AGS
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 RH2O LLC Simsboro Aquifer Evaluation Report

DATE: September 1, 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 RH2O LLC (RH2O) for five proposed new wells to be completed in the Simsboro Aquifer with a withdrawal amount of 8,130 acre-feet per year (ac-ft/yr). The TGI AER refers to the proposed RH2O wells as proposed Red Hill Farms (RHF) wells. The proposed wells are located on a tract of land located about 3 miles northwest of the City of Hearne. The locations of the wells are shown on Figure 1. The AER dated July 21, 2023 was submitted to BVGCD on that date. The AER was 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 west part of Robertson County.

AGS has evaluated the hydrogeological conditions, mapping of BVGCD permitted and registered Simsboro wells within one mile of the proposed RH2O 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 report.

Proposed RH2O LLC Wells

The five proposed RH2O wells have maximum production rates that range from 800 to 1,700 gallons per minute (gpm) and an annual permit allocation of 8,130 acre-feet. Table 1 below provides a summary of the maximum production rate in gpm and the annual permitted allocation in acre-feet for each of the proposed RH2O wells.

Well	Maximum Production Rate (gpm)	Annual Permit Allocation (acre-feet)
1	1,300	1,678
2	1,700	2,194
3	1,350	1,742
4	1,150	1,484
5	800	1,032

Table 1. Proposed RH2O LLC Well Maximum Production Rate and Annual Permit Allocation

The locations of the five proposed RH2O wells are shown below on Figure 1.

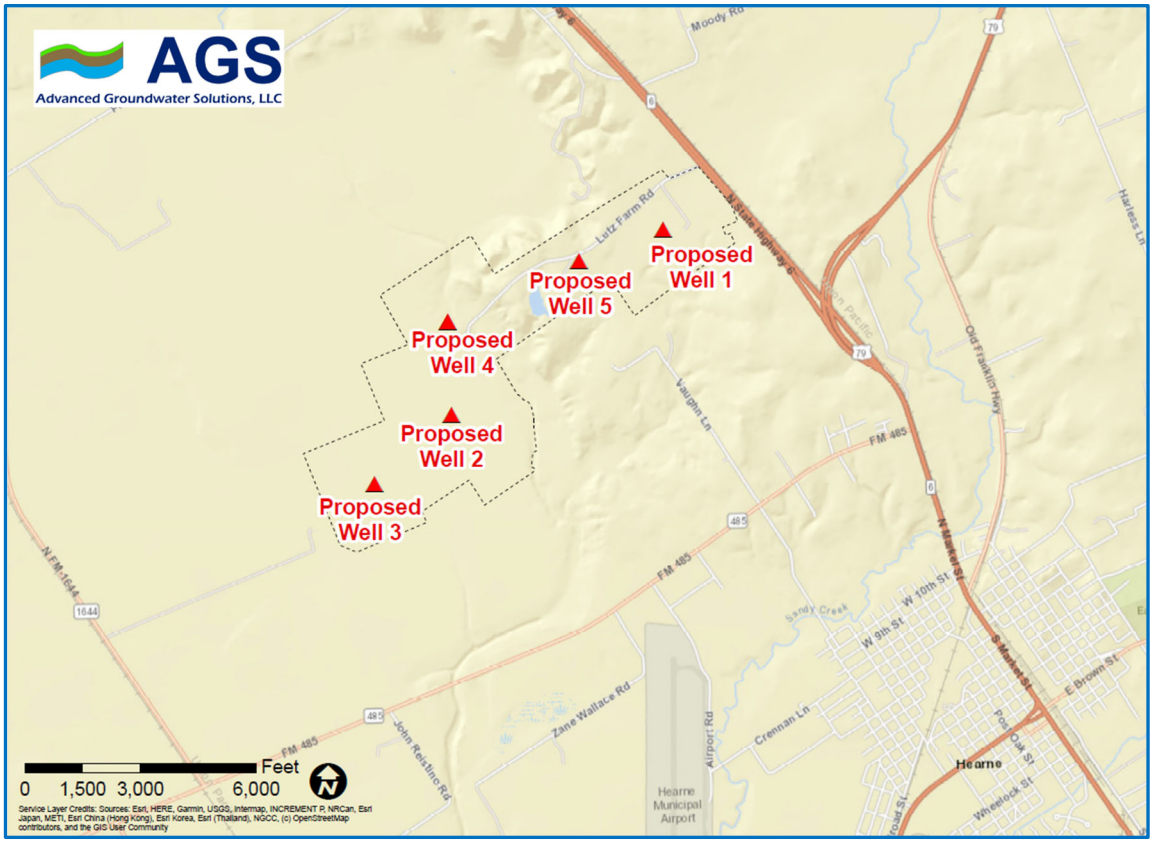


Figure 1. Proposed RH2O LLC Well Location Map

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 estimates the top of the Simsboro Aquifer to occur at depths between 870 and 1,050 feet below ground level (bgl) and the base of the Simsboro Aquifer to occur at depths between 1,340

and 1,550 feet bgl in the vicinity of the proposed RH2O wells based on the Central Portion of the Sparta, Queen City and Carrizo-Wilcox Aquifers GAM and Bureau of Economic Geology (BEG) mapping.

