Mirarco
MINING INNOVATION

THE CENTRE FOR MINE WASTE BIOTECHNOLOGY

2024/2025

STILETTO

INTRODUCING

THE CENTRE FOR MINE WASTE BIOTECHNOLOGY

The Mining Innovation, Rehabilitation, and Applied Research Corporation (MIRARCO) is spearheading the development of a new Centre for Mine Waste Biotechnology ("the Centre").

Located in proximity to active mines and legacy waste sites in Sudbury, Ontario, the Centre will provide a development and testing site where large samples of waste materials can be brought for pre-processing and treatment.

With the Centre's state-of-the-art facility and niche technical and business expertise, emerging mine waste biotechnologies will be optimized and ready to implement ***in-situ*** at mine sites. Access to this scale of research is crucial in bridging the bench-to-market gap.

The Centre will respond to the urgent need for innovative solutions that transform mine waste from an environmental hazard and costly liability, to an economic opportunity through sustainable mine waste strategies.

As critical minerals become more scarce and methods to extract them become more costly, it is vital to bring new mining technologies to market to improve economic and environmental outcomes.

The Centre for Mine Waste Biotechnology will be a pilot-scale facility equipped with tools and expertise to accelerate the commercialization of bioleaching and bioremediation technologies to extract critical minerals from waste while rendering it environmentally benign.

THE OPPORTUNITY

Canada needs critical minerals to support its transition to a low-carbon economy. It also faces significant environmental and financial liabilities associated with traditional mining practices.

Our mining industry would benefit from the commercial advantage of technologies for value recovery and stabilization/repurposing of waste. Mining biotechnologies (including bioleaching and bioremediation offer innovative solutions to these challenges.

ENVIRONMENTAL IMPACTS

200 ACTIVE MINES[1] | and approximately **10,000 abandoned mines**[2] in Canada present the single largest source of waste produced by any natural resources industry

OVER 650.0 MILLION TONNES
of mine waste are deposited by the Canadian mining industry yearly[3,4]

FOR MOST BASE METALS
20.0-200.0 TONNES OF SOLID WASTE ARE GENERATED
for every tonne of metal extracted[5]

70.0% OF CANADIAN MINES
report a substantial environmental risk[6]

FINANCIAL LIABILITIES

APPROXIMATELY $10.0 BILLION
in liability costs are associated with ongoing treatment of mine wastes[7]

MORE THAN $5.7 BILLION
in unsecured government liability costs are associated with contaminated mine sites in Canada[8]

OVER $1.8 BILLION
in government liability costs are associated with Ontario's contaminated mine sites[9]

FINANCIAL OPPORTUNITIES

$8.0-10.0 BILLION
worth of nickel is contained in waste from nickel mining in Sudbury region[10]

$10.0 BILLION
in estimated value is stored in Canada's gold mine waste[11]

$2.4 TRILLION
worth of copper is contained in mine waste globally[12]

OVER $2.0 BILLION
in mineral value is held in Alberta oil sands tailings[13]

DEMAND FOR **BATTERIES** | **is expected to triple** the available supply by 2030[14]

CORE ACTIVITIES

The Centre will accelerate the development, commercialization, and regulatory uptake of alternative green technologies in mine waste treatment by providing crucial infrastructure and expertise in three critical areas:

- Process and scale-up from bench to pilot
- Commercialization, de-risking, adoption, and implementation
- Highly-qualified personnel (HQP) training

CENTRE GOALS AND ACTIVITIES

MISSION
With pilot-scale facilities and world-class expertise, the Centre develops biotechnologies for use in real-world sites to improve the environmental and economic sustainability of mining and related sectors.

VISION
The Centre is a catalyst for transforming bench mine waste biotechnologies into commerical applications.

TARGET PROCESSES AND OUTPUTS

Research Lens
Interdisciplinary techniques from mineralogy, hydrometallurgy, process design and engineering, microbiology and biochemistry, genomics and bioinformatics and multivariate analysis

Commercialization Lens
Demonstrating, optimizing and implementing new approaches to transform mining practices

Collaborative Lens
Fostering unique collaborations among a dynamic team of researchers and subject matter experts in multiple academic institutions, research institutes, government agencies, the mining industry, the private sector, and mining innovation ecosystem

