THORNHILL GROUP, INC.

Professional Hydrogeologists • Water Resources Specialists

March 29, 2018

Mr. Trey Job, CPM, Director
Public Works, Parks, & Utilities
City of Bastrop
1209 Linden Street
Bastrop, Texas 78602

Re: Summary of Pumping Test Results and Drawdown Assessment —
City of Bastrop Simsboro Well No. 1 (District Well: 5854819)
Bastrop County, Texas

Dear Mr. Job:

Thornhill Group, Inc. (TGI) provides to the City of Bastrop (City) this summary of work conducted and results pertaining to the monitoring plan, production testing and analyses associated with the City's Simsboro Well No. 1 (District Well: 5854819). The assessments herein are based on the proposed and permitted production from Simsboro Well No. 1 (primarily referenced herein as **Well "J"** as noted on the State Well Report and other documents) as follows:

- Maximum instantaneous pumping rate of 1,500 gallons per minute (gpm); and,
- Annual permit allocation of 2,000 acre-feet per year, which is equivalent to a continuous pumping rate of 1,240 gpm.

## WORK CONDUCTED

The Work reported herein was conducted as outlined in TGI's Proposal to the City dated June 20, 2017, and in accordance with the provisions set forth by the Lost Pines Groundwater Conservation District (LPGCD) in the Special Conditions of the operating permit granted on October 12, 2016 for the subject well. Generally, TGI conducted the following:

- ✓ Compiling a list of water wells designated for monitoring per the Special Conditions of the Operation Permit granted by LPGCD and per all agreements between parties;
- ✓ Verifying local hydrogeologic conditions and completion details of proposed monitoring wells to delineate which wells are completed in the Simsboro aquifer as compared to other water-bearing zones;
- ✓ Conducting a field inventory of designated wells to assess access and suitability for monitoring, including needs for conducting any downhole video inspection and properly equipping the wells to enable sufficient monitoring before, during and after testing the required 36-hour production test;

- ✓ Implementing and executing an effective monitoring program to collect sufficient background (i.e., pre-testing) data, and to ensure comprehensive monitoring during the production test; and,
- ✓ Conducting hydraulic and hydrogeologic assessments based on the background and production testing monitoring to develop a scientific basis for determining "…proof of material impact caused by the pumping from Well No. 1…" per the terms in the Special Conditions of the Operating Permit.

TGI's entire proposed Scope of Services is provided in Appendix 1 and was intended to ensure that all work and information derived are in accordance with the Operating Permit, the subsequent Memorandum of Understanding (MOU), and any other applicable agreement relating to the monitoring and mitigation plan. The Scope of Services provided was based on the permit documentation provided by the City, on previous correspondence with the City, and on the meeting of June 14, 2017.

TGI has considerable experience in conducting monitoring programs and evaluating potential impacts due to pumping, and TGI professionals have conducted such assessments for wells completed in the Simsboro aquifer in Bastrop, Brazos, Burleson, Lee, Leon, Milam and Robertson counties, as well as in many aquifers across Texas. TGI is a licensed firm with the Texas Board of Professional Geoscientist and is comprised of licensed professional geoscientists specializing in groundwater and well evaluations.

# RESULTS

TGI has reviewed numerous regional and local reports in conducting this work, including reports by experts and consultants employed on behalf of XS Ranch, the City of Bastrop and the LPGCD. This report will not reiterate the detailed findings of those previous studies but will provide summary information and comparisons as applicable to explain and illustrate the results of production testing and associated impacts assessments associated with Well "J". Supporting data, information and documentation for this assessment are provided in the following:

Appendix 1 – Scope of Services
Appendix 2 – Basic Groundwater Concepts
Appendix 3 – Reference Illustrations

Attachment 1 – Report Figures and Tables
Attachment 2 – Monitoring Well Information and Results (Packets)
Attachment 3 – Selected References

## Well Location and Study Area

The City's new Well "J" is located on the XS Ranch approximately four (4) miles north of downtown Bastrop and about 0.6 mile west of State Highway 95. Figure 1 provides the location of the subject well and other wells permitted by LPGCD. The nearest large-capacity Simsboro wells are located in Aqua Water Supply Corporation's (AWSC) Camp Swift well field and the Lower Colorado River Authority's (LCRA) well field on the east side of Lake Bastrop. The wells monitored in this study include the City's monitoring well (MW-3) which is located approximately 1,400 feet south-southwestward from Well "J". Additionally, the City and TGI obtained permission and were able to access 17 private wells for monitoring before and during the 36-hour production testing. All of the private wells are exempt from permitting and are small-capacity wells used for domestic and stock purposes. The wells are located generally in three areas as follows:

- Area 1 – four (4) wells located within about 2,200 feet of Well "J", all along Phelan Road;
- Area 2 – nine (9) wells located near the Colorado River along the east side of Powell Bend, along and near Sayers Road. These wells are between 4,200 and 6,200 feet (approximately 0.8 to 1.2 miles) from the subject production well;
- Area 3 – four (4) wells reportedly located on the McCall Ranch property on the north side of the Colorado River near Powell Bend. These wells are approximately two (2) miles from the City's new Well "J".

Figure 2 provides the location of the Study Area, including the production well and wells monitored during testing.

## Hydrogeology

The long-term availability of groundwater resources and impacts associated with pumping from aquifers depend on the following key factors:

- Thickness, rock type and character, and geometry (e.g., structure) of geologic units forming aquifers and confining units;
- Hydrologic and hydraulic characteristics of producing zones and confining units including primary porosity, secondary porosity, effective porosity, hydraulic conductivity (i.e., permeability), transmissivity and storage coefficient, as well as the presence of faults and other hydraulic boundaries;
- The storage characteristics of the aquifer;
- Sources, amounts, timing and distribution of recharge and other inflows;
- Amounts, locations, and duration of discharge and other outflows, including naturally via springs, seeps, underflow, leakage and evapotranspiration, as well as artificially due to pumping; and,
- Quality of water in water-bearing zones with respect to the quality of water needed;

Appendix 2 provides TGI's handout titled "Basic Groundwater Concepts" which provides fundamental terms, definitions and explanations regarding how aquifers function, and presents necessary insights to assess effects of pumping. Such definitions are not re-stated in this summary report. Appendix 3 includes pertinent miscellaneous illustrations from selected reference materials.

## Aquifer Setting and Characteristics

The City's Well "J" is located atop the outcrop of the Calvert Bluff Formation and is completed in massive sand layers of the Simsboro aquifer, which is formed by saturated portions of the Eocene-age Simsboro Formation of the Wilcox Group. The Simsboro is part of the Major Aquifer identified by the TWDB as the Carrizo-Wilcox aquifer which is comprised, from shallower to deeper (i.e., younger to older), of the Carrizo Sands, the Calvert Bluff Formation, the Simsboro Formation and the Hooper Formation. The Carrizo is not present at the subject well site. Figure 3 provides a map illustration the Regional Surface Geology, and Figure 4 shows the Study Area Surface Geology (also see Appendix and USGS, 1984). The physical and hydraulic characteristics of each the geologic formations comprising the Wilcox Group are distinct from each other; therefore, each unit forms its own separate hydrostratigraphic unit. Figure 5 provides a summary Hydrostratigraphic Section.

The Calvert Bluff Formation is at land surface across most of the area between Well "J" and the Colorado River, and is characterized primarily by thin, alternating and interbedded layers of fine-grained sediments including mudstones, siltstones, lignite seams. Some significant sand channels ranging up to 100 feet in thickness occur in the Calvert Bluff, however, such channels are typically discontinuous and isolated laterally. The Calvert Bluff is up to 300 feet thick near Well "J" (see Appendix 3). Typical horizontal hydraulic conductivity values in Calvert Bluff sand channels range from four (4) to 18 feet per day (ft/d), which is equivalent to 30 to 135 gallons per day per square foot (gpd/ft$^2$) (TWDB 1991). The modeled hydraulic conductivity locally is between one (1) and three (3) gpd/ft$^2$ (see Appendix 3 and Dutton, Harden, Nicot and O'Rourke, 2008). Vertical hydraulic conductivity values in relatively uniform sand layers are generally one-tenth of the horizontal values, or less. The vertical hydraulic conductivity in the many clay layers within the Calvert Bluff likely ranges from $10^{-6}$ to $10^{-3}$ gpd/ft$^2$ (Driscoll, 1986). The Calvert Bluff is primarily considered an aquitard or confining unit, as horizontal and vertical groundwater flow through the Calvert Bluff is generally restricted across Bastrop County and the LPGCD. In some locations, the Calvert Bluff may yield sufficient quantities of water to wells for small industrial and municipal uses. While some interaquifer leakage always occurs as groundwater oozes from the Calvert Bluff into the Simsboro, the leakage is very slow and does not greatly affect the groundwater conditions in the Calvert Bluff due to low vertical hydraulic conductivity (i.e., permeability).

The Simsboro aquifer is the most prolific water-bearing unit in Bastrop and Lee counties and provides major water supplies across Groundwater Management Area 12 (GMA 12). The

Simsboro Formation is comprised of multistory, multilateral channel-fill sand complexes that are characteristic of fluvial-deltaic depositional systems (Ayers and Lewis, 1985). The Simsboro often contains two or more thick, massive sand units separated by clay layers. The Simsboro sands are characterized on geophysical logs by high formation resistivity. The sand units consist primarily of unconsolidated, medium- to coarse-grained sand, with some interbedded and stratified finer-grained sediments. Laterally, the thickness and character of the formation can vary considerably, but generally the sand layers are extensive and continuous. Locally, the Simsboro thickness reportedly ranges from 100 feet in its outcrop area near the Colorado River to more than 450 feet at the Well "J" site (see Appendix 3 and TGI, 2007). Appendix 3 provides maps from the Carrizo-Wilcox GAM showing the Simsboro sand channels to be between 100 and 300 feet thick in the study area (Dutton, Harden, Nicot and O'Rourke, 2003). The geophysical log for the City's Well "J" and logs for other nearby sites indicate that the total aquifer thickness is approximately 380 feet, and the net sand thickness ranges from 160 to 200 feet locally. The horizontal hydraulic conductivity for Simsboro sands ranges from 2 to 84 ft/d, which is equivalent to 15 to 630 gpd/ft$^2$ (TWDB, 1991). The Carrizo-Wilcox GAM utilizes hydraulic conductivity values of between 10 and 20 ft/d, or 75 and 150 gpd/ft$^2$ within the Study Area (see Appendix 3 and Dutton, Harden, Nicot and O'Rourke, 2003). Locally, the transmissivity of the Simsboro aquifer generally ranges from 25,000 to more than 50,000 gpd/ft (LAN and TGI, 2005). The upper contact with the Calvert Bluff and the basal contact with the underlying Hooper Formation tend to be sharp, although locally the occurrence of some lower sand channels in the Calvert Bluff may make identifying the top of the Simsboro difficult.

The Hooper Formation underlies the Simsboro and is comprised of upward-coarsening sequences of delta-plain mudstone, lignite and channel fill (Ayers and Lewis, 1985). Locally, the Hooper is more than 1,000 feet thick (see Appendix 3 and Dutton, Harden, Nicot and O'Rourke, 2003). In some areas, the Hooper contains significant thicknesses of very fine- to medium-grained sands and has been tapped to provide relatively small municipal supplies, particularly in southeastern Williamson County and southwestern Milam County. The Hooper is tapped for small public water supplies in western Bastrop County (near Cedar Creek) and by Aqua WSC south and east of Elgin (see Figure 1). Locally, the Hooper is tapped near the Colorado River for domestic well uses. Typical horizontal hydraulic conductivity in the Hooper ranges from 0.1 to one (1) ft/d, or 0.75 to 7.5 gpd/ft$^2$ (see Appendix 3 and Dutton, Harden, Nicot and O'Rourke, 2003). Vertical hydraulic conductivity values are at least an order of magnitude less than the vertical values in sand layers, vertical permeabilities are orders of magnitude less in clay zones. Because of its stratification and lower hydraulic conductivity, the Hooper Formation is considered a confining layer with respect to the Simsboro aquifer.

The depth, thickness and lateral continuity of the Simsboro are determined by land-surface topography, depositional system and the geologic structure. The City's Well "J" is completed to a total depth of 673 feet below ground level (BGL). The top of the Simsboro Formation occurs at a depth of 260 feet BGL, or an elevation of 201 feet above mean sea level (MSL). Some upper

sands in the Simsboro were not screened, which allows for more favorable available drawdown. The top of the screened (i.e., producing) interval for the well is 450 feet BGL, an elevation of 11 feet above MSL. Figure 6 provides a diagram illustrating the well completion settings for Well "J" as related to the geophysical log and hydrostratigraphic layers for the site.

The geometry of the local Simsboro aquifer is controlled primarily by two structural features; the geologic dip and faulting. The Simsboro is mapped at land surface (i.e., crops out) in a narrow southwest-northeast trending band (see Appendix 3, Figure 3 and Figure 4). Along the ancient and present-day course of the Colorado River, the Simsboro subcrops beneath deposits of the Colorado River alluvium, which are typically less than 50 feet thick but locally may consist of gravel deposits that can yield significant water supplies to wells. The closest portion of the outcrop to Well "J" is mapped by the University of Texas Bureau of Economic Geology (BEG) to occur near Powell Bend on the Colorado River, approximately 3,500 feet (0.7 mile) from the subject production well (see Figure 4). However, due to faulting it is likely that the outcrop actually occurs slightly further to the west. Generally, the Simsboro dips (i.e., slopes) toward the east-southeast with an incline of between 100 and 200 feet per mile (see Appendix 3 and TWDB, 1991). However, the dip is probably on the order of 130 feet per mile in the shallow confined zone and is gentler (i.e., flatter) at less than 100 feet per mile nearer to the outcrop area (USGS, 1984). Faults associated with the Balcones Fault Zone have displaced the Simsboro within and near its outcrop area. Local studies have revealed at least three mappable faults within and near the Study Area (see Figure 4 and Appendix 3). The faults trend northeastward generally parallel to the outcrop, and are downthrown on the northwestern (i.e., updip) side (USGS, 1984). The "Bastrop Fault" occurs within 3,600 feet downdip from the Well "J". The "Powell Bend Fault" occurs within approximately 3,000 feet of the subject well in the updip direction and is likely between the subject production well and Powell Bend of the Colorado River. The "Powell Bend Fault" may be an extension of the previously mapped "Well-Field Fault" in the Camp Swift area (see Figure 4 and Appendix 3). The "Sayersville Fault" occurs between two (2) and three (3) miles updip from the "Powell Bend Fault" (see Figure 3 and Appendix 3). The net displacement along the trend of the faults varies from one end of the fault to the other and are sometimes called "scissor faults". Reportedly, the "Sayersville Fault", the most prominent fault, exhibits about 250 feet of throw in the northwestern part of Camp Swift, and has a reported displacement of about 500 feet several miles southwest of Camp Swift (USGS, 1984). Based on TGI's review of several geophysical logs within the Study Area, the fault displacement along the "Powell Bend Fault" is probably about 100 feet; therefore, the Simsboro Formation is not completely displaced across the fault line locally. Likely, there are numerous smaller faults associated with and parallel to the known or mapped faults. Figure 7 provides a Cross Section for the Study Area, showing the thickness and structure of the Simsboro aquifer and its relationships to overlying and underlying aquifers.

The geologic structure and depositional environments heavily influence the hydraulic characteristics and responses in the Simsboro aquifer. Faults in the Simsboro aquifer typically

restrict or inhibit the flow of groundwater across the fault planes, due to the displacement (and saturated thickness change) across the fault and the associated low-permeability fault gouge along the fault plane. The amount of restriction varies, but typically results in more drawdown than anticipated on the pumping side of the fault, and less drawdown than anticipated on the side of the fault opposite of production. The close proximity to the outcrop area is also important with respect to the hydraulic setting and effects of pumping in the local Simsboro aquifer. Because the subject well is close to the water-table portions of the aquifer and the recharge area, the storage coefficient transitions from that of an artesian (i.e., confined) or leaky-artesian value (i.e., $10^{-4}$ to $10^{-3}$) in the downdip areas to one equivalent to the specific yield ($S_y$) in the unconfined or water-table areas (see discussion of aquifer storage coefficient in Appendix 2). Finally, all aquifers and aquitards (i.e., confining layers) leak. Because the Study Area is within the recharge zone of the Wilcox Group, groundwater continually moves laterally downgradient and attempts to leak vertically downward under non-pumping conditions. Modeled and measured water levels confirm that groundwater currently leaks downward from the Calvert Bluff to the Simsboro (see Appendix 3 and Dutton, Harden, Nicot and O'Rourke, 2003). Due to the stratified nature of the Simsboro aquifer and the overlying confining layers, the leakage from the Calvert Bluff into the Simsboro is quite slow. Modeled water levels indicate that artesian heads in the local Simsboro and Hooper formations are at similar elevations (see Appendix 3 and Dutton, Harden, Nicot and O'Rourke, 2003). Local water-level measurements indicate that Simsboro water level heads may be slightly higher than those in the Hooper, so groundwater is currently slowly leaking from the Simsboro to the Hooper. The confining layer between the Simsboro and Hooper greatly restrict the movement of water downward.

## Wells Monitored During Testing

Additional to the City's production well (Well "J") and monitoring well (MW-3), twenty-six (26) property owners requested that their wells, a total of 32 domestic wells, be monitored during testing of the subject production well. TGI inspected all 32 of the domestic wells and found that 17 wells were constructed with sufficient access to allow for effective monitoring by electric line water-level indicators. Also, TGI obtained permission and installed continuous water-level recorders (i.e., pressure transducers) in five (5) of the private wells and one in the City's MW-3. Background water-level monitoring began in September of 2017.

TGI assessed land surface topography, available well completion records, information provided in the City's permit application and the associated contested-case hearing, and geologic conditions including formation thickness and geologic structure, and determined in which aquifer each well is completed. Table 1 provides a summary of the wells monitored per the permit conditions and agreement, including depths, elevations and completion zones. Figure 3 provides a map illustrating the locations of the wells and aquifer of completion. Generally, the accessible private monitoring wells are concentrated in three geographic areas, as summarized below:

Area 1 – Four (4) Wells Closest to the Production Well

- Distances from wells to the production well range from 460 to 1,160 feet;
- Well depths range from 240 to 285 feet below ground level, with elevations of total depth (TD) of the wells ranging from 164 to 211 feet above MSL; and,
- Wells are completed in the Calvert Bluff Formation.

Area 2 – Nine (9) Wells Within and Near Colorado Shores Subdivision

- Distances from wells to the production well range from 4,250 to 6,260 feet;
- Known well depths range from 165 to 400 feet below ground level, with elevations of tops of producing zones ranging from 112 to 233 feet above MSL; and,
- All wells with known settings, except two, are generally completed into the uppermost Simsboro sands (see Figure 7);
- Dr. Uliana noted that the Mr. Robert Martinez well is "most likely completed in the Simsboro Formation" (Uliana, 2015). However, TGI has concluded based on available geologic information and the lack of water-level response in the well due to pumping from Well "J" that the well does not produce from the Simsboro and likely produces from the overlying Calvert Bluff Formation;
- Previous reports stated that the Mr. Charles Tarket well is completed in the Hooper Formation (Uliana, 2015). However, TGI has concluded based on geologic information and measured water levels that the Tarket well is in the Simsboro aquifer. If the Tarket well taps the Hooper Formation, it does not penetrate much of the formation and likely produces only from the Simsboro.

Area 3 – Four (4) Wells Along Sayers Road

- Distances from wells to the production well range from 10,200 to 11,300 feet;
- Well depths range from 300 to 500 feet below ground level, with elevations of tops of producing intervals ranging from 131 feet below MSL to 98 feet above MSL; and,
- Wells are completed in the Hooper Formation.

## Historical Water Levels and Pumping

The potentiometric surface in an aquifer determines the water levels in wells completed in the aquifer. Water levels below the top of the aquifer indicate unconfined or water-table conditions, while water levels above the top of the aquifer indicate that he well is completed in confined or artesian portions of the aquifer, and the water is under pressure greater than atmospheric pressure (see Appendix 2). Aquifer water levels change in response to changes in aquifer storage. Because storage coefficients in artesian aquifers are very small, large changes in water levels can occur with very small changes in storage. Conversely, the storage coefficient in water-table portions of aquifers is commonly three to five orders of magnitude larger than in artesian areas; therefore, water-level changes are typically slower and smaller in unconfined aquifers. The magnitude and rate of water-level changes in the Simsboro aquifer are primarily directly

attributable to the aquifer transmissivity and the quantity, proximity and duration of pumping. Drawdown in artesian aquifers can extend for several miles from pumping centers. In fact, drawdown due to pumping in neighboring counties can affect water levels in Bastrop and Lee counties.

Historically, the amount of pumping in the Simsboro aquifer has been relatively small within Bastrop County and all of the LPGCD area. Prior to commencement of depressurization pumping associated with the Three Oaks Mine located partially within Lee County, total reported permitted pumping within LPGCD was between 11,000 and 12,000 acre-feet per year (LPGCD Database, 2012), with most of the pumping from Bastrop County and Aqua WSC being the largest producer from its Camp Swift well field. Since 2004, pumping from the mine and other smaller increases by existing users increased pumping from the Simsboro to as much as 25,000 acre-feet per year. (Note that Manville WSC purchased some of the water produced at the ALCOA/Three Oaks mine near Blue in Lee County). During the period from 2006 through 2014, Aqua WSC pumping increased slightly to as much as approximately 8,500 acre-feet per year in 2011, as Aqua WSC added some additional pumping in deeper portions of the aquifer near Paige. Recently, Heart of Texas (HOT) and the LCRA obtained permits and began pumping from the Simsboro aquifer in Lee County and from the east side of Lake Bastrop, respectively. Figure 8 shows reported pumping by entity for Bastrop and Lee counties and locations of permitted wells and mining areas. The TWDB modeled the 2010 pumping from the Calvert Bluff and Hooper formations in Bastrop County at 1,510 and 1,125 acre-feet, respectively.

Figure 9 is a regional map showing historical water levels (i.e., hydrographs) for wells completed in the Simsboro aquifer across GMA 12. Note that water levels have remained stable in the outcrop or recharge (i.e., water table or unconfined) portions of the aquifer. Water levels have declined by 150 feet or more over several decades in deeper, artesian portions of the aquifer that are near larger pumping centers. Figure 10 provides some of the limited historical water-level measurements for Simsboro aquifer wells within and near the Study Area. Generally, the hydrographs in Figure 10 show the steadier water-level behavior within and near outcrop areas, and more fluctuation due to pumping cycles in downdip areas. The chart for SWN 58-54-506, an Aqua WSC Camp Swift well, shows seasonal fluctuations of between 15 and 20 feet. Similarly, wells located near Bastrop State Park show large fluctuations in water levels due to pumping cycles. There are not sufficient data to determine local hydraulic gradients or long-term water-level trends.

TGI conducted background monitoring in 18 wells, including the City's MW-3, from September 2017 through the completion of the 36-hour pumping test on December 29, 2017. TGI installed automated data recorders in six (6) wells and collected periodic manual measurements in all wells utilizing electric line water-level indicators and/or calibrated steel tapes. Water-level elevations and behaviors, combined with the geologic information available, allow for determining the aquifer(s) in which each monitoring well is completed. Attachment 2 provides water-level charts for all monitored wells. Table 2 provides average static water level elevations and the overall

water-level fluctuations for each of the monitored wells for the period between September 2017 and December 2017. Figure 11 provides representative static water level elevations for the monitored wells. The following provides a general summary of water levels per aquifer in the area near the City's Well "J":

- Calvert Bluff – static water elevations in the local Calvert Bluff wells varied from elevations of 294 feet to 386 feet above MSL indicating separate production intervals for several wells over a small area, which is indicative of the separate, isolated and small sand channels in the Calvert Bluff (see Figure 11). Water levels fluctuated by between two (2) and 21 feet over the three (3) months of monitoring prior to the production testing;
- Simsboro – static water level elevations in the Simsboro aquifer near the production well range from 298 feet to 305 feet above MSL, and the difference may be a function of the accuracy of land surface elevation datum (see Figure 11). Water-level elevations in Simsboro wells near the Colorado River, nearer to the outcrop area, ranged from 316 feet to 324 feet above MSL, with the differences potentially being due to accuracy of determination of land surface elevation datum due to relatively steep local topography. The Simsboro water levels indicate a uniform and interconnected aquifer between wells. The hydraulic gradient from the updip wells near Powell Bend to Well "J" is about 20 feet per mile, although sufficient data are not available to assess the effect of the faults on the hydraulic gradient. Static water levels fluctuated by about 0.5 to three (3) feet during the period from September 2017 until the production testing, indicating relatively uniform transmissivity and conditions. Some water levels may have been affected by development and short-term testing of Well "J" (see charts in Appendix 2);
- Hooper – Static water level elevations in wells likely completed in the Hooper Formation range from 316 feet to 332 feet above MSL, and land surface is relatively gently-sloping in the area of those wells (see Figure 11). Based on an estimated local hydraulic gradient in the overlying Simsboro aquifer and known water levels in the Simsboro monitoring wells, the water level elevation in the local Hooper is slightly deeper than that of the Simsboro, which is to be expected considering that groundwater moves downward within and near recharge zones. Measured static water levels fluctuated by 0.6 to almost six (6) feet during the three-month period prior to the production testing. Some of the fluctuation noted is due to pumping of the monitored wells, as indicated by the pattern of water levels (see Appendix 2).

## Pumping Test

Pumping a water well causes an instantaneous change in aquifer storage resulting in water-level decline or drawdown in the well and causing movement of groundwater radially toward the well. The resistance to flow or friction produced by the water movement through the aquifer media causes a slope or gradient of the potentiometric surface to be created radially around the well, which is commonly referred to as the cone of depression. Due to the nature of the converging flow to the well and the mathematics of groundwater flow in an aquifer, the cone of depression

is steeper near the well and slopes very gently at distance from the well. The magnitude of the drawdown and the slope of the cone of depression are primarily controlled by the friction of groundwater flow which is determined by aquifer transmissivity. Large aquifer transmissivity results in a shallow cone of depression with flat slopes and a large aerial extent, while low transmissivity results in a deep cone of depression with steep sides and a smaller radius. The rate of expansion of the cone of depression is primarily controlled by the aquifer storage coefficient (see Appendix 2). The extent of the cone of depression is a factor of both transmissivity and storage (see Appendix 3). Once the cone of depression expands sufficiently to supply flow to the well equal to its pumping rate, the drawdown ceases and the pumping reaches equilibrium (i.e., no more change in storage). Also, hydraulic boundaries such as faults or recharge areas can alter the shape or extent of the cone of depression. Generally, cones of depressions developing around wells completed in artesian (confined) aquifers extend for thousands of feet to miles from the pumping well, while drawdown typically extends out only hundreds to a couple thousand feet from wells completed in unconfined (i.e., water-table) aquifers. Drawdown is directly proportional to pumping rate and is additive if multiple wells are pumping (i.e., interference drawdown). Figure 12 and Figure 13 illustrate drawdown and interference drawdown in confined and unconfined aquifers, respectively.

## Measurements

TGI monitored water levels during the 36-hour constant-rate production test conducted by Brien Water Wells (BWW) from December 27th to December 29th of 2017. The pumping rate for the City's Well "J" was 1,560 gpm throughout the duration of the test. Once pumping was turned off after 36 hours, TGI measured recovery water levels for 12 hours. Graphs and charts illustrating the pumping test results are provided in Attachment 2. Table 2 and Figure 14 provide a summary of measured drawdown at each of the monitored wells due to pumping of Well "J".

## Hydraulic Parameters and Boundaries

Aquifer hydraulic parameters including transmissivity, hydraulic conductivity and storage coefficient (i.e., storativity) can be derived by analyzing measurements collected during pumping tests. Groundwater flow conforms to Darcy's Law, and C.V. Theis derived the mathematical equation for radial flow to a well taking into account the time of pumping (Theis, 1935). Theis' breakthrough allowed for solving pumping tests to determine hydraulic parameters before the pumping test reached a state of equilibrium, allowing for the effective use of shorter-term pumping tests. Additionally, the Theis "nonequilibrium well equation" allows for aquifer parameters to be determined utilizing observations in a single observation well, rather than at least two required by equilibrium well equations (Driscoll, 1986). The Theis nonequilibrium well equation is stated below:

$$s = \frac{114.6QW(u)}{T}$$

where;

s = drawdown, in feet
Q = pumping rate, in gpm
T = transmissivity, gpd/ft
*W(u)* = well function of *u* representing an exponential integral[1]

In the *W(u)* function, *u* is equal to:

$$u = \frac{1.87r^2S}{Tt}$$

where;

r = distance from center of pumped well to point drawdown is measured, in feet
S = storage coefficient, dimensionless
T = transmissivity, gpd/ft
t = time since pumping started, in days.

Due to the logarithmic relationship between drawdown, time and distance, graphical methods using log-log plots and a type curve can be utilized to analyze pumping tests and derive the various hydraulic parameters (see Attachment 2). Solutions using the Theis equation incorporate several assumptions including (see Driscoll, 1986):

- The aquifer is homogeneous and isotropic. That is, the water-bearing formation is uniform in character and the hydraulic conductivity is the same in all directions;
- The producing interval is uniform in thickness and is infinite in areal extent;
- The formation receives no recharge or leakage;
- The pumped well fully penetrates and producing water from the entire aquifer thickness;
- Water pumped from the well is removed from storage and discharged instantaneously when the head (i.e., water level) is lowered;
- The pumping well is 100-percent efficient;
- All water pumped from the well comes from aquifer storage;
- All flow in the aquifer and into the well is laminar; and,
- The potentiometric surface is flat (i.e., has no slope).

Commonly, a modified nonequilibrium well equation developed by Cooper and Jacob can be used when µ is sufficiently small, which commonly occurs when the pumping time is sufficiently long with respect to the distance to where drawdown is measured (Cooper and Jacob, 1946). Simplified graphical methods utilizing semi-log graphs and best-fit straight lines can be used to analyze the pumping tests. The Theis assumptions still apply. Most aquifers and pumping tests

[1] $\int_u^\infty \frac{e^{-x}}{x}dx = 0.577216 - \ln u + u - \frac{u^2}{2\cdot 2!} + \frac{u^3}{3\cdot 3!} - \frac{u^4}{4\cdot 4!} + \cdots$

reasonably conform to the Theis equation assumptions, especially for wells very near the pumping well and for short-term or early portions of pumping tests (e.g., two days or less). Both the Theis and Cooper and Jacob methods allow for predicting drawdown at any time after pumping has started. However, when the assumptions in the aquifer vary from the Theis assumptions, the aquifer test results must be analyzed with care. Commonly, hydraulic boundaries such as faults and recharge areas are encountered by the cone of depression, requiring knowledgeable solutions of aquifer test data. Typically, the longer a well is pumped the more the Theis assumptions do not hold true. Therefore, while short-term pumping tests can allow for estimates and predictions of future drawdown, long-term drawdown can only be estimated from such testing results. Commonly, numerical models are utilized to assess multi-year to multi-decade aquifer responses to pumping.

Only the Simsboro monitoring wells exhibited definite water-level responses due to pumping Well "J" during the 36-hour test. Table 3 provides a summary of pumping test results and hydraulic parameters derived from the pumping test and recovery. The test analysis showed that the transmissivity of the aquifer at and near the pumped well is between 37,000 and 53,000 gpd/ft based on the early test data. The local storage coefficient is $2.5 \times 10^{-4}$ during the period of pumping, which is reasonable for an artesian or slightly leaky artesian aquifer. Note that the storage coefficient will increase, probably by as much as an order of magnitude, as pumping continues due to recharge effects and leakage from overlying and underlying zones.

Calculated transmissivity values for the private Simsboro water wells range from 80,000 to 180,000 gpd/ft (see Table 3). These apparent transmissivity values are two (2) to five (5) times higher than known and estimated transmissivity based on geologic conditions (i.e., sand thickness and character), regional groundwater modeling, known values in other similar settings, and the calculated transmissivity values at Well "J" and MW-3. Based on the geologic setting, it is evident that the "Powell Bend Fault" disrupts the movement of groundwater between the private monitoring wells and the City's production well. Therefore, the Theis assumption of an infinite and uniform aquifer do not hold true, and the Theis analytical solutions result in "false" high transmissivity values. Also, the apparent storage coefficient values derived for the monitoring well areas are higher than for MW-3, ranging from $7.4 \times 10^{-4}$ to $1.3 \times 10^{-3}$.

One way to assess variations in aquifer conditions and to identify hydraulic boundaries is to compare actual measured drawdown to the theoretical or expected drawdown assuming the aquifer and well conform to the Theis conditions. Representative hydraulic coefficients derived from the pumping test for the area near the pumped well are:

Transmissivity = 45,500 gpd/ft
Storage Coefficient = 0.00025

Figure 15 shows the actual measured drawdown in the local Simsboro aquifer versus expected drawdown calculated with the Theis equation. Drawdown in the pumped well is considerably more than calculated by Theis, which is potentially due to effects of nearby faults, partial

penetration of the well into the aquifer, and slight inefficiency of the well. (Note that TGI assessed the well efficiency based on development testing and the 36-hour production test and estimated the well efficiency to be approximately 80 percent). It is possible that the actual hydraulic conductivity and transmissivity in the aquifer at the production location are higher than calculated; however, the proximity of the well to the "Powell Bend Fault" and the "Bastrop Fault" would cause the cone of depression to encounter those two "negative" hydraulic boundaries within the first 30 minutes of pumping. Drawdown in the nearby monitoring well (MW-3) is slightly less than calculated using Theis, which is likely due to an increase in aquifer transmissivity in the direction of MW-3. Measured drawdown in the Simsboro wells in Area 2 is between one (1) and two-and-one-half (2½) feet, while expected drawdown calculated using Theis is between six (6) and seven (7) feet. The primary cause for less drawdown occurring than expected is likely faulting associated with the "Powell Bend Fault", which forms a hydraulic boundary between the pumped well and the wells in Area 2. Other possible causes for less-than-expected drawdown occurring in Area 2 could be an increase in aquifer transmissivity and/or a higher storage coefficient due to proximity of the outcrop or recharge area (i.e., unconfined zone). There are currently no Simsboro wells in Area 3, so no aquifer test analyses are available for that area. While the anticipated drawdown based on Theis assumptions would be about one-and-a-half (1½) feet after 36 hours of pumping, it is probable that very little drawdown occurred in the Simsboro aquifer beneath Area 3 due to the hydraulic boundary conditions.

## Impacts Assessment

Aquifers serve two primary functions; storing water and transmitting water. Impacts to aquifers due to pumping are related to the capabilities of aquifer to perform these two functions. The Simsboro aquifer has tremendous capacity as a groundwater storage reservoir. The TWDB reports that the Simsboro stores approximately 18,000,000 acre-feet of water beneath Bastrop County and 28,000,000 acre-feet within Lee County (Wade and Shi, 2014). Water levels in the outcrop area across the Simsboro show that storage in the aquifer has not diminished over time. Therefore, any impacts due to pumping Well "J" will not be related to aquifer storage. The amount of groundwater available in the aquifer will not be diminished due to pumping of the subject well.

The primary impact associated with pumping in the Simsboro aquifer is the reduction in artesian pressure. While the aquifer remains completely full, the reduction in pressure causes water levels in wells completed in the aquifer to decline in accordance with the pressure change (see Appendix 2). The pressure change is logarithmically related to time of pumping and distance from pumping centers, and the magnitude of decline is primarily determined by how much water will move through the aquifer (i.e., transmissivity) but is also influenced by the storativity of the producing zone. The rate of expansion of the cone of depression is primarily determined by the aquifer storage characteristics. The shape and areal extent of the pressure change is affected by the aquifer hydraulic coefficients and the occurrence of any hydraulic boundaries. Artesian

pressure changes are directly related to pumping rates. Therefore, if pumping ceases the pressure and associated water levels in wells recover in essentially the same amount of time over which the drawdown had occurred.

## Short-Term Drawdown

The effects of pumping Well "J" continuously for 36 hours at slightly more than the maximum permitted rate of 1,500 gpm have been measured. It is impossible to directly correlate drawdown for longer-duration pumping periods to the 36-hour testing results due to the effects of boundaries such as faults, recharge, and interaquifer leakage. Particularly, the storage coefficient increases with pumping duration as recharge and vertical leakage are induced. Based on the results from the 36-hour pumping test and using reasonable assumptions based on the local aquifer conditions, TGI calculated drawdown estimates for the following pumping scenarios:

- 30 days of continuous pumping at the maximum permitted rate of 1,500 gpm; and,
- One year of continuous pumping at the maximum permitted allocation of 2,000 acre-feet per year, which is equivalent to a constant pumping rate of 1,240 gpm.

Drawdown at the private wells (i.e., Area 2) with continuous pumping for 30 days at the maximum permitted pumping rate will likely range from four (4) to seven (7) feet. Because of the logarithmic relationship between time of pumping and drawdown and because of increased storage coefficient with pumping duration, most drawdown occurs early in the pumping cycle. Drawdown at the private water wells in Area 2 after one year of pumping 2,000 acre-feet (1,240 gpm) will likely range from five (5) to nine (9) feet. Table 4 provides estimated drawdown at the 18 monitoring wells under various pumping scenarios.

## Long-Term Drawdown, Leakage and Storage Depletion

Long-term aquifer impacts due to pumping are best evaluated utilizing numerical groundwater flow modeling. Several experts including the LPGCD's hydrologist utilized the TWDB-approved groundwater availability model (GAM) to estimate impacts due to the permitted pumping from Simsboro wells on XS Ranch ranging from 2,000 to 6,000 acre-feet per year (see Appendix 3 and CH2MHill, 2014; Donnelly, 2014; Donnelly, 2013; R.W. Harden, 2013; and, Uliana, 2015). TGI also compared the impacts only due to Well "J" pumping to projected impacts based on all permitted pumping within LPGCD and other existing and projected regional pumping from neighboring counties (see Appendix 3 and Donnelly, 2013). LPGCD projects that pumping by 2060 will be as much as 40,400 acre-feet per year within the District, with the Aqua WSC, the City of Bastrop, Elgin, and Manville WSC all pumping at their maximum current permit amounts, and total pumping in Bastrop County increasing from 10,000 to 24,000 acre-feet. Based on current permits, long-term pumping within LPGCD could be 76,760 acre-feet per year or more, with notable new permits in Bastrop County granted to LCRA for their Lake Bastrop facilities. The largest pumping increases could occur in Lee County per Forestar's permits. Additionally, End Op

had been issued permits in Lee and Bastrop counties. Figure 16 provides locations of wells and allocation amounts for existing Simsboro aquifer permits. Based on the TWDB-approved GAM, the following table summarizes the amount of estimated local drawdown due to only the City's Well "J" pumping 2,000 acre-feet per year (i.e., equivalent to continuous pumping of 1,240 gpm), and due to all projected local and regional pumping, except EndOp, from the Simsboro aquifer through 2060 (see Donnelly, 2013):

| | **Approximate Drawdown Due to Projected Pumping Through 2060** | | |
|---|---|---|---|
| **Pumpage** | **Area 1** | **Area 2** | **Area 3** |
| Well "J" Only | 25 feet | 15 feet | 10 feet |
| All Other Pumping | 150 feet | 95 feet | 55 feet |
| Total | 175 feet | 110 feet | 65 feet |

The drawdown amounts in the above table are rounded to the nearest five (5) feet. Based on current water levels and well completion details for the Simsboro wells monitored, pumping from the City of Bastrop's Well "J" will not disrupt the availability of groundwater from local well owners. Long-term increases in local and regional pumping will impact water levels in local wells much more than the City's pumping.

Pumping from Well "J" is small with respect to the existing and projected cumulative local and regional pumping in the aquifer. Additionally, the projected pumping is extremely small as compared to the amount of water available in aquifer storage. Increases in pumping induce additional recharge into the aquifer. GAM runs have shown that the even large increases in pumping in Bastrop and Lee counties will reduce local aquifer storage by less than two (2) percent after more than 50 years of pumping (R.W. Harden & Associates, Inc., 2013). Therefore, pumping from Well "J" will have no adverse effect on the amount of groundwater stored and available for use in the Simsboro aquifer.

Long-term pumping induces additional recharge into the aquifer, which may reduce the amount of natural discharge associated with evapotranspiration, seeps, springs and baseflow. The amount of such impacts due to the City of Bastrop's pumping from Well "J", particularly as compared to projected regional pumping from the aquifer, will be so small as to be undetectable. Any impacts to water levels in the overlying Calvert Bluff and underlying Hooper due to interaquifer leakage will be very small and likely undetectable. Based on vertical hydraulic conductivity of $10^{-5}$ gpd/ft$^2$, confining layer thickness of 50 feet, and an average decline in artesian pressure of 50 feet in the Simsboro aquifer, the amount of leakage from the Calvert Bluff Formation would increase by only about 280 gallons per day per square mile of area within the cone of depression.

# CONCLUSIONS

Based on our assessment of the local hydrogeologic conditions and the results of the 36-hour production test for the City's Well "J", TGI provides the following conclusions:

- Eight (8) of the 17 private wells available and accessible for monitoring are completed in and produce from the Simsboro aquifer;
- Drawdown in the privately-owned monitoring wells completed in the Simsboro aquifer ranged from one (1) to 2.5 feet during the 36-hour production test for Well "J";
- Maximum drawdown in the private Simsboro wells monitored will likely be approximately eight (8) feet and 10 feet due to Well "J" pumping at maximum permitted rates for 30 days and one year, respectively;
- Hydraulic boundaries due to faulting cause drawdown in the private monitoring wells due to Well "J" pumping to be significantly less than would be expected in a uniform aquifer;
- Pumping from Well "J" will not decrease the amount of water stored in the Simsboro aquifer;
- The City's pumping from Well "J" will not disrupt local landowners' groundwater supplies;
- Pumping from Well "J" will not detectably affect water levels in the Calvert Bluff or Hooper Formations;
- Long-term artesian pressure declines due to other local and regional permitted and mining pumping could be as much as seven (7) times greater than drawdown caused by Well "J" pumping; and,
- As other local and projected regional pumping increases over several decades, it may be necessary for some landowners to lower pumps to maintain reliable supplies, depending on current pump settings. However, properly completed wells within the Study Area can be completed to maintain current supplies and increase local usage from the Simsboro aquifer.

We very much appreciate the opportunity to provide you this report and to serve 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 March 29, 2018.

Sincerely,
THORNHILL GROUP, INC.

Michael R. Thornhill, P.G.
President

Attachments

# Appendix 1 – Scope of Services

# SCOPE OF SERVICES

The Scope of Services is provided in subsequent tasks and is intended to ensure that all work and information derived are in accordance with the Operating Permit, the subsequent Memorandum of Understanding (MOU), and any other applicable agreement relating to the monitoring and mitigation plan. The Scope of Services provided is based on the permit documentation provided by the City, on previous correspondence with the City, and on the meeting of June 14, 2017. Specifically, TGI will conduct the following:

## Task 1 – Well Identification and Preliminary Completion/Aquifer Verification

This task will include identifying all wells within 5,000 feet of the proposed Well No. 1 location, and compiling a comprehensive list of wells designated for monitoring during the production testing, pending land-owner request and access to properly equip the wells. Additionally, this task will include preliminary verification, based on available records, information and data, as to which wells are completed in the Simsboro aquifer versus shallower or deeper water-bearing zones. Specifically, this task will include:

- ❑ Compiling records, data and information from the LPGCD database, Texas Water Development Board (TWDB) records, permit hearing records and files, City files and responses to the LPGCD notice/request for monitoring;
- ❑ Mapping the local geology using geophysical logs, reports, and TWDB groundwater availability model (GAM) model files to establish depths, character and geometry of the Calvert Bluff, Simsboro and Hooper members of the Wilcox Group, which are the local water-bearing units commonly tapped in the area near Well No. 1; and,
- ❑ Preparing preliminary schematic diagrams of the designated monitoring wells to illustrate total depth, producing (i.e., screened) interval, water-bearing units, and any available production, water-level or water-quality information;

Task 1 will be critical in forming the basis for subsequent tasks, and will be a critical first step in determining the work needs and costs for inventorying and equipping wells designated for monitoring (see Task 2 and Task 3).

## Task 2 – Field Services – Initial Well Inspection and Inventory

TGI will conduct initial field services to inspect and inventory the wells designated for monitoring and to field-verify the completion information compiled during Task 1. Specifically, this task will include:

- ❑ Notifying landowners prior to conducting field work, describing the field efforts, requesting permission for access, and providing timely notice before conducting site visits;
- ❑ Verifying the location and ownership information compiled during Task 1;

- ❑ Interviewing owners with respect to knowledge of the completion, pump setting and overall condition of the well, and to ascertain information regarding use of the well;
- ❑ Determining access to the well for, as appropriate, measuring with a manual e-line or steel tape, or installing an automated water-level recorder (i.e., pressure transducer);
- ❑ Determining whether some wells will be monitored on a long-term (i.e., multi-year) basis, including dedicating automated water-level recorders in certain wells;
- ❑ Evaluating the need for pulling the pump for downhole video purposes or to allow for measurement access;
- ❑ Assessing the suitability of the well for installing an exterior flow meter on discharge pipe; and,
- ❑ If accessible, tagging the total depths of wells, collecting an initial static (i.e., non-pumping) water-level measurement and, if possible, measuring a pumping water level during a short pumping period.

Task 2 work will be critical in determining the work needed and costs for equipping the selected monitoring wells (see Task 3). For cost estimate purposes, TGI has assumed field inventorying 30 wells.

### Task 3 – Field Services – Equipping Wells for Monitoring

Based on reconnaissance from Task 2, TGI will ensure that selected monitoring wells are properly equipped to allow for accurately collecting data needed to effectively assess the potential effects of pumping Well No. 1 on nearby wells. Wells will be equipped, as needed, to allow for manually measuring water levels. Some wells will be selected and equipped with automated downhole water-level recorders (i.e., pressure transducers). Additionally, temporary external flow meters may be installed on selected wells to monitor landowner pumping during the monitoring program. Depending on the results of Task 1 and Task 2 work, this task may include collecting water samples from selected wells for determination of field parameters (e.g., temperature, pH and specific conductance) and for laboratory analysis of mineral content. In some instances, downhole video surveys may be needed to determine completion details for wells, which could require removing and re-setting pumping equipment. For cost estimate purposes, TGI assumes the following work needed to properly equip wells:

- ❑ Slightly modifying well-heads for five (5) wells to allow for proper access to manually measure water levels with an e-line or chalked steel tape;
- ❑ Installing automated water-level recorders (i.e., pressure transducers) in 10 selected wells with suitable access. Recorders will be installed several weeks prior to beginning the 36-hour production test to monitor background (i.e., pre-pumping test) water levels. (Note: the City may determine that automated equipment remain in some wells for long-term monitoring after the production test is completed);
- ❑ Installing temporary, external flow meters on five (5) wells;

- ❑ Collecting water samples for laboratory analyses from four (4) wells; and,
- ❑ Conducting downhole video surveys in two (2) wells.

Note that downhole video surveys could require removing and re-setting pumping equipment, which requires engaging a licensed water well driller/pump installer. It is likely that the pump installer selected would also have downhole video equipment and capabilities. Prior to beginning Task 3 work, TGI will develop a specific work plan and cost estimates and obtain approval from the City. Note that, depending on the actual number of wells monitored and the site-specific conditions, the costs could vary significantly from those included in this Proposal.

**Task 4 – Background Monitoring**

After wells are inventoried and properly equipped, TGI will conduct background monitoring prior to commencement of the required 36-hour production test. TGI understands based on our meeting of June 14, 2017 that Well No. 1 will be completed, developed and ready for testing by the end of September. Background monitoring will include collecting manual water-level measurements, downloading data from automated recorders, and recording flow meter readings. For cost estimate purposes, TGI will manually measure water levels in 30 wells, and will conduct monthly measurements in July and August prior to the Task 5 pumping test. If completion and testing of Well No. 1 is delayed, TGI will conduct an additional monthly round of measurements in September.

**Task 5 – Pumping Test Monitoring**

TGI will monitor the selected monitoring wells during the required 36-hour production test. Monitoring will include:

- ❑ Collecting at least one round of measurements immediately prior to the commencement of the 36-hour pumping portion of the test;
- ❑ During the 36-hour pumping period, collecting at least three rounds of manual measurements in the selected wells;
- ❑ During the first 12 hours after the pump is turned off, collecting one round of measurements during the recovery period;
- ❑ At least 24 hours after test completed, downloading the data recorders; and,
- ❑ At a time agreed to by the City and landowners, removing automated data recorders from wells.

**Task 6 – Pumping Test Analysis and Impacts Assessment**

TGI will obtain from CH2MHill pumping test data for the production well (Well No. 1) and the City's monitoring wells. TGI will analyze the pumping test data using standard analytical and graphical techniques to derive the local aquifer hydraulic coefficients, and to assess the short-

term magnitude and extent of drawdown (i.e., cone of depression) due to pumping the subject well. TGI will compare measured water levels from the selected monitoring wells to the results calculated from the pumping test analysis, to determine if any wells were affected during the production test, and to ascertain potential hydraulic boundaries that affect drawdown. TGI will then utilize applicable analytical and/or numerical modeling to evaluate long-term drawdown due to permitted pumping at Well No. 1 at 2,000 acre-feet per year, which is an annual average of 1,240 gallons per minute (gpm). Additionally, TGI will assess potential local water-level impacts due to current or proposed pumping from other local or regional Simsboro permitted pumping.

### Task 7 – Reporting and Meetings

TGI will compile the information collected and formulate work products including maps, drawings, hydrologic and hydraulic calculations, diagrams and other applicable illustrations. Based on the work up of materials, TGI will compile its findings and opinions in a written letter report. For cost estimate purposes, TGI will attend three meetings, including presenting findings to the City upon completion of the written letter report.

# Appendix 2 – Basic Groundwater Concepts

**BASIC GROUNDWATER CONCEPTS**
**BASIC GROUND-WATER CONCEPTS HANDOUT**

**By Michael R. Thornhill, P.G., CPG**
**Thornhill Group, Inc.**

The occurrence, development, management and longevity of ground-water resources generally depend on the following key factors:

- Thickness, rock type and character, and geometry (e.g., structure) of geologic units forming aquifers and confining units;
- Sources, amounts, timing and distribution of recharge and other inflows;
- Hydrologic and hydraulic characteristics of producing zones and confining units including primary porosity, secondary porosity, effective porosity, hydraulic conductivity (i.e., permeability), transmissivity and storage, as well as the presence of faults and other hydraulic boundaries;
- Amounts, locations, and duration of discharge and other outflows, including naturally via springs, seeps, underflow, leakage and evapotranspiration, as well as artificially due to pumping;
- Quality of water in water-bearing zones with respect to the quality of water needed;

**General Hydrogeologic Concepts**

An **aquifer** is rock or sediment in a formation, group of formations, or part of a formation which is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs (Fetter 1980). The most important hydraulic properties of aquifers are their abilities to store and transmit water (Heath, 1983). In contrast, an **aquitard or confining layer** is a saturated, but poorly permeable bed, formation, or group of formations that does not yield water freely to a well or spring; however, an aquitard may transmit appreciable water to or from adjacent aquifers (Driscoll 1986). The occurrence of aquifers and the availability of ground-water resources are directly related to the geologic setting and characteristics of sediments and rocks forming important aquifers (water-bearing units) and layers between aquifers (non-water bearing units). Igneous, metamorphic, sedimentary and alluvial formations may form aquifers. Most prolific aquifers in Texas occur in sedimentary formations, particularly sands, sandstones and limestones, and gravel and sand layers of alluvium deposits. **Porous media** aquifers are composed of detrital material formed due to erosional processes and then deposited via wind (aeolian), rivers (fluvial) or ocean (marine) environments. Such materials, including silts, sands and gravels, are typically composed of materials that do not dissolve. Limestone, dolomite and evaporite (e.g., gypsum) layers generally do not contain significant pore space when they are deposited. After deposition, carbonate and evaporite layers are oftentimes broken by fracturing and faulting and are weathered, forming secondary porosity. As water moves through secondary porosity openings, it may dissolve large portions of the carbonate and evaporite layers, creating large solution openings in the rock. When these layers are saturated, they form **karst** aquifers.

**Outcrops**, or areas where geologic units occur at land surface, form the **recharge areas** for water-bearing formations. The locations, widths, shapes and orientations of outcrop areas are determined by geologic age (i.e., younger units generally occur above older rock layers), geologic structure, including the direction and magnitude of the slope (i.e., dip) of each unit, thickness of formations, the occurrence and displacement of faults, and land surface topography.

Ground-water **recharge** to aquifers occurs as part of the precipitation that falls on the outcrop areas infiltrates the soil and percolates downward to the saturated zone or water table. Additionally, recharge occurs as surface water flows in draws, drainages and streams across outcrop areas and water seeps through stream beds into the subsurface. Several factors influence the amount of recharge that enters an aquifer including: the amount and frequency of precipitation, areal extent of the outcrop, soil type on the outcrop, topography, vegetation, and the aquifer's ability to transmit water. **Effective recharge** is that portion of recharge that does not discharge to springs, seeps or streams in the outcrop area (i.e., **rejected recharge**) or is not taken up by plants and evaporation (i.e., **evapotranspiration**), but moves to deeper parts of the aquifer. For confined aquifers, current values calculated for effective recharge probably significantly underestimate the amount of inflows available and other water available for production from targeted aquifers. Other potential inflows into aquifers include rejected recharge that is captured, interaquifer leakage and other ground-water flows that can be captured from adjacent areas (i.e., ground-water **underflow**). Interaquifer leakage can be large where confining layers between aquifers are thin, but is small where these layers are thick. Underflow typically makes up a large portion of inflow into an aquifer area. These inflows increase with increased pumping and associated water-level declines in hydraulically connected pumping areas. Additionally, water that would otherwise move past pumping and discharge areas to poor quality zones is intercepted when aquifers are pumped; this captured discharge provides additional available water, and in essence prevents waste and loss of water due to natural degradation of water quality.

The **potentiometric surface** of an aquifer represents the levels to which water levels will rise in wells completed in an aquifer (i.e., water levels). An **unconfined** or **water-table** aquifer is an aquifer in which there is no confining layer between the saturated zone and land surface and in which the water at the top of the aquifer is at atmospheric pressure forming the **water table**. Water in a **confined or artesian aquifer** is under pressure greater than atmospheric pressure and water levels in wells completed in the aquifer rise to a height above the base of the overlying confining layer (or top of the aquifer). The pressure or height to which water rises above the base of the confining unit is often referred to as **artesian head**. Most aquifers, particularly those with alternating layers of productive and non-productive units (i.e., sands and clays, respectively), receive inflows through overlying or underlying confining units and are termed **leaky artesian** aquifers. Most artesian aquifers, if pumped long enough, exhibit leaky artesian conditions.

The **porosity** of an aquifer is defined as the ratio of the volume of void spaces in the rock or sediment to the total volume of the rock or sediment. In porous media, the total porosity and **effective porosity**, defined as the portion of porosity through which water or other fluid is able

to travel, may be approximately the same; however, in karst media the effective porosity may be substantially lower than the total porosity due to the occurrence of **vugs**, or small solution cavities, which are not interconnected. Also, limestone or karst aquifers typically have very little **primary porosity**, the porosity that represents the original pore openings when a rock or sediment formed, due to the nature of the rock matrix; rather, **secondary porosity**, porosity caused by fractures, dissolution or weathering in a rock or sediment after it has formed, typically dominates a karst aquifer.

Aquifers serve to store water and to transmit water from recharge areas to discharge areas. The **storage coefficient** of an aquifer is a measure of the volume of water that can be drained from a unit area of aquifer by lowering the water level by one unit (or per unit drawdown). In a water table aquifer, the storage coefficient is a measure of how much water will drain due to gravity from a unit volume of aquifer, and is essentially the same as the **specific yield**, which is essentially equal to the effective porosity of an aquifer. In water-table, porous media aquifers the storage coefficient is typically between 0.1 and 0.3. However, in karst aquifers the specific yield may be much lower due to the limited matrix porosity and lack of "connectedness" of secondary porosity. The storage coefficients in artesian aquifers range from about $10^{-5}$ to $10^{-3}$, with leaky artesian aquifers having storage coefficients of $10^{-3}$ or higher. A reasonable estimate for the storage coefficient in these aquifers is $10^{-4}$. Under long-term pumping conditions, the storage coefficient will increase and the aquifer will approach leaky artesian conditions with a likely storage coefficient of approximately $10^{-3}$.

The **hydraulic conductivity** of an aquifer is the volume of water at a certain temperature (i.e., viscosity) that will travel through a unit area of aquifer per unit time under a unit hydraulic gradient. Hydraulic conductivity is sometimes referred to as **permeability** and is a measure of the ability of the aquifer materials to transmit water. Units for hydraulic conductivity are commonly gallons per day per square foot ($gpd/ft^2$) and feet per day (ft/day). The **transmissivity** of an aquifer, expressed in units of gallons per day per foot (gpd/ft) and square feet per day ($ft^2$/day), is the rate at which water is transmitted through a unit width of aquifer over its entire thickness under a unit hydraulic gradient, and is the product of the hydraulic conductivity multiplied by the **saturated thickness**. Transmissivity and storage coefficient values can be determined directly from analyzing aquifer (i.e., pumping) test data. Higher transmissivity values are indicative of more highly productive aquifers.

Ground water moves in the direction of decreasing hydraulic head, or along a **hydraulic gradient**, which is the rate of change in total head per unit distance of flow in a given direction. The direction and magnitude of ground-water flow are determined primarily by the aquifer's geometry and hydraulic conductivity. The shape of the potentiometric surface, oftentimes presented in a water-level map, determines the overall direction of the flow of ground water. Under normal density conditions (i.e., fresh to slightly saline water), ground water generally moves from areas of high hydrostatic head (i.e., water levels in wells) to areas of low hydrostatic head, typically from recharge (i.e., outcrop) areas to downdip portions of the aquifer or discharge areas such as springs or pumping centers (i.e., well fields). In water-table portions of aquifers, the direction and slope of the hydraulic gradient (i.e., the water table) generally takes on the

form of a suppressed shape of land surface; recharge areas are topographically high areas and discharge areas such as springs, streams, creeks and wetlands occur in topographically low areas. In artesian aquifers, hydraulic gradients are typically flatter than the dip of geologic units, therefore, the height of water levels above the top of artesian aquifers increases significantly with aquifer depth. Karst and channelized alluvium aquifers typically exhibit significant **heterogeneity** and **anisotropy**, meaning that they are nonuniform in structure and composition and have physical and hydraulic properties that vary with direction, respectively. In karst aquifers, the direction and magnitude of water flow are often controlled primarily by the size and orientation of the rock openings. Due to extremely high transmissivity because of large openings, the hydraulic gradient can be relatively flat and large volumes of water still flow in the direction of the openings. Therefore, the direction in which most ground water flows in the system may not be accurately reflected by a potentiometric surface map.

Under non-pumping conditions and over periods of many years the rate of **natural discharge** from an aquifer equals the rate of recharge or inflows; therefore, the aquifer is in a state of **dynamic equilibrium**, which means that the potentiometric surface (i.e., water levels) are generally steady and the amount of water in storage in the aquifer is relatively constant. The **water balance** or budget of an aquifer is reflected by the simple equation:

Inflow – Outflow = Change in Storage

When wells are pumped, the equilibrium in the aquifer is disrupted and water levels decline for a time as outflows are greater than inflows and storage is reduced somewhere in the aquifer (Theis 1940). Water-level changes in an unconfined aquifer represent changes in the amount of drainable water (i.e., storage) in an aquifer. When water levels decline in a water-table aquifer it represents an actual dewatering of pore spaces in the drawdown area. Water-level changes in an artesian aquifer do not indicate draining of pore spaces in the drawdown area, but represent changes in pressure and very small changes in storage, typically over a large area. Typically, artesian aquifers can experience a substantial amount of drawdown and remain completely full (i.e., under artesian conditions). Drawdown (and the associated reduction in storage) will continue in a pumped aquifer until the pumping centers (i.e., well fields) have captured enough natural discharge or induced more inflows to supply the pumping; when this occurs, reduction in aquifer storage ceases and a new state of **equilibrium** is established. **Mining or overdraft** of an aquifer is commonly defined as when water usage (or pumping) is greater than recharge, although other available inflows and captured discharge should be considered. Commonly, effective recharge is one of the least known and smaller components of the water balance. Establishing a water balance for an aquifer allows for determining the rate and duration at which water can be removed from an aquifer while maintaining certain conditions (i.e., water levels and water quality).

The obtainable **pumping rate** for an individual well is dependent upon an aquifer's transmissivity, the completion of the well, efficiency of the well, the aquifer's static (i.e., non-pumping) water level at the well site, and water-level declines due to pumping from other nearby wells. Aquifer transmissivity can be calculated directly from pumping test data or estimated by a well's **specific**

**capacity**, which is equal to the pumping rate divided by the drawdown in the pumped well, and is reported in units of gallons per minute per foot of drawdown (gpm/ft). The pumping rate of a well can be estimated by multiplying the well's specific capacity by the **available drawdown**, which is the height of the static water level above the desired pumping level. Determining individual well yields is typically based on site-specific conditions, and requires pumping test data to determine the local hydraulic parameters. However, based on regional hydrogeologic estimates it is possible to determine reasonable ranges for anticipated well yields.

When pumping a well, a **cone of depression** develops and expands in depth and outward from the well until flow to the well (i.e., inflows, recharge, etc.) reaches equilibrium with the pumping rate. The geometry and expansion rate of the cone of depression is controlled by the aquifer's hydraulic parameters and geologic structure (i.e., hydraulic boundaries). Using estimated hydraulic parameters, pumping rate and pumping duration it is possible to easily calculate a hypothetical cone of depression from a point discharge by means of the Theis non-equilibrium formula. When the cone of depression from one well intersects the cone of depression of one or more other wells, **interference drawdown** results in additive water-level declines. With the additive property of the cone of depression and the Theis non-equilibrium equation the resulting regional cone of depression can be determined as well as the resulting drawdown at each well. Interference drawdown impacts within well fields and regionally may decrease available drawdown sufficiently to reduce obtainable pumping rates in wells. In porous media aquifers, interference drawdown is typically relatively uniform and can be determined by aquifer testing (i.e., pumping tests) and standard hydraulic calculations. In karst aquifers, interference drawdown is typically quite irregular and, in fact, commonly wells can be placed very close together without significant interference drawdown between the wells. With proper well placement and well-field planning, affects of interference drawdown can be mitigated or managed to optimize production from well fields and an aquifer.

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# Appendix 3 – Reference Illustrations

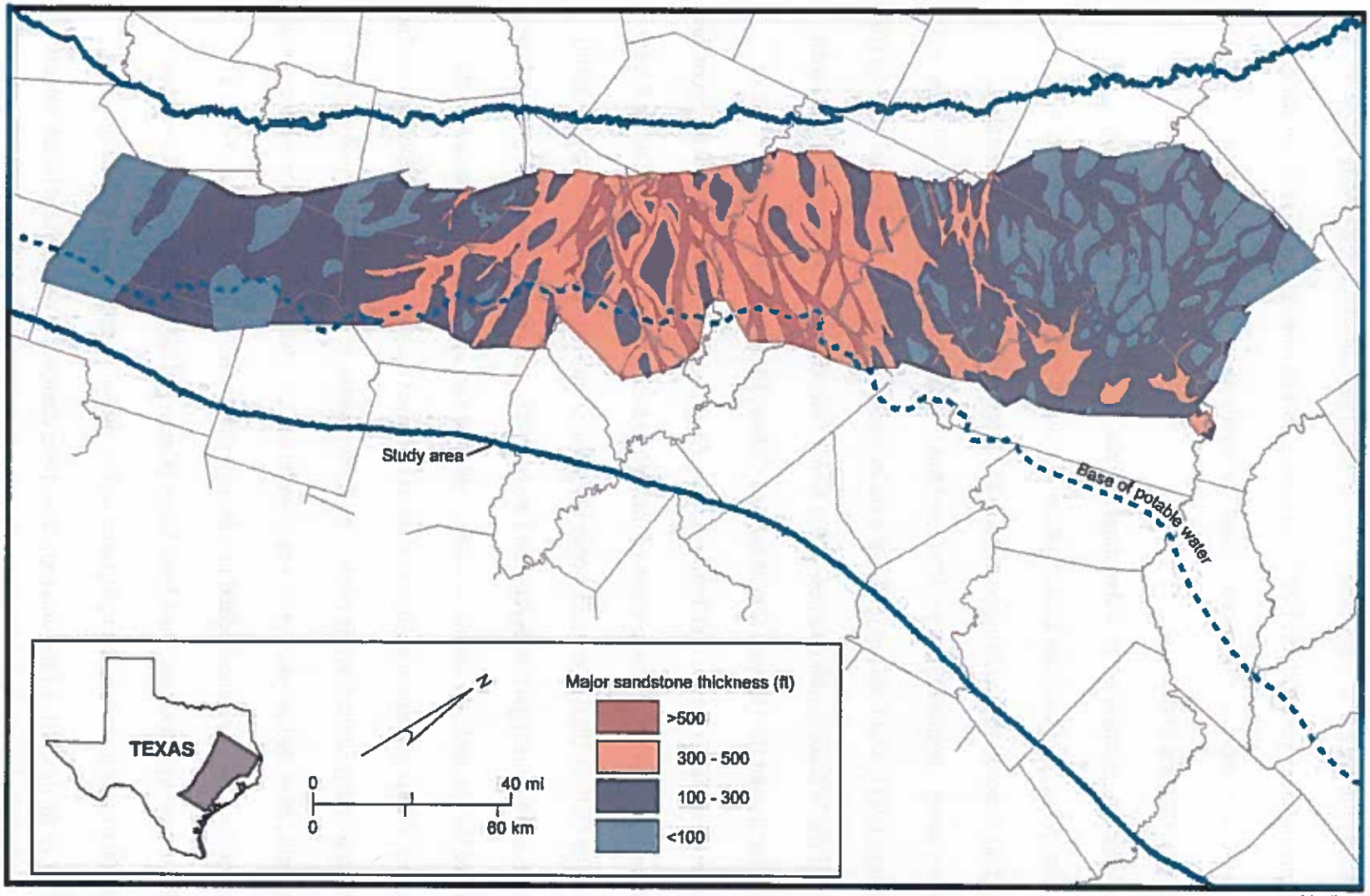



Figure 12. Thickness of major sandstones in the Simsboro Formation in the study area. Modified from Ayers and Lewis (1985).

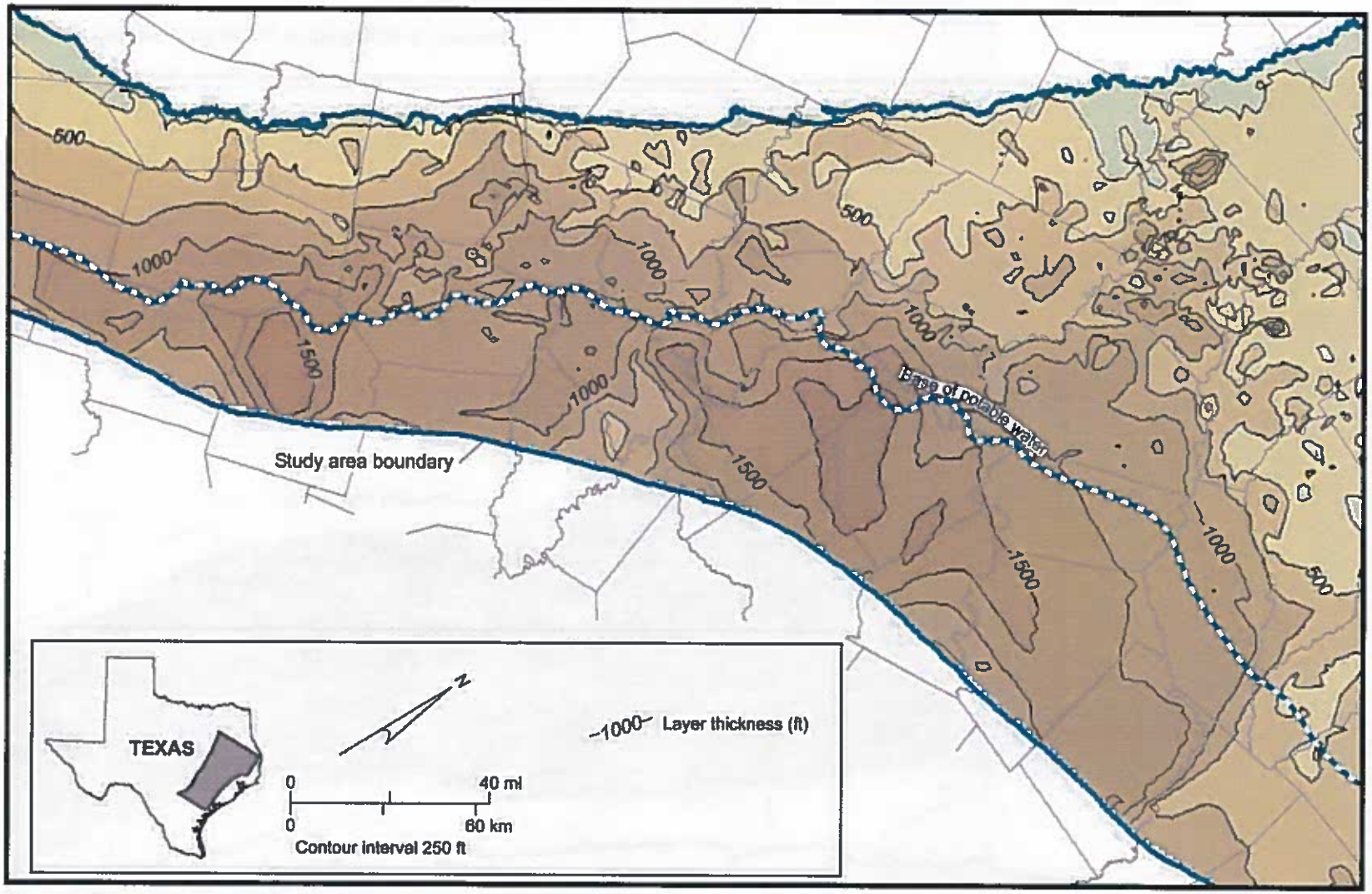



Figure 23. Total thickness of the Hooper Formation.

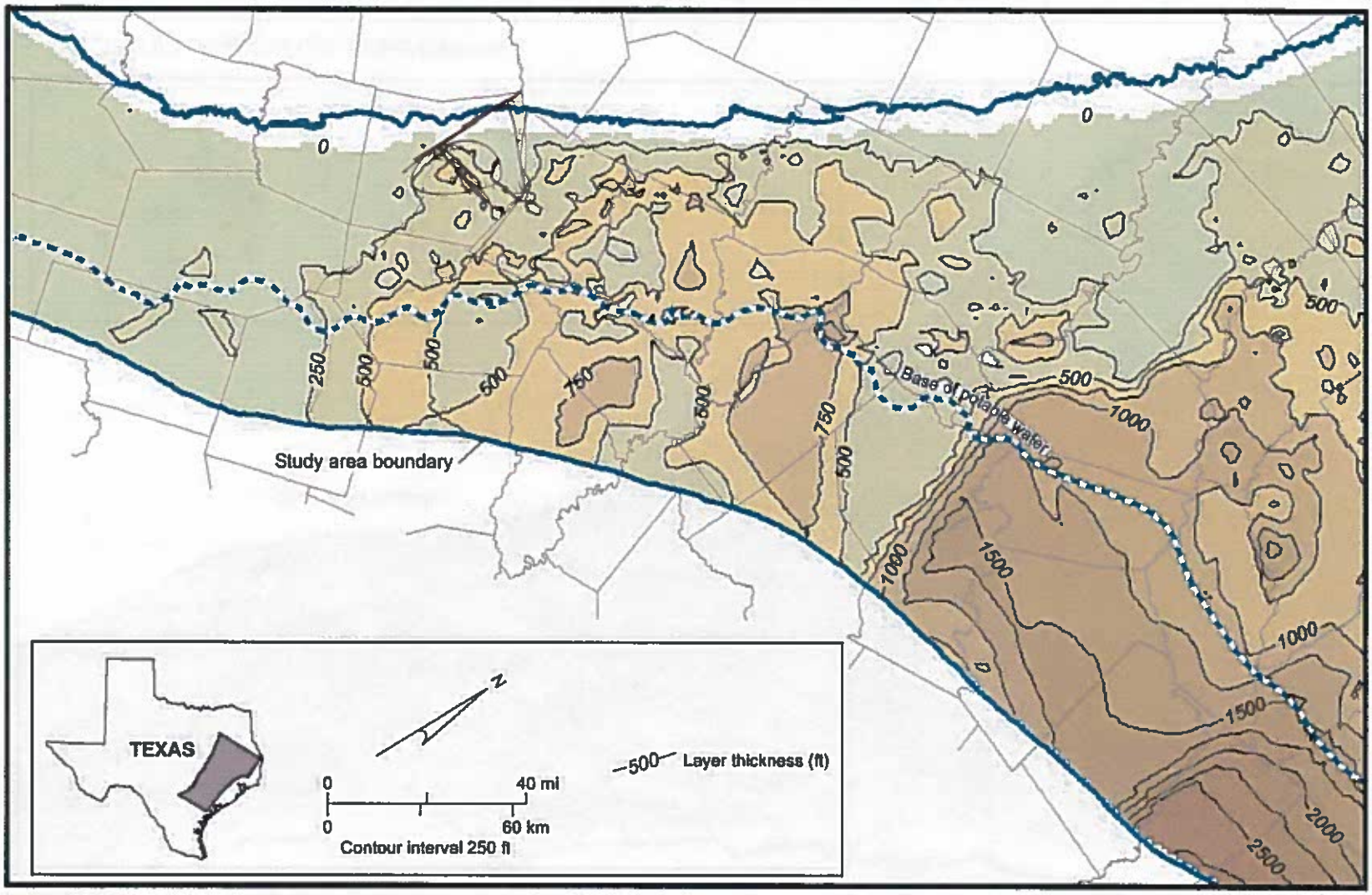



Figure 24. Total thickness of the Simsboro Formation.

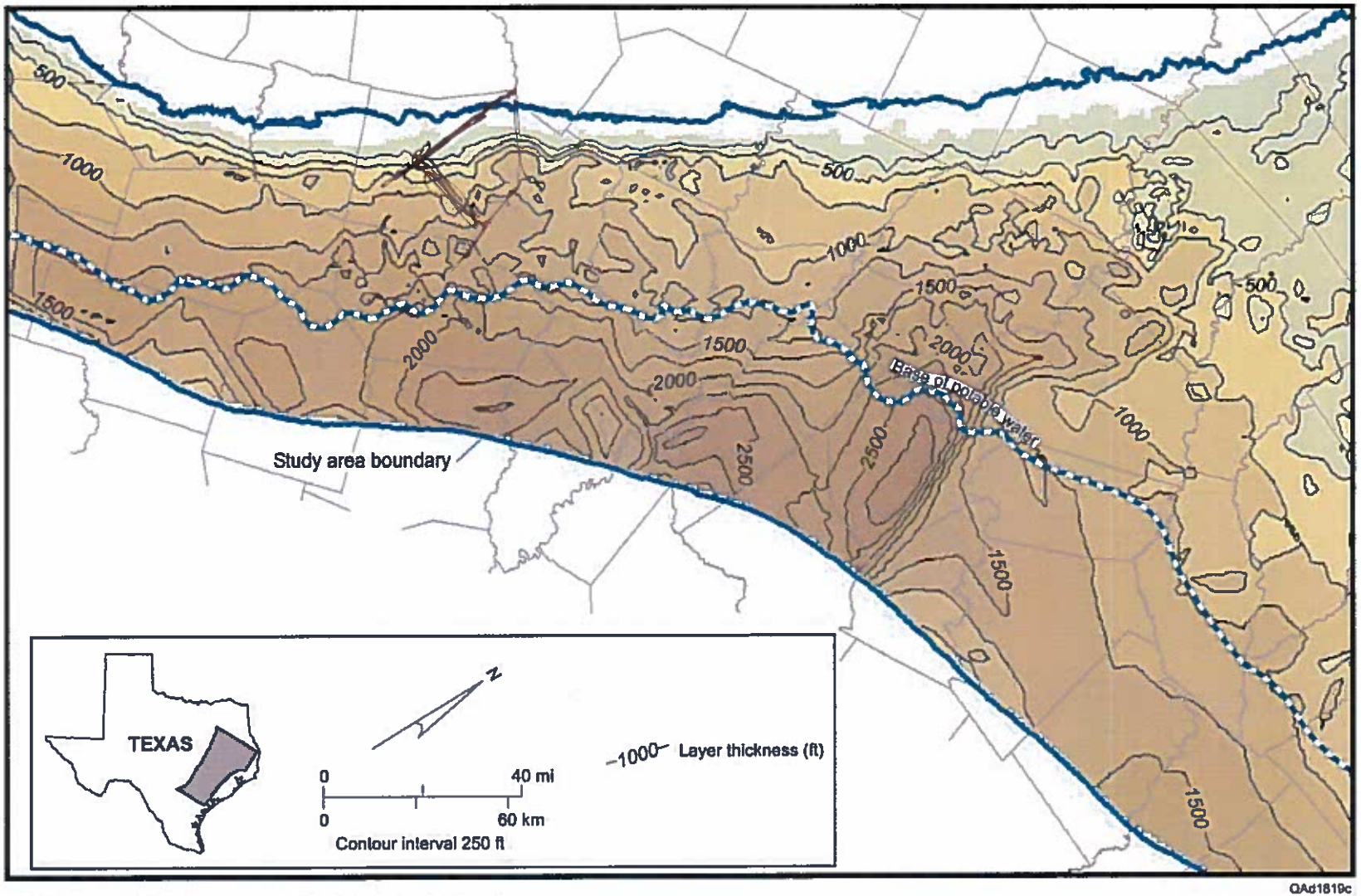



Figure 25. Total thickness of the Calvert Bluff Formation.

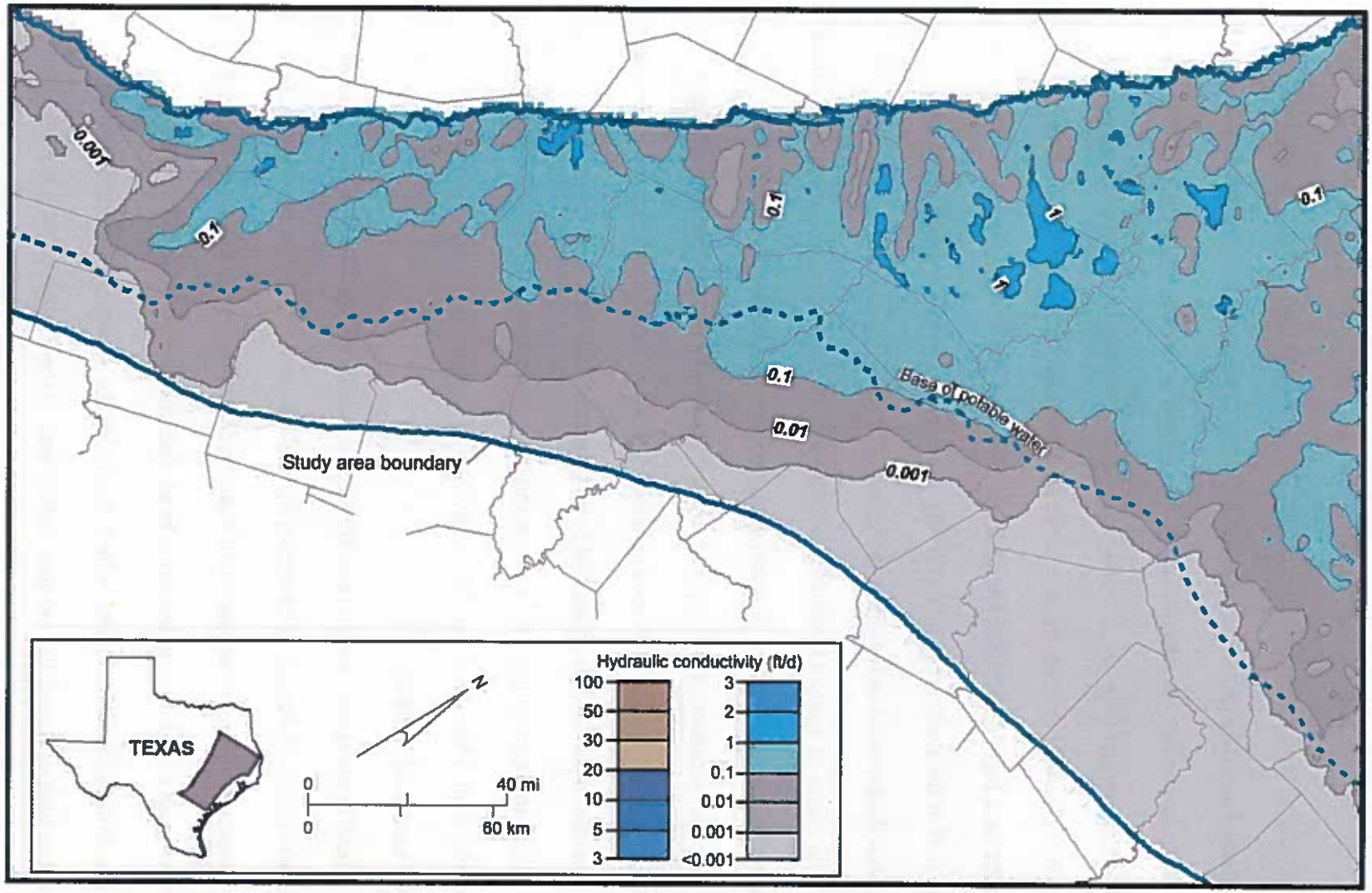



Figure 48. Map of average hydraulic conductivity in the Hooper Formation. Method of calculation described in text.

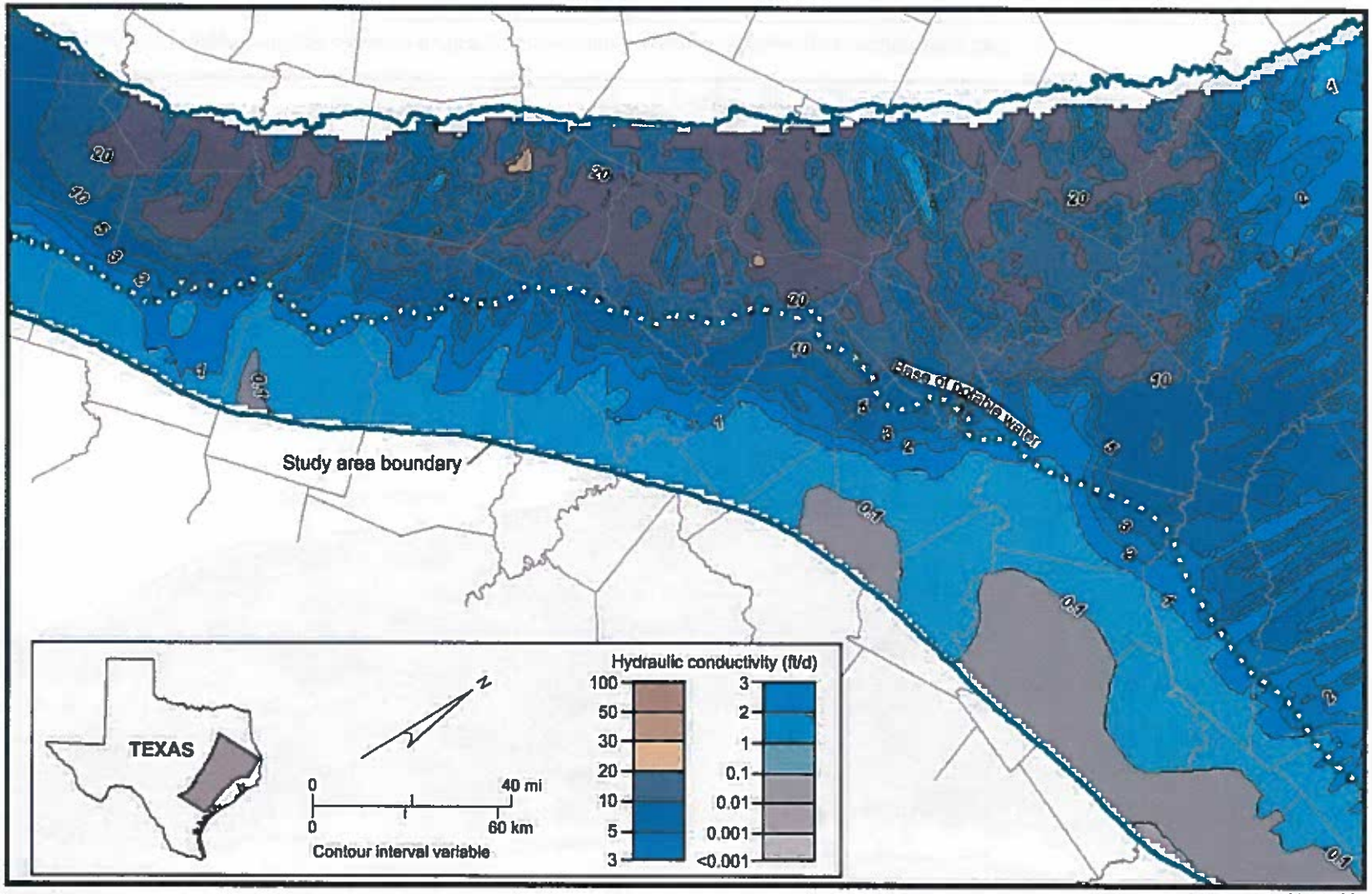



Figure 49. Map of average hydraulic conductivity in the Simsboro Formation. Method of calculation described in text.

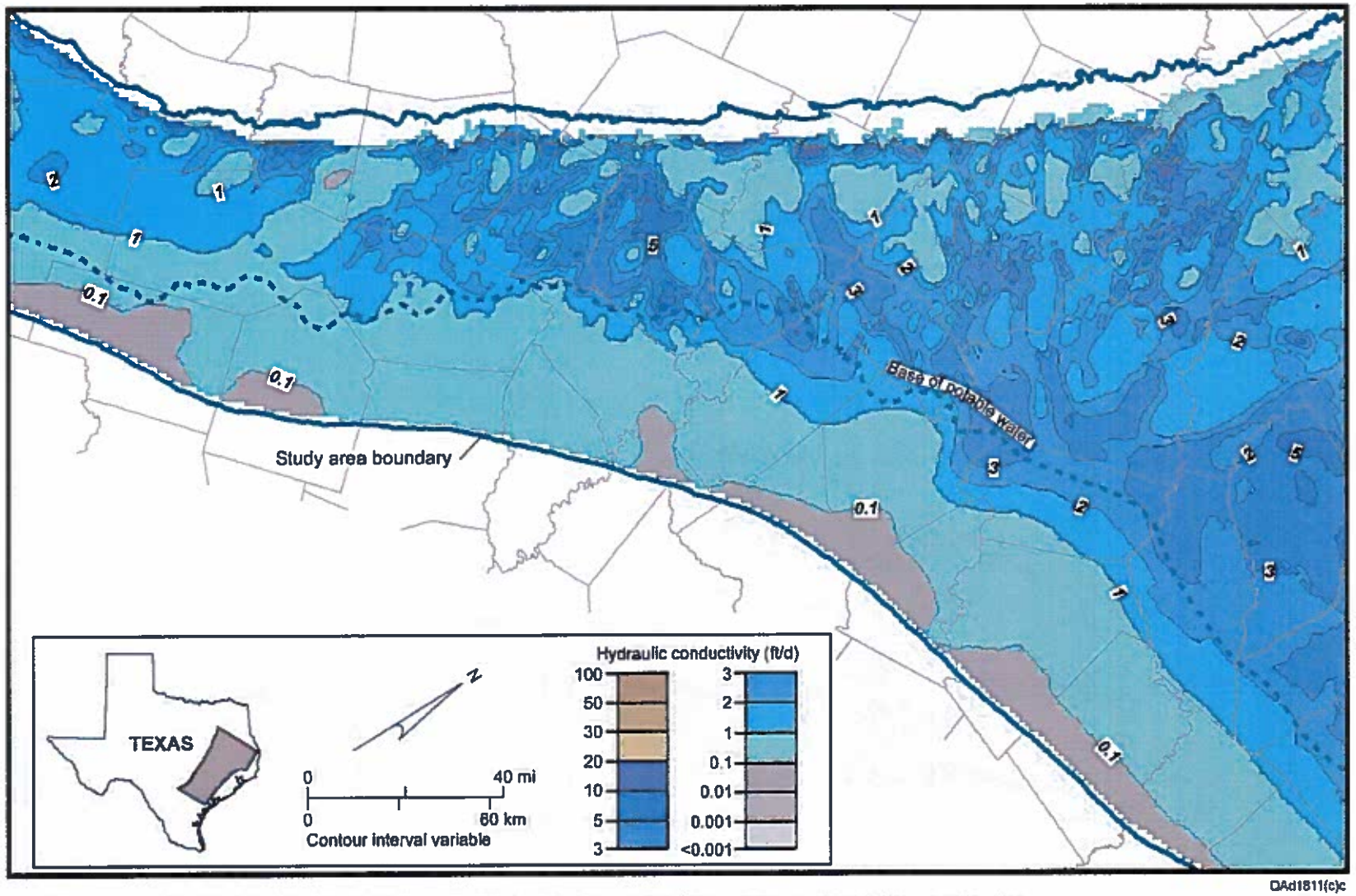
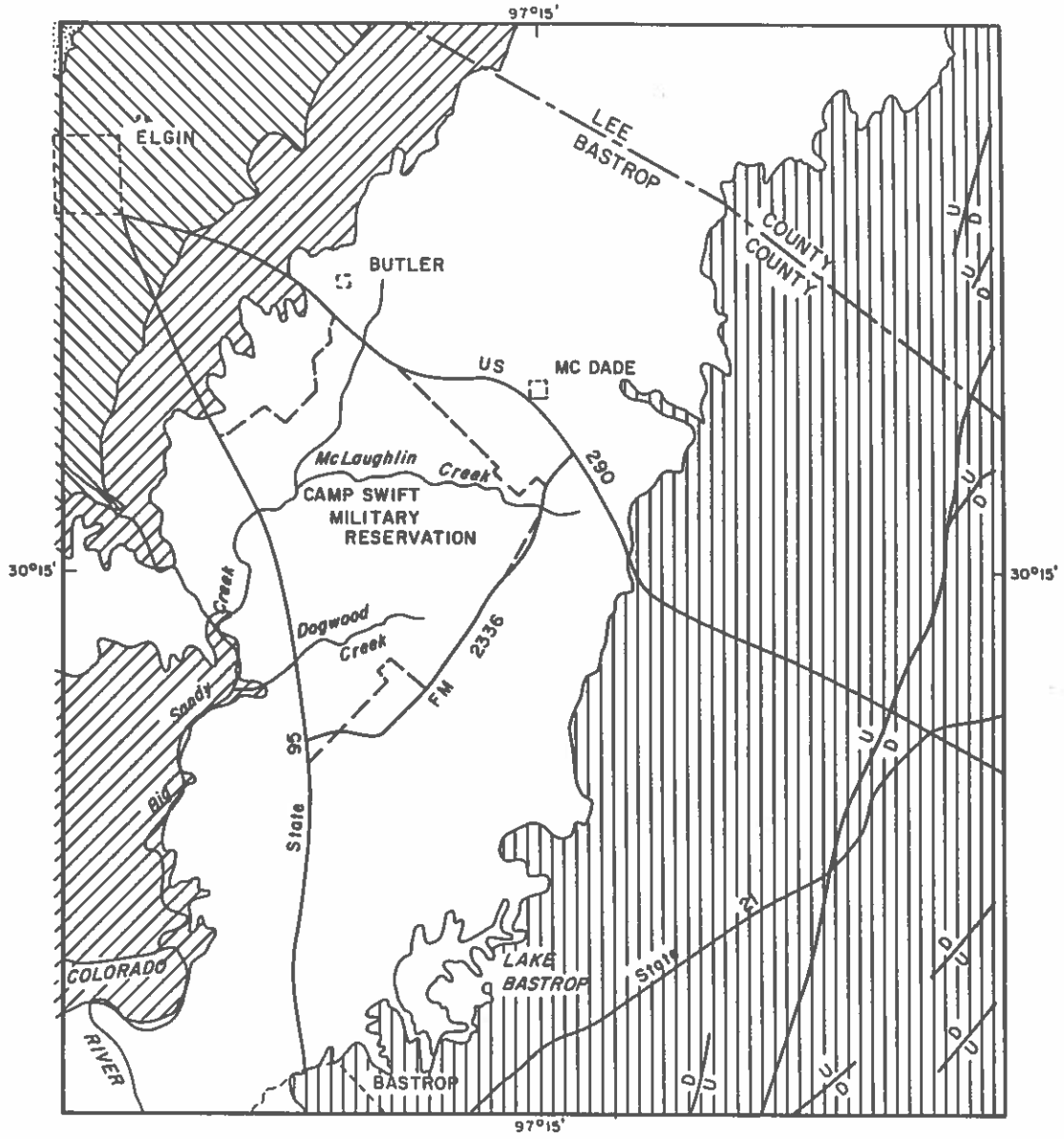
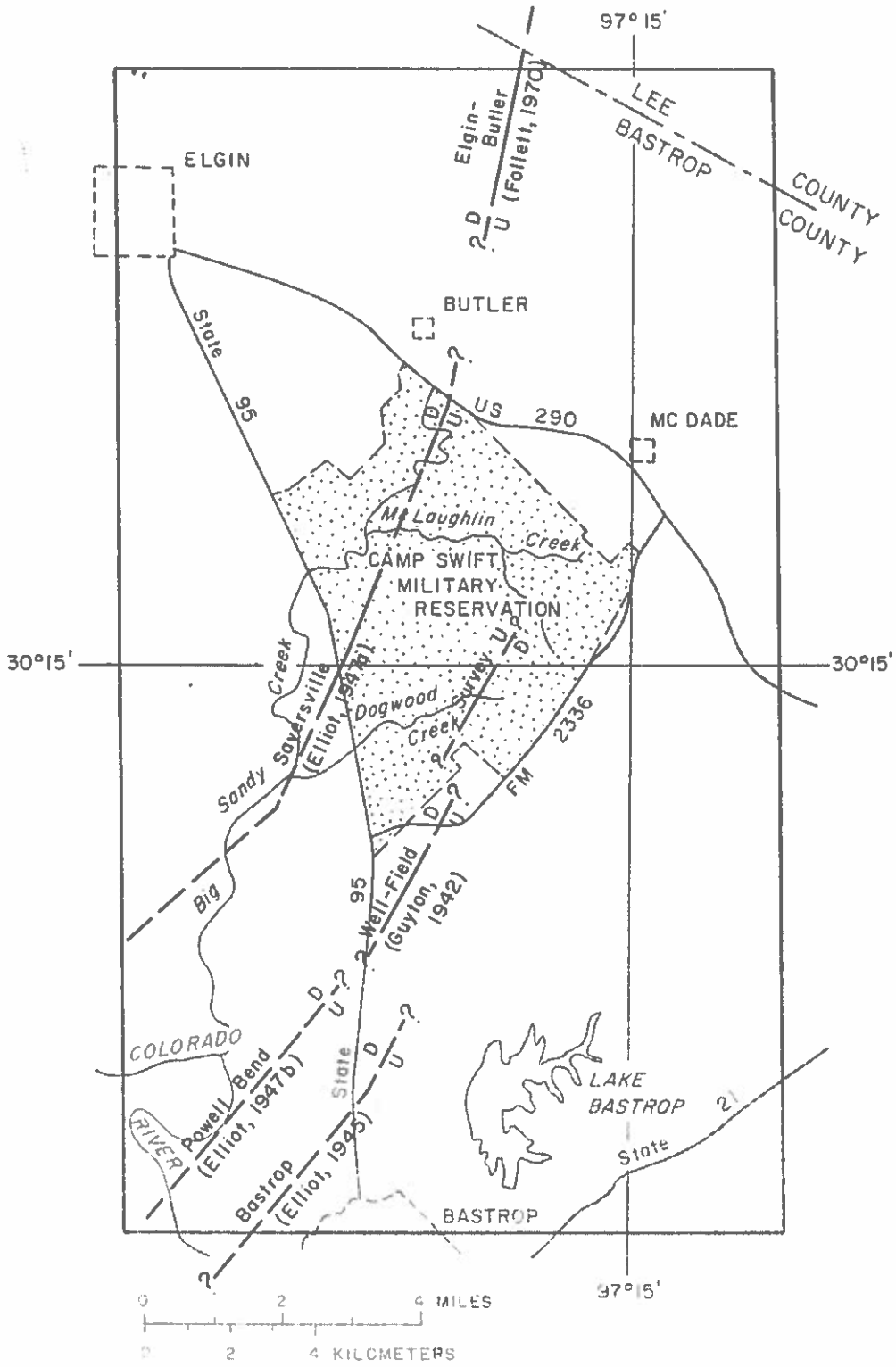



Figure 50. Map of average hydraulic conductivity in the Calvert Bluff Formation. Method of calculation described in text.




