Water Level Maps of the Edwards and Middle Trinity Aquifers, Central Texas

Barton Springs Edwards Aquifer CONSERVATION DISTRICT

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Abstract

The District periodically creates water level, or potentiometric surface, maps during different hydrologic conditions to better understand regional groundwater storage and flow. Four water level (potentiometric) maps are provided in this fact sheet. The available data cover water level conditions in the Barton Springs segment of the Edwards Aquifer during the drought of record, recent extreme drought (2009), and recent high flow conditions (2002) and low-flow conditions in the Middle Trinity Aquifer.

Water Level Maps

A water level map (also called a potentiometric map) is an imaginary water level surface defined by water level elevations in wells (Figure 1). The maps represent the general direction of groundwater flow for a given area at a particular time because flow always occurs from higher to lower (potentiometric) elevations. Water level maps provide critical information about the hydrologic relationships of recharge and discharge within an aquifer.

In karst landscapes, like central Texas, water level maps are commonly used to better understand groundwater flow; however, they should not be used to solely characterize groundwater flow direction or velocity in a karst aquifer. Water level maps should be combined with hydrogeologic mapping, dye trace studies, and other information for a more complete understanding of flow within a karst system (Kresic, 2007).

To construct a water level map one must measure the depth to water in a well from the land surface. This is usually done with an electronic tape called an eline. The depth to water is then subtracted from the land surface elevation to obtain the elevation of the water level in the well. These data are then plotted on a map and either contoured by hand or by computer programs (Figure 2).

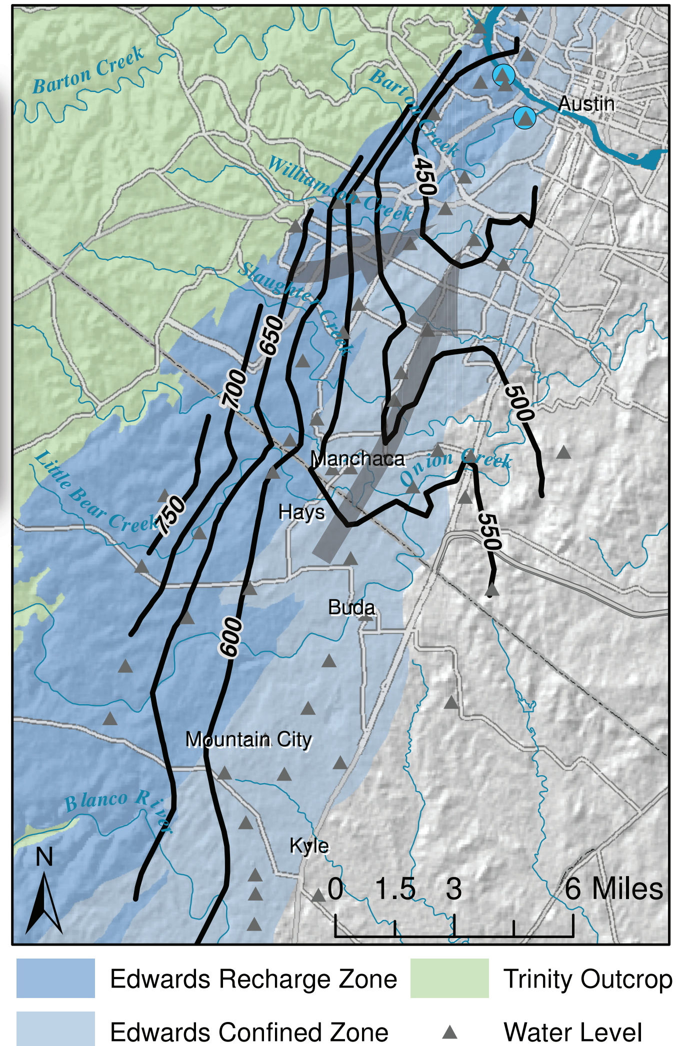


Figure 2: Water level map showing estimated groundwater elevations during the drought of record, in the 1950s. Relatively few data points were available, so the water level contours are a very coarse estimation of groundwater conditions at that time. The Recharge Zone is the area where the Edwards Group rock units crop out and water enters (recharges) the aquifer. The Confined Zone is the area where the aquifer units are below confining units and transition from unconfined to confined hydrologic conditions.

