



ANNUAL REPORT

July 1, 2007 – June 30, 2008

Submitted by:

The Center for Water and Society Advisory Committee

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2. CWS Mission Statement

The mission of the Center for Water and Society (CWS) at Michigan Tech is to support research, education, and outreach in all disciplines at Michigan Tech related to water issues. The goal is to establish Michigan Tech as a state, regional, national and international leader in these disciplines and, in particular, in interdisciplinary approaches to solving water-related problems. CWS is a “virtual” Research Center. By virtual, we mean that the CWS will not occupy physical space, but is a consortium of people at Michigan Tech whose focal point is water-related activities.

The objectives of the Center for Water and Society are:

- To serve as a focal point for instructional and research activities in water-related fields and water-related outreach activities across the Michigan Tech campus
- To provide an organizational structure that supports continuing growth in water-related fields and outreach activities and encourage interdisciplinary projects
- To promote the visibility of Michigan Tech’s water-related research in state, regional, national and international arenas
- To support interdisciplinary graduate and undergraduate education and research in water related fields
- To pursue external funding opportunities to support these objectives and to facilitate the acquisition of external support by faculty participating in CWS.

CWS has 49 faculty/staff participants and 45 graduate student and 3 undergraduate student participants in 13 units across the Michigan Tech campus (see Appendices 1 and 2). CWS is governed by a director and advisory committee (see Appendix 3)

3. CWS Year in Review

3.1. *World Water Day Events Sponsored by CWS – March 24, 2008*

Events included a keynote address “The Great Lakes Water Wars,” by Peter Annin, Author of “The Great Lakes Water Wars” and Associate Director, Institute for Journalism and Natural Resources; a research seminar, “Temperature in the Great Lakes” by Jay Austin, Assistant Professor, Large Lakes Observatory and Department of Physics, University of Minnesota, Duluth; a demonstration of watercolor techniques by MaryAnn Beckwith, Visual & Performing Arts Professor, MTU, a Research Poster competition, and a Fine Arts competition. The awards for the Research Poster and Arts competitions are as follows.

Research Poster Awards

Andrea Hernandez (\$250)

“The Impacts of Climate Change and Variability on Water Resources in a Semi Arid Region in Mexico: The Rio Yaqui-Basin”

Kevin Endsley, Silvia Espino, Josh Richardson (\$150)

“Groundwater Investigation Using Resistivity Surveys on a Terminal Moraine, Bering Glacier”

Stacey Pilling (\$100)

“Pesticide Exposure in the Yaqui Valley: Perceptions and Realities of the Green Revolution”

Photography Awards

Stacey Pilling (\$200)

“Salto de Agua”

Bode Morin (\$100)

“Closed”

Watercolor Award

Valerie Fuchs (\$200)

“Cavus Exploratus (the water beneath)”

3.2. *Degree Subcommittee Activities*

(**Members:** Nancy Auer, Kathy Halvorsen, Alex Mayer, Joan Chadde)

The primary activity of the Degree Subcommittee was the review of the Graduate Student Research and Travel grants awarded by CWS. The following grants were awarded in 2007-8.

3.2.1. CWS Graduate travel awards

Cory McDonald (\$300)

PhD student in Environmental Engineering

Event: 6th European Conference on Ecological Modeling (ECEM07) in Trieste, Italy
Date: November 27-30, 2007
Abstract: "An information-theoretic approach to aquatic biogeochemical modeling in Lake Superior"

Stacey Pilling (\$300)

MS student in Social Sciences
Event: American Anthropological Association Conference, Washington, D.C.
Date: November 28 – December 2, 2007

Joe Dammel (\$300)

Environmental Engineering undergrad
Event: 2008 ISSRM (International Symposium on Society & Resource Management), University of Vermont
Date: June 10-14, 2008
Poster Presentation Title: "Lake Superior's Vulnerability to Global Environmental Problems"

3.2.2. CWS Graduate research awards

Heather Wright (\$500)

PhD student in Environmental Engineering
Date: March 13, 2008
Research Topic: Wetland Rehabilitation in Santa Cruz, Bolivia

3.3. *Seminars & Symposia Subcommittee Activities*

(**Members:** Noel Urban, Kathy Halvorsen, Christine Anderson, Alex Mayer)

The primary activity of the Seminars & Symposia Subcommittee was the planning and organization of CWS seminars. The following seminars were sponsored or co-sponsored in 2007-8 by CWS.

Thomas E. Croley II, Great Lakes Environmental Research Laboratory

"Great Lakes Hydrology Modeling with the Advanced Hydrologic Prediction System"
October 8, 2007

Melvyn Visser, Chemical Engineer, MTU Class of 1959

"Persistent Organic Pollutants (POPs) in the Great Lakes: Evolution of the Understanding of their Source and Transport"
September 24, 2007

Peter Annin, Associate Director of the Institutes for Journalism and Natural Resources

"The Great Lakes Water Wars"
March 24, 2008

Colin Brooks, Research Scientist, Michigan Tech Research Institute

“The connection between land use / land cover and water quality in the agricultural Upper Tiffin River watershed of southeastern Michigan”

April 24, 2008

3.4. Awards and Recognition for CWS Participants

Andrea Munoz-Hernandez

Hydrology section of American Geophysical Union (AGU): Outstanding Student Paper Award
"The Impacts of climate change and variability on water resources in a semiarid region in Mexico: The Rio Yaqui-Basin"

Cory MacDonald

American Society of Limnology and Oceanography (ASLO): Outstanding Student Presentation Award

"An Information-Theoretic Approach to Aquatic Biogeochemical Modeling"
Summer Meeting in St. John's, Newfoundland

Brian Barkdoll: elected Fellow of the American Society of Civil Engineers

Nancy Auer: elected to the board of the Lake Superior Watershed Partnership

3.5. Participation of CWS Director in Initiatives, Conferences and Workshop in support of CWS.

1. Brookings Institute Freshwater convening

The Brookings Institution, along with the Great Lakes Science Center and the Great Lakes Commission, held a regional convening at the Great Lakes Science Center in Cleveland in Myer 2008 to discuss the region’s assets and challenges for emerging as a freshwater leader. CWS Director Mayer was invited to participate. This conference, the first of two, brought together representatives from the freshwater industry, research, education, and policy to share their expertise in exploring the potential for such an initiative. The goal of this project is to identify the core competencies available in the region – industry and business leadership, infrastructure capacity, natural abundance of freshwater, leading national and international research institutions and labs, human capital, and experiential know-how in cooperation and collaboration across multiple sectors and jurisdictions – that can serve as a foundation for enabling the Great Lakes region to emerge as a leader in freshwater research, technology and industry.

2. Michigan Economic Development Corporation Water Technology Cluster

CWS Director Mayer was invited to participate in the Michigan Economic Development Corporation (MEDC) Water Technology Cluster. In January 2008, the MEDC launched the

Michigan Water Technologies Cluster Initiative to more effectively coordinate and leverage existing assets such as the abundance of freshwater, extensive university expertise, advanced R&D capabilities, manufacturing know-how and environmental leadership. The overarching goal is to attract capital investment, spur job growth, and develop cutting-edge water technologies for industrial and municipal use. The Cluster includes representatives from industry, universities, and state agencies. CWS Director Mayer has attended or participated in five meetings of the cluster. CWS Director Mayer also is participating in the Environmental Resources and Agriculture and Forestry work groups.

3. IBM - T.J. Watson Research Center

In February 2008, CWS Director Mayer traveled to the IBM TJ Watson Research Center to explore potential collaboration between CWS participants and IBM researchers. This visit was arranged by John Soyring, an MTU alumnus and Vice President at IBM. IBM is pursuing several high performance computing initiatives in the water sector. In particular, MTU and IBM may collaborate on monitoring and modeling of Lake Superior or the Great Lakes in general. Discussions have continued between IBM and MTU.

4. Sustainability Faculty Hiring Initiative

CWS Director, Alex Mayer, served on the Sustainability Faculty Hiring Initiative committee and solicited CWS members for nominations for the SFHI positions. CWS participants were requested to submit nominations and encouraged to advertise the positions through their disciplinary professional associations. Three faculty members submitted suggestions for potential recruits. Letters from Provost Lovett-Doust were sent to those recruits, and Alex Mayer also made contact via email to encourage them to apply.

4. CWS Budget

CWS Institute O/H Inventive Account

Beginning Balance July 1, 2007	\$5,452.18*
Research Incentive Transfer In	\$9,372.02
Expenditures	\$13,617.53
CWS Sponsored Lectures.....	\$3,204.25
Project Support	\$714.09
Student Research & Travel Grants	\$1,400.00
Student Research Poster & Art Competition Awards.....	\$1,000.00
AISES Native American Student Travel.....	\$485.00
<i>(CWS commitment of NSF IGERT review recommendations)</i>	
Administrative Assistant.....	\$6,524.19
Miscellaneous	\$290.00
Balance as of June 30, 2008.....	\$1,206.67

*The ending balance reported in the 2006-7 Annual Report of \$5478.13 did not include a \$25.95 charge made at the very end of the 2006-7 fiscal year. The Beginning Balance for 2007-8 includes this charge to keep the center's reporting synchronous with the accounting reports.

