ACARP Project C25032

Supplementary Report S1

Processes to transfer post-mining lands to agricultural uses in the Bowen Basin: Review, Economics and Analysis

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Research Ethics

This study was approved by the CQUniversity Human Research Ethics Committee (Approval H16/11-305) according to the National Statement on Ethical Conduct in Human Research.

Contents

1. Introduction

Central Queensland's Bowen Basin is an area of intense coal mining activity, featuring the majority of the state's coal mines, including some of the state's largest by export volume (Huleatt and Jaireth, 2009; Queensland Government, 2016). Coal mining is a mature industry in the region, and increasing rates of mine closure over the next decade will require attention from industry and policy makers to ensure there is a well-defined process for closure and change of land use. The focus of this report is to identify the issues associated with land use change post-mining, and in particular, to explore the process for a return to grazing, which is the dominant pre-mining land use in the Bowen Basin.

Coal mining has been a major industry in the Bowen Basin since the mid-1970s, with rapid growth triggered by the resources boom from 2003 to 2012. In 2015 there were 52 operating mines in the Bowen Basin, however five were not operational: Jax Mine in the northern region, and the Blair Athol, Gregory, Norwich Park, and German Creek-Bundoora mines in the central region. The overall age of operations, combined with structural decline in the resource sector, means that there will be an increase in the number of Bowen Basin mine closures, either for end-of-life or for care-and-maintenance.

Land use change is just one of the many agendas that must be considered to achieve best practice for mine closures. However, few examples of mine lease relinquishment have occurred in Queensland to date, with these limited mostly to metals mines; and no final closures of coal mines in the Bowen Basin have occurred. While most attention on closure issues focuses on environmental rehabilitation and standards, issues relating to wider community acceptance and transfer of mining land back to agriculture or other uses are critically important as an underlying pre-requisite of closure. The scale of issues varies between mines, particularly between open cut and underground mines. Open cut mines comprise the largest areas of disturbance in the Bowen Basin, as well as being the sites that require the most rehabilitation, compared with underground mines that have much smaller footprints, with subsidence being the major impact of concern.

Substantial areas of central Queensland are disturbed by open-cut coal mining, with this varying from severely impacted lands to areas in various stages of rehabilitation. EPA (2007) estimated that coal operations in Queensland had disturbed a total of 95,619ha out of a total 146,424ha of mined disturbed land[1] in 2006, with 26,705ha of that disturbed land rehabilitated to some degree. Assuming the then-estimated annual increase of 5,619ha of additional disturbance (EPA 2007) continued to 2016, and assuming that coal mining continued in the same proportion of overall mining lands (65%), there are an estimated 202,000ha of mine disturbed land in Queensland, with approximately 132,000ha attributable to coal mining. This matches closely with the estimates of the Queensland Government (2017), where they identified that 220,000ha were disturbed by mining in Queensland, with only 9% currently rehabilitated. On these estimates, approximately 0.9% of the Bowen Basin land area[2] has been disturbed by mining.

A comprehensive approach to considering disturbance of mined lands involves not only the extent and nature of disturbance, but also the stage of rehabilitation of each domain. The different domains of an ex-mine site (such as pit, tailings, spoil heaps, revegetated areas, off-set zones and locations of

[1] This is only the land disturbed by mining; areas under mining lease or mine ownership will be larger.
[2] The Queensland Government Statistian's Office (www.statistics.qgso.qld.gov.au) reports the area of the Bowen Basin region at 147,838km^2.

decommissioned infrastructure) pose varying degrees of risk and need to be considered separately in packaging for post-mining use (Doley & Audet, 2013; Grigg, Mullen, Byrne, & Shelton, 2006). This is important because progressive rehabilitation is focussed on minimising the net area of disturbance and ensuring that ecological function and/or agricultural production is restored as soon as possible.

As part of the approval process, mining companies are required to identify the subsequent land use to guide closure and relinquishment processes. The Minerals Council of Australia's (MCA) Land Stewardship Policy outlines an aim of "beneficial post-mining land use, this may include future economic activity, conservation or social use" and should be "defined through an ongoing consultation process with regulators and relevant stakeholders" (Mattiske, 2016, p. 46). In the Bowen Basin, most mine lands can be expected to return to agricultural use, particularly beef cattle grazing (noting that sites may have a mix of more productive and less productive land types). Other options for land use include:

- Conservation (this and grazing have been the two most common options provided in Queensland Mining Operations Plans to date).
- Cultural (although this may potentially overlay on other land uses)
- Forestry (however lower rainfall means this is not particularly economically feasible)
- Ecosystem services (e.g. carbon sinks; biodiversity offsets and/or wildlife corridors; these may overlay with conservation options for land use).

The above options are consistent with 'reversion' philosophy (that is, returning the land to the pre-mined state). Other options include innovation for waste management, hydroponics, peri-urban uses and tourism, however these are not 'reversion' options and appear to have been less frequently considered for the Bowen Basin. In the dry, sub-tropical region of Central Queensland, prior uses, lease conditions, surrounding land uses and site characteristics have meant that pasture-based revegetation has been favoured as the rehabilitation strategy, representing about half of the rehabilitated land (Grigg, Shelton, & Mullen, 2000).

