Aquifer Assessment 10-28 MAG: Aquifer Assessment for the Leona Gravel Aquifer Within Uvalde County in Groundwater Management Area 10

by Robert G. Bradley, P.G.
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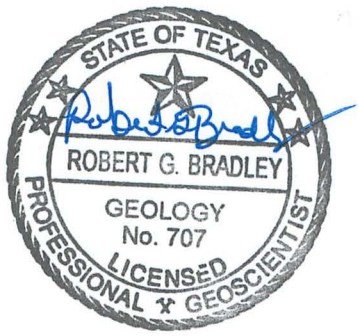
February 4, 2013



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EXECUTIVE SUMMARY:

This report summarizes the modeled available groundwater estimates for the Leona Gravel Aquifer in Uvalde County that lies within Groundwater Management Area 10. This report also updates a previous draft and addresses questions raised by the Uvalde County Underground Water Conservation District (UWCD) concerning the extent of the aquifer. The estimated modeled available groundwater from the Leona Gravel Aquifer within Uvalde County that achieves the desired future condition adopted by districts of Groundwater Management Area 10 is approximately 9,385 acre-feet per year.

REQUESTOR:

Mr. Rick Illgner of the Edwards Aquifer Authority acting on behalf of Groundwater Management Area 10.

DESCRIPTION OF REQUEST:

In a letter received August 30, 2010, Mr. Illgner submitted to the Texas Water Development Board (TWDB) the desired future condition of the Leona Gravel Aquifer within Uvalde County, as adopted by the districts of Groundwater Management Area 10.

The desired future condition for the Leona Gravel Aquifer, as described in Resolution No. 2010-11 and adopted August 23, 2010 by the groundwater conservation districts in Groundwater Management Area 10 is “regional average well drawdown of zero (0) feet (including exempt and non-exempt use)”.

TWDB has estimated the modeled available groundwater that achieves the above desired future condition for the Uvalde County Underground Water Conservation District (UWCD).

METHODS:

Groundwater Management Area 10, located in South Central Texas, includes part of the Leona Gravel Aquifer (Figure 1). This is neither a major nor a minor aquifer, but has been determined to be locally relevant for joint planning purposes. At the request of Groundwater Management Area 10, the TWDB previously estimated the "managed available groundwater" Leona Gravel Aquifer, documented in previous draft GTA Aquifer Assessment 10-28. This report replaces the previous draft report.

The Uvalde County UWCD determined that the extent for the Leona Gravel Aquifer used was too broad in the previous draft, and provided information to narrow the extent of the Leona Gravel Aquifer in Uvalde County. It was first narrowed by only using the mapped portion of the Leona Formation in Uvalde County, and excluding the Quaternary alluvium and terrace units included in the previous draft assessment. The aquifer was then limited by the area where it is used for groundwater production, primarily the Leona Formation that lies within the Leona River and Cooks Slough areas around Uvalde, Texas (Figure 1). The surface water divide between the Leona and Dry Frio rivers was used as the northeast limit of the aquifer.

The area covered by the delineated Leona Gravel Aquifer (Figure 1) aquifer within Uvalde County is 68,458 Acres, and the portion within GMA 10 is approximately 57,474 acres or 84 percent of the total area. This percentage was used to calculate estimated pumpage from Uvalde UWCD data. The previous extent included Quaternary Alluvium, terrace deposits, and additional exposures of the Leona Formation; however, these areas are now excluded as part of the aquifer (Figure 1).

Previous TWDB water budget calculations, with limited data, were used for the calculation of the Leona Gravel in Medina County (George, 2010). These calculations relied on the use of "effective recharge" or the portion of the total recharge available to be used from an aquifer without taking water from storage. If this approach were used for the narrowed Leona Gravel Aquifer, it would result in approximately 6,600 acre-feet per year (see George, 2010).

