Illinois Groundwater Association

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2006 Spring Meeting

Starved Rock State Park, Utica, IL
April 18, 2006

Agenda and Abstracts

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Illinois Groundwater Association
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8:15–9:00	Registration
9:00–9:15	Opening Remarks: **Steve van der Hoven**, IGA President
	Morning Session
9:15–9:35	**Al Wehrmann**, **Don Keefer**, *Illinois State Water Survey, Illinois State Geological Survey*, The Governor's Executive Order 2006-01 and What It Means for Water Supply Planning in Illinois.
9:35–9:55	**Ed Smith, Dave Larson, Don Keefer**, *Illinois State Geological Survey*, Groundwater Resource Investigations for Kendall County, Illinois
9:55–10:15	**Joe Konczyk**, *Illinois EPA*, Analysis of Illinois' Community Water Supply Well Monitoring data in Relation to the Potential Sources of Contamination for Right-to-Know Bill (Public Act 94-314)
10:15–10: 35	**BREAK**
10:35–10:50	**Business meeting and announcements**
10:50–11:10	**Sam Panno**, *Illinois State Geological Survey*, Techniques for Estimating Background and Threshold Concentrations of Cations and Anions.
11:10–11:30	**Kristen Krug,** *Southern Illinois University, Carbondale*, The Geochemistry and Hydrogeology of Abandoned Homestead Wells in the Shawnee National Forrest.
11:30–11:50	**Rashmi Mantha,** *Southern Illinois University, Carbondale*, Development of a solute transport model to characterize the movement of Sodium Chloride through glacial drift at Fermi National Accelerator Laboratory in Batavia, Illinois.
11:50–1:00	**Lunch**
	Afternoon Session
1:00–1:20	**William J. Weaver,** *STS Consultants, Ltd.*, Fen Wetland Groundwater Recharge Area Evaluation Approach and Site Development BMP's.
1:20–1:40	**Don Keefer, Sarah Rittenhouse,** *Illinois State Geological Survey*, Estimating the Uncertainty of 3-D Geologic Maps
1:40-1:55	**IGA Executive Committee Meeting**
1:55	**Adjourn and Caravan to Field Trip to U.S. Silica Mine, Ottawa, Illinois**

ABSTRACTS

(In order of presentation)

The Governor's Executive Order 2006-01 and What It Means for Water Supply Planning in Illinois

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Illinois State Water Survey
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On January 9, 2006, Governor Blagojevich issued Executive Order 2006-01. This EO requires the development of a comprehensive program for state and regional water supply planning and management. Most importantly, the EO calls for establishing a scientific basis and an administrative framework for implementation of water supply planning and management as well as developing at least two locally-based regional water supply planning committees. Because we are so early in the planning process for how this EO will be carried out, this presentation will provide background on the impetus for the EO and some thoughts on how the process will proceed.

Groundwater Resource Investigations for Kendall County, Illinois

Edward C. Smith, David R. Larson, and Donald A. Keefer
Illinois State Geological Survey

The Illinois State Geological Survey (ISGS) and Illinois State Water Survey (ISWS) are conducting a joint scientific study of the geology and groundwater resources of Kendall County, Illinois. The Surveys are providing technical information and support for the sustainable management and protection of groundwater resources. In particular, the Surveys are providing an evaluation of the long-term availability and sensitivity to contamination of groundwater resources in Kendall County. This research melds with and shares data resources from an ongoing mapping and modeling effort conducted by the Surveys for Kane County, Illinois. Data from the Kendall County mapping will add detail to the ISWS hydrologic modeling of this region.

The ISGS is currently engaged in data mining and development of existing subsurface records and the collection of new subsurface data. Soil boring locations have been sited throughout Kendall to add control to existing shallow subsurface boring data sets. Additionally, four sites are being identified for the placement of nested piezometers where detailed sampling of drill cuttings will be collected. The piezometers also allow for the collection of hydrologic and geochemical data from shallow bedrock and unconsolidated aquifers. Surface geophysical data are presently being collected. Seismic reflection and shear wave seismic surveys have been conducted in two areas in eastern Kendall County. In an area southeast of Yorkville, a previously unmapped buried bedrock valley has been identified with over two hundred feet of fill. Sands and gravels within this valley could provide an additional groundwater resource for nearby communities. Preliminary seismic data also indicate that the Sandwich Fault Zone is a complex of many faulted bedrock blocks.

Analysis of Illinois' Community Water Supply Well Monitoring Data in Relation to the Potential Sources of Contamination for Right-to-Know Bill (Public Act 94-314)

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With the July 2005 signing into law of the Right-to-Know Bill (Public Act 94-314), it is most important to know that The Illinois Environmental Protection Agency (Illinois EPA) has an accurate and efficient system in place to identify potentially impacted areas as they relate to known sources and potential sources of contamination.

Analyses of chemical data from statewide community water supply (CWS), wells and Geographic Information Systems (GIS) are being utilized as one factor to help in the determination of potentially impacted homeowners with private wells from known and yet to be determined contaminant sources.

