

S *Semi-Annual Report*

January - June

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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

Housing Systems Research

Patrick Donahue and Scott Johnson established a temporary housing systems pilot plant and began constructing ready-to-assemble housing demonstration units for FEMA. The outcome of this project has the potential to create a significant industrial development opportunity for the region. The innovative housing units will be erected at the Coleraine Minerals Research Laboratory in the fall of 2009. The development of these units has involved a team effort with key contributions from local architects, engineering and construction firms. Many national and local vendors have donated materials to the project. The project has also effectively utilized local union contractors as key skilled technical labor.

Mineral Bonded Fiber Composite Panels

Matthew Aro was awarded an IREE grant entitled “Mineral Bonded Strand Composite Panels.” This grant provides an opportunity to further his investigation into new non-petrol based building composites. This was the only award for UMD. This award adds to a growing number of research awards on the overriding topic of mineral bonded fiber composites.

Wood Modification

The field of wood modification is rapidly becoming an important field of endeavor throughout the world. Patrick Donahue was awarded a USDA Forest Service Grant entitled “Thermally-modified Eastern Hardwoods as High-Tech Fenestration and Exterior Shuttering.” This grant provides an opportunity to develop methods that will provide technical detail so that regional hardwoods might be used in place of traditional Western Pine species by major manufacturers of wood windows/doors. This award adds to a string of grant awards and contracts in the field of solid wood and wood fiber modification. One contract awarded this reporting period was a feasibility study to reopen a local shuttered wood products plant as a modern thermally modification production facility. This research focus area has significant job creation potential.

Three NRRI Proposals Selected for Funding by the Wood Education and Resource Center 2009 Grant Process

The following NRRI Proposals were selected for funding by the Wood Education and Resource Center: Wood Utilization Options for Urban Trees Infested by Invasive Species (Xiping Wang, Principal Investigator). This project focuses on transferring information and technology on urban wood utilization to existing business, local communities, and municipalities facing invasive species infestations. Evaluation and Demonstration of Nondestructive Assessment Technologies for Sorting Eastern Hardwoods for High-Value Products (Brian Brashaw, Principal Investigator). This project focuses on an assessment of the types of defects and sorting requirements for high-value hardwood materials, specifically guitar components and baseball bat materials and the identification of technology that could be used to identify defects and sort materials. Thermally-Modified Eastern Hardwoods as High-Tech Fenestration and Exterior Shuttering (Patrick Donahue, Principal Investigator). Information on this grant is noted in Highlights under the topic of Wood Modification. A fourth proposal entitled Lean, Clean and Green for Forest Product Companies was submitted by Missouri Enterprise, LLC, which included NRRI as a key collaborator, was also selected for funding. In this project, Natural Resources Research Institute staff will conduct technology transfer to Missouri Enterprise, LLC on lean manufacturing simulations for wood products companies.

Ninety-five proposals were received by the Wood Education and Resource Center for consideration, 20 were selected for funding, and four of these included NRRI.

Webinars Provide Innovative Approaches to Scientific Discussion

Brian Brashaw provided webinar technical and logistic support for a number of scientific meetings from January-June 2009. Webinars are a new technological means of providing key scientific and technical information via the internet, providing new options for continuing education while reducing travel costs. This included a Forest Products Society Upper Mississippi Valley Sections webinar, “Woody Biomass Opportunities in the Upper Midwest - Pellets, Fuels for Schools and Electrical Generation” and a webinar for Timber Ridge Energy

Enterprises and the U.S. Forest Service titled "Multiple Wood Using Systems at One Location," focused on maximizing utilization of forest resources through identification of production systems that could operate in one location and work together to optimize use of wood waste/forest residue. Two other webinars were hosted in June 2009 by NRRI in order to webcast presentations and audio from the 63rd International Forest Products Society Annual Meeting and the Society of Wood Science and Technology Annual Meeting, both held in Boise, Idaho.

Emerald Ash Borer Workshop Delivered in Effort to "Stop the Bug"

The Natural Resources Research Institute, in cooperation with the U.S. Forest Service Forest Products Laboratory, the Wisconsin Department of Natural Resources, and the USDA Forest Service Wood Education and Resources Center, developed and delivered a training workshop on "Heat Treatment of Firewood." This workshop focused on firewood heat treatment in an effort to kill emerald ash borer and other invasive species. Firewood movement is perhaps the most significant transportation mode for emerald ash borer in Minnesota and Wisconsin. The workshop highlighted the quarantine regulations for emerald ash borer, the firewood heating standard and certification process, new heat treatment operations research at the Natural Resources Research Institute, and a tour of Green Thumb Farms, a Wisconsin firewood producer.

Dr. Xiping Wang Helped Develop an Innovative Digital Video Presentation "Tree Decay Detection"

An innovative digital video presentation entitled "Tree Decay Detection" was developed as part of a 2008 project funded by the Wood Education and Resource Center, Northeastern Area State and Private Forestry, Forest Service, U.S. Department of Agriculture. This educational video was created by Dr. R. Bruce Allison, consulting arborist and Adjunct Professor of Forest and Wildlife Ecology at the University of Wisconsin, Madison, in cooperation with Dr. Xiping Wang of the University of Minnesota Duluth and the USDA Forest Service. This educational presentation was created to familiarize tree managers with a procedure to detect internal decay in standing trees using a combination of visual inspection plus acoustic and microdrill tools. It is now available on the internet and as a DVD. The internet version can be accessed at the following web link: www.nrri.umn.edu/cartd/forestp/treedecay.htm

Bill Berguson Co-authored a Paper "Driving on Biomass" Published in the May Issue of Science

A paper entitled "Driving on Biomass" was published in the May 22nd issue of Science. Bill Berguson is a co-author on this paper which compares biomass-to-electricity using plug-in hybrid vehicles versus cellulosic ethanol and conventional vehicles with a discussion of national policy implications. John Ohlrogge, a Distinguished Professor at Michigan State, is the primary author.

Poplar Breeding

The poplar breeding work being done at the Natural Resources Research Institute is achieving a high rate of success this year with a significant expansion of our population of new clones. Clones from the Natural Resources Research Institute program are being shared with cooperators both within the U.S. and worldwide for testing in a variety of wood products and energy applications.

Minerals

Taconite Aggregate Goes to Chicago

May 28th, 2009, saw the first shipment of taconite aggregate shipped from the Mesabi Iron Range to Chicago, Illinois, for use as aggregate in road projects and railroad ballast. Approximately 5,000 tons of material was shipped by rail from Laurentian Aggregate, located on the Mesabi Iron Range, to Hallett Dock No. 5 in Duluth, Minnesota. From the dock in Duluth, the aggregate was transported by the ship Pere Marquette through the Great Lakes to a dock in Chicago. Many parties participated in completing this project, including Laurentian Aggregate, Kreck & Ojard, and Hallett Dock. Originally, 3,000 tons of coarse taconite tailings were to be used for a slurry seal/pavement preservation application on the Eisenhower Expressway (I-290), in Chicago, Illinois. Discussions between the Natural Resources Research Institute (NRRI) and the Illinois Department of Transportation (IDOT) began in early 2009 to work out project material and logistics details, and continued in earnest during the latter half of March, culminating with a March 30, 2009, letter of commitment from NRRI to IDOT. During this same period, Laurentian Aggregate was working on the logistics of the move. However, it was not until April 9, 2009, prior to a conference call between NRRI and IDOT that an actual location map for the project was provided to NRRI by IDOT. The delivery would take place by a self-unloading lake vessel to a bulk

material facility along the Calumet River in Chicago having good truck access to the expressway. During the next two weeks, NRRI worked with ArcelorMittal USA-Minorca Mine, to secure coarse taconite tailings, and contracted Ulland Brothers, Inc. to process the needed amount of slurry seal aggregate. However, on April 27, 2009, following the production of 3,300 tons of slurry seal aggregate, IDOT informed NRRI that the I-290 project was cancelled because project bids came in too high, evidently due to the high cost of traffic control, and would be re-bid in July. Without having assurance from IDOT that the taconite fine aggregate would ever be used for an IDOT project, and because delivering high-quality taconite aggregate materials to a significant market area like Chicago and using them in one or more paving or construction applications was a major EDA program objective, a decision was made to deliver 5,000 net tons of coarser taconite aggregate materials instead, sourced from Laurentian Aggregate's Gross Nelson Site at Cliff Natural Resources' United Taconite mine. Laurentian Aggregate has customers for the aggregate.

Digitalizing Downhole Geologic Core Logs

The Center for Applied Research and Technology Development geologists have described the geology, mineralogy, and alteration observed in diamond drill cores within the State for approximately 23 years. During this time period, over 1.6 million feet of diamond drill core have been relogged. The geologic data observed in preserved drill core (mostly at Minnesota's drill core library at the DNR Lands & Minerals office in Hibbing, Minnesota) was recorded on paper logs. Some of the paper logs were digitized by entering the geologic and related data into Excel files back in the late 90s. The most recent project was funded by the Minerals Coordinating Committee. To date, over 180,000 feet of drill core from the Mesabi Iron Range have been relogged and digitized. From the Duluth Complex, over 1.1 million feet of logged drill core have been digitized from both studies. Along with the scanned core logs that are on the Economic Geology Group website (www.nrri.umn.edu/egg), the Excel files with NRRI's digitized drill logs will also be available to exploration and mining companies and other interested entities on the website to compile for use in their mineral exploration and/or mining programs. This core logging by the Center for Applied Research and Technology Development geologists has been the basis for the recent drilling programs in the Duluth Complex.

Mesothelioma Study

As the economic downturn has caused taconite operations on the Mesabi Iron Range to temporarily shut down, we have continued to sample in the communities to measure particulate matter characteristics without the contribution of the taconite mining industry. Preliminary analysis of gravimetric data for Silver Bay and Babbitt indicates that total suspended particulates and PM10 concentrations for the locations when the plants are active and inactive are within one standard deviation. We have now also sampled at UTAC's Forbes Plant and Northshore Mining's plant in Silver Bay. The PM10 concentration at the Forbes Plant ranged from 970 $\mu\text{g}/\text{m}^3$ at the balling drums to 108 $\mu\text{g}/\text{m}^3$ near the mills and magnetic separators. No elongated amphibole particles were found.

Non-Ferrous Developments

Copper/Nickel Processing Pilot Plant Installed at the Coleraine Minerals Research Laboratory

A 5-10 ton/hr mineral processing pilot scale plant has been constructed at the Coleraine Minerals Research Laboratory with capabilities for crushing, rod and ball mill grinding, screening, cycloning, flotation, thickening, and disc filtering of mineral samples requiring upgrading. A 1,500 ton crude ore Cu/Ni sample was recently processed in the circuit to produce a flotation concentrate for further hydrometallurgical processing in Vancouver, B.C. Copper was upgraded from a 0.4% Cu concentration to a 20% Cu concentration as a result of the grinding and flotation processing.

Infrastructure Improvement and Training

Installation of Upgraded Sinter Pot Test Equipment at the Coleraine Minerals Research Laboratory

Upgraded sinter pot equipment was installed at the Coleraine Minerals Research Laboratory with an automated Allen Bradley Programmable Logic Controller to produce blast furnace sinter feed products from various types of iron ore fine materials, as well as advancing our capabilities to handle 300mm to 600mm bed depths. This advancement in sinter pot equipment design allows the Coleraine Minerals Research Laboratory to simulate sintering plant conditions worldwide. More than 60 pilot scale tests have been run to date, producing different sinter feed chemistries and different firing sequences.

Plasma Furnace Installation for Project Work at the Coleraine Minerals Research Laboratory

The focus of this work is 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 (2800°F) melting in a plasma melting system installed on-site at the Coleraine Minerals Research Laboratory. Based on testwork conducted at the Natural Resources Research Institute, it has been shown that taconite rock and magnetite concentrate have radiation absorbing properties especially for UV and microwave radiation. 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 to be developed.

Horticultural Peat

New Honorary Member Named to the International Peat Society

Tom Malterer was named an Honorary Member of the International Peat Society. He was recognized for his numerous scientific contributions to peat science and his work in the development of Minnesota's peat industry.

Precambrian Research Center

Precambrian Research Center Hosted the 55th Annual Institute on Lake Superior Geology Conference

After months of planning, promoting, and organizing, the Precambrian Research Center hosted the 55th Annual Institute on Lake Superior Geology Conference in early May at the Grand Ely Lodge. The two days of technical sessions and seven field trips were attended by 240 participants from throughout the US and Canada, making it the third most attended meeting in the Institute on Lake Superior Geology history.

CENTER FOR WATER AND THE ENVIRONMENT

Water Resources

Climate Change Impacts on Minnesota's Water Resources

NRRI investigators and their colleagues have assembled millions of observations of historic water quality, fish community, lake level, and stream flow data, along with ice out records and historic climate conditions for Minnesota's lakes. Although the strength of trends varied across the state, increasing lake water levels and stream flow were observed over the period of record, with greater increases observed from the 1980s to the present. Increases in lake surface water temperatures were observed for more than 60% of lakes for which long term records are available. Walleye spawning was observed to coincide with ice out with patterns of earlier ice out coinciding with earlier spawning. Tools were developed by state climatologist to extract and summarize historic climate data. Another tool was developed to display trends in water quality data on a statewide or individual lake basis.

Algae and Paleoecology

Euan Reavie and EPA colleagues published the first manuscript from the USEPA's Great Rivers study. This work identified the best way to sample algae in large river systems in order to use the information to make management decisions. Great Rivers work is ongoing to develop powerful algae-based models that will be used to infer condition in North America's Great Rivers.

Members of NRRI-Ely's research team completed their sixth sampling cruise of the Great Lakes for the USEPA Great Lakes National Program Office's ongoing monitoring program. Phytoplankton collections from these cruises are being used to track long-term shifts in open-water conditions in the lakes. So far data indicate that dramatic declines in organism density and biomass are occurring throughout the food web, with the exception of Lake Erie where productivity seems to be increasing.

Rivers, Creeks, Lakes

The Great Ships Initiative ballast water research facility has been operating non-stop this summer. Candidate treatments for ballast water are currently being tested to determine if they meet criteria for ship-board applications. NRRI personnel are ensuring that candidate treatments meet International Maritime Organization criteria for mortality of microorganisms, such as potentially invasive algae and protists being transported in the ballast water of ships.

Land/Water Interaction

Stream restoration, runoff reduction:

The Lakeside Stormwater Runoff Reduction Project (joint with the city of Duluth) planted approximately 250 trees and shrubs in homeowners yards in a two-block area of the Lakeside neighborhood of Duluth in May. CWE was assisted in the planting by the Minnesota Conservation Corps. As they mature, the deep roots of these trees and shrubs will help more stormwater soak into the ground to become groundwater, which will keep this stormwater from becoming runoff. Reducing the amount of stormwater runoff from city neighborhoods and streets is important to help protect Duluth streams from high, damaging flows and pollution picked up from city streets.

Environmental Chemistry

Subhash Basak and coworkers published some papers in the prediction of environmentally important physicochemical properties using mathematical descriptors. They also applied their novel QSAR methods to the design of new anti-malarial drugs. Basak collaborated with colleagues in Jadavpur University, Kolkata, India, to predict infectivity and pandemicity of various strains of bird flu using mathematical descriptors of viral nucleic acid sequences.

Public Outreach/Information Dissemination

The lakesuperiorstreams.org website continues to be a primary outlet for current data and educational information regarding Lake Superior tributaries, stormwater information, and water pollution in general. With support from the city of Duluth, NRRI, Sea Grant, Minnesota's Lake Superior Coastal Program, and WSRI, the website continues to grow and is heavily used by regional stormwater managers and educators (dozens of regional high school and middle school teachers use the website for their environmental units). Current use exceeds 500,000 requests per month and the 20-25% bumps in use each spring and fall suggest heavy use by students and teachers. The use of real-time stream water quality data provides a better understanding of how landuse changes and potentially, restoration efforts, affect stream water quality and habitat.

Center for Research and Applied Technology Development

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 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 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 absorbency 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 University of Minnesota Office of Technology Commercialization (Docket #Z09111).

Current Activity

The further refinement and application of the two-part binder system has allowed green agglomerate moisture to be reduced to 64 percent while not negatively affecting either durability or integrity of the formed agglomerates. Raw material and drying cost estimates were prepared and submitted to CPI. Pilot scale agglomeration trials have commenced at CPI allowing their staff to become familiar with the technologies and operation of the machinery. Drying tests on the product have shown conventional, gravity flow grain dryers are too prone to mechanically abrade the product. A horizontal, moving bed dryer was found to offer less mechanical abrasion to the wet agglomerates while also offering more thermal efficiency. CPI was recently granted a distribution and sales partnership with a major automobile parts manufacturer to continue to present their products to the market place.