5. Research

5.1. *New Awards 2007-8*

New Research Funding 2007-8:

\$ 1,904,601

- Collaborative Research: Modeling and Analyzing the Use, Efficiency, Value and Governance of Water as a Material in the Great Lakes Region Through an Integrated Approach
PI: Alex Mayer
co-PIs: James Mihelcic, David Watkins, Qiong (Jane) Zhang
Sponsor: NSF
\$1,078,322 (9/2007 – 8/2012)
Award Date (8-20-2007)
- Streamside Lake Sturgeon Culture for the Ontonagon River, Michigan
PI: Nancy Auer
Sponsor: MI DNR
\$33,846 (10/2006 – 9/2008, Second Year of Funding)
- Evaluating Riparian Timber Harvesting Guidelines: Phase 3, Result 2 Evaluate Aquatic Habitat Impacts”
PI: Casey Huckins
Sponsor: USDA Forest Service, Northern Research Station
\$47,589 (5/2007-6/2009, Increase in funding of existing project [Oct 30, 2007])
- Characterizing Lessons Learned from Federal Biomass Removal Projects
PI: Kathy Halvorsen
Sponsor: U.S. Forest Service
\$35,603 (9/30/2007 - 3/31/2009)
- Graduate student scholarships to advance a global outlook of economic and social prosperity that protects the environment
PI: Judith Perlinger
co-PIs: Veronica Griffis, James Mihelcic, Kurt Paterson, Qiong Zhang
Sponsor: NSF
\$599,978 (6/1/2008 - 8/31/2012)
- Testing of Remote Sensing Methods for Delineating Fracture Systems in Volcanic Terrains to Cavity Networks in Karst
PI: John Gierke
co-PI: Carla Alonso
Sponsor: Univ of MI
\$5,000 (5/1/2008 - 4/30/2009)
- Intergovernmental Personnel Act Agreement with US Army Corps of Engineers
PI: Dave Watkins CEE/CWS/SFI
Sponsor: US Army Corps of Engineers
\$42,347 (1/7/2008 - 6/6/2008)
- Erosion Reduction by Air Entrainment, Phase I
PI: Brian Barkdoll
co-PI: Mohan Rao
Sponsor: S. Florida Water Management District
\$49,916 (3/1/2008 - 9/30/2008)
- Engaging Social Scientists in the WATERS Initiative: Special Sessions at the 2008 International Symposium on Society and Resource Management
PI: Alex Mayer
co-PI: Kathleen Halvorsen

Sponsor: NSF
\$10,600 (5/1/2008 - 11/1/2008)

- Associations Between Groundwater-Surface Water Dynamics and Coaster Brook Trout Spawning Habitat in the Salmon Trout River, Marquette County, Michigan
PI: Alex Mayer
co-PI: Casey Huckins
co-PI: Matthew VanGrinsven
Sponsor: Huron Mountain Wildlife Foundation
\$1,400 (4/15/2008 – 4/14/2009)

5.2. Active Research Projects Affiliated with CWS, 2007-8

Total Research Expenditures 2007-8: \$453,218

- **Sedimentation in Schoharie Reservoir: Temporal Dynamics**
PI: Noel R. Urban
Sponsor: Upstate Freshwater Institute (pass through funding from NYC Dept. Environmental Protection)

Sediment cores were obtained at six sampling stations down the length of Schoharie Reservoir to determine the spatial and temporal patterns of sediment accumulation within the reservoir. Sediments were characterized physically (bulk density, porosity, grain size), chemically (carbon content), and radiometrically (activities of ²¹⁰Pb and ¹³⁷Cs). Establishment of chronologies is difficult because the models typically applied to ²¹⁰Pb must be modified before application to these sediments. Nevertheless, general patterns of sediment accumulation are clear. Schoharie Reservoir is experiencing high sedimentation rates that are typical of many reservoirs. Rates of sediment accumulation in this reservoir are well within the range reported for other reservoirs. Highest rates of sediment accumulation occur at the southern end of the reservoir near the entrance of Schoharie Creek. Stations at the northern end of the reservoir, however, experience higher rates of sedimentation than do stations (2.0, 2.5) in the middle of the reservoir. A significant portion (15-40%) of the total sediment accumulated at each station was deposited during storm events. Rates of sediment accumulation have changed over time; there has been an increase in the median sedimentation rate at the southern end of the reservoir in the past two decades relative to earlier years. At the northern end of the reservoir, sedimentation rates have declined in recent years.

- **ExCit: Expanding Cities - People, Water and Infrastructure**
PI: Alex S. Mayer
Sponsor: US Dept. of Education

ExCit stands for Expanding Cities: People, Water and Infrastructure. ExCit is a student exchange program consortium of six universities in Canada, Mexico, and the U.S. The focus area for the program is decision making for meeting the growing demands on urban water resources systems. Student activities will consist of three stages: intensive language training, coursework in water resources and sustainable development, and professional or research internships with local businesses, municipalities, agencies or at the host university.

- **REF: Air: A Conduit between Water, Society, and Space**
PI: Alex Mayer
Sponsor: State of Michigan – REF

This project supported the acquisition of advanced analytical instrumentation for CO₂ (CO₂ analyzer) and for mercury (mercury analyzer and mercury air sampling equipment). The equipment is suitable for study of climate-change related issues and mercury contamination, two of the more pressing water resources issues facing the world as well as the Great lakes region. The new instrumentation has been integrated with an existing package of micrometeorological equipment currently in use on MTU's campus, and has enabled researchers to measure fluxes of CO₂ and mercury between the Great Lakes and the atmosphere. This enhanced system will be used extensively in other Great Lakes research projects.

- **Herring Gull BioSentinal Sampling Program Cooperative Agreement**

PI: Judith Perlinger

Sponsor: Clemson Univ

The purpose of the overall project is to develop a contaminant monitoring protocol for Michigan using herring gull (*Larus Argentatus*) eggs. The herring gull is a good indicator species to monitor trends in contaminant concentrations because it is near the top of the food chain. It is also a good indicator species because the protocol for using herring gull eggs for monitoring trends in contaminant levels has already been established by the Canadian Wildlife Service (CWS).

As part of a proposed Cooperative Agreement between Michigan Technological University, Clemson University, Michigan State University, Michigan Tech personnel collect gull eggs once annually from Gull Island in Lake Superior off W. Marquette County, Michigan, utilizing Michigan Tech's research vessel, the R/V Agassiz, and coordinate gull egg collection from Net Island off of Isle Royale with National Park Service personnel. In May each year, Gull eggs from Gull Island will be enumerated. Gull eggs collected from Gull Island and Net Island will be shipped according to specifications to the University of Windsor for chemical analysis and publication of the results of the monitoring work.

- **Streamside Lake Sturgeon Culture for the Ontonagon River, Michigan**

PI: Nancy Auer

Sponsor: MI DNR

Lake sturgeon were once abundant in the Ontonagon River but the Michigan DNR could not recover adults during several attempts in the 1980-1990s. In 2006 the State of Michigan agreed with other state and federal agencies to manage for lake sturgeon (*Acipenser fulvescens*) rehabilitation using best stocking practices. The objective of this project is to raise lake sturgeon in a streamside hatchery using ambient Ontonagon River water so that fish will imprint to the river to assure less chance of fish straying to other rivers as well as increase the greater likelihood of successful rehabilitation of the Ontonagon population. Using ambient river water enables the researchers to evaluate the effects of turbidity on lake sturgeon egg incubation and subsequent fish survival. The lake sturgeon reared in the Ontonagon streamside facility were raised from eggs taken on the Sturgeon River, Michigan, in the spring of 2007.

The fish in the streamside rearing facility were released into the Ontonagon River at two locations, and fifteen of the largest fish were selected for telemetry work. Ten of these fish will be fitted with ATS transmitters and released into the Ontonagon River to be located daily to determine movement patterns and habitat selection in the Ontonagon River.

Master's student, Tim Wilson, spent the summer of 2007 monitoring operations in the streamside facility and giving tours to the public. His research involves the study of maximum raceway rearing densities and possible disruptions the exotic ruffe (*Gymnocephalus cernuus*) may have on sturgeon recruitment and feeding.

- **Collaborative Research: The carbon balance of Lake Superior: modeling lake processes and understanding impacts on the regional carbon budget**

PI: Noel Urban

Sponsor: NSF

The purpose of the North American Carbon Program (NACP) is to (1) to develop quantitative scientific knowledge, robust observations, and models to determine emissions and uptake of CO₂, CH₄, and CO₁ changes in carbon stocks, and factors regulating these processes for North America and adjacent ocean basins; and (2) to develop the scientific basis for full carbon accounting on regional and continental scales. The Laurentian Great Lakes cover 25% of the land area of the 8 Great Lakes states, and CO₂ emission and seasonal cycling from them may be comparable to local terrestrial ecosystems. Although their contributions to the regional carbon balance may be significant, these fluxes are currently poorly understood. CO₂ fluxes from Lake Superior are of particular interest because they may directly impact observations at nearby AmeriFlux towers.

Motivated by the need for improved knowledge of Great Lake CO₂ fluxes, we will couple an exosystem-carbon module to an existing hydrodynamic model of Lake Superior to estimate these fluxes and their spatial and temporal variability. We will also obtain new wintertime observations of carbon parameters in the lake to constrain this model. Using model output, we will evaluate the impact of Lake Superior CO₂ fluxes on observations at AmeriFlux towers and on the regional carbon budget.

Sampling of water intakes has clearly shown the annual cycle in pCO₂, chlorophyll, and other analytes.

Comparison of municipal water intakes with ship-based sampling has revealed that while comparable results were obtained at one intake location, a second location has yielded large differences. All biological parameters (bacterial counts, bacterial growth rates, carbon fixation rates) are markedly lower in the samples from the Ontonagon municipal water intake than in samples collected from a boat at the same location.

Measurements of CO₂ concentrations in air above the lake have been collected with an open-path IRGA mounted on the ferry to Isle Royale over the 100-km route across the open lake from the Keweenaw Peninsula to Isle Royale. While concentrations above the lake are higher than above land at the corresponding time, we do not yet know if this is just the result of the time lag as an air mass is advected across the lake. We anticipate being able to make eddy covariance measurements of CO₂ fluxes on at least three occasions this year.