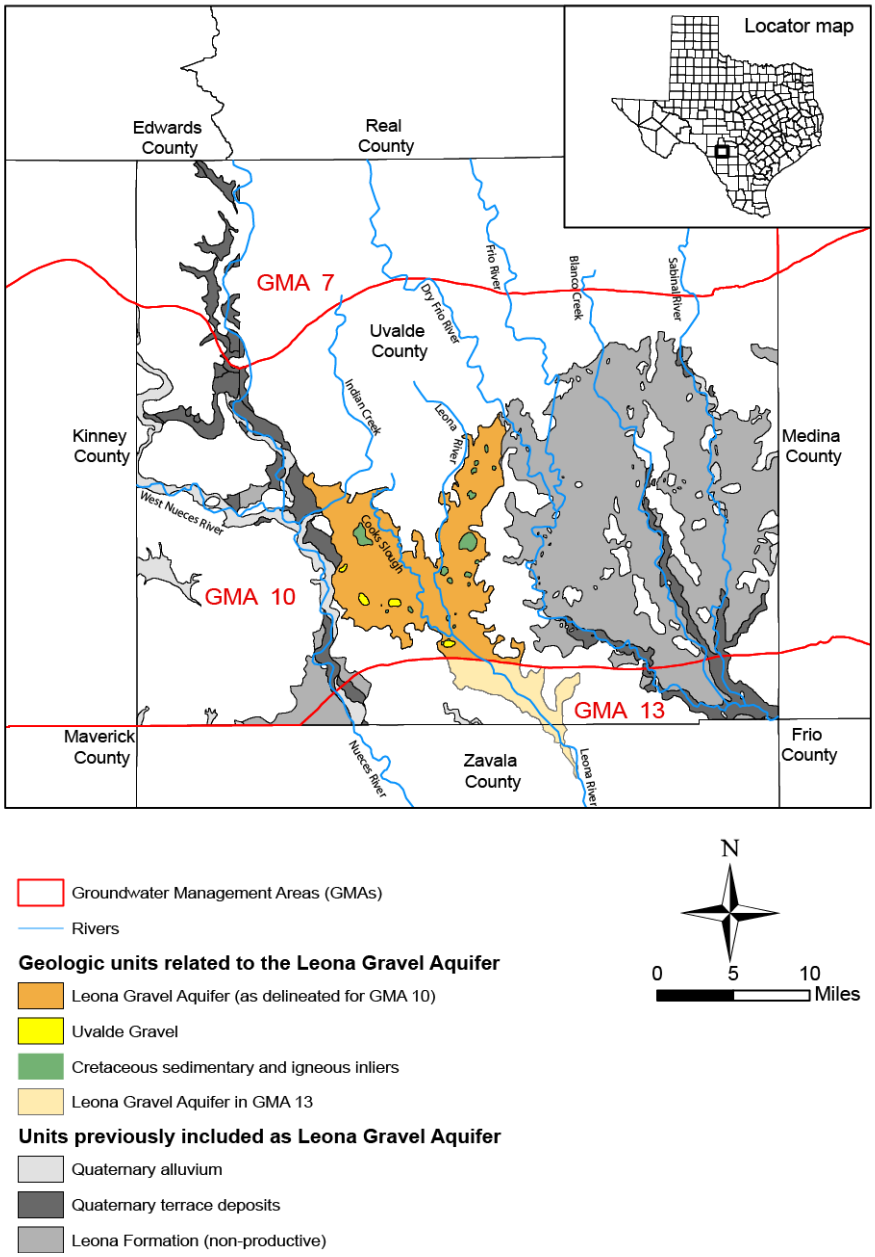

Figure 1. Map of Uvalde County showing the delineated Leona Gravel Aquifer and the previously delineated extent of the aquifer, groundwater management areas, and rivers.

There is a significant inflow from the Edwards Aquifer that flows into the Leona Gravel Aquifer; either directly from the Edwards Aquifer or indirectly through the Buda and Austin Chalk formations. Green and others (2008, p. 899) calculated flow through the Leona Gravel Aquifer near the GMA 10 and 13 boundary (about 4 mi south of Highway 90) to be approximately 74,000 acre-feet per year. This inflow is assumed to continue throughout the system, but it does recharge the aquifer when the Edwards Aquifer is at or above average conditions (Green and others, 2009).

