32ND ANNUAL MEETING **PROGRAM AND ABSTRACTS**

Great Waters
of Wisconsin

March 6 & 7, 2008

Sheraton Milwaukee Brookfield Hotel

Brookfield, Wisconsin

American Water Resources Association – Wisconsin Section

The Wisconsin Section of the American Water Resources Association provides an interdisciplinary forum for people involved in all aspects of water resources research and management.

AMERICAN WATER RESOURCES ASSOCIATION-WISCONSIN SECTION

32nd ANNUAL MEETING

Great Waters of Wisconsin

March 6-7, 2008

Sheraton Milwaukee Brookfield Hotel
Brookfield, Wisconsin

Hosts:

American Water Resources Association-Wisconsin Section
University of Wisconsin Water Resources Institute
Wisconsin Department of Natural Resources
Center for Watershed Science & Education, UW-Stevens Point
Wisconsin Geological and Natural History Survey
U.S. Geological Survey, Wisconsin Water Science Center

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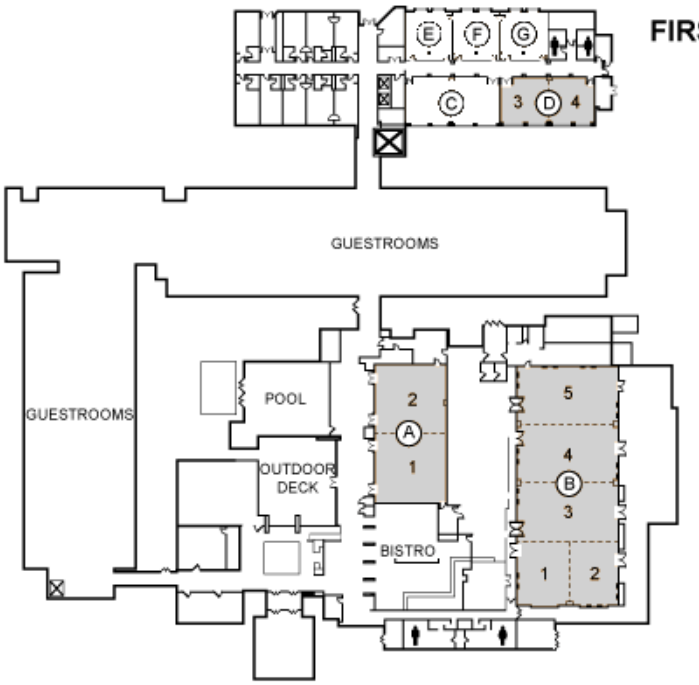

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Great Waters of Wisconsin

32nd Annual Meeting of the American Water Resources Association – Wisconsin Section

Brookfield, Wisconsin

Thursday, March 6, 2008

9:00 a.m. – 2:15 p.m.	Registration – Promenade
11:30 – 12:15	Welcome and Lunch – Brookfield 4-5
12:15 – 12:30	Business Meeting
12:30 – 2:00	**Plenary Session:** Great Waters of Wisconsin
	Judy Beck U.S. Environmental Protection Agency Great Lakes National Program Office
	Robert Biebel Southeastern Wisconsin Regional Planning Commission
	Kevin Shafer Milwaukee Metropolitan Sewerage District
2:00 – 2:20 p.m.	**Break**
2:20 – 3:20 p.m.	**Concurrent Sessions 1A and 1B**

Session 1A – Water Policy: National and State Perspectives

Brookfield 1-2
Moderator: Lynn Markham, UW-Stevens Point

2:20	United States Water Policy—A New Direction? Jane O. Rowan
2:40	Wisconsin Pilot to Develop Water Conservation and Efficiency Goals and Objectives. Jill Jonas

3:00 Promoting Water Conservation and Efficiency in Wisconsin. Jeffrey Ripp

Session 1B – Temporal Variability in Surface Water and Groundwater Systems

Brookfield 3
Moderator: Katherine Clancy, UW-Stevens Point

2:20 Identifying and Delineating Seasonal Wetlands at Chiwaukee Prairie, Wisconsin. John Skalbeck

2:40 Effects of Climate and Land Management Change on Streamflow in the Driftless Area of Wisconsin. Paul Juckem

3:00 Simulating climate change in the Trout Lake Watershed, northern Wisconsin. Randall Hunt

3:20 – 3:40 p.m. **Break**

3:40 – 5:20 p.m. **Concurrent Sessions 2A and 2B**

Session 2A – Hydrogeologic Investigations

Brookfield 1-2
Moderator: Stephen Gaffield, Montgomery Associates

3:40 Hydraulic Tomography for Characterizing Heterogeneity. Michael N. Fienen

4:00 An analysis of hydraulic conductivity with depth and stress in a clay aquitard. Carolyn Moeller-Eaton**

4:20 Vertical distribution of $\delta^{18}O$ in a clay-rich aquitard: Implications for groundwater recharge. Thomas Hooyer

4:40 Nitrate retention in a Central Sand Plains stream: incorporation of focused discharge in a mass balance model. Robert Stelzer

5:00 Implications of Diffuse and Focused Groundwater Discharge to Allequash Creek, Vilas County Wisconsin. Seann McClure**

Session 2B – Organic and Biological Contaminants

Brookfield 3
Moderator: Lori Severtson, UW-Madison

3:40 Triclosan- Why is it Still Used? William Sonzogni

4:00 Efficacy of nano-aluminum oxide fiber filters for concentrating bacteriophages and adenovirus from water for fecal source tracking. Samuel Sibley**

4:20 A Microbial Source Tracking Toolbox for the Great Lakes Region. Curtis Hedman**

4:40 Waterborne Illness Outbreak at Door County Restaurant Raises Questions on Available Aquifers and Land Use. Laurel Braatz

5:00 Dye Trace Study of Door County Restaurant Septic System in Response to Water Borne Illness Outbreak. William Schuster and Brian Forest

5:20 – 7:20 p.m. **Poster Session and Social Hour** — Milwaukee 1-2

1. Nutrients and Sediment in Surface-Water Runoff from Frozen Fields at a Crop and Livestock Farm in Southwest Wisconsin, 2004-2007. Todd Stuntebeck

2. Do artificial wetlands on golf courses have as much biodiversity as natural wetlands? Drew Ballantyne*

3. Formation and Evolution of Bars within a Sandy Braided Reach of the Lower Wisconsin River. Thomas Bellile**

4. Monitoring changes in subsurface hydrology, stream temperature, flood hydraulics, and vegetation following floodplain restoration on the East Branch Pecatonica River, WI. Eric Booth**

5. Filter strip attenuation of feedlot runoff contaminants. Dennis Busch

6. Positive relationship between episammic chlorophyll and porewater phosphorus in a Central Sand Plains stream. Damion Drover*

7. Rugged, Highly-Porous Fiber Claddings for Remote Sensing in Aqueous Environments. Paul Henning**

8. Estimation of basement topography in southeastern Wisconsin using 3-D modeling of gravity and aeromagnetic data. Adrian Koski*

9. Effect of tiled upland infiltration basins on runoff volume and pollutant export from field-scale agricultural basins. R.S. Mentz

10. Estimation of basement topography in Fond du Lac County using 3-D modeling of gravity and aeromagnetic data. Matthew Peterson*

11. Effects of Urbanization on Stream Ecosystems near Milwaukee and Green Bay, WI. Kevin Richards

12. Optical Fiber Sensors for Real-Time, Remote, and Spatially Resolved Oxygen Sensing. Veronica Rigo**

13. Impacts of Urban Runoff on Rain Gardens Planted with Native Vegetation vs. Collection Basin Constructed with Lawn Sod. Tiffany Short*

14. Aquatic Plant Management of the St. Croix/Gordon Flowage in Douglas County, Wisconsin. Brian Swenson*

15. Hydroecologic studies in the Save Valley Conservancy, Southeastern Zimbabwe. Kenneth Bradbury

16. Utilizing a Standardized Set of Environmental Construction Practices to Reduce Environmental Impacts on Linear Transmission Line Projects in the Midwest. Johanna Howard

17. Floods from Record Rains in Illinois, Iowa, Minnesota, and Wisconsin, August 17−30, 2007. J.D. Fallon, H.S. Garn, M.L. Harris , and K.D. Lund.

* Undergraduate student presentation
** Graduate student presentation

7:30 p.m. **Dinner** – Brookfield 4-5

Speaker: John Gurda, Milwaukee Historian and Author

Friday, March 7, 2008

7:00 – 8:00 a.m. AWRA–Wisconsin Section Board of Directors' Breakfast Meeting – Wisconsin 4

8:00 – 9:40 a.m. **Concurrent Sessions 3A and 3B**

Session 3A – Lake Management

Brookfield 1-2
Moderator: Jeffrey Stelzer, Lake and Pond Solutions

8:00 Implications of Low Water Levels for Natural Lake Ecosystems. Timothy Asplund

8:20 Regulatory Aspects of Managing Low Water Levels. Martin Griffin

8:40 Cyanobacteria and Cyanobacterial Toxins in Wisconsin Surface Waters: Results of a Statewide Monitoring Program. Elisabeth Harrahy

9:00 Zooplankton as bioindicators of anthropogenic impact to lake ecosystems Surveys from Southeast Wisconsin lakes. Scott Van Egeren**

9:20 Spatial and temporal variability of sediment deposition in Lake Mendota. Richard Lathrop

Session 3B – Investigations in Groundwater Management Areas

Brookfield 3
Moderator: Thomas Hooyer, Wisconsin Geological and Natural History Survey

8:00 Hydrostratigraphy and Groundwater Flow Model: Troy Valley Glacial Aquifer, Southern Waukesha Co., Wisconsin. Kallina Dunkle**

8:20 Anthropogenic Effects of Wastewater Treatment Plant Effluent on Shallow Groundwater and Streams of Southeastern Wisconsin. Rachel Wilberding**

8:40 Assessing ground-water supply problems and possible solutions in southeastern Wisconsin. Douglas Cherkauer

9:00 Sustainability analysis for shallow groundwater use in the SEWRPC region. Kenneth Bradbury

9:20 A Large Scale Pumping Test in the Northeastern Wisconsin Groundwater Management Area. David Hart

9:40 – 10:00 a.m. **Break**

10:00 – 11:55 a.m. **Concurrent Sessions 4A and 4B**

Session 4A – Stormwater, streams and runoff

Brookfield 1-2
Moderator: Randy Mentz, UW-Platteville

10:00 Nutrients and Sediment in Surface-Water Runoff from Frozen Fields at a Crop and Livestock Farm in Southwest Wisconsin, 2004-2007. Matthew Komiskey

