Environment and Natural Resources Trust Fund
2009 Phase 2 Request for Proposals (RFP)

LCCMR ID: 052-B1

Project Title: Urban Waters: Urbanization and Metropolitan Lakes and Lakes

Total Project Budget: $ $645,210

Proposed Project Time Period for the Funding Requested: 3 years from July 2009 to June 2012

Other Non-State Funds: $ $0.00

Priority: B1. Reduce Soil Erosion

First Name: Robert **Last Name:** Sterner

Sponsoring Organization: U of M

Address: 100 Ecology Building, 1987 Upper Buford Circle
St. Paul MN 55108

Telephone Number: 7032928480

Email: stern007@umn.edu

Fax: 6126246777

Web Address: http://www.tc.umn.edu/~stern007/

Region:	County Name:	City / Township:
Metro		Multiple

Summary: Effects of urbanization on lakes and ponds will be studied in one hundred randomly selected sites. Work will especially focus on organic contaminants, macrophytes, and chemical analysis of muds.

Main Proposal: 1008-2-004-proposal-2009_LCCMR_Sterner final final.doc

Project Budget: 1008-2-004-budget-Copy of Sterner_RFP_2009_Project Budget final final.xls

Qualifications: 1008-2-004-qualifications-RWS CV 1p LCCMR 2008.doc

Map: 1008-2-004-maps-Sterner LCCMR 2008 map final final.doc

Letter of Resolution:

MAIN PROPOSAL

PROJECT TITLE: Urban Waters -- Urbanization and metropolitan ponds and lakes

I. PROJECT STATEMENT

WHY – Improving water quality provides benefits for all. The lakes and ponds of the Twin Cities are one of the prime features giving the upper Midwest its distinctive and attractive quality. These aquatic resources are important in terms of drinking water supply, groundwater recharge, wildlife habitat, and as recreational areas. Though few studies have systematically examined how urbanization affects lakes and ponds, the Twin Cities is an exception. This project capitalizes on that opportunity to understand how urban activities influence multiple aspects of water quality in our region.

One hundred permanent lakes and ponds within the seven-county area were previously randomly selected and studied for common chemical and biological parameters as well as surrounding land use (see map). This statistically chosen set of study sites is a powerful tool to understand the effects of land use on water quality because strong inference can be drawn regarding the entire seven-county region. The initial survey of these sites has identified impervious surface land cover as an important variable affecting the chemistry and biology of these sites (Sterner et al. in prep.). Impervious surfaces reroute hydrological cycles, which presumably decreases the contribution of groundwater to associated lakes and ponds. In exchange, overland flow is increased and altered levels of chemical substances may affect the functioning of these aquatic ecosystems. In addition, urbanized Twin City lakes exhibit reduced phytoplankton and zooplankton biodiversity. Clearly, urbanization has affected the biology and chemistry of our lakes and ponds, but the underlying mechanisms driving these observed patterns remain unknown.

The primary focus of this study addresses multiple LCCMR priorities. The effect of urbanization on aquatic ecosystems is a highly visible yet understudied aspect of surface water quality. The planned macrophyte survey in this study will provide data relating lake and pond characteristics to the presence and relative abundance of native and invasive macrophyte species. The priority topics of reducing soil erosion will be addressed by linking land use characteristics to water quality. This approach will provide detailed quantitative information on the causes of nutrient and toxic loading to urban lake and pond ecosystems.

AIMS - Results will be disseminated by publication in free-access, peer-reviewed scientific literature. Data collected by this project will be archived and made available for others to download. A public website will be created and will consist of a photomicrographic atlas of common planktonic organisms in Twin Cities lakes and ponds. Users will be able to easily access information on the myriad of biological forms of organisms present in local lakes and ponds. This information will be linked to other WWW-based information on these organisms. This web site will be constructed in partnership with local K-12 educators, by way of summer fellowships to work alongside the scientific personnel on this project.

