TRINITY GLEN ROSE
GROUNDWATER
CONSERVATION
DISTRICT

A Geologic and Hydrologic Review of the Trinity Aquifer within the Trinity Glen Rose Groundwater Conservation District

(Developed for the TGR Management Plan)

August 30, 2025

E. WATER RESOURCES

TOPOGRAPHY AND DRAINAGE

The District includes the northern third of Bexar County as well as small parts of Comal and Kendall counties. This area is part of the Edwards Plateau, where the sedimentary Cretaceous units, including the Trinity Group and Edwards limestone, are on the upthrown side of the Balcones Fault Zone. This area is broad and topographically high, and is composed of Cretaceous Period limestone, dolomite, and marl. Deep erosion and downcutting by streams and rivers in the area have resulted in a unique landscape, typically characterized by rugged topography with steep stream valleys dissecting the limestone outcrop and juniper and oak woodlands being the primary vegetation in much of the area. Elevation within the District ranges from approximately 730 feet above sea level where the Cibolo Creek leaves northeastern Bexar County to approximately 1,892 feet above sea level at Mount Smith in the northwestern portion of the District.

The District is located entirely within the San Antonio River basin and is divided by three sub-basins: the Cibolo Creek, Medina River, and Upper San Antonio River sub-basins (Figure 1). The Cibolo Creek, Leon Creek, Salado Creek, and the Upper San Antonio River watersheds provide for surface drainage generally from the northwest to the southeast within the District. Cibolo Creek is a tributary of the San Antonio River and drains from northwest to southeast across the Trinity Group of Aquifers, where it is a major recharge feature of these aquifers. Cibolo Creek is also the county boundary between portions of northern Bexar County and adjacent counties to the north and east. Salado and Leon Creeks flow from northwest to southeast through the middle of the District, eventually joining the San Antonio and Medina Rivers to the south.

GEOLOGY

The rocks that make up the aquifers of the District are Cretaceous-age limestones, dolomites, and sandstones of the Trinity Group. A simplified stratigraphic and hydrostratigraphic section of the Edwards and Trinity Groups in the Hill Country area (Figure 2) shows the various units that underlie the District, including the Glen Rose Limestone, Hensell Sand, Cow Creek Limestone, Hammett Shale, Sligo Limestone, and Hosston Sand. The geologic formations that are present at the surface of most of the District (Figure 3) include the Glen Rose Limestone and the Edwards Limestone, as well as small outcrops of several other younger Cretaceous formations that are present at the surface in the southern parts of the District, including the Anacacho Limestone, Austin Chalk, Pecan Gap Chalk, and Buda Limestone. Quaternary deposits are also present along some streams and rivers, including the Leona Formation and Uvalde Gravel. The other important Trinity Group formations are present only in the subsurface in the District, including the Hensell Sand, Cow Creek Limestone, Sligo Limestone

Figure 1. River sub-basins in the TGRGCD.

Stratigraphic Units of the Trinity Group in South Central Texas
(adapted from Ashworth, 1983)

Stratigraphic Unit		Hydrologic Unit	Approx. Maximum Thickness (feet)	Character of Rocks	Water-Bearing Properties
Glen Rose Limestone	upper member	Upper Trinity	500	Alternating resistant and non-resistant beds of blue shale, nodular marl, and impure fossiliferous limestone. Also contains two distinct evaporite zones.	Yields very small to small quantities of relatively highly mineralized water.
	lower member	Middle Trinity	320	Massive, fossiliferous limestone grading upward into thin beds of limestone, dolomite, marl, and shale. Numerous caves and reefs occur in the lower portion of the member.	Yields small to moderate quantities of fresh to slightly saline water.
Travis Peak Formation	Hensell Sand Member / Bexar Shale Member		300	Red to gray clay, silt, sand, conglomerate, and thin limestone beds grading downdip into silty dolomite, marl, calcerous shale, and shaley limestone.	
	Cow Creek Limestone Member		90	Massive, fossiliferous, white to gray, argillaceous to dolomitic limestone with local thinly bedded layers of sand, shale, and lignite.	
	Hammett Shale Member		80	Dark blue to gray, fossiliferous, calcareous and dolomitic shale with thinly interbedded layers of limestone and sand.	Not known to yield water.
	Sligo Limestone Member / Hosston Sand Member	Lower Trinity	120	Sandy dolomitic limestone.	Yields small to large quantities of fresh to slightly saline water.
			350	Red and white conglomerate, sandstone, claystone, shale, dolomite, and limestone.	

