# ASSESSING SEASONAL VARIATIONS IN RECHARGE AND WATER QUALITY IN THE SILURIAN AQUIFER IN AREAS WITH THICKER SOIL COVER

**Project Identification:** DNR project #198

**Principal Investigators:** Dr. Maureen A. Muldoon, Dept of Geology, University of Wisconsin-Oshkosh; Dr. Kenneth R. Bradbury, Research Hydrogeologist/Professor, Wisconsin Geological and Natural History Survey, University of Wisconsin-Extension

**Period of Contract:** 7/1/2007-8/31/2008

**Objectives:**
The goal of this project was to gain an understanding of seasonal variations in recharge, the timing of recharge events, and the resulting water-quality variations in the Silurian dolomite aquifer in areas with 10 feet or more of surficial sediment.

**Background/Need:**
The fractured Silurian dolomite aquifer is an important, but vulnerable, source of drinking water in northeast Wisconsin. Well contamination events in the Town of Morrison in Brown County (Green Bay Press Gazette, Feb 8, 2006) and Cooperstown in Manitowoc County (Green Bay Press Gazette, May 12, 2008) refocused public attention on the aquifer's susceptibility to contamination. In both events, it appears that manure-contaminated recharge impacted several domestic wells completed in the underlying dolomite aquifer. While these events generated media attention, they are not isolated incidents. Historically, "brown-water" events during spring have been noted in several other counties underlain by the Silurian aquifer – specifically in Door, Calumet, Kewaunee and Manitowoc Counties. In response to these events, Kevin Erb of UW-Extension organized a Northeast Wisconsin Karst Task Force that was charged with developing recommendations for best management practices (BMPs) that would help minimize groundwater contamination in areas underlain by shallow carbonate aquifers with specific attention to BMPs relating to the storage and application of animal wastes.

Previous work in Door County, where soils are typically less than five feet thick, has demonstrated that recharge to the dolomite aquifer can be exceedingly rapid and there was general agreement that the aquifer underlying the Door Peninsula is vulnerable to contamination. Deliberations of the Karst Task Force revealed that there was less consensus on the relative vulnerability of the aquifer in places where the soils were thicker (greater than 5 feet, but less than 50 feet). In reviewing the literature, we were able to locate few field studies of recharge variability in areas where these thicker soils occur over the dolomite aquifer. The need for field data in such settings motivated this study.

**Methods:**
We installed shallow bedrock wells using air-rotary methods at sites in four counties ( Brown, Calumet, Kewaunee, and Manitowoc) where the Silurian aquifer was the uppermost bedrock aquifer and soil was greater than 10 feet thick. All wells were located at the edge of agricultural fields where manure or sewage sludge was being applied. Wells were sited to avoid interference

from septic systems. Geophysical logs were used to identify high-permeability bedding-plane fractures. Water levels and water temperature were recorded every 30 minutes using Solinst Leveloggers™. Each of the wells was also instrumented with a downhole temperature/conductivity probe placed adjacent to a major horizontal fracture. Probes were connected to a surface datalogger that was programmed to record hourly average values. All wells were sampled approximately monthly for nitrate-nitrogen, chloride, and dissolved phosphorus during the period September 2007 to August 2008. Samples were collected by lowering a submersible Grundfos sampling pump into the well to a point opposite the major bedding-plane-parallel fracture penetrated by that well.

**Results & Conclusions:**
This study documented variations in water levels, fluid temperature and electrical conductivity, and selected water-quality parameters in four wells completed in the Silurian dolomite aquifer. The data collected provide a better understanding of seasonal variations in recharge and the resulting water-quality variations in the aquifer in areas with ~10 to 20 feet of surficial sediment.

Water levels in all four monitoring wells show rapid responses to episodic recharge events throughout the year. Most recharge occurred following snow melt and large rainfall events in the early spring. However, significant recharge also occurred in autumn, winter, and summer. The response to recharge seems to be a function of the thickness and texture of the unconsolidated material. Water-table depth does not seem to be an important control on the response to recharge.

In all wells, rapid drops in fluid conductivity in response to recharge indicate that low-conductivity recharge water penetrated into the saturated zone within a day or two of the recharge event. Water from all four wells contained elevated nitrate-nitrogen and chloride. Average nitrate-nitrogen values in three of the wells exceed the drinking water standard of 10 mg/L and all wells exceeded nitrate standard at some time during year. Chloride values are elevated in all wells. Phosphorus values are elevated in the two shallow wells, but not in the deeper wells. Elevated nitrate and chloride values suggest that land-use activities are affecting water quality in all wells.

**Recommendations/Implications:**
This study indicates that, even in areas with 10 to 20 feet of soil cover, the Silurian dolomite aquifer is exceedingly vulnerable to contamination from activities at the land surface. Resource mangers should consider the timing of recharge events when developing best management practices for the application of animal wastes and sewage sludge. The fact that recharge water reaches the saturated zone very rapidly and that significant recharge occurs from December to April suggests that manure and sewerage sludge applied during the winter months has the potential to carry pathogens to the aquifer very rapidly.

**Availability of report**
WDNR, WGNHS

**Key Words:**
Recharge, fractured carbonates, water-quality