

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 DTB Investments LP Carrizo Aquifer and 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 DTB Investments LP (DTB) for 14 proposed new wells, with seven wells to be completed in the Carrizo Aquifer with a withdrawal amount of 7,612 acre-feet per year (ac-ft/yr) and seven wells to be completed in the Simsboro Aquifer with a withdrawal amount of 15,227 ac-ft/yr. The proposed wells are located on the DTB Astin Farms property, which is located near the community of Mumford. The locations of the 14 proposed wells are shown on Figure 1. The AER dated July 9, 2023 was submitted to BVGCD on July 11, 2023. AGS provided supplemental questions to TGI on July 19, 2023 and TGI provided a response to those questions on July 20, 2023. 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 Carrizo Aquifer and Simsboro Aquifer of the proposed new wells in the south part of Robertson County.

AGS has evaluated the hydrogeological conditions, mapping of BVGCD permitted and registered Simsboro wells within one mile of the proposed DTB 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 DTB Investments LP Wells

The proposed DTB Carrizo wells have maximum production rates that range from 525 to 1,100 gallons per minute (gpm) and an annual permit allocation of 7,612 acre-feet. The annual permit allocation of 7,612 acre-feet requested for the Carrizo Aquifer is slightly less than the 7,613 acre-feet discussed in the TGI AER. TGI provided clarification on this difference in a July 20, 2023 email response, which confirmed the requested Carrizo Aquifer allocation of 7,612 acre-feet. The proposed DTB Simsboro wells have maximum production rates that range from 1,050 to 2,200 gpm and an annual permit allocation of 15,227 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 DTB Carrizo and Simsboro wells. The proposed Simsboro Well 7 maximum pumping rate of 1,050 gpm shown in the TGI table on Page 3 of the AER should be 1,500 gpm.

Well	Maximum Production Rate (gpm)	Annual Permit Allocation (acre-feet)	
Carrizo			
C1	975	1,258	
C2	525	677	
C3	525	677	
C4	1,100	1,419	
C5	1,075	1,387	
C6	950	1,226	
C 7	750	968	
Simsboro			
S1	1,950	2,516	
S2	1,050	1,355	
S3	1,050	1,355	
S4	2,200	2,839	
S 5	2,150	2,774	
S6	1,900	2,452	
S 7	1,500	1,936	

Table 1. Proposed DTB Investments LP Well Maximum Production Rate and Annual Permit Allocation

The proposed DTB Carrizo and Simsboro wells are planned to be paired so that one Carrizo well and one Simsboro well will be completed at each location. The Carrizo and Simsboro wells are planned to be spaced about 50 feet apart. The locations of Carrizo Well 7 and Simsboro Well 7 have been modified from the estimated locations shown in the TGI AER. The updated latitudes and longitudes provided on July 20, 2023 by TGI for the proposed Carrizo Well 7 is 30.7379054835 / -96.5316828807 and 30.7377996553 / -96.5317988591 for proposed Simsboro Well 7. The locations of the 14 proposed DTB wells are shown on Figure 1 below.



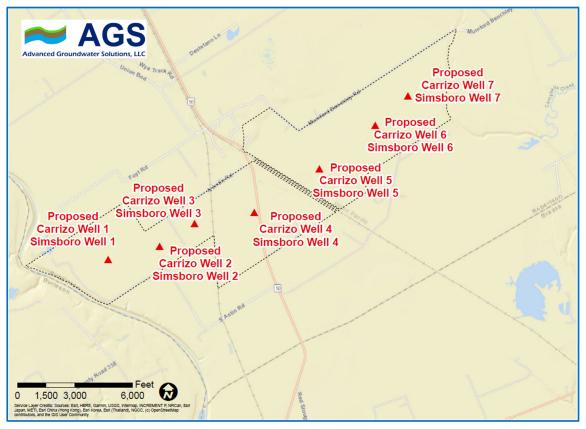


Figure 1. Proposed DTB Investments LP Well Location Map

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 Carrizo Aquifer to occur at depths between 490 and 560 feet below ground level (bgl) and the base of the Carrizo Aquifer to occur at depths between 800 and 1,000 feet bgl in the vicinity of the proposed DTB Carrizo wells. The AER estimates the top of the Simsboro Aquifer to occur at depths between 1,700 and 1,850 feet bgl and the base of the Simsboro Aquifer to occur at depths between 2,300 and 2,700 feet bgl in the vicinity of the proposed DTB Simsboro wells.