Principal Investigator(s)

Brian Brashaw
Timothy Hagen

Project Sponsor(s)

Clean Plus, Inc

Amount Account

5,000 3000-10414-00005187

Active

05/01/2008 04/30/2009

Total \$5,000

Start Date: 05/01/2008

End Date: 04/30/2009

Project ID: 1534

Corn Stover Agglomerates for Oil Sorbency Applications

Objective

This project seeks to identify a reactive two-part binding and agglomeration system capable of transforming delicate corn stover fibers into highly absorptive, free-flowing, porous granulates uniquely capable of absorbing a wide variety of hydrocarbon and water based fluids.

Background

Oil and coolant drips, leaks and spills from vehicles, machines, oil transfer units, and a myriad of business and personal activities account for nearly 36% of petroleum waste that is polluting the Nations surface water, ground water, surface soil and sub soil (US Dept. of the Interior Minerals Management Service). The usual cleanup method of these drips and spills on a hard surface is the use of clay or diatomaceous earth granules which are inefficient and pose expensive and potentially harmful disposal challenges, or polypropylene sorbents which are more efficient but are made from petroleum and present their own disposal problems. While no hard data exists, antidotal evidence indicates that as much as 60-70 percent of the clay based sorbents sold are disposed of improperly. Research performed by the University of Minnesota Duluth, Natural Resources Research Institute (NRRI) in cooperation with Clean Plus Inc. has demonstrated that the use of corn stover fiber shows promise as a highly absorbent medium for oils and other harmful fluids. Tests at NRRI have shown corn stover absorbs over five times more oil, on a pound for pound basis, than clay based sorbents.

Previous Activity

This is a new project.

Current Activity

Five, two-part binder systems were evaluated to agglomerate corn stover particles. These include: lime/molasses, calcium sulfate/sodium silicate, boric acid/polyvinyl alcohol, boric acid/polyvinyl acetate, and guar gum/bentonite. The boric acid with polyvinyl alcohol (PVA) or polyvinyl acetate (PVAc) was found to provide the best performance value as evidenced by superior green strength, low dosage, and sorbency values of 5x or greater. A feed grind specification of minus 3/32 offered the most efficient means by which to form the agglomerates. A 10 percent solution of PVAc in water combined with a 5 percent dosage of boric acid was found to offer the best agglomeration potential, had superior green strength, offered significant flame retardant properties, and met the lowest cost objectives. The optimal positioning of the feed of corn stover to the disc was in the upper left quarter section with binder addition just above that point. CPI staff was trained on the operation and optimal set-up parameters for the agglomeration system. Select distributors within CPI's network have shown remarkable interest in the product. A Small Business Innovation Research Grant application describing the challenges and opportunity of commercialization of this technology was submitted to the USDA and approved for funding in the amount of \$79,812. Momentum continues to build around the potential of this technology and product.

Principal Investigator(s)

Brian Brashaw
Timothy Hagen

Project Sponsor(s)

Clean Plus, Inc. (USDA prime)

Amount	Account	Active
25,231	3000-10414-00005616	05/01/2009 12/31/2009
Total	\$25,231	

Start Date: 05/01/2009

End Date: 12/31/2009

Project ID: 1549

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 bio-pesticides. 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 require 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

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, flow ability, 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.

Current Activity

TerraMax, Inc. personnel toured through the NRRI agglomeration lab to view firsthand the operational characteristics of a continuously running agglomeration disc in action with their material. Critical features of the system were explained and demonstrated including feed point and rate, culture point, slope, speed, and feed exit points. TerraMax, Inc. personnel were trained on the operation and features of the agglomeration disc and how each individual control parameter affected the distribution and integrity of their particular organism and carrier. TerraMax, Inc. continues to track and document the stability, viability, and longevity of their organism on this cooperatively developed engineered carrier granule. Survival of the TerraMax, Inc. organism, when compared to other commercial carriers has shown superior longevity and viability in a variety of stowage environments.

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

This project was extended until October 31, 2009. The final report is being prepared and sent to the technical advisory panel for review and comment.

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 12/31/2009

Start Date: 09/12/2006

End Date: 12/31/2009

Project ID: 1462

Epicurean Cutting Surfaces

Objective

The goal is to assist Epicurean to complete the business and technical assessment required to successfully enter the field of resin saturated paper board production.

Background

Epicurean's specialty products have found success in the cooking accessories niche as a food prep. and cutting board surface for both residential and commercial kitchens. Epicurean has seen continued growth and desires to develop other products both related to kitchen accessories and beyond. Vertically integrating composite board production as a core manufacturing capacity and taking full advantage of a regional base material supplier will lower Epicurean's cost of resin saturated boards for increased profitability and a stronger competitive advantage. This added capacity would improve Epicurean's long-term added-value business development potential.

Previous Activity

This is a new project.

Current Activity

Several pilot plant trials were completed with difficulty in the performance of the paper feedstock. The first trial the paper supplied was not manufactured with National Food Safety grade resin. This was not discovered until after the trial was complete. The second trial was only partially successful. The black composite panels work very well, however the tan paper failed because of decorative appearance. A third trial is being planned.

Machine tool assessment was completed. The team traveled to Danville, Virginia to inspect used equipment being considered for relocation to northern Minnesota. The assessment was very positive. The machine tools sourced seem to be ideal for the project. The cost to modify the machine tools, plant relocation, and plant set-up have been estimated and the purchase of the equipment is still pending.

Principal Investigator(s)

Brian Brashaw

Patrick Donahue

Project Sponsor(s)

John S & James L. Knight Foundation

Total

Amount Account

32,500 3001-10412-00009804

\$32,500

Active

11/01/2008 11/30/2010

Start Date: 11/01/2008

End Date: 11/30/2010

Project ID: 1554

Field Logic - NRRRI Product Development Fund

Objective

To develop an engineered archery target from recycled foam and textile materials.

Background

Field Logic approached the Natural Resources Research Institute in regards to the formation and construction of an engineered archery target made from either waste textiles or polyurethane foam scraps. Their specific intent was to supplement their layered polyethylene targets with a low cost bag style target. Competitive Background: Competitor target models were purchased for examination. These examinations confirmed the need to strive for a target using less than \$8 of materials. The typical 2' x 2' x 1' competitor's model consisted of a \$2.50 outer woven polypropylene bag containing polyester batting fluff scraps from a local mattress manufacturer and an internal core of folded burlap sacks from their local coffee roasting businesses. Total material cost of this 25 lb bag target was estimated to be about \$5, representing a significant comparative advantage over their current polyethylene foam targets.

Previous Activity

This is a new project.

Current Activity

Textile fibers were opened and blended with bi-component fibers to produce a lightweight bonded matrix capable of absorbing the kinetic energy from field tip arrows. The following types of fibers were investigated: cotton fibers, wood fibers, shoddy fibers, ceramic fibers, polyester fibers, polyester crimped, high loft fibers, kenaf fibers, and flax fibers. Several blends of fibers were produced using 6 x 12 in square molds to preliminarily evaluate mold ability and arrow stopping power. The blending and molding process encompassed opening the fibers on an opener, blending the fibers with a hot melt fiber, and compressing the fibers to a specified density into a mold. The molded mass was then heat activated at 315°F in a convection oven. Although several formulations appeared to have the required density of 6-8 pcf, mold ability and desirable arrow stopping capability, durability was significantly lacking as evidenced by "tunneling" throughout the fiberized matrix. This forced the project team to consider using polyurethane foam in the formulation. Efforts are now being directed at using steam cured polyisocyanates to bond foam scrap into engineered target structures. The scale-up and advancement of the densification and bonding procedure continues to be optimized in the pilot plant.

Principal Investigator(s)

Brian Brashaw
Timothy Hagen

Project Sponsor(s)

Project Sponsor(s)	Amount	Account	Active
John S and James L Knight Foundation	29,241	3001-10412-00011032	12/01/2008 11/30/2010
Total	\$29,241		

Start Date: 02/01/2009 **End Date:** 12/31/2009 **Project ID:** 1546

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 waste flue gas desulfurization (FGD) gypsum increases. This study will review patent literature and current applications as they relate to FGD gypsum's wet use as an agricultural soil amendment. This project parallels a second project that focuses on process residual gypsum that could potentially be generated by any of the three proposed precious metal mining operations in Northern Minnesota. The volume of process residual gypsum that might be produced is significant.

Previous Activity

This is a new project.

Current Activity

North American FGD gypsum production in 2006 was 12 million tons, and only 1.4 percent of that amount was used in agriculture; however, its use in agriculture is the market with the greatest potential for expanding gypsum use. The key advantages of using FGD gypsum as a soil amendment (vs mined gypsum) are: better quality and consistency, ability to be used in conventional agricultural equipment, no need for mining, grinding, and transporting rock gypsum, extra "points" for using a recycled material, and great abundance east of the Mississippi River. Also, there is a reduction in energy use, greenhouse gas emissions, and ecological damage.

Typical uses for FGD gypsum are as a nutrient source (calcium and sulfur) for crops, a conditioner to improve soil chemical properties, physical properties, and water infiltration and storage, and to reduce the transport of nutrients, sediment, pesticides, and other contaminants to surface waters/runoff.

Agricultural experts were consulted, and some of the key findings pertinent to our region include: (1) Possible benefit to applying FGD gypsum to forage crops (including alfalfa) in the Twin Ports region of MN and WI; (2) Ability to increase yield of tomatoes and corn crops; (3) Possible improvement of potato growth on sandy soils in northern MN/WI; (4) Improvement of soil structure in red clay soils of northwest WI and northeast MN near Lake Superior; (5) Ability to add needed sulfur to central sand plains area of MN (in and around St. Cloud), and (6) The possibility to mix FGD gypsum with nitrogen fertilizer to create nitrogen sulfate fertilizer, which is used in the Red River Valley due to high soil pH.

We have clearly identified the steps required to receive legal permission to land apply FGD gypsum. This involves submittal of a detailed proposal for a Case Specific Beneficial Use Determination from the MPCA. Once the Case Specific Beneficial Use Determination has been issued, an Agricultural Fertilizer License must be obtained from the Minnesota Department of Agriculture.

Finally, if the FGD gypsum is to be land spread as is, there appears to be no patent infringement issues. However, if the FGD gypsum is mixed with other minerals and/or additives, or is granulated/pelletized prior to land spreading, a thorough patent review should be completed.

Principal Investigator(s)

Matthew Aro
Patrick Donahue

Project Sponsor(s)

Minnesota Power

Amount	Account	Active
10,000	3000-10414-00007283	12/15/2008 12/31/2009
Total	\$10,000	

Start Date: 12/15/2008 **End Date:** 12/31/2009 **Project ID:** 1533

Goodwill Industries, Inc. - NRRI Product Development Fund

Objective

To develop and exploit a local market outlet for compacted mattress innersprings recovered from mattresses.

Background

Goodwill Industries, Inc. (GWI) operates a mattress recycling operation in Duluth, Minnesota. They have been operational since June 2004 processing over 46,000 units for deconstruction and recycling through 14 collection sites spanning ten counties in northeast Minnesota and Wisconsin. The operation has generated over \$282,699 in tipping fees, processed over 913 tons of steel, wood, cotton, foam toppers, and shoddy generating \$37,486 in sales for GWI and saved over 5,448 cubic yards of landfill space valued at \$169,962.

These activities create steady work for five GWI individuals, contributing over \$294,000 in the form of wages and overhead to the local economy. However GWI has been significantly challenged by deteriorating market outlets for the steel spring units recovered in their recycling operation. Previously, a local steel recycler would take the spring units and process them through an automobile shredding operation. However, the high tensile strength of the spring units have caused significant problems in the shredding operation and the processor recently banned any mattress or box spring unit from being accepted at the facility. This has caused an immediate backlog and buildup of stripped mattress and spring units at GWI. There is a critical need to find a sustainable and efficient means by which the steel mattress innersprings can be handled, properly processed, and prepared for sale into the local steel recycling market.

Previous Activity

This is a new project.

Current Activity

This project caught the attention of a local engineer and designer who after reading an article about mattress recycling in the NRRI Now, proposed a viable solution for the compaction and densification of stripped mattress innersprings. An initial working model of a triple axis mattress compactor was completed and tested using actual mattress springs recovered from Goodwill Industries, Inc (GWI). The tests revealed that the size and density of the compacted springs were consistent with the needs of a local foundry and were within chemical specification. The NRRI confirmed the chemical analysis of the steel matched specifications required by ME ElecMetal, the local foundry in Duluth. GWI continues to pave the way for cutting edge mattress recycling. They anticipate the acquisition and full implementation of the mattress spring compactor at their facility during the third quarter of 2009. In a true cooperative effort, ME ElecMetal took a hard look at the chemistry and density of the steel springs and determined they could use it at their facility. A local start-up, Olaf Industries, Inc. provided the design, engineering, and fabrication of the mattress spring compactor. The NRRI, through it Coleraine Minerals Research Lab, provided the chemical analysis of the steel.

Principal Investigator(s)

Brian Brashaw
Timothy Hagen

Project Sponsor(s)

Goodwill Industries

Amount	Account	Active
17,925	3001-10412-00009803	10/17/2008 04/01/2010
Total	\$17,925	

Start Date: 10/17/2008 **End Date:** 04/01/2010 **Project ID:** 1547

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 products 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. 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.

Current Activity

The data collected during this project is being analyzed and compiled to develop the final report and final training materials. Interviews have been conducted with several wood products companies that utilize lean in their primary sawmills and the information will be compiled into the final report.

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. PolyMet Mining 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 Natural Resources Research Institute will assist PolyMet Mining in assessing market opportunities for beneficial use of the gypsum residuals.

Previous 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.

Current Activity

Significant progress has been made in the discovery of wallboards produced with a "green building material" influence, in particular the discovery of the expanding role of phase change materials technology in the wallboard manufacturing industry.

Phase change materials are functional polymers that absorb heat energy from an interior space during the day and emit the heat energy back into the space at night when temperatures cool. These heat sink composite panels have begun to be commercialized by Knauf in Europe under the trade name "Smartboard."

Major chemical suppliers such as BASF and DuPont have led the developments with petrochemical-based phase change materials. We have begun to screen the BASF material under the trade name Micronal. In addition, it was discovered a Minnesota-based company, Entropy, has developed fatty acid-based phase change materials.

We believe this is a significant opportunity and have begun to develop proof-of-concept prototypes that will demonstrate several unique applications for future residual gypsum phase change materials structural wallboards.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

50,000 1750-10414-20090-

Active

11/20/2008 06/30/2010

Total \$50,000

Start Date: 11/20/2008

End Date: 06/30/2009

Project ID: 1535

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

A cost-effective temperature monitoring system has been built and installed at the heat treating facility of Green Thumb Farm, Inc. Three heat treatment demonstration runs have been completed and the system has proved to be durable, reliable, and robust. 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.

Current Activity

The second temperature monitoring system was built and installed at the heat treating facility of John's Welding in Tomah, Wisconsin in May 2009. A USB TC-08 Thermocouple Data Logger was selected for this facility and installed at the computer control room. This data logger is powered directly by the USB port of a PC, allows real-time monitoring of the heat treatment process. The system can measure and record up to eight temperatures during heat treatment operation. We have conducted two successful heat treatment runs at John's Welding. The system is currently under further testing for its accuracy and reliability. This temperature monitoring system will be demonstrated in a kiln certification workshop on July 28, 2009, hosted by the USDA APHIS.

The third heat treatment demonstration project will be conducted in the state of Illinois. A site visit has been scheduled for early August 2009. This demonstration project is expected to be completed by the end of September.

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 Natural Resources Research Institute 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 and will fulfill a need for additional temporary office space at the Coleraine Minerals Research Laboratory.

Previous Activity

A design detailing team was created consisting of an architect, a structural engineer, an electrical engineer, and a licensed contractor. These services are being provided as in-kind. 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 pilot space in Duluth to fabricate the units and prepare for shipping and site assembly. The project has received donated materials in support of the development of these units.

Current Activity

Public private partnerships created with this project continue to flourish. The architectural and engineering in-kind has exceeded \$100,000. The donated materials and discounts on materials have been substantial; 18 private companies have provided materials free or at cost.

The cooperation within the University of Minnesota has been outstanding. UMD Facilities Management and the Twin Cities Building Inspection Department have been proactively assisting the project with code compliance.

