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HYDROGEOLOGICAL REPORT: BRAZOS VALLEY FARM PERMIT APPLICATION – PROPOSED SIMSBORO WELLS TO BE COMPLETED ON THE BARTON, GOODLAND, AND HARLAN FARMS ROBERTSON COUNTY, TEXAS

Prepared for:

UW Brazos Valley Farm LLC
7670 Woodway Drive, Suite 200
Houston, Texas 77063

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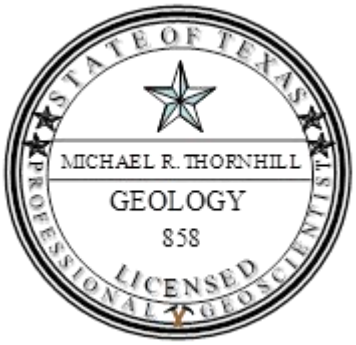

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1106 South Mays Street, Suite 100 • Round Rock, Texas 78664
(512) 244-2172 • E-mail: consult@tgi-water.com
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Introduction

UW Brazos Valley Farm LLC ("BVF") purchased all of the land and groundwater rights previously owned by CA Skiles Family Partnership, Ltd ("Skiles") including the previously-known Barton, Goodland, and Harlan farms which are collectively referenced herein as the Farm ("Farm"). The Farm totals 8,992.17 acres as surveyed in August of 2021 by Kerr Surveying. Additionally, BVF acquired in the purchase Brazos River surface water rights, groundwater rights in the Brazos River Alluvium aquifer, and Simsboro groundwater rights as follows:

- ✓ Historic Use Permit for annual allocation of 20,481 acre-feet per year as granted per a 2009 mediated settlement agreement (herein referenced as "Historic Use" permits*)
- ✓ Production Permits for annual allocation of 15,483 acre-feet per year granted in 2019 (herein referenced as "2019 permits or 2019 wells"**)

The asterisk (*) indicates that the Historic Use permits were granted based on a mediated settlement agreement with CA Skiles Family Partnership, Ltd (Skiles) that allows for pumping on a four-year rolling average 20,481 acre-feet per year perpetually, so long as aquifer conditions allow. The agreement also allows for pumping in any given calendar year of up to 30,000 acre-feet per year from the Simsboro, so long as the four-year rolling average is not exceeded. Therefore, currently permitted pumping for the Simsboro aquifer on the BVF properties is an average of 35,964 acre-feet per year, with some years of pumping up to 45,483 acre-feet per year. The double asterisk (**) indicates that the 2019 permits granted by BVGCD allow for municipal, industrial, commercial and irrigation uses.

BVF is submitting a drilling and production permit application for an additional 34,516 acre-feet per year from the three properties that comprise the Farm. The proposed permits combined with the 2019 production permits (i.e., 15,483 acre-feet per year) will bring the non-historic use permit total for wells completed in the Simsboro Aquifer to 49,999 acre-feet

per year. As a part of the long-term pumping plan, BVF will voluntarily rescind 10,400 acre-feet per year of the Historic Use groundwater permits so that the combined total pumping from all of the wells completed in the Simsboro Aquifer on the BVF properties will not exceed 59,999 acre-feet per year. The schedule for the reduction in Historic Use permit pumping once the subject permits are granted will correspond to the implementation of production permit pumping.

Per the rules of the Brazos Valley Groundwater Conservation District (BVGCD), Thornhill Group, Inc. (TGI) provides herein a description of the hydrogeologic conditions and an evaluation of the projected effects of pumping from the Farm located in western-southwestern Robertson County. Rather than simply assess the aquifer impacts due to pumping at the rates in the current permit request, TGI has conducted its analysis to evaluate the impacts based on pumping from existing, new, and proposed wells completed in the Simsboro Aquifer a total of 59,999 acre-feet per year, which includes 10,000 acre-feet per year of Historic Use pumping, 15,483 acre-feet per year of pumping based on permits granted during 2019, and 34,516 acre-feet per year in the current permit application. TGI conducted its evaluations and prepared this report in compliance with the rules and guidelines provided by the BVGCD in the District's rules amended on September 10, 2020, specifically in **Rule 8.4(b)(7)(B)** for wells (and multiple wells) capable of producing 800 or more acre-feet per year (BVGCD, 2020).

