

**Environment and Natural Resources Trust Fund**

# 2022 Request for Proposal

## **General Information**

**Proposal ID:** 2022-218

**Proposal Title:** Removing CECs from Stormwater with Biofiltration

## **Project Manager Information**

**Name:** Andy Erickson

**Organization:** U of MN - St. Anthony Falls Laboratory

**Office Telephone:** (612) 239-2046

**Email:** eric0706@umn.edu

## **Project Basic Information**

**Project Summary:** This project will optimize 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.

**Funds Requested:** $646,000

**Proposed Project Completion:** June 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): 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

## **Narrative**

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

Several ENRTF funded project 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 unregulated and 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 does not. Cities, counties, and watershed districts and organizations rely on neighborhood stormwater ponds and rain gardens (bioretention) to remove sediment and nutrients from runoff. Little is known about whether CECs are captured in these practices, so stormwater managers need cost-effective shovel-ready treatment practice designs to remove CECs from stormwater.

**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.**

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 CECs (e.g., biochar; Ulrich et al., 2015 & 2017), but the effectiveness 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 optimize the components to 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 outdoor experiment-scale and field pilot-scale study, 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 precious 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 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. CECs in stormwater are also a known stressor to fish, affecting their growth and reproduction in Minnesota lakes and streams. Removing 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.

## **Activities and Milestones**

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

**Activity Budget:** $365,833

**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 both simulated events and natural rainfall. 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, 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** | **Completion Date** |
| Outcome 1: Literature Review and Selection of Media Mixes | December 31 2022 |
| Outcome 2: Evaluate Performance of Media Mixes to Remove CECs from synthetic runoff. | December 31 2024 |
| Outcome 3: Prepare Final Activity Report | June 30 2025 |

### **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 at each location (overall total of 53 samples, including 5 quality-assurance samples). All samples will be analyzed for 82 pesticides, 110 pharmaceuticals, and 65 wastewater indicator contaminants at the USGS National Water Quality Laboratory. Results will be used to estimate contaminant removal from raw stormwater runoff at each biofiltration location and compare different media mixtures.

**Activity Milestones:**

|  |  |
| --- | --- |
| **Description** | **Completion Date** |
| Solicit stakeholder feedback for site selection | December 31 2022 |
| Sample collection and laboratory analyses | December 31 2024 |
| CEC removal calculations and final report preparation | June 30 2025 |

## **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 |
| Tina Carstens | Ramsey Washington Metro Watershed District | Discuss the availability of required data and coordinate collection of samples and/or provide access for sample collection. | 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 |

## **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?**This project expands on extensive stormwater research that is already being disseminated 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 through these established partnerships. Stormwater practitioners will learn about best design practices and begin incorporating those designs in new construction.

## **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 |

## **Project Manager and Organization Qualifications**

**Project Manager Name:** Andy Erickson

**Job Title:** Research Associate

**Provide description of the project manager’s qualifications to manage the proposed project.**Andy Erickson, PhD, PE, is a Research Associate at St. Anthony Falls Laboratory and the University of Minnesota and registered professional engineer. Much of his research, in conjunction with other faculty and staff, involves understanding water quality in urban and agricultural watersheds, assessment and maintenance of stormwater treatment practices, and developing new stormwater treatment technologies such as the Iron-Enhanced Sand Filter which removes dissolved and particulate phosphorus. Dr. Erickson’s current and recent research includes evaluating biofiltration media mixes for release or capture of phosphate and vegetation growth; investigating permeable pavement as a replacement for conventional pavement to reduce road salt use; predicting the environmental impact of road salt alternatives such as potassium acetate and propylene glycol, measuring salt transport through soil media, and quantifying sediment and gross solids capture in pretreatment for bioretention practices. Dr. Erickson is lead author for the book, "Optimizing Stormwater Treatment Practices: A Handbook of Assessment and Maintenance," and the editor of the University of Minnesota stormwater newsletter, UPDATES, which disseminates research results to over 2000 email subscribers. Andy is also the coordinator for the Minnesota Stormwater Seminar Series (https://www.wrc.umn.edu/swseminars) which engages approximately 170 stormwater practitioners and interested parties per month in an online presentation and panel discussion. Dr. Erickson also maintains the St. Anthony Falls Laboratory stormwater research websites (http://stormwater.safl.umn.edu). Dr. Erickson has been the principal investigator for ten externally funded research grants in the last five years and has been a primary project coordinator for many others.

**Organization:** U of MN - St. Anthony Falls Laboratory

**Organization Description:**The St. Anthony Falls Laboratory (SAFL), an interdisciplinary fluids research and educational facility, is focused at the intersection of fluid dynamics with major societal challenges in energy, environment, and health. SAFL serves as a resource for departments across the Twin Cities campus, the statewide University system, and the broader research community. The connections and collaborations between the University, St. Anthony Falls Laboratory, and the USGS reach across the country and all over the world, and our laboratories partner with local, state and federal agencies, and other educational institutions to expand knowledge and solve problems.