The stratigraphic nomenclature follows the usage of the Texas Bureau of Economic Geology (Barnes 1974)

Figure 2.1-2.--Geologic map of the study area.




EXPLANATION

Well-Field (Guyton, 1942) U/D — FAULT-- U, upthrown side; D, downthrown side. Dashed where approximately located. Author and date refer to publication where fault has been mapped or reported. Fault name, for example, "Well-Field", refers to a designated name of the fault for identification

Figure 2.3-2.--Location of faults in or near Camp Swift.

EXPLANATION

Quaternary to Recent alluvial and fluviatile deposits (shown only in areas near the outcrop trend of the Carrizo Formation and Wilcox Group)

Twis — Simsboro Formation of the Wilcox Group

Approximate downdip limit of slightly saline water (less than 3,000 milligrams per liter dissolved solids) in the Simsboro Formation

200 — Line showing approximate net thickness of sand containing fresh to slightly saline water in the Simsboro Formation Dashed where control is absent or limited. (Interval is 200 feet)

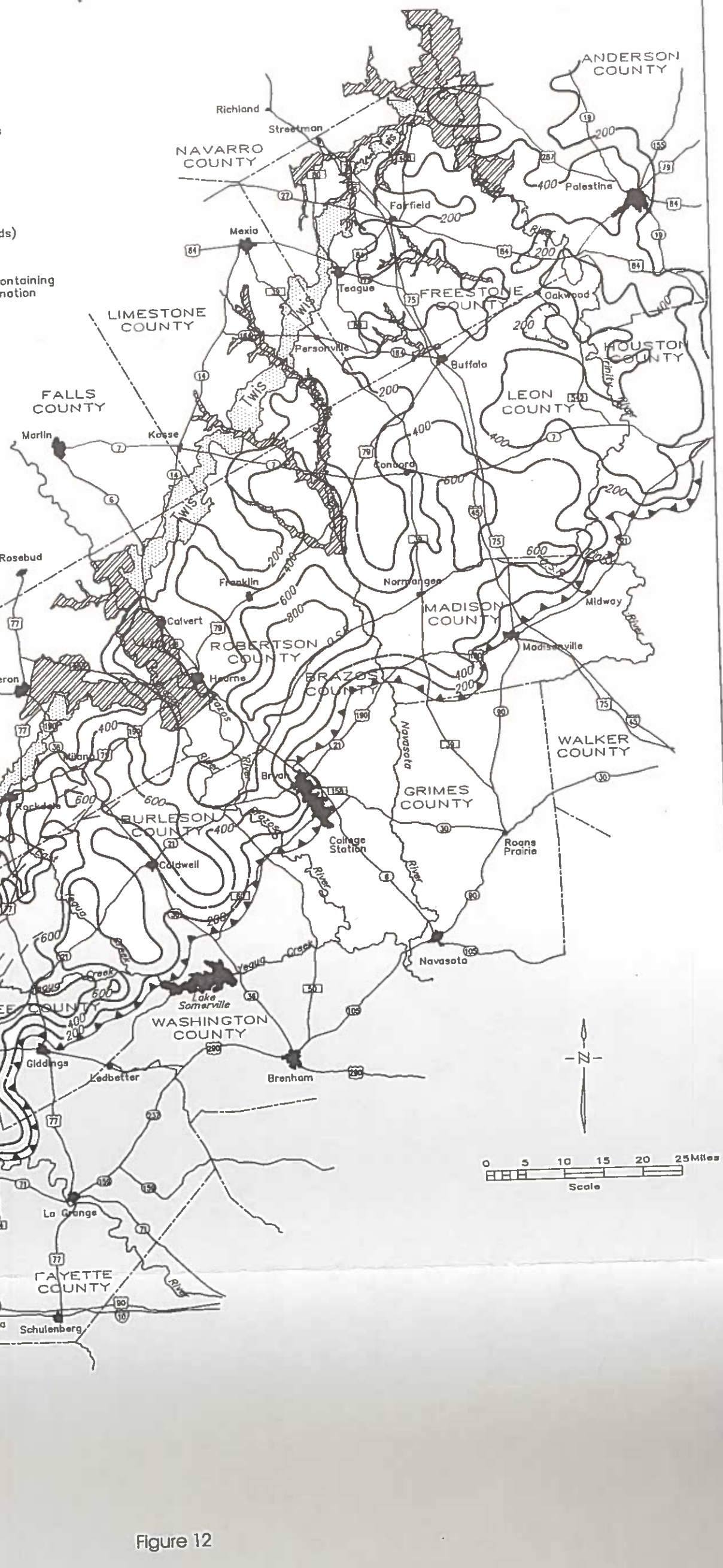



Figure 12

APPROXIMATE NET THICKNESS OF SAND CONTAINING FRESH TO TO SLIGHTLY SALINE WATER IN THE SIMSBORO FORMATION

EXPLANATION

Quaternary to Recent alluvial and fluviatile deposits (shown only in areas near the outcrop trend of the Carrizo Formation and Wilcox Group)

Twis — Simsboro Formation of the Wilcox Group

U / D — Fault, dashed where approximate; U, upthrown side; D, downthrown side

Approximate downdip limit of slightly saline water (less than 3,000 milligrams per liter dissolved solids) in the Simsboro Formation

-400 — Line showing altitude of the top of the Simsboro Formation. Dashed where control is absent or limited. (Interval is 400 feet)

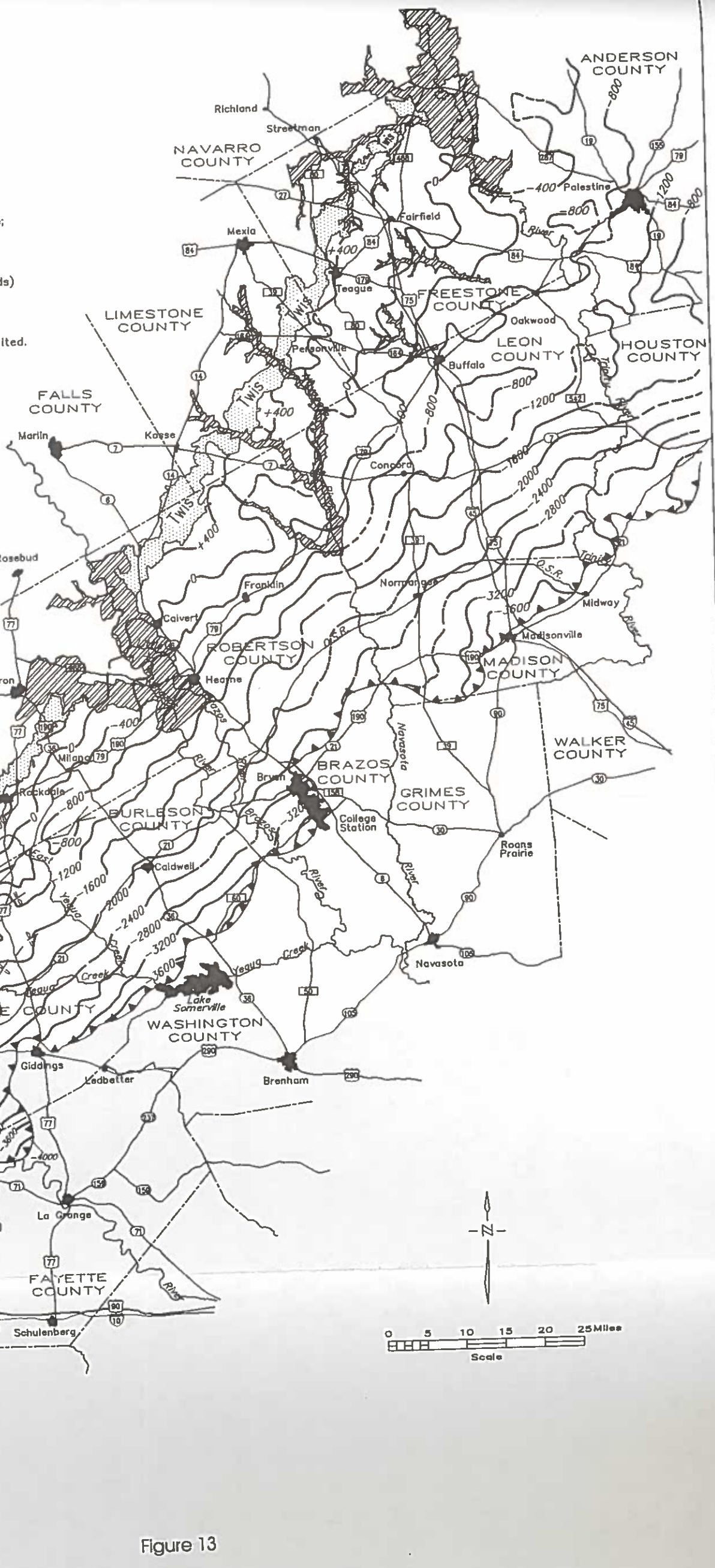
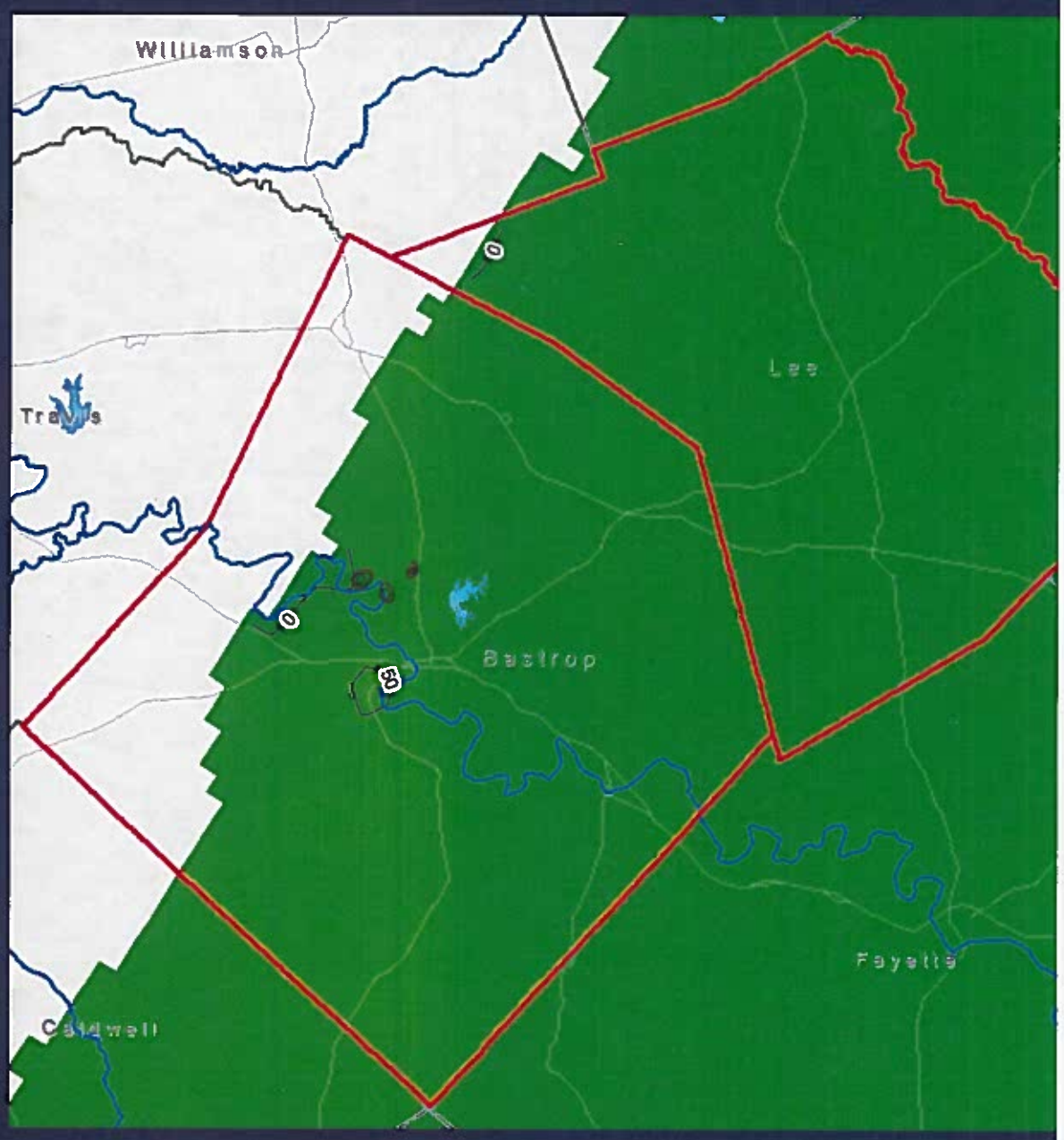



Figure 13

APPROXIMATE ALTITUDE OF THE TOP OF THE SIMSBORO FORMATION

# New Baseline Simulation

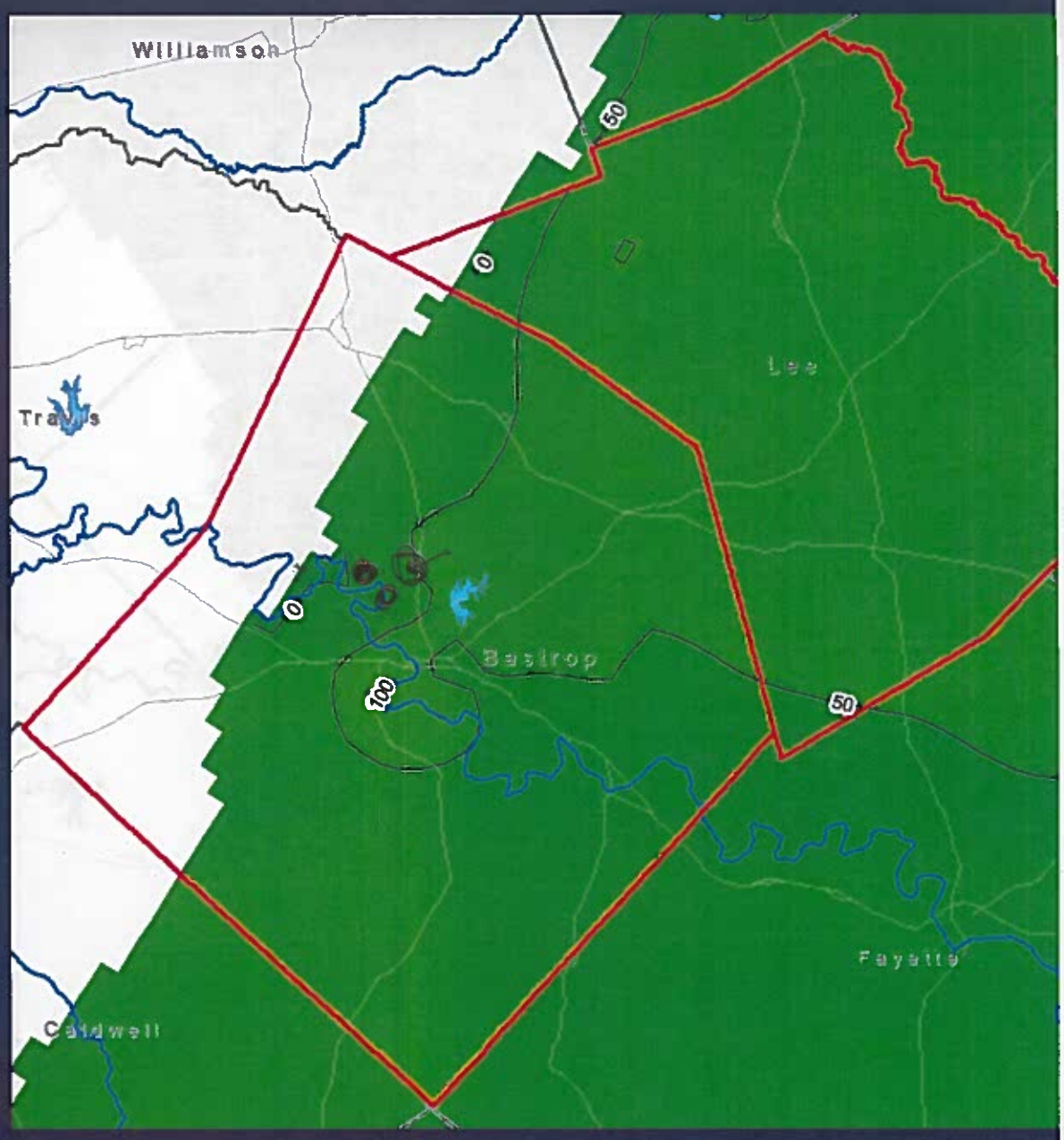
Total drawdown from 2000 to 2010 (feet)




*Daniel B. Stephens & Associates, Inc.*

# New Baseline Simulation

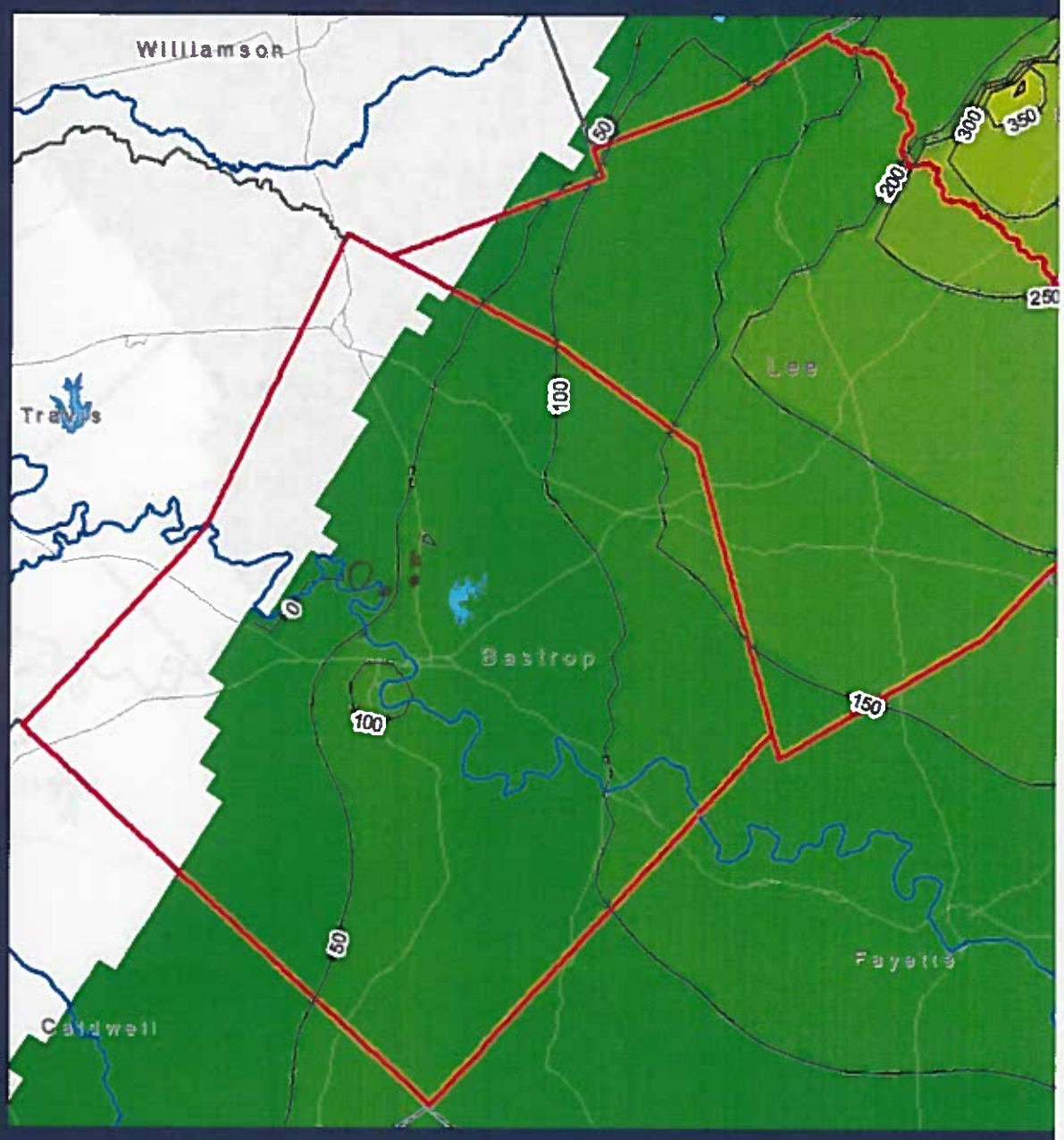
Total drawdown from 2000 to 2020 (feet)




*Daniel B. Stephens & Associates, Inc.*

# New Baseline Simulation

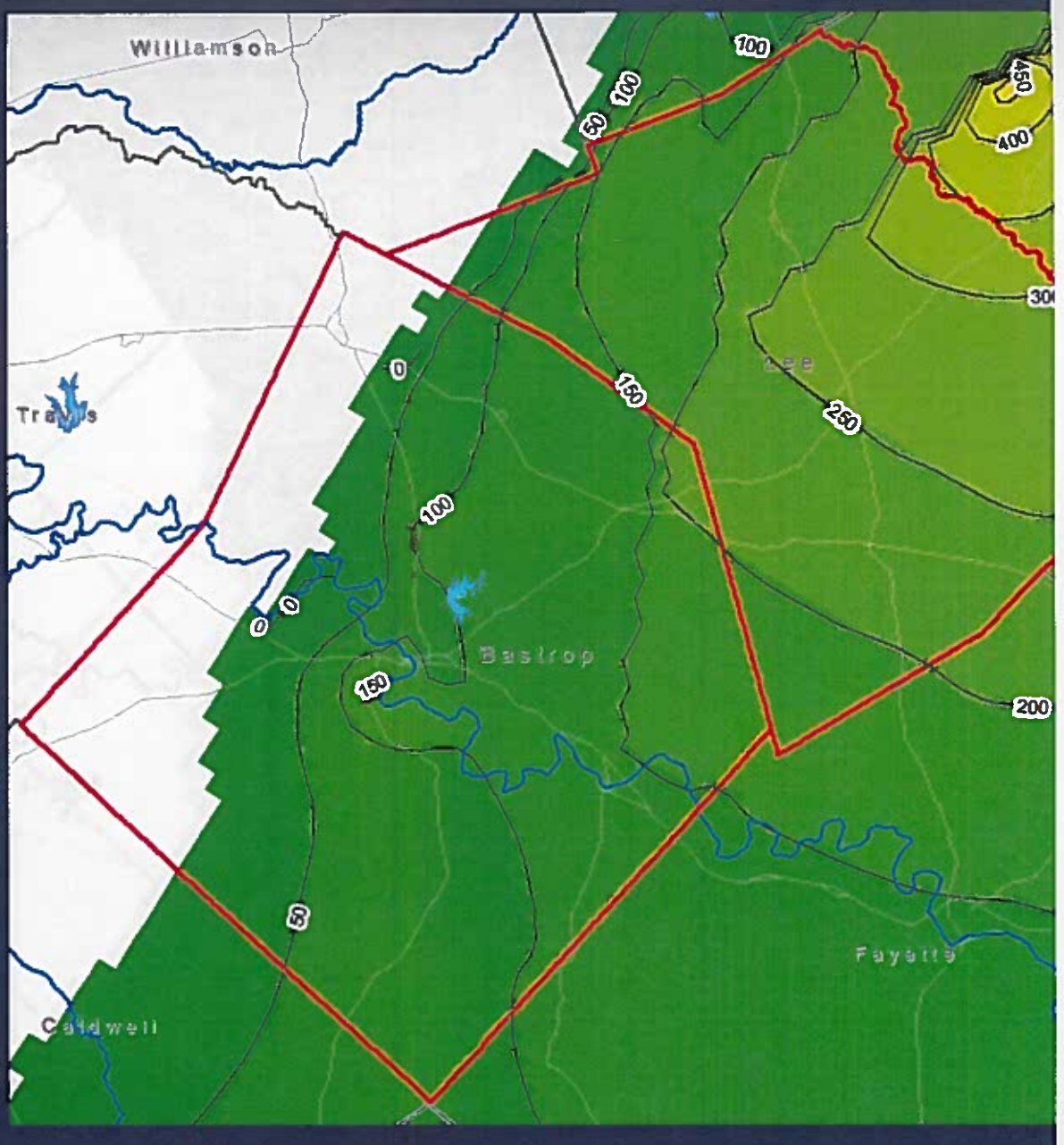
Total drawdown from 2000 to 2030 (feet)




*Daniel B. Stephens & Associates, Inc.*

# New Baseline Simulation

Total drawdown from 2000 to 2040 (feet)

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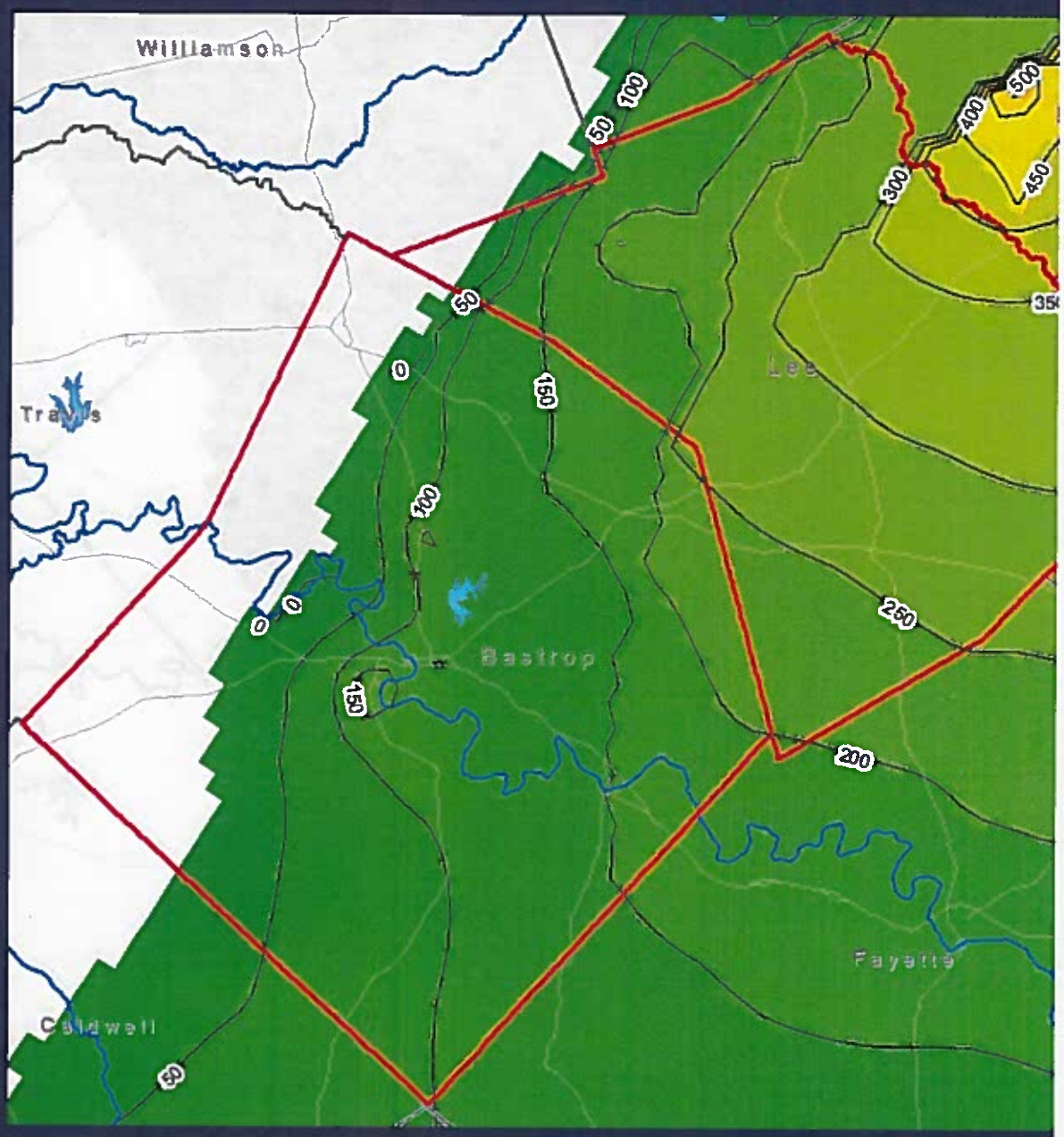
# New Baseline Simulation

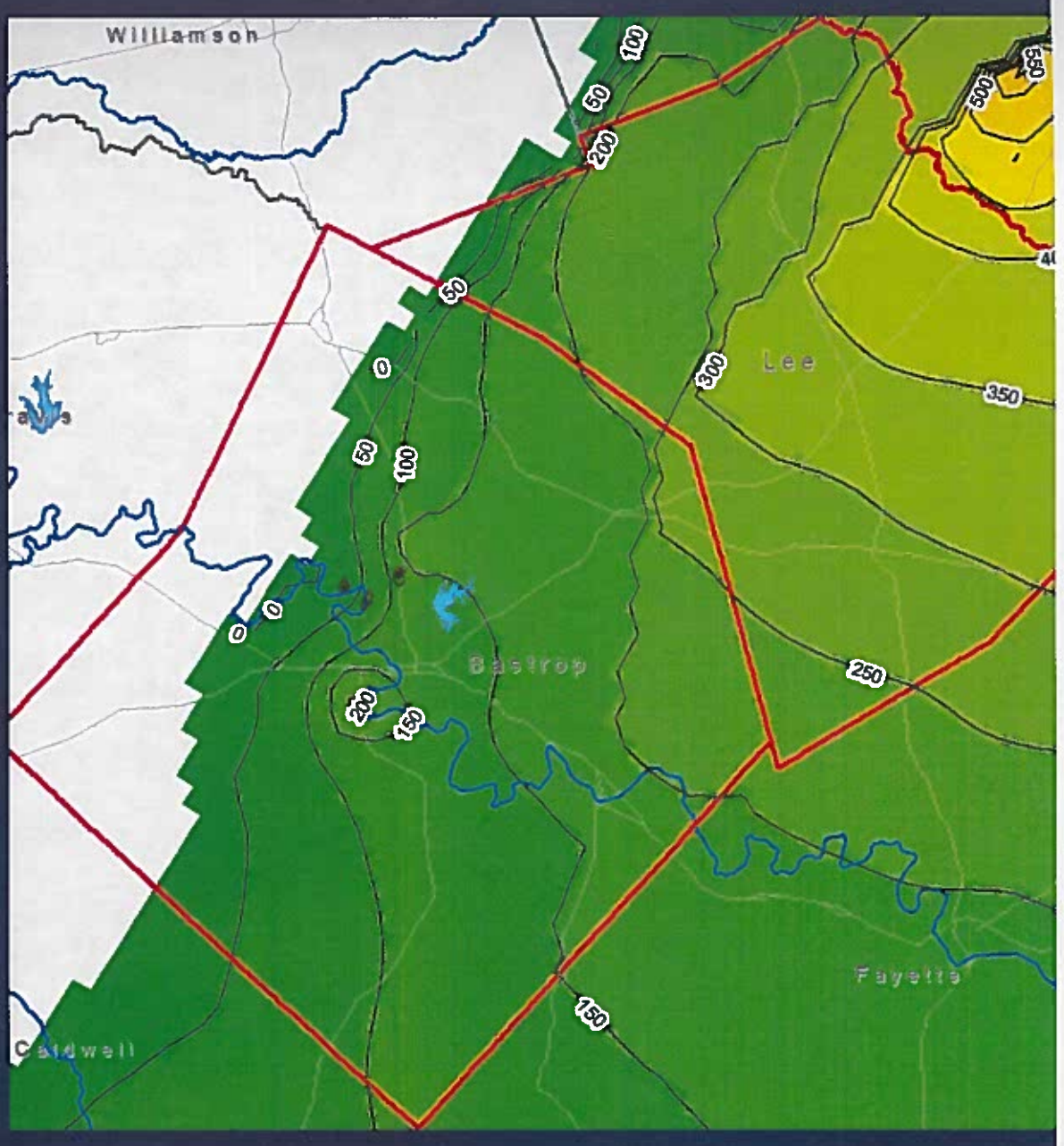
Total drawdown from 2000 to 2050 (feet)



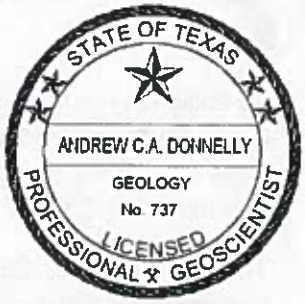

*Daniel B. Stephens & Associates, Inc.*

# New Baseline Simulation

Total drawdown from 2000 to 2060 (feet)




*Daniel B. Stephens & Associates, Inc.*




# Memorandum

**To:** Jim Totten, General Manager
Lost Pines Groundwater Conservation District

**From:** Andrew Donnelly

**Date:** February 14, 2014

**Subject:** Review of XS Ranch Operating Permit Application Packet

I have reviewed the operating permit application packet submitted by XS Ranch for a proposed well field located in Bastrop County. The well field consists of four wells that are located along State Highway 95 north of the City of Bastrop. The locations of the proposed wells are shown in Figure 1 below.

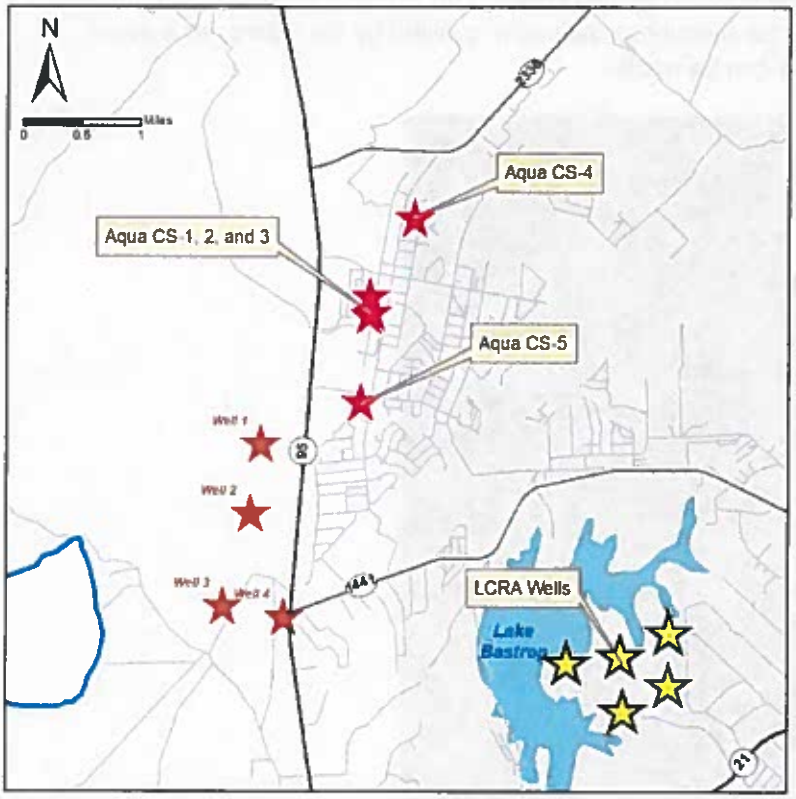



*Figure 1. Location of proposed XS Ranch well field.*

Four applications were included as part of this submittal, one for each of the four wells in the proposed well field. Supporting material for each of these applications was identical, and so was reviewed only one time.

As shown in Figure 1, the location of the proposed well field is just to the west of the Aqua Camp Swift well field, which produces from the Simsboro Aquifer. The closest of the proposed wells is just less than one mile from the Aqua CS-5 well. The proposed well field is also approximately 2 miles west of the newly permitted LCRA well field near Lake Bastrop.

The Central Queen City-Sparta Groundwater Availability Model (GAM) was run with the proposed pumpage of 6,000 acre-feet per year added in the cells where the proposed wells are located. The results of this run are shown in Figure 2. This figure illustrates that at the end of 50 years of continuous pumping the project-specific drawdown attributable to the proposed XS Ranch well field (i.e., drawdown caused by the pumpage from the proposed wells only) is more than 70 feet in the proposed well field location.

This drawdown estimate is only a rough approximation obtained using the regional GAM, which may not account for local hydrogeologic conditions. The simulation results are provided in anticipation that they may be useful to the District Board. This model run was done in the same manner as previous model runs for permit evaluations requested by the Board, so a direct comparison to the previous runs can be made.

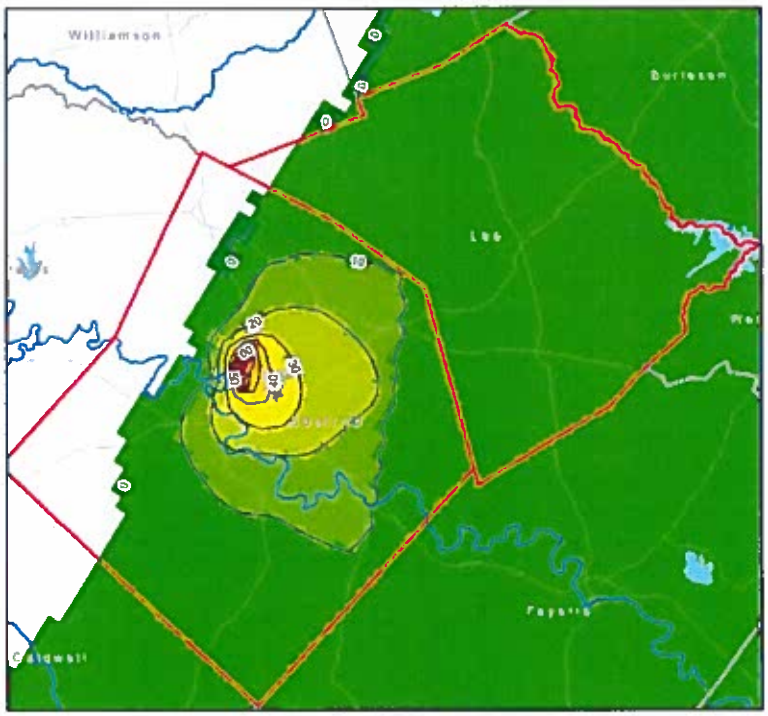



*Figure 2. Project-specific 50-year drawdown (in feet) in the Simsboro Aquifer attributable to the proposed XS Ranch pumpage*

## Required Application Items

Several items required in an operating permit application are not present in these applications, including:

1. A 36-hour pumping test was not conducted. A pumping test was conducted; however it lasted only 7.5 hours due to concerns about the stability of the borehole during the test. The applicant states that a 36-hour test will be completed at a later time, presumably if the operating permits are granted. This is a reasonable request.
2. All wells within 5,000 feet of the proposed well locations were not included on a map, only non-exempt wells. The applicant should obtain the District's database on exempt wells and plot these on their maps, and use the aquifer designation (if available) and/or total depths of the wells to attempt to identify which ones are Simsboro wells.
3. A statement agreeing to protect groundwater quality (per rule 5.2 C(6)) was not included.
4. A statement agreeing to avoid waste and achieve water conservation (per rule 5.2 C(5)) was not included.

Other than these items, these applications are complete.

## Permit Review Items 2 and 8

***(2) Whether the proposed use of water unreasonably affects existing groundwater and surface water resources or existing permit holders***

The proposed production of 6,000 acre-feet per year by XS Ranch from a well field in Bastrop County will impact water levels in the Simsboro Aquifer in the vicinity of the well. Drawdowns estimated using the GAM are summarized in Table 1. As indicated in the table, the drawdown estimated to occur due to the proposed well field is approximately 8 feet across the entire District. A map of project-specific drawdowns estimated by the GAM is shown in Figure 2. This proposed project does not appear to unreasonably impact groundwater users in the District.

**Table 1. Projected drawdown in 2060 from pumpage included in the XS Ranch well applications**

| Pumpage | Drawdown (feet) | | |
|---|---|---|---|
| | Bastrop County | Lee County | Lost Pines District Total |
| XS Ranch well field pumpage only | 12 | 4 | 8 |
| XS Ranch well field + Existing LPGCD pumpage + New permits | 173 | 362 | 262 |

A quantitative evaluation of the impact of the proposed pumpage on surface water resources within the District is difficult to make. The only quantitative tool available for such a calculation is the GAM, which is not well suited to accurately evaluate impacts to surface water within the District attributable to this application. However, because the majority of the flow in the Colorado River is controlled by the release of water from the Highland Lakes and because the amount of pumpage requested in this application is small, the impacts from the proposed well field on flow in the Colorado River would appear to be negligible.

***(8) Whether granting the application is consistent with the District's duty to manage total groundwater production on a long-term basis to achieve the applicable Desired Future Condition***

This project by itself does not cause more estimated drawdown than the Desired Future Condition (DFC) for the Simsboro Aquifer. The average estimated drawdown due to production from this application is approximately 8 feet when averaged across the entire District. However, production from the proposed well field combined with existing sources of groundwater production, newly approved permits in the District, and groundwater production outside of the District (as modeled in the final Groundwater Management Area 12 GAM run) is estimated to cause 262 feet of drawdown in the aquifer, which is greater than the DFC for the Simsboro Aquifer in the District of 237 feet.

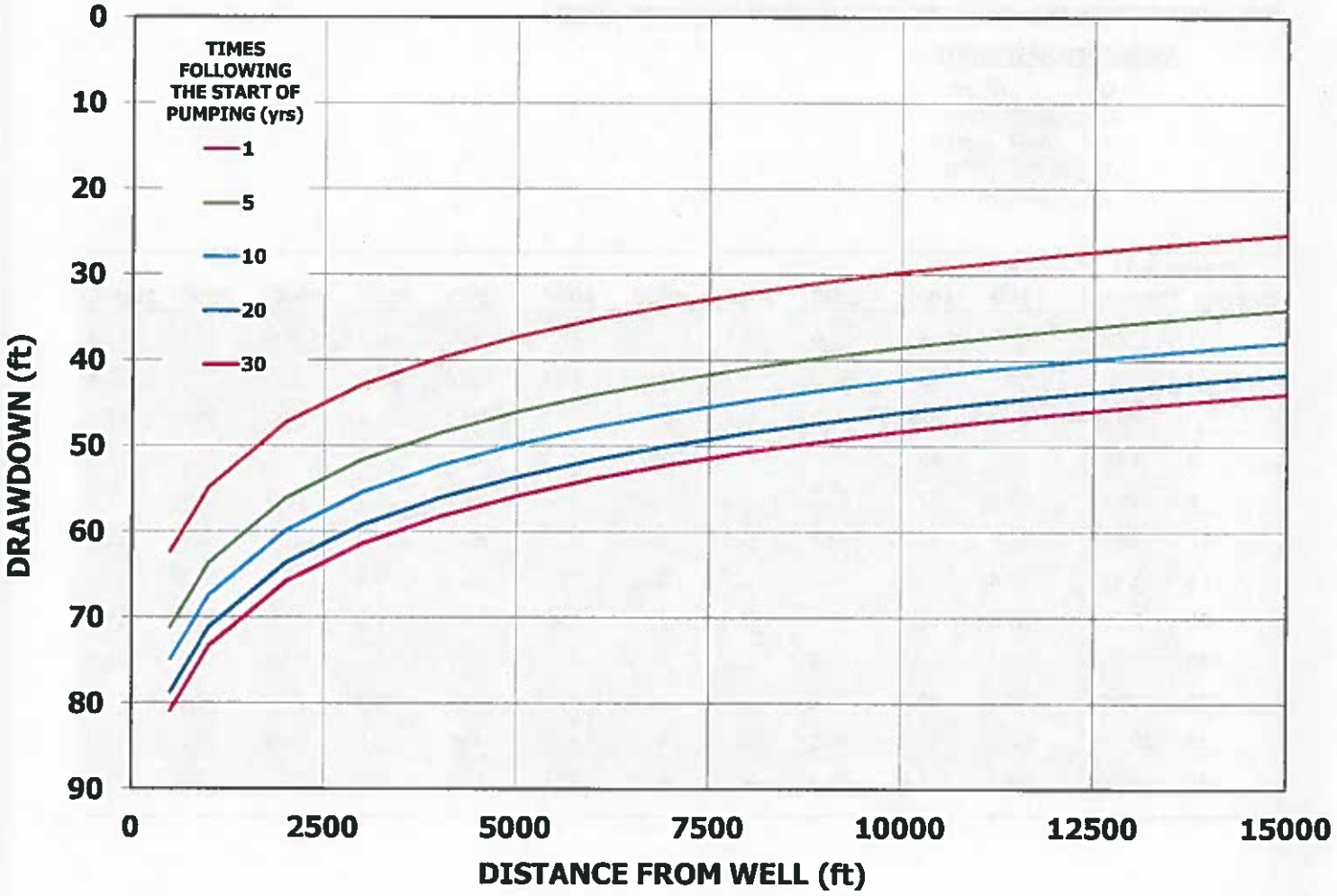
The District's duty to manage total groundwater production on a long-term basis to achieve the DFC will be based on a monitoring network that will be developed for each aquifer for which a DFC has been established. The District's intended approach is to diligently monitor the drawdown within the Simsboro Aquifer across the entire District and manage (i.e., reduce) groundwater production when the information from the monitoring network indicates that the DFC is in danger of being exceeded. If water levels in the Simsboro Aquifer monitoring network indicate the potential for the DFC to be exceeded, then the District's approach is to cut back production from all permitted users. This approach is consistent with the requirement that the DFC be achieved.

## Summary

The four applications for a proposed well field are for a total of 6,000 acre-feet per year from the Simsboro Aquifer in Bastrop County. The applications is missing several required items, including a map showing all registered wells within 5,000 feet of the proposed wells, a pumping test of sufficient length, and statements agreeing to protect groundwater quality, avoid waste and achieve water conservation.

A model run was done to simulate the impact of the proposed pumpage on the aquifer using the same assumptions as those applied in previous permit evaluations requested by the District Board. The simulated impact of the proposed well field is approximately 8 feet of drawdown averaged across the District.

# DISTANCE - DRAWDOWN GRAPH: T = 21,000 GPD/FT

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Printed on 9/28/2015

ULIANA003955

## MODEL WELL TEST

CALCULATE DRAWDOWNS IN A CONFINED AQUIFER USING THEIS EQUATION
FOR VARIOUS TIMES AND LOCATIONS (SEE GRAPH ON FOLLOWING SHEET)

### ASSUMPTIONS/INPUT

| | | |
|---|---|---|
| Q: | 1000 | gpm |
| Q: | 192500 | $ft^3/d$ |
| T: | 28857 | gpd/ft |
| T: | 3857.621 | $ft^2/d$ |
| S: | 0.0001 | |

| *drawdown* | | DISTANCE (ft) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TIME (yrs) | TIME (days) | 500 | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 |
| 1 | 365 | 46.7 | 41.1 | 35.6 | 32.4 | 30.1 | 28.4 | 26.9 | 25.7 | 24.6 | 23.7 | 22.9 |
| 2 | 731 | 49.4 | 43.9 | 38.4 | 35.2 | 32.9 | 31.1 | 29.7 | 28.4 | 27.4 | 26.5 | 25.6 |
| 3 | 1096 | 51.0 | 45.5 | 40.0 | 36.8 | 34.5 | 32.7 | 31.3 | 30.1 | 29.0 | 28.1 | 27.2 |
| 4 | 1461 | 52.2 | 46.7 | 41.1 | 37.9 | 35.6 | 33.9 | 32.4 | 31.2 | 30.1 | 29.2 | 28.4 |
| 5 | 1826 | 53.0 | 47.5 | 42.0 | 38.8 | 36.5 | 34.8 | 33.3 | 32.1 | 31.0 | 30.1 | 29.3 |
| 10 | 3653 | 55.8 | 50.3 | 44.8 | 41.6 | 39.3 | 37.5 | 36.1 | 34.8 | 33.8 | 32.8 | 32.0 |
| 15 | 5479 | 57.4 | 51.9 | 46.4 | 43.2 | 40.9 | 39.1 | 37.7 | 36.4 | 35.4 | 34.5 | 33.6 |
| 20 | 7305 | 58.5 | 53.0 | 47.5 | 44.3 | 42.0 | 40.3 | 38.8 | 37.6 | 36.5 | 35.6 | 34.8 |
| 25 | 9131 | 59.4 | 53.9 | 48.4 | 45.2 | 42.9 | 41.1 | 39.7 | 38.5 | 37.4 | 36.5 | 35.6 |
| 30 | 10958 | 60.2 | 54.7 | 49.2 | 45.9 | 43.6 | 41.9 | 40.4 | 39.2 | 38.1 | 37.2 | 36.4 |
| 35 | 12784 | 60.8 | 55.3 | 49.8 | 46.5 | 44.3 | 42.5 | 41.0 | 39.8 | 38.8 | 37.8 | 37.0 |
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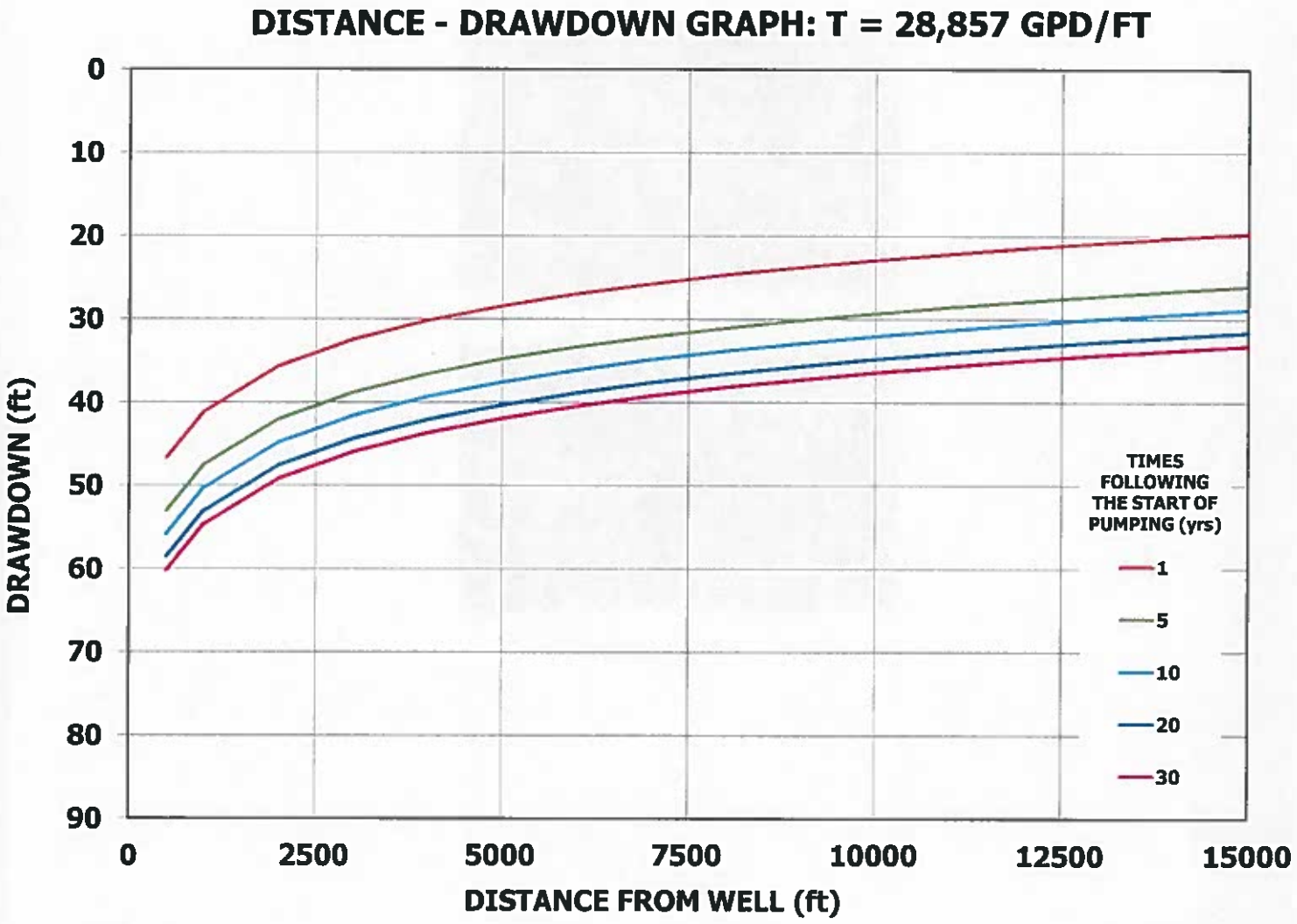


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ULIANA003960

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| 6.66503345 | 6.49194667 | 6.33200905 | 6.18395271 | 6.04613837 |
| 6.95333667 | 6.77941591 | 6.61944135 | 6.47134512 | 6.33348796 |
| 7.1763729 | 7.00243175 | 6.84243502 | 6.69431486 | 6.55643199 |
| 7.85930542 | 7.69532347 | 7.53528241 | 7.38711437 | 7.24918007 |
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| 8.78546735 | 8.61146092 | 8.45139325 | 8.30319646 | 8.1652313 |
| 8.96777459 | 8.79376544 | 8.63369481 | 8.48549484 | 8.34752624 |
| 9.12191505 | 8.94790396 | 8.78783121 | 8.63962896 | 8.50165792 |
| 9.25543878 | 9.08142622 | 8.9213519 | 8.77314793 | 8.63517505 |

| 11000 | 12000 | 13000 | 14000 | 15000 |
|---|---|---|---|---|
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| 0.00071564 | 0.00085167 | 0.00099953 | 0.00115922 | 0.00133073 |
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| 0.00014313 | 0.00017033 | 0.00019991 | 0.00023184 | 0.00026615 |
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| 31.2 | 30.6 | 29.9 | 29.3 | 28.8 |
| 32.9 | 32.2 | 31.5 | 30.9 | 30.4 |
| 34.0 | 33.3 | 32.7 | 32.1 | 31.5 |
| 34.9 | 34.2 | 33.6 | 33.0 | 32.4 |
| 35.6 | 34.9 | 34.3 | 33.7 | 33.1 |
| 36.2 | 35.5 | 34.9 | 34.3 | 33.8 |
| 36.8 | 36.1 | 35.4 | 34.8 | 34.3 |

| W(u) | | DISTANCE (m) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TIME (hrs) | TIME (sec) | 500 | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 |
| 1.0 | 365 | 11.74859499 | 10.3623139 | 8.97607281 | 8.1652313 | 7.58999134 | 7.1438839 | 6.779415908 | 6.47134512 | 6.20454835 | 5.96928372 | 5.75889954 |
| 2.0 | 731 | 12.44173996 | 11.0554522 | 9.6691845 | 8.85829864 | 8.28299659 | 7.83678933 | 7.472243789 | 7.16405774 | 6.89712799 | 6.66171269 | 6.45116015 |
| 3.0 | 1096 | 12.84720432 | 11.4609144 | 10.0746378 | 9.26373714 | 8.68841439 | 8.24218051 | 7.87760245 | 7.56937797 | 7.30240389 | 7.06693834 | 6.85632965 |
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| 5.0 | 1826 | 13.35802936 | 11.9717377 | 10.5854539 | 9.7745414? | 9.19920216 | 8.752947 | 8.388342917 | 8.08008769 | 7.8130781? | 7.57757237 | 7.36691875 |
| 10.0 | 3653 | 14.05117609 | 12.6648831 | 11.278594 | 10.4676727 | 9.89232096 | 9.44604982 | 9.081426225 | 8.77314793 | 8.50611176 | 8.27057585 | 8.05988853 |
| 15.0 | 5479 | 14.45664105 | 13.0703476 | 11.6840568 | 10.8731325 | 10.2977766 | 9.85150014 | 9.486370042 | 9.17858406 | 8.91153902 | 8.67599305 | 8.4652945 |
| 20.0 | 7305 | 14.74432305 | 13.3580294 | 11.9717377 | 11.1608119 | 10.5854539 | 10.1391748 | 9.774541469 | 9.46625164 | 9.19920216 | 8.96365117 | 8.752947 |
| 25.0 | 9131 | 14.96746656 | 13.5811727 | 12.1948805 | 11.3839538 | 10.808594? | 10.3623139 | 9.997678633 | 9.6893865 | 9.42233436 | 9.18678035 | 8.97607281 |
| 30.0 | 10958 | 15.14978809 | 13.7634942 | 12.3772016 | 11.56627?3 | 10.9909143 | 10.5446325 | 10.17999593 | 9.87170226 | 9.60464835 | 9.36909233 | 9.15838253 |
| 35.0 | 12784 | 15.30393875 | 13.9176448 | 12.5313519 | 11.7204242 | 11.1450636 | 10.6987811 | 10.33414357 | 10.0258488 | 9.75879362 | 9.52323617 | 9.31252477 |
| 40.0 | 14610 | 15.43747012 | 14.0511761 | 12.6648831 | 11.8539551 | 11.278594 | 10.8323109 | 10.46767268 | 10.1593771 | 9.89232096 | 9.65676243 | 9.44604982 |

| u | | DISTANCE (m) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TIME (hrs) | TIME (sec) | 500 | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 |
| 1.00 | 365 | 4.43578E-06 | 1.7743E-05 | 7.0973E-05 | 0.00015969 | 0.00028389 | 0.00044358 | 0.000638753 | 0.00086941 | 0.00113556 | 0.00143719 | 0.00177431 |
| 2.0 | 731 | 2.21789E-06 | 8.8716E-06 | 3.5486E-05 | 7.9844E-05 | 0.00014195 | 0.00022179 | 0.000319376 | 0.00043471 | 0.00056778 | 0.0007186 | 0.00088716 |
| 3.0 | 1096 | 1.47859E-06 | 5.9144E-06 | 2.3658E-05 | 5.3229E-05 | 9.463E-05 | 0.00014786 | 0.000212918 | 0.0002898 | 0.00037852 | 0.00047906 | 0.00059144 |
| 4.0 | 1461 | 1.10895E-06 | 4.4358E-06 | 1.7743E-05 | 3.9922E-05 | 7.0973E-05 | 0.00011089 | 0.000159688 | 0.00021735 | 0.00028389 | 0.0003593 | 0.00044358 |
| 5.0 | 1826 | 8.87156E-07 | 3.5486E-06 | 1.4195E-05 | 3.1938E-05 | 5.6778E-05 | 8.8716E-05 | 0.000127751 | 0.00017388 | 0.00022711 | 0.00028744 | 0.00035486 |
| 10.0 | 3653 | 4.43578E-07 | 1.7743E-06 | 7.0973E-06 | 1.5969E-05 | 2.8389E-05 | 4.4358E-05 | 6.38753E-05 | 8.6941E-05 | 0.00011356 | 0.0001437? | 0.00017743 |
| 15.0 | 5479 | 2.95719E-07 | 1.1829E-06 | 4.7315E-06 | 1.0646E-05 | 1.8926E-05 | 2.9572E-05 | 4.25835E-05 | 5.7961E-05 | 7.5704E-05 | 9.5813E-05 | 0.00011829 |
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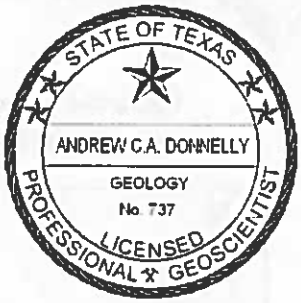
| 25.0 | 9131 | 1.77431E-07 | 7.0973E-07 | 2.8389E-06 | 6.3875E-06 | 1.1356E-05 | 1.7743E-05 | 2.55501E-05 | 3.4777E-05 | 4.5422E-05 | 5.7488E-05 | 7.0973E-05 |
| 30.0 | 10958 | 1.47859E-07 | 5.9144E-07 | 2.3658E-06 | 5.3229E-06 | 9.463E-06 | 1.4786E-05 | 2.12918E-05 | 2.898E-05 | 3.7852E-05 | 4.7906E-05 | 5.9144E-05 |
| 35.0 | 12784 | 1.26737E-07 | 5.0695E-07 | 2.0278E-06 | 4.5625E-06 | 8.1111E-06 | 1.2674E-05 | 1.82501E-05 | 2.484E-05 | 3.2445E-05 | 4.1063E-05 | 5.0695E-05 |
| 40.0 | 14610 | 1.10895E-07 | 4.4358E-07 | 1.7743E-06 | 3.9922E-06 | 7.0973E-06 | 1.1089E-05 | 1.59688E-05 | 2.1735E-05 | 2.8389E-05 | 3.593E-05 | 4.4358E-05 |




# Memorandum

**To:** Jim Totten, Assistant General Manager
Lost Pines Groundwater Conservation District

**From:** Andrew Donnelly

**Copy:** Robin Melvin

**Date:** October 21, 2014

**Subject:** Additional Modeling Results for XS Ranch Application

This memorandum is a supplement to a previous memorandum report dated April 29, 2014. The previous report was a complete review of the XS Ranch permit application. This supplemental report details the results of four new model runs completed using 2,000 acre-feet/year of pumping for one of the four wells included in the original application.

In the original application, a total of 6,000 acre-feet/year of production from the Simsboro Aquifer was requested from four wells. In this supplemental report, a total of 2,000 acre-feet/year of production from the Simsboro Aquifer was modeled from one well (XS Ranch Well No. 1, shown in Figure 1).

The XS Ranch pumpage was modeled using four different baseline pumpage data sets as follows:

- **1999 Pumpage**- This well file consists of the 1999 estimated historic pumpage repeated annually for each year of the predictive portion of the model runs for Bastrop and Lee counties.
- **2010 Pumpage**- This well file uses estimated historic pumpage for Bastrop and Lee counties for 2000 to 2010, and then repeats the 2010 estimated historic pumpage annually for the remainder of the predictive portion of the model run for Bastrop and Lee counties.
- **Estimated Demand-** This new "estimated demand" well file is identical to the one developed in May, 2013 except that the pumpage for permits approved immediately prior to the construction of this well file was removed, so the well file represents only the estimated future demand for the Simsboro Aquifer.
- **Estimated Demand Plus New Permits-** This well file is the combination of the "estimated demand" well file, described above, and all of the permits that have been approved since the District came out of the permitting moratorium in 2013. It should be noted that all new permits are included at their full permitted amounts. The new permits included in this well file include:
  - City of Bastrop- One Simsboro well at 1,613 acre-feet/year
  - Manville WSC- Two Simsboro wells at 1,613 acre-feet/year each
  - Heart of Texas- Two Simsboro wells at 1,680 acre-feet/year each
  - LCRA- Five Simsboro wells at 1,000 acre-feet/year each
  - Forestar- Ten Simsboro wells at 1,200 acre-feet/year each
  - Griffin Industries- One Simsboro well at 224 acre-feet/year

The newly approved Lee County WSC Carrizo well is not included in the well file because this well was approved with zero additional permitted production.

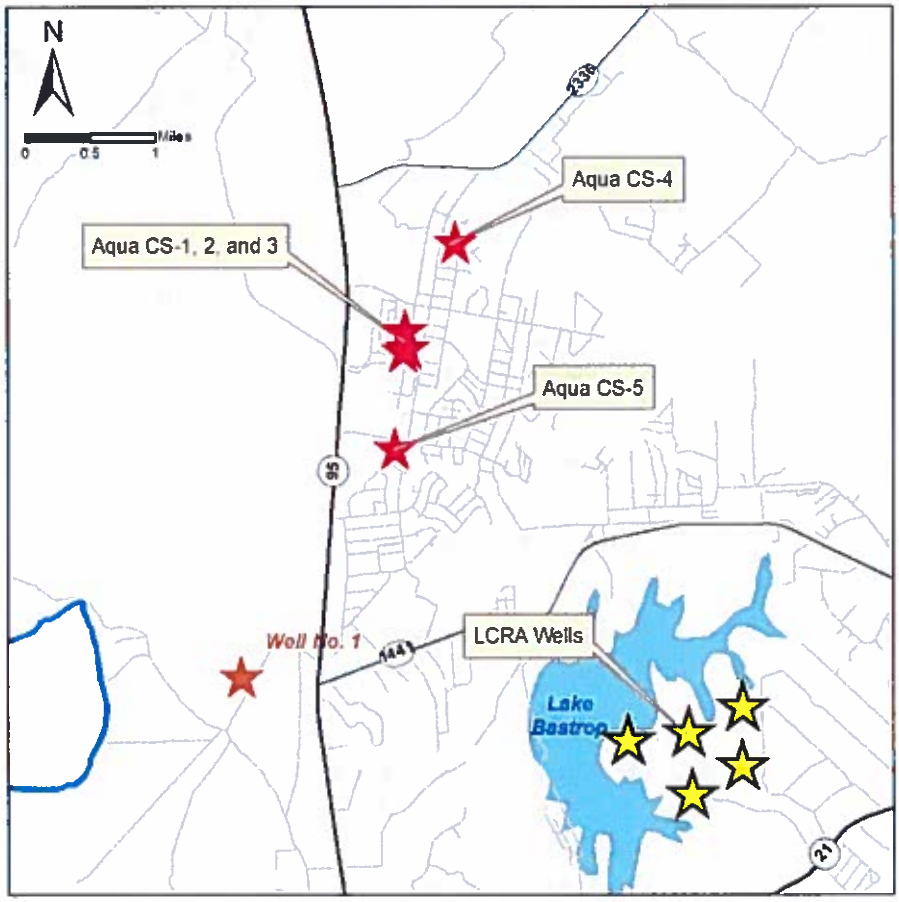



*Figure 1. Location of proposed XS Ranch Well No. 1*

The Central Queen City-Sparta Groundwater Availability Model (GAM) was run with a total pumpage of 2,000 acre-feet per year added to the cell where proposed Well No. 1 is located. The results of these runs are shown in Figure 2, which illustrates that at the end of 50 years of continuous pumping, the project-specific drawdown attributable to the proposed XS Ranch Well No. 1 (i.e., drawdown caused by the pumpage from the proposed well only) is over 20 feet at the proposed well location. The model run indicates that the Aqua Camp Swift wells may experience 9 to 12 feet of additional drawdown due to production from the proposed well, and the LCRA wells may experience 11 to 14 feet of additional drawdown.

It is important to note that these drawdown estimates are rough approximations obtained using the regional-scale GAM, which was developed to assess groundwater impacts on a regional basis and may not account for local hydrogeologic conditions. However, it is not unreasonable

to assume that the pumpage from the proposed XS Ranch well would result in approximately 10 feet of drawdown in both the Aqua Camp Swift and LCRA well fields.

The proposed production of 2,000 acre-feet per year by XS Ranch from a well in Bastrop County will impact water levels in the Simsboro Aquifer in the vicinity of the well. Drawdowns estimated using the GAM are summarized in Table 1. As indicated in the table, the drawdown estimated to occur due to the proposed well is approximately 3 feet across the entire District. A map of project-specific drawdown estimated using the GAM is shown in Figure 2. It should be noted that although four different baseline pumpage data sets were used, the project-specific drawdown is calculated by subtracting the drawdowns due to the baseline/background pumpage from the results. Therefore, the project-specific drawdowns for all four model runs are virtually identical.

**Table 1. Projected drawdown in 2060 due to pumpage from the proposed XS Ranch Well No. 1**

| Pumpage | Drawdown (feet) | | |
|---|---|---|---|
| | Bastrop County | Lee County | Lost Pines District Total |
| XS Ranch Well No. 1 only (2,000 acre-feet/year)- Project-specific drawdowns | 4 | 1 | 3 |
| XS Ranch Well No. 1 only (2,000 acre-feet/year) using 1999 pumpage as a baseline | 82 | 257 | 164 |
| XS Ranch Well No. 1 only (2,000 acre-feet/year) using 2010 pumpage as a baseline | 101 | 270 | 180 |
| XS Ranch Well No. 1 only (2,000 acre-feet/year) using estimated future demand as a baseline | 127 | 283 | 200 |
| XS Ranch Well No. 1 only (2,000 acre-feet/year) using estimated future demand plus new permits as a baseline | 165 | 360 | 257 |

## Summary

The proposed Well No. 1 producing 2,000 acre-feet per year from the Simsboro Aquifer in Bastrop County was modeled using four different baseline pumpage well files. Project-specific drawdowns were virtually identical for all four model runs, and indicate that the proposed well will cause District-wide drawdown in the Simsboro Aquifer of approximately 3 feet. Total 50-year drawdowns for the proposed well and the various amounts of assumed baseline pumping range from 164 to 257 feet.

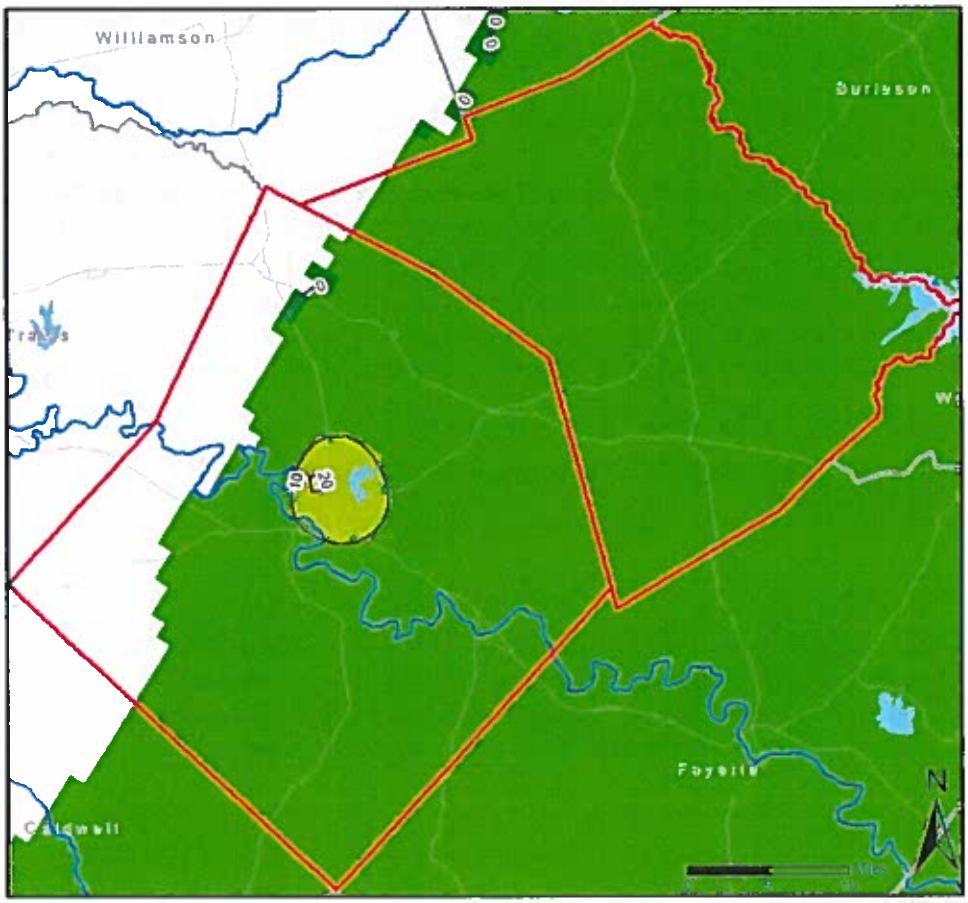



*Figure 2. Project-specific 50-year drawdown (in feet) in the Simsboro Aquifer attributable to 2,000 acre-feet per year of production from the proposed XS Ranch well*

# Memorandum

**To:** Jim Totten, General Manager
Lost Pines Groundwater Conservation District

**Copy:** Robin Melvin, David Lein, Matt Kutac

**From:** Andrew Donnelly

**Date:** March 17, 2015

**Subject:** Wells on the McCall Ranch property

At the request of the District, I attempted to determine if any of the wells located on the McCall Ranch property in Bastrop County were producing from the Simsboro Aquifer. The McCall Ranch is located northwest of the City of Bastrop along the Colorado River, as shown in Figure 1. Also shown in Figure 1 is the outcrop of the Simsboro Aquifer. This figure indicates that the McCall Ranch is located across the outcrop of the Simsboro.

Well locations and completion data were obtained from both the Lost Pines Groundwater Conservation District (LPGCD) well database and the Texas Water Development Board (TWDB) groundwater database. A total of seven wells were found in these two databases that appeared to be on ranch property, and the locations of these wells, based on coordinates included in the two databases, are shown in Figure 2. Details on each of these wells are given below.

- Well 58-54-714- This well is from the LPGCD database. It is 540 feet deep, was drilled in 2003, and is listed as being owned by Jo Goertz. No aquifer code is assigned to this well, and no information on the screened intervals is available. The total depth of this well would appear to be too great to be a Simsboro well. However, without well screen information and a drillers log we cannot eliminate the possibility that it is a Simsboro well.
- Well 58-54-715- This well is from the LPGCD database. It is 550 feet deep, was drilled in 2003, and is listed as being owned by Mike Goertz. No aquifer code is assigned to this well, and no information on the screened intervals is available. The total depth of this well would appear to be too great to be a Simsboro well. However, without well screen information and a drillers log we cannot eliminate the possibility that it is a Simsboro well.
- Well 58-54-717- This well is from the LPGCD database. The depth and year of installation are unknown, but it is listed as being owned by Michael Goertz. No aquifer code is assigned to this well, and no information on the screened intervals is available. Without any information it is impossible to speculate on which aquifer this well produces from.
- Well 58-63-712- This well is from the LPGCD database. However, the grid number, address, and listed well owner all indicate that this well is not on the McCall Ranch. Therefore, we feel that the coordinates for this well in the LPGCD database are erroneous and it is not actually located where it is shown in Figure 2.

- Well 58-54-705- This well is from the TWDB groundwater database. This well is 170 feet deep, was drilled in 1967, and is listed as being owned by C.D. McCall. It is listed in the TWDB database as being producing from the Simsboro Aquifer. The depth and location are appropriate for this well to be producing from the Simsboro. However, this well is not registered with the District.
- Well 58-54-706- This well is from the TWDB groundwater database. This well is 440 feet deep, was drilled in 1967, and is listed as being owned by C.D. McCall. It is listed in the TWDB database as being producing from the Hooper Aquifer. The depth and location appear to be too deep to be producing from the Simsboro, but without screen information and a driller's log, we cannot determine if this well is actually a Hooper well. However, this well is not registered with the District.
- Well 58-54-402- This well is from the TWDB groundwater database. This well is 105 feet deep, was drilled in 1970, and is listed as being owned by C.D. McCall. It is listed in the TWDB database as being producing from the Simsboro Aquifer. The depth and location are appropriate for this well to be producing from the Simsboro. However, this well is not registered with the District.

In addition, one well believed to be located on the McCall Ranch is not shown in Figure 1 because the coordinates listed for it put its location just north of Smithville. However, the well number is in the same grid as the other McCall Ranch wells, and the address and well owner are also the same as the other McCall Ranch wells. Therefore, we believe this is a McCall Ranch well but has erroneous coordinates in the LPGCD database, and therefore we do not know its exact location. Details on this well are given below.

- Well 58-54-716- This well is from the LPGCD database. It is 340 feet deep, was drilled in 2003, and is listed as being owned by Mike Goertz. No aquifer code is assigned to this well, and no information on the screened intervals is available. The total depth of this well would appear to be appropriate for a Simsboro well in the McCall Ranch area. However, without a correct location, well screen information, and a drillers log we cannot positively determine if it is a Simsboro well.

## Summary

Seven wells were found in the LPGCD and TWDB databases that appear to be located on the McCall Ranch. None of the four wells from the LPGCD database contained an aquifer designation. Of these, two appeared to be too deep to be Simsboro wells, but without well screen information and driller's logs, the actual producing aquifer cannot be determined. One well had a total depth that appeared to be appropriate for a Simsboro well, but the exact well location is unknown, and therefore we cannot determine whether or not this is a Simsboro well. The fourth well from the LPGCD database has no information on depth or well screen, and therefore nothing can be determined about this well.

Two of the three wells from the TWDB database are listed as Simsboro wells, and the third is listed as a Hooper well. Well depths listed for these appear to be appropriate for these aquifer designations. However, these wells are not registered with the District and are all over 40 years old, and therefore we are unsure if they still exist or not.

Based on the location of the McCall Ranch across the outcrop of the Simsboro, the information we have from the LPGCD and TWDB databases on wells located on the ranch, and the highly productive nature of the Simsboro Aquifer in this area, we feel it is highly likely that at least one well currently on the McCall Ranch is producing from the Simsboro Aquifer.

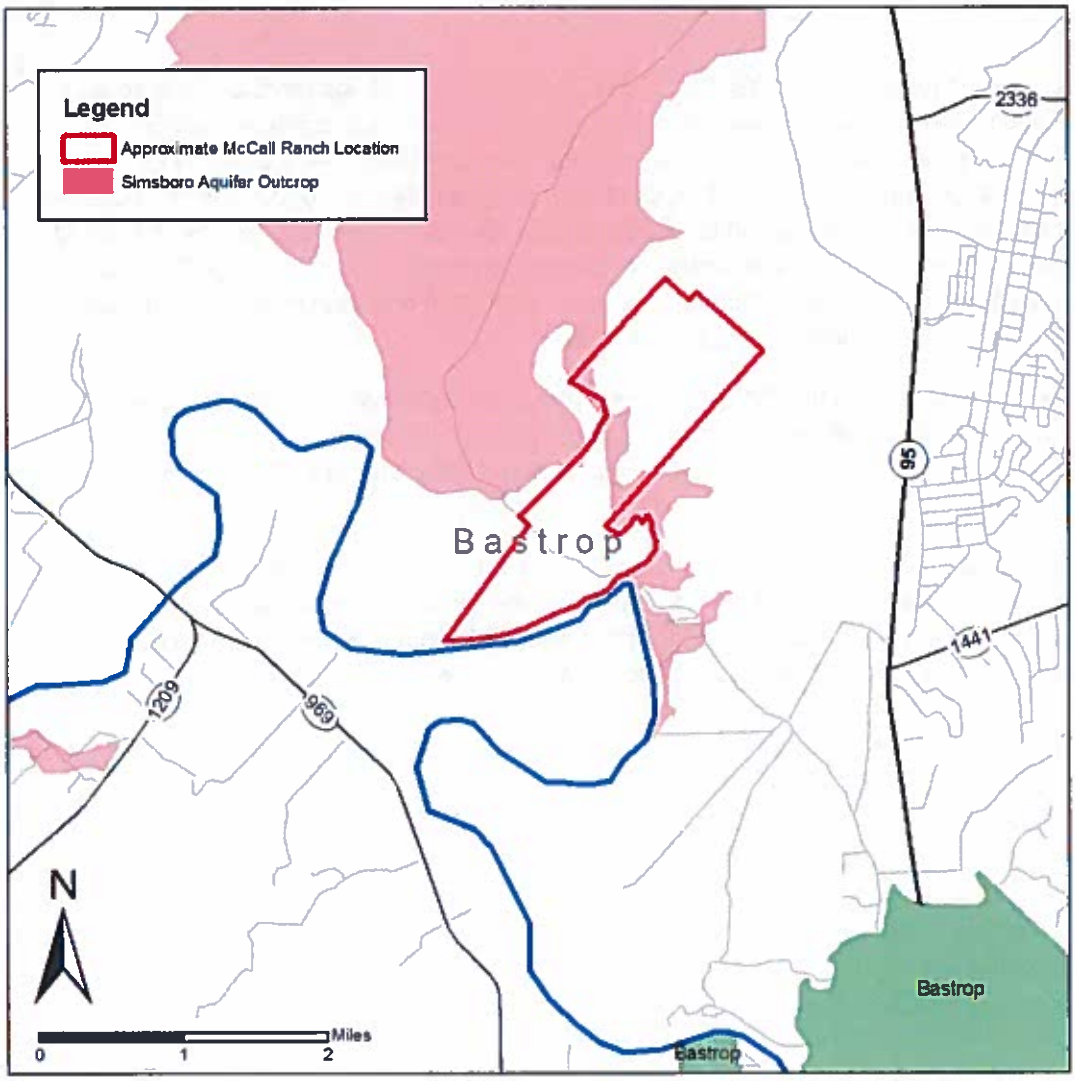



Figure 1. Approximate location of the McCall Ranch

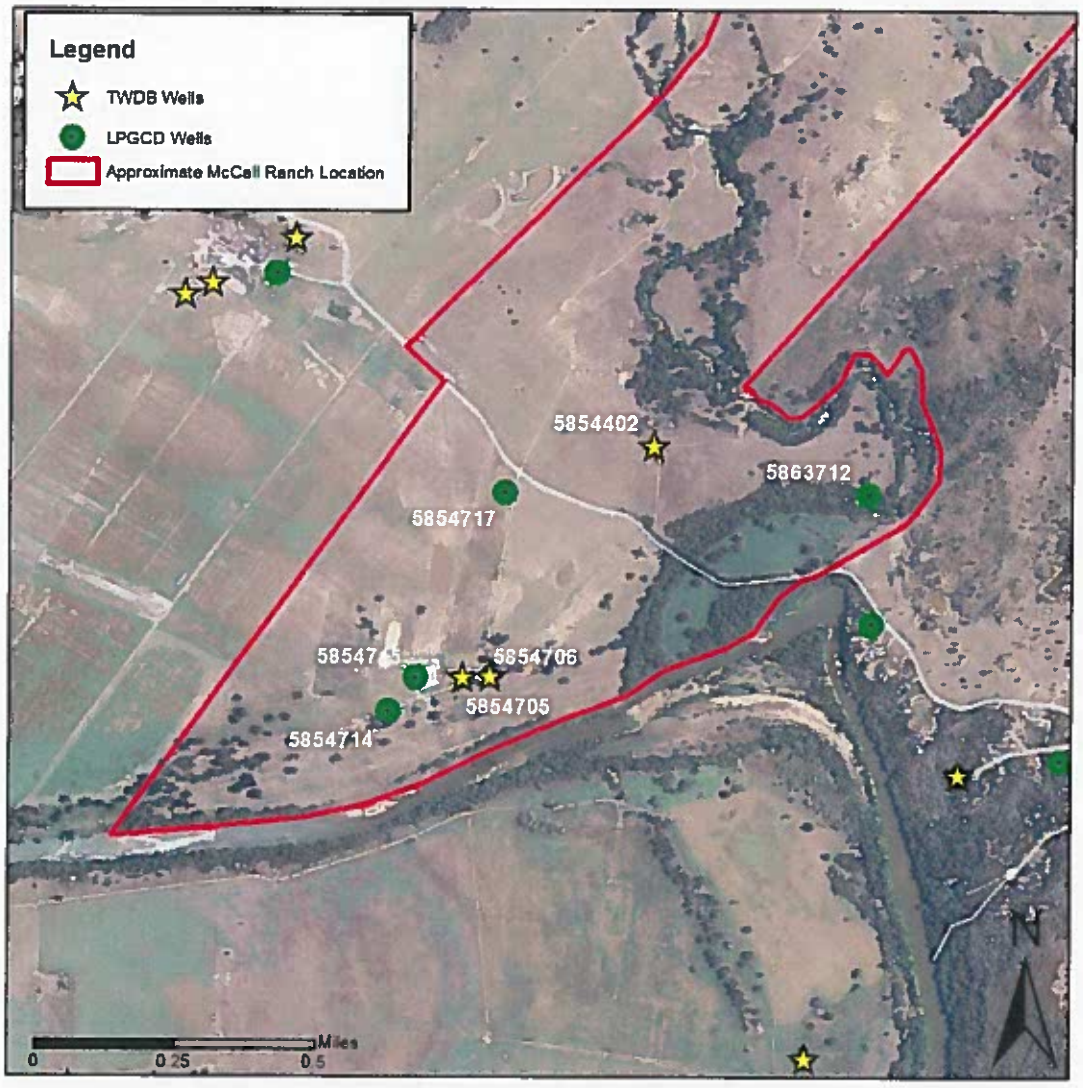
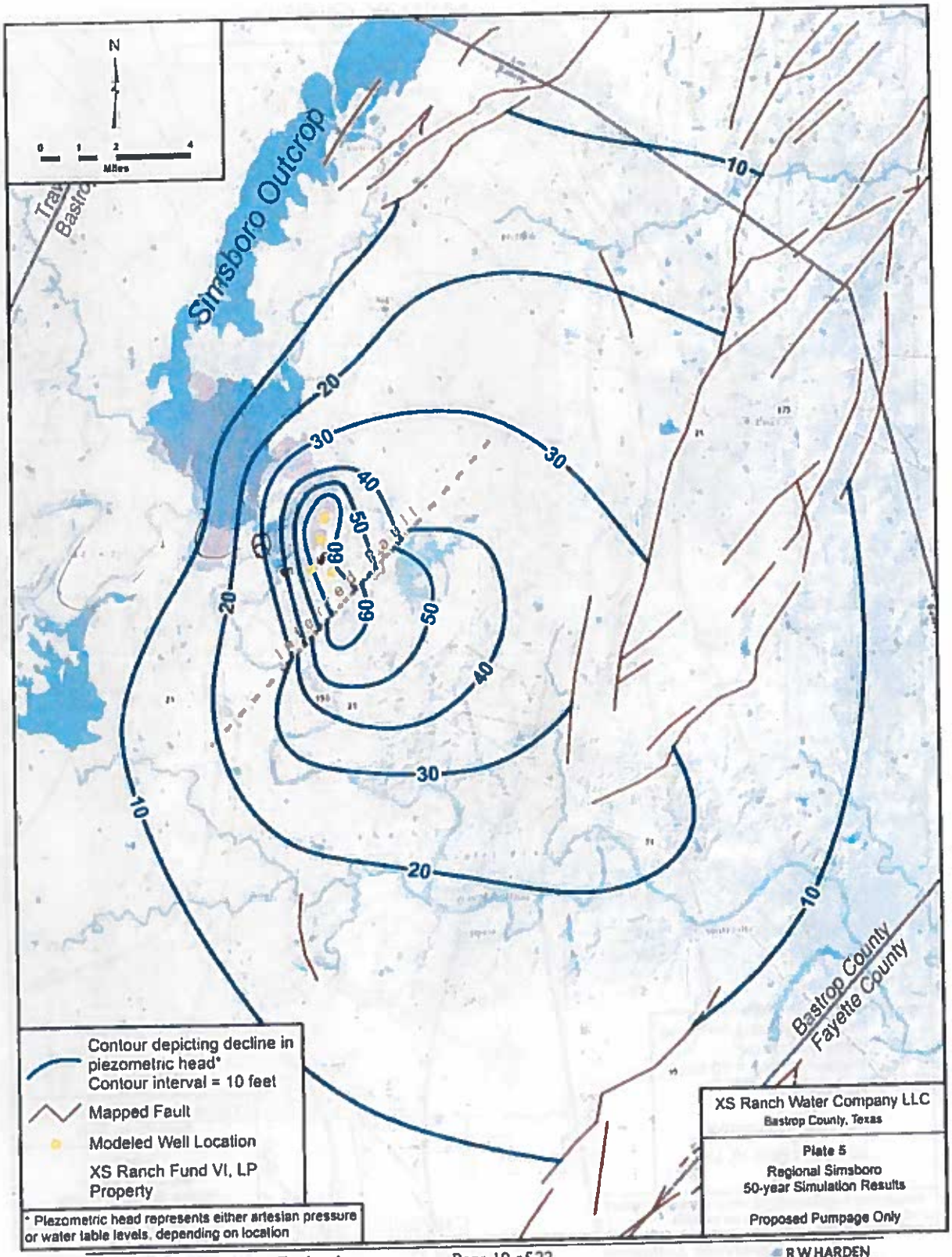
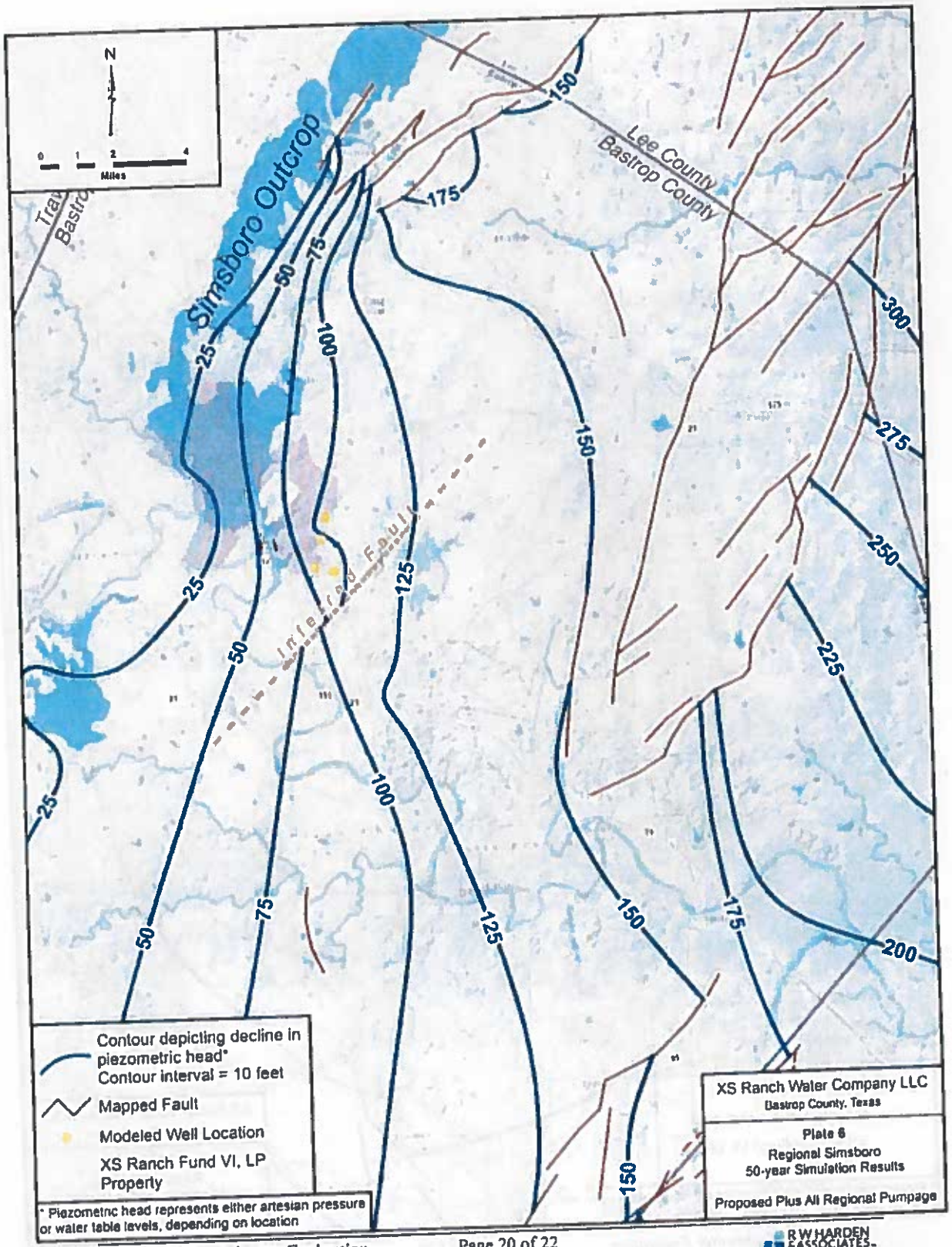


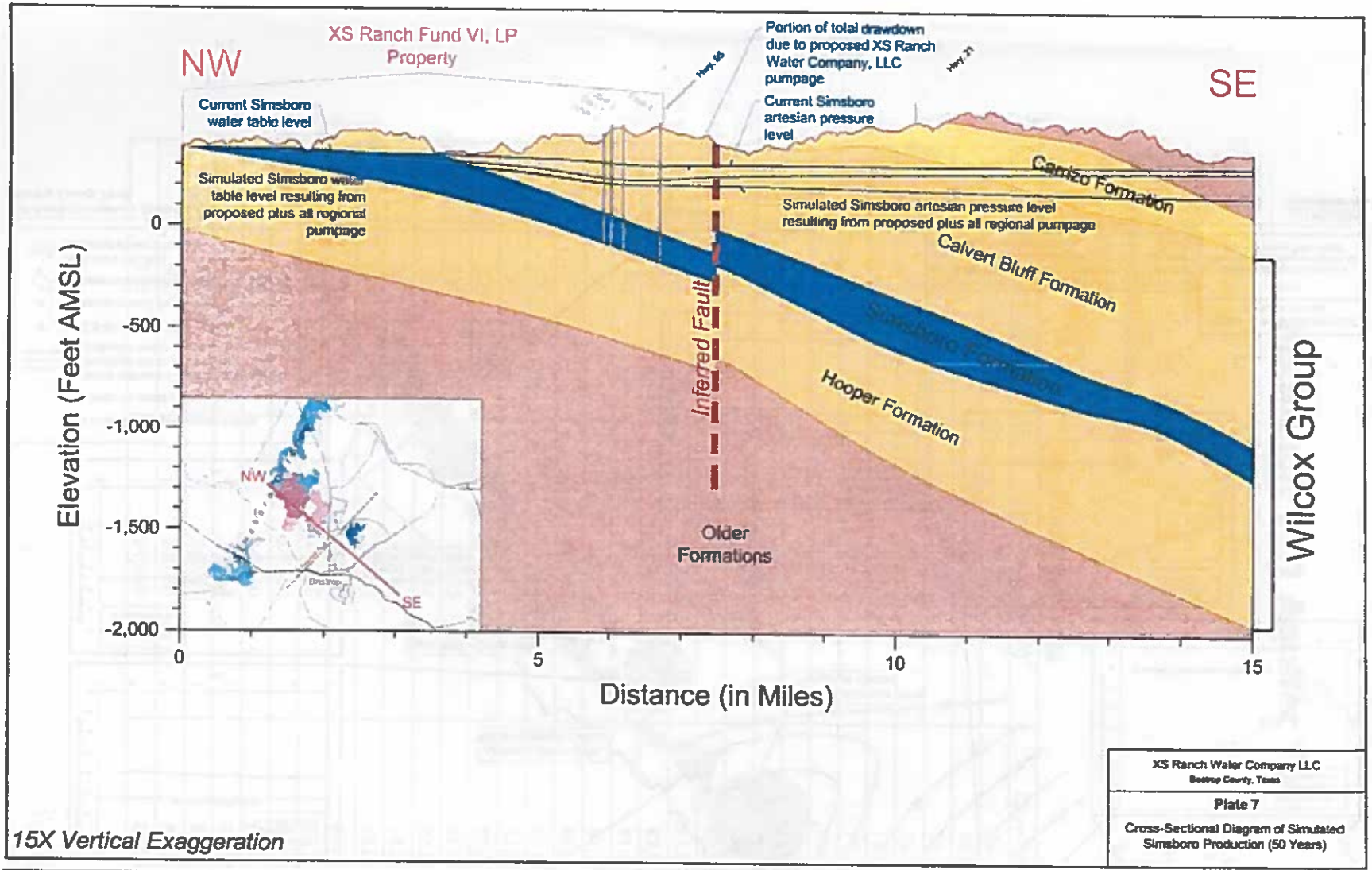

Figure 2. Location of wells found in the LPGCD and TWDB databases on the McCall Ranch.



