Illinois Groundwater Association

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2005 Fall Meeting

Morton Arboretum, Lisle, IL

October 27, 2005

Agenda and Abstracts

AGENDA
ILLINOIS GROUNDWATER ASSOCIATION
2005 FALL MEETING
OCTOBER 27, 2005
MORTON ARBORETUM, LISLE, ILLINOIS

8:15-9:00 Registration with refreshments

9:00-9:15 Opening Remarks: **Erik Spande**, IGA Chair

Morning Session

9:15-9:35 **Brian Hacker**, Leggette, Brashears & Graham, *Conversion of Farmland to Residential Properties: Pesticides and Drinking Water Quality Concerns*

9:35-9:55 **Nick Fromm,** Illinois State University, *Numerical modeling and mass balance of a single meander of Little Kickapoo Creek- Investigation of the ability of stream meanders to remove nitrogen*

9:55-10:15 **Maria Lemke**, The Nature Conservancy, *Effectiveness of agricultural best management practices on the ecological integrity of a Mackinaw River subwatershed, Illinois*

10:15-10:30 **Break**

10:30-10:50 **Business meeting and time for announcements**

10:50-11:10 **Doug Cherkauer**, University of Wisconsin Milwaukee, *Integrating groundwater resource information with community planning: Successes and failures from Richfield, Wisconsin*

11:10-11:30 **Robert Kohlhase and Danielle Wallin**, Farnsworth Group, *Regional Water Supply Planning for McLean County, Illinois Communities*

11:30-11:50 **Erik Spande**, CH2M Hill, *Waukegan Manufactured Gas and Coke Plant Remediation, Phase 1: Soil Removal to Soil Operable Unit*

11:50-1:00 **Lunch**

Afternoon Session

1:00-1:20 **Amy Schwarz,** Northern Illinois University**,** *Characterization of a Site Contaminated with Heavy Metals and Chlorinated Solvents in Southeast Rockford, Illinois*

1:20-1:40 **Bruce Hensel**, Natural Resources Technologies, *Groundwater Modeling to Predict Impacts of a New Highway near a Wetland*

1:40-2:00 **Craig Allen**, Meadow Well and Pump Service, *The benefits of down-hole television surveys*

2:00-2:20 **Break**

2:20-2:40 **Steve Van Hook**, Patrick Engineering, *Groundwater Remediation Using a Horizontal Groundwater Collection Drain*

2:40-3:00 **Kathy Bryant**, Northern Illinois University, *Changes in mineralogy and surface structure of clay-sized particles with long-term exposure to halogenated compounds*

3:00-3:30 **Brian Snelton**, Shaw Group, *Domestic Water Supplies*

3:30 **Adjourn and IGA Executive Committee Meeting**

ABSTRACTS

(In order of presentation)

Conversion of Farmland to Residential Properties: Pesticides and Drinking Water Quality

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A current trend in residential development is to convert farmland to residential subdivisions in which each home has its own domestic water supply well. The U.S. Geological Survey's (USGS) National Water-Quality Assessment (NAWQA) Program findings indicate that pesticides were found in more than one-half of shallow wells sampled in agricultural areas. The USEPA and many Illinois county health departments suggest testing drinking water supplies for pesticides, but it is not routinely done on domestic water supply wells. Because some tillage practices can promote pesticide leaching to ground water, agricultural pesticide application is imprecise, and lawn and landscape pesticides are used on as many as one-half of all residential properties nationwide, a potential exists for pesticide impact above regulatory limits in domestic water supply wells installed on converted farmland.

