

**Environment and Natural Resources Trust Fund
2017 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 028-A

Airborne Particulate Characterization Survey: Future Mining's Historic Reference

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: \$ 398,967

Proposed Project Time Period for the Funding Requested: 3 years, July 2017 - June 2020

Summary:

Collect and characterize ambient air samples where near-term non-ferrous mineral resource development potential is greatest, and create a foundational airborne mineral particulate dataset and archive of samples for future reference.

Name: Stephen Monson Geerts

Sponsoring Organization: U of MN - Duluth NRRI

Address: 5013 Miller Trunk Hwy
Duluth MN 55616

Telephone Number: (218) 788-2674

Email lzanko@d.umn.edu

Web Address http://www.nrri.umn.edu/default/contact.htm

Location

Region: Northeast

County Name: Lake, St. Louis

City / Township: Hoyt Lakes area

Alternate Text for Visual:

The visual, called Figure 1, includes three images. The first image (left) is a map of Northeastern Minnesota and the proposed study area, showing the Duluth Complex, prospective copper-nickel mining areas, the communities of Hoyt Lakes, Babbitt, and Ely, and three proposed ambient air sampling locations: near a prospective copper-nickel property, near Babbitt, and at a remote (background) site east of Ely, called Fernberg. The second image (upper right) is a photo of a typical ambient air sampling setup, showing a MOUDI sampler and weather station, below which is a brief description of the MOUDI impactor. The third image (lower right) is a schematic drawing of the air sampling setup, showing its various components.

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



PROJECT TITLE: Airborne Particulate Characterization Survey: Future Mining’s Historic Reference

I. PROJECT STATEMENT

Northern Minnesota is on the threshold of a new era of metallic mineral (copper, nickel, titanium, etc.) development. Before such mining and mineral processing activities begin, detailed foundational information and data are needed to better define the baseline/background concentrations and physical, chemical, and mineralogical characteristics of airborne mineral particulate matter (PM) – including elongate mineral particles (EMPs) – within the new mining area. Given the near-term timing for potential non-ferrous projects (e.g., within the next 2 to 5 years), the opportunity and need for conducting this survey is *now*.

Why now? Because as our particulate characterization team and partners at the School of Public Health learned during the recently completed Minnesota Taconite Workers Health Study (MTWHS), that study would have benefitted greatly from having access to historic airborne PM samples and data that were collected *before* the commencement of taconite mining. Future studies of non-ferrous mining impacts should not be deprived of a valuable historical reference when the ability to proactively create such a reference exists today.

Therefore, this proposed Phase I (pre-development and pre-mining) survey will create a statistically robust foundational dataset of high-quality airborne PM characterization data and archived samples of the type that regulatory agencies typically do not produce but future investigators would find extremely beneficial to reference; the type of information that is essential for having a more complete understanding of air quality with respect to the composition of mineral PM (dust). A total of forty-five (45) baseline ambient air samples will be collected from three locations near Hoyt Lakes, Babbitt, and Ely (Fernberg) (Fig. 1). This survey will give future investigators an unambiguous historic baseline to reference for assessing potential changes in local and regional air quality with respect to physical, chemical, and mineralogical characteristics of mineral particulate matter as these mineral resources are developed, thereby allowing those investigators – if asked years from now – to better answer the following question: “*What was in the air?*”

This baseline characterization survey will achieve its objectives by building on the experience and expertise gained by the NRRM PM team during its Minnesota Taconite Workers Health Study (MTWHS) investigations. Input/guidance from the Minnesota Pollution Control Agency (MPCA) will be sought, and data will be shared.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Air and Lake Sediment Sampling Site Selection and Sampling Plan **Budget: \$ 75,000**

The project team will select secure particulate matter (PM) air sampling and weather station locations: a) near and down-wind of the proposed mineral development; b) in one or more communities that are in close proximity to the new mineral development area (e.g., Hoyt Lakes, Babbitt); and c) a background/control location (Ely) that hosts an active MPCA/EPA air monitoring station, where the project’s air sampling equipment can be co-located. A statistically robust project sampling plan will be developed. Air sampling instrumentation and equipment will be prepared, tested, and field-checked.