The fabrication of the demonstration units has proceeded at a steady pace. The building materials used have been from local or regional sources whenever possible. Noteworthy cooperation has occurred with WTW Construction Services, Inc. who has provided equipment, labor, and advice on a daily basis. WTW Construction Services, Inc. provided a Journeyman Union Carpenter to assist in the fabrication.

The first unit is expected to be completed and installed in early September with the second unit to follow shortly. The FEMA-Joint Housing Solutions Group visit is expected to occur in September.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)

	Amount	Account	Active
Blandin Foundation	15,000	3001-10414-00006709	01/01/2009 01/01/2010
PUF Mineral Endowment	140,000	1750-10414-20090-	11/20/2008 06/30/2010
Total	\$155,000		

Start Date: 11/20/2008 **End Date:** 10/30/2009 **Project ID:** 1536

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 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

Several lean manufacturing projects incorporating total productive maintenance were completed with Shell Lake Furniture. These one-day projects included lean training, and a hands-on component to make immediate improvements to work stations and work cells. Dry ice blasting was utilized to clean the stain and varnish spray booth areas, restoring them to near original equipment condition. All other project activities have been completed and will be incorporated into the final report during 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 Srvs(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

Iron Phosphate Bonded OSB

Objective

The overall objective is to demonstrate technology to produce iron phosphate-bonded oriented strandboard (OSB) building construction panels and thermally-conductive refractory board, both of which have the potential to outperform current products and reduce overall production energy requirements.

Background

This project proposes to develop novel oriented strandboard building construction panels and thermally-conductive refractory board using innovative inorganic iron-phosphate ceramic binders. These iron-phosphate binders may be useful for the treatment of a distinct and locally-available iron-rich feedstock – magnetite (Fe₃O₄) concentrate produced from the beneficiation of magnetic taconite.

Fe₃O₄ generated from iron ore mining operations in northern Minnesota's Iron Range will be combined with an activator comprised of phosphoric acid (H₃PO₄) and/or other acids, phosphate salts, supplemental additives, and wood fibers with specific geometries to produce bench-scale iron phosphate-bonded OSB panels and thermally-conductive refractory board.

Previous Activity

This is a new project.

Current Activity

To begin this project, we focused not on bonding wood strands together to produce a consolidated strandboard, but on coating wood-based strandboard with the iron-phosphate coating to test its bonding tenacity.

Several prototypes were made to assess binder viscosity, heat evolution, activator concentration, and effects of various fillers. Preliminary results show that sodium phosphate (NaH₂PO₄) works well as the salt component of the activator. At this point, the ideal H₃PO₄: NaH₂PO₄ ratio appears to be 1.0: 0.4. Extra H₂O (in addition to the water present in the activator mix) can be added at an approximate ratio of 1:1 (NaH₂PO₄: H₂O) without hindering the setting properties of the mix.

However, there appears to be shrinkage cracks in the binder when it is applied as a sprayed-on thin coating to OSB substrate. Reasons for the shrinkage cracks could include excess H₂O or the binder setting too rapidly due to the pH differences between the binder components.

Our next step will be to overcome the shrinkage issues. We will experiment with different salts (such as monopotassium phosphate which has a lower dissociation constant than NaH₂PO₄), various latex additives, and fiber reinforcement via short and thin fiberglass fibers (such as those used to reinforce concrete and reduce cracking). Also, we will experiment with using other phosphates (such as triple super phosphate) to replace the more expensive H₃PO₄.

Principal Investigator(s)

Matthew Aro

Patrick Donahue

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

46,781 ---

Active

08/27/2008 06/30/2010

Total

\$46,781

Start Date: 11/03/2008

End Date: 10/31/2009

Project ID: 1553

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

We have identified and reviewed several emerging nondestructive testing technologies by attending the 2008 American 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.

Current Activity

Due to other project time constraints, little activity happened during this reporting period on this project. An extension request has been submitted. During the next phase, we plan to 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

Northern Sheer Veneer

Objective

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

Background

The University of Minnesota Duluth, Natural Resources Research 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

The project successfully built prototypes and supported US Gypsum Interiors in pilot production manufacturing. 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.

Current Activity

The project has been completed.

US Gypsum Interiors and Northern Sheer Veneer continue to develop a business to business relationship. Together they continue to develop the potential market.

US Gypsum Interiors has been working through the industrial building code and performance testing required to bring the product to market. The product was determined to retain its acoustical performance; creating a unique market position as a real wood finished acoustical tile.

US Gypsum Interiors also expanded the development project to include laminating to gypsum wall boards.

Principal Investigator(s)

Patrick Donahue

Project Sponsor(s)

John S & James L Knight FDN

	Amount	Account	Active
	14,978	1671-186-6121-00	03/30/2008 12/15/2008
Total	\$14,978		

Start Date: 07/01/2008

End Date: 01/01/2009

Project ID: 1537

Phosphate Bonded Fiber and Waste Residual Composites for Applied Commercialization

Objective

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

Background

This project is funded by the Wisconsin Business Innovation Corporation with resources they received from the US Environmental Protection Agency. There is 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

Much of the work was 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 be shared with Marshfield Door Systems, who has shown great interest in our technology. We worked 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.

Current Activity

Candidate magnesium oxychloride binders were researched and chosen. Prototype panels manufactured from paper mill residue and the candidate magnesium oxychloride binders were produced and analyzed. The prototypes were then shared with our industrial partner, Marshfield Door Systems. Marshfield Door Systems showed substantial interest in the prototypes; further, they asked for specific density and screw holding data. These parameters were tested and the preliminary data met Marshfield Door Systems technical requirements.

Marshfield Door Systems has now asked for us to manufacture 3' x 3' x 1.75" panel prototypes to be subjected to pilot-scale burn testing in their burn laboratory. Flame spread and burn-through tests will be conducted on the pilot-scale prototypes. The data will then allow us to further refine the pilot-scale prototypes, if necessary, to enhance flame spread and burn-through properties.

The next steps are to complete the pilot-scale burn tests at Marshfield Door Systems, refine the pilot-scale prototypes if necessary, retest, and then work with Marshfield Door Systems to identify options to incorporate our new technology into their product lines. We will also continue pursuing other door manufacturers who have shown interest in our technology.

Principal Investigator(s)

Matthew Aro

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 programs are widely accepted as a key strategy by world class manufacturers as a means to satisfy these needs. The total productive maintenance concept grew from the broader lean manufacturing philosophy, which is based on continuous improvement.

Previous Activity

During the first six months of the project, our team of cooperators attended training from Fuss & O’Neil and the Marshall Institute and participated in total productive maintenance 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. 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 LLC for use in conducting total productive maintenance demonstration projects.

Current Activity

A comprehensive total product maintenance project was completed with Shell Lake Furniture in their stain and varnish spray booth. Dry ice blasting was utilized to safely and effectively remove over five years of material buildup on the spray booths, their spray equipment, and their material handling equipment. Shell Lake Furniture staff was trained in safe use of the equipment, and developed new cleaning standards that were implemented in these areas. The results of this improvement will enhance the efficiency of their furniture finishing process by reducing time looking for materials and equipment, reduced downtime for their equipment, and improvements in finish quality. A demonstration of the equipment was also conducted for Birchwood’s Best, another project cooperator.

Due to the 2009 recession, most cooperators have requested that we not conduct projects since they have reduced staff availability and cannot conduct activities that do not have an immediate payback. They will be contacted again for fall 2009 project completion.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)

USDA Forest Service

Amount Account

95,479 1637-187-6601-00

Active

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 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, to facilitate economic growth and stability of Minnesota and other Lake States wood product manufacturers.

Previous Activity

Budget numbers were assigned in January 2009. No previous activity to report.

Current Activity

Subprojects focused on total productive maintenance and thermal modification of wood were initiated. In the total productive maintenance effort, a band saw rebuild was initiated. A 1960 Northfield (Minneapolis, Minnesota) band saw is being used to return the equipment to original equipment condition. Dry ice blasting was successfully utilized to clean the equipment. Damaged or defective parts were ordered from the manufacturer. A case study is being prepared to document the potential for rebuilding equipment instead of purchasing new equipment. In the thermal modification project, opportunities for using basswood for window applications are being assessed. A relationship is being developed with Stellac, a European equipment manufacturer, for completing test runs for these materials so that samples can be developed.

Principal Investigator(s)

Brian Brashaw

Project Sponsor(s)	Amount	Account	Active
USDA Coop ST Res ED&Ext Srvs(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

A report was published in December 2008 that described work done to assess brushland biomass on 40 sites across northern Minnesota. 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.

Current Activity

A part of the project involves assessment of poplar clone performance on various study sites in northern Minnesota. Data have been collected on both clone tests and yield blocks in the 2007 planting during the quarter. Survival on new clone tests planted in 2008 at the Thief River Falls site is greater than 90 percent. Height growth of two year old yield blocks varies significantly by clone with the new set of 9732-family clones performing well. Average heights of these clones range from 2.5 to 3.0 meters after two years which is very typical of the best-performing hybrids in similar tests in other regions of the state. Of particular note is the apparent resistance of some of the new *P. deltoides* X *nigra* clones to iron chlorosis, a condition that causes extreme yellowing of leaves and eventual mortality of trees. A significant amount of acreage in the northwestern region of Minnesota is relatively high in pH and identification of chlorosis-resistant clones is important for woody biomass production in this region. This result underscores the importance of breeding to increase genetic diversity and improve yield on a wide variety of sites.

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

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. 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.

Current Activity

An economic analysis integrating the information that was provided by NRRI to the US Forest Service and the UM-Department of Applied Economics has been completed. This document entitled "Economic Impacts of Establishing Short Rotation Woody Crops to Support Energy Production in Minnesota" by William Lazarus and Douglas Tiffany was published as a University of Minnesota, Department of Applied Economics staff paper. This document describes results of an IMPLAN econometric analysis assuming a theoretical ethanol production facility with feedstock being supplied solely by dedicated woody energy crops such as hybrid poplar plantations. The economic impact in terms of jobs and economic activity is discussed. The document is referenced the UM, Department of Applied Economics Staff Paper P09-02. With the publication of this analysis, the NRRI-portion of the project is complete.

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 MFPRC.

Previous Activity

Research being done under the MFPRC involved 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. 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.

Current Activity

Work is ongoing to establish the set of experiments to evaluate biological impacts of thinning on productivity of Aspen and Red Pine. Progress continues toward establishing a large network of multi-treatment thinning studies in young Red Pine stands. At this time, we have nine Red Pine thinning sites that have been established with a total of 13 study sites slated for establishment. Two of the remaining four stands have been selected and visited to assess suitability of these stands for research. Also, we continue to establish thinning studies in Aspen in cooperation with the Minnesota Department of Natural Resources. We will collect data from all of these sites in the coming fall. Poplar breeding has been very successful this year with 84 crosses made in the NRRI greenhouse facility. From this effort, we expect approximately 4,000 new genotypes that will be planted in nurseries for eventual field testing. Field tests using new poplar clones developed by the NRRI have been established this spring in Minnesota, Michigan, Indiana, Montana, and Poland under a variety of cooperative agreements with industry and other universities.

Principal Investigator(s)

William Berguson

Project Sponsor(s)	Amount	Account	Active
MN Power	20,000	1664-187-6594-00	07/01/2006 12/31/2006
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 Power	20,000	1664-187-6560-00	07/01/2005 06/30/2006
Plum Creek	20,000	1664-187-6561-00	07/01/2005 06/30/2006
Potlatch Corporation	20,000	1664-187-6562-00	07/01/2005 06/30/2006
MN Dep of Natural Resources(DNR)	40,000	1663-187-6542-00	11/30/2004 06/30/2007
Forest Capital Partners LLC	20,000	1664-187-6593-00	01/01/2007 06/30/2008
MN DNR	200,000	3005-10414-00005642	06/26/2008 06/30/2009
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
Minnesota Power	20,000	3000-10414-00006971	12/17/2008	12/31/2009
Blandin Paper Company	20,000	3000-10414-00006973	12/01/2008	12/31/2009
Potlatch Corporation	20,000	3000-10414-00006975	12/01/2008	12/31/2009
Verso Paper	20,000	3000-10414-00006976	12/01/2008	12/31/2009
Plum Creek Timber Company, Inc	20,000	3000-10414-00007251	12/01/2008	12/31/2009
St Louis County	20,000	3003-10414-00011548	07/01/2009	06/30/2010
State of Minnesota	20,000	3005-10414-00005615	07/01/2007	06/30/2009
Blandin Paper Company	20,000	1664-187-6563-00	07/01/2005	06/30/2006
Total		\$1,120,000		

Start Date: 10/28/2004 **End Date:** 06/30/2010 **Project ID:** 1363

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 the most common experimental techniques. It was found that the active catalytic substance can be easily prepared via alkaline 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. It was also found that this iron titanate compound is a good precursor for modification with other metal ions - copper, chromium, cobalt, etc. A number of various polymetallic catalysts have been synthesized on its base, and tested in the Fischer-Tropsch process.

Current Activity

Experimental study has been continued in order to explore the commercial potential of the ilmenite-based polymetallic catalysts. The study included tests on comparative activity, lifetime tests, and study of the side processes – water gas shifting and isomerization. A separate set of tests has been conducted for optimization of the first stage of processing the catalysts - the alkaline fusion of ilmenite. It was found that certain polymetallic ilmenite catalysts show a high yield of branched hydrocarbons in the Fischer-Tropsch process, unlike the common catalysts, which are selective to formation of linear hydrocarbons. This effect may be valuable for one-step processing of gasoline-like fuels. Another group of the ilmenite-based catalysts has been found active in a water-gas shift reaction. These catalysts may find an application for conversion of a low-hydrogen syngas, and for processing hydrogen.

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 06/30/2010
Total	\$40,000	

Start Date: 02/29/2008 **End Date:** 06/30/2010 **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 chem. lab pulps from previous copper-nickel studies indicated a mercury concentration in the head sample of 65nanograms per gram (ng/g) (or parts per billion) (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 and in the concentrate.

Previous Activity

The autoclave is being used for the production of biofuels. When the autoclave is available, the leaching will commence.

Current Activity

An autoclave is being purchased to be able to accomplish the leaching test work.

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 06/30/2010

Start Date: 02/09/2005

End Date: 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 the sorbent addition to evaluate the 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 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 postponed 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.

Current Activity

New dry sorbent materials are being tested in the pilot scale stack gas mercury removal system at Boswell to qualify for potential full scale mercury removal testing on Units 1 or 2.

Principal Investigator(s)

Blair Benner
David Hendrickson

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
350,000	1896-783-1227-00
Total	\$350,000

Active
04/10/2007 06/30/2010

Start Date: 04/10/2007

End Date: 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

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

Current Activity

Modifications of the minipot exhaust are being prepared to allow attachment of the Ohio Lumex on-line probe. Installation at Minnesota taconite operations will follow modification of the sampling probe as stated.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
45,500	1896-783-1200-00
Total	\$45,500

Active
02/09/2005 06/30/2010

Start Date: 02/09/2005

End Date: 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

Bench scale work was scheduled to 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 waste water 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. It was planned that new chemical design research would be tested in early 2009 to evaluate its mercury removal efficiency.

Current Activity

The mercury reduction team formed by WLSSD will be meeting in the summer of 2009 to initiate new test work described by the team. NRRI will be testing new mercury sorbents to remove oxidized and elemental mercury forms in WLSSD's discharge waters in the early fall of 2009.

Principal Investigator(s)

David Hendrickson

Project Sponsor(s)

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

Start Date: 06/02/2006 **End Date:** 06/30/2009 **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 UND. About a week was spent installing the unit and ancillary equipment and trying to get the unit to work. We were unable to get the unit to work, so it 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 four indicated that the unit was working properly.

Current Activity

The work 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. This longer heated sample line will be purchased in the summer of 2009, and on-line speciated mercury testing will commence at Minntac using the new Ohio-Lumex portable on-line continuous speciated mercury analyzer unit.

Principal Investigator(s)

Blair Benner
David Hendrickson

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
350,000	1896-783-1228-00	04/10/2007 06/30/2010
Total	\$350,000	

Start Date: 04/10/2007

End Date: 06/30/2010

Project ID: 1477

2009 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

Flux grinding circuit data were mass balanced, and a performance evaluation was completed. Simulations were carried out to quantify benefits from proposed circuit modifications. All results of the above work were reported to 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 benefits of soft water on flotation. Agglomerator sampling was conducted and data collected to improve green ball size distribution from rubber-lined balling drums. A statistical analysis was used to determine factors influencing green ball sizing. Testing was conducted to determine benefits of soft water on green ball properties, as well as filter studies and batch balling tests. For future optimization of green ball quality and process economics, a series of organic binders has been identified to be evaluated for full or partial replacement of bentonite. New on-line mercury analysis equipment was also used to determine baseline analysis data.

