Environment and Natural Resources Trust Fund (ENRTF)
M.L. 2019 ENRTF Work Plan (Main Document)

Today's Date: 8/26/2018

Date of Next Status Update Report: 3/1/2020

Date of Work Plan Approval: 6/5/2019

Project Completion Date: 6/30/2022

Does this submission include an amendment request? No

PROJECT TITLE: Transformation of Plastic Waste into a Valued Resource

Project Manager: Brett Barney

Organization: University of Minnesota

College/Department/Division: College of Food, Agricultural and Natural Resource Sciences/Bioproducts and Biosystems Engineering

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Location: Statewide

Total Project Budget: $225,000.00

Amount Spent: $0

Balance: $225,000.00

Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04j

Appropriation Language: $225,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota to develop technologies that use microbes to convert plastic waste into useful chemical compounds and fuels, lowering the likelihood that these materials end up in the environment. This appropriation is subject to Minnesota Statutes, section 116P.10.

I. PROJECT STATEMENT:

CONCEPT – We will develop technologies that utilize indigenous microbes to convert waste plastics into useful chemical compounds and fuels. By converting this waste stream into valuable commodity chemicals and a potential source of energy, we will increase the demand for this material, which will lower the likelihood that these materials to end up in our natural waters following disposal. This effort will also lay the groundwork for developing future methods to remediate plastics from contaminated soils and waters by identifying natural species from Minnesota that have the ability to degrade these undesirable contaminants.

BACKGROUND – Microplastics are small plastic beads that have been added to exfoliating soaps or skincare products, and also result from the general photochemical degradation process of plastics in our environment that results from exposure to sunlight. These are often unseen based on a visual inspection, but quickly become apparent when viewed under a microscope and based on collection techniques with precision screens. These microplastics have permeated into the food chain and act to concentrate environmental pollutants. Recent reports citing high levels of microplastics in freshwater lakes such as the Great Lakes have confirmed concerns that the accumulation of microplastics in the environment is not an issue facing only water bodies such as the Pacific Ocean, where this topic has been highlighted as a key element of the 'Great Pacific Garbage Patch'. Indeed, ***microplastics have infiltrated many standing bodies of water throughout the world and across the state of Minnesota***. Plastic waste within the environment contributes to the illness and deaths of countless fish, reptiles, marine mammals and bird species, and also diminishes the pristine nature of our public waters which are a valuable aspect of recreation in Minnesota. This unanticipated and detrimental result of our wide-scale adoption of plastics over the past century is an issue that will face generations to come.

Conventional plastics are widely believed to be non-biodegradable. Various reports of microbes that are capable of degrading common plastics such as those found in beverage bottles (PETE), Styrofoam (polystyrene) and those used to store everything from milk to household chemicals (polyethylene; HDPE or LDPE) are now challenging this belief. These studies are important because they have identified specific bacteria and fungi that can degrade many current common plastics, shattering the misconception that all petroleum-derived commodity plastics are non-biodegradable. Our project will build upon the foundations of these reports and preliminary studies in our own laboratories, and further incorporate the emerging realization that diverse microbial communities are better adapted than single organisms to degrading complex chemicals such as those that are found in conventional plastics.

GOAL – The goal of this project is to develop alternatives for disposing of problem-plastics by converting plastic waste materials into a valuable resource using conditions similar to what is commonly found in the lower gut of many plastic-degrading insects. Through this approach, we will create new markets for many of the problematic plastics found in our recycling and waste streams. By adding value and incentive to repurpose the waste, we will decrease levels of plastics reaching the environment, including our lakes and rivers.

II. OVERALL PROJECT STATUS UPDATES:

First Update March 1, 2020

Second Update September 1, 2020

Third Update March 1, 2021

Fourth Update September 1, 2021

Fifth Update March 1, 2022

Final Report between project end (June 30) and August 15, 2022

III. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1 Title: Collection and Analysis of Plastic-Degrading Microbial Communities
Description: We will enrich several microbial communities collected from Minnesota with the greatest ability to biodegrade targeted plastics. This effort will build upon current studies already underway that have resulted in several microbial communities that biodegrade targeted problem-plastics. This effort may include outreach with secondary school teachers across the state to increase the breadth of sites sampled and also educate students and their communities about the environmental impacts of poor plastic waste management and the impacts on our waters and the environment. This effort will expand our sample size and geographical diversity, while also educating future generations of Minnesotans.

