

Water Resources Center

# Biennial Report

2000-2002



Research



Outreach



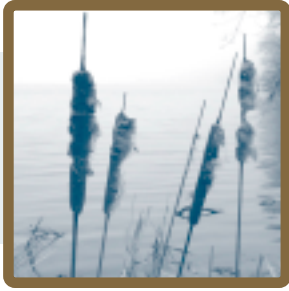
Education



Service



UNIVERSITY  
OF MINNESOTA



# From the Directors

We are pleased to present the third biennial report of the Water Resources Center. The mission of the Center continues to be to provide interdisciplinary research, education and outreach leading to land- and water-use practices that protect long-term quality of Minnesota's water resources. As you will see in the following pages, these efforts have continued to flourish and expand during the past two years, despite all the changes taking place in federal, state and local government funding because of budget and finance problems. This is testimony to the fact that Minnesotans remain deeply concerned about the state of their water.

The Center increasingly has become an entry point to the University for people with questions about water. This has led to the increasing variety of projects and activities that are described in this report. During the past biennium, the Center has been involved in the development of a regional project funded through the Cooperative State Research Extension Education System (CSREES) to increase the integration between research, education and extension in water resource management. This goal is a key to involving university faculty in solving local, state and national problems. In addition, the Center has played a leadership role in projects that address nutrient and manure management in agricultural systems. At the same time, the Center has played a role in developing an urban storm water initiative within the College of Agricultural, Food, and Environmental Sciences as well as within the Great Lakes States Region.

The Center's research program has prospered during the past two years. Faculty investigators in the WRC's external grant program conducted exciting and innovative research projects related to several water quality issues, including emerging contaminants. Research conducted by WRC staff produced important advances in several areas, including applying satellite imagery to monitoring and assessment of surface water quality, developing better procedures for nutrient management in lakes, and evaluating best management practices for use in rural watersheds.

The Water Resources Science graduate program continues to involve more than 70 students seeking advanced degrees under advice and council of over 85 recognized graduate faculty. The quality of applicants continues to be high, which insures the continued graduation of highly qualified water resource professionals.

We would like to thank both the former and current Deans of the College of Natural Resources, Al Sullivan and Susan Stafford, as well as Deans Chuck Muscoplat (College of Agricultural, Food, and Environmental Sciences) and Chuck Casey (University of Minnesota Extension Service) for continued support. We also express our thanks to the WRC staff for their hard work and cooperation. Finally, we acknowledge the work of our graduate student editor Johanna Schussler for assembling this document.

As we look ahead, we see a road filled with increasing challenges and opportunities. Change in the coming biennium will involve some new leadership in the Center, but the expectation is for continued growth and the export of knowledge to meet our mission.

James L. Anderson  
Co-Director

Patrick L. Brezonik  
Co-Director



# About the WRC

The Water Resources Center (WRC) is a multifaceted center with active programs in research, outreach, and education. The WRC helps coordinate water-related outreach and research within the University, enabling more effective delivery of water research to decision-makers and citizens, opening new avenues for multi-disciplinary and interdisciplinary partnerships, and providing a key link between students and water resources professionals.

The WRC's creation in 1996 united three long-standing University of Minnesota water programs, the Water Resources Research Center, the Center for Agricultural Impacts on Water Quality, and the Extension Water Quality Program. The WRC has integrated the missions of the three water programs into an expanded, collaborative partnership.

## Water Resources Center Staff



From front to back, left to right: Johanna Schussler, Tracy Thomas, Maria Juergens, Janelle Benusa, Les Everett, Patrick Brezonik, Roland Sigurdson, Jim Anderson, and Kevin Proescholdt. Not pictured: Larry Baker, Mary Renwick

The WRC also has staff in offices across Minnesota. They are: John Bilotta, Kevin Blanchett, Mary Blickenderfer, Dennis Busch, Jodi DeJong Hughes, Phil Nesse, Ken Olson, Leif Olmanson, and Ron Struss. A complete list of WRC staff can be found in appendix A.



Katherine Erdman

Barb Liukkonen and Mary Gullickson



# About the WRC

## Research



### Internal Research

Over the past biennium, WRC faculty and staff have conducted research in several new areas and formed research partnerships with new collaborators. Results from six WRC initiatives involving satellite imagery, human ecosystems, agricultural drainage, alternative sewage treatment, international irrigation, and water quality benefits in the Minnesota River Basin are described in this report.

### External Grants Program

The WRC sponsors research by faculty scientists throughout the University with an annual grants program. Grants are awarded on a competitive basis following peer review. Funds are provided through the Water Resources Research Institutes program of the USGS and the Center for Agricultural Impacts on Water Quality, a program of the College of Agricultural, Food, and Environmental Sciences. Over \$400,000 has been contributed to 14 projects through WRC grant funding during the past two years.

## Outreach



The WRC conducts outreach activities to protect and improve water quality in Minnesota in the following areas: agriculture and water quality; lakes, rivers, and

wetlands; on-site sewage treatment; safe drinking water; urban best management practices for water quality; volunteer monitoring; and youth and water resources.

## Education



The WRC administers the Water Resources Science (WRS) graduate program, a unique, multi-disciplinary approach to water-resources education. Through WRS, the WRC provides holistic training for students to prepare them to address complex problems in research and management of aquatic systems. Through excellent

research and classroom opportunities on the Twin Cities and Duluth campuses and with faculty from 25 departments, WRS students develop the breadth of scientific knowledge needed to understand the complicated aquatic ecosystems and watersheds on which they will work. As of this biennium's end the WRS program has had 60 graduates (53 M.S. and 7 Ph.D.).



## Public and Professional Service

WRC staff contribute time and expertise in a variety of ways to serve the public. During the 2000-2002 biennium, WRC staff provided such service for local, state, and national government agencies, University programs, and community, professional and non-governmental organizations.



# Internal Research

## Coupled biogeochemical cycles in human ecosystems

**PIs:** Patrick Brezonik (WRC, Civil Engineering), Larry Baker (WRC), Marvin Bauer (Forest Resources), David Mulla (Soil, Water, and Climate), Heinz Stefan (Civil Engineering), Robert Sterner (Ecology, Evolution, and Behavior); Diane Hope and Nancy Grimm (Arizona State University)

**Funding source:** National Science Foundation (Biocomplexity in the Environment)

**Duration of project:** September 2001 – August 2003

The goal of this project is to develop a framework for understanding biogeochemical cycles of major nutrient elements (carbon, nitrogen, phosphorus) in human ecosystems. Such a framework could replace the current fragmented approach to pollution management, leading to management practices that are more effective, fairer, and less expensive than current approaches.

A series of workshops were held to develop a conceptual framework for studying biogeochemical cycles in human ecosystems. The framework that evolved comprises four “couples.” The first is element-element coupling (stoichiometry). Stoichiometric coupling is generally tight in natural systems, but often decoupled in human ecosystems, leading to pollution. In some cases, “recoupling” might reduce pollution. For example, restoration of riparian areas in farmlands may provide sufficient organic carbon to allow denitrification to remove nitrate from agricultural runoff. The second couple is between hydrology and element cycling. Humans modify ecosystems toward a mesic (moderately wet) state, altering element cycling. Tile drainage of Minnesota farmland enhances nitrate export to rivers, but

water conservation in Phoenix promotes nitrogen accumulation. The third couple is among spatial scales. The connectedness of cycles at different scales may lead to novel approaches for managing pollution, illustrated by human protein consumption. Reducing protein consumption in urban areas would mean less nitrogen fertilizer would be needed to grow animal food crops, which would reduce nitrogen pollution of streams in agricultural areas. The fourth couple is between the human social world and the biophysical world. Of particular interest here is how cultural attitudes affect material consumption patterns. This couple is the least understood, but this understanding is vital if we are to understand how societies change in response to environmental problems.

A study plan developed in the workshops involves analysis of element budgets and cycling in two contrasting regions: the Twin Cities-Lower Minnesota River and Central Arizona-Phoenix, and three types of land cover (natural, agricultural, urban). The study will be a six-way comparison of hydrology/climate (cool/wet vs. hot/dry) and land cover (urban, agriculture, and natural). Element cycling will be examined at scales from households to regions. Work on a regional-scale nitrogen mass budget for the Twin Cities was initiated during project period to complement an existing one for the Phoenix area. Models of several types, from watershed-scale hydrologic process models to regional “box models” will be used to develop predictive capability. The applicability of models and databases to other settings will be examined later in the project. A larger proposal to NSF’s Biocomplexity program to continue this work was funded in summer of 2003.

More details on the internal and external research projects listed in this report can be found in WRC technical reports I42 and I47. These technical reports are available on the WRC website at <http://wrc.coafes.umn.edu/pubs>. They can be obtained in hardcopy by contacting the WRC.

# Internal Research

## Agricultural drainage and water quality in the Minnesota River Basin

**PIs:** James Anderson (WRC and CIAWQ), Lowell Busman (UM Extension Service), Gary Sands (Biosystems and Agricultural Engineering), Jeff Strock (Southwest Research and Outreach Center)

**Funding source:** Minnesota Department of Agriculture

**Duration of project:** October 20, 2000 – June 30, 2002

In recent years, farmers have been adopting “Best Management Practices” (BMPs) on their land to help reduce erosion, nutrient inputs, and other potential contaminants from farming operations. Use of BMPs has resulted in water quality improvements in local water resources.

Due to a combination of increased rainfall, lower margins of profit per acre, and higher land values, farmers have attempted to improve cropland by using more intensive drainage practices. These drainage practices have resulted in increased hydrologic pressure on rivers and streams, the storage of additional water in wetlands and lakes, and the increased transport of water through ditches, streams and rivers from rainfall and snowmelt events. -Model-based research also suggests that more intensive drainage may exacerbate losses of nitrate from drainage systems.

The goals of this project were to determine the impacts of drainage system design on hydrology, water quality, and crop response for a variety of soils, landscape positions, and agricultural management systems (organic and conventional) in the Minnesota River basin. Research and funding were divided between project sites in Lamberton and Waseca.

**Progress to date:**

**Lamberton** at the Southwest Research and Outreach Center (SWROC)

Runoff from crop lands in organic production and conventional production was collected and analyzed in 2002 and 2003 for nitrate, ammonia, orthophosphate, and total phosphorus. These data will be used to calibrate a computer simulation model to identify the impacts that

different agricultural management systems have on water quality.

An open-ditch research facility using flow from surface and subsurface runoff was constructed in 2002. The facility allows researchers to evaluate performance characteristics of the different drainage channels.

Over 130 people attended the SWROC’s *Agricultural Drainage and Water Quality Field Day* on August 14, 2002. Activities like the field day help the SWROC synthesize ongoing agricultural research into workable solutions that enhance agricultural production systems and protect environmental quality.

**Waseca** at the Southern Research and Outreach Center

Nine drained and one undrained watershed ranging in size from two to six acres were instrumented and have been collecting data since 2001. These data include surface and subsurface drainage flow, nitrate concentration in subsurface flow, total suspended solids and total phosphate in surface flow, and crop yields. The nine drained watersheds comprise two drainage depths and two drainage intensities. Preliminary data suggest that shallow drainage systems remove less water and less nitrate on a seasonal basis, compared to the deeper systems. Surface runoff is a very small component of the water balance on these fields.

These data are being used to calibrate and validate the subsurface drainage model, DRAINMOD, to examine the effects of these drainage practices on other soil types and over a long-term climatic record. In addition to these research watersheds, this project has helped to develop facilities to examine the impact of water table management, alternatives for surface intakes, and the use of wetlands for treating and storing drainage water.

The drainage research facilities have been used for educational programs in agricultural drainage. Field tours have been conducted for a variety of audiences, including federal, state, and local government personnel, agricultural producers, and drainage contractors. Preliminary data have been used in educational programming on drainage.