Development of the lower-food web model is being conducted by Cory McDonald, the doctoral student on the program. Cory is using information theory to derive an optimized food web model with a minimum number of components. This modeling shows that while model fit to experimental data generally improves with increasing number of calibration or fitting parameters, the Akaike Index reaches a minimum in models with an intermediate number of fitting parameters. The ratio of number of measurements to number of fitting parameters determines the optimal complexity of the model. Results from this work have been presented at four international conferences, and the first manuscript will be submitted in August 2008 to Ecological Modeling.

- **Evaluating Riparian Timber Harvesting Guidelines: Phase 3, Result 2 Evaluate Aquatic Habitat Impacts**

PI: Casey Huckins

Sponsor: USDA Forest Service, Northern Research Station

Our primary objective is to assess long-term effects of riparian harvest techniques on stream ecosystem function at the LCMR sites and Pokegema Creek sites. The following objectives are included into the study plan:

1. Quantify available food resources for stream food webs (periphyton and detrital standing crops), and macroinvertebrate response (biomass of functional feeding groups and diets) in stream reaches subjected to various riparian harvest treatments.
2. Evaluate breakdown rates of leaf litter and wood in streams under the different riparian treatments.

Results from this research will be used to validate or revise the State of Minnesota's riparian forest management guidelines and demonstrate the use of functional measures of ecological integrity for assessment of stream health..

- **Huron Creek Watershed Management Plan**

PI: Alex Mayer

Sponsor: MI-EPA

The Huron Creek Watershed is located in north-central in Houghton County in the Upper Peninsula of Michigan. The 3.4 square mile watershed includes portions the City of Houghton and Portage Township. Land use in the Huron Creek watershed is forested land (40%), commercial and residential developments (20%), and wetlands (20%). The Huron Creek watershed has been affected by human activity for decades. Historical mining activities, aging septic systems, and closed landfills constructed before modern environmental requirements have contributed to water quality concerns. Commercial development in the watershed since the mid-1970's has resulted in significant areas of impervious surface in the watershed. The creek has been traditionally used for recreation activities and runs through a heavily used public park before emptying into the Portage Canal.

These activities have catalyzed the development of a community-made watershed management plan formulated to address water quality issues in the Huron Creek watershed. A series of chemical, physical and biological surveys were conducted by the Michigan Tech Center for Water and Society, which indicated that the defined designated uses of the watershed were either impaired or threatened by metals, nutrients, sediment, "Flashy Flow", invasive plant species, and bacteria. Best Management Practices (BMPs) were identified as part of, or in combination with several of the recommended actions. BMPs are structural, vegetative, or managerial practices used to treat, prevent or reduce water pollution. Suggestions for potential project partners have been identified for each recommended action, along with an estimated implementation schedule, suggested milestones, estimated costs, and possible funding sources.

- **Collaborative Research: Modeling and Analyzing the Use, Efficiency, Value and Governance of Water as a Material in the Great Lakes Region Through an Integrated Approach**

PI: Alex Mayer

co-PIs: James Mihelcic, David Watkins, Qiong (Jane) Zhang
Sponsor: NSF

This multidisciplinary 5-year research project (funded by the National Science Foundation MUSES program) will determine, through integrated physical and economic models and under various scenarios of population growth, climate change, land use, and emissions, the impact of direct and indirect drivers on water quality, quantity, and availability in the Great Lakes region.

Though it is well known that nearly every product in global commerce is dependent on water, water has not traditionally been considered a material characterized by integrated analyses to quantify flows and stocks, opportunity costs, and full valuation (i.e., social, environmental, and service costs) through its myriad of uses. This has led to an undervaluing of water as a finite resource.

The Great Lakes region is chosen due to its large volume of available freshwater (but low rate of replacement), high economic impact, complex governance issues including an international border, and increasing competition for water allocation among industrial, agricultural, municipal, recreational, and ecosystem needs, as well as existing and future threats of water quality deterioration.

- **Characterizing Lessons Learned from Federal Biomass Removal Projects**

PI: Kathy Halvorsen
Sponsor: U.S. Forest Service

Since the inception of the National Fire Plan in 2001, fuels reduction treatments have increased from about 2.1 million acres to more than 3.0 million acres annually in 2006 (Healthy Forests and Rangelands 2007). Biomass utilization is seen as a growing component to treating greater numbers of acres at high risk of wildfire, particularly within an ever-expanding wildland-urban interface. There are however challenges to biomass removal that impede progress. Understanding those challenges and how land managers and community partners have worked together to overcome them is a necessary part of reducing the threat of wildfire.

We focus on understanding the challenges faced by and innovations created to overcome them that managers and communities around the U.S. have encountered as they try to reduce fire risk. To do this we have done 12 case studies of federal and tribal land management chosen based on a set of key characteristics. These case studies range from the Green Mountain National Forest in Vermont, to the South Carolina Francis Marion, to the Southwestern Four Corners area, to the Shasta-Trinity National Forest in Northern California, and to the Superior National Forest in Northern Minnesota. We have completed our case studies conducting about 150 open-ended interviews with managers, NGO staff, community members, and industry employees. Transcriptions of the interviews will be analyzed for patterns, and case studies will be prepared on our findings for distribution to the fire management community and publication in peer reviewed publications.

- **Graduate student scholarships to advance a global outlook of economic and social prosperity that protects the environment**

PI: Judith Perlinger
co-PIs: Veronica Griffis, James Mihelcic, Kurt Paterson, Qiong Zhang
Sponsor: NSF

Judith Perlinger, Veronica Griffis, James Mihelcic, Kurt Paterson, Jane Zhang of the Civil and Environmental Engineering's Michigan Tech Center for Water and Society have received an award in the amount of \$599,978 from the National Science Foundation for a project titled Graduate Student Scholarships to Advance a Global Outlook of Economic and Social Prosperity that Protects the Environment. The project provides up to eighteen need-based scholarships annually to an integrated community of MS and PhD graduate students who are not only educated in the economic, social, and environmental pillars of sustainability but will also transfer research techniques and knowledge from their different graduate perspectives. This program partners with the U.S. Peace Corps incorporating 2+ years of overseas engineering service.

- **Testing of Remote Sensing Methods for Delineating Fracture Systems in Volcanic Terrains to Cavity Networks in Karst**

PI: John Gierke
co-PI: Carla Alonso
Sponsor: Univ of MI

Groundwater in bedrock aquifers occurs in fractures. Fracture networks are incredibly difficult to characterize because of the inadequate information available from drilling records and conventional mapping. My current

research is aimed at helping to develop methods for analyzing remote sensing data to delineate fractures in volcanic terrains, in an attempt to improve well siting strategies in Pacific Latin America. This led me to consider another type of environment that surrounds my home: karst. Geologists refer to the terrain in Puerto Rico as Northern Karst, which is a series of mogotes (hills), underlain by a network of cavities connecting sinkholes. The Northern Karst is the main supply of water for inhabitants and surface water bodies. Karst areas are more susceptible to drought, subsidence, and contamination. I am testing the methods I am helping to develop for volcanic terrain to characterize the cavity network in karst systems.

- **Intergovernmental Personnel Act Agreement with US Army Corps of Engineers**

PI: Dave Watkins CEE/CWS/SFI
Sponsor: US Army Corps of Engineers

This project involved the development of a design document for the next generation of the HEC-FDA (Flood Damage Analysis) software tool. The design document incorporates suggestions and research items discussed during a two previous workshops. It also accommodates those recommendations that the Corps concurred with from the National Research Council (2000) report on the Corps implementation of risk analysis for flood damage reduction, and it will aide in implementing the Chief of Engineers' "Actions for Change." This new tool may include event sampling, the ability to do scenarios analysis, structure-by-structure analysis, cost analysis and agricultural damage analysis.

- **Erosion Reduction by Air Entrainment, Phase I**

PI: Brian Barkdoll
co-PI: Mohan Rao
Sponsor: S. Florida Water Management District

Excessive scour of sediment can be a problem at hydraulic structures if the scour depth is such that it undermines the structure's foundation, which can lead to sliding, tilting, and potentially to the collapse of the structure. Scour is induced by flowing water in the various modes of sediment rolling, saltation, or entrainment into the flow as suspended load. Moreover, drought conditions followed by a large storm may result in excessive scour due to the low-flow depth protecting the sediment from scour downstream of hydraulic structures. Under such conditions the flow sediment carrying capacity can be exacerbated by the type and length of the hydraulic jump at the terminal structure, which will, in turn, scour large holes in the channel bed downstream of the terminal structure.

The SFWMD has numerous gated control structures in which there is not only flowing water but plunging water as well. The primary objective of Phase I of this project is to demonstrate that the introduction of an air-bubble curtain downstream of the terminal structure of a gated spillway may be an inexpensive way to reduce the scour depth.

- **Engaging Social Scientists in the WATERS Initiative: Special Sessions at the 2008 International Symposium on Society and Resource Management**

PI: Alex Mayer
co-PI: Kathleen Halvorsen
Sponsor: NSF

Two sessions were conducted at the International Symposium on Society and Resource Management (ISSRM) Conference in Burlington, Vermont, June 11, 2008. The purpose of Session One was to familiarize the audience with the WATERS program and to present initial ideas about key fundamental social science questions and approaches that could be answered through participation in the WATERS program. Session Two was a facilitated discussion of potential fundamental social science questions and approaches to answer them that could fit within the overall structure of WATERS. This included a discussion of how the infrastructure-orientation of WATERS might fit with key social science research. WATERS provides an excellent opportunity to support the intensive, panel-based (repeated surveys over time) investigation of important research questions important to theory development about human relationships to water.