ACTIVITY 1 ENRTF BUDGET: $ 110,000.00

Outcome	Completion Date
1. Construct laboratory reactors to enrich microbial communities for the biodegradation of problematic plastics such as polyethylene (HDPE and LDPE), polystyrene (Styrofoam) and PETE (Water bottles).	Dec 15, 2019
2. Prepare sites to house simple microcosms to enrich natural organisms capable of using different plastics as a growth substrate (including insects, soil and water samples).	May 1, 2020
3. Determine the composition of enriched microbial communities to identify the diversity and abundance of plastic degrading organisms across Minnesota.	July 30, 2021

ACTIVITY 2 Title: Construction of Model Insect Gut Digesters to Transform Plastic Waste
Description: We will construct a laboratory-scale continuous system that will utilize waste plastics as a feedstock supply to produce useful commodity chemicals, methane and hydrogen gas. The goal of this activity will be to provide a proof of concept for the reactor design and approach, which could then be deployed across the state in the future as an alternative solution to landfilling waste plastics. Our efforts will target problem-plastics that do not have sufficient markets for recycling, and which are often found as contaminants in our lakes and rivers. Through the development of these reactors and the enrichment of strains able to biodegrade these problem-plastics, we will also isolate natural strains that could be used in future efforts to treat contaminated areas. Additional reactor designs will be tested as well to determine optimal methods to treat microplastics.

ACTIVITY 1 ENRTF BUDGET: $ 115,000.00

Outcome	Completion Date
1. Construct a laboratory-scale insect gut digesters to convert target plastic materials into methane and hydrogen for energy production.	Oct 15, 2020
2. Construct aerobic reactors to determine the potential to apply indigenous microbes as a means of bioremediation to plastics in the environment.	Feb 15, 2021
3. Analyze genes and genomes of different species from isolated communities to identify genes involved in plastic waste degradation.	June 1, 2022

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IV. DISSEMINATION:

Description: Results obtained from this project will be disseminated in several manners. The first is through peer-reviewed publication, which allows the results to be scrutinized by other experts in the field, and then shared with the larger research community. Since we also anticipate including various teachers and school children across the state, we aim to develop a webpage that narrates the project, goals and approaches, and provides an update of results that are obtained. This will allow those members of the public who are interested in this complex problem to see how we approach this problem and evolve our efforts over time based on the results that are obtained. Finally, it is expected that we will make several presentation as part of our outreach with other scientists and also with the community. The webpage will be developed as a component of the PI's current website, listed above.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgement Guidelines.

First Update March 1, 2020

Second Update September 1, 2020

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Final Report between project end (June 30) and August 15, 2022

V. ADDITIONAL BUDGET INFORMATION:
A. Personnel and Capital Expenditures

Explanation of Capital Expenditures Greater Than $5,000: N/A

Explanation of Use of Classified Staff: N/A

Total Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: We have budgeted such that a graduate student will receive ½ time support (standard research assistantship) for 2 years, so 1.0 FTE. The project manager and co-PIs will receive a total of 0.15 FTEs over the entire course of the grant. We anticipate undergraduate support distributed to multiple undergraduate students equivalent to 1.0 FTE over the course of the entire grant.

Enter Total Estimated Personnel Hours for entire duration of project:	Divide total personnel hours by 2,080 hours in 1 yr = TOTAL FTE:

Total Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: N/A

Enter Total Estimated Contract Personnel Hours for entire duration of project:	Divide total contract hours by 2,080 hours in 1 yr = TOTAL FTE:

VI. PROJECT PARTNERS: The research team includes Professor Brett Barney from the Department of Bioproducts and Biosystems Engineering and the BioTechnology Institute at the University of Minnesota, who will oversee the project. Professor Barney's lab has been isolating natural communities of microbes capable of biodegrading plastics for several years. Professor Jeff Gralnick from the Department of Plant and Microbial Biology will grow anaerobic communities and assist with metagenomics studies. Professor Bo Hu from the Department of Bioproducts and Biosystems Engineering is an expert in the area of anaerobic digestion, and will help with reactor design. We are also working with several industry partners that produce commodity plastics. These industry partners will provide materials that are key to enriching our cultures and confirming that strains are biodegrading the targeted plastics.

