

# Re-thinking our model of mine rehabilitation and closure—is it time for a new model of mined lands stewardship?

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## Abstract

*In Australia, as in many jurisdictions, (apart from the USA where the situation is more complicated) earth resources are typically owned by government. Mining companies apply for mining leases to extract those resources. A royalty is paid to the government as consideration for the extracted resource. Extracting mineral and petroleum resources has impacts. Open cut mining creates voids and out-of-pit waste structures. Underground mining may result in subsidence and waste structures on the surface. Ore beneficiation creates waste streams that can lead to environmental impacts, such as the daylighting of materials long sequestered underground. Many long-lived mines have not retained viable topsoil, or those that have can still face deficit challenges, simply from the new geometry and bulking volume of disturbed materials forming waste structures. These impacts are well-known and have been apparent for decades. When governments approve a mining lease, the expectation is that the land will be restored to its pre-mining state, that ecosystems can be restored, that agricultural lands can be reintroduced into production. However, we see that globally, the examples of complex mines returning to a safe, stable, non-polluting state, capable of sustaining a post-mining land use, are modest, to say the least. Yet we see this expectation or variations on it, persist around the world. At the same time global demand for natural resources, especially those facilitating the transition to a low-carbon economy, continues to increase. It is time to explore new paradigms of mined land stewardship - models in which governments and miners take on new responsibilities for the impacts from natural resource extraction. A new paradigm would not see regulators and miners so much 'meet in the middle' as move respectively towards management regimes that protect our limited natural resources, the environment, and the social-ecological systems in which mines operate. This paper reviews the status of 'successful' mine closure, presents some of the behaviours apparent in the industry regarding mine closure, and proposes some potential opportunities to re-imagine the mine closure task from a liability-laden burden to a long-term stewardship model.*

**Keywords:** *progressive rehabilitation, mine closure, stewardship models*

## 1 Introduction

*'Despite decades of mine closure research and rehabilitation activities, there are limited examples within Australia of mining operations closing successfully and allowing relinquishment of mine tenure.'* Tiemann et al (2019 p.1451)

The term 'mine closure' is commonly referred to in legislation and best practice guidance and has been the subject of widespread academic investigation (e.g. Keenan & Holcombe, 2021). However, the term itself encompasses a variety of actual states of non-operation of mines. Whether a site has been closed temporarily under 'care and maintenance', disclaimed and abandoned, or has progressed through full rehabilitation to final relinquishment, the term closure has been applied. Closure may not always be final and sites that have been ostensibly 'closed' may return to operation as technology, demand and economics make lower cut-off grades commercially viable (e.g see Mudd, 2010 and Figure 2).

Lebre et. al. (2021) undertook a global scan of 'mine life cycle disruptions'. Their research highlighted the iterative nature of mining, with projects frequently vacillating between commercial operations, care and maintenance, unplanned and premature closure and changes of ownership. Figure 1 shows their conceptual model of these disruptions in a mine life cycle.

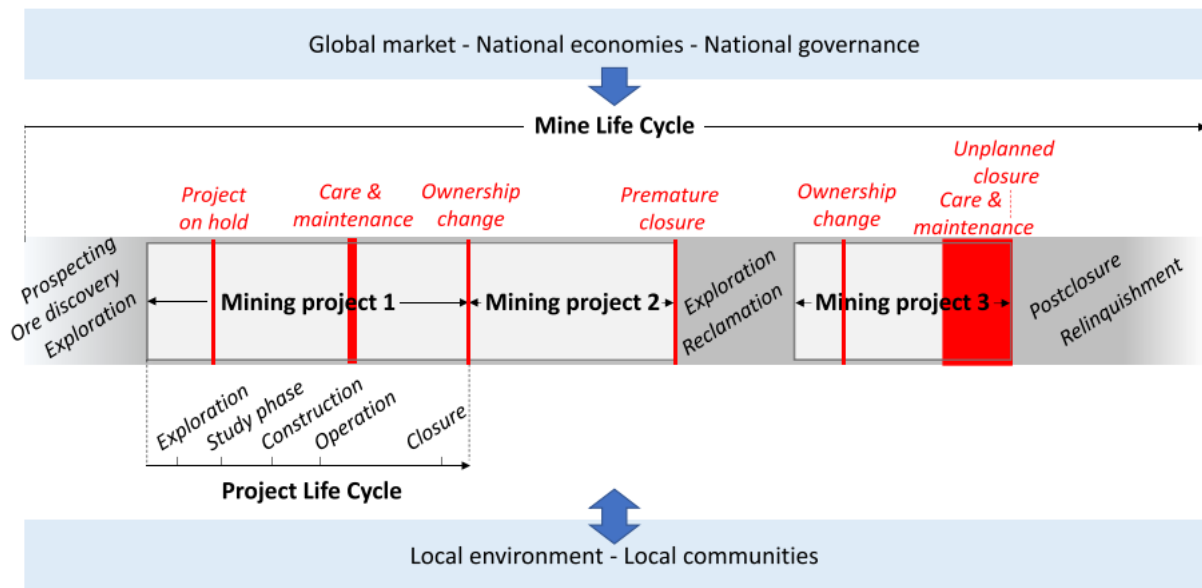


Figure 1 Disruptions in the mine life cycle and the extractive system (Lèbre et al., 2021 p.4325)