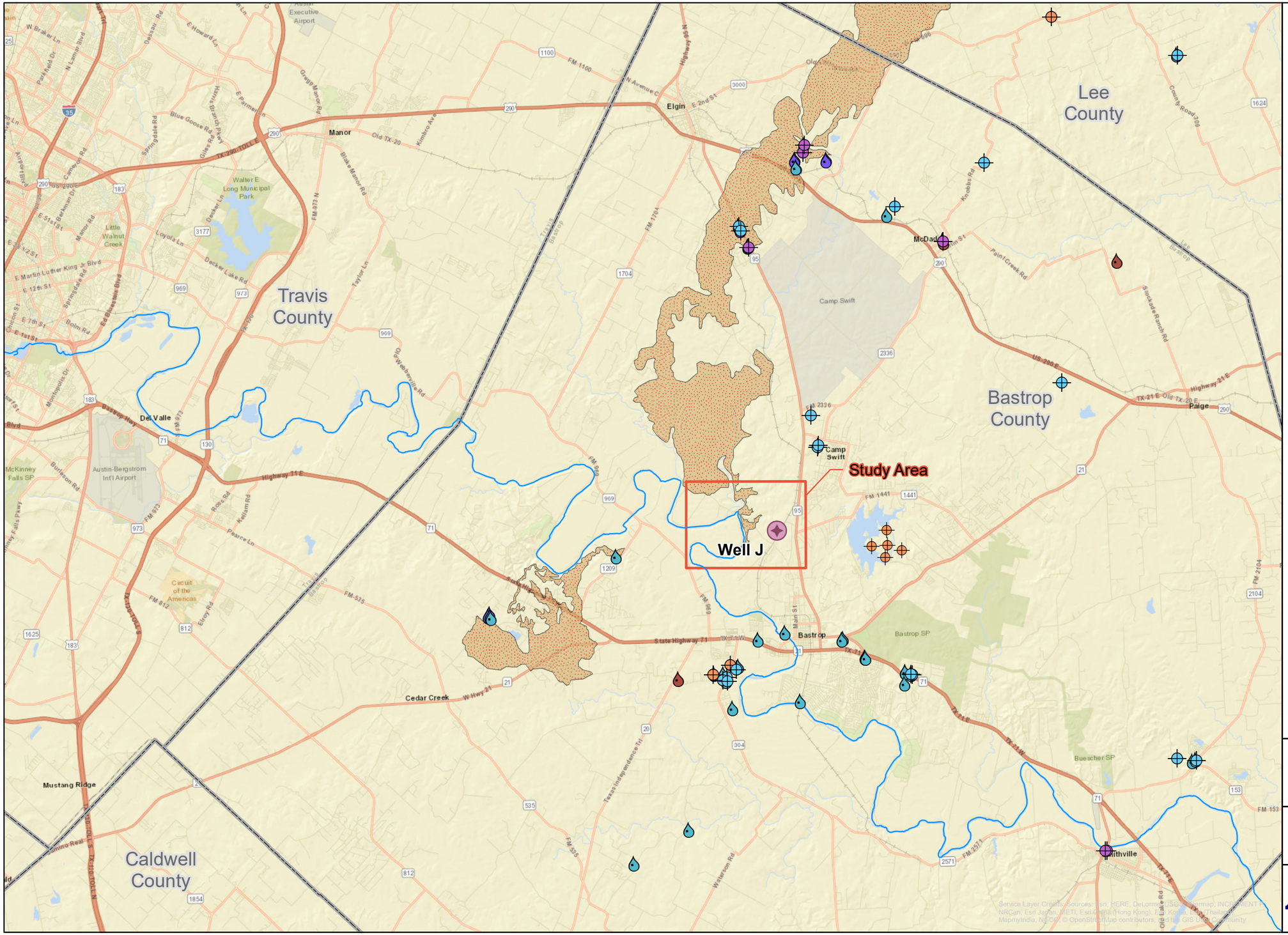





LPGCD 000040



# Attachment 1 – Report Figures and Tables




## Explanation

City of Bastrop Well J

**LPGCD Permitted Wells**

**Reported Aquifer**

- Simsboro Formation
- Wilcox Group
- Carrizo Sands & Wilcox Group

**Public Water Supply Wells**

**Reported Aquifer**

- Hooper Formation
- Calvert Bluff Formation
- Wilcox Group

N

0 3 6

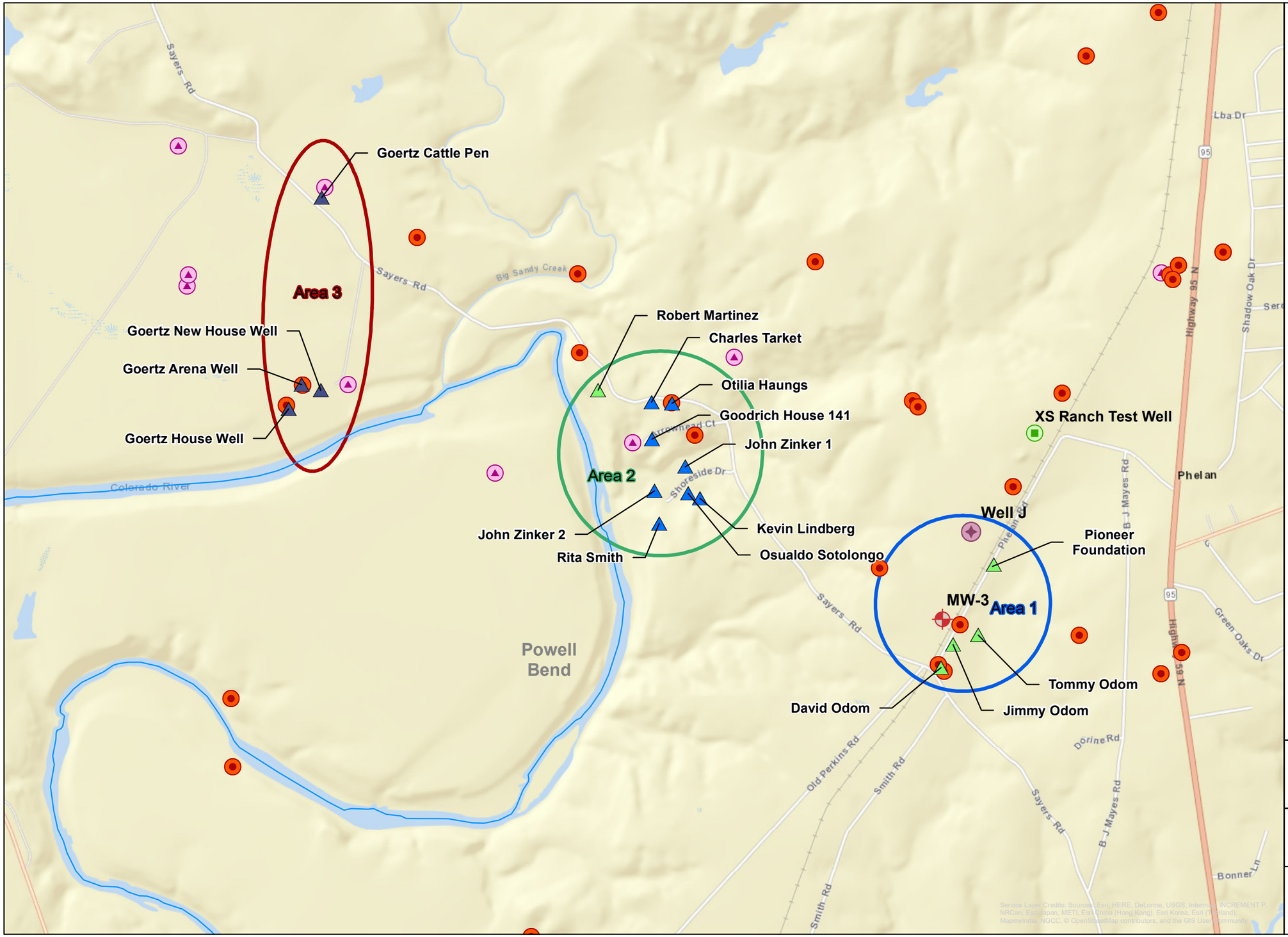
Miles

# City of Bastrop

Figure 1. Study Location Map

THORNHILL GROUP, INC.

Professional Hydrogeologists - Water Resources Specialists




# Explanation

**City of Bastrop**

- Well J
- MW-3

**Monitoring Wells**

**Producing Formation**

- Calvert Bluff
- Simsboro
- Hooper
- LPGCD Registered Wells
- Submitted Driller's Report-Plugged Well
- BRACS DB Well

N

0 1,500 3,000

Feet

# City of Bastrop

Figure 2. Study Area Map

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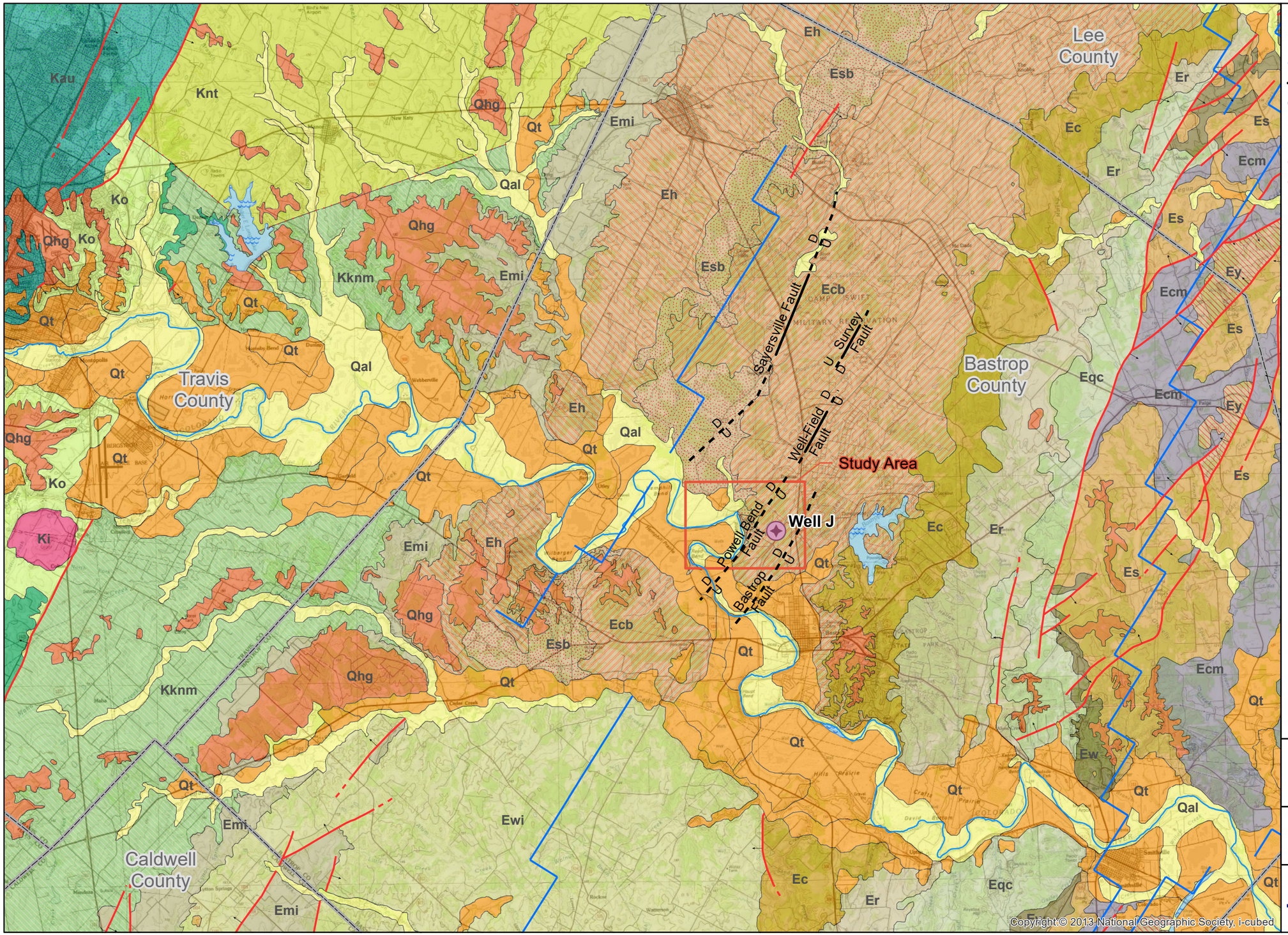


## Explanation

- City of Bastrop Well J
- QCSP GAM Modeled Fault
- USGS Rpt 84-4333 Fault
- USGS Rpt 84-4333 Inferred Fault

GAT Mapped Fault

- Concealed Normal
- Inferred Normal
- Normal

Geology

- Qal Alluvium
- Qt Terrace Deposits
- Qle Leona Formation
- Qhg High Gravel Deposits
- Ey Yegua Formation
- Ecm Cook Mountain Formation
- Es Sparta Sand
- Ew Weches Formation
- Eqc Queen City Sand
- Er Recklaw Formation
- Ec Carrizo Sand
- Ewi Wilcox Group Undivided
- Ecb Calvert Bluff Formation
- Esb Simsboro Formation
- Eh Hooper Formation
- Emi Midway Group
- Ki Cretaceous Rocks
- Knt Navarro & Taylor Groups
- Kknm Navarro Group & Marlbrook Marl
- Kpg Pecan Gap Chalk
- Ko Ozan Formation
- Kau Austin Chalk
- Wa Water

N

0 3 6

Miles

# City of Bastrop

Figure 3. Regional Surface Geology

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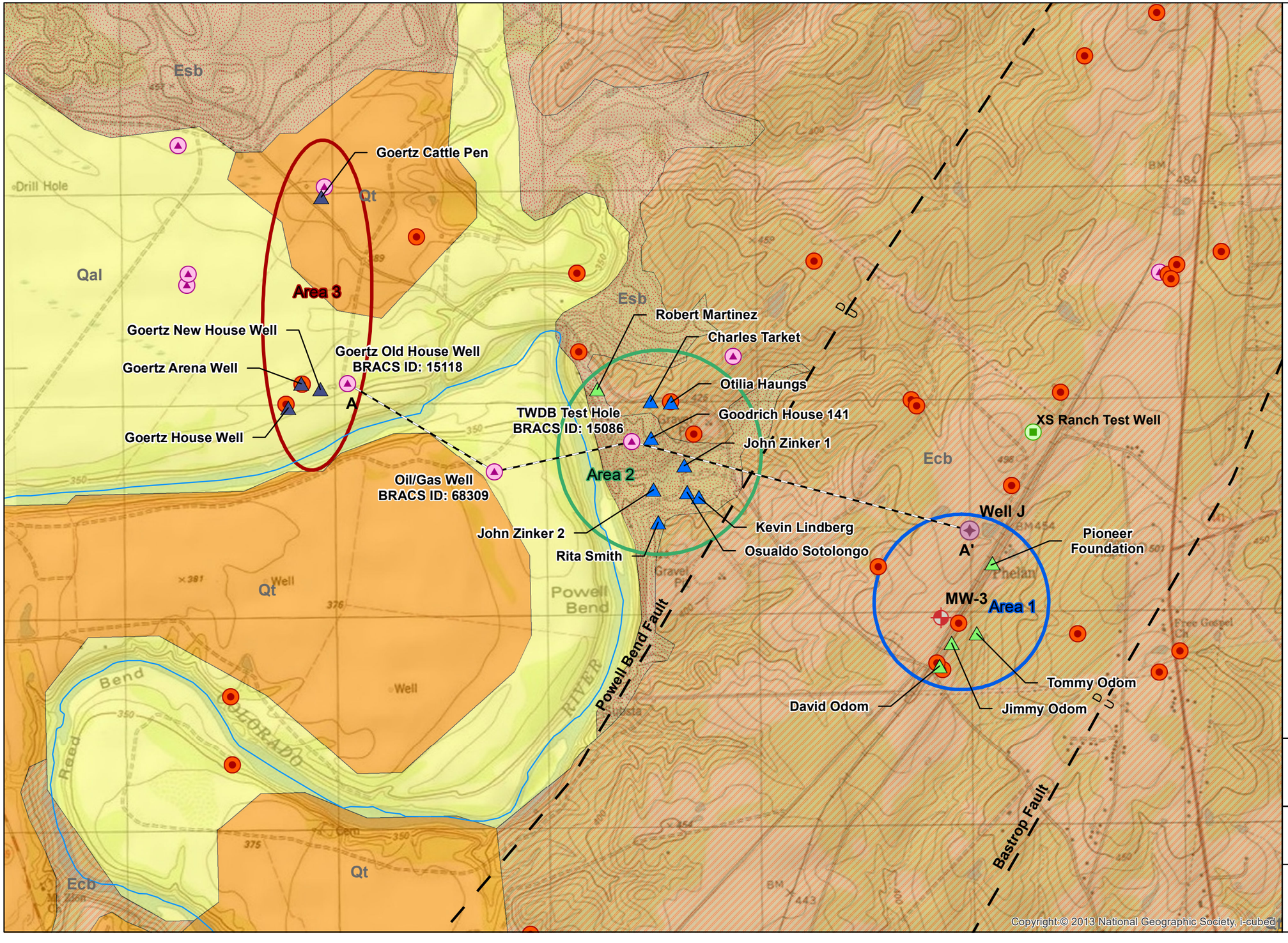


# Explanation

**City of Bastrop**

- Well J
- MW-3

**Monitoring Wells**

**Producing Formation**

- Calvert Bluff
- Simsboro
- Hooper
- LPGCD Registered Wells
- Submitted Driller's Report-Plugged Well
- BRACS DB Well
- Cross Section A-A'
- USGS Rpt 84-4333 Fault
- USGS Rpt 84-4333 Inferred Fault

**Geology**

- Qal Alluvium
- Qt Terrace Deposits
- Ecb Calvert Bluff Formation
- Esb Simsboro Formation

N

0 1,500 3,000

Feet

# City of Bastrop

Figure 4. Study Area Geology Map

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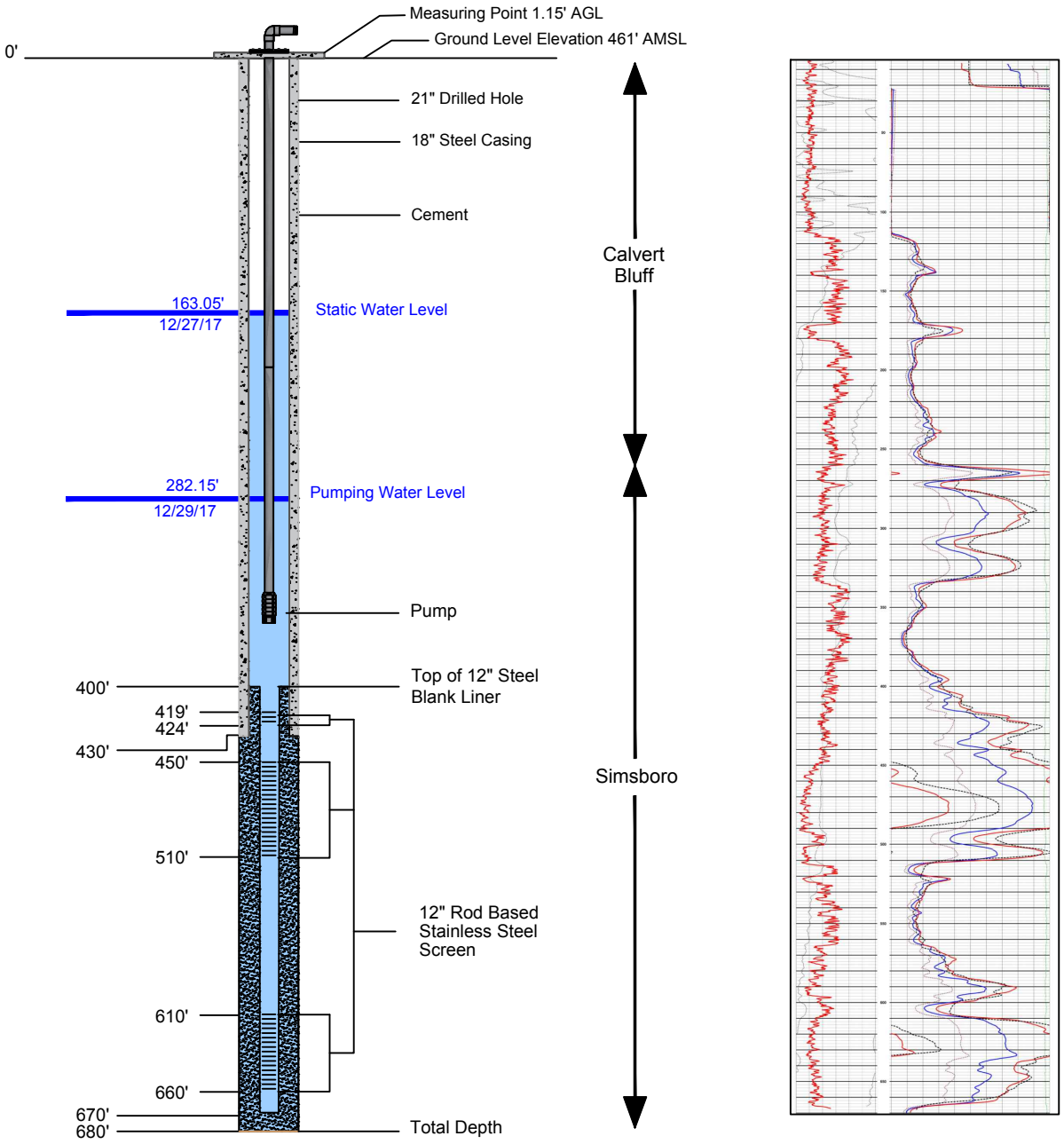
Figure 5. Hydrostratigraphic Section

| System | Series | Group | Formation | Abbreviation | Approximate Thickness | Geology | Hydrology |
|---|---|---|---|---|---|---|---|
| Quarternary | Holocene / Pleistocene | — | Alluvium and Terrace Deposits | Qal / Qt | 60 feet | Sand, gravel, silt and clay. Gravel more prominent in older terraces. | Yields small to moderate quantities of water to shallow wells. |
| Tertiary | Ecocene | Claiborne | Consists of seven distinct formations (from youngest to oldest): Yegua, Cook Mountain, Sparta, Weches, Queen City, Reklaw, and Carrizo. The formations formed as continental, marine, palustrine, and littoral facies. Formations are not encountered within study area. | | | | |
| | | Wilcox | Calvert Bluff | Ecb | 2,600 feet | Mudstone, silt, fine to medium grained sandstone, light gray to yellowish brown, lignite mostly in lower part. | Yields moderate to large quantities of typically good quality water. |
| | | | Simsboro | Esb | | Mostly sand, some clay and silt, light gray. | |
| | | | Hooper | Eh | | Mostly mudstone, medium to dark gray, some sandstone, minor lignite. | |

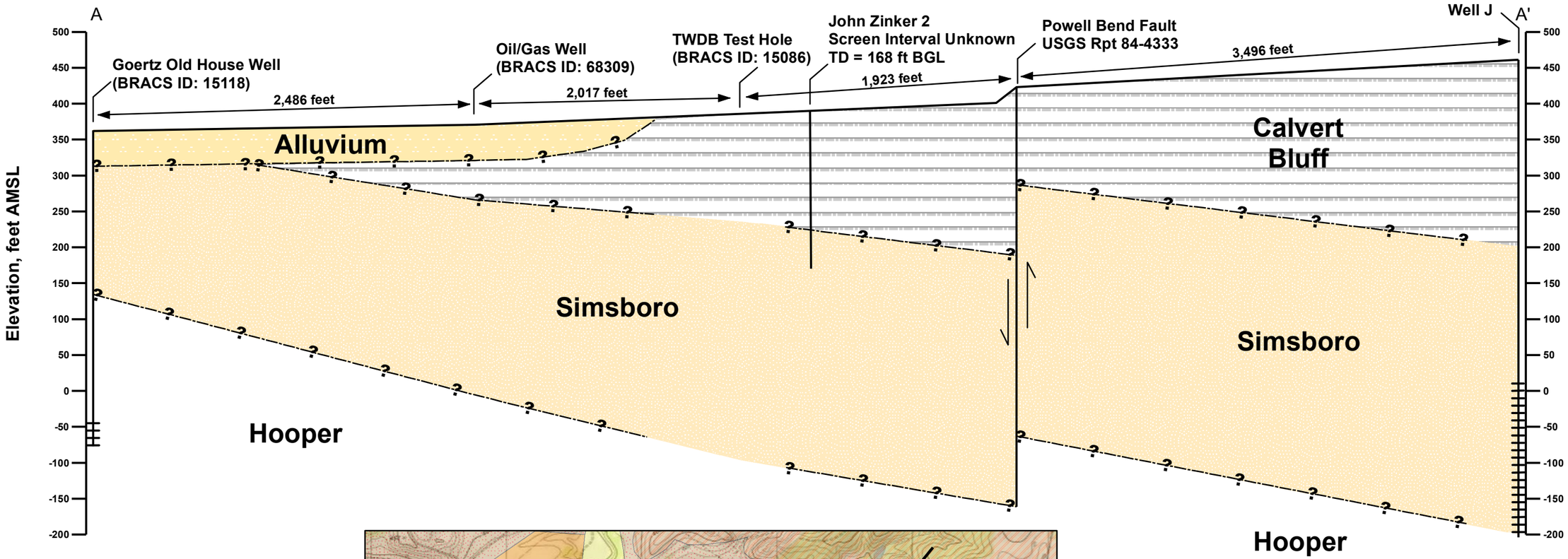
Modified from Follet 1970.

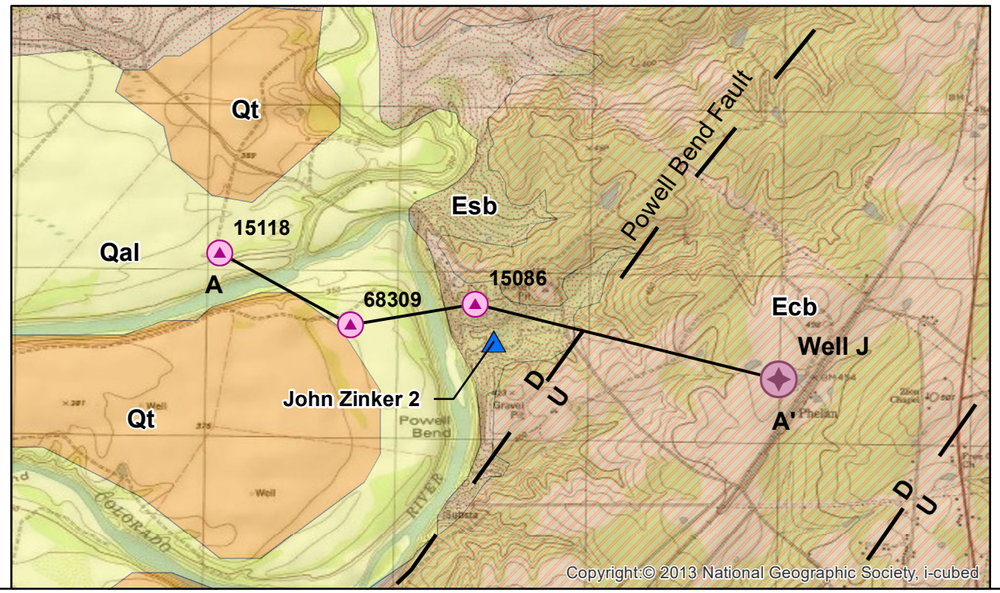
# Figure 6. City of Bastrop Well No. 1

## Well "J"



# Figure 7. Schematic Cross Section A – A'




* Vertical Exaggeration: 50x
Horizontal Exaggeration: 10x

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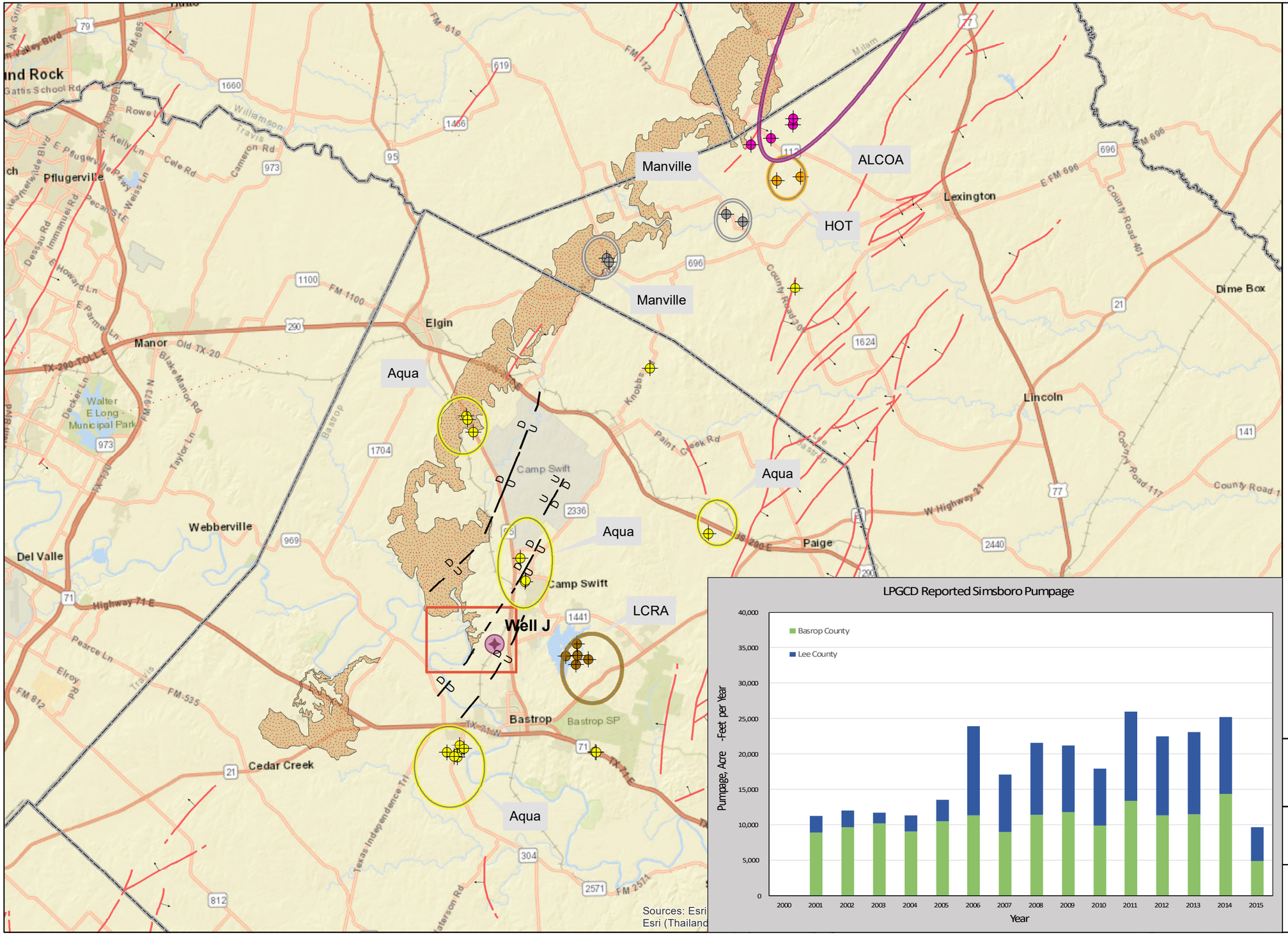





# Explanation

**City of Bastrop**

- Well J
- ALCOA
- Aqua WSC
- Manville WSC
- HOT
- LCRA Simsboro Wells
- USGS Rpt 84-4333 Fault
- USGS Rpt 84-4333 Inferred Fault

**GAT Mapped Fault**

- Concealed Normal
- Inferred Normal
- Normal
- Esb Simsboro Outcrop

N

0 4 8

Miles

# City of Bastrop

Figure 8. LPGCD Reported Pumpage

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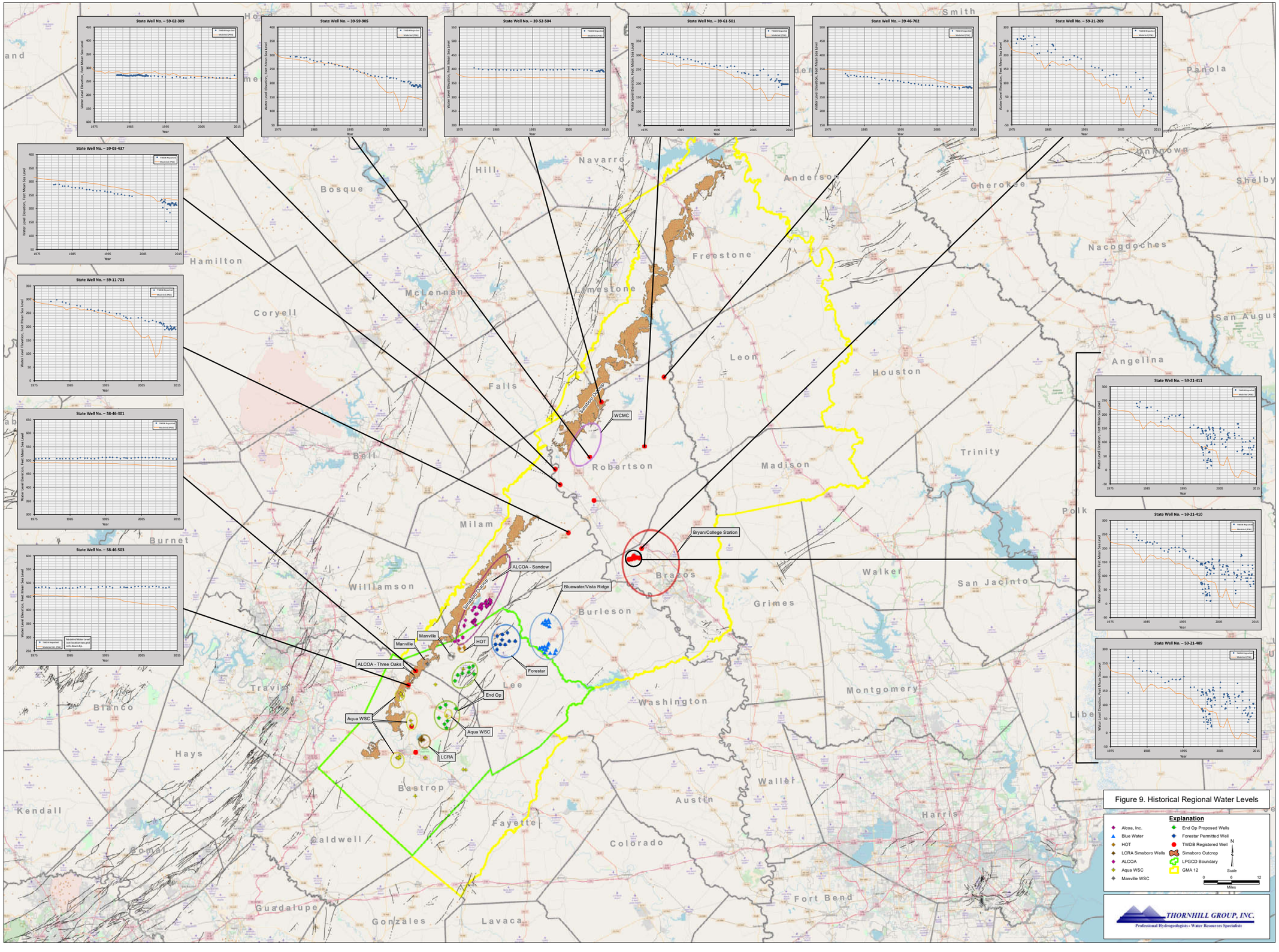
State Well No. – 59-02-309
State Well No. – 39-59-905
State Well No. – 39-52-504
State Well No. – 39-61-501
State Well No. – 39-46-702
State Well No. – 59-21-209
State Well No. – 59-03-437
State Well No. – 59-11-703
State Well No. – 58-46-301
State Well No. – 58-46-503
State Well No. – 59-21-411
State Well No. – 59-21-410
State Well No. – 59-21-409
TWDB Reported
Modeled (Pbs)
Water Level Elevation, Feet Mean Sea Level
Year
Simsboro Outcrop
WCMC
Bryan/College Station
ALCOA - Sandow
Bluewater/Vista Ridge
Manville
HOT
Forestar
ALCOA - Three Oaks
End Op
Aqua WSC
LCRA
Navarro
Hill
Bosque
Hamilton
McLennan
Coryell
Falls
Limestone
Freestone
Anderson
Cherokee
Nacogdoches
Angelina
Houston
Leon
Robertson
Madison
Trinity
Milam
Williamson
Burleson
Brazos
Grimes
Walker
San Jacinto
Polk
Montgomery
Washington
Lee
Travis
Blanco
Burnet
Bell
Hays
Bastrop
Caldwell
Fayette
Austin
Waller
Harris
Colorado
Fort Bend
Lavaca
Gonzales
Guadalupe
Comal
Kendall
Panola
Shelby
Smith
Unknown
Figure 9. Historical Regional Water Levels
Explanation
Alcoa, Inc.
Blue Water
HOT
LCRA Simsboro Wells
ALCOA
Aqua WSC
Manville WSC
End Op Proposed Wells
Forestar Permitted Well
TWDB Registered Well
Simsboro Outcrop
LPGCD Boundary
GMA 12
Scale
0
6
12
Miles
THORNHILL GROUP, INC.
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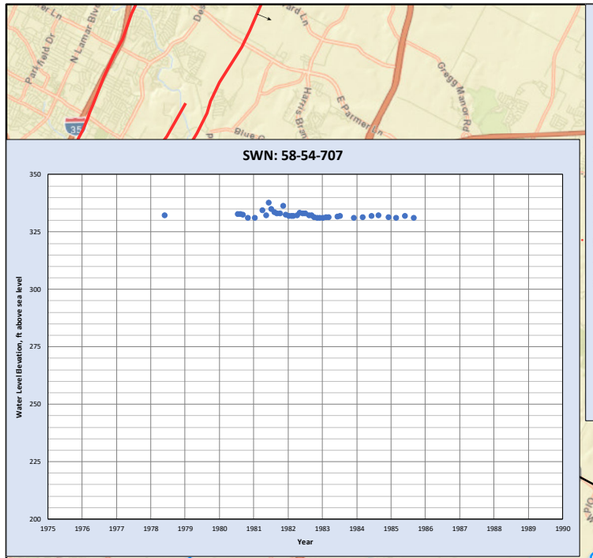


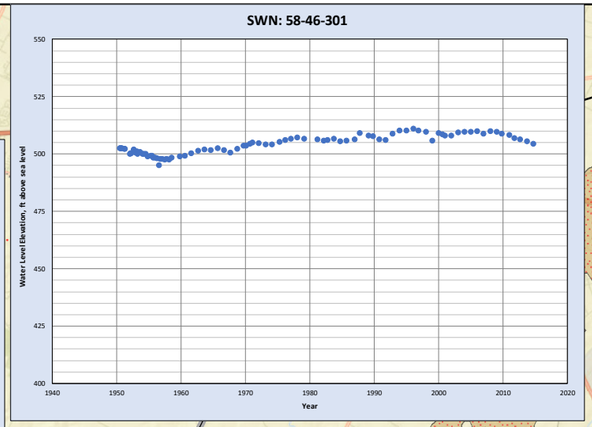


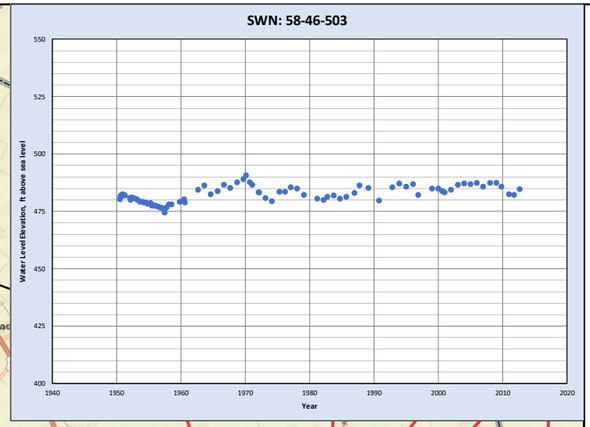


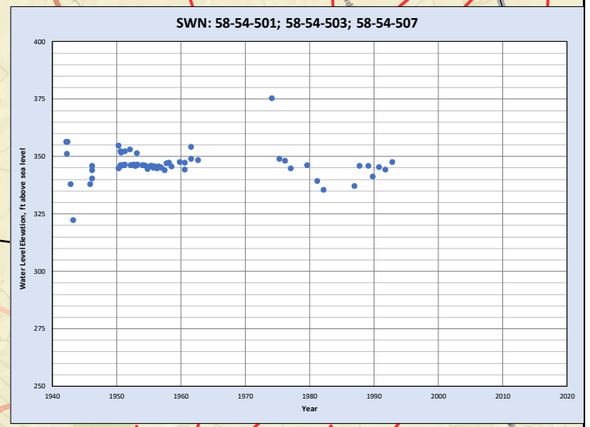


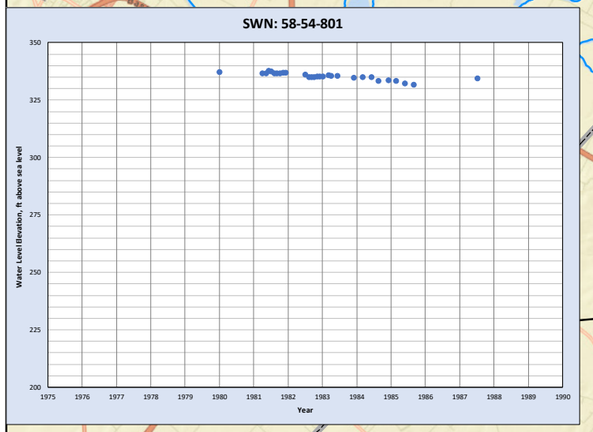


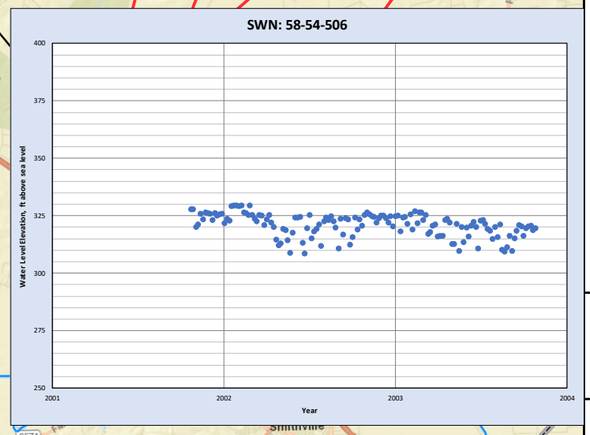


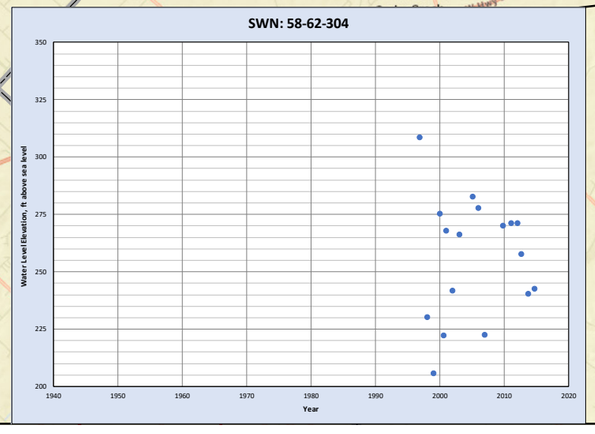


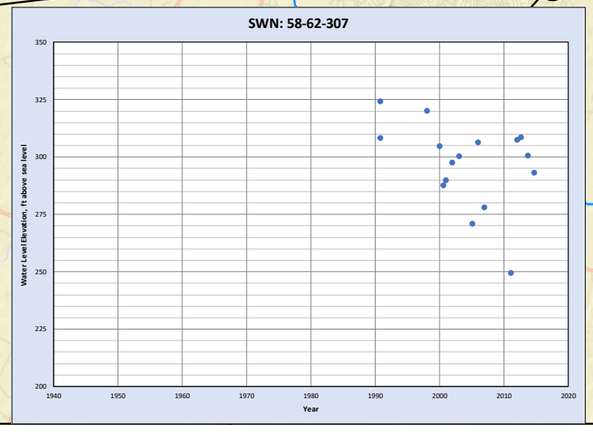





## Explanation

- City of Bastrop Well J
- TWDB Registered Well
- USGS Rpt 84-4333 Fault
- USGS Rpt 84-4333 Inferred Fault

GAT Mapped Fault

- Concealed Normal
- Inferred Normal
- Normal
- Esb Simsboro Outcrop

N

0 3 6

Miles

# City of Bastrop

Figure 10. Historical Local Water Levels

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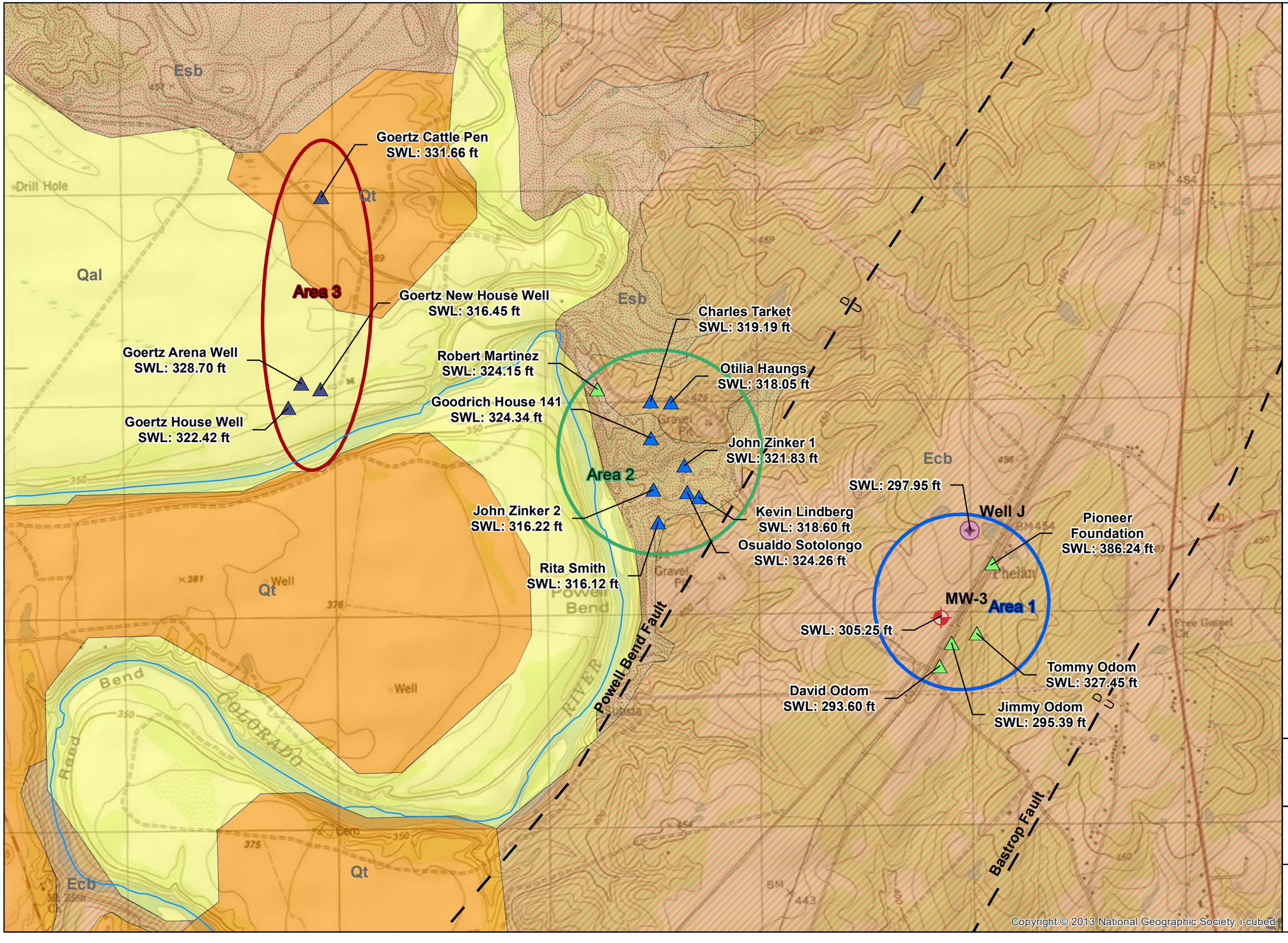


# Explanation

**City of Bastrop**

- Well J
- MW-3

**Monitoring Wells**

**Producing Formation**

- Calvert Bluff
- Simsboro
- Hooper

- USGS Rpt 84-4333 Fault
- USGS Rpt 84-4333 Inferred Fault

**Geology**

- Qal — Alluvium
- Qt — Terrace Deposits
- Ecb — Calvert Bluff Formation
- Esb — Simsboro Formation

Static water levels (SWL) are feet above mean sea level and represent the last recorded water level measured prior to the start of the 36-hour pumping test conducted at Well J starting on December 27, 2017.

N

0 1,500 3,000

Feet

# City of Bastrop

Figure 11. Static Water Level Elevation

THORNHILL GROUP, INC.

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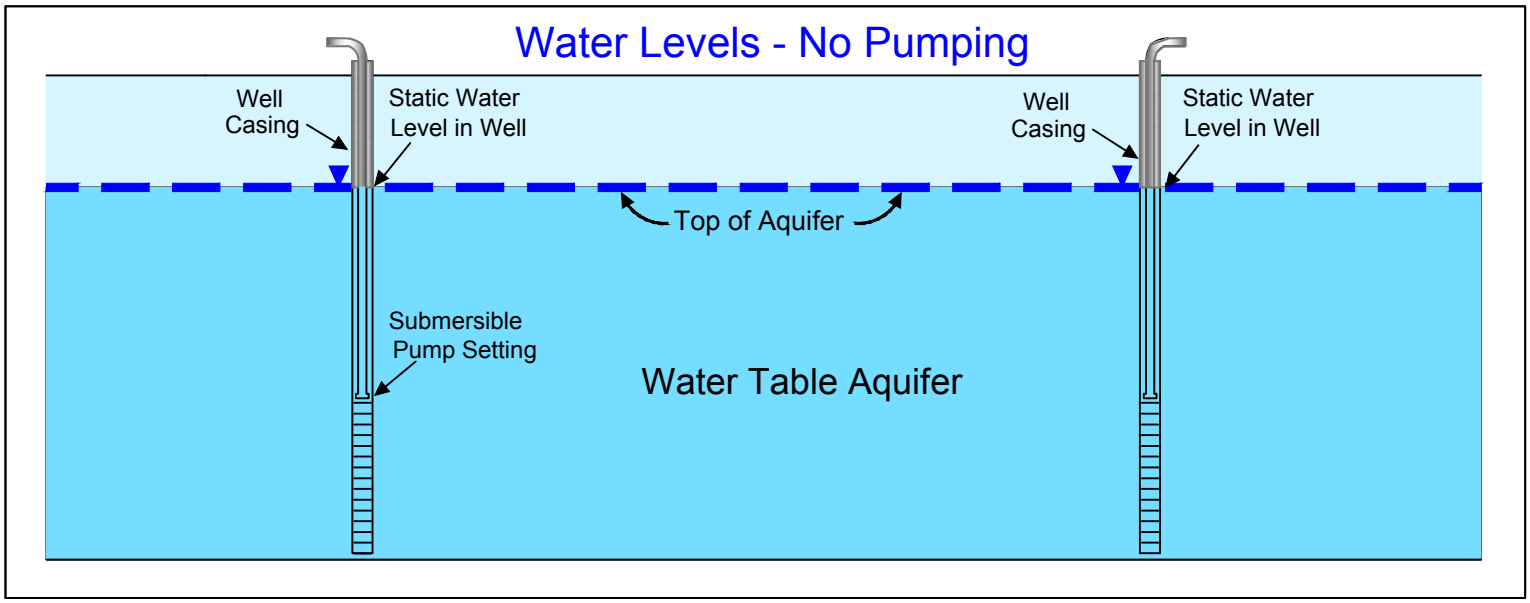
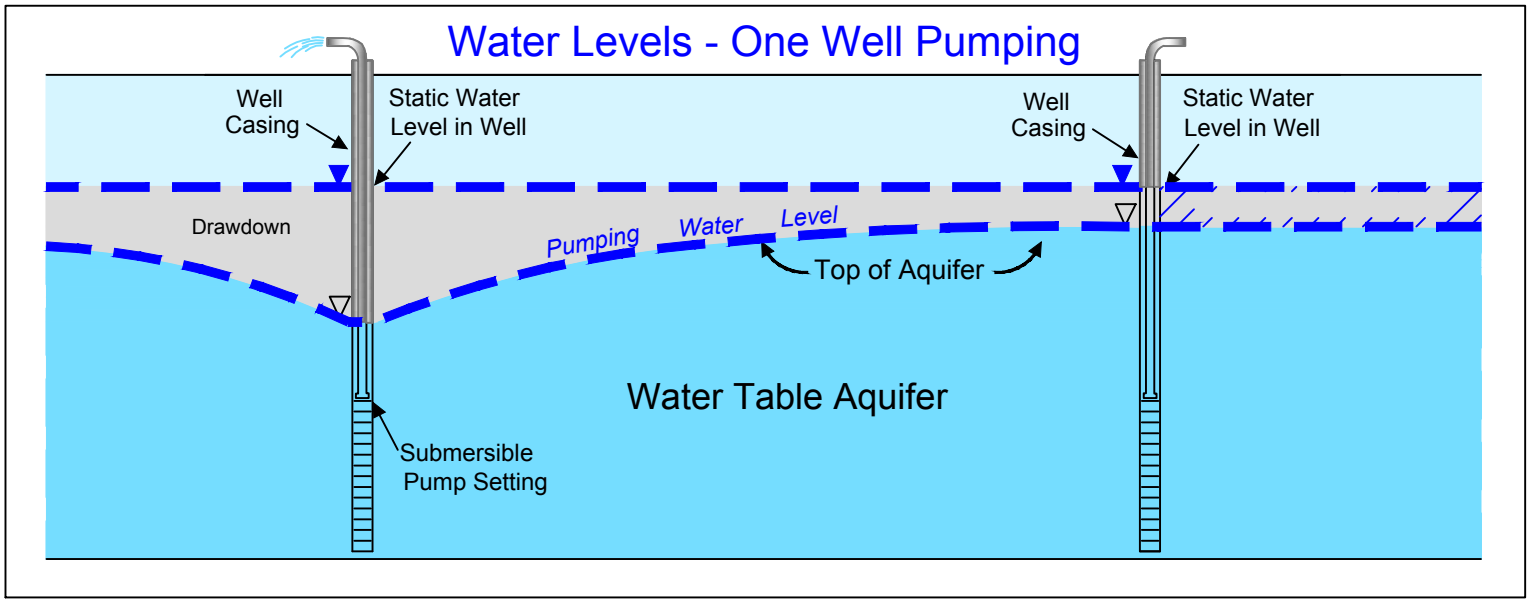
**Figure 12. Schematic Interference Drawdown - Water Table Aquifer**
**Distance Between Wells, Hundreds of Feet**



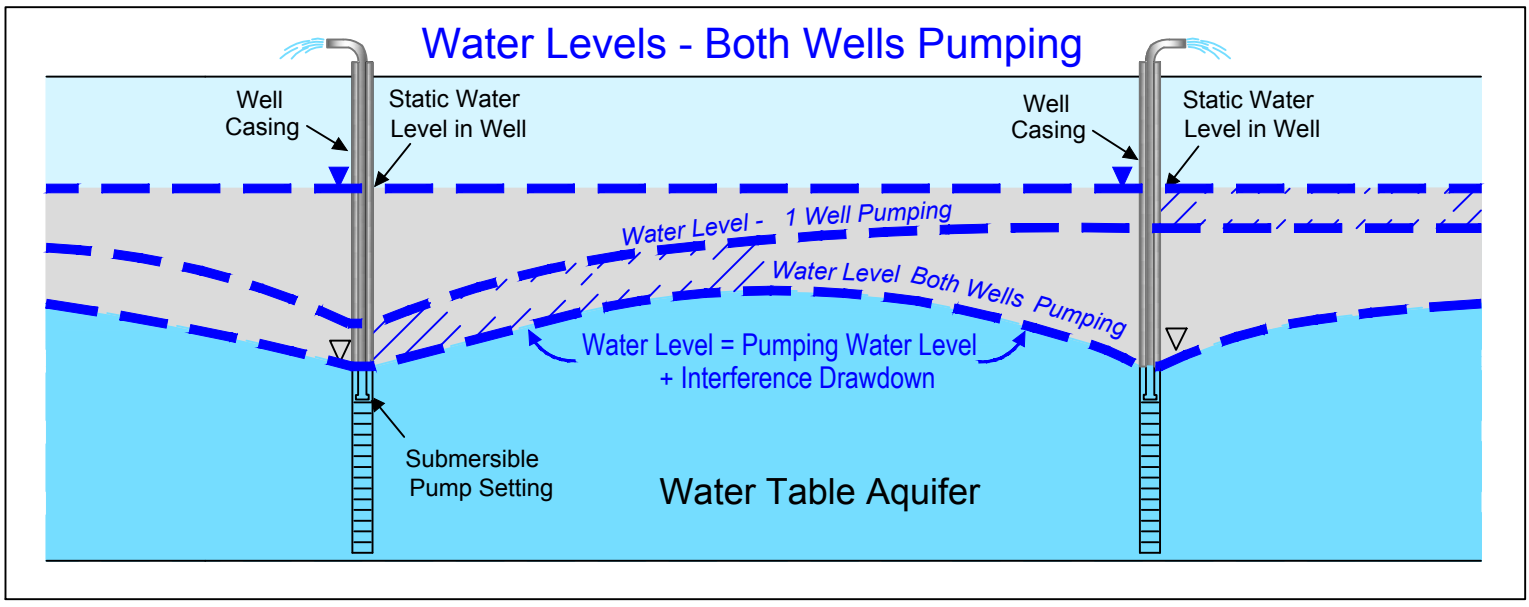
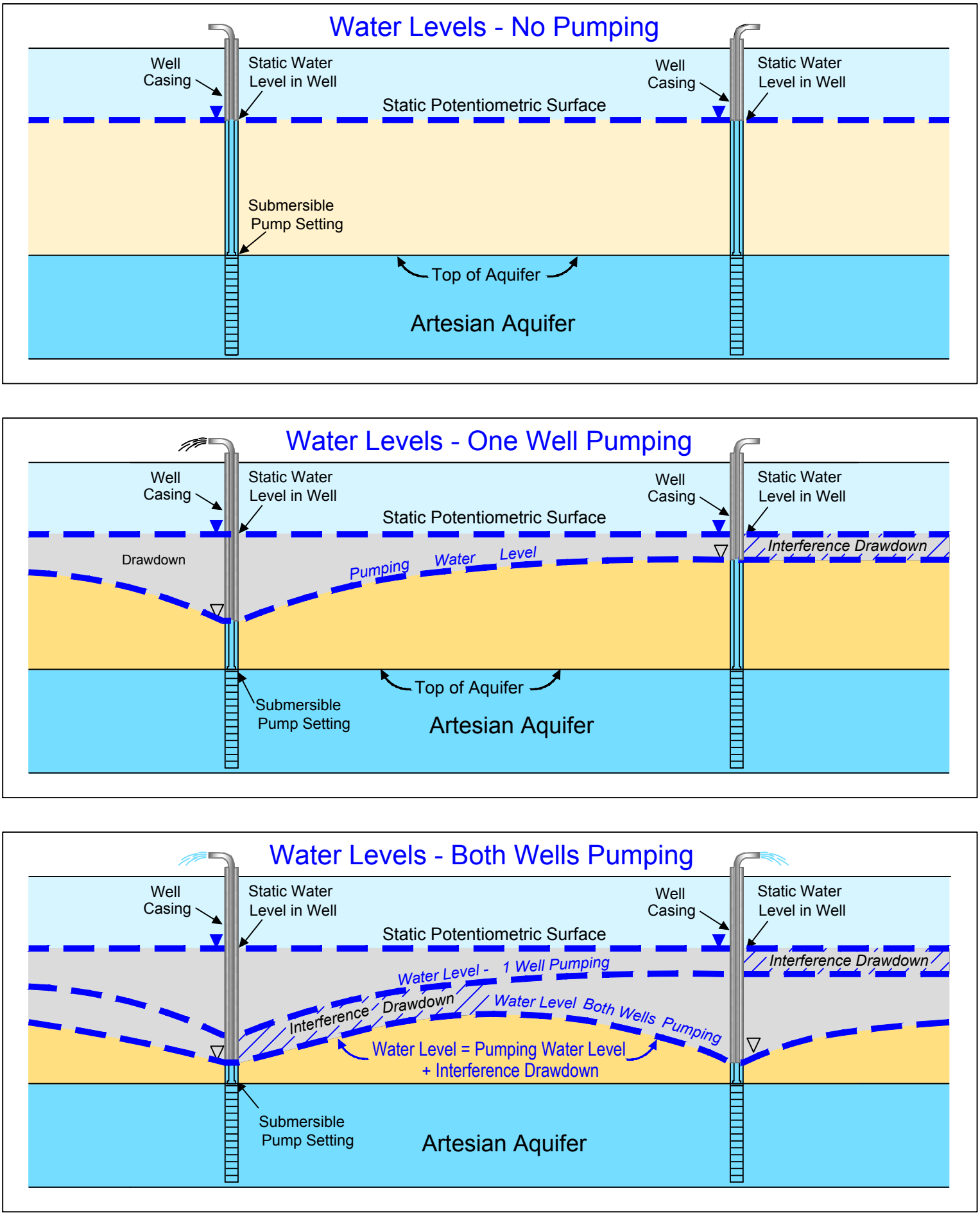
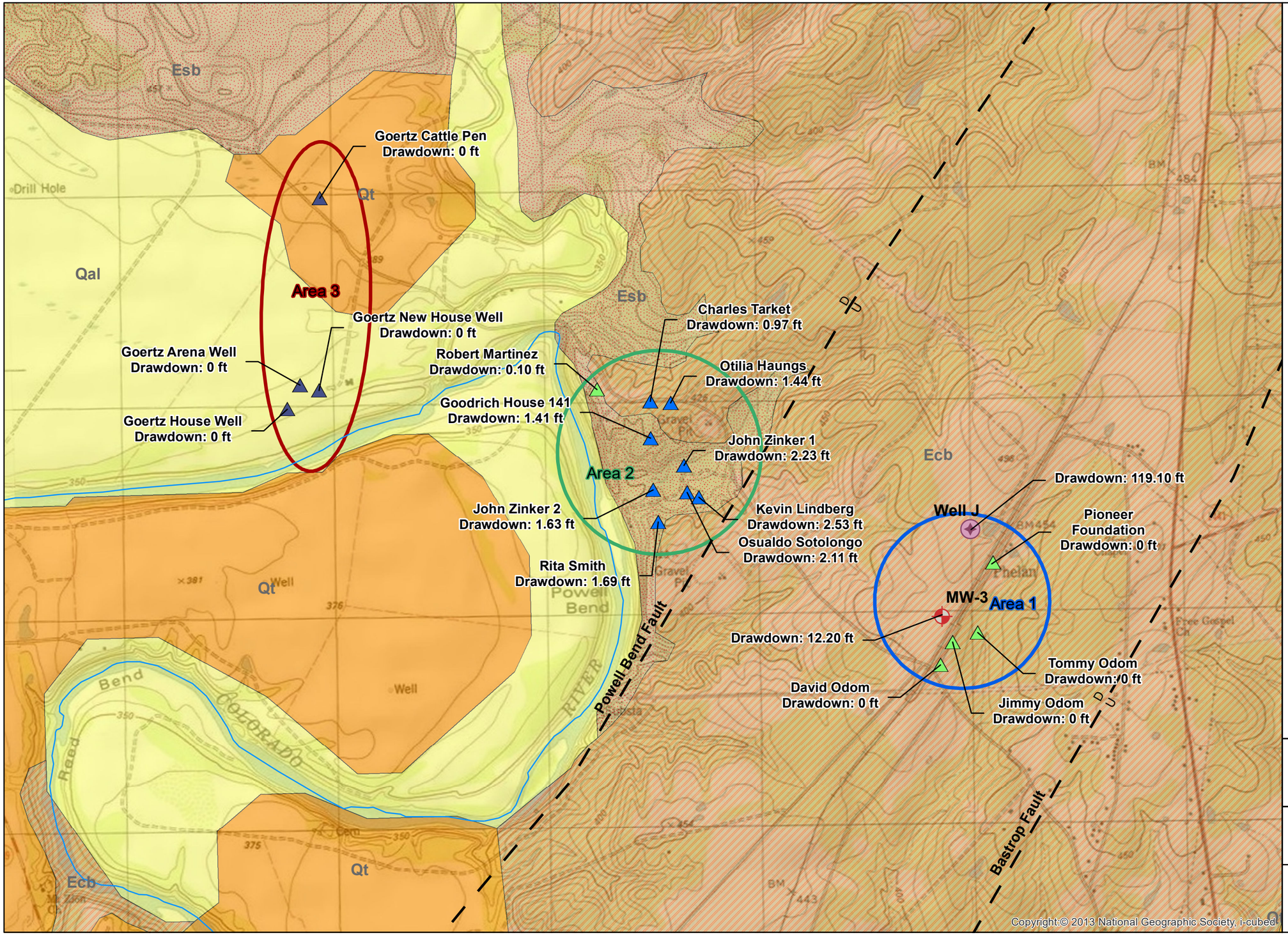



**Figure 13. Schematic Interference Drawdown - Artesian Aquifer**
**Distance Between Wells, Thousands of Feet, or Miles**






# Explanation

**City of Bastrop**

- Well J
- MW-3

**Monitoring Wells**

**Producing Formation**

- Calvert Bluff
- Simsboro
- Hooper

- USGS Rpt 84-4333 Fault
- USGS Rpt 84-4333 Inferred Fault

**Geology**

- Qal — Alluvium
- Qt — Terrace Deposits
- Ecb — Calvert Bluff Formation
- Esb — Simsboro Formation

Drawdown is the decline in water level attibutable to pumping at Well J during the 36-Hour pumping test. Although all wells showed a change in water level at the end of the pumping test (e.g. natural fluctuations), only the wells completed in the Simsboro Formation experienced drawdown due to pumping at Well J; therefore, all other wells are reported to have zero (0) drawdown.

N

0 1,500 3,000

Feet

# City of Bastrop

Figure 14. 36-Hour Pumping Test Drawdown

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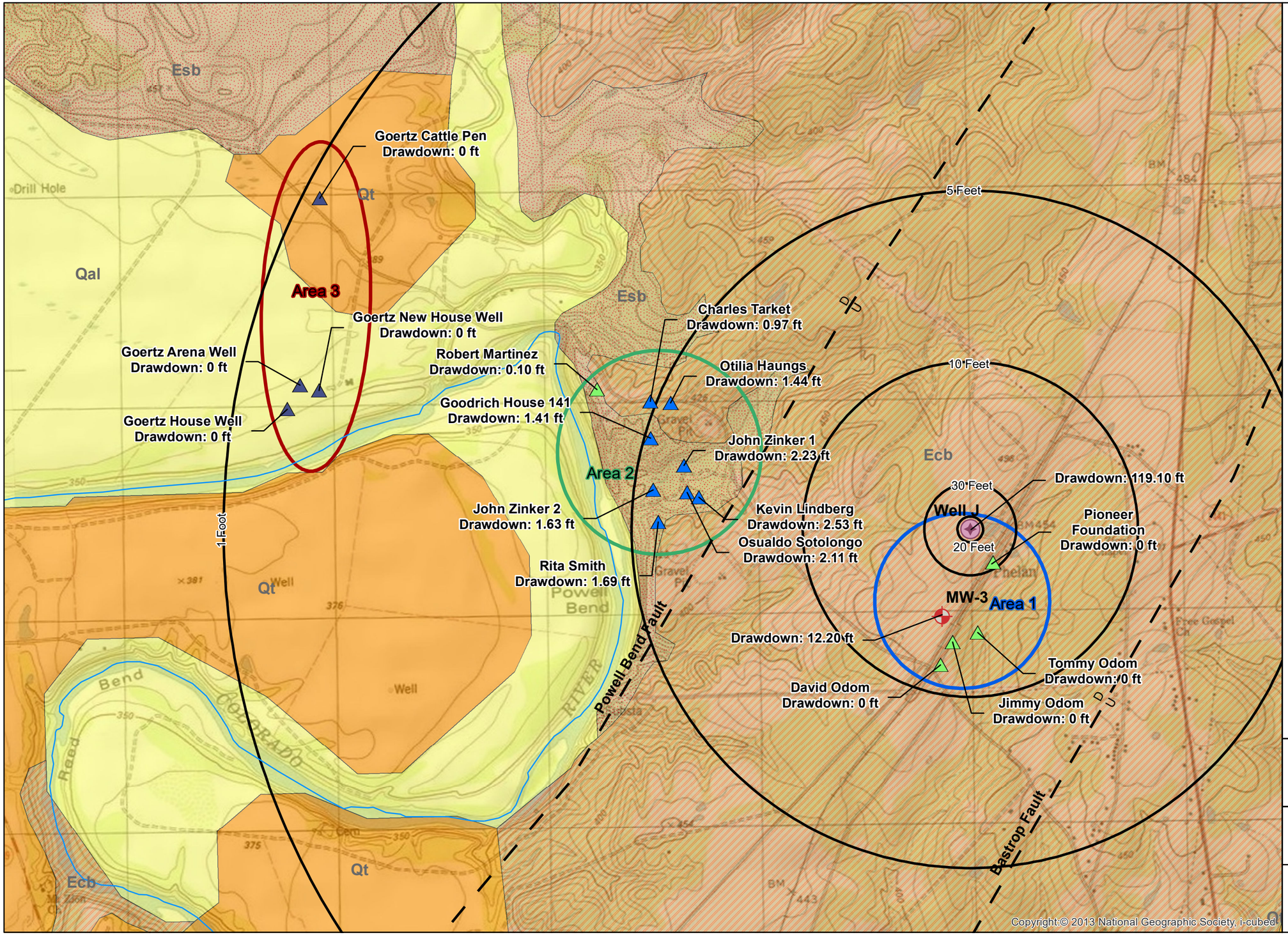


# Explanation

**City of Bastrop**

- Well J
- MW-3

**Monitoring Wells**

**Producing Formation**

- Calvert Bluff
- Simsboro
- Hooper
- USGS Rpt 84-4333 Fault
- USGS Rpt 84-4333 Inferred Fault
- Theis Predicted Drawdown

**Geology**

- Qal — Alluvium
- Qt — Terrace Deposits
- Ecb — Calvert Bluff Formation
- Esb — Simsboro Formation

Contours represent the predicted drawdown calculated using the Theis non-equilibrium well equation with Well J pumping. The parameters used to calculate drawdown are from the results of the 36-hour pumping test:
Transmissivity (T) = 45,500 gpd/ft
Discharge (Q) = 1,560 gpm
Storage (S) = 0.00025
Time (t)= 1.5 days

N

0 1,500 3,000
Feet

# City of Bastrop

Figure 15. Measured Drawdown vs. Predicted Drawdown

THORNHILL GROUP, INC.
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ALCOA - Sandow
2070 Q = 19,160 acre-feet

HOT
2070 Q = 1,886 acre-feet

Manville
2070 Q = 3,734 acre-feet

Forestar
2070 Q = 6,732 acre-feet

Bluewater/Vista Ridge
2070 Q = 30,304 acre-feet

Aqua WSC
2070 Q = 281 acre-feet

Aqua WSC
2070 Q = 9,607 acre-feet

LCRA
2070 Q = 3,648 acre-feet

Well J

Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

## Explanation

- City of Bastrop Well J
- ALCOA
- Aqua WSC
- Manville WSC
- HOT
- LCRA
- Forestar Proposed Well
- Bluewater/Vista Ridge
- USGS Rpt 84-4333 Fault
- USGS Rpt 84-4333 Inferred Fault

**GAT Mapped Fault**

- Concealed Normal
- Inferred Normal
- Normal
- Esb Simsboro Outcrop

N

0 4 8
Miles

# City of Bastrop

Figure 16. 2070 Projected Pumping

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## Table 1. Summary of Pumping Well and Monitoring Wells

| Well ID | Latitude | Longitude | Ground Level Elevation (Feet AMSL) | Total Depth (Feet BGL) | Producting Interval (Feet BGL) | Static Water Level (Feet BGL) | Static Water Level Elevation (Feet AMSL) | Producting Formation |
|---|---|---|---|---|---|---|---|---|
| **Area 1** | | | | | | | | |
| Well J | 30.155267 | -97.330017 | 461 | 670 | 450 to 660 | 163.05 | 297.95 | Simsboro |
| MW-3 | 30.158950 | -97.328517 | 454 | 590 | 453 to 579 | 148.75 | 305.25 | Simsboro |
| Pioneer Foundation | 30.157521 | -97.327447 | 451 | 240 | 200 to 240 | 64.76 | 386.24 | Calvert Bluff |
| Tommy Odom | 30.154545 | -97.328288 | 433 | 250 | 210 to 250 | 105.55 | 327.45 | Calvert Bluff |
| Jimmy Odom | 30.154166 | -97.329539 | 449 | 255 | 235 to 255 | 153.61 | 295.39 | Calvert Bluff |
| David Odom | 30.153218 | -97.330151 | 449 | 285 | 240 to 280 | 155.40 | 293.60 | Calvert Bluff |
| **Area 2** | | | | | | | | |
| Kevin Lindberg | 30.160635 | -97.341770 | 369 | 193 | 160 to 180 | 50.40 | 318.60 | Simsboro |
| Osualdo Sotolongo | 30.160850 | -97.342350 | 366 | unknown | unknown | 42.61 | 323.39 | Simsboro |
| John Zinker 1 | 30.161996 | -97.342462 | 361 | unknown | unknown | 39.17 | 321.83 | Simsboro |
| Rita Smith | 30.159620 | -97.343797 | 403 | unknown | unknown | 86.88 | 316.12 | Simsboro |
| John Zinker 2 | 30.160991 | -97.344002 | 362 | 168 | unknown | 45.78 | 316.22 | Simsboro |
| Otilia Haungs | 30.164684 | -97.343036 | 419 | 240 | 180 to 240 | 100.95 | 318.05 | Simsboro |
| Goodrich 141 | 30.163201 | -97.344059 | 398 | unknown | unknown | 76.66 | 321.34 | Simsboro |
| Charles Tarket | 30.164766 | -97.344032 | 412 | 400 | 300 to unknown | 92.81 | 319.19 | Simsboro |
| Robert Martinez | 30.165326 | -97.346632 | 413 | 180 | unknown | 88.85 | 324.15 | Simsboro |
| **Area 3** | | | | | | | | |
| Goertz New House Well | 30.165602 | -97.360239 | 364 | 400 | 330 to 390 | 47.55 | 316.45 | Hooper |
| Goertz Arena Well | 30.165862 | -97.361169 | 369 | 550 | 500 to 540 | 40.30 | 328.70 | Hooper |
| Goertz House Well | 30.164846 | -97.361831 | 362 | 540 | 490 to 530 | 39.58 | 322.42 | Hooper |
| Goertz Cattle Pen | 30.173784 | -97.359958 | 391 | 316 | 293 to 316 | 59.34 | 331.66 | Hooper |

## Table 2. Summary of Water Level Fluctuations

| Well ID | Elevation (feet AMSL) | Static Water Level | | | |
|---|---|---|---|---|---|
| | | Minimum (Feet AMSL) | Maximum (Feet AMSL) | Fluctuation (Feet) | Number of Observations |
| **Area 1** | | | | | |
| Well J | 461 | 297.66 | 297.08 | 0.57 | 1,019*† |
| MW-3 | 454 | 305.48 | 296.42 | 9.06 | 4,678† |
| Pioneer Foundation | 451 | 385.7 | 383.45 | 2.25 | 3 |
| Tommy Odom | 433 | 327.68 | 322.27 | 5.41 | 7 |
| Jimmy Odom | 449 | 295.45 | 290.37 | 5.09 | 6,078† |
| David Odom | 449 | 293.6 | 272.47 | 21.13 | 7 |
| **Area 2** | | | | | |
| Kevin Lindberg | 369 | 319.26 | 316.42 | 2.84 | 7 |
| Osualdo Sotolongo | 366 | 324.21 | 321.53 | 2.68 | 5 |
| John Zinker 1 | 361 | 322.7 | 321.83 | 0.87 | 2 |
| Rita Smith | 403 | 316.12 | 313.19 | 2.93 | 5 |
| John Zinker 2 | 362 | 316.74 | 314.27 | 2.48 | 6,129† |
| Otilia Haungs | 419 | 318.89 | 318.05 | 0.84 | 2 |
| Goodrich 141 | 398 | 322.32 | 320.48 | 1.84 | 3 |
| Charles Tarket | 412 | 320.26 | 317.59 | 2.67 | 5 |
| Robert Martinez | 413 | 324.6 | 324.15 | 0.45 | 3 |
| **Area 3** | | | | | |
| Goertz New House | 364 | 317.47 | 311.78 | 5.69 | 4,912† |
| Goertz Arena Well | 369 | 329.36 | 326.96 | 2.4 | 8** |
| Goertz House Well | 362 | 323.02 | 319.12 | 3.9 | 5,509† |
| Goertz Cattle Pen | 391 | 332.64 | 331.64 | 0.6 | 6 |

## Table 3. Summary of Pumping Test Results

| Well ID | Pumping Rate (GPM) | Static Water Level (Feet BGL) | 36-Hr Water Level (Feet BGL) | Drawdown (Feet) | Transmissivity (gpd/ft) | Storage Coefficient |
|---|---|---|---|---|---|---|
| **Area 1** | | | | | | |
| Well J | 1,500 | 163.05 | 282.15 | 119.1 | 37,000 to 43,000 | N/A |
| MW-3 | — | 148.75 | 160.95 | 12.2 | 50,000 to 63,000 | $1.8x10^{-4}$ to $3.3x10^{-4}$ |
| Pioneer Foundation | — | 64.76 | 65.76 | N/A | N/A | N/A |
| Tommy Odom | — | 105.55 | 106.1 | N/A | N/A | N/A |
| Jimmy Odom | — | 153.61 | 153.95 | N/A | N/A | N/A |
| David Odom | — | 155.4 | 160.1 | N/A | N/A | N/A |
| **Area 2** | | | | | | |
| Kevin Lindberg | — | 50.4 | 52.93 | 2.53 | 80,000 | $7.4x10^{-4}$ |
| Osualdo Sotolongo | — | 41.74 | 44.72 | 2.05 | 90,000 | $8.4x10^{-4}$ |
| John Zinker 1 | — | 39.17 | 41.4 | 2.23 | 100,000 | $7.7x10^{-4}$ |
| Rita Smith | — | 86.88 | 88.57 | 1.69 | 110,000 | $9.1x10^{-4}$ |
| John Zinker 2 | — | 45.78 | 47.41 | 1.63 | 125,000 | $8.8x10^{-4}$ |
| Otilia Haungs | — | 100.95 | 102.39 | 1.44 | 130,000 | $9.1x10^{-4}$ |
| Goodrich 141 | — | 76.66 | 77.87 | 1.41 | 157,300 | $9.3x10^{-4}$ |
| Charles Tarket | — | 92.81 | 93.78 | 0.97 | 180,000 | $1.3x10^{-3}$ |
| Robert Martinez | — | 88.85 | 88.85 | N/A | N/A | N/A |
| **Area 3** | | | | | | |
| Goertz New House Well | — | 47.55 | 48.21 | N/A | N/A | N/A |
| Goertz Arena Well | — | 40.3 | 40.25 | N/A | N/A | N/A |
| Goertz House Well | — | 39.58 | 39.53 | N/A | N/A | N/A |
| Goertz Cattle Pen | — | 59.34 | 59.25 | N/A | N/A | N/A |

## Table 4. Summary of Estimated Drawdown

| Well ID | 30 Day Predicted Drawdown, Feet* | 1 Year Predicted Drawdown, Feet** |
|---|---|---|
| **Area 1** | | |
| Well J | 75 | 68 |
| MW-3 | 18 | 19 |
| **Area 2** | | |
| Kevin Lindberg | 8.0 | 9.8 |
| Osualdo Sotolongo | 7.1 | 8.7 |
| John Zinker 1 | 6.5 | 7.9 |
| Rita Smith | 5.9 | 7.2 |
| John Zinker 2 | 5.3 | 6.4 |
| Otilia Haungs | 5.1 | 6.2 |
| Goodrich 141 | 4.4 | 5.2 |
| Charles Tarket | 3.9 | 4.6 |

Asterisk (*) Q=1,500 gpm, S=0.001

Double Asterisk (**) Q=1,240 gpm, S=0.002

Note that the calculated transmissivity from the pumping test workup for each monitoring well was used to calculate the predicted drawdown at each monitoring well site (see Table 3)

# Attachment 2 – Monitoring Well Information and Results (Packets)

# Area 1

# City of Bastrop
## Well J
## 36-Hour Continuous Pumping Test Results

**Project:** 10210
**County:** Bastrop County, Texas
**Aquifer Tested:** Simsboro Aquifer
**Well Completion/Screen Interval:** 450 to 510; 610 to 660 feet BGL
**Well Casing Diameter:** 12 inches
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Pumping Rate, gpm | Depth to Water, Feet | Remarks |
|---|---|---|---|
| 12/27/2017 12:30 | 0 | 163.05 | Static Water |
| 12/27/2017 12:31 | 1560 | 228.48 | Pump On |
| 12/27/2017 12:32 | 1560 | 246.98 | |
| 12/27/2017 12:33 | 1560 | 251.25 | |
| 12/27/2017 12:34 | 1560 | 253.84 | |
| 12/27/2017 12:35 | 1560 | 255.19 | |
| 12/27/2017 12:36 | 1560 | 256.18 | |
| 12/27/2017 12:37 | 1560 | 257.00 | |
| 12/27/2017 12:38 | 1560 | 258.26 | |
| 12/27/2017 12:39 | 1560 | 259.03 | |
| 12/27/2017 12:40 | 1560 | 259.50 | |
| 12/27/2017 12:41 | 1560 | 259.97 | |
| 12/27/2017 12:42 | 1560 | 260.35 | |
| 12/27/2017 12:43 | 1560 | 260.75 | |
| 12/27/2017 12:44 | 1560 | 260.98 | |
| 12/27/2017 12:45 | 1560 | 261.35 | |
| 12/27/2017 12:50 | 1560 | 262.51 | |
| 12/27/2017 12:55 | 1560 | 263.45 | |
| 12/27/2017 13:00 | 1560 | 264.08 | |
| 12/27/2017 13:05 | 1560 | 264.72 | |
| 12/27/2017 13:10 | 1560 | 265.33 | |
| 12/27/2017 13:15 | 1560 | 265.77 | |
| 12/27/2017 13:20 | 1560 | 266.25 | |
| 12/27/2017 13:25 | 1560 | 266.49 | |
| 12/27/2017 13:30 | 1560 | 266.89 | |
| 12/27/2017 13:40 | 1560 | 267.95 | |
| 12/27/2017 13:50 | 1560 | 268.35 | |
| 12/27/2017 14:00 | 1560 | 268.83 | |
| 12/27/2017 14:10 | 1560 | 269.14 | |
| 12/27/2017 14:20 | 1560 | 269.44 | |

# City of Bastrop
## Well J
## 36-Hour Continuous Pumping Test Results

**Project:** 10210
**County:** Bastrop County, Texas
**Aquifer Tested:** Simsboro Aquifer
**Well Completion/Screen Interval:** 450 to 510; 610 to 660 feet BGL
**Well Casing Diameter:** 12 inches
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Pumping Rate, gpm | Depth to Water, Feet | Remarks |
|---|---|---|---|
| 12/27/2017 14:30 | 1560 | 270.24 | |
| 12/27/2017 15:00 | 1560 | 273.19 | |
| 12/27/2017 15:30 | 1560 | 273.15 | |
| 12/27/2017 16:00 | 1560 | 274.23 | |
| 12/27/2017 16:30 | 1560 | 274.68 | |
| 12/27/2017 17:00 | 1560 | 274.98 | |
| 12/27/2017 17:30 | 1560 | 275.25 | |
| 12/27/2017 18:00 | 1560 | 275.65 | |
| 12/27/2017 18:30 | 1560 | 275.98 | |
| 12/27/2017 19:00 | 1560 | 276.15 | |
| 12/27/2017 19:30 | 1560 | 276.25 | |
| 12/27/2017 20:00 | 1560 | 276.41 | |
| 12/27/2017 20:30 | 1560 | 276.74 | |
| 12/27/2017 21:00 | 1560 | 276.95 | |
| 12/27/2017 21:30 | 1560 | 277.08 | |
| 12/27/2017 22:00 | 1560 | 277.61 | |
| 12/27/2017 22:30 | 1560 | 278.06 | |
| 12/27/2017 23:00 | 1560 | 278.53 | |
| 12/27/2017 23:30 | 1560 | 278.88 | |
| 12/28/2017 0:00 | 1560 | 279.33 | |
| 12/28/2017 0:30 | 1560 | 279.73 | |
| 12/28/2017 1:00 | 1560 | 280.08 | |
| 12/28/2017 1:30 | 1560 | 280.38 | |
| 12/28/2017 2:00 | 1560 | 280.55 | |
| 12/28/2017 2:30 | 1560 | 280.71 | |
| 12/28/2017 3:00 | 1560 | 280.85 | |
| 12/28/2017 3:30 | 1560 | 281.03 | |
| 12/28/2017 4:00 | 1560 | 281.15 | |
| 12/28/2017 4:30 | 1560 | 281.64 | |
| 12/28/2017 5:00 | 1560 | 282.04 | |

# City of Bastrop
## Well J
## 36-Hour Continuous Pumping Test Results

**Project:** 10210
**County:** Bastrop County, Texas
**Aquifer Tested:** Simsboro Aquifer
**Well Completion/Screen Interval:** 450 to 510; 610 to 660 feet BGL
**Well Casing Diameter:** 12 inches
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Pumping Rate, gpm | Depth to Water, Feet | Remarks |
|---|---|---|---|
| 12/28/2017 5:30 | 1560 | 282.14 | |
| 12/28/2017 6:00 | 1560 | 282.25 | |
| 12/28/2017 6:30 | 1560 | 281.41 | |
| 12/28/2017 7:00 | 1560 | 281.55 | |
| 12/28/2017 7:30 | 1560 | 281.44 | |
| 12/28/2017 8:00 | 1560 | 281.75 | |
| 12/28/2017 8:30 | 1560 | 281.84 | |
| 12/28/2017 9:00 | 1560 | 281.85 | |
| 12/28/2017 9:30 | 1560 | 282.35 | |
| 12/28/2017 10:00 | 1560 | 282.18 | |
| 12/28/2017 10:30 | 1560 | 282.35 | |
| 12/28/2017 11:00 | 1560 | 281.77 | |
| 12/28/2017 11:30 | 1560 | 281.44 | |
| 12/28/2017 12:00 | 1560 | 281.50 | |
| 12/28/2017 12:30 | 1560 | 281.56 | |
| 12/28/2017 13:00 | 1560 | 281.56 | |
| 12/28/2017 13:30 | 1560 | 281.59 | |
| 12/28/2017 14:00 | 1560 | 281.45 | |
| 12/28/2017 14:30 | 1560 | 281.53 | |
| 12/28/2017 15:00 | 1560 | 281.63 | |
| 12/28/2017 15:30 | 1560 | 281.65 | |
| 12/28/2017 16:00 | 1560 | 281.65 | |
| 12/28/2017 16:30 | 1560 | 281.79 | |
| 12/28/2017 17:00 | 1560 | 281.83 | |
| 12/28/2017 17:30 | 1560 | 281.85 | |
| 12/28/2017 18:00 | 1560 | 282.08 | |
| 12/28/2017 18:30 | 1560 | 282.05 | |
| 12/28/2017 19:00 | 1560 | 281.91 | |
| 12/28/2017 19:30 | 1560 | 281.98 | |
| 12/28/2017 20:00 | 1560 | 282.05 | |

# City of Bastrop
## Well J
## 36-Hour Continuous Pumping Test Results

**Project:** 10210
**County:** Bastrop County, Texas
**Aquifer Tested:** Simsboro Aquifer
**Well Completion/Screen Interval:** 450 to 510; 610 to 660 feet BGL
**Well Casing Diameter:** 12 inches
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Pumping Rate, gpm | Depth to Water, Feet | Remarks |
|---|---|---|---|
| 12/28/2017 20:30 | 1560 | 282.13 | |
| 12/28/2017 21:00 | 1560 | 282.13 | |
| 12/28/2017 21:30 | 1560 | 281.99 | |
| 12/28/2017 22:00 | 1560 | 282.15 | |
| 12/28/2017 22:30 | 1560 | 282.19 | |
| 12/28/2017 23:00 | 1560 | 282.25 | |
| 12/28/2017 23:30 | 1560 | 282.32 | |
| 12/29/2017 0:00 | 1560 | 282.25 | |
| 12/29/2017 0:30 | 1560 | 282.15 | Pump Off |
| 12/29/2017 0:31 | 0 | – | Recovery |
| 12/29/2017 0:32 | 0 | 190.11 | |
| 12/29/2017 0:33 | 0 | 190.44 | |
| 12/29/2017 0:34 | 0 | 189.31 | |
| 12/29/2017 0:35 | 0 | 188.23 | |
| 12/29/2017 0:36 | 0 | 187.30 | |
| 12/29/2017 0:37 | 0 | 186.50 | |
| 12/29/2017 0:38 | 0 | 185.82 | |
| 12/29/2017 0:39 | 0 | 185.47 | |
| 12/29/2017 0:40 | 0 | 184.69 | |
| 12/29/2017 0:41 | 0 | 184.33 | |
| 12/29/2017 0:42 | 0 | 184.02 | |
| 12/29/2017 0:43 | 0 | 183.37 | |
| 12/29/2017 0:44 | 0 | 183.18 | |
| 12/29/2017 0:45 | 0 | 182.85 | |
| 12/29/2017 0:50 | 0 | 181.30 | |
| 12/29/2017 0:55 | 0 | 180.45 | |
| 12/29/2017 1:00 | 0 | 179.60 | |
| 12/29/2017 1:05 | 0 | 178.95 | |
| 12/29/2017 1:10 | 0 | 178.39 | |
| 12/29/2017 1:15 | 0 | 177.85 | |

# City of Bastrop
## Well J
## 36-Hour Continuous Pumping Test Results

**Project:** 10210
**County:** Bastrop County, Texas
**Aquifer Tested:** Simsboro Aquifer
**Well Completion/Screen Interval:** 450 to 510; 610 to 660 feet BGL
**Well Casing Diameter:** 12 inches
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Pumping Rate, gpm | Depth to Water, Feet | Remarks |
|---|---|---|---|
| 12/29/2017 1:20 | 0 | 177.38 | |
| 12/29/2017 1:25 | 0 | 176.95 | |
| 12/29/2017 1:30 | 0 | 176.53 | |

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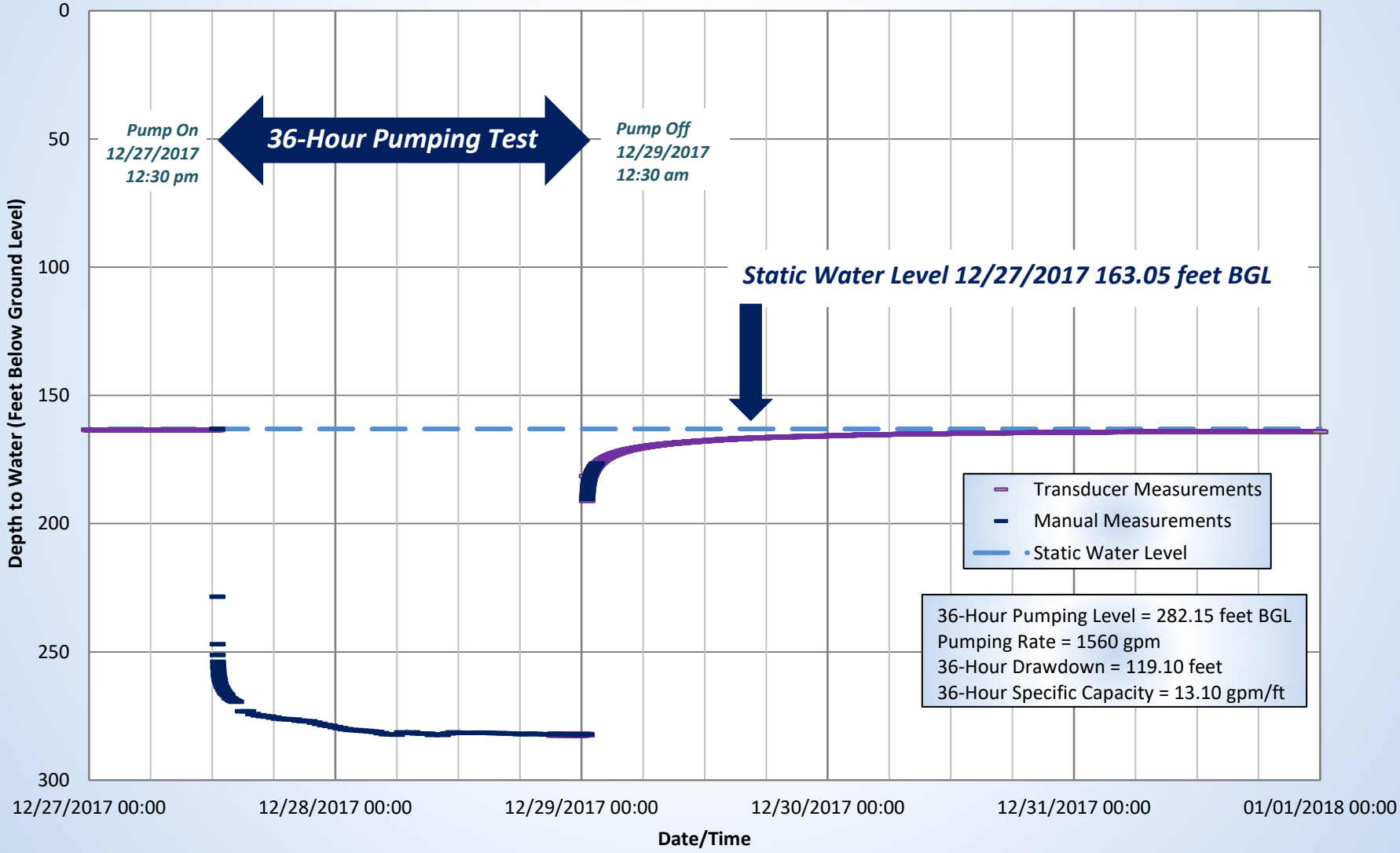
# City of Bastrop - Well J
# 36-Hour Production Test
# Hydrograph



