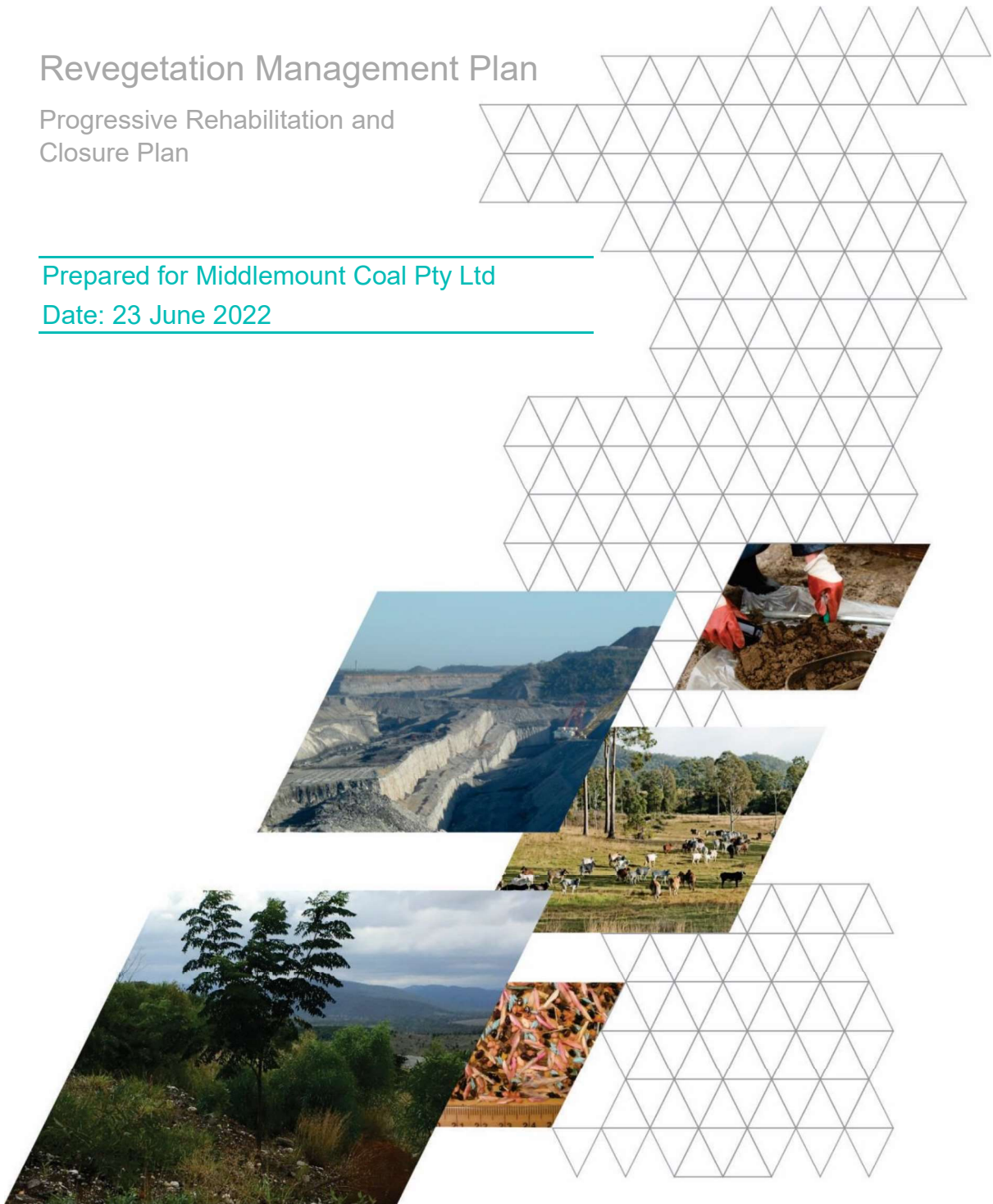


Revegetation Management Plan

Progressive Rehabilitation and
Closure Plan

Prepared for Middlemount Coal Pty Ltd

Date: 23 June 2022



Verterra

Location	Address	Phone
Brisbane, Qld	Level 14, 97 Creek Street, Brisbane Qld 4000	+61 (0)7 3221 1102
Nambour, Qld	c/- TPH, 23 Matthew Street, Nambour Qld 4560	+61 (0)7 3221 1102
Rockhampton, Qld	c/- FBA, Level 1, 80 East Street, Rockhampton Qld 4700	+61 (0)4 3808 7775
Collinsville, Qld	Pelican Creek Road, Collinsville Qld 4804	+61 (0)7 3221 1102
Newcastle, NSW	177 Merewether Street, Merewether NSW 2911	+61 (0)4 2397 6501
Perth, WA	68 Shaftesbury Avenue, Bayswater, WA 6053	+61 (0)4 1790 5644
Hobart, Tas	62 Coolamon Road, Taroona Tas 7053	+61 (0)4 3588 9592
Kigali, Rwanda	C/- Career Centre Bldg, 8 th Floor KG 7AV, Kigali, Rwanda	+250 788 304 070

info@verterra.com.au
www.verterra.com.au

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Laura McCallum
Senior Environmental Scientist
23 June 2022



