UNIVERSITY OF MINNESOTA

Water Resources Center

COLLEGE OF CONTINUING EDUCATION

*Sponsored by:*

Water Resources Center, University of Minnesota

College of Continuing Education, University of Minnesota

*Cosponsored by:*

Department of Civil Engineering, University of Minnesota

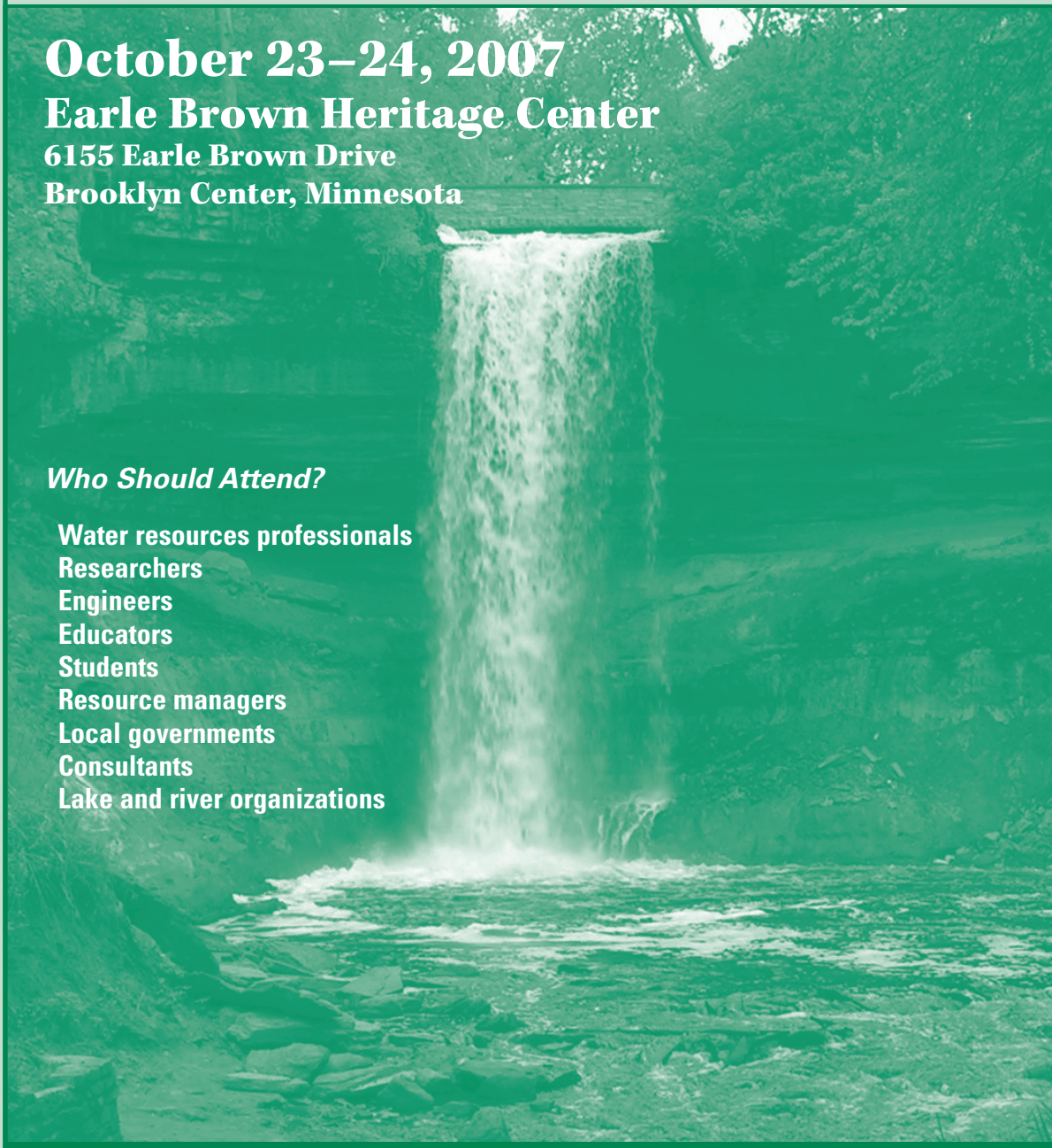
Minnesota Section, American Society of Civil Engineers

Minnesota Sea Grant College Program, University of Minnesota

Natural Resources Research Institute, University of Minnesota

## Final Program and Book of Abstracts

# Minnesota Water Resources Conference



**October 23–24, 2007**

**Earle Brown Heritage Center**
**6155 Earle Brown Drive**
**Brooklyn Center, Minnesota**

***Who Should Attend?***

**Water resources professionals**
**Researchers**
**Engineers**
**Educators**
**Students**
**Resource managers**
**Local governments**
**Consultants**
**Lake and river organizations**

***http://wrc.umn.edu/waterconf/***

# Minnesota Water Resources Conference
## October 23–24, 2007

The ***Minnesota Water Resources Conference*** – formerly called the Minnesota Water and Annual Water Resources Joint Conference – was successfully presented jointly in 2005 and 2006, and will be presented again under the new name in October 2007. This event presents innovative and practical water resource management techniques and highlights research about Minnesota's water resources. The conference provides an opportunity to address current and emerging issues and present on lessons learned and best practices discovered. The conference facilitates interaction among water resources professionals including resource managers; researchers; local, state, and federal agency staff; consultants and practicing engineers; as well as students in the field.

### Continuing Education Units (CEUs); Professional Development Hours (PDHs)

Conference attendees will receive .675 CEUs/PDHs for each day of the Minnesota Water Resources Conference and Pre-Conference Workshop attendees will receive 0.6 CEUs/PDHs. Participants who wish to receive full credit must attend all scheduled hours of the event. Forms will be available.



*Minnehaha Falls (front and back covers)*
*photo by Grace Wilson*
*Interior photos by Patrick O'Leary*

# Next year's Minnesota Water Resources Conference has been tentatively scheduled for October 21–22, 2008

## 2007 Water Resources Planning Committee

| | | |
|---|---|---|
| * | *James Anderson* | Water Resources Center and Department of Soil, Water, and Climate, University of Minnesota |
| | *John Baker* | Department of Soil, Water, and Climate, University of Minnesota |
| | *Tina Carstens* | Ramsey-Washington Metro Watershed District |
| | *Mark Edlund* | St. Croix Watershed Research Station |
| | *Lisa Goddard* | SRF Consulting Group, Inc. |
| | *Lori Graven* | College of Continuing Education, University of Minnesota |
| | *Julie Grazier* | College of Continuing Education, University of Minnesota |
| | *Lorin Hatch* | HDR Engineering, Inc. |
| | *Andrea Hendrickson* | Minnesota Department of Transportation |
| | *Jon Hendrickson* | U.S. Army Corps of Engineers |
| | *Maria Juergens* | Water Resources Center, University of Minnesota |
| | *Steve Kloiber* | Environmental Services, Metropolitan Council |
| | *Ron Leaf* | Short Elliott Hendrickson, Inc. |
| | *Barbara Liukkonen* | Water Resources Center, University of Minnesota |
| | *Randy Neprash* | Minnesota Cities Stormwater Coalition and Bonestroo |
| | *Jennifer L. Olson* | Emmons and Olivier Resources, Inc. |
| | *Wayne Sicora* | Ryan Companies US, Inc. |
| | *Faye Sleeper* | Water Resources Center, University of Minnesota |
| | *Gene Soderbeck* | Minnesota Pollution Control Agency |
| | *Heinz Stefan* | Department of Civil Engineering, University of Minnesota |
| | *Jeff Stoner* | U.S. Geological Survey |
| * | *John Thene* | Wenck Associates, Inc. |
| | *Stew Thornley* | Minnesota Department of Health |
| | *Rick Voigt* | Polaris Group, Inc. |
| | *Bruce Wilson* | Department of Biosystems and Agricultural Engineering, University of Minnesota |
| | *C. Bruce Wilson* | Minnesota Pollution Control Agency |
| | *Greg Wilson* | Barr Engineering Company |
| | *Steve Woods* | Board of Water and Soil Resources |

* Committee Co-Chairs

## Program at a Glance

## Tuesday, October 23, 2007

7:00 a.m. **Registration and Continental Breakfast**

8:00 **Welcome**, *Carriage Hall A*
*James Anderson,* Water Resources Center, University of Minnesota

8:10 **Dave Ford Water Resources Award**, *Carriage Hall A*
**Award Recipient:** *Patrick L. Brezonik,* National Science Foundation and Department of Civil Engineering, University of Minnesota

8:20 **Plenary Session**, *Carriage Hall A*
Moderator: *John Thene,* Wenck Associates, Inc.

**The Colors of a River: Pollution in the Upper Mississippi**
*John Anfinson*, Mississippi National River and Recreation Area (MNRRA), National Park Service

9:30 **Poster Session and Refreshment Break**

**10:00–11:30 CONCURRENT SESSIONS I**

| A *Carriage Hall B* | B *Tack Room* | C *Garden City Ballroom* | D *Harvest Room* |
|---|---|---|---|
| **Lake Management** | **Understanding Impacts on Groundwater** | **Urban Stormwater BMPs: Assessment, Effectiveness, and Performance** | **Trends Up, Down, Flat, or Absent** |

11:30 – 12:15 p.m. **Lunch,** *Carriage Hall A*

12:15 – 1:00 **Luncheon Presentation**
**Of Fire Hoses and Fish Ladders: How Does Information Move in Your Organization?**
*James R. Chiles,* Minnesota Pollution Control Agency and Author of *Inviting Disaster: Lessons from the Edge of Technology*

**1:15–2:45 CONCURRENT SESSIONS II**

| A *Harvest Room* | B *Tack Room* | C *Garden City Ballroom* | D *Carriage Hall B* |
|---|---|---|---|
| **Lake Assessment and Algae Research** | **Quality of Groundwater – An Important Source of Drinking Water for Minnesotans** | **Effectiveness of Storm Water BMPs** | **TMDL Policy: Learning from Recent Experience** |

2:45–3:15 **Poster Session and Refreshment Break**

**3:15–4:45 CONCURRENT SESSIONS III**

| A *Garden City Ballroom* | B *Harvest Room* | C *Carriage Hall A* | D *Tack Room* | E *Carriage Hall B* |
|---|---|---|---|---|
| **Environmentally Sensitive Design in the Aquatic Environment** | **Drinking Water in Minnesota** | **Volume Reduction/ Infiltration** | **Emerging Contaminants** | **Upper Mississippi River - Lake Pepin TMDL** |

4:45–5:45 **Poster Session and Reception,** *Captain's Room*

Join us for the
**Water Conference Poster Session and Reception**
4:45–5:45 p.m. in the Captain's Room

# Program at a Glance

## Wednesday, October 24, 2007

7:00 a.m. **Registration and Continental Breakfast**

8:00 **Welcome**, *Carriage Hall A*
*John Thene,* Wenck Associates, Inc.

8:10 **Plenary Session**, *Carriage Hall A*
Moderator: *James Anderson*, Water Resources Center, University of Minnesota
**Biofuels Production: Implications on Water Quality and Quantity**
*Steve Taff,* Department of Applied Economics, University of Minnesota; *Mark Collins*, HDR Engineering, Inc.

9:30 **Poster Session and Refreshment Break**

| 10:00–11:30 | **CONCURRENT SESSIONS IV** | | |
|---|---|---|---|
| **A** *Harvest Room* | **B** *Carriage Hall B* | **C** *Garden City Ballroom* | **D** *Tack Room* |
| **Management of Stream Habitats** | **Managing and Modeling Water in Agricultural Landscapes** | **Transportation Drainage** | **Sediment and Turbidity Issues Become More Transparent** |

11:30 – 12:15 p.m. **Lunch,** *Carriage Hall A*

12:15–1:00 **Luncheon Presentation**
**The National Water Research Agenda: Dawning of a New Era of Agency Collaboration**
*Patrick L. Brezonik,* National Science Foundation and Department of Civil Engineering, University of Minnesota

| 1:15–2:45 | **CONCURRENT SESSIONS V** | | |
|---|---|---|---|
| **A** *Carriage Hall B* | **B** *Harvest Room* | **C** *Garden City Ballroom* | **D** *Tack Room* |
| **Stream Morphology and Restoration** | **Emerging Issues in Agricultural Water Quality** | **The New Age of Low Impact Development** | **TMDL** |

2:45 – 3:00 **Refreshment Break**

| 3:00–4:30 | **CONCURRENT SESSIONS VI** | | |
|---|---|---|---|
| **A** *Harvest Room* | **B** *Carriage Hall B* | **C** *Garden City Ballroom* | **D** *Tack Room* |
| **Flooding: Information, Communication, Design** | **Landscape and Watershed Management** | **Water Resource Management** | **Managing Urbanization to Minimize Impacts on Stream Temperatures** |

4:30 **Adjourn**

# Program Schedule

## Tuesday, October 23, 2007

8:00 – 8:10 a.m. **Welcome,** *Carriage Hall A*
*James Anderson*, Water Resources Center, University of Minnesota

8:10 – 8:20 **Dave Ford Water Resources Award**, *Carriage Hall A*
Award Recipient: *Patrick L. Brezonik,* National Science Foundation and Department of Civil Engineering, University of Minnesota

8:20 – 9:30 **Plenary Session**, *Carriage Hall A*
Moderator: *John Thene*, Wenck Associates, Inc.

**The Colors of a River: Pollution in the Upper Mississippi**
*John Anfinson,* Mississippi National River and Recreation Area (MNRRA), National Park Service

9:30 – 10:00 **Break**

10:00 – 11:30 **CONCURRENT SESSIONS I**

### Track A *Carriage Hall B*

**Lake Management**
Moderator: *Lorin Hatch*
Co-Moderator: *Mark Edlund*

**St. Paul Regional Water Services and Vadnais Lake Area Water Management Organization Watershed Restoration Program**
*David Schuler,* St. Paul Regional Water Services; *Stephanie McNamara,* Vadnais Lake Area Water Management Organization

**Phosphorus Binding Elements in Lake Sediment: Implications for Lake Nutrient Management**
*Brian Huser* and *Keith Pilgrim,* Barr Engineering Company

**One-Dimensional Lake Modeling for the Evaluation of Impaired Waters: Implications for TMDLs**
*Keith Pilgrim,* Barr Engineering Company

### Track B *Tack Room*

**Understanding Impacts on Groundwater**
Moderator: *Barbara Liukkonen*
Co-Moderator: *Heinz Stefan*

**Minnesota Geochemical Database**
*Harvey Thorleifson* and *Rich Lively,* Minnesota Geological Survey; *Mindy Erickson,* Minnesota Pollution Control Agency; *Andrew Grosz,* U.S. Geological Survey

**Groundwater Recharge from a Changing Landscape**
*Timothy Erickson* and *Heinz Stefan,* University of Minnesota

**Evaluating Infiltration of Storm Water in Wellhead Protection Areas**
*Stephen Robertson, Art Persons, Terry Bovee,* Minnesota Department of Health

### Track C *Garden City Ballroom*

**Urban Storm Water BMPs: Assessment, Effectiveness, and Performance**
Moderator: *Randy Neprash*
Co-Moderator: *Tina Carstens*

**A Robust Method for Performance Assessment of Proprietary Underground Devices**
*Omid Mohseni* and *John Gulliver,* University of Minnesota

**Investigation of Sediment Sampling Effectiveness**
*John Gulliver* and *Missy Gettel,* University of Minnesota

**Reducing the Uncertainty in the Calculations of Street Cleaner Performance for Wisconsin Municipalities**
*Roger Bannerman,* Wisconsin Department of Natural Resources

### Track D *Harvest Room*

**Trends Up, Down, Flat, or Absent**
Moderator: *Steve Woods*
Co-Moderator: *C. Bruce Wilson*

**Three Decades of Water Quality Change (1976-2005) in the Mississippi National River and Recreation Area**
*Suzanne Magdalene,* St. Croix Watershed Research Station; *Brenda Moraska Lafrancois,* National Park Service; *D. Kent Johnson,* Metropolitan Council

**Modern-Day and Historical Sediment Transport in the St. Croix River, MN/WI: Preliminary Analysis and Implications for Native Mussel Populations**
*Kelly MacGregor, Dan Hornbach,* and *Mark Hove,* Macalester College

**Tracking Statewide Urban Changes 1990-2000 and Implications for Watershed Management**
*Bruce Wilson* and *Mike Walerak,* Minnesota Pollution Control Agency; *Marvin Bauer* and *Brian Loeffelholz,* University of Minnesota

11:30 – 12:15 p.m. **Lunch**, *Carriage Hall A*

12:15 – 1:00 **Luncheon Presentation**
**Of Fire Hoses and Fish Ladders: How Does Information Move in Your Organization?**
*James R. Chiles,* Minnesota Pollution Control Agency and Author of *Inviting Disaster: Lessons form the Edge of Technology*

## 1:15 – 2:45 CONCURRENT SESSIONS II

### Track A *Harvest Room*

**Lake Assessment and Algae Research**
Moderator: *Wayne Sicora*
Co-Moderator: *Lorin Hatch*

**Microcystin Levels in Eutrophic South Central Minnesota Lakes**
*Matt Lindon* and *Steven Heiskary,* Minnesota Pollution Control Agency

**New Ballast Water Treatment Technologies: Are We Killing Potentially Invasive Algae?**
*Euan Reavie,* University of Minnesota, Duluth

**National Lakes Assessment Project (NLAP): Enhancements for Minnesota**
*Steven Heiskary,* Minnesota Pollution Control Agency

### Track B *Tack Room*

**Quality of Groundwater, an Important Source of Drinking Water for Minnesotans**
Moderator: *Jeff Stoner*
Co-Moderator: *Barbara Liukkonen*

**PFCs in Ambient Shallow Groundwater in Minnesota**
*Mindy Erickson, Laura Solem, Andrew Streitz, Jim Stockinger, Mark Ferrey,* Minnesota Pollution Control Agency

**Organic Compounds in Source Water and Treated Water from Public Supply Wells, Twin Cities Metropolitan Area, Minnesota and Wisconsin**
*James Stark, Greg Delzer, Chris Hoard, Lan Tornes, Eric Smith,* U.S. Geological Survey

**Social Dimensions of Private Well Testing: Why Don't People Test Their Well Water?**
*Barbara Liukkonen and Eleonore Wesserle,* University of Minnesota

### Track C *Garden City Ballrm*

**Effectiveness of Storm Water BMPs**
Moderator: *Ron Leaf*
Co-Moderator: *Greg Wilson*

**Assessing the Effectiveness of Vegetated Buffers Using Simulated Residential Runoff**
*Sarah Stai,* Westwood Professional Services

**Collection of Total Mercury and Production of Methylmercury in Constructed Stormwater Wetlands**
*Bruce Monson,* Minnesota Pollution Control Agency

**Fish and Minnows Influence Phosphorus Loading from Stormwater Ponds**
*Steve McComas,* Blue Water Science

### Track D *Carriage Hall B*

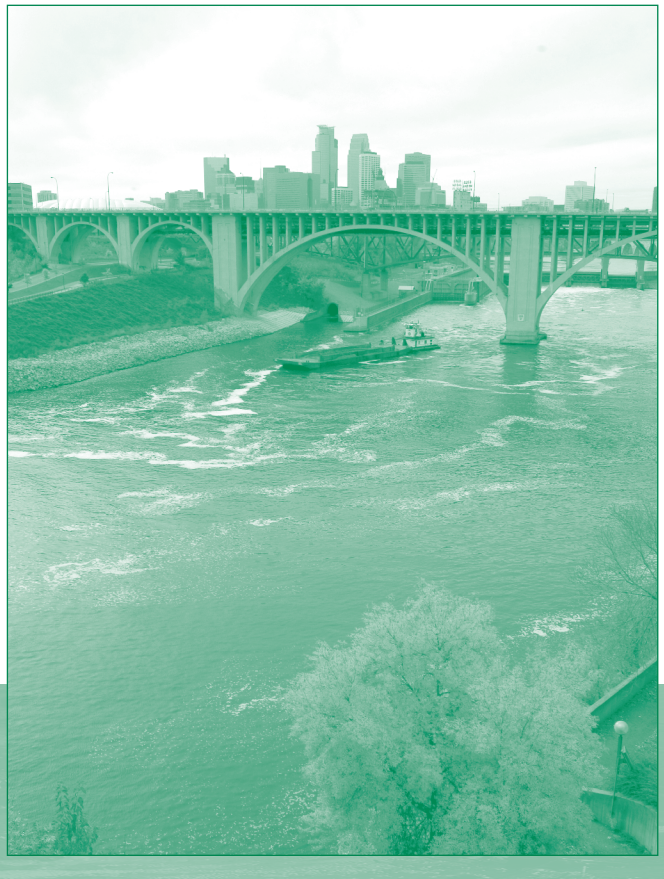
**TMDL Policy: Learning from Recent Experience**
Moderator: *Faye Sleeper*
Co-Moderator: *Lisa Goddard*

**MPCA Statewide Mercury TMDL Approval Process**
*Marvin Hora,* Minnesota Pollution Control Agency

**What Makes a Good TMDL for Urban Storm Water? - Lessons Learned**
*Michael Trojan, Timothy Larson,* and *Jeff Risberg,* Minnesota Pollution Control Agency

**TMDL and Clean Water Legacy from the Local Perspective**
*Kitty Tepley,* Todd Soil and Water Conservation District

2:45 – 3:15 **Break**



## 3:15 – 4:45 CONCURRENT SESSIONS III

### Track A *Garden City*

**Environmentally Sensitive Design in the Aquatic Environment**
Moderator: *Rick Voigt*
Co-Moderator: *John Thene*

**Opening up the River—A Multi-Purpose Approach Heiberg Dam Reconstruction, Fish Mitigation and Ice Control Project, Twin Valley, MN**
*Jerry Bents,* Houston Engineering, Inc. and *Dave Friedl,* Minnesota Department of Natural Resources

**Expedited Design and Construction of Judicial Ditch-2 Stream Restoration**
*Peter MacDonagh,* The Kestrel Design Group; *Ed Matthiesen,* Wenck Associates, Inc.

**Canisteo Mine Pit Outflow - Hydraulic Design of a Long Flat Siphon**
*John Thene,* Wenck Associates, Inc.

### Track B *Harvest*

**Drinking Water in Minnesota**
Moderator: *Stew Thornley*
Co-Moderator: *Nels Nelson*

**Targeting Management Strategies to Protect Mississippi River Water**
*Charles Regan,* Minnesota Pollution Control Agency and *Lisa Vollbrecht,* City of St. Cloud

**Twin Cities Area Water Supplies: Planning for Availability**
*Lanya Ross,* Metropolitan Council

**Source Water Protection Case Studies: What Are Municipal Public Water Suppliers Doing to Protect Their Drinking Water?**
*Terry Bovee,* Minnesota Department of Health

### Track C *Carriage A*

**Volume Reduction/ Infiltration**
Moderator: *Gene Soderbeck*
Co-Moderator: *Jennifer Olson*

**Volume Reduction BMPs to Address Flooding and Water Quality Problems in the Capitol Region Watershed District, St. Paul, Minnesota**
*Bob Fossum,* Capitol Region Watershed District and *Mark Doneux*

**Monitoring the Effectiveness of an Infiltration Trench**
*Jennifer Olson* and *Camilla Correll,* Emmons & Olivier Resources, Inc.