Limited data for both historic water levels and pumpage estimates hinder an estimate of the modeled available groundwater. However, there are four wells within Uvalde County that have short to long term measurements taken from the 1945s to 2001(Figure 2).

Based on historical water levels, the aquifer recharges in response to inflows from the Edwards Aquifer (Green and others, 2008) and behaves in a similar manner as the Edwards Aquifer. The hydrograph of well 69-51-406 shows a highly variable water level trend, that mimics changes in the Edwards Aquifer J-27 index well (Figure 3; EAA, 2012; TWDB, 2012) especially high and low water condition. During the drought of the 1950s, extreme water level declines show up in the other historic well measurements (69-51-801, 69-51-701) that also mimic the J-27 water levels (Figure 3). Figure 4 shows annual minimum and maximum measurements for the same wells to highlight that the Leona Gravel Aquifer reflects water levels in the Edwards Aquifer. Figure 5 shows the water levels for J-27 and well 69-51-406 for the period after 1996, which was the start of the current management of the Edwards Aquifer. Each well hydrograph shows lines indicating the mean water levels from 1996 to 2011.

Without current water level data to match up with current groundwater pumpage estimates from the Uvalde UWCD, it is difficult to ascertain the modeled available groundwater. However, J-27 hydrograph does indicate a possible correlation between water-level conditions in the Edwards Aquifer and water levels within the Leona Gravel Aquifer.

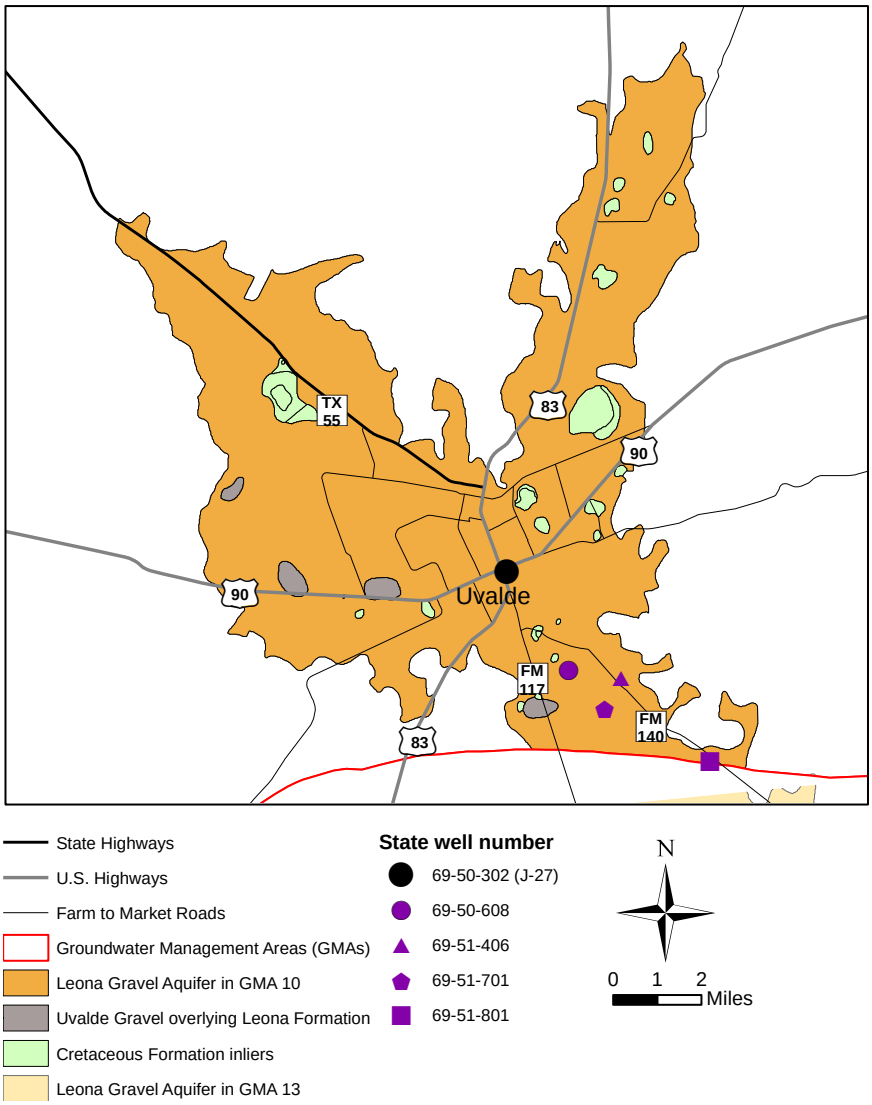

Figure 2. Hydrograph locations of J-27 and Leona Gravel Aquifer wells.

