

S *Semi-Annual Report*

July - December

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NATURAL RESOURCES
RESEARCH INSTITUTE

Our research goes to work.

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Project Highlights

CENTER FOR APPLIED RESEARCH & TECHNOLOGY DEVELOPMENT

Wood Products and Forestry

New Sources of Funding for Biomass Projects Have Been Approved Through the Department Of Energy

This funding will result in an additional \$250,000 from Laurentian Energy Authority Project and the SunGrant Initiative, a joint Department Of Energy/Department of Transportation consortium. The SunGrant project will provide \$150,000 in the first year for poplar tree crop research with the high likelihood of increased funding in subsequent years. Bill Berguson has been assigned as the Team Leader for the Woody Crops Team and is cooperating with three other research organizations across the country to increase biomass yield of woody crops.

NRRI Developed Housing System Methods Received High Marks for Innovation and Detail From FEMA Triggering An Opportunity to Build Two Demonstration Structures

A design team led by NRRI submitted a code compliant ready to assemble housing disaster relief plan to FEMA – Joint Housing Solution Group, completing a request for a formal document review of NRRI developed housing system methods. This submission got high marks for innovation and detail. FEMA requested a field inspection triggering an opportunity to build two demonstration structures at the NRRI Coleraine Minerals Research Laboratory.

US Brig Niagara Sails to Duluth While Steamboat Minnehaha Enters Dry Dock!

The US Brig Niagara participated in the Duluth Tall Ship Festival in August 2008, bringing nearly 100,000 visitors to the waterfront. A behind the scenes story in the Duluth News Tribune reported that NRRI researchers and engineers had conducted an inspection of the mast and structural beams of the US Brig Niagara in December 2006, as part of their annual inspection. The NRRI staff had provided key insight into inspection procedures and advanced equipment for use in the inspection, helping the Niagara staff complete their annual safety inspections in a timely manner. This story resulted in contact by the Museum of Lake Minnetonka, an organization that rebuilt the Steamboat Minnehaha, which had sailed at the turn of the 20th century. A detailed inspection in December identified several sections of the ship that contained decay and needed to be replaced, years before it would have been noted, saving them replacement time and resources.

Minerals

Mesothelioma Study

Six site locations for the Minnesota Taconite Workers Lung Health Partnership particle collection study were established July through December 2008. These sites are located on the rooftops of the Natural Resources Research Institute in Duluth, Virginia Courthouse, Hibbing High School, Keewatin Elementary School, Babbitt Municipal Building, and near the ground at a Forest Service station located 18 miles east of Ely.

Sample housings, set-up at each site location, were developed at NRRI and house the Micro-Orifice Uniform Deposit Impactor (MOUDI), Total Suspended Particulate Sampler (TSP), and associated sampling equipment (see figure below). The housing development underwent several modifications throughout the process, particularly during cold weather sampling. Insulation, along with a heating mechanism (light bulb), was installed and proved effective for sample collection during very cold temperatures.

Each sample collection site requires equipment set-up, sample collection (5-7 days), and equipment take-down with sample recovery and data download. Equipment transferred between site locations includes: MOUDI, TSP, rotometer, two pumps, tubing, weather station and console, omni-directional inlet with associated plumbing, collection substrates, including blanks, and laptop.

Sampling will continue through 2009 and 2010 with new sites setup on the high school in Silver Bay and in the taconite plants.



Figure 1: Chris Bicknese collecting data on the Hibbing High School rooftop on a very cold day.

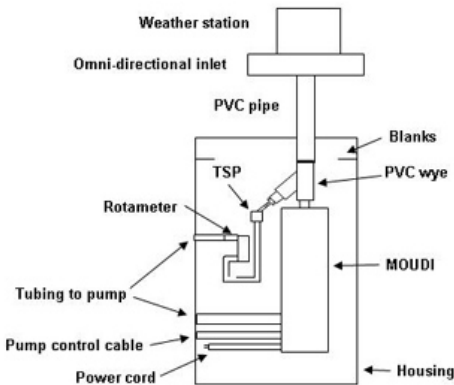


Figure 2: Schematic MOUDI, TSP and weather station set-up, not to scale. Pumps are located outside and next to the housing (not shown). Pumps are stored in plastic totes with holes cut in the side to attach the tubing and cables.

Geologic and Stratigraphic Controls of the Aggregate Potential of the Mesabi Iron Range

Mark Severson, John Heine, and Marsha Patelke completed drill core logging on the Mesabi Iron Range by completing 305 holes (118,863 feet of core) to date that include:

- 89 holes from ArcelorMittal's McKinley Extension Mine
- 16 holes from United Taconite
- 46 holes from Minntac (East and West Pits)
- 41 holes from Hibbing Taconite
- 63 holes from Keewatin Taconite (ongoing)
- 41 holes from the Welton Mine area (true collar locations unknown)

Complete stratigraphic sections have been determined for each of these areas, and a "Rosetta Stone" has now been developed that illustrates how each of the mine's geologic units correlate with an adjacent mine's units.

Preparation of 19 cross-sections for the McKinley Extension Mine has begun and will be used to show the three dimensional distribution of potential aggregate horizons associated with: 1) the top of the Lower Cherty (LC5B submember/Mesaba Select); and 2) similar adjacent material in the base of the Lower Slaty.

Taconite Aggregate Program

Various activities were completed for the Taconite aggregate program including a major study on the logistics of moving material from the Iron Range to various locations in Minnesota and other Midwestern locations. Potential depot sites were identified as part of this evaluation for Chicago, Northern Indiana, Milwaukee and down the Mississippi River System. In addition, various pavement mix designs for asphalt and Portland cement formulations have been developed by both UM Civil Engineering and the MN Department of Transportation which show very good structural properties. Also, work on repair compound formulation has led to mix designs that possess excellent properties for commercial application. Finally, environmental testing of actual taconite aggregate use in demonstration projects has led to no adverse environmental indications for materials taken from Western Mesabi Range operations

Non-ferrous Developments

Copper/Nickel Pilot Plant Testing of 1,000 Tons of Ore Completed

Construction of a 5-10 ton/hr copper/nickel processing pilot plant was completed at CMRL. This flow sheet included crushing, rod and ball mill grinding, screening, cycloning, flotation, thickening, and disc filtering capabilities. One thousand tons of a 3,000 ton crude ore Cu/Ni sample were processed in the circuit to produce a

flotation concentrate for hydrometallurgical processing. Ore having a copper concentration of 0.4% Cu was upgraded to a grade of 20% Cu using zanthate flotation in this processing circuit. Additional bench scale and pilot scale tests to produce more concentrate are planned in 2009 for several Minnesota Cu/Ni/PGM companies. A hydrometallurgical test laboratory is being planned for a future installation at the CMRL to support the various developments of our Minnesota copper/nickel, and precious group metal resources and future mining industries.

Taconite Flow Sheet Improvement

Minnesota Taconite Operations Research

Numerous mining, concentrating, agglomerating, and environmental projects were conducted for Minnesota's six operating taconite operations to enhance productivity and/or product quality. In the environmental area, NRRI continues working with the mining companies to evaluate and measure mercury and evaluate removal technologies for application in their stack gases. Process air flow studies have been conducted at many of the Minnesota taconite operations to improve on heat losses in the pelletizing process. Filtering and balling drum test work has aided the taconite operations in improving filter cake production and in reduction of bentonite consumption. Flotation audits have been conducted in several Minnesota operations which have resulted in reductions in magnetic iron losses and reduction in flotation chemical consumption.

Coleraine Minerals Research Laboratory Concentrator Center and CFD Modeling Center

The two centers completed a number of simulation-aided studies in the areas of furnace and burner design as well as hydro cyclone and flotation performance for our taconite industry partners. A number of energy and mass balance studies were completed for work in the nodular reduced iron research area. New flow sheet designs were completed for both US and international emerging mining company projects.

BASF at Coleraine

BASF, the world's largest chemical company, continues work with the Coleraine Minerals Research Laboratory to test various organic binder chemicals to replace bentonite. Several hundred tests have been completed in search of new organic binder chemicals to replace standard taconite inorganic binders.

Pellet Fines Removal System

New abrasion resistant AR400 steel chevrons were designed and successfully attached to the fines removal conveyor technology to greatly extend the lifetime of one of the critical wear items in order to advance the technology useful in the taconite and steel industries.

Environmental Remediation and Related Activities

Low Level Mercury Removal in Lake Superior/Erie Pier Discharges

Various sorbents are being tested to remove part per trillion levels of mercury in water discharged for the US Corp. of Engineers Erie Pier sediment storage facility in West Duluth.

Direct Iron/Nodular Iron Developments

DOE Nodular Reduced Iron Project at CMRL

Installation and commissioning of the new oxy-fuel combustion system is now complete in CMRL's pilot scale Linear Hearth Furnace. A total of eight 250,000 BTU oxy-fuel burners have been installed and the PLC control system has been modified to operate the new furnace firing system. The use of oxygen-fuel burners conserves energy associated with drying, reducing, and fusing nodular iron materials. Decreased fuel requirements also have a direct association with reduced CO₂ and NO_x emissions. The furnace sample car transport mechanism has also been replaced with an improved PLC controlled pneumatic mechanism to control the train of wheel mounted sample kiln cars which simulates larger scale continuous LHF operations. In addition, evaluations are in progress to utilize Powder River Basin coal and other carbon sources as reductant materials for production of nodular reduced iron.

NuIron Technologies, LLC Makes Significant Process with Prototype Plant

Nineteen test campaigns have successfully been completed for the new 5 ft wide by 300 ft long pilot scale NuIron Technologies Linear Hearth Furnace. High quality nodular reduced iron products have been produced on a routine basis. Future tests are focused on optimizing fuel consumption and nodular iron quality as well as

increasing furnace productivity. A number of CMRL engineers and metallurgical technicians are assisting in the operation and evaluation of the scaled up NRRI technology.

American Iron and Steel Direct Reduced Iron Project

CMRL has been chosen to conduct specialized balling test work for the American Iron and Steel Institute in support of a larger reduced iron project being advanced by US Steel and ArcelorMittal Steel. This program involves production of carbon containing iron oxide agglomerates that will be used in the direct reduction iron production system being designed as part of the program.

Mineral Processing Development

International Mineral Processing/Pyrometallurgy Test Projects

A number of smaller scale mineral processing and pyrometallurgical projects were completed or are in progress for testing various ore minerals from Peru, Bosnia, and Canada.

Alternative Energy

Biomass Fuel Characterization Facility Installed at CMRL

A unique 50 gram capacity Thermogravimetric Analyzer (TGA) system has been constructed to characterize biomass materials at CMRL and is being used for the purpose of developing a biomass materials database characterizing biomass materials for the State of Minnesota. The database is patterned after CSIRO's biomass database in Australia. Typical data will include biomass pyrolysis data, proximate and ultimate fuel analysis, emissions data, ash fusion data, charring characteristics, and fouling and corrosion information. Temperature controllers and on-line gas analyzers have been added to provide automated computer control of the processing as well as automated data logging. Woody biomass, agricultural biomass, and coal/biomass samples are being tested in the new TGA. In addition, a new calorimeter was installed at CMRL and is being used to add BTU content data to compliment the TGA database.

Biomass to Liquid Fuels Research at CMRL

Catalysts are being developed utilizing unique ore materials found in northeastern Minnesota to advance Fischer-Tropsch conversion of biomass to liquid fuels research being conducted at CMRL.

Vertical Wind Turbine to be Installed at CMRL

A vertical axis wind turbine produced by the PacWind Corporation of California has been ordered and will be installed at CMRL this summer. The vertical axis turbine is capable of producing 20 kW of power under good wind conditions.

Plasma Furnace Installation for Project Work at CMRL

An entire plasma arc furnace system has been moved and re-assembled at CMRL, including the plasma furnace, the annealing furnace, the tile mold assemblies, the cooling water system, and the power controller system. The furnace and auxiliary equipment will be used to produce energy absorbing tiles. This program will determine the conditions required in making high quality materials and will determine the processing conditions that will allow enhanced radiation absorption properties for the newly designed material mixes.

Infrastructure Improvement and Training

Installation of Upgraded Sinter Pot Test Equipment at CMRL

Upgraded sinter pot equipment was installed at CMRL with automated Allen Bradley PLC controls to produce blast furnace sinter feed products from various types of iron ore fine materials. Sinter pot test equipment and blower fan capacity was modified to allow test runs using up to 660 mm bed thicknesses to match new national and international test requirements.

Removal of the Old Administration Building at CMRL

The old CMRL administration building used for over 40 years was demolished and a new hydrometallurgical/biomass facility is being planned for installation on the site.

Construction of 60 ft by 120 ft Storage Building at CMRL

A new 60 ft by 120 ft equipment storage building was constructed on the CMRL site and will be used to store newly purchased heavy mobile equipment and other research test equipment used at the laboratory.

CMRL Analytical Laboratory Advancements

All of the 10 year old CMRL analytical laboratory metal fume hoods and associated metal ductwork have been replaced with polypropylene/lexan fume hoods and polypropylene ductwork to eliminate corrosion in the acid fume hood systems. Two Leco carbon/sulfur analyzers have been added to the compliment of instruments in the lab to add carbon and sulfur analysis for metallic and carbon related samples. In addition, a calorimeter has been added for BTU content measurement of fuels being studied in our biomass research program.

Five Engineers Complete Summer Internship Program at CMRL

Four chemical engineers from UMD and one minerals engineer from UND completed a 3 month engineering internship program at CMRL consisting of mineral processing, geology, and metallurgical engineering classes, taconite plant project work, and bench and pilot scale laboratory project work in metallurgy, geology, environmental remediation, and biomass research. Another engineering internship program is planned for the summer of 2009 due to the success of the project and interest shown by students.

Chemical Extractive

NRRI Opened Demonstration of New Pilot Station for Biofuel Production

A pilot station for Dry Distillers Grains Soluble (DDGS) extraction and High Protein Distillers Grains (HPDG) recovery, biodiesel production and solubles fraction separation was constructed and opened for broad demonstration. This pilot station will provide data for new DDGS processing plant construction. Five value-added products will potentially be recovered from DDGS in accordance with new technology of DDGS processing. This technology is currently on the way to industry for supporting dry mill ethanol plants.

NRRI Laboratory of Chemical Extractive Discovered New Organic Reaction

A new Iodonilium-de-Hydrogenation (I-de-H) reaction in organic chemistry was invented and used for synthesis of highly active anti-cancer and anti-HIV compounds. This invention has important fundamental and practical impact. I-de-H reaction will have a large practical use for chemical building blocks synthesis. Based on this discovery, the Laboratory of Chemical Extractives is providing synthesis of chemical blocks for various markets in cooperation with an external chemical company client.

NRRI Laboratory of Chemical Extractive Discovered New Transformation of Natural Products to Bioactive

Selective A-ring contraction for triterpenoids was developed and used for synthesis of bioactive compounds. This discovery opens new ways for synthesis of anticancer, anti-HIV, and anti-bacterial bioactives. Three highly active mitotoxic derivatives have been synthesized and tested as candidates for anti-cancer chemotherapy. Synthesis of more than a hundred potentially interesting bioactives were accomplished based on this discovery.

NRRI Laboratory of Chemical Extractive Developed New Dimethylpolysiloxane Material

New polydimethylsiloxane material was developed and successfully tested. This material will find use as new highly efficient sealant and is similar to silicone rubber material. Samples of material have been prepared for broad tests and comparison with existing commercial products. Industrial application testing of these materials is in progress.

CENTER FOR WATER AND THE ENVIRONMENT

GIS Modeling of Community Impacts on Water Resources

Many Lake Superior communities have specific goals or objectives in local plans on protecting water resources. However, making changes to existing ordinances regulating development is difficult, and communities are unable to fully evaluate the future impacts of today's decisions.

To help these communities better evaluate alternative development options, we used GIS and the Community Viz software to evaluate several scenarios of growth in a rural township, a small city, and a watershed spanning several communities. We used three scenarios: smart growth, conservation design, and existing zoning. For each scenario, we evaluated the potential effects on water resources by calculating estimates of impervious surface and forest cover loss, modeled annual runoff volumes, and looked at other indicators, including open space and road lengths.

3-D flyovers and visuals were created to help communities understand what these different styles of development would look like “on the ground”. Results indicate that by changing the style of development, communities could significantly reduce future impacts to water resources, with total runoff reductions of 25-66% over continuing existing zoning policies.

Center for Research and Applied Technology Development

Direct Hydrogen Production from Biomass Gasifier Using Hydrogen-Selective Membrane

Objective

To remove and characterize hydrogen from a synthetic gas produced from biomass using a highly selective membrane.

Background

Working in conjunction with the Gas Technology Institute, a highly selective membrane will be developed and used to separate hydrogen from a synthesis gas (syngas) produced from a downdraft gasifier operating on biomass fuel. A fully instrumented downdraft gasifier has been ordered from Community Power Corp. (Biomax 25) and will be installed at the Coleraine Minerals Lab. The gasifier will fuel a generator capable of producing 25 kW of electricity. A slip stream of this gas will be passed over this membrane and the products characterized.

Previous Activity

The Biomax 25 downdraft gasifier was purchased from Community Power Corporation, in Littleton, Colorado. The unit was installed at the Natural Resources Research Institute - Coleraine Minerals Research Laboratory. The installation of the Biomax 25 was conducted from May 21-25, 2007. The Biomax 25 downdraft gasifier has been commissioned and is operating using wood chips obtained from northern Minnesota sources. The producer gas composition consists of 15-20% CO, 15-20% H₂, 6-8% CO₂, and 2-4% CH₄. A slip stream of gas (2 L/min) was pumped through the membrane system provided by Gas Technology Institute. The membrane module consisted of a compressor, temperature controllers, and a water gas shift reactor to further enhance the hydrogen generation from the producer gas, followed by the selective membrane. Using gasifier operation temperature and pressure as variables, hydrogen was successfully separated from the producer gas with relatively high efficiency. Data analysis and a full report are currently in progress. The engine and generator module are pending delivery and installation.

Current

The Community Power Corporation Biomax 25 downdraft gasifier was used to produce syngas from wood chip feed materials. The syngas had a composition of 20-25% CO, 20-30% H₂, 6-8% CO₂, 4-5% CH₄, nitrogen and water vapor. The Gas Technology Institute provided specialized metal foil membranes to separate out pure hydrogen from the syngas produced from the Biomax unit. Hydrogen gas was successfully separated out from the syngas at a high efficiency and represented the first successful test of this type in the U.S. as reported by the Gas Technology Institute. A final report was generated from the test work and was issued during October 2008. Additional grant proposals are being written to continue this important research.

Principal Investigator(s)

Blair Benner
David Hendrickson
Donald Fosnacht
Richard Kiesel

Project Sponsor(s)

	Amount	Account	Active
Gas Technology Institute/Prime - Xcel En	327,520	1920-187-6592-00	10/17/2006 08/31/2007
PUF Mineral Endowment	130,000	1896-783-1230-00	04/10/2007 06/30/2009
Total	\$457,520		

Start Date: 10/17/2006 **End** 12/31/2008 **Project ID:** 1444

Energy Conversion Technologies
Polymetallic Gas to Liquid Catalysts

Objective

To conduct research and development to produce novel catalysts for thermochemical processing of biofuels based on local mineral sources.

Background

Recent publications show the significant potential of polymetallic catalysts in Fischer-Tropsch Reaction and related processes. Compared to the traditional pure iron or cobalt formulations, modification of iron catalysts with copper, chromium, titanium, manganese and/or others gives better conversion, improves the lifetime of the catalyst, positively influences the "C5+" selectivity and other parameters. Preparation of polymetallic catalysts requires multistep procedures to obtain the proper composition. On the other side, a number of minerals available for mining in Minnesota, such as ilmenite and magnetite, already contain the necessary metals in good proportion alongside the proper carrier compounds. These minerals may show the catalytic activity, and may be valuable for gas to liquid technology.

Previous Activity

A number of experiments have been conducted with the mineral samples, using two common experimental techniques. It was found that the active catalytic substance can easily be prepared via caustic fusion of ilmenite concentrate. Physically, this catalyst is a complex iron titanate with certain minor inclusions. It shows sufficient activity in the process of conversion of syngas to liquid hydrocarbons, and is much less expensive, compared to the commonly used catalysts.

Current

Experimental study of the ilmenite-based catalysts has been continued to explore the commercial potential of these substances. Tests on comparative activity and catalytic lifetime have been conducted and show promising results. It was found that iron titanate compounds are good precursors for modification with other metal ions - copper, chromium, cobalt, etc. A number of modified catalysts have been prepared this way and tested for syngas conversion. Some of the modified ilmenite catalysts show a high yield of branched hydrocarbons, unlike the common Fischer-Tropsch catalysts, which are selective to formation of linear hydrocarbons. Since gasoline-like fuels are composed mainly of the branched hydrocarbons, potential for one-step production of branched hydrocarbons may show some preferences for the fuel industry.

Principal Investigator(s)

Andriy Khotkevych
David Hendrickson
Richard Kiesel

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
40,000	1896-783-1239-00	02/29/2008 06/30/2009
Total	\$40,000	

Start Date: 02/29/2008 **End** 06/30/2009 **Project ID:** 1500

Distribution of Mercury During the Processing of Copper-Nickel Ores

Objective

To determine the distribution of mercury during flotation and subsequent pressure leaching of the bulk flotation concentrate.

Background

The development of a copper-nickel mine and processing plant would be a large economic boost to the area. The proposed development area is within the Lake Superior Basin, which is an environmentally sensitive area. Therefore, mercury in the ore and resultant concentrates and tailings will be of great concern. Preliminary analyses of chemical laboratory pulps from previous copper-nickel studies indicated a mercury concentration in the head sample of 65ng/g (ppb) and 108ng/g in a flotation concentrate sample. It should be noted that the samples had been previously pulverized (no effort to prevent mercury contamination) and had been stored in paper envelopes for as long as nine years prior to analyses. While the absolute values of the above analyses may be suspect; they do indicate the presence of mercury in the ore

Previous Activity

The autoclave has been repaired, but was needed for the bio-fuels project. When the autoclave is available, leach tests will begin.

Current

Awaiting availability of autoclave.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
18,750	1896-783-1203-00
Total	\$18,750

Active
02/09/2005 06/30/2009

Start Date: 02/09/2005 **End** 06/30/2010 **Project ID:** 1381

Full Scale Mercury Sorbent Testing at Boswell

Objective

To run a full scale sorbent addition test on Unit 1 at Minnesota Power's Boswell Energy Station in Cohasset, Minnesota. One or more mercury removal sorbents developed at the Coleraine Minerals Research Laboratory will be injected as dry sorbents into the 75 MW unit's 250,000 cfm stack gas stream prior to the unit's baghouse. Stack gas mercury measurements will be conducted before and after sorbent addition to evaluate efficiency of mercury removal.

Background

Three years of mercury removal research test work, utilizing funding from an EDA grant and the Permanent University Trust Fund (PUTF), has shown that chemically modified iron ore concentrate is an effective sorbent for the removal of oxidized and elemental forms of mercury in a 250 cfm flue gas slip stream from Unit 4 at Minnesota Power's Boswell Generating Station in Cohasset, Minnesota. NRRI-developed sorbents were shown to remove greater than 90% of total mercury at pilot scale in the stack gas stream. Previous test work has shown that it is possible to efficiently separate the sorbent from the fly ash. The mercury sorbent is capable of being reused and reinjected back into the gas stream for additional mercury removal. Sorbent regeneration work has shown that it is possible to remove greater than 90% of the total mercury from the "loaded" sorbent by heating in an inert atmosphere on a batch basis. Volatilized mercury can then be condensed and totally removed from the environment. Attempts to remove the mercury on a continuous basis, using an indirectly fired calciner, have shown that temperature control is critical to efficient removal. In addition to plant test work, computational fluid dynamics analysis of duct work in Unit 1 was also conducted at the Coleraine Minerals Research Laboratory to design an efficient dry sorbent injection system, ensuring good gas-sorbent contact.

Previous Activity

Full-scale mercury sorbent injection equipment was received at the Coleraine Minerals Research Laboratory. This equipment will be installed to evaluate full scale mercury reduction on Unit 1, treating 250,000 cfm of stack gas. Mercury reduction is to be measured using a newly purchased Ohio Lumex On-line Speciated Mercury Analyzer. Pilot scale mercury reduction tests were run at Boswell in the 250 cfm slip stream equipment installed on Unit 4. Besides mercury reduction, additional sorbent chemistry is being tested to remove SO₂ and NO_x.

Current

Full-scale dry sorbent injection equipment was obtained for sorbent injection into Unit 1 or 2 at Minnesota Power's Boswell Generating Facility in Cohasset, Minnesota. Full-scale test work has been rescheduled pending successful pilot scale test work being conducted on Unit 4 using a 250 cfm flue gas slip stream test system. Two pulse jet baghouses are being installed in the pilot system to enhance the quality of mercury removal research. The flue gas sampling point has been changed to provide a consistent 250°F flue gas temperature for sorbent testing in the flue gas stream.

Principal Investigator(s)

Blair Benner
David Hendrickson

Project Sponsor(s)

	Amount	Account	Active
PUF Mineral Endowment	350,000	1896-783-1227-00	04/10/2007 06/30/2009
Total	\$350,000		

Start Date: 04/10/2007 **End** 06/30/2010 **Project ID:** 1476

Investigation of Mercury Vaporization During Induration and Removal of Mercury from Scrubber Solids

Objective

To determine how mercury is volatilized during induration and to investigate methods of removing mercury from the scrubber solids.

Background

The taconite industry is under pressure to reduce the emissions of mercury from their induration process. Previous studies have shown that greater than 90 percent of the mercury in the green balls is vaporized during induration. What is not known is whether the mercury is vaporized quickly, early in the process, or is slowly evolved over the entire process. Once the temperature-time relationship for mercury volatilization is established, then it may be possible to treat a smaller portion of the gas stream to remove mercury. Previous studies have shown that the fine solids removed by the scrubbers contain mercury, which is recycled back to the indurating furnace. The solids cannot be simply discarded without a significant loss in iron units. However, if the solids could be treated to remove the mercury, then they could be recycled to recover the iron and still reject mercury.

Previous Activity

The probe for the Ohio Lumex mercury monitor has been modified to allow sampling of the mini-pot exhaust. Initial tests indicated a rather rapid evolution of mercury at between 400° and 500°C, which is consistent with static boat tests in a tube furnace.

Current

We are awaiting availability of the new Ohio Lumex on-line mercury analyzer and the mini-pot system to continue testing.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

45,500 1896-783-1200-00

Active

02/09/2005 06/30/2009

Total

\$45,500

Start Date: 02/09/2005 **End** 06/30/2010 **Project ID:** 1378

Mercury Reduction Tests - Bench/Pilot Scale - Western Lake Superior Sanitary District

Objective

To reduce the level of total mercury in the Western Lake Superior Sanitary District's discharge water from two parts per trillion to one part per trillion for Duluth's 40 million gallon per day wastewater treatment plant.

Background

As the new discharge limits for mercury in waters being discharged into Lake Superior have been reduced by the Minnesota Pollution Control Agency, the Western Lake Superior Sanitary District (WLSSD) needs to reduce to one part per trillion the mercury in their discharge water which flows into Lake Superior. WLSSD is Duluth's 40 million gallon per day wastewater treatment plant located in west Duluth along the Lake Superior waterfront.

Previous Activity

Following bench scale testing to evaluate a number of methods to remove part per trillion levels of mercury in Duluth's WLSSD discharge water, in-plant tests were conducted on continuous flow slip streams to evaluate mercury removal. Meetings were held at WLSSD to discuss research test findings. Continuous flow testing for mercury reduction was conducted, in which stannous chloride was added in the effluent to reduce oxidized mercury to a metallic mercury, (a condition where it would be volatilized into the air above the water surface). Results indicated only a small reduction was achieved in the part per trillion levels of mercury present in these tests. Additional tests will be run in the spring of 2009 to evaluate new NRRI mercury reduction methods to reduce total mercury to less than 1.0 part per trillion in WLSSD's effluent discharge into Lake Superior.

Current

Bench scale work will continue during the spring of 2009 to support the continuing effort requested by WLSSD to reduce its water discharge mercury levels to below 1.30 parts per trillion (ppt) total mercury. NRRI is part of a mercury reduction team assembled by WLSSD to continue bench and in-plant mercury reduction work at their 40 million gallons/day municipal wastewater treatment plant in west Duluth. Previous in-plant test work showed relatively low mercury removal. Therefore, WLSSD is seeking a more effective mercury reduction in-plant process. New chemical design research will be tested in early 2009 to evaluate its mercury removal efficiency.

Principal Investigator(s)

David Hendrickson

Project Sponsor(s)

	Amount	Account	Active
Western Lake Superior Sanitary District	44,047.77	1933-187-6583-00	06/02/2006 12/31/2007
Total	\$44,048		

Start Date: 06/02/2006 **End** 12/31/2008 **Project ID:** 1428

Slip Stream Pilot Plant for Testing Mercury Removal Methods for Taconite Flue Gases

Objective

To design and install a slip stream pilot plant at one of the taconite plants so that various mercury removal methods can be evaluated using real plant gases.

Background

The taconite plants are currently considered to be the second largest mercury emitters in the state. While millions of dollars have been spent on research and plant trials regarding mercury removal from power plant flue gases, relatively little has been done on taconite gases. With the large differences between the power plants and taconite plants, it is not clear that methods effective in power plants will be as effective in taconite plants. A slip stream is a more economical way to evaluate a relatively large number of alternatives without having the balance of the plant issues.