Outcome	Completion Date
1. Literature search performed; historic meteorological and air quality data compiled	Sep 30, 2017
2. Sampling sites and secure set-up locations identified, field-checked, and selected	Oct 31, 2017
3. Sample characterization methodologies finalized; analytical laboratories selected	Nov 30, 2017
4. Supplemental sampling equipment obtained	Dec 31, 2017
5. Air sampling equipment tested; project support supplies (pumps, tubing, weather stations, filter substrates, battery backup, power cords, sample containers, bottles, etc.) obtained; protective housings for equipment purchased or fabricated, as needed.	Jan 31, 2018

Activity 2: Year 1 Air Sampling, and Initial Laboratory Analysis **Budget: \$125,000**

The project team will conduct week-long (168-hour) air sampling at the three locations identified in Activity 1, with sampling occurring every 2 months, beginning in 2018. 18 samples will be collected and characterized.



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Outcome	Completion Date
1. Air samples collected at three locations every two months; 18 samples, total	Dec 31, 2018
2. Laboratory prep and gravimetric analysis of 18 Year 1 air samples	Feb 28, 2019
3. Air sample PM characterized (mineralogy, chemistry, and scanning and transmission electron microscopy – SEM and TEM – for EMP identification); TEM analyses by MPCA-approved Minnesota Department of Health (MDH) method 852.	Apr 30, 2019
4. Interim Summary Report to LCCMR	Jun 30, 2019

Activity 3: Years 2 & 3 Air Sampling and Analysis, Characterization, and Archiving

Budget: \$198,967

Remaining samples (27) will be collected, as in Activity 2, and undergo gravimetric, chemical, mineralogical, and microscopic analysis and characterization. A database of analytical results will be assembled/interpreted, and samples archived. A final report will be produced.

Outcome	Completion Date
1. Ancillary data (e.g., MPCA & EPA air quality monitoring – concurrent and historic; meteorological data, etc.) obtained, compiled, and analyzed relative to project sample data	Dec 31, 2019
2. Air sample PM characterized (particle size, mineralogy, chemistry, and scanning and transmission electron microscopy for EMP identification), using MPCA-approved methods (e.g., Minnesota Department of Health (MDH) method 852); results compiled/interpreted	Mar 31, 2020
3. All samples archived and stored	Apr 30, 2020
4. Final report published of baseline PM characteristics of ambient air in the vicinity of new mining in northern Minnesota	Jun 30, 2020

III. PROJECT STRATEGY

A. Project Team/Partners

ENRTF Funding Recipients: 1) NRRI Project Team – S. Monson Geerts, S.Post, S.Gordee, M. Cai, L.Zanko, G.Hudak (project management, geology, mineralogy, air sampling, field and lab work, EMP characterization, data analysis/interpretation, statistical analysis, reporting); 2) UM Twin Cities, Department of Mechanical Engineering (aerosol science and air sampling equipment consultation); 3) UM Duluth, Research Instrumentation Laboratory (scanning electron microscope and X-ray diffractometer analyses); and 4) UM Twin Cities, Characterization Facility (transmission electron microscopy analyses).

Non-ENRTF funding: Minnesota Pollution Control Agency (MPCA) – project guidance and data sharing.

B. Project Impact and Long-Term Strategy

This Phase I project will provide essential foundational air quality (particulate matter, or PM) data and archived samples for an area of northern Minnesota having the greatest near-term potential (next 2 to 5 years) for non-ferrous mineral resource development. These baseline data and samples will be needed as a fundamental reference, against which future PM sampling and characterization results can be compared; and their availability will expedite early-stage project assessments. NRRI brings \$120K of state-of-the-art air sampling equipment to the project – three Micro Orifice Uniform Deposit Impactors (MOUDIs) – plus approximately \$200K of accessory and laboratory equipment (balances, microscopes, etc.) Most importantly, NRRI brings an experienced team with air sampling/PM characterization skills, skills that were gained during the Taconite Workers Health Study.

This project would also provide a basis for a follow-up (Phase II) air quality characterization survey as mineral resources in this area are developed, and/or act as a model for similar baseline PM characterization projects elsewhere. Therefore, future LCCMR funding support would be requested.

C. Timeline Requirements

The proposed project will be 3 years (36 months) in duration (July 1, 2017 to June 30, 2020), which is necessary for conducting up to 2.5 years of seasonal ambient air sampling and sample analysis.

