# July 2021 Potentiometric Surfaces of the Lower and Middle Trinity Aquifers in Southwestern Hays County, Texas

**Hays Trinity Groundwater Conservation District**

**August 2021**

**HTGCD Technical Report 2021-0818**

**August 2021**

Disclaimer: All the information provided in this report is believed to be accurate and reliable; however, the author or associated agencies assume no responsibility for any errors or for the use of the information provided.

Cover photos: Top: HTGCD and CTGCD staff taking water quality data (Photo by Robin Gary of WVWA); Bottom left: H.L. Saur of CTGCD taking water level measurement; Bottom right: Shane Heath of HTGCD taking water quality data at Red Corral Ranch

# July 2021 Potentiometric Surfaces of the Lower and Middle

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## Introduction

The southwestern portion of Hays County and northeastern Comal County depend on the Lower and Middle Trinity Aquifers as their water sources. Water from these two aquifers is used for domestic and agricultural purposes for a rapidly expanding population. According to the United States Census Bureau, Hays County ranked second for all counties in the nation in percent growth from 2010 to 2019 (USCB, 2020). Development of data into science is critical for the future management of the resource in both aquifers.

This report's July 2021 Lower Trinity potentiometric surface map is the first in the study area. The Lower Trinity and Middle Trinity Aquifer potentiometric surface maps presented in this report are indices for aquifer health and provide an in-depth characterization of localized Trinity Aquifer flow regimes. The maps provided are compared to previous studies, such as Davidson (2008), Watson et al. (2014), and Hunt et al. (2019), and will be a useful timestamp for future studies. Additionally, basic water chemistry data was collected for both aquifers during this study and is discussed in this report.

The study area is predominantly within the Hays Trinity Groundwater Conservation District's (HTGCD) Regional Recharge Study Zone (RRSZ), located near the southwestern boundary of Hays County within the Blanco River and Cypress Creek watersheds (Gary et al., 2019). Some objectives in the RRSZ include increased monitoring of the Middle and Lower Trinity Aquifers and expanding existing water availability knowledge. Trans-boundary data was also collected in the Jacob's Well Groundwater Management Zone (JWGMZ) and in the adjacent northern section of Comal County's Comal Trinity Groundwater Conservation District.

**Regional Geology and Hydrogeology**

The Middle Trinity Aquifer is composed of, from youngest to oldest, the Lower Glen Rose, Hensel, Cow Creek, and Hammett Shale Formations. Our study area primarily exhibits surface outcrops of the Lower Glen Rose limestone, where the Blanco River and Cypress Creek watersheds are located (Figure 1). The Upper Glen Rose limestone is at the surface in higher elevation areas along the watershed divides. The Hensel and Cow Creek limestone are only exposed along a small portion of the Blanco River upstream of Pleasant Valley Spring. The Hammett Shale underlies the Cow Creek and acts as an aquitard separating the Middle Trinity and the older Lower Trinity Aquifers. A stratigraphic column of these units is shown in Figure 2.

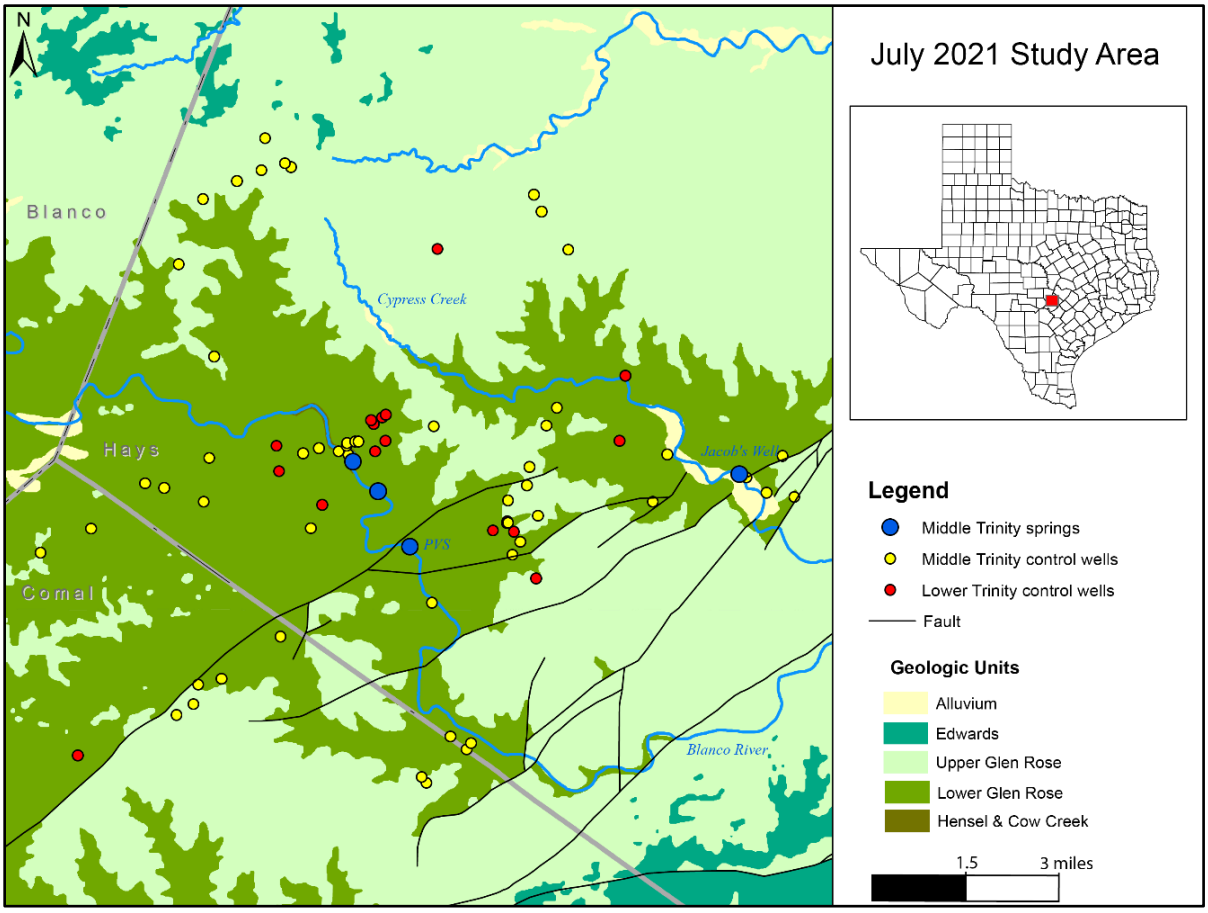


***Figure 1.*** Geologic map of the study area in southwestern Hays County, Texas. Faults and geologic units from BEG (2014).

The Lower Glen Rose limestone is approximately 250 ft thick and consists of alternating fossiliferous limestone and dolostone facies. It is a karstic formation containing caverns allowing for rapid recharge and groundwater flow. Storage is most prominent in the lower and upper rudist patch reef facies. The Hensel is about 35 ft thick and has semi-confining properties due to its shaley dolomitic composition (Wierman et al. 2010).

