Environment and Natural Resources Trust Fund
2016 Request for Proposals (RFP)

Project Title: **ENRTF ID: 048-B**

Triclosan Impacts on Wastewater Treatment - Phase 2

Category: B. Water Resources

Total Project Budget: $ 399,063

Proposed Project Time Period for the Funding Requested: 3 years, July 2016 to June 2019

Summary:

This project will quantify benefits (reduced antibiotic resistance and triclosan/dioxin loads to the environment) and costs (increased usage of alternative antibacterials) of Minnesotas pending ban of triclosan in cleaning agents.

Name: Timothy LaPara

Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Will Minnesotas pending ban of cleaning products containing triclosan reduce the levels of antibiotic resistance in wastewater effluents and dioxins in lake sediments? Or will it merely lead to an increase in the use of alternatives, such as chloroxylenol?

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

PROJECT TITLE: ***Triclosan impacts on wastewater treatment: Phase 2***

I. PROJECT STATEMENT

The goal of this proposed project is to evaluate the effect of banning the sale of cleaning products containing triclosan within Minnesota, which is scheduled to occur on January 1, 2017. This research is needed because the ban of triclosan sets a precedent in regulating a specific pharmaceutical compound for environmental purposes. Simply put: This research will provide guidance on whether it is appropriate to ban other pharmaceutical and personal care products for environmental reasons.

Triclosan (2,4,4′-trichloro-2′-hydroxydiphenyl ether) is an antibacterial agent used in numerous commercial products, including liquid hand soap, toothpaste, cosmetics, and children's toys. Triclosan is believed to impose numerous adverse effects on both human health and environmental quality, including increased levels of antibiotic resistance, the accumulation of triclosan-derived dioxins in lake sediments, and endocrine disrupting effects. With the end of the sale of triclosan-containing cleaning products in Minnesota, there should be immediate beneficial effects. There should be declines in the quantities of both triclosan and of antibiotic resistant bacteria in raw sewage, in wastewater treatment bioreactors, and in wastewater effluents. The reductions in antibiotic resistance are particularly important because antibiotic resistance currently costs $20-40 billion per year and leads to 30,000+ premature deaths each year. These benefits should become apparent over time as well as compared to other states that continue to allow the use of triclosan in cleaning agents. The quantities of triclosan and of antibiotic resistant bacteria will be measured prior to and after January 1, 2017. Similarly, beginning in July 2017 (i.e., well after Minnesota's ban commences), the quantities of triclosan and of antibiotic resistant bacteria in Minnesota will be compared to those of adjacent states that have yet to ban triclosan in cleaning agents. In contrast, the ban of triclosan could merely lead to a shift away from triclosan to a different antibacterial agent; for this reason we will also measure the levels of chloroxylenol (a similar antibacterial) to assess whether this unintended consequence is coming to fruition.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Measure the quantities of antibiotic resistance genes, triclosan, and chloroxylenol in Minnesota's wastewater treatment plants prior to January 1, 2017.* **Budget: $129,501**

Samples will be collected from up to four different locations (influent, effluent, aeration tanks, and sludge treatment system, if applicable) from within a least six different wastewater treatment facilities (Mankato, Brainerd, St. Cloud, Rochester, Metropolitan, and St. Peter) within Minnesota on at least five different occasions prior to January 1, 2017. Antibiotic resistance levels will be measured using a novel microarray technique that is currently being developed at the University of Minnesota. Triclosan and chloroxylenol concentrations will be measured by liquid chromatography-tandem mass spectrometry (LC-MS/MS). Because the chemical analyses are time-consuming, only a subset of the samples will be analyzed.

Outcome	Completion Date
1. Sample collection and genomic DNA extractions	April 15, 2017
2. qPCR targeting antibiotic resistance and related genes	July 31, 2017
3. Method development for analyzing for chloroxylenol	January 31, 2017
4. Quantification of antibacterial compounds in water/sludge	December 31, 2017

Activity 2: *Measure the quantities of antibiotic resistance genes, triclosan, and chloroxylenol in Minnesota's wastewater treatment plants after triclosan is banned.* **Budget: $129,501**

Samples will be collected from the same locations and the wastewater treatment facilities and analyzed as described in Activity 1. In this Activity, no samples will be collected until at least July 1, 2017 (6 months after Minnesota's ban on triclosan goes into effect) to allow us to make comparisons with measurements taken prior

to the ban. The outcome of Activity 1 and Activity 2 will allow us to compare the levels of antibiotic resistance, triclosan, and other antibacterials in response to the ban on the sale of cleaning agents containing triclosan that will occur in Minnesota on January 1, 2017.

