
# 2005 Spring Meeting

**Illinois State University, Bone Student Center**
**April 26, 2005**

# Agenda and Abstracts

# AGENDA
# ILLINOIS GROUNDWATER ASSOCIATION
# 2005 SPRING MEETING
# APRIL 26, 2005

### BONE STUDENT CENTER, ILLINOIS STATE UNIVERSITY, NORMAL, ILLINOIS

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| 8:15-9:00 | Registration with refreshments |
| 9:00-9:15 | Opening Remarks: **Erik Spande**, IGA Chair |

## Morning Session

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| 9:15-9:35 | **Robert Finley**, Illinois State Geological Survey, *An Assessment of Geological Carbon Sequestration in the Illinois Basin: Opportunities and Research Progress* |
| 9:35-9:55 | **Patrick McNulty,** McHenry County Department of Health, *McHenry County Groundwater Resource Plan* |
| 9:55-10:15 | **David English**, City of West Chicago, *City of West Chicago Central Lime Softening Facility Construction Project* |
| 10:15-10:40 | **Break** |
| 10:40-11:00 | **Business meeting and time for announcements** |
| 11:00-11:20 | **Daniel Injerd**, Illinois Department of Natural Resources, *Annex 2001 - An Update on the Proposed Great Lakes Regional Water Management Initiative* |
| 11:20-11:40 | **Becky A. Ciske**, Northeastern Illinois University, *Effects of Precipitation on Methane Production at a Landfill Site in Northwestern Illinois* |
| 11:40-12:00 | **Benjamin Ruddell**, University of Illinois at Urbana-Champaign, *A Hydrologic Observatory in the Illinois River Basin* |
| 12:00-1:10 | **Lunch** |

## Afternoon Session

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| 1:10-1:30 | **Philip J. Carpenter, Dean Ekberg, and Ivan Camilo Higuera-Diaz**, Northern Illinois University, *Karst Conduit Detection Using Seismic Refraction Tomography and Ground-penetrating Radar Surveys* |
| 1:30-1:50 | **Eric Peterson,** Illinois State University**,** *Fluid and Solute Transport from a Conduit to the Matrix in a Carbonate Aquifer System* |
| 1:50-2:20 | **Break** |
| 2:20-2:50 | **Wade Boring**, Illinois Environmental Protection Agency, *Illinois EPA Source Water Assessment Program and Internet Mapserver* |
| 2:50-3:10 | **Gregory Dunn**, Illinois Environmental Protection Agency, *Interaction Between the Illinois Brownfields and Site Remediation Programs* |
| 3:10-3:30 | **Don Keefer and Edward Mehnert**, Illinois State Geological Survey, *Making Sense of Pesticide Detections Obtained from a Dedicated Statewide Monitoring Well Network* |
| 3:30 | **Adjourn and IGA Executive Committee Meeting** |

# ABSTRACTS

(In order of presentation)

# An Assessment of Geological Carbon Sequestration in the Illinois Basin: Opportunities and Research Progress

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Within the Illinois Basin some 122 stationary facilities emit approximately 276 million metric tons of carbon dioxide each year. An estimated 90 percent of the Basin's $CO_2$ emissions are derived from coal-fired power plants. Evolving scientific evidence continues to link anthropogenic $CO_2$ emissions to global warming; consequently, worldwide attention is being given to investigations that reduce $CO_2$ venting to the atmosphere. One approach is geological sequestration, the injection of $CO_2$ into deep saline reservoirs, into mature oil reservoirs where it can be used for enhanced oil recovery (EOR) and ultimately $CO_2$ storage, or into deep coal beds where it is adsorbed on the coal and may improve the recovery of coalbed methane. The Illinois State Geological Survey, Indiana Geological Survey, and Kentucky Geological Survey are assessing the potential for geological carbon sequestration in the Illinois Basin. Financial support has been received from all three state governments and the U.S. Department of Energy (DOE). Results to date, three-quarters through a two-year Phase I project, indicate that Illinois Basin reservoirs are appropriate to support further studies of $CO_2$ sequestration in all three possible sinks, thus creating an opportunity to implement full pilot tests beginning in 2006. If these pilot tests are successful, expansion of $CO_2$ EOR technology within the Basin could target hundreds of millions of barrels of unrecovered oil in known fields. Estimates of original oil-in-place have been raised as a result of new, detailed assessments from about 12 billion to between 14 and 15 billion barrels. The development of deep saline reservoir storage in formations like the Mt. Simon and St. Peter Sandstones might begin to be tested in 2007, however the regulatory framework for $CO_2$ injection outside of oil-field EOR operations (covered by UIC Class II) remains to be developed. A Phase II proposal has been submitted to DOE which would support research continuing through 2009.

