



Preliminary Report Project 1.2

Post mining land uses – a literature review

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Executive summary

This Preliminary Report provides an overview of published and other work on the re-use of mines in Australia and internationally. It was produced as the first output of a project supported by CRC TIME into the broader question of how best to advance the re-use of mines in order to achieve positive economic, social and environmental outcomes. The research recognises that the repurposing of mines creates distinctive opportunities and risks for mining communities and their broader regions, and that there is value in seeking to find new, and productive futures for these places. The research focussed on the following seven questions:

- What can we learn from national and international experience with respect to the re-purposing of mines?
- What are the adverse impacts of current closure planning processes?
- What are the optimal conditions for the re-purposing of sites with respect to location, mine type, engagement with the community and broader regional planning processes?
- How can the re-purposing of mine sites better incorporate long-term community priorities?
- Is repurposing best enacted immediately post mine closure, or is it better placed – and more likely to come to fruition – after a significant period has elapsed?
- What do we understand as current thinking or best practice in this field? and,
- What can we learn from case studies drawn from across Australia?

The review found that:

- Globally there are a significant number of instances where mines have been repurposed across a range of industries, including:
 - Active tourism, including mine sites as places for physical activity and adventure tourism;
 - Recreation uses and hotel accommodation;
 - Office accommodation;
 - The processing of waste and other materials in bio-reactors;
 - Science precincts;
 - Energy generation; and,
 - Environmental assets, including wetlands.
- While there is considerable case study literature on the re-use of mine sites, to date, the issue has not been considered in a systematic fashion. Those resources that are available, including The International Council of Mining and Metals' *Good Practice Guide* (ICMM 2019), provide valuable advice but it may be difficult to translate these insights into specific action for some mines;
- For Australia, our current, piecemeal approach to the re-purposing of mines results in lost economic opportunities, and potentially profound impacts within individual regions;
- The available evidence suggests that each example of mine repurposing has been dealt with as a unique, 'one off' project, with consequent significant implementation costs;
- In many instances the re-use of mine sites is made more difficult by regulatory frameworks that focus solely on harm minimisation and the rehabilitation of mine sites. There is often limited scope for consideration of alternative uses for these sites;

- Some features of contemporary mining practice, including the periodic shut-down and re-opening of mines as resource prices vary, make it more difficult to plan for repurposing as the end of mine life is difficult to determine. Staff turnover on mines placed on ‘care and maintenance’ may result in the loss of corporate knowledge, and the associated failure to implement previously identified plans;
- Drawing on broader research on change in regional economies we find there are three key questions that need to be considered systematically in order to better inform, and empower, mine repurposing in Australia and elsewhere:
 - What are the opportunities available at each mine site for redevelopment and the creation of new opportunities?
 - Who has the capacity to bring about change?
 - How is the process of change discussed publicly and in forums of influence?

Early insights into how to find solutions to these questions will be provided as part of the Final Report for this project, and it is anticipated further investigations will be needed in order to provide industry with the tools they need to more systematically implement the repurposing of mines.



1. Introduction

This Preliminary Report is the first of two written outputs into Post Mining Land Uses produced as part of a project funded by CRC TiME. This report focusses on documenting what is already known about this topic: what we know from other research about alternative uses for these sites after mining operations have come to an end; how mines come to take on a second life across different parts of the world; how the barriers to their re-purposing are overcome; and, who are the stakeholders shaping the re-use of mines? In undertaking this work, the research team has been very much aware of the need to draw from insights from around the globe but consider first and foremost the range of applications and possibilities in Australia.

As recent research has noted, abandoned or former mine sites are a common feature around the world, with Gutierrez (2020) estimated there are approximately 500,000 such sites in the USA, 50,000 in Australia and 10,000 in Canada. Werner et al (2020) identified 95,320 mine sites in Australia, of which some 89 per cent were inactive. Mines and their potential for re-use are an important issue economically, socially and environmentally.

Over recent decades a number of reviews have been written on post mining land uses, including detailed analysis of the characteristics of individual projects and their location (Holcombe and Keenan 2020; Mborah et al 2016; Limpitlaw et al 2014; and, Soltanmohammadi et al 2009). There has been a focus on some specific characteristics of individual mines such as the type of mining, the mineral resource, the remoteness of the mine location, and the impact of government regulation on the re-use of these sites. Other research has focused on issues of community consultation, the interests of Indigenous landowners and the potential to make use of new technologies to find innovative solutions to the future of these sites once mining has come to an end. This Report, however, takes a different perspective: it considers the nature of mining activity and its organisation as an industry – including government oversight – and considers how these shape the repurposing of mines. The report also looks at mines as important regional assets – drivers of economic growth, sources of employment and opportunity, and major infrastructure hubs – and what we can learn from recent research on how regions change to better understand mine site repurposing.

As we learn more, and develop better insights into, mine repurposing we are empowered to achieve outcomes that work for the benefit of all.



