

**Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 041-B

Contaminant Removal Efficiency of Urban Stormwater Treatment Ponds

Category: B. Water Resources

Total Project Budget: \$ 377,588

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

Urban stormwaters contain biologically harmful contaminants of emerging concern whose abatement through best management practice ponds requires evaluation to safeguard habitats for aquatic species from mussels to birds.

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Location

Region: Statewide

County Name: Otter Tail, Ramsey, St. Louis, Stearns

City / Township: Duluth, Fergus Falls, St. Cloud, St. Paul

Alternate Text for Visual:

Map of study sites and previous studies of endocrine active compounds. Stormwater treatment technologies and some study species are also shown.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____ %



PROJECT TITLE: Contaminant Removal Efficiency of Urban Stormwater Treatment Ponds

I. PROJECT STATEMENT

Recent stormwater monitoring studies in Minnesota have determined that **urban stormwater is a significant source of contaminants of emerging concern** containing a broad suite of pharmaceuticals (including prescription drugs), current-use pesticides, personal care products, and other organic wastewater chemicals. These pollutants are currently discharged into major streams, rivers, and lakes at concentrations that may exceed those of treated wastewater effluent and are harmful to organisms in receiving waters. Understanding how existing stormwater treatment systems process these contaminants of emerging concern and how aquatic biota respond to stormwater discharges is central to safe-guarding Minnesota's aquatic environment. The level of exposure of aquatic organisms to stormwater contaminants of emerging concern discharge will depend upon the ability of best management practices (BMPs) to abate pollutant loading to surface waters. A recent pilot study by the MN Pollution Control Agency, St. Cloud State University, and US Geological Survey monitored three different stormwater BMP systems and found evidence of reductions in the number and concentrations of contaminants of emerging concern in some BMP outflow samples. In this study, 83% of the paired BMP inflow/outflow samples showed reductions in the number of contaminants detected. Reductions in the number of detections also varied by season, with the largest reductions observed in February (38%) and the lowest in May (< 2%). One third of the 48 most frequently detected contaminants of emerging concern showed significant reductions between BMP inlets and outlets suggesting that properly designed BMP treatment systems can reduce some pollutant concentrations depending upon season and stormwater composition. However, biological activity was not always reduced at the same rate as pollutant reduction suggesting differential efficiency in contaminant removal by BMP systems with room for improvement.

A comprehensive assessment of stormwater composition and treatment across urban centers in Minnesota is needed to inform natural resource managers to the best options for reducing urban stormwater related pollution to Minnesota Waters.

The proposed study will:

- (i) monitor contaminants of emerging concern in stormwater inflows and outflows for two emerging-technology stormwater BMPs: advanced biofiltration-infiltration and iron-enhanced sand filtration ponds.
- (ii) Measure contaminants of emerging concern in stormwater during snowmelt runoff and in late spring in four Minnesota cities.
- (iii) Measure the biological activity of all collected stormwater samples across a range of seven species commonly found in receiving waters (mussel, fathead minnow, bass, sunfish, Leopard frog, painted turtle and wood duck) using a common cell based assay to allow for direct comparison between species.

Stormwater outfalls and stormwater BMPs provide important wetland habitats for many aquatic species, especially in urban environments. Bivalve, fish, amphibians, reptilians and birds all utilize these wetlands to obtain food, reproduce, and hibernate. Given the complexity of stormwater and the diversity of species utilizing stormwater impacted habitats, a whole animal study is inappropriate and premature given the many unknowns of stormwater. Instead, we will focus on key species at multiple taxonomic levels (invertebrate, fish, amphibian, reptilian, bird) using a common cell-based assay to identify the most vulnerable species in impacted wetlands and to identifying the most effective stormwater treatment technologies to remove harmful biological effects.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Measure BMP effectiveness of Contaminants of Emerging Concern Removal **Budget: \$230,000**