AGS estimates the top of the Simsboro Aquifer to occur at depths between about 885 and 990 feet bgl and the base of the Simsboro Aquifer to occur at depths between about 1,260 and 1,415 feet bgl in the vicinity of the proposed RH2O wells based on the review of available local geophysical logs.

Site specific information will be available once the test holes are drilled and logged for each of the proposed RH2O wells.

Simsboro Aquifer Wells Within 1-mile of the Proposed RH2O Wells

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

Table 1 in the TGI AER provides information on the BVGCD permitted or registered Simsboro wells within 1-mile of the proposed RH2O wells and locations of the permitted or registered wells are shown on Figures 6, 6a and 6b in the TGI AER. The table does not include information on the well screened interval.

AGS reviewed permitted and registered well data available from BVGCD and identified four additional BVGCD permitted wells that are located within 1-mile of the proposed RH2O wells that were not included in Table 1 of the AER. Table 2 below provides a summary of the additional permitted wells identified by AGS.

Permit	Permit Holder	Well
BVDO-0298	UW Brazos Valley Farm, LLC	PS4
BVDO-0302	UW Brazos Valley Farm, LLC	PS9
BVDO-0304	UW Brazos Valley Farm, LLC	PS11
BVDO-0300	UW Brazos Valley Farm, LLC	PS6

Table 2. Addition BVGCD Permitted Wells Identified Within 1-mile of the Proposed RH2O LLC Wells

AGS also noted that UW Brazos Valley Farm, LLC Well CS3 (BVDO-0256) is located at or just slightly beyond a distance of 1-mile from the proposed RH2O wells.

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 RH2O wells at a combined rate of 8,130 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 9 and 10) are attached to this memorandum. Tables 1 and 2 in the TGI AER shows GAM simulated 1-year and 10-year drawdown estimates at most BVGCD permitted and registered Simsboro wells within a 1-mile and 5-mile radius of the proposed RH2O wells. The TGI report did not discuss the GAM simulation methodology, but the TGI GAM model results 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 8,130 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 8,130 ac-ft/yr show about 8 to 18 feet of drawdown at 5 miles and about 30 to 38 feet of drawdown at 1 mile after 1-year of pumping and about 10 to 20 feet of drawdown at 5 miles and about 35 to 40 feet of drawdown at 1 mile after 10-years of pumping.

The GAM estimated drawdown contours near proposed RH2O wells 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. The TGI AER did not discuss the input parameters used in the analytical modeling.

AGS simulated the drawdown at the pumping wells using the Theis analytical model and estimated the drawdown at one foot from the well. A transmissivity of 55,117 gallons per day per foot (gpd/ft) and a storage value of 0.000151 were used in the AGS analytical simulations with each proposed RH2O well pumping its average annual production rate. The transmissivity and storage values used in the AGS analytical simulations represent an average of the Simsboro Aquifer parameters in the GAM at the proposed RH2O well locations.

AGS was able to generally recreate the 1-year simulation results of the TGI analytical modeling. The TGI 10-year analytical simulation appears to underestimate the drawdown compared to simulations performed by AGS using the aquifer parameters as described above. Simulated drawdown could be less if TGI used a larger storage value in the 10-year simulation. Figure 2 below shows the estimated AGS analytical modeling drawdown contours that result from pumping 8,130 ac-ft/yr for 10-years.

