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

Project Title: **ENRTF ID: 085-B**

Characterization of Glacial Lake Clay for Mitigative Uses

Category: B. Water Resources

Total Project Budget: $ 363,925

Proposed Project Time Period for the Funding Requested: 2.5 years, July 2016 to December 2018

Summary:

Characterize glacial lake clay from the western Lake Superior watershed to assess its potential as a low-permeability geotechnical material for Superfund/brownfield site restoration/redevelopment projects and for sulfide-bearing stockpile mitigation applications.

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Location

Region: NE

County Name: Carlton, Lake, St. Louis

City / Township: Duluth area/Mesabi Iron Range/Two Harbors

Alternate Text for Visual:

Map of northeast Minnesota showing extent of glacial lake clays relative to Lake Superioro and Mesabi Range (Fig. 1a); and schematic of capping concept (Fig. 1b)

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

PROJECT TITLE: Characterization of Glacial Lake Clay for Mitigative Uses

I. PROJECT STATEMENT

The project will characterize glacial lake clay from selected locations in the western Lake Superior watershed to assess its geotechnical and mitigative potential as a source of low permeability material for: 1) superfund / brownfield site restoration and redevelopment projects; and 2) capping sulfide-bearing stockpiles on Minnesota's eastern Mesabi Range. The project will generate important geological, geographical, geotechnical, and environmental information, information that can be referenced by regulatory agencies and by the end-users who would ultimately be responsible for conceptualizing and implementing engineering designs that make best use of the clay material for the two applications cited.

Background and Intent – Glacial lake clays were deposited by Lake Superior's precursor – Glacial Lake Duluth – after the last Ice Age about 11,000 years ago. These fine-grained glacial lake sediments underlie and surround the western end of present-day Lake Superior (Fig. 1a) and its watershed, including the areas drained by the St. Louis and Nemadji Rivers. These glacial lake clay deposits represent a significant but generally non-utilized natural resource. Glacial Lake Duluth was just one Minnesota's former glacial lakes.

Recent discussions with MPCA have indicated that substantial quantities of clay may be needed as a natural low-permeability material for various geotechnical applications such as lining, capping (Fig. 1b), or berm coring at the former US Steel Plant property, a Superfund site located along the St. Louis River in far western Duluth. Mitigation of the property – overseen by MPCA – is underway. The goal is to delist the property as a Superfund site and make it environmentally suitable for re-development by the City of Duluth and the Duluth Seaway Port Authority. Low-permeability clay materials could also be used as a capping material to retard and reduce precipitation infiltration into sulfide-bearing stockpiles located on the eastern Mesabi Range. Studies by NRRI (Hauck, et al., 1990; Toth, et al., 1990) showed these clays contain calcite, dolomite and plagioclase, minerals that have acid buffering capacity – a potential additional benefit for the capping of sulfide-bearing stockpiles.

Justification – Glacial lake clay has the potential to play an important role as an environmentally useful geotechnical material in restoration, redevelopment and/or reclamation projects where negative impacts on water quality must be minimized or mitigated. Therefore, a thorough characterization study of the clay is warranted, along with an assessment of the potential short, near, and long-term needs for material of this type.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Baseline Data Compilation; Sample Site Selection; Equipment/Supply Order Budget: $40,000

Obtain and compile background/historic information about potential clay resource geology and sampling locations; identify potential end-use sites, types, and needs; estimate potential clay quantities needed for various near- and long-term end-use applications; confirm property access; select sampling sites. Based on site selection develop sampling plan to finalize number of core samples needed; develop analytical plan and analytical protocols; order initial supplies and equipment; make project status presentation(s) at a relevant in-state conferences/meetings.

