THORNHILL GROUP, INC.

Professional Hydrogeologists • Water Resources Specialists

July 19, 2023

Mr. Brad Ely
Ely Family Partnership, LP
P.O. Box 177
Hearne, Texas 77859

Re: Aquifer Evaluation Report –
Drilling/Production Permit Applications for Five (5) New Simsboro Wells to be Completed on Ely Family Partnership, LP Property, Robertson County, Texas

Dear Mr. Ely:

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 Ely Family Partnership, LP, herein referenced as Ely Family Partnership, completing eight (8) new wells into the Simsboro Aquifer underlying Ely Family Partnership Property in Robertson County, Texas and producing an annual allocation of 13,872 acre-feet per year.

The subject Ely Family Partnership Property includes several properties that form two separate contiguous tracts totaling approximately 1,874 acres of land; the northern property totals 1,411 acres and the southern property includes 462 acres. The Ely properties are located south to slightly southeast of the City of Hearne between Farm Road 50 (FM 50) and U.S. Highway 190/State Highway 6 (US 190/SH 6). The northern property boundary is about 2.15 miles south of downtown Hearne, while the southernmost boundary is 6 miles south-southeast of the City. The primary access road to Ely Family Partnership property is along River Ridge Drive off of Old Hearne Road, which is along the eastern boundary of the central portion of the farm. The Little Brazos River runs through the northern portion of the subject property and forms the western boundary of southern portions of the subject land.

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 Ely Family Partnership 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:

Well Identification	Latitude*	Longitude*	Est. Land Surface Elevation
No. 1	96°35'40.04"W	30°50'36.07"N	260
No. 2	96°35'02.70"W	30°50'19.85"N	256
No. 3	96°34'24.84"W	30°50'17.37"N	256
No. 4	96°34'03.78"W	30°49'37.20"N	298
No. 5	96°34'18.42"W	30°49'23.43"N	256
No. 6	96°33'35.83"W	30°49'52.96"N	305
No. 7	96°48'55.99"W	30°44'19.75"N	352
No. 8	96°32'41.09"W	30°48'24.69"N	273

*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:

Well Identification	Maximum Pumping Rate	Annual Permit Allocation
No. 1	1,150 gpm	1,484 acre-feet
No. 2	2,000 gpm	2,581 acre-feet
No. 3	850 gpm	1,097 acre-feet
No. 4	1,600 gpm	2,065 acre-feet
No. 5	1,100 gpm	1,419 acre-feet
No. 6	1,600 gpm	2,065 acre-feet
No. 7	1,400 gpm	1,807 acre-feet
No. 8	1,050 gpm	1,355 acre-feet
Total Annual Allocation		**13,873 acre-feet**

The radii attributed to the pumping rates for each of the wells lie within the Ely property boundaries. The nearest known existing wells completed into the Simsboro Aquifer are between 3,700 and 6,350 feet from the nearest proposed Simsboro well. The landowners will request in the permit application an internal waiver per BVGCD Rule 6.2 to allow for slight overlap between the radii of Well No. 5 and Well No. 4 (less than 850 feet) and between Well No. 6 and Well No. 4 (less than 350 feet). The proposed overlap of well radii will result in an additional 550 gpm of average combined pumping rate. As will be discussed later in this report, the slight overlap will have minimal effects on interference drawdown between the proposed Ely wells and will not significantly change impacts on surrounding wells. With an approved waiver, the proposed well locations comply with the BVGCD rules regarding spacing between wells and allocation of acreage per well.

Hydrogeologic Conditions and Aquifer Characteristics

Surface Geologic Setting

Figure 2 illustrates that the entire Ely Family Partnership property is underlain by downdip portions of the Carrizo-Wilcox Aquifer, a Major Aquifer delineated by the TWDB. Figure 3 shows that the northern approximately one-third of the property lies atop the Brazos River Alluvium Aquifer. The western portion of the middle section of the subject farm lies atop the Brazos River Alluvium Aquifer along the Little Brazos River and atop the outcrop of the Queen City Aquifer along the eastern part of the land. The southern portions of the Ely properties lie atop the downdip part of the Queen City. There are no other Major or Minor aquifers as identified by TWDB that occur beneath the subject properties.

Figure 4 is a Surface Geology Map for the Ely Family Partnership farm area. The alluvial and terrace deposits associated with the Brazos River occur at land surface across most of the property. The Queen City Formation subcrops the alluvial and terrace deposits and crops out across the eastern portions of the middle section of land. The Weches Formation crops out across the southern parts of the Ely property. The entire local sections of the Reklaw, Carrizo, and Wilcox Group (i.e., Calvert Bluff, Simsboro, and Hooper) occur beneath the subject properties.

