Environment and Natural Resources Trust Fund

2022 Request for Proposal

General Information

Proposal ID: 2022-116

Proposal Title: Rainy River Drivers of Lake-of-the-Woods Algal Blooms

Project Manager Information

Name: Anna Baker

Organization: US Geological Survey - Upper Midwest Water Science Center

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Project Basic Information

Project Summary: Guiding management for reduction of phosphorus inputs to Lake of the Woods by examining sources, mobility, and storage of sediment-bound phosphorus within Rainy River.

Funds Requested: $683,000

Proposed Project Completion: September 30 2025

LCCMR Funding Category: Water Resources (B)

Project Location

What is the best scale for describing where your work will take place?

Region(s): NE, NW,

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Lake of the Woods (LoW) is a treasured recreational area and economic resource for northern Minnesota, providing critical habitat and generating tens-of-millions of dollars of tourism revenue annually. Despite major reductions in total-phosphorus (TP) concentrations entering LoW, its economic and ecological integrity is still threatened by excess phosphorus and harmful algal blooms. Historical loading has created a long-term source of phosphorus bound to lake-bottom sediments, which may re-enter the water column via geochemical release or wind mixing and resuspension. The Rainy River comprises approximately 80% of the total drainage area to LoW and contributes 45-75% of the TP. Previous studies have described phosphorus loads contributed by the Rainy River and its tributaries to LoW, but we lack detailed information describing the sediment-bound phosphorus that has accumulated through current and historical loading in this river network, and its potential to be released and transported. This study will show where sediment-bound phosphorus is stored in the Rainy River and its tributaries, and whether that storage is permanent or if it may become a long-term source. The results of this study are critical for local resource managers required to find targeted reductions in TP loading to reduce noxious algae in LoW.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

We will develop effective strategies for reducing phosphorus entering LoW by providing critical information describing how the Rainy River Basin, from tributaries to river mouth, acts as a source and sink for sediment-bound phosphorus. We will examine storage and mobility of sediment-bound phosphorus by mapping stream-bed fine-sediment deposits, collecting suspended-sediment from the Rainy River, its largest tributaries, and Fourmile Bay, and analyzing these sediments for phosphorus concentrations and potential for phosphorus binding and release. Long sediment cores will be collected in Fourmile Bay to examine the depositional history of sediment and sediment-bound phosphorus, and sediment traps will be used to collect suspended-sediment entering Fourmile Bay as well as sediment that is resuspended via mixing in this dynamic river-mouth. Data will quantify storage of phosphorus within Fourmile Bay and will characterize its potential for release to LoW. In all sampled locations, sediment chemistry will be paired with water chemistry to identify hotspots of phosphorus retention and release. These data represent critical missing information that will be used to improve existing remediation strategies developed by the Minnesota Pollution Control Agency (MPCA) and its partners for targeting phosphorus management across the 6,400 square mile Lower-Rainy River Basin and improving LoW water quality.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

We will identify hot-spots for sediment-bound phosphorus in the Rainy River, its tributaries, and Fourmile Bay. We will guide development of watershed-based management strategies for reducing phosphorus inputs to LoW by describing the distribution of stored sediment-bound phosphorus in the Rainy River, the relative inputs of sediment bound phosphorus from riverine sources, and the future potential for release of sediment-bound phosphorus from hot-spots. Mapped sediment-bound phosphorus deposits in the Rainy River and data describing contributions from its tributaries will pinpoint where management should be targeted to achieve the greatest reduction in nutrient pollution and improvement in LoW water quality.

Activities and Milestones

Activity 1: Characterization of sediment-bound phosphorus deposition and mobility in Rainy River and Lake of the Woods