The Cow Creek limestone, about 75 ft thick, contains three major Middle Trinity springs along a stretch of the Blanco River and Jacob's Well Spring to the east where Cypress Creek baseflow originates (Wierman et al. 2010; Gary et al. 2019). The Cow Creek is considered the most productive water-bearing zones of the Middle Trinity Aquifer (Wierman et al. 2010), as evidenced by most wells targeting the Middle Trinity produce from the Cow Creek Formation. Little Park Spring is found where the Hensel and Cow Creek limestone outcrop and is the most upstream spring of the three. Just downstream is Park Spring, and further downstream is Pleasant Valley Spring. Pleasant Valley Spring (PVS) is the largest Trinity Aquifer spring (median discharge is 30.75 cubic feet per second according USGS Gage Station 08153500) and marks the boundary between a perennially flowing section of the Blanco River downstream and losing/gaining stretches upstream (Watson et al. 2014).

The Sligo Formation is a carbonate unit that underlies the confining Hammett Shale and is the uppermost unit of the Lower Trinity Aquifer. Below the Sligo is the Hosston Sand. It is a combination of conglomerate, sandstone, and claystone beds most likely derived from erosion of the Llano Uplift (Stricklin et al. 1971). These two units are not as karstified as the Middle Trinity rocks, and the units of the Lower Trinity Aquifer do not outcrop within the study area.

The study area commonly finds faults and fractures associated with the Balcones Fault Zone (BFZ). These Miocene-age normal faults occur in limestones and provide some of the most permeable parts of the Trinity aquifer (Wierman et al. 2010). Faults and Trinity Group rock formations in the area generally have a low slope dip to the southeast and may strongly influence the direction of groundwater flow (Wierman et al. 2010). Groundwater can by-pass impermeable units via joints and fractures. Over time groundwater will dissolve the carbonate host rock, enhancing these fractures and joints and promoting increased groundwater flow.

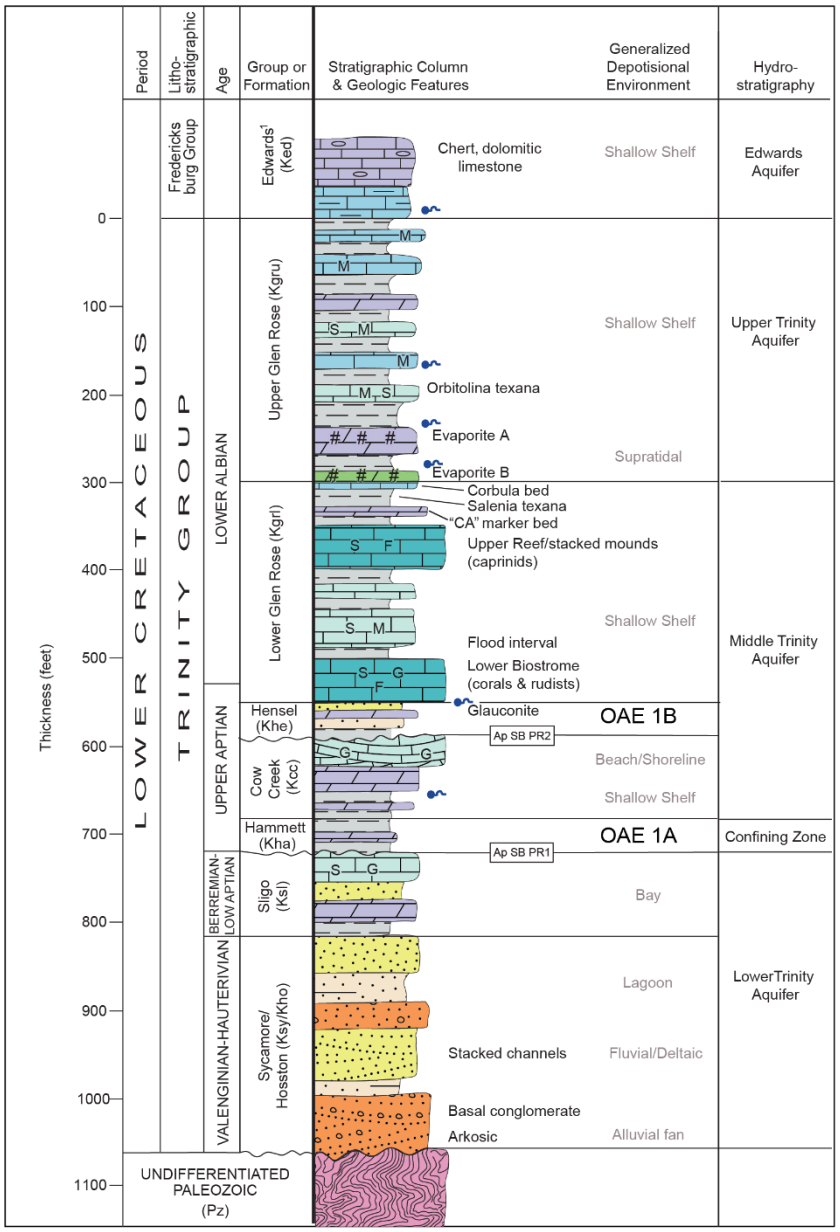


Figure modified from Stricklin & Lozo, 1971

Stratigraphic notes:
1- Edwards Group, Kainer Fm, as defined by Rose (1972).
2 - Ages and sequence boundaries from R.W. Scott, 2007.
3- Oceanic Anoxic Events (OAE 1A, 1B) approximated from Kerans, et al., 2019.

***Figure 2.*** *Stratigraphic column containing the Trinity Group. From Hunt et al. (2019).*

**Hydrologic Conditions**

During the data collection period from July 12th – August 5th, the study area received 0.64 inches of rain. The area also received a generous amount of rain on July 9th, with 1.57 inches total (NOAA, 2021) at the Wimberley 1 NW, TX US NOAA weather station. According to the Palmer Drought Severity Index, this area was classified as very moist during July 2021. In 2020 the study area was classified as moderate to severe drought (NOAA, 2021).

Multiple wells were measured at the beginning and end to ensure stable conditions throughout the synoptic event (Table 1). Overall, these show less than +/- 3 feet of change over the study period. Several wells showed more significant swings (McMeans and Lost Springs Ranch in Table 1); these variations were considered when developing the potentiometric surface maps.

**Table 1.** Before and after data collection period results.

| Well | Aquifer | 7/15/2021 | 8/19/2021 | Change |
|---|---|---|---|---|
| Byrum Dry Cypress | Lower | 892.8 | 890.9 | -1.9 |
| McMeans | Lower | 880.7 | 887.7 | 7.0 |
| Roberts | Lower | 957.3 | 958.4 | 1.1 |
| Still Well #1 - WH | Lower | 996.0 | 996.0 | 0.0 |
| Lost Springs Ranch Telemetry | Lower | 249.8 | 249.3 | -0.5 |
| High Gate Ranch Toenail | Middle | 1007.0 | 1004.4 | -2.6 |
| Lost Springs Ranch | Middle | 952.4 | 959.5 | 7.1 |
| Still Well #4 - 1st WM | Middle | 1022.0 | 1020.8 | -1.2 |
| ESD | Middle | 283.6 | 283.3 | -0.3 |

**Methods**

Water level measurements were primarily taken from privately owned domestic wells in the communities of Hill Country Ranches, Burnett Ranch, Mustang Valley, Ledgerock, Fischer in Comal County, and other nearby areas within and surrounding the study area. Additional data was collected from HTGCD permittees and monitoring sites. Measurements were taken over about four weeks and included wells completed in the Lower Trinity Aquifer and Middle Trinity Aquifer. 53 water levels were used for the Middle Trinity potentiometric map, and 18 water levels were used for the Lower Trinity potentiometric map. Some water levels were heavily influenced by pumping and were omitted when constructing contours because they were too dissimilar from nearby wells completed in the same aquifer. Staff members from HTGCD, Wimberley Valley Watershed Association (WVWA), and Comal Trinity Groundwater Conservation District (CTGCD) aided in collecting water levels and water quality data.