Outcome	Completion Date
1. Sample collection and genomic DNA extractions	December 31, 2017
2. qPCR targeting antibiotic resistance and related genes	July 31, 2018
3. Quantification of antibacterial compounds in water/sludge	December 31, 2018

Activity 3: *Measure the quantities of antibiotic resistance genes, triclosan, and other antibacterial compounds in other states.* **Budget: $129,501**

Samples will be collected and analyzed as described above for Activity 2, but from ten different wastewater treatment facilities outside the State of Minnesota (most likely, Wisconsin: Eau Claire, Madison; Illinois: Rockford, Indiana: South Bend; Iowa: Des Moines, Ames) on at least three different occasions.

Outcome	Completion Date
1. Sample collection and genomic DNA extractions	December 31, 2017
2. qPCR targeting antibiotic resistance and related genes	December 31, 2018
3. Quantification of antibacterial compounds in water/sludge	April 15, 2019

Activity 4: *Dissemination and outreach* **Budget: $10,558**

A substantial, multi-faceted effort will be made to disseminate the results of this study. We will explicitly present the results at the Minnesota Water Conference, make the data publically-available using the University of Minnesota's digital data repository, and share our results with interested parties (for example, the participating wastewater treatment facilities, the Minnesota State Legislature, the Minnesota Department of Health, and the Friends of the Mississippi River).

Outcome	Completion Date
1. Presentations at the Minnesota Water Conference (annual, starting in Fall 2017)	June 30, 2019
2. Post data at the University of MN digital data repository (continuous, as data is available)	June 30, 2019
3. Data sharing with interested parties (continuous, as data is available)	June 30, 2019

III. PROJECT STRATEGY

A. Project Team/Partners:

The project will be led by Timothy LaPara and William Arnold (University of Minnesota, Department of Civil, Environmental, and Geo- Engineering). The team will also consist of a post-doctoral researcher and two undergraduate student researchers. Dr. LaPara is an expert on the quantification of resistance genes; Dr. Arnold has extensive experience quantifying chemicals in environmental matrices.

B. Project Impact and Long-Term Strategy:

This project will provide an understanding of the impact of Minnesota's historical decision to ban the sale of cleaning products containing triclosan. This ban is expected to lead to improvements in Minnesota's environment, the accumulation of triclosan-derived dioxins in lake sediments) and public health (i.e., reduced antibiotic resistance and endocrine disrupting effecting). In contrast, the ban of the sale of triclosan-containing cleaning agents could merely result in the increased use of other antibacterial compounds, resulting in no improvement to Minnesota's public health and environment.

C. Timeline Requirements:

The proposed project will be completed in a three-year period. Samples will be collected over a 2-year period. Chemical and microbiological analyses are time-consuming and will be performed throughout the 3-year period.

2016 Detailed Project Budget

Project Title: *Triclosan impacts on wastewater treatment, Phase 2*

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Personnel:	
Timothy M. LaPara, Project Manager (75% salary, 25% benefits); 6% FTE; Project supervision, supervision of post-doctoral research associate, project reporting, dissemination and outreach.	$ 36,606
William A. Arnold, co-Project Manager (75% salary, 25% benefits); 6% FTE; Project supervision, supervision of post-doctoral research associate, project reporting, dissemination and outreach.	$ 43,914
Post-doctoral researcher, to be hired (82.4% salary, 17.6% benefits); 100% FTE; Collect samples, quantify antibiotic resistance genes, triclosan and chloroxylenol, dissemination and outreach	$ 170,247
2 undergraduate researchers, to be hired (100% salary, 0% benefits); 100% FTE in summer, 25% during academic year, sample collection and processing	$ 63,796
Professional/Technical/Service Contracts:	$ -
University of Minnesota Genomics Center: Microarray analysis of antibiotic resistance genes, PCR primers, standards for quantification	$ 15,000
University of Minnesota Cancer Center: Quantification of triclosan and chloroxylenol via LC-MS-MS	$ 12,500
Equipment/Tools/Supplies:	
DNA extraction kits ($3 per sample, 1500+ samples)	$ 5,000
Reagents for qPCR (135,000 quantifications of different antibiotic resistance genes)	$ 15,000
Reagents/solvents/supplies for solid phase extractions	$ 15,000
Miscellaneous laboratory supplies (chemical regeants, filters, micropipette tips, etc)	$ 10,000
Travel:	
In-state travel to collect samples (Activities 1, 2, and 4)	$ 7,500
Out-of-state travel to collect samples from adjacent states (Activity 3)	$ 4,500
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 399,063