Activity Budget: $513,000

Activity Description:
Investigation of sediment-bound phosphorus storage and transport through the Rainy River and tributaries to LoW will include mapping of streambed-storage of phosphorus and potential for its release. Sediment deposits will be mapped via side-scan-sonar and multi-frequency echo-sounder from International Falls to Wheelers Point and in a grid of transects in LoW (Fourmile Bay). Passive samplers at seven tributary locations and three Fourmile Bay locations will collect suspended sediment. All sediments will be analyzed for total phosphorus and properties that relate to the potential for binding and release of phosphorus to the water column. Water chemistry will be monitored continuously via towable sensors (pH, conductance, dissolved oxygen, turbidity), and water samples will be collected near the streambed coincident with sediment collection and analyzed for total- and dissolved-phosphorus, total-nitrogen and nitrate, chlorophyll-a, and total suspended solids. These data will define mechanisms for exchange of phosphorus between sediment and the water column. Long sediment cores will also be collected in Fourmile Bay to determine historical sediment and legacy phosphorus deposition and exchange in the mouth of the Rainy River. These data will be linked to prior studies in LoW to enhance understanding of potential for internal loading from current versus legacy nutrient pollution.

Activity Milestones:

Description	Completion Date
Survey, collect, and prepare sediment from gage locations and bed-sediment storage deposits in the Rainy River and Lake of the Woods (Fourmile Bay)	May 31 2024
Chemical analyses of sediment and water samples completed, and data prepared for analysis	September 30 2024
Identify hot-spots of sediment-bound phosphorus export and deposition	May 31 2025
Complete draft report and present results to stakeholders	September 30 2025

Activity 2: Evaluation of tributary contributions to sediment-bound phosphorus in Rainy River sediment deposits

Activity Budget: $170,000

Activity Description:
Water quality and suspended sediment chemistry will be evaluated for four tributaries to the Rainy River, and at three mainstem Rainy River locations including upstream International Falls and downstream at Wheeler's Point over a full year. Collection of water quality samples for total-suspended-solids, total and dissolved phosphorus, total nitrogen and nitrate, and chlorophyll-a will be paired with existing gaged streamflow data at each of seven locations to calculate nutrient and sediment loads. Suspended sediments will be collected via passive samplers at each gage location. These sediments will be analyzed for total phosphorus and extractable forms of phosphorus to evaluate how phosphorus is bound to sediment and its potential for release. Loss on ignition, particle size, and elemental concentrations of iron, aluminum, and calcium will also be evaluated as they relate to the binding of phosphorus to sediment. Equilibrium phosphorus concentration will be measured to determine the potential of these sediments to desorb phosphorus and act as a legacy source of pollution when deposited downstream. The chemistry of suspended sediment in transport and water chemistry from tributaries will contextualize the sediment and sediment-bound phosphorus in storage in the Rainy River and its impact on LoW.

Activity Milestones:

Description	Completion Date
Collect water and suspended sediment from all gage locations on the Rainy River and tributaries	May 31 2024
Complete water and sediment chemistry analyses, review and check data, analyze nutrient and sediment loads	September 30 2024
Complete draft report and present project results	September 30 2025

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Jesse Anderson	Minnesota Pollution Control Agency	Project management oversight - expertise in resource management and years of experience developing Lake of the Woods TMDL	No
Mike Kennedy, M.Ed.	Minnesota Pollution Control Agency	Project management oversight - expertise in resource management, overseeing Little Fork Watershed TMDL studies	No
Kevin Stroom	Minnesota Pollution Control Agency	Project management oversight - expertise in resource management and watershed biology	No
Dr. Faith Fitzpatrick	U.S. Geological Survey - Upper Midwest Water Science Center	Science leadership – expertise in fluvial geomorphology, stream evolution, and sediment transport	Yes
Dr. Adam Heathcote	St. Croix Watershed Research Station, Science Museum of Minnesota	Science leadership – expertise in lake biogeochemistry and plankton ecology, years of experience researching sediment and phosphorus deposition and algal bloom history and drivers in Lake of the Woods	Yes
Dr. Mark Edlund	St. Croix Watershed Research Station - Science Museum of Minnesota	Science leadership – expertise in aquatic biology and algae, years of experience researching sediment and phosphorus deposition and algal bloom history and drivers in Lake of the Woods	Yes
Sam Soderman	Koochiching Soil and Water Conservation District	Field and technical expertise and support	Yes
Phil Norvitch	Northern St. Louis Soil and Water Conservation District	Field and technical expertise and support	Yes
Mike Hirst	Lake of the Woods Soil and Water Conservation District	Field and technical expertise and support	Yes
Dr. Chris Parsons	Environment Climate Change Canada	Science collaboration – expertise in stream and watershed biogeochemistry	No

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this be funded?

