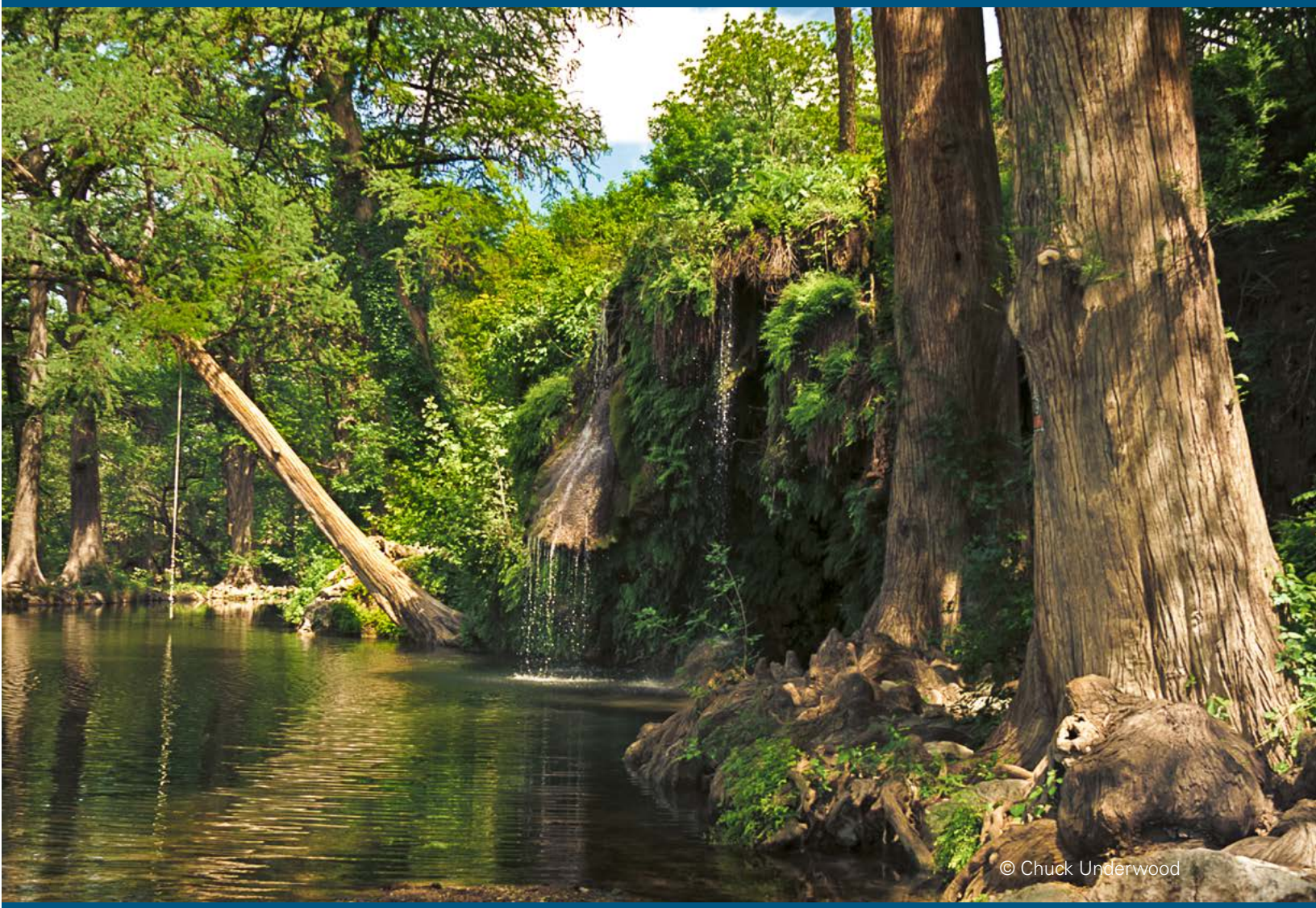
Krause Springs Occurrence of Flowing Water, Burnet County, Texas

Report: 2021-02
January 2021



The Meadows Center
for Water and the Environment
Texas State University

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MEMBER **THE TEXAS STATE UNIVERSITY SYSTEM**

Acknowledgments

The Meadows Center for Water and the Environment would like to thank Central Texas Groundwater Conservation District for providing funding for the project.

We also thank Brian Hunt of the Bureau of Economic Geology at the University of Texas for providing comments on the report.

We especially thank all of the landowners that allowed us to enter their property. Without cooperation of private landowners, opportunities for us to expand our knowledge of the river would not be possible.

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Texas Geosciences Firm #50541

Mr. Wierman was the lead researcher for the project.

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LIST OF ACRONYMS

cfs: cubic feet per second
CTGCD: Central Texas Groundwater Conservation District
LCRA: Lower Colorado River Authority
MRLC: Multi-Resolution Land Characteristics
GIS: Geographic Information Systems
TWDB: Texas Water Development Board
MCWE: Meadows Center for Water and the Environment
NELAP: National Environmental Laboratory Accreditation Program
SWR: State Well Report
GPM: Gallons Per Minute
LCC: Little Cypress Creek
EPA: Environmental Protection Agency
EARDC: Edwards Aquifer Research Data Center
TU: Tritium Units
MW: Monitoring Well
BGS: Below Ground Surface

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EXECUTIVE SUMMARY

Little Cypress Creek and Krause Springs are at a cross-roads as rapid growth in the Austin region intersect a fragile groundwater-fed ecosystem. The combined effects of increased groundwater pumping, extended droughts, and climate change influences recharge and springflow from the aquifers and springs of the area. Furthermore, land fragmentation within the larger Colorado watershed is already evident, altering the habitat and land management activities. However, the source of water to Krause Springs is poorly understood, and without that knowledge, what will the future hold for this remarkable Hill Country jewel?

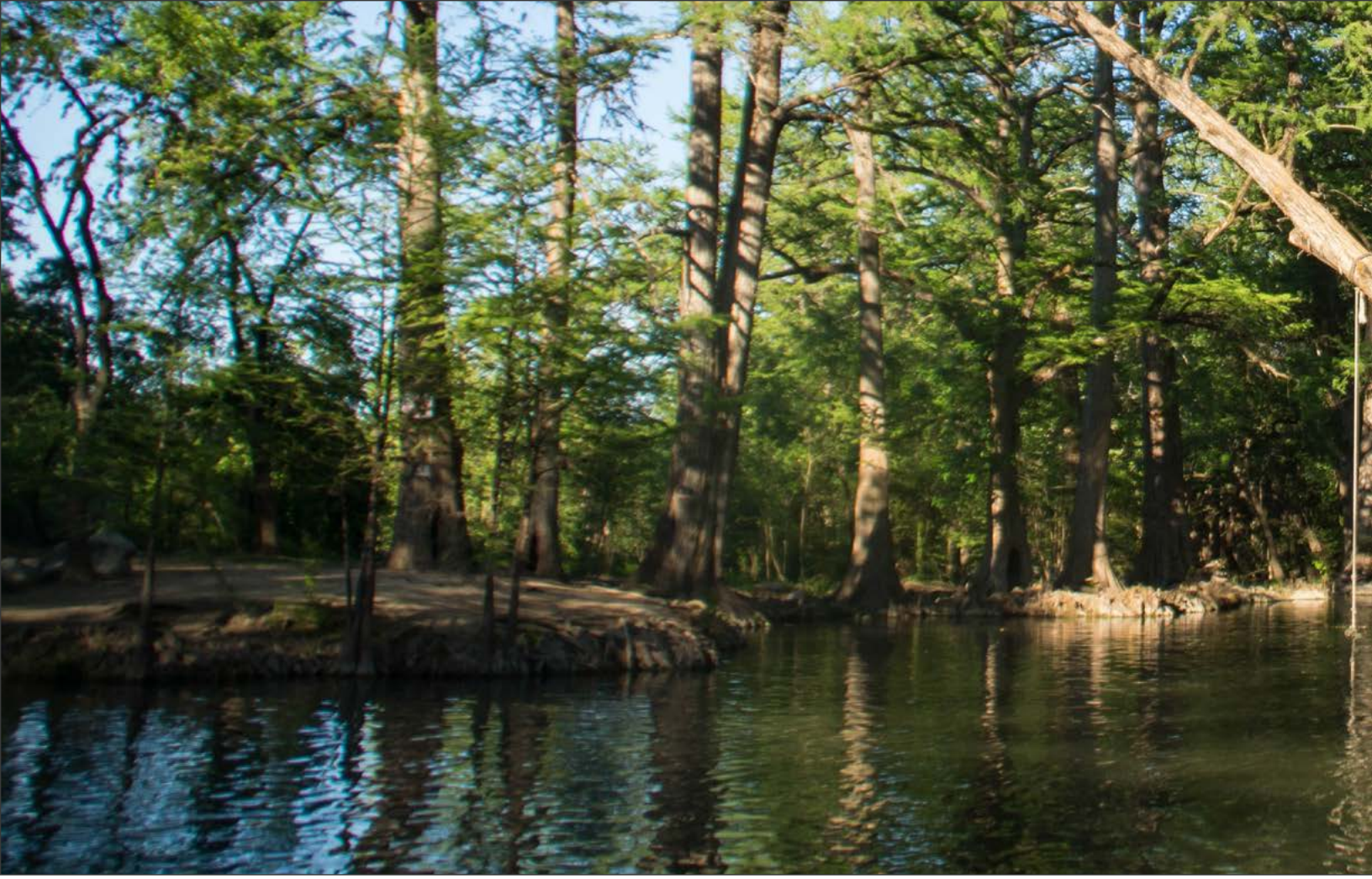
This study represents an opportunity to better understand our creeks and rivers and how they interact with the local aquifers. Improved understanding of these groundwater and surface water systems can lead to new development practices and land management strategies that can change the way we use water while sustaining the economic vitality of the region. The challenge is understanding and communicating potential water crisis, its cost, and strategies of efficient management and conservation measures that are recognized and accepted by the Hill Country's residents and visitors.

The Meadows Center for Water and the Environment's "How Much Water is in the Hill Country?" research (2015-2019) series focused on the surface and groundwater resources of the Pedernales and Guadalupe Rivers and the threats to their continued sustainability by examining water quality and flows across the watershed. These studies have helped us to better define the primary water sources and potential management and conservation activities that would protect and enhance the river flow and quality. Additional similar studies are essential in a more in-depth understanding of the health of the Hill Country watersheds.

The primary question for this study is, what is the source of water for Krause Springs? Based on the data collected during this study, in addition to work previously performed by others, it appears the basal sands and gravels of the Cretaceous Sycamore Sand Formation (Ksy) provide the majority of the source water to Krause Springs and support base flow in Camp Creek a tributary of Little Cypress Creek,. The Sycamore Sand is also known as the Lower Trinity Aquifer. Accordingly, recharge to the Lower Trinity, and pumping within the springshed directly influences Krause Springs. The Sycamore Sand overlays the Pennsylvannian Marble Falls Limestone (Cmf), which may also provide additional water to the Lower Trinity and springs, or simply may act as a local conduit from the Sycamore (Ksy) and alluvium (Qal) to the creek. Alluvial deposits in Little Cypress Creek to the southwest of the park area may also be hydraulically connected to the Sycamore Sand (Ksy).

This provides critical data regarding the hydrogeology of Krause Springs and a portion of Little Cypress Creek. However, to fully characterize the system additional hydrogeologic studies could be performed on the broader watershed. Suggested next steps include: 1) Geologic characterization including geologic mapping, additional borings including cuttings and core, and geophysical logging coupled with the collection of cuttings in area wells. 2) Hydrogeologic characterization including: monitor wells (automated recorders) in various aquifer units, weather stations, and multiple surface flow gauges, surface geophysical surveys, targeted dye tracing along losing (recharge) reaches of the creek, additional synoptic water level, and streamflow (gain-loss) data, and geochemistry.

Combined, these data should further delineate the source water or springshed area. Ultimately, all this information could culminate in the development of a conceptual and numerical groundwater flow model.



INTRODUCTION

The Hill Country is a unique region of Texas where rivers and springs rise out of a complex system of multiple and overlapping aquifer systems. Over the past several years, the Meadows Center for Water and the Environment has been working to answer the question – How much water is in the Hill Country? Although this seems like a straightforward question that merits a straightforward answer, the reality is that the largely hidden and unknown complexities of Hill Country hydrogeology make it challenging to answer.

The Meadows Center teamed up with the Central Texas Groundwater Conservation District (CTGCD) to direct this question towards Little Cypress Creek, Krause Springs, and the surrounding aquifers, a small but significant tributary of the Colorado River that flows into Lake Travis. Multiple aquifers contribute to base flow in Little Cypress Creek, but there is a lack of research and awareness about the contributing and recharge zones within the system.

The Little Cypress Creek watershed is currently made up of mostly undeveloped land use with steady spring flows and good water quality. The goal of this study is to collect data to characterize these types of natural systems and the interconnectedness between surface and groundwater. Such data are important for water planning, policy, and the health of Hill Country springs, streams, and rivers.

The focus of this study performed by the Meadows Center and CTGCD was on the stream gains and losses and a synoptic groundwater (water level) map focused around Krause Springs. The data allows for a better understanding of Little Cypress Creek's flow moving downstream and where there are gaining and losing reaches where surface water recharges the underlying aquifers. The results of this research contribute valuable insight towards strategic conservation prioritization and sustainable water resource management.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SCOPE OF STUDY

The study area included Little Cypress Creek north of Highway 71 to the confluence with Lake Travis. The study consisted of several primary efforts: a literature review, preliminary data analysis of well logs and water quality, GIS data collection and mapping, water quality sampling and laboratory analysis, a synoptic groundwater level and streamflow gain and loss event, and interpretation of the data in this report.

METHODS AND DATA

Mapping and Database

GIS is a versatile tool that can be used for a variety of functions, including mapping physical and hydrological features of a certain area, housing and centralizing multiple forms of environmental data, and performing spatial and data analysis using various tools offered within the program. The study used the ESRI suite of GIS products, specifically ArcGIS Pro. Land cover data was collected and analyzed for patterns using National Land Cover Database (NLCD) raster files, along with shapefiles of watershed and subwatershed boundaries, tributaries and flowlines from the National Hydrological Database (NHD). A composite geologic map of the watershed created from Bureau of Economic Geology at the University of Texas at Austin geologic quadrangle maps was added for analysis of geology. Groundwater quality data was extracted from the Texas Water Development Board online database and sorted by aquifer in addition to the water quality samples collected and analyzed by Meadows Center staff and partner laboratories.

Subsurface Data

The primary area of interest for this study is the area around Krause Springs in the eastern part of the watershed near the confluence of Little Cypress Creek and Lake Travis. Driller's logs were retrieved from the Texas Water Development Board (TWDB) website to gain insight into area-specific subsurface hydrogeology. There are a limited number of wells as not all logs were submitted to the state prior to 2002. In addition, individual drillers record subsurface conditions differently and sometimes inaccurately. In some cases, location coordinates on the logs were corrected. The TWDB database extents back to 2002, therefore no wells drilled before 2002 are included. There are few driller's logs in the area with uneven distribution and very sparse in the area immediately south of the park. Even though there are limitations, there is data that can be interpreted from the logs. The wells with available logs from the TWDB are plotted on Figure 8 along with their State Well Report (SWR) number. The SWRs are included in Appendix B.

An electrical and electromagnetic geophysical survey was performed by Ikard (2019) at the Krause springs park. The results indicated there may be a deeper vertical flow path, potentially along a fault, supporting the springs. An apparent shallow flow path following the topographic gradient may also support the flow at the springs.

WATER CHEMISTRY MAPPING AND ANALYSIS

Chemical analysis of surface water and groundwater is used to evaluate water quality, examine human impacts, and understand water pathways of groundwater to the surface and vice versa. Major ion chemistry is a standard tool used to decipher hydrogeochemical patterns as well as impacts of human activity (Dunne and Leopold, 1978). Spatial patterns in water chemistry were evaluated as related to both man-made and natural sources by utilizing spatial analysis in ArcGIS. The field data points provide spatial locations for the water samples. Surface and groundwater samples were collected by Meadows Center team and were analyzed for naturally occurring cations and anions by the Edwards Aquifer Research Data Center (EARDC) Laboratory at Texas State University. Existing water chemistry, including isotopes, data from Texas Water Development Board (TWDB) were also evaluated.

DISCHARGE MEASUREMENTS

To determine losing and gain reaches of the creek, four synoptic discharge measurement events were performed. Based on available landowner access, measurements were made at semi-regular intervals along the length of the creek with "live" water. Flow measurements were made using a FlowTracker (FT2) handheld Acoustic Doppler Velocimeter® generally following USGS protocols. River miles from the confluence of Little Cypress Creek and Lake Travis were determined using GIS techniques. Due to low flows during the synoptic gauging events, discharge values are expressed as gallons per minute (gpm) as opposed to cfs (1 cfs= approximately 449 gpm).

LAND COVER ANALYSIS

Land cover, particularly developed land use containing impervious cover, septic systems, sewage treatment, and nonpoint source pollution plays a role in determining water quality, and both storm and base flow. GIS files of basin land cover data from 2001 and 2016 were obtained from the National Land Cover Database (NLCD) provided by the Multi-Resolution Land Characteristics (MRLC) Consortium (MRLC 2011). Although the data sets contained a detailed breakdown of many land cover types, many similar land uses were combined for the purpose of this report and consolidated into six categories. As stated in the Regional Water Quality Plan (2005), "various published and unpublished reports and in unpublished data compilations, the City of Austin has indicated that physical and biological degradation of streams begins to occur at between five and eighteen percent (5-18 percent) impervious cover". Analysis of several water chemistry parameters could indicate water chemistry is primarily influenced by geology and land cover.

SETTING AND WATERSHED SUMMARY

The Little Cypress Creek watershed, a tributary to the Colorado River basin, is located in Burnet County, approximately 30 miles west the City of Austin and 14 miles southeast of the City of Marble Falls, TX. US Hwy 71 traverses the watershed from southeast to northwest. The watershed covers an area of 13.55 square miles (8,673 acres). The creek is approximately 8 miles in length and originates in the western part of the watershed, before coming to a confluence with Lake Travis.

Large ranches occupy most of the watershed. Other land uses include pastureland, vineyards, single family residences and some commercial development along Hwy 71 at CR 191 and CR 413 in the town of Spicewood (LCRA, 2008).

Krause Springs, a major tourist attraction in Burnet County, TX, is located on a 150-acre piece of property owned by the Krause family for over 50 years (Brune, 1981). This property contains as many as 32 springs, as well as a man-made swimming pool and 25 acres of campground. Located near the town of Spicewood, Texas, Krause Springs is listed on the National Registry of Historical Sites and has served as a recreational destination for central Texas residents since its founding in 1955 (Krause Springs, 2020).

The surrounding land cover of Krause Springs is primarily undeveloped (National Land Cover Database, 2011). The 115-acre property containing Krause Springs has sparse recreational development, including campsites, a man-made swimming pool, parking lots, and a few small structures (Krause Springs, 2020). Under a mile away from Krause Springs is the town of Spicewood (population 7,666), containing development that ranges from rural to low-density urban (U.S. Census Staff, 2011) (National Land Cover Database, 2011). Aside from sparse areas of moderate development, the land surrounding Krause Springs is primarily dominated by scrublands, grasslands, and small concentrations of deciduous and evergreen forest (National Land Cover Database, 2011).

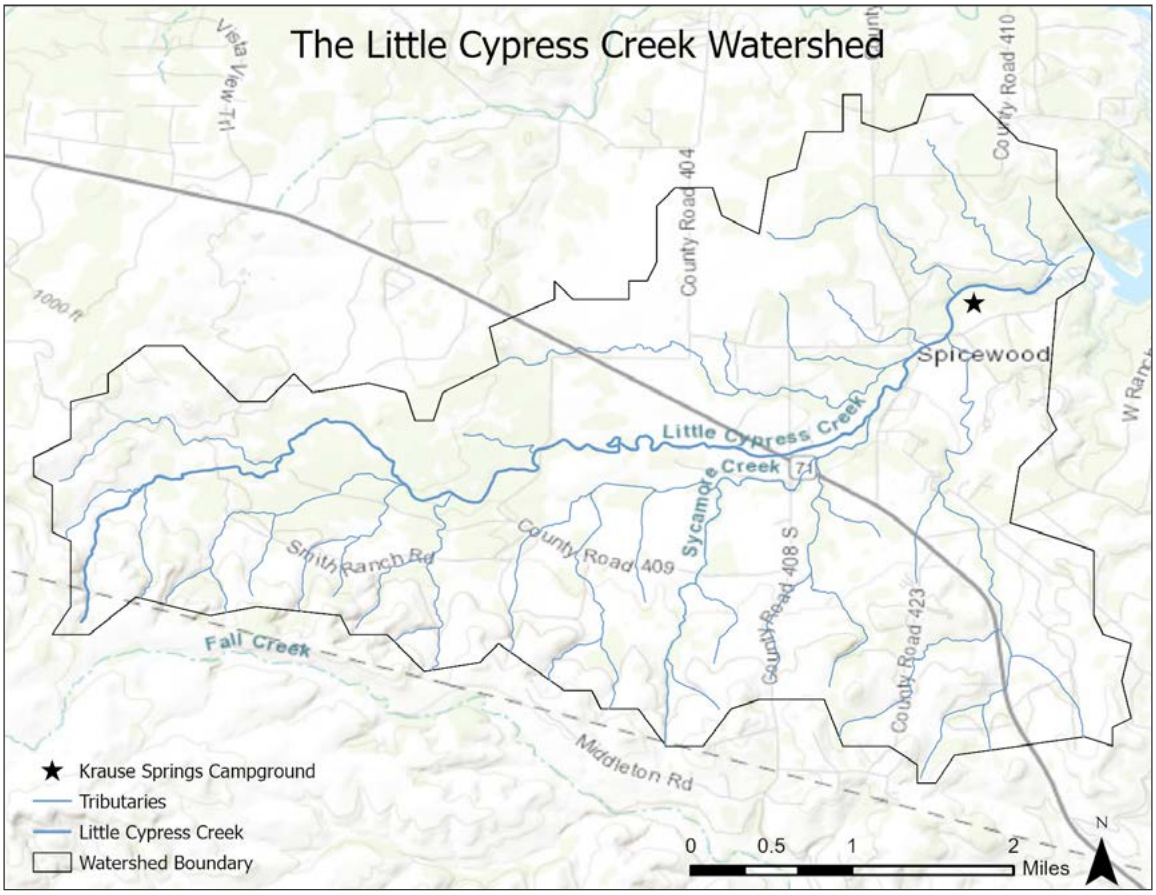


Figure 1. Little Cypress Creek

LAND COVER

GIS files of basin land cover data from 2001 and 2016 were obtained from the National Land Cover Database (NLCD) provided by the Multi-Resolution Land Characteristics (MRLC) Consortium (MRLC 2016). NLCD is updated every five years. The surrounding land cover of Krause Springs is primarily undeveloped (National Land Cover Database, 2011). The 115-acre property containing Krause Springs has sparse recreational development, including campsites, a man-made swimming pool, parking lots, and a few small structures (Krause Springs, 2020). Under a mile away from Krause Springs is the town of Spicewood (population 7,666), containing development that ranges from rural to low-density urban (U.S. Census Staff, 2011) (National Land Cover Database, 2011). Aside from sparse areas of moderate development, the land surrounding Krause Springs is primarily dominated by scrublands, grasslands, and small concentrations of deciduous and evergreen forest (National Land Cover Database, 2011). Figures 2 and 3 indicate 2001 and 2016 land cover of the Cypress creek watershed.