A manual electric line (e-line) depth-finder was used for a majority of the water levels as they are typically the most accurate tool for measurements with an error of ±0.01 feet. When it was not possible to use an e-line for measurement, a sonic meter was used to detect the water level in the well. Sonic meters have an accuracy of ±2 feet. To confirm the sonic meter results, water levels were compared to nearby wells completed in a known aquifer.

Since the measuring point (MP) of each well was usually not at the land surface, the MP height above the land surface was recorded to subtract from the depth to water measured with the e-line or sonic, which allowed us to obtain the depth to water from the surface elevation and then subtract that depth from the surface elevation to get a water level elevation at each well. Coordinates of each well were taken with an iPhone, and USGS NED DEM was used to find the surface elevation at each well site.

ArcMap 10.8.1 was used to plot the data and create the contour maps. Water level elevations were used for the Simple Kriging method from the Geostatistical Wizard component of the Geostatistical Analyst extension to make an initial interpolation of the data. The kriging maps were then converted to grids using the GA Layer to Grid tool. Next, contours were created using the Contour Spatial Analyst tool. Contours were adjusted and finalized in Adobe Illustrator.

To collect basic water quality data at wells, a HANNA Multiparameter Water Quality Meter was used. A water sample was taken from the nearest spigot that produced untreated well water. The HANNA instrument was inserted into the sample, and temperature, pH, conductivity, dissolved oxygen, and total dissolved solids (TDS) levels were recorded for the sample. TDS measurements were not lab tested. TDS was calculated by taking the conductivity reading from the water quality meter and multiplying it by a correction factor of 0.63. Nitrates and nitrites were also tested using sample testing strips.

**Results**

Well data, including water level elevations and TDS, for all Middle Trinity wells, are shown in Table 2 and Lower Trinity wells in Table 3. Figures 3 and 4 are the potentiometric surface contour maps for the Middle Trinity Aquifer and Lower Trinity Aquifer. Where sufficient data were available, the producing formation(s) are noted. Some differences in water elevations will be due to wells having multiple producing intervals and, therefore, wells producing from varying producing formations. Overall, this was not an issue when developing the potentiometric surface maps as wells producing from the same aquifer but different formations had similar water elevations.

***Table 2.*** *Middle Trinity potentiometric data and TDS for wells used during study (lowest TDS value shown in blue, highest TDS value shown in red)*

| ***Name*** | ***SWN*** | ***Well Report Tracking #*** | ***Latitude*** | ***Longitude*** | ***Aquifer*** | ***Producing Formation*** | ***Surface Elevation (ft-msl)*** | ***Measurement Date*** | ***Water Level Elevation (ft-msl)*** | ***TDS (mg/L)*** | ***Notes*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Archer | | | 30.11039 | -98.2456 | Middle Trinity | | 1273 | 7/27/2021 | 1020 | 375.48 | |
| Berry | | | 30.10002 | -98.1752 | Middle Trinity | | 1389 | 7/29/2021 | 1000.1 | 631.89 | |
| Blincow | | 294563 | 30.01716 | -98.1806 | Middle Trinity | LGR, Hensel, Cow Creek | 1099 | 8/3/2021 | 918 | 599.13 | |
| Brieger | | | 29.98846 | -98.2543 | Middle Trinity | | 1140 | 7/28/2021 | | 364.14 | |
| Buffington | | | 29.99993 | -98.2119 | Middle Trinity | | 1112 | 8/5/2021 | | 445.41 | |
| Cabler | | | 30.04073 | -98.2312 | Middle Trinity | | 1080 | 7/20/2021 | 960.8 | 281.61 | |
| Camp Young Judaea | 5764714 | | 30.02953 | -98.1188 | Middle Trinity | | 958 | 7/15/2021 | 920 | | |
| Christian | | 41640 | 30.04232 | -98.2212 | Middle Trinity | LGR, Hensel, Cow Creek | 1055 | 7/22/2021 | 954.6 | 367.29 | |
| Clark | | | 29.98135 | -98.2614 | Middle Trinity | | 1139 | 7/21/2021 | 958.4 | 423.99 | |
| Crow | | | 30.02053 | -98.2332 | Middle Trinity | LGR, Hensel, Cow Creek | 1115 | 7/20/2021 | 949.6 | 299.88 | |
| Davidson | | | 30.02194 | -98.1836 | Middle Trinity | | 1100 | 8/3/2021 | 931.9 | | |
| Davis | | | 30.10317 | -98.2602 | Middle Trinity | | 1274 | 7/29/2021 | 1019.3 | 484.47 | |
| Ded. ESD | 5763504 | 488861 | 30.04613 | -98.2023 | Middle Trinity | Cow Creek | 1237 | 7/22/2021 | 953.6 | | |
| Dyson - Stude #3 | | | 30.02725 | -98.2601 | Middle Trinity | | 1120 | 7/19/2021 | 993 | 482.58 | |

| *Name* | *SWN* | *Well Report Tracking #* | *Latitude* | *Longitude* | *Aquifer* | *Producing Formation* | *Surface Elevation (ft-msl)* | *Measurement Date* | *Water Level Elevation (ft-msl)* | *TDS (mg/L)* | *Notes* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dyson - Stude Windmill #1 | | | 30.03074 | -98.27 | Middle Trinity | | 1082 | 7/19/2021 | 998 | | |
| Dyson - Stude Windmill #2 | | | 30.03183 | -98.2748 | Middle Trinity | | 1092 | 7/19/2021 | 1001.2 | | |
| Elsey | | 304162 | 30.00472 | -98.1833 | Middle Trinity | | 1110 | 8/3/2021 | | 486.99 | |
| Finley | | 423031 | 30.04298 | -98.2147 | Middle Trinity | Cow Creek | 1147 | 8/5/2021 | | 411.39 | |
| Fischer Community Center | 6806306 | 6806306 | 29.97649 | -98.2626 | Middle Trinity | | 1202 | 7/28/2021 | 971 | 401.94 | |
| Fossum | | 281404 | 30.03141 | -98.179 | Middle Trinity | | 1147 | 8/5/2021 | 934.9 | 418.32 | |
| Galassini | | 541827 | 30.02372 | -98.1762 | Middle Trinity | Cow Creek | 1146 | 8/3/2021 | 924.5 | | |
| Graham | 5764716 | | 30.03333 | -98.1239 | Middle Trinity | | 956 | 7/15/2021 | 922.7 | | |
| Gunnarson | | | 30.05083 | -98.1714 | Middle Trinity | | 1117 | 7/29/2021 | 919 | 373.59 | |
| HCP3 | 5764718 | | 30.03871 | -98.1147 | Middle Trinity | | 1040 | 7/13/2021 | 921.9 | | |
| Hernandez | | 497461 | 30.02778 | -98.177 | Middle Trinity | | 1158 | 8/3/2021 | | 454.23 | |
| High Gate Ranch Toenail | 5763203 | | 30.09046 | -98.1685 | Middle Trinity | | 1293 | 7/15/2021 | 1004 | | |
| Hobbs | | | 30.04239 | -98.2221 | Middle Trinity | | 1042 | 7/20/2021 | 949.4 | 316.26 | |
| Holt | | | 29.95817 | -98.2053 | Middle Trinity | | 1046 | 7/21/2021 | 911.7 | 381.78 | |
| Holt | | | 29.95671 | -98.2042 | Middle Trinity | | 1060 | 7/21/2021 | 914.4 | | |
| Howard | | | 30.11216 | -98.2397 | Middle Trinity | | 1280 | 7/29/2021 | 1022.4 | 378.63 | |