Previous Activity

The Ohio Lumex mercury continuous emission monitor was taken to Minntac for comparison testing with the Energy and Environmental Research Center at the University of North Dakota. Approximately one week was spent installing the unit and ancillary equipment and attempting to operate the monitor. These attempts were unsuccessful, so the unit was brought back to Coleraine, where it was discovered that a gasket had been installed backwards, so that we were not drawing in gas from the stack. Subsequent testing at Boswell Unit #4 indicated that the unit was working properly.

Current

Testing at Minntac pointed out a need for a longer heated sample line from the stack to the detector and a better environment for the instruments. A longer heated sample line and a portable shed will be purchased, so that testing can begin when weather permits.

Principal Investigator(s)

Blair Benner

David Hendrickson

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

350,000 1896-783-1228-00

Active

04/10/2007 06/30/2009

Total \$350,000

Start Date: 04/10/2007 **End** 06/30/2010 **Project ID:** 1477

Agglomerated Corn Stover Oil Absorbent Beads

Objective

To develop a superior oil sorbent product made from ground corn stover.

Background

The CPI Parts Division (CPI) recently developed an all natural absorbent panel made from compressed corn stover fiber which the company calls Drip-Trap™. The product and manufacturing technology was developed and patented by the University of Minnesota's Natural Resources Research Institute. This user-friendly absorbent board is used to catch and retain oil from beneath cars, trucks, buses, and general manufacturing machinery. The product has achieved modest sales and is currently a featured product at Canadian Tire Auto Parts stores throughout Canada. Several inquiries throughout CPI's sales network have identified the need for a supplemental granular corn stover oil absorbent product. In response to this need, CPI contacted the NRRI for help in the development of an optimally configured granular absorbent product made from corn stover fiber.

Previous Activity

The oil sorbency applications lab at the NRRI conducted a series of tests in which ground corn stover fiber was gently agglomerated with an emphasis towards conserving the natural cellular structure of the corn stover fibers using a two part natural binding system. Agglomerated corn stover fibers were found to absorb more than 4.5 times more oil than a competitive clay-based product. These initial investigations helped to establish the potential of the agglomeration process for more detailed optimization trials.

Current Activity

The optimal configuration for preparing the corn stover agglomerates was identified. Pan agglomeration was found to be the most effective technique as fiber destruction was minimal and oil sorbency maximized. In particular, binder dosage, feed grind, binder type, and drying method were appropriately optimized. Operational challenges associated with the light weight nature of the corn stover was solved by using a two-part binding system. This allowed agglomeration to proceed quickly and at low moisture content. CPI management was given a demonstration of the agglomeration process. Additionally, a 36 inch pan agglomerator was installed in West Concord, Minnesota, to test and verify its capabilities and confirm pilot-scale performance requirements are met. Pilot scale test marketing of the media is planned for the spring. An invention disclosure detailing the unique features and process steps to prepare the media were submitted to U of M Office of Technology Commercialization (Docket #Z09111).

Principal Investigator(s)

Brian Brashaw
Timothy Hagen

Project Sponsor(s)

Clean Plus, Inc

Amount	Account	Active
5,000	3000-10414-00005187	05/01/2008 04/30/2009
Total	\$5,000	

Start Date: 05/01/2008

End Date: 04/30/2009

Project ID: 1534

Development of an Advanced Carrier for Microorganisms

Objective

To identify the optimal granular formulation for an engineered carrier using a base feedstock combination of natural materials to carry and harbor specific microbial strains currently manufactured by TerraMax, Inc.

Background

TerraMax, Inc. is a microbiological research and development company located in Cottage Grove, Minnesota. The company was founded in February 1998 to develop products that offer environmentally and economically sound solutions for agricultural markets. The two main areas in which the company has focused its research have been the development of nutritional aids for plants and biopesticides. TerraMax, Inc's proprietary formulation technologies allow the company to bring microorganisms from the laboratory to the field. The recent introduction of granular microbial formulations have allowed easy to use microbial formulations to be uniformly broadcast and applied to turf surfaces, sports and athletic fields, agricultural crops, and the like. The selection, specification, and production of a granular carrier requires a foundation formulary which:

- Harbors and protects the organism for extended periods.
- Has an appropriate and acceptable shelf life.
- Is easy to use and spread with conventional fertilizer spreaders, planter boxes, and seeder boxes.
- Is cost effective to produce.
- Releases the biological organism in an acceptable manner.
- Results in a significant and detectable rise in yield or output for the end user.

Previous Activity

Pan agglomeration was chosen for scale-up to pilot production as it covers the widest array of targeted performance parameters for dry strength, disintegration, pH and particle size distribution properties. Several 1,000 gram batches of media were pan agglomerated while applying culture to targeted levels. Agglomerate moisture in the range of 35-40 percent was near optimal while still having the desirable free flowing properties. Performance targets for strength, durability, speed of disintegration, particle size distribution, and pH were met with non-thermal drying techniques. Titer counts for several microbial strains impregnated into the media have been very encouraging.

Current Activity

Several additives offering superior longevity and survival of the organism were identified and incorporated into the formulation. Titer counts spanning a period of 90 days have indicated one particular additive having a pronounced effect on the survival, longevity, and viability of the organism. Moisture migration, flowability, integrity, and mold growth during long-term storage appear to be acceptably optimized. Side-by-side comparisons of survival and longevity to peat and clay-based carriers were initiated. Field trials are planned for the spring planting season. An appropriate breathable bag for storing the carrier was identified.

Principal Investigator(s)

Brian Brashaw
Timothy Hagen

Project Sponsor(s)

TERRAMAX, Inc

Amount	Account
5,000	1664-187-6617-
Total	\$5,000

Active
04/03/2008 04/02/2009

Start Date: 04/03/2008

End Date: 04/02/2009

Project ID: 1514

Development of Flexural Vibration Inspection Equipment, Techniques to Assess Structural Health of Rural Bridge Systems: Phase II

Objective

The objective of this project will be to conduct vibration testing of dowel laminated timber bridge systems to better understand the potential for using vibration testing to evaluate the structural health and condition of bridges in Minnesota. A secondary objective is to improve and automate the vibration testing system.

Background

This proposal supplements and continues a FY 05/06 UMD NATSRL project, Development of Flexural Vibration Inspection Techniques to Rapidly Assess the Structural Health of Rural Bridge Systems by expanding the bridge type to include dowel laminated bridges and by designing and fabricating an automated testing system. In this project, the UMD Natural Resources Research Institute and research partners have worked to refine rapid in-place testing techniques for assessing the structural health of timber bridges. These techniques were used to determine the natural frequency of the entire bridge which is analyzed and converted to an equivalent measure of the bridge system stiffness leading to an assessment of the bridge integrity.

Previous Activity

An automated testing system based on Labview Windows software has been designed and fabricated. It is based on a laptop computer and includes data processing and control software. The automated testing equipment was evaluated and modified during troubleshooting activities on a timber bridge that is instrumented with a forcing vibration system. This bridge is located near Meadowlands, Minnesota. In cooperation with the USDA Forest Products Laboratory, we designed and constructed a continuous nail laminated timber bridge at the Natural Resources Research Institute. Vibration testing of the bridge was conducted at each one ft interval during construction and the vibration frequency characteristics were determined.

Current Activity

Ten dowel laminated St. Louis County timber bridges were tested to determine the vibration characteristics and the static load performance. The vibration testing was conducted using the automated testing equipment developed in this project. The static load testing was completed by placing a fully loaded gravel truck on the bridge and measuring the deflection characteristics in the loaded and unloaded conditions. The data will be analyzed during the next reporting period. The NRRI test bridge was also tested for vibration starting at the full width and in 1 ft intervals as it was deconstructed. This data will be analyzed and compared to the vibration testing that was completed in the summer of 2007 as the bridge was constructed. This testing should prove useful in development and implementation of bridge monitoring technology to ensure the reliability of our rural bridges in Minnesota.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)

MN Dept of Transportation (MNDOT)

Total

Amount Account

52,980 1663-187-6590-00

\$52,980

Active

09/12/2006 06/30/2009

Start Date: 09/12/2006

End Date: 06/30/2009

Project ID: 1462

Development of Value-Added Opportunities from Recycled Cotton Mattress Fiber

Objective

To identify revenue generating applications for low grade cotton fiber from recycled mattresses in support of Hennepin County's planned recycling program.

Background

Hennepin County is currently analyzing options for developing a metro area mattress recycling operation. They are in planning stages for a program that would recycle over 30,000 mattresses annually. Based on these projections, over 142 tons of cotton fiber will be recovered annually. At this time, they are not associating a value or disposal cost to the cotton, therefore any revenue or cost for the cotton would change the \$15-\$23 per mattress fee for disposal that they are projecting. Hennepin County's goals are to work with a non-profit or for profit organization to develop a self-sufficient mattress recycling facility to serve the metro area.

Previous Activity

A meeting was held in Hennepin County with Ryan Trainer, Executive Vice President and General Counsel of the International Sleep Products Association. Discussions centered on industry initiatives to improve, foster, and implement long term sustainability for mattress construction and disposal. The Minnesota Pollution Control Agency was also in attendance. Initial contacts were made with several companies regarding the use of mattress cotton in ceiling tiles, oil filters, non-woven landscape products, and bulk cotton bleachers.

Current Activity

The final report was prepared and submitted to the project sponsor and cooperators. The major conclusions for the use of cotton fiber included:

- (1) Cotton batting recovered from mattress recycling and dismantling operations can be woven into viable filtration substrates by mixing the cotton fibers with appropriately prepared wood fibers using conventional air laid non-woven technology. This graded cotton batting closely resembles first cut cotton linters, which is essentially a by-product of the cotton seed refining industry. The approximate value of this graded material is around \$0.20/lb and is approximately 50% cheaper than first cut cotton linters. An order for 20,000 lbs of mattress cotton was placed during this project.
- (2) Black light fluorescence is a viable means to grade or separate cotton batting into separate streams – one containing high proportions of synthetics and the other containing a lower proportion of synthetics.
- (3) Approximately 21 percent of the cotton batting recovered from a random sampling of 38 mattresses was deemed bleachable by a major cotton bleaching operation.
- (4) Shoddy pads pass water freely through their surface and can prevent weed growth.
- (5) The cotton batting recovered from mattress recycling and dismantling operations is a viable material to use as a replacement for first cut linters in oil filter substrate applications.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)

Hennepin County

Amount	Account
40,000	1676-187-6610-00
Total	\$40,000

Active
12/01/2007 10/01/2008

Start Date: 12/01/2007

End Date: 10/01/2008

Project ID: 1502

Flue Gas Desulfurization (FGD) Gypsum Residual

Objective

To develop alternative uses for flue gas desulfurization gypsum.

Background

As Minnesota Power continues to improve flue gas emission reduction the volume of flue gas desulfurization (FGD) gypsum produced increases. This study will review worldwide patent literature and current commercial process to add value to these residuals. This project parallels a second project that focuses on process residual gypsum that could be potentially generated by any of the three proposed precious metal mining operations in Northern Minnesota. The volume is significant.

Previous Activity

This is a new project.

Current Activity

The project was funded in mid December. No new progress to report.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)

Minnesota Power

Amount Account

10,000 3000-10414-00007283

Active

12/15/2008 12/31/2009

Total \$10,000

Start Date: 12/15/2008

End Date: 12/31/2009

Project ID: 1533

Great Lakes Wood Manufacturing Partnership: Lean Production for Forest Harvesting and Primary Wood Processing

Objective

The goal of the proposed project is to expand the efforts of the Partnership into forest harvesting and primary wood product manufacturing to include sawmills, rough mills, and dry kiln operations. We will develop strategies for helping logging operations and primary hardwood and lumber processing companies understand and implement lean manufacturing.

Background

The Great Lakes Wood Manufacturing Partnership was formed in 2003 by the University of Minnesota Duluth Natural Resources Research Institute (NRRI), Michigan Technological University, the USDA Forest Products Laboratory, and the Michigan, Minnesota, and Wisconsin Department of Natural Resources. This cooperative partnership of regional specialists in wood products manufacturing was established to help secondary wood products manufacturers enhance their competitive position in the wood products industry.

Previous Activity

The eight kinds of waste were identified in hardwood and softwood sawmills and logging operations in Minnesota. Site visits to sawmill and logging operations allowed for the development of value stream maps for a softwood sawmill, a hardwood rough mill, a traditional feller-buncher pulp wood harvesting operation, and a cut-to-length pulpwood harvesting operation. Lean project activities were conducted with Cass Forest Products. This included a tour of a lean manufacturing operation and lean manufacturing training and facilitation of a continuous improvement event. Invited presentations on lean manufacturing production were made to the Hardwood Manufacturers Association, the Great Lakes Timber Professionals Association, and the Minnesota Logger Education Program.

Current Activity

There was no activity on this project during the past reporting period. An extension was requested and approved until 9/30/2009 changing the scope of work. We will replace the continuous improvement projects with logging companies with interviews and strategies developed in cooperation with paper companies and logging equipment companies. This was necessary due to the lack of implementation interest expressed from logging companies in Minnesota.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)

	Amount	Account	Active
Blandin Foundation	8,000	1670-187-6576-00	02/01/2006 12/31/2007
USDA Forest Service	90,248	1637-187-6550-00	09/01/2005 09/30/2009
Total	\$98,248		

Start Date: 09/01/2005

End Date: 09/30/2009

Project ID: 1398

Gypsum Residual Beneficial Use

Objective

The objective is to assess three specific market opportunities for beneficial use of PolyMet Mining's gypsum residuals.

Background

PolyMet Mining controls 100 percent of the NorthMet copper-nickel precious metals project located in the established mining district of the Mesabi Range in Northeastern Minnesota. They plan to produce three products on-site: high-grade copper cathode, nickel-cobalt hydroxide, and precious metals precipitate. As a byproduct, they will generate large volumes of market-quality gypsum residuals. The NRRI will assist PolyMet Mining in assessing market opportunities for beneficial use of the gypsum residuals.

Previous Activity

This is a new project.

Current Activity

This project began in late 2008 with the discovery phase that included literature and patent review to identify previous research and case studies on land application, bulk commodities, and wallboard.

Early work on commodity-grade gypsum wallboards show that there is significant excess capacity with some new plants yet to be commissioned. However, there are a number of new niche products with new manufacturing capacity that are gaining momentum, most of these new boards are based on magnesium oxide cements. This is very encouraging based on the high level of related activity in the field of non sintered phosphate ceramics underway at the NRRI. Also encouraging is the interest by the Minnesota Pollution Control Agency. They are demonstrating an active role in finding new uses of residual gypsum and have linked this work closely to their land fill reduction goals since our outcomes will also help define new uses for gypsum construction debris.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

50,000 1750-10414-20090-

Active

11/20/2008 06/30/2009

Total

\$50,000

Start Date: 11/20/2008

End Date: 06/30/2009

Project ID: 1535

Heat Sterilization of Ash Firewood for Thermal Eradication of Emerald Ash Borer

Objective

The objectives of this project are: (1) to develop practical and efficient kiln drying and heat treatment schedules for thermally eradicating of Emerald Ash Borer in ash firewood; and (2) to develop user-friendly heating timetables that can be used by communities and firewood producers in their heat treatment operations to meet the heat sterilization requirement.

Background

Due to the potential risk associated with moving emerald ash borer infested firewood, interstate movement of all hardwood firewood is currently restricted under a Federal Quarantine. Communities and firewood producers are now faced with decisions on how to treat their firewood for interstate commerce. The new regulations for heat sterilization of ash firewood require holding a core temperature of 160°F (71°C) for 75 min. (APHIS 2006), which is much higher than the current heating standard for treating solid wood packaging materials. Therefore, the heating schedules developed for heat treating solid wood packaging materials are not acceptable for ash firewood.

Previous Activity

Laboratory heating experiments have been completed. The heating options evaluated included:(1) Heat treatment with moisture reduction: dry heat (160° to 280°F dry bulb temperature); (2) Heat treatment without moisture reduction: wet heat (160°, 170°, 180°F dry bulb temperature with 0°F wet bulb depression); and (3) Heat treating seasoned ash firewood: dry heat (160°, 170°, and 180°F dry bulb temperature without wet bulb control). The production heat treatment trials have been conducted at Green Thumb Farm, Inc.

Current Activity

The data from the experimental kiln runs have been analyzed. Both analytical and empirical models for predicting heating times under various heating conditions were developed and evaluated. The best prediction model has been selected and used to develop heating timetables for treating green ash firewood using dry heat schedules (160° to 280°F). The current heating standard for ash firewood is to heat firewood to a core temperature of 160°F and hold for 75 min. With the recent new research development on the lethal temperature for emerald ash borer, a lower heating temperature for killing the emerald ash borer is likely introduced. We are currently incorporating a lower kill temperature (150°F) into our analysis and developing prediction models for a potential new heating standard. A final report that summarizes the results of this project is being prepared and will be submitted to the US Forest Service WERC. A technical article will be prepared and submitted to one major scientific journal.

Principal Investigator(s)

Brian Brashaw
Xiping Wang

Project Sponsor(s)

USDA Forest Service

Amount Account

44,804 1637-187-6603-00

Active

07/01/2007 12/31/2008

Total

\$44,804

Start Date: 07/01/2007

End Date: 12/31/2008

Project ID: 1468

Heat Treatment of Firewood - Meeting the Phytosanitary Requirements

Objective

The purpose of this project is to transfer the knowledge and most advanced heat treating technology to field application through demonstration projects and via on-site and web-based training workshops.

Background

Due to the potential risk associated with moving emerald ash borer infested firewood, the interstate movement of all hardwood firewood is currently restricted under the federal quarantine. Heat treatment is an approved treatment to kill the emerald ash borer in firewood and prevent their transfer between regions and states. However, states and firewood producers are faced with challenges on implementing a heat treating process and safely treating their firewood for interstate commerce. Federal Plant Protection and Quarantine officers and regulatory field staff have had little training and few internal resources to bring their knowledge of heat treatment operations to the level desired for program integrity.

Previous Activity

This is a new project.

Current Activity

We have identified a series of temperature sensors, thermocouple wires, and data loggers for their suitability for heat treatment application. Two types of data loggers and one digital temperature reader have been purchased and evaluated. A cost-effective temperature monitoring system has been built and installed at the heat treating facility of our industrial cooperator, Green Thumb Farm, Inc. Three heat treatment demonstration runs have been completed and the system has proved to be durable, reliable, and robust. A comprehensive demonstration project will be conducted with this cooperator in the next reporting period. With our project cooperators (US Forest Products Laboratory, USDA Animal and Plant Health Inspection Service, and the Wisconsin DNR), we have conducted the first training workshop on heat treatment of firewood. This on-site workshop was held on February 25, 2009, in Madison, Wisconsin. It covered the following topics:

- (1) Wisconsin federal and state regulations on emerald ash borer infested firewood;
- (2) Current heat treatment standard for firewood and treating facility certification process;
- (3) Fundamentals of the heat treating process; and
- (4) Heat treating options, temperature monitoring, and thermal verification.

Principal Investigator(s)

Brian Brashaw
Xiping Wang

Project Sponsor(s)

USDA Forest Service

Amount Account

89,500 3002-10414-00005000

Active

07/01/2008 12/31/2009

Total

\$89,500

Start Date: 07/01/2008

End Date: 12/31/2009

Project ID: 1531

House3: FEMA-Housing Assessment Tool Demonstration

Objective

To build two demonstration buildings that serve Coleraine Minerals Research Laboratory`s expanding office needs and also demonstrate ready to assemble housing technology for FEMA.

Background

The NRRI has been creating an economic development initiative focused on wood based systems for transitional housing. The chief aim is maximizing the industrial development potential of added-value regional forest resources; resulting in new manufacturing and technology employment opportunities. The current work is based on a request by FEMA.

Previous Activity

This is a new project.

Current Activity

A design detailing team was created consisting of an architect, a structural engineer, an electrical engineer, and a licensed contractor to complete remaining construction documents. These services are being provided as in-kind. The team visited and selected building sites at the Coleraine Minerals Research Laboratory.

The project team has been working closely with UMD Facilities Management to verify code compliance and vendor selections. The utilities have been trenched in. The NRRI has leased a small shop to fabricate the units and prepare for shipping and site assembly. We have set up process equipment to fabricate the units and expect to begin in early March. We have received donated materials in support of the development of these units. Noteworthy gifts include plumbing fixtures by Kohler and insulation materials from Dow. We have remained closely linked to FEMA in preparation of a building and systems performance assessment.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)

PUF Mineral Endowment

	Amount	Account	Active
	140,000	1750-10414-20090-	11/20/2008 06/30/2009
Total	\$140,000		

Start Date: 11/20/2008

End Date: 06/30/2009

Project ID: 1536

House3: FEMA Housing Assessment Tool Opportunity

Objective

To design a structure that is used to complete the requested housing assessment tool review.

Background

FEMA requested a formal review of the NRRI housing systems design.

Previous Activity

We submitted our transitional housing system to FEMA’s Joint Housing Solutions Group for review. It is an international residential code-compliant house with mobility. The structure is a hybrid consisting of modular and closed wall panels fitted with internal connectors and gaskets allowing for disassembly and reuse.

This unit is designed as cold-climate housing (Minnesota); however dwellings can be configured for other climate zones. It is a naturally-ventilated residence consisting of low formaldehyde materials creating an energy efficient and comfortable environment.

Current Activity

We hired Robert Berquist (architect) and James Berry (PE structures) to assist in this development. The design submitted to FEMA got high marks for design and innovation and triggered a request by FEMA to inspect and verify the performance of a working model; thus creating a need for a full scale demonstration project. This led to an opportunity to build two demonstration units at the Coleraine Minerals Research Laboratory. This final step will make possible FEMA’s field inspection. The Blandin Foundation provided a grant to continue this development work. In addition to the above it will also create a working model for transitional workforce housing, a current topic of interest in our region.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)

Blandin Foundation

Amount	Account
15,000	1670-187-6612-00
Total	\$15,000

Active

03/01/2008 09/01/2008

Start Date: 03/01/2008

End Date: 09/01/2008

Project ID: 1512

Innovative Wood Research for Economic Development

Objective

The overall objective of the project is to assist with the sustainable development of private sector forest products opportunities in Minnesota and the Upper Midwest.

Background

Major goals include: (1) helping existing small and mid-size wood products companies remain or become competitive through research and development; (2) conducting forest productivity work in hybrid poplar, red pine, and other Minnesota species to ensure the sustainability of the forest products industry; and (3) formation of new regional industries based on forest products materials and technologies. Specific sub-projects include the following topics: (1) lean manufacturing concepts for wood products manufacturers and forest harvesting companies; (2) nondestructive evaluation technologies for timber bridges; (3) condition assessment of residential wall structures; (4) implementation of new housing technologies; (5) utilization of paper mill black liquor/soap fraction wastes; and (6) biomass for energy from Minnesota's brushlands.

Previous Activity

NRRI staff attended additional total productive maintenance (TPM) training as part of the development of maintenance capacity to help companies implement lean manufacturing. This information was used to develop a hands-on maintenance short course utilizing gas powered compressors. Initial training was conducted for several companies in Minnesota. The housing component of this wood utilization research project got a major push forward with a formal request by FEMA to assess the technology. The assessment received high marks from FEMA for innovation and design leading to an opportunity to build two demonstration units. Sampling of brushland sites is ongoing with the Department of Natural Resources completing sampling on 48 sites to develop estimates of total aboveground biomass on these sites.

Current Activity

A total productive maintenance event was completed on a laboratory press at NRRI, in order to develop addition case studies for use in both USDA CSREES projects and the current Forest Service total productive maintenance project. In the housing subproject, significant funding was received in November 2008 from the University of Minnesota Permanent University Trust Fund to construct and erect two demonstration units at the Coleraine Minerals Research Laboratory in the spring 2009. A design team was created consisting of an architect, a structural engineer, an electrical engineer, and a licensed contractor to complete remaining construction documents. After installation of the 2 units, we expect to participate in with FEMA in a building and systems performance assessment in the summer of 2009, with a goal of creating specification purchases through the agency in the future. The remaining project activities are complete and the final reports are being prepared for the next reporting period.

Principal Investigator(s)

Brian Brashaw
Donald Fosnacht
Patrick Donahue

Project Sponsor(s)	Amount	Account	Active
USDA Coop ST Res ED & Ext Srvc(CSREES)	233,747	1636-187-6589-00	08/15/2006 08/15/2009
Total	\$233,747		

Start Date: 08/15/2006 **End Date:** 08/15/2009 **Project ID:** 1446

Nondestructive Assessment of Advanced Composite Material

Objective

The purpose of this research is to investigate the potential of using several emerging nondestructive evaluation technologies to assess the performance of wood/nonwood based composite materials.

Background

As new wood/nonwood based composite materials are being developed and used in structural and nonstructural applications, their performance and product quality need to be tested as part of product development and production quality assurance. There is an urgent need from the manufacturers' perspective to develop effective nondestructive assessment procedures to evaluate the performance of these new composite materials and detect internal defects that could cause failure in-service.

Previous Activity

This is a new project.

Current Activity

We have identified and reviewed several emerging nondestructive testing technologies by attending the 2008 America Society of Nondestructive Testing Conference and a subsequent literature search. The techniques with potential to meet the project's objectives include:

- (1) Portable laser shearography - a vibration resistant imaging laser interferometer, designed for the nondestructive inspection of aerospace composite repairs, structures, and components;
- (2) Infrared thermography - a widely used imaging technique for nondestructive inspection of different materials and structures;
- (3) Ultrasonic phased array system - incorporates an array of sensors to detect defects in different depths, provide B-, C-, and D-scans of the materials;
- (4) Resonant acoustic inspection system.

During the next phase we will work of the project, we will work with our project sponsor to obtain samples of the composite materials that are under evaluation. We will then contact some NDT/NDE equipment vendors and develop a collaboration plan for evaluating the potential of these techniques in assessing the performance and quality of the composite materials.

Principal Investigator(s)

Brian Brashaw
Xiping Wang

Project Sponsor(s)

USDA Forest Products Lab

Amount	Account
20,000	---
Total	\$20,000

Active

07/14/2008 06/30/2009

Start Date: 07/14/2008

End Date: 06/30/2009

Project ID: 1532

Nondestructive Evaluation of Wood Materials

Objective

The goal of this research is to evaluate recently developed and commercialized acoustic technologies to assess stress levels of trees affected by oak decline and evaluate grade yield and mechanical properties of boards obtained from the trees.

Background

Recent research developments of NDE technologies at NRRI and the USDA Forest Products Laboratory offer opportunities for industry and forest managers to evaluate standing trees for general wood quality, mechanical properties, and internal defects. This information could help managers make economic and environmental decisions on treatments for individual trees and forest stands and to efficiently allocate timber resources for optimal utilization. For example, the information could be used to predict insect and disease damaged trees that should be treated or removed to preserve the health of the forest stands or range of forests. Another example is to determine the relationships between environmental conditions, silvicultural treatments, and wood fiber properties so that the most effective treatment can be selected for future plantations for desired fiber quality.

Previous Activity

A preliminary report that summarized the results of tree-log data analysis has been completed. Acoustic data of the trees and corresponding logs were analyzed on both individual tree levels and stand levels to examine the effects of tree dbh, stand age,

and thinning regime on tree acoustic velocity. A paper was published in the Proceedings of the 15th International Symposium on Nondestructive Testing of Wood in October 2008.

Current Activity

Nondestructive evaluation of Alaskan young-growth wood: This project was designed to address the quality concerns on the young-growth wood in Tangass National Forest, southeast Alaska. Our primary goal of the study is to investigate the applicability of the newly developed acoustic wave technique for assessing wood properties in standing young-growth trees. The secondary goal is to determine if the effects of thinning on wood properties could be properly identified with this technique.

All experiments and data analysis have been completed. A final report that summarizes the results and findings of this study has been submitted to the US Forest Products Laboratory. A technical article is being prepared and will be submitted to a major scientific journal upon completion.

Principal Investigator(s)

Brian Brashaw

Xiping Wang

Project Sponsor(s)

USDA-Forest Service

USDA Forest Products Lab

Amount	Account
25,000	1653-187-6533-00
198,500	1637-187-6527-00
Total	\$223,500

Active
06/01/2004 06/01/2006
06/24/2004 09/30/2008

Start Date: 06/24/2004

End Date: 09/30/2008

Project ID: 1343

Northern Sheer Veneer

Objective

To assist two local companies in developing new wood ceiling tile products.

Background

The University of Minnesota Duluth Natural Resources Institute and Northern Sheer Veneer collaborated with US Gypsum (USG) Interiors - Ceiling Tile Division in the development of a new class veneer-laminated ceiling tile. Northern Sheer Veneer provided both cash and in-kind project matches.

Previous Activity

Short term project. No previous results.

Current Activity

The goal of this project was to build market-ready wood veneer ceiling prototypes for USG using Northern Sheer Veneer's wide-web veneer. The project successfully built prototypes and supported USG in pilot production manufacturing. As commercial markets eroded the project got less than optimistic support from the USG marketing department. The breakthrough came when the plant manager from Cloquet, William Schmidt, reviewed the project results and realized the potential. The product concept that caught the attention was the simplest prototypes made. It was also targeted for the Do-It-Yourself market and not the commercial market as originally thought. This new product could be done immediately with existing equipment. It was also likely the highest volume Northern Sheer Veneer could have hoped for. Mr. Schmidt felt samples had retail appeal. The NRRI involvement has been completed. This project return investment could be significant and royalty income is expected.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)

John S & James L Knight FDN

Amount	Account
14,978	1671-186-6121-00
Total	\$14,978

Active
03/30/2008 12/15/2008

Start Date: 07/01/2008

End Date: 01/01/2009

Project ID: 1537

Phosphate Bonded Fiber and Waste Residual Composites for Applied Commercialization, Research into

Objective

To develop durable building materials from paper mill waste using novel phosphate ceramic binders.

