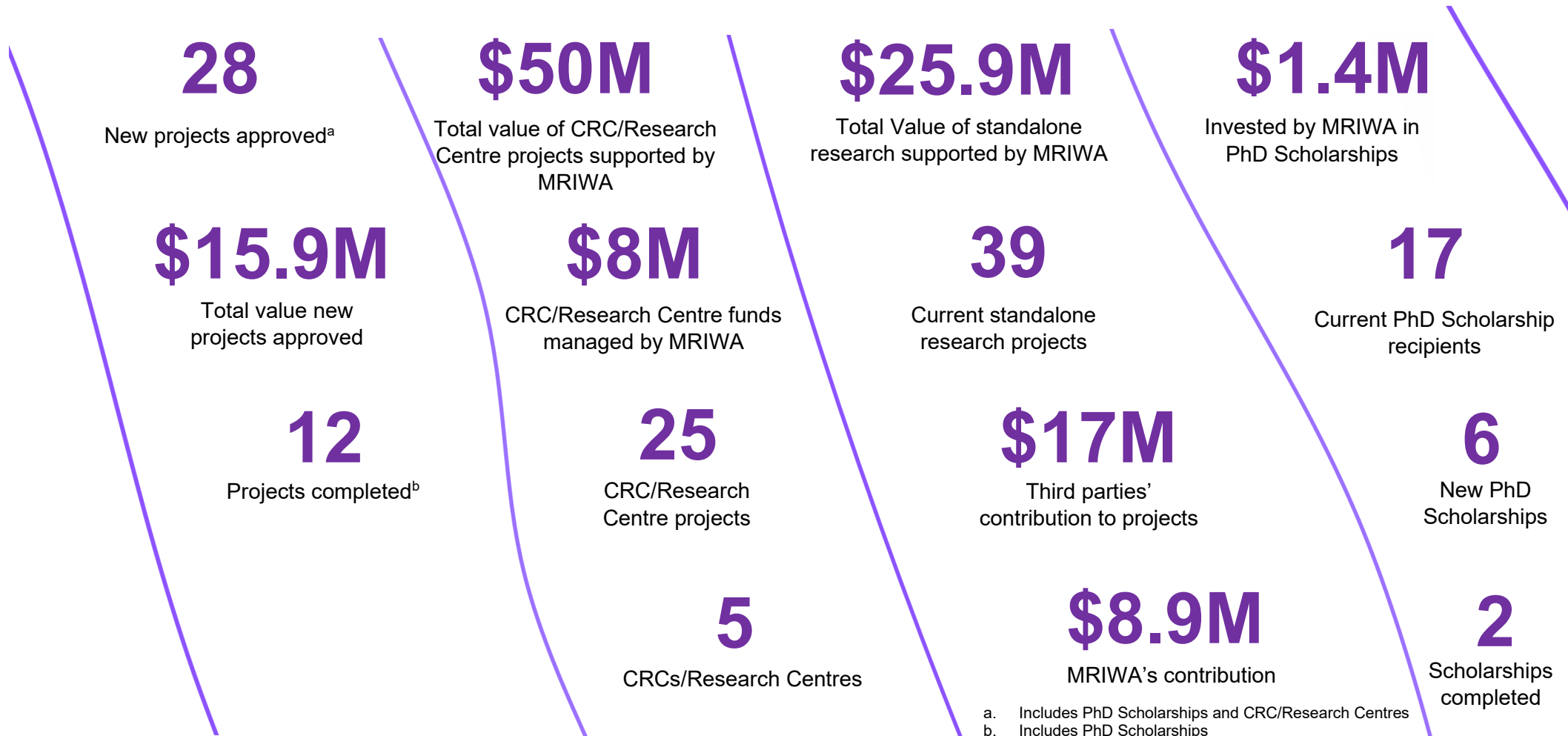


Our Projects

This section outlines MRIWA's applied research projects, how they create capability and deliver economic, environmental, and social benefit for Western Australia.

Through the MRIWA research portfolio, industry, academic and government relationships are activated enabling innovation and research networks to attract investment in high-value research activities.

Highlights for 2023 – 2024



Our Focus Areas

MRIWA Focus Areas are campaigns targeting specific areas which seek to stimulate and amplify activities of high value to the State.

Focus Areas may fall in areas specific to parts of the mining value chain or have impact across the entire value chain, with the benefit to be realised in Western Australia.

MRIWA will use these Focus Areas to enable industry, academic and government relationships to activate innovation and research networks and attract investment in high value activities. Calls to action, objectives and anticipated outcomes will vary for each Focus Area.

Areas for focus are selected by the MRIWA Board and informed by government priorities and the Research Priority Plan, with input from the MRIWA College and MRIWA networks.

The following are MRIWA's focus areas:

- Net Zero Emission Mining
- Green Steel
- Critical Minerals
- Exploration Amplification
- Precision and Low Impact Mining
- Alternative Use of Tailings and Waste
- Mineral Carbonation
- Mining Equipment and Technology Services (METS)
- Supply Chain Risk (work on this is not yet commenced)

View the full list of projects for each focus area and find out more information on our website.¹

¹ <https://www.mriwa.wa.gov.au/minerals-research-advancing-western-australia/focus-areas/>

Net Zero Emission Mining

The Challenge

This strategic focus area aims to reduce the carbon footprint, lower overall energy costs and improve the energy efficiency of the Western Australian mining sector through harnessing collective efforts, enabling decarbonisation to become an opportunity for the sector, not a cost.

The Context

With a global shift towards decarbonisation, the need for mineral resources to support the energy transition places Western Australia at the forefront of a significant economic opportunity.

Western Australia supplies the minerals used for wind and solar energy generation, electric vehicles, and battery storage which are critical for the international community's efforts to achieve the Paris Agreement goals of net zero emissions by 2050.

With this opportunity also comes a challenge, in ensuring new and increased demand for these resources meets rising environmental, social and governance (ESG) expectations and does not negatively impact on the competitiveness of the mining sector.

Innovation is needed for our mining sector to capture this opportunity, develop new ways of working and transform how energy is generated and used. The lead time to new technology development and deployment means preparations need to start now.



Green Steel

The Challenge

Green Steel – the question is not ‘is it possible’, but rather ‘how to make it possible’.

This MRIWA Focus Area aims to promote further research as identified in the green steel study² to enable Western Australia to understand and identify magnetite and hematite iron ore resources best suited to supporting the global green steel ambitions, creating new markets and industries for the state.

The Context

Western Australia accounts for 38% of the global supply of iron ore and is the leading Australian state in iron ore production – 934 million tonnes (mt) in 2022 – according to the Australian Government’s Office of the Chief Economist. Brazil, our major competitor, accounted for only 17% of the global supply³.

The iron ore industry is the State’s largest and most important industry, providing direct and indirect economic and social contributions which are greater than any other industry to the State. Its contribution is also significant to the national economy.

It is for this reason opportunities to develop further testing of the iron ore and energy requirements in the identified pathways to green iron in Western Australia are required. A capability to produce green iron will attract further investment in sustainable processing of iron ores to produce green steel.

With the steel industry generating more than 7% of global carbon emissions, there is a significant focus on the development of green steel technology.

Western Australian iron ore will have a key role to support the steel industry decarbonise.

² <https://www.mriwa.wa.gov.au/minerals-research-advancing-western-australia/focus-areas/green-steel/green-steel-resources/>

Critical Minerals

The Challenge

The critical minerals challenge is to meet the demand for processed metals driven by changing technical requirements and metal types for a low emissions economy.

The Context

The industry recognises critical minerals present a once in a generation opportunity to re-strategise global supply chains. There is a collective demand from countries around the world to democratise the production, transmission, and consumption of energy, which is altering international balances and requirements of minerals.

A new national critical minerals strategy was released by the Federal Critical Minerals Office in June 2023⁴. MRIWA will be working to help align Western Australian research programs led by the State’s universities, industry, and the Western Australian government.

³ WA Department of Jobs, Tourism, Science and Innovation: Western Australia Iron Ore Profile – February 2022 as reported in <https://www.mriwa.wa.gov.au/minerals-research-advancing-western-australia/focus-areas/green-steel/green-steel-resources/>

⁴ <https://www.industry.gov.au/publications/critical-minerals-strategy-2023-2030>



Exploration Amplification

The Challenge

Mineral exploration and discovery represent the foundations of Western Australia's successful mining sector. The continued productivity of this key industry will require discovery and characterisation of ore bodies deeper below the surface and hidden from traditional methods of discovery, pushing industry to reduce both the cost and the environmental footprint of exploration technology.

The Context

Investment in exploration innovation is critical for Western Australia to meet the emerging challenges of mineral discovery and maintain the State's position as a preferred supplier of mineral commodities.

Through our Exploration Amplification Focus Area, MRIWA works to define a future vision of productive mineral exploration for Western Australia and to support the areas of priority research and education needed to deliver on this vision.

In striving toward this goal, MRIWA encourages collaboration between the minerals industry, researchers and government to:

- Create and nurture global networks and knowledge leadership in mineral exploration.
- Increase adoption and implementation of exploration research outcomes.
- Maintain strategic foresight regarding research and education needs related to mineral exploration.
- Stimulate partnership opportunities in areas of exploration research initiated by industry.
- Generate awareness of and enthusiasm for career pathways in exploration, and in broader geoscience and technology as they relate to mineral exploration.

Precision and Low Impact Mining

The Challenge

The Western Australian mining industry has seen an increasing focus on precision and low impact mining approaches, driven by both industry and government initiatives, such as the adoption of autonomous haulage systems, and the implementation of advanced environmental monitoring technologies. Despite these advancements, there are still challenges to overcome, including the rehabilitation of legacy mine sites, the management of water resources, and the engagement of Traditional Owner communities in decision-making and project milestone processes.

The Context

The minerals sector is undergoing a significant global shift towards responsible practices as a result of growing community environmental and social concerns, changing regulations, and increasing pressure from stakeholders. Initiatives such as the International Council on Mining and Metals (ICMM) and the United Nations Sustainable Development Goals (SDGs) provide platforms for dialogue and cooperation on sustainable mining issues. Emerging trends in precision and low impact mining include collaboration and knowledge exchange among mining nations to share best practices, and development of innovative technologies to address common challenges.

