

**Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 057-B

Preventing Nitrate Contamination of Groundwater Using Perennial Grains

Category: B. Water Resources

Total Project Budget: \$ 759,312

Proposed Project Time Period for the Funding Requested: 2 years, July 2018 to June 2020

Summary:

Establish and monitor 120 acres of intermediate wheatgrass (Kernza), a new perennial grain crop, in vulnerable wellhead protection regions of Minnesota to profitability reduce nitrate leaching to drinking water.

Name: Heidi Peterson

Sponsoring Organization: Minnesota Department of Agriculture

Address: 625 Robert Street North
Saint Paul MN 55155

Telephone Number: (651) 201-6014

Email heidi.peterson@state.mn.us

Web Address www.mda.state.mn.us

Location

Region: Statewide

County Name: Fillmore, Olmsted, Pipestone, Wadena

City / Township:

Alternate Text for Visual:

A conceptual diagram indicating how nitrogen can leach from annual crops, and how perennial grains can reduce nitrate leaching and subsequent contamination of groundwater and drinking water.

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

PROJECT TITLE: Preventing nitrate contamination of groundwater using perennial grains

I. PROJECT STATEMENT

Annual row-crop production on coarse textured soils above shallow aquifers contributes to nitrate leaching and drinking water contamination. Preventing nitrate contamination through innovative land-use practices could be a more cost-effective method to protecting groundwater. Converting row-crop agriculture to perennial cover is known to reduce nitrate leaching; however, converting annual crops to perennials is rarely an economically viable solution to improve water quality, until now. Almost two decades of traditional plant breeding (non-GMO) has resulted in a new perennial grain crop from intermediate wheatgrass (IWG) called Kernza®. The University of Minnesota has partnered with The Land Institute (a non-profit from Kansas) to develop IWG into a new perennial grain crop, which requires fewer pesticides since it is resistant to most wheat diseases and crop pests. IWG has a deep, dense root system that filters nitrate from soil water before it pollutes groundwater. **This project will establish production-scale fields of IWG to demonstrate and confirm that reductions in nitrate leaching below the perennial crop can reduce nitrate in groundwater compared to annual row crops in vulnerable wellhead catchment areas.**

This project will be Phase 1 (2 years) of a long-term (6-10 years) study to reduce groundwater nitrate contamination in high-risk, wellhead protection areas using IWG. Phase 1 will establish a network of instrumented IWG demonstration and research fields at three diverse locations to measure water and soil quality improvements compared to an annual row-crop. The three locations and partnering entities are:

- **Lincoln-Pipestone Rural Water** (LPRW) land in a highly vulnerable wellhead protection area (pumps 1.8 billion gallons of water annually to 36 municipalities and rural residents in a 10 county region).
- **City of Chatfield** (Olmsted and Fillmore counties) Karst soil land owned by the city and a private party.
- **Central Lakes College** managed farmland (Staples, Wadena County) in the Central Sands Region with coarse-textured soil vulnerable to nitrate leaching. This land typically has low annual crop yield unless irrigated.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Establish IWG fields for demonstration, economic analysis and outreach events Budget: \$262,021

Establish approximately 120 acres of IWG within three wellhead protection areas considered high priority for protection by MDH and MDA. Collect yield and economic data to develop IWG enterprise budgets. Host annual field day/demonstrations to showcase production-scale IWG fields to farmers, and local business end-users (e.g. bakeries, restaurants, breweries). Use IWG fields as field labs for K-12 and undergraduate education.

Outcome	Completion Date
1. Planting 120 acres of IWG for grain production and water quality	July 1, 2018
2. Enterprise budgets for IWG based on market opportunities in the three project regions	June 30, 2020
3. Demonstration programs for educating stakeholders and students about IWG	June 30, 2020

Activity 2: Initiate field instrumentation and data collection of IWG water studies Budget: \$372,602

Replicated experimentation to measure nitrogen use dynamics and hydrology beneath IWG and annual row crops complete with lysimeters, sampling wells, and soil moisture sensors. Collect soil nitrate data at various depths, measure root growth and turnover, measure crop yields, and report baseline data.

Outcome	Completion Date
1. Report soil water nitrate vulnerable to leaching below IWG and annual crops	June 30, 2020
2. Report crop yield, water use, groundwater infiltration rates, and water table depth	June 30, 2020
3. Develop nitrogen use budget for the early production phase of IWG	June 30, 2020

Activity 3: Develop statewide nitrate leaching model related to land use in Minnesota Budget: \$ 124,689

Apply empirical research data to parameterize a crop simulation and water balance model to simulate IWG production on all farm acres in designated wellhead protection areas to identify when and where it is most economical to replace or accompany annual crops with perennials to prevent nitrate leaching to groundwater.

