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

Project Title: **ENRTF ID: 138-E**

Atmospheric Transport of Antibiotic Resistance Genes

Category: E. Air Quality, Climate Change, and Renewable Energy

Total Project Budget: $ 449,325

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

Summary:

Antibiotic resistance is a growing problem in the world, and Minnesota. We propose to characterize agricultural operations and wastewater treatment plants as sources of antibiotic resistance genes to the atmosphere.

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Sponsoring Organization: U of MN

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Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Flow diagram describing how antibiotic use in humans and agriculture could result in antibiotic resistance genes entering the atmosphere

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

PROJECT TITLE: Atmospheric Transport of Antibiotic Resistance Genes

I. PROJECT STATEMENT

Antibiotics are used prolifically to treat infections in agricultural animals and humans, and prophylactically in agricultural settings. These compounds are poorly absorbed and metabolized and are typically excreted in the urine and feces. Antibiotics taken by people enter wastewater where it can undergo treatment at a municipal wastewater treatment plant (WWTP). In agriculture, animal manure is frequently stored and applied to agricultural fields. Whether in the soil or a WWTP these antibiotics are present at low concentrations in bacteria-rich environments. This low-level exposure of bacteria to antibiotics can create antibiotic resistance, which leads to $20-$40 billion in extra medical costs and 30,000+ premature deaths each year. Genes from antibiotic resistant bacteria, antibiotic resistance genes (ARGs), have been recently found in aerosols near confined animal feed operations (CAFOs). Our *overall goals* are to quantify the presence of ARGs in aerosols from farms and WWTPs. These sources include manure spreading, wind eroded soil, aerosols generated by aerosolized from sewage sludge treatment, and dust from biosolids entering the atmosphere. Ultimately, we expect to describe situations/techniques to minimize atmospheric transport of ARGs from agricultural and WWTP sources. High volume total suspended particulate (TSP) samples will be taken upwind and downwind of municipal WWTP's, fields during manure spreading, and beef, dairy, poultry and swine production facilities. These data will provide baseline information on small- and large-scale air quality impacts from WWTPs and CAFOs and would provide a "fingerprint" that would allow source tracking of these emissions. This research will help Minnesota optimize its agricultural activity while minimizing its unintended impacts on human and environmental health.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Determine the relative magnitude of different types of CAFOs as sources of atmospheric ARGs* **Budget: $292,846**

We propose to sample upwind and downwind of CAFOs using high-volume TSP air samplers and atmospheric dry deposition plates. The filters and deposition substrates will be analyzed for ARGs using established techniques. The high volume air samples will indicate the relative magnitude of CAFOs as sources of atmospheric ARGs, and the dry deposition plates will indicate the relative deposition velocities of these aerosols for modeling their fate and transport.

Outcome	Completion Date
1. Determine atmospheric ARGs specific to beef production	*June, 2018*
2. Determine atmospheric ARGs specific to dairy production	*June, 2018*
3. Determine atmospheric ARGs specific to poultry production	*June, 2018*
4. Determine atmospheric ARGs specific to swine production	*June, 2018*
5. Model the fate and transport of atmospheric ARGs from CAFOs	*June, 2019*
6. Suggest techniques for reduction of atmospheric ARGs from CAFOs	*June, 2019*

Activity 2: *Determine the relative magnitude of different WWTPs as sources of atmospheric ARGs* **Budget: $146,423**

We propose to sample upwind and downwind of WWTPs using high-volume TSP air samplers and atmospheric dry deposition plates. The filters and deposition substrates will be analyzed for ARGs using established techniques. The high volume air samples will indicate the relative magnitude of WWTPs as sources of atmospheric ARGs, and the dry deposition plates will indicate the relative deposition velocities of these aerosols for modeling their fate and transport. Additionally, we will compare different aeration systems to determine the effect that they have on the production of atmospheric ARGs from sewage sludge production.

Outcome	Completion Date
1. Determine the Atmospheric ARGs specific to WWTPs	*June, 2017*
2. Determine the effect of different aeration techniques on the production of atmospheric ARGs	*June, 2018*
3. Suggest techniques for reduction of atmospheric ARGs from WWTPs	*June, 2019*

Budget: $10,056

Activity 3: *Dissemination and Outreach*

Results from this project will enable state agencies, facility managers, and the greater scientific community to allocate appropriate resources toward reducing antibiotic resistance from these potential sources. The results of this study will be disseminated to the relevant state agencies (MPCA, MDA, MDH), and interest groups (Air and Waste Management Association, Minnesota Farmers Union, etc.) through written reports and the University of Minnesota outreach efforts. The results will be disseminated to the greater scientific community through presentations at scientific conferences and publication in the peer reviewed literature.