All 48 stormwater samples and 7 QA/QC samples will be analyzed for the presence and concentrations of over 400 contaminants of emerging concern including pharmaceuticals, organic wastewater chemicals, and current-use pesticides. The sampling design will be replicated in three urban areas located in three different regions of Minnesota; candidate sites have been identified in St. Paul, Duluth, St. Cloud, and Fergus Falls. Comparison of results between the two types of BMP treatment technology will assess the effectiveness of stormwater BMP mitigation of contaminants of emerging concern contaminants. A total of 55 environmental and quality



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assurance samples will be collected from these sites and analyzed by the USGS National Water Quality Laboratory (NWQL). Data analysis of USGS laboratory results will be coordinated with samples collected and analyzed by researchers at St. Cloud State University (SCSU) under Activity 2.

Outcome	Completion Date
<i>1. Measure contaminants of emerging concern in 48 stormwater samples from 12 BMP sites</i>	<i>June 30, 2020</i>
<i>2. Identify the most efficient BMP treatment for contaminants of emerging concern removal based on analysis of samples</i>	<i>Dec 31, 2020</i>
<i>3. Publish the data in a publicly-available, web-accessible database</i>	<i>Dec 31, 2020</i>
<i>4. Produce a final report summarizing the results of Activity</i>	<i>June 30, 2021</i>

Activity 2: Measure the biological activity of collected stormwater across seven species. Budget: \$147,588

Stormwater samples from all 55 collection and QA/QC events (see Activity 1) will be analyzed for biological effects using a common cell-based assay for the following seven species commonly found in stormwater ponds and receiving waters: mussel, fathead minnow, bass, sunfish, Leopard frog, painted turtle and wood duck. Target proteins will be isolated from each species, and be tested in a species-specific cell-based assay. Stormwater samples will be concentrated and then cells will be exposed to the concentrate at two concentrations for 48hrs. We have already developed the cell-assays for mussel and fathead minnow. This assay will identify vulnerable species and the stormwater BMP most effective in reducing biological effects.

Outcome	Completion Date
<i>1. Develop the cell-based assay for Leopard frog, turtle and wood duck species</i>	<i>June 30, 2019</i>
<i>2. Measure biological effects in 55 storm water samples collected for Activity 1</i>	<i>Dec 31, 2020</i>
<i>3. Evaluate efficacy of storm water treatment methods using cell-based assay</i>	<i>June 30, 2021</i>

III. PROJECT STRATEGY

A. Project Team/Partners

The project team has considerable experience in all aspects of the proposed study. The principal investigator Schoenfuss (St. Cloud State University, Aquatic Toxicology) has studied the biological impacts of contaminants of emerging concern in Minnesota water for the past 20 years and directed stormwater studies in the past. He will supervise the entire project. Dr. Satomi Kohno (SCSU – environmental toxicology) is an expert in developing and running cell-based assays to determine the biological risk of environmental pollutants in non-model species. Dr. Richard Kiesling (USGS) is an expert in water quality sampling and statistical analysis. Sarah Elliott (USGS) is an expert in contaminants of emerging concern data analysis including data QA/QC and public database support. Mark Brigham (USGS) is a contaminant hydrology expert and program manager.

B. Project Impact and Long-Term Strategy

The proposed research supports a state-wide research agenda focused on sources of contaminants of emerging concern and the protection of aquatic environments in Minnesota. The proposed research complements current and prior research that to date did not previously focus on storm water sources of contaminants of emerging concern. Most previous studies have not addressed effects of CECs on diverse wild species, which are excellent sentinel in aquatic ecosystem. This study will assess the efficiency of BMPs to remove harmful contaminants of emerging concern from urban stormwater across multiple municipalities in Minnesota. Results will be applicable to all urban stormwater systems in the State.

C. Timeline Requirements

Stormwater collections will occur in the first year of the study and contaminants of emerging concern analysis will be completed by the end of the second study year (Activity 1). Activity 2 will begin in year 2 and will be completed in Year 3. The proposed project will be completed in the allotted three-year period.

