

2005 Project Abstract

For the Period Ending June 30, 2007

TITLE: Hydrology, Habitat and Energy Potential of Mine Pit Lakes
PROJECT MANAGER: Doug Hildenbrand
ORGANIZATION: Architectural Resources, Inc.
ADDRESS: 704 E. Howard St., Hibbing, MN 55746
WEB SITE ADDRESS: (If applicable)
FUND: Environment and Natural Resources Trust Fund
LEGAL CITATION: ML 2005, First Special Session, Chp. 1, Art. 2, Sec. 11, Subd. 7(K).

APPROPRIATION AMOUNT: \$500,000

Overall Project Outcome and Results

This four-part project studied aspects of existing post-mining landforms to provide baseline data for developing a long-range land-use plan. The goal of such a plan is to design landforms for the most desirable results in 30 – 50 years, transforming landforms through current mining activities with a predetermined post-mining outcome suitable for residential, commercial, recreation and transportation uses. Understanding the ultimate pit water level is the key in planning for future land uses and future lake bottom configurations to maximize the ultimate future benefit.

- The Geology and Ultimate Pit Morphology study, a \$101,000 research project conducted by the Minnesota Geological Survey (MGS), reviewed existing data and conducted fieldwork to produce maps and databases describing the interconnection of subsurface features in the hydrologic system of existing pit lakes directly east of Chisholm, MN. This data helped agencies like the Minnesota DNR and MGS, landscape architects, mine engineers and municipal governments understand the impact decades of open-pit mining has had on water tables and groundwater movement within and among mine pits.
- The Ultimate Mine Pit Water Levels study was conducted by the Minnesota DNR, Division of Lands and Minerals and Division of Waters. The \$218,174 project examined an predicted groundwater levels in five mine-pits: Twin City North, Twin City South, Fraser, Sherman, and Hartley-Burt/Forester. Phase I evaluated whether or not water levels in these pits were rising, using monitoring wells, slug tests and watershed delineation. Phase II examined 12 scenarios for water discharge from hypothetical “megapit” complexes resulting from continued ore mining to assess potential pit outflow impacts on the Lake Superior, Red River, and Mississippi watersheds. Results from this study provide natural resource managers, land use planners and mining companies with conceptual data that can be used as a starting point to engineer solutions to mitigate potential environmental impacts.
- In the Sport Fish Habitat project, which was conducted as part of this project but was not funded from this appropriation, the Minnesota DNR and the Center for Water and the Environment at the Natural Resources Research Institute examined five existing mine pit lakes: Canisteo, Embarrass, Judson, Larue, and Tioga. These pits were selected because fish population assessment data was available. A compilation of the assessment data showed that the pit lakes contain 18 species of fish. Cold-water species, particularly rainbow trout, are common due to regular stocking programs. Analysis of the lakes’ chemical make-up found water clarity high, but that pit lake waters do not always contain optimum amounts of chemicals that foster and support fish life cycles. In addition, pit lake structure could be a limiting factor to fish diversity. The study found a positive relationship between littoral areas and fish species diversity, yet most existing mine pit lakes have steep slopes both above and below the water line. Land use planners, mine engineers, and natural resource managers can use these results to plan current mining activity that results in mine pit lake basins with shallow, gently sloping lake beds conducive to fish habitat.

- Wind Power Development and Pumped Energy Storage on Minnesota's Iron Range was a \$15,000 study done by Barr Engineering that researched the feasibility of and possible sites for wind turbines and hydro-storage energy potential in mine-pit lakes. Two sites – one for each type of alternative energy source – were identified on the Central Iron Range.

Project Results Use and Dissemination

With information from the four studies outlined above, CIRI has the baseline information about key features of existing mine pit lakes needed to move toward development of a regional comprehensive landform and lakeform plan. Such a plan would be detailed enough that mining companies could use it in their permitting processes. It also would provide public and private Iron Range interests – mining companies, regulatory agencies, municipal government, and the private sector – with a roadmap for creating landforms that will maximize residential, commercial, and recreational activity. The next step in this process will be to secure funding to examine planning and zoning requirements and other locally specific land management issues not covered by this project.