# McHenry County Groundwater Resources Plan

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Located approximately 60 miles northwest of Chicago, McHenry County is one of the fastest growing counties in the nation. The existing and anticipated growth has sparked concerns regarding the impact of growth on our natural resources including groundwater. McHenry County is completely dependent on Groundwater for its water supply. McHenry County also has vast sand and gravel deposits that are excellent aquifers but are also prone to contamination.

There are several aspects of groundwater that are of concern in McHenry County. First is the primary impact of increased groundwater pumping on the existing water supply. Second is the potential for groundwater contamination form man's activities. This threat includes spilling of hazardous materials on the surface and the subsurface discharge of treated and untreated wastewater. Another aspect of groundwater is the potential impact on natural areas, fens, streams and lakes. These natural areas are dependent on quantity and quality of groundwater discharges for survival.

McHenry County's elected and appointed officials have take steps to implement a coordinated approach to improve management of regional groundwater resources. In 1996, the county organized a series of public workshops to obtain stakeholder input to identify, organize, prioritize and refine issues to be addressed in a countywide groundwater resources plan and the preferred approach to each issue.

In March 2001, McHenry County executed a contract with the engineering firms of Baxter and Woodman Inc., Ayres and Associates, and the planning firms of Environmental Planning and Economics, and Planning and Management Ltd. To prepare the Groundwater Resources Plan.

The Groundwater Resources Plan is a series of four separate studies that look at the different aspects of groundwater use in McHenry County. They are;

Groundwater Resources Management Framework
Groundwater Resources Information for Planning
Countywide Groundwater Protection Plan
Countywide Wastewater Management Plan

# West Chicago Lime Softening Facility Construction Project

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The City of West Chicago endeavored to provide a solution to complying with federally mandated radium standards that became effective in December 2000. Furthermore, the City decided to include the issue of overall water quality as it moved forward in its efforts to comply with the regulation. A number of alternatives were considered, including: Lake Michigan Water, Ion Exchange Plants, and Central Lime Softening. In early 2001, City Council decided to pursue the design and construction of a Central Lime Softening facility.

Staff sought the services of an engineering firm to design and oversee construction of our chosen facility. Crawford, Murphy & Tilly, Inc. was chosen to fulfill these needs. After reviewing water system studies, visiting a number of like facilities and considering a number of additional factors, a site was chosen and the City pursued land acquisitions. Additionally, staff participated in proceedings with IEPA and IPCB regarding the establishment of a project completion date for compliance. Through the efforts of a number of communities including West Chicago, Joliet and Plainfield, a compliance commitment was entered into with the IEPA citing May 31, 2006 as our compliance deadline.

Based upon funding projections from the late 1990's, the City pursued funding initiatives totaling nearly $30,000,000 to construct the facility. Additionally, these funding levels would provide the necessary resources to construct a major collector main project, two additional wells and an elevated storage tank, as well as various distribution system improvements. Funding was secured via the following mechanisms: bond issue, SRF loan, NEPA grant and two DCCA grants. Our efforts were focused largely on controlling the impact of rates to our customers.

Once funding for the project was in place, we began an aggressive campaign to bring the project to our customers. We accomplished this with a number of City newsletter articles explaining what the City had decided to do to meet the radium regulation and improve water quality. Additionally, we held a number of focus meetings explaining the impact of the project to those who expressed interest. Finally, we were fortunate enough to be contacted by NBC and asked to take our approach to the news media. Additionally, there were a number of articles that appeared in the local newspaper, the Daily Herald and the Chicago Tribune. With the exception to the concern over higher rates, the project was well received.