Rehabilitated mining lands take time to stabilise and develop pastures and vegetation, so there is no immediate threshold point where land can be transferred to full agricultural use. In many cases post-mining land may need careful management (e.g. low stocking rates) and on-going monitoring in a transition period to agriculture. Some of the current gaps in knowledge around the potential transfer of mining lands back to agriculture include:

- the features of post-mining landscapes that potential agricultural producers may regard as positive or negative;
- the assignment and management of residual risk, monitoring and management responsibilities;
- tenure and contractual arrangements that match the responsibilities; and
- the timeline and process to negotiate appropriate mechanisms and standards for returning mined lands to agriculture.

The purpose of this report is to provide an overview of the key issues in future relinquishment of mines and transfer of land use, primarily focussing on a reversion to agriculture. The report captures work from a desktop review as well as a series of discussions with industry and government stakeholders that have been conducted between March and August 2016. The report is structured in the following way. The policy framework is summarised in the next section, followed by an outline of the stages of mine closure and then an overview of the agricultural sector in the Bowen Basin. Options for returning post-mined lands to agricultural use are summarised in section five. Barriers and the economics of

returning mining lands to grazing are reported in sections six and seven, and research gaps are identified in the last section.

2. Policy and practice of mine closure in Queensland

Mines in the Bowen Basin are regulated by the Queensland Government through the Department of Natural Resources and Mines (DNRM) which issues mining leases, as well as approving surrender or relinquishment of same. In addition, the Department of Environment and Heritage Protection (DEHP) issues the environmental authority (EA) specifying conditions under which a mine must operate, and also certifies that rehabilitation and completion criteria have been met as a precursor to discharge or amendment of the financial assurance (FA) and to relinquishment being approved. The FA is an environmental bond that the holder of an EA provides to the government as security that company will comply with rehabilitation obligations. This is intended to cover any costs or expenses incurred in taking action to prevent or minimise environmental harm, or rehabilitate or restore the environment, should the holder fail to meet their environmental obligations. However, there has been some debate that bonds may not account for full costs of rehabilitation in the event of disaster or closure (Queensland Audit Office 2013).

Plans for closure are initially required in the Environmental Impact Assessment (EIA) process at the time a company seeks approval to mine, and prior to issuing of both an environmental authority and a mining lease. However, mine closure plans appear to be absent or scant for many earlier mines (e.g. those that commenced operations prior to the 1980s). Recently, increased attention has been paid by regulators to the rehabilitation and relinquishment issues and the policy landscape is rapidly changing as the resources sector shrinks. This has resulted in changes such as the *Environmental Protection (Chain of Responsibility) Amendment Act 2016*. This legislation is intended to prevent irresponsible businesses from leaving Queensland taxpayers with costly environmental clean-up bills and ensure that companies, particularly those in financial difficulties, and their related parties properly bear the cost of managing and rehabilitating sites.

After approval, mine closure planning is an iterative process with plans continually revised over the life of the mine and becoming more detailed as production proceeds and knowledge increases. The rehabilitation objectives specified in the EIS must: "address potential environmental impacts; achieve the highest practicable level in the rehabilitation hierarchy (see below); and identify post-mining land uses that are acceptable to the community, local government and any other relevant stakeholders[3]" (Department of Environment and Heritage Protection 2014: 9). The hierarchy of rehabilitation goals delineated by the Queensland regulator suggests a preference for re-establishing natural ecosystems (Doley & Audet, 2013). In descending order of acceptability (Department of Environment and Heritage Protection, 2014), the hierarchy is:

1. avoid disturbance that will require rehabilitation
2. reinstate a "natural" ecosystem as similar as possible to the original ecosystem
3. develop an alternative outcome with a higher economic value than the previous (pre-mining) land use

[3] "The proposed post mining land use must be clearly specified using terms such as grazing (up to a particular intensity), cropping (including type of crop), forestry plantation (for a specified type of wood), habitat (for a nominated species), or return to native vegetation (see next dot point). Indicating that the land will achieve a specific land capability class (DME 1995) will generally not be sufficient description of the proposed land use. The prior land capability and use of the site, the existing uses of adjacent land and the views of landholders when selecting the future land use should be considered" (DEHP, 2014, p. 12).

4. reinstate previous land use (e.g. grazing or cropping)
5. develop lower value land use

A further option is to leave the site in 'an unusable condition or with a potential to generate future pollution or adversely affect environmental values'; however this is likely to be unacceptable to Government.

The Queensland Government regards this hierarchy as the optimal way of ensuring mined land is (i) safe for humans and animals, (ii) stable, (iii) non-polluting (i.e. not generating adverse off-site impacts) and (iv) able to sustain a beneficial sequential land use that is acceptable to stakeholders such as grazing or conservation (Department of Environment and Heritage Protection, 2014, p. 8). This regulatory framework strongly influences choices of post-mining land use and particularly supports level 2 outcomes, "*returning mined land to some approximation of a pristine environment and to conservation functions*" (Harvey, 2016, p. 18). However this goal implies different standards of rehabilitation than may be required to convert land to agricultural production.

