MERC

Mineral Exploration Research Centre
at the **HARQUAIL** School of Earth Sciences

STRATEGIC PLAN
2019 - 2028

LaurentianUniversity
Université**Laurentienne**

HARQUAIL SCHOOL OF EARTH SCIENCES
ÉCOLE DES SCIENCES DE LA TERRE

EXECUTIVE SUMMARY

MERC's focus is to be the world's leading mineral exploration research centre, with the goal of advancing the fundamental science needed to discover the next generation of orebodies.

The Centre works with industry and governments on collaborative research projects across Canada and around the world. These projects support the development of new exploration methods and technologies, including artificial intelligence and digital environments, to ensure the research reflects industry best practices and addresses its changing needs while training highly qualified personnel (HQP) for careers in the minerals industry, academia and government.

MERC facilitates and manages research projects, typically field-based and exploration related, taking these findings to the next level through data compilation, processing and interpretation. Its largest current project is *Metal Earth*, a $104 million, seven-year (2016–2023) global applied R&D effort, supported in large part by the Canada First Research Excellence Fund. During Metal Earth, MERC continues to manage and deliver other unrelated research projects.

Membership in MERC has more than doubled compared to its 2014 levels **(Table 2)** due to numerous recruitment initiatives fueled by MERC's increased visibility as the scientific and administrative hub of Metal Earth.

In addition to applied research, the Centre offers short and modular courses targeted at industry professionals, which often run in partnership with events hosted by the Prospectors & Developers Association of Canada and the Association for Mineral Exploration Roundup.

MERC is the mineral exploration research arm of the Harquail School of Earth Sciences (HES) at Laurentian University in Sudbury. Together, MERC and HES offer an integrated approach to undergraduate and graduate studies through applied research, education and HQP training that is designed to **i)** solve challenges related to mining and mineral exploration, **ii)** fill knowledge gaps and promote the advancement of geological and exploration education, and ultimately **iii)** supply the sector with a qualified workforce.

This Strategic Plan:

◦ reviews MERC's operations, past and current (2014–2019), including achievements in the first three years of the Metal Earth project;

○ looks at the remaining years of Metal Earth (2019–2023) and presents an action plan for achieving the organization's goals; and

○ provides a five-year forecast from 2023–2028.

Challenges have been identified and mitigation plans have been developed to address succession concerns and ensure MERC maintains a broad range of research expertise. Opportunities include advanced HQP training in response to the mining sector's imminent need for a more highly educated workforce. The necessary financial framework to implement action plans in support of long-term sustainability is outlined within this document.

» RESEARCH OUTLOOK

MERC's 2014 five-year Business Plan correctly predicted that research support would rise from 2014–2019 as metal prices increased and the profitability of the mining industry improved. Research support increased between 2013–2019 when MERC was the Secretariat for the $13M Canada Mining Innovation Council (CMIC) Footprints project. Although now complete, at that time Footprints was Canada's largest multidisciplinary, collaborative mineral exploration research network. For details visit **merc.laurentian.ca/footprints**.

From 2017 and beyond, research support for MERC increased substantially through the Metal Earth project and other industry- and government-funded projects.

MERC undertook eight weeks of stakeholder engagement interviews in the spring of 2019 to identify areas of research focus considered to be most beneficial by industry and the public sector. Their recommendations are outlined in this strategic plan and provided in more detail in **Appendix 2: Key Interview Highlights**. Additionally, a best practices comparative review was conducted **(Appendix 3: Global Research Organization Comparative Survey)** to identify MERC's position within peer research centres.

» PROPOSED STRATEGIC DIRECTIONS

This strategic plan is MERC's 10-year roadmap for long-term sustainability during the next five years of the Metal Earth program and the subsequent five years beyond the end of Metal Earth. MERC will leverage the expertise and networks developed by Metal Earth and other research initiatives to maintain its relevance to industry, government, Laurentian University, professionals and students.

STRATEGIC DIRECTIONS FOR THE NEXT FIVE YEARS (2019–2023)

Strategic Direction #1: DEMONSTRATE MINERAL EXPLORATION RESEARCH EXCELLENCE

Demonstrate research excellence in Precambrian geology and ore systems with a modern, interdisciplinary, collaborative applied research approach focused on mineral exploration

Strategic Direction #2: COLLABORATE GLOBALLY

Maintain and build the current research network to strengthen MERC's leadership position and foster global linkages in industry, geological surveys and academia

Strategic Direction #3: EDUCATE & TRAIN

Become the global source for mineral exploration research and HQP training, with a continued focus on professional development

Strategic Direction #4: SHARE KNOWLEDGE

Transfer knowledge and technology through short courses, workshops, publications, presentations and field trips to improve best practices and business results

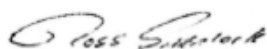**Strategic Direction #5: DIVERSIFY TRAINING OFFERINGS**

Expand education and training offerings to help address the mineral industry's HR crisis and professional development needs and position MERC as the world's preeminent centre of excellence in mineral exploration research and education

From 2019–2023, MERC will continue to build upon the research capacity developed by Footprints and Metal Earth to **i)** strengthen existing global partnerships, **ii)** attract new partners in the mineral exploration research sector, and **iii)** develop a broader range of partnerships in the mining supply and service sectors and beyond.

Research in support of base and precious metals exploration in greenstone terrains remains a priority, with increased emphasis on gold exploration research over the next 5–10 years. MERC research will continue to focus on Precambrian ore systems and Precambrian geology in the Canadian Shield. MERC will continue to provide industry with focused field-based research solutions and access to data and theses, education and professional development.

Beyond 2023, MERC's challenge will be to maintain the momentum created by the Metal Earth project and other major initiatives. For long-term sustainability, MERC must seek sources of funding to support research projects, new faculty and increased in-house analytical testing – to attract more students and to provide opportunities for research that stays current with the needs of industry. MERC's partnership focus from 2023–2028 will broaden to include the commercialization of data integration tools and technologies.

Ultimately, MERC's vision is an expanded network of partners for exploration-focused research and educational initiatives. MERC will continue to welcome sponsored projects and workshops while actively seeking large multi-year, multi-partner, multi-disciplinary projects with global impact.

Ross Sherlock

Dr. Ross Sherlock
Director, Mineral Exploration Research Centre (MERC) and Metal Earth

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» RESEARCH DIRECTIONS AND ACHIEVEMENTS

MERC'S VISION IS TO

- be the world's leading mineral exploration research centre, and

- equip the next generation of geoscientists working in Precambrian mineral deposits with knowledge and tools that will lead to the discovery of new mines.

MERC's research is predicated on the fact that the discovery of orebodies has the biggest multiplier effect in the creation of new wealth for society. Its activities **i)** support development of new exploration methods and technologies; **ii)** offer real-world experiential learning for new and existing geoscientists; and **iii)** provide crucial highly qualified personnel (HQP) training for the next generation of geoscientists working in the mineral sector, academia and government.

MERC'S MISSION IS TO

- be a world class, self-sustaining **geoscience centre** that conducts and promotes cutting-edge, field-based, collaborative research on mineral deposits and their environments;

- **train** highly qualified personnel for careers in the minerals industry, academia or government; and

- serve as a **learning** centre for methodologies in the exploration of Precambrian ore systems.

MERC was informally founded in 1995 and was formally established by the Laurentian University (LU) Senate in 1997 as a semi-autonomous exploration geoscience research centre. The Centre now acts as the mineral exploration research arm of Harquail School of Earth Sciences (HES). MERC has established a global reputation for research excellence in Precambrian ore systems and geology, having delivered collaborative, typically field-based research projects across Canada and in 11 countries spanning 5 continents.

MERC's applied research projects are traditionally supported by Canadian and international mining companies and through government funding from the National Science and Engineering Research Council of Canada (NSERC), the Geological Survey of Canada, the Ontario Geological Survey and other provincial and territorial government geological surveys and agencies.

MERC receives no financial support or endowment from LU, with the exception of office space in the Willet Green Miller Centre on LU's Sudbury campus and the salary of the director. MERC finances its activities through industry memberships and revenues generated by short courses, workshops and field courses.

» MAJOR CHANGE IN RESEARCH FUNDING LANDSCAPE

For the years 2015–2017, MERC's annual research portfolio **(Table 1)** was approximately $2.7M based on expenditures and funding 63–77 graduate students. Approximately 50% was from the NSERC-CMIC Exploration Footprints project. The remainder was from smaller projects that were a combination of industry and government funding for an annual average of 16 projects.

In 2016, the Canada First Research Excellence Fund recognized MERC's global leadership by awarding LU $49.2M in funding towards the Metal Earth project. In addition, LU was awarded a $5M grant from the Northern Ontario Heritage Fund Corporation. The project obtained additional cash and in-kind support from LU and 21 other Canadian and international academic, government and industry partners.

MERC serves as the scientific and administrative hub of Metal Earth.

For 2018 and 2019, MERC's annual research portfolio increased to about $9M–$10M with 11–12 projects funding up to 96 graduate students in 2019. This increased level of funding from fewer projects was a function of the large Metal Earth grant and the limited capacity of MERC to manage additional projects or students.

At Earth Science Departments across Canada, the student-to-faculty ratio typically does not exceed 6 on average. Although Metal Earth has facilitated the hiring of 5 new faculty, including 4 at LU, the current graduate student-faculty ratio at HES is 6.4 which suggests that the Metal Earth project has saturated HES-MERC faculty ability to supervise students. This limits the ability of MERC to bring on new research projects until Metal Earth decreases, creating new research opportunities within the next 3–5 years.

CATEGORY	2015	2016	2017	2018	2019
# of Projects managed by MERC	15	17	16	12	11
Annual value of managed projects*	$2,752,092	$2,754,602	$2,756,556	$10,030,698	$9,151,615
# of Government funding partners	12	14	13	9	8
# of Industry funding partners	8	7	8	10	7
# of HES M.Sc. students supervised	40	54	54	52	64
# of HES Ph.D. students supervised	23	23	23	29	32
*based on expenditures					

CURRENT STATUS

» RESEARCH DIRECTIONS

MERC's projects are largely conducted in Canada and focused on Precambrian ore systems with an emphasis on the Canadian Shield. The research aims to improve base and precious metal exploration in greenstone terrains and focuses on site-specific discovery challenges faced by the mineral exploration sector.

From 2014–2019, industry-government sponsored research projects enabled MERC to prioritize its activities in the following core themes:

- Precambrian gold environments;

- Mafic and ultramafic environments – Ni, Cu, PGEs;

- Felsic intrusive environments – Ag, Sn, W, REEs;

- Volcanic environments – Cu, Zn, Pb, Au, Ag;

- Sedimentary environments – U, Cu, Zn, Pb; and

- Geophysical mapping, detection and discovery.

