Desired Future Conditions
For
Real Edwards Conservation & Reclamation District

Executive Summary

The Edwards-Trinity Aquifer is a karst aquifer it is a complex geological structure and difficult to model its hydrology. The Texas Water Development Board (TWDB) has made numerous attempts at modeling it for a Groundwater Availability Model (GAM) with only limited success. Eight counties/water districts adjacent to one another recognized these facts and cooperated in a joint study, a water budget analyses, by hiring Dr. Ron Green, Ph.D., P.G. and Mr. F. Paul Bertetti, P.G. from Southwest Research Institute (SwRI) to work on this project. The information contained in this report entitled "Investigating the Water Resources of the Western Edwards- Trinity Aquifer," June 2010[1](a.k.a. SwRI Report); is an integral part of the calculation of desired future conditions (DFC) for these water districts. The interpretation of this data is the basis for determining the amount of water available for the next 50 years. The basis for determining the DFC for Edwards and Real Counties are derived from information contained in this water budget analyses and the actual pumpage of the various uses within the county.

Description

The District lies within the Edwards Plateau and consists of approximately 1,810,169 acres in Real and Edwards Counties over the Edwards-Trinity Aquifer in West Central Texas.. The land is generally rolling to mountainous with elevations from 1500 to 4000 ft. The District is included in three different river basins, the Nueces, Colorado, and the Rio Grande. The Headwaters of the Nueces, and Frio Rivers along with a portion of the Headwaters of the Sabinal and South Llano Rivers are located within the District. The western half of Edwards County slopes southwestward into the Devils River. The eastern part of Edwards County drains into the Nueces River, the western part drains into the Devil's River, and the northern part drains into the Llano River. Real County drains into the Nueces and Frio River with a small portion of the Northern part draining into the South Llano River. The land also includes shallow depressions that catch rainfall and runoff to be either evaporated or infiltrated into the soil.

Limestone is the predominant rock underlying the Edwards Plateau soils. The permeability of the limestone is not necessarily due to intergranular pore space as in sandstone, but more to joints, crevices, and solution openings that have been enlarged by solvent action of water charged with carbon dioxide. The Edwards Formation is a granular to crystalline, dolomitic limestone called brown lime or brown sand on local well driller's logs. Caverns or caves and smaller solution channels are common in the Edwards. The Edwards Trinity Plateau Aquifer covers approximately thirty-one (31) counties or the boundary of GMA 7. Edwards and Real Counties sit on the South Eastern Border of this aquifer. According to the most recent data from the Plateau Region Planning Group Plan (accepted as part of the TWDB 2007 State Water Plan) there are approximately 14,436 acre feet of water per year available to the District from this aquifer. As state above, the permeability of the formation is due to joints, crevices, and small caves that are in the limestone. This means that a well's pumping capacity may vary from as little as one (1) gallon per minute (gpm) to several hundred gpm in a few limited places. For the most part wells completed in this formation within Edwards and Real County consistently yield between 6 and 10 gpm. The Trinity aquifer is composed of marine sediments (primarily limestone) deposited during the Cretaceous Period. The Trinity Group in the Edwards and Real Counties includes the Glen Rose and underlying Travis Peak formations. In some areas, the Glen Rose consists of up to approximately 1,000 feet of limestone with interbedded shale, marl and occasional anhydrite (gypsum) and is the primary unit in the Trinity in the southern part of the Edwards Plateau area. Springs issuing from the aquifer form the headwaters of several

flowing rivers. The Travis Peak contains sands, clays and limestones and is subdivided into water-bearing members of the Hensell, Cow Creek, Sligo and Hosston. More than one-third of the samples from the Trinity aquifer have TDS concentrations above the secondary standard of slightly saline (1,000 - 3,000 mg/l).

Plateau Region Water Plan

Wells completed within the Trinity units in some areas of the District (primarily in Real County) tend to yield substantially more water (50 -150+ GPM). However, as noted above often the high TDS and sulfide content requires water from this formation to undergo fairly extensive treatment prior to becoming potable. In some areas of Edwards County these units produce limited amounts of water.