Numerical modeling and mass balance of a single meander of Little Kickapoo Creek- Investigation of the ability of stream meanders to remove nitrogen

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Excessive nitrate is a major pollutant of both surface water and groundwater, contributing to adverse effects on both human and ecological health. The hyporheic zone, where surface water and groundwater interact is a poorly understood but important ecotone. The aim of this study is to quantify the flux of water and loss of nitrate occurring beneath a meander of a low gradient stream, which flows across an unconfined glacial outwash aquifer. 13 monitoring wells were installed throughout the site and were screened at the water table. Physical measurements of hydraulic head, pH, and temperature were taken on a nearly monthly basis for a period of 11 months at which time water samples were also collected and processed for major ion chemistry. Ammonia and nitrite samples were also taken on a seasonal basis. Results of the chemical analysis show a reduction of nitrate concentration as stream water passes beneath the meander, indicating denitrification or plant uptake of nitrate. Ammonia in the meander increases along flow paths as nitrogen is released from the decomposition of organic matter. Chloride concentrations in Little Kickapoo Creek vary seasonally from 100 to 1000 mg/L, while local groundwater ranges from 10 to 15 mg/L. Chloride concentrations in the groundwater found beneath the meander exceed 100 mg/L indicating that the water is mainly stream water. A numerical model was constructed based on the hydraulic head measurements and conservative solute concentrations to quantify the flux of water beneath the meander. Flow and transport models were constructed in Groundwater Vistas using the MODFLOW and MT3D packages. Calibration of the flow model resulted in a good fit to the actual water table elevation data with an absolute residual mean of 0.15 ft. Calibration of the transport model was not as precise though many of the patterns seen on spatial diagrams of chloride concentrations in the meander are also visible on the model generated diagrams. MODPATH simulations were performed and yielded travel times across the neck of the meander in the range of 60 to 120 days. Sensitivity analysis performed on the model indicates that the model is only sensitive to changes in the elevation and position of the constant head boundary representing Little Kickapoo Creek. Results of a mass balance performed using the flux data from the model and the results of the nitrogen analysis suggests that 2.1 percent of the nitrogen in Little Kickapoo Creek is lost as the stream moves around the meander. 84.4 percent of the nitrogen entering into the meander is lost before rejoining the stream on the down-gradient side of the meander, suggesting that the mechanism of stream meanders for removing nitrogen in low gradient streams is significant and warrants further study.

Effectiveness of agricultural best management practices on the ecological integrity of a Mackinaw River subwatershed, Illinois

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The 301,000-ha watershed of the Mackinaw River is a major contributor of sediments and nutrients to the Illinois River. Because row crop agriculture comprises >90% of land-use practice in the Mackinaw River watershed we focused on addressing the effectiveness of agricultural best management practices (BMPs) at improving ecological integrity of a small watershed. Although positive impacts of specific BMPs have been documented for a given farm or field, there is little evidence of the effectiveness of BMPs at the watershed scale. Consequently, the influence of BMPs in conserving soil and water quality at larger scales has been questioned. We present an ongoing 6-y paired watershed study designed to demonstrate the (1) effectiveness of focused outreach on BMP implementation and (2) cumulative effects of BMPs on hydrology, water quality, and biological resources of a 4000-ha subwatershed of the Mackinaw River, Illinois. During the first 5 years, participation in cost-share programs and the number and types of BMPs implemented were tracked in an experimental and a control watershed in conjunction with the monitoring of instream hydrology, water quality, and biological resources. Focused outreach significantly increased use of strip-till agriculture (13 vs. 5% of watershed), grass waterways (38 vs. 10 ac) and buffer strips (120 vs. 40 ac) in the experimental versus the control watershed, respectively. Increased BMP implementation in the experimental watershed significantly reduced baseflow nitrate and suspended sediment concentrations compared to the control watershed; however, nitrate concentrations in the experimental watershed still exceeded 10 mg/L almost 5 months per year over the study period. This study shows that surface BMPs alone will not improve the overall biological health of local watersheds and illustrates that reduction of nutrient and sediment loads at a watershed scale will require intercepting and retaining tile drainage. We are in the process of implementing the next stage of research to specifically address agricultural tile runoff by testing and comparing the effectiveness of constructed wetlands and sub-irrigation systems at improving hydrology and reducing nutrient inputs at the experimental watershed scale. This research will provide the technical and experimental data that are necessary to expand water quality conservation efforts in the Mackinaw River watershed, and is directly applicable to The Conservancy's efforts to protect and improve water quality in larger agricultural watersheds such as the Illinois and upper Mississippi Rivers.

