

**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

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## **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

## **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 ENTRF 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. Ineli gible** | **% Bene fits** | **# FTE** | **Class ified 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](https://lccmrprojectmgmt.leg.mn/media/map/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](https://lccmrprojectmgmt.leg.mn/media/attachments/1a49a93c-da8.pdf) |
| UMN SPA Cover Letter | [2ecdd62e-310.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/2ecdd62e-310.pdf) |
| Research Addendum | [4ca83355-84a.docx](https://lccmrprojectmgmt.leg.mn/media/attachments/4ca83355-84a.docx) |
| Background Check Form | [6a3ca846-65d.pdf](https://lccmrprojectmgmt.leg.mn/media/attachments/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