TGI's evaluations focused on assessing local aquifer conditions and parameters, and the extent to which production from the subject wells could influence other groundwater users in the BVGCD. Source data and information for the analyses for this study were derived from previous investigations including field-testing conducted for Skiles that supported prior permit applications for Harlan Farms and nearby tracts, unreported and published data and reports, newly acquired geologic and geophysical logs from three test holes drilled at recently permitted sites on the Farm, the applicable Groundwater Availability Model (GAM), and TGI's own 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;
- Utilizing iterative analytical modeling to estimate and calculate the potential short-term and long-term drawdown at each of the wells, interference drawdown between wells, and to verify feasibility of locations of and spacing between wells;
- Evaluating potential long-term drawdown from other planned or possible pumpage within BVGCD and the region, 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, and determining the proposed annual groundwater allocation for the drilling and production permit application request;
- Conducting numerical 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), deriving the water balance in the simulation, and evaluating other potential impacts due to proposed pumping; and,
- Providing this Hydrogeological 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 – Records for Selected Existing Skiles Wells
Attachment 5 – Selected References

Proposed Pumping Locations and Permit Pumping Rates

BVF has proposed well locations, pumping rates, annual allocations in compliance with Section 6 and Section 7 of the BVGCD Rules. Additionally, BVF will commit to retain only 10,000 acre-feet per year of the average 20,481 acre-feet per year of Historic Use permits once the subject permits are granted and actual production reaches a substantial portion of the total production permit amount. Therefore, the proposed Simsboro pumping for the Farm will not exceed 59,999 acre-feet per year.

Well Locations, Pumping Rates, Spacing, and Allocations

Figure 1 provides a map showing the following: location of the combined approximately 8,992 acres of the Farm, which is comprised of tracts previously known as Barton, Goodland, and Harlan farms; locations of Historic Use wells, newly permitted wells, and proposed wells on the BVF properties; and, the one-mile and five-mile radii from wells. TGI selected well locations and pumping rates based on considerations of the hydrogeologic conditions including aquifer depths, artesian pressures, aquifer productivity, and hydraulic characteristics. Figure 2 illustrates differences in drawdown at various distances from a pumped well based on the Theis equation (Theis, 1935). The graph shows drawdown calculated based on the following: aquifer transmissivity of 65,000 gallons per day per foot (gpd/ft); storage coefficients of 10^{-3} and 10^{-4}; time periods of 30 and 90 days; and, pumping rates including a low of 1,000 gallons per minute (gpm), medium of 2,000 gpm, and a high of

3,000 gpm. Note that drawdown is proportional to pumping rate. The well layouts are based on iterative analytical modeling calculations utilizing the Theis equation, which is as follows:

$$h_0 - h = s = \frac{Q}{4\pi T}\int_{r^2S/4Tt}^{\infty}\frac{e^{-z}}{z}dz$$

where:

$$\int_u^{\infty}\frac{e^{-z}}{z}dz = -0.577216 - \ln u + u - \frac{u^2}{2\cdot 2!} + \frac{u^3}{3\cdot 3!} - \frac{u^4}{4\cdot 4!} + \cdots$$

where:

$$u = \frac{r^2 S}{4Tt}$$

and:

h is head of fluid [L]
h_0 is initial head of fluid [L]
Q is pumping rate [L^3/T]
r is radial distance [L]
s is drawdown [L]
S is Storativity [dimensionless]
t is time [T]
T is transmissivity [L^2/T]

The Theis equation is based on numerous assumptions, most of which are sufficiently satisfied for local and short-term evaluations, and is the most widely accepted and accurate methodology for assessing drawdown in confined aquifers near pumping wells. Its usefulness is most effective with proximity to subject discharge points (e.g., wells) and with shorter pumping durations. The selected distances between wells for the permit application are based on the analytical calculations using the maximum instantaneous pumping rates for each well and are all reasonable with respect to normal engineering/hydrogeological practices. Otherwise, BVF and TGI determined the well locations based on the following:

- No well-to-well buffers [see Rule 6.1(b)(3)] extend across the property lines of any of the BVF properties, potentially reducing the effects on off-property registered or permitted Simsboro wells (see Figure 3). Note that wells with Historic Use permits are exempt from spacing rules in Section 6 of the BVGCD Rules; and,
- While the proposed spacing between wells in this permit application will accommodate the maximum instantaneous pumping rates based on analytical modeling results, the property line and well-to-well buffers and annual allocations requested are based on pumping the maximum pumping rates 80 percent of the time, which allows for some redundancy and periodic well outages. Therefore, for

long-term modeling (i.e., several months to years) the pumping rate used (and the corresponding buffers) for each well are based on each well's maximum pumping rate multiplied by 80 percent.

Table 1 provides a listing of all existing, newly permitted, and proposed Simsboro wells on the BVF properties including well identifications, coordinates, maximum pumping rates, and annual allocations. Figure 3 illustrates the locations of the Historic Use wells, the three newly permitted wells, and the 13 proposed wells for the subject permit application. Additionally, Figure 3 shows the property line and well spacing buffers around each of the non-historic use well locations and shows general locations of pipelines and easements on the properties. The proposed wells are located between the Brazos River and State Highway 6 (HW6). The nearest wells are 3.8 and 4.5 miles from the centers of the City of Hearne and the City of Calvert, respectively.

Figure 3 shows that the only Simsboro well within any of the existing or proposed permitted well-to-well buffers is a private, domestic well located on the Farm itself. Therefore, if needed BVF will provide a waiver regarding the spacing requirement on its own properties per BVGCD Rule 6.2(a) (BVGCD, 2020). Due to the scale of the map shown in Figure 3, it may appear that some of the buffers encounter the Farm property line or may overlap an adjacent well (e.g., Well CS_1 and Well PS_03). However, any apparent overlap is simply due to the visual depiction and does not exist based on surveyed locations of the wells and property boundaries.

Overlapping Well Buffers and Total Allocation

While the spacing of all proposed and existing BVF Simsboro wells comply with the well spacing requirements of Rule 6 in the BVGCD Rules, some of the well-to-well radii as drawn for the purposes of BVGCD Rule 7.1(c) for the proposed BVF well locations will overlap. BVGCD Rule 7.1(c) states, "More than one well may be assigned to the production acreage at the discretion of the Board as long as the spacing requirements are met" (BVGCD, 2020). The reasoning for proposing some well sites with overlapping buffers include:

- Well placement that accounts for aquifer geometry, specifically the dip of the formation and resulting depths to the top of the aquifer and available drawdown. Wells with overlaps are in portions of the property where the Simsboro aquifer is deeper;
- Analytical modeling results showed that the proposed well placement with some overlaps is reasonable based on standard hydrogeological and engineering considerations; and,

- The shape of the Barton, Goodland, and Harlan properties restricted the size and placement of wells, specifically on northern tracts and particularly considering BVF's determination to not have well-to-well buffers extend across property lines.

With a combined production permit pumping of 49,999 acre-feet per year which includes the 15,483 acre-feet per year from permits approved in 2019, and the proposed 34,516 acre-feet per year in this current permit application, the resulting maximum per-acre annual allocation for the approximately 8,992 acres of BVF is about 5.6 acre-feet per acre. Adding 10,000 acre-feet per year of Historic Use pumping would raise the annual per-acre pumping to 6.7 acre-feet per acre, which is slightly less than the allocation allowed for each well pumping the maximum rate (i.e., 3,000 gpm) permissible under the BVGCD rules (that is, translating what is allowed under BVGCD Rule 7.1(c) to an acre-feet per acre for comparison purposes).

Plan for Reduction in Historic Use Pumping

BVF currently owns Historic Use permits set forth in the mediated settlement agreement of June 2009 which resulted in permit provisions that allow for average annual Historic Use pumping of 20,481 acre-feet per year for irrigation purposes. The Historic Use permits are attached to 12 existing Simsboro wells (see Figure 1 and Figure 3). Additionally, the settlement agreement and resulting permit conditions allow BVF to pump as much as 30,000 acre-feet per year during any calendar year, so long as the average annual usage over a four-year rolling average is not more than 20,481 acre-feet per year. As part of the subject permit application and its long-term production plan, BVF will, voluntarily, commit to reducing its Historic Use allocation as production permit pumping is implemented. Ultimately, BVF will commit to retaining and utilizing no more than 10,000 acre-feet per year of Historic Use permits for the Simsboro Aquifer and total pumping from the Farm will not exceed 59,999 acre-feet per year.