AGS estimates the top of the Carrizo Aquifer to occur at depths between about 720 and 745 feet bgl and the base of the Carrizo Aquifer to occur at depths between about 890 and 940 feet bgl in the vicinity of the proposed DTB Carrizo wells based on the review of available local geophysical logs. AGS estimates the top of the Simsboro Aquifer to occur at depths between about 1,780 and 1,860 feet bgl and the base of the Simsboro Aquifer to occur at depths between about 2,330 and



2,500 feet bgl in the vicinity of the proposed DTB Simsboro 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 DTB Carrizo and Simsboro wells.

The TGI AER discusses hydraulic property estimates for the Carrizo Aquifer based on GAM estimates and TGI estimates. The Carrizo Aquifer transmissivity is estimated to be about 23,000 to 26,000 gallons per day per foot (gpd/ft) based on the GAM and about 20,000 to 30,000 gpd/ft based on TGI estimates.

Data from a 36-hour pumping test for the City of College Station Carrizo Well 1 indicates that the well has an estimated transmissivity value of about 6,547 gpd/ft. The City of College Station Carrizo Well 1 (BVDO-0001) screens sands of the Carrizo Aquifer in the depth interval of about 1,120 to 1,360 feet bgl and is located about 4 miles to the east-southeast of proposed DTB Carrizo Well 5. The City of College Station Carrizo Well transmissivity is substantially less than the GAM and TGI transmissivity estimates.

Simsboro Aquifer Wells Within 1-mile of the Proposed DTB Investments LP Wells

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

The TGI AER did not identify any BVGCD permitted or registered Carrizo or Simsboro wells within one mile of the proposed DTB wells. TGI Figure 7 and Figures 7a through 7d show a 1-mile radius from the proposed DTB Carrizo wells and Figure 9 and Figures 9a through 9d show a 1-mile radius from the proposed DTB Simsboro wells.

AGS reviewed permitted and registered well data available from BVGCD and did not identify any BVGCD permitted or registered Carrizo or Simsboro well within 1-mile of the proposed DTB Carrizo and Simsboro 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 DTB wells at a combined rate of 7,613 ac-ft/yr for the Carrizo Aquifer simulation and 15,227 ac-ft/yr for the Simsboro Aquifer simulation for 1 year and 10 years each. A copy of the TGI 1-year and 10-year GAM simulated interference drawdown illustrations from the AER (TGI Carrizo Figures 12 and 13; TGI Simsboro Figures 14 and 15) 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 Carrizo wells (Table 1) and Simsboro wells (Table 2) within a 5-mile radius of the proposed DTB wells. The TGI AER text mentions that Tables 1 and 2 shows the Carrizo impacts at 1-mile and 5-miles, and Tables 3 and 4 shows the Simsboro impacts at 1-mile and 5-miles. This statement is incorrect as the TGI AER only includes two tables as described above (Table 1 Carrizo Aquifer 5-mile effects; Table 2 Simsboro Aquifer 5-mile effects).

The TGI report did not discuss the GAM simulation methodology, but the TGI GAM Carrizo and Simsboro model results appear to be reasonable based on AGS simulation verification runs.

In the AGS Carrizo and Simsboro Aquifer verification runs, two GAM simulations were completed for each aquifer 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 pumping (7,612 ac-ft/yr for the Carrizo simulation; 15,227 ac-ft/yr for the Simsboro simulation) was included in the MODFLOW WEL file. The estimated 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.

Table 2 below provides a summary of the AGS GAM simulated Carrizo and Simsboro drawdown estimates at 1-mile and 5-miles from the proposed DTB wells after pumping for 1-year and 10 years. The Carrizo simulation had the seven proposed Carrizo wells pumping 7,612 ac-ft/yr and the Simsboro simulation had the seven proposed Simsboro wells pumping 15,227 ac-ft/yr.