Toby Roscoe
Principal Mine Rehabilitation Specialist
23 June 2022

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Glossary

EM	Electromagnetic
EOPD	Eastern Out of Pit Dump
RE	Regional Ecosystem
MCM	Middlemount Coal Mine
MCPL	Middlemount Coal Pty Ltd
MSES	Matters of State Environmental Significance
PCRP	Progressive closure and rehabilitation plan
PMLU	Post mining land use
TEC	Threatened ecological community
TSF	Tailings storage facility
TFC	Tailings flocc cell
MIA	Mining infrastructure area
CHPP	Coal handling and preparation plant

1. Introduction

1.1 Background

The Middlemount Coal Mine (MCM) is an existing open cut coal mine located approximately 90 kilometres (km) north-east of Emerald and approximately 3 kilometres (km) to the south-west of the Middlemount Township, Queensland (QLD). The MCM is owned and operated by Middlemount Coal Pty Ltd (MCPL), an incorporated joint venture between Peabody Energy Australia (Peabody) and Yancoal Australia (Yancoal).

On 27 May 2021, the Department of Environment and Science (DES) issued MCPL a transition notice requiring a Progressive Rehabilitation and Closure Plan (PRCP) for the MCM, to be submitted to the administering authority by 30 June 2022. The PRCP is to be prepared to meet the requirements of section 126C and 126D of the *Environmental Protection Act 1994* (EP Act) and the *Guideline – Progressive Rehabilitation and Closure Plans (PRC Plans)* (the PRCP Guideline).

Consistent with the requirements of section 3.6.1 of the *PRCP Guidelines* (DES, 2021) a Revegetation Plan is required to be prepared and included in the rehabilitation planning part of the PRCP.

1.2 Guideline Requirements

This Revegetation Plan has been prepared consistent with the PRCP Guideline, and the requirements under section 126C and 126D of the EP Act. The relevant sections of this Revegetation Plan, which satisfy these requirements, are provided in Table 1.

Table 1: Cross reference of Guideline requirements

Guideline Requirement	Section
<i>Clearly articulate revegetation objectives for the site that are consistent with the Post mining land use (PLMU), Non-use management areas (NUMAs), and rehabilitation milestones identified in the PRCP schedule.</i>	Section 3.1
<i>Identify key flora species including pasture plants and tree and shrub species representative of the proposed PMLU.</i>	Section 7.1.2
<i>Identify any species of conservation significance relevant to the mine’s approval.</i>	Section 0
<i>Identify any fauna habitat and use requirements - where fauna habitat is proposed, a management and monitoring plan to describe how the rehabilitated areas will be utilised by fauna and what other management measures would need to be implemented.</i>	N/A
<i>Include evidence and justification for any analogue sites of the monitoring plan.</i>	Section 9.1
<i>Describe the works for establishing and managing the revegetation, including a description of proposed site preparation and the timeframe for works.</i>	Section 5.1 and Section 5.2
<i>Identify what plant/seed mixes are appropriate for the PMLU and where the mixes will be sourced – locally sourced seed should be used where appropriate.</i>	Section 7.1.2 and Section 7.1.3
<i>Identify seed density application rate and timing of seeding.</i>	Section 7.1.2
<i>Identify the proposed location of any infrastructure required to protect revegetation.</i>	N/A

Guideline Requirement	Section
<i>Identify the growth media that would be suitable to sustain the PMLU and whether this is available on site.</i>	Section 6.2.1
<i>Identify topsoil depth requirements for revegetation success and sustainable PMLU.</i>	Section 6.3

In addition to the above requirements, the following detail has been provided in this revegetation plan:

- Application and incorporation of ameliorants (if required for chemical balance) and bulk ameliorants such as gypsum, lime, and other organic materials.
- Spreading of a growth medium layer (topsoil, topsoil / rock mix, or suitable waste rock material, if appropriate) to a depth suitable for the target vegetation.
- Application of seed and fertiliser.

2. Site Details

2.1 Location

The MCM is an operational open cut coal mine located in the Bowen Basin (QLD), 3 km south-west of Middlemount and 90 km north-east of Emerald. The MCM is owned and operated by MCPL, an incorporated joint venture between Peabody and Yancoal. Operations at the MCM commenced in 2011 with an initial coal production of 1.8 million tonnes per annum (Mtpa) increasing to 5.7 Mtpa by 2016. Mining is undertaken at the MCM by conventional open cut strip mining using truck, shovel, and dozer operations. Coal is processed at the on-site coal handling and preparation plant (CHPP) and transported by rail to port for export (MCPL, 2020).

2.2 Climate

The MCM experiences a sub-tropical climate, with a hot and wet summer followed by a distinct dry winter (BOM, 2021). Average annual rainfall is approximately 600 millimetres (mm) per annum, with a distinct wet season occurring in the summer months, between November and March (Figure 1). Mean temperatures shown in Figure 1 indicate a hot summer (20 degrees Celsius [°C] to 40°C) and a mild winter (5°C - 25°C).

