



Environment and Natural Resources Trust Fund (ENRTF)

M.L. 2013 Work Plan

Date of Status Update Report:

Date of Next Status Update Report: December 31, 2013

Date of Work Plan Approval: June 11, 2013

Project Completion Date: June 30, 2016

Is this an amendment request? No

PROJECT TITLE: Assessment of Natural Copper-Nickel Bedrocks on Water Quality

Project Manager: Steve Hauck

Affiliation: Natural Resources Research Institute, University of Minnesota Duluth

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Location: St. Louis and Lake Counties

Total ENRTF Project Budget:

ENRTF Appropriation: \$585,000

Amount Spent: \$0

Balance: \$585,000

Legal Citation: M.L. 2013, Chp. 52, Sec. 2, Subd. 05b

Appropriation Language:

\$585,000 the first year is from the trust fund to the Board of Regents of the University of Minnesota in cooperation with the United States Geological Survey to assess impacts of existing mineralization and potential mining on northeastern Minnesota regional water quality, including impacts from copper, nickel, and other metal concentrations in rocks, streambed sediments, and soils in areas of potential base-metal mining. This appropriation is available until June 30, 2016, by which time the project must be completed and final products delivered.

I. PROJECT TITLE: How Do Natural Copper-Nickel Concentrations in Bedrock Influence Water Quality?

II. PROJECT STATEMENT: The large deposits of copper, nickel, cobalt, and platinum-group-elements, and titanium oxide minerals occurring in the Duluth Complex of northeast Minnesota could provide huge economic and employment benefits to the State and provide critical metals to the Nation. The complicated geologic setting of the mineral deposits within the Duluth Complex and the complex glacial history of the region make assessment of any potential water-quality impacts from future metal mining challenging. Streams and rivers that flow over mineralized rocks discharge into the Boundary Waters Canoe Area Wilderness as well as other environmentally sensitive watersheds. Federal, State, local, and tribal entities, mining companies, and environmental groups need up-to-date and accurate geochemical data to assess and predict water-quality impacts of existing mineralization and potential impacts from future mining. This study will determine if copper, nickel, and other metal concentrations in bedrock, streambed sediments, and soils are currently influencing regional water quality in areas of potential base-metal mining. The geochemical and water quality data and accompanying hydrologic analysis will be used by Federal, State, local, and tribal entities to better assess water-quality impacts of existing mineralization and any future mining.

Water-quality, streambed sediment, soil, and rock samples will be collected and analyzed in three watersheds with differing mineral potential: (1) Filson and South Filson Creeks with known copper, nickel, cobalt, and platinum group-element mineralization, (2) St. Louis River with titanium-oxide potential, and (3) Keeley Creek, with no known mineralization. In each of these three watersheds, water samples will be collected 4 times a year for two years (total of a maximum of 96 samples). Water samples will be analyzed for 18 metals, 12 major constituents (ions) and dissolved organic carbon. Up to 20 soil samples, 10 streambed sediment samples, and 10 bedrock samples will be collected in each of the three watersheds. All solid media samples will be analyzed for 46 major and trace elements. In addition, streambed sediment and soil samples will be analyzed for 10 metals by a weak-leach method. Streamflow data from 2 installed stream gages and one existing stream gage will be combined with existing and new water-quality data to develop conceptual hydrologic models for each watershed. Water-quality and modeling results will be compared to data available in the 1979 *Minnesota Regional Copper-Nickel Study* to assess long-term trends in water quality.

III. PROJECT STATUS UPDATES:

Project status reports will be submitted not later than December 31, 2013, June 30, 2014, December 31, 2014, June 30 2015, December 31, 2015, and June 30, 2016. A final work program report and associated products will be submitted between June 30 and August 1, 2016 as requested by the LCCMR.

Project Status as of December 31, 2013:

Project Status as of June 30, 2014:

Project Status as of December 31, 2014:

Project Status as of June 30, 2015:

Project Status as of December 31, 2015:

Project Status as of June 30, 2016:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Characterize distribution of major and trace elements in streambed sediment, soil, and bedrock samples from mineralized and non-mineralized watersheds along the basal Duluth Complex.