Beneficial Use and Water Needs

The groundwater requested in this application will be used for a beneficial purpose as defined in Chapter 36 of the Texas Water Code. Specifically, BVF intends that most of the water produced from the Farm will be provided for municipal, manufacturing, industrial, and commercial uses. Some of the produced water may be used for on-farm agricultural (i.e., irrigation) purposes. Per requirements of Chapter 36 of the Texas Water Code and the BVGCD Rules, BVF will not cause any of the groundwater to be wasted.

Due to unprecedented rapid population growth in Texas and surface water rights being essentially fully allocated in several basins, groundwater appears to be a viable and feasible resource to meet many of the imminent and developing water needs. The 2022 State Water

Plan states that water demands for all counties within 50 miles of the BVF properties, or immediately adjacent to the Brazos River downstream from the property, will increase from 311,973 acre-feet per year to 601,561 acre-feet per year from 2030 to 2070 (Texas Water Development Board, 2022). Additionally, water demands within the BVGCD boundaries, largely satisfied with groundwater historically, will more than double from 21,726 acre-feet per year to 51,891 acre-feet per year during the same time period

The Central Texas growth corridor, including along Interstate Highway 35 (IH35) and Texas Highway 130, is also experiencing explosive growth leading to associated water demands and needs. For example, the 2021 Brazos Region G Regional Water Plan (Region G RWP) notes that by 2070 Williamson County will have unmet water needs of 162,000 acre-feet per year (2021 Brazos G Regional Water Plan, 2021). As there is limited groundwater resources within counties along the IH35 corridor, the regional plan includes strategies to import groundwater from counties to the east. Additionally, and not currently included in 2021 regional water plan, numerous companies needing significant reliable water supplies have announced moves to Central Texas along the east side of IH35. Companies making such announcements include Tesla, Google, Amazon, Oracle, Samsung, and likely Applied Materials. This announced growth is reflected in economic projects across the State: real gross product (RGP) for manufacturing is projected to experience 3.85% annual expansion, resulting in an additional $45.2 billion in manufacturing RGP by 2026, while expected gains in services RGP total $93.8 billion over the period, a 4.31% annual rate of increase (The Perryman Group, 2022).

The location of the Farm and the reliability of the groundwater provide for a water supply that can competitively supply water needs. Water produced from the Farm could be used to meet some of the demands noted in the Regional and State Water Plans. In fact, water from the Farm is being considered as a water supply strategy to be expressly included in the 2026 Brazos Region G and 2026 Region H regional water plans, and the subsequent 2027 State Water Plan.

Hydrogeologic Conditions and Aquifer Characteristics

The following information is provided to fulfill the requirements set forth in the BVGCD Rule 8.4(b)(7)(B)(1) for this study and evaluation report.

Surface Geologic Setting

Figure 4 shows that almost the entirety of the Farm lies atop the Brazos River Alluvium Aquifer, a minor aquifer in Texas. The Carrizo-Wilcox Aquifer occurs immediately below the Brazos River Alluvium Aquifer and is present beneath the entirety of the subject property. The Carrizo-Wilcox Aquifer is geologically older than the Queen City and Sparta aquifers which crop out south of the BVF properties. The Queen City and Sparta aquifers do not occur beneath any of the BVF properties.

Figure 5 provides a map of surface geology illustrating that almost the entire Farm property lies atop Brazos River alluvial and terrace sediments, which were deposited in the ancient and present-day floodplains of the Brazos River. Units forming the Carrizo-Wilcox Aquifer directly underlie the alluvial deposits. 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. The Reklaw Formation overlies the Carrizo. The top of the Simsboro Formation subcrops below the Brazos River alluvium approximately four (4) miles to the north-northwest of the Barton property, which is the northernmost tract of the BVF properties. The Calvert Bluff Formation, the uppermost unit in the Wilcox Group, subcrops beneath the alluvium across the Barton tract, and the Carrizo Sand and Reklaw formation subcrop beneath the Goodland and Harlan properties.

