



## MEMORANDUM

**To:** Executive Committee of Faculty Council (February 2, 2021)  
Faculty Council (February 24, 2021)

**From:** Professor Ramin Farnood  
Vice-Dean, Research and Chair, Research Committee

Professor Lesley Warren  
Director, Lassonde Institute of Mining

**Date:** January 15, 2021

**Re: Elevation of the Lassonde Institute of Mining from an Extra-Departmental Unit, Type D to an Extra-Departmental Unit, Type C**

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## REPORT CLASSIFICATION

This is a major policy matter that will be considered by the Executive Committee for endorsing and forwarding to Faculty Council for vote as a regular motion (requiring a simple majority of members present and voting to carry).

This proposal was originally endorsed by the Executive Committee at its November 5, 2020 meeting; however, it has since been updated and is coming forward again as a revised proposal for the Executive Committee's endorsement and Faculty Council's approval.

## BACKGROUND

The Lassonde Institute of Mining (LIM) is currently an Extra-Departmental Unit, Type D (EDU-D) within the Department of Civil & Mineral Engineering, however, it has operated unofficially for some time as a multi-department institute with PIs in Civil & Mineral Engineering, Chemical Engineering & Applied Chemistry, Materials Science & Engineering, Mechanical & Industrial Engineering, and Aerospace Studies, as well as in the Faculty of Arts & Science's Earth Sciences department.

As an EDU-C, LIM will focus on innovation and sustainability of mining for the 21st century. It will coalesce its pursuit of research and scholarly interest in the research domain of mining and related areas, increase visibility, enhance multidisciplinary aspects through non-budgetary cross appointments (internal and external to FASE), develop and house a graduate collaborative specialization, and present a coordinated, public facing "storefront" for mining expertise that can connect FASE academics with industry, government and other mining stakeholders.

## **PROCESS AND CONSULTATION**

Comprehensive consultations across FASE departments and institutes and the Faculty of Arts & Science's Department of Earth Sciences revealed widespread support for LIM to be elevated to an EDU-C.

## **RECOMMENDATION FOR COUNCIL**

THAT the elevation of the Lasonde Institute of Mining (LIM) from an Extra-Department Unit, Type D to an Extra-Department Unit, Type C, be approved as described in Report 3673 Revised, effective March 1, 2021.

# **Proposal to Elevate the Lassonde Institute of Mining (LIM) at the University of Toronto to an Extra-Departmental Unit, Type C**

**January 15, 2021**

## **1. EXECUTIVE SUMMARY**

Mining in the 21st Century is a complex business, requiring new capabilities to locate and mine deeper ores, profitably extract lower grade ores and manage increasing amounts of waste that represent significant financial liability to the industry and risk to the environment. Globally, the industry is confronted by the real need for better strategies that can maintain shareholder and investor confidence and convince regulatory and community stakeholders that current and planned mines will not pose a threat to important environmental resources. The development of smarter, more sustainable mining operations requires advanced, multidisciplinary research that will fuel the disruptive innovations required to meet these challenges. The growing demand for mining life cycle technologies requires a coordinated, approach that focuses on engineering applications and solutions that improve environmental, social and regulatory outcomes. A key focus of the Lassonde Institute of Mining (LIM) is innovative development of enabling technologies and solutions required for a sustainable mining sector. Such innovation is of vital global importance, as resource extraction activities are expanding to meet the increased demands for elements such as copper (Cu) and lithium (Li), required for renewable energy generation and storage “green” technologies; a cornerstone of the UN's 2030 Agenda for Sustainable Development.

Researchers in the Faculty of Applied Science and Engineering (FASE) and elsewhere at the University of Toronto (U of T) have relevant expertise across the entire mining life cycle and associated areas such as public policy, human health, Indigenous relations and economics, providing the ideal nucleus to drive innovative world-leading solutions for this industry. LIM is currently an EDU-D within the Department of Civil and Mineral Engineering (CivMin). Upon elevation to an EDU-C, it would, like most FASE EDU-Cs, report to the Dean or his designate. CivMin will continue to provide space and may provide additional support as needed to ensure mutual mining success for all at FASE. LIM has operated unofficially for some time as a multi-department institute with PIs across the Faculty that includes CivMin, Chemical Engineering

and Applied Chemistry (ChemE), Materials Science and Engineering (MSE), Mechanical and Industrial Engineering (MIE), the University of Toronto Institute for Aerospace Studies (UTIAS), as well as the Faculty of Arts and Science's Earth Sciences Department. The cohort of current LIM PIs cover cross-cutting research needs of this unique sector including mineral exploration, mining engineering, computational geomechanics, mineral process engineering, metallurgy, emerging needs of water management and environment, sustainability, regulatory policy and circular economy models for improved business operations. We have identified an opportunity to coalesce, coordinate and increase both LIM's visibility and impact by elevating it to an EDU-C. Through faculty consultation and industry feedback we have established six key research areas that cluster LIM PI expertise: 1) Energy & Sustainability; 2) Exploration; 3) Robotics, Machine Learning & Big Data; 4) Safer Mines; 5) Society and the Economy; and 6) Water & Tailings. Next steps include appointing a Faculty Lead for each priority area in order to further identify new collaborative, transdisciplinary research opportunities for LIM's collaborative, transdisciplinary research activities. We will have the Lassonde Research & Innovation Priority Leads in place for winter 2021.

Elevating the LIM to an EDU-C will further unite, grow, and bring greater visibility to the many exceptional mining and mining-related researchers, groups and students across the university. As an EDU-C, LIM will:

- Coalesce its pursuit of research and scholarly interest in the defined research domain of mining and related areas;
- Increase visibility, enhance multidisciplinary aspects through non-budgetary cross appointments (internal and external to FASE);
- Develop and house a graduate collaborative specialization program; and
- Present a coordinated, public facing "storefront" for mining expertise serving as a matching platform that can connect FASE academics with industry and government stakeholders as well as with other mining ecosystem stakeholders.

Consultations conducted across FASE departments and EDU-As and EDU-Bs (see Appendix 1) revealed widespread support for LIM's elevation as well as The Faculty of Arts and Science. By legitimizing the current ad hoc Institute collaborations and arrangements through an EDU-C, opportunities will become more transparent, engagement and collaborative initiatives will be incentivized, and their recognized impacts captured in the Institute's value-add.

This expanded and coordinated approach aligns well with key areas of research strength and focus identified in the Faculty's *Academic Plan, 2017-2022* and with the strategic research

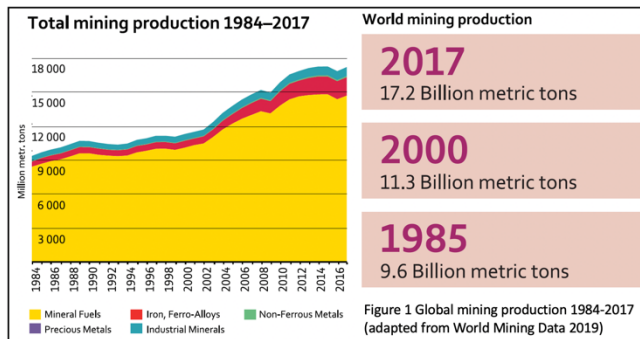
areas identified in the University's *Institutional Strategic Research Plan, 2018-2023*: DISCOVER, SUSTAIN, ADVANCE, INNOVATE, BUILD (Table One), and will facilitate and accelerate the Faculty's and U of T's strategic development. Furthermore, the elevation of LIM to an EDU-C will enable the institute to deliver new and expanded outcomes across all FASE research clusters identified in the Faculty's Academic Plan, 2017-2022.

Table One – Critical Mining Areas Mapping to University's and FASE Research Themes/Clusters

<b>U of T's Institutional Strategic Research Plan, 2018-2023 Research Themes</b>	<b>Faculty's Academic Plan, 2017-2022 Research Clusters</b>	<b>Critical and Relevant Mining Areas</b>
SUSTAIN: Societies, the Environment, and Natural Resources	<ul style="list-style-type: none"> <li>• Robotics</li> <li>• Sustainability</li> <li>• Water</li> </ul>	Increasing fundamental knowledge around mining's impacts leading to environmental changes and how to mitigate future risk to the environment through site closure; socio-economic challenges of sustainable mining and clean-tech energy/reduction of GHG underground and above, etc.
PROMOTE: Healthy People, Healthy Communities, and a Healthy World	<ul style="list-style-type: none"> <li>• Human Health</li> <li>• Sustainability</li> <li>• Water</li> </ul>	Improving economic, health and environmental outcomes for rural and First Nation communities impacted by mining activities
ENGAGE: Language, Culture, Art, and Values		Development of community engagement and value proposition tools for mining companies to ensure best industry practices
ADVANCE: Governance, Diversity, and Social Justice		Resource scarcity, government permitting and licensing, stakeholder/community management and relations and mining working conditions internationally are having major impacts on economies globally and on mining companies here at home and abroad
INNOVATE: Technologies for the Future	<ul style="list-style-type: none"> <li>• Human Health</li> <li>• Advanced Manufacturing</li> <li>• Data Analytics and AI</li> </ul>	The applications of big data and artificial intelligence to mining are improving asset maintenance planning, safety monitoring for workers and improving efficiencies at

		the rock face and in exploration e.g., core logging.
BUILD: Community and Livable Societies	<ul style="list-style-type: none"> <li>• Water</li> <li>• Sustainability</li> </ul>	Improving water impacted by mining activities affecting northern and Indigenous communities' water supplies is one of the many way LIM can affect positive outcomes for living conditions