Education & Training Lens
Providing training and support for HQP

Attracting top international students, researchers and companies

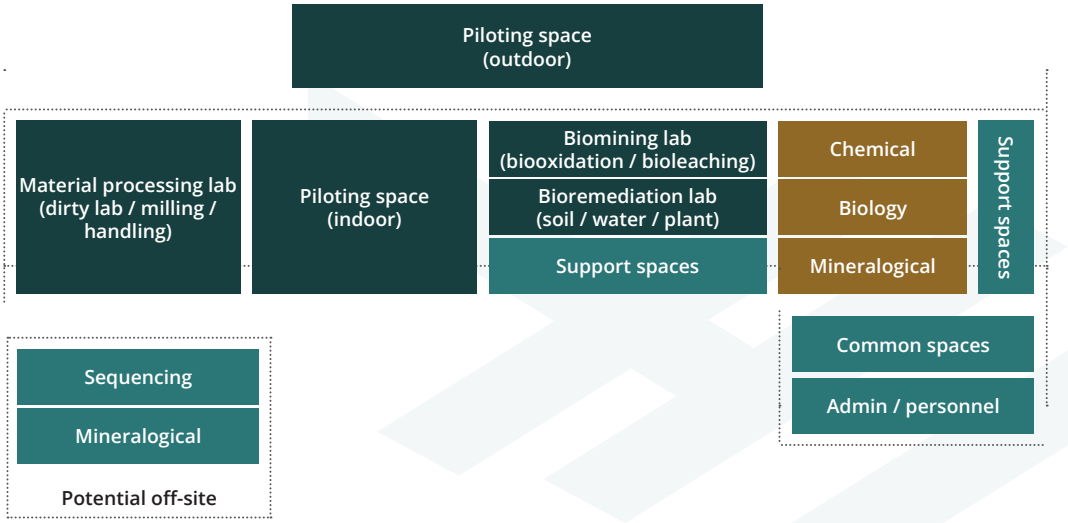
TYPES OF FACILITIES

Core pilot / demonstration facilities
including tools, technology, and space for testing, optimizing, and demonstrating mine waste biotechnologies

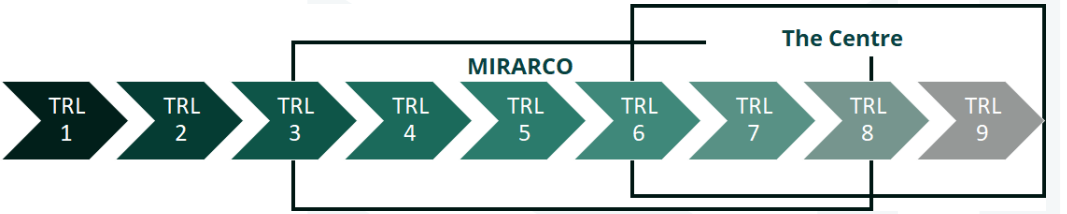
Support labs
Including a suite of analytical equipment for mineralogy, microbiology, geochemistry, and molecular analyses

Support spaces
for staff, administration, students, and project/ industry partners

ARRANGEMENT OF SPACE



TECHNOLOGY READINESS LEVELS OF RESEARCH



WHY THE CENTRE IS FEASIBLE

An in-depth study (March 2022) of proposed facilities, services, and revenues concluded that the Centre for Mine Waste Biotechnology is a feasible opportunity because:

Financial positioning is strong

A 45,000 sq. ft. building size has been extensively assessed in the feasibility study. This option, coupled with the optimal funding scenario, is confirmed to be viable and pursued by MIRARCO and their consultants. The decision to proceed with a 45,000 square foot building is pending final confirmation, based on available financing.

The Centre offers a powerful return on investment

Economic modelling forecasts that this investment will be more than paid back in the federal and provincial taxes generated by construction and by the Centre operations within 10 years.

The initiative responds to an identified gap in the mining innovation ecosystem

The Centre will provide the facility, instruments, access to waste material, and expertise needed to build a clear path for innovators to reach the market. The Centre will focus specifically on biotechnology as a mine waste strategy, offer pilot-scale mining biotechnology facilities, provide bench- to-market innovation support, and coordinate industry, government, and academic research in biotechnology.

The Centre has a unique value proposition/key differentiator

With pilot-scale facilities and world-class expertise, the Centre will be a hub for biotechnology collaboration, commercialization, and training. Its facilities and resources will accelerate the process of bringing emerging technologies from bench to mine.

The Centre aligns with government and industry priorities

As the world embraces a clean energy transition, Canada's reserves of critical minerals will make it an important global supplier. Canada has the opportunity to extract these minerals from waste in a greener way.