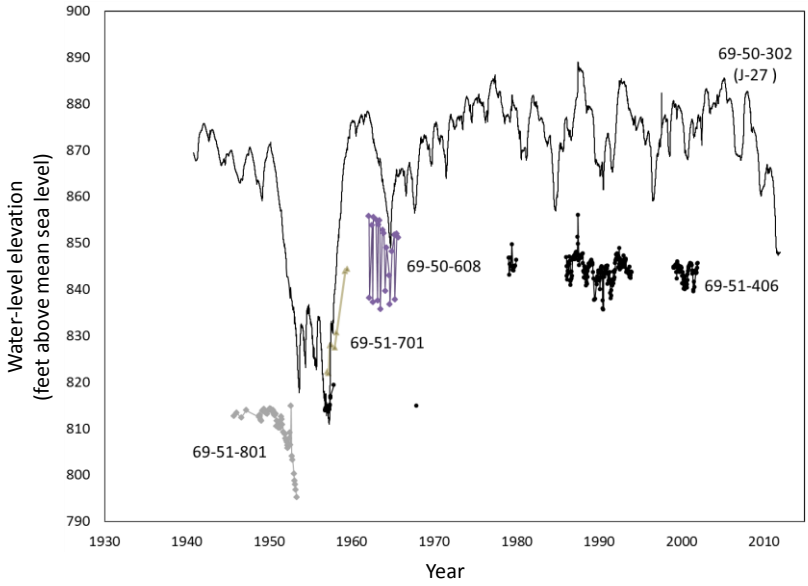

Figure 3. Hydrographs of the J-27 Edwards Aquifer index well and Leona Gravel Aquifer wells in Uvalde County (EAA, 2012; TWDB, 2012).

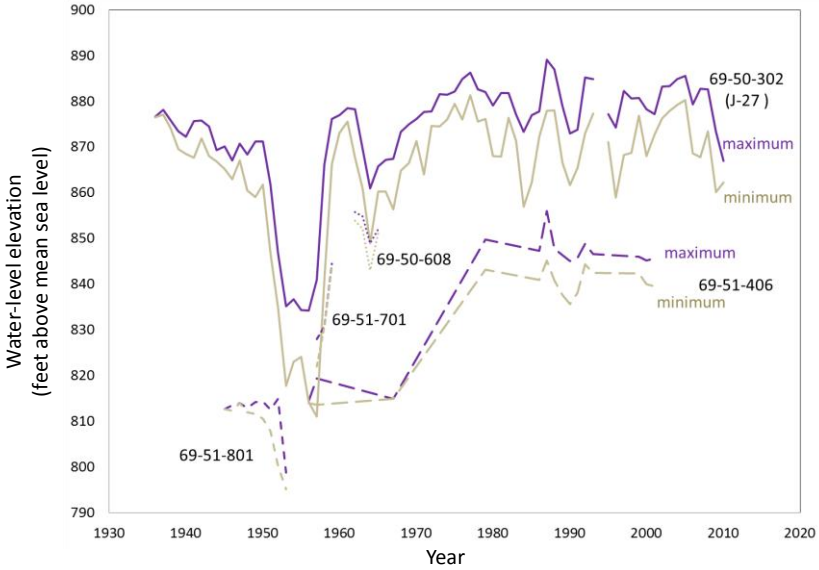

Figure 4. Hydrographs showing maximum and minimum annual water levels for the J-27 Edwards Aquifer index well and Leona Gravel Aquifer wells in Uvalde County (EAA, 2012; TWDB, 2012).