Background

This project has been funded by the Wisconsin Business Innovation Corporation with resources they received from the US Environmental Protection Agency. There are over 3,000 tons of primary paper mill waste in Wisconsin daily. This waste consists of 50 percent fiber and 50 percent clay. The goal is to use novel mineral based binder technology to create a series of durable building materials using this waste stream as the primary manufacturing feedstock.

Previous Activity

We collected paper mill waste samples from project collaborators, and continued our field and industry outreach efforts. We broadened our industry outreach network by contacting multiple regional paper making industry consulting groups. We began moving away from the original concept of magnesium phosphate ceramics as a binder system, largely due to the rising cost of phosphate fertilizers. With this new economic reality, we began to explore cements and other more cost-effective ceramic binders. The most promising alternative ceramic binder is magnesium oxychloride cement.

Current Activity

As phosphate fertilizer prices continue to dramatically rise, it is not feasible to utilize magnesium phosphate ceramics in this project (one component of these ceramics is an expensive phosphate fertilizer). Therefore, further research has identified a viable alternative ceramic binder - magnesium oxychloride cement. Magnesium oxychloride cement binders are comprised of

common chemicals (magnesium oxide and magnesium chloride) and readily bind to a variety of organic and inorganic aggregates and fillers. They also set at room temperature, have high crushing and transverse strengths, abrasion resistance, and low viscosity (which adds workability). Much of the work has been focused on identifying proper purity levels and acceptable fillers, as well as proper mixing times and component ratios. To compare the various mixes, they were subjected to compressive strength tests. Multiple prototypes have been developed using paper mill residue as the primary filler. Key prototypes were manufactured using the new magnesium oxychloride cement bonded paper mill residue products as door stile and rail material. These samples were shared with the Wisconsin Business Innovation Corp. The samples will also soon be shared with Marshfield Door Systems, who has shown great interest in our technology. We are also working on finding sources and pricing for bulk purchases of the binder constituents. The Wisconsin Business Innovation Corp. is assisting us in this task. The next step will be to: (1) refine product formulations to meet the desired end-use requirements, (2) get bulk pricing estimates for all raw materials used to make the products, and (3) get the samples tested on a pilot-scale with our industry partners.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)

	Amount	Account	Active
Wisconsin Bus Innov Corp-Prime EPA	136,407	1653-187-6609-00	11/01/2007 09/30/2010
Total	\$136,407		

Start Date: 11/01/2007 **End Date:** 09/30/2010 **Project ID:** 1501

Total Productive Maintenance for the Wood Products Industry

Objective

Develop customized total productive maintenance programs for wood products manufacturers through development of short courses and in-plant demonstration projects. A secondary objective is to use web-based video conferencing to conduct total productive maintenance training for regional groups of manufacturers as a means of reducing travel costs for employees and instructors.

Background

The project cooperators at Virginia Tech, Iowa State University, and the University of Minnesota Duluth have worked to help wood products manufacturers understand and implement lean manufacturing as a preferred continuous improvement program to support their economic stability and growth. Through these efforts, these cooperators have identified the need for wood products companies to strengthen their equipment reliability, minimize downtime, and improve productivity. Total productive maintenance (TPM) programs are widely accepted as a key strategy by world class manufacturers as a means to satisfy these needs. The TPM concept grew from the broader lean manufacturing philosophy, which is based on continuous improvement. TPM is often the first place to begin in the lean manufacturing journey because it creates a manufacturing infrastructure of stability and capability.

Previous Activity

During the first six months of the project, our team of cooperators identified a number of excellent TPM training programs and TPM programs developed by wood products companies. These team members attended training from Fuss & O'Neil and the Marshall Institute and participated in TPM events at Andersen Windows (Bayport, Minnesota), Merrilat (Akins, Virginia), and Anchor Packaging (Paragould, Arkansas). A one day hands-on training course was developed and conducted for our wood products cooperators including Crystal Cabinet Works, Epicurean Cutting Surfaces, Shell Lake Furniture, Birchwood's Best, and Ferche Millwork.

Current Activity

A relationship was established with ColdJet LLC, a manufacturer of dry ice blasting equipment that is used to clean equipment and other work surfaces. Using matching funds, we purchased a unit from ColdJet for use in conducting TPM demonstration projects. In order to increase our experience, a TPM event was held at our facility on a laboratory hot press. During this event, we focused on early stage TPM "basic equipment care." This included the following activities: TPM overview and philosophy, basic equipment care, clean to inspect, countermeasures and visual aids, planned maintenance and development of cleaning and lubrication standards, predictive tools, and summary and implementation. TPM principles to develop a daily operator inspection sheet, a critical spare parts list, lubrication and cleaning standards - all focusing on improving the reliability and availability of the equipment. The before and after pictures and reliability of the lab press is remarkable.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)

USDA Forest Service

Amount	Account	Active
95,479	1637-187-6601-00	07/01/2007 12/31/2009
Total	\$95,479	

Start Date: 07/01/2007

End Date: 12/31/2009

Project ID: 1467

Wood Utilization Research

Objective

To help the forest products sector develop new products, new technologies, and new business systems to position Minnesota as a continued leader in wood products manufacturing and renewable energy.

Background

The Wood Utilization Research (WUR) is a special research grant from the USDA Cooperative State Research Education and Extension Service. This program has been funded by Congress to provide needed research, education and outreach to the wood products industry to help enhance the competitiveness of the industry. These funds are leveraged with University state special funds to conduct applied research in the areas of wood materials and manufacturing, market oriented wood technology, applied forestry and chemical derivatives facilitate economic growth and stability of Minnesota and other Lake States wood product manufacturers.

Previous Activity

This is a new project.

Current Activity

Budget numbers were not assigned until January 2009.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)

	Amount	Account	Active
USDA Coop ST Res ED&Ext Srvc(CSREES)	163,130	3002-10414-00000-00002756	09/01/2008 08/31/2010
Total	\$163,130		

Start Date: 09/01/2008

End Date: 08/31/2010

Project ID: 1538

Assessment of Biomass Sources for Energy in Northern Minnesota for the Laurentian Energy Project

Objective

To assess resources and economic feasibility of procuring woody biomass from poplar plantations, brushlands, and forest harvest residues for energy for the Laurentian Energy Authority project.

Background

This project is funded through the US Department of Energy with the purpose to assess the feasibility of producing woody biomass for energy for delivery to the Laurentian Energy Authority facilities in Virginia and Hibbing, located in northern Minnesota. The project will evaluate the economic and practical feasibility of the various biomass options and conduct research on plantation forestry and harvesting of brushlands. The following tasks are part of this project: (1) Assessment of Best Management Practices for Harvesting of Brushlands and Forest Harvest Residues, (2) Development and Analysis of Best Available Technology for Harvesting Brushlands, (3) Biomass Availability and Collection Technology for Forest Harvest Residues, (4) Biomass Availability from Rights-of-Way and, (5) Evaluation of Available Soils and Variation in Productivity of Hybrid Poplar Plantations.

Previous Activity

NRRI and Laurentian Energy Authority staff participated in the development of Biomass Harvesting Guidelines as part of the statewide effort headed by the Minnesota Forest Resource Council. The guidelines were developed and have been included as a section in the more comprehensive Timber Harvesting and Forest Management Guidelines Handbook. Studies of the feasibility of harvesting biomass from brushland sites is a goal of this project. This area of study includes both evaluation of harvesting equipment and the extent of the resource. A forwarder has been purchased and modification is being done to facilitate collection of low-density brushland biomass. Work is also ongoing to quantify biomass amounts on brushland sites across Minnesota. Sampling protocols were developed with the DNR and biomass analyses are underway.

Current Activity

A report was published in December that describes work done to assess brushland biomass on 40 sites across northern Minnesota. This research evaluated methods to identify potential sites having an adequate stocking of shrub biomass using a combination of aerial photography and on-the-ground measurement. Results showed that photo interpretation prior to visiting brushland sites could be a useful tool to make a general distinction between high and low biomass sites but subsequent visits to high-biomass sites will be necessary to adequately assess the potential for commercial harvest. This work was done in cooperation with the Minnesota Department of Natural Resources. Meetings were held with staff from the Department of Energy, Golden Field Office to discuss extension of the current project with new funding that has been allocated to this project. This project was originally slated to end in May of 2009 but will be extended to 2011 with additional funds being provided by a second round of funding.

Principal Investigator(s)

William Berguson

Project Sponsor(s)

	Amount	Account	Active
Laurentian Energy Authority LLC (USDOE)	455,265	1906-187-6616-00	01/01/2007 09/30/2009
Total	\$455,265		

Start Date: 01/01/2007 **End Date:** 09/30/2009 **Project ID:** 1513

Breeding and Testing New Hybrid Poplar Clones

Objective

To conduct breeding activities to improve genetic quality and increase disease resistance, growth rate, and wood quality of native cottonwood and hybrid poplar for plantations in the Lake States.

Background

The purpose of this project is to continue to improve the genetic quality of the hybrid poplar resource for the Lake States. This project builds upon a well-developed research history and infrastructure at the University of Minnesota, Natural Resources Research Institute, and the US Forest Service. Collectively, the project team has over 50 years of research experience in hybrid poplar productivity and genetic improvement. The specific work being done under this contract is to hybridize among *P. deltoides*, *P. nigra*, *P. maximowiczii*, and *P. trichocarpa* to improve yield, disease resistance, and rooting ability of poplar. This project involves breeding and field testing of material resulting from the breeding program planted on industrial cooperator's lands.

Previous Activity

With the renewal of this project, the emphasis has shifted to assisting the US Forest Service with economic analysis of poplar plantations and collection of yield data from our existing poplar clone tests. Data have been collected from both clone tests and yield blocks in the fall of 2007. Clones DN2, DN5, NM6, as well as newer clones arising from genetics research such as D109 and D125 are included in these tests. Mean annual incremental yields range from a low of 2.0 oven-dry tons/acre/year to 4.6 oven-dry tons/acre/year. Sites have not been fertilized and it appears that with a focused genetic improvement program, biomass yields of approximately five tons/acre/year could be attained on sites of moderate quality in central Minnesota.

Current Activity

Data were collected and provided to the US Forest Service to define a range of expected biomass yields from hybrid poplar as well as production costs for poplar plantations. These data were used by cooperators at the University of Minnesota, Department of Applied Economics to evaluate a number of biomass production options and fuel production scenarios. This analysis showed that hybrid poplar production is a potentially cost effective option to produce liquid fuels in the future. This analysis evaluated the economics of poplar and switchgrass biomass production systems as well as several pathways for fuel production. We have continued to collect biomass production information with all data from yield tests collected in the late fall of 2008. These data are currently being analyzed and incorporated into our dataset of poplar yields. Work continues on propagation of new clonal material to provide sufficient plant material to allow planting of new yield tests in 2009. At this time, dormant plant material has been collected from nurseries at Grand Rapids and Belle River, Minnesota and is being processed into cutting for 2009 field tests.

Principal Investigator(s)

William Berguson

Project Sponsor(s)

	Amount	Account	Active
USDA Forest Svc N. Central Res Station	110,000	1635-187-6529-00	06/17/2004 06/16/2009
Total	\$110,000		

Start Date: 06/17/2004 **End Date:** 06/16/2009 **Project ID:** 1340

Minnesota Forest Productivity Research Cooperative

Objective

To improve the productivity and value of natural stands and plantations in Minnesota, develop economically and environmentally sound silvicultural practices, and transfer this knowledge to Minnesota Forest Productivity Research Cooperative (MFPRC) members and the public.

Background

This MFPRC is a consortium of University of Minnesota personnel, industry members, and the USDA Forest Service with the purpose to enhance the productivity of Minnesota's forests. Research done as part of the MFPRC includes Norway Pine management, aspen productivity research, and hybrid poplar genetics and yield improvement. The goal of Norway Pine research proposed is to better understand productivity of Norway Pine plantations and optimize management of these stands both in terms of productivity and value. Aspen research is concentrating on assessment of productivity of regenerating aspen stands, an important issue as it relates to future wood resources. Hybrid poplar breeding and yield improvement is ongoing and replaces the previous activity done as part of the MHPRC.

Previous Activity

The work plan for the MFPRC has been completed and approved for the 2008 growing season. This work plan includes a continuation of Red Pine thinning research, poplar breeding, and an expansion of research in thinning of aspen. The purpose of this work is to evaluate post-thinning growth rates of stands after receiving a variety of thinning treatments. We are interested in the effects of early thinning in maintaining high periodic volume increments evident in these young stands. Breeding of poplar continues with a new set of poplar hybrids being produced with crosses being weighted toward *P. deltoides* X *nigra*, a cross noted for high growth potential and disease resistance. Genetics trials were planted at several locations throughout Minnesota in the spring of 2008 to evaluate the performance of new genotypes across a range of site conditions.

Current Activity

Research being done under the MFPRC during the reporting period involves establishment of new Red Pine and Aspen thinning trials and expansion of breeding of Hybrid Poplar. The intent of this work is to develop management tools to maximize productivity and value of these stands. Early results indicate that Red Pine stands likely respond quickly to thinning with very little reduction in growth rate immediately after thinning. The earliest of these trials were established in the spring of 2005 and all field tests are measured annually to track growth rates. A new set of aspen thinning trials have been established in cooperation with the Minnesota Department of Natural Resources. Permanent tree growth plots are being established and will be measured annually. Poplar breeding activities included measurement of large-scale genetics trials and collection of plant material for establishment of new genetic field tests in 2009.

Principal Investigator(s)

William Berguson

Project Sponsor(s)	Amount	Account	Active
Potlatch Corporation	20,000	1664-187-6562-00	07/01/2005 06/30/2006
MN Dept of Natural Resources (DNR)	400,000	1663-187-6581-00	07/01/2005 06/30/2007
Blandin Paper Company	20,000	1664-187-6534-00	11/01/2004 06/30/2005
Boise White Paper LLC	20,000	1664-187-6535-00	07/09/2004 06/30/2005
International Paper Company	20,000	1664-187-6536-00	09/01/2004 06/30/2005
Minnesota Power	20,000	1664-187-6537-00	07/14/2004 06/30/2005
Potlatch Corporation	20,000	1664-187-6538-00	10/28/2004 06/30/2005
Forest Capital Partners LLC	20,000	1664-187-6558-00	07/01/2005 06/30/2006
International Paper Company	20,000	1664-187-6559-00	07/01/2005 06/30/2006
MN Dep of Natural Resources(DNR)	40,000	1663-187-6542-00	11/30/2004 06/30/2007
Plum Creek	20,000	1664-187-6561-00	07/01/2005 06/30/2006
MN DNR	200,000	3005-10414-00005642	07/01/2008 06/30/2009
Blandin Paper Company	20,000	1664-187-6563-00	07/01/2005 06/30/2006
Forest Capital Partners LLC	20,000	1664-187-6593-00	01/01/2007 06/30/2008
MN Power	20,000	1664-187-6594-00	07/01/2006 12/31/2006

Plum Creek	20,000	1664-187-6595-00	01/01/2007	06/30/2008
Blandin Paper Company	20,000	1664-187-6597-00	01/01/2007	06/30/2008
Verso Paper	20,000	1664-187-6598-00	01/01/2007	06/30/2008
St Louis County Land Department	20,000	1676-187-6585-00	11/15/2005	06/30/2007
State of Minnesota	20,000	3005-10414-00005615	07/01/2007	06/30/2009
MN Power	20,000	1664-187-6560-00	07/01/2005	06/30/2006
Total	\$1,000,000			

Start Date: 10/28/2004 **End Date:** 06/30/2009 **Project ID:** 1363

2008 USS Research Contract

Objective

NRRI's Coleraine Minerals Research Laboratory (CMRL) will conduct research and development work for U.S. Steel's Minntac and Keewatin Taconite plants in the areas of size reduction, classification, flotation, magnetic separation, filtering, balling, indurating, and pellet quality improvement. Research and development work will be conducted using bench and pilot scale equipment at CMRL in addition to in-plant test work at the mining operations plant sites.

Background

The Coleraine Minerals Research Laboratory has provided research support to the Minntac operation for many years. This research has helped Minntac reduce costs, improve their product, and better understand processes.

Previous Activity

Recent data from the primary grinding circuit were analyzed for quantifying benefits from the change in makeup ball size. A simulation study was initiated to define the effects of using smaller balls in the secondary ball mill circuit. Tests were conducted to improve green ball sizing distribution produced from the rubber lined balling drums at Minntac. Rod and ball mill feed sizing were evaluated to optimize mill throughput in these mills. In the Minntac concentrator, froth stability was studied to discover a way to cause faster flotation froth collapse, rather than the froth surviving and overflowing the flotation tanks.

Current

Simulations were carried out to investigate the effects of makeup ball size modifications at the secondary ball mill circuit. A flotation circuit audit was completed. Flux grinding circuit data were mass balanced, and a performance evaluation was completed. Simulations were carried out to quantify the benefits from proposed circuit modifications. All results of the above work were reported to the plant engineers. United States Steel (USS) research reports for the past 50 years were searched for test results on Minntac ore crushing. In a report to Minntac personnel, applicable reports were summarized along with recommendation for future research. Testing is under way to determine the benefits of soft water on flotation. Agglomerator sampling was conducted and data collected to improve green ball size distribution from the rubber-lined balling drums. A statistical analysis is being used to determine factors influencing green ball sizing. Testing is also under way to determine benefits of soft water on green ball properties. Filter studies and batch balling tests are in progress. For future optimization of green ball quality and process economics, a series of organic binders has been identified and will be evaluated for full or partial replacement of bentonite. New on-line mercury analysis equipment was also used to determine baseline analysis data.

Principal Investigator(s)

Andriy Khotkevych
Blair Benner
Dave Englund
David Hendrickson
Iwao Iwasaki
Kyle Bartholomew
Richard Kiesel
Salih Ersayin

Project Sponsor(s)	Amount	Account	Active
USS MN Ore Operations	250,000	1664-187-6614-00	01/01/2008 12/31/2008
Total	\$250,000		

Start Date: 01/01/2008 **End** 12/31/2008 **Project ID:** 1504

An Investigation of Seasonal Performance Variations in Taconite Plants

Objective

To investigate potential causes of seasonal variations in taconite plant productivities and develop simulation-based strategies to neutralize the negative effects of winter conditions.

Background

All of the taconite plants on Minnesota's Iron Range experience reduced productivities during winter months. A number of studies were performed in the past to postulate plausible causes of this trend. However, no strategy has been developed to tackle this problem. The Coleraine Minerals Research Laboratory (CMRL) has detailed plant data from one of the plants on the Iron Range representing the winter and summer operating conditions and performances. In the past, the data were analyzed by conventional techniques. Present availability of mass balancing and simulation software at the CMRL creates an opportunity to assess the data using a modern tool and, furthermore, to develop a strategy to alleviate the negative effects imposed by winter conditions.

Previous Activity

Plant data representing winter and summer performance in 1995 at the Minntac plant's two different lines were obtained. Raw data were mass balanced. Mass balanced data were analyzed and simulations were carried out to identify the source of performance deterioration during winter months. Data indicated a step change in performance around the secondary ball mill circuit. This implied that variations in the secondary cyclone performance were the most probable cause of the problem. A separate, privately-funded project showed that fine screening as well as hydrocyclones could be playing a role in deterioration of plant performance during winter months. Available plant data were re-examined from this point of view. The hydrocyclone model with a capability of simulating slurry temperature effect was tested on the available plant data. These simulations were based on a set of assumptions about the prevailing hydrocyclone operations during these sampling periods. Plant data were re-examined to find further clues for the cause of performance deterioration in winter months. Simulation-based study provided a vague conclusion due to lack of operating data during the summer sampling period. It was concluded that changes in hydrocyclone performance were the most significant seasonal variation causing lower throughputs in winter.

Current

The project report was completed.

Principal Investigator(s)

Blair Benner
Salih Ersayin

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

16,500 1896-783-1205-00

Active

02/09/2005 06/30/2009

Total

\$16,500

Start Date: 02/09/2005 **End** 06/30/2009 **Project ID:** 1383

Characterization of Taconite Particles

Objective

To characterize particulates associated by taconite mining in northeast Minnesota, both on the mining properties and in the population centers surrounding the taconite operations. The work being done on the mining properties will support an exposure assessment of taconite workers being performed by University of Minnesota School of Public Health researchers. The community environmental study is an inventory of particulates across the Mesabi Iron Range that can be compared with the particulate characteristics in other locations in Minnesota.

Background

A recent update by the Minnesota Department of Health on a cohort of former iron miners from northeast Minnesota reported that in this group there have now been a total of 58 cases of mesothelioma. The report renewed longstanding concerns over the safety of exposure to dust derived from crushing taconite. The State requested the University of Minnesota to take a lead in studying whether mesothelioma and possibly other lung diseases were caused by exposure to taconite dust, as opposed to workplace exposure to commercial asbestos. NRRI will conduct in-plant area sampling and detailed analysis of particulate characteristics. NRRI will inventory particulate characteristics in population centers around taconite operations. The results of the inventory can be used to compare the particulate populations in communities on the Mesabi Iron Range with other towns in Minnesota.

Previous Activity

TamaraDiedrich and Devon Brecke made progress on implementing the field survey portion of the taconite particulate project. They held their first meeting of their Science Advisory Board members in January. They presented the proposal for the project. The Science Advisory Board provided them with a review and suggestions on how to proceed. With this advice, they compiled a study glossary of terminology relevant for the project. A Micro-Orifice Uniform Deposit Impactor (MOUDI) from the University of Minnesota Mechanical Engineering Department was used to experiment with sampling durations and substrates. Samples were collected in Virginia, Hibbing, and Duluth. Other identified sampling sites with access are: Grand Rapids, Keewatin, Babbitt, Silver Bay, and Ely. Colleagues from the Mechanical Engineering Department aerosolized taconite tailing samples and deposited them on filters. They examined the loaded filters with the Scanning Electron Microscopes at the Twin Cities and Duluth campuses to familiarize themselves with the particles to be collected.

Current Activity

Samples have now been collected at Virginia, Duluth, Ely, Babbitt, Hibbing, and Keewatin. Sampling is ongoing at these locations. Progress has been made on developing and codifying standard procedures for the analysis of these samples. Megan Schreiber has been analyzing samples collected using scanning electron microscopy at UMD; Devon Brecke has been performing the gravimetric analysis, and a subset of the loaded filters has been sent to Braun Intertec for standard fiber analysis. Results have not been received. Future work on this project will be reported under NRRI Project Tracking #1539, Environmental Taconite Particulate Project – Mesothelioma. Reporting under this project number is complete.

Principal Investigator(s)

Steven Hauck
Tamara Diedrich

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

200,000 1896-783-1237-00

Active

07/23/2007 06/30/2009

Total \$200,000

Start Date: 07/23/2007

End Date: 06/30/2009

Project ID: 1475

Closing the Loop on Filter Cake Moisture Analysis and Control

Objective

To determine what the best and least expensive on-line moisture analyzer and associated sampling system is and then how best to structure the actual moisture control loop program to achieve constant filter cake and green ball moisture.

Background

Previous test programs conducted by taconite plants and R&D laboratories have evaluated various on-line filter cake moisture analyzers, yet have not identified any analyzer that gives accurate and reproducible moisture data.

Previous Activity

A newly hired chemical engineer at the Coleraine Minerals Research Laboratory (CMRL) began work on completing the on-line filter cake moisture analysis system. He will be incorporating an optional design for an on-line filter cake sampling system to be used to feed filter cake samples to the on-line moisture analyzer. The accuracy and repeatability of CMRL's new system will be compared to other on-line moisture analysis equipment. In addition, an Allen Bradley Programmable Logic Controller (PLC) is being installed in the system with new software that will make the moisture analyzer universally compatible with plant process control communication software.

Current

Using DeviceNet communications, a new Allen Bradley Compact Logix PLC is being programmed to streamline the weight analysis scale reading and weight loss calculations for the taconite filter cake moisture analysis system. An Allen Bradley Panel View data screen will be used to display ongoing operations and data history.

Principal Investigator(s)

David Hendrickson
Kyle Bartholomew
Richard Kiesel

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
88,800	1896-783-1060-00
Total	\$88,800

Active
02/01/2002 06/30/2009

Start Date: 02/01/2002 **End** 06/30/2010 **Project ID:** 1181

Development of Engineered Tiles with Radiation Absorbing Properties from Taconite Raw Materials

Objective

To determine the feasibility of producing architectural quality tiles with unique engineering attributes from taconite iron ore raw materials. The tiles will be produced through high temperature melting in a plasma melting system provided by MetalRecovery and located at the Coleraine Minerals Research Laboratory. Tile formation and annealing will be conducted using other equipment at the same site provided by MetalRecovery.

Background

Based on previous test work already conducted at NRRI, it has been shown that taconite rock and magnetite concentrate have radiation absorbing properties, especially for UV and microwave radiation. It is thought that the creation of high density tiles and other consolidated products will result in material having unique engineering properties. This program will determine the conditions required to make high quality materials and will determine the processing conditions that will allow enhanced radiation absorption properties to be developed.

Previous Activity

Equipment from Phoenix Solutions Co. (aka: MetalRecovery) was received at the Coleraine Minerals Research Laboratory. Coleraine personnel have made space in the dry pilot plant and have placed the plasma furnace, tile press, and annealing oven in position. Refractory lining of the plasma furnace is complete. A fluid cooler and an air compressor and air dryer have been ordered to accommodate the air and cooling water needs specified for the plasma torch. Electrical service upgrade work, needed to power the plasma torch and annealing oven, has been in progress.

Current

The electrical service upgrade is complete. The new air compressor and fluid cooler have been received and installed. The compressed air lines, cooling water loop, and torch water loop are plumbed and are currently going through leak testing. Furnace exhaust fabrication is complete. An access platform for the furnace has been fabricated and installed. Taconite crude and tailings samples have been identified and set aside for startup testing.

Principal Investigator(s)

David Hendrickson
Donald Fosnacht
Kyle Bartholomew
Lawrence Zanko
Richard Kiesel

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
139,396	1896-783-1241-00
Total	\$139,396

Active
04/28/2008 06/30/2009

Start Date: 04/28/2008 **End** 06/30/2010 **Project ID:** 1517

Drop Weight Test for Predicting SAG and FAG Mill Performance, Development of

Objective

To develop a drop weight test procedure that can be used to predict semi-autogenous and fully autogenous mill performance from small samples.

Background

For optimum performance of both semi-autogenous (SAG) and fully-autogenous (FAG) mills, the feed must contain a certain portion of "competent" (hard) rock. However, there is no test available for determining the competency of the rock from small samples. In the 1960s, U.S. Steel developed a drop weight test procedure for autogenous grinding of Canadian specular hematite ore. This procedure correlated well with plant grinding energy and was used for designing several plants. This test procedure was also used for preliminary mine planning for the Kudremukh ore body in India. This test was never applied to taconite. Julius Kruttschnitt Mineral Research Centre (JKMRC) has also developed a drop weight test, which can be related to several parameters in their autogenous grinding model. There are several differences in the test procedures. The U.S. Steel procedure uses multiple drops of different heights on single particles of the "same" material and measures the broken size distribution as a function of energy applied. Keewatin Taconite is very interested in having a test procedure developed and will supply material for the testing.

Previous Activity

Analyses of the drop weight test results showed no significant correlation to the previously determined grinding energy. No additional testing is planned.

Current

The final report will be submitted during January 2009.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
18,370	1896-783-1202-00
Total	\$18,370

Active
02/09/2005 06/30/2009

Start Date: 02/09/2005 **End** 06/30/2009 **Project ID:** 1380

Environmental Taconite Particulate Project-Mesothelioma

Objective

To characterize particulates associated by taconite mining in northeast Minnesota, both on the mining properties and in the population centers surrounding the taconite operations. The work being done on the mining properties will support an exposure assessment of taconite workers being performed by University of Minnesota School of Public Health researchers. The community environmental study is an inventory of particulates across the Mesabi Iron Range that can be compared with the particulate characteristics in other locations in Minnesota.

Background

A recent update by the Minnesota Department of Health on a cohort of former iron miners from northeast Minnesota reported that in this group there have now been a total of 58 cases of mesothelioma. The report renewed longstanding concerns over the safety of exposure to dust derived from crushing taconite. The State requested the University of Minnesota to take a lead in studying whether mesothelioma and possibly other lung diseases were caused by exposure to taconite dust, as opposed to workplace exposure to commercial asbestos. NRRI will conduct in-plant area sampling and detailed analysis of particulate characteristics. NRRI will inventory particulate characteristics in population centers around taconite operations. The results of the inventory can be used to compare the particulate populations in communities on the Mesabi Iron Range with other towns in Minnesota.

Previous Activity

Tamara Diedrich and Devon Brecke made progress on implementing the field survey portion of the taconite particulate project. They held their first meeting of their Science Advisory Board members in January. They presented the proposal for the project. The Science Advisory Board provided them with a review and suggestions on how to proceed. With this advice, they compiled a study glossary of terminology relevant for the project. A Micro-Orifice Uniform Deposit Impactor (MOUDI) from the University of Minnesota Mechanical Engineering Dept. was used to experiment with sampling durations and substrates. Samples were collected in Virginia, Hibbing, and Duluth. Other identified sampling sites with access are: Grand Rapids, Keewatin, Babbitt, Silver Bay, and Ely. Colleagues from the Mechanical Engineering Department aerosolized taconite tailing samples and deposited them on filters. They examined the loaded filters with the Scanning Electron Microscopes at the Twin Cities and Duluth campuses to familiarize themselves with the particles to be collected.