As the Farm is located within the ancient and recent floodplains of the river and because the land has been leveled for cultivation, the land surface is relatively flat across most of the property with elevations ranging mostly from an estimated 280 feet above MSL in the floodplain to about 420 feet above MSL on hilltops adjacent to the river bottom. Geologic units dip generally from northwest to southeast and dip angles generally increase downdip and with depth in the geologic section. Locally, the dip of the base of the Wilcox Group is approximately 75 feet per mile (See structure maps provided in Attachment 3). Faults associated with the Milano Fault Zone are mapped at land surface generally to the north of the Farm, although one fault is mapped across the western edge of the Barton tract (see Figure 5).

The Carrizo Sand is likely present across all or most of the Goodland and Harlan tracts, although it may be very thin near the northern property boundary. Where the alluvial deposits are not present along the extreme northeastern boundary of the property, the Carrizo Sand and Reklaw Formation are exposed at land surface. The base of the Carrizo Sand ranges in depth from land surface to approximately 230 feet below ground level (BGL) and the unit is likely between 50 and 130 feet thick across the Farm. Figure 6 and Figure 7 show

locations for wells within the BVGCD boundaries that are located within five (5) miles and one (1) mile of the nearest subject proposed wells. The five (5) mile buffer for the proposed wells within the Goodland and Harlan areas combined contain 23 wells completed in the Carrizo Sand, and 19 Carrizo wells are mapped primarily downdip (southeast) and eastward from the property.

The Calvert Bluff Formation directly underlies the Carrizo Sand 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 Sand 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. Depth to the top of the Calvert Bluff likely ranges from 50 to 150 feet BGL across the Farm properties and the formation ranges in thickness from 440 to 750 feet. The base of the Calvert Bluff Formation is approximately 1,050 feet BGL along the downdip property boundary of the Farm. Between 10 and 20 percent of the total thickness of the Calvert Bluff consists of sand, so the net sand thickness typically ranges from 100 to 200 feet. Figure 6 displays wells from the BVGCD database, and 154 of the 711 reported wells within five (5) miles of the nearest BVF wells are designated by the BVGCD as being completed in the Calvert Bluff. Most Calvert Bluff wells are small-capacity wells used for domestic and stock purposes. Most local wells are likely 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 forms the aquifer that will be tapped by all of the proposed BVF wells, existing Historical Use wells, and 2019 permitted wells evaluated in this study. Figure 7 shows all wells within one-mile radius from each of the proposed wells, and Figures 7a through 7k provide maps at a scale of 1 inch = 1,000 feet (per BVGCD Rule 8.4(b)(7)(B)(2)) showing the locations of the proposed wells and other wells within a one-mile radius of each of the proposed wells that will comprise the BVF well field. Figure 7l provides an index for Figures 7a through 7k, showing the area of view for each map. Based on the BVGCD database, there are 15 Simsboro wells not owned by BVF within one mile of at least one of the proposed wells. Table 2 provides a tabulation of wells completed in the Simsboro Aquifer located within one (1) mile of the nearest Simsboro wells proposed in the subject permit application.

Based on GAM datasets and geologic maps and cross sections from the University of Texas Bureau of Economic Geology (BEG), the elevation of the top of the Simsboro Aquifer ranges from 550 to 700 feet below MSL across the BVF properties (see Attachment 3). Locally, the Simsboro dips (i.e., slopes) structurally from northwest to the southeast at an incline of between 70 and 80 feet per mile, and crops out (i.e., occurs at land surface) about four (4) miles northwest of the proposed well sites. Based on the geologic dip and land surface elevation, the depth to the top of the Simsboro should range from 350 to 960 feet BGL across the Farm. Attachment 4 provides available well records for nearby wells on both the Goodland and Harlan properties. Based on drilling records for the 2019 permitted wells (CS-1, CS-2 and CS-3), the depth to the top of the Simsboro Aquifer is approximately 825, 780 and 820 feet BGL, respectively. Maps by the University of Texas Bureau of Economic Geology (BEG) show that the net sand thickness of the Simsboro ranges from 300 to 500 feet across the subject property (see Attachment 3). Records for nearby wells indicate that the wells completed on and near the Barton, Harlan, and Goodland properties did not penetrate the entire thickness of the Simsboro (see Attachment 4).