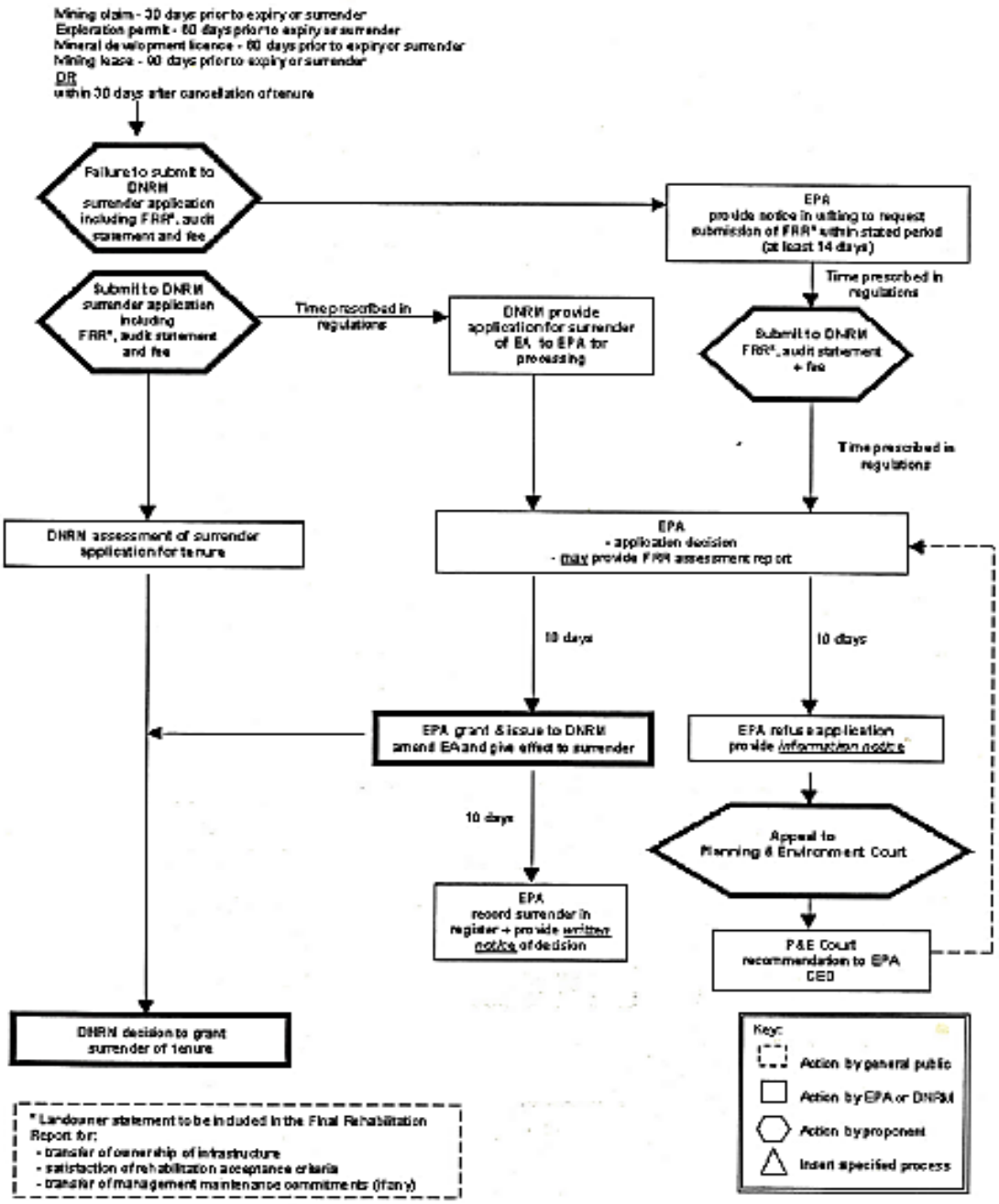
Meanwhile, increasing interest exists in Central Queensland to consider the productive potential of the historical, alternative practice– namely, rehabilitating to pasture. This is closer to level 4 in the hierarchy and aligns with an argument for "*ongoing human and economic occupation of former mine sites …[since] a continuing human presence with economic returns provides the best motivation for, and monitoring of, post-closure site integrity*" (Harvey, 2016, p. 1). It also responds to the livestock industry's criticism of the approaches to rehabilitation used by the mining industry, because, "*traditionally the mining industry focuses on an environmental outcome and not a commercial outcome as well*." [4] Consequently, in the later stages, closure planning typically focuses on the dismantling and removal of unusable infrastructure, decommissioning of the works and plant; and especially reshaping of remaining landforms and 'science-based' rehabilitation of disturbed land as well as financial provisioning for these 'active closure' activities. There has not been commensurate attention to more holistic planning about subsequent productive land uses to leave a positive legacy of future economic activity, conservation, ecosystem services or community use.

At the final stage of mine life, the Queensland regulator requires that a company demonstrate attainment of completion criteria to the satisfaction of stakeholders including government. Recent work has identified both ecological and socio-economic development pathways of post-mining landscapes in relation to the severity of the disturbance impact and the design of rehabilitation approaches. The first regulatory step in this closure process is to receive **certification** by DEHP that the environmental conditions linked to the EA have been met (see Figure 1).

