



LBG-GUYTON ASSOCIATES

TECHNICAL MEMORANDUM



TO: Dirk Aaron

FROM: Kristie Laughlin, PG and Michael Keester, PG

SUBJECT: Evaluation of Edwards Aquifer Water Quality

DATE: September 30, 2015



A desktop investigation was performed by LBG-Guyton Associates to evaluate spatial and temporal changes of water quality in the Edwards Aquifer. Goals of the investigation included: 1) delineation of the brackish water line, 2) extent of migration of the brackish water line over time, and 3) determination of the potential impacts of pumping on the fluctuation of the brackish water line. This investigation focused primarily on total dissolved solids (TDS) as well as fluoride concentrations in groundwater from the Edwards Aquifer in Bell County, Texas.

TWDB INVESTIGATIONS

The Texas Water Development Board (TWDB) conducted studies of the "bad-water line" in 1986 and again in 1990. TWDB delineated both the 1,000 mg/L TDS and 3,000 mg/L TDS lines in each of the studies. Those water quality lines are shown on Figure 1 for reference, along with all TDS concentrations in wells sampled by TWDB between 1979 and 2007 within the mapped area.

Drought conditions occurred in south-central Texas in 1983-1984 as well as 1996, so the water quality lines that are shown are representative of interim or non-drought years. Note that the water quality lines converge near the northern extent of the Edwards Aquifer. This convergence suggests that the lateral fluctuation of water quality does not vary in Bell County to the extent that it does in Williamson and Travis Counties. In other words, based on the available data, the zone that is subject to variability appears to be narrower in Bell County than it is to the south.

DISTRICT WELL DATA

Using water quality sample data provided by the District, delineation of the water quality lines in 2015 are shown in Figure 2. Note that there is not enough data density in any one year for an adequate spatial representation of quality in a single year, so the water quality data over a multi-year period is included on the map. That is, the water quality lines are derived from water quality samples collected between 2004 and 2015. Sufficient data is not available to estimate a precise position of the water quality divide (i.e., the 1000 mg/L TDS contour) during the recent severe drought nor can a correlation between migration of the water quality divide and pumping be determined using available data.

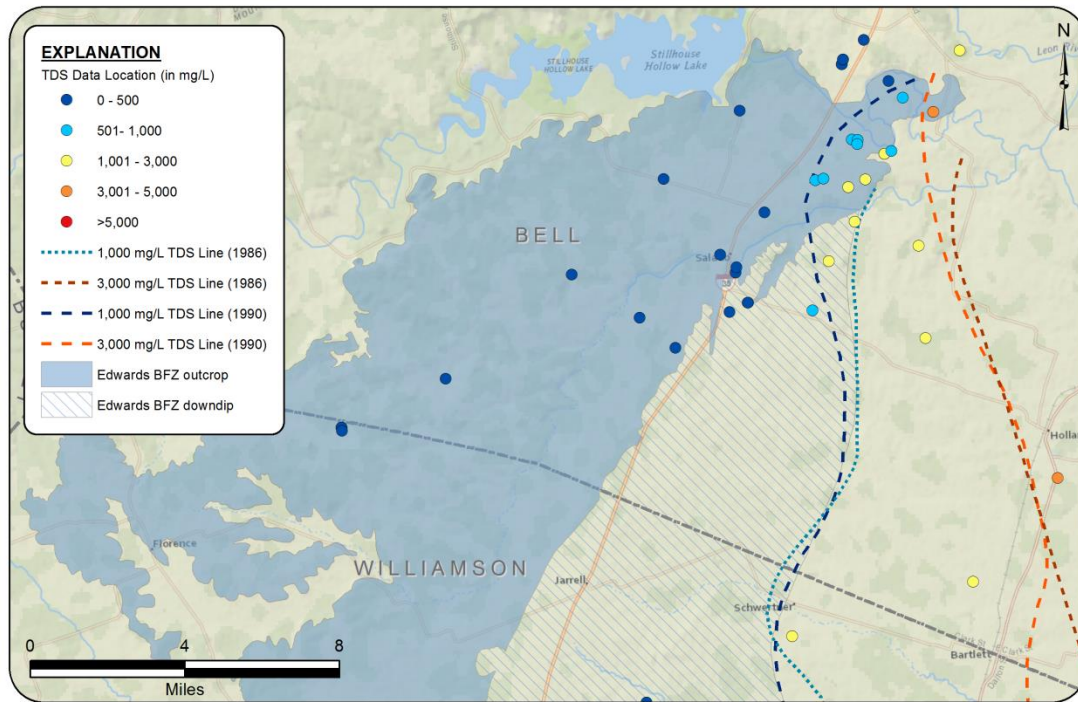


Figure 1. TWDB delineation of water quality lines from previous studies.