Presentations on project results were made to the Central Iron Range Initiative, which has approximately 140 members. Information was also shared with area mining engineers, local legislators, and area chambers of commerce. Reports on each study are available at the Iron Range Research Center at Ironworld Discovery Center in Chisholm, MN.

August 1, 2007

LCMR Work Program Final Report

LCMR 2005 Work Program

Date of Report: August 1, 2007

Date of Work program Approval: June 6, 2005

Project Completion Date: June 30, 2007

I. PROJECT TITLE: Habitat and Energy Potential of Mine Lakes

Project Manager: Affiliation: Doug Hildenbrand, AIA, President/CEO
Architectural Resources, Inc.

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Location: The Central Iron Range Initiative area includes Balkan Township, Great Scott Township and the cities of Buhl, Chisholm, Hibbing and Kinney, all in St. Louis County.

Total Biennial LCMR Project Budget:	LCMR Appropriation:	\$ 500,000.00
	Minus Amount Spent:	<u>\$ 384,119.00</u>
	Equal Balance:	\$ 115,881.00

Legal Citation: ML 2005, First Special Session Chp.1, Art.2 Sec. [11], Subd. 7K.

Appropriation Language: \$188,000 the first year and \$211,000 the second year are from the trust fund to the commissioner of natural resources for agency work and agreements with Architectural Resources, Inc., and Northeast Technical Services, Inc for a coordinated effort of the Central Iron Range Initiative to establish ultimate mine water elevations, outflows, and quality; design optimum future mineland configurations for fish habitat and lakeshore development; and evaluate wind pumped hydropower potential. \$62,000 the first year and \$39,000 the second year are from the trust fund to the Minnesota Geological Survey at the University of Minnesota to assess the geology and mine pit morphometry.

II. PROJECT SUMMARY AND RESULTS:

Establish ultimate mine water elevations and outflows. Design optimum mineland configurations for fish habitat and lakeshore development within the 50 foot contour with broad recommendations for in-pit configurations. Evaluate wind/pumped hydropower potential in support of regional development goals. The project will deliver components that are essential to public sector land use planning and mine planning modifications to support the public sector goals.

Mine pit lakes and their watersheds represent a valuable Minnesota resource. Delineating future water levels is the key to planning for fish and wildlife habitat, recreation, lakeshore development, water supply and potential energy generation. Insufficient understanding of future configuration, hydrology and biology of the pits can lead to undesirable results such as random outfalls and unuseable shorelines.

Past efforts have provided a general vision for land uses and land design ideas, mapping data, tools for hydrologic modeling, preliminary geology and more. These data will be assimilated with some additional hydrologic and habitat studies to provide the level of detail required to understand the dynamics of this developing ecosystem to the extent that we may design for the most desirable results.

Recent establishment of CIRI has created a favorable climate to implement the results of this project through public involvement and mine planning. CIRI is a nonprofit, 501-C3 corporation with a mission exclusively directed towards community and regional betterment by operating in cooperation with neighboring units of local, county and state governments, mining companies and other public and private agencies.

III. SUMMARY OF PROGRESS AS OF AUGUST 1, 2007.

Meetings continued to coordinate activities between agencies within the LCMR participants in this last 6 months generated attendance by local community engineering staff to gain a further understanding. The process has been very well supported by the mining community as well.

We had 2 review meetings with the DNR waters in the final 2 months to help us further understand their findings and for us to communicate our needs. The resulting hydrology study gives us the information we need to move forward with planning as we fund further projects.

The sport fishery final report is a great start to understanding fish habitat needs and further study will be required to provide a true fish habitat specification to allow direction of future mining activities in creating quality fish habitat for our region. The positive note here is we are seeing results of fish survival and propagation where living environments are conducive.

With this information now complete and documented it is my desire to implement a regional land form and community operation plan communicated to communities and mining companies with the hope to see added value to land and lake formation by the mining companies and lay the ground work for future community growth options.

The outcome is a great success story and will provide for future direction.