These iterations challenge the prevailing paradigm of mine closure. Relatively few mines completely exhaust the resource in a single iteration. If mining is considered a temporary land use (Holcombe & Keenan, 2020; Keenan & Holcombe, 2021), ‘post-mining land uses’ might also be considered as temporary land uses, occurring between mining disruptions. Such a view changes the paradigm of mine closure from a state of finality, to one where mined lands are used in a series of temporary land uses including potentially a return as a mine, should residual resources become commercially viable. Thus, mined lands can be re-imagined under a new vision of stewardship.

Figure 2 depicts the history of commercial extraction of copper, by way of illustration. Improvements in extraction technologies continue to make lower grades commercially viable, as does increasing global demand for these commodities. Apposite to mine rehabilitation, Mudd (2009) also notes that as ore grades continue to decline, so too the ratio of waste rock to ore increases, thereby magnifying the rehabilitation task, particularly since the 1990s.

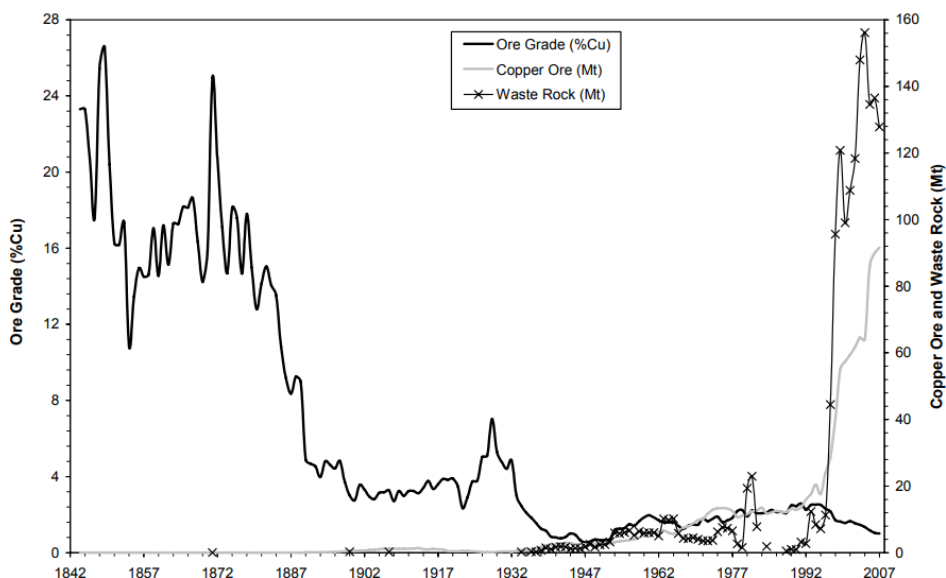


Figure 2 Indicative ore grades over time—copper (Mudd, 2009 p.70)

Progressive mine rehabilitation runs the risk of sterilising future resources. Miners are rightly concerned that future changes to mine plans, or new development will result in ‘dehab’ of previously rehabilitated areas (e.g. see Muswellbrook Coal Company Limited, 2014 p. 85). Miners argue that forced schedules of progressive rehabilitation may sterilise future probable resources (e.g. BHP, 2018 p. 12).

Relinquishment, as opposed to ‘mine closure’ infers that the mining company has completed its requirements for a mine to move to its post-mining land use, as opposed to abandonment, cessation of operations, or even long-term care and maintenance or monitoring.

Commentators have questioned whether this is even feasible, especially for those mines with large amounts of land disturbance or complex geochemical residues (e.g. Sanders, J. and Murphy, 2019). The International Council on Mining and Metals defines relinquishment as follows:

*‘Relinquishment occurs when ownership, residual liabilities and responsibility for a former mine site can be returned to the corresponding jurisdiction or original owner, or transferred to a third party, following completion of closure activities and satisfying the agreed success criteria. If ongoing maintenance and management is required, the responsibility for this under relinquishment would also transfer to the responsible party.’* ICMM (2019 p.59)

Even after relinquishment, some jurisdictions retain the right to pursue the miner should unforeseen costs or liabilities arise. The ICMM (2019 p.60) noted that both Canadian and US jurisdictions retain some lien over mining companies. In Canada for example, the Saskatchewan Institutional Control Program states *unforeseen impacts remain the responsibility of the ‘person responsible for the discharge’* Saskatchewan Ministry of Energy and Resources (2018 p.8).

