Environment and Natural Resources Trust Fund
2019 Request for Proposals (RFP)

Project Title: **ENRTF ID: 101-BH**

Evaluating Locally-Sourced Sanding Materials for Road Salt Reduction

Category: H. Proposals seeking $200,000 or less in funding

Sub-Category: B. Water Resources

Total Project Budget: $ 162,445

Proposed Project Time Period for the Funding Requested: June 30, 2021 (2 yrs)

Summary:

The project will evaluate the effectiveness and benefits/impacts of locally sourced woodchip, corncob, and iron-bearing minerals as alternative effective abrasive materials to lower salt use for protecting Minnesotas water resources.

Name: Chanlan Chun

Sponsoring Organization: U of MN - Duluth

Title:

Department: Natural Resources Research Institute

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Duluth MN 55811-1442

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Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Environmental benefits of natural byproducts as alternative abrasives on winter maintenance to reduce environmental impacts of road salt.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%
____ If under $200,000, waive presentation?			

PROJECT TITLE: Evaluating Locally-Sourced Sanding Materials for Road Salt Reduction

I. PROJECT STATEMENT

Minnesota uses hundreds of thousands of tons of salt annually for winter road maintenance. Unfortunately, road salt is also a major contributor to elevated chloride levels in Minnesota waterbodies because the chloride in road salt is not naturally broken down, transformed, or removed from the environment. This is a serious problem, because elevated chloride levels have detrimental impacts on ecological and water quality, including toxicity to aquatic life in freshwater and contamination of drinking water supplies. Along with road salt, sand is the most common abrasive used at all temperatures, particularly during very cold temperatures, when salts are ineffective. But the use of conventional sands has been declining to straight road salt application due to a recognition of their limited effectiveness in sand/salt mixtures. So how might chloride loadings be reduced? By using locally sourced alternative sanding (abrasive) materials. There are natural materials such as woodchips, corncob, and iron-bearing minerals which may be better alternatives to sand. Their effectiveness and environmental benefits/impacts, however, have not examined in Minnesota.

The proposed project will evaluate the effectiveness and feasibility of locally available natural materials including agricultural and iron industry byproducts as alternative effective abrasive materials to sand. The materials include corncob, various types of woodchips, and iron industry byproducts such as taconite tailings, crushed iron ores, and processing byproducts. Potentially, these materials may not only offer traction and skid resistance required on the icy and frozen roads during winter, but also hold effectiveness of salt for a longer duration and capture other contaminates on roads. We hypothesize that **more effective sanding materials on roadways will eventually lower salt use for the protection of water resources.** In addition, agricultural byproducts are biodegradable, and iron industry byproducts have high solar absorbance to enhance deicing efficiency. This project will characterize their physical and chemical properties, develop the formulation and application practice to use them as sanding materials with the combination of chloride and non-chloride deicers, and assess their deicing efficacy and potential environmental impacts and benefits.

This project aligns well with the state's collaborative efforts to reduce the amount of chloride entering the environment while still providing safe winter driving road conditions for Minnesota. A positive project outcome will result in the following environmental benefits: reducing impacts of chloride on watersheds through the reduction of road salt use, and beneficially utilizing waste and byproduct materials as green and more effective sanding alternatives. Moreover, the outcomes of the project will provide essential information for the development of implementation research. In the long term, this project will help to facilitate adoption of chloride management and mitigation practices and enhance sustainability of our economy and natural water resources in Minnesota.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Physical and chemical properties of woodchip, corncob and iron-bearing minerals as alternatives to sand*

We will explore and review locally available corncob, various types of woodchips, and iron industry byproducts including taconite tailings, crushed iron ores, and processing byproducts (approximately 20-30 samples) for sanding materials' quality based on current sand specification/recommendation (i.e., material larger than a No. 50 sieve and smaller than 3/8 inch) and applications. The characterization data of each source that are available from previous studies will be collected and compared to select the final materials to be tested. Physical and chemical properties of the acquired materials will be characterized. The characterizations include particle size distribution, mineralogy, and chemical compositions. Their

morphological features and analytical surface chemistry will be examined using several materials characterization methods such as scanning electron microscopy, x-ray diffraction, and x-ray fluorescence. Such characterization data will determine their properties (e.g., hardness, durability, angularity, silt generation potential) required for the quality sanding/abrasive material for winter maintenance.

