



THORNHILL GROUP, INC.

Professional Hydrogeologists • Water Resources Specialists

July 26, 2023

Ms. Laura Wiese Moore
L. Wiese Moore, LLC
2208 Churchill Loop
Grapevine, Texas 76051

Re: Aquifer Evaluation Report –
Drilling/Production Permit Applications for Two (2) New Simsboro Wells to be
Completed on the Moore Property, Robertson County, Texas

Dear Ms. Moore:

Per your request and in compliance with the rules of the Brazos Valley Groundwater Conservation District (BVGCD), Thornhill Group, Inc. (TGI) provides herein an evaluation of the projected effect of L. WIESE MOORE, LLC, herein referenced as WIESE MOORE, completing two (2) new wells into the Simsboro Aquifer underlying the Moore Property in Robertson County, Texas and producing an annual allocation of 4,452 acre-feet per year.

The subject Moore Property encompasses approximately 590 contiguous acres of land. The eastern boundary of the property is three (3) miles west of the intersection of Farm Road 485 (FM 485) and State Highway 6/State Highway 79 (SH 6/SH 79) near downtown Hearne. The northern boundary of the Moore Property abuts FM 485 and the western boundary is along FM 1644. The western boundary of the farm is between 1.3 and 1.6 miles east of the Brazos River. Figure 1 provides the location of the subject property.

TGI conducted its evaluations and prepared this report in compliance with the rules and guidelines provided by the BVGCD, specifically in Rule 8.4(b)(7)(B) for wells (and multiple wells) capable of producing 800 or more acre-feet per year. TGI's evaluations focused on assessing local aquifer conditions and parameters, and the extent to which production from the subject wells may influence other groundwater users in the BVGCD. TGI's evaluations are based on previous investigations conducted in the District, including permit applications and field-testing associated with several local landowners. Additionally, TGI relied upon reported data, published reports, the applicable groundwater availability model (GAM), and TGI's extensive experience with and knowledge of the Simsboro Aquifer in Central Texas, within the BVGCD, and particularly in Robertson County. Specifically, TGI's work was conducted to accomplish the following goals:



- ❖ Assessing the local hydrogeologic setting, focusing on the physical characteristics and hydraulic parameters of the local Simsboro Aquifer;
- ❖ Estimating and calculating the potential short-term and long-term drawdown at each of the wells, including interference drawdown between wells;
- ❖ Evaluating potential interference drawdown from other pumpage in the area and predicting long-term water levels in the proposed well-field area;
- ❖ Establishing a target maximum proposed pumping rate for each well and for the aggregated well field;
- ❖ Modeling to assess the feasibility of the targeted pumping rate and the potential impacts (e.g., artesian pressure reduction) to the aquifer and other nearby well owners (e.g., drawdown); and,
- ❖ Providing this Hydrogeological Evaluation Report in compliance with District rules.

For convenience, applicable illustrations and supporting documentation are included in the following attachments:

- Attachment 1 – Figures
- Attachment 2 – Tables
- Attachment 3 – Reference Materials
- Attachment 4 – Selected References

Proposed Pumping Locations and Permit Pumping Rates

Figure 1 illustrates the locations for the proposed Simsboro wells on the Moore Property. Proposed well identifications, coordinates, and estimated land-surface elevations in feet above mean sea level (MSL) as estimated from Google Earth are as follows:

<u>Well Identification</u>	<u>Latitude*</u>	<u>Longitude*</u>	<u>Est. Land Surface Elevation</u>
No. 1	30°52'19.14"N	96°38'55.23"W	274 feet AMSL
No. 2	30°52'03.41"N	96°39'32.28"W	273 feet AMSL

*Coordinate system is NAD83 State Plane Texas Central (feet)

The proposed production capacities in gallons per minute (gpm) and requested permit allocations in acre-feet per year are as follows:

<u>Well Identification</u>	<u>Maximum Pumping Rate</u>	<u>Annual Permit Allocation</u>
No. 1	1,550 gpm	2,000 acre-feet
No. 2	1,900 gpm	2,452 acre-feet
Total Annual Allocation		4,452 acre-feet

The radii attributed to the pumping rates for each of the wells lie within the Moore property boundaries. The nearest known existing wells completed into the Simsboro Aquifer are mapped by the BVGCD adjacent to the Moore property; however, the proposed Simsboro wells are sufficiently distant from existing wells. The proposed well locations comply with the BVGCD rules regarding spacing between wells and allocation of acreage per well.

