Environment and Natural Resources Trust Fund

2024 Request for Proposal

General Information

Proposal ID: 2024-057

Proposal Title: Characterization of Chemicals in Structural Fire Wastewater

Project Manager Information

Name: Grace Wilson

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Basic Information

Project Summary: The wastewater from extinguishing structural fires will be analyzed to identify and characterize chemicals present and better understand potential toxicity to humans and water systems.

Funds Requested: $369,000

Proposed Project Completion: July 31, 2026

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?

In the Future

Narrative

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

Water used to extinguish structural fires may be a significant source of toxic chemicals into Minnesota's waters. During a structural fire, building and household materials (especially vinyl materials) undergo chemical transformations under the extreme fire temperatures. Some of these chemicals can become mobile in the water used in extinguish the fire, and are then transported into storm drains and water systems. In addition to contaminant sources from the fire itself, the effluent (described by first responders as resembling "black sludge"), may also transport toxic PFAS chemicals found in fire-fighting foams. First-responders are also exposed to these chemicals while on the scene, and may transport them on their clothing, gear, personal protective equipment. Chemicals generated during burning and those used in fire-fighting foams are categorized as persistent organic pollutants (or POPs), and are known to be very slow to breakdown in the environment while also being extremely toxic to humans and aquatic ecosystems. However, there has been little research into the specific types and the amounts of these chemicals in the water effluent following fires. A better characterization of the chemicals found in fire wastewater is needed in order to identify and address potential toxicity to humans and aquatic systems.

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.

We propose to characterize the chemicals found in the wastewater resulting from extinguishing structural fires by:

1. Identifying the presence and amounts of toxic chemicals in fire wastewater
2. Analyzing the timing of chemical release into the water during a live fire event
3. Modelling the fate and transport of these chemicals in storm water systems

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 work will identify and characterize contaminants that are present in firefighting wastewater. This includes identifying the presence and amount of those that are known to be toxic to humans (carcinogens, endocrine disrupters, etc), as well as those that can also damage aquatic ecosystems. We will also make predictions on the amounts of these chemicals delivered to receiving waterbodies (including rivers, ponds, and other waters) after considering potential degradation or transformation. Initial identification and characterization of these chemicals is necessary in order to better understand their effect on human and aquatic ecosystem health.

Activities and Milestones

Activity 1: Identify chemicals present in fire wastewater

Activity Budget: $209,744

Activity Description:
The wastewater resulting from fighting structural fires will be analyzed to determine the concentrations of chemicals known to be toxic to humans and aquatic systems, including heavy metals and persistent organic pollutants. We will test for toxic chemicals likely to be found in the fire-water effluent, including: per- and poly-fluoroalkyl substances (PFAS) used in fire-fighting foams, polychlorinated dioxins and furans (by-products formed when PVC plastics burn), heavy metals (used in structural components of buildings), and polyaromatic hydrocarbons (formed during combustion of materials used in household items). Sample kits will be provided to partnering firefighting agencies (including the Minneapolis and St. Paul Fire Departments), and fire fighters on the scene will take grab samples of this water following structural fires. These samples will be delivered to a laboratory and analyzed to determine the concentrations of the chemicals identified above. The total amount of the chemical in the wastewater will be calculated based on measured concentrations and estimates of water volumes used at the fire. Additionally, 2-3 chemicals from the full list will undergo further analysis to characterize decomposition. For this, the water sample will be subdivided, and some of the samples will be sent in for analysis on a time-lagged basis.

Activity Milestones:

Description	Approximate Completion Date
Identify chemicals present and their concentrations in wastewater grab samples from fire scenes	October 31, 2025
Estimate total chemical load in this effluent	October 31, 2025
Determine decomposition and chemical transformation of select contaminants from effluent	October 31, 2025

Activity 2: Analyze the chemicals present and timing of their release into stormwater systems during a live fire

Activity Budget: $123,886

Activity Description:
Samples of wastewater from a structural fire will be collected at different times during a fire-fighting exercise at a controlled burn at the East Metro Public Safety Training Center located in Maplewood, MN. In coordination with partnering fire-fighting agencies, researchers will set-up collection devices at the controlled burn, and take water samples and measurements of flow at set times during the fire scenario. These samples will be analyzed to determine chemical species present in the water and their concentrations (as in Activity 1). This data will provide a detailed picture of how concentrations of chemicals in the fire wastewater change over the course of fighting a fire. Estimates of the flow rate of the effluent will also be taken so that the total load of the chemicals can be calculated. These samples will be analyzed for the same constituents identified in Activity 1.

Activity Milestones:

Description	Approximate Completion Date
Determine the time-response of chemical release into waters during fire-fighting efforts	July 31, 2026
Identify chemicals present and their concentrations in fire-water effluent from a controlled burn	July 31, 2026

Activity 3: Model the fate and transport of chemicals released into waters from structural fires

Activity Budget: $35,370

Activity Description:

Data from activities 1 and 2 will be used to model the fate and transport of water-born chemicals resulting from firefighting activity. Modeling will be limited to those chemicals selected for determining the rates of decomposition in Activity 1. These rates will be modeled using a first-order process or other relatively simple relationships. The resulting equations will be used to develop a spreadsheet tool that estimates the chemical load to receiving surface water bodies. This spreadsheet tool will account for the initial mass of the chemical entering the stormwater system (including the water volume from fire-fighting and the initial concentration of the chemical expected in the effluent), as well as changes in its concentration due to decomposition or chemical transformation and dilution from lateral flow in the storm drain. Given these variables, and an estimate of the length of the storm drain and travel time, we will be able to estimate the total discharge of the chemical into receiving surface water bodies.