ENRTF BUDGET: $ 71,283

Outcome	Completion Date
1. Database of locally available natural byproducts for the selection of abrasive materials	October 31, 2019
2. Selected abrasive materials characterized: Chemical and mineralogical composition and physical properties	June 30, 2020

Activity 2: *Evaluation of deicing efficacy and potential environmental benefits and impacts*

Based on outcomes of activity 1, we will formulate natural byproduct-based abrasive materials and perform laboratory tests on deicing efficacies of the formulation including freezing points with eutectic temperature, ice melting ability, and viscosity with the combination with chloride and non-chloride deicing chemicals. For traction efficiency, skid resistance will be quantified on ice and/or snow-covered road at various environmental conditions. To evaluate potential environmental benefits and impact of natural byproduct-based abrasives, their chemical reactivity (e.g., sulfate and heavy metal leaching and capture of contaminants including deicing chemicals) and silt generation potential will be examined. Additionally, the pavement health will be evaluated upon the application of the abrasive materials. Based on the laboratory results and statistical analyses from Activity 2, preliminary recommendations will be developed for the application of natural byproducts as sanding/abrasive material in northeastern Minnesota based on current practice and equipment, in consultation with St. Louis County and MnDOT District 1. The recommendations will include road types and application methods (e.g., pre-wetting and loading), and methods for the interception and recovery of sanding materials from reaching the watershed (e.g., stormwater grit chamber and holding ponds).

ENRTF BUDGET: $91,162

Outcome	Completion Date
1. Deicing efficacy and traction efficiency of natural byproduct-based abrasives determined	January 31, 2021
2. Potential environmental benefits and impacts evaluated	March 31, 2021
3. Preliminary recommendations made for the application of natural byproducts as abrasive material in Minnesota, in the form of a final report	June 30, 2021

III. PROJECT PARTNERS:

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Duane Hill	District Engineer	MnDOT District 1	Consultation

IV. LONG-TERM - IMPLEMENTATION AND FUNDING:

A key project outcome will be the generation of essential information for developing best-use implementation strategies and guidelines. Potential funding sources for long-term implementation will be obtained from MnDOT and Federal Clean Water Act Section 319 Grant.

V. TIME LINE REQUIREMENTS:

The project will be completed in 2 years.

2019 Proposal Budget Spreadsheet

Project Title: Evaluating Locally-Sourced Sanding Materials for Road Salt Reduction