Outcome	Completion Date
1. Updated crop simulation and water balance models for predicting IWG production.	June 30, 2019
2. Watershed planning maps showing where implementing IWG can improve water quality	June 30, 2020
3. Estimate time requirements for IWG to reduce nitrate concentration to safe levels	June 30, 2020

III. PROJECT STRATEGY

A. Project Team/Partners:

No ENRTF Funding:

Minnesota Department of Agriculture (MDA): Dr. Heidi Peterson will serve as project manager. Mr. Bruce Montgomery, Ms. Margaret Wagner and Mr. Luke Stuewe will assist with project coordination and outreach.
Minnesota Department of Health (MDH): Mr. Randy Ellingboe will advise on project objectives and deliverables.
Minnesota Rural Water Association (MRWA): Mr. Aaron Meyer and Mr. Scott Hanson will advise on project objectives and deliverables.

ENRTF Funded Partners:

University of Minnesota, St. Paul: Drs. Jacob Jungers, Craig Sheaffer and Jessica Gutknecht will oversee the experiments including crop agronomics, plant and soil sampling, data analysis, and modeling.
United States Geological Survey (USGS): Mr. Jared Trost will oversee the hydrological sampling and modeling.
Agricultural Utilization Research Initiative (AURI): Mr. Michael Sparby and Mr. Al Doering will conduct lab analysis of crop biomass and grain samples related gluten quality. Contribute to education/outreach events.
Central Lakes College (CLC): Mr. Keith Olander will conduct lab analysis of water quality samples and manage field research in Wadena County. Coordinate education/outreach events at CLC.
City of Chatfield: Mr. Brian Burkholder will coordinate land arrangements in Fillmore and Olmstead counties.
Lincoln Pipestone Rural Water (LPRW): Mr. Jason Overby will coordinate farmer involvement and land-use that will be provided through LPRW.

B. Project Impact and Long-Term Strategy: Four million Minnesotans depend on groundwater for drinking water. This two-year project will initiate the framework and establishment of an IWG research, production, and education network to allow the project team an opportunity to secure federal and private funds for an additional four to six year project. It balances the need for implementation and continued research on a new perennial grain crop in Minnesota. In the short-term, citizens of the project communities will directly benefit through reduced nitrate leaching to their drinking water source; long-term impacts could be statewide as this project will demonstrate the environmental benefits and economic viability of IWG to Minnesota’s farmers and landowners. This unique opportunity is timely because General Mills, Inc. has recently committed to using IWG as a food ingredient¹, which will catalyzed the market. IWG fields established for this project will be used to demonstrate economic viability and to introduce this new crop into rural Minnesota communities during educational field days. Fields will be managed as full-scale production fields; from which we will collect both water quality and economic data (e.g. cost savings from reduced chemical inputs, tillage, and annual reseeding) that will be used to produce enterprise budgets for IWG profitability.

C. Timeline Requirements: IWG will be planted in the fall of 2017 and instrumented in the spring of 2018 using outside funding. Data collection will begin in summer of 2018 and continue through 2019. Field days and demonstration events will occur in 2018 and 2019. Results will be available in 2020.

2018 Detailed Project Budget

Project Title: Preventing nitrate contamination of groundwater using perennial grains