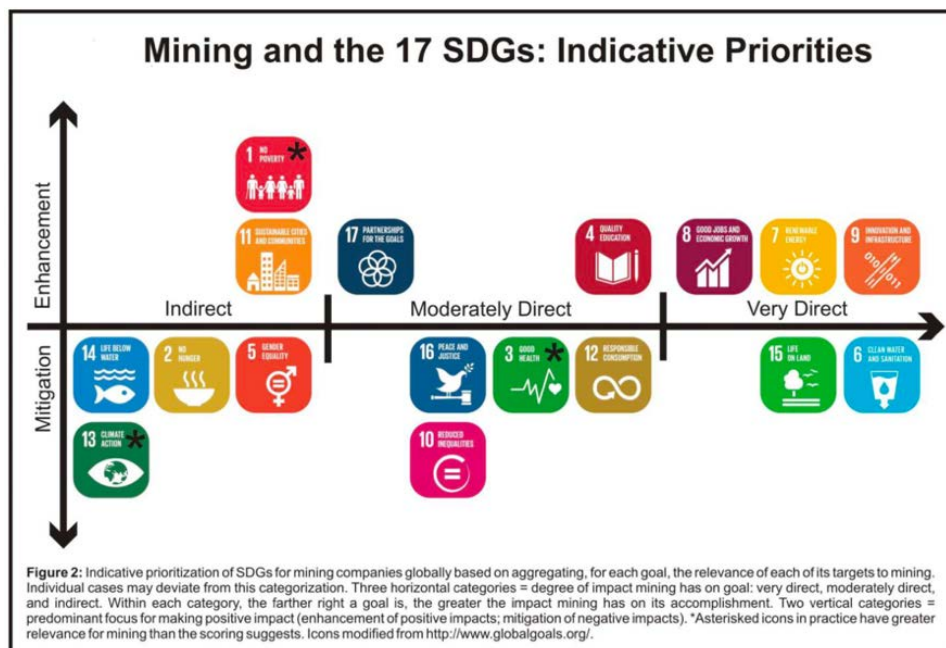
### The Global Need and Growing Canadian Leadership of U of T's Mining Expertise



The mining sector is profoundly integral to continued prosperity and economic development for Canada, as well as many other countries around the world. Canada ranks among the top five countries in the global production of 15 minerals and metals, many of which are essential to the

low carbon technology (Mining Association of Canada). The global expansion of mining activities (Figure 1) reflecting increased demand, declining ore grades and the necessity to mine deeper deposits, must be balanced by better solutions to manage the growing tailings and water issues. Science-based policies for effective regulatory governance and improved sustainable

practices are needed. Indeed, like no other sector, mining is profoundly linked to all the 17 Sustainable Development Goals (SDGs) identified in 2030 Agenda for Sustainable



Development (2015), which represents the world's plan of action for social inclusion, environmental sustainability and economic development (Figure 2). Thus, the research needs of this sector, on national and international scales, are broad and of global importance. They

span advanced manufacturing and the development of green technologies, data analytics, artificial intelligence and robotics that can improve operations and lead to fully automated mines, new breakthroughs in water and sustainability that can improve environmental stewardship, community impacts and resiliency for the sector, as well as governance and development of science-based policies to better steward environment and public health. The breadth of these research needs aligns to both FASE and university-level strategic areas (Table One, p. 3) and underscores the substantial opportunities for broad EDU-C LIM to contributions of impact.

**It is therefore recommended to elevate the Lasonde Institute of Mining (LIM) from an EDU-D to an EDU-C within the Faculty of Applied Science and Engineering, effective January 1, 2021.**

The EDU-C will be organized around three drivers: 1) Research and Innovation, 2) Talent and Development and 3) Collaborations. This synergistic platform will drive collaborative research between technical mining experts and those with domain-specific knowledge across the Faculty and U of T. It will also act as a central resource for up-to-date information on FASE programs and courses related to mining. Collaborations with industry, government and other groups will be the foundation for long-term financial sustainability. Additionally, through industry relationships, the institute will cultivate new experiential learning opportunities for students, including internships, Professional Experience Co-op Program placements in collaboration with the Engineering Career Centre, as well as enhance capstone projects. In addition, our expansive mining sector connections will provide expanded industry-collaborative and/or focused research activities, advanced graduate (MAsc and PhD) and PDF, RA research opportunities and MEng projects.

The Institute will be led by a Director and supported by a Managing Director who will promote the Institute, facilitate new research and talent development initiatives, foster industry engagement and seek new collaborative opportunities. The mining sector is unique compared to other industry sectors engaged with FASE and U of T in that it has a widespread perceived lack of value-add associated with university research. Unlike many sectors where research is recognized as core to business development and thus of high value, this industry has moved away from university-collaborative research at a broad scale and thus a critical component for the Institute is their re-engagement and socialization of the idea that U of T research (as opposed to near commercialization-stage research leading to new widgets) is vital to improve their adaptability, resilience and long-term viability.

As the major and global challenges facing this industry include environment, social license and resilient economic models under climate change, there is continued pressure on the industry to find effective solutions and a new imperative to drive research that can fuel innovative technologies ensuring their continued viability. Thus, the Institute has created the Managing Director role explicitly to engage, re-educate and build a robust industry collaborator base in order to mine this rich research opportunity. An Academic Steering Committee and Industry Advisory Team will provide guidance to the Institute's leadership, along with the Research Area Leads that were determined by the Research Area workshop in May 2020.

## 2. VISION AND MISSION

Based on broad consultations across Engineering and other Faculties (Appendix 1), the following vision and mission have been formed for the Institute:

**Vision: LIM will be a world-leading institute of innovative mining research, delivering solutions for the extractive resources sector and training the next generation of leaders for the industry, thus securing FASE and U of T's position at the global forefront of mining transformation in research, education and thought leadership.**

Globally, the industry is confronted by the need for better strategies that can maintain shareholder and investor confidence, especially in light of boom or bust cycles of mining profits while convincing regulatory and community stakeholders that current and planned mines will not pose a threat to important environmental resources. Thus, the industry faces myriad issues that require advanced, multidisciplinary research and strategic development of new disruptive technologies to innovate current practices and support Canada's continued role as a global mining leader.

### **LIM Vision Outcomes**

- LIM will generate globally needed solutions and strengthen the global competitiveness of the Canadian mining and mineral processing sectors.
- LIM will coalesce and integrate research expertise both in FASE (ChemE, CivMin, ECE, MIE, MSE, ISTEP, UTIAS) and university-wide (The Faculty of Arts and Sciences including Department of Earth Sciences), to address the growing need to process increasingly low-grade mineral deposits, develop new technologies for mining deeper and mineral processing with limited environmental impact, and extract high value metals from primary or secondary sources such as wastes and post-consumer products – and to do these things in an innovative, sustainable, socially



responsible and economically viable manner.

- LIM will allow FASE to capitalize on strategic growth areas such as industrial water and big data, enabling new industry-academia-research collaborations.
- LIM will develop new education and experiential learning opportunities at the undergraduate and graduate levels, as well as professional development courses. These multi-disciplinary and industry-integrated offerings will provide cutting-edge knowledge and emerging skill sets needed by mining leaders for the future.
- LIM will improve U of T's mining reputation through expanded opportunities to help attract new undergraduate and graduate students and to broaden the competencies our students develop to increase their employability and standing within the mining industry and beyond.

Over 35 faculty from across FASE and The Faculty of Arts and Science are currently involved in the LIM EDU-D and have research collaborations in place with diverse mining companies that span multiple key industry research needs, underscoring the advanced research expertise that LIM can successfully leverage with industry.

As an EDU-C, LIM's mandate will be to address the most pressing scientific and broader societal challenges facing the industry, to deepen and develop fruitful and on-going collaborations amongst existing and new LIM PIs that reflect industry pull and to provide ongoing industry financial support to ensure LIM's viability. Furthermore, these collaborations will help cultivate demand from industry, lower the barriers for collaboration with faculty, and accelerate the training of highly qualified personnel (HQP) across all levels through expanded and new collaborative opportunities for undergraduate summer research and Professional Experience Co-op placements as well as graduate, PDF and RA personnel. LIM's unique geographic proximity to the headquarters of many mining companies in Toronto is a critical factor that facilitates ease of engagement, community development and opportunities for collaboration.

**Mission: To facilitate collaborative, cross-disciplinary fundamental and translational research in mining; attract, educate and develop expert personnel in this area; and catalyze our collaborators to make a significant and lasting impact in the global marketplace.**

**LIM's expanded mission is to:**

1. Foster innovation, collaboration, leadership and research excellence.
2. Address the most pressing scientific and broader societal challenges facing the industry and provide Canadian leadership and an institute of mining research, talent and thought leadership for the world.
3. Attract the brightest minds and highest potential leaders from multidisciplinary fields that will enhance and transform the mining industry from mineral engineering to material sciences, to computer sciences, to public policy and finance.
4. Create an external and internal facing point of access for collaborative applied and fundamental research related to the mining industry leading to new innovations, technologies and knowledge that address the most pressing mining challenges to improve across triple bottom line success: people, profits and planet.
5. Provide students and working professionals with knowledge and real-world experiences coupled with interdisciplinary competencies and leadership abilities to develop an exceptional mining talent pipeline ready to steer the next generation of mining industry success from engineering through applied sciences, public policy and governance, environmental stewardship and improved community relations and community resiliency.