Description: Solid media (streambed sediments, soils, and bedrock) sampling will be conducted in the first year of the proposed work. A second round of solid media sampling from a reduced number of sites may be done if results from the first round identify areas of special geochemical interest. Collection sites for streambed sediments are in conjunction with water quality sites (Activity 2). Ten streambed sediment samples will be collected from Filson/South Filson Creeks, 4 streambed sediments will be collected from Keeley Creek, and 7 streambed sediments will be collected from the St. Louis River for a total of 21 streambed sediment samples. Within each of the 3 watersheds, 20 upland soil sites will be selected and 2 samples (topsoil/deeper soil) will be collected at each site, for a total of 120 soil samples. Also within each watershed, up to 10 bedrock samples will be collected from outcrop, supplemented by drill core samples for a total of 30 bedrock samples. Bedrock samples and the < 2 mm fraction of streambed and soil samples will be submitted to the USGS geochemistry contract laboratory (SGS) for total analysis for 48 major and trace elements. In addition, soils and streambed sediments will be analyzed by a partial leach method for 10 metals.

Summary Budget Information for Activity 1:

ENRTF Budget: \$ 119,858
Amount Spent: \$ 0
Balance: \$ 119,858

Activity Completion Date: 12/2014

| Outcome | Completion Date | Budget |
|---|------------------------|---------------|
| Determine major and trace elements in 30 bedrock samples, 120 soil samples, and 21 streambed sediment samples in 3 watersheds, with the possibility of an additional round of sampling from a reduced number of sites | 12/2014 | \$ 119,858 |

Activity Status as of December 31, 2013:

Activity Status as of June 30, 2014:

Activity Status as of December 31, 2014:

Activity Status as of June 30, 2015:

Activity Status as of December 31, 2015:

Final Report Summary:

Activity 2: Determine natural metal and major constituent loads in streams.

Description: Streamflow will be continuously monitored at two USGS gage sites. One gage will monitor flow rates in Filson Creek and a second gage will monitor flow in the St. Louis River. The Minnesota Department of Natural Resources currently has a stream gage on Keeley Creek. The two USGS stream gages will be installed in the fall of 2013 and maintained for two years. Once the gages are in operation, stream discharge measurements will be taken between October 2013 and September 2015 under varying flow rates to develop a water-level/flow rating curve at each gage. This water-level/flow rating curve will be used with continuous water-level data collected at the gages to determine continuous flow data over the two years. Water quality samples will be collected from Filson/South Filson Creeks, Keeley Creek, and the St. Louis River between August 2013 and September 2015 and analyzed for 18 metals, 12 major constituents, and dissolved oxygen to determine temporal and spatial variations in metals, major constituents, and dissolved oxygen concentrations. A total of 96 samples (12 quarterly samples over 8 quarters) will be collected over the two years from the three streams under differing flow rates. Streamflow and water-quality data will be used to compute metal and major constituent loads in each of the stream systems and assess variations in loads under various flow rates.

Summary Budget Information for Activity 2:

ENRTF Budget: \$ 275,612
Amount Spent: \$ 0
Balance: \$ 275,612

Activity Completion Date:

| Outcome | Completion Date | Budget |
|--|------------------------|---------------|
| 1. Determine temporal flow rates in streams/installation and maintenance of two stream gages | 6/2015 | \$ 127,240 |
| 2. Determine background metal and major constituent loads in streams | 6/2015 | \$ 148,372 |

Activity Status as of December 31, 2013:**Activity Status as of June 30, 2014:****Activity Status as of December 31, 2014:****Activity Status as of June 30, 2015:****Activity Status as of December 31, 2015:****Final Report Summary:****Activity 3: Assess hydrologic conditions prior to potential future mine development. Report all findings.**