10:20 Estimating Runoff Dissolved Phosphorus Losses Following Manure Applications to Cropland for the Wisconsin Phosphorous Index. Laura Good

10:40 Utilizing Dredging Methodologies for Stormwater Detention Pond Rehabilitation & Aquatic Resource Management. Brian L. Hinrichs

11:00 Comparison of Stormwater Runoff Quantity and Quality Using Conventional and Low-Impact Development Strategies. William Selbig

11:20 Relation of Physical Measures of Steamflow Conditions to Ecological Effects of Urbanization in Streams. Jeffrey Steuer

11:40 Closing remarks and announcement of student paper award winners

Session 4B – Planning and Management

Brookfield 3
Moderator: David Lindorff, Wisconsin Department of Natural Resources

10:00 Arsenic in Wisconsin's Residential Drinking Water: Planning for Action Grant Summary. Reynee Kachur

10:20 Understanding Private Well Water Testing in Wisconsin. Dolores J. Severtson

10:40 Centralizing Access to Wisconsin Groundwater Information for Use in Comprehensive Planning. Lynn Markham

11:00 Planning future urban development in Verona based on a hydrologic and ecological resource assessment approach. Stephen Gaffield

11:20 Understanding and Mitigating the Water Supply Impacts of Development. Nancy Zolidis and Kamran Mesbah

11:40 Closing remarks and announcement of student paper award winners

* Undergraduate student presentation
** Graduate student presentation

12:00 – 2:00 p.m. Student Career Workshop – Milwaukee 1

SESSION 1A:
Water Policy: National and State Perspectives
Thursday, March 6, 2008
2:20 – 3:20 p.m.

United States Water Policy—A New Direction?

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The water resources of the United States are at risk and the nation's "ad hoc" water policy is deficient. Water resources protection laws passed since 1950 often contradict water resources development laws passed before 1950, and complicate efficient and effective responses to the nation's water resources challenges. Water law and policy determination, management and enforcement are so broadly distributed between, local, state and federal responsibilities that effective responses are difficult. Good science is often overshadowed by political considerations.

Attendees of AWRA's Third National Water Resources Policy Dialogue held in January 2007 in Arlington, VA, recommended the following to set a new direction for water resources policy:

1. A review of water resources challenges as well as policy gaps, overlaps, and contradictions. It has been 30 years since the last national assessment.
2. A vision for water resources management and planning that includes input from local, state, tribal and national levels.
3. Greater policy responsibilities for watershed or basin level organizations - less emphasis on state boundaries.
4. Better federal coordination – forums between federal water resources leaders to resolve conflicts and align programs.
5. Better communication between the scientific community, policy makers, and the public.
6. Incorporate more risk-based analyses into the evaluation and decision making processes.
7. Use market forces, public-private partnerships, private equity, credit trading, employment of cost recovery and decentralized decision making, and creation of data and information-rich environments to improve decision making.

The paper also will include specific recommendations about "who needs to do what" to move the recommended policy changes from suggestion to reality.

Wisconsin Pilot to Develop Water Conservation and Efficiency Goals and Objectives

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A critical aspect of the Great Lakes - Saint Lawrence River Basin Sustainable Water Resources Agreement is the focus on the need for consideration of water conservation and efficiency in the decision-making process for proposals for new and increased water withdrawals and diversions. As a result of the Great Lakes Governors' and Premiers' commitments in the Agreement, the Great Lakes-St. Lawrence River Water Resources Regional Body will be adopting regional water conservation and efficiency objectives. Then, through a pilot project, the State of Wisconsin will develop goals and objectives for implementation at the State level for the Great Lakes Basin.

This effort directly relates to Governor Jim Doyle's Conserve Wisconsin call for a State water conservation program and the Groundwater Advisory Committee's efforts on water conservation. This talk will present the process, draft product and intent of this effort.

Promoting Water Conservation and Efficiency in Wisconsin

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Recent news headlines highlight the water shortages that are occurring in many parts of the United States. In fact, the federal government estimates that 36 states will face water shortages within five years. As demand for water outpaces the available supply, additional pressure will be placed on the nation's finite water resources, especially during droughts. Although Wisconsin citizens have access to relatively abundant water supplies, regional and temporal water shortages exist.

In some parts of Wisconsin, groundwater withdrawals have exceeded natural recharge, resulting in declining aquifer levels. Additionally, contaminants in groundwater can limit its availability for human uses. Further, growing public concern about protecting water quantity has led to laws that regulate high-capacity wells and interstate agreements that restrict withdrawals and diversions from the Great Lakes. These measures are expected to change the way that water is used and managed in Wisconsin.

Water conservation will become increasingly important for meeting future water supply needs while protecting the environment. The Public Service Commission of Wisconsin (PSC) is working with public water utilities and other government agencies to implement a water conservation program that will help ensure the long-term sustainability of the state's water resources. PSC's efforts include: coordinating State water and energy efficiency programs; working with utilities to reduce water loss from their systems; establishing water rates that encourage efficiency and discourage wasteful practices; partnering with the U.S. EPA's *WaterSense* program to promote water-saving products and practices; and encouraging more efficient water use through education and outreach.

SESSION 1B:
Temporal Variability in Surface Water and Groundwater Systems
Thursday, March 6, 2008
2:20 – 3:20 p.m.

Identifying and Delineating Seasonal Wetlands at Chiwaukee Prairie, Wisconsin

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Historically, drier types of wetlands have been difficult to characterize and thus are not well researched. This study investigated two seasonal coastal wetland types (low prairie and sedge meadow) in the Lake Michigan Basin over three growing seasons (2003, 2004, 2005). The six seasonal wetlands are dominated by hydrophytic vegetation based upon percent cover values, subtended by hydric soils, and each site exhibits a positive FAC-neutral test, a secondary hydrology indicator. Water levels from pressure transducers in six water-table wells and hand measurements in three piezometers record large magnitude short-term fluctuations that indicate these wetland sites respond rapidly to precipitation.

These seasonal wetlands typically are dry for most of the growing season. But even during years with low annual precipitation, they all met wetland hydrology criterion during the early portion of the growing season. Root-zone duration analyses discriminated the plant communities and showed that wet prairie communities had shorter durations of continuous soil saturation than sedge meadow communities. Thus, during multiple year droughts or extended lake level lows, these might be the first communities to not exhibit wetland hydrology for that year. Root zone duration calculations for this study did not fit a lognormal distribution. 7- and 10-day high water level average statistics were not able to discriminate between the two plant communities, but when combined with minimum water level reporting, may be superior to the root zone duration methods for wetland delineation because they are more straight-forward to calculate.

Effects of Climate and Land Management Change on Streamflow in the Driftless Area of Wisconsin

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Baseflow and precipitation in the Kickapoo River Watershed, located in the Driftless Area of Wisconsin, exhibit a step increase around 1970, similar to that found for minimum and median flows in many other central and eastern USA streams. Increases in precipitation do not fully account for the increase in baseflow, however. The increase in baseflow appears to be equal to the increase in precipitation plus the volumetric decrease in stormflow that has occurred during this period. This suggests that changes have occurred in the processes that distribute precipitation into either overland runoff or infiltration/recharge to the groundwater system. A transition from relatively more intensive to relatively less intensive agricultural land use is generally associated with higher infiltration rates, and likely influences this partitioning of flow. Gradual changes in agricultural land-management practices in the Driftless Area, which began in the mid-1930s, do not correspond with the abrupt increase in baseflow. Instead, the *timing* of hydrologic change appears to coincide with changes in precipitation, whereas the *magnitude* of the change in baseflow and stormflow appears to have been amplified by changes in agricultural land management.

Simulating climate change in the Trout Lake Watershed, northern Wisconsin

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Simulations of climate-change effects on groundwater systems have often been coarse, utilizing approaches such as “X percent reduction in recharge”. More encompassing simulations have been difficult due to differences in temporal and spatial scales. The recently developed USGS ground-water/surface-water code, GSFLOW (Markstrom et al., 2007), couples two widely used models, PRMS and MODFLOW. The advantage of this coupled approach is that common outputs of climate-change models (e.g., changes to temperature and/or precipitation intensity) can be directly input into the model, which in turn can be applied to the hydrologic system in a physically based manner.

Two relatively simple climate scenarios were examined using the USGS’s Trout Lake WEBB model in northern Wisconsin, USA. The first evaluated a uniform 4.4^{o} C increase in air temperature that represented one projected year 2100 condition. The second evaluated the same uniform increase in air temperature, but added the effects of additional extreme precipitation events by combining weekly precipitation into a single day in that week (changing precipitation timing, but not total annual rates). Expected decreases in lake stage and stream flow were observed; more interesting, results suggested that climate change can result in changes in the dominant sources of water to ecosystems, as illustrated by a rain-dominated soft-water lake changing to a ground-water dominated flow-through lake. Even though the simulations could be improved by including more climate sophistication, these results demonstrate a potential utility for GSFLOW modeling for today’s resource management actions.

SESSION 2A:
Hydrogeologic Investigations
Thursday, March 6, 2008
3:40 – 5:20 p.m.

Hydraulic Tomography for Characterizing Heterogeneity

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A principal challenge facing ground water modelers is the characterization of hydrogeologic parameters in the subsurface. Traditional pump test analyses yield homogeneous estimates of parameters that may average over important heterogeneity due to limited numbers of observation wells. Hydraulic tomography is a valuable procedure to incorporate multiple aquifer tests into a single inverse problem, solving for a heterogeneous hydraulic conductivity field using observations of hydraulic head in wells. For the inverse method, the Bayesian geostatistical approach is selected here for its ability to formally elucidate a most-likely solution using observations collected during the tests to bolster an appropriate level of prior information. Every model node in the area of interest is allowed to vary rather than reducing the problem to a set of homogeneous zones. While this can introduce computational challenges, such challenges can be overcome, in an approach consistent with the Method of Multiple Working Hypotheses, which warns of premature adoption of a specific conceptual model.

Often, adjacent materials have appreciably different hydraulic conductivities, so the parameter field can be segregated into zones which each have a distinct mean value about which parameters fluctuate. While geologic observations or geophysical information can inform the location of parameter zone boundaries, this method interrogates the hydraulic head observations to guide the delineation of zones. The technique is demonstrated on synthetic aquifers in which the only information available is the collection set of head measurements collected in during the hydraulic tomography experiments.