As an EDU-C, LIM will carry out this mission by providing a coordinated, external facing “storefront” for mining expertise at the Faculty and university levels. It will be an important vehicle to promote U of T and its contributions to mining externally. It will connect and catalyze collaborations between academic stakeholders within the Faculty and across U of T who might not otherwise work together. LIM will build strategic relationships with leading global academic collaborators and external stakeholders for the benefit of our students, research and industry.

**Deepening LIM's Talent and Development Objectives as an EDU-C**

Mining is global in scale, scope and impact with ever growing needs for new talent with diversified competencies, as the world's requirements for critical metals increase and the associated environmental, social and economic challenges of resource extraction concomitantly expand. However, mining programs are typically small and given the growing breadth of disciplines working in and around the mining space there is a real need to expand “traditional mining” education and research to address not only what the industry needs today but also what it will demand for the future. LIM has an outstanding opportunity to build new programming to meet this global need. While any university will have excellent faculty

members in core areas, they will not house expertise across all of the current and emerging areas of importance to the mining sector. We aim to build new and more robust international network with mining, environment and policy focused programs to develop global electives that can build broader comprehensive technical and industrial expertise for scholarship. By cultivating collaborations with other universities, we can leverage the global mining brain trust to provide and deliver joint offerings including co-delivered field courses and global classroom experiences that are more efficient for smaller cohorts, for example Mineral Engineering and Mineral Processing at U of T. Such a global network for talent development would enhance U of T student experiences through global undergraduate experiential learning opportunities that broaden technical, cultural and direct job-related skillsets and increase job opportunities and the attractiveness of our graduates to industry through their enhanced fit for purpose skill sets.

We conducted a new joint undergraduate field pilot to great success with the University of Western Australia (UWA) in September of 2019 at mines in and around Western Australia on reclamation, bringing together soil (UWA) and water (U of T) expertise together to broaden both institutional UG student learnings through this shared offering (Appendix 8). We are planning the second phase of this pilot to bring AU students to Canada and learn more about water and mining reclamation from a Canadian perspective (timing was planned for summer 2020 but dependent on COVID19 developments). In addition, we have begun talks with the Colorado School of Mines (October 2019) to partner on a joint mining innovation project. We recently met with Unearthed Solutions representatives during PDAC 2020 to build open data source learning opportunities for our students (<https://unearthed.solutions/>). Through the elevation of LIM to an EDU-C, we would coordinate the collective mining complement across the university to allow students to work across disciplines and acquire leadership skillsets, including: collaboration, discovery, communication and adaptive thinking. Externally, there is appetite across mining programs to venture into such joint offerings including both in person and online course offerings and field courses that would expand student numbers, whilst increasing technical and experiential learning outcomes including a collaboration with Imperial College to do a course in mining finance.

Further, the Institute will support the current development of an Online MEng in Mineral Engineering in the Department of Civil & Mineral Engineering and will explore opportunities to develop a new MEng Lassonde Leaders program (name to be confirmed), also within the department and with the support of the department chair, Professor Brent Sleep. The latter program would involve multiple global companies focusing on international and diverse students, to launch them into leadership trajectories within the industry and to facilitate

industry recruitment of top talent associated with this program. We have seen significant industry support for this initiative from Lundin Mining, Kinross, Teck and Anglo American. The MEng Lassonde Leaders program would develop course content in collaboration with industry and across thematic areas such as mine design and operations, environment and reclamation, and Indigenous studies and governance.

Funds brought into the Institute will be used primarily to support the training of HQP including undergraduate students, graduate students, post-doctoral fellows and research associates who will play an integral role in all collaborations. The talent pipeline that flows through the Institute will be a key resource for attracting continued industry investment.

### **3. ACADEMIC RATIONALE**

#### **LIM strengthens the strategic goals of FASE and other Faculties**

Currently LIM membership extends across FASE and the University. There is growing interest across FASE and U of T (evidenced by the hiring of five new PIs with budgetary appointments in the Department of Earth Sciences and FASE in the last 18 months) to participate in the development and offering of new mining related initiatives including courses and global classroom learning opportunities that an EDU-C LIM could coordinate and house. As an EDU-C, LIM will increase credibility, visibility, enhance multidisciplinary research opportunities through non-budgetary cross-appointments, and enable the development and housing of new collaborative graduate specializations. As outlined below, the elevation of LIM to an EDU-C will allow it to deliver new and expanded outcomes across research, education and equity, diversity and inclusion (EDI) that align with the five strategic objectives outlined in the University's *Strategic Research Plan*.

#### **1. Demonstrate National and Global Leadership in Research and Innovation**

Mining impacts at least 13 of the 17 identified UN Sustainable Development Goals (SDGs; many of which currently lack metrics and frameworks of assessment) that will drive the UN's 2030 Agenda for Sustainable Development (World Economic Forum, *How can mining contribute to the Sustainable Development Goals?* 2015). Thus, ensuring that this vital sector has transformative new solutions is a global imperative and research opportunity of profound significance. As a multidisciplinary, coordinated EDU-C, LIM will leverage the collective expertise of FASE and university mining expertise, generating disruptive energy and real-world solutions and innovations. This collaborative and integrated approach will propel LIM to be a leader of mining research nationally and internationally, focusing on increasing our funded research programs and

the number and quality of our collaborations in Canada and globally. This will lead to increasing recognition of our research and talent outcomes as well as LIM innovations. Through greater collaboration efforts and projects, LIM will also improve the strength of our funding applications from Tri-Agency programs, Canada Foundation for Innovation and Canada Research Chairs, and CFI. Improved research outcomes will lead to more quality publications and higher citations.

## **2. Foster Collaborations and Engagement**

Coalesced PI research expertise will provide clear mechanisms to enhance collaboration and engagement across U of T, with other leading universities and the international mining industry. Through coordinated research cluster workshops, the EDU-C will increase the number of collaborations among LIM's U of T researchers and the amount of associated funding. Moreover, through greater mining researcher engagement across the university, LIM will strive to develop more successful applications for Natural Sciences and Engineering Research Council (NSERC) Collaborative Research and Development Grants, Strategic Research Network Grants, Strategic Project Grants and other collaborative programs. With coordinated outreach, LIM will be better positioned to engage with local and international governments, NGOs and industry collaborations to showcase the Faculty's and university's vast mining expertise and define new collaborative approaches to increase engagement impact.

## **3. Enhance Equity, Diversity and Inclusion across Research and Innovation**

LIM is committed to EDI and has initiated inter-department workshops and programming focused on STEM (Women in Mining Breakfasts and the planned #MeTooMining Workshop in collaboration with the Me Too Mining Association) that create the foundations for a comprehensive EDI platform. In particular, the underrepresentation of Indigenous peoples within academic Institutions, as well as within mining companies excludes their participation and values inclusion in decisions in areas where they are predominantly affected and thus will be a key focus for LIM. The University of Toronto's (U of T) Statement of Equity, Diversity and Excellence, Canada Research Chairs EDI Action Plan and UofT endorsed Dimensions, Equity, Diversity and Inclusion Canada Charter will guide LIM's on-going and future EDI efforts to address the lack of Indigenous educational opportunities that are inclusive, the lack of inclusivity of other cultural viewpoints in western science and engineering paradigms and in decision-making vis à vis mining activities. LIM will coordinate and build new experiential learning modules into current and new course offerings at both undergraduate and graduate levels that are developed from sound EDI principles. It will expand multidisciplinary and collaborative inclusive research opportunities at every level of education to increase opportunities to build research, EDI and global perspectives

into student curricular and co-curricular experiences. Expanding the breadth of disciplines upon which to draw will allow LIM to further increase the diversity of its PIs and initiatives. With a broader presence on campus, the EDU-C will have a stronger and expanded voice to tackle one of the most non-diverse industries in the global economy (McKinsey Women in the Workplace Report, 2017). Furthermore, with increased touchpoints and engagements with U of T researchers approaching EDI through alternative lenses, LIM can share best practices to enhance all mining scholarship at U of T.

#### **4. Support Integration of Research and Innovation in Student Curricular and Co-Curricular Experience**

LIM's heightened visibility within the university and externally will increase new collaborations and attraction of top engineering students and faculty, as well as enhance and expand international academic collaborations. Currently, LIM has research collaborations with many global institutes and is piloting educational collaborations with University of Western Australia (ENVT3339 Land Rehabilitation) and establishing pilots with Imperial College (Mining Finance) and University of Peru (Mining and Social License). With the elevation to an EDU-C, LIM will be better positioned to create more transdisciplinary and experiential learning experiences with integrated industry and non-industry collaborators, such as mineral engineering and Indigenous relations (industry collaborations), bioengineering and public policy (NGO collaborations), and civil engineering and sociology (government collaborations). With these enhanced learning opportunities, LIM can increase the number of undergraduate students who obtain research opportunities and the proportion of both undergraduate and graduate students who have research-based curricular or co-curricular community engaged learning experiences.

#### **5. Strengthen the Institutional Supports that Foster Research and Excellence**

The integration of LIM PIs and research and educational offerings associated with the EDU-C will provide greater concrete connections amongst diverse faculty that can foster new, innovative collaborative research and increase the overall excellence of U of T's research portfolio.

Similarly, expanding coordinated collaborative research capabilities through the EDU-C includes multidisciplinary research opportunities associated with critical challenges of energy (critical metals and recycling and electrification and autonomous mines), environment, social licence and sustainability, while continuing to increase important research efforts in core mining-related areas of exploration (fundamental research into earth systems), mining engineering (rock fractures, mine planning) and processing (hydrometallurgy and pyrometallurgy).

