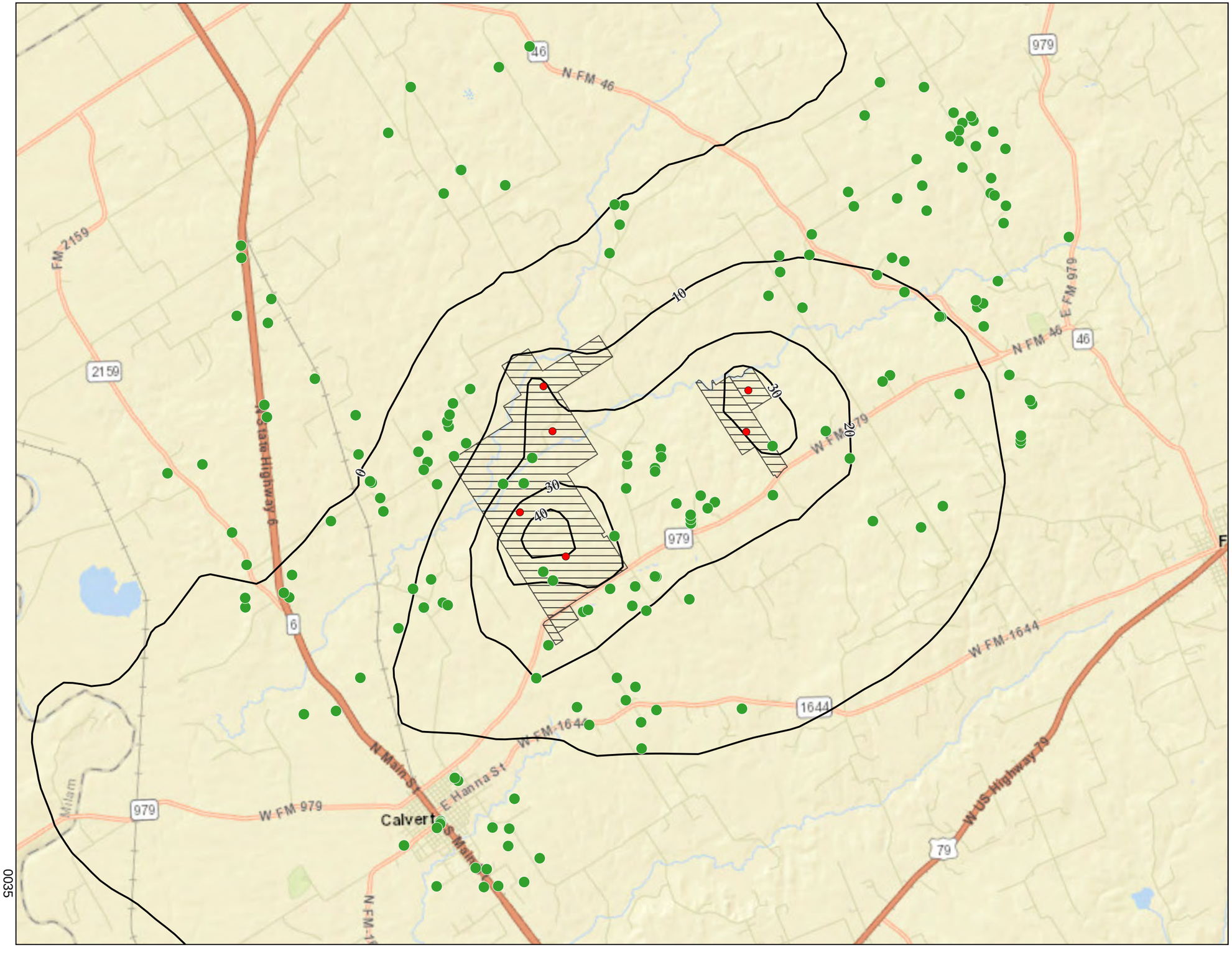


Figure 5: 1-Year QCSP GAM Drawdown Contours