Hydrogeologic Conditions and Aquifer Characteristics

Geologic Setting

Figure 2 illustrates that the entire Moore Property is underlain by downdip portions of the Carrizo-Wilcox Aquifer, a Major Aquifer delineated by the TWDB. Figure 3 shows that essentially the western half of the Moore property lies atop the Brazos River Alluvium Aquifer, a Minor Aquifer in Texas. There are no other Major or Minor aquifers beneath the subject property.

Figure 4 is a Surface Geology Map illustrating that the entire extent of the subject Moore Property lies atop the Brazos River Alluvium deposits. The surface geology maps show that the Reklaw subcrops the alluvial deposits and an inferred trend indicates that the Reklaw (unconformably) underlies the alluvium across the entire property. The Carrizo Sand is likely relatively shallow and thin beneath the property due to proximity to the outcrop. Otherwise, the entire local sections of the Wilcox Group including, from younger to older, the Calvert Bluff, Simsboro, and Hooper formations occur beneath the subject property.

Due to the inherent nature of the floodplain and farming operations the topography across the Moore Property is relatively flat with land surface elevations ranging generally from 270 to 280 feet above mean sea level (MSL). Geologic units dip generally from the north-northwest to the south-southeast. Locally, the dip along the base of the Wilcox Group is between 90 and 100 feet per mile (see Attachment 3). There are no faults mapped locally at land surface across the subject property. Based on available structural geology maps and GAM datasets estimates of the elevations and thicknesses of hydrostratigraphic layers beneath the Moore property are summarized in the table below:

Layer	Elevation	Depth	Thickness
Land Surface	270 to 280 feet AMSL	Not Applicable	Not Applicable
Base of Alluvium	200 to 210 feet AMSL	60 to 80 feet BGL	60 to 80 feet
Base of Reklaw	155 to 165 feet AMSL	105 to 125 feet BGL	25 to 65 feet
Base of Carrizo	105 to 120 feet AMSL	150 to 175 feet BGL	25 to 70 feet
Base of Calvert Bluff	690 to 705 feet BMSL	960 to 985 feet BGL	785 to 835 feet
Base of Simsboro	1,165 to 1,185 feet BMSL	1,435 to 1,465 feet BGL	450 to 505 feet
Base of Hooper	1,690 to 1,730 feet BMSL	1,960 to 2,010 feet BGL	495 to 575 feet

Aquifer Conditions and Hydraulic Parameters

This report focuses on proposed permitted production from the Simsboro Aquifer. The top of the Simsboro Formation is estimated to be at depths of between 950 and 1,050 feet BGL based on GAM datasets and BEG mapping (BEG, 1985). Net sand thickness maps indicate productive sands with thicknesses of between 350 and 450 feet, with sands potentially as thick as 500 feet. As most of the Simsboro Formation is comprised of sand, it is likely that Simsboro wells on the Moore Property will be between 1,400 and 1,550 feet deep. Figure 5 illustrates locations for registered and permitted Simsboro wells within five (5) miles of the proposed Moore wells. Attachment 4 provides available well records for selected nearby Simsboro wells. Figure 6 shows locations for registered and permitted Simsboro wells within one (1) mile of the proposed Moore wells locations. Figure 6a and Figure 6b provide the locations for Simsboro wells within one (1) mile of the proposed well locations on maps with a scale of 1"=1,000 feet per BVGCD Rules. Eight (8) Simsboro wells are mapped by BVGCD within one (1) mile of the Moore property. Four (4) of the wells are historic use Simsboro irrigation wells owned by Upwell/Brazos Valley Farms. Three (3) wells are domestic wells with reported depths ranging from 1,080 to 1,250 feet and one well has no record. The depths of the domestic wells ensures that groundwater can be produced in perpetuity with proper well completion.

