# Table of Contents

Message From The Chair .................................................. 2  
Message From The Executive Director & CEO. ................. 3  
Who We Are ................................................................. 4  
Our Members ................................................................. 5  
Corporate Strategy .......................................................... 6  
Our Business Model ......................................................... 7  
Projects ........................................................................... 8  
Continuous Underground Mining Program ...................... 8  
Surface Mining Program .................................................. 9  
Processing ................................................................. 15  
Our Innovation Pipeline .................................................. 20  
Fit With TZWM ............................................................. 21  
Project Portfolio Management ....................................... 22  
Project Management Practices ..................................... 25  
Partnerships ................................................................. 26  
Challenges ................................................................. 27  
Financials ................................................................. 28  
Board of Directors ......................................................... 29  
Glossary of Acronyms ..................................................... 35
Message From The Chair

As I write this letter, we are emerging from over 10 weeks in some form of lock-down across Canada in response to the COVID-19 pandemic. We are now slowly, and selectively, re-opening and re-starting economic activity that collapsed global trade, rocked capital markets, disrupted supply lines and impacted the daily lives and well-being of billions of people globally.

As global economic activity slowed to a halt, with only “essential” services and businesses permitted to continue, many businesses – large and small – were shuttered as they scrambled to find short-term financial liquidity to keep the administrators away while they wait-out the pandemic storm and reinforce their balance sheets to allow them to rehire furloughed employees and restart their businesses. At last count, collectively, governments around the world responded with over $9-trillion of support programs, to not only stave-off personal financial ruin, but to allow people impacted by the economic shut-down to pay their rent and feed their families.

Of course mining companies around the world were not exempt from the impact of COVID-19. The health and economic consequences of the pandemic reduced demand for our products, weakened commodity prices, and created operational challenges to keep employees at operations safe. Companies also adjusted to supply chain disruptions while ensuring working capital was adequate to keep companies and operations solvent – even if on a care and maintenance basis.

While the mining industry has focused on cost-saving and productivity improvements for years, improvements going forward through traditional means will be limited. To protect profitability, this cost-containment drive will shift to the adaption, adoption, and sharing technology and innovation, especially among miners that have not already started integrating technology into their operations. And while in the short term, financial liquidity constraints arising from the pandemic may limit spending on technology, CMIC sponsors and members recognize that collaborative innovation initiatives can accelerate cost containment, not only through the economic recovery we are experiencing in the short term, but importantly in the long-term by achieving CMIC’s goal of Towards Zero Waste Mining, through reductions in the use of energy, water, and operating footprint by 50%.

CMIC sponsors and members recognize the importance and long-term value of innovation risk-sharing. CMIC is committed to a collaborative approach to innovation – just as our industry is committed to a collaborative approach to deal with and manage the economic and health and human impacts of the COVID-19 pandemic.

To all of our sponsors and members, our management team, and our Board, thank you for your support and continued commitment to CMIC.

As has been said many times over these many weeks, we will get through this, together.

Gordon J. Bogden
Chair, CMIC
Chairman, Black Loon Group
Message From The Executive Director & CEO

Throughout 2019, CMIC remained focused on our vision of transforming the industry towards zero waste mining, in addition to the core of our mission of connecting people, organizations and innovators. Those external to CMIC have naturally focused on the “measured” results of our business, for example, how much money have we managed to acquire for projects, what has been the impact or return on investment in mining operations, or how many new technologies have been developed and deployed.

However, innovation is about much more than just numbers. Many have heard me say, it is more about people than it is about technology and that innovation happens at the speed of trust. Thus, for CMIC, the story we are proud to tell is one that is at the heart of our organization, our ability to influence and shift innovation culture in the mining sector both in Canada and abroad. It is our ability to be a trusted broker with the mining industry and other members of the supply chain.

To maintain the focus on transforming the industry, it has been necessary to build a foundation for collaborative innovation in the mining industry. Elements of our Towards Zero Waste Mining (TZWM) strategy, originally launched in 2014, have been adopted by organizations such as ICMM, the Government of Canada and the Ontario Mining Association. Roadmaps and the process employed to develop these roadmaps have been adopted by mining companies, research organizations and others.

With the foundation in place, CMIC focused efforts during the past year on building project teams to deliver innovative results at levels not seen in the industry for decades. Project activity at CMIC accelerated significantly in the underground mining, surface mining and processing portfolios. These project teams are comprised of organizations and people that have never worked together before. Our partnership with the Canadian Oil Sands Innovation Alliance (COSIA) brought together innovative teams from oil and gas, precious metals and base metals companies to solve common challenges related to surface mining. Our efforts in underground mining, specifically building the world’s first and only consortium dedicated to mechanical cutting in hard rock underground mines, has garnered international attention.

Our processing portfolio had a very successful year, securing over $4 million in financing for three projects that aim to provide new technology to drastically reduce energy use in processing circuits and provide new potential sorting technology. In the Government of Canada’s CrushIt Challenge, CMIC projects – CanMicro and Monoroll – secured two of the six semi-finalist positions and associated funding.

The minerals industry experienced significant change during 2019 and throughout it all CMIC stayed strong, continued to grow and increased the participation and engagement of its Members. I wish to thank our Members for their dedication and the CMIC team for their tireless efforts to transform the mining industry.

I invite you to experience what CMIC has to offer in the following pages.

Carl Weatherell
Executive Director & CEO
Who We Are

The Canada Mining Innovation Council (CMIC) is a national non-profit organization whose vision is to “Transform Mining Towards a Zero Waste Industry”. By 2027, CMIC will enable deployment of technologies that reduce energy use, water use and environmental footprint by 50%.

CMIC’S TOWARDS ZERO WASTE MINING (TZWM) INNOVATION STRATEGY

The Canadian mining industry is focused on transforming how it operates through innovation. Companies through the mining supply chain are working towards significant emissions reductions and the eventual elimination of mine waste and tailings both in Canada and abroad. The radical reduction in mining’s environmental footprint is at the core of the CMIC Towards Zero Waste Mining (TZWM) innovation strategy.

