Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)

Project Title: **ENRTF ID: 055-B**

Maximizing the Benefits of Water Reuse

Category: B. Water Resources

Total Project Budget: $ 148,000

Proposed Project Time Period for the Funding Requested: 2 years, July 2017 – June 2019

Summary:

The goal of this project is to provide pathogen data needed to maximize the benefits to groundwater resources and surface water quality by eliminating barriers to water reuse.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

This graphic depicts a proposal for analysis of microbial water quality in water reuse systems. The sources of reuse will include graywater, stormwater, and industrial process water. Water samples will be collected from the source (pre-treatment) and again after treatment (post-treatment). The samples will be analyzed for human pathogens to obtain a representation of microbial water quality by source and treatment type. The risk associated with the type and concentration of pathogens will be evaluated, and recommendations for water quality standards and system design will be made for the end use of the water based on this information. Groundwater resources are protected and surface water quality is improved by maximizing the potential for water reuse.

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

PROJECT TITLE: Maximizing the Benefits of Water Reuse

I. PROJECT STATEMENT

The goal of this project is to maximize the potential of water reuse in Minnesota by eliminating barriers to water reuse implementation. Reusing water will reduce demands on groundwater aquifers and improve surface water quality. Since there are no national regulations for reuse, the Minnesota Department of Health (MDH) has been asked by other agencies to set water quality requirements for graywater, stormwater and industrial process water to be used for purposes such as toilet flushing, vehicle washing, irrigation and final product rinse to set a clear path forward to those interested in implementing reuse. MDH does not have the pathogen data needed to set these standards. In addition, the cost of water reuse systems can be reduced by utilizing design components that minimize pathogens. By characterizing human disease-causing microbes (pathogens) in Minnesota water reuse systems, the University of Minnesota (U of M) will be able to provide MDH the data needed for setting water quality standards and making design recommendations.

The specific goals of this work are to:

1. Pathogens: Quantify and characterize the human pathogens found in water reuse systems within the state by collecting 144 samples and comparing the pathogen data for 24 water reuse systems.
2. System Design: Collect information on design elements (including water source, storage, and treatment devices) for the 24 water reuse systems and relate to pathogen occurrence.
3. Risk Assessment: Relate the pathogen data to health risk through quantitative microbial risk assessment (QMRA) in order to ensure the health and safety of the public is protected.
4. Recommendations: Make recommendations about water quality standards and treatment design to set a clear path for water reuse in Minnesota.

The U of M previously developed innovative tools to quantify multiple pathogens (both bacteria and viruses) in many water samples. By taking advantage of these tools, we can help MDH comprehensively analyze the safety of water reuse and relate system design to pathogen occurrence. Thus, we have a unique opportunity to advance water reuse both in Minnesota and across the country.

Activity 1: *Quantify and characterize the microbial pathogen communities in reuse systems in Minnesota.* **Budget: $107,000**

144 samples will be collected from 24 water reuse systems around the state. Most of the water reuse systems are located in the metro area, but there are examples in Duluth, Cold Spring and other locations. We anticipate collecting samples from each reuse system on two different occasions, sampling at the source, after treatment and distributed water as appropriate for the site.

We will then make detailed characterizations of the microbial pathogens using microfluidic qPCR to generate quantitative information of over 20 human pathogenic organisms (both bacteria and viruses). We will target all major waterborne pathogens including *E. coli* O157, *Salmonella*, *Campylobacter*, *Shigella*, *Clostridium perfringens*, *Legionella pneumophila*, *Listeria monocytogenes*, human adenovirus, Astrovirus, Enterovirus, human Norovirus (GI, GII, and GIV genotypes), Hepatitis A virus, Hepatitis E virus, Rotavirus A, and Sapovirus.

Outcome	Completion Date
1. Sample collection and DNA/RNA extractions	September 30, 2018
2. Microfluidic qPCR analysis	December 31, 2018

Activity 2: *Document water reuse system design components.* **Budget: $3,000**

For this step, we will inventory and record the types of water reuse design components such as source of reuse water, storage and treatment devices used in each water system. Sources will include rainwater (from

roofs), stormwater, graywater and industrial process water. Storage includes cisterns, stormwater ponds and underground storage. Treatment devices include first flush devices, disinfection such as chlorine or ozone, or filters. These components can affect water quality by affecting the ability of pathogens to collect, survive, and multiply.

Outcome	Completion Date
1. Documentation of water reuse system design.	September 30, 2018

Activity 3: *Analyze microbial data and system design data.* **Budget: $38,000**

Based on the quantitative information of various pathogens, we will partner with MDH to assess the potential health risks associated with the water samples through QMRA. We will also develop an understanding of how system design components affect the microbial pathogen populations in the water.

Outcome	Completion Date
1. Risk assessment.	March 31, 2019
2. Analysis of microbial data in relation to system design.	March 31, 2019

Activity 4: *Set a clear pathway for implementing reuse by recommending water quality and design standards for water reuse.* **Budget: $ N/A**

Results of the QMRA and design understanding will be used by MDH to set water quality standards and make design recommendations using best public health and engineering practices. Benefits of water reuse will be maximized due to elimination of barriers.

Outcome	Completion Date
1. Set water quality standards.	June 30, 2019
2. Make design recommendations.	June 30, 2019

III. PROJECT STRATEGY

A. Project Team/Partners

University of Minnesota
Project Manager and Lab Lead: Satoshi Ishii (Department of Soil, Water and Climate)
Technical support: Timothy LaPara (Department of Civil, Environmental, and Geo- Engineering): In-Kind
Sample collection and analysis: Undergraduate students (to be hired)
Data analysis: Graduate student (to be hired)
Minnesota Department of Health (No ENRTF Funding)
Partners: Anita Anderson (Section of Drinking Water Protection), Nancy Rice (Health Risk Assessment)

B. Project Impact and Long-Term Strategy

This project will maximize the potential of water reuse to conserve Minnesota's groundwater and improve surface water quality by providing the pathogen data needed to eliminate barriers to water reuse. This research will provide assurances to the public, regulators and system owners that water reuse can become common practice without negative effects on public health and safety and provide design information to reduce cost.