Description: Existing hydrologic data and streamflow and water-quality data collected during Activity 2 will be used to develop a conceptual hydrologic model for each of the three watersheds between September 2014 and September 2015. The type of conceptual model (i.e., watershed rainfall/runoff model, groundwater-flow model) chosen to represent each watershed will be based on: 1) the main factors controlling stream water chemistry in each of the watersheds determined from the water-quality data and streamflow data collected during this study, and 2) the ability of the model to represent potential water-quality impacts from different mine settings (i.e., surface mine versus underground mine). Once constructed, these conceptual models will be used to assess hydrologic settings present in the watersheds prior to mine development and to assess potential mining-related impacts on water quality. A final interpretive report will be written, summarizing all collected data, interpretations, and hydrologic modeling results, and describing the regional geochemical and hydrological landscape.

Summary Budget Information for Activity 3:

ENRTF Budget: \$ 189,530
Amount Spent: \$ 0
Balance: \$ 189,530

Activity Completion Date:

| Outcome | Completion Date | Budget |
|---|------------------------|---------------|
| 1. Develop conceptual hydrologic models – 3 watersheds | 12/2015 | \$ 23,598 |
| 2. Develop hydrologic scenarios of various mining activities – 3 watersheds | 5/2016 | \$ 90,419 |
| 3. Preparation of final interpretive report of all data and hydrologic modeling results | 6/2016 | \$ 75,513 |

Activity Status as of December 31, 2013:**Activity Status as of June 30, 2014:****Activity Status as of December 31, 2014:****Activity Status as of June 30, 2015:**

Activity Status as of December 31, 2015:

Final Report Summary:

V. DISSEMINATION:

Description: A U.S. Geological Survey Scientific Investigations Report will be prepared that will summarize analytical results, present interpretations of bedrock, soil, streambed sediment, and water-quality data, and describe conceptual hydrologic modeling results. Presentations will be given at mining, geologic, and hydrologic conferences in the State outlining project results. Geochemical data for bedrock, soils, and streambed samples will be entered and stored in the USGS National Geochemical Database (http://minerals.cr.usgs.gov/projects/geochem_database/index.html). Metal and major constituent concentrations for water samples collected in the project will be entered and stored in the USGS National Water Information System (NWIS) (<http://waterdata.usgs.gov/nwis>). A link on the NRRI website (http://www.nrri.umn.edu/egg/pubs_nonferrous.html) will be established.

Status as of December 31, 2013:

Status as of June 30, 2014:

Status as of December 31, 2014:

Status as of June 30, 2015:

Status as of December 31, 2015:

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget:

| Budget Category | \$ Amount | Explanation |
|---|------------|---|
| Personnel: | \$ 61,800 | A total of two positions at NRRI will be paid: A Geologist to assess bedrock geology.199 FTE ; Project Manager (1) to manage the project (.263 FTE) total over three years. |
| Professional/Technical/Service Contracts: | \$ 518,200 | U.S. Geological Survey, (total: \$505,200) (1) geologist to assess bedrock, glacial overburden, soil, and streambed samples. (.38FTE) Hydrologist (1) to assess water-quality and loads in streams and conduct conceptual hydrologic models for the watersheds (.81 FTE); Hydrologic Technicians (2) to collect and manage water-quality, bed-sediment, and streamflow data (.85 FTE and .1 FTE). All FTEs are expressed as a total over 3 years, not as an average for each year. Geochemical Laboratory - geochemical analysis of soil, bed-sediment, and bedrock samples |