Outcome	Completion Date
1. Background data acquired for potential clay sites (geologic, geographic, analytical, etc.)	Sep 2016
2. Information acquired about potential end-use sites (Superfund site, stockpiles, etc.)	Oct 2016
3. Data compiled and interpreted; three (3) ~40 acre clay sites selected for sampling	Jan 2017
4. Project sampling and characterization plan written; protocols and QA/QC developed	Mar 2017
5. Project introduced and presented at in-state conference(s)/meeting(s)	April 2017
6. Initial field and laboratory supplies and equipment ordered in advance of Activity 2	June 2017

Activity 2: Field and Laboratory Work - Sample Collection and Characterization Budget: $278,925

Collect, log (geologically describe) and sample representative glacial lake clay material using core drilling (and possibly hydraulic excavation); perform physical/geotechnical, chemical, and mineralogical characterization.

Obtain "typical" Superfund site and sulfide stockpile samples for testing in combination with clay. Chemical analyses will be performed by one or more certified analytical laboratories; NRRI/UMD will conduct physical/geotechnical/mineralogical testing. Characterization and testing results will be evaluated to assess the clay's potential usability and suitability relative to locations like the US Steel Superfund site in Duluth or other restoration/redevelopment sites, and for potential sulfide stockpile capping. An overview of the project will be presented at relevant in-state conference(s)/meeting(s).

Outcome	Completion Date
1. Bids received and contractor(s) chosen for clay coring (and possible excavator work)	Jun 2017
2. Superfund site & sulfide stockpile(s) samples (3 to 6) collected for analysis/leachate tests	Aug 2017
3. Clay sites drilled and cores collected; ~ 15 to 25 core holes; ~600' to 1000' of drilling	Sep 2017
4. Drill core logged/described/sampled; geological cross-sections created	Nov 2017
5. 50 to 100 samples prepared and submitted for characterization tests	Dec 2017
6. Characterization tests completed and results received	Mar 2018
7. Updated project findings presented at in-state conference(s)/meeting(s)	Jun 2018
8. Characterization results compiled, evaluated, reviewed, and interpreted	Jul 2018

Activity 3: Clay Resource/Usage Estimate, Transportation Logistics Overview, and Map Budget: $20,000

Clay resource estimates will be produced for each location. An overview of transportation options (truck/rail/barge) from the source sites to the Duluth area and Mesabi Range destinations will also be performed. GIS maps for project sites (sources and destination) will be produced.

Outcome	Completion Date
1. Overview of transportation options to/from clay sources and destination completed	Jan 2018
2. Project GIS maps produced	Mar 2018
3. Clay resource estimates (volume, tonnage, quality, etc.) produced for each project site	June 2018

Activity 4: End-of-Project Workshop, Data Assembly, Draft and Final Report Budget: $25,000

Hold a workshop to disseminate project information; produce draft and final reports.

Outcome	Completion Date
1. Project workshop/open house held at NRRI; information exchanged; sites visited	Sep 2018
2. Draft and final reports completed	Dec 2018

III. PROJECT STRATEGY

A. Project Team/Partners

NRRI and UMD Project Team (ENRTF Funding): NRRI - Larry Zanko, Principal Investigator; Marsha Patelke, co-Investigator/Geologist; Sara Post, Field and Lab Scientist; Tom Levar, Project Scientist; Craig Maly, Field and Lab Scientist; Julie Oreskovich, Scientist/GIS Specialist; Patrick Schoff, Toxicologist; Stephen Monson-Geerts, Geologist and Research Fellow; Kurt Johnson, Research Fellow; **UMD** - David Saftner, Asst. Professor Civil Engineering (UMD), geotechnical testing; and associated NRRI technical staff and UMD students.

B. Project Impact and Long-Term Strategy: The immediate project impact will be the creation of a body of characterization and resource information needed by agencies and end users (developers, engineering firms, mines, etc.) that could potentially use glacial lake clay material. For example, the project's findings could: 1) further assist MPCA in developing improved mitigative and ecological practices for the Duluth Superfund site; 2) have implications for using glacial lake clay material from other parts of Minnesota for similar mitigative applications; and 3) help advance a shelved Two Harbors small craft harbor project whose development would generate about 300,000 cubic yards of this type of material. Lastly, the project fits ongoing efforts by the NRRI to identify uses of natural resources that have overlapping and synergistic environmental and economic benefits.