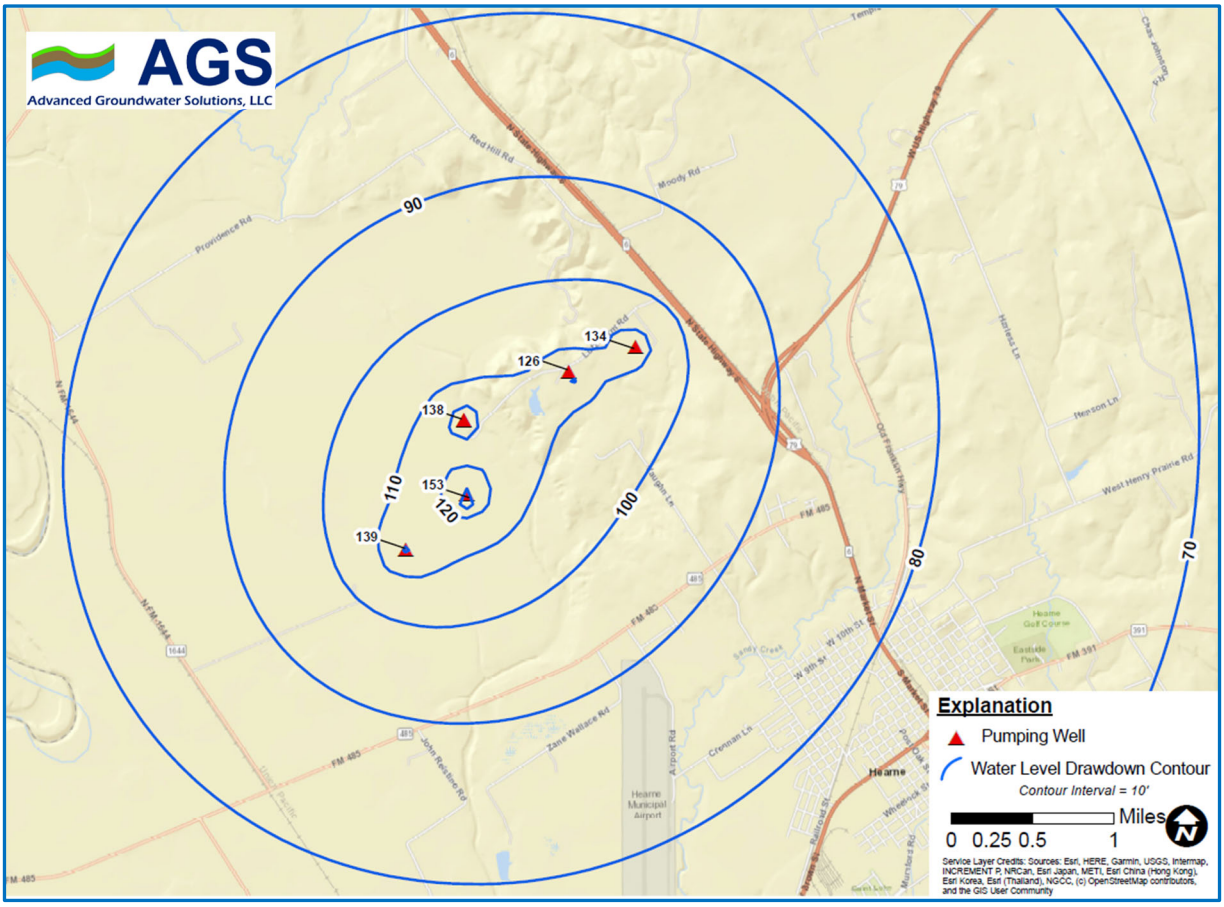


Figure 2. AGS Theis Analytical Simulated Drawdown After Proposed RH2O Pumping of 8,130 ac-ft/yr for 10-Years

Table 3 below provides a summary of the AGS simulated drawdown estimates at 1-foot from each of the proposed RH2O wells after pumping 8,130 ac-ft/yr for 1-year and 10 years.

Well	AGS Simulated Drawdown After 1-Year of Pumping (feet)	AGS Simulated Drawdown After 10-Years of Pumping (feet)
1	110	134
2	129	153
3	115	139
4	114	138
5	102	126

Table 3. AGS Theis Analytical Simulated Drawdown at the Proposed RH2O Wells After 1-Year and 10-Years of Pumping 8,130 ac-ft/yr

Estimated Long-term impacts at the Proposed RH2O LLC Wells based on the GMA 12 2021 DFC Run

As a way of evaluating potential long-term estimated water level decline at the proposed RH2O 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 3 through 7. 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 RH2O 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 and the estimated top and bottom of the Simsboro Aquifer based on review of available local electric logs near the locations of the proposed RH2O wells.

Water levels available from the City of Hearne Well 4 (POW) (BVGCD Permit BVHU-0013) are shown on Figure 3. The well screen sands of the Simsboro Aquifer in the depth interval of about 1,221 to 1,425 feet below land surface. BVHU-0013 is located about 1.7 miles south of proposed RH2O Well 1.

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 RH2O 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.

The TGI GAM simulations look reasonable and AGS was able to recreate the TGI simulation results. There are minor differences in the simulated drawdown estimated by TGI and AGS near the proposed RH2O well locations, but these can most likely be attributed to differences in the approach to the GAM simulation(s).

AGS was able to generally recreate the TGI analytical simulation results of pumping the requested permitted amount of 8,130 ac-ft/yr for 1-year from the proposed RH2O wells. The 10-year analytical simulation results in the TGI AER appear to underestimate the drawdown compared to simulations performed by AGS using the same aquifer parameters used in the 1-year simulations. The TGI simulated drawdown could be less if a larger storage value was used in the 10-year simulation.

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

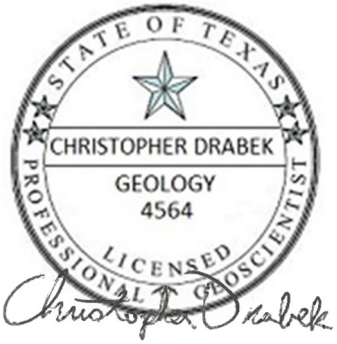
References

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 9/1/2023.
Advanced Groundwater Solutions, LLC (TBPG Firm Registration No. 50639)