**Monitoring Success of Infiltration Requirements—Combining Regulation with Outreach, Demonstration and Assistance**
*Paul Moline,* Carver County

### Track D *Tack Room*

**Emerging Contaminants**
Moderator: *Steve Kloiber*
Co-Moderator: *Steve Woods*

**Gaps and Opportunities for Addressing Emerging Issues in Minnesota**
*Judy Crane, Mark Ferrey, Laura Solem, Steven Hennes, Angela Preimesberger, Catherine O'Dell,* and *Paul Hoff,* Minnesota Pollution Control Agency

**Wastewater Treatment Plant Effluent Reduces Male Competitive Reproductive Success in Fathead Minnows but Has Little Effect on Females**
*Candice Lavelle, Dalma Martinovic,* and *Peter Sorensen,* University of Minnesota

**Can Rural Communities Comply with the New Standard for Arsenic in Drinking Water?**
*K. William Easter* and *Yoshifumi Konishi,* University of Minnesota; *Yongsung Cho*, Korea

### Track E *Carriage B*

**Upper Mississippi River - Lake Pepin TMDL**
Moderator: *C. Bruce Wilson*

**Water Quality Model for the Support of the Upper Mississippi River - Lake Pepin TMDL: An Update**
*Joseph DePinto,* Limno-Tech, Inc.

4:45 – 5:45 **Poster Session and Reception,** *Captain's Room*

## Program Schedule

### Wednesday, October 24, 2007

8:00 – 8:10 a.m. **Welcome**, *Carriage Hall A*
*John Thene*, Wenck Associates, Inc.

8:10 – 9:30 **Plenary Session**, *Carriage Hall A*
Moderator: *James Anderson*, Water Resources Center, University of Minnesota

**Biofuels Production: Implications on Water Quality and Quantity**
*Steve Taff,* Department of Applied Economics, University of Minnesota; *Mark Collins,* HDR Engineering, Inc.

9:30 – 10:00 **Break**

10:00 – 11:30 **CONCURRENT SESSIONS IV**

#### Track A *Harvest Room*

**Management of Stream Habitats**
Moderator: *Bruce Wilson*
Co-Moderator: *Ron Leaf*

**Forest Harvest Effects on a Northern Minnesota Stream System: Nine Years Later**
*Eric Merten, Raymond Newman, Bruce Vondracek,* University of Minnesota; *Nat Hemstad,* Inver Hills Community College; *Lucinda Johnson,* University of Minnesota, Duluth*; Randall Kolka, Sandy Verry, Sue Eggert,* U.S. Forest Service

**Completing the Incidental Take Permit Process for the Endangered Topeka Shiner**
*Jeff Madejczyk,* Wenck Associates, Inc.; *Dennis Healy,* Lincoln Pipestone Rural Water

**Using a Dimensionless Multivariate Analysis Technique to Explore the Landscape Influence on Stream Ecosystem Health**
*Mark Green, Dario Canelon-Sanchez, Bruce Wilson*, University of Minnesota; *Bruce Vondracek,* U.S. Geological Survey, Minnesota Cooperative Fish and Wildlife Research Unit, and University of Minnesota

#### Track B *Carriage Hall B*

**Managing and Modeling Water in Agricultural Landscapes**
Moderator: *Les Everett*
Co-Moderator: *Kevin Blanchet*

**Drainage Water Management to Reduce Edge-Of-Field Nitrate Loss in Southwest Minnesota**
*Stacey Burns* and *Jeffrey Strock,* University of Minnesota

**Ditch Management to Mitigate Nonpoint Source Pollution**
*Jeffrey Strock,* University of Minnesota

**Simulation of Storm Runoff Using the Gridded Surface Subsurface Hydrologic Analysis (GSSHA) Model**
*Brennon Schaefer,* Houston Engineering, Inc.; *Greg Eggers,* TetraTech, EM; *John Nieber,* University of Minnesota

#### Track C *Garden City Ballrm*

**Transportation Drainage**
Moderator: *Andrea Hendrickson*
Co-Moderator: *Wayne Sicora*

**Storm Sewer Pipe Dreams: The Challenge of Delineating Urban Watersheds**
*Steve Kloiber,* Metropolitan Council

**Pervious Pavements: An Emerging Technology in Minnesota for Storm Water Management**
*Bernard Izevbekhai* and *Shongtao Dai,* Minnesota Department of Transportation

**Minnesota Local Road Research Board (LRRB): Investigating Water Resources Issues and Improving Storm Water Management**
*Alan Rindels,* Local Road Research Board; *Krysten Saatela,* Minnesota Department of Transportation

#### Track D *Tack Room*

**Sediment and Turbidity Issues Become More Transparent**
Moderator: *Greg Wilson*
Co-Moderator: *Suzanne Jiwani*

**River Turbidity and the Optics of Suspended Sediment**
*Robert Megard,* University of Minnesota

**Sediment and Nutrient Load Measurements in Western Lake Superior Streams: In-Stream Turbidity Sensors Versus Grab Sampling and Modeling**
*Elaine Ruzycki, Richard Axler, Jerald Henneck, Norm Will, George Host,* University of Minnesota, Duluth

**Determining "Normal" Levels of Fine Sediments in Lake Superior North Shore Streams Using Aquatic Macroinvertebrates**
*Valerie Brady* and *Dan Breneman*, University of Minnesota, Duluth; *Nathan Schroeder,* South Saint Louis Soil and Water Conservation District

11:30 – 12:15 p.m. **Lunch,** *Carriage Hall A*

12:15 – 1:00 **Luncheon Presentation**
**The National Water Research Agenda: Dawning of a New Era of Agency Collaboration**
*Patrick L. Brezonik,* National Science Foundation and Department of Civil Engineering, University of Minnesota

## 1:15 – 2:45 CONCURRENT SESSIONS V

### Track A *Carriage Hall B*

**Stream Morphology and Restoration**
Moderator: *John Thene*
Co-Moderator: *Andrea Hendrickson*

**The University of Minnesota Multi-Purpose Riparian Demonstration Project**
*Christian Lenhart, Kenneth Brooks, Dean Current, Craig Sheaffer,* and *Joseph Magner,* University of Minnesota; *Linda Meschke*, Rural Advantage, Inc.

**Evaluating the Morphodynamic Evolution of a Semi-Urbanized Stream: Riley Creek, Minnesota**
*Miguel Wong, Janna Kieffer,* and *Jeff Weiss,* Barr Engineering Company

**Quarry Hill Ravine and Streambank Stabilization**
*Jonathon Kusa,* Howard R. Green Company; *Marty Melchior,* Inter-Fluve, Inc.; *Barbara Huberty,* Rochester Public Works Department

### Track B *Harvest Room*

**Emerging Issues in Agricultural Water Quality**
Moderator: *John Baker*
Co-Moderator: *Jeff Stoner*

**Antibiotic Transport in Percolation and Runoff from Manure-Amended Soil**
*Holly Dolliver* and *Satish Gupta,* University of Minnesota

**A Link Between Pesticides and Nitrate-Nitrogen in Groundwater**
*John Hines,* Minnesota Department of Agriculture

**A Fluid Success Story: Conservation Implementation in the Redwood and Cottonwood River Watersheds of the Minnesota River Basin. A Reflection of Twenty-four Years in a Successful JPO Partnership.**
*James Doering,* Redwood-Cottonwood Rivers Control Area

### Track C *Garden City Ballrm*

**The New Age of Low Impact Development**
Moderator: *Tina Carstens*
Co-Moderator: *Ron Leaf*

**Volume Reduction and Sustainable Design at the Washington County South Service Center**
*Erin Krueger, Dan Cazanacli, Veronica Anderson,* SEH, Inc.

**Evaluation of the Effectiveness of Low-Impact Design Practices**
*William Selbig,* U.S. Geological Survey

**Calculation of Stormwater Credits for Low Impact Development Techniques**
*Lorin Hatch,* HDR Engineering, Inc.; *Paul Nelson,* Scott Watershed Management Organization

### Track D *Tack Room*

**TMDL**
Moderator: *Gene Soderbeck*
Co-Moderator: *Mark Edlund*

**Establishing Site-Specific Water Quality Targets for TMDLs in a Large Urban Watershed: The Lake Minnetonka Drainage**
*Mark Edlund* and *Joy Ramstack,* St. Croix Watershed Research Station; *Lorin Hatch,* HDR Engineering, Inc.

**Biological Endpoints For Shallow Lake TMDLs**
*Joe Bischoff,* Wenck Associates, Inc.; *Steve McComas,* Blue Water Science

**North Branch of the Sunrise River Fecal Coliform TMDL**
*Andrea Plevan,* Emmons & Olivier Resources, Inc.; *Jerry Spetzman,* Chisago County

2:45 – 3:15 **Break**

## 3:00 – 4:30 CONCURRENT SESSIONS VI

### Track A *Harvest Room*

**Flooding: Information, Communication, Design**
Moderator: *Jon Hendrickson*
Co-Moderator: *Steve Kloiber*

**Estimating the Magnitude and Frequency of Annual Maximum Flow for Unregulated Streams in Minnesota**
*Dave Lorenz* and *Chris Sanocki,* U.S. Geological Survey

**Development of the Red River Basin Decision Information Network (RRBDIN) Flood Forecast Display Tool (FFDT)**
*Christy Shostal,* Houston Engineering, Inc.

**The Fish Creek Project: A History of Restoration, Flood Damage, and Reconstruction**
*Clifton Aichinger,* Ramsey-Washington Metro Watershed District; *Brad Lindaman,* Barr Engineering Company

### Track B *Carriage Hall B*

**Landscape and Watershed Management**
Moderator: *David Mulla*
Co-Moderator: *Jim Anderson*

**Using Small-Plot Research Information to Guide Development of Agricultural Management Research at the Watershed Scale**
*Gyles Randall,* University of Minnesota

**Comparison of Water Quantity and Quality Between Subsurface Tile and Edge-of-Field Runoff from a Wisconsin Agricultural Landscape**
*Dennis Frame,* University of Wisconsin, Extension

**Property Tax Credits as a Tool for Watershed Management: Results of a Wisconsin Pilot Project**
*Mike Kinney,* Prior Lake-Spring Lake Watershed District

### Track C *Garden City Ballrm*

**Water Resource Management**
Moderator: *Lisa Goddard*
Co-Moderator: *Randy Neprash*

**Guidance for Scope and Effect and Hydrology (Well) Studies to Support Wetland Delineation in Minnesota and the Upper Midwest**
*James Arndt,* Natural Resource Group, Inc.; *Sandy Verry,* Ellen River Partners, Inc.

**Integrated Water Resource Management: Minneapolis' New Approach to Controlling Impacts of CSOs, Inflow/Infiltration, Stormwater, and TMDLs**
*Lois Eberhart, Rhonda Rae, H.R. "Bo" Spurrier*, City of Minneapolis Public Works; *Jodi Polzin,* Camp Dresser & McKee, Inc.

**Lakesuperiorstreams.org: Making Storm Water and Stream Data Come Alive for Citizens, Students, Teachers, Contractors, Resource Agencies, Decision Makers, and Scientists**
*Richard Axler, George Host, Norm Will, Jerald Henneck, Jane Reed, Elaine Ruzycki,* and *Gerald Sjerven*, University of Minnesota, Duluth; *Cynthia Hagley* and *Jesse Schomberg,* University of Minnesota, Duluth; *Marnie Lonsdale* and *Todd Carlson,* City of Duluth

### Track D *Tack Room*

**Managing Urbanization to Minimize Impacts on Stream Temperatures**
Moderator: *Heinz Stefan*
Co-Moderator: *John Baker*

**Predicting Thermal Impact: Application of an Urban Storm Water Model to a Housing Development in Plymouth, Minnesota**
*Ben Janke, William Herb, Omid Mohseni,* and *Heinz Stefan*, University of Minnesota

**Temperature Trading in the Vermillion River**
*Jay Coggins* and *Yoshifumi Konishi,* University of Minnesota

**Scientific Tools for Creating a Market-Regulatory Framework for Temperature in the Vermillion River Watershed, Minnesota**
*Kim Alan Chapman and Rio Roland,* Applied Ecological Services, Inc.

4:30 **Adjourn**

## Poster Display

*The following posters will be displayed in the Captain's Room during the breaks and during the Tuesday reception.*

**Meeting No Net Loss at a Landscape Scale for Future Land-Use Alternatives**
*Melissa Arikian* and *Jason Naber*, Emmons & Olivier Resources, Inc.

**Stormwater Management Structure Maps for Mosquito Control**
*Kyle Beadle, Jon Peterson,* and *Nancy Read*, Metropolitan Mosquito Control District

**Heron Lake Watershed District Conservation Tillage Demonstration Project: Education and Citizen Involvement in Water Resources**
*Ross Behrends,* Heron Lake Watershed District and *Chris Bauer*, Heron Lake Watershed District

**Use Water Conservation Toolbox**
*Sara Bertelsen*, Metropolitan Council

**A Watershed-Wide Stream Habitat Survey and Infrastructure Inventory for Restoration Prioritization**
*Doug Bradley, Michele Koehler* and *Michael Sullivan*, LimnoTech; *Mary Searing*, Anne Arundel County, Maryland

**Effects of Macroinvertebrate Availability, Diet, and Habitat on Reintroduction Success of Slimy Sculpin in Southeast Minnesota**
*Rebecca Bronk*, University of Minnesota

**Rainwater Gardens and Native Plantings Protect High Quality Wetlands in a Low Impact Development, St. Cloud, Minnesota**
*Amy Carolan*, *Stan Hanson*, and *John Smyth*, Bonestroo

**Lake Sweeney Shoreland Restoration: How Teamwork Leads to Success**
*Deric Deuschle*, SEH, Inc.; *Cathy McCarty*, Minneapolis Clinic of Neurology, Ltd.; *Al Lundstrom*, City of Golden Valley

**Risk Assessment in a World Without Boundaries**
*Christopher Greene*, *Helen Goeden*, and *Paul Moyer*, Minnesota Department of Health

**Wetland Delineation of Problem and Atypical Areas**
*Wayne Jacobson*, Jacobson Environmental, PLLC

**Making Sense of Chaotic Water Quality Data for a Well-Head Protection Area Assessment Project**
*Heather Johnson*, *Mark Zabel*, *Bruce Montgomery*, and *Don Sirecuk*, Minnesota Department of Agriculture

**The Phosphorous Source Assessment Tool: A Tool for Education and Watershed Planning**
*Ann Lewandowski*, *John Moncrief*, *Carl Rosen*, University of Minnesota; *Norman Krause*, Central Lakes College; *Bruce Montgomery*, Minnesota Department of Agriculture

**Possible Effects of Arsenic in Drinking Water on Dairy and Beef Products**
*Barbara Liukkonen*, *Vince Crary*, *Michael Murphy*, and *James Linn*, University of Minnesota; *Melinda Erickson*, Minnesota Pollution Control Agency

**Effects of Estrogens on Fecundity, Survival, and Embryonic Development in Daphnia Magna**
*Timothy G. Loes II* and *Heiko L. Schoenfuss*, St. Cloud State University

**Constructed Wetlands Provide Storm Water Management and Mitigate Thermal Inputs of Urban Runoff to a Premiere Trout Resource**
*Corey Markfort* and *Rich Brasch*, Bonestroo

**Is Effective and Economical Storm Water Management Treatment for Intensive In-Fill Developments Possible? Yes!**
*William McCully*, Rehbein Environmental Solutions, Inc.

**Effects of Emerging Contaminant Exposures on Innate Behaviors of Larval Fathead Minnows**
*Meghan R. McGee*, *Kent J. Grove*, and *Heiko L. Schoenfuss*, St. Cloud State University

**Stop, Think, and Drink: Protecting Health Through Assessing the Risk of Groundwater Contaminants**
*Paul Moyer*, *Helen Goeden*, and *Christopher Greene*, Minnesota Department of Health

**Multi-Scale Quantitative Mapping of Recharge/Discharge to Ground Water Systems as Related to Freshwater Sustainability in Minnesota**
*John Nieber*, *Roman Kanivetsky*, *Bruce Wilson*, and *David Mulla*, University of Minnesota; *Boris Shmagin*, South Dakota State University

**Adaptation of the Watershed Model SWAT (Surface Water Assessment Tool) to Water Quality Improvement in the Wild Rice River Basin**
*Jonathan Petersen*, University of Minnesota

**An Inexpensive Flow-Proportional Sampler for Tipping Buckets**
*Michael Russelle* and *Warren Rugger, Jr.*, USDA-ARS

**Incorporating Risk and Uncertainty for Evaluating Infiltration and Volume Control**
*Wesley Saunders-Pearce*, Houston Engineering, Inc.

**A Water-Based Nitrogen Budget for the University of Minnesota St. Paul Campus**
*Erica Schram* and *Jim Perry*, University of Minnesota

## Poster Display, continued

**Saving a Desert Lake: The Role of Modeling in Reversing the Decline of Walker Lake, Nevada**
*Ted Shannon*, HDR Engineering, Inc.

**New Mexico State University Study Investigating Various Approaches to Irrigating Turf Grass**
*Brett Shroyer*, Rehbein Environmental Solutions, Inc.

**Precipitation Data Retrieval Tool for Wetland Delineation Efforts**
*Greg Spoden*, Minnesota Department of Natural Resources

**Mn/DOT Metro District's MS4 Program**
*Kellie Thom* and *Barb Loida*, Minnesota Department of Transportation

**Watonwan River Watershed Citizen Stream Monitoring, 2000-2006**
*Bill Thompson*, Minnesota Pollution Control Agency

**Spatial and Temporal Variation of Mercury in Minnesota Streams and Rivers**
*Martin Tsui*, *Edward Nater*, and *Jacques Finlay*, University of Minnesota

**Use of Minnesota's Renewable Water Resources: Moving Toward Sustainability**
*Princesa Van Buren* and *John Wells*, Minnesota Environmental Quality Board

**Results From Seven Years of Groundwater Monitoring for Agricultural Chemicals in the Sand Plains of Central Minnesota**
*Mark Zabel* and *John Hines*, Minnesota Department of Agriculture

# Minnesota Water Resources Conference

October 23–24, 2007

Earle Brown Heritage Center

6155 Earle Brown Drive

Brooklyn Center, Minnesota

# Book of Abstracts

**Arranged by session in order of presentation**

**Index of first authors on page 73**

# Contents

## Plenary Session 8:20 – 9:30

### The Colors of a River: Pollution in the Upper Mississippi

John Anfinson, Mississippi National River and Recreation Area, National Park Service

## Concurrent Sessions I 10:00 – 11:30

## Track A: Lake Management

### St. Paul Regional Water Services and Vadnais Lake Area Water Management Organization Watershed Restoration Program

David Schuler, St. Paul Regional Water Services, dave.schuler@ci.stpaul.mn.us, and Stephanie McNamara, Vadnais Lake Area Water Management Organization

The Saint Paul Regional Water Services (SPRWS) serves over 415,000 customers. The single treatment facility receives source water from a chain of reservoirs that are augmented with water from the Mississippi River and local watersheds. VLAWMO is a joint powers organization that governs the 24 square mile watershed in the northeast twin city area that drains to Vadnais Lake; the final impoundment reservoir for the SPRWS.

In 1984 SPRWS initiated an intensive diagnostic study of the source water reservoir system and contributing watersheds. The results of the study indicated that phosphorus enrichment of the reservoirs caused water-treatment problems. Identified sources of phosphorus loads into the reservoir system included the Mississippi River, internal loads from lake sediments and drainage from local watersheds – primarily Lambert Creek.

Phosphorus (P) loadings from the Mississippi River source and reservoir sediments were addressed by capital projects funded by SPRWS in the form of chemical feed applications and hypolimnetic aerators in two reservoirs. In 1989 the Vadnais Lake Area Watershed Management Organization initiated a Clean Water Partnership with funding from Minnesota Pollution Control Agency and later the Section 319 funding from the US Environmental Protection Agency. The project resulted in stop-log weir construction that was completed on two of the wetlands along Lambert Creek in 1995 in an effort to restore them to their former hydrology.

Further reductions in P loading are desirable for improved water quality in Vadnais Lake. Lambert Lake, the final wetland in the Lambert Creek watershed, provides an opportunity, via ponding, flow dispersion, and infiltration to reduce the P loadings to Vadnais Lake. However, the project site has many constraints due to the flat topography and lack of flood protection for several homes. An innovative approach was taken in the restoration of Lambert Lake involving the diversion of the ditch system through a low-head weir, the promotion of sheet flow through the wetland, and the addition of aluminum/iron compounds.

### Phosphorus Binding Elements in Lake Sediment: Implications for Lake Nutrient Management

Brian Huser, Barr Engineering Co., huse0002@umn.edu and Keith Pilgrim, Barr Engineering Co.

Considerable attention has been paid to the application and dosing of phosphorus binding elements to limit internal cycling of phosphorus in lakes. Dosing has progressed from being based on unrelated factors to specific binding ratios needed to convert the entire phosphorus pool that contributes to internal loading to a more inert form. The ability to fine tune any one dosing method to reduce internal loading by a specific amount, however, is lacking. This study presents a method to do just that; calculate a dose to reduce available sediment phosphorus an equivalent amount to reach a required internal phosphorus loading goal. Using the method developed in this study, and accurate lake modeling detailing the transfer of phosphorus from the sediment into the active area of the water column (epilimnion), lake managers will be able to calculate how much alum, for example, is needed to reduce internal phosphorus loading in a lake by a specified amount. Differences between the use of iron, aluminum and calcium will also be discussed.

## Concurrent Sessions I 10:00 – 11:30

### Track A: Lake Management, *continued*

**One-Dimensional Lake Modeling for the Evaluation of Impaired Waters: Implications for TMDLs**

Keith Pilgrim, Barr Engineering Co., kpilgrim@barr.com

The impending need to properly diagnose nutrient-impaired waters will likely require more sophisticated approaches. The primary problem is determining the relative contribution of internal phosphorus loads and external phosphorus loads to phosphorus concentrations in the surface water during the summer growing season. This is particularly important for lake and reservoir TMDLs because nutrient impairment is based upon summer average phosphorus levels (as well as Secchi disc depth and Chl-a concentration). Most currently available and commonly used lake models do not have the sophistication necessary to properly evaluate the required time scale (summer conditions) or determine the true effect of internal and external phosphorus loads on surface concentrations.