2017 Detailed Project Budget

Project Title: Airborne Particulate Characterization Survey: Future Mining's Historic Reference

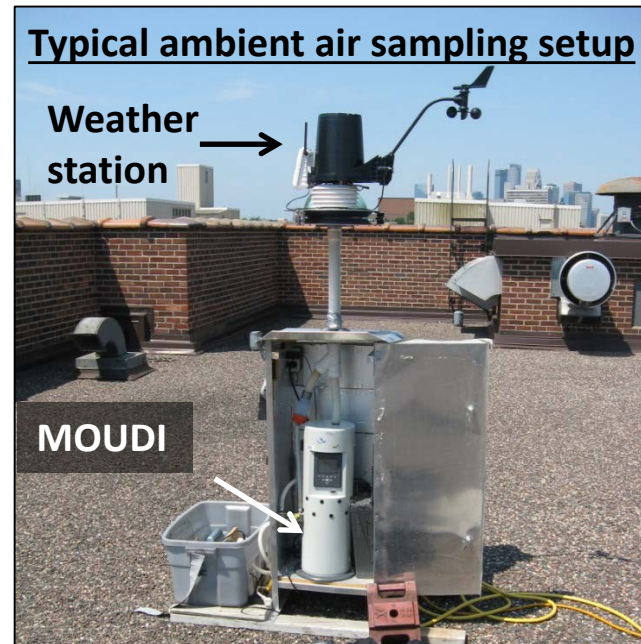
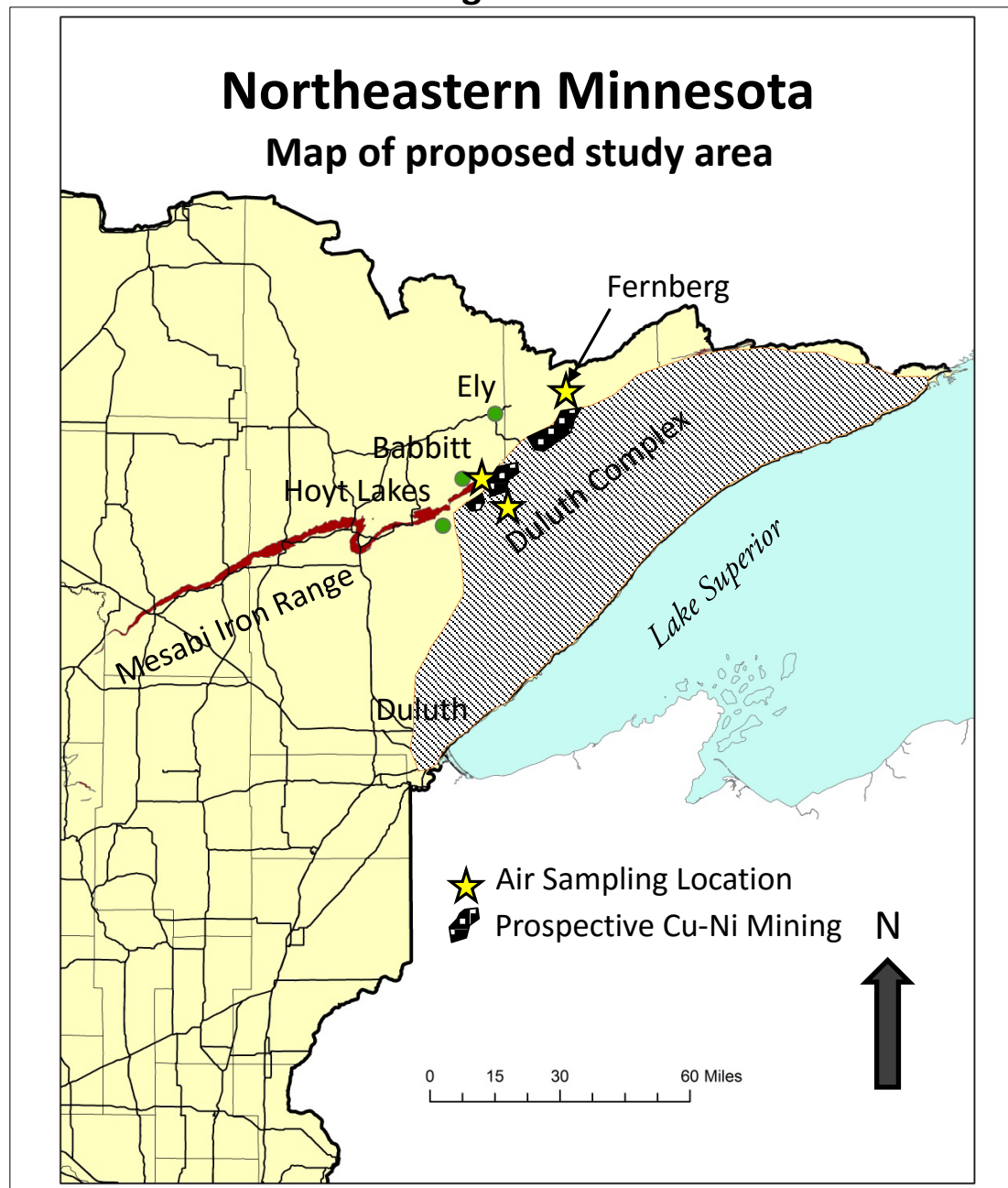
IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Personnel:	
Steven Monson Geerts, Project Manager (75% salary; 25% benefits): 25% FTE per year	\$ 70,230
George Hudak, PhD, Geologist, Co-PI, (75% salary; 25% benefits): 8.5% FTE per year	\$ 43,418
Lawrence Zanko, Co-PI, 75% salary; 25% benefits): 20% FTE per year	\$ 69,408
Sarah Gordee, Geologist/Mineralogist, field and lab responsibilities (75% salary; 25% benefits): 25% FTE per year	\$ 66,759
Sara Post, Asst. Scientist, Field/Lab responsibilities, (78% salary; 22% benefits): 25% FTE per year	\$ 49,840
Meijun Cai, Statistician, Project sampling design and data interpretation (75% salary; 25% benefits): 10% FTE per year	\$ 26,677
Professional/Technical/Service Contracts:	
Pace Analytical, MDH 852, Transmission Electron Microscope analysis to identify elongate mineral particles (EMPs): 45 samples @\$500/sample	\$ 22,500
Elemental Analysis, Inc.; Proton Induced X-Ray Emission (PIXE) chemical analysis of particulate matter: 45 samples @\$85/sample	\$ 3,825
Equipment/Tools/Supplies:	
2 Vacuum Pumps (\$1000 each): for providing air flow for ambient air sampling	\$ 2,000
Davis weather station (1): for collecting/recording weather conditions during air sampling	\$ 650
Field supplies: safety gear and first-aid supplies, extension cords for powering sample collection instrumentation and support instruments/equipment, battery power backups for air sampling instrumentation	\$ 1,000
Lab supplies: air sampling filter substrates (polycarbonate, mixed cellulose ester, foil, teflon), flexible tubing for pumps and MOUDs, lubricant, reagents, cutting tools, gloves, glassware, cleaning supplies, thermometer.	\$ 500
Travel:	
Mileage (~16,500 miles), lodging, and meals for travel between NRRI, sampling/field sites; and to Twin Cities for meetings/consultations/laboratory visits	\$ 16,410
Additional Budget Items:	
UMD Instrumentation Laboratory: Fees for use of scanning electron microscope (SEM) and X-ray diffractometer; for mineral particle analysis	\$ 5,000
UM Twin Cities Characterization Facility: Fees for use of transmission electron microscope for supplemental mineral particle analysis	\$ 5,000
UM Dept. of Mechanical Engineering: Expenses/fees related to experimental design consultation and air collection instrumentation operation, calibration, and testing	\$ 15,000
Shipping/mailing: Delivery of samples to analytical labs, and return of samples	\$ 750
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 398,967