THORNHILL GROUP, INC.
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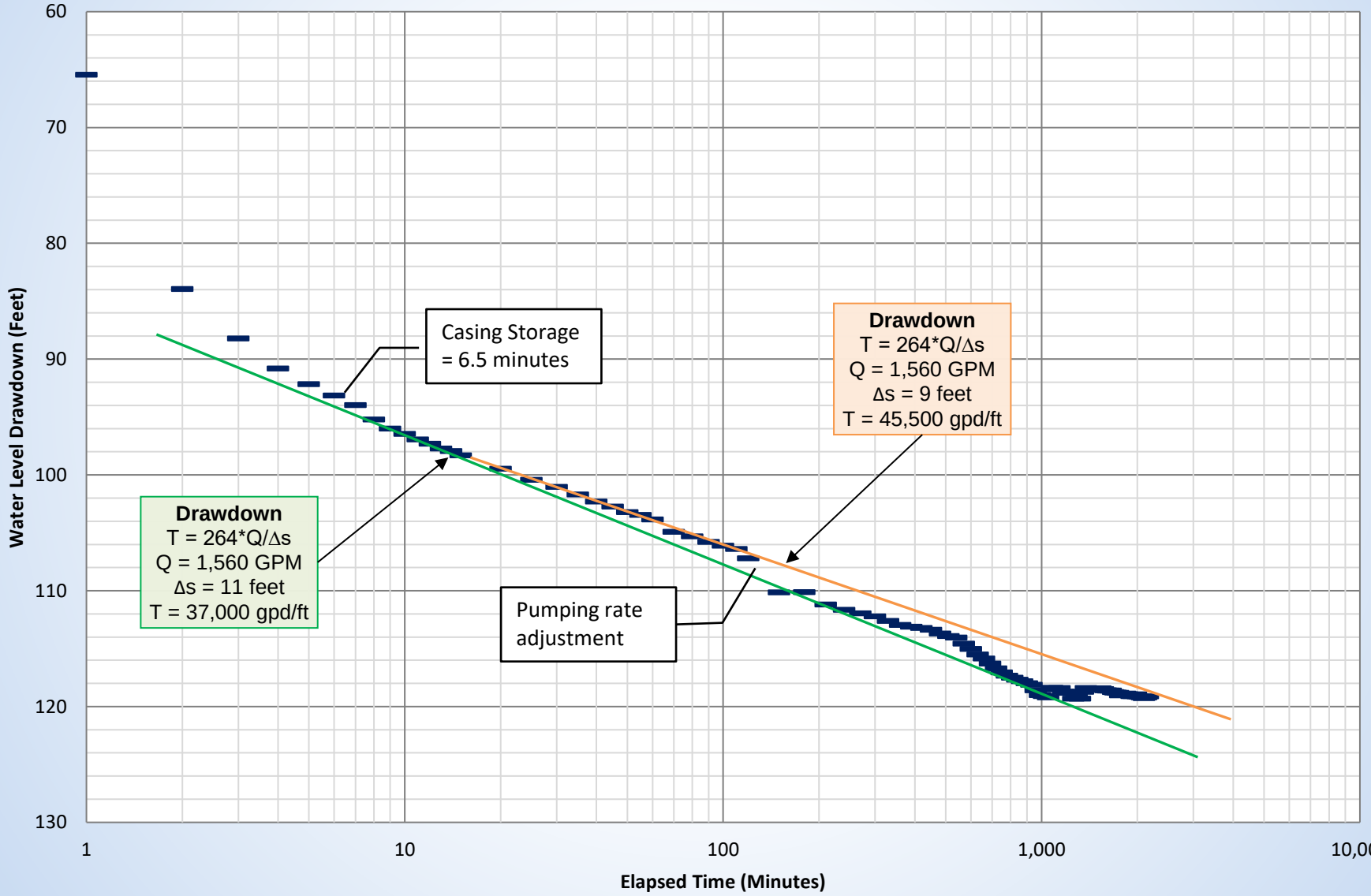
# City of Bastrop - Well J
# Cooper-Jacob Drawdown Chart



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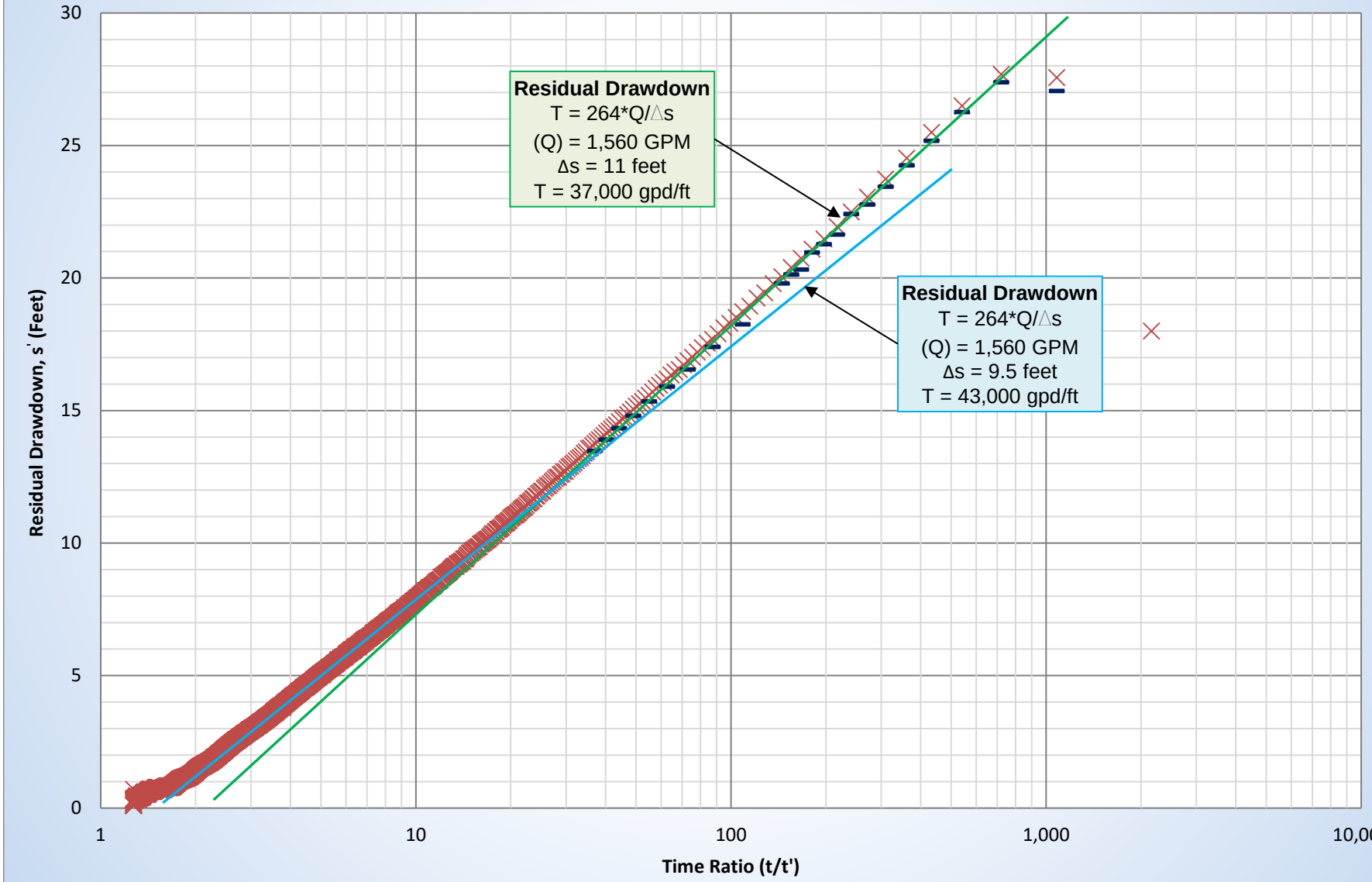
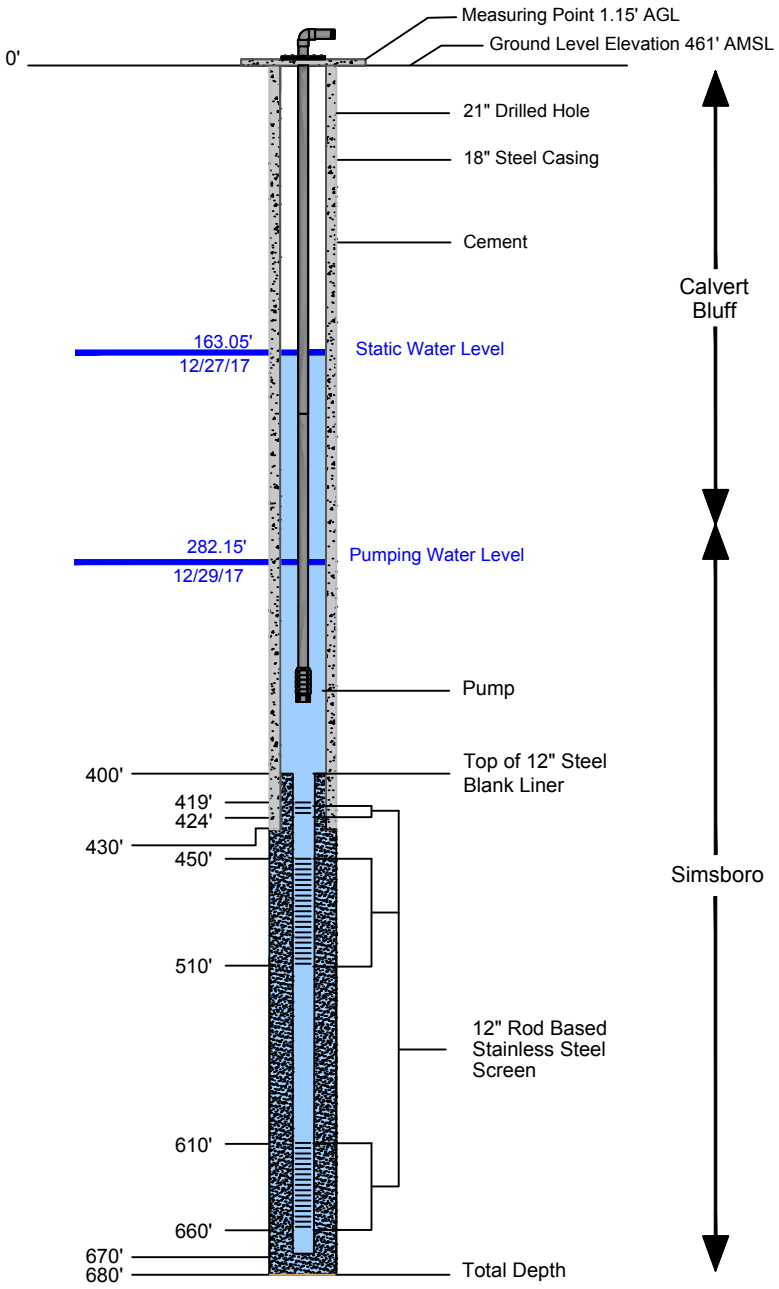
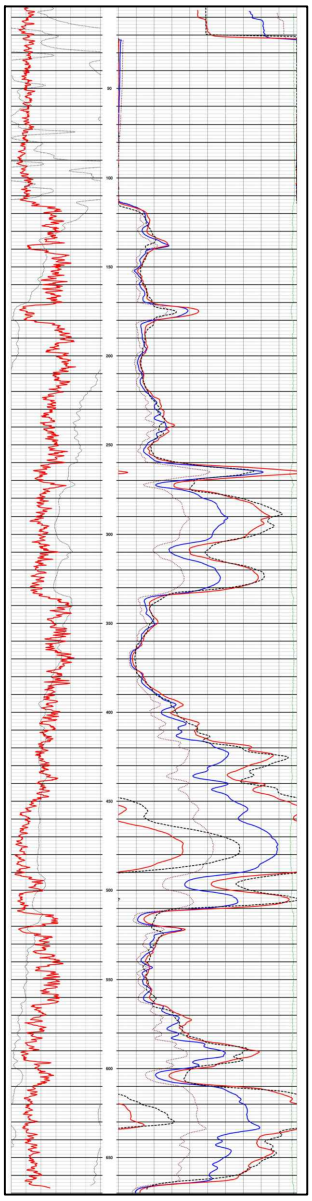
# City of Bastrop - Well J
# Cooper-Jacob Recovery Chart



# City of Bastrop Well No. 1

## Well "J"



# City of Bastrop
## MW 3 Monitoring Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 1,423 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 11/10/2017 16:45 | 155.23 | Background |
| 11/13/2017 9:30 | 155.15 | Background |
| 12/22/2017 12:45 | 148.74 | Background |
| 12/27/2017 9:14 | 148.70 | Background |
| 12/27/2017 12:30 | 148.70 | Static Water Level |
| 12/27/2017 12:31 | 148.75 | Production Well on: 12/27/2017 12:30 |
| 12/27/2017 12:32 | 148.75 | |
| 12/27/2017 12:33 | 148.75 | |
| 12/27/2017 12:34 | 148.75 | |
| 12/27/2017 12:35 | 148.75 | |
| 12/27/2017 12:36 | 148.75 | |
| 12/27/2017 12:37 | 148.75 | |
| 12/27/2017 12:38 | 148.77 | |
| 12/27/2017 12:39 | 148.77 | |
| 12/27/2017 12:40 | 148.80 | |
| 12/27/2017 12:41 | 148.81 | |
| 12/27/2017 12:42 | 148.82 | |
| 12/27/2017 12:43 | 148.84 | |
| 12/27/2017 12:44 | 148.86 | |
| 12/27/2017 12:45 | 148.88 | |
| 12/27/2017 12:46 | 148.92 | |
| 12/27/2017 12:47 | 148.94 | |
| 12/27/2017 12:48 | 148.97 | |
| 12/27/2017 12:49 | 149.00 | |
| 12/27/2017 12:50 | 149.03 | |
| 12/27/2017 12:55 | 149.19 | |
| 12/27/2017 13:00 | 149.35 | |
| 12/27/2017 13:05 | 149.53 | |
| 12/27/2017 13:10 | 149.70 | |

# City of Bastrop
## MW 3 Monitoring Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 1,423 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 12/27/2017 13:15 | 149.88 | |
| 12/27/2017 13:25 | 150.21 | |
| 12/27/2017 13:30 | 150.37 | |
| 12/27/2017 13:40 | 150.65 | |
| 12/27/2017 13:50 | 150.95 | |
| 12/27/2017 14:00 | 151.29 | |
| 12/27/2017 14:10 | 151.50 | |
| 12/27/2017 14:20 | 151.73 | |
| 12/27/2017 14:30 | 151.95 | |
| 12/27/2017 14:40 | 152.21 | |
| 12/27/2017 14:50 | 152.37 | |
| 12/27/2017 15:00 | 152.62 | |
| 12/27/2017 15:10 | 152.75 | |
| 12/27/2017 15:20 | 152.90 | |
| 12/27/2017 15:30 | 153.08 | |
| 12/27/2017 15:45 | 153.31 | |
| 12/27/2017 16:00 | 153.55 | |
| 12/27/2017 16:17 | 153.80 | |
| 12/27/2017 17:54 | 155.97 | |
| 12/27/2017 19:31 | 155.80 | |
| 12/27/2017 21:35 | 156.62 | |
| 12/27/2017 23:24 | 157.30 | |
| 12/28/2017 1:35 | 157.87 | |
| 12/28/2017 3:05 | 158.25 | |
| 12/28/2017 4:55 | 158.62 | |
| 12/28/2017 6:53 | 158.90 | |
| 12/28/2017 8:30 | 159.25 | |
| 12/28/2017 11:20 | 159.68 | |
| 12/28/2017 13:30 | 159.90 | |

# City of Bastrop
## MW 3 Monitoring Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 1,423 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 12/28/2017 15:20 | 160.10 | |
| 12/28/2017 18:10 | 160.43 | |
| 12/29/2017 0:27 | 160.95 | |
| 12/29/2017 0:29 | 160.95 | |
| 12/29/2017 0:30 | 160.95 | Production Well off: 12/29/2017 0:30 |
| 12/29/2017 0:31 | 160.95 | |
| 12/29/2017 0:35 | 160.96 | |
| 12/29/2017 0:40 | 160.90 | |
| 12/29/2017 0:45 | 160.81 | |
| 12/29/2017 1:03 | 160.23 | |
| 12/29/2017 1:10 | 159.95 | |
| 12/29/2017 1:15 | 159.71 | |
| 12/29/2017 1:20 | 159.63 | |
| 12/29/2017 1:25 | 159.45 | |
| 12/29/2017 1:40 | 158.94 | |
| 12/29/2017 1:50 | 158.72 | |
| 12/29/2017 2:00 | 158.46 | |
| 12/29/2017 2:10 | 158.20 | |
| 12/29/2017 2:20 | 157.96 | |
| 12/29/2017 2:30 | 157.75 | |
| 12/29/2017 5:36 | 155.17 | |

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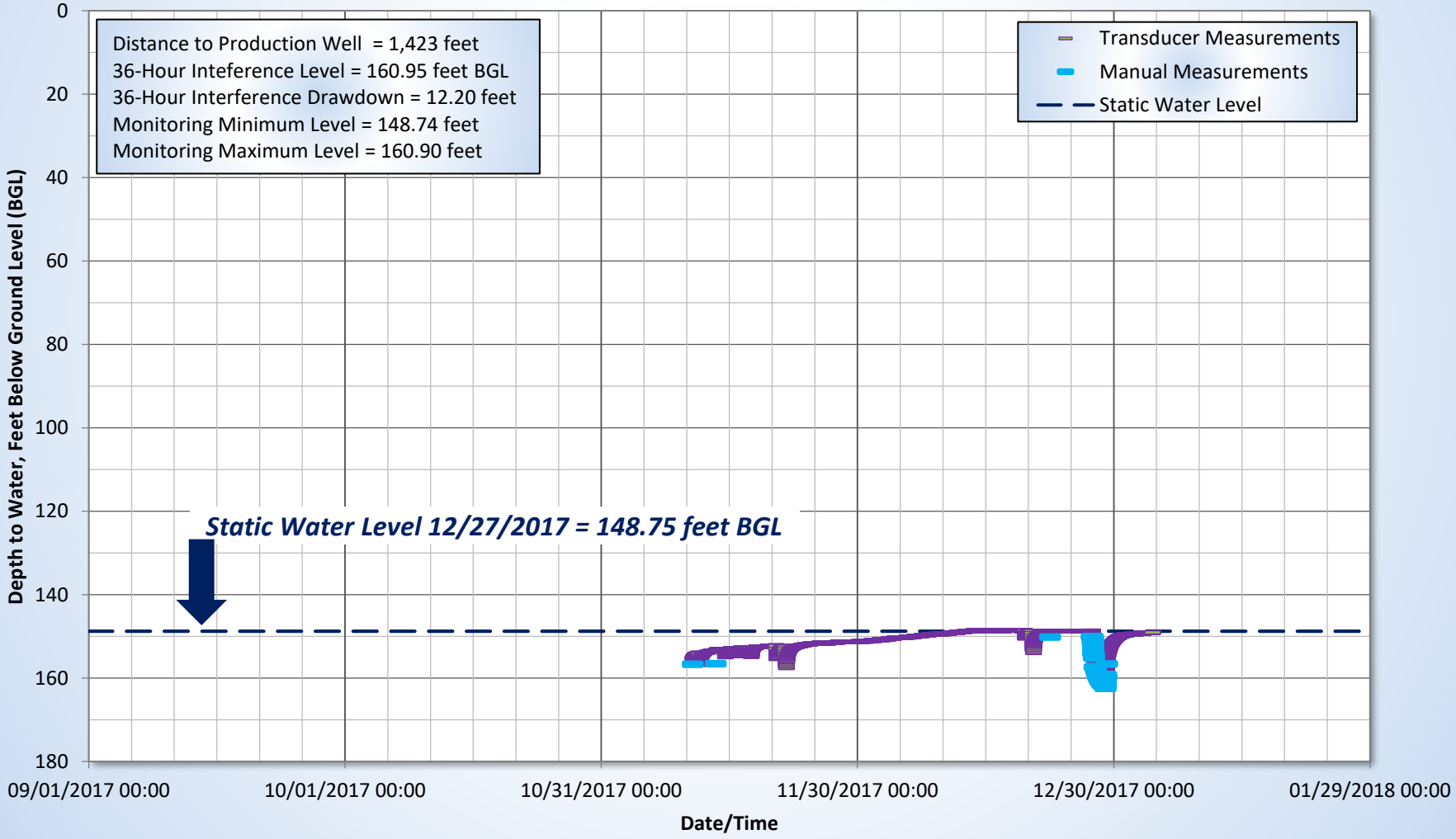
# City of Bastrop
# Well J Production Well 36-Hour Test
# MW-3
# Hydrograph

Simsboro



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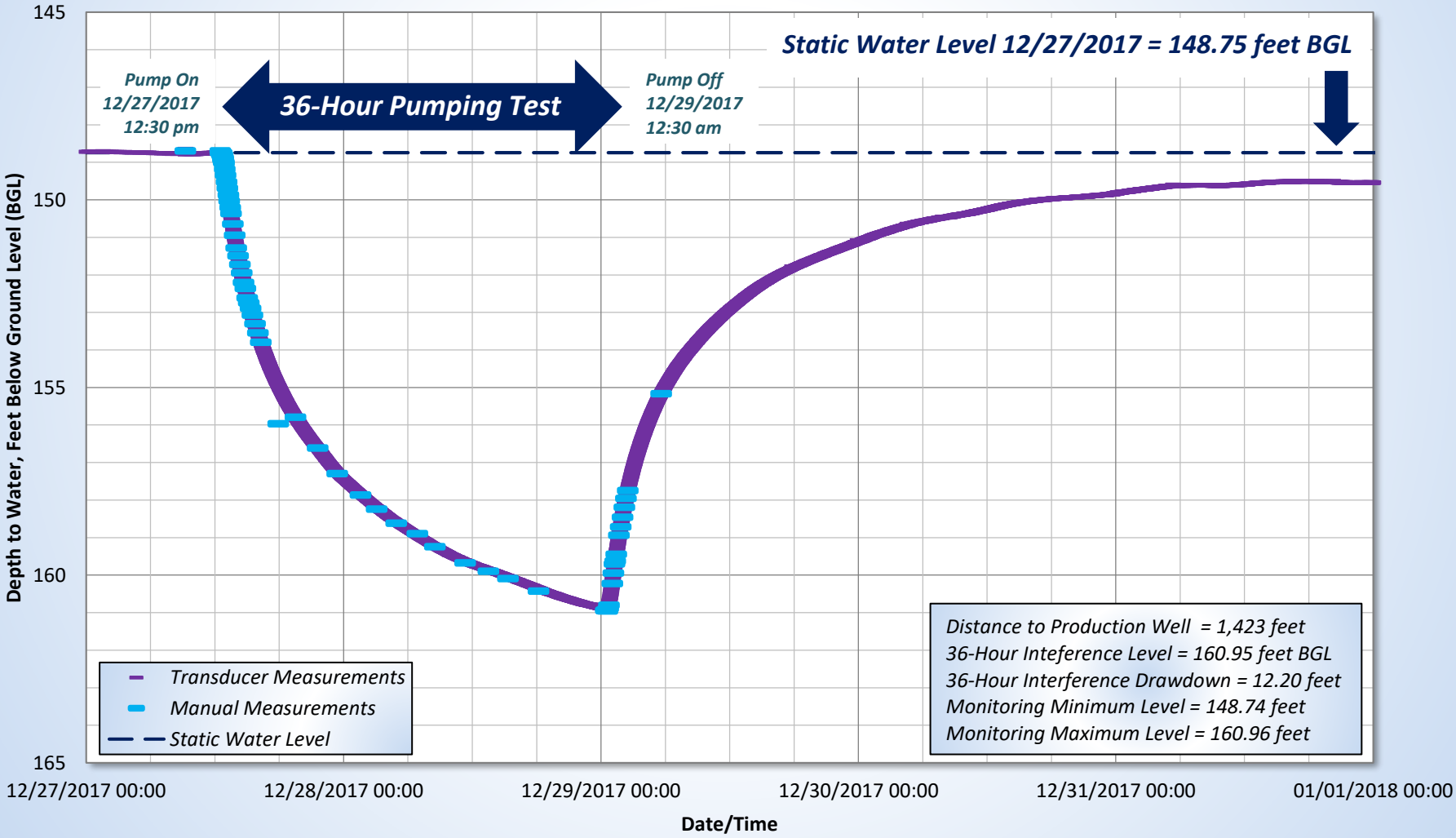
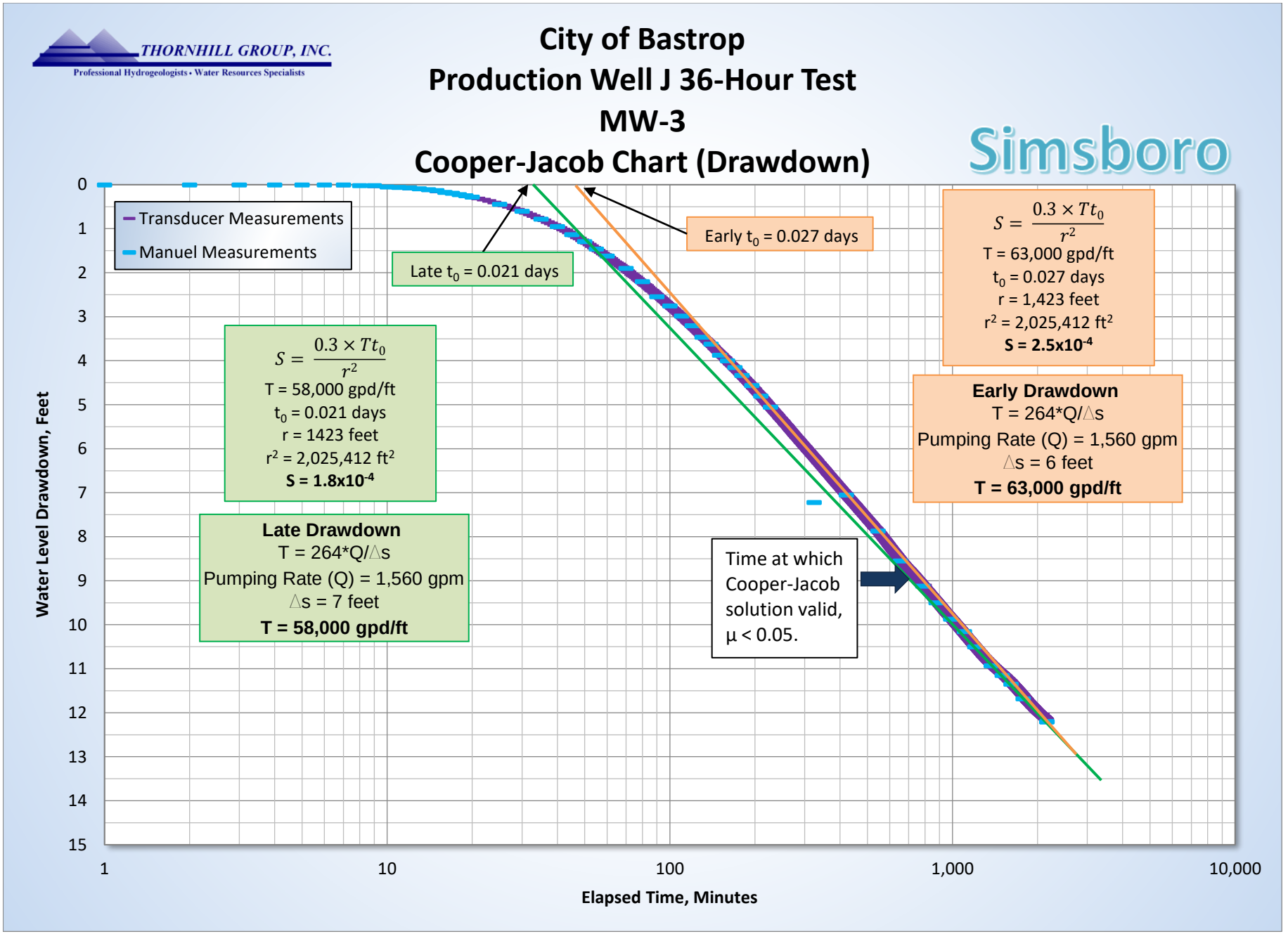
# City of Bastrop
# Well J Production Well 36-Hour Test
# MW-3
# Hydrograph

Simsboro

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City of Bastrop
Production Well J 36-Hour Test
MW-3
Cooper-Jacob Chart (Drawdown)
Simsboro
Transducer Measurements
Manuel Measurements
Late $t_0$ = 0.021 days
Early $t_0$ = 0.027 days
$S = \frac{0.3 \times Tt_0}{r^2}$
T = 58,000 gpd/ft
$t_0$ = 0.021 days
r = 1423 feet
$r^2$ = 2,025,412 ft²
S = 1.8x10⁻⁴
Late Drawdown
T = 264*Q/△s
Pumping Rate (Q) = 1,560 gpm
△s = 7 feet
T = 58,000 gpd/ft
$S = \frac{0.3 \times Tt_0}{r^2}$
T = 63,000 gpd/ft
$t_0$ = 0.027 days
r = 1,423 feet
$r^2$ = 2,025,412 ft²
S = 2.5x10⁻⁴
Early Drawdown
T = 264*Q/△s
Pumping Rate (Q) = 1,560 gpm
△s = 6 feet
T = 63,000 gpd/ft
Time at which Cooper-Jacob solution valid, μ < 0.05.
Water Level Drawdown, Feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
1
10
100
1,000
10,000
Elapsed Time, Minutes

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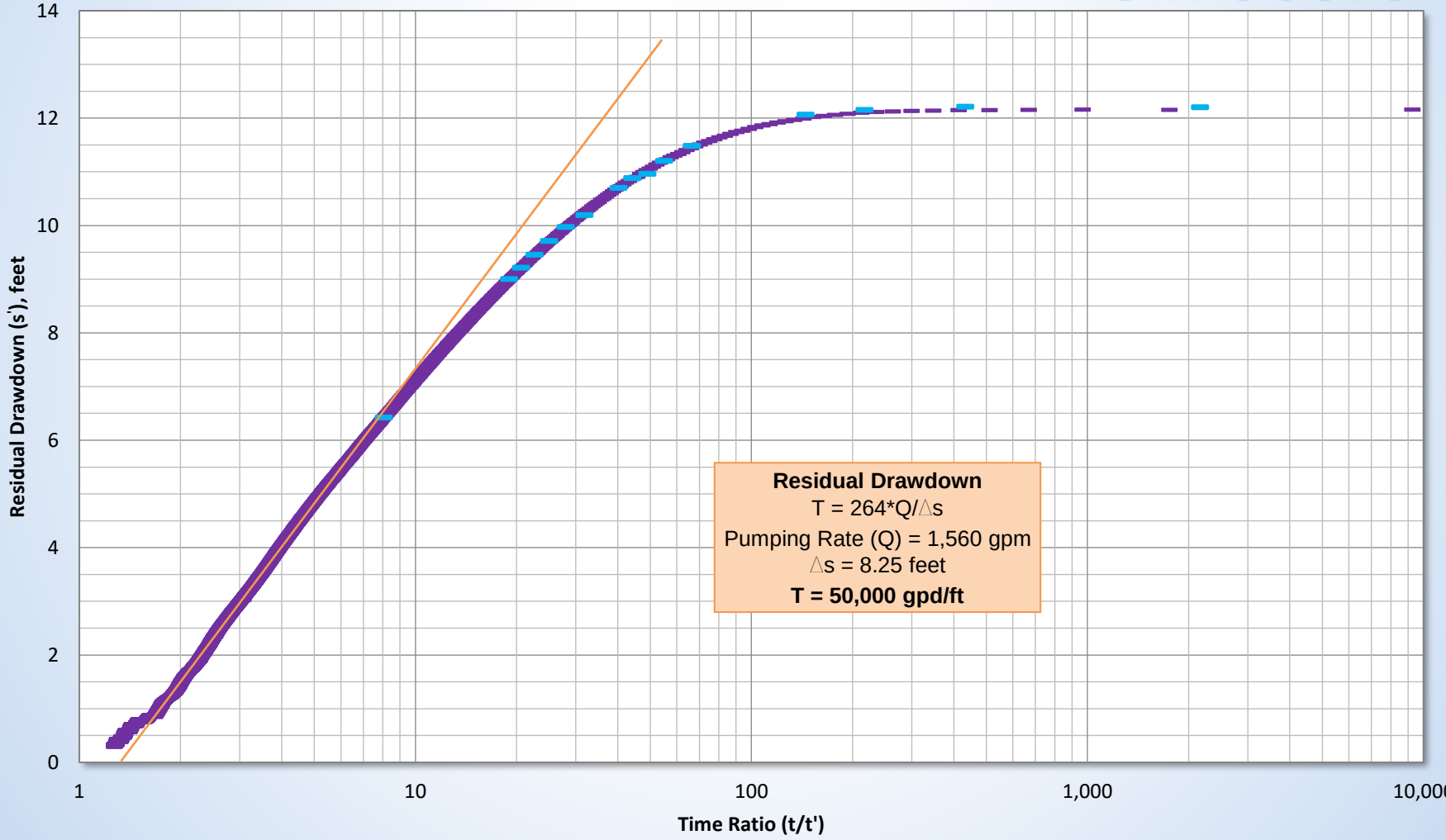
# City of Bastrop
# Production Well J 36 Hour Test
# MW-3
# Cooper-Jacob Chart (Recovery)

Simsboro



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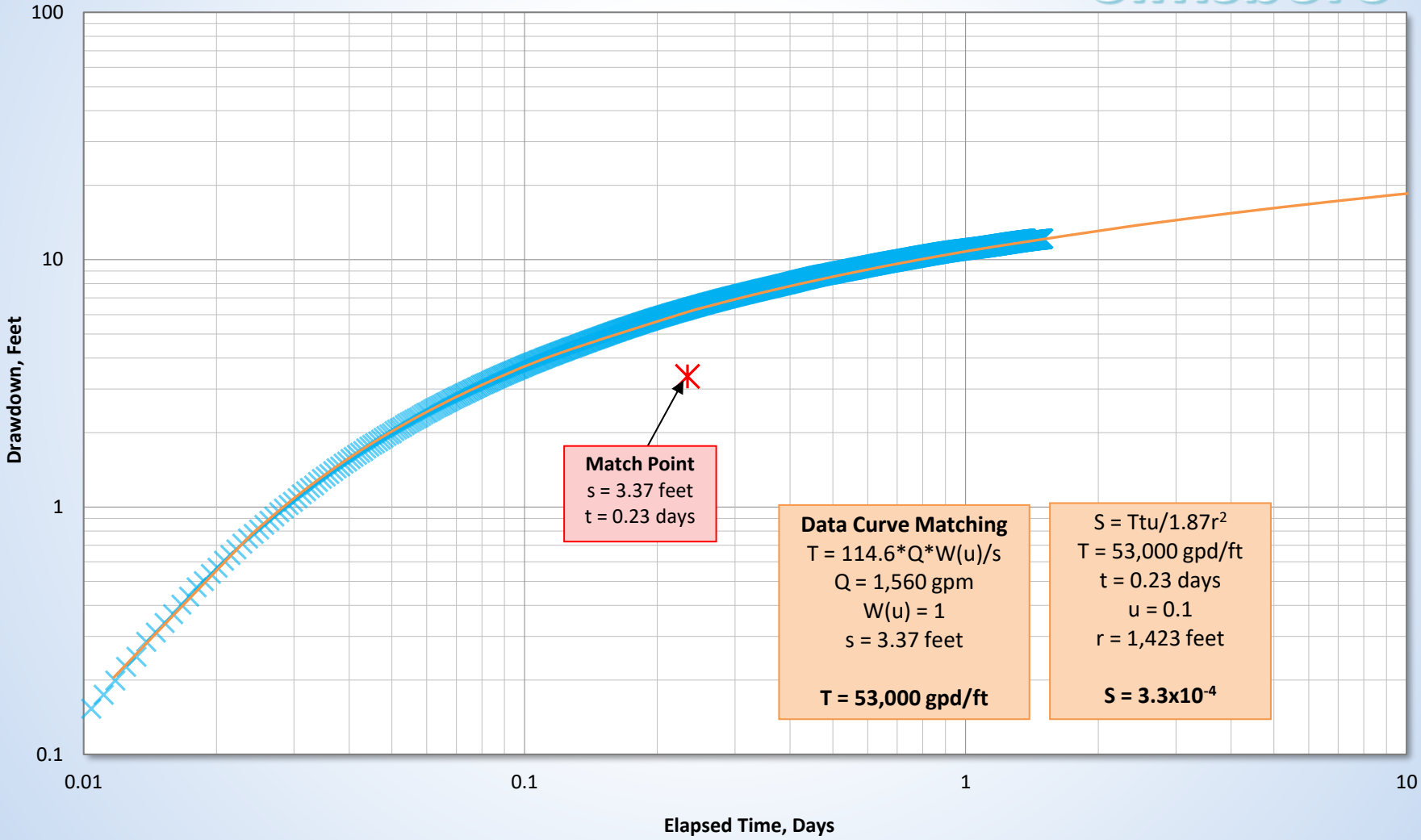
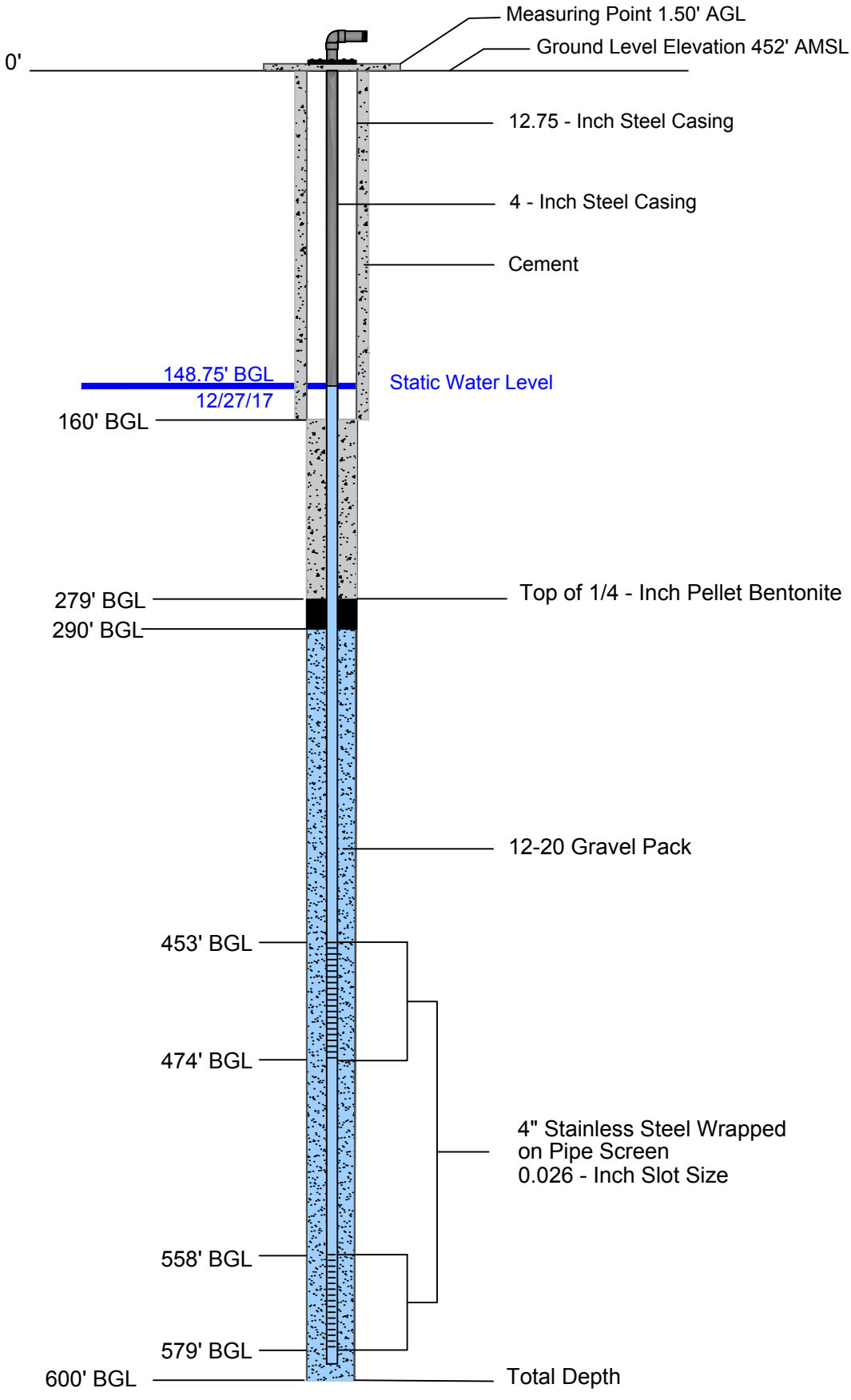
# City of Bastrop
# Production Well J Well 36-Hour Test
# MW-3
# Theis Curve

Simsboro



# City of Bastrop MW-3




Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Name: MW-3
Distance from Well J: 1,423.17 feet
Static Water Level 12/27/2017: 148.75 feet BGL
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors

# City of Bastrop
## Pioneer Foundation Well
## 36-Hour Drawdown and Recovery Results

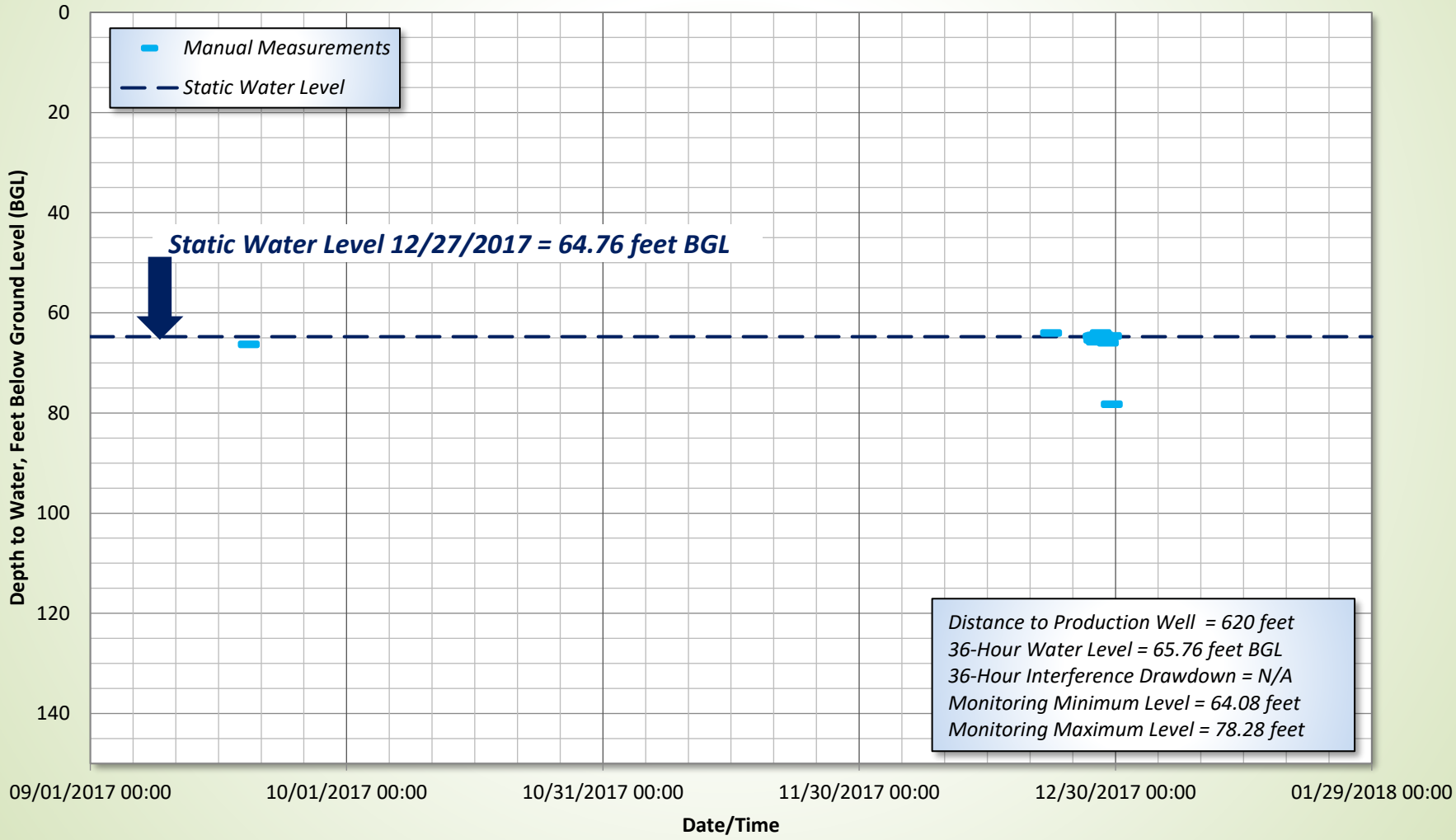
**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 620 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/19/2017 13:21 | 66.33 | Background |
| 12/22/2017 10:45 | 64.08 | Background |
| 12/27/2017 10:28 | 64.76 | Static Water Level |
| 12/27/2017 12:46 | 65.43 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 15:45 | 64.68 | |
| 12/27/2017 17:46 | 64.60 | |
| 12/27/2017 19:25 | 65.79 | |
| 12/27/2017 21:30 | 64.63 | |
| 12/27/2017 23:15 | 64.58 | |
| 12/28/2017 2:00 | 64.58 | |
| 12/28/2017 4:15 | 64.47 | |
| 12/28/2017 6:32 | 64.08 | |
| 12/28/2017 8:46 | 64.68 | |
| 12/28/2017 11:30 | 64.51 | |
| 12/28/2017 13:10 | 65.03 | |
| 12/28/2017 20:16 | 65.35 | |
| 12/29/2017 0:17 | 65.76 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 2:46 | 66.00 | |
| 12/29/2017 8:12 | 64.73 | |
| 12/29/2017 11:08 | 64.63 | |
| 12/29/2017 13:20 | 78.28 | Pump might have kicked on. |

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854815 / Pioneer Foundation
# Hydrograph

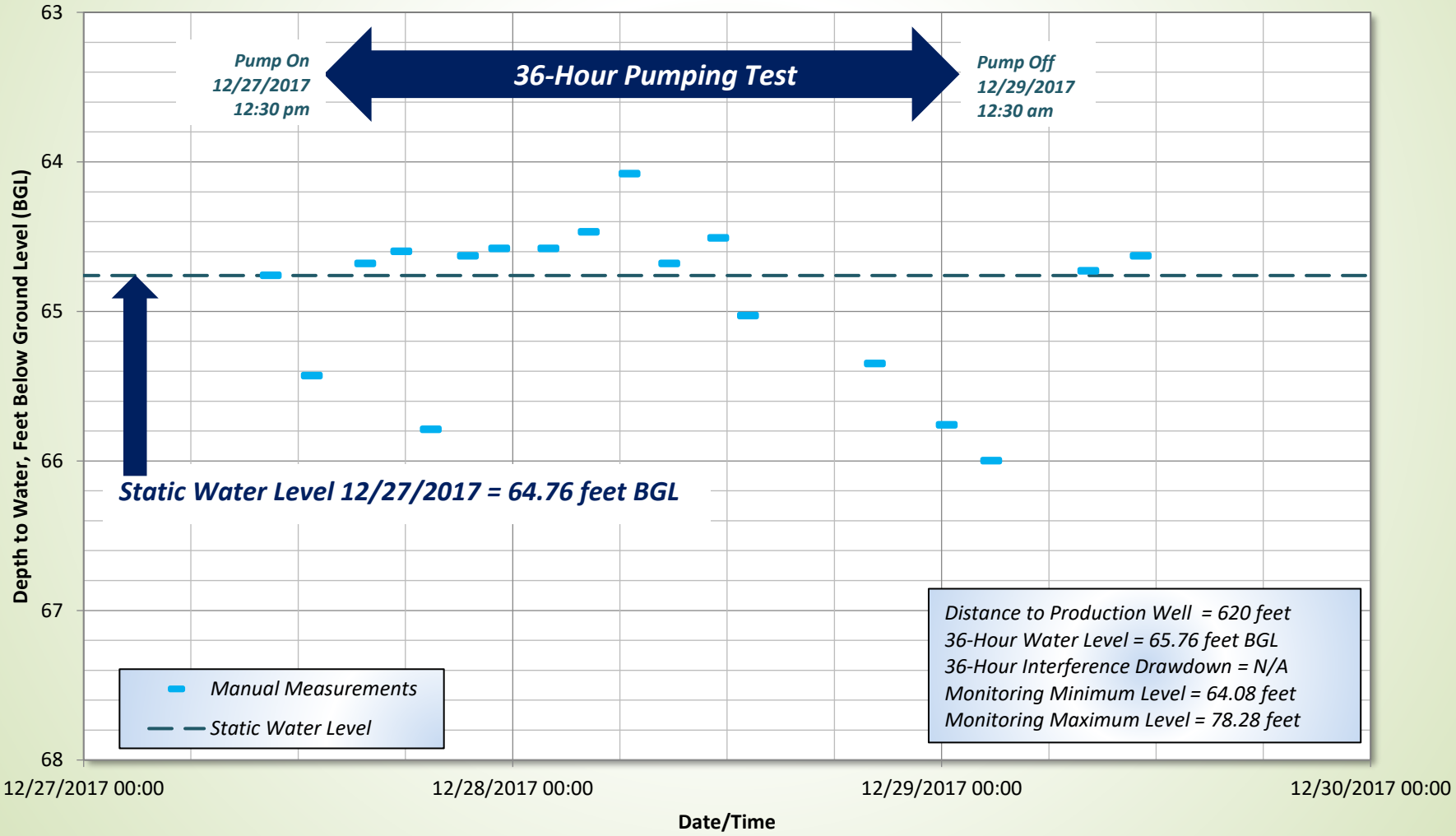
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854815 / Pioneer Foundation
# Hydrograph

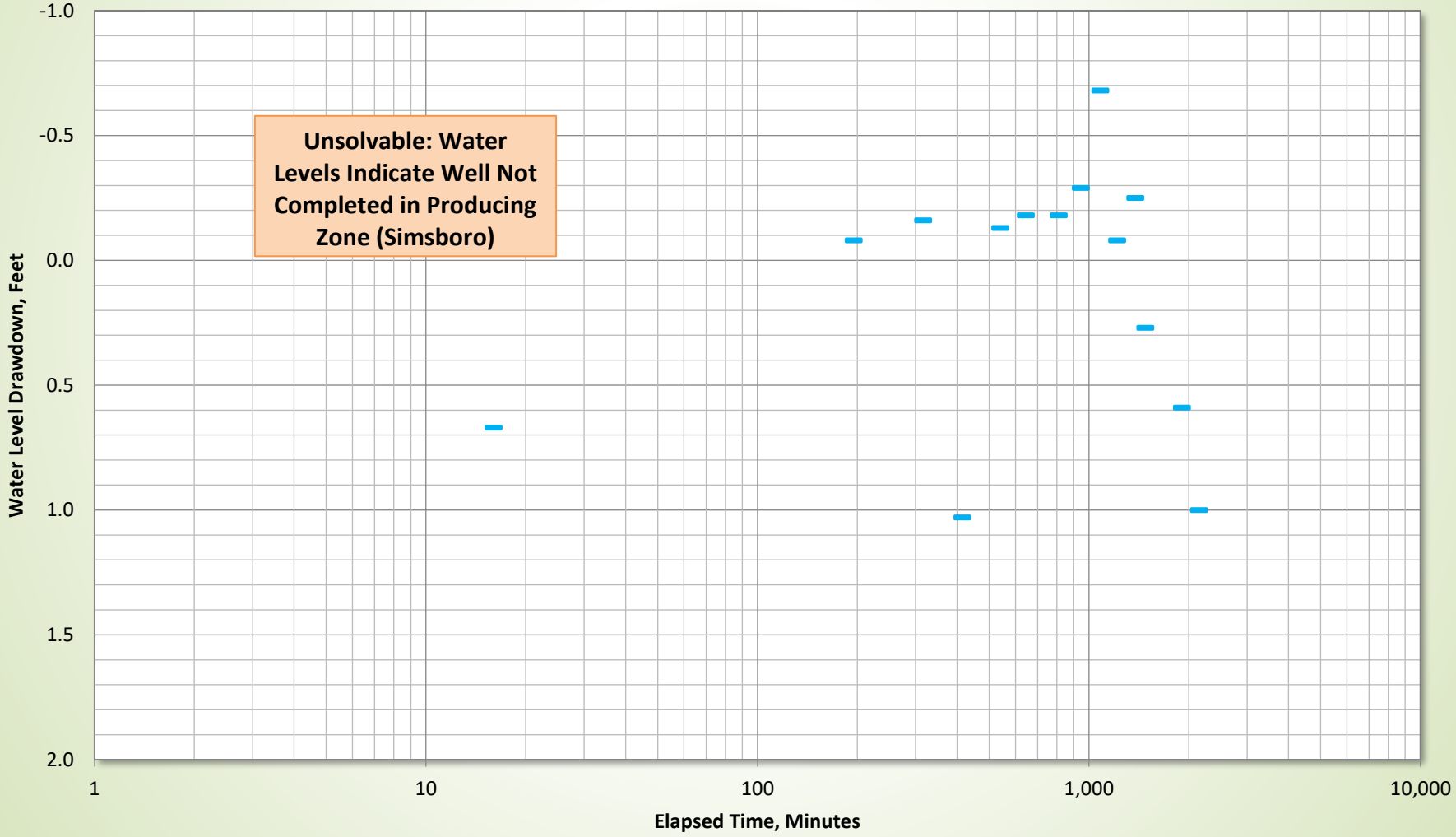
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854815 / Pioneer Foundation
## Cooper-Jacob Chart (Drawdown)

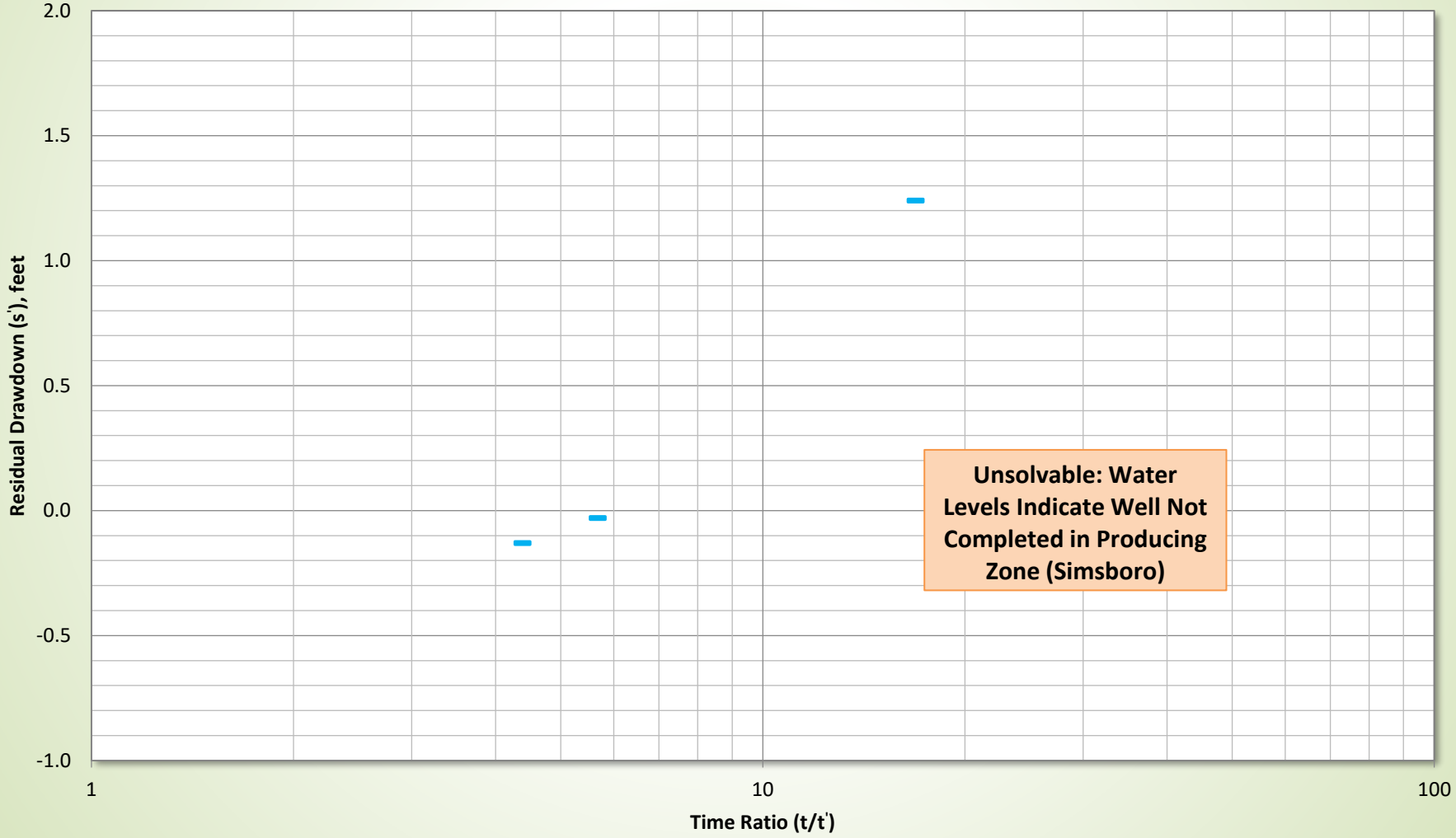
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854815 / Pioneer Foundation
## Cooper-Jacob Chart (Recovery)

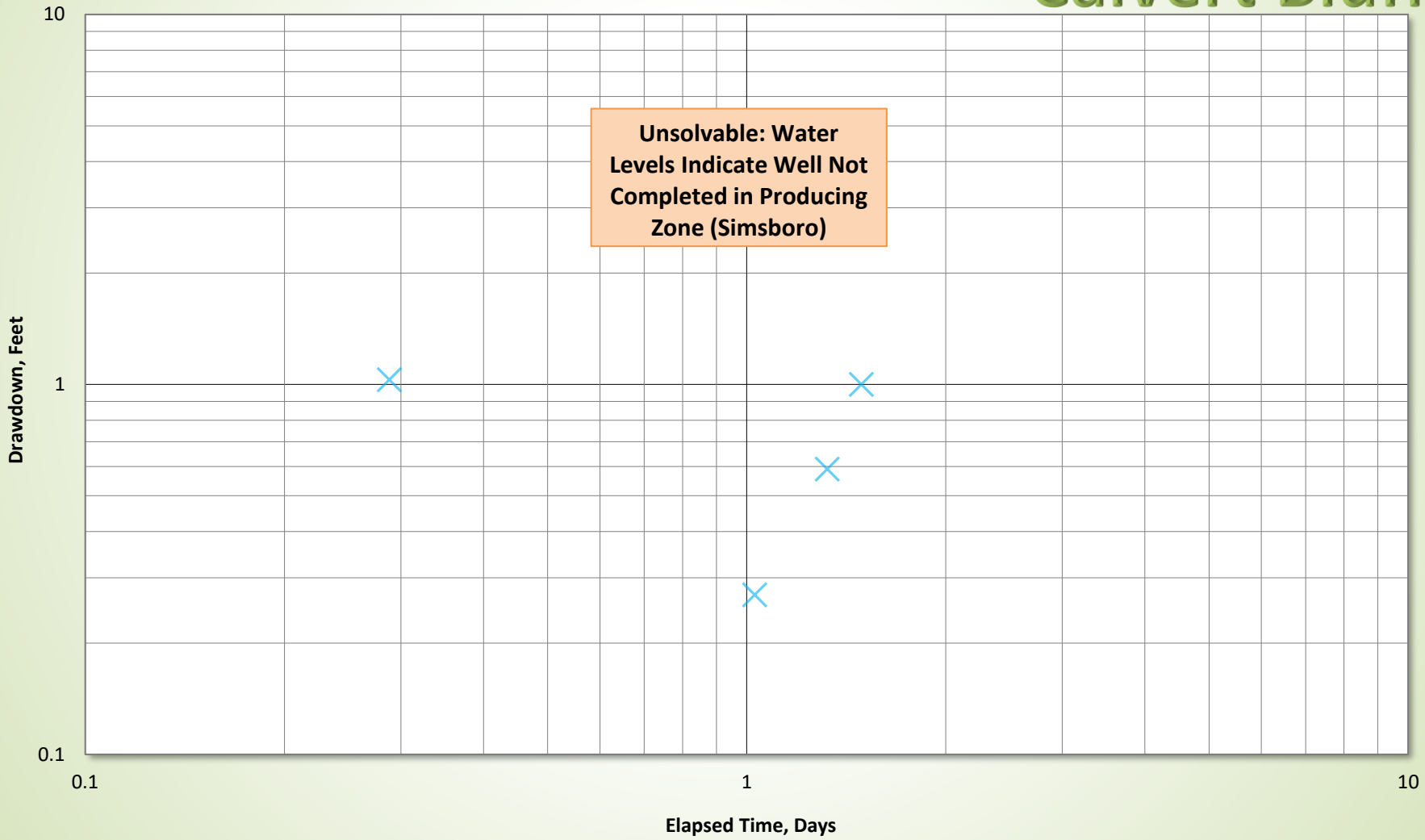
Calvert Bluff



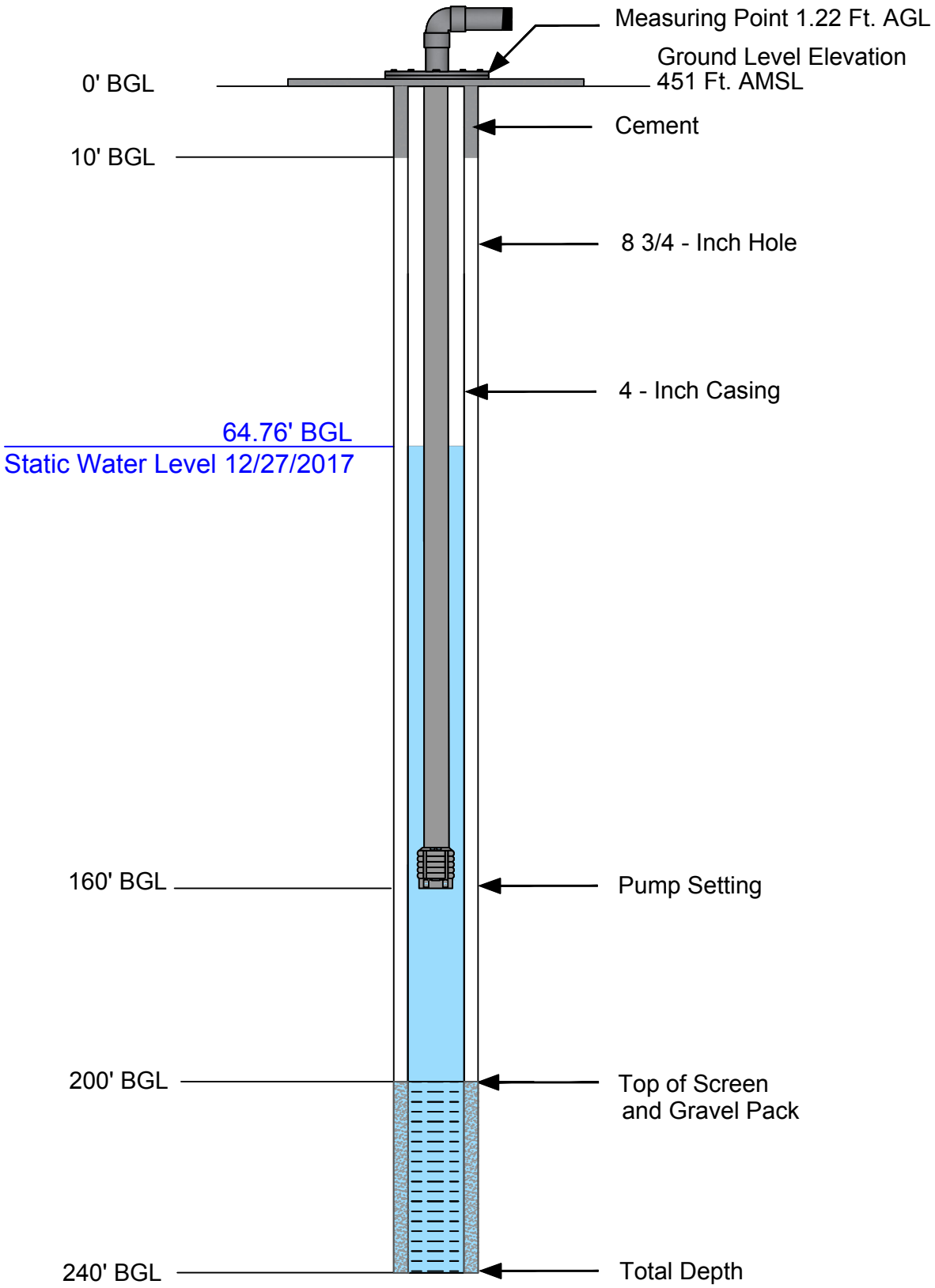
THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854815 / Pioneer Foundation
## Theis Curve

Calvert Bluff



# LPGCD Well 5854815 / Pioneer Foundation




Well construction details compiled from State of Texas Well Report, LPGCD records, owner, and/or TGI field investigations.

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists


Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Name: Pioneer Foundation
Distance from Well J: 620.49 feet
Static Water Level 12/27/2017: 64.76 feet BGL
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors

# City of Bastrop
## Tommy Odom Well
## 36-Hour Drawdown and Recovery Results

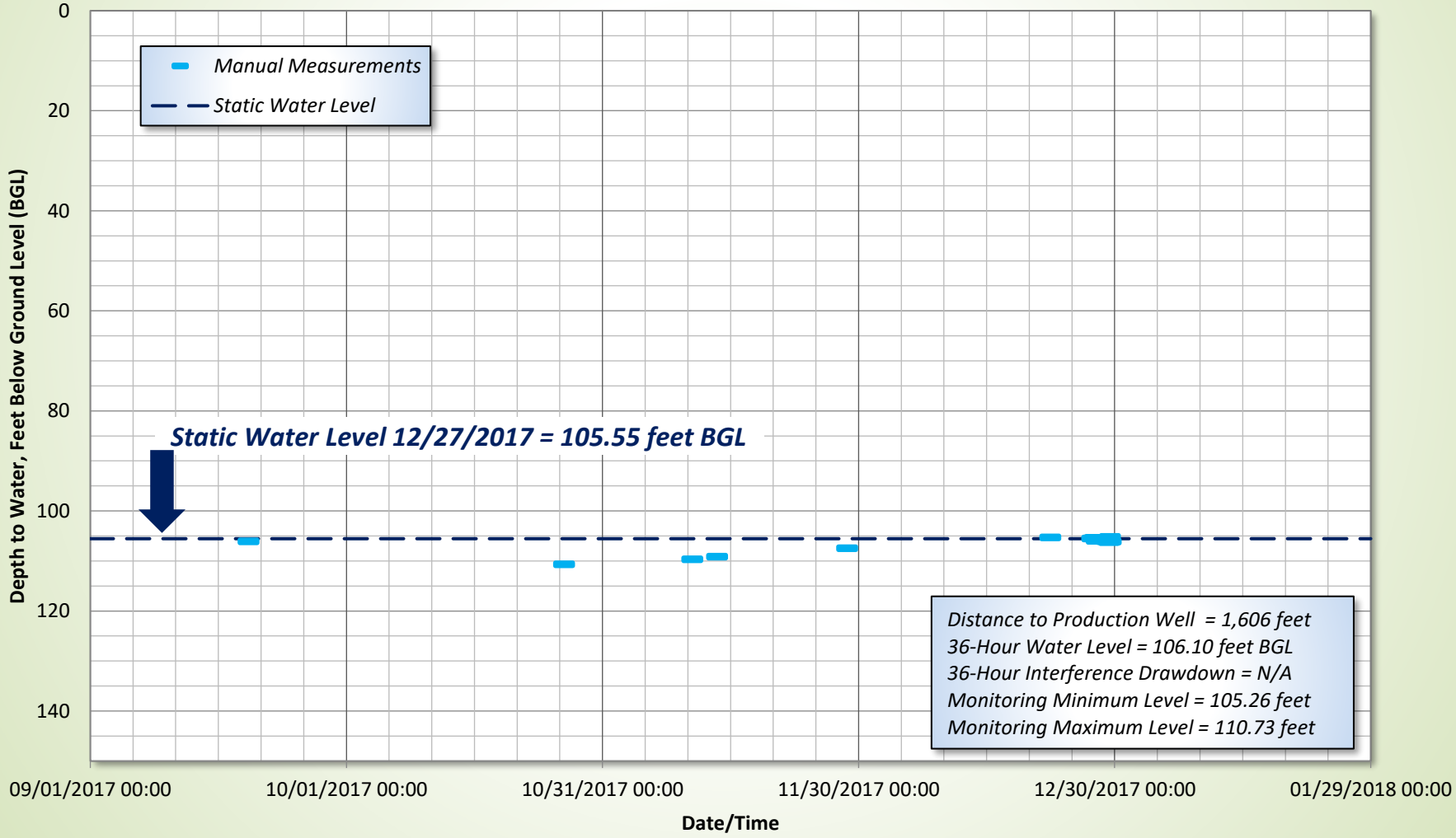
**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 1,606 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/19/2017 12:35 | 106.15 | Background |
| 10/26/2017 12:09 | 110.73 | Background |
| 11/10/2017 12:48 | 109.70 | Background |
| 11/13/2017 10:03 | 109.20 | Background |
| 11/28/2017 15:48 | 107.52 | Background |
| 12/22/2017 11:03 | 105.32 | Background |
| 12/27/2017 8:41 | 105.55 | Static Water Level |
| 12/27/2017 12:56 | 105.55 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 15:52 | 105.43 | |
| 12/27/2017 17:42 | 105.44 | |
| 12/27/2017 19:21 | 105.47 | |
| 12/27/2017 21:25 | 106.01 | |
| 12/27/2017 23:10 | 105.62 | |
| 12/28/2017 1:49 | 105.64 | |
| 12/28/2017 4:13 | 105.92 | |
| 12/28/2017 6:28 | 105.82 | |
| 12/28/2017 8:53 | 105.85 | |
| 12/28/2017 11:35 | 105.82 | |
| 12/28/2017 13:16 | 105.82 | |
| 12/28/2017 20:10 | 106.00 | |
| 12/29/2017 0:10 | 106.10 | |
| 12/29/2017 2:50 | 106.06 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 8:06 | 106.27 | |
| 12/29/2017 11:01 | 105.26 | |
| 12/29/2017 13:15 | 106.21 | |

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854809 / Tommy Odom
# Hydrograph

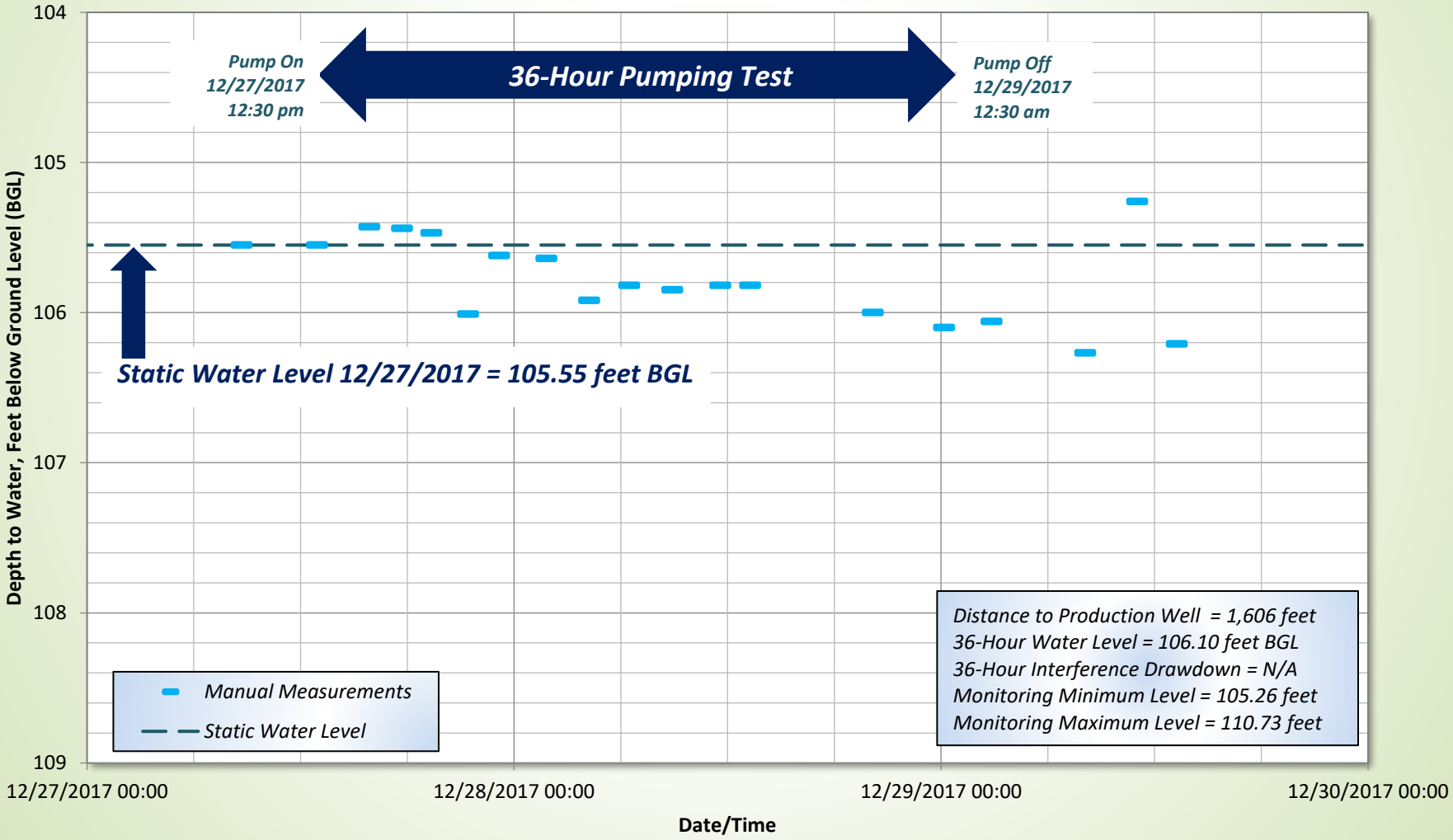
## Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854809 / Tommy Odom
# Hydrograph

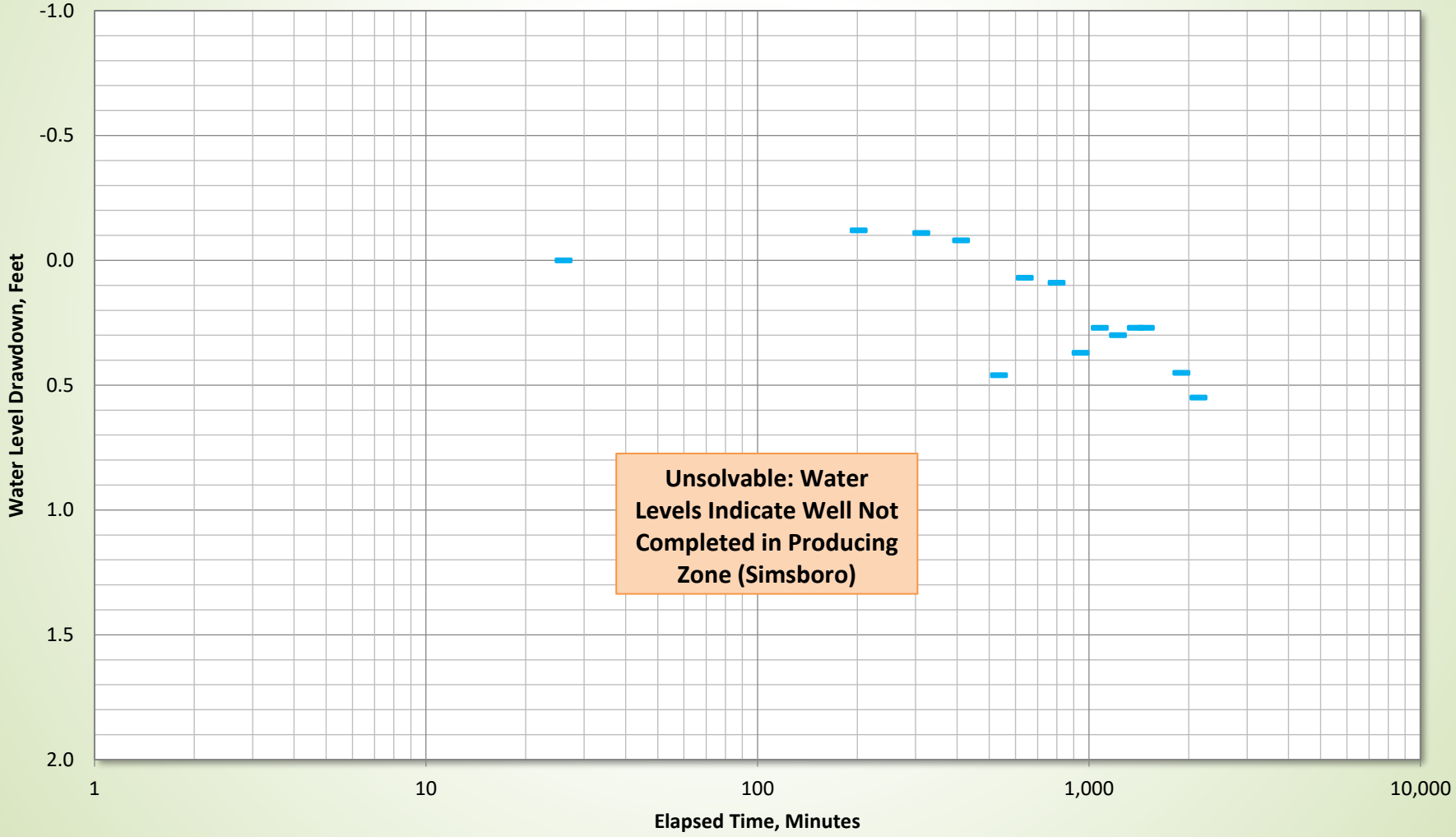
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854809 / Tommy Odom
## Cooper-Jacob Chart (Drawdown)

Calvert Bluff



THORNHILL GROUP, INC.
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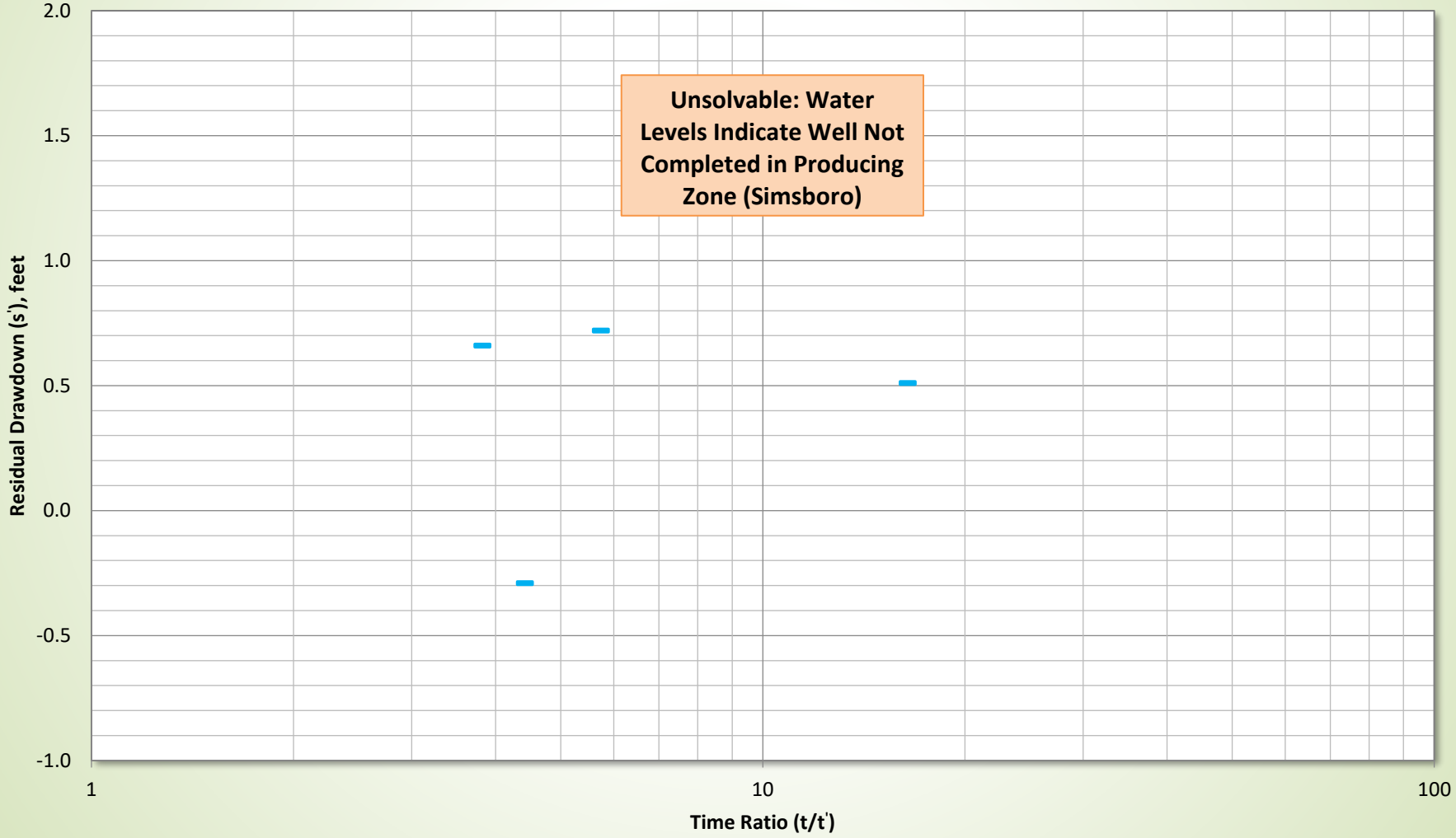
# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854809 / Tommy Odom
## Cooper-Jacob Chart (Recovery)

Calvert Bluff



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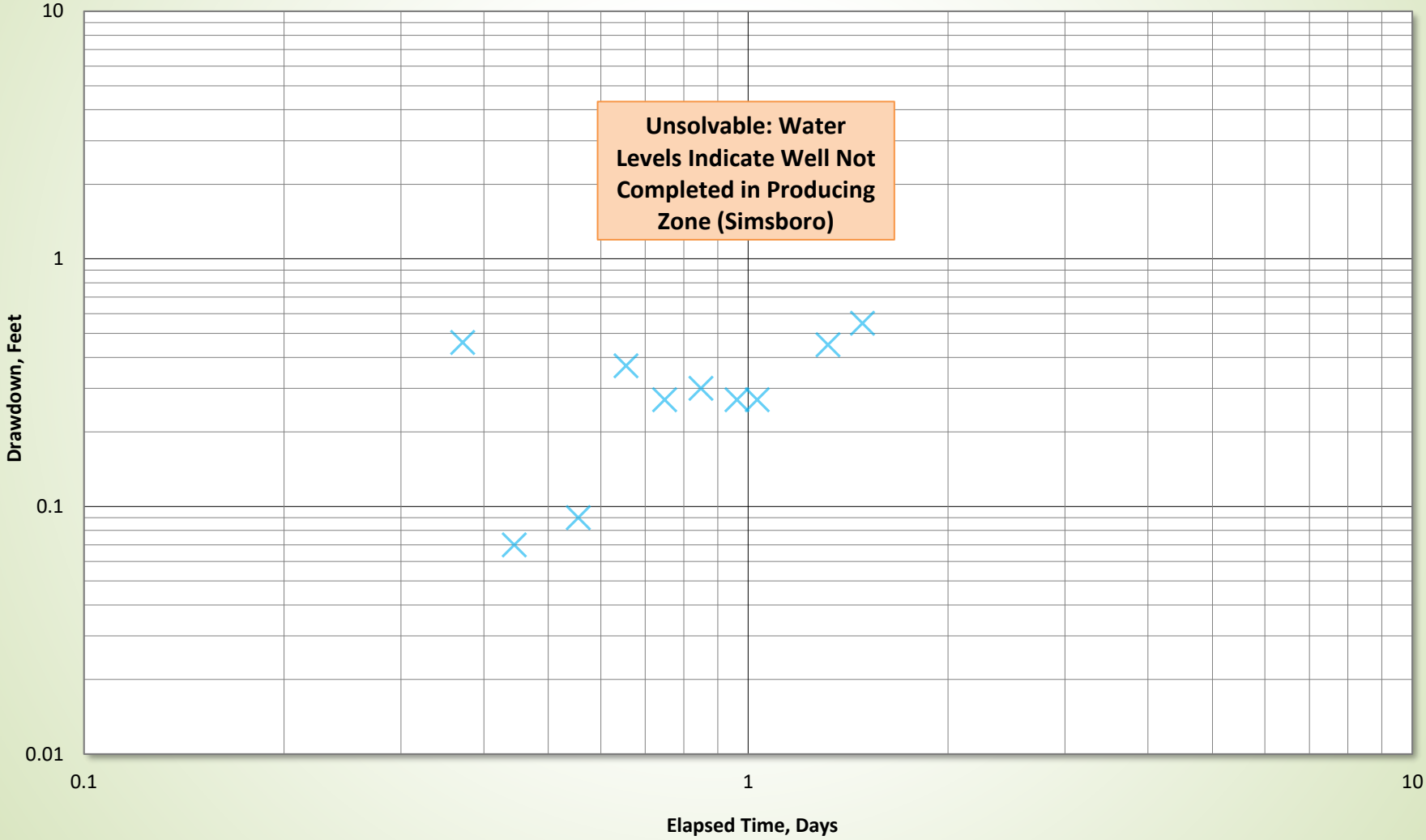
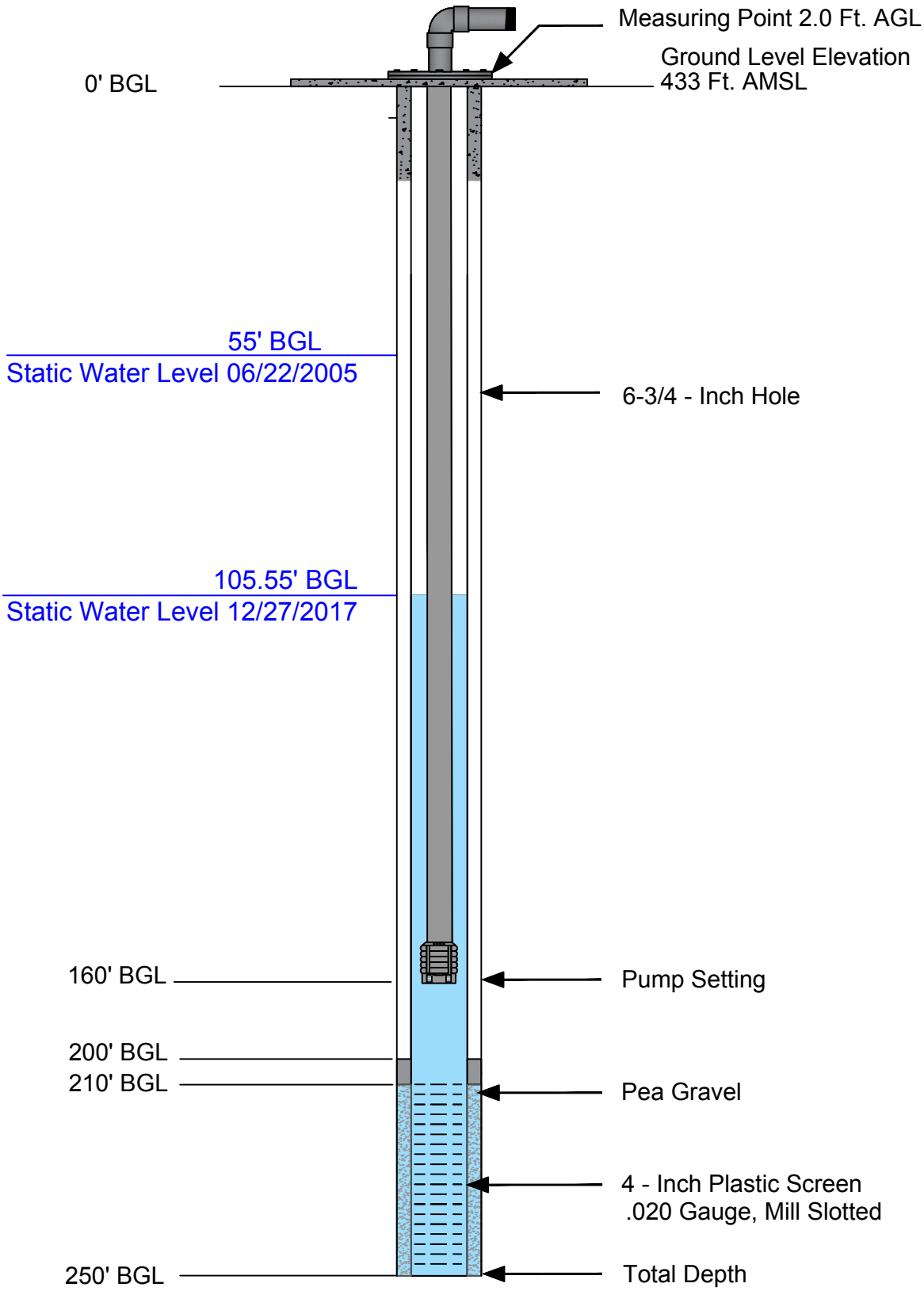
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854809 / Tommy Odom
## Theis Curve

Calvert Bluff



# LPGCD Well 5854809 / Tommy Odom




Well construction details compiled from State of Texas Well Report, LPGCD records, owner, and/or TGI field investigations.