From 2019–2023, these core themes plus additional themes which are the focus of Metal Earth will be pursued:

- Fluid, magma and heat pathways;

- SCLM variations and differences in endowed and less endowed areas;

- Fluid and metal sources in mantle and crust; and

- Archean tectonics and metallogeny.

Feedback from MERC members **(Appendix 2: Key Interview Highlights)** has been very clear, indicating that MERC should focus efforts on its current research areas, excel in these areas and only selectively expand research efforts into new arenas.

KEY ACHIEVEMENTS – METAL EARTH PROJECT

The main goal of the Metal Earth project is to understand the processes that govern differential metal endowment within the evolution of the host terrane. This is addressed through extensive geophysical and geological research on transects across different greenstone belts in the Abitibi and Wabigoon subprovinces. These transects cut across ancestral fault systems and volcanic and intrusive complexes which have variable and different metal endowment. By comparing the results of these transects, we will gain an understanding of the different processes that were active at the time of formation and gain an understanding of processes that control endowment.

Achievements in the first 3 years of Metal Earth include:

◦ Release of the **Superior Craton Geological Compilation map**, a novel composite map for geoscientists to seamlessly visualize, interrogate and investigate geological information across jurisdictional boundaries;

◦ Completion of ~$6.5M in **seismic, MT and gravity geophysical data** collected over 13 transects totalling ~1,000 kms of seismic lines;

◦ Method development for **full waveform inversion seismic processing** in crystalline rocks, to potentially revolutionize how seismic data in Shield environments is collected, processed, visualized and interpreted;

◦ **More than 60** craton-scale, transect scale, thematic research and geophysics projects and spin-off projects conducted or completed;

◦ **Two NSERC and international scholarships** awarded to graduate students in Metal Earth projects;

◦ **Twenty-four** government survey reports and maps; and **157 scientific publications**, presentations and theses;

◦ **Training and employment opportunities** for 11 postdoctoral fellows and 34 graduate students;

◦ Unprecedented opportunities for more than **400 person years of training and mentorship**;

◦ Creation of one of the **world's largest geoscience teams** from 7 international academic and research institutions; and

◦ Implementation of **advanced research equipment** including a state-of-the-art Analyte G2 laser and a Neptune iCap-TQ quadruple inductively coupled plasma mass spectrometer (ICP-MS).

KEY ACHIEVEMENTS – NSERC-CMIC FOOTPRINTS PROGRAM

As Secretariat for the NSERC-CMIC Exploration Footprints Network, MERC played a key role in this major research initiative with its focus on discovering the next generation of mines. Through the project *Integrated Multi-Parameter Footprints of Ore Systems: The Next Generation of Ore Deposit Models*, MERC facilitated an extensive research network including 35 professors; 46 research associates, Ph.D., M.Sc., and B.Sc. Honours students; and 36 laboratory or field assistants from 20 universities across Canada; and more than 100 industry collaborators from 30 industry partner companies.

Research projects collectively contributed 10 new geophysical surveys developed after 18,500 hours of field work; 1,440 drill-hole lithology logs, 10,775 geochemical analyses and hyperspectral imaging from 1,686 new samples collected; 12 new age dates; and the identification of over 160 new structural, geophysical, geochemical, mineralogical and petrophysical footprints and vectors. Technologies and methodologies developed for better exploration data interpretation included a total of more than 22 of the following: merged surveys, magnetic property measurements, data compilations, 3D models and image enhancement software. The five-year *Footprints* program has concluded.

» MERC OPERATING MODEL

MERC GOVERNANCE

MERC operates semi-autonomously under the guidance of an external Advisory Board comprised of representatives from member companies, the Ontario Geological Survey, HES and Laurentian University.

MERC achieves scientific and fiscal governance through its complement of support staff, its Advisory Board and its partners. The Chair and the Science Advisor of the MERC Advisory Board are both appointed by the MERC Director, in consultation with membership.

MERC OPERATIONS

Per Advisory Board guidance, the MERC Director has an international reputation as a geoscientist and is a full-time tenured faculty member within HES actively engaged in exploration-related research.

The Director provides the continuity between MERC and the Advisory Board, collaborates with the Director of HES, and as a faculty member reports to the Dean of Science, Engineering and Architecture. The Director is responsible for MERC's long-term strategic vision, yearly plans and budgets; and communicates on behalf of the organization with the LU community, industry sponsors and the Advisory Board.

Prior to the Metal Earth project, the Director's compensation was entirely through LU as a tenured professor. For the duration of the Metal Earth project, the Director will be compensated through Metal Earth funding, after which LU will assume these costs. For the duration of the Metal Earth project, the Director of MERC will also serve as the Director of the Metal Earth project.

The Director is assisted by a part-time Associate Director (adjunct faculty member) whose role is to co-manage MERC operations including communications, promotion, project generation, budgeting and reporting. The Associate Director also coordinates MERC's activities such as developing and delivering courses and workshops. Costs associated with the Associate Director are covered through MERC operating funds.

Historically, MERC administrative support has been provided by a part-time administrator or LU employee on an as-needed basis, with the annual compensation provided directly through MERC operating funds. Since 2016, MERC's administrative staff has grown significantly due largely to the increased requirements of Metal Earth. Until August 2023, administrative support will be funded mainly through the Metal Earth grant.

METAL EARTH OPERATIONS

Operations and communications for the Metal Earth project are managed by the MERC Director and the Metal Earth Associate Director appointed from HES faculty **(Figure 1)**. The executive team is supported by an administrative manager, administrative assistant and IT and GIS technologists.

Figure 1: MERC organizational chart highlighting the reporting relationships and positioning of MERC and its Metal Earth (ME) program in relation to LU's administration
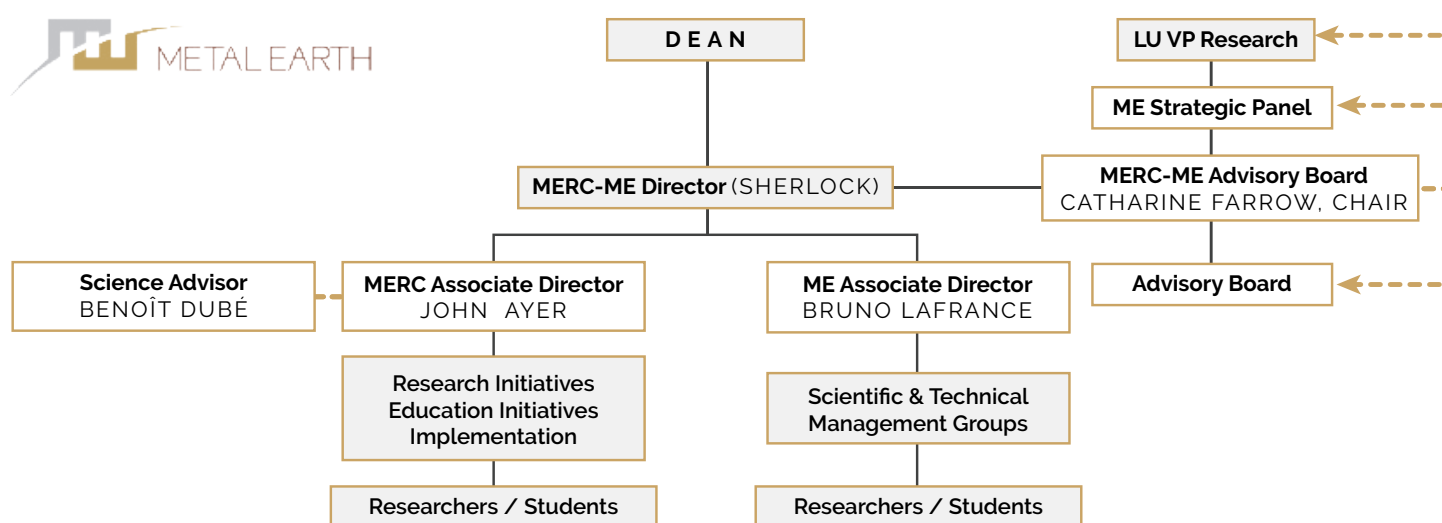
MERC MEMBERSHIP

Membership grew substantially from 2014–2018 **(Table 2)** due to targeted recruitment by the MERC team and its stakeholders, informational luncheons with mining and exploration executives, recommendations from trusted peers and the credibility built by running large initiatives such as Metal Earth. As a result, total membership numbers grew to 24, more than double MERC's 2014 levels.

A comparison of membership growth targets with actuals is shown in Table 2. A list of members from 2014–2018 is in **Appendix 1: MERC Members and Advisory Board**.

MEMBERSHIP LEVEL	# OF MEMBERS 2014-2015		# OF MEMBERS 2017-2018	
	GOAL	ACTUAL	GOAL	ACTUAL
Foundation level - $20,000 annual membership	3	3	4	4
Tier 1 level - $10,000 annual membership	4	3	5	6
Tier 2 level - $5,000 annual membership	4	3	6	1 4
Total number of members	**11**	**9**	**15**	**24**

Table 2: MERC membership level targets and actuals (2014–15 and 2017–18)

» MERC PARTNERSHIPS

In addition to collaborating with its member companies, MERC works with industry, government and academic partners across Canada and around the world on a project-by-project basis. As the scientific and administrative lead for Metal Earth and the past-Secretariat of the Footprints project, MERC has developed partnerships with 14 Canadian and international universities, 6 government agencies and 64 industry collaborators from 29 mining and exploration service companies.

» ACCOUNTABILITY FRAMEWORK

MERC abides by principles of excellence, accountability, respect for others and prudent use of funds. MERC operates in a transparent and open manner and maintains accountability for the following:

- RESEARCH

- Involving project partners and the research team in the development of focus areas, methodologies and protocols while ensuring funder goals are met.

- KNOWLEDGE TRANSFER

- Respecting knowledge sharing agreements and endeavouring to generate the greatest possible benefit to end users, stakeholders and the exploration industry at large.

- FINANCES

- Responsible management of cash and non-cash assets and maintaining at least one year of operating costs in reserve, with additional funds available to invest in other initiatives to capitalize on timely opportunities.

In these areas, ultimately the Director is responsible to report to the Advisory Board.

» FINANCIAL PERFORMANCE (2015–2019)

MERC's financial position has improved significantly since 2015 **(Table 3)** due largely to the increase in memberships in 2017–2018. Revenue from conferences, short courses and workshops also increased, up more than 400% from 2015.