Current Activity

Samples have now been collected at Virginia, Duluth, Ely, Babbitt, Hibbing, and Keewatin. Sampling is ongoing at these locations. Progress has been made on developing and codifying standard procedures for the analysis of these samples. Megan Schreiber has been analyzing samples collected using scanning electron microscopy at UMD; Devon Brecke has been performing the gravimetric analysis, and a subset of the loaded filters has been sent to Braun Intertec for standard fiber analysis. Results have not been received.

Principal Investigator(s)

Steven Hauck
Tamara Diedrich

Project Sponsor(s)	Amount	Account	Active
PUF Mineral Endowment	200,000	1896-783-1237-00	07/23/2007 06/30/2009
U of M School of Public Health	350,349	1806-10416-20080	07/01/2008 06/30/2011
Total	\$550,349		

Start Date: 07/23/2007 **End Date:** 06/30/2009 **Project ID:** 1539

Gas Chemistry Measurements in Taconite Induration Furnaces

Objective

To determine the effect of chloride concentration on mercury oxidation and to develop a mercury balance around the induration process at plants with grate-kilns and those with straight grates.

Background

The Minnesota Department of Natural Resources is investigating the effect of chloride concentration on the oxidation of mercury from taconite induration. The Coleraine Minerals Research Laboratory (CMRL) has been contracted to measure mercury concentration in the gas into and out of the plant scrubbers. CMRL will also measure the O₂, SO₂, NO_x, and Cl_x concentrations in the scrubber input gases and will also conduct gas flow measurements as needed. While CMRL is measuring the gas, the Department of Natural Resources will be sampling the green balls, coal, fired pellets, and scrubber discharge.

Previous Activity

The project has been completed. All of the mercury data have been transmitted to the Department of Natural Resources.

Current

The Department of Natural Resources has issued a technical report covering all of the test work, including the mercury and gas analyses provided by Coleraine. Research under this funding is complete.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)

	Amount	Account	Active
MN Dept of Natural Resources (DNR)	87,450	1663-187-6555-00	10/25/2005 06/30/2007
Total	\$87,450		

Start Date: 10/25/2005 **End** 12/31/2008 **Project ID:** 1409

Geological Resources of Ox Tac Ore in the Vicinity of the Canisteo, Hunner, King, Jennison, Buckeye, Jessie 1 and 2, and West Hill Mines: A Continuing Evaluation of Ox Tac Resources in Itasca County

Objective

To: (1) produce a geological resource estimate of the oxidized taconite ore in the area of the Canisteo, Danube, Morrison, Walker, Fletcher, Hunner, King, Jennison, and Buckeye mines (Sections 25, 36, R25W, T56N and Sections 20, 29, 30, 31, R24W, T56N) in Itasca County, and (2) make the data available in a Geographical Information System (GIS) format that can be used by industry, Itasca County, the State of Minnesota, and local towns and townships for use in future land-use planning.

Background

A current Permanent University Fund project is compiling data on the Judd, Sally, Plummer, Holman-Cliffs, Homestead, Diamond, and Arcturus mine areas located northeast of this proposed study area. Approximately 20 to 30 years ago, there was a great deal of activity aimed at determining the occurrence and quantity of oxidized taconite in both Minnesota and Michigan, as well as evaluating alternative schemes for its exploitation. Currently, there is no mining on the western end of the Mesabi Iron Range in Itasca County, but there has been and are many other uses, i.e., boating, water resource management, other construction, that will directly affect the availability of these oxidized ores in the future. These oxidized taconite, or non-magnetic ore reserves, could become economic in the future with new mineral processing and mining techniques and with lower stripping and blasting costs. The study will provide these data in a GIS format to local, county, and state agencies that are involved with land-use issues and allow them to become more aware of the mining potential of the area. Thus, it is hoped that these various entities will use the data to make informed land-use decisions for the western Mesabi Iron Range.

Previous Activity

No work was done on this project due to commitments to complete other projects.

Current Activity

No work was done on this project due to commitments to complete other projects. The final processing and modeling of the data needs to be completed to complete this project.

Principal Investigator(s)

Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
60,000	1896-783-1045-00
Total	\$60,000

Active

07/01/2000 06/30/2009

Start Date: 07/01/2000

End Date: 06/30/2009

Project ID: 962

Grant Writing and Grant Search for Minnesota Taconite Operations, State and Federal Department of Energy (DOE)

Objective

To provide funding to NRRI/CMRL Director and staff engineers to evaluate State and Federal DOE grant opportunities, and to work with Minnesota taconite operations to write and submit grant proposals for energy projects in taconite.

Background

More and more State and Federal Department of Energy grants are appearing that apply directly to the taconite industry. For example, the Federal DOE "Industries of the Future" program requests specific grant projects for the mining industry that apply to taconite mining. On a State level, NRRI/CMRL can now work directly with the Minnesota State Energy Office to submit grant proposals for potential energy reduction projects in various fields of research and development.

Previous Activity

Grant writing and grant searching are important elements for obtaining research funds to operate our University research facilities. NRRI's biomass gasification system was recently purchased and installed at the Coleraine Minerals Research Laboratory, for example, as a result of submitting a research grant to Xcel Energy in Minnesota. Five research grant proposals in the energy field were submitted to the Minnesota Department of Commerce to obtain funding for NRRI's energy program. In addition, a number of Minnesota Department of Natural Resources Iron Ore Cooperative Research grants were submitted and received by NRRI. A \$4.8 million grant was recently submitted to the U.S. Department of Energy to extend our research work on Nodular Reduced Iron production beyond our initial \$1.2 million Department of Energy grant in this research area.

Current

On a State basis, grants are being submitted to the Minnesota Department of Natural Resources Iron Ore Cooperative Research program to seek project funding for taconite research work as well as to the State Minerals Coordinating Committee group to support R & D in statewide minerals research. A \$1.3 million grant proposal was recently submitted to the University of Minnesota Institute on the Environment to advance forest productivity and biomass torrefaction research in support of the renewable energy field. Most recently, a \$10 million grant proposal was submitted to the Department of Energy and the U.S. Department of Agriculture for funding to install specialized biomass torrefaction reactor technology at a Minnesota-based coal-fired power plant.

Principal Investigator(s)

Blair Benner
Dave Englund
David Hendrickson
Iwao Iwasaki
Richard Kiesel
Salih Ersayin
Kyle Bartholomew

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
106,315	1896-783-1214-00
Total	\$106,315

Active

02/09/2005 06/30/2009

Start Date: 02/09/2005 **End** 06/30/2010 **Project ID:** 1390

Hydrocyclone Performance, Effects of Demagnetizing Coil and Dispersant Chemicals on

Objective

To assess the effects of demagnetizing coil and dispersant use in treating the hydrocyclone feed stream for improved hydrocyclone performance.

Background

Use of magnetic separators prior to hydrocyclone operation causes magnetite particles to flocculate. Most of these flocs are assumed to be broken through pumping action. Recent data from the Mittal Steel plant suggest that some very fine magnetite particles stay flocculated and behave as coarse particles. These particles report to the underflow and are unnecessarily circulated back to the ball mill. Two remedies will be tested: (1) demagnetization of feed stream, and (2) use of dispersant chemicals. The effect of a dispersant chemical will be tested with and without a demagnetizing coil. Findings from this project would provide guidance for other plants having similar problems.

Previous Activity

A kick-off meeting was held with engineers from the Mittal plant to discuss details of the project. A chemical vendor was contacted to inquire about the potential dispersant and mode of addition. Due to the complexity of testing chemical addition into the hydrocyclone feed stream, this option was removed from the plant testing plan. Sampling for the demagnetizing coil system was postponed at the last minute due to melting of copper wires within the coil.

Current

A new demagnetizing coil was installed at the plant. Electrical problems with the coil still persisted. Due to planned temporary shut down of the plant in March, it appeared that this project would not be completed in time. The Iron Ore Cooperative Research group canceled project funding.

Principal Investigator(s)

Salih Ersayin

Project Sponsor(s)

MN DNR

Amount Account

33,000 1663-187-6604-00

Active

11/07/2007 06/30/2009

Total \$33,000

Start Date: 11/07/2007 **End** 06/30/2009 **Project ID:** 1494

Hydroseparator Modeling

Objective

To develop a mathematical model of hydroseparators, which could be used for simulation, optimization, and control of hydroseparator operating conditions.

Background

The existing hydroseparator model does not take into account the effect of any operating variables. Available plant data indicate that there are large differences between hydroseparator performances from one plant to another. They are not operated at their optimum due to a lack of quantitative information defining their performance. Analysis of plant data led to the development of the current model, which could simulate the effect of variations in feed grade. Although there appears to be a good correlation between upward velocity and separation efficiency, systematic test work is required to establish such a relationship. Recently, the Coleraine Minerals Research Laboratory (CMRL) received Iron Ore Co-Op funding to carry out pilot scale hydroseparator tests in plants to demonstrate the benefits of magnetic field application. These tests will produce samples that could generate data needed for hydroseparator modeling. Funding will be used for additional analysis of these samples and model development.

Previous Activity

A recently completed Iron Ore Cooperative funded study formed a database for this project. Several sets of detailed plant hydroseparator data that became available were analyzed to examine capabilities of the existing model. It was also found that model prediction could be improved by inclusion of additional model parameters based on defining upward velocity within the separator. Using plant data that has recently become available, capability of the existing partition-curve-based approach was reexamined. It was found that the model was capable of accurately predicting product flow rates and underflow size distributions. However, it failed to have a satisfactory fit to the overflow size distributions. Therefore, a search for a different mathematical structure was initiated. A conclusion was reached that a liberation-based model coupled with partition-curve type modeling could overcome this inefficiency. The existing conventional model for hydroseparators was modified to have the capability of simulating liberation-based data, and was incorporated into Usim Pac. Available pilot scale test data were examined. Relationships between upward velocity, feed size distribution, feed % solids and feed grade, and performance, were examined. Results show that all of these operating conditions have a certain degree of effect on performance. Model parameters for recently obtained plant data were calculated and examined. Preliminary mathematical relationships and a methodology for correlating pilot scale data with plant operation were developed.

Current

The most recent data from the Keetac plant were analyzed. Samples were sent to Julius Kruttschnitt Mineral Research Centre (JKMRC) for liberation analyses.

Principal Investigator(s)

Blair Benner
Salih Ersayin

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

36,000 1896-783-1201-00

Active

02/09/2005 06/30/2009

Total \$36,000

Start Date: 02/09/2005 **End** 06/30/2010 **Project ID:** 1379

Liberation-Based Simulations, Plant Database Generation for

Objective

To generate a plant database for validation of liberation-based simulations of the Keetac plant.

Background

The concentrator Modeling Center now has the capability of simulating taconite plants using liberation-based data. However, such simulations need to be validated by plant data. This project will generate plant data through purpose oriented sampling and sample analysis. Validation will increase the confidence for other plants to rely on this type of advanced simulation. Plant data will also be useful in further improvements in unit operation models and simulations based on conventional size-recovery modeling. This study would also provide an opportunity to test the semi-autogenous grinding mill model in taconite processing.

Previous Activity

A sampling plan was reviewed with Keetac plant engineers. Plant sampling was scheduled for early March 2008, but was delayed due to flow meter calibrations in the plant. Julius Kruttschnitt Mineral Research Centre (JKMRC) agreed to send a graduate student to visit the plant and eventually to do liberation analyses on certain samples.

Current

Plant sampling was carried out. Samples were analyzed. Raw data were mass balanced. Mass balanced data were sent to plant engineers and then revised for plant feed rate corrections. Some samples were shipped to JKMRC for liberation analysis and semi-autogenous grinding (SAG) mill grindability testing. A graduate student from JKMRC visited the NRRI/Coleraine Minerals Research Lab. He was trained in liberation characterization test work as part of the collaborative work between the two research facilities. Recently, the Iron Ore Cooperative Research group cancelled project funding due to the plant being temporarily shut down for an indefinite period.

Principal Investigator(s)

Salih Ersayin

Project Sponsor(s)

MN DNR

Amount	Account	Active
28,970	1663-187-6606-00	11/07/2007 06/30/2009
Total	\$28,970	

Start Date: 11/07/2007 **End** 06/30/2009 **Project ID:** 1496

Magnetic Iron Losses in Taconite Plants, An Investigation into

Objective

To investigate magnetic iron losses occurring in a taconite plant, assess whether these losses are avoidable, and develop ideas for recovery improvements.

Background

In taconite plants, magnetic iron losses are generally a compromise to get an optimum separation of gangue particles in each separation stage. When magnetic iron losses are high, it becomes questionable as to whether separators are operating correctly. This study will focus on one of the plants and analyze performance of separators with specific emphasis on tailing streams. This project will illustrate the capability of a methodology for such an assessment. If successful, such a methodology could be applied to other plants.

Previous Activity

The sampling plan was reviewed with engineers from the Keetac plant. It was mutually agreed that separator samples to be obtained from a complete plant sampling survey would also be used for this project.

Current

Plant sampling was carried out. The first set of samples was analyzed. Results showed that most losses occurred at cobbles. These losses correlated well with size by size Davis tube tests. It was planned that future plant sampling would focus on this separator. Recently, however, the Iron Ore Cooperative Research group canceled project funding due to the plant being temporarily shut down for an indefinite period. Therefore, this project has been discontinued.

Principal Investigator(s)

Salih Ersayin

Project Sponsor(s)

	Amount	Account	Active
MN Dept of Natural Resources (DNR)	37,100	1663-187-6605-00	11/07/2007 06/30/2009
Total	\$37,100		

Start Date: 11/07/2007 **End** 06/30/2009 **Project ID:** 1495

Magnetic Separator Model Development

Objective

To develop a magnetic separator model for simulating the effects of significant operating variables, which model can then be used as a tool in circuit design and optimization.

Background

There exists no magnetic separator model capable of simulating the effects of the variables involved in taconite processing. The Concentrator Modeling Center at the Coleraine Minerals Research Laboratory has evaluated plant data and developed a mathematical structure for magnetic separators. Further analysis of plant data showed that this structure could successfully be used to include the effects of operating and design variables. A model defining the effects of significant variables under various operating conditions is yet to be developed. This proposal will generate systematic pilot scale data for constructing mathematical relationships defining the effects of these variables. The model will provide answers to a large number of “what if” questions commonly asked by plant engineers and operators for improving their plant performance. Funding for this proposal will also constitute matching funds for a larger Department of Energy project.

Previous Activity

Available data and existing models were reexamined in order to have an efficient experimental design. Several sets of magnetic separator data that became available to the Center were analyzed in terms of improving capabilities of the existing model. Inclusion of some operating variables into the model structure was explored. Capability of the model was examined by using several data sets that were recently obtained from two different plants. The magnetic separator data normalization procedure was modified in line with the findings of this evaluation. A liberation-based magnetic separator model was incorporated into Usim Pac, and its capability of simulating plant operation was tested. Mathematical structure of the existing liberation-based model was examined so as to improve its flexibility and handle minor variation in feed characteristics.

Current

Data generated from Keetac plant sampling were added into the database. Davis tube tests were conducted on semi-autogenous grinding (SAG) mill feed and cobber magnetic separator feed samples to define liberation characteristics. Product samples were sent to the Julius Kruttschnitt Mineral Research Center (JKMRC) for liberation analysis.

Principal Investigator(s)

Salih Ersayin

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
45,000	1896-783-1204-00	02/09/2005 06/30/2009
Total	\$45,000	

Start Date: 12/09/2005 **End** 06/30/2010 **Project ID:** 1382

Mechanical Sampling Device for Hard to Sample Streams

Objective

To develop a mechanical device capable of taking accurate samples from hard to sample plant streams.

Background

Analysis of data generated by plant audit sampling shows that it is very difficult to obtain a representative sample from some of the streams in any given plant. This can be caused by large volumes of slurry and/or limited access to sampling points, requiring unconventional methods for sampling. Current methods of sampling involve cutting a small fraction of a stream under the influence of gravity. These methods provide representative samples in most cases. However, mass balancing of plant data indicate that one or more streams around some devices in a plant are not properly sampled. In such cases, the operator judgment is used to decide which sample is more reliable. This adds subjectivity into the process. Development of a device capable of accurately sampling these problematic streams will eliminate subjectivity and improve assessment of actual performance. This will eventually lead to improved plant performance.

Previous Activity

A number of off-the-shelf devices were examined for their possible use for mineral processing plant stream sampling. Currently available sampling devices were reviewed. A preliminary testing methodology was established. These will be used for different sampling situations that are encountered in plants and pilot scale tests. Several plants were visited, their sampling practices for “difficult to sample” streams were observed, and their success in obtaining a representative sample was evaluated by examining their data. Several conventional attempts to obtain representative samples from streams having coarse size distributions and high flow rates failed to provide reliable mass balances. Sampling points in a number of plants were examined to finalize a universal system that would be capable of taking samples from awkward sampling points.

Current

During the recent sampling survey in the Keetac plant, notes were taken in terms of sampling difficulty and expected sample accuracy. These notes were then reevaluated when mass balance of the circuit was carried out. It was found that the streams with difficult to sample locations produced higher error in mass balancing.

Principal Investigator(s)

Salih Ersayin

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

15,000 1896-783-1217-00

Active

02/09/2005 06/30/2009

Total \$15,000

Start Date: 02/09/2005 **End** 06/30/2009 **Project ID:** 1393

Metallized Iron Nodule Production

Objective

To demonstrate the ability to continuously produce high-quality iron nodules at low cost as a result of a joint team effort between Nucor and the University of Minnesota Duluth's Natural Resources Research Institute (NRRI) through their joint venture - Nu-Iron Technologies, LLC.

Background

This project has been implemented to scale up the previous results obtained in converting iron oxide concentrates from the Mesabi Range into nodular reduced iron. The project is focused on development of a prototype processing facility that will allow design and engineering of a full-scale commercial unit to be undertaken with reduced risk. The project is being funded by a joint venture company, Nu-Iron Technologies, LLC.

Previous Activity

The construction was completed and the commissioning work on the new facility was also undertaken and completed in a satisfactory manner. The working furnace was used to verify various operating parameters related to iron nodule production using similar techniques as employed on the pilot furnace operation at the Coleraine Minerals Research Laboratory. The results of this work have confirmed that high quality iron nodules with low residual levels can be routinely produced using certain operating conditions. Further developmental work was undertaken to optimize the energy usage in nodule production and to determine the utility of low cost reductants in the iron reduction and smelting process.

Current Activity

The work with Nu-Iron Technologies has continued. Various campaigns have been conducted using the prototype equipment under a variety of operating and raw material mixture variables. As this is a proprietary development, no detailed reporting can be given on the overall findings to date.

Principal Investigator(s)

Donald Fosnacht

Project Sponsor(s)

	Amount	Account	Active
NU Iron Tech LLC	700,004	1664-187-6600-00	04/01/2007 01/20/2009
Nu Iron Tech LLC	1,329,850	1664-187-6564-00	01/20/2006 01/20/2008
Total	\$2,029,854		

Start Date: 06/10/2005

End Date: 01/20/2009

Project ID: 1447

Next Generation Metallic Iron Nodule Technology in Electric Furnace Steelmaking

Objective

To investigate the following three major issues for producing high-quality metallized iron nodules at low cost: (1) reduce the processing temperature; (2) control the furnace gas atmosphere over the metallized iron nodules; and (3) effectively use sub-bituminous coal as a reductant.

Background

To counteract the oxidizing effect of CO₂ and the high turbulence of combustion gas in the gas-fired Linear Hearth Furnace, several atmosphere control methods are proposed. Also, previous work shows that medium-volatile bituminous coal is the most desirable reductant and is routinely used in the process. Western sub-bituminous coal is an economically attractive alternative, however, its direct use has led to operational difficulties. Effective use of this coal as an iron reductant or hearth layer material, with the volatile matter providing supplemental fuel for heating the furnace, will contribute toward reducing the overall cost.

Previous Activity

Modification of the linear hearth furnace was completed in the fall and is now ready for experimental testing. The revised system includes oxy-fuel and air-fuel combustion burners for supplying heat in the process. It is now possible to regulate the amount of oxygen in the furnace to react with volatilized reaction products to minimize the amount of natural gas used in the process. Work also continued in developing ways to better utilize sub-bituminous coals in the reaction mixture and in some of the protective layers that are associated with coal utilization. It is desired to maximize the use of this coal since the economics are compelling for the long term use of the process on the Iron Range of Minnesota. The linear hearth furnace was also modified to utilize a cart transportation system instead of the walking beam pallet moving system. This allows the furnace to be a more complete match with the larger prototype furnace which is part of another research program.

Current Activity

Furnace modifications for the addition of oxy-fuel burners were completed and a series of experiments were undertaken to evaluate the change in furnace operation using the new burner configuration. The turbulence associated with air/fuel burners was greatly reduced with the oxy/fuel technology. In addition, sufficient heat is provided using the new burners to achieve complete metallization of the carbon and iron oxide reaction mixture to produce high quality metallic iron nodules on a repeatable basis. The new cart based pallet movement system has now shown to be very reliable in moving the test materials through the furnace and has reduced issues associated with refractory failures in the furnace although refractory wear remains a key issue. Finally, the new automation systems have performed well for both cart transport and oxy-fuel burner control. The focus for the next period will be further modification of the technology to add other atmosphere control methods and oxy-coal burner technologies to the system.

Principal Investigator(s)

Donald Fosnacht
Iwao Iwasaki
Richard Kiesel

Project Sponsor(s)	Amount	Account	Active
PUF Mineral Endowment	238,798	1896-783-1229-00	04/10/2007 06/30/2009
PUF Mineral Endowment	125,000	1896-783-1213-00	02/09/2005 06/30/2007
US Dept of Energy (USDOE)	948,825	1643-187-6554-00	09/15/2005 09/14/2009
Total	\$1,312,623		

Start Date: 09/15/2005 **End Date:** 09/14/2009 **Project ID:** 1407

Pellet Fines Removal System

Objective

To construct and test a larger scale of a prototype fines removal system in a pellet plant operation on 150-250 LTPH fired pellets. A prototype fines removal system was developed at the Coleraine Minerals Research Laboratory as an alternative method for the sizing of pellets, ores, agglomerates, or coarse materials. Conventional screening methods typically use vibrating or roll screens. However, the high capital and maintenance costs associated with this equipment make the separation of fines uneconomical. The potential of this unit operation is to conduct a clean fines separation at a low cost and by more efficient means, replacing screening operations that are both costly and maintenance intensive.

Background

The fines removal system is proposed as a low cost, more efficient means of separating fines from coarser materials. Preliminary results show that 80-90 percent of the fines can be effectively removed while retaining 97-98 percent of the fired pellets in the product.

Previous Activity

It was expected that a patent would be issued for the NRRI Fines Removal System in early 2008, and a conveyor belt company is being licensed to market, manufacture, and distribute the system for the University. A research contract is being issued to work with the conveyor belt manufacturer to make additional improvements to the Fines Removal System. A steel company was visited to discuss placing three units at their dock site to screen all of their taconite pellets feeding their blast furnaces. Discussions were held with Northshore Mining Company to have the Coleraine Minerals Research Laboratory help improve their existing 750 ton per hour pellet fines removal system. The small pilot-scale pellet fines removal system at the Coleraine Minerals Research Laboratory is being fitted with new chevron lifter configurations to determine a better design for these chevron units, which experience high wear.

Current

A U.S. Patent was issued for the Pellet Fines Removal System in March 2008, and a Minnesota conveyor belt company is interested in marketing, manufacturing, and distributing the system for the University. In order to provide better wear characteristics and reduce system maintenance requirements, smaller scale tests were completed to investigate new materials to replace existing rubber chevrons with high wear resistant materials. Results indicated that specially designed abrasion resistant (AR 400) steel chevrons worked well when embedded in the surface of the conveyor belt system. The pilot scale 300 tph pellet fines removal system is currently being fitted with these newly designed AR400 steel chevrons as replacements for the existing rubber chevrons prior to field testing at a taconite operation in the spring of 2009.

Principal Investigator(s)

David Hendrickson
Richard Kiesel

Project Sponsor(s)	Amount	Account	Active
PUF Mineral Endowment	136,664	1896-783-1073-00	02/01/2003 06/30/2007
MN Department of Natural Resources	115,000	1663-187-6506-00	09/18/2003 06/30/2005
Total	\$251,664		

Start Date: 02/01/2003 **End** 06/30/2009 **Project ID:** 1309

Preclassification of the Final Stage of Magnetic Separation Feed

Objective

To investigate the utility of pretreating the feed material to the final stage of magnetic separation via size classification.

Background

Conventional magnetic separation units are relatively efficient at separating liberated non-magnetic material from magnetite. However, middling particles, high in non-magnetic material, are passed into the concentrate and are difficult to separate via further magnetic separation without additional grinding and liberation. Adjustment of operating conditions such as field strength and pulp density can facilitate higher rejection rates of non-magnetic material, but at a cost of usually unacceptable iron losses. This leaves the obvious alternative of regrinding the tailing material to reclaim iron units, but this is prohibitively expensive. However, preclassifying the feed to magnetic separation, particularly the final stage of separation, may provide an alternative approach to this problem. Preclassification would provide two independent streams of material to magnetic separation: (1) the fine stream, which is low in non-magnetic material/silica and, (2) the coarse stream, which is high in non-magnetic material. Therefore, the fine stream can be treated in a magnetic separator to maximize iron recovery, and the coarse stream can be treated to maximize silica rejection. To gain benefits, the magnetic reject from the coarse stream will require regrinding. However, the volume of material requiring regrinding will be significantly lower than without preclassification at equivalent upgrading. This should facilitate an improvement in the grind/grade relationship in taconite facilities.

Previous Activity

Davis tube tests were performed on selected screen fractions from a magnetic separator feed sample with the objective of trying to determine an ideal cut point and what effect magnet strength has on grade. Results indicate that Davis tube concentrate grade increases with decreasing magnetic strength, but as the size distribution becomes finer, the degree of upgrading seems to approach a limiting value. A small system was designed and constructed, with the ability to continuously feed a small magnetic separator for testing. Bulk magnetic separator feed samples were obtained from an operating plant, and a series of tests of unclassified feed has been conducted with varying magnetic field strengths, percent solids, and feed rate. Additionally, two bulk cyclone underflow samples with unique size distributions were prepared for continuous magnetic separator testing. All of the test work has been completed. The last of the chemical analyses were recently completed and sent to the principal investigator.

Current

This test work was completed by an engineer who left the University. Test results will be reported by a newly assigned process engineer at the Coleraine Minerals Research Laboratory, with an expected completion date of June 1, 2009.

Principal Investigator(s)

Jeremy Pletka

Kyle Bartholomew

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

26,200 1896-783-1076-00

Active

06/01/2003 06/30/2005

Total

\$26,200

Start Date: 06/01/2003

End

06/30/2009

Project ID: 1318

Research, Development and Marketing of Minnesota's Iron Range Aggregate Materials for Midwest and National Transportation Applications

Objective

To develop various applications for taconite aggregates in highway and construction applications and identify the logistical and transportation requirements for bringing these materials to market.

Background

The economics of mining taconite ore relative to other worldwide iron mining resources shows our mining resources are more costly to extract than many competitors. In order to secure a stable future for our mining operations, new revenue sources from current mining activities are required. One avenue for this purpose is to find uses for taconite mining by-products in highway and construction applications and to develop a logistical and transportation system that will economically bring these products to these marketing areas. This project is being undertaken to fully explore how the taconite by-products can be utilized as highway and construction aggregates and in other value-added opportunities related to these markets.

Previous Activity

Major activities for the first half of 2008 included: 1) Presentation of historical use of Taconite Aggregate (Tac Agg) at the January 2008, Transportation Research Board (TRB) meeting in Washington, D.C. 2) Delivery of approximately 2,000 tons of coarse Tac Agg base material to Mn/DOT's MnROAD test facility for use in I-94 reconstruction, and about 20 tons of fine Tac Agg for developing a new stone matrix asphalt mix design, also to be tested at MnROAD; 3) Two demo shipments of Tac Agg materials by American Surface Lines' RailMate system from the Iron Range to MnROAD; 4) May 2008, meetings and site visits to Chicago, Illinois, with Illinois Department of Transportation (IDOT) and other parties related to delivering aggregate for demo projects; 5) Planning meetings with Mn/DOT facilitated by project consultants, The Tinklenberg Group, for late summer 2008 bridge deck friction surfacing projects using fine Tac Agg; 6) Project presentations at SME, Duluth, and CTS Research Conference, St. Paul, respectively, in April and May; 7) Ongoing interaction with mining companies, contractors and transportation professionals for providing and transporting aggregate materials for demonstration projects and testing; 8) Start-up of wash plant at the CMRL for preparing bridge deck aggregate; 9) A portable prototype microwave unit was built for small-scale field testing of deicing and pavement heating.

Current Activity

A semi-annual report draft (TSR-2009-01) is in editing. A summary of the results from the last six mos. of 2008 are: a) Approximately 120 tons of fine Tac Agg for developing a new 4.75mm stone matrix asphalt (SMA) mix design, also for use and testing at MnROAD. The construction & paving applications were completed in the fall of 2008; b) Presentation at the TERRA Innovation Series, Engineering Better Roads through Dynamic Research Partnerships, July 30, 2008, MnROAD open house; c) Preparation and delivery of 100 tons of crushed Tac Agg to Illinois in late Aug. 2008, for testing and evaluation by IDOT; d) Completion of a bridge deck friction resurfacing demo project in International Falls, MN, in September 2008; and e) The acceptance of 2 papers: 1) Gray is Green: The Aggregate Potential of Mn Taconite Industry Byproducts at the 88th Transportation Research Board meeting in Washington, DC, in Jan. 2009; and 2) Construction Aggregate Potential of Mn Taconite Industry Byproducts for presentation at the 14th Conference on Cold Regions Engineering in Duluth, MN, August 30 - September 2, 2009.

