



Environment and Natural Resources Trust Fund

M.L. 2021 Approved Work Plan

General Information

ID Number: 2021-144

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: July 21, 2021

Project Title: Microgeographic Impact of Antibiotics Released from Identified Hotspots

Project Budget: \$508,000

Project Manager Information

Name: Randall Singer

Organization: U of MN - College of Veterinary Medicine

Office Telephone: (612) 625-6271

Email: rsinger@umn.edu

Web Address: www.cvm.umn.edu

Project Reporting

Date Work Plan Approved by LCCMR: July 20, 2021

Reporting Schedule: December 1 / June 1 of each year.

Project Completion: June 30, 2024

Final Report Due Date: August 14, 2024

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 04d

Appropriation Language: \$508,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to inform protection of environmental, animal, and human health from proliferation of antibiotic resistance by quantifying and mapping the extent of antibiotic spread in waters and soils from locations identified as release hot spots.

Appropriation End Date: June 30, 2024

Narrative

Project Summary: We will quantify the release of antibiotics from hotspots identified in our previous project to surface waters in Minnesota using field, laboratory, and modeling approaches to ultimately inform interventions.

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

Antimicrobial resistance (AMR) threatens public health, animal health, and ecosystem health. Antibiotic use in hospitals, long-term care facilities, and animal husbandry operations (point sources) play a major role in AMR emergence. Discharges and runoff from these point sources enter the natural environment, in some cases after going through a treatment system at the point source itself or at a wastewater treatment plant. More than 50% of the antibiotic compounds used at the point source may be released unchanged or as an active metabolite into the environment. Antibiotic residues are found in the surface waters nearby the point sources. We still do not fully understand how far these residues can be transported, how long they remain in the water, and how they vary depending on the antibiotic use at the point sources. It is imperative to understand these issues to establish appropriate mitigation strategies at the point source to minimize the impact to human, animal, and ecosystem health. This project will quantify the antibiotics released from hotspots in space and time and how the dissemination and persistence of these antibiotics is affected by environmental characteristics as well as specific traits of the chemicals themselves.

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.

To fill in the important knowledge gaps that are needed to establish interventions to combat the impact of AMR on health-related outcomes, we propose to assess the influence of specific point sources on the dissemination of antibiotics in surface waters spatially and temporally. We will choose these point sources based on our previous large-scale footprint model of the entire state of Minnesota established with previous ENRTF support. By evaluating specific point sources (i.e. hospitals, wastewater treatment plants, animal husbandry operations) at a micro-geographical scale and over time, we will be able to correlate antibiotic prescription data throughout the year with environmental concentrations of antibiotic residues. We will be collecting field samples following our refined methodology from our previous project, as well as conducting laboratory experiments to fully understand factors such as degradation and association with particulates in the water column, which are critical variables to include in modeling efforts. Our models will ultimately indicate what type of interventions are needed at these point sources to minimize the impact of antibiotics on human, animal, and ecosystem health.

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?

We will generate data that correlates the impact of specific point sources with the dissemination of antibiotics into the environment both temporally and spatially. That information will allow improvement of waste management interventions at each one of the point sources studied, and better mitigation strategies to decrease the spread of antibiotics and AMR into the environment.

Project Location

What is the best scale for describing where your work will take place?

Statewide

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

8/22/2021

Activities and Milestones

Activity 1: Point source data collection and modeling of antibiotic residues on surface waters

Activity Budget: \$273,750

Activity Description:

We will select point sources in specific watersheds in Minnesota that represent hospitals, wastewater treatment plants, and animal husbandry operations. This selection will be based on our previously developed footprint model for the entire state, which highlighted hotspots of antibiotic levels in surface waters in relation to point sources. We will collect data on antibiotic use and on waste management practices at these sources. This information will be provided leveraging the Minnesota One Health Antibiotic Stewardship Collaborative, as well as through collaborations that spearheaded from our previous ENTRF funded projects. Using these data and results from Activity 2, we will develop geospatial and hydrological models to predict the dissemination of antibiotic residues from the point sources over time and over space in the watersheds of interest. We will also conduct epidemiological analyses to correlate antibiotic use and waste management practices with the field measurements for the antibiotic residues (Activity 2). Finally, we will integrate all results into a user-friendly interface to be used by managers at the point sources to visualize their impact into the watershed. That interface will also allow us to model intervention strategies and assess how the antibiotic emission levels change based on different treatment scenarios.