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists


Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Name: Tommy Odom
Distance from Well J: 1,606.80 feet
Static Water Level 12/27/2017: 105.55 feet BGL
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## Jimmy Odom Well
## 36-Hour Drawdown and Recovery Results

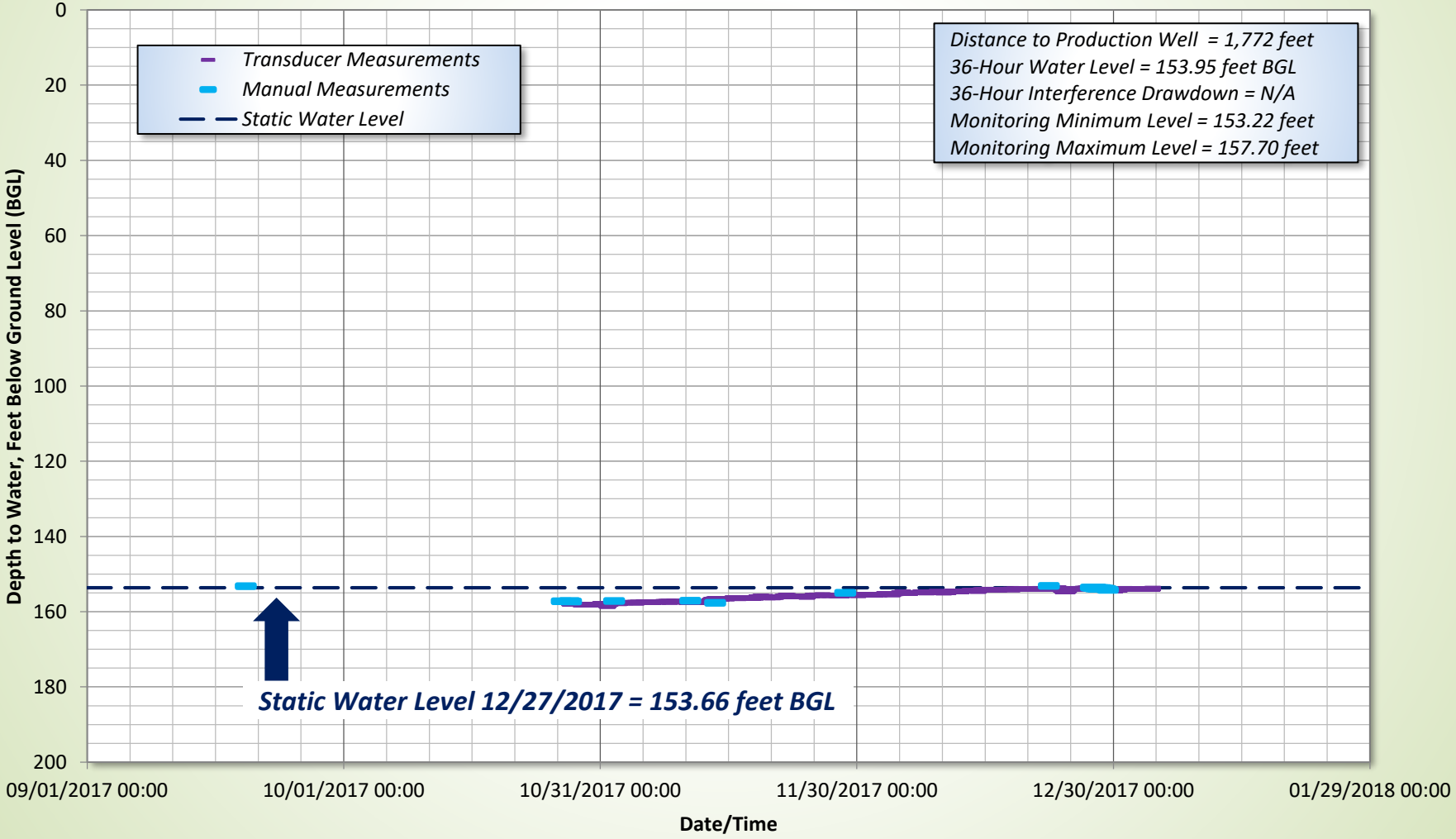
**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 1,772 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/19/2017 12:48 | 153.31 | Background |
| 10/26/2017 11:56 | 157.30 | Background |
| 10/27/2017 13:55 | 157.35 | Background |
| 10/27/2017 9:25 | 157.25 | Background |
| 11/1/2017 14:30 | 157.24 | Background |
| 11/10/2017 12:35 | 157.15 | Background |
| 11/13/2017 10:00 | 157.70 | Background |
| 11/28/2017 15:43 | 155.05 | Background |
| 12/22/2017 10:52 | 153.22 | Background |
| 12/27/2017 8:44 | 153.66 | Static Water Level |
| 12/27/2017 13:00 | 153.70 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 15:54 | 153.60 | |
| 12/27/2017 17:40 | 153.60 | |
| 12/27/2017 19:17 | 153.69 | |
| 12/27/2017 21:16 | 153.90 | |
| 12/27/2017 23:08 | 154.66 | |
| 12/28/2017 4:05 | 153.98 | |
| 12/28/2017 6:24 | 153.80 | |
| 12/28/2017 8:56 | 153.95 | |
| 12/28/2017 11:45 | 153.82 | |
| 12/28/2017 13:19 | 153.80 | |
| 12/28/2017 20:05 | 153.94 | |
| 12/29/2017 0:06 | 153.95 | |
| 12/29/2017 2:58 | 154.02 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 8:03 | 154.25 | |
| 12/29/2017 10:57 | 154.20 | |
| 12/29/2017 13:10 | 154.20 | |
| 1/3/2018 14:15 | 153.75 | |

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854826 / Jimmy Odom
# Hydrograph

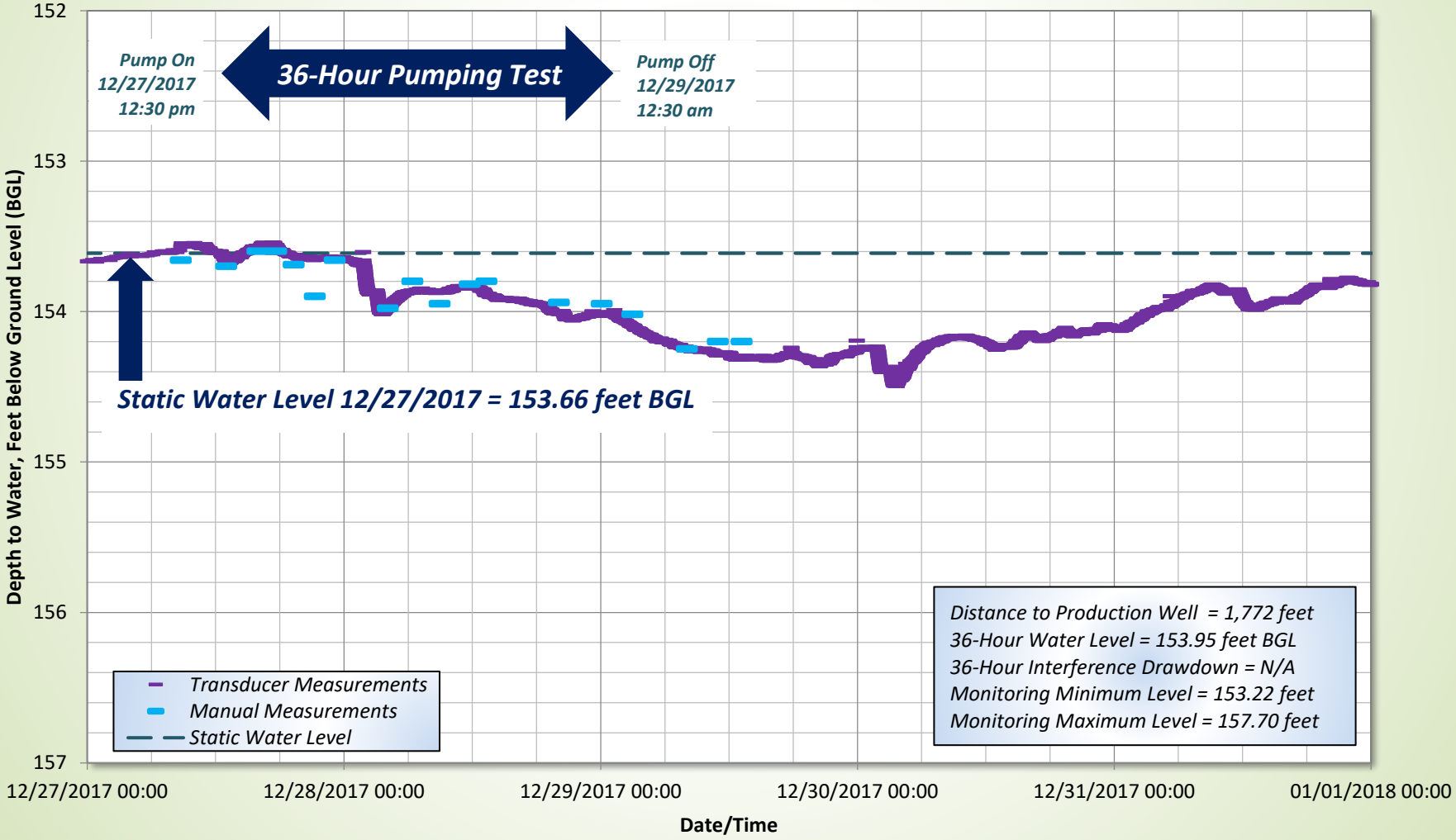
## Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854826 / Jimmy Odom
# Hydrograph

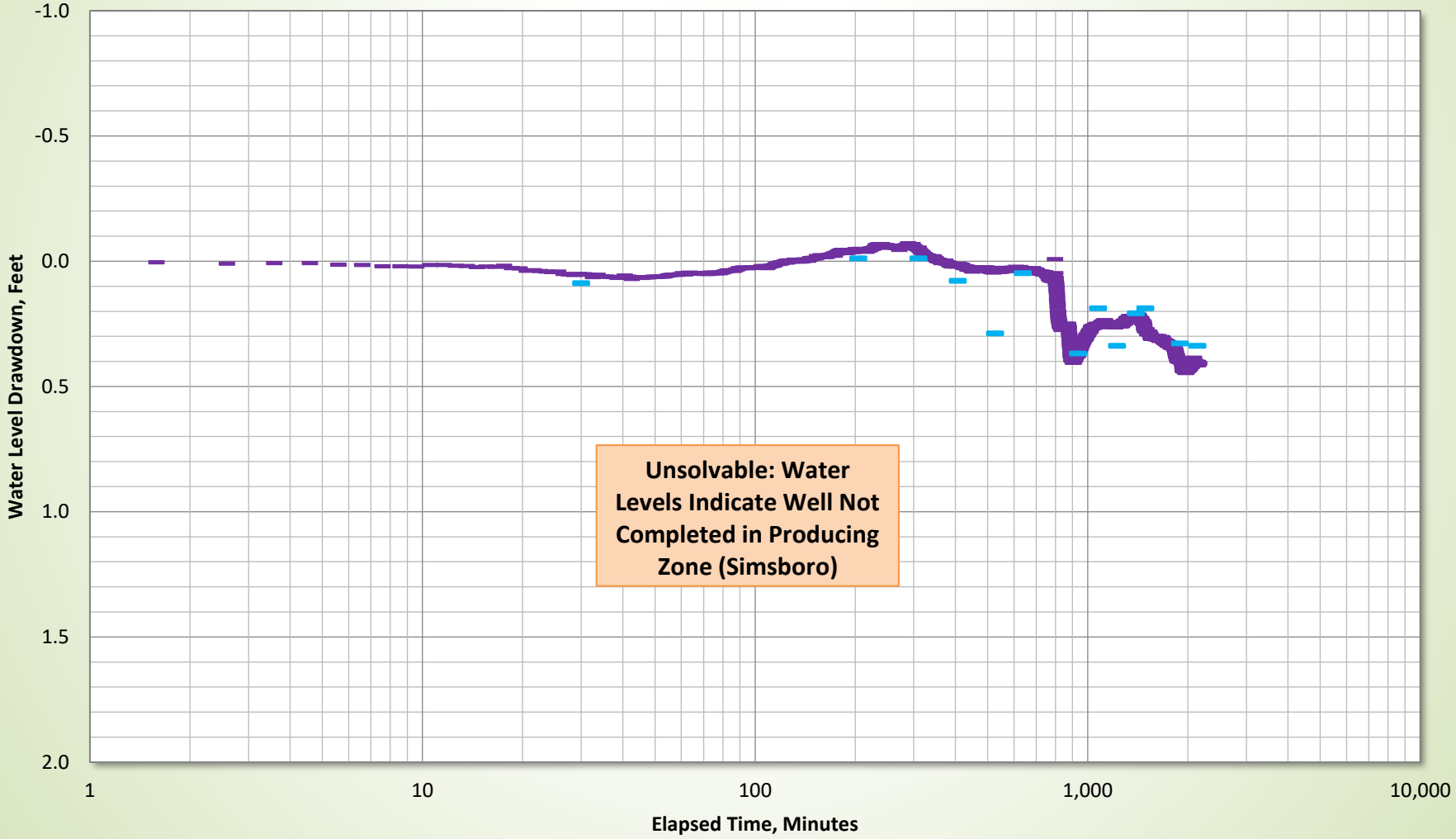
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854826 / Jimmy Odom
## Cooper-Jacob Chart (Drawdown)

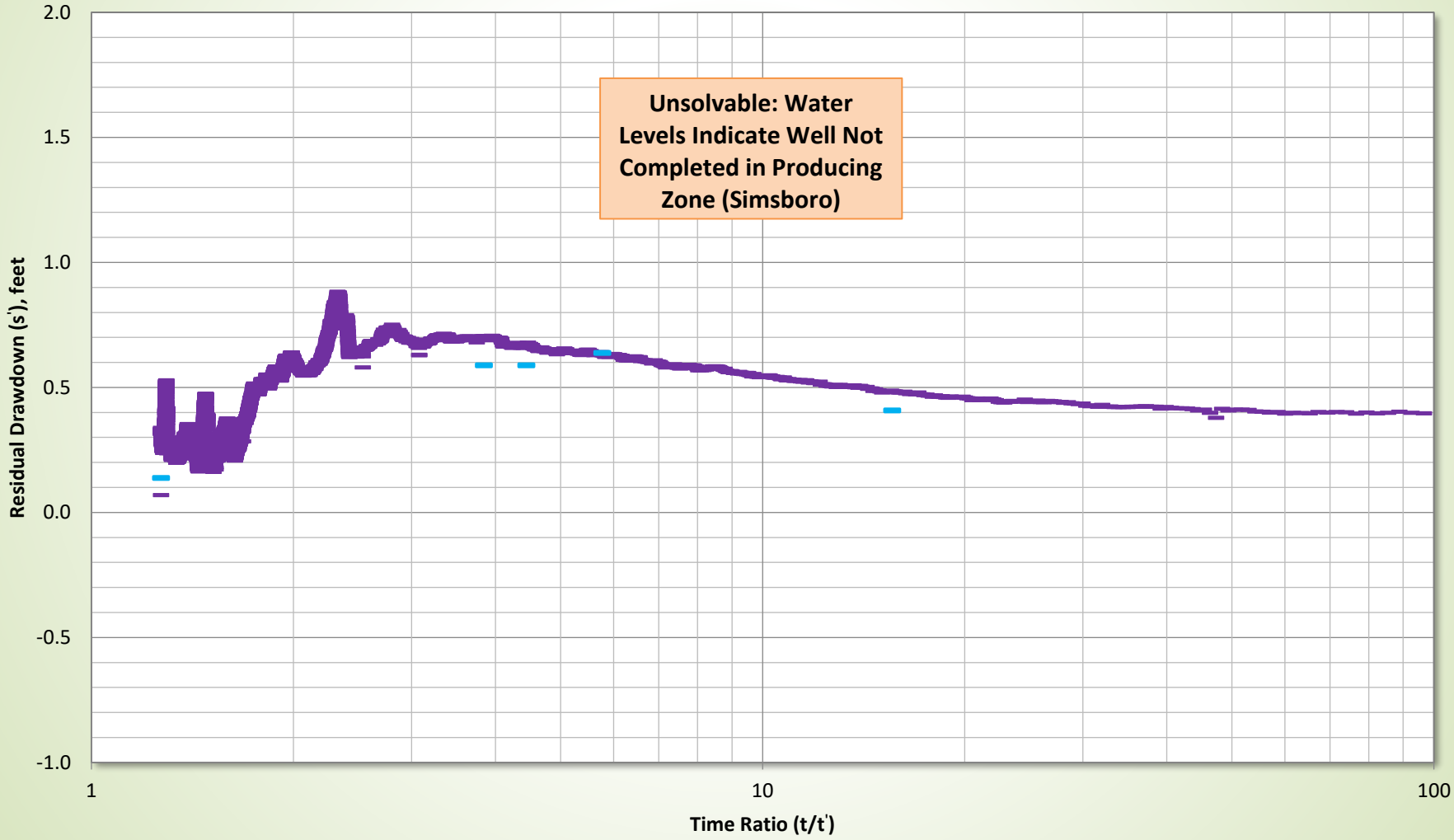
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854826 / Jimmy Odom
## Cooper-Jacob Chart (Recovery)

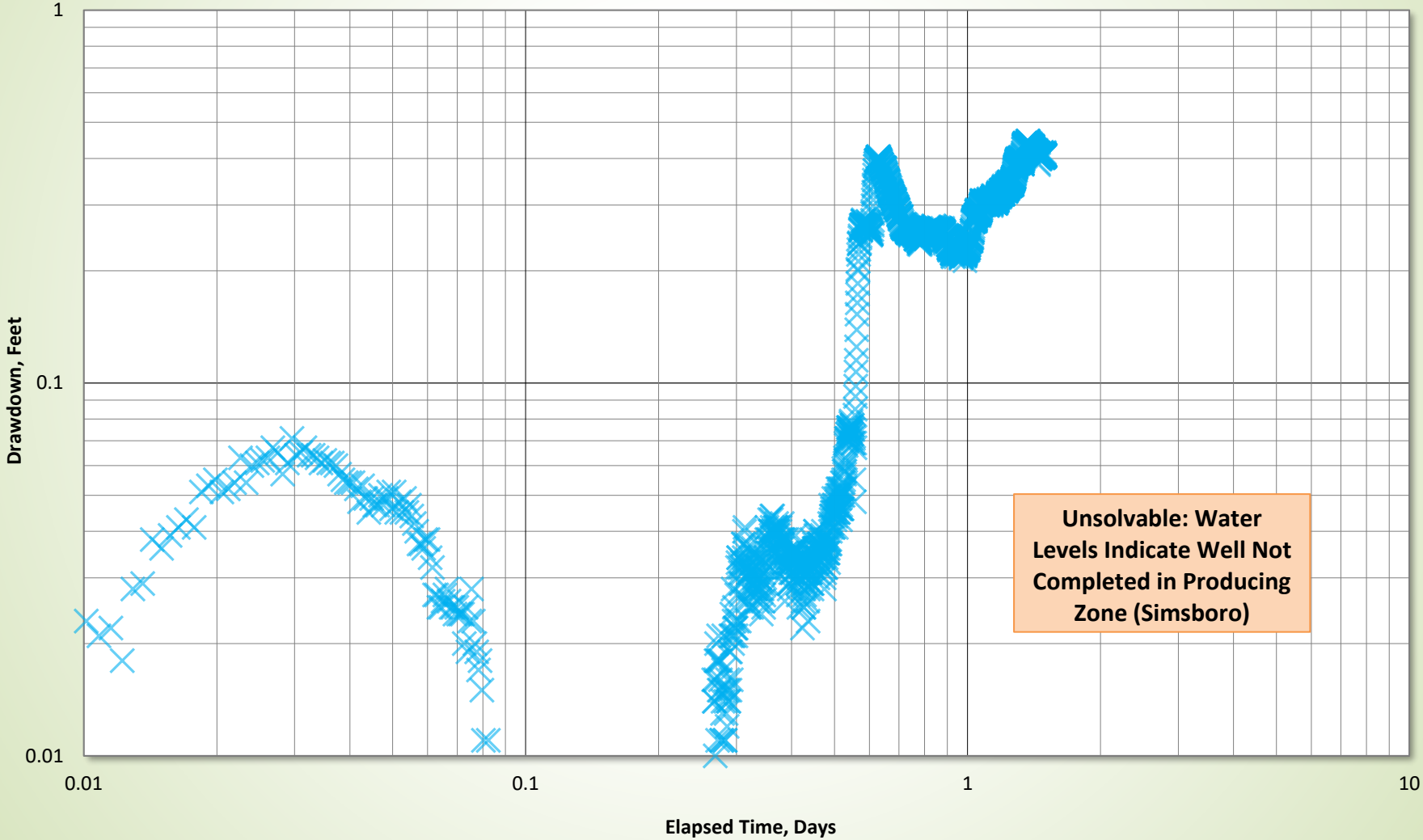
Calvert Bluff



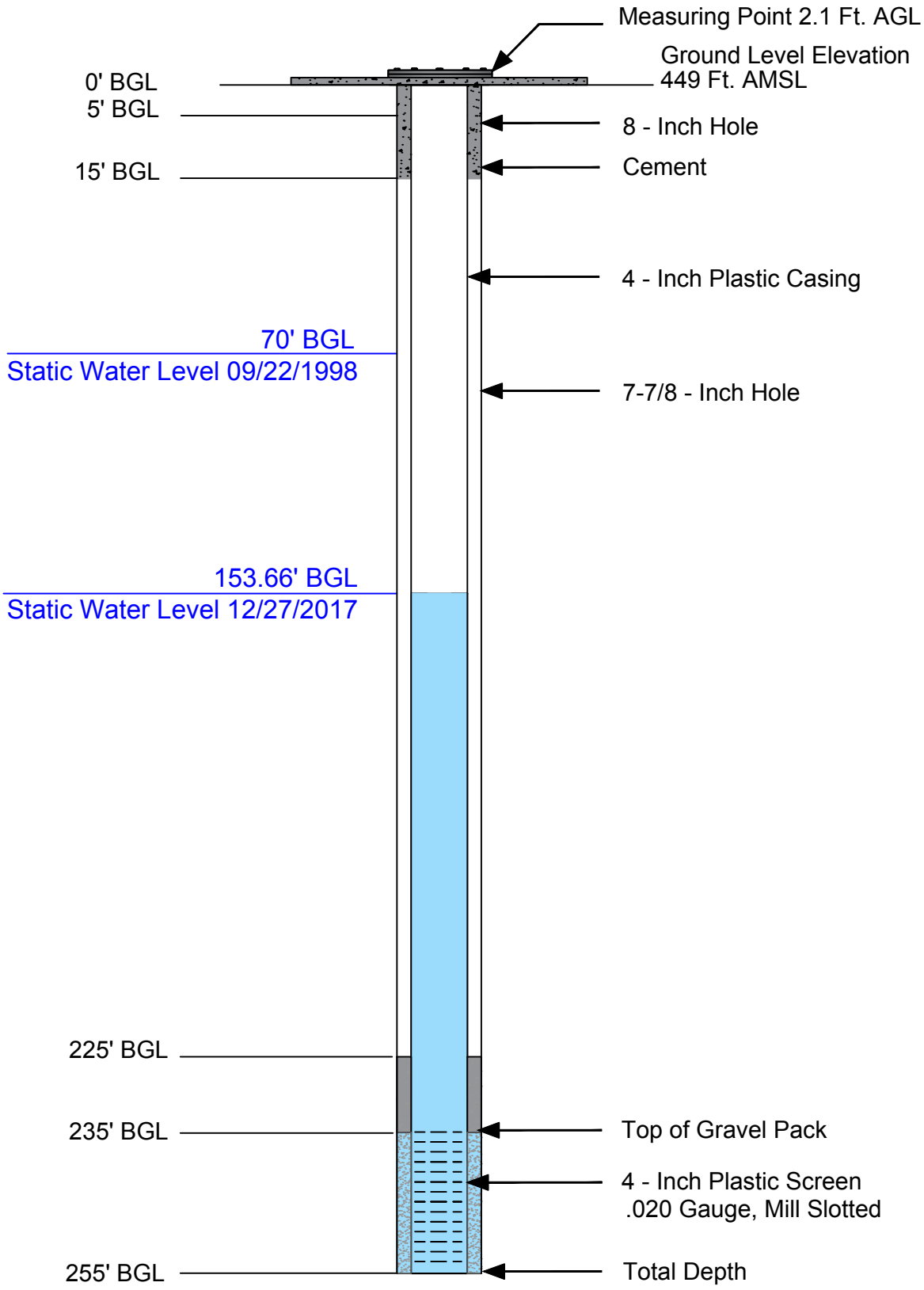
THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854826 / Jimmy Odom
## Theis Curve

Calvert Bluff



# LPGCD Well 5854826 / Jimmy Odom




Well construction details compiled from State of Texas Well Report, LPGCD records, owner, and/or TGI field investigations.

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists


Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Name: Jimmy Odom
Distance from Well J: 1,772.86 feet
Static Water Level 12/27/2017: 155.66 feet BGL
Sayers Rd
Old Perkins Rd
Smith Rd
Dorine Rd
Explanation
City of Bastrop
Well J
N
0
500
1,000
2,000
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## David Odom Well
## 36-Hour Drawdown and Recovery Results

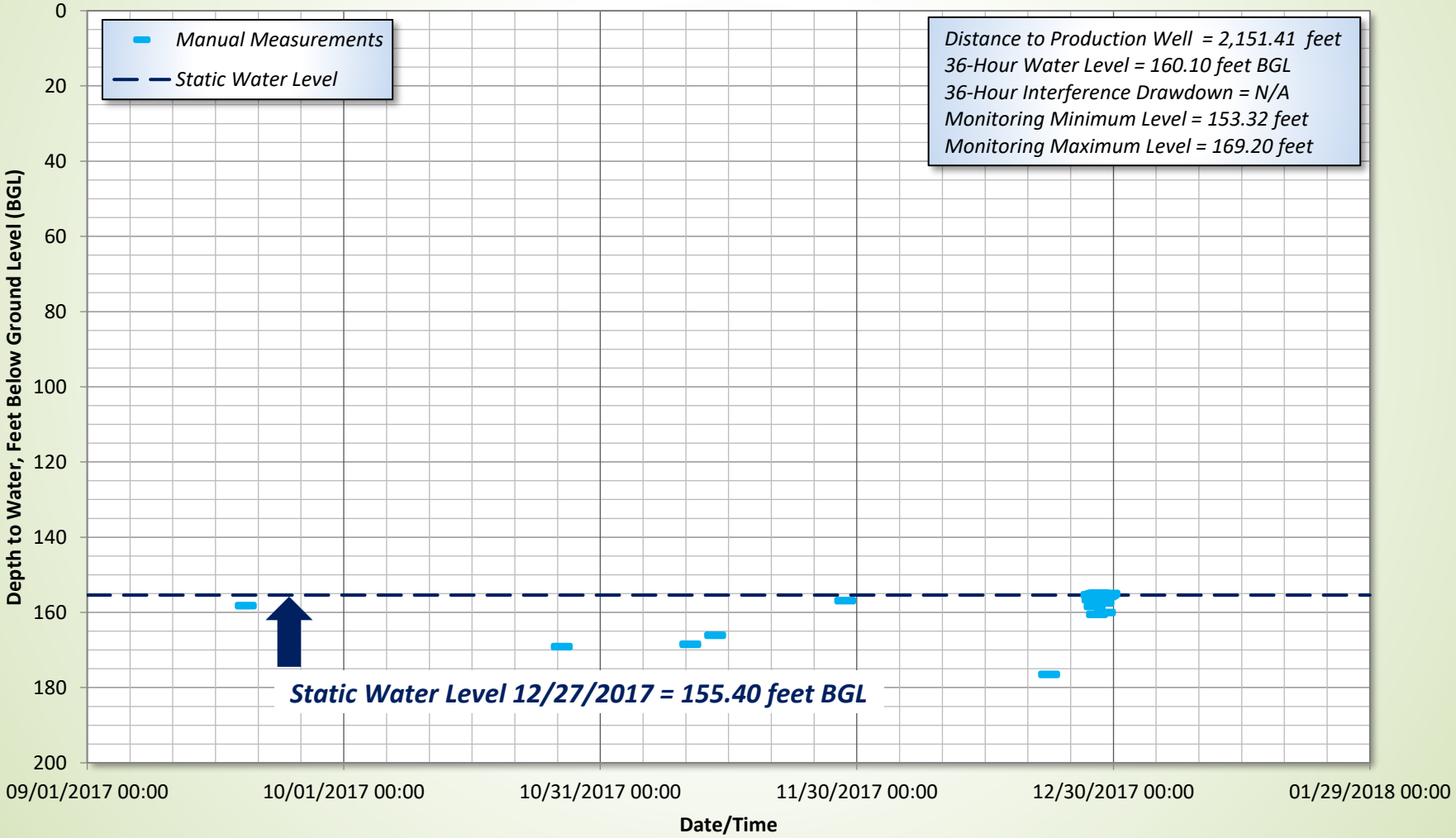
**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 2,151.42 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/19/2017 12:45 | 158.30 | Background |
| 10/26/2017 11:49 | 169.20 | Background |
| 11/10/2017 12:43 | 168.55 | Background |
| 11/13/2017 9:54 | 166.13 | Background |
| 11/28/2017 15:37 | 156.91 | Background |
| 12/22/2017 11:11 | 176.53 | Background |
| 12/27/2017 9:55 | 155.40 | Static Water Level |
| 12/27/2017 13:12 | 156.70 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 15:58 | 156.50 | |
| 12/27/2017 17:36 | 156.24 | |
| 12/27/2017 19:13 | 158.50 | |
| 12/27/2017 21:14 | 155.10 | |
| 12/27/2017 23:06 | 155.41 | |
| 12/28/2017 1:42 | 160.61 | |
| 12/28/2017 4:11 | 154.96 | |
| 12/28/2017 6:21 | 155.26 | |
| 12/28/2017 9:09 | 155.05 | |
| 12/28/2017 11:40 | 155.07 | |
| 12/28/2017 13:24 | 155.75 | |
| 12/28/2017 20:00 | 157.55 | |
| 12/29/2017 0:03 | 160.10 | |
| 12/29/2017 2:55 | 155.90 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 8:02 | 155.62 | |
| 12/29/2017 10:55 | 155.32 | |
| 12/29/2017 13:05 | 155.01 | |

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854827 / David Odom
# Hydrograph

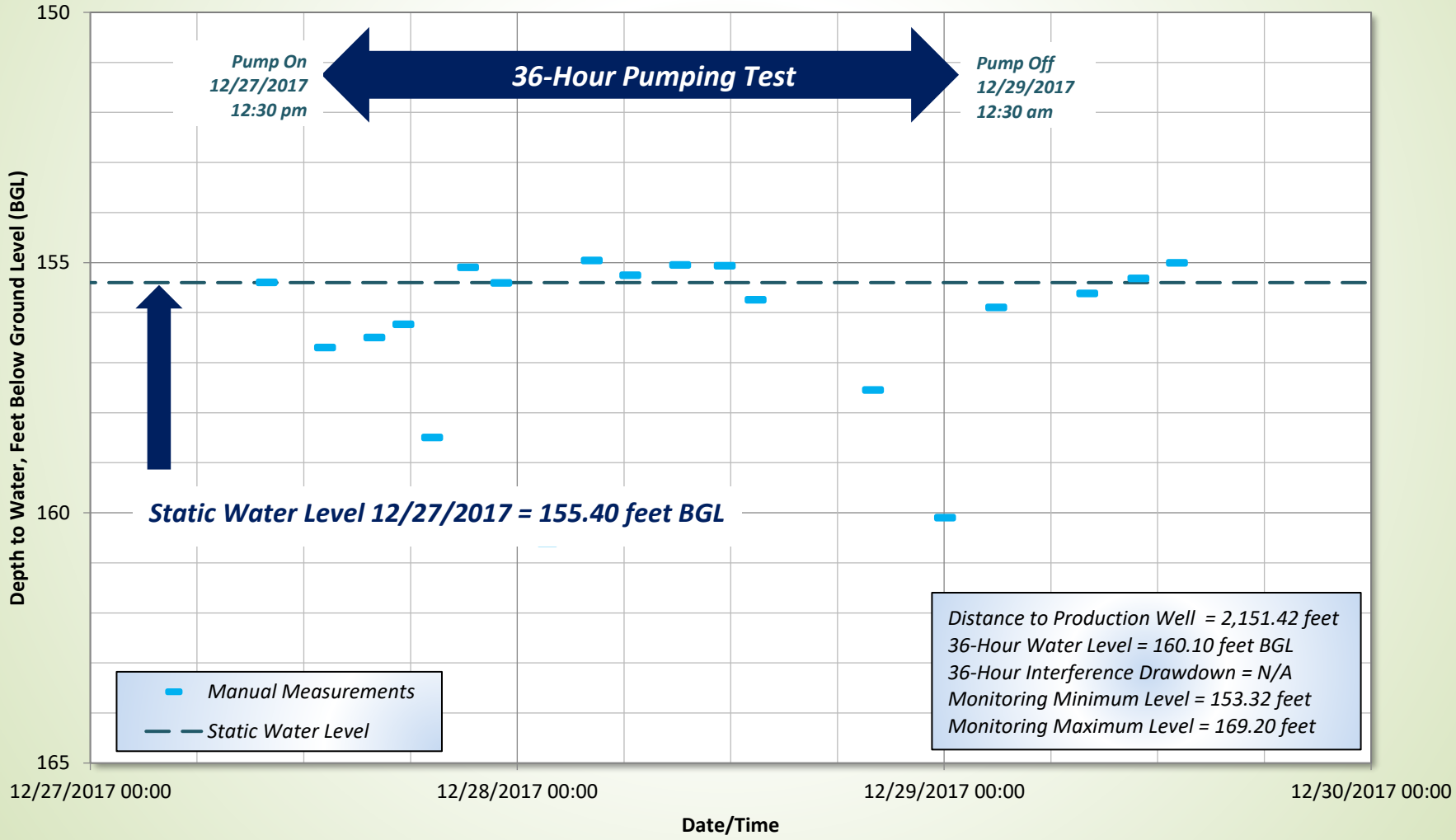
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854827 / David Odom
# Hydrograph

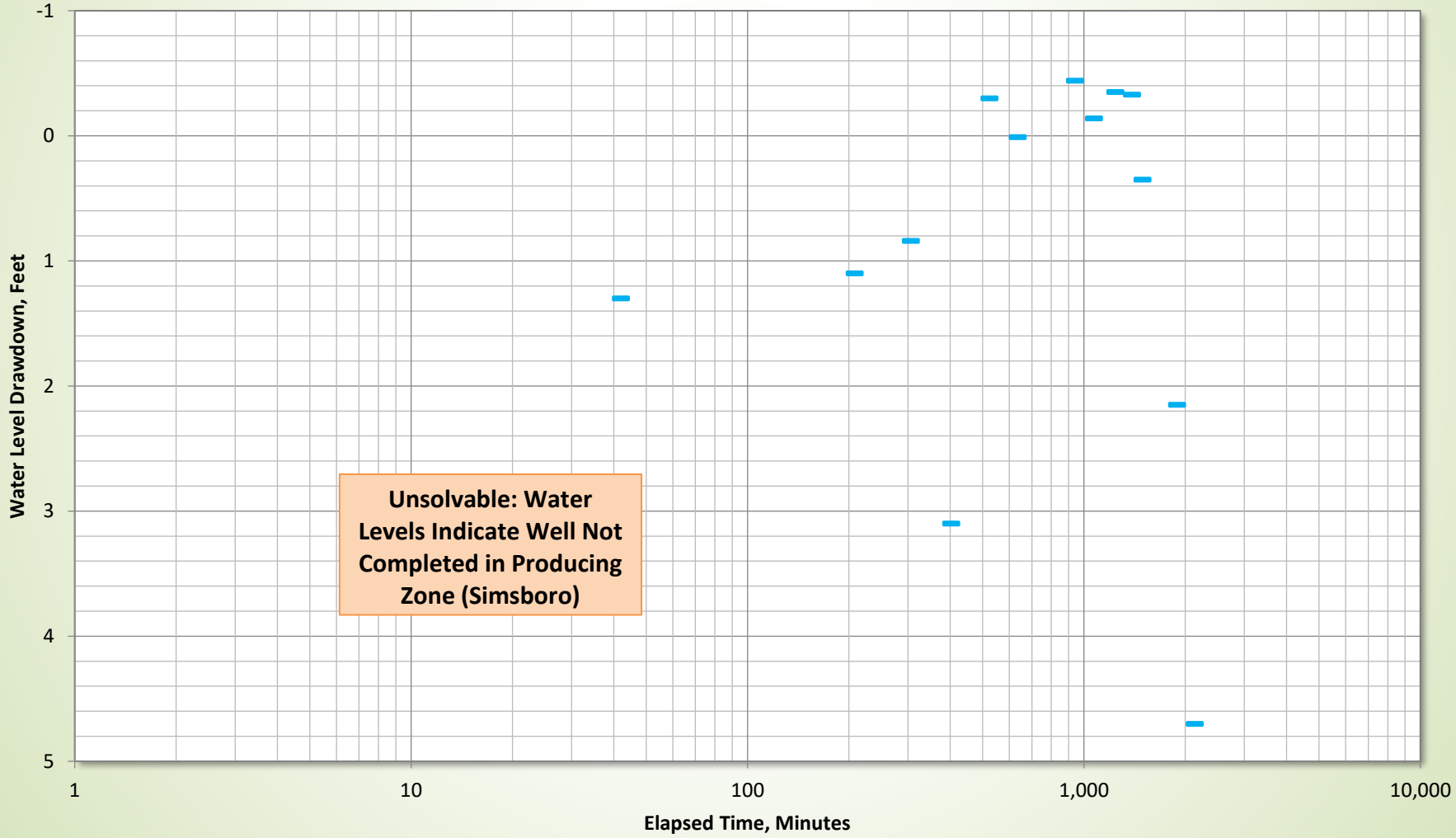
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854827 / David Odom
# Cooper-Jacob Chart (Drawdown)

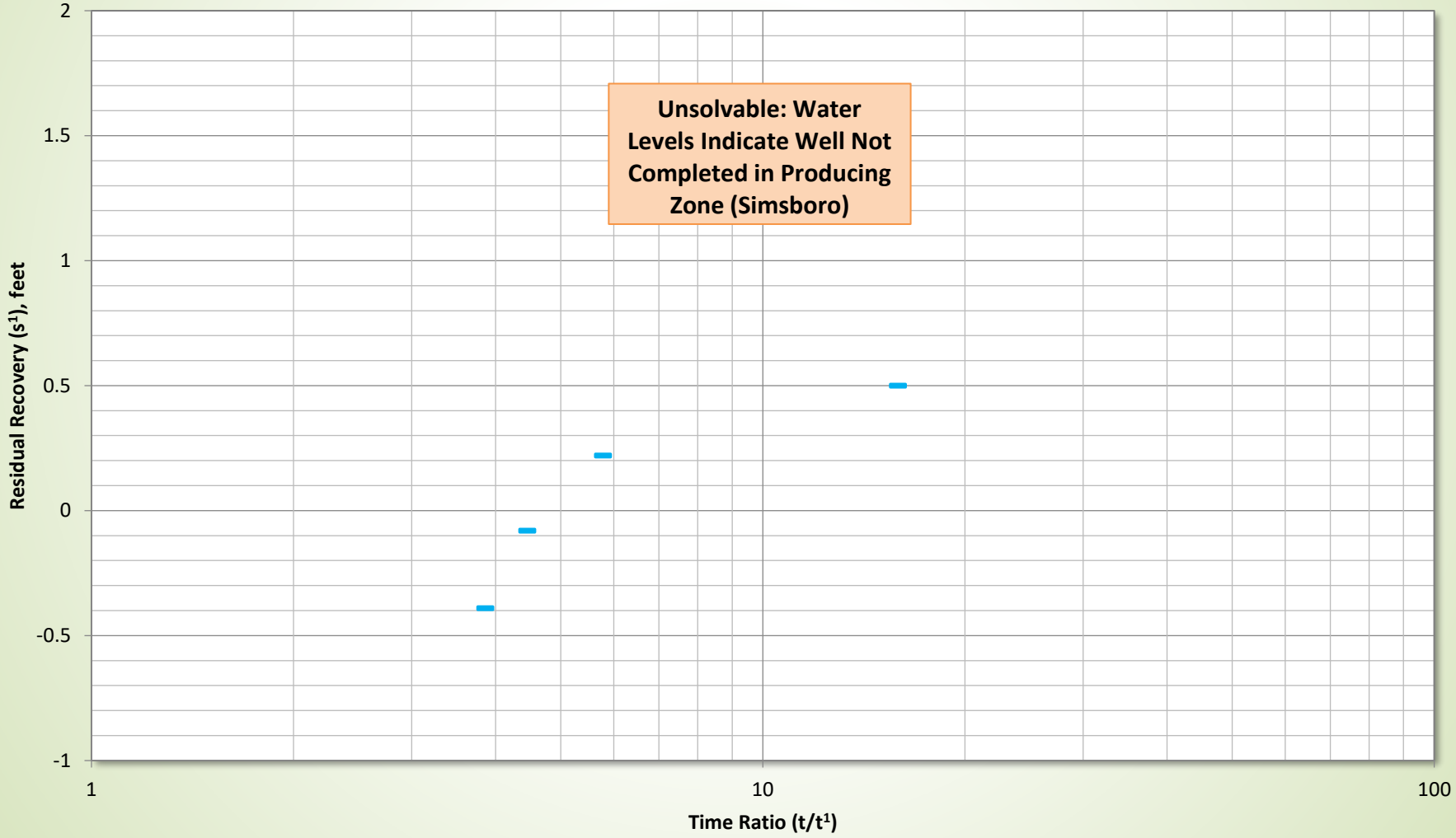
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854827 / David Odom
## Cooper-Jacob Chart (Recovery)

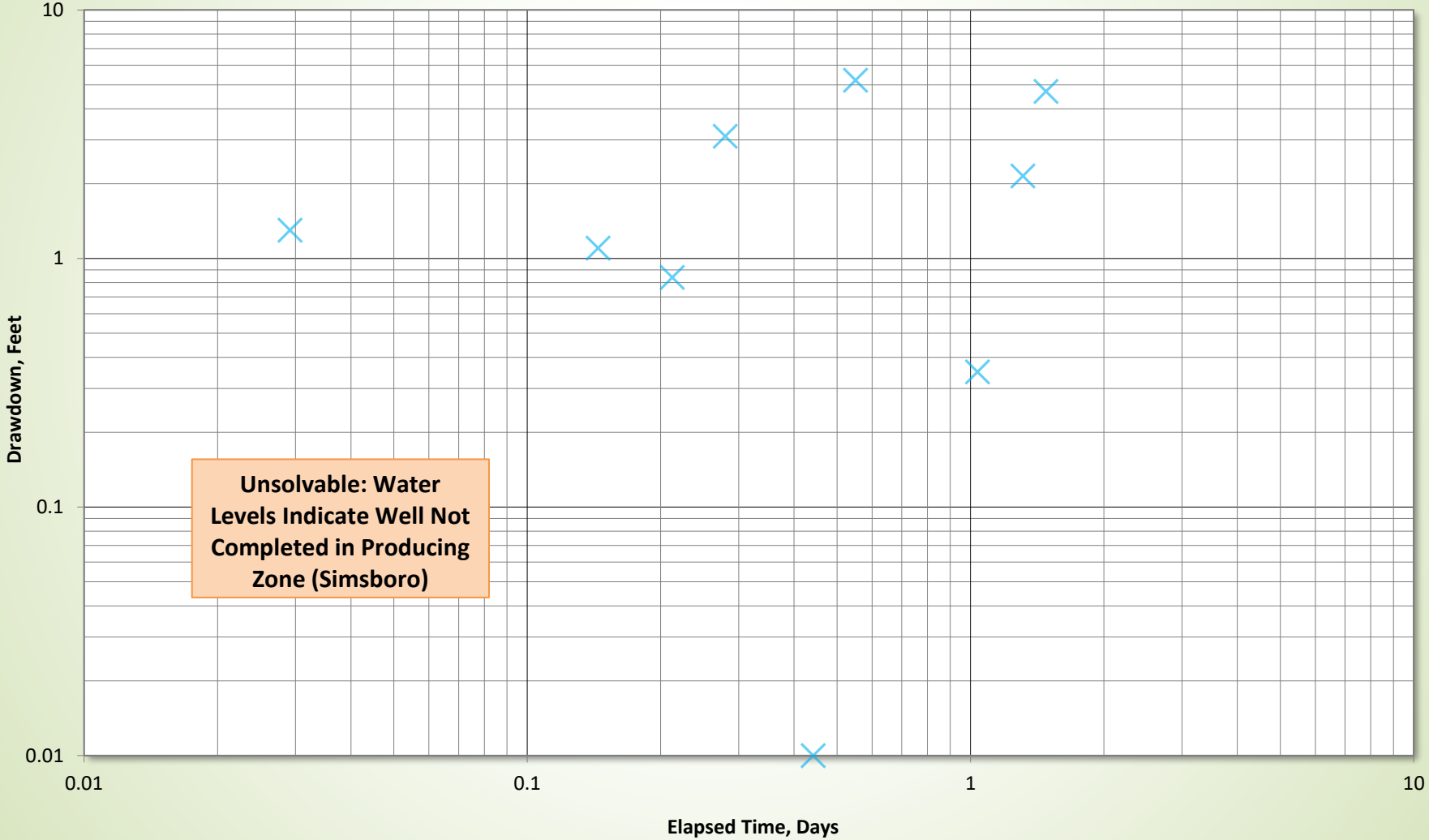
Calvert Bluff



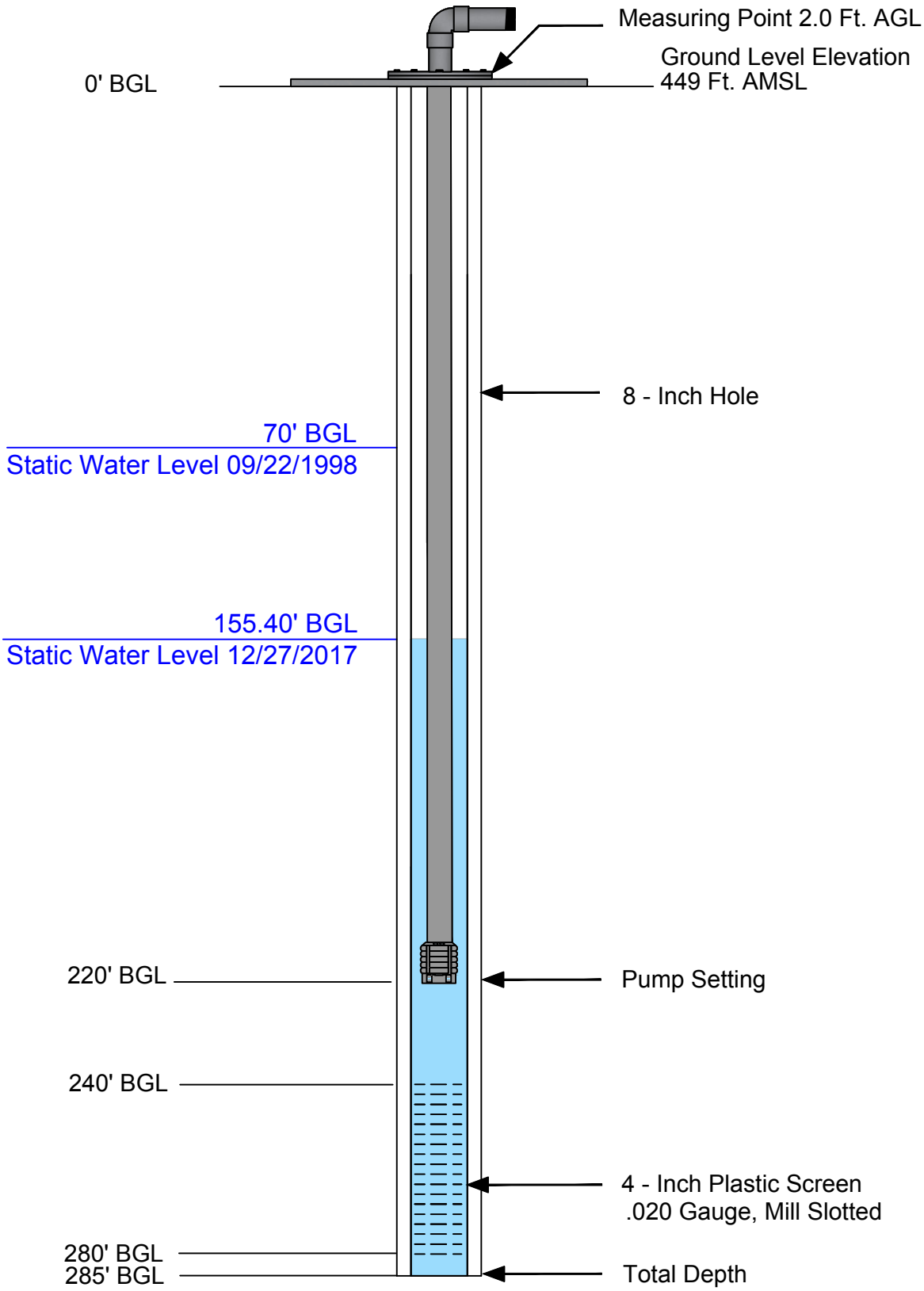
THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854827 / David Odom
## Theis Curve

Calvert Bluff



# LPGCD Well 5854827 / David Odom




Well construction details compiled from State of Texas Well Report, LPGCD records, owner, and/or TGI field investigations.

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists


Rd
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Name: Odom, David
Distance from Well J: 2,151.42 feet
Static Water Level 12/27/2017: 155.40 feet BGL
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors

# Area 2

# City of Bastrop
## Lindberg Well
## 36-Hour Drawdown and Recovery Results

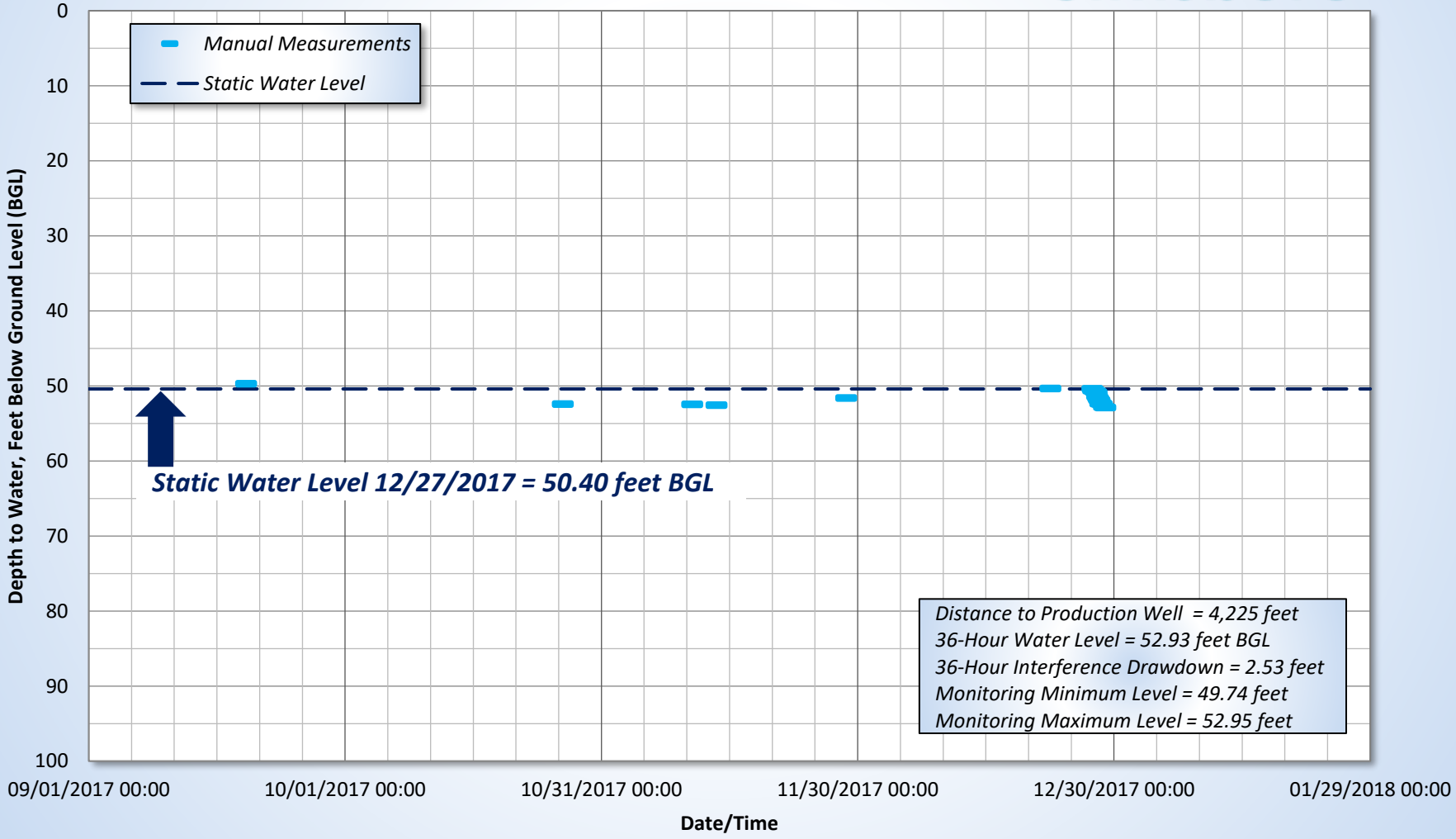
**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 4,225 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/19/2017 10:10 | 49.74 | Background |
| 10/26/2017 11:26 | 52.45 | Background |
| 11/10/2017 15:05 | 52.50 | Background |
| 11/13/2017 11:05 | 52.58 | Background |
| 11/28/2017 16:00 | 51.63 | Background |
| 12/22/2017 12:55 | 50.39 | Background |
| 12/27/2017 11:00 | 50.40 | Static Water Level |
| 12/27/2017 13:32 | 50.67 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 17:25 | 50.65 | |
| 12/27/2017 19:00 | 50.79 | |
| 12/27/2017 21:13 | 50.83 | |
| 12/27/2017 23:00 | 50.95 | |
| 12/28/2017 0:36 | 51.42 | |
| 12/28/2017 3:47 | 51.69 | |
| 12/28/2017 6:00 | 51.90 | |
| 12/28/2017 7:32 | 51.98 | |
| 12/28/2017 9:18 | 52.40 | |
| 12/28/2017 11:50 | 52.36 | |
| 12/28/2017 13:40 | 52.45 | |
| 12/28/2017 19:48 | 52.84 | |
| 12/28/2017 23:50 | 52.93 | |
| 12/29/2017 3:08 | 52.95 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 5:28 | 52.91 | |
| 12/29/2017 7:54 | 52.60 | |
| 12/29/2017 10:37 | 52.56 | |
| 12/29/2017 13:00 | 52.55 | |

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854732 / Lindberg
# Hydrograph

Simsboro



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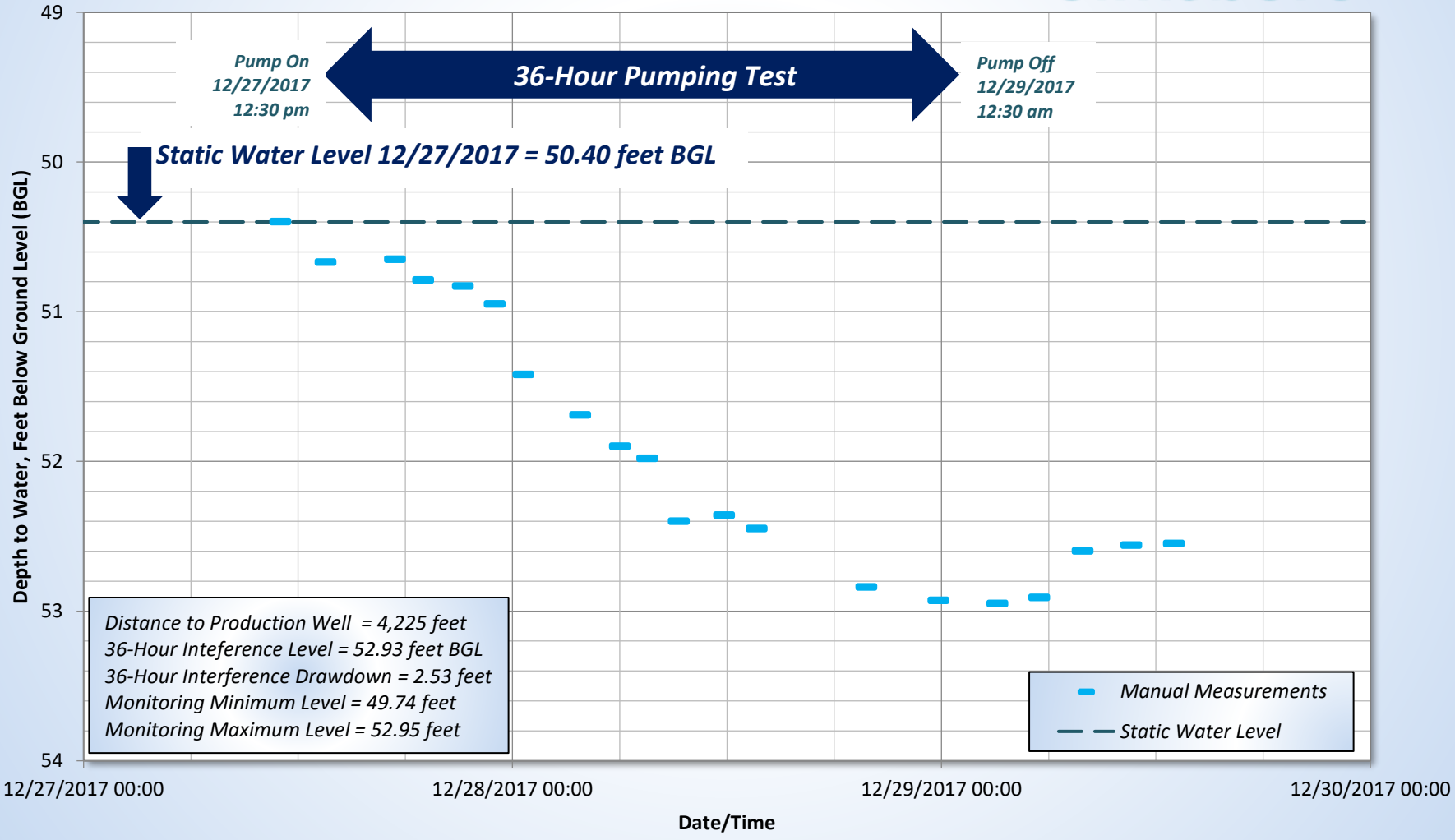
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854732 / Lindberg
# Hydrograph

Simsboro



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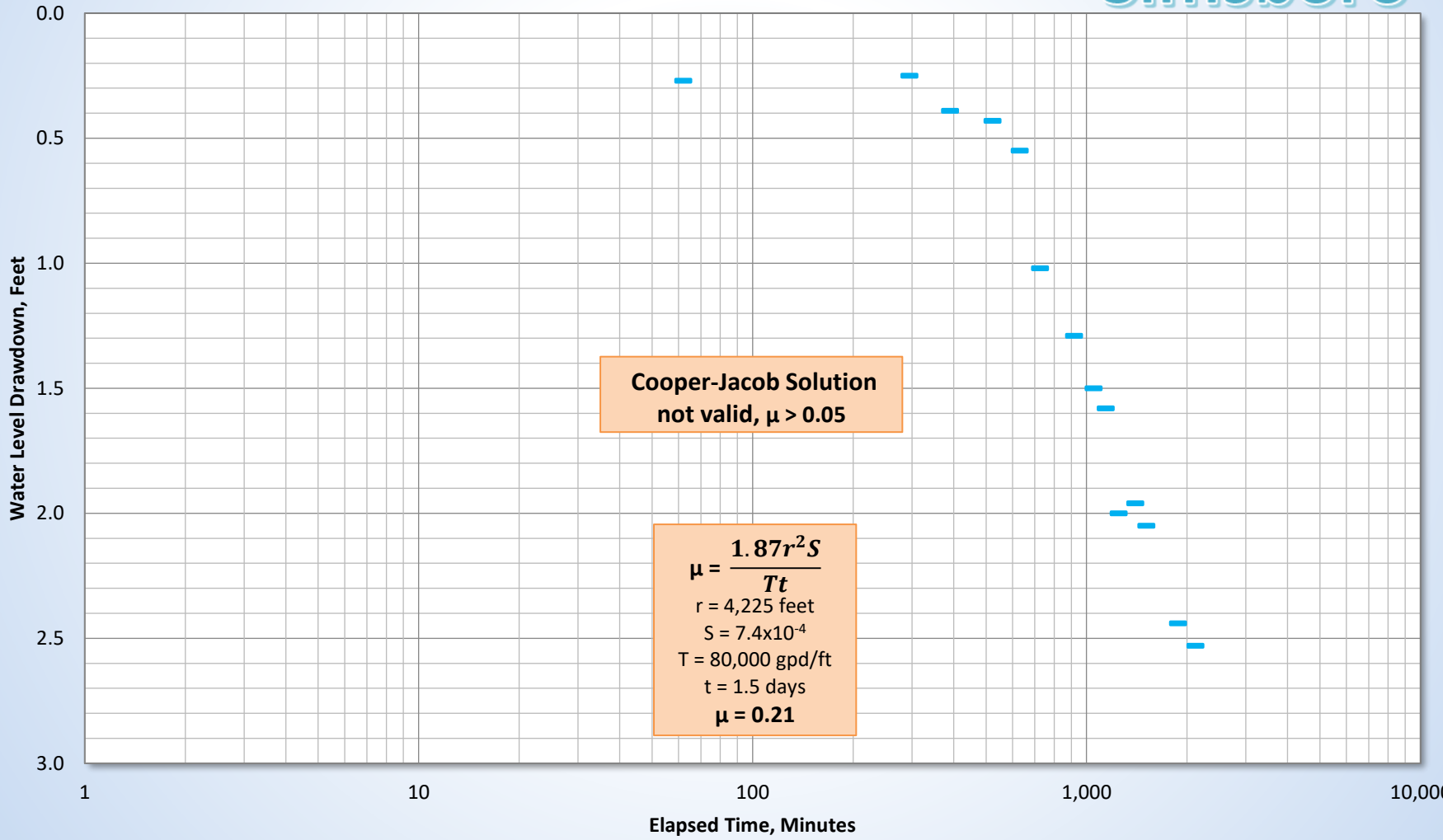
# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854732 / Lindberg
# Cooper-Jacob Chart (Drawdown)

Simsboro



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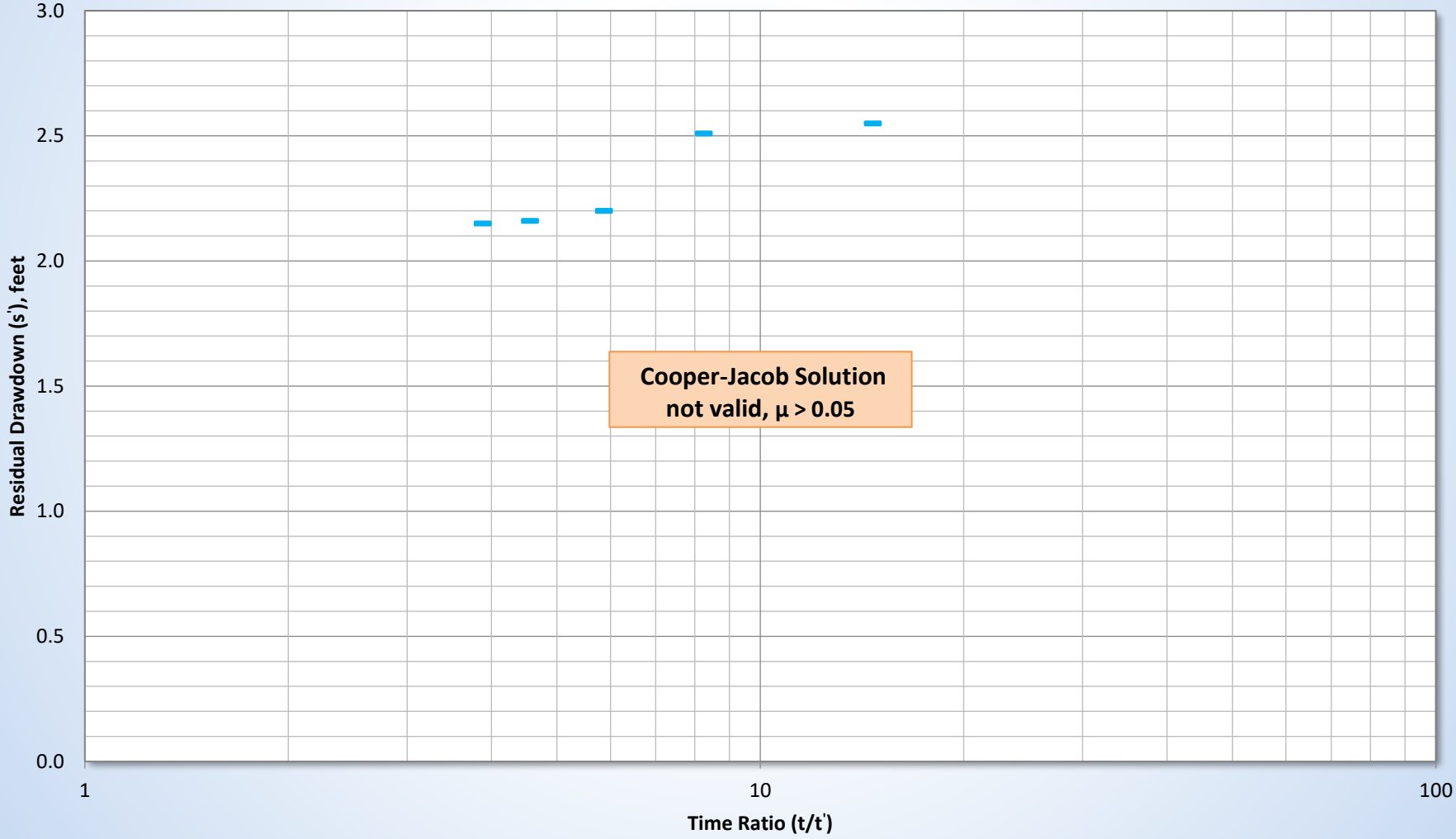
# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854732 / Lindberg
## Cooper-Jacob Chart (Recovery)

Simsboro



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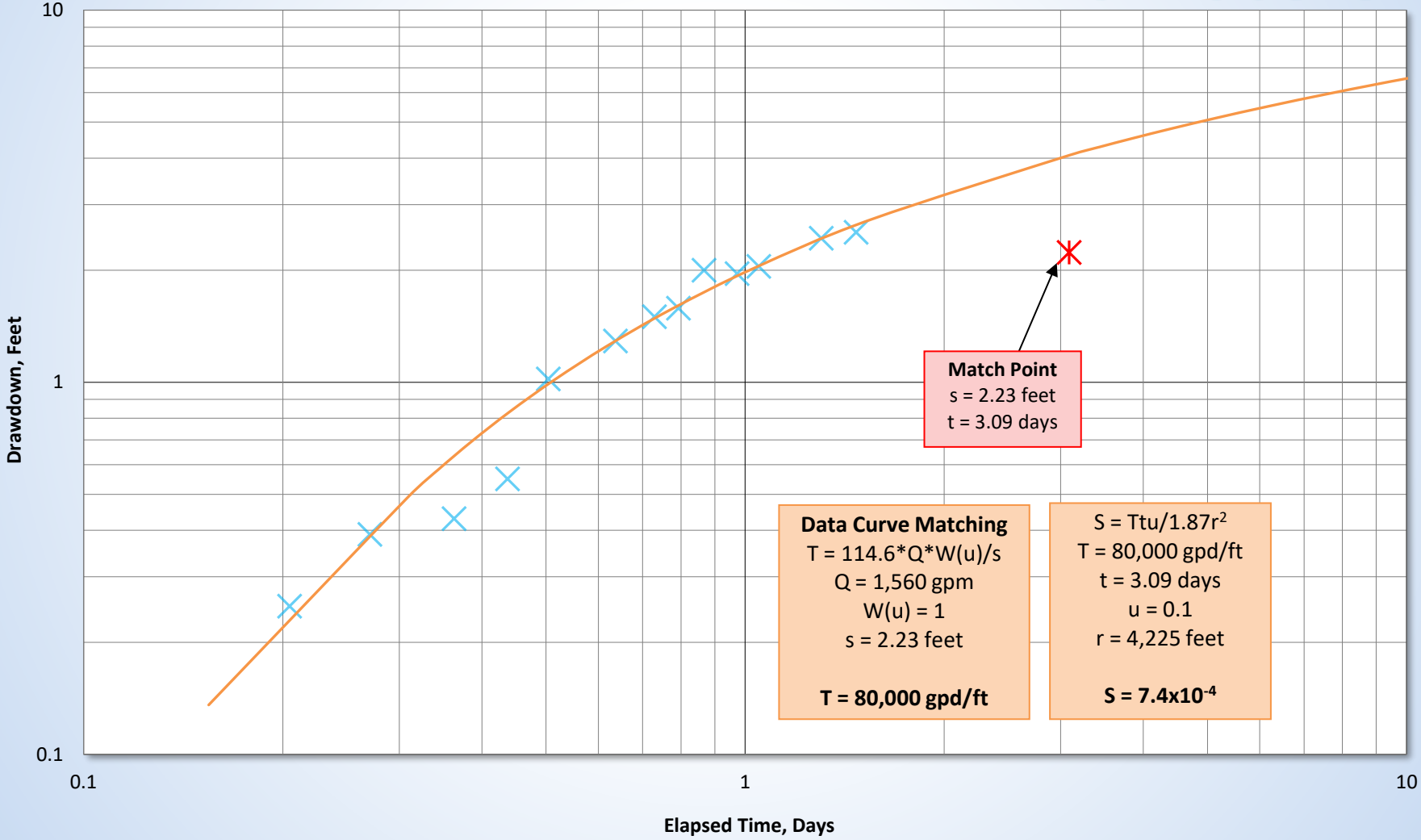
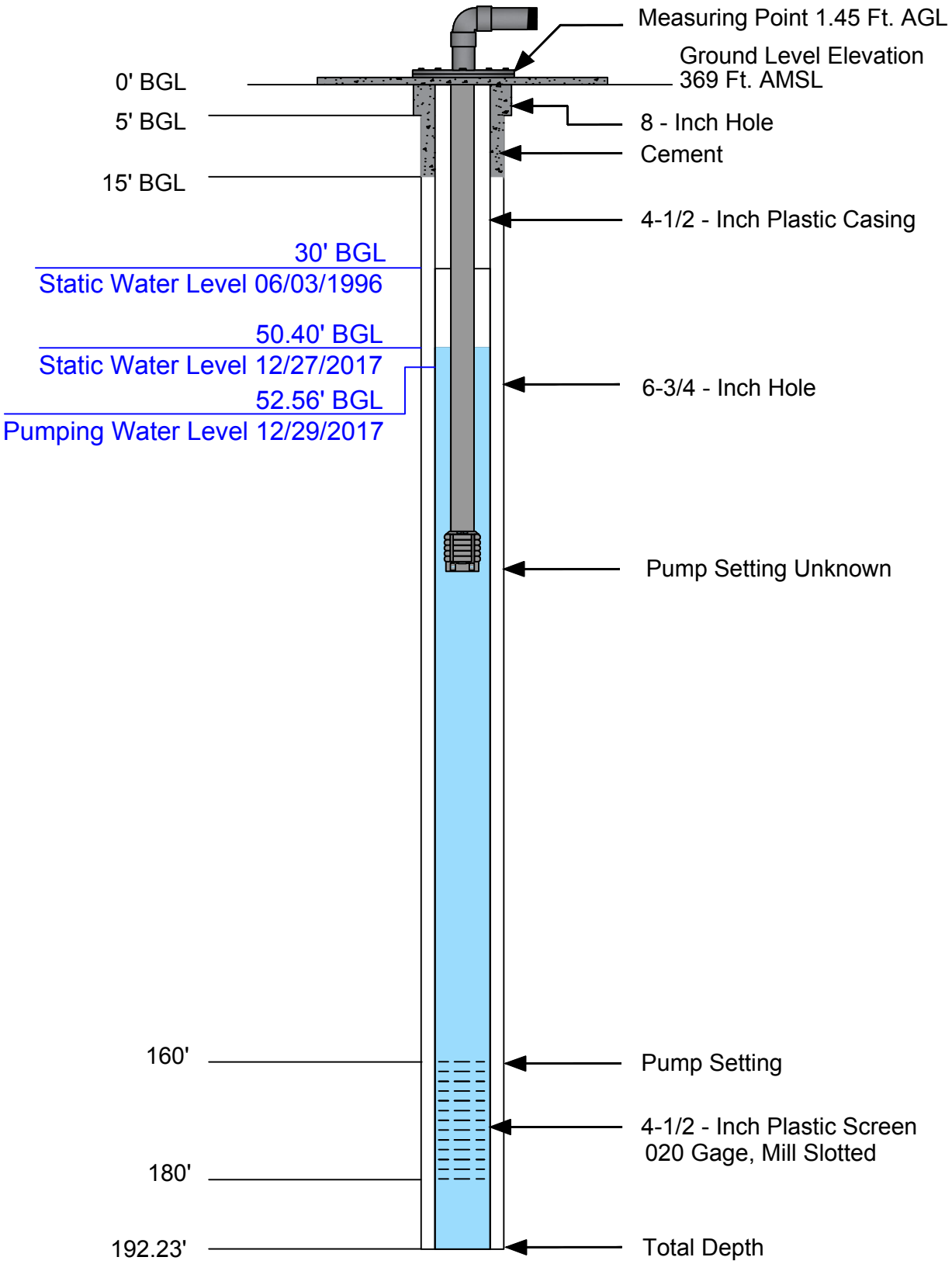
# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854732 / Lindberg
# Theis Curve

Simsboro



# LPGCD Well 5854732 / Lindberg




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

THORNHILL GROUP, INC.
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Name: Kevin Lindberg
Distance from Well J: 4,225.45 feet
Static Water Level 12/27/2017: 50.40 feet BGL
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Dorine Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## Sotolongo Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 4,418 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/19/2017 9:25 | 41.79 | Background |
| 10/26/2017 10:35 | 44.39 | Background |
| 11/10/2017 13:15 | 44.47 | Background |
| 11/28/2017 15:25 | 43.18 | Background |
| 12/27/2017 11:05 | 42.61 | Static Water Level |
| 12/27/2017 13:35 | 42.67 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 17:29 | 42.73 | |
| 12/27/2017 19:05 | 42.87 | |
| 12/27/2017 21:10 | 43.17 | |
| 12/27/2017 22:57 | 43.33 | |
| 12/28/2017 0:43 | 43.34 | |
| 12/28/2017 3:37 | 43.61 | |
| 12/28/2017 5:52 | 43.78 | |
| 12/28/2017 7:30 | 43.84 | |
| 12/28/2017 9:23 | 44.09 | |
| 12/28/2017 11:57 | 44.20 | |
| 12/28/2017 13:46 | 44.27 | |
| 12/28/2017 19:53 | 44.70 | |
| 12/28/2017 23:54 | 44.72 | |
| 12/29/2017 3:05 | 44.72 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 5:25 | 44.68 | |
| 12/29/2017 7:49 | 44.57 | |
| 12/29/2017 10:33 | 44.32 | |
| 12/29/2017 12:50 | 44.14 | |

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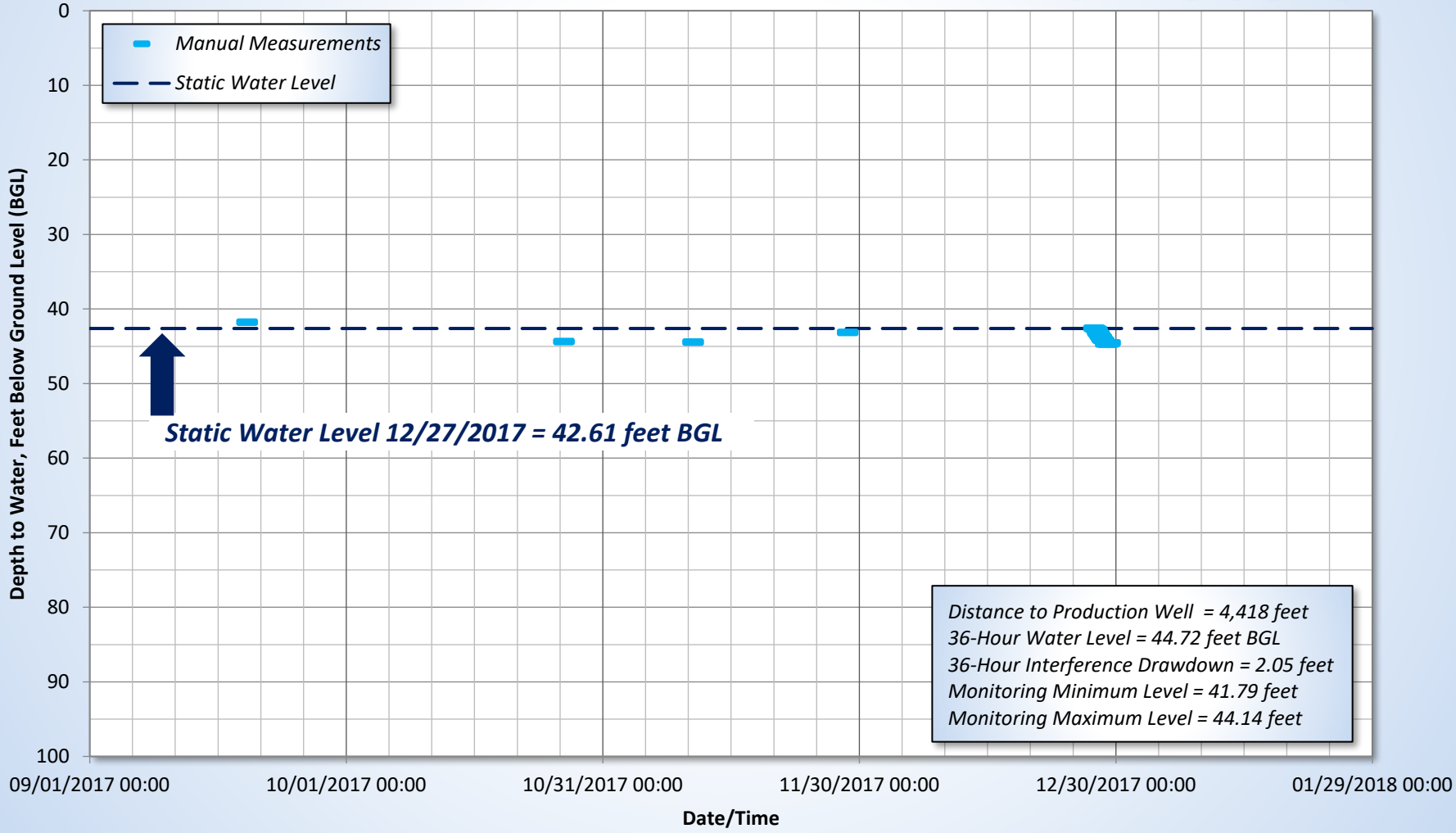
# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854743 / Osualdo Sotolongo
# Hydrograph

Simsboro



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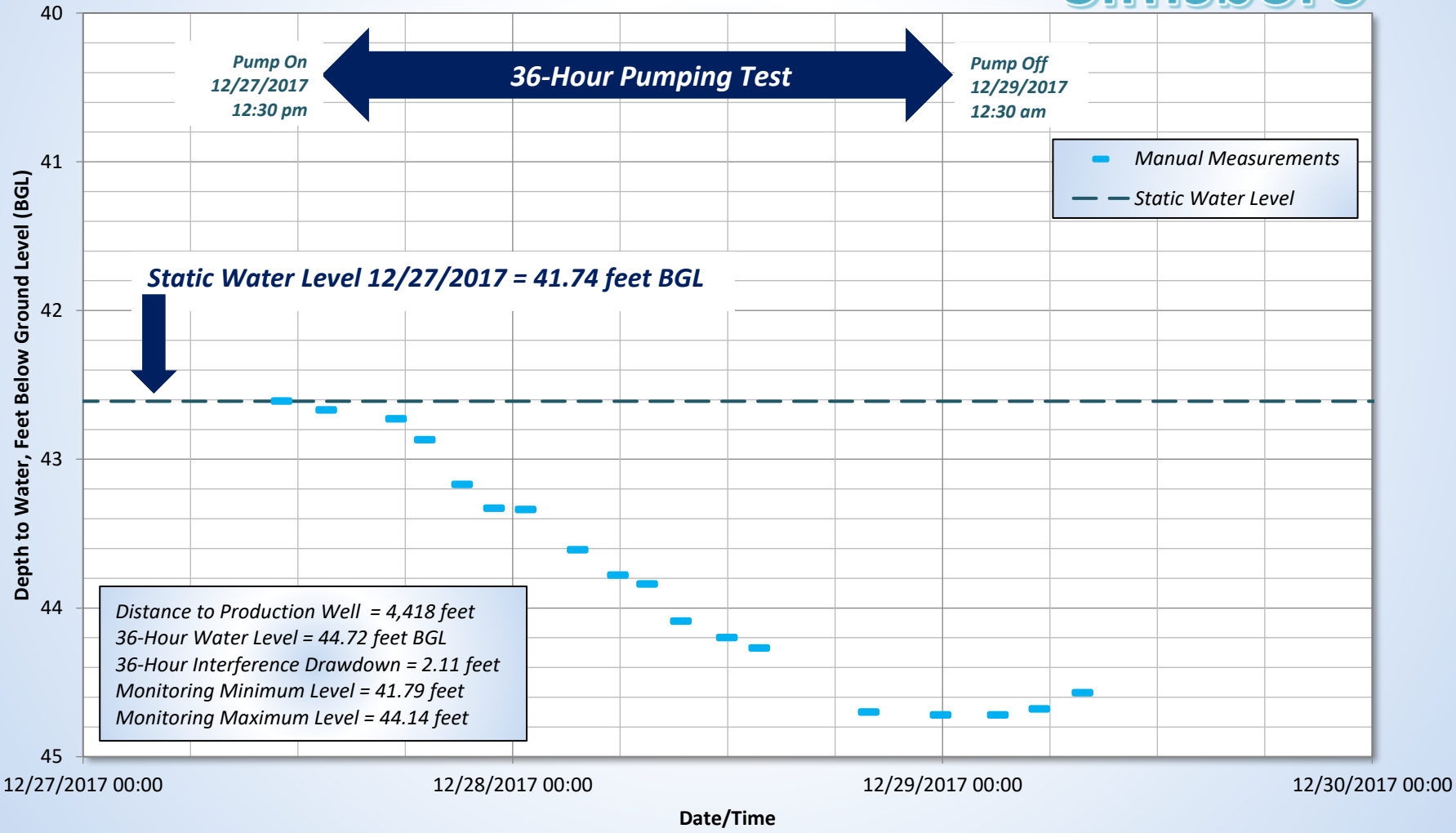
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854743 / Osualdo Sotolongo
# Hydrograph

Simsboro



THORNHILL GROUP, INC.
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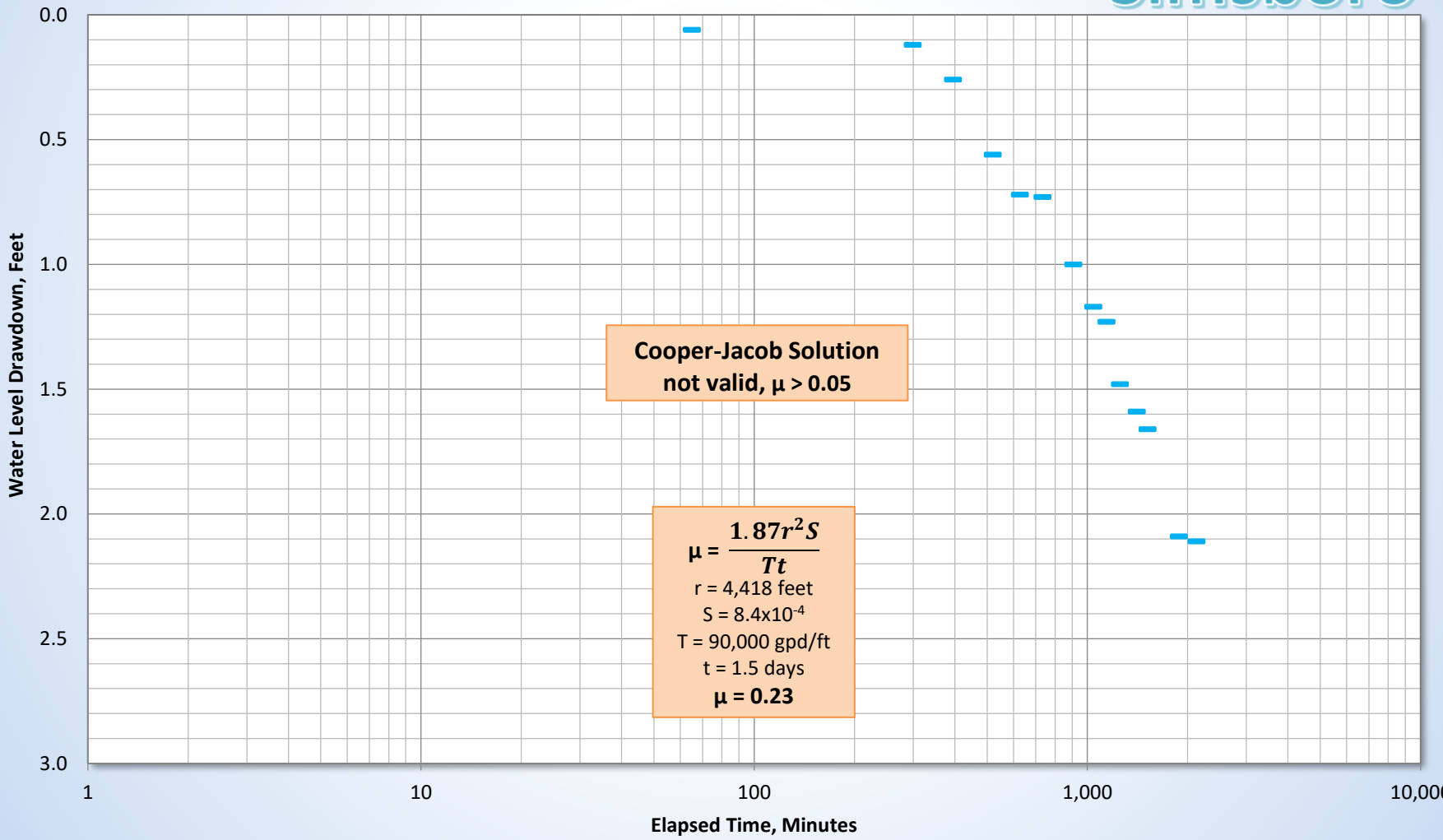
# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854743 / Osualdo Sotolongo
## Cooper-Jacob Chart (Drawdown)

Simsboro



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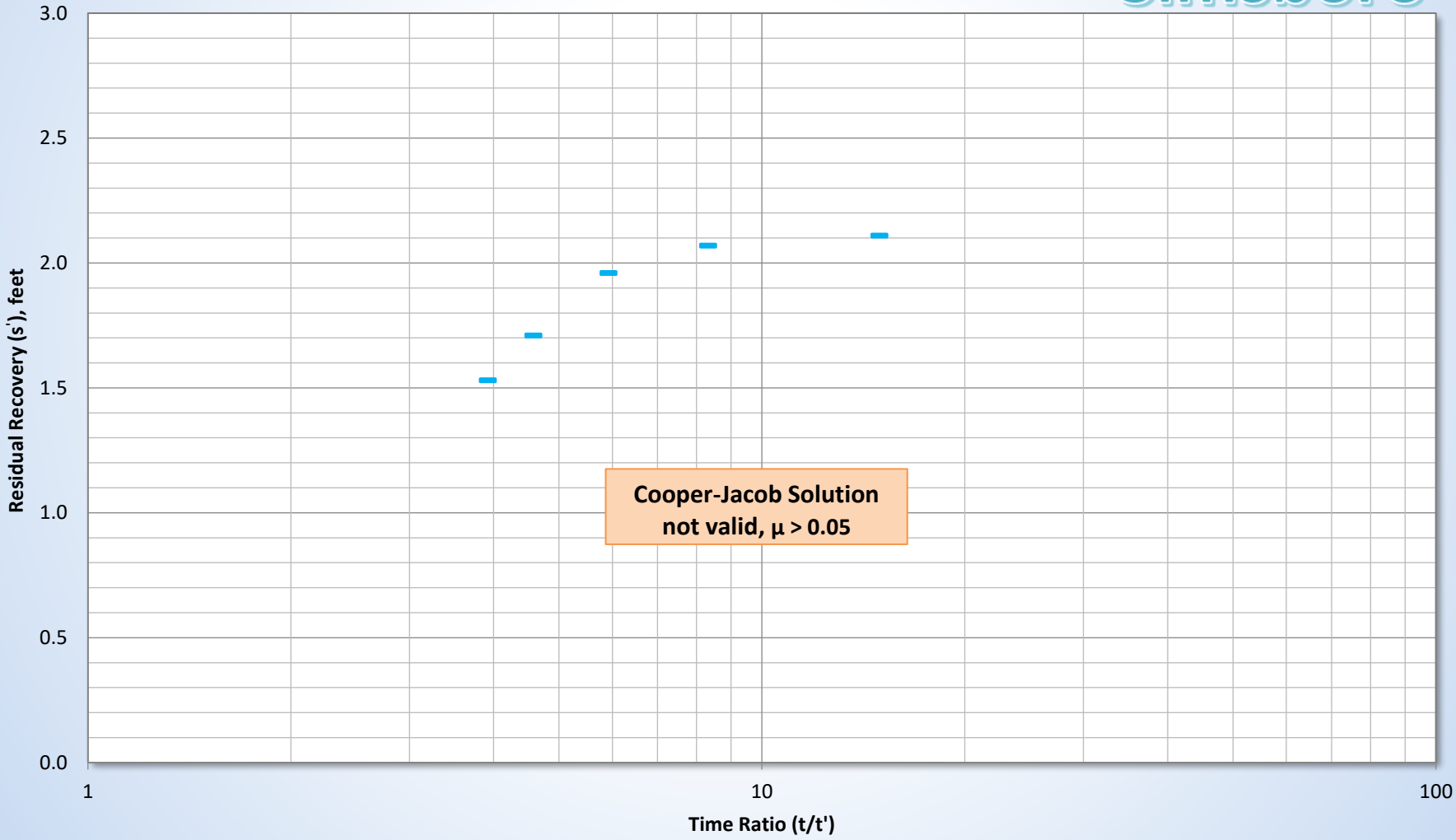
# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854743 / Osualdo Sotolongo
## Cooper-Jacob Chart (Recovery)

Simsboro



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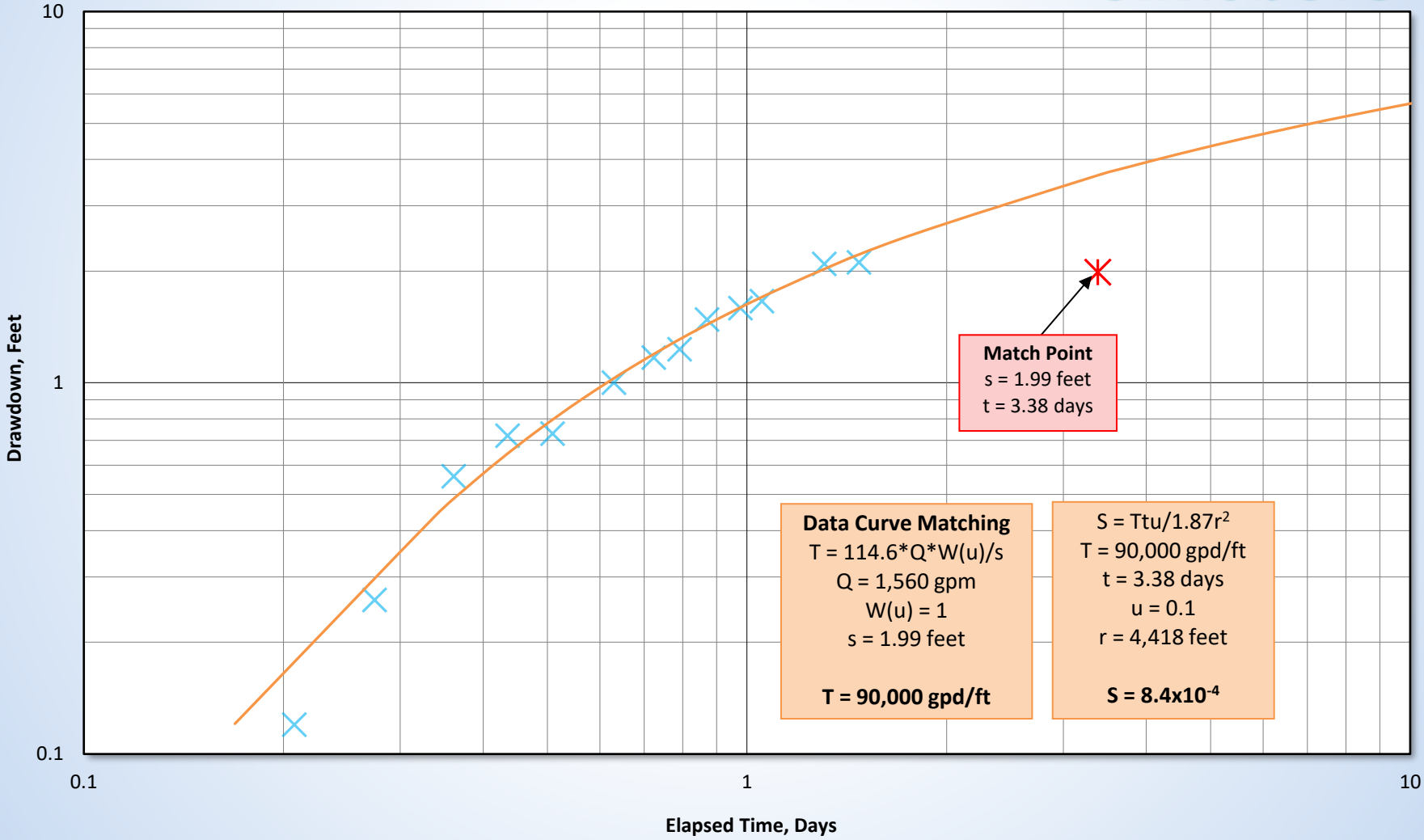
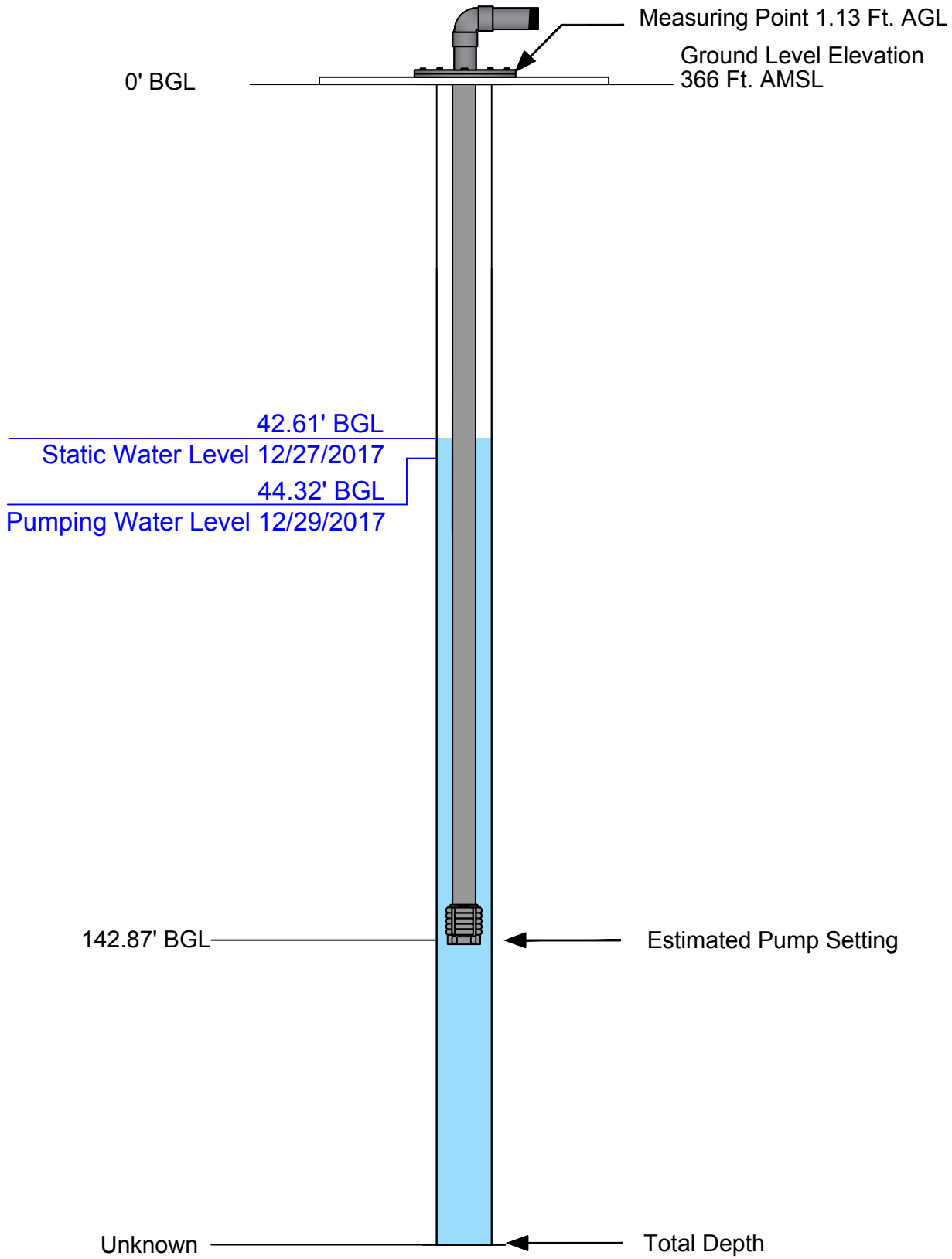
# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854743 / Osualdo Sotolongo
# Theis Curve

Simsboro



# LPGCD Well 5854743 / Sotolongo




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

THORNHILL GROUP, INC.
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Name: Osualdo Sotolongo
Distance from Well J: 4,418.14 feet
Static Water Level 12/27/2017: 42.61 feet BGL
Arrowhead Ct
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## Zinker 1 Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 4,536 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/20/2017 10:35 | 38.30 | Background |
| 12/27/2017 11:17 | 39.17 | Static Water Level |
| 12/27/2017 14:00 | 39.13 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 17:13 | 39.29 | |
| 12/27/2017 18:46 | 39.46 | |
| 12/27/2017 20:50 | 39.90 | |
| 12/28/2017 0:55 | 40.05 | |
| 12/28/2017 4:00 | 40.27 | |
| 12/28/2017 6:12 | 40.42 | |
| 12/28/2017 7:46 | 40.60 | |
| 12/28/2017 9:40 | 40.69 | |
| 12/28/2017 12:10 | 40.80 | |
| 12/28/2017 13:58 | 40.89 | |
| 12/28/2017 19:29 | 41.12 | |
| 12/28/2017 23:36 | 41.40 | |
| 12/29/2017 3:25 | 41.30 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 5:13 | 41.20 | |
| 12/29/2017 7:36 | 41.07 | |
| 12/29/2017 10:15 | 41.07 | |
| 12/29/2017 12:39 | 40.70 | |