| *Name* | *SWN* | *Well Report Tracking #* | *Latitude* | *Longitude* | *Aquifer* | *Producing Formation* | *Surface Elevation (ft-msl)* | *Measurement Date* | *Water Level Elevation (ft-msl)* | *TDS (mg/L)* | *Notes* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Jones | | 350795 | 29.9813 | -98.2614 | Middle Trinity | | 1138 | 7/21/2021 | | 966 | |
| King | | | 30.04303 | -98.2059 | Middle Trinity | | 1215 | 7/22/2021 | 1018.5 | 364 | Sonic reading likely not reliable |
| Klug | | 234492 | 30.01395 | -98.1825 | Middle Trinity | Cow Creek | 1060 | 8/5/2021 | 916.9 | 461 | |
| Lendacky | | 464798 | 30.02161 | -98.1794 | Middle Trinity | | 1132 | 8/3/2021 | | 523 | |
| Little | | 161520 | 30.04632 | -98.1741 | Middle Trinity | Cow creek | 1203 | 7/27/2021 | 923.1 | 373 | |
| LSR Water Supply Corp | 5763702 | | 30.03936 | -98.2352 | Middle Trinity | | 1150 | 8/4/2021 | 956.6 | 442 | |
| Lundgren | | | 30.00195 | -98.2028 | Middle Trinity | | 995 | 8/5/2021 | 911.9 | 363 | |
| Menem | | 506435 | 30.02762 | -98.1836 | Middle Trinity | Cow Creek, also LGR/Hensel | 1127 | 8/5/2021 | 935.5 | 574 | |
| Nicholson | | | 30.01444 | -98.3011 | Middle Trinity | | 1249 | 7/21/2021 | 1107.9 | 426 | |
| Owen | | | 29.96669 | -98.193 | Middle Trinity | | 960 | 7/28/2021 | 913.3 | 369 | |
| Owen | | | 29.96506 | -98.1941 | Middle Trinity | | 951 | 7/28/2021 | 904.8 | | |
| Pixley | | | 30.04363 | -98.227 | Middle Trinity | | 1039 | 7/20/2021 | | 261 | |
| Pope - Cowboy Well | 5763402 | 312566 | 30.04199 | -98.2241 | Middle Trinity | LGR, Hensel, Cow Creek | 1010 | 7/20/2021 | 955.7 | 230 | |
| Pope - Riverhouse | | 407575 | 30.0412 | -98.2241 | Middle Trinity | Cow Creek | 1001 | 7/20/2021 | 954.7 | 324 | |

| *Name* | *SWN* | *Well Report Tracking #* | *Latitude* | *Longitude* | *Aquifer* | *Producing Formation* | *Surface Elevation (ft-msl)* | *Measurement Date* | *Water Level Elevation (ft-msl)* | *TDS (mg/L)* | *Notes* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Pousson | | | 30.1184 | -98.2446 | Middle Trinity | LGR, Hensel, Cow Creek | 1346 | 7/29/2021 | 1016.9 | 401 | |
| Price | | | 30.04408 | -98.1766 | Middle Trinity | | 1196 | 7/27/2021 | | 365 | |
| Ramachandran | | 222564 | 30.04245 | -98.2123 | Middle Trinity | | 1168 | 7/22/2021 | | **3867** | |
| Red Corral Ranch | 5762305 | | 30.08686 | -98.2663 | Middle Trinity | | 1256 | 7/15/2021 | 1015.8 | | |
| Roberts | | | 29.98279 | -98.2557 | Middle Trinity | Cow Creek | 1109 | 8/5/2021 | 953.5 | 755 | |
| Rockefeller | | | 29.96832 | -98.1981 | Middle Trinity | | 978 | 7/28/2021 | 901.4 | 378 | |
| Sampsel | | | 30.11124 | -98.2382 | Middle Trinity | LGR, Hensel, Cow Creek | 1283 | 7/27/2021 | 1014.5 | 416 | |
| Section 25 | 5763901 | | 30.0272 | -98.1473 | Middle Trinity | | 1039 | 7/13/2021 | 922.4 | | |
| Smith | | | 30.03907 | -98.2237 | Middle Trinity | | 1023 | 7/22/2021 | 958 | 345 | |
| Stancliff | | 551189 | 30.02049 | -98.2884 | Middle Trinity | primary LGR, also Hensel and Cow Creek | 1165 | 7/21/2021 | 1059.9 | 389 | |
| Stang | | | 30.0399 | -98.2262 | Middle Trinity | | 1026 | 7/22/2021 | 951.3 | 349 | |
| Stewart | | 511820 | 30.10429 | -98.1772 | Middle Trinity | LGR, Hensel, Cow Creek | 1367 | 7/27/2021 | 994.8 | 564 | |
| Still #1 | 5762901 | | 30.03818 | -98.2587 | Middle Trinity | | 1075 | 7/15/2021 | 992 | | |
| Still #4 | 5762602 | | 30.06367 | -98.2575 | Middle Trinity | | 1209 | 7/15/2021 | 1029 | | |

| *Name* | *SWN* | *Well Report Tracking #* | *Latitude* | *Longitude* | *Aquifer* | *Producing Formation* | *Surface Elevation (ft-msl)* | *Measurement Date* | *Water Level Elevation (ft-msl)* | *TDS (mg/L)* | *Notes* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vallejo | | | 30.03599 | -98.1783 | Middle Trinity | | 1179 | 7/29/2021 | 932.3 | 408 | |
| WC Maint 2 | 5764703 | | 30.02846 | -98.1117 | Middle Trinity | | 962 | 7/13/2021 | 916.4 | | |
| Weinberg | | | 30.10769 | -98.2517 | Middle Trinity | | 1305 | 7/29/2021 | 1021.3 | 363 | |
| Woodcreek 23 | 5763908 | | 30.03908 | -98.1437 | Middle Trinity | | 1050 | 7/13/2021 | 922 | | |
| Zlatkovich | | | 29.97375 | -98.2669 | Middle Trinity | | 1190 | 7/28/2021 | 949.2 | 381 | |
| Zoboroski | | | 29.99343 | -98.2408 | Middle Trinity | | 1140 | 7/28/2021 | 936.2 | 375 | |

