



Environment and Natural Resources Trust Fund

M.L. 2023 Approved Work Plan

General Information

ID Number: 2023-215

Staff Lead: Mike Campana

Date this document submitted to LCCMR: May 23, 2023

Project Title: Removing CECs from Stormwater with Biofiltration

Project Budget: \$641,000

Project Manager Information

Name: Andy Erickson

Organization: U of MN - St. Anthony Falls Laboratory

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Project Reporting

Date Work Plan Approved by LCCMR: June 22, 2023

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: June 30, 2026

Final Report Due Date: August 14, 2026

Legal Information

Legal Citation: M.L. 2023, Chp. 60, Art. 2, Sec. 2, Subd. 04j

Appropriation Language: \$641,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota for the St. Anthony Falls Laboratory to develop a treatment practice design using biofiltration media to remove contaminants of emerging concern (CECs) from stormwater runoff and to provide statewide stormwater management guidance.

Appropriation End Date: June 30, 2026

Narrative

Project Summary: This project will develop a treatment practice design for removing contaminants of emerging concern (CECs) from stormwater runoff using biofiltration media. Guidance will be developed for stormwater managers statewide.

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

Several ENRTF funded projects have measured the number and concentration of Contaminants of Emerging Concern (CECs) throughout Minnesota, but no research has developed a treatment practice design that can remove a wide spectrum of CECs from stormwater runoff. CECs include hormones, pesticides, herbicides, industrial compounds, pharmaceuticals, personal care product ingredients, “lifestyle” compounds such as caffeine and nicotine, and many other commercial-consumer product-related compounds (Fairbairn et al. 2018). Most of these chemicals are typically not regulated and may pose a hazard to fish and biota such as mussels and insect larvae in receiving waterbodies. For example, phosphate-based flame retardants are estrogenic, which can interfere with organisms’ development and ability to reproduce. Stormwater runoff frequently contains CECs and carries them to our surface and groundwaters (Fairbairn et al. 2018). While sanitary wastewater and municipal drinking water have large treatment facilities to remove pollutants, stormwater runoff typically does not.

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

Biofiltration practices are an urban stormwater treatment practice designed to capture pollutants such as sediment, nutrients, and polycyclic aromatic hydrocarbons (PAHs), among others (LeFevre et al., 2015, Erickson et al., 2021). The mixed media within biofiltration practices have the potential to also capture some CECs (e.g., biochar; Ulrich et al., 2015 & 2017; Kozarek 2008), but the effectiveness, especially in field settings, and best design has yet to be determined. This project proposes to develop new treatment designs that can remove CECs from stormwater runoff. First, we will evaluate biofiltration by determining the best media components (e.g., compost, biochar, peat, iron, spent lime, etc.) and mix ratios for capturing CECs using outdoor experiments (Activity 1). These experiments will determine the components that balance cost and CEC removal to produce the most cost-effective shovel-ready design. This project will also validate the experiments by monitoring CECs in paired inflow (untreated) and outflow (treated by biofiltration media) stormwater samples at several field locations (Activity 2). Through this combined field pilot-scale study and outdoor experiment, guidance will be developed to empower water resource planners and managers with a treatment practice design to remove harmful CECs from stormwater runoff and protect Minnesota’s water resources.

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 project proposes to develop a new treatment practice design that can remove some CECs from stormwater runoff. By removing CECs from stormwater runoff, the public is protected from direct contact with these pollutants because they are not delivered to our lakes, rivers, streams, and groundwater via stormwater runoff. Some CECs in stormwater are also a known stressor to fish, affecting their growth and reproduction in Minnesota lakes and streams. Removing some CECs from runoff reduces exposure of fish and biota to this stress, helping preserve existing water resources and habitat as well as improving impacted water resources throughout Minnesota.