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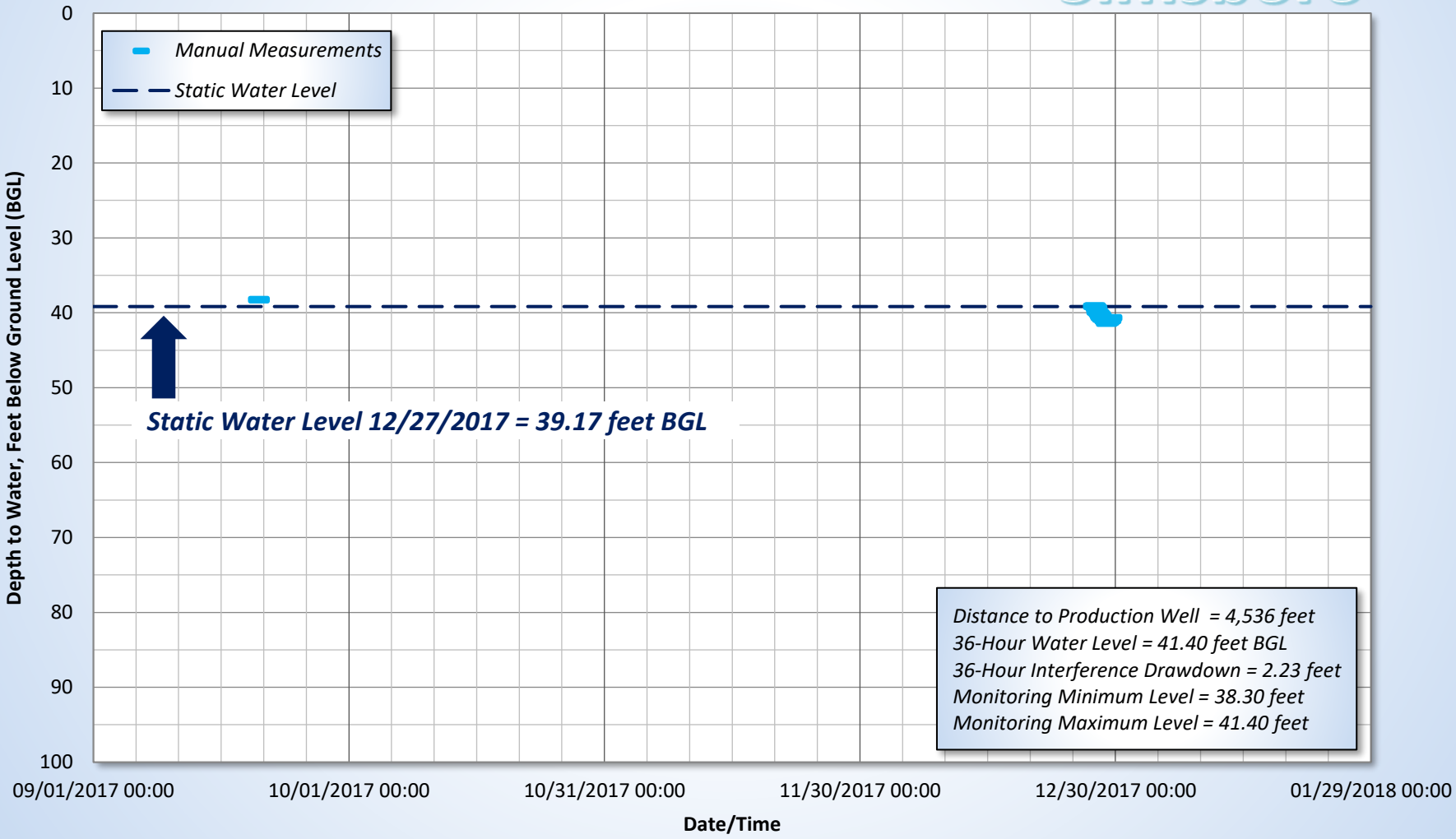
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854736 / Zinker 1
# Hydrograph

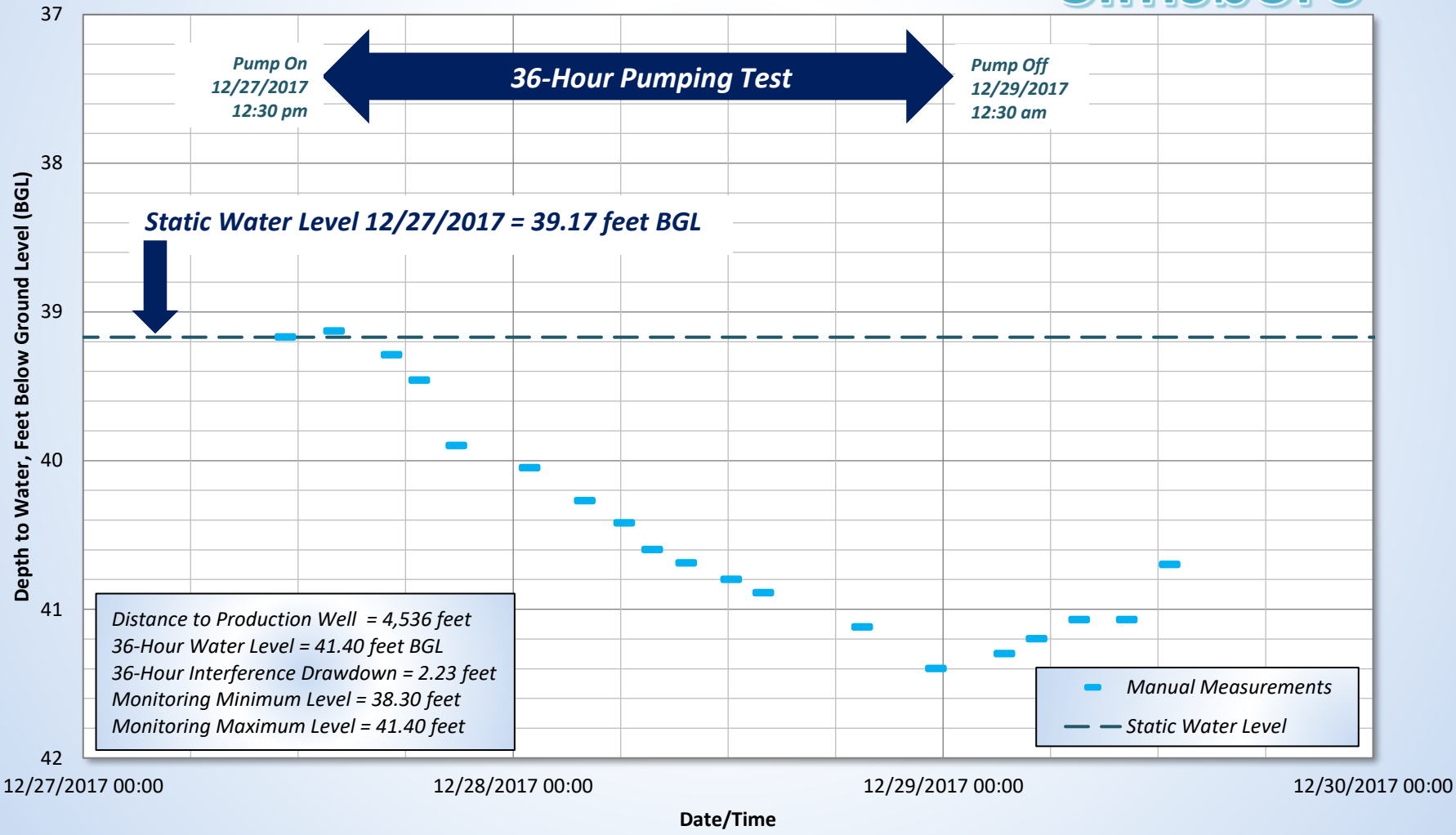
Simsboro



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854736 / Zinker 1
# Hydrograph

Simsboro



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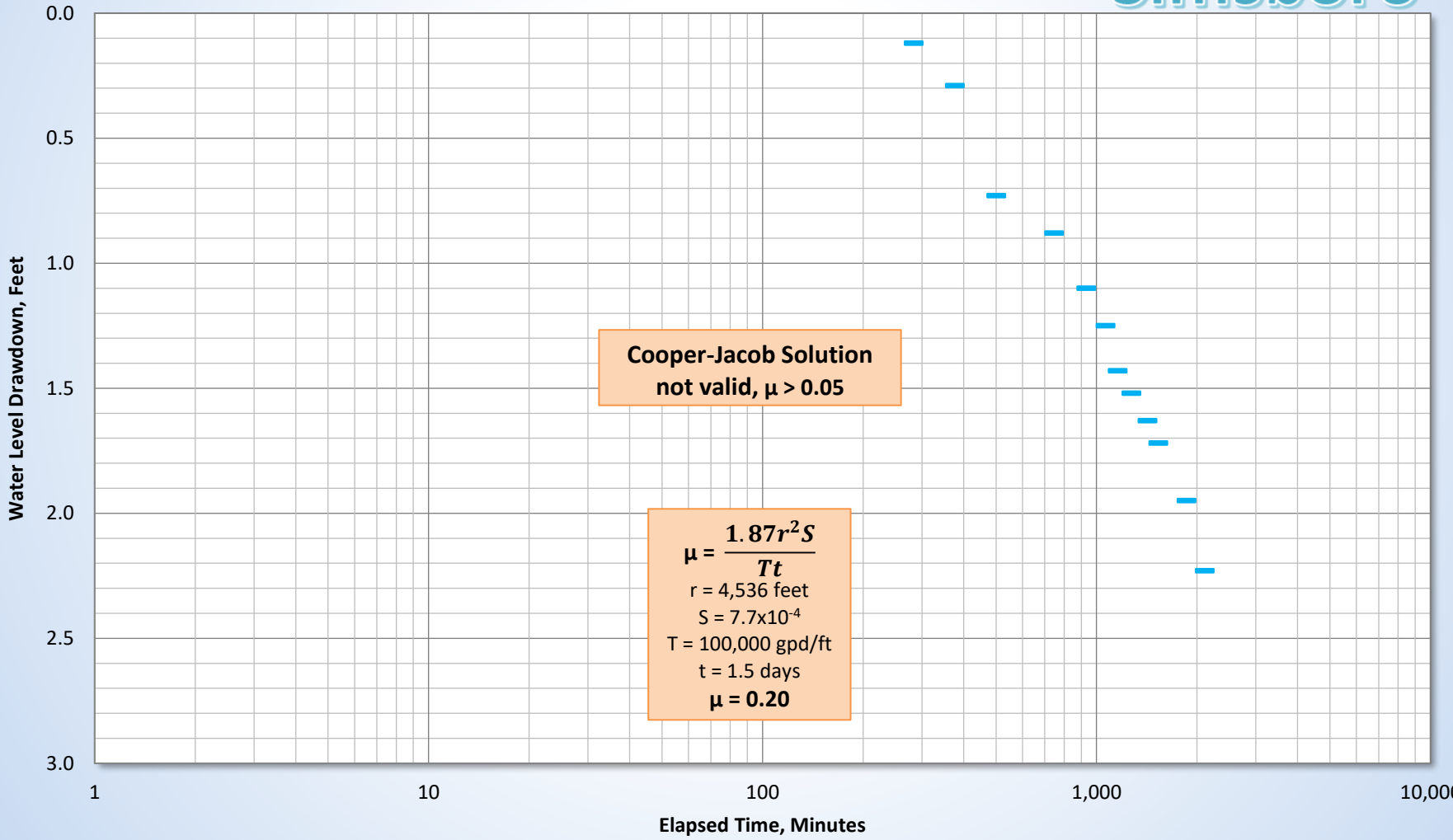
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854736 / Zinker 1
# Cooper-Jacob Chart (Drawdown)

Simsboro



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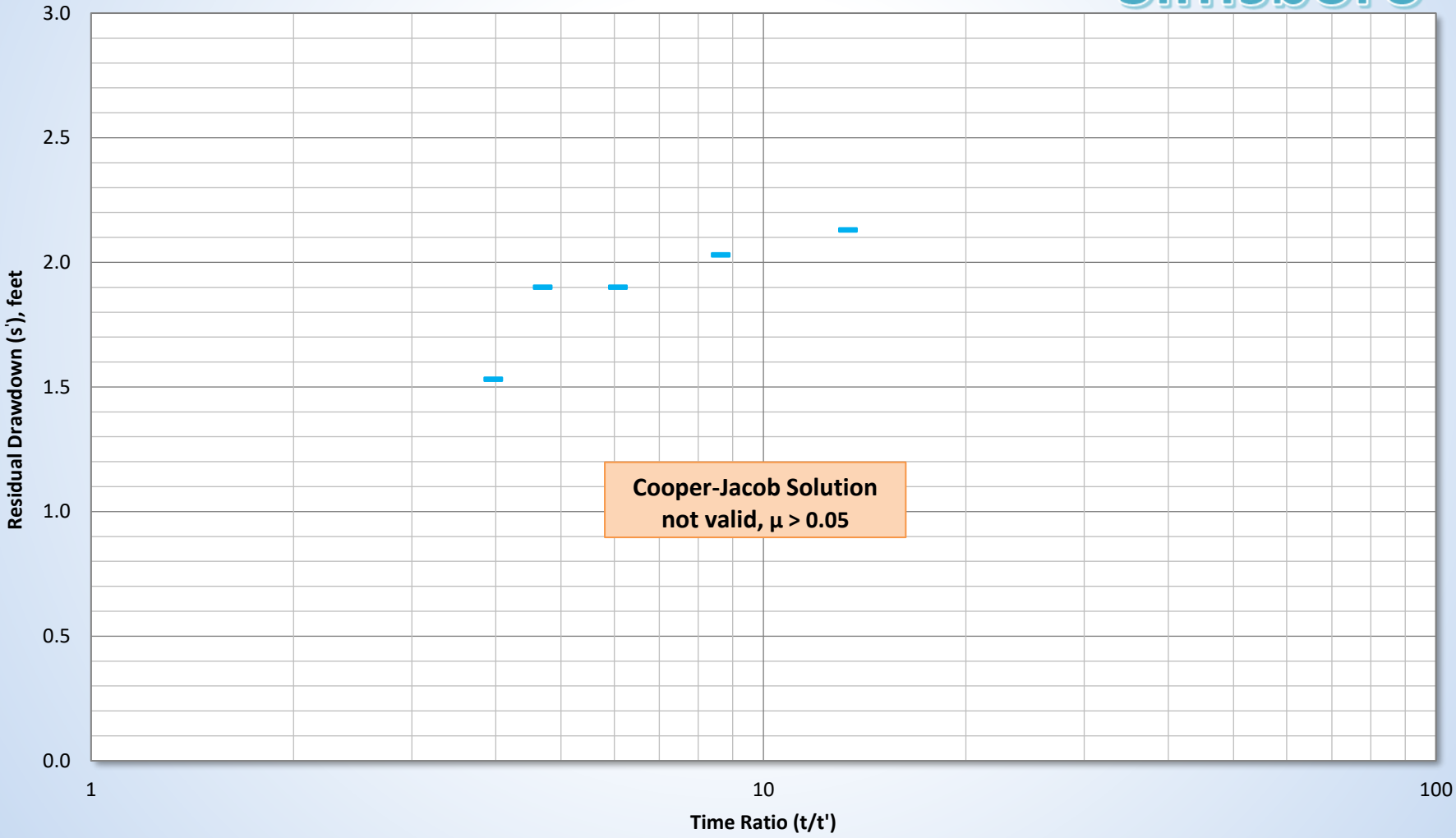
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854736 / Zinker 1
## Cooper-Jacob Chart (Recovery)

Simsboro



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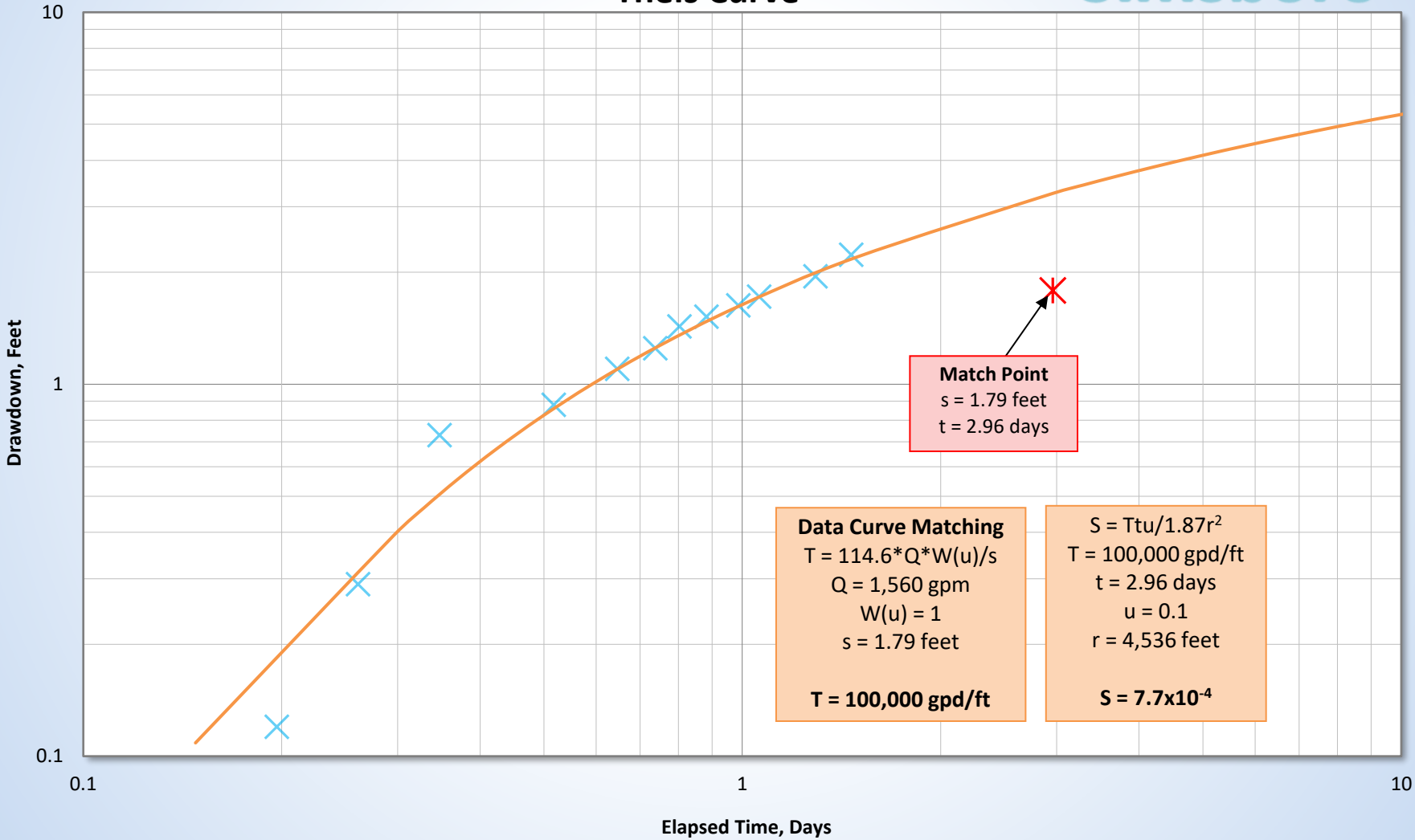
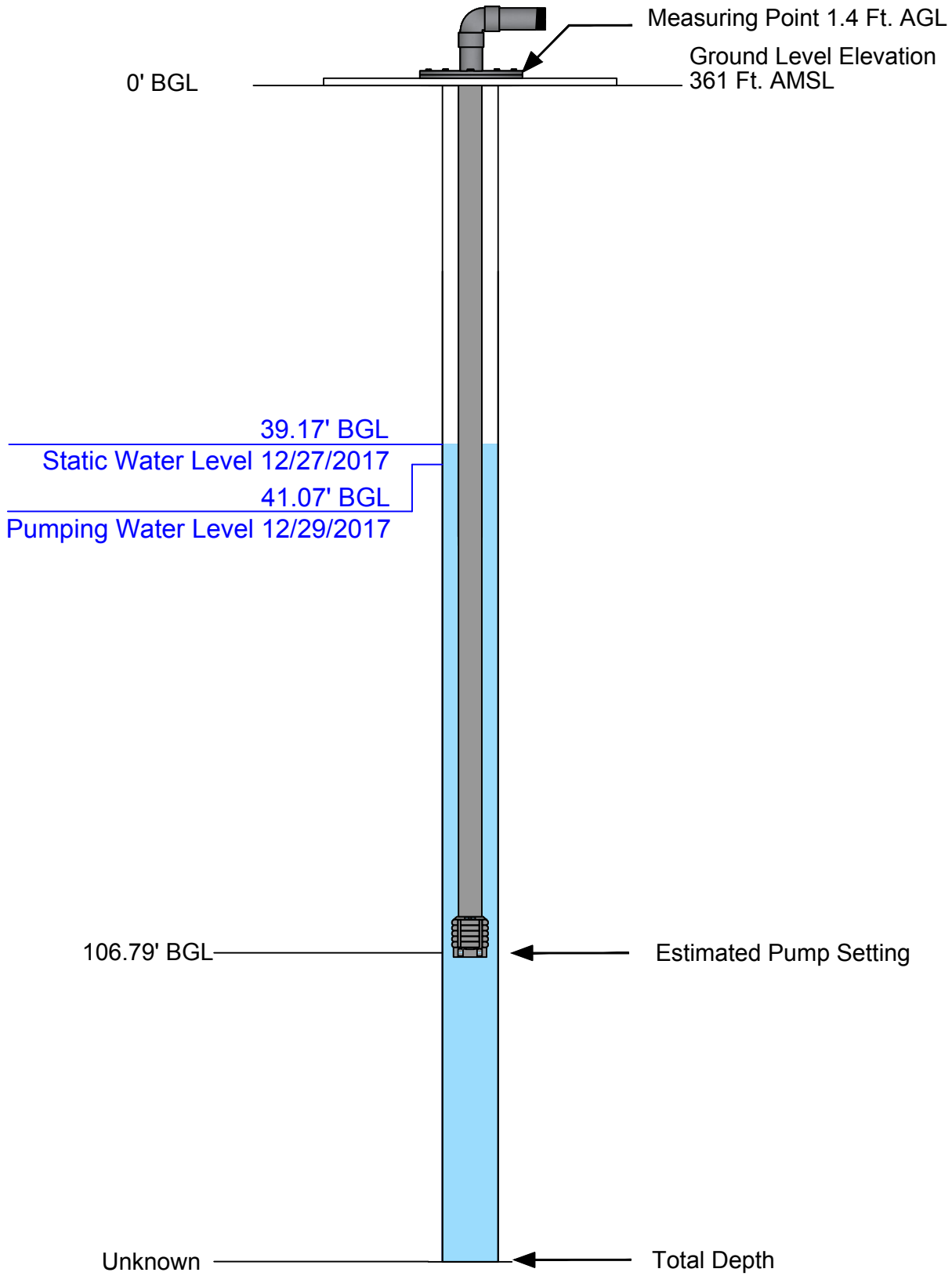
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854736 / Zinker 1
# Theis Curve

Simsboro



# LPGCD Well 5854736 / Zinker 1




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

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Name: Zinker 1
Distance from Well J: 4,536.73 feet
Static Water Level 12/27/2017: 39.17 feet BGL
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors

# City of Bastrop
## Smith Well
## 36-Hour Drawdown and Recovery Results

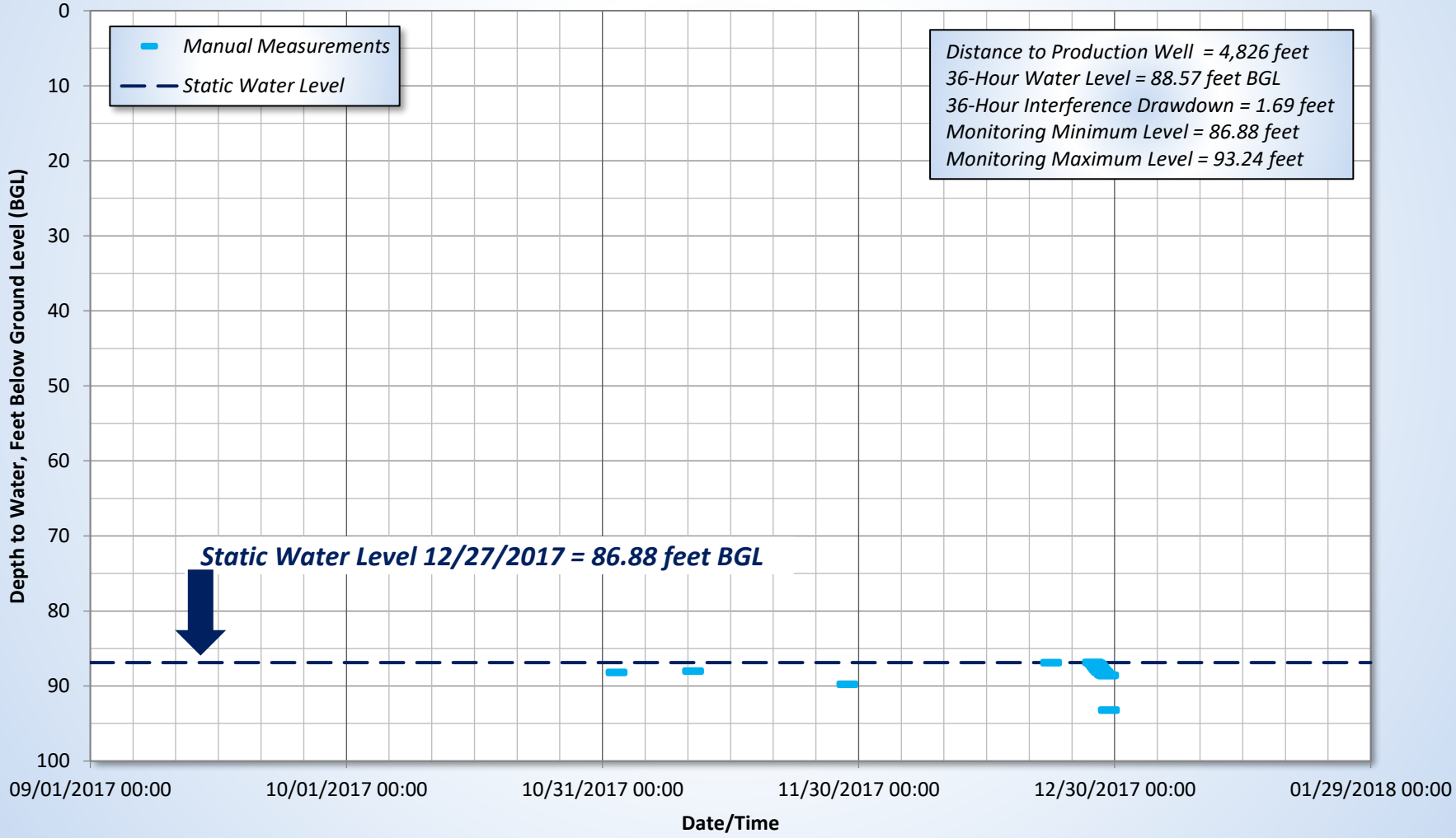
**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 4,826 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 11/1/2017 15:41 | 88.22 | Background |
| 11/10/2017 14:50 | 88.05 | Background |
| 11/28/2017 16:30 | 89.81 | Background |
| 12/22/2017 13:08 | 86.91 | Background |
| 12/27/2017 11:09 | 86.88 | Static Water Level |
| 12/27/2017 17:21 | 87.03 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 18:51 | 87.14 | |
| 12/27/2017 21:02 | 87.20 | |
| 12/27/2017 22:53 | 87.39 | |
| 12/28/2017 0:49 | 87.47 | |
| 12/28/2017 3:54 | 87.65 | |
| 12/28/2017 6:07 | 87.85 | |
| 12/28/2017 7:41 | 87.90 | |
| 12/28/2017 9:27 | 88.02 | |
| 12/28/2017 12:04 | 88.15 | |
| 12/28/2017 13:50 | 88.18 | |
| 12/28/2017 19:43 | 88.48 | |
| 12/28/2017 23:42 | 88.57 | |
| 12/29/2017 3:14 | 88.65 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 5:18 | 88.61 | |
| 12/29/2017 7:45 | 93.24 | Pump On |
| 12/29/2017 10:29 | 88.44 | |
| 12/29/2017 12:44 | 88.27 | |

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854734 / Rita Smith
# Hydrograph

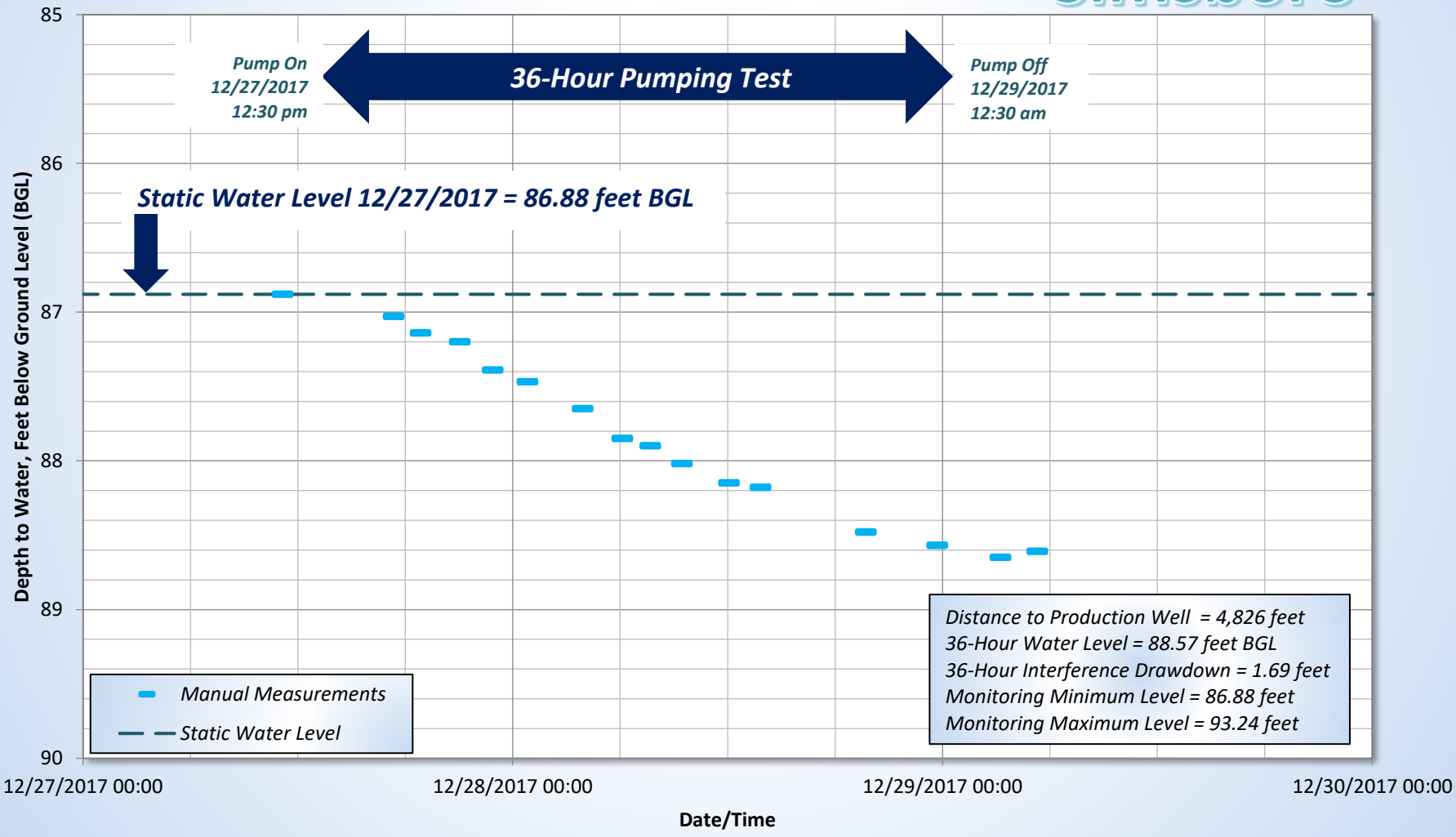
Simsboro



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854734 / Rita Smith
# Hydrograph

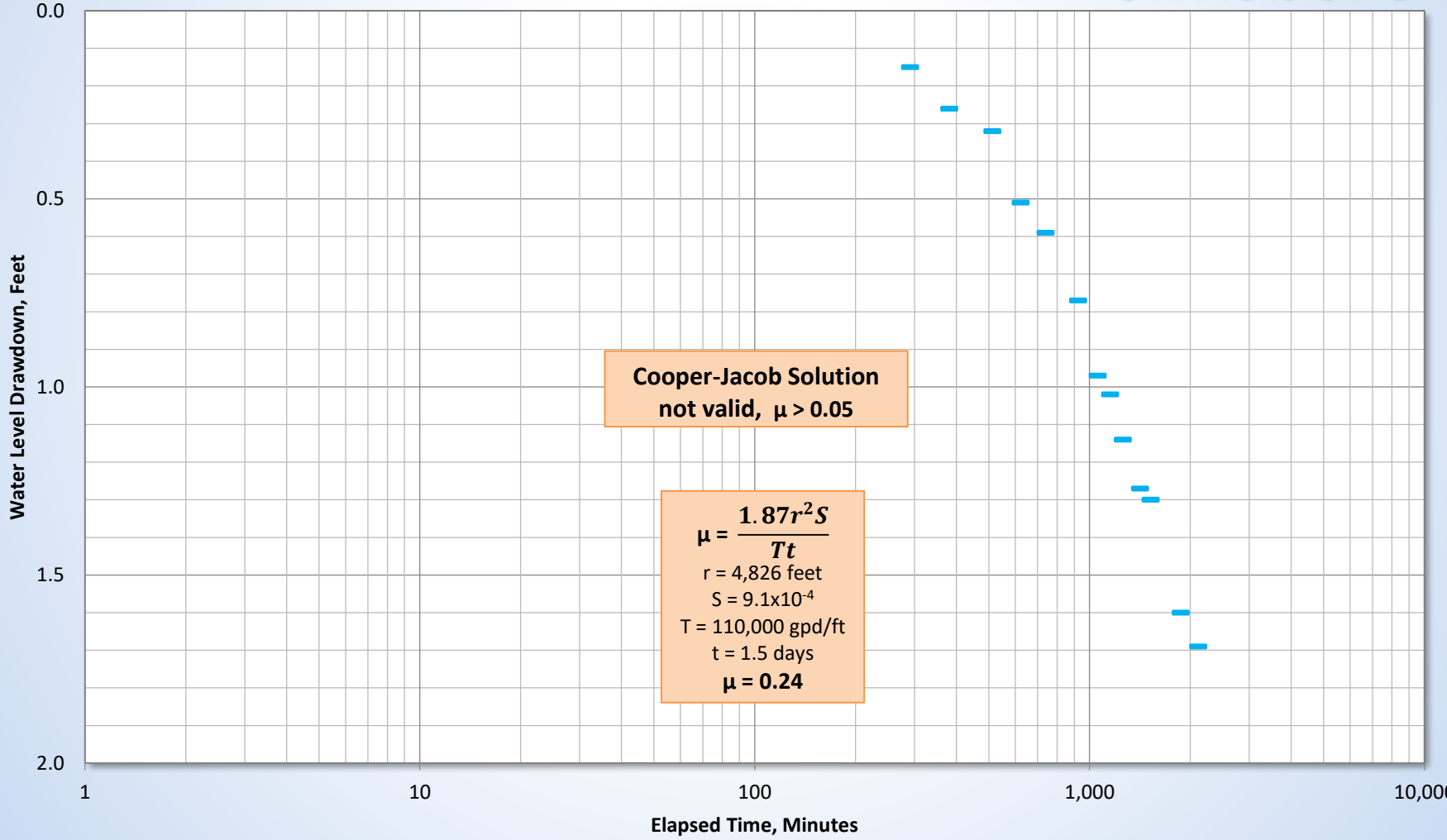
Simsboro



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# _LPGCD Well 5854734 / Rita Smith
# Cooper-Jacob Chart (Drawdown)

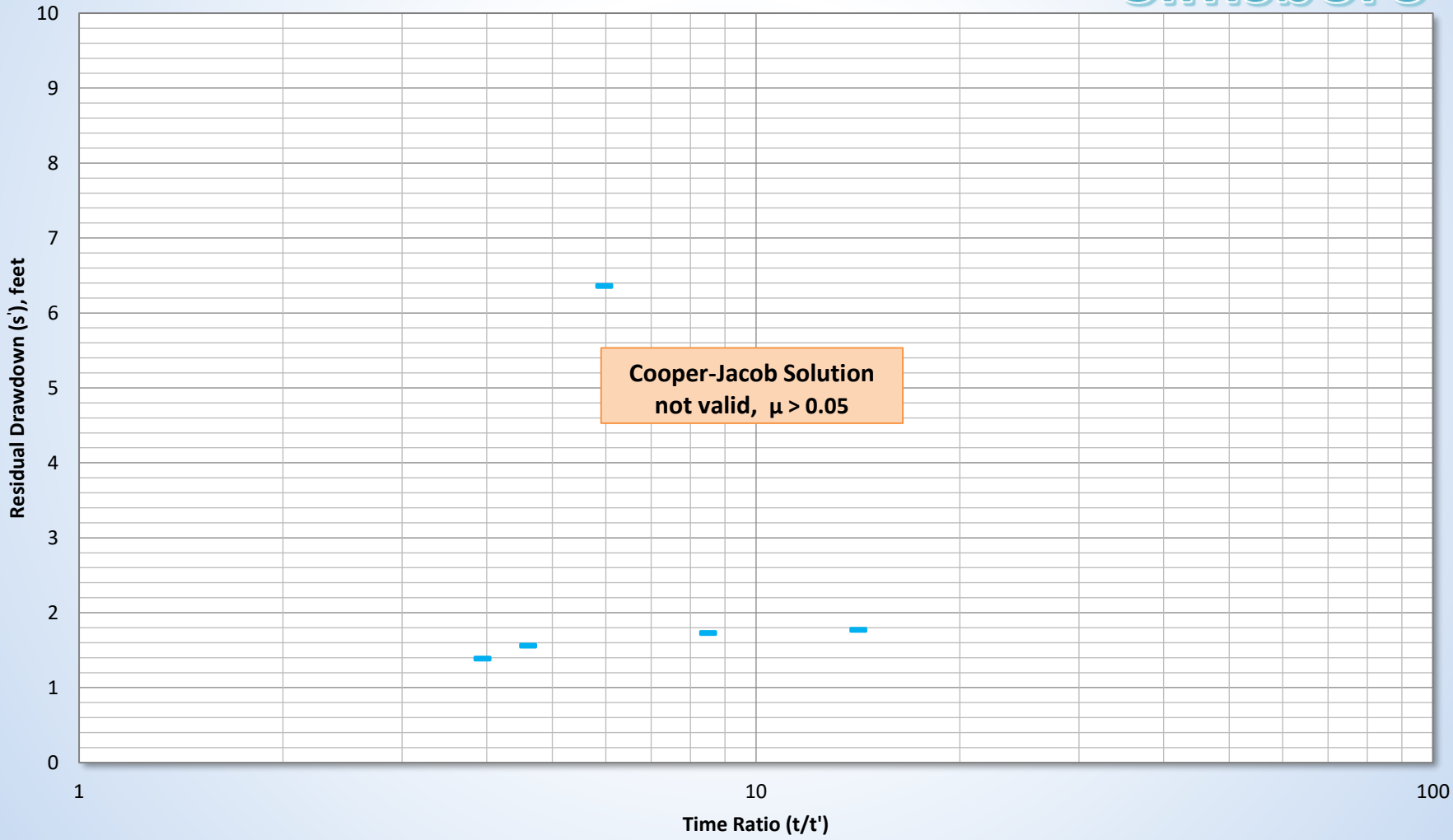
Simsboro



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854734 / Rita Smith
## Cooper-Jacob Chart (Recovery)

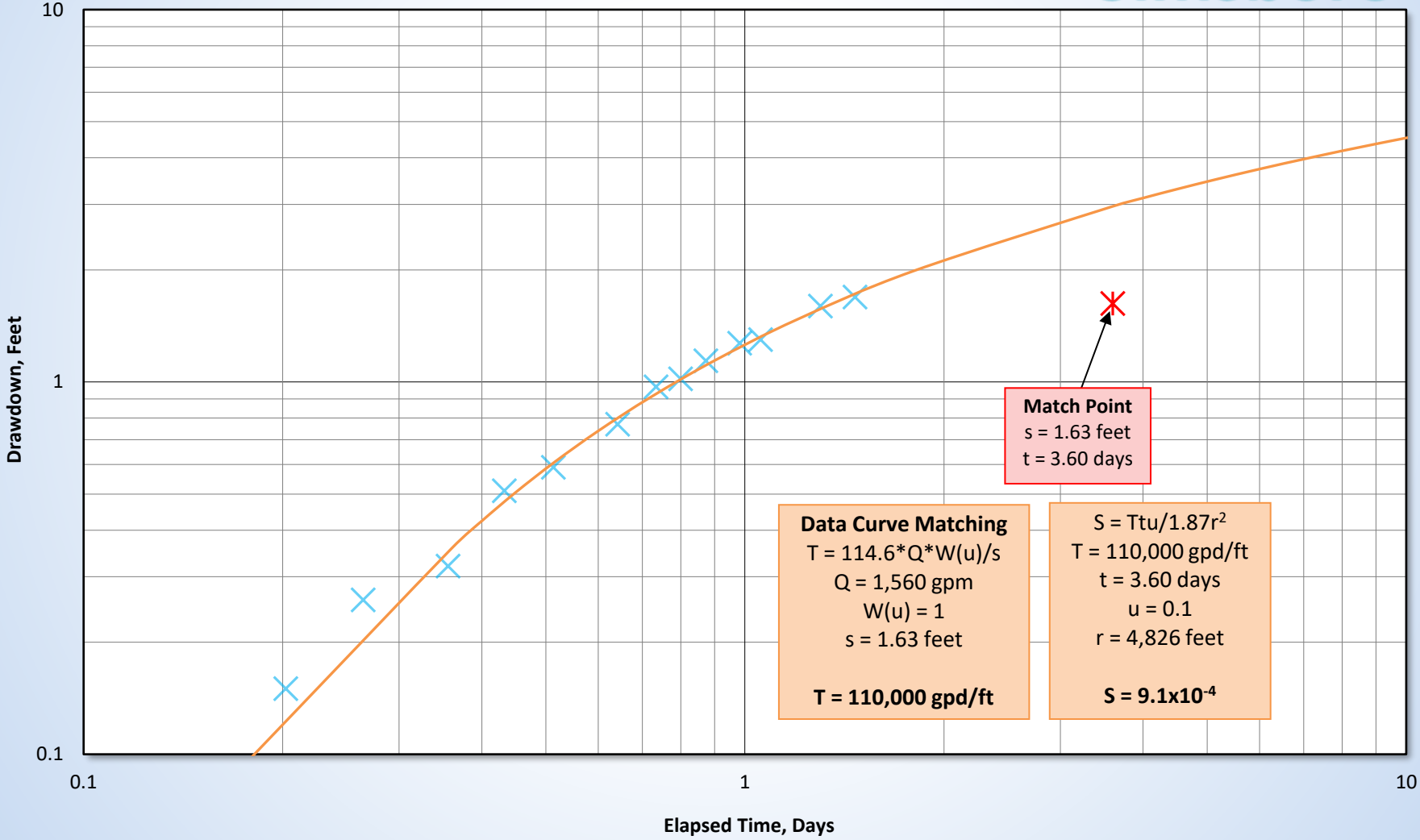
Simsboro



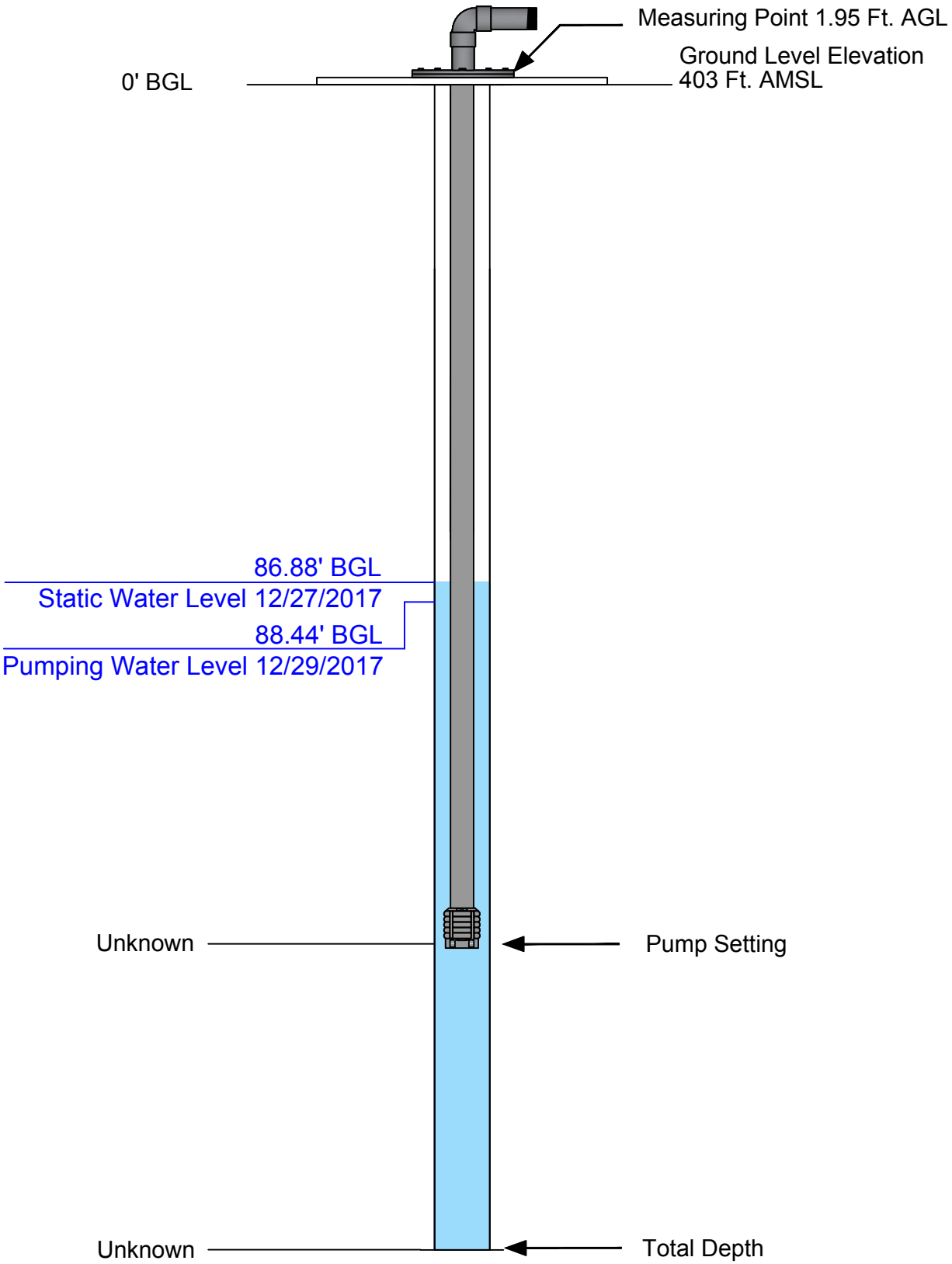
THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854734 / Rita Smith
# Theis Curve

Simsboro



# LPGCD Well 5854734 / Rita Smith




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists


Name: Rita Smith
Distance from Well J: 4,826.12 feet
Static Water Level 12/27/2017: 86.88 feet BGL
Arrowhead Ct
Shoreside
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## Zinker 2 Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 4,940 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/20/2017 10:50 | 44.95 | Background |
| 10/26/2017 10:00 | 47.10 | Background |
| 11/10/2017 14:40 | 46.85 | Background |
| 11/28/2017 16:13 | 46.00 | Background |
| 12/22/2017 13:03 | 45.67 | Background |
| 12/27/2017 11:15 | 45.80 | Static Water Level |
| 12/27/2017 14:07 | 45.80 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 17:17 | 45.87 | |
| 12/27/2017 20:58 | 46.15 | |
| 12/28/2017 9:45 | 46.90 | |
| 12/28/2017 19:37 | 47.28 | |
| 12/28/2017 23:39 | 47.40 | |
| 12/29/2017 3:20 | 47.44 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 7:40 | 47.38 | |
| 12/29/2017 10:22 | 47.21 | |
| 12/29/2017 12:38 | 47.10 | |
| 1/3/2018 14:40 | 46.00 | |

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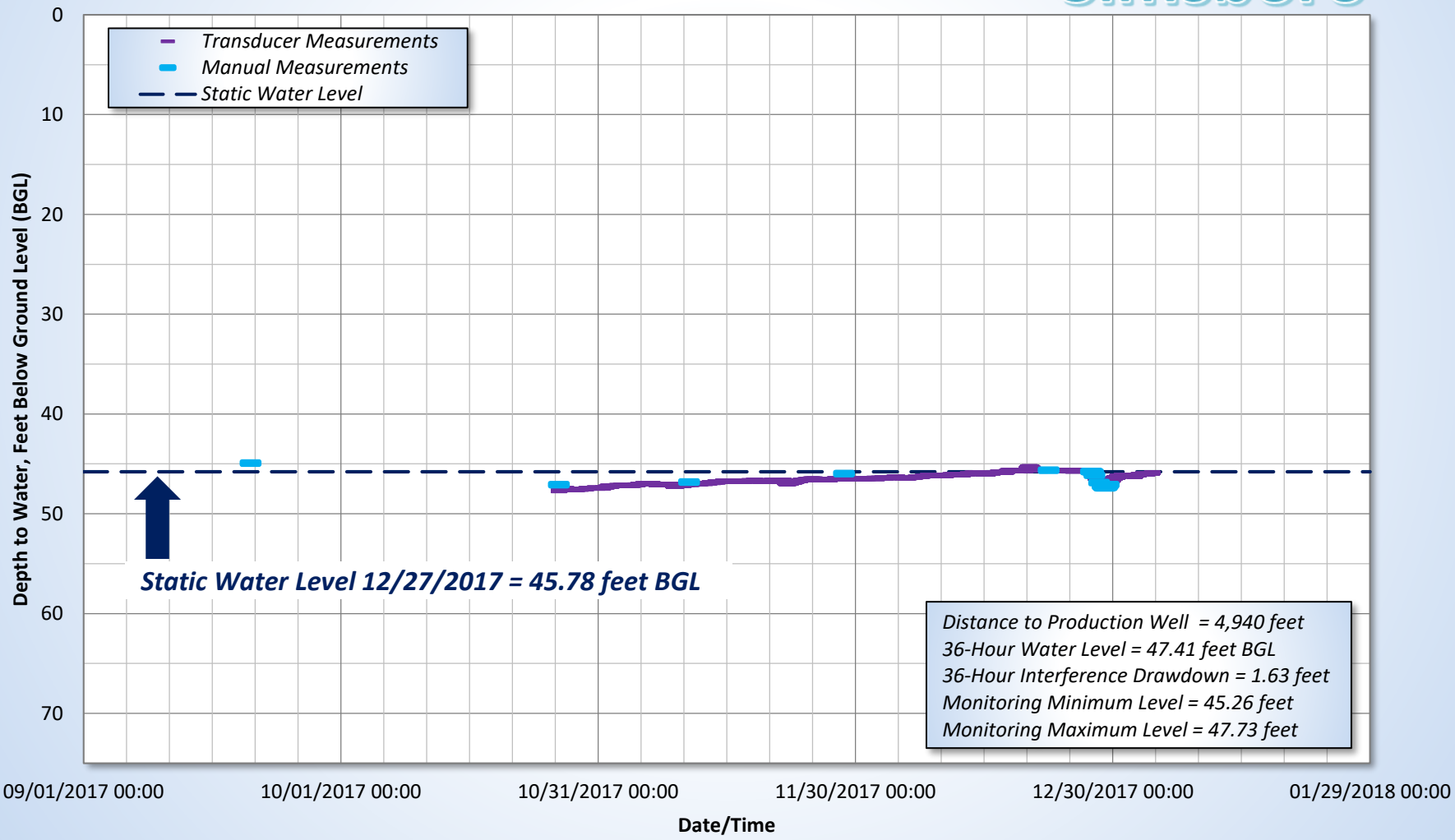
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854737 / Zinker 2
# Hydrograph

Simsboro



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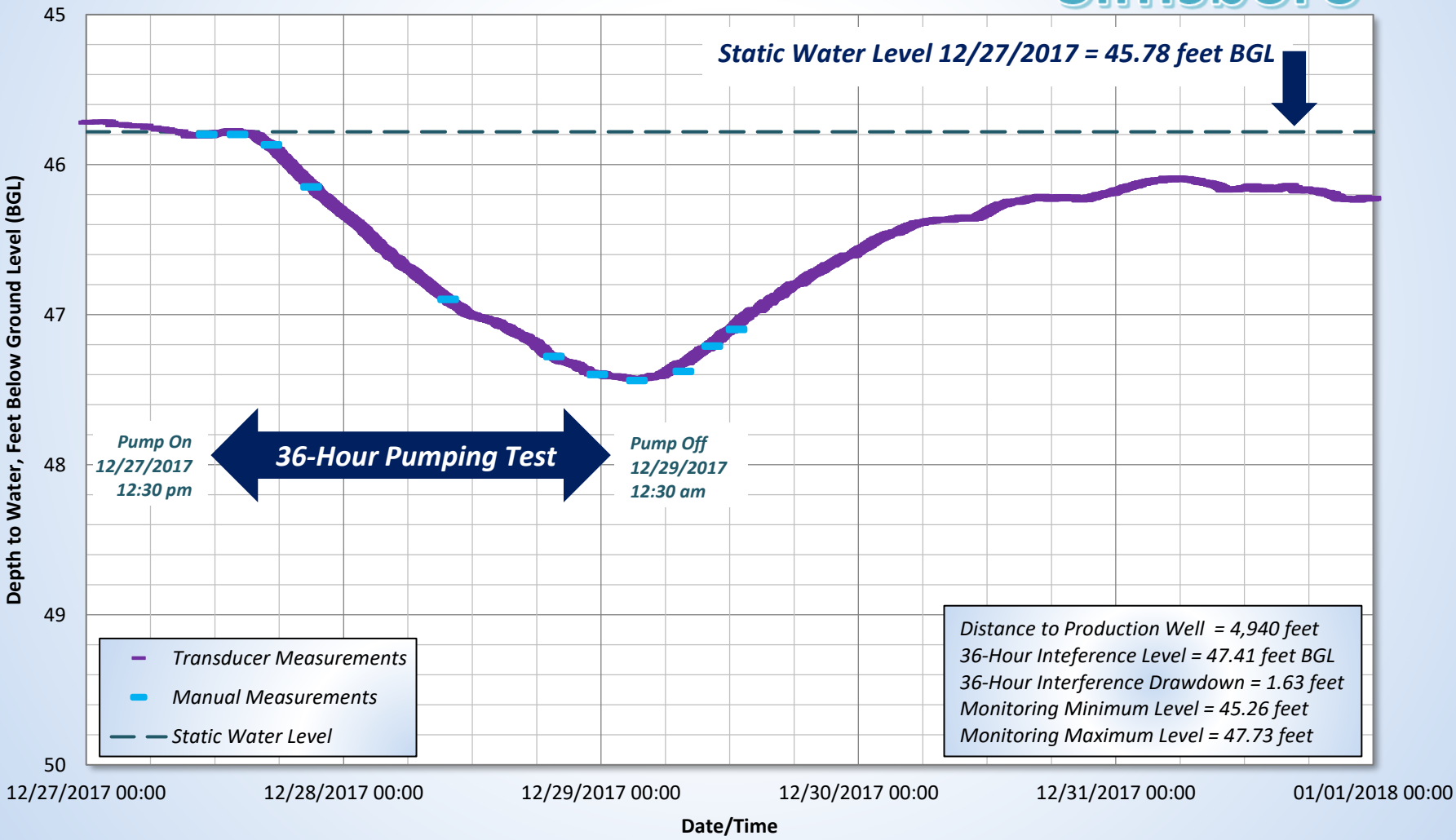
# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854737 / Zinker 2
# Hydrograph

Simsboro



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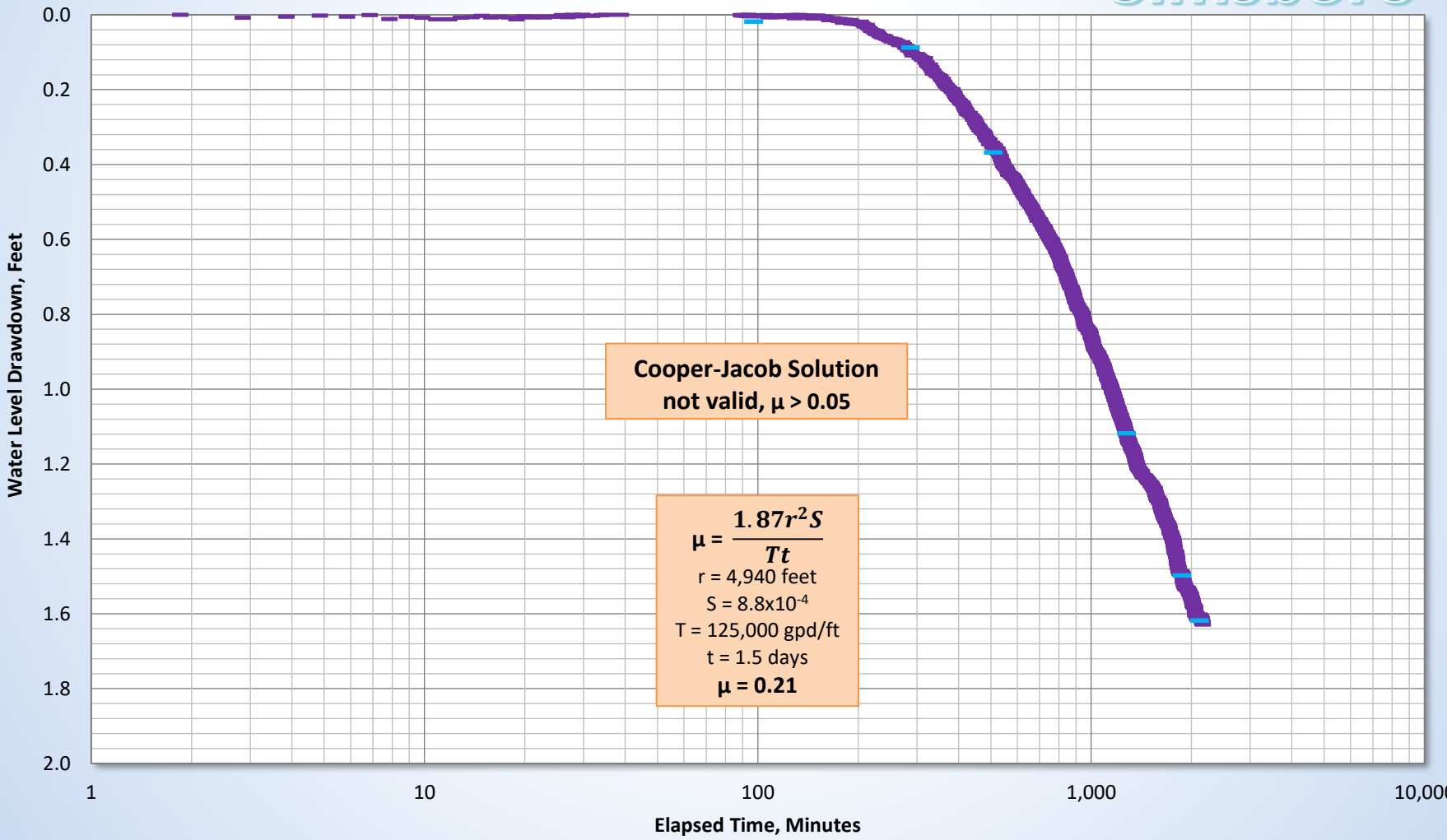
# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854737 / Zinker 2
## Cooper-Jacob Chart (Drawdown)

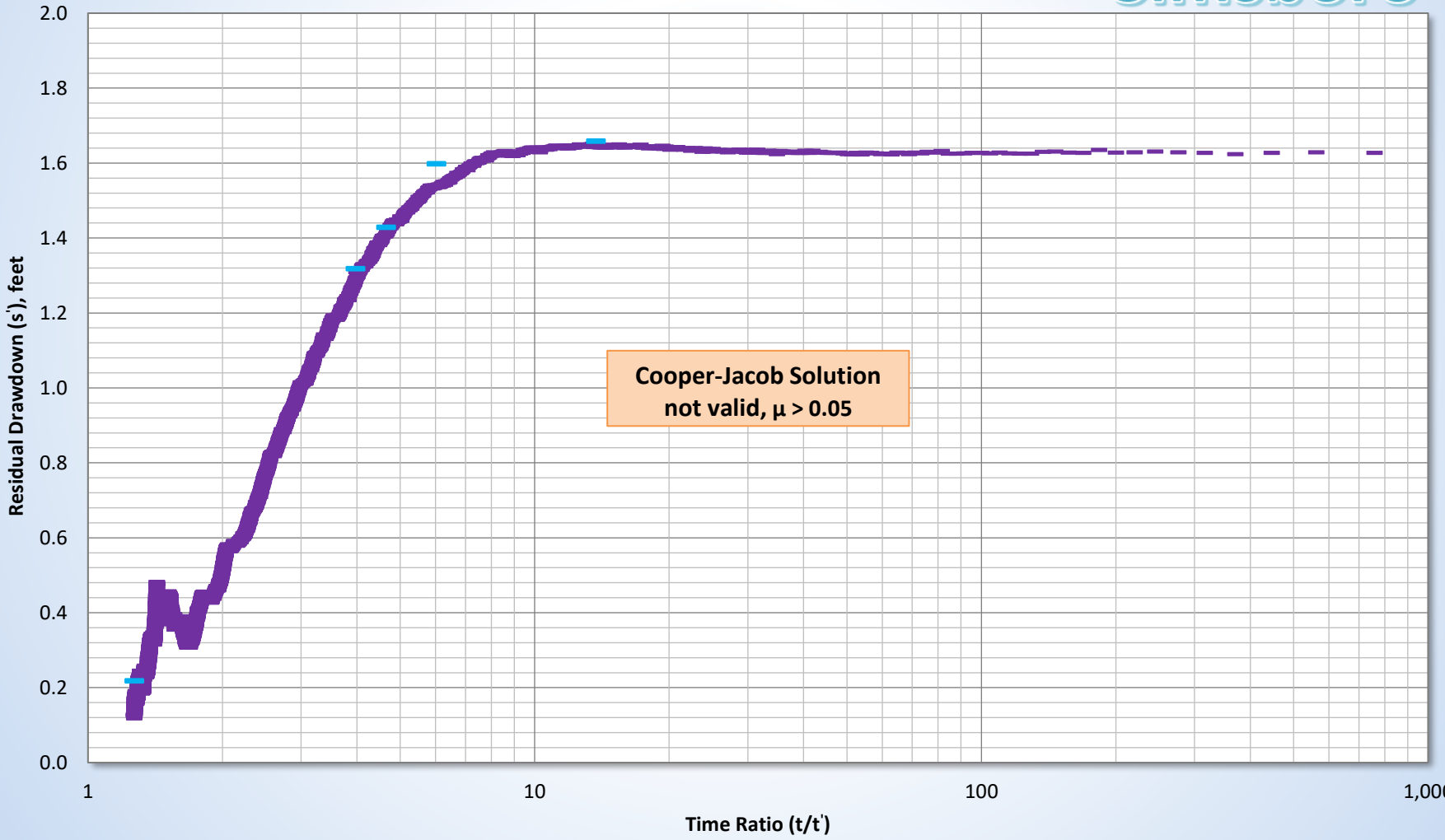
Simsboro



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854737 / Zinker 2
## Cooper-Jacob Chart (Recovery)

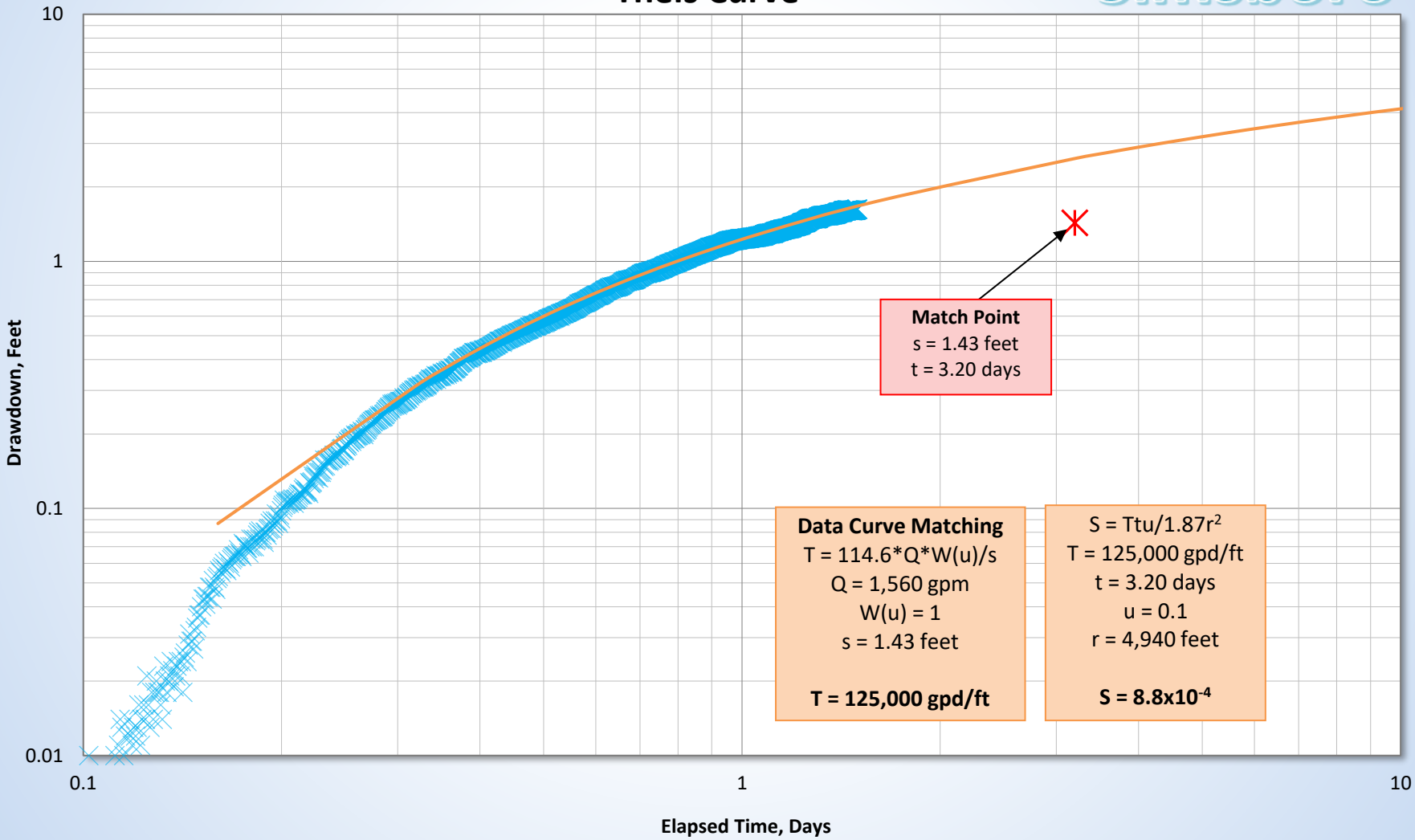
Simsboro



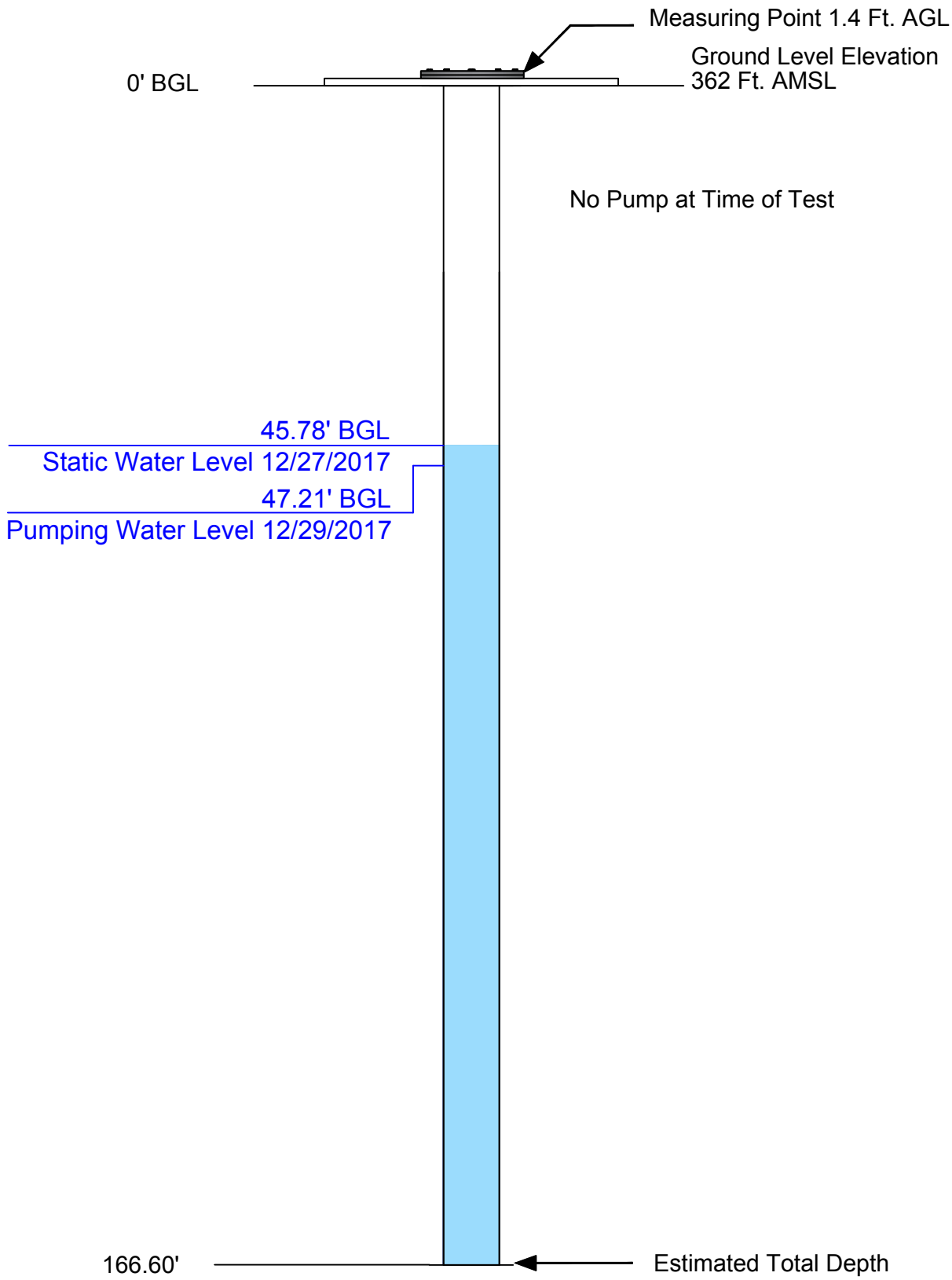
THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854737 / Zinker 2
# Theis Curve

Simsboro



# LPGCD Well 5854737 / Zinker 2




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

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Name: Zinker 2
Distance from Well J: 4,940.95 feet
Static Water Level 12/27/2017: 45.78 feet BGL
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## Haungs Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 5,034 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/21/2017 14:31 | 100.11 | Background |
| 12/27/2017 11:36 | 100.95 | Static Water Level |
| 12/27/2017 17:00 | 101.05 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 18:34 | 101.24 | |
| 12/27/2017 20:47 | 101.35 | |
| 12/27/2017 22:40 | 101.41 | |
| 12/28/2017 1:28 | 101.61 | |
| 12/28/2017 5:23 | 101.80 | |
| 12/28/2017 10:09 | 102.05 | |
| 12/28/2017 14:13 | 102.10 | |
| 12/28/2017 19:16 | 102.27 | |
| 12/28/2017 23:20 | 102.39 | |
| 12/29/2017 4:16 | 102.37 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 7:25 | 102.26 | |
| 12/29/2017 10:10 | 102.29 | |
| 12/29/2017 12:24 | 102.35 | |

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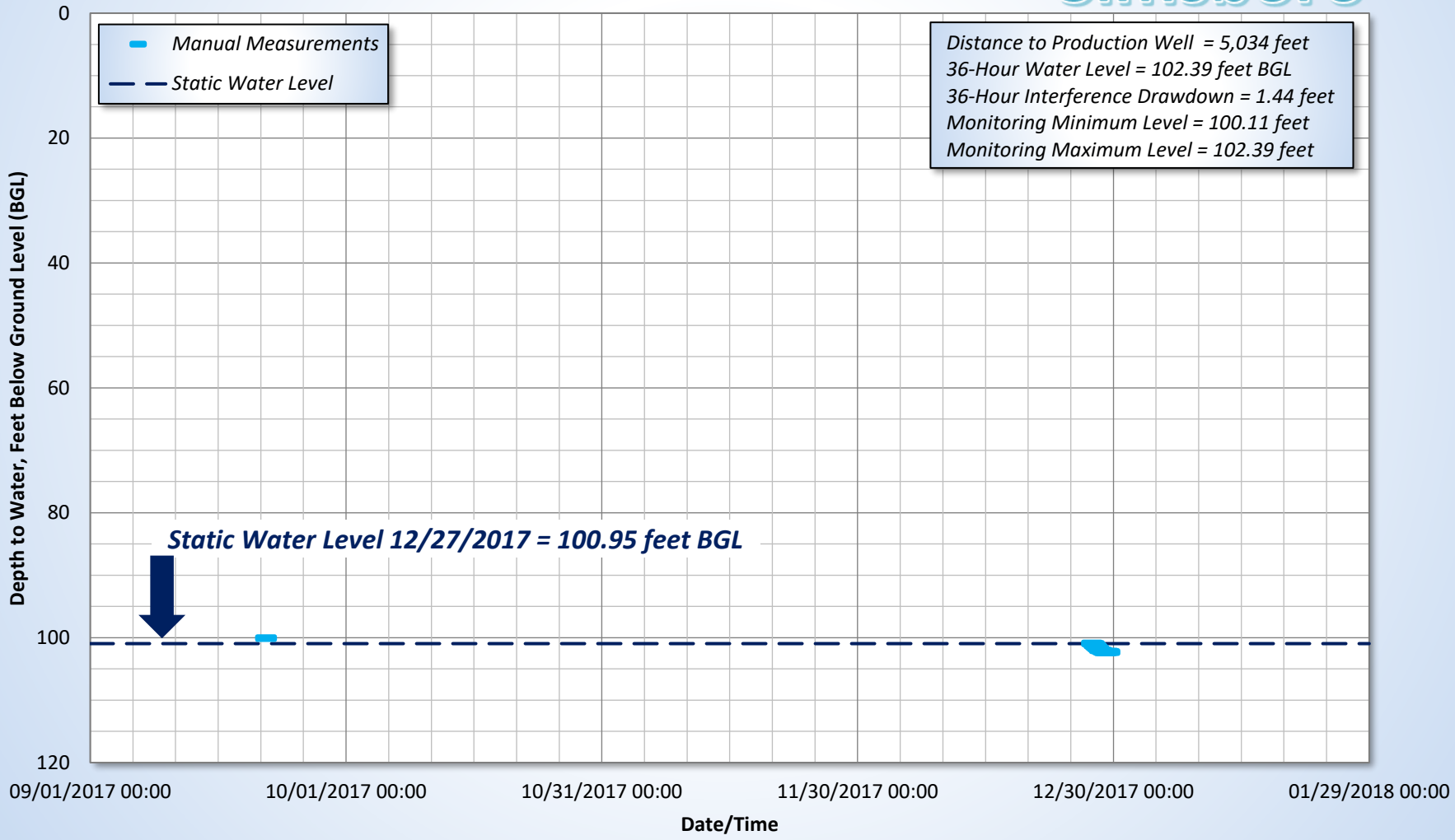
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854719 / Haungs
# Hydrograph

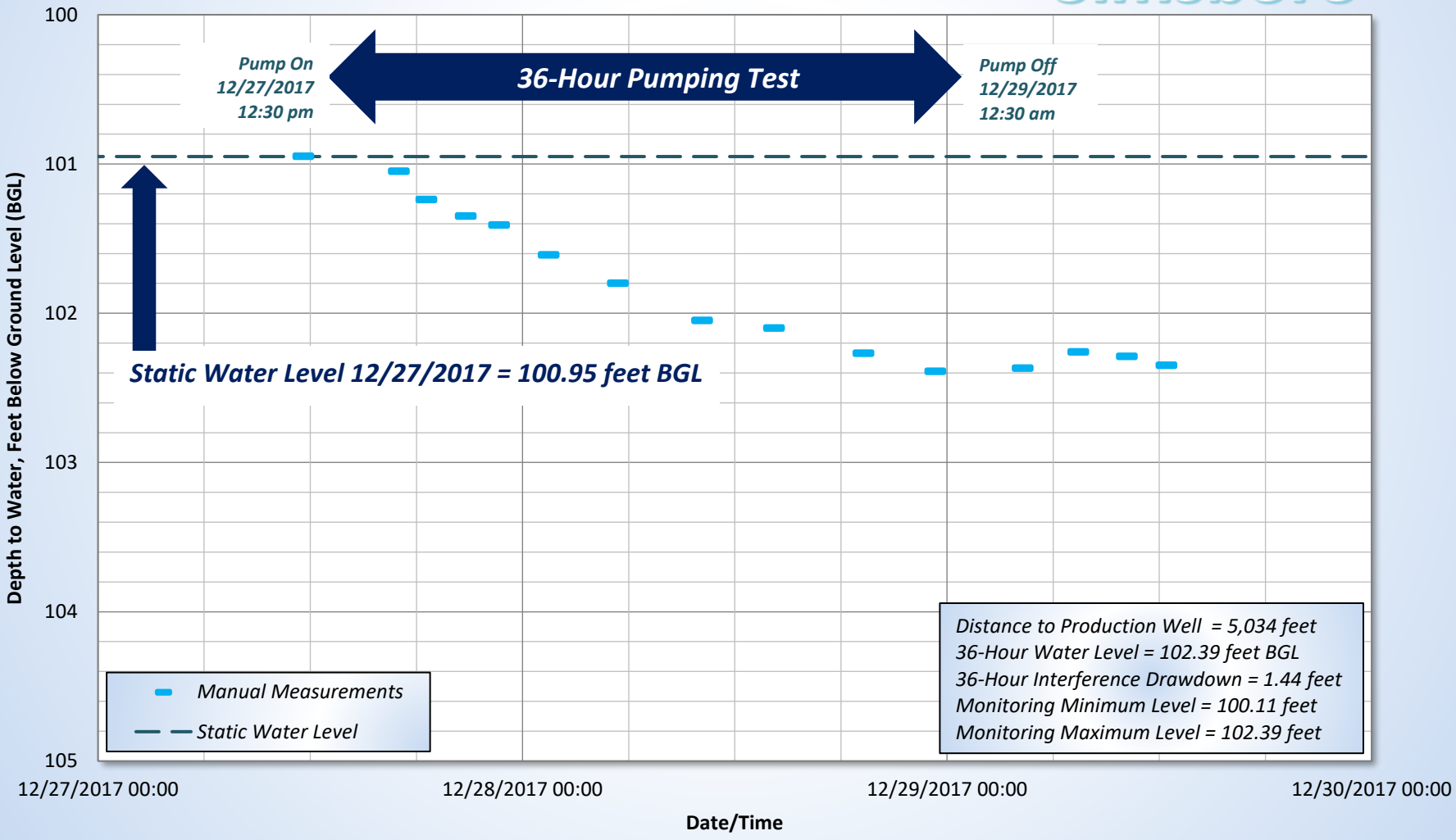
Simsboro



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854719 / Haungs
# Hydrograph

Simsboro



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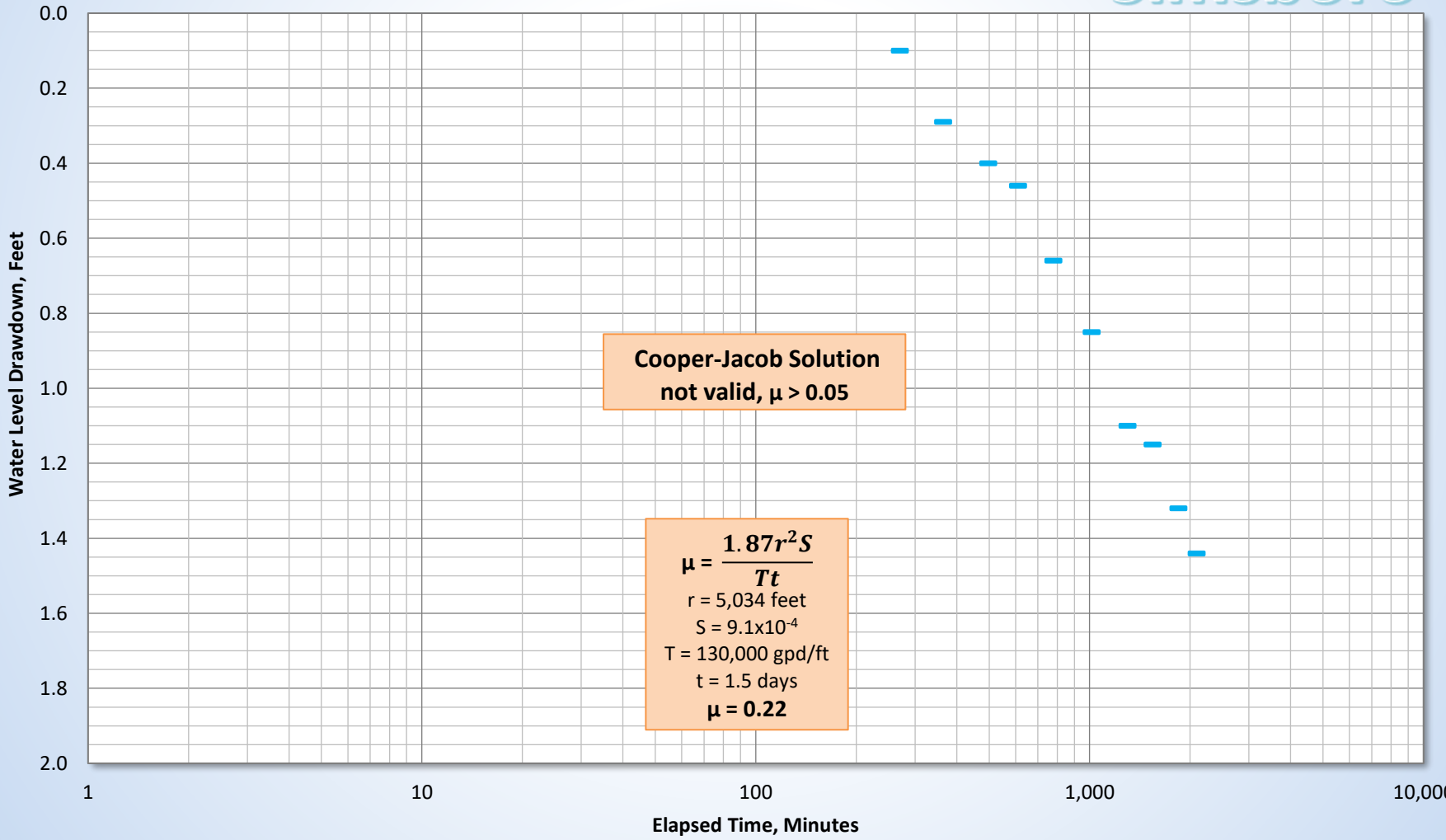
# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854719 / Haungs
# Cooper-Jacob Chart (Drawdown)

Simsboro



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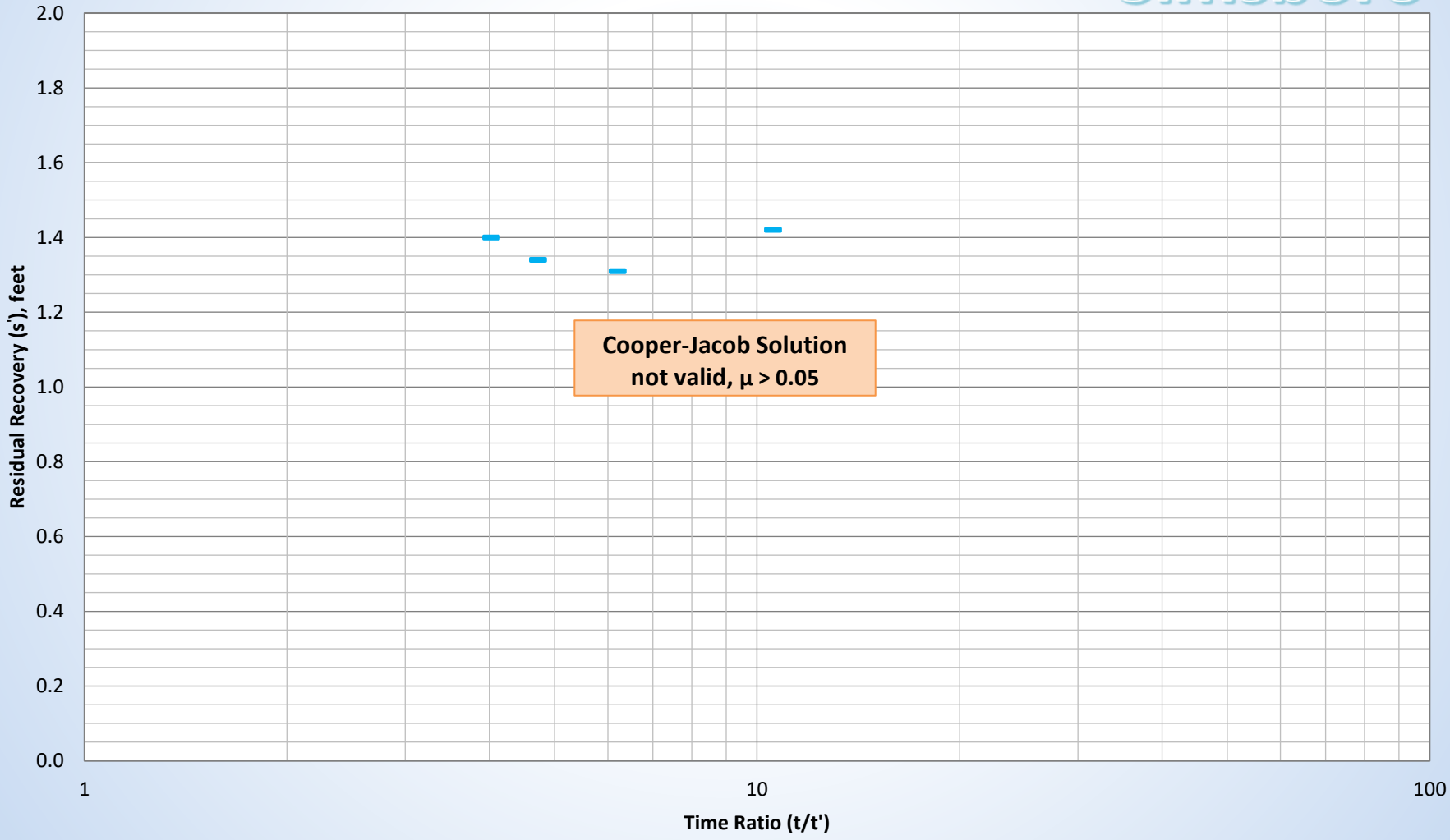
# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854719 / Haungs
## Cooper-Jacob Chart (Recovery)

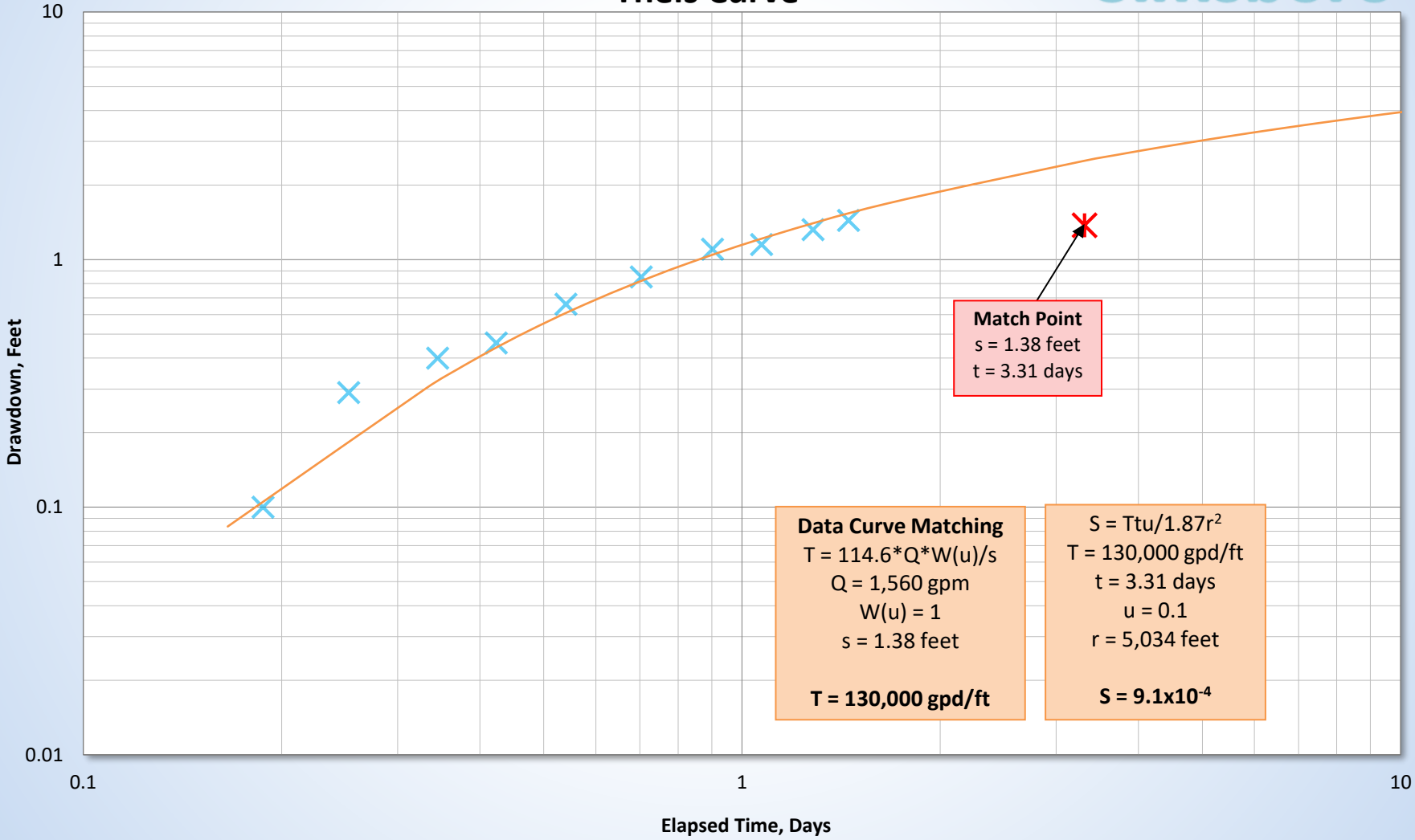
Simsboro



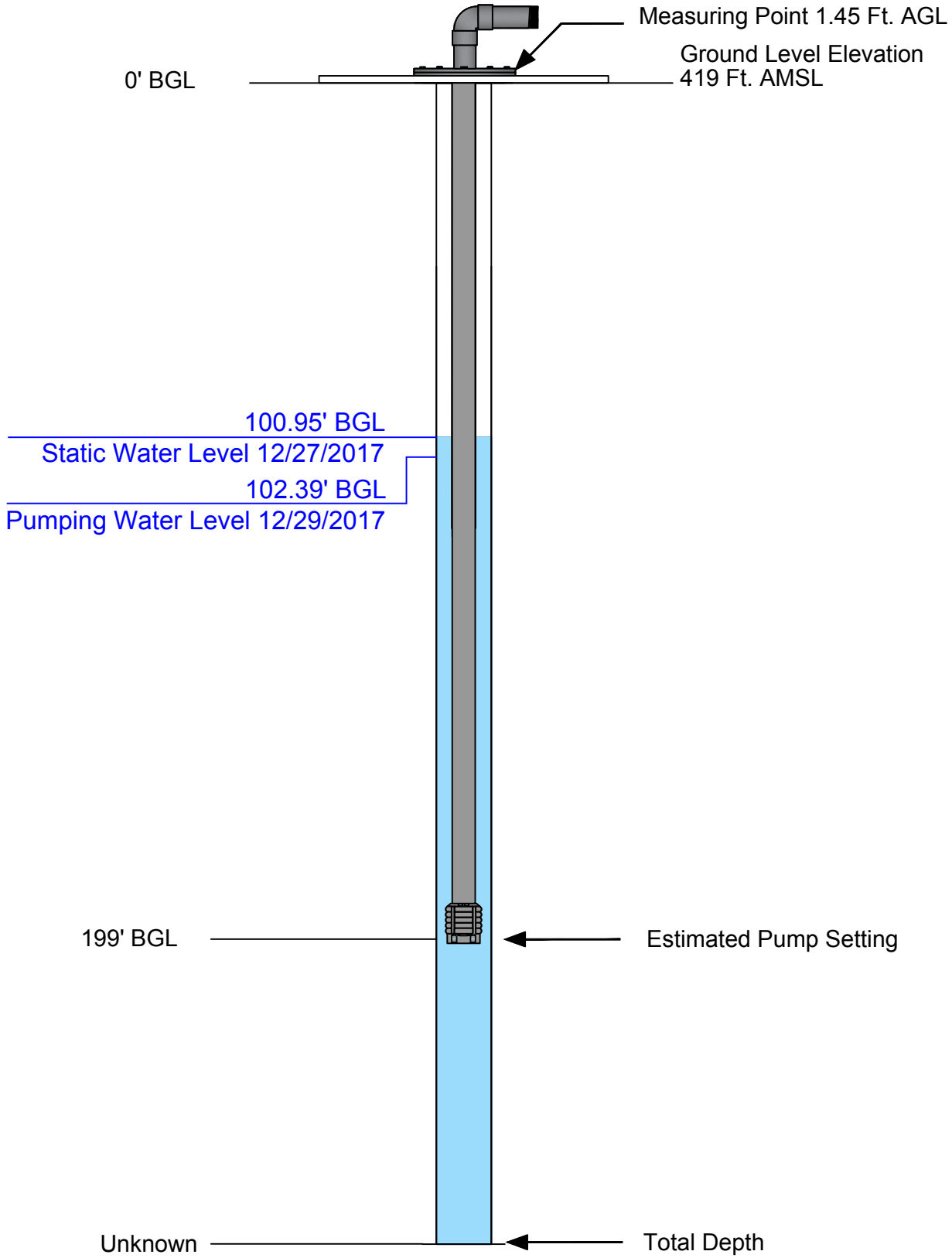
THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854719 / Haungs
# Theis Curve