Current Activity

A balling circuit audit was conducted to examine factors that influence green-ball sizing and to identify opportunities for improving target green-ball sizing. Measurements and data were collected on green ball size distribution by individual balling drum, operating parameters, recycle loads, roll screen performance, and green ball quality. Data analysis and a final report are in progress. Filter tests and bench balling studies were conducted to determine benefits associated with the use of soft water vs. typical plant water. Batch balling tests were subsequently fired using the mini-pot furnace to evaluate any effect on fired pellet physical quality properties. Plant water was used as a baseline and dried flot con was then prepared for each of the tests by re-pulping in softened water and pressure filtering to produce target moisture concentrate. Three levels of water hardness were evaluated, as follows: 100% plant water, 50:50 plant water/DI water and 100% DI water. Concentrator improvements gained as a result of using softened water at each step in the concentrator flowsheet at Mintac were also evaluated and reported.

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
US Steel Corp, MN Ore Operations	190,000	3000-10417-00008245	01/01/2009 12/31/2009
Total	\$190,000		

Start Date: 01/01/2009 **End Date:** 12/31/2009 **Project ID:** 1543

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 productivity 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 Activity

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
Total	\$16,500

Active
02/09/2005 06/30/2009

Start Date: 02/09/2005

End Date: 06/30/2009

Project ID: 1383

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

Using DeviceNet communications, a new Allen Bradley Compact Logix Programmable Logic Controller (PLC) was 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.

Current Activity

Programming is being completed for the NRRI moisture analysis system using Allen Bradley DeviceNet communications and an Allen Bradley Programmable Logic Controller (PLC). Design components are built into the system to make it capable of future automation in a taconite plant so as to create an automated on-line filter cake moisture analysis system.

Principal Investigator(s)

David Hendrickson
Kyle Bartholomew
Richard Kiesel

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
88,800	1896-783-1060-00	02/01/2002 06/30/2010
Total	\$88,800	

Start Date: 02/01/2002

End Date: 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 MetalRecovry sited at the Coleraine Minerals Research Laboratory (CMRL) and tile formation and annealing in other equipment at the same site provided by MetalRecovry.

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 in making 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 MetalRecovry) was received at CMRL. Coleraine personnel prepared a dry pilot plant work area and placed the plasma furnace, tile press, and annealing oven in position. Refractory lining of the plasma furnace was completed. A fluid cooler, air compressor, and air dryer were ordered to accommodate the specified plasma torch air and cooling water needs. Electrical service upgrade work was completed so as to power the plasma torch and annealing oven. The new air compressor and fluid cooler were received and installed. Compressed air lines, cooling water loop, and torch water loop were plumbed and leak tested. Furnace exhaust fabrication was completed. An access platform for the furnace was fabricated and installed. Taconite crude ore and tailings samples were identified and set aside for startup testing.

Current Activity

The plasma torch has been installed and tested. The first run ramped the furnace through the refractory curing schedule, reaching a maximum temperature of 1200°F. The second run was an attempt to melt tailings. The furnace was heated to 1,100°F when a torch cooling water leak was discovered, so the run was aborted. The cause of the leak was identified and corrective action has been taken. A second attempt at melting tailings will be performed shortly.

Principal Investigator(s)

David Hendrickson
Donald Fosnacht
Kyle Bartholomew
Lawrence Zanko
Richard Kiesel

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
209,396	1896-783-1241-00
Total	\$209,396

Active

04/28/2008 06/30/2010

Start Date: 04/28/2008

End Date: 06/30/2010

Project ID: 1517

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

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 grinding (SAG) and fully-autogenous grinding (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

The final report will be submitted during January 2009.

Current Activity

No correlation was found between the drop weight results and the previous grinding results. Therefore, the project was ended and the data were issued in a final report. This project is completed.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

18,370 1896-783-1202-00

Active

02/09/2005 06/30/2009

Total \$18,370

Start Date: 02/09/2005

End Date: 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 Dept. 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 U of MN take a lead in studying whether the 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

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.

Current Activity

We have continued to collect air samples as mining activity has slowed and, in some cases, ceased, along the Mesabi Iron Range due to the present economic downturn. These samples represent a "baseline" for the community without the contribution from the iron ore mines. We have also begun sampling within the taconite operations themselves, wherever the nature of the dust produced would be expected to change, either in its physical or chemical characteristics; for example, at primary crusher, magnetic separators, agglomerator, and kiln.

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 06/30/2010
U of M School of Public Health	350,349	---	07/01/2008 06/30/2011
Total	\$550,349		

Start Date: 07/01/2008 **End Date:** 06/30/2011 **Project ID:** 1539

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 06/30/2010

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 grants 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 grants proposals for potential energy reduction projects in various fields of research and development.

Previous Activity

On a State basis, grants were 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 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.

Current Activity

On a Federal basis, three DOE grants were recently submitted to pursue transformational energy technology projects including: (1) A project on the use of microwave energy for producing iron nuggets and using microwave energy to convert plastics into an energy fuel source, (2) A project on the use of coal-oxy burner technology to produce nodular reduced iron, and (3) A project on the use of plasma gasification technology to gasify biomass, followed by conversion of the syngas into liquid fuels via Fisher Tropsch technology.

On a State basis, six grant proposals were submitted to the DNR's Iron Ore Co-Op group for advancing taconite research projects from CMRL.

Principal Investigator(s)

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

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
50,000	1896-783-1214-00
Total	\$50,000

Active

02/09/2005 06/30/2010

Start Date: 02/09/2005

End Date: 06/30/2010

Project ID: 1390

Hydrocyclone Performance, Effects of Demagnetizing Coil and Dispersant Chemicals

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 end up in 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 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.

Current Activity

Due to time constraints, Minorca could not run dispersant tests. It was decided to run duplicate cyclone tests to confirm results. Tests were run at cyclone feed pressures of 12, 14 and 16 psi with the de-magnetizing coil being energized or de-energized. The resulting samples were screened, and the fractions were analyzed for magnetic iron (Satmagan) and silica. The use of the demagnetizing coil had a significant effect on the amount of minus 500 mesh iron that reported to the cyclone underflow. For all tests, approximately twice as much minus 500 mesh iron reported to the underflow with the coil off (normal plant conditions). Preliminary computer simulations were run using historical plant data for the other portions of the flowsheet, which indicated modest improvements in throughput and grade. A final report was submitted to the DNR. This project is completed.

Principal Investigator(s)

Salih Ersayin

Project Sponsor(s)

MN DNR

Amount	Account	Active
33,000	1663-187-6604-00	11/07/2007 06/30/2009
Total	\$33,000	

Start Date: 11/07/2007

End Date: 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

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

Current Activity

A final report will be drafted after liberation analytical results have been received from the JK Minerals Research Centre in Australia.

Principal Investigator(s)

Blair Benner
Salih Ersayin

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
36,000	1896-783-1201-00	02/09/2005 06/30/2009
Total	\$36,000	

Start Date: 02/09/2005

End Date: 06/30/2010

Project ID: 1379

Liberation Based Simulations, Plant Database Generation

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, 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 Activity

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 canceled 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

28,970 1663-187-6606-00

Active

11/07/2007 06/30/2009

Total

\$28,970

Start Date: 11/07/2007

End Date: 06/30/2009

Project ID: 1496

Magnetic Iron Losses in Taconite Plants

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 Activity

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 Date:** 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 a number of 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 budget 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 variations in feed characteristics.

Current Activity

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. The Principal Investigator for this project left the University but will complete this report by the end of summer 2009.

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 Date: 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 of 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 Activity

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. The Principal Investigator for this project left the University but will complete this report by end of summer 2009.

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 Date: 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

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	1,329,850	1664-187-6564-00	01/20/2006 01/20/2008
NU Iron Tech LLC	1,225,004	1664-187-6600-00	04/01/2007 01/20/2009
Total	\$2,554,854		

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 so as 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 to a 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 was 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	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
PUF Mineral Endowment	238,798	1896-783-1229-00	04/10/2007 06/30/2010
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

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 was 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.

Current Activity

Meetings were held with a Minnesota taconite operation who agreed to test the newly modified fines removal system on their stockpiled pellets during the summer and fall seasons of 2009.

Principal Investigator(s)

David Hendrickson
Richard Kiesel

Project Sponsor(s)

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

Start Date: 02/01/2003 **End Date:** 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 process 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. The objective was to determine an ideal cut point and the effect of magnet strength 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. Bulk magnetic separator feed samples were obtained from an operating plant; a series of tests of unclassified feed was conducted with varying magnetic field strengths, percent solids, and feed rates. Two bulk cyclone underflow samples with unique size distributions were prepared for continuous magnetic separator testing. Test work has been completed. Final chemical analyses were completed and sent to the principal investigator. 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.

Current Activity

Kyle Bartholomew has taken over this project and will draft a final report.

Principal Investigator(s)

Jeremy Pletka

Kyle Bartholomew

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account
26,200	1896-783-1076-00
Total	\$26,200

Active
06/01/2003 06/30/2005

Start Date: 06/01/2003

End Date: 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

A semi-annual report draft (TSR-2009-01) was being edited and a summary of the results from July 1, 2008 to December 31, 2008, were: (a) ~120 tons of fine Tac Agg was obtained for developing a new 4.75mm stone matrix asphalt (SMA) mix design, also for use and testing at MnROAD. The construction and paving applications were completed in the fall of '08; (b) Presentation at the TERRA Innovation Series, Engineering Better Roads through Dynamic Research Partnerships, July 30, '08, MnROAD open house; (c) Preparation and delivery of 100 tons of crushed Tac Agg to Illinois in late Aug. '08, for testing and evaluation by the Illinois Department of Transportation (IDOT); (d) Completion of a bridge deck friction resurfacing demonstration project in International Falls, MN, in Sept., '08; and (e) The acceptance of two 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. '09; and 2) Construction Aggregate Potential of Mn Taconite Industry Byproducts for presentation at the 14th Conf. on Cold Regions Engineering in Duluth, MN, Aug. 30-Sept. 2, '09.

Current Activity

Considerable progress was made on several project fronts. Highlights include:

- 1) Presented "Gray is Green: The Aggregate Potential of Mn Taconite Industry Byproducts", at the 88th Transportation Research Board meeting in Washington, DC, in Jan. '09
- 2) Completed geological work for correlating stratigraphy of Biwabik Iron Formation, and its relationship to potential aggregate horizons.
- 3) Compiled water chemistry and water quality data related to taconite tailings.
- 4) Filed a patent application and continued work on taconite-based patching and paving formulations.
- 5) Over 3,300 tons of Arcelor Mittal coarse taconite tailings were prepared by Ulland Brothers on 4/23/2009.
- 6) Presented to CTS 20th Annual Transportation Research Conference, on 5/19/09.
- 7) Shipped 5,000 tons of taconite aggregates from Duluth to Chicago on 5/28. L. Zanko and D. Fosnacht traveled to Chicago, IL, Cleveland, OH, and Pittsburgh, PA, to document the delivery & hold meetings with taconite parent companies and potential end users.
- 8) Began compilation of project findings.

Principal Investigator(s)

Donald Fosnacht
Lawrence Zanko
Steven Hauck

Project Sponsor(s)

	Amount	Account	Active
Blandin Foundation	10,000	1670-187-6516-00	02/01/2004 12/31/2006
USDOD EDA	1,250,000	1661-187-6565-00	01/01/2006 12/31/2009
Minnesota Power	10,000	1831-187-2680-00	02/08/2005 06/30/2010
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. It was decided to rebuild the sinter pot facility for deep bed, high suction conditions. This work was slated to be in progress during 2009, and NORAMCO was providing detailed engineering support. CMRL staff continued to handle installation of new equipment, which was being ordered as needed.

Current Activity

All major pieces of equipment are on site and in place. A new sinter pot has been fabricated. Wiring is currently underway, and programming of the PLC (Programmable Logic Controller) will commence the second week of August. Commissioning tests are expected to begin in the third or fourth week of August.

Principal Investigator(s)

Dave Englund

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

309,869 1896-783-1238-00

Active

01/31/2008 06/30/2010

Total \$309,869

Start Date: 01/31/2008

End Date: 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 (EDA) aggregate project. Therefore, completion of the final report will be delayed until the completion of the EDA project.

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; potential as a raw material source for cement making; and communicating related research findings to others, including the submittal of two papers (accepted) to the 88th Meeting of the 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

Active

05/01/2002 06/30/2010

Total

\$65,000

Start Date: 02/01/2002

End Date: 06/30/2009

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 Activity

Testwork is planned to be completed by August 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

30,000 1896-783-1075-00

Active

06/01/2003 06/30/2010

Total

\$30,000

Start Date: 06/01/2003

End Date: 06/30/2010

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 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

Development of a typical straight grate furnace firing cycle was established. Green balls were collected from a commercial balling drum to eliminate any variance associated with balling, and these were then fired as a baseline. Pot grate tests will be used for comparing the standard firing cycle to one adding additional heat in the pre-heat zone. Pelletizing feed mixtures were prepared containing bentonite binders with 0.3% and 1.2% fluxstone. Mini-pot furnace tests were conducted to observe the effect of additional temperature in the pre-heat section of a straight grate furnace. Pre-heat tests were also conducted with the mini-pot furnace using the same cycles. A pre-heat test is quenched in nitrogen following the preheat stage of induration so as to stop the oxidation. This was done for the purpose of comparing physical quality at this intermittent point in the process.

Current Activity

Additional full pot grate firings will be used to confirm the results using the temperatures for pre-heat established by the mini-pot tests and compared to the previously established baseline. These tests are currently pending the completion of the pot grate upgrade to the control system, airflow, plumbing and combustion system. A final report for the results 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 06/30/2010
Total	\$25,000	

Start Date: 02/09/2005

End Date: 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

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.

Current Activity

Based on the research findings, a patent application has been filed. Next steps in the project include making adjustments to the binder formulation.

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 06/30/2010

Start Date: 02/09/2005

End Date: 06/30/2009

Project ID: 1392

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

Current Activity

Two first-year engineering students were used to begin developing 3D SolidWorks models for this project. The goal was to complete as many coolers as possible. Only one model was completed (United Taconite Line 2) by the project deadline of June 30, 2009, which prevented starting the CFD modeling phase. However, the project was successful in starting a collaborative effort between the NRRI Coleraine Minerals Research Lab (CMRL) and Itasca Community College Engineering Program. One of the students was hired as a summer intern at CMRL and will continue building the remaining models during July/August. The Iron Ore Co-Op portion of this project ended on June 30, 2009. A continuation of the project received high ranking and is awaiting budget approval.

Principal Investigator(s)

Dave Englund

Project Sponsor(s)

MN DNR

Amount Account

55,200 1663-187-6607-00

Active

11/07/2007 06/30/2009

Total \$55,200

Start Date: 11/07/2007

End Date: 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

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).

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.

Current Activity

A rough draft detailing the stratigraphy of the Biwabik Iron Formation has been completed (along with over 37 plates) and is currently being proof-read by Severson, Heine, and Patelke. This report divides the iron-formation into 25 major units that are tied into the bedding type, which in turn, can be correlated with each of the various mine's submember nomenclatures. This report also identifies six potential aggregate horizons within the iron-formation that are (listed according to a priority basis): 1. "Mesabi Select" unit at the top of the Lower Cherty; 2. "Mesabi Select Equivalent" material from the Lower Slaty at the McKinley Extension mine near Biwabik; 3. Silicate taconite waste zones/channels within the Lower Cherty Wavy-bedded Unit at Hibtac and Minntac; 4. Upper IBC Unit (channel-like bodies of waste materials referred to as "interbedded cherts") in the Lower Slaty at Minntac; 5. Upper half of the Upper Cherty at Hibtac, Minntac, and Utac; and 6. Uppermost portions of the Lower Slaty at numerous mines (very low priority).

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

176,000 1896-783-1225-00

Active

07/16/2006 06/30/2010

Total \$176,000

Start Date: 07/16/2006

End Date: 06/30/2009

Project ID: 1437

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 publicly 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

Lithologic data for 48 of the recently logged holes (that are publicly 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.