While Western Australia is a major contributor to Australia's mining industry, and plays a crucial role in its economy, generating employment, export revenue, and economic growth, there remains opportunities for the state to position itself as a global leader in responsible mining regulation, practices and innovation.

MRIWA encourages and supports precision and low impact mining research which advances technologies, provides clean energy solutions and responsible practices to optimise resource extraction and management, minimise environmental disruption and uphold social values.



Alternative Use of Tailings and Waste

The Challenge

Byproducts generated in the extraction and processing of minerals represent one of the largest bulk waste streams globally, and the safe storage and handling of this material imposes a large and increasing cost on the mining industry. Continued growth of the WA mining sector requires industry practice to be redefined to reduce both the volume of waste created by mining, and the impact of waste materials on the environment and communities where mining takes place.

The Context

The volume of waste rock and tailings produced by the WA mining sector is expected to double by 2035, as the transition to renewable energy drives increased demand for critical minerals and other key resources.

The handling and storage of these waste materials impose significant and growing direct costs on the mining industry and lock up further potential resource value – with existing tailings facilities known to contain a range of metal content – including critical raw materials – that could represent a valuable secondary resource with appropriate reprocessing technology⁵.

Finding ways to reduce the volume of waste created by mining and extract this value from waste streams could help on both sides of the ledger – reducing the environmental impact of mining and mineral processing, and creating additional business value and social opportunities for Western Australia.

Extraction of valuable components from mining residue could also enable further upcycling of bulk mine waste into high-value products amenable for use in the construction and ceramic industries, or downcycling for backfilling, road construction and to support carbon capture through mineral carbonation.

⁵ Kinnunen et al., 2022 - <https://doi.org/10.1016/j.clet.2022.100499>

Mineral Carbonation

The Challenge

Increasing the rate of direct air capture and the rate of reaction via mineral carbonation to enable cost effective rapid, large-scale carbon dioxide (CO₂) sequestration.

The widespread, industrial-scale utilisation of mineral carbonation has enormous potential to sequester CO₂ emissions but is inhibited by technological and economic challenges.

The Context

The goal of the 2015 Paris Agreement is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal will require not only global peaking of greenhouse gas emissions as soon as possible but will also require the removal of CO₂ from the atmosphere.

Mineral carbonation, one form of carbon capture, use and storage (CCUS), has the potential to be a versatile approach to both remove and permanently store carbon dioxide at the gigatonne scale while also providing strategic economic advantage to quickly transition Western Australia to a low carbon economy supporting global low carbon supply chains.

The best types of materials for mineral carbonation are those rich in the metals calcium, magnesium and iron. Mafic and ultramafic rocks found within Western Australia's prolific greenstone belts are particularly rich in magnesium and calcium-rich minerals, hence are particularly prospective for mineral carbonation.

Mineral carbonation combined with direct air capture provides added opportunity for Western Australia.



Mining Equipment and Technology Services

The Challenge

Research is only impactful if effectively translated into innovations that can diffuse into the marketplace and be adopted by users. Internal analysis undertaken by MRIWA has shown limited direct evidence of uptake of MRIWA-funded research outputs by industry sponsor companies.

With Knowledge Transfer a key pillar in the MRIWA strategic plan, ongoing consideration is given to how minerals research outcomes can be promoted for adoption and implementation.

The Context

MRIWA recognises the role the Mining Equipment, Technology and Services (METS) sector plays in the mining innovation lifecycle by translating new knowledge created through research into solutions which can benefit Western Australia.

The MRIWA METS Innovation Program is intended to assist Western Australian based METS companies develop products and services which address issues in one or more of the Focus Areas.

The METS Innovation Program consists of a grant scheme and project facilitation to assist in connecting with potential collaborators and sponsors, as well as navigating the innovation ecosystem and other available forms of support.



Our Research

The Minerals Research Institute of Western Australia (MRIWA) is focused on the research and development needs of the Western Australian minerals industry to ensure it remains an engine of responsible economic growth and social benefit for Western Australia.

The MRIWA Research Priority Plan⁶ identifies the areas where MRIWA may make investment into high-impact research and development. Priorities included in the Plan reflect those issues which industry, the research sector and the MRIWA Board agree present real and significant challenges inhibiting Western Australians from fully benefiting from the minerals sector; and where resolution of these challenges will create opportunities and deliver value.

The revised Research Priority Plan was released in February 2020 and describes the medium to long term knowledge and technology needs of the State's minerals industry.

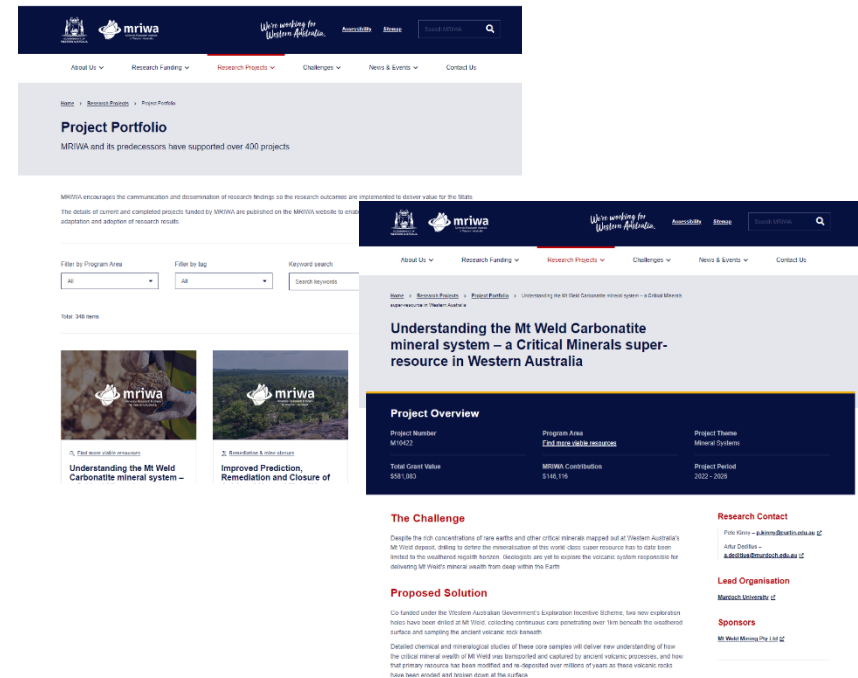
Those seeking to work with MRIWA on our **Impactful Research** program need to demonstrate alignment with the priorities outlined in the Plan, and establish how their proposals would deliver economic, social or environmental benefit for Western Australia.

The priorities fall across six broad areas of research (Program areas). The Program areas incorporate priorities specific to parts of the mining value chain, and broader themes applicable across the value chain, with an integrated approach required to achieve the intended outcomes outlined in the Plan.

⁶ See page Pr - 9 for MRIWA's Research Priority Plan Program Summary.

MRIWA Project Portfolio

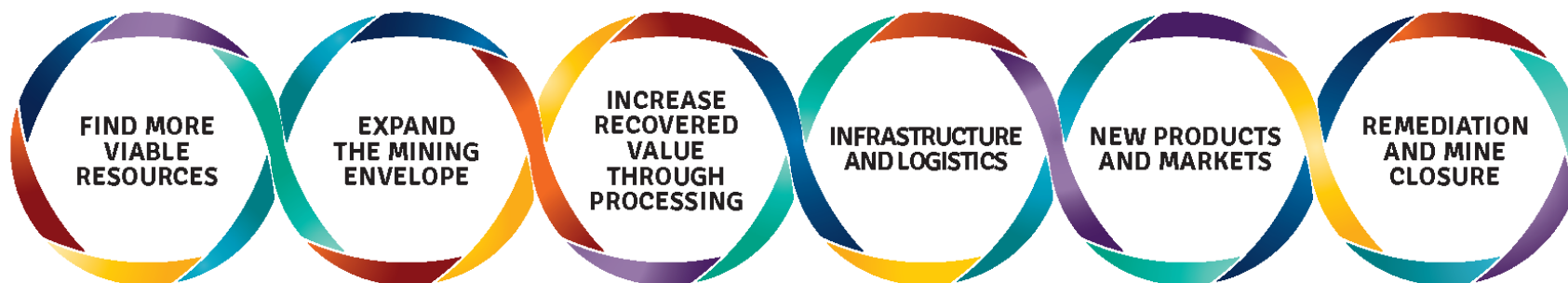
The MRIWA [website](#) features current and completed MRIWA-funded research projects, the challenges they are seeking to address and the intended benefits the projects will deliver to Western Australia.



Research Priority Plan Summary



Research Portfolio Summary 2023-2024



No. Projects	19	5	13	3	19	5
MRIWA Contribution⁷	\$5.6M	\$598K	\$3.2M	\$800K	\$4.8M	\$414K
Third-Party Contribution	\$16.3M	\$1.2M	\$9.2M	\$2.5M	\$26.2M	\$5M
Total Grant Value	\$21.9M	\$1.8M	\$12.4M	\$3.3M	\$31M	\$5.4M

*Note: Due to rounding, some totals may not correspond with the sum of the separate figures
Does not include scholarships*

⁷ Includes the contribution from Department of Jobs Tourism Science and Innovation for the FBI CRC (\$500,000) and HILT CRC (\$1 million)



CRC/Research Centre Participation



The Cooperative Research Centre for Transformations in Mining Economies (CRC TiME) brings together mining companies, regulators and community participants to deliver coordinated investment into research addressing the challenges underpinning mine closure and relinquishment.

CRC TiME's research mission is structured around four program areas targeting those aspects of the transition from mining to post-mine scenarios to which Australia's economic, environmental and social resilience is most vulnerable.

Over its lifetime, this research centre is intended to deliver practical outcomes empowering and supporting transformational and world-leading change in the Australian mine closure sector.

In 2023-24, seven CRC TiME projects were supported by allocation of MRIWA funds. One of these projects was also completed in 2023-24.



ARC Industrial Transformation Training Centre (ITTC) in Transforming Maintenance through Data Science.