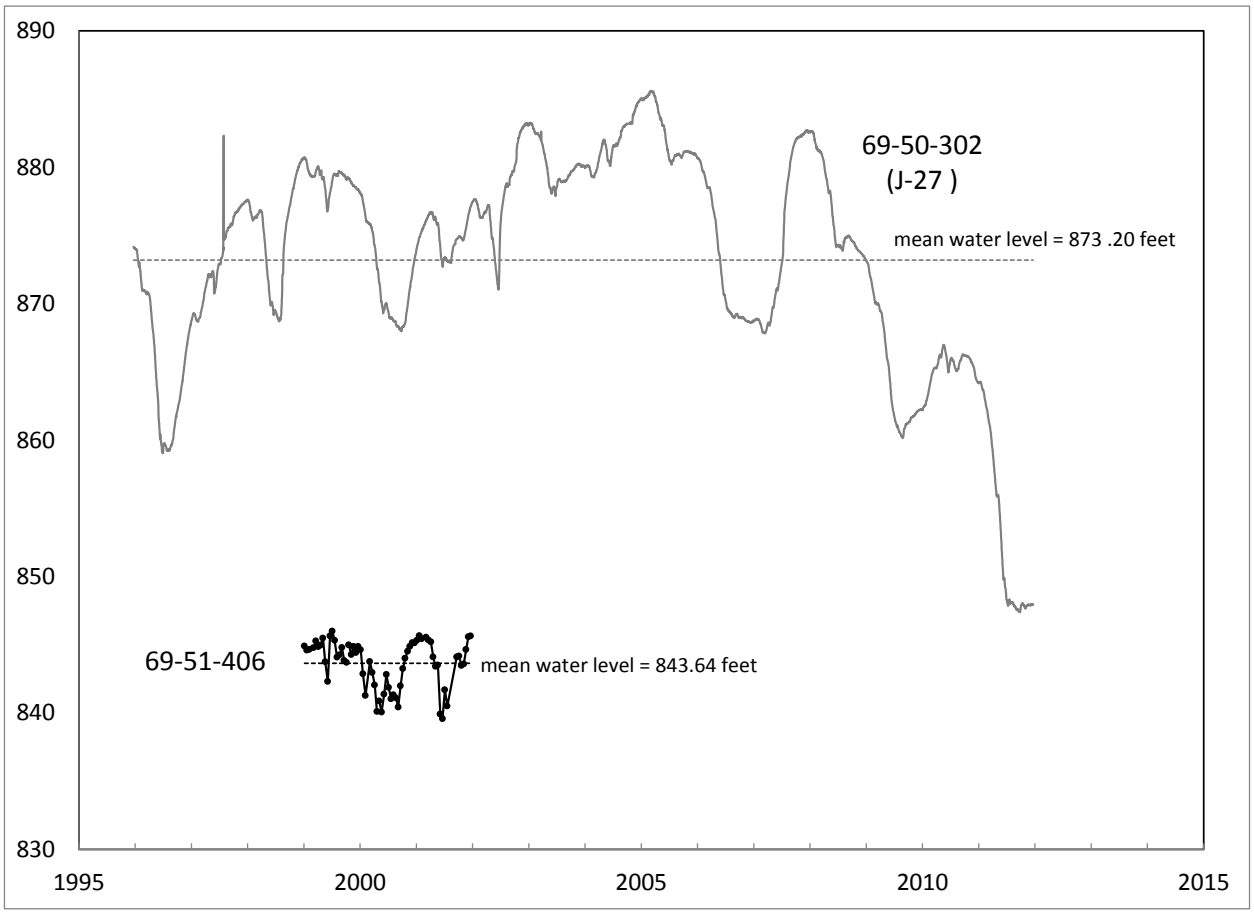

Figure 5. Hydrographs of the J-27 Edwards Aquifer index well and Leona Gravel Aquifer well in Uvalde County for the period 1996 to 2011 (EAA, 2012; TWDB, 2012).