***Table 3.*** *Lower Trinity potentiometric data and TDS for wells used during study (lowest TDS value shown in blue, highest TDS value shown in red – excluding two wells with TDS in 300s)*

| ***Name*** | ***SWN*** | ***Well Report Tracking #*** | ***Latitude*** | ***Longitude*** | ***Aquifer*** | ***Producing Formation*** | ***Surface Elevation (ft-msl)*** | ***Measurement Date*** | ***Water Level Elevation (ft-msl)*** | ***TDS (mg/L)*** | ***Notes*** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Buffington | | 564245 | 30.00151 | -98.2124 | Lower Trinity | | 1112 | 8/5/2021 | | 3852 | |
| Byrum Dry Cypress | 5763603 | 86847 | 30.05889 | -98.1542 | Lower Trinity | Hosston | 1069 | 7/15/2021 | 893.8 | | |
| Davidson | | 556897 | 30.02229 | -98.1838 | Lower Trinity | Sligo/Hosston | 1100 | 8/3/2021 | 844 | 1799 | |
| Davidson | | | 30.02185 | -98.1839 | Lower Trinity | | 1100 | 8/3/2021 | 859.2 | | |
| Finley | | 92903 | 30.0425 | -98.2144 | Lower Trinity | Sligo/Hosston | 1147 | 8/5/2021 | 930 | | |
| Livingston - Prima Vista | | 482381 | 30.04909 | -98.2144 | Lower Trinity | Sligo | 1136 | 7/20/2021 | 942.2 | 372 | |
| Loschiavo | | 458031 | 30.04772 | -98.2181 | Lower Trinity | Hosston | 1096 | 7/22/2021 | 937.3 | 1435 | |
| LSR Telemetry | 5763705 | | 30.03486 | -98.2411 | Lower Trinity | | 1185 | 7/22/2021 | 935.2 | | |
| Getaway Austin | | 523359 | 30.06882 | -98.2003 | Lower Trinity | Hosston | 1258 | 7/27/2021 | 881.7 | 2167 | Omitted, too much pumping influence |
| McMeans | 5763806 | | 30.00804 | -98.1767 | Lower Trinity | | 1102 | 8/10/2021 | 875.9 | | |
| Mozisek | | 508961 | 30.02006 | -98.1875 | Lower Trinity | Hosston | 1099 | 8/3/2021 | 862.5 | 1428 | |
| Nesby | | 474497 | 30.04671 | -98.2174 | Lower Trinity | Sligo/Hosston | 1068 | 7/20/2021 | 939.6 | 1217 | |
| Regante | | 421458 | 30.02644 | -98.2304 | Lower Trinity | Sligo/Hosston | 1078 | 7/22/2021 | 910.7 | 3000 | |
| Roberts | 5763201 | | 30.09064 | -98.2014 | Lower Trinity | | 1344 | 7/15/2021 | 961.3 | | |

| *Name* | *SWN* | *Well Report Tracking #* | *Latitude* | *Longitude* | *Aquifer* | *Producing Formation* | *Surface Elevation (ft-msl)* | *Measurement Date* | *Water Level Elevation (ft-msl)* | *TDS (mg/L)* | *Notes* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Shadowens | | 291138 | 30.01972 | -98.1822 | Lower Trinity | Sligo/Hosston | 1097 | 8/3/2021 | 858 | 1916 | |
| Stanovich | | 575340 | 30.03985 | -98.2171 | Lower Trinity | Sligo | 1083 | 7/22/2021 | 941.4 | 323 | |
| Still #6 | 5763706 | 89794 | 30.04121 | -98.2418 | Lower Trinity | | 1105 | 8/10/2021 | 928 | | |
| Tucker | | | 29.96364 | -98.2918 | Lower Trinity | | 1230 | 7/21/2021 | 875.8 | 2669 | |
| WC Arapahoe | 5763604 | 297090 | 30.04252 | -98.1557 | Lower Trinity | | 1090 | 7/13/2021 | 886.6 | | |
| Wilks | | 463965 | 30.04832 | -98.2153 | Lower Trinity | Hosston | 1116 | 7/20/2021 | 928.9 | 1482 | |
| Wimberley Oaks Water Supply Corp | | | 30.00315 | -98.1839 | Lower Trinity | | 1095 | 8/4/2021 | 745.1 | 2312 | Omitted, too much pumping influence |