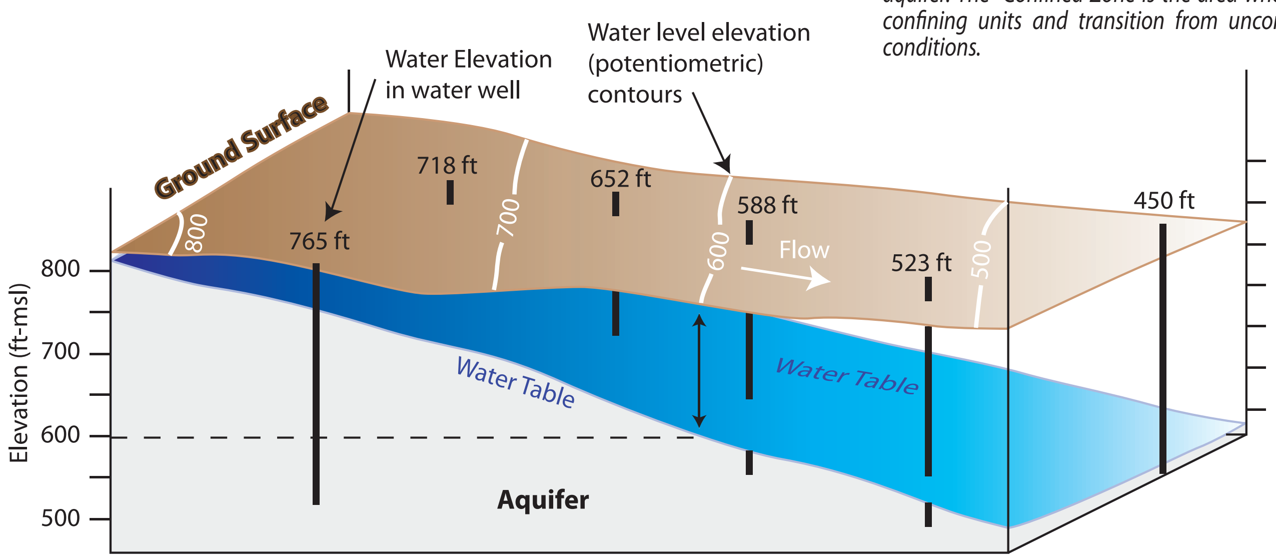
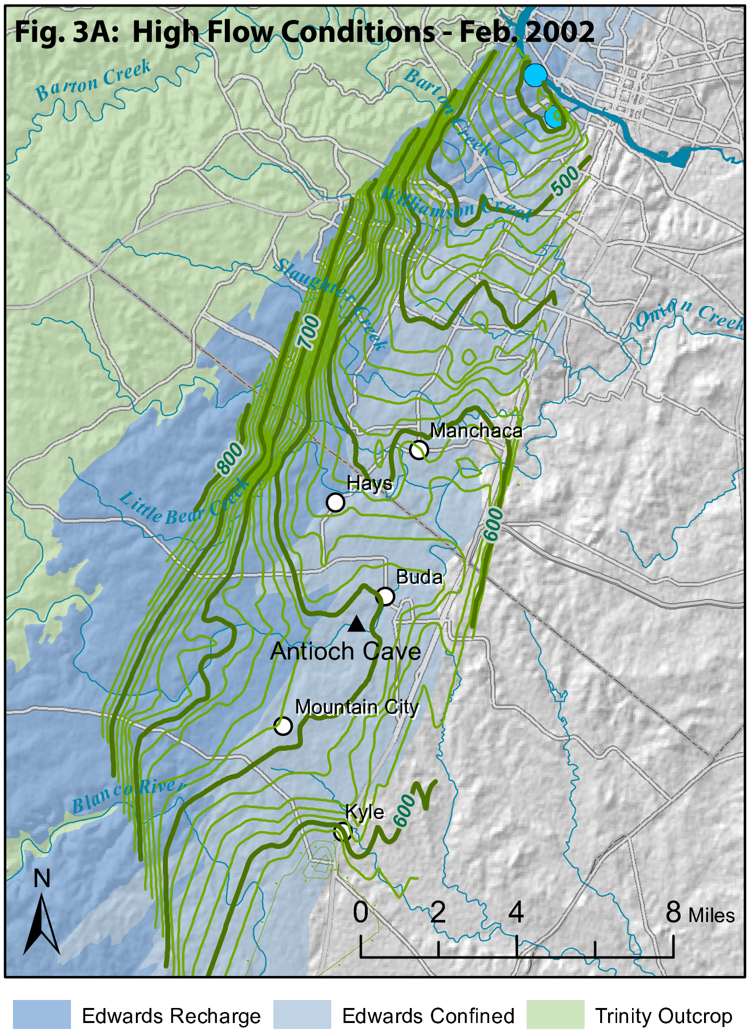
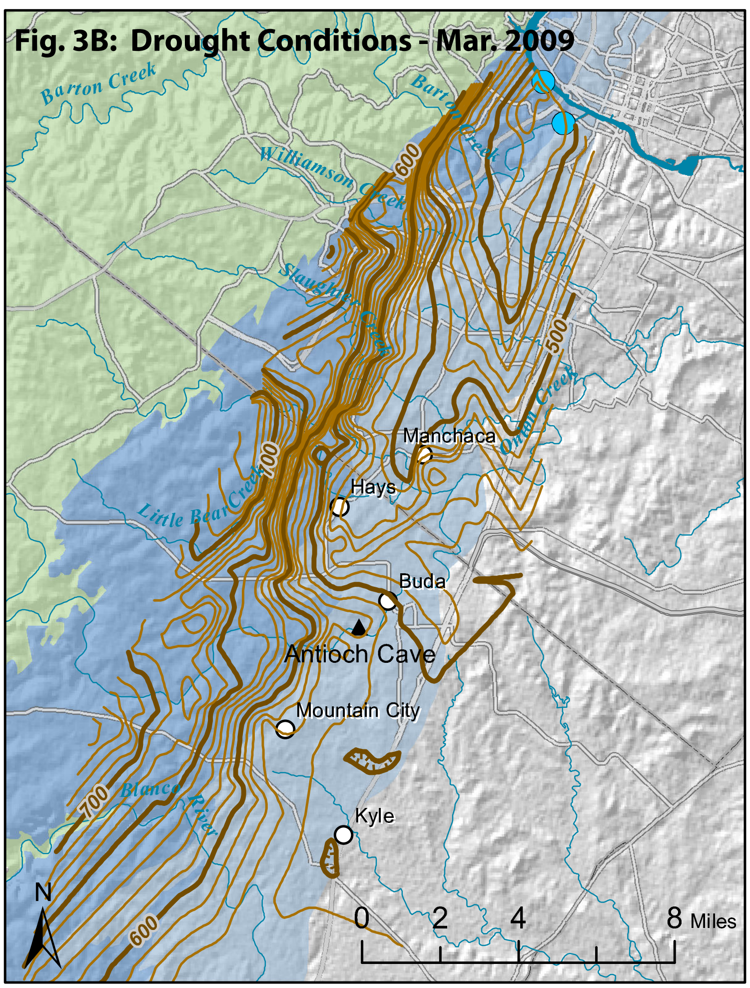


