Title: **Drawdown in the Northeast Groundwater Management Area (Brown, Outagamie, and Calumet Counties, WI)**

Project I.D.: DNR project # 204

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Background/Need: In Eastern Wisconsin, water levels over large regions have decreased due to many wells pumping from beneath a confining layer. This combination of geology and cumulative pumping from the wells has resulted in a large regional drawdown cone centered around Brown County, Wisconsin. The region has experienced drawdowns greater than 400 feet with a significant portion of Brown County showing drawdowns greater than 150 feet in the confined aquifer.

Wisconsin groundwater quantity legislation, 2003 Act 310, addresses these large drawdowns by designating areas with drawdowns greater than 150 feet as Groundwater Management Areas (GMAs). These GMAs are to receive special attention. However, there had not been any analysis of the drawdowns or pumping rates in nearly 10 years (Walker and others, 1998) in the Northeastern GMA, the region in this study. In this report we remedy this gap in our knowledge with compilations of drawdowns, pumping rates, and an improved hydrostratigraphy of the Northeastern GMA in Brown, Outagamie, and Calumet Counties, WI. In addition, eight communities in the Northeastern GMA switched from groundwater to surface water, providing an opportunity to observe changes in water levels from the decreased pumping rates.

Objectives: The objective of this study was to improve our understanding of the hydrogeology, flow system, and drawdowns in the northeastern GMA. This will allow the WDNR to assist those communities and parties in the northeastern GMA who still rely on groundwater for their current and future water supply needs.

Methods: We collected basic data: water levels, pumping rates, and hydrostratigraphy. These data were compiled into a database of water levels and pumping rates (municipal and non-municipal hi-cap) over time. We analyzed those data and developed maps of drawdown cones and created tables with associated pumping rates. We used the switch from groundwater to surface water by the eight municipalities to estimate a vertical conductivity of the confining layer through a Hantush leaky aquifer analysis. We refined the hydrostratigraphy by using results from an ongoing STATEMAP proposal and the Glacial Lake Oshkosh project (Moeller and others, 2007; Hooyer and others, 2009). We tested several boreholes using geophysical logging, flowmeters, and packer testing to improve the geologic interpretation and to derive hydraulic properties of the confining unit and the confined aquifer.

Results and Discussion: In general, the water levels in the deep sandstone aquifer have increased more than 100 ft around the central portion of the main cone of depression located in central Brown County since the eight communities switched from groundwater to surface water. Although the rate of water level increase has slowed, water levels are still slowly rising. In fact, water levels in the deep sandstone aquifer have the potential to rise above the land surface causing flowing wells; the town of Howard's well #3 has already begun to flow. A smaller portion of the cone of depression in the Northeastern GMA, located to

the south and centered around the Fox Cities area near the north end of Lake Winnebago has not shown any change. This smaller portion is located too far from the change in pumping to have seen any changes in water levels.

Pumping rates in the Northeastern GMA decreased by 12 mgd due to the switch from groundwater to surface water supplies by the eight communities. Current pumping rates in the area in central Brown County are around 4.2 mgd. However pumping rates in the Fox Cities area remain at around 7 mgd.

The hydrostratigraphy of the area has been refined. Analyzing recovery curves from central Brown County wells with the Hantush method using an automated fit approach resulted in horizontal conductivity (Kh) values of the deep aquifer that ranged from 2.7 to 19.1 feet per day. Vertical conductivity (Kv) values of the confining unit ranged from 2.8x10-7 to 2.3x10-3 feet per day. Geophysical logs, flowmeter logs, and packer testing were collected at several wells. One result of this logging is an increased appreciation for high conductivity zones in the sandstone aquifer, whether it be vertical fractures seen in the Shorewood golf course well, BN-422, or the horizontal high K zones in the McKeefry borehole, BN-424, that received or produced flows greater than 50 gpm over zones less than 1 foot in thickness.

Conclusions and Recommendations: Pumping rates control water levels in the deep sandstone aquifer in the Northeastern GMA. We now have two instances, one from 1957 and one from 2005-2007, where pumping rates have decreased dramatically and the aquifer has been allowed to recover. As a result we know that if the aquifer is over-pumped (around 7 mgd in central Brown County), the mineralized zone of the St. Peter Sandstone may become dewatered and might act as a source of arsenic. Also, if the pumping rate is too low, many wells open to the deep sandstone aquifer may begin to flow, creating a need to deal with the excess water.

Related Publications (Abstracts):

Hart, D.J., Luczaj, J.A., and Chase, P.M., 2008, A Large Scale Pumping Test in the Northeastern Wisconsin Groundwater Management Area. American Water Resources Association Conference, Wisconsin Chapter, Brookfield, WI, page 50.

Maas, J.C., Hart, D.J., and Luczaj, J.A., 2009, Groundwater Recovery and Hydrostratigraphy in the Northeastern Groundwater Management Area of Brown, Outagamie, and Calumet Counties, Wisconsin. American Water Resources Association Conference, Wisconsin Chapter, Stevens Point, WI, page 39.

Keywords: Hydrostratigraphy, pumping rates, drawdowns, groundwater management area

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Final Report: A final report containing more detailed information on this project is available for loan from Wisconsin's Water Library, University of Wisconsin–Madison, 1975 Willow Drive, Madison, Wisconsin, 53706; (608) 262-3069.