Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2019 ENRTF Work Plan (Main Document)

Today's Date: August 27, 2018

Date of Next Status Update Report: March 1, 2020

Date of Work Plan Approval:

Project Completion Date: June 30, 2022

Does this submission include an amendment request? _No_

PROJECT TITLE: Setting realistic nitrate BMP goals in southeast Minnesota

Project Manager: John L. Nieber

Organization: University of Minnesota

College/Department/Division: College of Food, Agriculture and Natural Resources

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Location: Southeast Minnesota

Total Project Budget: $350,000

Amount Spent: $0

Balance: $350,000

Legal Citation: M.L. 2019, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

I. PROJECT STATEMENT:

This project will provide tools for improving the ability of state agencies to assess how well nitrate reduction BMPs are working in southeastern Minnesota. Nitrate contamination of groundwater is a serious concern because of the direct impact on drinking water safety and resulting nitrate concentrations in the streams into which groundwater discharges. The karst region of southeastern Minnesota, and the sandplain region of central Minnesota are both areas where the impact is most severe due to the close connection between surface conditions and aquifers in those regions. Reducing nitrate contamination of groundwater aquifers has becoming a priority in the state because of the need to protect drinking water quality (MDA Draft Groundwater Protections Rule), and also to meet the nutrient reduction goals set by the MPCA for 2025 (25% nitrate reduction) and 2050 (45% nitrate reduction).

Various degrees of nitrate contamination are present in the four major aquifers in southeastern Minnesota (Galena, Prairie du Chien, Jordan, and Ironton-Galesville aquifers), with the shallowest, the Galena and Prairie du Chien having the highest contamination. With time nitrate is moving into the deeper aquifers (Jordan, and Ironton-Galesville aquifers). The deeper aquifers are important sources of drinking water in the region, while all four aquifers discharge to surface streams at various locations within the region.

Efforts are underway in the region to reduce nitrate leaching to groundwater through the use of improved nitrogen best management practices, but assessments as to whether those practices are being effective within the region is not clear because of the difficulty to interpret collected monitoring data. Some data shows increasing trends for nitrate concentrations, while other data shows decreasing trends. A main part of the problem with water-quality interpretation has to do with the time required for water containing nitrate to travel through the groundwater system before discharging to streams. More detailed information about the age of water in these aquifers and the time of travel of water within the aquifers is needed to be able to provide improved assessments of trends in nitrate concentrations throughout the region.

II. OVERALL PROJECT STATUS UPDATES:

First Update March 1, 2020

Second Update September 1, 2021

Third Update March 1, 2021

Fourth Update September 1, 2022

Fifth Update March 1, 2022

Final Report between project end (June 30) and August 15, 2022

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1

Title: Develop decadal resolution age-dating of water in the four major aquifers in southeast Minnesota

Description: Water samples will be collected mostly from wells and a few selected springs within the area represented by the inset map on the illustration. Water samples will be analyzed for determining sulfur-hexafluoride, chlorofluorocarbons, tritium and helium-3 concentrations. The sampling and analyses need to be done with extreme expert care due to the low concentrations of these elements and the need to avoid sample contamination. These data will be used to quantify the age of the aquifer water with an accuracy of ± 10 years, a much higher resolution than currently available. Additional sampling of streamflows, aquifers and springs will be conducted to measure chloride, nitrate, and the stable isotopes of oxygen and hydrogen. These data will be used to quantify the source of water (which aquifer the flows originate from) in the streamflows, and to help quantify travel time of water in the aquifers.

ACTIVITY 1 **ENRTF BUDGET: $150,000**

Outcome	Completion Date
1. Quantified age of groundwater in the major aquifers in southeastern Minnesota. The time resolution will be $\pm$ 10 years.	10/31/2020
2. Estimates of the travel time distributions of water in the major aquifers based on the chemical analyses.	03/31/2021

First Update March 1, 2020

Second Update September 1, 2021

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ACTIVITY 2

Title: Determine travel times for flows within the major aquifers to streams based on hydraulic analyses.

Description: Springshed boundaries of the four major aquifers will be delineated using geological information derived from the County Geologic Atlases available for the region. A groundwater flow model will be constructed using the detailed geological information and applied to calculation of travel time within the individual aquifers. The model will be formulated to be able to include the complex fracture flow and dissolution-channel flow characteristic of groundwater flow in the karst region of the southeast. The model will be calibrated to match recorded flows and nitrate concentrations emerging from sampled springs. The calibrated model will then be able to be used with monitoring data to assess the impact of existing BMPs on water quality.

