AGENDA
ILLINOIS GROUNDWATER ASSOCIATION
2010 SPRING MEETING

April 22, 2010
Morton Arboretum, Lisle, Illinois

8:30 – 9:15 Registration

9:15 – 9:30 Opening Remarks, Steve Kroll, IGA Chair

9:30 – 10:00 **Al Stone**, *CES Group of Illinois, Inc.*, Modeling the Potential Downgradient Extent of Groundwater Contamination Caused by Leaching of Vadose Zone Contaminants: Comparison of TACO and Domenico Transient Models

10:00 – 10:30 **Colin Booth and Christopher Greer**, *Northern Illinois University*, Modeling the Hydrologic Effects of Longwall Mining on Shallow Bedrock Aquifers Using Modflow with TMR

10:30 – 11:00 Break

11:00 – 11:45 **James Adamson**, *V3 Companies*, Groundwater Development in Haiti and an Account of the Earthquake

11:45 – 1:00 Lunch & IGA Executive Committee Meeting

1:00 – 1:30 **Ben Moss**, *Illinois State University*, Investigation of Spatial and Temporal Variations in Water Quality around Nora, Illinois

1:30 – 2:00 **Al Wehrmann,** *Illinois State Water Survey*, Opportunities and Challenges of Meeting Water Demand in Northeastern Illinois

2:00 – 2:30 Break

2:30 – 3:15 **Jerry Dalsin**, *Illinois Department of Public Health*, Water Wells – Navigating the IDPH Internet; the Penn State Study on Water Well Contamination; Major Proposed Changes to the Water Well Construction Code; and Update on SB254

3:15 – 3:30 Open for Comments / Announcements

3:30 – 3:45 Closing Remarks, Steve Kroll, IGA Chair

Modeling the Potential Downgradient Extent of Groundwater Contamination Caused by Leaching of Vadose Zone Contaminants: Comparison of TACO and Domenico Transient Models

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Tiered Approach to Corrective Action Objectives (TACO) Tier 2 equations are currently used to model the downgradient extents of groundwater contamination emanating from impacted vadose-zone soils at Leaking Underground Storage Tank (LUST) sites in Illinois. The TACO equations are relatively easy to use with a spreadsheet, but have some limitations. TACO provides steady-state solutions, and assumes source area concentrations remain constant and do not decrease over time. Therefore, TACO may overestimate maximum downgradient extents, which may require institutional controls at properties that may never become impacted. TACO equations also do not determine time required for the plume to reach its calculated maximum extent (steady state conditions). Time to reach steady state can be calculated using an equation that is not part of TACO.

An alternative model that incorporates the transient Domenico equation with source area degradation (USAFCEE, 1995), calculated source-area degradation factor based upon infiltration, and some TACO equations (hereafter called Domenico for soil) can also calculate theoretical downgradient extents of groundwater contamination. This solution would theoretically calculate smaller downgradient compliance distances than TACO, and can calculate the extent of the groundwater plume, and theoretical source area soil and groundwater concentrations, with respect to time.

Soil analytical and site-specific hydrogeologic data from a site in Sheboygan, WI were entered into a spreadsheet model that calculates TACO and Domenico for soil solutions. TACO and Domenico for soil results were compared. TACO provided a larger theoretical downgradient extent of groundwater contamination than Domenico for soil. The Domenico for soil solution calculated a smaller downgradient extent, which could impact less off-site properties. In addition, Domenico for soil calculated times for source area soil and groundwater concentrations to reach their remediation objectives.