| | | |
|----------------------------|-------------------|---|
| | | (\$17,541). U.S. Geological Survey National Water-Quality Laboratory analysis of water-quality samples (major constituents, dissolved oxygen, and trace elements) (\$43,288). U.S. Geological Survey Minnesota Water Science Center, Data Section - installation and maintenance of two stream gages (\$116,507). Water-quality sampling equipment and supplies – e.g., peristaltic pumps, filters, sample bottles, preservatives for the samples, tubing for the pumps (\$4,772). Printing: editing and publishing USGS Scientific Investigations Report (\$7,000). Shipping costs to send bedrock, soil, and streambed sediment samples to USGS Geochemical Laboratory, and send water-quality samples to USGS National Water-Quality Laboratory (\$1,395). Vehicle mileage, lodging, and meals costs for (2) bedrock, soil, and streambed sediment sampling trips and (2) water-quality sampling trips (\$44,582). MN DNR (\$13,000) ; One glacial geologist to assist with understanding and interpreting the effects of the glacial material in each watershed (.115 FTE total over 3 years). Mileage, lodging, and meals costs for (2) bedrock, soil, and streambed sediment sampling trips (\$1,000). |
| Travel Expenses in MN: | \$5,000 | NRRI Vehicle mileage, lodging, and meals costs for (2) bedrock, soil, and streambed sediment sampling trips. |
| | | |
| TOTAL ENRTF BUDGET: | \$ 585,000 | All Items listed above |

Explanation of Use of Classified Staff: N/A

Explanation of Capital Expenditures Greater Than \$3,500: N/A

Number of Full-time Equivalent (FTE) funded with this ENRTF appropriation: .462 FTE total over 3 years

Number of Full-time Equivalent (FTE) estimated to be funded through contracts with this ENRTF appropriation: 2.25 FTE total over 3 years

B. Other Funds:

| Source of Funds | \$ Amount Proposed | \$ Amount Spent | Use of Other Funds |
|--|--------------------|-----------------|---|
| Non-state | | | |
| U.S. Geological Survey Water Cooperative Program | \$ 253,098 | \$ 0 | To cover computer, cell phone, office space, and other USGS MN Water Science Center costs for the project (estimated amount; not a specific match commitment) |
| U.S. Geological Survey Midwest | \$ 216,000 | \$ 0 | To cover computer, cell phone, office |

| | | | |
|---------------------------|-------------------|-------------|---|
| Region Mining Initiative | | | space, and other USGS MN Water Science Center and Eastern Minerals Resources Science Center costs for the project (estimated amount, not a specific match commitment) |
| TOTAL OTHER FUNDS: | \$ 469,098 | \$ 0 | To cover computer, cell phone, office space, and other USGS MN Water Science Center and Eastern Minerals Resources Science Center costs for the project |

VII. PROJECT STRATEGY:

A. Project Partners:

Partners receiving funding from the Environment and Natural Resources Trust Fund

Duluth Minerals Section of the Natural Resources Research Institute [NRRI]: Steve Hauck (Director) will co-manage the project; **Mark Severson** (geologist) will provide the bedrock samples and mineral deposit expertise. (\$66,800)

U.S. Geological Survey: Laurel Woodruff (geologist) will co-manage the project, overseeing streambed sediment, soil, and bedrock sampling and geochemical analyses; **Perry Jones** (hydrologist) will oversee stream gaging, water-quality sampling and analyses, and hydrologic model development. (\$505,200)

Minnesota Department of Natural Resources: Carrie Jennings (geologist,) will provide expertise on glacial and sediment geochemistry. (\$13,000)

Collaborative partners not receiving funding from the Environment and Natural Resources Trust Fund

U.S. Forest Service – Superior National Forest

Duluth Metals

Twin Metals Mining

Great Lakes Indian Fish and Wildlife Commission

B. Project Impact and Long-term Strategy:

Minnesota faces a daunting challenge. A world-class domestic resource for copper (Cu), nickel (Ni), cobalt (Co), platinum-group-elements (PGE) and titanium (Ti) hosted by rocks of the Duluth Complex in northeastern Minnesota could provide tremendous economic and employment benefits to that part of the State. However, northeastern Minnesota also contains the Boundary Waters Canoe Area Wilderness, one of the most pristine and environmentally sensitive regions of the country. The large tonnage of metals in the basal part of the Duluth Complex and increasing metal prices strongly suggest that metal mining in the area is inevitable. If regional details about current, existing surface water quality, and the concentration and distribution of elements in rocks, soils, and stream bed sediments are not available before mining begins, then it will not be possible for any regulatory agency to formulate accurate predictions of mining impacts on the environment. This lack of data could make it more problematic for mining companies to demonstrate remediation of mine sites to pre-mining 'baseline' water quality levels. Water-quality and modeling results will be compared to data available in the 1979 *Minnesota Environmental Quality Board Regional Copper-Nickel Study* to assess long-term trends in water quality. The new data and hydrologic analysis will be used by Federal, State, local, and tribal entities to better assess water-quality impacts of existing mineralization and potential mining.

