FOUNDATION PROJECT 3.5

A systematic and systemic review of mined landform stability and its impact on transitioning for regional benefits

Despite the benefits produced during operations, the minerals industry has a reputation for often poor mine site rehabilitation and regional benefits post-closure. To be able to inform suitable future final mined landforms for a range of Australian mine site settings and mineral commodities, an assessment of past and current mined landforms is needed. It should have regard for their geotechnical, erosional and geochemical stability, and acceptability for closure and post-closure land use and/or ecological function.

KEY FINDINGS

- **The mine site case studies showed effective mined landform design, construction and sustainability in the Australian context, for regional benefit.**
- **Key among the mine site settings is the climate; in particular, the rainfall of the site. The Australian climate ranges from the wet tropics in the north, through the sub-tropics to the Mediterranean in the south, and the temperate, wet maritime climate of the west coast of Tasmania.**
- **The industry and regions would benefit from a more whole-of-life approach to mining and mineral processing, involving planning, design, construction and operation with effective and sustainable closure front of mind. Recommendations are therefore made for further research to help drive this.**

This was the key aim of this project, which, through a review of 12 case studies, considered the dominant mine site settings of climate, topography and seismicity, noting that the Global Industry Standard on Tailings Management (GISTM, 2020) has added others. These include affected communities, management and governance (incorporating environmental, social and governance, known as ESG), emergency response and long-term recovery, and public disclosure and access to information.

The range of mineral commodities considered included bulk commodities such as coal and iron ore, precious and base metals, and metals processed from oxide ores. It also included the associated open pits, overburden and waste rock dumps, underground workings, and tailings storage facilities.

THE CHALLENGE

The key issues driving mined landform stability transitioning for regional benefits are to plan, design, construct, operate and close a mine to achieve a safe, stable, and non-polluting mined landform in perpetuity, with the potential to add regional benefit. This can be challenging because of the site settings, particularly the variable climate in Australia, and because of cost pressures and perceptions.

The challenges addressed in this project included:

- The importance of site settings.
- The impact of net present value accounting.
- Open pit versus underground versus block cave mining.
- Surface waste rock management.
- Tailings management.
- Closure risks and challenges.
- What constitutes a stable mined landform?
- Value-added mine site rehabilitation.

THE OPPORTUNITY

The project objectives were to:

- Collect and collate information and data on the geotechnical, erosional and geochemical stability, and acceptability for closure, of past and current mined landforms in a range of Australian site settings and for a range of mineral commodities, impacting regional benefit.
- Define the appropriate steps needed for mined landform design and construction.

- Define the information and data required to inform stable mined landform design, focusing on material characterisation.
- Define mined landform construction to ensure stability over time.
- Develop a conceptual model of the often overlooked physical, chemical and biological interactions determining effective mined landform stability post closure in a range of site settings and for a range of mineral commodities in the Australian context.
- Make preliminary recommendations for effective mined landform design, construction and sustainability in the Australian context, and recommendations for further research.

OUTCOMES

The project involved a literature search and input from the experiences of the project research and industry end-user teams, on the performance of past and current mined landforms, covering a range of Australian mine site settings and mineral commodities.

The considered mine site case studies showed effective mined landform design, construction and sustainability in the Australian context, for regional benefit.

NEXT STEPS

Too few examples of effective, and cost-effective, mined landform design and regional benefits post-closure are publicised. Also, lessons learned are typically not presented.

Further research should be directed at identifying, highlighting and publishing other case studies from the industry of successful mine site rehabilitation, reuse, and repurposing for regional benefit, and directed also at presenting the lessons learned. The minerals industry is encouraged to make data and examples publicly available to serve as benchmarks, to which future mine site rehabilitation, reuse, and repurposing can aspire.

PROJECT PUBLICATIONS

REVIEW FULL REPORT

Williams, D. J. (2023). *A systematic and systemic review of mined landform stability and its impact on transitioning for regional benefits.* CRC TiME Limited.

D.J. Williams, D.J., Short, A.T. and McGhie, A. (2022). Forensic investigation of the performance of a 25-year old store and release cover. *Proceedings of 12th International Conference on Acid Rock Drainage 2022 Virtual, 18-24 September 2022, Australia*, 14 p.

D.J. Williams, D.J., Short, A.T. and McGhie, A. (2022). Repurposing of the Genex Kidston mine site in Queensland, Australia. *Proceedings of the 15th International Conference on Mine Closure, 4-6 October 2022, Brisbane, Australia*, 14 p. Australian Centre for Geomechanics.

CONTACT

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Mine site case studies considered in this project

SITE	DESCRIPTION
Kidston Genex, North Queensland	Rehabilitated by 2001, Genex constructed a Solar Farm on the tailings storage facility in 2017, and is constructing a Pumped Storage Hydro utilising the two pits
New Century, North Queensland	Reprocessing of tailings for zinc and final in-pit disposal
New Acland Coal Mine, South-East Queensland	Rehabilitating surface and in-pit tailings storage facilities, and backfilling of pits with spoil, for return to grazing
McArthur River Zinc Mine, Northern Territory	Rehabilitating waste rock dump to restore license to operate
Bengalla Coal Mine, Hunter Valley, New South Wales	Rehabilitating spoil piles for a visual bund and grazing
Loy Yang Mine, Latrobe Valley, Victoria	Progressive rehabilitation of Loy Yang overburden dump
Sovereign Hill, Victoria	Repurposing of abandoned old gold workings for tourism
Henty Gold Mine, West Coast of Tasmania	Combined peat and water cover over sulfidic tailings
Kanmantoo Copper Mine, South Australia	Integrated waste landform
Collie Coal Mine, South-West Western Australia	Lake Kepwari pit lake relinquishment
Beenup Mineral Sands Mine, South-West Western Australia	Wetland rehabilitation and relinquishment
Pardoo Iron Ore Mine, Pilbara, Western Australia	Waste rock dump rehabilitation

ABOUT US

The Cooperative Research Centre for Transformations in Mining Economies is part of Australia's national innovation ecosystem. Our diverse partnership brings scale, collaboration and coordinated investment to tackle the most complex mine closure and post-mine transition challenges. Together we're rethinking what's possible to improve outcomes for people, communities, the environment and industry.

We acknowledge the traditional custodians across all the lands on which we live and work, and we pay our respects to Elders both past and present.

Australian Government
Department of Industry, Science and Resources
AusIndustry
Cooperative Research Centres Program