TZWM employs an open innovation business model, one that is unique in the natural resources industry. This approach harnesses innovation and leverages talent, knowledge, intellectual property and existing technology from industries inside and outside of mining to create solutions. Technology development, deployment and adoption is accelerated by taking advantage of global assets in an open and shared intellectual property framework with the entire supply chain. This business model also provides technology test beds, reduces barriers to the adoption of technology and significantly reduces financial risk for all collaborators.
Our Members

Strategic
- Newmont
- IAMGOLD Corporation
- Glencore
- Agnico Eagle

Enterprise
- HATCH
- Suncor Energy
- Syncrude
- Teck
- Deloitte
- Vale

Solutions Mining Companies
- Eldorado Gold
- Torex Gold Resources Ltd.
- Gold Fields

Solutions Suppliers
- Sepro
- Komatsu
- Maclean
- Sandvik

Associate
- PDAC
- Cosia
- MSTACanada

The Mining Association of Canada

National Research Council Canada

CMIC Annual Report 2019
Corporate Strategy

The strategic goals of the CMIC remain consistent with those of 2018:

1. **Focus on TZWM roadmap implementation, to deliver the vision** – a significant amount of resources has been invested in developing the TZWM strategy and the six roadmaps. The focus going forward is on project delivery.

2. **Deepen collaboration across mining companies and involve a broader range of innovation players to work on new solutions** – CMIC has made considerable progress primarily among mining companies; the focus is now on strengthening relationships with existing members, new members, technology companies and organizations outside of the mining industry.

3. **Secure the funding needed to implement TZWM roadmaps, connect innovators, and catalyze transformation** – taking a refined focus on project delivery, matching companies to specific challenges, and adopting a venture-capital type of investment vehicle will help secure essential project and operational funding.
Our Business Model

The CMIC business model is based on the building blocks of successful innovation models in other companies and industries, including software engineering, microelectronics, defense, and pharmaceuticals.

**Roadmaps** – creating roadmaps to plot the pathway to the future and to align the industry.

**Platforms** – identify platform technologies and processes that are destroying value in the industry and replace them.

**Business Ecosystem** – harness innovation globally to solve the complex challenges identified by the industry, create new technology and process platforms with a clear pathway to deployment on mine sites.

**Open Innovation** – employ the sharing or project results and intellectual property amongst project participants to ensure rapid development and deployment of solutions.

This model is unique in the natural resources industry and CMIC relies heavily on involvement, participation, and funding from multiple organizations across the supply chain. Participants include academia, startups and small and medium enterprise's to research, technology and innovation organizations and mining companies across Canada.

This collaborative approach reduces duplication of effort, leverages existing assets (e.g., expertise, knowledge, technology, intellectual property, resources), and focuses on the key challenges the mining industry is facing. The primary reliance on volunteers means significant executive oversight, thought leadership, and program/project management are spread across multiple organizations.
Projects

CONTINUOUS UNDERGROUND MINING PROGRAM

CMIC’s underground mining program continued project development and execution on Phase 2 of the plan through 2019. With the focus on collaboration opportunity identification and partnership development, with the goal of moving 2 key collaboration projects into execution:

1. Hard rock mechanical cutting demonstration
2. Continuous underground requirements discovery

Hard Rock Mechanical Cutting Demonstration

In the first quarter of 2019 several hard rock cutting demonstration and technology opportunities were developed by the CMIC team and select Partners including:

1. Master Drilling – MTB (Mobile Tunnel Borer) with AEM and Norcat
2. Bergteamet – MM 55V with Goldcorp
3. Hecla – MM40V at Lucky Friday Mine
4. Vale – equipment selection RFP and MRE demonstration project

By mid-2019, CMIC had narrowed and focused the scope for the mechanical cutting demonstration project as per member direction and focused on 2 main projects:

1. Hecla – MM40 V implementation at Lucky Friday
2. Vale – MRE demonstration project development

Throughout the remainder of 2019 both projects progressed. Negotiation for CMIC member companies to participate in the Hecla MM40V implementation kicked off in March of 2019 and the Vale equipment selection process kicked off in Q2. It was expected that these projects would be in execution by end of Q2 and Q1 2020, respectively.

CMIC also participated in the equipment demonstration events for both the MM40V and the Sandvik MX650. The events brought together mining and contracting companies to witness and learn about the latest cutting technologies, while laying the foundation for continued learning in the cutting space, relationship building with ecosystem partners and membership development.
Continuous Underground Requirements Discovery

This Discovery project was designed to examine and outline the various requirements related to the remainder of the integrated continuous mining platform. These requirements include mine design, maintenance, material handling and ground support.

Throughout the first half of 2019, this project was under development with a host company external to CMIC membership. As a result of changing priorities with both the member companies and the host, project development efforts were reduced and channeled towards the Hecla implementation project and some other higher potential collaboration projects. The direction and scope of this project will be re-evaluated in 2020 to align with industry priorities.

CONTINUOUS SURFACE MINING PROGRAM

The CMIC surface mining program gained momentum in 2019, with a combination of project identification, project execution, ecosystem development and organizational collaboration. CMIC and COSIA (Canadian Oil Sands Innovation Alliance) collaboratively executed the first company sharing and project identification workshop held in Calgary and hosted by Teck Resources. The workshop process was successfully employed earlier in the year hosted by the Alberta Chamber of Commerce and the University of Alberta’s Mining Industry Advisory Committee (MIAC).

With the CMIC surface mining road map as an anchor, the following project themes were identified in the following order of priority:

1. Alternative haulage
2. Ore sensing /ore sorting
3. Fully autonomous parts of the operation
4. Electrification of all mining processes
5. Improve predictive analytics of equipment and mining process performance
The Team agreed to focus on deploying two projects in 2019, Alternative Haulage and Ore Sensing / Sorting, with the others to be planned for execution in 2020 and 2021. Following the success of the workshop, it was evident there was a desire to align and grow the collaboration network and to reduce project duplication. As a result, CMIC and COSIA became strategic partners and formal Associate Members of each other’s organizations in the third quarter.