Principal Investigator(s)

Donald Fosnacht
Lawrence Zanko
Steven Hauck

Project Sponsor(s)	Amount	Account	Active
Minnesota Power	10,000	1831-187-2680-00	02/08/2005 06/30/2009
Blandin Foundation	10,000	1670-187-6516-00	02/01/2004 12/31/2006
USDOC EDA	1,250,000	1661-187-6565-00	01/01/2006 12/31/2009
Total	\$1,270,000		

Start Date: 01/01/2006 **End Date:** 12/31/2009 **Project ID:** 1411

Sinter Pot Equipment, Activation of the Coleraine Minerals Research Laboratory

Objective

To reactivate the sinter pot test equipment at the Coleraine Minerals Research Laboratory.

Background

The sinter pot was last used in 1996. In 2007 several inquiries regarding conducting sintering tests at the Coleraine Minerals Research Laboratory (CMRL) were received. It was decided to reactivate the sinter pot, including the incorporation of Programmable Logic Controller (PLC) based data logging and process automation. The test equipment suffered severe corrosion damage, necessitating extensive cleaning and rebuilding. It was also necessary to have the sinter fan inspected and balanced. Additionally, a new burner and burner train were required to bring the equipment into compliance with University and industry safety standards. NORAMCO was contracted to redesign the exhaust gas handling and cleaning equipment, providing a capital cost estimate for replacing the existing system with a new fan and gas cleaning system, to facilitate gas flow measurement and gas sampling for volatile organic compounds (VOCs).

Previous Activity

The sinter pot was successfully reactivated. One series of tests was completed for a client, and two more series of tests were begun. This account was used to fund an engineering study conducted by NORAMCO, aimed at determining a cost to upgrade the sinter pot to current state-of-the-art standards. This study was nearing completion. This account has also been used to acquire flux, coke breeze and hydrate lime samples for use in sinter tests.

Current

It was decided to rebuild the sinter pot facility for deep bed, high suction conditions. This work will be in progress during 2009. NORAMCO is providing detailed engineering support. CMRL staff are handling the installation of new equipment, which is being ordered as needed.

Principal Investigator(s)

Dave Englund

Project Sponsor(s)

PUF Mineral Endowment

	Amount	Account	Active
	130,209	1896-783-1238-00	01/31/2008 06/30/2009
Total	\$130,209		

Start Date: 01/31/2008 **End** 06/30/2010 **Project ID:** 1493

Taconite Industry Products and By-products: An Investigation of Alternative Uses and Their Economic Potential

Objective

To investigate and identify alternative uses for taconite mining products and by-products from each Mesabi Range taconite operation that have the best potential for providing the greatest short- and long-term economic benefit to the industry. These products and by-products can include gross physical features like pits, stockpiles, and tailings basins; mined materials such as crude taconite, waste rock, and overburden; and processed materials like crushed taconite, tailings, taconite concentrate, and pellets. The project will attempt to quantify the potential economic impact of the various alternative uses and assign real dollar and cents values to each. The challenge will be to find opportunities that could have meaningful positive economic impacts, given the scale at which the industry operates. Therefore, the project's focus will be on finding alternatives that have the best income-generating potential, such as those that: (1) demand large volumes/tonnages of lower value materials, (2) have a significant value-added component, or (3) command a steady stream of revenue via property or equipment rental or lease arrangements.

Background

Minnesota's taconite industry is experiencing difficulties that are negatively impacting the region and the entire state. While everyone's main focus should be on helping the industry remain competitive in its primary role, i.e., making iron units from Minnesota ore, it is very important that we try to expand the industry's revenue-generating options by investigating alternative uses and markets for the products and by-products of taconite mining. Even if only one new alternative use or market were identified, it could benefit the entire taconite industry.

Previous Activity

Minimal work was done on this project due to work on the Economic Development Administration aggregate project. Therefore, completion of the final report will be delayed.

Current Activity

Because this project is closely related to NRRI's ongoing taconite aggregate research efforts, it has provided additional resources that were used for pursuing alternative value-added use options such as various size fractions of taconite tailings; and communicating related research findings to others, including the submittal of two papers (accepted) to the 88th Meeting of Transportation Research Board, January 11-16, 2009; and the Fourteenth Conference on Cold Regions Engineering, August 30-September 2, 2009.

Principal Investigator(s)

Julie Oreskovich
Lawrence Zanko
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

65,000 1896-783-1065-00
Total \$65,000

Active

05/01/2002 06/30/2009

Start Date: 02/01/2002

End Date: 12/31/2009

Project ID: 1186

The Effect of Fluorine and Chlorine on Fired Pellet Metallurgical Properties

Objective

To evaluate the effect of fluorine and chlorine on fired pellet metallurgical properties, specifically Reducibility (R40) and Low Temperature Disintegration (LTD). This will include the influence of halogenated process water for agglomeration and when applied to the surface of fired pellets for the purpose of pellet cooling, conveyor belt protection, and dust control.

Background

Reducibility (R40) and Low Temperature Disintegration (LTD) are established metallurgical tests used to distinguish the quality of iron ore pellets for their performance in the blast furnace. Fired pellet quality has been historically influenced by chlorinated water when applied as dust control or cooling water. Process water containing high levels of chlorine has been shown to be detrimental to metallurgical properties when applied to the surface of cooled pellets. Quenching hot fired pellets for cooling or with conveyor belt protection water is known to degrade metallurgical properties due to the stresses created within the microstructure of the pellet. However, the impact of the chlorine levels in this water must be evaluated. The concentration of these halogens in process water used for agglomeration should also be included in this investigation for its effect on R40 and LTD.

Previous Activity

Several 5-gallon pails of fired acid pellets were collected from Minntac to be used in this project. Appropriate halogen-bearing reagents were also identified and located at the Coleraine Minerals Research Laboratory. The experimental plan, a 2³ factorial with 2x replication and two center point trials, was also designed. Control factors include: chloride concentration of process water, chloride concentration of quench water, fluoride concentration of process water, fluoride concentration of quench water, and pellet temperature at time of quench. An infrared thermometer was purchased to be used to measure pellet temperature at quench.

Current

Testwork is planned to be completed by July 2009, to evaluate the potential effect fluorine and chlorine have on fired pellet metallurgical properties.

Principal Investigator(s)

Kyle Bartholomew
Richard Kiesel

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
30,000	1896-783-1075-00	06/01/2003 06/30/2009
Total	\$30,000	

Start Date: 06/01/2003 **End** 06/30/2009 **Project ID:** 1317

The Effect of Preheat Burners on a Straight Grate Induration Furnace

Objective

To utilize pot-grate testing to evaluate the effect of adding preheat burners to supplement the thermal energy required when adding low levels of fluxstone.

Background

The addition of low level limestone can have a positive effect on fired pellet quality and can be advantageous to blast furnace iron reduction. The addition of limestone (calcite) to magnetite concentrates requires a significant amount of energy to calcine the fluxstone. This energy "sink" will partially prevent the pellets from reaching an effective induration temperature under normal operating conditions. This is because the calcination reaction takes place at relatively the same temperature as that when the oxidation of the magnetite begins to accelerate (600-800°C). The CO₂ released from the fluxstone fills the pellet pores, inhibiting the diffusion of oxygen into the pellet and slowing the oxidation kinetics. Although the same thermal energy is eventually available, the temperature rise as a result of the oxidation will be slower. Supplemental burners in the preheat section of the furnace may be required to add additional heat during critical stages of induration to maintain production levels and pellet quality.

Previous Activity

Pelletizing feed mixtures were prepared containing bentonite binders with 0.3 percent and 1.2 percent fluxstone. Initially, mini-pot furnace tests were used to generate the effect of additional temperature in the preheat section of a straight grate furnace and establish parameters for full pot-grate tests. Preheat tests were also conducted with the mini-pot furnace using the same cycles. Mini-pot firing tests show an increase in fired pellet physical quality in both pre-heat and full fired pellets with additional heat in the pre-heat zone. Data analysis is in progress to correlate a 50°F increase in pre-heat temperature with pellet physical quality.

Current

Pot grate testing is scheduled to be completed in the spring of 2009 for verification of these results on the full pot-grate furnace, and a final report is in progress.

Principal Investigator(s)

Richard Kiesel

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
25,000	1896-783-1215-00	02/09/2005 06/30/2009
Total	\$25,000	

Start Date: 02/09/2005 **End** 06/30/2009 **Project ID:** 1391

The Utility of Taconite Materials as Road Patch for Highway Construction

Objective

To confirm the utility of using inorganically bound taconite aggregate and concentrate as highway road patching and construction materials.

Background

Preliminary test work using a proprietary binder formulation has demonstrated the utility of using taconite mining products as a highway patching material. Actual field demonstrations show that the material, if properly formulated, can act as a semi-permanent patch.

Previous Activity

Ongoing work is being performed to refine the patching compound, specifically with regard to activator composition. The effect of using taconite as the coarse aggregate in the compound on the aggregate gradation was modeled. A sinking drain in the parking lot at NRRI in Duluth was repaired using the patching compound.

Current Activity

Testing was completed on the compressive strength of taconite cement concrete cylinders. Testing was conducted to gauge the effect of mixing time, aggregate composition, and curing time on strength. Additional road repairs were made with a cement mixer and hand tools to demonstrate the application of road patch materials with conventional tools.

Principal Investigator(s)

Donald Fosnacht
Lawrence Zanko
Steven Hauck
Tamara Diedrich

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
50,000	1896-783-1216-00
Total	\$50,000

Active
02/09/2005 06/30/2009

Start Date: 02/09/2005

End Date: 06/30/2009

Project ID: 1392

Thermodynamic Modeling - Combustion Systems

Objective

To develop expertise using thermodynamic modeling software with application to biomass conversion and high temperature metallurgical processes.

Background

This software provides another tool to assist Coleraine Minerals Research Laboratory engineers with thermodynamic modeling of metallurgical systems.

Previous Activity

This software has been used in support of various projects where chemical equilibrium calculations or phase diagrams can be of use, and has also been used extensively in mass/energy balance calculations for various projects. Funds from this account were used to initiate development of a Computational Fluid Dynamics (CFD) combustion model as part of the Next Generation Metallic Iron Nodule Technology Program. This work is nearing completion, with receipt of basic model settings and a report from ANSYS Canada. Work is now focused on final tuning of model parameters and evaluation on specific burner design and operating conditions in a furnace environment. The burner/combustion models were completed in early October 2007. Boundary conditions were tuned to yield burner performance, and validated through discussion with the burner's manufacturer and with recently published results on oxy-fuel combustion flame temperatures. Several progress reports were issued in October, which detailed burner firing characteristics under varied firing conditions. It is expected that additional work will be carried out on an "as needed basis." At this time, no further work is planned.

Current

FactSage thermodynamic software has been used extensively in mass and energy balance calculations for the iron nugget process. It has also been used in support of taconite induration modeling projects. FactSage has phase diagram, chemical reaction and aqueous chemistry modules that could be used for non-ferrous pyro and hydrometallurgical studies in the future. It might also be used in support of bio-mass related projects. Research reporting under this funding is complete.

Principal Investigator(s)

Dave Englund

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
40,664	1896-783-1211-00	02/09/2005 06/30/2008
Total	\$40,664	

Start Date: 02/09/2005 **End** 12/31/2008 **Project ID:** 1394

Up-Grade Computational Fluid Dynamic Cooler Models and Evaluate Bed Depth vs. Energy Recovery

Objective

The objective of this project is two-fold as follows: (1) To up-grade cooler model grids to Solid Works 3D model versions, because original grids exist in an electronic format that can no longer be modified if future studies require evaluation of physical changes to cooler, and (2) to perform an evaluation of cooler speed and bed depth effects on process stream temperatures and energy recovery.

Background

Computational Fluid Dynamics (CFD) cooler models were developed for five operating taconite lines in Minnesota between 1997 and 2002. However, as the result of a change in CFD software, and advances to mesh generation software, the grids for these models have become obsolete. They cannot be modified to reflect proposed physical changes, and they are not compatible with existing CFD software. This project will develop new cooler grids using Solid Works 3D modeling software, which will leave them in a forwardly compatible format so that future changes can be made as needed. Revised models will be completed for the seven existing grate-kiln taconite lines.

Previous Activity

It was planned that one model would be selected to perform a fundamental study of cooler performance where bed depth is varied over a pellet production range. This study will lead to a better understanding of energy recovery as a function of bed depth and production rate, and may ultimately lead to new control strategies for the cooler.

Current

A collaborative initiative was proposed, using Itasca Community College (ICC) students to begin the model development. The proposal was approved and work will begin effective March 2009.

Principal Investigator(s)

Dave Englund

Project Sponsor(s)

MN DNR

Amount	Account
55,200	1663-187-6607-00
Total	\$55,200

Active
11/07/2007 06/30/2009

Start Date: 11/07/2007 **End** 06/30/2009 **Project ID:** 1497

Geologic and Stratigraphic Controls of the Aggregate Potential of the Mesabi Iron Range

Objective

To continue to compile and generate baseline geological, technical, and economic information on the quality of potential higher-value aggregate products (e.g., Class A-type aggregate, concrete aggregate, railroad ballast) derived from the major stratigraphic units within the Biwabik Iron Formation. This research will build upon our current investigation of the Virginia Horn area (Mittal Steel-Minorca through United Taconite), by continuing westward in the iron-formation through U.S. Steel-Minntac in 2006 and through Hibbing Taconite in 2007.

Background

Minnesota's taconite industry generates potentially huge amounts of aggregate in the form of taconite mining and processing byproducts. However, geology and stratigraphy control the ultimate quality of the taconite rock used for aggregate, just as geology and stratigraphy control the quality of the ore used for pellet production. A more systematic and larger-scale research program of geologic mapping, sampling, and testing is geared toward identifying "optimal" (both technically & economically) geologic units.

Previous Activity

A geological intern from the Coleraine Minerals Research Laboratory, Seth Trobec, started work with J. Heine learning to log iron-formation drill core from the Keetac mine, and how to use the computer to stitch a photographic record together of the drill holes. At the same time J. Heine began logging recently "found" drill core from ArcelorMittal's new Biwabik mine. These drill cores are stored at Lerch Brothers in Hibbing in an out building. The former U.S. Steel drill core belongs to Cleveland-Cliffs. M. Patelke has been logging drill core at Hibtac. This logging and future logging will be concentrating logging drill holes up dip of the deeper drill holes logged previously.

Current Activity

Mark Severson, John Heine, and Marsha Patelke completed drill core logging on the Mesabi Iron Range by completing 305 holes (118,863 feet of core) to date that include:

- 89 holes from ArcelorMittal's McKinley Extension Mine;
- 16 holes from United Taconite;
- 46 holes from Minntac (East and West Pits);
- 41 holes from Hibbing Taconite;
- 63 holes from Keewatin Taconite (ongoing); and
- 41 holes from the Welton Mine area (true collar locations unknown).

Complete stratigraphic sections have been determined for each of these areas, and a "Rosetta Stone" has now been developed that illustrates how each of the mine's geologic units correlates with an adjacent mine's units. Preparation of 19 cross-sections for the McKinley Extension Mine has begun and will be used to show the three dimensional distribution of potential aggregate horizons associated with: 1) the top of the Lower Cherty (LC5B submember/Mesaba Select); and 2) similar adjacent material in the base of the Lower Slaty.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
176,000	1896-783-1225-00
Total	\$176,000

Active

07/16/2006 06/30/2009

Start Date: 07/16/2006

End Date: 06/30/2009

Project ID: 1437

The Economics and Logistics of Transporting Taconite Mining and Processing Byproducts (Aggregate): Minnesota and Beyond

Objective

To focus on rail transport by reviewing/identifying transportation networks, logistics, equipment availability, costs, and potential difficulties associated with moving taconite aggregate through that network. Truck, barge, and Great Lakes shipping will also be addressed.

Background

Lower value/higher volume commodities like construction aggregates are often economically limited by their distance to market, due to the cost of transportation. If taconite-based aggregate is to be competitive beyond the Iron Range, cost-effective rail, truck, barge, and laker transport options will be needed, and their economic and logistical barriers must be identified, quantified, and overcome.

Previous Activity

A final draft technical report was completed and is undergoing final review. The report updates and expands upon an interim project progress report submitted to the State in late 2007 (Zanko, 2007). While this report focuses on taconite aggregates, many of its findings are applicable to the crushed stone aggregate industry in general, and relies heavily on an integrated companion report by project contractor Ms. Elizabeth E. Ogard, Prime Focus, LLC; and her collaborator and colleague, Dr. Richard D. Stewart, UWS and UMD.

Current Activity

The project is complete, and the following final report was published: Zanko, L.M., Ogard, E.E., and Stewart, R.D., 2008, The Economics and Logistics of Transporting Taconite Mining and Processing Byproducts (Aggregate): Minnesota and Beyond, Final Report to the Minerals Coordinating Committee: Natural Resources Research Institute, University of Minnesota, Duluth, MN, Technical Report NRRI/TR-2008/19, 73 pp.

Selected findings are presented below: Per-ton transportation-only rates are presented for the four major modes of aggregate transportation reviewed during the study, and reflect the cost of fuel in first half of 2008:

Great Lakes Vessel – Duluth to Chicago: \$ 8 to 15	Unit Train – Iron Range to Chicago: 25
Truck – Iron Range to Twin Cities: 25 to 30	Barge (depending on point of origin) 15 to 41

Long-term large volume requirements can provide the critical mass that justifies investment in dedicated unit trains, bi-modal systems, lake vessels, and/or river barges to move aggregate materials from the Iron Range to markets where the high quality aggregates are needed. Our view is that a combination of factors could put taconite aggregates on a list of “preferred” construction material types, and increase their value to a level that outweighs the cost of delivery to multiple regional and national markets. These factors could include innovative construction practices that result in longer-lasting roads, such as composite pavements, or life cycle/performance-based costing of state and federal infrastructure construction projects, and efforts to reduce greenhouse gases through more efficient use of resources and recycled materials.

Principal Investigator(s)

Lawrence Zanko
Steven Hauck

Project Sponsor(s)	Amount	Account	Active
MN Department of Natural Resources	50,000	1663-187-6587-00	08/10/2006 06/30/2008
Total	\$50,000		

Start Date: 08/10/2006 **End Date:** 06/30/2008 **Project ID:** 1439

Compile and Make Digital the Lithologic Data for all NRRI Drill Logs, with Emphasis on the Duluth Complex Drill Holes (an Update)

Objective

To update a 2003 NRRI report that provided a database that listed the lithologic/geologic picks in over 600 drill holes that the NRRI had logged in the Duluth Complex.

Background

The above-referenced report presented virtually all of the publicly available drill hole location data and Cu-Ni assay data for 2,145 drill holes in and near the Duluth Complex. These databases are also available online and have been extensively used by at least four exploration companies (PolyMet, Teck Cominco, Duluth Metals, and Encampment Exploration) in order to more fully understand and model the mineralization trends at their respective properties. Since 2003, all of the remaining publically available holes (approximately an additional 200 holes) along the western margin of the Duluth Complex will have been logged by NRRI personnel. The lithologic information from these holes needs to be added to the 2003 database. Locations for holes drilled in the Duluth Complex since 2003 will also be added to the database.

Previous Activity

Work began in June by Julie Oreskovich prior to her returning to her contract work at the Minnesota Department of Natural Resources Lands and Minerals on the location of Underground Iron Mines on the Mesabi Range. The database is being built upon the 2003 work of Richard Patelke, who initiated this database compilation along with Mark Severson.

Ms. Oreskovich completed over 1,200 lithological records from 25 of the Babbitt drill holes. In addition, data for 186 Duluth Complex drill holes (2002-on) have been obtained from the Drill Abandonment Logs and entered into a spreadsheet.

Additional staff is being contemplated to assist in finishing this project on time.

Current Activity

Lithologic data for 48 of the recently logged holes (that are publically available) for the Mesaba Cu-Ni deposit in the Duluth Complex have been entered into a database. Data entry for holes recently logged at the Dunka Pit Cu-Ni deposit has been initiated. A header file for holes logged by NRRI staff in the Mesabi Range has been created and lithologic picks for the individual drill holes will be entered in the near future.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)

	Amount	Account	Active	
PUF Mineral Endowment	40,000	1896-783-1240-00	04/01/2008	06/30/2009
MN DNR	40,000	1663-187-6613-00	03/07/2008	06/30/2009
Total	\$80,000			

Start Date: 03/07/2008 **End Date:** 06/30/2009 **Project ID:** 1505

Copper-Nickel Grinding and Flotation Pilot Plant, Set-up of Large Scale

Objective

To clean out the majority of the Coleraine Minerals Research Laboratory Building 171 and install necessary equipment, plumbing, and electrical apparatus to process up to 10 tons per hour (tph) of minus 3/4-inch copper-nickel ore.

Background

With the expanding exploration of the sulfide deposits in the Duluth Complex, the Coleraine Minerals Research Laboratory has been getting many inquiries about producing bulk quantities of flotation concentrates for hydrometallurgical testing. Teck Cominco expressed an interest in processing up to 2,000 tons of ore in 2008. The Coleraine Minerals Research Laboratory presently has a 5- by 10-ft rod mill (last operated in 1994) and a 6- by 4-ft ball mill (last operated in 1972) in Bldg 171. This building has been used as cold storage up to the present time. Installation of the copper-nickel (CuNi) pilot plant will allow the Coleraine Minerals Research Laboratory to process large quantities of sulfide ore to help the development of non-ferrous mining in Minnesota.

Previous Activity

The main bay in building 171 was cleaned out. A bank of five 50 cubic foot used Denver flotation cells was procured and installed as rougher cells. A 35-inch diameter ball mill was installed as a regrind mill to process the froth from the rougher flotation cells (rougher concentrate). The mill discharge feeds a bank of five 1 cubic foot cleaner flotation cells. The cleaner frother goes to another bank of 5 cells, which act as recleaners. Recleaner froth is the final concentrate. Cleaner and recleaner tails are recycled within the circuit. The rougher tails go to a series of three thickeners. Thickener overflow goes to the main water feed sump. Thickener underflows are sent to a disk filter. The filtercake goes by conveyor belt to a load out pocket where it will be placed in super sacks for disposal. Emergency lighting and portable eyewash/dose tanks were installed, along with extra fire extinguishers. Major pieces of equipment were installed, and final plumbing connections between the various pieces of equipment were completed. It was expected that the plant would be operational in October 2008.

Current

The pilot plant installation was completed, and the plant was operational in October 2008. A 1,000-ton bulk sample of copper-nickel ore was processed in the plant, which produced a flotation concentrate product for hydrometallurgical testing at Teck Cominco.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

92,000 1896-783-1242-00

Active

04/28/2008 06/30/2009

Total \$92,000

Start Date: 04/28/2008 **End** 06/30/2009 **Project ID:** 1515

Copper-Nickel-PGE Mineralization Potential of the Cloquet Lake Intrusion, NE MN

Objective

To conduct a first pass reconnaissance sampling campaign to evaluate the potential of the Cloquet Lake Intrusion to host basal Cu-Ni-PGE deposits and/or stratiform PGE “reef” deposits related to a sulfide saturation event.

Background

The Cloquet Lake Intrusion, comprising part of the Beaver Bay Complex, represents one of the largest Keweenawan-age intrusions in NE Minnesota – the intrusion is 2-3 times larger than either the Partridge River or South Kawishiwi intrusions, which contain several Cu-Ni-PGE deposits. However, exploration for base and precious metals in the Cloquet Lake Intrusion has been limited to three drill holes. All three holes intersected massive sulfide at the basal contact but PGE, Cu, and Ni values were generally low and further exploration efforts were discontinued. Despite this lack of encouraging results, the Cloquet Lake Intrusion should still be explored for the following reasons: (1) the intrusion is situated near a buried crustal ridge of older country rock that may have served as a local sulfur source for basal disseminated Cu-Ni-PGE sulfide deposits; (2) the massive sulfide in the 3 holes may be related to proximity to a vent, wherein, additional massive sulfide with higher Cu-Ni-PGE values (related to fractional crystallization) may be present and could be located more distally to the vent; and (3) the layered nature of this intrusion suggests that it may be possible that one or more stratiform PGE “reefs” (associated with low sulfide contents) lies hidden in the upper portions of the intrusion. This project would be aimed at collecting more samples of weak to moderately-mineralized rock in order to gain a better appreciation of the mineralized potential of the Cloquet Lake Intrusion.

Previous Activity

Field work is set to commence in September 2008 with the final report completed by December 30, 2008.

Current Activity

Field work did not happen in September due to more immediate work and in part by weather. Field work is scheduled for summer 2009.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
15,000	1896-783-1082-00	09/01/2004 06/30/2009
Total	\$15,000	

Start Date: 09/01/2004 **End Date:** 06/30/2009 **Project ID:** 1358

Detailed Research and Geological Mapping of the Nickel Lake Macrodiike and the Northern South Kawishiwi Intrusion

Objective

The objectives of this project are twofold: (1) publish a series of adjacent 1:10,000 scale bedrock geological maps of the region that incorporates the known igneous stratigraphy revealed in drill holes into units on the bedrock geology maps; and (2) describe the outcome of the mapping and integrated research through publication of the results in the Society of Economic Geologists Journal, Economic Geology.

Background

Cu-Ni-PGE exploration and drilling programs by Duluth Metals Limited, Franconia Minerals, and Encampment Resources are currently in progress in the northern South Kawishiwi Intrusion (SKI). These programs, which collectively will spend >\$10 million in 2007, are generating worldwide interest throughout the geological community. One of the hurdles that these companies are facing is envisioning how subsurface rock units (as revealed in drill holes) correlate with outcrops and map units on the earth's surface. Such correlations are the basis of all types of geological models, e.g., ore deposit models, mineral potential models, and grade-tonnage block models that are needed to convert mineral exploration programs into economically significant ore deposits.

Previous Activity

Detailed geological mapping was completed in the Nickel Lake Macrodiike and adjacent northern South Kawishiwi Intrusion. Such mapping includes the description and georeferencing of over 3,000 new outcrops. These outcrops complement the existing database of 7,000 outcrops in the area. This mapping has confirmed the existence of two major pulses of magmatic injection into the South Kawishiwi chamber, and clearly defines the boundary of highly contaminated, sulfide-bearing magmas of the Spruce Road deposit and virtually uncontaminated magmatic injections associated with sulfide mineralization of the Maturi and Nokomis (formerly Maturi Extension) deposit areas.

Current Activity

The completed bedrock geologic map is the result of numerous investigations by the author and many others over the last eight years in SKI and its contained Cu-Ni-PGE mineralization. Detailed geological mapping evolved from a study of the Nickel Lake Macrodiike (NLM) into a comprehensive geologic mapping and compilation project (104,000 acres) to answer some of the questions on the origin of the extensive known and undiscovered Cu-Ni-PGE mineralization in the northern portion of the SKI. This increase in scope is needed due to the economic significance of the published resource estimates (>\$146 billion in contained metal) from this area. To date, nearly 15,000 outcrops, 1,400 structural measurements, geology and geochemistry from 773 drill holes totaling over 845,000 feet of core, and 12,500,000 meters of elevated contour lines were integrated into the comprehensive GIS database. The map units of the SKI depicted on this map sheet differ from previous maps from the area, in that the author has consulted with numerous company geologists and defined map units based on what industry geologists use to define rock masses encountered in drill core.

Principal Investigator(s)

Dean Peterson
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

50,000 1896-783-1081-00

Active

09/01/2004 06/30/2009

Total

\$50,000

Start Date: 09/01/2004

End Date: 06/30/2009

Project ID: 1463

Finish Logging of Duluth Complex Drill Core

Objective

To complete a logging campaign of these remaining holes and establish a complete stratigraphic section for all portions of the two intrusions. These data will then be used to understand many aspects of Cu-Ni±PGE mineralization controls and to define horizons that could potentially contain significant Platinum Group Elements enrichments.

Background

To date, 955 drill holes from the basal zone of the Duluth Complex have been re-logged by personnel at NRRI. The major result of all this effort was the establishment of igneous stratigraphic packages, which in turn, were used to improve our understanding of the mineralization controls on the Cu-Ni deposits and the distribution of Platinum Group Elements. However, there are still over 200 drill holes (>210,000 feet of core) that remain to be re-logged from portions of the Partridge River and South Kawishiwi Intrusions.

Previous Activity

The cross-sections from Teck Cominco's Mesaba Cu-Ni deposit (formerly the Babbitt deposit) are complete, including new drill holes drilled during 2008. The new cross-sections define a new intrusion, Bathtub, which was formerly the Bathtub Layered Interval. This is the most complete set of cross-sections for any of the deposits in the public domain. A few smaller cross-sections remain to be made.

Current Activity

The final report has been completed and is now available on the NRRI-Economic Geology Group's website. The report by Mark Severson and Steven Hauck is titled "Finish Logging of Duluth Complex Drill Core (And a Reinterpretation of the Geology at the Mesaba (Babbitt) Deposit)," NRRI/TR-2008/17, 2008, 68 p. + 94 plates.