Activity Milestones:

Description	Completion Date
Data collection on antibiotic use and waste management practices at the identified point sources	December 31, 2021
Identify specific point sources within a watershed based on previous state wide footprint model	June 30, 2022
Development of user-friendly interface	June 30, 2024
Geospatial and hydrological modeling using data from Activity 2	June 30, 2024
Epidemiological analyses	June 30, 2024

Activity 2: Field measurements downstream of point sources and laboratory transformation studies

Activity Budget: \$234,250

Activity Description:

Once point sources are identified, the levels emitted into the environment and any seasonal variations need to be quantified with field measurements. Based on information collected in Activity 1, up to 10 sites that cover different sources (e.g., hospitals, wastewater treatment plants, animal husbandry operations) will be selected. For three of these sites, monthly sampling from April to October will be conducted (upstream, at the discharge point, and five locations downstream). For the other seven sites, quarterly sampling will be performed. To fully understand the persistence of antibiotics in aquatic systems and fully parameterize models (Activity 1), information about degradation rates of different compounds is needed. Relevant removal processes include transformation by sunlight, degradation by bacteria, and sorption to settling particles. While degradation by bacteria seems counter-intuitive, at subtherapeutic levels, bacteria can degrade antibiotics. For the targeted compounds, a literature review will be conducted to compile relevant rate constants. Because biodegradation rates will be affected by season and the native microbial community and sorption will be affected by the type and load of particles present, experiments will be needed to obtain rate constants relevant to Minnesota. Experiments for sunlight degradation will be used to fill in literature gaps.

Activity Milestones:

Description	Completion Date
Literature review of transformation rates	July 31, 2022
Photolysis studies	December 31, 2022

Sorption studies	July 31, 2023
Field measurements of antibiotic levels over distance from point sources (monthly sites)	October 31, 2023
Biodegradation studies	May 31, 2024
Field measurements of antibiotic levels over distance from point sources (quarterly sites)	May 31, 2024

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Amy Kinsley	University of Minnesota	Co-Investigator	Yes
Amanda Beaudoin	Minnesota Department of Public Health	Co-Investigator	No
Kristine Wammer	University of St. Thomas	Co-Project Manager	Yes
Irene Bueno	University of Minnesota	Co-Project Manager	Yes
William Arnold	University of Minnesota	Co-Project Manager	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines. Findings will be disseminated and archived via reports to LCCMR, peer-reviewed publications (note funds are requested to allow publication in open access journals to enhance dissemination), and presentations at conferences. We will also, when appropriate, disseminate results via the media. The audience is not only the scientific community, but also the public, policymakers, and practitioners. The work will also be of interest to the medical community, and we will seek avenues to share the results with this community. Acknowledgment of funding from the Environment and Natural Resources Trust Fund will be made following the guidelines described at https://www.lccmr.leg.mn/pm_info/acknowledgement_guidelines.pdf. For example, all presentations will include the ENRTF logo on the acknowledgment slide. All published manuscripts will acknowledge the specific grant that was awarded.

Water, soil, sludge, and manure samples will be freeze-dried for potential future analyses. Extracts will also be labeled and archived (frozen) for potential future analyses.

In July 2016, Minnesota Departments of Health and Agriculture, Minnesota Pollution Control Agency, and Minnesota Board of Animal Health pledged multi-agency support to address the problem of AMR. Since that time, the Minnesota One Health Antibiotic Stewardship Collaborative, consisting of professionals from state government agencies, academia, clinical human and animal health practice, industry, and professional groups, have worked together to meet the goals of the Minnesota One Health Antibiotic Stewardship strategic plan. The Collaborative will provide ongoing support and access to subject matter expertise throughout this project. In addition, this group of professionals, organizations, and supporting policy makers, will be kept up to date on progress and provided with practical documents developed as a result of this work (e.g., fact sheets, reports, publications). The broad Collaborative structure will also facilitate dissemination of outcomes from this work to the public, medical and agricultural industries, and human, animal, and environmental health professionals throughout Minnesota.