This ITTC was established to support the development and implementation of techniques to deliver transformational value in mining industry maintenance through application of innovative Data Science technology, and to support the training of a data-science-savvy future workforce.

MRIWA is supporting the development and research training of two PhD students working within the ITTC.

The centre is winding down as its student cohort completes its activities over 2024 with final reporting due later in 2024.

	Commenced operation:	2020
	Funding duration:	10 years
	Participants:	74 participants including leading mining and METS companies, regional development organisations, government and research partners
	Total Project Value:	\$130M comprised of \$29.5M cash from the CRC Program \$30.5M cash from industry and research participants \$70M in-kind support
	MRIWA contribution: (M0558)	\$300,000 over 10 years Additional \$480,000 in project funding

	Commenced operation:	2019
	Funding duration:	5 years
	Participants:	Partners from mining companies and research organisations
	Total Project Value:	\$9.10M comprised of \$3.95M cash from the ARC ITTC program \$3.05M industry cash contributions \$1.88M university cash contributions
	MRIWA contribution: (M0508)	\$240,000 over 5 years





MinEx CRC is delivering coordinated investment in research to develop more productive, safer and more environmentally friendly drilling technologies and workflows to

improve the success rate and efficiency of discovering and defining mineral deposits.

Key deliveries from the MinEx CRC will include development of a new style of mineral exploration drilling rig incorporating revolutionary coiled tubing drilling technology, and a suite of new and innovative technologies for collecting data while drilling.

MinEx CRC is intended to operate for three contract phases. Phase 1 of the MinEx research program was completed at the end of December 2021, with phase 2 commencing in January 2022 and due to run until the end of December 2024.

Three phase 2 projects were supported by allocation of MRIWA funds in 2023-24.











HILT CRC will enable our heavy industry sector to compete in the low-carbon global economy for carbon-neutral materials such as 'green' iron, alumina, cement and other processed minerals. The Australian Heavy Industries sector will benefit

substantially from a carefully considered mix of electrification and hydrogen-based fuels.

HILT CRC has continued with the delivery of the research strategy outlined in 2022. The 16 quickstart projects have been completed and have then resulted in 13 stage 2 projects being approved in 2023 and 2024. There are another 7 new projects under evaluation or awaiting execution in 2024.

MRIWA has approved 5 projects for in-kind and allocated funding support including Beneficiation of iron ores, Hydrometallurgical treatment of iron ores using brines stage 1 and stage 2, green steel market evaluation and China green steel outlook study.

	Commenced operation:	2018
	Funding duration:	10 years
	Participants:	Over 40 partners from mining and METS companies, government, and research organisations
	Total Project Value:	\$219M comprised of \$50M cash from the CRC Program \$42M cash industry and research participants \$52M non-staff in-kind \$74M staff in-kind
	MRIWA contribution: (M0509)	\$1M over 10 years Additional \$560,000 in direct project funding

	Commenced operation:	2021
	Funding duration:	10 years
	Participants:	Partners from mining and METS companies, government, and research organisations
	Total Project Value:	\$176M comprised of \$39M cash from Dept Industry, Science & Technology \$34M cash from the CRC Program \$43M cash industry and research participants \$29M non-staff in-kind \$31M staff in-kind
	MRIWA contribution: (M10425)	\$1M over 10 years ⁸ Additional \$500,000 in direct project funding

⁸ Funding provided in full by the Department of Jobs, Tourism, Science and Innovation and managed by MRIWA.










The Future Battery Industries Cooperative Research Centre (FBI CRC) is enabling the growth of battery industries to power Australia's future and ensure Australia plays a leading role in the global battery revolution.

The FBI CRC brings together organisations covering the full extent of the battery value chain, including mining, extraction, processing, and refining of battery minerals, metals and materials, as well as downstream uses such as precursor chemical manufacture, battery cell manufacture, battery recycling and battery deployment in defence, electrical utilities, mining, and other mobile and stationary applications.

At the end of 2023-24 MRIWA was actively involved in 9 FBI CRC projects with these projects all expected to be completed within the budget framework ending 2025.

	Commenced operation:	2019
	Funding duration:	6 years
	Participants:	73 participants from mining and METS companies, government, and research partners
	Total Project Value:	\$129.1M comprised of \$25M cash from the CRC Program \$38.6M cash from industry and research participants \$32M non-staff in-kind \$33.5M staff in-kind
	MRIWA contribution: (M0533)	\$6M over 6 years (including \$500,000 contributed by Department of Jobs, Tourism, Science and Innovation)



Future Battery Industries Cooperative Research Centre (FBI CRC)



Our Research

PROGRAM 1: Find More Viable Resources

Western Australia's known mineral deposits in the key domain close enough to the surface for their extraction to be economically viable are being developed faster than they are replenished by new discoveries.

To meet the challenge of finding significant new discoveries and building on the focus of UNCOVER Australia and the Western Australian Government's Exploration Incentive Scheme, research supported under Program 1 is intended to systematically advance knowledge and capability in mineral system understanding, exploration technology and prediction to improve mineral exploration productivity.

In doing so, this research will inform the pre-competitive geological, geochemical and geophysical knowledge base and create exploration capability to:

- position Western Australia as a global leader in exploration technology
- facilitate private sector investment in existing and newly-identified Western Australian mineral provinces to develop the State's rich natural resources

Themes

- Mineral Systems
- Detection Technology
- Data Driven Decisions
- Regulatory Tools and Processes
- Safety, Social and Environmental Sustainability
- Workforce of the Future

\$5.6M

MRIWA contribution

\$21.9M

Total value of research projects

6

Projects completed

3

CRC/Research Centre projects

16

Standalone research projects



Project Case Studies

Field-based XRF for prompt Au analysis

Program 1 – Find More Viable Resources

STATUS: Final Report Published⁹

Project No: M0543

THE CHALLENGE

Sample analysis for mining companies previously involved turn-around periods ranging from a few days to many weeks, due to a need to send samples away to laboratories for assay. This results in inefficient exploration practices and higher costs, especially when exploring in remote areas.

KEY FINDINGS

A revolutionary in-field assay method for gold, detectORE™, has been developed and is now commercially available for most exploration purposes. Field trials of this new 'reactive sampling™' technique demonstrated detectORE™ results from one day's sampling activities can direct the next day's sampling activity, with gold able to be measured in as little as 6 hours in concentrations as low as 10 parts per billion. The method is non-hazardous, robust, reliable, simple, compact, environmentally-benign, cost-effective and easily transported to sites around the world.

BENEFIT TO WA

Technology development achieved through this project and through the formation of a new WA-based METS company:

- Puts WA at the forefront of an exciting new gold technology
- Accelerates gold analysis and exploration in the field
- Reduces exploration costs through faster turnaround
- Improves exploration efficiencies increasing the potential for future gold discoveries
- Encourages more investment in gold exploration in WA particularly in remote areas

Sponsors

Barrick Gold Corporation
Bellevue Gold Mines Ltd
Centerra Madencilik A.Ş.
Fosterville Gold Mine Pty Ltd
Gold Fields St Ives Gold Mining Company Pty Ltd
Gold Road Resources Ltd
Newcrest Mining Limited
Perseus Mining
Portable PPB Pty Ltd

Lead Organisation

Portable PPB Pty Ltd

Research Contact

Simon Bolster

Total Grant Value

\$952,518

MRIWA Contribution

\$218,000



Pictured (L-R) MRIWA Chairperson Miriam Stanborough, Managing Director Portable PPB Pty Ltd Simon Bolster, the Hon. David Michael MLA, Minister for Mines and Petroleum; Ports; Road Safety; Minister Assisting the Minister for Transport at the Portable PPB Pty Ltd site 20 December 2023.

⁹ <https://www.mriwa.wa.gov.au/research-projects/project-portfolio/field-based-xrf-for-prompt-au-analysis/>



Current Projects/ Contracts Executed

Program 1 – Find More Viable Resources

Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0462a	Detection technology	(Was M556) The paradigm shift for minerals exploration using ultrafine soils and intelligent data integration tools - Extension to M462	Commonwealth Scientific Industrial Research Organisation (CSIRO) Dr Ryan Noble	Anax Metals Limited Condamine Resources De Grey Mining Department of Energy, Mines, Industry Regulation and Safety (GSWA) Dreadnought Resources Emmerson Resources Limited Fortescue Metals Group Ltd Geological Survey of New South Wales Geological Survey of Queensland Geological Survey of South Australia Greenmount Resources Pty Ltd Hexagon Energy Materials Limited IGO Limited Kairos Minerals Kalamazoo Resources Lodestar Minerals Limited MCA Nominees Mining Investments Australia Monger Gold Ltd New Age Exploration Limited Newmont Goldcorp Tanami Pty Ltd Northern Star Resources Limited Northern Territory Geological Survey Ozz Resources Limited Strategic Energy Resources Limited Tojo Minerals Western Gold Resources Limited	3	1,238,249	117,000



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0470a	Mineral systems	(WAS M555) A multi-scale approach to controls on mineralisation in the Fraser Zone, Western Australia	Curtin University Katy Evans	Curtin University Department of Energy, Mines, Industry Regulation and Safety - Geological Survey of Western Australia IGO Limited Legend Mining Limited MG Creasy	3.67	1,023,300	341,300
M0521	Mineral systems	Lithospheric and crustal-scale controls on multi-stage basin evolution: Impacts on Mineralising System	University of Western Australia (CET - Centre for Exploration Targeting) Weronika Gorczyk	Department of Energy, Mines, Industry Regulation and Safety (GSWA) First Quantum Minerals Exploration (Australia) Pty First Quantum Minerals Ltd Fortescue University of Western Australia (CET - Centre for Exploration Targeting)	4	1,493,737	733,737
M0530	Mineral systems	Yilgarn 2020	University of Western Australia (CET - Centre for Exploration Targeting) Nicolas Thebaud	BHP Nickel West Pty Ltd Bogada Gold Pty Ltd Evolution Mining Limited Gold Fields Australia Pty Ltd Gold Road Resources Ltd Newmont Mining Services Pty Ltd Northern Star Resources Limited Saracen Mineral Holdings Limited	4.58	2,346,000	796,000
M0551	Mineral systems	Integrated 3G - Geochronology-geochemistry-grain shape: a new toolkit for mineral sands understanding	Curtin University Milo Barham	Curtin University Iluka Resources	4	979,000	345,000



