Environment and Natural Resources Trust Fund
2016 Request for Proposals (RFP)

Project Title: **ENRTF ID: 071-B**

Reducing Early Spring Nutrient Inputs to Agricultural Streams

Category: B. Water Resources

Total Project Budget: $ 482,563

Proposed Project Time Period for the Funding Requested: 3 years, July 2016 to June 2019

Summary:

This project will determine the importance of early spring nutrient inputs to agricultural streams, and evaluate alternative best management practices to reduce these inputs.

Name: Lawrence Baker

Sponsoring Organization: U of MN

Address: Department of Bioproducts and Biosystems Engineering, 1390 Eckles Ave.
St. Paul MN 55108

Telephone Number: (763) 370-1796

Email baker127@umn.edu

Web Address larrybakerlab.umn.edu

Location

Region: SE

County Name: Statewide

City / Township:

Alternate Text for Visual:

The graphic shows the location of the two study watersheds (Albert Lea and Le Sueur), the experimental plot study at the Southern Research and Outreach Center, one of our sampling devices, a graphical output from the SWAT model, and a list of outcomes.

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

PROJECT TITLE: Reducing early spring nutrient losses from agricultural watersheds.

I. PROJECT STATEMENT

PROJECT RATIONALE. Nutrient impairment of rivers draining agricultural regions is widespread, with more than 100 nutrient-impaired stream segments in the southern region of the state (see figure), caused mainly by phosphorus (P). The long-term persistence of water quality problems in agricultural landscapes suggests that new approaches are required to reduce nutrient delivery to streams and rivers. One reason we have not solved the problem of excess P is that the focus of "best management practices" (BMPs) has been on reducing erosion during rain storms or trapping eroded particles before they reach streams. The traditional approach has been based on the premise that nearly all P is bound to soil particles. Research over the past 20 years has shown that the system is not that simple. Three important facts have emerged from recent studies:

(1) A major fraction, sometimes more than 50%, of annual P loss occurs during early spring, often associated with snowmelt. For this proposal, '***early season'*** refers to runoff events that occur prior to crop emergence.
(2) Much of the P entering our agricultural streams is in the *soluble form* (not bound to soil particles), but most of our best management practices (BMPs) are designed to trap only the soil-bound P;
(3) In some situations, current best management practices, such as conservation tillage, may increase the input of soluble P during early spring because plant material can be a source of P.

Our *primary* focus for this work is to understand how runoff events that occur during early spring contribute to nutrient export to Minnesota's streams and rivers. We anticipate that this framework holds the most promise for identifying ways to reduce P export, however we will also study nitrogen pollution with this study.

GOALS. This project has three main goals:

1. Determine the significance of early spring runoff events in driving annual export of nutrients from agricultural landscapes to streams and rivers.
2. Identify and evaluate alternate BMPs for their ability to reduce early season nutrient export.
3. Evaluate BMP effectiveness under a variety of weather scenarios to determine how different springtime runoff conditions can impact nutrient export.

OUTCOMES. The outcomes of this project will be a much better understanding of the problem of early season P inputs (soluble and total) in causing nutrient impairment, and an evaluation new or modified BMPs to reduce soluble P inputs to agricultural streams.

APPROACH. We will focus on two watersheds that we have previously studied: the watersheds of Albert Lea Lake and of the Le Sueur River. We will augment current monitoring programs (mostly during the growing season only) with year-round monitoring to gain a better understanding of the nutrient dynamics throughout the entire year. We will study nutrient runoff from fields utilizing permanent agricultural plots and whole fields at the Southern Research and Outreach Center (SROC), under varying cropping and tillage practices, including some with fall/spring cover crops. We will also conduct leaching experiments from soil/plant residue samples collected from the sample plots. This information will be to calibrate and, if necessary, modify the SWAT model, which will then be used to evaluate nutrient runoff in BMP scenarios.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Lab and field experiments to quantify early season nutrient export* **Budget: $376,879**

Conduct plot-scale runoff measurements during snowmelt periods using previously tested "dustpan collectors". Plots will include various cover crop experiments and standard corn-soybean rotation plots at the Southern Research and Outreach Center (SROC) in Waseca, plus runoff measurements on buffer strips and ditch walls in the Albert Lea and Blue Earth watersheds.

Outcome	Completion Date

1. Identification of watershed factors that influence early spring nutrient losses to agricultural streams.	June 2019
2. Identification of factors affecting cover crop performance for retaining P, N and water during early spring.	June 2019
3. Develop a publicly available water quality database and peer reviewed publications.	June 2019

Activity 2: *Development of BMPs to reduce early season nutrient export.* **Budget: $105,683**

Data from field monitoring and lab experiments will be used to calibrate and, if necessary, modify the SWAT model. Simultaneously, we will select and/or design new BMPs that have a high likelihood of reducing early season inputs of nutrients to streams, based on literature review, workshops with farmers and Extension agents, and discussion among academic colleagues. We will evaluate the capacity of each BMP to reduce nutrient loadings (soluble P, total P, and nitrate) in agricultural runoff in early spring under a range of weather conditions (high/low snowpack, etc.) and then, the reduction of early spring nutrient loads with the cumulative adoption of these BMPs at the watershed scale.