Simsboro



# LPGCD Well 5854719 / Haungs




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

THORNHILL GROUP, INC.
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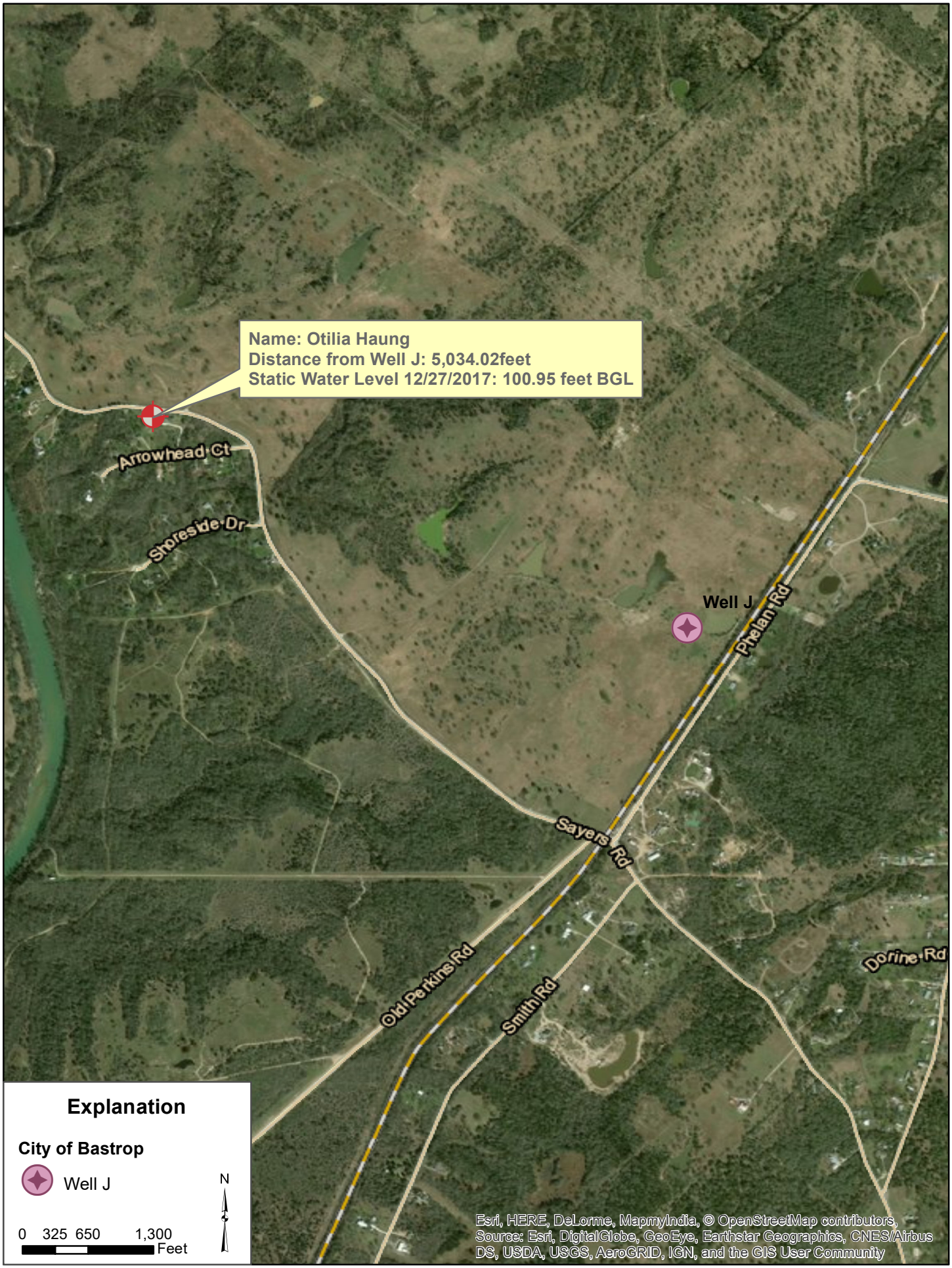
Name: Otilia Haung
Distance from Well J: 5,034.02feet
Static Water Level 12/27/2017: 100.95 feet BGL
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Dorine Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## LPGCD Well 5854739 / Goodrich House 141
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 5,141 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/21/2017 11:35 | 75.48 | Background |
| 11/10/2017 14:29 | 77.32 | Background |
| 12/27/2017 11:26 | 76.46 | Static Water Level |
| 12/27/2017 14:26 | 76.46 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 17:07 | 76.52 | |
| 12/27/2017 18:41 | 76.67 | |
| 12/27/2017 20:52 | 76.80 | |
| 12/27/2017 22:45 | 76.88 | |
| 12/28/2017 1:04 | 77.10 | |
| 12/28/2017 3:30 | 77.09 | |
| 12/28/2017 5:45 | 77.18 | |
| 12/28/2017 10:00 | 77.50 | |
| 12/28/2017 14:05 | 77.60 | |
| 12/28/2017 19:24 | 77.74 | |
| 12/28/2017 23:26 | 77.87 | |
| 12/29/2017 3:31 | 77.94 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 5:06 | 77.90 | |
| 12/29/2017 7:30 | 77.77 | |
| 12/29/2017 10:13 | 77.75 | |
| 12/29/2017 12:26 | 77.71 | |

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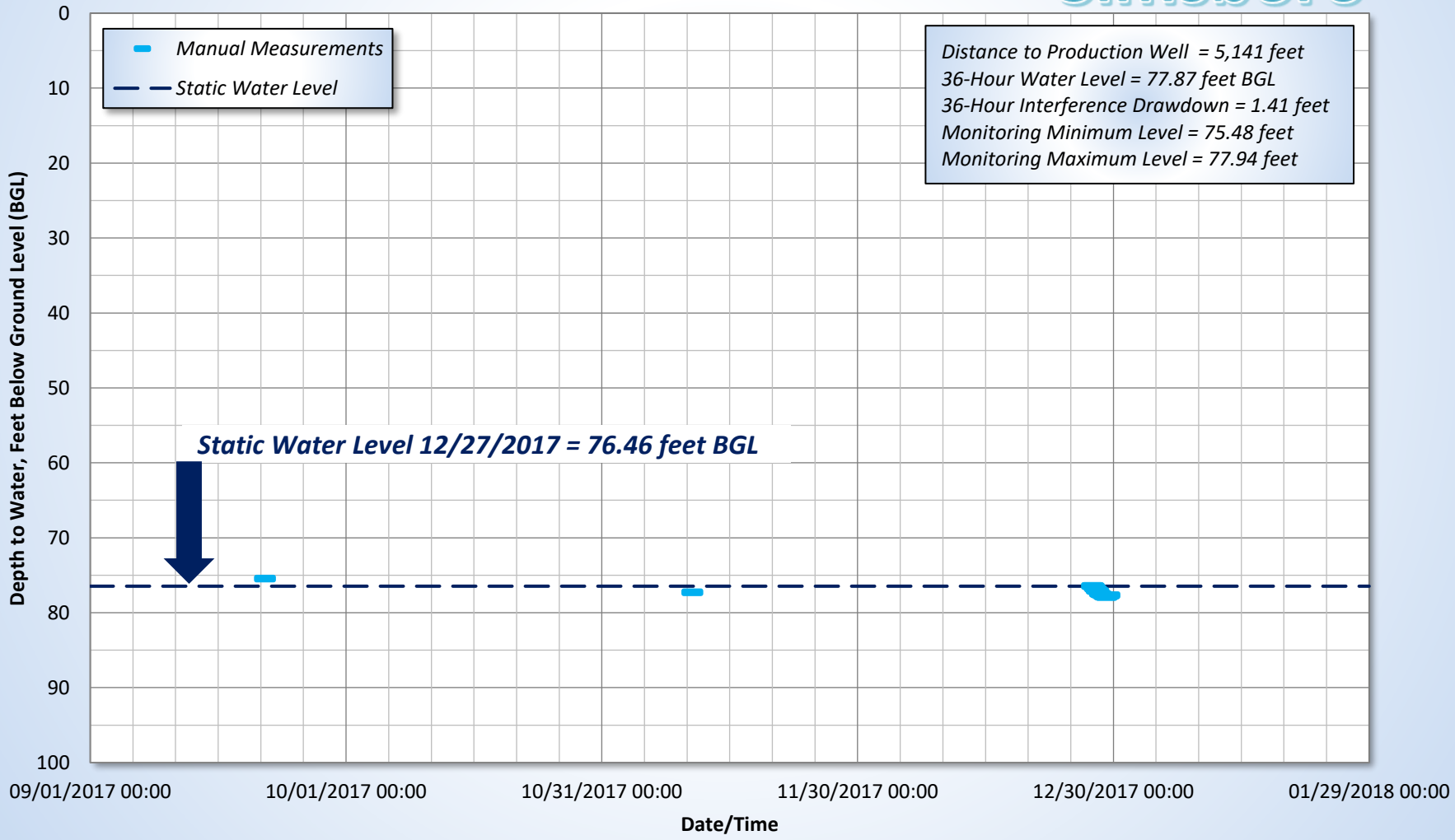
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854739 / Goodrich House 141
# Hydrograph

Simsboro



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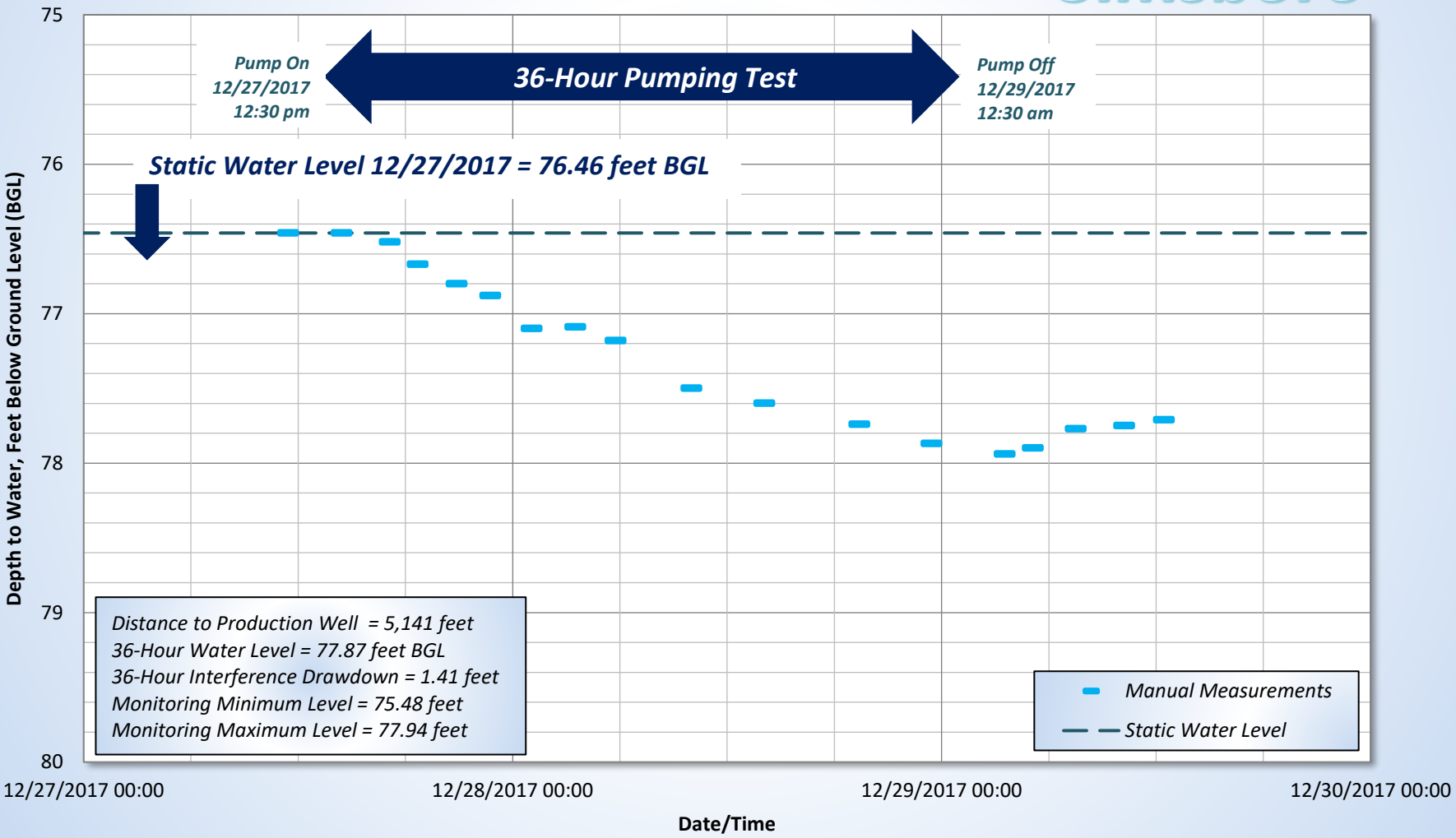
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854739 / Goodrich House 141
# Hydrograph

Simsboro



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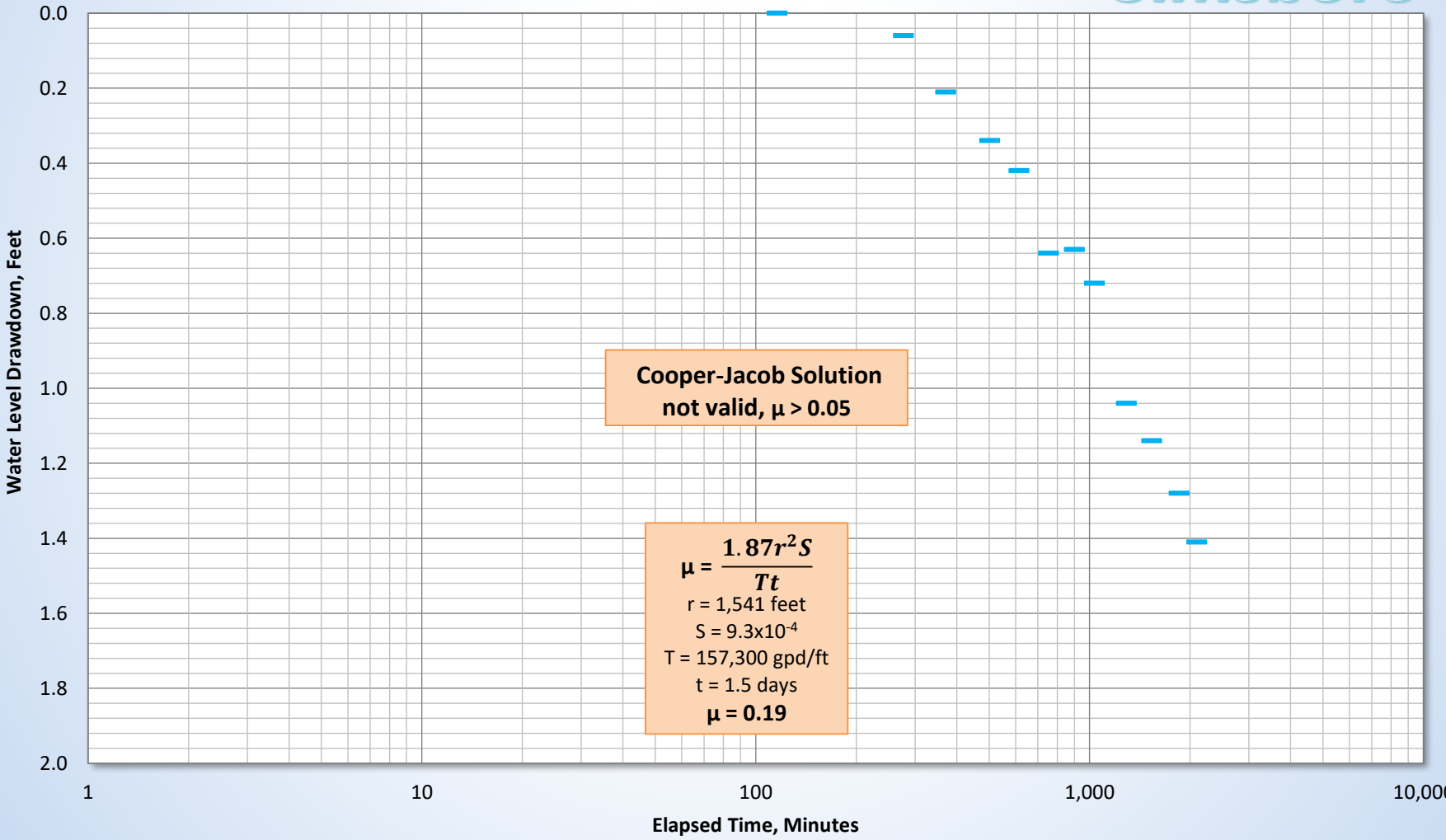
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854739 / Goodrich House 141
## Cooper-Jacob Chart (Drawdown)

Simsboro



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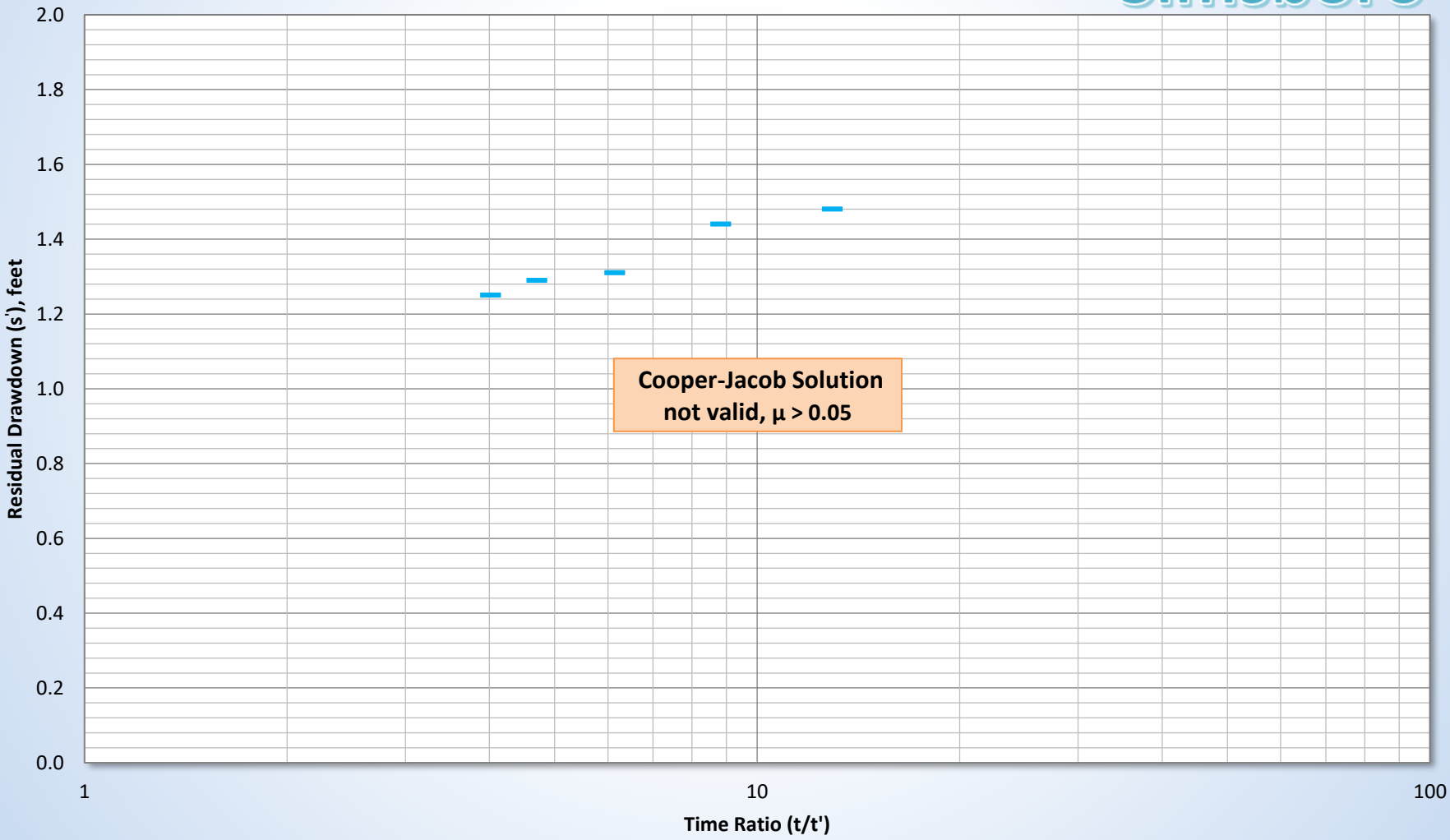
# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854739 / Goodrich House 141
## Cooper-Jacob Chart (Recovery)

Simsboro



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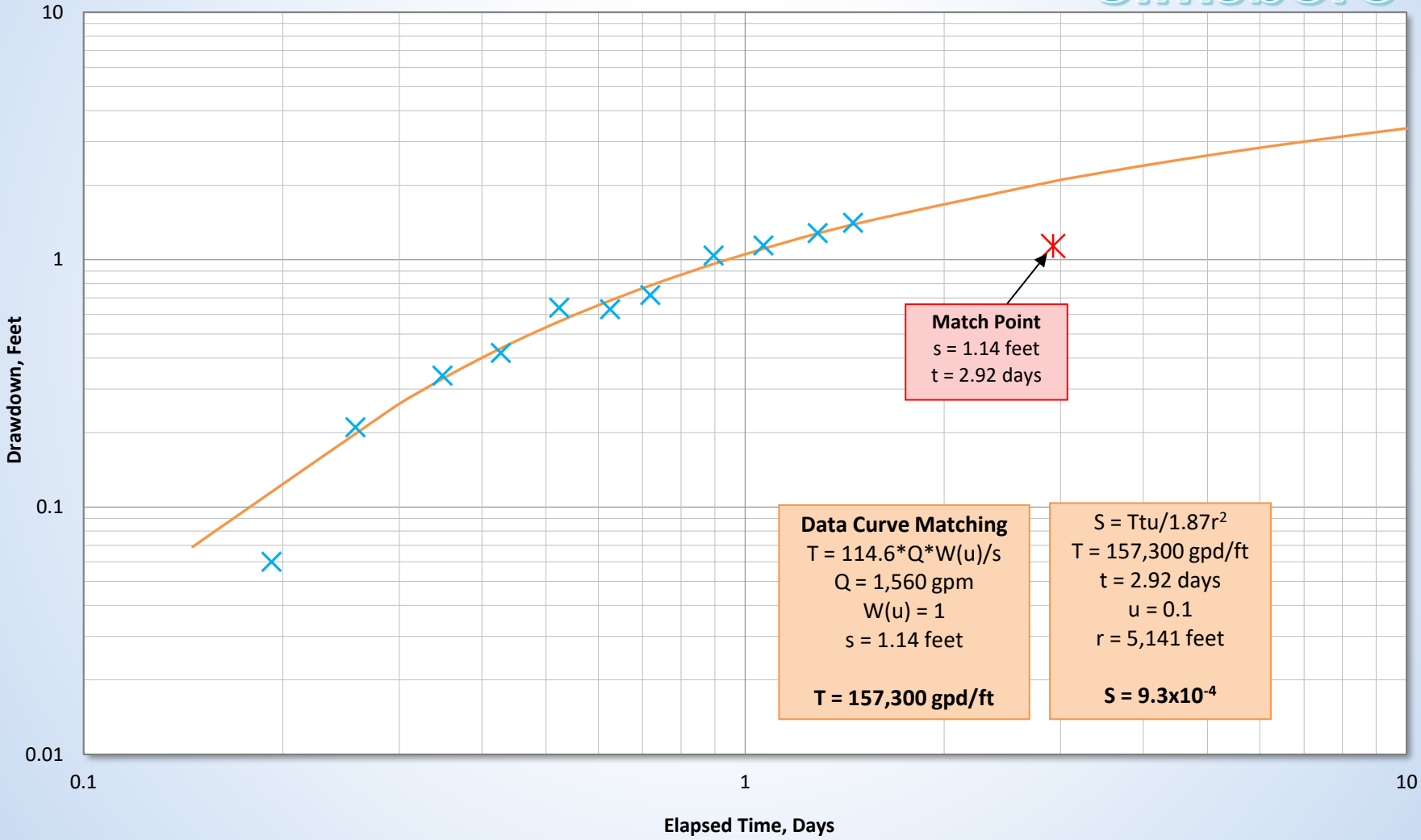
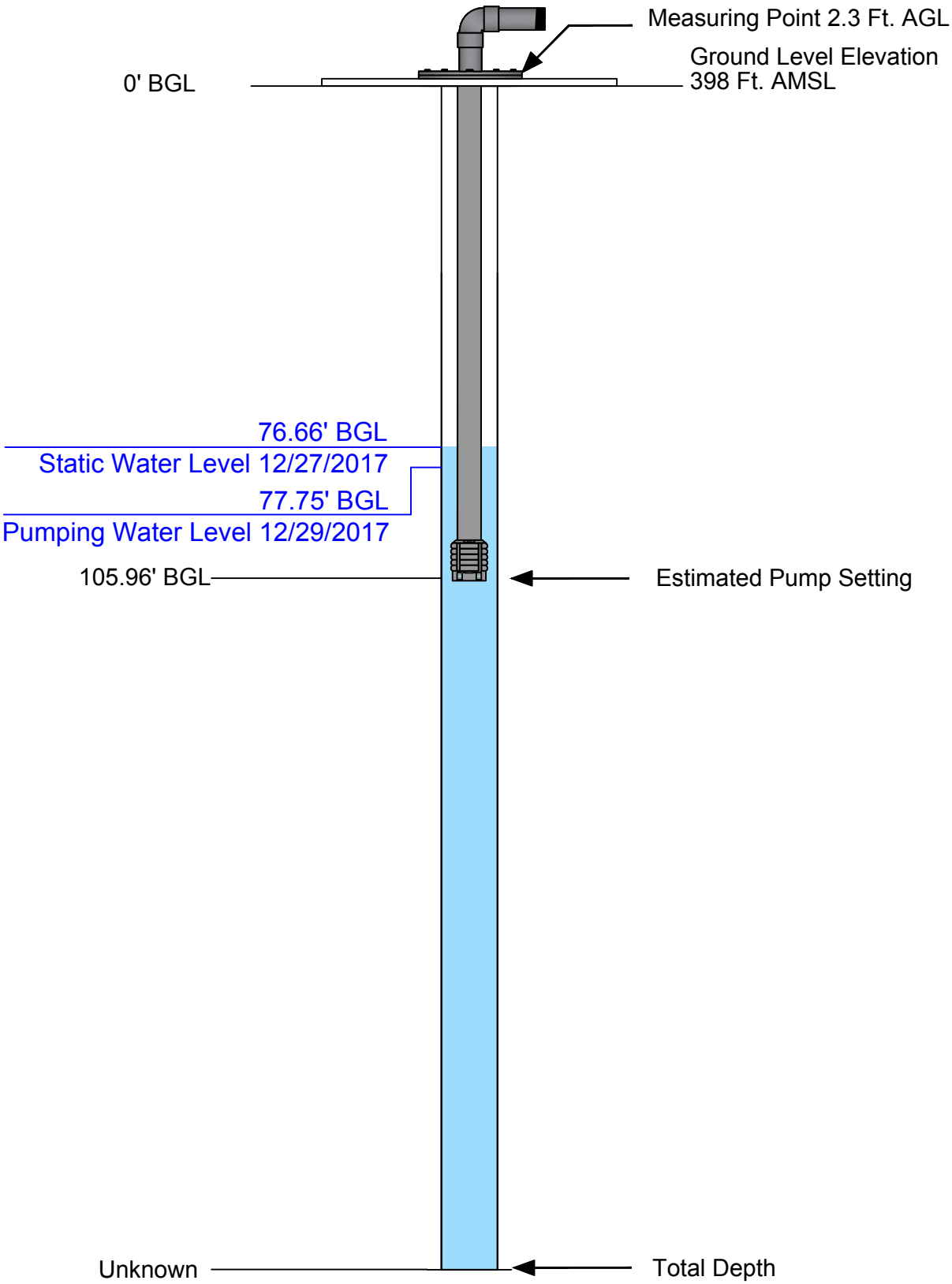
# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854739 / Goodrich House 141
## Theis Curve

Simsboro



# LPGCD Well 5854739 / Goodrich House 141




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

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Rd
Name: Goodrich House 141
Distance from Well J: 5,141.48 feet
Static Water Level 12/27/2017: 76.66 feet BGL
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community, Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors

# City of Bastrop
## Tarket Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 5,333 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/20/2017 9:35 | 91.74 | Background |
| 10/26/2017 10:48 | 93.54 | Background |
| 11/10/2017 14:20 | 94.41 | Background |
| 11/28/2017 15:20 | 93.11 | Background |
| 12/27/2017 11:41 | 92.81 | Static Water Level |
| 12/27/2017 16:54 | 92.84 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 18:29 | 92.91 | |
| 12/27/2017 20:43 | 93.05 | |
| 12/27/2017 22:35 | 93.11 | |
| 12/28/2017 1:18 | 93.12 | |
| 12/28/2017 3:20 | 93.22 | |
| 12/28/2017 5:25 | 93.39 | |
| 12/28/2017 7:57 | 93.41 | |
| 12/28/2017 10:14 | 93.51 | |
| 12/28/2017 14:18 | 93.56 | |
| 12/28/2017 19:11 | 93.66 | |
| 12/28/2017 23:15 | 93.78 | |
| 12/29/2017 3:38 | 93.81 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 5:00 | 93.80 | |
| 12/29/2017 7:14 | 93.71 | |
| 12/29/2017 10:05 | 93.69 | |
| 12/29/2017 12:14 | 93.56 | |

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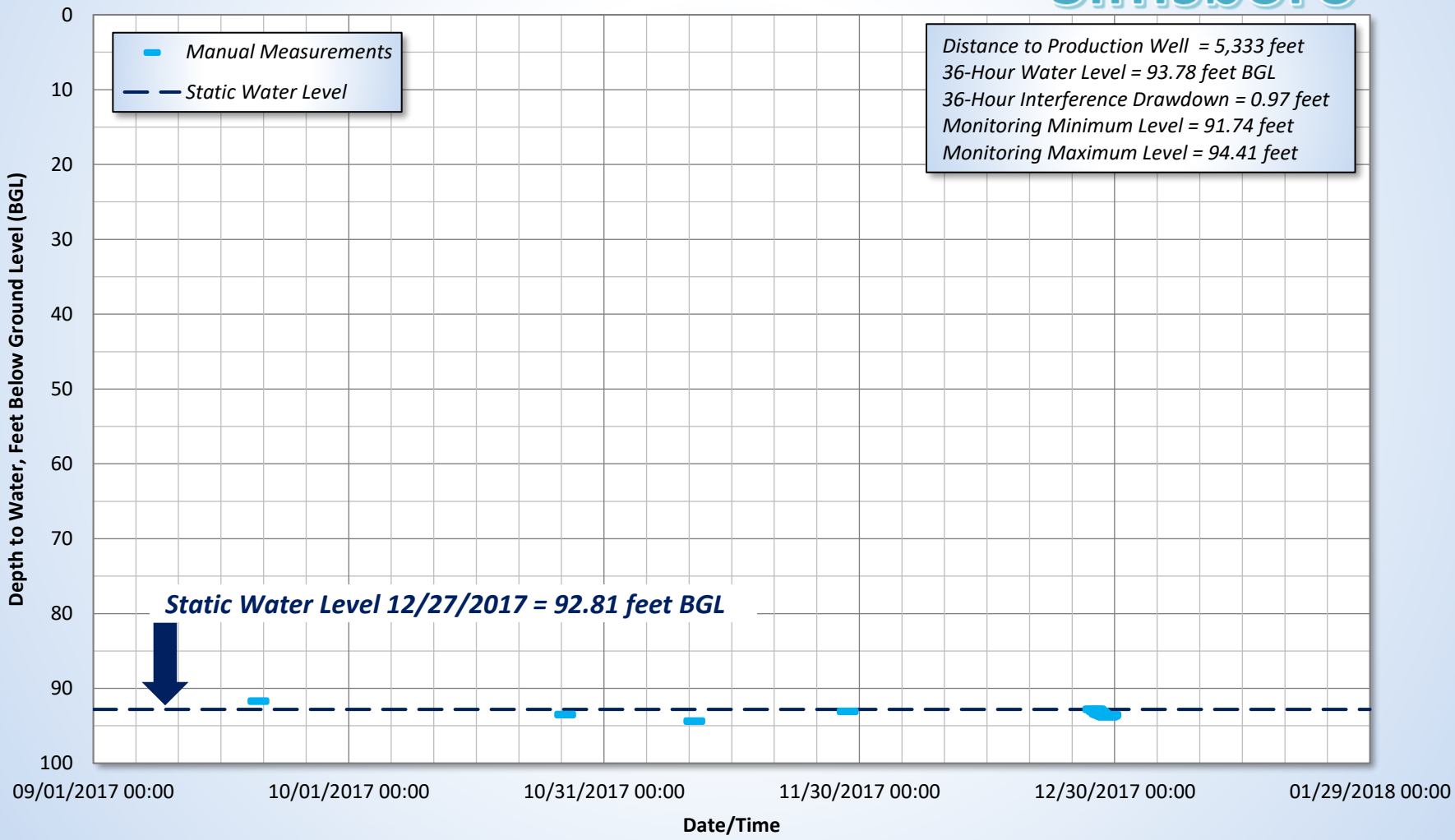
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854733 / Charles Tarket
# Hydrograph

Simsboro



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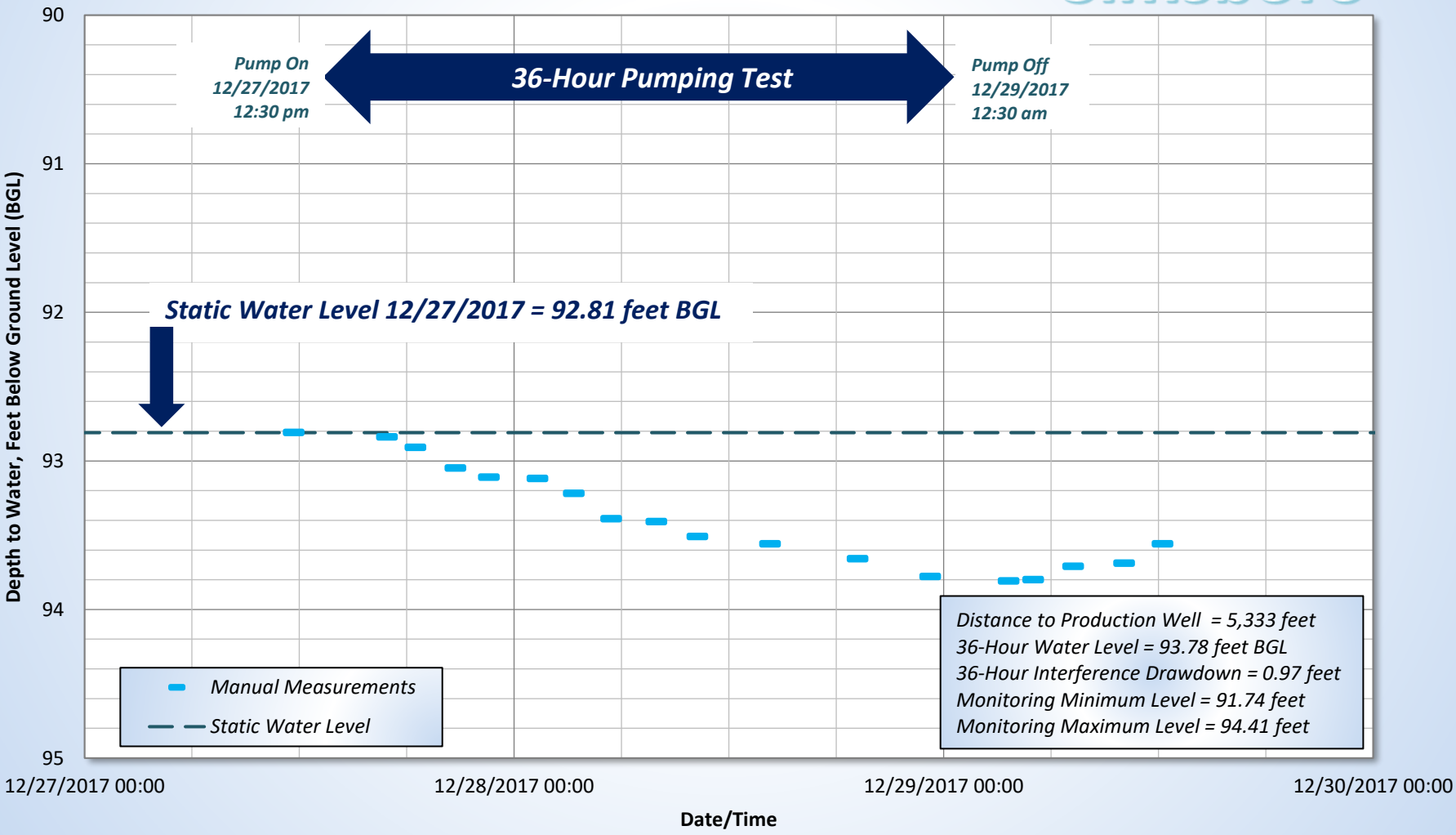
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854733 / Charles Tarket
# Hydrograph

Simsboro



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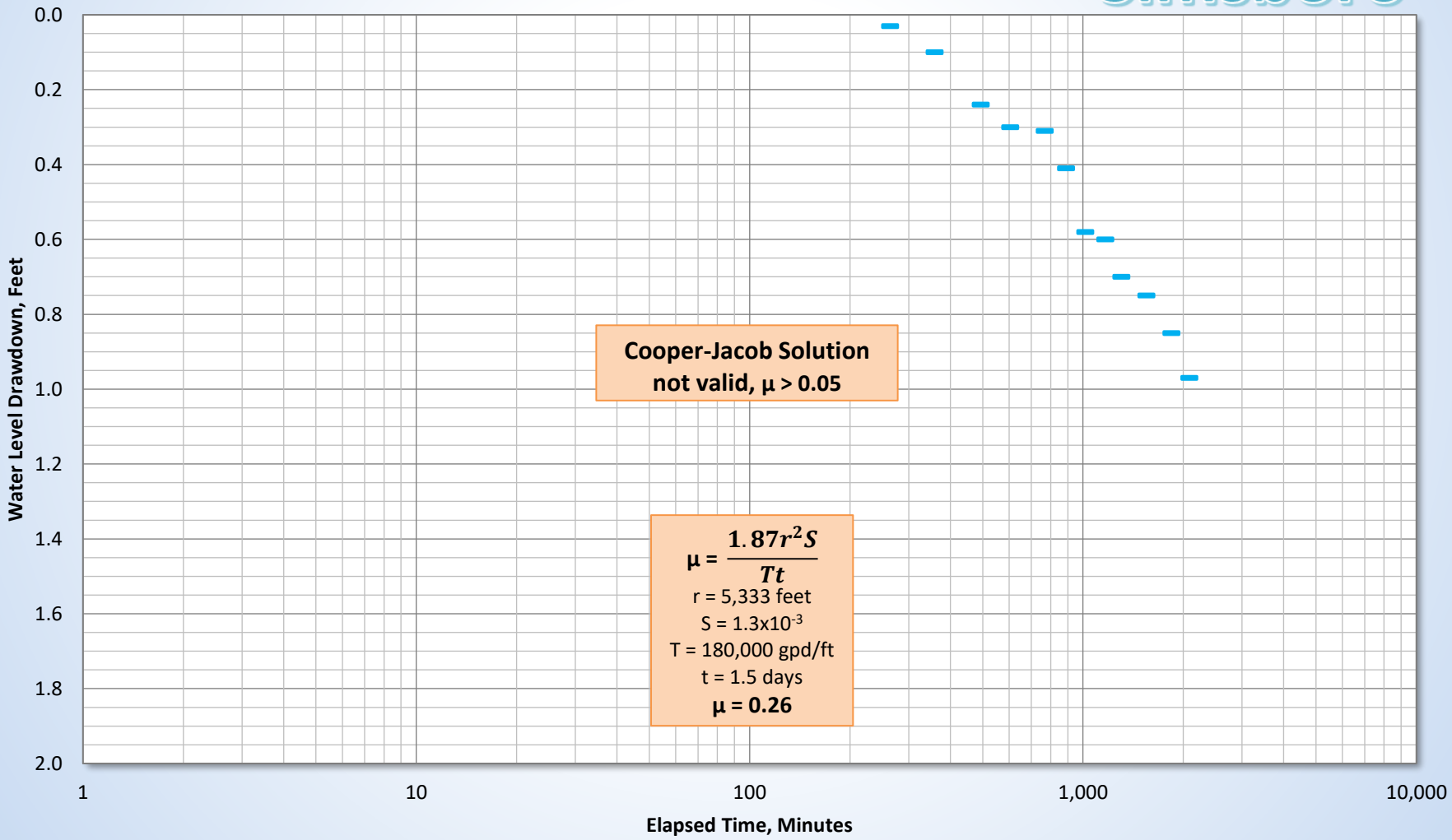
# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854733 / Charles Tarket
## Cooper-Jacob Chart (Drawdown)

Simsboro



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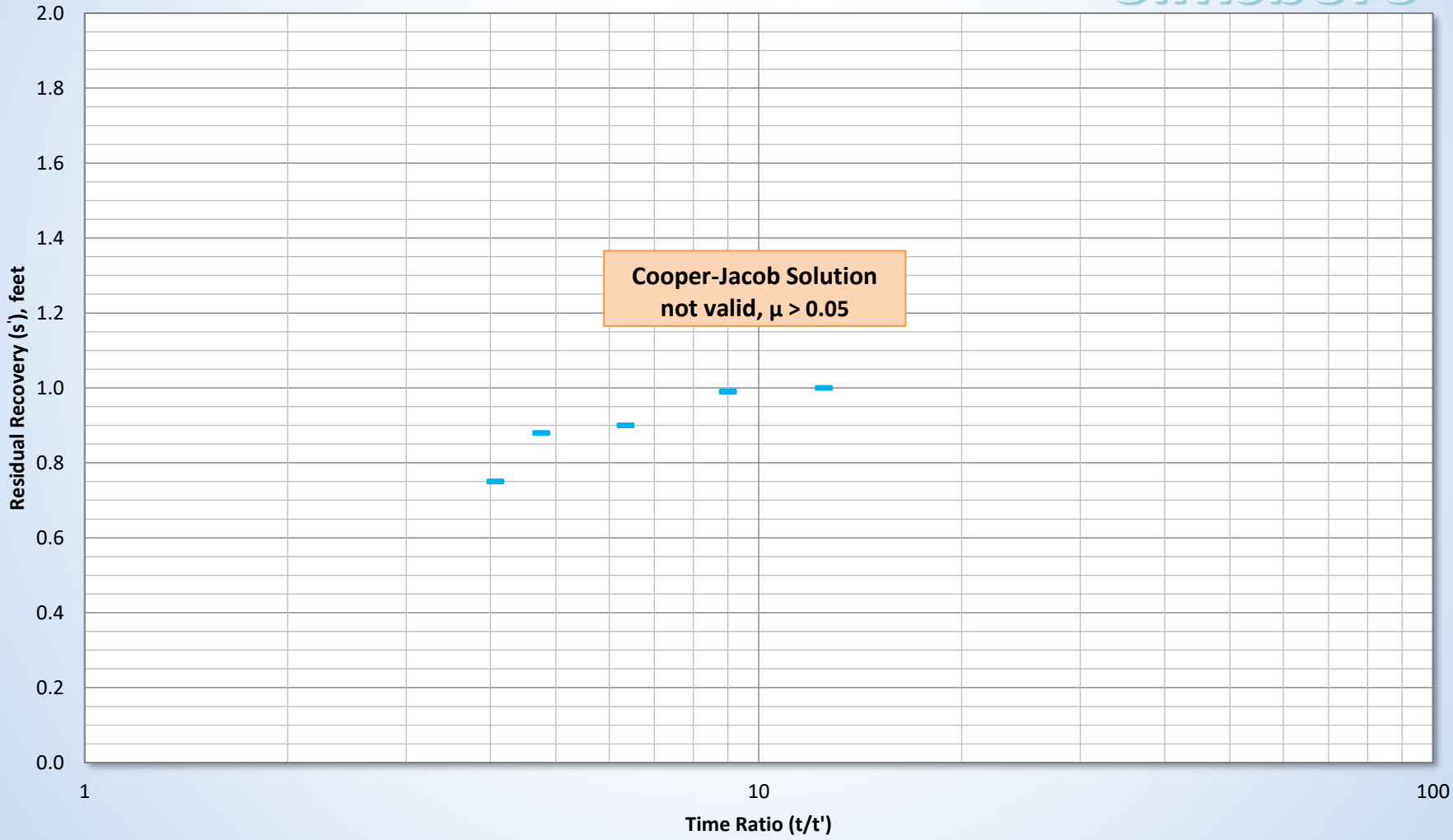
# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854733 / Charles Tarket
## Cooper-Jacob Chart (Recovery)

Simsboro



THORNHILL GROUP, INC.
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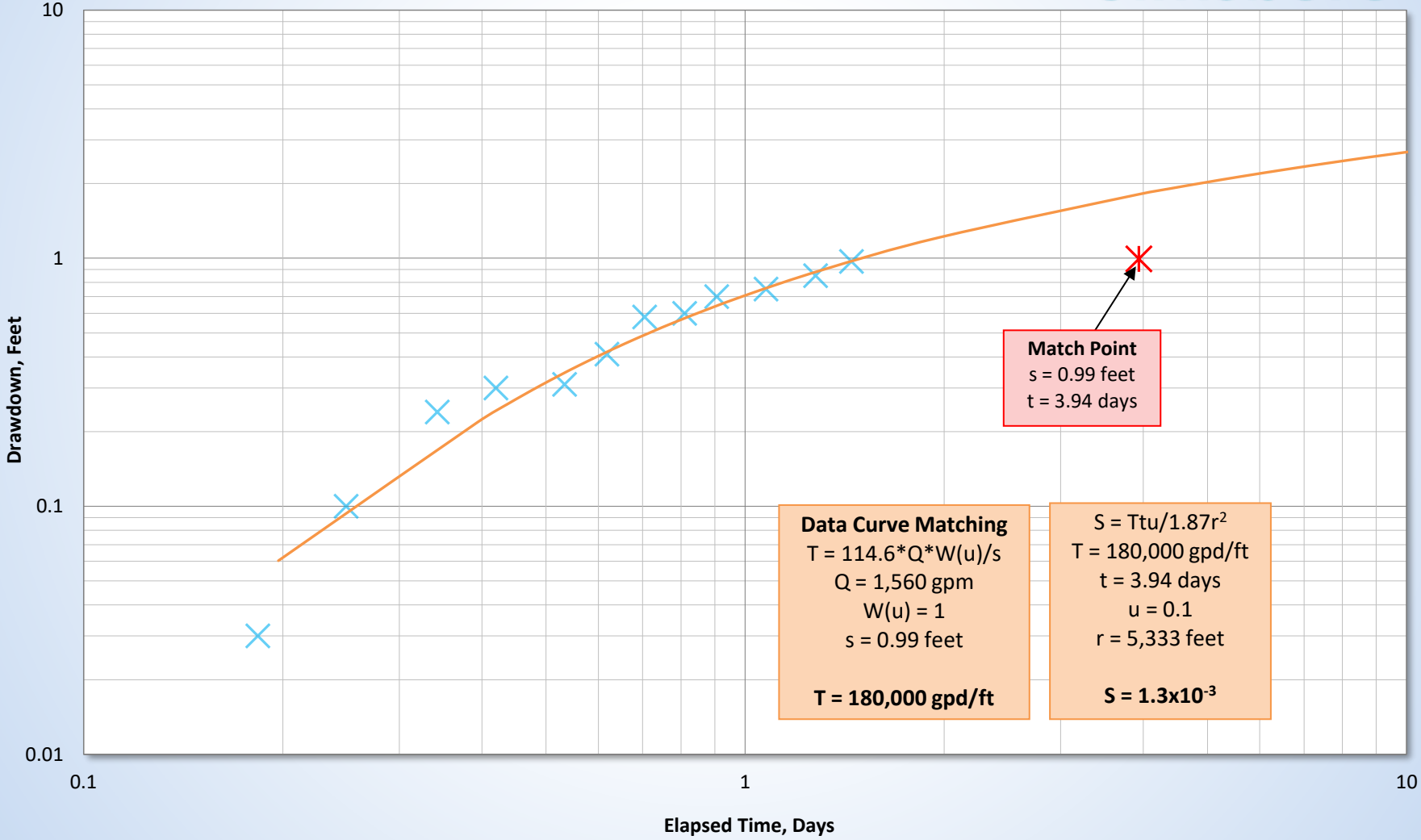
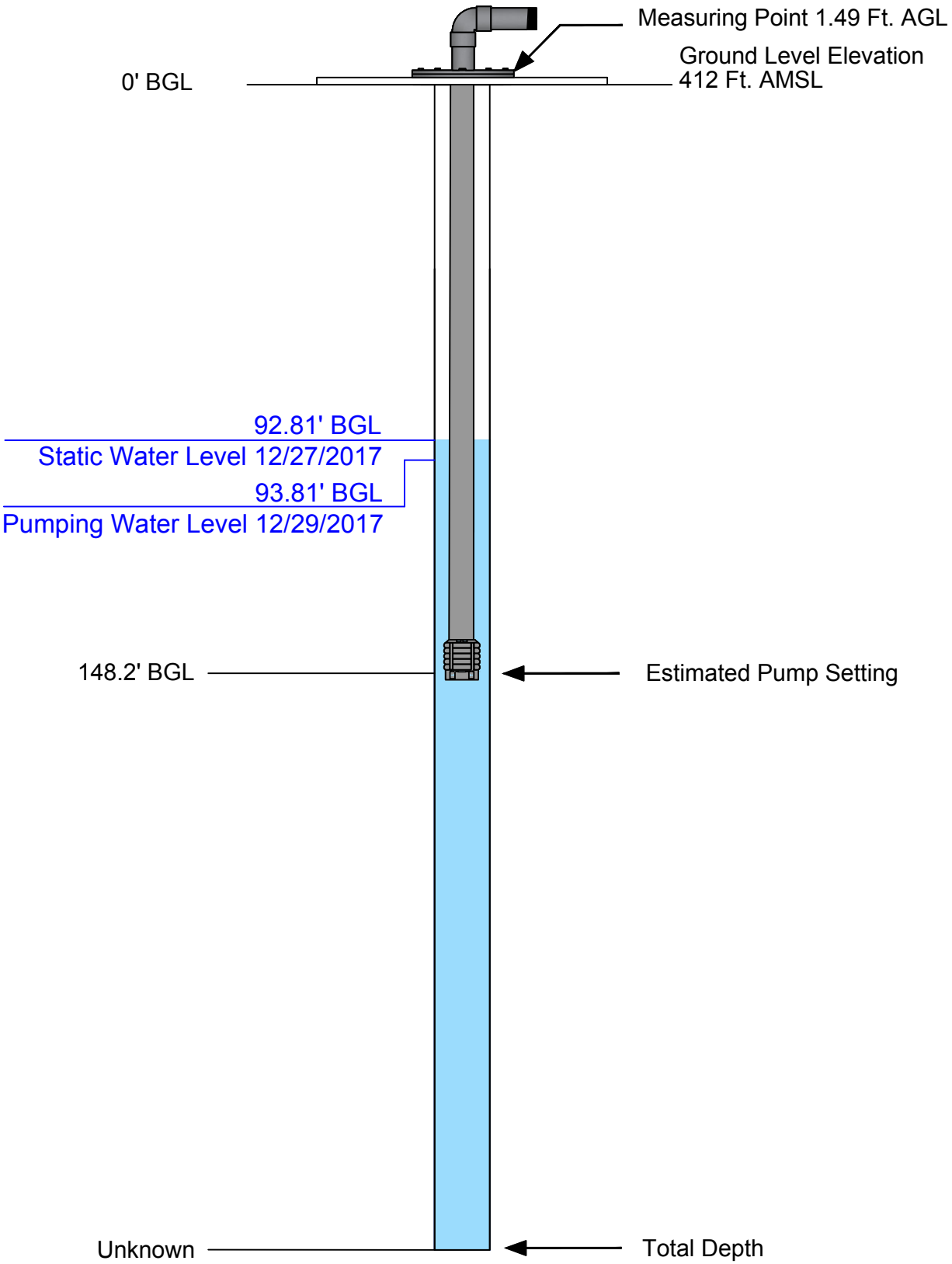
# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854733 / Charles Tarket
## Theis Curve

Simsboro



# LPGCD Well 5854733 / Tarket




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

THORNHILL GROUP, INC.
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Name: Charles Tarket
Distance from Well J: 5,333.20 feet
Static Water Level 12/27/2017: 92.81 feet BGL
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## Martinez Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 6,168 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 11/13/2017 10:16 | 88.40 | Background |
| 12/22/2017 13:31 | 88.55 | Background |
| 12/27/2017 11:48 | 88.85 | Static Water Level |
| 12/27/2017 14:32 | 88.76 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 16:47 | 88.76 | |
| 12/27/2017 18:24 | 88.78 | |
| 12/27/2017 20:38 | 90.20 | |
| 12/27/2017 22:30 | 88.84 | |
| 12/28/2017 1:10 | 88.74 | |
| 12/28/2017 3:20 | 88.77 | |
| 12/28/2017 5:40 | 88.76 | |
| 12/28/2017 8:00 | 88.83 | |
| 12/28/2017 10:17 | 88.85 | |
| 12/28/2017 19:06 | 88.88 | |
| 12/28/2017 23:10 | 88.95 | |
| 12/29/2017 3:43 | 88.85 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 4:55 | 88.80 | |
| 12/29/2017 7:14 | 89.02 | |
| 12/29/2017 10:02 | 89.05 | |
| 12/29/2017 12:14 | 88.99 | |

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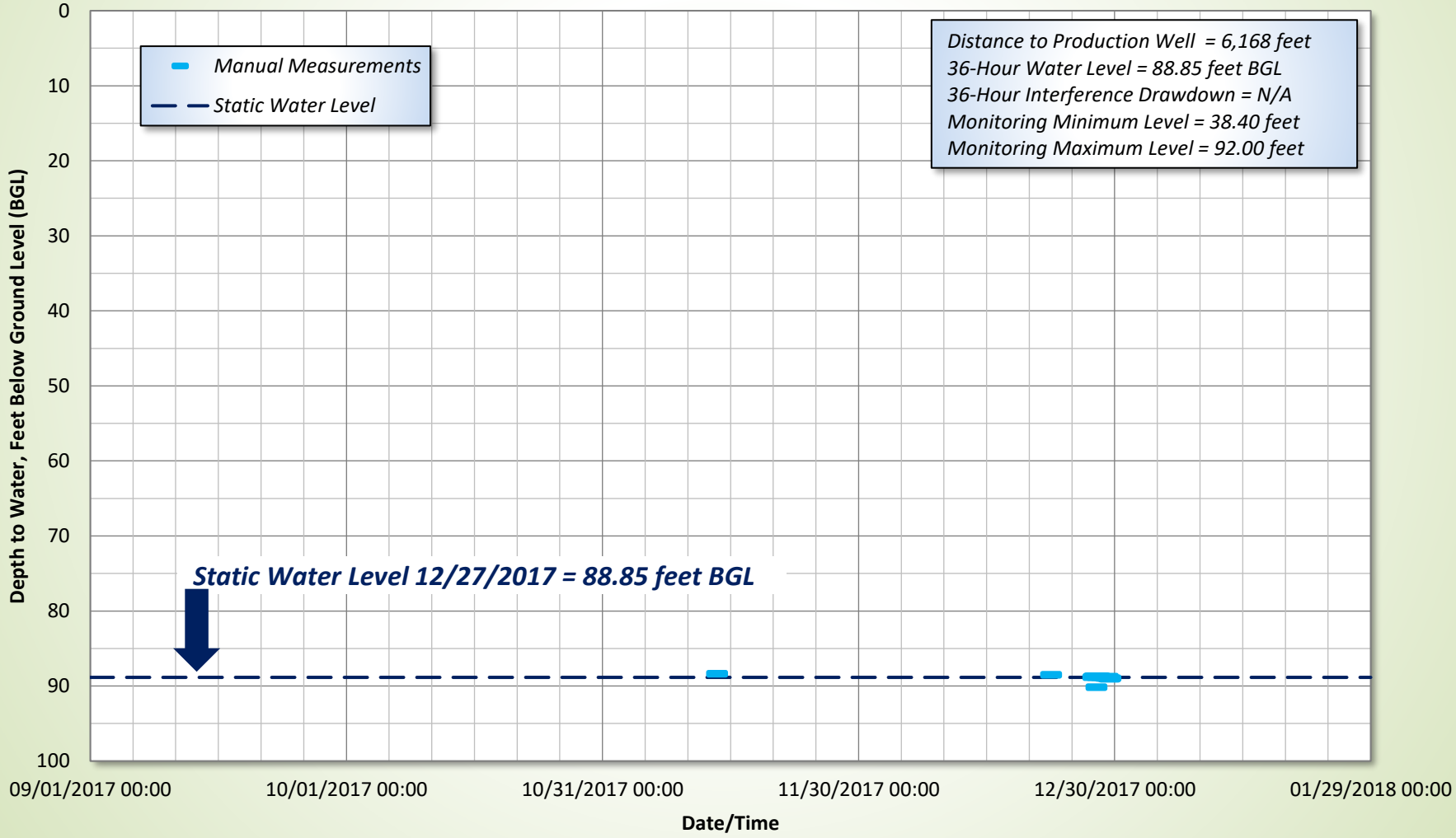
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854726 / Martinez
# Hydrograph

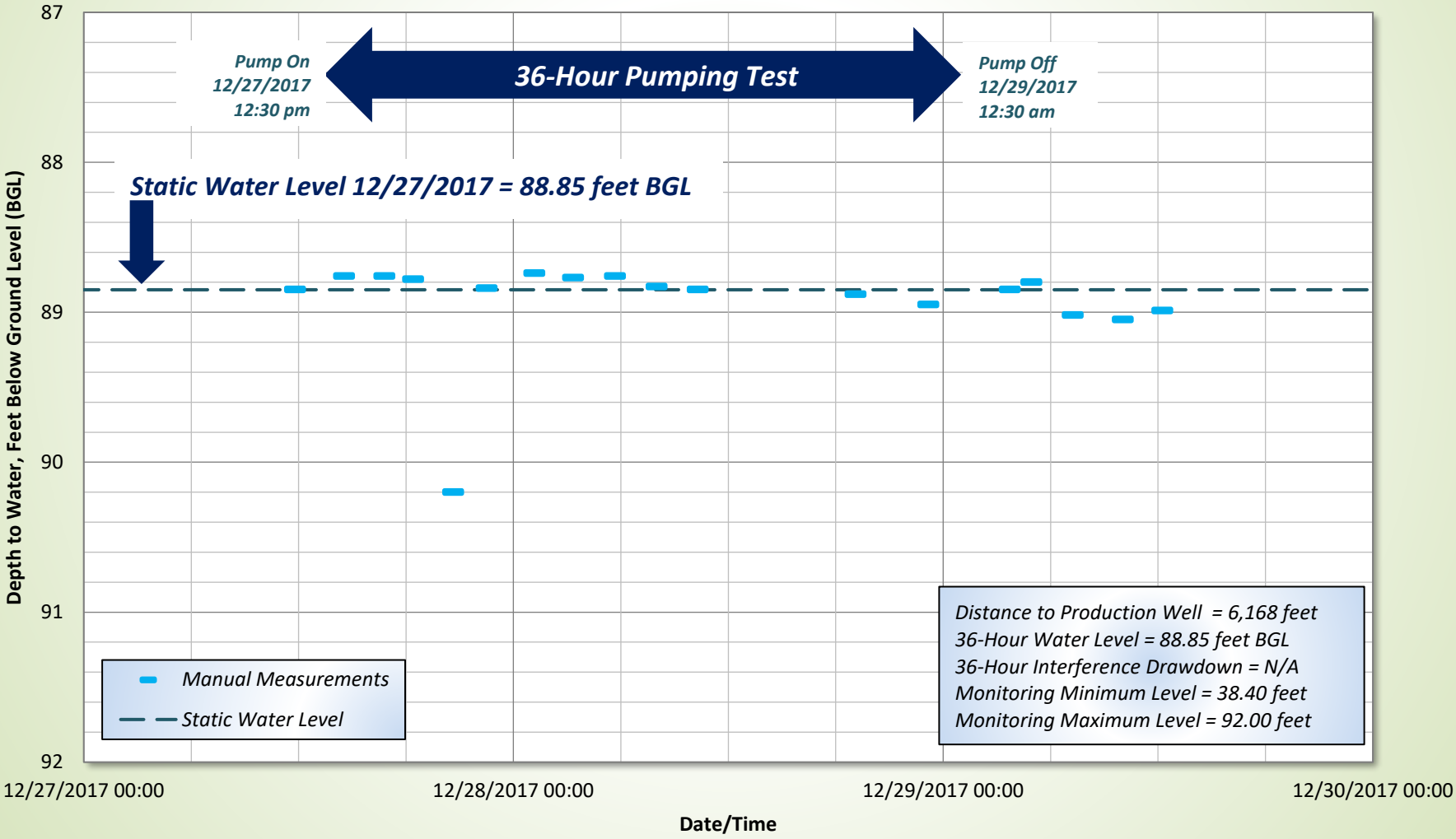
## Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854726 / Martinez
# Hydrograph

Calvert Bluff



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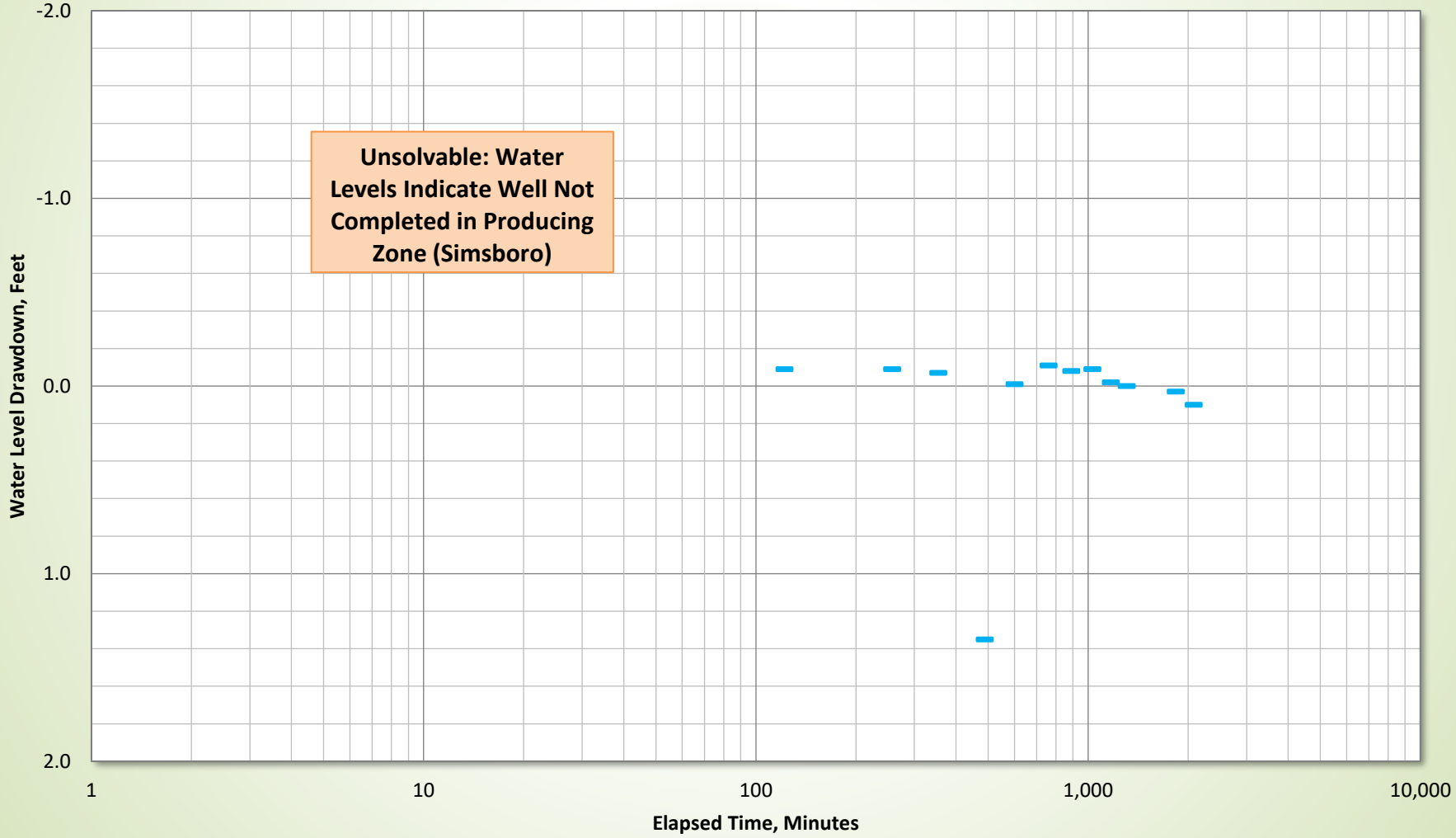
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854726 / Martinez
## Cooper-Jacob Chart (Drawdown)

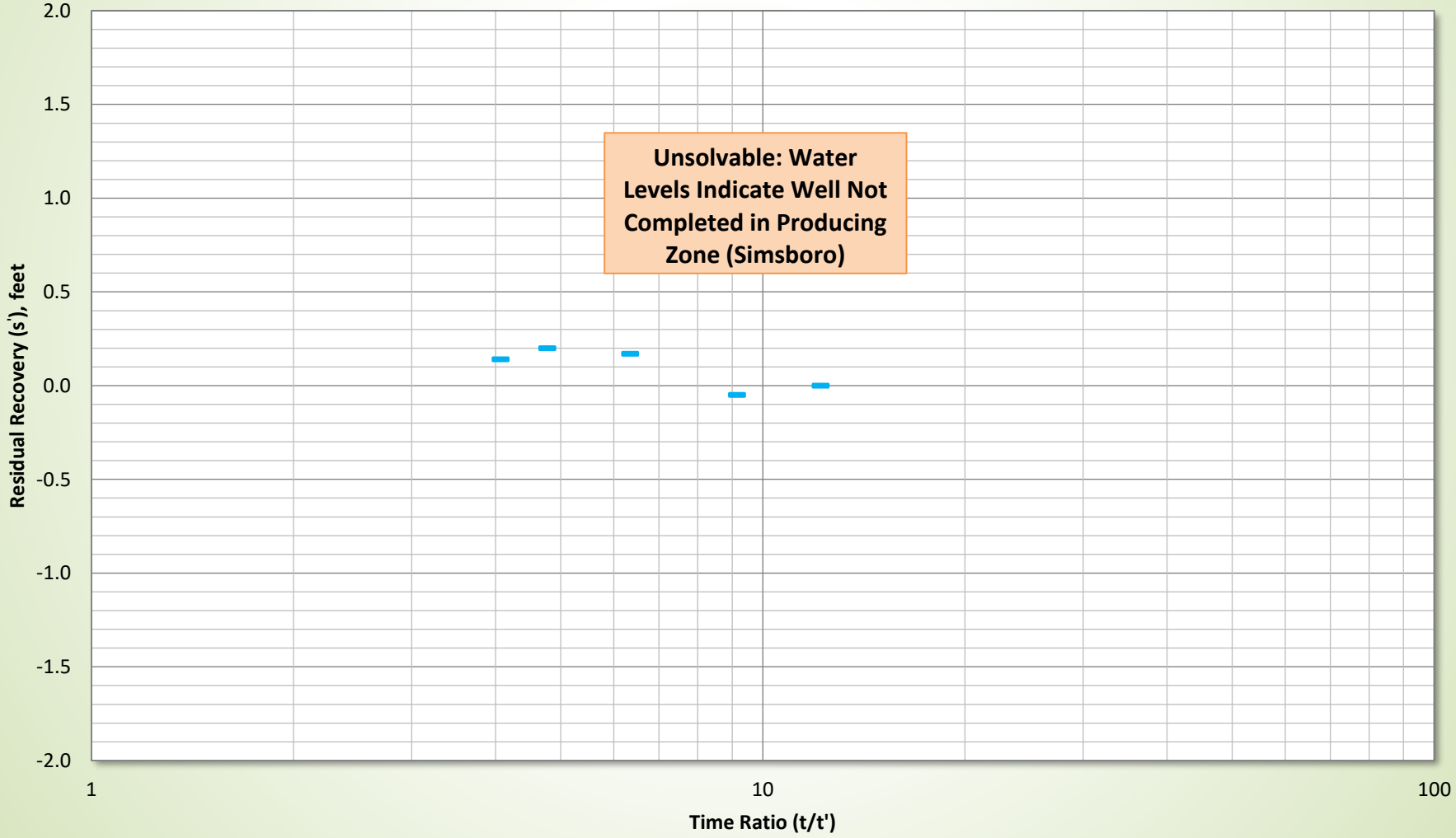
Calvert Bluff



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854726 / Martinez
## Cooper-Jacob Chart (Recovery)

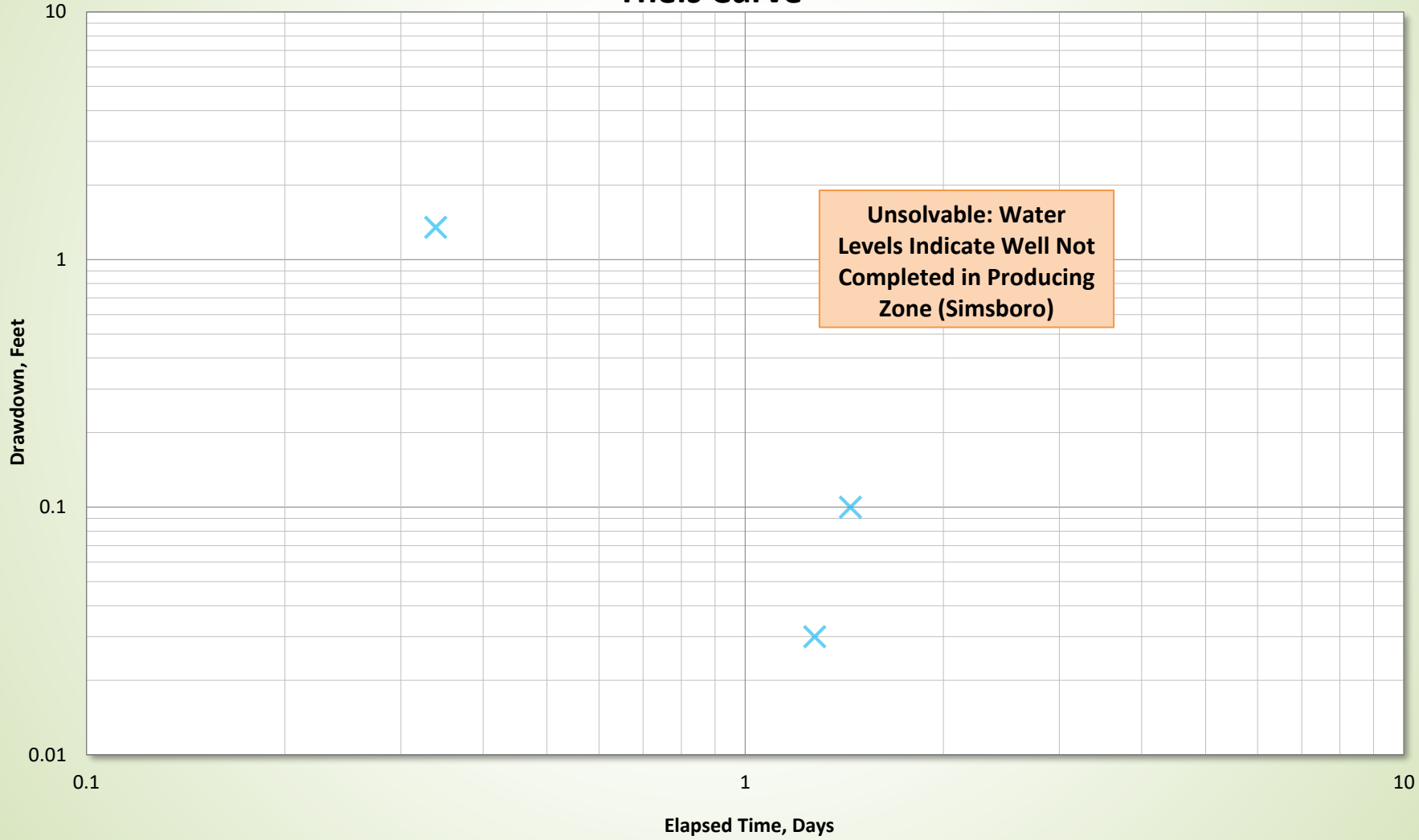
Calvert Bluff



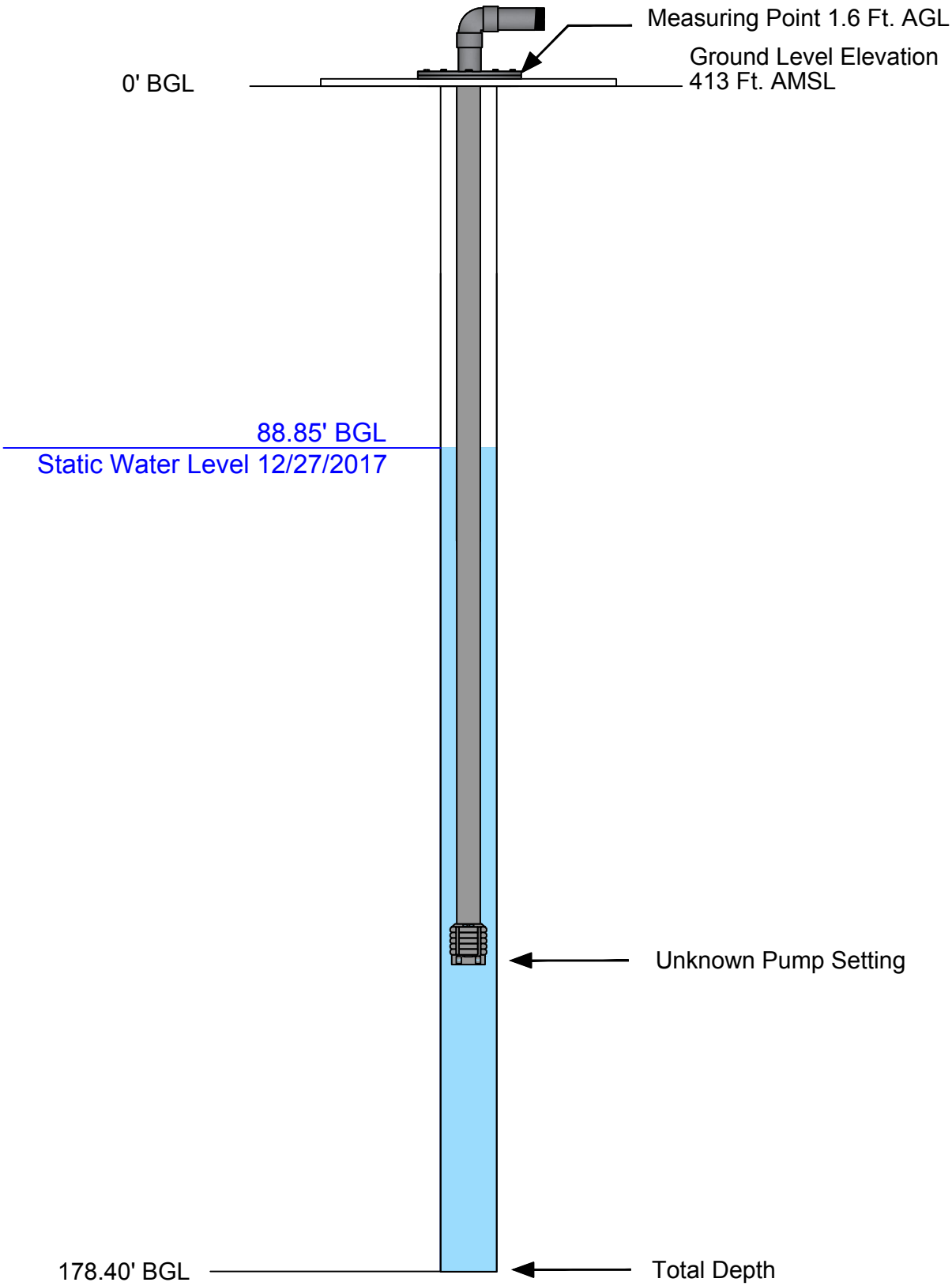
THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854726 / Martinez
## Theis Curve

Calvert Bluff



# LPGCD Well 5854726 / Martinez




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists


Name: Robert Martinez
Distance from Well J: 6,168.42 feet
Static Water Level 12/27/2017: 88.85 feet BGL
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 325 650 1,300
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# Area 3

# City of Bastrop
## Goertz New House Well
## 36-Hour Drawdown and Recovery Results

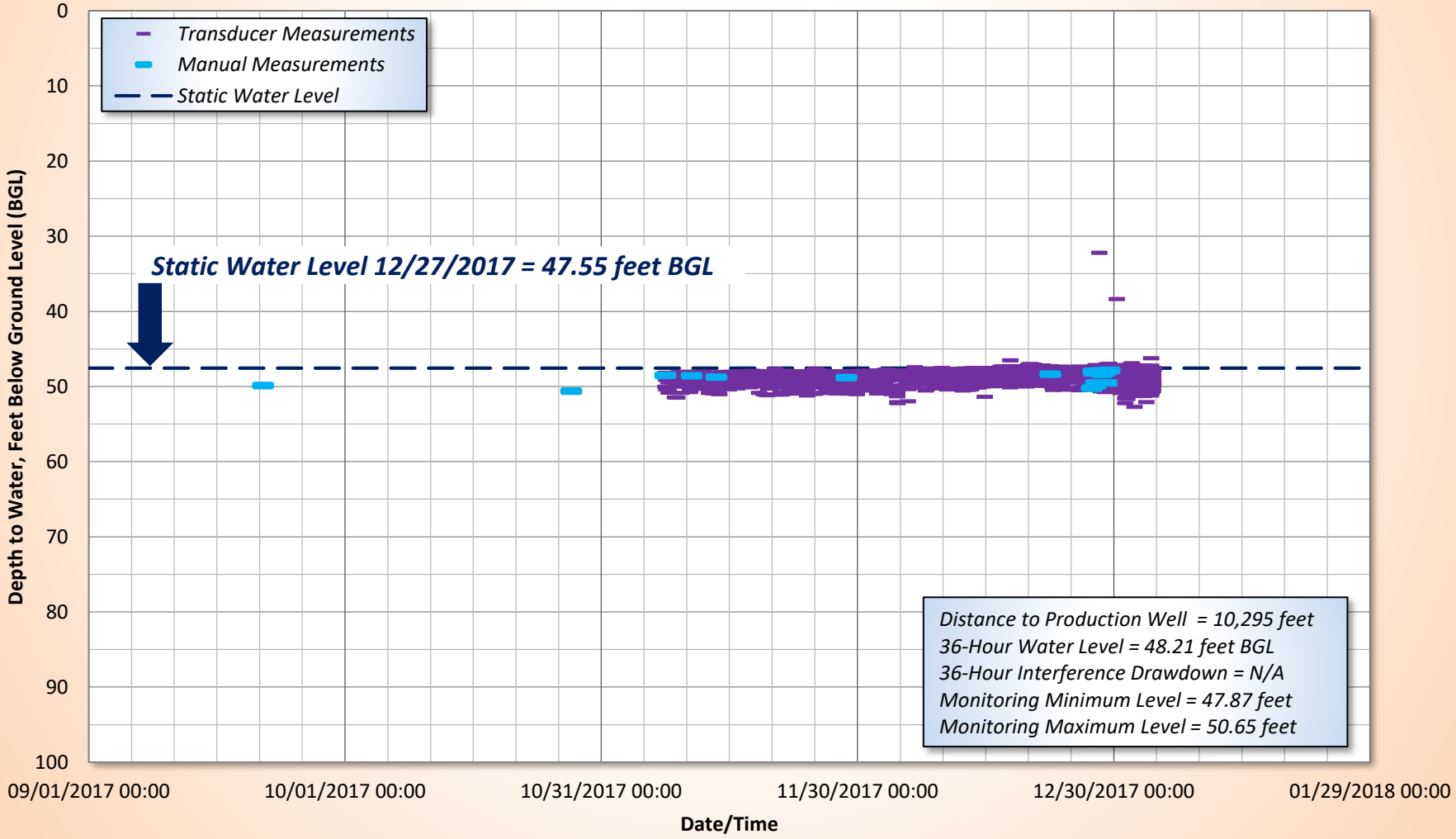
**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 10,295 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/21/2017 9:40 | 49.90 | Background |
| 10/27/2017 11:11 | 50.65 | Background |
| 11/7/2017 11:47 | 48.55 | Background |
| 11/10/2017 13:57 | 48.61 | Background |
| 11/13/2017 11:42 | 48.80 | Background |
| 11/28/2017 16:40 | 48.86 | Background |
| 12/22/2017 13:49 | 48.40 | Background |
| 12/27/2017 10:36 | 50.25 | Static Water Level |
| 12/27/2017 14:53 | 48.02 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 16:27 | 48.21 | |
| 12/27/2017 20:30 | 49.95 | |
| 12/27/2017 22:20 | 49.56 | |
| 12/28/2017 10:39 | 47.95 | |
| 12/28/2017 14:38 | 48.45 | |
| 12/28/2017 18:30 | 48.00 | |
| 12/28/2017 22:54 | 48.21 | |
| 12/29/2017 3:56 | 49.55 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 7:05 | 47.95 | |
| 12/29/2017 9:56 | 47.94 | |
| 12/29/2017 12:05 | 47.87 | |
| 1/3/2018 14:55 | 48.18 | |

THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854725 / Goertz New House
# Hydrograph

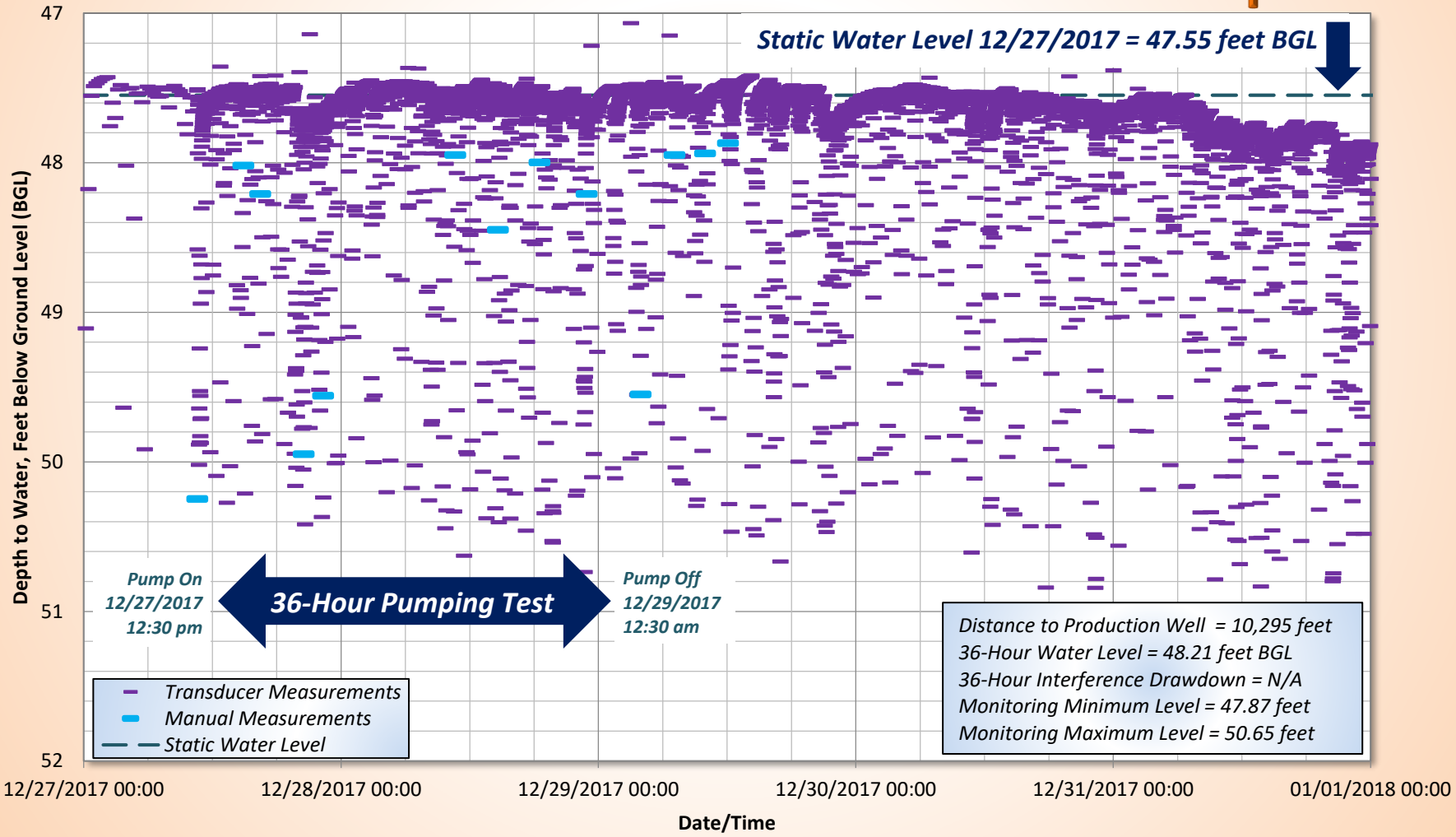
Hooper



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well 5854725/ Goertz New House
# Hydrograph

Hooper



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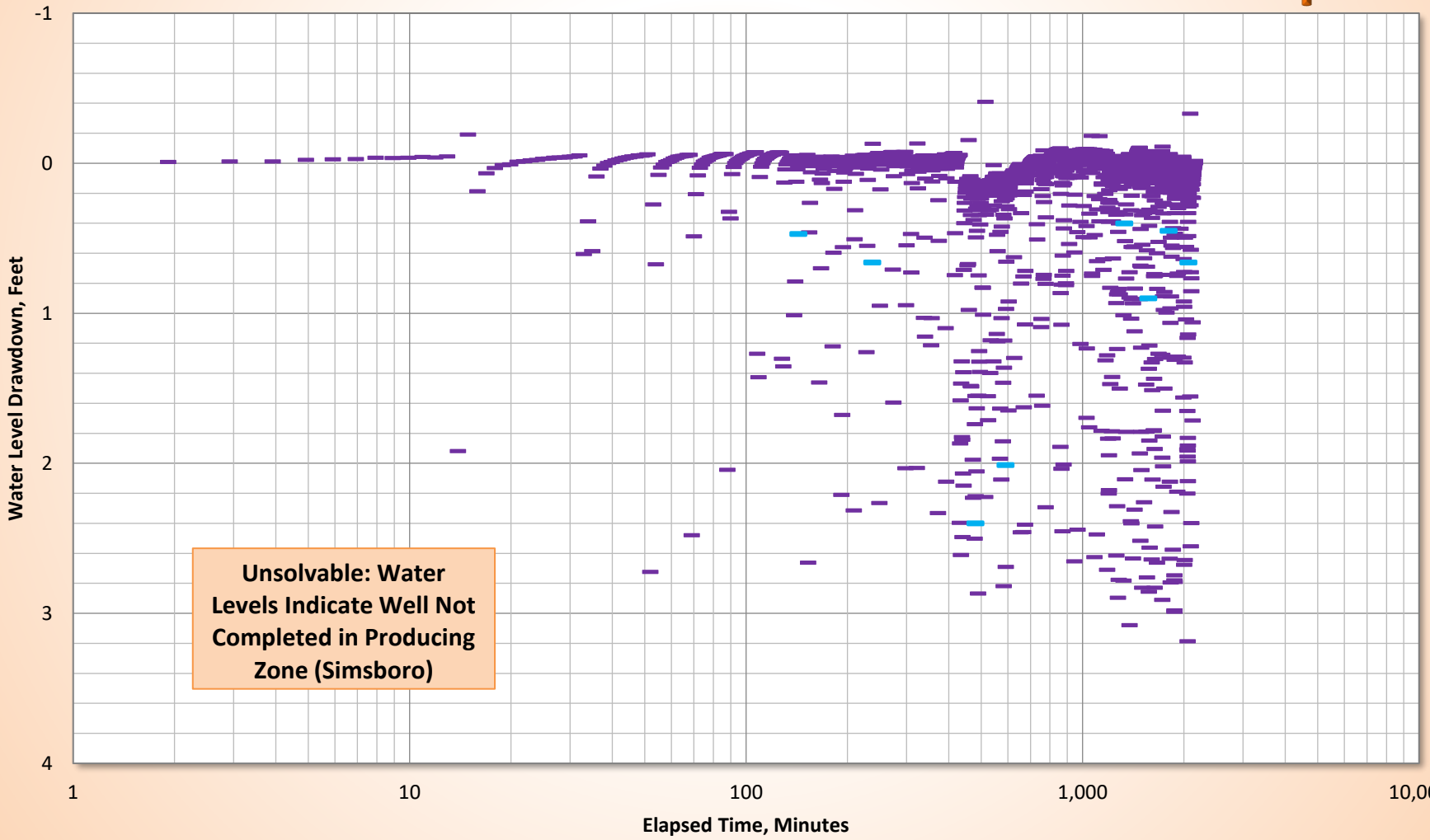
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854725/ Goertz New House
## Cooper-Jacob Chart (Drawdown)

Hooper



THORNHILL GROUP, INC.
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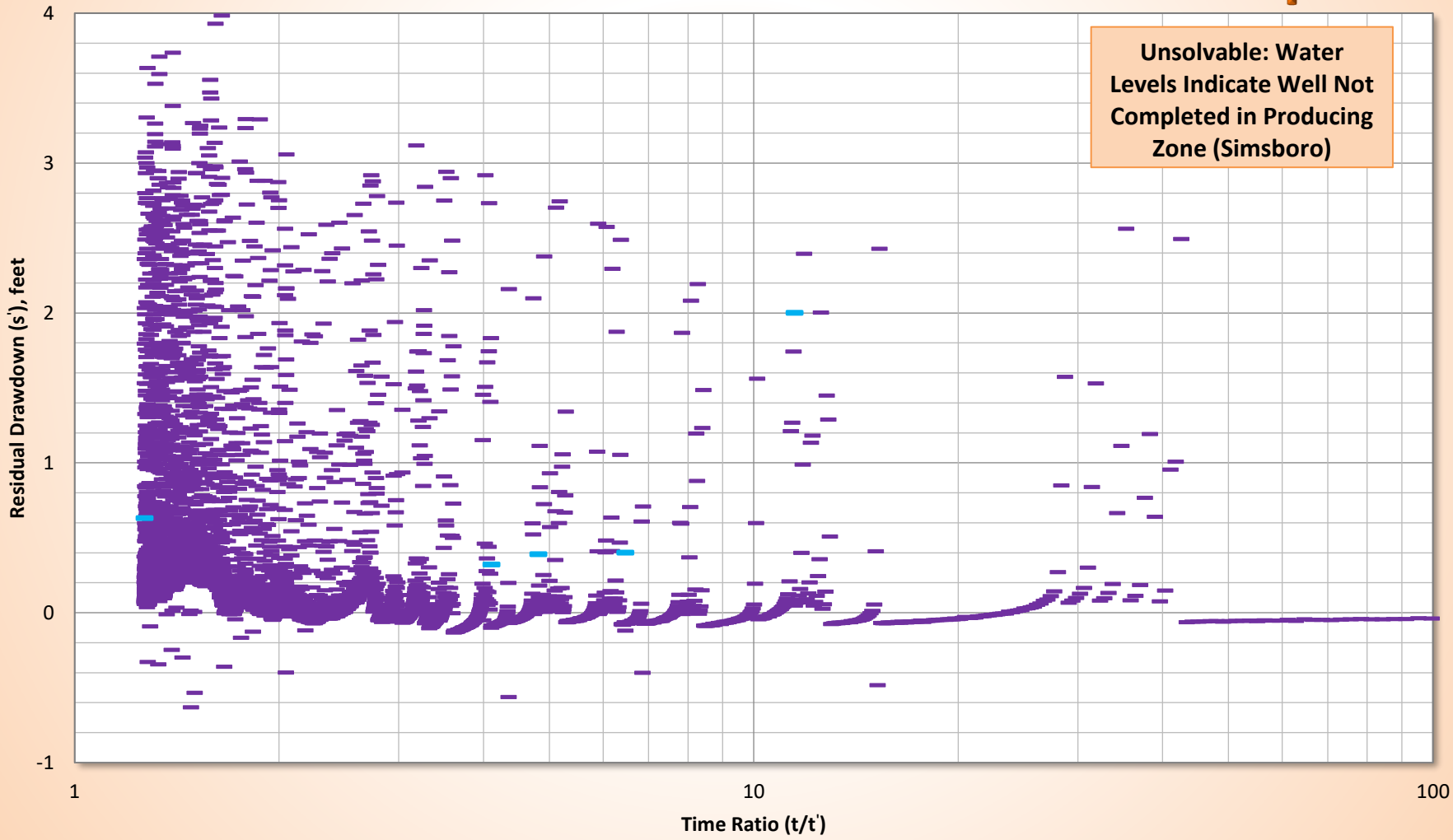
# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well 5854725/ Goertz New House
## Cooper-Jacob Chart (Recovery)

Hooper



THORNHILL GROUP, INC.
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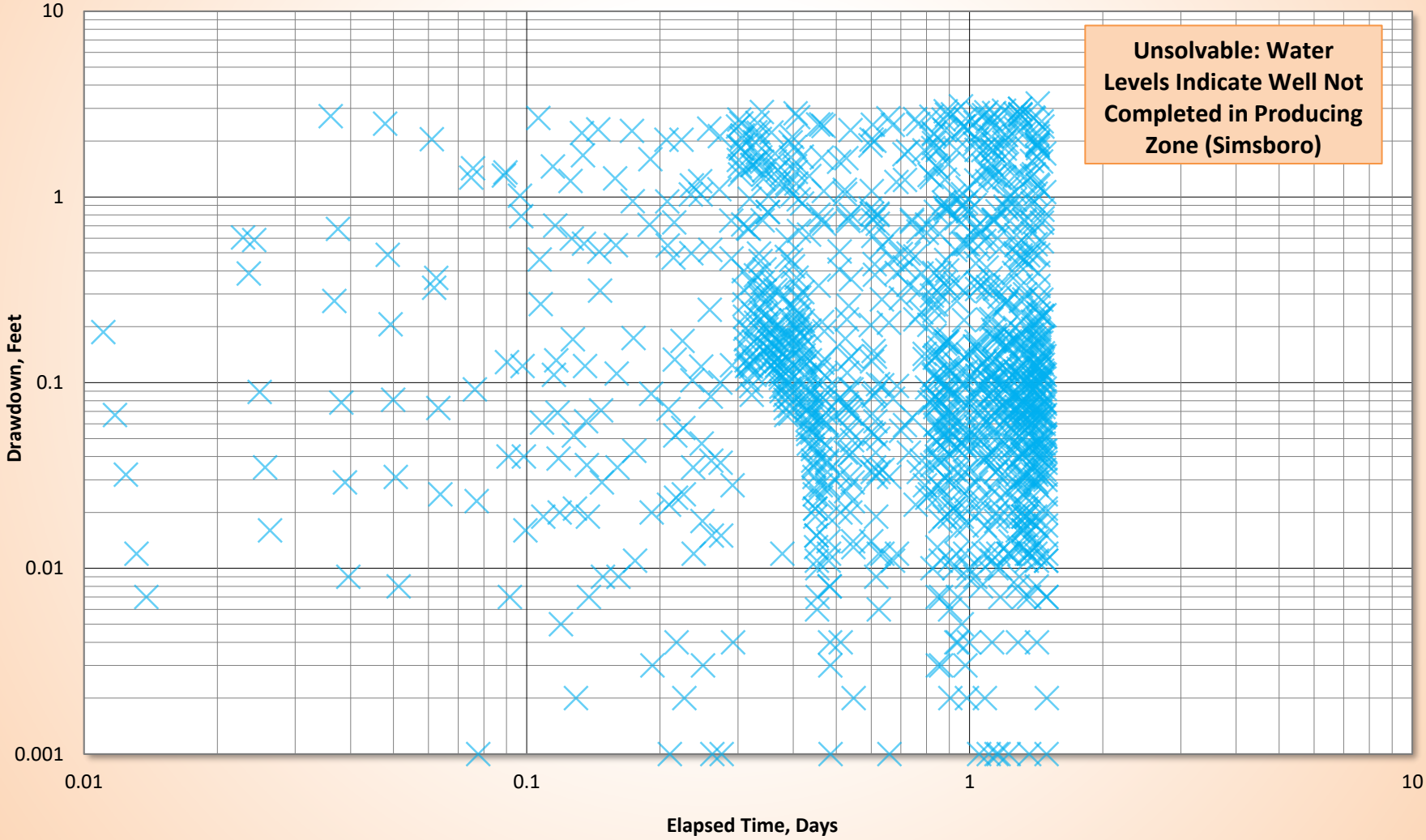
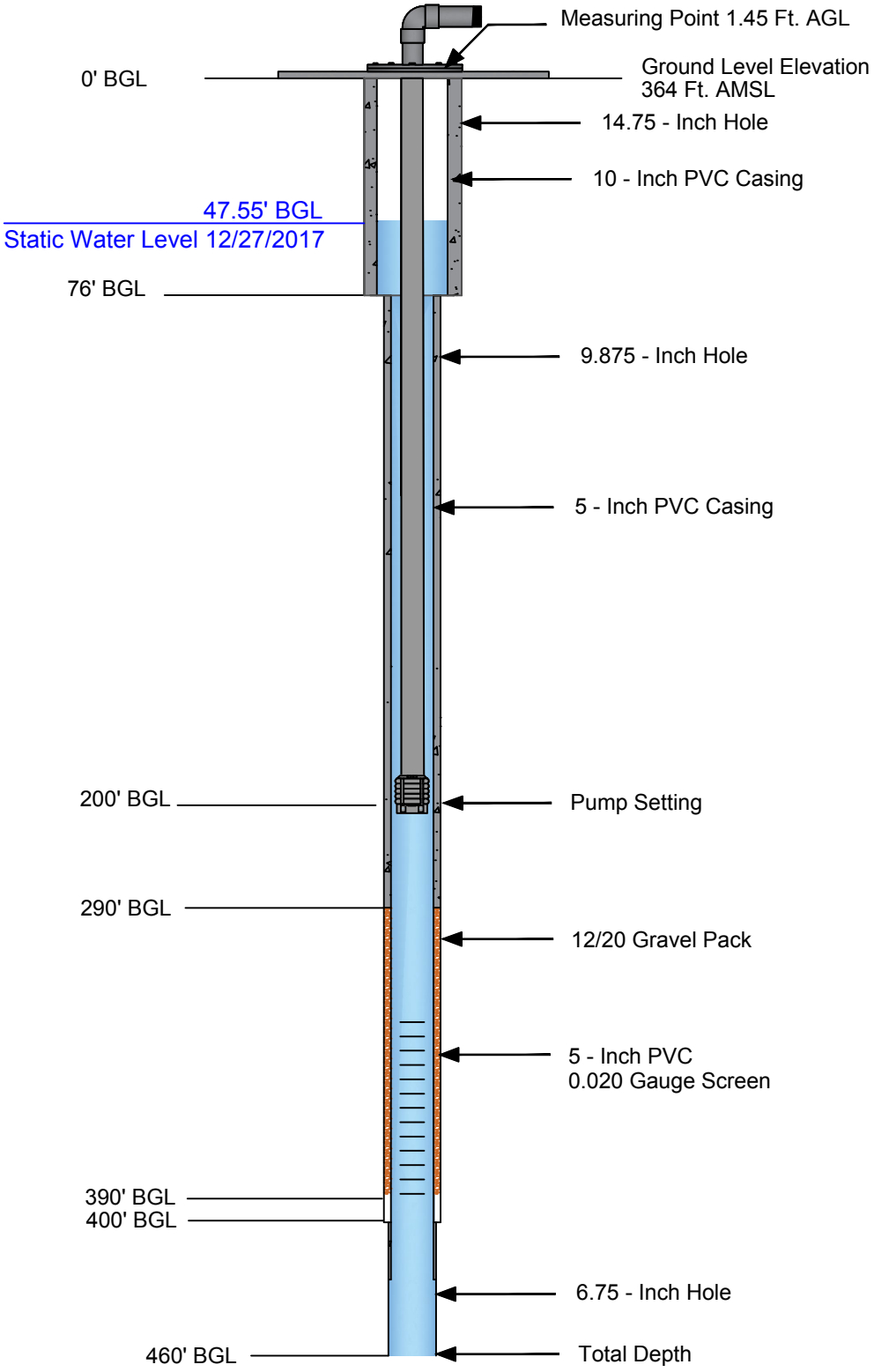
# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well 5854725/ Goertz New House
## Theis Curve

Hooper



# LPGCD Well Unknown / Goertz New House Well




Well construction details compiled from State of Texas Well Report, LPGCD records, owner, and/or TGI field investigations.