C. Timeline Requirements: The timeline is two and a half (2.5) years to accommodate sampling and analytical work, data generation and review, report writing, and a final workshop/open house to disseminate project information to agencies and prospective end-users.

2016 to 2018 Detailed Project Budget

Project Title: ***Characterization of Glacial Lake Clay for Mitigative Uses***

IV. TOTAL ENRTF REQUEST BUDGET 2.5 years

BUDGET ITEM	AMOUNT
Personnel: L Zanko, Project Manager and Prinicipal Investigator (25% FTE: 74.8% salary, 25.2% fringe; 2.5 years; $72,012): Overall project management and coordination of all activities, technical supervision, resource estimates, reporting, presentations, seminars. M.Patelke (25% FTE: 78.5% salary, 21.5% fringe; 2.5 years; $43,891), co-Investigator: field and laboratory studies and characterization management and oversite, and project coordination.	$ 115,903
Personnel: 6 NRRI CARTD and CWE personnel; combined weighted approximately equivalent of one 60% FTE position: (77.65% salary, 22.35% fringe; 2.5 years; $111,361): Project researchers/scientists; field and laboratory work; data entry, GIS, reporting	$ 111,361
Personnel: UMD Science and Engineering faculty (10% FTE: 74.8% sal.; 25.2% fringe: $37,632); and undergraduate student(s) (25% FTE: 100% salary; 2.5 years; 100.0% salary; 0.0% Fringe; $14,429): for geotechnical characterization work, and other field/lab assistance	$ 52,061
Professional/Technical/Service Contracts 1: Clay coring contractor (TBD) for collection of representative samples for characterization: bids to be solicited.	$ 35,000
Professional/Technical/Service Contracts 2 and 3: 2) Analytical lab services (TBD) for chemical characterization of project geological materials ($5,000) **3)** water/leachate analyses ($20,000): quotes/bids to be solicited for 2 and 3	$ 25,000
Equipment/Tools/Supplies/Shipping: Columns/accessory equipment for leachate & permeability tests ($5,000); Field and laboratory supplies such as soil samplers, shovels, safety and first-aid supplies, sample bags/buckets ($750); and reagents, chemicals, glassware, etc. ($500); sample shipping ($600)	$ 6,850
Travel: Vehicle mileage (6000 miles at $0.575 per mile) for in-state travel to and from project sites and in-state meetings/conferences	$ 3,450
Travel: Per-diem expenses for in-state travel to and from project sites and in-state meetings/conferences/presentations (Duluth, Two Harbors, Iron Range, Twin Cities)	$ 2,500
Travel: In-state conference registration for two NRRI project team members (e.g., as co-presenters at annual SME meeting and symposium in Duluth at est'd. $400 per attendee; 2017 and 2018)	$ 1,800
UMD Lab Services: UMD Scanning Electron Microscope Laboratory: Mineralogical (X-ray diffraction) analysis: $12.07/hr + $90.53/hr and staff assistance. Microscopic (SEM) characterization of samples: $39.14/hr + $90.53/hr staff assistance	$ 10,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	**$ 363,925**

V. OTHER FUNDS

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: The University of Minnesota's federally negotiated indirect cost rate for research is 52% of modified total direct costs. This unrecovered indirect cost is the University's cost share on the project.	$ 181,440	Secured
Funding History: I am a co-investigator on current LCCMR project to NRRI colleague Tom Levar, titled: "Dredged Sediment for Forest Restoration on Unproductive Minelands". The project is using dredged sediment as a soil material for supporting vegetative growth on minelands, but the sediment is not suitable as a low-permeablity capping material. It is possible, however, that the dredged material could be placed *on top of* glacial lake clay material to complete the capping and revegetation of sites described in this current proposal.	$300,000	Project underway; End date is 6/30/2017
Remaining $ From Current ENRTF Appropriation: *"Dredged Sediment for Forest Restoration on Unproductive Minelands" (see funding history).*	$264,914	not yet legally obligated