A. Partners outside of project manager's organization receiving ENRTF funding: N/A

B. Partners outside of project manager's organization NOT receiving ENRTF funding: N/A

VII. LONG-TERM- IMPLEMENTATION AND FUNDING: We expect this to be a long-term project. The goals of the project are not the immediate cleanup of any specific site, as it does not make sense to clean a site until we determine ways to eliminate the further addition of these plastics to the environment. Our belief is that the best solution to this problem is to create an incentive for these problem materials to be directed away from the current waste streams. While some of these materials are recyclable, these tend to be difficult recycling streams that are not fully utilized. By developing a technology that converts these materials into a fuel, we are creating new markets and solutions. The research will also contribute to other future directions that could be applied to site specific cleanup strategies.

VIII. REPORTING REQUIREMENTS:

- Project status update reports will be submitted March 1 and September 1 each year of the project
- A final report and associated products will be submitted between June 30 and August 15, 2022

IX. SEE ADDITIONAL WORK PLAN COMPONENTS:

A. Budget Spreadsheet
B. Visual Component or Map
C. Parcel List Spreadsheet
D. Acquisition, Easements, and Restoration Requirements
E. Research Addendum

Attachment A:
Environment and Natural Resources Trust Fund
M.L. 2019 Budget Spreadsheet
Legal Citation: M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04j
Project Manager: Brett Barney
Project Title: Transformation of Plastic Waste into a Valued Resource
Organization: University of Minnesota/CFANS/BBE
Project Budget: $225,000.00
Project Length and Completion Date: 3 Years, 6/30/2022
Today's Date: 2/4/2019

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 167,000	$ -	$ 167,000
Brett Barney, Project Manager (75% salary, 25% benefits), Associate Professor, 9 Month Appointment, Summer Salary; 5% FTE for 2 years, $14,000		$ -	
Jeff Gralnick, co-Project Manager (75% salary, 25% benefits), Professor, 9 Month Appointment, Summer Salary; 2% FTE for 2 years, $9,000		$ -	
Bo Hu, co-Project Manager (75% salary, 25% benefits), Associate Professor, 9 Month Appointment, Summer Salary; 2% FTE for 2 years, $8,000		$ -	
1 Graduate Research Assistant, UMN (Twin Cities), Laboratory Experiment Data Analysis, supervised by Barney and Gralnick (56% salary, 44% fringe), 50% FTE for 2 years, $100,000		$ -	
Undergraduate Research Assistants, UMN (Twin Cities), Laboratory Experiment and Field Study Data Collection, Supervised by Barney/Gralnick/Hu (100% salary) approximately 800 hours per year, 3 years, $36,000		$ -	
Professional/Technical/Service Contracts			
Lab Services - DNA sequencing for metagenomics work, performed at University of Minnesota Sequencing Facilities. Six sequencing runs at $2,500 each.	$ 15,000	$ -	$ 15,000
Equipment/Tools/Supplies			
Laboratory Supplies: General Laboratory Chemicals, Media, and Reagents ($400 per month) and Kits for Performing Routine Molecular Biology ($400 per kit), Analytical Reagents, DNA Synthesis of Primers ($100 per month), Liquid Nitrogen for Strain Storage ($400 per year). Combined laboratory supplies for the labs for all 3 PIs (Barney, Gralnick, Hu).	$ 40,000	$ -	$ 40,000
Capital Expenditures Over $5,000			
	$ -	$ -	$ -
Fee Title Acquisition			
	$ -	$ -	$ -
Easement Acquisition			
	$ -	$ -	$ -
Professional Services for Acquisition			
	$ -	$ -	$ -
Printing			
	$ -	$ -	$ -
Travel expenses in Minnesota			
Travel by Brett Barney and students between the Twin Cities campus and various field sites across Minnesota, to be reimbursed by the University Compensation Plan.	$ 3,000	$ -	$ 3,000
Other			
	$ -	$ -	$ -
COLUMN TOTAL	$ 225,000	$ -	$ 225,000

OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State:		$ -	$ -	$ -
State:		$ -	$ -	$ -
In kind: Unpaid Indirect Costs		$ 105,000	$ -	$ 105,000

PAST AND CURRENT ENRTF APPROPRIATIONS	Amount legally obligated but not yet spent	Budget	Spent	Balance
Current appropriation:		$ -	$ -	$ -
Past appropriations:		$ -	$ -	$ -