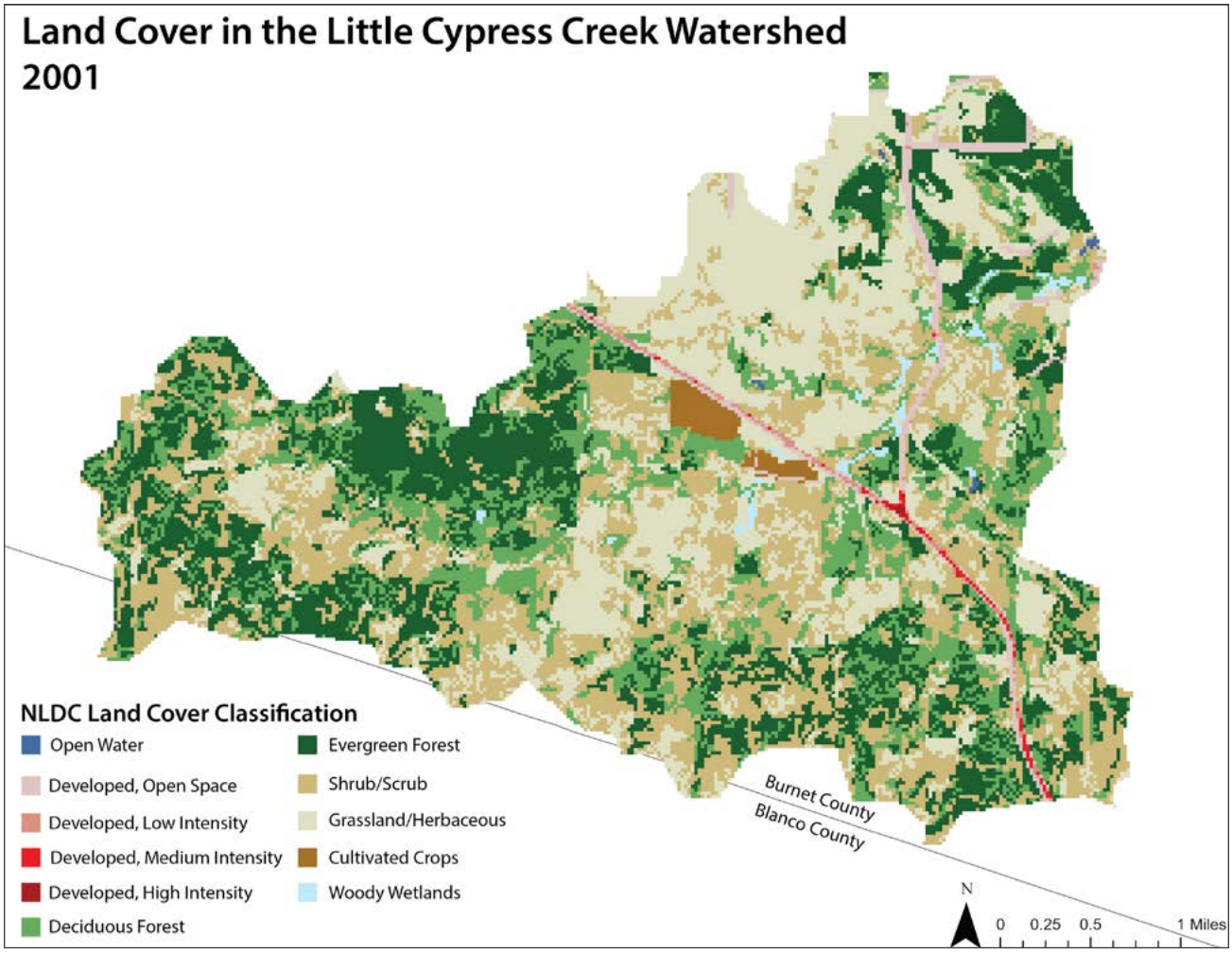
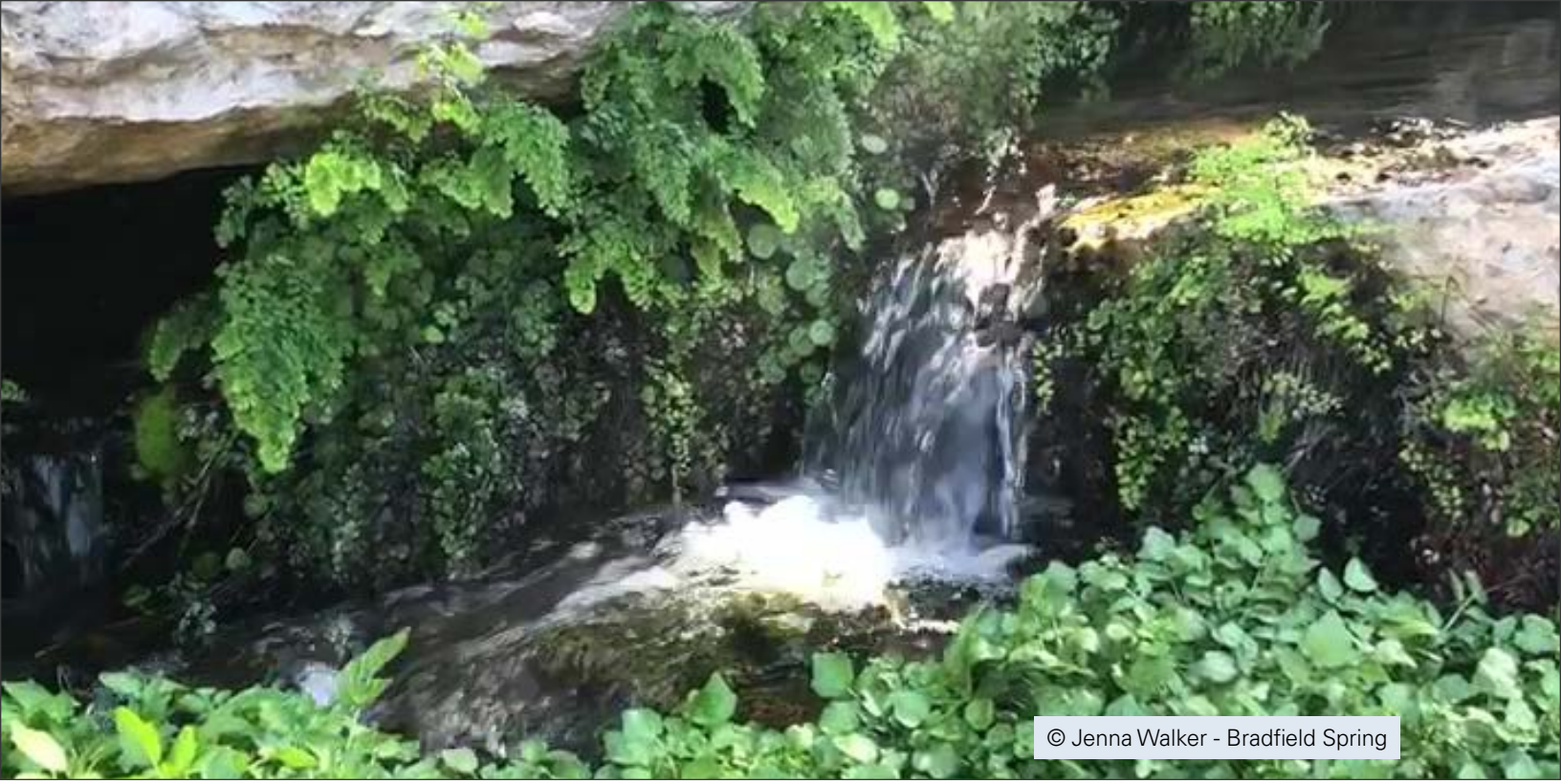


Figure 2. NLCD Land Cover – 2001



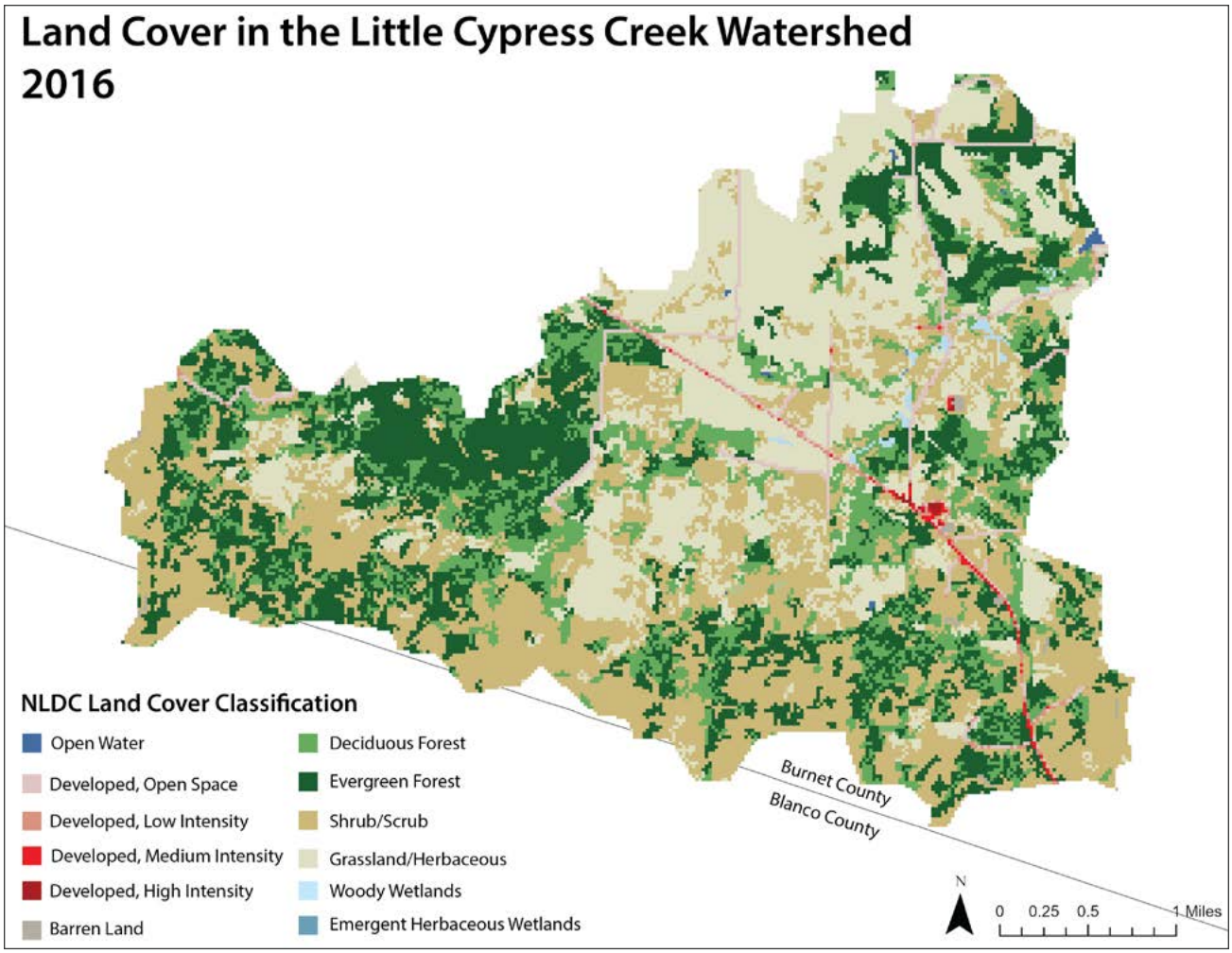


Figure 3. NLCD Land Cover – 2016

The land cover data sets from 2001 and 2016 were compared to determine land cover changes over the fifteen-year period. Although the data sets contained a detailed breakdown of many land cover types, similar land uses were combined for the purpose of this report and consolidated into a few categories to analyze land use changes. The watershed was primarily deciduous forest, evergreen forest, shrub/scrub, grasslands and developed in 2001. Table 1 includes a listing of land cover types with a detailed description of each type contained in Appendix A.

In general, there were small changes in land use types between 2001 and 2016. While the six major land cover types still dominate the watershed in 2016, there was a decline in deciduous forest and grasslands, totaling approximately 323 acres. Shrub and scrub areas increased by 349 acres (Table 1). All of the cultivated land along Hwy 71 has been replaced by grasslands. In total, there have been land cover changes of approximately 10% between 2001 and 2016.

Table 1. Land Use Change 2001 – 2016

Land Cover Type	2001 Land Cover (acres)	2016 Land Cover (acres)	Change in Land Cover (acres)
Open Water	7	10	3
Developed, Open Space	175	185	10
Developed, Low Intensity	41	49	8
Developed, Med. Intensity	20	22	2
Developed, High Intensity	2	6	4
Barren Land	0	16	16
Decid. Forest	1549	1308	-241
Evergreen Forest	2002	2028	26
Mixed Forest	0	28	28
Shrub/Scrub	2507	2825	318
Grassland/Herbaceous	2285	2220	-65
Cultivated Crops	79	0	-79
Woody Wetlands	57	28	-29
Emergent Herbaceous Wetlands	0	1	1

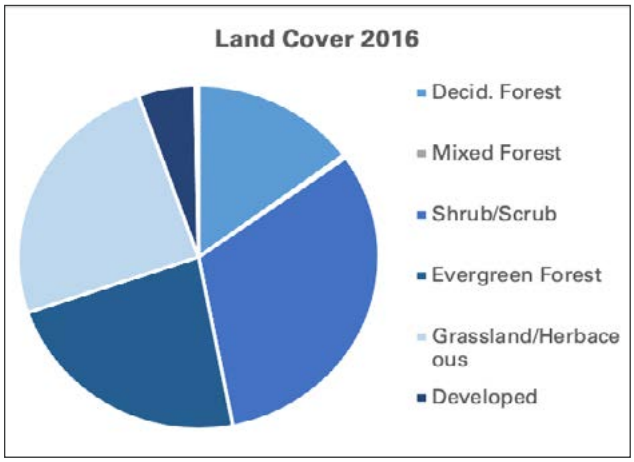


Figure 4. Land Cover - 2016

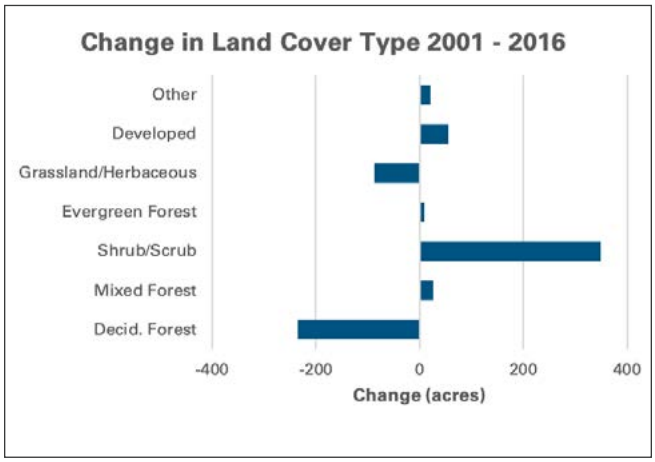


Figure 5. Land Cover Change 2001 - 2016

CLIMATIC CONDITIONS

Precipitation during the 2020 study period was variable. Monthly precipitation for 2020 is shown on Table 2. Precipitation was above average (wet conditions) during the first three months of the year, whereas below average (-3.8") for the last six months of the year (dry conditions).

Table 2: Precipitation Data, 2020

PRECIPITATION DATA* -2020			
Month	**Actual**	**30 Year Average**	**Departure From Average**
January	1.97	1.75	0.22
February	2.29	2.02	0.27
March	4.01	2.76	1.25
April	2.88	2.09	0.79
May	4.44	7.48	-3.04
June	4.33	2.67	1.66
July	0.63	1.88	-1.25
August	1.25	2.035	-0.785
September	5.96	2.99	2.97
October	0.35	3.88	-3.53
November	0.73	2.96	-2.23
December	4.07	2.4	1.67
Total	**32.91**	**34.92**	**-2.005**

**Data from Austin Camp Mabry station.*
Source: https://w2.weather.gov/climate/index.php?wfo=ewx

STUDY RESULTS

GEOLOGY OF THE LITTLE CYPRESS CREEK BASIN

There are several sources of geologic mapping data which include all or parts of the Little Cypress Creek Watershed. Primary sources used in this study include:

- Geology of the Spicewood Quadrangle by V. Barnes (Barnes, 1984),
- Geologic Map of the Upper Lake Travis Area by C. Woodruff and E. Collins (Woodruff and Collins, 2016), and
- Hydrogeologic Atlas of Southwest Travis County by B. Hunt and others (Hunt et al., 2020).

Complete citations are included in the reference section of this report.

The surficial geologic units of the Little Cypress Creek watershed range in age from Ordovician to Quaternary, though most of the watershed is dominated by Lower Cretaceous strata. There is a complex of strata of in the western part of the watershed consisting of Ordovician, Mississippian, and Pennsylvanian formations, though this area is not the prime area of interest for this study. Individual units in this area include the Honeycutt formation (Oh) of the Ellenberger group, Barnett Shale (Cb)(Mississippian), and the Pennsylvanian Marble falls Limestone (Cmf) (Figure 6).

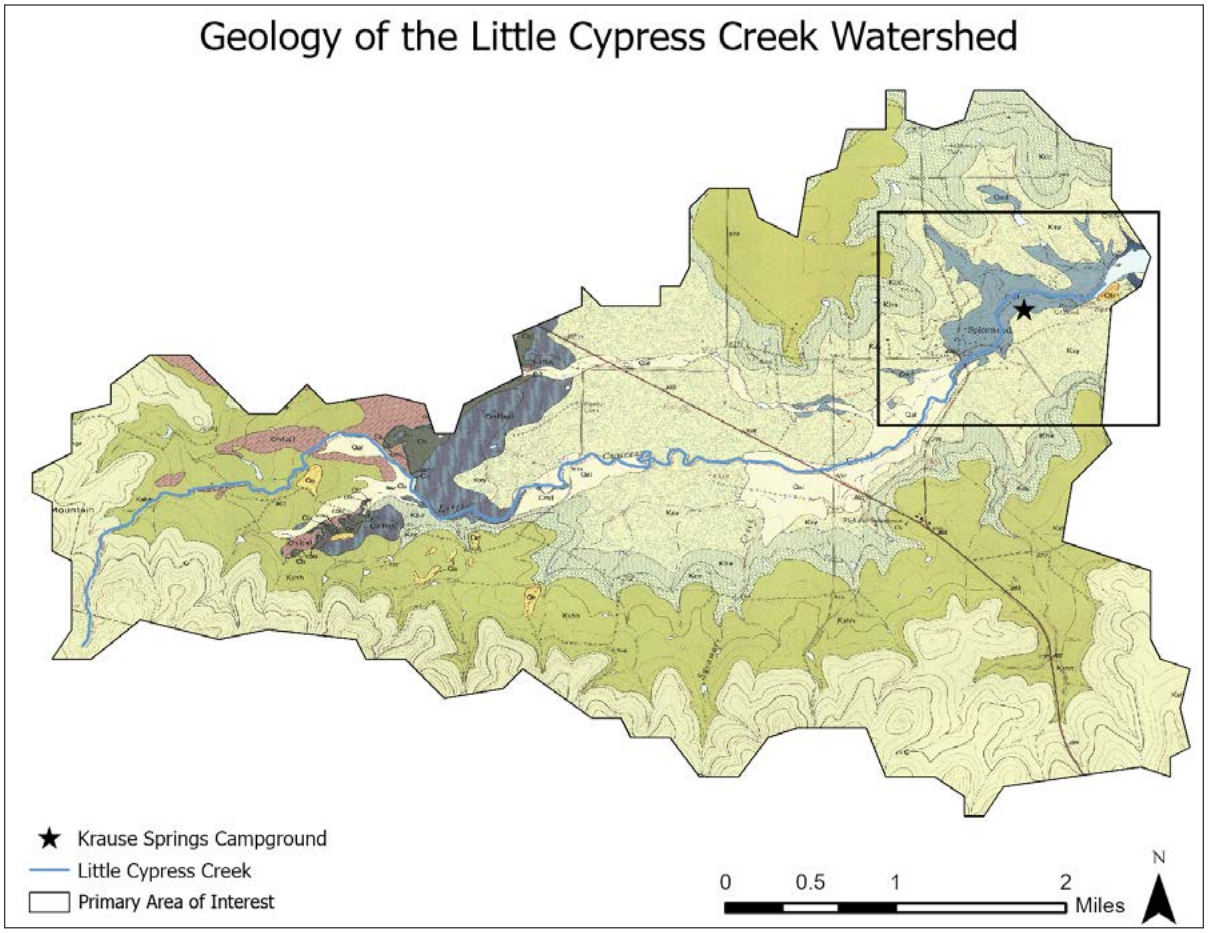


Figure 6. Geologic Map of the Little Cypress Creek Watershed (after Barnes, 1982)

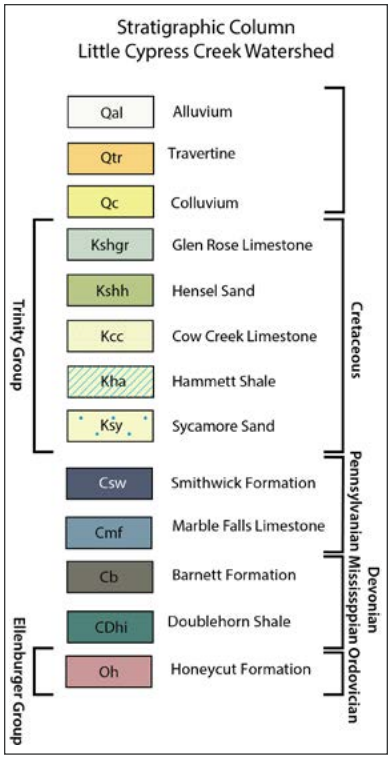


Figure 7. Stratigraphic Column of the Little Cypress Watershed (after Barnes, 1984)

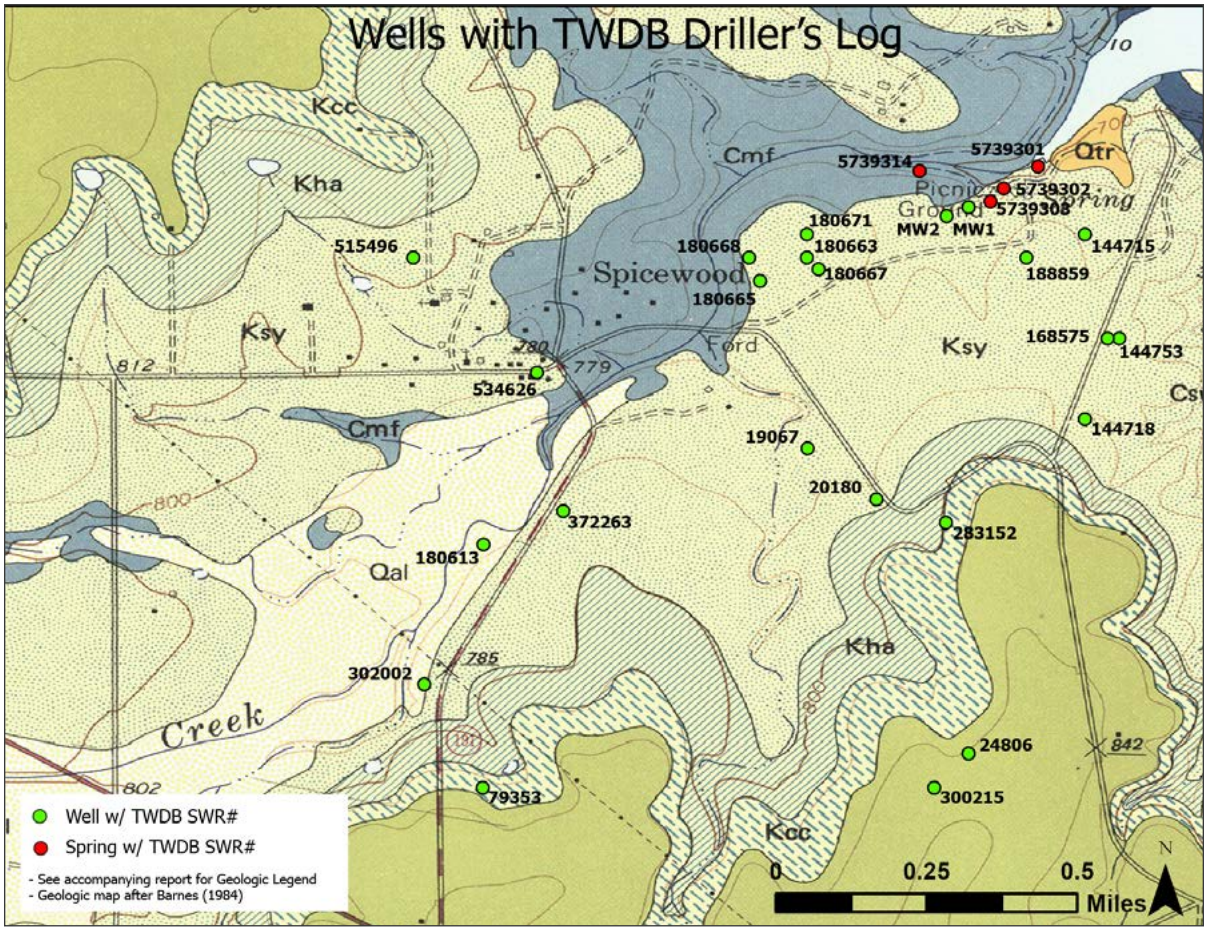


Figure 8. Location map of wells with TWDB State Well Reports (base map after Barnes, 1982)

The surficial geology is primarily Pennsylvanian and Cretaceous strata. The Pennsylvanian Marble Falls Formation (Cmf) is a limestone that primarily crops out along the north side of the creek starting at TX Hwy 191 and extends to the confluence with Lake Travis. It is also found on the southside of the creek just upstream of the park. The formation dips to the southeast (Figure 9) and is primarily characterized by disarticulated crinoid columnals (Figure 10). To the south of the creek, the Marble Falls is overlain by the Pennsylvanian Smithwick Formation (Csw). Hunt (2020) inferred a southwest - northeast trending fault along the southside of the creek that brought the Marble Falls (Cmf) to be juxtaposed alongside the Smithwick (Csw) (Figure 11). The Marble Falls (Cmf) is highly fractured just upstream of the park on the south side of the creek (Figure 12).