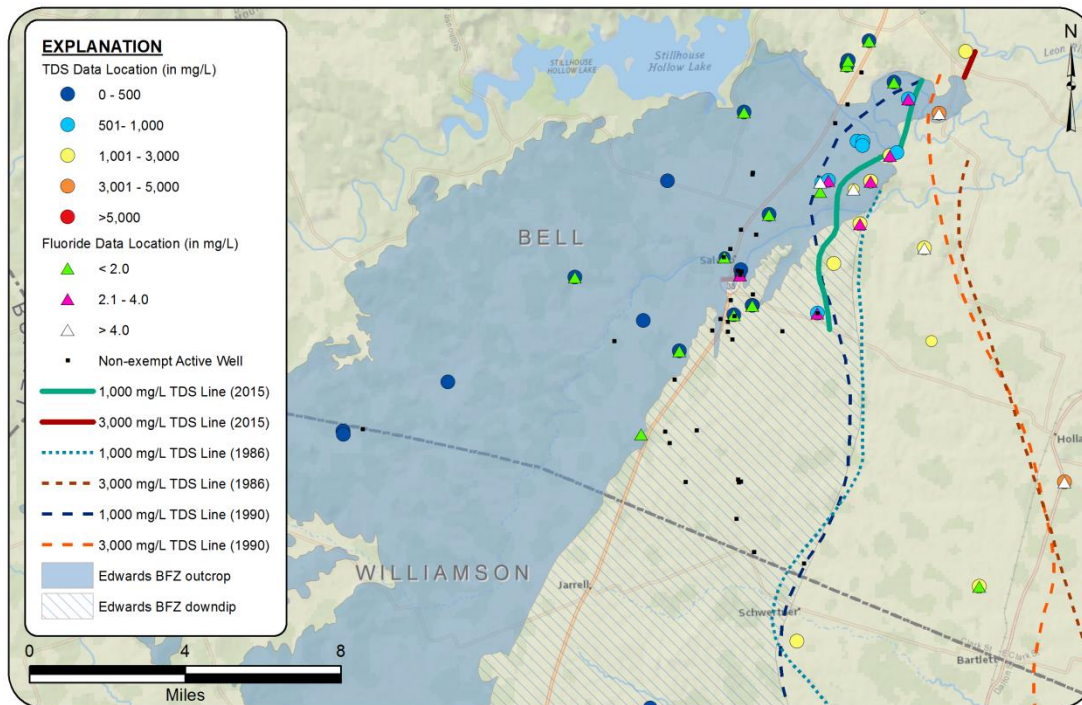


Figure 2. Estimation of recent water quality divide using District data.



The water quality boundaries defined by the TWDB during previous investigations are included on Figure 2 for reference. Non-exempt active wells are also shown on the map. The delineations derived from the District data align relatively well with the boundaries determined by the TWDB in 1986 and 1990. Although not shown on Figures 1 and 2, the direction of groundwater flow in the Edwards is primarily to the east and northeast.

Figure 2 also shows the fluoride concentrations from wells sampled by both the District and TWDB to show the relationship between the two parameters. It appears that fluoride does not exceed the drinking water standard of 2.0 mg/L in any of the samples with a TDS of less than 500 mg/L. However, at locations with TDS concentrations ranging between 501 and 3,000 mg/L, some of the samples exceed the fluoride standard while others do not. It appears that there is an area of relatively high fluoride concentrations (greater than 2.0 mg/L) located within the freshwater and also in the slightly brackish portions of the aquifer located east and northeast of Salado, Texas. Samples with a fluoride concentration greater than 4.0 mg/L are shown as white triangles.

DISCUSSION

Local migration of the water quality divide may occur on a seasonal basis, due primarily to the effects of varying rainfall, recharge, and pumping. To better understand the relationship between these parameters and the location of the water quality divide, it would be beneficial for the District to monitor water quality in more wells located near the 1,000 mg/L TDS divide. The area that contains groundwater samples which have previously equaled or exceeded a concentration of 2.0 mg/L fluoride is an additional area considered to be relevant for focused water quality monitoring. Ideally, the closest scrutiny in future investigations would be given to the areas defined on Figure 3 as the Brackish Divide Focus Area and the High Fluoride Zone.

The District could potentially sample these wells with regular frequency (quarterly, semi-annually, or annually) in an effort to: 1) determine local seasonal migration of the Edwards Aquifer brackish water divide, 2) characterize the extent and potential migration of the High Fluoride Zone, and 3) determine any potential relationship between the High Fluoride Zone, the lateral migration of the brackish water line, and groundwater pumping.