<u>Former Title</u>

Suggested Modifications to TACO Tier 2 Soil Contaminant Leaching to Groundwater to Account for Calculated Changes in Source Area Concentrations with Respect to Time

Modeling the Hydrologic Effects of Longwall Mining on Shallow Bedrock Aquifers using Modflow with TMR

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High-extraction longwall underground coal mining creates extensive drainage, complex fracturing and subsidence of the overlying strata that are difficult to model to examine and predict groundwater impacts. Standard groundwater models such as MODFLOW are not well suited to the deep, variably saturated, heavily fractured roof zone immediately above the mine, but are more easily applied to the shallow aquifer system (of most interest for groundwater resources) that is typically separated hydraulically from the mine and roof zone by a confining aquitard layer in the mid-level of the overburden. However, several problems must be resolved: the changing hydraulic properties, advancing subsidence zone, steep hydraulic gradients and sharp spatial changes over the longwall panels. We are applying MODFLOW (Groundwater Vistas® version) with Telescopic Mesh Refinement (TMR) to simulate the hydrologic responses in the shallow system, using a well-documented case study (Jefferson County, Illinois, 1988-1995) as the conceptual model and data base for subsidence impact and recovery. The mine was about 220 m deep, overlain by a shale-dominated overburden that includes a 23-m-thick sandstone aquifer at a depth of around 22 m, and a thin cover of glacial deposits. Approximately the upper 70-80 m of the overburden is modeled. In TMR, which has been extensively used in other hydrogeological problems but not for longwall modeling, a finely discretized local model (LM, here about 7 km2) is embedded in a coarser regional model (RM, about 20 km2). Currently, the base RM is calibrated and we are experimenting with LM approaches to the longwall hydrologic problems. The primary driver for head changes during subsidence is rapid increase in fracture porosity during the tensional phase; this may be simulated by transient well sinks defined in MODFLOW stress steps. There is no MODFLOW structure to accommodate changes in hydraulic properties, so these will be modeled as stress zones in discrete steps associated with the advancing subsidence front. The modeling development is in progress. We hope that this development of MODFLOW with TMR will ultimately demonstrate an application that can be readily used by hydrogeologists to better evaluate and predict the hydrological impact of longwall coal mining.

Investigation of Spatial and Temporal Variations in Water Quality around Nora, Illinois

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The geologic landscape around Nora, Illinois is composed of Galena Group, overlaid by thin Quaternary deposits. The weathering of the Galena Group has created a terrain with karst and mantled epikarst. A high degree of connectivity between the surface water and the groundwater, associated with the karst, causes the groundwater to be very susceptible to contamination. Construction of a large dairy operation, 6,850 head of cattle, was initiated southwest of Nora late in 2008. Owing to the potential for contamination of surface water, groundwater, and private wells, surface water and groundwater were monitored for a year to assess the spatial and temporal variability of the water quality parameters. Six streams and six springs, in close proximity to the dairy operation, were sampled monthly for this study. Baseline water chemistry was established through monitoring the concentrations of major anions and cations, pH, temperature, specific conductance, carbon dioxide, alkalinity, hardness, and dissolved oxygen, which will allow for the comparison to future water quality data. Nitrate as nitrogen values ranged from 2.90 to 14.55 ppm for stream locations and from 0.28 to 30.10 ppm for spring locations. Except for fluoride, potassium, sodium, and sulfate, the water quality of streams and springs were statistically different from each other. As a whole, the streams experienced less spatial variation than the springs. Statistically different concentrations of chloride, nitrate-nitrogen, and sulfate were observed among both the streams and the springs. Almost all of the alkalinity and calcite levels for the streams were statistically similar spatially. Conversely, alkalinity and calcite values at the spring locations were statistically different spatially. Temporal analyses were only conducted on the stream data and one spring location; with the exception of temperature, dissolved oxygen, and pH, none of the locations exhibited statistically different temporal variation among the parameters. The data indicate that the stream water quality characteristics exhibited some spatial variations, in example chloride, magnesium, nitrate as nitrogen, sulfate, and pH,, but temporal variations in water quality characteristics were not observed. The springs experienced spatial variations in all of their water quality parameters. The spatial variability among the stream and spring water quality parameters, especially the nitrate as nitrogen, sodium, and sulfate concentrations, is believed to indicate that the surface water and groundwater are susceptible to local influences.