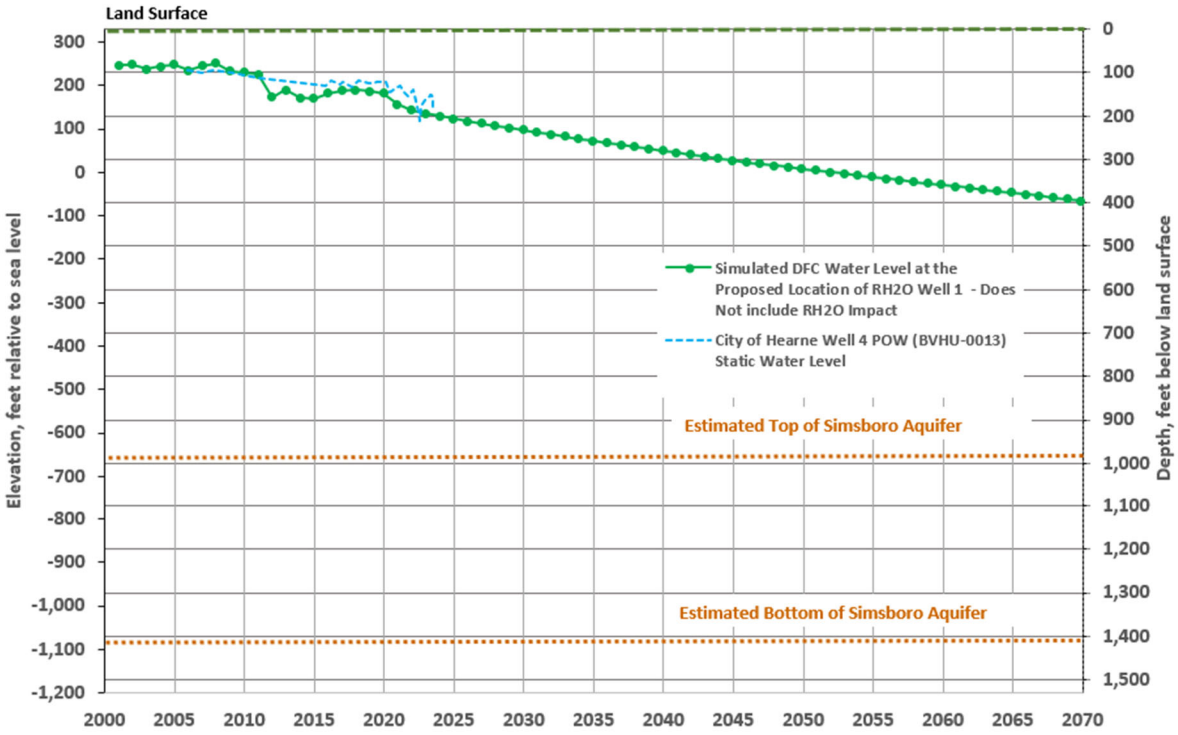


Figure 3. Projected DFC Water Level Change at Proposed RH2O Well 1

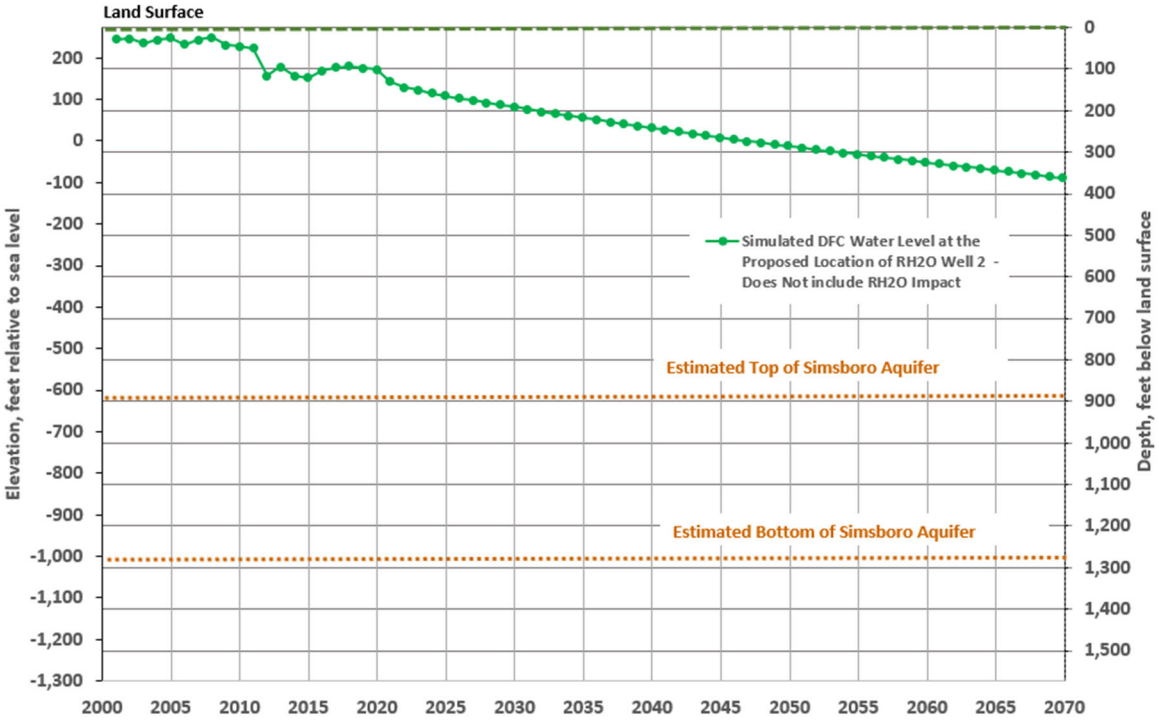