Figure 1: Schematic diagram of an aquifer showing a water level contour map and the wells used to draw the contours.

Edwards Aquifer Water Levels

Like all aquifers, water levels in the Edwards Aquifer vary according to the amount of water stored in the aquifer, which is dependent upon the climatic conditions. In addition, the location (unconfined or confined zones) within the aquifer can also influence the water levels and how much they may vary over time. Water levels do not show long-term declines in storage, but generally recover from low conditions quickly (Smith et al., 2001), typical of many karst systems. Barton Springs and some wells respond very quickly to recharge events reflecting their influence by conduit (fast) permeability (Lindgren et al., 2004; Worthington, 2003). Most water wells show a combined influence of matrix (slow) and conduit flow.





High Flow Conditions

In February of 2002, Barton Springs discharge was ~100 cubic feet per second (cfs) reflecting high-flow conditions. Throughout the District, water levels in 172 wells were measured within a month. These water level measurements were contoured to make a potentiometric map. Contours represent 10-foot intervals and the 100-foot intervals are labeled (Figure 3A).

Potentiometric troughs along known preferential flow paths are pronounced as broad features that extend from Buda to Barton Springs. The troughs in the Barton Springs aquifer appear to occur along the east side of the recharge zone (unconfined) boundary. Significant mounding due to recharge along Onion Creek, and due to Antioch Cave, is evident in the potentiometric surface during high-flow conditions. Depressions in the potentiometric surface are evident around areas that have high levels of pumping, such as the City of Kyle.