The results from this LCCMR project will assist local partners implementing restoration and protection projects in the Rainy River Basin. Four local partner organizations (Lake of the Woods, Koochiching, Itasca, and North St. Louis Soil and Water Conservation Districts (SWCDs) on the US side of the basin will be engaged in the development of sediment/phosphorus reduction projects in various streams in the Rainy Basin and use project results to inform various project options for maximum effect on reductions. This project work is funded into the future by County-based Soil and Water Districts and the Minnesota Clean Water Legacy Act.

Project Manager and Organization Qualifications

Project Manager Name: Anna Baker

Job Title: Hydrologist

Provide description of the project manager's qualifications to manage the proposed project.

her career with USGS in Maryland, where she was involved with a diverse array of studies in water resources ranging from bioremediation of toxic contaminants to trends in nutrient loading to tributaries to the Chesapeake Bay to sediment sourcing studies in Maryland and Virginia. She served as a team organizational lead for the Fate and Bioremediation Team and Fluvial Geomorphology Team at the Maryland-Delaware-DC Water Science Center and managed a sediment laboratory where she oversaw several staff. Baker completed her masters at the University of Minnesota in Water Resources Science in 2018, where she studied sediment-phosphorus interactions in the Le Sueur River basin. Baker is currently co-leading a study in the Little Fork River Basin examining sources of sediment and sediment-derived phosphorus to the river system, a project which is taking place in collaboration with the Minnesota Pollution Control agency and which will guide the development of a sediment TMDL for the basin. She is also co-leading a study in tributaries to Lake Superior, investigating the role of nutrients, sediment, and sediment bound phosphorus loading in driving nearshore cyanobacterial blooms – an emerging problem that was highlighted by the International Joint Commission's Triennial Assessment as a top priority for research and management. She has co-authored eleven publications including three journal articles and four USGS interpretive reports, one of which was awarded "Best Groundwater Report of the Year" by the USGS Office of Groundwater. She has produced over 20 published abstracts corresponding to oral and poster presentations and has been extensively involved with science communications both as a student and professional.

Organization: US Geological Survey - Upper Midwest Water Science Center

Organization Description:

The U.S. Geological Survey is a non-regulatory research and monitoring agency within the U.S. Department of Interior that provides research to inform environmental management and policy development across the Nation. The Upper Midwest Water Science Center is comprised of three offices in Minnesota, Wisconsin, and Michigan. This center provides critical information about flood conditions and natural hazards through our stream-gaging program, and maintains a robust network of water quality monitoring sites including groundwater and surface waters. The USGS uses state-of-the-science technology for monitoring and is at the forefront of development of analytical methods for detection of trace contaminants. The USGS is also a leader in statistical and data analysis methods to provide valuable predictions regarding water quality and quantity. The Minnesota office of the Upper Midwest Water Science Center has one of the most active sediment monitoring programs within USGS – a program that receives leadership from project collaborator Dr. Faith Fitzpatrick. Furthermore, Dr. Fitzpatrick brings a wealth of expertise in fluvial geomorphology and stream evolution, and currently serves as the USGS Water Mission Area Hazards Program Manager. Project manager Anna Baker brings expertise in phosphorus-sediment interactions and their implications for water quality management.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
USGS Hydrologist - GS-13		Science Leadership, data collection, analysis, interpretation, writing, communications			35%	0.24		$66,767
USGS Specialist - GS-12		Interpretive science oversight			35%	0.16		$30,000
USGS Specialist - GS-11		Data management oversight			35%	0.38		$9,067
USGS Hydrologist - GS-11		Project management, data collection, analysis, interpretation, writing, communications			35%	0.32		$51,309
USGS Hydrologist - GS-11		Field mapping and data collection, data analysis			35%	0.14		$17,375
USGS Hydrologist - GS-11		Field support, equipment installation and maintenance, sample data analysis			35%	0.22		$46,481
USGS Hydrologist - GS-11		Field support, equipment installation and maintenance, sample data analysis			35%	0.08		$34,729
USGS Hydrologist - GS-7		Field support, equipment construction, sample collection and preparation, data analysis, writing			35%	0.24		$22,886
USGS Hydrologist - GS-12		Data analysis and support			35%	0.03		$8,356
Koochiching Soil and Water Conservation District - Water Resource Specialist		Sample collection, field and technical support			35%	0.7		$7,500
Lake of the Woods Soil and Water Conservation		Sample collection, field and technical support			35%	0.07		$7,500