Figure 2. Generalized stratigraphic and hydrostratigraphic section of the Trinity Group (source: edwardsaquifer.net).

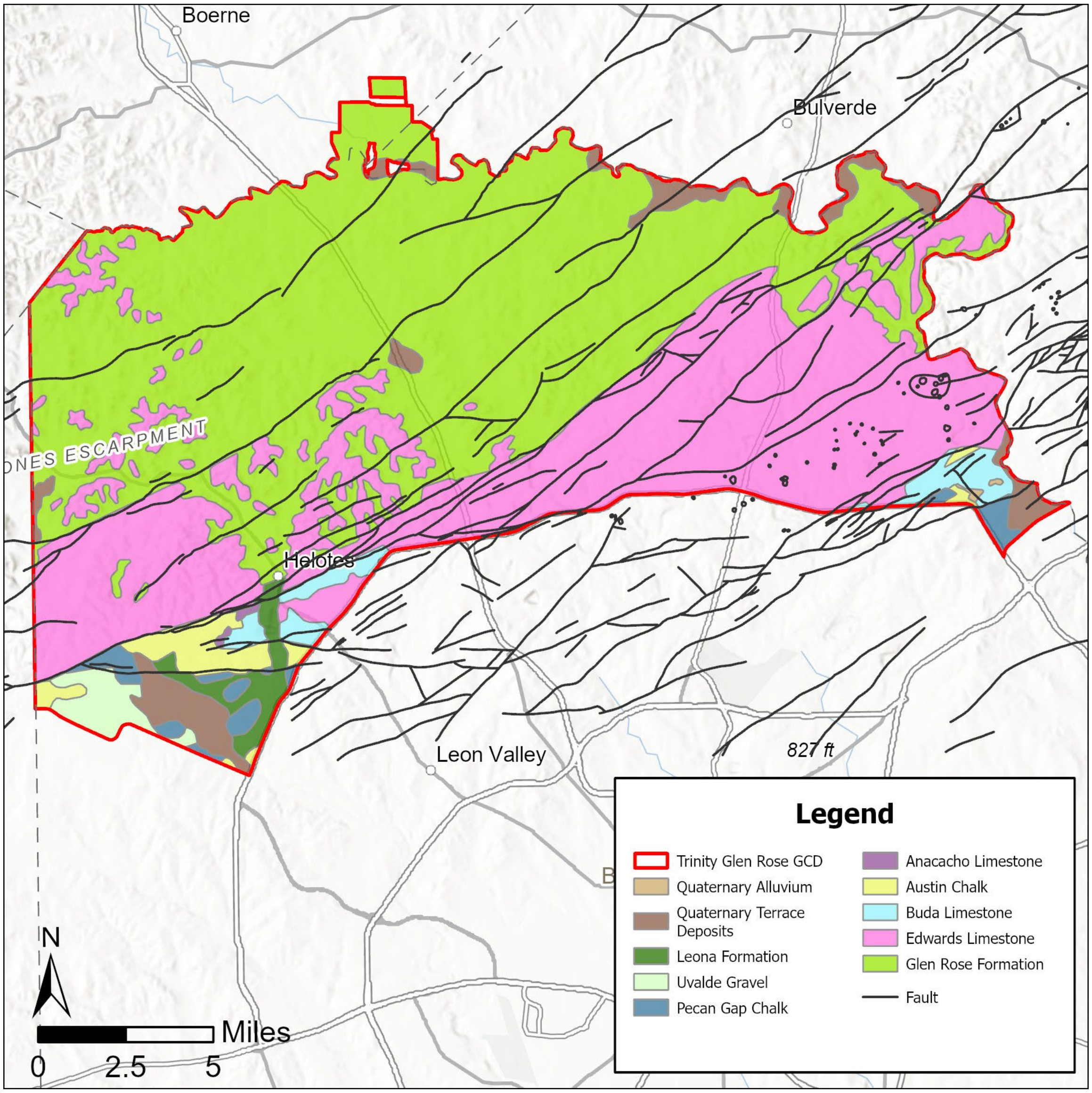

Figure 3. Surface geology map in the TGRGCD.

and Hosston Sand, which are sometimes referred to collectively as the Travis Peak Formation in the region (Figure 2). Although the Edwards Limestone and other younger formations are present in the southern portion of the District, and there are wells that produce groundwater from this formation, groundwater production from these units do not fall within the District's authority and therefore are not described in this plan.