Drought Conditions

In March of 2009, Barton Springs discharge varied between 16-26 cfs, reflecting drought conditions. The District had been in Stage III Critical Drought since early December 2008. Throughout the District water levels in 274 wells were measured within about a month. Contours represent 10-foot intervals and the 100-foot intervals are labeled (Figure 3B).

The aquifer shows significant declines (contours shift to the south) from wet (Figure 3A) to drought conditions (Figure 3B). Troughs in the potentiometric surface are very pronounced with steep gradients. Multiple troughs begin to develop as seen in the 500-ft contour. In addition, troughs develop along known preferential flow paths (conduits) documented by dye tracing, such as the one originating at Antioch Cave. Significant troughs in the potentiometric surface appear to develop in the confined portion of the Barton Springs aquifer.

Figure 3. Potentiometric contour maps of the Barton Springs segment of the Edwards Aquifer. The map on the top was constructed with 172 well and spring measurements during a relatively wet period, February 2002 (modified from Hunt et al., 2007). The map on the bottom was constructed with 274 wells and springs during a relatively dry period, March 2009.

Middle Trinity Aquifer Water Levels

The Trinity Aquifer is the primary groundwater source for a variety of needs throughout the Texas Hill Country. The Trinity Aquifer is composed of Cretaceous-age limestones and sandstones that are divided into the Upper, Middle, and Lower Trinity Aquifers. In the District the Edwards Aquifer overlies the Trinity Aquifer, and because of faulting, can also be adjacent to the Trinity Aquifer. Groundwater quality of the Trinity Aquifer is generally poorer than the Edwards Aquifer containing higher total dissolved solids (TDS) and undesirable constituents such as sulfates. Due to low yields and poorer water quality the Trinity has not historically been targeted for production except along the western part of the District, where the Edwards Aquifer is thin. Where the Edwards is thin, water-supply wells commonly penetrate the lower Edwards units and are completed in units that comprise the Upper and Middle Trinity Aquifers.

The Middle Trinity Aquifer is composed of (from stratigraphically lowest to highest) the Cow Creek, Hensel, and the Lower Glen Rose Formations. It is the primary aquifer in the Trinity Aquifer system for water-supply needs in the Hill Country. Nine Groundwater Conservation Districts (GCDs) within the Texas Hill Country are tasked with managing groundwater resources in that area. Increasing water-supply demands have raised concerns about the availability of groundwater in the Texas Hill Country.

Nine GCDs and several other organizations collaborated to collect 232 water-level measurements from the Middle Trinity Aquifer during the Spring of 2009. Spring 2009 was a period of extreme to exceptional drought according to the U.S. Drought Monitor, and these water level measurements reflect a drought condition potentiometric map; contours represent 100-foot intervals (Figure 4).

The Spring 2009 potentiometric map suggests that flow within the Middle Trinity is generally from northwest to southeast. This is predominantly down-dip of the geologic units from outcrop into the subsurface. A prominent potentiometric ridge exists along the Blanco-Kendall County line and separates a more west to east flow system within Blanco, Hays, and Travis Counties. A portion of the flow appears to deviate to the northeast along the Balcones Fault Zone as it approaches Travis County. The Lower Glen Rose is exposed along the Colorado River west of the Balcones Fault Zone and could be the discharge point for the Middle Trinity in that area. Other features noted in the map include predominantly converging flow centered along the Guadalupe River west of Canyon Lake.