Well locations that we suggest as candidates for inclusion in an enhanced water quality monitoring program are listed in Table 1. The suggested wells have been subdivided in three tiers. Not every well listed is suggested for monitoring, the list represents wells that are ideally located to satisfy the goal designated for the individual Tier.

The three tiers are defined as follows:

- Tier 1 wells are non-exempt wells located within the Brackish Divide Focus Area that would ideally be monitored quarterly, semi-annually or annually, pending initial TDS results. Those locations with concentrations very near 1,000 mg/L TDS would be ideal for quarterly monitoring, while sampling frequency for the other locations (semi-annual or annual) could be determined by well operators and the District. Only one monitoring well located in the western Schwertner Farms well cluster would be necessary, if the location is included in a monitoring plan.



- Tier 2 wells are exempt wells located within the High Fluoride Zone delineated on Figure 3. Note that only a few of the wells in Tier 2 would need to be monitored to characterize this zone. Perhaps five wells selected from the Tier 2 list would suffice, with one located in the center of the zone with two up-gradient and two down-gradient locations. Ideally these would be monitored quarterly, semi-annually and/or annually, pending initial fluoride concentrations from the first round of sampling. For example, if the concentration exceeds 4.0 mg/L, it could be monitored quarterly, if it exceeds 2.0 mg/L, the location could be sampled semi-annually, and if it is less than 2.0 mg/L, it could be sampled annually. The frequency of sampling would change based on this fluoride concentration. Any wells sampled peripheral to those that are selected for continuous monitoring that report a fluoride concentration of greater than 4.0 mg/L should be added to the monitoring network. Any wells with fluoride concentrations that do not exceed 2.0 mg/L for four events could be dropped.
- Tier 3 wells are exempt wells that are located near the water quality divide. Those locations with concentrations near 1,000 mg/L TDS would be ideal for quarterly monitoring, sampling frequency for the other locations (semi-annual or annual) could be determined by well operators and the District.

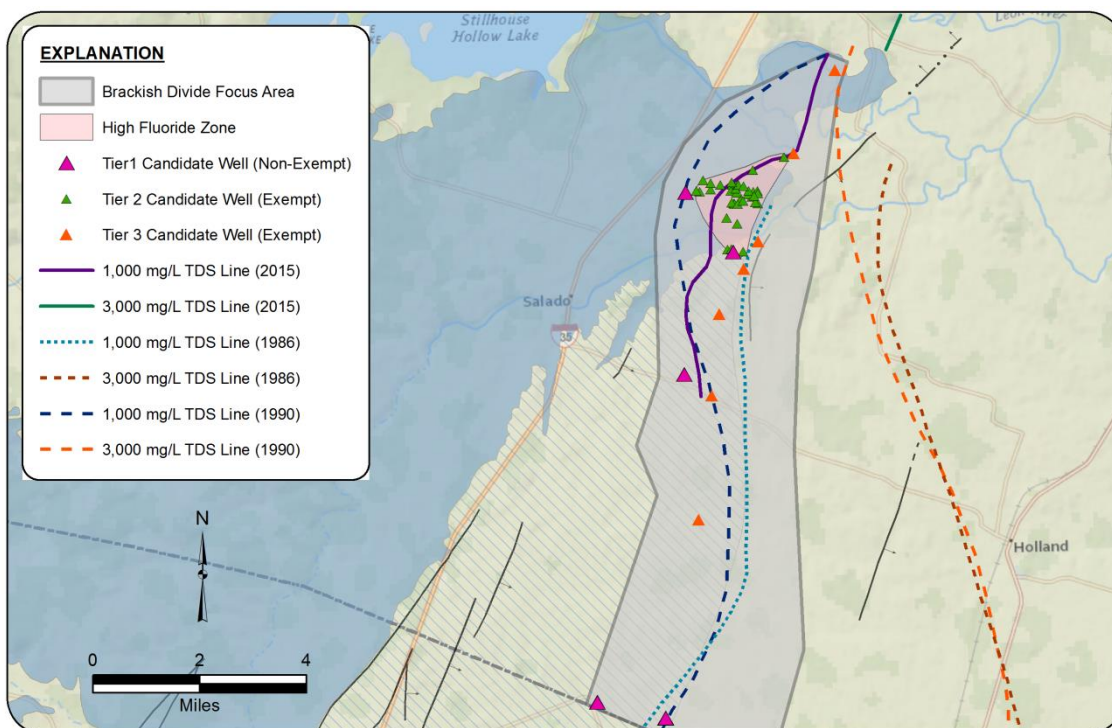


Figure 3. Brackish Divide Focus Area, High Fluoride Zone and Monitoring Well Candidates.