Table 3: MERC financial summary (2015–2019)

MINERAL EXPLORATION RESEARCH CENTRE FINANCIAL PERFORMANCE				
	2015–16 ($)	2016–17 ($)	2017–18 ($)	2018–19 ($)
Opening Balance	341,813			
Revenue*	**146,109**	**117,358**	**181,544**	**243,136**
*Industry sponsorships, memberships; conferences, short courses and workshops; government grants; and overhead				
Expenditures**	**147,283**	**139,561**	**144,553**	**215,556**
**Conferences, short courses and workshops; lab expenses; marketing and promotions; operating expenses; salaries / benefits; sponsorships; and travel				
Excess/(Deficiency) of Revenue over Expenses	**-1,174**	**-22,204**	**36,991**	**27,580**
Accumulated Surplus (beginning of year)	341,813	340,639	318,436	355,426
Accumulated Surplus (end of year)	340,639	318,436	355,426	383,006

COMMUNICATIONS OVERVIEW

MERC communicates with partners, industry professionals, government and academia as well as current and prospective students worldwide. One theme that arose in canvassing stakeholders **(Appendix 2: Key Interview Highlights)** was the importance of timely and clear communication to **i)** ensure sponsor awareness, **ii)** stimulate an inclusive community, and **iii)** build momentum for future initiatives.

In the next five years, MERC will improve communication models within projects and generally across the organization, leading to increased visibility of project findings and deliverables. The following fundamentals will support this goal.

▸ MERC Website

○ With the volume of research results increasing from 2019–2023 there is a need for MERC to share and manage data in a user-friendly fashion, ensuring that information is searchable by students, government and industry stakeholders around the world. The MERC website is a centralized location for stakeholders to access published scientific reports, research presentations, newsletters and professional training opportunities. On average the MERC website receives over 1,000 visitors per month comprised of Canadian and international users. The targeted outcome for the MERC website is to have all theses and publications from the past 20+ years be accessible to MERC members, where copyright allows.

▸ Internal Communications

○ In order to improve internal communication, MERC is committed to **i)** standardize the member intake process, **ii)** standardize project kickoff and setup, **iii)** set up communication channels to simplify connection (e.g. setting up online groups and using project management platforms), and **iv)** continue to provide newsletters.

▸ Engaging and Reader-friendly Content

○ To keep MERC's diverse audience engaged, MERC will produce reader-friendly and action-oriented content. MERC strives to achieve this by conducting interviews with researchers, publishing brief project updates and by illustrating major project milestones via video. To improve content generation, MERC will involve students in the ownership and distribution of content.

▸ Social Media

○ Social media provides MERC with the opportunity to reach new audiences. MERC is active on LinkedIn, Facebook and Twitter with the largest, most engaged and fastest growing audience on LinkedIn. With over 1,000 LinkedIn followers, MERC reaches professionals across all seniority levels and numerous industries including mining and exploration, higher education, oil and energy, research and government. Growing MERC's social media presence will increase the reach of MERC online and will be considered as a means to provide MERC with a cost-effective communication channel for releasing project updates.

▸ Conferences and Media

○ To broaden MERC's audience across the mining service and supply industry, MERC will seek opportunities to partner with international media journals and publications. Media journals build awareness for research, education and professional training opportunities. To connect with partners globally, MERC will continue to have a presence at conferences by leading short courses and workshops and by sharing information at a MERC booth, when appropriate.

HUMAN RESOURCES

Proper succession planning and implementation is vital and a priority for MERC, as it will directly impact the core competencies of the organization. The Director, Associate Directors, Chairs, lead researchers and many faculty are all on a retirement track within the next 5–10 years. Therefore, it is of utmost importance to begin succession planning immediately, even if only at the level of identifying core competencies required and designing a pathway to capture and transfer knowledge to incoming leaders.

Ideally, succession planning will seek out professionals in mid-career **(Table 4)**, with broad areas of expertise and whose established research and industry collaborations add to MERC's network. Avenues such as Industrial Research Chairs will be considered to attract mid-career researchers. This focus on MERC's human resources will demonstrate to its stakeholders a proactive approach to ensuring the continuity of its research, programs, training and deliverables.

Succession planning for MERC has to be integrated into the overall strategic plan for HES. The long-term success of MERC is intimately tied to the success of HES and vice versa.

Table 4: Succession planning challenges and opportunities (2019–2028)

INDUSTRY CHALLENGES	MERC CHALLENGES	MERC OPPORTUNITIES
Professional development for young geoscientists will continue to need pragmatic field-based courses led by faculty who are experienced geologists Succession planning within academia is crucial to meeting HQP training needs	Aging faculty at MERC-HES Areas of risk related to succession planning can only be mitigated by ensuring that **i)** faculty is replaced with parallel hires, **ii)** the knowledge of retiring faculty is somehow retained, and **iii)** team changes do not negatively impact either program continuation or the running of the organization	Systematic and well-timed succession planning Replace retiring faculty with mid-career geoscientists who possess the requisite field skills, in a manner that allows them time to **i)** interact with existing faculty, and **ii)** develop high quality field-based mapping courses

PLANNING FOR THE FUTURE

» MINERAL EXPLORATION INDUSTRY CHALLENGES AND PRIORITIES (2019–2028)

The mineral sector is in flux due to **i)** workforce retirements, **ii)** an industry shift to innovative technology, and **iii)** a growing role for data analytics within the traditional exploration workflow. Over the next 10 years, the mineral industry can expect a smaller human resource pool, more complex methods needed to identify resources, and economic challenges due to an increasingly volatile mining cycle.

Studies by Deloitte, PricewaterhouseCoopers, the World Economic Forum and the Mining Association of Canada have put forward additional priorities and trends over the next decade. Although the list below is not exhaustive, it highlights a few of industry's more prevalent priorities, some of which will be examined in this plan.

To better understand how these changes could impact its members over the next decade, MERC contacted a cross-section of stakeholders over a period of eight weeks in the spring-summer of 2019 for a discussion on where they see industry priorities and the role of MERC. Interviews were conducted by MERC's Executive and Chair of the Advisory Board. A summary of these interviews can be found in **Appendix 2: Key Interview Highlights**.

Below is a snapshot of industry priorities as revealed by these interviews.

APPLIED RESEARCH AND TARGETING PRIORITIES

- Maintain focus on Superior Craton, Precambrian geology and ore system research

- Re-emphasis on Ni-Cu work

- Focus on geologic mapping, greenstone belts and magmatic processes

- Automation, digital workflow, analytics, artificial intelligence and machine learning

- Workforce management including diversity, inclusivity, hiring, training and managing human resources in a new era of automation and advanced technology

APPLIED RESEARCH METHODOLOGY AND TARGETING PRIORITIES

- Predictive mapping, machine learning and similar tools

- Environmentally-conscious methods and processes to address industry's move to a low-carbon economy

- Continued emphasis on field-based approach to HQP training and geology research

- Innovative lower-cost exploration methods that make higher-risk resources more economically feasible

INDUSTRIAL PROFESSIONAL EDUCATION AND TRAINING PRIORITIES

- Short courses, modular courses and field trips

- Requests for training that meets the needs of generalists, while others have requested training options for specialists

- Non-traditional geoscience topics including **i)** basics of resource estimation, **ii)** basics of metallurgy, **iii)** basics of mining methods, **iv)** mining value chain, **v)** report writing, **vi)** how to read financial reports, **vii)** understanding and interpreting resource and reserve statements, **viii)** data analytics, **ix)** artificial intelligence, **x)** mineral economics, **xi)** topics of interest to prospectors, and **xii)** digitization

OTHER INDUSTRY PRIORITIES

- Navigating geopolitical forces

- Social contracts for mining, including First Nations communities

- Collaboration with other entities including **i)** other research organizations in Canada and abroad, **ii)** mining supply and service companies, **iii)** financial institutions and investment companies, and **iv)** law firms

LAYING THE STRUCTURAL FOUNDATION FOR SUCCESSFUL PROJECTS

As MERC moves forward in developing large research initiatives that address many of these industry priorities, the Centre will continue to incorporate the structural lessons learned as Secretariat for the NSERC-CMIC Exploration Footprints Network and consequently adapted for Metal Earth:

1. There are significant benefits in developing a Canada-wide research network that will collectively address common problems.

2. A governance structure that includes both a board of directors and a science advisory board works well.

3. Changes in scope mid-project are difficult, therefore a clear understanding of expectations from sponsor companies and researchers needs to be developed at the beginning.

4. Staggering HQP training over the course of the project is beneficial for several reasons including providing access to the best candidates.

5. A dedicated year of funding after fieldwork and data collection facilitates a greater number of publications and increases scientific output.

Both MERC and HES recognize that the mineral industry is in need of new HQP to meet the increased global need for minerals and metals. The Mining Industry Human Resources Council (MIHR) estimates that nearly 70% of professional and physical sciences occupations will need to be filled over the next 10 years due to forecasted retirements. [1]

Increased reliance on technology will increase the educational requirements of the workforce. [2] The exploration industry will need a higher percentage of replacement workforce who have completed graduate and postgraduate degrees than were previously required, as the industry makes better use of technologies.
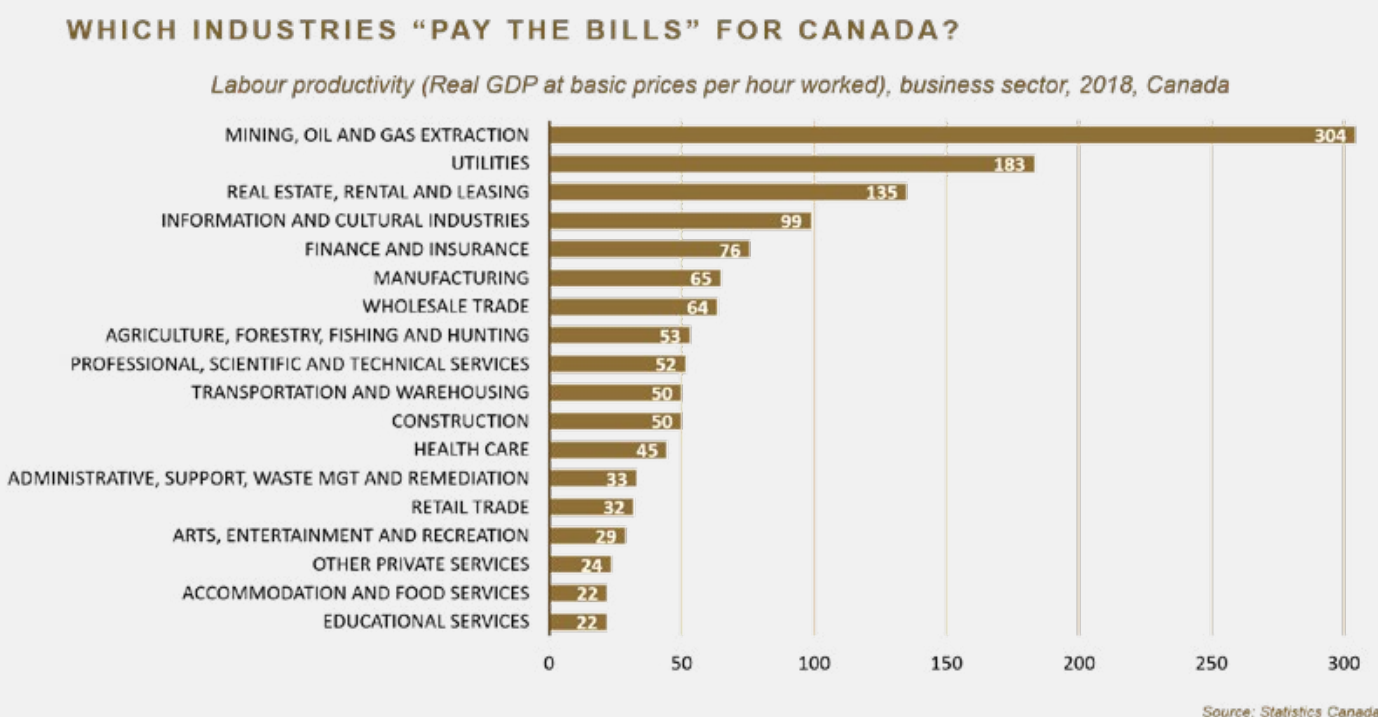
Many students are not made aware of the opportunities that exist in geology-related jobs where hands-on meets high-tech (e.g. 54% of respondents to a 2017 MIHR Exploration Survey did not learn about careers in mining or exploration until post-secondary education). [3]

The perception of urban youth is that resource development, including oil & gas, is viewed as low-tech, manual and environmentally destructive. Those with direct experience with the industry soon realize the opposite. They recognize that resource development is one on the most beneficial activities for society and that it can create a lasting positive legacy **(Figure 2)**.