The Smithwick Shale (Csw) overlies the Marble Falls (Cmf) in the subsurface in the park area (Figure 11) and crops out along the shore of Lake Travis to the east (LCRA Grelle Recreation Area). A sandy facies of the Smithwick (Csw) was identified in this area (Brian Hunt personal communication, 2020).

Figure 9. Southeast dipping Marble Falls Limestone (Cmf)

Figure 10. Photograph of disarticulated crinoid columnals (up to 1/2″ diameter) of the Marble Falls Limestone (Cmf)

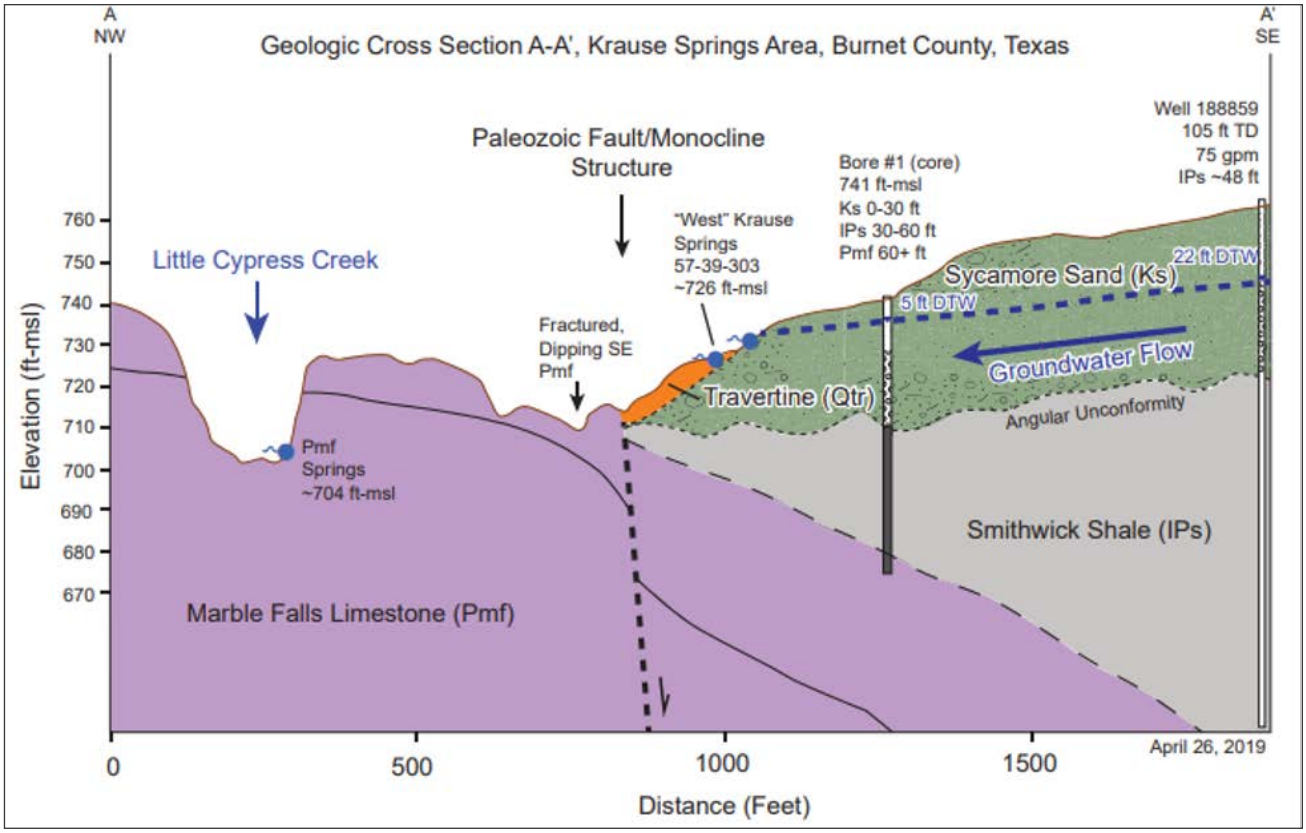


Figure 11. Geologic Cross Section (from Hunt et al., 2020)

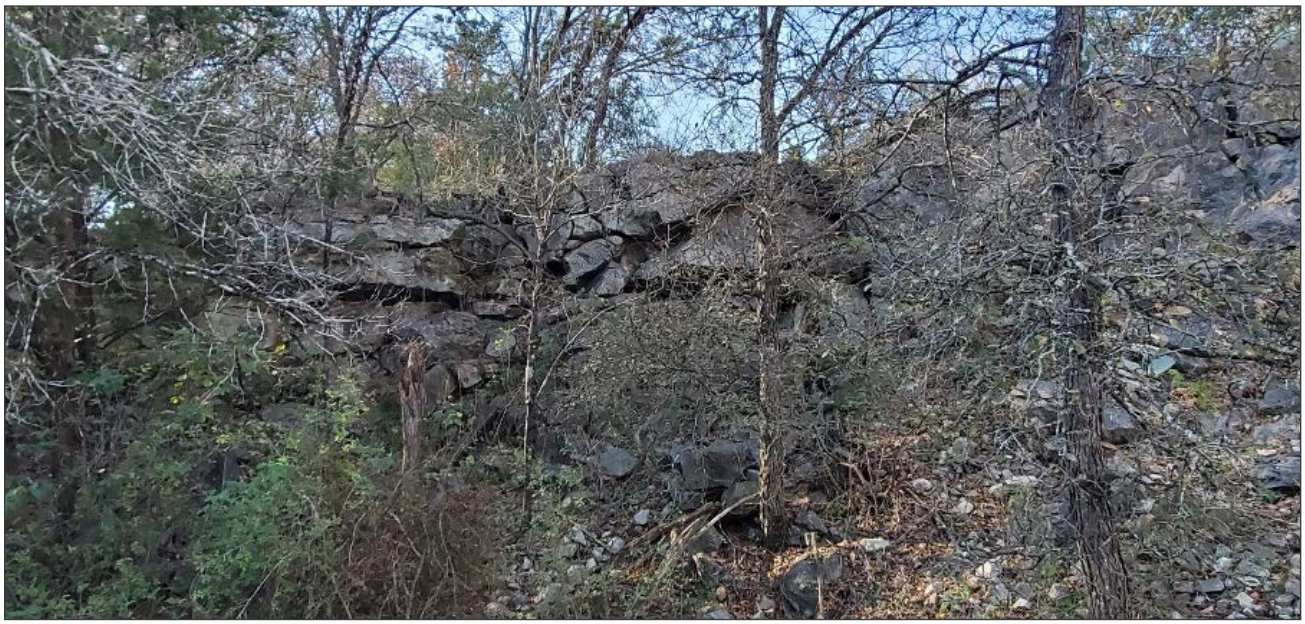


Figure 12. Fractured Marble Falls Limestone (Cmf) upstream of Krause Springs Park

Unconformably overlying the Smithwick (Csw) and Marble Falls (IPmf) in the study area is the Cretaceous Trinity Group. Near the Krause Park, the Sycamore Sand (Ksy) is the surficial unit. The Sycamore (Ksy) may be in contact with the Marble Falls (Cmf) just west of the park picnic grounds due to the aforementioned fault. The Sycamore (Ksy) is of variable lithology, though commonly expressed as a well cemented, poorly sorted, pebble to boulder sized conglomerate (Figures 13a and 13b) composed of Paleozoic and Precambrian rocks (Barnes, 1982). Woodruff (2016) describes the Sycamore (Ksy) as "mostly conglomerate, local sand lenses deposited on underlying Paleozoic terrain: up to 50 feet thick". Based on a review of local driller's logs, it appears there is an unconsolidated water bearing sand and gravel component to the Sycamore (Ksy), likely similar to the sand lenses mentioned by Woodruff (2016). The occurrence of sand and gravel from drillers well logs showing the top elevation and thickness is shown on Figure 14 and Figure 15 is an isopach map of the unit. The top of the unit ranges in elevation from 752 feet above msl at Krause Springs Park, to 779 feet above msl to the southwest. Thus, the structural dip of the top of the Ksy from the Southwest to the Northeast toward the Springs. The sand/gravel unit itself ranges in thickness from 5 feet to 65 feet. Figure 16 is a geologic cross section showing the thickness of the unit.

Table 3 is an inventory of available SWRs indicating the presence/absence of the sand facies. The lateral extent of the sand/gravel unit is in part inferred from drilled water wells that did not encounter the unit. Many of these wells did not produce water and were subsequently plugged as shown on Figure 14. The transition along the margins of the sand/gravel unit to limestone can be very abrupt as shown on margins of Figure 15. The sand unit may be in connection with the alluvium (Qal) of Little Cypress Creek southwest of the park.

Figure 13a. Core showing the Sycamore Sand in the shallow subsurface at CTGCD MW1

Figure 13b. Outcrop of the Sycamore Sand (Ksy) conglomerate

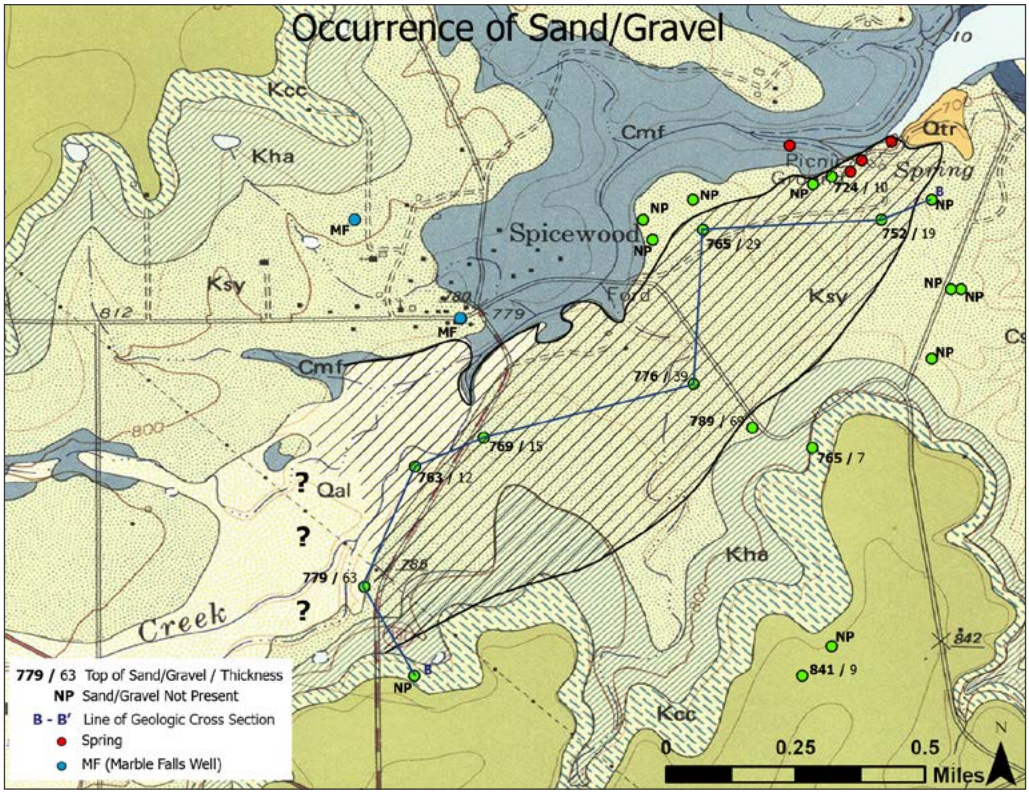


Figure 14. Inferred Occurrence of Sycamore Sand. Hatched area represents the inferred extend of sand and gravel of the Sycamore Sand based upon outcrops and subsurface well data. Base map after Barnes, 1982.

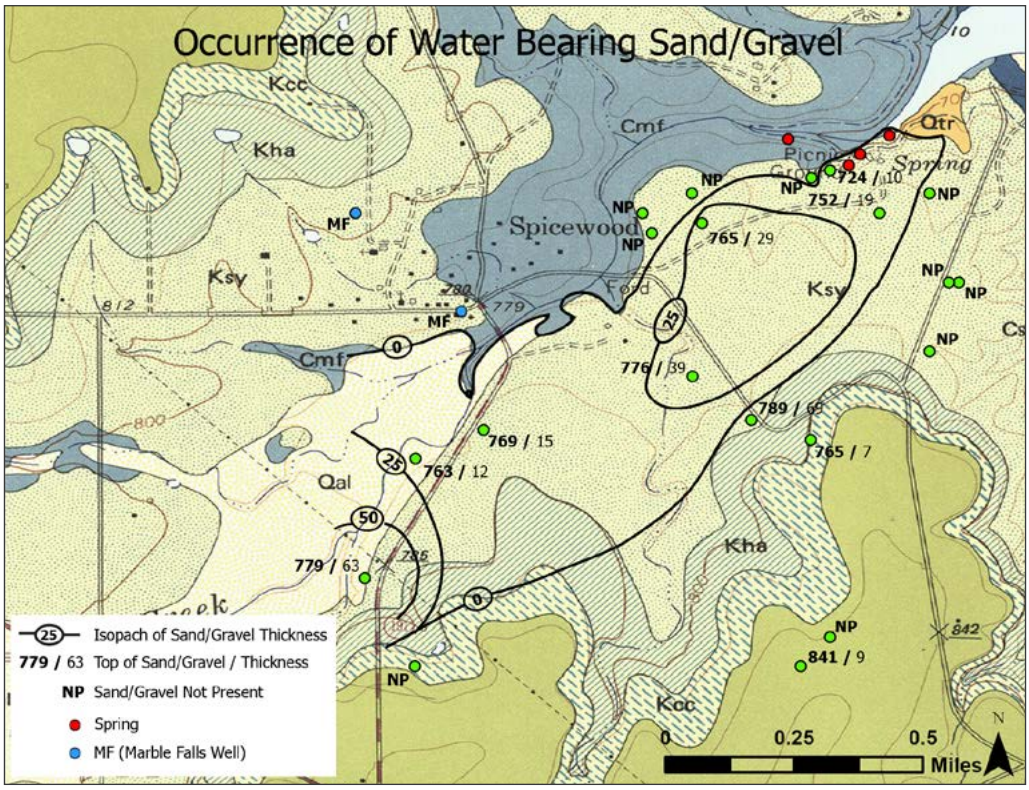


Figure 15: Occurrence of Water Bearing Sand/Gravel

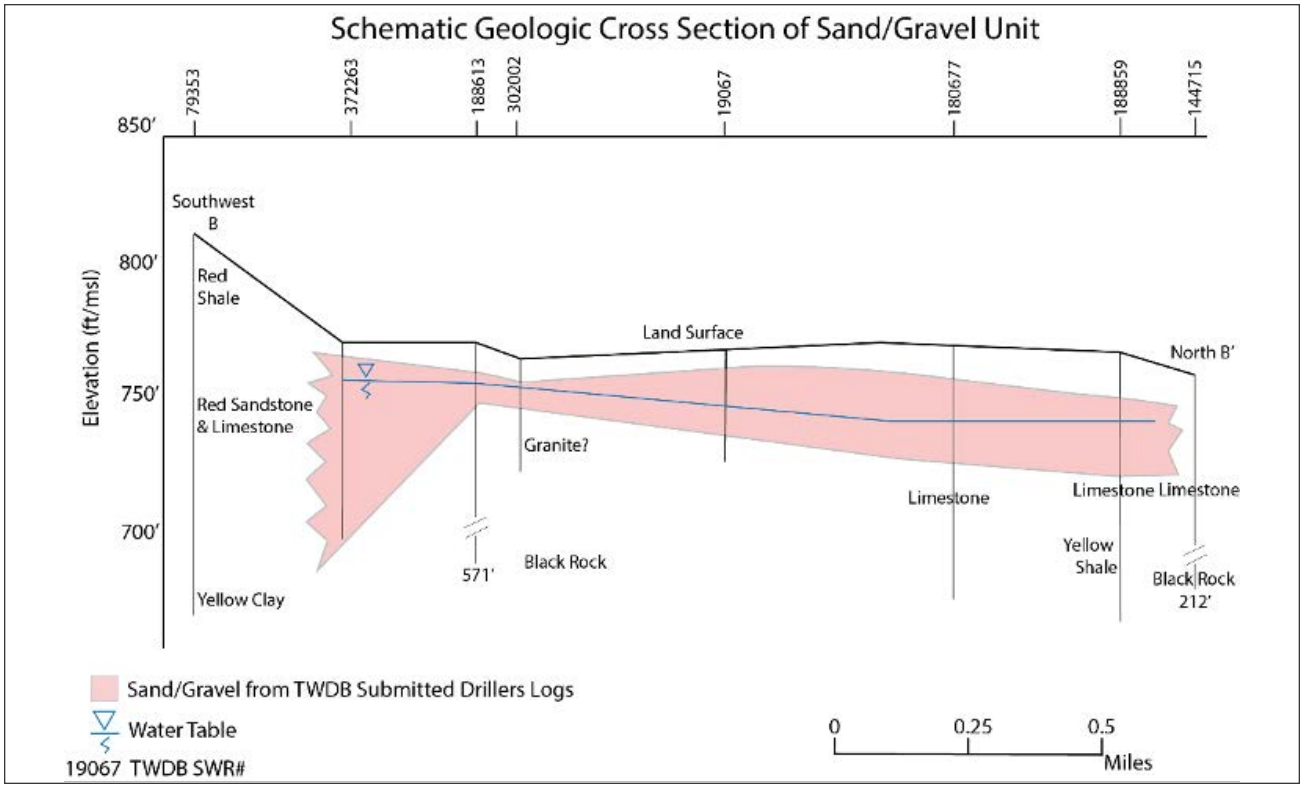


Figure 16. Schematic Geologic Cross Section of Sycamore Sand (Ksy) and gravel unit

Table 3. Inventory of TWDB Wells

SWR #	Latitude	Longitude	Elevation	TD	Plugged P/N	Depth to SA/GR	Elev Top S/G	Elev Bottom S/G	Thickness S/G	Yield	Screen Interval
19067	30 28 33	98 09 03	777	40	N	1	776	737	39	15	0-35
20180	30 28 21	98 08 55	790	270	P	1	789	720	69	0	P
24805	30 27 57	98 08 40	845	180	P	11	834	829	5	0	P
24086	30 27 59	98 08 47	850	205	N	9	841	832	9	2	80-205
79353	30 27 56	98 09 29	836	160	N	NP	NP	NP	NP	2	30-100
131486	30 26 33	98 09 20	1044	120	N	NP	NP	NP	NP	5	20-40
144715	30 28 44	98 08 37	752	480	P	NP	NP	NP	NP	0	P
144718	30 28 28	98 08 37	764	140	P	NP	NP	NP	NP	0	P
144753	30 28 35	98 08 34	781	140	P	NP	NP	NP	NP	0	P
168575	30 28 35	98 08 35	783	140	N	NP	NP	NP	NP	0.5	40-140
180663	30 28 42	98 09 01	778	90	P	1	777	739	38	0	P
180666	30 28 40	98 09 05	784	90	P	NP	NP	NP	NP	0	P
180668	30 28 42	98 09 06	777	105	P	NP	NP	NP	NP	0	P
180671	30 28 44	98 09 01	775	105	P	NP	NP	NP	NP	0	P
180677	30 28 41	98 09 00	774	105	N	9	765	736	29	30	27-38
180613	30 28 24	98 09 24	771	200	N	8	763	751	12	2	0-30
188859	30 28 42	98 08 42	767	105	N	15	752	733	19	75	22-41
283152	30 28 19	98 08 49	821	144	N	56	765	758	7	0.6	50-100
300215	30 27 56	98 08 50	855	155	N	NP	NP	NP	NP	3	75-135
372263	30 28 20	98 09 22	791	75	N	12	779	716	63	33	35-75
302002	30 28 05	98 09 34	789	50	N	20	769	754	15	7	15-50
534626	30.475556	-98.15675	781	45	N	25	756	741	15	5	25-45

P = plugged
N = not plugged
NP = not present

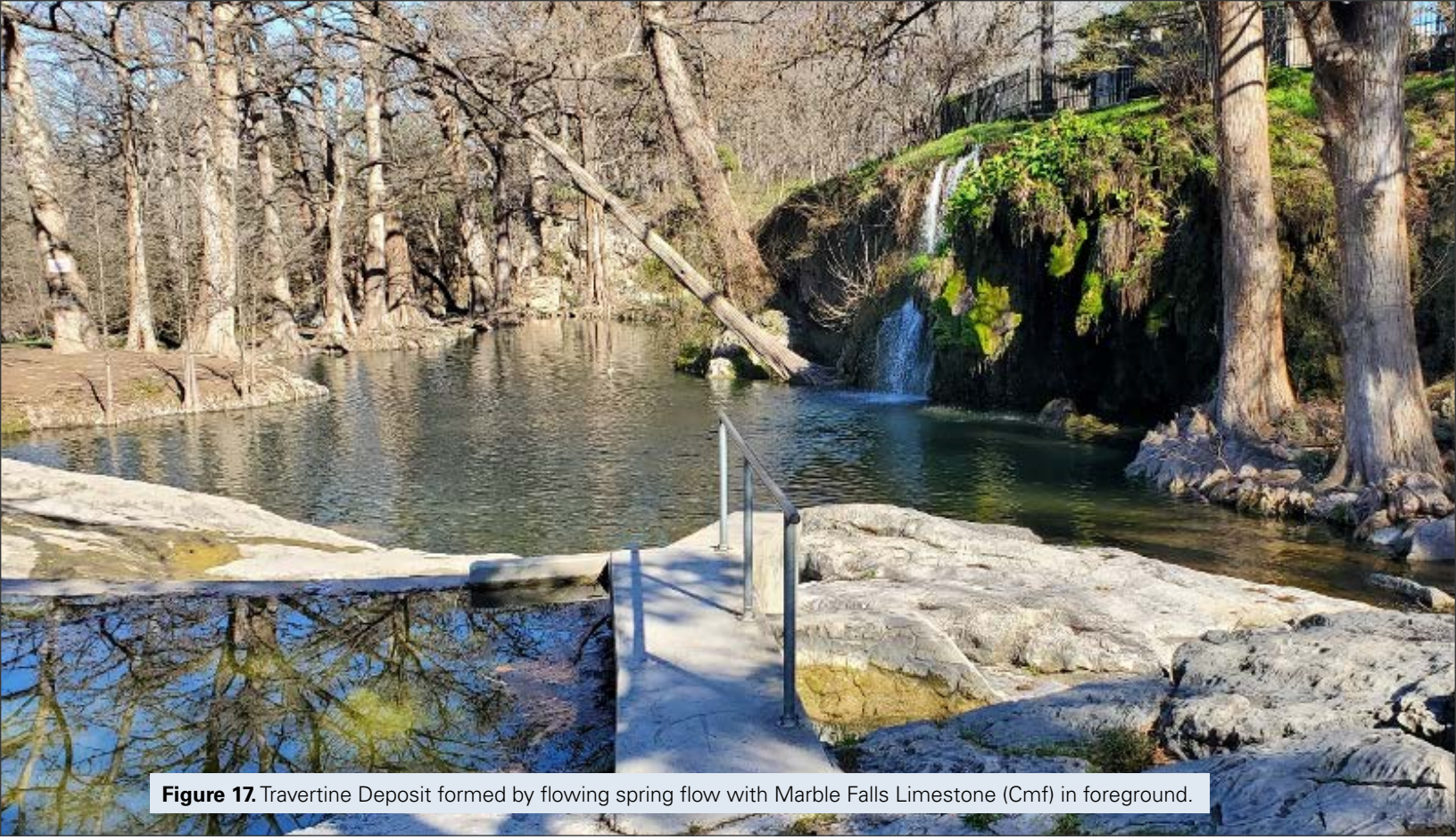


Figure 17. Travertine Deposit formed by flowing spring flow with Marble Falls Limestone (Cmf) in foreground.