Table 1. Water Quality Monitoring Well Candidates.

Well ID	Primary Use	Date Drilled	Well Depth	Aquifer
TIER 1				
N2-10-006P	Livestock/Poultry	10/25/2010	720	Edwards
N2-04-002G	Livestock/Poultry		660	Edwards
N2-04-003G	Livestock/Poultry		660	Edwards
N2-04-001G	Livestock/Poultry		665	Edwards
N2-04-009G	Livestock/Poultry		720	Edwards
N2-08-004P	Ag/Irrigation	7/30/2008	430	Edwards
N1-07-003P	Domestic	8/25/2007	180	Edwards
N1-09-004P	Domestic		200	Edwards
TIER 2				
E-02-032G*	Domestic		75	Edwards (BFZ)
E-10-048P	Domestic	10/25/2010	220	Edwards
E-02-132G	Livestock/Poultry	1/1/1979	165	Edwards
E-02-349G	Domestic		207	Edwards
E-02-922G	Domestic		160	Edwards
E-02-1567G	Domestic		0	Edwards (BFZ)
E-02-3310G	Domestic		180	Edwards
E-03-025G	Domestic	10/13/1999	210	Edwards
E-02-2988G	Livestock/Poultry		165	Edwards
E-02-3431G	Domestic		0	Edwards (BFZ)
E-03-181P	Domestic	2/14/2003	180	Edwards
E-03-419P	Domestic	6/16/2003	218	Edwards
E-03-420P	Domestic	6/17/2003	218	Edwards
E-03-411P	Domestic	7/30/2003	160	Edwards
E-04-009P	Livestock/Poultry	1/28/2004	172	Edwards
E-04-057P	Domestic	6/28/2004	190	Edwards
E-05-048P	Domestic	3/2/2005	210	Edwards
E-04-076P	Domestic	9/11/2004	200	Edwards
E-06-024P	Domestic	4/17/2006	220	Edwards
E-05-014P	Domestic	2/5/2005	210	Edwards
E-05-021P	Domestic	2/28/2005	200	Edwards
E-06-045P	Domestic	7/25/2006	210	Edwards
E-08-024P	Domestic	4/3/2008	220	Edwards
E-09-005P	Domestic	6/26/2009	220	Edwards
E-09-051P	Domestic	10/5/2009	220	Edwards
E-10-010P	Domestic	4/5/2010	200	Edwards
E-10-009P	Domestic	3/18/2010	220	Edwards
E-10-011P	Domestic	3/29/2010	220	Edwards
E-12-042P	Domestic	9/6/2012	175	Edwards
E-12-013P	Domestic	4/17/2012	200	Edwards
E-11-078P	Domestic	11/17/2011	220	Edwards
E-13-009P	Domestic	3/6/2013	210	Edwards
E-13-010P	Domestic	3/1/2013	220	Edwards
E-13-042P	Domestic	10/14/2013	220	Edwards
E-14-003P	Domestic	1/15/2014	181	
E-14-012P	Domestic	2/26/2014	200	
TIER 3				
E-10-037G	Domestic		0	Edwards (BFZ)
E-02-1957G*	Domestic		212	Edwards (BFZ)
E-02-3066G	Domestic		175	Edwards
E-02-3086G	Domestic		0	Edwards (BFZ)
E-09-045P	Domestic	10/7/2009	380	Edwards
E-11-035P	Domestic	6/24/2011	350	Edwards
E-13-001P	Domestic	1/3/2013	620	Edwards
* - Taylor Marl completion indicated				



RECOMMENDATIONS

- Monitor water quality, specifically for TDS and fluoride, according to the suggested Tier structure detailed above. For fluoride, if the concentration exceeds 2.0 mg/L, the location could be sampled quarterly or semi-annually, and if it is less than 2.0 mg/L, it could be sampled annually. The frequency of sampling would change based on this metric. Fluoride monitoring should be continued until four events of less than 2.0 mg/L are reported. Numerous data points from a single location through a period of record of several years would be ideal for further characterization of local water quality dynamics and trends. Blind split samples should be incorporated into the sampling plan to develop statistical data on the variation in TDS and fluoride concentration results due to laboratory variability.
- Request non-exempt permit holders to submit water quality results to the District on the same schedule as the designated monitoring frequency.
- Perform annual water quality sampling at gaging station 08104300 Salado Creek at Salado, Texas. The U.S. Geological Survey has performed seven sampling events at this station with an extensive list of analytes. Four samples were taken in 1978 and 1979. Three samples have been collected recently: October 31, 2013, December 19, 2013 and May 29, 2014. For the district's objectives, we recommend analytes include: specific conductance, pH, temperature, TDS, and fluoride.