THORNHILL GROUP, INC.

Professional Hydrogeologists • Water Resources Specialists

February 8, 2023

Mr. Trey Skiles
c/o Robertson County Veterinary Services
3206 State Highway 6, South
Hearne, TX 77859

Re: Aquifer Evaluation Report –
Permit Amendment to Add Beneficial Uses and Increase Production Amount to Well BVDO-0108 and Drilling and Production Permit Application for Proposed One (1) New Well To Be Completed in the Simsboro Aquifer, Robertson County, Texas

Dear Mr. Skiles:

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 producing 2,100 acre-feet of water per year from one (1) proposed new production well to be completed in the Simsboro aquifer on the property identified as 000031-003760 in the Robertson County Central Appraisal District (CAD) database located in western-southwestern Robertson County, and increasing the permitted production amount of existing well BVDO-0108 from 1,400 acre-feet of water per year to 2,700 acre-feet. 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. Additionally, the aquifer evaluation report provides sufficient information to validate your Permit Amendment to add additional beneficial uses to your existing well permitted as BVDO-0108. Pumping from both wells should be aggregated for a total allocation from your 732-acre property of 4,800 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, including permit applications and field-testing associated with other nearby groundwater producers. 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;
- Establishing a target maximum proposed pumping rate for the proposed well;
- 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 Location and Permit Pumping Rates

Figure 1 provides a map showing the location of the proposed and existing wells and the outline of the approximately 732-acre contiguous tract owned by Mr. Skiles. Proposed well identification, coordinates, and estimated land-surface elevation in feet above mean sea level (MSL) as obtained from the National Elevation Dataset (NED) are as follows:

Well Identification	Latitude*	Longitude*	NED Land Surface Elevation
TreySkiles_1	30.854431° N	96.628822° W	276 feet AMSL
BVDO-0108	30.851042° N	96.635889° W	274 feet AMSL

*Coordinate system is NAD83 State Plane Texas Central (feet) (EPSG 32039) converted to NAD 83 (EPSG 4269).

The proposed wells are located between the Brazos River and State Highway 6 (HW6), approximately 2.6 miles from the center of the City of Hearne and 8.8 miles from the center of the City of Calvert. The proposed production capacity in gallons per minute (gpm) and requested permit allocation in acre-feet per year are presented in the following table:

Well Identification	Maximum Pumping Rate	Annual Permit Allocation
TreySkiles_1	1,600 gpm	2,100 acre-feet
BVDO-0108	2,000 gpm	2,700 acre-feet

The proposed and existing wells are spaced 2,537 feet apart, and both wells are sited to comply with the ½ foot per GPM spacing from the subject property line rule, as well as the 1 foot per GPM spacing from other registered Simsboro wells rule. Therefore, the proposed well location complies with the BVGCD rules regarding spacing between wells and distance from property lines based on production, as well as the production based acreage requirement. Figure 2 in the Attachments shows all BVGCD registered wells within 1 (one) mile at a 1-inch to 1,000-foot scale. Figure 3 shows all BVGCD wells within 5 miles of the proposed and existing well.

Hydrogeologic Conditions and Aquifer Characteristics

Surface Geologic Setting

Figure 4 shows that the entire tract is located atop the Brazos River Alluvium aquifer, which is designated a Minor Aquifer by the Texas Water Development Board (TWDB). The Brazos River Alluvium was deposited in the ancient and present-day floodplains of the Brazos River and consists of sedimentary deposits of various grain sizes, along with lenses and structures typical of riverine deposits. The geophysical log of CS-1, located approximately 2.7 miles northwest of the subject site, indicates that the alluvium could be as thick as 95 feet.

The Queen City formation, another Minor Aquifer in Texas, would potentially underlie the alluvium at the subject site to a minimal extent were it not for incision of the Brazos River. However, it is unlikely that any Queen City exists in the subsurface across the subject property. Stratigraphically underneath the Queen City is the Reklaw Formation, which is not evident in the geophysical log for CS-1 and may also be completely eroded by the action of the Brazos River at the subject property depending on its thickness. If so, underlying the surficial alluvial aquifer are the formations of the Carrizo-Wilcox Aquifer. Because the property is in the floodplain of the Brazos River and is predominately used for agricultural purposes, the land surface is relatively flat across the property.