The U.S. Geological Survey’s mission is to provide unbiased science about the natural hazards that threaten lives and livelihoods, the water, energy, minerals, and other natural resources we rely on, the health of our ecosystems and environment, and the impacts of climate and land-use change. With respect to water resources, USGS scientists work with local partners to monitor, assess, and conduct targeted research on the wide range of water resources and conditions, including streamflow, groundwater, water quality, and water use and availability.

## **Budget Summary**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Category / Name** | **Subcategory or Type** | **Description** | **Purpose** | **Gen. Ineli gible** | **% Bene fits** | **# FTE** | **Class ified Staff?** | **$ Amount** |
| **Personnel** |  |  |  |  |  |  |  |  |
| Andy Erickson |  | Manager and PI |  |  | 26.7% | 0.6 |  | $61,463 |
| John Gulliver |  | Research Support |  |  | 7.4% | 0.06 |  | $13,953 |
| Bill Arnold |  | Research Support |  |  | 26.7% | 0.06 |  | $13,443 |
| Jess Kozarek |  | Research Support |  |  | 26.7% | 0.3 |  | $30,927 |
| Post-Doctoral Fellow |  | Research Support |  |  | 20.3% | 2.01 |  | $150,099 |
| Chris Milliren |  | Research Support |  |  | 24.1% | 0.09 |  | $5,545 |
| Undergraduate Staff |  | Research Support |  |  | 0% | 0.57 |  | $17,309 |
|  |  |  |  |  |  |  | **Sub Total** | **$292,739** |
| **Contracts and Services** |  |  |  |  |  |  |  |  |
| US Geological Survey | Professional or Technical Service Contract | Stormwater sampling and analysis coordinated by the US Geological Survey (Activity 2) including analytical services from the USGS National Water Quality Laboratory for the analysis of 53 samples (48 environmental, 5 QA/QC) for three analytical schedules of approximately 250 chemicals ($103,880), expendable supplies ($3,264), sample shipment to laboratory ($900), contingency for unanticipated costs (2% of total project cost = $5,000), and travel to collection sites and project meetings ($400). Subcontract includes salary and benefits for project staff: (Kiesling – 0.27 FTE at 79% salary, 21% benefits = $63,512; Elliott – 0.31 FTE at 72% salary, 28% benefits = $58,418; GS-11 Hydrologic Technician – 0.15 FTE at 72% salary, 28% benefits = $18,094; Water quality database manager – 0.19 FTE at 71% salary, 29% benefits = $1,664; Administrative Assistance – 0.16 FTE at 69% salary, 31% benefits = $25,035) |  |  |  | 3.24 |  | $280,167 |
|  |  |  |  |  |  |  | **Sub Total** | **$280,167** |
| **Equipment, Tools, and Supplies** |  |  |  |  |  |  |  |  |
|  | Tools and Supplies | Lab supplies for water sampling | Sampling Supplies |  |  |  |  | $2,513 |
|  | 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 CEGE-lab analysis of CEC samples. |  |  |  |  | $67,500 |
|  |  |  |  |  |  |  | **Sub Total** | **$72,544** |
| **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. |  |  |  |  | $550 |
|  |  |  |  |  |  |  | **Sub Total** | **$550** |
| **Travel Outside Minnesota** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Printing and Publication** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
| **Other Expenses** |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Sub Total** | **-** |
|  |  |  |  |  |  |  | **Grand Total** | **$646,000** |

### **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 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 (54%) | Pending | $214,958 |
|  |  |  | **State Sub Total** | **$510,884** |
| **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** | **$632,287** |

## **Attachments**

### **Required Attachments**

#### ***Visual Component***

File: [30449479-896.pdf](https://lccmrprojectmgmt.leg.mn/media/map/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 or Other***

|  |  |
| --- | --- |
| **Title** | **File** |
| Letter of Support: Shingle Creek Watershed Management Organization | [abac7cb3-da1.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/abac7cb3-da1.pdf) |
| Letter of Support: City of St. Cloud | [506b40f2-c51.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/506b40f2-c51.pdf) |
| Letter of Support: City of Duluth | [d1e9b96e-928.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/d1e9b96e-928.pdf) |
| Letter of Support: Coon Creek Watershed District | [8bdda2da-083.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/8bdda2da-083.pdf) |
| Letter of Support: Ramsey Washington Metro Watershed District | [50c1b5b4-364.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/50c1b5b4-364.pdf) |
| Letter of Support: USGS Upper Midwest Water Science Center | [941adf02-368.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/941adf02-368.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?**
 Yes, Sponsored Projects Administration