The desired outcome of this presentation is to demonstrate how a one-dimensional lake model called DYRESM/CAEDYM can be used to accurately evaluate the relative contribution of internal and external phosphorus loads to phosphorus levels in surface waters. Advances in the understanding of lake sediment chemistry, the spatial distribution of releasable phosphorus in lake sediments, and effective methods to inhibit internal loading are now coming to a point where there will be significant improvement in diagnostic methods. One-dimensional modeling will be necessary to make use of this emerging science. This presentation will demonstrate the use of the DEYRESM/CAEDYM model for three lakes located in Minnesota and Wisconsin. Subjects that will also be discussed include data requirements, calibration, and model deficiencies.

## Concurrent Sessions I 10:00 – 11:30

### Track B: Understanding Impacts on Groundwater

#### Minnesota Geochemical Database

Harvey Thorleifson, Minnesota Geological Survey (MGS), thorleif@umn.edu, Mindy Erickson, Minnesota Pollution Control Agency (MPCA), Rich Lively, Minnesota Geological Survey (MGS), and Andrew Grosz, US Geological Survey (USGS)

Soil and water geochemical data that are statewide, consistent, available, and documented are needed to help clarify what is contamination and what is background. MPCA conducted a statewide groundwater baseline study in the 1990s, USGS has provided statewide soil geochemical data based on limited analysis of A horizon soil at a ~75 km spacing, and MGS recently released statewide data for C horizon till at a 40 km spacing. USGS will, however, soon complete analysis of soil samples at a 15 km spacing on all parent materials, based on archival samples in western Minnesota, and new sampling in eastern Minnesota. These agencies are presently cooperating to enhance the accessibility of these databases, to serve as a guide to interpretation on the regional scale, and to place more detailed sampling into a regional context. The compilation also will support planning for the Minnesota role in the next phase of national soil sampling led by USGS, to be based on soil at a 40 km spacing, and focusing on public health.

#### Groundwater Recharge from a Changing Landscape

Timothy O. Erickson, University of Minnesota, eric1003@umn.edu, and Heinz G. Stefan, University of Minnesota

An investigation on the change of groundwater recharge associated with urbanization of rural and natural areas was conducted on the Vermillion River watershed, located south-east of the Twin Cities, in Minnesota. The investigation included a review of methods used to estimate groundwater recharge including: two methods using stream records, a recharge map developed for the USGS (Lorenz and Delin, 2006), a recharge map developed for the MNGS (Ruhl et al. 2002), and various soil water budget methods.

Two models were developed using the soil-water budget methods and a case study was performed on a small tributary watershed (area of 1675.3 acres (6.78 $km^2$)). The case study shows that a projected 18% increase of impervious area can decrease natural recharge (as a fraction precipitation) from 0.17 ± 0.05 to 0.12 ± 0.02, decreasing recharge by ~30% to 40% seasonally. A change of this magnitude could substantially affect the water supply to the shallow aquifer which discharges into the cold water stream.

#### Evaluating Infiltration of Storm Water in Wellhead Protection Areas

Stephen W. Robertson, Minnesota Department of Health, steve.robertson@state.mn.us; Art Persons, Minnesota Department of Health, and Terry L. Bovee, Minnesota Department of Health

Storm water management is a key concern in urban or suburban areas and in developing communities where impervious surfaces begin to replace natural ground cover. Infiltration is widely promoted in such areas because it is a practice with demonstrated long-term value in addressing a wide range of storm water issues. Its use is encouraged in most settings.

However, infiltration practices redirect storm water into the subsurface, where it becomes groundwater. As most people in Minnesota use groundwater as a source of drinking water, and as storm water runoff may carry with it contaminants that can lead to adverse health effects, it is important to plan infiltration projects with care, especially in vulnerable wellhead protection areas.

One of the goals of wellhead protection planning is to manage a well's recharge area in a manner consistent with safeguarding the drinking water supply. Infiltration of possible contaminated water is clearly a potential threat, so the Minnesota Department of Health has recently developed guidelines for evaluating infiltration projects proposed in wellhead protection areas. This presentation will review this guidance, with particular emphasis on vulnerable wellhead areas, such as those with aquifers characterized by coarse soils or secondary porosity features.

## Concurrent Sessions I 10:00 – 11:30

## Track C: Urban Storm Water BMPs: Assessment, Effectiveness, and Performance

### A Robust Method for Performance Assessment of Proprietary Underground Devices

Omid Mohseni, University of Minnesota, omohseni@umn.edu and John Gulliver, University of Minnesota

Underground proprietary devices have become popular stormwater BMPs in urban areas because of their small footprints. For more than a decade they have been monitored by different agencies and consulting firms to verify their capabilities in removing suspended solids. The disparity among the results of field monitoring studies has been so drastic that it has made it difficult to assess the performance of these devices.

A simple repeatable laboratory testing method was developed in 2005 to evaluate these devices under treatment flow conditions. In 2006, the laboratory testing was expanded to assess the performance of these devices in the field, and in 2007, new method of field testing began to assess the performance of these devices under high flow conditions.

In this presentation, the results of laboratory testing of two devices and field testing of four other devices will be presented. In addition, the preliminary results of field tests under high flow conditions will be discussed.

### Investigation of Sediment Sampling Effectiveness

John Gulliver, University of Minnesota, gulli003@umn.edu; and Missy Gettel, University of Minnesota

Automatic water samplers are used frequently in the field of water quality monitoring. They can sample a wide variety of pollutants to be analyzed in the laboratory at a later time. There have been concerns, however, about the ability of automatic water samplers to accurately measure suspended solids and the associated constituent pollutants. Suspended solids concentration varies throughout the water column due to settling, but the standard location for a sampling inlet tube is at the bottom of a pipe or channel in the region of main flow. Concentrations of suspended solids and the associated chemicals are therefore often measured inaccurately. An improved understanding this process and its impact on sampling is needed.

In this presentation, sediment suspension theory and the associated obstacles posed in standard sampling methods of suspended solids will be reviewed. The results of empirical tests of the performance of standard storm water sampling techniques which utilize automatic storm water samplers will be presented. The results of this research will be incorporated into the manual, Assessment of Storm Water Best Management Practices.

## Track C: Urban Storm Water BMPs: Assessment, Effectiveness, and Performance, *continued*

### Reducing the Uncertainty in the Calculations of Street Cleaner Performance for Wisconsin Municipalities

Roger Bannerman, Wisconsin Department of Natural Resources, roger.bannerman@wisconsin.gov

Street cleaning is an effective way of removing debris that can make the streets less safe and unsightly. Municipalities in Wisconsin and other states want to know if their street sweeping programs will also be given credit towards achieving the total suspended solids (TSS) reduction goals required in their stormwater permits. An evaluation of the water quality benefits of three types of street cleaners was recently completed in Madison, Wisconsin. No statistically significant improvement was indicated for TSS or most other pollutants measured at the end of the pipes for the two residential areas that were cleaned once per week. Because of the high variability in the constituent concentrations, a statistically significant change in water quality of 25 percent would require the collection of at least five times as many samples. However, there is probably some improvement in water quality, because the street dirt load data showed a statistically significant reduction in street dirt loads when the streets were cleaned. Street dirt load data also showed an average pick-up efficiency of about 3, 27, and 30 percent for the mechanical broom, regenerative air, and vacuum assisted street cleaners respectively.

Although the water quality benefits of street cleaning was not measurable, the TSS load reduction could be estimated by calibrating the Windows Source Loading and Management Model (WinSLAMM) with the new street dirt load data. Street dirt load data was used to provide new coefficients for the street dirt accumulation, wash-off, and pick-up efficiency equations in the model. After calibration the measured and modeled street dirt loads had similar trends and magnitudes. The models improved ability to match the saw-tooth pattern observed for street dirt loads was coupled with a street deliver file that helped account for deposition of the larger solids in the pipes. Further confidence in the model output was gained from observing the good match between measured and modeled TSS loads for end of the pipe data from previous monitoring studies. A calibrated WinSLAMM overcomes much of the uncertainty of not being able to measure the water quality benefits of street cleaning.

The modeled annual TSS reduction for the vacuum assisted street cleaner is usually about twice that of the mechanical broom. For example, a high annual TSS reduction calculated for a vacuum assisted machine is 20 percent and the same cleaning program with a mechanical broom machine is calculated to reduce the annual TSS load by 10 percent. Only the vacuum assisted street cleaner can achieve a 20 percent reduction in TSS without installing any other stormwater treatment practices. None of the tested street cleaners will achieve a 40 percent TSS reduction for an urban drainage area, but the vacuum assisted can approach a 30 percent reduction with a cleaning frequency of five times each week for medium density residential and commercial strip land uses.

## Concurrent Sessions I 10:00 – 11:30

## Track D: Trends Up, Down, Flat, or Absent

### Three Decades of Water Quality Change (1976-2005) in the Mississippi National River and Recreation Area

Suzanne Magdalene, St. Croix Watershed Research Station, smagdalene@smm.org; Brenda Moraska Lafrancois, National Park Service, and D. Kent Johnson, Metropolitan Council Environmental Services

The Mississippi National River and Recreational Area (MNRRA) spans a 116 km stretch of the Mississippi River in the Twin Cities Metropolitan Area. Although many agencies monitor Mississippi River water quality, none has analyzed or interpreted the data with specific respect to MNRRA. To understand park-specific water quality trends, we compiled thirty years of Metropolitan Council monitoring data (1976-2005) for six Mississippi River sites, a nearby Minnesota River site, and the Metropolitan Wastewater Treatment Plant outflow. Data showed strong spatial trends, with increasing concentrations of nutrients and sediments from upstream to downstream, and strong temporal trends, with significant decreases (as per seasonal Kendall trend tests) in the flow-adjusted concentrations of most nutrients, total suspended solids, and turbidity over the period of record at all sites. Only nitrate concentrations increased significantly over time. Water quality in MNRRA appears highly sensitive to changes in both wastewater treatment and tributary inputs.

### Modern-day and Historical Sediment Transport in the St. Croix River, MN/WI: Preliminary Analysis and Implications for Native Mussel Populations

Kelly Macgregor, Macalester College, macgregor@macalester.edu; Dan Hornbach, Macalester College, and Mark Hove, Macalester College

Sediment budgets in river networks are notoriously difficult to construct but can be extremely important for quantifying both short and long-term changes to fluvial environments. Adequate sediment supply is critical for in-channel, bar, and near-shore ecosystems (both aquatic and terrestrial), as well as for recreation and navigation purposes. Hydrologic and sedimentologic conditions in the St. Croix River play a significant role in the stability of native freshwater mussel populations. The transport of sediment controls overall geomorphology, riverbed composition, and water turbidity, all of which are important to mussel habitat. Data shows a decrease in suspended sediment concentration, a decrease in the grain size of bed sediment, and a 96% decline in the juvenile mussel population in the last decade below the only major dam in the river system. The St. Croix River is home to two federally endangered mussel species; we need to better understand the controls on sediment transport to understand the causes for this decline and to evaluate future threats to these species.

In conjunction with mussel habitat analyses, we have collected surface and near-bed suspended sediment, as well as bedload transport samples since summer 2004. While discharge in the St. Croix typically ranges from 1,000-20,000 cfs, the majority of samples were collected between 1,700 and 10,000 cfs. Along with other suspended sediment transport data (1974-2003, USGS) we examine predictors for suspended sediment flux, including daily average and instantaneous discharge, water velocity, depth, shear stress, shear velocity, and stream power. Preliminary analyses show a positive correlation between suspended sediment concentration and instantaneous discharge, but only for discharges above 5,000 cfs. Using rating curves we calculate total sediment load over the past century, and compare this to rates of sediment accumulation in Lake St. Croix (Triplett and others, 2003). Further work will allow us to understand the controls on sediment transport and deposition over daily to decadal timescales, and to explore the impact of sedimentological changes on mussel populations.

## Concurrent Sessions I 10:00 – 11:30

### Track D: Trends Up, Down, Flat, or Absent, *continued*

**Tracking Statewide Urban Changes 1990-2000 and Implications for Watershed Management**

Bruce Wilson, Minnesota Pollution Control Agency, bruce.wilson@state.mn.us; Mike Walerak, Minnesota Pollution Control Agency; Marvin Bauer, University of Minnesota; and Brian Loeffelholz, University of Minnesota

Satellite remote sensing summary of changes in impervious cover and land uses from 1990 to 2000 have been tabulated and are available via interactive GIS for ~4000 watersheds (http://www.land.umn.edu). Coverages have been defined for all counties, and in more detail for Metro communities (1986 to 2002) and approximately 300 outstate communities, 25 lake districts, the Sauk and Crow River watersheds. In general, increases in community and lake districts' impervious cover have ranged from 50% to 76% or about 2 X to 4 X growth suggested by population increases. Growth occurs via ripple effect from transportation corridors and urban centers as well as with a water orientation. Projected demographic changes coupled with 1990-2000 impervious cover changes suggest continued significant landscape changes in watersheds of very sensitive water bodies.

## Luncheon Presentation 12:15 –1:00

### Of Fire Hoses and Fish Ladders: How Does Information Move in Your Organization?

James R. Chiles, Minnesota Pollution Control Agency and author of *Inviting Disaster: Lessons from the Edge of Technology*

## Concurrent Sessions II 1:15 – 2:45

## Track A: Lake Assessment and Algae Research

### Microcystin Levels in Eutrophic South Central Minnesota Lakes

M.J. Lindon, Minnesota Pollution Control Agency, matthew.lindon@state.mn.us and S.A. Heiskary, Minnesota Pollution Control Agency

During May-September of 2006 the cyanobacteria hepatotoxin microcystin (MC) and additional physicochemical data was collected on 12 lakes in two Minnesota counties, (McLeod and Blue Earth). The study had two major goals: determine the prevalence of the toxin and trend through the summer; and assess environmental variables associated with elevated MC. Results indicated lower MC levels at pelagic locations as opposed to near-shore locations. MC ranged from <0.150 (MDL) to 8,400 µg/L. Risk analysis was done corresponding to World Health Organization (WHO) guidelines for MC. 80 percent of MC results were within the WHO low risk category for MC. MC distribution varied at low levels between the pelagic and near-shore sites. No overall seasonal MC trend was observed. Using Spearman ranked regressions, MC exhibited moderately high correlations with pH and Chl-a of MC producing species. The study indicated Chl-a levels above 30 µg/L and pH levels greater than 9.3 had significantly greater likelihood of a high risk MC event. Better understanding of this toxin and it relationship and linkages to other water quality parameters will allow for better risk management and public awareness.

### New Ballast Water Treatment Technologies: Are We Killing Potentially Invasive Algae?

Euan D. Reavie, Center for Water and the Environment, ereavie@nrri.umn.edu

Ballast water discharge from ocean going vessels has been identified as a significant source for the introduction and spread of aquatic invasive species. A new research facility in Duluth Harbor is the first in the Great Lakes region designed to focus on developing technologies to prevent the introduction of nuisance species into the Great Lakes by ships. This pilot-scale facility is part of the collaborative Great Ships Initiative (GSI), and simulates a ship's complete ballast water system. Various candidate treatments, including physical and chemical methods, are being applied during the simulated ballast water holding periods. Efficiency of these candidate procedures are evaluated by comparing numbers of surviving organisms in treatment and control (no-treatment) tests. Determining organism viability is a fairly established process for vertebrates and invertebrates (e.g., Are they moving?). Algae are more difficult; even under a microscope, living and dead algae can look identical following treatment. I present a method for determining algae viability following test treatments at the GSI facility using a fluorescing DNA stain. Findings from this work will support the development of a ship-board treatment system that meets International Maritime Organization (IMO) standards for species introductions.

## Concurrent Sessions II 1:15 – 2:45

### Track A: Lake Assessment and Algae Research, *continued*

**National Lakes Assessment Project (NLAP): Enhancements for Minnesota**

Steve Heiskary, Minnesota Pollution Control Agency, steven.heiskary@pca.state.mn.us

USEPA is leading a survey of the Nation's lakes in conjunction with the states in 2007. A total of 909 lakes are included in this survey. Minnesota's NLAP effort is lead by the Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Natural Resources (MDNR). Minnesota drew 41 lakes as a part of the initial draw for this statistically-based national survey effort and immediately chose to add nine lakes to allow for state-based assessment. Several meetings were held to describe this effort and to invite participation from other program areas and agencies. This communication led to several enhancements that were added to the base-level program including: collaboration with USFS in sampling in the BWCAW; near-shore assessments that included macrophyte identification and determination of maximum rooting depth of plants; sampling in support of lake IBI development; measurement of water Hg; measurement of water pesticides in conjunction with an ongoing MN Department of Agriculture Program; measurement of sediment contaminants to provide improved baseline and spatial data; and a region-wide assessment of the Prairie Pothole Region conducted in conjunction with the states of ND, SD, MT, and IA.

The presentation will provide a brief update of NLAP survey efforts in summer 2007 and progress to date on data analysis and the potential future applications of this dataset.

## Concurrent Sessions II 1:15 – 2:45

### Track B: Quality of Groundwater, an Important Source of Drinking Water for Minnesotans

**PFCs in Ambient Shallow Groundwater in Minnesota**

Mindy L. Erickson, Minnesota Pollution Control Agency, Mindy.Erickson@state.mn.us; Laura Solem, Minnesota Pollution Control Agency; Andrew Streitz, Minnesota Pollution Control Agency; Jim Stockinger, Minnesota Pollution Control Agency; and Mark Ferrey, Minnesota Pollution Control Agency

Perfluorochemicals (PFCs) are and have been widely used in a variety of manufactured products. Because of their transport properties and recalcitrant nature, PFCs are widely distributed in the environment.

As part of its ongoing investigation of PFCs, MPCA sampled 17 shallow monitoring wells for 13 different PFCs during fall 2006.

At 9 of 17 sample locations, one or more PFCs were detected at or above the current reporting level of 25 ng/L. PFBA was the most commonly detected PFC, and it was detected at the highest concentration. All but one of the PFC detections above the reporting level were in the Twin Cities Metro Area. All detections were below MDH drinking water guidance levels.

Detailed results will be presented in the context of MPCA's continuing effort to understand the presence of, human health risk from, and ecological risk due to the presence of PFCs in multiple Minnesota media.

**Organic Compounds in Source Water and Treated Water from Public Supply Wells, Twin Cites Metropolitan Area, Minnesota and Wisconsin**

J.R. Stark, U.S. Geological Survey, Stark@usgs.gov; G. C. Delzer, U.S. Geological Survey; C.J. Hoard, U.S. Geological Survey; L. H. Tornes, U.S. Geological Survey; and E.A. Smith, U.S. Geological Survey

Water-quality assessments were conducted on sources of drinking water from the Prairie du Chien- Jordan and glacial-sediments aquifers underlying the Twin Cities Metropolitan Area. In 2005, the occurrence of 260 anthropogenic organic compounds (AOCs) were assessed in source water (untreated) from 30 high-capacity public-supply wells during the first phase of the effort AOCs included volatile organic compounds, pesticides, and other anthropogenic organic compounds. During the second phase 15 of the wells, with the greatest number of AOC detections, were re-sampled in conjunction with associated treated water. Concentrations of AOCs detected in source water and in treated waters generally were low (defined as less than 1.0 microgram per liter (µg/L)). Concentrations typically were less than human–health benchmarks. With the exception of disinfection by-products, most of the volatile organic compounds and other anthropogenic compounds were detected more frequently in source-water samples than in treated water samples. Pesticides were detected in source-water and in treated water samples at similar frequencies and concentrations, however, suggesting that monitoring for pesticides in source water may indicate the occurrence of pesticides in treated water samples.

The U. S. Geological Survey (USGS) is communicating the relevance of water-quality findings of the National Water Quality Assessment (NAWQA) Program in a human-health context by comparing water-chemistry data with human-health benchmarks. Benchmarks include Maximum Contaminant Levels established by U.S. Environmental Protection Agency or State agencies (regulated compounds) and USGS Health-Based Screening Levels (HBSLs) (unregulated compounds). HBSLs are not available for all unregulated compounds and are not regulatory standards. HBSLs are estimates of benchmark concentrations and may be used as thresholds to evaluate water chemistry data in a human-health context.

## Concurrent Sessions II 1:15 – 2:45

### Track B: Quality of Groundwater, an Important Source of Drinking Water for Minnesotans, *continued*

**Social Dimensions of Private Well Testing: Why Don't People Test Their Well Water?**

Barbara Liukkonen, University of Minnesota, liukk001@umn.edu, and Eleonore Wesserle, University of Minnesota

In March 2007, 2600 private well owners in Michigan, Wisconsin, and Minnesota were surveyed to assess their attitudes about well water quality and water testing behaviors. Survey results will help water resource professionals and educators create more effective well testing campaigns and clinics by identifying the challenges and barriers faced by private well owners.

In Minnesota, 600 private well owners were randomly selected from property tax records in Otter Tail, McLeod, and Dakota counties. A survey (43 questions) was developed to assess well water use, perceptions about water quality risk, reasons for testing and not testing, preference for getting information, willingness to pay, and demographics. The survey process included a pre-survey letter, survey with a $2 incentive and postage-paid envelope, and 2 reminder postcards. Our target response rate was 50%. Overall the return rate was 65%, with 68% from Dakota and Otter Tail counties and 58% from McLeod County.

Preliminary findings: Most respondents felt their well water was safe or very safe (60%); about 7% felt it was unsafe or very unsafe; over 50% were not worried about the safety of their well water. However, 38% believed there was a serious or very serious problem with ground water safety in their township. Twenty-one percent of respondents said they had never had their well water tested and another 9% did not know if it had been tested. Primary reasons cited for getting a well water test were learning that a neighbor's well was contaminated (60%), a change in taste or appearance (57%), or unexplained health problems (46%). The most common reasons given for not testing their well water were "have been drinking it for years without problems" (24%), "don't know what to test for" (16%), "the water is probably fine" (12%), and "don't know how to test" (11%).

## Concurrent Sessions II 1:15 – 2:45

### Track C: Effectiveness of Storm Water BMPs

**Assessing the Effectiveness of Vegetated Buffers Using Simulated Residential Runoff**

Sarah M. Stai, Westwood Professional Services, sarah.stai@westwoodps.com

Although water quality concerns have prompted more frequent incorporation of vegetated buffers in developing areas adjacent to water resources, the quantitative factors that characterize an effective buffer are not thoroughly understood. A runoff simulation system was developed and used to test the effects of buffer width and slope on removal of sediment and phosphorus from simulated residential runoff. Four experimental plots were established on slopes ranging from 5:1 to 2:1 at a study site in Eden Prairie. Plots were covered primarily in herbaceous vegetation and were outfitted with in-ground runoff collectors at downslope intervals of 5, 10, 20 and 40 feet. Simulated runoff was prepared with known concentrations of phosphorus and sediment and applied to plots in volumes representing a 2- or 100-year rainfall event. The results of 108 trials, addressing runoff volume and concentration of phosphorus and sediment as a function of buffer width and slope, will be presented and discussed.