HES and MERC are working collaboratively to help young people see this reality. Partnerships with entrepreneurial companies such as Orix Geoscience show youth how cutting-edge new tools are being used to solve geoscience problems and to discover new resources.

Post-secondary institutions play an important role in addressing all of these issues. MERC has a strategic role as a premier training centre for students and professionals.

Figure 2: Extractive industries comparative, Canada (2018)

WHICH INDUSTRIES "PAY THE BILLS" FOR CANADA?

Labour productivity (Real GDP at basic prices per hour worked), business sector, 2018, Canada

Industry	Value
MINING, OIL AND GAS EXTRACTION	304
UTILITIES	183
REAL ESTATE, RENTAL AND LEASING	135
INFORMATION AND CULTURAL INDUSTRIES	99
FINANCE AND INSURANCE	76
MANUFACTURING	65
WHOLESALE TRADE	64
AGRICULTURE, FORESTRY, FISHING AND HUNTING	53
PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES	52
TRANSPORTATION AND WAREHOUSING	50
CONSTRUCTION	50
HEALTH CARE	45
ADMINISTRATIVE, SUPPORT, WASTE MGT AND REMEDIATION	33
RETAIL TRADE	32
ARTS, ENTERTAINMENT AND RECREATION	29
OTHER PRIVATE SERVICES	24
ACCOMMODATION AND FOOD SERVICES	22
EDUCATIONAL SERVICES	22

Source: Statistics Canada

1 "Canadian Mining Labour Market Outlook 2019", Mining Industry Human Resources Council, https://mihr.ca/wp-content/uploads/2020/02/NationalOutlook2019_EN_Final-Chap3Fix.pdf

2 "Canadian Mining Labour Market Outlook 2019", Mining Industry Human Resources Council, https://mihr.ca/wp-content/uploads/2020/02/NationalOutlook2019_EN_Final-Chap3Fix.pdf

3 "FactSheet": Mining Industry Human Resources Council, https://talentegg.ca/incubator/2018/08/02/mining-industry-human-resources-council-factsheet/

» SHORT- AND MEDIUM-TERM CHALLENGES AND OPPORTUNITIES FACING MERC (2019–2023)

There are many universities, colleges and research entities in Canada that offer geology degrees that could lead to careers in mineral exploration. MERC and HES compete with these institutions for students, faculty and research funding. During development of this strategic plan, a best practices comparative review was conducted on research centres located in Canada and Australia that are similar to MERC in function or structure **(Appendix 3: Global Research Organization Comparative Survey)**. The research helped inform strategic priorities outlined in this plan.

The challenge for both MERC and HES is to demonstrate a mandate and benefit to industry, government funding agencies and prospective students that is distinctly unique from other institutions. Despite its strengths, MERC must overcome funder fatigue due to requests from multiple groups across Canada **(Table 5)**.

Addressing this will require a clear selling proposition in support of MERC, with calculable benefits for industry. MERC's track record yields an appealing justification to stakeholders for membership and future project investment.

Table 5 presents an overview of external (industry-wide) and internal (MERC) challenges and opportunities for MERC anticipated over the next 5–10 years.

CATEGORY	INDUSTRY CHALLENGES	MERC CHALLENGES	MERC OPPORTUNITIES
Research	Lack of budget to undertake research that will bring step-wise advances	Risk of over- and under-diversifying areas of research focus	Provide ample outputs to package as short courses for industry and public sector Help differentiate MERC from other geoscience research institutions
Education and training	Professional development needs are changing due to waves of new hires, demographics and knowledge gaps in topics such as mineral economics, machine learning and other technological advances	The sector is shifting to digital and integrated environments and will demand MERC to modify its focus and its recruitment messaging to meet the education and training needs of a new generation	Meet industry demands by further incorporating artificial intelligence and digital environments into ongoing research methodologies Deliver on requests for non-geoscience training (finance, mineral economics, etc) MERC could become a bridge for students to gain employment and industry to secure highly-trained HR
Human resources	Educational institutions are not producing enough qualified HQP to fill impending retirements across the mineral sector	Undergrad and grad student enrolment is trending downwards in favour of other high-tech disciplines	Broaden MERC's areas of expertise through strategic hires Support long-term sustainability Increase recognition of MERC as a learning centre of excellence
Innovation	New methods and technologies will modify job requirements which need to be included in degree programs	Need to identify applied research topics and specialties that will offer tangible results for industry without losing MERC's identity or mandate	Pioneer innovation within MERC's research programs Become the go-to knowledge hub by defining industry best practices

CATEGORY	INDUSTRY CHALLENGES	MERC CHALLENGES	MERC OPPORTUNITIES
Collaboration	Globalization of exploration companies Lack of industry participation by Toronto-based corporate offices that require stronger justification to maintain MERC membership and project sponsorship	How to sustain and grow industry membership and participation Longer-term challenge is to maintain a sufficient number of MERC Foundation and Tier 1 members to support the large-scale projects, student influx and team growth	Build on current successes and credibility to promote MERC's benefits to potential members Identify members that could profit from transitioning to higher membership levels
Funding	Funder fatigue due to several groups across Canada vying for support dollars from the same companies	Continuing research at current levels will require actively applying for new grants and determining an appropriate balance of grants, industry support and institutional contributions	Leverage Metal Earth, Footprints and other major initiatives for next phase funding and research activities

» MOVING FORWARD: MERC STRATEGIC DIRECTIONS (2019–2023)

MERC's strategic directions for the final five years of Metal Earth (2019–2023) are outlined below. Action items flow from the proposed strategic directions and will be carried out by internal staff and external support. These strategic directions and implementations are key performance indicators (KPIs) for MERC.

STRATEGIC DIRECTIONS AND IMPLEMENTATION PLAN (2019–2023)

STRATEGIC DIRECTION #1: DEMONSTRATE MINERAL EXPLORATION RESEARCH EXCELLENCE

Demonstrate research excellence in Precambrian geology and ore systems with a modern, interdisciplinary, collaborative applied research approach focused on mineral exploration

Over the next five years, MERC will continue to tackle major research questions informed by faculty expertise and the changing needs of industry. Artificial intelligence and digital environments will play a more advanced role in projects driven by the search for new exploration methodologies and tools to discover orebodies. MERC will build the knowledge base developed by Footprints, Metal Earth, Metal Oceans and others by continuing to conduct and collaborate on major programs, with a primary focus on Precambrian ore systems and geology mainly in the Superior Craton. Metal Earth has built a world-class research centre and partnership network that has proven its capacity to deliver geoscience research projects of significant scale.

MERC will seek to develop further research projects that build upon Metal Earth **(Table 6)**, possibly through testing

Table 6: Excellence in mineral exploration research: High-level action, timeline and personnel required		
HIGH-LEVEL ACTION	**TIMELINE (BY YEAR)**	**HUMAN RESOURCE(S)**
Standardize project kickoff and setup	2019–2020	Administrative Manager
Write profiles outlining needed skills and roles of future administration and share with Board to initiate succession planning	2020	Director, Administrative Manager
Undertake a funding leverage review to evaluate whether any support is unintentionally being unleveraged	2020	Administrative Manager, Grant Services
Review potential funding programs that could sustain operations and research programs	2020–2021	Grant Services
Apply for major program grant and individual project grants including any currently unleveraged contributions, if possible	2020–2022	Director, Associate Director, Administrative Manager, Grant Services
Meet with team and project lead to plan new phases of research within and beyond 2023	2020–2022	Director, Associate Director, team and project leads
Renew commitment to maintain grant support services, to leverage incoming dollars and to ensure members receive optimal return for investment	2022–2023	Director

results with deep drilling or taking results to new jurisdictions that have similar geology and ore systems, such as West Africa or the Guiana Shield. Data compilation, processing and interpretation will continue to be a focus to support generation of new knowledge.

Although efforts have been made to ensure non-Metal Earth projects are continued by MERC, the Centre's capacity is finite. Only a select number of projects are able to be delivered outside of Metal Earth. Research funding in the short to medium term (2019–2023) will remain at about $7M–$9M/year, largely through Metal Earth but also supplemented with spinoff or unrelated research projects.

Implementation and Outcomes

The pathway to implementation is outlined in Table 6.

The expected outcome for 2019–2023 is a continuation of the current portfolio of projects, positioning MERC so that one or more research project(s) is initiated in 2022 and ramped up through 2023 to collectively provide $5M–$7M in research funding annually going forward.