# Internal Research

## Impact assessment of the irrigation development in the Uda Walawe River Basin, Sri Lanka

**PI: Mary Renwick (WRC)**

**Funding Source:** International Water Management Institute

**Duration of project:** June 2001 – December 2002

In the 1950s, irrigation was viewed as an engine of growth in developing countries. It was seen as a means to transform subsistence peasant societies into highly productive modern agricultural societies. However, the history of large-scale irrigation projects in achieving this transformation has been mixed. Decision makers are now rethinking the role of irrigation in poverty alleviation and economic development strategies, trying to understand what has worked, what has not, and why. While proposed irrigation projects undergo substantial study, *ex post* analysis that examine planned versus actual outcomes are seldom conducted, particularly in developing countries.

Because there are often divergences between planned and actual outcomes, *ex post* analyses are done to better understand the causes and implications of these divergences. Such analyses can help make better water management decisions in the future.

This project examined historical irrigation investment decisions for the Uda Walawe Irrigation and Resettlement Project (UWIRP) in the southern dry zone of Sri Lanka. UWIRP, initiated just after independence in the early 1950s, was part of Sri Lanka's new post-colonial vision for economic development and modernization. The original plans for UWIRP envisioned bringing 81,000 acres of arid land into highly efficient agricultural

production by constructing a reservoir and irrigation facilities, and moving landless farmers onto the newly developed lands.

The main project objectives were to 1) review successive phases of investment related to the Uda Walawe Project and identify planned versus actual outcomes; 2) analyze the evolution of decision-making for investment and interventions in Uda Walawe, identifying objectives, assumptions and underlying rationale, and 3) estimate cumulative project costs to date for benefit-cost analysis.

The Uda Walawe Irrigation Project is part of a larger international assessment of irrigation impacts in developing countries, known as the Comprehensive Assessment of Water Management in Agriculture, by the 16 Centers for International Agricultural Research.

The vision for UWIRP has never been fully realized. The irrigated area is substantially less than planned and farmers continue to engage in subsistence-based paddy production, although in recent years there has been some diversification of cropping systems. Despite the substantial shortfall in anticipated benefits, the project experienced substantial costs overruns. The failure of the UWIRP project is largely the result of top-down decision-making, in which politicians and engineers developed plans that were to be carried out by peasants who had no input into the creation of UWIRP plans. The results of this study provide further evidence of the unanticipated economic, environmental, and social costs of large-scale irrigation projects and stress the importance of involving local communities in future decision making.

# Internal Research

## Paired watershed studies for nutrient reductions in the Minnesota River Basin

**PIs:** David J. Mulla (Soil, Water, and Climate), Mary Renwick (Water Resources Center), and Jim Anderson (WRC and Center for Impacts of Agriculture on Water Quality)

**Funding Source:** U.S. Department of Agriculture

**Duration of project:** October 1, 2001 – September 30, 2004

Farmer-initiated efforts to improve water quality are important in watersheds with significant non-point source pollution. In Minnesota, most water quality improvement projects are organized by local government or by non-government organizations (NGOs). To date, they have not been very successful in addressing nutrient reductions from cultivated cropland. For real progress in reducing non-point source pollution, it is important for producers to be directly involved in determining which best management practices (BMPs) are most feasible for adoption, what these BMPs will cost, and how effective the BMPs will be in reducing non-point source pollution.

This project is a farmer initiated and led effort to accelerate the voluntary adoption of BMPs for nutrient management in the Minnesota River Basin. Farmers have helped to assemble a team of University of Minnesota soil scientists, economists, and extension educators; state

agricultural training and education personnel; local government water planners; water quality monitoring specialists; and policy makers to conduct paired watershed water quality studies in Nicollet County, Minnesota. The objectives of this project are to: 1) accelerate the voluntary adoption of BMPs in MN River Basin to achieve measurable improvements in water quality 2) evaluate the effectiveness of farmer-selected BMPs to improve water quality, and 3) develop and disseminate farmer led and sanctioned water quality initiatives in the Minnesota River Basin.

The project has just completed its second year. It has been extremely well received by local producers and there is an unprecedented level of collaboration among farmers, local coops, agency personnel and research and extension educators from the University of Minnesota. In 2002, farmers identified a number BMPs they would be willing to adopt beginning in the 2003 growing season including rock tile drainage inlets, crediting of manure for phosphorus fertilizer applications, soil/plant testing for better nutrient management, and various levels of conservation tillage. These have been adopted on over 80% of the cultivated land in the treated watershed. In the control watershed, farmers agreed not to change practices on over 75% of the cultivated land.



# Internal Research

## Satellite-based remote sensing of Minnesota lakes and wetlands

**PIs:** Patrick Brezonik (WRC, Civil Engineering) and Marvin Bauer (Forest Resources, Environmental Resources Spatial Analysis Center – ERSAC)  
**Staff/students:** Leif Olmanson (WRC), Steven Kloiber (Civil Engineering, Metropolitan Council), Katherine Erdman (Water Resources Science)

**Funding sources:** NASA (Regional Earth Science Applications Center – RESAC), Minnesota Department of Natural Resources

**Duration of project:** July 2000 –

This project continues earlier work of the WRC and RESAC to develop satellite tools for use in assessing surface water quality across Minnesota. During the biennium, we completed a regional assessment of lake water clarity in the seven-county Twin Cities Metropolitan Area (TCMA), accomplished the first census of Minnesota lakes for water clarity, demonstrated the usefulness of high-resolution satellite imagery in assessing water quality of small urban ponds, and began to develop satellite-based techniques for mapping and classifying aquatic vegetation.

The satellite imagery work on lakes in the TCMA formed the basis of the Ph.D. dissertation by Steven Kloiber (2002) and was published in two articles (Kloiber et al. 2002a, 2002b). This research developed the basic procedures we now are applying across Minnesota and that others are using in Wisconsin and Michigan to assess lake clarity from Landsat imagery. The TCMA work evaluated spatial patterns of water clarity in the TCMA and temporal trends of more than 450 lakes over the period 1973-1998. Surprisingly few lakes (only ~10%) showed significant temporal trends in clarity over this period despite major urban development in the region, and more lakes improved in clarity than had declining clarity. These results probably reflect the fact that most of the land converted to urban use in the region previously was in agricultural use rather than in pristine forests or prairies.

Using 19 Landsat images that covered the entire state of Minnesota, we produced a census of water clarity in more than 10,500 lakes across the state for the early 1990s (images were a composite from 1990 and 1991). Nearly all lakes over 20 acres in area were included in the census. A similar census was completed for the early 2000s (2000 and 2001). Images were calibrated using

ground-based measurements of Secchi disk transparency collected by agencies or citizen monitors on dates nearly contemporaneous with the dates of the satellite images. Results from the two lake censuses have been used to produce a database of lake clarity data in Minnesota that is available to the public on the RESAC Web site: <http://water.umn.edu>. The database allows one to search for a lake of interest on a map, access clarity information, and obtain background information on lake clarity assessment and methods.

The lake clarity procedure also was adapted for use with high-resolution images from the IKONOS and Quickbird satellites, which have pan-sharpened ground resolution of 1.0 and 0.6 meters, respectively. As a demonstration, an IKONOS image of Eagan, Minnesota was processed, and the water clarity of 375 ponds in the city was determined. Only 14 of the ponds are large enough to be assessed by Landsat imagery.

Methods are being developed with funding from the Minnesota Department of Natural Resources to map and assess aquatic vegetation in lakes and wetlands using IKONOS and Quickbird images. An initial survey performed on Swan Lake (Nicollet County), a large Type 5 wetland with extensive beds of emergent and submersed aquatic vegetation, yielded promising results. Additional studies are underway in lakes of the TCMA to evaluate the extent and limitations to which such images can be used to identify types or classes of aquatic vegetation and to map submerged vegetation.

### Publications:

Kloiber, S. M. 2002. Satellite imagery and GIS-based watershed modeling as tools for regional-scale assessment of lake quality. Ph.D. thesis, University of Minnesota, Minneapolis.

Kloiber, S. M., P. L. Brezonik, L. G. Olmanson, and M. E. Bauer. 2002a. Development of a remote sensing protocol for synoptic, regional water quality assessment. *Remote Sens. Environ.* 82: 38-47.

Kloiber, S. M., P. L. Brezonik, and M. E. Bauer. 2002b. Application of a synoptic, remote sensing, water quality assessment method for lake management. *Water Research* 36:4330-40.

# Internal Research

## On-site sewage treatment alternatives

**PIs:** James Anderson (WRC and CIAWQ), Dave Gustafson, Sara Heger-Christopherson (Biosystems and Agricultural Engineering and Extension Service), Rich Axler, and Barb McCarthy (Natural Resources Research Institute)

**Funding source:** Legislative Commission on Minnesota Resources, WRC (CIAWQ), Metropolitan Council

**Duration of project:** July 1, 1999 – June 30, 2006

With approximately 30 percent of Minnesota residents served by individual sewage treatment systems, there was a need to evaluate small-scale on-site technologies for their performance under cold weather conditions. Much of the on-site treatment technology was developed in climates significantly warmer than Minnesota (Hines and Favreau 1974). Therefore, many questions remain about performance, maintenance, cost and necessary cold weather modifications.

Two research sites were established in the summer of 1996 near Mankato and Duluth. The on-site technologies of the research sites include an aerobic treatment unit; a drip distribution system; and a system consisting of two recirculating sand filters, four peat filters and four constructed wetlands. These systems are being evaluated as pretreatment devices for their ability to remove contaminants, in particular, biochemical oxygen demand, nitrogen, phosphorus, total suspended solids, and fecal coliform bacteria. Monitoring will continue for the duration of the study. Sampling occurs bimonthly, and data analysis began in the fall of 1996. In addition, research trenches were constructed to determine the long-term acceptance rate for different qualities of wastewater.

The research focusing on recirculating sand filters was completed in June of 2001, but work continues on

evaluation of these systems for their long-term performance. This is funded as a cooperative effort with the Minnesota On-site Sewage Contractors Association, and will continue for the next five years.

### Findings to date

- Alternative systems typically require more management than standard systems.
- Alternative systems typically achieved secondary treatment standards, and many systems consistently achieved commonly used recreational beach standards.
- Gravity peat filters failed hydraulically during the second winter of operation.
- Recirculating sand filters, peat filters, and constructed wetlands achieved significant nitrogen removal.
- Long-term phosphorus removal rates have not been established, but most of the systems remove some phosphorus.
- There are seasonal variations in performance and management.

### References

Hines, M. and R.E. Favreau. 1974. Recirculating Sand Filters; An Alternative to Traditional Sewage Absorption Systems. Proceedings of the National Home Sewage Disposal Symposium. American Society of Agricultural Engineers, St. Joseph, Michigan.



# External Grants Program

## Investigation of the abiotic reduction of the herbicides trifluralin and pendimethalin

PI: William Arnold (Civil Engineering)

Duration of project: March 1, 2000 – February 28, 2001

The widespread use of dinitroaniline herbicides, such as trifluralin and pendimethalin, throughout the Midwestern United States has led to their detection as contaminants in groundwater, surface water, air, and precipitation (Barbash and Resek 1996, Capel et al. 1998, Larson et al. 1999). According to previous work, reduced inorganic forms of iron and sulfur such as Fe(II) and H<sub>2</sub>S are important reductants under typical groundwater conditions (Stumm and Morgan 1996, Klausen et al. 1995, Schwarzenbach et al. 1997, Schwarzenbach et al. 1990, Hofstetter et al. 1999).