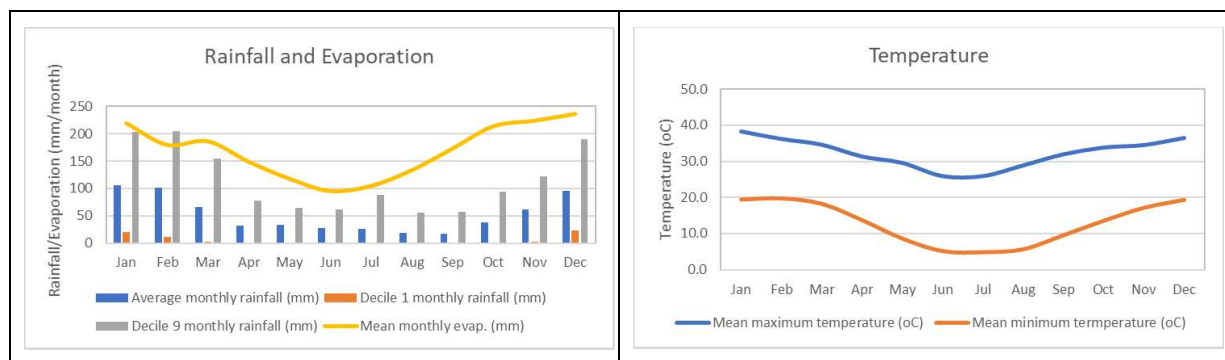


Figure 1: Average rainfall and temperature conditions (after BOM, 2021)

2.3 Pre-clearing vegetation

A broad bioregional description of vegetation communities on, and surrounding, the MCM includes narrow-leaved ironbark (*Eucalyptus crebra*) woodland on undulating plateaus, and bendee (*Acacia catenulate*) or lancewood (*Acacia shirleyi*) on the rocky hills and mesas.

Tertiary sediments are dominated by brigalow (*Acacia harpophylla*) and Dawson gum (*Eucalyptus cambageana*) communities on undulating clay or texture contrast soils. These communities dominate the Isaac-Comet Downs biogeographic sub-region.

Quaternary alluvium is also prominent with fine-textured soils carrying brigalow or coolabah (*Eucalyptus coolabah*) woodlands. Permian sediments are exposed in some areas, supporting grasslands, open woodland, and areas of brigalow (Sattler and Williams, 1999).

A total of 18 Regional Ecosystems (REs) have been recorded and ground-truthed within the MCM Mining Lease Boundaries (ML 70379, ML 70417, ML 700027 and ML 700014) and progressively refined through successive surveys since 2014. Ground-truthed REs are generally represented by Eucalypt woodlands and small patches of Acacia dominated woodland. Of the 18 REs, three are listed as Endangered, and six as Of Concern under the Vegetation Management Act 1999. These are:

1. 11.3.1b (Endangered) – *Acacia harpophylla* and/or *Casuarina cristata* open forest.
2. 11.3.2 (Of Concern) – *Eucalyptus populnea* woodland on alluvial plains.
3. 11.3.2b (Of Concern) – *Eucalyptus camaldulensis* (sometimes *E. populnea* and or *E. tereticornis*) woodland on drainage depressions.
4. 11.3.2c (Of Concern) – *Eucalyptus populnea* woodlands on floodplains.
5. 11.3.2/11.3.4 (Of Concern) – *Eucalyptus populnea* woodland on alluvial plains / *Eucalyptus tereticornis* and/or *Eucalyptus spp.* woodland on alluvial plains.
6. 11.3.7 – *Corymbia spp.* open woodland on alluvial plains.
7. 11.3.21 (Of Concern) – *Dichanthium sericeum* and/or *Astrebla spp.* grassland on alluvial plains. Cracking clay soils.
8. 11.3.25 – *Eucalyptus tereticornis* or *E. camaldulensis* woodland fringing drainage lines.
9. 11.3.25e – *Eucalyptus camaldulensis*, *E. tereticornis* woodland fringing larger, permanent water courses.
10. 11.3.27d - *Eucalyptus camaldulensis* and/or *E. tereticornis* woodland.
11. 11.4.9 (Endangered) – *Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.
12. 11.5.3 – *Eucalyptus populnea* +/- *E. melanophloia* +/- *Corymbia clarksoniana* woodland on Cainozoic sand plains and/or remnant surfaces.
13. 11.5.3b – *Eucalyptus populnea* woodland on closed depressions.
14. 11.5.9d – *Corymbia citriodora* and/or *E. crebra* woodland.
15. 11.5.18 (Of Concern) – *Micromyrtus capricornia* open shrubland on Cainozoic sand plains and/or remnant surfaces.
16. 11.7.1 – *Acacia harpophylla* and/or *Casuarina cristata* and *Eucalyptus thozetiana* or *E. microcarpa* woodland on lower scarp slopes on Cainozoic lateritic duricrust.
17. 11.7.2 – *Acacia spp.* woodland on Cainozoic lateritic duricrust. Scarp retreat zone.
18. 11.7.4 – *Eucalyptus decorticans* and/or *Eucalyptus spp.*, *Corymbia spp.*, *Acacia spp.*, *Lysicarpus angustifolius* woodland on Cainozoic lateritic duricrust.

2.4 Species of conservation significance

2.4.1 Native vegetation

The MCM Southern Extension Project Environmental Values Assessment (EVA) (MCPL, 2020) identified two vegetation communities within the Approved Disturbance Footprint which conform to the threshold criteria to constitute forming threatened ecological communities (TECs) (i.e. Matters of National Environmental Significance [MNES]). Namely, Brigalow (*Acacia harpophylla* dominant and co-dominant) Endangered Ecological Community (Brigalow TEC) and Poplar Box Grassy Woodland on alluvial plains Endangered Ecological Community (Poplar Box TEC).