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

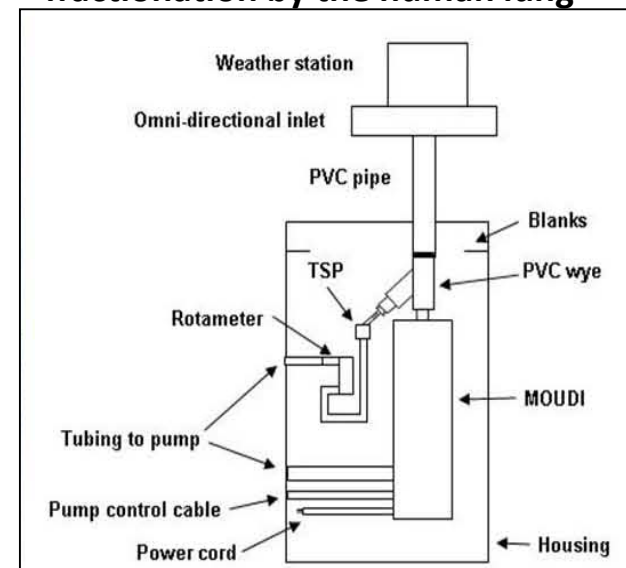
SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period:	\$ -	N/A
Other State \$ To Be Applied To Project During Project Period:	\$ -	N/A
In-kind Services To Be Applied To Project During Project Period: Foregone Facilities and Administrative costs at 53% in FY '18, 54% in FY '19 and FY '20:.	\$214,173	N/A
Funding History: \$810,000: State of MN - Minnesota Taconite Workers Health Study (MTWHS) 2008-2013 \$800,000: Permanent University Trust Fund (Match to MTWHS) 2008-2016	\$ 1,610,000	
Remaining \$ From Current ENRTF Appropriation:	\$ -	N/A