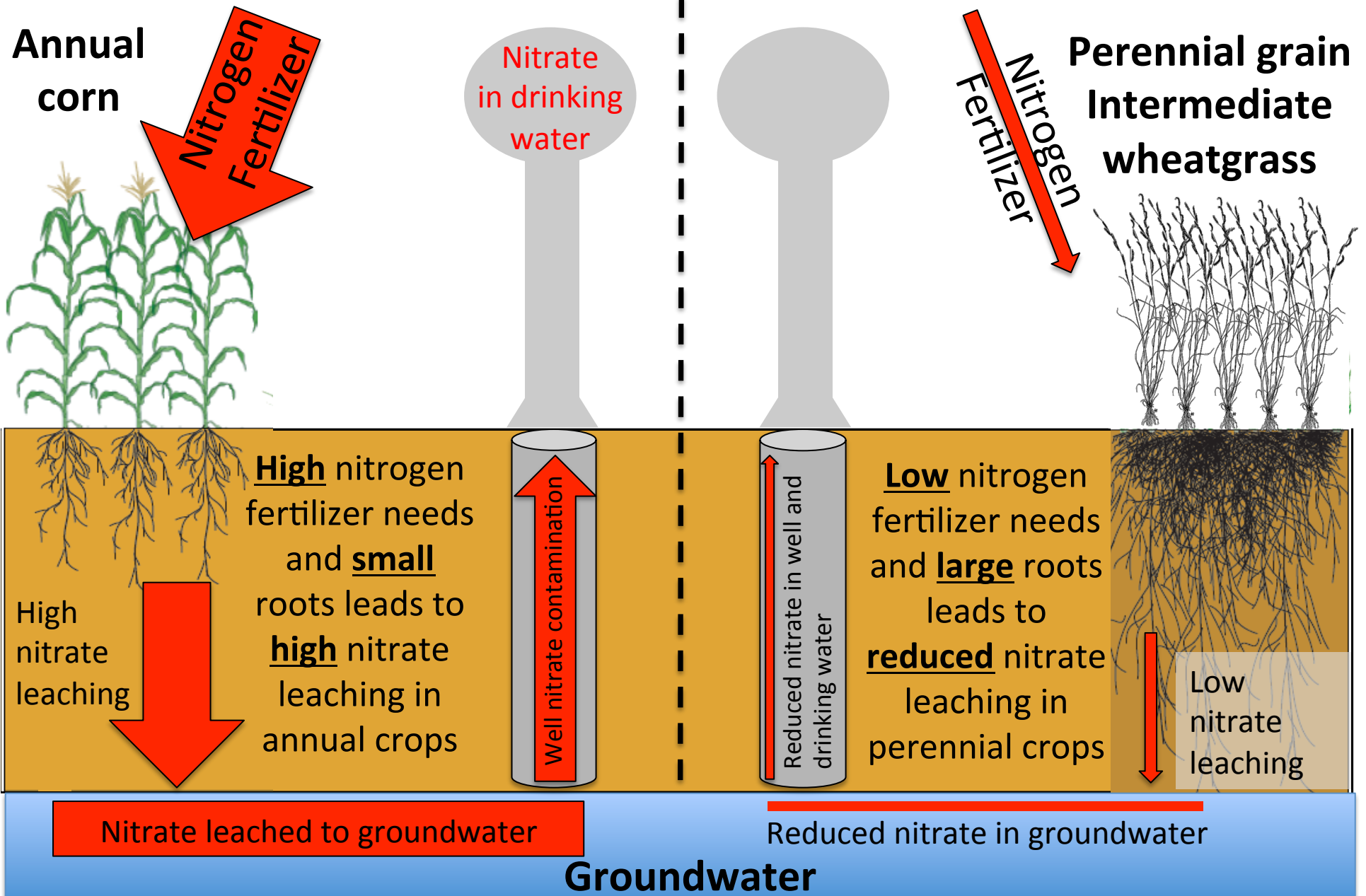
IV. TOTAL ENRTF REQUEST BUDGET 2 years

BUDGET ITEM	AMOUNT
Personnel: NA	\$ -
Professional/Technical/Service Contracts:	\$ -
University of Minnesota (UMN; St. Paul) - Kernza field management, data collection and management, field day organization, analysis of soil, biomass, and yield, samples. 1.0 FTE plot technician for 2 years (\$115,625; 21% fringe), 1.0 FTE post-doc for 2 years (\$120,162; 18% fringe), Undergraduate interns (\$30,000). Equipment/Tools/Supplies = \$31,080 (Lysimeters - 96 @ \$80 each, soil moisture sensors - 288 @ \$150 each, groundwater sample wells - 6 @ \$500 each, well transducers - 6 @ \$1500 each). Sample Analysis = \$46,784 (Soil total N - 432 @ \$4 each, Soil extractable N - 216 @ \$5 each, soil physical properties - 72 @ \$34 each, plant C/N - 720 @ \$4 each, soil water nitrate - \$720 @ \$9 each, bromide tracer supplies - \$20000). Land rental - \$48000 (120 acres @ \$200 per acre per year). Travel = \$13070 (40 trips to/from St. Paul and project research sites @ \$0.535/mile, 40 nights lodging at project sites @ \$91/night, 80 days per diem for fieldwork and travel @ \$51/day).	\$ 404,721
Central Lakes College (CLC; Staples) - Oversight of experiments, data collection and management, analysis of soil water samples. 1.0 FTE technician for 2 years (\$107,868; 25% fringe), undergraduate interns (\$30,000). Travel = \$2500 (4763 miles at \$0.535/mile). Education and outreach materials (\$2,000).	\$ 144,868
United States Geological Survey (USGS; Mounds View) - Hydrology data management and modeling. 0.39 FTE hydrologist and 0.17 FTE technician for 2 years (\$122,500). Travel = \$2500 (4763 miles at \$0.535/mile). Supplies = \$500 (lab and fieldwork disposables). Vehicle rental = \$1,215. Publication expenses = \$2,500.	\$ 129,215
Agricultural Utilization Research Institute (AURI; Waseca) - Grain and biomass analysis, field day demonstrations. 0.2 FTE Process scientist for 2 years (\$45,760), 0.1 FTE outreach coordinator for 2 years (\$22,880), 0.03 FTE project management team (\$6,864). Travel = \$5,000 (for visiting labs and field locations for sampling and outreach events 9526 miles at \$0.535/mile).	\$ 80,508
Equipment/Tools/Supplies:	NA - In service contracts
Travel:	NA - In service contracts
Additional Budget Items: NA	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 759,312