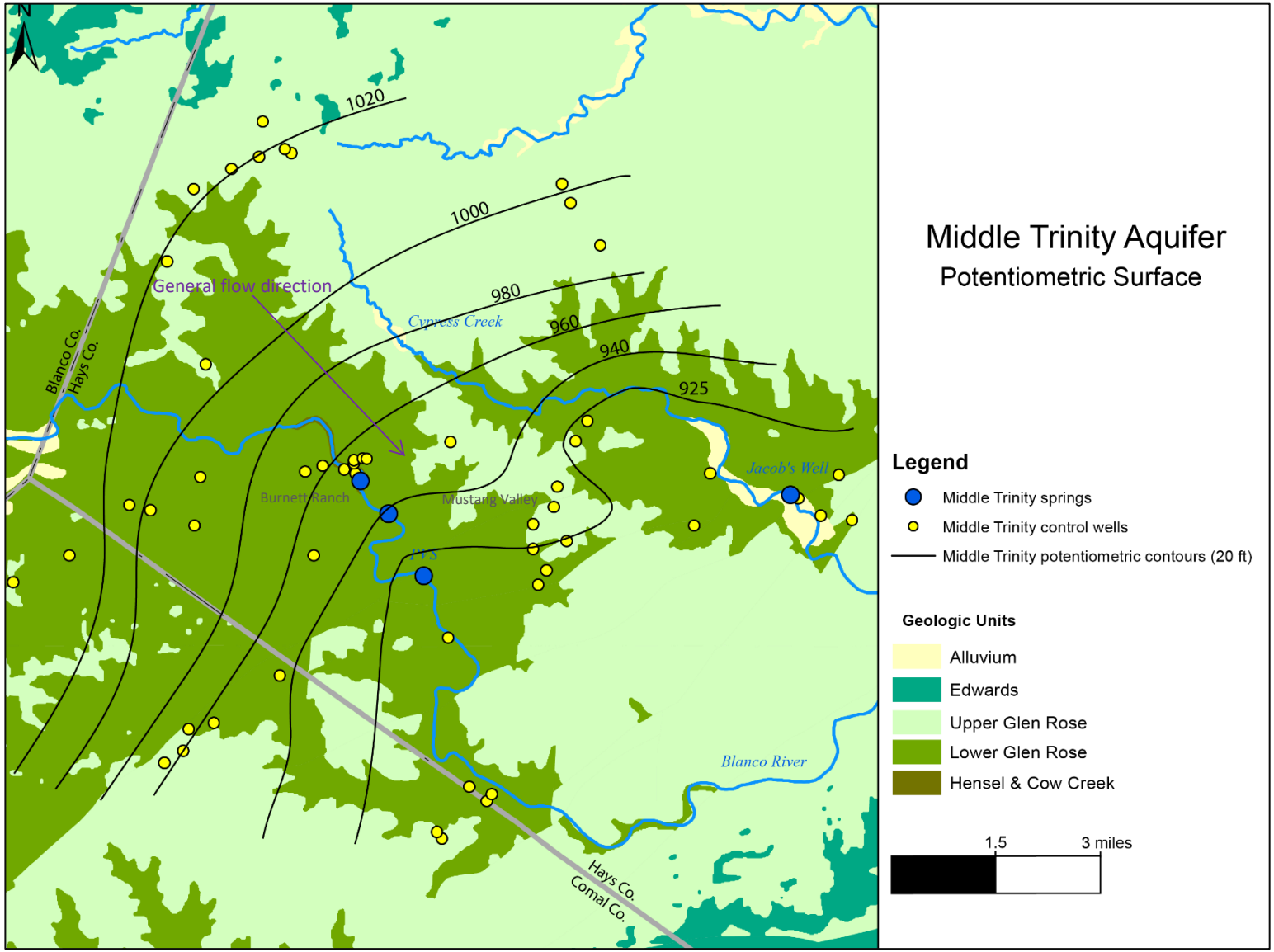


***Figure 3.*** *Potentiometric map of the Middle Trinity Aquifer, July 2021.*

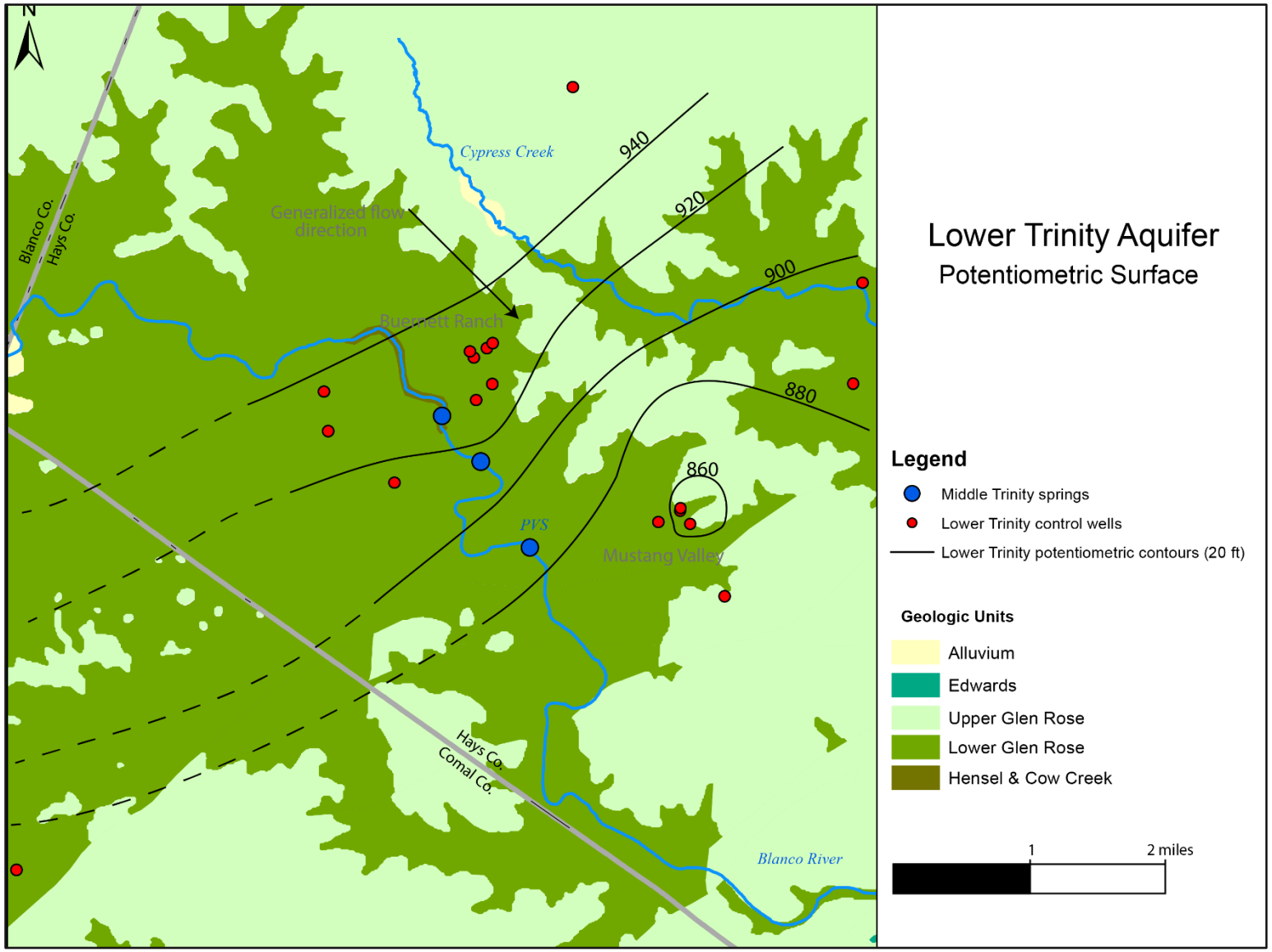


***Figure 4.*** *Potentiometric map of the Lower Trinity Aquifer. Dashed lines are inferred.*

**Discussion**

*Middle Trinity Aquifer*

The July 2021 Middle Trinity potentiometric map (Figure 3) shows a general trend of groundwater flow from the northwest to the southeast. Groundwater flow generally follows the dip direction and structure of the Middle Trinity units. The map indicates groundwater entering the RRSZ flows from Blanco and Comal County. Groundwater contributing to the Cypress Creek watershed flows from the north and continues downdip towards Jacob's Well. Groundwater that does not discharge at Jacob's Well or Pleasant Valley Springs continues downdip across the faults towards the southeast. As flow approaches the BFZ, contour spacing tightens and the gradient steepens, as seen in the 2014 and 2018 potentiometric map. Steeper gradients reveal that BFZ faults act as low-flow boundaries downdip of the study area (Watson et al. 2014; Hunt et al. 2019).

Deviations from the generalized flow direction can be caused by geologic or hydrologic factors (e.g., facies change, faults, recharge, springs, etc.), some exemplified in the potentiometric surface maps. A notable potentiometric trough can be observed updip of Jacob's Well along the 925-ft contour line and can be described as a preferential flow path towards Jacob's Well. Another smaller trough is likely present upstream of Pleasant Valley Spring. A higher concentration of water level data around PVS is needed to delineate the extent of the trough. Also along the 925-ft contour line, a potentiometric ridge is observed separating the two spring's troughs. The ridge serves as a groundwater divide causing water to either flow towards JW or PVS. The updip extent of the groundwater divide is uncertain; additional water level data in this area are needed. In north Cypress Creek, flow transitions from southeast to the south; this has been observed in previous studies and is likely attributable to Onion Creek recharging the Middle Trinity and the Cypress Creek Anticline (Wierman et al., 2010; Hunt et al., 2019).

The hydraulic head in feet above the top of the Cow Creek is mapped to assess influences on water column thickness (Figure 6). The Burnett Ranches region shows unconfined conditions for the Middle Trinity Aquifer surrounding the outcropping of the Hensel and Cow Creek Formations in the Blanco River (Figure 6), the two most likely being related. The hydraulic head above the Cow Creek top increases sharply downdip due to the formational offsetting of the faults, this rate increases along strike towards Wimberley as the throw increases.

Despite differing hydrologic conditions, general groundwater flow directions and significant features of the potentiometric surface map are similar to previous studies (e.g., Davidson 2008; Watson et al. 2014; Hunt et al. 2019). The similarity to previous studies indicates a consistency of the troughs and ridge and flow regimes over various hydrologic conditions.