Plateau Region Planning Group 2006

The soil in this area supports oak, juniper, mesquite, prickly pear, range grasses of the type that survive in dry regions. The area contains a variety of wildlife: white-tailed deer, Rio Grande turkey, dove, and a number of migratory birds that traverse the area at different times of the year along with the numerous exotic species that have been introduced. Over the years the wild hog population has steadily increased. Ranching is a major economic activity where sheep, goats, and cattle are stocked on the ranches in this area. Currently the area is experiencing an increasing number of Game Management and Exotic Game Ranches and along with this comes food plots and high fences. These fences block the normal game pathways to surface water and increase the need for groundwater. Many of the exotics are more dependent upon water than native game which in turn increases the need for additional water sources.

The water district maintains a water well database that currently contains 2,287 wells. This data base is divided into several categories, please see Table 1.0. Along with this data, the District has been and is continuing a major effort to identify and obtain registration on existing wells that were drilled prior to the adoption of District rules. Currently, the District has a separate data file containing the information on an additional 1,332 wells and it is thought that there are at least another 1,500 if not more that we have yet to identify.

Table 1.0

Well Type	Number of Wells
Domestic	1661
Livestock	445
Public Water Supply	39
Irrigation	43
Industrial	1
Miscellaneous	69

The domestic use of water in the District is based on the assumption that an average domestic well will use approximately the same amount of water as the average public water supply connection within the same area. In 2008 the District conducted a study of the public water supply systems within Edwards and Real Counties to obtain estimates of average connection use. While it varied slightly between Edwards and Real County the overall average was approximately 0.3 acre feet per year. After further investigation, it was determined that domestic well users who later started using a public supply system use about 15-20% more water than other public supply customers, the District set the average use to approximately 0.33 acre feet per year per well. Table 2.0 reflects the overall estimated use within the District.

Table 2.0

Projected Water Use Summary

Real County	Acre Ft/Yr
Camp Wood	143.63
Leakey	204.61
Real Water Supply Corp.	36.73
Domestic Wells	333.08
Livestock	219.09
Native & Exotic Game	345.63
Permits other than Real City Well	132
Other Use	13.26
Total County Use	1428.02

Edwards County	Acre Ft/Yr
Rocksprings	199.77
Barksdale	7.34
Domestic Well	305.61
Livestock[2]	776.23
Native & Exotic Game	974.01
Permits other than Rocksprings City well	334.5
Other use	5.78
Total County Use	2603.23

Total Use District	4031.25

[2] Livestock Estimates Supplied by USDA. Figures for domestic stock water use come from Ministry of Agriculture and Rural Affairs, Ontario Canada see info under water consumption

NOTE, this total does not include the additional wells that have been identified and not yet registered. Since the ratio of domestic wells to livestock wells in the main data base is close to 3 to 1 (75% domestic vs: 25% livestock) the inclusion of an addition 1,000 domestic wells would increase the domestic use by another 333 acre feet per year; or for a total District use of 4,364 acre feet. Then, adding in the estimated 1,500 well not yet identified using the same 75% domestic ratio, another 371 acre feet per/year should be added for a District total of **4,735 acre feet per/year.** For the purpose of this paper, these additional estimates have been split out evenly between Edwards and Real County.

Numerous ranches within the District have and continue to switch from normal ranch practices to “Gamer Management”: operations. Along with that process comes high fences that tend to block native game migration to surface water. This creates the need for additional groundwater use and as more ranches convert to similar operations, the need for additional wells well will

continue. Table 3 list out the estimated numbers of both native and exotic game in Edwards and Real County and the water use estimates for said game.