New South Wales, Australia, also retains the right to pursue costs post-relinquishment:

*‘... regulatory action may be taken against the former lease holder based on the circumstances and nature of the issue.’* NSW Resources Regulator (2021 p.17)

The ICMM identified that, in Australia:

*‘Over the past 25 years ... 70 per cent of mines in Australia have undergone unplanned closures for various reasons, including economic, technical, regulatory, social and other unforeseen circumstances, leaving few examples of successful relinquishment.’* ICMM (2019 p.60)

Holcombe and Keenan (2020) reviewed the global Standard and Poors database to interrogate mine closure. The assessment revealed not only the paucity of successful relinquishment but also the likely disparity in definition of mine closure. Table 1 shows their analysis. The authors do not suggest the results to be either exhaustive or definitive, rather they indicate a trend in mine closure globally.

**Table 1 Activity status of ‘closed operations’ reported in Standard and Poor’s database (Keenan & Holcombe, 2021 p.3)**

Activity status	Number of cases
Abandoned	1
Active	1
Care and maintenance	21
Inactive	1719
No info	2
Rehabilitation	49
Relinquished	1
Temporarily on hold	2
Under litigation	2
(not specified)	6
Total	1804

This paper explores several international jurisdictions and their models of mine rehabilitation and closure. It then reviews the performance of mine rehabilitation and closure in those jurisdictions. Finally, it proposes that failures in successful rehabilitation and closure require a new model of mined lands stewardship that involves all stakeholders that benefit from the mining of our precious natural resources. More research is required to refine the details of such a model.

## 2 Models of mine rehabilitation and closure governance

*‘There is no such thing as a zero risk closure, however, many regulators see this as the only acceptable outcome.’ Anglo American (2019 p.3)*

Many jurisdictions have developed statutes and guidelines requiring mining companies to prepare progressive rehabilitation and mine closure plans (e.g. Faizuldayeva, 2016; Kabir et al., 2015; Morrison-Saunders et al., 2016; Tiemann et al., 2022). The World Bank (2021 p.5) recommends all countries with mining activities require closure plans. The level of specificity on what final landforms and post-mining land uses are acceptable is more variable, but nevertheless guidance is provided. Financial assurance in the form of cash, bonds, bank guarantees or other sureties are also common provisions (e.g. see Sassoon, 2009). However, the actual process of successfully closing a mine, relinquishing the tenures that were conferred upon the site, and releasing the site to its underlying landowner or next landowner, appears opaque (Butler & Bentel, 2011).

Guidance commonly stresses the need for stakeholder consultation and support for post-mining landforms and land uses (e.g. ICM, 2019; World Bank Group, 2021). However, the complexity of the rights and interests of landholders post-mining (such as native title rights, conflicting post-mining land use aspirations between pastoralists and conservationists) may contribute to the paucity of contemporary mine relinquishment cases globally. This section briefly reviews some jurisdictional models from Canada and Australia.

## 2.1 Saskatchewan, Canada

In Canada, mines require closure plans by law and the Towards Sustainable Mining Framework commits signatory companies to mine closure planning including a commitment to consultation with communities of interest (Mining Association of Canada, 2021).

The Saskatchewan Ministry of Energy and Resources (2018) maintains a registry of relinquished mine sites under its Institutional Control program (ICP). The ICP is a voluntary system and applies only to Crown Lands. The ICP also manages two Institutional Control Funds – the Monitoring and Maintenance Fund and the Unforeseen Events Fund. Funds are either administered or invested following advice from the Institutional Control Advisory Committee. The requirements for release of a miner’s obligations are similar to the Queensland context; an *Application for Release from Decommissioning and Reclamation* must be made to the regulator, demonstrating compliance with the conditions imposed on the site, and the monitoring results during the ‘transition phase’ (nominal minimum period 10 years). Contribution to the two funds is analogous to the residual risk payments required in Queensland.

Responsibility for management of the sites once released falls to the provincial Ministry of Energy and Resources. Importantly, the ICP provides limited absolution from liability and particular aspects of future, unforeseen impacts remain the responsibility of the ‘*person responsible for the discharge*’ (Saskatchewan Ministry of Energy and Resources, 2018 p.8). The 2018 amendments allow for sites to transfer out of the ICP to a ‘*responsible person*’ for future development (p.9) and the transfer requirements suggest the primary land use would continue to be resource extraction, although at the date of publication (2018) no sites had transitioned out. According to the Ministry of Energy and Resources Annual Report for 2021-22, 30 sites were managed in the ICP (Saskatchewan Ministry of Energy and Resources, 2022 p.15) although many sites listed are satellite workings or mine features associated with a smaller number of former operational mine sites.