2. Our goals and objectives

We know that across Australia and globally, former mines have been converted into a range of other uses, including their use for power generation, science laboratories (Productivity Commission 2017), adventure tourism and diverse other uses, but we lack a systematic evidence base on how these successes have been achieved and what hurdles have needed to be overcome in order to bring their potential for re-use to realisation. There is also a pressing need for better insights into how change has been achieved. This is, of course, a very broad question as it touches upon issues of governance, risk management, the impacts of incumbency with respect to mine operations and ownership and broader attitudinal factors, including expectations. It is important to acknowledge also that the repurposing of mine sites is affected by larger-scale economic opportunities and disruptions, as well as the appetite within the community, governments and businesses for risk. Who carries which type of risk – reputational, environmental, financial et cetera – can be an important consideration in the repurposing of mines.

This research has been undertaken as part of the program of work focussed on questions of regional development and regional impacts within CRC TIME. The research seeks to provide answers to specific questions around the re-use of mine sites, and the opportunities for repurposing, now and into the future. The research asks seven key questions:

- What can we learn from national and international experience with respect to the re-purposing of mines?
- What are the adverse impacts of current closure planning processes which often set out what is to happen once a mining closes, without detailed analysis of all potential options?
- What are the optimal conditions for the re-purposing of sites with respect to location, mine type, engagement with the community and broader regional planning processes?
- How can the re-purposing of mine sites better incorporate long-term community priorities?
- Is repurposing best enacted immediately post mine closure, or is it better placed – and more likely to come to fruition – after a significant period has elapsed?
- What do we understand as current thinking or best practice in this field? and,
- What can we learn from case studies drawn from across Australia?

This Preliminary Report provides a first set on insights into these questions. A second, more definitive set of responses will be developed as part of the project's Final Report, where the insights and knowledge drawn from the review of the literature will be complemented by the findings of eight case studies of mine closure and re-purposing – achieved and proposed.



3. Understanding mine sites as a regional economic asset

There is now a large and emerging literature focussed on the repurposing of mine sites around the world that either specifically concentrates on that topic or includes a discussion of the issue as part of a broader understanding of the end-of-life for mines (see, for example, Young et al 2021). Internationally and nationally, there is no shortage of examples of mine sites that have been repurposed in many, very different, ways (Table 1) with former mines used to host tourism activities such as zip lines and bike trails, while also serving as sites for the recycling of materials, part of pumped hydroelectricity schemes and industrial parks. Germany's Lausatian Lakeland witnessed the transformation of an entire landscape affected by the impact of strip mining for brown coal developed into a tourism attraction. In the United States former mines have been used to provide government offices, serve as a data storage hub and the site of a mushroom farm. Critically, the re-purposing of mines has received comparatively little attention in the academic literature relative to other mining-related issues, and the topic would appear to have limited prominence within the mining industry also. There is, however, clear evidence of a growing engagement nationally and internationally with this important topic.

Mining as a distinctive economic activity

Mining is an industry with distinctive characteristics. Mining in Australia and in many other parts of the world is an industry of national and international significance, with the minerals and other resources produced from mining a key input into global production networks (Coe and Yeung 2015). Mining, however, is differentiated from many other industries in that activity is concentrated in a specific site or sites, for a limited period that is usually known prior to commencement. In some instances, mining has persisted for generations and has supported townships and communities for an extended period but in other cases the life of a mine may be less than two decades. As the ICMM (2019) acknowledged, mining is a temporary land use but its impact on the local environment and economy may remain evident long after the site has closed. Importantly, each mine is unique: its location is unique, as are its configuration, resource base, potential environmental impacts, rehabilitation options and prospects for re-use. Mining, therefore, has much in common with the construction of infrastructure and other project-based economic activities, rather than industries with the capacity to continue over longer periods. As a project-based economic activity, post mining land uses tend to be bespoke – tailored to the individual circumstances and opportunities evident at each site. Unlike in manufacturing, professional services or some types of construction, there is no system-wide response available for the re-use of mine sites that is able to be applied at scale with uniformly positive outcomes. Each repurposed mine site must be considered individually, with solutions shaped to those conditions. For this reason, much of the literature on post mining land use appears as a collection of case studies (Decipher 2020; Murphy 2018; Verweijen and Dunlap 2021), with each setting out a response to a particular set of opportunities and challenges, but not necessarily building upon the commonalities that could be found with more detailed analysis.

Before moving on to examine some of the other distinctive elements of mining, it is important to acknowledge that the question of mine life is made more complex by fluctuations in the pricing of minerals. Mines may be viable when their minerals are at a favourable point in the price cycle, but uneconomic when prices fall below the cost of production. Mines may be placed on 'care and maintenance' until prices return to a higher level and extraction becomes profitable again. Mines may even be reopened even after repurposing, if this is still feasible. This practice introduces considerable ambiguity into the end of life for a functioning mine, especially as shifting

prices and further investment by the mining company may result in the expansion of the mine and an extension of its life.