Current Activity

Five databases have been generated for the project that include: 1. a header file listing locations of all holes drilled in the Duluth Complex since 2003; 2. a header file listing locations of all Biwabik Iron Formation holes that have been logged by NRRI personnel; 3. a listing of rock types and units in 106 drill holes (9,933 lines of data) for the Mesaba Cu-Ni deposit; 4. a listing of rock types and units in 46 drill holes (1,332 lines of data) for the Dunka Pit Cu-Ni deposit; and 3. a listing of the members and submembers in 86 holes (4,600 lines of data) in the Biwabik Iron Formation for holes logged by NRRI personnel. Data that are still pending and need to be added to various databases are: Teck American's holes (64) from the Mesaba deposit; Duluth Metals holes (seven) from the Nokomis deposit; drill holes from the Deer Lake Complex (Itasca County); drill holes from the Animikie Basin (most were logged by Severson for a previous SEDEX project).

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)

	Amount	Account	Active
MN DNR	40,000	1663-187-6613-00	03/07/2008 06/30/2009
PUF Mineral Endowment	40,000	1896-783-1240-00	04/01/2008 06/30/2010
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 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.

Current Activity

Installation of the flotation pilot plant gave Coleraine the capacity to grind tonnage quantities of copper-nickel ore and run the ground material through rougher, cleaner, and recleaner flotation stages with the option for regrinding of the cleaner concentrate. The system was set up for zero discharge. The process water was recycled, all the tailings were thickened and filtered, and the filtercake was loaded into super sacks and transported to a land fill. The system was successfully used to process over 1,000 tons of crushed copper-nickel ore.

Principal Investigator(s)

Blair Benner

Project Sponsor(s)

PUF Mineral Endowment

Amount	Account	Active
92,000	1896-783-1242-00	04/28/2008 06/30/2010
Total	\$92,000	

Start Date: 04/28/2008

End Date: 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 Keweenaw-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 did not take place in September 2008 due to more immediate work and in part by weather. Field work is scheduled for summer 2009.

Current Activity

Field reconnaissance mapping will begin in July and continue into August 2009.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

15,000	1896-783-1082-00
Total	\$15,000

Active

09/01/2004 06/30/2010

Start Date: 09/01/2004

End Date: 06/30/2009

Project ID: 1358

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

Objective

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

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 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.

Current Activity

Two poster presentations of the glacial indicator data were conducted, i.e., Heine, J., Hauck, S., and Thorleifson, H., 2009, Selected Indicator Mineral and Till Chemistry Results from Multiple Till Surveys in Minnesota: University of Minnesota, Duluth, MN, Natural Resources Research Institute, Economic Geology Group Poster Series, NRRI-POSTER-2009/01, presented at the Prospectors and Developers Association of Canada, in Toronto in March, and the second poster by Hauck, S.A., Heine, J.J., and Thorleifson, L.H., 2009, A Follow-up Glacial Till Indicator Mineral Survey in Minnesota: What Does it Indicate About Exploration for Diamonds and Other Mineral Deposits?: University of Minnesota, Duluth, MN, Natural Resources Research Institute, Economic Geology Group, Poster Series NRRI-POSTER-2009/04, presented at the 55th Annual Meeting of the Institute on Lake Superior Geology, in Ely, MN, in May.

Work is continuing on the final report.

Principal Investigator(s)

John Heine
Steven Hauck

Project Sponsor(s)	Amount	Account	Active
MN Department of Natural Resources	74,700	1663-187-6586-00	08/10/2006 06/30/2008
PUF Mineral Endowment	95,000	1896-783-1223-00	07/16/2006 06/30/2010
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

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.

Current Activity

Tom Larson was contacted by the new principal investigator, and data from the project has been located. Testwork is complete and final report writing is underway. The primary conclusion from the project is that the concentrator shows technical promise for upgrading taconite ore, but the physical configuration of the Falcon concentrator likely makes it too capital intensive for the proposed application.

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 Date: 06/30/2009

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

The microprobe identification of materials continues, but is still in preliminary stages due to more immediate commitments.

Principal Investigator(s)

Mark Severson
Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

Amount Account

76,000 1896-783-1071-00

Active

05/01/2002 06/30/2010

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

July 1-Dec 31 2008 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.

Current Activity

PRC co-director Dean Peterson took a position with Duluth Metals in late 2008, but retains a ¼ position with the PRC that will continue his involvement in the field camp.

Field Camp: Promoted camp by distributing 250 posters and making several school visits; 2009 camp enrollment was 19.

Workshops: Promoted and planned a professional workshop on Mafic Layered Intrusions to be held at UMD in Oct. 2009.

Student Awards: UMD student Tom Johnson was supported during the spring semester with a PRC Graduate Research Assistantship. Student research grants were awarded to five students this spring (3 UMD, 1 U of TN-Knoxville, 1 U of MN – Twin Cities).

Fundraising: Solicitations were made by email correspondence, distribution of the annual report, and contacts made at industry conferences - PDAC and SME. Contributions for 2009 currently total \$31,000 due largely to continued memberships by our main corporate sponsors – Anglo American, Newmont, and Cliffs NR. Other Activities: The PRC hosted the 55th Annual Institute on Lake Superior Geology in Ely, MN, May 5-10. The meeting was attended by 235 people.

Principal Investigator(s)

Dean Peterson

Jim Miller

Steven Hauck

Project Sponsor(s)

PUF Mineral Endowment

	Amount	Account	Active
	150,000	1896-783-1226-00	07/18/2006 06/30/2010
Total	\$150,000		

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 compiled and published "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 06/30/2010

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

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

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

Current Activity

Several holes have been earmarked for future logging and a form to be used in this endeavor has been prepared. Logging of core should begin in August.

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 06/30/2010

Start Date: 09/01/2004

End Date: 06/30/2009

Project ID: 1356

Peat Expansion Premier Horticulture, Inc.

Objective

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 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.

Current Activity

NRRI personnel completed a National Pollutant Discharge Elimination System (NPDES) permit renewal for Premier's Black Lake Bog (formerly Peatrex) in March.

Premier is currently pursuing an easement with a local landowner to allow construction of a drainage ditch from the Wright Bog. NRRI's involvement in the Wright Bog horticultural peat development is on hold until this issue is resolved.

Principal Investigator(s)

Kurt Johnson
Steven Hauck

Project Sponsor(s)

Minnesota Technology, Inc

Amount	Account	Active
99,982	1673-187-6441-00	07/01/1999 06/30/2004
	1196-187-2428-00	10/25/2001 06/30/2010
Total	\$99,982	

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

Wetland Banking Fens Research Facility

Objective

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

In 2002 and 2005, the University of Minnesota entered into agreements with BWSR and Mn/DOT to restore 333.2 acres of drained peatlands for new wetland credit at the Fens. Under the 2002 and 2005 agreements, the land was cleared, vegetation killed, and the soil rototilled. Subsequently, the ditches were filled, the land leveled and donor material (plant fragments) from nearby bogs was gathered and spread at the Fens. Water wells and vegetation plots were monitored and herbicide was sprayed on invasive species in August and September of each year since bank establishment. In 2006 and 2007, the University of Minnesota developed a peatland restoration plan and proposed establishing another 145.4 acre wetland bank. The proposal was approved by BWSR in the fall of 2008 and the resulting new wetland credits would be bought by BWSR.

Current Activity

The new 145.4 acre bank site was prepared for planting during late-winter and early-spring. Donor material was collected from a donor site in a nearby bog by rototilling the surface, bulldozing the tilled material into piles, and loading the donor material with an excavator onto a large manure spreader. The donor material was then spread onto the prepared fields. Subsequently, straw mulch was spread over the seeded area. Seventeen new monitoring wells were installed in the new 145.4 acre wetland bank. In May, at each monitoring well, water table elevation measurements were begun in the previously established wetland banks and the newly established wetland bank.

Principal Investigator(s)

Thomas Malterer

Project Sponsor(s)	Amount	Account	Active
Minnesota DOT	1,531,760	1196-187-2426-00	05/01/2001 06/30/2010
MN Board of Water and Soil Resources	809,906	1196-187-2426-00	05/01/2001 06/30/2010
Total	\$2,341,666		

Start Date: 07/01/2002 **End Date:** 09/30/2009 **Project ID:** 1367

Wetland Mitigation in Abandoned Gravel Pits

Objective

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

The project contract was amended to allow a no-cost extension to include the 2009 growing season. 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. 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.

Current Activity

Research plot data entry and analysis are ongoing. Project abstracts for oral presentations were prepared and submitted for the Society of Wetland Scientists annual meeting scheduled for June in Madison, Wisconsin, and the International Conference on Ecology and Transportation scheduled for December in Duluth, Minnesota. Bog donor material collected from NRRI's Fens Research Facility and Premier's Black Lake Bog was spread on selected areas of the Mitigation 4 site in March. A mulch study was also established on the site. A new study site was established on Mitigation 3 in late May to test the effects of mulch, new BWSR seed mixes, and conifer seedlings on wetland success. Another plant survey of all the plots was conducted in late June. The presentation "Wetland Mitigation in Abandoned Gravel Pits" was given at the Society of Wetland Scientists 2009 Annual Meeting in Madison, Wisconsin, in June.

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 (APT), 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

Results from mercury analyses up to the fall 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.

Approximately 10 samples of APT product are being used in each of the mechanism experiments. The study is about 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.

Current Activity

The project was completed in February, 2009, and a final report was submitted on March 2. This project yielded recommendations for potential future studies on the APT granules and refining the understanding of the mechanisms that promote the attraction of mercury and other metals to APT's peat product. They include:

- The NRRI Coleraine lab suggested that it may be worthwhile to complete mercury analyses on the various peat products.
- Based on the results of total and dissolved mercury analyses, evaluation of the APT product in tandem with a filtering medium is suggested.
- Further research should be done to estimate the number of sites created by physical (not chemical) H₂S adsorption on the peat granules.
- The cobalt analysis method utilized in this study failed. Other cobalt test methods should be used to evaluate the loading capacity of the granules.

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

Forestry/Forest Products

Personnel

Matthew Aro successfully completed a Masters of Science Management of Technology Program from the University of Minnesota.

University of Minnesota Duluth mechanical engineering students, **Anthony Kraft** and **Tyler Johnson**, were hired for the Market Oriented Wood Technology Program to assist in project activities this summer.

Will DeRocher was hired as a student laboratory scientist in the Wood Materials and Manufacturing Program. He is a civil engineering student at the University of Minnesota Duluth.

Scientific Meetings/Presentations

Bill Berguson gave a presentation entitled “The SunGrant Woody Crops Development Program” at the annual joint meeting of the SunGrant Biomass Feedstock Partnership and Department of Energy, Office of Biomass Programs in Washington, D.C., on March 12, 2009.

Bill Berguson gave a presentation entitled “Biomass Sources and Production in Minnesota” at a meeting sponsored by the University of Wisconsin – Extension Service in Cable, Wisconsin, on April 8, 2009.

Bill Berguson gave a presentation entitled “The Laurentian Energy Biomass Program” at the annual DOE Biomass Program review in Washington, D.C., on April 9, 2009.

Xiping Wang gave a presentation entitled “Heat Treatment Operations – Heat Treating Options and Temperature Monitoring” at a training workshop on heat treatment of firewood in Madison, Wisconsin, on February 25, 2009.

Xiping Wang gave a presentation entitled “NDT Technologies for Wood – From Research to Practice” at a seminar at the Beijing Forestry University, School of Technology in Beijing, China, on June 30, 2009.

Xiping Wang gave a presentation entitled “NDT Technologies for Wood – Current Research and Development” at a seminar at the Chinese Academy of Forestry, Forest Machinery Research Institute, in Beijing, China, on July 1, 2009.

Publications

Y. An, Y. Yin, **X. Wang**, R.J. Ross, J. Lu, and X. Jiang. 2009. Evaluation of Bending Performance of Structural Lumber Using Nondestructive Methods. *China Wood Industry*. 23 (4): 5-8. (July 2009).

B.K. Brashaw, **R. Vatalaro**, **X. Wang** and R. Ross. 2009. Condition Assessment of the Steamboat Minnehaha. Natural Resources Research Institute Technical Report NRRI/TR-2009/04.

B.K. Brashaw, V. Bucur, F. Divos, R. Goncalves, J. Lu, R. Meder, R.F. Pellerin, S. Potter, R.J. Ross, **X. Wang**, and Y. Yin. (Authors are in alphabetical order). 2009. Nondestructive Testing and Evaluation of Wood: A Worldwide Research Update. *Forest Products Journal* 59 (3): 7-14. (Feature article March 2009).

B.K. Brashaw, **V. Krause**, and **R. Vatalaro**. 2009. Dimensional Stability of Various Lumber Groups. Natural Resources Research Institute Technical Report NRRI/TR-2009/08.

V. Krause. 2009. Engineered Hardwood Floor Testing. Natural Resources Research Institute Technical Report NRRI/TR-2009/14.

V. Krause. 2009. Engineered Hardwood Floor Testing. Natural Resources Research Institute Technical Report NRRI/TR-2009/18.

V. Krause. 2009. Evaluation of 3D Laminated Parts. Natural Resources Research Institute Technical Report NRRI/TR-2009/17.

V. Krause. 2009. Laminate Performance Testing Black Expanded PVC. Natural Resources Research Institute Technical Report NRRI/TR-2009/26.

V. Krause. 2009. Laminate Performance Testing BS3, BS4, and EB. Natural Resources Research Institute Technical Report NRRI/TR-2009/25.

V. Krause. 2009. Laminate Performance Testing on High Gloss Materials. Natural Resources Research Institute Technical Report NRRI/TR-2009/13.

V. Krause. 2009. Surface Performance Testing: Powdercoat on MDF. Natural Resources Research Institute Technical Report NRRI/TR-2009/23.

J. Ohlrogge and **W. Berguson.** 2009. Driving on Biomass. Science May 2009 Edition.

X. Wang, R. Bergman, W.T. Simpson, T. Mace, and S. Verrill. 2009. Heat Sterilization of Ash Firewood for Thermal Eradication of Emerald Ash Borer. Natural Resources Research Institute Technical Report NRRI/TR-2009/02. Submitted to U.S. Forest Service Wood Education and Resources Center, Princeton, West Virginia. April 2009.

X. Wang, J. Wiedenbeck, and S. Liang. 2009. Acoustic Tomography for Decay Detection in Black Cherry Trees. Wood and Fiber Science 41 (2): 127-137. (Refereed) (April 2009).

X. Wang, H.E. Stelzer, J. Wiedenbeck, P.K. Lebow, and R.J. Ross. 2009. Assessing Wood Quality of Borer-Infested Red Oak Logs with a Resonance Acoustic Technique. Wood and Fiber Science 41 (2): 180-193. (Refereed) (April 2009).

Outreach

Armstrong Cabinet Products, Addison, Texas: The Wood Materials and Manufacturing Program conducted KCMA hot/cold crack testing of various cabinet door products.

Cirrus Design, Duluth, Minnesota: The Wood Materials and Manufacturing Program conducted resin flow testing in support of the quality assurance program for incoming materials. Performed shear testing of various products.

Epicurean Cutting Surfaces, Duluth, Minnesota: The Wood Materials and Manufacturing Program conducted humid/dry cycling of cutting boards to assess dimensional stability of new products.

Ferche Millwork, Rice, Minnesota: The Wood Materials and Manufacturing Program performed an evaluation of several door jamb components to assess product failures.

Hedstrom Lumber, Grand Marais, Minnesota: Patrick Donahue and Scott Johnson provided Hedstrom Lumber a feasibility report regarding the reopening of a shuttered wood products factory in the region. The report was the outcome of several months of discovery work that included 250 pictures of the factory detail. The report also provided a gross estimate of the cost to reopen the factory.

Hill Wood Products, Cook, Minnesota: The Wood Materials and Manufacturing Program conducted internal bond testing and visual assessment of plywood products to assess defects and performance in support of the product development efforts for engineered wood flooring.

Lake States Lumber, Duluth, Minnesota: Patrick Donahue and Scott Johnson provided Lake States Lumber a feasibility report regarding the reopening of a shuttered wood products factory in the region. The report was the

outcome of several months of discovery work that included 250 pictures of the factory detail. The report also provided a gross estimate of the cost to reopen the factory.

Lumber Jack's Firewood, Woodstock, Illinois: Jack Foss, Owner of Lumber Jack's Firewood, requested technical assistance from the Wood Materials and Manufacturing Program on kiln modification and heat treatment options for special firewood.

Neenah Paper, Alpharetta, Georgia: The Wood Materials and Manufacturing Program provided information on KCMA testing standards to Neenah Paper.

Norske Wood Works II, Inc., Black Earth, Wisconsin: Harold Norske, Owner of Norske Wood Works II, Inc. requested the Wood Materials and Manufacturing Program to provide technical assistance on kiln design for heat treating of firewood.