Upon application to enter a site into the ICP Registry, the operator must relinquish the ‘*associated mineral dispositions*’ and surface leases (Saskatchewan Ministry of Energy and Resources, 2018 p.18). As stated above, this relinquishment does not absolve the operator from future liability, unlike mine relinquishment in Queensland. However, the ICP process does transition former mine sites and any associated rights to mine the resource from the operator to the province, at least on Crown Lands.

The first mine to complete its reclamation requirements and enter into Saskatchewan’s ICP was Cameco’s Contact Lake gold mine. The mine opened in 1995, closed three and a half years later in June 1998, and was rehabilitated in the intervening period to 2008 (Butler & Bentel, 2011).

## 2.2 Australia

As early as 2006, the Australian Government had called for *establishment of formal closure, sign-off and relinquishment mechanisms* (Australian Government 2006).

The Australia Institute, in its submission to the Senate Committee on mine rehabilitation (Commonwealth of Australia, 2019) stated:

*‘Mine closure, complete rehabilitation and relinquishment of the former mine site is almost unknown in Australia...There are no examples of major, modern open cut mines completing rehabilitation to the point where the site can be relinquished.’* (Campbell et al., 2017 p.4)

Kung et. al. (2020) identified that no Australian jurisdictions had a clear relinquishment pathway, nor several other jurisdictions reviewed;

*‘Few of the jurisdictions reviewed set up a clear pathway to relinquishment. In Australian jurisdictions, no pathway is mapped out, and criteria to demonstrate successful completion of the closure process are ill-defined. The same applies in Brazil, New Zealand, the Philippines and South Africa.’* Kung et. al. (2020 p.18)

During 2023, the Office of the Queensland Mine Rehabilitation Commissioner met with resources regulators in New South Wales, Victoria and Western Australia, to gain greater understanding of the practical implementation of mine rehabilitation and closure regulation in those states.

### 2.2.1 *Western Australia*

The Western Australian Department of Mines, Industry Regulation and Safety oversees that state's Statutory Guidelines for Mine Closure Planning (Government of Western Australia, 2020) that were initially published in 2011 (version 1.0) (Faizuldayeva, 2016). Similar to many jurisdictions, mines in Western Australia must articulate the rehabilitation outcomes required and agreed:

*'...post-mining land use(s) that has been proposed or agreed with key stakeholders, including regulators.'* Government of Western Australia (2020 p.4)

Approximately 23 million hectares, over 85 per cent, of land in Western Australia is Crown Land (Department of Planning, Lands and Heritage, 2022), with various forms of leases provided to land users. Notwithstanding native title rights and interests, this results in the majority of mined lands being relinquished back to the state as the owner.

Formal processes for tenure relinquishment were identified as lacking in 2017 (Finucane-Woodman, 2017). The author identified three mines as having successfully achieved mine closure and tenure relinquishment – Bottle Creek gold mine, Jarrahdale bauxite mine and the Yoganup mineral sands project. Finucane-Woodman (2017) also observed that a disproportionate amount of research had been focused on closure, with relatively little regard to the need for processes to work through relinquishment.

Young (2018) described the WA hearings of the Australian senate inquiry into rehabilitation of mining and resources projects (Commonwealth of Australia, 2019), stating witnesses could not point to a single example of a successful mine closure in the state. However, in 2005, Alcoa successfully relinquished 975 ha from the former Jarrahdale bauxite mine as cited above. A 'certificate of acceptance' was issued by the then Department of Conservation and Land Management, after recommendations from a multi-departmental Mining and Management Program Liaison Group (Grant, 2006). The land reverted to the protected area estate managed by that department. More contemporary examples of successful relinquishment are more difficult to identify.

### 2.2.2 *Victoria*

The Victorian Earth Resources Regulator's *Guideline: Preparation of Rehabilitation Plans* (Earth Resources Regulation, 2020 p.22) states that rehabilitated mine lands *should be able to achieve a post-mining land form that requires little to no ongoing maintenance as a result of mining activities.*

A meeting was held with Earth Resources Regulator (ERR) personnel in Melbourne on 15 March 2023, to clarify the Victorian position with respect to records of progressive rehabilitation and mine closure processes. ERR staff confirmed that few mines had ever been relinquished under contemporary environmental regulation. Some sand mining in the Murray basin (Iluka Resources) was identified as having been rehabilitated and returned to the freehold owners of the properties. Anecdotally, staff advised that the portion of the brown coal (lignite) mine currently operating as Yallourn previously known as Yallourn North, had been relinquished. However, no further details were available to confirm this.

