ILLINOIS GROUNDWATER ASSOCIATION

Advancing Groundwater Knowledge Since 1983

www.illinoisgroundwater.org

Spring-Summer Meeting – June 6th, 2025

In person at I-Hotel and Illinois Conference Center

And Online on Zoom

Program Topics and Speakers [Times are Central Daylight Time (GMT-5)]

08:30 — *Check-in and Online Open/Light Breakfast & Snacks*

08:45 — M.C.— Opening Remarks

09:00 — Carbon Sequestration in Saline Reservoirs– Ginny Walsh M.S., Batelle.

10:00 — Recent Legislative Activities Regarding Carbon Sequestration and the Mahomet Aquifer– Dr. Chris Stohr P.G. C.E.G. & Allen Wehrman, P.E.

11:00 — *Break.*

11:15 — Exploring Nitrate Reduction in a Saturated Riparian Buffer Through a Three-Dimensional Reactive Contaminant Transport Model in an Agricultural Area, Mclean County – Franklin Ijigade, 2024 IGA Student Research Grant Recipient, ISU

12:15 — *Lunch/Optional Virtual Lunch and Discussion*

13:00 — Dissolved nitrogen dynamics through wetland hydrology of the leveed middle Mississippi River floodplain – Dr. Joseph Krienert, SIU & ISGS

14:00 — The Illinois River Basin Groundwater Flow Model – Dr. Daniel Abrams, ISWS.

15:00 — Hydrogeologic Investigation of the Intersection of the Teays Valley Aquifer and the Wabash River Alluvial Aquifer, Tippecanoe County, Indiana – Oliver Wittman P.G., Intera Inc.

16:00 — M.C. — *Meeting Adjourned*

16:15 — *Online chat remains open until 16:30*

Carbon Sequestration in Saline Reservoirs

Ginny Walsh, Sr. Geologist III
Batelle

Storing carbon in deep saline aquifers presents a promising approach for reducing atmospheric CO_2 emissions, but safe and effective implementation depends on a comprehensive understanding of both subsurface and above-ground factors. Key geologic considerations include ensuring the reservoir has adequate porosity and permeability, a competent sealing formation, and favorable structural geology. The acquisition and analysis of high-quality geologic, geophysical, and hydrogeologic data are essential for confirming site suitability and reducing uncertainties. Detailed assessment of both the injection reservoir and the overlying seal is required, with a level of geologic characterization and risk analysis sufficient to demonstrate groundwater protection to the EPA and other regulatory authorities. Comprehensive geologic evaluations inform clients about the areal extent of sequestration impact and support the design and operation of projects with a strong emphasis on environmental safety and regulatory compliance.

Recent Legislative Activities Regarding Carbon Sequestration and the Mahomet Aquifer

Chris Stohr PhD, PG, CEG (cstohr@illinois.edu)
Allen Wehrmann, PE (allenwehrmann@gmail.com)

The Mahomet Aquifer of East-Central Illinois is a major regional potable water resource, serving more than 500,000 people in 15 Illinois counties, providing an estimated 220 million gallons of water per day to communities, agriculture, industry, and rural wells. Owing to the dependence of the region on this aquifer and the lack of alternative water sources, the Mahomet Aquifer was designated by the USEPA as a Sole Source Aquifer in 2015.

Concerns regarding increasing atmospheric carbon dioxide's contribution to climate change have generated much interest in the capture of atmospheric carbon dioxide and deep storage underground (i.e., CCS, carbon capture and storage). Below central Illinois, the Mt. Simon sandstone presents a favorable geologic environment for CCS. However, numerous local concerns have been raised over potential effects on groundwater, crop damage, and taking of land. These concerns are notable because of Mahomet Aquifer contamination from a 2016 leak in the Manlove Gas Field in Champaign County; a reported 2020 pipeline break in Mississippi that injured dozens; and concerns about eminent domain. National policies, Illinois state legislation and local county ordinances have been drafted regarding CCS in deep saline aquifers [Mt Simon Fm].

We will focus on Senate Bill 1723 [Engrossed] that seeks to prohibit CCS activity that overlies, underlies, or passes through a sole-source aquifer and creates a Mahomet Aquifer Advisory Study Commission to study and review any reports regarding the safety of CCS in the Mahomet Aquifer. We will also focus on recent Champaign County activities to prohibit such activities over, under, or through the Mahomet Aquifer in Champaign County.

Exploring Nitrate Reduction in a Saturated Riparian Buffer through a Three-Dimensional Reactive Contaminant Transport Model in an Agricultural Area, Mclean County, Central Illinois

Franklin Ijigade, 2024 IGA Student Research Grant Recipient

Illinois State University, M.S. student

Saturated Riparian Buffers (SRBs) are engineered systems designed to remove nitrate and other pollutants from subsurface agricultural drainage water before reaching a stream. This study utilizes a high-resolution coupled flow and reactive transport model to explore nitrate reduction and transformation in an SRB in glacial sediment. The influence of material heterogeneity on nitrate reduction and the effectiveness of the SRB was investigated. The study was conducted in an SRB located next to and receiving tile drainage water that ultimately drains into a 3rd order stream (T3 stream) in central Illinois, USA. A three-dimensional steady groundwater flow model was developed using MODFLOW-USG code to simulate the groundwater flow. The model consists of two layers: organic topsoil and clay with sand and gravel. The calibrated and validated root-mean-squared-error (RMSE) values were 0.33 and 0.35 m, respectively. The calibrated hydraulic conductivity ranges from 0.2-16.8 m/day, confirming the existence of heterogeneity in the glacial sediment. The calibrated flow model was then converted into a transient MODFLOW-USG transport model to stimulate advection, dispersion, and decay processes. Sensitivity analysis of the model suggests that recharge is the most sensitive parameter controlling NO_3-N reduction and removal by dilution and denitrification respectively. Transient simulation from March 2021 to June 2021 shows significant (70-90%) NO_3-N reduction occurred in low hydraulic conductivity zones, while low to average (17-54%) reduction occurred in moderate-high hydraulic conductivity zones. NO_3 load was estimated at 168.06 g per day reaching the stream compared to nitrate load of 5136g/delivered to the SRB from the distribution tile. About 4895g/d of nitrate load was lost for the entire stress period which accounts for 95% nitrate reduction, while a storage of 7g/day remained, indicating the effectiveness of the saturated riparian buffer. This research provides insight into improving the design of SRBs by optimizing tile flow and redirecting tile flow to interact with low hydraulic conductivity zones. Thus, increasing SRB efficiencies in the reduction of NO_3-N contamination and ultimately improving stream health conditions.

