Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)

Project Title: **ENRTF ID: 064-B**

Assessing Legacy Waters with Advanced Sensors

Category: B. Water Resources

Total Project Budget: $ 1,568,000

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 - June 2020

Summary:

Installing advanced water quality sensors on Minnesotas main rivers and tributaries, along with an associated econometric analysis on agricultural BMP adoption, will inform Minnesota decision-makers if conservation expenditures are effective.

Name: Jeff Peterson

Sponsoring Organization: U of MN - Water Resources Center

Address: 1985 Buford Ave, 173 McNeal Hall

St. Paul MN 55108

Telephone Number: (612) 624-9282

Email jmpeter@umn.edu

Web Address https://www.wrc.umn.edu/

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Minnesota map showing locations where sensors will be installed; image of a sensor unit.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

PROJECT TITLE: Assessing Legacy Waters with Advanced Sensors

I. PROJECT STATEMENT

WHY –Millions of dollars are spent each year in Minnesota in efforts to improve water quality and to monitor water quality changes. The current monitoring system is based on laboratory analysis of water samples from watershed outlet points ten times throughout the summer months. While extensive compared to other states, more measurements are needed to determine **where** in the watershed the contaminants originate, **which practices** are responsible for the improvements, and a more detailed picture of **when** during the year the contamination levels change. Recent advances in optical sensor technologies have rendered real-time measurements possible for nutrients (e.g. nitrates, carbon), bacteria (e.g. *E. coli*), and other pollutants (e.g. oil – refined hydrocarbons) using green technology (i.e. no chemical reagents). An automated sampling device has been developed that reports nearly 30 water quality parameters every 2 minutes. An effort is also needed to isolate the impact that public investment in cost-sharing for best management practice (BMP) installation have had on water quality in watersheds, disentangling it from the numerous other factors influencing land uses, BMPs installed by landowners at their own cost, and transport of contaminants into water bodies. Higher quality monitoring data can also improve the models that address these questions.

GOALS – This project will: 1) Quantify real-time water quality concentrations at five test locations on the Mississippi, Minnesota, Red, and Rainy Rivers; 2) develop inexpensive sensors to be deployed and used by citizens at finer scales in Minnesota streams listed as impaired (i.e. 303(d) listed waters); 3) examine effectiveness of public investments that have been applied in agricultural watersheds; and 4) disseminate research results to the scientific community and to Minnesota decision-makers.

OUTCOMES – Build on existing approaches and partnerships, provide a nested approach to water quality monitoring in Minnesota's rivers and streams. Add value to Prof. Ruan's LCCMR "tiny cheap sensors" project that was recently funded; those researchers strongly support corroborating their efforts with our proposed efforts. Real-time data will provide pollutant loads with higher accuracy and lower uncertainty than presently calculated. The project results will inform Minnesota decision-makers as to what progress, if any, is being made with regards to our conservation expenditures towards improving Minnesota's river and stream water quality.

HOW – The project will be divided into four main activities below.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Establish statewide river real-time monitoring network* **Budget: $766,000**

One-time purchase, installation, and maintenance of real-time water quality monitoring sensors at five locations: Mississippi River near St. Cloud and above the Twin Cities, Minnesota River near Mankato, Red River near Moorhead, and Rainey River near International Falls. Locations to be established by USGS river monitoring stations where infrastructure is already in place. Periodic calibration and maintenance required.

Outcome	Completion Date
1. Install real-time monitoring sensors at 5 locations in Minnesota	*October, 2017*
2. Calibrate sensors using discrete sampling data	*Ongoing*
3. Periodic maintenance of sensors	*Ongoing*
4. Analysis of water quality data	*June, 2020*

Activity 2: *Develop and deploy inexpensive sensors* **Budget: $296,000**

Development of water quality sensors for long-term placement into impaired streams. Sensors will complement key water quality parameters in Activity 1. Sensors will be deployed into smaller rivers and streams listed as impaired and located in Activity 1 river basins. Citizens will assist with stream observations, and will be invited to assist with required periodic calibration and maintenance.

Outcome	Completion Date

1. Develop and deploy sensors	*June, 2018*
2. Calibrate sensors using discrete sampling data	*Ongoing*
3. Periodic maintenance of sensors	*Ongoing*
4. Analysis of water quality data	*June, 2020*

Activity 3: *Determine economic effectiveness of Clean Water Funds* **Budget: $495,000**

Isolate the impact that investments from public investments in cost-sharing for BMPs have had on water quality in agricultural watersheds. Collect survey data in three selected watersheds to obtain information from a statistical sample of farmers about their recent acreages planted to various crops, fertilizer rates and timing, tillage and other practices. Identify farmers within this sample who received state cost sharing funds within the last 3 years and ask them about maintenance activities. Econometrically analyze this data to determine the role of cost-share programs in BMP adoption. Link this model to a watershed model to estimate the impacts of the practice adoption on water quality. Expected results of this activity are estimates of the water quality effects of public expenditures in the study watersheds, compared to the impacts of other factors on water quality. We will be able to assess not only whether water quality is improving, but the causes underlying those improvements.