A site inspection of the former Alcoa Anglesea brown coal mine was completed on 16 March 2023. The mine and adjacent power station ceased operating in 2015 (Alcoa, n.d.). Mine rehabilitation works have continued since closure. Substantive landform shaping was completed by 2023, with a final void proposed to be water-filled via groundwater pumping. Although the final landform configuration has been formed to host a water-filled void, the final approvals for water allocations were yet to be resolved.

The mine overlies a combination of freehold and crown lands, and as of 16 March 2023, negotiations were ongoing to finalise potential land swaps and a process for handover of mine lands (under both tenures) to the underlying landowner, the Department of Environment, Energy and Climate Action. Relinquishment processes are considered to be bespoke for the site.

The Mineral Resources (Sustainable Development) Act 1990 (MR Act) provides the head of power for the establishment of the Victorian Mine Land Rehabilitation Authority (MLRA). Similar to many jurisdictions, the Act requires ‘declared’ mines to prepare plans outlining a progressive rehabilitation schedule and a post-closure plan, which will remain in place despite any change in title (Tiemann et al., 2022).

Section 84AZZF of the MR Act allows for the transfer of land to the MLRA. This arrangement is unique amongst Australian states and territories in that a government entity is empowered to assume responsibility for these mines upon successful completion of their registered post-closure plan. As of January 2023, the Hazelwood mine was the only closed mine of the three declared mines. The rehabilitation program is yet to establish a clear strategy to achieve relinquishment and any handover to the MLRA is decades away.

The Victorian Government cited as a case study, its agreement with CopperChem Limited for the ongoing rehabilitation and monitoring of its tailings storage facility for the Stockman project. The Victorian Government is to receive a *payment immediately prior to the closure of the site, following the cessation of mining and completion of site rehabilitation* (Government of Victoria, 2018, p.28).

The project, subsequently owned by Aeris Resources, including an existing tailings storage facility, remained in feasibility study stage in 2023 and the arrangement is subject to recommencement of the activity at the brownfields site. The agreement requires WHSP Stockman Pty Ltd to fund the total cost of monitoring and maintaining the Tailings Storage Facility in perpetuity by making a payment to the state. The process to relinquish tenure to a subsequent landholder remains opaque. While this is the first agreement of its kind in Victoria, the project is in its nascent stages and the closure arrangements will be years into the future.

### 2.2.3 New South Wales

New South Wales requires a similar suite of mine rehabilitation commitments and plans as other jurisdictions reviewed. A 2017 audit recommended a suite of reforms to address perceived shortcomings in mine rehabilitation regulation including improving mine closure plans, a refresh of the rehabilitation cost calculator, improved oversight including addressing mines in care and maintenance and to explore the merits of a ‘sinking fund’ (Audit Office of New South Wales, 2017 p.4-5).

Initial environmental impact assessment reports are required to outline the proposed rehabilitation plans, and Mine Operations Plans outline progressive rehabilitation during operations. Clause 5 Schedule 8A of the Mining Regulation 2018 requires progressive rehabilitation to occur ‘*as soon as reasonably practicable.*’ Financial assurance bonds are held for rehabilitation liability similar to other jurisdictions.

Effective 1 July 2021, large mines are required to produce an annual rehabilitation report. A number of mines reviewed in this early period of reporting were providing information in a variety of forms (BHP, 2020; Glencore, 2021; Yancoal, 2021). BHP Mt Arthur reported 4,152 ha disturbed, 1,182 ha under active rehabilitation and zero certified (BHP, 2020 p.67). Glencore presented the section on rehabilitation (1.71) but no data (Glencore, 2021). Yancoal reported in calendar year 2021 481 ha disturbed, 227.7 ha completed (the exact same amount the previous year and forecast for the following year), and certified areas not reported (Yancoal, 2021). The quality and consistency of rehabilitation reporting will hopefully improve as operators become familiar with the requirements.

The New South Wales Resources Regulator (NSW Resources Regulator, 2021) provides guidance documentation and application ‘form and way’ documents for mine closure and relinquishment of mining leases and environmental and planning approvals. The New South Wales legislation allows the government to seek redress from miners after relinquishment should rehabilitation fail ‘*(e.g. where there has been a*



*revegetation failure*)’ (NSW Resources Regulator, n.d. p.3). A section of Glencore’s Westdie Open Cut operations in the Hunter Valley is cited as the first coal mine rehabilitation in New South Wales to achieve certification ‘under contemporary mine rehabilitation criteria’ (Glencore, n.d.). The certification issued in 2020, was for 38 ha. However, the Timbarra gold mine successfully relinquished its two mining leases in 2012 (Barrick Australia, 2012a, 2012b).