The origin of the groundwater in the Sycamore Sand (Ksy) is the same as the "Basement sands" as described by Hill (1891). These Basement sands are undoubtedly of shallow-water or near shore origin and represent the ancient marginal deposits of the sea as it encroached upon the land. Everywhere next to the Paleozoic floor and conformable to its slope, this bed of sand, which seldom reaches 200 feet in thickness, persists as an apparent formation, blanketed between the underlying Paleozoic floor and overlying calcareous beds, and inclines towards the sea at a slightly greater angle than the latter (Hill, 1891).

In April of 2019, the CTGCD drilled two corings in the parking lot of the park above the springs (See Figure 8 for location). Coring #1 was converted to Monitoring Well #1 (SWR# 510663, Appendix B) and represented on Figure 12 Geologic Cross Section. The coring was advanced to a depth of 65 feet below ground surface (bgs). MW1 was instrumented with a screen bottom section between 15 and 25 feet bgs, solid riser the surface and a pressure transducer to record water levels installed in the well. A downhole geophysical log was run and contained in Appendix B. The core samples and geophysical log show the upper unit present is the Sycamore Sand (Ksy). The unit varies from a pebble conglomerate, to light brown sandy clay to a clean, fine quartz water bearing sand at 20 feet Figure 16?. The Sycamore (Ksy) extended to 29 feet bgs. Depth to water at the time of drilling was approximately 5 feet indicating the Sycamore (Ks) is saturated. Smithwick (Csw) (Figure 15) was cored from 29 feet bgs to 59 feet bgs. The coring penetrated 6 feet into the underlying Marble Falls (Cmf).

Coring #2 was advanced to 25 feet bgs and a downhole geophysical log run (Appendix B). The log indicates Sycamore sand (Ksy) was encountered from 0-20 feet bgs. The Smithwick (Csw) was encountered from 20 feet bgs to the terminus of the coring at 25 feet bgs.

The Smithwick (Csw) is a light brown clay, extending to 59 feet bgs (Figure 19) at MW 1. The Smithwick (Csw) is a shale unit that can act as an underlying perching layer for shallow groundwater. The Marble Falls Limestone (Cmf) was encountered at 59 feet bgs and extended to the terminus of the coring at 65 feet bgs. The Marble Falls (Cmf) is the surficial geologic unit just north of MW1 indicating there is likely a fault just north of MW1 as noted by Hunt et al. (2020).

Overlying the Sycamore Sand (Ksy) to the south of the park is the Hammett Shale (Kha). Based on driller's well logs, the unit is approximately 30 feet thick. The shale acts as an aquitard restricting the downward percolation of surface recharge to the Sycamore Sand (Ksy).

The Cow Creek Limestone (Kcc) of the Trinity Group is fine to medium grained, skeletal limestone and fine crystalline dolomite overlying the Hammett Shale (Kha). It is resistant to weathering and often forms steep cliffs in the region, although the Cow Creek is very thin in the study area. The Hensel sand (Kshh) overlies the Cow Creek (Kcc). It is commonly a sandy dolomite in this area of Central Texas with lesser amounts of silt and clay. Further to the south, the Hensel (Kshh) is overlain by the Glen Rose Limestone (Kshgr). The Glen Rose (Kshgr) has alternating layers of limestone, dolomite, marl and clay (Barnes, 1982).

There is a large cliff forming travertine deposit in the park created by the precipitation of carbonate minerals from solution of spring flow (Figures 17). Spring flow creates waterfalls above the main pool in the park.

Figure 18. Sycamore sand (Ksy) facies encountered at MW1 at 20' bgs. (photo: Paul Babb)

Figure 19. Core of the Smithwick Shale (Csw) at MW1. Photo from (Hunt et al, 2020)

WELL YIELDS

Well yields reported on driller's logs are generally noted during development of the well during construction. Yields are usually visually estimated by the driller so should be considered estimates. Figure 20 shows reported well yields from the Sycamore Sand (Lower Trinity). The wells with measured yields correlate very closely with wells that encountered sand and gravel. Wells that produce water are generally screened across the sand and gravel zone. Many of the wells that have been drilled in the area did not encounter sand/gravel, had no yield and were subsequently plugged. In several areas there are producing wells that encountered sand and gravel near wells that were drilled and plugged due to lack of production. This may be indicative of facies changes in the Sycamore Sand having poor porosity and permeability, or additional faulting, particularly in the vicinity of the park.

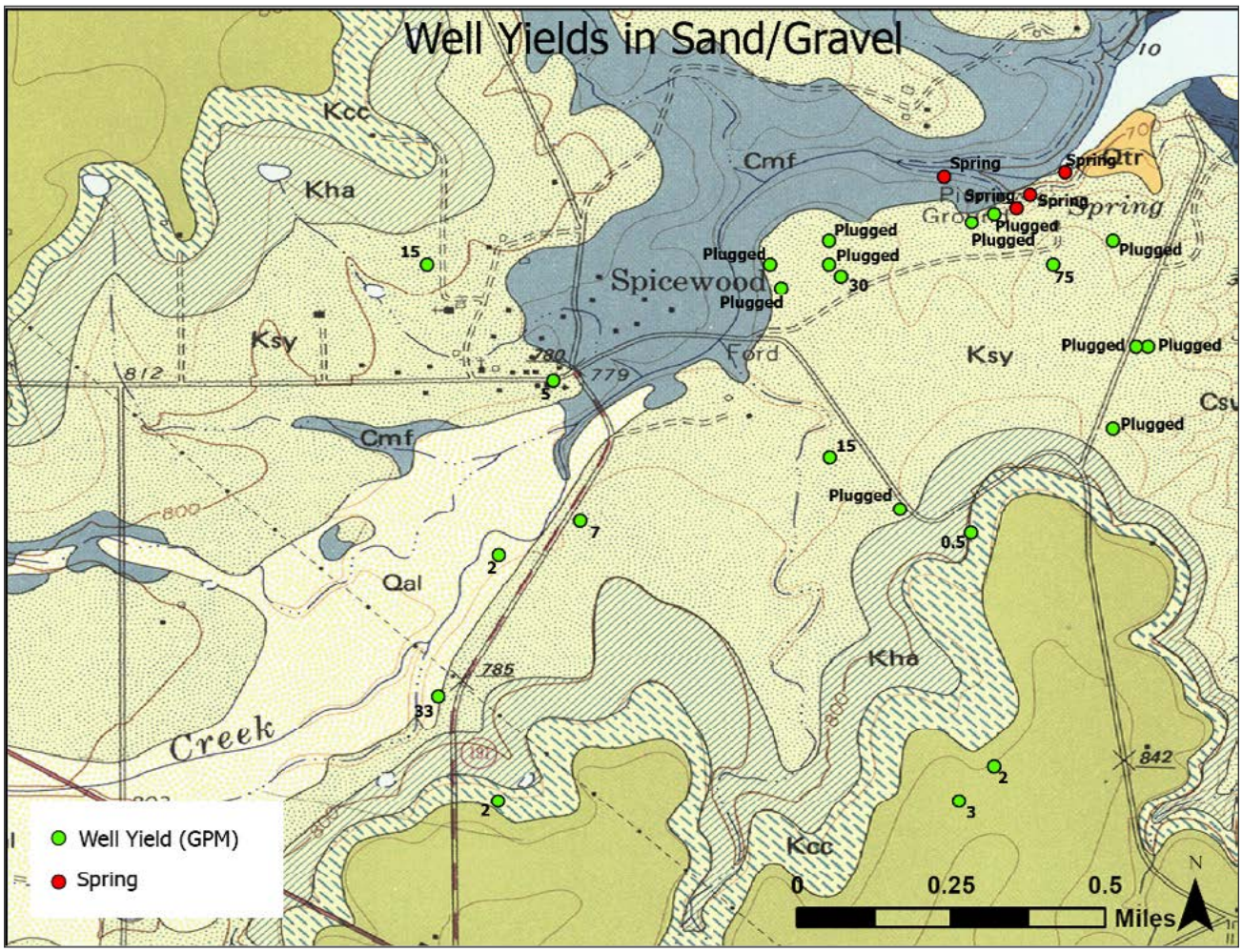


Figure 20. Well yields obtained from TWDB State Well Reports

GROUNDWATER RESOURCES

Groundwater Level Monitoring

Water levels were obtained on July 30 and December 3, 2020 from accessible wells with landowner permission. Approximately 15 wells were measured. The wells are shown on Figure 20 and the data tabulated on Table 5.

Water levels were consistent between the two monitoring events. Water level elevations measured in wells on the July event ranged from 743.6 feet msl near the park to 768.6 feet msl south of the park along TX Spur 191, and 737.2 feet msl to 769.7 ft-Mal during the December event. Shallow groundwater across the area of interest flows from south to north towards Little Cypress Creek and the discharging springs as shown on Figure 22. Water level elevations in the vicinity of the park were relatively low gradient, varying only by approximately one foot. Flat water levels are typical of high permeability deposits such as sand and gravel and also near major discharge locations, such as springs. The pressure transducer in MW1, installed in 2019, records water pressure/levels daily. The water level data from the transducer, Figure 23, shows little seasonal fluctuations with water levels generally varying by less than 1 foot. Water level elevations likely continue to drop near the park springs along the south bank of Little Cypress Creek.

Table 4. Water Quality Wells and Groundwater Elevations

Map #	CTGCD #	SWR #	Owner	Latitude	Longitude	Ground Surface Elevation	TD	MP	DTW 7/30/2020	Elevation 7/30/2020	DTW 12/3/2020	Elevation 12/3/2020
1	212	19067	Wall	30.473411	-98150870	777	40	NM	NM	NM	NM	NM
2	1993	168575	LCRA	30.476389	-98.143056	783	140	1.5	39.6	744.9	39.72	744.8
3	2113	180677	Krause	30.478055	-98.150001	774	105	1.5	31.15	744.35	30.6	745.0
4	2198	180613	Jeager	30.471841	-98.158571	771	200	4.9	15.35	760.55	15.55	760.35
5	2201	188859	Krause	30.478338	-98.145108	767	105	1.9	24.3	744.6	24.08	744.8
6	5555	283152	Parish	30.471949	-98.146934	821	144	1.78	63.2	759.58	74.6	748.2
7	6032	372263	Miller	30.472236	-98.156111	791	75	1	34.5	757.5	34.78	757.2
8	7177	510663	CTGCD	30.479458	-98.146369	744	25	0	7	737	6.77	737.2
9	NR	NR	Bible HD	30.478001	98.153254	756	NM	NM	NM	NM	NM	NM
10	NR	5739312	Krause	30.478634	-98.145278	764	NM	1.7	22.05	743.65	21.82	743.9
11	NR	NR	Wall HD	30.075106	-98.152661	767	NM	2.5	13.2	756.3	13.25	756.3
12	7397	534626	Arnold	30.475656	-98.156667	781	45	NM	NM	NM	NM	NM
13	7172	515469	Naumann	30.478422	-98.159733	NM	100	NM	NM	NM	NM	NM
14	NR	NR	Jeager	30.469497	-98.159267	783	80	1.3	15.7	768.6	16.06	768.2
15	3569	NR	Ashmore	30.486477	-98.159162	788	80	1.2	19.5	769.7	19.5	769.7

NR = Not Registered
NM = Not Measured
MP = Height of measuring point
TD = Total Depth

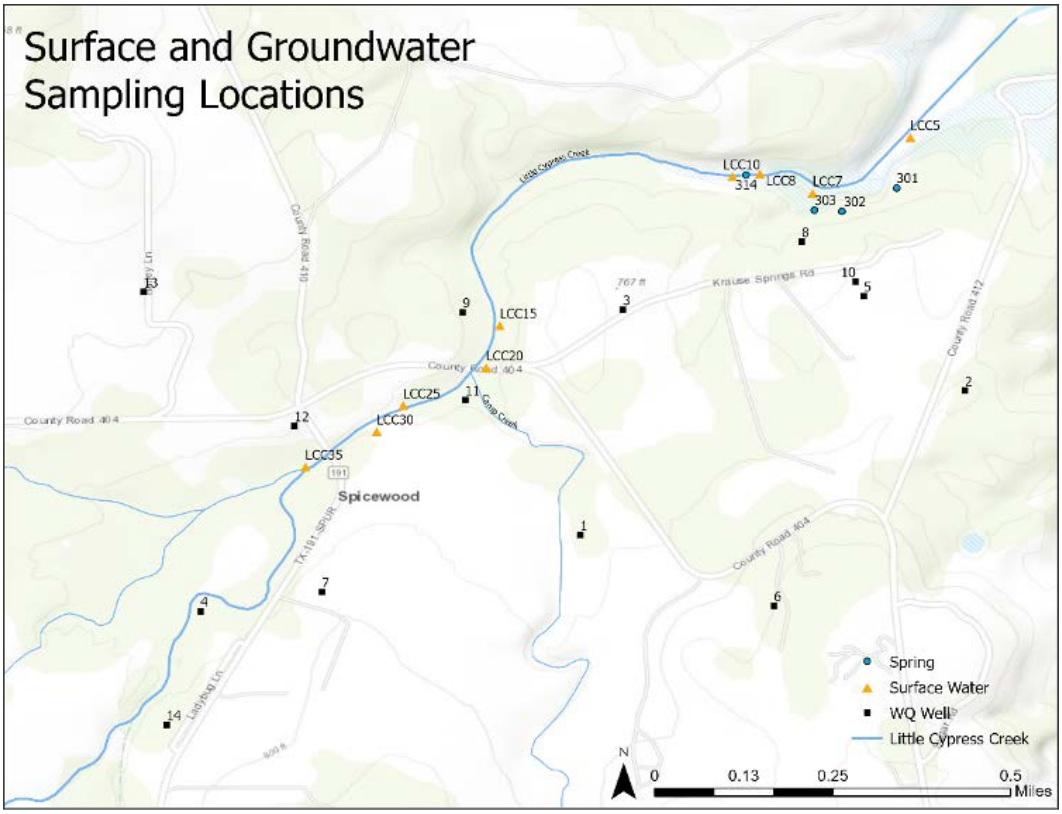


Figure 21. Surface and Groundwater Sampling Locations

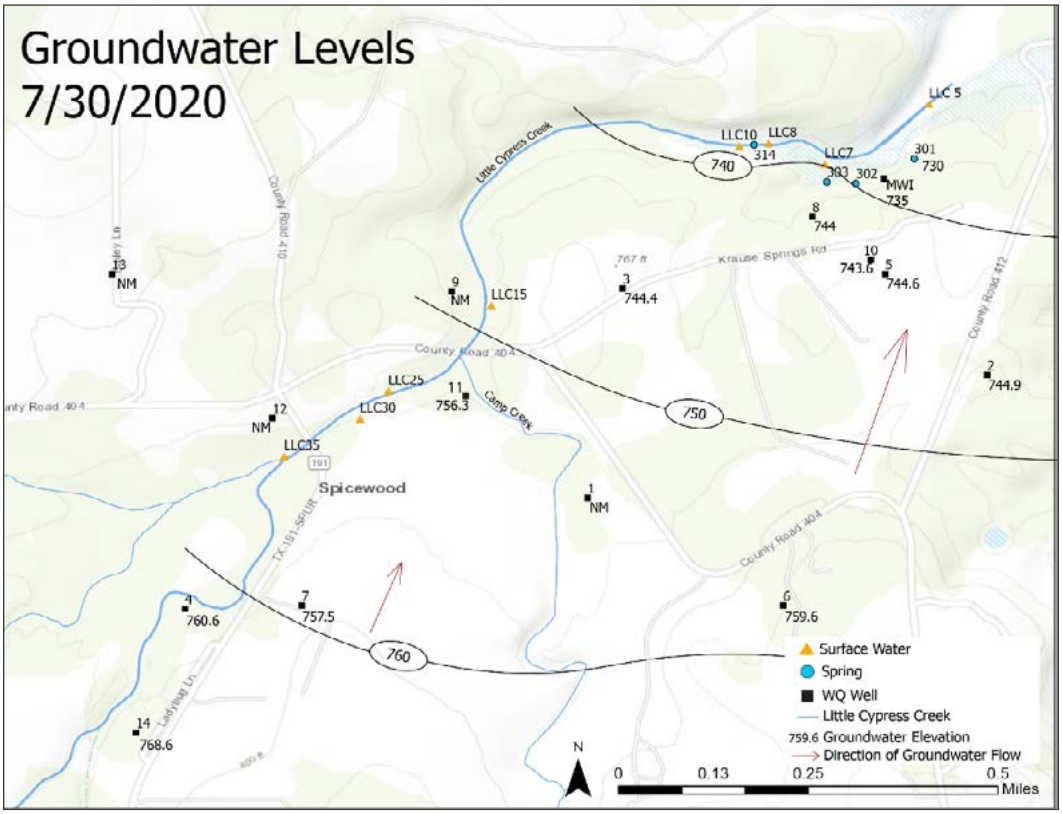


Figure 22. Potentiometric surface map

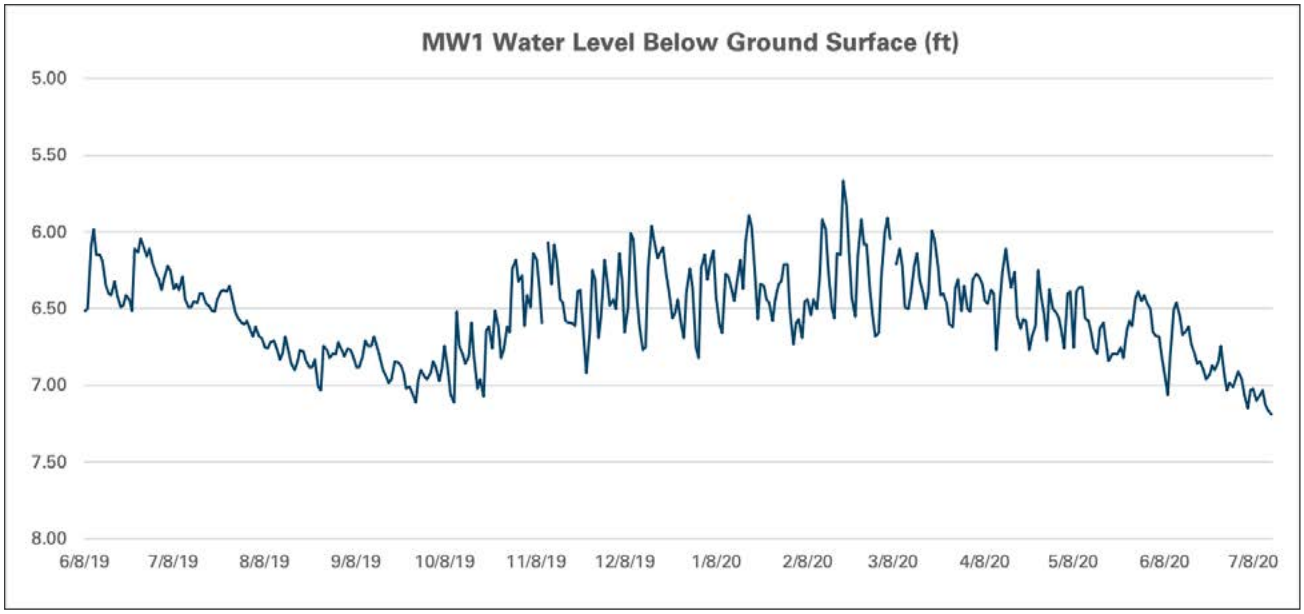


Figure 23. CTGCD MW1 transducer water level data

Surface Water/Groundwater Interactions

Previous literature indicated that the springs may originate from the Marble Falls Limestone (Cmf).

From Brune (1981): "One-kilometer northeast of Spicewood are the beautiful Krause Springs, the main source of Little Cypress Creek. Formerly known as Spicewood Springs, they served as a water supply for the settlement of Spicewood. The thousands of wild turkeys that once fed in this area gave their name to Turkey Bend of Lake Travis to the northeast. The springs issue at a relatively constant discharge (about 19 liters per second (lps) (0.67 cubic feet second (cfs) or 300 gallons per minute (gpm)) on August 3, 1975) from many openings in the Marble Falls limestone with deposits of travertine."

The springs of Krause Springs have consistent, year-round flow from openings in the Marble Falls limestone with deposits of travertine (Brune, 1981). The recharge area of Krause Springs is thought to be a few kilometers to the west of the springs, where the flowing water in Little Cypress Creek crosses crevices and faults in the Marble Falls limestone, eventually entering the ground through the underlying aquifer (Brune, 1981).

Also from LCRA (2008): "The main spring that feeds the swimming pool flows at 70 gpm [gallons per minute] at a constant temperature of 70 degrees. The springs have never gone dry, even during the severe drought of the 1950s. The springs issue from the Marble Falls Limestone (Cmf) into Little Cypress Creek. The creek has perennial flow from County Road 191 crossing near Spicewood to Lake Travis."

The most obvious expression of surface water/groundwater interactions are the many springs at the Krause Springs Park and its immediate vicinity. Springs flow from the hillside springs on the south bank of the creek creating waterfalls. The main springs (5739301, 5739302 and 5739303) in the park appear to originate from sand/gravel facies of the Sycamore Sand (Figure 10). At the Bradfield spring (5739314), flow originates from the base of a cliff of the Marble Falls (Cmf) at creek bed level just upstream of the park. (Figure 20) The Marble Falls (Cmf) in this area is highly fractured and likely faulted (Figure 8).

Figure 24. Bradfield Spring originating from base of a cliff of the Marble Falls Limestone (Cmf)

FLOW DISCHARGE MEASUREMENTS

Stream flow measurements were made on several occasions to determine which reaches of Little Cypress Creek are gaining water and which reaches may be losing water to the subsurface. By measuring stream flow above and below the springs, the amount of water discharged from the aquifer via springs can be quantified. These measurements may provide insight into the size of the recharge area for the springs.

Stream flow measurements were obtained on 3/5/2020, 3/26/2020, 7/30/2020 and 12/3/2020. Flow measuring locations are shown on Figure 21 and flow data contained in Table 5. There were some changes in gauging locations between events due to changing land access issues.