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0554	Mineral systems	Evolution of Proterozoic multistage rift basins – key to mineral systems - ARC Linkage proposal linked to M521	University of Western Australia Mark Jessell	Anglo American Exploration (Australia) Anglo American PLC Australian Research Council BHP Group Operations Pty Ltd IGO Limited Monash University Teck Australia Ptd Ltd	4	2,041,040	540,837
M0557	Mineral systems	Orebody knowledge, landscape history and mineralisation of Martite–Goethite Ores in the Hamersley Province (WA)	Commonwealth Scientific Industrial Research Organisation (CSIRO) Erick Ramanaidou	BHP Billiton Iron Ore Pty Ltd Bureau Veritas Minerals Pty Ltd Commonwealth Scientific Industrial Research Organisation (CSIRO) FMG Resources Pty Ltd Rio Tinto Pilbara Iron Company (Services) Pty Ltd Roy Hill Iron Ore Pty Ltd	2	1,552,000	388,000
M10412	Mineral systems	Primary and secondary high-grade gold mineralisation processes in orogenic systems: key to a sustainable mining?	University of Western Australia (CET - Centre for Exploration Targeting) Nicolas Thebaud	Australian Research Council Fosterville Gold Mine Pty Ltd Karora Resources Pty Ltd Monash University Newmont Australia Pty Ltd Northern Star Resources Limited University of Western Australia (CET - Centre for Exploration Targeting)	3	1,942,114	450,417
M10422	Mineral systems	Understanding the Mt Weld Carbonatite mineral system - a Critical Minerals super-resource in Western Australia	Murdoch University Artur Deditius	Curtin University Murdoch University Lynas Corporation Ltd	3.5	581,083	146,116



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M10426	Mineral systems	Indicator Minerals for Nickel Exploration	Commonwealth Scientific Industrial Research Organisation (CSIRO) Louise Schoneveld	Anglo American Technical & Sustainability Services Ltd Ardea Resources Limited Australian Vanadium Ltd BHP Pty Ltd Bryah Resources Estrella Resources IGO Limited St George Mining Limited Western Areas NL	2.17	1,489,677	354,914
M10433	Mineral systems	Distal footprints in the South West Terrane	Commonwealth Scientific Industrial Research Organisation (CSIRO) Ignacio Gonzalez-Alvarez	Anglo American Exploration (Australia) Department of Energy, Mines, Industry Regulation and Safety - Geological Survey of Western Australia Ramelius Resources Limited	3.17	1,233,000	308,000
M10444	Detection technology	Coiled Tubing Drilling for definition of Mineral Deposits - Phase 2: MinEx CRC Project	University of South Australia Soren Soe	Anglo American Services (UK) Ltd Anglo American Technical & Sustainability Services Ltd BHP Billiton Iron Ore Pty Ltd Department of Regional New South Wales Epiroc LKAB Wassara MinEx CRC South32 Ltd	3	2,833,505	207,561 ¹⁰
M10445	Detection technology	Petrophysics for Mineral Discovery during Drilling - Phase 2: MinEx CRC Project	Curtin University Brett Harris	Imdex Limited MinEx CRC Rio Tinto Technological Resources Pty Ltd South32	3	816,000	123,000 ¹¹

¹⁰ MRIWA support for M10444 consists of \$121,000 drawn down from MRIWA's commitment to the MinEx CRC, and an additional \$86,561 cash contribution.

¹¹ MRIWA contributions are drawn down from MRIWA's commitment to the MinEx CRC.



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M10446	Detection technology	Seismic in the Drilling Workflow - Phase 2: MinEx CRC Project	Curtin University Konstantin Tertyshnikov	Anglo American Exploration (Australia) Pty Ltd BHP Pty Ltd MinEx CRC Rio Tinto Technological Resources Pty Ltd Sercel	3	940,000	123,000 ⁹
M10472	Regulatory tools and processes	Amplification of Exploration Education and Research Collaboration	CRU International (Australia) Pty Ltd Allan Trench		0.5	306,758	306,758
M10500	Mineral systems	Characterisation of clay-hosted rare-earth element deposits in Australia	RSC Global Pty Ltd Nishka Piechocka	Auric Mining Dreadnought Resources Golden Mile Resources Heavy Rare Earths Ltd Mt Ridley Mines NickelSearch Ltd Terrain Minerals Voltaic Strategic Resources	1	202,500	67,500
M10502	Mineral systems	CuBAS - Structural and sedimentological reconstruction and fluid flow simulations for copper exploration in the Yeneena Basin – Paterson Orogen, WA	Commonwealth Scientific Industrial Research Organisation (CSIRO) Susanne Schmid	BHP Metals Exploration Pty Ltd Department of Energy, Mines, Industry Regulation and Safety (GSWA)	2	600,000	150,000
M10513	Data driven decisions	A Value Case for Exploration Research: Establishing the ASX Market Value of Minerals Research in the Exploration Sector	University of Western Australia Sistine Sun		0.6	20,000	20,000 ¹²

¹² Co-operative Education for Enterprise Development project fully funded by MRIWA.



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M10525	Data driven decisions	ChatGeo: Forging Trust in Spatial Semantic Document and Knowledge Retrieval	University of Western Australia Eun-Jung Holden	Department for Energy and Mining (SA) Department of Energy, Mines, Industry Regulation and Safety (GSWA)	2	300,401	100,401



PROGRAM 2: Expand the Mining Envelope

A significant proportion of the future Western Australian resource base is likely to reside in deep and complex geotechnical environments. Additionally, most major open-cut and underground operations are known to have extensions to their mineralisation, albeit at possibly lower grade. Mining methods need to adapt to allow continued economic and safe extraction of resources.

The research priority areas in Program 2 are intended to systematically advance knowledge and capability toward solutions for mining more ore from challenging deposits.

In doing so, the research will create engineering capability and demonstrate the technical feasibility of mining more selectively and deeper to:

- position Western Australia as a global leader in extraction technologies
- decrease the capital and operating costs associated with mining
- allow for safer and increased productivity from existing mines and for a new generation of deposits to be brought into production

Themes

- Deep and complex extraction systems
- Engineering in highly stressed and complex rock masses
- Mining technology
- Data driven decisions
- Energy utilisation
- Regulatory tools and processes
- Safety, social and environmental sustainability
- Workforce of the future

\$598K

MRIWA contribution

\$1.8M

Total value of research projects

3

Projects completed

5

Standalone research projects



Project Case Studies

Establishing the in situ rock bolt behaviour underground in order to model and design improved rock bolt support systems

Program 2 – Expand The Mining Envelope

STATUS: Final Report Published¹³

Project No: M0499

THE CHALLENGE

Rock bolts are subjected to complex loading conditions in underground mines with axial, shear and combined loads (axial and shear). Establishing the behaviour of in-situ rock bolts by testing and monitoring with fibre optic sensors to develop improved models and design of rock bolt support systems.

KEY FINDINGS

- Under combined load conditions: 80% of the rock bolt axial load capacity should be assumed for the rock bolt design.
- However, in situations with large shear, this is further reduced to only 50%. For both conditions, if the displacement percentage is higher than 80% then the rock bolt selection should be reconsidered (i.e. low-stiffness bar).
- FLAC3D pile elements underestimate shear deformation in the case of localised high shear stress as found in a rock bolt installed across a joint. The modified pile model can simulate the correct shear response of rock bolt and combined axial and shear load failure of the rock bolt at joints and discontinuities.
- Optical instrumented rock bolts provide a very high-resolution strain profile of the rock bolt installed in-situ.

BENEFIT TO WA

Continuous improvement in the design of rock bolts and associated support system may lead to improved safety outcomes in underground mining operations in Western Australia. A new and improved instrumented rock bolt was designed for underground testing and software development which enables strain values to be monitored.

Sponsors

Mining 3
Curtin University
Peabody Australia

Lead Organisation

Mining 3

Research Contact

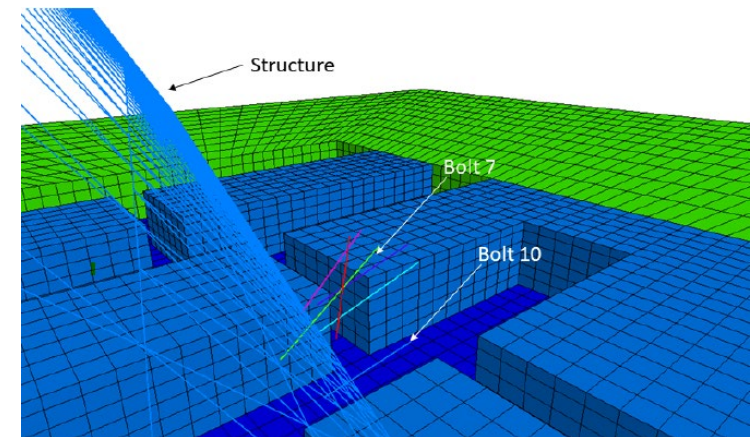
Ewan Sellers

Total Grant Value

\$1,270,000

MRIWA Contribution

\$400,000



Content: Model showing the instrumented rock bolts and the structure

¹³ <https://www.mriwa.wa.gov.au/research-projects/project-portfolio/establishing-the-in-situ-rock-bolt-behaviour-underground-in-order-to-model-and-design-improved-rock-bolt-support-systems/>



Physics Models for Ore Tracking in Surface Mines

Program 2 – Expand The Mining Envelope

STATUS: Final Report Published¹⁴

Project No: M0522

THE CHALLENGE

Undertaking material tracking in parts of the mining value chain where physical processes change the bulk shape and mixing of large scale material units, obscuring the original grade distribution. Existing tracking technologies require regular intervention, unsafe work practices and only provide data when sensors pass loggers.

KEY FINDINGS

Rapid, real time approaches to material mixing across the mining value chain were developed using algorithms and codes to predict the mixing in the stages of blasting, dozer push, stockpile stacking and depletion. Accurate GPS and dozer data are essential to validate the approach and identify how the material mixes during the transfer processes.