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?

Our project will define relationships between essential activities (e.g., healthcare, wastewater treatment, animal agriculture) and the maintenance and proliferation of AMR in Minnesota’s natural environment. The long-term goal is to develop scientific and risk-based guidance in human, animal, and environmental health for the mitigation of AMR in the natural environment. Our approach will also be useful to explore other biologically active chemicals in Minnesota’s environment, such as hormones and endocrine disruptors. Results will be shared at local conferences, in open-access scientific publications, by publicly available final report, and through the Minnesota One Health Antibiotic Stewardship Collaborative.

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
Assessing Techniques for Eliminating Contaminants to Protect Native Fish and Mussels	M.L. 2016, Chp. 186, Sec. 2, Subd. 04d	\$287,000
Assessing Neonicotinoid Insecticide Effects on Aquatic and Soil Communities	M.L. 2016, Chp. 186, Sec. 2, Subd. 04e	\$400,000
Assessment of Household Chemicals and Herbicides in Rivers and Lakes	M.L. 2017, Chp. 96, Sec. 2, Subd. 04a	\$236,000
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

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
Undergraduate		Assist with field sampling/laboratory experiments and literature review			0%	0.5		\$17,500
Undergraduate		Assist with field sampling/laboratory experiments and literature review			0%	0.5		\$17,500
Undergraduate		Assist with field sampling/laboratory experiments and literature review			0%	0.5		\$17,500
Post-Doctoral Associate		Perform field measurements/laboratory experiments			25%	1		\$94,500
Amy Kinsley		Co-Investigator			27%	0.06		\$9,000
Irene Bueno		Co-Project Manager and Geospatial Modeler			20%	3		\$233,000
William Arnold		Co-Project Manager			27%	0.12		\$35,750
Randall Singer		Project Manager			27%	0.12		\$27,250
							Sub Total	\$452,000
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Tools and Supplies	Maintenance of mass spectrometry service contracts for use on the project	Instrument fees for analysis of ~500 samples					\$20,000
	Tools and Supplies	Laboratory consumables, including solvents, standards, gloves, vials, columns	For processing of field samples and conducting laboratory experiments					\$21,000
	Tools and Supplies	Laboratory services for mass spectrometry time	Instrument fees for analysis of ~500 samples					\$5,000
							Sub Total	\$46,000
Capital Expenditures								
							Sub Total	-

Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Mileage for sample collection	To get water samples from selected sites					\$3,000
	Conference Registration Miles/ Meals/ Lodging	Conference fees	To present results at local conferences					\$1,000
							Sub Total	\$4,000
Travel Outside Minnesota								
	Conference Registration Miles/ Meals/ Lodging	Conference fees	To present results at conferences	X				\$3,000
							Sub Total	\$3,000
Printing and Publication								
	Publication	Open access fees for peer-reviewed journals	To disseminate results to the scientific community and the general public					\$3,000
							Sub Total	\$3,000
Other Expenses								
							Sub Total	-
							Grand Total	\$508,000

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Travel Outside Minnesota	Conference Registration Miles/Meals/Lodging	Conference fees	This project is developing methodology that is of interest to the broader scientific community. It is important to present the results of this project at scientific conferences outside of Minnesota. This budget item reflects some of the costs associated with presenting the results at high profile scientific conferences.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
In-Kind	Waived facilities and administrative costs	The University of Minnesota is waiving the income normally generated from extramural research grants that contribute Facilities and Administrative (F&A). The current full rate is 55% of direct costs.	Pending	\$322,025
			State Sub Total	\$322,025
Non-State				
			Non State Sub Total	-
			Funds Total	\$322,025

Attachments

Required Attachments

Visual Component

File: [f57b8e5a-5d4.pdf](#)

Alternate Text for Visual Component

Antibiotic residues are found in surface waters near hotspots like hospitals or animal farms. We still need to understand how far these residues can be transported, how long they remain in water, and how they vary depending on the antibiotic use at the source. As shown in the image, this project will 1) select hotspots identified from the antibiotic footprint model of Minnesota developed in the previous ENRTF funded project, 2) collect field measurements over time upstream and downstream from...