Mine location is a second distinctive feature of the industry, especially in Australia. Unlike many other industries where there are advantages in being close to population centres (Beer and Clower 2019), some mines are in remote places while others are relatively close to large towns or cities. In large measure this variability reflects the location of the existing resources being extracted but, in some instances, it is a product of the incompatibility of industrial-scale mining in proximity to major urban centres. One consequence is that the infrastructure – power and water supply, roads, railways, airstrips and townships – created to support mining activities commonly represent a significant percentage of the infrastructure in undeveloped regions. These investments therefore represent important regional assets, potentially critical in the future development of that locality and its broader environment. In some instances it may be necessary to invest in new, complementary, infrastructure in order to make possible new industries and associated investment (AgroSense 2020). Who pays for this new infrastructure may be disputed, with the former owners of the mine, the community, governments and the new enterprise all interested stakeholders. McCullough et al (2020) observed that pit lakes associated with abandoned open cut mines are potentially valuable to many regional communities but this opportunity may not be realized because of issues including water quality, slope stability and safety.

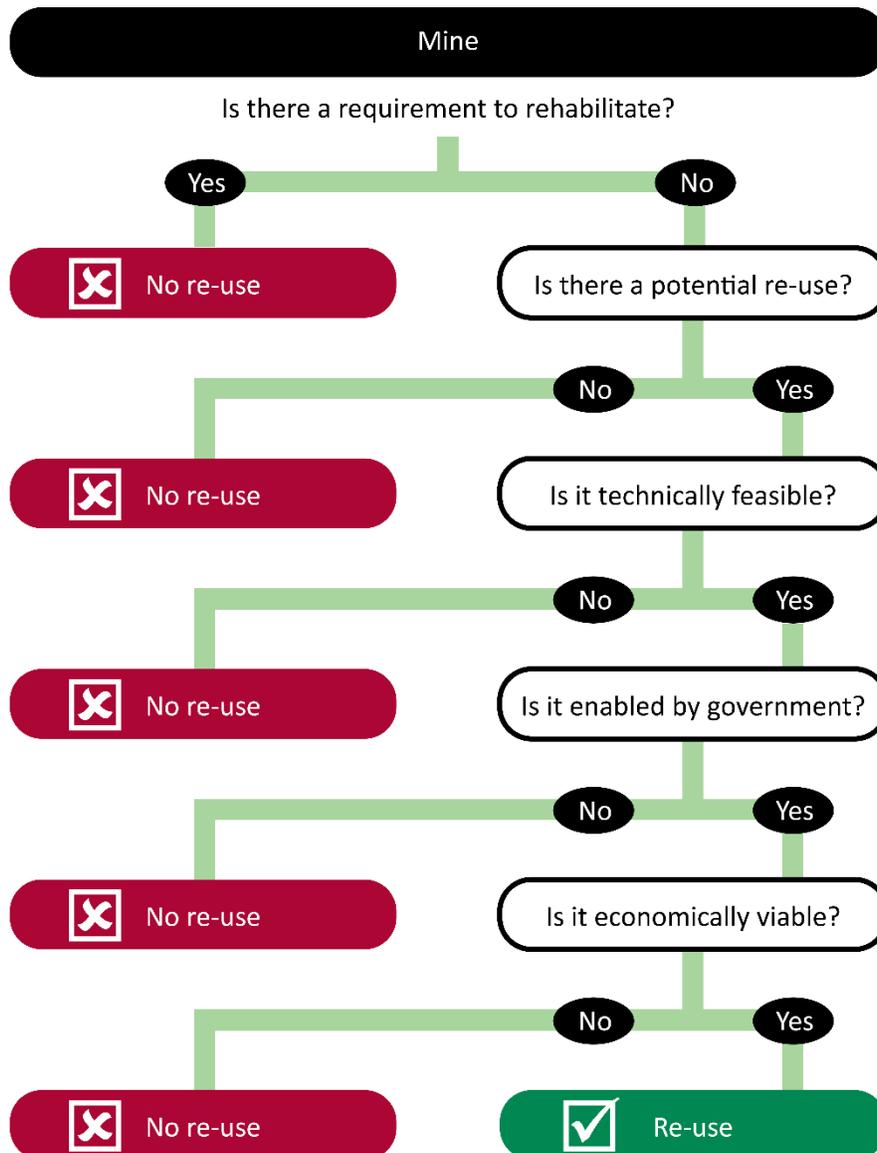
Third, mining is both a mature and a heavily regulated industry, where considerable attention has been paid to the consequences of mining activity and the desire to restore the land once mining has ended (Young et al 2021). In many instances, the restoration of the mine site is the only possible outcome: one mandated by mine licence conditions under state or other legislation (see Weller et al 2020; Hall 2020). These outcomes have been imposed because of a history of former mines remaining un-restored, with significant negative environmental impacts (Roche and Judd 2016). Some have argued this remains a risk across Australia and elsewhere (Walters 2016). In other instances, companies are encouraged to consider alternative uses for mines, but ‘regulatory inertia and mining company aversion to risk inevitably results in closure criteria focused on environmental protection, with post closure land use defaulting to the pre-mining land use’ (Jacobs 2018 p. i). In many instances, rehabilitation is essential as there are significant issues of contamination or danger on-site. Rehabilitation, however, is expensive and in a number of instances mines are not closed formally but are instead ‘mothballed’ indefinitely until eventual abandonment. Legislative requirements focused on mine rehabilitation may make it difficult to repurpose a mine, and this may represent the loss of a significant economic opportunity for the local community.