Figure 3 also illustrates many northeast-southwest trending faults that are part of the Balcones Fault Zone. This fault zone is a series of normal faults that run from Del Rio to Dallas and form the Balcones Escarpment, which is the eastern edge of the Texas Hill Country. A generalized cross-section across the Balcones Fault Zone is shown in Figure 4, which reflects how the formations that make up the Trinity Aquifer get progressively deeper across the fault zone.

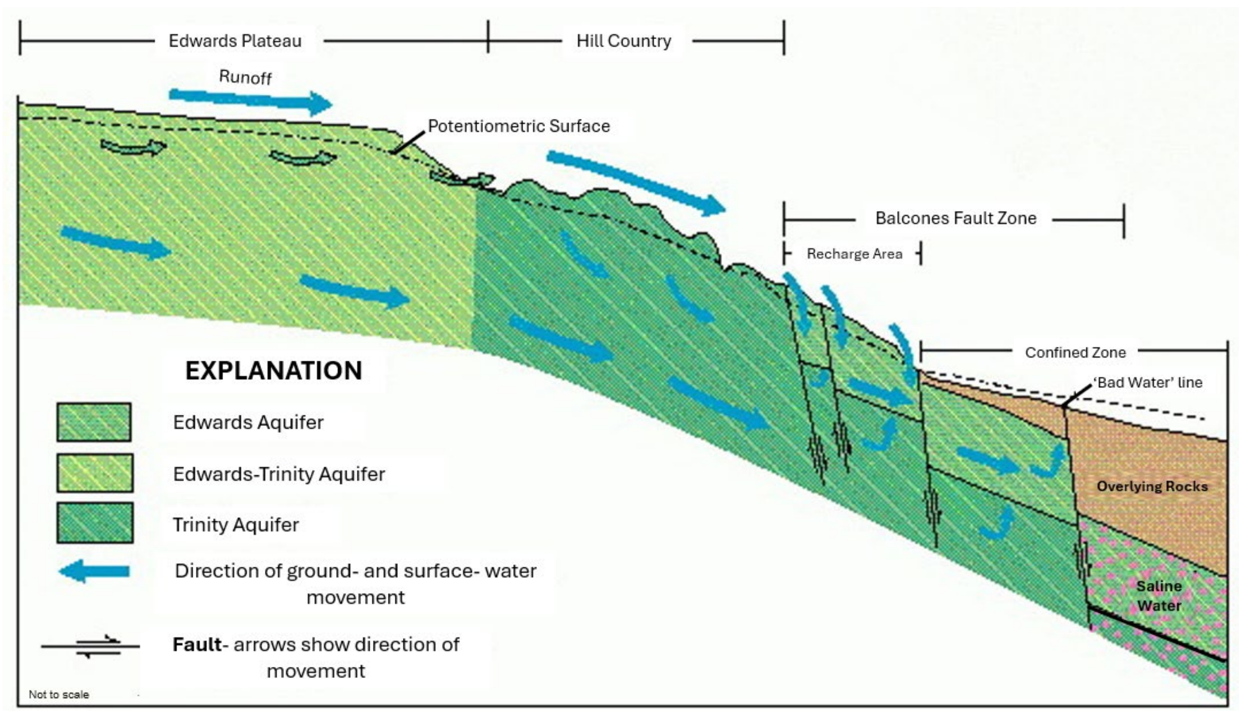

Figure 4. Generalized cross-section across the Balcones Fault Zone (from Ryder, 1996).

The main Trinity Group of Aquifers that make up the groundwater resources managed by the District are the Glen Rose Limestone, the Cow Creek Limestone, the Sligo Limestone, and the Hosston Sand. Each of these are described below (descriptions based on Manford and others (1959), Jones and others (2011), and Robinson and others (2022)).