Aquifer	AGS GAM Simulated Drawdown After 1-Year of Pumping at 1-mile (feet)	AGS GAM Simulated Drawdown After 1-Year of Pumping at 5-miles (feet)	AGS GAM Simulated Drawdown After 10- Years of Pumping at 1-mile (feet)	AGS GAM Simulated Drawdown After 10- Years of Pumping at 5-miles (feet)
Carrizo	65-90	15-43	75-100	20-55
Simsboro	56-65	35-45	70-78	48-60

Table 2. AGS GAM Simulated Carrizo and Simsboro Drawdown After Proposed DTB Investments LP Pumping 1-Year and 10-Years.

Note: the Carrizo and Simsboro pumping was simulated in separate model simulations.

The AGS GAM simulations generally show drawdown similar to TGI at distance for the Carrizo Aquifer simulations. The AGS Simsboro Aquifer GAM simulations show slightly less drawdown than the TGI simulations at distances of 1-mile and 5-miles after 1 and 10 years of pumping.

The GAM estimated drawdown contours appear to be influenced by faults included in the GAM, which are in the same general area as faults that have been mapped by Ground Water Consultants 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 DTB Carrizo and Simsboro 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 25,000 gpd/ft and a storage value of 0.000133 were used in the AGS Carrizo Aquifer analytical simulations with each proposed DTB Carrizo well pumping its average annual production rate. The transmissivity and storage values used in the AGS analytical simulations represent an average of the Carrizo Aquifer parameters in the GAM at the proposed DTB well locations. AGS was able to generally recreate the 1-year simulation results of the TGI Carrizo analytical modeling. The TGI 10-year Carrizo 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 Carrizo analytical modeling drawdown contours that result from pumping 7,612 ac-ft/yr for 10-years.

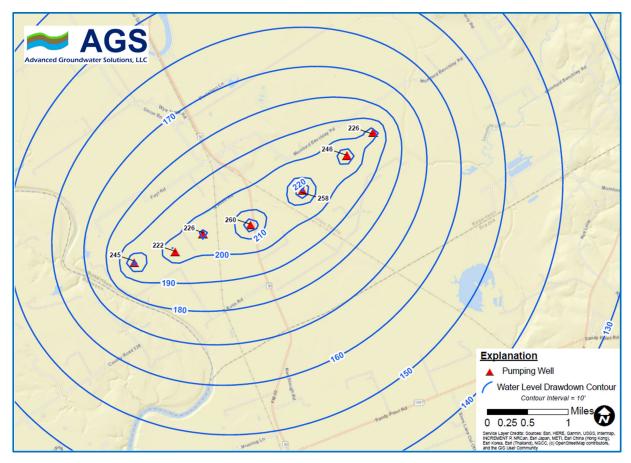


Figure 2. AGS Theis Analytical Simulated Carrizo Aquifer Drawdown After Proposed DTB Investments LP Carrizo Pumping of 7,612 ac-ft/yr for 10-Years

Table 3 below provides a summary of the AGS simulated drawdown estimates at 1-foot from each of the proposed DTB Carrizo wells after pumping 7,612 ac-ft/yr for 1-year and 10 years. Table 2 below also shows the results of a 1-year simulation that estimated Carrizo Aquifer drawdown at 1-foot from the proposed DTB Carrizo wells using a transmissivity value derived from the 36-hour pumping test data from the City of College Station Carrizo Well 1. The City of College Station Carrizo Well transmissivity of 6,547 gpd/ft is substantially less than the transmissivity estimates discussed in the report. Additional drawdown could result from the DTB production if the Carrizo Aquifer transmissivity in the vicinity of the proposed DTB Carrizo wells is closer to the transmissivity of the City of College Station Carrizo Well 1.