This level of funding will provide sufficient resources to build upon the results of Metal Earth and test new exploration tools and ideas in new jurisdictions. Critically, it will also maintain stability of the research consortium and network developed during Metal Earth, allowing the group to tackle problems that are beyond the capacity of a single university.
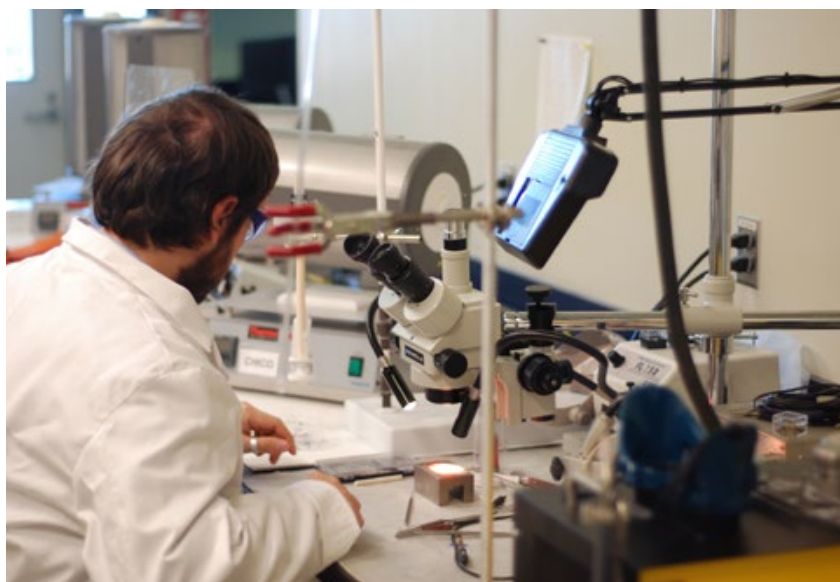
STRATEGIC DIRECTION #2: COLLABORATE GLOBALLY

Maintain and build the current research network to strengthen MERC's leadership position and foster global linkages in industry, geological surveys and academia

MERC's success will be marked by its ability to collaborate with industry and government partners in order to deliver large, complex research programs. To that end:

- MERC will pursue new members and partners by offering access to data and student placements, a better understanding of the Superior province and how to explore within it. In turn, these members can serve as advisors of policy and activity trends.

- Junior exploration companies will be targeted for membership and project sponsorship. They are agile end users, yet are typically not able to fund research in-house.

- Major mining and exploration companies will appoint executive champions **(Table 7)** to ensure value is realized by companies participating in MERC initiatives.

- Students will continue to obtain hands-on experience in the field and the lab, with field placements that will also help the consortium train and retain potential candidates for future positions.

○ Additional collaboration will be sought with other organizations in Canada and abroad including MDRU in British Columbia (focusing on the Cordillera), the Prospectors and Developers Association of Canada and the Geological Survey of Canada.

○ Ongoing collaboration will be key to overcoming the obstacles of forecasted human resource gaps in both academia and industry. A blended collaborative approach is needed to ensure continuity of research programs. This will stem the impact of any gaps in available LU university faculty and industry professionals due to ongoing recruitment efforts and the approach will afford research teams an opportunity to recalibrate in the background.

Table 7: Collaborate globally: High-level action, timeline and personnel required		
HIGH-LEVEL ACTION	**TIMELINE (BY YEAR)**	**HUMAN RESOURCE(S)**
Develop a clear membership structure with benefits according to industry priorities	2019–2020	Director and other designates
Rebrand membership package including 5-year memberships with extra benefits to encourage longer-term commitments	2019–2020	Designate supported by Office Manager, Communications Manager, Membership Coordinator
Assign or hire a Membership Coordinator	2020	Director or Associate Director to assign
Standardize member intake process	2020	Membership Coordinator
Develop a team of MERC Partner Liaison Representatives and assign each with members and partners	2020	Director, designated research staff
Identify executive champions within each member and partner company and develop a database for MERC to house this information	2019–2021	Office Manager and other designates
Contact each current member with an invitation to renew at a higher level, and contact each past member with an invitation to return at previous level or higher	2020	MERC Membership Coordinator, MERC Partner Liaison Representatives
List and pursue new members and partners from governments and industry through Board and Committee member contacts and at networking events	2020–2022	Director, Associate Director, research leads, Board members

Implementation and Outcomes

Pathways to implement these goals are laid out in Table 7. Additionally, see
Appendix 1: MERC Members and Advisory Board.

The anticipated outcome is a solid base of 8 foundation members, 10 Tier 1 members and 14 Tier 2 members by 2023.

STRATEGIC DIRECTION #3 – EDUCATE & TRAIN

Become the global source for mineral exploration research and HQP training, with a continued focus on professional development

In response to the geoscience needs of student researchers and professionals, MERC will continue to offer short and modular courses of relevance to seasoned professionals and new geoscience recruits. From 2019–2023, these offerings will be provided by MERC, HES, Goodman School of Mines, LU faculty and external trainers. For this strategic direction, education is defined as knowledge delivered through traditional educational settings while training denotes applied and hands-on activities such as workshops, field studies, etc.

Implementation and Outcomes

The pathway to implementation is outlined in Table 8.

Through the coordinated efforts of MERC and HES, outcomes are anticipated to include creation of new courses to broaden HQP training and professional development of existing geoscientists.

Table 8: Educate & train: High-level action, timeline and personnel required		
HIGH-LEVEL ACTION	**TIMELINE (BY YEAR)**	**HUMAN RESOURCE(S)**
Hire or assign a Learning Coordinator	2020	Director, Administrative Manager
Evaluate each project for potential spinoffs in education, training or commercialization	2019–2023	Associate Director
Define expansion topics for education and training beyond current offerings, in consultation with stakeholders	2020	Director, Associate Director, Partner Liaison Representatives
Rebrand education and training initiatives	2021	Director, Administrative Manager, Communications Manager

STRATEGIC DIRECTION #4 – SHARE KNOWLEDGE

Undertake targeted knowledge and technology transfer efforts to accelerate the incorporation of research results into business and technical processes through short courses, workshops, publications, presentations and field trips

Projects undertaken in 2019–2023 will be evaluated on an ongoing basis for spinoff potential in terms of education, hands-on training and commercialization. As an applied research centre, MERC's goal is to generate results that balance scholarly publications and contributions to the body of knowledge, with practical and effective findings to help stakeholders undertake cost-effective exploration.

The Metal Earth project will produce an enormous amount of data, maps and research results. These data and derivative products will be packaged, marketed and disseminated to end users through **i)** a knowledge transfer plan, **ii)** a commercialization plan, and **iii)** offered online or through a similar means to effectively share data and maps **(Table 9)**.

Knowledge transfer efforts will:

o   Focus more on process improvements and not solely on the development of new models;

o   Provide details on results of Metal Earth and other projects as they become available;

o   Share information though workshops, seminars, conferences and short courses; and

o   Be packaged in ways that can be of value to stakeholders in other countries, thereby fostering global linkages.

Table 9: Share knowledge: High-level action, timeline and personnel required		
HIGH-LEVEL ACTION	**TIMELINE (BY YEAR)**	**HUMAN RESOURCE(S)**
Develop a commercialization plan	2020	Designate
Review project, program and organization communication channels in consultation with stakeholders to identify **i)** what is working, **ii)** what is not working, **iii)** what to add, **iv)** the role of social media, and **v)** other approaches	2020	Communications Manager, Designate
Assign or hire students and research associates in communications efforts including marketing to other students	2022–2023	Associate Director, Administrative Manager, Communications Manager
Hold partner networking expo to identify end users to partner with MERC and to advance knowledge transfer	2023	Communications & Promotions Manager
Develop or adapt a knowledge transfer platform or other means to ensure research outcomes are made available in a format relevant to end users	2021–2023	Designate

Commercialization will require partnerships with companies and organizations that have the capacity to transform research results into software modules, APIs, technology, courses and workshops, etc. Although these activities are long-term in nature they will increase the value of stakeholder investments and increase implementation success, which is the ultimate goal of the work.

Implementation and Outcomes

The pathway to implementation is outlined in Table 9.

The anticipated outcomes include:

1. Greater buy-in from partners and stakeholders;

2. Wider recognition within the research and academic communities in Canada and abroad, leading to additional partnerships;

3. Development of large applied research project initiatives; and

4. New partnerships with analytical and technology companies seeking quantitative research for commercialization of exploration targeting tools.

STRATEGIC DIRECTION #5 – DIVERSIFY TRAINING OFFERINGS

Expand education and training offerings to help address the mineral industry's HR crisis and professional development needs and position MERC as the world's preeminent centre of excellence in mineral exploration research and education

Technology represents a clear challenge and several opportunities for MERC as it is infiltrating the operations of every industry sector including exploration. Mining tends to be viewed as a low-tech industry and so requires an aggressive educational effort to raise the profile of technologically-advanced aspects of the sector.

Without an effort to modify its educational offerings to appeal to a modern audience, MERC will feel the consequence of lower enrolment rates which in turn will impact its capacity to deliver large-scale projects and source HQP.

In order to reflect the diversified and growing needs of industry, MERC will expand professional development and training offerings as appropriate **(Table 10)** and leverage the expertise from faculty hired through Metal Earth. Expertise gaps will be addressed through external resources. This interdisciplinary, consortia-based approach will cross over from sectors such as oil & gas, ocean research, mining supply and service and business and information technology.

An expansion of industry-relevant, non-geoscience courses and workshops will provide additional revenue, support MERC's training mandate and further differentiate MERC. Topics could include those listed in the previous section Mineral Exploration Industry Challenges and Priorities (2019–2028).

Implementation and Outcomes

The pathway to implementation is outlined in Table 10.

Anticipated outcomes are increased enrolment of students and existing geoscientists and new research partnerships from a broader range of sectors.

HIGH-LEVEL ACTION	TIMELINE (BY YEAR)	HUMAN RESOURCE(S)
Seek experienced geoscientists to contribute guidance and input for development of new short courses and workshops	2020–2022	Director, Associate Director
Expand existing course curriculums to include new tools and technologies with input from industry	2021–2022	Associate Director, Partner Liaison
Promote expanded curriculum and new courses at the high school level	2021–2023	Marketing & Communications Manager

» LONG-TERM STRATEGIC DIRECTIONS (2023–2028)

As previously indicated in **Table 5**, there is a striking similarity between challenges and opportunities for the years during and after Metal Earth. Therefore, many of the strategic directions for 2023–2028 bear a strong resemblance to the priorities and goals outlined for 2019–2023.

The challenges of funding and enrolment will remain post-Metal Earth and are possibly exacerbated due to the elevated levels of funding and human resources sustained by this and other major initiatives. Thus, if research budgets and teams are to be maintained and MERC is to achieve long-term sustainability it is essential to prioritize funding development efforts now. This will help achieve student enrollment targets, afford continued hiring and facilitate the efforts of MERC and HES in updating facilities and equipment.

Implementation plans for 2023–2028 will be developed during the final two years of Metal Earth, based on foreseeable enrolments and MERC's secured or anticipated level of research funding and in consultation with partners and stakeholders. The following strategic priorities will serve as a guide in the formation of those plans.

STRATEGIC DIRECTION #1: OPERATE AS A CENTRE OF EXCELLENCE IN MINERAL EXPLORATION RESEARCH

Operate as a centre of excellence in Precambrian geology and ore systems with a modern, interdisciplinary, collaborative applied research approach focused on mineral exploration

Managing a research portfolio the magnitude of Metal Earth presents administrative challenges due to the sheer volume of work, which requires substantially more human resources and administrative support. The research activities contribute to a substantial volume of data and findings, undoubtedly leading to more research questions that need to be tackled. The challenge then becomes a two-fold question of sustainability: **i)** how to maintain the same level of research activity, and **ii)** how to secure the significant ongoing funding required to support this research.