Table 3.0

Edwards County	Estimated Number	GPD	GP Year	Acre Feet Year
White Tail	106,899.39	106,899.39	39,045,003.64	119.84
Axis	67,840.00	77,168.00	28,185,612.00	86.51
Ferral Hog	135,680.00	678,400.00	247,785,600.00	760.55
Black Buck	4,500.00	2,925.00	1,068,356.25	3.28
Elk	500.00	1,950.00	712,237.50	2.19
Other	1,500.00	1,462.50	534,178.13	1.64
Totals	316,919.39	868,804.89	317,330,987.51	974.01

Real County	Estimated Number	Gpd	GP Year	Acre Feet Year
White Tail	44,800.00	44,800.00	16,363,200.00	50.22
Axis	29,866.67	33,973.33	12,408,760.00	38.09
Ferral Hog	44,800.00	224,000.00	81,816,000.00	251.12
Black Buck	2,500.00	1,625.00	593,531.25	1.82
Elk	500.00	1,950.00	712,237.50	2.19
Other	2,000.00	1,950.00	712,237.50	2.19
Totals	124,466.67	308,298.33	112,605,966.25	345.63

Native and Exotic Game Estimates based upon Game Biologist, Game Wardens and Ranchers. Water use for game based upon Game Biologist information. Wild Hog use is based upon Domestic Swine use.

Of the total estimated water use approximately 3,565 acre feet are what the District considers to be “Exempt” use. Table 4 reflects the exempt use by county.

Table 4

Exempt Use	
Edwards County	2268.73
Real County	1296.02
Total	3564.75

Background Information

Numerous attempts at establishing the Groundwater Availability Model (GAM) for the Edwards-Trinity aquifer for the District and its adjacent counties: Menard, Schleicher, Sutton, Crockett, Kimble and Val Verde have been made over the past several years. These GAMs have included data obtained from the state water plan, (2007) and other sources. These data have appeared in various reports over the years; there are inconsistencies among the various publications presenting this data. The negative qualities of the data make it difficult to accept it on a hydrogeological basis. With this in mind the above named counties/water districts decided

to join in on a project with Southwest Research Institute (SwRI) and Dr. Ron Green PH.D., P.G. and Mr. F. Paul Bertetti, P.G. to establish a water budget for this area of the Edwards-Trinity aquifer. This water budget, in turn, would be utilized by these districts to establish their DFCs.

The reports and documentation published on the Edwards-Trinity aquifer contains quantitative data collected over many years of painstaking research. The numbers presented in these publications are derived from actual measurements, the methods and techniques proven to be hydrologically valid can be repeated and verified. Anyone can read these publications and appreciate the work reported. However, it takes a person with the training and knowledge in hydrology to correctly interpret and explain the results, identify the pitfalls, and connect the dots for proper use of this data when establishing the DFC. Highlights from this report note:

- Groundwater catchments in the study area extend farther north compared with their overlying surface watersheds.
- Counties with the greatest uncertainty in the water budget assessments are Crockett, Val Verde, and Menard.
- River discharge measurements provide an opportunity to calculate recharge for the area that contributes to baseflow in the river.
- Long-term average annual river discharge values corrected to baseflow were converted to estimates for recharge for each contributing area analyzed.
- Recharge values were correlated with precipitation in the study area.
- Knowing the correlation between precipitation and recharge allowed prediction of how recharge in the study area will vary during periods when precipitation is less than the long-term average precipitation for extended periods.
- Recharge for each county in the study area was calculated for average precipitation conditions and predicted for periods when precipitation was reduced by 10, 20, and 30 percent.
- Within the study area, specifically, Edwards and Real County are less vulnerable to drought because they receive greater amounts of precipitation, on average, and their groundwater catchment areas extend beyond the extents of their surface watersheds.

Establishment of the Desired Future Conditions for the Real Edwards Conservation and Reclamation District