An analysis of hydraulic conductivity with depth and stress in a clay aquitard

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Throughout the Fox River valley, the Cambrian–Ordovician bedrock aquifer is used extensively for residential and municipal water supply. A regional aquitard may control groundwater recharge to this aquifer. The aquitard is composed of silt and clay deposited in glacial Lake Oshkosh, which formed in front of the receding Green Bay Lobe of the Laurentide Ice Sheet approximately 13,000 to 19,000 years ago. Some of this lake sediment was subsequently eroded and deposited on upland areas by readvances of the ice. As a result, much of the Fox River valley is covered with varying thicknesses of fine-grained sediment. Much like the Maquoketa Formation in southeast Wisconsin, this fine-grained sediment may act as an aquitard, limiting infiltration to the bedrock aquifer.

The ability of the fine-grained sediment to transmit water was determined using consolidometers in the laboratory and slug tests in the field. Intact samples for consolidation testing were collected from several rotosonic boreholes drilled in the region. Hydraulic conductivity of these samples ranged from 1×10^{-8} ms^{-1} to 1×10^{-11} ms^{-1}, decreasing with applied load. These results show that hydraulic conductivity could vary several orders of magnitude from the surface to the base of the sequence.

Multilevel well systems, installed in two of the rotosonic boreholes, support this conclusion. Slug tests conducted in three of the well ports at one location revealed that hydraulic conductivity decreases with depth from 2.7×10^{-8} ms^{-1} at 20 ft to 3.0×10^{-11} ms^{-1} at 160 ft. These findings indicate that the hydraulic conductivity of these sediments decreases in relation to depth below land surface as a result of stress caused by overlying sediment.

**Graduate student presentation

Vertical distribution of $\delta^{18}O$ in a clay-rich aquitard: Implications for groundwater recharge

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The vertical distribution of $\delta^{18}O$ in a clay-rich aquitard can be used to constrain groundwater residence times and recharge to underlying bedrock aquifers. In the Fox River valley, porewater was extracted from sediment samples collected from seven boreholes drilled through a regional aquitard. In boreholes where the aquitard was less than 50 m thick, variation in the $\delta^{18}O$ values was limited to -6 to -10 $^{o}/_{oo}$, indicating that sufficient time had elapsed for modern-day pore water to move through the aquitard. However, in boreholes where the aquitard was at least 80 m thick, a bow-shaped curve was observed. Modern $\delta^{18}O$ values (-9 $^{o}/_{oo}$) near the surface gradually decreased with depth (-16 $^{o}/_{oo}$ to -18 $^{o}/_{oo}$) before increasing toward the bedrock surface (-11 $^{o}/_{oo}$ to -12 $^{o}/_{oo}$). These bow-shaped curves are typical of diffusion-dominated systems. We interpret the lighter $\delta^{18}O$ values in the middle of the aquitard to be an indication of relatively old pore water of glacial age. The heavier $\delta^{18}O$ values near the top of the aquitard are probably the result of local modern-day precipitation. However, the heavier $\delta^{18}O$ values near the bottom of the aquitard are probably the result of modern-day recharge to the bedrock aquifer that is occurring beyond the extent of the aquitard.

To better understand the $\delta^{18}O$ vertical profiles, we plan to use several one-dimensional advection-diffusion models. These models will include a homogenous advection-dispersion model, a two-layer diffusion model, and a two-layer advection-dispersion model. The layering will be chosen to reflect variation of the sediment lithology as observed in the sediment samples. This modeling effort should help us identify the physical processes controlling the vertical distribution of $\delta^{18}O$ in the aquitard.

Nitrate retention in a Central Sand Plains stream: incorporation of focused discharge in a mass balance model

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Humans are increasingly modifying the global nitrogen cycle by increasing quantities of available forms of nitrogen in ecosystems. Many streams in the Central Sand Plains of Wisconsin receive large, spatially variable fluxes of nitrate in ground water. Our main objective was to determine the capacity of a sand plains stream, Emmons Creek, to retain nitrate, while accounting for focused discharge of ground water. We quantified nitrate inputs and outputs in a gaining 750-m reach of Emmons Creek and used a mass balance model to estimate nitrate retention. Water samples were collected weekly from surface water at upstream and downstream stations and biweekly from 23 instream minipiezometers. Chloride was used to establish water balance. Groundwater nitrate concentrations were weighted by specific discharge. Nitrate concentrations in the surface water were lower in summer than in winter while nitrate concentrations in ground water did not show seasonal variation. Nitrate retention ranged from < 0.5 kg NO_3-N/d in the winter to 2.5 kg NO_3-N/d in the summer. These values represented < 5 and 20 % of inputs to the reach during winter and summer respectively. Our results suggest that instream nitrate retention can be substantial during the growing season in these high-N ecosystems. We plan to assess the mechanisms of nitrate retention in sand plain streams in the future.

Implications of Diffuse and Focused Groundwater Discharge to Allequash Creek, Vilas County Wisconsin

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Allequash Creek flows through Allequash Wetland in the Trout Lake basin in Vilas County, Wisconsin. The wetland is underlain by a regionally extensive sand and gravel aquifer and is comprised of heterogeneous peat up to 17m thick. Groundwater discharges to the creek via diffuse flow through the peat and possibly focused flow through soil pipes in the peat. The different flow regimes are thought to have important implications for nutrient and chemistry budgets in the stream, as well as the location of potential biogeochemical cycling in the watershed. Previous researchers identified high dissolved organic carbon (DOC) concentrations in shallow groundwater compared to DOC sampled from deeper in the peat. Because this is a groundwater discharge area, it is expected that shallow water with low DOC represents rapid travel times through preferential flow paths in the peat that allow groundwater to flow rapidly to the stream from the sand and gravel aquifer. As a result, residence times will be reduced and so will enrichment of DOC that originates in the peat.

Stable water isotopes were used to distinguish groundwater flowpaths derived from a lake located south of the creek from flowpaths derived from terrestrial recharge to the north. We then measured DOC and tritium concentrations in zones of focused discharge to compare with concentrations in diffuse flowpaths adjacent to these zones. Results from field sampling and implications of findings for the carbon budget of the stream will be presented.

**Graduate student presentation

SESSION 2B:
Organic and Biological Contaminants
Thursday, March 6, 2008
3:40 – 5:20 p.m.

Triclosan—Why is it still used?

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Chemists at the State Laboratory first noticed triclosan in environmental samples around the mid-1990s. An obscure contaminant at the time, it was soon discovered to be used, mainly as an antimicrobial, in a variety of common products ranging from tooth paste to hand soap. This was disconcerting because triclosan is a chlorinated organic with a structure that is similar to a PCB or a dioxin. In fact, it is a derivative of a polychlorinated diphenyl ether (of flame retardant fame). In the late 1990s there was considerable scientific interest in triclosan, indicating it was a worrisome organic contaminant. Based on the publicity the chemical received, it seemed sure to be taken out of use like other chlorinated organics. However, as the first decade of the 21st century nears an end, it is being used more than ever. In fact, the U.S. Geological Survey has found it to be one of the top five microcontaminants in U.S. rivers. Triclosan seems to pass through sewage treatment plants quite readily, so its occurrence in rivers is not too surprising. What is surprising is why this chemical was used in the first place. Wisconsin should consider restricting the use of triclosan or encouraging manufacturers to stop using it in their products. At least Wisconsin citizens need to be warned of this compound.

Efficacy of nano-aluminum oxide fiber filters for concentrating bacteriophages and adenovirus from water for fecal source tracking

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Confirming the presence and determining source(s) of fecal contamination to water is critical for the protection of human health and environmental quality. Adenoviruses (AdVs) have been suggested as potentially valuable, source-specific fecal indicator organisms for distinguishing between human and livestock species. Viruses in water are commonly collected using a virus adsorption-elution ("viradel") protocol, where contaminated water is passed through a charged filter from which viruses are eluted, typically with beef extract. In light of the rapidly expanding use of the polymerase chain reaction (PCR) for the detection of viruses in environmental waters, methods that improve virus recovery by (i) avoiding the use of beef extract, a known PCR inhibitor, and/or (ii) minimizing the co-concentration of environmental PCR-inhibiting compounds (e.g., humic acids) are desired. We explored the laboratory-scale adsorption/elution of bacteriophages MS2 and PRD1, enteric virus surrogates, and a murine AdV from moderately hard water (EPA 821/R-02-012) using a recently developed and highly promising electropositive, nano-aluminum oxide filter (NanoCeram®, Argonide Corporation). A variety of solutions, chosen for their demonstrated/assumed (i) ability to disrupt electrostatic interactions between viruses and cationic surfaces and (ii) compatibility with PCR, were evaluated as possible eluents. Initial results demonstrated quantitative removal and 0 – 80% recovery of phages from feed water, depending on eluent composition and bacteriophage identity. NanoCeram filters may provide an effective means for primary concentration of water samples or secondary concentration of samples after, e.g., hollow-fiber ultrafiltration. Research on the efficiency of PCR in the presence of the most promising eluents and recovery of prototype human and bovine AdVs is underway.

**Graduate student presentation

A Microbial Source Tracking Toolbox for the Great Lakes Region

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Protection, monitoring, and remediation are facets of a holistic approach to protecting drinking water. Traditional monitoring for microbial safety of source and drinking waters does not provide the ability to determine the source of offending microorganisms, if found. A toolbox of methods, termed microbial source tracking (MST), is emerging as a component of monitoring that can support targeted remediation and protection efforts. Reports on more than 22 MST methods can be found in the scientific literature. Many of the MST methods have been reported to be limited temporally and geographically. This project is evaluating the applicability of a suite of MST methods for their use in Wisconsin waters. The Wisconsin State Laboratory of Hygiene (WSLH) MST toolbox includes: *Bacteroides* spp. by qPCR as a fecal indicator; sorbitol-fermenting Bifidobacteria by membrane filtration as a human-specific indicator; male-specific coliphage genotypes to discriminate between human and non-human wastes; *Rhodococcus coprophilus* by spread-plating as a grazing animal-specific indicator; fecal sterol quantification to discriminate between human and non-human wastes; and targeted pharmaceutical and personal care product components that can provide additional evidence of anthropogenic inputs. This paper reports on the MST methodologies utilized as components of the WSLH toolbox and examples of their use for monitoring source water and ground water contamination incidents in Wisconsin.