BENEFIT TO WA

Implementation of this software into mine systems will enable operations to plan blend strategies to improve the quality and efficiency of product delivery. Being able to process an expected blend at the correct time will reduce costs, energy and carbon footprint. Reduction of waste sent to the plant will improve throughput providing increased profitability to mining operations.

Sponsors

Fortescue Metals Group Ltd
South32

Lead Organisation

Mining 3

Research Contact

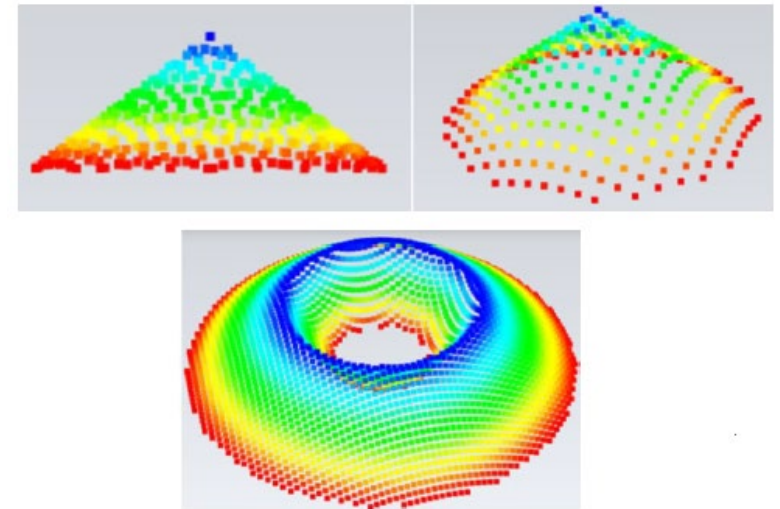
Ewan Sellers

Total Grant Value

\$760,000

MRIWA Contribution

\$380,000



Example of the outer layer of a conical stack a) side view and b) 3D view from below. Colour shading indicates the height, and c) example of a tunnel reclaim in a conical stockpile

¹⁴ <https://www.mriwa.wa.gov.au/research-projects/project-portfolio/physics-models-for-ore-tracking-in-surface-mines/>



Current Projects/ Contracts Executed

Program 2 – Expand the Mining Envelope

Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0510	Mining technology	Safe, sustainable management of filtered tailings	University of Western Australia Andy Fourie	Alcoa of Australia Ltd Alumina Quality Workshop Inc International Aluminium Institute Rio Tinto Technological Resources Pty Ltd BHP Group Operations Pty Ltd	3	482,500	142,000
M0529	Deep and complex extraction systems	Lixiviant access creation in impermeable hard rock mass for the in-situ underground leaching of metals from ore	Murdoch University Aleks Nikoloski	CMTE Development Ltd T/A Mining3 Murdoch University	5.6	120,000	30,000
M0544	Deep and complex extraction systems	Towards a mechanistic understanding of electrokinetic in-situ leaching	University of Western Australia Andy Fourie	BHP Pty Ltd Evolution Mining Limited Newcrest Mining Limited Newmont Goldcorp Services Pty Ltd	6	842,605	290,605
M0545	Deep and complex extraction systems	Evaluation of in-situ barrier technology for risk mitigation and extraction optimisation for in-situ recovery operations	Curtin University Navdeep Dhami	BHP Pty Ltd CMTE Development Ltd T/A Mining3 Newcrest Mining Limited Orano Mining	5.1	225,000	75,000
M10430	Data driven decisions	Sustainable Optimisation of Mining Complexes through Innovative Algorithms	Curtin University Waqar Asad	Norton Gold Fields Ltd	3.5	165,000	60,000



PROGRAM 3: Increase Recovered Value Through Processing

More complex and lower-grade orebodies, combined with higher energy costs and the need for a lower environmental footprint, are driving development of advanced methods of processing to transform low value deposits to be economic.

The research priority areas in Program 3 are intended to systematically advance knowledge and capability toward solutions for increasing yield and throughput and optimising the use of raw materials by breaking down operational silos.

In doing so, the research will create mineral processing capability and accelerate the development, testing, piloting, scale-up and other technical de-risking activities associated with new processing technologies to:

- position Western Australia as a global leader in mineral processing
- decrease the capital and operating costs associated with mineral processing
- allow for safer and increased productivity from processes and for a new generation of processing technologies to be deployed

Themes

- Processing Technology
- Data driven decisions
- Energy utilisation
- Regulatory tools and processes
- Safety, social and environmental sustainability
- Workforce of the future
- Interoperability

\$3.2M

MRIWA contribution

\$12.4M

Total value of research projects

2

Projects completed

6

CRC/Research centre projects

7

Standalone research projects



Green Steel Value Chain Model Demonstration Upgrade

Program 3 – Increase Recovered Value Through Processing

STATUS: Final Report Published¹⁵

Project No: M10475

THE CHALLENGE

The iron ore industry is the State’s largest and most important industry, providing direct and indirect economic and social contributions which are greater than any other industry to the State. Its contribution is also significant to the national economy.

For this reason it is important to understand the future market dynamics of the steel industry to ensure forward planning and how to ensure the longevity of the iron ore industry in Western Australia.

KEY FINDINGS

A value chain model has been constructed to analyse opportunities and key obstacles to a formation of a Western Australian green steel industry. Its main goal is to understand the capital requirements, costs and emissions for expanding beyond business as usual iron ore mining and switching from fossil fuels to renewable energy sources.

The model created for the analysis in the Western Australia’s Green Steel Opportunity Report maps the value chain of steel production in ten distinct blocks representing separate stages of the production process.

Using the model, comparisons can be drawn between fossil fuel-driven processes and existing whole-value chain costs and emissions for steel.

BENEFIT TO WA

Technologies are emerging which can, and will, begin to reduce the energy and emissions intensity of steelmaking. Overtime there will be multiple pathways to achieve net zero emissions steelmaking.

Lead Organisation

GHD Digital

Total Grant Value

\$45,000

Research Contact

Abhishek Tammina

MRIWA Contribution

\$45,000



Green Steel Value Chain Model Demonstration Interface Upgrade

¹⁵ <https://www.mriwa.wa.gov.au/research-projects/project-portfolio/green-steel-value-chain-model-demonstration-upgrade/>



Current Projects/ Contracts Executed

Program 3 – Increase Recovered Value Through Processing

Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0508a	Data driven decisions	Unlocking Knowledge from Technical Texts using Deep Active Learning and Entity Typing	University of Western Australia Tyler Bikaun		3.5	120,000	120,000 ¹⁶
M0508b	Data driven decisions	Risk-based Inspection Intervals: A Practical Approach	Curtin University Gabriel Gonzalez		3.5	120,000	120,000 ¹⁴
M0519	Processing technology	Broadening the opportunity for in-situ recovery of value from mineral deposits	CMTE Development (trading as Mining3) Ewan Sellers	Barrick Gold Corporation CMTE Development Ltd T/As Mining3 Environmental Copper Recovery Pty Ltd Freeport Minerals Corporation Gold Fields St Ives Gold Mining Company Pty Ltd Hatch Heathgate Resources Pty Ltd Mining and Process Solutions Pty Ltd Newcrest Mining Limited Newmont USA Limited Solvay-Cytec Industries Inc. BHP Group Operations Pty Ltd	4.25	960,000	240,000

¹⁶ Projects are supported by funds drawn down from MRIWA's contribution to the Centre for Transforming Maintenance Through Data Science



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0533f	Processing technology	Hydrometallurgical processing for nickel and cobalt ores, concentrates, tailings, wastes - Stage 2 (FBI CRC)	Curtin University Elsayed Oraby	Ardea Resources Limited BASF Australia Ltd BHP Nickel West Pty Ltd Blackstone Minerals Limited Future Battery Industries CRC Ltd IGO Limited JordProxa Pty Ltd Lycopodium Pty Ltd Mineral Carbonation International Pty Ltd Mining and Process Solutions Pty Ltd Pure Battery Technologies Pty Ltd	3.5	3,607,080	562,500 ¹⁷
M0533v	Processing technology	Beneficiation and chemical processing of lithium minerals - Phase 2 (FBI CRC)	Murdoch University Aleks Nikoloski	Allkem Ltd BASF Australia Ltd Calix Limited Department of the Chief Minister and Cabinet (Northern Territory) EV Metals Group PLC Future Battery Industries CRC Ltd IGO Limited JordProxa Pty Ltd Lycopodium Pty Ltd	3.4	3,195,000	673,000 ¹⁵
M0537	Processing technology	The effect of water quality on rare earth minerals flotation	Curtin University Bogale Tadesse	Curtin University Lynas Corporation Ltd Mt Weld Mining Pty Ltd	4.2	210,500	70,000
M0541	Processing technology	Organic acid leach system for rare earth extraction technology development	Curtin University Laurence Dyer	Curtin University Department of Industry, Innovation and Science Lynas Corporation Ltd Mt Weld Mining Pty Ltd	5.1	345,160	115,000
M10473	Processing technology	Microwave Reactor for Critical Minerals	Northern Minerals Louis DeKlerk	Northern Minerals	0.67	625,000	125,000

¹⁷ MRIWA contributions are drawn down from MRIWA's commitment to the FBI CRC and include Department of Jobs Tourism Science and Innovation funds



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M10477	Safety, social and environmental sustainability	Advanced electrometallurgy for improved recovery of green metals	University of Sydney Alejandro Montoya	ECOX Australia PTY LTD	3	1,515,139	378,785
M10480	Processing technology	Flexible pilot plant for low emissions iron making prefeasibility study	Commonwealth Scientific Industrial Research Organisation (CSIRO) Adrien Guiraud		0.83	450,000	450,000
M10481	Processing technology	New Opportunities for the PGM Industry in WA	Acil Allen Pty Limited Ryan Buckland		0.58	292,678	292,678
M10497	Processing technology	Green pyromet/hydromet beneficiation pathways	University of Adelaide Alfonso Chinnici	Calix Limited Curtin University FMG Procurement Services Pty Ltd HILT CRC Limited Onesteel Manufacturing Pty Ltd Roy Hill Holdings Pty Ltd South32 Group Operations Pty Ltd The Australian National University University of Adelaide	1	504,350	20,000 ¹⁸
M10504	Processing technology	The upgrading of iron ore for DRI production using products from seawater	Curtin University Jacques Eksteen	Curtin University FMG Procurement Services Pty Ltd HILT CRC Limited Roy Hill Holdings Pty Ltd University of Adelaide	1	455,000	20,000 ¹⁶

¹⁸ MRIWA contributions are drawn down from MRIWA's commitment to the HILT CRC and include Department of Jobs Tourism Science and Innovation (JTSI) funds.