Outcome	Completion Date
1. Select watersheds and perform surveys	*June, 2018*
2. Perform econometric analyses	*June, 2019*
3. Compare results to water quality (modeled and sensor data)	*June, 2020*

Activity 4: *Disseminate research results to stakeholders* **Budget: $11,000**

Disseminate results to and stakeholders (e.g. MN state and federal agencies).

Outcome	Completion Date
1. Presentations at in-state scientific conferences (on-going/continuous)	*Ongoing*
2. Meetings with stakeholders to disseminate results (on-going/continuous)	*Ongoing*

III. PROJECT STRATEGY

A. Project Team/Partners

The project will be led by Jeff Peterson (Director, UMN Water Resources Center) and include three co-PIs: Joe Magner and Peter Marchetto (UMN Dept. Bioproducts and Bioengineering), and Lorin Hatch (Outside Collaborator). Together they provide the necessary expertise to execute the proposed project. Also included are three research associates (econometric modeler, watershed modeler, and sensor expert/project manager), two graduate students (economics, water quality) and five summer assistants (2 graduate, 3 undergraduate).

B. Project Impact and Long-Term Strategy

The long-term goal of the proposed research is gain a better understanding of river and stream water quality in Minnesota and determine if water quality is improving or not based on state expenditures. This research is especially important because millions of dollars are being spent in Minnesota (e.g. watershed districts, LCCMR) in efforts to improve river and stream water quality, but there is no monitoring network in place to determine the effectiveness of those expenditures, nor an effort to econometrically link these dollars to their effectiveness in the field in regards to improving water quality.

C. Timeline Requirements

The proposed project will be completed in a three-year period. The five sampling units will be installed during the first 3 months, while inexpensive sensor development and field deployments by spring 2018. Data collection and sensor maintenance will be ongoing. Surveys will take place the first year, followed by econometric modeling and watershed modeling. Dissemination of results will occur annually as interim results are analyzed.