Outcome	Completion Date
1. Present results at the scientific conferences (continual as data is available)	*June, 2019*
2. Publish results in the peer reviewed literature (continual as data is available)	*June, 2019*
3. Post data to the University of Minnesota data repository (continual as data is available)	*June, 2019*
4. Present results to interested parties at a seminar to be held at the University of Minnesota	*June, 2019*

III. PROJECT STRATEGY

A. Project Team/Partners

Dr. Matt F. Simcik is an Associate Professor in the Division of Environmental Health Sciences in the School of Public Health at the University of Minnesota. He is an expert in the fate and transport of contaminants, especially atmospheric transport. He will lead the project, and be responsible for the atmospheric sampling. He will receive funding from the Trust Fund for his effort.

Dr. Timothy M. LaPara is a Professor in the Department of Civil, Environmental, and Geo-Engineering. He is an expert in antibiotic resistance. He will be responsible for the ARG analysis of the atmospheric samples. He will receive funding from the Trust Fund for his effort.

B. Project Impact and Long-Term Strategy

This project will determine the relative importance of agricultural operations and wastewater treatment plants as sources of atmospheric transport of ARGs, and the relative importance of atmospheric transport as a source of antibiotic resistance to the environment. To support this effort the University of Minnesota will provide $204,297 as in kind contribution in the form of indirect costs.

C. Timeline Requirements

This project will require three years to complete. The first two years will be spent sampling and analysis of atmospheric aerosols for ARGs. The last year will be spent interpreting results, modeling the fate and transport of ARG aerosols and determining the best techniques for minimizing their production from CAFO and WWTP facilities.

2016 Detailed Project Budget

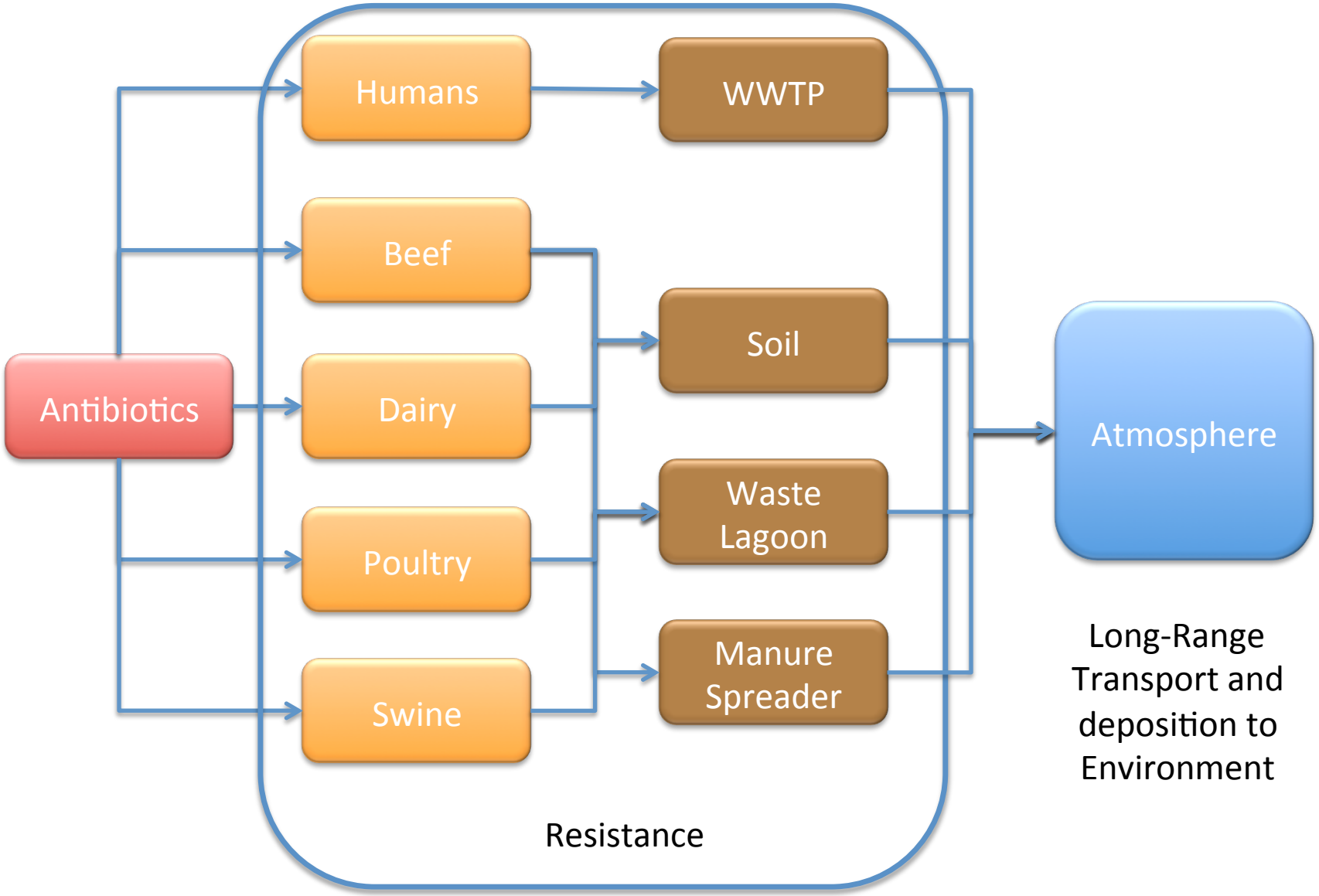
Project Title: *Atmospheric Transport of Antibiotic Resistance Genes*