Further to the university's strategic objectives, an EDU-C can deploy a coordinated and multidisciplinary research and innovation approach that is aligned with the strategic research themes described in the *University of Toronto Strategic Research Plan, 2018-23*, namely DISCOVER, SUSTAIN, ADVANCE, INNOVATE and BUILD (see Table One, p. 3). Faculty and university researchers have world-leading mining expertise in all key innovation areas, and in fields that are critical to innovating practice across the mining life cycle from exploration, financing, permitting and operation, to closure and reclamation and beyond to public policy, human health, economics and finance. In addition, elevating LIM to an EDU-C will enable it to deliver new and expanded outcomes across all FASE research clusters identified in the Faculty's *Academic Plan, 2017-2022* (See Table One, p. 3).

## **The Growing Role and Need of the University of Toronto in the Mining Industry**

### ***Focus One: Talent and Development***

As discussed with LIM's PIs and at the consultation workshop in November 2019 (Appendix 4), the lack of a dedicated Faculty-level institute impedes our ability to respond to the growing demand for mining professionals. The Mining Industry Human Resources Council (MIHR)'s *Canadian Mining Labour Market Outlook* states that the workforce and pipeline to the industry are dwindling: the industry's direct and indirect employment exceeds 626,000 jobs, accounting for one in every 30 jobs in Canada. The industry will need to hire 79,680 new workers over the next decade. This workforce shortage is compounded by the wave of core skilled industry workers who are retiring. Growing the talent pipeline also presents an opportunity to increase the Faculty's impact and visibility through a coordinated approach to mining research and education. A new mandate to foster basic and applied research, support mining-focused educational programs and grow industry collaborations will further build U of T's international brand in mining.

### ***Focus Two: Research and Innovation, Talent and Development, and Collaborations***

Over the past decade, there has been a sustained rise of operation expenses and capital development costs coupled with a rapid decline in mining productivity due to many variables, such as ores being mined at increased depths. With declining ore grades and more stranded assets the industry is in dire need of transformative solutions, new knowledge and innovations.

Almost all top mining companies include a "Mine of the Future" priority in their strategic plans as well as a "Risk Portfolio". Top mining companies are increasing their investments in related technology roadmaps and are seeking entities that can provide fundamental and translational

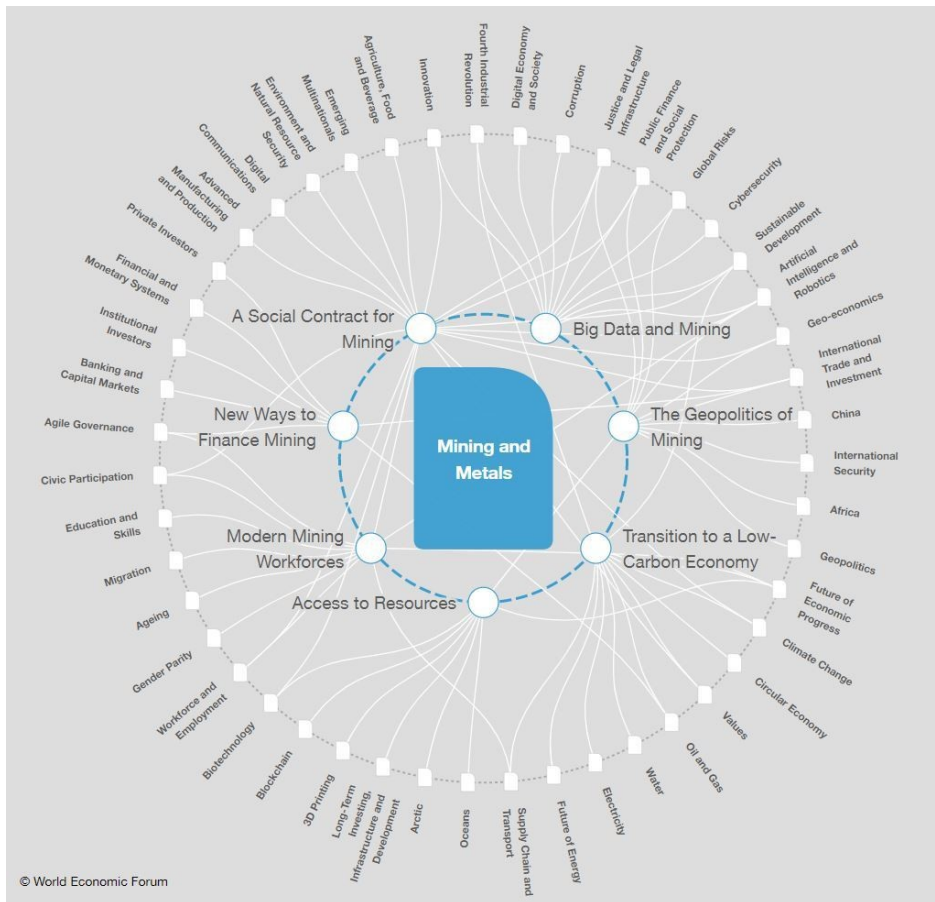
R&D to help them achieve their goals. Today, these “Mine of the Future” technology roadmaps are more comprehensive, and companies are diverting more capital and investment into R&D.

An excerpt from the World Economic Forum (2019) highlights the global relevance of mining as well as the imperative for innovation, fundamental research and extensive collaboration amongst academia, industry, government and NGOs to create a more resilient and sustainable industry. The World Economic Forum identified the top pressing mining innovation challenges as:

1. Social Contract for Mining (public policy, Indigenous relations, systems management and engineering)
2. New Ways to Finance Mining (economics, innovative technologies to improve value-aligned investing)
3. Modern Mining Workforce (AI and big data, electrification of mines, autonomous/remote workforce, safety monitoring and human health)
4. Access to Resources (resources automation and digitalization innovation can result in more targeted, efficient and cost-effective mining)
5. Transition to a Low-Carbon Economy (low-emission energy and transportation systems are mineral-intensive creating a greater demand for minerals – exploration, recycling materials)
6. Geopolitics of Mining (domestic policy, foreign policy, circular economy)
7. Big Data and Mining (collecting and processing massive amounts of data will be essential for mining companies as they digitalize and automate their operations)

The interconnected multidisciplinary research that is needed must be coordinated across U of T to support not only the mining industry, but all industries that rely on mining to benefit the global economy (Figure 3 WEF, 2019).





**Figure 3 - Mapping the connections in mining** (Figure from “seven trends shaping the future of the mining and metals industry”; World Economic Forum, <https://www.weforum.org/agenda/2019/03/seven-trends-shaping-the-future-of-the-mining-and-metals-sector/> accessed March 3, 2020)

The elevated EDU-C will unite our efforts for a university-wide mining strategy that focuses on translating research into effective application-specific solutions and on training individuals who can implement them. As the top-ranked university in Canada, located in the heart of the world’s mining finance capital, U of T is well-placed to bolster its current position as a globally recognized leader in mining research and teaching, and to leverage that expertise to create economic and societal impact.

As indicated by the number of engineering faculty already associated with LIM (Appendix 2), the Faculty has a critical mass of researchers who work in mining or related disciplines. This research expertise is coalesced in such FASE EDU-Cs as the Institute for Water Innovation, the Institute for Sustainable Energy, the Centre for Global Engineering, the Centre for Analytics and AI Engineering, BioZone, and in the Hatchery, an entrepreneurship accelerator. LIM will establish or deepen connections with these units to continue to build a broad connected community of mining research expertise.

Through linkages to the Faculty's Institute for Studies in Transdisciplinary Engineering Education and Practice (ISTEP), the Engineering Career Centre and Engineering Outreach, and to U of T's Centre for International Experience, LIM will further support the research pipeline through access to and enhanced opportunities for HQP and broader visibility of LIM within and external to the university.

### **Scope of Activity**

Driven by the central goal of advancing engineering-focused mining research and translating the associated technologies into real-world impact, LIM will be organized around the three drivers of i) Research and Innovation, ii) Talent and Development, and iii) Collaborations. Funding from industry will seed research collaborations and accelerate student training and experiential learnings, which will inject innovations and a robust talent pipeline back into the global economy, forming a virtuous cycle.

#### **i. Research and Innovation**

Capitalizing on U of T's position as a world-class research institute, the elevation of LIM to an EDU-C will help create a leading, vibrant research powerhouse for the global extractive resources sector. LIM will leverage its critical mass of expertise to extend the Faculty's reach by building new research collaborations with a diverse base including industry and other non-industry groups and entities.

LIM will seed small-scale research projects and catalyze the launch of large-scale multi-investigator initiatives. Recognizing the interdisciplinary nature of many mining applications, the EDU-C will facilitate the formation of cross-disciplinary collaborations between faculty and with external collaborators. LIM has identified six Lassonde Research & Innovation Priorities: (1) Energy & Sustainability; 2) Exploration; 3) Robotics, Machine Learning & Big Data; 4) Safer Mines; 5) Society and the Economy; and 6) Water & Tailings). Next steps involve appointing a faculty member (Lassonde Research & Innovation Priority Lead) to drive and expand research activity within these domains. The Lassonde Research & Innovation Priorities facilitate and coordinate strategic research collaborations that might not otherwise form, generate a multidisciplinary research expertise base to enable the pursuit of larger opportunities, support the development of HQP with advanced, highly desirable skillsets, and deepen engagement with collaborators associated with their targeted relevance to mining sector needs.