Figure 8, Figure 9, and Figure 10 provide geophysical logs for test holes drilled at the 2019 permitted sites for wells CS-1 (BVGCD No. BVDO 0254), CS-2 (BVGCD No. BVDO-0255), and CS-3 (BVGCD No. BVDO 256) located on the Harlan and Goodland properties of the Farm. The Carrizo Sand, Calvert Bluff Formation, and Simsboro Formation are all delineated on the geophysical logs, with the top of the Simsboro at an elevation of 552 feet below MSL, 507 feet below MSL and 504 feet below MSL at CS-1, CS-2, and CS-3, respectively. Based on TGI's interpretations of the logs, the Simsboro is between 375 and 420 feet thick with a net sand thickness of 340 to 360 feet. Based on reasonable values of hydraulic conductivity ranging from 125 to 225 gallons per day per square foot (gpd/ft^2), or 16.7 to 30.1 feet per day (ft/d), the transmissivity for the Simsboro Aquifer is between 42,500 and 80,500 gallons per day per foot (gpd/ft) beneath the Goodland and Harlan tracts. Specific capacity values available from testing conducted on several of the existing irrigation (i.e., Historic Use) wells upon their completion suggest that transmissivity values are significantly lower. However, log data and existing mapping of the Simsboro indicate that the existing irrigation wells on the Farm properties did not penetrate the entire thickness of the Simsboro Formation, and the efficiency of the wells is unknown. Therefore, the transmissivity values indicated by the logs for CS-1, CS-2, and CS-3 are likely reasonable. The Simsboro Aquifer is under artesian conditions so the short-term (i.e., days to months) storage coefficient is on the order of about 0.0001 (10^{-4}). However, due to the likelihood of inter-aquifer leakage from overlying (i.e., Calvert Bluff) and underlying (i.e., Hooper) formations, the longer-term storage coefficient is likely on the order of 0.001 (10^{-3}). During a 45-day pumping test at the Walnut Creek Mine located approximately nine (9) miles north-northeastward of the Farm, the storage coefficient increased from 0.0001 to 0.00238 within the duration of the test. While the mine

pumping test was conducted in areas within 1.5 miles of the Simsboro outcrop, it is likely that the storage coefficient would act similarly near the Farm due to inter-aquifer leakage.

TGI extracted aquifer hydraulic data for the Farm and nearby areas from the newly released version of the groundwater availability model (GAM) for the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers (Young, et al., 2018). For previous investigations, TGI assessed hydraulic parameters derived from the previous versions of the GAM and compared to transmissivity values derived from specific capacity values for some of the nearby wells. The following table provides a summary comparison of average estimated parameters extracted from the GAM datasets to those derived by TGI for the local Simsboro Aquifer at the three2019 permitted well sites:

Parameter	Previous GAM Avg. Estimates	Updated GAM Estimates Range	TGI Estimates*
Sand Thickness	450 feet	450 to 500 feet	450 to 500 feet
Hydraulic Conductivity	210 gpd/ft^2	75 to 150 gpd/ft^2	125 to 200 gpd/ft^2
Transmissivity	94,200 gpd/ft	35,000 to 75,000 gpd/ft	60,000 to 70,000 gpd/ft
Storage Coefficient	1.2 x 10^{-4}	1.44 x 10^{-4} to 1.56 x 10^{-4}	10^{-4} (10^{-3})**

The asterisk (*) in the above table indicates that TGI's estimates are based on and are consistent with previous hydrologic investigations and include adjustments to local transmissivity values to account for producing from the entire aquifer thickness. The double asterisk (**) indicates that the longer-term storage coefficient is likely that of a leaky artesian aquifer.