Groundwater monitoring data were collected through groundwater-quality monitoring programs including the Ambient Network of CWS Wells (Ambient Network), Pesticide Monitoring Subnetwork of the Ambient Network, Problem Site Monitoring Network and Safe Drinking Water Act monitoring program. The latter of these programs collects water data that has been treated by conventional means, while the former are based on source waters from water wells. After analyses of these data, results and other facility information are entered into U.S. EPA Safe Drinking Water Information Systems (SDWIS).

Illinois EPA is concentrating on analytes that have a numerical Groundwater Quality Standard (GWQS) and could be attributed to anthropogenic causes. These analytes include volatile organic compounds (VOC)s, synthetic organic compounds (SOC)s and Nitrate.

Retrieving these data from SDWIS, the Illinois EPA is able to move forward with the mandate to give timely notification to Illinois citizens about contamination in soil or groundwater that may threaten public health. In taking a proactive approach, the Illinois EPA is using GIS to locate any known or potential sources of contamination that threaten potable wells. Using these data and GIS, the Agency is able to implement the Right-to-Know Law with the identification of priority areas for potential notification.

Techniques for Estimating Background and Threshold Concentrations of Cations and Anions

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Because of the ubiquitous nature of anthropogenic sources of contaminants such as nitrate (NO3–) and chloride (Cl-) in many parts of the world, determining background concentrations of these ions in shallow ground water from natural sources is probably impossible in most environments. Present-day background must now include diffuse sources of many ions derived from disruption of soils and oxidation of organic matter, and atmospheric inputs from products of combustion, evaporation and aerosols of road salt, livestock waste, and ammonia from fertilizer. Anomalies can be defined as Cl- and NO3– (for example) derived from inputs to the environment from anthropogenic activities.

Several examples of background determinations will be discussed. The first is an examination of historic data and its usefulness in characterizing background concentrations.. The second is a comparison of Cl- and specific conductance yielding a range of Cl- concentrations in shallow groundwater in sand and gravel deposits of northeastern Illinois. The third is a new technique using cumulative probability graphs to identify threshold concentrations separating background and anomalous concentrations of ions and or populations. Nitrate-N data from wells and karst springs in southwestern Illinois' sinkhole plain were used to test the latter technique. We found that threshold concentrations were 0.4, 2.5, and 6.7 mg/L for spring-water samples, and 0.1, 2.1 and 17 mg/L for well-water samples. The 0.4 and 0.1 mg/L values are assumed to represent thresholds for present-day precipitation. Thresholds at 2.5 and 2.1 mg/L are interpreted to represent present-day background concentrations of NO3-N. The population of spring-water samples with concentrations between 2.5 and 6.7 mg/L represents an amalgam of all sources of NO3– in the ground water basins that feed each spring; concentrations greater than 6.7 mg/L were typically samples collected soon after springtime application of synthetic fertilizer. The 17 mg/L threshold (adjusted to 15 mg/L) for well-water samples is interpreted as the level above which livestock wastes dominate the N sources.

The Geochemistry and Hydrogeology of Abandoned Homestead Wells/Cisterns in the Shawnee National Forest

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Abandoned hand dug homestead wells and cisterns in the Shawnee National Forest provide an opportunity to understand the relation between the water chemistry of the wells and geologic conditions. The research described here is an outgrowth of another project funded through the United States Forest Service, to investigate the freshwater Crustaceans, such as Copeopods and Arthropods living within these abandoned homestead wells/cisterns. Understanding the factors controlling the environmental conditions of the wells/cisterns may help us understand the distribution of the aquatic biota.

The purpose of this study is to determine the relationship between well/cistern water chemistry to the hydrology and geology. Specific study objectives include 1) assess the landscape, geology, vegetation, and surface hydrology around the wells/cisterns; 2) collect water quality samples from wells/cisterns; 3) conduct an exploratory statistical analysis of the water quality data and other factors; and 4) determine the hydrology of the wells/cisterns, including the hydraulic conductivity of the sediments.

Cluster Analysis (CA) and Principal Component Analysis (PCA) were applied to identify groups of sites with similar characteristics, to find correlations between the variables and to understand underlying controls of these groups and variables. The abandoned homestead wells/cisterns have large diameters (0.5-1.4 meters) and are lined in sandstone. Well/cistern shape ranges from straight (vertical) to bell-shaped. Water quality appears to be controlled by the design of these wells/cisterns. A plot of the two main principal components shows two distinct groups, one consisting of wells/cisterns with large diameter casings and shallow water depth and the other consisting of wells/cisterns with small diameter casings and deep water depth. The different chemical constituents correlate inversely to these two groups suggesting that well/cistern design controls environmental conditions.

Development of a Solute Transport Model to Characterize the Movement of Sodium Chloride through Glacial Sediments at Fermi National Accelerator Laboratory in Batavia, Illinois

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Southern Illinois University at Carbondale

Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois, is the largest U.S. laboratory for research in high-energy physics and is second in the world only to CERN, the European Laboratory for Particle Physics. The Central Utilities Building (CUB) Pipe and Clay Tile Field (study area) within Fermilab, is a leach field system designed to dispose effluent generated by the CUB resin regeneration system. The tile lines are 1.2 m below ground level on two acres of ground within the Main Accelerator Ring. The field received ion-exchange regeneration effluent from the CUB in the fall of 1978 to the fall of 1994. The effluent contains very high levels of chlorides and low levels of various metals including mercury, copper and lead. The purpose of this study is to develop a numerical contaminant transport model that can simulate the extent and rate of contaminant migration through the glacial units to Class I groundwater.