This research evaluates the importance of abiotic reductive transformations as a sink for four dinitroaniline herbicides (trifluralin, pendimethalin, nitralin, and isopropalin). Using reductants representative of abiotic reductants found in natural systems, the results of this study indicate that nitro groups present on the dinitroaniline herbicides can be reduced by surface-bound Fe(II) species in goethite suspensions or by hydroquinone moieties such as (mercapto)juglone in a hydrogen sulfide solution. Aqueous iron species are also effective at pH values above 7.0. Montmorillonite clay, however, is not effective in mediating the reduction of dinitroaniline herbicides in the presence of Fe(II). Because the selected dinitroaniline herbicides have a mixture of electron withdrawing and electron donating groups, linear free energy relationships (LFERs) were developed for the H<sub>2</sub>S / (mercapto)juglone and Fe(II) / goethite systems. The products of the reduction of the herbicides currently in use were identified. Anilines resulting from reduction of the nitro group as well as cyclization products

(benzimidazoles) were observed in the degradation of trifluralin. Only one aniline product was observed for pendimethalin.

### References:

- Barbash, J.E. and Resek, E.Z. 1996. Pesticides in Groundwater. Distributions, Trends and Governing Factors. In: Pesticides in the Hydrologic System. R.J. Gilliom (ed), vol. 2. Ann Arbor Press, Chelsea, MI.
- Capel, P.D., Lin, M., and Wotzka, P.J. 1998. Wet Atmospheric Deposition of Pesticides in Minnesota, 1989–1994. U.S. Geological Survey, Mounds View, MN.
- Hofstetter, T.B., Heijman, C.G., Harderlein, S.B., Holliger, C., and Schwarzenbach, R.P. 1999. *Environ. Sci. Technol.*, 33, 1479–1487.
- Klausen, J., Trober, S.P., Harderlein, S.B., and Schwarzenbach, R.P. 1995. *Environ. Sci. Technol.*, 29, 775–783.
- Larson, S.J., Gilliom, R.J., and Capel, P.D. 1999. Pesticides in Streams of the United States—Initial Results from the National Water-Quality Assessment Program. U.S. Geological Survey, Sacramento, CA.
- Stumm, W. and Morgan, J.J. 1996. *Aquatic Chemistry* (3<sup>rd</sup> ed.) Wiley-Interscience, New York, NY.
- Schwarzenbach, R.P., Angst, W., Holliger, C., Hug, S.J., and Klausen, J. 1997. *Chimia*, 51, 908–914.
- Schwarzenbach, R.P., Stierli, R., Lanz, K., and Zeyer, J. 1990. *Environ. Sci. Technol.*, 24, 1566–1574.

During the biennium, 14 grants were underway. We highlight five of them in this report. All of the external grant projects in progress during the biennium are listed at the end of the section.

# External Grants Program

## Runoff water quality and crop responses to variable manure application rates

PIs: Neil Hansen (Soil, Water, and Climate) and Sagal Goyal (Veterinary Diagnostic Medicine)

Duration of project: March 1, 2000 – February 28, 2001

Livestock producers and society want to protect water in their environment. Applications of manure to cropland can contaminate water if applied improperly. Contamination of water with excess nutrients or pathogens limits the use and function of water and may compromise public health.

One practice that impacts both water quality and crop production is the use of livestock manure in crop production systems. Studies have shown that applying manure at rates based on the crop requirements for nitrogen (N) can improve infiltration and reduce runoff. Applying manure at phosphorus (P)-based rates, which are lower than N-based rates, may improve water quality, but has yet to be investigated. This study evaluates the effects of applying manure at various P-based rates on soil

hydraulic properties, the loss of nutrients in surface runoff, the presence of pathogens in runoff water, and crop production.

Two years of runoff data suggest that liquid hog manure applied at P-based rates improved infiltration and reduced runoff. As a result, associated particulate pollutant losses were also reduced. Soluble pollutant losses were not affected by manure application, but total P was reduced as manure increased.

While the manure application rate initially raised pathogen levels in the soil, the rate had a negligible effect on the fatality of the pathogens. No rate-related persistence in the soil could be detected for any of the pathogens in any of the treatments. There appeared to be a weak relationship overall between application rate and pathogen populations. Because of the unpredictable nature of the weather, further research is needed to determine the potential for pathogen loss in runoff, especially immediately after manure application and incorporation.

## Fluorochemicals in Minnesota waters: an emerging environmental issue

PI: Matt Simcik (Environmental and Occupational Health)

Research Assistant: Kelly J. Dorweiler (Environmental and Occupational Health)

Duration of project: January 31, 2001 – January 30, 2003

Fluorochemicals are an emerging environmental concern because of their global distribution, persistence, and bioaccumulation. In particular, perfluorooctanesulfonate has been found in high levels in the blood of production workers, and more surprisingly it has been found in air, water, and biota throughout the northern hemisphere. To date, no information is available on concentrations of fluorochemicals in water bodies of Minnesota.

This study involves sampling 32 sites across the state of Minnesota and analyzing them for fluorochemicals. The hypothesis is that the global distribution of perfluorochemicals is due to atmospheric transport. Consequently, lakes that are expected to be subject only

to atmospheric deposition were chosen for the study. Specific objectives of the study are to provide baseline information on the levels of fluorochemicals in Minnesota waters, determine the degree of spatial variability, investigate the relative importance of sediments versus water column transport, and determine the relative importance of atmospheric deposition, regional, and point sources.

Surface water samples were collected from Minnesota lakes, rivers and sewage treatment plants. Fish tissue samples were collected from some of the lakes as well. Future analysis of water samples will include filtering and sediment analysis to determine partitioning of perfluorochemicals.

To date, this research has developed a clean-up technique to identify and quantify fluorochemicals in water and fish tissue using single quadrupole IC/MS. It has also detected perfluorooctanesulfonate (PFOS) in fish from Voyageurs National Park and Lake Erie, supporting the hypothesis that atmospheric transport is responsible for global distribution of fluorochemicals.

# External Grants Program

## Evaluation of bank erosion inputs to the Blue Earth River with airborne laser scanner

PIs: Satish Gupta (Soil, Water, and Climate), Marvin Bauer (Forest Resources)  
 Research Assistant: David Thoma, Ph.D. student,  
 Water Resources Science

Duration of Project: March 1, 2000 – February 28, 2001

Development of effective pollution management practices requires knowing which pollution sources are the largest contributors. Sediment and nutrient pollution in the Minnesota River result from a variety of sources, including upland erosion from agricultural areas and stream bank collapse. The relative contributions from these sources, however, are not well understood. This project's goal is to determine how accurately airborne scanning laser altimetry can measure stream bank mass failure rates and phosphorus inputs on the Blue Earth River, a tributary to the Minnesota River. If results are favorable, this technology will be an important tool for resource managers to determine which projects have the greatest potential for pollution abatement and to assess the effectiveness of current control efforts.

The study examined the Blue Earth River between Rapidan Dam and Anboy. Field data were collected for use as supporting information for interpretation and accuracy assessment of the laser scans. A LIDAR scan was taken of the corridor from the convergence of the Watonwan and Blue Earth rivers and Anboy, MN in April of 2001 and 2002.

The project thus far has produced a digital elevation model (DEM) of the Blue Earth River created from the 2001 airborne LIDAR elevation. The DEM was then converted to a 3-D animation of the river valley. Currently, the accuracy of the 2001 LIDAR elevation data is being verified with ground elevation measurements. The elevation data from the 2002 scan has not yet been received. When these data are processed, the 2002 digital elevation model will be overlaid with the digital elevation model from 2001 to calculate the volume change of the stream banks. Field data on bulk density and particle size distribution of sediment along the corridor will be used to convert volume change to mass wasting rates and then suspended sediment load due to bank sloughing and erosion.

## A novel *in situ* technology for the treatment of nitrate contaminated groundwater

PIs: Paige Novak and Michael Semmens (Civil Engineering)

Duration of project: March 1, 2000 – February 28, 2002

Nitrate contamination of groundwater, which often results from heavy fertilizer use from agricultural activities, is a significant problem in the Midwest. In many wells, the maximum contaminant level of 10 mg/L set by the Safe Drinking Water Act has been exceeded. Several treatment options are available to remove nitrate from contaminated drinking water supplies, but current options are expensive or create additional water quality

problems. *In situ* autotrophic denitrification is a process that can selectively remove nitrate within the aquifer. The process relies on microorganisms that use  $H_2$  to reduce nitrate to harmless  $N_2$ . Its use, however, has been hampered by the inability to transfer  $H_2$  gas into an aquifer efficiently. This project studied the effectiveness of using hollow fiber membranes to add  $H_2$  gas to an aquifer to promote *in situ* denitrification.

This membrane technology was found to support excellent nitrate ( $NO_3^-$ ) and nitrite ( $NO_2^-$ ) removal once  $H_2$  and carbon limitations were corrected. The *in situ* treatment process produced a high quality water containing less than 0.5 mg/L total organic carbon.

# External Grants Program

Proposal Title	PIs	Duration of project	Amount
An investigation of the factors affecting removal of cryptosporidium and giardia from drinking water supplies by granular media filtration	Raymond Hozalski	3/1/99-2/29/01	\$48,241.00
Investigation of the abiotic reduction of the herbicides trifluralin and pendimethalin	William Arnold	3/1/00-2/28/01	\$19,840.00
Evaluation of bank erosion inputs to the Blue Earth River with airborne laser scanner	Satish Gupta, Marvin Bauer	3/1/00-2/28/01	\$16,666.00
Assessing the effects of endocrine disrupters (EDCs) from a St. Paul sewage treatment plant on sperm viability and testicular development in fish: adding a new dimension to an existing project	Peter Sorensen, Heiko Schoenfuss, Ira Idelman	3/1/99-2/29/01	\$29,000.00
Runoff water quality and crop responses to variable manure application rates	Neil Hansen, Sagar Goyal	3/1/00-2/28-01	\$14,580.00
Feasibility of controlled drainage for mitigating nutrient loss from tile drainage systems in south central MN	Gary Sands, David Mulla, Lowell Busman, Steve Taff	2/1/99-2/28/01	\$50,318.00
Effects of riparian forest harvest on instream habitat, fish and invertebrate communities	Raymond Newman, Bruce Vondracek, James Perry	3/1/02-2/29/05	\$47,378.00
Biodiversity in urban ponds and lakes: human effects on plankton populations	Robert Sterner	3/1/02-2/29/04	\$48,000.00
Eutrophication and remediation in context: high-resolution study	Emi Ito	3/1/01-2/28/02	\$23,000.00
Characterization of nitrifying bacterial populations in wastewater treatment bioreactors	Timothy LaPara	3/1/02-2/29/04	\$26,580.00
Arsenic in Minnesota groundwater and its impact on the drinking water supply	Randal Barnes, Melinda Erickson	3/1/02-2/29/04	\$18,000.00
A novel in situ technology for the treatment of groundwater contaminated with agriculturally-derived nitrate	Paige Novak, Michael Semmens	3/1/00-2/28/02	\$20,962.00
Fluorochemicals in Minnesota waters: an emerging environmental issue	Matt Simcik	3/1/01-2/28/03	\$41,800.00
Paleohydrologic response of the Mississippi Headwaters watershed to Holocene climate change	Howard Mooers	3/1/01-6/30/03	\$44,600.00
	<b>Total</b>		<b>\$448,965.00</b>



# Outreach

## Volunteer Stream Monitoring

The Water Resources Center provided leadership to begin a new outreach program in 2001 called the Volunteer Stream Monitoring Partnership (VSMP).

In 1998 and 1999, representatives from organizations involved in volunteer stream monitoring in the Twin Cities metropolitan region began discussing the need for a program to coordinate and expand the monitoring that had already begun. Working through a coalition of water educators called the WaterShed Partners, the Metropolitan Council awarded a multi-year start-up grant of \$400,000 in 2000 to fund the Volunteer Stream Monitoring Partnership. The University of Minnesota's Water Resources Center houses VSMP in its office on the St. Paul campus, providing administrative support and infrastructure to help the program succeed. A steering committee of agency, nonprofit, and local partners, was formed to provide guidance and support.



Photo courtesy of Jennifer Stelton

Students use kick nets to sample aquatic organisms. The community structure of these organisms can be used to determine stream water quality.