To maintain the momentum generated by Metal Earth, MERC will need to target new research funding of $5M–$7M/year in the medium to long term (2023–2028) by focusing on next steps for the research results generated from Metal Earth.

Using Metal Earth as a proxy, graduate student support is typically $60,000/year including financial support and funds for research. This targeted level of funding will support approximately 100 graduate students per year (about 6 graduate students per each of the 15 faculty members). Further growth in HES would provide MERC with additional capacity to support students and undertake research. Securing funding at these levels will be a significant challenge.

MERC needs an increased focus on postdoctoral fellows or research associates. These researchers can deliver results with minimal supervision, are a good value for industry as an embedded researcher and can dramatically increase the research capacity of MERC without increasing faculty numbers or overhead costs.

Government funding should be seen as only one of many sources, as changing governments and programs are historically unpredictable and represent a risk of sinking high potential research initiatives. Therefore, industry has an opportunity to take a stronger leadership role in support of areas that most benefit the sector, as a measure to de-risk the success of future funding.

MERC will leverage the faculty hired through Metal Earth and expand its reach to include experts outside the organization. This approach will prevent MERC from straying from its mandate and identity as perceived by stakeholders and bolster its reputation as a reliable and relevant knowledge provider for its members.

Embracing innovation within the research program will also help differentiate MERC amongst other geoscience research organizations, for the sake of its own sustainability and the competitiveness of its stakeholders. Technology and innovation are disrupting exploration methods and processes and presenting industry ample opportunities (defining reserves faster and more economically) and challenges (finding HR to do the work).

STRATEGIC DIRECTION #2: BE KNOWN GLOBALLY AS THE PARTNER OF CHOICE FOR ACADEMIC AND APPLIED MINERAL EXPLORATION RESEARCH

Expand the current research network to strengthen MERC's leadership position and foster global linkages in industry, geologic surveys and academia

MERC's success will always be indicated by its collaborative capacity and ability to deliver multidisciplinary research projects. To that end:

- MERC will maintain its existing members and pursue new members and partners by offering trained research teams that undertake sector-relevant applied research projects with a commercialization pathway for guaranteed uptake of results by end users.

- MERC will operate outside of the Superior craton, partnering with new or current members that operate in geologically similar jurisdictions such as West Africa and South America.

- Students will continue to obtain hands-on experience in the field and the lab, which will help the consortium train and retain potential candidates for future positions.

- Additional collaboration will be maintained with other organizations in Canada and abroad.

○ Industry professionals will continue to be actively sought out and positioned as key members to undertake research, transfer knowledge and address any HR gaps in the LU team. They will be essential during seasons of recruitment and replacement of retiring faculty.

STRATEGIC DIRECTION #3 – PIONEER NICHE DIGITAL AND IN-PERSON GEOSCIENCE TRAINING EXPERIENCES

Offer the technology and expertise to provide seamless access to digital and in-person geoscience skill-building experiences

In order to reflect the diversified and growing needs of industry, MERC will expand professional development and training offerings from 2023–2028 based on research results, the backgrounds of faculty hired over the next five years (2019–2023) and external collaborations secured.

Collaboration will play an important role as MERC will partner with internal and arm's length experts from the private and public sectors to deliver the material and will invite the mining supply and service sector to contribute to the knowledge ecosystem.

An expansion of industry relevant, non-geoscience courses and workshops will provide additional revenue, support MERC's training mandate and further differentiate MERC from other research centres. Topics could include those previously listed in the Industrial Professional Education and Training Priorities section of this document.

» MEMBERSHIP AND PARTNERSHIPS

MERC offers three levels of membership: Foundation, Tier 1 and Tier 2. It is unclear whether members currently make full use of the benefits and which benefits are the most relevant to the members. Therefore, beginning in 2021 MERC will be revamping its membership program to ensure a clear and beneficial offering to all members commensurate with their membership level. This includes taking three key steps:

1. Designating MERC Partner Liaison Representatives who will each be assigned a cluster of members and tasked with **i)** keeping current members informed; **ii)** sharing opportunities to participate in projects; and **iii)** encouraging members to access benefits (training opportunities, release dates for datasets and maps, etc). Representatives will be from among the Director, Associate Director, research project leads, research associates and postdoctoral fellows.

2. Developing a new five-year membership option set up as a first year commitment and four additional years pledged in principle, subject to budgetary approval and deliverables.

3. Setting up tiered access to research results, datasets and maps, as permitted by confidentiality agreements and according to membership level.

MERC industry members remain an integral key to the organization's success. Through membership and partnership, companies and government organizations have shown confidence in MERC. As membership is an annual pledge, year-over-year projections remain uncertain and are wholly dependent on efforts to secure member renewals. The challenge will undoubtedly remain in the forefront unless a more sustainable model is established and the numbers of Foundation and Tier 1 members increase.

Membership growth is a collective responsibility and depends on peer recommendations and clear communication of demonstrated success, short-term value and adaptability to meet the changing needs of the sector. Exceptional results have been seen through events involving the professional network of Board members and the MERC team. Additional events of this nature are planned to follow the membership relaunch.

As the economic criteria for drilling and resource interpretation becomes more stringent, MERC membership will become most appealing to agile mining and exploration companies looking for a competitive advantage through early access to data, advanced methods, models and HQP. Government agencies, academic and research institutions will also find value in the collaborative nature of MERC's projects.

Table 11 highlights select current and proposed new benefits.

MERC's membership targets will focus on the goal of doubling the number of Foundation and Tier 1 members through recruitment of new members and by transitioning existing members to higher levels (e.g. Tier 2 member upgrading to Tier 1 status and Tier 1 member elevated to Foundation status). It is anticipated that Tier 2 targets will therefore remain fairly static because it is a common starting point for newly committed members.

Table 12 demonstrates the potential revenue increase possible with a conservative projected member configuration. By reaching these targets, MERC stands to gain more than $100,000 over current levels by 2023 which would contribute significantly to the Centre's sustainability and ability to deliver results to industry.

Table 11: MERC membership levels and benefits

	MEMBERSHIP LEVEL		
	FOUNDATION	TIER 1	TIER 2
Annual cost per membership	$20,000	$10,000	$5,000
Workshop and course discount	20%	10%	5%
Guaranteed course reservation(s)	4	2	1
Additional benefits	Tier 1 benefits plus: ○ Voting position on MERC Advisory Board ○ Access to MERC research teams ○ Embedded MERC researcher (RA, PDF, Ph.D. or M.Sc.) one day per week, or a visiting industry scientist ○ Full access to available datasets, maps and reports	Tier 2 benefits plus: ○ Preferential access to HQP ○ Discounted access to MERC facilities	○ Seat on MERC Advisory Board ○ Invitation to MERC project results dissemination events ○ Access to restricted website with select data and maps ○ Receive newsletters ○ Receive select reports ○ Recognition in MERC materials

Table 12: Membership targets (2019–2023)

	NUMBER OF MEMBERS				
	FOUNDATION	TIER 1	TIER 2		
	$20,000	$10,000	$5,000	($) Revenue*	
2018-19	4	6	14	$190,000	ACTUAL
2019-20	4	6	14	$190,000	PROJECTION
2020-21	6	6	14	$230,000	PROJECTION
2021-22	7	10	14	$290,000	PROJECTION
2022-23	8	10	14	$310,000	PROJECTION

*Foundation membership dues for HES are absorbed by MERC

MERC's revenue will come from the five sources listed below. This includes revenue and expense projections **(Table 13)** from 2019–2023 developed conservatively with the following assumptions:

REVENUES

▶ **Industry Project Sponsorship**

○ Sponsorship funds relate to research projects where the industry partner may control the IP. Conservative estimates are assumed to stay at moderate levels as the focus will be on developing projects relevant to the broader membership.

▶ **Industry Membership**

○ Member investments offer one of the highest levels of flexibility in terms of use of funds as they can be used directly in research projects, leveraged to obtain government grants, applied to operations costs or even used to support new initiatives such as scholarships, early stage innovation and building databases and knowledge-sharing platforms.

▶ **Conferences, Short Courses and Workshops**

○ As the volume of research results increases during 2019–2023, there will be more opportunities to convert information into knowledge assets and make them available to students, government and industry stakeholders. This in turn will increase learning activities and conferences with revenues anticipated to follow. An expansion in the types of learning offered including mineral economics and technology-oriented topics will also increase revenues compared to current levels. Revenues include assumptions of 2–5 events per year at $15,000 each and hosting one conference in Year 5.

▶ **Government Grants**

○ This only includes revenues to the Centre for management and support of government-funded initiatives according to budgets and agreements on a per-project basis.

▶ **Overhead**

○ MERC receives no cash overhead contributions from the University. As current projects close there is an anticipated shift to a stronger balance of overhead-bearing projects (e.g. through NSERC and OCE). Thus, future arrangements may see this revenue category increase over the next few years, as reflected in the projected budget **(Table 13)**.

▶ **MERC Sustainability Fund**

○ Accumulated funds are reflected in the MERC Sustainability Fund. The target level is to maintain one year of operational costs in reserve; plus additional funds for scholarships, innovation initiatives, project cash flow

MINERAL EXPLORATION RESEARCH CENTRE
FINANCIAL PROJECTIONS, 2019–2023 *

	2019–20 ($)	2020–21 ($)	2021–22 ($)	2022–23 ($)	Total ($)
Opening Balance	383,006				**383,006**
Revenue	**255,000**	**310,000**	**390,000**	**455,000**	**1,410,000**
Industry sponsorship	20,000	20,000	20,000	20,000	**80,000**
Industry membership	190,000	230,000	290,000	310,000	**1,020,000**
Conferences, short courses and workshops	30,000	45,000	55,000	100,000	**230,000**
Government grants	10,000	10,000	10,000	10,000	**40,000**
Overhead	5,000	5,000	15,000	15,000	**40,000**
Expenditures	**184,000**	**292,500**	**356,500**	**397,000**	**1,230,000**
Conferences, short courses and workshops	27,000	40,500	49,500	90,000	**207,000**
Lab expenses	5,000	5,000	5,000	5,000	**20,000**
Marketing and promotions	20,000	20,000	20,000	20,000	**80,000**
Operating expenses	5,000	5,000	5,000	5,000	**20,000**
Salaries and benefits / subcontractors	105,000	200,000	250,000	250,000	**805,000**
Sponsorship	2,000	2,000	2,000	2,000	**8,000**
Travel	20,000	20,000	25,000	25,000	**90,000**
Excess/(Deficiency) of Revenue over Expenses	**71,000**	**17,500**	**33,500**	**58,000**	**180,000**
Accumulated surplus (beginning of year)	$383,006	$454,006	$471,506	$505,006	**563,006**
Accumulated surplus (end of year) **MERC sustainability fund**	$454,006	$471,506	$505,006	$563,006	

*exclusive of research funds

contingency and bridge funding for higher risk R&D initiatives; and earmarked funds to support multi-year projects that may have unexpected changes in industry contribution levels, thus ensuring they are funded to completion. The projected net revenues will help MERC build up a fund that can sustain these measures and lead to long-term success.