Project Location

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

Region(s): Metro

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

Statewide

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Outdoor Mesocosm Evaluation of CECs capture by Biofiltration Media

Activity Budget: \$360,833

Activity Description:

An existing research project developed thirty outdoor mesocosms for the evaluation of nutrient capture and release and vegetation growth by biofiltration media over four rainy seasons (see Non ENRTF Funds). The mesocosms allow us to measure a wide variety of media components and mix ratios, which is typically not possible in most field studies. Activity 1 will use the existing mesocosm research infrastructure to measure capture of CECs by biofiltration media mixes for simulated events. Media components that are readily available in Minnesota and could be tested include: sand, food- or leaf-based compost, reed sedge or sphagnum peat, spent lime, biochar, granular activated carbon, and iron aggregate. Specific CECs from several classes (e.g., neonicotinoids, herbicides, pharmaceuticals, and phosphate-based flame retardants) will be selected and known concentrations of these CECs will be added to synthetic stormwater runoff. This synthetic runoff will be added to mesocosms to represent natural rainfall runoff and samples will be collected from the inflow and outflow to calculate capture performance. This process will be repeated several times throughout the rainy seasons of the project, as weather permits. Any impacts to vegetation growth will also be evaluated.

Activity Milestones:

Description	Approximate Completion Date
Literature Review and Selection of Media Mixes	December 31, 2023
Experimental Design and Construction	August 31, 2024
Preliminary Experiment Results – Year 1	March 31, 2025
Evaluate Performance of Media Mixes to Remove CECs from synthetic runoff.	December 31, 2025
Outcome 3: Prepare Final Report for stormwater professionals	June 30, 2026

Activity 2: Field Monitoring of CEC Removal by Biofiltration Practices

Activity Budget: \$280,167

Activity Description:

Up to four biofiltration practices will be selected within or near the Twin Cities Metropolitan Area to characterize the presence and removal of CECs in stormwater runoff. Sites with media mixtures that align with Activity 1 will be chosen to compare CEC removal between mesocosms and field practices. At each site, paired inflow (stormwater that has not flowed through the biofilter media) and outflow (stormwater that has flowed through the biofilter media) samples will be collected during at least 3 rain events for two rainy seasons, for a total of 6 rain events over 2 years at each location (overall total of 60 samples, including 12 quality-assurance samples). All samples will be analyzed for up to 203 CECs: 184 pesticides, 6 bisphenol analogues, and 13 organophosphate flame retardants (OPFR). Results will be used to estimate contaminant removal from raw stormwater runoff at each biofiltration location and compare different media mixtures.

Activity Milestones:

Description	Approximate Completion Date
Solicit stakeholder feedback for site selection	December 31, 2023
Develop and implement field monitoring plan	August 31, 2024
Preliminary Field Monitoring Results – Year 1	March 31, 2025
Sample collection and laboratory analyses	December 31, 2025
CEC removal calculations and prepare final report for stormwater professionals	June 30, 2026

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Sarah Elliott	U.S. Geological Survey	General project management, data analysis, report preparation	Yes
Richard Kiesling	U.S. Geological Survey	Oversee site selection and field sampling logistics, data analysis, report preparation	Yes
Mike Trojan & Mark Ferrey	Minnesota Pollution Control Agency	Develop guidance and update information in the Minnesota Stormwater Manual, providing review of materials or other tech support, and conducting outreach as needed.	No
Tim Kelly	Coon Creek Watershed District	Discuss the availability of required data and coordinate collection of samples and/or provide access for sample collection.	No

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.

Results from this project will be disseminated directly to stormwater professionals and is intended to be incorporated into stormwater design guidance (e.g., MN Stormwater Manual, hosted by the MPCA). The project team has established extensive stormwater research outreach efforts via presentations (~10 per year), online email newsletters (2000+ email subscribers), webpages (620+ pageviews per month), webinars (~170 registrants per month) and publications, in addition to upcoming workshops and training programs such as the Minnesota Pollution Control Agency (5000+ email subscribers). The results generated by the proposed project will be disseminated by similar means. The Environment and Natural Resources Trust Fund will be acknowledged through use of the trust fund logo and/or attribution language on project print and electronic media, publications, signage, presentations, and other communications per the ENRTF Acknowledgment Guidelines.

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 work be funded?