**VSMP** continued on page 15

## Why Monitor?

Across the nation, citizens have increasingly identified volunteer stream monitoring as an engaging way to evaluate the health of water resources in their communities. Educational institutions, state and local agencies, and nonprofit organizations have initiated a variety of volunteer monitoring programs using national, state, or locally developed methods and protocols. Some of these programs work in isolation, while others coordinate with state or local natural resource agencies. Many of these programs have lacked connections and coordination with other volunteers, agencies, and decision-makers.

Successful volunteer monitoring blends education and science, with support from local units of government, educators, agencies, industry, and nonprofit organizations. Monitoring helps improve communication among volunteers and local, regional, and state agencies, and involves citizens in decision-making to protect water resources. Volunteer monitoring programs can also make the public more aware of river issues and better informed to take action to protect streams and rivers.

Monitoring activities can range widely, depending on volunteers' interests and skill levels. Monitoring can include physical habitat assessment, stream water transparency measurements, identification of bottom-dwelling water insects and other organisms which serve as indicators of water quality, and chemical analyses of water quality.

# Outreach

## VSMP continued from page 14

VSMP, which began its first full year of operation in 2001, faces many challenges, including: 1) strengthening local programs already in existence in several Twin Cities area counties, 2) improving the quality of the data collected by volunteers, 3) coordinating efforts to standardize monitoring methods, protocols, and training, 4) improving data consistency and interpretation, and 5) increasing communication among volunteers, agencies, and decision-makers. VSMP also worked to secure funds to extend the partnership beyond the Metropolitan Council grant. The McKnight Foundation has also now contributed funds to the operation of VSMP.

Mary Gullickson has served at the VSMP Technical Coordinator since the beginning. Julia Frost Nerbonne served at the Program Coordinator until September 2001, and Kevin Proescholdt began work as the Outreach Coordinator in 2002. Barb Liukkonen is the PI for the project, and Tracy Thomas of the Water Resource Center provides staff expertise.

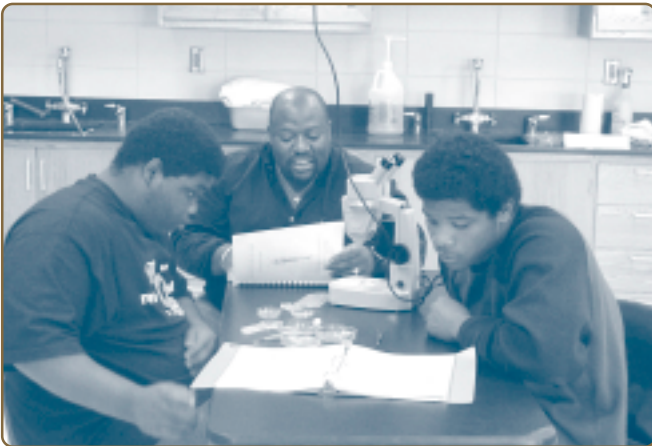


Photo courtesy of Jamie Schurbon, Anoka Conservation District

Students at Crossroads Vocational School identify aquatic macroinvertebrates with the help of their teacher, D.C. Randle.

## 2001-2002 Highlights

Although it is a relatively new program, the Volunteer Stream Monitoring Partnership has had many successes. VSMP convened a stakeholders' meeting in February, 2001, to determine needs, explore collaborative opportunities, and chart a direction for the young program. Staff and the Steering Committee have worked on four main goals: ensuring quality data, strengthening partner collaboration and expanding outreach, securing funds, and increasing the capacity of VSMP to meet the needs of coordinating and improving volunteer stream monitoring across the Twin Cities region. Technical committees have identified and refined appropriate and consistent monitoring protocols and a communications committee developed an outreach plan and visual identity for the partnership. A monthly electronic newsletter reaches over 300 educators, professionals, and volunteers, via email.

During 2001-2002, VSMP offered 26 training workshops that reached 391 participants, including teachers, local government agency staff, naturalists, consultants, and volunteers. The training workshops ranged from an *Introduction to Biological Monitoring* through *Advanced Macroinvertebrate Identification* to *Chemical Monitoring and Data Management*. Currently, over 2000 volunteers monitor 54 sites on 31 streams and rivers in the seven-county Twin Cities area. In 2001 and 2002, VSMP sponsored River Summits that brought together volunteers and agency professionals to share results and data, learn more about streams and monitoring techniques, and celebrate the contributions that volunteers make to our knowledge of water resources.



# Outreach

## MinnAqua

Teaching people about lake and stream ecology by teaching them to fish is the idea behind MinnAqua, a collaborative coordinated by the Minnesota Department of Natural Resources (DNR). MinnAqua is a statewide education program designed to teach angling recreation and stewardship as well as the ecology and conservation of aquatic habitats.



MinnAqua programs teach Minneapolis youth how fishing and water quality are interrelated.

Family groups, youth groups like scouts or 4H, women, seniors, new immigrants, and people with disabilities can all enjoy the opportunities for fun and connecting with nature that fishing provides. Our goal is to provide a fun, active, “hands-on” experience with fishing to get participants excited about learning and being involved with their local aquatic ecosystems. To this end, the MinnAqua program serves approximately 40,000 participants each year across Minnesota.

The Minnesota Fish Watch program was initiated this past year with the completion of the Warmwater Sportfish edition. This guide is designed to help people know where and when to look for different species of fish, what habits aid various fish species’ survival, which foods are on their menu, and what tackle should be used when fishing for them. Each species has a full color illustration and a description to assist anglers in identification. For more information on this publication, consult the Minnesota DNR website at <http://www.dnr.state.mn.us>.

Progress has been made on a revised MinnAqua curriculum for use as an outreach and education tool in a formal classroom setting. Completion of the new curriculum is expected to occur in 2004.

Roland Sigurdson is the MinnAqua program contact in the Twin Cities metropolitan area. MinnAqua also has contacts in Brainerd and New Ulm, as well as a statewide coordinator. More information about MinnAqua can be found at <http://www.dnr.state.mn.us/minnaqua>.

MinnAqua continues to serve approximately 40,000 participants each year in our statewide aquatic education and angling programs. Some organizations that use our expertise are listed below:

- Boy Scouts of America
- County Soil and Water Districts
- Dept of Natural Resources Diversity Outreach Program
- Girl Scouts of America
- Great Lakes Aquarium
- Metro Children’s Water Festival
- Minneapolis Aquatennial
- Minnesota Outdoor Heritage Alliance
- Minnesota State Fair
- National Turkey Federation
- St Paul Sports Show
- Three Rivers Park District
- University of Minnesota Extension Service
- Walleye Expo
- Wildlife Forever

## Metro Children’s Water Festival

For the past five years, the Metro Children’s Water Festival has educated about 1,300 fifth graders (annually) on all aspects of water on the last Wednesday in September. A joint effort of organizations across the seven county metro area, the Festival enjoys strong Water Resources Center support. Ron Struss serves on the Festival Steering Committee as the Education Program Coordinator and Mary Gullickson, Barb Liukkonen, and Roland Sigurdson and conduct learning stations on the day of the event.

# Outreach

## Environmental Quality Incentives Program (EQIP) Education

**Kevin Blanchet, Jodi DeJong-Hughes (U of M Extension Service, WRC), Les Everett (U of M Agricultural Experiment Station, WRC)**

**Funding source:** U.S. Department of Agriculture 1996 Farm Bill administered through NRCS

**Duration of project:** 1997 – September 30, 2003

The EQIP Education project, a conservation education partnership with USDA-NRCS, arose out of the recognition that landowners and farm operators need to understand the resource concerns on their land and how to implement better practices if cost-share and incentive programs like EQIP are to succeed.

The core of EQIP Education has been a team of UM Extension and NRCS staff working together to determine education priorities, develop education materials, and deliver or organize education programs. Some specialized programs have been developed and delivered by UM Extension and research faculty based at research stations and county offices around the state.

Education emphasis in 2000-2002 continued in the high impact areas of crop nutrient, manure, and grazing management. Additional education programs were added to serve the needs of audiences that traditionally do not participate in USDA programs: beginning farmers and rural residents on small acreages.

During the past biennium, Extension and NRCS staff jointly prepared and distributed publications, including “Components of a Nutrient Management Plan” and “Sample Nutrient Management Plan.” The Extension-NRCS team updated the nutrient and manure management planning software, and presented nine regional trainings to agency staff, agricultural professionals, and producers. Workshops were presented in western Minnesota on soil management for beginning farmers and livestock mortality composting. In northeast and east-central Minnesota, three workshops were presented on the environmental aspects of rural residences and small farms. A traveling display was developed, and workshops were delivered to 200 farmers to assist them in design of effective livestock watering facilities for rotational grazing paddocks.

## On-Site Wastewater Treatment

Through its On-Site Wastewater Treatment Program (OSWTP), Extension works with homeowners, professionals, local officials, and small communities on a wide range of wastewater concerns.

Nearly 600,000 septic systems are currently in use in Minnesota. Program evaluations from OSWTP presentations have shown that homeowners save money and protect their family’s health and the public water supply by learning how to properly use and take care of their septic systems. OSWTP also publishes a *Septic System Owner’s Guide*, a 24-page septic system user’s manual, which has sold in excess of 200,000 copies since 1995.

In addition to homeowner education, Extension provides basic, advanced, and continuing training for licensure of all on-site wastewater treatment professionals in Minnesota. This program works with

designers, installers, and inspectors of on-site wastewater treatment systems. This professional training program has been in operation for over 30 years, and generates approximately \$400,000 in annual revenue.

Another service offered by the OSWTP is its program for small communities. Thousands of communities across the state must find viable solutions to their wastewater needs in the next few years. Extension’s Small Community Wastewater Solutions Program helps these communities develop strategies to find solutions that offer effective protection of human and environmental health that are economically feasible and socially acceptable. Government agencies, organizations, and the private sector offer communities technical services and resources, but Extension’s program provides these communities with a framework to use those resources to meet the community’s needs.

# Outreach

## Shoreland Education

Shoreland education efforts continued to expand during the past biennium, including development of educational materials, shoreline restoration projects, and volunteer training.

The Shoreland Management Guide web site ([www.shorelandmanagement.org](http://www.shorelandmanagement.org)) was completed and received a national Gold Award from the Association of Natural Resource Extension Professional. Electronic visitors to the site continued to grow, averaging about 1000 visitors a month. Local government units, educators, students, and lake association leaders use the PDF fact sheets for meetings, in newsletters, and for press releases. The Shoreland Management Guide was funded through a legislative appropriation of \$100,000 to the University of Minnesota Extension Service and developed as a joint project between the Sea Grant Program and the Water Resources Center.

Shoreland revegetation programs flourished under the leadership of Mary Blickenderfer. During the biennium, 43 workshops held in 16 counties attracted 856 citizen leaders, master gardeners, landscape and nursery professionals, and agency staff. During the period, 62,000 square feet of shoreline were revegetated to reduce erosion and runoff, increase infiltration, improve habitat, increase privacy, discourage waterfowl, and protect water resources. This work was partially funded through a 319 grant from the Minnesota Pollution Control Agency.

Partnerships with the Minnesota Lakes Association (MLA) and Rivers Council of Minnesota (RCM) were strengthened and several joint proposals were submitted to further shoreland education. In conjunction with MLA, Barb Liukkonen helped develop and teach a workshop for elementary teachers entitled, "Interactive Lake Ecology." The curriculum was developed in New Hampshire and was customized to fit Minnesota's water resources. Teachers participating in the workshop have subsequently incorporated the curriculum into their classrooms. Evaluation and further adaptation of the curriculum will take place during the current biennium.



Cass Lake volunteers plant and water shoreland vegetation.

Photo courtesy of Steve Mortenson,  
Leech Lake DRM



Shoreland Revegetation workshop participants learn to identify common aquatic plants.