Figure 4. Projected DFC Water Level Change at Proposed RH2O Well 2

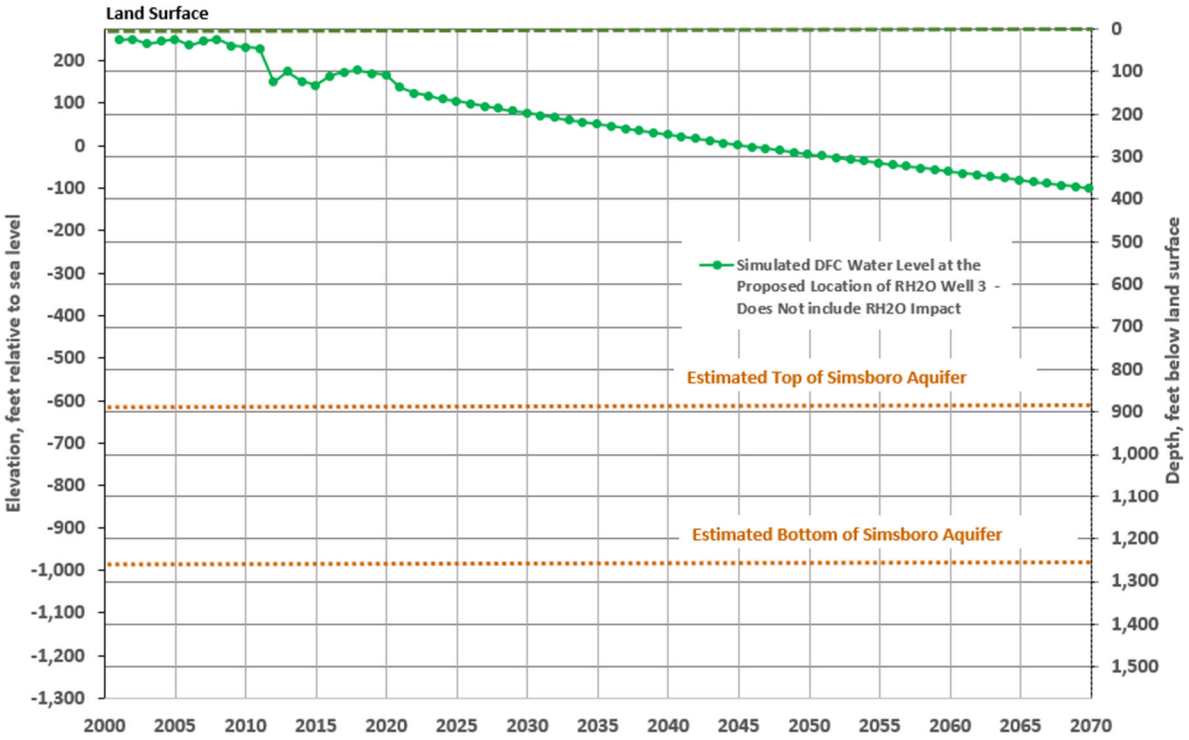