Opportunities and Challenges of Meeting Water Demand in Northeastern Illinois

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This presentation will include a brief discussion of the principal sources of water for northeastern Illinois; historical, current, and projected future water demands for the 11-county region; and the Water Survey's recent investigations of the impacts of trying to meet those demands on the principal aquifers of the region. Groundwater flow modeling shows the deep bedrock (Cambrian-Ordovician) aquifers are being overpumped along a corridor between Aurora and Joliet. Water levels may have already fallen below the top of the Ancell unit in some areas. Water levels are projected to fall below the top of the deeper Ironton-Galesville unit by 2035. As these water levels continue to drop, water quality may also become a concern as underlying saline waters move upward. Greater dependence on shallow groundwater is not without problems. Modeling shows there have been impacts to stream base flows and these impacts will increase as withdrawals increase to meet demand. However, while water diverted from Lake Michigan is limited by Supreme Court decree, studies by IDNR suggest this supply can support growth within the present service area, home to 77% of the region's population. The Fox River may also provide additional supplies – flows continue to increase as more treated effluent is discharged to the Fox, a resource that could be tapped to meet downstream demand currently using the deep aquifers.

Water Wells – Navigating the IDPH Internet; the Penn State Study On Water Well Contamination; Major Proposed Changes to the Water Well Construction Code; and Update on SB254

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Recently, IDPH has made several additions to its internet site that would be of particular interest to groundwater professionals. They include References and Study Manual for the Water Well and Pump Installation Contractors License Examinations; Approved Water Well and Closed-Loop Heat Pump Well Construction Materials pertaining to backflow preventers, grouts, hand pumps, pitless well adapters and units, closed-loop well piping, and well caps. There are four Guidance Documents: *Arsenic in Private Wells, Closed-Loop Wells, Dewatering Wells, and Monitoring Wells.* The two on monitoring wells and closed-loop wells are one page summary documents with several links on each for additional information.

Pennsylvania is one of four states that do not have construction requirements for private water wells; however, they do have guidelines, and some local ordinances do have such requirements. During 2006 the Pennsylvania College of Agricultural Sciences, Cooperative Extension, conducted a study, *Protecting Wells with Sanitary Well Caps and Grouting*. The study centered on two important missing features of private well construction – the grout seal of the annular space, and sanitary well caps. Bacterial contamination occurs in about 50 percent of private wells. Ungrouted wells are three times more likely to be contaminated with E. coli bacteria compared to grouted wells; however, coliform bacteria were still common in grouted wells.

None of the wells had sanitary well caps. Referencing another study by Penn State, sanitary well caps are most successful in eliminating bacteria from wells that previously contained small numbers of coliform bacteria. They are not nearly as effective on wells that had more gross contamination. Two conclusions came out of the study – if a well tests positive for coliform bacteria, a sanitary well cap may help solve the problem, especially if the well contains small numbers of bacteria. If a well is currently free of bacteria, a sanitary well cap will help to ensure that it does not become contaminated in the future by insects or other contaminants around the wellhead.

A number of changes to Well Code are being proposed. Among the more significant ones, under Sections 920.60 and 920.70, the entire annular space between the borehole and the outer casing would have to be grouted, thus eliminating the present minimum grouting depth of 60 feet requirement. The setback table of minimum lateral distances between water wells, closed-loop heat pump wells and sources of contamination in Section 920.50 b) would be eliminated and replaced by Section 920.TABLE C. In Section 920.90 h) Grouting, shale traps would not be allowed for the purpose of suspending grout above the open annular space.

In Section 920.180 Closed-Loop Heat Pump Wells, bentonite grout, containing sand to enhance thermal conductivity, would be allowed if the Department approves it for a particular application. Individual loops would have to be tested with air or potable water at a pressure of 1.5 times the system operating pressure. From an environmental perspective, propylene glycol would be changed to USP food grade propylene glycol; and for direct expansion (DX) systems with copper piping, the refrigerant would be R-134a, R-290, or any equivalent with less ozone depletion potential. Section 920.180 d), the requirements for sealing closed-loop heat pump wells was both clarified and expanded.

SB254 to require the permitting of closed-loop heat pump well systems and the registration of closed loop well contractors passed the Senate and progressed to the House Rules Committee on May 8, 2009.