Figure 11 provides a hydrograph illustrating water-level measurements collected for a nearby TWDB/BVGCD monitoring well (State Well No. 59-04-701) screened within the Simsboro Aquifer. This monitoring well is located near the City of Hearne and is about 1.5 miles eastward from the nearest proposed BVF well (see Figure 1). The water level in 1979 was less than 10 feet below land surface and has declined by about 110 feet over almost 40 years. The current water-level elevation at well 59-04-701 is approximately 149 feet above MSL, and the corresponding depth to water is about 147 feet BGL. 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 (Intera, 2015). Water-level elevations will likely be about 35 feet higher in the northern portion of the Farm than near the southern boundary of the properties. Therefore, current depth to water on the subject property will likely range from 112 to 147 feet BGL. Water levels will probably be between 388 and 405 feet above the top of the aquifer in the proposed new wells, verifying that the local Simsboro Aquifer 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 drawdown at the pumping wells. As groundwater pumping continues, artesian pressure or potentiometric head around the wells

will decline, forming a cone of depression. The cone of depression will extend radially from each well within 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 and the positive boundary effects of the recharge area (i.e., outcrop), reduction in artesian pressure is the only anticipated measurable effect from the proposed pumping. The aquifer will remain fully saturated and there will be only an infinitesimal reduction in storage as a result of declining hydrostatic pressure at depth. There will likely be inter-aquifer leakage induced from the overlying Calvert Bluff confining layer, the Carrizo Sands aquifer and Brazos River Alluvium Aquifer. The leakage will serve to lessen the artesian drawdown in the Simsboro Aquifer and will likely not result in any identifiable water-level changes in the Calvert Bluff, Carrizo Sand or alluvium due to the stratification in the geologic layers inhibiting significant vertical migration of groundwater. GAM simulations indicate that reductions in flows in the Brazos River will be less than five (5) cubic feet per second (cfs), while the lowest historical flow in the river near Bryan, Texas was more than 100 cfs (USGS, 2022). Therefore, diminution in flow in the Brazos River due to BVF would be essentially non-detectable.

Drawdown Simulations Using the GAM

R.W. Harden & Associates provided modeling support for TGI and provided results from simulations from the recently released revision and update of the Central Portion of the Sparta, Queen City, and Carrizo-Wilcox Aquifers GAM (Young, et al., 2018). Figure 12 and Figure 13 provide maps showing modeled drawdown contours after one (1) year and the (10) years of pumping, respectively, at the maximum authorized rate from each proposed and 2019 permitted well, and from selected Historical Use wells (Table 1), so that the total pumpage is 59,999 acre-ft/year. Table 2 provides modeled drawdown at registered and permitted Simsboro wells within one (1) mile of the nearest BVF production well associated with this permit application after one (1) year and ten (10) years of continuous pumping.

Due to the grid scale and configuration of the model, the GAM does not provide an accurate spatial representation of drawdown at the well sites within the well field and in the immediate surrounding area. As such, GAM simulations likely predict less drawdown than will physically occur near the pumping wells. The GAM drawdown results at some distance from the proposed well field are probably more representative of the actual aquifer conditions and the potential results from pumping. For the nearest Simsboro wells located off the BVF properties, the GAM runs predicted between 86 and 218 feet of drawdown after one (1) year, and a total of between 115 and 260 feet after ten (10) years. The GAM simulated approximately 170 feet of drawdown at Hearne and 135 feet of drawdown at Calvert after 10 years of pumping 59,999 acre-feet per year from the Farm.

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 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 areas in the immediate vicinity of the proposed well field. 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 several months to 10 years) by incorporating a leaky artesian storage coefficient. 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. The Theis model is also more accurate for shorter pumping durations; therefore, the 10-year calculation likely significantly overestimates drawdown from the well field.

Figure 14 and Figure 15 provide the Theis-modeled drawdown contours for pumping periods of one (1) year and ten (10) years, respectively. Table 2 provides the tabulated drawdown at Simsboro wells within one (1) mile of the nearest proposed BVF wells, 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 predicts drawdown in the proposed pumping wells of between 175 and 272 feet after one (1) year of continuous pumping, with an additional 150 to 160 feet of drawdown at each well with continuous pumping for 10 years. The Theis calculation results in one-year interference drawdown of about 160 feet at the City of Hearne and approximately 150 feet at Calvert. The analytical model predicts drawdown after 10 years of 310 feet and 300 feet at Hearne and Calvert, respectively, assuming continuous pumping of the maximum permitted volume. Table 2 allows for comparison of the drawdown calculations using the Theis model and the GAM.