Northern Contours, Fergus Falls, Minnesota: The Wood Materials and Manufacturing Program conducted KCMA kitchen cabinet assessment testing, and laminate performance testing to Northern Contours. We also provided technical assistance for a variety of products and manufacturing processes in support of their product families.

Owens Flooring Company, Shawano, Wisconsin: The Wood Materials and Manufacturing Program conducted dimensional stability testing of various engineered flooring products in support of Owens Flooring Company's research and development process.

Renewable Resource Solutions LLC, Crystal Falls, Minnesota: The Wood Materials and Manufacturing Program moderated a webinar on woody biomass and wood pellet production for the Northeastern Woody Biomass Utilization Program of the USDA Forest Service.

Rockland Industrial Products, Red Wing, Minnesota: The Wood Materials and Manufacturing Program conducted load testing of various truck flooring products in support of Rockland Industrial Products new product development.

St. Louis County Land Department: Bill Berguson and Dan Buchman provided assistance to the St. Louis County Land Department in developing estimates of harvest residue biomass associated with thinning of young red pine stands.

Bill Berguson and Bernie McMahan hosted a tour of NRRI's hybrid poplar research in central Minnesota for Dan Kiethley, Forestry-Department Head, at Michigan State University in May 2009.

Cloquet Kiwanis Club, Cloquet, Minnesota: Bill Berguson gave a presentation to the Cloquet Kiwanis Club on biomass and emerging energy technology in May 2009.

The Idea Circle, Bemidji, Minnesota: The Wood Materials and Manufacturing Program provided information on wood pellet manufacturing processes and manufactured wood pellet samples from various wood residues for their evaluation.

U.S. Army Corps of Engineers, St. Louis, Missouri: The Wood Materials and Manufacturing Program provided information on in-place assessment techniques for wood piles.

USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine Office, Madison, Wisconsin: JoAnn Cruse, State Plant Health Director, requested the Wood Materials and Manufacturing Program to provide technical assistance on training federal and state Plant Protection and Quarantine officers on heat treating ash firewood for EAB and certifying heat treating facilities in the state of Wisconsin.

Van Technologies, Duluth, Minnesota: The Wood Materials and Manufacturing Program conducted abrasion testing of finished flooring pieces for internal assessment of coating performance.

Willamette Valley Company, Eugene, Oregon: The Wood Materials and Manufacturing Program provided information on industry contacts for engineered flooring manufacturers in the upper Midwest in support of new product development.

Facilities

The greenhouse and growth chamber at the NRRI are being used for the 2009 poplar breeding activities being done under the Minnesota Forest Productivity Research Cooperative program. Crosses have been very successful this year and seed is being collected to produce a new population of clones to be propagated for eventual field testing.

Coleraine Minerals Research Lab & Economic Geology Group

Personnel

Jeffrey Antonovich, Shaun Gram, Aaron Hicks, Anthony Larson, Michael Swanson and Steven Zaitz were hired on full time status as of April 2009 as Senior Laboratory Technicians. They were originally hired on six month temporary status for the Teck Cominco copper nickel project July 2008 to December 2008.

Student Interns at CMRL

In April 2009 NRRI-CMRL employed **Christian Potocnik** and **Matthew Niesen**, students in the Itasca Community College Engineering program, through ICC's student intern service. The students were utilized to complete a three dimensional rotary cooler model for one taconite line. Their work was funded using Iron Ore Cooperative Research funds from the Cooler Up-Grade Project, which ended on June 30.

In late June, **Christian Potocnik** continued working as a student intern at CMRL, using PUTF funding. The goal is to complete 3-D rotary cooler models for all operating taconite plants in Minnesota by the end of August 2009. The models will be used to develop Computational Fluid Dynamics (CFD) models at CMRL for process improvement and efficiency studies. Chris is in his second year at Itasca Community College and is conducting programming work using "Solid Works" 3D programming software to aid our modeling efforts in the area of CFD (Computational Fluid Dynamics) modeling.

Scientific Meetings/Presentations/Papers

Salih Ersayin, W.M. Bond, J. Arola, R.S.Strukel, B. Kettunen, "Simulation assisted performance improvements at iron ore processing plants," *Minerals and Metallurgical Processing*, V.26, No.1, 2009, pp41-48.

Dave Hendrickson spoke about sustainability of our Minnesota Natural Resources at the 2009 Iron Range Earth Fest conference held in Mountain Iron, Minnesota, on April 18, 2009. Earth Fest's first year on the Iron Range produced benefits that would help reduce home energy costs. Ideas presented included starting or improving a vegetable garden, practical methods for composting, watching a blacksmith at work, a wind turbine contest for kids, riding an energy bike, financial assistance for weatherizing homes, information about installing geo-thermal heating and solar panels, how to obtain tree seedlings, making and using rain barrels, and understanding the new biomass project in Virginia. (hometownfocus.us April 2009) Earth Fest is designed to help us develop a new understanding of how we can bring sustainability back into our homes.

Mark Severson co-led two field trips associated with the meeting of the Institute of Lake Superior Geology (ILSG) that was held in Ely, MN, in early May.

Diedrich, T., Brecke, D., Schreiber, M., Zanko, L., Marple, V., and Olson, B., Environmental Study of Mineral Dust in Population Centers on Mesabi Iron Range: Progress Report: Presentation, 82nd Annual Meeting SME, Minnesota Section, April 14th, 2009.

Diedrich, T., Brecke, D., Schreiber, M., and Zanko, L., 2009, Taconite-Derived Mineral Dust in Population Centers on Mesabi Iron Range: Tracking Mineral Fibers from Ore to Air [abs.]: University of Minnesota Duluth, Natural Resources Research Institute, NRRI Poster 2009/05, and presented at Institute on Lake Superior Geology, v. 55, Part 1 – Proceedings, p. 18-19, Ely, MN.

Diedrich, T., Brecke, D., Schreiber, M., Zanko, L., Marple, V., and Olson, B., 2009, Environmental Study of Mineral Dust in Population Centers on Mesabi Iron Range: Progress Report: University of Minnesota, Duluth, MN, Natural Resources Research Institute, Economic Geology Group Poster Series, NRRI-POSTER-2009/02.

Hauck, S.A., Heine, J.J., and Thorleifson, L.H., 2009, A follow-up glacial till indicator mineral survey in Minnesota: What does it indicate about exploration for diamonds and other mineral deposits? [abs.]: University of Minnesota Duluth, Natural Resources Research Institute, NRRI Poster 2009/04 and presented at Institute on Lake Superior Geology, v. 55, Part 1 – Proceedings, p. 18-19, Ely, MN.

Heine, J., Hauck, S., and Thorleifson, H., 2009, Selected Indicator Mineral and Till Chemistry Results from Multiple Till Surveys in Minnesota: University of Minnesota, Duluth, MN, Natural Resources Research Institute, Economic Geology Group Poster Series, NRRI-POSTER-2009/01. Presented at the Prospectors and Developers Convention, Toronto, Canada, March 2009.

Jefferson, T. and **Severson, M.,** 2009, Part 4: Mesaba Deposit – Teck American Incorporated, *in* Field Trip 1, Cu-Ni deposits of the Duluth Complex, Patelke, R., compiler, *in* Peterson, D.M. ed., Field Trip Guidebook, Institute on Lake Superior Geology, v. 55, Ely, MN, Part 2, p. 43-57.

Johnson, K., 2009, Wetland Mitigation in Abandoned Gravel Pits: Society of Wetland Scientists, 2009 Annual Meeting, Madison, Wisconsin, June 22-26.

Ojakangas, D., **Severson, M.,** Halverson, D., Bird, J., Campbell, T., Lubben, J., Jongewaard, P., and Everett, W., 2009, Geology and Metamorphism of the Eastern Mesabi Range, Field Trip 5, *in* Peterson, D.M., ed., Field Trip Guidebook, Institute on Lake Superior Geology, v. 55, Ely, MN, Part 2, p. 116-155.

Oreskovich, J.A., Cartwright, D., and Oberhelman, M., 2009, 2009, Documenting Underground Mine Workings on the Mesabi Range in GIS Format – Updates, Insights, and the Road Ahead: Presentation, 82nd Annual Meeting SME, Minnesota Section, April 14th, 2009.

Patelke, R., Geerts, S., and **Severson, M.,** 2009, Part 2: PolyMet NorthMet Deposit, *in* Field Trip 1, Cu-Ni deposits of the Duluth Complex, Patelke, R., compiler, *in* Peterson, D.M., ed., Field Trip Guidebook, Institute on Lake Superior Geology, v. 55, Ely, MN, Part 2, p. 16-37.

Patelke, R. **Severson, M.,** Jefferson, T., and Peterson, D., 2009, Part 1: Introduction, deposits, and regional geology of the field trip area, *in* Field Trip 1, Cu-Ni deposits of the Duluth Complex, Patelke, R., compiler, *in* Peterson, D.M. ed., Field Trip Guidebook, Institute on Lake Superior Geology, v. 55, Ely, MN, Part 2, p. 1-15.

Routledge, R.E.(extracted from 2004 NI 43-101), and **Severson, M.,** 2009, Part 5: Franconia Birch Lake Project, *in* Field Trip 1, Cu-Ni deposits of the Duluth Complex, Peterson, D.M. ed., Field Trip Guidebook, Institute on Lake Superior Geology, v. 55, Ely, MN, Part 2, p. 58-61.

Severson, M., 2009, Part 3: Dunka Road Field Trip Stops, *in* Field Trip 1, Cu-Ni deposits of the Duluth Complex, Patelke, R., compiler, *in* Peterson, D.M. ed., Field Trip Guidebook, Institute on Lake Superior Geology, v. 55, Ely, MN, Part 2, p. 38-42.

Severson, M.J., 2009, The Mesaba Deposit (and other Cu-Ni deposits), Duluth Complex: Presentation, 82nd Annual Meeting SME, Minnesota Section, April 14th, 2009.

Severson, M.J., Heine, J.J., and Patelke, M.M., 2009, Geologic and Stratigraphic Controls of the Biwabik Iron Formation and Aggregate Potential of the Mesabi Iron Range, Minnesota: University of Minnesota, Duluth, MN, Natural Resources Research Institute, Economic Geology Group Poster Series, NRRI-POSTER-2009/03. Presented at the Society of Mining Engineers, Minnesota Section, 82nd Annual Meeting, April 14-15, Duluth, MN

Severson, M.J., Heine, J., and Patelke, M.M., 2009, Geologic and Stratigraphic Controls of the Aggregate Potential of the Biwabik Iron Formation, Mesabi Range, northern Minnesota: University of Minnesota, Duluth, MN, Natural Resources Research Institute, Technical Report NRRI/TR-2009/09, in prep.

Velasquez, R., Turos, M., Moona, K. H., **Zanko, L.**, and Marasteanu, M., 2009, Using recycled taconite as alternative aggregate in asphalt pavements: *Construction and Building Materials*, v. 23, no. 9, p. 3070–3078.

Zanko, L., 2009, Gray Is Green: Aggregate Potential of Minnesota Taconite Industry By-products, Use of Mine and Industrial By-products as Aggregate: 88th Transportation Research Board meeting in Washington, DC, January 11-15, 2009.

Zanko, L.M., Fosnacht, D.R., and Hauck, S.A., 2009, Research, Development, and Marketing of Minnesota's Iron Range Aggregate Materials for Midwest and National Transportation Applications: January 2009, Progress Report to the Economic Development Administration: University of Minnesota, Duluth, MN, Natural Resources Research Institute, Technical Summary Report, NRRI/TSR-2009/01, 38 p.

Zanko, L.M., Fosnacht, D.R., and Hopstock, D.M., in prep., Construction Aggregate Potential of Minnesota Taconite Industry Byproducts: American Society of Civil Engineers (ASCE), Fourteenth Conference on Cold Regions Engineering in Duluth, Minnesota, August 30-September 2, 2009.

Zanko, L., Wittle, J.K., Pamukcu, S., Bowman, D., and Doering, F., in prep., Field Studies on Sediment Remediation: Chapter, *in* Reddy, K. and Cameselle, C., *Electrochemical Remediation Technologies for Polluted Soils, Sediments and Groundwater*: John Wiley and Sons.

Outreach

BASF at Coleraine

BASF, the world's largest chemical company, is working with the Coleraine Minerals Research Laboratory to test various organic binder chemicals to replace bentonite. More than 400 hundred tests have been completed to date in search of new organic binder chemicals to replace standard taconite inorganic binders.

AMIRA International Visit and Potential Collaboration

A representative of the Australian Minerals Industry Research Administration International visited CMRL to seek NRRI collaboration with this international mining research organization based in Melbourne, Australia. Resulting potential collaboration would greatly increase NRRI's outreach work with the world's largest mining companies.

Facilities

Two New House³ Units to be Installed at CMRL

Two new House³ housing facilities designed by NRRI staff have been ordered and are being built in Duluth for installation at CMRL in August 2009. These two facilities will be located on CMRL property near Highway 169. Each unit has about 650 sq. ft. of floor space and will serve as the first NRRI House³ units built to date.

Biomass Fuel Characterization Facility Installed at CMRL

A unique 100 gram capacity Thermogravimetric Analyzer (TGA) system has been constructed to characterize biomass materials at CMRL and will be used for the purpose of developing a biomass materials database for characterizing biomass materials for the State of Minnesota. The database will be patterned after CSIRO's (Commonwealth Scientific and Industrial Research Organisation) 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. More than 50 samples have been processed in the newly designed TGA analysis equipment.

Wind Turbine to be Installed at CMRL

A new 10 kw wind turbine will be installed at CMRL in the fall of 2009. DC power generated by the turbine will be converted to AC power via an inverter supplied with the system. The AC power will be connected to CMRL's

AC electrical power grid to supplement power provided by Minnesota Power. AC and DC power produced by the wind turbine will be used in future alternative energy projects conducted at CMRL.

Automation of Metallurgical Test Equipment at CMRL

Allen Bradley automated PLC control systems have been installed and networked at CMRL to enhance the control and data logging capabilities of many sets of metallurgical test equipment. Plans include additional automation of the pellet pot grate system frequently used at CMRL.

New CMRL Instrumentation

CMRL has added an automated calorimeter unit used in biomass energy and coal research project work to its analytical laboratory facilities, as well as two new Leco Carbon / Sulfur analyzers used for metallic and carbon sample analysis.

DOE Nodular Reduced Iron Project at CMRL

A total of eight new natural gas fired 250,000 BTU oxy-fuel burners have been installed in CMRL's pilot scale Linear Hearth Furnace (LHF) and a number of test runs have been conducted over the past 6 months to optimize the production of quality nodular reduced iron and lower operating costs. The automation of furnace car movement through the furnace is working successfully to simulate a continuous furnace operation. Evaluations are in progress to utilize Powder River Basin (PRB) coal as a reductant material, since PRB coal has the advantage of availability, low cost, and high volatile content to benefit the metallizing reaction. In addition to using coal as a reductant, a specialized coal-fired oxy-fuel burner has also been ordered, which will be used in the LHF to evaluate the use of coal as a fuel source to the oxy-burners.

NuIron Technologies, LLC Continues to Make Significant Progress with Its Prototype Plant

A number of commissioning test runs have successfully been conducted for the new pilot scale NuIron Technologies Linear Hearth Furnace over the past six months, and quality nodular reduced iron products have been produced for use as feedstock in Electric Arc Furnace (EAF) steelmaking. Future tests are focused on optimizing fuel consumption and increasing furnace productivity.

Copper/ Nickel Research Work Advances

Bench scale Cu/Ni research projects are currently being conducted at CMRL with companies having deposits in northeastern Minnesota. In addition, NRRI/CMRL is evaluating an expansion of equipment and facilities to advance our capabilities in the area of hydrometallurgy, with a specific focus on advancing mining activities and processing of Cu/Ni and PGM metals in northeastern Minnesota.

Minnesota Taconite Operations Research

Numerous mining, concentrating, agglomerating, and environmental projects were conducted for Minnesota's six operating taconite plants to enhance productivity and/or product quality. In the environmental area, NRRI is continuing work with the mining companies to evaluate and measure mercury 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 test work continues to aid the taconite operations in improving filter cake production and reducing bentonite consumption. Balling circuit audits were conducted to examine factors that influence green-ball sizing to identify opportunities for improving target green-ball sizing. Measurements and data were collected on green ball size distribution by individual balling drum, operating parameters, recycle loads, roll screen performance, and green ball quality. Flotation audits have also been conducted in several Minnesota operations, which have resulted in reductions in magnetic iron losses and in flotation chemical consumption. New circuit designs have been recommended in several taconite operations to reduce operating costs.

American Iron and Steel Institute (AISI) Project Completed

A balling study was conducted for the AISI group to advance one of their new projects for the steel industry.