ACTIVITY 2 **ENRTF BUDGET: $134,000**

Outcome	Completion Date
1. Maps illustrating calculated travel time distributions of water within the four studied aquifers.	06/30/2021
2. Interpretation of the aquifer sources of water in streamflows and an assessment of the current trends in nitrate concentrations from each source.	10/31/2021
3. Calibrated groundwater flow model. The calibrated model will be documented and made ready for use by state agencies and consultants.	03/31/2022

First Update March 1, 2020

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Third Update March 1, 2021

Fourth Update September 1, 2022

Fifth Update March 1, 2022

Final Report between project end (June 30) and August 15, 2022

ACTIVITY 3

Title: Develop tools for estimating lag-time for nitrate transport through major aquifers, and for interpreting monitoring data for evaluation of BMP effectiveness.

Description: A mathematical modeling tool will be developed for use in applying travel time distributions for groundwater for the determination of the lag-time required for nitrate to travel from the land surface to the aquifer discharge point. This model will be supplemented by '**smart machine/learning machine**' technologies to improve the ability to quickly, efficiently and accurately interpret flow and chemical monitoring data.

ACTIVITY 3 **ENRTF BUDGET: $66,000**

Outcome	Completion Date
1. Report outlining the features of the modeling tools and results of testing the tools for the major aquifers in southeastern Minnesota. The modeling tools will be provided to state agencies and available on-line for use by consultants and educators.	03/31/2022

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Third Update March 1, 2021

Fourth Update September 1, 2022

Fifth Update March 1, 2022

Final Report between project end (June 30) and August 15, 2022

IV. DISSEMINATION:

Description: The results of the proposed research will be reported in the peer-reviewed literature, and will be presented at scientific meetings such as the annual Minnesota Water Conference, forum(s) at the Minnesota Department of Agriculture, and to national/international audiences at meetings such as those hosted by the American Geophysical Union. The proposed project has Mr. Kevin Kuehner as a collaborator from the Minnesota Department of Agriculture and he is currently managing a project on nitrate reduction BMPs in the South Branch of the Root River. With Kevin as a collaborator it will be possible for the practical applications of the results of the proposed project to be presented to farmer/producers he is working with within the region. In addition, the project team, through Dr. Joe Magner is making connections with crop consultants who have an interest in the successful outcome of the proposed project. Interactions with a group of crop consultants with regard to fertilizer management will help to increase the impact of the proposed project results.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgement Guidelines.

First Update March 1, 2020

Second Update September 1, 2021

Third Update March 1, 2021

Fourth Update September 1, 2022

Fifth Update March 1, 2022

Final Report between project end (June 30) and August 15, 2022

V. ADDITIONAL BUDGET INFORMATION:

A. Personnel and Capital Expenditures

No ENRTF funding required:

Dr. John L. Nieber, Professor, Dept. of Bioproducts and Biosystems Engineering. Serve as project principal investigator.

Dr. David Mulla, Professor, Dept. of Soil, Water and Climate. Assist with assessments of chemical leaching to groundwater within the region of study.

Dr. Bruce Wilson, Professor, Dept. of Bioproducts and Biosystems Engineering. Assist with the probabilistic, statistical and time series analyses of flow and chemical data.

ENRTF funding required:

Dr. Robert Tipping, Minn. Geol. Survey. Lead effort on water chemical sampling, and historical chemical data compilation and analysis.

Dr. Anthony Runkel, , Minn. Geol. Survey. Lead the effort on aquifer identification, characterization, and hydrogeological assessments.

Dr. Joseph Magner, Professor, Dept. of Bioproducts and Biosystems Engineering. Assist with interpretation of chemical tracer data.

Assistant Research Scientist, Professor, Dept. of Bioproducts and Biosystems Engineering. Manage field sampling and chemical analysis of samples.

Graduate Research Assistant, Univ. of Minn. Assist with all aspects of the project including field sampling, data analysis, and modeling.

Undergraduate Research Assistants, Univ. of Minn. Assist with all aspects of the project including field sampling and modeling.

Explanation of Capital Expenditures Greater Than $5,000:

Explanation of Use of Classified Staff:

N/A

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:

Enter Total Estimated Personnel Hours for entire duration of project: 6,840	Divide total personnel hours by 2,080 hours in 1 yr = TOTAL FTE: 3.3

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation:

Enter Total Estimated Contract Personnel Hours for entire duration of project: 1,726	Divide total contract hours by 2,080 hours in 1 yr = TOTAL FTE: 0.83

VI. PROJECT PARTNERS:

A. Partners outside of project manager's organization receiving ENRTF funding

Mr. Perry Jones, USGS. Develop the aquifer water age dating (decadal scale) using various chemical tracers.