Fourth, mining and the re-purposing of mines is an issue that brings forward many stakeholders with often differing perspectives and agendas. Mining companies, government agencies, the local community, industry, unions and environmental groups may all have distinct agendas. Critically, while mining companies can benefit from the re-purposing of mines through reduced rehabilitation costs and reputational benefits, some stakeholders may be strongly interested in the re-use of a mine but have little power with which to shape outcomes. This would include First Nations peoples, other local communities, economic development agencies and companies seeking to make use of the mine’s land and/or infrastructure potential (Kirton and Anthonisz 2020; AgGrow nd).

The closure of any mine brings to an end one form of economic activity on that site, which may mean mining ceases in the region entirely. Mine closure commonly results in the loss of employment for many workers, although staff may be redeployed by large companies to other sites (Weller et al 2020; Kalogiannidis 2020; O’Connell L & Arnau 2020). Mine closures may also result in reduced economic activity in a region, which in turn contributes to reduced turnover and employment in supporting firms and local townships. Put simply, mine

closure may be a significant shock to the regional economy, and there may be a social and economic imperative to reuse mine sites to help sustain the local economy and make full use of the infrastructure in place. Importantly, in many developed economies the pathway to mine reuse is both time consuming and potentially influenced by a substantial number of hurdles. Essentially for a mine to be repurposed, the site needs to pass through a number of gateways (Figure 1) all of which may undermine the viability of the proposed re-use. These barriers include regulations that may mandate particular outcomes – such as the rehabilitation rather than the re-use of sites; what is technologically feasible at this point in time; the economics of repurposing, including the possibility of needing to undertake significant remediation or reconfiguration of the site prior to re-use; and community attitudes and sentiments.

Figure 1: A stylised set of gateways for mine site repurposing



Recent research into how regional economies change provides a valuable perspective on how to think about, and plan for, mine closures. Beginning with Grillitsch and Sotarauta (2020) researchers have acknowledged there are three over-arching questions and nine supporting questions that must be addressed in seeking to understand how change takes place (Beer, Barnes and Horne 2021). Translated to fit the goal of better understanding mine re-purposing, these nine questions are:

- What are the opportunities available at each mine site for redevelopment and the creation of new enterprises?
 - Do these opportunities emerge from, or are dependent on, new technologies?
 - Are these opportunities a product of conditions unique to, or a product of, that location? Do the enablers of transition include land capability/capacity, infrastructure assets, water availability and other features associated with the mine?
 - To what degree do these opportunities reflect the resource endowments of that site and its region?
- Who has the capacity to bring about change?
 - Does the leadership of change sit with the private sector?
 - What is the role of the public sector – in all its dimensions – in leading and enabling the transition of former mines to new forms of economic activity?
 - What is the potential role of the local community, First Nations people and those who speak on behalf of the community?
- How is the process of change discussed publicly and in forums of influence?
 - Is there a narrative of change that focusses on the regulation of the mine and the minimum thresholds it must achieve post closure?
 - Is there a discussion of how to bring about positive change, enabling the capture and realisation of the potential re-use of the site? And,
 - Can a partnership between private sector and government stakeholders better explore the full range of possible outcomes for mine sites, including re-use?

Providing answers to these questions represents a first step towards a more systematic and evidence-based approach to the repurposing of mines and the full development of the opportunities they represent. For Australia, our current, piecemeal approach to the re-purposing of mines results in lost economic opportunities, and potentially profound impacts within individual regions.

Table 1: Examples of some re-purposed mines

SITE	LOCATION	NEW PURPOSE
Selby Coalfield	North Yorkshire, UK	Industrial park, business park, waste processing, storage
The Eden Project	Cornwall, UK	Botanical garden/concert venue
Zip World	Wales	Adventure tourism
Louisville Mega Cavern	Kentucky, USA	Mega underground bike park
Green Forests Work (non-profit)	Virginia, USA	Daniel Boone National Forest (restored forest)
White Pine Mine	Michigan, USA	Plant nursery for a biomedical company
Former gold mine at Lead	South Dakota, USA	Physics lab
Former mine in upstate NY	New York, USA	Data storage
Former limestone mine at Boyers	Pennsylvania, USA	Room 48, data storage
Former mine at Boyers	Pennsylvania, USA	Government office
Creekside Mushrooms Ltd	Pennsylvania, USA	Mushroom farm
NRG Dewey Prairie Garden	Jewett, Texas, USA	Farm
Lake Ore-Be-Gone	Minnesota, USA	Artificial lake
Butchart Gardens	Vancouver Island, Canada	Sunken garden
Springhill Mine	Nova Scotia, Canada	Flooded sub-surface coal mine with geothermal energy providing heating to several commercial buildings
White Mountain Publications	Ontario, Canada	Independent bookstore
Former limestone quarry	Dalarna, Sweden	Dalhalla concert venue
Gotland Ring	Gotland, Sweden	Subterranean racetrack
Lefdal Mine	Norway	Data Centre
Zollverein Coal Mine	Germany	Entertainment hub
Salina Turda	Transylvania, Romania	Amusement park
Wieliczka Salt Mine	Poland	Underground spa, museum
Roman Catholic Church	Zipaquirá, Colombia	Salt cathedral
Clube de Braga	Portugal	Soccer stadium
Tianma Pit	Shanghai, China	Shimao Wonderland InterContinental Hotel
Former iron-ore mine	Yanahara, Japan	Hypoxic running track
Kebun Raya Megawati Soekarnoputri	Indonesia	Botanical garden
Iluka Resources Limited	South Capel, Western Australia	Wildlife animal hospital, research centre and Kaatijinup Biodiversity Park
Fassifern Coal Mine	Fassifern, near Newcastle, New South Wales	Pumped hydro energy storage facility [planned]
Schwenkes Dam	Greenbushes, Western Australia	Wetland habitat
Lake Kepwari	Collie, Western Australia	Recreational facility
Peak Hill Open Gold Mine	Peak Hill, New South Wales	Tourist attraction
Laverton	Western Australia	cARpeT: Reclaiming the Void art project
Ranger Uranium Mine	Jabiru, Northern Territory	Indigenous-run tourism town
Hannan's North Tourist Mine	Mullingar, Kalgoorlie, Western Australia	Tourist attraction
Gove	The Gove Peninsula, East Arnhem Land, Northern Territory	Industrial and recreational areas