**Graduate student presentation

Waterborne Illness Outbreak at Door County Restaurant Raises Questions on Available Aquifers and Land Use

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A recent waterborne illness outbreak in Door County in Northeast Wisconsin demonstrated how the limited natural groundwater protection available for shallow fractured bedrock aquifers can contribute to negative impacts on human health. Local land use practices in this area introduce pathogens into the shallow Silurian dolomite aquifer that most residents use for their drinking water.

Traditional water testing for *coliform* and *E.coli* provides information that a water system may have been impacted by fecal contamination. Newer testing methods have allowed the source of contamination to be identified as animal or human. In addition, human specific viral testing has provided an opportunity to identify the source of gastrointestinal illness outbreaks.

Source water tracking for a fecal contamination source is one tool to help direct changes in land use management. Land use practices including agriculture, industry, and human wastewater treatment all require careful management to preserve the quality of groundwater. When groundwater/drinking water becomes contaminated with fecal material and the source is known the resources for improving water quality can be focused on that specific source.

The shallow Silurian dolomite aquifer in Door County is very susceptible to groundwater contamination due to the presence of fractured bedrock and limited soil cover. The ability to obtain a usable quality and quantity of drinking water becomes increasingly difficult when local land use is not sustainable with maintaining good quality groundwater in the shallow aquifer. The quantity and quality of the groundwater from the deeper Ordovician aquifer is unknown and costly to drill to that depth. The challenge for prospective well owners located in areas vulnerable to contamination becomes whether to risk the cost and unknowns of the deep aquifer or work with the known risks in the shallow aquifer and installing microbial treatment if necessary.

Dye Trace Study of Door County Restaurant Septic System in Response to Water Borne Illness Outbreak

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Shortly after the opening of a new restaurant located in rural Door County a reported number of 239 patrons and 18 employees became ill with viral gastroenteritis. The restaurant is located in a topographically closed depression in a karst environment.

The subsequent testing of the new code compliant water supply well indicated the presence of contamination with a viral agent which caused the illnesses. Stool samples tested positive for norovirus, campylobacter and salmonella.

Efforts to identity the source of the well contamination began with the delineation of the likely zone of contribution for the well. Land use reviews and septic systems inspections were conducted in the delineated up-gradient contributing area. Potential sources of groundwater polluting activities that were identified included failing private septic systems. Free bacteriological private well testing was offered to property owners in both the up-gradient zone of contribution and mapped down-gradient areas as a screening tool for possible more widespread contamination and contamination distribution.

The high level, and persistent nature, of the restaurant well contamination suggested to some members of the investigative team that the restaurant's septic system was a potential if not likely source. The restaurant's septic system is a professionally designed, installed and inspected conforming waste water treatment system.

A dual dye trace was conducted to identify possible rapid connection between the septic system and the restaurant's well. Dye that was introduced to the dosing tank appeared in the well after 15 days; representing the flow through time from the dosing tank through the drain field to the restaurant's well. Dye that was introduced to a restaurant toilet appeared in the well after 6 days. The appearance of the second dye indicates that there is leak in the system before the waste enters the dosing tank. The trace results in a new conforming rural septic system calls for a future discussion on the validity of septic system construction, components, standards, guidelines and practices in karst.

POSTER SESSION
Thursday, March 6, 2008
5:20 – 7:20 p.m.

1. Nutrients and Sediment in Surface-Water Runoff from Frozen Fields at a Crop and Livestock Farm in Southwest Wisconsin, 2004-2007

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Nutrients and sediment in surface-water runoff from rainfall and snowmelt events were measured in grassed waterways within three small, adjacent, cropped basins at a no-till farm in southwest Wisconsin for four years (2004-2007). Event volumes and event-mean concentrations for runoff during frozen-ground periods within each year were statistically compared to detect changes associated with the surface application of liquid-dairy and solid-beef pen manure to fields within the basins.

Despite varying types, rates, and timing of manure applications, no significant differences were detected in the volume of runoff between basins in any frozen-ground period. Sediment losses were low – generally less than 20 lb. $acre^{-1}$ – and statistical differences between basins were not attributable to the applications of manure or the volume of runoff. Event-mean concentrations (and thus losses) of total nitrogen (TN) and total phosphorus (TP) were significantly increased when either manure was applied to frozen and snow-covered fields less than one week preceding runoff. These significant differences occurred despite relatively low manure-application rates. The highest event-mean concentrations of TN (46.6 mg L^{-1}) and TP (14.6 mg L^{-1}) occurred in 2004 when liquid-dairy manure was applied to frozen and snow-covered fields four days before snowmelt-runoff began. Lower nutrient concentrations and losses in runoff were observed when manures were applied in fall and early winter when sufficient time elapsed and necessary conditions occurred before runoff to facilitate processes such as sorption, infiltration, and/or volatilization that provided alternate pathways for nutrient transport.

2. Do artificial wetlands on golf courses have as much biodiversity as natural wetlands?

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Scott Hegrenes, Carthage College

Tracy Gartner, Carthage College

The number of wetlands in Wisconsin is decreasing, however by government definition man-made residential ponds and golf course water hazards are considered wetlands. If this is the case, we would expect that artificial wetlands would have similar communities of life relative to natural wetlands. Three golf courses that contained both natural and anthropogenic water hazards were chosen for the study. The aquatic macroinvertebrate community was sampled over a period of two months. Using the Shannon index of biodiversity, natural wetlands tended to have a more diverse macroinvertebrate community relative to the artificial wetlands. However, artificial wetlands may exhibit characteristics of natural wetlands with age. Adjacent land use may also be a contributing factor to the diversity of artificial wetlands. Although the government definition of wetlands may be misleading, carefully designed artificial wetlands can provide some of the functions of natural wetlands.

* Undergraduate student presentation

3. Formation and Evolution of Bars within a Sandy Braided Reach of the Lower Wisconsin River

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Sedimentation in braided fluvial systems is inherently controlled by complex interactions between multiple variables (e.g., sediment flux, discharge, flow dynamics). Determining the dynamics of sedimentation in modern braided streams is of importance in establishing aquifer and reservoir heterogeneity and in developing an understanding of modern and ancient fluvial deposits. A stretch of the Wisconsin River located east of Spring Green, Wisconsin was investigated over a two-month period during the summer of 2007. The study interval encompassed both low and high water discharge events. This study utilized GPR, GPS, topographic mapping (laser transit), and flow measurements (depth, direction flow velocity) to identify the variables of sedimentation associated with bar evolution within a sandy braided reach of the river. Our analysis identified the internal stratigraphy of an exposed bar and the migration (and evolution) of exposed and subaqueous bars. Formation and development of these depositional features are related to changes in flow dynamics.

Preliminary results suggest that the exposed bar is a compound structure composed of numerous unit bars. The amalgamation of the unit bars into a single composite bar occurred as a result of down-stream and oblique cross-channel bar migration during both high and low water flow events. This study is significance as it shows the complexities and compartmentalization of fluvially-derived aquifers and reservoirs.

** Graduate student presentation

4. Monitoring changes in subsurface hydrology, stream temperature, flood hydraulics, and vegetation following floodplain restoration on the East Branch Pecatonica River, WI

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The Wisconsin Department of Natural Resources and The Nature Conservancy are implementing a new floodplain restoration technique in the headwaters of the East Branch Pecatonica River, WI. The technique consists of restoring the pre-settlement floodplain topography by removing the cultural sediment deposited due to poor agricultural practices throughout the late 19th and early 20th centuries. Current research is focused on monitoring a site restored in August 2006 and another to be restored in October 2008 to quantify changes in subsurface hydrologic fluxes and their influence on the establishment of various vegetation communities. The removal of sediment and the subsequent decrease in the depth to the water table is expected to increase evapotranspiration and encourage establishment of wet prairie species on the floodplain. Insights and preliminary results from the first summer of monitoring including site response to August flooding will be presented.

** Graduate student presentation

5. Filter strip attenuation of feedlot runoff contaminants.

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Feedlots are a common component of Midwestern animal agriculture, providing an economical option for the feeding and raising of livestock. However, feedlot runoff, if not properly treated, can contribute to environmental pollution. Filter strips are designed to treat runoff by reducing concentrations of nutrients and sediment, mitigating potential environmental impacts. The goal of this study is to determine the ability of a filterstrip to attenuate pollutants.

Research was conducted in southwest Wisconsin at the University of Wisconsin-Platteville's Pioneer Farm. The filter strip was constructed in the 1970's according to Natural Resource Conservation standards and treats effluent from a feedlot containing dairy young stock.

Filter strip treatment performance was determined by comparing water samples entering and exiting the filter strip. Water samples were collected and water volume determined using United States Geological Survey gauging stations. Samples were analyzed for the following: total solids, suspended solids, nitrate-N, ammonium-N, total-N, organic-N, dissolved reactive phosphorus, and total phosphorus. Treatment performance was based on percent removal for each of the above constituents.

At last year's AWRA annual meeting we presented preliminary research findings. This year we will summarize final data.

6. Positive relationship between episammic chlorophyll and porewater phosphorus in a Central Sand Plains stream

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The land use in the Central Sand Plains of Wisconsin is largely agricultural. Nutrients not taken up by crops can be leached out of the soil into the ground water. This can lead to high concentrations of nutrients such as nitrate and phosphate in the shallow ground water (porewater) of gaining stream reaches. Ratios of available nitrogen to phosphorus usually greatly exceed Redfield proportions in these streams. Elevated levels of nutrients in porewater can have large effects on benthic biological activity, including the production of episammic algae (algae growing on sand grains). Phosphorus is often a limiting nutrient for aquatic plant growth and excess phosphorus can lead to algal blooms and decreased dissolved oxygen levels. The study was based on the hypothesis that increased phosphorus concentrations in the porewater lead to increased episammic algal biomass. The study was conducted in a 650-meter reach of Radley Creek, in southwestern Waupaca County. Porewater at a depth of 5 cm and sediment cores (5.3 cm^2) were collected every 30-meters along the reach once a month from July to December 2007. Chlorophyll-a extracted from the cores, which is an indicator of algal biomass, and soluble reactive phosphorus (SRP) were measured spectrophotometrically. The ranges of chlorophyll-a and SRP were 0.4 – 3.7 μg/cm^2 and 8 – 185 μg/L respectively. Episammic chlorophyll-a increased nonlinearly with porewater SRP concentration. We plan to conduct nutrient amendment experiments to determine if there is a causal relationship between porewater phosphorus concentration and episammic algal biomass.