Photo courtesy of Cindy Hagley, MN Sea Grant

## Assistance to local water planning

Watershed Districts are local units of government dedicated to the management of water and related natural resources. State statute requires Watershed Districts to revise their plan of operations every ten years. Ron Struss has been assisting Watershed Districts in the seven-county metropolitan area with two aspects of the planning process: strategies to involve citizens in the plan development process, and development of educational programs that will assist in reaching plan goals.

In the past two years, the following Watershed Districts have been assisted: Bassett Creek, Comfort Lake - Forest Lake, Elm Creek, and Pioneer - Sarah Creek.

# Outreach

## Feedlot Rules Education Project

**Dennis Busch, Phil Nesse, Kevin Blanchet, Jodi DeJong-Hughes (U of M Extension Service, WRC), Les Everett (U of M Agricultural Experiment Station, WRC)**

**Funding source:** EPA grant administered through MPCA

**Duration of project:** 1999 – ongoing

New state feedlot rules in 1999 brought opportunities for environmental protection as well as challenges for livestock producers. The Water Resources Center organized a team of UM Extension, Minnesota Pollution Control Agency (MPCA), and USDA-NRCS staff to assist producers in understanding what improvements in practices would be necessary. The team prepared education materials, trained county-based staff, and facilitated delivery of local information sessions for livestock producers on the content of the rules (2000–2001) and practices related to land application of manure (2001–2002).

Basic requirements for land application of manure are common to most farms, and these were the focus of the second year of education: management of environmentally sensitive areas, rates of manure and crop nutrient application, and record keeping. Progress in these areas will significantly reduce water pollution by nitrogen and phosphorus, and, in many cases improve farm profitability through reduced fertilizer purchases. Minnesota Department of Agriculture on-site surveys consistently show that livestock producers do not take sufficient “credits” for nutrients supplied in manure and thus apply fertilizer above the rates needed for an economically optimum yield response. Soil and manure sampling, manure spreader calibration, and records of previous manure applications provide the essential information for taking manure credits and reducing supplemental fertilizer.

During 2000–2002, UM Extension, MPCA, and NRCS staff jointly prepared publications on management of environmentally sensitive areas, manure and crop nutrient planning, manure sampling and manure spreader calibration. In 2001, 222 county-based staff of Extension, County Feedlot Officers, and SWCDs attended nine regional “train the trainer” sessions on land application of manure, including rates,

record keeping, and environmentally sensitive areas. In 2001–2002, more than 1140 livestock producers and others attended information meetings on land application of manure.

## Response to Minnesota’s 2002 lawn fertilizer phosphorus law

On April 19, 2002, Governor Ventura signed SF 1555, the Phosphorus Lawn Fertilizer Bill into state law and by so doing, created the need to educate landowners and the lawn care industry so they can remain in compliance. This added to an already existing educational need generated by phosphorus lawn fertilizer ordinances enacted by several local governments, including the cities of Minneapolis and St. Paul. An initial response to these needs was the creation of:

- *“Green up your lawn – not your lakes and rivers,”* a publication produced by 14 cities and two counties in the metro area, and,
- *New phosphorus lawn fertilizer law aims to protect Minnesota lakes and rivers,* a joint publication of the Minnesota Department of Agriculture, Minnesota Office of Environmental Assistance, WaterShed Partners and University of Minnesota Extension Service.

Ron Struss coordinated the production of the first publication and served on the design team for the second. Barb Liukkonen provided technical review of both.

# Outreach

## WRC Website

The Water Resources Center operates and manages four websites related to the programs that the WRC houses. The main site is the Water Resource Center site at <http://wrc.coafes.umn.edu/>. This site contains information about all activities of the WRC including research, outreach, education, and publications as well as information on WRC staff, an expertise directory and water links on the web.

The Volunteer Stream Monitoring Partnership (VSMP) site is located within the WRC site at [www.vsmpp.org](http://www.vsmpp.org). Here you can find information on the history of the program, local partners maps of monitoring sites, educational materials, and a variety of other monitoring-related information.

The Water Resources Science website is managed through the WRC at <http://wrs.coafes.umn.edu/>. The WRS site contains much helpful information for current and prospective students on admission, program requirements, faculty, courses offered, areas of emphasis, and an online copy of the student handbook. Information such as seminar schedules, employment opportunities, professional societies, and current student and alumni information is also available at this site.

The WRC also operates a Water Quality Extension website through the University of Minnesota Extension Service at [www.extension.umn.edu/water/](http://www.extension.umn.edu/water/). This site describes and provides information on the many Water Quality Extension programs including Safe Drinking Water, Sewage Treatment, Shoreland Development, Agriculture and Water Quality and water education links.

## MNRUnoff

MNRUnoff stands for “Minnesota Runoff” and is an email discussion group for Minnesota urban water resource issues. Currently 160 members use the list, which was created in June 2001. Some of the topics discussed on MNRUnoff include:

- Environmental impacts of urban stormwater
- Low Impact Development concepts
- Design and maintenance of stormwater BMPs
- Stormwater educational programs
- Meeting EPA Phase II requirements

An email sent to [MNRUnoff@extension.umn.edu](mailto:MNRUnoff@extension.umn.edu) will be shared with all list subscribers. A reply to a MNRUnoff message goes back to the message sender, and not the entire list. To join the list, go to the MNRUNOFF information page at <http://lists.extension.umn.edu/mailman/listinfo/MNRUnoff> and follow the subscription instructions.

MNRUNOFF is sponsored by the UM Water Resources Center and is administered by Ron Struss and Tracy Thomas.

## K-12 Education

Water Resources Center staff have been involved in many educational programs for youth including environmental field days, Envirothon coordination and teaching, and curriculum development. Kamal Alsharif, Ron Struss, Roland Sigurdson, and Barb Liukkonen created and presented learning stations as conservation field days and water festivals reaching thousands of students from more than 20 counties across the state. They also helped coordinate pre/post educational efforts and evaluate the educational effectiveness of field days and festivals.

In 2000 and 2001, Kamal Alsharif coordinated the statewide Envirothon competition in which teams of high school students compete in an environmental knowledge bowl. Coordination included providing educational materials for student presentations; enlisting and training presenters and judges, arranging facilities and awards, and compiling questions for the competition.

# Outreach

## *Minnegram*

The WRC publishes *Minnegram*, a quarterly newsletter, to serve as a vehicle of communication for individuals in the water resources community. *Minnegram* provides a resource for information and communication to over 1500 water professionals, researchers, students, and interested citizens throughout Minnesota and the U.S.

*Minnegram* provides feature-length coverage of important water issues. Some of the feature articles in *Minnegram* during the past biennium have included topics such as alternative individual sewage treatment systems in Minnesota, monitoring projects in the Minnesota River basin, Minnesota phosphorus legislation, research by Water Resource Center faculty and students, and water conference highlights. *Minnegram* also provides brief updates on water-related issues in Minnesota, upcoming conferences and events, new publications, and news related to WRC faculty and students, as well as listing Water Resources Science program graduates and their thesis titles.



## Minnesota Water 2002

Minnesota Water 2002 was the 8<sup>th</sup> biennial conference on Minnesota's critical water issues. The 2002 conference, "Working Together in a Climate of Change to Manage Minnesota's Water Resources," was offered in conjunction with the Minnesota Lakes and Rivers Conference. Nearly 500 participants from federal, state, and local agencies, academia, and non-governmental organizations gathered in St. Cloud to listen to plenary speakers address the implications of changing climate, demographics, and water- and land-use patterns; intensifying development; and growing recreational conflicts for water resources management. Over 50 concurrent sessions examined technical and citizen-based topics ranging from ground water in the Twin Cities, mercury contamination in fish, and TMDLs, to emerging GIS tools, shoreland landscaping, and how to manage a non-profit organization.



Water Resources Science students Michelle Marko and Barbara Peichel discuss the poster session.

Plenary speakers at the conference included Tom Johnson, Director of the Large Lakes Observatory at the U of M Duluth, Gyles Randall, Southern Research and Outreach Center, Mark Seeley, U of M

Soil, Water and Climate and Extension climatologist, J. Drake Hamilton of Minnesotans for an Energy-Efficient Economy, John Kari of the Metropolitan Council, and Jack Uldrich and Gretchen Sabel of Minnesota Planning.



# Education

## Water Resources Science

The WRC is the administrative home for the interdisciplinary graduate program in Water Resources Science. Since its founding in 1995, the program has grown to involve approximately 90 faculty on the Twin Cities and Duluth campuses of the University and an enrollment of 70 to 80 graduate students. Since its inception, the program has produced 60 graduates, including 53 M.S. students and seven Ph.D.s. During the 2000-2002 biennium, 31 students graduated and began their careers in water resources fields (see Appendix G).

Patrick Brezonik resumed the position of Director of Graduate Studies for a two-year term in fall of 2002, succeeding Jim Perry, who stepped down because of his new position as head of the Department of Fisheries, Wildlife, and Conservation Biology. Howard Mooers (Geology), former Associate DGS in Duluth replaced Erik Brown (Geology, Large Lakes Observatory) in that position for academic year 2001-2 while Brown was on sabbatical in southern France. Maria Juergens has continued as the program's administrator since its inception.

### Approximate breakdown of faculty disciplinary interests\*

Agricultural water quality:	9
Aquatic biology/microbiology:	9
Environmental chemistry/biogeochemistry:	10
Environmental engineering:	6
Landscapes (geography), watersheds, GIS:	5
Limnology:	23
lakes:	14
streams:	7
wetlands:	2
Physical hydrology:	14
ground water:	6
surface water	4
climatology:	4
Water resour. engineering/env. fluid mechanics:	4
Water resources socio-economics/policy:	1

\*Primary interest only; many faculty have more than one area of interest/expertise

### Facts about the WRS faculty

Currently number:	91
TC Saint Paul:	45
TC Minneapolis:	25
Duluth:	21
Departments/units represented:	26
Twin Cities:	17
Duluth:	9
Colleges represented:	11
Twin Cities:	8
Duluth:	3
Faculty who have advised/are advising a WRS student:	49
Full Professors:	47
Associate Professors:	12
Assistant Professors:	19
Other appointments:	13

The WRS Web site (<http://wrs.coafes.umn.edu>) serves as the program's chief recruiting tool and a major resource about the program for current students and faculty. The site underwent major reorganization and updating in 2002 under the direction of then Webmaster Anne Jefferson and WRC Editor Tracy Thomas. The revised site provides a wealth of information about the program's, faculty, curriculum, current students and graduates in a crisp, clean and modern format.

WRS conducted an internal program review in 2001-2 and produced a report highlighting the activities and successes of the program. As part of the review, WRS faculty were polled to document their involvement and interest in the program, as well as for suggestions to improve the program. The survey showed that the great majority of the program's faculty have been active in program

**WRS** continued on page 23

# Education

**WRS** continued from page 22

governance, teaching, or advising of graduate students. Another result of the review was strengthening the program's committee structure. A new seminar committee was established with Professor David Mulla (Soil, Water, and Climate) as chair, and an ethics training committee chaired by Professor Paige Novak (Civil Engineering) also was formed. In a further effort to distribute governance responsibilities, Professor Ray Newman (Fisheries, Wildlife, and Conservation Biology) was appointed chair of the WRS Admissions Committee; formerly this position was a responsibility of the DGS.