Integrating ground water resource information with community planning: Successes and failures from Richfield, Wisconsin

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Sustainable development in ground-water using communities requires an understanding of the dynamics and quantity of the water supply available. Too many communities haven't factored water supply into their development plans. As a result, there are many whose population density exceeds the ability of the ground-water system to support it.

The Town of Richfield, Washington County, is serving as a test case for incorporating analysis of ground water resources into the planning process. In a two-year study, the magnitude of the Town's supply has been assessed, and both the Town's leaders and populace have been apprised about the supply's limits. The Town began its comprehensive planning process shortly after the ground-water study began. It simultaneously adopted a moratorium on development to allow the plan and water study to proceed without the pressure from development decisions.

A number of intriguing scientific results have occurred in the water study. The hydrogeology consists of a complex sequence of glacial sediments over discontinuous dolomite. As a result, residents draw water from multiple aquifers which have spatially varied interconnections. A well water level and streamflow monitoring program coupled with GIS-based mapping have revealed the spatial and temporal variations of recharge. A MODFLOW model of the ground-water system allows quantification of the Town's total ground water budget and testing the effects of different development scenarios on it.

The policy results are particularly important. Protection of ground-water resources has become a significant component of the Town's plan. They have adopted a land use plan designed to minimize heavy demand and maximize water recycling. The Town Board has drafted an ordinance intended to ensure continued resource protection in the future. They failed, however, to require that new developments install the monitoring wells at which future observations could be made.

Regional Water Supply Planning for McLean County, IL Communities

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The drought of 1989-1990 created a serious water supply shortage for the City of Bloomington. The City relies upon two reservoirs for its water source. During the drought the supply was lowered to a 30-60 day supply level. There are interconnections between the Town of Normal and the City supply that helped stretch the available supply. During the drought, emergency water supply studies were performed that reviewed water sources available in the area. A side-channel pumping pool was determined to be the immediate solution. This side-channel pumping pool has the capability to pump 20 mgd from the Mackinaw River to Evergreen Lake during certain permitted flow conditions. Six years later Lake Evergreen was raised 5-ft increasing the lake storage by 35%.

After the drought, the community leaders led an effort to fund several studies to prepare for the expansion of the area's long-term water supply and to determine the feasibility of a regionally based water supply system. The first effort was to evaluate the potential water supply sources that would sustain a 15- mgd supplemental supply. Alternative water supplies included new reservoirs, the Illinois River, recycling of wastewater treatment plant effluent and groundwater supplies. The findings of this study were that the Mahomet/Sankoty Aquifer system would provide the most viable supplemental water supply.

Next a master plan was created that outlined the required research in three areas. First, a Regional Water Needs assessment was recommended and performed. Eighteen communities were studied by the Farnsworth Group to determine their immediate and long-term water needs. It was determined that a regionally based supply would be feasible and beneficial to certain communities at different points in time. Next, an extensive hydrogeologic study was commissioned with the Illinois Department of Natural Resources. Detailed aquifer tests were part of this study. This cutting edge study determined that the area of the Mahomet/Sankoty aquifer studied could yield 30 mgd. A tremendous knowledge base was gained from this study.

Lastly, an Infrastructure Plan was recommended. In 2002, Farnsworth Group completed a preliminary infrastructure plan that updated past analysis, created a development plan and identified how to implement this new water supply. The development of a regional supply requires a comprehensive approach that includes technical, scientific, political, financial and planning considerations. Currently, the Communities are looking at the creation of an agreement for a governing entity to develop a supplemental water supply. This presentation will outline the complexity of reaching the goal of new water supply source of this magnitude.

Waukegan Manufactured Gas and Coke Plant Remediation, Phase 1: Soil Removal to Soil Operable Unit

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The Waukegan Coke Plant (WCP) site is located on a peninsula between Lake Michigan and the Waukegan Harbor in Waukegan, Illinois. A wood treating plant operated at the WCP site in the early 1900s, followed by a manufactured gas plant in the 1920s and a coke oven gas plant in the 1940s. Manufacturing ceased at the site in the late 1960s and the site was disassembled in approximately 1972. Since that time the site has been used for fire training, waste oil storage, parking, dredge sand stockpiling, and snowmobile testing.