2.4.2 Fauna species

The EVA (MCPL, 2020) also identified four conservation significant fauna species that were recorded within the Approved Disturbance Footprint that constitute both Matters of State Environmental Significance and MNES:

- Koala (*Phascolarctos cinereus*) – listed as vulnerable under the *Nature Conservation Act 1992* (NC Act) and Vulnerable under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- Greater glider (*Petauroides volans*) – listed as vulnerable under the NC Act and Vulnerable under the EPBC Act;
- Ornamental snake (*Denisonia maculata*) – listed as vulnerable under the NC Act and Vulnerable under the EPBC Act, and
- Squatter pigeon (southern subspecies) (*Geophaps scripta scripta*) – listed as vulnerable under the NC Act and Vulnerable under the EPBC Act.

3. Rehabilitation Considerations

3.1 Objectives

The primary revegetation objective for the MCM is to establish a self-sustaining vegetation cover suited to the target post-mining land use (PMLU) of mixed-use open woodland (Section 3.4). Revegetation, achieving the target PMLU, will assist in establishing a safe, stable, self-sustaining, and non-polluting landform consistent with the requirements of Condition G9 of the MCM Environmental Authority (EA) EPML00716913.

3.2 Vegetation community description

Vegetation communities selected for revegetation of the MCM will primarily utilise a species palette suited to achieving the target PMLU, such as grasses known for preventing erosion and also being highly palatable, as well as native shrubs and tree species found in the Middlemount region. Vegetation communities will be selected in consideration of the MCM's climatic conditions, typical chemical characteristics of disturbed soils in the Bowen Basin (e.g., salt tolerance capabilities) and also with respect to the new topography, aspect and drainage of the post-mining landscape. Native tree and shrub species will be planted in areas such as steep slopes and riparian corridors, to maximise biodiversity, ground stability, provide corridors for wildlife, shelter belts for stock (from sun and wind), aesthetic enhancement and other ecosystem services that will complement the PMLU of mixed-use open woodland.

3.3 Pre-mining land use

The predominant pre-mining land use over the MCM area was low density cattle grazing of native and modified pastures, Land Use Classification 2.1 and 3.2 (ABARES, 2016). Large areas of the pre-existing native woodland were historically subject to broadacre clearing for grazing. This is consistent with areas adjoining the MCM, and within the broader region in general, which has been extensively developed for beef grazing since the 1800's. It is likely that surrounding areas will continue to be used for the purpose of grazing of improved pastures, consisting of exotic and native grasses. Areas of remnant native shrubs and trees predominantly remain on ridges, in riparian zones and other areas that were difficult for graziers to clear.

3.4 Post-mining land use

The target PMLU for the MCM is mixed use open woodland. The target PMLU has been selected to achieve the rehabilitation objectives described in Section 3.1.

The MCM has six primary domains;

- in-pit and out-of-pit waste rock emplacement areas (includes the western and eastern emplacement areas);
- infrastructure areas (includes CHPP, haul roads, workshops, and associated other mine infrastructure activities);
- water management areas (includes mine water dams and sediment dams_;
- tailings storage facility (includes two flocculation cells);
- diversions; and
- residual voids (includes the northern and southern voids).

MCPL proposes that the majority of the MCM will have a PMLU of mixed-use open woodland, in association with other PMLUs including:

- Mixed use open woodland;
- Grazing (retained water management infrastructure); and
- Native ecosystem.

3.5 Non-use management areas

There are two approved residual voids at the MCM, located in the north (i.e., North Void) and south (i.e., South Void) of the Approved Surface Disturbance Footprint. The North Void will be approximately 358 hectares (ha) in area and the South Void will be approximately 163 ha in area. The residual voids including high-wall and portions of the low-wall are all approved NUMAs.

The maximum slope of the residual void is as per Plate 1 below, and the maximum slope of the residual void low wall is 37° (1V:3H). Due to physical and safety constraints, natural recruitment of native species is recommended on the high-wall slopes where practicable.

Table 5 Recommended slope geometry for the final voids

Material	Overall Slope Angle (°)	Bench Height (m)	Berm Width (m)	Batter Angle (°)
Surficial Soils	20	NA	NA	NA
Weathered Permian	NA	30	25	55
Fresh Permian	NA	60	60	60

Table 6 Recommended slope geometry for lowwalls

Material	Overall Slope Angle (°)~	Max. Bench Height (m)	Berm Width (m)*	Batter Angle (°)
Lowwall CAT3 Spoil	27	40	12 to 25	37

~This is the maximum OSA allowed for lowwall designs

*The bench geometries maybe changed to satisfy the OSA, this include bench height and berm width

Plate 1: Residual Void and Longwall slope geometry

The high-wall and the low wall of the residual voids may be revegetated, where safe and practicable to do so, to improve stability. As residual voids form approved NUMAs neither will be used for grazing due to safety concerns for the cattle (i.e., the steep slopes).

4. Risk Assessment

4.1 Erosion risk modelling approach

4.1.1 Modelling overview

Erosion risk was assessed by applying the Australian Coal Association Research Program (ACARP) *Dispersive Spoil Decision Support Tool* (Dale et al., 2018a, 2018b, 2018c, 2021) (the model). This decision support system is built based on assessment of QLD and New South Wales (NSW) mine sites. The tool employs a Bayesian modelling approach. Bayesian modelling allows exploration of the conditional probability of an outcome given the prior probability or state of other interacting factors.

