Poster Abstracts

Modern Advances in Groundwater

November 16, 2016
Minnesota Ground Water Association
Fall Conference

Promoting Sustainable Groundwater Use and Safeguarding Calcareous Fens in a Perched Groundwater Setting, Southeastern Minnesota

John Greer, Jonathon Carter, Evan Christianson
Barr Engineering Co., 4300 MarketPointe Dr, Suite 200, Minneapolis, MN 55435
Todd Osweiler, Rochester Public Utilities
4000 East River Road NE, Rochester, MN 55906-2813

Abstract
The hydrogeologic setting of southeastern Minnesota is characterized by extensive aquifers in shallow-dipping Paleozoic bedrock. These aquifers are the sole source of water for the City of Rochester. Rochester Public Utilities has recently undertaken an initiative to ensure the sustainability of the Rochester water supply. Preliminary simulations using a regional groundwater model indicated that proposed future pumping of supply wells in the Prairie du Chien and Jordan aquifers may cause several feet of drawdown in the vicinity of calcareous fens situated on the Decorah Edge. The Decorah Edge is the erosional edge of the Decorah Shale, Platteville Formation, and Glenwood Formation. Calcareous fens are explicitly protected by Minnesota statute, and any potential impacts to their source water quality or quantity must be assessed and mitigated or avoided. A site investigation performed to assess the hydraulic connection between one of the fens and a nearby supply well revealed that pumping had no discernible impact on the fen, due in part to vertically extensive unsaturated conditions in the St. Peter Sandstone. The perched nature of the shallow groundwater system relative to the St. Peter Sandstone is a significant and not fully known aspect of the hydrogeologic setting that presents a challenge to accurate characterization of the hydrogeologic setting and its representation in the groundwater model. Available information on the saturation conditions in the St. Peter Sandstone in the vicinity of Rochester was compiled and used to update the groundwater model. We will present the findings of hydrogeologic studies further investigating the extent of perched conditions, the approach to incorporating this aspect of the hydrogeologic setting into the regional groundwater model, and implications for similar hydrogeologic settings elsewhere.

Characterization of the Effects of Perfluoroalkyl Substances on Biological Membranes

Nicole Mohapp, Dr. Andreas Wargenau, Dr. Nathalie Tufenkji, Dr. Matt Simcik, Dr, Paige Novak

Abstract
Perfluoroalkyl substances (PFAS) are strictly manmade compounds that are found in a multitude of environmental systems as a result of use in many industrial and consumer products. While PFAS have been associated with a variety of biotic effects including an increased susceptibility to co-contaminants, their primary mechanism of action is yet unknown. It is also not known whether PFAS have an effect on microbial function. A few studies have cited evidence of altered permeability of biologic membranes upon exposure to PFAS though this has not been shown conclusively. Because microorganisms are essential to waste treatment and nutrient cycling and are often subjected to higher levels of PFAS and co-contaminants, we are interested in studying the effect of PFAS on microbial membrane permeability and function. Three different approaches are being used in this work: (1) Measurement of metabolic response of nitrifying and digester communities to PFAS in the presence and absence of co-contaminants, (2) Quantification of the quorum sensing response of Aliivibrio fischeri to acyl homoserine lactone (AHL) in the presence of PFAS, and (3) Changes in artificial phospholipid bilayers in the presence of PFAS. Preliminary results show that the presence of PFAS altered an anaerobic digester community's response to 1 mg/L of 2,4-dichlorophenol. Additionally, the quorum sensing response of Aliivibrio fischeri increased after growth in solutions containing various PFAS. Finally, both PFOS and PFOA distorted the phase transition of an artificial phospholipid bilayer, demonstrating that lipid interactions are altered in their presence. These results will help the scientific community to understand the types of effects associated with PFAS exposure and at what concentrations these effects become important.

“Smart” Well Field™ Analytics

John Dustman, Brian Gulbranson, Bill Gregg
Summit Envirosolutions, Inc. 1217 Bandana Blvd. North St. Paul, Minnesota 55108
www.summite.com

Abstract
A “Smart” Well Field™ is that part of a water supply system that is equipped with technology to monitor water levels, flow rates, and water chemistry and automatically sets pumping rates to achieve aquifer management objectives. As such, a “Smart” Well Field is a valuable building block of a city’s smart water grid. Hydrogeologic monitoring data are also used to continuously calculate and track specific capacity and flag wells that may warrant redevelopment, pump repairs, or other routine maintenance. Professional hydrogeologists can determine the source of water to wells and recommend source area protection strategies.