District - Resource Conservationist								
Northern St. Louis Soil and Water Conservation District - Resource Conservationist		Sample collection, field and technical support			35%	0.7		$7,500
							Sub Total	**$309,470**
Contracts and Services								
U.S. Geological Survey Laboratories	Professional or Technical Service Contract	Sediment chemical and physical properties analysis				-		$32,488
TBD	Professional or Technical Service Contract	Field communications support, boat maintenance, sample shipping				0		$15,000
Minnesota Department of Health Laboratory	Professional or Technical Service Contract	Water quality sample analyses				-		$59,529
St. Croix Watershed Research Station Laboratory or competitive bid	Professional or Technical Service Contract	Specialized sediment and water chemistry including sediment phosphorus fractions, equilibrium phosphorus concentration, age dating, and other analyses				-		$142,736
St. Croix Watershed Research Station or competitive bid	Professional or Technical Service Contract	Data collection, analysis, and interpretation of specialized sediment chemistry and other data, writing and communications				-		$63,810
							Sub Total	**$313,563**

Equipment, Tools, and Supplies								
	Equipment	Calibration standards for sensors, sample bottles, passive sampler materials, autosampler rental	collection of sediment and water quality data					$16,500
							Sub Total	**$16,500**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Koochiching SWCD travel - 225 miles x 20 trips x 56 cents per mile	mileage for sample collection					$2,500
	Miles/ Meals/ Lodging	Lake of the Woods SWCD travel - 225 miles x 20 trips x 56 cents per mile	mileage for sample collection					$2,500
	Miles/ Meals/ Lodging	Northern St. Louis SWCD travel - 225 miles x 20 trips x 56 cents per mile	mileage for sample collection					$2,500
	Miles/ Meals/ Lodging	lodging and meals for 5 people, 35 days, $134/day; mileage - 2 vehicles traveling 535 miles 3 times, 5 vehicles traveling 500 miles 3 times, 56 cents per mile	Travel to conduct boat based surveys of Rainy River and Fourmile Bay, travel for equipment installation and maintenance at seven gage locations					$32,967
							Sub Total	**$40,467**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Printing	Publishing costs	Providing project results communication					$3,000
							Sub Total	**$3,000**

Other Expenses								
							Sub Total	**-**
							Grand Total	**$683,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	Minnesota Pollution Control Agency	In-kind contribution of staff time for Jesse Anderson, Mike Kennedy, and Kevin Stroom to provide technical expertise and project oversight.	Potential	$12,298
			State Sub Total	**$12,298**
Non-State				
In-Kind	U.S. Geological Survey matching funds - approximate	Supporting all aspects of USGS work except for analytical costs	Potential	$144,171
			Non State Sub Total	**$144,171**
			Funds Total	**$156,469**

Attachments

Required Attachments

Visual Component

File: ac979676-a64.pdf

Alternate Text for Visual Component

The visual component for the proposed study, “Rainy River drivers of Lake-of-the-Woods algal blooms” shows several images of algal blooms in Lake of the Woods, including a sample bottle filled with dark green algae-laden water, a researcher from the Science Museum of Minnesota with an algae bloom on Lake of the Woods, a close up of algae on the surface of the lake’s water, and an aerial image of the entire lake showing in bloom as it is visible from space. The visual lists the problem, quest...