- **Associations Between Groundwater-Surface Water Dynamics and Coaster Brook Trout Spawning Habitat in the Salmon Trout River, Marquette County, Michigan**

PI: Alex Mayer
co-PI: Casey Huckins
co-PI: Matthew VanGrinsven
Sponsor: Huron Mountain Wildlife Foundation, Trout Unlimited, DeVlieg Foundation

The Salmon Trout River (STR) is the only river on the south shore of Lake Superior known to sustain a reproducing coaster brook trout population. Related studies demonstrate that brook trout tend to select spawning sites, based on the presence of groundwater discharge into the river. The results of these studies also suggest that groundwater presence is vital to the reproductive success of CBT. Previous studies of the STR have characterized the life history strategies and ecology of CBT, but to date no study has investigated the influence of groundwater on CBT spawning habitat in the STR. We hypothesize that spatial distributions of groundwater inflows through river-bottom sediments are a critical factor in the selection of spawning sites.

In this study, high-resolution data collection methods are implemented to quantify the interaction between the groundwater and surface water in order to verify the presence or absence of groundwater discharge into the river at sites that support a reproducing population of coaster brook trout. By independently inverting temperature and pressure measurements the exchange of water between groundwater and surface water can be simultaneously analyzed, permitting a more precise estimate of groundwater velocity.

- **Limnological Research in Lake Superior for Middle/High School Students, Teachers and Communities**

PI: Joan Chadde (Western U.P. Center for Science, Mathematics & Environmental Education)

Sponsor: Michigan Space Grant Consortium

This MSGC-funded program provides scientific excursions aboard Michigan Tech's research vessel (R/V) Agassiz on Lake Superior and connecting waters for community members and middle/high school students and teachers in the Upper Peninsula.

These scientific excursions provide firsthand experience in how Great Lakes research is conducted, the equipment used, and what research is telling us about the health of the Great Lakes. Project goals are to: (i) increase middle/high school students' interest in science by providing real-world science applications; (ii) enhance citizen understanding of Great Lakes science and how research is conducted; and (iii) introduce teachers and students to careers in earth science and Great Lakes research. The scientific excursions are led by MTU scientists and graduate students from the Departments of Civil & Environmental Engineering, Chemistry, and Biological Sciences.

- **Lake Superior Education Program for Teachers, Students and Communities**

PI: Joan Chadde (Education Program Coordinator) and Shawn Oppliger (Director), Western Upper Peninsula Center for Science, Mathematics and Environmental Education

Sponsor: Copper Country ISD (subcontract) with funding from Michigan Department of Environmental Quality Coastal Management Program;

The project has four major components: i) K-12 and community education programs aboard MTU's research vessel (R/V) Agassiz; ii) educational workshops for decision-makers, developers, and business owners in four shoreline communities; iii) Lake Superior Educators Instructor Manual; and iv) a five-day Great Lakes Watershed Investigations Teacher Institute in June 2008. This program is projected to reach 800-1,000 middle/high school students, teachers and community members through the teacher institute and Lake Superior education programs aboard the R/V Agassiz.

- **Lake Superior Stewardship Initiative**

PI: Joan Chadde (Western U.P. Center for Science, Mathematics & Environmental Education)

Funding Source: Copper Country ISD

The Western Upper Peninsula Center for Science, Mathematics and Environmental Education received a \$200,000 grant from the Great Lakes Fishery Trust to create a hub for the Great Lakes Stewardship Initiative that will partner 11 Copper Country schools with 15 community organizations in Houghton and Baraga counties. The goals are to implement place-based education, engage students in real-world learning and to serve as valued resource in their communities. The Initiative incorporates three strategies:

(1) Implementing 'place-based curricula' in the classroom that engages students in learning about their community, cultural heritage, local watershed, and the Great Lakes;

(2) Providing teacher-training and student programs that increase content knowledge about the Great Lakes and opportunities for students to visit and learn about Lake Superior, tributary streams, wetlands, forests, and other outdoor environments near their schools;

(3) Developing school-community partnerships with local units of government and community organizations to address local needs by working together on local stewardship projects. For more information about the Lake Superior Stewardship Initiative, visit <http://www.wupcenter.mtu.edu/Issi>.

5.3. Proposals Submitted under CWS, 2007-8

- Global Watershed: Integrating Rural and Global Perspectives with Research and Technological Advances
PI: Alex Mayer
co-PIs: Linda Nagel, Casey Huckins, Bradley Baltensperger
Sponsor: NSF- GK12
\$2,287,782 (7/1/2008 - 6/30/2013)
- Characterizing Lessons Learned from Federal Biomass Removal Projects
PI: Kathy Halvorsen
Sponsor: U.S. Forest Service
\$35,603 (9/30/2007 - 3/31/2009)
Awarded
- Scholars Award Examining Society's Changing Knowledge of and Interactions with the Nitrogen Cycle, 1880 to the Present
PI: Hugh Gorman
Sponsor: NSF
\$88,013 (5/1/2008 - 12/31/2009)
- Graduate student scholarships to advance a global outlook of economic and social prosperity that protects the environment
PI: Judith Perlinger
co-PIs: Veronica Griffis, James Mihelcic, Kurt Paterson, Qiong Zhang
Sponsor: NSF
\$599,978 (6/1/2008 - 8/31/2012)
Awarded
- Testing of Remote Sensing Methods for Delineating Fracture Systems in Volcanic Terrains to Cavity Networks in Karst
PI: John Gierke
co-PI: Carla Alonso
Sponsor: Univ of MI
\$5,000 (5/1/2008 - 4/30/2009)
Awarded
- Fall 2008 EPA Greater Research Opportunities (GRO) Fellowships for Undergraduate Environmental Study:
Carla Alonso
PI: Alex Mayer
Co-PI: Carla Alonso
Sponsor: US EPA
\$41,500 (9/1/2008 - 8/31/2010)
- Intergovernmental Personnel Act Agreement with US Army Corps of Engineers
PI: Dave Watkins
Sponsor: US Army Corps of Engineers
\$42,347 (1/7/2008 - 6/6/2008)
Awarded
- Water Quality Evaluation Initiative for Best Management Practices on Stream Restoration Projects
PI: Casey Huckins
Sponsor: Conservation Resource Alliance
\$24,000 (5/1/2008 - 4/30/2010)
- Erosion Reduction by Air Entrainment, Phase I
PI: Brian Barkdoll
co-PI: Mohan Rao
Sponsor: S. Florida Water Management District
\$49,916 (3/1/2008 - 9/30/2008)
Awarded

- Engaging Social Scientists in the WATERS Initiative: Special Sessions at the 2008 International Symposium on Society and Resource Management
 PI: Alex Mayer
 co-PI: Kathleen Halvorsen
 Sponsor: NSF
 \$10,600 (5/1/2008 - 11/1/2008)
 Awarded
- SustR: Sustainable Development for Rural Communities: Social, Health, Economic, and Environmental Advances
 PI: Alex Mayer
 co-PI: Carol MacLennan
 co-PI: Blair Orr
 Sponsor: U.S. Dept. of Education Fund for the Improvement of Post-Secondary Education
 \$180,000 (9/1/2008 - 8/31/2012)
 Awarded in FY2008-09
- IGERT: Multi-scale stressors and the sustainability of the Lake Superior basin
 PI: Alex Mayer
 co-PI: Noel Urban
 co-PI: Judith Perlinger
 co-PI: Kathy Halvorsen
 co-PI: Casey Huckins
 Sponsor: NSF IGERT
 \$2 (Pre-proposal, 7/1/2009 - 6/30/2014)
- Coastal stream inventory in support of flow-based, aquatic community protection
 PI: Casey Huckins
 Sponsor: MI DEQ
 \$38,724 (1/1/2009 - 3/31/2010)
- Herring Gull BioSentinal Sampling Program Cooperative Agreement
 Judith Perlinger
 Sponsor: Clemson Univ.
 \$3,999 (continuation, 5/11/2008 - 5/10/2009)
- Associations Between Groundwater-Surface Water Dynamics and Coaster Brook Trout Spawning Habitat in the Salmon Trout River, Marquette County, Michigan
 PI: Alex Mayer
 co-PI: Casey Huckins
 co-PI: Matthew VanGrinsven
 Sponsor: Huron Mountain Wildlife Foundation
 \$1400 (4/15/2008 – 4/14/2009)
 Awarded
- Characterizing Human Health and Ecosystem Impacts of Increasing Sediment and Pollutant Transport in Great Lakes Watersheds Induced by Climate Change
 PI: Dave Watkins
 co-PI: Veronica Griffis
 co-PI: Alex Mayer
 co-PI: Colin Brooks
 co-PI: Robert Shuchman
 Sponsor: EPA
 \$799,998 (1/1/2009 - 12/31/2012)
- Enhancing the Capacity for Sustainable Forest Management in Chiapas and Oaxaca
 PI: Alex Mayer
 Co-PI: Kathleen Halvorsen
 Sponsor: Higher Education In Development/USAID
 \$250,000 (1/1/2009 - 12/31/2011)

6. Publications by CWS Participants, 2007-8

Publications are ordered by first CWS author or co-author and include journal articles, books, and chapters in books that are published, in press, forthcoming, or accepted. Items which are in press, forthcoming, or accepted will be counted as published with complete references in the next CWS Annual Report.