The controversial gold mine ceased operations after only six months, in October 1999 (Barrick Australia, 2012a p.5). Closure planning and stakeholder consultation commenced in 2000. One underlying landowner, Forests NSW, accepted the site back after the leases were sequentially relinquished in 2012. Leases were also relinquished over that part of ML1386 owned by a private freehold landowner, who agreed to accept the land returned. As with other case studies of successful mine relinquishment, the process followed a bespoke arrangement; the mines department (the then Department of Trade and Investment, Regional Infrastructure and Services (Division of Resources and Energy)) represented the NSW government in negotiations on behalf of Forests NSW.

### 2.2.4 Mine closure in Queensland

Only one mine, New Hope Group’s Chuwar thermal coal mine, has been successfully relinquished (Chan, 2022). The Chuwar mine consisted of two open cut pits with adjacent spoil dumps. The mine did not host wash plant, maintenance or load out facilities and thus was very modest in size and complexity. No other mines in Queensland have been closed under contemporary environmental legislation, that is, since the assent of the Environmental Protection Act 1994. Abandoned mines (approximately 120) remain under management by the state. Figure 3 shows the two small rehabilitated open cuts at Chuwar.



Figure 3 New Hope’s Chuwar mine rehabilitated voids (reproduced with permission)

The Mount Morgan gold mine near Rockhampton, central Queensland, was surrendered to the state of Queensland in 1991. ‘An Agreement between the State of Queensland and Mount Morgan Limited on Decommissioning of Mining Leases at Mount Morgan’, was signed in March 1991 (The State of Queensland, 1991). In 2023 dollars, the mine produced around AUD16B (~USD11B) worth of gold and copper during its life. The company completed limited rehabilitation works and paid the government AUD 300,000 to cover ten years of monitoring and water pumping. Mount Morgan mine continues to be managed under the Abandoned Mine Lands Program in the Queensland Government.

In Queensland, ‘stakeholder consultation’ must be demonstrated in mine closure documentation. The Queensland Government (2021) cites the following legislative requirements:

*‘In accordance with section 126C(1)(c)(iii) and (iv) of the EP Act, the rehabilitation planning part of the PRC [progressive rehabilitation and closure] plan must include:*



- *details of the consultation undertaken by the applicant in developing the proposed PRC plan, and*
- *details of how the applicant will undertake ongoing consultation in relation to the rehabilitation to be carried out under the plan.'*

Section 264A(2)(b) of the Environmental Protection Act 1994 requires

*'details of the consultation with affected owners and occupiers about*

- (i) Any assumptions made in relation to the rehabilitation or future use of the land; and*
- (ii) The remedial action or ongoing management activities that may need to be carried out in relation to the land...'*

The legislation and guidance are silent on what level of support from stakeholders is required to gain approval for relinquishment. There is an implicit assumption that support is required. Many large mines on freehold land are owned by the miner themselves, thus giving consent to themselves seems redundant. If the government has approved a residual void on a third party's freehold property, how are they to be compensated? One freehold landholder in central Queensland has negotiated the post-mining compensation as part of the initial conduct and compensation agreement (the land access agreement struck between the miner and landholder). What free, prior, informed consent is afforded the landholder? And can they reasonably be expected to assume liability for major engineered structures, such as levee banks, bridges and diversions?

### 3 Trends and performance in mine rehabilitation and closure

Mines can move through multiple stages of activity and inactivity, depending on commodity prices, foreign exchange rates, technology improvements, activism and other drivers. Seldom does a mine close because of the complete exhaustion of the resource (e.g. Laurence, 2006). Mudd (2009) showed commercial cut off grades continue to fall, again driven by the range of factors above.

A common expectation in the jurisdictions reviewed in this paper and others is that rehabilitation will deliver a safe, stable, non-polluting landform, that sustains a post-mining land use. Saskatchewan's ICP (voluntary and confined to Crown Lands) is a rare example of a provincial government directly taking responsibility for mined lands post-mining.

The expectation that mined lands can be returned to a state close to original has been challenged, especially in the case of mines hosting large-scale open cut, or geochemically active ore bodies and more complex chemical extraction techniques. Rehabilitation to deliver alternative landforms and post-mining land uses invites a plurality of divergent views from various stakeholders.

Given the clearly articulated outcomes across jurisdictions, why are there so few mines successfully closed (relinquished) under contemporary environmental regulation? Figure 4 shows a model of the 'regulatory gap' using the environmental regulator as the example.