Well	AGS Simulated Drawdown After 1-Year of Pumping (feet), GAM T	AGS Simulated Drawdown After 10-Years of Pumping (feet), GAM T	AGS Simulated Drawdown After 1-Year of Pumping (feet), T= 6,547 gpt/ft
C1	194	245	628
C2	171	222	542
C3	175	226	555
C4	210	260	688
C5	208	258	680
C6	195	246	633
C7	176	226	558

Table 3. AGS Theis Analytical Simulated Carrizo Drawdown at the Proposed DTB Investments LP Carrizo Wells After 1-Year and 10-Years of Pumping 7,612 ac-ft/yr

A transmissivity of 161,833 gpd/ft and a storage value of 0.000125 were used in the AGS Simsboro Aquifer analytical simulations with each proposed DTB 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 DTB well locations. AGS was able to generally recreate the 1-year simulation results of the TGI Simsboro analytical modeling. The TGI 10-year Simsboro 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 3 below shows the estimated AGS Simsboro analytical modeling drawdown contours that result from pumping 15,227 ac-ft/yr for 10-years.



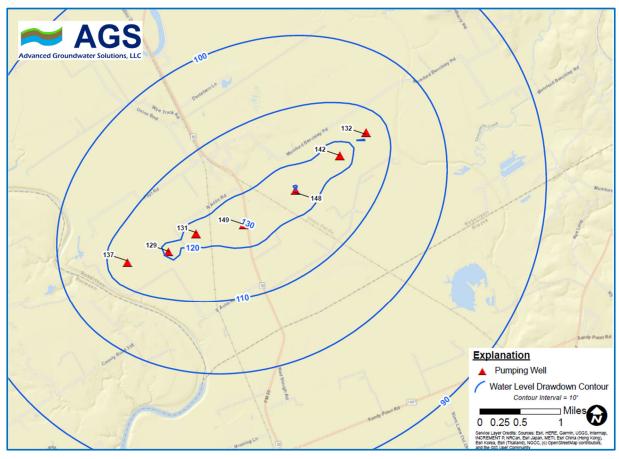


Figure 3. AGS Theis Analytical Simulated Simsboro Aquifer Drawdown After Proposed DTB Investments LP Simsboro Pumping of 15,227 ac-ft/yr for 10-Years

Table 4 below provides a summary of the AGS simulated drawdown estimates at 1-foot from each of the proposed DTB wells after pumping 15,227 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)	
S1	112	137	
S 2	104	129	
S 3	107	131	
S 4	124	149	
S 5	123	148	
S6	117	142	
S 7	107	132	

Table 4. AGS Theis Analytical Simulated Drawdown at the Proposed DTB Investments LP Simsboro Wells After 1-Year and 10-Years of Pumping 15,227 ac-ft/yr

Estimated Long-term impacts at the Proposed DTB Investments LP Wells based on the GMA 12 2021 DFC Run

As a way of evaluating potential long-term estimated water level decline at the proposed DTB 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 Carrizo and Simsboro Aquifer as shown on the attached Figures 4 through 10. 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 DTB Carrizo and Simsboro 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 Carrizo and Simsboro Aquifers based on review of available local electric logs near the locations of the proposed DTB wells.

Texas A&M University Well 5 (BVGCD BVHU-0453) screens sands of the Carrizo Aquifer in the approximate depth interval of about 1,120 to 1,330 feet bgl and is located about 4.9 miles southeast of proposed DTB Carrizo Well 4. Available water level data for BVHU-0453 is shown on Figure 7. The City of College Station Carrizo Well 1 (BVGCD BVDO-0001) water levels are shown on Figure 8 and the well screen sands of the Carrizo Aquifer in the depth interval of about 1,120 to 1,340 feet bgl. BVDO-0001 is located about 4 miles southeast of the proposed DTB Carrizo Well 5.

The City of College Station Well 6 (BVGCD BVHU-0043) screen sands of the Simsboro Aquifer in the depth interval of about 2,352 to 2,876 feet below land surface. Water levels available for the City of College Station Well 6 are shown on Figure 4. BVHU-00043 is located about 5.1 miles east-southeast of proposed DTB Simsboro Well 1. The College Station Well 8 (BVGCD BVDO-0053) water levels are shown on Figure 9. The well screen sands of the Simsboro Aquifer in the depth interval of about 1,976 to 2,749 feet bgl. BVDO-0053 is located about 2.5 miles southeast of proposed DTB Simsboro Well 6. The City of College Station Well 9 (BVGCD BVDO-0152) screens sands of the Simsboro Aquifer in the depth interval of about 2,088 to 2,444 feet bgl. The BVDO-0152 static water levels are shown on Figure 10 and the well is located about 1.7 miles southeast of proposed DTB Simsboro Well 7.