These conditions typically involve rehabilitation of the mining areas to an appropriate standard as well as control of any pollutants. The expectations of rehabilitation standards have increased over time; many older mines have very broad targets. Mining companies have to table plans for the rehabilitation of sites to DEHP, and these are then negotiated towards a standard that will be accepted. Within the industry there are a number of codes of practice or guides that help companies to identify all of the steps involved. For example, the Mine Closure and Completion Handbook (DITR 2006) provides an overview of leading practices (see https://www.qrc.org.au/wp-content/uploads/2016/07/04-LPSDP-Mine-Closure-Completion-Handbook-2006.pdf).

[4] http://www.newhopegroup.com.au/content/projects/operations/agriculture

Figure1: Regulatory process to surrender an Environmental Authority (Queensland)



Source: Queensland Mining Council (QMC) (2001) Guidelines for Mine Closure Planning P. 14

Despite the number of planning processes, it is not always clear what the rehabilitation requirements are (or will be) in the Bowen Basin, due to several issues:

- it is very unclear how final voids will be treated at some mines ;
- the requirements for many older mines were not very specific;
- the type of and approaches to rehabilitation appear to vary between individual mines;

- the target for rehabilitation at many mines has traditionally been to return the land use to grazing, but nature conservation has also been identified as an important alternative at some sites; and
- the process does allow progressive certification to occur (i.e. rehabilitation is signed off as reaching an appropriate standard for part of the mine site), but there has been limited takeup to date[5].

In some cases it appears full ecological rehabilitation is deemed unachievable or financially prohibitive, so long term care-and-maintenance may be a strategy for avoiding rehabilitation (Lamb, Erskine, & Fletcher, 2015). Another strategy is sell a mine as a going concern to a smaller 'mining' party; this transfers the responsibility for closure to a different entity but carries the risk that there may be less capacity to meet all closure responsibilities.

The current practice is to renew the mining tenement until the rehabilitation requirements under the environmental authority have been met. Once certification has been achieved, the second regulatory step is **relinquishment**, involving surrender of the mining lease to DNRM. The four goals to be achieved for relinquishment can be briefly expressed as: 'Safe, Stable, non-polluting and sustains an agreed land use' (DEHP, 2014, p. 13-16). Relinquishment (or surrender) implies that the mining company is no longer responsible for any residual risks, although some level of financial or other assurance may be retained or levied alongside relinquishment to cover residual risks. Ideally, relinquishment occurs when residual risks are very low; however, the time frames involved and the thresholds for residual risk are currently not well defined.

Where the tenure has ended, there is no certainty of access to complete rehabilitation and environmental management works if the company does not have separate title to the land. Authorisation of access must be gained by another method, for example by the environmental authority holder obtaining an entry order from a Magistrates Court to enter the land to meet their environmental requirements under section 575 of the Environmental Protection Act 1994 or a mechanism under other legislation. These alternatives can be complicated and may not provide timely access to the EA holder or to subsequent users especially in the case where native title rights must be considered. This has been highlighted recently in the case of North Stradbroke Island, where there was a special amendment to legislation to respond to the desire of North Stradbroke Island's native title holders to regain the greatest possible use and enjoyment of their traditional lands, while providing the authority needed for an ex-leaseholder (or its rehabilitation contractor) to access land to fulfil it rehabilitation obligations (an authorisation for rehabilitation activities under chapter 13, part 4 of the *Mineral Resources Act 1989*). Different interpretations by stakeholders of standards and indicators show how open the criteria are to interpretation with some regarding seeded land as 'rehabilitated' compared with others whose measure of rehabilitation focuses on the degree of land stabilisation.

The final step in the process is for the land to be transferred to its new use. This could involve a transfer of title (which only relates to surface rights). Transfers in ownership (i.e. freehold title) can occur independently of the certification and relinquishment stages which relate to sub-surface rights and responsibilities. However, the fourth of DEHP's rehabilitation criteria (sustaining an agreed land use)

[5] The only example of progressive rehabilitation being signed off to date relates to an area of underground mining (Kestrel Mine).

does not speak specifically to a particular type of subsequent land use. As well, it does not specify the time horizon over which the sustainability of a subsequent land use must be demonstrated.

3. The stages of closure and land use change

There are three time frames to consider once a mine ceases production. The first stage involves the completion of rehabilitation activities, noting that mines should be progressively rehabilitating through the mining period. Some areas of a mine site may not be available for rehabilitation until shutdown because of operational needs (e.g. haul roads), so there will normally be a pulse of earthworks, decommissioning of plant and infrastructure, capping and seeding in the immediate closure period.

The second stage of closure is a subsequent 'active management and monitoring period' focused on establishing vegetation, monitoring to confirm that no adverse impacts (e.g. pollution of watercourses or erosion of landforms) are occurring, and remediating any issues that arise (e.g. replanting pasture and trees). Certification is unlikely to occur until this period is completed, and any alternative land use at this stage is likely to be closely controlled (e.g. restricted grazing access) to ensure rehabilitation is successful.

The third stage is an extended passive management and monitoring period, intended to ensure that there are no adverse impacts on site. By this stage all active risks should be managed. The remaining residual risks relate to the risks that some rehabilitation may not be successful (e.g. due to subsidence or erosion) or that there is unanticipated movement of pollutants. Residual risks are expected to diminish over time, however there may need to be controls on land use (e.g. restricted stocking rates, protection against fires) to minimise residual risk. Certification is expected to occur in this period, but may be earlier or later depending on the size of residual risk and other issues.