HOW This project will do new synoptic measurements on all 100 lakes and ponds. This large number insures a wide diversity of sites will be included, and provides for good statistical power to determine trends, but it will limit the temporal resolution of sampling. Therefore, a set of ten-twelve sites will also be selected and studied on a monthly basis for two annual cycles. The temporal stability of the relationships previously observed in the 100 lakes and ponds is currently unknown. Sampling these study sites again will provide both increased statistical power and an important insight into the long-term functioning of these ecosystems. These lakes will be further sampled for new variables to extend the power of the original study. First, sampling and analysis of lake and pond bottoms will be performed and biological and chemical (organic carbon, nutrients) measurement of bottom sediments and muds, including trace metal analysis, will be performed. Second, detailed, species-level macrophyte surveys will be performed. Macrophytes are an important variable in controlling plankton community structure, but current information is limited to presence/absence of emergent and submerged vegetation. Organic contaminants will be measured in these sites, with a focus on polycyclic aromatic hydrocarbons (PAH's). PAHs are representative of combustion related pollution and uncombusted petroleum. The National Water Quality Assessment (NAWQA) performed by the US Geological Survey (USGS) showed these to

be some of the most abundant organic contaminants detected in surface water of North America. Finally, this project will be the first of its kind to make use of new sensing technology involving pulse amplitude fluorescence measurement, that has been shown to yield quick and accurate measurement of total chlorophyll as well as relative biomass of major algal groups (greens, diatoms and bluegreens), as well as nutrient status of the phytoplankton community. Its success will potentially have a large impact on the design of water quality sampling protocols. Additionally, opportunistic sampling will take place in several ways. Event-driven samplings of storm water runoff, and surface streams will take place several times during high precipitation events. Samplings of snow and ice in locations near each of the 100 lakes and pond will take place.

II. DESCRIPTION OF PROJECT RESULTS

Result 1: Nutrients, mud, macrophytes surveys **Budget:** $ 413,762

Deliverable	Completion Date
1. **Scientific publications**	**2010, 2011**
2. **Publicly accessible data archive**	**2011**
3. **Web site of microorganisms**	**2010**

Result 2: Organic contaminants **Budget: $** 231,448

Deliverable	Completion Date
1. **Scientific publications**	**2010, 2011**
2. **Publicly accessible data archive**	**2011**

III. PROJECT STRATEGY AND TIMELINE

A. Project Partners This work will be performed by two laboratories. Dr. Robert W. Sterner, Professor of Ecology (http://www.tc.umn.edu/~stern007/) will lead the project. Dr. Matt Simcek, Assistant Professor of Environmental Health Sciences (http://enhs.umn.edu/files/facultypages/simcik.html), will direct the organic contaminants portion of the project.

B. Project Impact The global human population is becoming increasingly urbanized. The intense level of landscape alteration, commerce, transportation and other activities place great stress on surface water quality in urban areas. Though there is a quantity of scientific literature on urban streams, few studies have examined the effect of urbanization on lakes and ponds. This study will contribute significantly and meaningfully to our understanding of the effects of urbanization on surface water quality and will make the Twin Cities Metropolitan Area a leading example in this field. Informed management, improved baselines and a better understanding of the connections between land use change and local water quality will result.

C. Time Upon notification of funding: project personnel will reestablish contact with the private land owners who originally gave permission for us to access some of the lakes and ponds in the set of 100 lakes. The subset of lakes to be examined frequently will be selected. Equipment will be purchased.

Summer, 2009 (abbreviated field season): one hundred sites will be visited once each for a synoptic survey. Plankton samples and macrophyte samples will be taken. PHYTO-PAM surveys will be performed. Monthly sampling of the subset of lakes will begin

Field seasons 2010, 2011: The full sampling regimen applied. The monthly sampling of the lake subsets will end during summer 2011. The outreach web site will be built in draft form on 2010 and finished and made live in summer, 2011 so it is ready for testing in schools in the 2011-12 academic year.

Remainder of 2011 up to summer of 2012. Data will be analyzed and written for publication.

D. Long-Term Strategy (if applicable) The 100-lake Urban Waters set of sites will be a new, long-term research emphasis of Dr. Robert Sterner. Few ecologists and limnologists to date have done much work in urban lakes and ponds, and the Twin Cities is thus poised to become recognized as a leading example of this kind of research.