Table 5. Summary of Stream Discharge Monitoring - Little Cypress Creek

River Mile	Station ID	Station Name	3/5/2020 (GPM)	3/26/2020 (GPM)	7/30/2020 (GPM)	12/3/2020 (GPM)
1.5	LCC30	LCC below 191 bridge	NM	NM	20.2	40.4
1.44	LCC20	LCC at low water crossing on CR 404	85.3	190.7	NM	NM
1.27	LCC15	LCC @ Bible property	NM	NM	68.7	67.4
0.18	LCC10	Bradfield site creek channel + Bradfield spring (LCC10+303A)	170.5	264.8	NM	*
0.15	LCC8	Krause Springs property line at Bradfield Ranch	NM	NM	32.8	148.2
0.07	LCC7	Bridge site with five spillways at Krause Springs Park	251.3	327.6	44.4	139.3
0	LCC5	Little Cypress Creek downstream from Krause Springs Park	502.7	1552.8	204.0	368.2
	7177	Contribution to Little Cypress Creek From Krause Park Springs (LCC5-LCC7)	251.3	1225.2	159.5	228.9
	NR	Contribution to Little Cypress Creek From Bradfield and Krause Park Springs (LCC5-LCC15)			135.3	300.8
	CC1	Camp Creek Tributary			89.8	40.4

Notes:
Discharge Measurements expressed in gallons per minute
**Main Channel adjacent to Bradfield Spring was dry*
NM = No Measurement

No flow was observed from the upper reaches of Little Cypress Creek, from the headwaters south of Hwy 71 to near Sampling Location LCC 35 during any of the measurement events. This long reach of the creek is ephemeral, likely only flowing during significant precipitation events. The first flowing water encountered was just upstream of LCC 35 at the confluence of Little Cypress Creek and a small tributary joining from the north. The flow was too low to reliably measure in either channel on all occasions. Water likely originates from the alluvial deposits in the stream channels. The Marble Falls Limestone (Cmf) crops out approximately 100 yards downstream of the first occurrence of water in the main channel. Water originating from the outcrop was not observed.

Measurable flow (20-40 gpm) was encountered at LCC30 several hundred feet downstream of LCC35. The creek straddles the creek alluvium (Qal) /Sycamore Sand (Ksy) with the Marble Falls Limestone (Cmf). Flow was measured on two occasions at Camp Creek (CC1), a tributary of Little Cypress Creek that joins just south of CR 404 low water crossing. Consistent flow in Camp Creek originates approximately 100 yards upstream of CC1 where a large pool of water was observed. This was confirmed by the long-time landowner. The creek is ephemeral upstream (south) of the pool. The combined flow from Camp Creek and Little Cypress Creek is represented at LCC15 on 7/30/2020 and 12/3/2020 and at LCC20 on the two March measurement events. Flow was consistent between the July and December measurements at 67 to 69 gpm. Flow gains upstream of CR 404 likely originates in the confined Sycamore Sand (Ksy) /alluvium (Qal) which in places is likely transmitted through the Marble Fall Limestone (Cmf) to the creek.

On two occasions there was a loss of water along the reach from CR 404 to the western boundary of the park downstream of Bradfield spring (5738314). On two occasions there were gains. No flow was observed in the creek channel adjacent to the Bradfield spring on 12/3/2020, though the spring as measured approximately 100 yards downstream (LCC8) and was flowing at 148 gpm (Figure 27). Access was not available to the creek between LCC15 and LCC8 during the 12/3/2020 event to further investigate the total loss of stream flow. Discharge from the Bradfield spring as measured at LCC8 on 12/3 was 148 gpm versus the 68 gpm loss downstream of LCC15. The reach between LCC15 and LCC8 is mapped as Marble Falls limestone (Cmf). It is not clear if the lost water resurfaces at the spring. Additional gains via the spring may occur directly from the Marble Falls (Cmf) or in combination with the overlying Sycamore Sand (Ksy) contributing via fractures in the Marble Falls (Cmf). Water may migrate downward from the Sycamore (Ksy) through the Marble Falls (Cmf) and discharge at the base of the cliff.

Downstream of the park boundary, flow increases through the park as the hillside springs contribute significant flow to the creek. The increase is creek flow from upstream of the Krause Springs (LCC7) to downstream of the park (LCC5) ranged from 158.8 gpm to 1225.2 gpm (Table 5).

Based on this study, the typical discharge is 150 gpm to 300 gpm. The increase from spring flow represents the discharge from the basal sand/gravel unit of the Sycamore Sand (Ksy).

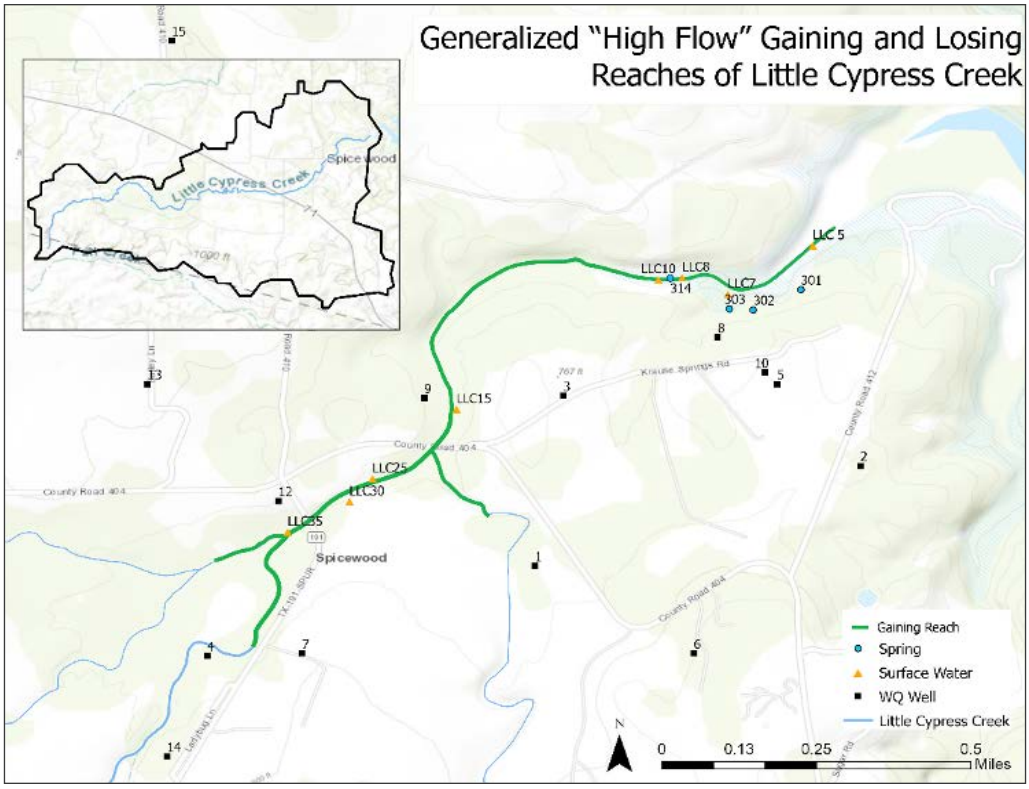


Figure 25. Generalized "High Flow" Gaining and Losing Reaches of Little Cypress Creek

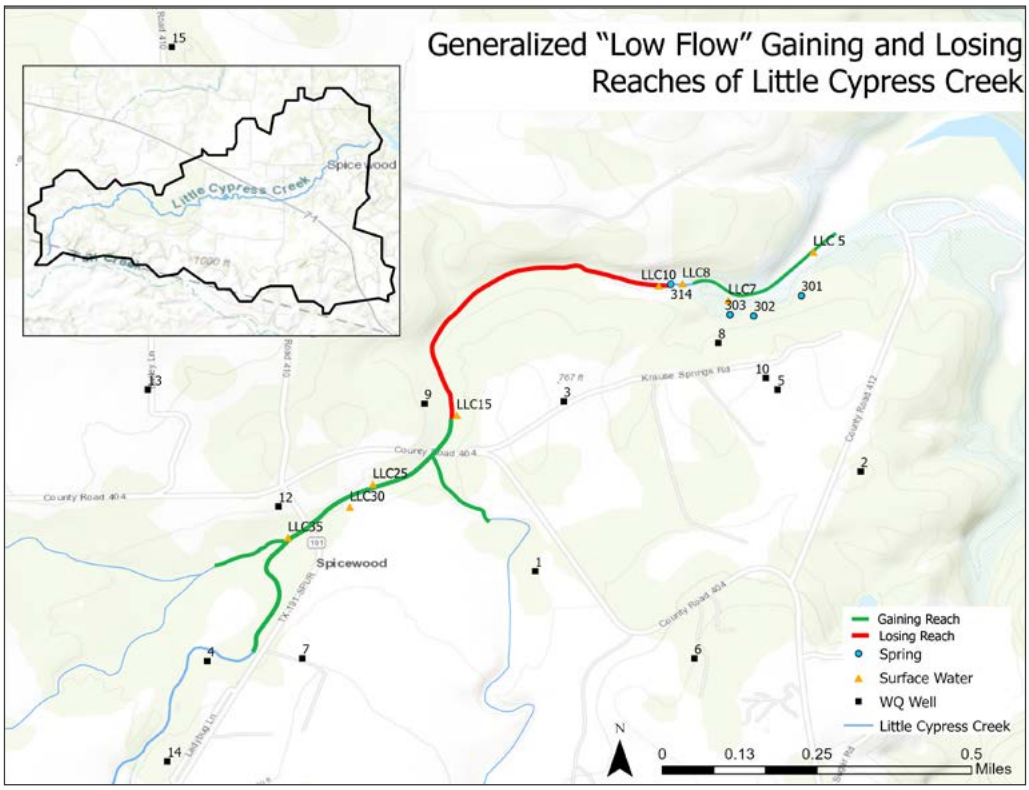


Figure 26. Generalized "Low Flow" Gaining and Losing Reaches of Little Cypress Creek

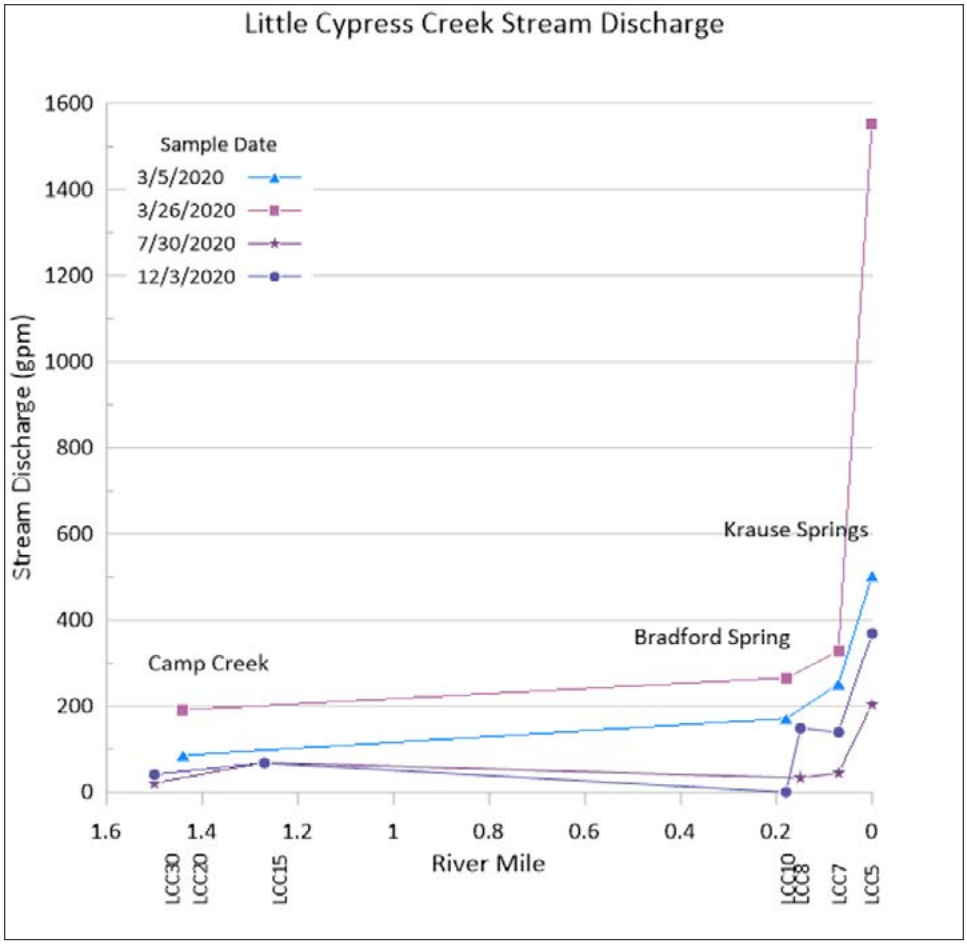


Figure 27. Streamflow Discharge Monitoring Results

Figure 28. Monitoring site LCC7

Figure 29. Little Cypress Creek near Bradfield Spring. Note main channel is dry with all flow originating from spring

Surface and Groundwater Quality

Waters of similar quality can be inferred as having the same source. Water quality samples were obtained from 12 surface/spring water and 8 groundwater samples on July 30, 2020. Field parameters of pH, specific conductivity, temperature and dissolved oxygen were obtained at the time of sampling. Common cation and anions were analyzed using US EPA Methods at the Edwards Aquifer Research Data Center (EARDC) at Texas State University (Appendix C). During 2017 and 2019, water quality samples were collected from several springs and wells as part of the TWDB routine sampling of water around the state. In addition to an extensive list of parameters analyzed, age dating isotope (Carbon-14 was analyzed to estimate the age of the water at several locations. Tritium was also analyzed at several locations. These isotopes can reflect a relative age of the groundwater, with younger water indicative of water that recharged the aquifer and has not had long residency time in aquifer. In addition, TWBD has collected a few well water samples in the area over time. These data were retrieved as part of this study. Water samples for analysis of liquid water stable isotopes of oxygen (δ18O) and hydrogen (δ2H) were run on several samples.

The results of the July 2020 surface water and groundwater sampling event are shown on Table 6.

Table 6. Water Quality Sampling Results

Site ID	1	3	5	6	7	8	9	10	11	12	14	15	301	302	303	314	CC1	LCC35	LCC30	LCC25	LCC15	LCC8	LCC7	LCC5	LCC8 Dup
Description	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Spring	Spring	Spring	Spring	Creek	Creek	Creek	Creek	Creek	Creek	Creek	Creek	Creek
Fluoride (mg/L)	3.4	3.3	3.2	3.1	2.6	3.8	3.7	3.6	2.8	3.7	2.5	3.9	3.6	3.3	0.3	0.4	2.7	2.7	3.4	3.4	3.5	3.3	2.9	2.7	4.0
Chloride (mg/L)	15.0	14.3	19.8	24.3	14.4	17.4	68.5	18.4	16.1	35.5	12.2	17.0	19.1	19.0	17.4	25.8	15.8	16.6	20.2	19.6	19.1	20.0	22.0	21.6	20.2
Nitrite (mg/L)	<1	<1	<1	<1	<1	<1	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.0	<1
Bromide (mg/L)	1.1	<1	<1	<1	<1	1.1	1.2	<1	<1	1.1	<1	1.1	<1	1.1	<1	<1	<1	<1	<1	<1	<1	1.1	1.1	1.1	1.1
Nitrate (mg/L)	3.9	3.4	3.0	3.8	3.6	1.5	16.5	2.8	3.9	16.1	3.5	2.5	1.9	2.5	<1	2.3	2.6	1.4	1.6	1.5	1.5	1.8	1.3	2.8	1.6
Phosphate (mg/L)	0.0	0.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Sulfate (mg/L)	16.5	17.2	16.4	21.6	17.6	14.6	44.5	16.3	16.5	31.5	14.7	18.4	16.3	17.6	17.4	18.5	16.4	17.7	18.3	17.3	16.1	14.3	15.9	17.1	14.3
Lithium (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium (mg/L)	10.9	12.5	8.9	32.9	11.2	30.8	36.1	10.4	12.8	30.7	9.5	12.8	9.5	11.6	11.1	20.3	12.7	14.9	18.0	18.1	16.4	17.4	17.6	13.9	17.2
Ammonium (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NM	NM	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium (mg/L)	<0.1	<0.1	<0.1	2.0	<0.1	1.6	19.2	<0.1	<0.1	0.6	<0.1	<0.1	<0.1	<0.1	<0.1	1.6	<0.1	0.1	0.1	0.1	0.3	0.2	0.3	0.1	0.2
Magnesium (mg/L)	26.8	24.4	28.9	31.7	23.3	26.5	32.4	27.8	25.6	26.3	22.1	35.8	29.9	27.7	31.7	27.6	24.4	24.8	25.9	26.1	26.6	26.8	26.9	28.3	26.5
Manganese (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<1	<1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium (mg/L)	90.9	91.9	82.0	57.1	91.0	77.9	123.5	83.3	93.1	102.3	94.4	96.6	84.4	87.3	90.3	90.4	90.6	88.4	88.6	88.5	90.2	87.4	80.6	75.9	86.1
Strontium (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Barium (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Total Alkalinity (as CaCO3) (mg/L)	320	322	298	288	880	406	316	332	338	318	320	302	324	376	343	321	318	318	312	330	338	330	326	298	324
Bicarbonate (calculated as HCO3)	390	393	364	351	1074	495	386	405	412	388	390	368	395	459	418	391	388	388	381	403	412	403	398	364	395
E. coli (MPN/100mL)																		26	43						
Temperature (°C)	22	22.3	21.8	22.3	NM	29.2	22	22.7	21.8	23	22.2	22.7	21.5	22.1	NM	NM	23.8	NM	25.2	25.4	26.1	23.7	25.4	25.8	NM
pH (su)	6.94	6.97	7.23	7.27	NM	6.79	7	7	6.99	7.6	7	7	6.98	7.09	NM	NM	7	NM	7.3	7.5	7.6	7.3	7.5	7.8	NM
DO (mg/L)		NM	NM	NM	NM	NM	NM	NM	NM	7.2	6.25	NM	NM	NM	NM	NM	5	NM	3.1	5	6.4	6.1	4.3	5.8	NM
Conductivity (µS/cm)	691	694	994	677	NM	1044	734	717	838	691	697	674	675	955	NM	NM	697	NM	722	724	736	714	697	667	NM
NM = Not Measured																									
Spring 303 sampled 6/27/2016																									
Spring 314 sampled 7/30/2019																									

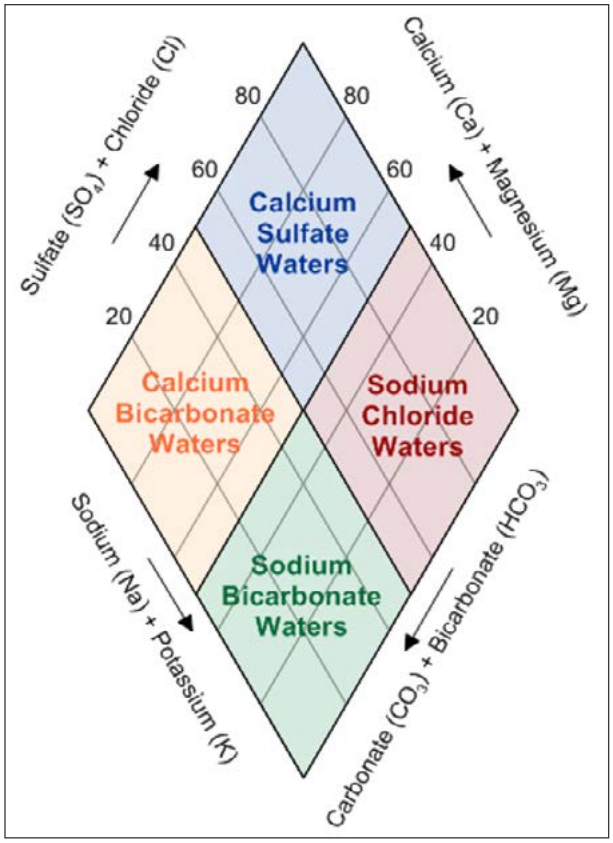


Figure 30. Sample Piper Plot

Piper plots (also known as trilinear diagrams) are used to visualize the abundance of common, natural ions in water. The plot comprises a ternary diagram showing cations (lower left), a ternary diagram representing anions (lower right) and a rhombic plot in middle.

Samples in the top quadrant are calcium sulfate waters, which are typical of gypsum ground water and mine drainage. Samples in the left quadrant are calcium bicarbonate waters, which are typical of shallow fresh ground water. Samples in the right quadrant are sodium chloride waters, which are typical of marine and deep ancient ground water. Samples in the bottom quadrant are sodium bicarbonate waters, which are typical of deep ground water influenced by ion exchange (Golden Software, 2020).

The water quality data obtained during the study in addition to the limited amount of previously collected TWDB well data were plotted on the Little Cypress Creek Piper Plot (Figure 30).

In general, cations and anions are very similar for all sampling points except for a few outliers at Wells 9 and 12, highlighted on Table 6. Chloride, nitrate, sulfate and sodium were elevated at Wells 9 and 12. Sodium was somewhat higher at wells 6 and 8. These wells are completed in the Marble Falls limestone (Cmf) whereas the other wells are completed, or screened through, the Sycamore (Ksy) indicating differing water quality between the two aquifers. Spring water quality is very similar to Sycamore Sand (Ksy) water quality. The Bradfield spring (5739314), which originates from the Marble Falls (Cmf), closely resembles the water quality of the other springs that originate out of the Sycamore (Ksy).

Carbon-14 dating, also called radiocarbon dating, is a method developed in the 1940s to determine the age of organic material. The half-life of Carbon-14 is 5730 years. Any sample containing a Carbon-14 fraction of 1 is very young water with Carbon-14 reflecting atmospheric level. All of the waters sampled indicated Carbon-14 fraction at one or slightly above one indicating the water is very young. The young age indicates the aquifer recharge area is near and there has been little residency time in the subsurface.

Tritium was detected in two springs (5739301 and 5739303), Table 7. Tritium is a naturally occurring radioactive isotope of hydrogen, which decays as a beta emitter. It is produced in small quantities in the upper atmosphere where it is incorporated into water molecules and, therefore, present in rainwater and surface recharge to aquifer systems. With a half-life of 12.3 years, tritium can be used to trace and date ground water. The amount of tritium in the atmosphere was greatly increased as a result of nuclear weapons testing causing recharge waters to be "tagged" with excess tritium beginning in about 1954. Given the short half-life of tritium, the presence of tritium indicates relatively young water. Samples collected indicate values between 1.48 TU and 1.81 TU, indicative of relatively young water. For comparison, 2017 sample of rainwater (TWDB Sample# 58-49-324) collected in southwest Austin indicated a tritium value of 2.65 TU.

Stable water isotopes follow the global meteoric water line indicating the samples reflect meteoric, or atmospheric, conditions. The global meteoric water line reflects the relationship between oxygen and hydrogen stable isotopes in natural meteoric (atmospheric) waters. Groundwater that reflects this relationship has been recently recharged by precipitation and not altered by rock water interaction or evaporation. This is also indicative of spring flow/ groundwater being of recent origin.