Optional Attachments

Support Letter or Other

Title	File
Letter of support for Dr. Amanda Beaudoin	1a49a93c-da8.pdf
UMN SPA Cover Letter	2ecdd62e-310.pdf
Research Addendum	4ca83355-84a.docx
Background Check Form	6a3ca846-65d.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

The budget for this project was adjusted to the recommended funding amount. To do this, salaries for some of the project participants were reduced, estimates for the costs of instrument time and certain supplies were reduced, and funding for publication in open access journals was reduced. No changes were made to the actual project, as the reductions in requested funding do not impact the scope of the project.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

Yes, I agree to the UMN Policy.

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?

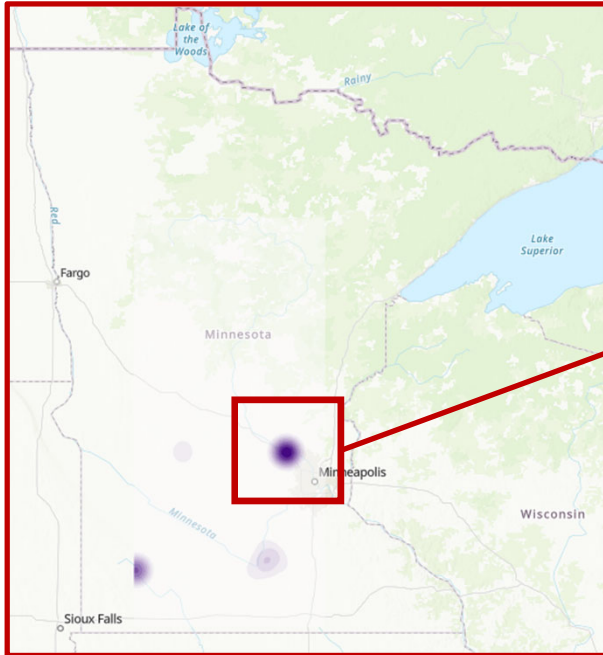
Yes

Does the organization have a fiscal agent for this project?

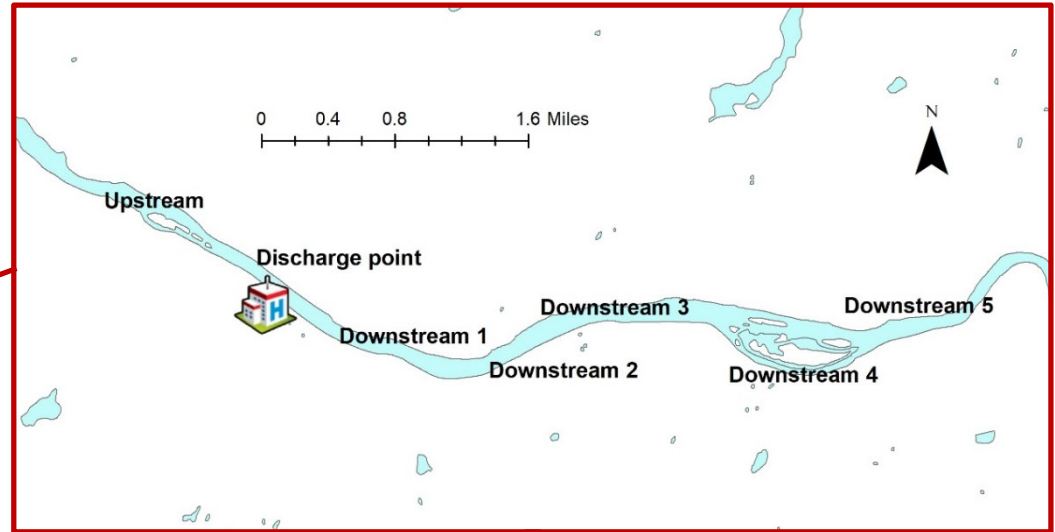
Yes, Sponsored Projects Administration

Microgeographic Impact of Antibiotics Released from Identified Hotspots

1. Hotspots identified in previous grant



2. Field measurements in different seasons & Laboratory transformation studies



4. Develop user-friendly interface



3. Geospatial and hydrological modeling