EXPENSES

Conferences, Short Courses and Workshops

- Educational and training events generally cost nearly all of the revenues brought in. They carry the possibility of

a breakeven or even a loss, depending on enrolment numbers. The budget conservatively assumes cost at 90% of revenues.

- **Marketing and Promotions**

  - Activities relating to business development, membership promotion, networking and Centre marketing.

- **Operating Expenses**

  - Calculated at $5,000 per year using an average of the preceding period.

- **Salary and Benefits / Subcontractors**

  - Builds on current salaries and benefits of the MERC team with the addition (over the first five years) of time from a Membership Coordinator, Business and Funding Development personnel and additional administrative support. This additional HR will be necessary to achieve the goals and fulfill the mandates of the strategic directions to 2023 and beyond.

- **Sponsorship**

  - Sponsoring students and events at an approximate average of the preceding period.

- **Travel**

  - Travel for Board members; and MERC team travel for networking, membership development, recruitment and succession planning.

» MONITORING AND EVALUATION OF THE STRATEGIC PLAN

The strategic plan will be monitored and its progress evaluated in terms of **i)** impact on the operations, research and educational programming; **ii)** industry membership targets; **iii)** student and faculty recruitment; **iv)** MERC Administration capacity; **v)** collaboration with internal departments (HES, GSM, LU Admin, etc); and **vi)** external partners from industry and government. The strategic directions and implementations as indicated should be viewed as key performance indicators (KPIs) for MERC in the respective time frames.

Implementation of the strategic plan will be assured through a structured follow-up process including the following actions:

- Formally assigning each task listed in the preceding activity tables to one responsible lead and 1–2 additional support staff;

- Internal bi-annual progress reviews;

- Reporting by the Director to the Advisory Board at each Board meeting; and

- Annual progress update to stakeholders, as appropriate.

Success will be determined by MERC's ability to undertake the assigned tasks in support of the strategic directions and ultimate goals for industry and MERC.

CONCLUSIONS

The exploration industry is currently indicating optimism and an openness to embrace advances in field methods, data collection and interpretation. Through existing strengths and established partnerships, MERC is on a strong trajectory to grow its global leadership in mineral exploration research, education and training and maintain its relevance for years to come. Current research programs such as Metal Earth and Footprints have laid a foundation of research excellence relating to Precambrian geology and ore systems. This volume of research will lead to significant knowledge transfer opportunities and more in-depth projects that will help discover keys to unlocking the mysteries of mineral exploration on earth.

APPENDIX 1:

MERC MEMBERS AND ADVISORY BOARD

MERC members from 2014–2018. All members are current except where dates are indicated.

FOUNDATION MEMBERS

- Barrick Gold Corporation
- Harquail School of Earth Sciences
- Kirkland Lake Gold Limited
- Ontario Geological Survey

- Goodman School of Mines (2015–2017)
- Teck Resources Limited (2015)

CORPORATE TIER 1 MEMBERS

- Alamos Gold Incorporated
- Goodman School of Mines
- IAMGOLD Corporation
- Ivanhoe Mines Limited
- Kinross Gold Corporation
- Teck Resources Limited

- Detour Gold Corporation (2016–2017)
- Gold Fields Canada Exploration Limited (2014–2015)
- Goldcorp Incorporated (2017)
- KGHM International Limited (2014–2016)

CORPORATE TIER 2 MEMBERS

- Battery Mineral Resources Limited
- Exiro Minerals Corporation
- First Cobalt Corporation
- Highland Copper Company Incorporated
- KGHM International Limited
- McEwen Mining Incorporated
- Northern Superior Resources Incorporated
- Pelangio Exploration Incorporated
- Phoenix Geophysics Limited

- SRK Consulting
- Sudbury Integrated Nickel Operations – Glencore
- Taseko Mines Limited
- Transition Metals Corporation
- Vale Canada Limited

- Cliffs Natural Resources Incorporated (2015)
- Detour Gold Corporation (2015)

CHAIR

Dr. Catharine Farrow (June 2018–Present)
Consultant, Director, Franco-Nevada Corporation, Exiro Minerals Corporation and Centamin plc

Dr. Thomas E. Lane (2003–2018) (┼)
Director, Exploration Division, CAMIRO

EXPLORATION SCIENCE ADVISOR

Dr. Howard Poulsen (2018)
International Consultant

Benoît Dubé
Research Geoscientist, Geological Survey of Canada

EX-OFFICIO

Ross Sherlock
Director, Mineral Exploration Research Centre (MERC) and Metal Earth

Harold L. Gibson
Past Director, MERC and Metal Earth

Douglas K. Tinkham
Director, Harquail School of Earth Sciences (HES)

John Ayer
Associate Director, MERC

Bruno Lafrance
Associate Director, Metal Earth

Osman Abou-Rabia
Dean, Faculty of Science, Engineering and Architecture, Laurentian University

APPENDIX 2:
KEY INTERVIEW HIGHLIGHTS

OVERVIEW OF STAKEHOLDER ENGAGEMENT PROCESS

Over a period of eight weeks in the spring of 2019, numerous industry and public sector stakeholders were contacted and interviewed by key members of MERC's Executive and its Advisory Board Chair. These interviews were conducted in person or via teleconferencing to gain the external perspective required to assess MERC's current strategic position regarding **i)** reputation and value, **ii)** strengths and successes to date, and **iii)** areas for improvement.

Through this engagement process, stakeholders provided recommendations on strategies to strengthen the long-term sustainability of MERC including ways for MERC to position itself after the conclusion of the Metal Earth project (beyond 2023).

The following data was provided by senior representatives from a cross-section of industry and public sector including Barrick Gold Corporation, Exiro Minerals Corporation, Glencore Canada Corporation, IAMGOLD Corporation, Kinross Gold Corporation, Ontario Geological Survey, Transition Metals Corporation and Vale Canada Limited.

OVERVIEW OF FINDINGS

MERC'S REPUTATION AND VALUE: PROFESSIONAL DEVELOPMENT FOR INDUSTRY AND ORGANIZATIONS

Based on feedback from stakeholders, MERC was able to confirm that the Centre is known for its excellent location and respected for providing a solid foundation of **i)** hands-on field work training, **ii)** well-rounded geological study and research of Archean greenstone belts, and **iii)** conducting research projects relevant to the mining sector.

Representatives from industry, especially junior mining and mineral exploration companies, recognized the benefits of **i)** valuable industry-specific research that is conducted and shared by MERC, and **ii)** highly qualified personnel (HQP) training which continues to provide a new qualified labour market.

MERC's identity is around the training of young geologists. Both industry and the public sector acknowledged the value of MERC's professional development training.

STRENGTHS AND SUCCESSES TO DATE: WHAT MERC DOES WELL

Further to the findings above, stakeholders unanimously acknowledged the calibre of MERC's:

- Field-based approach to HQP training and geology research;
- All aspects of geosciences studies and research;
- Research of the Superior region, Archean geology and mineral deposits;
- Training and professional development short courses, modular courses and field trips; and
- MERC's wide range of faculty skill sets.

Throughout this process, feedback indicated that MERC's main strengths contribute to making the Centre unique among research and educational centres.

AREAS FOR IMPROVEMENT: WAYS IN WHICH MERC CAN IMPROVE

Feedback regarding ways for MERC to increase the Centre's value to stakeholders included recommendations in the following areas:

COMMUNICATIONS

Communication with partners **i)** to strengthen collaborations by increasing opportunities for input on, and alignment with, research project development and ongoing research activities; **ii)** to ensure industry stays current with research activities and results and to potentially increase active industry participation; and **iii)** to ensure that exit interviews with research associates are conducted, thereby building an idea flow to generate more projects.

Social media communications through blogs and podcasts to **i)** disseminate information, **ii)** strengthen MERC's reputation for education and training, and **iii)** attract new collaborative partnerships.

FACULTY

On the whole, MERC's faculty is seen as strong and capable, however the lack of a geochemistry faculty member is seen as a gap. Additionally, there is a slight perception that MERC faculty is stretched outside its normal focus of core activities. Note: This comment specifically excluded Metal Earth faculty.

There was concern expressed that Metal Earth is providing MERC's sustainability and therefore maintaining that sustainability beyond 2023 is an issue.

HQP TRAINING AND PROFESSIONAL DEVELOPMENT

The main challenge for MERC, as identified by stakeholders, is in making improvements while continuing to do what MERC does well.

In the area of research, there was a clear divide between stakeholders recommending MERC stick to the Centre's Precambrian, and specifically Archean focus, and those suggesting that MERC expand its research focus beyond Archean.

It was indicated that MERC needs more process-driven projects rather than models. Predictive mapping is seen as most beneficial to industry.

Several respondents acknowledged that LU-HES-MERC is better known by Toronto-based companies than the University of Toronto's Geology Department. Suggestions to strengthen this reputation further included considering combining the efforts of LU's Earth Sciences and Engineering departments similar to the approach of Queen's University.

The suggestion was also made to develop artificial intelligence (AI) capacity with other organizations.

Most of the stakeholders who were interviewed recommended adding Mineral Economics to the Earth Sciences program.

Feedback on professional development overall was positive, however there are two "camps" regarding whether or

not to stay with generalists who can work across a broad range of environments or to move forward with specialists focusing on specific datasets. There was broad agreement that MERC maintain and increase Ni-Cu focus through courses and research.

MERC's 1–2 day courses are unanimously seen as beneficial and are utilized by all industry and public sector stakeholders. Since the value of professional development is so clearly seen, there were numerous suggestions for ways to increase benefits even further including:

○ Field courses and trips offering hands-on looks at core and models in different geological environments and potentially even including field trips overseas;

○ Increased professional development around particular deposits and deposit types;

○ Holding more professional development in Sudbury to provide opportunities for direct participation by Toronto-based head offices;

○ Additional modular courses;

○ Workshops on Metal Earth projects to better disseminate information and provide further professional development opportunities;

○ Adding content that addresses the non-geoscience aspects of the mining and mineral exploration industry including **i)** basics of resource estimation, **ii)** basics of metallurgy, **iii)** basics of mining methods, and **iv)** mining value chain;

○ Further to the above, offering 1–2 day courses including an editing assignment on how to write a report; and

○ Offering 2–3 day courses on **i)** how to read financial reports, and **ii)** understanding R&R statements and what they mean.

RECOMMENDATIONS FOR PARTNERSHIP DEVELOPMENT

For the purposes of this summary, partnership recommendations provided by stakeholders have been divided into two categories: **i)** upcoming projects, and **ii)** new partnerships and collaborations.