Available drawdown in wells in the Carrizo and Simsboro Aquifers will decline over time based on the DFC simulation. In other words, the line with red dots (Carrizo) or green dots (Simsboro) do not include the impact of the proposed DTB 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 for the Carrizo and Simsboro wells 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 DTB 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 7,612 ac-ft/yr from the Carrizo Aquifer and 15,227 ac-ft/yr from the Simsboro Aquifer for 1-year from the proposed DTB wells. The 10-year analytical simulation results for the



Carrizo Aquifer and Simsboro Aquifer shown 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 for each aquifer. The TGI simulated drawdown could be less if a larger storage value was used in the 10-year simulation.

The transmissivity of 6,547 gpd/ft estimated from the 36-hour City of College Station Carrizo well pumping test is substantially lower than the GAM and TGI Carrizo Aquifer transmissivity estimates of about 20,000 to 30,000 gpd/ft. Additional drawdown may occur if the transmissivity at the proposed DTB Carrizo wells is similar to the transmissivity value estimated for the City of College Station Carrizo Well 1.

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



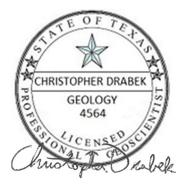
References

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)

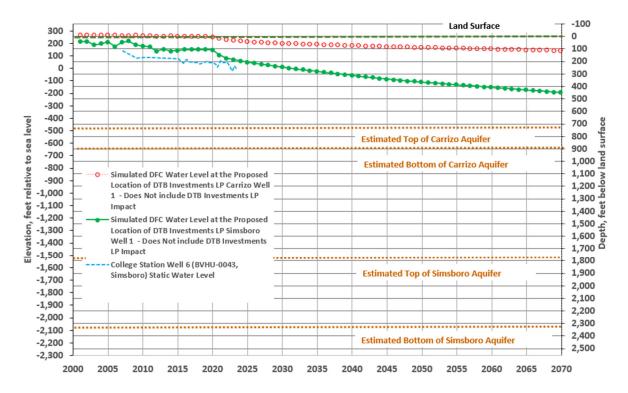


Figure 4. Projected DFC Water Level Change at Proposed DTB Investments LP Carrizo Well 1 and Simsboro Well 1

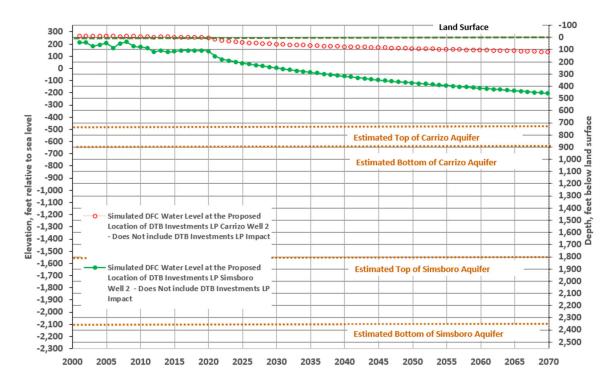


Figure 5. Projected DFC Water Level Change at Proposed DTB Investments LP Carrizo Well 2 and Simsboro Well 2

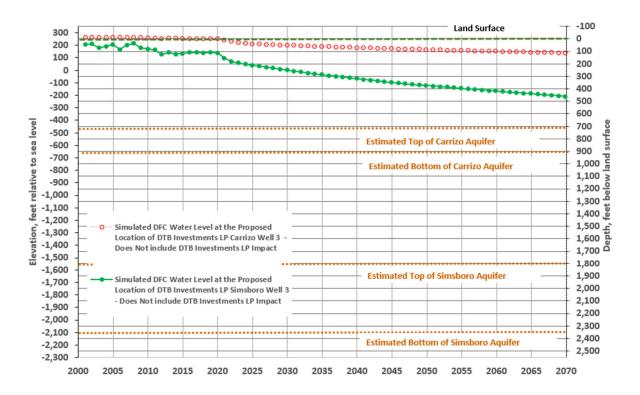


Figure 6. Projected DFC Water Level Change at Proposed DTB Investments LP Carrizo Well 3 and Simsboro Well 3