Biomass Processing for Northeastern Minnesota

A number of meetings and national conferences were attended to advance the science of biomass pretreatment at NRRI, with specific focus on the torrefaction process. This process would allow coal fired power plants to achieve partial replacement of their coal with pretreated biomass in order to gain renewable energy credits by cofiring torrefied woody biomass with their coal fuels.

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 for taconite plant agglomerator facilities, as well as hydrocyclone, demagnetization, and flotation performance improvements for taconite plant concentrator facilities.

DOE Grant Applications Submitted

Three separate large-scale DOE grant applications have been submitted in the area of biomass fuel utilization. CMRL was also included in a Biomass Plasma Gasification DOE submittal from a Minnesota-based plasma arc technology corporation.

Coleraine Technical Reports

CMRL/TR-09-01 – (aka: NRRI/TR-2009/03) – Confidential Report issued to U.S. Steel – D. J. Englund – January 16, 2009 – 18 pgs.

CMRL/TR-09-02 – (aka: NRRI/TR-2009/04) – Confidential Report issued to ArcelorMittal– D. J. Englund – January 20, 2009 – 52 pgs.

CMRL/TR-09-03 – (aka: NRRI/TR-2009/05) – An Investigation of Seasonal Performance Variations in Taconite Plants – S. Ersayin – January 23, 2009 – 37 pgs. – Sponsor: PUTF

CMRL/TR-09-04 – (aka: NRRI/TR-2009/16) – Confidential Report issued to Nucor – D. J. Englund – April 7, 2009 – 46 pgs.

CMRL/TR-09-05 – (aka: NRRI/TR-2009/15) – Applicability of U.S. Steel’s Drop Weight Test to Autogenous Grinding – B. R. Benner – January 14, 2009 – 16 pgs. – Sponsor: PUTF

CMRL/TR-09-07 – (aka: NRRI/TR-2009/22) – The Effect of Demagnetizing Cyclone Feed on a Plant Cyclone Performance – B. R. Benner – June 29, 2009 – 40 pgs. – Sponsor: Iron Ore Co-Op

Center for Water and the Environment

Biomass Harvest Effect on Wildlife (Minnesota)

Objective

Forest fuel reduction near houses and removing residual woody material for biomass energy plants (biomass harvest) seem to be complementary solutions that would help save property, conserve energy, and reduce the risk of large forest fires. A hidden cost to biomass harvest may be a negative effect on species that depend on down and decayed woody material for survival. Acquiring data on mammal and amphibian responses to biomass harvest that will enable planning for appropriate levels of biomass removal is the primary objective of this research.

Background

Previous Activity

Discussions with Co-PI and planning for field season has been done. We trapped beaver with Hancock live traps in the fall of 2008 following protocols (previously used in GPIR [Smith and Peterson 1988]) and methods currently being used in an ongoing study in VOYA.

Current Activity

No results to report at this time.

Principal Investigator(s)

Ronald Moen

Project Sponsor(s)

National Fish & Wildlife Foundation

Amount Account

10,637 3011-10430-00001053

Active

01/15/2009 09/30/2010

Total

\$10,637

Start Date: 01/15/2009

End Date: 09/30/2010

Project ID: 1541

ECOSYSTEM STUDIES - Land Resources
Marten Studies in Northeastern Minnesota

Objective

Background

Previous Activity

Work took place in east-central St. Louis and west-central Lake counties in September and October using sampling locations from past work.

Current Activity

Data entered and given to DNR, with decision to be made on second year.

Principal Investigator(s)

Ronald Moen

Project Sponsor(s)

MN DNR

Amount	Account
20,000	3005-10430-00005917
Total	\$20,000

Active
10/16/2008 09/14/2009

Start Date: 09/15/2008 **End Date:** 06/30/2010 **Project ID:** 1540

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

Quantifying Parcelization Potential of Private Forest Lands in North Central Minnesota

Objective

To identify parcels of forest land likely to be subdivided for commercial or residential development.

Background

Previous Activity

Current Activity

Principal Investigator(s)

George Host

Project Sponsor(s)

MN Dept of Natural Resources (DNR)

Amount Account

40,000 1663-189-6328-00

Active

04/01/2008 06/30/2009

Total

\$40,000

Start Date: 04/01/2008

End Date: 06/30/2009

Project ID: 1523

Survey of Beaver Ecology in Grand Portage National Monument

Objective

Baseline characteristics of the beaver population in Grand Portage were established in a 1987 study, which was originally intended to be a comprehensive comparison of beaver populations in national parks in and near Lake Superior (Smith and Peterson 1988). We will trap beaver with Hancock live traps in 2008 and 2009. We will also deploy trail cameras on paths used by beaver to move from the pond to trees, which will be cut in fall 2008 and 2009. We will use 0.025 ha circular plots to determine tree species composition around beaver ponds, and interpret a historical series of aerial photos for pond occupancy.

Background

Previous Activity

Current Activity

Data collected to date will result in a good review of beaver status on the Boardwalk pond in the Grand Portage National Monument.

Principal Investigator(s)

Ronald Moen

Project Sponsor(s)

USDI National Park Service

Amount Account

18,985 3002-10430-00000804

Active

06/05/2008 09/30/2010

Total

\$18,985

Start Date: 06/05/2008

End Date: 09/30/2010

Project ID: 1555

Synoptic Mapping of Native Plant Communities of the Laurentian Mixed Forest

Objective

Background

By analyzing similarities between Land Type Associations in the northern forests of Minnesota we will identify a set of plant survey data from beyond the Aitken target area which can be used to augment mapping of Native Plant Communities in the Aitken target area.

Previous Activity

Current Activity

Some preliminary data collection has been completed (Land Type Association attributes for clustering). A framework for the rest of the project has been laid out.

Principal Investigator(s)

Terry Brown

Project Sponsor(s)

MN DNR

Amount	Account	Active
27,894	3005-10424-00006899	11/18/2008 12/30/2009
Total	\$27,894	

Start Date: 11/18/2008

End Date: 12/30/2009

Project ID: 1530

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 super canopy 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 whitepine. 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
Total	\$35,646

Active
06/01/2007 09/30/2010

Start Date: 06/01/2007

End Date: 09/30/2010

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

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.

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.

Current Activity

We have nearly completed 4 years of the Great Rivers-algae project. Four articles from this project have been published or are in review:

1. Reavie ED, Jicha TM, Angradi TR, Bolgrien DW, Hill BH. 2009. Algal assemblages for large river monitoring: comparison among biovolume, absolute and relative abundance metrics. *Ecological Indicators*.
2. Sgro et al. Development of new rapid-assessment indicators using river algae, and comparing these indicators to approximately 20 indicators currently in use worldwide.
2. Kireta et al. Development of a weighted-averaging model to infer environmental quality using periphytic and phytoplanktonic algae from the Great Rivers.
3. Kireta et al. 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)

	Amount	Account	Active
Environmental Protection Agency	535,199	1628-189-6289-00	10/01/2005 09/30/2010
Total	\$535,199		

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

Continued Research and Development for Ballast Treatment 2008-09

Objective

Background

The Great Ships Initiative (GSI) is a innovative collaboration whose objective is to end the problem of ship-mediated invasive species in the Great Lakes-St. Lawrence Seaway System, including through independent research and demonstration of environmental technology, financial incentives and consistent basin-wide harbor monitoring.

The near-term objective of the GSI is to significantly accelerate research, development and implementation of effective ballast treatment systems for ships that visit the Great Lakes from overseas. To that end, the GSI has established research capabilities at three scales—bench, land-based, and shipboard. Each scale is dedicated to addressing specific evaluation objectives, with protocols as consistent with IMO and federal requirements as practicable.

NRRI's role in the GSI is to test candidate ballast water systems to ensure they are able to meet the IMO's criteria for mortality of the microorganisms carried in ballast water.

Previous Activity

Current Activity

Significant development and testing of the land-based testing facility has been completed over the last two years. This past summer we completed testing of the first candidate system, and several others are in the queue for testing in September 2009 and summer 2010.

Substantial efforts have been allocated to determining appropriate methods for assessing whether treatment systems are effectively killing organisms. One article establishing a new method for assessing phytoplankton mortality in ballast water is in review.

Principal Investigator(s)

Euan Reavie

Project Sponsor(s)

Northeast Midwest Institute

	Amount	Account	Active
	115,715	---	06/01/2008 05/31/2010
Total	\$115,715		

Start Date: 06/01/2008

End Date: 05/31/2010

Project ID: 1521

Duluth Residential Stormwater Reduction Demonstration

Objective

Determine whether property-owner-based stormwater reduction practices are effective in reducing peak stormwater runoff in Duluth due to the cold climate, clay soils, and surficial bedrock.

Background

We propose to demonstrate the effectiveness of residential best management practices (BMPs) at reducing stormwater runoff problems for Lake Superior tributaries. We will install residential BMPs in a subwatershed in an older residential neighborhood and compare the runoff to that of a similar control subwatershed without stormwater BMPs. The neighborhoods identified for the program are located in the Lester-Amity stream system that is on the Minnesota 303(d) list for turbidity. Tributaries receiving the runoff from the targeted neighborhoods/subwatersheds are being severely eroded by high peak flows and deliver highly turbid water to Amity Creek. Water flow, temperature, and turbidity measurements will be taken within storm sewers in both subwatersheds before and after BMP installation, requiring three full field seasons of work. Flow, temperature, and turbidity data from storm sewer flow will be posted and interpreted on the educational Lake Superior Streams website, as will final results. Resident knowledge of runoff issues, solutions, and responsibilities will be evaluated at the beginning and end of the project. Results from this demonstration project should be applicable throughout the Great Lakes.

Previous Activity

Monitoring equipment (flow, temperature, conductivity, and turbidity) was installed in the two neighborhood storm sewer systems in April 2008 and was kept in place until the ground began freezing in November 2008. Snowmelt runoff data were captured, as well as several spring storm events. Two volunteers willing to read rain gauges were found near the target neighborhoods and provided with rain gauges, monitoring instructions, and data collection spreadsheets.

Current Activity

All residents of both neighborhoods and the intervening street were invited to a neighborhood meeting in early September 2008. The main goal of the meeting was to provide the residents with a description of the project and information about the potential BMPs that we will be offering to the street that is chosen as the treatment street. Surprisingly, the street showing the most interest was the one we had not considered because its storm sewer pipes are a slightly different configuration than the other two streets.

After walking all three streets with an engineer who does residential stormwater reduction work in neighborhoods in the Minneapolis area, we decided that the middle street (previously not considered, but whose residents lobbied us for inclusion) would work best as the treatment street after all. We immediately installed monitoring equipment in the storm sewer to catch the fall rains, which, along with spring 2009 rains, should provide us with sufficient pre-installation data.

Principal Investigator(s)

Valerie Brady

Project Sponsor(s)	Amount	Account	Active
City of Duluth-MPCA(Prime)	121,482		02/27/2008 06/01/2011
Total	\$121,482		

Start Date: 02/27/2008 **End Date:** 06/01/2011 **Project ID:** 1528

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

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.

Current Activity

All 2007 and 2008 samples have been analyzed, and analyses are ongoing. Six month-long sampling cruises aboard the R/V Lake Guardian have been completed. 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.

Several taxonomic workshops and QA/QC sessions were held to ensure taxonomic accuracy for the project.

Sample assessments show that significant changes have occurred in the Great Lakes food web over the last decade. These shifts are being examined for causes and trophic linkages.

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

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

Literature Review, International Upper Great Lakes Study

Objective

Do a literature review and write a summary on the topic of the effects of water level fluctuations on Great Lakes coastal ecosystems and biota.

Background

We were asked to create an annotated bibliography of literature relating to the effects of water level fluctuations on ecosystems and biota of the Laurentian Great Lakes. This report will support investigations into the potential ecosystem effects of altering the water level regulation of Lake Superior at the St. Marys River lock and dam system. Because such a change would most affect lakes Superior, Michigan, and Huron, we tried to concentrate on these lakes. However, we have included quite a bit of literature from lakes Erie and Ontario, where there has been more investigation of water level fluctuations (or lack thereof) and water level regulation. We have also included pertinent literature from around the world on effects of water level fluctuations in large lake and reservoir systems, primarily because of the paucity of pertinent literature for the upper Great Lakes.

Previous Activity

Current Activity

Of the approximately 220 references found, 134 deal directly with water level fluctuations while the rest provide general background information. Of the 134 water level references, 30 are on the upper Great Lakes (3 for Superior, 16 for Michigan, and 11 for Huron), while 49 are on the lower Great Lakes (17 for Erie, 25 for Ontario, and 7 for the St. Lawrence River). The remaining water level fluctuation papers are more general in nature, with 31 on the Great Lakes in general and 24 on general information from other areas, often Europe.

For those papers that deal directly with water level fluctuations, the majority discuss effects on invertebrates (42 papers) or vegetation, particularly wetland vegetation (40 papers). Fish (10 papers) and birds (12 papers) are the next most-discussed biota, with algae (3 papers) and amphibians (2 papers) having received little attention in the water level fluctuation discussions. The other subjects include contaminants (5 papers), water quality (2 papers), and wetland hydrology or water quality (11 papers).

There were a number of topics of interest for which we found no information. These include:

- Effects on long-lived, wetland-obligate species
- Effects on most lake-oriented species of fish of interest (e.g., lake sturgeon, coaster brook trout)
- Effects on turtles, snakes, and their habitat
- Effects on beaver
- Effects on meadow and heather voles and their habitat
- Effects on wild rice
- Effects on benthic metabolism

This project is complete and a full report has been submitted.

Principal Investigator(s)

Valerie Brady

Project Sponsor(s)

The Louis Berger Group, Inc

Amount Account

26,081 3010-10426-00006714

Active

10/10/2008 09/30/2009

Total

\$26,081

Start Date: 10/10/2008

End Date: 04/08/2009

Project ID: 1527

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

Active

07/01/2007 06/30/2010

Total \$172,860

Start Date: 07/01/2007

End Date: 06/30/2010

Project ID: 1518

Predicting Impacts of Development on Lake Superior North Shore Streams/GIS Data

Objective

1. To quantify the impacts of development, as estimated by watershed land use and land cover (LULC), on in-stream water quality, habitat, and biota for North Shore Lake Superior watersheds. 2. To quantify the appropriate a) spatial extent, and b) map resolution for detecting LULC impacts on in-stream water quality, habitats, and biota in the Lester and Amity watersheds, a region undergoing moderate urbanization and the focus of a multi-organization collaboration. 3. To determine whether position, connectivity and other spatial attributes of urban and riparian areas influence the predictive power of the LULC data in the Lester-Amity watersheds.

Background

Natural landscape modification for human use is a major threat to health of Lake Superior's North Shore and the Great Lakes ecosystem as a whole. Tributary streams are increasingly threatened by development as urbanization and rural development place increased pressure on the Lake Superior region's coastal communities. Links between land use and in-stream responses are now well-documented. This study is creating both a moderate resolution land cover classification map from the St Louis River to the Beaver River and a multi-institution historical database covering 28 streams along Lake Superior's North Shore in order to mitigate past challenges and understand the relationships between land use and in-stream responses. Using our higher resolution map we are evaluating how land use spatial position and riparian connectivity affect in-stream responses.

Previous Activity

We completed a high resolution land use classification from 2007 Landsat TM satellite data for the North Shore of Lake Superior extending from Duluth to Beaver Bay. Multi-institution historical water quality, habitat, and invertebrate data have been summarized for 28 North Shore streams. In 2008, water quality, biological, and physical habitat data were collected on 9 streams in the Duluth area and added to the historical database. Additional work has been conducted to assess the potential impact of development on ecosystem functions, including stream metabolism (the balance of gross primary production and respiration), nutrient spiraling, and stream temperature. All three of these projects are being conducted as part of master's degree program at the University of Minnesota Duluth.

Current Activity

The remaining government agency historical data sets are being added to the North Shore database. Empirical models assessing the influence of data resolution and land use assessment methods will follow. Currently we are using GIS distance weighting methods to determine if land use spatial location influences in-stream responses. In short, distance weighting functions give land uses whose flow paths are closer to the stream, greater influence. We are processing the remaining biotic samples which will then be used in conjunction with the existing data to develop predictive models similar to those described above for the water quality data.

Principal Investigator(s)

Jeremy Erickson
Lucinda Johnson

Project Sponsor(s)

MN Sea Grant

Amount	Account
134,644	1001-189-1033-00
Total	\$134,644

Active

07/01/2007 06/30/2010

Start Date: 07/01/2007

End Date: 06/30/2009

Project ID: 1522

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

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 project to demonstrate their effectiveness at reducing stormwater runoff problems as indicated by upstream-downstream and before-after water quality and biological monitoring.