Published journal articles, books, and book chapters	38
Proceedings	24
Journal articles, books, chapters, and proceedings in press, forthcoming, or accepted	27
Presentations	81
Patents	1
FY 2006-7 references which completed publication in 2007-8.....	16
FY 2006-7 references <i>in press</i> in 2007-8.....	3

6.1. *Journal articles, books, and book chapters*

1. Rucinski, D. K., **Auer, M. T., Watkins, D. W. Jr.**, Effler, S. W., Doerr-O'Donnell, S. M. and R. K. Gelda. 2007. Accessing assimilative capacity through a dual discharge approach. *ASCE Journal of Water Resources Planning and Management*, 133: 474-485.
2. Lewis, G. N., **Auer, M. T.**, Xiang, X., and Penn, M. R. 2007. Modeling phosphorus flux in the sediments of Onondaga Lake: Insights on the timing of lake response and recovery. *Ecological Modelling*, 209(2-4): 121-135.
3. Gons, H. J., **Auer, M. T.** and Effler, S. W. 2008. MERIS satellite chlorophyll mapping of oligotrophic and eutrophic waters in the Laurentian Great Lakes. In Press, *Remote Sensing of the Environment*.
4. Verhamme, E. and **Auer, M. T.** 2008. Carbon flux, sediment enrichment and macroinvertebrate activity at slope and profundal sites on Lake Superior. Accepted for publication, *Verh. Internat. Verein. Limnol.*
5. Powell, K. D. and **Auer, M. T.** 2008. Organic carbon lability and community-level physiological profiling of bacterial populations in Lake Superior. Accepted for publication, *Verh. Internat. Verein. Limnol.*
6. Oyadomari, J.K. and **Auer, N. A.** Accepted – Page Proofs 4/30 2008. Transport and growth of larval cisco (*Coregonus artedii*) in the Keweenaw Current region of Lake Superior. *Canadian Journal of Fisheries and Aquatic Sciences*.
7. Chiotti, J. A., Holtgren, J. M., **Auer, N. A.** and Ogren, S. A. Accepted 9/24/2007 Lake Sturgeon Spawning Habitat in the Big Manistee River, Michigan. *North American Journal of Fisheries Management*.
8. Oyadomari, J. K. and **Auer, N. A.** 2007. Influence of Rearing Temperature and Feeding Regime on Otolith Increment Deposition in Larval Cisco. *Transactions of the American Fisheries Society*. 136 (3):766-777.
9. Duan, J., Chen, and **Barkdoll, B.** (2006) "Surface-Based Fractional Transport of Sediment", *American Society of Civil Engineers Journal of Hydraulic Engineering*, v 134, n 3, March, 2008, p 350-353
10. Melville, B. W.; van Ballegooy, S.; Coleman, S. E.; **Barkdoll, B.** "Riprap size selection at wing-wall abutments

“, American Society of Civil Engineers *Journal of Hydraulic Engineering*, v 133, n 11, November, 2007, p 1265-1269

11. **Barkdoll, B. D.**; Duan, J. G. “Sediment modeling: Issues and future directions”, Introduction to Special Issue on Sediment Modeling, American Society of Civil Engineers *Journal of Hydraulic Engineering*, v 134, n 3, March, 2008, p 285
12. Morey, E. R., **Breffle, W. S.**, Greene, P. A., “Two Nested Constant-Elasticity-of-Substitution Models of Recreational Participation and Site Choice: An “Alternatives” Model and “Expenditures” Model”, Herriges, J., Kling, C., (Revealed Preference Approaches to Environmental Valuation, Ashgate Publishing limited, I.K., 2008), vol. 1.
13. **Breffle, W. S.**, Morey, E. R., Lodder, T. S., “Using Contingent Valuation to Estimate a Neighborhood’s Willingness to Pay to Preserve Undeveloped Urban Land”, Carson, R., Tietenberg, T., (The Stated Preference Approach to Environmental Valuation: Applications: Benefit-Cost Analysis and Natural Resource Damage Assessment, Ashgate Publishing Limited, U.K., 2007), vol. 3.
14. **Breffle, W. S.**, “In pursuit of the optimal design: a guide for choice experiment practitioners,” International Journal of Ecological Economics and Statistics. (*Accepted*) (Peer-Review/Refereed)
15. **Chadde, J.**, Spring 2008. *Stormwater Runoff: Understanding Ecological Impacts of Changing Land Uses*, Green Teacher Journal. Issue No. 83. Pp. 9-13.
16. **Chadde, J.**, and J. Gannon, M. Ginnebaugh, F. Lichkoppler, R. Sturtevant. *The Great Lakes: At A Crossroads*. (2007). International Association for Great Lakes Research.
17. **Chadde, J.**, *Teaching Teachers*, Great Lakes Seaway Review, July-September 2007, Vol. 36, No. 1.
18. **Flaspohler, D.J.**, C. Webster, and R. Froese. (In press) Bioenergy, Biomass, and Biodiversity: A review of key issues for terrestrial and aquatic ecosystems. Chapter 7 in Renewable energy from forest resources in the United States, B. Solomon and V. Luzadis, eds. Publisher
19. **Fry, L., Watkins, Jr., D. W., and Mihelcic, J. R.** “Water and Non-Water-Related Challenges of Achieving Global Sanitation Coverage,” *Environmental Science and Technology*, web release, April 1, 2008.
20. Anderson, H. M., **Gale, M. R., Jurgensen, M. F.**, and Trettin, C.C. 2007. Vascular and non-vascular plant community response to silvicultural practices and resultant microtopography creation in a forested wetland. *Wetlands* 27: 68 – 79.
21. VanAntwerp, D. J., Falta, R. W., and **Gierke, J. S.**, Numerical Simulation of Field-Scale Contaminant Mass Transfer during Air Sparging, *Vadose Zone J.* 2008 7: 294-304.
22. **Gorman, H.**, “The Houston Ship Channel and the Changing Landscape of Industrial Pollution,” in The Energy Metropolis: An Environmental History of Houston and the Gulf Coast, ed. Martin V. Melosi and Joseph A. Pratt (University of Pittsburgh Press, 2007), Chapter 2, pp. 52-68.
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24. Stedinger, J. R., and **Griffis, V. W.**, “Flood Frequency Analysis in the United States: Time to Update,” *Journal of Hydrologic Engineering, ASCE*, 13(4), 199-287, 2008.
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27. **Griffis, V.W.** and Stedinger, J. R., “The Log-Pearson Type 3 Distribution and its Application in Flood Frequency Analysis: 2. Parameter Estimation Methods,” *Journal of Hydrologic Engineering, ASCE*, 12(5), 592-500, 2007.
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 29. **Hand, D.W., Qiong Z.**, “Water Treatment,” In: *Environmental Engineering: Fundamentals, Sustainability and Design*, Chapter 10, 80 pages, John Wiley & Sons, Inc. New York, (In Press) (2008).
 30. Jarvie, M.E., and **Hand, D.W.** "Predicting Influent Estradiol and Estrone Concentrations for Wastewater Treatment Facilities," *Water Environment Research*, March, 2007 (In press).
 31. Webster, C. W., **Huckins, C. J F.**, Shields, J. M. 2008. Spatial Distribution of Riparian Zone Coarse Woody Debris in a Managed Northern Temperate Watershed. *American Midland Naturalist*, Volume 159(1), January 2008.
 32. **Huckins, C. J.** and Baker, E. A. 2008. Migrations and Biological Characteristics of Adfluvial Coaster Brook Trout in a South Shore Lake Superior Tributary. *Transactions of the American Fisheries Society. in press.*
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 35. Cerdà, A. and **Jurgensen, M.F.** 2008. The influence of ants on soil and water losses from orange orchards in eastern Spain. *Journal of Applied Entomology* 132: 306-314.
 36. **Kerfoot, W. C., Budd, J.W.**, Churchill, J.H., and Chen, C., Metacommunity perspective on zooplanktonic communities in Lake Superior. In *State of Lake Superior* Ecovision World Monograph Series, M. Munawar, (Ed). International Association of Theoretical and Applied Limnology, (In press).
 37. **Kerfoot, W. C.**, Jeong, J., and Robbins, J.A. Lake Superior mining and the proposed mercury zero-discharge region for Lake Superior In *State of Lake Superior* Ecovision World Monograph Series, M. Munawar, (Ed). International Association of Theoretical and Applied Limnology, (In press).
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 39. Josberger, E., Shuchman, R., Meadows, G., **Liversedge, L.**, and Meadows, L. (2009). Hydrologic Processes at Bering Glacier, Alaska. *Bering Glacier: Interdisciplinary Studies of Earth’s Largest Temperate Surging Glacier. (In press)*
 40. Shuchman, R., Josberger, E., Payne, J., **Liversedge, L.**, Hatt, C. and Spaete, L. (2009). Remote Sensing of the Bering Glacier. *Bering Glacier: Interdisciplinary Studies of Earth’s Largest Temperate Surging Glacier. (In press)*
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46. Bau, D. and **Mayer, A.S.**, "Optimal Design of Pump-and-Treat Systems under Uncertain Hydraulic Conductivity and Plume Distribution," *Journal of Contaminant Hydrology*, accepted, 2008.
47. Endres, K.L., **Mayer, A.S.**, and **Hand, D.W.** "Groundwater Treatment Modeling in the Optimal Design of Pump-and-Treat Groundwater Remediation Systems" *ASCE Jour. Environmental Engineering*, Vol 133(8), 809 – 819 (August, 2007)
48. McConville, J.R., and **Mihelcic, J.R.**, "Adapting Life Cycle Thinking Tools to Evaluate Project Sustainability in International Water and Sanitation Development Work," *Environmental Engineering Science*, September 2007: 937-948.
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50. **Mihelcic, J.M.**, Zimmerman, J. and others, *Environmental Engineering: Fundamentals, Sustainability and Design*. John Wiley Publishers, New York, New York, 2008, in press.
51. **Mihelcic, J.R.**, Zimmerman, J.B., and **Perlinger, J.A.**, "Environmental Risk," In: *Environmental Engineering: Fundamentals, Sustainability, Design*, J.R. Mihelcic, Chapter 6, John Wiley & Sons, NY, 2008, in press.
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54. **Rowe, M.D.**, **Perlinger, J.A.**, and **Urban, N.R.**, "Modeling contaminant behavior in Lake Superior: A comparison of PCBs, PBDEs, and mercury", In *State of Lake Superior*, Ecovision World Monograph Series, M. Munawar (Ed.), International Association of Theoretical and Applied Limnology, in press.
55. **Solomon, B.D.**, Corey-Luse, C.M., and **Halvorsen, K.E.**, "Save minimum standard analysis of the Florida manatee," Chapter 7 in *Frontiers in Ecological Economic Theory and Application*, eds. J.D. Erickson and J.M. Gowdy (Edward Elgar, Cheltenham, UK, 2007), pp. 131-148.
56. Schultz, P., **Urban NR**, 2007, Effects of bacterial dynamics on organic matter decomposition and nutrient release from se1-2):1-14, doi:10.1016/j.ecolmodel. 2007.06.026
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6.2. Proceedings