2018 Detailed Project Budget

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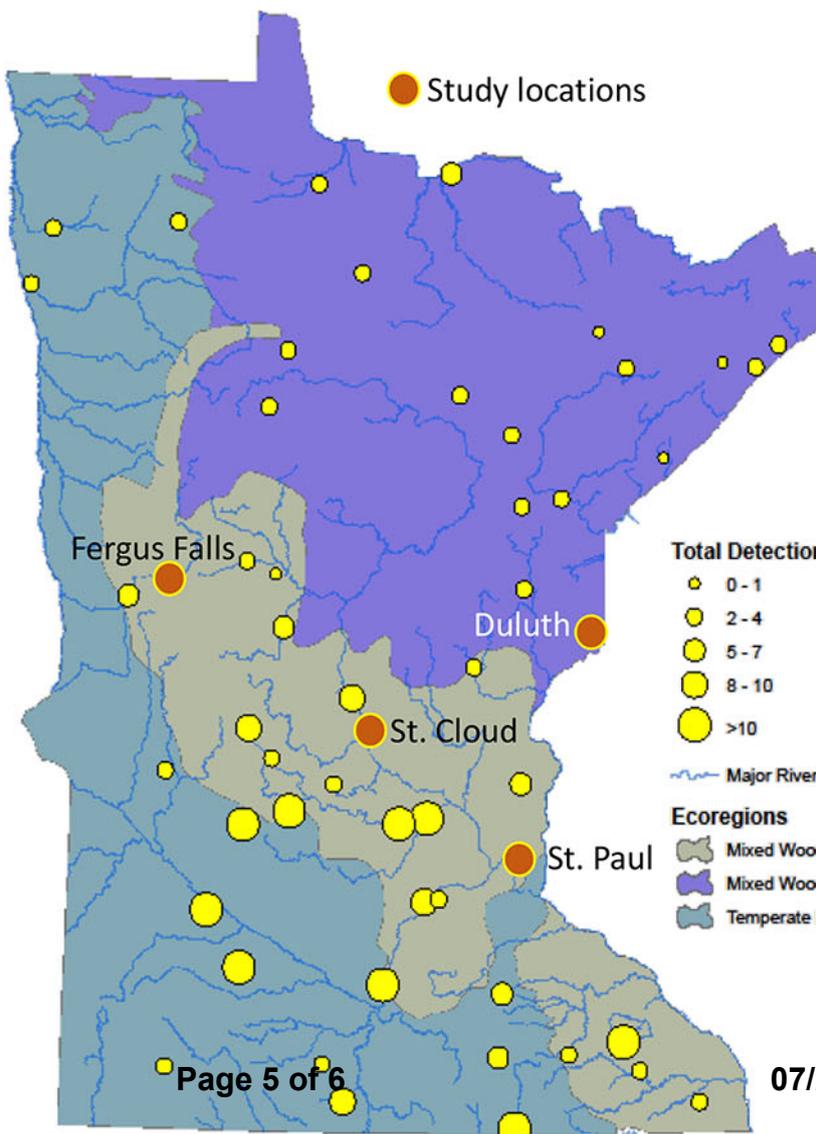
IV. TOTAL ENRTF REQUEST BUDGET 3 years