PROGRAM 4: Infrastructure and Logistics

Western Australia's export-oriented mining projects place heavy demands on regional infrastructure, requiring long term planning and a high level of capital investment by both government and industry. As the sector moves to adopt automated technologies, greater demand will be placed on network bandwidths.

The research priority areas in Program 4 are intended to systematically advance knowledge and capability to:

- optimise supply chain infrastructure usage, haulage and export logistics
- enable enhanced networks and accurate geo-positioning
- decrease the capital and operating costs associated with getting commodities to market

Themes

- Communications and Positioning Technology
- Data Driven Decisions
- Energy Utilisation
- Safety, Social and Environmental Sustainability

\$800K

MRIWA contribution

\$3.3M

Total project value

3

CRC/Research centre projects



Current Projects/ Contracts Executed

Program 4 – Infrastructure and Logistics

Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0533u	Data driven decisions	Assessment, design and operation of battery-supported electric mining vehicles and machinery (FBI CRC Project)	University of Adelaide Ali Pourmousavi Kani	BHP Nickel West Pty Ltd Department for Energy and Mining (SA) Department of Energy and Public Works (Qld) Energetics Pty Ltd Future Battery Industries CRC Ltd IGO Limited Multicom Resources Limited Allkem Limited	3.5	1,160,000	300,000 ¹⁹
M10443	Energy utilisation	Stationary Mine Electrification (FBI CRC Project)	University of Western Australia Tyrone Fernando	Energetics Pty Ltd Future Battery Industries CRC Ltd Lycopodium Pty Ltd Magellan Powertronics Pty Ltd Ultra Power Systems Pty Ltd	2.5	1,112,000	300,000 ¹⁷
M10451	Energy utilisation	Development of Vanadium Electrolytes (FBI CRC Project N)	Murdoch University Aleks Nikoloski	Department of Energy and Public Works Department of the Chief Minister and Cabinet (Northern Territory) Future Battery Industries CRC Ltd King River Resources Limited Lycopodium Pty Ltd Lynas Corporation Technology Metals Australia Limited Ultra Power Systems Pty Ltd	3	1,073,000	200,000 ¹⁷

¹⁹ MRIWA contributions are drawn down from MRIWA's commitment to the FBI CRC and include Department of Jobs Tourism Science and Innovation (JTSI) funds



PROGRAM 5: New Products and Markets

Rapid adoption of new high-tech products and manufacturing processes is changing the demand for high-value, low-volume minerals and creating opportunities for the re-use and recycling of by-products and waste.

Increasing emphasis is being placed on those critical minerals which are subject to high risks of supply but represent irreplaceable inputs for important technological and industrial innovations, especially renewable energy systems, electric vehicles, rechargeable batteries, consumer electronics, telecommunications, specialty alloys, and defence technologies.

Given Western Australia is well-positioned with significant reserves of a broad variety of minerals now required globally, the research priority areas in Program 5 are intended to systematically advance knowledge and capability which will:

- create new industries
- result in increased demand for one or more minerals found in this State
- develop and demonstrate ethical and sustainable production of minerals, metals and chemicals
- create premium products which can be marketed and sold to new generations of customers

In doing so, the research will create new niche markets for minerals and position Western Australia as a global supplier of critical minerals while also creating opportunities for progressive downstream processing activity in the State.

Themes

- Strategic Foresight
- Downstream Processing Technology
- Data Driven Decisions
- Energy Utilisation
- Regulatory Tools and Processes
- Safety, Social and Environmental Sustainability
- Workforce of the future

\$4.8M

MRIWA contribution

\$31M

Total project value

10

CRC/Research centre projects

9

Standalone research projects



Current Projects/ Contracts Executed

Program 5 – New Products and Markets

Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0533d	Downstream processing technology	Process Legacy - Stage 2 (FBI CRC Project)	Curtin University Arie van Riessen	Anax Metals Limited Australasian Pozzolan Association ChemCentre Department of the Chief Minister and Cabinet (Northern Territory) EV Metals Group PLC Future Battery Industries CRC Ltd FYI Resources Limited IGO Limited	3.5	2,957,386	589,500 ²⁰
M0533h	Downstream processing technology	Cathode Precursor Production Pilot Plant - Stage 2 (FBI CRC Project)	Curtin University Alireza Rabieh	Alpha HPA Limited Ardea Resources Limited BASF Australia Ltd BHP Nickel West Pty Ltd Blackstone Minerals Limited Calix Limited ChemX Materials Ltd Cobalt Blue Holdings Limited EV Metals Group PLC Future Battery Industries CRC Ltd IGO Limited JordProxa Pty Ltd King River Resources Limited Lycopodium Pty Ltd Mn Energy Limited Pure Battery Technologies Pty Ltd	3	5,916,300	879,750 ¹⁸

²⁰ MRIWA contributions are drawn down from MRIWA's commitment to the FBI CRC and include Department of Jobs Tourism Science and Innovation (JTSI) funds.



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0533j	Data driven decisions	Establishment of the National Battery Testing Centre (FBI CRC Project)	Queensland University of Technology Joshua Watts	Australian Vanadium Ltd BASF Corporation USA BHP Nickel West Pty Ltd Calix Limited Defence Science and Technology Department of the Chief Minister and Cabinet (Northern Territory) ESS Asia Pacific Pty Ltd Future Battery Industries CRC Ltd Lava Blue Ltd Magellan Powertronics Pty Ltd Multicom Resources Limited Sunrise Energy Metals Limited Syrah Resources Ltd Ultra Power Systems Pty Ltd	4	7,145,342	200,000 ²¹
M0533k	Downstream processing technology	Super Anode (FBI CRC Project)	University of Melbourne Amanda Ellis	AnteoTech Ltd Calix Limited EcoGraf Limited Future Battery Industries CRC Ltd Koppers Carbon Minerals and Chemicals Pty Ltd Syrah Resources Ltd Talga Group Ltd	4	4,200,000	200,000 ¹⁹

²¹ MRIWA contributions are drawn down from MRIWA's commitment to the FBI CRC and include Department of Jobs Tourism Science and Innovation (JTISI) funds.



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0533m	Data driven decisions	Electrochemical Testing of Li-ion Battery Materials in Standard Cell Formats (FBI CRC Project)	Queensland University of Technology Michael Horn	Alpha HPA Limited Ardea Resources Limited BASF Australia Ltd BHP Nickel West Pty Ltd Calix Limited ChemX Materials Ltd Cobalt Blue Holdings Limited EV Metals Group PLC Future Battery Industries CRC Ltd FYI Resources Limited IGO Limited Koppers Carbon Minerals and Chemicals Pty Ltd Lava Blue Ltd Pure Battery Technologies Pty Ltd Sicona Battery Technologies Pty Ltd Sunrise Energy Metals Limited Talga Group Ltd	4	4,210,396	500,000 ²²
M0533q	Data driven decisions	Development of a trusted supply chain for Australian battery minerals and products (FBI CRC Project)	Curtin University Prokopi Vasilyev	Ardea Resources Limited Australasian Pozzolan Association BASF Australia Ltd EV Metals Group PLC Everledger Australia Pty Ltd Future Battery Industries CRC Ltd Source Certain International Pty Ltd	3	2,400,000	500,000 ²⁰

²² MRIWA contributions are drawn down from MRIWA's commitment to the FBI CRC and include Department of Jobs Tourism Science and Innovation (JTSI) funds.



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0533r	Data driven decisions	Battery Materials for a Circular Economy (FBI CRC Project)	University of Technology Sydney Damien Giurco	Ardea Resources Limited Australasian Pozzolan Association BASF Australia Ltd BHP Nickel West Pty Ltd Energetics Pty Ltd Future Battery Industries CRC Ltd IGO Limited Multicom Resources Limited Galaxy Resources Limited - now Allkem Limited	4.5	1,688,550	400,000 ²³
M10462	Strategic foresight	Roadmap to Decarbonise WA Through Integrated Mineral Carbonation	Curtin University Michael Hitch		0.58	250,000	250,000
M10469	Safety, social and environmental sustainability	Use of Industrial Tailings as Alternative to Virgin Sands	ChemCentre John Moursoundis	Albemarle Covalent Lithium Mineral Resources Limited Sustainability Waste Alliance (SWA) Northern Minerals	1.6	319,165	79,788
M10482	Safety, social and environmental sustainability	Circular Economy Assessment and Strategy	GHD Pty Ltd Huia Adkins		0.5	150,845	150,845
M10488	Safety, social and environmental sustainability	Alternative Use of Tailings and Waste - Stakeholder Engagement Workshops	Curtin University Fran Ackerman		0.92	26,000	26,000
M10505	Strategic foresight	Intermediate product exports for Australia-China green steel (HILT CRC Project)	The Australian National University Jorrit Gosens	Curtin University FMG Procurement Services Pty Ltd Grange Resources (Tasmania) Pty Ltd HILT CRC Limited Onesteel Manufacturing Pty Ltd Roy Hill Holdings Pty Ltd The Australian National University	1.25	254,461	20,000 ²⁴

²³ MRIWA contributions are drawn down from MRIWA's commitment to the FBI CRC and include Department of Jobs Tourism Science and Innovation (JTSI) funds.

²⁴ MRIWA contributions are drawn down from MRIWA's commitment to the HILT CRC and include Department of Jobs Tourism Science and Innovation (JTSI) funds.