In 1990, the U.S. EPA and the site responsible parties entered into an administrative order on consent for completion of a remedial investigation and feasibility study (RI/FS). The RI that was completed in 1995 showed that soil at the Waukegan Coke Plant site is impacted with coal tar and creosote from previous site operations, and that these materials act as a continuing source of contamination. Site groundwater is contaminated in some areas with ammonia, arsenic, phenol, and benzene. Groundwater in the shallow sand aquifer discharges to the adjacent Waukegan Harbor and Lake Michigan.

A final FS was released in 1998 and the U.S. EPA signed a Record of Decision in 1999 with site responsible parties for the final remediation of the site. Groundwater will be cleaned up to remove arsenic, ammonia, and benzene; soils at and above the water table will be excavated to remove PAH and arsenic.

This presentation presents the results of the soil remediation portion of the ROD that began December 2004 was completed in August 2005. The extent of contaminated soil was identified in the RI and pre-design investigations, and soil was excavated, visually classified, and staged on site for analytical testing to determine the type of off-site disposal. Highly impacted 'tarry' soil was sent offsite for thermal treatment, and soil that failed the site-specific cleanup criteria was taken to a RCRA Subtitle C or D landfill. Soil that passed the analytical criteria and selected site debris (such as crushed concrete), stockpiled dredge sand, and imported clean soil were used to fill the excavation. Remaining on site structures were demolished, site debris removed, and the site regraded to complete the soil removal portion of the ROD.

Groundwater design is expected to be completed in fall 2005, and construction on the remedy completed in 2006. Starting in the spring of 2007, the site should begin around 3 to 5 years of pump and treat remediation of the affected groundwater. The City of Waukegan purchased the site and plans to develop the property for residential use.

Characterization of a Site Contaminated with Heavy Metals and Chlorinated Solvents in Southeast Rockford, Illinois

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The Acme Superfund Site is located in New Milford, Illinois, approximately five miles south of Rockford in Winnebago County. Between 1960 and 1973, this site was used as a disposal site for paints, oils, and still bottoms from the Acme Solvent reclamation plant. Since 1985, much work has been done to clean up the site, however geologic and hydrogeologic data from various reports appears to be questionable for regions south of the site near homeowners. The objective of this study is to develop a conceptual model of the contaminated groundwater flow in this region. Soil corings along with previous data were used to determine an accurate cross-section that was then used to provide data to aid in the construction of a conceptual groundwater flow model. In order to determine the hydraulic conductivity of the area, slug tests were conducted on four wells on this study site. The results suggest that the groundwater flow paths are of a south-southwesterly flow as shown in previous studies. However, with this extended cross section, a different no flow boundary has been identified which indicates that the contaminants are much farther from the homes as anticipated. Also, contaminants were identified close to the dump site with decrease concentration closer to the homes. The data conducted by this study does differ slightly in ways compared to previous studies. However, the fact remains that the contamination has not gotten to the homes yet nor will for some time due to particle travel times.

Groundwater Modeling to Predict Impacts of a New Highway near a Wetland

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A groundwater flow and transport model was developed to evaluate changes in groundwater quality and discharge to three wetlands resulting from addition of a new highway, and new lanes to an existing highway, in Kane County. The wetland of greatest concern was a sedge meadow, supported by groundwater discharge. Highway expansion issues included concerns that the chloride loading from increased road salting would negatively effect vegetation, or that mitigations to control runoff would reduce groundwater recharge, and subsequently, discharge to the fen. Chloride was used as an indicator parameter for anthropogenic effects on groundwater quality due to its high mobility in groundwater, its occurrence in road salt, landfill leachate, and septic systems; and its potential impact on some types of wetland vegetation. A key aspect to successful application of the model was a field study that provided an estimate of the chloride mass loading from the existing two-lane highway, and from a four-lane highway similar to the proposed new highway.

Initial model results indicated that a new, four-lane road, without mitigations, could increase chloride loading via groundwater to the wetlands. The same road, with mitigations that included stormwater drains and removal of nearby septic systems, could decrease chloride loading, relative to current conditions. The model also predicted that changes in groundwater discharge to the wetlands would be negligible. Sensitivity testing demonstrated that these predictions were consistent for a range of hydrogeologic input parameters and a variety of mitigation assumptions.