IV. OUTLINE OF PROJECT RESULTS:

Result 1: Geology and Ultimate Mine Pit Morphometry

Description: Result Attached

Summary Budget Information for Result 1:	LCMR Budget	\$101,000.00
	Minus Amount Spent	<u>\$101,000.00</u>
	Balance	\$ 0

Final Report Summary: August 1, 2007

Existing data available at the MGS, MnDNR, NRRI, MN Dept of Revenue and the mining companies were augmented with field work focused in the Chisholm area, as specified by CIRI partners, to produce interim products. These were transmitted to project partners in October 2005, for their use in identifying geologic features that required further investigation. During the summer 2006, we conducted extensive field work in the broader CIRI area, visiting every active and inactive mine and many off-mine properties. MGS staff logged, described, sampled, and analyzed drilling materials in the holes drilled by DNR. There were far few holes drilled than we anticipated, which resulted in the need to acquire drilling records from a number of other sources, including the archived files of companies and agencies, to flesh-out the interpretations. All of these data were integrated to produce a revised set of maps and data bases. In-kind services from mining companies and other CIRI members (primarily DNR Division of Lands and Minerals) produced maps of the inferred ultimate configuration (“morphometry”) of mine pits, which is reported elsewhere. The mapping in 3 dimensions of historic underground mining by the DNR became very important to issues of ground water movement; particularly because that mining affected more of the area than the project partners anticipated. It may, in fact, be the primary consideration in evaluating the hydrology of many parts of the study area. The likelihood exists for the interconnection of subsurface sand and gravel deposits and zones of fractured bedrock mapped by MGS with the underground workings, resulting in a complex hydrologic system that nearly defies accurate characterization.

Result 2: Ultimate Mine Pit Water Levels

Description: Result Attached

Summary Budget Information for Result 2:	LCMR Budget	\$ 316,055.00
	Minus Amount Spent	<u>\$ 218,174.00</u>
	Balance	\$ 97,881.00

Final Report Summary: August 1, 2007

The purpose of this study was to determine the hydrologic state of several existing Abandoned natural ore pits east of Chisholm and predict hydrologic conditions of future taconite-pit complexes in the central Mesabi Iron Range area. Overall, this project went very well and project goals were met. The biggest obstacle encountered during this project was the difficulty in obtaining landowner permission for drilling ground water monitoring wells. It took long periods of time, months in most cases, for contracts to be written, agreed upon between the landowner and the DNR and signed. In one instance, the landowner and the DNR could not agree on contract language and therefore it was not possible to install ground water monitoring wells in that area. In another instance, the landowner could not be found and an alternate drill site had to be chosen. Problems encountered obtaining landowner permission for ground water monitoring well installation were not anticipated. For Phase I of the project, these problems led to alternate sites being chosen and wells were not installed as early in the project as planned. For Phase 2 of the project, wells were not drilled at all. This is because by the time landowner permission could be obtained it was too late in the project period to begin installation of ground water monitoring wells. However, existing wells installed during a previous mining hydrology study were located, along with their drilling records and water level records. New ground water levels were measured on them and that data was used for this project.

For Phase 1 of the project, historical water level data was neither dense nor accurate enough to be used to achieve well-calibrated surface water models. Because of this, monthly water level data collected during this project became even more imperative to the modeling process. Water level data was also collected on one additional pit, Monroe Pit, to aid in ground water outflow zone analysis. Other data collected for Phase 1 included bathymetric data (the measurement of depths of water in the pit lakes) and climate data. Watersheds for each pit were also delineated. This data was necessary for model calibration and prediction. Water levels in two of the pits to be modeled, Hartley-Burt and Forster Pits, had risen and formed one pit prior to the beginning of this project, and therefore only one pit needed to be modeled instead of two. It was also found that one pit (Grand Pit) was already out-flowing and had stabilized and therefore did not need to be modeled. This left five abandoned iron ore pits to be modeled for Phase 1 of the study. Twin City North, Twin City South, Fraser, Sherman, and Hartley-Burt/Forster Pits. When

this project began, it was unknown if water levels in the Phase 1 abandoned iron ore pits were rising or not. Using water level data collected for the project, it was possible to achieve a well-calibrated model for each of the pits studied, and then model predicted water levels. Modeling results showed that each pit was at or near a stable elevation and not predicted to outflow.

Five ground water monitoring wells were installed during Phase 1 to investigate potential ground water outflow zones mapped by the Minnesota Geological Survey. Ground water levels were measured monthly on each well. Slug tests, which help to describe aquifer characteristics, were also performed on each well. This data was used to help determine whether ground water was moving between the individual pits and/or on a larger, more regional scale southward to other mining pits. Results of the ground water level monitoring and slug tests showed that ground water is not a significant part of the water balances of the modeled pits. In addition, no evidence was found suggesting that under current hydrological conditions ground water moved on a more regional scale, particularly to Monroe Pit.