4. Approaches to end of mine life and mine site reuse

Recently Weller et al (2020) examined the International Council of Mining and Metals' *Integrated Mine Closure Good Practice Guide* (ICMM 2019), as an influential document within the mining sector globally and as a source of insight into the perspective of mining enterprises. That Good Practice Guide emphasised stakeholder involvement in the processes surrounding mine closures and emphasised the degree to which mining firms should be held responsible for longer-term economic development outcomes. As a key industry resource it provided guidance on how to repurpose mine sites as part of its examination of land use after closure, but concluded that:

Not all closed sites will be amenable to repurposing. In some instances, only certain domains may be available for repurposing. If the screening identifies an alternative land use and a positive business case can be developed, this approach may be incorporated into the mine closure plan. Prior to incorporation in the plan, the repurposing must be the subject of engagement with stakeholders to ensure the option aligns with what the community and government desires (2019, p. 86).

The International Council of Mining and Metals' *Good Practice Guide* (ICMM 2019) is an important resource for the repurposing of mines and it places an emphasis on stakeholder involvement in the closure process. The *Guide's* Tool 4: Screening Alternatives for Repurposing notes that 'there is a growing body of successful repurposing case histories....with a productive repurposing of the land secured, repurposing facilitates the relinquishment of the former mine site (ICMM 2019 p. 86). This Tool provides broad-scale guidance on how to repurpose mine sites, but it clearly cannot provide detailed advice on all possible sites and circumstances. The ICMM (2019) *Good Practice Guide* is highly influential and often cited. Its key elements, outlined in Box A, concern engaging with stakeholders in what is essentially a firm-led process.



Box A: The ICMM Good Practice Guide

The guide begins from the position that mine closure processes form an “integral part of the mine operations’ core business”. It lists the key elements of mine closure planning and plan implementation, including the environmental, social and economic aspects of mine closure” (ICMM 2019 p 6).

The Guide stresses the involvement of the community and stakeholders throughout the closure planning process. It advocates learning from previous experiences.

The need for stakeholders to agree on success criteria is also crucial (p 37). This should include the identification of “leading indicators” to guide the monitoring closure activities and to ensure successful closure outcomes (ICMM 2019 p 38). Effective closure planning is characterised by:

- consistent and transparent engagement with stakeholders.
- community participation in planning and implementing actions that underpin successful closure.
- stakeholder support of closure decisions.
- better management of closure throughout the mining life cycle.
- more accurate closure cost estimates.
- early identification of risks and mitigation strategies.
- progressive reduction of liabilities.
- working towards an agreed-upon vision for the post-closure period.
- a better social transition for affected stakeholders as the mine moves from operations to closure.
- opportunities for lasting benefits being recognised and planned for adequately

In relation to transition, this publication views best-practice as restricted to managing the process, by “promot(ing), to the extent practical, a smooth transition from the socioeconomic conditions that existed during mining activities to the state that will be present after mining. Where practicable, the net socioeconomic impact on the affected region should be beneficial” (ICMM 2019 p 17). It also recognises mine closure can create opportunities to “encourage the development of sustainable post-closure options”, which, “build capacity of local communities and their governments to meet their needs without the mine’s involvement” (ICMM 2019 p 43).

The ICMM Guide included a risk assessment flow chart to be used in identifying risks associated with closure and how to deal with them.

The ICMM guidelines are valuable, but they are limited by their universality in that they were developed regardless of the capacities of local institutions and regulatory frameworks. A more fine-tuned approach is needed across Australia, as each state and territory imposes their own regulatory frameworks and expectations.

Within Australia, the Commonwealth Government’s Department of Foreign Affairs and Trade (DFAT) has developed a best practice guide that is more relevant to both Australian mines and Australian mining companies

working internationally (Commonwealth of Australia 2016). The Government of Western Australia (2015) has also developed mine closure guidelines.