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M10506	Strategic foresight	Analysis of market, cost and locational factors for green iron and steel in Australia (HILT CRC Project)	The Australian National University Frank Jotzo	FMG Procurement Services Pty Ltd HILT CRC Limited Onesteel Manufacturing Pty Ltd Queensland University of Technology Roy Hill Holdings Pty Ltd Swinburne University of Technology The Australian National University University of Adelaide	1.25	261,517	20,000 ²²
M10511	Strategic foresight	Western Australian Battery and Critical Minerals Institute (FBI CRC Project)	Future Battery Industries CRC Ltd Shannon O'Rourke		0.5	268,942	268,942 ²⁵
M10515	Strategic foresight	Western Australia Critical Minerals priority scheme	University of Western Australia Sineth Kannangara		0.58	20,000	20,000 ²⁶
M10521	Downstream processing technology	Pre-feasibility study into the development of a pilot plant for the adaption of Direct Lithium Extraction	Edith Cowan University Amir Razmjou		0.67	450,000	450,000
M10530	Data driven decisions	Retrieval Augmented Generation (RAG) on large technical reports ²⁷	University of Western Australia Henri Scaffidi		1	24,300	24,300
M10535	Strategic foresight	Net Zero Research Development and Demonstration Roadmap	Low Carbon Australia Pty Ltd Tristy Fairfield	Department of Jobs Tourism Science and Innovation	0.5	450,000	150,000
M10576	Data driven decisions	Enabling utilisation of information generated by MRIWA funded grants	Samarah Solutions Melinda Hodkiewicz		0.25	20,000	20,000

²⁵ MRIWA contributions are drawn down from MRIWA's commitment to the FBI CRC and include Department of Jobs Tourism Science and Innovation (JTSI) funds.

²⁶ Co-operative Education for Enterprise Development project fully funded by MRIWA.

²⁷ Co-operative Education for Enterprise Development project fully funded by MRIWA.



PROGRAM 6: Remediation and Mine Closure

An increasing number of Western Australian mining operations are approaching scheduled mine closure with a lack of certainty in the process for relinquishment of rehabilitated land to the State and the potential for trailing liabilities.

To meet the challenge of mine closure and to support the Western Australian Biodiversity Science Institute's Research Priorities and other work happening across government, the research priority areas in Program 6 are intended to systematically advance knowledge and capability toward developing new technologies and approaches for mine remediation and alternative land use, while filling knowledge gaps to ensure a sustainable positive legacy for the industry and surrounding communities.

In doing so, the research will:

- position Western Australia as a global leader in mine closure
- decrease the capital and operating costs associated with remediation and mine closure
- support evidence-based decision making

Themes

- Acid Mine drainage and treatment of tailings
- Sustainable land use post-mining
- Data driven decisions
- Regulatory tools and processes
- Safety, social and environmental stability

\$414K
MRIWA contribution

\$5.4M
Total project value

1
Projects completed

3
CRC/Research centre projects

2
Standalone research projects



Project Case Studies

Opportunities for growth in Australian Mine closure solutions (MCS) industry

Program 6 – Remediation and Mine Closure

STATUS: Final Report Published²⁸

Project No: M10476

THE CHALLENGE

As a significant mining jurisdiction, WA has many operating mines approaching their planned end of life. Although the closure of mine sites is expensive for both mining companies and governments, mine closure activities can also offer a revenue stream for a range of businesses, and this economic opportunity is expected to grow in coming decades.

KEY FINDINGS

This project identified a market for Australian mine closure solutions (MCS) providers over the coming decades that could exceed \$4 billion annually across four categories of industry activity: engagement and partnership with communities impacted by mining; waste reduction and recovery; mine rehabilitation, and; land use transitions.

To realise this opportunity MCS industry participants need to work collaboratively with mining companies, government and the other partners they service to demonstrate the success and value that can be delivered through well-managed mine closure.

BENEFIT TO WA

The findings of this project are supporting the planning and structured development of the mine closure ecosystem in Western Australia. This strategic approach to development is helping ensure relevant services and infrastructure are available to meet the future closure needs of the local mining sector, delivering positive outcomes for mining communities and positioning WA as a leading provider of mine closure solutions.

Sponsors

Cooperative Research Centre for Transformations in Mining Economies (CRC TiME)
Deswick Mining Consultants (Australia) Pty Ltd
Ecoplant Australia Pty Ltd
Fortescue Metals Group Ltd
GHD Pty Ltd

Lead Organisation

Commonwealth Scientific Industrial Research Organisation (CSIRO)

Research Contact

Dominic Banfield

Total Grant Value

\$410,350

MRIWA Contribution

\$50,000



Image courtesy of CSIRO Australia's National Science Agency

²⁸ <https://www.mriwa.wa.gov.au/research-projects/project-portfolio/opportunities-for-growth-in-australian-mine-closure-solutions-mcs-industry/>



Current Projects/Contracts Executed

Program 6 – Remediation and Mine Closure

Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M0513	Regulatory tools and processes	Validation and standardisation of sequential leaching tools to better predict the impact of iron ore mining on ground and surface water quality – Phase 2	ChemCentre John Moursounidis	BHP Billiton Iron Ore Pty Ltd CRC for Contamination Assessment and Remediation of the Environment (CRC CARE) Fortescue Metals Group Ltd Rio Tinto Limited (Iron Ore)	2.92	525,000	216,000
M10409	Acid mine drainage and treatment of tailings	How can CRC TiME help industry, government and communities prevent closure related acid and metalliferous drainage (AMD) impacts?	University of Western Australia Carolyn Oldham	CRC for Transitions in Mining Economies (CRC TiME)	0.67	100,000	15,000 ²⁹
M10413	Sustainable land use post-mining	Post Mining Land Use – Practice Mapping Options	University of South Australia Andrew Beer	CRC for Transitions in Mining Economies (CRC TiME)	1	149,459	15,000 ²⁵

²⁹ MRIWA contributions are drawn down from MRIWA's commitment to the CRC TiME.



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M10442	Acid mine drainage and treatment of tailings	Improved Prediction, Remediation and Closure of Acid and Neutral Metalliferous Drainage (AMD/NMD) Sites (CRC TiME Project)	Flinders University Sarah Harmer	Australian Genome Research Facility Limited Australian Research Council BHP Group Operations Pty Ltd CRC for Transitions in Mining Economies (CRC TiME) Fortescue Metals Group Ltd MMG Australia Ltd Newmont Mining Services Pty Ltd Rio Tinto Services Limited Teck Resources Limited	5	4,558,586	125,000 ³⁰
M10447	Acid mine drainage and treatment of tailings	Wetland in a Box (EnphytoBox®) - a smart water treatment system to support the decarbonisation of water in mining	Syrinx Environmental PL Kathy Meney	Syrinx Environmental PL	0.83	86,600	43,300

³⁰ MRIWA contributions are drawn down from MRIWA's commitment to the CRC TiME.



Project No	Theme	Project Title	Lead Org. and Contact	Sponsors	Duration (yrs)	Total Project Value \$	MRIWA Contribution \$
M10476	Safety, social and environmental sustainability	Opportunities for Growth in Australia's Mine Closure Solutions Industry (CRC TiME Project)	Commonwealth Scientific Industrial Research Organisation (CSIRO) Dominic Banfield	Commonwealth Scientific Industrial Research Organisation (CSIRO) CRC TiME Department of State Growth, Tasmanian Government Deswick Mining Consultants (Australia) Pty Ltd Ecocene (Emapper) Ecoplant Australia Pty Ltd EnviroMETS (Qld) Ltd Fortescue Metals Group Ltd GHD Pty Ltd Intract Australia Pty Ltd K2Fly Ltd T/as Decipher Landloch Pty Ltd METS Ignited Australia Ltd O'Kane Consultants Pty Ltd Queensland Department of State Development, Infrastructure, Local Government and Planning Sustainable Solutions Global Pty Ltd University of Queensland	0.5	410,350	50,000 ²⁸



Education Program

MRIWA provides a program of scholarships and education opportunities to shape and empower future mining industry thought leaders.

The MRIWA Education Program supports the development of exceptional talent to help meet the future needs of the Western Australian mining industry through:

- Attracting domestic and international applicants of exceptional academic capability to the Western Australian research community.
- Effectively marketing MRIWA and the participating universities and research institutions.
- Expanding the diversity of research supported by MRIWA.
- Producing highly skilled graduates aligned to the needs of the Western Australia mining sector.

Education Program components

- A minimum of three prestigious MRIWA scholarships available each year to support post-graduate research students at Western Australian universities.
- Tailored professional and communication skills training for research students and professionals accepted into the MRIWA program.
- Outreach and mentoring to encourage students of exceptional ability to consider careers in the mining industry.
- Administration of PhD scholarships awarded under the WA Government MARS (Mental Awareness, Respect and Safety) Program.
- Sponsorship of the work of Australian Earth Science Education³¹ (formerly Earth Science Western Australia) supporting earth science teaching in WA schools.
- Professional Development Bursary support for minerals research and industry professionals

³¹ <https://ausearthed.com.au/wa/>



Pictured (L-R) MRIWA PhD Scholar Yamini Kannappan, MRIWA PPO Melissa Cianfrini, MRIWA PhD Scholar Emad Al-Hemyari, the Hon. David Michael MLA, Minister for Mines and Petroleum; Ports; Road Safety; Minister Assisting the Minister for Transport, MARS Program PhD Scholar Michael Ajith, MRIWA PhD Scholar Sistine Sun, MRIWA RPM Geoffrey Batt and MRIWA Chair Miriam Stanborough at the 2024 MRIWA Scholarship Induction event, Parliament House



MRIWA Scholarships

MRIWA Scholarships are awarded through a competitive application process to students undertaking research aligned to MRIWA's Research Priority Plan at any university in Western Australia.

The MRIWA scholarship program currently supports the studies and professional development of a cohort of 17 students undertaking PhD degrees at three different Western Australian universities. Two student projects supported under the program were successfully completed in 2023-24.

This scholarship program delivers on MRIWA's mission for applied research to create capability and deliver economic and social benefit for Western Australia by supporting the development of professionals prepared for the future workforce needs of the minerals industry.