**Alternative Haulage**

Early in 2019, work was kicked off on the Alternative Haulage Project Phase 1 – the technology scan. This phase of the project was completed in Q3.

A detailed technology evaluation was performed to identify and categorized haulage technologies that were:
- Being utilized in the mining industry;
- Being utilized outside of the mining industry;
- New and emerging.

This information was then graphically presented and rated based on:
1. Types of energy sources used;
2. What energy options could be used;
3. The technology drive types;
4. Current technology types;
5. The technology readiness level for each technology type.

A total of 27 technologies were identified and summarized by technology type shown and in a technology matrix illustrated in the figure on the next page.
Subsequently, each individual technology was further analyzed and graphically presented based on:

1. Technology payload capacity;
2. Particle size management capability;
3. Overall technology range capability;
4. Gradient effectiveness;
5. Optimum haulage distance;
6. System Horizontal flexibility;
7. System effectiveness and management to vertical variation.

The core goals of this project were to:

1. Identify technology options;
2. Challenge haulage system evaluation processes;
3. Offer an option to traditional haulage segment equipment selection, and;

The common mine site haulage process is illustrated in the figure on the next page. These haulage routes are traditionally managed through the use of very flexible truck haulage equipment. This process revealed that a multiple haulage system could be deployed to optimize haulage efficiencies, re-think the mine processes including mine design to potentially drastically improve overall project NPV (Net Present Value) through for example lower unit costs and increasing production.
This new “Value Based Technology Adoption” analysis, shown below, offers an alternative to historical mine project evaluation and can provide significant benefits. It is believed that this process flow will form the basis for project evaluation transformation in the mining industry by employing the use of technology to model and evaluate projects.
In the fourth quarter 2019, work continued to lay the groundwork for the next phases of the Alternative Haulage Project – Phase 2 – technology evaluation and modeling preparation as per the below proposed project schedule:

<table>
<thead>
<tr>
<th>Alternative Haulage – Program Schedule</th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology scan (Phase 1)</td>
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<tr>
<td>Evaluation assessment of technologies (Phase 2 a and b)</td>
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<tr>
<td>Simulation and Modelling (Phase 3)</td>
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<td>Pilot (Phase 4)</td>
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<td>Demonstrations (Phase 5)</td>
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**Sensor Based Ore Sorting**

Ore sorting was identified as a key industry priority through our workshop process. As a result of these initial discussions in Q4 2019, it was agreed that a consortium approach could best leverage existing knowledge by building on the foundation of past work/experiences from our member companies. A consortium proposal, outlining the scope, timeframe and deliverables will be issued to members in 2020. The intent is to organize three fast paced workshops to support the Level Setting Process as shown below.
PROCESSING

In 2019, CMIC successfully launched two consortium processing projects. The Consortium Agreements and Project Charters clearly outline the roles of each participant, the expected financial and in-kind contributions and the Steering Committee members. In both projects, the Consortium agreed to have CMIC act as the Project Administrator to hold all background and foreground intellectual property and equipment until the Steering Committee confirms the commercialization pathway. Options and scenarios for the expected commercialization path forward were also detailed within the Project Charter. This structure has now become the standard for future technology development projects.

The Conjugate Anvil Hammer Mill (CAHM) Technology Platform

In 2019, CMIC led the Conjugate Anvil Hammer Mill (CAHM) Platform Technology consortium and actively began working together to design, build and test two distinct technologies, namely the CAHM and the CAHM Hammer (also known as the MonoRoll). The consortium includes five mining companies with a sixth mining company expected to join in 2020, along with the technology provider, Comminution and Transport Technologies Inc (CTTI) and Corem, a CMIC project partner. The project aims to demonstrate a revolutionary new comminution technology platform that will reduce energy in comminution by as much as 50% at specific unit operations within the comminution circuits (based on existing technologies as well as additional potential benefits that may significantly improve OPEX and CAPEX through flowsheet simplification).

The platform technology will advance the CAHM and MonoRoll from a Technology Readiness Level (TRL) 3 to 6. Both technologies were developed and optimized using Discrete Element Method (DEM) modelling to which CTTI is a world expert. The model results predict that the CAHM will outperform high pressure grinding rolls (HPGR) by at least 3 times in terms of energy efficiency with a much higher reduction ratio. Similarly, the MonoRoll variant has the potential to retrofit inefficient rod and ball mills at existing operations and significantly improve size reduction with much higher grinding efficiency.

On May 1, 2019, the MonoRoll became one of six Natural Resources Canada (NRCan) Crush It finalists and received an $800,000 non-repayable grant to design and test a prototype that will demonstrate significant energy savings on or before November 30, 2020. If the MonoRoll wins this phase and is awarded the $5 million grand prize, these funds will be used to retrofit a larger scale MonoRoll for on site demonstration at a mining operation with the ultimate goal of rapid commercial adoption.

In July 2019, the CAHM project received confirmation from NRCan’s Clean Growth Program that it had successfully completed the due diligence process and was now eligible to submit claims for up to $2 million towards a non-refundable grant. The CAHM project must be completed on or before March 31, 2021. In addition to this federal funding the CAHM project has also received $150,000 from the Quebec Provincial Government along with $275,000 from its mining company consortium partners. The total technology platform project budget is over $5 million and includes significant in-kind contributions along with the aforementioned cash contributions.
These two large scale prototypes will be designed, built, tested and their performance compared with Corem’s pilot scale HPGR and pilot scale ball mill respectively. The platform technology pilot results will be used to update the value propositions in terms of simplifying grinding circuits that will ultimately result in reduced operating and capital expenditures through reduced energy consumption and potential comminution circuit flowsheet simplification. The pilot results will also be used to develop proposals for the next stage of technology development.