Glen Rose Limestone- The Glen Rose Formation is up to 1,500 feet thick in the Hill Country and is generally subdivided into the Upper Glen Rose Limestone and the Lower Glen Rose Limestone. The Upper Glen Rose represents the top of the Trinity Group and is characterized by thin to medium beds of marl, limestone, and dolostone. The alternating beds of nonresistant marl and resistant limestone and dolostone give the classic stair-step topography that is characteristic of much of the Texas Hill Country. The Upper Glen Rose makes up the Upper Trinity hydrologic unit.

The Lower Glen Rose is composed of massive beds of limestone, dolostone, and dolomitic limestone separated by clay-rich intervals. The Lower Glen Rose is the upper member of the Middle Trinity hydrologic unit.

Bexar Shale/Hensell Sand- The Bexar Shale/Hensell Sand can be up to 200 feet thick and is composed of poorly cemented clay, quartz, calcareous sand, chert, and dolomitic gravel. In Bexar County, this unit is characterized by shales, silts, and fine sand layers. The Hensell is the middle member of the Middle Trinity hydrologic unit.

Cow Creek Limestone- The Cow Creek Limestone is a relatively thin unit, up to 90 feet thick, in the Hill Country. The lower part consists of fine- to coarse-grained calcareous sandstone, which is overlain by silty calcareous sandstone in the middle portion of the unit, and a coarse-grained fossiliferous limestone in the upper part of the unit. The Cow Creek is the basal member of the Middle Trinity hydrologic unit.

Hammett Shale - The Hammett Shale is up to 80 feet thick and is a dark dolomitic shale with thin interbedded limestone layers. The Hammett is not known to yield water in the region.

Sligo Limestone- The Sligo Formation is composed of up to 250 feet of evaporites, limestone, and dolostone with some interbedded shale. The Sligo represents the upper member of the Lower Trinity hydrologic unit.

Hosston Sand- The Hosston Sand can be up to 900 feet thick and consists of sandstone and shale. The sandstones are generally fine-grained, can be massive, and contain some silt and clay. Some conglomerates have been found at the base of the Hosston. The Hosston is the basal member of the Lower Trinity hydrologic unit.

HYDROGEOLOGY

The Trinity Aquifer is the primary water source within the District. The Trinity Aquifer is one of nine major aquifers defined by the state, stretching from the Texas Hill Country into Oklahoma. The District is located in the southern portion of the Trinity Aquifer where it underlies the Texas Hill Country as shown in Figure 5. Although it is defined by the state as a major aquifer, the water quality and productivity of the Trinity Aquifer throughout the region, including the District, varies greatly. Trinity Aquifer water well depths vary from shallow, hand-dug wells to drilled wells ranging from 100 feet deep to over 1,200 feet deep based on TWDB records for Bexar County. Depths are highly variable and depend entirely on site-specific topography and geology, especially faulting. Well yields in the Trinity are typically dependent on the nature of fractures and dissolution features intersected by the well bore, which can be highly variable over short distances (Jones and others, 2011). Well yields are typically low (less than 20 gallons per minute (gpm)) but may occasionally be significantly higher, with yields of 400-600 gpm being reported in some wells. Water quality within a specific aquifer can be defined or characterized in a general sense, but can vary significantly based on local geology, hydrology, and structure.

The Trinity Aquifer is generally subdivided into the Upper, Middle, and Lower Trinity Aquifers in the Hill Country region. Each of these is described below (descriptions based on Manford and others (1959), Ashworth (1983), Jones and others (2011), and Robinson and others (2022)).

Upper Trinity Aquifer- The Upper Trinity Aquifer is composed of the Upper Glen Rose Limestone. This part of the Glen Rose has been shown to be hydrologically separated from the Lower Glen Rose by numerous permeability barriers and so forms a separate aquifer unit. The Glen Rose Limestone has limited permeability, although in the outcrop area joint and fissures have allowed solution channels to form in some areas. The Upper Trinity Aquifer generally yields only small quantities of water to wells that may be sufficient for domestic or livestock use in and near the outcrop. However, some larger producing wells may be possible where the solution channels are intersected by the well. Water from deeper wells producing from the Upper Trinity can have poorer water quality than shallow wells producing in or near the outcrop. Water is often produced from the layers that contain gypsum, and the dissolution of gypsum results in relatively poor water quality in wells completed in Upper Glen Rose unit. Wells producing from the underlying Middle Trinity Aquifer are required to seal off the Upper Glen Rose to reduce the potential for lower quality water from the Upper Trinity Aquifer from moving into the Middle Trinity Aquifer.