Figure 5. Projected DFC Water Level Change at Proposed RH2O Well 3

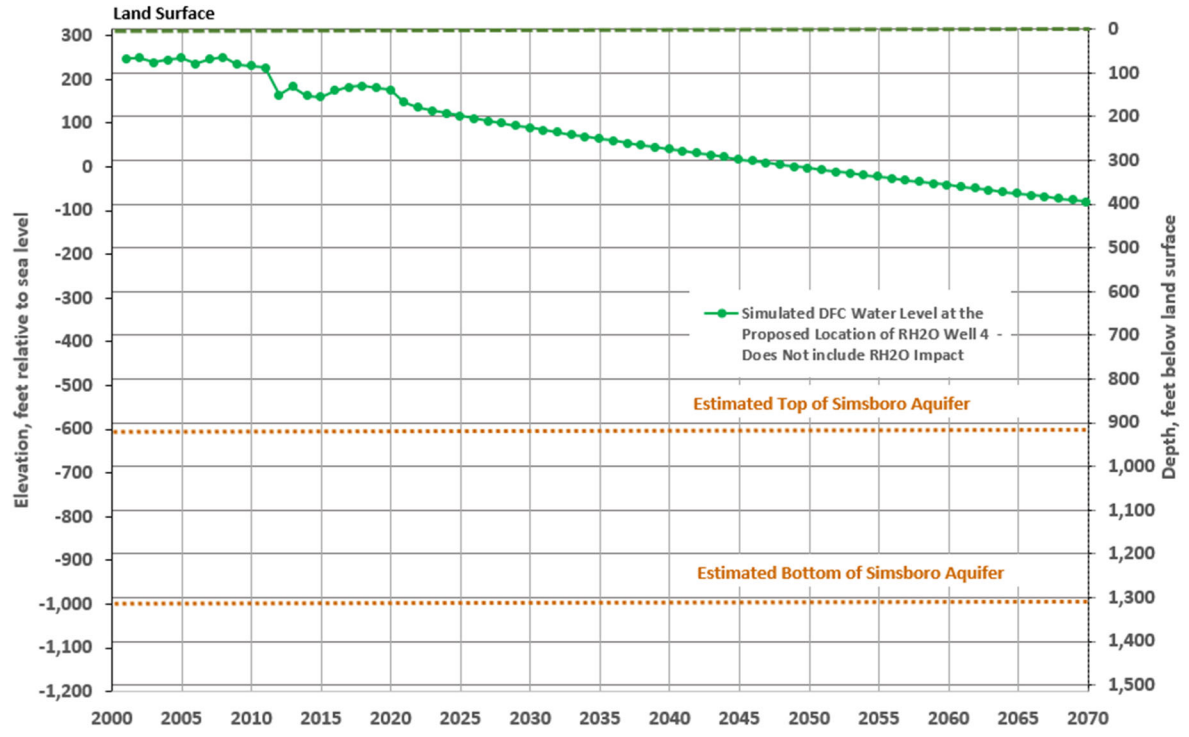


Figure 6. Projected DFC Water Level Change at Proposed RH2O Well 4