IV. TOTAL ENRTF REQUEST BUDGET 2 years

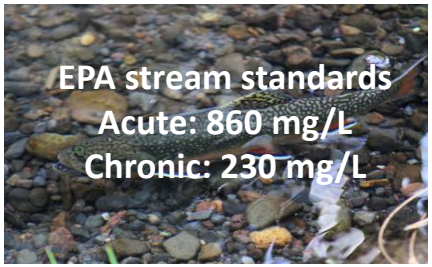
BUDGET ITEM	AMOUNT
Personnel:	**$ 130,945**
Chanlan Chun, Principal Investigator: $23,568 (fringe rate 33.5%); 8% FTE each year	
Manik Barman, Co-Investigator: $8,859 (fringe rate 33.5%); 12% FTE Summer only each year	
Larry Zanko, Co-Investigator: $10,168 (fringe rate 33.5%); 4% FTE each year	
Graduate Student Research Assistant: $85,854 (fringe rate 15%) and tuition reimbursement in AY; 50% FTE AY and 50% FTE SUM each year	
Undergraduate Student Research Assistant: $2,496 (100% salary); 5% FTE each year	
Professional/Technical/Service Contracts:	**$ -**
Equipment/Tools/Supplies:	**$ 22,000**
Lab supplies ($22,000): chemicals, thermal control, friction tester, and expandable lab supplies (e.g. plasticware, sampling bottles, columns)	
Acquisition (Fee Title or Permanent Easements):	**$ -**
Travel:	**$ 2,500**
In-state travel for employees ($2,500): Sample collectionMate Sampling collection, meetings with state agency, and field testing	
Additional Budget Items:	**$ 7,000**
University of Minnesota mineralogical, chemical, and microscopic instrument user fee ($7,000): SEM-EDX ($34/hr, 70 hrs), XRD ($15/hr, 50 hrs), ICP ($26/sample, ~100 samples), chemical and nutrient analyses ($64/sample, ~20 samples)	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	**$ 162,445**

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period:	$ -	
Other State $ To Be Applied To Project During Project Period:	$ -	
In-kind Services To Be Applied To Project During Project Period:	$ -	
Unrecovered indirect: 54% modified total direct costs ($134,649 base; excludes graduate student tuition reimbursement)	$ 71,286	Secured
Past and Current ENRTF Appropriation:	$ -	
Other Funding History:	$ -	

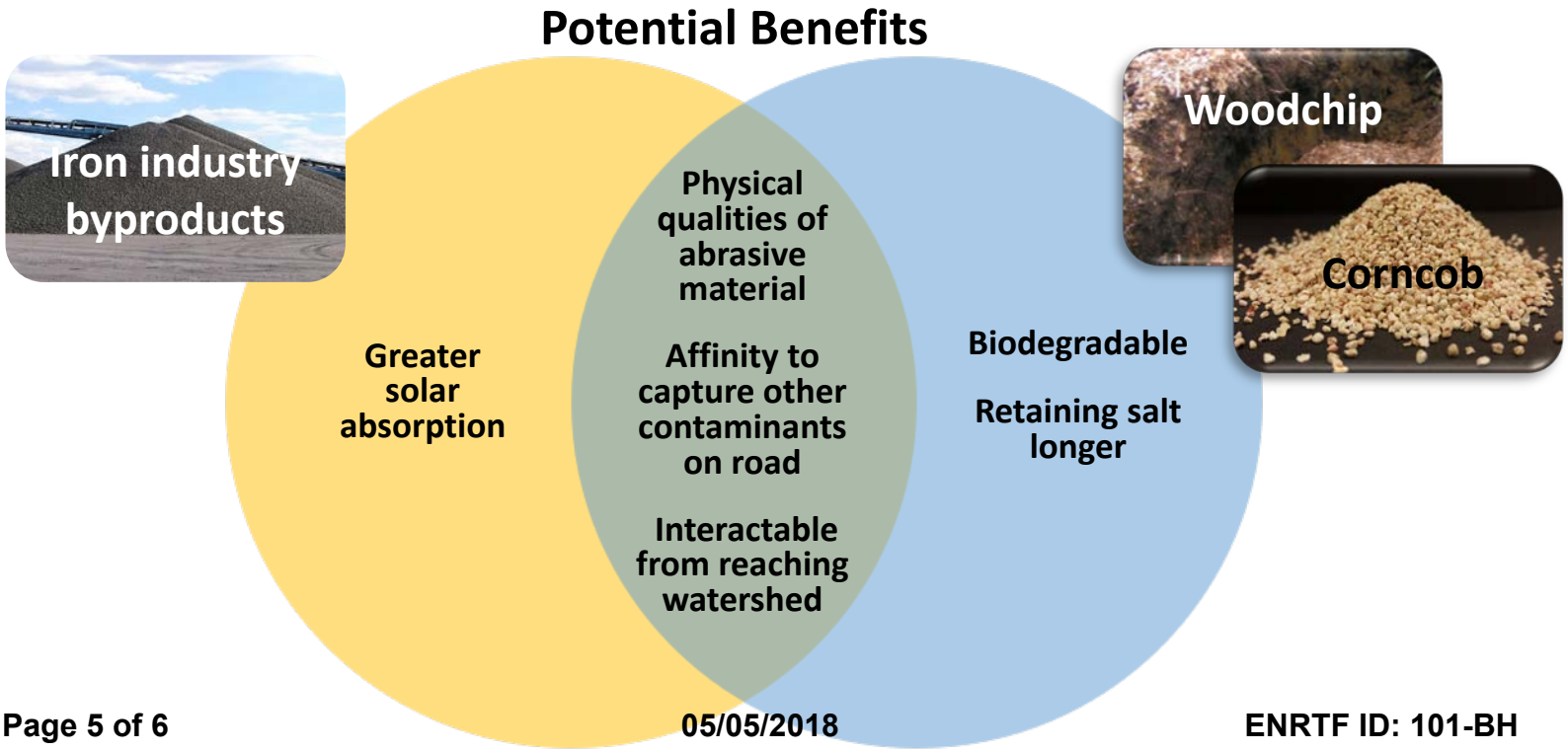
Chloride Contamination in Minnesota Water Resources by Road Salts