The benefits of down-hole television surveys

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Down-hole television surveys are an essential tool in the documentation of well construction and identification of well problems. Pulling and inspecting the well equipment is only half the equation Meadows down-hole/360 degree side view camera enables us to visually identify conditions which affect a wells specific capacity. This presentation will review well videos which document a host of well conditions and ailments.

Groundwater Remediation Using a Horizontal Groundwater Collection Drain

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For eight years, the City of Carthage, Illinois expended considerable time and resources grappling with groundwater contamination at its closed municipal landfill. In 2003, Patrick Engineering Inc. was hired by the City to develop an alternative remediation solution since the Illinois Environmental Protection Agency (IEPA) had previously deemed another plan as unacceptable. Other remedial options such as a slurry wall, leachate extraction and groundwater pump and treat were too expensive for the City to afford. Patrick's professionals developed an innovative remedial solution that included the construction of a horizontal drain system with a cost of $700,000 -- significantly lower than the $1 to $4 million required to implement other remediation options.

The horizontal drain system was constructed in low to moderately permeable soils on a bluff between the waste boundary and the contaminated monitoring wells. Additional soil borings and groundwater testing were completed along the projected drain path for the design and permitting of the drain. Bid specifications were prepared and Direct Technologies Drilling was selected to construct the drain. Drilling turn radius, entrance angles, elevation, drain slope, drain material, drilling fluids, and installation methods were all major design considerations. The drain construction consisted of slotted PVC pipe installed using a biodegradable drilling fluid. Major receiving components of the systems include butterfly values, an underground storage tank and force main.

Currently, the city trucks the groundwater to their municipal wastewater treatment plant. Plans for future disposal may be to extend the city sewer system and run the force main to a direct hookup. Another disposal system being evaluated is bioremediation of the groundwater and discharging the treated groundwater into a nearby creek, if an NPDES discharge permit can be obtained.

Changes in mineralogy and surface structure of clay-sized particles with long-term exposure to halogenated compounds

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Halogenated compounds are widespread contaminants in industrialized areas of many US cities and towns, that originate from leaking tanks, spills, and unregulated disposal practices. Halogentated solvents are dense non-aqueous phase liquids (DNAPLs) that can form pools on top of impermeable subsurface layers. These pools attenuate slowly, and so remain in contact with subsurface materials for many years. This long-term immersion of soils and sediments to concentrated industrial solvents may alter the material, possibly changing the permeability of contaminant-confining layers and affecting the migration of contaminants.

In this research project, soil samples were collected from a chlorinated solvent contamination site located in Rockford, IL to determine possible alterations in mineralogy and grain surfaces of the confining layers. Clay-sized particles were analyzed for mineralogical and chemical composition using X-ray diffraction and electron dispersive spectroscopy, comparing clean samples to contaminated samples to determine any significant alterations. Physical grain textures were examined using a scanning electron microscope (SEM) to detect any significant observable weathering features of grains. Advanced weathering or changes in mineralogy may indicate an alteration of the physical texture on a larger scale, potentially affecting travel of the contamination. The geologic material may become more porous, facilitating contaminant travel through increasing permeability, or it may become more cemented if there is reprecipitation of minerals within pore spaces. This may lead to less retardation of contaminants and eventually cause unexpected movement of a plume through or around confining layers and into surrounding aquifers.

Domestic Water Supplies

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1.5 million Illinois residents rely on private water wells (domestic water supplies) for their supply for clean and safe drinking water. Shallow and deep aquifers provide 135 million gallons of water per day to these households (NGWA, 2004). Water well contractors need to have the understanding of local and regional geology and hydrogeology to be able to obtain the yield required to supply the need of the public. Guidelines set forth by the Illinois Water Well Construction Code hold the licensed contractor to minimum requirements to assure the public that the well was constructed properly so that potential routes of contamination will be prevented and the water supply is safe to drink. The water well drilling industry is also driven by a combination of science, technology and associations to continue to provide a safe reliable product for homeowners. An understanding how the three work together will continue to protect our drinking water from contamination and/or overuse.