* Undergraduate student presentation

7. Rugged, Highly-Porous Fiber Claddings for Remote Sensing in Aqueous Environments

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Optical fibers can be employed for remote monitoring in harsh environments. The entire fiber length may be utilized for sensing by placing fluorosensors outside of the fiber core where excitation occurs through the evanescent field. Conversely, light emitted by sensor molecules may be captured by evanescent fields and guided to the fiber ends. Pulsed laser excitation and time-resolved detection allow for pinpointing the location of a sensor along the fiber. Thus, many different parameters may be monitored simultaneously.

The sensor density may be increased significantly by adding a second fiber that forms orthogonal fiber-fiber junctions with the first fiber at the sensor regions. The second fiber provides an optical delay, which results in the desired increase in spatial resolution. Small displacements between the fibers, however, can result in large signal changes due to the exponential decay of evanescent fields away from the fiber core/cladding interface. This can be remedied by a polymer to maintain fiber position.

We have used a poly(ethylene) glycol material as a replacement cladding because it has a tunable refractive index and high resistance to biofouling. Microsphere templating was used to create pores that allow analyte passage to the evanescent region close to the core. The fluorosensors were modified for covalent attachment to the polymer to minimize leaching. This yields fiber-fiber junctions with significantly enhanced signal repeatability and reproducibility as well as sensor longevity for use in multiple sensor arrays.

**Graduate student presentation

8. Estimation of basement topography in southeastern Wisconsin using 3-D modeling of gravity and aeromagnetic data.

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As water issues permeate society it becomes increasingly important to understand groundwater systems. An accurate estimation of the subsurface basement topography in southeastern Wisconsin is vital to determining flow and quality of groundwater in this region. A 3D model of the Precambrian basement was developed using existing USGS compilations of gravity and aeromagnetic data and state lithologic data (wiscLITH) in conjunction with commercially available GMSYS-3D and Oasis Montaj modeling software. Model grids of 1000 m spacing were constructed for each data set and each geologic unit to match original grid size of gravity data. The surface elevation layer is from DEM data obtained from Wisconsin Department of Natural Resources. Initial elevations grids and physical property assignments for the base of glacial deposits, top of the Mount Simon, and the top of Precambrian basement were obtained from previous modeling along profiles (Skalbeck et al., 2007). A layer was developed to represent mafic intrusive bodies with an initial elevation of -5000 m msl and well constrains grid was created using wiscLITH elevations that limit the structural inversion of the model. A forward structural inversion for the basement layer was performed using the gravity data followed by a forward structural inversion for the mafic intrusion layer using the aeromagnetic data. The 3D model yields reasonable fits between observed and calculated gravity and aeromagnetic data and provides additional detail relative to the previous basement surface estimation from profile modeling.

*Undergraduate student presentation

9. Effect of tiled upland infiltration basins on runoff volume and pollutant export from field-scale agricultural basins

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Non-point source pollution of surface water with sediment, nutrients, and other agrichemicals is a growing public and regulatory concern. Pollutants exported from agricultural fields are often estimated using computer models and simulated runoff experiments, rather than with actual field measurements. Pioneer Farm, a 430-acre mixed-livestock farm associated with the University of Wisconsin-Platteville, is intensively instrumented with USGS runoff monitoring stations that are equipped with H-flumes and automated samplers to sample runoff at intervals throughout individual storm events.

Two runoff monitoring stations were positioned on opposite sides of a hill to monitor runoff from two field-scale basins of similar size in 2003 (Site 3 and Site 5). The basins were calibrated for a period of two years before two tiled infiltration basins were installed in the Site 3 basin. These basins are a conservation practice designed to reduce runoff export during rainstorms. After the installation, runoff volumes and nutrient and sediment loads were measured year-round for two years before the structures were removed. Preliminary analysis shows that runoff volumes from rain storms have been reduced fifty percent. This presentation will display the full analysis of this data set and discuss the implications of the findings.

10. Estimation of basement topography in Fond Du Lac County using 3-D modeling of gravity and aeromagnetic data

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The Precambrian basement surface throughout Fond du Lac County is known to be very undulated and this uneven basement topography may controls water well yields and zones of stagnant water. Therefore, an accurate estimation of the basement topography in Fond Du Lac County is vital to determining ground water flow and quality of groundwater in this region. A three dimensional model of the Precambrian basement was developed using modeling software GMSYS-3D and Oasis Montaj and existing of gravity and aeromagnetic (USGS compilations) and lithologic (wiscLITH) data. The model is constructed with 250 m grids for each data set and each geologic unit. DEM data was used for the surface elevation layer while layers for the base of glacial deposits and the top of Precambrian basement were created using wiscLITH data from over 90 wells. Initial physical property assignments for the layers were obtained from modeling results in southeastern Wisconsin (Skalbeck et al., 2007). A mafic intrusive bodies layer with an initial elevation of 5000 m below mean sea level and well constrains grid created using wiscLITH elevations that limit the structural inversion of the model are also included in the model. Forward structural inversions were performed for the basement layer using the gravity data and the mafic intrusion layer using the aeromagnetic data. The 3D model yields reasonable fits between observed and calculated gravity and aeromagnetic data and provides an acceptable basement surface.

*Undergraduate student presentation

11. Effects of Urbanization on Stream Ecosystems near Milwaukee and Green Bay, WI

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In 2003 and 2004, 30 streams near Milwaukee and Green Bay, Wisconsin were part of a national study by the USGS National Water-Quality Assessment program to assess urbanization effects on stream ecosystems. An urban intensity index was developed using GIS-based data to quantify the gradient of urbanization within relatively homogeneous environmental settings. Stream physical habitat, hydrology, stream temperature, water chemistry, benthic algae, benthic invertebrates, and fish were examined. Physical habitat measurements reflective of channel enlargement increased with urbanization but river engineering features in some of the watersheds may have confounded other potential habitat responses to urbanization. Streamflow flashiness, duration of low flow, and stream temperature increased with urbanization; the duration of high flow decreased with urbanization. Spring and summer chloride concentrations were greater with increasing road infrastructure characteristics, urban land, and other landscape variables related to urbanization as a result of road salt deicer usage. Spring sulfate, prometon, and diazinon increased with road indices, percent impervious surface, and percent urban land-use. Potential aquatic toxicity and organic contaminants, as measured from semi-permeable membrane devices, were higher with increasing road density, percent impervious surface, and urban land. The quality of algae, invertebrate and fish assemblages showed negative relations to increasing percentages of urban land and associated characteristics of increasing impervious surface, streamflow flashiness, chloride, and decreases in watershed wetland area and streambank vegetative cover.

12. Optical Fiber Sensors for Real-Time, Remote, and Spatially Resolved Oxygen Sensing

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Real-time monitoring of surface and groundwater systems over extended time periods at many different locations for parameters such as dissolved oxygen concentration, pH, etc., is important for characterizing environmental processes. For measurement of dissolved-oxygen concentrations, the use of standard electrochemical sensors is limited to few locations over limited time periods. Optical fiber based sensors promise to overcome these limitations, as sensing can take place along the entire length of a fiber.

This contribution describes fiber optic sensor arrays for dissolved oxygen concentration measurements. Sensing is based on the oxygen-induced quenching of the fluorescence of the complex dichlorotris (1,10-phenanthroline) ruthenium(II). This complex is encapsulated in a porous hydrogel, which, in turn, is attached to the fiber core at a senor region. In our sensor architecture, a light pulse produced by a nitrogen laser is carried by one optical fiber to a sensor region; fluorescence generated at the probe is then captured by a second fiber at right angle to the fiber carrying the excitation light and guided to the detector. We evaluated response interval, detection limits, repeatability, and the temperature-dependence of the sensor response. These sensors have been in submerged in water for more than 30 days without leaching of the sensor complex and performance degradation. Finally, we describe the development of a new class of optical fiber sensors that employ the effect of metal-enhanced fluorescence to improve signal intensities.

**Graduate student presentation

13. Impacts of Urban Runoff on Rain Gardens Planted with Native Vegetation vs. Collection Basin Constructed with Lawn Sod

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The University of Wisconsin-Stevens Point campus has a large amount of impervious surfaces. To help prevent urban runoff into the Wisconsin River, we built two rain water collection basins, one lawn sod and one a rain garden with native vegetation. The two depressions were built under two different runoff areas of 757 sq. ft. with a depth of 6 in.

Essential dissolved inorganic nutrients, such as chloride and nitrogen, are taken up by plant roots through the root membrane and transported through the plant by the vascular system. The objective will be to compare the soil moisture and dissolved constituent uptake capacity of collection basins between native prairie vegetation and lawn sod with the same roof drainage area and depth of collection basin.

We hypothesize that the native prairie vegetation will exhibit a greater infiltration rate and dissolved constituent uptake capacity than the lawn sod because native vegetation generally have deeper tap roots making the soil more porous and absorbing more water and dissolved constituents. The importance of this study is to find out if rain gardens planted with native vegetation are more efficient than a collection basin constructed with lawn sod at infiltrating water and reducing contaminant loading from urban runoff.

*Undergraduate student presentation

14. Aquatic Plant Management of the St. Croix/Gordon Flowage in Douglas County, Wisconsin.

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The St. Croix/Gordon Flowage is a 1,913 acre impoundment of the St. Croix River. It is located just west of Gordon in Douglas County. Just below this impoundment is the beginning of the St. Croix National Scenic Riverway. Aquatic plants play a significant role in a reservoir's ecosystem. They provide habitat for the fishery and other aquatic organisms, stabilize the sediment, reduce erosion, buffer temperature changes and waves, infuse oxygen into the water, and utilize nutrients that may otherwise be used by algae. The survey was conducted using DNR protocol. In total 744 sites were surveyed. Fifty-six aquatic plant species were collected and identified in the survey conducted in July/August 2007. Additional data analysis included Frequency of Occurrence, Simpson Diversity Index, and Floristic Quality Index assessments. Two invasive species, curly leaf pondweed and Eurasian water milfoil, were identified in relatively small abundance in the flowage. Through this survey and citizen involvement a management plan will be developed to best fit the needs and expectations of the flowage.