Optional Attachments

Support Letter or Other

Title	File
U.S. Geological Survey - letter of support and authorization for PI submission of proposal	48f61539-d07.pdf
Koochiching SWCD Letter of Support	c35be39e-173.pdf
Northern St. Louis SWCD Letter of Support	829aa2a8-08d.pdf
Lake of the Woods SWCD Letter of Support	55e257aa-b80.pdf
Minnesota Pollution Control Agency Letter of Support	04ecf3b7-722.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

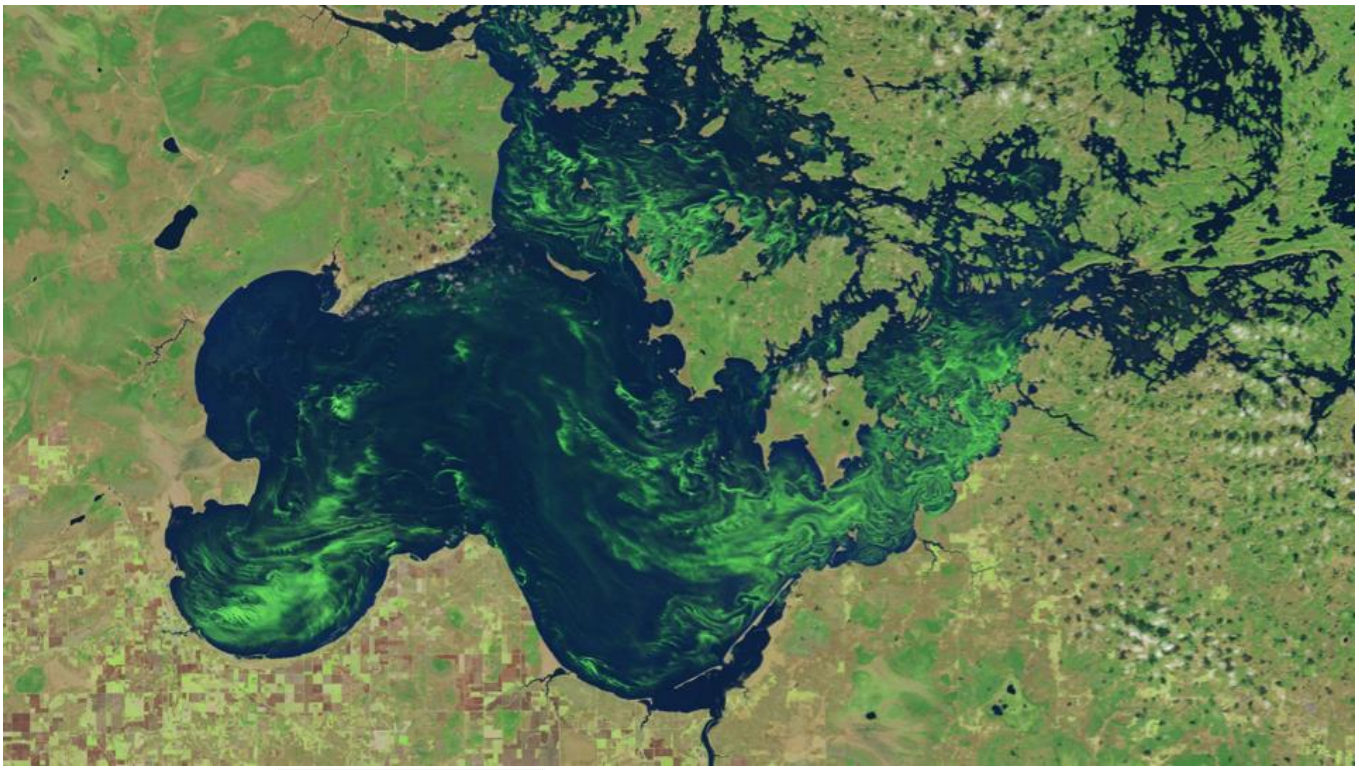
Does the organization have a fiscal agent for this project?

No

Environment and Natural Resources Trust Fund (ENRTF)
2022 Proposal
Title: Rainy River drivers of Lake-of-the-Woods algal blooms

Rainy River drivers of Lake-of-the-Woods algal blooms

- **Problem:** Algal blooms threaten fisheries and tourism in Lake-of-the-Woods, and Rainy River is the largest source of nutrients for these blooms
- **Question:** Is legacy phosphorus in sediments driving algae blooms?
- **Solution:** Work with local resource managers to target problem areas in the Rainy River watershed for the most efficient reduction of legacy phosphorus to Lake-of-the-Woods



USGS science for a changing world

Koochiching Soil & Water Conservation District

North St. Louis Soil & Water Conservation District

Lake of the Woods SWCD Soil & Water Conservation District

St. Croix Watershed Research Station

Science Museum of Minnesota