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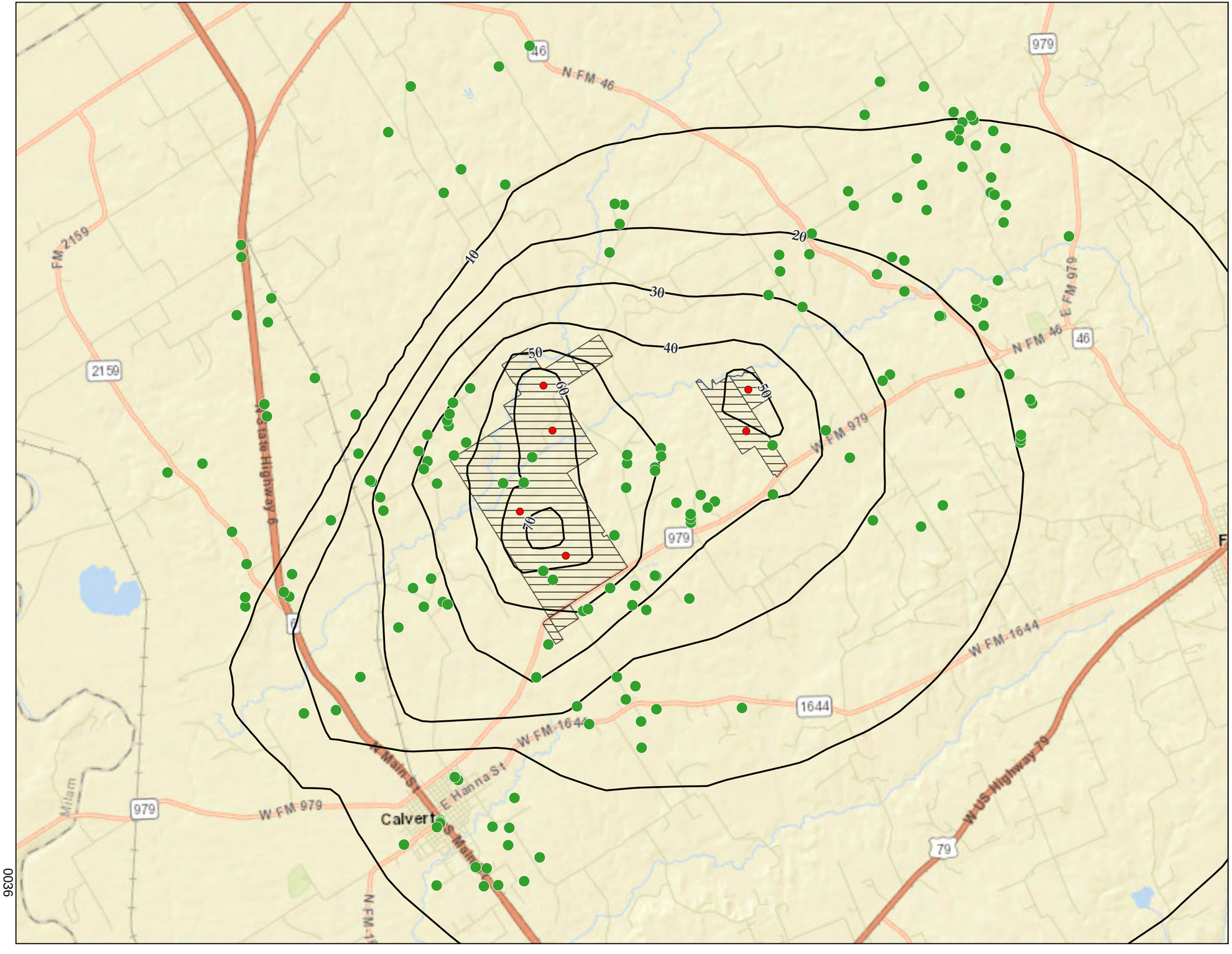