## WRS Curriculum

### Core Courses

Hydrology  
 Environmental Chemistry  
 Limnology/stream ecology  
 Water Resources Policy and Economics  
 (social forces involved in water management)

### Areas of Specialization

Aquatic Biology  
 Environmental Chemistry  
 Hydrologic Science (surface and ground water)  
 Limnology  
 Water Management Technology  
 Water Policy and Economics  
 Water Quality  
 Watershed Management

### Electives

More than 96 courses in 18 departments

The following WRS students received awards during the 2000-2002 biennium:

Geoffrey Chavala	2002 MacArthur Fellowship
Filiz Dadaser	2002 MacArthur Fellowship
Brent Dalzell	USDA National Needs Fellowship to pursue Ph.D. at Purdue University
Kathy Draeger	Charles A. and Anne Morrow Lindbergh Foundation grant Honorable Mention in 2002 UCOWR Dissertation Competition
Melinda Erickson	2002 CURA research grant on arsenic in Minnesota groundwater
Heather Hendrixson	2001 liMNology Fellowship; Dayton and Wilkie Natural History Funds research award
Matt Hudson	2002 Scholarship from International Association for Great Lakes Research
Brian Huser	2001 Fullbright Fellowship in Sweden
Thomas Jabusch	2001 Student Award in Environmental Chemistry from American Chemical Society; 2002 Great Lakes Commission-Sea Grant Fellowship
Anne Jefferson	NSF Fellowship to pursue Ph.D. at Oregon State University
Stefanie Miklovic	Alexander and Lydia Anderson grant; Carolyn M. Crosby Fellowship
Edith Mussukuya	Fellowship from Global International Waters Assessment (GIWA)
Rachel Walker	2000 Graduate School Fellowship; 2002 NSF Fellowship



# Education

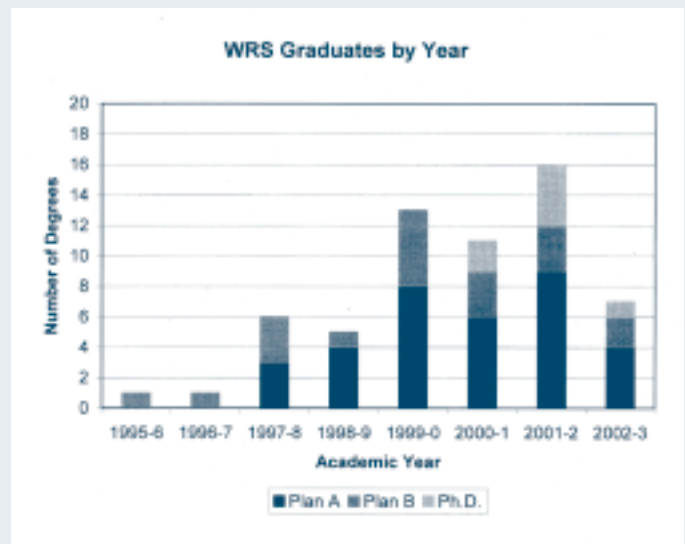
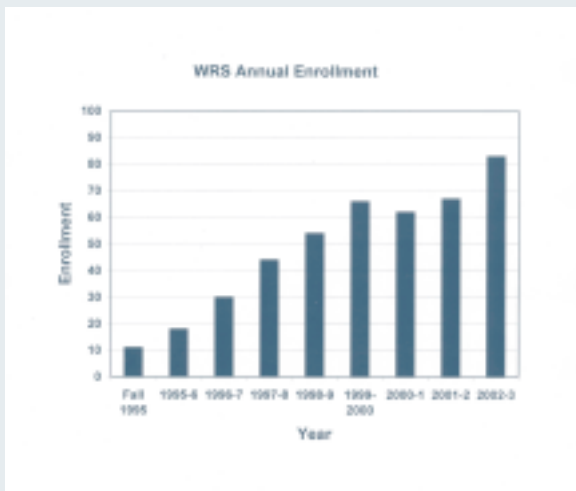
## Student Demographics

	Applicants to date	Students enrolled to date
<b>Total</b>	<b>400</b>	<b>162</b>
<b>U.S.</b>	<b>295</b>	<b>140</b>
Minnesota	135	73
<b>Non-U.S.*</b>	<b>105</b>	<b>22</b>
China	40	3
India	9	3
Africa	21	8
Sub-Sahara	15	6
SE Asia**	13	2
S. America***	7	1
Europe	5	3
Middle-East	5	2

\*Includes applicants from 33 countries and enrollees from 17 countries

\*\*Includes Korea, Japan, Taiwan: excludes China, India

\*\*\*Includes Caribbean and Central America





# Public and Professional Service

WRC staff are active in many professional societies and contribute their time, energy, and expertise to support the goal of the University to be engaged in activities that serve the public good. Such activities include serving on review panels, advisory boards, expert study committees, and presenting talks to community organizations. During the reporting period, WRC staff participated in such activities for local, state, and federal government agencies, as well as within the University of Minnesota and in non-governmental organizations.

## **Jim Anderson**

Chair, Advisory Committee for Individual Sewage Treatment Systems for MN Pollution Control Agency  
 Extension representative, MN Board of Water and Soil Resources  
 Member, Project Coordination Team for Clean Water Partnerships and EPA 319 projects, MN PCA  
 Member, Board of Directors, National Association of Wastewater Transporters  
 Member, Regional Committee NCS-5 on water quality issues for Agricultural Experiment Station Directors  
 University representative, Water Resources Committee, of MN Environmental Quality Board

## **Larry Baker**

Associate Editor, *Urban Ecosystems*, 2001-  
 Member, panel on salinity management, Arizona Water Pollution Control Association Annual Conf., 2001  
 Speaker, workshop on taste and odor control strategy, City of Phoenix, 2002  
 Speaker, Integrating social science into LTER Programs: ecosystem function in coupled systems, Baltimore, 2002  
 Workshop participant, Integrating education in biocomplexity research, National Academy of Sciences, 2002

## **Patrick Brezonik**

Chair, Faculty Education Advisory Committee on ethics training for U of MN Vice-President of Research, 2001-  
 Chair, Research Committee, Universities Council on Water Resources, 2002-  
 Co-organizer, Midwest Environmental Chemistry Workshop, 2001  
 Co-organizer, session on linking research and education in limnology, Amer. Soc. Limnol. Oceanogr., 2001 mtg  
 Member, U of MN Committee to revise the Graduate School Constitution, 2001-2  
 Member, U of MN Senate Judicial Committee, 2001-  
 Member, National Research Council, Committee on Restoration of the Greater Everglades, 2000-  
 Member, Planning committee for Lakes and Rivers Conference in Brainerd, 2001  
 Member, ASLO steering committee for workshop and report on future research directions in limnology, 2002-  
 Member, review panel for WRI national competitive grants program, 2001  
 Member, review panels for NSF's Biocomplexity program and major research instrumentation grant program in environmental engineering, 2001  
 Organizer, symposium on mercury cycling in water and soil systems, Am. Chem. Soc., 2001

## **Les Everett**

Member, NRCS State Technical Committee and EQIP Subcommittee  
 Member and author, National Conservation Title Working Group of Cooperative Extension System  
 Member, St. Paul District 10 Environment Committee  
 Member, U of MN Waste Abatement Committee

# Public and Professional Service

## **Barb Liukkonen**

President, MN Community and Natural Resources Association, 10/2001 - 10/2002; Member  
Chair, Extension Faculty Consultative Committee, 5/2002 - 5/2003; Executive Committee 5/2001-5/2002; Member 6/  
2000 - 6/2003  
Chair, Selection committee for Extension Distinguished Service Awards, /2002  
Member, Extension Natural Resources and Environmental Capacity Area Leadership Team: 6/2000 -6/2003  
Member, National Advisory Team for the Water on the Web project: 2001 - present  
Member, HECUA Advisory committee for course on Sustainability in the Mississippi River Basin, 9/2001 to present  
NextStep Sustainability web site, Guide to the Water page, 8/2000 - present  
President, 11/1999 - 11/2002, Sugarloaf Interpretive Center Association, Board of Directors; Member, 1992 - present  
Chair, Legal Advocacy Fund and Educational Equity, American Association of University Women, NE Metro Branch  
Presenter, “Eye to the Future” workshop for girls on careers in math and science, May 2002; Nov 2003

## **Kevin Proesholdt**

Presenter at Neighborhood Environmental Sustainability Conference, Minneapolis, 2002  
Presentation to WaterShed Partners, St. Paul, 2002  
Presenter at Earth Day event, Patrick Henry High School, Minneapolis  
Member and Vice-chair, Board of Directors, Swedish-American Historical Society, Chicago  
Author, *Environmental Briefing Book, 2002 Legislative Session* for Minnesota Environmental Partnership, 52 p.  
Author, *The Prolific Pen of George M. Stephenson: An Annotated Bibliography*, for *Swedish-American Historical Quarterly*, 2002  
Author, *Wilderness Celebrates 75 Years*, for *International Journal of Wilderness*, 2002

## **Mary Renwick**

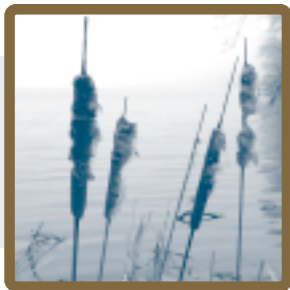
Member, development team for *Lower Minnesota River Watershed Strategic Action Plan*  
Member, Water Resources Science Graduate Program Curriculum Committee  
Member, Planning Committee for *Minnesota Water 2002*  
Conceptualized and assisted in development of IWMI/MacArthur Graduate Fellowship Program  
Member, doctoral research grants selection committee, U of MN MacArthur Program  
Member, Compton Foundation and IWMI/MacArthur grant selection committee for MacArthur Program  
Member, MacArthur Scholars selection committee for MacArthur Program  
Reviewer of manuscripts for *Internat. J. Water Management, Resource and Energy Economics, J. Environ. Management, and Water Resources Research*

## **Roland Sigurdson**

Member, TMDL oversight committee for North Branch of the Sunrise River

## **Ron Struss**

Member, Steering Committee and Meeting Convener, Metro WaterShed Partners  
Member, Planning Committee and Program Coordinator, Metro Children’s WaterFestival  
Judge, oral presentations at Minnesota State Environthon  
Presenter, Anoka County Conservation Days and Pokegama Lake Association Water Fair  
Representative for MN BWSR on state Environmental Education Advisory Board



# Appendix A

## WRC staff list

<b>Name</b>	<b>Position</b>
Kamal Alsharif	Extension Educator, Water Resources
Jim Anderson	Co-Director
Larry Baker	Researcher, Urban Ecosystems
Janelle Benusa	Account Specialist
John Bilotta	Extension Educator, Feedlots/Nutrient Management
Kevin Blanchett	Extension Educator, Nutrient Management
Mary Blickenderfer	Extension Educator, Shoreland Revegetation
Patrick Brezonik	Co-Director
Dennis Busch	Extension Educator, Manure Management
Jodi DeJong Hughes	Extension Educator
Katherine Erdman	Web Master, Graduate Student
Les Everett	Program Coordinator, Agriculture Extension Projects
Mary Gullickson	Technical Program Coordinator, Volunteer Stream Monitoring Partnership
Maria Juergens	Administrator
Bryn Kiel	Account Specialist
Barb Liukkonen	Water Resources Education Coordinator
LeAnne Mfalingundi	Account Specialist
Phil Nesse	Extension Educator, Manure Management
Ken Olson	Extension Educator, Wastewater Treatment
Leif Olmanson	Senior Scientist, Remote Sensing
Kevin Proescholdt	Outreach Program Coordinator, Volunteer Stream Monitoring Partnership
Mary Renwick	Researcher, Economics
Johanna Schussler	Editor, Graduate Student
Roland Sigurdson	Program Coordinator, MinnAqua Youth Fishing Education
Ron Struss	Extension Educator, Urban Water Quality
Tracy Thomas	Editor