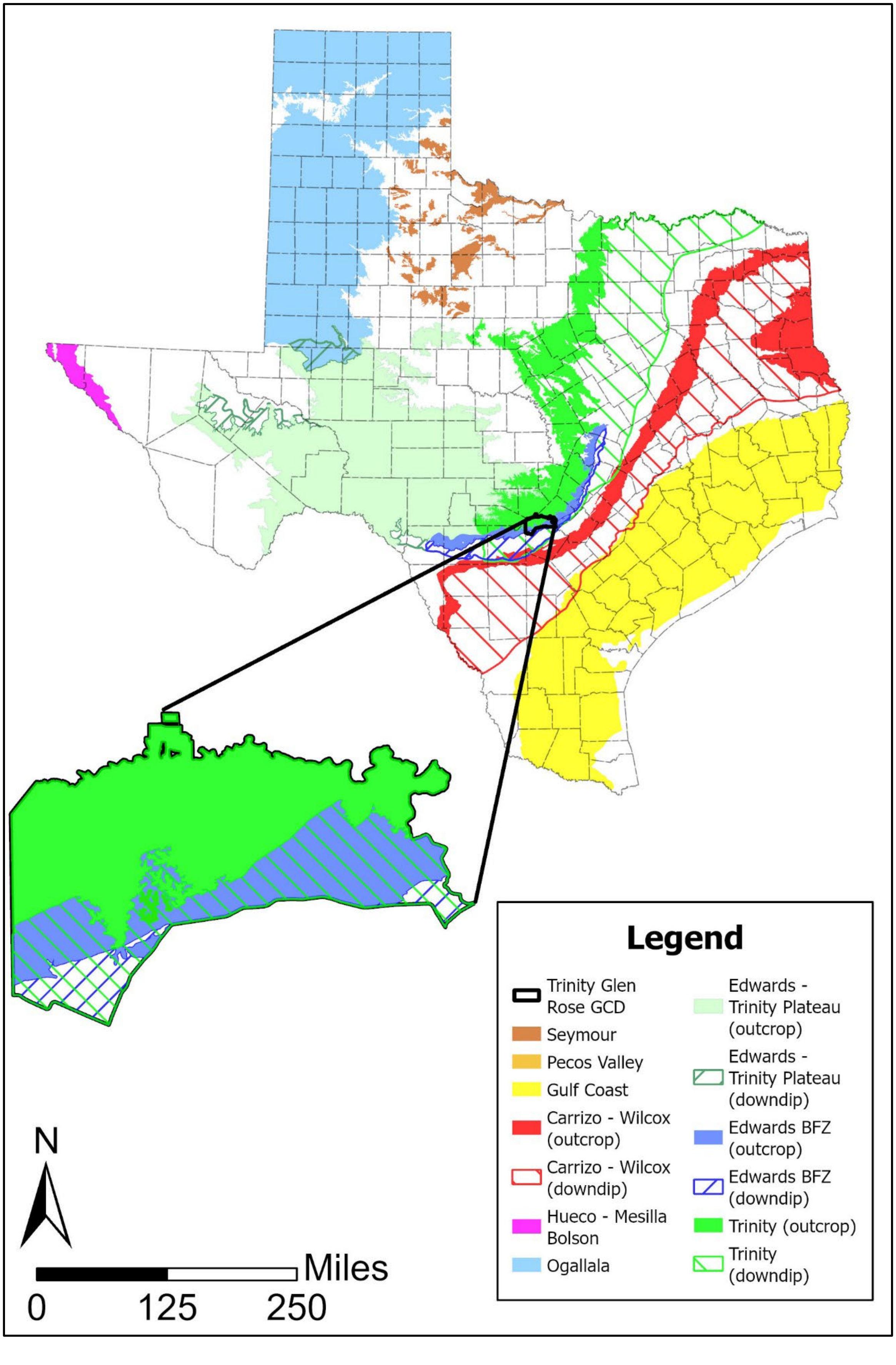

Figure 5. The major aquifers of Texas and the Trinity Glen Rose GCD.