IV. TOTAL PROJECT REQUEST BUDGET

BUDGET ITEM	AMOUNT	% FTE
Personnel: PI (1.5 sum. mos. YR 2 & YR 3)	$ 53,528	13%
Co-PI (1.5 sum. mos. per year)	$ 39,848	13%
Lab Tech	$ 95,655	50%
Graduate Students (2)	$ 241,469	50%
Undergraduate Student (summer)	$ 19,516	25%
Contracts: Local K-12 teacher (approx. 2 summer months per year)	$ 21,851	
Equipment/Tools: Phyto-PAM sensing device for phytoplankton community	$ 29,133	
Multi-sonde field instrument for measuring oxygen, temperature, pH and other variables	$ 4,525	
Other: Laptop	$ 1,500	
Supplies (lab/field supplies, GIS software license, etc.)	$ 105,606	
Lease Cargo Van (lease, mileage, insurance, parking)	$ 32,579	
TOTAL PROJECT BUDGET REQUEST TO LCCMR	$ 645,210	

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Remaining $ From Previous Trust Fund Appropriation (if applicable):	$ -	
Other Non-State $ Being Leveraged During Project Period:	$ -	
Other State $ Being Spent During Project Period:	$ -	
In-kind Services During Project Period:	$ -	
Past Spending:	$ -	

PROJECT MANAGER QUALIFICATIONS AND ORGANIZATION DESCRIPTION

Dr. Robert W. Sterner
Email: rsterner@nsf.gov url: http://www.tc.umn.edu/~stern007/

Dr. Sterner is a Professor of Limnology at the University of Minnesota and until September, 2009 the Director of the Division of Environmental Biology at the U.S. National Science Foundation. He has published widely on various topics in pond and lake ecology (see references on web site), including general review papers on topics such as nutrient limitation, a book on the topic of Ecological Stoichiometry and numerous encyclopedia entries. As Director of DEB at the NSF he is the senior manager responsible for $110 million of federal investment in ecology, ecosystems, population dynamics, and systematics. His position at NSF is as a "rotator" and he will return to full time teaching and research at the University of Minnesota in Fall, 2009. Dr. Sterner will have overall responsibility for the project and will direct day to day sampling, analysis, and data management with the exception of the organic contaminants component of the project, which will be directed by Dr. Matt Simcik.

Education: Ph.D., Ecology, University of Minnesota, 1986
B.S., Biology, University of Illinois, 1980

Professional experience:

2007-present Division of Environmental Biology, National Science Foundation
2003-present Professor, University of Minnesota
1999-2003 Head, Department of Ecology, Evolution and Behavior, University of Minnesota
1988-94 University of Texas at Arlington, Arlington TX, Assistant then Associate Professor
1987 NATO and Max Planck Postdoctoral Fellow