Once design of the project was complete, the project was bid in late 2002. The project was awarded to Williams Brothers Construction, Inc. based in Peoria, Illinois. Additionally, the City bid and awarded contracts for the following: site clearing, site demolitions, steel vessel construction, SCADA system design and implementation and nearly 7.5 miles of water main installations that would tie our existing wells to the new treatment facility.

Once all contracts were awarded, we officially broke ground in January 2003. The project was finally becoming a reality! The City and its contractors established a construction timeline that

saw delivery of treated water to the City by December 31, 2004. In order to meet this timeline, coordination of the many disciplines necessary to assemble the project would prove to be the biggest challenge.

The general contractor took the lead in this role and did a great job of coordinating the site related activities that would meet our timeline. Additionally, we chose building materials that provided the necessary flexibility to work through the winter months. However, the largest reason for our success in this endeavor was the Resident Engineer. He was able to work with the City and its contractors in a way that kept everyone focused on the desired end result; providing treated water by the end of 2004.

As the City anticipated a timely project, we began addressing the staffing needs of the facility in September 2004. A total of six operators were hired to operate the facility on a 24/7 basis. While we were filling vacancies, we began planning for start-up of the facility. After a number of challenges, successes and setbacks, the City was in a position to initiate start up activities in mid-December 2004. By January 15, 2005, the facility was producing a finished product and valved into the distribution system. Our customers immediately began reaping the benefit of a greatly enhanced water quality that was removing radium to levels well below the federal standards.

On December 17, 2005, the Mayor and City Council, joined by a number of federal, state, county and local government officials, dedicated the facility to the residents and businesses of the City of West Chicago.

As we go forward, the City continues to endeavor to complete final punch list work and close the contract out by April 30, 2005. We continue to hear a number of positives from our customers, as well as a number of concerns as well. Most of these concerns are related to the fact that our water quality has undergone such a dramatic change. Many or our residents are life-time inhabitants of the City and were perfectly content with our untreated water supply.

Additionally, we continue to focus on addressing capacity needs to meet the future demands of the City, additional storage needs and the ongoing issue of addressing the needs of an aging infrastructure system.

# Annex 2001 - An Update on the Proposed Great Lakes Regional Water Management Initiative

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On June 18, 2001, the Great Lakes Governors and Premiers joined together in Niagara Falls, New York to sign the Great Lakes Charter Annex 2001. The Annex is an amendment to the Great Lakes Charter of 1985, and was developed to strengthen the Great Lakes regional water management system first proposed in the Great Lakes Charter of 1985.

Annex 2001 is a commitment by the Governors and Premiers to: 1) develop a new set of binding agreements that will retain authority by the Governors and Premiers over water withdrawals, building upon the existing structure and collective management efforts of the various governmental organizations within the Great Lakes basin, 2) include a broad-based public participation program in the process of developing and implementing the agreements, 3) establish a new decision-making standard that will be used by the States and Provinces to review proposals for water withdrawals, and 4) improve the Great Lakes water use data base.

On July 19, 2004, the Governors and Premiers Water Management Working Group released two documents for a 90 day public review period. The Great Lakes Basin Sustainable Water Resources Agreement, a good faith agreement among the 10 Great Lakes States and Provinces, and the Great Lakes Basin Water Resources Compact, an agreement amongst the eight Great Lakes States to join together in an interstate compact to utilize a common standard when reviewing proposals for new or increased water withdrawals.

The Water Management Working Group has received over 10,000 comments from interested citizens, environmental groups, industry and governmental bodies, expressing a broad range of viewpoints. While protecting and restoring the Great Lakes is a goal that all interested parties share, there are very different and conflicting views on just what should be done. The comments are being carefully reviewed as the Working Group begins the process to reshape the agreements.

This presentation will provide an overview of the Annex Implementing Agreements, discuss some of the key areas of the proposed agreements that generated the most interest during the public review period, and review some of the policy options the Working Group may consider as they seek to respond to the comments received.

# Effects of Precipitation on Methane Production at a Landfill Site in Northwestern Illinois

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This research project investigated the effects of precipitation on the production of methane gas at a landfill site in Lee County, Illinois. In addition, this study examined the relationships between and among $CH_4$, $CO_2$, $O_2$, the temperature within the landfill, and precipitation.