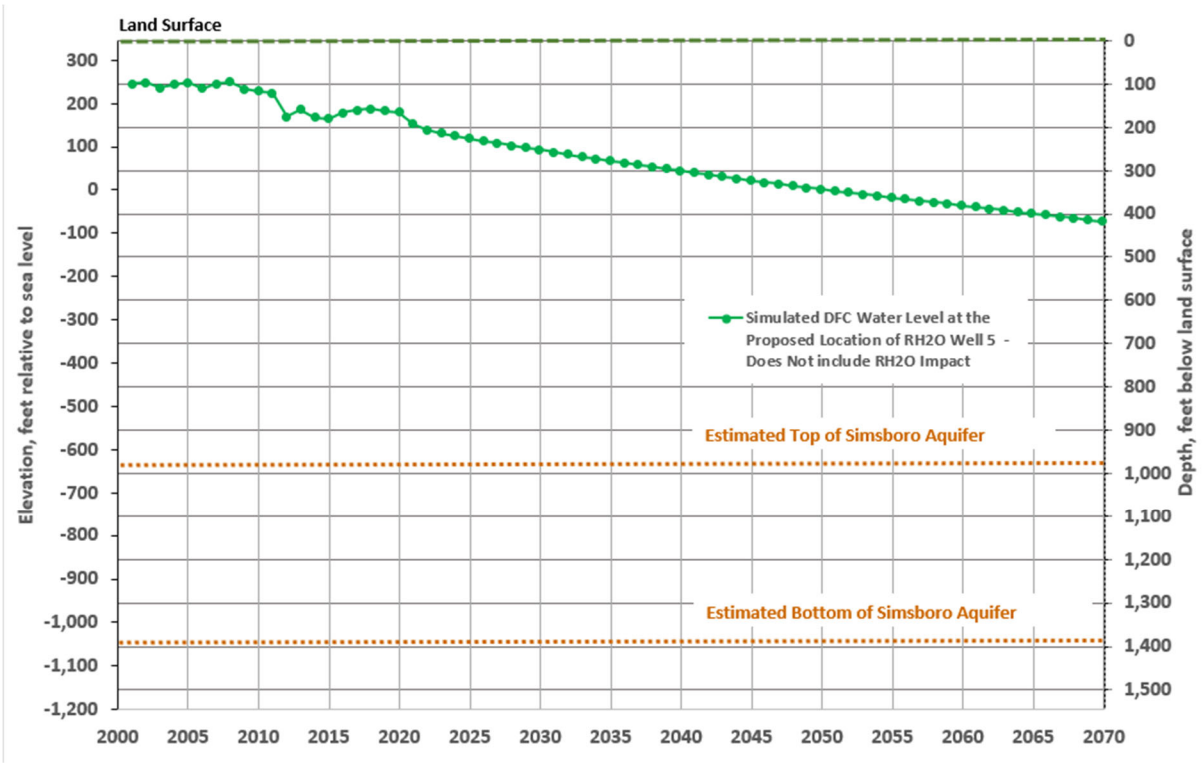
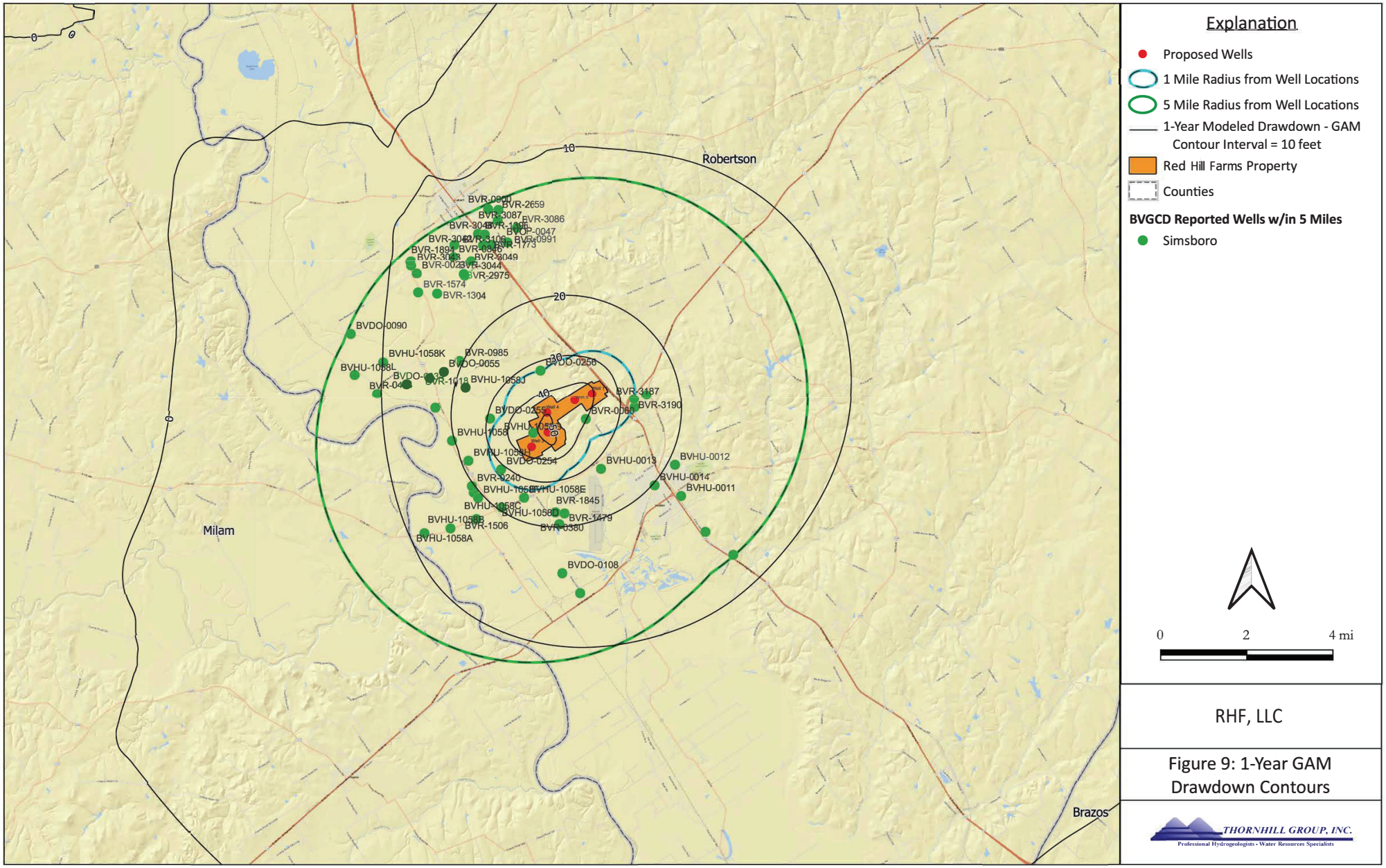
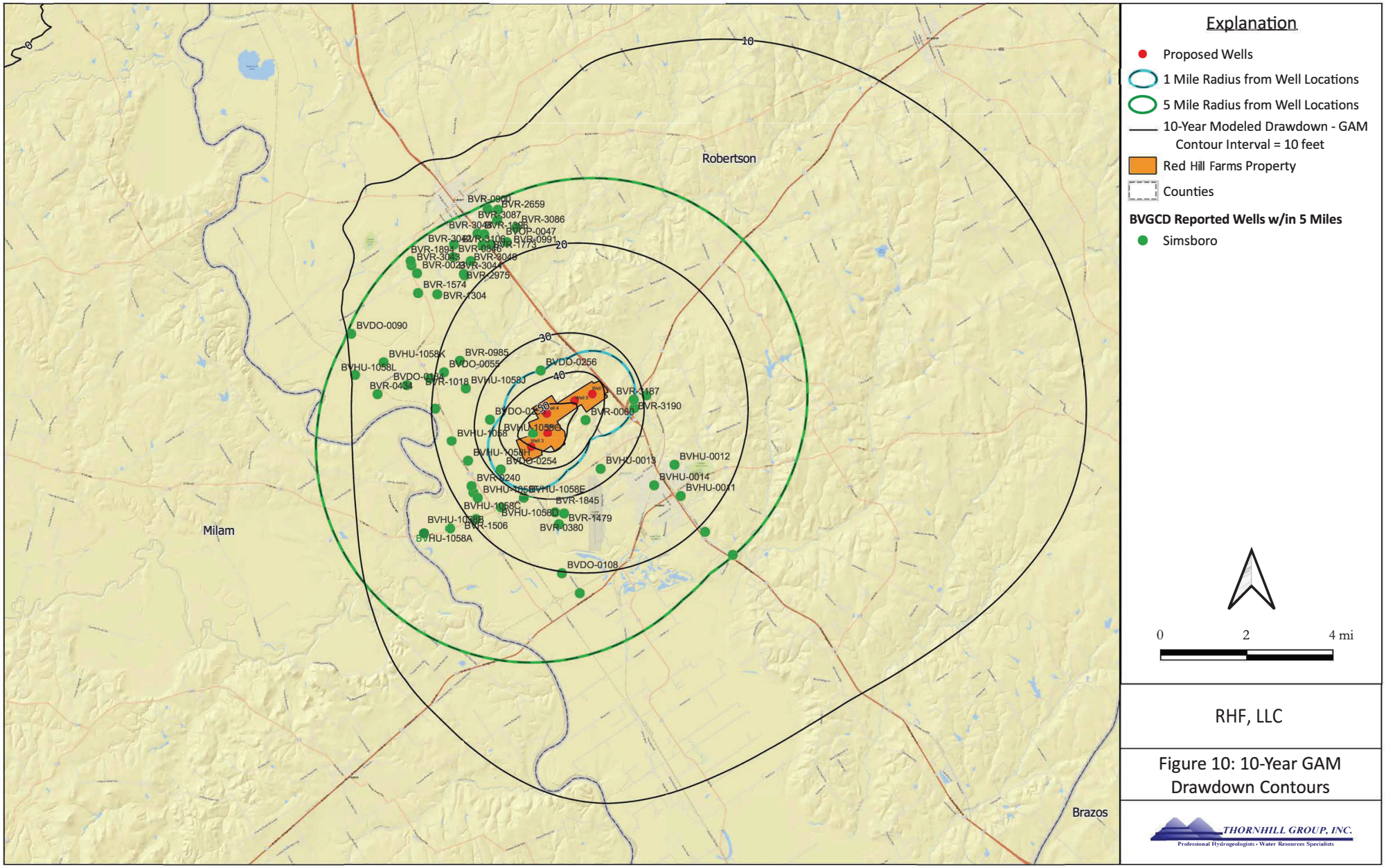