1. **Barkdoll, B. D.; Ghimire, S. R.** "Heuristic method for the battle of the water network sensors: Demand-based approach", 8th Annual Water Distribution Systems Analysis Symposium 2006, 2007, p 102
2. **Barkdoll, B. D.; Ghimire, S. R.** "A heuristic method for water quality sensor location in a municipal water distribution system: Mass-released based approach", 8th Annual Water Distribution Systems Analysis Symposium 2006, 2007, p 110
3. **Campbell, G. A., Walck, C. L.**, (2008), The Debate over the Impact of Mining on the Environment and Sustainability in the Local Community. (Preprint 08-024) 1-6. Littleton, Colorado: Society for Mining, Metallurgy, and Exploration. (Published)
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5. **Cowden, J.R, Mihelcic, J.R., and Watkins Jr., D.W.**, "Climate Change Impacts on Rainwater Harvesting and Health in West Africa Urban Slums," *Proceedings*, 3rd International Conference on Climate and Water, Helsinki, Finland, September 2007.
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7. **Fry, L.M., Mihelcic, J.R., and Watkins Jr., D.W.**, "Meeting the Millennium Development Target for Sanitation: Barriers and Solutions," *Proceedings*, 43rd Annual American Water Resources Association Conference, Albuquerque, NM, Nov. 12-15, 2007.
8. **Fuchs, V.J., Gierke, J.S., and Mihelcic, J.R.**, "Hydraulic Model Comparison of Vertical Flow Regimes During

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19. Bond, B.J., Kennedy, A., Barnard, H., **Pypker, T.**, Czarnomski, N., Conklin, D. Controls over vegetation water use in a small watershed at varying scales of time and space? EOS Transactions AGU 88(52), Fall Meeting Suppl., Abstract B24C-01.
20. Barnard, H.R., Brooks, J., Kayler, Z., Sulzman, E.W., Phillips, C.L., **Pypker, T.**, McDonnell, J.J., Bond, B.J. Linking soil moisture, microclimate, and transpiration in a headwater catchment EOS Transactions AGU 88(52), Fall Meeting Suppl., Abstract H44C-07.
21. *Invited presentation:* **Rowe, M.D.**, and **Perlinger, J.A.**, “Thermal extraction and analysis of semivolatile organic compounds collected in multicapillary collection devices”, Proceedings of the 28th International

Symposium on Halogenated Persistent Organic Pollutants, Birmingham, UK, August 17-22, 2008, *Organohalogen Compounds*, 70, in press.

22. Garcilaso, L., Jordan, K. L., Kumar, V., Hutchins, M. J., and **Sutherland, J. W.**, "A Life-cycle Comparison of Clothes Washing Alternatives," Proceedings of 14th CIRP International Conference on Life Cycle Engineering 2007: Advances in Life Cycle Engineering for Sustainable Manufacturing Businesses, June 2007, Tokyo, Japan, on CD-ROM.
23. Etkin, D., Kirshen, P., **Watkins, D.**, Diallo, A., Hoogenboom, G., Roncoli, M., Sanfo, J., Sanon, M., Somé, L., Zoungrana, J. "Stochastic linear programming for improved reservoir operations for multiple objectives in Burkina Faso, West Africa." World Environmental and Water Resources Congress, ASCE, Honolulu, Hawaii, May 12-16, 2008.
24. **Watkins, D.W.**, and **Griffis, V.W.** "Conditioning Ensemble Streamflow Prediction Forecasts Using Climate Signals in the Midwestern U.S.," World Environmental and Water Resources Congress, ASCE, Honolulu, Hawaii, May 12-16, 2008.
25. **Watkins, D.W.**, and **Wei, W.** "The Value of Seasonal Climate Forecasts and Why Water Managers Don't Use Them," World Environmental and Water Resources Congress, ASCE, Honolulu, Hawaii, May 12-16, 2008.
26. Tice, A., **Zhang, Q.**, **Hand, D.W.**, Hokanson, D.R., "A Transient Model for Predicting Powdered Activated Carbon Adsorption Performance in a Completely Mixed Flow Reactor," *Proceedings of AWWA ACE'07*, June 24-28, Toronto, 2007.

6.3. Presentations

1. **Auer, M.** "Measurement of Sediment Oxygen and Nitrate Demand in Onondaga Lake Using Flow-Through Reactors," with Albert Galicinao, Poster Presented at the 9th Onondaga Lake Scientific Forum, November, 2007.
2. **Auer, M.** "Microelectrode-Derived Oxygen and Hydrogen Sulfide Profiles in Onondaga Lake Sediments," Poster Presented at the 9th Onondaga Lake Scientific Forum, November, 2007.
3. **Auer, M.** "Assaying Labile Organic Carbon in Onondaga Lake Sediments by Nitrate and Oxygen Consumption," with Philip DePetro, Poster Presented at the 9th Onondaga Lake Scientific Forum, November, 2007.
4. **Auer, M.T.**, Bub, L.A., **Auer, N.A.**, **Urban, N.R.**, Primary production, carbon flux, and the distribution of the amphipod *Diporeia* in Lake Superior, 30th Congress of the Internat. Assoc. of Theoretical and Applied Limnology (SIL), Montreal, 8/06
5. **Auer, N.**, "Importance of woody material in Great Lake aquatic food webs." International Association of Theoretical and Applied Limnology (SIL) August 2007, Montreal Canada.
6. **Auer, N.**, "Rehabilitating Lake Sturgeon: Challenges in a Time of Climate and Economic Change," Xi Sigma Pi National Forestry Honor Society – 4/4/2008 School of Forest Resources and Environmental Science, MTU.
7. **Auer, N.**, **Gierke, J. S.**, **Pennington, W. D.**, Shuchman, R., **Liversedge, L.**, Spaete, L., Endsley, K., Espino, S., Richardson, J., and Josberger, E. (2008). MTRI/Michigan Tech Collaborative 2007 Research Activities 2008 Bering Glacier Annual Meeting. Anchorage, AK.
8. **Brooks, C.**, Shuchman, R., Keefauver, E., Koziol, B., Erickson, T., Ide, C. 2007. Great Lakes and Molecular Sciences Center web-based Decision Support System tools for assessing human and ecological health risk.

Michigan Environmental Health Association (MEHA) 2007 Annual Education Conference. Kalamazoo, Michigan.

9. **Brooks, C.**, "Using web-based decision support systems to understand the impacts of contamination on Great Lakes rivers and human health", Michigan Tech Research Institute Lecture at Michigan Technological University, October 9, 2007.
10. **Barkdoll, B. D., Ghimire, S. R.** "Heuristic method for the battle of the water network sensors: Demand-based approach", 8th Annual Water Distribution Systems Analysis Symposium 2006, 2007, p 102
11. **Barkdoll, B. D. Ghimire, S. R.** "A heuristic method for water quality sensor location in a municipal water distribution system: Mass-released based approach", 8th Annual Water Distribution Systems Analysis Symposium 2006, 2007, p 110
12. **Brooks, C.**, Shuchman, R., Keefauver, E., Koziol, B., Erickson, T., Ide, C. 2007. Great Lakes and Molecular Sciences Center web-based Decision Support System tools for assessing human and ecological health risk. Michigan Environmental Health Association (MEHA) 2007 Annual Education Conference. Kalamazoo, Michigan.
13. **Brooks, C.**, Shuchman, R., Powell, R., French, N., **Liversedge, L.**, Schaub, D., Daining, C., Straub-Heidke, A., Shaffer, R. 2007. Integrating geospatial algorithms for evaluating the effect of Michigan's agricultural land use on water quality. The Soil and Water Conservation Society's 2007 Annual Conference, Tampa, Florida.
14. **Brooks, C.**, Powell, R., Schaub, D., French, N., **Liversedge, L.**, and Shaffer, R. (2006). Integrating multi-temporal and multi-platform agricultural remote sensing with water quality and geospatial data for evaluating the effectiveness of conservation practices in Michigan. Managing Agricultural Landscapes for Environmental Quality: Strengthening the Science Base. Kansas City, MO.
15. **Brooks, C.**, French, N., Shaffer, R., **Liversedge, L.**, Powell, R., and Schaub, D. (2007). Integrating Geospatial Algorithms for Evaluating the Effect of Michigan's Agricultural Land Use on Water Quality. The Soil and Water Conservation Society's 2007 Annual Conference. Tampa, FL.
16. **Campbell, G. A., Walck, C. L.**, 2008 SME Annual Meeting, "The Debate Over the Impact of Mining on the Environment and Sustainability in the Local Community", Society for Mining, Metallurgy, and Exploration, Salt Lake City, Utah. (February 27, 2008).
17. **Chadde, J.** Michigan Science Teachers Association, March 6-8, 2008, Lansing, MI.
MEECS Water Quality Workshop (w/ Jessica Wagenmaker)
Summer Teacher Institutes at MTU are Fun!
Changing Land Uses: Engaging Students in Assessing Environmental Impacts! (w/ Gary Cousino, teacher, Hart Middle School, Rochester, MI)
Great Lakes Maritime Transportation Why Don't Those 1000' Freighters Sink?
18. **Chadde, J.** *Making A Great Lake Superior*, October 29-31, 2007, Duluth, MN
19. **Chadde, J.** Ship Operations Cooperative Program, April 2-4, 2008, Baltimore, MD *Great Lakes Maritime Transportation Teacher Education & Outreach Programs.*
20. **Chadde, J.** National Science Teachers Association, March 29-31, 2008, Boston, MA.
Family Engineering Programs Prepare Students & Parents for the Future
Measure Environmental Impacts of Changing Land Use
Family Engineering Programs Prepare Students & Parents for the Future
21. **Fuchs, V. J., Gierke, J. S., and Mihelcic, J. R.**, "Hydraulic Model Comparison of Vertical Flow Regimes During Soil Clogging," Water Environment Federation's Annual Technical Exhibition and Conference (WEFTEC), San Diego, California, October, 2007.