Comparing water levels in areas included in previous studies, the Burnett Ranch and Mustang Ranch subdivisions do not appear to have significant differences beyond expected hydrological conditions and seasonal differences. Two wells included in previous studies with continuous data are Still #1 and Still #4 (Figure 5). The Still wells are just west of the Burnett Ranch subdivision and produce from the Middle Trinity Aquifer. No decreasing trend in either of these wells has been observed since data collection started, likely due to the Middle Trinity's connectivity with surface water and high transmissivity as well as being outside an area with a high concentration of wells.

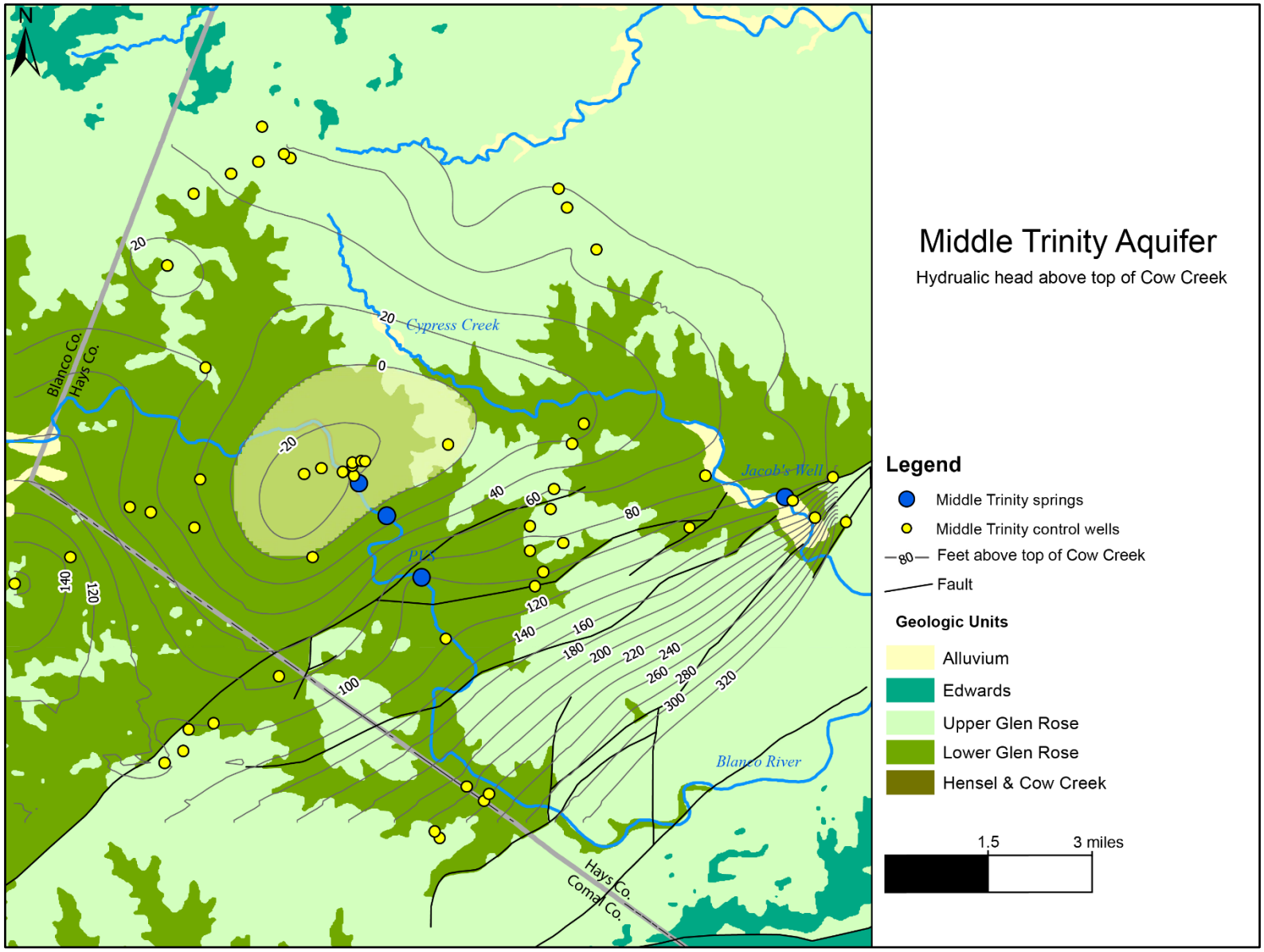


***Figure 6.*** *Feet of hydraulic head above top of Cow Creek Formation. Shaded yellow area around Burnett Ranch shows unconfined conditions. Faults and geologic units from BEG (2014).*

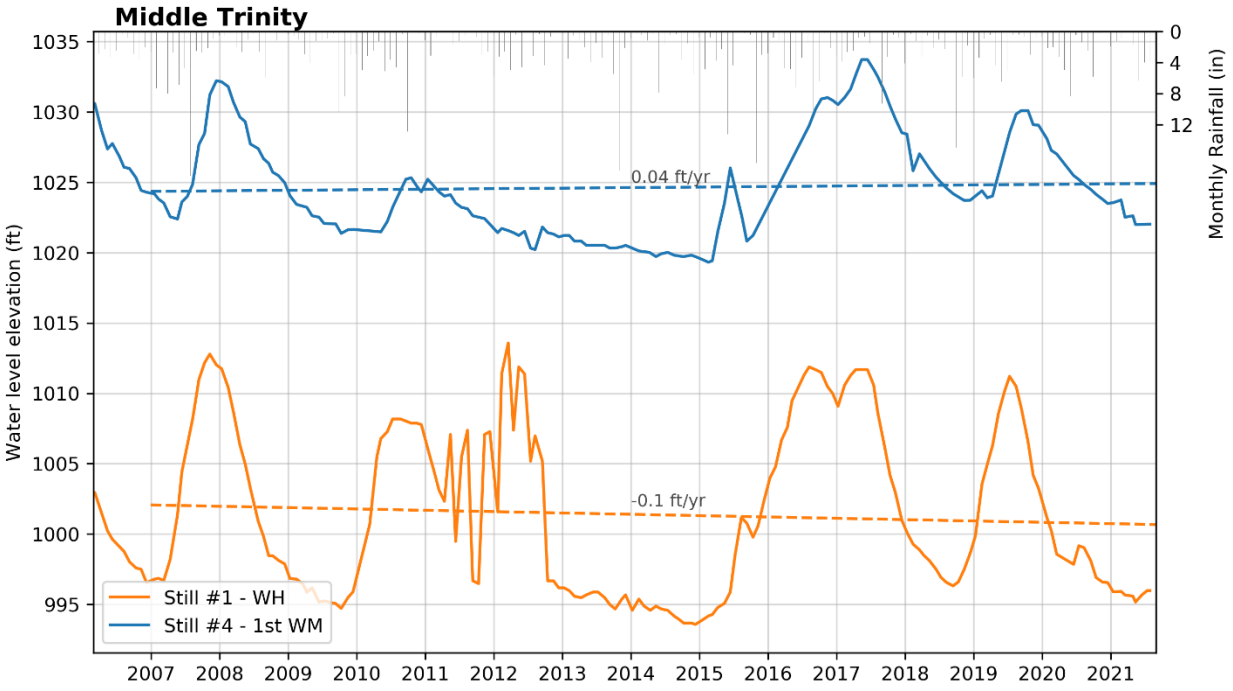


***Figure 5.*** *Hydrograph of Still #1 and #4 with monthly rainfall on the secondary x-axis.*

*Lower Trinity Aquifer*

The July 2021 Lower Trinity potentiometric map shows a general trend of groundwater flow from the northwest to the southeast (Figure 4). Similar to the Middle Trinity, groundwater flow generally follows the dip and structure of the Lower Trinity units.