For CAHM, it is expected that the existing 40 tonnes per hour prototype will be modified and then operated periodically at a mine site or quarry to evaluate component wear, operational availability and confirm energy and performance metrics. The pilot results for the MonoRoll will be used as the design basis for retrofitting a commercial scale rod or ball mill. This retrofitted mill would then be operated at a mine site where a slip stream from the production line would allow it to function without the risk of impacting production targets.
CanMicro: Combined Microwave Assisted Sorting and Comminution

The CanMicro project consortium was first conceived during the December 2018 CMIC project development workshop. CanMicro became one of six NRCan Crush It finalists and was awarded a non-refundable grant from for $800,000. Like the MonoRoll project, CanMicro has the chance to win the $5 million grand prize in November 2020 to further the technology demonstration for rapid commercialization. CMIC actively supported CanMicro during this Crush It competition and was asked in May 2019 to act as the Project Administrator. The project lead is Dr. Erin Bobicki from University of Toronto. Dr. Bobicki, Sepro Mineral Systems and Glencore XPS along with CMIC are the Steering Committee members. Other project participants and subject matter experts include Dr. Chris Pickles from Queens University, SRC and Corem.

CanMicro Concept to achieve up to 70% Energy Reduction

Infrared Image of Ore Treated by Microwave
The Consortium Agreement, Charter and Contribution Agreement were signed in August 2019 and since that time additional funds have been received directly to UofT from an NSERC Alliance grant and Ausenco. Taking into account both cash and in-kind contributions the total project budget is close to $2.5 million. The first Crush It Milestone was submitted in September 2019 and these funds were used to purchase a 150 tonnes per hour multi-mode microwave. The unit has since been installed and commissioned at Sepro Mineral Systems and 5 tonnes of Glencore ore was shipped for testing. To date, the technical results have shown to be extremely promising which has resulted in another mining company requesting to join the Consortium. The team continues to test multiple ores from various commodities from various mining companies and welcomes additional members to the consortium.

Data Mining for Value

In May 2019, CMIC, Agnico Eagle, Newmont, Glencore XPS and Teck agreed that it would be worthwhile to work together to explore where AI technologies can be effectively used in mining operations (mine, mill and smelter) to improve operational performance. The importance of identifying where gaps exist that make AI implementation ineffective was also key.

In November 2019, Glencore XPS agreed to act as the project lead with CMIC as the Project Administrator. A Project Charter was completed, and the specific problems and expected outcomes were identified. Specific short-term outcomes include:

- To leverage existing infrastructure (equipment, instrumentation and systems) to establish best practices for real-time operational decision making.
- To identify infrastructure gaps that require augmentation in order to effectively implement AI technologies
- Provide a clear picture / methodology of where and how to use AI in mining and metallurgy operations and where it is ineffective.
- Demonstrate on how the data can be used effectively to generate value.

It is hoped that this project will officially launch in 2020.

Microwave Pilot Plant
Global Water Curves to Complement the CEEC’s Global Energy Curves

The mining industry uses water in most of its processes and globally water resources are under increased scrutiny. The Coalition for Eco-efficient Comminution (CEEC) and CMIC are collaborating on a project to produce tools that can be used to benchmark and evaluate water usage across mine sites with a focus on mineral processing circuits. The ultimate deliverable will allow participants access to a global water curves database where they can benchmark their performance against similar anonymous operations with comparable water issues/constraints.

The proposed project structure includes five distinct phases with clear deliverables following each phase to allow for “quick wins” and rapid industry feed-back and re-alignment prior to a large-scale water curves database roll out. Phase 2 would be completed after 14 months and a clear decision in regard to large scale database development would result.

CMIC and CEEC are working with mining companies to recruit the first five companies to create the initial consortium and launch the project.

Global Water Curves Workshop Partners, CEEC, CMIC, KPMG
## Our Innovation Pipeline

<table>
<thead>
<tr>
<th>Concept</th>
<th>Development</th>
<th>Execution</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration Under Cover – New Technologies</td>
<td>Underground Mechanical Cutting Demonstration</td>
<td>Expected 2020</td>
<td>Defragmenting the Mining Innovation ecosystem (NRCan)</td>
</tr>
<tr>
<td>Continuous Underground Mining</td>
<td>Safe Deep Development</td>
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<td>Predictive Analytics</td>
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<tr>
<td>Rock Face Pre-Treatment</td>
<td>Continuous Underground – Discovery</td>
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<td>Alternative Haulage Surface Mining – Phase 1</td>
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<tr>
<td>Material Haulage</td>
<td>Alternative Haulage – Surface Mining (Phase 2)</td>
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<tr>
<td>Mine Design</td>
<td>Global Water Curves</td>
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<tr>
<td>Continuous Surface Mining</td>
<td>Data Mining for Value</td>
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<tr>
<td>Predictive Analytics</td>
<td>Sensor Based Ore sorting</td>
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<tr>
<td>Fully Autonomous Surface Mine</td>
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<td>Fully Electric – Surface Mine</td>
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<td>Small Modular Reactors</td>
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<tr>
<td>Renewable Energy &amp; Mine Operations</td>
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<tr>
<td>New processing technologies: CAHM, Monoroll, CanMicro</td>
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## Fit with TZWM

CMIC PORTFOLIO ALIGNMENT WITH TOWARDS ZERO WASTE MINING

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Project</th>
<th>Fit with Towards Zero Waste Mining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>Continuous Mining – Mechanical Cutting Demonstration</td>
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<td></td>
<td>Safe Deep Development</td>
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<tr>
<td></td>
<td>Mechanical Cutting – Continued Learning</td>
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<td></td>
<td>Alternative Haulage – Surface Mining</td>
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<tr>
<td>Processing</td>
<td>Conjugate Anvil Hammer Mill</td>
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<td>MonoRoll</td>
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<td>CanMicro</td>
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<td>Global Water Curves</td>
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<td>Data to Knowledge</td>
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<tr>
<td>Integrated</td>
<td>Transforming the Mining Innovation Ecosystem</td>
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<td>Sensor Based Ore Sorting</td>
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CMIC builds its project pipeline by identifying and prioritizing concepts and facilitating their development into projects with our Members. Each project is a consortium and involves multiple mining company members. CMIC follows international standards related to project, program and portfolio management defined by the Project Management Institute (PMI). Documentation and controls are put in place commensurate with the scale and scope of the project to balance effective project control and efficient project execution. Project participants are bound by a Consortium Agreement and/or a Project Charter. Third party experts or other organizations are bound by Non-Disclosure Agreements.