EXPENSES AND REVENUES

The estimated total project costs for the 45,000 square foot facility is detailed below. The financial model demonstrates that the Centre has the potential to achieve long-term sustainability regardless of which building size option is selected.

Project Construction Costs

Figure 2: Project construction costs

	45,000 sq. ft. Building
Square feet	
Building (sq. ft.)	45,000
Office space %	75.0%
Office space (sq. ft.)	33,550
Lab space (sq. ft.)	11,250
Hard costs	($)
Site development and roadways	3,375,000
RFP fees	67,500
Base building costs	18,801,788
Lab costs	7,547,738
Construction Insurance	112,500
Landscaping	225,000
Subtotal hard costs	30,129,525
Soft costs	
Legal fees	150,648
Financing fees	225,971
Architect and engineering fees	1,807,772
Development fees	602,591
Subtotal soft costs	2,786,981
Other costs	
Tenant inducements (office only)	1,687,500
Leasing fees (office only)	135,000
Contingency	3,012,959
Subtotal other costs	4,835,453
Total building project costs	37,751,959
Equipment	1,000,000
TOTAL CAPITAL COSTS	38,751,959

FEASIBILITY AND FINANCIAL MODEL

The Centre will offer a variety of services and programs, each generating valuable revenue:

Industry space and common area rentals	Memberships	Consulting services
Research projects	Training sessions and workshops	Equipment and site rentals

Governance Structure

SUPERUSER MEMBERSHIP

At Sudbury's Centre for Mine Waste Biotechnology

A SUPERUSER MEMBERSHIP IS IDEAL FOR:

- Organizations that want to commercialize, adopt, and / or implement biotechnologies
- Entities working on large or multiple projects
- Projects that require a pilot/demonstration site and/or access to specialized equipment and expertise

Term: Three Years

Annual Cost: $150,000

Equipment and Site Rentals (-10% reduced fee)

Prioritized access and reduced fee to rent the pilot / demonstration facilities and specialized equipment:

- Material processing (dirty lab / milling / handling) lab
- Biomining (biooxidation / bioleaching) lab
- Bioremediation (soil / water / plant) lab
- Piloting spaces (indoor)
- Piloting spaces (outdoor)

From $2,700-$3,000/day for equipment
From $4,700-$5,000/day for site access

Research and Technical Consulting Services (up to 20 hours)

Access to world-class, cross-sector expertise: research associates, technicians, and a hands-on managing director

Approximate value of $23,000

Sponsorship Benefits (Platinum Member - $10,000 value)

Opportunity to be viewed as a leader in the Centre, and have your corporate logo included in marketing / event materials

Research Project Support (up to 10 hours)

Support or collaboration on a grant application

Analytical Package (valued at $5,000)

Suite of sample analyses from Centre capabilities

Workshops / Training Sessions (5 annually)

Five customized workshops / training sessions on biomining / bioleaching advancements and other related topics

Dedicated Students (2 annually)

Dedicated students to support your research initiatives, fully supervised by the Centre's team

Access to Collaborative Space (20 days)

Opportunity to leverage the network of members at the Centre with 20 days of access to collaborative space

Commercialization Support

Advice and linkages to networks to support technology commercialization

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KEY USER MEMBERSHIP

At Sudbury's Centre for Mine Waste Biotechnology

A KEY USER MEMBERSHIP IS IDEAL FOR:

- Organizations advancing research in biotechnology for mining
- Entities working on smaller projects
- Projects that require a pilot / demonstration site and / or access to specialized equipment and expertise

Term: Three Years

Annual Cost: $50,000

Equipment and Site Rentals (-5% reduced fee)

Prioritized access and reduced fee to rent the pilot / demonstration facilities and specialized equipment:

- Material processing (dirty lab / milling / handling) lab
- Biomining (biooxidation / bioleaching) lab
- Bioremediation (soil / water / plant) lab
- Piloting spaces (indoor)
- Piloting spaces (outdoor)

From $2,850-$3,000/day for equipment
From $4,850-$5,000/day for site access

Research and Technical Consulting Services (up to 5 hours)

Access to world-class, cross-sector expertise: research associates, technicians, and a hands-on managing director

Approximate value of $5,700

Sponsorship Benefits (Gold Member - $5,000 value)

Opportunity to be viewed as a leader in the Centre, and have your corporate logo included in marketing / event materials

Research Project Support (optional add-on)

Support or collaboration on a grant application

Analytical Package (value of up to $1,500)