**Collection of Total Mercury and Production of Methylmercury in Constructed Stormwater Wetlands**

Bruce Monson, Minnesota Pollution Control Agency, bruce.monson@state.mn.us

Wetlands are a major site of mercury methylation in pristine watersheds; however, we do not know if this is true for constructed stormwater wetlands. This study addressed the question: How do constructed stormwater wetlands compare to natural wetlands regarding methylmercury, given the important differences in hydrologic and pollutant loads? Water chemistry data was collected in 2005 and 2006 from ten urban stormwater wetlands, including an intensive study of McCarrons-Villa Park (MVP) stormwater wetland treatment system. The results indicate that stormwater wetlands do indeed have methylmercury concentrations similar to natural wetlands; however, stormwater detention removes a large mass of inorganic mercury from stormwater. Total mercury and methylmercury fluxes from MVP were on the low end of the range of values for natural wetlands. Phosphorus and methylmercury concentrations were strongly correlated in the stormwater wetlands.

**Fish and Minnows Influence Phosphorus Loading from Stormwater Ponds**

Steve McComas, Blue Water Science, mccomas@pclink.com; Jo Stuckert, Blue Water Science, and Connor McComas, Iowa State University

For several decades, stormwater ponds have been the backbone of residential stormwater management. However, water quality monitoring shows the ponds don't always remove as much phosphorus as modeled. We think we have found one of the factors to explain the observed excessive phosphorus concentrations. Significant minnow populations were present in most ponds surveyed in the last couple of years. Excessive fish densities appear to have the same effect in shallow stormwater ponds as they have in shallow wetlands, that is, they elevate phosphorus levels resulting in algae domination and few aquatic plants. Subsequently, we have started to remove fish from stormwater ponds to improve water quality. When barley straw is added to a pond with low fish densities, phosphorus removal is further enhanced. Fish removal combined with barley straw installation can reduce phosphorus loading from stormwater ponds by 40%.

## Concurrent Sessions II 1:15 – 2:45

## Track D: TMDL Policy: Learning from Recent Experience

### MPCA Statewide Mercury TMDL Approval Process

Marvin Hora, Minnesota Pollution Control Agency, marvin.hora@pca.state.mn.us

The EPA has approved a statewide pollutant-loading, or Total Maximum Daily Load, study for mercury in fish that the Minnesota Pollution Control Agency (MPCA) proposed last year. The TMDL study includes goals that the MPCA has set to reduce mercury pollution of Minnesota's lakes and streams to acceptable levels.

The MPCA's statewide approach to the mercury TMDL is a first for the nation. While other states have tackled the mercury-pollution problem by having a separate TMDL for each impaired water, the MPCA took a statewide approach because so much of the excess mercury comes from outside the state and atmospheric deposition of mercury is relatively uniform across the state. The mercury deposition-reduction goal set by the TMDL is high enough to address the mercury-pollution problem in northeastern Minnesota, where the highest concentrations are found.

The presentation will describe the scientific backing behind the Hg TMDL, the timeframe, and implementation planning.

### What Makes a Good TMDL for Urban Stormwater? Lessons Learned

Michael Trojan, Minnesota Pollution Control Agency, mike.trojan@pca.state.mn.us; Timothy Larson, Minnesota Pollution Control Agency, and Jeff Risberg, Minnesota Pollution Control Agency

Urban stormwater runoff is an important contributor to surface water quality impairments. Total Maximum Daily Load (TMDL) studies provide information and strategies for bringing impaired waters into compliance with water quality standards. It is important to develop TMDLs that have a high likelihood of success. Unfortunately there are many obstacles to success for TMDLs that have an urban stormwater component. For example, because of fundamental differences between the Federal TMDL and NPDES programs, it is difficult to align TMDL language with stormwater permit requirements. Based on lessons learned in the past year, we present insight and strategies for writing TMDLs that have a high potential of success. Numerous examples will illustrate the characteristics of a good TMDL for urban stormwater.

### TMDL and Clean Water Legacy from the Local Perspective

Kitty Tepley, Todd Soil & Water Conservation District, kitty.tepley@mn.nacdnet.net

A discussion of the Long Prairie River Watershed project starting with citizen interest, to impaired waters, through Clean Water Partnerships, to a TMDL study and implementation project, and finally Clean Water Legacy.

In 1994, a Citizen group was awarded an LCMR grant to monitor and develop a plan for the Long Prairie River. The Todd Soil & Water Conservation District (SWCD) partnered with this group and volunteered to do the water monitoring. In 1996 the Todd SWCD was approved for a small CWP grant from MPCA for monitoring and assessment, and in 2000 and 2003 for implementation grants to continue the monitoring plus cost share for installing non-point source Best Management Practices.

In part, because the monitoring had already been started, the Long Prairie River was one of the first small watersheds to complete the TMDL study and is one of a small group to have an EPA approved TMDL implementation plan in place. The Long Prairie River project is a success story, but has just scratched the surface of what needs to be done. The Clean Water Legacy (CWL) is providing the tools to continue the restoration. The Todd SWCD has long standing partnerships starting with private citizens, with adjacent watersheds, with county offices, and state and federal agencies. CWL is giving us the opportunity to expand and improve these relationships at the state and local level.

## Concurrent Sessions III 3:15 – 4:45

## Track A: Environmentally Sensitive Design in the Aquatic Environment

### Opening up the River—A Multi-Purpose Approach

### Heiberg Dam Reconstruction, Fish Mitigation and Ice Control Project, Twin Valley, MN

Jerry D. Bents, Houston Engineering, Inc., Jbents@Houstonengineeringinc.com; and Dave Friedl, Minnesota Department of Natural Resources

The Wild Rice River is the principal water course of the Wild Rice Watershed District encompassing over 2,000 square miles of land in Northwestern Minnesota. The Hieberg Dam has been in place since approximately 1895. Since that time it has blocked fish migration to over 125 miles of riverine habitat and numerous lakes in the Upper Watershed. In addition, the dam has resulted in substantial erosion river bank downstream of the structure, a hydraulic safety hazard to local residents and visitors, and virtually no recreational value. For over 20 years local recreational enthusiasts, conservation groups, local, state, federal, and tribal representatives wanted to remove the structure to eliminate these issues.

This presentation will focus on the measures included in the re-construction project to mesh the original project purpose of ice control with the need for fish migration, increased safety, and recreational opportunities. In addition, the presentation will explain the biological monitoring measures currently underway to ensure the project is fulfilling each of the goals and the roles that of each of the project partners played in the implementation of the project.

### Expedited Design and Construction of Judicial Ditch-2 Stream Restoration

Peter MacDonagh, The Kestrel Design Group, kbergesch@tkdg.net and Ed Matthiesen, Wenck Associates

The Rice Creek Watershed District received a LCMR grant for the Ecological and Physical Stream Restoration of JD-2. Issues outside of the District's control, forced an April 26, 2006 start date, but the grant expired June 30, 2006. The time frame demanded an unconventional design, contracting and construction process that met both schedule and quality requirements. This process has become a model for stream restoration: It reduced design costs and provided the flexibility that is required for design, placement, size and cost control of stream restoration.

Problems facing the creek included failing banks, falling trees, silted substrate and homemade attempts at bank stabilization.

In one day, the design team held its kick-off meeting, then field-designed the entire 2100-ft reach. After one week, plans were completed on the basis of an aerial photo and GPS locations of 30 design features (root wads, rock vanes, grade control riffles, bank restoration, and vegetation). Three short-form contracts were issued that included plans and bid schedules along with descriptions by location of the restoration activities and standard details. Bidding occurred in the second week and notices-to-proceed were issued the day after the receipt of quotes. The project was completed before the grant expired.

## Concurrent Sessions III 3:15 – 4:45

### Track A: Environmentally Sensitive Design in the Aquatic Environment, *continued*

**Canisteo Mine Pit Outflow – Hydraulic Design of a Long Flat Siphon**

John R. Thene, Wenck Associates, Inc., jthene@wenck.com

Operations at the Canisteo Mine Pit on the Western Mesabi Iron Range ended in 1985 and the pit began filling with groundwater and surface water inflows. The water level has risen 200 feet and is within 15 feet of its natural overflow which would discharge water through the town of Bovey. The Western Mesabi Mine Planning Board selected a siphon as the preferred alternative to draw the pit down to a safe elevation and maintain water levels in the pit. The discharge is to Trout Lake, about one mile south of the pit. The presentation will focus on the design challenges, particularly hydraulic, with the design of a 4,000 ft siphon with as little as 7 feet of head and design discharge of 18 cfs. Specifically it will cover:

- Selection of the design discharge
- Design criterion for minimum pressure
- Dissolved air
- Movement and removal of air near the high point
- Invasive species control (Rainbow smelt in the mine pit)
- Discharge rate control
- Outfall and effects on Trout Lake and the Swan River

## Concurrent Sessions III 3:15 – 4:45

### Track B: Drinking Water in Minnesota

**Targeting Management Strategies to Protect Mississippi River Water**

Charles Regan, Minnesota Pollution Control Agency, charles.regan@pca.state.mn.us; Lisa Vollbrecht, City of St. Cloud

The Mississippi River is the primary source of drinking water for St. Paul and the exclusive source for St. Cloud and Minneapolis. These three water suppliers have been working cooperatively through MPCA Clean Water Partnership and Section 319 Grants to prepare Source Water Protection (SWP) Plans. This presentation will describe these Source Water Protection Plans, including the delineation of Source Water Protection Areas, the inventory of contaminants of concern and development of source water protection strategies, and the measures to implement these plans by the water suppliers.

Each of the water suppliers has completed Part 1 of their SWP Plan, the delineation of their Source Water Protection Area. The three water suppliers' delineated SWP Areas form a contiguous "composite" area of approximately 7,700 square miles. Each of the individual SWP Areas consists of a "Priority Area A," focused on point and non-point contaminant sources, and "Priority Area B," focused primarily on non-point contaminant sources. The basis for these delineations will be discussed.

The water suppliers are currently finalizing Part 2 of their SWP Plan. This includes inventorying potential contaminants of concern within their SWP Area, and applying methodologies, such as radionuclide sediment fingerprinting, to support the development of source water protection strategies and practices to address contaminant sources within their SWP Area.

Finally, the presentation will review some of the implementation measures that the water supplies will use to put their SWP Plans in place to advance source water protection, emphasizing the importance of collaboration with local units of government.

**Twin Cities Area Water Supplies: Planning for Availability**

Lanya Ross, Metropolitan Council, Laya.Ross@metc.state.mn.us

In 2005, the Minnesota State Legislature directed the Metropolitan Council to conduct planning activities addressing the water supply needs of the metropolitan area (Minnesota Statue 473.1565). One of the first steps in this regional planning effort was a rudimentary assessment of future water supply availability by community. Results indicate that, although most of the region is expected to have an adequate water supply through 2050, a striking 11% of metropolitan area communities may face significant water shortages. At the same time, several communities may have excess supplies. Regional management of these disparate supplies is intended to strengthen their sustainability, reliability, security and cost-effectiveness. New tools such as an updated regional groundwater flow model and web services are intended to verify previous determinations of water availability and to facilitate inter-jurisdictional collaboration where supplies are limited.

**Source Water Protection Case Studies – What are Municipal Public Water Suppliers Doing to Protect Their Drinking Water?**

Terry Bovee, Minnesota Department of Health, terry.bovee@health.state.mn.us

Many municipal water suppliers are now implementing wellhead protection plans as a result of requirements of the state wellhead protection program. A public water supplier, based on ground water vulnerability must develop wellhead protection plan strategies. The public water supplier is also responsible for long-term implementation of these strategies. As a result of this program, some cities are taking actions that directly address land use issues near public water wells, long-term drinking water infrastructure needs and ground water use conflicts. In this session the audience will hear how some municipal wellhead protection managers have addressed local water supply and protection issues.

## Concurrent Sessions III 3:15 – 4:45

## Track C: Volume Reduction/Infiltration

### Volume Reduction BMPs to Address Flooding and Water Quality Problems in the Capitol Region Watershed District, St. Paul, MN

Bob Fossum, Capitol Region Watershed District, and Mark Doneux, Capitol Region Watershed District, mark@capitolregionwd.org

The Capitol Region Watershed District along with the Cities of St. Paul, Falcon Heights, Roseville and Ramsey County worked cooperatively to fund and construct stormwater facilities to address flooding, and water quality problems. Specifically, these problems existed in a subwatershed (#7) west of Como Lake in St. Paul, MN. Como Lake is a 303d impaired water for nutrients. To alleviate the flooding, the City of St. Paul increased the size of storm sewers as part of a street reconstruction project within the subwatershed. Subwatershed 7 discharged to Como Lake via a 60" pipe through Como Golf Course and frequently surcharged. A preliminary study indicated that an additional 60" pipe through the Golf Course was needed at an estimated cost of $2.5 million. The Como Subwatershed 7 Study was completed in 2003 and identified many volume and peak rate reduction BMPs to eliminate the need for an additional storm sewer through the Como Golf Course. The BMPs identified also would result in significant water quality improvement. In 2005 and 2006 these BMPs were constructed. They included the Arlington-Hamline Underground Storage Facility, and the Como Golf Course Pond. CRWD also funded 8 underground infiltration trenches under Arlington and Nebraska Avenues and 8 rain gardens in the project area.

The Arlington-Hamline Underground Storage Facility used 849 feet of 10' perforated corrugated metal pipes surrounded by 1-3" washed rock. This facility has 1.9 ac-ft of storage and utilized a proprietary water quality chamber upstream to remove solids. The drainage area to the facility is 47 acres. The facility is designed to remove 12 lbs of phosphorus on an annual basis. This project was located in parkland and after restoration was the same fully usable green space as before the project. The Arlington-Hamline Underground Storage Facility had construction cost of $480,000.

The Golf Course Pond will be constructed during 2007. This project will divert flow to the pond from the northern part of the Como Subwatershed 7 to reduce peak flows and improve water quality. The Golf Course Pond project has approximately 10 ac-ft of storage and result in annual reduction in total phosphorus of 41 lbs. The estimated construction cost is $820,000.

The infiltration trenches were constructed under the streets during the street reconstruction project. They were constructed in 2006 for a cost of $240,000. In total they provided 38,292 cu. ft. of storage volume. Sumped catchbasins and manholes with hoods provide pretreatment to prevent solids from entering the systems.

The rain gardens were constructed areas adjacent to the streets and within the right-of-way during the street reconstruction project. They were constructed in 2006 for a cost of $53,000. In total they provided 24,662 cu. ft. of storage volume. The District was able to construct these rain gardens because of street realignments that narrowed the intersections and removed pavement.

This project has resulted in significant water quality treatment and the reduction of flooding in a dense urban area. The project was completed in conjunction with a street reconstruction project.

## Track C: Volume Reduction/Infiltration, *continued*

### Monitoring the Effectiveness of an Infiltration Trench

Jennifer Olson, Emmons and Olivier Resources, Inc., jolson@eorinc.com and Camilla Correll, Emmons and Olivier Resources, Inc.

An infiltration trench was constructed at the Math and Science Academy (MSA) in Woodbury in 1999. This trench serves as a demonstration site for infiltration practices in the South Washington Watershed District. The overall site design included a treatment train approach which utilized a dry swale, pretreatment pond and infiltration trench. The trench was set adjacent to the pretreatment pond, which was vegetated with native species of grasses and forbs.

Monitoring of the MSA trench began in 1999 and included rainfall, water quality and water quantity. Grab samples were collected within the trench to monitor the quality of water infiltrating. An automatic sampling station was used to monitor any water that left the practice. In addition, sampling of water quality was also obtained within the swale, pretreatment pond, and at roof downspouts on the site. Water levels have been measured within the trench and pretreatment pond and infiltration rates have been calculated for the trench for over 60 rainfall events. Infiltration rates have been measured as high as 7.5 inches per hour within the trench.

This talk will present the overall design and construction of the infiltration trench, results of a 6 year monitoring program, and lessons learned.

### Monitoring Success of Infiltration Requirements—Combining Regulation with Outreach, Demonstration and Assistance

Paul Moline, Carver County, pmoline@co.carver.mn.us

Many jurisdictions and watersheds promote infiltration as an alternative to traditional wet pond treatment and use demonstration sites or education to promote these practices. Use of uniform regulations to achieve greater stormwater treatment is less prevalent. Successful implementation of infiltration & filtration regulations is largely based on the acceptance of such practices by contractors, developers, engineers, and landowners.

Carver County, MN adopted stormwater infiltration requirements in 2002. In addition to achieving improved water quality and reduced runoff through these regulations, the County's goal is to ensure the compatibility of treatment methods with a variety of development patterns and a willingness to be flexible on a site-by-site basis.

Infiltration demonstration sites at County facilities played a large role in securing trust from the development community and were phased in to be in place as regulations went into effect. The sites were intended to show infiltration methods which were aesthetically pleasing and relatively simple to construct and designs which functioned well.

"Filtration shelves" were also promoted and ultimately installed in a variety of locations. These provide water quality benefit, some volume control benefit and can be installed within the wet pond footprint. They have been successful in meeting the additional challenges for meeting infiltration standards in the Carver County watershed including tight clay soils.

As part of the implementation program, the County has been monitoring installed sites since 2002. Infiltration\ filtration areas were monitored for water quality, runoff control, aesthetics, and ease of construction.

This session will cover the results of this monitoring, the methods used in outreach to the stormwater management audience (developers, engineers, contractors and landowners), and the types of practices installed including the use of "Filtration shelves." The approach of combining regulations with outreach, technical assistance, stakeholder input and demonstration sites has led to successful implementation of innovative stormwater practices and has applicability to other jurisdictions.

## Concurrent Sessions III 3:15 – 4:45

## Track D: Emerging Contaminants

### Gaps and Opportunities for Addressing Emerging Issues in Minnesota

Judy Crane, Minnesota Pollution Control Agency, judy.crane@state.mn.us; Mark Ferrey, Minnesota Pollution Control Agency, Laura Solem, Minnesota Pollution Control Agency, Steven Hennes, Minnesota Pollution Control Agency, Angela Preimesberger, Minnesota Pollution Control Agency, Catherine O'Dell, Minnesota Pollution Control Agency, and Paul Hoff, Minnesota Pollution Control Agency

The Minnesota Pollution Control Agency's (MPCA) Emerging Issues Team recently developed an emerging issues inventory to identify those issues most important to Minnesota. In a broad sense, this approach considered how widespread the contaminant or issue is, the current national or state regulatory stance on the issue, a characterization of the risk associated with the contaminant or issue, and the pertinence of the topic to Minnesota's environment. A list of the highest priority emerging issues was produced. As a next step, the team examined the gaps in scientific understanding of each priority issue and the opportunities for the MPCA to either conduct applied research with collaborators to fill data gaps, prepare technical guidance, hold informational seminars, and/or provide management with recommendations for pollution prevention. The team recommended a few emerging issues for focus during state fiscal year 2008.

### Wastewater Treatment Plant Effluent Reduces Male Competitive Reproductive Success in Fathead Minnows but has Little Effect on Females

Candice Lavelle, University of Minnesota, lave0083@umn.edu; Dalma Martinovic, University of Minnesota; Peter Sorensen, University of Minnesota

Endocrine disrupters are environmental compounds that modify hormone function in fish and wildlife. They are commonly released by wastewater treatment plants (WWTP) as well as other sources and their effects on populations of fish are poorly understood. Our overarching goal is to address this question using the fathead minnow as a model. Our previous studies have found that male minnows exposed to effluent from the St. Paul WWTP have lower male hormones levels and are markedly less successful at mating when forced to compete with unexposed males. Here, we tested whether female reproductive success might also be affected by this effluent by exposing them and then monitoring their reproductive activities. Remarkably, we found no effects on egg production and only small effects on female behavior, suggesting estrogenic compounds pose the greatest threat. Future work will examine other plants to see how common this is and to model effects of sex-specific reproductive deficits on populations.

### Can Rural Communities Comply with the New Arsenic Standard for Drinking Water?

K. William Easter, University of Minnesota, weaster@umn.edu; Yoshifumi Konishi, University of Minnesota, and Yongsung Cho, Korea University

Our primary concern in this paper is to determine to what extent small communities have difficulty meeting the new stricter 2001 standard for arsenic levels in their drinking water. To do this we survey water users in rural Minnesota communities that had arsenic levels in their water supply exceeding 10 µg/L during 2001-2006. Our survey results show that after obtaining complete information concerning the arsenic levels in their drinking water consumers with relatively low levels of arsenic were willing to pay $8-9 annually, while those with high levels of arsenic were willing to pay $15-17 annually. We also found that consumer WTP didn't vary by community size. Thus, we conclude that compared to compliance costs ($58-327 per capita annually) small rural communities are likely to find it difficult to cover the cost of compliance through increased water charges. Since many of the communities have to cover these costs of compliance by raising water charges, we ask the basic question: are there better treatment options for these rural communities that will lower the cost to consumers? One option might be to encourage individual householders to use household water treatment devices for communities serving fewer than 500 people. The devices could be made available by the local entity supplying the community's water possibly at a subsidized rate along with complete information about the arsenic level in the water supply.

## Concurrent Sessions III 3:15 – 4:45

### Track E: Upper Mississippi River – Lake Pepin TMDL

**Water Quality Model for the Support of the Upper Mississippi River – Lake Pepin TMDL: An Update**

Joseph V. DePinto, LimnoTech, jdepinto@limno.com

Nationally, nutrients and sediment/siltation rank among the top four impairments reported by states on their 303(d) lists. The State of Minnesota is developing a TMDL for a 90 mile section of the Upper Mississippi River that is driven by 303(d) priority listings for both turbidity and nutrient enrichment (total phosphorus and chlorophyll a). This stretch of the river receives wastewater discharge from the Minneapolis-St. Paul urban area as well as erosional solids and nutrients from an extremely large contributing watershed (48,634 square miles, encompassing about 48% of the State of Minnesota and a portion of Wisconsin), including a very high suspended sediment load from the Minnesota River. The impaired river reach contains two impoundments, Spring Lake and Lake Pepin, located behind two of the four Lock & Dam control structures that bound the three morphometrically and hydraulically distinct "pools" of the system. Because of the complex nature of the system and the complexity of the program objectives, there are a number of challenges that must be met with this TMDL analysis:

- The large watershed with many tributaries to the mainstem guarantees significant non-point sources of both sediments and nutrients, thus requiring a linked watershed-receiving water analysis;
- The potentially large variations in flow impact hydraulic residence time in impoundments, thus affecting available nutrient to phytoplankton biomass relationships;
- The high turbidity generally produces a situation of light limitation to phytoplankton growth, thus creating a negative feedback situation between turbidity reduction and phytoplankton production; and
- Critical conditions for turbidity and phytoplankton production differ because high flow produces high yields of sediment erosion and associated turbidity, while low flows provide time for sediment settling and sufficient residence time in impoundment areas to produce high phytoplankton biomass.