Figure 7. Projected DFC Water Level Change at Proposed RH2O Well 5


Explanation
Proposed Wells
1 Mile Radius from Well Locations
5 Mile Radius from Well Locations
1-Year Modeled Drawdown - GAM
Contour Interval = 10 feet
Red Hill Farms Property
Counties
BVGCD Reported Wells w/in 5 Miles
Simsboro
0
2
4 mi
Robertson
Milam
Brazos
10
20
30
40
50
BVR-0990
BVR-2659
BVR-3087
BVR-3086
BVR-3045
BVR-1305
BVOP-0047
BVR-3046
BVR-3106
BVR-0991
BVR-1773
BVR-1894
BVR-0546
BVR-3049
BVR-0023
BVR-3044
BVR-2975
BVR-1574
BVR-1304
BVDO-0090
BVHU-1058K
BVR-0985
BVHU-1058L
BVDO-0055
BVDO-0258
BVR-1618
BVHU-1058J
BVR-3187
BVR-3190
BVR-0066
BVDO-0255
BVHU-1058
BVHU-1058H
BVDO-0254
BVHU-0013
BVHU-0012
BVHU-0014
BVR-0240
BVHU-1058G
BVHU-1058E
BVHU-0011
BVR-1845
BVHU-1058C
BVHU-1058D
BVR-1479
BVHU-1058B
BVR-1506
BVR-0380
BVHU-1058A
BVDO-0108
RHF, LLC
Figure 9: 1-Year GAM Drawdown Contours
THORNHILL GROUP, INC.
Professional Hydrogeologists - Water Resources Specialists


Explanation
Proposed Wells
1 Mile Radius from Well Locations
5 Mile Radius from Well Locations
10-Year Modeled Drawdown - GAM
Contour Interval = 10 feet
Red Hill Farms Property
Counties
BVGCD Reported Wells w/in 5 Miles
Simsboro
0
10
20
30
40
50
Robertson
Milam
Brazos
BVR-0990
BVR-2659
BVR-3087
BVR-3086
BVR-3045
BVR-1895
BVOP-0047
BVR-3042
BVR-3106
BVR-0991
BVR-1773
BVR-1894
BVR-0846
BVR-3043
BVR-3049
BVR-0023
BVR-3041
BVR-2975
BVR-1574
BVR-1304
BVDO-0090
BVHU-1058K
BVR-0985
BVHU-1058L
BVDO-0055
BVDO-0256
BVDO-0158
BVR-1018
BVHU-1058J
BVR-0434
BVR-3187
BVR-3190
BVDO-0150
BVR-0060
BVHU-1058G
BVHU-1058
BVHU-1058H
BVDO-0254
BVHU-0013
BVHU-0012
BVR-0240
BVHU-0014
BVHU-1058E
BVHU-0011
BVR-1845
BVHU-1058C
BVHU-1058D
BVR-1479
BVHU-1058B
BVR-1506
BVR-0380
BVHU-1058A
BVDO-0108
0
2
4 mi
RHF, LLC
Figure 10: 10-Year GAM Drawdown Contours
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