Proposed Pumping and Desired Future Conditions

Desired future conditions (DFCs) are a "quantitative description, adopted in accordance with Section 36.108 (of the Texas Water Code), of the desired condition of the groundwater resources in a management area at one or more specified future times" (BVGCD, 2020). The TWDB states that DFCs "are defined in Title 31, Part 10, §356.10(6) of the Texas Administrative Code as 'the desired, quantified condition of groundwater resources (such as water levels, spring flows, or volumes) within a management area at one or more specified future times as defined by participating groundwater conservation districts within a groundwater management area as part of the joint planning process.'" The DFC for the Simsboro Aquifer is defined by Groundwater Management Area 12 (GMA 12) average drawdown. The DFC from the previous planning period for BVGCD was set at 295 feet of average drawdown by 2070. The modeled available groundwater (MAG) is essentially the rate of pumping for a period of approximately 50 years that will result in the DFC being achieved. The MAG for BVGCD for the previous planning period was 96,198 acre-feet per year through the year 2069 (BVGCD, 2019). The BVGCD Management Plan reports metered pumping of 55,229 acre-feet for the year 2018 (BVGCD, 2019). The proposed BVGCD DFC for the Simsboro Aquifer during the current planning period is district-wide average drawdown of 262 feet (GMA 12, 2022). Based on the current DFC GAM simulation (S-19), GMA 12 consultants reported that simulated pumping of 147,233 acre-feet per year will result in 195 feet of average drawdown within the BVGCD by 2070, which is less than the proposed DFC (Donnelly, 2021). The TWDB has not yet determined the MAG from the most recent round of joint planning by GMA 12; however, it is clear that the resulting MAG will be more than 147,233 acre-feet per year. Therefore, the GAM indicates that the proposed BVF pumping will not cause the DFC for the Simsboro Aquifer within BVGCD to be violated. Determination of whether the Simsboro Aquifer DFC is achieved must be based on actual measured water levels in a monitoring well network. Therefore, BVGCD aquifer management decisions must be based on water-level data. BVF will commit to providing water level data, access to wells, and potentially dedicated monitoring wells to the BVGCD.

Conclusions

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

- The BVF request in this production permit application is 34,516 acre-feet per year. With a proposed voluntary rescinding of 10,481 acre-feet per year of the currently 20,481 Historic Use permits over time, the Simsboro production proposed from the Farm, inclusive of the pending application, will not exceed 59,999 acre-feet per year;
- All groundwater produced from the Farm will be used for a beneficial purpose and not wasted. The primary uses for the proposed production permits in this permit application

and the 2019 production permits will be municipal, manufacturing, industrial, and commercial;

- The State of Texas is experiencing unprecedented and rapid growth that is leading to current and future potentially unmet water demands. The Farm is favorably located and can produce reliable and excellent-quality supplies to economically meet many of such demands. Production permits will allow the BVF Simsboro groundwater supply to be competitive as a viable water solution. The Farm supply is being considered as a water management strategy to be expressly included in the 2026 Brazos G and Region H regional water plans and the subsequent 2027 State Water Plan;
- 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 existing BVF wells (March 18, 2009), current available drawdown, and predicted drawdown all demonstrate that the wells will be capable of easily sustaining the pumping rates designated in the permit application;
- The predicted drawdowns derived from the Theis analytical model are more accurate than the GAM predictions for the proposed well sites and areas near the well field, and for short pumping durations;
- 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;
- Production from the proposed pumping will cause only infinitesimal reduction in aquifer storage as the Simsboro Aquifer will stay completely full and groundwater in the formation will remain under considerable artesian pressure within the well-field area and the five-mile study radius; and,
- The pumping proposed in the subject BVF production permit application will not cause unreasonable impacts to the Simsboro Aquifer, other groundwater owners and users, or surface water.

ATTACHMENT 1

Figures

ATTACHMENT 2

Tables

ATTACHMENT 3

Reference Materials

ATTACHMENT 4

Records for Selected Existing Skiles Wells

ATTACHMENT 5

Selected References

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