Middle Trinity Aquifer- The Middle Trinity Aquifer is composed of the Lower Glen Rose Limestone, the Hensell Sand, and the Cow Creek Limestone and is the main aquifer unit that is used within the District. Wells producing from the Middle Trinity have highly variable productivity, with many wells only producing a few tens of gallons per minute, but some capable of producing 400 to 600 gpm in some areas. Wells producing from the Middle Trinity are typically between 400 and 700 feet deep in the northern part of the District but can be nearly 1,200 feet deep in the southern part of the District. In Bexar County, very little groundwater production occurs from the Bexar Shale/Hensell Sand layers because it is generally too shaley. The top 20 feet of the Cow Creek Limestone is often the best producing unit of the Middle Trinity Aquifer, and, occasionally, the reef deposits in the Lower Glen Rose can also be good groundwater producers. Water levels in the Lower Glen Rose portion of the Middle Trinity Aquifer tend to fluctuate in some areas, resulting in many wells being drilled deeper into the Cow Creek Limestone where water levels are more stable. Historically, some wells in the Middle Trinity requiring larger production have been "acidized" to dissolve limestones near the wellbore and produce higher capacity wells.

Lower Trinity Aquifer- The Lower Trinity Aquifer is composed of the Sligo Limestone and the Hosston Sand. These units do not crop out within the District but are present in the subsurface beneath the Glen Rose. A fewer number of wells within the District produce from the Lower Trinity Aquifer from wells that are generally at least 900 feet deep in the northern part of the District. A few higher capacity wells produce from the Lower Trinity Aquifer in the Fair Oaks Ranch area. The Lower Trinity is a less productive unit than the Middle Trinity Aquifer, and the water quality is generally poorer than in the overlying Middle Trinity.

Vertical hydraulic conductivities have not been investigated but are likely to be much lower than lateral hydraulic conductivities in the aquifer system (Jones and others, 2011). Historic estimates of vertical conductivity in the Trinity have been low, and past investigators have noted the preferential movement of water laterally along low-permeability beds rather than vertically through them (Baker and Ardis, 1996; Jones and others, 2011). This relatively low vertical connectivity results in the three separate aquifer units described above.

RECHARGE AND DISCHARGE

Recharge to the Trinity Group of Aquifers occurs via local precipitation on its outcrop, infiltration of flows in Cibolo Creek, and through the overlying units where the Trinity is present in the subsurface. The quantification of recharge to the Trinity Aquifer in the Hill Country is difficult and estimates of recharge to the Trinity Aquifer vary significantly, from as low as 1.5 percent of precipitation to as much as 11 percent of precipitation (Muller and

Prince, 1979; Kuniansky, 1989). Most estimates are between 4 and 7 percent of precipitation (Mace and others, 2000). However, the recharge dynamics in the District are quite different than the Trinity Aquifer throughout much of the Hill Country due to the rapid recharge that occurs through large recharge features, which are present in many areas of the District, but most prevalent in the Cibolo Creek area. When Cibolo Creek has water in the stretches along northern Bexar County, the losses of water from the creek are substantial and serve as a significant recharge source to the Trinity Aquifer in the District. Although this rapid recharge can occur in other isolated areas of the Trinity Aquifer in the Hill Country, it is a dominant recharge mechanism in the District. The substantial volume of recharge that periodically occurs during wet periods and flooding along Cibolo Creek creates relatively large variations in water levels in the Trinity Aquifer in the District. When water levels are high in the District, there is a natural hydraulic gradient that drives groundwater laterally to the southeast into the Edwards Aquifer.

After groundwater is recharged to the aquifer, the karstic nature of many of the formations allow the rapid movement of groundwater through the aquifer. The result can be large fluctuations in water levels in wells as groundwater moves quickly through the aquifer. Water levels in the Boerne Stage Road well are shown in Figure 6, where rapid increases in water levels of over 200 feet are repeatedly observed, followed by almost equally rapid declines in the water levels. Water levels in the La Escondida well are shown in Figure 7, which show a similar water level dynamic through time. Although the water level changes are not as “flashy” as the Boerne Stage well, they also indicate periods of rapid recharge in the Trinity Aquifer.