Existing information on aquifer structure, recharge, and hydrology are analyzed to calculate the water budget for the western Edwards-Trinity aquifer and in particular Edwards and Real Counties. The rate of precipitation for these calculations is taken from Figure 12 of the SwRI Report which shows 29” for the Eastern half of the District and 21” for the Western half. Recharge of 1.30 inch/year is assigned to the area around north-central Edwards County by averaging the baseflow calculated recharge rates for the Nueces River at Laguna (2.25 inch/year) and for the North Llano River at Junction (0.46 inch/year). This recharge rate is assumed uniform for the area with a long-term precipitation rate of 21 to 25 inch/year and supports the contention of groundwater piracy from the north. Recharge for this area accounted for approximately 5 percent of precipitation. Based on this analysis, recharge of 1.30 inch/year is assigned to Edwards County to account for the increased size of the groundwater catchment area that discharges to the Nueces River. Recharge of 2.14 inch/year is assigned to Real County to reflect the observation that the groundwater catchment area of Frio River discharge at Concan extends farther north than the Frio River watershed. The primary justification for the larger recharge rate is implied by the river discharge measurements that indicate groundwater piracy is taking place which, contributes additional recharge from north of the surface water divide. Groundwater flow through karst aquifers can occur as porous media flow through the

aquifer matrix and preferential flow through conduits or other solution cavities enhance flow pathways facilitating groundwater piracy.

The recharge rates calculated for each water district in the study area came from data and analyses contained in the SwRI report. The methodology equated recharge to the baseflow discharge calculations that are averaged over the perceived groundwater catchment area. Also, there is an approximate linear relationship between recharge and precipitation where recharge decreases linearly as precipitation decreases from 31 inch/year in the southeastern corner of the study area to a low of about 17 inch/year in the northwest corner of the study area. Recharge approaches zero when precipitation decreases below about 17 inch/year. A mathematical relation describing the correlation of recharge to precipitation can be written as:

$$R = 0.15(P - 16.5) \text{ for } P > 16.5, \; R = 0 \text{ for } P \leq 16.5 \quad \text{(Eq. 1)}$$

Where R is recharge (inch/year) and P is precipitation (inch/year). This expression provides a basis to predict hypothetical recharge based on anticipated precipitation for the study area.

Table 5.0 below compares calculated recharge, recharge predicted at 10, 20, and 30 percent reduction in precipitation, recharge values assigned to the 2004 Edwards-Trinity Aquifer GAM, groundwater availability documented in the 2007 Texas State Water Plan for Edwards and Real County.

Table 5.0

Recharge Parameter	Edwards County
Calculated Recharge	144,160
Predicted recharge @ 90% precipitation	101,760
Predicted recharge @ 80% precipitation	59,360
Predicted recharge @ 70% precipitation	1,837

Recharge Parameter	Real County
Calculated Recharge	81,200
Predicted recharge @ 90% precipitation	63,840
Predicted recharge @ 80% precipitation	46,480
Predicted recharge @ 70% precipitation	5,193

However, based on weather predictions by climatologists the region will become dryer due to a reduction in rainfall which, in turn, will reduce aquifer recharge. It is necessary, then, to consider recharge within the framework of usage (pumpage) for the next 50 years. Making predictions is not an easy task, future generations will adapt to the circumstances; in the meantime, we have to make sure we do not squander resources at their expense. It is with this premise that we must establish the means necessary to secure our water resources by establishing a Desired Future Condition for Edwards and Real County. Therefore, in Edwards County using the parameter for predicted recharge at 80% precipitation, (43,034 acre feet/year)

with an estimated 20% pumpage rate the total available equals 8,607 acre-feet/year. When you subtract the current estimated uses based upon our data (2,603 acre/ft + an additional 150 acre feet for identified but yet unregistered wells and the additional 185.5 acre feet per year for additional estimated wells) the MAG for Edwards County would be **5,658.5 acre/feet per year** Likewise, in Real County using the parameter for predicted recharge at 80% precipitation, (46,480 acre feet/year) with an estimated 20% pumpage rate we have available 9,296 acre-feet/year. When you subtract the current estimated uses based upon our data (1,428 acre/ft plus an additional 150 acre feet for identified but yet unregistered wells and the additional 185.5 acre feet per year for additional estimated wells) the MAG for Real County would be **7,532.5 acre/feet per year**

1) "Investigating the Water Resources of the Western Edwards-Trinity Aquifer," Fianl report, Prepared by: Ronald T. Green, Ph.D., P.G. and F. Paul Bertetti, P.G., June 2010.