<u>BUDGET ITEM</u>	<u>AMOUNT</u>
Personnel:	
Heiko L. Schoenfuss, Project Manager (74% salary, 26% benefits); 10% FTE per year for 3 years	\$ 27,846
Satomi Kohno - Activity 2 oversight (62% salary, 38% fringe); 25% FTE year 1, 50% FTE years 2 & 3	\$ 103,813
Professional/Technical/Service Contracts:	
<u>Subcontract:</u> Stormwater sampling and analysis coordinated by the US Geological Survey (Activity 1) including analytical services from the USGS National Water Quality Lab for the analysis of 55 samples (48 stormwater samples & QA/QC samples) for three analytical schedules of approximately 400 chemicals (\$165,770), expendable supplies (\$2,300), shipping of samples to Nat'l Quality Lab (\$2,800), communication costs with remote equipment (\$550), and travel to collection sites (\$5,680). Subcontract includes salary and benefits for two Hydrologist (Kiesling - 79% salary, 21% benefits = \$16,500; Sarah Elliott - 72% salary, 28% benefits = \$14,000); the Program Manager (M. Brigham = \$15,000) and Administrative Assistance (69% salary, 31% benefits = \$7,400).	\$ 230,000
<u>Subcontract:</u> Transcriptome analyses for Leopard frog, painted turtle and wood duck species at the University of Minnesota, \$1,200 each species x 3 = \$3,600 (Activity 2)	\$ 3,600
Equipment/Tools/Supplies: Analysing biological activity of contaminants across seven species for 48 stormwater samples, \$95/species x 7 species x 55 stormwater & QA/QC samples (Activity 2).	\$ 36,575
Acquisition (Fee Title or Permanent Easements): N/A	\$ -
Travel: For sampling, visiting 6 stormwater BMPs twice for 3 years, \$200 x 6 lakes x 3 years=\$3,600	\$ 3,600
Additional Budget Items: N/A	\$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 377,588

V. OTHER FUNDS

<u>SOURCE OF FUNDS</u>	<u>AMOUNT</u>	<u>Status</u>
Other Non-State \$ To Be Applied To Project During Project Period: N/A	\$ -	N/A
USGS Cooperative water fund support	11,933	Secured
USGS Cooperative water fund support	23,866	Pending
Other State \$ To Be Applied To Project During Project Period: N/A	\$ -	N/A
In-kind Services To Be Applied To Project During Project Period: N/A	\$ -	N/A
Past and Current ENRTF Appropriation: N/A		
Funding History: ML 2009, Chap.142, Sec. 2, Subd. 5b "Vulnerability of Lakes to Endocrine Disruption"	\$ 297,000	completed
Funding History: M.L. 2010, Chp. 362, Sec. 2, Subd. 5c "Ecological Impacts of Effluent in Surface Waters and Fish"	\$ 340,000	completed
Funding History: M.L. 2010, Chp. 362, Sec. 2, Subd. 5e "Assessing Septic System Discharge to Lakes"	\$ 594,500	completed
Funding History: M.L. 2014, Chp. 226, Sec 2, Subd. 03d "Evaluation of Wastewater Nitrogen and Estrogen Treatment Options" (Novak, PI - Activity 2: Schoenfuss \$186,600)	\$ 186,600	completed (6/30/17)
Funding History: M.L. 2015, Chp. 76, Sec 2, Subd. 04c " Biological Consequences of Septic Pollution in Minnesota Lakes" (Schoenfuss, PI, Kiesling Co-PI)	\$ 364,000	in progress
Other Funding History: Indicate funding secured but to be expended prior to July 1, 2018, for activities directly relevant to this specific funding request. State specific source(s) of funds and dollar amount.	\$ 60,689	Secured (MN PCA)

of Chemicals detected in 50 MN waters (2014)