Methane is a product of refuse decomposing in a landfill. Landfill decomposition depends on several factors. The one factor that was studied more closely in this thesis project was the moisture input due to precipitation. The waste in a landfill passes through a series of three decomposition stages as it ages under constant moisture input: the aerobic stage, the anaerobic stage, and the second aerobic stage. Methane forms in the anaerobic stage, which is also referred to as the methanogenesis phase. During the anaerobic stage, facultative anaerobic organisms decompose waste and produce large amounts of volatile fatty acids. The volatile fatty acids along with other organic matter are converted to methane and carbon dioxide. The precipitation that infiltrates into a landfill allows nutrients and carbon-rich organic matter to become more available and mix. Methane is a potentially explosive gas that can seep into buildings near the proximity of the landfill and cause explosions or fires. In addition, methane can also wreak havoc in the landfill itself. If the temperature of the gas within the landfill is not carefully monitored, subsurface fires may occur. Therefore, it is important to know the effects moisture has on methane production.

Various data were collected in the field once a week over an 18 week period. Measurements were taken at all 24 gas extraction wells located in the landfill site. The following measurements were gathered based on the composition of the landfill gas: the percentages of $CH_4$, $CO_2$, and $O_2$, and the temperature within the landfill. The gas parameters and temperature were measured using the CES Landtec GEM-2000, which is a portable landfill gas monitoring system. Rainfall was measured using a precipitation gauge, placed within the premises of the landfill facility, which was hooked up to a data logger. The data logger provided a tabular printout of date-stamped accumulated rainfall.

This research builds directly upon that of a team of Canadian scientists who recently discovered a correlation between rainfall and methane production at a landfill in Vancouver, Canada at Burns Bog. Wreford et al. (2000) found that methane production in a landfill peaks about 14 days after a significant storm event. Also, the ratio of methane to carbon dioxide was found to increase seven days after a storm event. This study attempted to replicate their study, and to either confirm or contradict their findings. Results of this study show that a relationship does not exist between cumulative precipitation and methane production. Results also indicate a weak relationship between cumulative precipitation and the ratio of methane to carbon dioxide in the gas.

# A Hydrologic Observatory in the Illinois River Basin

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The goal of this proposal to the National Science Foundation is to establish the Illinois River Basin as a Hydrologic Observatory for the study of critical water related issues associated with atmosphere, land, and water bodies in intensively managed landscapes. This effort is being proposed through the collaboration of representatives from a group of universities in the region in partnership with a growing cast of state and federal agencies and stakeholders who value hydrologic science and the Illinois River Basin.

The objectives of this proposal are to 1) Enable interdisciplinary research by providing infrastructure that will attract scientists and water resource professionals to pursue research in the basin, 2) Answer interdisciplinary questions of high societal relevance around the broad themes of (i) hydrologic variability and extremes, (ii) biogeochemistry, (iii) ecology, (iv) contaminant transport, and (v) water resources management, and 3) Develop stakeholder partnerships, and education and outreach programs for rapid dissemination of knowledge to derive immediate societal benefits for sustainable development.

# Karst Conduit Detection Using Seismic Refraction Tomography and Ground-Penetrating Radar Surveys

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Settlers Cave is a network-type cave of interconnected solutionally-enlarged fractures, located south of Rockford, IL. Ground-penetrating radar (GPR) profiles made over Settlers Cave show strong diffractions over air-filled "rooms" above the water table. These diffractions are probably from the roof of the rooms and occur between 50 and 200 ns 2-way travel times (approximate depth 2 - 8 m at a velocity of 0.08 m/ns). The 50 MHz signal penetrated to an approximate depth of 250 ns (about 10 m) at this location. A GPR profile over a clay-filled solutionally-enlarged fracture exhibited abnormally high attenuation at the fracture location. A 4-m wide "shadow" was observed with signal penetration no deeper than 4 m. Experiments with 25 MHz antennas at this same location reveal similar diffractions over air-filled passages with an approximate penetration depth of 360 ns (about 14 m). Saturated conditions may lead to strong GPR attenuation below this depth. Similar GPR diffractions were recorded over an air-filled cave at 2.5 m depth in Silurian dolomite adjacent to Bourbonnais Creek, near the Kankakee River. Water intermittently emerges from this conduit after heavy rains, after percolating through a shallow (0 - 4 m deep) thinly mantled karst system.