Closure is negotiated largely on a case-by-case basis, with substantial variation in standards. In particular, older mines have less stringent standards whereas newer operations have more rigorous contemporary requirements (due to more stringent EIS standards and more awareness of best practice).

Given the site variability, the time frames involved and the complexity of the considerations, some stakeholders interviewed for this project - notably the regulators - hold strong reservations about the potential for land use change to play a role in certification and relinquishment until the ecological criteria have been met for a prolonged period. They observe that the prevailing policies and practices result in a number of issues and challenges for mine operators, government authorities and for community stakeholders including aspiring graziers.

One much-debated issue relates to so-called abandoned mines (although this term is a misnomer – since it is often the case that initial rehabilitation conditions were met prior to land use change/relinquishment, but later these have later been viewed as unacceptable). This situation has resulted in liabilities for state government (or the taxpayer) together with concern about increasing that liability by premature sign-off or inadequate surety. This latter point relates not only to the levels of FA held, but also, as revealed in the recent chain of responsibility legislation, to the fact that in future, a responsible party may no longer be solvent or able to be held to account over any rehabilitation failure.

4. Summary of grazing uses in current or post-mining contexts

The Bowen Basin intersects with important agricultural lands in the Fitzroy and Mackay-Whitsunday regions in Central Queensland. The region is predominately used for beef cattle grazing, particularly in the northern part of the Basin. There are more cropping and mixed cropping-grazing land uses in the southern part of the basin, and some irrigation (particularly for cotton) in the Comet, Nogoa, Dawson and Mackenzie River areas.

The quality of land for agriculture varies from very high quality farming land and improved pastures for cattle, to poor quality land that has marginal grazing capacity. In many cases mixes of land types may be found on the same property. Property sizes tend to be smaller in the southern part of the Bowen Basin and larger in the northern part, as well as larger for less productive land types. The scale and ownership of agricultural operations vary, but most can be classified into three groups:

- family owned and operated enterprises (on a single site);
- consolidated large-scale family operations over several properties; and
- agricultural companies.

Mining companies are substantial landholders in the Bowen Basin, as companies typically have purchased the land on which mines are operated from agricultural users. In some cases the companies have converted that land from leasehold to freehold (as companies are precluded from owning some forms of agricultural leasehold title). In many cases the mining operations occur only on a small proportion of the land that is held, for two reasons:

- the original agricultural property was a large block; and/or
- additional land is required for buffer zone purposes.

Mining operations account for approximately 1% of land use in the Bowen Basin, although mining companies own a larger (but unknown) amount of land, as direct mining operations typically occur only on a portion of a land title. As mines are often linear in layout and spread across the Bowen Basin, they are in proximity to a number of agricultural enterprises.

Most mining operations already have some agricultural use, typically using the buffer zone. There are three main types of arrangements for current agricultural use of mining lands:

1. Lease back to original owner (sometimes negotiated in purchase arrangements)
2. Lease to other landholders (usually short term leases to neighbours)
3. Operated by mining company itself.

Many mines also have areas of rehabilitated land. These are more sporadically used for agricultural purposes, often only on a trial basis, as most are still in the 'active management and monitoring' phase. There is limited research evidence about longer-term performance of rehabilitated areas subject to grazing and the most relevant variables by which the performance of these areas could be measured.

5. Options for implementing grazing as a post-mining land use

As mining operations cease, there is potential for mined lands to transfer back to agricultural ownership, with grazing expected to be the major post-mining land use in the Bowen Basin. This is because grazing is typically the land use that existed before mining activities, and the land is regarded as only being suitable for this form of agricultural activity, noting that some mine lands may not be returned to productive use.

There are different opportunities for agricultural use and the mechanisms under which it can occur. Mine lands vary in their suitability for transformation back to agricultural use due to the levels of disturbance and opportunities for rehabilitation. For example:

- un-impacted buffer zones are easy to convert back to agricultural use; many of these areas are still used for agriculture;
- mine periphery areas, such as areas used for roads, have low levels of impact and will require low levels of rehabilitation to be suitable;
- active mine areas, which include mine pits, spoil heaps and coal reject disposal areas will require substantial rehabilitation effort to be suitable for agricultural use.

Notably, not all areas within a mine may be returned to full agricultural use:

- some areas may be deliberately returned to conservation use so as to provide a mosaic landscape mix of conservation and agricultural purposes;
- some areas may be too expensive to rehabilitate to agricultural use; instead they may be only returned to a level suitable for nature conservation or left as an usable area (subject to the requirements of certification);
- some areas and especially some infrastructure, such as roads and buildings, may be left as they may have productive use for future landholders.

Some areas may require specialised management or exclusion from agricultural use (e.g. fire control, controls on stocking rates, sensitive areas fenced off from livestock). These controls may be achieved through lease conditions, contracts or covenants on land title, or with the aid of financial instruments such as bonds.

Landholders considering the use of previous mined areas will assess the value proposition and are likely to consider a range of factors:

- *Risk*/uncertainty (e.g. ability to use/access the infrastructure, concerns about residual risk)
- *Return*/Opportunities (different production possibilities and the level of potential production)
- *Responsibilities* (including legal, financial and ecological)
- *Title* (Freehold or leasehold, plus any covenants or conditions, and whether or not certification and relinquishment stages have been completed)
- *Interruptions* (e.g. where there is potential for ongoing monitoring requirements by third parties)
- *Scale and operational factors* (e.g. site conditions and characteristics including topography, soil types and vegetation cover, water supplies, the size and layout of a production area, available infrastructure, ease of operation, proximity to and compatibility with other holdings) (Bohnet et al, 2011).