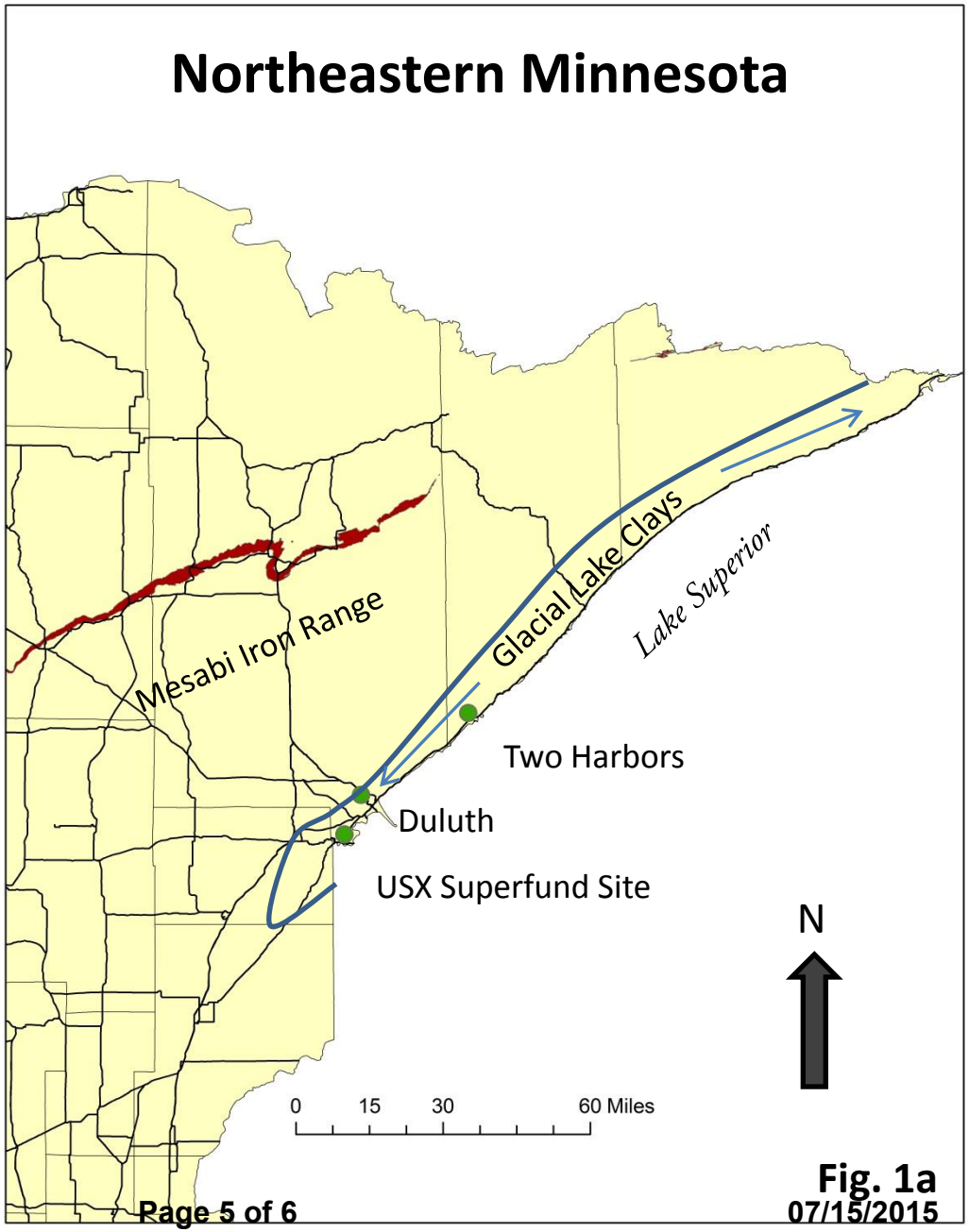

Fig. 1a

Characterization of Glacial Lake Clay for Mitigative Uses

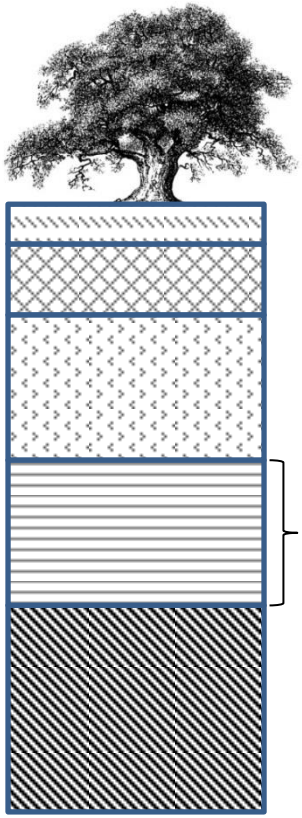

Fig. 1b

Characterize and assess the potential beneficial use or re-use* of glacial lake clays for mitigative applications at Superfund or brownfield site restoration projects and as low-permeability capping material for sulfide bearing rock stockpiles on the Mesabi Iron Range.

* e.g., excavated during construction projects

PROJECT MANAGER QUALIFICATIONS

Larry Zanko is a Senior Research Fellow and Group Leader for By-Product Reuse and Remediation within the Minerals Division of the Center for Applied Research and Technology Development of the Natural Resources Research Institute (NRRI), University of Minnesota Duluth (UMD). He has worked in the minerals field and has conducted geological, mineral resource and minerals industry-related applied research for most of his 30+ year professional career. Since his start with NRRI in 1986, he has participated in or led a broad spectrum of research projects – often conducted in cooperation with private industry – dealing with non-ferrous minerals, ferrous minerals, industrial minerals, contaminated and uncontaminated sediment remediation and reuse, resource modeling and estimation, and related policy issues. He regularly interacts and collaborates with community and public and private sector professionals and academicians in the geological, minerals, transportation, and environmental fields, inside and outside Minnesota. He is a graduate of the University of Minnesota – Twin Cities, where he received bachelor degrees in Geological Engineering and Microbiology (1986), and a Masters degree in Geological Engineering (1995).

Since 2000, Mr. Zanko has also worked on projects pertaining to the remediation of contaminated sediment and soil, and the beneficial reuse of uncontaminated sediment. Related work has continued via a Jobs Accelerator Grant from the U.S. Department of Commerce, Economic Development Administration, and a follow-up NRRI-led applied research program, called: "Minnesota's