# Appendix B

## WRC Administrative council

**Jim Anderson** WRC co-Director and Professor, Department of Soil, Water and Climate  
**Sandra Archibald** Associate Dean and Professor, Hubert H. Humphrey Institute of Public Affairs  
**Victor Bloomfield** Vice Provost for Research and Professor, Department of Biochemistry  
**Patrick Brezonik** WRC co-Director and Professor, Department of Civil Engineering  
**Charles Casey** Dean and Director, University of Minnesota Extension Service  
**H.H. Cheng** Professor and Head, Department of Soil, Water and Climate  
**John Gulliver** Professor and Head, Department of Civil Engineering  
**Chuck Muscoplatt** Dean of the College of Agricultural, Food and Environmental Sciences  
**Carl Richards** Director, Minnesota Sea Grant  
**Robert Sterner** Professor and Head, Department of Ecology, Evolution and Behavior  
**Al Sullivan** Vice Provost for Academic Programs and Facilities

## WRC External advisory committee

**Dave Biesboer** Associate Professor, Department of Plant Biology  
**Ken Brooks** Professor and Director of Graduate Studies, Department of Forest Resources  
**Greg Buzicky** Minnesota Department of Agriculture  
**K. William Easter** Director of the Center for Food and Agricultural Policy and Professor, Department of Applied Economics  
**Efi Foufoula-Georgiou** Professor, Department of Civil Engineering, St. Anthony Falls Laboratory  
**Jack Frost** Metropolitan Council Environmental Services  
**Ray Hozalski** Assistant Professor, Department of Civil Engineering  
**Emi Ito** Director, Limnological Research Center and Professor, Department of Geology and Geophysics  
**Tom Johnson** Director, Large Lakes Observatory and Professor, Department of Geology, Duluth  
**Anne Kapuscinski** Director, Institute for Social, Economic, and Ecological Sustainability and Professor, Department of Fisheries, Wildlife and Conservation Biology  
**Kathy Klink** Associate Professor, Department of Geography  
**Kent Lokkesmoe** Minnesota Department of Natural Resources  
**Dave Mulla** Professor, Department of Soil, Water and Climate  
**Gerald Niemi** Director, Center for Water and the Environment and Professor, Department of Biology, Duluth  
**Faye Sleeper** Minnesota Pollution Control Agency  
**Jeff Stoner** U.S. Geological Survey  
**Doug Thomas** Minnesota Board of Water and Soil Resources  
**Bruce Wilson** Professor, Department of Biosystems and Agricultural Engineering  
**Donald Wyse** Professor, Department of Agronomy and Plant Genetics

# Appendix C

## Presentations given

### **Lawrence Baker**

Baker, L. A., and W. Stefanov. 2002. Information engineering: a new paradigm for environmental management in the 21<sup>st</sup> century. Minnesota Water Conference, 17-19, April 2002.

Baker, L. A., Hope, D., Xu, Y., and Edmonds, J. 2001. Multi-compartment ecosystem nitrogen balances as a tool to understand and manage biogeochemical cycles in human ecosystems. The Science World, Proc. Second International Nitrogen Conference. 14-18 October 2001. Potomac, MD.

Baker, L. 2001. An ecosystem-level approach for engineering the biogeochemical cycles of cities and farms. Keynote Talk, Midwest Water Chemistry Conference, 6-7 October 2001.

Westerhoff, P., Bruce, D., Nguyen, M. L., Sommerfeld, M., Dempster, T., Hu, Q., Lowry, L., Baker, L. 2001. Production sources of algal metabolites (MIB and geosmin) in Arizona reservoirs, rivers, and canals. AWWA conference, June 2001, Washington.

Baker, L. A., Xu, Y., McPherson, N. 2001. Salinity: an emerging issue for western cities. AZ Water Pollution Control Association Annual Conference, 2-5, May 2001.

### **Les Everett**

Everett, L. A. and J. L. Anderson. 2001. A University-Federal contractual partnership for conservation education under EQIP. Presented at the Annual Meetings of the American Society of Agronomy, October 2001, Charlotte, NC.

Everett, L. A. and J. L. Anderson. 2001. Crop nutrient management, grazing management, and local education through EQIP. Presented at the Annual Meetings of American Society of Agronomy, October 2001, Charlotte, NC.

### **Barb Liukkonen**

Hagley, C. and B. Liukkonen. 2001. The Minnesota shoreland management resources guide: a web-based resource for citizens and educators. Proceedings, NALMS annual meeting, Madison, WI. November 7-9.

Liukkonen, B, C..Hagley, and B. Peichel. 2002. Lake Access: water quality information to help change behavior. Proceedings ANREP biennial meeting, Naples, FL. June 2-5

Liukkonen, B. and M. Gullickson. 2002. Volunteer stream monitoring: Involving citizens in collecting quality data. Proceedings ANREP biennial meeting, Naples, FL. June 2-5

### **Ken Olson**

Operation and Maintenance Presentations:

Greenwood Township, St Louis County

Kanabeck County Rural Living Day

Murray County

Pipestone County

Lincoln County

Chisago Rural Living Day

Hubbard County

Alternative Treatment Systems:

Kanabeck Rural Living Day

# Appendix C

## Presentations given, continued

### Small Community Wastewater Treatment:

- Bemidji Township, Beltrami County
- Crow Wing County “Small Community Workshop Series”
- Sylvan Shores, Todd County
- City of Corcoran, Hennepin County
- USDA Rural Development Staff Conference, “Small Community Options”
- Mahtomedi, South Warner Neighborhood
- MN Lakes and Rivers Conference, “Solving Unique Sewage Treatment Problems on Shoreland Properties”
- County Staff Workshops: “Small Community Wastewater Solutions,” Grand Rapids, Crookston, Morris,

### Waseca

- Hubbard County
- Cinosam, Crow Wing County

### **Mary Renwick**

Renwick, Mary E. 2002. Integrating science and economics to enhance agricultural nonpoint pollution abatement policy. Dept. of Ag. And Applied Economics, Natural Resource and Environmental Economics Seminar series, May 2002.

Renwick, M. E., Anderson, J., Mulla, D., Gowda, P. 2002. Dual nature of nonpoint source pollution. American Ag. Engineering TMDL Conference, March 2002, Fort Worth, TX.

Renwick, Mary E. 2001. Valuing water in a multiple-use system. Dept. of Ag. and Applied Economics, Natural Resource and Environmental Economics Seminar Series, December 2001.

Renwick, Mary E. 2001. Valuing ground water when quality is an issue. Minnesota Ground Water Association Annual Meeting, November 2001, MN.

Renwick, Mary E. 2001. The dual nature of nonpoint agricultural pollution. 34<sup>th</sup> Annual Minnesota Water Resources Conference, November 2001, MN.

Renwick, M. E., Costa, N. 2001. Risks and benefits of traditional food consumption by Ojibwe. U.S. Ecological Economics Annual Meeting, July 2001, MN.

Renwick, Mary E. 2001. Willingness-to-Pay for water in urban areas. Conference of the International Water and Resource Economics Consortium, June 2001, Girona, Spain.

Renwick, Mary E. 2001. The value of water. Minnesota Lakes and Rivers Conference, March 2001, MN.

### **Dave Thoma and Satish Gupta**

Thoma, D.P., S.C. Gupta , 2002. Water quality research in the Minnesota River Basin. Invited presentation at American Farm Bureau Watershed Heroes conference. Saint Peter, MN June 20.

Thoma, D.P., S.C.Gupta, C. E. Kirchoff and M.E. Bauer, 2002. Airborne scanning laser altimetry for bank erosion assessment - Blue Earth river, MN. Poster presented at U.S. Army Corps of Engineers Regional Sediment Workshop. Mobile, AL May 19-22.

# Appendix C

## Presentations given, continued

Thoma, D.P., S.C.Gupta, M.E. Bauer and C. E. Kirchoff, 2002. Laser altimetry assessment of river bank erosion, Blue Earth river, MN. Invited presentation at U.S. Army Corps of Engineers Regional Sediment Management Workshop. Mobile, AL May 19-22.

Thoma, D.P., 2002. Laser Altimetry in Water Quality Research in the Minnesota River Basin (and other applications). Seminar in Soil Science, Department of Soil, Water and Climate, University of Minnesota April 22.

Thoma, D.P., S.C. Gupta, and M.E. Bauer, 2002. Laser Altimetry Assessment of Riverbank Erosion, Blue Earth River, MN. Talk presented at Minnesota Water 2002 Conference, St. Cloud, MN April 18.

Thoma, D.P., 2002. Laser Altimetry in Water Quality Research in the Minnesota River Basin (and other applications). Invited lecture presented to Remote Sensing Class at University of Minnesota April 10

Thoma, D.P., 2002. Laser Altimetry Assessment of Riverbank Erosion, Blue Earth River, MN. Water Resources Science seminar April 10.

Thoma, D.P., and S.C. Gupta, 2002. Tillage and nutrient source effects on surface inlet and tile drain water quality & Remote Sensing Applications for Measuring Crop Residue Cover and River Bank Erosion. University of Minnesota, Southwest Research and Outreach Center – Research Update February 27.

Thoma, D.P., 2002. Surface runoff experiments and remote sensing techniques for assessing watershed scale sediment partitioning. Blue Earth River Basin Initiative meeting, Waseca, MN February 6.

Thoma, D.P. 2001. Quantifying river bank erosion with scanning laser altimetry. International Society for Remote Sensing and Photogrammetry: Workshop in Land surface Mapping and Characterization Using Laser Altimetry, Annapolis, MD October 22-24.

Francis Zvomuya

Zvomuya, F., C. J. Rosen, M. P. Russelle and S. C. Gupta. 2000. Effect of polymer-coated urea on leaching and efficiency of N in potato production. Presented at The Annual Meeting of the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America, 5-9 November 2000, Minneapolis, MN.



# Appendix D

## Conferences planned

### **Larry Baker**

Workshop series on *Coupled biogeochemical cycles in human ecosystems*. Series of three workshops held at the University of Minnesota and Arizona State University, October 2001 through January 2002 (supported by NSF)

*Integration of Biogeochemical Studies Across LTER Sites*. Workshop held at the Ecological Society of America Meeting, August 2001, Madison, Wisconsin.

**Les Everett** was on the program planning committee for the conference *Working at a Watershed Level*, September 11-12, 2001, St. Cloud, Minnesota.

### **Barb Liukkonen**

*Venture into the St. Croix Basin: Challenges in a diverse landscape*. State Water Planners Conference, Hinckley, MN. September 23-25, 2002

*Minnesota Water 2002. Working together in a climate of change to manage Minnesota's water resources*. April 17-2002, St. Cloud, MN.

*Minnesota Water Resources Conferences*, October 29, 2001 and October 29, 2002, Bloomington, MN

*Working at a Watershed Level*. St. Cloud, MN. September 12-14, 2001.

*Building Bridges to Manage Minnesota's Surface Waters*. Brainerd, MN May 3-5, 2001

**Ken Olson** was a member of the education committee that planned the educational programs for the 2002 Minnesota Onsite Sewage Treatment Contractor's Assn. Convention and Exposition, January 27-30, 2002, St Cloud, Minnesota. The theme was "Protecting and Building Your Future."