On an annual basis, subject to availability of funds and receipt of suitable applications, MRIWA may award:

- 3 Postgraduate research scholarships each valued at no less than \$46,559 per year
 - o MRIWA Odwyn Jones PhD Scholarship
 - o MRIWA PhD Scholarship for Women
 - o MRIWA Indigenous Postgraduate Scholarship

MRIWA's support for scholarships directed at groups traditionally under-represented in mining industry leadership positions contributes to a diverse and innovative minerals industry delivering value to all Western Australians.

MRIWA also:

- funds the scholarships of two students undertaking PhD research within the ARC Centre for Transforming Maintenance through Data Science,
- administers Mental Awareness, Respect and Safety (MARS) Program PhD Scholarships on behalf of the Department of Energy, Mines, Industry Regulation and Safety (DEMIRS), and
- indirectly supports a further 57 PhD students and 8 students completing other higher degrees by research funded under individual projects in the research portfolio summarised in the previous section.

MRIWA's Professional Development Bursary program also currently provides 9 awardees with a suite of training opportunities supporting professional practice and career success spanning the boundaries of applied minerals research and innovation.



2024 MRIWA Scholarship Recipients

Yamini Kannappan – MRIWA PhD Scholarship for Women

Project Title

Extraction of Rare Earth Elements (REE) from Sub-economic Ores and Process Tailings

Host University	Curtin University	MRIWA Contribution
Project Number	M10541	\$26,207 over 1.5 years
Status	Commenced	

Yamini completed her undergraduate studies in Metallurgical Engineering at PSG College of Technology at Anna University, India, and holds a Master of Engineering Science (Metallurgy) from Curtin University.

She was awarded the 2024 MRIWA PhD Scholarship for Women for her PhD research under the supervision of Associate Professor Laurence Dyer, Dr Bogale Tadesse and Dr Richard Alorro at the Western Australian School of Mines: Minerals, Energy and Chemical Engineering (WASM: MECE).

Yamini is developing an environmentally friendly method for extracting Rare Earth Elements (REE) from low-grade ores and process tailings using green solvents. Her work could help unlock WA reserves to increase global supply of these critical elements and create value for WA.

Emad Al-Hemyari – MRIWA Odwyn Jones PhD Scholarship

Project Title

Data Processing and Inversion for Seismic While Drilling and Mining Using Distributed Acoustic Sensing and Machine learning

Host University	Curtin University	MRIWA Contribution
Project Number	M10540	\$34,942 over 2.5 years
Status	Commenced	

Emad holds a Bachelor of Science in Electrical Engineering from King Fahd University of Petroleum & Minerals and a Master of Science in Electrical Engineering from King Abdullah University of Science and Technology in Saudi Arabia.

He was awarded the 2024 MRIWA Odwyn Jones PhD Scholarship under the supervision of Drs Konstantin Tertyshnikov and Olivia Collet and Professors Roman Pevzner and Andrej Bona at Curtin University, and Dr Tim Dean at Anglo American Exploration Pty Ltd.

Emad is developing non-invasive methods for processing and analysing passive seismic data. Various physics-based methods, machine learning and their applications will be investigated to infer valuable information for data-driven decision-making for resource exploration.



Sistine Sun – MRIWA PhD Scholarship

Project Title

The Unintended Effects of Carbon Emission Policy: International Evidence from the Paris Agreement

Host University	University of Western Australia	MRIWA Contribution
Project Number	M10542	\$116,398 over 2.5 years
Status	Commenced	

Sistine holds a Bachelor of Management (Business Administration) from Shandong University in China, a Bachelor of Business Administration (Accounting) (Magna Cum Laude) from the University of Cincinnati (USA), and a Master of Commerce (Advanced) from Australian National University.

She was awarded a MRIWA PhD Scholarship to support her PhD studies under Associate Professor George Shan and Dr Lyndie Bayne at the UWA Business School.

Sistine's research investigates the impact of carbon emissions on tax and investment behaviour within WA's minerals sector, leveraging the Paris Agreement as a global catalyst. She is also exploring the impact of tax avoidance behaviour, with international insights revealing how national institutions shape regulatory outcomes, directly benefiting local regulators and mining companies.

Muzammil Khan – MRIWA PhD Scholarship

Project Title

Towards decarbonisation in steelmaking: Grey-box modelling for optimisation of green and sustainable metallurgical coke production from biomass

Host University	Murdoch University	MRIWA Contribution
Project Number	M10544	\$61,149 over 3.5 years
Status	Commenced	

Muzammil holds a Bachelor of Science in Chemical Engineering from the University of Engineering & Technology in Pakistan, and a Master of Science in Process Systems Engineering from the National University of Sciences and Technology (Pakistan).

Muzammil was awarded a MRIWA PhD Scholarship to support his studies in the Centre for Water, Energy and Waste at Murdoch University's Harry Butler Institute, under the supervision of Drs Xiangpeng Gao and Kevin Wong.

Muzammil's research will develop a comprehensive grey-box modelling framework for enhancing green metallurgical coke production from biomass to enhance decision-making and optimising steel production by integrating machine learning and mechanistic modelling.



Michael Ajith – MARS Program PhD Scholarship

Project Title

Impact of COVID-19 on the leadership of operational leaders in the oil, gas, and mining sector of Australia

Host University	Edith Cowan University	MRIWA Contribution
Project Number	M10562	\$104,758 over 4.6 years
Status	Commenced	

Michael holds a Bachelor of Engineering Science (Mining Engineering) and a Master of Mining Engineering from the University of Ballarat, and a PhD in Mining and Metallurgical Engineering from Curtin University.

Michael has been awarded the inaugural MARS PhD Scholarship for his ongoing studies at ECU under the supervision of Professor Tim Bentley, and Drs Michelle Striepe and Andrei Lux.

Michael's research will investigate the impact of COVID-19 on the roles and leadership styles of Australian resource industry operational leaders, focusing on their role in fostering employee wellbeing and resilience. The findings will inform strategies for enhancing leadership practices and promoting resilience in the face of challenges within the industry.



MRIWA PhD Scholarships

MRIWA PhD Scholarships are awarded through a competitive application process to students undertaking research aligned to MRIWA's Research Priority Plan at any university in Western Australia. One or more MRIWA PhD Scholarships may be awarded annually at the discretion of the MRIWA Board.

Current recipients

Project No	Scholarship Recipient	Project Title	Host University	Duration (yrs)	Status	MRIWA Contribution \$
M10408	Alexandra Halliday	Integrating field monitoring and numerical modelling to better quantify the stability of tailings storage facilities	University of Western Australia	3.5	Commenced	52,973
M10486	Daniel Goldstein	Orebody Characterisation using Machine Learning and Measure-While-Drilling Data	Curtin University	2.9	Commenced	45,598
M10487	Nilan Jayasiri Mudiyansele	Accelerating Consolidation of Mine Tailings using Electro-osmosis Dewatering Technology	University of Western Australia	3.5	Commenced	58,034



MRIWA PhD Scholarships for Women

The MRIWA PhD Scholarships for Women is awarded annually. It was first awarded in 2018 and aims to promote opportunities for women in higher-degree research in the minerals sector.

Current recipients

Project No	Scholarship Recipient	Project Title	Host University	Duration (yrs)	Status	MRIWA Contribution \$
M0524	Kudzai Angeline Mchibwa	Direct Methods for Lithium Extraction from Lepidolite and Spodumene Minerals	Murdoch University	4	Commenced	120,000
M0547	Polyanna Moro	Geodynamics and basin evolution of the Paterson Orogen from the Paleoproterozoic to Neoproterozoic based on 3D geophysical modelling and data inversion	University of Western Australia	4	Commenced	76,200
M0563	Alicja Polewacz	Processes at the interface between fluids and lithium minerals	Murdoch University	3.5	Commenced	140,000
M10452	Bishenka Mahaulpatha	Feasibility of effective metal recovery from tailings material via electrokinetic in-situ leaching	University of Western Australia	3.5	Commenced	144,228
M10485	Hyunjin Na	Development of cementation-magnetic separation method for sulfide mineral processing and AMD prevention	Curtin University	3.3	Commenced	143,735



MRIWA Odwyn Jones PhD Scholarships

The MRIWA Odwyn Jones PhD Scholarships is awarded annually. This prestigious scholarship is named for Emeritus Professor Odwyn Jones AO, in recognition of his outstanding contribution to education in support of the mining industry in Western Australia.

Current recipients

Project No	Scholarship Recipient	Project Title	Host University	Duration (yrs)	Status	MRIWA Contribution \$
M0548	Xingjie Chen	Investigating the underground support provided by shotcrete using tailings and waste rock	University of Western Australia	4	Commenced	120,000
M0561	John Grigson	Giant rare-metal pegmatite deposits of the East Pilbara Terrane, Western Australia: mineral systems analysis and criteria for terrane-scale exploration	University of Western Australia	3.5	Commenced	52,500
M10406	Liz Wall	Evaluating the mining industry's view of their success in delivering a positive legacy for host communities at the time of mine closure	University of Western Australia	5	Commenced	52,973
M10453	Kylie Blackwell	Beneficiation of Gold Telluride Ores	Curtin University	2.7	Commenced	41,208
M10484	Alex Eves	Petrogenesis and metallogenic significance of the Speewah V-Ti Deposit - a large-scale orthomagmatic deposit and associated PGE+Au reef hosted within a multi-stage intrusive sill of the Hart-Carson Large Igneous Province, North Australian Craton	University of Western Australia	2.9	Commenced	48,361

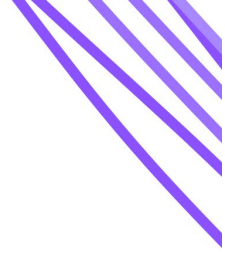


2023 -2024 Completed MRIWA PhD Scholarships

Current recipients

Project No	Scholarship Recipient	Project Title	Host University	Duration (yrs)	Status	MRIWA Contribution \$
M0501	Yihao Fu	Director's Scholarship - Yihao Fu Characterization of ore and bulk solid systems by use of multivariate by image analysis and deep learning neural networks	Curtin University	3.5	Completed	104,006
M10407	Devika Bhatia	Taxation of Australian Mining Firms	University of Western Australia	2.6	Completed	107,627





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