CMIC is in the process of streamlining these agreements into a single Master Agreement with a term of 3–5 years, to be decided. Projects would then be driven by Project Charters eliminating a project-by-project negotiation of consortium agreements.

CMIC also put into place a project-based accounting system to ensure proper fiduciary control of projects at the various stages of development.

The CMIC project cycle and funding sources is illustrated in Figure 1 providing a backdrop to how CMIC project finances are allocated and managed.

### Project Development / Cost Accounting

<table>
<thead>
<tr>
<th>Concept</th>
<th>Development</th>
<th>Execution</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs covered by Membership. Incorporated into Operating Budget as Corporate Portfolio Development. Cumulative cost and time, triggers go-no go discussion.</td>
<td>Costs covered by CMIC Membership. Separate monthly P&amp;L created per project. Cumulative cost and time, triggers go-no go discussion. Some CMIC costs may be recovered by creating new project.</td>
<td>Fully funded by external sources. CMIC and overhead included in project budget. Projects initiated after Board approval and acquisition of project funding. May be reallocation of appropriate project development cost.</td>
<td>Final Project Execution cost Validation of final scope and actual costs. Project cost reconciliation. Funding balance management (refund or roll over). Project phases continue.</td>
</tr>
</tbody>
</table>
CMIC recognizes that companies are at different states in terms of their ability and or readiness to collaborate. Accordingly, we have created a Collaboration Readiness Level (CRL) scale shown below that helps to identify the state of readiness of each company. The CRL also enables us to work with these companies to move them into a higher CRL state. As we build projects and project consortia, the CRL scale is an effective tool to ensure project participants are at similar CRL levels to guarantee efficient and effective collaboration.
CMIC relies heavily on the business cycle of the Partner mining companies and has developed a process for ensuring alignment of project activities to the business of our partners. This process is shown in Figure 3 below:

These tools will be further developed, refined, socialized, and implemented throughout 2020 in order to assist in increasing the speed of trust, reducing the development time and cost, as well as fostering the creation of a stronger alignment and commitment culture towards collaboration projects in the constantly changing mining industry.

**Project Business Planning Cycle**

- **Feb / March**
  - Project identification workshops
  - Project alignment
  - Strategic plan (3 yrs).

- **June / July**
  - Finalize Project budget *
  - Surface and UG roadmap review and update

- **Oct / Nov**
  - Compilation of final company internal budget reviews

- **April / May**
  - Project alignment socialization agreement to collaborate
  - Project scope and budget

- **Aug / Sept**
  - Incorporation of CMIC projects into Company budgets

- **Dec / Jan**
  - Final Budget approval by organizations

* Including provision for appropriate ad hoc projects
CMIC follows internationally accepted PMI (Project Management Institute) guidelines for project, program, and project portfolio management. Projects that the CMIC leads include multiple organizations and take a general project structure including executive sponsors, senior responsible authorities, a project manager from CMIC and a delivery team. A Steering Committee is comprised of project participants whose responsibilities typically include:

(a) Overseeing the course, direction and timing/schedule of the Project;
(b) Approval of any material change(s) to the Project;
(c) Approval of the requirements and protocols with respect to the performance of the Project, if applicable;
(d) Approval of all reports and any proposed publication relating to the Project;
(e) Approval of any budget or expense reimbursement in relation to the Project;
(f) Establishing Background IP required for the Project at different stages;
(g) Advising CMIC on the appointment of subcontractors; and
(h) All such other matters as the Parties may agree in writing from time to time.

Project management structures are tailored to the size and complexity of each project, to ensure appropriate oversight while maintaining the greatest possible agility. All projects require project charters (created from project charters supplied by four mining companies) and consortium agreements. CMIC ensures that project funding is secured prior to project initiation.
Sound partnerships are essential to achieving CMIC’s goal of TZWM. The following outlines some of the organizations CMIC works with, in Canada and abroad:

**CANADA**

**Mining Supply Trade Association (MSTA)** – Connects mining supply and services companies to business opportunities across Canada and around the world. The MSTA and the CMIC have been working together to bridge the gap between industry needs and supplier capabilities, by collaborating in terms of events, workshops, and dialogue with suppliers, and work with national, provincial, and foreign governments.

**Corem** – The largest organization in Canada fully devoted to mineral processing. Recognized as a world-class organization, Corem provides a wide range of mineral processing and analytical services to companies that explore and develop ore bodies and transform or recycle mineral substances. The CMIC is currently working with Corem on three separate mineral processing projects.

**COSIA (Canada Oil Sands Innovation Alliance)** – A collation of oil and gas producers committed to accelerating improvements in environmental performance in Canada’s oil sands, through collaborative innovation. CMIC is exploring opportunities with its members to form an alliance that would result in:

- A vital foothold in Alberta
- A solid national presence
- Breaking down the silos between hard rock mining and oil and gas
- Providing CMIC members with exposure to how the members of other industries collaborate

**GMG (Global Mining Guidelines Group)** – A technical society of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM). This network of like-minded companies develops multi-disciplinary guidelines to manage risk, enhance performance, design solutions, inform planning and decision-making, and save time and money. The CMIC and GMG collaborated on developing guidelines for both battery electric vehicles and short-interval control. We continue to explore future opportunities concerning industry needs.