Both the DFAT and the Western Australian Government documents approach the issue of mine closure and mine repurposing from a regulatory perspective. This has resulted in a continued focus predominantly on the physical, site specific, environmental requirements for mine closure and site rehabilitation. Their overall message on best practice is similar to the ICMM report, but with more emphasis on adopting ‘leading’ practices as a prerequisite to mining’s ‘social licence to operate’.

Like the ICMM, the DFAT Guide stresses stakeholder engagement (but including regulators), agreement on a clear set of closure objectives, and a clear ‘performance framework’ able to facilitate a consistent approach and enable the success of the closure process to be measured. The DFAT guide is focused on legal compliance, recommending the needs of stakeholders and proponent criteria are a part of the initial mine approval process to ensure that companies relinquishing mine sites meet regulatory requirements and community objectives. It also recommends a Life of Mine (LoM) risk management approach to identify risks and develop controls to guide mine closure, rehabilitation and relinquishment. It recommends the AS/NZS ISO 31000:2009 Risk management—principles and guidelines (Standards Australia/ Standards New Zealand 2009) for that purpose. The Western Australian Guidelines provide detailed information on statutory requirements (Government of Western Australia 2015).

The DFAT Guide (Commonwealth of Australia 2016) directs more attention than the ICMM Guide to long-term outcomes. In its view, community capacity building and stakeholder/community engagement throughout the closure process is fundamental to providing “long-term positive outcomes” within affected communities (Commonwealth of Australia 2016 p 28). The DFAT guide’s international case studies provide examples where mining companies have remained invested in the community through establishing education and training centres and assisting the expansion of other industries within affected regions.

A third perspective on mine closure and re-use was presented by Bainton and Holcombe (2018), who viewed mine closure from a community and environmental perspective. Although developed out of analysis undertaken in a developing economy (Ok Tedi in PNG), this research made observations and recommendations of considerable value.

For Bainton and Holcombe (2018 p 472) best practice in planning for mine closure and re-use called for a focus on both both integration and sustainability. As well as the issues canvassed in the other guides – considering mine closure prior to the start of mine operation, stakeholder engagement, formal planning, goal setting and measurement of outcomes – they put much more emphasis on active community engagement. This, they argued, entails involving local communities in the design for mine closure process and in the setting of goals, developing resources and local capabilities (‘social capital’) to better manage the closure, building genuine partnerships among stakeholders, and establishing multi-disciplinary teams (internal and external) to work on different aspects of the closure.

Bainton and Holcome (2018) also stressed the need for communication with the community in order to to build social cohesion, share inter-generational perspectives on the mine’s lifecycle, and acknowledge the past. It also provides an opportunity to drawing on exemplary closure processes from other places (see also Weller et al 2020).

Because mine closures are an integral aspect of mining enterprises, Bainton and Holcombe (2018) viewed closures as manageable through local level agreements with communities and affected landholders, and not as exceptional events requiring government intervention. The authors saw mine closure as presenting a positive

opportunity for communities to build ‘local capital’ in its natural, produced, human, financial, social and cultural forms, as a way of forging “the foundations for a more sustainable post-mining future” (Bainton and Holcombe 2018 p 469).

To that end, Bainton and Holcombe (2018) argued that the collaborative mine closure process should be structured to involve activities such as:

- repurposing mining infrastructure and landscape;
- reskilling and redeploying labour;
- establishing alternative economic opportunities; and,
- strengthening local livelihoods.

Bainton and Holcombe (2018) extended the responsibilities of firms beyond the boundaries of the industry and government perspectives. However, the expectation of long-term commitments by firms was limited to mine closures in developing countries where governments do not have the financial or management capacity to intervene to ensure positive outcomes (see also Commonwealth of Australia 2016).

The Centre for Social Responsibility in Mining (CSRSM) at the University of Queensland has produced an online resource on the social aspects of mine closure <https://www.mineclosure.net/projects> that provides a number of insights into various dimensions of the closure process. With a strong focus on professional development and international Indigenous exchange, the CSRSM has examined a number of research questions including:

- Woodlawn mine site repurposing: success factors, enablers and challenges;
- Indigenous groups, land rehabilitation and mine closure: exploring the Australian terrain;
- Examining mine closure through the lens of industry social practitioners;
- Mining regions in transition – a global scan;
- Community participation in mine closure planning processes;
- Participatory processes, mine closure and social transitions;
- Mining as a temporary land use: industry-led transitions and repurposing;
- Integrated mine closure planning: a rapid scan of innovations in corporate practice;
- Government engagement: insights from three Australian states; and,
- Social aspects of mine closure: governance and regulation.

Of these projects the most relevant to this Preliminary Report are the work on mining as a temporary land use (Holcombe and Keenan 2020), as well as the examination of the development of the Woodlawn mine into a bioreactor (Holcombe 2020) and the consideration of community consultation processes in planning for mine closure (Everingham et al 2020).