C. Spending History:

| Funding Source | M.L. 2007 or FY08 | M.L. 2008 or FY09 | M.L. 2009 or FY10 | M.L. 2010 or FY11 | M.L. 2011 or FY12-13 |
|---|-------------------------|-------------------------|-------------------------|-------------------------|----------------------------|
| U.S. Geological Survey Midwest Region Mining Initiative | | | | | \$72,500 |

VIII. ACQUISITION/RESTORATION LIST: N/A

IX. MAP(S): N/A

X. RESEARCH ADDENDUM:

Research Addendum will be added following USGS internal review.

XI. REPORTING REQUIREMENTS:

Periodic work program progress reports will be submitted not later than December 31, 2013, June 30, 2014, December 31, 2014, June 30 2015, and December 31, 2015. A final work program report and associated products will be submitted between June 30 and August 1, 2016 as requested by the LCCMR.

Attachment A: Budget Detail for M.L. 2013 Environment and Natural Resources Trust Fund Projects

Project Title: How Do Natural Copper-Nickel Bedrocks Influence Water Quality?
Legal Citation: M.L. 2013, Chp. 52, Sec. 2, Subd. 05b
Project Manager: Steve Hauck
M.L. 2013 ENRTF Appropriation: \$ 585,000
Project Length and Completion Date: 3 years, 06/30/2016
Date of Update: October 1, 2012

| ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET | Activity 1 Budget | Amount Spent | Balance | Activity 2 Budget | Amount Spent | Balance | Activity 3 Budget | Amount Spent | Balance | TOTAL BUDGET | TOTAL BALANCE |
|---|-------------------|--------------|---------|-------------------|--------------|---------|-------------------|--------------|---------|--------------|---------------|
|---|-------------------|--------------|---------|-------------------|--------------|---------|-------------------|--------------|---------|--------------|---------------|