Outcome	Completion Date
1. An Extension report on BMP selection to reduce snowmelt & annual nutrient exports to streams in agricultural settings.	Jan. 2019
2. Workshops in farm-related settings, to convey findings to farmers and watershed managers.	March 2019
3. Presentations of findings at several state conferences & peer reviewed publications	June 2019

III. PROJECT STRATEGY

A. Project Team/Partners

We will work in an informal partnership with the Shell Rock Watershed District, which will help us with installation of winter flow measurement devices, share their monitoring data on tile drains, ditches, and streams draining into Albert Lea Lake. We will also partner with SROC, utilizing some of their permanent plots for runoff measurements.

B. Project Impact and Long-Term Strategy

Because the early spring period now appears to contribute a major fraction of annual P loadings, and especially soluble P, in many agricultural watersheds, new types of BMPs will be needed to meet water quality goals. Our proposed study will be a major step in this direction, and will set the stage for further studies by identifying BMPs that will likely work – based on SWAT modeling – in early spring. We are also proposing a study to the US Department of Agriculture that would allow us to expand the scope of the proposed LCCMR study, especially with respect to detailed mechanisms of nutrient mobilization. If our USDA proposal were successful, its project period would be 2017 to 2021. As the model-based selection process matures, we will also look for opportunities to implement several types of BMPs that appear to be (based on SWAT modeling) the most likely candidates for successful reduction of soluble nutrients during early spring and throughout the year.

C. Timeline Requirements

The three-year project period will be sufficient for the work proposed. The three-year period is needed because we need a first year of data to modify the SWAT model, and then two years to validate (test) it. Selection of candidate BMPs (for controlling soluble nutrients) will be done in year 2, and SWAT model predictions of these BMPs will start in year 2 and proceed through the middle of year 3, with the last six months reserved for synthesis of data, reporting, etc.

2016 Detailed Project Budget

Project Title: Reducing early spring nutrient losses from farmland

IV. TOTAL ENRTF REQUEST BUDGET 3 years

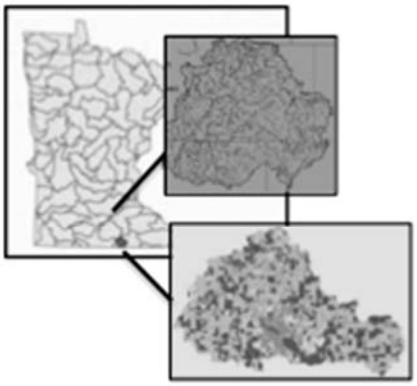
BUDGET ITEM	AMOUNT
Personnel:	
Larry Baker, PI, self-supporting, 3 months per year (75% salary/25% fringe benefits) - he will lead the overall effort	$ 120,364
Jacques Finlay 0.5 month per year (75% salary/25% benefits) - he will lead the water quality analysis task	$ 20,828
Brett Dazell - 3 months per year (75% salary/25% benefits) he will do the SWAT modeling	$ 54,582
Lab technician - 4 months per year (salary/ % benefits) - will conduct analyses	$ 42,423
Field technician - 1 month per year (salary%/ %benefits) - will assist with the plot funoff studies	$ 16,573
Undergraduate students (100% salary) to assist in the field sampling and lab analysis	$ 21,851
Graduate research assistant - 50% time (% salary/ % benefits) - will be responsible for collecting and analyzing water quality samples and interpreting results	$ 134,322
Contracts:	
Lab services for analyses of isotopes at external lab	$ 10,000
Equipment/Tools/Supplies:	
Laboratory (reagents) $13,000 and field equipment (flow meters, construction materials for building samplers, carboys, etc.) $10,000	$ 23,000
	$
Travel:	
We will need to make about 15 trips per year to the study region, mostly to collect snowmelt samples. "Short trips" (7 per year) will take 2 days, about 400 miles of driving ($50/day rental + 0.21/mile = $234/trip), plus 1 night of lodging for 2 on each trip (est. $100/room per night x 2 = $200/trip), plus per diem (1 full day+breakfast/lunch = 46 + 34 = $80/person x 2 = $160/trip), for a total of $593/trip x 7 = $4151/year; for all 3 years = $12,452; 8 longer trips (for more involved field measurements, with 3 people) in years 1 and 2 only will require 4 days; costs are $234 for rental and mileage + (100 x 2 x 4 = 800 for lodging) + 3 days per diem x 3 x 46 = $414, for a total of $1448 per trip x 8 trips x 2 years = $23,168 total. Total for in-state travel = $35,620	$ 35,620
Registration to present findings at Minnesota Water Resources Conference (or similar i-state conferences) $500/conference attendee; 1 in year 1, 2 in year 2 and 3 in year 3 - $3,000	$ 3,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 482,563