B. Partners outside of project manager's organization NOT receiving ENRTF funding

Mr. Kevin Keuhner, Minnesota Dept. of Agriculture. Assist with data acquisition from field sites, and work with landowners associated with BMPs.

VII. LONG-TERM- IMPLEMENTATION AND FUNDING:

Setting realistic planning horizons for the time required to meet water-quality standards in aquifers and streams should account for the lag time that occurs between landuse improvement and water-quality response. This project will provide a framework for interpreting water-quality monitoring data (well data and stream data) to assess the effectiveness of established BMPs. The framework will be applicable to other contaminants such as pesticides. The results of the project will provide detailed groundwater flow information also useful to other environmental management activities such as well-head protection mapping. This project should be viewed as being a piece of a larger effort that should be initiated to map the lag-time for aquifers around the entire state of Minnesota. The project will also provide support for the training of one Ph.D. graduate student and several undergraduate students.

The topic of the project is one of national and international interest, with a broad variety of scientists having interest. It is expected that the project manager will continue to work with computer scientists and other hydrologists in developing the tools proposed to be developed within this project. Currently the project manager is collaborating with Dr. Vipin Kumar in the Department of Computer Sciences at the University of Minnesota on the application of smart machine/machine learning techniques applied to hydrologic modeling. The collaboration is funded by a small seed grant from the University of Minnesota Digital Technology Center and it is hoped that this will be carried forward to compete for federal funding to promote the work proposed in the LCCMR project. The ENTF funding is critical to the further development of this collaboration.

VIII. REPORTING REQUIREMENTS:

- Project status update reports will be submitted March 1 and September 1 each year of the project
- A final report and associated products will be submitted between June 30 and August 15, 2022

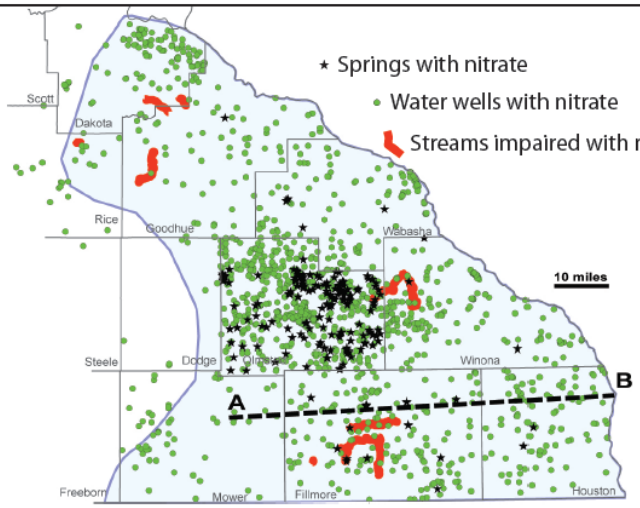
IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet. Accompanying the workplan.