**MIRARCO (Mining Innovation Rehabilitation and Applied Research Corporation)** – A provincial not-for-profit with an R&D focus. Its newly constituted Board of Directors comprises mining companies, many of which are also CMIC members. Members of their Board of Directors have asked that MIRARCO and the CMIC work together, and we are in early discussions to examine project collaboration opportunities.

**AUSTRALIA**

**CEEC (Coalition for Eco-efficient Comminution)** – An Australia-based non-profit whose focus is knowledge dissemination related to reducing energy consumption in comminution. This objective connects directly to the CMIC’s mineral processing roadmap. Achieving a better understanding of the correlation between water and energy use is critical to reducing water and energy consumption in processing circuits. The CEEC and the CMIC have created a project charter that is currently under review by CMIC industry members, and these entities look to create tools by which to elucidate water and energy use in processing circuits.

**Mining3** – A non-profit founded as part of the Australian government’s Cooperative Research Centre (CRC) program. Mining3 has developed modified mining methods and processes and cutting-edge mining equipment. CMIC is working with Mining3 as part of our continuous mining initiative, as it has developed models that estimate OPEX and CAPEX for mine sites that implement new mining technologies and/or processes.

**CHILE**

**Expande** – An Open Innovation Program for Mining of a public-private nature that is based on a concept of collaboration within a linked model that enables the demand for the technological solutions required by the mining industry to be matched with offers made by suppliers. CMIC is sharing grand challenges in mineral processing with Expande as well as CMIC roadmaps in mining and processing in the expectation of attracting additional members to the ever expanding CMIC innovation ecosystem.
Challenges

CMIC continues to face three core challenges, as follows:

1. **Access to capital funding** – CMIC does not maintain a readily available pool of capital for projects. This forces each project to fundraise, resulting in launch delays.

2. **Access to relevant and accessible matching funding** – government programs are numerous, diverse, and complex. Identifying, accessing, and negotiating relevant matching funding from public sources can create delays and for the CMIC mission drift, at either the organizational or project level.

3. **Perceived competition with other entities** – CMIC has made considerable progress in this area, and in terms of being the umbrella organization for innovation in Canada, it is broadly recognized by research, development, and innovation organizations in British Columbia, Alberta, Saskatchewan, Quebec, and Ontario, and organizations in Australia and Chile.
MEMBERSHIP MODEL
CMIC’s membership model consists of the following four tiers:

1. Strategic Membership ($100,000)
2. Enterprise Membership ($50,000)
3. Solution Membership
   a. Adopter ($25,000)
   b. Provider ($11,000 or $5,500)
4. Associate ($5,000)

CMIC has made considerable progress in attracting new Members and meeting financial expectations. The figures below show performance against the plan and Members by type since 2013.

CMIC Performance Against the Plan

CMIC’s fiscal year ended December 31, 2019. Andrews & Company provided audit services to CMIC for the 2019 fiscal year.

The following is a summary of CMIC’s last three (3) years of audited financial statements. Final audited statements are available on our web site.

<table>
<thead>
<tr>
<th></th>
<th>2019</th>
<th>2018</th>
<th>2017</th>
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<tbody>
<tr>
<td>Revenues</td>
<td>$1,318,294</td>
<td>$1,402,069</td>
<td>$1,666,726</td>
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<tr>
<td>Expenses</td>
<td>$1,181,464</td>
<td>$1,281,458</td>
<td>$1,657,233</td>
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<tr>
<td>Excess of revenue over expenditures</td>
<td>$136,830</td>
<td>$120,611</td>
<td>$9,493</td>
</tr>
</tbody>
</table>

CMIC Membership by Organization Type, 2013–2019
Board of Directors

The CMIC Board currently consists of 12 Directors. The Directors span a wide range of leadership from inside and outside of the mining industry – including the private sector, public sector, and academia – and represent significant executive leadership value for CMIC.

As CMIC is a non-profit corporation, its proper governance is the responsibility of its Board of Directors. The key responsibilities of the Board are as follows.

1. Define and/or safeguard the mission, values framework, and operating principles within which it expects CMIC to be administered;
2. Oversee development and approval of a long-term organizational plan and develop or approve annual budgets and operating plans;
3. Monitor the overall performance of the organization as it works to achieve its objectives, mission, and strategic goals;
4. Seek and secure the resources the organization needs to adequately finance its operational and capital requirements;
5. Account to members, sponsors, other key stakeholders, and the public for the services of the organization and the use of funds;
6. Ensure prudent and proper management of the organization’s resources;
7. Anticipate, mitigate, and manage risks to which the organization, its staff, Board, and other key stakeholders are exposed.

To discharge these responsibilities, the Board created four standing Committees of the Board, with Terms of Reference. Each Director is required to serve on at least one Committee. The members of the Board of Directors are listed below, each with a short biography and the Committee on which he or she serves.

GORDON BOGDEN
Chair

Mr. Bogden began his professional career as a geophysicist, co-founding Quantec Geoscience, moving on to CIBC, Rothschild, and National Bank Financial as a mining investment banker advising boards of directors and management teams of some of the largest mining companies in the world. He concluded his investment banking career as Vice Chairman, Mining & Metals, for Standard Chartered Bank after its acquisition of Gryphon Partners in 2011 where he was a co-founder and Managing Partner. Upon retiring from the financial services industry in 2012, he assumed a number of corporate board positions and engaged in board leadership, strategic development and corporate responsibility initiatives.

Mr. Bogden is currently Chairman of Black Loon Group, a private mining investment company, and is a former President and CEO of Alloycorp Mining Inc. He has served as a director of over a dozen public mining companies including Royal Gold Inc., IAMGOLD, Orvana Minerals Corporation and is the former Chairman of Volta Resources, and of Nexgen Energy. He is Director Emeritus of the Mt. Sinai Hospital Foundation Board in Toronto and the Bridgepoint Health Foundation Board. In 2013 he was awarded the Queen Elizabeth II Diamond Jubilee Medal for his work with Right To Play where he currently serves as a member of the Canadian Advisory Board.