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:		
Indirect Costs/Facilities and Administration (52%)	$ 223,169	
Funding History:		
Remaining $ From Current ENRTF Appropriation:	N/A	

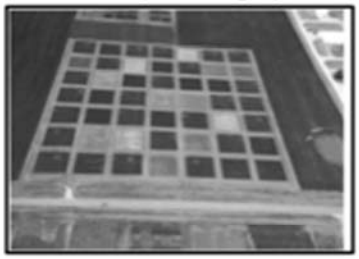
Most nutrient-impaired streams are in the southern part of the state (from MPCA)

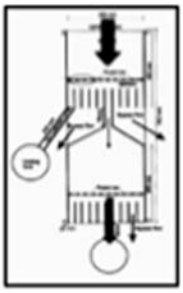
GOALS
(1) Determine the importance of early season runoff P among several agricultural watersheds (below)
(2) Develop best management practices to reduce early season runoff P.

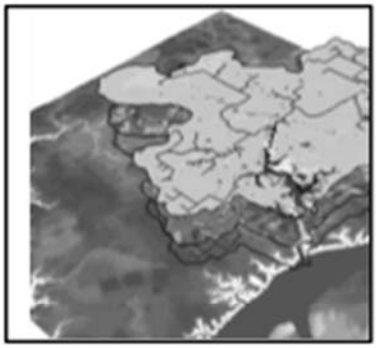


Activity 1: Year-round stream monitoring would occur in the Le Sueur (top) and Albert Lea Lake (bottom) watersheds.

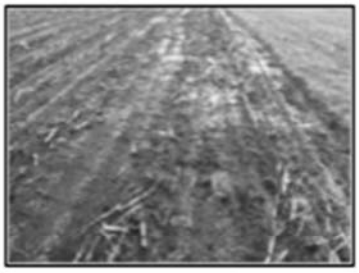
Activity 1 (continued): Plot and field level runoff studies be conducted at the Southern Research and Outreach Center (lower left)) using "dustpan" collectors (lower right).







Activity 2. Example of a graphic from the SWAT model we would be using.



Activity 2 (continued): Cover crop experiment, one of several types of BMPs that would be evaluated.

Outcomes
- Workshops with user groups
- Extension report
- Presentations at state-wide conferences

PROJECT MANAGER QUALIFICATIONS

The project will be led Dr. Lawrence Baker, a Research Professor in the Department of Bioproducts and Biosystems Engineering. Much of his research examines nutrient flows and balances for both urban and agricultural systems, often leading highly interdisciplinary teams. He has also studied natural treatment systems (wetland, groundwater recharge, etc.), which are closely analogous to agricultural BMPs. One of his recent studies was a very detailed P balance for the three watersheds draining into Albert Lea Lake.

He will lead an interdisciplinary team that includes a hydrologist (Dr. John Nieber), a biogeochemist/stream ecologist (Dr. Jacques Finlay), and water quality modeler (Dr. Brent Dalzell). All team members have experience working on agricultural water quality problems. Baker has worked extensively with team members Nieber and Finlay, and Drs. Finlay and Dalzell currently collaborate on several projects, including a study of the Le Sueur River.

The project will be conducted at the University of Minnesota, one of the country's leading agricultural research and outreach universities. Water analyses will be conducted in Dr. Finlay's Lab in the Department of Ecology, Evolution, and Behavior. Runoff plots studies will be done at the Southern Research and Outreach Center in Waseca (funds are included for technician support there), in collaboration with the Director, Forrest Izuno. Watershed monitoring will be conducted in collaboration with the Shell Rock River Watershed District (SRRWSD) for the Albert Lea Lake watersheds and the USGS (for the Le Sueur River watersheds). Team members Baker and Nieber have previously worked with the SRRWSD and Finlay has worked with the USGS. Isotopic analysis (N-15) will be done through an external contract.

Project management will include regularly meetings with faculty, graduate students, and staff at roughly monthly intervals. We will develop field teams for winter/early spring stream sampling and for runoff plot study sampling. Dr. Dalzell will coordinate the SWAT modeling. Baker will coordinate the BMP design workshops. A project web page will be developed early in the project, to keep the stakeholder community up to date on early findings. Project data will be archived with metadata, allowing others to use the data in future studies.