The potential for risks, responsibilities and interruptions will be lower in the passive monitoring stage compared to the active monitoring stage, and will decrease further over time. Different types of landholders (small family operations, large family operations and agricultural companies) have quite different capacity to manage risks, responsibilities and interruptions. They may also feature different priorities and management practices, which should be taken into account when designing an adequate process to manage post-mine (pastoral) land use changes. Landholders generally do not have the expertise to manage residual risks from mining areas and may be reluctant to accept any

residual risks and Financial Assurance liabilities (although they may be willing to own post-mine lands that have some areas unsuitable for agriculture).

Mining companies will typically be interested in achieving certification, relinquishment and land transfer in shorter rather than longer time frames. As noted above, land transfer is a separate process to certification and relinquishment, which could happen during or after those stages (depending to some extent on the conditions set for certification and relinquishment and arrangements for site access). Land transfers that occur in shorter time frames are more likely to occur before certification and relinquishment, or within the passive monitoring period after certification when there are still some residual risks and responsibilities.

Mechanisms that may help to speed up the processes include mechanisms that cover the costs of monitoring and residual risks (e.g. bonds, insurance mechanisms) and financial incentives that cover the issues of responsibilities, impacts on clear title, interruptions, and impacts on productive capacity. There are a number of potential mechanisms for transferring mining lands to agricultural use.

1. Continue the lease as a mining title (no transfer to agricultural use)
2. Use long-term leases until residual risk is diminished such that a private purchaser could take it on.
3. 'Stepwise' lease relinquishment (a staged process where the new land owner purchases a lease for only a short period, but is then given first-option for outright purchase).
4. Split the land into parcels of varying characteristics (e.g. voids versus rehabilitated slopes) and treat these under different arrangements (e.g. low impact areas may be sold, and high impact areas put under long term lease).
5. Setting conditions on the land use as it transfers to agriculture (either ecological conditions, or financial conditions such as bonds) so that requirements in the active monitoring or passive monitoring stage can be transferred to landholders.
6. Another option would be to make the choices clearer at the *beginning* of the mine life – for example, some landholders have signed across land for mining uses, on the proviso that it is returned to them on a 'first-refusal' basis at the end-of-mine life.

6. Barriers to agriculture as a post-mining land use

While it appears that agriculture is the major land use relevant to post-mining in the Bowen Basin, there are several issues that mean that the transfer from mining to agriculture may be complex. The major issue is the need for a process that makes closure 'acceptable' but which doesn't discourage mining companies from undertaking it; as if this is not satisfactorily addressed, then the companies may move into an indefinite care and maintenance cycle. A second issue is that no specific process exists for transferring mining lands to agriculture:

- companies have to propose a sustainable final land use but there is little guidance about what process and criteria for this would be; and
- the bulk of attention of both companies and government is on defining and meeting the environmental criteria without calibrating those against final land use.

A third issue is that mining companies may sometimes be reluctant to seek land use change as a way of managing end-of-life scenarios. Companies may be interested in the certification stage but not relinquishment (in case they want to reopen the site in the future). Alternatively, they might pursue certification and relinquishment, but keep exploration rights. For the mining companies, a barrier to

land use change is the loss of control or potential sterilisation of potential resources (i.e. coal deposits under mining land that have not yet been extracted). A parallel effect is the potential reluctance of agricultural producers to purchase post-mining land where remaining coal resources are not sterilised. In this case there may be some risk of future disruption to agricultural production by renewed mining on the sites.

A fourth issue is that the quantification and management of residual risk is a barrier to land use change. It appears unlikely that residual risk should be assigned to future land owners, and the State Government is unlikely to accept the transfer of large residual risks to the Crown/State. The key items that are currently missing include:

- mechanisms to assess residual risks associated with post-mining sites; and
- clarification of the level of residual risks appropriate for transfer to the State.

There are opportunities for mechanisms to cover the residual risks and manage their incidence, such as bond or insurance instruments, or tenure mechanisms and conditions that clearly specify responsibilities. Post-mining land may not be suitable for unconditional ownership because of monitoring and management requirements over all or part of the land, and the potential for some of the post-mining land to be assigned for conservation purposes. Options to handle this with tenure arrangements are not well developed, but could include:

- lease tenure with conditions over management and allowing monitoring access;
- freehold tenure with covenants or contractual arrangements (similar to operation of Contaminated Lands issues);
- realignment of property boundaries to exclude highly sensitive and/or conservation areas from post-mining lands for agriculture; and
- development of a new 'Rehabilitated land title' that meets the various needs of a post-mining landscape, or treatment of some parts of a title area in a similar manner to lands classified as contaminated lands under the *Environmental Protection Act 1994.*

A fifth issue is that engagement with stakeholders and communities about closure processes and post-mining land use seems largely absent. Returning land from mining to agriculture will be one of the most significant land use changes in Central Queensland in the next two decades. Yet there is no coordinated process in place to involve key stakeholders in discussions about the standards, processes and conditions under which this should occur. Initial indications, during short-term rotational and long-term continuous grazing trials a decade ago by Grigg et al., (2006, p. 13) found "Local graziers were typically enthusiastic about the potential for grazing as a post-mining land use, with a number expressing interest in stocking areas of pasture rehabilitation while the mine was still operating".

