



# Environment and Natural Resources Trust Fund

## 2021 Request for Proposal

### General Information

**Proposal ID:** 2021-130

**Proposal Title:** Sediment-phosphorus management in Rainy-Lake of the Woods Basin

### Project Manager Information

**Name:** Anna Baker

**Organization:** US Geological Survey - Upper Midwest Water Science Center

**Office Telephone:** (763) 783-3156

**Email:** abaker@usgs.gov

### 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:** \$515,000

**Proposed Project Completion:** 2024-09-30

**LCCMR Funding Category:** Water Resources (B)

### Project Location

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

Region(s): NE

**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% of the TP. Previous studies have described total and dissolved 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 provide data describing 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 data produced by this study will inform existing models used in decision support targeting reductions in TP loading to 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.**

This study will support development of effective strategies for reducing phosphorus entering LoW by providing critical information describing how the Rainy River and its tributaries act as a source and sink for sediment-bound phosphorus. We propose to examine storage and transport of sediment-bound phosphorus by mapping stream-bed fine-sediment deposits, collecting suspended sediment from the Rainy River and its largest tributaries, and analyzing these sediments for phosphorus concentrations and potential for phosphorus binding and release. The relative age of the material in storage and in transport will also be determined to provide an estimate of how long sediment-bound phosphorus remains in the system. Sediment chemistry will be paired with water chemistry data to identify hotspots of phosphorus retention and release. These data represent a critical missing piece of information that will be used to improve existing models developed by the Minnesota Pollution Control Agency and its partners for targeting phosphorus management across the 6,400 square mile Lower Rainy River Basin. Additionally, this study will leverage work currently underway in the Little Fork River examining sources of fine-sediment and fine-sediment-derived phosphorus by examining the role of sand in phosphorus loading to this disproportionately large contributor to Rainy River phosphorus loading.

### **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?**

This study will identify hotspots for sediment-bound phosphorus transport and storage in the Rainy River and its tributaries. By providing detailed information describing the distribution, residence time, and potential for release of sediment-bound phosphorus, this study will guide the development of TMDL regulations and management strategies for reduction of phosphorus inputs to LoW. Mapped bed-sediment phosphorus-storage deposits in the Rainy River and detailed information describing sediment-bound phosphorus in storage and transport in its tributaries will help pinpoint sub-basins where management would provide the greatest reduction of inputs of sediment-bound phosphorus with high potential for release in bioavailable form.

## Activities and Milestones

### Activity 1: Characterization of Sediment-Bound Phosphorus Deposition, Transport, and Mobility

**Activity Budget:** \$280,000

**Activity Description:**

Fine sediment in suspension and streambed storage will be collected as part of a synoptic study of sediment-bound phosphorus occurrence in the Rainy River and its tributaries. Streambed-storage in the Rainy River will be mapped via sidescan sonar survey from International Falls to Wheelers Point, with sediment samples collected at intervals for analysis. Passive samplers deployed at seven locations will collect suspended sediment during this synoptic study. All sediments will be analyzed for total phosphorus and elemental concentrations of iron, aluminum, and calcium, which relate to how phosphorus is bound to sediment. Extractions for loosely-bound and iron-bound phosphorus will provide information describing the potential for phosphorus release. Water chemistry parameters will be collected continuously via a towable YSI probe (pH, conductance, dissolved oxygen). Water samples will be collected near the streambed coincident with sediment collection using a Van Dorn sampler, and analyzed for total and dissolved phosphorus, iron, oxidation-reduction potential, chlorophyll-a, total suspended solids and total suspended volatile solids. These data will be paired with sediment chemistry to examine potential mechanisms for exchange of phosphorus between sediment and the water column. The residence time of sediment in storage will also be analyzed using a ratio of the fallout radionuclides  $^{7}\text{Be}:$  $^{210}\text{Pb}$ .

**Activity Milestones:**

Description	Completion Date
Collect and prepare sediment from gage locations and bed-sediment storage deposits in the Rainy River	2022-10-31
Chemical analyses of sediment and water samples completed and data prepared for analysis	2023-06-30
Identify hot-spots of sediment-bound phosphorus export and deposition	2023-12-31
Complete draft report and present results to stakeholders	2024-09-30

### Activity 2: Enhancement to Little Fork Sediment-Phosphorus Source Analysis – Examination of contributions of phosphorus from coarse grained sediment

