

## **New Approaches for Exploiting Water-Level Responses to Fluctuations in Barometric Pressure**

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The Kansas Geological Survey (KGS) is in the process of setting up a network of monitoring wells at which continuous records of water level, barometric pressure, and, in some cases, temperature and specific conductance are obtained. The three recently installed High Plains aquifer “Index Wells” in western Kansas (Young et al., 2008) are part of this KGS effort. The Larned Research Site (LRS), established in 2001 a short distance downstream of the confluence of the Arkansas and Pawnee Rivers, is the most heavily studied of the sites in this incipient network. At the LRS, a series of monitoring wells have been placed in the semi-confined High Plains aquifer as well as the overlying unconfined Arkansas River alluvial aquifer, and water-level and barometric-pressure data have been collected at 15-minute intervals for more than seven years. Although the initial focus of work at the LRS was on stream-aquifer interactions and groundwater consumption by phreatophytes (Butler et al., 2004, 2007a,b), a new research focus is directed at assessing what additional hydrogeologic information can be gleaned from commonly collected monitoring well data. In this presentation, I will discuss one aspect of this new focus: the information that can be obtained from a more intensive examination of the relationship between barometric pressure and the water level in a well.

Hydrologists have long recognized that changes in barometric pressure can produce changes in water levels in wells. The relationship between barometric pressure and water level has traditionally been characterized using the barometric efficiency (BE), the ratio of the change in water level to the change in barometric pressure head. Although BE has proven to be an effective means of characterizing the short-term response of a well to a change in barometric pressure, the barometric response function (BRF) is a more effective means to characterize the longer-term response. The BRF, which can be determined through a regression deconvolution procedure developed by Rasmussen and co-workers (Rasmussen and Crawford, 1997; Toll and Rasmussen, 2007), characterizes the water-level response over time to a step change in barometric pressure, essentially BE as a function of time since the imposed load. The BRF has been successfully used to remove the effect of barometric pressure changes from water levels, often a critical step in the interpretation of pumping tests. My colleagues and I have recently extended earlier work of Rasmussen and Spane (Rasmussen and Crawford, 1997; Spane, 2002) to show that the BRF can be utilized to obtain important insights into semi-confined aquifer systems and I will demonstrate the power of this approach using data from the LRS monitoring wells. The form of the BRFs from the LRS wells indicates the degree of aquifer confinement, while a comparison of functions from different wells provides insight into the continuity of the low-permeability confining unit (aquitard) separating the two aquifers. We have developed a new approach for estimating aquitard hydraulic

conductivity (K) by fitting theoretical type curves to field-determined BRFs. The aquitard K estimates obtained in this manner at the LRS are within 25% of the estimate determined from a previously performed four-day pumping test (Butler et al., 2004). The LRS data indicate that the BRF for a well in a semi-confined aquifer can also be used to gain insights into conditions in the overlying unconfined aquifer and vadose zone. Although the BE is considered an invariant parameter of a well, the BRF of a well in a semi-confined aquifer can change as a function of vadose-zone conditions. The findings from the LRS indicate that the BRF is a promising tool for gaining important insights into site hydrostratigraphy through passive monitoring of water levels and barometric pressure, and can often be a cost-effective supplement to a conventional pumping test for assessing aquitard properties.

## References

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