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period: NA	\$ -	
Other State \$ To Be Applied To Project During Project Period: NA	\$ -	
In-kind Services To Be Applied To Project During Project Period: MDA match of \$15,000 for H. Peterson time. USGS match of \$91,850. UMN match of \$8,410 for C. Sheaffer, J. Gutknecht, and J. Jungers time.	\$ 115,260	Secured
Past and Current ENRTF Appropriation: None	\$ -	
Other Funding History: UMN Institute for Renewable Energy and the Environment - \$600,000: Funded the preliminary, plot-scale lysimeter study showing that intermediate wheatgrass has less nitrate in the soil water compared to corn. MDA + Forever Green - \$98,405: Funding to study agronomic aspects of intermediate wheatgrass grain production. Perennial Agriculture Project - \$100,712: Funded additional environmental and agronomic studies on intermediate wheatgrass.	\$ 799,117	Secured

Using the new perennial grain crop intermediate wheatgrass (Kernza) to reduce nitrate leaching to groundwater in vulnerable wellhead protection areas.



Manager Qualifications

Heidi Marie Peterson

EDUCATION

Ph.D. in Biosystems and Agricultural Engineering, 2011

University of Minnesota, St. Paul, Minnesota

Dissertation Title: Estimating Renewable Water Flux from Landscape Features

M.S. in Agronomy, 2003

Purdue University, West Lafayette, Indiana

Area of Specialization: Pedology and Land Use

Thesis Title: Soils and Onsite Wastewater Treatment System Performance in Northern Indiana

B.S. in Natural Resources and Environmental Science, 2000

Purdue University, West Lafayette, Indiana

RESEARCH EXPERIENCE

Research Scientist 2 - Impaired Waters Technical Coordinator

Minnesota Department of Agriculture, **2013 - Present**

- Lead technical expert on best management practices (BMPs) to address impaired waters issues in agricultural landscapes
- Identify, coordinate and implement Clean Water Funds (CWF) research (*approx. \$2 million, biannually*) and technical assistance projects (*approx. \$2.5 million, biannually*)
- Manage numerous (~10) CWF research projects with various focus areas including cover crops, sediment budgets, multi-purpose drainage, precision conservation, and nutrient management
- Chair the Interagency Research Team and NRCS Watershed Subcommittee, active participant on Interagency Watershed Restoration and Protection Strategy Implementation Team (WRAPs), Statewide Soil Health Team, and Drainage Management Team

Adjunct Assistant Professor – Department of Bioproducts & Biosystems Engineering

University of Minnesota, **2014 – Present**

- Member of graduate faculty
- Collaborate on department research projects and grant proposals
- College of Food, Agriculture and Natural Resources (CFANS) Mentor
- Reviewer for Canadian Water Resources J., Water Resources Management (WARM), J. Env. Qual., Hydrological Processes, J. of Hydrology, and Inter. J. of Geographical Information Science

PUBLICATIONS

(Maiden name is Stout)

Peterson, H.M., L.A. Baker, J.S. Ulrich, D. Bruening, J.L. Nieber and B.N. Wilson. 2016. Agricultural P Balance Calculator- A tool for watershed planning. *J. Soil Water Conserv.* In press.

Powers, S.M., T.P. Burt, N. Chan, J.J. Elser, P.M Haygarth, N.J. K. Howden, H.P. Jarvie, **H.M. Peterson**, J. Shen, F. Worrall, and A.N. Sharpley. 2016. Long-term accumulation and transport of anthropogenic phosphorus in three river basins. *Nature Geoscience*. doi:10.1038/ngeo2693

Peterson, H.M., J.L. Nieber, R. Kanivetsky, and B. Shmagin. 2013. Regionalization of landscape characteristics to map hydrologic variables. *J. Hydroinformatics*. doi:10.2166/hydro.2013.051

Peterson, H.M., J.L. Nieber, R. Kanivetsky, and B. Shmagin. 2012. Assessing water resources sustainability: application of the watershed characteristics approach. *Water Res. Management*. doi:10.1007/s11269-012-0232-9