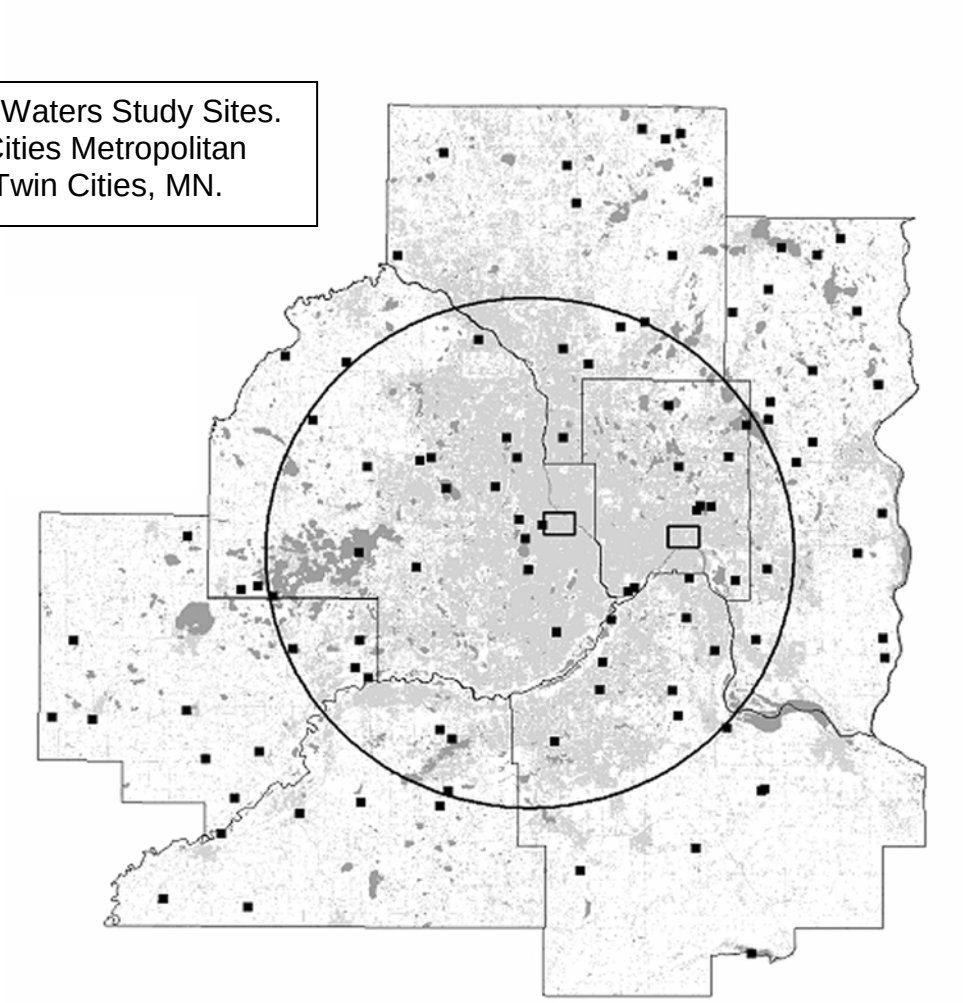
Selected publications (see web site for full list):

1. Sterner, R. W., T. Andersen, J. J. Elser, D. O. Hessen, J. M. Hood, E. McCauley, and J. Urabe. 2008. Scale-dependent carbon:nitrogen:phosphorus seston stoichiometry in marine and freshwaters. *Limnology and Oceanography* 53:1169-1180.
2. Finlay, J., R. W. Sterner, and S. Kumar. 2007. Isotopic evidence for in-lake production and accumulation of nitrate in Lake Superior. *Ecological Applications* 17: 2323-2332.
3. Hendrixson, H. A., Sterner, R. W. & Kay, A. D. 2007 Elemental stoichiometry of freshwater fish in relation to phylogeny, allometry and ecology. *Journal of Fish Biology* 69: 121-140.
4. Sterner, R.W., Smutka, T.M., R.M.L. McKay, Xiaoming, Q., Brown, E.T., Sherrell, R.M. 2004. Phosphorus and trace metal limitation of algae and bacteria in Lake Superior. *Limnology and Oceanography* 49: 495-507.
5. Sterner, R. W. and J.J. Elser. 2002. *Ecological Stoichiometry: The Biology of Elements from Molecules to the Biosphere*. Princeton University Press, Princeton, NJ. 439 pp.

Description of the Organization

The University of Minnesota is one of the most comprehensive public universities in the United States and ranks among the most prestigious. It is both the state land-grant university, with a strong tradition of education and public service, and the state's primary research university, with faculty of national and international reputation.

Urban Waters Study Sites. Twin Cities Metropolitan Area, Twin Cities, MN.



Study sites in the Urban Waters project. One hundred permanent ponds and lakes (dark squares) were randomly selected and studied for basic water chemistry (chlorophyll, nutrients) and plankton communities in 2002. Land use in different buffer sizes was also determined using GIS. The large dark circle indicates an interior "urbanized" zone and an exterior "nonurbanized" zone, which was used to stratify the random selection process; fifty sites were chosen inside and fifty outside the circle. The small rectangles indicate the urban centers of Minneapolis and St. Paul.

This work identified some of the characteristics of more urbanized ponds and lakes, including reduced plankton biodiversity, reduced macrophyte abundance, and altered dissolved organic carbon and total dissolved nitrogen. Impervious surface was an important land use variable. There was no dominant signal of eutrophication with increasing urbanization.