Water elevation contours near Burnett Ranch and Mustang Valley show a steeper gradient and tightening of contours relative to Cypress Creek watershed and Comal County regions. The tightening of contours may be due to faults offsetting the aquifer units and wells throughout the region, influencing the hydraulic head's gradient. Unlike the Middle Trinity, the Lower Trinity has no significant surface recharge or springs in the study area. Instead, the Mustang Valley pumping center and dip of the aquifer units are the predominant factors influencing the flow regimes depicted in the potentiometric map.

There is a high concentration of wells throughout the two major developments. The 860 and 880-ft contours show a trough around the Mustang Valley development, most likely because of a high concentration of Lower Trinity wells. More data needs to be collected to delineate this depression with more certainty.

There are no previous studies with which to compare the Lower Trinity potentiometric map, but two District monitoring wells within the study area have data going back before 2008 (Figure 6). The McMeans well is just southwest of Mustang Ranch while the LSR Telemetry is on the western end of Burnett Ranch. Both wells show a higher drawdown over time than the two Middle Trinity wells.

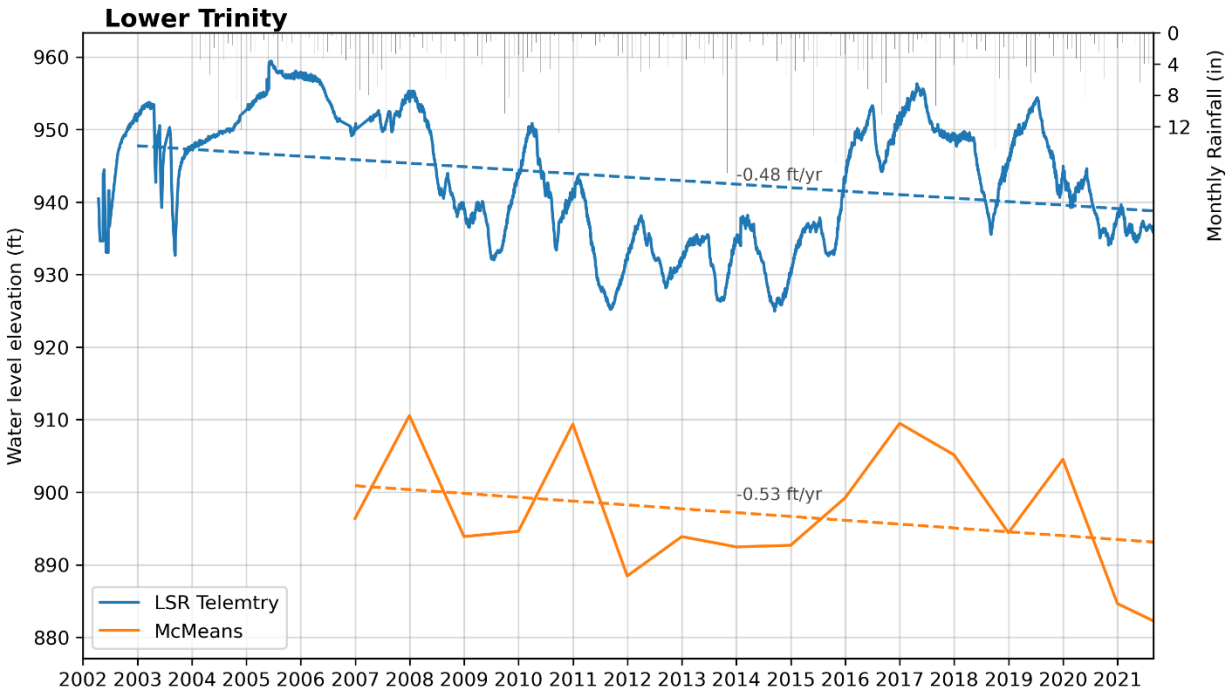


***Figure 6.*** *Hydrograph of LSR Telemetry and McMeans wells with monthly rainfall on the secondary x-axis.*

*Stacked Heads*

Potential relationships between the aquifers can be evaluated with water elevations from the Lower and Middle Trinity Aquifers. In all cases, the hydraulic head of the Middle Trinity was higher than the Lower Trinity and, except where noted, both exhibits confining conditions. Hydraulic head comparisons are limited to the Burnett Ranch and Mustang Valley regions due to the limited Lower Trinity data. The Middle Trinity was about 15-20 feet higher throughout the Burnett Ranch subdivision, while the Mustang Valley subdivision was about 50-60 feet higher. The increased difference being attributable to the overlapping of the Middle Trinity ridge and Lower Trinity depression as seen in the potentiometric maps.

*Water Quality*

The most prominent trend identified from water quality data collected is the difference in total dissolved solids (TDS) measurements between Middle Trinity and Lower Trinity wells. Middle Trinity wells had TDS levels from 230-966 mg/L, and Lower Trinity Wells ranged from 1217-3852 mg/L.

The freshwater versus brackish water threshold is 1000 TDS mg/L, where freshwater is below 1000 mg/L, and brackish is above. The Middle Trinity wells gave measurements for freshwater, and the Lower Trinity measurements were more brackish or salty due to a longer residence time and no direct recharge from surface water. The Middle Trinity receives recharge directly from the surface because of an abundance of karst features.

Two Lower Trinity wells had TDS values in the 300s and are excluded from the Lower Trinity TDS range given. The well construction reports for these two wells indicate they were completed in the Lower Trinity aquifer, so the cause for low TDS values is uncertain but may be due to commingling with the fresher water in the Middle Trinity. The water levels for these wells were consistent with other nearby Lower Trinity wells, but their TDS values were more similar to Middle Trinity wells.

**Conclusion**

Karst topography is a defining characteristic of the Trinity system in the central Texas Hill Country. It provides a unique groundwater network containing many recharge features and springs, such as Pleasant Valley Spring and Jacob's Well Spring. These springs are key indicators of aquifer conditions for areas near the city of Wimberley and allow for rapid recharge and discharge of the Middle Trinity. Many recharge features are found within the RRSZ, an area that supplies large amounts of recharge to the Middle Trinity Aquifer in southwestern Hays County.

The July 2021 potentiometric maps for the Middle and Lower Trinity Aquifers provide useful insight into the current state of groundwater flow paths and water level trends for both aquifers in southwestern Hays County. The Lower Trinity map is the first potentiometric map created for this study area. Both maps display a general flow from the northwest to the southeast towards the Balcones Fault Zone. The Middle Trinity potentiometric surface has a significant trough and ridge near Jacob's Well, consistent with previous studies. From this study, there seems to be a clear distinction between TDS in the Middle Trinity and Lower Trinity.

**Future Works**

- To further understand the troughs and ridges observed in the Middle Trinity potentiometric map, more data points are needed in this area where the Cypress Creek and Blanco River watersheds share a boundary.
- Very little information is available for the Lower Trinity Aquifer in this region. More data points are needed to better characterize groundwater flow in this aquifer.
- More extensive water quality data was collected from Lower Trinity wells, and results will be ready for review in the future.

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