Land surface elevation across the Ely properties generally ranges from 255 feet above mean sea level (MSL) in the floodplain and near the Little Brazos River to about 355 feet above MSL on eastern parts of the subject land. Geologic units dip generally from the north-northwest to the south-southeast and dip angles typically increase with depth in the geologic section. Locally, the dip along the base of the Wilcox Group is up to 140 to 145 feet per mile based on available maps (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 Ely property are summarized in the table below:

Layer	Elevation	Depth	Thickness
Land Surface	265 to 320 feet AMSL	Not Applicable	Not Applicable
Base of Alluvium	205 to 215 feet AMSL	55 to 105 feet BGL	55 to 105 feet
Base of Weches	165 to 175 feet AMSL	100 to 155 feet BGL	40 to 50 feet
Base of Queen City	-63 to +129 MSL	135 to 385 feet BGL	40 to 230 feet
Base of Reklaw	5 to 188 feet BMSL	270 to 510 feet BGL	125 to 135 feet
Base of Carrizo	120 to 390 feet BMSL	385 to 710 feet BGL	115 to 205 feet
Base of Calvert Bluff	1,020 to 1,355 feet BMSL	1,285 to 1,675 feet BGL	900 to 965 feet
Base of Simsboro	1,565 to 1,950 feet BMSL	1,830 to 2,270 feet BGL	550 to 600 feet
Base of Hooper	2,175 to 2,705 feet BMSL	2,440 to 3,025 feet BGL	610 to 750 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 1,270 and 1,700 feet BGL. Net sand thickness maps indicate productive sands of between 400 and 500 feet and potentially more. As most of the Simsboro Formation is comprised of sand, it is likely that Simsboro wells on the Ely properties will be between 1,800 and 2,300 feet deep. Figure 5 illustrates locations for registered and permitted Simsboro wells within five (5) miles of the proposed Ely 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 Ely wells locations. Figures 6a, 6b, and 6c 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. Due to the depth and dip of the aquifer there are not a vast

number of local wells completed into the Simsboro. There is one Simsboro well mapped within one mile of the proposed wells. Simsboro wells are generally north of the Ely properties.

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). 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 Astin Farms property:

Parameter	GAM Estimates Range	TGI Estimates
Sand Thickness	550 to 600 feet	400 to 500 feet
Hydraulic Conductivity	97 to 208 gpd/ft^2	150 to 250 gpd/ft^2
Transmissivity	54,825 to 123,540 gpd/ft	60,000 to 125,000 gpd/ft
Storage Coefficient	1.21 x 10^{-4} to 1.29 x 10^{-4}	10^{-4}

Figure 7 provides a hydrograph illustrating water-level measurements collected for TWDB Well No. 59-04-701 (i.e., BVGCD Well BVHU-0013 and City of Hearne Well No. 4) which is located within 3 ¼ miles of the northernmost proposed Ely well (see Figure 5). Water levels in the well declined by between 110 and 140 feet from 1979 to 2021. AGS reported artesian head decline of 81 feet between 1999 and 2023 in TWDB Well No. 59-04-701 (AGS, May 11, 2023). The AGS map shows between 70 and 80 feet of artesian head decline in the Simboro beneath the Ely properties from 2000 to 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 1,100 and 1,500 feet above the top of the aquifer in the 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. The Ely Family Partnership has requested a permit allocation for the Simsboro Aquifer of 13,872 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 maximum authorized rate, respectively. Table 1 and Tab3e 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 70 feet immediately adjacent to the Ely property boundaries and from 42 to 52 feet one (1) mile from the proposed wells within the first year of pumping. Declines during the initial year are simulated to be 18 to 29 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 80 feet adjacent to the subject property and is simulated to range from 52 to 62 feet one (1) mile from the well locations. Simulated drawdown ranges from 25 to 42 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. Note that due to the depth of the local Simsboro and the prolific transmissivity the overlap of well radii (see Rule 6.2) on the Ely properties will not cause adverse interference drawdown effects on the Ely wells or on local wells. Local wells will continue to maintain hundreds of 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 t after one (1) and 10 years, respectively. Table 1 and Tab3e 2 provide drawdown values at specific well locations. The analytical model calculated artesian pressure declines of as much as 95 feet adjacent to the subject property after one (1) year of pumping. Drawdown at a distance of one (1) mile was modeled to be 70 to 85 feet after the first year of pumping. At five (5) miles away the drawdown calculation resulted in 48 to 55 feet of artesian pressure decline after a year of pumping at the annual allocation rate. After 10 years the calculated drawdown at the Ely property lines is as much as 105 feet and the drawdown at a distance of a mile was modeled to be 80 to 94 feet. The drawdown at five (5) miles was modeled to be between 57 and 63 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 Ely Family Partnership 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 assist you in our specialty. If you have any questions, please call.

The seal appearing on this document was authorized by Michael R. Thornhill, P.G. on July 19, 2023.

Attachments

Sincerely,
THORNHILL GROUP, INC.

Michael R. Thornhill, P.G.
President