Holcombe and Keenan (2020) undertook a global review of re-purposed sites as part of their work on mining as a temporary land use. They found 313 sites around the globe and from their analysis they concluded that the

most common category of repurposing was ‘community and culture’. This category includes: cultural/historical precincts, reclamation art, museums or exhibitions of mining/industrial history, and community event spaces. This form of repurposing emerged 76 times in our sample....However, this

form of repurposing was not usually led by industry and tends to relate to abandoned mines and/or historical sites....The next most predominant repurposing practice we found was ‘conservation and ecosystem services’ at 63 occurrences. This category encompasses wildlife habitat, native woodlands, carbon offset and sequestration, and wetlands..... Non-intensive recreation is the third most predominant category of land use with 51 occurrences. This category encompasses park and open green space, public/botanical gardens, paths for walking, hiking, running, cycling and horse-riding and eco-tourism. Of note, is that the categories of ‘conservation and eco-system services’ and ‘non-intensive recreation’, together make-up more than one third of the total in terms of primary re-purposing categories. And, as repurposing activities, they are co-located at least 37 sites (Holcombe and Keenan 2020 p. v).

Holcombe and Keenan (2020 p.6) also concluded that the following attributes appeared to influence the likelihood of mine reuse. With respect to mine location the critical factors were:

Proximity to one or more urban settlement;

- The attachment local residents may feel towards a mine and its working history;
- Connection to infrastructure;
- The environmental status and potential of the mine; and,
- Land use zoning.

With respect to economic viability, Holcombe and Keenan (2020) concluded that the critical issues included:

- Local supply and demand for the goods or services to be produced at the repurposed mine;
- A coming together of inter-related projects that assist each other in achieving viability;
- The potential to diversify into alternative energy projects or real estate development.

The factors internal to the mining company found to be important included:

Regional stakeholder engagement and the company’s willingness to look beyond their immediate operations, as indicated by:

- The level of community engagement and commitment to being inclusive;
- The establishment of community trusts and similar legacy schemes;
- Company policies and standards; and,
- The length on the mine life. With long-life mines more likely to result in post-mining land uses, in part because of enduring attachment to the community. Small, locally based operations, such as quarries, were also more likely to invest in re-use of the site.

Overall, the work reviewed above provides considerable insight into both the principles that should inform the repurposing of mines, and the extent and reality of such efforts to date. Holcombe and Keenan’s (2020) research is particularly relevant to this Preliminary Report as it provides invaluable insights into some of the factors that appear to shape the likelihood of re-use. What is needed are processes and competencies to better identify and assess repurposing options, which then needs to be accompanied by collaboration with partners (the mining company, governments, communities and other industries) to realise these opportunities. The University of

Queensland's Centre for Social Responsibility in Mining *Knowledge Hubs* <https://smi.uq.edu.au/csr-knowledgehub>

Box B: Social aspects of mine closure <https://www.mineclosure.net/projects>

- Woodlawn mine site repurposing: Success factors, enablers and challenges
<https://www.mineclosure.net/elibrary/woodlawn-mine-site-repurposing>
- Indigenous groups, land rehabilitation and mine closure: exploring the Australian terrain (Phase 2)
<https://www.mineclosure.net/elibrary/indigenous-groups-land-rehabilitation-and-mine-closure-exploring-the-australian-terrain-phase-2>
- Examining mine closure through the lens of industry social practitioners
<https://www.mineclosure.net/elibrary/innovations-from-practitioners-lessons-learned-from-specialist-and-site-based-practitioners>
- Mining regions in transition - a global scan <https://www.mineclosure.net/elibrary/mining-regions-in-transition-a-global-scan>
- Community participation in mine closure planning processes
<https://www.mineclosure.net/elibrary/mine-closure-planning-and-community-participation-structures-and-mechanics>
- Indigenous groups, land rehabilitation and mine closure: exploring the Australian terrain
<https://www.mineclosure.net/elibrary/indigenous-groups-land-rehabilitation-and-mine-closure-exploring-the-australian-terrain>
- Participatory processes, mine closure and social transitions
<https://www.mineclosure.net/elibrary/participatory-processes-mine-closure-and-social-transitions>
- Mining as a temporary land use: industry-led transitions and repurposing
<https://www.mineclosure.net/elibrary/mining-as-a-temporary-land-use-industry-led-transitions-and-repurposing>
- Integrated mine closure planning: A rapid scan of innovations in corporate practice
<https://www.mineclosure.net/elibrary/integrated-mine-closure-planning-a-rapid-scan-of-innovations-in-corporate-practice>
- Government engagement: insights from three Australian states
<https://www.mineclosure.net/elibrary/government-engagement-insights-from-three-australian-states>
- Social aspects of mine closure: governance and regulation
<https://www.mineclosure.net/elibrary/social-aspects-of-mine-closure-governance-regulation>

5. Conclusion

This Preliminary Report has provided a succinct review of the literature on the repurposing of mine sites. It has shown that the re-use of mines is an important, but under-researched, topic that has not received a great deal of attention in the research, policy or industry literature. In consequence the repurposing of mines in Australia and elsewhere appears to be unsystematic, with solutions and processes tailored to the circumstances of each location and dealt with as an individual project, rather than an instance of a global, system-wide, trend. This in turn has resulted in relatively few sites being repurposed, with consequent costs with respect to undeveloped opportunities for industry participants, the local community and region, as well as broader national economies. However, around the globe there are innovative examples of the re-use of mines and these instances provide examples of how to find better solutions to the challenges of mine reuse.