However, researchers have also identified that landholders have a number of questions about grazing rehabilitated mining lands and that many personal, social, cultural and economic factors may influence their decision-making. In respect of post-mining land use decisions at the interface of policy and practice, "the user perspective may be the ultimate criterion for evaluation" (Hill, 2007, p. 19). For example:

- Landholders and agricultural groups are an important group of stakeholders to involve. The key requirement should be that post-mining landscapes should be available under conditions where landholders would be prepared to accept ownership.
- Local communities and other local stakeholders are a second important group to involve. A key requirement is that the post-mining land uses and the standards and processes to transfer those lands should meet broad acceptance across local and regional communities.

7. The economic returns and flows from transitioning mining leases to grazing lands

The outcomes of the workshops and other research data indicated that, before taking on post-mining land for grazing purposes, a grazier would first consider economic issues across three categories:

- Expected returns from production;
- Direct costs of site maintenance and monitoring; and
- Indirect costs of impacts on title, responsibilities and shared access to site.

7.1 Expected returns from production

Expected returns from production of beef cattle grazing can be estimated from either a herd modelling approach, gross margin analysis, or an asset valuation approach. The asset valuation approach is selected here as the simplest to present because it essentially represents the returns after all variable costs of cattle management have been accounted for. This approach involves two steps:

- Convert sale prices for grazing land in the Bowen Basin into livestock equivalents (value per beast area)
- Convert the values per beast area into annual equivalents.

The annualised beast area values provide an indication of what buyers of agricultural land consider to be the annual return after operating costs have been accounted for. For this study the values per beast area (AE) for grazing properties on better quality land in Central Queensland have been identified from Herron Todd White (2015) (Table 4.1), where there are normally 3-5 hectares per beast area.

Table 1: Land and Beast Values for Central Queensland

District and land type	**Land value ($/ha)**	**Annualised land value (5% discount rate)**	**Beast value ($/AE)**	**Annualised beast value (5% discount rate)**
Moura/Rolleston Scrub	$1,600 - $1,850	$128 - $148	$3,250 - $4,000	$261 - $321
Central Highlands Scrub	$1,250 - $1,600	$100 - $128	$3,000 - $3,500	$241 - $281
Central Highlands Downs	$750 - $1,100	$60 - $88	$2,500 - $3,000	$201 - $241
Alpha Scrub	$675 - $875	$54 - $70	$2,750 - $3,250	$221 - 261
Average	$1,213/ha	$97/ha	$3,156/AE	$253/AE

Data sourced from Herron Todd White (2015).

The results demonstrate that the expected return per beast on grazing lands in the Bowen Basin region are approximately $3,156 or $253 per annum. In area terms, the expected return is $1213/ha, or $97/ha/year. This is the net return, broadly equivalent to average revenues less average operating costs. The implications of these estimates are that if post mining land could be perfectly returned to grazing capability with no additional management requirements or caveats on the title, the expected demand would be approximately $3,156 per beast area or $1,213 per hectare. As the rural property market increases (or decreases) in the Bowen Basin region from those 2015 values, then the values will change accordingly.

There are three important adjustments to these preliminary estimates that may be relevant.

Lower productivity of post-mining lands

Discussions with landholders in the workshops revealed that the productivity of lands rehabilitated to grazing was expected to be lower than standard grazing country. Four reasons were identified for this:

- Not all land in a mined area may be returned to grazing (e.g. voids may be fenced off),
- The water holding capacity of rehabilitated soils may not be as high as intact lands,
- There may be management conditions that limit grazing pressures and activities, particularly in very wet and dry conditions, and
- Pastures on rehabilitated lands may decline over time as the benefits of initial fertilisation wear off.

It proved difficult to identify a ratio of grazing productivity between post-mining pasture lands and un-mined pasture lands. There are few assessments of the results of cattle grazing on mine rehabilitation pastures, although Grigg et al. (2002; 2006) (ACARP Project C9038) are a notable exception. In that study the research identified sustainable stocking rates at sites on the Blackwater and Norwich Park mines of 2.7 and 2.2 ha/head respectively, which were comparable with improved pastures on unmined land in the region. However predicted sustainable stocking rates for a site at the Goonyella Riverside of 5.9 ha/head were lower than on unmined land.

However some indication of expected productivity was generated from the workshops that were conducted as part of this ACARP project. Data was collected from six workshop participants on their assessment of the productivity of rehabilitated lands compared to undisturbed grazing land. Using the mid-points of the categories that were offered (e.g. 0-20%, 20-40% and so on), the average productivity of post-mining relative to undisturbed land was identified as:

- Land that has been open-cut mined, then rehabilitated : 65% as productive
- Land that has been underground mined, then rehabilitated : 80% as productive
- Highly disturbed land, e.g. spoil piles, mining pits, washdown areas : 20% as productive

For the purpose of this exercise it is assumed that productivity will be between 25% - 75% of normal grazing lands:

- 25% means that a lower proportion of the mine site is available for grazing, pastures are not as productive, and there are more restrictions over the grazing of sites.
- 50% means that a moderate proportion of the mine site is available for grazing, pastures are reasonably productive, and there are some restrictions over the grazing of sites.