22. FitzGerald, K. A., **Gierke, J. S.**, et al., "Engaging Urban Students in Geoenvironmental Education Using Storm Water Management Techniques," 2008 Ground Water Summit, Memphis, Tennessee, March 31 - April 2, 2008.
23. **Ghimire, S. R.** and **Barkdoll, B. D.** "Incorporating Environmental Impact in Decision Making for Municipal Drinking Water Distribution Systems through Eco-Efficiency Analysis," Proceedings of the 2007 World Environmental and Water Resources Congress, May 15-19, 2007, Tampa, Florida; Sponsored Environmental and Water Resources Institute (EWRI) of ASCE, pp. 1-10
24. **Ghimire, S. R.** and **Barkdoll, B. D.** "Issues in Energy Consumption by Municipal Drinking Water Distribution Systems" Proceedings of the 2007 World Environmental and Water Resources Congress, May 15-19, 2007, Tampa, Florida; Sponsored Environmental and Water Resources Institute (EWRI) of ASCE, pp. 1-10
25. **Gierke, J.S., Bruning, J. N.**, et al., "Remote Sensing for Characterizing Water-Bearing Fractures for Groundwater Supply in Volcanic Terrains: Boaco, Nicaragua," First Annual D80 Conference, November 3, 2007, Michigan Technological University, Houghton
26. **Gierke, J. S., Gross, E. L., Myre, E. A.**, and Kome, A., "A Technologically Appropriate Method for Measuring the Specific Capacity of Rope-Pump Wells," 2008 Ground Water Summit, Memphis, Tennessee, March 31 - April 2, 2008.
27. **Gorman, H.**, Managing Resources versus Managing a Commons: Sustainability and Societal Interactions with the Nitrogen Cycle," presented at the conference "Managing the Unknown" sponsored by the German Historical Institute, Feb. 21-23, 2008, Washington, D.C.
28. **Griffis, V. W.** and Stedinger, J. R., "Value of Regional Information using Bulletin 17B and LP3 Distribution", Paper 40927-2319, World Environmental & Water Resources Conference - Restoring our Natural Habitat, K.C. Kabbes editor, Tampa, Florida, May 15-18, 2007.
29. **Griffis, V. W.** and Stedinger, J. R., "Incorporating Climate Change and Variability into Bulletin 17B LP3 Model", Paper 40927-2320, World Environmental & Water Resources Conference - Restoring our Natural Habitat, K.C. Kabbes editor, Tampa, Florida, May 15-18, 2007.
30. **Griffis, V. W.** (2007) "Integrating Global Hydrology Into Graduate Engineering Education and Research," American Geophysical Union (AGU) Fall Meeting, December 11, 2007, San Francisco, CA.
31. Kashelkar, A. S., and **Griffis, V. W.** (2007) "Improving Forecasts of Flood Risk by Incorporating Climate Variability Into Bulletin 17B LP3 Model," American Geophysical Union (AGU) Fall Meeting, December 11, 2007, San Francisco, CA.
32. **Gross, E. L., Gierke, J. S.**, and Kome, A., "Characterization of Seasonal Effects on the Specific Capacity of Rope-Pump Wells in a Fractured-Rock Aquifer in Nicaragua," 2007 Annual Water Resources Conference of the American Water Resources Association, November 12-15, 2007, Albuquerque, New Mexico.
33. **Halvorsen, K.**, "Michigan State Watershed Management Policies and Local Watershed Groups", International Symposium on Society and Resource Management Conference, June 2007, Park City, Utah.
34. **Halvorsen, K. and Mayer, A. S.**, *Conference Session Organizers*, "Engaging Social Scientists in the WATERS Initiative," International Symposium on Society and Resource Management (ISSRM) Conference, June 2008, Burlington, Vermont.
35. **Huckins, C. J.**, Life History, Biology and Bottlenecks of Coasters - Lake Superior's Brook Trout. Biological Sciences. Feb. 2008.

36. **Huckins, C. J.**, Life History and Bottlenecks of Coasters - Lake Superior's Brook Trout. Wildlife Society 2008 North Central Section Student Conclave. April 2008.
37. **Huckins, C. J.**, Life History, Biology and Bottlenecks of Coasters - Lake Superior's Brook Trout. Purdue University. April 2008.
38. **Liversedge, L.** (2008). Turbidity Mapping and Prediction in Glacial Lakes. IAGLR's 51th Annual Conference on Great Lakes Research. Peterborough, Ontario, Canada.
39. **Liversedge, L.** (2008). Turbidity Mapping and Prediction in Ice Marginal Lakes at the Bering Glacier System, Alaska 2008 Bering Glacier Annual Meeting. Anchorage, AK.
40. Shuchman, R., Josberger, E., Hatt, C., **Liversedge, L.**, Spaete, L., Guyer, S., Noyles, C., Fleisher, J., and Payne, J. (2008). Bering Glacier Ablation 2008 Bering Glacier Annual Meeting. Anchorage, AK.
41. Shuchman, R., Meadows, G., and **Liversedge, L.** (2008). Automated Lagrangian Water-Quality Assessment System (ALWAS). IAGLR's 51th Annual Conference on Great Lakes Research. Peterborough, Ontario, Canada.
42. **Liversedge, L.**, Shuchman, R., Meadows, G., and Payne, J. (2007). Automated Lagrangian Water-Quality Assessment System (ALWAS) Measurements of North Slope Lakes and the Bering Glacier, Alaska. Building Bridges to Information Sharing, Geospatial 2007. Portland, OR.
43. Shuchman, R., Meadows, G., **Liversedge, L.**, and Payne, J. (2007). Automated Lagrangian Water-Quality Assessment System (ALWAS) Measurements of North Slope Lakes and Bering Glacier, Alaska. Annual AAAS Arctic Science Conference. Anchorage, AK.
44. **Liversedge, L.**, Shuchman, R., Savage, S., Payne, J., Guyer, S., and Noyles, C. (2006). Bering Glacier Geographic Information System and Web Portal. 2006 Bering Glacier Annual Meeting. Anchorage, AK.
45. Shuchman, R., Josberger, E., Erickson, T., Hatt, C., **Liversedge, L.**, Roussi, C., and Payne, J. (2006). Quantifying Spatially-Variable Ablation of Bering Glacier Lobes Using Low-Cost Automated Samplers and Remote Sensing Imagery. American Geophysical Union Fall Meeting. San Francisco, CA.
46. Shuchman, R., **Liversedge, L.**, Powell, R., and Spaete, L. (2006). Remote Sensing of the Bering Glacier Region. 2006 Bering Glacier Annual Meeting. Anchorage, AK.
47. Erickson, T., Shuchman, R., O'Haver, M., **Liversedge, L.**, and Savage, S. (2005). Lake St. Clair Web-based Geospatial Information Management System for Watershed Data. Lake Michigan: State of the Lake 4th Biennial Conference. Green Bay, WI.
48. **Martin, S.**, "Understanding the Links: Meteorology, Geology, and Religious Belief in the Lake Superior Basin," Duluth-Superior Archaeology Week, May 7, 2007, Duluth, MN.
49. **Mayer, A. S.** Huron Creek Watershed Management Plan: Towards Restoration of an Urban Creek. Great Lakes Environmental & Molecular Sciences Center State of the Upper Peninsula's Water Quality, Houghton, Michigan, September, 2007.
50. **Munoz Hernandez, A., and Mayer, A. S.** The impacts of climate change and variability on water resources in a semi arid region in Mexico: The Rio Yaqui-Basin. American Geophysical Union Fall Meeting. San Francisco, CA, December, 2007.
51. **Munoz Hernandez, A., and Mayer, A. S.** Sustainable Groundwater and Surface Water Management in the Rio Yaqui Basin, Sonora, Mexico. American Geophysical Union Spring Meeting. Ft. Lauderdale, FL, May, 2008.