**Fig.1 Airborne Particulate Characterization Survey:
Future Mining's Historic Reference**



MOUDI cascade impactor

- 10-stage, size-fractionated sampling
- Designed to sort particles similar to fractionation by the human lung



2016 LCCMR Proposal: Airborne Particulate Characterization Survey: Future Mining's Historic Reference

PROJECT MANAGER QUALIFICATIONS

Stephen Monson Geerts is a Research Fellow for the Particle and Minerals Characterization Group within the Minerals Division of the Center for Applied Research and Technology Development at the Natural Resources Research Institute (NRRI), University of Minnesota Duluth (UMD). He is also a Registered Professional Geologist in the state of Minnesota. Mr. Monson Geerts is a key member of NRRI's particle characterization team, and recently has been responsible for coordinating and conducting much of the project's mining property and community environmental aerosol/particulate matter sampling activities. He is well-versed in igneous stratigraphy, mafic precious metal deposits and detailed petrography work, including waste rock characterization. He also has environmental work experience related to mine land reclamation/vegetative cover, and acid-mine drainage modeling.

Mr. Monson Geerts has 30+ years of professional geologic experience and has worked as a principal and co-principal investigator at the NRRI since the fall of 1988. He has conducted numerous geological research studies involving the igneous intrusive rocks associated with the Duluth Complex in northeastern Minnesota, specifically related to the precious metal deposit that is now being developed as the NorthMet Deposit (Minnesota's first non-ferrous/precious metal mine) by PolyMet, Corp. near Hoyt Lakes, Minnesota. In fact, after completing two applied research studies/technical reports on the NorthMet Deposit, he also completed his graduate work at the University of Minnesota – Duluth, earning a Master's degree in Geology with a minor in Hydrogeology. During the years 2004-2009, he left the NRRI temporarily to work for PolyMet, Corp. in the completion of their pre-feasibility study and initial environmental impact statement (EIS).

Since 2009, Mr. Monson Geerts has been a co-principal investigator and primary leader in the NRRI's particle characterization team, which recently completed the Minnesota Taconite Workers Health Study (MTWHS). Partnering with the University of Minnesota's Mechanical Engineering Department and the School of Public Health (SPH), the NRRI's role was to sample and characterize the particulate matter in Mesabi Iron Range communities and taconite processing facilities, with an emphasis on detecting and characterizing elongate mineral particles. This necessary environmental component of the study was focused on answering the general question – "What is in the air?" – to be utilized by researchers in explaining the increased incidence of the rare disease mesothelioma in taconite workers.

Organization Description:

The Natural Resources Research Institute (NRRI), University of Minnesota – Duluth (UMD) was established in 1983 by Governor Perpich and the State Legislature. NRRI's mission is to foster economic development of Minnesota's natural resources in an environmentally sound manner to promote private sector employment. NRRI's goals include: 1) Involvement in near-term economic development efforts that directly contribute to private sector job creation and retention and to the vitality of communities; 2) Establishment and utilization of applied research capabilities in focused natural resource areas to develop the products, processes and services that serve northern Minnesota, the state and the region in an intermediate to long-term time frame; and 3) Performance of research on natural resources to provide the tools, knowledge and experiential training required for sound short and long term environmental and economic decisions.

The NRRI collaborates with its partners (including industry, government, universities, tribes, agencies and communities) in fostering a sustainable, more diversified economy and a healthy environment. The effort will be based on both research to make informed economic and environmental decisions and on an integrated effort to provide the range of outreach services necessary for technology development and transfer, business development and experiential learning in the context of informed environmental stewardship.