**Activity Budget:** \$235,000

**Activity Description:**

A study currently underway in the Little Fork River Basin is investigating the role of distinct sources of fine sediment in contributing to total suspended solids and phosphorus loading from the Little Fork to downstream Rainy River. The current study is focused on fine sediment because fine sediment disproportionately serves as a vector for phosphorus due to its high surface area. However, previous studies have shown that as much as half of the total suspended sediment load can be missed by focusing solely on fine grained sediments (Ellison et al., 2013). The proposed project would enhance the current study by incorporating analysis of coarse-grained (sand sized) sediment in phosphorus loading to downstream waters, which would help to understand the relative phosphorus contributions of sands and fine sediments from the Little Fork River. We will develop a complete sediment fingerprinting model and budget for sand-sized particles and will use sand-phosphorus chemistry data to also produce a budget describing sediment-bound phosphorus derived from sand. The developed model will help fill the knowledge gap about how sand contributes to sediment loading and how that sand loading contributes to phosphorus loading in this disproportionately large source of sediment to the Rainy River.

**Activity Milestones:**

Description	Completion Date
Collect and prepare sediment from all gage locations in the Little Fork Basin	2023-02-28
Review and check data	2023-05-31
Construct a sediment-derived phosphorus budget for coarse sediment	2023-12-31
Construct a sediment fingerprinting model for coarse sediment	2023-12-31
Complete draft report and present project results	2024-09-30

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Karen Gran	University of Minnesota-Duluth	Technical expert in geomorphology and sediment transport, project management and student mentoring and oversight for the development of a sand-budget for the Little Fork River Basin.	Yes
Faith Fitzpatrick	Upper Midwest Water Science Center	Technical expert in geomorphology and sediment transport	Yes
Jeff Ziegeweid	Upper Midwest Water Science Center	Technical expert in sediment monitoring methods	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 Districts) 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.**

Anna Baker is a Hydrologist at the Upper Midwest Water Science Center office in Mounds View, Minnesota. She began 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 ran a sediment laboratory where she managed several staff. Baker recently completed her masters at the University of Minnesota in Water Resources Science, 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 will guide the development of a sediment TMDL for that basin. She has co-authored four USGS publications and one journal article, including a report 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 also 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 in the country – a program that is led by proposal collaborator Jeff Ziegeweid. Furthermore, project collaborator Faith Fitzpatrick brings expertise in fluvial geomorphology and stream evolution, and 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
<b>Personnel</b>								
1 Research Hydrologist		Provide technical expertise and assist with survey and sample collection, data analysis and interpretation, and report drafting			24%	1.5		\$139,000
1 Hydrologic Technician		Oversee sampling efforts			25%	0.25		\$39,000
1 Hydrologist		Oversee boat based surveying			22%	0.06		\$9,000
1 Hydrologic Technician		Support sampling efforts and carry out lab analyses and data review			27%	0.86		\$40,000
1 Project Manager Hydrologist		Oversee all aspects of project work, participate in sampling and lab analyses, analyze and interpret data, draft report			27%	2.19		\$103,000
1 University Professor		Oversee graduate student contributions to study			36%	0.08		\$7,000
							<b>Sub Total</b>	<b>\$337,000</b>
<b>Contracts and Services</b>								
USGS Laboratories	Professional or Technical Service Contract	Laboratory analyses on water and sediment samples				-		\$85,000
TBD	Professional or Technical Service Contract	Boat rental and maintenance fees or boat used in surveys, cellular communications during field work				-		\$9,000
University of Minnesota-Duluth	Professional or Technical Service Contract	Research Assistant position for a graduate assistant working with Dr. Karen Gran on this project. Includes tuition, benefits, and stipend.				-		\$43,000
							<b>Sub Total</b>	<b>\$137,000</b>
<b>Equipment, Tools, and Supplies</b>								

	Equipment	Sampling equipment including materials for construction of passive sampler devices, sample bottles, sample preservatives, chemicals for equipment calibration, laboratory single use items such as pipet tips, centrifuges tubes and other equipment for in house sample analyses.	Construction of passive samplers and equipment for sampling, materials for conducting in house extractions of loosely-bound and iron-bound phosphorus					\$17,000
							<b>Sub Total</b>	<b>\$17,000</b>
<b>Capital Expenditures</b>								
							<b>Sub Total</b>	-
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Miles/ Meals/ Lodging	Travel for all personnel involved with synoptic sampling efforts	Travel for all staff to the Rainy River basin for surveying and sampling activities to be conducted over the course of one month.					\$24,000
							<b>Sub Total</b>	<b>\$24,000</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
							<b>Sub Total</b>	-
<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	<b>\$515,000</b>



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				
			State Sub Total	-
Non-State				
			Non State Sub Total	-
			Funds Total	-

## Attachments

### Required Attachments

#### *Visual Component*

File: [31e4c2e6-57f.pdf](#)

#### *Alternate Text for Visual Component*

Figure showing the Rainy River Basin and subwatersheds to be sampled including the Little Fork, Big Fork, Rapid, and Black Rivers.