TGI extracted hydraulic data for the subject property and nearby areas from the currently-used version of the groundwater availability model (GAM) for the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers (Young, et al., 2018). Note that the units for hydraulic parameters are: gallons per day per square foot (gpd/ft²) for hydraulic conductivity; gallons per day per foot (gpd/ft) for transmissivity; and, dimensionless for storativity (or storage coefficient). The following table provides a summary of estimated parameters extracted from the GAM datasets to those derived by TGI for the local Carrizo and Simsboro aquifers across the Wiese Moore property:

<u>Parameter</u>	<u>GAM</u>	
	<u>Estimates Range</u>	<u>TGI Estimates*</u>
Aquifer/Sand Thickness	470 to 480 feet	350 to 450 feet
Hydraulic Conductivity	105 to 125 gpd/ft ²	125 to 175 gpd/ft ²
Transmissivity	51,000 to 58,000 gpd/ft	43,750 to 78,750 gpd/ft
Storage Coefficient	0.000151	0.0001 (0.0005)

The asterisk indicates that TGI utilized a storage coefficient representative of a slightly leaky artesian aquifer for the 10-year analytical model calculations.

Figure 7 provides two hydrographs illustrating water-level measurements collected for Texas Water Development Board (TWDB) and/or BVGCD Simsboro monitoring wells: the first chart

illustrates data for TWDB Well No. 59-03-437 (BVR-1283) which is the Lee Fazzino House Well located about seven (7) miles north-northwest of the center of the Moore property; and, the second well is TWDB Well No. 59-04-701 (BVHU-0013) which is the City of Hearne Well #4, also known as the POW well, which is 2.3 miles east-northeast of the center of the subject Moore property. Water levels declined from 1979 to 1999 by approximately 40 feet and 70 feet in the Lee Fazzino well and the POW well, respectively. Additionally, Advanced Groundwater Solutions (AGS) reported that water-levels declined between 1999 and 2023 by 44 feet in the Lee Fazzino House Well and by 81 feet in Hearne’s POW well (see AGS, May 11, 2023). Also, AGS reported a 85-foot artesian pressure decline in TWDB Well No. 59-11-703 which is at the City of Gause and is about 6.8 miles southwest of the Moore property. AGS mapped water-level declines in the Simsboro of approximately 70 feet at the Moore property from 1999 to 2023 (AGS, May 11, 2023). Based on the updated data provided by AGS, current depths to water on the subject property will likely range from 150 to 250 feet BGL. Therefore, water levels will probably rise between 720 and 900 feet above the top of the aquifer in the proposed new wells, verifying that the local Simsboro is under artesian or confined conditions with hundreds of feet of artesian head.

Projected Effects of Proposed Pumping

The immediate impacts from production will be artesian head decline (i.e., drawdown) at the pumping wells. As the wells pump, artesian pressure or potentiometric head around the wells will decline forming a cone of depression. As production continues the cone of depression will extend radially from the well field until an aquifer boundary is reached or the production rate reaches equilibrium with the captured groundwater flows. Due to the distance of the proposed wells from the outcrop of the aquifer, reduction in artesian pressure is the only anticipated measurable effect from the proposed pumping. The aquifer will remain completely full and there will be only an infinitesimal reduction in storage. Pumping from the Simsboro aquifers will cause some vertical leakage from overlying and underlying zones. While leakage can serve to dampen drawdown due to boundary effects and inflows, the leakage will likely not result in any identifiable water-level changes or water-quality variations in any of the overlying or underlying zones.