*Undergraduate student presentation

15. Hydroecologic studies in the Save Valley Conservancy, southeastern Zimbabwe

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The Save Valley Conservancy is located along the Save River in the southeastern Lowveld of Zimbabwe and covers more than 845,000 acres (342 km^2). The Conservancy supports a diversity of wild game, including elephant, giraffe, Black Rhino, zebra, lion, antelope, and many other species. Large intermittent wetlands, locally called pans, provide a water source for local animals and represent a diverse temporary habitat for flora and fauna. The pans commonly hold water during the wet season (November through April) but dry completely during the winter months (May through October).

An interdisciplinary team of hydrogeologists, biologists, and ecologists is currently assessing the hydroecology of the Suni Pan, one of the largest pans in the conservancy. In November, 2007, the team developed a research transect extending approximately 2 km through several different vegetation zones from the edge of the pan to the Save River floodplain. Along this transect the team installed boreholes and obtained soil and sediment samples.

The Suni Pan does not intersect the water table, but probably provides recharge for the local groundwater system. The dry-season water table is in arkosic sands more than 8 m below the surface. Soils nearer the river are developed on alluvial silt, and the river valley contains coarse, well-sorted sand, forming an important local aquifer directly connected to the river. On the basis of the current conceptual model, the Suni Pan fills with water from direct precipitation and runoff during the rainy season, then slowly recharges the underlying aquifer while also losing water to evapotranspiration. Future studies by the research team will refine this model and assess management implications.

16. Utilizing a Standardized Set of Environmental Construction Practices to Reduce Environmental Impacts on Linear Transmission Line Projects in the Midwest

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The construction and operation of above ground high voltage transmission lines inherently involves differing levels of impacts to waterways, wetlands, and sensitive species. American Transmission Company (ATC) has created and implemented a standardized set of Environmental Construction Practices (ECP's) in an effort to manage and minimize these impacts through all phases of construction and maintenance activities.

The Environmental Construction Practices contain a set of specific work instructions to be implemented during construction activities that address issues such as wetland construction, waterway crossings, erosion control, dewatering, threatened and endangered species, and restoration. Each of the work instructions contains specific standards to minimize impacts to natural resources based on regulatory requirements, performance standards, and Best Management Practices. The ECP's standardize the way the company permits, constructs, and maintains its transmission lines. This standardization minimizes construction impacts to surface waters and natural resources and raises the companies overall environmental awareness.

17. Floods from Record Rains in Illinois, Iowa, Minnesota, and Wisconsin, August 17−30, 2007

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Record rainfall occurred August 17-23 causing severe floods in parts of the Upper Mississippi River Valley. Widespread, slow-moving thunderstorms developed and redeveloped along a stationary front stretching from northern Iowa through northern Illinois, while a low-level jet stream transported warm, moist air from remnants of Tropical Storm Erin into southern Minnesota and Wisconsin. Rains relieved drought conditions in parts of Minnesota and Wisconsin, but fell on saturated ground in Iowa and Illinois. The greatest rainfall occurred in southeast Minnesota and southwest Wisconsin. Many locations exceeded the 100-year recurrence interval for 24-hour rainfall (6-7 inches) and 100-year 5-day rainfall (9-10 inches). The 24-hour rainfall record was broken for Minnesota in Houston County when 15.10 inches of rain fell August 18-19.

Flooding was severe in parts of the four states. In Iowa, flooding occurred in the north central and south central regions.. The most severe flooding occurred in the Des Moines and Chariton River Basins, with recurrence intervals ranging from approximately 15-60 years. Streams in northeastern Iowa generally had peak streamflows with recurrence intervals of < 10 years.

In northern Illinois and the Chicago area flooding occurred on the Kishwaukee River, Fox River tributaries, the Skokie River, and the Little Calumet River tributaries. Additional precipitation Aug. 23 caused flooding at the 100-year recurrence interval on the South Branch Kishwaukee River, Tyler Creek, and Deer Creek near Chicago Heights. Streamflows in larger rivers, including the DuPage and Fox, reached or exceeded recurrence intervals of 25- 50 years.

In southeast Minnesota, the most severe flooding occurred in and adjacent to the Whitewater and Root River basins. Two streamgages in the Root River basin recorded peak flows of record. One gage on the Root River recorded greater than a 100-year recurrence interval while the other on a tributary is likely to exceed the 500-year recurrence interval. In the Zumbro River basin, flooding was less severe but with peaks of 10-year recurrence intervals.

In southern Wisconsin flooding was most severe in the Lower Wisconsin River, Grant/Sugar/Pecatonica River basins, southern Lake Michigan tributaries, Illinois/Fox River, and the Rock River. Recurrence intervals ranged from 2- 100 years.

Federal disaster areas were declared for 14 counties in Iowa, 6 in Illinois, 8 in Minnesota, and 14 in Wisconsin. Flood and storm damages were estimated at greater than $240.6 million for the four states.

SESSION 3A
Lake Management
Friday, March 7, 2008
8:00 – 9:40 a.m.

Implications of Low Water Levels for Natural Lake Ecosystems

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Recent drought conditions in Wisconsin, both in agricultural and forested regions, have caused some lakes to reach historic low water levels. Water level fluctuations are normal for certain types of lakes, depending upon lake morphology, hydrology, climate, and geography. Indeed, water level fluctuations can be beneficial to healthy lake ecosystems; for example, encouraging emergent plant growth, compacting sediments, and deterring invasive species. However, global climate change, land use patterns, and increasing human demands for water may be altering these normal cycles, with long term implications for water quality and ecosystem services. Decreased water clarity, spread of native and invasive aquatic plants, loss of shoreline and littoral habitat, and increased human use of exposed lake beds are some of the potential consequences of extended periods of low lake levels. Using long term datasets and case studies from lakes in northern Wisconsin and the Central Sands, this talk will highlight potential ecological implications of low lake levels to inform sound decision-making about water resource management and adaptation to global climate change in Wisconsin.

Regulatory Aspects of Managing Low Water Levels

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Water diversions, from surface water or groundwater pumping, can have an adverse affect on aquatic communities and on downstream beneficial users. Section 30.18, Wis. Stats., was created to preserve the public interest in our waterways and requires a permit to divert surface water from any water of the state for certain uses. Section 31.02 allows the Department to establish a minimum level on any navigable body of water to protect public rights and interests.

Although Wisconsin's water laws are strong, there are still regulatory gaps. For example, if you are a riparian owner that is diverting water for non-agricultural or non-irrigation purposes, and your diversion is less than 2 million gallons per day (in a 1 month period) you do not need a permit. To compound the issue, "domestic purposes" (e.g. watering the lawn, non-commercial gardening, etc.), also do not need a permit provided the diversion is of a 'nominal amount'. In addition, permitted diversions must reflect the minimum flow required for water quality standards related to pollutant discharges (administrative code NR 104)

All of these issues are complex and are compounded by regulatory gaps. The resulting lack of data can be problematic for resource professionals managing water levels. This presentation will outline Wisconsin's current water laws as it relates to water diversions and water levels, present ideas on how to fill the data gaps that exist, and highlight an approach to managing water levels through the management of the resource.

Cyanobacteria and Cyanobacterial Toxins in Wisconsin Surface Waters: Results of a Statewide Monitoring Program

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The presence of cyanobacteria (also known as blue-green algae) and the toxins that they may produce are of increasing concern in recreational and drinking waters due to their potential health risks to humans and other biota. The Wisconsin Department of Natural Resources conducted a multi-year study to assess the presence of cyanobacteria in Wisconsin surface waters. The objectives of this study were to identify and enumerate cyanobacteria in select eutrophic lakes and ponds, and to determine the concentrations of three cyanobacterial toxins (microcystin-LR, cylindrospermopsin, and anatoxin-a) in samples where concentrations of cyanobacteria were high. Samples were collected from lakes and ponds in each region of the state five times during the summers of 2004 and 2005, and one time during the summer of 2006. Cyanobacteria were detected in 74% of the samples in both 2004 and 2005, and in 68% of the samples in 2006. Cyanobacteria cell densities were above the World Health Organization (WHO) guidance value of 100,000 cells/mL in approximately 20% of the samples tested. Approximately 50% of the samples analyzed for toxins contained one or more toxins. Microcystin-LR was the most frequently detected toxin. Concentrations of microcystin-LR ranged from 1.2 to 7,600 µg/L and concentrations of anatoxin-a ranged from 0.68 to 1,750 µg/L. Cylindrospermopsin was not detected in any of the samples analyzed. The information gathered in this monitoring study allowed the Wisconsin Department of Natural Resources and local public heath agencies to better assess the risks associated with cyanobacteria.

Zooplankton as bioindicators of anthropogenic impact to lake ecosystems: Surveys from Southeast Wisconsin lakes

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Lake managers are always looking for ways to estimate the biological health of lake ecosystems. For a bioindicator to be useful in lake assessment there must be a demonstrated relationship between the bioindicator and some form of anthropogenic disturbance, be it land-use change, eutrophication, chemical toxicity, invasive species or other stressors. Zooplankton have rarely been used in Wisconsin for this type of lake assessment, likely because little is known about the relationship between human environmental impact and zooplankton communities.

I have collected data on zooplankton communities in 32 lakes in Southeast Wisconsin lakes and compared these zooplankton communities to historical zooplankton samples collected in the 1970's to look for community shifts over time. I also have collected water chemistry data on the lakes to compare with historical water chemistry. Current and historical watershed land use will also be evaluated.

My primary research questions are: Do changes in zooplankton communities over time follow patterns in lake trophic status and/or land use? Do historical or present zooplankton communities correlate with a gradient of nutrient levels and/or land use? I hypothesize that zooplankton communities will change with changing land use patterns due to large increases in suburban and urban land use in Southeast Wisconsin over the past thirty years. It is unclear how changes in nutrient levels and water chemistry will have changed over the past thirty years because of improvements in water quality regulation and concurrent increases in human population and land development. I hypothesize that nutrient levels will have changed little due to these conflicting factors. Additional evidence for impacts on species should be gained by studying changes in zooplankton communities over both space (historically and currently) and time. Preliminary analysis has shown that zooplankton species richness and abundance has increased since the 1970's in Southeast Wisconsin lakes.