## ii. Talent and Development

One of LIM's strategic initiatives is to rejuvenate mining education and student interest within the Faculty through the following actions:

1. Support recruitment of graduate students in the area
  - Support the development of more online graduate-level courses
  - Expand research visibility and activity to attract more quality applicants
  - Offer a collaborative specialization in mining with the participation of the Department of Earth Sciences; explore additional opportunities with other units in the future
2. Help increase the number of undergraduate students entering areas of study reflective of mining
  - Develop mining programming to be integrated into the undergraduate curriculum
  - In collaboration with Mining Matters and PDAC, LIM has launched a series of workshops across the country for grade 7 and 8 students on mining, water and the environment. Pilots are being run in northern and ingenious communities; further expand collaborations to include high school students and offer workshops that focus on women in mining.
3. Promote excellence in mining education, life-long learning and executive development programming focused on global leadership and innovation
  - In collaboration with our industry supporters, including companies and individuals, provide specialized events, talks and other short courses delivered or co-delivered by our LIM PIs to support and promote life-long learning in Toronto and globally (by way of virtual platforms, etc.)
4. Encourage current U of T students and recent alumni to act as mining ambassadors to potential new students and potential employers
  - Initiate a U of T Mining Alumni Network in conjunction with the Faculty's Advancement office to host events and a mentoring program, and convene a committee of alumni to help steward and direct efforts.
  - Work with young mining professionals to launch a Young Mining Professionals Chapter at U of T.

LIM will facilitate discussions within the Faculty (e.g., ChemE, ECE, MIE, MSE, BME and UTIAS) and with the Faculty of Arts and Science's Department of Earth Sciences to develop short courses in areas of emerging interest and relevance to the mining sector and to explore new program collaborative developments.

### **iii. Collaborations**

Developing industry, government and NGO collaborations will be key to launching and sustaining thriving world-class mining research programs. Funding from this base will both seed collaborative research and provide support for the day-to-day operations of LIM. To catalyze collaborations and connect consumers and producers of mining expertise, the EDU-C will organize networking events that bring together faculty both within FASE and beyond.

Once LIM is re-launched as an EDU-C, it will consult the Faculty's large base of potential collaborators to inform the development of its collaborative model. Several such models will be explored, including a consortium model with pooled funding and/or an individual collaboration model based on specific projects and deliverables. Models worth exploring within FASE, at U of T and at other academic institutions and external organizations are listed in Appendix 3. The structure of the collaboration model is expected to adapt as new relationships are formed and the funding landscape evolves. LIM leadership, including an Industry Advisory Team (described below), will regularly review and augment the model.

## **4. CONSULTATION**

The consultation process to elevate LIM to an EDU-C began in 2018 (Appendix 1), when select faculty identified as being active and/or having a strong interest in mining (specifically J Harrison, K Esmaeili, M Grabinski, E Bobicki, B Sherwood Lollar and M Barati) were convened to determine support for the EDU-C and began framing its vision and mandate. From these initial meetings, it was agreed that in some respects the existing institute had been acting as an ad hoc Faculty-level institute for many years. The PIs noted that elevating LIM to an EDU-C would position it to coordinate research and scholarship activities for more comprehensive and robust results. Moreover, it would send a clear message to external stakeholders that U of T is prioritizing mining research and education and is taking on a leadership position in Canada and globally. This in turn will encourage renewed interest and expanded collaboration opportunities to stimulate the goals of LIM including increased research funding, experiential learning opportunities and greater societal impact and outcomes.

At the same time, PIs and LIM leadership met with industry and other mining-related professionals to provide insights to help raise LIM's standing and shape its mission as reflected in sections 2 and 3 of this proposal. Through these conversations with industry members, technical-level professionals and NGO leaders (Appendix 6) and with LIM PIs, a working draft of the institute's new vision and mission was compiled.

Informal conversations within the Faculty throughout 2018, 2019 and 2020 continued to confirm the need for LIM to be recognized as a cross-departmental and university-wide EDU. This elevation would enable LIM to deliver the cohesive approach required for many of its proposed objectives, including research, professional workshops, student events and EDI efforts, and would allow LIM to coordinate with units outside the Faculty for greater breadth and relevance to collaborators such as students, industry, government, NGOs and donors. PIs further identified the growing demand for FASE mining research and scholarship to be integrated with other pressing areas for the mining industry including public policy, law, Indigenous studies and economics.

Consultations were conducted with relevant U of T Faculties to learn about similar ongoing or planned initiatives and to identify opportunities for collaboration (Appendix 1). Faculties were selected for consultation based on research and educational activity in mining. These consultations reaffirmed the need and opportunity for a broader organized initiative in this domain and ongoing consultations will be aimed at advancing plans for collaboration beyond the Faculty.

In **August 2019**, LIM leadership met with members of the Dean's Office to understand the steps, recommended resources and definitions to navigate the elevation process. In **September 2019**, an overview of LIM's timeline and achievements to date, rationale for elevation and next steps was provided to current and potential LIM PIs. Support for the proposed elevation was expressed by the CivMin Chair and the FASE Dean and Vice-Dean, Research. It was determined that the office of the Vice-Dean, Research would help facilitate a half-day strategic planning workshop in November 2019 that would involve a broad set of FASE and U of T researchers (Appendix 1).

Key learnings from the **November 2019** workshop shaped the development of this proposal and the nature of the proposed EDU-C including its strategic and implementation plan (Appendix 4). These were discussed at a **December 2019** meeting of FASE Chairs and Directors, and at a **January 2020** meeting of the Faculty's Research Committee.

In **October 2020**, the proposal was circulated to FASE Chairs and Directors, and Dean's offices in both FASE and the Faculty of Arts and Science. Support for establishing the EDU-C was universal at all meetings and the feedback received was integrated into this proposal.

This is a fully comprehensive representation of all those invested in mining research and scholarship across U of T.

## 5. FACULTY PARTICIPATION

As an EDU-C, the Institute will hold only non-budgetary faculty cross-appointments. Appendix 2 lists faculty members engaged in mining-related research and education within FASE and other Faculties including Arts and Science who have confirmed their interest in continuing to actively participate in the Institute. The chairs and directors of departments and EDUs expressed their support of the proposed LIM vision.

LIM will continue to engage with other academic units, post-launch, with the goal of expanding participating faculty to include new PIs from both inside and outside of Engineering. The intent of the EDU-C is to broaden LIM to include all “extractive industries”, to focus on the application of a broad range of topics including robotics, AI etc., to mining problems, and to include work on health, policy, etc., as it relates to the mining field.

## 6. ADMINISTRATIVE STRUCTURE

As lead Faculty, FASE will assume administrative and budgetary responsibility for the Institute.

The Institute’s leadership will consist of two key positions, a Director, who is an academic faculty member, and a Managing Director, who is a senior, full-time administrative staff member with industry/business development experience. These individuals will be advised by an Academic Steering Committee (ASC) and an Industry Advisory Team (IAT). Currently we in the process of appointing Lassonde Research & Innovation Priority (LRIP) Leads to form the LRIP Lead Groups in winter 2021. These individuals will be supported by an administrative assistant and special projects coordinator.

**Director:** The Director is accountable to the Dean or designate and is responsible for administrative and financial operation of the Institute. Specifically, the Director will:

- Develop the Institute’s vision, strategic priorities and implementation plan
- Prepare annual reports to the Dean or designate based on deliverables defined in the implementation plan
- Conduct a self-study as part of the Institute’s periodic review process
- Coordinate with the Dean and Vice-Deans on Faculty-level strategic vision
- Update FASE Chairs and Directors on LIM planning and activities
- Chair meetings of the Academic Steering Committee and Industry Advisory Team
- Promote the vision and goals of the Institute to the external community

Professor Lesley A. Warren will serve as the interim Director. Upon approval of the re-launched Institute, the Dean will appoint a Director for a fixed term of not more than five years, renewable once by the Dean.

**Managing Director:** The Managing Director will work closely with the Director to:

- Support the Director in developing Institute's strategic priorities and implementation plan
- Execute the strategy and implementation plan, with deliverables defined in the implementation plan
- Support the Director in preparing the Institute's annual report to the Dean or designate
- Support the Director in conducting cyclical self-studies, as required
- Build and manage relationships with the Institute's industry and government collaborators
- Coordinate with the Faculty's Advancement and Government and Foundation Partnerships offices to attract funding and projects
- Promote the vision and goals of the Institute to the external community

**Administrative Assistant:** This position will report to the Managing Director and will provide a full range of general administrative duties supporting the Lassonde Institute and potentially all initiatives related to research, talent and development and collaborations. Expected hiring date May 2021.

**Special Projects Coordinator:** this position will report to the Managing Director and will be responsible for planning and executing special projects (including events) and as related to the priorities of LIM including research, talent and development and collaborations. Expected hiring date of May 2021.

**Lassonde Research & Innovation Priority Group (LRIPG):** We are currently in the process of appointing faculty leads to our Lassonde Research & Innovation Priorities. Each lead will be named according to each research area PIs consensus in winter 2021.

**Academic Steering Committee (ASC):** The ASC will advise on the LIM's priorities, mandate and strategy with a focus on research and education. It will review and approve LIM's annual report and strategic plans, and oversee major academic activities including awarding of research funding to participating faculty and contributing to curriculum development. The committee will comprise:

- LIM Director, who will chair the Committee meetings
- Faculty members, one each from the departments and EDU-As and EDU-Bs most

closely involved in LIM activities (i.e., Chemical Engineering and Applied Chemistry, Civil and Mineral Engineering, UTIAS, Materials Science and Engineering, Mechanical and Industrial Engineering, Earth Sciences)

- FASE Vice-Dean, Research
- Chair of the LIM Industry Advisory Team
- One graduate student from the FASE graduate units associated with LIM, who will be appointed to the committee in consultation with the Graduate Engineering Council of Students (GECoS)

The Committee is expected to meet two to three times a year. The term of Committee members will be three years, except for the graduate student representative, whose term will be one year.