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM *(See "Guidance on Allowable Expenses", p. 13)*	**AMOUNT**	
Personnel:		
Matt F. Simcik, Project Manager (20% salary +Fringe)	$	74,455
Timothy M. LaPara, ARG analysis (2 weeks salary + Fringe)	$	24,413
Post-Doctoral Fellow to be named (100% salary + Fringe)	$	170,247
Research Assstant to be named (50% time: salary + Tuition and Fringe)	$	125,566
Professional/Technical/Service Contracts: *University Genomics Center: ARG analysis*	$	12,000
Equipment/Tools/Supplies:		
Air Sampling Media	$	5,000
Lab Supplies for ARG analysis	$	24,000
Travel: travel to and from air sampling locations, lodging and per diem	$	10,644
Additional Budget Items: *Instrument maintenance and repair*	$	3,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$	449,325

V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ To Be Applied To Project During Project Period:	NA	
Other State $ To Be Applied To Project During Project Period:	NA	
In-kind Services To Be Applied To Project During Project Period: *Indirect costs contributed in-kind by the University of Minnesota*	$ 199,265	*Secured*
Funding History:	NA	
Remaining $ From Current ENRTF Appropriation:	NA	


Humans
WWTP
Beef
Soil
Antibiotics
Dairy
Atmosphere
Waste Lagoon
Poultry
Manure Spreader
Swine
Resistance
Long-Range Transport and deposition to Environment

Project Manager Qualifications and Organization Description

Dr. Matt Simcik (University of Minnesota)
Associate Professor, Environmental Health Sciences, School of Public Health, University of Minnesota

B.S., Chemistry, 1992, Michigan State University
M.S., Civil Engineering, 1994, University of Minnesota
Ph.D., Environmental Sciences, 1998, Rutgers, The State University of New Jersey

Dr. Simcik is an expert in environmental chemistry. He will direct the sampling, sample custody and data interpretation. He will supervise the graduate Research Assistant. He has been sampling and analyzing trace organic contaminants in various environmental media for 20 years, including atmospheric sampling of particles.

Dr. Tim LaPara (University of Minnesota)
Professor, Civil Environmental and Geo-Engineering, University of Minnesota
B.S. Civil Engineering, Notre Dame
Ph.D. Environmental Engineering, Purdue University

Dr. LaPara is an expert in antibiotic resistance. He will direct the ARG analysis and supervise the post-doctoral researcher.

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/01_about.php). The laboratories and offices of the PI and co-PIs contain all of the necessary fixed and moveable equipment and facilities needed for the proposed studies.