To help meet these challenges, the State has contracted LimnoTech to develop an advanced hydrodynamic-sediment transport-water quality model to support and inform this TMDL. This presentation will describe the formulation and current status in the development of this model, and discuss how this model will be applied to support the TMDL.

## Poster Presentations

### Meeting No Net Loss at a Landscape Scale for Future Land-Use Alternatives

Melissa Arikian, Emmons & Olivier Resources, marikian@eorinc.com; Jason Naber, Emmons & Olivier Resources

A regionally adapted landscape-scale wetland functional assessment methodology based on MnRAM 3.0 has been developed to evaluate overall wetland functional changes under different land use scenarios in the Rice Creek Watershed District. One example, the Lino Lakes Resource Management Plan (RMP), is being developed in close coordination with the City of Lino Lakes' Comprehensive Land Use Planning process. The results of the functional assessment are being used to shape the City's land use decisions and the Watershed District's rule making process to achieve no net loss of function under future fully developed conditions.

Standards for land use controls and watershed rules are based on forecasting wetland functions approximately 20 years out. Existing and future conditions models for runoff and nutrient loading are used to help score indicators of wetland function. Through the RMP process, various land use options and watershed rules are evaluated to ensure no net loss of function.

### Stormwater Management Structure Maps for Mosquito Control

Kyle Beadle, kbeadle@mmcd.org; Jon Peterson and Nancy Read, Metropolitan Mosquito Control District

Abstract: Since the introduction of West Nile virus (WNV) to Minnesota, the Metropolitan Mosquito Control District (MMCD) has increased surveillance and control in street catch basins and natural wetlands where vector Culex mosquito larvae are found. Storm water management structures built in or near wetlands may have been treated along with other mosquito control operations, but have not been identified on our field maps. MMCD's Dakota County field office has worked on a project the past 2 years to map, survey, and provide targeted control in structures classified as culverts, washouts, rip/rap, risers (pond level regulators), and intermittent streams. Field inspectors mapped and inspected over 3000 structures, and found 2/3 holding water and about 1 in 10 inhabited by mosquito larva at the time they were inspected. Most of the larvae found were of mosquito species known to be enzootic WNV vectors in Minnesota. These types of structures can provide prolific habitat for WNV vectors and their location and treatment is becoming a regular part of the MMCD control program throughout the 7-county metro area.

### Heron Lake Watershed District Conservation Tillage Demonstration Project Education and Citizen Involvement in Water Resources

Ross Behrends, Heron Lake Watershed District, ross.behrends@mn.nacdnet.net; Chris Bauer, Heron Lake Watershed District

Soil erosion from cropped agricultural land delivers sediment to surface waters and causes irreversible loss of soil productivity. Strip tillage is a promising and relatively new conservation tillage system with potential to reduce this problem. More research and demonstration, however, is needed for farmers to consider implementing this practice.

Tasks:

1. Conduct on-farm research of tillage demonstration site consisting of six tillage treatments (strip-till, one pass, no-till, chisel plow, ridge-till, and chisel plow with an alternate fertilizer program) in both corn and soybeans.
2. Conduct field days and workshops for public education, presenting scientific data showing economic and environmental benefits of reduced tillage systems.
3. Conduct regular meetings of project partners.
4. Disseminate results to producers and agricultural professionals.

Partners: Heron Lake Watershed District, University of Minnesota Extension, Fairland Management, Alba Grain Inc. / Mark Pietz, Vern Uit de Flesch, North Heron Lake Game Producers Association, Inc.

### Use Water Conservation Toolbox

Sara Bertelsen, Metropolitan Council, sara.bertelsen@metc.state.mn.us

This abstract is being submitted for consideration as part of a session(s) on safe drinking water. As population grows, our demand for water grows with it. Our sources for water, however, remain the same. In response to increasing populations and limited water sources in western and southwestern United States, aggressive water conservation programs have effectively reduced water use demand in these regions. While water supplies in the Midwest are relatively abundant, they are not limitless and must be consumed wisely to ensure adequate supplies for future generations. In 2006, the Metropolitan Council (Council) began assessing the adequacy of water supplies to meet future water demands in preparation of the metropolitan area master water supply plan, as directed by the 2005 Minnesota Legislature. While Twin Cities metropolitan area communities' are already implementing conservation programs, the Council developed a water conservation toolbox, as an element of this planning effort. The toolbox provides water suppliers and customers in the metropolitan area with resources to help expand their existing efforts to reduce water use demands.

## Poster Presentations

### A Watershed-wide Stream Habitat Survey and Infrastructure Inventory for Restoration Prioritization

Doug Bradley, Limnotech, Inc, dbradley@limno.com; Michele Koehler, Limnotech, Inc.; Michael Sullivan, Limnotech, Inc.; Mary Searing, Anne Arundel County

Anne Arundel County, Maryland conducts surveys of county subwatersheds to maintain and update its spatial database on county-wide resources. Within the Upper Patuxent River watershed, an inventory documented the conditions of their water resource utilities and channel conditions. The Anne Arundel County National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit, issued by the Maryland Department of Environment (MDE), required the study and assessment of land use conditions within the Upper Patuxent River Watershed as a means to support planning of projects to maintain and improve the overall watershed health and quality of water resources. A watershed-wide survey was conducted to identify and verify county-wide stream and channel mapping, inventory stormwater infrastructure, and assess riparian and aquatic habitats and the potential effects of surrounding land uses on the health and quality of the local waters. The Upper Patuxent River Watershed drains approximately 22,000 acres, is subdivided into nineteen subwatersheds and contains approximately 170 miles of perennial stream reaches. All perennial streams and associated information within the watershed were documented and assessed using state and project specific habitat protocols entered into an electronic database, developed by Ann Arundel County. The product of the field surveys resulted in an updated, comprehensive, and spatially-correct watershed database of the entire Upper Patuxent River watershed. The mapping, inventory and habitat assessment information will be incorporated into the Watershed Management Tool (WMT) suite of models to assist Anne Arundel County in watershed management decision-making, NPDES Permitting and restoration prioritization.

### Effects of Macroinvertebrate Availability, Diet, and Habitat on Re-Introduction Success of Slimy Sculpin in Southeast Minnesota

Rebecca Bronk, University of Minnesota, hunt0448@umn.edu

Slimy sculpin (Cottus cognatus) are benthic fish that were historically widespread across southeast Minnesota. Their habitat has been disturbed due to sedimentation of the streambed by agricultural practices and populations were extirpated from many streams. In 2001, the Minnesota Department of Natural Resources began re-introduction efforts to protect the species and restore the biotic community, however, success has been varied. For this study, I am investigating the effects of prey availability, diet, and habitat on sculpin abundance and biomass across 10 streams in Minnesota's re-introduction program. I am interested in determining which factors contribute to the establishment of sculpin populations, so that we may better understand this species and increase the efficiency of re-introduction efforts.

**Rainwater Gardens and Native Plantings Protect High Quality Wetlands in a Low Impact Development, St. Cloud, Minnesota**

Amy L. Carolan, Bonestroo, amy.carolan@bonestroo.com, Stan M. Hanson, Bonestroo, John R. Smyth, Bonestroo

A variety of site constraints including a high groundwater table, flat topography, and an abundance of high quality wetlands (36 acres, 32% of site) made traditional development and stormwater management practices unfeasible at the Stone Gate residential development site in St. Cloud, MN. To overcome these challenges and to protect the site's water resources, Bonestroo's engineers and ecologists developed a low impact design to treat stormwater using more than 100 rainwater gardens. The rainwater gardens were designed to meet regulatory requirements by infiltrating a one-inch, 24- hour rainfall event. Following construction, field-tested infiltration rates exceeded these requirements.

All rainwater gardens were planted with a custom native seed mix designed to facilitate infiltration and improve the aesthetics of the development. In addition to the rainwater gardens, restoration and management of native plant communities began in the Fall of 2006, which will buffer and protect high quality wetlands while creating open space for future residents.

This development received high praise from the local Soil and Water Conservation District, Department of Natural Resources, City of St. Cloud, and Stearns County Environmental Services. We will present details on rainwater garden design and installation procedures, infiltration testing, and restoration activities.

**Lake Sweeney Shoreland Restoration: How Teamwork Leads to Success**

Deric Deuschle, SEH, Inc., ddeuschle@sehinc.com, Cathy McCarty, Minneapolis Clinic of Neurology, Ltd, Al Lundstrom, City of Golden Valley

In 2006, the Minneapolis Clinic of Neurology was awarded a matching grant from the Minnesota Department of Natural Resources Shoreland Habitat Program to restore 0.87 acres of shoreland over approximately 600 feet of shoreline. This project successfully restored a historically turfed area with undercut and eroding slopes to a stable vegetated shoreland with adjacent wetland and upland buffers. While this appears to be a simple outcome, it fails to convey the collaborative effort of seven agencies/entities to see it happen, each with a small but important link to the final success of this site. This presentation will discuss the sequence of events that put the clinic, the City of Golden Valley, two DNR Divisions, the University of Minnesota, a contractor, and a consultant into the position to make this restoration a success. A discussion of the plan, process, outcomes, and status of the site will also be presented.

**Risk Assessment in a World without Boundaries**

Christopher Greene, Minnesota Department of Health, christopher.greene@health.state.mn.us; Helen Goeden, Minnesota Department of Health, Paul Moyer, Minnesota Department of Health

The assessment of contaminants from multiple sources, such as surface water, ground water, and ingestion of fish, is of great importance to regulators as they promulgate rules to safeguard human health. Because individuals may be exposed to chemicals from a wide range of media, the development of media-specific values must account for sources of exposure that lie outside the medium of concern in order to ensure that individuals' total risk across all media remains at an acceptably low level. These issues have been addressed by the Minnesota Department of Health as it revises its Health Risk Limits Rule for groundwater. That process, consisting of a qualitative assessment of multiple exposure sources yielding a numerical relative source contribution (RSC) factor for health risk limits, may be informative to those in the regulatory community who address environmental threats that cross media and population boundaries.

## Poster Presentations

### Wetland Delineation of Problem and Atypical Areas

Wayne Jacobson, Jacobson Environmental, PLLC., jacobsonenv@msn.com

Wetland Delineation is a technical activity which involves the sampling of vegetation, soils, and hydrology to establish a boundary line between upland and wetland habitats. Methodology from the 1987 Corps of Engineers Wetland Delineation Manual is used to determine wetland boundaries along with other procedures that have been developed over the years. This presentation will involve a brief introduction to routine field wetland delineation, and a short discussion of intermediate, comprehensive, offsite and winter delineations. Further, discussion of atypical situations such as delineating 1) unauthorized activities, 2) areas where natural events have impacted wetlands, and 3) man induced wetlands shall occur. Finally, the presentation will cover wetland delineation in typical Minnesota problem areas such as 1) Wetlands on Drumlins, 2) Seasonal Wetlands, 3) Lake Superior Red Clay, 4) Anoka Sand Plain, and 5) Mollisols.

The oral presentation with photographs will be made on powerpoint will include handouts comprising of powerpoint note sheets and the DNR publication "Wetland Types and Definitions". Also, a flyer on the Wetland Delineator Certification Program of the University of Minnesota will be provided.

### Making Sense of Chaotic Water Quality Data for a Well-Head Protection Area Assessment Project

Heather Johnson, Minnesota Department of Agriculture, hjohnson@mda.state.mn.us; Mark Zabel, Minnesota Department of Agriculture; Bruce Montgomery, Minnesota Department of Agriculture; Don Sirecuk, Minnesota Department of Agriculture

Staff of the Minnesota Department of Agriculture has worked with citizens in Perham Minnesota in establishing assessments and management responses for elevated levels of nitrate nitrogen in the well head source water since 1993. Part of the assessment included sampling of private wells in the general area for nitrate nitrogen as both an educational effort regarding the well head protection program and as a method for gathering water quality data. In 2006 further analysis was requested to evaluate the existing data for relevance to effectiveness of BMPs and for trend. The initial review of over three hundred wells sampled since 1993 revealed that data had not been collected in a designed or systematic method. Continued analysis of sampled wells revealed that all wells sampled were not pertinent to analysis of conditions impacting source water for the city wells. Final analysis revealed that judicious use of data and the methods applied lead to differing conclusions.

### The Phosphorus Source Assessment Tool: A Tool for Education and Watershed Planning

Ann Lewandowski, University of Minnesota, alewand@umn.edu; John Moncrief, University of Minnesota; Norman Krause, Central Lakes College; Carl Rosen, University of Minnesota; Bruce Montgomery, Minnesota Department of Agriculture

Many central Minnesota lakes and streams have water quality problems related to excess phosphorus (P). To reduce P inputs to a water body, planners must determine the relative contribution from diverse P sources including agricultural land, septic systems, runoff from developed land, point sources, and others. Sophisticated models exist to assess P loss, but their use is limited by time, money, and expertise requirements. To help educate a broader range of stakeholders and give them the ability to assess potential P sources in a watershed, we modified an existing Excel-based model (the Watershed Treatment Model) making it suitable for central Minnesota. To provide training in the use of this modified tool and to explain risk factors for P loss, workshops were presented in four central Minnesota locations in June 2007. The workshops targeted agency watershed planners as well as lake association leaders. This poster will outline the structure of the assessment tool, and will discuss its uses for education and planning.

### Possible Effects of Arsenic in Drinking Water on Dairy and Beef Products

Barbara Liukkonen, University of Minnesota, liukk001@umn.edu; Vince Crary, University of Minnesota Extension; Michael Murphy, University of Minnesota; James Linn, University of Minnesota; Melinda Erickson, Minnesota Pollution Control Agency

The USEPA's decision to lower the standard for arsenic in drinking water from 50 to 10 ppb has elevated public concern about potential health risks from naturally-occurring arsenic in ground water across the U.S. With funding from the Extension Great Lakes Regional Water Program we conducted an initial study (2004-2005) on dairy cattle from four farms with high arsenic concentrations in well water (>50 ppb). We identified that urine serves as a reliable biomarker of arsenic exposure in dairy cattle and that arsenic was not detected in bulk milk from the four farms. Additional funding from the U of MN's Agricultural Rapid Response program allowed us to further explore the effects of arsenic on dairy products and beef from dairy cattle exposed to arsenic in drinking water.

Private well water was tested on 92 dairy farms in west central Minnesota; eighteen farms were recruited for the second phase of the study. The farms were divided into three groups: high, with arsenic concentrations >40 ppb in their water supply; medium, with arsenic between 10 and 40 ppb; and low, with arsenic levels <10 ppb. The U of MN St. Paul dairy herd, which uses water from a municipal water supply, served as a control.

We sampled feed and mineral supplements, bulk milk, and urine from 6-8 cows on each farm. Milk from the high and low farms was processed into cheese. Meat samples and organ tissue were collected from cull cows. Organ issue was collected from bull calves that were fed milk replacer made from well water for three months.

Arsenic was not detected in any bulk milk samples, cheese, or whey (at 5 ppb detection limit). No arsenic was detected (at 5 ppb detection limit) in any meat samples or organ tissues, except kidney, from cull cows and bull calves.

### Effects of Estrogens on Fecundity, Survival, and Embryonic Development in Daphnia Magna

Timothy G. Loes II, St. Cloud State University Aquatic Toxicology Laboratory, loti0301@stcloudstate.edu; Heiko L. Schoenfuss, St. Cloud State University Aquatic Toxicology Laboratory

Natural and synthetic estrogens are known to be present in the waters of many lakes and river ecosystems. Many of these environments contain invertebrates, such as Daphnia magna, which contribute to the trophic cascade of the aquatic ecosystem as primary consumers. Neonate daphnids (brood parents <24 hrs) were individually exposed to three environmentally relevant concentrations of ethinylestradiol; 0.1 ng/L, 2.5 ng/L and 10 ng/L, for 21 days (n=10 per treatment). Neonates were collected from each beaker and counted daily. A picture of each neonate was taken and survival was determined based on heartbeat. Developmental abnormalities were assessed using a digital camera and dissecting scope. Published 50% mortality rates (LC50) for 17β-estradiol (E2) and ethinylestradiol (EE2) were 2.97 mg/L and 5.7 mg/L respectively. We confirmed LC50 for both compounds using the daphnia cultures in the St. Cloud State University Aquatic Toxicology Laboratory to ensure similar sensitivity of our daphnia cultures. A twenty-one day exposure to EE2 singularly at three environmentally relevant concentrations did not result in increased mortality or incident rates of embryonic developmental abnormalities. There was a positive correlation between the concentration of EE2 and fecundity (i.e., average number of offspring). The average number of offspring per daphnid from the EE2 high treatment was over twice that of the control. Results from additional singular exposures to estrone, 17β-estradiol, and an environmental estrogen mixture will be presented at the conference.

## Poster Presentations

### Constructed Wetlands Provide Stormwater Management and Mitigate Thermal Inputs of Urban Runoff to a Premiere Trout Resource

Corey D. Markfort, Bonestroo, corey.markfort@bonestroo.com; Rich G. Brasch, Bonestroo

The City of Farmington is located along one of the foremost urban trout resources in the upper Midwest. Unlike most growing Cities, Farmington must manage its stormwater for thermal quality as well as chemical quality. The City has experienced significant development since the mid 1990s. The East Farmington expansion led the City to construct an environmental corridor that provides stormwater management functions as well. Known as the Prairie Waterway, this system consists of a network of constructed wetlands and low gradient open channel waterways that drain 12,400 acres of mostly residential development. Runoff from this area is collected in the system and slowly released providing attenuation for runoff peaks, treatment of stormwater and attenuation of surface thermal discharges. By slowing the release of stormwater runoff and shading by native wetland vegetation, increases in temperatures to the River are largely mitigated.

Monitoring of discharge from the Prairie Waterway and temperatures, upstream and downstream in the Vermillion River, between July and September 2006 revealed a relatively small effect of thermal discharge on River temperatures.

### Is Effective and Economical Storm Water Management Treatment for Intensive In-Fill Developments Possible? Yes!

William McCully, Rehbein Environmental Solutions, Inc., wmccully@rehbeinsolutions.com

The Problem:

Wildwood Commons Townhouse development, located in the City of Willernie, MN is an intensive in-fill development with minimal space for traditional stormwater management. Situated near White Bear Lake and in the Rice Creek Watershed District (RCWD), this site required the development of a stormwater management plan which would satisfy the City of Willernie's and RCWD's stormwater management objectives.

The solution:

The poster presentation will illustrate how the installation of a single system satisfied all stormwater management objectives. The EPIC™ system technology was installed in all the available green spaces within this intensive townhouse development. This project solution was a scheduled stop on the 2007 Twin Cities Low Impact Development (LID) tour, recently held in the Twin Cities.

Results:

This "project case study" will show the layout, profile design, site design parameters, detailed cost information on the EPIC™ system installation. We will also present some recent water quality monitoring data (WQ). This WQ data was obtained from a monitoring grant with RCWD and collected by EOR, Inc. It shows the effectiveness of the EPIC™ system which combines biological pre-treatment, sand filtration and mini detention basins within one system. It will also show how subsurface irrigation is possible and how water harvesting and re-use is also feasible with this EPIC™ system technology.

### Effects of Emerging Contaminant Exposures on Innate Behaviors of Larval Fathead Minnows

Meghan R. McGee, St. Cloud State University, mcme0401@stcloudstate.edu; Kent J. Grove, St. Cloud State University; Heiko L. Schoenfuss, St. Cloud State University

A wide variety of emerging contaminants, including xenoestrogens, have been found in anthropogenically altered surface waters. The effects of these compounds on adult fishes, including the fathead minnow, Pimephales promelas, have been well established and include changes in morphology, physiology, and behavior. However, the effects of these compounds on larvae are less clear, and previous studies often considered only lethality and vitellogenin induction as endpoints. In this study, we tested the hypothesis that larval fathead minnows exposed to the emerging contaminants 17β-estradiol (n=120), estrone (n=120), and ethinylestradiol (n=120) singularly and in mixture (n=144) suffer reduced ability to perform innate avoidance behaviors. Fathead minnow larvae, like many other larval fishes, use an innate "C"-start behavior to rapidly move away from any threat stimulus. The C-start response is initiated by central nervous system Mauthner cells (M cells), and a clear connection exists between the activity of a specific Mauthner cell and a discreet behavioral response within the vertebrate nervous system. An auditory or vibrational stimulus of a single M cell results in a discreet and predictable muscular activation thought to correlate with the first stage of the C-start behavior. The contaminants tested are known to affect the hypothalamus -pituitary axis and may either delay the fish's response to a threatening stimulus or decrease the velocity of the ensuing avoidance motion. We used high-speed (1,000 frames per second) video recordings to measure latency period as well as the escape velocity in exposed larval fish. Video recordings were transferred to NIH Image software for frame-by-frame analysis of reaction delay and reaction velocity. Cross-sections of larvae were prepared for histological analysis. Detailed results of these experiments will be presented at the conference.

### Stop, Think, and Drink: Protecting Health through Assessing the Risk of Groundwater Contaminants

Paul Moyer, Minnesota Department of Health, paul.moyer@health.state.mn.us; Helen Goeden – Minnesota Department of Health, Christopher Greene, Minnesota Department of Health

One of the responsibilities of the Minnesota Department of Health's (MDH) Health Risk Assessment (HRA) unit is to calculate health protective values for environmental contaminants. The derivation of Health Risk Limits (HRLs) and Health Based Values (HBVs) can help protect the public against established groundwater contaminants and emerging public health threats. By providing an overview of this assessment process including requests for evaluations, chemical reviews, and rule promulgation, a better understanding of the origin of these values may be gained. Through the examination of some of the key concepts involved in calculating health protective values, an awareness of the meaning and potential application of this information can be achieved. These concepts include reference and benchmark dose, uncertainty factors, intake rates, and the roles that HRLs and HBVs play in groundwater protection.