While the Carrizo-Wilcox is mapped as a single Major Aquifer by the Texas Water Development Board (TWDB), it does not behave as a single aquifer within the BVGCD boundaries. In fact, it is comprised of four geologic units including, from deeper to shallower (older to younger), the Hooper formation, the Simsboro formation, the Calvert Bluff formation and the Carrizo Sand. Geologic units dip generally from northwest to southeast and dip angles generally increase downdip and with depth. Locally, the dip of the base of the Wilcox Group is approximately 80 feet per mile (see Attachment 3). There are no faults mapped at land surface across the subject property. A representative hydrostratigraphic column for the region follows:

Period	Series	Strata	Hydrogeologic Unit
Tertiary	Eocene	Jackson Group	Yegua-Jackson Aquifer
		Yegua Fmn.	
		Cook Mountain Fmn.	Confining Unit
		Sparta Sand	Sparta Aquifer
		Weches Fmn.	Confining Unit
		Queen City Sand	Queen City Aquifer
		Reklaw Fmn.	Confining Unit
		Carrizo Sand	Carrizo-Wilcox Aquifer
		Calvert Bluff Fmn.	
		Simsboro Fmn.	
	Paleocene	Hooper Fmn.	
		Miday Fmn.	Confining Unit

The Carrizo Sands comprise the first water bearing unit of the Carrizo-Wilcox Aquifer that underlie the Brazos River Alluvium at the subject property. The Calvert Bluff formation directly underlies the Carrizo and is a thick unit characterized by numerous and alternating relatively thin layers of clay, silt and sandy clays. The Calvert Bluff formation also contains numerous lignite seams ranging in thickness from less than one foot to more than 10 feet. Surface mining operations are ongoing in Robertson County in which lignite seams from the Calvert Bluff are mined to feed power plants. In some areas, the Calvert Bluff includes discontinuous sand channel deposits, with sand layers ranging from a few feet to more than 50 feet in thickness. Generally, the Calvert Bluff formation is considered a confining layer or aquitard between the Carrizo and Simsboro aquifers. However, the intermittent sand layers in the Calvert Bluff can be tapped locally to produce small to moderate quantities of water with variable water quality. Most Calvert Bluff wells are small-capacity wells used for domestic and stock purposes. Probably, most local wells are completed in zones of the Calvert Bluff formation that are under artesian conditions due to the significant stratification of the formation and discontinuity of sand layers.

Simsboro Aquifer Conditions and Hydraulic Parameters

The Simsboro formation constitutes the production zone for the existing well on Mr Skiles's property and is also the target for the proposed new well. Based on GAM datasets and geologic maps and cross sections from the University of Texas Bureau of Economic Geology (BEG), the depth to the top of the Simsboro formation at the subject property is approximately 1,050 to 1,150 feet bgl. The net thickness ranges from 370 to over 500 feet within the local area of the subject property, putting the base of the Simsboro at approximately 1,420 to 1,650 feet below land surface.

TGI extracted hydraulic data for the subject property from the most recent version of the groundwater availability model (GAM) for the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers (Young, et al., 2018) which are presented in the following table. TGI estimates based on recently conducted pumping tests for the neighboring Brazos Valley Farms are also included, which is between 2 and 3 miles updip of the subject property.

Parameter	Updated GAM Estimates Range	TGI Estimates*
Sand Thickness	475 to 525 feet	475 to 525 feet
Hydraulic Conductivity	150 to 240 gpd/ft^2	165 to 250 gpd/ft^2
Transmissivity	71,000 to 126,000 gpd/ft	78,000 to 131,000 gpd/ft
Storage Coefficient	1.42 x 10^{-4} to 1.59 x 10^{-4}	10^{-4}

The asterisk (*) in the above table indicates that TGI's estimates are based on and are consistent with previous hydrologic investigations conducted within BVGCD boundaries and include adjustments to local transmissivity values to account for producing from the entire aquifer thickness.

Figure 5 provides a hydrograph illustrating water-level measurements collected for nearby TWDB/BVGCD Simsboro monitoring well (State Well No. 59-04-701) which is located near the City of Hearne and is about 2.2 miles northeast from the proposed well. The water level in 1979 was less than 10 feet below land surface and has declined over 40 years to its current depth at roughly 150 to 175 feet bgl. Nearby well BVR-0380 similarly shows a water level of 194 feet bgl in July of 2022, which is its only reported water level measurement. The depth to water in the Simsboro at the existing and proposed new well on the Skiles property will likely be in general agreement with these nearby wells and is anticipated to be between 150 and 200 feet bgl. Therefore, water levels will probably rise between 850 to 950 feet above the top of the Simsboro formation, verifying that the local aquifer conditions are confined with hundreds of feet of artesian head. Water-level data presented by INTERA indicate that there is a slight cone of depression near Hearne, although the overall gradient is from northwest to southeast.

Projected Effects of Proposed Pumping

The immediate impacts from production will be 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 until an aquifer boundary is reached or the production rate reaches equilibrium with the captured groundwater flows. Due to the distance 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. There may be some inter-aquifer leakage induced from the overlying Calvert Bluff confining layer, Carrizo aquifer and Brazos River Alluvium aquifer; however, the amount of leakage will serve to lessen the artesian drawdown in the Simsboro and will likely not result in any identifiable

water-level changes in the Calvert Bluff, Carrizo or alluvium due to the stratification in the geologic layers. In order to assess the effects from the pumping of the existing and proposed new well, analytical and numerical models were utilized to quantify drawdowns.