Suite of sample analyses from Centre capabilities completed to a total of $1,500

Workshops / Training Sessions (2 annually)

A total of two workshops and / or training sessions on biomining / bioleaching advancements and other related topics

Dedicated Students (optional add-on)

Dedicated student(s) to support your research initiatives, fully supervised by the Centre's team

Access to Collaborative Space (5 days)

Opportunity to leverage the network of members at the Centre with five days of access to collaborative space

Commercialization Support

Advice and linkages to networks to support technology commercialization

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ECOSYSTEM MEMBERSHIP

At Sudbury's Centre for Mine Waste Biotechnology

A ECOSYSTEM MEMBERSHIP IS IDEAL FOR:

Organizations that want to be part of a unique, pilot-scale facility

Mining stakeholders who want package flexibility

Those who need to connect with other members and keep abreast of activities and advancements in this space

Term: Three Years

Annual Cost: $5,000

Workshops / Training Sessions (access to 1)

Access to 1 workshop / training session on biomining / bioleaching advancements and other related topics

Access to Collaborative Space (2 days)

Opportunity to leverage the network of members at the Centre with two days of access to collaborative space

Commercialization Support

Advice and linkages to networks to support technology commercialization

Sponsorship Benefits (Silver Member - $500 Value)

Opportunity to be viewed as a leader in the Centre, and have your corporate logo included in marketing / event materials

Research and Technical Consulting Services (optional add-on)

Access to world-class, cross-sector expertise: research associates, technicians and a hands-on managing director

Research Project Support (optional add-on)

Support or collaboration on a grant application

Analytical Package (optional add-on)

Suite of sample analyses from Centre capabilities

Dedicated Students (optional add-on)

Dedicated students to support your research initiatives, fully supervised by the Centre's team

Equipment and Site Rentals (optional add-on)

Prioritized access and reduced fee to rent the pilot / demonstration facilities and specialized equipment:

- Material processing (dirty lab / milling / handling) lab
- Biomining (biooxidation / bioleaching) lab
- Bioremediation (soil / water / plant) lab
- Piloting spaces (indoor)
- Piloting spaces (outdoor)

From $3,000 / day for equipment
From $5,000 / day for site access

INVESTMENT: THE ASK

A total capital investment of $38.7 million commencing in 2024 aiming to break ground in late 2024/early 2025.

MIRARCO is seeking support from municipal, provincial, federal, and private sector partners to help build and equip the Centre.

Once constructed, the facility will rapidly begin to generate revenues from its suite of memberships, services, and programs.

Investing in the Centre will:

1. Spark the creation of a biotechnology in mine waste cluster / ecosystem in Sudbury by:

   a. Fostering market confidence in new biotechnologies by demonstrating the ROI in terms of value creation and cost reduction;

   b. Attracting investment from technology companies, small-and medium-sized enterprises (SMEs), and multinational corporations;

   c. Supporting the growth of biotechnology firms with connections to local, provincial, and federal resources; and

   d. Increasing access to talent / HQP workforce in mine waste biotechnology;

2. Support the industry transition towards sustainable, zero-waste / zero-footprint mining operations by supporting the development and commercialization of green mining alternatives.

3. Improve the security and resiliency of critical mineral supply chains in Ontario and Canada by advancing the development and implementation of biotechnology techniques that recover metals from waste.

POTENTIAL IMPACT

The Centre's economic model has been thoroughly assessed to confirm its potential economic impact. The economic impact model is based on three sources of impact: 1) facility construction; 2) Centre operations; and 3) increased mining output generated by Centre technologies and innovations.

For the ten-year period between 2024-2034 **the Centre is forecasted to generate:**

Construction

$20.7M boost in provincial GDP

$9.6M household spending

$5.7M tax revenue in Canada (**$3.4M** in Ontario)

$12.9M employment income

184 FTE Jobs

Operations

Cumulative over 10 years

$28.5M boost in provincial GDP

$14.6M household spending

$4.5M tax revenue in Ontario

$19.7M employment income

26.1 average annual employment

Impact Scenarios

1% national mining output

$446.8M mining output

$446.1M GDP

$209.1M labour income

$109.9M taxes (all government)

2,515 FTE employment

MEET THE TEAM

Dr. Nadia Mykytczuk

Dr. Nadia Mykytczuk is currently serving as the CEO and President of MIRARCO and also serves as Executive Director of the Goodman School of Mines at Laurentian University.