2017 Detailed Project Budget

Project Title: *Assessing Legacy Waters with Advanced Sensors*

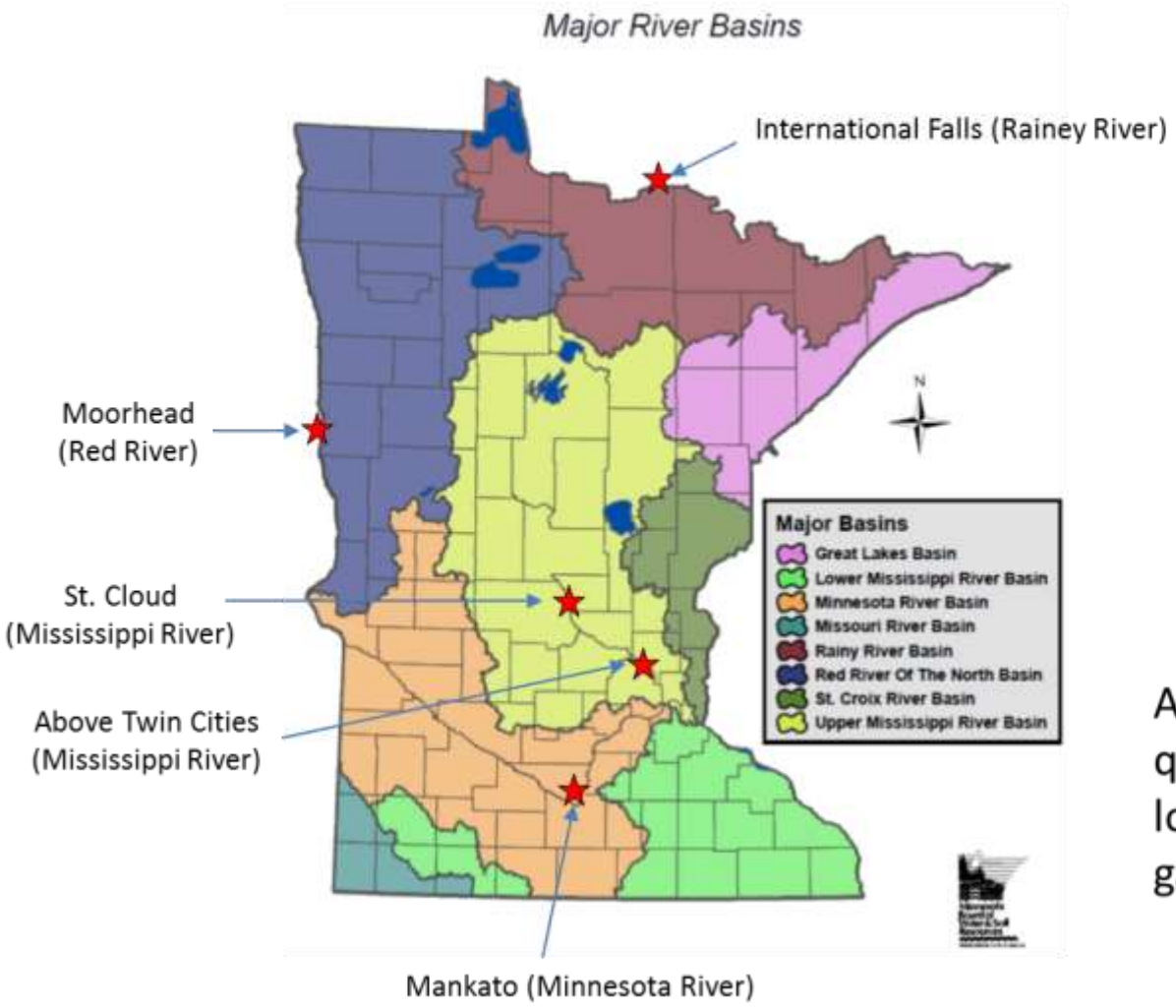
IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Personnel: Jeff Peterson, Project Manager (100% state appoitment - not seeking any LLCMR funding); Project supervision, supervision of research associates and graduate students, project reporting, dissemination and outreach.	none
Personnel: Joe Magner, co-Project Manager (75% salary, 25% benefits); 8% FTE; Project supervision for Activity 1, supervision of research associates and graduate students, project reporting, dissemination and outreach.	$ 49,000
Personnel: Peter Marchetto, co-Project Manager (75% salary, 25% benefits); 32% FTE; Project supervision for Activity 2, supervision of research associates and graduate students, project reporting, dissemination and outreach.	$ 154,000
Personnel: Three research associates (59% salary, 41% benefits); 60% FTE; One project coordinator, one econometric modeler, and one watershed modeler.	$ 574,000
Personnel: Two graduate research assistants (53% salary, 47% benefits); 50% FTE; one performing research on econometrics, one performed research on water quality sensors. Two summer graduate research assistants (hourly) to assist with summer fieldwork.	$ 214,000
Personnel: Summer undergraduate (n=3) and graduate (n=2) research assistants (hourly, no benefits); assist year-round researchers with summer fieldwork.	$ 114,000
Professional/Technical/Service Contracts: Year 1 survey to assess landowner practices in	$ 35,000
Equipment/Tools/Supplies: One-time purchase of five LiquID real-time water quality units for Real-time monitoring network (Activity 1).	$ 325,000
Equipment/Tools/Supplies: Supplies for all activities; mostly for monitoring network and sensors.	$ 76,000
Travel: Travel to 5 primary and multiple monitoring locations for sampling and maintenance. Mileage to in-state meetings to present results.	$ 27,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 1,568,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	N/A	
Other State $ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period: The University of Minnesota does not charge the State of Minnesota its typical overhead rate of 52% of the total modified direct costs (graduate tuition and academic fringe are excluded).	$ 621,024	*Secured*
In-kind Services To Be Applied To Project During Project Period: Dr. Peterson cannot acquire salary/benefits for the project because he has a State appointment. However, he is able to provide 8% in-kind time for supervision of the project, as noted above.	$ 53,121	*Secured*
Funding History:	N/A	
Remaining $ From Current ENRTF Appropriation:	N/A	

Assessing Legacy Waters with Advanced Sensors



Automated water quality sensor to be located at USGS gauging stations

Project Manager Qualifications

Jeffrey M. Peterson is the Director of the University of Minnesota's Water Resources Center (WRC), a partnership of University Extension and the College of Food, Agricultural, and Natural Resource Sciences. The WRC will coordinate project activities and provide administrative support. The WRC manages the Minnesota Water Resources Research Institute (WRRI) program, houses an interdisciplinary Water Resources Sciences graduate program with over 100 participating faculty in 23 departments, conducts statewide professional training in three disciplines, and coordinates grant based water research and outreach projects. It has facilities and staff to coordinate and host meetings (including videoconferencing), maintain project and program websites (home page www.wrc.umn.edu), and provide office space and computer hardware and software for the research associates students on the project. The WRC accountant and communications associate will also provide administrative and communications support.

As WRC Director, Dr. Peterson provides overall leadership for the center's outreach, teaching, and research activities involving faculty and students across the university. He also holds a faculty appointment as a professor in the Department of Applied Economics. He earned his Ph.D. from Cornell University in agricultural and resource economics. Prior to coming to Minnesota he held a faculty position in the Department of Agricultural Economics at Kansas State University for 15 years, including service as Director of Graduate Studies from 2014 to 2015. He is the recipient of national awards for his research on environmental policy analysis, focusing on water use and water quality impacts from agriculture. He currently serves as an editor of the Journal of Agricultural and Resource Economics.

Lorin K. Hatch will provide assistance to Dr. Peterson with regards to project management, in addition to his other project duties. Dr. Hatch previously served as a project manager for the Water Resources Center for a remarkably similar project. As a post-doctoral research associate, Dr. Hatch coordinated a team of UMN researchers from various disciplines (engineering, ecology, economics, anthropology, soils) studying the impacts of spatial and temporal scale on nutrient generation and transport in the Minnesota River Basin. A paper resulting from that project received the Best Research Article Award from the Journal of Soil and Water Conservation.