In jurisdictions where the mineral resources are owned by the state or province, a mining lease is the licence to extract those resources, and the royalty paid the price the government charges for that commodity. In order to obtain a licence, the miner must demonstrate their capability, and commit to abiding by a suite of conditions, including the condition of mined lands upon relinquishment. Government, understandably risk averse, sets high expectations. If miners want a lease, then they must agree to those conditions, and they do. It may be the case that the rehabilitation goals set are technically unachievable, but the miners are expected to agree to such conditions to gain approvals to access the resource. Is it this gap that causes so few complex mines to be relinquished under contemporary environmental regulation?

Each party may have differing objectives, or at best, differing levels of emphasis on the objectives. In mine rehabilitation, a spectrum of external stakeholders - e.g. landholders, traditional owners, local and federal governments, conservation groups, investors and consumers all have legitimate views on the what outcomes are acceptable.

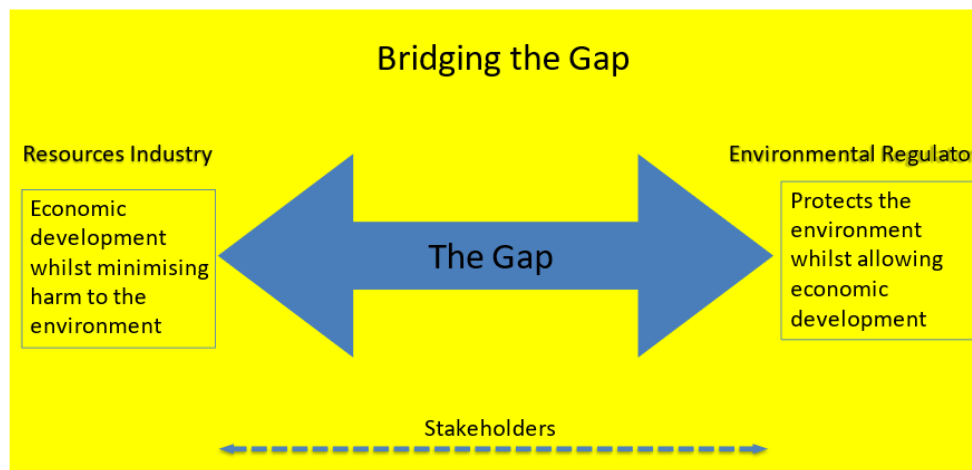


Figure 4 The regulatory gap—a conceptual model

Several key trends affecting progressive rehabilitation and closure planning have emerged in the last decade which have challenged public policy in Queensland, and likely elsewhere. The global decarbonisation movement and demands for new technology minerals have raced ahead of many jurisdictions' reforms (e.g. see Delevinge et al., 2020).

EY's Top 10 Business Risks and opportunities for Mining and Metals 2023 (EY, 2023) identified ESG-related issues as the top priority business risk, and mine closure features as part of this no.1 risk as identified by c-suite executives in the mining and metals sector. It therefore remains an anomaly that so few 'successful' mine closures have occurred.

In contrast, a dichotomy exists between the ESG-related pressure to discourage fossil-fuel based commodities with the growing demand for 'strategic minerals' (e.g. Calvo & Valero, 2022; Giese, 2022). The pressure to discover and exploit the resources credited with enabling a future low-carbon economy may drive exploitation into increasingly challenging social-ecological settings (e.g. Lèbre et al., 2022). The imperative to get progressive rehabilitation and mine closure right grows in response to both sets of pressures.

Concerns have been raised regarding the practice of larger miners disposing of assets to smaller, less capable operators (e.g. Commonwealth of Australia, 2019; Marlow, 2016). Sales of mines in Queensland have seen a change in the counterparty risk profile of the industry. The Queensland Financial Provisioning Scheme Manager noted the following:

*'...a trend has emerged where resource sites are being transferred from stronger, more financially sound entities to entities either with a lower level of financial soundness or lower recourse potential for government being either private equity or foreign entity acquired.'* Queensland Government (2022 p.5)

Unger et al (2020 p.99) are blunt in their assessment:

*'One method mining companies use to avoid tackling financial, social and environmental risks at the end of mine life is to sell the mine.'*

Assets are not only being sold to potentially riskier entities, but companies are using innovative governance structures to separate assets classes. Idemitsu, in its announcement of the sale of the Ensham mine stake to Sungela, highlighted its commitment to carbon neutrality by 2050.