The Uvalde County Underground Water Conservation District reported water use in their 2011 management plan for the years 2007 to 2010 for all of the aquifers in the district. Table 1 shows the estimates for the Leona Gravel Aquifer that was reported by the district for years 2008 to 2010. The district also reported pumpage from the Leona gravel for 2007, but it is not included due to the low number of reports filed that year. Because the delineated portion of the Leona Gravel Aquifer within GMA 10 is 84 percent of the total aquifer area in Uvalde County, the estimated pumping was determined by multiplying the district estimates for the Leona Gravel Aquifer by 84 percent (Table 1).

Table 1. Leona Gravel Aquifer reported groundwater pumpage for Uvalde County and estimated pumpage for groundwater management area 10 portion (UCUWCD, 2011)

Year	Reported pumpage (acre-feet/year)	Estimated GMA 10 pumpage (acre-feet/year)
2008	11,173	9,385
2009	7,780	6,535
2010	7,176	6,028
Average	8,710	7,142

PARAMETERS AND ASSUMPTIONS:

See George 2010 for assumptions and parameters used to estimate effective recharge in the previous report.

Recharge is received mainly from inflow from the Edwards Aquifer (Green and others, 2008) with additional recharge from direct precipitation.

The period 1996 to 2011 was selected for analysis of J-27 water levels due to the start of mandated management of the Edwards Aquifer in 1996.

RESULTS:

Based on a comparison of 2008 pumpage and the 1996 to 2001 water levels in J-27, (Figure 5), it is inferred that 9,385 acre-feet per year could be available from the Leona Gravel Aquifer as modeled available groundwater. Because the DFC requires no drawdown, the MAG equals the 2008 pumping estimated to occur in the Leona Gravel Aquifer as limited by previous statements. Therefore, the DFC will not allow for an increase in pumping over the 2008 levels. Unless a long-term drought of record occurs that affects the Edwards Aquifer, it appears that the adopted desired future condition is achievable under normal conditions. However, the modeled available groundwater would be lower if a repeat of the 1950s drought occurs.

The estimated modeled available groundwater from the Leona Gravel Aquifer within Uvalde County in Groundwater Management Area 10 that achieves the adopted desired future condition is approximately 9,385 acre-feet per year. This pumping has been divided by county, regional water planning area, and river basin for each decade between 2010 and 2060 for use in the regional water planning process (Table 2).

Table 2. Modeled available groundwater by decade for the Leona Gravel Aquifer in Groundwater Management Area 10 for the Uvalde County UWCD. Results are in acre-feet per year and are divided by county, regional water planning area, and river basin.

County	Region	Basin	Year					
			2010	2020	2030	2040	2050	2060
Uvalde	L	Nueces	9,385	9,385	9,385	9,385	9,385	9,385

LIMITATIONS:

Additional data are needed to develop improved estimates; these estimates are based on an interpretation of the requested conditions and limitations. This analysis assumes homogeneous and isotropic aquifers; however, conditions for the Leona Gravel Aquifer may not behave in a uniform manner. There is also uncertainty with respect to the distribution of the sand and gravel in the aquifer (Green, 2004).

The analysis further assumes that the Edwards Aquifer supplies a substantial part of the groundwater inflow to the Leona Gravel Aquifer, and this may be interrupted by multi-year drought events.

This analysis was determined to be the best method to develop a modeled available groundwater estimate. However, this method has limitations and should be replaced with better tools; including groundwater models and additional data that are not currently available. This analysis assumes that the aquifer is in a state of dynamic equilibrium. This assumption needs to be considered and compared to actual future water level and pumping data when evaluating the desired future condition of no drawdown.

Given these limitations, users of this information are cautioned that the modeled available groundwater estimates should not be considered a definitive, permanent description of the amount of groundwater that can be pumped to meet the adopted desired future condition. The TWDB makes no warranties or representations relating to the actual conditions of any aquifer at a particular location or at a particular time.

It is important for groundwater conservation districts to monitor future groundwater pumping and water levels to know if they are achieving their desired future conditions.

Because of the limitations and assumptions in this analysis, it is important that the groundwater conservation districts work with the TWDB to refine these modeled available groundwater numbers given the reality of how the aquifer responds to the actual amount and location of pumping now and in the future. The Uvalde UWCD should continue to collect pumpage data and restart water level monitoring in the aquifer.

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