The most important parts of the re-interpretation of Teck American's Mesaba deposit into two different intrusions could not have been done without access to Teck American's new drilling. The plates to this report represent new cross-sections of not only the Mesaba deposit, but also the Dunka Pit deposit and an updated cross-section from the Nokomis deposit area that includes seven new drill holes.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)

	Amount	Account	Active
PUF Mineral Endowment	60,000	1896-783-1224-00	07/16/2006 06/30/2009
MN Dept of Natural Resources (MN DNR)	70,000	1663-187-6574-00	03/03/2006 06/30/2007
Total	\$130,000		

Start Date: 07/16/2006 **End Date:** 06/30/2009 **Project ID:** 1436

Further Evaluation of Diamond Base Metal, and Precious Mineral Potential of Minnesota Using Various Glacial Till Sampling and Analytical Methods

Objective

The objectives of this proposal are to: (1) compile all pertinent Minnesota geological and geophysical information that are relevant to the formation of diamond pipes; (2) conduct additional processing and mineral analyses on some of the 120 previously collected glacial till samples from the Vermilion District for mineral potential; and (3) conduct a down-ice glacial till demonstration study in the International Falls area using the methods of Larson and other recognized glacial till sampling methodologies for identifying kimberlite and base and precious mineral indicator minerals.

Background

In Canada, sampling glacial till has been successfully used to locate diamond pipes and base metal mineralization. Very limited similar surveys have been conducted in Minnesota, but there has not been a systematic glacial till sampling survey conducted in northern Minnesota.

Previous Activity

Less than 1 mm sized mineral samples from the glacial tills were mounted for microprobe analyses to determine the chemistry and ultimately the mineralogy of this finest size fraction of the collected glacial till samples. The microprobe analyses were made difficult by interference from a bad mounting medium and poorly polished samples. Several sets of samples were re-analyzed due to bad chemical totals, i.e., <98% or >102%. Data are further being refined to enable plotting of this information on a map of Minnesota. Additionally, Dr. Harvey Thorleifson had similar material from Manitoba. These samples were also analyzed by microprobe. Since much of Minnesota's glacial debris comes from Manitoba, it was determined that analysis of these samples would provide provenance for many of the samples found in Minnesota.

Current Activity

Progress was made on assembling the microprobe, and determining what minerals were present. Data were then compiled into separate worksheets by mineral, and these mineral chemistries were then analyzed to see if any anomalies in the data were present, e.g., acceptable and unacceptable totals.

These data will be compiled with the WMC (formerly Western Mining Company) mineral chemistry, which will create a database of over 2,300 analyzed mineral grains throughout the State of Minnesota.

Next, the data will be compiled into Minnesota and Manitoba data. Indicator mineral chemistry will then then be requested from the Province of Manitoba along with data on past glacial movements through or originating in Manitoba, e.g., the Des Moines lobe, to try to determine which Minnesota mineral grains may have originated in Manitoba.

Principal Investigator(s)

John Heine
Steven Hauck

Project Sponsor(s)	Amount	Account	Active
PUF Mineral Endowment	95,000	1896-783-1223-00	07/16/2006 06/30/2009
MN Department of Natural Resources	74,700	1663-187-6586-00	08/10/2006 06/30/2008
Total	\$169,700		

Start Date: 08/10/2006 **End Date:** 06/30/2009 **Project ID:** 1438

Heavy Stream Discharge from the Falcon Concentrator

Objective

To test various modifications designed to enable a free flow of the heavy mineral stream out of the standard Falcon concentrator bowl. If successful, a performance evaluation will measure the device's ability to separate low silica magnetite out of a mixed stream that contains middlings and gangue.

Background

Previously, the Coleraine Minerals Research Laboratory completed evaluation of the Falcon concentrator, which is a device that separates minerals based on specific gravity. While performance was promising, the previous researcher was concerned regarding clogging of the heavy mineral discharge hardware. On the other hand, investigators from the gold industry state that the Falcon is the device of choice for "fine" particle size distributions, such as those used in the taconite industry. In addition, they report: "The ability to recover a mineral of density equal to 5.2 from a gangue of density 2.7, especially below 50 um (270 Mesh), is clearly demonstrated." (La Plante, Andre, "A Comparative Study of Two Centrifugal Concentrators," CMP Mineral Processing Proceedings, 1993). Existing magnetic separators are designed to remove magnetite out of the tailings stream, while sending both liberated magnetite and middlings on to further processing. These machines are not designed to separate pure magnetite away from the middlings. However, if that can be done with a Falcon, then the combination of the two devices could produce a returning mill feed stream consisting of only middlings. As the net mill feed tonnage is reduced, so the line productivity increases. In addition, if the heavy concentrate is sufficiently low in silica, then flotation recovery will increase. Solving the heavy particle discharge problem with the Falcon concentrator could result in large improvements for taconite plants.

Previous Activity

The Falcon's newly designed separator is capable of producing particles with concentrate grade silica assays in the fine sizes. A feed sample was taken from the primary grinding section of a local taconite plant and was separated by the Falcon into heavier and lighter particles. It is encouraging that the finer particles of the heavier particle stream are concentrate grade, although capturing this advantage requires that the heavies stream be sent to a size separation step. In plant application, the heavy particle stream might be bypassed out of the primary grinding circulating load into an existing screen or cyclone located downstream, providing economic advantage through increased circuit productivity.

Current

A new principal investigator has been assigned to prepare the final report for the completed study using the Falcon concentrator to separate a low silica magnetite concentrate from middlings and gangue. In addition, the centrifuge-type device was recommended for use in a tungsten processing circuit in the Yukon and is being run successfully at that location. The unit is also being evaluated for possible copper-nickel upgrading for Minnesota copper-nickel ore.

Principal Investigator(s)

Kyle Bartholomew
Thomas Larson

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
40,000	1896-783-1208-00	02/09/2005 06/30/2006
Total	\$40,000	

Start Date: 02/09/2005 **End** 12/31/2008 **Project ID:** 1386

Origin and Distribution of Chromium Mineralization in the Duluth Complex and Related Keweenawan Intrusives in Minnesota and its Relationship to PGE Mineralization

Objective

To expand our knowledge of Cr-mineralization and its potential relationship to PGE mineralization by: (1) using existing geochemistry data and collecting Cr-bearing samples for polished thin section analysis; (2) identifying other unassayed drill core that may contain chromium mineralization, analyzing the drill core, and collecting samples for polished thin sections; (3) supporting one Ph.D. thesis on the Birch Lake area that will investigate the PGE-Cr mineralization and relationships to oxide mineralization; (4) conducting quantitative microprobe analyses to determine the various chromium-related minerals; and (5) evaluating and further analysis of one chromium occurrence identified in a drill hole outside of the Duluth Complex.

Background

Chromium (Cr) mineralization associated with PGEs in the Duluth Complex was first recognized by Sabelin and Iwasaki (1985, 1986) in Du-15 in the Birch Lake area. The presence of chromium spinels was noted earlier by Weiblen and Morey (1976) at the Spruce Road deposit. Severson (1995) identified chromium and platinum mineralization in drill hole SL-19 northeast of the Water Hen deposit. Severson (1991) identified Cr-rich spinels in the Local Boy ore zone of the Babbitt deposit. Hauck et al. (in prep.) have identified a variety of Cr-rich spinel in the Birch Lake area, not all of which are directly associated with PGE mineralization. In addition, Heine et al. (1998) reported 1.64% Cr₂O₃ in saprolite in a drill hole drilled into a Keweenawan ultramafic body in Stearns County.

Previous Activity

A peer-reviewed paper was published in Chemical Geology titled "Re-Os and O isotopic variations in magnetite from the contact zone of the Duluth Complex and the Biwabik Iron Formation, northeastern Minnesota," by Ripley, Shafer, Li, and Hauck. The data show the South Kawishiwi intrusion was contaminated by crustal rocks, i.e., iron-formation and granite, but also interacted with meteoric (groundwater) waters. All of the data give clues to the emplacement, melting of crustal rocks, and subsequent alteration by later fluids.

Current Activity

Identification of minerals to probe is ongoing, but slowly due to other more immediate commitments.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
76,000	1896-783-1071-00	05/01/2002 06/30/2009
Total	\$76,000	

Start Date: 02/01/2002

End Date: 06/30/2009

Project ID: 1192

Precambrian Research Center

Objective

To provide training and support to the next generation of geoscientists in modern methods of geological mapping and mapmaking. This training will focus on the unique attributes of mapping the ancient Precambrian rocks of the southern Canadian Shield. The Canadian Shield and similar terranes on every continent are host to many of the world's premier ore deposits.

Background

The Precambrian Research Center (PRC) was created at UMD in 2006 to satisfy an urgent, long-term demand for and critically low supply of geoscientists skilled in field mapping. The PRC seeks to reverse the two decades-long decline in the teaching of geologic mapping skills in U.S. colleges and to provide advanced training to professional geologists.

Previous Activity

Jan 1-June 30, 2008 Activities:

Field Camp: Promoted 2008 camp by distributing 250 posters, making 9 school visits, and presenting at Institute on Lake Superior Geology (ILSG); 2008 Enrollment included: 10 Workshops: April workshop for approximately 50 investors focused on Duluth Complex and Mesabi Range deposits. Student Awards: Chris White, 2007-08 Graduate Research Assistantship (GRA) recipient, is in the final writing stage of his MS thesis. Five research grants were awarded to four UMD students and one UW-Milwaukee student. UMD Courses: Jim Miller and Vicki Hansen taught a new 3-credit Geologic Maps course (GEOL 3000) for 25 students. Outreach: Jim Miller and Penny Morton taught a 2-week course in June for 20 middle school teachers on field-based inquiry methods in earth science. Fundraising: Solicitations were made by email correspondence, distribution of the annual report, and contacts made at industry conferences - Prospectors and Developers Association of Canada (PDAC), The Society for Mining, Metallurgy and Exploration (SME), Northwestern Ontario Prospectors Association (NWOPA). Contributions for 2008 currently total \$30,000.

Current Activity

July 1-Dec 31 Activities:

Field Camp: Ran 2008 camp for 10 students July-August; in Fall, updated website and promoted camp with talks at six upper Midwest colleges.

Workshops: October professional workshop for 15 geologists focused on mineral deposits in greenstone belts. Planning underway for Oct. 2009 Workshop on Layered Intrusions.

Outreach: Aug- Miller and Peterson participated as instructors and field trip leaders for the 12th Annual MMEW Workshop for K-12 teachers; Sept-Miller gave presentation on Lake Superior geology and resources to Elderhostel group; Oct-Miller gave field trip on Duluth area geology to Minnesota Geological Society.

Fundraising: Continued solicitations for corporate support of PRC. Raised over \$40,000 in last half of 2008

Principal Investigator(s)

Dean Peterson

Jim Miller

Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
150,000	1896-783-1226-00
Total	\$150,000

Active
07/18/2006 06/30/2009

Start Date: 07/18/2006

End Date: 06/30/2009

Project ID: 1432

Research and Map the Nickel Lake Macrodiike and Northern Portion of the South Kawishiwi Intrusion

Objective

To map and collect samples in the Nickel Lake macrodiike feeder to the northern portion of the South Kawishiwi intrusion.

Background

The mineral industry in Minnesota is actively engaged in numerous advanced exploration programs at the Birch Lake, Maturi, Maturi Extension, and South Filson Creek deposits within the northern portions of the South Kawishiwi Intrusion of the Duluth Complex.

Previous Activity

The Nickel Lake Macrodiike project has evolved from a geological mapping study of a small area (to understand magma inflow into the South Kawishiwi Intrusion) into a comprehensive geologic mapping and compilation project (104,000 acres) to answer some of the fundamental questions on the origin of the extensive known and undiscovered Cu-Ni-PGE mineralization in the northern portion of the South Kawishiwi Intrusion. Such an increase in scope is needed due to the economic significance of the published resource estimates (>100 billion tons) from this area. To date, nearly 14,000 outcrops, 1,400 structural measurements, and 12,500,000 meters of elevated contour lines have been integrated into the comprehensive GIS database. The new map area includes the geology from each of the five major lithologic units in the area, namely the Late Archean Giants Range batholith, the Anorthositic Series, Bald Eagle Intrusion, South Kawishiwi Intrusion, and the Nickel Lake Macrodiike of the Mesoproterozoic Duluth Complex. One main new insight of this recently completed compilation is the recognition that the northern South Kawishiwi Intrusion is not a shallowly dipping sill, but rather a southwest trending funnel-like body. Such an interpretation leads to the conclusion that the eastern contact of the South Kawishiwi Intrusion, which previously was interpreted as the top of the intrusion, is a basal contact, and thus has great potential for hosting Cu-Ni-PGE mineralization at its base.

Current Activity

Dean Peterson worked on and published the "Bedrock Geologic Map of the Duluth Complex in the Northern South Kawishiwi Intrusion and Surrounding Area; Lake and St. Louis Counties, Minnesota." University of Minnesota, Duluth, Economic Geology Group Map Series NRRI-MAP-2008/01.

Principal Investigator(s)

Dean Peterson
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

50,000 1896-783-1081-00

Active

09/01/2004 06/30/2009

Total

\$50,000

Start Date: 07/01/2007

End Date: 06/30/2009

Project ID: 1350

Volcanogenic Massive Sulfide (VMS) Potential in Lake of the Woods, Koochiching & Beltrami Counties, Reconnaissance Evaluation of the

Objective

To determine the volcanogenic massive sulfide potential of an area drilled between the late 1960s and middle 1980s using new ideas about the generation and occurrence of base-metal sulfides.

Background

The main objective of this proposal is to make a first pass evaluation of the volcanogenic massive sulfide potential, through logging of selected drill holes, within a portion of a greenstone belt (80 mile strike-length) that was drilled by several exploration companies from the late 1960s through the middle 1980s. Many of the holes drilled by the companies intersected massive sulfide horizons associated with a variety of volcanic, chemical, and sedimentary rock packages. However, the massive sulfides in the holes were mainly pyrite and pyrrhotite with limited amounts of base metal sulfides – a fact that discouraged further exploration in the area. At the time, detailed alteration and volcanic facies studies were not routinely conducted by the companies, nor was it recognized that volcanogenic massive sulfide districts typically contain some amounts of base metal-deficient massive sulfides that are distally-located relative to volcanogenic massive sulfide vent areas. In essence, the exploration companies never tried to put together a “big picture” in an attempt to further refine the mineral potential of the area. The goal of this project is to begin to relog the holes, with emphasis on conducting alteration studies and detailed volcanogenic facies mapping (as has been recently done in the Vermilion District by the NRRI and UW-Oshkosh) in order to fully assess and document the mineralization potential of this greenstone belt.

Previous Activity

No work was done on this project due to commitments to other projects. However, plans are to complete reconnaissance mapping in the summer and fall of 2008. A short Report of Investigation will be written at the completion of the mapping.

Current Activity

Field work was scheduled to begin in the fall, but was pushed off to summer 2009 due to weather and hunting season.

Principal Investigator(s)

Dean Peterson
Mark Severson
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
10,000	1896-783-1087-00
Total	\$10,000

Active
09/01/2004 06/30/2009

Start Date: 09/01/2004

End Date: 06/30/2009

Project ID: 1356

Peat Expansion Premier Horticulture, Inc.

Objective

The overall goal of this project is to locate, assess, and secure a suitable horticultural peat resource for Premier Horticulture, Inc., to allow expansion of their Peatrex operation, and to initiate the environmental review and permitting process.

Background

Premier Horticulture, Inc. contacted NRRI for assistance in expanding their Peatrex operation located west of Cromwell, Minnesota. It is estimated that their current peat resource (approximately 240 acres) will be depleted in the next 5 to 10 years. Also, their packaging facilities are presently operating under capacity and could readily handle additional peat from another resource, making the operation more cost-effective and profitable. An expansion would not only maintain present employment at Peatrex, but would also result in 15 additional jobs at the processing plant and harvesting site. Supplementary employment would also occur in spin-off industries such as trucking. NRRI will assist Premier Horticulture, Inc. by: (1) conducting a detailed assessment of potential peat resources in proximity to the Peatrex operation, (2) identifying financial assistance and other incentives available for peatland development from State, County, and local agencies, and (3) assisting in the purchase or lease of the property, and beginning the environmental review and permitting process required by Federal and State regulatory agencies prior to peat development.

Previous Activity

NRRI personnel met with the DNR in St. Paul in January to discuss the Wright Bog EAW and responses to comments received from the MPCA and Army Corps. NRRI personnel also met with the MPCA in Duluth to discuss their comments. NRRI completed revisions and responses to the draft EAW and is currently awaiting Premier Horticulture's review before final submission to the DNR.

Current Activity

NRRI and Premier personnel met in September to discuss peat permit requirements and the Wright Bog environmental review. NRRI and a contract botanist set up permanent plots and conducted a plant survey of restored areas on Premier's Black Lake Bog. Water monitoring wells were also installed per their 404 permit.

Principal Investigator(s)

Kurt Johnson

Project Sponsor(s)

	Amount	Account	Active
Minnesota Technology, Inc	99,982	1673-187-6441-00	07/01/1999 06/30/2004
Premier Horticulture, Inc.	30,000	1196-187-2428-00	10/25/2001 06/30/2009
Total	\$129,982		

Start Date: 07/01/2000 **End Date:** 06/30/2009 **Project ID:** 1074

Wetland Banking Fens Research Facility

Objective

The objective of the project is to restore much of the effectively drained Fens Research Facility (Fens) to a variety of wetland types so new wetland credits can be deposited into a state wetland bank for future withdrawal as wetland mitigation credits.

Background

For about 100 years, the Fens has been used for agriculture, horticulture, fuel peat production, and peatland research. The peat soils have been intensively drained. With recent demand for wetland mitigation credits, the Fens became a candidate for peatland restoration. The Minnesota Board of Water and Soil Resources (BWSR) and the Minnesota Department of Transportation (Mn/DOT) approached NRRI about establishing several wetland banks at the Fens. After lengthy review, three banks are in the process of being established and a fourth has been approved. A variety of wetland types are being established. New wetland credits will be deposited into the wetland banks. The credits will be used for wetland replacement mitigation following loss of wetlands as a result of road construction in Northeast Minnesota.

Previous Activity

Vegetation and well monitoring of the BWSR and Mn/DOT banks was carried out in the summer and early fall of 2007. Control of invasive species, primarily reed canary grass, involved "spot spraying" with glyphosate. The entire bank site was sprayed. Besides the land associated with the building site at the Fens, there is a 146 acre parcel of the Fens that is located three miles south of the building site, called the "Fens South Fields." It has a history of intensive drainage. NRRI has submitted a proposal to BWSR that was accepted for establishing a fourth wetland bank. The review process has approved the site and a bank plan was submitted.

Current Activity

Vegetation and well monitoring of the 2002 and 2005 BWSR and Mn/DOT banks was carried out in the summer and early fall of 2008. A mosaic of wetland types have been established at the banks. Control of invasive species, primarily reed canary grass, involved "spot spraying" with glyphosate. The entire bank site was sprayed. Draft reports were written for the two wetland banks. BWSR gave preliminary approval for full acceptance of wetland restoration for new wetland credits for these two banks. In late-summer 2008, the University of Minnesota entered into an agreement with BWSR to establish another 145.4 acre wetland bank. After approval by several other regulatory agencies, the vegetation was sprayed, fields rototilled and the ditches were filled on this new bank site. The entire 145.4 acre site was prepared for spreading of plant fragments in the winter of 2009.

Principal Investigator(s)

Thomas Malterer

Project Sponsor(s)

	Amount	Account	Active
Minnesota DOT	1,531,760	1196-187-2426-00	05/01/2001 06/30/2009
MN Board of Water and Soil Resources	809,906	1196-187-2426-00	05/01/2001 06/30/2009
Total	\$2,341,666		

Start Date: 07/01/2002

End Date: 06/30/2009

Project ID: 1367

Wetland Mitigation in Abandoned Gravel Pits

Objective

The main goal of the project is to determine if viable mitigation wetlands can be created on abandoned gravel pit sites to compensate for wetland impacts due to road construction in northeastern Minnesota.

Background

It is becoming increasingly difficult to provide on-site mitigation for wetland impacts due to road construction in northeastern Minnesota counties which retain greater than 80 percent of their pre-settlement wetlands. Abandoned gravel pits are one of the few remaining areas which can serve as wetland mitigation sites within the impacted watersheds. The main goal of the project is to determine if viable mitigation wetlands can be created on abandoned gravel pit sites to compensate for wetland impacts due to road construction in northeastern Minnesota. To achieve this goal a wetland creation demonstration site will be established in an abandoned gravel pit within the U.S. Trunk Highway 53 reconstruction corridor. The site will allow research and evaluation of hydrologic controls, soil amendments, direct seeding, mulch, and other techniques for wetland establishment. Soil and plant materials displaced by the TH 53 reconstruction will also be evaluated for use in wetland creation. The completed demonstration site will consist of a complex of several wetland types most likely to be impacted in northeast Minnesota (Types 2, 6, 7, and 8). The research will result in preliminary recommendations for creating wetlands in abandoned gravel pits based on information acquired during the funding period.

Previous Activity

To alleviate high water levels the site inlets and outlets were adjusted and additional ditching was conducted to route peak water flows around the site. Invasive plant species identified in the September 2007 plant survey (reed canary grass and purple loosestrife) were sprayed with herbicide in June. Another plant survey was conducted in June which showed a decrease in weedy species and increased native plant cover and diversity. Water level and invasive species monitoring is ongoing with another plant survey scheduled for September 2008.

Current Activity

The project contract was amended to allow a no-cost extension to include the 2009 growing season. Another plant survey was conducted in September 2008 which included willow measurements and plot photography. Invasive plant species were spot sprayed with glyphosate in July and September.

Site tours for Mn/DOT and BWSR personnel were conducted in July, September, and October. High and low elevations for each plot were determined and soil samples were collected and submitted for analysis. Vegetation was cut and removed from the Mitigation 4 site to prepare for reapplication of bog donor material early next spring. Preliminary data analysis shows increasing cover by native species and increasing species richness over time.

Principal Investigator(s)

Kurt Johnson

Project Sponsor(s)

	Amount	Account	Active
MN Dept of Transportation(MNDOT)	109,562	1663-187-6591-00	10/09/2006 03/31/2010
Total	\$109,562		

Start Date: 10/09/2006 **End Date:** 03/31/2010 **Project ID:** 1445

NRRI Product Development Fund-American Peat Technologies

Objective

To evaluate the effectiveness of dissolved and particulate mercury removal by American Peat Technologies peat products to below the Great Lakes Initiative.

Background

This project will evaluate an American Peat Technologies, LLC, granular peat product for its potential to remove mercury and other heavy metals from water. Water taken from the Erie Pier confined disposal facility in Duluth, Minnesota, and from a non-ferrous metallic mineral runoff source will be tested. Mercury (Hg), and heavy metals, most likely copper (Cu), nickel (Ni), lead (Pb), cobalt (Co), and iron (Fe), will be the project focus. Other metals could be added to the analytical package. This evaluation and confirmation work will be performed by NRRI at its Duluth and Coleraine Minerals Research Laboratory facilities in close collaboration with American Peat Technologies, LLC.

Previous Activity

Based on meetings and discussions with American Peat Technologies in June 2008, a request for a project extension through December 31, 2008, was made and granted. This extension will give the project the time required to complete work as outlined in the original work plan and satisfy the needs of American Peat Technologies. An updated work plan that will screen several newly developed American Peat Technologies peat product formulations has been developed. New water samples from Erie Pier were collected in late June 2008, and will undergo further testing at Coleraine from July to October, with results confirmed by an external laboratory, as required. The work schedule calls for final testing results to be generated in mid-October, followed by a final project report and wrap-up meeting.

Current Activity

Results from mercury analyses up to the fall of 2008 did not provide useful or repeatable results. Therefore, the approach to the project was changed. A change order was completed in November 2008. Evaluation of five potential mechanisms for the attraction of mercury ions to peat granules is now being pursued. Mechanism evaluation experiments are being conducted by Dr. Igor Kolomitsyn at NRRI in Duluth. Due to the changes to the study, an extension to the end of February 2009 was requested and granted.

About 10 samples of APT product are being used in each of the mechanism experiments. The study is approximately half-way completed. Testing for pH has been completed using a 0.01 mol calcium chloride (CaCl₂) solution, which is considered a more accurate method for peat and peat products. To compare pH results for using water versus CaCl₂, measurements were completed on one peat sample. Water gave a result of 2.8 and CaCl₂ gave a result of 3.9. Testing for cation exchange and unique exchange are about halfway completed. Experiments for absorption have not been started, but will be completed next.

Principal Investigator(s)

Lawrence Zanko
Steven Hauck

Project Sponsor(s)
Blandin Foundation

Amount	Account
30,000	1670-186-6117-00
Total	\$30,000

Active
05/01/2007 03/02/2009

Start Date: 05/01/2007

End Date: 03/02/2009

Project ID: 1481

Center for Applied Research and Technology Development – Program Notes

Coleraine Minerals Research Laboratory

Coleraine Technical Reports

CMRL/TR-08-05 – (aka: NRRI/TR-2008/23) – Confidential Report issued to Clariant – B. Benner – July 31, 2008 – 28 pgs.

CMRL/TR-08-06 – (aka: NRRI/TR/2008/25) – Confidential Report issued to Cardero – R. Kiesel and S. Ersayin – September 9, 2008 – 14 pgs.

CMRL/TR-08-07 – (aka: NRRI/TR-2008/32) – Confidential Report issued to MQes – B. R. Benner – December 4, 2008 – 13 pgs.

Personnel

Seth Trobec, Jason George, Jed Peterson, Jeremy Elbers and Mike Christensen were student summer interns (from UMD & UND Engineering programs) at the Coleraine Minerals Research Laboratory (CMRL) from June to August 2008. The objective of the internship program was to educate engineering students regarding taconite and ore processing. They also had the opportunity to work with environmental and biomass energy, mining, mineral processing, hydrometallurgy, biomass gasification, geological and environmental research projects. Some projects involved plant visits, measurement and sampling.

Jeffrey Antonovich, Shaun Gram, Aaron Hicks, Anthony Larson, Michael Swanson and Steven Zaitz were hired on 6 month positions to assist in the Teck Cominco copper nickel project and later with other test work.

Jon Anderson, Pat Casey, Jack Kangas, Jake Nordlund, Mike Miller, Andrew Clark and Russell Pence were hired as temporary technicians working on the Teck Cominco copper nickel project.

Paul Hanson was hired as a Senior Laboratory Technician at the NRRI Coleraine Minerals Research Laboratory, assisting in the Chem Lab.

Facilities

Removal of the Old Administration Building at CMRL. The old CMRL administration building used for over 40 years was demolished and a new hydrometallurgical/biomass facility is being planned for installation on the site.

Construction of 60-ft by 120-ft Storage Building at CMRL. A new 60-ft by 120-ft equipment storage building was constructed on the CMRL site and will be used to store newly purchased heavy mobile equipment and other research test equipment used at the laboratory.

CMRL Analytical Laboratory Advancements. All of the 10 year old CMRL analytical laboratory metal fume hoods and associated metal ductwork have been replaced with polypropylene/lexan fume hoods and polypropylene ductwork to eliminate corrosion in the acid fume hood systems. Two Leco carbon/sulfur analyzers have been added to the compliment of instruments in the lab to add carbon and sulfur analytical capabilities for metallic and carbon related samples. In addition, a calorimeter has been added for BTU content measurement of fuels being studied in our biomass research program.

Economic Geology Group

Personnel

Megan Schreiber was hired as a Junior Scientist to work with Tamara Diedrich and Devon Brecke on the Minnesota Taconite Workers Lung Health Study (MTWLHS). Megan's primary job will be using the Scanning Electron Microscope (SEM) at UMD to identify particles collected by the Micro-Orifice Uniform Deposit Impactor (MOUDI) in the communities along the Mesabi Iron Range.

Chris Bicknese was hired as a student worker for the MTWLHS. Chris's primary duty is to prepare filters for the MOUDI impactor and to assist Devon Brecke with setting up and removing the impactor from various sites along the Mesabi Iron Range.

Dean Peterson left the Economic Geology Group and now works as Senior Vice-President of Exploration for Duluth Metals Corporation with offices in Duluth, Ely, and Oakdale, MN.

Facilities

Due to recommendations from the Advisory Board regarding the MTWLHS, a new clean laboratory was renovated from a Center for Water and the Environment (CWE) lab (with their blessings) in Room 477 to minimize contamination of the samples.

Reports/Papers/Presentations

Diedrich, T., and Brecke, D., 2008, Taconite-Derived Airborne Particulates on Mesabi Iron Range, Natural Resources Research Institute, University of Minnesota, Duluth, MN, Economic Geology Group Poster Series NRRI-POSTER-2008/03.

Severson, M.J., and Hauck, S.A., 2008, Finish Logging of Duluth Complex Drill Core (And a Reinterpretation of the Geology at the Mesaba (Babbitt) deposit), Natural Resources Research Institute, University of Minnesota, Duluth, MN, Technical Report NRRI/TR-2008/17, 68 pp. + 94 plates.

Zanko, L.M., Ogard, E.E., and Stewart, R.D., 2008, The Economics and Logistics of Transporting Taconite Mining and Processing Byproducts (Aggregate): Minnesota and Beyond, Final Report to the Minerals Coordinating Committee, Natural Resources Research Institute, University of Minnesota, Duluth, MN, Technical Report NRRI/TR-2008/19, 73 pp.

Proposals in Progress

L. Zanko and B. Benner, Evaluation of tailings generated by Cu-Ni ore processing for additional value recovery. Proposal to the Minerals Coordinating Committee, \$15,000 + equal Permanent University Trust Fund (PUTF) match.

D. Brecke, T. Diedrich, M. Severson, and S. Hauck, Systematic Survey and Characterization of Amphibole and Phyllosilicate Minerals in Duluth Complex Ores and Related Waste Rocks of Northeastern Minnesota. Proposal to the Minerals Coordinating Committee, \$105,000 + equal PUTF match.

M. Severson, History and Compilation of all Gold Exploration Data in Minnesota. Proposal to the Minerals Coordinating Committee, \$31,000 + equal PUTF match.