| BUDGET ITEM | Characterize streambed sediment, soil, and bedrock chemistry | | | Determine natural metal and major constituent loads in streams | | | Assess hydrologic conditions prior to potential future mine development | | | | |
|---|--|--------|-------------|--|--------|--------------|---|--------|--------------|--------------|--------------|
| Personnel (Wages and Benefits) | \$48,800.00 | \$0.00 | \$48,800.00 | \$0.00 | \$0.00 | \$0.00 | \$13,000.00 | \$0.00 | \$13,000.00 | \$61,800.00 | \$61,800.00 |
| Steve Hauck, Project Manager, Natural Resources Research Institute Director, \$38,400 (.263 FTE over 3 years, 36% fringe) | | | | | | | | | | | |
| Mark Severson, Natural Resources Research Institute Geologist, \$23,400 (.199 FTE over 3 years, 36% fringe) | | | | | | | | | | | |
| | | | | | | | | | | | |
| Professional/Technical/Service Contracts | | | | | | | | | | | |
| USGS Contract Total | \$65,058.00 | \$0.00 | \$65,058.00 | \$275,612.00 | \$0.00 | \$275,612.00 | \$164,530.00 | \$0.00 | \$164,530.00 | \$505,200.00 | \$505,200.00 |
| USGS Personnel | \$42,767.00 | \$0.00 | \$42,767.00 | \$69,696.00 | | \$69,696.00 | \$157,530.00 | \$0.00 | \$157,530.00 | \$269,993.00 | \$269,993.00 |
| Laurel Woodruff, U.S. Geological Survey, Geologist, \$55,497 (.38 FTE over 3 years, 30% fringe) | | | | | | | | | | | |
| Perry Jones, U.S. Geological Survey, Hydrologist, \$140,560 (.81 FTE over 3 years, 26% fringe) | | | | | | | | | | | |
| U.S. Geological Survey, Hydrologic Technician, \$63,203 (.85 FTE over 3 years, 22% fringe) | | | | | | | | | | | |
| U.S. Geological Survey, Hydrologic Technician, \$10,733 (.1 FTE over 3 years, 30% fringe) | | | | | | | | | | | |
| U.S. Geological Survey, Geochemical Laboratory - geochemical analysis of soil, bed-sediment, and bedrock samples | \$17,541.00 | \$0.00 | \$17,541.00 | | \$0.00 | \$0.00 | | | \$0.00 | \$17,541.00 | \$17,541.00 |
| U.S. Geological Survey National Water-Quality Laboratory - analysis of water-quality samples (major constituents, dissolved oxygen, and trace elements) | | | | \$43,288.00 | \$0.00 | \$43,288.00 | | | | \$43,288.00 | \$43,288.00 |
| U.S. Geological Survey Minnesota Water Science Center, Data Section - installation and maintenance of two stream gages | | | | \$116,507.00 | \$0.00 | \$116,507.00 | | | | \$116,507.00 | \$116,507.00 |
| USGS Travel: Eastern Minerals Science Center Lodging/Meals/Vehicle Costs - for soil, bed-sediment, and bedrock sampling | \$4,500.00 | \$0.00 | \$4,500.00 | | | | | | | \$4,500.00 | \$4,500.00 |
| USGS Travel: Minnesota Water Science Center Lodging/Meals/Vehicle Costs - for water-quality sampling and streamflow measurements | | | | \$40,082.00 | \$0.00 | \$40,082.00 | | | | \$40,082.00 | \$40,082.00 |
| USGS Water-Quality Sampling Supplies - bottles, sampling tubing, filters, pumps | | | | \$4,894.00 | \$0.00 | \$4,894.00 | | | | \$4,894.00 | \$4,894.00 |
| USGS Shipping Costs: Soil, Bed-Sediment, and Bedrock Samples | \$250.00 | \$0.00 | \$250.00 | | | | | | | \$250.00 | \$250.00 |
| USGS Shipping Costs: Water-Quality Samples | | | | \$1,145.00 | \$0.00 | \$1,145.00 | | | | \$1,145.00 | \$1,145.00 |
| USGS EPN Printing Costs | | | | | | | \$7,000.00 | \$0.00 | \$7,000.00 | \$7,000.00 | \$7,000.00 |
| MN DNR Contract Total | \$3,500.00 | \$0.00 | \$3,500.00 | \$0.00 | \$0.00 | \$0.00 | \$9,500.00 | \$0.00 | \$9,500.00 | \$13,000.00 | \$13,000.00 |
| Carrie Jennings, Minnesota Department of Natural Resources Glacial Geologist, \$12,000 (.115 FTE over 3 years, 30% fringe) | \$3,000.00 | \$0.00 | \$3,000.00 | | | | \$9,000.00 | \$0.00 | \$9,000.00 | \$12,000.00 | \$12,000.00 |
| MN DNR Travel: Minnesota Department of Natural Resources Lodging/Meals/Vehicle Costs - for soil, bed-sediment, and bedrock sampling | \$500.00 | \$0.00 | \$500.00 | | | | \$500.00 | | \$500.00 | \$1,000.00 | \$1,000.00 |
| | | | | | | | | | | | |
| Travel | | | | | | | | | | | |
| Natural Resources Research Institute Lodging/Meals/Vehicle Cost - for soil, bed-sediment, and bedrock sampling | \$2,500.00 | \$0.00 | \$2,500.00 | | | | \$2,500.00 | \$0.00 | \$2,500.00 | \$5,000.00 | \$5,000.00 |
| | | | | | | | | | | | |
| COLUMN TOTAL | \$119,858 | \$0 | \$119,858 | \$275,612 | \$0 | \$275,612 | \$189,530 | \$0 | \$189,530 | \$585,000 | \$585,000 |