Phase 2 of the project involved predicting hydrologic conditions of the future, large taconite-pit complexes expected to form as mining progresses across the central Mesabi Iron Range. Two different methods were used to develop Phase 2 mining scenarios. First, data developed through the Laurentian Vision Partnership for regional land use was used to delineate future taconite-pit complexes by outlining general land areas necessary to sustain magnetic taconite mining into the future at expected production rates. Nine hypothetical pit complexes were developed: 2020 East, Central, West Central and West; 2020-2050 East, Central and West; and Ultimate (beyond 2050) East and West/Central. Three additional mining scenarios were developed regarding the westward expansion of the current Minntac taconite pit complex. Water sheds were delineated for each mining scenario. Because data necessary for model calibration of the pits, such as water level and bathymetric data, does not exist it was not possible to determine time to fill for each pit. Therefore, for modeling purposes it was assumed that the pits had filled and were out-flowing. The assumption that the pits will fill and outflow is based on the hydrology of several larger Mesabi Iron Range pit complexes in which the water surface of the pit complex has reached its outflow elevation or is predicted to outflow.

For Phase 2 of the project mine pit discharge for twelve different scenarios was modeled. Again, in each scenario the primary assumption was that the water surface elevation of the simulated pit complex had reached its runout elevation. Watersheds for the Phase 2 area reach into three major watershed boundaries: St. Louis (tributary to Lake Superior), Little Fork (tributary to the Red River), and Mississippi. It is possible that diversion of water from any of these watersheds into another could occur if these large taconite-pit complexes are ever realized. For example, if an outflow is not constructed for the Ultimate East Pit complex, it is possible that the entire Ultimate East Pit complex watershed (part of the Lake Superior and Red Rive watersheds) would drain into the Ultimate West/Central Pit complex, which would outflow into the Mississippi watershed through Swan Lake. Modeling showed that the mean annual flow into Swan Lake would increase by about 32 cfs, which is about 50% of the current mean annual flow into the lake. If the mega-pit scenario is realized, significant environmental impacts will result.

Potential impacts to Swan Lake need to be further evaluated by the DNR and mining companies to engineer a solution that mitigates hydrologic impacts.

A substantial amount of money is leftover in the project's budget. Out of the \$93,500 budgeted for monitoring well installation, approximately \$30,000 had been set aside for Phase 2 drilling and was not spent. Also left over is approximately \$37,000 in the budget for Professional/Technical Contracts (NTS). This is because the following tasks that were budgeted for NTS were not performed: well oversight during drilling of Phase 2 wells by a geologist from NTS, slug tests on Phase 2 wells and the survey of each surface outlet of the Phase 1 pits. Because none of the Phase 1 pits were predicted to outflow, it was not necessary to survey their surface outlets. Personnel is another budget area that has a large amount of leftover funds. In March 2007, the Hydro 2 that was working on this project full-time transferred into another position within the DNR. Although that employee did continue to work on the project on a part-time basis, a Hydro 1 helped to complete remaining tasks. This accounts for less money being spent on salaries than originally anticipated.

The geology and hydrology of the Mesabi Iron Range is complex, yet understanding it is important in understanding ground water flow out of and around both abandoned natural iron ore pits and future taconite-pit complexes. Results from this study provide resource managers, land use planners and mining companies with conceptual data that can be used as a starting point to engineer solutions that mitigate potential environmental impacts.

Result 3: Sport Fish Habitat
Description: Result Attached

Summary Budget Information for Result 3:	LCMR Budget	\$18,000.00
	Minus Amount Spent	
	Balance	\$18,000.00

Final Report Summary: August 1, 2007

Existing mine pits managed for fish were examined to identify key factors for successful fish management. Existing pits formed prior to reclamation rules often have very steep walls, are very deep, have limited access and are generally oligotrophic. Current fish management is directed at trout species and the fish community is generally very limited. The primary limiting factor is littoral area. The lack of shallow water areas limit aquatic vegetation, where shallow water exists the substrate is generally unsuitable. A positive relationship between fish species diversity and littoral area was found. Future taconite pits have the potential to provide large basins and there is an opportunity while mining is active to construct suitable fish habitat features to provide diverse, sustainable recreational fisheries.