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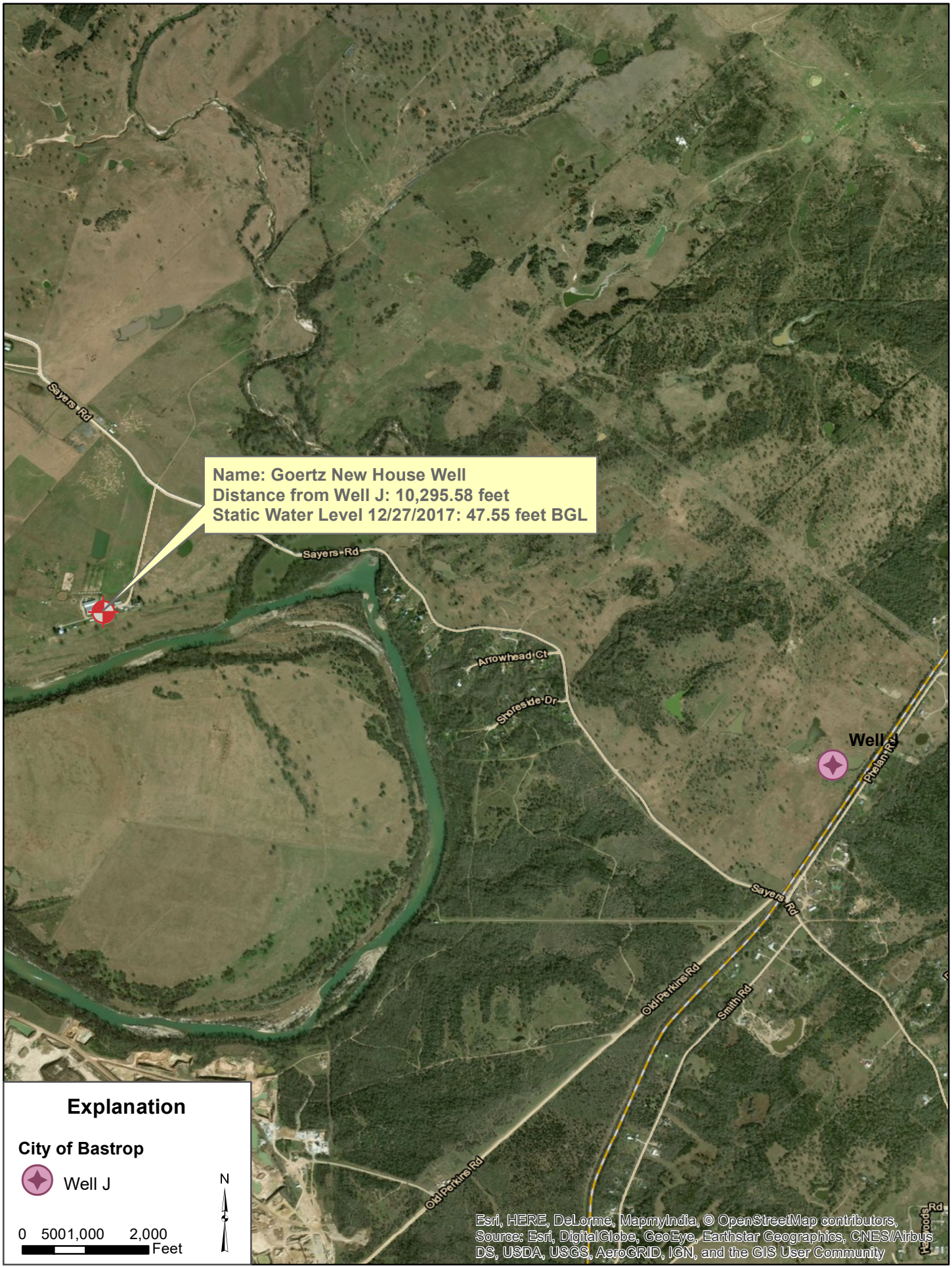
Name: Goertz New House Well
Distance from Well J: 10,295.58 feet
Static Water Level 12/27/2017: 47.55 feet BGL
Sayers Rd
Sayers Rd
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Old Perkins Rd
Explanation
City of Bastrop
Well J
N
0 5001,000 2,000
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## Goertz Arena Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 10,602 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/21/2017 10:00 | 39.64 | Background |
| 10/27/2017 10:52 | 40.30 | Background |
| 11/1/2017 13:56 | 40.30 | Background |
| 11/10/2017 13:47 | 41.86 | Background |
| 11/13/2017 12:05 | 42.04 | Background |
| 11/28/2017 16:55 | 41.89 | Background |
| 12/22/2017 13:53 | 40.20 | Background |
| 12/27/2017 10:27 | 40.35 | Static Water Level |
| 12/27/2017 15:06 | 40.15 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 16:31 | 40.53 | |
| 12/27/2017 20:25 | 39.73 | |
| 12/27/2017 22:12 | 40.07 | |
| 12/28/2017 10:45 | 40.28 | |
| 12/28/2017 14:54 | 40.30 | |
| 12/28/2017 18:38 | 40.25 | |
| 12/28/2017 22:58 | 40.25 | |
| 12/29/2017 4:00 | 40.25 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 7:01 | 40.29 | |
| 12/29/2017 10:00 | 40.29 | |
| 12/29/2017 12:00 | 40.32 | |

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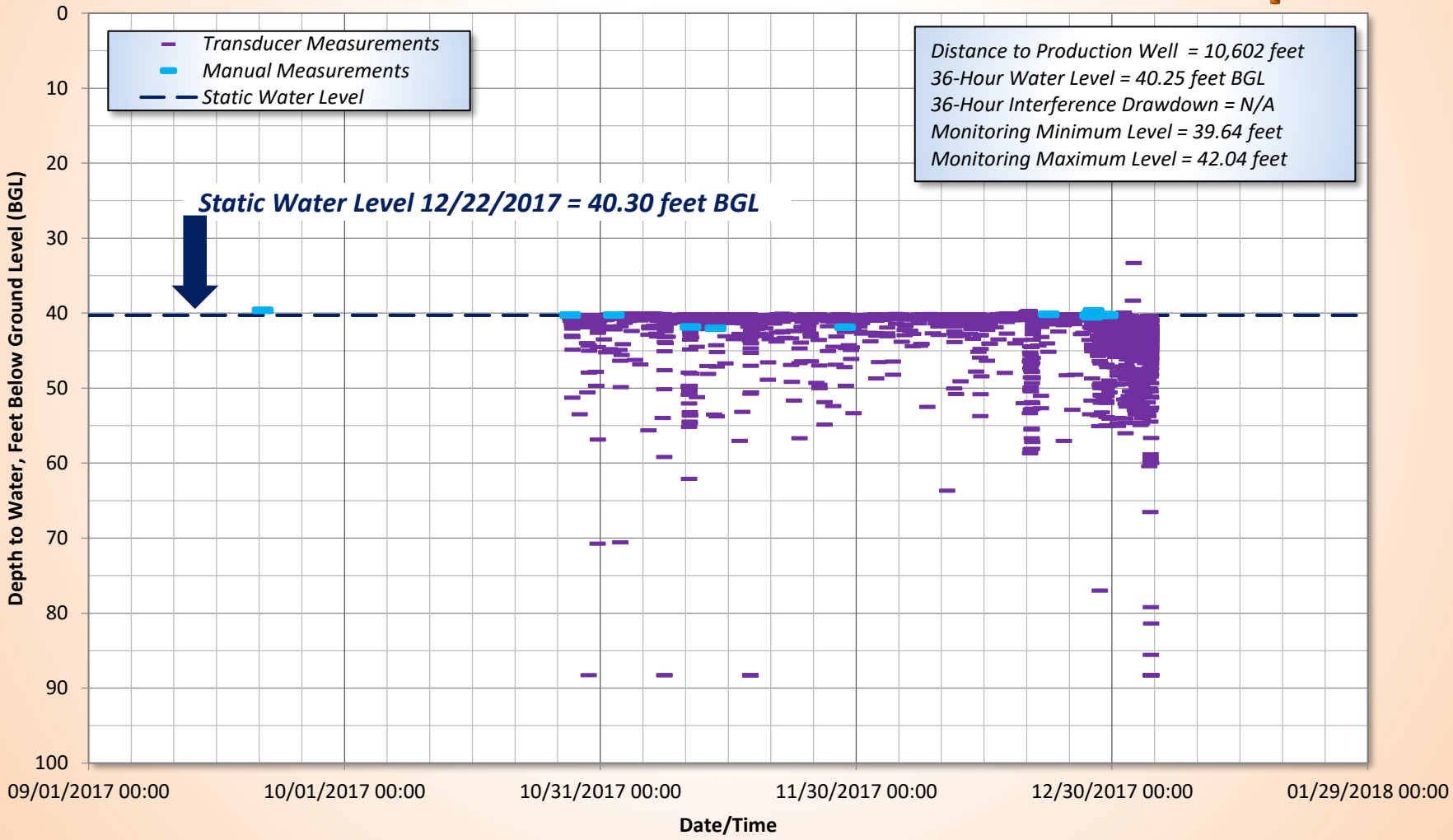
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well Unknown / Goertz Arena Well
# Hydrograph

Hooper



THORNHILL GROUP, INC.
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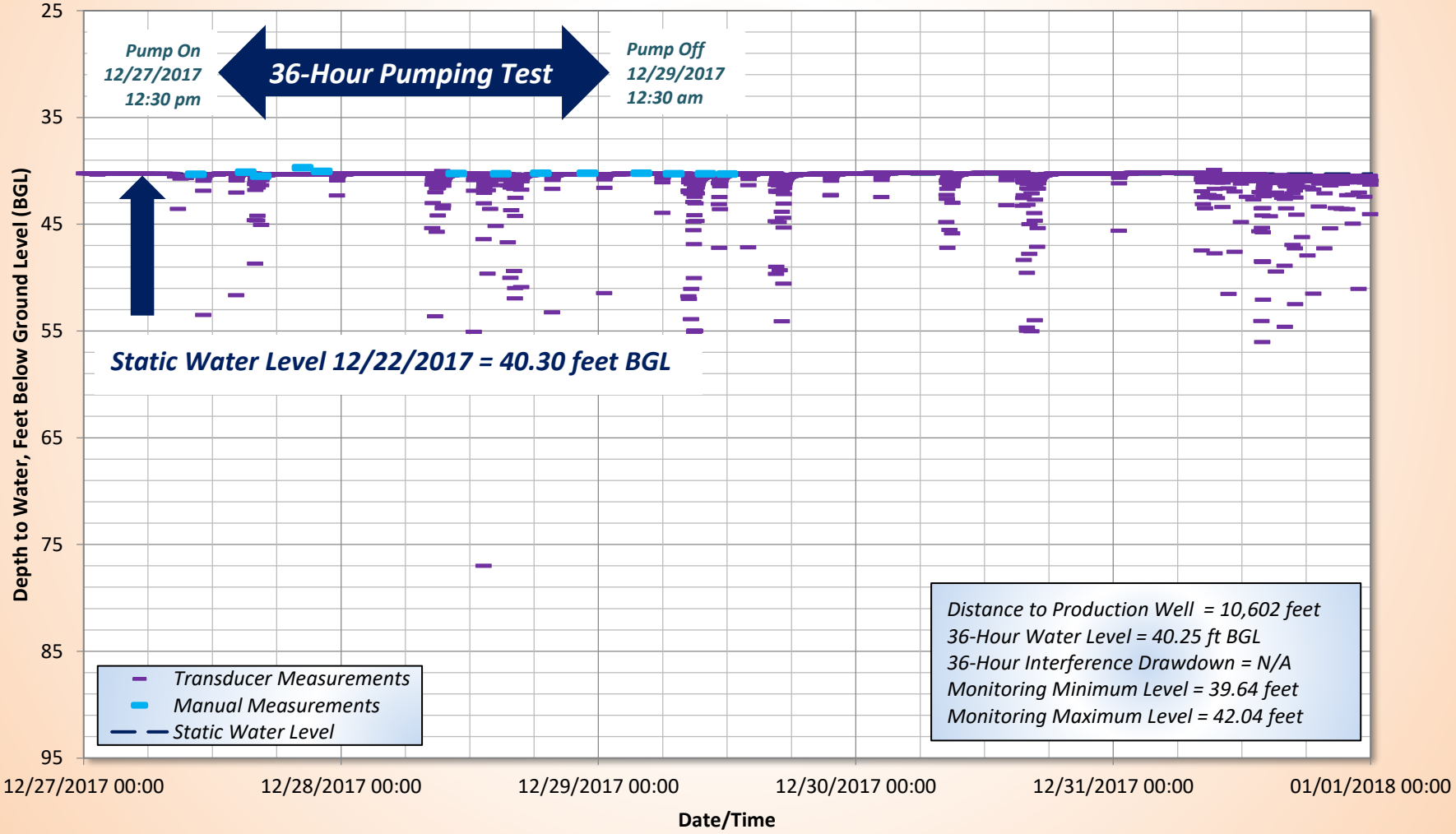
# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well Unknown / Goertz Arena Well
# Hydrograph

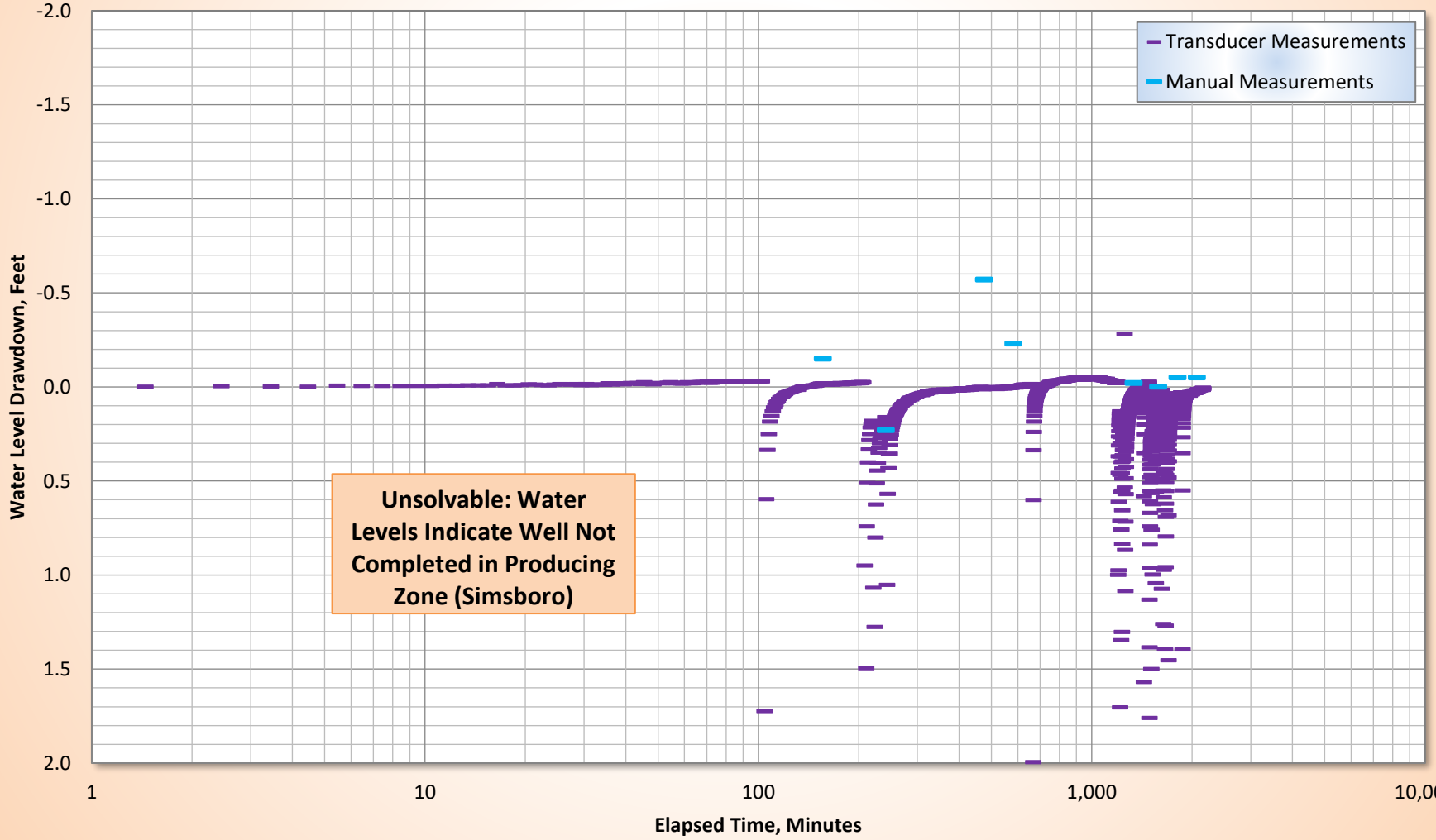
Hooper



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well Unknown / Goertz Arena Well
## Cooper-Jacob Chart (Drawdown)

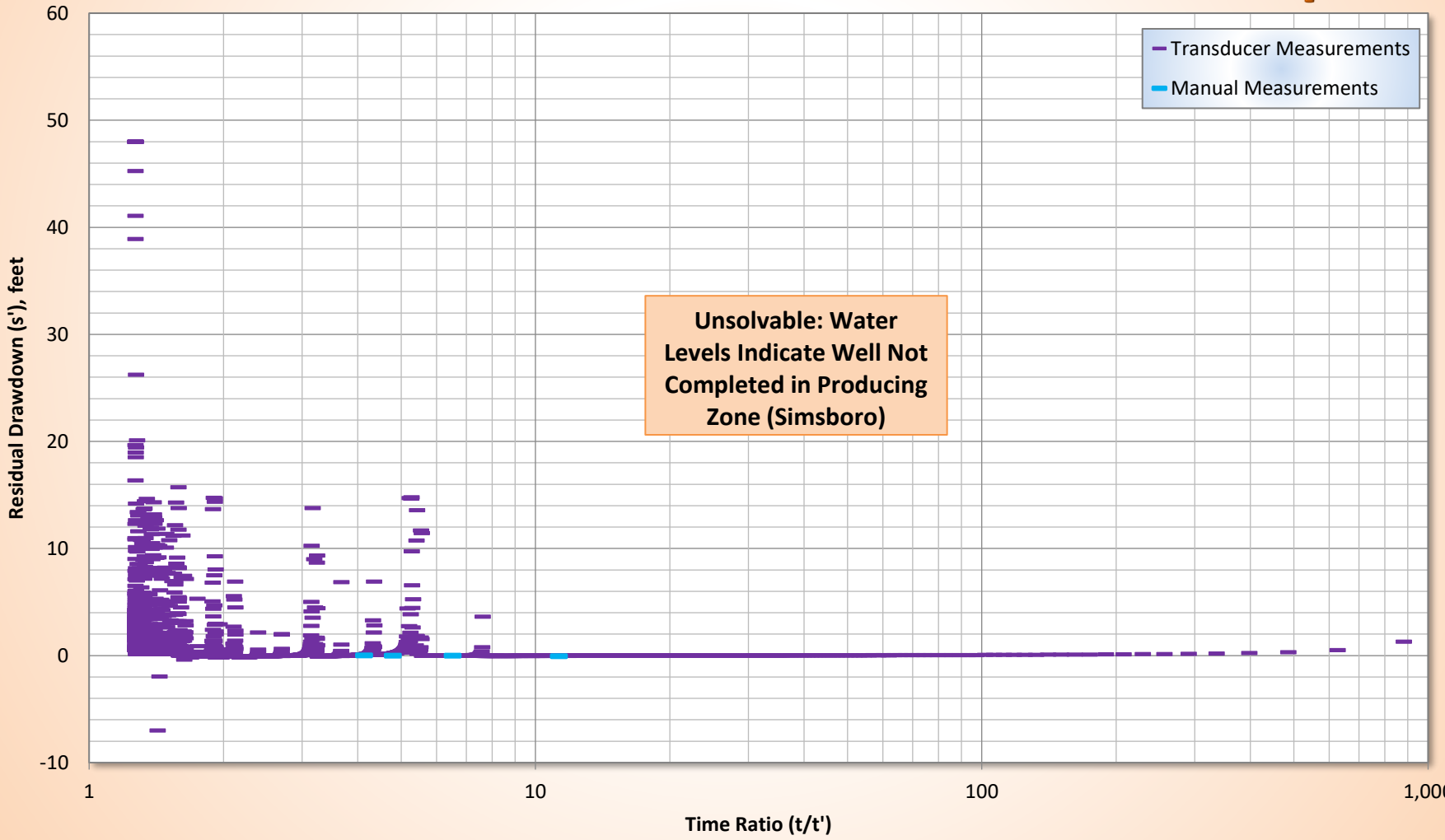
Hooper



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well Unknown / Goertz Arena Well
## Cooper-Jacob Chart (Recovery)

Hooper



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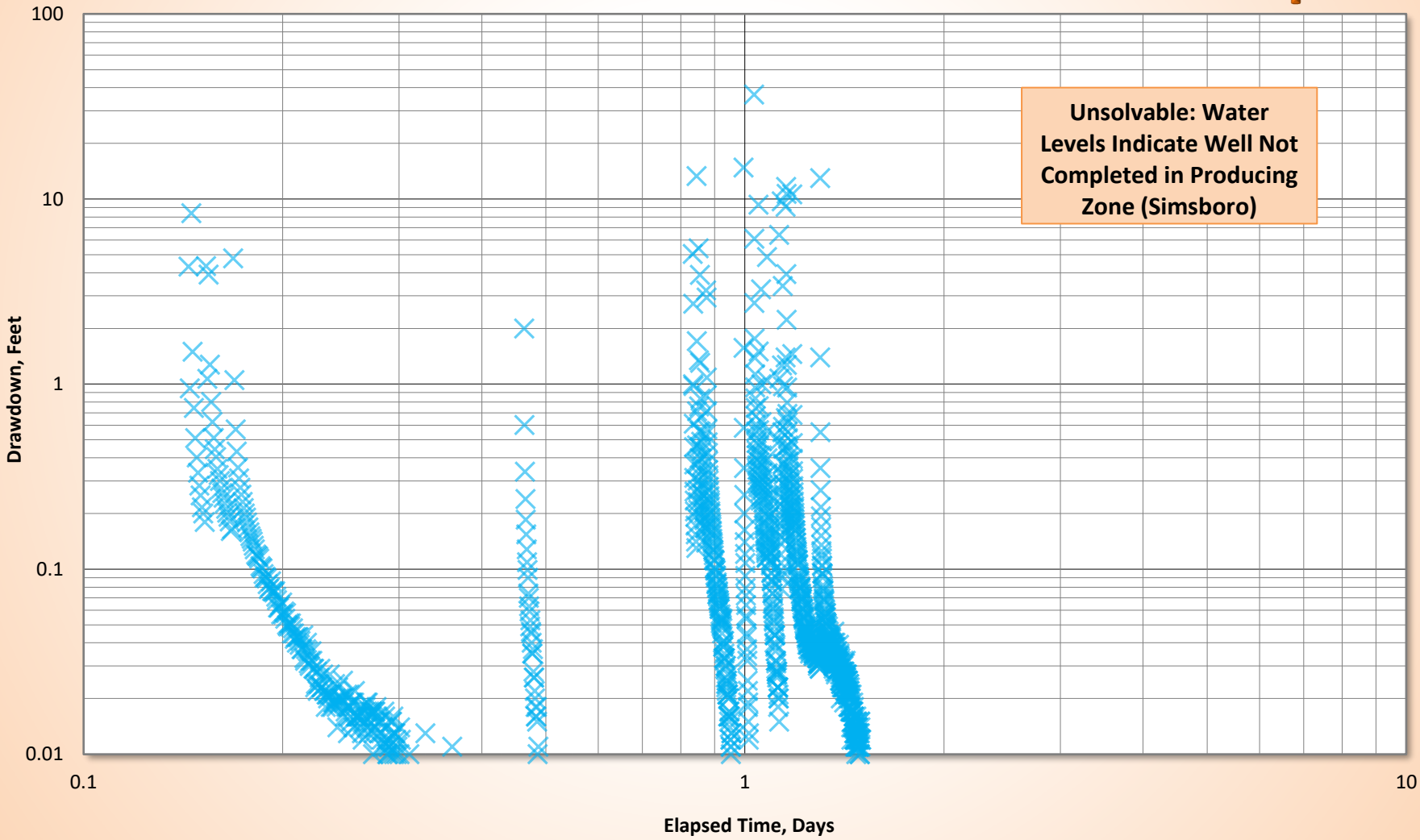
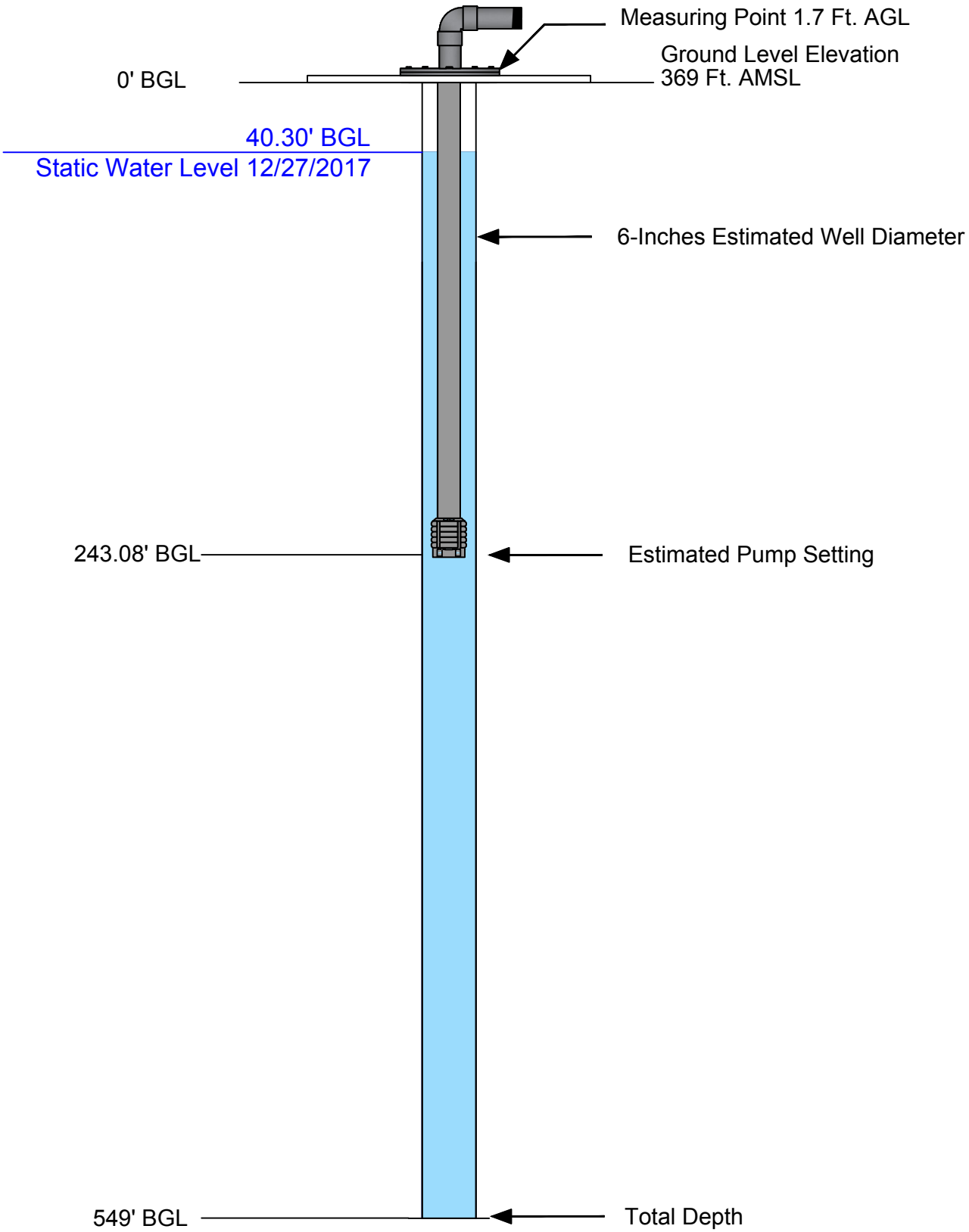
# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well Unknown / Goertz Arena Well
## Theis Curve

Hooper



# LPGCD Unknown / Goertz Arena Well




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

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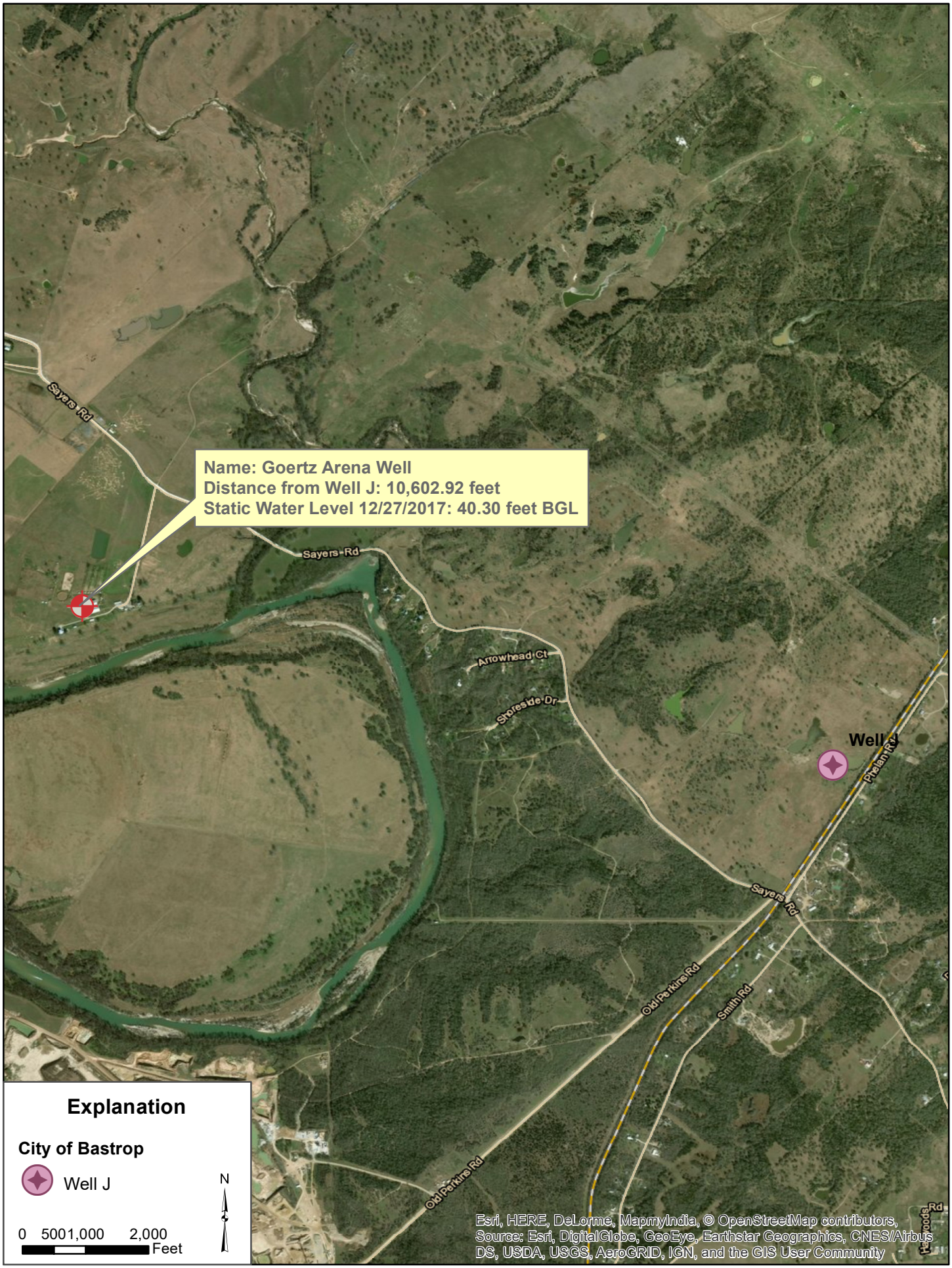
Name: Goertz Arena Well
Distance from Well J: 10,602.92 feet
Static Water Level 12/27/2017: 40.30 feet BGL
Sayers Rd
Sayers Rd
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Old Perkins Rd
Explanation
City of Bastrop
Well J
N
0 5001,000 2,000
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## Goertz House Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 10,725 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 10/27/2017 10:45 | 39.37 | Background |
| 11/1/2017 13:20 | 39.12 | Background |
| 11/10/2017 13:42 | 40.75 | Background |
| 11/13/2017 11:52 | 40.50 | Background |
| 11/28/2017 16:32 | 40.34 | Background |
| 12/22/2017 13:53 | 39.56 | Background |
| 12/27/2017 10:20 | 39.50 | Static Water Level |
| 12/27/2017 15:00 | 39.63 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 16:36 | 39.70 | |
| 12/27/2017 20:20 | 39.51 | |
| 12/27/2017 22:08 | 39.40 | |
| 12/28/2017 0:02 | 39.67 | |
| 12/28/2017 10:49 | 39.65 | |
| 12/28/2017 18:46 | 39.59 | |
| 12/28/2017 23:02 | 39.53 | |
| 12/29/2017 4:04 | 39.55 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 6:56 | 39.53 | |
| 12/29/2017 9:51 | 39.54 | |
| 12/29/2017 11:50 | 39.53 | |
| 1/3/2018 15:13 | 40.30 | |

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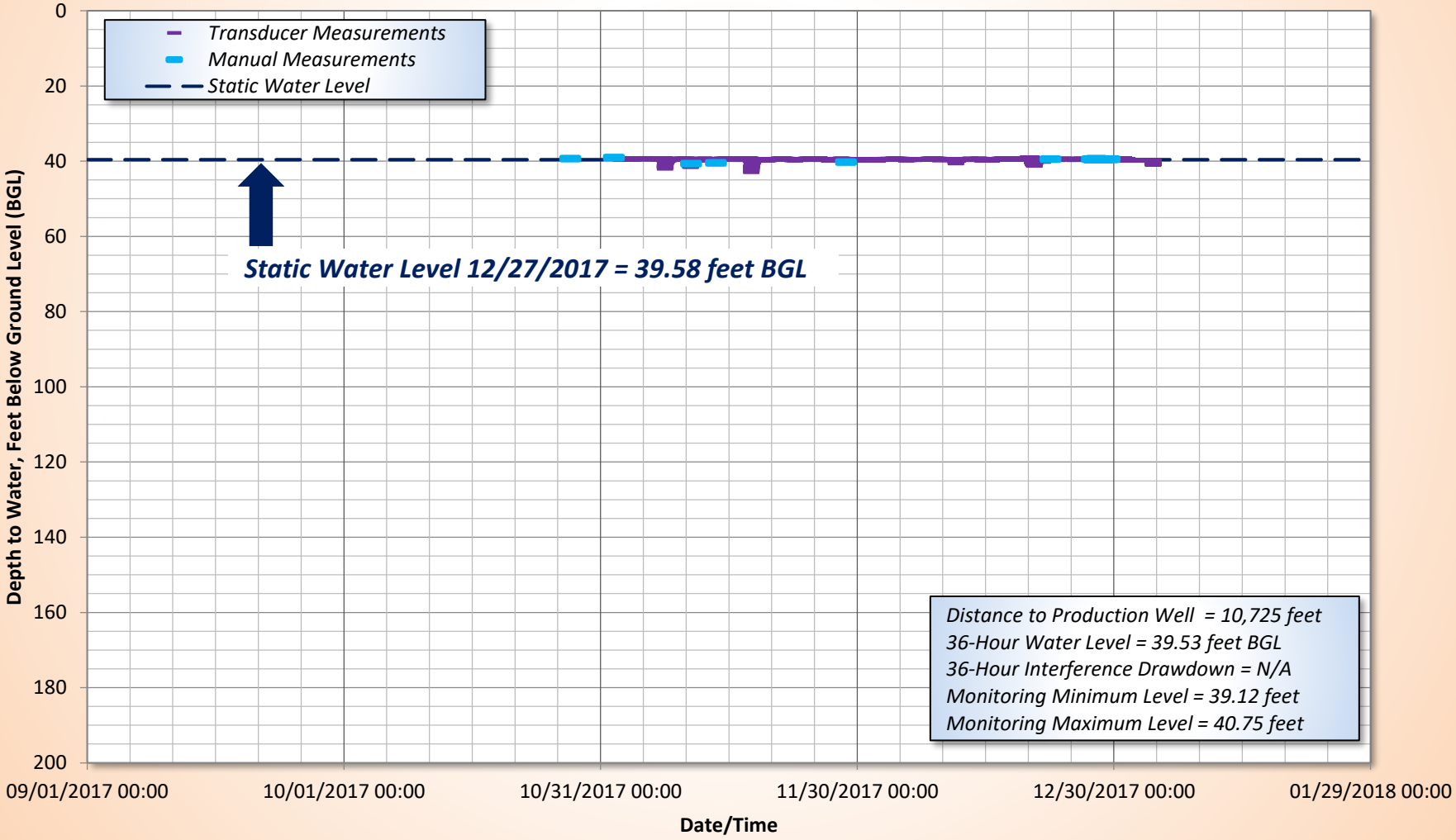
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well Unknown / Goertz House Well
# Hydrograph

Hooper



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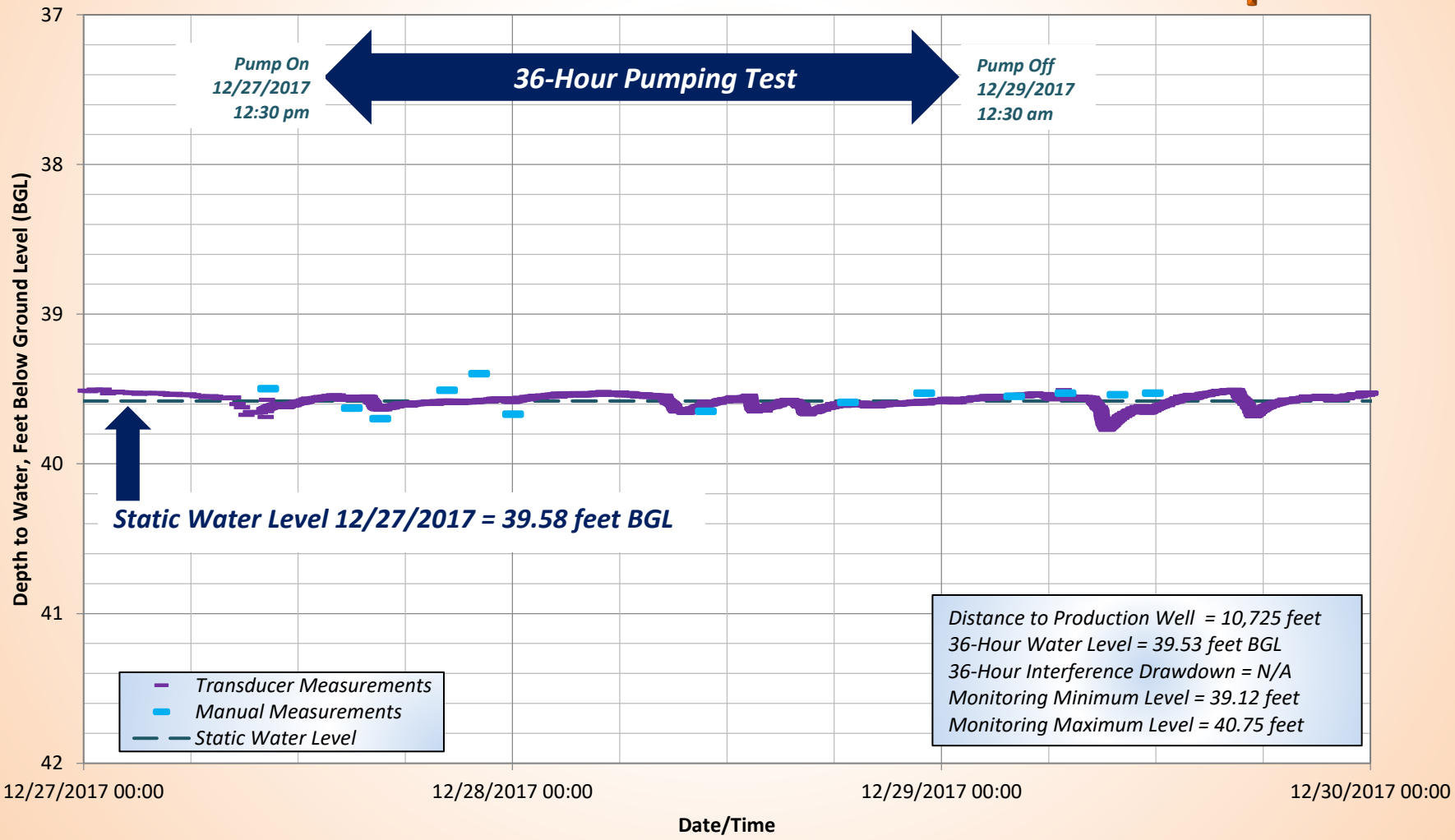
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well Unknown / Goertz House Well
# Hydrograph

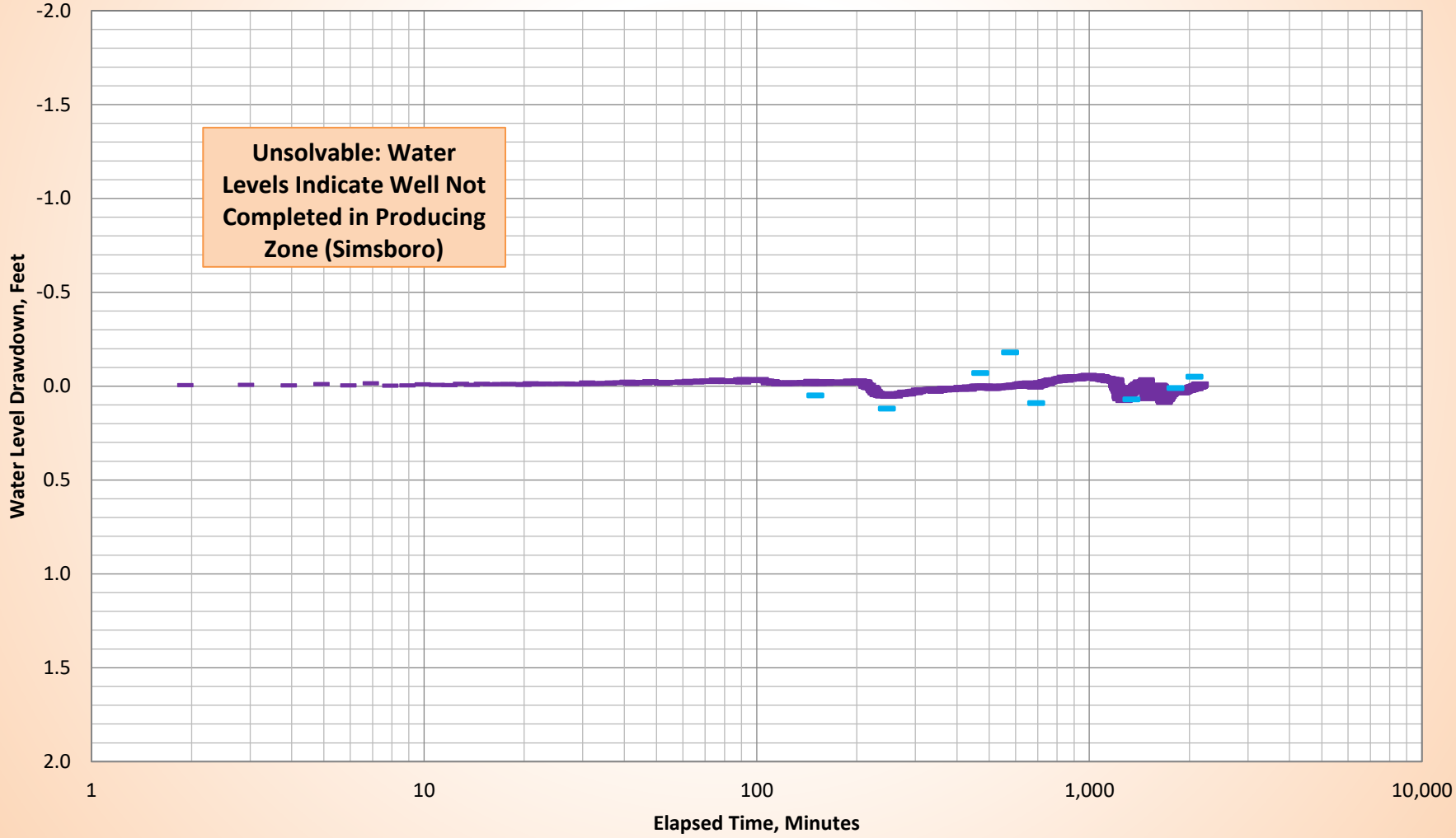
Hooper



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well Unknown / Goertz House Well
## Cooper-Jacob Chart (Drawdown)

Hooper



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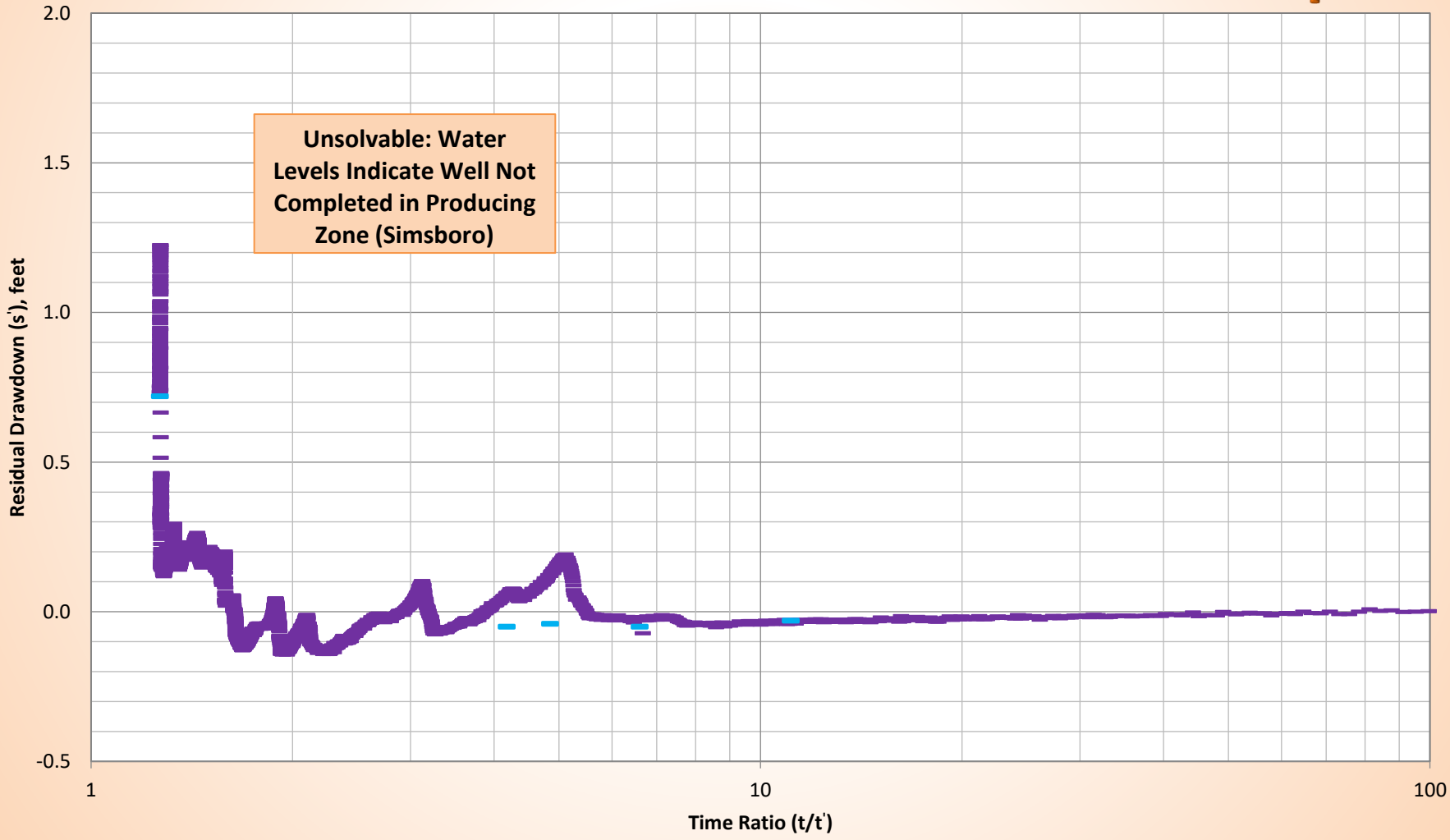
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well Unknown / Goertz House Well
## Cooper-Jacob Chart (Recovery)

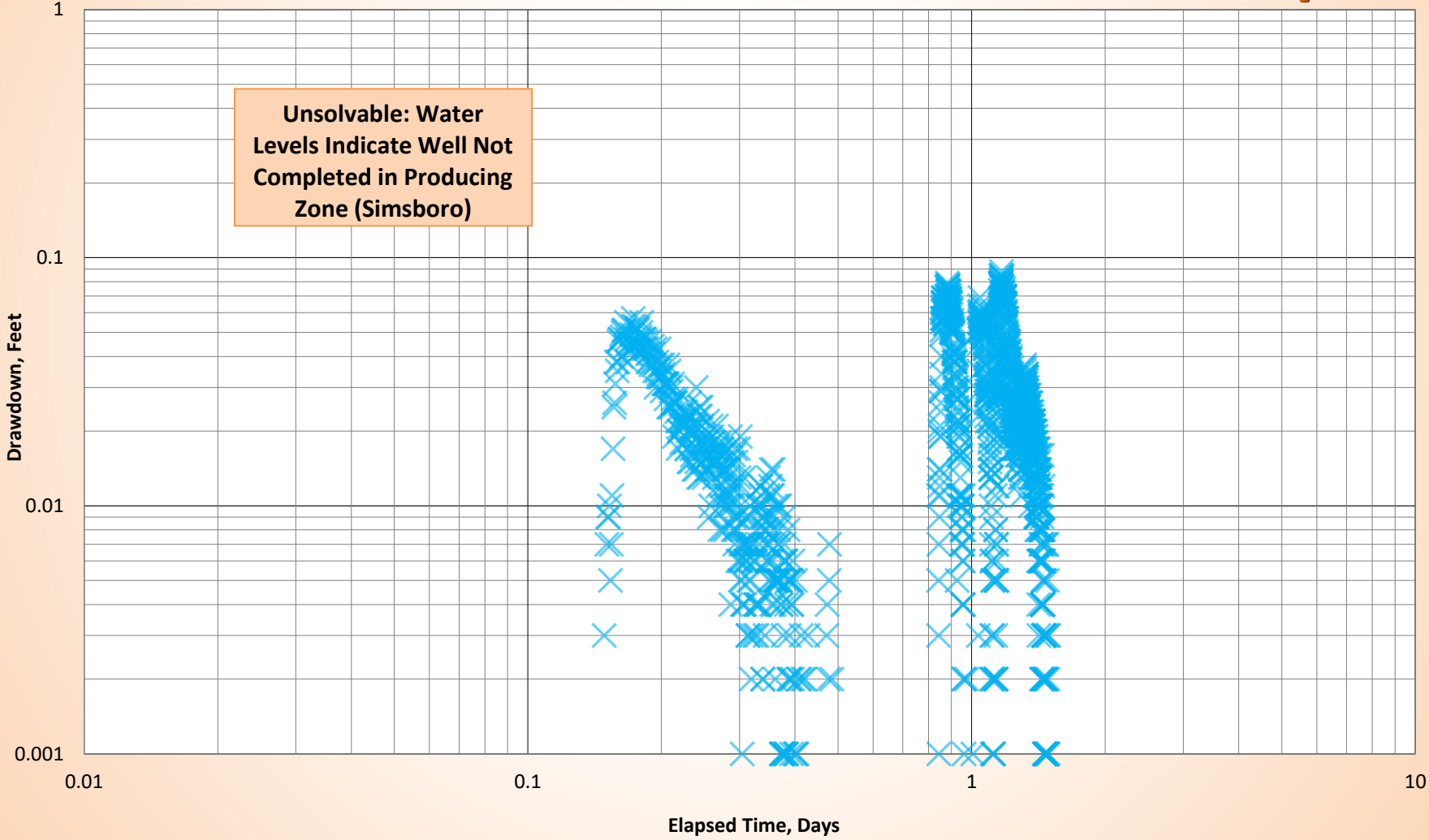
Hooper



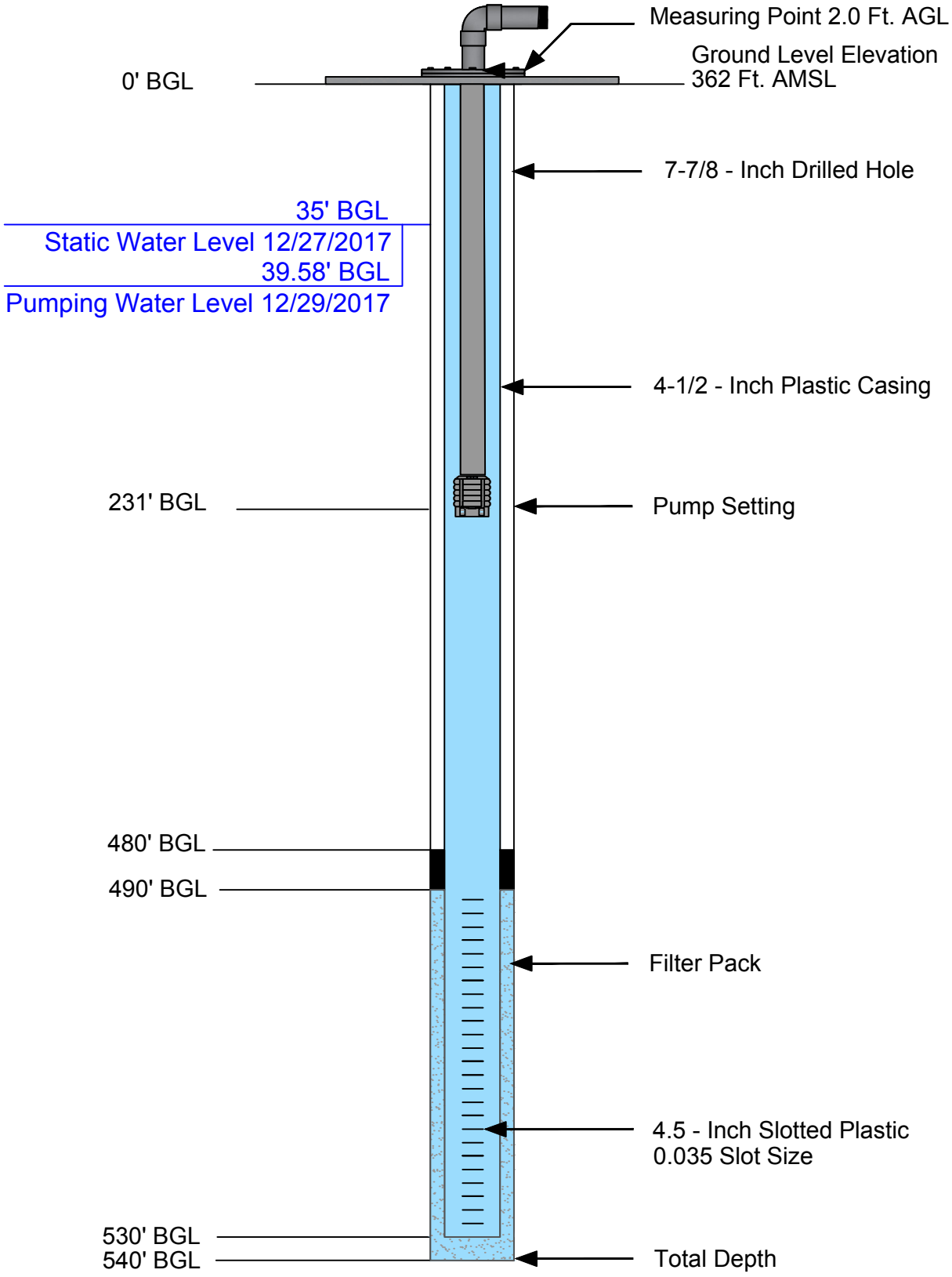
THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well Unknown / Goertz House Well
## Theis Curve

Hooper



# LPGCD Well Unknown / Goertz House Well




Well construction details compiled from State of Texas Well Report, LPGCD records, owner, and/or TGI field investigations.

THORNHILL GROUP, INC.
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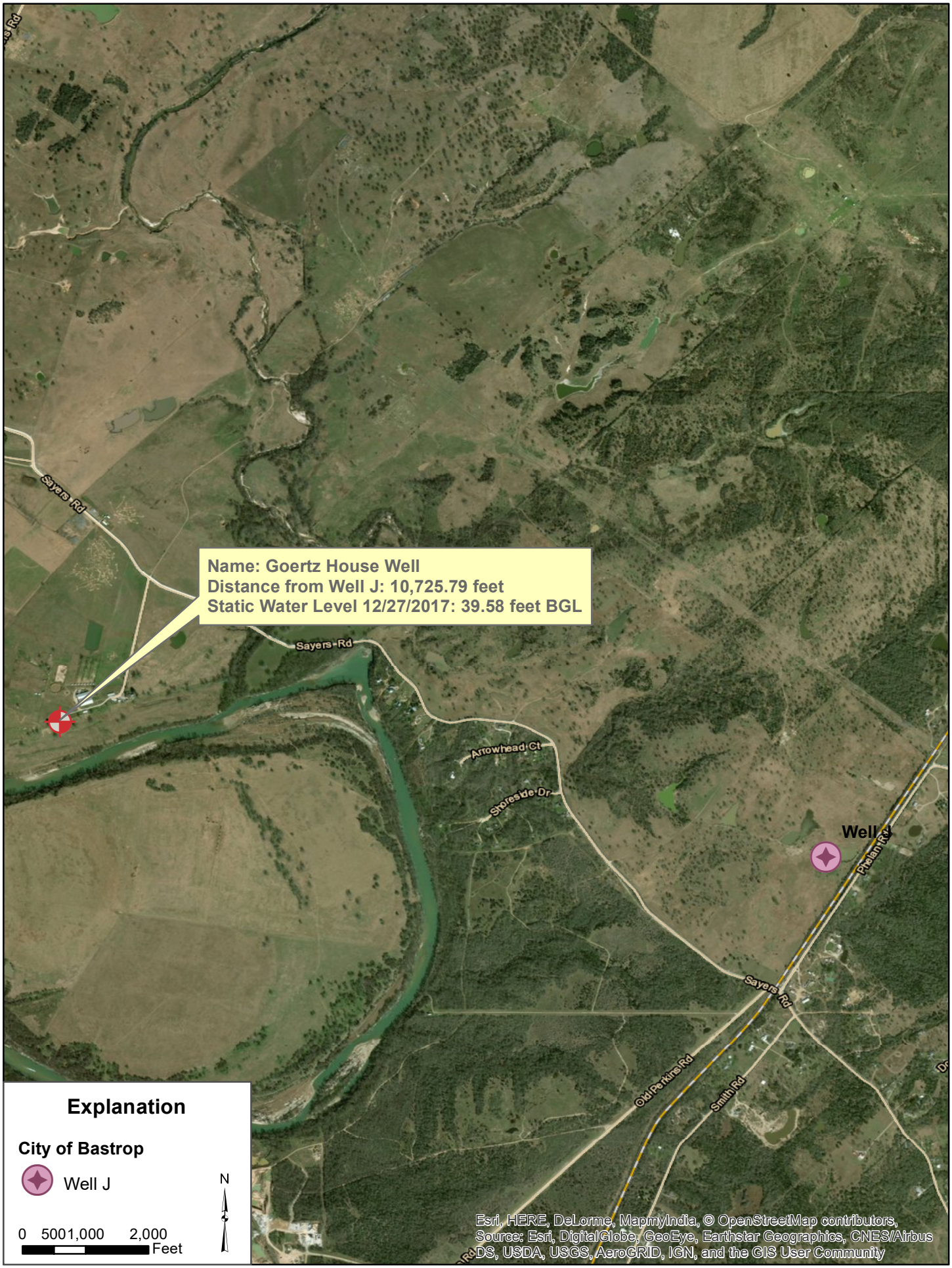
Name: Goertz House Well
Distance from Well J: 10,725.79 feet
Static Water Level 12/27/2017: 39.58 feet BGL
Sayers Rd
Sayers Rd
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Explanation
City of Bastrop
Well J
N
0 5001,000 2,000
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors,
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus
DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# City of Bastrop
## Goertz Cattle Pen Well
## 36-Hour Drawdown and Recovery Results

**Project:** 10210
**County:** Bastrop
**Aquifer Tested:** Simsboro
**Distance from Production Well:** 11,294 feet
**Production Well:** Well J
**Test Conducted By:** Brien Water Wells & Thornhill Group, Inc.

| Date / Time | Depth to Water (Feet Below Land Surface) | Remarks |
|---|---|---|
| 9/21/2017 10:39 | 58.76 | Background |
| 2/12/1900 13:47 | 59.35 | Background |
| 11/13/2017 11:31 | 59.36 | Background |
| 11/28/2017 17:02 | 59.32 | Background |
| 12/22/2017 13:36 | 59.13 | Background |
| 12/27/2017 10:45 | 59.34 | Static Water Level |
| 12/27/2017 14:45 | 59.20 | Production Well on: 12/27/2017 12:30 pm |
| 12/27/2017 16:42 | 59.33 | |
| 12/27/2017 20:14 | 59.26 | |
| 12/27/2017 21:59 | 59.25 | |
| 12/27/2017 23:55 | 59.25 | |
| 12/28/2017 2:45 | 59.21 | |
| 12/28/2017 5:14 | 59.21 | |
| 12/28/2017 10:30 | 59.27 | |
| 12/28/2017 14:38 | 59.23 | |
| 12/28/2017 19:00 | 59.28 | |
| 12/28/2017 22:44 | 59.25 | |
| 12/29/2017 3:50 | 59.25 | Production Well off: 12/29/2017 12:30 am |
| 12/29/2017 6:47 | 59.25 | |
| 12/29/2017 9:46 | 59.25 | |
| 12/29/2017 11:45 | 59.25 | |

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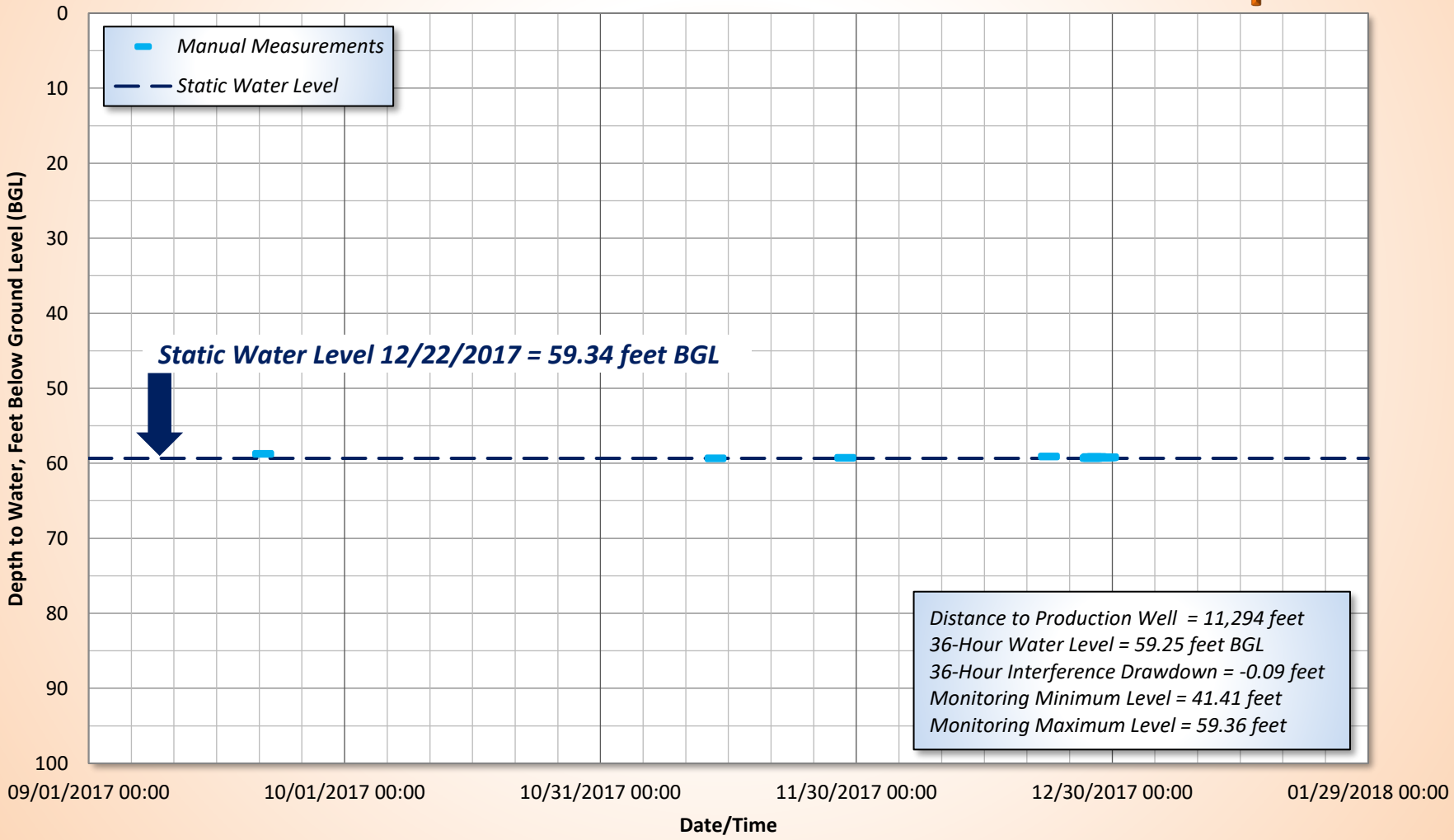
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well Unknown / Goertz Cattle Pen
# Hydrograph

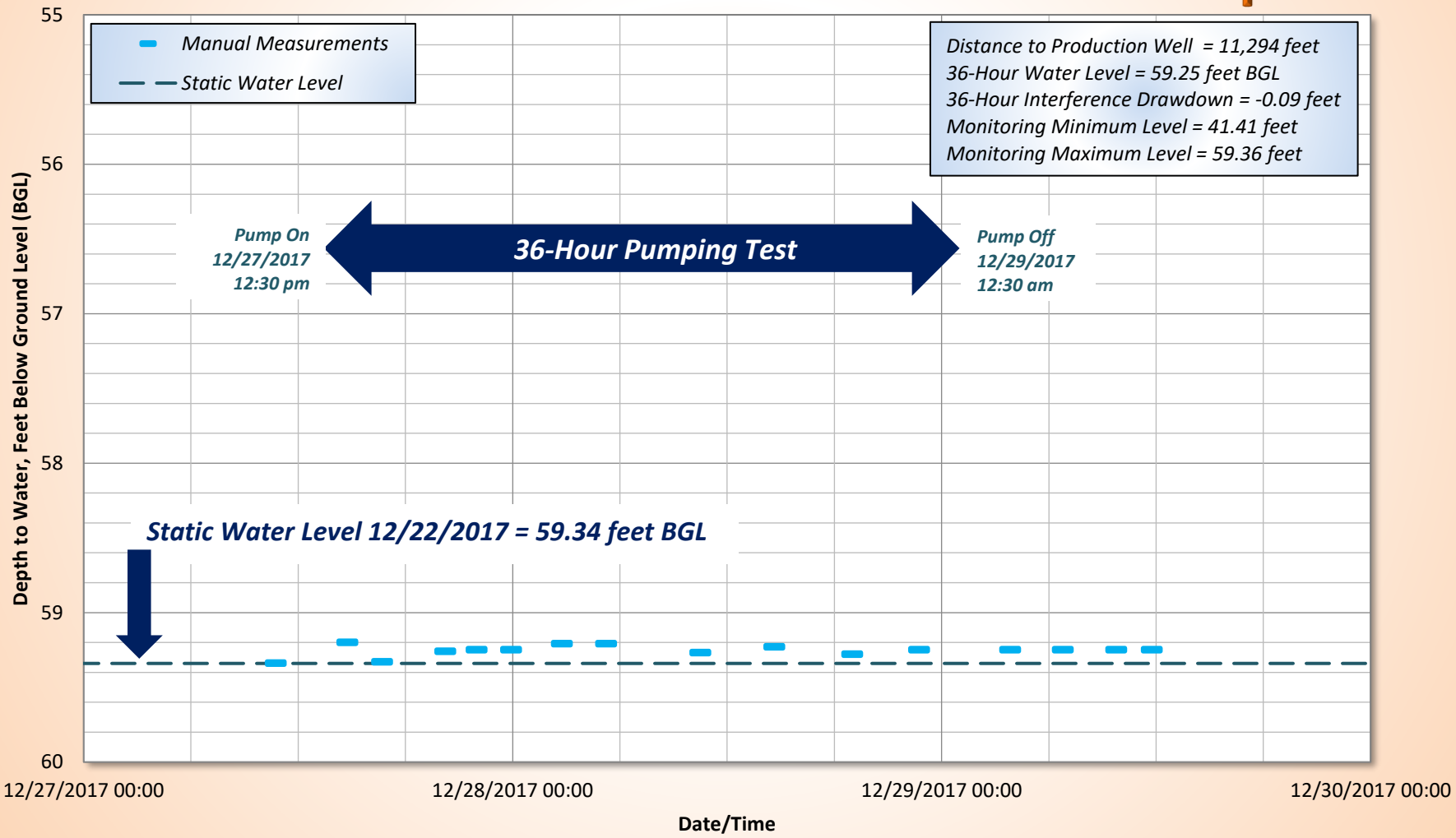
Hooper



THORNHILL GROUP, INC.
Professional Hydrogeologists • Water Resources Specialists

# City of Bastrop
# Well J Production Well 36-Hour Test
# LPGCD Well Unknown / Goertz Cattle Pen
# Hydrograph

Hooper



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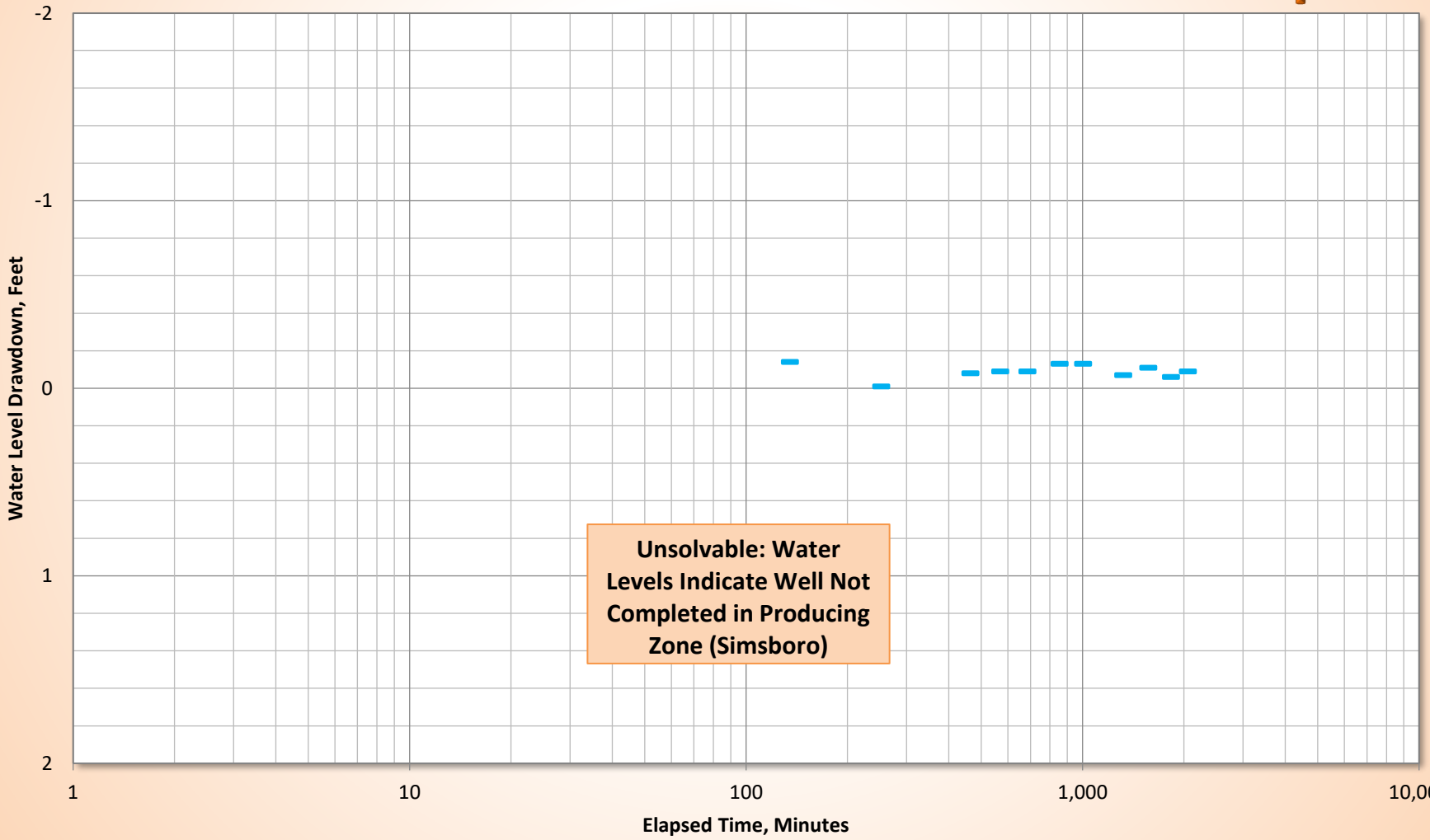
# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well Unknown / Goertz Cattle Pen
## Cooper-Jacob Chart (Drawdown)

Hooper



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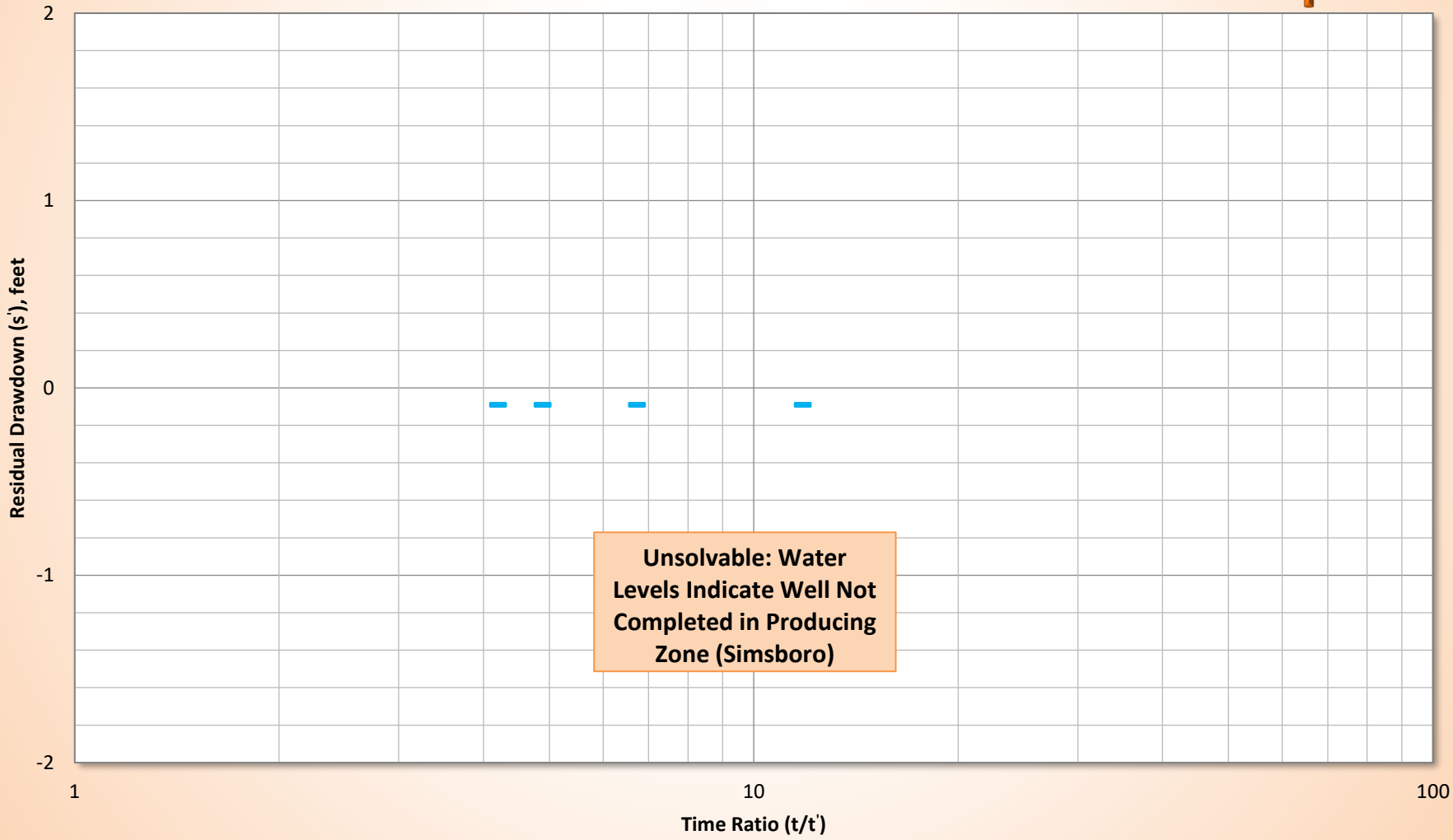
# City of Bastrop
## Well J Production Well 36 Hour Test
## LPGCD Well Unknown / Goertz Cattle Pen
## Cooper-Jacob Chart (Recovery)

Hooper



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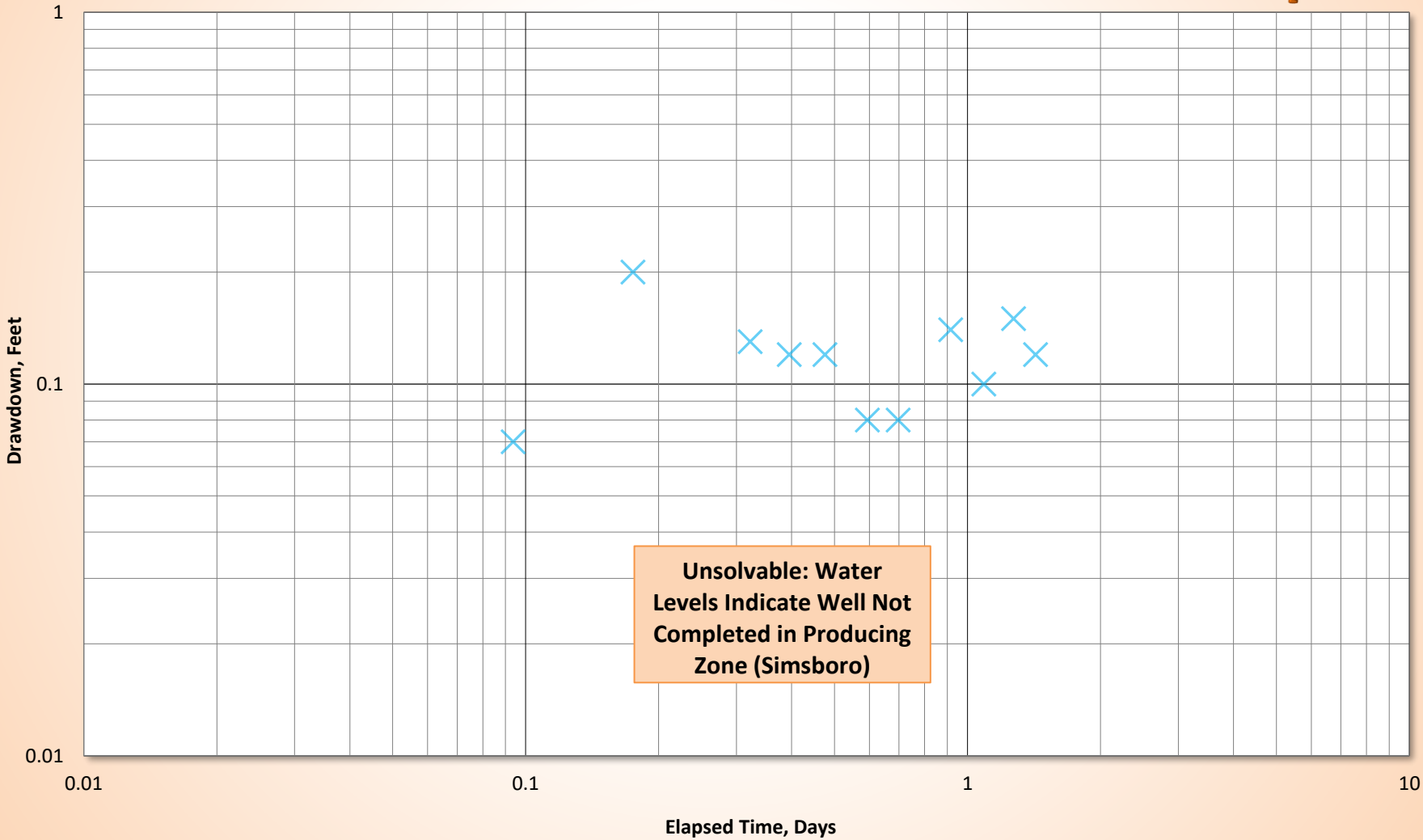
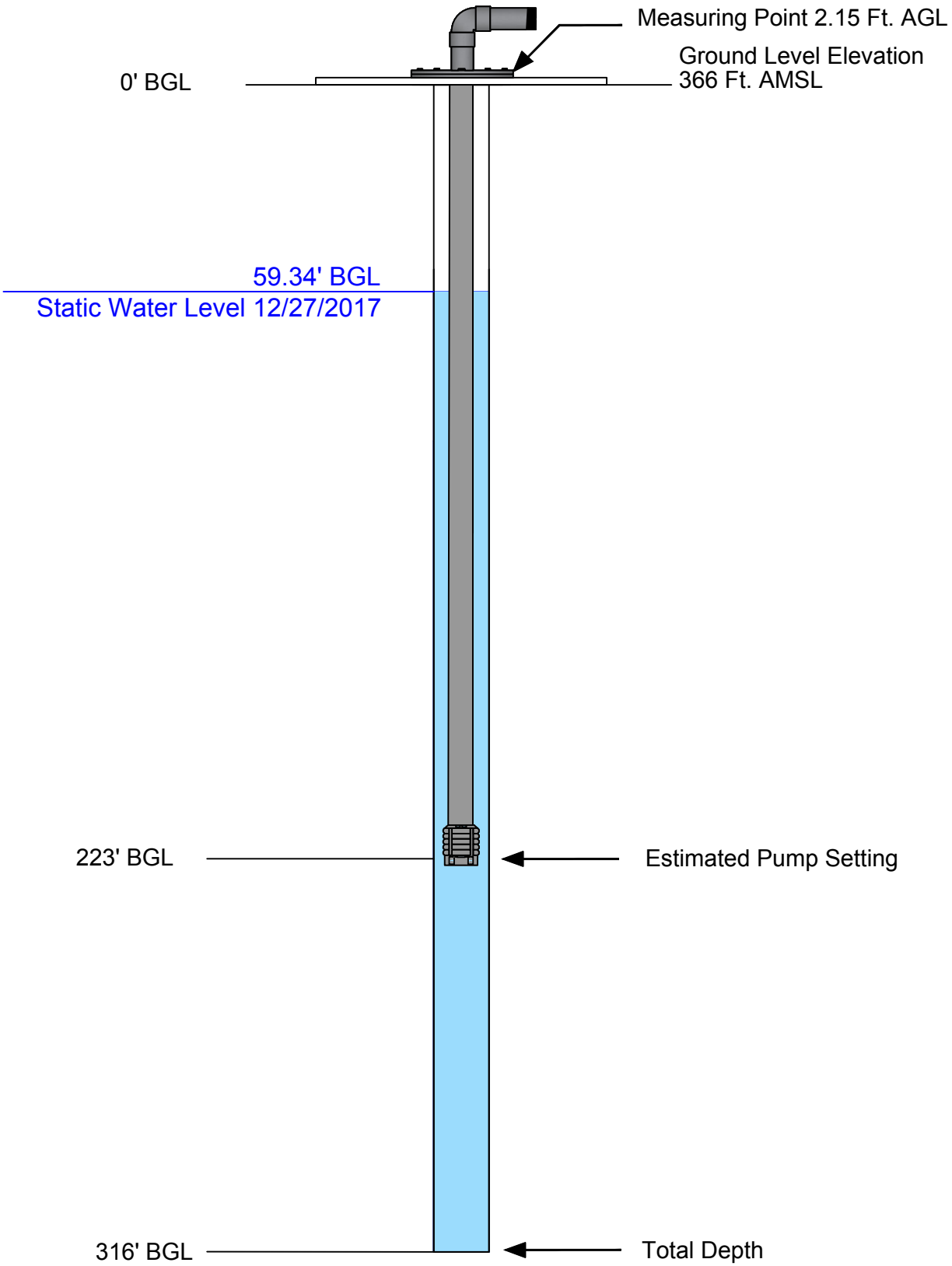
# City of Bastrop
## Well J Production Well 36-Hour Test
## LPGCD Well Unknown / Goertz Cattle Pen
## Theis Curve

Hooper



# LPGCD Well Unknown / Goertz Cattle Pen Well




Well construction details compiled from State of Texas Well Report, LPGCD records, and/or TGI field investigations.

THORNHILL GROUP, INC.
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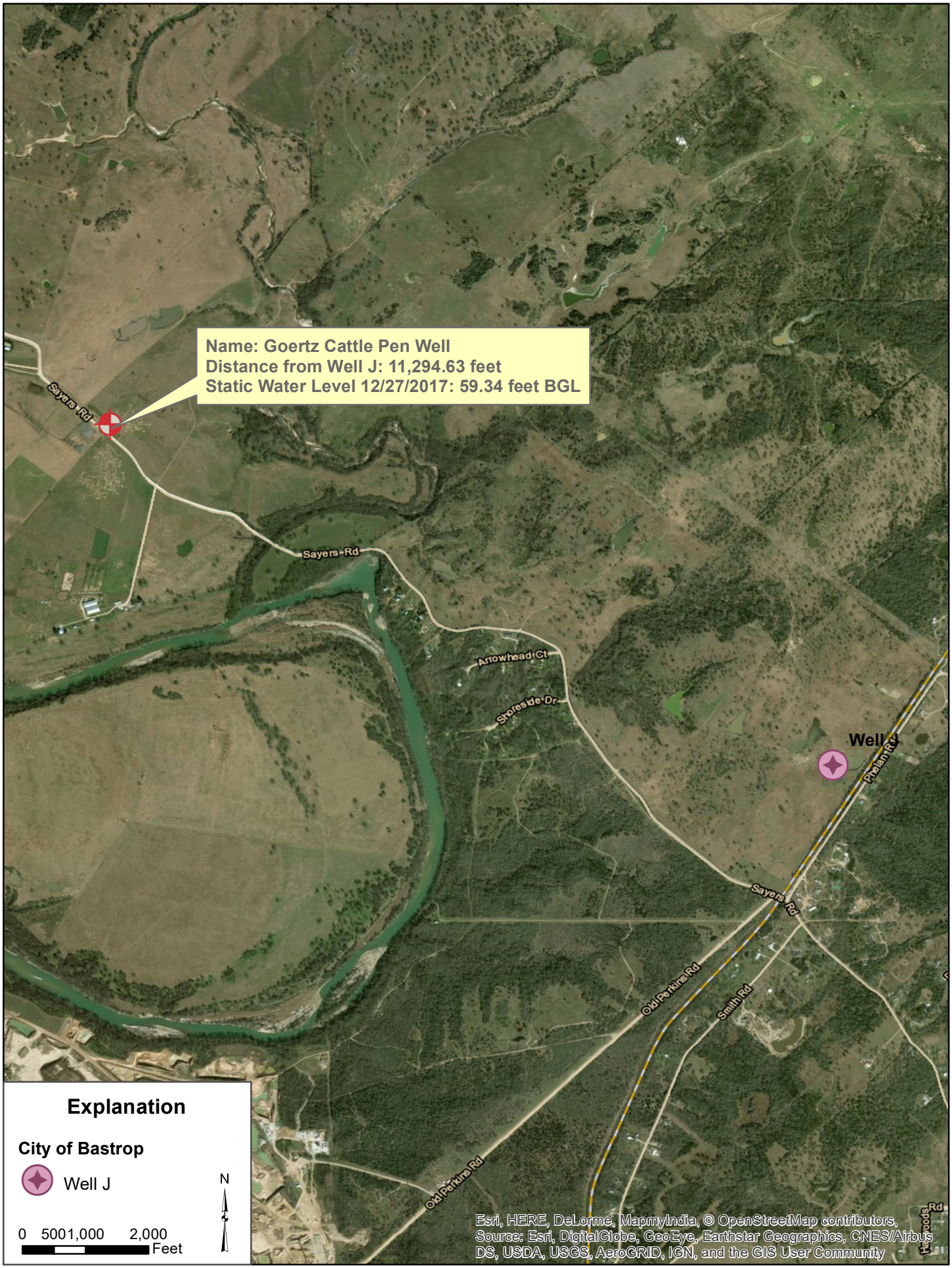
Name: Goertz Cattle Pen Well
Distance from Well J: 11,294.63 feet
Static Water Level 12/27/2017: 59.34 feet BGL
Sayers Rd
Sayers Rd
Arrowhead Ct
Shoreside Dr
Well J
Phelan Rd
Sayers Rd
Old Perkins Rd
Smith Rd
Old Perkins Rd
Explanation
City of Bastrop
Well J
N
0 5001,000 2,000
Feet
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

# Attachment 3 – Selected References

# REFERENCES

Aluminum Company of America. "Three Oaks Mine Surface Mining and Reclamation Permit Application." Railroad Commission of Texas, 2001.

Ayers, W.B., Lewis, Amy H., The Wilcox Group and Carrizo Sand (Paleogene) in East-Central Texas: Depositional Systems and Deep-Basin Lignite. The University of Texas at Austin, Austin: Bureau of Economic Geology, 1985.

CH2M HILL. Water Level Analysis for the Initial Production Permit for XS Ranch Wells (3,000 Acre-Feet/Year). May 12, 2014

Donnelly, Andy. Memorandum. Additional Information on LPGCD Permitted Wells. April 29,2013.

Dutton, Alan R. Groundwater Availability in the Carrizo-Wilcox Aquifer in Central Texas – Numerical Simulations of 2000 through 2050 Withdrawal Projections. Report of Investigations No. 256, The University of Texas at Austin, Austin: Bureau of Economic Geology, 1999.

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