The ACARP *Dispersive Spoil Decision Support Tool* integrates the complex interaction of 104 variables. These are grouped into five sub-models:

1. climate (rainfall amount, intensity and timing);
2. waste rock material characteristics (chemical, physical, plus waste rock material amelioration interventions);
3. management practices (including landform design - slope, slope shape, slope length; and erosion mitigation – surface roughness, armouring, run-on controls, contours banks, etc);
4. vegetation management factors; and
5. tunnel initiation factors.

The model is structured around a standard risk assessment approach, where the risk of surface and tunnel erosion is quantified by combining assessments of:

- **Vulnerability** comprising the combination of inherent soil erodibility (resistance/susceptibility to erosion) landform design, soil and vegetation management practices that modify erodibility; and
- **Exposure** comprising exposure to erosive energy forces (cumulative rainfall, rainfall intensity, frequency, duration).

In this way, the model presents the outputs of surface erosion risk and tunnelling risk as a matrix of exposure by vulnerability in a similar manner to the intersection between likelihood and consequence in a conventional risk assessment matrix. In the absence of erosive forces, no erosion will occur. Conversely, a site that is highly vulnerable to erosion will not erode unless erosive forces are applied, or a site that has a low vulnerability to erosion will only be likely to erode when exposed to extreme erosive forces.

4.1.2 Modelling scenarios

A total of 11 treatment scenarios were explored using the *Dispersive Spoil Decision Support Tool* to determine the likelihood of surface and tunnel erosion (Table 2) and the changes over time. Each modelling scenario varied the treatments to ascertain changes in erosion. Topsoil treatment to address dispersive properties and nutrient deficiencies, and waste rock material amelioration to address dispersive properties. The variables utilised were:

- use of rock mulch;
- placement of topsoil;
- treatment of topsoil;

- waste rock material treatment depth (variable depths); and
- waste rock material treatment rate (variable rates).

Key differences between scenarios are summarised in Table 2.

Each of the 11 modelling scenarios listed in Table 2 was simulated:

- with no vegetation to reflect site conditions at the point of rehabilitation completion (i.e., pre-vegetation); and
- with target vegetation cover levels anticipated two years post rehabilitation (i.e., post-vegetation).

The pre- and post-vegetation scenarios enable exploration of the change in erosion risk over time.

Table 2: Erosion risk modelling scenarios

Amendment Scenario	1	2	3	4	5	6	7	8	9	10	11
Rock mulch	-	✓	✓	-	-	-	-	✓	✓	✓	✓
Placement of topsoil	-	-	✓	✓	✓	✓	✓	✓	✓	✓	✓
Treatment of topsoil	-	-	-	✓	✓	✓	✓	✓	✓	✓	✓
Full exchangeable sodium percentage (ESP) treatment rate	-	-	-	✓	✓	-	-	✓	✓	-	-
Half ESP treatment rate	-	-	-	-	-	✓	✓	-	-	✓	✓
Waste rock material treated with gypsum to 300mm (full depth)	-	-	-	✓	-	✓	-	✓	-	✓	-
Waste rock material treated with gypsum to 150mm (half depth)	-	-	-	-	✓	-	✓	-	✓	-	✓

4.1.3 Modelling results interpretation

Unlike many other modelling approaches, Bayesian networks use probabilistic, rather than deterministic expressions to characterise the strength of relationships between variables. This allows Bayesian network models to integrate a range of data types (including expert opinion) where data are limiting, thereby facilitating identification of key knowledge gaps and enabling explicit analysis of uncertainty associated with potential management and/or environmental scenarios.

All data (both categorical and continuous) entered into a Bayesian model is reduced to a series of “states” or categories. Consequently, the output from a Bayesian model is the probability of each possible state. For surface gullyng and tunnelling risk, the model output is the probability of each possible state or level of erosion severity classified as:

- Low;
- Medium;
- High; or
- Very high.

The specific probability of any state is less important than the relative probability of any given state between treatments and the other overall average of states. This is important as the minimum or maximum probability of low erosion is not 0% or 100% respectively. It is also important, as scenario modelling necessarily looks at the outcome of varying a small number of parameters while maintaining the majority of “background” conditions constant. Varying one of the background conditions will change the probability of each of the “treatment” outcomes. Hence, the relative change between treatment outcomes is more important than their specific probabilities.

4.1.4 Erosion risk modelling results

Verterra undertook modelling at the MCM in 2021 (Verterra, 2021) of a subset of soils located in the 2021 rehabilitation areas in the east of the MCM. Modelling in these areas indicated that the risk of high/very high surface erosion is decreased with vegetation establishment. This highlights the importance in establishing vegetation cover early in rehabilitation works at the MCM. It was also found that the risk of high/very high surface erosion was reduced in scenarios where the full depth of waste rock material was treated with ameliorants. Relative erosion risk by scenario is presented in Table 3 and absolute risk by scenario in Appendix 1.

Results indicated that across each scenario, the primary activity impacting the modelled tunnel erosion is the inclusion of ripping in scenarios where ameliorants have been included. Whilst ripping can provide benefits in terms of reducing compaction, ripping on the contour may lead to ponding and seepage resulting in tunnelling. Furthermore, deep ripping on rocky, dispersive profiles may result in dispersive material being brought to the surface, creating the opportunity for ponding and preferential flow paths. It can also create channels leading to preferential flow and ponding leading to tunnelling. Additionally, ripping when the soil profile is too dry may create open channels with the potential for seepage, ponding, and preferential flow paths following rain.