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.

Previous Activity

1) Graves Road Cr. restoration -lower Amity Creek. We 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 2009. This ~400 ft project will replace and extend old concrete culverts on the steepest, critical clay banks sections; to prevent further headcutting; 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 via funding from the Weber Stream Restoration Initiative 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 Creek 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 Creek bank stabilization. Engineering designs are being developed to stabilize two eroding bluffs with anticipated implementation in 2009. 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.

Current Activity

Principal Investigator(s)

Dan Breneman
Richard Axler

Project Sponsor(s)

MN Pollution Control Agency

Amount Account

103,553 1662-189-9023-00

Active

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 Lake 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 water quality and “bugs” – invertebrate data from ~ 30 North Shore stream sites sampled from the late 1990s through 2007 (by NRRI, EPA, and 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. Water quality 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 Lake 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 water quality sampling for North Shore and St. Louis River tributaries (Obj 2) or performed independently by MPCA, the Flute Reed River Partnership, or the St Louis River Citizens Action Committee. 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 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.

Current Activity

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

Center for Water and the Environment - Program Notes

Personnel

Lucinda Johnson was named interim director of the Center for Water and the Environment. Previous CWE director **Gerald Niemi** is continuing research and his role as biology professor at UMD.

Dr. Johnson was elected president of the North American Benthological Society for 2010. NABS is an international professional society representing stream and aquatic ecologists with membership of approximately 1,700.

Dr. Johnson is also serving as president of the Association of Ecosystem Research Centers (AERC) Board of Directors 2009. AERC brings together 43 U.S. research programs in universities and private, state and federal laboratories that conduct research, provide training and analyze policy at the ecosystem level of environmental science and natural resources management. These centers are located throughout the U.S. mainland, as well as Alaska and Puerto Rico. Their scientists, who number more than 500, conduct a major share of the ecosystem research in the United States. Although AERC is an association of professional scientists rather than environmental activists, its goals and interests complement those of conservation organizations.

Presentations/Posters

Ron Moen held a seminar in Grand Rapids March 11, "Land of 10,000 lynx locations."

Euan Reavie gave a seminar presentation titled "Algae as indicators of stress in great rivers: phytoplankton versus periphyton" at the North American Benthological Society 57th Annual Meeting in Grand Rapids, Michigan, May 2009.

Euan Reavie, along with, M.D. Balcer (Lake Superior Research Institute, UWS), A.A. Cangelosi (Northeast-Midwest Institute, Washington, DC), gave a presentation titled "Testing ballast water treatments on microorganisms at the Great Ships Initiative land-based facility," at the 16th International Conference on Aquatic Invasive Species in Montreal, Quebec, April 2009.

Euan Reavie also gave the following invited presentations: "Tracking changes in the Great Lakes -- using phytoplankton for retrospective analyses and remedial solutions," at the EPA Region 5, Great Lakes National Program Office in Chicago, Illinois, May 2009 and "Tracking changes in the Great Lakes - quality phytoplankton data are needed for retrospective analyses and remedial solutions," at the EPA National Health and Environmental Effects Research Laboratory in Duluth, Minnesota, May 2009.

Subhash Basak was the co-chairman of the Fourth Indo-U.S. Lecture Series on Discrete Mathematical Chemistry (with applications to drug discovery, environmental protection, genomics, and proteomics), organized jointly by NRRI and Nizam College, Osmania University, Hyderabad, Andhra Pradesh, India, January 6-9, 2009. This event was sponsored by the University Grants Commission, Department of Biotechnology, Council of Scientific and Industrial Research, Government of India, New Delhi; Andhra Pradesh State Council of Higher Education, Hyderabad; Indo-U.S. Science and Technology Forum, New Delhi; and the International Society of Mathematical Chemistry. **Basak** and collaborators gave the following invited presentations at the lecture series:

- 1) At the inaugural session, **Basak** described the relevance of the advancing frontiers of mathematical chemistry research in chemistry, drug discovery, environmental protection and the impact of the Indo-U.S. series of workshops and lecture series in advancing research in the particular area.
- 2) An invited lecture entitled, "Use of mathematical descriptors in drug discovery and predictive toxicology: A hierarchical QSAR approach."
- 3) A talk on "Mathematical biodescriptors of proteomics maps: Development and applications."
- 4) A talk on "Realizing a balance via mathematical chemistry" at the valedictory session of the lecture series.
- 5) "The application of computational descriptors in public health practice," by M. Moiz Mumtaz, (Agency for Toxic Substances and Disease Registry, Center for Disease Control and Prevention, Atlanta, GA), and **Basak**.

Dr. Basak visited the research laboratory of Professor Pallu Reddanna (Hyderabad Central University) to discuss collaborative research involving NRRI and Reddanna's group in the area of Nanotoxicity; a joint project in this area has been submitted to the Asia Office of the U.S. Air Force.

Basak continued his trip to Kolkata where he gave the following invited lecture at the conference "Modeling in environmental, earth, mathematical and chemical sciences," January 12-13, at Presidency College, Kolkata, India: "Chemodescriptors and biodescriptors: Mathematical basis and applications in drug discovery and environmental protection."

Basak gave an invited presentation at "Chemodescriptors and biodescriptors: Mathematical basis and applications" at the Department of Pharmaceutical Technology, Jadavpur University, Kolkata, on January 16, 2009.

Basak gave the following two lectures at the Heritage Institute of Technology, Kolkata, on January 19, 2009:

- 1) "Structure: what is she?"
- 2) "Mathematics in practical drug design and protection of human and environmental health"

Basak gave an invited seminar on "What mathematics and computers can do for drug discovery and environmental protection," at the Jagadish Bose National Science Talent Search Institute, Kolkata, January 27, 2009.

Lucinda Johnson, Valerie Brady, Dan Breneman, Bob Hell, Noah Kroenig, Josh Dumke, Jeremy Erickson, and Brian Black attended the 57th Annual Meeting of the North American Benthological Society in Grand Rapids, Michigan, in May and gave the following presentations:

Lucinda Johnson presented a talk on "Multi-scale approaches for quantifying effects of multiple stressors in aquatic ecosystems" co-authored by **Jennifer Olker, Pat Schoff**, Glen Guntenspergen (U.S. Geological Survey), Cathy Johnson (USDA Forest Service), J. Rohr (University of South Florida), and V. Beasley (University of Illinois School of Veterinary Medicine).

Josh Dumke presented a talk on "A selective wood removal technique to expose coarse substrate in small sand-embedded streams" co-authored by **Valerie Brady** and Tom Hrabik (UMD).

Jeremy Erickson presented a poster on "Determining the effects of urbanization on stream metabolism in Duluth streams" with co-authors L. Lehto (U.S. EPA-MED), **Lucinda Johnson, Rich Axler**, and B. Hill (U.S. EPA-MED).

Brian Black presented a poster on "Landscape effects on stream temperature in Minnesota streams of the Lake Superior Basin" with co-authors **Lucinda Johnson, Rich Axler, Valerie Brady**, and H. Mooers (UMD).

Valerie Brady presented a poster on "Efficient and effective aquatic macroinvertebrate monitoring for rocky coasts" with co-authors **Lucinda Johnson, Dan Breneman, and Matt Gearhiser**.

Community Service/Outreach

The Center presented \$50 awards for excellence in environmental science to junior high students Hannah Anderson of Carlton, Katelyn Litke of Cloquet, and Eugenia Kim of Winona at the 2009 Northeastern Minnesota Regional Science Fair at UMD on February 7. Also awarded for excellence in environmental science were senior high students Benedict Scheuer and Bethany Rosemore, of Cloquet High School, at the 72nd annual Minnesota State Science Fair held in St. Paul on March 29-31.

The Center hosted author Michael Shuman March 2-4 at NRRI and an evening talk at UMD to share his theories on why buying local is better for a community. Shuman is the author of seven books, including the highly acclaimed book, "The Small-Mart Revolution."

Valerie Brady assisted the Duluth Township with their stormwater issues, including assisting them with their Stormwater Protection Plan, their annual MS4 report to MPCA, and with road and ditch issues related to stormwater runoff.

Awards/Honors

The St. Louis River Alliance awarded the **Weber Stream Restoration Initiative** at Natural Resources Research Institute with the Milton Pelletier Environmental Stewardship Award in January, 2009. The award was given for the Initiative's efforts to enhance habitat and biodiversity in Lake Superior tributary streams by protecting and restoring watersheds along the North Shore. Weber Initiative coordinator and NRRI scientist **Dan Breneman** accepted the award as one of several other awardees of the alliance which seeks to restore and protect the lower St. Louis River and its estuary.

Learn more about the Weber Stream Restoration Initiative at www.lakesuperiorstreams.org/weber.

Euan Reavie has been recognized as one of the top 10 most cited authors 2006-2009 for his article "Diatom-based weighted-averaging transfer functions for Great Lakes coastal water quality: Relationships to watershed characteristics" from the Journal of Great Lakes Research published in volume 32, issue 2 2006, pp. 321-347.

Among the 20 most-accessed papers of the Journal of Chemical Information and Modeling in 2006 is "Combining chemodescriptors and biodescriptors in quantitative structure-activity relationship modeling" authored by Douglas M. Hawkins, **Subhash C. Basak**, Jessica Kraker, Kevin T. Geiss, and Frank A. Witzmann, published in volume 46, issue 1, 2006 pp 9-6.

Subhash Basak joined the Jagadis Bose National Science Talent Search of Kolkata, India, as an invited member of the Academic Advisory Board. This institution, founded in 1958, motivates, identifies and nurtures young, talented students of science in 14 selected states of India.

Publications

Cindy Hale's research is the focus of an article in this month's Scientific American (March 2009, page 22). The article by Michael Tennesen is titled "Crawling to oblivion: invasive earthworms denude Great Lakes forests."

Gerald Niemi, Lucinda Johnson, and Valerie Brady are three of eight co-authors of the International Joint Commission's white paper entitled "Ecosystem responses to regulation-based water level changes in the Upper Great Lakes." This paper forms the basis for evaluation of ecosystem effects of the potential water level regulation plans in the Upper Great Lakes of Huron, Michigan, and Superior and their connecting channels.

Carol Johnston, **Terry Brown**, Tom Hollenhorst, Peter Wolter, Nicholas Danz, and **Gerald Niemi** authored the chapter "GIS in support of ecological indicator development" in the book Manual of Geographic Information Systems, pg 1095-1113. Published in 2009 by the American Society for Photogrammetry and Remote Sensing, Bethesda MD.

Douglas Hawkins, Jessica Kraker, **Subhash Basak**, and **Denise Mills** published the paper, "QSPR checking and validation: a case study with hydroxyl radical reaction rate constant" in the international journal SAR and QSAR in Environmental Research, volume 19, pp. 525-539, 2008.

Subhash Basak, Denise Mills, Ramanathan Natarajan and Brian Gute published the chapter "Predicting chemical reactivity and bioactivity of molecules from structure," pp. 479-502, in the book Chemical Reactivity Theory, edited by P. K. Chattaraj, CRC Press, Taylor and Francis Group, 2009.

Ramanathan Natarajan, Subhash C. Basak, Denise Mills, Jessica Kraker (University of Wisconsin, Eau Claire), and Douglas Hawkins (School of Statistics, University of Minnesota Twin Cities) published "Quantitative structure-activity modeling of mosquito repellents using calculated descriptors" in Croatica Chemica Acta, v. 81, pp. 333-340, 2008.

Basak, Mills, and Douglas M. 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).

Multi-scale mechanistic indicators of Midwestern USA stream macroinvertebrates was written by John Hutchens, Jeffrey Schuldt, Carl Richards, **Lucinda B. Johnson, George E. Host,** and **Dan H. Breneman.** It was published Ecological Indicators, volume 9, pp. 1138-1150, 2009.

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 January through June of 2009, efforts have primarily been focused on the following technologies:

- Biodiesel Technology – Although the \$1 mm grant was denied from the Institute on the Environment, NRRI has been actively working OTC and a potential licensee for this technology. An LLC was formed to evaluate and take this technology to commercialization. People from various parts of the UMN have been working together to validate the economics of the technology. This includes individuals from the UMN Animals Sciences, Extension, Technology Commercialization and Venture Center. 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.
- Systemic Plant Conditioning Composition (SPCC) – The UMN has been in negotiations with an option holder to convert this technology to a license for browse deterrents. It is anticipated that a license could be executed by December of 2009, with product going to market in 2010. 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, insecticides, and fungicides for non-agricultural plants. The principle investigator is Tomas Levar, who has worked with collaborators from the private industry for several years.
- Road Patch –A license was executed with a Minnesota company to bring the road patch technology to commercialization. The company has an existing distribution channel in an eleven state region. NRRI and the licensee had a preliminary strategy session to discuss this technology and other potential products that could utilize taconite by-products. 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.
- Fines Removal System – NRRI has been working to resolve the wear issues on the chevrons for this technology, and had a meeting with an end-user and potential licensee. After much testing at NRRI's Coleraine Minerals Laboratory, a new chevron material and design has been agreed upon. The potential licensee that NRRI is working with will manufacture the new chevrons for the working prototype. It is anticipated that another test run will be conducted at the end-users site by the end of 2009. This technology had a patent issued on March 25, 2008. The inventors for this technology are David Hendrickson, Richard Kiesel, and Rodney Bleifuss.

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 30 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 seven completed projects and five additional 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, \$657,907 private sector investment has been committed, plus \$40,921 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 to those businesses focusing on the commercialization or conservation of natural resources. The assistance is related to business planning, financial planning, financing plans, marketing plans, ecommerce, etc, which complements the research and development activities at NRRI.

During the first half of 2009, 440 businesses were provided one-on-one consulting, of that 12% were manufacturing businesses. Additionally, over \$1,200,000 of capital was raised with the assistance of CED consultants. Between January and June of 2009, CED assisted 45 businesses that would be considered "green." The industries included alternative energy using solar, wind or alternative fuels, energy saving initiatives, environmentally sustainable products and geo-thermal processes. Some of the current businesses involve the development of bio-fuels, financing for sprinkler system that has been successfully used in the preservation of buildings during wild-fires, plasma gasification, the bottling of natural, pure water in bottles made of corn, and a researcher who has a carbon sequestration process he is developing.

One of the NRRI Product Development Fund recipients is also participating in the CED Business Incubator Program and has been working on numerous business and financial projections with CED staff members in order to obtain additional financing. With the potential of new investors, this business will be in the market by the end of 2009 or the first part of 2010.

Additionally, CED assisted several of the regional businesses that are part of the aviation sector with business planning, marketing and financial support, along with assistance and encouragement to participate in the Pohlads Foundation/MN Chamber Grow Minnesota grants and loans.

NRRI Public Relations

NRRI PUBLIC RELATIONS ACTIVITIES

Media Progress/Results

NRRI media coverage for the first half of 2009 (January - June) amounted to an official commercial advertising equivalent of \$178,839.68, about the same as the second half of 2008. NRRI was represented in 48 newspaper stories, four Web story, four television news stories (aired multiple times) and two radio broadcasts. Broadcasts that are not reflected with commercial advertising equivalents include two Minnesota Public Radio stories and one WDSE/PBS story on Almanac North. NRRI research was also featured in four magazines— *Scientific American* (national), *Science* (national), *Minnesota* (U of M – state-wide), and *Living North* (regional), The *Duluth News Tribune* continues to show interest in NRRI projects and printed 10 stories this half. Rural and small town newspapers ran a total of 35 NRRI stories. In the Twin Cities, NRRI was mentioned in one *St. Paul Pioneer Press* story this half.

The NRRI Web site receives an average of 6,000 successful page requests per day (up from 4,000 reported in the last half of 2008). The top query words that bring people to the NRRI Web site are: lynx (and related words), NRRI, worm (and related words), Minnesota, lake(s), superior, natural, forest, research, resources, and Duluth.

Visibility/Other PR Projects

Public Relations staff gave tours to a total of 58 people in the first half of 2008.

Other Public Relations efforts to promote NRRI research and programs included:

- Coordination of two presentations to Cloquet Kiwanis groups on NRRI and energy.
- Developed display and staff attendance at the Blandin Forest Values Conference.
- PR staff played a key role in the development of a communications plan for UMD's new Office of Sustainability.
- Developed a display for Lake Superior College's Earth Day event in April.
- PR staff worked with other staff to develop new posters for the Center for Water and the Environment, as well as updated posters for the Center for Applied Research and Technology Development.