The cross-formational flow of groundwater from the Trinity units into the Edwards-BFZ Aquifer is also a significant source of discharge from the Trinity Aquifer in the region. The quantification of this regional movement of groundwater from the Trinity to the Edwards is not directly measurable but has been estimated as being tens to hundreds of thousands of acre-feet per year in the region, making it a significant component of the overall water budget of the Trinity Aquifer. Dye tracing studies conducted by the Edwards Aquifer Authority have shown that this interaction is significant and have shown a direct connection between water in the Trinity and in the Edwards through preferential flow pathways (Johnson and others, 2010).

Discharge from the Trinity Aquifers is to wells and springs in the region as well as cross-formational flow to the Edwards Aquifer. Spring discharge from karst aquifers such as the Trinity can be significant, although most of the spring discharge within the District is not from larger, regional springs but rather smaller, intermittent, and/or lower discharge springs that are discharging on the hillsides in the deeply incised topography that characterizes much of the District. These springs are not typically sourced from pressurized aquifers of the District but rather are sourced from downward moving groundwater from infiltrated precipitation on the land surface during wet periods, which continues downward until encountering a less permeable bed. The infiltrating water then moves laterally until it discharges in a small spring or seep on a hillside. The groundwater sourcing these springs is often referred to as "perched" groundwater because it is not sourced from the deeper portions of the aquifers where wells are typically screened. Clark and others (2013) inventoried 141 springs within Northern Bexar County, noting they all discharged at rates of less than 1.5 cubic feet per second (cfs). Overall, discharge from these relatively small springs is seasonal and account for only a small portion of the discharge from the Trinity Aquifer in the District.

Wells are a primary source of discharge from the aquifer. Historic pumping from the Trinity Aquifer within Bexar County has increased over time, from approximately 11,000 acre-feet in 2009 to greater than 23,000 acre-feet per year since 2016. Production from wells can vary significantly based on water levels in the Trinity. Water demand will continue to increase in the Hill Country, and this may add more pressure to increase groundwater production from the Trinity Aquifer in the District. Production from the Trinity Aquifer is primarily used for municipal purposes, with some production for domestic, irrigation, livestock and mining. Over 80 percent of the current groundwater production from the Trinity in the District is used for public water supply.