**Volunteer Stream Monitoring Partnership** River Summit, November 15, 2001.

# Appendix E

## Refereed journal articles

- Baesman, J. L., and **P. J. Novak**. 2001. Degradation of common groundwater contaminants by an excreted biomolecule under environmental conditions. *Biotechnology and Bioengineering*, 75(6):634-641.
- Baker, L. A.**, D. Hope, Y. Xu, L. Lauver, and J. Edmonds. 2001. Nitrogen mass balance for the Phoenix ecosystem. *Ecosystems* 4(6): 582-602.
- Danielopol, D. L., **E. Ito**, G. Wansard, T. Kamiya, T. M. Cronin, and A. Baltanas. 2002. Techniques for the collection and study of Ostracoda. In: J. T. Holmes and A. R. Chivas (ed.). *The Ostracoda: Applications in Quaternary Research*, Geophysical Monograph Series Volume 131, 65-97. American Geophysical Union.
- Donovan, J. J., A. J. Smith, D. R. Engstrom, **E. Ito**, and V. A. Panek. 2002. Climate-driven hydrologic transients in lake sediment records: calibration of groundwater conditions using 20<sup>th</sup> century drought. *Quaternary Science Reviews*, 21 :605-624.
- Gerke, S., **L. Baker**, and Y. Xu. 2001. Sequential model of nitrogen transformations in a treatment wetland receiving lagoon effluent. *Water Research* 35 (16): 3857-3866.
- Grimm, N. B., **L. A. Baker**, and D. Hope. 2001. An ecosystem approach to understanding cities: familiar foundations and uncharted frontiers. In: Berkowitz, A. R., Nilon, C. H., and Hollweg, K. S (eds.). *Understanding Urban Ecosystems: A New Frontier for Science and Education*. Springer-Verlag.
- Haugen, K. S., M. J. Semmens, and **P. J. Novak**. 2002. A novel *in situ* technology for the treatment of nitrate contaminated groundwater. *Water Research*, 36:3497-3506.
- Hu, F.S., **E. Ito**, T. A. Brown, B. B. Curry, and D. R. Engstrom. 2001. Pronounced climatic variations in Alaska during the last two millennia. *Proceedings of the National Academy of Science*. 98: 19552-10556.
- Ito, E.** 2001. Application of stable isotope techniques to inorganic and biogenic carbonates. In: W. M. Last and J. P. Smol (ed.). *Tracking Environmental Change Using Lake Sediments: Vol. 2. Physical and Chemical Techniques*. Kluwer Academic Publishers, 351-371.
- Ito, E.** 2002. Mg/Ca, Sr/Ca,  $\delta^{18}O$  and  $\delta^{13}C$  Chemistry of quaternary lacustrine Ostracoda shells from the North American continental interior. In: J.T. Holmes and A.R. Chivas (ed.). *The Ostracoda: Applications in Quaternary Research*, Geophysical Monograph Series Volume 131, 267-278. American Geophysical Union.
- Kloiber, S. M., **P. L. Brezonik**, and **M. E. Bauer**. 2002. A procedure for regional lake water clarity assessment using Landsat multispectral data. *Remote Sensing of Environment* 82 (1):38-47.
- Kloiber, S. M., **P. L. Brezonik**, and **M. E. Bauer**. 2002. Application of a synoptic, remote sensing, water quality assessment method for lake management. *Water Research* 36:4330-40.
- Koons, B. W., J. L. Baesman, and **P. J. Novak**. 2001. Investigation of extracellular biomolecules active in Carbon Tetrachloride and Chloroform degradation. *Biotechnology and Bioengineering*, 74(1):12-17.

# Appendix E

## Refereed journal articles, continued

- Maurice, P. A., S. E. Cabaniss, J. Drummond, and **E. Ito**. 2002. Hydrogeochemical controls on the variations in chemical characteristics of natural organic matter at a small freshwater wetland. *Chemical Geology*, 187:59-77.
- Nyguen, My Lin, **L. Baker**, and P. Westerhoff. 2002. Sources of DOC and DBP precursors in western U.S. watersheds and reservoirs. *J. Am. Water Works Assoc.* 94(5): 98-112.
- Renwick, Mary E.** 2001. Valuing water in irrigated agriculture and reservoir fisheries: a case study from Sri Lanka. *International Water Management Research Series* 51.
- Renwick, Mary E.** 2001. Valuing water in a multiple-use irrigation system. *Journal of Irrigation and Drainage Systems Management* 15.
- Stevens, L. R., H. E. Wright, and **E. Ito**. 2001. Changes in the seasonality of climate during the late-glacial and Holocene at Lake Zeribar, Iran. *The Holocene*. 11:747-755.
- Smith A. J., J. J. Donovan, **E. Ito**, D. R. Engstrom, and V. A. Panek. 2002. Climate-driven hydrologic transients in lake sediment records: multiproxy record of mid-Holocene drought. *Quaternary Science Reviews*, 21 :625-646.
- Urban, N. R., C. J. Sampson, **P. L. Brezonik**, and **L. A. Baker**. 2001. Sulfur cycling in the water column of Little Rock Lake, Wisconsin. *Biogeochem.* 52: 41-77.

# Appendix F

## Other publications

- Brezonik, P.L.**, S.M. Kloiber, L.G. Olmanson, and **M.E. Bauer**. 2002. Satellite and GIS tools to assess lake water quality. Water Resources Center Technical Report 145. University of Minnesota, St. Paul, MN.
- Baker, L. A.**, Y. Xu, N. McPherson. 2001. Salinity: an emerging issue for the Phoenix Metropolitan Area. Proc. Arizona Water Pollution Control Association Conference, 4-5 May 2001, Mesa AZ.
- Gullickson, M. L., Liukkonen, B.** 2002. A guide to volunteer stream monitoring. Volunteer Stream Monitoring Partnership, St. Paul, MN.
- Gupta, S.C., D.P. Thoma, M.E. Bauer**, 2001. Sediment origins: agriculture's role in river water quality questioned by farmers. Resource: Engineering and Technology for a Sustainable World. 8(12) 9-10.
- Latch, D. E., **W. A. Arnold, K. Mcneill**. 2002. Direct and indirect photolysis of Triclosan. Presented in The Science and Policy of Topical Antimicrobial Agents, Environmental Chemistry Division, American Chemical Society National Meeting, 7-11, April 2002, Orlando, FL.
- Olmanson, L.G., S.M. Kloiber, **M.E. Bauer**, and **P.L. Brezonik**. 2001. Image processing protocol for regional assessments of lake water quality. Water Resources Center and Remote Sensing Laboratory, University of Minnesota, St. Paul, MN.
- Olson, K.** 2002. A quick guide to small community wastewater treatment decisions. Extension publication # 07735.
- Olson, K.**, B. Chard, D. Malchow, and D. Hickman. 2002. Small community wastewater solutions: a guide to making treatment, management and financing decisions. Extension publication # 07734.
- Packer, J. L., **K. Mcneill, W. A. Arnold**. 2002. Direct and indirect photolysis of Triclosan. Presented in The Science and Policy of Topical Antimicrobial Agents, Environmental Chemistry Division, American Chemical Society National Meeting, 7-11, April 2002, Orlando, FL.
- Renwick, M. E., J. Anderson, D. Mulla**, P. Gowda. 2002. Dual nature of nonpoint source pollution. Total Maximum Daily Load Environmental Regulations. Proceedings of the Society for engineering in agricultural, food and biological systems, March 2002, Fort Worth, TX.
- Renwick, Mary E.** 2001. TMDLs in rural watersheds. Presented to Minnesota Department of Agriculture.
- Renwick, M. E.**, J. A. Lamb, J. L. **Anderson**, R. H. Dowdy, C. A. Laboski. 2001. Farming systems, ground water quality and economic incentives.
- Thoma, D.P., S.C. Gupta, M.E. Bauer**. 2002. Evaluation of bank erosion inputs to the Blue Earth River with airborne laser scanner. Advances in Water Resources Research: Project Summaries for 2001. University of Minnesota Water Resources Center, Technical Report 142, pp 42-47.
- Thoma, D.P., S.C. Gupta, M.E. Bauer**. 2001, Quantifying river bank erosion with scanning laser altimetry. International Archives of Photogrammetry and Remote Sensing, Vol. XXXIV-3/W4 Annapolis, MD, 22-24 Oct., pp. 169-174.

# Appendix G

## 2000-2002 WRS graduates and thesis titles

Student	Degree	Thesis or Paper Title
Stanley Asah	M.S. Plan A	The stoichiometry of detrital processing and detritivore food quality preferences in a cold spring stream
Sylvia Barry Musielewicz	M.S. Plan A	Paleoclimate signals from Lake Malawi sediments
Benjamin Bertsch	M.S. Plan A	Groundwater flow modeling and the delineation of well-head protection areas, Cass County, Minnesota
Meghan Elizabeth Brown	M.S. Plan B	A 2001 survey of crustacean zooplankton in the western arm of Lake Superior
Adam Birr	M.S. Plan A	Evaluation of regional water quality trends in Minnesota using indexing and land classification approaches
Tara Carson	M.S. Plan A	The effect of sediment nutrient variation, water depth and emergent aquatic perennials on wild rice ( <i>Zizania palustris</i> ) production at the Rice Lake National Wildlife Refuge
Jeffrey Christopherson	M.S. Plan A	Hybrid poplar plantation effects on frost depth and snow distribution on agricultural lands in northwestern Minnesota
Leah Class	M.S. Plan B	Towards watershed development: two case studies of soil erosion and participatory development in northwest India
Erin Day	M.S. Plan A	Landsat 5 & 7 as tools for monitoring water quality
Kathryn Draeger	Ph.D.	Defining and evaluating watershed organizational effectiveness
Feng Fang	Ph.D.	Phosphorus retention by soils and suspended sediments in the Minnesota River Basin

# Appendix G

## 2000-2002 WRS graduates and thesis titles, continued

<b>Student</b>	<b>Degree</b>	<b>Thesis or Paper Title</b>
Michael Friedel	Ph.D.	Simultaneous estimation of coupled water, heat, and solute transport parameters--application to ground water studies in arid and semi-arid regions of the United States
Peter Gessel	M.S. Plan A	Variable-rate land application of liquid hog manure: effects on contaminant persistence and transport
Sarah Heger-Christopherson	M.S. Plan A	Evaluation of recirculating sand filters in Minnesota
Erik Heinen	M.S. Plan A	Carbon and nutrient cycling in Lake Superior
Heather Hendrixson	M.S. Plan A	Stoichiometry of freshwater fish in relation to allometry and phylogeny, and the role of skeleton in fish stoichiometry
Thomas Jabusch	Ph.D.	Mechanistic studies of the bioaccumulation of polychlorinated biphenyls in phytoplankton
Anne Jefferson	M.S. Plan B	Early Tertiary and modern hydrological environments of the Stenkul Fiord Area, Ellesmere Island, Canada.
Anthony Kaster	M.S. Plan B	Predicting the effect of hybrid poplar trees on a water budget, Pomme de Terre Watershed, Minnesota
Mickelson, David	M.S. Plan A	The effect of agricultural tile drainage on flood events in the Minnesota River Basin
Stefanie Miklovic	M.S. Plan B	Effects of road salt on glacial marshes
James Musielewicz	M.S. Plan A	Estimates of sediment transport in conjunction with the Keweenaw Current using copper mine tailings as a sediment tracer

# Appendix G

## 2000-2002 WRS graduates and thesis titles, continued

<b>Student</b>	<b>Degree</b>	<b>Thesis or Paper Title</b>
James Noren	M.S. Plan B	The effects of a change in withdrawal operations at Eau Galle Reservoir, Wisconsin (USA)
Barbara Peichel	M.S. Plan B	A protocol for prioritizing wetland habitat restoration in the St. Louis River Watershed
Keith Pilgrim	Ph.D.	Evaluation of the benefits and potential adverse effects of alum treatment to remove phosphorus from lake inflows
Mark Riedel	Ph.D.	Geomorphic impacts of land use on clay channel systems
David Stark	M.S. Plan B	Application of the Revised Universal Soil Loss Equation within a Geographical Information System for the Munising Bay Watershed, Munising, Michigan
Scott Stockhaus	M.S. Plan B	Comparisons of nutrient export among switchgrass, hybrid poplar, wheat, and aspen in northwest Minnesota
David VanderMeulen	M.S. Plan A	
Marcey Westrick	M.S. Plan A	The classification and prediction of macroinvertebrate communities to the upper St. Croix River basin
Joshua Woodward	M.S. Plan A	An examination of the role of spatial scales in describing fish communities: Testing the Watershed-Agroecoregion Intersection

## Credits

**Editing and design:**

Johanna Schussler

**Cover photographs:**

Cattails, Holly Swanson

Research, Bill Christner Jr.

Outreach, Dakota County Environmental Education Program

Education, Bill Christner Jr.

Service, UM Extension Service



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