**Industry Advisory Team (IAT):** In accordance with the Provost's *Statement on the Role of Advisory Bodies* (April 30, 1998) the Dean, with input from the Director, will establish an IAT consisting of senior industry representatives with a direct interest and experience in mining, to provide non-binding advice. IAT members will fill one or more primary roles:

- Provide strategic connections between the Institute's researchers and industry leaders
- Secure projects and speakers for educational initiatives
- Raise industry and government-sponsored research funding with support from the Faculty's Advancement and Government and Foundation Partnerships offices
- Support the raising of philanthropic funds coordinated through the Faculty's Advancement office

Continued service on the IAT will require tangible contributions in one or more of these areas.

## 7. SPACE

Initial LIM space requirements are anticipated to include office space for increased staffing required to support the LIM's activities. This space has been confirmed to continue to be provided by the Civil & Mineral Engineering Department as per Chair Brent Sleep in the Lassonde Mining Building and additional space is available as needed.

## 8. RESEARCH FUNDS

All monies and research funding will flow through the Dean's Office or designated department in line with the Faculty's normal practice. Any research contracts or agreements will be approved through the Dean's Office and Central Administration (IPO), as required. An EDU-



C may not administer research funds or enter directly and on its own authority into commitments, agreements and contracts unless explicitly designated by the Dean in consultation with the Provost.

## 9. BENCHMARKS AND MEASURES OF SUCCESS

As an EDU-C, LIM aims to be a world-leading institution for mining transformation across research, education and collaborations. Consistent with the vision outlined in this proposal, a five-year strategic plan and a detailed implementation plan including timelines, milestones, metrics and key performance indicators will be developed by the Director for approval by the ASC and the Dean or designate during the first year of approval of the EDU-C. In addition, the Director will submit annual reports outlining the Institute's progress against these milestones to the Dean or designate.

Strategic planning will be centered on these major activities of the Institute:

**Fundraising from industry/government/donors:** We will aim to secure funding for the Institute through a combination of industry, non-industry, NGO's, government, and private donors to support research collaborations, student training, and day-to-day operations.

**Securing industry collaborators:** To ensure long-term sustainability of the Institute, we will aim to secure industry partners from the extractive resources sector, as well as supporting industries (i.e., consulting firms, OEMs, law firms and financial institutions operating in the mining space). Partner engagement may be monitored via funding, visits, collaborative projects, participation in educational events, and attendance at seminars and industry showcase events.

**Recruiting graduate students:** To increase the number of students in the mining space, we will aim to attract and fund qualified graduate students to participate in collaborative research projects and experiential learning opportunities that fall within the Institute's mandate. Student engagement and success may be tracked via their scholarly outputs, participation in national and international conferences, completed internships, and post-graduation job placements.

The Institute will benchmark itself against and will aspire to be competitive with the top industry-supported mining research programs in Canada, the US and internationally (Australia) (Appendix 5). These established centres of mining research are housed within universities and are focused on industry research collaborations, providing calibration for LIM activities as they build and grow. We will follow their ongoing development and impact closely as LIM moves forward.

## **10. GOVERNANCE AND REVIEW**

An EDU-C requires approval from the Council of the lead Faculty, Applied Science and Engineering and will be reported to the Office of the Vice-President and Provost for information and for inclusion in U of T's list of extra-departmental units.

In line with normal practice, an EDU-C is subject to periodic review at fixed intervals (normally every five years), conducted by the Dean or designate. This would typically coincide with the term of the EDU Director, and the first review would be approximately fall 2026. As part of this review process, the EDU Director is required to submit a self-study report to the Dean summarizing progress against the EDU's five-year strategic plan goals. Any review would normally assess the EDU's sustainability, performance and achievements relative to the goals set out at its establishment. Possible outcomes of the review could include closure. An EDU-C is also expected to report annually to the Dean or designate on the progress made toward its goals.

## APPENDIX 1: CONSULTATIONS

### Faculty of Applied Science and Engineering

DATE	DEPARTMENT	NAME
Nov 2018	MSE	M Barati
Nov 2018	Engineering Career Centre	R Francis (Executive Director)
Dec 2018	MSE	M Barati, E Bobicki
Dec 2018	CivMin	J Harrison, K Esmaili
Jul 2019	MSE	E Bobicki
Jul 2019	CivMin	J Harrison
Sep 2019	Dean's Office	R Farnood (VD-Research), M Sterling (Assistant Dean, EDI), C Yip (Dean)
Sep 2019	MSE	G Hibbard (Chair)
Sep 2019	CivMin	M Grabinsky, B Mohanty, B Sleep (Chair)
Nov 2019	MSE	G Azimi
Nov 2019	CivMin	S Andrews, E Bentz, J Drake, K Esmaili, M Ghafghazi, G Grasselli, J Ha (Grasselli Group), J Harrison, M Hatzopoulou, B Mohanty, K Peterson, M Roorda, A Shalaby, B Sleep (Chair)
Nov 2019	MIE	A Bazylak, M Consens, S Molodecky, J Mostaghimi
Nov 2019	ISTEP	E Moore (Director, Troost ILead)
Nov 2019	UTIAS	C Damaren (Director)
Dec 2019	Chairs and Directors	G Allen (ChemE), M Bussmann (MIE), W Chan (IBBME), W Cluett (EngSci), C Damaren (UTIAS), G Evans (ISTEP), G Hibbard (MSE), D Kundur (ECE), B Sleep (CivMin)
Jan 2020	FASE Research Committee	R Farnood (VD-Research and Chair), FASE Associate Chairs, Research

Oct 2020	Chairs and Directors	G Allen (ChemE), M Bussmann (MIE), W Chan (IBBME), W Cluett (EngSci), C Damaren (UTIAS), G Evans (ISTEP), G Hibbard (MSE), D Kundur (ECE), B Sleep (CivMin)
Oct 2020 (proposal)	Research Committee	R Farnood (VD-Research and Chair), FASE Associate Chairs, Research

### Faculty of Arts and Science

<b>DATE</b>	<b>DEPARTMENT</b>	<b>NAME</b>
Jul 2019	Earth Sciences	B Sherwood Lollar
Nov 2019 (LIM Elevation Consultation (LEC))	Earth Sciences	B Bergquist
Nov 2020 (proposal)	Earth Sciences	R Pysklywec (Chair)
Nov 2020 (proposal)	Dean's Office	Vince Tropepe (Vice-Dean, Research), J Stafford (Vice-Dean, Academic Operations), M Woodin (Dean)

## APPENDIX 2: PARTICIPATING FACULTY

As an EDU-C, the LIM may only hold non-budgetary cross-appointments of tenure and teaching stream faculty. The following University of Toronto faculty members are involved in mining research and have confirmed their interest in being active participants in the EDU-C. This is an initial list, cultivated primarily through departmental and institute consultations or email confirmations from individuals interested in participating and is not exhaustive. It is anticipated that additional faculty members will participate in the LIM after it has been established as an EDU-C.

Home Unit	Last Name	First Name	Appt. Category (Stream or Rank)
ChemE	Edwards	Elizabeth	Professor
ChemE	Gu	Frank	Professor
ChemE	Papangelakis	Vladimirov	Professor
CivMin	Esmaili	Kamran	Associate Professor
CivMin	Ghafghazi	Mason	Assistant Professor
CivMin	Goodfellow	Sebastian	Assistant Professor
CivMin	Grabinsky	Murray	Associate Professor
CivMin	Grasselli	Giovanni	Professor
CivMin	Hadjigeorgiou	John	Professor
CivMin	Harrison	John	Professor
CivMin	MacLean	Heather	Professor (Research)
CivMin	Mohanty	Bidhu	Professor Emeritus
CivMin	Posen	Daniel	Assistant Professor
CivMin	Warren	Lesley	Professor
CivMin	Xia	Kaiwen	Associate Professor
CivMin	Young	Paul	Professor Emeritus
Earth Sciences	Anderson	Melissa	Assistant Professor
Earth Sciences	Bergquist	Bridget	Associate Professor
Earth Sciences	Gregory	Daniel	Assistant Professor
Earth Sciences	Sherwood Lollar	Barbra	University Professor
Earth Sciences	Zajacz	Zoltan	Associate Professor
ISTEP	Moore	Emily	Director
MIE	Amon	Cristina	Professor
MIE	Donmez	Birsan	Associate Professor
MIE	Jamieson	Greg	Professor

<b>Home Unit</b>	<b>Last Name</b>	<b>First Name</b>	<b>Appt. Category (Stream or Rank)</b>
MIE	Jardine	Andrew	Professor Emeritus
MIE	Kim	Michael	Assistant Professor
MIE (C-MORE)	Montgomery	Neil	Associate Director
MSE	Barati	Mansoor	Associate Professor
MSE	Chattopadhyay	Kinnor	Associate Professor
MSE/ChemE	Azimi	Gisele	Associate Professor
MSE/ChemE	Bobicki	Erin	Assistant Professor
Munk School of Global Affairs and Public Policy	Warrian	Peter	Distinguished Fellow
UTIAS	Schoellig	Angela	Assistant Professor

### APPENDIX 3: OTHER ORGANIZATIONS/MODELS WORTH EXPLORING

Once LIM is relaunched as an EDU-C, ongoing consultations with FASE's large existing base of potential collaborators will inform the development of our collaboration model. Several collaboration models will be explored, including a consortium model with pooled funding, and/or an individual collaborative model based on specific projects and deliverables. Models worth exploring within FASE, at U of T and at other academic institutions and external organizations are listed below.