Result 4: Facilitating Wind Pumped Storage Energy Production
Description: Result Attached

Summary Budget Information for Result 4:	LCMR Budget	\$ 15,000.00
	Minus Amount Spent	\$ <u>14,999.98</u>
	Balance	\$ <u>0.00</u>

Final Report Summary: December 31, 2006

Barr Engineering has completed their resource assessment and site selection for the wind power development and pumped energy storage; the Laurentian Divide at Hibbing Taconite provides the best opportunities for wind power and the Hull Rust Mine and Glen Mine provide over 400' in vertical images to provide the best opportunities for pump storage. Their report dated November 2006 has been presented to CIRI. With this info in hand, wind measuring stations are being erected to collect data and is a part of a separate project and separate funding source.

Result 5: Project Management

Description: This project will require a well coordinated effort for all of our results to come to a point of common consensus. The project involves many participants of private and public sector with some entities being contracted for work and others participating at no charge, all working together to create a mutually acceptable regional plan, a plan that will be used by the mining companies in future permitting processes to ultimately leave land and water as a well planned and instantly usable and marketable resource.

The role of the project manager / coordinator will be to keep all participants moving forward together to reach this mutually acceptable defined outcome.

We see some of the duties to be as follows:

- 1) Review and approve contracts for execution of a defined scope of work for a set dollar amount for all hired consultants
- 2) Direct the project process
- 3) Set the quality of work product
- 4) Conduct / coordinate regular project meetings
- 5) Review / assess progress of participants
- 6) Review / accept products developed by the consultants at various stages of progress in the process
- 7) Approve payments to participants based on progress in the process
- 8) Be responsible to CIRI that outcomes are met

The project must be a well coordinated and controlled effort to assure we have global consensus on the final plan. It will be the role of this manager/coordinator to be the single point contact to see that all parties communicate and reach a mutually adopted final plan.

Summary Budget Information for Result 5:	LCMR Budget	\$ 49,945.00
	Minus Amount Spent	<u>\$ 49,945.00</u>
	Balance	\$ -0-

Final Report Summary: August 1, 2007

At the completion of the two years of this project I commend all the entities for working together to achieve our goals. MGS data was provided to the DNR waters in a timely fashion which allowed DNR to complete their report titled Central Mesabi Iron Range Hydrology Study dated June 2007. CIRI received 25 bound copies of the report and distributed them to participants of our other projects. DNR fisheries along with NRRI has completed their report titled Sport Fish Habitat and water quality guidelines. Barr Engineering completed the site selection process and further development of wind energy production of power continues under another program.

V. TOTAL LCMR PROJECT BUDGET:

All Results: Personnel:	\$ 300,485.00
All Results: Equipment:	\$ 4,760.00
All Results: Development:	
All Results: Acquisition:	\$176,555.00
All Results: Other:	\$ 18,200.00

TOTAL LCMR PROJECT BUDGET: \$500,000.00

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

VI. OTHER FUNDS & PARTNERS:

A. Project Partners:

Result 1:	Geology & Ultimate Mine Pit Morphology Minnesota Geological Survey Department of Natural Resources
Result 2	Ultimate Mine Pit Water Levels Department of Natural Resources Northeast Technical Services
Result 3	Sport Fish Habitat and Water Quality Guidelines Department of Natural Resources
Result 4	Facilitating Wind-Pumped Storage Energy Production Barr Engineering
Result 5	Budget Information Architectural Resources, Inc.