Drawdown Simulations Using the GAM

TGI utilized the recently released revision and update of the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers GAM to calculate drawdown due to the proposed pumping for continuous pumping periods of one (1) year and 10 years from the Simsboro Aquifer. L. Wiese Moore, LLC has requested a permit allocation for the Simsboro Aquifer of 4,452 acre-feet per year. Figure 8 and Figure 9 provide maps showing modeled drawdown contours after one (1) year and 10 years of pumping at the proposed authorized annual rate,

respectively. Table 1 and Table 2 provide modeled drawdown at specific registered and permitted Simsboro well sites after one (1) year and 10 years of continuous pumping, respectively. The GAM predicts that Simsboro artesian pressure will decline by as much as 29 feet immediately adjacent to the Moore property and from 16 to 19 feet one (1) mile from the proposed wells within the first year of pumping. Declines during the initial year are simulated to be less than 5 to 7 feet five (5) miles of the wells. After 10 years of pumping the proposed Simsboro wells drawdown (i.e., artesian head decline) will be as much as 31 feet adjacent to the subject property and range from 18 to 20 feet one (1) mile from the well locations. Simulated drawdown 7 to 8 feet five (5) miles from the wells. Based on the geologic structure, estimates of current artesian head, and drawdown calculated from the GAM simulations, the Simsboro aquifer will remain full and under artesian conditions in the well-field area and within the five-mile radius. Local wells will continue to maintain a few hundred feet of artesian head.

[Drawdown Simulations Using Analytical Modeling](#)

Due to the scale and configuration of the GAM grid, the GAM probably does not provide accurate drawdown calculations for the specific well sites and areas in the immediate vicinity of the proposed well field. Therefore, for comparison purposes and per the BVGCD rules TGI used an analytical modeling program based on the Theis non-equilibrium equation to calculate theoretical potentiometric head declines at and surrounding the proposed production wells. TGI has used the Theis model for several previous submittals to the BVGCD as well as for evaluations and submittals to numerous districts across the State of Texas. The Theis model incorporates many assumptions, most of which are sufficiently satisfied in the local Simsboro aquifer. However, the Theis model assumes an aquifer that is uniform over an infinite area. To account for recharge boundaries and possible inter-aquifer leakage into the producing aquifers, TGI modeled long-term pumping (i.e., from one to 10 years) by incorporating a leaky artesian storage coefficient. However, it is likely that, while the Theis model likely provides more reliable results within and near the well field, it probably overstates drawdown at distance from the pumping center. Also, the Theis model is more accurate for shorter pumping durations; therefore, the 10-year calculation likely overestimates drawdown from the well fields.

Figure 10 and Figure 11 provide drawdown contours from Theis calculations due to pumping the Simsboro wells proposed for the Moore Property after one (1) and 10 years, respectively. Table 1 and Table 2 provide drawdown values at specific well locations. The analytical model calculated artesian pressure declines of as much as 45 feet adjacent to the subject property after one (1) year of pumping. Drawdown at a distance of one (1) mile was modeled to be 36 to 38 feet after the first year of pumping. At five (5) miles away the drawdown calculation resulted in 22 to 23 feet after a year. After 10 years the calculated drawdown at the Moore

property line is as much as 48 feet and the drawdown at a distance of a mile was modeled to be 39 to 41 feet. The drawdown at five (5) miles was modeled to be between 26 and 27 feet.

Conclusions

Based on our review of the BVGCD rules and the work conducted as described herein, TGI concludes the following:

- ❖ The proposed wells and pumping amounts for the Moore Property can be completed and produced in accordance with the well spacing and production-based acreage (i.e., allocation) rules set forth by the BVGCD;
- ❖ The predicted drawdown derived from the Theis analytical model are more accurate than the GAM predictions for the proposed well sites and areas near the well field;
- ❖ GAM-predicted drawdown probably provides a more reasonable estimate of future impacts at greater distances from the proposed well field and for longer time periods. The updated GAM predicts significantly less drawdown regionally than the previous version of the GAM; and,
- ❖ Production from the proposed pumping will cause only infinitesimal reduction in aquifer storage as the local Simsboro Aquifer will stay completely full and groundwater in the formation will remain under considerable artesian pressure within the well-field areas and the five-mile study radius.

We very much appreciate the opportunity to again assist you in our specialty. If you have any questions, please call.



Sincerely,
THORNHILL GROUP, INC.



Michael R. Thornhill, P.G.
President

The seal appearing on this document was authorized
by Michael R. Thornhill, P.G. on July 26, 2023.

Attachments