Dissolved nitrogen dynamics through wetland hydrology of the leveed middle Mississippi River floodplain

Joseph Krienert PhD

Southern Illinois University Carbondale and Illinois State Geologic Survey

Total dissolved nitrogen (TDN) in the Mississippi River is a persistent water quality issue. Wetlands can promote sustainable reduction of TDN. This research explores that potential for wetlands on the middle Mississippi River floodplain. Before 1850 the River inundated >80% the floodplain and groundwater system below, consisting of a semi-confining surficial clay (<20m thick), a thicker sand and gravel glaciofluvial aquifer (>60m thick), all confined within the partially faulted and karstic sedimentary bedrock valley (<90m deep). By 1950 levees were built that have permanently divided the floodplain surface water system, with <40% of the area remaining river-connected and seasonally flooded, and >60% the area levee-protected from any river flood input. Wetlands still subsist on both sides of the levee, yet their efficacy of TDN transport dynamics has been unknown. This research bridges that knowledge gap with two years of field monitoring both these wetlands seven primary hydrologic reservoirs, including precipitation, the Mississippi River, wetland surface water, and the three geologic groundwater layers below. Several measurement types were made of these reservoirs, including hydrologic, geochemical, isotopic, and microbiological attributes. Measurements were collected for all operational monitoring sites in <36 hours during each month to biweekly survey. The hydrologic measurements doubly served as calibration targets for a as-built contiguous numerical forecast of exchange throughout the valley, to reveal phenomena between observations, and highlight long-term effects.

River floods were the greatest TDN flux observed overall, and the only surface water with enough hydraulic head to recharge the confined glaciofluvial aquifer. The River flood recharge was well oxygenated, with TDN speciation as >80% nitrate and <20% ammonia, with trace nitrite and ammonium. A considerable loss of oxygen, nitrate and ammonia occurred during recharge of the clay and aquifer. However, that loss did not fully reduce the nitrogen from solution. Rather, the TDN accumulated in the subsurface as nitrite with trace nitrate and ammonium. That accumulation of metastable nitrogen from above also appears to occur from the bedrock below, which was consistently the greatest nitrite concentration observed. Isotope and chemical tracers confirm the bedrock is a near-constant source of groundwater, nitrite-TDN, and other constituents to the aquifer above, and eventually by baseflow to the surface. The river-connected wetlands TDN output was less than input during fall/winter flooding and spring/summer draining, yet during fall/winter draining and spring/summer flooding the TDN output was greater. The levee-protected wetland surprisingly produced more oxidized TDN than sourced for all seasons and flood conditions. Agents of these changes were somewhat evident by amplicon sequencing of sediment microbiomes genera, which were more commonly complete TDN reducers below the river-connected wetland, and TDN oxidizers below the levee-protected wetland.

These findings indicate the river-connected wetlands can support partial reduction of TDN, while the levee-protected wetland more-often discharged oxidized TDN into the river. Some of the discovered limiting factors on river-connected TDN reduction include incomplete oxidation of TDN before groundwater recharge, lack of dissolved carbon in deeper groundwater for microbiome density, cooler temperate temperatures that reduce reaction rates, and too-short of residence times in groundwater.

Toward a Living Groundwater Flow Model of the State of Illinois

Dr. Daniel Abrams, Scientist for Research and Development,

Illinois State Water Survey

The United States Geological Survey (USGS) is deploying state of the art monitoring and modeling in several Integrated Water Science basins, spread throughout the United States. The Illinois River Basin is the third such basin selected for study by the USGS to evaluate such water issues as the fate and transport of nutrients and water availability. The Illinois State Water Survey has partnered with the USGS as part of this study.

In this presentation, we will highlight the evolutions to the groundwater flow modeling framework of the Illinois River Basin, including:

- Streamlining of raw data sources into a model preparation framework developed in Python
- Capabilities to pair regional and local model domains within a single simulation
- Streamflow routing that includes the addition of effluent discharges
- The ability to zoom in and out in both space and time
- Robust evaluation of uncertainty using PESTPP-IES

Hydrogeologic Investigation of the Intersection of the Teays Valley Aquifer and the Wabash River Alluvial Aquifer, Tippecanoe County, Indiana

Oliver Wittman, P.G., Senior Hydrogeologist

Intera Incorporated

This study aim was to characterize the properties and geometries of the Teays Valley Aquifer at its intersection with the Wabash Alluvial Aquifer. The goal was to assess the potential for groundwater production from radial collector wells along the Wabash River. An extensive field study and modeling analysis were conducted, including a regional airborne electromagnetic (AEM) survey, exploratory drilling, monitoring well installation and instrumentation, aquifer testing, passive seismic surveys, development of a 3D conceptual geologic model, stream-aquifer characterization, water quality analysis, and predictive groundwater modeling. The objective of the analysis and characterization was to provide a conservative, lower bound on collector well yield at three select field locations. Recommendations were made for further design and impact analysis.