*‘Idemitsu has set a global target to be carbon neutral by 2050 and our operations will evolve accordingly as we seek to diversify and grow our renewable energy and critical minerals interests.’  
Steve Kovac, CEO, Idemitsu Australia, 3 February 2023 (Idemitsu, n.d.)*

Glencore’s April 2023 proposal to Canada’s Teck Resources to merge coal mining assets in 2023 (Parker, n.d.) was rejected by Teck. Teck itself had announced its own demerger into Teck Resources (base metals) and Elk Valley Resources (coal). Despite the proposal being premised on a merger of metallurgical coal assets, Parker (n.d.) reported the new entity would include Glencore’s large thermal coal fleet; an exposure deemed unacceptable to Teck. AGL Energy, Australia’s largest thermal energy producer, recently attempted to spin off its coal-fired energy generation assets (ABC News, n.d.). Shareholder agitation cause the demerger to fail, followed soon after by the departure of the firm’s CEO and Chair. Such changes in corporate business structure demonstrates industry driven change to manage ESG risk.

Mines entering ‘care and maintenance’ represent an existential risk of default on rehabilitation, and represent stranded or under-performing contributors to economic development (Lamb et al., 2015; Marlow, 2016; Pepper, 2020). Butler and Bentel (2011 p.4) noted the disparity between relinquished mines and those retained in care and maintenance, and identified four key reasons for this:

- Inability to demonstrate performance.
- Absence of regulatory procedures (to relinquish).
- Inconsistent expectations.
- Uncertainty in closure objectives and performance criteria.

In Queensland, approximately 10% of the ~AUD 13B estimated rehabilitation cost (i.e. outstanding contingent liability) is held by mines in care and maintenance.

The ultimate failure of policy manifests in mines abandoned by their operators. Queensland has approximately 120 abandoned mines under active management of the Queensland Government. This is of course a global challenge (e.g. Unger, 2017).

## 4 A new model of mined land stewardship

Queensland legislation (and many other analogous jurisdictions) insists that mined land be progressively rehabilitated as land becomes available such that land becomes safe, stable, non-polluting and able to sustain a post-mining land use. Environmental legislation is predicated on an assumption that miners must return land to its pre-mining state, or as close as possible to that state. If successful closure of mines post-mining is the desired objective, then the current performance suggests a manifest failure. Is this failure because miners are shirking their responsibilities or is government policy simply unrealistic – the eggs are broken – or both?

One potential approach (rather than a potential ‘solution’) is that the progressive rehabilitation and mine closure task be re-cast as a shared responsibility of all who benefit from or are impacted by, extraction of mineral resources. The primary stakeholders, miners and governments, need to work more closely to manage mined lands during and after the current phase of extraction. The views and aspirations of other legitimate stakeholders must also be considered. ‘Post-mining land use’ should be seen as simply the next temporary land use in a continuum that can just as readily return to resource extraction and move onto another use (such as mined land rehabilitated to grazing, then moving onto hosting a renewable energy project) and thus that stewardship must ensure we don’t permanently sterilise future resources. Our imaginations of post mine

futures are limited by thinking that residual resources, currently not commercial, will remain so *ad infinitum*; history clearly shows this is not the case.

More research is required to better understand the obligations of miners with the changing expectations of society. One area of research the Office of the Queensland Mine Rehabilitation Commissioner will continue to pursue is the use of a dedicated tenure, a ‘rehabilitation tenure’ that may provide the circuit-breaker required. Mined lands may be better managed under an interim authority, closing the gap between the very challenging requirements to relinquish mining and environmental permits and the final rehabilitation outcomes quite fittingly demanded by regulators. Miners, with a calculated compensation contribution, might exit sites sooner and a responsible authority assume the funded, ongoing rehabilitation and post-mining land use management, until such time as the site reaches its rehabilitation outcomes, or the site is re-imagined to an alternative post-mining land use.

## 5 Conclusions

Sections 1 -3 can be summarised as:

- Many jurisdictions require mine rehabilitation and closure planning to be an integral part of the mining process.
- Many jurisdictions require progressive rehabilitation, without clear guidance as to the criteria by which regulators would determine when land becomes available for progressive rehabilitation.
- Most statutes require mine rehabilitation and closure plans, without clear specifications of the rehabilitation objectives or criteria for closure, these being left to the proponent to propose.
- Orderly mine closure under contemporary environmental regulatory settings is rare and primarily confined to mines with relatively less complex waste features or landform changes.
- Processes for ultimate mine lease and environmental permit relinquishment are often bespoke, with each case being processed on a case-by-case basis.

As such, we see a gap between the policy and regulatory settings and the actual performance on ground. The gap between the capability and performance of the industry and the expectations of the regulator, manifests as:

- a growth of rehabilitation liability as land disturbance outpaces progressive rehabilitation.
- few mines successfully rehabilitating to a safe, stable, non-polluting landform, able to sustain a post-mining land use.
- larger mining entities exiting fossil-fuel based commodities as decarbonisation pressures mount.
- mines entering long-term care and maintenance.

A new paradigm of mined land stewardship can re-caste the rehabilitation task from an expectation that the eggs can be unbroken, to a model of responsible stewardship of our resources endowment.

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