EVALUATING THE HYDROLOGIC CONNECTION OF THE BLANCO RIVER AND BARTON SPRINGS USING DISCHARGE AND GEOCHEMICAL DATA

Richard Casteel [1], MaryLynn Musgrove [2], Brian Hunt [3] and Brian Smith [3]

[1] Jackson School of Geosciences, University of Texas at Austin

[1,2] US Geological Survey

[3] Barton Springs Edwards Aquifer Conservation District

Barton Springs Edwards Aquifer CONSERVATION DISTRICT

Abstract

The karstic Edwards aquifer provides public supply and springflow for endangered species in drought-prone central Texas. Delineating source areas and flow paths in karst aquifers is important for understanding water availability. Groundwater divides separate the aquifer into different segments (Figure 1). It has been previously proposed that the divide between the Barton Springs and San Antonio segments migrates in response to changes in hydrologic conditions. This study evaluated historical discharge and geochemical data to characterize and quantify the hydrologic connection between recharge from the Blanco River and Barton Springs, the main discharge point for the Barton Springs segment. Hydrologic data, including stream discharge, spring discharge, and estimated stream recharge data (1987 through 2012) for extremely dry hydrologic time periods, when it was inferred that there was likely no recharge occurring within the Barton Springs watershed, were identified and evaluated. A hydrologic connection was inferred between the Blanco River and Barton Springs when estimated recharge from the Blanco River increased and there was a time lagged increase in discharge and gage height at Barton Springs. Sixteen events were identified that met these criteria. The average increase in recharge from the Blanco River for these 16 events was 2.7 ft^3/s, while the average increase in discharge at Barton Springs was 1.4 ft^3/s. The increase in Barton Springs discharge is likely attributable to Blanco River recharge for 4 of the 16 events, and potentially attributable for another 6 events. The 6 remaining events of increased discharge at Barton Springs are within instrument uncertainty and cannot be attributed with confidence to an increase in recharge from the Blanco River. The geochemical analysis was inconclusive. Results indicate that during dry hydrologic conditions, when the divide is closer to the Blanco River, the Blanco River contributes recharge to Barton Springs and the northern segment. These results are consistent with previous dye-tracing studies (Johnson et al., 2012).

Setting

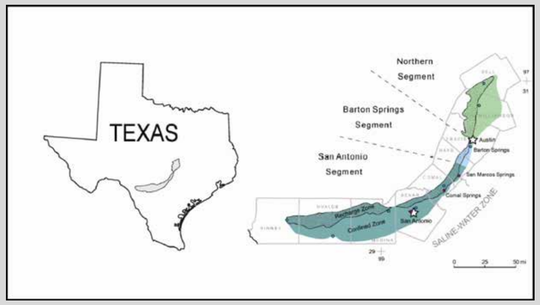


Figure 1. The Edwards Aquifer in central TX. The aquifer is divided into three segments. This study focused on the Barton Springs and San Antonio segments (modified from Hunt et al., in review).

Hydrologic setting

The division of the aquifer between the Barton Springs and San Antonio segments is delineated by a hydrologic divide formed by a potentiometric ridge between Onion Creek and the Blanco River (Figure 2)

The hydrologic divide is estimated to shift locations due to variations in hydrologic conditions:

Wetter conditions: closer to Onion Creek (northerly)

Drier conditions: closer to the Blanco River (southerly)

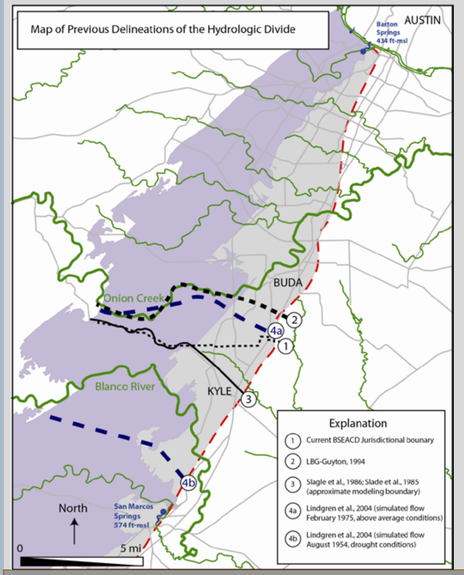


Figure 2. Approximate locations of the hydrologic divide between the Barton Springs segment and the San Antonio segment of the Edwards Aquifer as it moves during dry to wet intervals (from Hunt et al., 2005).

Research questions

This investigation focuses on "dry hydrologic conditions", defined as no flow (0 ft^3/s) in the five major contributing streams to the Barton Springs segment.

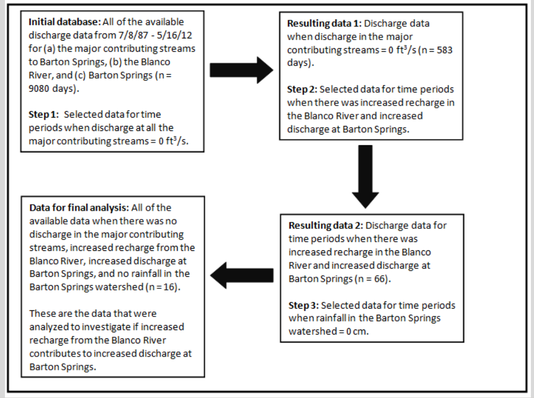
The main research question is if cross-segment flow occurs from the San Antonio segment to the Barton Springs segment under dry hydrologic conditions.