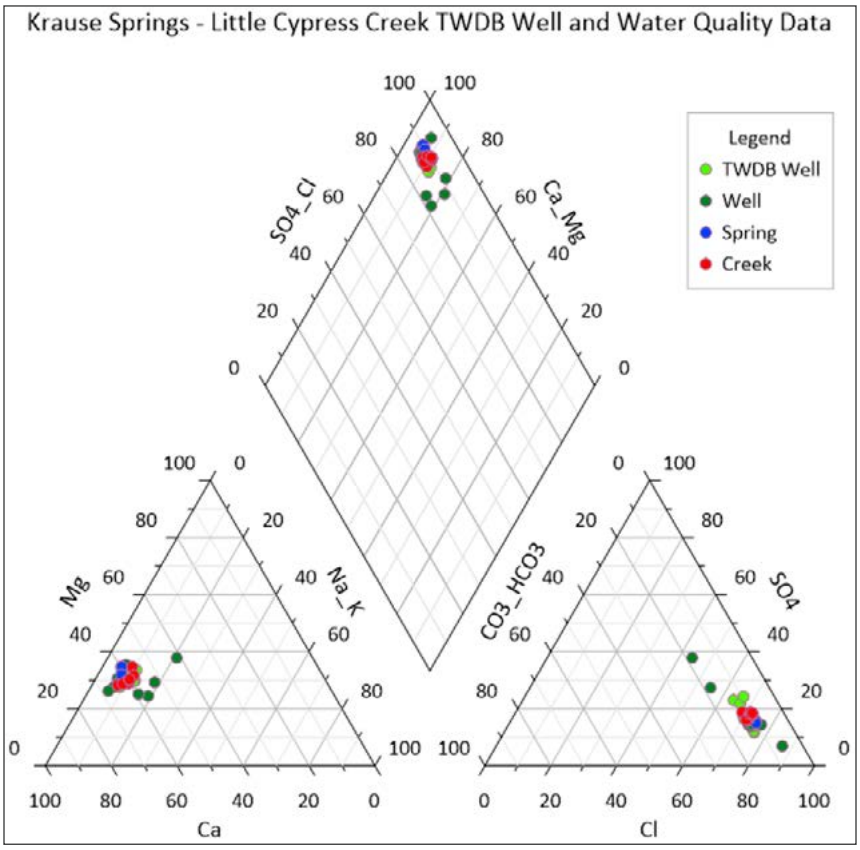


Figure 31. Piper Plot of July 2020 water quality data

Table 8. Carbon 14 and Tritium Sampling Results (* units - 0/00)

Sampling Location Dates	Carbon-14 Fraction Modern	Tritium in Water (Tritium Units)	Stable Isotope Oxygen* (δ18O)	Stable Isotope Hydrogen* (δ2H)
5739301 Upper Spring (6/26/2017)	1.028	1.48	-4.62	-26.3
5739303 Western Spring (6/26/2017)	1.039	1.81	-4.76	-27.3
5739314 Bradfield Spring (7/29/2019)	1.033	NM	-3.91	-24.28
5739312 Krause Feed Shed (7/29/2019)	1.024	NM	-4.36	-27.07
5739313 Krause Pasture (7/29/19)	1.028	1.89	-4.51	-26
5739313 Krause Pasture (7/29/2019)	1.028	NM	-4.2	-26.61
5739304 Krause House Well (7/29/2019)	1.025	NM	-4.02	-25.62
5739315 Ashmore (7/29/2019)	1.028	NM	-3.36	-22.3

WATER BUDGET

A preliminary water budget was performed to get an order of magnitude estimate the size of the recharge area to support the spring flow at Krause Springs Park. Assuming all recharge in the springshed discharges at the springs, a 200 gpm annual discharge rate (323 acre-feet) for the springs and recharge rate of 0.25 -1.17 inches per year (Chowdhury (2009), approximately 3300 to 15000 acres would be of sufficient size to provide the recharge. Recharge rate is the key variable in a simple water budget. The low recharge rates used in this example would be indicative of diffuse recharge which is precipitation that infiltrates the ground surface and percolates through the unsaturated zone to the saturated zone. Focused recharge is precipitation overland and reaches the saturated zone via a focused source such as a losing stream, swallet or fractures. Both diffuse and focused recharge typically occur in the Hill Country. In certain circumstances, focused recharge can be as high as total runoff. Developing a groundwater model could provide additional insight into actual recharge rates.

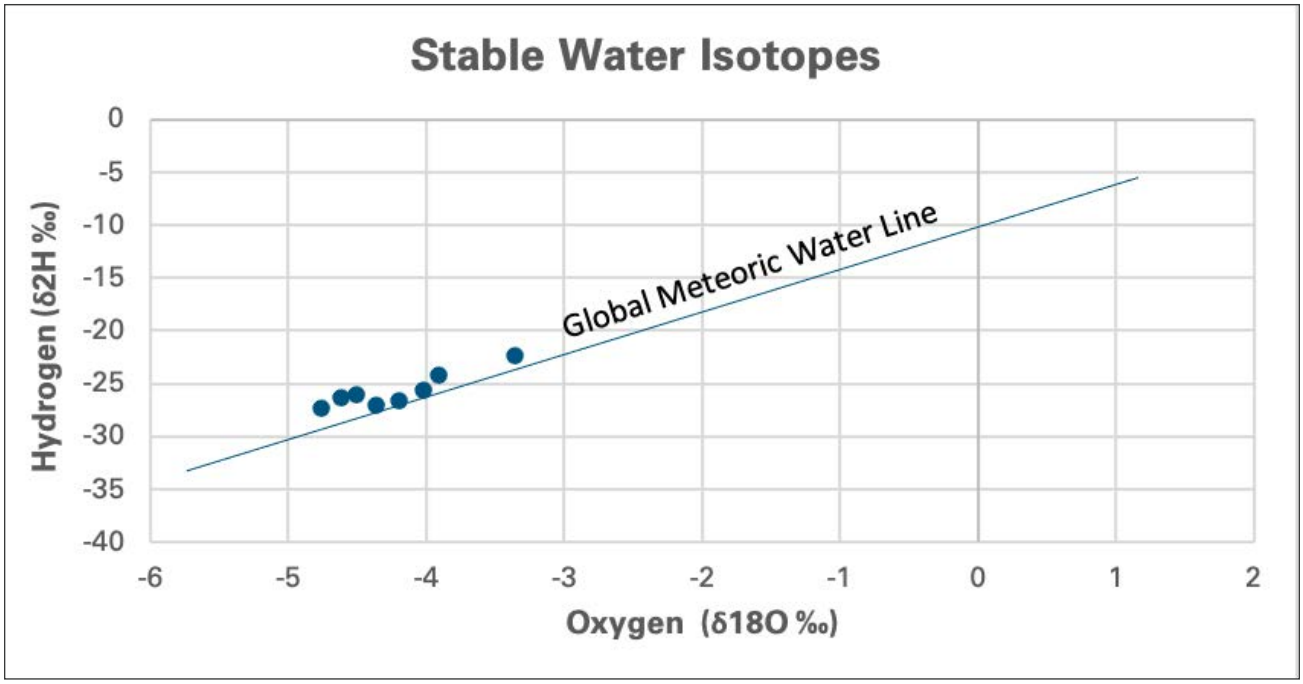


Figure 32. Stable Water Isotopes Preliminary Water Budget Analysis

© Jenna Walker - Meadows Center staff conducting water quality sampling at Krause Springs

DISCUSSION

Based on the data collected during this study, in addition to work previously performed by others, it appears the basal sands and gravels of the Sycamore Sand Formation (Ksy) provide the majority of the source water to the springs at Krause Springs and support base flow in Camp Creek. The Marble Falls Limestone (Cmf) may provide additional water or simply be a conduit from the Sycamore (Ksy) and alluvium (Qal). Alluvial deposits in Little Cypress Creek to the southwest of the park area may be hydraulically connected to the Sycamore Sand (Ksy). Due to land access issues, the source of stream losses and gains at and upstream of the Bradfield spring are not clear.

The results of a rock coring by the CTGCD indicate a clean, saturated sand unit at the base of the Sycamore (Ksy) near the springs. The Smithwick Shale (Csw) underlies the Sycamore (Ksy) at this location and acts as an impermeable layer retarding the downward movement of groundwater and likely influencing lateral flow.

Review of driller's logs from the Texas Water Development Board database show the presence of a sand/gravel unit beneath the park, though these data are sparse. There are many wells that did not encounter any water bearing formations and were plugged, helping the bracket the lateral extent of sand and gravel. Wells completed in the Marble Falls (Cmf) produce little or no water. Well yields from TWDB SWRs correlate with wells that encountered sand and gravel with higher yielding wells.

A low gradient potentiometric head surface in the vicinity of the park reflects the permeable nature of the Sycamore Sand (Ksy). Groundwater flow in the area of interest is from south to north towards the discharging springs.

Surface water, spring flow, and groundwater quality results show that surface water and groundwater from the Sycamore Sand (Ksy) are very similar, indicating the same source. Two wells completed in the Marble Fall Formation (Cmf) had a slightly different water quality signature than the Sycamore (Ksy) groundwater and spring flows. Carbon 14 isotopic age dating shows the springs and groundwater in the vicinity of the park to be very young. Stable water isotopes also indicate young water. Young water is indicative of a nearby recharge area and water that has not been in storage in the aquifer for long periods of time.

© Jenna Walker - Doug Wierman analyzing rocks

CONCLUSIONS

Based on the data collected during this study, in addition to work previously performed by others, it appears the basal sands and gravels of the Cretaceous Sycamore Sand Formation (Ksy) provide the majority of the source water to Krause Springs and support base flow in Camp Creek a tributary of Little Cypress Creek. The Sycamore Sand is also known as the Lower Trinity Aquifer. Accordingly, recharge to the Lower Trinity, and pumping within the springshed directly influences Krause Springs. The Sycamore Sand overlays the Pennsylvanian Marble Falls Limestone (Cmf), which may also provide additional water to the Lower Trinity and springs, or simply may act as a local conduit from the Sycamore (Ksy) and alluvium (Qal) to the creek. Alluvial deposits in Little Cypress Creek to the southwest of the park area may also be hydraulically connected to the Sycamore Sand (Ksy).

NEXT STEPS

This study provides critical data regarding the hydrogeology of Krause Springs and a portion of Little Cypress Creek and provides an initial conceptual model of the springshed. However, to fully characterize the system additional hydrogeologic studies could be performed on the broader watershed. Suggested next steps include: 1) Geologic characterization including geologic mapping, additional borings including cuttings and core, and geophysical logging coupled with the collection of cuttings in area wells. 2) Hydrogeologic characterization including: monitor wells (automated recorders) in various aquifer units, weather station(s), and surface flow gauges, surface geophysical surveys, targeted dye tracing along losing (recharge) reaches of the creek, additional synoptic water levels, and streamflow (gain-loss) data, and geochemistry.

Combined, these data should further delineate the source water or springshed area. Ultimately, all this information could culminate in the development of a conceptual and numerical groundwater flow model.

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APPENDIX A: LAND COVER DESCRIPTIONS

Class\ Value	Classification Description
Water	
	11Open Water- areas of open water, generally with less than 25% cover of vegetation or soil.
	12Perennial Ice/Snow- areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
Developed	
	21Developed, Open Space- areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
	22Developed, Low Intensity- areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
	23Developed, Medium Intensity -areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single family housing units.
	24Developed, High Intensity- highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% or more of the total cover.
Barren	
	31Barren Land (Rock/Sand/Clay) - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Forest	
	41Deciduous Forest- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
	42Evergreen Forest- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
	43Mixed Forest- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
Shrubland	
	51Dwarf Scrub- Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.
	52Shrub/Scrub- areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Herbaceous	
	71Grassland/Herbaceous- areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.
	72Sedge/Herbaceous- Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.
	73Lichens- Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.
	74Moss- Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.
Planted/Cultivated	
	81Pasture/Hay-areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
	82Cultivated Crops -areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Wetlands	
	90Woody Wetlands- areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
	95Emergent Herbaceous Wetlands- Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

APPENDIX B: STATE WELL REPORTS

STATE OF TEXAS WELL REPORT for Tracking #144753

Owner:	**Grelle Resource Area c/o LCRA**	Owner Well #:	**Grelle#5**
Address:	**Mail Stop L412; PO Box 220 Austin, TX 78767**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 35" N**
Well Location:	**Krause Springs Road Spicewood, TX 78669**	Longitude:	**098° 08' 34" W**
Well County:	**Burnet**	Elevation:	**802 ft. above sea level**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #120912**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **5/30/2008** Drilling End Date: **5/30/2008**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**9**	**0**	**140**

Drilling Method: **Air Hammer**

Borehole Completion: **Unknown**

Annular Seal Data: **No Data**

Seal Method: **Not Applicable**

Sealed By: **Unknown**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Unknown**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Plug Information:

Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
0-10 6 portland		
10-140 back fill cutting		

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Whisenant & Lyle Water Services Inc**

P.O. Box 525
Dripping Springs, TX 78620

Driller Name: **Martin D. Lingle Jr.** License Number: **54813**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**topsoil**
1	**2**	**caliche**
2	**3**	**red clay**
3	**5**	**clay**
5	**23**	**red clay red sandstone**
23	**27**	**brown limestone**
27	**32**	**void**
32	**55**	**white limestone hard**
55	**56**	**light gray limestone**
56	**62**	**light brown limestone**
62	**67**	**green/brown limestone**
67	**95**	**brown limestone**
95	**98**	**green/gray limestone**
98	**110**	**gray limestone**
110	**140**	**dark gray limestone**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
No Data			

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #168575

Owner:	**Grelle Resource Area c/o LCRA**	Owner Well #:	**Grelle#6**
Address:	**Mail Stop L412; PO Box 220 Austin, TX 78767**	Grid #:	**57-39-3**
Well Location:	**Krause Springs Road Spicewood, TX 78669**	Latitude:	**30° 28' 35" N**
		Longitude:	**098° 08' 35" W**
Well County:	**Burnet**	Elevation:	**759 ft. above sea level**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **5/30/2008** Drilling End Date: **1/30/2009**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**12.25**	**0**	**140**

Drilling Method: **Air Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
Filter Pack Intervals:	**38**	**140**	**Gravel**	

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**0**	**40**	**3bensl19portlnd**

Seal Method: **PRESSURE GROUT**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Water Level: **40 ft.** below land surface on **2008-07-01** Measurement Method: **Unknown**

Packers: **No Data**

Type of Pump: **Submersible** Pump Depth (ft.): **120**

Well Tests: **Pump** **Yield: LESS1/2 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
40-140	GOOD

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **WHISENANT & LYLE WATER SERVICES**

P.O. BOX 525
DRIPPING SPRINGS, TX 78620

Driller Name: **MARTIN D. LINGLE** License Number: **54813**

Apprentice Name: **GARY S. TUCKER** Apprentice Number: **58291**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	1	topsoil
1	30	red clay/red sandstone
30	38	brown limestone
38	50	white limestone hard
50	62	brown limestone
62	78	gray limestone
78	83	dark gray limestone
83	94	green limestone
94	140	gray limestone

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
4.5	N	PVC-SDR 17IB	+2'-40'
4.5	N	PVC-17 SLOTTED.085	40'-140'

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #180663

Owner:	**David Krause**	Owner Well #:	**No Data**
Address:	**2107 Whispering Dr. Round Rock, TX 78664**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 42" N**
Well Location:	**Krause Springs Spicewood, TX 78669**	Longitude:	**098° 09' 01" W**
Well County:	**Burnet**	Elevation:	**No Data**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #124282**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **5/13/2009** Drilling End Date: **5/13/2009**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6	**0**	**90**

Drilling Method: **Air Hammer**

Borehole Completion: **Plugged**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**15**	**1 cement**

Seal Method: **gravity cemented**

Sealed By: **Driller**

Distance to Property Line (ft.): **>100**

Distance to Septic Field or other concentrated contamination (ft.): **> 150**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **estimated**

Surface Completion: **Unknown**

Water Level: **No Data**

Packers: **none**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 0 GPM**

Plug Information:

Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
no casing 0 - 15 cement 1 sack		

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **L & L Drilling Co.**

P.O. Box 217
Hye, TX 78635

Driller Name: **Gregory A. Smith** License Number: **1595**

Apprentice Name: **Lynette Smith** Apprentice Number: **56980**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**black topsoil**
1	**39**	**gravel, sand & brown clay**
39	**54**	**yellow clay & brown limestone**
54	**90**	**brown limestone**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
no casing			

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #180666

Owner:	**David Krause**	Owner Well #:	**No Data**
Address:	**2107 Whispering Dr. Round Rock, TX 78664**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 40" N**
Well Location:	**Krause Springs Spicewood, TX 78669**	Longitude:	**098° 09' 05" W**
Well County:	**Burnet**	Elevation:	**No Data**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #124283**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **5/13/2009** Drilling End Date: **5/13/2009**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6	**0**	**90**

Drilling Method: **Air Hammer**

Borehole Completion: **Plugged**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**15**	**1 cement**

Seal Method: **gravity cemented**

Sealed By: **Driller**

Distance to Property Line (ft.): **>100**

Distance to Septic Field or other concentrated contamination (ft.): **> 150**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **estimated**

Surface Completion: **Unknown**

Water Level: **No Data**

Packers: **none**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 0 GPM**

Plug Information:

Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
no casing 0 - 15 cement 1 sack		

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **L & L Drilling Co.**

P.O. Box 217
Hye, TX 78635

Driller Name: **Gregory A. Smith** License Number: **1595**

Apprentice Name: **Lynette Smith** Apprentice Number: **56980**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**black topsoil**
1	**27**	**brown clay & white & yellow limestone**
27	**30**	**red clay & white limestone**
30	**44**	**gray limestone**
44	**45**	**red clay & gray limestone**
45	**90**	**gray limestone**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
no casing			

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STATE OF TEXAS WELL REPORT for Tracking #180668

Owner:	**David Krause**	Owner Well #:	**No Data**
Address:	**2107 Whispering Dr. Round Rock, TX 78664**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 42" N**
Well Location:	**Krause Springs Spicewood, TX 78669**	Longitude:	**098° 09' 06" W**
Well County:	**Burnet**	Elevation:	**No Data**
		Plugged Within 48 Hours	

This well has been plugged Plugging Report Tracking #124284

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **5/14/2009** Drilling End Date: **5/14/2009**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6	0	105

Drilling Method: **Air Hammer**

Borehole Completion: **Plugged**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	15	1 cement

Seal Method: **gravity cemented**

Sealed By: **Driller**

Distance to Property Line (ft.): **>100**

Distance to Septic Field or other concentrated contamination (ft.): **> 150**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **estimated**

Surface Completion: **Unknown**

Water Level: **No Data**

Packers: **none**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 0 GPM**

Plug Information:

Description (number of sacks & material)	Top Depth (ft.)	Bottom Depth (ft.)
no casing 0 - 15 cement 1 sack		

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **L & L Drilling Co.**

P.O. Box 217
Hye, TX 78635

Driller Name: **Gregory A. Smith** License Number: **1595**

Apprentice Name: **Lynette Smith** Apprentice Number: **56980**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**black topsoil**
1	**12**	**white limestone & yellow clay**
12	**16**	**yellow clay & white, yellow & red limestone**
16	**21**	**yellow clay & yellow limestone**
21	**30**	**red clay & yellow & white limestone**
30	**32**	**yellow clay & white limestone**
32	**37**	**gray limestone**
37	**39**	**red & yellow clay & white limestone**
39	**44**	**light brown limestone**
44	**46**	**gray clay**
46	**105**	**light brown & gray limestone**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
no casing			

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STATE OF TEXAS WELL REPORT for Tracking #180671

Owner:	**David Krause**	Owner Well #:	**No Data**
Address:	**2107 Whispering Dr. Round Rock, TX 78664**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 44" N**
Well Location:	**Krause Springs Spicewood, TX 78669**	Longitude:	**098° 09' 01" W**
Well County:	**Burnet**	Elevation:	**No Data**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #124285**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **5/14/2009** Drilling End Date: **5/14/2009**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6	**0**	**105**

Drilling Method: **Air Hammer**

Borehole Completion: **Plugged**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**15**	**1 cement**

Seal Method: **gravity cemented**

Sealed By: **Driller**

Distance to Property Line (ft.): **>100**

Distance to Septic Field or other concentrated contamination (ft.): **> 150**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **estimated**

Surface Completion: **Unknown**

Water Level: **No Data**

Packers: **none**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 0 GPM**

Plug Information:

Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
no casing 0 - 15 cement 1 sack		

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **L & L Drilling Co.**

P.O. Box 217
Hye, TX 78635

Driller Name: **Gregory A. Smith** License Number: **1595**

Apprentice Name: **Lynette Smith** Apprentice Number: **56980**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**black topsoil**
1	**11**	**red clay & white limestone**
11	**24**	**white & yellow limestone**
24	**26**	**yellow clay & white & yellow limestone**
26	**35**	**gray limestone**
35	**38**	**red clay & white limestone**
38	**45**	**gray limestone**
45	**53**	**gray limestone**
53	**105**	**brown limestone**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
no casing			

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STATE OF TEXAS WELL REPORT for Tracking #180677

Owner:	**David Krause**	Owner Well #:	**No Data**
Address:	**2107 Whispering Dr. Round Rock, TX 78664**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 41" N**
Well Location:	**Krause Springs Spicewood, TX 78669**	Longitude:	**098° 09' 00" W**
Well County:	**Burnet**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **5/14/2009** Drilling End Date: **5/15/2009**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
13	**0**	**30**
8.62	**30**	**43**
6	**43**	**105**

Drilling Method: **Air Hammer**

Borehole Completion: **Filter Packed; Straight Wall**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
10	**43**	**Gravel**	**#4 pea**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**20**	**4 cement**

Seal Method: **gravity cemented**

Sealed By: **Driller**

Distance to Property Line (ft.): **600**

Distance to Septic Field or other concentrated contamination (ft.): **1000**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **estimated**

Surface Completion: **Pitless Adapter Used**

Water Level: **28 ft.** below land surface on **2009-05-15** Measurement Method: **Unknown**

Packers: **none**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 30 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
27	500 TDS, 17 grains hardness

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **L & L Drilling Co.**

P.O. Box 217
Hye, TX 78635

Driller Name: **Gregory A. Smith** License Number: **1595**

Apprentice Name: **Lynette Smith** Apprentice Number: **56980**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	1	black topsoil
1	9	large gravel & brown clay
9	14	brown sand & gravel
14	33	brown clay & gravel
27	38	water 30 gpm
33	37	gray limestone
37	40	red clay
40	60	brown & gray limestone
60	61	black & dark gray limestone
61	105	light brown limestone

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
6	new	steel	solid 0 - 27 0.188
6	new	steel	slotted 27 - 38 0.188
6	new	steel	solid 38 - 43 0.188

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STATE OF TEXAS WELL REPORT for Tracking #188613

Owner:	**PERMELIA YEAGER**	Owner Well #:	**001**
Address:	**PO BOX 5 SPICEWOOD, TX 78669**	Grid #:	**57-39-3**
Well Location:	**800 SPUR 191 SPICEWOOD, TX 78669**	Latitude:	**30° 28' 24" N**
		Longitude:	**098° 09' 24" W**
Well County:	**Burnet**	Elevation:	**791 ft. above sea level**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **5/29/2009** Drilling End Date: **6/1/2009**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
10	**0**	**12**
6.75	**12**	**200**

Drilling Method: **Air Hammer**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**30**	**Gravel**	**3/8"**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**13 CEMENT**

Seal Method: **SLURRIED & POURED**

Sealed By: **CESAR RAMOS**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **500**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **STEEL TAPE**

Surface Completion: **Surface Sleeve Installed**

Water Level: **22 ft.** below land surface on **2009-06-02** Measurement Method: **Unknown**

Packers: **NEOPRENE 30**

Type of Pump: **Submersible** Pump Depth (ft.): **60**

Well Tests: **Jetted** **Yield: 2 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEE CAVE DRILLING INC**

185 ANGELFIRE DR
DRIPPING SPRINGS, TX 78620

Driller Name: **BOBBY ROBERTS** License Number: **54416**

Apprentice Name: **CESAR RAMOS** Apprentice Number: **57534**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**8**	**TOPSOIL**
8	**20**	**SAND W/B 2 GPM**
20	**150**	**GRANITE**
150	**200**	**BLACK ROCK**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.) New/Used Type Setting From/To (ft.)
6 NEW PLASTIC 0 - 10
6 NEW SCREEN MFG 10 - 30 .050

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STATE OF TEXAS WELL REPORT for Tracking #188859

Owner:	**Alton Krause**	Owner Well #:	**No Data**
Address:	**404 Krause Springs Spicewood, TX 78669**	Grid #:	**57-39-3**
Well Location:	**Krause Springs Spicewood, TX 78669**	Latitude:	**30° 28' 42" N**
		Longitude:	**098° 08' 42" W**
Well County:	**Burnet**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **7/16/2009** Drilling End Date: **7/17/2009**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
10.75	**0**	**34**
6.75	**34**	**105**

Drilling Method: **Air Hammer**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
12	**34**	**Gravel**	**pea**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**3 cement**

Seal Method: **gravity cemented**

Sealed By: **Driller**

Distance to Property Line (ft.): **>75**

Distance to Septic Field or other concentrated contamination (ft.): **300**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **estimated**

Surface Completion: **Surface Sleeve Installed**

Water Level: **22 ft.** below land surface on **2009-07-17** Measurement Method: **Unknown**

Packers: **none**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 75 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
22	400 TDS, 19 grains hardness