Implementation: The research team will disseminate results from this project to educate stormwater professionals, as described above. With this guidance, cities, watershed districts, watershed management organizations, conservation districts, counties, state agencies, private consultants, non-profits, and other organizations can use the results to design better stormwater treatment practices, resulting in less pollution in stormwater runoff. Ongoing Effort and Funding: Funding for the direct implementation of stormwater treatment practices is already supported by federal, state, and local funds. Additional research on this topic is provided by concurrent matching funds from the Minnesota Stormwater Research Council with allocations from the Clean Water Council.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Solar Driven Destruction of Pesticides, Pharmaceuticals, Contaminants in Water	M.L. 2014, Chp. 226, Sec. 2, Subd. 03a	\$291,000
Antibiotics and Antibiotic Resistance Genes in Minnesota Lakes	M.L. 2014, Chp. 226, Sec. 2, Subd. 03e	\$300,000

Biological Consequences of Septic Pollution in Minnesota Lakes	M.L. 2015, Chp. 76, Sec. 2, Subd. 04c	\$364,000
Assessing Neonicotinoid Insecticide Effects on Aquatic and Soil Communities	M.L. 2016, Chp. 186, Sec. 2, Subd. 04e	\$400,000
Assessment of Surface Water Quality With Satellite Sensors	M.L. 2016, Chp. 186, Sec. 2, Subd. 04i	\$345,000
Assessment of Household Chemicals and Herbicides in Rivers and Lakes	M.L. 2017, Chp. 96, Sec. 2, Subd. 04a	\$236,000
Water Quality Monitoring in Southeastern Minnesota Trout Streams	M.L. 2017, Chp. 96, Sec. 2, Subd. 04d	\$500,000
Protect Water Quality with Efficient Removal of Contaminants in Treatment Ponds for Storm Water	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 04d	\$325,000
Mapping Antibiotic Resistance in Minnesota to Help Protect Environmental, Animal, and Human Health	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 04h	\$750,000
Determining Influence of Insecticides on Algal Blooms	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04a	\$350,000
Benign Design: Environmental Studies Leading to Sustainable Pharmaceuticals	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04b	\$415,000
Improving Drinking Water for Minnesotans through Pollution Prevention	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04f	\$345,000
Protecting Minnesota Waters by Removing Contaminants from Wastewater	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04g	\$250,000
Managed Aquifer Recharge	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04t	\$350,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Andy Erickson		Manager and PI			26.9%	0.45		\$66,598
John Gulliver		Research Support: John Gulliver has over 40 years of experience conducting complex field and laboratory research. Dr. Gulliver will provide input and guidance on experiment design and execution; data analysis and interpretation; and developing guidance for stormwater professionals.			7.7%	0.06		\$13,991
Bill Arnold		Research Support: Bill Arnold is a national expert on environmental water chemistry and complex chemical interactions in both laboratory and field conditions. Dr. Arnold will provide guidance on experimental design and execution; sample collection, preservation, and analysis; and data analysis and interpretation.			26.9%	0.06		\$13,472
Jess Kozarek		Research Support: Jess Kozarek is the manager for outdoor research spaces at SAFL and an expert in field-scale experiments. Dr. Kozarek will provide guidance on experimental design and execution; sample collection and preservation; proper chemical handling and safety to prevent environmental impacts; and data analysis and interpretation.			26.9%	0.3		\$30,995
Graduate Research Assistant		Research Support: The Ph.D. graduate student (Zihang Wang) will assist with all outdoor experiments at SAFL; collect, preserve, and analyze all samples collected from outdoor experiments; process and QA/QC all data from samples analysis; and prepare interpretation of data and results including written and calculation results.			20.4%	2.31		\$174,176
Chris Milliren		Research Support: Chris Milliren is an instrumentation expert and will provide guidance on instrumentation and telemetry; digital data acquisition, storage, and protection; and electronics and electrical power supply required to operate the outdoor experiments.			26.9%	0.06		\$4,606

Undergraduate Staff		Research Support: Undergraduate staff will assist with construction and preparation of outdoor experiments at SAFL; conducting experiments including collection, preservation, and transport of samples (as needed); and maintenance and repair of outdoor experiments between synthetic runoff events.			0%	0.57		\$16,619
							Sub Total	\$320,457
Contracts and Services								
US Geological Survey	Sub award	Stormwater sampling and analysis coordinated by the USGS (Activity 2) including analytical services (\$150,000), expendable supplies (\$6,000), sample shipment (\$900), travel to collection sites and project meetings (\$400), and salary and benefits for project staff (\$122,867). Administrative assistance costs must be directly incurred by project tasks.				3.24		\$280,167
							Sub Total	\$280,167
Equipment, Tools, and Supplies								
	Tools and Supplies	Lab supplies for water sampling	Sampling Supplies					\$2,515
	Tools and Supplies	Lumber, buckets, hoses, etc.	Mesocosm supplies					\$1,516
	Tools and Supplies	Parts and supplies for flow rate monitoring, datalogger, etc.	Data recording system supplies					\$1,015
	Tools and Supplies	Analytical supplies: Vials, standards, isotopic standards, cartridges, etc.	Supplies to support CECE-lab analysis of CEC samples.					\$30,780
	Tools and Supplies	Equipment Maintenance	Maintenance services and repair on LC-MS/MS analytical equipment.					\$4,000
							Sub Total	\$39,826
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								