S. Hauck and W. Gosnold (University of North Dakota-Grand Forks), Minnesota's Geothermal Energy Production Requires Heat Flow Mapping. Proposal to the Legislative and Citizens Committee on Minnesota Resources. \$300,000 + \$35,000 PUTF match. Failed to be selected for funding in December 2008. Will be resubmitted.

L. Zanko, S. Valppu, K. Wittle, and D. Hopstock, Heating of sediment to eradicate purple loosestrife seeds. Proposal to the Legislative and Citizens Committee on Minnesota Resources. \$280,000. Failed to be selected for funding in December 2008.

Technical Assistance

Technical assistance was provided to Bill and Elaine Maunu, who brought a very large field stone to be identified.

Russell Mining Company of Nevada requested information on the Duluth Complex mineralization, mining companies, and available land.

New Contracts

New external sales contracts were signed with: U.S. Steel – Keetac (core logging and cutting); Numax Resources (for a preliminary resource appraisal of the Fe-Ti property in Ontario, Canada); Yawkey Minerals (aggregate related work).

Existing Contracts

Duluth Metals Corp. (data evaluation); Encampment Minerals (data evaluation); PolyMet Mining (core logging, data evaluation, mineral processing at CMRL); Teck Cominco (core logging).

Forestry/Forest Products

Scientific Meetings/Presentations

Patrick Donahue gave a presentation entitled “Inorganic Bonded Wood Composite Panels” at the University of Minnesota – Initiative for Renewable Energy and the Environment sponsored conference, E3 in November 2008.

Xiping Wang gave a presentation entitled “Heat Sterilization of Firewood - Heat Treating Options” at the Firewood Regulations Workshop: What They Mean to Your Business. This workshop was held in Appleton, Wisconsin, on July 23, 2008.

Publications

R.B. Allison, **X. Wang**, and R.J. Ross. 2008. Visual and Nondestructive Evaluation of Red Pines Supporting a Ropes Course in the USFS Nesbit Lake Camp, Sidnaw, Michigan. *In: Proceedings, 15th International Symposium on Nondestructive Testing of Wood, September 10-12, 2007, Duluth, MN.* pp. 43-48. Oct. 2008.

Brian Brashaw. 2008. Performance Testing of Engineered Hardwood Flooring. Natural Resources Research Institute Technical Report NRRI/TR-2008/20.

Brian Brashaw. 2008. Loll Designs Product/Process Development. Natural Resources Research Institute Technical Report NRRI/TR-2008/26.

Brian Brashaw. 2008. Whiskeyjack Product/Process Development. Natural Resources Research Institute Technical Report NRRI/TR-2008/29.

Brian Brashaw. 2008. Resin Trial for Composite Board Resin Materials. Natural Resources Research Institute Technical Report NRRI/TR-2008/30.

B.K. Brashaw, R.J. Ross, and **X. Wang**. 2008. Innovative Technology Transfer of Nondestructive Evaluation Research. *In: Proceedings, 15th International Symposium on Nondestructive Testing of Wood, September 10-12, 2007, Duluth, MN.* pp. 25-28. Oct. 2008.

B.K. Brashaw, **R. Vatalaro**, **X. Wang**, **K. Sarvela**, and J.P. Wacker. 2008. Development of Flexural Vibration Inspection Techniques to Rapidly Assess the Structural Health of Rural Bridge Systems. CTS 08-22, Intelligent Transportation Systems Institute, Center for Transportation Studies, University of Minnesota, September 2008.

Victor Krause. 2008. Laminate Performance Evaluation. Natural Resources Research Institute Technical Report NRRI/TR-2008/21.

Victor Krause. 2008. Laminate Performance Evaluation BioSurf. Natural Resources Research Institute Technical Report NRRI/TR-2008/22.

Victor Krause. 2008. Evaluation of Thermoformed Cabinet Door Failures. Natural Resources Research Institute Technical Report NRRI/TR-2008/28.

S. Liang, **X. Wang**, J. Wiedenbeck, Z. Cai, and F. Fu. 2008. Evaluation of Acoustic Tomography for Tree Decay Detection. *In: Proceedings, 15th International Symposium on Nondestructive Testing of Wood*, September 10-12, 2007, Duluth, MN. pp. 49-54. Oct. 2008.

J.P. Wacker, **X. Wang**, R.J. Ross, and **B.K. Brashaw**. 2008. Condition Assessment of Historic Wood Vessels. *In: Proceedings, 15th International Symposium on Nondestructive Testing of Wood*, September 10-12, 2007, Duluth, MN. pp. 223-226. Oct. 2008.

X. Wang and R.J. Ross. 2008. Acoustic Evaluation of Alaskan Young-Growth Wood. *In: Proceedings, 15th International Symposium on Nondestructive Testing of Wood*, September 10-12, 2007, Duluth, MN. pp. 97-105. Oct. 2008.

Outreach

Cirrus Design, Duluth, Minnesota: The Wood Materials and Manufacturing Program staff conducted resin flow testing and assessment of properties as part of the Cirrus Material Assessment Program.

Contech Stormwater Solutions, Portland, Oregon: The Wood Materials and Manufacturing Program leased processing equipment to Contech Stormwater Solutions to allow them to crumble compost pellets for stormwater filtration products.

DIC Imaging Products, Oak Creek, Wisconsin: The Wood Materials and Manufacturing Program staff determined the testing protocol for UV finishes for wood and PVC.

Epicurean Cutting Surfaces, Duluth, Minnesota: The Wood Materials and Manufacturing Program staff evaluated products for accelerated aging and resistance to cutting.

Ferche Millwork, Rice, Minnesota: The Wood Materials and Manufacturing Program staff evaluated finishing and adhesive failures for Ferche Millwork.

Goodwill Industries, Duluth, Minnesota: The Wood Materials and Manufacturing Program staff provided engineering and material processing services as part of their mattress recycling program.

HB Fuller Corporation, White Bear Lake, Minnesota: The Wood Materials and Manufacturing Program staff conducted resin testing of new formations for particleboard and medium density fiberboard.

Horizon CNC, Travelers Rest, South Carolina: The Wood Materials and Manufacturing Program staff evaluated cabinet doors for adhesive failures.

Marvin Windows, Warroad, Minnesota: The Wood Materials and Manufacturing Program staff evaluated material stability and accelerated aging.

Mat, Inc., Floodwood, Minnesota: The Wood Materials and Manufacturing Program staff provided assistance with the use of cotton fiber in their air laid processing production line in support of new product development.

Museum of Lake Minnetonka, Excelsior, Minnesota: The Wood Materials and Manufacturing Program staff conducted an inspection of the Steamboat Minnehaha as part of the winter dry dock maintenance activities.

Northern Contours, Fergus Falls, Minnesota: The Wood Materials and Manufacturing Program staff conducted testing of various product families for Northern Contours in support of their manufacturing, research, and marketing departments.

Owens Flooring Company, Shawano, Wisconsin: The Wood Materials and Manufacturing Program staff performed an assessment of dimensional stability of engineered flooring products.

Rockland Industrial Flooring, Red Wing, Minnesota: The Wood Materials and Manufacturing Program staff performed testing of laminated truck flooring for strength and adhesive bond.

Facilities

The greenhouse and growth chamber at NRRI are being prepared for the 2009 poplar breeding activities. Female branches are being conditioned in the controlled climate facility to enhance rooting prior to being placed in the greenhouse. Breeding activities will begin in March in the greenhouse and continue through July.

Center for Water and the Environment

Development of a Risk Assessment Plan for Acadia National Park

Objective

To assist in the design of a cost-effective monitoring plan, we propose to develop a mechanism to identify wetlands most vulnerable to anthropogenic threats. Landscape-scale indicators developed within a geographic information system combined with knowledge of how landscape pattern influences ecosystem condition, will be used to evaluate potential risk to, or vulnerability of, ecological resources at different spatial scales.

Background

To assist managers in the implementation of a wetland monitoring plan, a suite of indicators have been developed to assess their condition and quantify future trends. Implementation of a monitoring system, however, is an expensive and resource-intensive endeavor. This risk assessment can then be used to stratify a wetland monitoring program, so that wetlands most at risk are carefully monitored.

Previous Activity

Initial summaries of anthropogenic stressors have been summarized by watershed and related to the wetlands within each watershed. Other indicators are currently in development. The park was visited in the fall of 2005 to assess wetlands and meet with National Park Service staff, resulting in a better understanding of wetland risks and park service needs for implementing a monitoring protocol for those wetlands.

Data from existing United States Geological Survey and National Park Service wetland study sites was compiled. Specific watersheds for each site were delineated and landscape metrics were summarized. United States Geological Survey personnel used these data to compare these landscape metrics with existing water quality data. These results will further guide the development of indicators and the monitoring protocol. Also, aerial photos (1997 CIR) owned by Acadia National Park were scanned and are currently being georeferenced. This will provide for better delineation of wetland study sites and landscape characterizations.

Current Activity

To assist in the design of a cost-effective monitoring plan, we developed a mechanism to identify wetlands most vulnerable to anthropogenic threats. Landscape-scale indicators developed within a geographic information system, combined with knowledge of how landscape pattern influences ecosystem condition, were used to evaluate potential risk to or vulnerability of ecological resources at different spatial scales.

Principal Investigator(s)

Jennifer Olker
Lucinda Johnson
Thomas Hollenhorst

Project Sponsor(s)

USDI Geological Survey

Amount	Account
65,000	1648-189-6274-00
Total	\$65,000

Active

08/01/2004 07/30/2008

Start Date: 08/01/2004

End Date: 07/30/2008

Project ID: 1372

Development of Sampling Framework/Key Protocols for Monitoring Natural Resources in the Great Lakes Network

Objective

Coordinate development of field sampling protocols among five investigative groups.

Background

The National Park Service Great Lakes Inventory and Monitoring Network has developed a prioritized list of 46 indicators, termed Vital Signs, for monitoring long-term ecosystem health for nine National Park Service units in the Great Lakes region. Great Lakes Inventory and Monitoring Network must submit a draft final monitoring plan, the phase three report, to their national inventory and monitoring office by December 15, 2005. This draft plan must describe how Great Lakes Inventory and Monitoring Network intends to monitor Vital Signs across all nine parks. The plan must also include an overall sampling framework, protocols for high priority Vital Signs, brief summaries for lower priority Vital Signs, and a data management plan. This phase three report will be peer reviewed and approved by the National Park Service national inventory and monitoring team before the network can proceed with monitoring.

This project coordinates the development of protocols for several suites of Vital Signs.

Previous Activity

The phase three document was submitted to the national review team in December 2005, and was well-received. National Park Service cooperators are revising the document based on review comments.

An extension was granted to the project to develop a manuscript on National Park Service sampling designs for the peer-reviewed literature.

Current Activity

We have completed a first draft of a manuscript that details the statistical design behind sampling across multiple biological and physical variables (amphibians, toxicants, lake water quality, large river water quality, and several others. This draft is now under internal review.

A project website was created and can be found at www.nrri.umn.edu/npsprotocol.

Principal Investigator(s)

George Host
Richard Axler

Project Sponsor(s)	Amount	Account	Active
USDI National Park Service	25,850	1648-189-6272-00	07/01/2004 12/30/2008
USDI National Park Service	66,849	1648-189-6271-00	07/01/2004 12/30/2008
USDI National Park Service	75,346	1648-189-6270-00	07/01/2004 12/30/2008
Total	\$168,045		

Start Date: 07/01/2004 **End Date:** 12/30/2008 **Project ID:** 1345

Distribution of Canada Lynx in the Upper Midwestern United States

Objective

The objective of this project is to understand the factors affecting the apparent reappearance, current distribution, and long-term persistence of the Canada lynx in Minnesota. This requires a much greater understanding of the biology and ecology of lynx in this geographic region than we currently have. Methods used will include telemetry, snow-tracking, documentation of habitat use, and geographic information system analysis of locations.

Background

This project will increase understanding of Canada lynx (*Lynx canadensis*) in Minnesota, ranging from demographic information to habitat use data that can be used to make management recommendations for Canada lynx, a species which is listed as threatened under the Endangered Species Act. The only previous study on Canada lynx in the region was conducted by L. David Mech in the 1970s.

Previous Activity

To date 19 Canada lynx have been captured and fitted with either VHF or GPS collars since March 2003. About 700 VHF locations and almost 3000 GPS collar locations have been obtained from collared animals. Two collared animals have died, one was trapped in Ontario, cause of death of the second animal is unknown. Three den sites were found in June 2004. Kittens were raised by the female through at least December 2004. Kitten survival will be monitored through the winter. The trapping program continues, with attempts to recapture previously collared animals and deploy collars on uncollared animals.

Current Activity

Thirty Canada lynx have now been live-trapped and radiocollared on the project. Almost 10,000 global positioning system locations of lynx have been collected with GPS radiocollars. Other lynx are wearing standard VHF telemetry collars. Several mortalities have been documented over the past year. The project website at www.nrri.umn.edu/lynx provides full details and a current update.

Principal Investigator(s)

Gerald Niemi
Ronald Moen

Project Sponsor(s)	Amount	Account	Active
USDA Forest Srvs/Superior National Fores	30,000	1636-189-6186-00	09/03/1999 10/13/2000
USDA/Forest Service	117,000	1636-189-6202-00	08/29/2000 09/30/2005
USDI- US Geological Survey	56,242	1727-189-6251-00	06/09/2003 12/31/2006
USDA Geological Survey	285,482	1648-189-6255-00	04/21/2003 12/31/2006
MN DNR	180,165	1662-189-6287-00	06/01/2005 04/30/2008
USDA Forest Service	121,210	1636-189-6252-00	07/16/2003 07/16/2008
NCASI National Council for Air & Stream	40,000	1665-189-6288-00	04/01/2005 03/31/2009
Total	\$830,098		

Start Date: 09/03/1999 **End Date:** 07/16/2008 **Project ID:** 740

LTREB: Spatial Dynamics of the Moose-Forest-Soil Ecosystem on Isle Royale

Objective

To determine the spatial patterns of moose foraging and associated ecosystem properties through population cycles.

Background

In previous grant awards from National Science Foundation on this long-term project, we have determined that the spatial patterns of ecosystem properties, such as soil fertility and the distribution of tree species, were accentuated during the latest moose population cycle on Isle Royale. There is, therefore, a connection (albeit poorly understood) between animal population cycles and the spatial patterns of ecosystem properties across the landscape. In this project, we will monitor moose browsing intensity and associated ecosystem properties on three grids of 1000 points apiece in different sectors of Isle Royale to determine the dynamics of spatial patterns of ecosystem properties during moose population cycles.

Previous Activity

Geostatistical analyses of spatial patterns of soil nitrogen, conifer abundance, browse availability, and browse consumption by moose show that these are arranged in patches across the landscape of about 100-300m in diameter and that the patches repeat themselves every 300-500 meters. A reaction-diffusion model is proposed to account for these higher order patterns. This is the first demonstration in the scientific literature that herbivores determine the spatial patterns not only of their food supply but also of the ecosystem properties that support them. A paper on these results and discussing the implications for foresters and wildlife managers has been published in *Ecological Applications* 8: 411-424 (1998).

Current Activity

Angela Hodgson is completing her PhD in Ecology, Evolution and Behavioral Biology at the University of Minnesota Twin Cities with her work at Isle Royale. She has looked at spatial patterning at a finer scale while continuing to collect data from the original grids. It appears that with a relatively stable moose population the past few years the pattern of moose use and ecosystem variables are becoming more uniform across the landscape. Nathan deJager, PhD candidate from the same department, is continuing to collect soil nitrogen availability, available browse, and moose consumption data from the original grids.

Principal Investigator(s)

John Pastor
Yosef Cohen

Project Sponsor(s)

National Science Foundation
National Science Foundation

Amount	Account
299,997	1638-189-6167-00
299,997	1638-189-6268-00
Total	\$599,994

Active
07/15/1998 09/30/2004
08/15/2004 07/31/2009

Start Date: 09/01/1993

End Date: 07/31/2009

Project ID: 370

Monitoring Birds in Great Lakes National Forests

Objective

To develop strategies to monitor the abundance of forest bird populations.

Background

Forest bird populations are a key biological indicator of the health and stability of forest ecosystems. Recent evidence suggests that some North American species are declining in abundance, in particular, Neotropical migrants or species that breed in North America and winter in Central or South America. With the increased interest and awareness of the status of Neotropical migrant birds in the United States, several organizations have developed strategies to monitor abundance of these species. We have established monitoring programs in three Great Lakes national forests: Chippewa (1993), Superior (1991), and Chequamegon (1992). Long-term monitoring will give us information on species abundance patterns over time and data will be used to identify species that are significantly increasing or decreasing in abundance.

Previous Activity

The summer of 2005 marked the 15th year of sampling for the forest bird monitoring project. Sixty-nine species were tested for trends. Twenty species increased in at least one national forest, including four (Red-eyed Vireo, Black-capped Chickadee, Cedar Waxwing, and American Redstart) that increased in multiple national forests. Twenty-three species decreased in at least one national forest, including nine (Eastern Wood-Pewee, Great Crested Flycatcher, Winter Wren, Veery, Hermit Thrush, Black-throated Green Warbler, Ovenbird, Scarlet Tanager, and White-throated Sparrow) that decreased in multiple national forests. Short-distance migrants showed highly significant declines in each national forest. Ground nesting birds showed highly significant declines in all study areas, while shrub/sub-canopy nesters increased in all study areas. The lowland coniferous, deciduous and early-successional forest bird guilds showed widespread declines on our study areas.

Current Activity

A field crew of four people conducted 10-minute point counts on 1,257 points on the Superior, Chippewa, and Chequamegon National Forests during June-July of 2006, for the 16th year of sampling. Field data are still being error-checked and trend analyses will be conducted in the fall of 2006. Results of the forest bird monitoring program were presented to the Chippewa National Forest Leadership Team in early April, the annual meeting of national forest biologists and Natural Resources Research Institute personnel in mid-April, and the 1st annual Boreal Hardwood Transition Zone Forest Bird Diversity Workshop in mid-July.

Principal Investigator(s)

Gerald Niemi
Nicholas Danz

Project Sponsor(s)	Amount	Account	Active
US Dept of Agriculture	198,710	1635-186-6037-00	05/01/1991 12/31/1995
USDA/Nicolet National Forest	30,000	1637-189-6129-00	01/01/1996 12/31/1996
USDA/Nicolet National Forest	49,000	1637-189-6146-00	05/01/1997 04/30/1998
Chequamegon/National Forest	49,000	1637-189-6171-00	05/01/1998 10/31/1999
USDA/Chequamegon/Nicolet National Forest	98,000	1637-189-6187-00	05/01/1999 04/30/2001
USDA/Forest Service	290,554	1637-189-6219-00	05/01/2001 12/31/2005
USDA Forest Service	61,148	1637-189-6294-00	05/19/2006 12/31/2006
USDA Forest Service	66,156	1637-189-6327-00	04/15/2008 12/31/2008
Total	\$842,569		

Start Date: 05/01/1999 **End Date:** 12/31/2010 **Project ID:** 420

North Shore Community Futures: Aquatic Resources and Growth Scenarios

Objective

Develop community growth (also known as `build-out`) scenarios for several locations along Lake Superior`s North Shore to demonstrate potential effects on natural resources based on existing zoning, a conservation design scenario, and a smart growth scenario. The three locations are; the Lester-Amity watershed, Lakewood Township, and the town of Two Harbors.

Background

A build-out scenario creates a map showing changes in land use patterns and development of infrastructure (chiefly roads) that would result from a particular land use plan or set of zoning regulations. Such scenarios are used to help communities visualize the results and potential impact of their land use decisions for some time period in the future. Thus, these scenarios represent possible "futures" for communities and can help them make decisions based on their priorities. These scenarios can also help communities estimate potential impacts of various zoning regulations or growth types to significant environmental and community resources. The goal of this project is to demonstrate how local units of government can better protect north shore aquatic resources by applying a land use planning tool that promotes natural resource protection while still allowing the full amount of community growth that would have been expected.

Previous Activity

We have compiled the current zoning ordinances for the four townships, city of Duluth, and town of Two Harbors, and these have been coded into the Community Viz software. Creating the futures scenarios requires accurate projections of growth in each community for the next 50 years. We have refined population projections using census information from all project areas.

Finally, we presented a summary of our project's goals and objectives to the NRRI Advisory Board, the Northeast Landscape Association, and at the Watershed Festival, highlighting how the information generated by this project can be used in future planning efforts by north shore communities.

Current Activity

We have determined the guiding principles and growth amounts for the Conservation Design and Smart Growth scenarios and have chosen example locations within each community to show what each scenario type would look like "on the ground".

We have developed our list of indicators to use to compare the scenarios and determined the types of data and calculations needed for each indicator. The data will be generated either by Community Viz or by ArcGIS.

The Lakewood Township comprehensive planning group continues to be interested in our project and keeps in touch. We gave a presentation on our approach and progress at the May 1 State of the Coast conference, with many local planning groups in attendance.

Principal Investigator(s)

Valerie Brady

Project Sponsor(s)

	Amount	Account	Active
MN's Lake Superior Coastal Program	58,043	1662-189-6306-00	09/28/2006 12/31/2008
Total	\$58,043		

Start Date: 09/28/2006 **End Date:** 12/31/2008 **Project ID:** 1456

Vegetation Characterization and Conifer Regeneration Strategies for the Grand Portage National Monument

Objective

Identify sites on the Grand Portage National Monument where white pine is most likely to succeed, work with park staff to develop and implement regeneration strategies

Background

The major natural resource management goal of the Grand Portage National Monument is to restore the trail corridor to conditions that existed during the fur trade era, or approximately 200 years ago. At this time, white pine (*Pinus strobus*) was a major species in the landscape, growing in concert with red pine or as supercanopy trees in mixed forest conditions. Due to turn of the century logging, the advent of white pine blister rust, and the reduction in the occurrence of natural wildfires, the numbers of white pine are now considerably reduced in the landscape.

This project will identify areas where restoration and enhancement actions are the most likely to succeed. These areas will then receive site specific recommendations for conifer restoration.

Previous Activity

Current Activity

We conducted an analysis of 20 vegetation plots placed along the Grand Portage National Monument by the National Park Service Great Lakes Network in 2006. Three major vegetation types were identified, two of which seem well suited to white pine. We also used digital elevation data to create a Topographic Moisture Index (TMI) for the trail - TMIs relate well to potential species composition and site productivity.

Finally, we visited the Grand Portage trail with NPS cooperators to discuss potential sites and methods for restoring white pine. Collecting seeds from local sources and using field crews to scarify small plots are among the options being considered for white pine restoration.

Principal Investigator(s)

George Host

Project Sponsor(s)

USDI National Park SRVC

Amount Account

35,646 1648-189-6321-00

Active

06/01/2007 09/30/2009

Total

\$35,646

Start Date: 06/01/2007

End Date: 09/30/2009

Project ID: 1480

Assessing the Condition of Great Rivers using Benthic and Planktonic Algal Indicators

Objective

The United States Environmental Protection Agency Environmental Monitoring and Assessment Program has embarked on a comprehensive survey of Great Rivers in order to provide tools the states need to better manage and protect these important national resources. This survey will assess the health status of the Missouri, Mississippi, and Ohio Rivers using indicators of water quality, sediments, algae, plants, insects, and fish. The Natural Resources Research Institute's task in this project is to develop indicator tools from the algae, collected from hundreds of sites throughout the Great Rivers system. A variety of algal based tools will be developed for use by environmental managers and agencies.

Background

The Natural Resource Research Institute is developing indicator tools from algae, collected from hundreds of sites throughout the Great Rivers system. These indicator approaches will support future monitoring and paleoecological programs, and be used to identify and verify reference locations in rivers.

Previous Activity

Current Activity

We have completed 3 years of the Great Rivers-algae project. Preparation and analyses for 2004 and 2005 samples are complete, and data analysis is ongoing.

A Microsoft Access-based database was developed for the algae data so that count, density, biovolume and other parameters for the algae can be rapidly calculated. This database contains all of the algae shape formulae for calculating biovolumes, so that biovolume/biomass calculations can be automated for the full-algae counts.

Current developments include:

1. Development of new rapid-assessment indicators using river algae, and comparing these indicators to approximately 20 indicators currently in use worldwide.
2. Development of a weighted-averaging model to infer environmental quality using periphytic and phytoplanktonic algae from the Great Rivers.
3. Determination of the appropriate data structure for Great Rivers algae indicators. For instance, should we be using relative abundance of species? Biovolumes? Relative biovolumes? Density? Other considerations include comparison of species- and genus-based indicators.

Principal Investigator(s)

Euan Reavie

Project Sponsor(s)

Environmental Protection Agency

Amount	Account
535,199	1628-189-6289-00
Total	\$535,199

Active
10/01/2005 09/30/2010

Start Date: 10/01/2005 **End Date:** 09/30/2010 **Project ID:** 1397

Great Lakes Biological Monitoring: Phytoplankton

Objective

The primary objectives of the Great Lakes phytoplankton program are to: 1) collect phytoplankton from the Great Lakes; 2) identify and enumerate phytoplankton, maintaining quality assurance standards; 3) maintain a database of phytoplankton data; 4) interpret phytoplankton data, including evaluation of long-term trends in phytoplankton and food web dynamics; 5) dissemination of data and interpretations through reports, presentations, peer-reviewed journals and on the internet.

Background

Phytoplankton are known to respond to stressors such as nutrient loading and invasive species. We will take a comprehensive approach to GLNPO's Biological Monitoring program for the Great Lakes using proven sampling and evaluation techniques. New and long-term phytoplankton data will be used to track shifts in the offshore biological community related to natural and anthropogenic influences. Integration with other program components (e.g., zooplankton) will allow the evaluation of interactions among trophic levels and provide a more holistic interpretation of causal factors in biological changes.

The research will characterize and evaluate phytoplankton communities throughout the Great Lakes. Analyses of these data in concord with long-term sampling data, and other project data (e.g., zooplankton, water quality) will provide interpretations of stressor influences on lake biology. A database of detailed, quality-assured phytoplankton data will be provided for contemporary and future evaluations of Great Lakes condition.

Previous Activity

Over phytoplankton samples were collected from the Great Lakes in 2007 and 2008. These samples are being analyzed for their phytoplankton assemblages. Significant workshop activity has occurred in efforts to refine the phytoplankton database, including revising and updating taxonomic information and ensuring continuity of long-term data.

Current Activity

All spring and summer 2007 samples have been analyzed, and analyses for summer 2007 samples are ongoing. Significant efforts have been undertaken to create photographic plates and refine diatom taxonomy using virtual communications among team members and iterative revisions to these plates.

The algae database underwent much revision to accommodate older (1990s) data and to resolve issues with biovolume calculations. Two workshops and a QA/counting session were held.

Sample assessments show that, with the exception of Lake Erie, algal biovolume in the lakes is much lower than that in the 1990s. Dramatic changes in the lake food webs are being examined.

Principal Investigator(s)

Euan Reavie

Project Sponsor(s)

	Amount	Account	Active
Environmental Protection Agency (EPA)	590,295	1628-189-6315-00	03/01/2007 02/28/2010
Total	\$590,295		

Start Date: 03/01/2007 **End Date:** 02/28/2012 **Project ID:** 1487

Historical and Projected Water Quality Trends in Itasca County Lakes - Past and Future

Objective

Diatom paleolimnology is a widely used tool applied to lake management and especially to shoreland development issues, and it operates on a time-scale of interest to managers, covering changes over the period of many decades. Itasca County is continuing with a detailed paleolimnological study on four Itasca County lakes. With the technical expertise of the Natural Resources Research Institute/Center for Water and the Environment's Ely Field Station, sediment cores have been collected. The fossil materials in these cores will allow us to reconstruct water quality in the lakes dating back to presettlement times and potentially predict their future water quality. This project will provide one of the first applications for the newly developed model for inferring water quality variables for lakes in the Northern Lakes and Forests Ecoregion, and the relationships we discover will build on existing diatom calibration data for this region to significantly improve the paleolimnological tools available for lake management throughout Northeastern Minnesota.

Background

Diatom paleolimnology is a widely used tool applied to lake management and especially to shoreland development issues, and it operates on a time-scale of interest to managers, covering changes over the period of many decades. Itasca County is continuing with a detailed paleolimnological study on four Itasca County lakes. With the technical expertise of the Natural Resource Research Institute/Center for Water and the Environment Ely Field Station, sediment cores have been collected. The fossil materials in these cores will allow us to reconstruct water quality in the lakes dating back to presettlement times and potentially predict their future water quality. This project will provide one of the first applications for the newly developed model for inferring water quality variables for lakes in the Northern Lakes and Forests Ecoregion, and the relationships we discover will build on existing diatom calibration data for this region to significantly improve the paleolimnological tools available for lake management throughout Northeastern Minnesota.

Previous Activity

Current Activity

Cores from four lakes were collected in summer 2006. The cores have been sectioned, photographed, and analyzed for magnetics and loss-on-ignition. A number of sediment samples have been prepared for diatom counts, and about 20 counts have been completed so far. We are in the process of drying sediments which will be sent to the St. Croix Watershed Research Station for Pb-210 analysis.

Principal Investigator(s)

Euan Reavie

Project Sponsor(s)

	Amount	Account	Active
Itasca County Soil & Water Cons District	38,735	1676-189-6304-00	07/01/2006 09/30/2008
Total	\$38,735		

Start Date: 07/01/2006 **End Date:** 09/30/2008 **Project ID:** 1451

Impacts on Minnesota's Aquatic Resources from Climate Change

Objective

Background

Over the past 150 years Minnesota's climate has become increasingly warmer, wetter, and variable, resulting in unquantified economic and ecological impacts. More recent changes in precipitation patterns combined with urban expansion and wetland losses have resulted in an increase in the frequency and intensity of flooding in parts of Minnesota with extensive and costly damage to the State's infrastructure and ecosystems. We will examine historic climate records and develop a database on key climatic measures and their variability. To assess the ecological consequences of those climate trends on aquatic resources we will analyze hydrologic (e.g., streamflow, lake levels, water quantity and quality) and ecological response data (e.g., fish species distributions, waterbird nest initiation, amphibian breeding, aquatic vegetation distribution). We will identify and test potential hydrologic and aquatic indicators and develop cost-effective monitoring methods that can be implemented in Minnesota.