Code developed for this project is based on random walk theory described by Prickett (1981). The resulting two-dimensional contaminant transport model simulates vertical flow through glacial deposits to the top of the Silurian bedrock (Class I groundwater). Model results are visualized in Microsoft Excel and ESRI ArcMap. The code was verified by comparing model simulations under the same boundary conditions to Hunt's (1978) two-dimensional analytical solutions for continuous and instantaneous sources. The model of conditions at the study site was calibrated using historical data from the field measurements of concentrations by varying key parameters such as dispersivity and velocity, which have a direct impact on the travel time of the plume. An extensive sensitivity analysis was performed on the calibrated model.

The developed model can predict the movement and the concentration of sodium chloride in the wells located within the clay tile field and the Class I groundwater zone located at the boundary between the glacial deposits and the bedrock. The initial concentration of the source was also determined through modeling.

Fen Wetland Groundwater Recharge Area Evaluation Approach and Site Development BMP's

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Keywords: riparian protection, fen, BMP, groundwater recharge

Without proper planning, the dwindling number of remaining fen wetland areas may be adversely impacted by urbanization. Regulations provide some protections against direct fen impacts; however, indirect impacts to groundwater recharge areas can be just as devastating.

Pulte Homes Corporation (Pulte) has recently completed construction of the Carrington Reserve residential development located adjacent to and partially within the recharge area of a fen in West Dundee, Illinois. Pulte implemented a groundwater protection plan that emphasizes Best Management Practices (BMP's) to strike a balance between development and fen preservation. This paper presents a summary of groundwater recharge characteristics at several fen sites and illustrates the complexity and diversity of these areas. Furthermore, the paper presents a case history for the Carrington Reserve site.

The Carrington Reserve site design includes an innovative approach to recharge area infiltration balancing. In addition, a wide range of BMP's employed by Pulte address potential adverse impacts within the groundwater recharge zone. Baseline groundwater data collected prior to construction provides a benchmark for future performance monitoring. Future monitoring will provide a basis for making necessary adjustments to BMP's. Future monitoring and maintenance is funded by an escrow account that is partially supported through an open space association of individual property owners.

The Pulte project is an example of how responsible development that respects nature can also provide a great place to live. Like a fen wetland area, Carrington Reserve has become a unique place immersed in and surrounded by a rich and diverse environment.

Estimating the Uncertainty of 3-D Geologic Maps

Donald A. Keefer, Sarah C. Rittenhouse
Illinois State Geological Survey

End users of geologic maps are increasingly interested in estimates of the uncertainty of the maps to guide them in their application. Uncertainty, however, is a complex and difficult property to estimate. Rather than attempt an exhaustive delineation of all the sources and impacts of uncertainty associated with a given set of 3-D maps, we chose to characterize the uncertainty associated with the thicknesses of the individual geologic units. This approach focused on the uncertainty caused by the spatial distribution of data points and the variability of the thickness values. We developed a 4-step method that was based on a combination of geostatistical tools and traditional mapping insights. We tested this method using a 3-D geologic map that was developed for Kane County, Illinois.

Our first step involved a rigorous documentation of the conceptual models describing the individual geologic units. To do this, we held meetings with the geologists responsible for mapping in Kane County. During these meetings we discussed and documented, for each unit, their conceptual models governing the direction of ice movement, the location of ice boundaries, the type and thickness of sediment distribution and any associated heterogeneities and anisotropies within these deposits. The second step combined the insights gained from Step 1 with histograms and semivariograms to compare differences between the conceptual models and the data. This evaluation revealed surprising differences between the conceptual models and the data. Step three involved the application of the area of influence method to determine the probability of detecting specified elliptical targets with the available well data. In the fourth step, we used the geostatistical technique of conditional simulation to combine the insight from steps 1-3 and quantitatively estimate the uncertainty associated with the unit thicknesses.

For the Kane County 3-D map, we found that the conceptual models for the individual units were highly structured and provided specific interpretations on the variability (i.e., heterogeneity and anisotropy) of unit thicknesses. The data points, although densely spaced, were still highly variable in their thickness values and often did not clearly support the interpretations of heterogeneity and anisotropy that were expressed in the conceptual models. Rather than seeing this as an indication of problems with the conceptual models, we felt that these differences indicated the importance of the interpretations of the mappers in creating geologically meaningful maps. The use of conditional simulation in this approach provided a valuable means of quantifying the uncertainty surrounding important aspects of the 3-D map. The results from the various simulations should also be of value to users of the maps (e.g., planners, groundwater hydrologists) who are interested in identifying areas of high confidence and areas where the confidence is lower and alternate interpretations may be worth considering.