GPR surveys imaging conduits below the water table are often hampered by strong attenuation. An alternative approach is to utilize seismic waves to image conduits. At Ft. Campbell, KY, seismic refraction tomography was used to identify probable karst conduits in the St. Genevieve and St. Louis limestone below 20-30 m of unconsolidated deposits consisting primarily of residuum. Local groundwater beneath the CAAF has been contaminated in places by fuel spills and pipeline leaks. Seismic refraction surveys utilizing 6 shots and 48 geophones were able identify bedrock "lows" along two lines. These were identified using delay-time models and commercial seismic refraction tomography programs. Hydrogeological information obtained during remediation operations suggest both of the lows are part of a hydraulically-active buried sinkhole or bedrock fracture.

# Fluid and Solute Transport from a Conduit to the Matrix in a Carbonate Aquifer System

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Within carbonate systems, the working hypothesis suggests that when a conduit is flooded, fluid and solute migrate from the conduit into the matrix. This flux of fluid and solute into the matrix creates a reservoir that can be slowly released once the flooding recedes. Although hypothesized, these fluxes have never been measured. To quantify the distance that a fluid and solute would move into a matrix, the fluxes of fluid and solute from a conduit into a matrix were simulated for nine different carbonate aquifer systems. Two independent numerical approaches were used to simulate 1) fluid flux into the matrix and 2) solute flux into the matrix during a flooding event. When flooding occurs within the conduit, the volume of water transported into and stored in the matrix with a high porosity and high hydraulic conductivity (Floridan Aquifer) was less than 0.34 $m^3$ along a 1 m length of conduit, resulting in a penetration depth of $7.2 \times 10^{-2}$ m into the matrix. In a low porosity and low hydraulic conductivity matrix (Ozark Plateau), the volume of water transported into and stored in the matrix was less than $6.85 \times 10^{-5}$ $m^3$ along a 1 m length of conduit, resulting in a penetration depth of $2.0 \times 10^{-4}$ m into the matrix. Simulated solute flow shows that less than 0.1% of the solute moves in to the matrix. The two approaches demonstrate that during high flow conditions fluid and solute are forced through the conduits, with very little moving into the carbonate matrix. Once the fluid and solute enter a conduit and are moving, they will remain in the conduit until they are discharged at an outlet. Thus, a carbonate matrix does not become a reservoir for solute and fluid during a high-flow event.

# Illinois EPA Source Water Assessment Program and Internet Mapserver

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Illinois EPA began its Source Water Assessment Program in 1997 in response to amendments to the Safe Drinking Water Act. These amendments require States to assess all sources of public drinking water. Assessments consist of the delineation of a Source Water Protection Area for each source of drinking water, an inventory of potential sources of contamination within the area, a determination of the source's susceptibility to contamination and a plan to make the assessments available to the public. Illinois was one of the first States to have an approved Source Water Assessment Program.

The first step in the program was to delineate the Source Water Assessment Areas. For groundwater supplies, the Wellhead Protection Area was used. Unconfined Community Water Supply (CWS) wells had a 5-Year Recharge Area delineated using computer modeling, while for confined CWS and Non-CWS wells, a 1,000 foot radial Area of Concern was utilized. For Non-CWS & CWS Surface Water supplies using impoundments & side channel reservoirs, the 12-digit Watershed was used. For supplies using interstate & major rivers, a Critical Area of 25 miles upstream of the intake was used or a 5-hour time of travel was modeled if the data was available. Critical Areas for Lake Michigan intakes were determined in coordination with U.S. EPA Region 5.

Potential sources of contamination were inventoried using several State and Federal databases as well as field gathered information and data collected from local water supply operators. Susceptibility to contamination was determined using water quality data, engineering evaluations, geologic and hydrologic data, and the potential source inventory.