Previous Activity

To date we have assembled a comprehensive database of Minnesota lakes, and have populated this database with information pertaining to water chemistry, fisheries surveys, aquatic vegetation, and ice-out dates. Most recently, fish spawning data and a greater set of ice-out data was added. With this comprehensive data of Minnesota lakes we are able to select lakes that are appropriate for further analyses based on the years and number of types of data available. Years that represent the four climate scenarios (cold/wet, cold/dry, warm/wet, warm/dry) have been identified. Accumulated lakesheds are in hand and will be used to summarize land use for three time periods (1970s, 1991-1992, and 2001).

Current Activity

Analyses are underway for each component of the project. Lake water quality data from lakes with long-term records have been compiled and analyzed for trends over time. A website was developed for making the data available to project scientists. The timing of walleye spawning runs have been analyzed as a potential indicator of climate change and were found to be strongly related to ice-out date. Daily lake evaporation rates were estimated from six Class A weather stations; these data were used to investigate correlations among lake levels of 25 lakes and annual evaporation and annual water availability. The climate data access and analysis tool has continued to be enhanced and climate episodes in the historical record have been identified. We continue to acquire ice-out records and are building a complete ice-out dataset with the capability of detect potential errors and observation biases. Land use data from three time steps have been summarized for 3929 lakes and are available to include as covariates in analyses.

Principal Investigator(s)

Jennifer Olker
Lucinda Johnson

Project Sponsor(s)

MN Legislative Commission on MN Rsrc
Total

Amount	Account
78,808	1527-189-6301-00
\$78,808	

Active
06/27/2006 06/30/2009

Start Date: 06/27/2006

End Date: 06/30/2009

Project ID: 1488

Minnesota's Water Resources: Impacts of Climate Change - Phase II

Objective

Background

Minnesota's climate has become increasingly warmer, wetter, and variable, resulting in unquantified economic and ecological impacts. More recent changes in precipitation patterns combined with urban expansion and wetland losses have resulted in an increase in the frequency and intensity of flooding in parts of Minnesota with extensive and costly damage to the State's infrastructure and ecosystems. We are examining historic climate records and developing a database of key climatic measures and their variability in a current LCCMR project "Impacts on Minnesota's aquatic resources from climate change". To assess the consequences of past climate trends on aquatic resources we are analyzing hydrologic, water quality, and fish community responses. We propose to expand that study to develop prediction for future climate specific to Minnesota, and then quantify the potential economic impact of climate-induced changes in precipitation and hydrology on the water resource infrastructure, including storm sewers, bridges, water treatment facilities, and shoreline development. The current biological analyses will be expanded beyond fish to invertebrates (e.g., mosquitos) and projections of future biotic responses from hydrologic and water quality models will be developed. Lastly, to assist the state's natural resource managers and regulators, we will identify potential hydrologic and aquatic indicators and propose monitoring methods that can be implemented in Minnesota.

Previous Activity

Substantial progress has been made in the refinement of the climate retrieval tool, which has allowed for the identification of past climate episodes. These data are currently being used to develop down-scaled predictions of Minnesota's climate into the coming century. The tool is available to project scientists and cooperators.

Current Activity

We are in the process of completing compilation of the historic responses to climate, and also identifying subsets of lakes and covariates for these biological response projections. In addition to the down-scaled climate predictions for Minnesota, we have acquired projected 2020 land use data for the seven county metropolitan area.

We have begun to identify data-sets and analytical methods to identify biotic indicators of climate change. We have identified a set of more than 90 data-dense lakes which we will use as our test set to develop indicators. These lakes have the greatest breadth (time-series) and depth (across data types) of records in our accumulated database. A larger subset (up to 500 lakes) will be used for validation, and then projections can be applied state-wide (greater than 4000 lakes).

Principal Investigator(s)

Lucinda Johnson

Project Sponsor(s)

LCCMR

Amount Account

172,860 1527-189-6320-00

Total \$172,860

Active

07/01/2007 06/30/2010

Start Date: 07/01/2007

End Date: 06/30/2010

Project ID: 1518

Prioritized Monitoring for Lake Superior Basin; Agency Education Initiative

Objective

To quantify the gradient of environmental stressors within the US and Canadian sides of Lake Superior basin at a fine spatial resolution.

Background

To quantify the gradient of environmental stressors within the US and Canadian sides of Lake Superior basin at a fine spatial resolution. Projects uses ArcHydro to identify fine-scale catchments, and subsequently summarize land use, point source, and other environmental stressors for each catchment.

Previous Activity

Current Activity

We are just completing the ArcHydro classification, which produced over 75,000 catchments for the basin. We also developed a prototype visualization model to allow comparisons of relative health among watersheds.

Principal Investigator(s)

George Host

Project Sponsor(s)

	Amount	Account	Active
EPA	75,818	1628-189-9022-00	10/01/2007 03/01/2009
Total	\$75,818		

Start Date: 10/01/2007 **End Date:** 03/01/2009 **Project ID:** 1486

Restoring Impaired Lake Superior Tributaries: Stormwater BMP Evaluation Education and Outreach

Objective

Urban Duluth streams are generally similar to the less developed watersheds of the North Shore with >70% forested, similar geology and hydrology, and in the case of Amity in particular, the potential for increased development pressure. Therefore, Duluth's streams can serve as suitable pilot-watersheds for evaluating restoration, mitigation and planning strategies for potential use in other more pristine, but developing, North Shore streams. Our primary goal is to coordinate with local agency remediation/BMP projects and the existing Chester, Kingsbury, Tischer, Amity and Poplar Creek/River automated water quality monitoring and public education effort carried out by the LakeSuperiorStreams.org (LSS) project to demonstrate their effectiveness at reducing stormwater runoff problems as indicated by upstream-downstream and before-after water quality and biological monitoring. Project began Oct 1, 2007 after EPA approval although funding to grantee began in March 2008.

Background

Urban Duluth streams are generally similar to the less developed watersheds of the North Shore with >70% forested, similar geology and hydrology, and in the case of Amity in particular, the potential for increased development pressure. Therefore, Duluth's streams can serve as pilot-watersheds for evaluating restoration, mitigation and planning strategies for use in protecting more pristine, but developing, North Shore streams. Our goal is to coordinate with local agency remediation/BMP projects and the existing LakeSuperiorStreams.org (LSS) on-line monitoring and public education effort to demonstrate their effectiveness at reducing stormwater runoff problems as indicated by upstream-downstream and before-after water quality and biological monitoring.

Previous Activity

Three potential projects were identified in 2007 with a high likelihood for long-term success and a high potential for educational potential and public visibility: 1) Graves Road Cr. Restoration- lower Amity Cr. – just upstream from the LSS automated water quality sensors. This small tributary has discharged a muddy plume during rainstorms and snowmelt runoff for decades since Graves Rd was destroyed and abandoned after a flood in the late 1930s. We have worked with the City of Duluth to develop a project including new culverts, flow rerouting, bank slope reductions, and sediment stabilization. Survey and design elements were outlined by city engineers, with construction and implementation targeted for Summer 2009. This ~400 ft project will replace and extend old concrete culverts on the steepest, critical clay banks sections; to prevent further headcutting; use a combination of facines, wattling and other bio-engineered methods to stabilize the clay sloughing on the other creek sections, and engineered rip rap to prevent further scour; address side channel headcutting and erosion on a side creek just above present culvert location. The engineering design is in progress (10/08) via funding from the Weber Stream Restoration Initiative (WSRI: www.lakesuperiorstreams.org/weber) and an extensive baseline data set of upstream-downstream water quality, habitat and invertebrates has been developed; 2) We are sampling upstream and downstream of a sediment trap installed in Miller Cr. in 2004 behind Miller Hill Mall to evaluate its performance. Sediment depth has also been determined throughout the trap and it will be re-surveyed if we can locate original engineering drawings; 3) Upper Amity Cr bank stabilization - Engineering designs are being developed by Partner S.St Louis Cnty SWCD to stabilize two eroding bluffs with anticipated implementation in Summer 2009 with funding again from WSRI. NRRI has sampled for water quality, and benthic invertebrates below the funding to generate a year of intensive baseline water quality, suspended sediment levels and turbidity, and biological monitoring data to assess project results and cost-effectiveness.

Principal Investigator(s)

Dan Breneman
Richard Axler

Project Sponsor(s)	Amount	Account	Active
MN Pollution Control Agency	103,553	1662-189-9023-00	02/01/2007 06/30/2011
Total	\$103,553		

Start Date: 02/01/2007 **End Date:** 06/30/2011 **Project ID:** 1511

Volunteer-Assisted Water Quality/Bio Monitor North Shore Superior Streams

Objective

Collect intensive water quality, stream invertebrate(bug), and habitat data to help the MN Pollution Control Agency assess the condition of >20 Superior Basin trout streams.

Background

The overall project goal is to develop complementary (same year) physical, biological and chemical data sets for a range of agency-prioritized streams to process and/or incorporate historical, but modern, biological data into the overall State database. Major objectives are: (1) Historical WQ & “Bugs” – Invertebrate (bug) data from ~ 30 NS stream sites sampled from the late 1990’s through 2007 (NRRI, EPA, UMD) will be screened, further analyzed where necessary, and entered into STORET/EDA. These efforts also included substantial water quality, flow, and habitat data, and sampling of other biota (fish, diatoms). Some data was recently used for the Knife River TMDL, but additional processing is needed for it to become truly useful. WQ data is also available from the same studies using certified methods/labs and from the LakeSuperiorStreams project (3-4 urban streams at >20/yr), that would also be entered into STORET; (2) Sample 12 Superior Basin streams intensively for flow, TSS, turbidity, nutrients and other parameters and establish CSMP sites for 12 sites in 8 priority streams; (3) sample benthic invertebrates at 13 Superior Basin stream sites coordinated with 2008/2009 WQ sampling for NS and SLR tributaries (Obj 2) or performed independently by MPCA (Superior Loading and Milestone projects), the Flute Reed River Partnership, or the St Louis River CAC. This proposal is based on discussions with MPCA/MDNR staff regarding priority Basin watersheds and the need for concurrent physical, chemical, biological, and geomorphic stream data over a gradient of stressor indicators.

Previous Activity

A quality Assurance Project Plan (QAPP) was developed and can be loaded or viewed on the LakeSuperiorStreams.org website. Spring sampling for water quality parameters began during snowmelt runoff in Apr 2008 and continues through Sep 2008 with sampling about evenly distributed between high flow and base flow periods with particular attention to sampling during and/or immediately following rainstorms. Samples are being analyzed for a suite of parameters related to suspended sediments, color, dissolved salts, nutrients, and indicator bacteria (E. coli) plus additional field sensor measurements. Habitat assessments and benthic invertebrate sampling was done for all streams in May-June and has been repeated later in summer and fall.

Principal Investigator(s)

Dan Breneman
Richard Axler
Valerie Brady

Project Sponsor(s)

MN Pollution Control Agency

Amount	Account
229,533	1663-189-6325-00
Total	\$229,533

Active
04/07/2008 06/30/2010

Start Date: 04/07/2008 **End Date:** 06/30/2010 **Project ID:** 1519

Wetland Classification and Inventory for Carlton and South St. Louis County

Objective

To map and classify wetlands for the Carlton and South St. Louis Counties.

Background

Accurate maps of the type and locations of wetlands are critical for land use planning, particularly for watersheds undergoing rapid development or facing increased development pressure. The important role wetlands play in maintaining habitat, water quality and surface and ground-water protection is well documented, but current information on the types, sizes, and locations of wetlands is difficult to obtain. As coastal environments come under increased pressure from development, this information is essential for zoning, buildout scenarios and numerous other planning objectives. Within the coastal program boundary, however, up-to-date information on wetland type and distribution is sparse, outdated, or lacking for many watersheds.

The project will consist of three specific tasks:

1) acquisition and georectification of Minnesota Department of Natural Resources aerial photographs of the selected watersheds; 2) classification of wetlands from these photographs according to classes of the National Wetland Inventory. This task includes development of metadata according to Federal Geographic Data Committee standards and field evaluation of selected wetland sites; and 3) delivery of data through electronic media and web-based sources

The key deliverables for this project are: 1) compressed versions of the scanned and rectified color-infrared photographs; 2) a National Wetland Inventory classification of wetlands within the targeted watersheds, delivered in standard geographic information system database format, included descriptions of the data and a report on data accuracy; and 3) electronic media and Internet-based copies of all data developed by this project

Previous Activity

We have systematically been mapping wetlands within high-growth areas of the Minnesota's Lake Superior Coastal Program. The intent of the current proposal is to use recent Minnesota Department of Natural Resources aerial photography and other spatial data to delineate and characterize wetlands for the southwestern portion of the area. These includes approximately three townships in Carlton County, and watershed extensions into St. Louis County. The end product of these efforts will be publicly-available digital maps of classified wetlands and with associated data tables.

Current Activity

We have assembled the supporting data layers for the study region, including the existing National Wetland Inventory, digital elevation models and topographic maps, road and hydrology networks, and others.

The Minnesota Department of Natural Resources is collecting new color infrared air photos in summer 2007, which will become available in fall. We have decided to defer classifying the older sets of photos in order to base the new wetland delineation on current photography. Wetland mapping will begin in fall 2007.

Principal Investigator(s)

George Host

Project Sponsor(s)

MN's Lake Superior Coastal Program

Amount	Account
27,003	1662-189-6303-00
Total	\$27,003

Active
09/28/2006 09/30/2008

Start Date: 09/28/2006

End Date: 09/30/2008

Project ID: 1448

Evaluation of Problems and Solutions Relating to Stormwater Runoff from Roadside Ditches

Objective

1. To compile a list of problems related to roadside ditches and stormwater runoff in the Arrowhead and suggest ways to resolve these problems;
2. To explore possibilities for one or more workshops that would help solve ditch stormwater runoff problems.

Background

Roadside ditches move stormwater runoff quickly off of roads, as they are designed to do. However, these ditches dump large amounts of stormwater very quickly into streams at every location where a road crosses a stream. This project will collect a list of stormwater problems associated with roadside ditches in the Arrowhead region and compile a list of recommendations to begin to solve these problems. The results of this project should lead to a future workshop on ditch solutions.

Previous Activity

Current Activity

Officials and interested parties from a number of agencies, including the Minnesota Department of Transportation (MNDOT), South Saint Louis Soil and Water Conservation District, City of Duluth Utilities, NRRI, Minnesota Sea Grant, and the Minnesota Lake Superior Coastal program met to begin compilation of ditch stormwater problems and solutions. The type of workshop(s) that should be held and whom should be invited were also explored.

Principal Investigator(s)

Valerie Brady

Project Sponsor(s)

	Amount	Account	Active
Minnesota`s Lake Superior Coastal Program	5,000	1662-189-9025-00	03/12/2008 08/31/2008
Total	\$5,000		

Start Date: 03/12/2008 **End Date:** 08/31/2008 **Project ID:** 1510

Center for Water and the Environment - Program Notes

Scientific Meetings/Presentations

Subhash Basak, co-chaired a joint meeting of the Eighth International Conference on Mathematical Chemistry and the Fifth Indo-U.S. Workshop on Mathematical Chemistry, held at UMD, June 22–27. Basak and collaborators gave the following presentations at the conference:

- 1) "Chemo-bioinformatics: An integration of molecular structure and 'omics' based approaches for predicting bioactivity," **Basak**.
- 2) "Numerical characterization molecular chirality," Ramanathan Natarajan (Lakehead University, Thunder Bay, Ontario).
- 3) "Recent directions in predictor selection" Jessica Kraker (University of Wisconsin-Eau Claire) coauthored with Douglas M. Hawkins (University of Minnesota, Twin Cities campus).
- 4) "Tailoring molecular similarity methods to optimize activity estimation," **Brian Gute** coauthored with **Basak** and Hawkins.
- 5) "Prediction of biological partition coefficients: Calculated molecular descriptors vs. experimentally determined properties" a poster presentation by **Denise Mills** coauthored with **Basak**, **Gute**, and Moiz M. Mumtaz (Agency for Toxic Substances and Disease Registry, Atlanta, Georgia).
- 6) "Numerical characterization studies of mutations among neuraminidase gene sequences of the H5N1 avian flu strains from 1997 to 2007," a poster presentation by **Gute** presented the poster coauthored with Ashesh Nandy (Jadavpur University, Kolkata, India), Ambanil Ghosh (Jadavpur University, Kolkata, India), and **Basak**.

Subhash Basak delivered an invited keynote lecture on "Pattern recognition of chemical and biological systems by information theoretic invariants" at the *Information Theory and Statistical Learning* workshop of WORLDCOMP '08 - World Congress in Computer Science, Computer Engineering, and Applied Computing, held in Las Vegas, Nevada, held July 13-17.

Cindy Hale conducted a seminar entitled "Developing Management Recommendations to Limit the Continued Spread of Invasive Earthworms in Working Forests" at the Cary Institute of Ecosystem Studies in Millbrook, New York, on December 4.

Amy Kireta gave a presentation on "Diatoms in America's Great Rivers: Periphyton Versus Phytoplankton Indicators," co-authored by herself, **E.D. Reavie** and G.V. Sgro (John Carroll University) at the International Diatom Symposium (IDS) in Dubrovnik, Croatia, held September 7-13.

Euan Reavie presented a seminar entitled "New Ballast Water Treatment Technologies: Killing Potentially Invasive Algae," at the Minnesota Invasive Species Conference in Duluth in October.

Cindy Hale participated in a media event and gave a presentation entitled "Management Recommendations to Limit the Continued Spread of Exotic Earthworms in Working Forests" at the 2008 Minnesota Invasive Species Conference, held in Duluth on October 27.

Cindy Hale participated in the Natural Resources "Ask a Specialist" session at the Wisconsin Citizen-Based Monitoring Conference, held on October 24 in Onalaska, Wisconsin. The session was followed by a hands-on earthworm sampling session.

Cindy Hale gave a presentation entitled "Ecological consequences of exotic earthworm invasions: Forest decline syndrome" at the Natural Areas Conference, in Nashville, Tennessee, held on October 17.

Gerald Niemi and Michael McDonald (U.S. EPA) were featured in ScienceWatch.com, Fast Moving Fronts, for their highly cited article "Application of ecological indicators" in the Annual Review of Ecological Evolution and Systematics, 2004 (35:89-111). The interview can be read at <http://sciencewatch.com/sciencewatch/dr/fmf/2008/08novfmf/08novfmfNiemiET/>

Publications

Amphibian research of **Lucinda Johnson** and **Patrick Schoff** was published in *Nature*, 455 (7217), pp.1235 – 1239, in the article “Agrochemicals increase trematode infections in a declining amphibian species.” The authors are: Jason Rohr (University of South Florida), Anna Schotthoefer (University of Illinois at Urbana-Champaign), Thomas Raffel (University of South Florida and Penn State), Hunter Carrick (Penn State), Neal Halstead (University of South Florida), Jason Hoverman (University of Tennessee), Catherine Johnson (formerly at NRRI), **Lucinda Johnson**, Camilla Lieske (University of Illinois at Urbana-Champaign), Marvin Piwoni (Illinois Waste Management and Research Center), **Patrick Schoff**, and Val Beasley (University of Illinois at Urbana-Champaign).

George Host and co-authors Harlan Stech, Kathryn Lenz, **Kyle Roskoski**, and Richard Mather (all four from UMD’s Dept. of Mathematics and Statistics) recently published “Forest patch modeling: using high performance computing to simulate aboveground interactions among individual trees” in *Functional Plant Biology*, volume 35, pp.976-987 (2008).

Basak, Mills, and Hawkins published the paper “Predicting allergen contact dermatitis: a hierarchical structure-activity relationship (SAR) approach to chemical classification using topological and quantum chemical descriptors,” in the *Journal of Computer Aided Molecular Design*, volume 22, pp.339-343 (2008).

N.P. McCann, **Ron Moen** and **Gerald Niemi** recently published “Using pellet counts to estimate snowshoe hare numbers in Minnesota,” in the *Journal of Wildlife Management*, volume 72(4), pp.955-958 (2008).

Patrick Schoff co-authored with J.R Rohr, A.M. Schotthoefer, T.R. Raffel, H.J. Carrick, N. Halstead, J.T. Hoverman, C.M. Johnson, **Lucinda Johnson**, C. Lieski, M.D. Piwoni, and V.R. Beasley, “Agrochemicals increase trematode infections in a declining amphibian species” in *Nature*, volume 455, pp.1235-1239.

Euan Reavie, Amy Kireta, J.C. Kingston, G.V. Sgro, N.P. Danz, **Richard Axler**, and T.P. Hollenhorst co-authored “Comparison of simple and multimetric diatom-based indices for Great Lakes coastline disturbance” in the *Journal of Phycology*, volume 44, pp.787-802 (2008).

R. Natarajan, **Subhash Basak, Denise Mills**, J.J. Kraker, and D.M. Hawkins co-authored, “Quantitative structure-activity relationship modeling of mosquito repellents using calculated descriptors” for the journal *Croatica Chemica Acta*, volume 81(2), pp.333-340 (2008).

Ron Moen, Gerald Niemi and C. Burdett co-authored “Movement and habitat use of Canada lynx during denning in Minnesota,” in the *Journal of Wildlife Management* (2008).

B.J. Mattsson and **Gerald Niemi** co-authored “Causes and consequences of distribution patterns in a migratory songbird across its geographic range” in the *Canadian Journal of Zoology* volume 86, pp.314-328 (2008).

Nick Danz, **Annie Bracie**, and **Gerald Niemi** published a report entitled, “Breeding bird monitoring in western Great Lakes national forests 1991-2007.” NRRI/TR-2008/11.

NRRI Business Development

Intellectual Property Development

The NRRI Business Group has been working closely with the Office of Technology Commercialization (OTC) as OTC continues to evolve and develop and/or adapt existing policies and procedures relating to intellectual property. NRRI's intellectual property portfolio is quite large with multiple inventors and stages of development for each disclosure that has been made. NRRI's primary concern is providing the OTC with direction regarding priority of potential technologies as related to NRRI's strategic initiatives with both public and private industry. Although different than the rest of the University, the OTC has welcomed the liaison role that has been developed at NRRI. NRRI and OTC work together to develop patenting and marketing strategies for each of the technologies in the NRRI portfolio.

From July through December of 2008, efforts have primarily been focused on the following technologies:

- Biodiesel Technology - This technology has a non provisional patent application and is awaiting a first office action. The PI is Pavel Krasutsky. The concept for this technology is that an ethanol plant can improve its economics by processing the Dry Distillers Grain and Solubles (DDGS) to extract additional oil and High Protein DDGS. Through this technology's process, the PI discovered additional byproducts that would improve the economics of the ethanol plant by even more. Additional experiments need to be conducted in addition to animal feeding studies to provide the data to support additional intellectual property disclosures. NRRI applied for a \$1 mm grant from the Institute on the Environment to support the additional research for the technology.
- Systemic Plant Conditioning Composition (SPCC) - This particular technology has a non provisional patent application filed and is awaiting office action. The technology addresses plant protection through a systemic level approach. Active ingredients are assimilated into tissue and dispersed through the plant. It may have applications for pesticides, herbicides, and fungicides for non-agricultural plants. The principle investigator is Tomas Levar, who has worked with collaborators from the private industry for several years. NRRI worked with OTC to go through a Request for Proposal process to identify a number of companies that may be interested in collaborating with NRRI to further validate the efficacy of the technology. The University executed Option License Agreements with two different companies, which basically reserves specific fields of uses for six (6) month blocks of time so the companies can evaluate efficacy as well as commercial application. The third company that expressed interest has some internal issues that are precluding it from finalizing an agreement.
- Road Patch - This technology had a provisional application which was converted to a non provisional patent application in November 2008. The primary principle investigator is Don Fosnacht, but there are several other inventors from NRRI that have contributed to the technology as well. NRRI continues to refine the formulation of the road patch to create the optimum composition for what is called a "cold patch". Research and demonstrations have resulted in a road patch that can be placed in potholes in below zero temperatures. The durability of the product makes it unnecessary to replace the patch when the spring thaw arrives. NRRI continues to work with OTC on negotiating a license with a Minnesota based company that has an established distributor chain throughout the United States. It is anticipated that an exclusive license agreement will be reached by first semester 2009.
- Fines Removal System - This technology had a patent issued on March 25, 2008. The inventors for this technology are David Hendrickson, Richard Kiesel, and Rodney Bleifuss. Marketing for this technology was a high priority in the first quarter of 2008. A preferred manufacturer was contacted and discussions have been underway regarding a potential licensing arrangement. The potential licensee made some customer visits with NRRI to hear how the technology benefits the mining industry first hand. Unfortunately, there were some wear issues on the chevrons that need to be resolved in order to be operational effective. NRRI is working to research, modify, and test alternative materials. It is anticipated that NRRI will have resolution to this issue by first quarter 2009.

NRRI Product Development Fund

The Knight Foundation and Blandin Foundation granted NRRI a total of \$350,000 for product development initiatives. NRRI applied for the Blandin Foundation and Knight Foundation grant to be able to support the economic development efforts of entrepreneurs and/or small businesses in creating or retaining jobs with product development. NRRI has built an infrastructure over the last 25+ years which can support applied research efforts; however, NRRI is only able to provide a limited amount of technical support without payment for services. NRRI anticipated that entrepreneurs and/or small businesses would be willing to match any contributions from the Product Development Fund with cash and/or in-kind services and materials. A key outcome of the grant is to work with up to 30 businesses that will fully understand their proposed product's market which gives them the ability to evaluate and make a "go/no go" decision based on the on whether the economics of the product support a commercialization effort.

NRRI is on task with the major activities identified for the grant. It established an application process, as well as a review committee to evaluate each proposal. At 24 months into the grant period, direct results include new products, job creation, and manufacturing efficiencies which have increased revenues and net profits for our clients. The Product Development Fund has six completed projects and an additional six projects in progress. In addition to the investment by Blandin and Knight, each project required a cash and in-kind match. For the \$236,616 awarded through the Product Development Fund, \$661,652 private sector investment has been committed, plus \$35,775 in-kind from UMD Natural Resources Research Institute.

UMD CENTER FOR ECONOMIC DEVELOPMENT

Small Business Development Assistance

The NRRI supports the UMD Center for Economic Development (CED) for small business development assistance that is related to business planning, financial planning, financing plans, marketing plans, ecommerce, etc, which complements some of the research and development activities at NRRI. During 2008, 631 businesses were provided one-on-one consulting, of that 10% were manufacturing businesses. Over \$16,000,000 of capital was raised by these businesses with the assistance of CED consultants. Twelve businesses receiving assistance provide goods and services in geo-thermal heating and cooling, solar energy production and use, and the production of heating units using biomass as the main fuel. One client was investigating the financial feasibility of small scale wind energy equipment for use in very rural areas for single or small community use.

One of the NRRI Product Development Fund recipients is also participating in the CED Business Incubator Program and has been working in parallel with NRRI and CED on business planning and financial projections to prepare for new investors. One other Product Development Fund recipient participated in the Student to Business Initiative covering potential marketing plans for the business.

Through independent, third party surveys completed by CED business clients, the economic modeling tool used with the survey data has concluded that approximately \$5,500,000 of federal and state tax revenues were generated through CED activity in 2008.

NRRI Public Relations

NRRI PUBLIC RELATIONS ACTIVITIES

Media Progress/Results

NRRI media coverage for the second half of 2008 (July - December) amounted to an official commercial advertising equivalent of \$82,523.55, a decrease of \$24,561.47 over the first half of 2008. NRRI was represented in 63 print stories, 11 web stories (up considerably from previous report), and one television news stories.

In the Duluth area, the *News Tribune* printed 14 stories, the Duluth Budgeteer ran four stories and *Business North.com* printed one story. Rural and small town newspapers ran a total of 42 NRRI stories. In the Twin Cities, NRRI wood testing research on the Steamboat Minnehaha was featured the Minneapolis *Star Tribune*. Increasingly, the print stories are also featured on the newspaper's Web site, increasing the visibility of the work at NRRI. Associated Press State Online published two stories referencing NRRI and MinnPost.com posted one story.

NEW MEDIA: As communication/media tools continue to change, we may see a decline in "trackable" commercial advertising equivalent, while actually increasing our PR visibility via the Internet. To this end, the PR staff worked with a Web site designer to revamp the institute's Web site, updated the information, added new features and work to constantly update it. On average, the Web site receives 4,000 page requests per day.

Visibility/Other PR Projects

Public Relations staff toured 90 people through the institute between July and December, 2008, which included a group of 60 UMAC agricultural bankers from southern Minnesota.

Other Public Relations efforts to promote the research of NRRI staff:

- PR developed and staffed a display for an Academic and Corporate Relations Center event on the Twin Cities campus.
- PR developed and staffed a display booth at the BioEnergy Days at Minnesota State University in Mankato.
- Coordination of presentations and tour of NRRI's energy research for the BioEnergy Days Study Tour attendees.
- Developed a display for Jerry Niemi to staff at the SOLEC 2008 conference.
- PR staff joined UMD's new Sustainability Communicators Team.
- PR staff is cooperating with UMD's Continuing Education Dept. to coordinate the SME Minnesota conference, held in April each year.