## Poster Presentations

### Multi-scale Quantitative Mapping of Recharge/Discharge to Ground Water Systems as Related to Freshwater Sustainability in Minnesota

John Nieber, University of Minnesota, nieber@umn.edu; Roman Kanivetsky, University of Minnesota; Boris Shmagin, South Dakota State University; Bruce Wilson, University of Minnesota; David Mulla, University of Minnesota

Multi-scale estimates of recharge/discharge are quantified based on a novel watershed-based methodology that involves the quantification of stream runoff characteristics and their association with landscape components defined as the geology, hydrogeology, the stream network system, relief, soils, vegetation and climate. For ground water recharge estimation the watershed-based methodology is based on analysis of the monthly minimum flow stream runoff component and involves three procedures: (1) System analysis of Earth landscape systems in three-dimensional format; (2) Classification and hierarchical subdivision of the ground water flow field; and (3) Spatial-temporal mapping of the stream flow characteristics. The investigation proceeds from a global to a regional or basin level and then to a local level, with the greater detail available at the smaller scale adding refinement to the description of the landscape components such as hydrogeological units for ground water systems. Within the approach the stream runoff characteristics are determined using a system analysis of overlying layers of the Earth landscape systems (atmosphere, pedosphere, lithosphere, and anthroposphere) and a system of stream basins (i.e. watersheds, representing the hydrosphere). The spatio-temporal structure of the minimal monthly runoff for this system was derived using the methods of multidimensional statistics. The recharge/discharge measurement is not only better than just 'recharge' measurements as a reflection of the natural process of surface and ground water connectivity, but such measurement is quantified by using more reliable codependent empirical data. The methodology was applied to Minnesota in the following four stages: (1) The temporal-spatial variability of global stream runoff was quantified and its pattern was identified; (2) The spatio-temporal structure of stream runoff as well as minimal stream runoff was estimated for the entire state; (3) The recharge/discharge rates were quantified for east-central Minnesota, and (4) For the Twin Cities Metropolitan area (TCMA) the values were derived from results derived for east-central Minnesota, and the minimal annual ground-water recharge/discharge map for TCMA was compiled at a scale of 1:200,000. This methodology demonstrates a mapping technique that has direct practical application to the challenge of freshwater sustainability.

### Adaptation of the Watershed Model SWAT (Surface Water Assessment Tool) to Water Quality Improvement in the Wild Rice River Basin

Jonathan W. Petersen, University of Minnesota, Jonathan.W.Petersen@mvp02.usace.army.mil

With the designation of the Wild Rice River as an impaired water body (per Section 303 (d) of the Clean Water Act) by the Minnesota Pollution Control Agency (MPCA), there is considerable local interest in improving river conditions. The river is considered impaired due to unacceptable suspended sediment concentrations and turbidity. This study aims to evaluate the Surface Water Assessment Tool (SWAT) capabilities to match daily gauged records of flow and sediment yield, as well as Best Management Practices (BMPs) effectiveness. Model capabilities were evaluated using Nash-Suttcliffe (N-S) and Root-Mean-Square (R2) error functions. Model results are strong for both flow and sediment total balance and daily comparison to gauge data. For flow calibration N-S is 0.6 and R2 is 0.59, and flow validation N-S is 0.75 and R2 is 0.7. Sediment calibration N-S is 0.67 and R2 is 0.65, and sediment validation N-S is 0.57 and R2 is 0.65. Due to large variances in watershed properties, including slope, land use and soils, sub-watersheds sediment yield also has large variances and is summarized in order to direct future sediment reduction practices. Sediment delivery ratios (SDR) for individual sub-watersheds varied considerably, however compared well to common SDR relationships. BMPs evaluated in SWAT include agricultural practice modifications, filter strips, wetlands, and ponds; results for the Wild Rice River match related studies very well. However, not all BMPs typically used to reduce sediment are able to be modeled in SWAT, including streambank fencing, stream stabilization, and grassed waterways. An estimate of the sediment reduction required to meet TMDL guidelines, based on recent gauged data, is 85%. Therefore, obtaining de-listing status for the Wild Rice River will require a considerable effort; however, with the findings from this report and others, specific areas should be targeted which will obtain maximum reductions of sediment to the river.

### An Inexpensive Flow-Proportional Sampler for Tipping Buckets

Michael P. Russelle, USDA-ARS, Michael.Russelle@ars.usda.gov; Warren E. Rugger, Jr., USDA-ARS

Reliable evaluation of water quality requires accurate assessment of contaminant concentrations, often in conjunction with quantification of flow volume. Short-duration, high-concentration flow events can be missed with occasional grab sampling. Although powered, programmable units that collect samples on a time-, event-, or flow volume-basis are available, they often are not affordable, especially when monitoring several collection sites. We developed a simple, reliable way to collect flow-proportional water samples from tipping buckets, which are used often for flow measurement. The samplers are constructed from readily available materials. It is time-consuming to calibrate and test each collector, but they collect a reasonably constant volume of water per tip. With acid preservation and adequate bag volume, sampling intervals for nitrate can be at least 7 days apart. This new sampler offers a robust, affordable way to collect high-quality samples from subsurface tile drain flows and runoff plots.

### Incorporating Risk and Uncertainty for Evaluating Infiltration and Volume Control

Wesley Saunders-Pearce, Houston Engineering, Inc., Wsaunders-pearce@houstonengineeringinc.com

Controlling stormwater runoff volume is becoming a common industry practice. Incorporating volume control during land disturbance activity, or identifying retrofit opportunities in developed areas, is a tool to address and improve water quality and downstream resources. Most often, the benefits assigned to infiltration and volume control are assessed based on a design event – a single hypothetical storm associated with a statistically derived frequency of occurring. Given that most runoff controlled by infiltration practices are below the magnitude of the design event, how certain is it that the intended benefit is achieved?

This poster highlights a different, innovative approach for evaluating infiltration and volume control to address an unstable ravine system. The case study will examine the uncertainty associated with estimating runoff conditions, both from "existing" and urbanized conditions. This poster illustrates ways to incorporate probability and risk into watershed modeling, especially important for assessing the frequency and magnitude of runoff affecting an unstable ravine system. Results show that a design event based approach can have substantial limitations in evaluating the benefit associated with infiltration and volume control.

### A Water-Based Nitrogen Budget for the University of Minnesota St. Paul Campus

Erica Schram, University of Minnesota, schra163@umn.edu; Jim Perry, University of Minnesota, Deborah Swackhamer, University of Minnesota

Urban, agricultural, and other sources of nitrogen can negatively impact natural resources. The St. Paul Campus of the University of Minnesota has water resources at risk from nitrogen pollution. To evaluate the sources and amount of nitrogen reaching ground and surface water on campus, a water-based nitrogen budget was developed. The budget included commercial fertilizer, animal manure, atmospheric deposition, and biological fixation as inputs. Outputs were agricultural export, crop senescence, leaching to groundwater, denitrification, volatilization, and surface water flow. The total input to the campus system for 2005 was 10718 kg of nitrogen, while the total output was 9365 kg of nitrogen. Total outputs of nitrogen to groundwater accounted for 7.1% of the inputs, and outputs to surface water accounted for 5.1% of the inputs. The results of this budget can be used to focus nitrogen management on campus to provide the greatest reductions in nitrogen export to ground and surface water.

## Poster Presentations

### Saving a Desert Lake: The Role of Modeling in Reversing the Decline of Walker Lake, Nevada

Ted Shannon, HDR Engineering, Inc., tshannon@hdrinc.com

Walker Lake ("lake") is a terminal lake in western Nevada, one of the few existing remnants of the prehistoric Lake Lahontan. The Walker River Basin ("basin"), in which the Lake is located, spans the states of California, Nevada, and the Walker River Paiute Indian Reservation. The basin has a unique hydrologic characteristic of being predominately isolated from other basins. This is also true within the basin, with flow between the six valley regions primarily confined to the river and river alluvium.

At the beginning of the 1900s, the lake contained nearly four million acre-feet of water. Salinity was relatively low, and the lake is home to two endangered fish species. The condition of the lake has dramatically changed with build-out of irrigation in the basin. The adjudication of surface water rights in 1935 and increased groundwater pumping following the Second World War resulted in reduced river flows to the lake. Lake levels have fallen by over 100 feet to a recent volume of under two million acre-feet. The change in volume has resulted in corresponding higher salinity levels. If left unaltered the collapse of the fish population, economic losses of recreation and other environmental changes are possible.

Several multi-stakeholder processes involving federal, state, county, tribal, and irrigation district entities have been active. This poster will cover the role of modeling and analysis in assessing the effectiveness of possible solutions being considered to stabilize or reverse the decline of Walker Lake, as described by the current Walker Basin Project. As the stakeholder process is still on-going, the poster and discussion will be limited to publicly available information.

### New Mexico State University Study Investigating Various Approaches to Irrigating Turf Grass

Bret Shroyer, Rehbein Environmental solutions, Inc., bshroyer@rehbeinsolutions.com

Given the increase in both the demand for agricultural irrigation and the increasing scarcity of available water, there have been steady improvements in the efficiency of agricultural irrigation over the last decade. Subsurface irrigation, for example, presents immediate savings when compared to sprinkler systems, as it avoids evaporation and delivers water directly to the plants via appropriately placed emitters. This same approach cannot be directly applied to the subsurface irrigation of turf grass, including golf courses, sports fields, and landscapes. The plants are not arranged in a linear fashion, as in an agricultural setting.

This presentation will share the experimental design and results of a study conducted by the University of New Mexico investigating various approaches to irrigating turf grass. In particular, the study uses the test case of a sloped golf green, using various growing media and various irrigation methods. The significant results of the study indicate that a particular emerging technology exceeds all other approaches studied, by simultaneously:

- Using the smallest volume of water
- Maintaining the highest soil moisture content
- Attaining the highest turf quality at all stages of slope
- Consistently outperforming other systems at all points throughout the calendar year

The presentation will also extrapolate upon these results, showing how this same technology can be, and indeed already been, used to

- Minimize water demand in water-scarce areas
- Utilize grey water reclaimed water sources
- Clean and recycle water

**Precipitation Data Retrieval Tool for Wetland Delineation Efforts**

Greg Spoden – State Climatology Office, Minnesota Department of Natural Resources, greg.spoden@dnr.state.mn.us

Any analysis of wetland hydrology for a particular location requires an evaluation of the precipitation regime leading up to the time of interest. Assessing the precipitation regime involves two components: quantifying the precipitation amounts leading up to the time of interest, and describing those precipitation amounts in historical context. Creating a serially complete precipitation data time series for a particular location can be a difficult and time-consuming exercise. The Minnesota State Climatology Office offers users access to a "synthetic" precipitation data set via a Web-based retrieval tool. The synthetic data are made up of regularly spaced grid nodes whose values were derived using interpolations from Minnesota's outstanding historical precipitation database. Using the Web application, the user can generate a precipitation data time series and summary statistics for any location in Minnesota. The poster paper will explain the techniques used in creating the synthetic data set, and provide the viewer with examples of output from the Web application.

**Mn/DOT Metro District's MS4 Program**

Kellie Thom, Minnesota Department of Transportation, Kellie.Thom@Dot.state.mn.us; Barb Loida, Minnesota Department of Transportation

Mn/DOT Metro District is a designated MS4 program. Our display board and educational materials summarize our efforts as well as informing the public what they can do while traveling to help minimize stormwater pollution.

**Watonwan River Watershed Citizen Stream Monitoring, 2000-2006**

Bill Thompson, Minnesota Pollution Control Agency, bill.thompson@pca.state.mn.us

The Watonwan River is a major tributary to the Blue Earth River, and drains 851 square miles of land area in portions of three south-central Minnesota counties (Watonwan, Cottonwood, and Blue Earth Counties). The Watonwan River watershed system includes about 311 miles of perennial streams. Citizen volunteer stream monitoring for this county-led watershed project began in 2000 with 11 volunteers. These dedicated volunteers have used Minnesota's Citizen Stream Monitoring Program (CSMP) methods to record stream water transparency data from a variety of different types of sites across the watershed. Volunteer data has been useful to "fill in the gaps" temporally and spatially. The pros and cons of this type of monitoring network will be illustrated and discussed, in terms of volunteer resources, local government support and assistance, usefulness for TMDL and effectiveness monitoring needs, and comparisons to standard water quality monitoring stations. Possible changes to improve upon the basic CSMP for this watershed will also be introduced.

**Spatial and Temporal Variation of Mercury in Minnesota Streams and Rivers**

Martin T.K. Tsui, University of Minnesota, tsuix010@umn.edu; Edward A. Nater, University of Minnesota; Jacques C. Finlay, University of Minnesota

We analyzed total mercury (Hg) concentration and factors thought to influence Hg transport in 13 streams and rivers in eastern and southern Minnesota that spanned gradients in land use and climate. During mid-March 2007, we found that stream water near St. Croix State Forest contained much lower Hg concentrations (2 to 19 times) than at sites within Twin Cities and near Mankato. This pattern was related to the onset of snowmelt, which has not occurred in the northern sites. Despite the very different land use patterns at these sites (agriculture, urban, forested, groundwater-fed), Hg concentrations during March had moderate relationships with both dissolved organic carbon and total suspended solids in the water, indicating a strong terrestrial control of Hg in the water. Further on-going investigation of these patterns will help to determine if the relationship between total Hg and dissolved organic carbon persists over time for all land use types.

**Use of Minnesota's Renewable Water Resources: Moving Toward Sustainability**

Princesa VanBuren, Minnesota Environmental Quality Board, princesa.vanburen@state.mn.us; John Wells, Minnesota Environmental Quality Board

Minnesota Statutes, section 103A.43 directs the Environmental Quality Board and Department of Natural Resources to conduct a biennial assessment of the availability of water to meet the state's long range needs. The most recent report, Use of Minnesota's Renewable Water Resources: Moving Toward Sustainability, was completed April 2007, with ongoing activities in preparation for the next biennial reporting.

The assessment compared current supply estimation techniques with permitted water use data over the period 1995-2005 on a county level. Additionally, water use values were projected to 2030. The analysis found that counties in the Twin Cities-St. Cloud growth corridor already place significant demands on their water resources, making water supply management a special concern. In the remainder of the state, because water is not evenly distributed, care must be taken by local and state officials in planning to meet new demands.

**Results from Seven Years of Groundwater Monitoring for Agricultural Chemicals in the Sand Plains of Central Minnesota**

Mark Zabel, Minnesota Department of Agriculture, mzabel@mda.state.mn.us, and John Hines, Minnesota Department of Agriculture

In the first quarter of 2000 the Minnesota Department of Agriculture implemented a groundwater monitoring project in the Minnesota Department of Agriculture Pesticide Monitoring Region 4 (Central Sands). This reflects implementation of a groundwater monitoring design specific to evaluating impacts of normal use of agricultural chemicals in intensive row crop agricultural settings to surficial aquifers in the glacial outwash sands of central Minnesota. This network is sampled on a quarterly basis from a subset of eighty five sites distributed across ten counties. This presentation/poster will provide an overview of the results of the past seven years of repeated quarterly sampling on this network of sites.

*Wednesday, October 24*

## Plenary Session 8:10 – 9:30

### Biofuels Production: Implications on Water Quality and Quantity

Steve Taff, Department of Applied Economics, University of Minnesota, and Mark Collins, HDR Engineering, Inc.

## Concurrent Sessions IV 10:00 – 11:30

## Track A: Management of Stream Habitats

### Forest Harvest Effects on a Northern Minnesota Stream System: Nine Years Later

Eric Merten, University of Minnesota, mert0042@umn.edu; Raymond Newman, University of Minnesota; Bruce Vondracek, U.S. Geological Survey, MN Cooperative Fish and Wildlife Research Unit, and University of Minnesota; Nat Hemstad, Inver Hills Community College; Lucinda Johnson, University of Minnesota-Duluth; Randall Kolka, U.S. Forest Service; Sandy Verry, Ellen River Partners, Inc.; Sue Eggert, U.S. Forest Service

Riparian forests provide a wide variety of ecosystem benefits that include erosion control, a supply of leaf litter and wood, and shade for aquatic systems. Tree harvest in riparian areas can diminish or negate these benefits for a period of time. We examined the effects of riparian logging on Pokegama Creek in north central Minnesota nine years after Best Management Practices were implemented during a timber harvest. Some basin-scale effects that had been documented in the first few years after harvest were still evident, whereas other variables had recovered; for example, an initial pulse of fine sediments was still present although eroding banks have been revegetated. Brook trout abundance and fish IBI were also reduced nine years after harvest. Most other responses showed high variability, thus could not be attributed to effects of harvest.

### Completing the Incidental Take Permit Process for the Endangered Topeka Shiner

Jeff Madejczyk, Wenck Associates, jmadejczyk@wenck.com; Dennis Healy, Lincoln Pipestone Rural Water

The Topeka shiner (Notropis Topeka) is Minnesota's first federally-listed endangered fish. This small silver minnow lives in prairie streams of the Missouir River basin in southwestern Minnesota. The Topeka shiner is a pool species that prefers areas with clean, cool, well-oxygenated water that has depths of two meters or less, and velocity less than one meter/second. Due to it's endangered status, private or public entities who are proposing actions that may impact the Topeka shiners are required to apply for an Incidental Take Permit from the U.S. Fish and Wildlife Service. The Lincoln-Pipestone Rural Water Association learned that they would need an Incidental Take Permit to expand the production capacity of the existing wellfield in Adrian, Minnesota. My presentation will describe the permitting process including: Topeka shiners surveys in the stream near the wellfield; estimating the wellfield's potential impacts on Topeka shiners in the stream; mitigation strategies to offset potential impacts; and completion of the Incidental Take Permit application to the U.S. Fish and Wildlife Service.

### Using a Dimensionless Multivariate Analysis Technique to Explore the Landscape Influence on Stream Ecosystem Health

Mark B. Green, University of Minnesota, mgreen@umn.edu; Bruce N. Wilson, University of Minnesota; John Nieber, University of Minnesota; James Perry, University of Minnesota; and Bruce Vondracek, University of Minnesota and United States Geological Survey, Minnesota Cooperative Fish and Wildlife Research Unit

Stream ecosystem management requires understanding how the landscape influences biological health. The University of Minnesota has examined the relationships between landscape variables with stream ecosystem health metrics (index of biotic integrity, total suspended solids, nutrients, and dissolved oxygen). Previous efforts using multiple linear regression provided important insights, but making relationships dimensionless allows a more general understanding of landscape control on stream health. Furthermore, the dimensionless approach allows an extension of the general relationship to regions with limited data. Results show the method's promise for understanding and predicting the landscape influence on stream ecosystem health, and should have important applications in other aspects of watershed science. This presentation provides a brief background on the dimensionless approach and summarizes our specific results.

## Concurrent Sessions IV 10:00 – 11:30

### Track B: Managing and Modeling Water in Agricultural Landscapes

**Drainage Water Management to Reduce Edge-of-Field Nitrate Loss in Southwest Minnesota**

Stacey E. Burns, University of Minnesota, burn0263@umn.edu; Jeffrey S. Strock, University of Minnesota

Agricultural runoff has contributed to the decline of water quality in the Minnesota River and many of its tributaries. Drainage water management is the practice of using a water table control structure to manage the depth of the drainage outlet. Water table control structures allow the water table to be managed in undrained (water table near the soil surface), conventional drainage (water table at the drain depth), or drainage water management (water table maintained at a predetermined depth) modes. The objective of this field study was to evaluate the performance of drainage water management to reduce drainage discharge and nutrient loads to surface water under Minnesota conditions. This study was conducted in Redwood County at the Hick's Family Farm near Tracy, MN. The field site consisted of two management zones, one 22 ha and the other 15 ha. Drainage discharge, nitrate-nitrogen and total phosphorus (TP) loads, crop yield, and drainage system performance from 2006 and 2007 will be presented. If drainage water management is found to perform well in Minnesota, it has the potential to be implemented on up to 1 million acres of artificially drained land. Benefits may include reduced nutrient loads to surface water and improved crop yields.

**Ditch Management to Mitigate Nonpoint Source Pollution**

Jeffrey Strock, University of Minnesota, jstrock@umn.edu

New, innovative Best Management Practices are needed to reduce agricultural nonpoint source pollution of surface waters. In artificially drained agricultural landscapes, drainage ditches transport excess water, sediment, bacteria, pesticides, and dissolved nutrients from fields to rivers and streams. The objective of this study was to measure the effects of managing ditch hydrology on drainage discharge and nitrogen and phosphorus concentration and loss. This study was conducted at the University of Minnesota, Southwest Research and Outreach Center near Lamberton, MN. Two parallel vegetated ditches consisted of treatment and control channels. A water-level control structure, located at the outlet of the treatment channel, was used to impound water in the channel to a depth of 0.46 m (18 in.). During 2006, reductions in nutrient concentrations from the treatment ditch were observed. Results from 2006 and 2007 will be presented. If this strategy is proven successful, it would be a simple, inexpensive method for mitigating nonpoint source pollution for agricultural producers.

**Simulation of Storm Runoff Using the Gridded Surface Subsurface Hydrologic Analysis (GSSHA) Model**

Brennon Schaefer, Houston Engineering, Inc., bschaefer@houstonengineeringinc.com; Greg Eggers, TetraTech, EM; and John Nieber, University of Minnesota

This presentation describes a project involving the modeling of two headwater watersheds located in an agricultural region of southeastern Minnesota. The watersheds were monitored as a part of a U.S. Environmental Protection Agency (EPA) National Monitoring Program (NMP) project. To be a useful assessment tool, the various hydrologic components in the model need to be correctly simulated. Ground water and surface water interactions in the study area make modeling hydrologic systems in the area difficult. The Gridded Surface Subsurface Hydrologic Analysis (GSSHA) model, a physically-based, distributed parameter model developed by the United States Army Corps of Engineers (USACE), was selected to model the complex hydrology of the watersheds. The hypothesis of this study was that the GSSHA model could effectively simulate the hydrology of the study watersheds, using data collected under the monitoring program. Results showing comparisons of the predicted runoff hydrology to observed runoff hydrology will be presented.

## Concurrent Sessions IV 10:00 – 11:30

## Track C: Transportation Drainage

### Storm Sewer Pipe Dreams: The Challenge of Delineating Urban Watersheds

Steve Kloiber, Metropolitan Council, steve.kloiber@metc.state.mn.us

There are major challenges in modeling water quality for urban watersheds that seem to get little attention. One of these challenges is the difficulty in adequately characterizing urban drainage paths in the presence of storm sewers and other cultural drainage alterations. Lake-watershed boundaries were mapped for more than 100 lakes in the Twin Cities region using a semi-automated delineation method. This process utilized the ArcHydro model and other GIS tools to modify the height-of-land watershed boundaries by incorporating cultural drainage features into a flow network. Problems encountered during this watershed mapping project will be discussed along with practical short-term solutions for semi-automated watershed boundary delineation in urban areas. A long-term strategy for improved urban watershed mapping is proposed.

### Pervious Pavements—An Emerging Technology for Storm Water Management in Minnesota

Bernard Izevbekhai, Minnesota Department of Transportation, bernard.Izevbekhai@dot.state.mn.us; and Matthew Lebens, Minnesota Department of Transportation

Changes in watershed district guidelines, and efforts toward "green" construction design, led to the development of improved tools to address storm water management on and near roadways. Minnesota cities and private corporations have proposed pervious pavements as a solution for reducing or controlling storm water runoff from roads and parking lots. While pervious pavements have been used in warmer climates, their performance is still under study for application in cold climates. To increase understanding of pervious pavements in Minnesota, experimental test sections have ether been built, or are being built around the State and at the Minnesota Road Research facility (MnROAD). This presentation will outline the goals of the experimental designs at MnROAD, as well as design and construction of pervious pavements in Minnesota.