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 52% of the total modified direct costs (graduate tuition and academic fringe are excluded).*	$ 207,513	*Secured*
Funding History:		
$264,000 - ENRTH for ML 2010-05f - Evaluation of dioxins in Minnesota Lakes	$ 264,000	*Complete*
$380,000 - ENRTF for ML 2014-03c - Triclosan impacts on wastewater treatment	$ 380,000	*In progress*
Remaining $ From Current ENRTF Appropriation:		
ML 2014-03c - Triclosan impacts on wastewater treatment	$ 203,309	*Unspent*

Triclosan impacts on wastewater treatment: Phase 2

Minnesota's Wastewater Treatment Plants

Less Antibiotic Resistance?
Fewer Dioxins?
More chloroxylenol?

Wastewater Treatment in other states

More Antibiotic Resistance?
More Dioxins?

Project Manager Qualifications and Organization Description

Timothy M. LaPara

Professor, Environmental Engineering, Department of Civil, Environmental, and Geo-Engineering, University of Minnesota

B.S.C.E., Civil Engineering, 1995, University of Notre Dame, Notre Dame, IN
Ph.D., Civil Engineering, 1999, Purdue University, West Lafayette, IN

Dr. Timothy LaPara will be responsible for overall management of the proposed project. Dr. LaPara's research is focused on the role of municipal and industrial wastewater treatment plants in preserving environmental quality and in protecting public health. His research has a strong interdisciplinary nature, stemming from his unique background in both environmental engineering and microbiology.

William A. Arnold

Joseph T. and Rose S. Ling Professor and Associate Head, Environmental Engineering, Department of Civil, Environmental, and Geo- Engineering, University of Minnesota

B.S., Chemical Engineering, 1994, Massachusetts Institute of Technology, Cambridge, MA.
M.S., Chemical Engineering, 1995, Yale University, New Haven, CT.
Ph.D., Environmental Engineering, 1999, The Johns Hopkins University, Baltimore, MD.

Dr. William Arnold has been studying the fate of pharmaceutical and pesticide compounds in aquatic environments for fourteen years. The main focus has been the photolysis rates of pharmaceuticals and personal care products in surface water to determine the persistence of these compounds in the environment. As part of these efforts, reaction products have been identified to determine if photolysis leads to a loss of biological activity of the compounds and/or if reaction products are of additional environmental concern. Recent work in Dr. Arnold's group funded by the Environmental Natural Resource Trust Fund revealed that triclosan and its associated dioxins are accumulating in Minnesota Lakes. He has published over twenty peer-reviewed papers on pharmaceutical fate since 2003, and he is the co-author of a textbook on water chemistry published in 2011. Dr. Arnold is a Resident Fellow of the University of Minnesota Institute on the Environment, an Associate Fellow of the Minnesota Supercomputing Institute, and a member of the graduate faculty in Water Resources Science. He won the *Arcadis/Association of Environmental Engineering and Science Professors Frontier in Research Award* in 2012 and the University of Minnesota College of Science and Engineering *George W. Taylor Award for Distinguished Research* in 2011.

Organization Description

The University of Minnesota is one of the largest, most comprehensive, and most prestigious public universities in the United States (http://www1.umn.edu/twincities/about/index.html). The laboratories and offices of the PIs contain the necessary fixed and moveable equipment and facilities needed for the proposed studies.