#### Within Engineering:

- IWI (for seed funding, WaterSeed)
- Pulp and Paper Centre (for student events and successful industry consortium)
- C-MORE (Industry consortium)
- U of T Robotics Institute (from all U of T campuses, putting together compelling events)
- CARTE (Incentivizing bringing in junior faculty)

#### Within U of T

- Centre for Global Climate Science (Competitive funding for summer projects open across all of U of T or beyond)
- Munk School of Global Affairs and Public Policy (ability to put together diverse expertise to roundtables)
- UHN (bringing together organizations in geographic proximity)

#### Other academic institutions

- UBC mining group
- University of Western Australia (for facilities and centralized funding)
- Ryerson (urban engineering, institutional funding)
- ICITY (OCAD, UWaterloo)
- Laurentian U
- CORE (Australia)

#### Other organizations

- Perimeter Institute (in terms of visibility in its field)
- Vector Institute (in terms of visibility in its field and scholarships)
- Communitech Waterloo (bringing together organizations in geographic proximity)
- COSIA (potential consortium model, pre-competitive)
- Forestry Innovation Council
- Canadian Masonry Institute

## APPENDIX 4: GOALS AND ACTIONS EMERGING FROM CONSULTATIONS

The following key goals and actions emerged from the consultations to date and have shaped the stated vision and mission of LIM. They will help inform the strategic and implementation plans that will be developed by the end of Year 1.

- 1. Continue and develop a strategic and financial plan for LIM as an EDU-C**
- 2. Improve LIM branding and visibility**
  - a. Identify global mining challenges
  - b. Improve web presence
  - c. Showcase application of new technology like robotics and AI to mining
  - d. Showcase research in sustainability and environment
  - e. Showcase success stories
  - f. Provide a directory of research expertise and infrastructure/equipment
  - g. Bring in visiting scholars/professors
- 3. Build community among students and PIs**
  - a. Involve more faculty members in Lassonde leadership and organization
    - i. Identify research pillars within Lassonde and appoint pillar leads
    - ii. Provide roles for faculty within Lassonde, e.g., outreach
  - b. Find a physical space for LIM to allow for physical proximity of LIM students/PIs
  - c. Organize annual student trips/tours of mining sites or processing facilities
  - d. Organize events for scholarship recipients
  - e. Host regular speaker or seminar series
- 4. Facilitate discussion between other divisions and make connections where they may not be obvious**
  - a. Host networking events/roundtables
  - b. Participate in/create joint seminar series
  - c. Explore joint programs and capstone projects
- 5. Facilitate large collaborative, inter-disciplinary grant applications including aspects of social sciences, finance, policy, health**
  - a. Provide seed funding for collaborative projects that involve joint student supervision



**6. Involve collaborators that span sectors including**

- a. Indigenous communities and groups as true collaborators
- b. All levels of government and government organizations like NRC, NRCan, IGF
- c. Associations such as CIM, IEEE, CMIC, etc.
- d. Consulting firms such as Deloitte, Hatch, etc.
- e. Industry including SMEs, mining value chain collaborators such as equipment manufacturers, and broaden reach to include all extractive industries

Specific consultation identified short-term and longer-term actions that can be taken to ensure these identified LIM goals are met include:

- a. Mapping existing collaborations among LIM PIs
- b. Building a value proposition including external marketing materials
- c. Providing courses for industry professionals
- d. Hosting events that bring together a diverse range of stakeholders
- e. Identifying cross-cutting issues for multi-collaborator, multi-PI projects, which could lead to building an industry consortium
- f. Taking advantage of geographic location within Toronto and proximity to many mining head offices

## APPENDIX 5: TOP INDUSTRY-SUPPORTED MINING INSTITUTES

Canada					
Institute	Scope	Management Structure	Educational Program	Research Foci	Industry Engagement
Institute of Mining and Environment	UQAT-Polytechnique Montreal Partnership	Board of Directors (university and industry members) 2 Scientific Director, 2 Executive Directors, Coordinator and administration team; 20 researchers	No programs or courses listed	Research focuses on mine site reclamation; circular air economy applied to mines: valorization and integrated management of wastes; geotechnical and geo-environmental stability of mine waste storage facilities; water quality prediction; treatment and management of mine waters; transport of contaminants in the environment; influence of climatic conditions; knowledge sharing and exchanges with local communities	Key partnerships with industry: Agnico Eagle, Newmont Goldcorp, IAMGOLD, Canadian Malartic Mine, Ragland Mine – Glencore, Rio Tinto
MERC (Mineral Exploration Research Centre)	Semi-autonomous research centre at Laurentian University	Director, Associate Director, Advisory Board comprised of industry, government and academic leaders. Staff: Communications and Program Manager, 3 Administrative Coordinate, IT Specialist, GIS Specialist	Modular Courses: Each of the 10- to 12-day intensive modular courses covers fundamentals and advances in concepts and techniques applicable to mineral exploration and is equivalent to a regular 3-credit full-term course ( <a href="https://merc.laurentian.ca/modular-courses/about">https://merc.laurentian.ca/modular-courses/about</a> )	The research projects are global and address fundamental ore deposit problems and technology and method development that aid exploration in Precambrian and younger terrains.	MERC corporate membership come in 3 different levels (Foundation, \$20,000; Tier 1, \$10,000; and Tier 2, \$5,000). They provide varying levels of benefits.
Norman B. Keevil Institute of Mining Engineering (including: Mine Energy Systems Laboratory (MES-Lab) Laboratory for Process	Department within the Faculty of Applied Science at UBC	Industry Advisory Committee	Undergraduate, Graduate and Professional Development; 21-month part-time EMBA was developed jointly by Sauder and UBC's Norman B. Keevil	Advanced mining and mineral processing systems, recycling electronic waste, mine energy systems, multi-physics characterization of geo-materials and	Not listed

Intensification in Minerals Engineering (PIME) Laboratory for Accelerated Discovery in Resource Engineering (ADRE) Laboratory for Research in Advanced Rock Engineering The Mineral Resources Biosystems Laboratory (MRBL) Urban Mining Innovation Centre (UMIC) The GOE 2 Initiative Minerals and Coal Characterization Laboratory (MCCL) Laboratory for Advanced Mining and Mineral Processing Systems (LAMMPS))			Institute of Mining Engineering with an advisory council of senior mining executives	processes, among several other areas	
<b>USA</b>					
Colorado School of Mines	Public research university; 28 Research Institutions	70+ degrees, minors, (undergrad and graduate), etc.	Regular University structure with industry advisory committees	Materials and Manufacturing; Energy; Biology; Subsurface; Water; Space Resources	With industry, national laboratories, other universities, funding agencies and international institutions
Penn State (including: EMS Energy Institute Earth and Environmental Systems Institute; Institute for CyberScience; Institute for Natural Gas Research; Institutes of Energy and the Environment Materials Research Institute; Center for Environmental	John and Willie Leone Family Department of Energy and Mineral Engineering	Undergraduate and Graduate programs	Regular University structure with industry advisory committees	Advanced Technology and Materials for Energy and Environmental Applications Energy and Natural Resource Data, Economics, and Policy Fossil Fuel and Georesource Exploration, Extraction and Utilization Renewable Energy Technologies and Power Systems	Not listed

geoChemistry and Genomics; Center for Geomechanics, Geofluids, and Geohazards; Center for Quantitative Imaging; Initiative for Sustainable Electric Power Systems; University Coalition for Fossil Energy Research (UCFER)					
<b>International</b>					
University of Western Australia	Department of Civil, Environmental and Mining Engineering	Undergraduate and Graduate programs	Regular University structure with industry advisory committees	Real time Optimisation Scheduling and Logistics; Automation and Robotics;	Pritchard Francis BE & E Georgiou Arup NGI Atteris Main Roads Golder Associates Water Corporation GHD Aurecon CMW Geosciences
University of Queensland	School of Mechanical and Mining Engineering	Undergraduate and Graduate programs	Regular University structure with industry advisory committees	Mining engineering research in the areas Energy, Safety and Environment Mining Geomechanics Mining Methods and Equipment Mine Planning	Mining3 is an internationally recognised multi-million-dollar mining research centre. The Centre conducts research to advance mining technology and equipment to support the Australian and global mining industry. There are several university participants and Mining3 is headquartered at UQ.