75% means that a higher proportion of the mine site is available for grazing, pastures are close to being fully productive, and there are limited restrictions over the grazing of sites.

Direct costs of site management and monitoring

There may be additional requirements for management associated with a post-mining land use, particularly for items such as:

- Monitoring
- Weed control
- Firebreaks
- Maintaining fences around exclusion zones
- Water infrastructure (watering points/pipes) monitoring and repair
- Minor repairs (e.g. washouts from cattle pads).

Implicit costs of owning a post-mining property

Landholders on a post-mining site will not have the same unencumbered title and use of the land that would be expected of a normal grazing property. This is because there may be:

- Conditions on the title
- Contractual obligations to manage the land in particular ways
- Requirements to allow access to 3rd parties for monitoring and management
- Risks of rehabilitation failure (particularly in extreme conditions)

One example is available of the expected impact of a mining vegetation offset on the value of a grazing property in the Bowen Basin. The vegetation offset has been contracted by a mining company on a separate grazing property with a total area of 9,000 hectares. This offset is for approximately 200 hectares with annual inspections and monitoring over a 15 to 20 year period. The landholder will not have any direct costs. A Central Queensland valuer has estimated the negative impact of the vegetation offset on market value of the property because of the 'blot on the title' at $50,000 for the 200 ha[6].

Market apprehension about taking on the title over a post-mining land parcel is likely to exist because:

- Banks are reluctant to lend against encumbered titles
- Banks and landholders are reluctant to fund/purchase land with potential risks
- Landholders are reluctant to have conditions or requirements on land

The extent of impact on land values can also be expected to vary according to the area of the land affected and the severity of the conditions involved.

7.2 Bowen Basin Case study exercise:

Assume 1,000 hectares of rehabilitated land is returned from mining to grazing use. The land will require some level of ongoing monitoring and management to ensure that rehabilitation is successful, and this is associated with covenants on the title to ensure that the management conditions are complied with. The additional costs are assumed as follows:

- Maintenance costs = 10 additional days for weed control and maintenance of fences and firebreaks, with machinery and equipment included = $10,000
- Impacts on title = $50,000 x 5 (1,000 ha of land) amortised at 5% = $20,000 per annum

[6] A copy of the valuation has been provided to the research team on a confidential basis.

Table 2 Valuation of post-mining land under three productivity scenarios

Factor	Grazing Land	Post mining land		
		75% productive	50% productive	25% productive
Annual net return (1000 ha x $97)	$97,000	72,750	48,500	24,250
Maintenance costs	$0	$10,000	$10,000	$10,000
Impacts on title	$0	$20,000	$20,000	$20,000
Total annual return	$97,000	$42,750	$18,500	-$5,750

The results of this illustrative example show that expected economic returns from grazing rehabilitated mine lands could vary between 44% and -5% of the returns from undisturbed grazing lands. Values for post mining land will be higher with:

- Increased productivity
- Lower additional maintenance costs
- Lower impacts on title

8. Research gaps and/or priorities

Identifying post-mining land use is an important step to complete rehabilitation and certification processes for mines in closure stages. However the processes by which the land use is negotiated and transferred to the next user/owner within the Bowen Basin are currently not very clear.

Some of the important stages in mine closure are mostly out of the scope of this report: these include rehabilitation standards, the certification process to complete rehabilitation, and the relinquishment process to lift the mining lease. Yet there is some interplay between rehabilitation standards and post-mining land uses, where more 'complete' rehabilitation is likely to be associated with greater potential for subsequent agricultural use, and lower ongoing risks and specific management requirements. Therefore, there may be some relationship between the type and standards of rehabilitation at specific mines and the willingness of agricultural producers to take over the site post-mining.

This review has identified a number of gaps in information and processes relevant to planning for post-mining land uses that are relevant to the scope of this research project.

- One challenge is that there is limited public information about the scale of the problem, such as the areas of land owned by coal companies, area disturbed by mining, and the area already rehabilitated.
- Second, the role of land use change in environmental rehabilitation certification and lease relinquishment is very unclear. It appears that mining companies should nominate the future land use but how this is considered and assessed is not known. In particular the notion of 'sustaining' a land use and 'acceptability' of the land use are ill-defined.
- Third, mechanisms to make post-mining lands attractive to agriculture and reduce the environmental risk of agricultural use of post-mining land are not known. There are a number of factors that will make post-mining lands more or less attractive to agriculture, but no formal structure exists to identify and communicate these to prospective purchasers.

- Fourth, mechanisms to achieve stakeholder and community input into land use change options are largely absent**.** The positions of the various stakeholders are variable and often oppositional – for example, mining companies, state government, peak bodies, neighbouring land owners and broader community (including farming and NRM groups) often have different ideals and drivers. Variations exist even amongst different government departments.
- Fifth, factors influencing the optimal process and timing for land use change to occur seem to be poorly understood. Currently both government and industry processes seem to be focused on the rehabilitation and certification stages of the mining process, and issues relating to the relinquishment and land use changes are much less visible.

These are important issues for both the mining sector and the Queensland Government to address as the industry matures from a growth and development phase to a stage when mine closures become a normal part of industry operations.

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