UPCOMING RESEARCH PROJECTS

Numerous industry stakeholders suggested projects tailored to their company's mine locations and exploration needs, whether transect or craton-based. Interest was indicated in finishing upcoming geology surveys, and greenstone and magmatic processes.

NEW PARTNERS AND STRONGER COLLABORATIVE RELATIONSHIPS

Recommendations for establishing new partners included a wide range of suggestions such as **i)** other research organizations (i.e. NORCAT) in Canada and abroad, **ii)** mining supply and service companies, **iii)** financial institutions and investment companies, and **iv)** law firms.

Increased Indigenous relations was seen as another appropriate focus for partnership development.

Additionally, the suggestion was made for MERC to better align with prospector training.

Recommendations were made for stronger collaboration with the public sector including Geological Survey of Canada, Ontario Geological Survey and Prospectors & Developers Association of Canada to increase projects and fill in gaps in the current faculty.

It was noted that MERC already has a collaborative consortium of partners through Metal Earth, collaborative research and development (CRD) projects and longer-term projects involving a number of companies and researchers (such as partnerships developed through the NSERC-CMIC Footprints project). The suggestion was made to make these partnerships more robust by engaging partners in the research to a greater degree and perhaps by embedding researchers.

RECOMMENDATIONS FOR SUSTAINABILITY AFTER METAL EARTH (BEYOND 2023)

MERC is seen as well placed to be the lead institution working in Archean environments.

Recommendations were to focus on process research while staying true to MERC's strengths. Multiple stakeholders cautioned MERC against losing its identity in the Centre's pursuit of long-term sustainability.

That noted, stakeholders made the following recommendations on ways for MERC to position itself after Metal Earth:

- Strive for further international collaborations and research projects leveraging off the results of Metal Earth;

- Develop non-geoscience based courses including **i)** financial, **ii)** data analytics, and **iii)** targeting;

- Create a think-tank to strategize expanded training in all aspects of **i)** mineral exploration, **ii)** management leadership, and **iii)** society roles and values related to the mining sector;

- Build on the strengths of MERC by replacing outgoing faculty with those of comparable areas of expertise who are at mid-career level; there was specific mention of need for a geochemistry faculty position; and finally,

- Some stakeholders recommended focusing on work around Ontario, while others recommended reaching out across Canada and abroad.

APPENDIX 3:
GLOBAL RESEARCH ORGANIZATION COMPARATIVE SURVEY

BEST PRACTICES – COMPARATIVE REVIEW OF MDRU, CODES, CET AND MERC

Mineral deposit research groups are mainly located in Canada and Australia, each of which has one or more area(s) of specialization. Each group competes for resources such as industry and government funding, researchers and graduate students. MERC has a comparable mandate to several other geoscience organizations, namely the Mineral Deposit Research Unit (MDRU) in Vancouver, Canada; the Centre for Ore Deposit and Earth Sciences (CODES) in Tasmania, Australia; and the Centre for Exploration Targeting (CET) in Perth, Australia. These organizations have similar mandates, operations and linkages with industry, government and academic institutions. As such, they serve as comparable centres to MERC.

For a detailed comparison between these centres, see **Table 14**.

MERC started up approximately 10 years after MDRU and CODES and its support initially consisted of government funding for one research chair. No other support was received from Laurentian University or government. This is in contrast to the Australian centres which received considerable and continuous startup funding from government and institutional sources. In contrast, MERC grew its operations and research budget incrementally through member fees and industry-sponsored research with a core group of mineral sector companies. This ensured its applied research focus was relevant to the needs of its supporters.

Similar to the other organizations, MERC has a broad global reach. The 2014–19 business plan posited how MERC could expand beyond the Sudbury Basin and select regions in Canada. Shortly thereafter, MERC became secretariat of the NSERC-CMIC Footprints project and the lead organization on Metal Earth, both of which greatly expanded MERC's research capacity.

On the knowledge transfer front, all organizations publish and offer short courses with the differentiating factor in the areas of focus. MERC's focus is on Precambrian geology and ore systems, a niche market in which MERC has dominated.

MERC has a large complement of faculty, research associates, adjuncts and graduate students similar to CODES and CET. These institutions have tenured faculty from their respective departments as their faculty members. MDRU is different, as only the Director has a grant- tenured faculty position in the Department of Earth and Ocean Sciences. MERC's operating and research budget is close to CODES and CET, although the number of graduate students at MERC is almost double the numbers at CODES and CET.

MERC provides value to industry, government and academic partners by serving as scientific and administrative hub of active high value projects. This has **i)** increased MERC's credibility; **ii)** resulted in additional projects being launched in parallel; and **iii)** led to participation in initiatives such as the Metal Oceans program, a study that for the first time ever compares the modern ocean crust and its evolution with the structure and composition of greenstone belts.

Category	MDRU* Canada *information source 2019 website	CODES* Tasmania, Australia *information source 2018 annual report	CET* Western Australia *information source 2014 annual report	MERC* Canada *information as of 2018-2019
Startup	Established in 1989 with support and financial assistance from mining industry and NSERC	Formed in 1989 at University of Tasmania	Established in 2005 as unincorporated joint venture between minerals exploration industry, University of Western Australia, Curtin University and Government of Western Australia	Established in 1997 as semiautonomous research centre within LU's Department of Earth Sciences (now Harquail School of Earth Sciences)
	Income from an endowment generating approximately $100,000/year in operational funding in 2006, 2007 and 2008. Forecasted funding estimate for 2009 was $50,000	Federal government-funded ARC Key Centre (1989–1996), ARC Special Research Centre (1997–2005) and ARC Centre of Excellence (2005–2013) Centre of Excellence status triggers approximately $3M in annual government core funding, matched or exceeded by industry funding; fee-for-service revenues generate another $1M+ annually; University of Tasmania funding provides additional $1.5M–$2M/year	Established with key funding support from Government of Western Australia through the Centres of Excellence in Science and Innovation Program	No financial support or endowment from LU except provision of office space First director (M. Lesher) was an IRC Chair with salary paid by NSERC

Category	MDRU Canada	CODES Tasmania, Australia	CET Western Australia	MERC Canada
Global reach	Corporate and individual members currently include major and junior mining and exploration companies from Canada, United States and Australia and several associate members	Research collaborations with industry, academic institutions and research centres in 27 countries	Corporate and individual members include major producers, emerging producers, junior explorers and individuals	Corporate and individual members and strategic research consortium include major producers, major and junior exploration companies, research centres and governments from Canada, United States, Australia and Germany
	Collaborative research projects with economic geology research groups in Canada, United States, South America, Asia and Eastern Europe	Satellite facilities known as "nodes"; international research partners at University of Queensland, University of Melbourne, Australian National University, Commonwealth Scientific Industrial Research Organisation, University of British Columbia, Colorado School of Mines, Imperial College London and Russian Academy of Sciences	Collaborative research projects with research groups in Australia, Africa, North America, South America, Europe and Asia	Collaborative research projects across Canada and in 11 countries spanning 5 continents. Global collaboration with mining companies; international collaborators from academia, the public sector and industry from United States, Australia, New Zealand, Germany, the Netherlands, Switzerland and Sweden
	Journals, maps and theses available publicly Archive resource available with login	82 journal publications	103 journal publications	>80 publications per annum

Category	MDRU Canada	CODES Tasmania, Australia	CET Western Australia	MERC Canada
Key resources	Economic geology-related library including geologic and mining archive for Island Copper donated by BHP Minerals, Sheahan-MDRU Library and GIS-computer facility	CODES Rock Library	N/A	John B. Gammon Mines Library
	Fluid inclusion laboratory Access to departmental facilities including scanning electron microscope (SEM) and petrographic microscope, microprobe and sample preparation labs, etc	Analytical facilities including 5 laser ablation ICP-MS laboratories, an XRF laboratory, solution ICP-MS and clean room, fluid/melt inclusion laboratory, lapidary department and sample preparation facilities, shortwave infrared (SWIR) and portable XRF Reciprocal access to UTAS Central Science Laboratory including electron microscopy and mineral liberation analysis (MLA), X-ray microanalysis, laser Raman and FTIR spectroscopy and ICP-MS	Access to departmental facilities (SEM, microprobe, sample preparation labs, etc) Sensitive High Resolution Ion Microprobe (SHRIMP) Laser ablation ICP-MS, X-ray fluorescence and X-ray diffraction	Ontario Geoscience Labs LU Central Analytical Facility Fluid Inclusion Laboratory Isotopic Geochemical Laboratory

Category	MDRU Canada	CODES Tasmania, Australia	CET Western Australia	MERC Canada
Operating priorities	Ore deposit research	Ore deposit research	Ore deposit research	Mineral exploration and ore deposit research
	Advanced education workshops Short courses for professional development	Advanced education modular graduate courses for Australian and international students Workshops and short courses for professional development	Advanced education graduate courses for Australian and international students Workshops and short courses for professional development	Advanced education modular graduate courses for Canadian and international students Workshops and short courses for professional development
Management and staff	5 staff including: ○ Director ○ Associate Director ○ Project Manager ○ Event Manager ○ Finance Processing Specialist	13 staff including: ○ Director (CODES and ARC TMVC Research Hub) ○ Deputy Director (CODES and ARC TMVC Research Hub) ○ Executive Assistant ○ Administrative Officers ○ Communications Manager ○ Lab Manager ○ Lab Tech ○ Lab Analyst ○ Lapidary Tech ○ Program Coordinator ○ IT Officer ○ Publications ○ Rock Store Curator	10 staff including: ○ Director ○ Project Coordinator ○ 8 business support staff	10 staff including: ○ Director (MERC and Metal Earth) ○ Associate Director (part-time) ○ Administrative & Finance Manager ○ Communications & Promotions Manager ○ Administrative Coordinator ○ Administrative Assistant ○ Information Technologist ○ GIS Specialists ○ Petrographic Technologist

Category	MDRU Canada	CODES Tasmania, Australia	CET Western Australia	MERC Canada
Governance	Board of Directors	Advisory Board	Board of Directors	Advisory Board
	Research Generative Group	Executive Committee	Executive Management Committee Finance, Risk and Commercialization Committee External Advisory Group	Dean, Faculty of Science, Engineering and Architecture
Members	5 foundation members, 44 corporate members, 4 government agencies, and 11 individual members	12 industry partners (generally equivalent to foundation members)	13 major producers, 6 emerging producers, 16 junior explorers, and 15 individuals	4 Foundation members, 6 Tier 1 corporate members, 14 Tier 2 corporate members
Professors, research associates and adjuncts	4 faculty	59 faculty / research staff	16 faculty	16 faculty
	12 research associates	N/A	8 research associates	16 research associates
	26 adjuncts	N/A	55 adjuncts	30 adjuncts
Graduate students	2 Ph.D.	133 postgraduates	32 Ph.D.	48 Ph.D.
	23 M.Sc.	N/A	N/A	38 M.Sc.