Mr. Bogden holds a B.Sc. in Applied Science (Geology) from Queen’s University, is a Professional Engineer, and earned his professional certification as a Corporate Director (ICD.D) from the Institute of Corporate Directors in Toronto.
JEAN ROBITAILLE
Past – Chair

Mr. Robitaille is Senior Vice-President / Business Strategy & Technical Services at Agnico Eagle Mines Ltd., a position he has held since Feb. 2014. Prior to his appointment, he served Agnico-Eagle in various capacities for more than 25 years, most recently as Senior Vice-President, Technical Services and Project Development, Vice-President, Metallurgy & Marketing, General Manager, Metallurgy & Marketing and as Mill Superintendent and Project Manager for the expansion of the LaRonde mill. Before joining Agnico-Eagle, Mr. Robitaille worked as a metallurgist with Teck Mining Group. Mr. Robitaille is a mining graduate of the College de l’Abitibi-Témiscamingue with a specialty in mineral processing.

NILS VOERMANN
Chair, Governance Committee

Nils Voermann has executive responsibility for Hatch’s Business Practices globally, including Technologies, Systems, Consulting, Environmental Services and Operational Performance. These groups serve clients across the Mining & Metals, Energy and Infrastructure sectors. He also leads our Central North America region.

Nils joined Hatch in 1989 as a Mechanical Engineer. In 1995 he was appointed leader of Hatch’s Metallurgical Furnace Design Group. Through a string of innovative and successful projects in Canada, USA, South Africa, Colombia and Korea, he expanded Hatch’s metallurgical furnace design team more than four-fold. The Furnace Group achieved global scope and became recognized as a world leader in its field. In 2003, Nils took on broader responsibility for development of Hatch’s proprietary know-how, as Global Managing Director, Technologies. Under his leadership Hatch maintains a strong pipeline of technologies in progressive stages of development and commercialization.

From 2009 to 2013 Nils was based in Brisbane, Australia to provide leadership for Hatch’s expanding business in the Asia-Pacific region.

Nils is a graduate of Queen’s University in Kingston, Ontario where he received his B.Sc. in Engineering. He also earned his MBA from INSEAD in France. Nils is an award-winning author, having published and presented over 30 technical papers, with a focus on new technology implementation and management. He holds several patents and has received various awards including the Natural Resources Canada, CANMET Technology Transfer Award and The Minerals, Metals & Materials Society (TMS) Extraction and Processing Award. In 2011, he was awarded the Medal for Engineering Excellence by Professional Engineers Ontario (PEO).

Nils is a Fellow of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) and a Fellow of the Australian Institute of Mining and Metallurgy (AusIMM). An airplane pilot in his free time, Nils enjoys sharing his passion for flying with aspiring young aviators.
BONNIE ROSE
Chair, Finance Committee

Bonnie Rose, P.Eng., was appointed President and CEO of the Technical Standards and Safety Authority effective April 4, 2018. Overseeing all aspects of TSSA’s business operations, Bonnie provides leadership on the overall direction and strategic priorities of the organization. Bonnie is focused on strengthening TSSA’s role as a well-respected leader in the safety industry and upholding safety excellence.

Bonnie is a seasoned executive with a passion for safety and in-depth knowledge and experience in technical standards. This passion is evident in her previous executive positions as the former CEO and Registrar of Retirement Homes Regulatory Authority; President of the Canadian Standards Association Group – CSA Standards; and Vice President of Service Delivery and Service Quality with CSA International.

Bonnie holds a Bachelor of Applied Science in Electrical Engineering from Queen’s University, a Master of Business Administration from the University of Toronto, and a Chartered Director from The Directors College.

Bonnie is also a member of the Board of Directors for CWB Group. She has also served on the Board of the Electrical Safety Foundation International Canada (ESFi), and the American National Standards Institute (ANSI).

MARK THORPE
Chair, Communications Committee

Dr. Thorpe is a senior mining executive with over 30 years’ experience both in mining operations and as an international corporate responsibility consultant working on mining projects from potash to diamonds and gold.

His experience spans five continents and covers mining from greenfields exploration to closure and post-closure management. Having lived and worked in Latin America and Africa, Dr. Thorpe’s experience includes permitting a mine in a tropical rainforest area of Venezuela with several regulatory changes and working with the project teams to reduce the LTIFR at a mine in Africa from 2.1 per million hours worked to 0.15 per million hours worked.

Dr. Thorpe holds a Ph.D. in mine land rehabilitation from the University of Saskatchewan and is the Chair of the Environmental Stewardship Initiative of the Canada Mining Innovation Council.
IMOGEN COE

Dr. Imogen Coe is the former Dean of the Faculty of Science at Ryerson University and is Internationally recognized for her pioneering research in membrane protein cell biology and biochemistry. Throughout her 15-year career in academia, Imogen has been a strong independent voice for science. She is committed to student experiential learning through participation in research projects having supervised more than 30 graduate and undergraduate students to date. Imogen is an advocate in the support and promotion of girls and women in science and has spoken on the topic locally and nationally. She is also active in promoting and highlighting the importance and relevance of science to her local community.

An accomplished researcher and speaker, Imogen has presented her research at conferences and seminars across the globe for more than a decade and has more than 70 scholarly papers, book chapters and abstracts to her credit. Imogen has received many research grants and awards throughout her career, currently holds grants from both NSERC and CIHR and was awarded the Premier’s Research Excellence Award (now known as the Early Researcher Award) for her research activities from 2000–2005. She has also dedicated her time as an internal reviewer for multiple Canadian funding agencies including NSERC, CIHR, and the National Cancer Institute of Canada, as well as acting as a reviewer for other national and international funding groups. Previously, Imogen was Associate Dean, Research and Partnerships, in the Faculty of Science and Engineering, York University. Imogen received a PhD in Biology from the University of Victoria, an MSc from the University of Victoria and a bachelor’s degree from Exeter University in the U.K.

JIM GOWANS

Jim is currently involved with several companies as a corporate Director.