Figure 6:
10-Year QCSP GAM
Drawdown Contours

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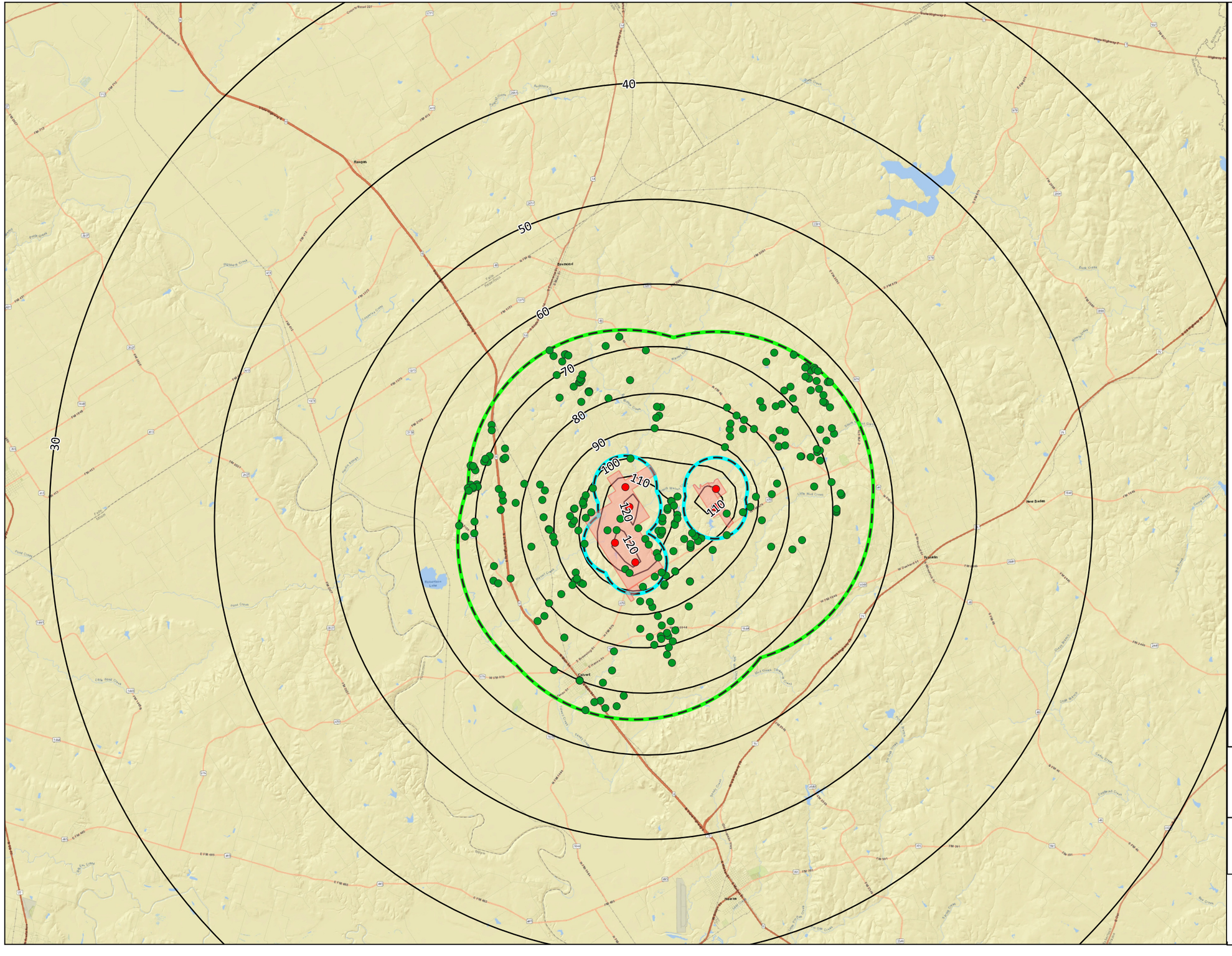

Explanation

- BVGCD Reported Well Completed in the Simsboro and W/in 5 Miles
- Proposed High Timber Well
- 1-Yr Modeled Drawdown Contour Interval = 10 feet
- 1 Mile Radius from Well Locations
- 5 Mile Radius from Well Locations
- High Timber Property Boundary