These modelling results indicated that treating the waste rock material chemistry to the full recommended depth was important and that the addition or omission of rock mulch had little impact on the surface erosion risk.

Table 3: Relative erosion risk of each amendment scenario

Scenario	1	2	3	4	5	6	7	8	9	10	11
Relative surface erosion risk (Pre-vegetation)	1.35	1.33	1.33	1.02	1.13	1.02	1.13	1.00	1.11	1.00	1.11
Relative surface erosion risk (Post-vegetation)	1.58	1.46	1.46	1.00	1.13	1.00	1.13	1.06	1.19	1.06	1.19
Relative tunnel erosion risk (Pre-vegetation)	1.00	1.18	1.18	1.36	1.46	1.36	1.46	1.36	1.46	1.36	1.46
Relative tunnel erosion risk (Post-vegetation)	1.00	1.17	1.17	1.35	1.45	1.35	1.45	1.35	1.45	1.35	1.45

4.2 Rock armour study

A study of the MCM undertaken by Landloch in 2019 relating to the erodibility and assessment of landform designs using rock armour (Landloch, 2019) indicated that achieving soil erosion targets, particularly at steeper gradients, was closely associated with sufficient vegetation ground cover. Furthermore, the Landloch study suggested that the rock:soil mix used in rock armouring required a layer thickness of 1.5 to 2 times the mean diameter (D_{50}) of the rock used (Landloch, 2019). It was also noted that the very steep slopes (>33%) required the addition of rock and a minimum of 40% vegetation cover for long-term stability. Additionally, it was recommended that while a topsoil-only approach could be successful, it should be restricted to gradients of less than approximately 16%.

5. Revegetation Strategy

The MCM rehabilitation strategy described below consists of five components:

- rehabilitation overview (this Section 5);
- soil management (Section 6);
- revegetation (Section 7);
- maintenance (Section 8); and
- monitoring (Section 9).

5.1 Revegetation approach

The revegetation approach for the MCM is consistent with the rehabilitation objective to attain a final landform that is safe, stable, self-sustaining, and non-polluting (Section 3.1), as well as the outcomes of site-specific studies undertaken by Verterra (2021) and Landloch (2019) (Section 4). Revegetation to achieve the target PMLU of mixed-use open woodland will be undertaken primarily through direct seeding. The recommended revegetation approach is to chemically ameliorate the waste rock material (substrate) and topsoil (growth medium) to conditions that will promote seed germination and sustain long-term vegetation growth.

Aligned with leading practice revegetation techniques, and based on previous site specific risk modelling and rock mulching studies (Sections 4.1.4 and 4.2), the proposed landform batters (with slope angles of less than or equal to 16%) would not require the application of rock mulch. Soils placed on slopes $\leq 16\%$ may require amelioration to achieve chemical stability and germination suitability; specific soils will be analysed at an accredited laboratory to determine the required amelioration strategy. By not applying rock mulch to large areas of the MCM, greater consistency will be achieved between the revegetation approach and the target PMLU of mixed-use open woodland.

Slopes with angles $> 16\%$ require rock mulch to stabilise the landform.

5.2 Revegetation sequence

The revegetation sequence comprises the following 11 steps which are described in detail within Table 4 below:

1. Infrastructure Decommissioning and Removal.
2. Landform Establishment.
3. Spoil and Soil Characterisation.
4. Spoil Waste Treatment.
5. Growth Medium Application.
6. Final trimming of topsoil (areas of slopes $< 16\%$) or rock mulching.
7. Application of soil ameliorants.
8. Seed application plus harrow.
9. Application of cover mulch.
10. Monitoring.
11. Maintenance.

Table 4: Revegetation sequence and proposed timeframes

Step	Activity	Timeframe and optimal season
1. Infrastructure decommissioning and removal	Decommission and remove all infrastructure as per PRCP.	Prior to landform reshape.
2. Landform Establishment	Reshape of waste rock material dumps as per final landform design (e.g. Dozer Push), including implementation of drainage to residual voids and other erosion and sediment controls.	As soon as practicable after wet season (April – June).
3. Waste rock and soil characterisation	Sampling, Analysis, Amelioration Recommendation, and Seed Selection. Waste rock and soil sampling and analysis should be completed from the landform (prior to topsoil placement) and topsoil stockpiles. Historic data should not be relied upon. Sufficient samples should be taken and analysed to enable physical and chemical characterisation of the materials used in the rehabilitation process. This data is then used for erosion risk modelling, amelioration recommendations and species selection.	As soon as material is available to analyse (dry season). Early seed ordering enhances probability of acquiring the desired seed.
4. Waste rock material treatment	<i>In situ</i> waste rock material amelioration, spreading of ameliorants over reshaped landscape, ripping of ameliorants into waste rock material – ripping should not be deep enough to pull up large boulders from the surface.	As soon as practicable after analysis data available to inform amelioration recommendation (dry season).