She holds an NOHFC Industrial Research Chair in Biomining, Bioremediation in partnership with Vale and Cambrian College. She brings 20 years of experience in biomining and bioremediation along with HQP training to MIRARCO, to expand these research efforts and help commercialize biotechnology applications in mining.

Dr. Eva Pakostova

Dr. Eva Pakostova is the Associate Director of MIRARCO and the Goodman School of Mines at Laurentian University. She also holds an Adjunct Assistant Professor position at the University of Waterloo.

She brings 18 years of research experience in biomining of metals from ores and waste materials, remediation of mine wastes, geomicrobiology and microbial ecology, to develop innovative biotechnologies and help implement them in the mining industry.

Kyle Loney

Kyle is a seasoned executive with a diverse skill set, excelling as a proficient public and motivational speaker. As an accomplished project manager, they specialize in optimizing budget, schedule, and operational processes. Notably, they privately financed, planned, and supervised the construction of a gold processing mill for tailings recovery.

Kyle has successfully managed multiple mining projects exceeding 100 million. With comprehensive responsibilities ranging from general management to troubleshooting, their industry expertise spans construction, mining, and environmental remediation.

Endnotes

[1] "Mining in Canada," The Canadian Minerals and Metals Plan, 2020, https://www.minescanada.ca/en/content/mining-canada-0
[2] "Abandoned Mines – Overview," *MiningWatch Canada*, June 4, 2009, https://miningwatch.ca/blog/2009/6/4/abandoned-mines-overview
[3] "Tailings and Waste Rock Disposal in the Canadian Mining Industry 2006-14," *Mining Sector Performance Report 2006-2015*, August 2016, https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/emmc/pdf/MSP_report_access_en.pdf
[4] "Waste Materials Diverted, by Type and by Source," Statistics Canada, Table 38-10-0138-01, March 8, 2021, https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=3810013801
[5] "Mine Waste in Canada: A Growing Liability," *MiningWatch Canada*, October 5, 2020, https://miningwatch.ca/blog/2020/10/5/mine-waste-canada-growing-liability
[6] "Third National Assessment of Environmental Effects Monitoring Information from Metal Mines Subject to the Metal Mining Effluent Regulations," Environment Canada, June 30, 2017, https://www.canada.ca/en/environment-climate-change/services/managing-pollution/publications/third-national-assessment-monitoring-data/chapter-3.html
[7] "Mine Waste in Canada: A Growing Liability," *MiningWatch Canada*, October 5, 2020, https://miningwatch.ca/blog/2020/10/5/mine-waste-canada-growing-liability
[8] "Table 1 – Environmental Liability for Contaminated Mine Sites in Canada (August 2017)," *MiningWatch Canada*, August 2017, https://miningwatch.ca/sites/default/files/2017-08-emmc-table1.pdf
[9] "3.10 Management of Contaminated Sites," Auditor General of Ontario, 2015, https://www.auditor.on.ca/en/content/annualreports/arreports/en15/3.10en15.pdf
[10] "3rd Mining Value from Waste Workshop," Natural Resources Canada, April 29, 2020
[11] "Mining Value from Waste: A Potential Game Changer," Government of Canada, May 23, 2019, https://www.nrcan.gc.ca/simply-science/mining-value-from-waste-potential-game-changer/21944
[12] "Mining Copper Tailings Could Answer Supply Deficits Later This Decade", Mining.com, May 19, 2021, https://www.mining.com/mining-copper-tailings-could-answer-supply-deficits-later-this-decade/
[13] "Mining Value from Waste Workshop Report," Natural Resources Canada, December 19, 2017
[14] Ian Ross, "Temiskaming Battery Metals Park Should Fill Missing Link in Supply Chain," *Timmins Today*, January 1, 2022, https://www.timminstoday.com/local-news/temiskaming-battery-metals-park-should-fill-missing-link-in-supply-chain-4903713

To maintain its competitive edge, Canadian mining must look beyond traditional practices and invest in innovative technologies and expertise. By expanding the capacity for biotechnology research and commercialization, the Centre for Mine Waste Biotechnology will provide crucial support to the mining industry as Canada positions itself as a global competitor.

The Centre's forward-looking approaches will support the mining sector in achieving its environmental, social, and governance (ESG) goals and help cement the mining industry's ongoing social license to operate. Making a unique contribution to the mining innovation ecosystem, the Centre will generate long-term environmental, social, and economic impacts for Sudbury, Ontario, and Canada.

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