Does the Blanco River contributes to discharge at Barton Springs during dry hydrologic conditions?

Is this cross-boundary flow evidenced by increased recharge at Barton Springs in response to increased aquifer recharge from the Blanco River?

Approach

We examined estimated recharge data from the Blanco River and discharge data from Barton Springs. We isolated time periods when there was no recharge from the major contributing and no rainfall in the Barton Springs segment.



Recharge and discharge results

16 events when increased recharge from the Blanco River corresponded with increased discharge at Barton Springs.

Average increase in recharge from the Blanco River was 2.7 ft^3/s (0.2 to 13.8 ft^3/s). Average increase in discharge at Barton Springs was 1.4 ft^3/s (1 to 2 ft^3/s).

Average lag time from the Blanco River to Barton Springs was 4.8 days (2 to 10 days).

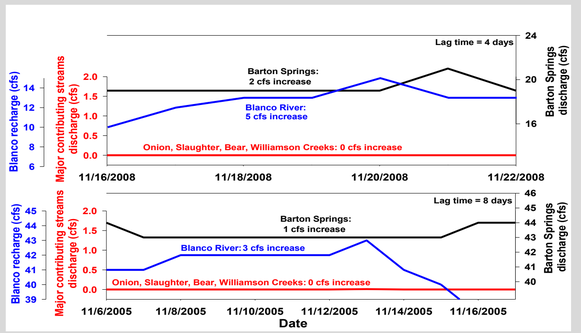


Figure 3. Discharge at Barton Springs, estimated recharge from the Blanco River, and discharge at the major contributing streams to Barton Springs. Lag time is the amount of time it takes to see an increase in discharge at Barton Springs once there is increased recharge from the Blanco River.

Gage height results

Gage height increase was used as a second measure of increased discharge at Barton Springs.

Occurrence date	Increase in gage height (ft.)	Increase in Barton Springs discharge (%)	Inferred increase (x = no; 0 = maybe; + = yes)
9/29/00 – 9/30/00	n/a	11.1	0
11/7/05 - 11/16/05	0.03	2.4	0
8/3/06 - 8/14/06	0.01	4.6	x
8/19/06 - 8/26/06	0.01	4.9	x
9/21/06 – 9/30/06	0	5.1	x
10/6/06 - 10/8/06	0	10.3	0
9/20/08 – 9/24/08	0.01	4.4	x
11/9/08 - 11/15/08	0.04	10.9	+
11/17/08 - 11/21/08	0.04	11.5	+
12/2/08 - 12/6/08	0.02	11.6	+
12/23/08 - 12/30/08	0.02	5.1	0
12/30/08 - 1/2/09	n/a	11.3	0
1/19/09 - 1/24/09	0.03	11.8	+
1/26/09 - 1/31/09	0.01	5.9	x
6/18/09 - 6/22/09	0.01	6.5	x
9/28/11 – 10/4/11	0.07	6.0	0

Table 1. The increase in gage height and percent increase in discharge at Barton Springs. A "+" represents when both gage height and discharge increase by more than analytical uncertainty; a "0" represents when either gage height or discharge increase; and a "x" represents when neither gage height nor discharge increase.

Conclusions

Increase in recharge from the Blanco River can account for the increase in discharge at Barton Springs:

- in 4 of the 16 occurrences
- can possibly account for 6 of the remaining 12 occurrences.
- 6 remaining occurrences are within analytical uncertainty

During dry hydrologic conditions the hydrologic divide shifts towards the Blanco River and there is cross-segment flow from the San Antonio segment of the aquifer to the Barton Springs segment.

Variations in specific conductance are within analytical uncertainty while there is no temporal matching with major ion data.

References and acknowledgements

Hunt, B.B., Smith, B.A., Campbell, S., Beery, J., Hauwert, N., Johns, D., 2005, Dye tracing recharge features under high-flow conditions, Onion Creek, Barton Springs segment of the Edwards aquifer, Hays County, Texas, Austin Geological Society Bulletin, v. 1, 70-86.

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This study was financed through a granted awarded to the National Wildlife Foundation (NWF). The NWF and the Barton Springs/Edwards Aquifer Conservation District (BSEACD) developed a memorandum of understanding on the collaboration (Contract No. 1204-039). The final scope of work was discussed at a technical meeting held at the Sierra Club Offices, Austin TX on February 24, 2012. Attendees included: Brian Hunt (BSEACD), Brian Smith (BSEACD), MaryLynn Musgrove (USGS), Barbara Mahler (USGS), Geary Schindel (Edwards Aquifer Authority), Sylvia Pope (City of Austin), Myron Hess (NWF), Jennifer Walker (Sierra Club), and Tyson Broad (Sierra Club). MaryLynn Musgrove wrote the initial scope of work for this project.