## Track C: Transportation Drainage, *continued*

### Minnesota Local Road Research Board (LRRB): Investigating Water Resources Issues and Improving Storm Water Management

Alan Rindels, Local Road Research Board, alan.rindels@dot.state.mn.us; Krysten Saatela, Minnesota Department of Transportation

Established in 1959 through state legislation, the Minnesota Local Road Research Board (LRRB) has sponsored more than 150 individual projects on a variety of topics. LRRB research generally falls under four main goals: design, construction, maintenance/operations, and environmental compatibility. Related to water resources under the goal of environmental compatibility, LRRB established strategies to conduct research related to the effects of design, construction, and maintenance on the natural environment (soil, water, air, plants, and animals) including storm water management and erosion control and to conduct research on mitigating environmental impacts of public roadway infrastructure at the source, such as porous pavements, quiet pavements, warm asphalts, culverts, etc.

Each fall the LRRB solicits for research proposals. Currently, the LRRB has committed over $600,000 of funding to ongoing and upcoming water resources research being performed by the University of Minnesota. This research spans to include roadway subsurface drainage practices, storm water management practices and devices, stream geomorphology, and the environmental effects of deicing salt on water quality.

The presentation will be focused on the rich history of the "LRRB's Historical Funding of Water Resources Projects;" explore currently funded projects and explain the role of City and County Water Resources Professionals in identifying and managing future research topics in the subject areas of the conference.

Upcoming Research Principal Investigators

- The Impact of Stream Geomorphology and Fish Passage Requirements on Construction Costs of Culvert Structures in Minnesota: John Nieber, Bruce Wilson
- Assessment of the Underground Storm Water Management Devices under High Flow Conditions: Omid Mohseni, John Gulliver

Ongoing Research Principal Investigators

- Evaluating Roadway Subsurface Drainage Practices: John Nieber, Gary Sands
- Design Tool for Controlling Runoff and Sediment from Highway Construction: Bruce Wilson
- Assessment of Storm Water Management Practices on the Water Quality of Runoff: John Gulliver, Omid Mohseni
- Study of Environmental Effects of Deicing Salt on Water Quality in Minnesota: Heinz Stefan, Omid Mohseni
- Subsurface Drainage Manual for Pavement in Minnesota: John Nieber

Recently Completed Project Report Authors (June 2005 – Jan 2007):

- Erosion Risk Assessment Tool for Construction Sites: Bruce Wilson, Aleksey Sheshukov, Reid Pulley
- Impact of Alternative Storm Water Management Approaches on Highway Infrastructure: Guide for Selection of Best Management Practices – Volume 1, Caleb Arika, Dario Canelon, John Nieber, Robert Sykes
- Impact of Alternative Storm Water Management Approaches on Highway Infrastructure: Project Task Reports – Volume 2, Caleb Arika, Dario Canelon, John Nieber, Robert Sykes
- The Cost and Effectiveness of Storm Water Management Practices: Peter Weiss, John Gulliver, Andrew Erickson

## Concurrent Sessions IV 10:00 – 11:30

## Track D: Sediment and Turbidity Issues Become More Transparent

### River Turbidity and the Optics of Suspended Sediment

Robert O. Megard, University of Minnesota, megar001@umn.edu

The Mississippi River, Minnesota River, and many other rivers are impaired by high turbidity, due to high concentrations of suspended sediment. The optical properties of the suspensoids that cause river turbidity have received little study, but they must be understood in order to estimate the amount of sediment reduction that will be needed to attain future management targets. I used optical equations and data obtained by several agencies during the past 20 years to evaluate coefficients that link both organic and inorganic suspensoids to turbidity and transparency in the Mississippi and Minnesota Rivers. The analysis exposes important misconceptions about the causes of turbidity and a mechanistic basis for predicting river turbidity from suspensoid concentration.

### Sediment and Nutrient Load Measurements in Western Lake Superior Streams: In-Stream Turbidity Sensors Versus Grab Sampling and Modeling

Elaine Ruzycki, University of Minnesota-Duluth, eruzycki@nrri.umn.edu; Richard Axler, University of Minnesota-Duluth, Jerald Henneck, University of Minnesota-Duluth, Norm Will, University Of Minnesota-Duluth, George Host, University of Minnesota-Duluth

Urbanization and rural development are putting pressure on Duluth and north shore Lake Superior trout streams. Stormwater flows with higher volume and peak values, pollutant loads, and temperature all can degrade the streams and coastal zone of oligotrophic Lake Superior. LakeSuperiorStreams.org began in 2002 as a City-University-Agency partnership to use in-stream, intensive (15 min) real-time water quality data and interactive, web-based data animation-visualization tools and interpretive materials to help educate the region about stormwater issues and the connections between watershed activities and the condition of Superior Basin waters. Grab samples for other water quality parameters are collected ~20 times/yr emphasizing snowmelt runoff and major rainstorms. The accuracy of using intensive turbidity values as a surrogate for total suspended sediments has been assessed for three urban streams since 2002 and for two north shore streams since 2006. Regression models have also provided estimates of nutrient loads which are compared to those using FLUX software, a standard assessment technique.

### Determining "Normal" Levels of Fine Sediments in Lake Superior North Shore Streams Using Aquatic Macroinvertebrates

Valerie J. Brady, University of Minnesota Duluth, vbrady@umn.edu; Dan Breneman, University of Minnesota Duluth; Nathan Schroeder, South Saint Louis Soil and Water Conservation District

Many streams along Lake Superior's north shore flow through unstable clay soils, leading to fine sediments embedding the substrate and high turbidity levels during runoff events. A number of Lake Superior tributaries are listed as impaired due to turbidity. Currently it is unclear what levels of embeddedness and turbidity should be considered "normal" for these stream types vs. excessive due to human impacts. We compared stream invertebrate assemblages to determine the amounts of stream embeddedness, suspended solids, and turbidity that led to assemblage differences. Preliminary analyses indicate that moderate to high levels of embeddedness cause invertebrate diversity to decrease due to a loss of sensitive taxa, particularly mayflies, caddisflies, and stoneflies. Invertebrates in embedded areas often had traits that made them less sensitive to excessive fine sediments. Determining linkages between habitat condition and land use alterations within these watersheds is critical to understanding and addressing this issue.

*Wednesday, October 24*

## Luncheon Presentation 12:15 – 1:00

### The National Water Research Agenda: Dawning of a New Era of Agency Collaboration

Patrick L. Brezonik, National Science Foundation and Department of Civil Engineering, University of Minnesota

## Concurrent Sessions V 1:15 – 2:45

## Track A: Steam Morphology and Restoration

### The University of Minnesota Multi-Purpose Riparian Demonstration Project

Chris Lenhart, University of Minnesota, lenh0010@umn.edu; Kenneth Brooks, University of Minnesota; Craig Sheaffer, University of Minnesota; Joseph Magner, Department of Forest Resources and University of Minnesota, Linda Meschke, Rural Advantage, Inc.

A multi-purpose riparian system is now being installed near Huntley, Minnesota on Elm Creek, with funding from the EPA. A cooperative project between landowners, university, government and non-profit organizations, the site will demonstrate alternative agricultural systems for use in riparian zones that provide ecological and economic benefits. The project will reduce stream channel erosion, enhance wildlife habitat, establish alternative perennial cropping systems, stabilize upland gullies, and employ rotational grazing. Components of the plan include: re-establishment of stable natural channel dimensions, installation of perennial crops on high terraces, floodplain forest restoration, and reconnection of oxbow channels at peak flows to restore floodplain functionality. The impact of the project on the sites' hydrologic, vegetative and soil characteristics will be monitored over several years. Expected benefits include: reduced sediment loading, improved floodplain connectivity, pasture productivity, crop diversity, and identification of channel management practices that are affordable at larger watershed scales.

### Evaluating the Morphodynamic Evolution of a Semi-urbanized Stream: Riley Creek, Minnesota

Miguel Wong, Barr Engineering Company, mw1@barr.com; Janna Kieffer, Barr Engineering Company, Jeff Weiss, Barr Engineering Company

Riley Creek is a small tributary of the Minnesota River, which in its lowest 4.4-mile course varies downstream from a deeply incised, highly entrenched channel carving in loamy till to a more stable, steeper gradient stream flowing through outwash deposits of sand and gravel. Changes in the hydrology and sediment supply of the watershed have occurred during the past century, in particular after the shift from field to row crop agriculture beginning in the early 1950s and subsequent urban sprawl beginning in the late 1980s. As a result, it is hypothesized that the morphology of this stream is evolving toward a new morphologic equilibrium configuration. To evaluate the morphodynamic evolution in Riley Creek since pre-European settlement times, we propose to apply a methodology that connects hydrologic and sediment production processes taking place in the watershed with the hydraulics and sediment transport responses along the stream corridor. This methodology is alternative to the standard approach used for evaluating the stability of a stream, which simplifies the assessment to a static view (snap-shot) of its morphologic configuration in a given time and to the representation of the driving force by a single value (e.g., the bankfull discharge).

### Quarry Hill Ravine and Streambank Stabilization

Jonathon Kusa, Howard R. Green Company, jkusa@hrgreen.com; Marty Melchior, Inter-Fluve, Inc.; Barbara J. Huberty, Rochester Public Works Department

Solutions to erosion issues in an urban ravine and stream environment with Karst geology were recently started using a blend of traditional and bioengineering techniques on a City of Rochester project. The team of Howard R. Green Company and Interfluve resolved several stabilization problems in Quarry Hill Park resulting from a variety of historical land use impacts. The interrelated problems were bank erosion, head cuts, incision, sediment transport, induced groundwater discharge, and wetland dewatering. These issues were simultaneously addressed with design solutions including bioengineered bank stabilization, a wet pond, a filtration basin, an infiltration basin, a groundwater control trench, storm sewers, and a return to native vegetation.

## Concurrent Sessions V 1:15 – 2:45

## Track B: Emerging Issues in Agricultural Water Quality

### Antibiotic Transport in Percolation and Runoff from Manure-Amended Soil

Holly A.S. Dolliver, University of Minnesota, hswanson@umn.edu; Satish C. Gupta, University of Minnesota

There is growing concern that land-applied antibiotics in manure are reaching surface and ground waters and contributing to the development and spread of antibiotic resistance in the environment. The objective of this three-year field study was to quantify both seasonal and annual leaching and runoff losses of chlortetracycline, monensin, and tylosin from land application of manure under two tillage systems. The study was located in a karst landscape, with shallow macroporous soil. Manure sources were solid beef manure (chlortetracycline, monensin, and tylosin) and liquid hog manure (chlortetracycline and tylosin). Tillage treatments were chisel plowing and no-tillage. There was large variation in annual antibiotic losses during the study period. Chlortetracycline losses only occurred in runoff, while monensin and tylosin losses occurred in both leachate and runoff. Highest concentrations of monensin and tylosin in the leachate were 40.9 and 1.2 μg L-1, respectively. Highest chlortetracycline, monensin, and tylosin concentrations in runoff were 0.5, 57.5, and 6.0 μg L-1, respectively. The majority of antibiotic losses occurred during the non-growing season, due to fall manure application and slow degradation of antibiotics at cold temperatures. For all three antibiotics, greater than 90% of antibiotic detections and 99% of the total leaching and runoff antibiotic losses occurred during the non-growing season in all three years. During years of high snowmelt, runoff accounted for nearly 100% of total antibiotic losses, whereas during years of minimal snowmelt, runoff accounted for approximately 40% of total antibiotic losses. Total antibiotic losses were generally higher from the no-tillage compared to chisel plow treatment. This was due to greater water percolation as a result of macroporosity and greater runoff due to lack of surface roughness in the no-tillage plots during the non-growing season. Relative mass losses of chlortetracycline, monensin, and tylosin were generally less than 1% of the total amount applied with manure. The results from this study suggest that small quantities of antibiotics could potentially reach surface and ground waters as a result of losses from manure-amended agricultural land.

### A Link Between Pesticides and Nitrate-Nitrogen in Groundwater

John W. Hines, Minnesota Department of Agriculture, jhines@mda.state.mn.us

This presentation discusses the link between pesticides and nitrate-nitrogen in groundwater samples collected from around the state of Minnesota. Pesticide and nitrate data from samples collected at monitoring wells and domestic drinking water wells were compared to determine whether such a link exists. Results of this analysis indicate that it is not possible to predict the concentration of pesticides in a well from the concentration of nitrate in that same well. However, it appears that mobile pesticides are more likely to be detected in a well when nitrate-nitrogen concentrations increase beyond natural background levels. Data analyzed for this report shows much higher probabilities of detecting a pesticide when nitrate-nitrogen levels rise above 3.0 parts-per-million. When levels of nitrate go above 10.0 parts-per-million the likelihood of detecting a pesticide increases even more. Different aquifer types have different actual percentages of wells containing pesticides at various nitrate ranges, although the general shape of the relationship across nitrate ranges is similar for all aquifer types.

## Concurrent Sessions V 1:15 – 2:45

### Track B: Emerging Issues in Agricultural Water Quality, *continued*

**A Fluid Success Story: Conservation Implementation in the Redwood and Cottonwood River Watersheds of the Minnesota River Basin. A Reflection of Twenty-fourYears in a Successful JPO Partnership.**

James Doering, Executive Director, Redwood-Cottonwood Rivers Control Area, jim.doering@mn.nacdnet.net

This presentation will highlight the endeavors of the Redwood-Cottonwood Rivers Control Area (RCRCA). An eight County Joint Powers Organization (JPO) pursuant to MN State Statute 471.59. A brief history of the key grassroots efforts that preceded the formation of JPO will be discussed while emphasizing the importance of organizations such as this having a green foundation. Key aspects of BMP implementation success will be presented over this time span and the challenge to enumerate these watershed activities. Significant pollutant reduction trends will be presented based on an annual water quality monitoring program which began in 1990 and continues to the present. Finally, a quick update of the current Total Maximum Daily Load efforts in the watersheds will be discussed, followed by an exciting outlook to the future of RCRCA and non-point source pollution reduction in the watersheds while facing high corn and land prices.

## Concurrent Sessions V 1:15 – 2:45

## Track C: The New Age of Low Impact Development

### Volume Reduction and Sustainable Design at the Washington County South Service Center

Erin Krueger, SEH, Inc., ekrueger@sehinc.com; Dan Cazanacli, SEH, Inc., Veronica Anderson, SEH, Inc.

The Washington County South Service Center serves as an important extension of County services for the southern portion of the County. The County adopted sustainable design requirements, and one important aspect of this design was the storm water management system. The project is located in the City of Cottage Grove, and is within the South Washington Watershed District. The Washington Conservation District was also involved in review of the design. The goal of the design of the storm water management system was to provide volume control and minimize the amount of runoff volume as much as possible. The design consisted of Low Impact Design elements such as raingardens and infiltration basins. The overall system achieves zero runoff for events up to and including the 2.0-inch storm event. The raingardens and infiltration basins were planted with native vegetation that will enhance the features and assist in the infiltration/filtration capabilities. This presentation will go through the interesting aspects of the design of this system, including sizing of the system, construction diversion methods, construction staging, and landscape plantings.

### Evaluation of the Effectiveness of Low-Impact Design Practices

William Selbig, U.S. Geological Survey

As development continues to push further into the natural landscape, controlling nonpoint sources of contamination has become a major focus for the regulatory community. Land that was once covered with vegetation is commonly replaced with impervious surfaces introducing more diverse pollutants, reducing infiltration, and increasing runoff volumes and peak flows. 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. The U.S. Geological Survey, in cooperation with the Wisconsin Department of Natural Resources, evaluated two residential basins in Cross Plains, Wisconsin, from 1999 through 2005. A paired-basin study design was used to compare the hydrologic and water quality characteristics of two basins representing different construction philosophies. The fully developed "conventional" basin consisted of curb and gutter, 40 foot street widths, and a fully connected stormwater conveyance system. The LID basin utilized grassed swales, reduced impervious area (32 foot street widths), street inlets draining to grass swales, a detention pond, and an infiltration basin. Data collected in the LID basin represented predevelopment through near complete build-out conditions. Comparison of runoff volumes and loadings of total solids, total suspended solids, and total phosphorus in stormwater runoff between the two basins were used to evaluate hydrologic and water quality benefits of a low-impact design.

Annual loads, normalized by basin area, were estimated to characterize the overall effectiveness of low-impact design practices at mitigating delivery of total and suspended solids, and total phosphorus loads. Annual total suspended solids loads were greater in the LID basin than the conventional basin in two of the seven years (82 percent greater in 2001 and 12 percent greater in 2004). Annual total phosphorus loads were also greater in the LID basin than the conventional basin in 2001 and 2004 by 200 and 100 percent, respectively. Much of the difference can be attributed to climatic conditions. Ninety and 75 percent of total suspended solids load in the LID basin was associated with a single runoff event in 2001 and 2004, respectively. Similarly, these same runoff events produced 75 and 52 percent of total phosphorus load in 2001 and 2004, respectively. Each of these runoff events was associated with considerable precipitation depth and/or intensity. 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 design techniques to reduce runoff, and thus constituent loads, can be greatly diminished.

## Concurrent Sessions V 1:15 – 2:45

## Track C: The New Age of Low Impact Development, *continued*

### Calculation of Stormwater Credits for Low Impact Development Techniques

Lorin K. Hatch, HDR Engineering, Inc., lorin.hatch@hdrinc.com

The Vermillion River Watershed Joint Powers Organization (VRWJPO) is located in the Minneapolis-St. Paul Metropolitan Area, spanning two counties and 21 communities and townships. The VRWJPO is encouraging developers to reduce stormwater volume between pre-construction and post-construction; the overall goal is no net runoff through a combination of low impact development (LID) techniques and traditional (e.g., retention/infiltration ponds) techniques.

Using a 2-year 24-hour design storm (2.8 in), the required volume for a given parcel to be developed must be infiltrated within 72 hours. Infiltration rates were selected based on the least permeable soil horizon within the first 5 feet below the bottom of the infiltration practice. In general, the JRWJPO has 78% B soils and 22% D soils in its watershed. Runoff generated from an undeveloped parcel was compared to a fully-developed parcel with no LID techniques utilized, the difference being the required volume control. Various LID techniques were then assessed and the reduction in runoff calculated as a stormwater credit. The difference between the required volume control and the stormwater credit represents the amount of runoff remaining to be controlled by traditional techniques.

Stormwater credits were generated for natural conservation areas, green roofs, permeable pavers, irrigation, rooftop and non-rooftop disconnects, grassed channels, soil amendments/remediation, and forest or prairie restoration. Due to site-to-site variations, stormwater credits for the first four LID techniques above need to be calculated each time by the developer, but the last five LID techniques can be assigned a 'rule of thumb' regarding a stormwater credit. Site-specific requirements for each of the LID techniques will also be presented.

## Concurrent Sessions V 1:15 – 2:45

## Track D: Total Maximum Daily Load

### Establishing Site-Specific Water Quality Targets for TMDLs in a Large Urban Watershed: The Lake Minnetonka Drainage

Mark B. Edlund, St. Croix Watershed Research Station, mbedlund@smm.org; Joy Ramstack, St. Croix Watershed Research Station, Lorin Hatch, HDR Engineering , Inc.

State water quality standards provide one set of guidelines for establishing nutrient targets during TMDL development. However, each lake in Minnesota is unique; some may have long been very productive systems and are likely incapable of meeting proposed water quality (WQ) standards. The sediment record in a lake provides the evidence necessary to develop lake-specific nutrient targets by understanding historical variability of water quality and the timing and magnitude of environmental changes that lead to impaired WQ. Sediment cores (1-2 m long) are recovered from central depositional basins, dated using magnetic and radioisotopic (210-Pb and 137-Cs) analyses, and analyzed for biogeochemical signals of change in sedimentation and WQ. Of particular note is the analysis of sediment diatom assemblages to reconstruct historical water column total phosphorus concentrations using existing regional calibration models.

The Lake Minnetonka watershed comprises a set of morphologically complex lakes subjected to varying degrees of urbanization and agricultural impacts. Between May and September 2005 WQ was tested and showed a wide range of conditions across the watershed. Sediment cores were recovered from ten Minnetonka watershed sites. Two down-core samples, representing lake conditions before European settlement, and two up-core samples, representing modern lake conditions, were analyzed from each core for diatom microfossils to estimate historical and modern total phosphorus levels.

Lakes and bays in the Minnetonka watershed generally showed three patterns of change between pre-European and modern nutrient condition. Three sites with good modern water quality (mesotrophic) showed little change between pre-European and modern conditions. Three sites were mesotrophic in pre-European times and are currently eutrophic to hypertrophic with modern TP levels above 60 ppb. Lastly, two bays and one lake were eutrophic systems in pre-European times and are currently eutrophic to hypertrophic. Using this information, site-specific TMDL targets can be justified and nutrient reduction controls can be better targeted to sites capable of achieving improved water quality.

(Project funding provided by the Minnehaha Creek Watershed District)

### Biological Endpoints for Shallow Lake TMDLs

Joe Bischoff, Wenck Associates, Inc., jbischoff@wenck.com; Steve McComas, Blue Water Science

The Minnesota Pollution Control Agency (MPCA) has recognized the functional differences between deep and shallow lakes and has set higher nutrient criteria thresholds for shallow lake systems. Watershed Best Management Practices (BMPs) to control nutrient inputs are not always enough to restore an impaired shallow lake. To meet State criteria, the biological conditions of the lakes including aquatic plants, zooplankton, and fish need to be addressed. Consequently, for nutrient TMDLs, watershed projects are only a part of the overall effort needed to restore these complex systems. When lake TMDLs include biocriteria (biological endpoints) management plans will be produced that can actually meet the MPCA standards for shallow lakes. Incorporating biocriteria in the development of shallow lake TMDLs within the Rice Creek Watershed District identified ecological and economical solutions that should improve water quality in several impaired lakes.

## Concurrent Sessions V 1:15 – 2:45

## Track D: Total Maximum Daily Load, *continued*

### North Branch of the Sunrise River Fecal Coliform TMDL

Andrea Plevan, Emmons & Olivier Resources, Inc., aplevan@eorinc.com; Jerry Spetzman, Chisago County

In 1998, the North Branch of the Sunrise River was listed as impaired for primary contact recreation and swimming due to excessive levels of fecal coliform bacteria. A TMDL report and implementation plan were completed to address the impairment. The primary sources of contamination were identified to be unregulated livestock facilities, pastures near the river, and poorly functioning individual sewage treatment systems. The relative contribution of these sources differs according to season and wet vs. dry conditions. A watershed-wide reduction goal of 52% in fecal coliform loading is needed to comply with water quality standards.