SCADA systems are commonly used to compile pertinent data to assist operators with the control of key water quantity needs of the community. SCADA systems can record the pumping rates of wells over time and the corresponding water level elevation changes that take place in pumping and observation wells. These key data - water level elevations and pumping rates – are the monitoring data that “Smart” Well Fields use to accomplish the following:

- Determine optimum pumping rates to reduce energy costs
- Identify wells that require maintenance
- Calculate aquifer parameters and define well head protection areas

The “Smart” Well Field concept begins by equipping wells with continuous water level measurement sensors for compilation in the SCADA system along with flow rates and other information. Professional services include installation and startup assistance. Innovative computer technologies are then used for sophisticated trend analysis essential to understanding the dynamic operation of the system. Kriging algorithms and other visualization tools enhance this understanding in real time or for any segment within the period of record for routine reporting and documentation. Thus, a “Smart” Well Field can minimize energy costs for pumping – for example by analyzing well interference, highlight the need for basic well maintenance, and focus well head protection areas for existing and proposed wells.

A HYDROGEOLOGIAL AND GEOCHMICAL APPROACH TO ESTIMATING GROUNDWATER RECHARGE TO BURIED VALLEY AQUIFERS IN MINNESOTA

Alyssa N. Witt[1,2] and Dr. William W. Simpkins[1]
[1] Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA 50011. witta@iastate.edu
[2] U.S. Geological Survey, Minnesota Water Science Center, Mounds View, MN 55112.

Abstract
Buried-valley aquifers in glacial sediments provide drinking water to thousands of Minnesota residents. However, long-term water-resource planning is impeded by the lack of groundwater recharge data through overlying confining units The U.S. Geological Survey Minnesota Water Science Center, in cooperation with Iowa State University, Minnesota Departments of Health and Natural Resources, and the Minnesota Geological Survey have characterized hydraulic and geochemical properties of till confining units at two sites in central and northeastern Minnesota to estimate recharge to buried-valley aquifers. In summer 2015, 19 piezometers were installed in 3 nests as deep as 340 ft. Two well nests (LF01, LF02) were installed near Litchfield, Minnesota through Des Moines Lobe tills and one well nest (CWO1/2) was installed near Cromwell, Minnesota through Superior Lobe tills. Hydraulic heads were measured and hydraulic conductivities (K) were estimated with slug tests to calculate vertical recharge flux to underlying aquifers. Vertical profiles of groundwater were analyzed for chloride (Cl), nitrate-N (NO3-N), tritium, and stable isotope signatures (δ18O, δ2H) to estimate the ages of water in the confining units. At the Des Moines Lobe nests, downward-directed, vertical hydraulic gradients occur in the confining unit (LFO1 geometric mean K = 3 x 10-7 ms-1, LFO2 geometric mean K = 7 x 10-10 ms-1) suggesting recharge to the aquifer. At CWO1/2, hydraulic gradients suggest an upward component of flow and no vertical recharge to the aquifer through the confining unit (geometric mean K = 2 x 10-7 ms-1). Results for δ18O and δ2H indicated modern precipitation. LFO1 and LFO2 showed uniform isotope values with depth, with mean δ18O and δ2H values of -9.53‰ (S.D. =0.55) and -65.87‰ (S.D. =4.30), respectively. CWO1/2 isotope values are consistently 2‰ lower. Cl concentrations ranged from 12 to 294 mg/L at LFO1 and LFO2 and 2 to 43 mg/L at CWO1/2, suggesting inputs from road salt. At nest LFO2 the Cl concentration declines sharply with depth, indicating limited or no downward movement. LFO1 showed elevated Cl levels through the entire vertical profile. Enriched tritium is present in the aquifer at LFO1 and CWO1/2, indicating recent recharge, and is absent from the aquifer at LFO2. Results indicate that the hydrologic properties of till confining units are highly variable, even at a local scale. Water quality in confined aquifers within the Des Moines and Superior lobe tills showed evidence of recent anthropogenic activities at land surface. This project was supported by funding from Environment and Natural Resources Trust Fund with U.S. Geological Survey Cooperative Matching Funds.