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **L & L Drilling Co.**

P.O. Box 217
Hye, TX 78635

Driller Name: **Gregory A. Smith** License Number: **1595**

Apprentice Name: **Lynette Smith** Apprentice Number: **56980**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	2	topsoil
2	15	brown clay
15	30	brown sand
22	34	water 75 gpm
30	34	brown gravel & sand
34	41	red, brown & yellow limestone
41	68	yellow shale & clay
68	105	oily gray shale

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
5	new	plastic	solid 0 - 22 0.265
5	new	plastic	slotted 22 - 41 0.265
5	new	plastic	solid 41 - 105 0.265

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STATE OF TEXAS WELL REPORT for Tracking #283152

Owner:	**Jerry Parish**	Owner Well #:	**No Data**
Address:	**143A 4th St.** **Hill AFB, UT 84056**	Grid #:	**57-39-3**
Well Location:	**CR 404** **Spicewood, TX 78669**	Latitude:	**30° 28' 19" N**
		Longitude:	**098° 08' 49" W**
Well County:	**Burnet**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **3/14/2012** Drilling End Date: **3/14/2012**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.62	**0**	**144**

Drilling Method: **Air Hammer**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
30	**144**	**Gravel**	**pea**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
1	**3**	**0.5 cement**
3	**30**	**3 bentonite**

Seal Method: **gravity grouted**

Sealed By: **Driller**

Distance to Property Line (ft.): **53**

Distance to Septic Field or other concentrated contamination (ft.): **115**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **estimated**

Surface Completion: **Pitless Adapter Used**

Water Level: **17 ft.** below land surface on **2012-03-14** Measurement Method: **Unknown**

Packers: **none**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 0.5-0.7 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **L & L Drilling Co.**

P.O. Box 217
Hye, TX 78635

Driller Name: **Gregory A. Smith** License Number: **1595**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**24**	**brown & white limestone**
24	**30**	**yellow clay**
30	**45**	**gray clay**
45	**56**	**red clay**
56	**63**	**brown gravel**
63	**70**	**brown limestone**
70	**76**	**brown clay & limestone**
76	**96**	**brown, red & yellow limestone**
96	**144**	**brown clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
5	**new**	**plastic**	**solid 0 - 50 0.265**
5	**new**	**plastic**	**slotted 50 - 100 0.265**
5	**new**	**plastic**	**solid 100 - 144 0.265**

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STATE OF TEXAS WELL REPORT for Tracking #300215

Owner:	**Rick Waldrop**	Owner Well #:	**1**
Address:	**P.O. Box 39 Spicewood, TX 78669**	Grid #:	**57-39-3**
		Latitude:	**30° 27' 56" N**
Well Location:	**8500 CR 404 Spicewood, TX 78669**	Longitude:	**098° 08' 50" W**
Well County:	**Burnet**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **4/9/2012** Drilling End Date: **4/9/2012**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8	**0**	**20**
6.5	**20**	**155**

Drilling Method: **Air Rotary**

Borehole Completion: **Straight Wall**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**20**	**4 of Portland**

Seal Method: **Slurry**

Sealed By: **Driller**

Distance to Property Line (ft.): **50+**

Distance to Septic Field or other concentrated contamination (ft.): **100+**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **Landowner**

Surface Completion: **Surface Sleeve Installed**

Water Level: **No Data**

Packers: **Burlap/Neoprene 75', 70', 20'**

Type of Pump: **No Data**

Well Tests: **Pump** **Yield: 3 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
81-135	**Trinity**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Apex Drilling, Inc.**

P.O. Box 867
Marble Falls, TX 78654

Driller Name: **Michael G. Becker** License Number: **54516**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**Topsoil**
1	**4**	**Tan Limestone**
4	**20**	**Red Sandstone**
20	**38**	**Tan Limestone**
38	**42**	**Gray Limestone**
42	**73**	**Gray Clay**
73	**81**	**Red Sandstone**
81	**135**	**Gravel **H2O**
135	**155**	**Tan Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.) New/Used Type Setting From/To (ft.)
4.5" (5" OD) New PVC +2' to 75' SDR17
4.5" (5" OD) New Slotted PVC 75' to 135' .035
4.5" (5" OD) New PVC 135' to 155 SDR17

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #302002

Owner:	**Todd Ashmore**	Owner Well #:	**2**
Address:	**P O Box 637 Spicewood, TX 78669**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 05" N**
Well Location:	**125 Spur 191 Spicewood, TX 78669**	Longitude:	**098° 09' 34" W**
Well County:	**Burnet**	Elevation:	**789 ft. above sea level**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **9/2/2012** Drilling End Date: **9/2/2012**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
10	**0**	**50**

Drilling Method: **Air Rotary**

Borehole Completion: **Filter Packed; Open Hole**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
15	**50**	**Gravel**	**3/8**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**15**	**4 cement**

Seal Method: **Unknown**

Sealed By: **Steve Stewart**

Variance Number: **no**

Distance to Property Line (ft.): **20**

Distance to Septic Field or other concentrated contamination (ft.): **300**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **measured**

Surface Completion: **Pitless Adapter Used**

Water Level: **15 ft.** below land surface on **2012-09-03** Measurement Method: **Unknown**

Packers: **none**

Type of Pump: **Submersible** Pump Depth (ft.): **40**

Well Tests: **Estimated** **Yield: 7 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
20 to 35	**fresh**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Bee Cave Drilling**

185 Angel Fire Dr
Dripping Springs, TX 78620

Driller Name: **Jim Blair** License Number: **54416**

Apprentice Name: **Steve Stewart** Apprentice Number: **11049501**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**4**	**Topsoil**
4	**18**	**Tan llimestone**
18	**20**	**White limestone**
20	**35**	**Gravel**
35	**50**	**Tan limestone**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.) New/Used Type Setting From/To (ft.)
4 1/2 New Plastic +1 to 20 sdr 17
4 1/2 New Plastic / perf 1/4" 20 to 50 sdr 17

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #131486

Owner:	**Lowell Turner**	Owner Well #:	**No Data**
Address:	**2809 Oak Ridge Dr Spicewood, TX 78669**	Grid #:	**57-39-3**
Well Location:	**8110 CR 404 Spicewood, TX 78669**	Latitude:	**30° 28' 33" N**
		Longitude:	**098° 09' 20" W**
Well County:	**Burnet**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **10/27/2007** Drilling End Date: **10/27/2007**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8	**0**	**20**
6	**20**	**120**

Drilling Method: **Air Rotary**

Borehole Completion: **Straight Wall**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**3 of Portland**

Seal Method: **Slurry**

Sealed By: **Driller**

Distance to Property Line (ft.): **50+**

Distance to Septic Field or other concentrated contamination (ft.): **100+**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **Landowner**

Surface Completion: **Surface Sleeve Installed**

Water Level: **No Data**

Packers: **Burlap/Neoprene 10'**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 5 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
10-50	**Ellenberger**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Apex Drilling, Inc**

PO Box 867
Marble Falls, TX 78669

Driller Name: **Michale G Becker, P.G.** License Number: **54516**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**2**	**Top Soil**
2	**10**	**Tan-Grey Limestone**
10	**12**	**Tan-Grey Limestone**
12	**75**	**Broken Limestone**
75	**120**	**Black Limestone**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.) New/Used Type Setting From/To (ft.)
4.5" (5" OD) New PVC +2' to 20' Sch40
4.5" (5" OD) New Slotted PVC 20' to 40' .035
4.5" (5" OD) New PVC 40' to 60' Sch40
4.5" (5" OD) New Slotted PVC 60' to 100' .035
4.5" (5" OD) New PVC 100' to 120' Sch40

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #144715

Owner:	**Grelle Resource Area c/o LCRA**	Owner Well #:	**Grelle#1**
Address:	**Mail Stop L412; PO Box 220 Austin, TX 78767**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 34" N**
Well Location:	**Krause Springs Road Spicewood, TX 78669**	Longitude:	**098° 08' 37" W**
Well County:	**Burnet**	Elevation:	**778 ft. above sea level**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #120906**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **4/21/2008** Drilling End Date: **4/21/2008**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8	**0**	**60**
6.75	**60**	**480**

Drilling Method: **Air Hammer; Air Rotary**

Borehole Completion: **Unknown**

Annular Seal Data: **No Data**

Seal Method: **Not Applicable**

Sealed By: **Unknown**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Unknown**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Whisenant & Lyle Water Services Inc**

P.O. Box 525
Dripping Springs, TX 78620

Driller Name: **Martin D. Lingle Jr.** License Number: **54813**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**2**	**topsoil**
2	**5**	**red brown limestone**
5	**6**	**caliche**
6	**7**	**red limestone**
7	**25**	**red caliche limestone**
25	**58**	**pink gray white limestone**
58	**65**	**dark brown limestone**
65	**90**	**light gray limestone**
90	**460**	**gray limestone**
460	**480**	**black rock**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
No Data			

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P.O. Box 12157
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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #144718

Owner:	**Grelle Resource Area c/o LCRA**	Owner Well #:	**Grelle#3**
Address:	**Mail Stop L412; PO Box 220 Austin, TX 78767**	Grid #:	**57-39-3**
Well Location:	**Krause Springs Road Spicewood, TX 78669**	Latitude:	**30° 28' 28" N**
		Longitude:	**098° 08' 37" W**
Well County:	**Burnet**	Elevation:	**742 ft. above sea level**
			****Plugged Within 48 Hours****
	****This well has been plugged****		**Plugging Report Tracking #120908**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **4/23/2008** Drilling End Date: **4/23/2008**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**6.75**	**0**	**140**

Drilling Method: **Air Rotary**

Borehole Completion: **Unknown**

Annular Seal Data: **No Data**

Seal Method: **Not Applicable**

Sealed By: **Unknown**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Unknown**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Whisenant & Lyle Water Services Inc**

P.O. Box 525
Dripping Springs, TX 78620

Driller Name: **Martin D. Lingle Jr.** License Number: **54813**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**2**	**topsoil**
2	**3**	**brown sandstone**
3	**10**	**red sandstone**
10	**90**	**brown sandstone**
90	**125**	**brown tan limestone**
125	**140**	**gray black limestone**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
No Data			

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Texas Department of Licensing and Regulation
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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #510663

Owner:	**Krause Springs**	Owner Well #:	**B-01MW**
Address:	**424 CR 404 Spicewood, TX 78669**	Grid #:	**57-39-3**
Well Location:	**424 CR 404 Spicewood, TX 78669**	Latitude:	**30° 28' 46.36" N**
		Longitude:	**098° 08' 47.08" W**
Well County:	**Burnet**	Elevation:	**744 ft. above sea level**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **4/15/2019** Drilling End Date: **4/15/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**6**	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Perforated or Slotted**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**2**	**Concrete 1 Bags/Sacks**
2	**15**	**Bentonite 2 Bags/Sacks**
15	**25**	**Sand 2 Bags/Sacks**
25	**65**	**Bentonite 8 Bags/Sacks**

Seal Method: **Hand Mixed**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **5.5 ft.** below land surface on **2019-04-15** Measurement Method: **Electric Line**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Holt Engineering**

2220 BARTON SKWY
Austin, TX 78704

Driller Name: **Will McGee** License Number: **59972**

Comments: **No Data**

Report Amended on 5/10/2019 by Request #27820

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**3**	**Dark Brown Clay**
3	**30**	**Tan and Light Brown Sandy Clay**
30	**58.5**	**Brown Clay**
58.5	**65**	**Gray Limestone**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Blank**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Perforated or Slotted**	**New Plastic (PVC)**	**40 0.010**	**15**	**25**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #515469

Owner:	**H.E. Nauman**	Owner Well #:	**No Data**
Address:	**P O Box 278 Spicewood, TX 78669**	Grid #:	**57-39-3**
Well Location:	**7685 CR 404 Spicewood, TX 78669**	Latitude:	**30° 28' 42" N**
		Longitude:	**098° 09' 35" W**
Well County:	**Burnet**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **5/17/2019** Drilling End Date: **5/17/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8	**0**	**20**
6.25	**20**	**100**

Drilling Method: **Air Rotary**

Borehole Completion: **Straight Wall**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**20**	**Portland 4 Bags/Sacks**

Seal Method: **Slurry**

Sealed By: **Driller**

Distance to Property Line (ft.): **50**

Distance to Septic Field or other concentrated contamination (ft.): **100**

Distance to Septic Tank (ft.): **50**

Method of Verification: **Land Owner**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **Burlap/Neoprene at 20 ft.**
Burlap/Neoprene at 30 ft.
Burlap/Neoprene at 55 ft.
Burlap/Neoprene at 60 ft.

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 15-20 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
61 - 88	**Marble Falls**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Apex Drilling, Inc.**

P.O. Box 867
Marble Falls, TX 78654

Driller Name: **Andrew Jackson Johnson** License Number: **54989**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**Top Soil**
1	**3**	**Red LS**
3	**30**	**Gravel**
30	**33**	**Gray LS**
33	**42**	**Red Clay**
42	**46**	**Gray LS**
46	**52**	**Tan Clay**
52	**61**	**Gray LS**
61	**72**	**Broken**
72	**100**	**Gray LS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
4.5	**Blank**	**New Plastic (PVC)**	**SDR17**	**2**	**60**
4.5	**Screen**	**New Plastic (PVC)**	**.035**	**60**	**100**

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #534626

Owner:	**Stanley Arnold**	Owner Well #:	**No Data**
Address:	**p.o. box 341442 Austin, TX 78734**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 32" N**
Well Location:	**8006 cr 404 spicewood, TX 78669**	Longitude:	**098° 09' 24.3" W**
Well County:	**Burnet**	Elevation:	**781 ft. above sea level**
Type of Work:	**New Well**	Proposed Use:	**commercial**

Drilling Start Date: **12/16/2019** Drilling End Date: **1/16/2020**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**10.625**	**0**	**45**

Drilling Method: **Air Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
Filter Pack Intervals:	**22**	**45**	**Gravel**	**3/8**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**0**	**22**	**Cement 12**

Seal Method: **Pressure**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Water Level: **22 ft.** below land surface on **2019-12-17** Measurement Method: **Electric Line**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 5 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Bee Cave Drilling, Inc.**

185 Angel Fire Dr.
Dripping Springs, TX 78620

Driller Name: **jim blair** License Number: **54416**

Comments: **CTGCD #7397**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**topsoil**
1	**5**	**brown gravel**
5	**20**	**white limestone**
20	**22**	**tan limestone**
22	**25**	**brown limestone**
25	**30**	**red gravel**
30	**40**	**red gravel/clay**
40	**45**	**granite**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
4.5	**Blank**	**New Plastic (PVC)**	**sdr-17**	**0**	**25**
4.5	**Perforated or Slotted**	**New Plastic (PVC)**	**sdr-17**	**25**	**45**

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #19067

Owner:	**LINDA WALL**	Owner Well #:	**001**
Address:	**PO BOX 127** **SPICEWOOD, TX 78669**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 23" N**
Well Location:	**CR 404** **SPICEWOOD, TX 78669**	Longitude:	**098° 09' 03" W**
Well County:	**Burnet**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **3/19/2003** Drilling End Date: **3/19/2003**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
10	**0**	**40**

Drilling Method: **Air Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
10	**35**	**Gravel**	

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**12**

Seal Method: **SLURRIED & POURED**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **NOT YET INSTALLED**

Surface Completion: **Surface Sleeve Installed**

Water Level: **0 ft.** below land surface on **2003-03-19** Measurement Method: **Unknown**

Packers: **NONE**

Type of Pump: **DID NOT SET** Pump Depth (ft.): **0**

Well Tests: **Jetted** **Yield: 15 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEE CAVE DRILLING, INC.**

185 ANGELFIRE DR.
DRIPPING SPRINGS, TX 78620

Driller Name: **BOBBY ROBERTS** License Number: **54416**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**TOPSOIL**
1	**40**	**GRAVEL W/B 15 GPM**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
4.5	**NEW**	**PLASTIC**	**0 - 35**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #20180

Owner:	**LINDA WALL**	Owner Well #:	**003**
Address:	**PO BOX 127 SPICEWOOD, TX 78669**	Grid #:	**57-39-3**
		Latitude:	**30° 28' 21" N**
Well Location:	**CR 404 SPICEWOOD, TX 78669**	Longitude:	**098° 08' 55" W**
Well County:	**Burnet**	Elevation:	**852 ft. above sea level**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #107557**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **3/19/2003** Drilling End Date: **3/19/2003**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
10	**0**	**30**
8	**30**	**270**

Drilling Method: **Air Rotary**

Borehole Completion: **Unknown**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**5**	**8**

Seal Method: **SLURRIED & POURED**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **NOT YET INSTALLED**

Surface Completion: **Unknown**

Water Level: **No Data**

Packers: **NONE**

Type of Pump: **No Data**

Well Tests: **Unknown** **Yield: 0 GPM**

Plug Information:

Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
NONE 0 5 CEMENT 8		

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEE CAVE DRILLING, INC.**

185 ANGELFIRE DR.
DRIPPING SPRINGS, TX 78620

Driller Name: **BOBBY ROBERTS** License Number: **54416**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**TOPSOIL**
1	**30**	**RED SAND & GRAVEL**
30	**70**	**GRAVEL**
70	**230**	**TAN ROCK**
230	**270**	**BLUE CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
NONE			

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #24805

Owner:	**HAROLD A. HUDSON, JR.**	Owner Well #:	**1**
Address:	**31439 HIGH RIDGE DR. BULVERDE, TX 78163**	Grid #:	**57-39-3**
		Latitude:	**30° 27' 57" N**
Well Location:	**BURNET COUNTY ROAD 404 MARBLE FALLS, TX 78654**	Longitude:	**098° 08' 40" W**
Well County:	**Burnet**	Elevation:	**No Data**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #108084**

Type of Work: **New Well** Proposed Use: **Domestic**

Drilling Start Date: **8/12/2003** Drilling End Date: **8/12/2003**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.62	**0**	**180**

Drilling Method: **Air Hammer**

Borehole Completion: **Plugged**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**20**	**3**

Seal Method: **GRAVITY CEMENTED**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **200**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **ESTIMATED**

Surface Completion: **Unknown**

Water Level: **No Data**

Packers: **NONE**

Type of Pump: **No Data**

Well Tests: **Jetted** **Yield: 0 GPM**

Plug Information:

Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
NONE 0 20 CEMENT 3		

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **L & L DRILLING CO.**

DRAWER 217
HYE, TX 78635

Driller Name: **GREGORY A. SMITH**

License Number: **1595**

Apprentice Name: **LYNETTE SMITH**

Apprentice Number: **WWDAPP00001264**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

From (ft)	To (ft)	Description
0	**1**	**BROWN TOPSOIL**
1	**4**	**YELLOW & WHITE CALICHE**
4	**11**	**RED SHALE**
11	**16**	**BROWN SAND**
16	**19**	**WHITE LIMESTONE & BROWN SAND**
19	**31**	**GRAY LIMESTONE & SHALE**
31	**68**	**GRAY CLAY & SHALE**
68	**75**	**RED CLAY**
75	**96**	**WHITE, RED & YELLOW GRAVEL**
96	**102**	**YELLOW SHALE & WHITE & YELLOW SAND**
102	**127**	**WHITE LIMESTONE WITH RED CLAY STREAKS**
127	**130**	**WHITE & RED LIMESTONE WITH YELLOW**
		SHALE STREAKS
130	**139**	**WHITE, BROWN & RED LIMESTONE**
139	**180**	**YELLOW & BROWN SHALE**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
NONE			

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #24806

Owner:	**HAROLD A. HUDSON, JR.**	Owner Well #:	**2**
Address:	**31439 HIGH RIDGE DR. BULVERDE, TX 78163**	Grid #:	**57-39-3**
		Latitude:	**30° 27' 59" N**
Well Location:	**BURNET COUNTY ROAD 404 MARBLE FALLS, TX 78654**	Longitude:	**098° 08' 47" W**
Well County:	**Burnet**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Domestic**

Drilling Start Date: **8/12/2003** Drilling End Date: **8/12/2003**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
9.75	**0**	**205**

Drilling Method: **Air Hammer**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
20	**205**	**Gravel**	

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**20**	**2**

Seal Method: **GRAVITY CEMENTED**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **300**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **ESTIMATED**

Surface Completion: **Surface Sleeve Installed**

Water Level: **76 ft.** below land surface on **2003-08-12** Measurement Method: **Unknown**

Packers: **NONE**

Type of Pump: **No Data**

Well Tests: **Estimated** **Yield: 2 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
118, 136	No Data

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **L & L DRILLING CO.**

DRAWER 217
HYE, TX 78635

Driller Name: **GREGORY A. SMITH**

License Number: **1595**

Apprentice Name: **LYNETTE SMITH**

Apprentice Number: **WWDAPP00001264**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

From (ft)	To (ft)	Description
0	2	BROWN TOPSOIL
2	9	WHITE CALICHE
9	18	RED CLAY WITH BROWN SAND LAYERS
18	38	GRAY & WHITE LIMESTONE
38	71	GRAY CLAY & SHALE
71	78	RED CLAY
78	115	WHITE & BROWN GRAVEL WITH RED CLAY
115	137	WHITE, BROWN, & RED LIMESTONE WITH RED SHALE STREAKS
137	181	YELLOW SHALE
181	205	GRAY OILY SHALE
118	120	WATER 1 GPM
136	137	WATER 1 GPM

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
6	NEW	PLASTIC	SOLID +2 80 .280
6	NEW	PLASTIC	SLOTTED 80 205 .280

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #79353

Owner:	**Opie's Barbcue**	Owner Well #:	**2**
Address:	**PO Box 637** **Spicewood, TX 78669**	Grid #:	**57-39-3**
		Latitude:	**30° 27' 56" N**
Well Location:	**125 Spur 191** **Spicewood, TX 78669**	Longitude:	**098° 09' 29" W**
Well County:	**Burnet**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Public Supply**

Drilling Start Date: **4/5/2005** Drilling End Date: **4/6/2005** **Plans Approved by TCEQ - NO**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**9**	**0**	**160**

Drilling Method: **Air Rotary**

Borehole Completion: **Straight Wall**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**0**	**30**	**10 sx portland**

Seal Method: **Tremmie pipe**

Sealed By: **MWS**

Distance to Property Line (ft.): **150+**

Distance to Septic Field or other concentrated contamination (ft.): **150+**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **measured**

Surface Completion: **Surface Slab Installed**

Water Level: **30 ft.** below land surface on **2005-04-14** Measurement Method: **Unknown**

Packers: **neoprene @ 30'**

Type of Pump: **Submersible** Pump Depth (ft.): **100**

Well Tests: **Estimated** **Yield: 1-2 GPM**

Water Quality:

Strata Depth (ft.)	Water Type
30-100	**fresh**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Motal Well Service**

3315 Galseburg Dr
Austin, TX 78745

Driller Name: **Paul Motal** License Number: **54313**

Comments: **TWDB SW #57-39-310**
9/30/2010 Doc Jones

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**Red shale and clay**
30	**100**	**Red limestone and sandstone**
100	**160**	**Yellow clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia. (in.)	New/Used	Type	Setting From/To (ft.)
4 1/2	**N**	**PVC**	**0-30**
4 1/2	**N**	**slotted PVC**	**30-100 0.125**

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APPENDIX C: WATER QUALITY DATA