### Optional Attachments

#### *Support Letter or Other*

Title	File
Letter of Support from Dr. Karen Gran	<a href="#">03e5aeb6-974.pdf</a>
Rainy River Basin sub-watersheds and gage locations	<a href="#">43325756-b1b.pdf</a>

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

**Does your project have patent, royalties, or revenue potential?**

No

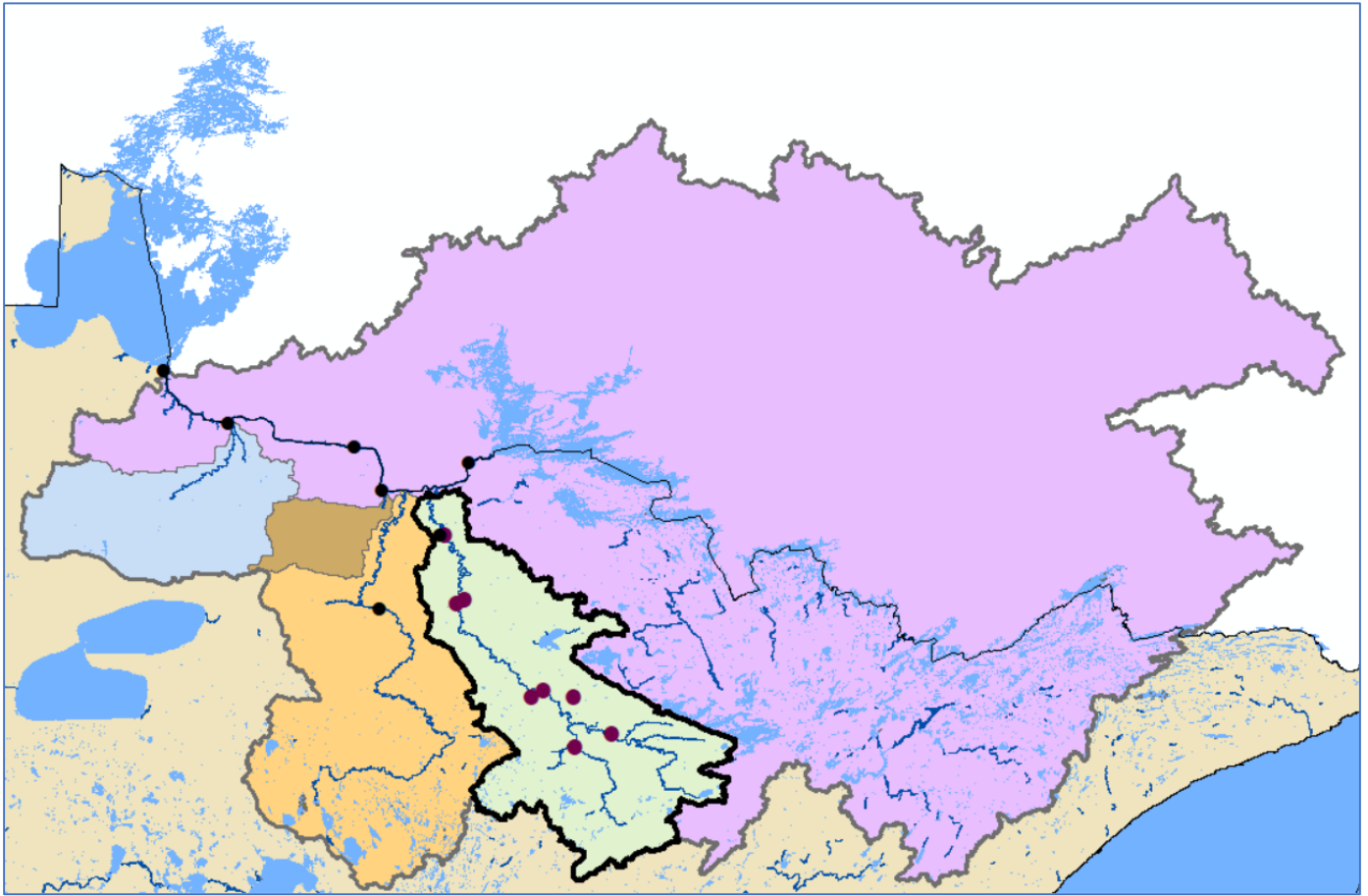
**Does your project include research?**

Yes

**Does the organization have a fiscal agent for this project?**

No

# Rainy River Basin sub-watersheds and gage locations



## EXPLANATION

- Rainy River Sampling locations
- Little Fork River Sampling locations
- Little Fork River Watershed
- Big Fork River Watershed
- Rapid River Watershed
- Black River Watershed
- Rainy River Watershed