**Graduate student presentation

Spatial and temporal variability of sediment deposition in Lake Mendota

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Lake Mendota (Wisconsin, USA) is a eutrophic lake (40 km2, 25.3 m deep) with a large agricultural watershed (604 km2) that is becoming increasingly urbanized. Phosphorus (P) and sediment loadings associated with runoff events have been highly variable temporally, but also spatially due to unique characteristics of the major tributary inflows. To identify major periods and events of sediment and P deposition in the lake, sediment cores 55-60 cm in length were collected from four distinct depositional locations and sliced in 2-mm intervals. We conducted a wide array of physical and chemical analyses on the nearly 300 sediment samples per core representing more than a century of depositional history. Comparison of these detailed profiles allowed for the identification of similar historical depositional patterns between sites, as well as inter-site variation in sediment deposition. A distinct “Z” pattern of aluminum, potassium, and iron especially prominent in the deep-hole sediment core indicated significant erosion had occurred when the lake level was raised 1.5 m in 1849. Erosion signals declined rapidly in sediments deposited in ensuing years followed by another major increase that peaked during the mid-1900’s. Since then, erosion-associated elements have steadily declined to the present. From these and other analyses, we discuss the implications on sediment P dynamics in Lake Mendota.

SESSION 3B
Investigations in Groundwater Management Areas
Friday, March 7, 2008
8:00 – 9:40 a.m.

Hydrostratigraphy and Groundwater Flow Model: Troy Valley Glacial Aquifer, Southern Waukesha Co., Wisconsin

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The Troy Valley is a pre-glacial valley that was probably deepened by subglacial meltwater and is now filled mostly with till, fluvial sand and gravel, and fine-grained lacustrine deposits. Detailed mapping of the valley fill deposits is lacking, so we used well logs and geophysical data to produce a 3D hydrostratigraphic model using Rockworks software. Given the uncertainty inherent in the hydrostratigraphic model, we used geostatistics (indicator kriging) to generate a set of alternative representations (realizations) of the hydrostratigraphy. The hydrostratigraphic model is being used in a 3D groundwater flow model based on the computer code MODFLOW. Streams, wetlands, and lakes are represented using MODFLOW's Stream and Lake Packages. The model will be used to assess the Troy Valley's potential as a municipal water supply. The effects of potential future groundwater pumping from the Troy Valley on surface water features will be evaluated. The development of the hydrostratigraphic model and results of the initial testing of the groundwater model for selected realizations of the geology will be discussed.

**Graduate Student Presentation

Anthropogenic Effects of Wastewater Treatment Plant Effluent on Shallow Groundwater and Streams of Southeastern Wisconsin

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Drawdown of the potentiometric surface and radium levels exceeding federal regulatory standards in the Cambrian-Ordovician aquifer have caused several municipalities in Southeastern Wisconsin, including the City of Waukesha, to seek alternative sources of potable water, including the shallow aquifers and/or a Lake Michigan diversion. The city currently discharges its treated wastewater into the Fox River, part of the greater Mississippi River basin. This research examines alternative uses for this treated wastewater: as induced recharge to the shallow aquifer system, or as discharge into the greater Lake Michigan watershed as mitigation of a Great Lakes diversion.

A database of water chemistry data was created from historical data sources and from current sampling of shallow groundwater wells and streams. Data analysis reveals elevated levels of chloride in both aquifers and in surface waters. Analysis for prescription and personal care products (PPCPs) revealed the presence of these anthropogenic compounds in surface and ground water. Surface waters were found to contain 5 of 11 compounds analyzed. In ground waters, caffeine was detected in 100% of wells, and paraxanthine was detected in 33% of wells. Geochemical modeling and chloride/bromide ratios show impacts by road salting to shallow groundwaters. Geochemical models suggest that the changes in groundwater chemistry under multiple treated wastewater infiltration scenarios may not be large enough to discount this as a mitigation strategy to Southeastern Wisconsin's water issues.

**Graduate Student Presentation

Assessing ground-water supply problems and possible solutions in southeastern Wisconsin

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Laws intended to protect ground-water supplies in Wisconsin rely exclusively on drawdown as an indicator of problems. Areas with drawdown greater than 150 feet are designated ground- water management areas (GMAs) and required to develop a management plan to resolve the problem. Unfortunately such drawdowns can only occur in aquifers much thicker than 150 feet, and then usually only occur if the aquifer is confined. Furthermore, if the resolution process reduces drawdown below 150 feet, the legally-defined supply Aproblem@ may go away, even if the action dries up springs and streams.

Alternative measures of the sustainability of a management plan and the extent of its hydrologic impacts are needed. For the southeastern WI GMA, several measures of water budget balance and impact {demand to supply ratio (DSR), human impact ratio (HIR), baseflow reduction index (BRI)} are presented and compared to drawdown and each other to assess their validity and effectiveness. Drawdown is somewhat effective in confined systems, but does not pinpoint where current problems are located. DSR and HIR are much more effective. In unconfined systems, drawdown is absolutely meaningless; BRI is the single most meaningful measure of current ground-water impacts.

In assessing future management plans, southeastern Wisconsin faces another, longer-term concern. Most options being considered will eventually generate impacts that exceed acceptable levels, although sometimes not for many decades into the future. The presentation will examine the longevity of effectiveness of the management options under consideration.

Sustainability analysis for shallow groundwater use in the SEWRPC region

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In response to concerns over declining groundwater levels and water quality issues in the deep sandstone aquifer in southeastern Wisconsin, many local communities are turning to shallow aquifers (either sand and gravel or Silurian dolomite) for water supply. Wells developed in the shallow aquifers commonly provide adequate yield, but can impact nearby surface-water resources and are generally more vulnerable to contamination than deeper bedrock wells. Communities that have turned to shallow aquifer sources can have an overall negative groundwater balance if wastewater leaves the community via surface water rather than returning to the local groundwater system through septic systems.

We have investigated the sustainability of shallow groundwater resources by constructing simple two-dimensional analytic-element groundwater flow models for six demonstration areas across the Southeastern Wisconsin Regional Planning Commission (SEWRPC) region. Demonstration areas reflect the range of hydrogeologic properties found across the region. Development scenarios consider lot size and wastewater disposal method. We assessed impacts using three metrics: drawdown, baseflow reduction, and overall water balance – the proportion of local recharge used by simulated wells.

If water quality is not considered, shallow wells can provide adequate water supplies for single-family homes on lots of 1 acre or larger for the foreseeable future over much of the SEWRPC region. However, all development scenarios have some impact on nearby water resources. Both drawdown and reductions in stream baseflows increase linearly as lot sizes decrease. Under the most aggressive development scenarios (1 acre lots, no return flow), simulated drawdowns beneath developed areas range from one to 27 feet, and baseflow reductions range from 20 to 40 percent in small nearby streams. In general, impacts are inversely proportional to recharge rates and hydraulic conductivity. Even under the most aggressive development scenarios, most of the demonstration areas withdraw less than 40 percent of the local recharge. However, simulated withdrawals in areas having clayey soils and low infiltration exceed 100 percent of natural recharge for lots smaller than 5 acres. Analyses of groundwater and baseflow impacts should be a standard part of development planning.

A Large Scale Pumping Test in the Northeastern Wisconsin Groundwater Management Area

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In northeastern Wisconsin, a large regional drawdown cone, centered on Brown County, has developed in a deep sandstone aquifer due to pumping from beneath an aquitard. The maximum depth of the cone of depression is greater than 300 feet with drawdown greater than 150 feet covering almost all of Brown County. Wisconsin groundwater quantity legislation, Act 310, identifies areas with drawdown greater than 150 feet as Groundwater Management Areas (GMAs). As such, this region, the northeastern GMA, is subject to advice and funding for research and planning from the Wisconsin Department of Natural Resources.

Water supply is a concern in this region. In August, 2007, six communities, realizing that water levels continued to decrease in the deep aquifer and wanting a long-term reliable source of water, switched from pumping groundwater to surface water. As a result of this change, water levels in the deep sandstone aquifer have recovered by up to 70 feet in 3 months.

We plan to use the decrease in pumping and the recovery of water levels to better constrain the hydrogeology of this region. This data can be simply viewed as a very large leaky aquifer test to estimate vertical hydraulic conductivities in the aquitard and horizontal hydraulic conductivities in the deep sandstone aquifer. Regardless of whether or not the pumping test analysis is applicable, the pumping and water level data are essential for understanding groundwater in the region.

SESSION 4A
Stormwater, Streams and Runoff
Friday, March 7, 2008
10:00 – 11:55 a.m.

Nutrients and Sediment in Surface-Water Runoff from Frozen Fields at a Crop and Livestock Farm in Southwest Wisconsin, 2004-2007

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Nutrients and sediment in surface-water runoff from rainfall and snowmelt events were measured in grassed waterways within three small, adjacent, cropped basins at a no-till farm in southwest Wisconsin for four years. Event volumes and event-mean concentrations for runoff during frozen-ground periods for each year were statistically compared to detect changes associated with the surface application of liquid-dairy and solid-beef pen manure to fields within the basins.

Despite varying types, rates, and timing of manure applications, no significant differences were detected in the volume of runoff between basins in any frozen-ground period. Sediment losses were low – generally less than 20 lb. acre^{-1} – and statistical differences between basins were not attributable to the applications of manure or the volume of runoff. Event-mean concentrations (and thus losses) of total nitrogen (TN) and total phosphorus (TP) were significantly increased when either manure was applied to frozen and snow-covered fields less than one week preceding runoff. These significant differences occurred despite relatively low manure-application rates. The highest event-mean concentrations of TN (46.6 mg L^{-1}) and TP (14.6 mg L^{-1}) occurred in 2004 when liquid-dairy manure was applied to frozen and snow-covered fields four days before snowmelt-runoff began. Lower nutrient concentrations and losses in runoff were observed when manures were applied in fall and early winter when sufficient time elapsed and necessary conditions occurred before runoff to facilitate processes such as sorption, infiltration, and/or volatilization that provided alternate pathways for nutrient transport.

Estimating Runoff Dissolved Phosphorus Losses Following Manure Applications to Cropland for the Wisconsin Phosphorous Index

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The Wisconsin Phosphorus (P) Index is a field-level runoff P loss risk assessment tool for evaluating agricultural management practices. It assigns an annual risk ranking to a field by estimating annual sediment-bound and dissolved P losses to the nearest surface water. For fields without recent manure or fertilizer applications, the P Index uses the strong relationship between crop land runoff dissolved P (DP) concentrations and soil test P in the assessment of potential runoff DP losses from the field. This relationship can not be used, however, to estimate DP loss potential for fields with recent manure additions. Simulated rainfall experiments have shown that runoff DP concentrations increase following surface manure applications and are not related to soil P. In these experiments, the proportion of rain converted to runoff greatly influenced runoff DP concentrations as well as DP loads. We have developed a simple method for estimating DP losses following manure application that uses long-term weather and runoff averages to determine the potential for runoff during the season of manure application. With this method, the P Index appropriately ranked the DP loss potential following manure application for Wisconsin fields where runoff was monitored from 2004 to 2006. Winter applications had the highest estimated and measured DP losses. In addition, when the estimated DP losses following manure application were summed with estimated annual soil P-related runoff DP losses, the resulting “Soluble P Index” appropriately ranked fields by annual DP yields.