Piper Plot Data

Ca	Na+K	Mg	Cl	SO4	HCO3+CO3	Site ID	Description	Date
62.87	6.60	30.55	5.90	4.80	89.30	1	Well	7/30/20
64.25	7.64	28.12	5.62	4.97	89.41	3	Well	7/30/20
59.69	5.68	34.65	8.16	4.97	86.87	5	Well	7/30/20
41.03	20.81	37.61	9.96	6.53	83.51	6	Well	7/30/20
65.35	7.05	27.62	2.20	2.00	95.80	7	Well	7/30/20
52.22	18.54	29.25	5.49	3.41	91.10	8	Well	7/30/20
56.59	18.93	24.48	21.06	10.10	68.85	9	Well	7/30/20
60.24	6.60	33.18	6.93	4.53	88.54	10	Well	7/30/20
63.57	7.62	28.82	6.01	4.56	89.44	11	Well	7/30/20
59.22	15.67	25.12	12.51	8.17	79.32	12	Well	7/30/20
67.83	5.99	26.20	4.89	4.35	90.76	14	Well	7/30/20
57.92	6.69	35.41	6.96	5.55	87.49	15	Well	7/30/20
59.45	5.85	34.72	7.31	4.62	88.08	301	Spring	7/30/20
60.98	7.09	31.95	6.36	4.36	89.28	302	Spring	7/30/20
63.88	7.83	28.31	6.25	4.79	88.96	CC1	Creek	7/30/20
60.70	9.74	29.56	7.07	4.39	88.54	LCC15	Creek	7/30/20
60.10	10.74	29.16	7.35	4.80	87.85	LCC25	Creek	7/30/20
60.26	10.72	29.02	7.93	5.29	86.78	LCC30	Creek	7/30/20
62.13	9.13	28.74	6.51	5.11	88.38	LCC35	Creek	7/30/20
56.30	9.05	34.65	8.79	5.15	86.06	LCC5	Creek	7/30/20
57.39	11.03	31.58	8.32	4.42	87.26	LCC7	Creek	7/30/20
59.49	10.42	30.09	7.55	3.98	88.47	LCC8	Creek	7/30/20
59.38	10.44	30.18	7.75	4.06	88.19	LCC8 Du	Creek	7/30/20

Me_Norm_Calc

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1			Cations									Normalized						Anions			
2	Site ID	Description	Calcium mg/L	Ca (me)	Sodium mg	Na (me)	Potassium	K (me)	Magnesium	Mg (me)	Cation Sum	Ca	Na	K	Na+K	Mg		Chloride mg/L	Cl (me)	Sulphate mg/L	SO4 (me)
3	1	Well	90.88	4.54	10.89	0.47	0.1	0.00	26.78	2.20	7.22	62.86	6.56	0.04	6.60	30.54	100.00	14.99	0.42	16.51	0.34
4	3	Well	91.93	4.59	12.49	0.54	0.1	0.00	24.40	2.01	7.14	64.24	7.61	0.04	7.64	28.12	100.00	14.35	0.40	17.19	0.36
5	5	Well	81.97	4.09	8.89	0.39	0.1	0.00	28.86	2.37	6.85	59.68	5.64	0.04	5.68	34.64	100.00	19.84	0.56	16.38	0.34
6	6	Well	57.07	2.85	32.92	1.43	0.1	0.00	31.73	2.61	6.89	41.31	20.77	0.04	20.81	37.88	100.00	24.34	0.69	21.63	0.45
7	7	Well	91.01	4.54	11.21	0.49	0.1	0.00	23.33	1.92	6.95	65.33	7.01	0.04	7.05	27.62	100.00	14.35	0.40	17.63	0.37
8	8	Well	77.88	3.89	30.76	1.34	1.63	0.04	26.45	2.18	7.44	52.22	17.98	0.56	18.54	29.25	100.00	17.35	0.49	14.58	0.30
9	9	Well	123.47	6.16	36.12	1.57	19.15	0.49	32.39	2.67	10.89	56.59	14.43	4.50	18.93	24.48	100.00	68.52	1.93	44.50	0.93
10	10	Well	83.31	4.16	10.41	0.45	0.1	0.00	27.83	2.29	6.90	60.22	6.56	0.04	6.60	33.18	100.00	18.43	0.52	16.31	0.34
11	11	Well	93.14	4.65	12.76	0.55	0.1	0.00	25.60	2.11	7.31	63.56	7.59	0.03	7.62	28.81	100.00	16.09	0.45	16.54	0.34
12	12	Well	102.25	5.10	30.67	1.33	0.63	0.02	26.30	2.16	8.62	59.22	15.48	0.19	15.67	25.12	100.00	35.54	1.00	31.47	0.66
13	14	Well	94.43	4.71	9.51	0.41	0.1	0.00	22.12	1.82	6.95	67.81	5.95	0.04	5.99	26.20	100.00	12.22	0.34	14.72	0.31
14	15	Well	96.62	4.82	12.75	0.55	0.1	0.00	35.82	2.95	8.33	57.91	6.66	0.03	6.69	35.40	100.00	17.02	0.48	18.41	0.38
15	301	Spring	84.35	4.21	9.46	0.41	0.1	0.00	29.87	2.46	7.08	59.44	5.81	0.04	5.85	34.71	100.00	19.05	0.54	16.30	0.34
16	302	Spring	87.31	4.36	11.59	0.50	0.1	0.00	27.74	2.28	7.15	60.97	7.05	0.04	7.09	31.94	100.00	18.98	0.54	17.64	0.37
17	CC1	Creek	90.64	4.52	12.69	0.55	0.1	0.00	24.36	2.00	7.08	63.87	7.80	0.04	7.83	28.30	100.00	15.84	0.45	16.44	0.34
18	LCC15	Creek	90.17	4.50	16.39	0.71	0.35	0.01	26.63	2.19	7.41	60.70	9.62	0.12	9.74	29.56	100.00	19.13	0.54	16.11	0.34
19	LCC25	Creek	88.53	4.42	18.12	0.79	0.06	0.00	26.05	2.14	7.35	60.10	10.72	0.02	10.74	29.16	100.00	19.56	0.55	17.31	0.36
20	LCC30	Creek	88.56	4.42	18.02	0.78	0.09	0.00	25.86	2.13	7.33	60.26	10.69	0.03	10.72	29.02	100.00	20.20	0.57	18.26	0.38
21	LCC35	Creek	88.42	4.41	14.87	0.65	0.06	0.00	24.80	2.04	7.10	62.13	9.11	0.02	9.13	28.74	100.00	16.60	0.47	17.66	0.37
22	LCC5	Creek	75.86	3.79	13.95	0.61	0.07	0.00	28.32	2.33	6.72	56.30	9.02	0.03	9.05	34.65	100.00	21.58	0.61	17.11	0.36
23	LCC7	Creek	80.61	4.02	17.60	0.77	0.29	0.01	26.90	2.21	7.01	57.39	10.92	0.10	11.03	31.58	100.00	22.04	0.62	15.86	0.33
24	LCC8	Creek	87.45	4.36	17.43	0.76	0.23	0.01	26.82	2.21	7.33	59.49	10.34	0.08	10.42	30.09	100.00	19.95	0.56	14.25	0.30
25	LCC8 Dup	Creek	86.12	4.30	17.24	0.75	0.24	0.01	26.54	2.18	7.24	59.38	10.36	0.09	10.44	30.18	100.00	20.17	0.57	14.33	0.30

	A	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
1									Normalized					
2	Site ID	**Total Alkalinity (mg/L)**	HCO3	HCO3 (me)	CO3	CO3 (me)	HCO3+CO3	Anion Sum	Cl	SO4	HCO3	CO3	HCO3+CO3	
3	1	320	390.40	6.40	0.00	0.00	6.40	7.16	5.90	4.80	89.30	0.00	89.30	100.00
4	3	322	392.84	6.44	0.00	0.00	6.44	7.20	5.62	4.97	89.41	0.00	89.41	100.00
5	5	298	363.56	5.96	0.00	0.00	5.96	6.86	8.16	4.97	86.87	0.00	86.87	100.00
6	6	288	351.36	5.76	0.00	0.00	5.76	6.90	9.96	6.53	83.51	0.00	83.51	100.00
7	7	880	1073.60	17.60	0.00	0.00	17.60	18.37	2.20	2.00	95.80	0.00	95.80	100.00
8	8	406	495.32	8.12	0.00	0.00	8.12	8.91	5.49	3.41	91.10	0.00	91.10	100.00
9	9	316	385.52	6.32	0.00	0.00	6.32	9.18	21.06	10.10	68.85	0.00	68.85	100.00
10	10	332	405.04	6.64	0.00	0.00	6.64	7.50	6.93	4.53	88.54	0.00	88.54	100.00
11	11	338	412.36	6.76	0.00	0.00	6.76	7.56	6.01	4.56	89.44	0.00	89.44	100.00
12	12	318	387.96	6.36	0.00	0.00	6.36	8.02	12.51	8.17	79.32	0.00	79.32	100.00
13	14	320	390.40	6.40	0.00	0.00	6.40	7.05	4.89	4.35	90.76	0.00	90.76	100.00
14	15	302	368.44	6.04	0.00	0.00	6.04	6.90	6.96	5.55	87.49	0.00	87.49	100.00
15	301	324	395.28	6.48	0.00	0.00	6.48	7.36	7.31	4.62	88.08	0.00	88.08	100.00
16	302	376	458.72	7.52	0.00	0.00	7.52	8.42	6.36	4.36	89.28	0.00	89.28	100.00
17	CC1	318	387.96	6.36	0.00	0.00	6.36	7.15	6.25	4.79	88.96	0.00	88.96	100.00
18	LCC15	338	412.36	6.76	0.00	0.00	6.76	7.63	7.07	4.39	88.54	0.00	88.54	100.00
19	LCC25	330	402.60	6.60	0.00	0.00	6.60	7.51	7.35	4.80	87.85	0.00	87.85	100.00
20	LCC30	312	380.64	6.24	0.00	0.00	6.24	7.19	7.93	5.29	86.78	0.00	86.78	100.00
21	LCC35	318	387.96	6.36	0.00	0.00	6.36	7.19	6.51	5.11	88.38	0.00	88.38	100.00
22	LCC5	298	363.56	5.96	0.00	0.00	5.96	6.92	8.79	5.15	86.06	0.00	86.06	100.00
23	LCC7	326	397.72	6.52	0.00	0.00	6.52	7.47	8.32	4.42	87.26	0.00	87.26	100.00
24	LCC8	330	402.60	6.60	0.00	0.00	6.60	7.46	7.55	3.98	88.47	0.00	88.47	100.00
25	LCC8 Dup	324	395.28	6.48	0.00	0.00	6.48	7.35	7.75	4.06	88.19	0.00	88.19	100.00

Collected Data

Site ID	**1**	**3**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**14**	**15**	**301**	**302**	**CC1**	**LCC15**	**LCC25**	**LCC30**	**LCC35**	**LCC5**	**LCC7**	**LCC8**	**LCC8 Dup**
Description	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Well	Spring	Spring	Creek	Creek	Creek	Creek	Creek	Creek	Creek	Creek	Creek
Fluoride (mg/L)	3.3669	3.3007	3.1972	3.0836	2.5558	3.7607	3.7076	3.5756	2.831	3.6829	2.5255	3.8885	3.6386	3.2635	2.7071	3.5076	3.4214	3.4319	2.7298	2.7051	2.879	3.3067	4.0246
Chloride (mg/L)	14.9876	14.3474	19.8436	24.3414	14.353	17.3531	68.5154	18.4316	16.0902	35.5434	12.2227	17.0214	19.0522	18.9751	15.8404	19.1285	19.5616	20.1996	16.6041	21.5831	22.0372	19.9525	20.17
Nitrite (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0404	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.9874	<1.0	<1.0	<1.0
Bromide (mg/L)	1.0534	<1.0	1.0714	<1.0	<1.0	1.0621	1.2108	<1.0	<1.0	1.1196	<1.0	1.0807	<1.0	1.0559	<1.0	<1.0	<1.0	<1.0	<1.0	1.0696	1.0695	1.0559	1.0535
Nitrate (mg/L)	3.8597	3.4009	2.9747	3.7601	3.6026	1.4803	16.5213	2.8078	3.8908	16.1371	3.4536	2.4549	1.8698	2.5222	2.6337	1.4767	1.5415	1.5748	1.4072	2.7891	1.278	1.7571	1.6371
Phosphate (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sulphate (mg/L)	16.5111	17.1892	16.3803	21.631	17.6342	14.5821	44.5005	16.3149	16.5375	31.47	14.7215	18.4077	16.3044	17.6384	16.4444	16.1104	17.3117	18.2589	17.6567	17.1097	15.8587	14.2527	14.3333
Lithium (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sodium (mg/L)	10.8899	12.4897	8.8929	32.9175	11.21	30.7585	36.1151	10.4145	12.7557	30.6684	9.5086	12.7505	9.4618	11.5891	12.6937	16.3862	18.1167	18.0213	14.8737	13.9467	17.5991	17.4342	17.235
Ammonium (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Potassium (mg/L)	<0.1	<0.1	<0.1	1.9961	<0.1	1.6251	19.1525	<0.1	<0.1	0.6269	<0.1	<0.1	<0.1	<0.1	<0.1	0.3488	0.0606	0.0921	<0.165	0.0739	0.2862	0.2289	0.2438
Magnesium (mg/L)	26.7804	24.4048	28.8573	31.7317	23.3282	26.45	32.388	27.8304	25.6029	26.2997	22.1238	35.822	29.8707	27.744	24.358	26.6271	26.0541	25.8612	24.8044	28.3196	26.9042	26.8197	26.541
Manganese (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium (mg/L)	90.8849	91.934	81.9668	57.0698	91.0065	77.8767	123.469	83.3079	93.1366	102.253	94.4296	96.6188	84.3517	87.3131	90.637	90.1666	88.5282	88.5618	88.4184	75.8624	80.6125	87.4459	86.1176
Strontium (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Barium (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.0204	<0.1	<0.1
Total Alkalinity (mg/L)	320	322	298	288	880	406	316	332	338	318	320	302	324	376	318	338	330	312	318	298	326	330	324
E. coli (MPN/100mL)																		43	26				
Discharge (cfs)																0.1530		0.0450		0.4545	0.0990	0.0730	
Discharge (gpm)																68.6664		20.1960		203.9796	44.4310	32.7624	
Temperature (°C)	22	22.3	21.8	22.3		29.2	22	22.7	21.8	23	22.2	22.7	21.5	22.1	23.8	26.1	25.4	25.2		25.8	25.4	23.7	
pH (su)	6.94	6.97	7.23	7.27		6.79	7	7	6.99	7.6	7	7	6.98	7.09	7	7.6	7.5	7.3		7.8	7.5	7.3	
DO (mg/L)										7.2	6.25				5	6.4	5	3.1		5.8	4.3	6.1	
Conductivity (µS/cm)	691	694	994	677		1044	734	717	838	691	697	674	675	955	697	736	724	722		667	697	714	
Depth to Water (ft)		31.15	24.3	63.7			22.05	13.2				34.5	15.7	19.5									
MP (ft)		1.5	1.9	1.8			1.7	2.5				1	1.3	1.2									
Water Level (ft)		29.65	22.4	61.9			20.35	10.7				33.5	14.4	18.3									
Hardness (mg/L)	337.221	330.058	323.505	273.174	323.309	303.379	441.676	322.625	337.995	363.627	326.897	388.772	333.634	332.271	326.627	334.7964	328.346	327.6352	322.925	306.0485	312.0809	328.7959	324.331

Anions

Site ID	Description	Fluoride mg/L	Chloride mg/L	Nitrite mg/L	Bromide mg/L	Nitrate mg/L	Phosphate mg/L	Sulphate mg/L
1	Well	3.37	14.99	<1.0	1.05	3.86	<1.0	16.51
3	Well	3.30	14.35	<1.0	<1.0	3.40	<1.0	17.19
5	Well	3.20	19.84	<1.0	1.07	2.97	<1.0	16.38
6	Well	3.08	24.34	<1.0	<1.0	3.76	<1.0	21.63
7	Well	2.56	14.35	<1.0	<1.0	3.60	<1.0	17.63
8	Well	3.76	17.35	<1.0	1.06	1.48	<1.0	14.58
9	Well	3.71	68.52	1.04	1.21	16.52	<1.0	44.50
10	Well	3.58	18.43	<1.0	<1.0	2.81	<1.0	16.31
11	Well	2.83	16.09	<1.0	<1.0	3.89	<1.0	16.54
12	Well	3.68	35.54	<1.0	1.12	16.14	<1.0	31.47
14	Well	2.53	12.22	<1.0	<1.0	3.45	<1.0	14.72
15	Well	3.89	17.02	<1.0	1.08	2.45	<1.0	18.41
301	Spring	3.64	19.05	<1.0	<1.0	1.87	<1.0	16.30
302	Spring	3.26	18.98	<1.0	1.06	2.52	<1.0	17.64
CC1	Creek	2.71	15.84	<1.0	<1.0	2.63	<1.0	16.44
LCC15	Creek	3.51	19.13	<1.0	<1.0	1.48	<1.0	16.11
LCC25	Creek	3.42	19.56	<1.0	<1.0	1.54	<1.0	17.31
LCC30	Creek	3.43	20.20	<1.0	<1.0	1.57	<1.0	18.26
LCC35	Creek	2.73	16.60	<1.0	<1.0	1.41	<1.0	17.66
LCC5	Creek	2.71	21.58	0.99	1.07	2.79	<1.0	17.11
LCC7	Creek	2.88	22.04	<1.0	1.07	1.28	<1.0	15.86
LCC8	Creek	3.31	19.95	<1.0	1.06	1.76	<1.0	14.25
LCC8 Du	Creek	4.02	20.17	<1.0	1.05	1.64	<1.0	14.33

Cations

Site ID	Description	Lithium mg/L	Sodium mg/L	Ammonium mg/L	Potassium mg/L	Magnesium mg/L	Manganese mg/L	Calcium mg/L	Strontium mg/L	Barium mg/L
1	Well	<0.1	10.89	<0.1	<0.1	26.78	<0.1	90.88	<0.1	<0.1
3	Well	<0.1	12.49	<0.1	<0.1	24.40	<0.1	91.93	<0.1	<0.1
5	Well	<0.1	8.89	<0.1	<0.1	28.86	<0.1	81.97	<0.1	<0.1
6	Well	<0.1	32.92	<0.1	<0.1	31.73	<0.1	57.07	<0.1	<0.1
7	Well	<0.1	11.21	<0.1	<0.1	23.33	<0.1	91.01	<0.1	<0.1
8	Well	<0.1	30.76	<0.1	1.63	26.45	<0.1	77.88	<0.1	<0.1
9	Well	<0.1	36.12	<0.1	19.15	32.39	<0.1	123.47	<0.1	<0.1
10	Well	<0.1	10.41	<0.1	<0.1	27.83	<0.1	83.31	<0.1	<0.1
11	Well	<0.1	12.76	<0.1	<0.1	25.60	<0.1	93.14	<0.1	<0.1
12	Well	<0.1	30.67	<0.1	0.63	26.30	<0.1	102.25	<0.1	<0.1
14	Well	<0.1	9.51	<0.1	<0.1	22.12	<0.1	94.43	<0.1	<0.1
15	Well	<0.1	12.75	<0.1	<0.1	35.82	<0.1	96.62	<0.1	<0.1
301	Spring	<0.1	9.46	<0.1	<0.1	29.87	<0.1	84.35	<0.1	<0.1
302	Spring	<0.1	11.59	<0.1	<0.1	27.74	<0.1	87.31	<0.1	<0.1
CC1	Creek	<0.1	12.69	<0.1	<0.1	24.36	<0.1	90.64	<0.1	<0.1
LCC15	Creek	<0.1	16.39	<0.1	0.35	26.63	<0.1	90.17	<0.1	<0.1
LCC25	Creek	<0.1	18.12	<0.1	0.06	26.05	<0.1	88.53	<0.1	<0.1
LCC30	Creek	<0.1	18.02	<0.1	0.09	25.86	<0.1	88.56	<0.1	<0.1
LCC35	Creek	<0.1	14.87	<0.1	0.06	24.80	<0.1	88.42	<0.1	<0.1
LCC5	Creek	<0.1	13.95	<0.1	0.07	28.32	<0.1	75.86	<0.1	<0.1
LCC7	Creek	<0.1	17.60	<0.1	0.29	26.90	<0.1	80.61	<0.1	0.02
LCC8	Creek	<0.1	17.43	<0.1	0.23	26.82	<0.1	87.45	<0.1	<0.1
LCC8 Dup	Creek	<0.1	17.24	<0.1	0.24	26.54	<0.1	86.12	<0.1	<0.1

EC_Alk_Field

Date	Time	Site ID	Description	Total Alkalinity (mg/L)	E. coli (MPN/100mL)	Discharge (cfs)	Temperature (°C)	pH (su)	DO (mg/L)	Conductivity (µS/cm)	Water Level (ft)	MP (ft)	Comments
7/30/20	10:03	1	Well	320			22	6.94		691			No water level access
7/30/20	9:05	3	Well	322			22.3	6.97		694	31.15	1.5	
7/30/20	8:20	5	Well	298			21.8	7.23		994	24.3	1.9	
7/30/20	9:55	6	Well	288			22.3	7.27		677	63.7	1.8	Averaged well #1, #2 and #3.
7/30/20	8:40	8	Well	880									
7/30/20	11:55	9	Well	406			29.2	6.79		1044			No water level access; sammpling point is for 500+ feet from well.
7/30/20	8:45	10	Well	316			22	7		734	22.05	1.7	
7/30/20	11:10	11	Well	332			22.7	7		717	13.2	2.5	
7/30/20	11:35	12	Well	338			21.8	6.99		838			No water level access
7/30/20	8:00	301	Spring	318			23	7.6	7.2	691			No flow measured.
7/30/20	8:10	302	Spring	320			22.2	7	6.25	697			No flow measured.
7/30/20	12:55	7	Groundwater	302			22.7	7		674	34.5	1	
7/30/20	12:30	14	Groundwater	324			21.5	6.98		675	15.7	1.3	
7/30/20	13:10	15	Groundwater	376			22.1	7.09		955	19.5	1.2	
7/30/20	11:20	CC1	Creek	318			23.8	7	5	697			
7/30/20	11:35	LCC15	Creek	338		0.153	26.1	7.6	6.4	736			
7/30/20	10:30	LCC25	Creek	330			25.4	7.5	5	724			
7/30/20	10:50	LCC30	Creek	312	43	0.045	25.2	7.3	3.1	722			
7/30/20	12:35	LCC35	Creek	318	26								
7/30/20	9:05	LCC5	Creek	298		0.45	25.8	7.8	5.8	667			
7/30/20	8:35	LCC7	Creek	326		0.099	25.4	7.5	4.3	697			5 gallon bucket flow measurement
7/30/20	10:00	LCC8	Creek	330		0.073	23.7	7.3	6.1	714			
7/30/20	10:00	LCC8 Duplicate	Creek	324									

APPENDIX D: MAP CREDITS

Figure 1 – Little Cypress Creek

Untied States Geological Society, Texas Natural Resources Information System, Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri Chain (Hong Kong), © OpenStreetMap contributors, and the GIS User Community

Figure 2 – NLCD Land Cover 2001

United States Geological Society National Land Cover Database, 2001, Texas Department of Transportation

Figure 3 – NLDC Land Cover 2016

United States Geological Society National Land Cover Database, 2016, Texas Department of Transportation

Figure 4 – Geologic Map of the Little Cypress Creek Watershed

Texas Natural Resources Information System, V.E. Barnes, 1982, Geology of the Spicewood Quadrangle, Bureau of Economic Geology Scanned, collars clipped, and georeferenced November 2014 at UT Austin Walter Geology Library by BSEACD intern Chase Svoboda.

Figure 6 – Location Map of wells with TWDB State Well Reports

V.E. Barnes, 1982, Geology of the Spicewood Quadrangle, Bureau of Economic Geology

Scanned, collars clipped, and georeferenced November 2014 at UT Austin Walter Geology Library by BSEACD intern Chase Svoboda

Figure 12 – Inferred Lateral Occurrence of Sycamore Sand/Gravel (Ksy)

V.E. Barnes, 1982, Geology of the Spicewood Quadrangle, Bureau of Economic Geology

Scanned, collars clipped, and georeferenced November 2014 at UT Austin Walter Geology Library by BSEACD intern Chase Svoboda

Figure 16 – Well yields obtained from TWDB State Well Reports

V.E. Barnes, 1982, Geology of the Spicewood Quadrangle, Bureau of Economic Geology

Scanned, collars clipped, and georeferenced November 2014 at UT Austin Walter Geology Library by BSEACD intern Chase Svoboda

Figure 17 – Surface and Groundwater Sampling Locations

Texas Natural Resources Information System, Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri Chain (Hong Kong), © OpenStreetMap contributors, and the GIS User Community

Figure 18 – Potentiometric surface map

USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri Chain (Hong Kong), © OpenStreetMap contributors, and the GIS User Community

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