Mining Cluster – the Next Generation of Innovation and Diversification to Grow America." Two Mining Cluster project areas of focus include: 1) Continued development of aggregate use from iron ore by-product materials mining byproduct and co-product utilization; and 2) Reclamation of iron ore tailings basins using sediment collected from dredging operations from Lake Superior and creation of renewable biomass energy sources for use at mine plants to displace hydrocarbon fuels.

Other major project collaborators with whom the Project Manage has worked or collaborated include the U.S. Army Corps of Engineers (Detroit District, Duluth Area Office, and the Engineer Research and Development Center in Vicksburg, MS) via the United States Environmental Protection Agency (USEPA) Great Lakes National Program Office (GLNPO); the Duluth Seaway Port Authority; and the City of Duluth (Duluth Economic Development Authority); and the Minnesota Department of Transportation (MnDOT) . Those project activities have included interactions with the Minnesota Department of Natural Resources (MDNR) and the Minnesota Pollution Control Agency (MPCA) and the project being proposed to LCCMR.

SYNERGISTIC ACTIVITIES

Member:	Transportation Research Board (TRB) of the National Academies Mineral Aggregates Committee (AFP70); Society for Mining, Metallurgy, and Exploration (SME); Mesabi Range Geological Society (MRGS)
Participant:	Harbor Technology Advisory Committee (HTAC)
Session Chair:	Society for Mining, Metallurgy & Exploration (SME), 87th Annual Meeting of the SME Minnesota Section, 75th Annual University of Minnesota Mining Symposium, April 2014
Member:	Duluth Township Planning and Zoning Commission

Organization Description:

The Natural Resources Research Institute (NRRI) affiliated with the 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. 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. NRRI's scientific staff within the Center for Applied Research and Technology Development (CARTD) and elsewhere within the Institute, as well as UMD technical staff, form the core of the proposed research team.