Utilizing Dredging Methodologies for Stormwater Detention Pond Rehabilitation & Aquatic Resource Management

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Management of aging stormwater detention ponds and sedimentation issues in inland waterways have long been a problem without a viable solution. Recent advances utilizing hydraulic dredging technologies, the incorporation of geotextile tubes, and the direct injection of sediments are producing amazing results to this quandary. This session will discuss the dredging process from permitting to final disposal and provide case studies for both inland waterways and detention pond management.

Comparison of Stormwater Runoff Quantity and Quality Using Conventional and Low-Impact Development Strategies

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Environmental managers must consider strategies to accommodate development while minimizing adverse environmental impacts. Low-impact development (LID) is one such strategy that attempts to mitigate environmental degradation commonly associated with impervious surfaces. A paired-basin study design was used to compare the hydrologic and water-quality characteristics of two basins in Cross Plains, Wis. from 1999-2005. Each basin represented different construction philosophies. The “conventional” basin consisted of curb and gutter draining to a fully connected stormwater-conveyance system. The LID basin disconnected the stormwater conveyance system by incorporating grassed swales, reduced impervious area, street inlets draining to grass swales, a detention pond, and an infiltration basin.

Smaller, more frequent precipitation events that produced stormwater discharge from the conventional basin were retained in the LID basin. Precipitation events capable of producing appreciable discharge in the LID basin were typically those of high intensity or those that occurred after soils were already saturated. Total annual discharge volume measured from the conventional basin ranged from 1.3 to 9.2 times that from the LID basin.

Annual total solids, total suspended solids, and total phosphorus loads were greater in the LID basin than in the conventional basin in 2000 and 2004. Fifty percent or more of the annual constituent loads during these years were linked to one or two discharge events. Each of these discharge events was associated with considerable precipitation depths and (or) intensities. These same storms did not contribute as much of the annual load in the conventional basin. With large storms and saturated soils, the ability of low-impact development techniques to reduce runoff, and thus constituent loads, can be greatly diminished.

Relation of Physical Measures of Steamflow Conditions to Ecological Effects of Urbanization in Streams

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Aquatic biological conditions may be influenced by both hydrologic (i.e. magnitude, duration, frequency, rate of change) or hydraulic (i.e. depth, Froude number, shear stress) conditions. In a 2004 NAWQA Effects of Urbanization on Stream Ecosystems study we utilized a 1-dimensional hydraulic model (HEC-RAS) with habitat and continuous stream stage data to calculate hydraulic and hydrologic characteristics at 30 small (11-119 km^2) Western Lake Michigan watersheds. Utilizing correlation and multi-variate regression tree modeling we evaluated the association between aquatic communities (fish, invertebrates, and algae) and two characterizations of hydrologic/hydraulic conditions: 1) hydrologic metrics based upon hourly and daily streamflow data, and 2) hydraulic variables based upon hourly and daily time series resulting from 1-dimensional hydraulic modeling. The hydrologic (flow regime) data foundation had slightly stronger correlation and models (~ 10%) with biology than the hydraulic time series variables. There were, however, individual biologic metrics and periods of record in which the hydraulic data foundation performed best. Conceptually, the hydrologic and hydraulic variables provide insights about the link between watershed change and stream biology. Furthermore, the hydraulic time series variables may provide deterministic or process insight not obtainable from the more general flow regime hydrologic metrics. Hydraulic foundation variables may also respond to modifications at the more immediate reach scale thus providing a potential link between channel modification and biology. In any of the applications, the relations should be considered as one quantification approach in a much larger tool box.

SESSION 4B
Water Resources Planning and Management
Friday, March 7, 2008
10:00 – 11:55 a.m.

Arsenic in Wisconsin's Residential Drinking Water: Planning for Action Grant Summary

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Outagamie and Winnebago Counties, located in Northeastern Wisconsin, have some of the highest arsenic levels found in Wisconsin and over 27,000 private residential wells. An Arsenic Advisory Area (AAA) was developed to decrease the risk of consuming elevated levels of arsenic in well water extracted from the St. Peter Sandstone aquifer. The current Environmental Protection Agency (EPA) maximum contaminant level for arsenic in drinking water is 10 parts per billion (ppb). Within the AAA, over 20% of the private residential wells may contain arsenic levels above the EPA level.

In 2006, a multi-partner collaborative planning grant from the Medical College of Wisconsin, *Healthier Wisconsin Partnership Program* was obtained for the purpose of understanding well water testing preferences, attitudes, and beliefs, with a goal of developing recommendations that would increase the capacity of the environmental health community to comprehensively address elevated arsenic levels in residential drinking water. This planning grant reviewed regulatory and voluntary testing programs, evaluated key indicators of and barriers to testing and behavior change, and conducted interviews with professionals and community members to assess Wisconsin's environment or receptivity to changes in identified regulations, voluntary testing, and outreach. Results of this grant were used to develop recommendations and conclusions to increase the level of arsenic and well water information for residents, to enhance professional capacity and infrastructure at the local level to provide resources and information to residents, and to increase well testing throughout the state.

Understanding Private Well Water Testing in Wisconsin

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Social indicators of private well water testing were explored using a mailed survey study among 1500 Wisconsin residents in 27 towns and 1200 residents across Michigan and Minnesota. Towns were targeted based on residential private well status, arsenic risk and well test outreach. A questionnaire was developed to measure 1) water use and testing behavior, 2) beliefs about water safety, quality and health risks, and 3) information use and preferences. Wisconsin findings will be reported. 1057 out of 1467 eligible (72%) participated. In the Arsenic Advisory Area, a regularly offered arsenic test program was related to higher rates of program testing (42%), compared to a one time program (18%) or no program. Rates of private testing were similar (~40%) across these three conditions. Among participants that tested for arsenic, satisfaction with aesthetic qualities was most strongly related to water quality beliefs (β=.71) and less so with safety beliefs (β=.34). Arsenic test results were related to safety beliefs (β=.31), but not water quality beliefs. Participants indicated that learning their neighbor has a contaminated well or noticing a change in the aesthetic qualities of water would be most likely to prompt them to have their water tested. The most commonly cited barriers to testing were beliefs of 'no problems so far', or not knowing how or what to test for. Other findings will be shared including information preferences, opinions about sharing water test results for state groundwater monitoring, and implications for providing well water testing information to residents.

Centralizing Access to Wisconsin Groundwater Information for Use in Comprehensive Planning

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Wisconsin law requires that by January 1, 2010 all communities that make specified land-use decisions must do so consistent with a comprehensive plan. Groundwater is a recognized factor in all nine required elements of comprehensive plans; much information and data exist to address the role of groundwater in those nine elements. However, many Wisconsin communities, particularly smaller communities, do not have the resources or expertise to locate, evaluate, and incorporate appropriate groundwater information and data in their comprehensive plans. In many instances it is difficult for a community to know where to begin.

To address this problem, an interagency team of 16 federal, state and local agencies has assisted numerous Wisconsin communities in their comprehensive planning by providing groundwater information and data in an accessible and user-friendly manner. Specifically, the interagency team prepared a centralized website housed at *http://wi.water.usgs.gov/gwcomp* and organized into four sections:

- Learn more about how groundwater is used in Wisconsin and what scientific researchers have found about how groundwater moves and how it can be contaminated.
- Integrate groundwater into your community plans using groundwater-specific recommendations and Wisconsin examples for each step of the planning process.
- Find data and policies about groundwater in each of Wisconsin's 72 counties including sources of drinking water, groundwater protection policies, money spent on cleanup, groundwater use, susceptibility of groundwater to pollutants, groundwater quality, and potential sources of contaminants.
- Browse additional resources.

Planning future urban development in Verona based on a hydrologic and ecological resource assessment approach

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The links between aquatic resources and hydrologic alteration have been the subject of considerable recent research, however translating this research into management plans that balance development with ecosystem protection is challenging. The City of Verona is planning future development to be compatible with protecting trout streams and wetlands of the Upper Sugar River and Badger Mill Creek. This effort strikes a balance between simple “rule-of-thumb” approaches and long-term habitat data collection and modeling, seeking to identify the key functional relationships between local hydrology and ecology and producing recommendations for development patterns, intensity and design standards that maintain these processes.

Analysis of existing data and additional monitoring of fish, habitat, streamflow, and water quality, indicate that maintaining stream baseflow is important to support temperature and dissolved oxygen conditions required by trout. Limiting increases in runoff volume is also important for channel stability. We used the soil water balance model RECARGA to quantify the impacts on recharge and runoff for a range of development intensities and soils. This analysis provides the rationale for performance standards for development that maintain groundwater recharge and stormwater runoff at levels protective of the trout fishery. In addition to recharge, future trends in water supply pumping must also be considered in assessing stream baseflow; this is an issue of cumulative impacts that is best addressed by comprehensive regional planning.

Understanding and Mitigating the Water Supply Impacts of Development

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Groundwater withdrawals for water supply are producing increasingly significant impacts on groundwater levels, quality, and flow to springs, wetlands and streams. Although alternative supplies for municipal systems have been evaluated in some areas of the state, procedures for evaluating water supply impacts of new development areas are only now being developed. This paper describes experience in addressing incremental water supply impacts for projects in southern Wisconsin.

The extension of sewer service areas in Dane County has been conditioned on mitigating the adverse impacts on surface water and groundwater resources. Site specific approaches have included measures to mitigate groundwater recharge reduction due to increased imperviousness, as well as impacts resulting from groundwater withdrawal for water supply. Analysis of water supply demand-side initiatives such as low flow plumbing fixtures, rainwater harvesting and greywater reuse indicate that the easier options for water use reduction may be achievable. To date, efforts to reduce water quantity impacts have been limited to sensitive areas adjacent to headwater streams. However, hydrologic modeling results indicate that a regional approach to incremental impacts will be necessary to protect the surface water resources of this region, which covers headwaters areas of three river basins. Significant changes in community priorities, standards and review procedures will be required to implement advanced approaches to improving efficiency.

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