The implementation plan outlines a combination of actions designed to address the impairment over the upcoming three years, including landowner education, facilitation of landowner adoption of BMPs, expansion of the septic pilot program, and monitoring. Funding will come from a variety of sources, including Clean Water Act 319, State Cost-Share, EQIP, and AgBMP loans.

## Concurrent Sessions VI 3:00 – 4:30

## Track A: Flooding: Information, Communication, Design

### Estimating the Magnitude and Frequency of Annual Maximum Flow for Unregulated Streams in Minnesota

Dave Lorenz, U.S. Geological Survey, lorenz@usgs.gov; Chris Sanocki, U.S. Geological Survey

Regression equations for estimating peak flow at ungaged sites on unregulated streams with drainage areas less than about 2,500 square miles were updated for Minnesota. These regression equations relate physical and climatic characteristics of drainage basins to peak flow for selected recurrence intervals from1.5 to 500 years. New, automated geographic-information-system methods for estimating the physical and climatic characteristics facilitated this analysis. New regions for estimating peak flow were defined for the State and were based on additional physical characteristics from the new methods. The new regression equations also include 10 additional years of peak-flow data at some of the 318 sites in Minnesota that were used to develop the equations. These regression equations provide the potential for improved estimates of peak flows for the design of culverts and bridges and other flood-plain applications.

### Development of the Red River Basin Decision Information Network (RRBDIN) Flood Forecast Display Tool (FFDT)

Christy Shostal, Houston Engineering, Inc., cshostal@houstonengineeringinc.com

The Red River Basin Decision Information Network (RRBDIN) is a web-based Decision Support System (DSS) for managing communications, water and natural resources within the Red River of the North Basin. The RRBDIN, completed in response to the 1997 flood, now provides a one-stop portal to information about water management within the basin. This information includes databases, references, technical tools, communication tools and GIS data.

The International Water Institute (IWI) retained Houston Engineering, Inc. to conceptualize, develop and implement a near real-time flood forecast tool within the RRBDIN. This project uses flood forecast data generated from the National Weather Service (NWS) River Forecast Center FLDWAV model to generate interactive flood inundation maps and graphics depicting time until occurrence of peak elevation for areas in and around Fargo, ND and Moorhead, MN. The project serves as a working example of a private-public partnership that focuses on emerging hydrologic and web-based technologies, the use of LIDAR, and their application to the Red River Basin.

This presentation will focus on the creation of a seamless Digital Elevation Model (DEM) of the area from LIDAR, development of a custom ArcMap tool used to automate the creation of flood inundation data, and the development of a MapServer Internet web application to disseminate the flood forecast information. Lessons learned and challenges encountered will be discussed.

### The Fish Creek Project: A History of Restoration, Flood Damage, and Reconstruction

Clifton Aichinger, Ramsey-Washington Metro Watershed District, cliff@rwmwd.org; Brad Lindaman, Barr Engineering Co.

Fish Creek runs for three miles from Carver Lake in Woodbury through Maplewood and St. Paul to the Mississippi River in southern Ramsey County. Most of the creek buffer and adjacent lands are owned by Ramsey County and are kept as passive open space. This unique creek and bluffland area was severely eroded in the late 1980s due to increased stormwater runoff from developing suburbs. The RWMWD completed a stabilization and flood control project in 1989. This project held up against all storm events until October 2006. This major rainfall event overtopped the upstream berm and caused major damage to the project and the creek system. The District redesigned major features of the system to improve operation and aesthetic appearance of the creek system. This project was completed in late 2006. The presentation will review the original creek problems, original project, 2006 storm damage and the redesign and construction project.

## Concurrent Sessions VI 3:00 – 4:30

## Track B: Landscape and Watershed Management

### Using Small-Plot Research Information to Guide Development of Agricultural Management Research at the Watershed Scale

Gyles W. Randall, University of Minnesota-Southern Research and Outreach Center, grandall@umn.edu

Small plot, edge-of-field research information may be extremely valuable when developing research to quantify the environmental benefits of management practices on a watershed scale. This information can help explain the effects and interactions of weather and landscape features on the performance of various practices as well as define the time lag between application of the practice and measurement of an environmental effect. Numerous small-plot, tile drainage studies have been conducted in southern Minnesota in the last 30 years to determine the effect of cropping systems, nitrogen rates and sources ( fertilizer and manure), time of N application, nitrification inhibitors, cover crops, and tillage systems on nitrate losses to subsurface drainage and crop production. These long-term studies, which have integrated weather variability into the environmental assessment of various practices, have allowed us to measure and study the effects of wet vs. dry years, temporal distribution of precipitation, and precipitation amount on the resulting hydrology and performance of the system. Information of this type should be helpful for scientists who are developing objectives and protocol for watershed-scale research to reduce nitrate losses in drainage water.

### Comparison of Water Quantity and Quality between Subsurface Tile and Edge-of-Field Runoff from a Wisconsin Agricultural Landscape

Dennis Frame, University of Wisconsin Extension, drframe@facstaff.wisc.edu

Two years (Nov. 04 – Oct. 06) of discharge and water-quality data were collected from two subsurface tile and surface-water sites within two small (13.2 and 20.5 acres) basins on a private northeastern WI dairy. Discharge was monitored continuously and composite water samples for precipitation and snowmelt-induced runoff events were collected and analyzed for nutrients and sediment.

Tiles flowed for most of the study period – even when ground was frozen. Comparison of hydrograph responses to precipitation or snowmelt events indicated rapid, preferential flow from surface water to tiles.

Tiles accounted for up to 85 percent of annual runoff from each basin, but only 14-32 percent of sediment losses. Tiles accounted for less than 45 percent of total phosphorus losses, but up to 90 percent of annual total nitrogen losses.

Dissolved phosphorus comprised 45-67 percent of the total phosphorus lost from the tiles. In the first year of monitoring, nitrate contributed 20-58 percent of the total nitrogen losses from tiles. In the second year of monitoring, nitrate contributions increased to over 95 percent of the total nitrogen lost from tiles.

A majority of the total nitrogen lost was nitrate. In the first year of monitoring, average concentrations of nitrate in tile and surface water runoff ranged between 5.4-16.7 mg/L and 1.1-2.8 mg/L, respectively. During the second year of monitoring, average concentrations of nitrate in tile and surface water runoff ranged between 31.8-50.7 mg/L and 10.8-22.0 mg/L. Application of liquid dairy manure to each basin likely caused the increase in nitrate concentrations in tile and surface water runoff during the second year of monitoring.

## Track B: Landscape and Watershed Management, *continued*

### Property Tax Credits as a Tool for Watershed Management: Results of a Wisconsin Pilot Project

Mike Kinney, Prior Lake-Spring Lake Watershed District, mkinney@plslwd.org

The South Fork Hay River Priority Watershed, located in west-central Wisconsin, was approved as a pilot project by the Wisconsin Land and Water Conservation Board in January, 1998. The focus of this pilot project was to determine if property tax incentives would motivate farming landowners to make the necessary changes to achieve the pollution reduction objectives at less cost for both the landowner and the taxpayer.

From July 1, 1998 to June 30, 2005, the Dunn and St. Croix County watershed staff worked with 110 landowners to install various water quality and soil conservation practices. These farms comprised 21,235 acres of the approximately 46,600 acres of available cropland in the watershed. Approximately 7,500 acres were in CRP and were not eligible acres for this program. The farmers that participated soil tested all the acres they operated, updated their conservation plans, participated in annual one day training sessions on nutrient management, and wrote or updated their nutrient management plans annually. It is estimated that approximately 75% of the participating farmers now have a solid understanding of the basic framework of a nutrient management plan.

These 21,235 acres represent about 46% of the available cropland in the watershed. The Citizens Advisory Committee established a goal in the watershed plan for 50% of the cropland to be under a conservation plan and a nutrient management plan by the end of the 8 year proposed project. This was a rather aggressive goal and it appeared to be achievable until funding cuts limited the project's progress over time. There were additional farmers who wanted to participate but could not without additional funding. The known farmers who were turned away operated at least an additional 1,000+ acres of cropland. In spite of the funding limits, the efforts of the participating farmers helped achieve an estimated 19% reduction in sediment from upland sources in spite of a rapid growth in row crops. This reduction was 63% of the goal and would have been higher had funding not been reduced to the point of limiting participation.

Since the vast majority of the sediment and associated phosphorus actually came from cropland erosion, the CAC and watershed staff targeted a very limited amount of barnyard work. A sliding scale of payments was devised that paid for barnyard phosphorus reduction based on a per pound basis rather than traditional cost-sharing. As a result, the TOTAL incentive payments for various low-cost barnyard practices were only $20,116 for all 8 years! This was achieved by placing low cost practices in the right places, some farmers constructing innovative practices without any financial assistance, and the expected attrition within the farm community. This combination of changes in barnyards reduced 3,596 lbs of phosphorus annually which was 98% of the goal. Several riprap projects were completed during the life of the project. These accounted for 225T/yr of sediment reduction which in turn was 40% of the 560 T/yr sediment reduction goal for streambank erosion. Another project within the watershed has been designed but is being funded through another program.

Overall, the CAC and watershed staff are extremely pleased with the results of this unique approach to watershed management. The utilization of property tax credits as a tool for change has proven to be very effective. This concept got the landowners attention early on in the program and, over time, the farmers' attitude toward these conservation practices evolved into established cultural practices of good farm management. Most noticeably, the level of awareness and acceptance of what is required of a 590 plan and overall agronomics has increased dramatically. These participants are far more likely to be utilizing no-till or reduced tillage than other farmers in the area and they have also proven to be more receptive to other conservation practices on their farms.

## Concurrent Sessions VI 3:00 – 4:30

## Track C: Water Resource Management

### Guidance for Scope and Effect and Hydrology (well) Studies to Support Wetland Delineation in Minnesota and the Upper Midwest

James Arndt, Natural Resource Group, Inc., jlarndt@nrginc.com; Sandy Verry, Ellen, River Partners, Inc.

Wetlands that have been historically ditched and/or tiled for agricultural use constitute problem and atypical areas that frequently require hydrologic modeling and monitoring to discriminate remaining (partially drained) jurisdictional wetlands from effectively drained upland. Ditching and tiling frequently remove surface water. Wetland hydrology is absent or present for only a short time, and wetland plant communities are altered from their pre-disturbance composition or are missing altogether. Various hydrologic models and well studies that range from simple to complex with respect to both modeling capability and data requirements have been used to assess wetland hydrology in such situations. This presentation: (1) summarizes interagency guidance regarding wetland delineation in ditched and tiled areas, (2) identifies situations where hydrology studies are indicated, (3) provides essential background on modeling and strengths and weaknesses of the various hydrology models available, (4) provides recommendations for proper well design and interpretation of hydrographs, and (5) provides recommendations for scope and effect modeling procedures and well study design to assist with wetland delineations in ditched and/or tiled historic wetland.

### Integrated Water Resource Management: Minneapolis' New Approach to Controlling Impacts of CSOs, Inflow/Infiltration, Stormwater, and TMDLs

Lois Eberhart, City of Minneapolis Department of Public Works, lois.eberhart@ci.minneapolis.mn.us; Rhonda Rae, City of Minneapolis Department of Public Works; H. R. "Bo" Spurrier, City of Minneapolis Department of Public Works; John Aldrich, Camp Dresser & McKee, Inc.; Jodi Polzin, Camp Dresser & McKee, Inc.

Much of Minneapolis' policy and programs with respect to water resources management are based on directives contained in the NPDES permits issued to the City: Combined Sewer Overflow, Stormwater, Construction Activities, and Industrial Activities. Parallel with the NPDES permitting process are the requirements imposed on the City by Minnesota Statute 103B, and the MCES I/I Program. Although the goals of each of these programs are improved water quality, implementation activities may differ. It is possible that meeting the requirements of one program may create a challenge in another. For example, removing inflow sources from the sanitary sewers could add to flooding problems in the storm drainage system. For this reason, the Public Works Department commissioned the creation of a Water Resources Management Strategic Plan based on a principle that water resource management solutions must be integrated, and that solutions to one water resource problem cannot create a problem in a different area of water resources management.

## Track C: Water Resource Management, *continued*

### Lakesuperiorstreams.Org: Making Stormwater and Stream Data Come Alive For Citizens, Students, Teachers, Contractors, Resource Agencies, Decision-Makers and Scientists

Richard Axler, University of Minnesota-Duluth, raxler@nrri.umn.edu; Cynthia Hagley and Jesse Schomberg, University of Minnesota-Duluth; Marnie Lonsdale, City of Duluth Stormwater Utility; Todd Carlson, City of Duluth Stormwater Utility; George Host, University of Minnesota-Duluth; Norm Will, University of Minnesota-Duluth; Jerald Henneck, University of Minnesota-Duluth; Jane Reed, University of Minnesota-Duluth; Elaine Ruzycki, University of Minnesota-Duluth; Gerald Sjerven, University of Minnesota-Duluth

Urbanization and rural development are placing pressure on western Lake Superior streams and nearshore zones via increased stormwater runoff. Stream and coastal zone degradation represents a significant social and economic impact to a region whose economy and character are tied to its pristine natural state. The LakeSuperiorStreams.org project uses web-based delivery of real-time stream monitoring data to address issues of sustainability in critical Minnesota watersheds at the headwaters of the Great Lakes. The website delivers intensive flow, temperature, turbidity and conductivity data via a unique interactive data animation tool from three urban trout streams, the St. Louis River, and two North Shore Superior tributaries. Data are incorporated as vignettes into interpretive information, curricula, case studies and a site design toolkit to educate contractors, consultants, developers, students, teachers, homeowners, agencies, decision-makers and scientists about stormwater issues and links to watershed activities. The website averages >300,000 requests/mo and ~ 55,000 page requests/mo. LSS is a partnership between the University, City of Duluth, MPCA and the Western Lake Superior Sanitary District.

## Concurrent Sessions VI 3:00 – 4:30

## Track D: Managing Urbanization to Minimize Impacts on Stream Temperatures

### Predicting Thermal Impact: Application of an Urban Storm Water Model to a Housing Development in Plymouth, MN

Ben Janke, University of Minnesota, janke024@umn.edu; William Herb, University of Minnesota; Omid Mohseni, University of Minnesota; Heinz Stefan, University of Minnesota

Our current work is focused on investigating the impact of urban development on the temperature of trout streams in urbanizing watersheds. The goal of the project is to characterize this impact, and to produce a tool that can be used by watershed managers in the permitting process for proposed developments. A preliminary version of the tool, MINUHET (MINnesota Urban Heat Export Tool), has been developed. MINUHET tracks heat transfer processes associated with the routing of storm water through a development-scale watershed, producing a time series of flow rate and temperature at the development outlet. Currently, the tool is capable of modeling the effect of various management practices, including storm water ponds, storm sewers, and rain gardens. A case study will be presented in which MINUHET has been applied to a housing development in Plymouth, MN. The case study includes a comparison of simulated and measured runoff flow rate and temperature, and an analysis that characterizes the uncertainty of simulated runoff based on the uncertainty of watershed parameters.

### Temperature Trading in the Vermillion River

Jay Coggins, University of Minnesota, jcoggins@umn.eduand; Yoshifumi Konishi, University of Minnesota

The Vermillion River Watershed is the largest in the Twin Cities region and contains 45.5 miles of designated trout stream. The watershed offers a unique world-class trout stream within the metropolitan area. Two surrounding counties, Scott and Dakota, are among the nation's fastest-growing counties and are faced with rapid suburbanization pressures. Scientific findings suggest that development pressure has resulted in increases in both stream flows and average stream temperatures.

As part of a larger project aimed at developing a program for trading thermal credits in the Vermillion watershed, this paper contains, first, a summary of existing trading programs for water quality. The special considerations that must be brought into play for temperature trading are highlighted. The primary difference is that the information needed to create and implement a temperature trading program must be spatially explicit in a way that nutrient trading may not be.

Trading is employed to protect the stream from warming at least cost. A new subdivision, for example, involves converting a certain amount of previously permeable surface to rooftops, streets, and parking areas. A scientific model of the sort under development for the Vermillion project allows the resulting increase in thermal loading to be predicted. An example of a trade would be between the developer (as buyer of a thermal credit) and, say, a landowner (as seller of a credit) who agrees to convert tilled farmland to forest. If the two land uses together lead to no increase in thermal loading, the trade would be allowed and the buyer would pay the seller a agreed-upon price.

Some of the spatial characteristics of the Vermillion program are presented using GIS maps of land use and property values. Based upon these maps, a series of simulation exercises are developed to illustrate how a potential buyer of credits (typically a developer) might choose to participate in the market. A set of preliminary results show the type of options that a developer will face in offsetting the thermal increases due to a particular development project. The data on land values are used to calculate the cost of a given offsetting credit and to illustrate decision problem faced by both potential buyers and potential sellers of credits.

The paper also contains a discussion of the important policy questions that must be addressed in developing a water-quality trading program. These include the geographical scope of the market, which parties are allowed to trade, baseline calculations, whether trades are bilateral or through a clearinghouse, and how the program is monitored and enforced.

## Concurrent Sessions VI 3:00 – 4:30

### Track D: Managing Urbanization to Minimize Impacts on Stream Temperatures, *continued*

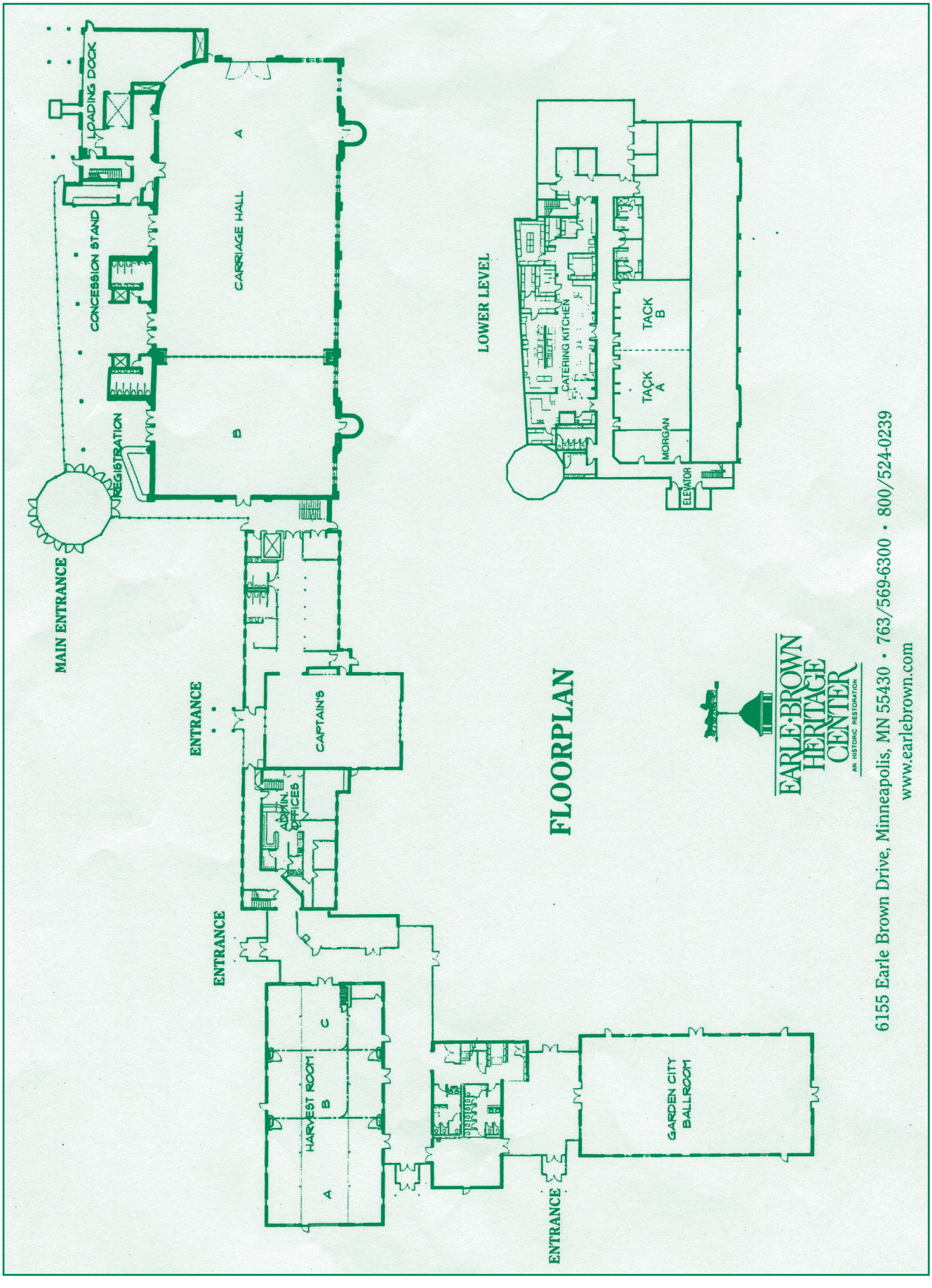
**Scientific Tools for Creating a Market-Regulatory Framework for Tsemperature in the Vermillion River Watershed, Minnesota**

Kim Alan Chapman and Rio Roland, Applied Ecological Services, Inc.

Temperature trading to maintain water quality in the United States is in its infancy. Trading in other pollutants is more advanced, but even this is relatively rare. The greatest challenge in trading efforts is the creation of scientific tools that can be used by economists, regulators, municipalities, and end users (e.g., developers). Without such tools, a mitigating trade between a residential developer (the buyer) and a farmer who is changing a land use practice (the seller) will have great uncertainty. Is the trade going to result in mitigation of new heat input to a trout stream? Is the developer actually getting the right amount of heat mitigation by trading with the farmer? The Vermillion River Watershed Joint Powers Organization received an EPA Targeted Watershed Grant to answer these questions, develop scientific tools, and consider whether to implement a market-regulatory framework to mitigate heat inputs to the DNR-designated trout stream area of the Vermillion River. Chapman and Roland will present the GIS-based scientific research, data, and models being used to support the market-regulatory framework which is being developed by the University of Minnesota Department of Applied Economics. The scientific research involves stream and groundwater temperature sampling, a land cover thermal loading model for likely damaging storm events, a stream heat transport model, and a method for arriving at a thermal cap for the system.

## Index of First Authors

## *Index of First Authors*


LOADING DOCK
CONCESSION STAND
REGISTRATION
CARRIAGE HALL
A
B
MAIN ENTRANCE
ENTRANCE
CAPTAIN'S
ADMIN OFFICES
ENTRANCE
HARVEST ROOM
A
B
C
GARDEN CITY BALLROOM
ENTRANCE
LOWER LEVEL
CATERING KITCHEN
TACK A
TACK B
MORGAN
ELEVATOR
FLOORPLAN
EARLE·BROWN HERITAGE CENTER
AN HISTORIC RESTORATION
6155 Earle Brown Drive, Minneapolis, MN 55430 • 763/569-6300 • 800/524-0239
www.earlebrown.com