52. **Munoz Hernandez, A., and Mayer, A. S.** The impacts of climate change and variability on water resources in a semiarid region in Mexico: The Rio Yaqui Basin. Regional Climate Forum for Northwest Mexico and the Southwest United States, Ensenada, Mexico, March 2008.
53. **McDonald, C. P., Urban, N. R.** Reinventing "REINVENTING THE WHEEL" in aquatic biogeochemical modeling, 30th Congress of the Internat. Assoc. of Theoretical and Applied Limnology (SIL), Montreal, 8/06
54. **McDonald, C. P., Urban, N. R.,** Using Information Theory To Determine Optimal Model Complexity In Aquatic Biogeochemical Modeling, AGU Ocean Sciences meeting, Orlando, FL 3/08
55. *Invited presentation:* **Perlinger, J. A.,** Hulting, M. L., Hicks, B. B., and Dettling, J. E., Future directions in atmospheric monitoring systems and techniques, 50th Conference of the International Association for Great Lakes Research, Penn State, Pennsylvania, May 28 – June 1, 2007.
56. **Pypker T. G.,** Climate Change and Hydrology, Ecosystems and Climate change seminar series, Xi Sigma Pi National Forestry Honor Society, Michigan Technological University, April 4, 2008.
57. **Pypker, T. G.,** From Lichens to Entire Watersheds: Interactions between Biology and Hydrology, Environmental, Water Resources Engineering Graduate Seminar, Michigan Technological University, Jan. 28, 2008.
58. *Invited presentation:* **Pypker, T. G.,** Hauck, M., Sulzman, E. W., Unsworth, M. H., Mix, A. C., Kayler, Z., Conklin, D., Kennedy, A., Phillips, C., Barnard, H. R., and Bond, B. J. (2007) Using the $\delta^{13}\text{C}$ of ecosystem respiration to monitor ecosystem metabolism of entire watersheds in complex terrain. EOS Transactions AGU 88(52), Fall Meeting Suppl., Abstract B21D-03
59. *Invited presentation:* Bond, B. J., Kennedy, A., Barnard, H., **Pypker, T.,** Czarnomski, N., Conklin, D. Controls over vegetation water use in a small watershed at varying scales of time and space? EOS Transactions AGU 88(52), Fall Meeting Suppl., Abstract B24C-01
60. Barnard, H. R., Brooks, J., Kayler, Z., Sulzman, E. W., Phillips, C. L., **Pypker, T.,** McDonnell, J. J., Bond, B. J. Linking soil moisture, microclimate, and transpiration in a headwater catchment EOS Transactions AGU 88(52), Fall Meeting Suppl., Abstract H44C-07
61. **Pypker, T. G.,** Forest hydrology and micrometeorology, In House Seminar Series, School of Forest Resources and Environmental Science, Michigan Technological University, Sept. 27, 2007.
62. **Pypker, T. G.,** Forest Hydrology, Guest lecture, FW 3020 – Forest and Landscape Ecology, School of Forest Resources and Environmental Science, Michigan Tech, October 15, 2007.
63. **Pypker, T. G.,** The importance of canopy structure in controlling rainfall interception loss, Wood to Wheels Seminar, Michigan Tech, Sept 13, 2007.
64. **Pypker, T. G.,** Toward using carbon isotopes to monitor ecosystem physiology of forests in mountainous terrain. USDA Forest Service, North Central Research Station, Grand Rapids, MN, Sept 6, 2007.
65. **Pypker, T. G.,** Instructor - National Advanced Silviculture Program, Forest Hydrology, May 15-16, 2007
66. **Rowe, M. D., and Perlinger, J. A.,** "Thermal extraction and analysis of semivolatile organic compounds collected in multicapillary collection devices", Proceedings of the 28th International Symposium on Halogenated Persistent Organic Pollutants, Birmingham, UK, August 17-22, 2008, *Organohalogen Compounds*, 70, *in press*.
67. **Rowe, M. D., Tobias, D. E. and Perlinger, J. A.,** Modeling the influence of atmospheric stability on air-water exchange of persistent bioaccumulative toxics in the Great Lakes, 50th Conference of the International

Association for Great Lakes Research, Penn State, Pennsylvania, May 28 – June 1, 2007.

68. **Sutherland, J.**, “A Life-Cycle Comparison of Clothes Washing Alternatives,” 14th CIRP Conference on Life Cycle Engineering, June 11-13, 2007, Tokyo, Japan.
69. **Tobias, D. E., Rowe, M. D., and Perlinger, J. A.**, Measuring the influence of atmospheric stability and fetch on air-water exchange fluxes of persistent bioaccumulative aoxicants along transects in Lake Superior, 50th Conference of the International Association for Great Lakes Research, Penn State, Pennsylvania, May 28 – June 1, 2007.
70. **Urban, N. R., Auer, M. T., Green, S. A., McDonald, C. P., Lu, X., and Apul, D.**, Are the Laurentian Great Lakes a source or sink of CO₂ to the atmosphere?, 30th Congress of the Internat. Assoc. of Theoretical and Applied Limnology (SIL), Montreal, 8/06
71. Desai, A., McKinley, G., **Urban, N. R.**, and Wu, C., Carbon Cycling in Lake Superior: Impact on Upper Midwest Regional Carbon Balance, AGU Fall 2007, San Francisco, 12/07
72. Attila, N., McKinley, G., **Urban, N.**, Kimura, N., Bennington, V., Desai, A., and Wu, C., Carbon cycling in Lake Superior: Observations, Models and Impacts on regional carbon cycling, AGU Ocean Sciences meeting, Orlando, FL 3/08
73. **Urban N. R., Perlinger, J. A.**, McKinley, G., **McDonald, C. P.**, Attila, N., Desai, A., and C. Wu, Contributions To The CO₂ Effluxes From The Laurentian Great Lakes, AGU Ocean Sciences meeting, Orlando, FL 3/08
74. Attila, N., Bennington, V., McKinley, G., **Urban, N.**, Kimura, N., Desai, A., and C. Wu, The Carbon Budget Of Lake Superior: First Results From The Cycles Project, 51st Conference Internat. Assoc. Great Lakes Res., Peterborough, ONT, 5/08
75. **Urban N. R., Perlinger, J. A.**, McKinley, G., **McDonald, C. P.**, Attila, N., Desai, A., and C. Wu, CO₂ fluxes across the Lake Superior surface: coupling of physics, chemistry and biology, 51st Conference Internat. Assoc. Great Lakes Res., Peterborough, ONT, 5/08
76. **Van Grinsven, M. and Mayer, A. S.** Associations Between Groundwater-Surface Water Dynamics and Coaster Brook Trout Spawning Habitat in the Salmon Trout River, Marquette County, Michigan. American Geophysical Union Fall Meeting. San Francisco, CA, December, 2007.
77. **Watkins, D. W.** (2007). “Seasonal Forecasts for Water Management in Central Texas,” Seminar presented at the International Research Institute for Climate and Society, Columbia Univ., Palisades, NY, November.
78. **Watkins, D. W.** (2008). “Optimal Use of Climate Forecasts in Water Management,” Seminar at Univ. of California-Davis, Davis, CA, February 11.
79. **Watkins, D. W.** (2007). “Systems Analysis Case Studies for Environmental and Water Resources Engineering Education,” Presentation at the INFORMS International Conference, Rio Del Mar, Puerto Rico, July 8-11.
80. **Watkins, D. W.**, McConville, J. R., and **Mihelcic, J. R.** (2008). “A Sustainability Matrix Approach to Project Planning and Evaluation,” Presentation at the World Environmental and Water Resources Congress, ASCE, Honolulu, Hawaii, May 12-16.
81. Tice, A. T., **Zhang, Q., Hand, D. W.**, and Hokanson, D. R., “A Transient Model for Predicting Powdered Activated Carbon Adsorption Performance in a Completely Mixed Reactor,” Presented at the 2007 American Water Association National Conference held in Toronto, Ontario Canada, June (2007)

6.4. Patents

1. **Perliger, J. A.** and Rowe, M. D., Atmospheric Semivolatile Organic Chemical Sampling and Thermal Extraction Transfer System (ASOCSTETS), U.S. Provisional Patent Serial No. 60/990,333, 11-27-07.

8. Appendix 1: CWS Faculty/Staff Participants

Biological Sciences

Nancy A. Auer
Susan T. Bagley
Casey J. Huckins
Charles W. Kerfoot

Chemistry

Sarah A. Green

Civil & Environmental Engineering

Martin T. Auer
C. Robert Baillod
Brian D. Barkdoll
Kristine L. Bradof
Veronica Griffis
David W. Hand
Neil J. Hutzler
Alex S. Mayer
James R. Mihelcic
Kurtis G. Paterson
Judith A. Perlinger
Noel R. Urban
David W. Watkins
Qiong Zhang

Educational Opportunity

Christine S. Anderson

Geological & Mining Eng. & Science

Judith R. Budd
Suzanne J. Beske-Diehl
John S. Gierke
Alex S. Mayer
Wayne D. Pennington

Humanities

R. Craig Waddell

Mechanical Engineering

John W. Sutherland

Michigan Tech Research Institute (MTRI)

Colin Brooks
Liza Liversedge

School of Business & Economics

William S. Breffle
Gary Campbell
Thomas E. Merz
Christa L. Walck

School of Forest Resources & Environmental Science

David J. Flaspohler
Margaret R. Gale
Kathleen E. Halvorsen
Martin F. Jurgensen
Linda M. Nagel
Blair D. Orr
Tom G. Pypker
James M. Schmierer

Social Sciences

Hugh Gorman
Kathleen E. Halvorsen
Carol A. MacLennan
Patrick E. Martin
Susan R. Martin
Timothy Scarlett
Bruce E. Seely
Barry D. Solomon

Visual & Performing Arts

Mary Ann Beckwith

Western UP Center for Science, Mathematics & Environmental Education

Joan F. Schumaker Chadde

9. Appendix 2: CWS Student Participants

Biological Sciences

Kevin Mann
Emily Ninmann
Tim Wilson
Foad Yousef

Chemistry

Qili Hu

Civil & Environmental Engineering

Mark Anderson
Meredith Ballard
Josh Cowden
Joe Dammal, undergrad
Phillip DePetro
Carly Dusseau
Lauren Fry
Valerie J Fuchs
Albert Galicinao
Santosh Ghimire
Rabi Gywali
Maureen Habarth
Jennifer Heglund
Fredline Ilorme
Ashwini Kashelkar
Linda Kersten
Matthew J. Kucharski
Cory McDonald
Andrea Munoz
Jennider Mwangi

Elizabeth A Myre
Crystal Payment
Agustin Robles
Mark Rowe
Erin Satchell
David Tobias
Wenge Wei
Heather Wright

Social Sciences

Genevieve Borg
Khila Dahal
Jessica Koski, undergrad
Andrew Kozich
Stacey Pilling

School of Forest Resources & Environmental Science (SFRES)

Elizabeth Boisvert
Kassidy Yatso, undergrad

Geological & Mining Engineering & Sciences

Jill N Bruning
Miriam Rios-Sanchez
Matt Van Grinsven
Randall E Fish
Essa L Gross
Robert F. Hegemann
Jeremy M. Jenson
Cara W. Shonsey

10. Appendix 3: CWS Advisory Committee

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Environmental Education