The public availability portion of the Assessment Program was accomplished in two phases. The first phase was providing hard copies of the individual Assessments to each water supply for inclusion in their Consumer Confidence Report. The supply can also make this Assessment available by other methods, for instance at City Hall or in a local newspaper if desired. The second phase was the development of a web-based interactive GIS mapserver. This site is based on ESRI's ArcIMS software and will allow the user to access all the databases and coverages used in the Source Water Assessments, as wells as additional information such as pumpage data, land use data, and aerial photos. The website is secure and requires the user to complete and submit a Confidentiality Agreement to gain access.

http://www.epa.state.il.us/water/groundwater/source-water-assessment/

# Interaction Between the Illinois Brownfields and Site Remediation Programs

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The Illinois Environmental Protection Agency's (Illinois EPA) Office of Brownfields Assistance has issued over $13.4 million in Municipal Brownfield Redevelopment Grant sites to 109 communities since inception. The Illinois EPA's Site Remediation Program has issued over 1,200 No Further Remediation letters that remediated over 9,600 acres. Although these are two separate programs, the municipalities receiving the redevelopment grants are required to enter the Site Remediation Program as part of their grant commitment. Therefore, coordination is crucial between the two Illinois EPA programs, the municipality and their consultant to ensure a smooth process from the start to the end. The presentation will include statistics from each program, a brief summary of the Site Remediation Program and a short video on the Brownfields Program.

# Making Sense of Pesticide Detections Obtained from a Dedicated Statewide Monitoring Well Network in Illinois

**Donald A. Keefer**, P.G., Illinois State Geological Survey; and
**Edward Mehnert**, Ph.D., Illinois State Geological Survey

*Background*

An aquifer sensitivity map was developed to predict pesticide occurrence within shallow aquifers in Illinois, and to assist implementation of a USEPA-mandated statewide pesticide program. After the map was completed, a dedicated monitoring well network was designed to validate the predictive utility of the aquifer sensitivity map. This network design was only partially implemented. The first round of samples were collected, between 1997 and 2001, from the existing monitoring wells. This round of sampling included two separate tasks, a one-time sampling of 159 wells and a limited time-series sampling from only 21 wells. Fourteen pesticides were included as analytes, the funding agent refused to include metabolites as analytes.

*Results*

Results from the one-time sampling effort included an 18% total analyte detection rate (29 of 159 samples contained analytes with >MDL) with the occurrence of only 8 of the 14 selected pesticide analytes. For single analytes, high detection rates were 15% (atrazine in 24 of 159 samples) followed by 2% (metolachlor and bromacil in 3 of 159 samples). The map stratification units were not reliable predictors of total pesticide occurrence rate, based on the 159 collected samples. However, the mapped depth to uppermost aquifer was able to predict the relative frequency of total pesticide occurrence. The seasonal occurrence of any pesticide was more likely in the months June through October than in the remainder of the year, but this seasonal occurrence appeared to be limited to wells in the shallowest aquifers.

The results from the time series sampling effort included a 16% total analyte occurrence rate (34 of the 215 samples contained analytes with concentrations >MDL) with the occurrence of only 4 of the 14 selected pesticide analytes. The single-analyte high detection rates were 12% (atrazine in 26 of 215 samples) followed by 3% (metolachlor in 7 of 215 samples). The occurrence of any pesticide was more likely in the months June through October than in the remainder of the year. On average, pesticide occurrence in individual wells was found to be consistent over time, however, the individual data were highly variable in frequency of occurrence.

*Interpretations*

The depth to top of the uppermost aquifer appears to be a good general predictor of the frequency of total analyte occurrence. It is not a good predictor, however, of the frequency of individual analyte occurrence. The importance of regionalized soil properties on pesticide occurrence in shallow monitoring wells are more difficult to resolve. Local relief appears to have an effect on total pesticide occurrence, even in Illinois, and likely plays a complicating role in mass transport and occurrence in monitoring wells. These results suggest, not surprisingly,

that the length of the flow path through non-aquifer materials is the overriding mappable variable for predicting total mass occurrence of pesticides.

Individual-analyte occurrence and concentration results suggest that pesticide mass distribution in shallow aquifers is complex and temporally variable. The results suggest that soil properties may have observable impacts on total pesticide occurrence, but that it will take many more samples to resolve the differences in detection rate that may exist. Because of shifting priorities by the funding agent, insufficient samples were collected to conclusively evaluate most of the desired objectives. This effort demonstrates the importance of a long-term institutional commitment to fully understand pesticide fate and transport in shallow groundwater.