Toxic to aquatic life in freshwater



Drinking water supply contamination

Evaluating Locally-Sourced Sanding Materials for Road Salt Reduction



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2019 LCCMR Project Manager Qualifications and Organization Description

Dr. Chan Lan Chun, Natural Resources Research Institute and Department of Civil Engineering, University of Minnesota Duluth

EDUCATION

Ph.D. 2006	University of Minnesota	Civil, Environmental, Geo Engineering
M.S. 2001	Ewha Womans University	Environmental Science and Engineering
B.S. 1999	Ewha Womans University	Environmental Science and Engineering

RELEVANT RESEARCH EXPERIENCE

Faculty of Water Resources Science Graduate Program, University of Minnesota, 2015-Present

Faculty of Minnesota Aquatic Invasive Species Research Center, University of Minnesota, 2015-Present

Assistant Professor, Department of Civil Engineering and Natural Resources Research Institute, University of Minnesota Duluth, 2015-Present

Research Assistant Professor, Biotechnology Institute, University of Minnesota, 2014-2015

Teaching Specialist of Civil, Environmental, and Geo-Engineering, University of Minnesota 2011-2013

Researcher, Korean Institution of Construction Technology, South Korea, 2001-2002

KEY QUALIFICATIONS

Dr. Chun is an assistant professor of civil engineering, performing her research at the Natural Resources Research Institute. Her research focuses on the fate and transport of chemical and microbial contaminants in natural and engineered systems and the development of new water technology to treat contaminants. Likewise, Chun's research group is working on water quality and microbial ecology on wild rice water, innovative bioreactor to treat sulfate in natural and industrial water, electromagnetic bioreactor to treat nutrients from agricultural drainage, biofiltration for stormwater treatment, and iron filtration to capture sulfide in water. Currently, she has worked on the project to utilize locally available natural resources for water treatment system. She has published over 25 scientific journal articles and book chapters in the area of aquatic environment and water engineering. Dr. Chun will have chief management responsibilities for overseeing the proposed project. She will be responsible for working with Mr. Larry Zanko, Dr. Manik Barman, and research partner (Duane Hill, MnDOT) to ensure that project goals, results, and timelines are met.

The Natural Resources Research Institute is a University of Minnesota Duluth applied research organization. NRRI's mission is to deliver research solutions to balance Minnesota's economy, resources and environment for resilient communities. The collective research and organizational experiences of the project team members and the resources available to this project from the University of Minnesota Duluth should ensure the successful completion of the proposed project goals.