C. Timeline Requirements

The proposed project will be completed in a two-year period. Samples and system information will be collected for the first 15 months of the project followed by microbiological and data analyses for the final 9 months of the project.

2017 Detailed Project Budget

Project Title: *Maximizing the Benefits of Water Reuse*

IV. TOTAL ENRTF REQUEST BUDGET 2 years

BUDGET ITEM	AMOUNT
Personnel:	
Satoshi Ishii,Assistant Professor (75% salary, 25% benefits); 8% FTE for two years; project supervision, supervision of post-doctoral or graduate student, project reporting.	$ 26,000
Graduate research assistant (55% salary, 45% benefits); 50% FTE for 18 months; perform microfluidic qPCR and quantify pathogens, perform data analysis	$ 93,000
Undergraduate researcher (100% salary, 0% benefits); 100% FTE in summer for 5 months, 25% FTE during academic year for 10 months, sample collection and processing	$ 13,000
Professional/Technical/Service Contracts:	
University of Minnesota Genomics Center: microfluidic qPCR (144 bacteria samples at $15/sample and 144 virus samples at $15/sample)	$ 5,000
Equipment/Tools/Supplies:	
Lab supplies (Membrane filters: 144 samples at $20/sample; DNA extraction kits for bacteria: 144 samples at $3/sample; RNA extraction kits for viruses: 144 samples at $5/sample; Reagents for qPCR: (144 bacteria samples at $5/sample and 144 virus samples at $5/sample; otherl lab suppplies: 144 samples at $5/sample)	$ 7,000
Travel:	
In-state travel to collect samples: (Approximately 3000 miles at .54/mile, meals at maximum $36/day)	$ 4,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST	$ 148,000

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	N/A	
Other State $ To Be Applied To Project During Project Period:	N/A	
In-kind Services To Be Applied To Project During Project Period:		
The University of Minnesota does not charge the State of Minnesota its typical overhead rate of 53% of the total modified direct costs (graduate tuition and academic fringe are excluded).	$ 56,000	secured
Funding History:	N/A	
Clean Water Fund	$ 200,000	
Remaining $ From Current ENRTF Appropriation:	N/A	

Maximizing the Benefits of Water Reuse

Source water		Test Water (Pre-Treatment)	Treatment	Test Water (Post-Treatment)	Analyze/ Characterize	Set a Clear Pathway	Benefit Resources
 Graywater (sinks, shower, tub, laundry)		Microbial sampling 	Examples: filtration, ultraviolet light, ozone, chlorine, or none	Microbial sampling 	Identify human pathogens 	Make recommendations for water quality and design appropriate to end use	 Protect groundwater resources and improve water quality by maximizing the potential for water reuse
 Stormwater					Perform Quantitative Microbial Risk Assessment and Design Analysis		
Industrial Processes 							

Project Manager Qualifications and Organization Descriptions

Satoshi Ishii

Satoshi Ishii is Assistant Professor in the BioTechnology Institute (BTI) and the Department of Soil, Water, and Climate (SWC) at the University of Minnesota. He joined the BTI and SWC in April, 2015. He has over 10 years of experiences on water quality microbiology. He has developed novel microfluidics tools to simultaneously quantify multiple pathogens and applied these tools to the risk assessment of water samples. The Ishii Lab (located in the St. Paul campus of the University of Minnesota) is equipped with all the necessary items for the proposed research. In addition, his group has a full access to the microfluidic qPCR and related instruments in the University of Minnesota Genomics Center.

Timothy M. LaPara

Tim LaPara is a Professor in the Department of Civil, Environmental, and Geo- Engineering at the University of Minnesota. Dr. LaPara's research focuses on the microbiology of municipal wastewater treatment and the treatment of public water supplies; the goal of his research is to preserve environmental quality and to protect public health. His research has a strong interdisciplinary nature, stemming from his unique background in both environmental engineering and microbiology.

Anita Anderson

Anita Anderson, P.E. is a Principal Engineer Supervisor with the Minnesota Department of Health Drinking Water Protection Section. Anita Anderson has 20 years of experience as a water supply engineer with the Minnesota Department of Health. Her primary area of expertise is surface water treatment, specializing in small systems. Currently she is also working on special projects to implement water reuse in Minnesota in a safe and sustainable way and to predict the vulnerability of groundwater drinking water sources to microbial pathogens. She is a registered professional engineer in Minnesota.

Nancy Rice

Nancy Rice is a Research Scientist with the Minnesota Department of Health Environmental Surveillance and Assessment Section. Nancy has been working since 2013 to research, develop, and implement quantitative microbial risk assessment (QMRA) for specific exposure scenarios, particularly water reuse. This work involves coordinating with other health department staff, state interagency staff, and University of Minnesota researchers to gather and analyze data concerning microbial exposure potentials and populations affected and communicating the results of QMRA to staff for use in policy decisions.

Organization Descriptions

The University of Minnesota is the main research and graduate teaching institution in the state of Minnesota. The BioTechnology Institute provides advanced research, training, and university-industry interaction in biological process technology. In the Department of Soil, Water, and Climate, we seek to improve and protect the quality of soil, air, and water resources in natural and managed ecosystems, through research, reaching, and extension.

The mission of the Minnesota Department of Health is to protect, improve, and maintain the health of all Minnesotans.