							Sub Total	-
Travel In Minnesota								
	Conference Registration Miles/ Meals/ Lodging	2 conference registrations (\$275 per person x 2 people)	Attending and presenting research results at the Minnesota Water Resources Conference.	X				\$550
							Sub Total	\$550
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
							Sub Total	-
Other Expenses								
							Sub Total	-
							Grand Total	\$641,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel In Minnesota	Conference Registration Miles/Meals/Lodging	2 conference registrations (\$275 per person x 2 people)	Attending to participate in formal presentation of project findings.

Non ENRTF Funds

Category	Specific Source	Use	Status	\$ Amount
State				
In-Kind	Minnesota Stormwater Research and Technology Transfer Program administered by the University of Minnesota Water Resources Center through an appropriation from the Clean Water Fund established by Minnesota Clean Water Land and Legacy Amendment and from the Minnesota Stormwater Research Council.	Research Project titled: "Biofiltration Media Optimization"	Secured	\$295,926
In-Kind	University of Minnesota	Unrecovered F&A at Federally Negotiated Rate (55%)	Pending	\$217,158
In-Kind	Minnesota Stormwater Research and Technology Transfer Program administered by the University of Minnesota Water Resources Center through an appropriation from the Clean Water Fund established by Minnesota Clean Water Land and Legacy Amendment and from the Minnesota Stormwater Research Council.	Capturing Contaminants of Emerging Concern (CECs) with Biofiltration	Secured	\$210,258
			State Sub Total	\$723,342
Non-State				
In-Kind	Coon Creek Watershed District	Salary for field monitoring coordination and planning, sample collection from field sites, and coordination of sample delivery to USGS staff for shipment to the USGS laboratory. Justin Dauphinais (20 hours at \$76.02) - \$1,520 and Chase Vanderbilt (25 hours at \$56.14)	Pending	\$1,403
In-Kind	U.S. Geological Survey Cooperative Matching Funds	Cover U.S. Geological Survey overhead and other indirect charges accrued by the project, open-access for a journal article, and conference registration and travel to disseminate results	Pending	\$120,000
			Non State Sub Total	\$121,403
			Funds Total	\$844,745

Attachments

Required Attachments

Visual Component

File: [30449479-896.pdf](#)

Alternate Text for Visual Component

Image 1: outdoor gray cylindrical containers labeled mesocosm 1, mesocosm 2, mesocosm 3, and so on with 5-gallon buckets above and below for inflow and outflow. Image 2: outdoor bowl-shaped vegetated basin within a parking lot with two individuals collecting scientific measurements and samples with caption: Typical biofiltration practice. Image 3: a cross-section of a biofiltration practice with arrows depicting stormwater movement through the system and where CECs will be measured....

Optional Attachments

Support Letter, Photos, Media, Other

Title	File
Letter of Support: USGS Upper Midwest Water Science Center	2b688243-b50.pdf
Letter of Support: Coon Creek Watershed District	f19892cf-791.pdf
Letter of Support: City of Duluth	5da08037-179.pdf
Letter of Support: City of St. Cloud	04817264-33c.pdf
Letter of Support: Shingle Creek Watershed Management Organization	35959d2c-9c2.pdf
background check certification form	d6cbb2f0-6dc.pdf
Research Addendum Post Peer Review	83252504-36b.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Personnel was revised as follows: Post-Doctoral Fellow was replaced with Graduate Research Assistant, which reflects available staff. The Budget was revised as follows: 1) FTE was increased for Graduate Research Assistant, 2) laboratory supplies was reduced to compensate, 3) Graduate Research Assistant FTE was decreased because recommended funding (\$641,000) was less than requested (\$650,000). Dissemination Activities were added (new item) as requested. Long-Term Implementation and Funding was revised to complement Dissemination. Uploaded the background check certification form (Attachments), as requested.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I agree to the UMN Policy.

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?

Yes, Sponsored Projects Administration