B. Visual Component or Map.

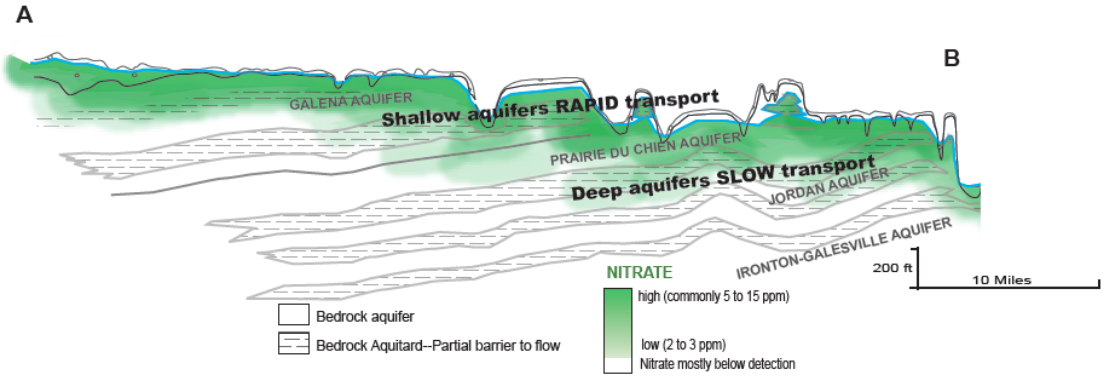
SETTING REALISTIC NITRATE BMP GOALS IN SOUTHEAST MINNESOTA

NITRATE AND OTHER CONTAMINANTS ARE COMMMON IN GROUNDWATER OF SOUTHEASTERN MINNESOTA



KNOWING THE RATE OF NITRATE MOVEMENT IS CRUCIAL FOR MEASURING THE EFFECTIVENESS OF BEST MANAGEMENT PRACTICES

NITRATE TRAVELS AT VERY DIFFERENT RATES THROUGH THE VARIOUS AQUIFERS



OUR PROJECT WILL CALCULATE THE TRAVEL TIMES FOR NITRATE THROUGH SE MINNESOTA AQUIFERS

PROJECT RESULTS WILL PROVIDE A TOOL FOR WATER MANAGERS TO SET REALISTIC BEST MANAGEMENT PRACTICE GOALS

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2019 Budget Spreadsheet
Legal Citation:
Project Manager: John L. Nieber
Project Title: Setting realistic nitrate BMP goals in southeast Minnesota
Organization: University of Minnesota
Project Budget: $350,000
Project Length and Completion Date: 3 years; June 30, 2022
Today's Date: August 27, 2018

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 235,012	$ -	$ 235,012
Robert Tipping; Hydrogeologist/hydrogeochemist, Minnesota Geological Survey. Lead effort on water chemical sampling, and historical chemical data compilation and analysis. 72.6% salary, 27.4% fringe. 13% of full time, soft money, 7/1/19-6/30/22.			
Anthony Runkel; Hydrogeologist, Minnesota Geological Survey. Lead the effort on aquifer identification, characterization, and hydrogeological assessments. 72.6% salary, 27.4% fringe. 13% of full time, soft money,7/1/19-6/30/22.			
Joseph Magner; Hydrogeologist, University of Minnesota, Department of Bioproducts and Biosystems Engineering. Assist with effort on travel time estimation and evaluation of geochemical analysis results. 66.5% salary, 33.5% fringe. 8% of full time, soft money, 7/1/19-6/30/21.			
Graduate Research Assistants; One Ph.D. Assist with all aspects of the project. 61% salary, 39% fringe. 50% of full time, 7/1/19-6/30/22.			
Senior Scientist, University of Minnesota, Department of Bioproducts and Biosystems Engineering. Manage field sampling activitiesdel. 72.6% salary, 27.4% fringe. 8% of full time, soft money, 7/1/19-6/30/22.			
Undergraduate Research Assistants; Number to be determined. Assist with all aspects of the project. 100% salary, 0% fringe. 100% of full time in summer, 25% full time in school year, 7/1/19-6/30/21.			
Professional/Technical/Service Contracts	$ 93,800	$ -	$ 93,800
Age-dating of water samples. Subcontract with the USGS, Minnesota Water Science Center Office. The water samples will be tested for elements that are extremely difficult to analyze, and the sampling itself requires a very specific skill possessed by a very limited group of scientists. Water sample analysis cost, for 10 samples and 1 replicate, four chemical constituents (sulfur-hexafloride, chloroflorocarbon, tritrium and helium-3) analyzed for each sample, is $21,890 ($1,990 per sample). Cost for sample collection and analysis of sample analytical results for age-dating of water, $89,709; this includes travel costs, salary for USGS researchers, and equipments for water sampling.			
Equipment/Tools/Supplies	$ 2,000	$ -	$ 2,000
Miscellaneous lab supplies need for bottles for collecting samples, batteries on equipment, other misc supplies, repairs and calibration of equipment, etc.			
Capital Expenditures Over $5,000	$ -	$ -	$ -
Fee Title Acquisition	$ -	$ -	$ -
Easement Acquisition	$ -	$ -	$ -
Professional Services for Acquisition	$ -	$ -	$ -
Printing	$ -	$ -	$ -
Travel expenses in Minnesota	$ 5,000	$ -	$ 5,000
Travel will be limited to visiting field sites to collect water samples and monitor streamflows, and to participate in meetings with agency staff and stakeholders to present results of the project activities.			
Other; chemical analysis	$ 14,188	$ -	$ 14,188
	$ 350,000	$ -	$ 350,000
COLUMN TOTAL			

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
		$ -	$ -	$ -
Non-State:	pending	$ 37,043	$ -	$ 37,043
State:	secured	$ 168,153	$ -	$ 168,153
In kind:				

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
				$ -
Current appropriation:				
Past appropriations:				