● Study locations

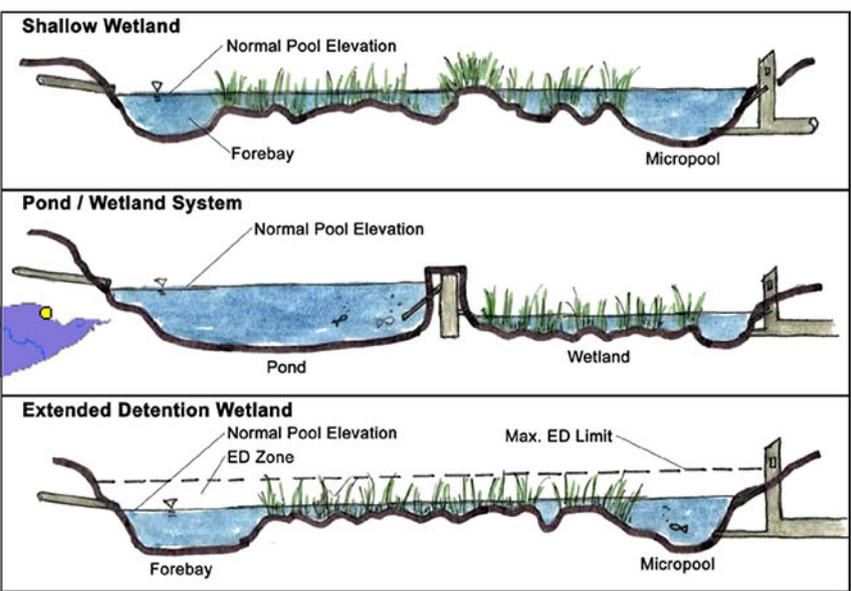
Fergus Falls

Duluth

St. Cloud

St. Paul

- Total Detections**
- 0 - 1
 - 2 - 4
 - 5 - 7
 - 8 - 10
 - >10
- Major Rivers
- Ecoregions**
- Mixed Wood Plains
 - Mixed Wood Shield
 - Temperate Prairies



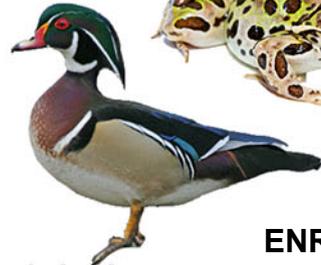
Mussel



Fathead minnow



Leopard frog



Wood duck



Painted turtle

07/29/2017

ENRTF ID: 041-B

Project Manager Qualifications & Organization Description

Project Manager Qualifications

Heiko Schoenfuss, the director of the St. Cloud State University *Aquatic Toxicology Laboratory*, will serve as the project manager for this project. He will oversee the logistical preparations of the project, identify the appropriate timing of stormwater collections and coordinate between the Co-Principal Investigators (Kohno, SCSU; Kiesling USGS) on all aspects of the proposed research. He will also establish *Quality Assurance and Quality Control (QA/QC)* plans, maintain a comprehensive data record and provide timely updates to the legislation on study progress.

Dr. Schoenfuss has a well-established record of completing extensive research studies on time and on budget and has been the principal investigator in several large-scale field studies across North America. For the past 20 years and in over 85 publications, Dr. Schoenfuss has focused his research on the effects of contaminants of emerging concern on aquatic ecosystems. His research in Minnesota has helped to establish the link between treated wastewater effluent discharge and compromised fish health, between septic discharge and reduced reproduction in lake fish, and between stormwater discharge and environmental contaminant loads. Dr. Schoenfuss is the chair of the *Endocrine Disruptor Testing and Risk Assessment Steering Committee (Society for Environmental Toxicology & Chemistry World Council)*, has served on the *EPA Science Advisory Board*, on a *National Institute of Environmental Health* review committee, and the *MN Department of Health Advisory Board*.

Satomi Kohno is an assistant professor at St Cloud State University (SCSU, Biology) and an expert in endocrine toxicology with 15 years' experience in research. Kohno has played a key role in developing molecular biological techniques to study endocrine disruption in wildlife.

Richard Kielsing is a hydrologist at the US Geological Survey (Mounds View, MN) and has collaborated with Schoenfuss on several State and Federally funded projects, including a recent study on stormwater discharge. Dr. Kiesling will coordinate sample submission and data analysis as it relates to the analytical water chemistry of the stormwater samples through the USGS National Water Quality Laboratory.

Organization Description

St. Cloud State University is a comprehensive, Master's degree granting university with 200 undergraduate and 60 graduate degree programs. Our infrastructure is well equipped to complete the proposed study on time and on budget utilizing existing facilities in the SCSU Aquatic Toxicology Laboratory and in the recently complete *Integrative Science & Engineering Laboratory Facility (ISELF)*. SCSU faculty in this project (Schoenfuss, Kohno) closely interact with outstanding undergraduate and graduate students who are continuously recognized in regional and national science competitions for their scientific excellence (web.stcloudstate.edu/aquatictox). St. Cloud State is ranked in Forbes magazine's "America's Top Colleges" and Money magazine's "Money's Best Colleges."