Step	Activity	Timeframe and optimal season
5. Growth medium application	<p>Areas ≤16% slope</p> <ul style="list-style-type: none"> • Spread stockpiled topsoil. • Apply ameliorants (fertiliser, gypsum and/or organic matter) to dumped topsoil, where possible. <p>Areas >16% slope</p> <ul style="list-style-type: none"> • Truck and dump topsoil and rock mulch on upslope area of target rehabilitation area. • Apply ameliorants (fertiliser, gypsum and/or organic matter) to dumped topsoil, where possible. • Mix rock mulch and topsoil. • Push this ameliorated mixture down slope to spread topsoil. 	<p>In dry season.</p> <p>In sequence with, or immediately following waste rock material treatment</p>
6. Final trimming of topsoil (<16%) or rock mulching	<p>Areas <16% slope</p> <ul style="list-style-type: none"> • Remove vertical rills and troughs created by downslope topsoil push by traversing grader or dozer across slope, when assessed as safe to do so. <p>Areas >16% slope</p> <ul style="list-style-type: none"> • Apply rock mulch. 	<p>In dry season.</p> <p>In sequence with, or immediately following growth medium application.</p>
7. Application of soil ameliorants	<p>Where it has not been possible to apply and mix ameliorants before the topsoil push, it is recommended that this step is completed before final trim of topsoil and/or rock mulching. Additional detail on the soil amelioration process is described in Section 6.</p>	<p>In dry season.</p> <p>In sequence with, or immediately following growth medium application</p>

Step	Activity	Timeframe and optimal season
8. Seed application plus harrow (very shallow incorporation)	<p>Additional detail on the revegetation process is provided in Section 7.</p> <p>Areas <16% slope</p> <ul style="list-style-type: none"> Apply seed and harrow to incorporate seed to average depth of approximately 50 mm (Section 7.2) – this may be completed with a tractor mounted seeder, when assessed as safe to do so. <p>Areas >16% slope</p> <ul style="list-style-type: none"> Apply seed over rock mulch using tracked equipment (e.g., dozer mounted seeder). Note: ripping is not required after seeding over rock mulch. 	<p>Preferably immediately prior to wet season. In sequence with, or immediately following final trim of topsoil or application of rock mulch.</p>
9. Application of cover mulch (if applicable).	<p>Areas <16% slope</p> <ul style="list-style-type: none"> Apply cover mulch such as weed free hay or straw to defined rate. <p>Areas >16% slope</p> <p>Note: cover mulch is not required after seeding over rock mulch.</p>	<p>Immediately after wet season.</p>
10. Monitoring	<p>Monitoring to ensure suitable growth/development of revegetation (Section 9)</p>	<p>Ecological monitoring: immediately after wet season and annually thereafter. Survival monitoring: initially and then at three, six and twelve-month intervals thereafter.</p>
11. Maintenance	<p>Maintenance to sustain revegetation (Section 10)</p>	<p>Immediately after monitoring has been completed</p>

5.3 Treatment Zones

The MCM Final Landform has been stratified into Treatment Zones corresponding with landscape characteristics (such as slope) to allow for the application specific landform establishment approaches (Section 5.1) (Figure 2).

Each Treatment Zone will be revegetated through the general sequence described in Table 4, soil amelioration will be undertaken as per Section 6 and revegetation as per Section 7.

5.3.1 Treatment Zone 1 – Low slope areas ($\leq 16\%$, 9°)

Treatment Zone 1 consists of all revegetation areas with low slopes (i.e., slopes of less than 16%) (indicated by green areas in Figure 2). The upper surface of the in-pit and out-of-pit waste rock (pale orange areas in Figure 2) are also included in Treatment Zone 1. This zone does not require rock mulch if the waste rock material (substrate) and topsoil is chemically treated for dispersive properties. Treatment Zone 1 includes portions of:

- in-pit and out-of-pit waste rock emplacements (both upper surface and slopes if $\leq 16\%$);
- rehabilitated infrastructure areas (including mine infrastructure area (MIA), CHPP, water storage infrastructure, and roads); and
- rehabilitated Tailings Storage Facilities and Tailings Flocc Cell (i.e., Flocc Cell [FC]1 and FC2).

5.3.2 Treatment Zone 2 – High slope areas ($>16\%$, 9°)

Treatment Zone 2 consists of all revegetation areas with high slopes (i.e., slopes of greater than 16%) (indicated by dark orange areas in Figure 2), noting this zone does not include the high-walls and some portions of the low-walls for the residual voids (refer to Treatment Zone 4).

Treatment Zone 2 requires the addition of rock mulch to stabilise the steep slope and includes portions of in-pit and out-of-pit waste rock emplacements (where slope $>16\%$)

5.3.3 Treatment Zone 3 – Riparian areas

Treatment Zone 3 consists of all revegetation areas associated with creek diversions (blue area adjacent to the blue creek line shown in Figure 2). This includes:

- Roper Creek Diversions 1 and 2; and
- Thirteen Mile Gully Diversion.

5.3.4 Treatment Zone 4 – Non-use Management Areas

Treatment Zone 4 consists of the residual voids at end of mine life (i.e., approved NUMAs as described in Section 3.5). This includes residual void:

- equilibrated void waterbody;
- high wall; and
- portions of the low wall.

Revegetation of the low walls and high walls will be undertaken, where safe and practicable to do so, to stabilise the landform (consistent with the approach for Treatment Zone 2 [i.e., slopes $>16\%$]). Where revegetation cannot be facilitated, it will occur by natural recruitment, and will drain internally to the residual void, to prevent sediment leaving site. The NUMAs will not be used for grazing and will therefore not form a PMLU.