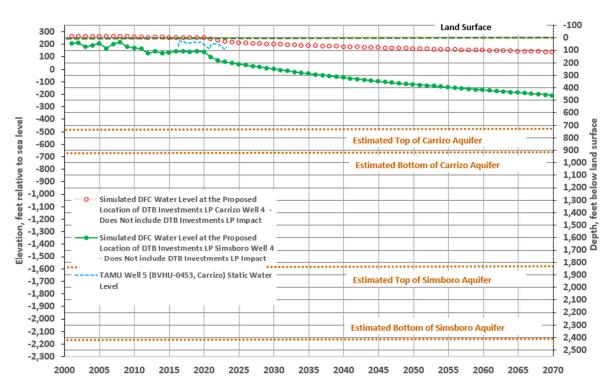


Figure 7. Projected DFC Water Level Change at Proposed DTB Investments LP Carrizo Well 4 and Simsboro Well 4

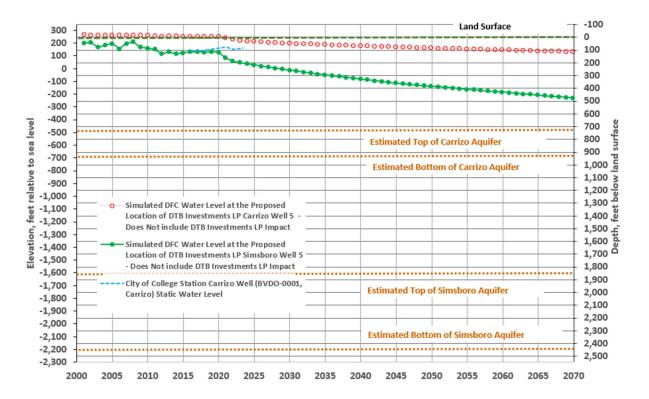


Figure 8. Projected DFC Water Level Change at Proposed DTB Investments LP Carrizo Well 5 and Simsboro Well 5

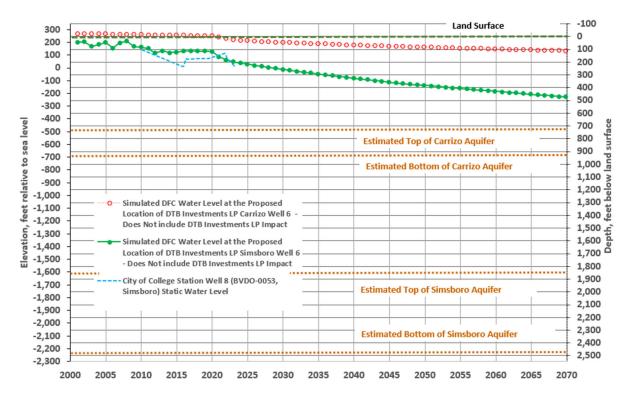


Figure 9. Projected DFC Water Level Change at Proposed DTB Investments LP Carrizo Well 6 and Simsboro Well 6

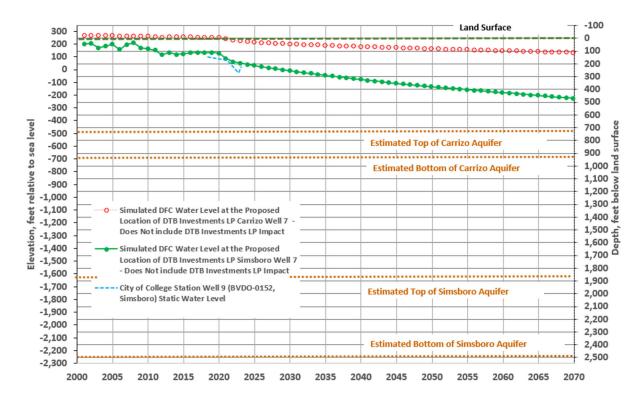


Figure 10. Projected DFC Water Level Change at Proposed DTB Investments LP Carrizo Well 7 and Simsboro Well 7