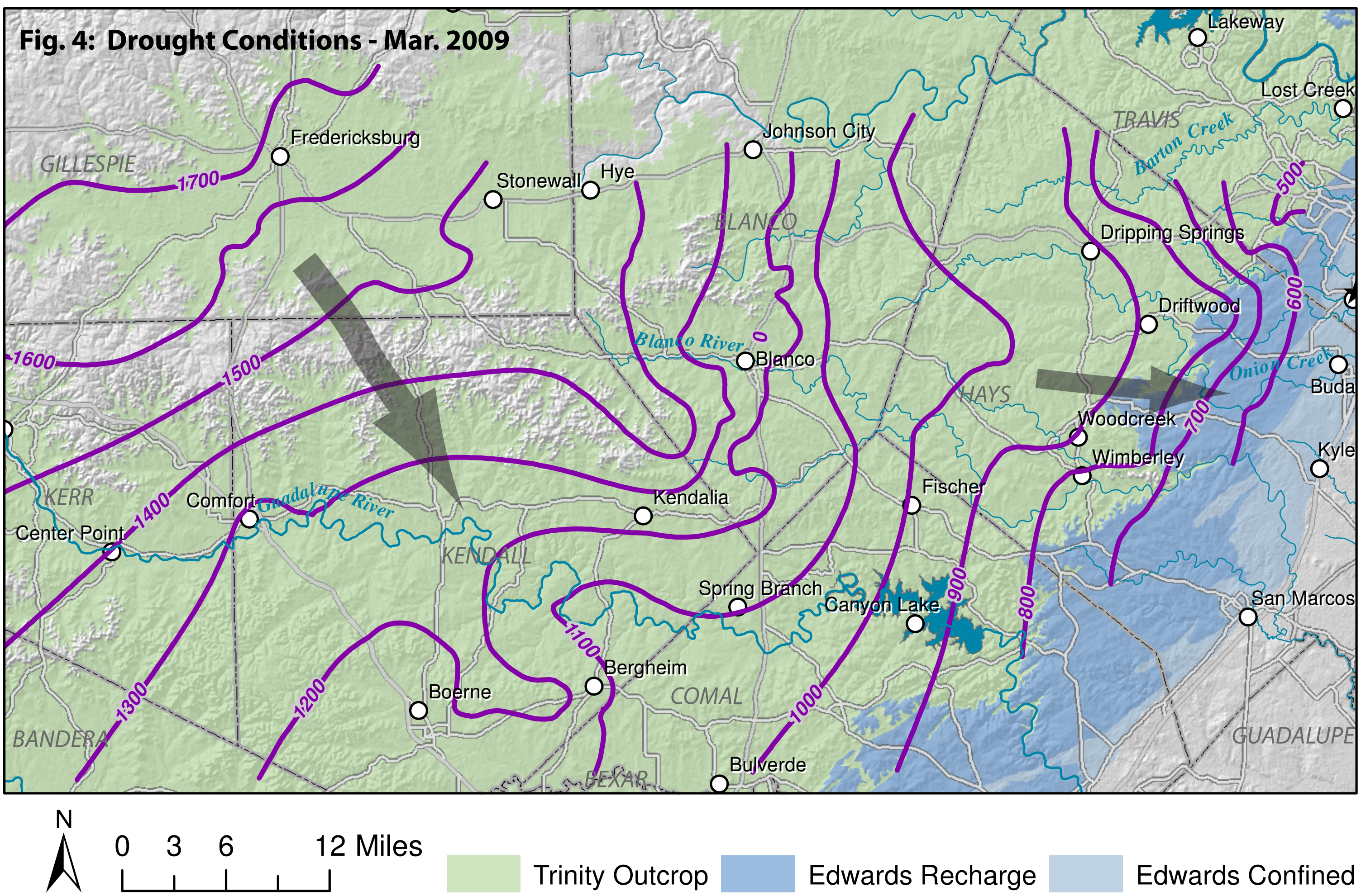


Figure 4: Potentiometric contour map of the Middle Trinity Aquifer of the Texas Hill Country during relatively dry period of March 2009 (modified from Hunt and Smith, 2010).

Conclusions

Water level maps can create a snapshot of aquifer conditions for a given area at a particular moment in time. Both the Edwards and Trinity Aquifers have dynamic water levels that are substantially influenced by drought, wet weather patterns, and geology. In some areas, wells can fluctuate more than 100 ft between the high and low flow conditions in the Barton Springs aquifer. Influences of discrete recharge and discrete discharge (pumping) are evident on potentiometric surfaces. Troughs and ridges in the potentiometric surfaces correspond to preferential flow paths (conduits), or potential barriers to flow, respectively.

Selected References

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Figure 5: Picture of staff measuring the depth to water in a well with an eline.

Data Availability

This fact sheet, the maps, as well as the data that was used to construct them, are available in digital format. To access the data online, visit the District's Scientific Publications page:

www.bseacd.org/publications/reports/#WaterLevelsRpt

Acknowledgments

Regional synoptic water level maps require collaboration, cooperation, and input from multiple agencies, well owners, and scientists. The maps and data presented in this factsheet are the result of many hours of data collection and analysis. The District would like to thank all agencies, well owners, and scientists that contributed to this body of work.

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