Drawdown Simulations Using the GAM

TGI utilized the most recent version of the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers GAM to calculate drawdown due to the proposed pumping for continuous discharge periods of one (1) year and 10 years. Figure 6 and Figure 7 provide maps showing modeled drawdown contours after one (1) year and 10 years of pumping at the maximum authorized rate, respectively. Table 1 provides modeled drawdown at specific registered and permitted Simsboro well sites for the same durations. Table 2 provides casing and screen depth information for registered BVGCD wells within one mile of the proposed wells.

Due to the grid scale (i.e., one mile) and configuration in the model, the GAM does not provide an accurate spatial representation of drawdown at the well sites and in the immediate surrounding area, and the simulation likely predicts less drawdown than will actually occur in the immediate vicinity. The GAM drawdown results at some distance from the proposed wells are probably more representative of the potential effects. For the nearest Simsboro wells located off the subject property, the GAM runs predict approximately 14 feet of drawdown after one (1) year, and 22 feet after 10 years. The GAM simulated approximately 14 feet of drawdown at Hearne and 5 feet of drawdown at Calvert after 10 years.

Note that several of the wells designated by the BVGCD as “Simsboro” wells may not actually be deep enough to penetrate the Simsboro aquifer. TGI did not attempt to verify the completion intervals of those wells, but simply reported the dataset as provided by BVGCD. 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.

Drawdown Simulations Using Analytical Modeling

As stated previously, 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 the immediate vicinity. 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 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 Simsboro, TGI modeled long-term pumping (i.e., from one to 10 years) by incorporating a leaky artesian storage coefficient. However, 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 field. Analytical modelling hydraulic parameters were the same for both wells with a transmissivity of 75,000 gallons per day per foot (gpd/ft), and 1- and 10-year storage coefficients of 0.0001.

Figure 8 and Figure 9 provide the Theis-modeled drawdown contours for pumping periods of one (1) year and 10 years, respectively. Table 1 provides the tabulated drawdown according to the analytical modelling at specific Simsboro well sites, based on the locations and designations of aquifers provided by BVGCD in their database files.

Assuming properly completed and highly efficient production wells, the Theis model predicted drawdown in TreySkiles_1 and BVDO-0108 of approximately 36 and 43 feet after one (1) year of continuous pumping, respectively, and 43 and 51 feet of drawdown at 10 years. For comparison purposes, the Theis calculation resulted in one-year drawdown of about 20 feet at the City of Hearne and 11 feet at Calvert, increasing to 27 and 19 feet at 10 years. Predicted drawdown at Simsboro wells between one (1) and five (5) miles from the proposed wells will be less than 100 feet. It is worth noting that in both the GAM and analytical modelling, the distribution of pumping is a constant flat rate for the entire duration of interest, which is not realistically how wells or well fields are pumped and the increased down time in reality will result in less drawdown than is calculated here.

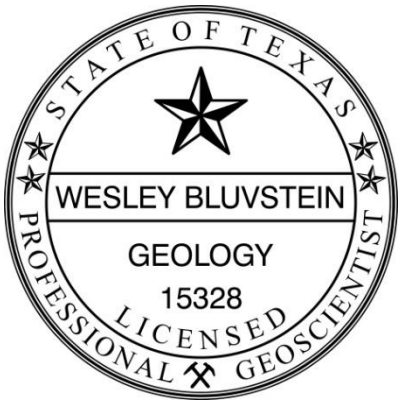
Conclusions

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 can be completed and produced in accordance with the well spacing and production-based acreage (i.e., allocation) rules set forth by the BVGCD;
  - Specific capacities determined from existing well records, testing conducted by BVGCD representatives on nearby wells (March 18, 2009), current available drawdown, and predicted drawdown all demonstrate that the wells will be capable of easily sustaining their target rates;
- The predicted drawdown derived from the Theis analytical model are more accurate than the GAM prediction for the proposed well site and immediate vicinity;

- GAM-predicted drawdown probably provides a more reasonable estimate of future impacts at greater distances from the proposed well and for longer time periods; and,
- Production from the proposed pumping will cause only infinitesimal reduction in aquifer storage as the Simsboro will stay completely full and groundwater in the formation will remain under considerable artesian pressure within the well area 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.



The seal appearing on this document was authorized by Wesley Bluvstein, P.G. on February 8, 2023.

Attachments

Sincerely,
THORNHILL GROUP, INC.

Wesley Bluvstein, P.G.