## APPENDIX 6: External and Notable Mining Leaders Consulted

Zita Cobb	Ex-Vice President of Strategy and Business, JDS Uniphase
Samantha Epsley	President-Elect Canadian Institute of Mining
David Garofalo	Ex-CEO, Goldcorp Inc.
George Hemingway	Partner, Head of Innovation, Stratalis
Glen Ives	Mining and Metals, Partner, Chair of Deloitte
Claire Kennedy	Chair of the University of Toronto's Governing Council
Pierre Lassonde	Chair, Franco Nevada
Patrice Merrin	Independent Non-executive Director, Glencore and Detour Gold Inc.
Ian Pearce	Chair and Independent Non-executive Director, New Gold; Chair and Non-Executive Director at MineSense; Non-Executive Director Outotec Oyj.; Chair of Nevsun Resources Ltd.
Andrew Swart	Global Mining and Metals Lead, Deloitte (Monitor)
Ian Telfer	Ex-Chairman and Founder, Goldcorp Inc.
Paul Tomory	CTO, Kinross Gold

\*\*Meeting with Glenn Mason – Assistant Deputy Minister, Lands and Minerals Sector, Natural Resources Canada was cancelled but is being rescheduled pending COVID-19 updates

# Lassonde Institute

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## Updates and Next Steps



# Lassonde Institute Strategic Growth and Activities 2018

LASSONDE  
**PIVOT  
POINT** 2018



Pro-bono Industry Strategy  
Consultancy Work

New Vision and Advisory  
Team Competencies



2018-19 Lassonde  
Strategic Framework  
Launched  
**OCTOBER**

**DECEMBER**



Partnered with  
Goldcorp



Lassonde Board  
Refresh & Reset



Three Horizons for Global Leadership



**NOVEMBER**



Launched Lassonde  
Student Talent and  
Professional  
Development Series

# Lassonde Institute Strategic Growth and Activities 2019

## SUMMER 2019

Engaged **National and International Partners** for research, sponsorship and thought leadership



Partnership: University of Western Australia

Launched **international UWA Pilot** for increased global & inquiry based learning for undergrads

## SEPTEMBER

Expanding our PI's: L/I Researchers Social + Community Survey

## Rotman

Partnering with Rotman:

- Indonesian Government Mining Course
- Executive Courses
- High Potential Mining Leaders Program
- Industry Mining Certificate

**BHP**



Stantec



stratalis

Monitor  
**Deloitte.**

**KINROSS**



L'association minière du Canada | The Mining Association of Canada



Bennett Jones



**lundin mining**

Initiating Lassonde Institute EDI Vision in Partnership with Assistant Dean & Director of Diversity, Inclusion and Professionalism

EDU:C Proposal Process initiated with Vice Dean – Research Office



UNIVERSITY OF TORONTO  
FACULTY OF APPLIED SCIENCE & ENGINEERING



Lassonde Institute of Mining  
UNIVERSITY OF TORONTO



# Lassonde Institute Strategic Growth and Activities 2019

## OCTOBER

Future of Mining Americas Conference  
 Featured Academic Partner: Lassonde Institute

Lassonde Institute Keynote Panel

Innovating the CEO's Agenda:

Why we must collaborate to innovate



Launching 2019-20 Lassonde Student Talent and Professional Development Series with OMA & Industry

CIM SDC 2019 Student Presentation



## NOVEMBER



Initiating MEng Proposal and Development

UofT Engineering Strategic Planning Workshop:  
 Lassonde Institute (Date TBC)



L/I Representing Canadian Mining Researchers on COP25 Chile 2019 Panel

## DECEMBER



Lassonde Institute created Elementary and High School content and launched across Canada

## LASSONDE PIVOT POINT



- Ian Telfer, Ex-Chairman Goldcorp
- Jennifer Rogers, Head of Learning, Anglo American
- Andrew Swart, Global Lead Mining, Deloitte



# Lassonde Institute Strategic Growth and Activities 2020

**UPCOMING**

**Monitor Deloitte.**

Deloitte Internal Communication & Collaboration Workshop



Lassonde Institute Research Clusters Workshop

Institute Research Projects Launching



Continue to build national and international partnerships

2020

Final EDU:C Proposal Presentation

Lassonde Institute Advisory Team AGM

Lassonde Institute PI Retreat

Continued Student Programming



**LASSONDE PIVOT POINT**

Lassonde Pivot Point Australia Event Series



Expanding industry integrated: skills development and leadership student initiatives



## Lassonde Institute Alignment with UofT Strategic Plan

UofT Priority: Strengthening International Partnerships Goals	Lassonde Institute Activities
Position the UofT as a strong research with leading peer institutions around the world, while creating more opportunities for our students to benefit from an internationalized learning experiences	UWA Partnership Establishment and launch of our International Undergrad Field Course (September 2019)
Enhance ability of our faculty and students to meet global challenges	Global Mining Initiatives Research Projects Lassonde Institute Big Thinking Series (November 2019, January & February 2020)
Enhance the University's global reputation, profile	Lassonde Pivot Point Events, Lassonde EDI Vision, Lassonde Institute Research Prospectus, MEng Mining Leaders Program

UofT Priority: Leveraging Our Location	Lassonde Institute Activities
Taking better advantage of our location as the Mining Finance Capital of the World: Toronto Stock Exchange and Global Mining Headquarters on Bay Street	Meet the New Lassonde Institute Industry Packages (including L/I Research Prospectus)

# Lassonde Institute Alignment with FASE Academic Plan

## FASE Priority: Innovative Research and Entrepreneurship

We will continue to develop a compelling research vision with the mandate to enhance our impact by leading research benefiting the Province of Ontario, Canada and global society through creativity, multidisciplinary collaboration and innovation.

FASE Research Excellence Goals	Lassonde Institute Activities
Transformative cross-disciplinary collaborative research that inspires innovation	L/I Research Prospectus and establish Mining Research Clusters (Early 2020)
Lead impactful multi-institutional research collaborations in strategic areas that will address local and global needs, in addition to creating new technologies that will act as an engine of prosperity and economic development.	Identifying Research Industry Partners and L/I Research Prospectus
Increase our reputation and visibility, and be recognized for excellence and the impact of our contributions.	Building a brand and presence at International Conferences and Panel (Future Of Mining Americas & COP25)
Enhance our impact through international institutional and industry research cooperation that addresses global challenges	Lassonde Institute Big Thinking Incubators (2020)

# Lassonde Institute Alignment with FASE Academic Plan

## FASE Priority: Influence, Collaboration and Partnerships

To strengthen collaborations and create impactful partnerships, we have set the following goals to direct our Faculty's efforts in these areas for the next five years.

FASE Strengthen Collaborations and Create Impactful Partnerships Goals	Lassonde Institute Activities
Inspire and influence education and learning in science, technology, engineering and math (STEM) for K-12, while enhancing the student experience for undergraduate and graduate students.	PDAC & Mining Matters Elementary and High School Lassonde Institute Content (nationally launched October 2019)
Create connections within our community to enrich the City and the University.	Partnering with traditional and non-traditional mining companies: Bennet Jones LLP, Deloitte, MARS
Continue nurturing cross-disciplinary collaborations with other University of Toronto Faculties.	Partnering with Earth Sciences and Rotman – various activities
Develop strategic partnerships with key institutions and industry (local, national and international).	Partnering with UWA and expanding more
Raise the profile of the Faculty by actively participating in and providing leadership to professional societies, editorial boards and external research committees.	Board of Directors Geo-Chemical Society; UBC Mining External Review Panelist





## APPENDIX 8: Media Release for Joint Undergraduate Course between University of Toronto and University of Western Australia



MEDIA STATEMENT October 2019

### DIGGING DEEP FOR MINE REHABILITATION

Improving environmental management during mine rehabilitation and closure was the focus of a week-long field course for environmental science students from The University of Western Australia and mineral engineering students from Canada's University of Toronto.

Thirty undergraduate students from UWA and the University of Toronto travelled to five active and closed mine sites across south-west Western Australia as part of a new international partnership between the two universities.

The sites included end pit lakes at Collie, Newmont Goldcorp's Boddington gold mine, processing plant, and tailings storage facility, Talison Lithium's Greenbushes lithium mine and processing plant, and a bauxite mine and residue storage facility.

The field trip was coordinated by Dr Talitha Santini, Director of the Environmental Stewardship in Mining Initiative at UWA, and Professor Lesley Warren, Director of the Lassonde Institute of Mining at the University of Toronto.

"This international field trip is an outstanding opportunity for students at both universities to see first-hand the challenges involved in effective mine site rehabilitation and closure," Dr Santini said.

"It has helped them understand the long-term value and benefits for the environment, regional economies and communities, as well as gain hands-on experience in dealing with these challenges.

"It's the first step in developing a more comprehensive partnership in mining research and education between our two universities, each of which is a global leader in these fields."

Professor Warren said mining was global in scope, scale and impact but the challenges differed according to the countries of operation.

"Having students begin to appreciate the full breadth of the challenges as well as the innovative and best practices emerging around

the world, increases their competencies and develops a globalised community of talent for this vital Australian and Canadian sector. We are excited to grow this initiative between our two universities.

UWA Environmental Science student Gabriella Gray said the field trip provided an awesome experience for students, enabling them to see these mine sites in person and realise the large scale of their operations. University of Toronto Mineral Engineering student Sarah Kumar said the experience had given her valuable knowledge that will help her to make more insightful decisions as a future mining engineer.

The University of Toronto's Lassonde Institute is returning back to Australia engaging industry, community members and students in February 2020 at the Lassonde Pivot Point Event in Perth. This two-day summit will feature industry's innovative executives, experts and world leading thinkers from Canada, Australia, South Africa and beyond. Launched in 2017, The Lassonde Pivot Point Global Event Series is a bi-annual international mining thought leadership forum generating ideas that have the power to pivot an industry. To request an invite please visit: [uoft.me/MiningMail](http://uoft.me/MiningMail)

#### MEDIA REFERENCE

Dr Talitha Santini (UWA School of Agriculture and Environment) 08 6488 1249

Simone Hewett (UWA Media and PR Adviser) 08 6488 7975



UWA and University of Toronto Lassonde students and teaching staff, and Newmont Goldcorp staff onsite at Newmont Goldcorp's Boddington gold mine.



UWA and University of Toronto Lassonde students and teaching staff, and Talison Lithium staff onsite at Talison Lithium's Greenbushes lithium mine.