This Preliminary Report has drawn together some of the work that has attempted to provide a more comprehensive insight into mine closures and the reuse of those sites including the ICMM (2019) *Good Practice Guide*, the guide from the Australian Government (Commonwealth of Australia 2016) and published work by Bainton and Holcombe (2018), as well as the Knowledge Hub produced by the Centre for Social Responsibility in Mining. Overall this body of work provides an important, and valuable, starting point for better understanding mine reuse, but more needs to be done in this important area of research and practice if Australia is to make better use of the opportunities embedded in mine sites.

To sum up, there is no single notion of best practice in mine closures. The mining industry and community perspectives operate from the assumption of limited government regulation of the process. The Australian Government's (Commonwealth of Australia 2016) guidelines promote the use of regulatory controls and extend the closing firm's responsibility beyond management of the immediate repercussions of closures. The ICMM and the Australian Government guidelines both conclude that the responsibility of firms does not continue indefinitely after closure, which implies setting an agreed time limit on the firm's responsibilities. This also implies that the benefits of mine ownership – which may include rights such as access to and use of water – are also time limited. The strength of this literature is its detailed knowledge of rehabilitation issues. However, as Table 1 has shown, there appears to be limited knowledge within the broader academic literature or mining community of success in re-purposing of mine sites despite highly impactful research including that undertaken by Holcombe and Keenan (2020).

The research is focused on seven key research questions and it is possible, through the work undertaken to inform this Preliminary Report, to provide interim solutions to some, though not all of these issues.

► RQ1: What can we learn from national and international experience with respect to the re-purposing of mines?

We can conclude that the repurposing in mines for economic, social and environmental benefit is more common than is acknowledged by the public, the mining industry or academic research. Around the world former mines are used for a wide diversity of purposes, and while not all mines, or all types of economic activity, are appropriate for re-use, there is considerable potential to add to community and regional wellbeing through such transformation.

Often mines represent both unique regional assets, and important concentrations of infrastructure that should be repurposed for the betterment of the host region.

► **RQ2: What are the adverse impacts of current closure planning processes which often set out what is to happen once a mining closes, without detailed analysis of all potential options?**

Current planning processes in Australia bring with them a range of unintended outcomes. Where these are negative, much of this impact comes from a perspective that emphasises the desirability of rehabilitating sites while simultaneously paying little attention to the potential re-purposing of these places.

In many instances, there is little scope to consider alternative land uses and their economic, social, or environmental benefits.

► **RQ3: What are the optimal conditions for the re-purposing of sites with respect to location, mine type, engagement with the community and broader regional planning processes?**

To date, it is not possible to shed substantial new insights into this Research Question, except that it would appear reasonable to conclude that many mine types, in many locations, have the potential for reuse. This translation from potential to reality is, however, dependent on regulatory requirements, the types of re-use available within the characteristics of the site and the current technological envelope, the economic viability of re-use and community acceptance.

Importantly, it is clear from the work of Bainton and Holcombe (2018), the Government of Australia (2016) and Weller et al (2020) that early engagement with the community and regional planning processes is essential.

► **RQ4: How can the re-purposing of mine sites better incorporate long-term community priorities?**

The review of the literature has highlighted the importance of early engagement with the community, or communities, affected as well as with government agencies and other decision makers.

► **RQ5: Is repurposing best enacted immediately post mine closure, or is it better placed – and more likely to come to fruition – after a significant period has elapsed?**

It is clear from the evidence globally that some mines have been repurposed relatively soon after closure while others have been repurposed after a considerable period has elapsed. All things being equal, it would appear that in Australia a site is more likely to be repurposed successfully if planning for its re-use is well under way prior to closure and that change is implemented in a relatively speedy fashion. Timing is important for a number of reasons, of which the need to act before infrastructure is removed, or the site degraded, are prominent.

► RQ6: What do we understand as current thinking or best practice in this field?

It is difficult to document best practice in mine repurposing as while the ICM (2019) and Bainton and Holcombe (2019) have both provided important insights, there are few insights into the practices currently followed by mining companies currently. Industry informants suggest that many mine operators seek to repurpose mine sites and routinely consider the opportunities, but there has not been an audit of the uptake of this practice and the impediments firms experience to its realization. This finding highlights the importance of both the work being undertaken by CRC TiME broadly, and the specific activities of the Regional Development theme within the CRC.

► RQ7: What can we learn from case studies drawn from across Australia?

Research Question will be answered by the next stage of this project when the outcomes of a number of case studies across Australia will be presented.

Finally, it is important to restate, that in the longer term we will need to develop a more comprehensive, systematic perspective on mine reuse that provides scope to take full advantage of the opportunities these sites present for their host communities and regions. We currently do not know the value of the opportunities that are being foregone because of the failure to consider mine site repurposing as a priority, but it is clear that it comes as a significant lost opportunity for Australia.



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