0 3 6 mi

High Timber Resources, LLC

Revised Figure 7:
1-Year Analytical Drawdown

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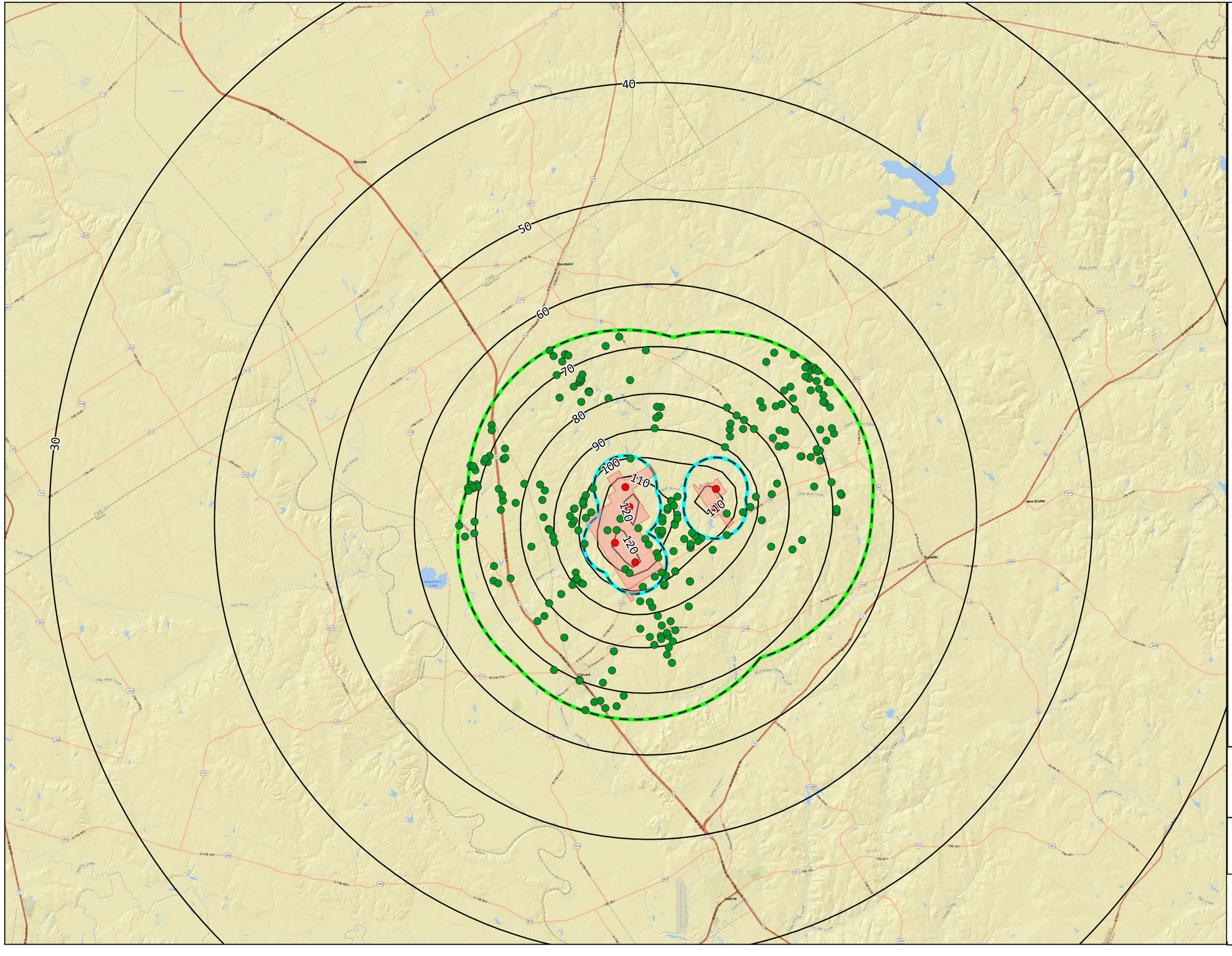

Explanation

- BVGCD Reported Well Completed in the Simsboro and W/in 5 Miles
- Proposed High Timber Well
- 10-Yr Modeled Drawdown Contour Interval = 10 feet
- 1 Mile Radius from Well Locations
- 5 Mile Radius from Well Locations
- High Timber Property Boundary

0 3 6 mi

High Timber Resources, LLC

Revised Figure 8:
10-Year Analytical Drawdown

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