B. Other Funds being Spent during the Project Period:

C. Required Match (if applicable):

D. Past Spending:

Blandin Foundation	\$60,000.00
Laurentian Vision	\$45,000.00
ARI CIRI Planning	\$25,000.00
NTS CIRI Planning	\$ 6,800.00
RLK CIRI Planning	\$ 5,000.00
US Steel CIRI Planning	\$10,000.00
Hibbing Taconite CIRI Planning	\$10,000.00
John Fedo Associates	\$ 7,500.00
Central Iron Range Initiative (CIRI)	\$ 2,000.00
Chisholm Community Foundation	\$ 2,500.00
City of Buhl	\$ 1,000.00
City of Kinney	\$ 200.00
Great Scott Township	\$ 800.00
Balkan Township	\$ 840.00
City of Chisholm	\$ 6,800.00
Iron Range Resources	\$20,000.00
Minnesota Power	\$ 5,000.00
City of Hibbing	\$ 7,000.00
Security State Bank	\$ 750.00

E. Time: Two (2) Years 07-01-05 to 06-30-07

VII. DISSEMINATION: Final presentation at a town meeting coordinated by CIRI in the Fall of 2007.

VIII. REPORTING REQUIREMENTS: Progress reports December 31, 2005, June 30, 2006, December 31, 2006 and final report August 17, 2007

IX. RESEARCH PROJECTS: N/A

Attachment A: Budget Detail for 2005 Projects - Summary and a Budget page for Total Project

Proposal Title: Hydrology, Habitat and Energy Potential of Mine Lakes

Project Manager Name: Doug Hildenbrand

LCMR Requested Dollars: \$ 500,000.00

- 1) See list of non-eligible expenses, do not include any of these items in your budget sheet
- 2) Remove any budget item lines not applicable

2005 LCMR Proposal Budget	Result 1 Budget:	Amount Spent	Balance	Result 2 Budget:	Amount Spent (date)	Balance	Result 3 Budget:	Amount Spent (date)	Balance	Result 4 Budget:	Amount Spent (date)	Balance	Result 5 Budget:	Amount Spent	Balance		
	Geology and Ultimate Mine Pit Morphometry		8/1/2007	Ultimate mine Pit Water Levels		8/1/2007	Sport Fish Habitat		8/1/2007	Facilitating Wind Pumped Storage Energy Production		8/1/2007	Project Management		8/1/2007	Total for Budget Item	
BUDGET ITEM																	
PERSONNEL: Staff Expenses, wages, salaries - MGS Staff on an hourly rate for producing all maps under result #1	\$61,531.00	\$61,531.00															\$61,531.00
PERSONNEL: Staff Expenses, wages, salaries - DNR Hydro II full time 2 years for the modeling effort and GIS coordination				\$105,600.00	\$86,737.00	\$18,863.00											\$105,600.00
PERSONNEL: Staff Expenses, wages, salaries - DNR temporary Fisheries Specialist							\$15,000.00		\$15,000.00								\$15,000.00
PERSONNEL: Staff benefits - MGS staff, 20% for benefits	\$21,869.00	\$21,869.00															\$21,869.00
PERSONNEL: Staff benefits - DNR Hydro II 20% for benefits				\$26,400.00	\$21,684.00	\$4,716.00											\$26,400.00
Contracts																	\$0.00
Professional/technical - NTS for well logging, installation oversight, aquifer testing, well survey, outfall survey, static water level measurement, pit water levels, chisholm pits bathymetry				\$81,055.00	\$43,636.00	\$37,419.00											\$81,055.00
Professional/technical - Barr for completing wind pumped storage evaluation.										\$15,000.00	\$15,000.00						\$15,000.00
Professional/technical - ARI for administration and project management													\$49,945.00	\$49,945.00			\$49,945.00
Other contracts - Low bid contractor for monitoring well installation				\$93,500.00	\$61,838.00	\$31,662.00											\$93,500.00
Equipment / Tools Field sampling supplies and water quality analyses.	\$5,925.00	\$5,925.00					\$3,000.00		\$3,000.00								\$8,925.00
Office equipment & computers - Computer adequate to run modeling software.				\$5,000.00	\$1,850.00	\$3,150.00											\$3,500.00
Printing/Other Supplies	\$2,600.00	\$2,600.00		\$2,500.00	\$2,049.00	\$451.00											\$4,600.00
Travel expenses in Minnesota	\$9,075.00	\$9,075.00		\$2,000.00	\$380.00	\$1,620.00											\$13,075.00
COLUMN TOTAL	\$101,000.00	\$101,000.00	\$0.00	\$316,055.00	\$218,174.00	\$97,881.00	\$18,000.00	\$0.00	\$18,000.00	\$15,000.00	\$15,000.00	\$0.00	\$49,945.00	\$49,945.00	\$0.00	\$500,000.00	