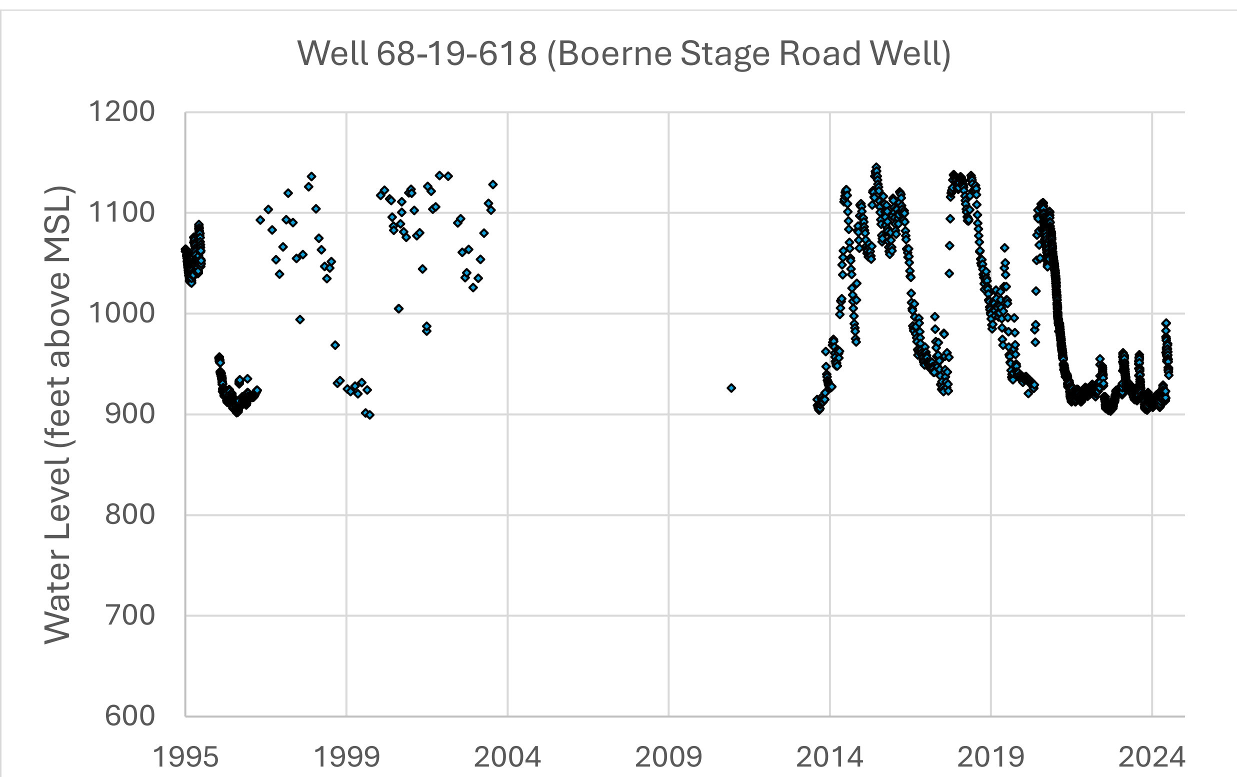

Figure 6. Historic water levels in the Boerne Stage well.

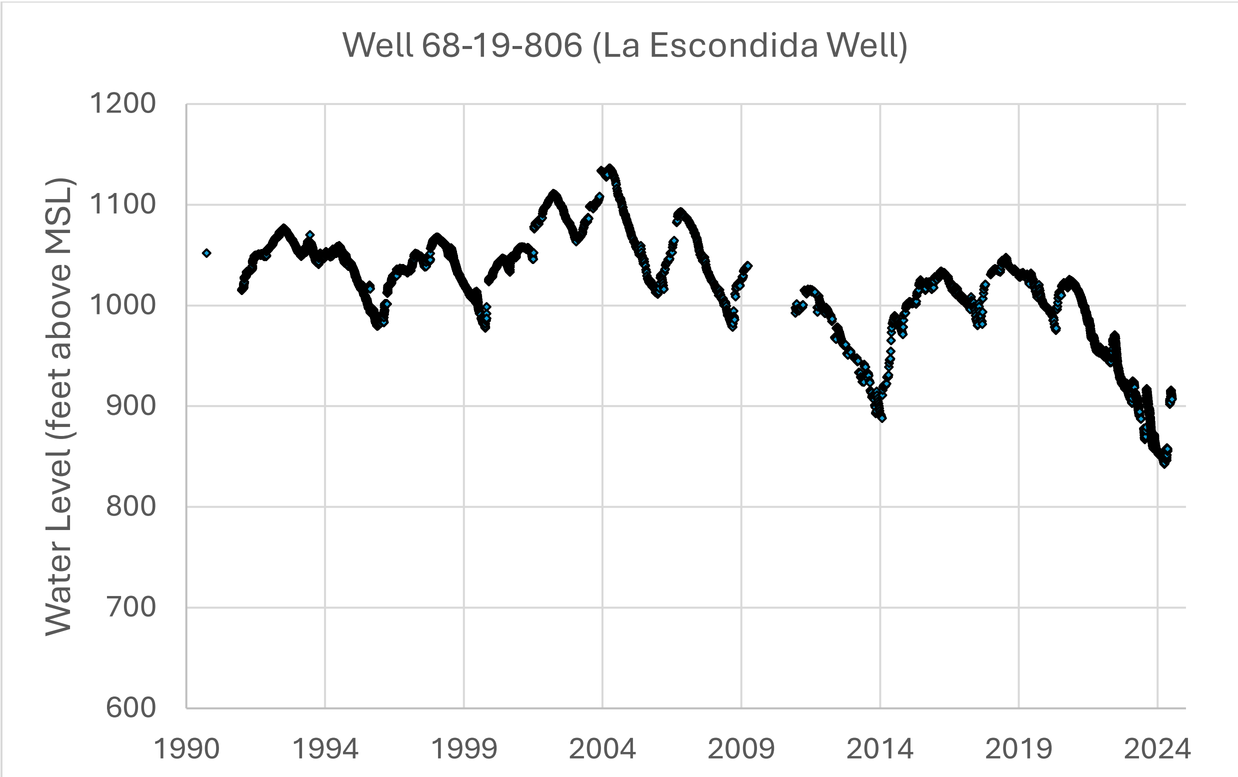

Figure 7. Historic water levels in the La Escondida well

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