Jim was the President & Chief Executive Officer at Arizona Mining, from January 2016 until August 2018 when the company was sold to South32, an Australian based multi-national resource/mining company. He was formerly Co-President of Barrick Gold from July 2014 to August 2015 and Executive Vice President and Chief Operating Officer from January to July 2014.

Recent prior roles include Managing Director of Debswana Diamond Company (Pty) Ltd., President and Chief Executive Officer of De Beers Canada Inc., Chief Operating Officer and Senior Vice President of PT International Nickel Indonesia tbk and Executive Vice President at Placer Dome Inc. Mr. Gowans has more than 40 years of experience in mineral exploration, mine feasibility studies, opening new mines (including the Red Dog and Polaris zinc mines), commissioning mine expansions and in the development of best practices in mine safety, mine operations and economic performance improvement, particularly in the application of innovative new technologies in the mining space.

He is currently a director of Cameco Corporation, Titan Mining and New Gold Inc. He was Chairman of the Board of Dominion Diamond Corporation from April 2017 until its sale in October 2017, and was recently appointed a director of Gedex Inc., an innovative geophysics systems company. He has served on the Boards of various junior mining companies over the years including Phoscan, Arizona Mining and Newcastle Gold. He previously served as the President of the Canadian Institute of Mining, Metallurgy and Petroleum (CIM), Chair of the Mining Association of Canada (MAC), and as a Director of the Conference Board of Canada.

Mr. Gowans is a Professional Engineer and received a Bachelor of Applied Science degree in mineral engineering from the University of British Columbia and attended the Banff School of Advanced Management.
MICHELLE ASH
Michelle is, CEO of GEOVIA at Dassault Systèmes, has made significant contributions to the mining sector with a focus on Innovation Strategy, Technology, and Digital Transformation.

Michelle is highly passionate about Mining and Infrastructure and remains focused on delivering sustainable solutions that help these sectors to continue to create and shape the world in which we live, through digital transformation and the 3DEXPERIENCE platform.

As Chair of the Global Mining Guidelines Group – GMG, Michelle has contributed to develop best practices and guidelines for the implementation of technology and socially enabled changes in the mining industry. She is also on the advisory board of several start-ups such as Petra Data Science, OffWorld, Behault, Descartes Labs and MineSpider.

Previously she was Chief Innovation Officer at Barrick Gold Corporation where she oversaw the company’s innovation program, looking both at how innovation can drive productivity in the existing business as well as how it can be harnessed to deliver alternative business models.

She began her career as a blasting engineer with Rio Tinto and has held several operational roles in various mining companies and across commodities.

Michelle was named to the 2016 list of “100 Global Inspirational Women in Mining” by Women in Mining UK and won the Technology Innovator of the Year Award by Mines and Technology in 2019. She holds a degree in Civil Engineering and an Executive MBA from the Melbourne Business School; she also holds a degree in Psychology from Deakin University.

DEAN BRAUNSTEINER
Dean was the former Partner National Assurance Leader, Mining, PwC and provides public companies with audit and assurance services including advice on implementing new accounting standards, assistance on acquisitions and divestitures, and helps companies respond to comment letters received from Canadian and US regulatory bodies. Dean has extensive experience in IFRS and US GAAP, as well as SEC reporting, and is one of the firm’s subject matter experts on mining industry issues. As PwC Canada’s National IPO Services Leader, he also has significant experience with initial and secondary public offerings.

Dean obtained a BBA (Honours) degree from Wilfrid Laurier University in 1993 and received his CA designation in 1996. In 2001, Dean also received his CPA designation in Illinois.
ANDREW SWART
Andrew is a Partner at Monitor Deloitte based in Toronto, Canada and is the Deloitte Global Mining Consulting Leader.

He has more than 22 years of industrial experience of which the last fifteen years has been in consulting. He has worked for senior executives in a range of industries including mining, oil and gas, and government. Within the government arena most of his work has operated at the intersection of business and government – a key interface for natural resource companies. His client engagements have included corporate and competitive strategy engagements, innovation systems, cost reduction through energy management and organizational transformation and economic development programs.

Andrew has worked for clients around the world including Canada, Russia, Ukraine, Kazakhstan, Brazil, Germany, India, South Africa, the United Kingdom and the United States of America.

KEN BELL
Ken Bell was appointed Vice President, Strategic Planning in January 2019.

He joined Syncrude as a Mining Engineer in 2001, and his career progression included many senior roles in areas of Production and Technical. Ken became Manager, Tailings and Lease Development in March 2016.

Ken holds a Bachelor of Science in Mine Engineering and a master’s degree in Natural Resources, Energy and Environment both from the University of Alberta.

In the community, Ken serves on the Board of Directors for Indigenous Works and is a member of Syncrude’s Aboriginal Relations Steering Committee.

Ken is a long-time Fort McMurray resident and has two children.
## Glossary of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>CAHM</td>
<td>Conjugate Anvil Hammer Mill</td>
</tr>
<tr>
<td>CEEC</td>
<td>Coalition for Eco-efficient Commination</td>
</tr>
<tr>
<td>CIM</td>
<td>Canadian Institute for Mining, Metallurgy and Petroleum</td>
</tr>
<tr>
<td>CMIC</td>
<td>Canada Mining Innovation Council</td>
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<tr>
<td>CRL</td>
<td>Collaboration Readiness Level</td>
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<tr>
<td>COSIA</td>
<td>Canadian Oil Sands Innovation Alliance</td>
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<tr>
<td>CTTI</td>
<td>Comminution &amp; Transportation Technologies Inc.</td>
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<tr>
<td>DEM</td>
<td>Discrete Element Modelling</td>
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<tr>
<td>NRCan</td>
<td>Natural Resources Canada</td>
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<tr>
<td>PMI</td>
<td>Project Management Institute</td>
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<td>SME</td>
<td>Small–medium enterprise</td>
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<tr>
<td>TZWM</td>
<td>Towards Zero Waste Mining</td>
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