Activity Milestones:

Description	Approximate Completion Date
Decomposition/transformation model for selected chemicals	July 31, 2026
Spreadsheet tool that calculates chemical delivered at downstream locations	July 31, 2026

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Matt Simcik	University of Minnesota	Co-principal investigator for the proposed research; will work with sample collection design and analysis and general grant management	Yes
Barton Inks	St. Paul Fire Department	The St. Paul Fire Department is a partner organization which will collect water samples for the study. As fire chief, Barton Inks will work with the researchers to facilitate sample collection by staff at the St. Paul Fire Department.	No
Byran Tyner	Minneapolis Fire Department	The Minneapolis Fire Department is a partner organization which will collect samples for the study. As fire chief, Bryan Tyner will work with the researchers to facilitate sample collection by staff at the Minneapolis Fire Department.	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 work be funded?

The team will give open scientific presentations and publish scientific papers addressing the project objectives. We expect to achieve the stated objectives of this project within the bounds of this grant timeline. However, there has been little previous research in this area, and results of this work may indicate additional research is necessary to fully characterize the chemicals, their transport, and to consider mitigation strategies. Any additional work will be funded by separate grants after completion of the deliverables from this project.

Project Manager and Organization Qualifications

Project Manager Name: Grace Wilson

Job Title: Researcher and Lecturer

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

Dr. Wilson received a B.A degree from Macalester College in 2007, majoring in Biology with a minor in Chemistry. In 2012, she received her M.S. degree in Applied Plant Sciences, and her Ph.D. in Land and Atmospheric Sciences in 2018, both from the University of Minnesota. Her long-term research interests involve finding solutions to water quality and water resources problems using tools that combine chemical, biological, and physical sciences. Dr. Wilson's research and academic experiences have focused on utilizing statistical and hydrologic/water quality models to study pollution of surface and groundwater. During work on her M.S. and PhD degrees at the University of Minnesota, she developed in-depth knowledge of hydrologic processes and contaminant transport, including topics related to surface and groundwater hydrology, water quality field methods, and computer modeling of watershed processes. Dr. Wilson has worked on research projects focused on water quality in agricultural and urban watersheds. Her work in agricultural watersheds has included interdisciplinary projects which utilized models to examine the effect of different cropping systems, farm management practices, and livestock systems on water quality. In addition to her work in agricultural water quality, Dr. Wilson has worked on research projects related to urban stormwater runoff, including work related to nutrient contributions to urban raingardens from organic solids. Her work has also included statistical evaluation of hydrologic model performance.

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

Organization Description:

The College of Food, Agriculture, and Natural Resources Sciences (CFANS) at the University of Minnesota is dedicated to using science to find answers to the world's grand challenges and solve tomorrow's problems. The College includes twelve academic departments along with ten research and outreach centers, all representing a range of disciplines and research expertise. This breadth of expertise allows the College to tackle challenges in novel ways, including the Grand

Challenge research and education investments program which specifically focuses on research geared towards water resources and uses.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Faculty		Manage project and consult on analysis of results; general grant management			36.8%	0.2		$38,879
Researcher		Conduct analysis of results; manage sample collection; general grant management			36.8%	1		$102,600
Graduate Student		Provide research support and data analysis support			24.1%	0.15		$22,115
Undergraduate Reseacher		research support; position would pay 1 undergraduate 25% time during academic year; 2 students 75% over the summer			0%	0.75		$21,600
							Sub Total	**$185,194**
Contracts and Services								
TBD	Professional or Technical Service Contract	Analyzing water samples for specified chemicals and reporting results to the researchers				2		$177,908
							Sub Total	**$177,908**
Equipment, Tools, and Supplies								
	Tools and Supplies	Sample Collection kits (coolers, water collection bottles, ice packs)	Collect water samples. Each kit costs $100 x 40					$4,000
	Tools and Supplies	Materials to sample water from controlled burn (sampling bottles, equipment to funnel water to sampling location)	Items will be used to collect water samples from a controlled burn					$1,000
	Tools and Supplies	Extra sampling bottles and sampling supplies (quantity 20-40)	Additional sampling bottles to use in chemical degredation analysis					$500
							Sub Total	**$5,500**
Capital Expenditures								
							Sub Total	**-**

Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	4 trips with a rented University fleet truck or large van @ $70/day	Carry supplies to controlled burns					$398
							Sub Total	**$398**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$369,000**

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

Attachments

Required Attachments

Visual Component

File: 12813f19-ee0.pdf

Alternate Text for Visual Component

The graphic shows a structural fire with a firefighter putting out the blaze. Water is shown leaving the fire and entering a wetland. A magnifying glass is shown zooming in on the water from the fire, and showing toxins leaving the fire in that water entering the wetland....

Optional Attachments

Support Letter, Photos, Media, Other

Title	File
Support Letter-Minneapolis Fire	7523fd31-289.pdf
Support Letter-St Paul Fire	8114407f-b70.pdf
UMN PRF	1f5ce179-b3d.doc

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

Does your project include the design, construction, or renovation of a building, trail, campground, or other capital asset costing $10,000 or more?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services, as defined in Minnesota Statutes section 299C.61 Subd.7?

No