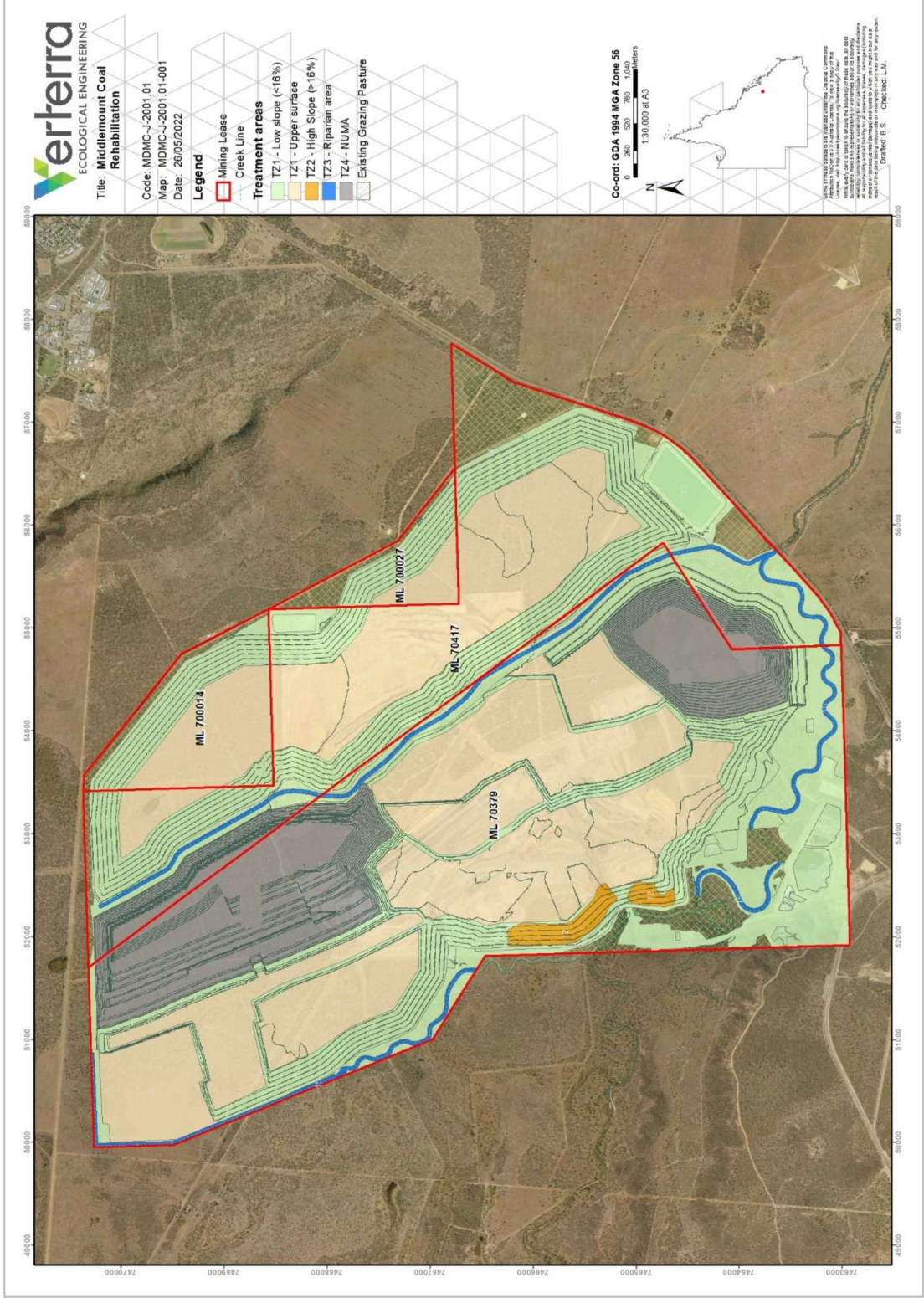


Figure 2: Treatment Zones

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5.4 Rehabilitation Areas

The MCM final landform has been further stratified into Rehabilitation Areas (RAs). RAs consider the relevant Treatment Zone (described Section 5.3) and additionally consider the underlying mining domain prior to rehabilitation. RAs will assist in informing the rehabilitation success criteria required to progress through the rehabilitation sequence (Section 5.2). RAs at the MCM are as follows (Figure 3):

- RAs 1, 2, 3, 4, 5, 6
 - Mining Domain: Waste Rock Emplacement.
 - Treatment Zone: Zone 1.
 - PMLU: Mixed use open woodland.
- RAs 7, 8, 9, 10, 11
 - Mining Domain: Infrastructure Area (including MIA and TSF).
 - Treatment Zone: Zone 1.
 - PMLU: Mixed use open woodland.
- RA 12 (slopes >16%)
 - Mining Domain: Waste Rock Emplacement.
 - Treatment Zone: Zone 2.
 - PMLU: Mixed use open woodland.
- RA 13
 - Mining Domain: Water Management Infrastructure (Mine Water Dams).
 - Treatment Zone: Zone 1.
 - PMLU: Grazing (retained water management infrastructure).
- RA 14
 - Mining Domain: Water Management Infrastructure (Sediment Dams).
 - Treatment Zone: Zone 1.
 - PMLU: Grazing (retained water management infrastructure).
- RA 15
 - Mining Domain: Creek diversion.
 - Treatment Zone: Zone 3.
 - PMLU: Native ecosystem.

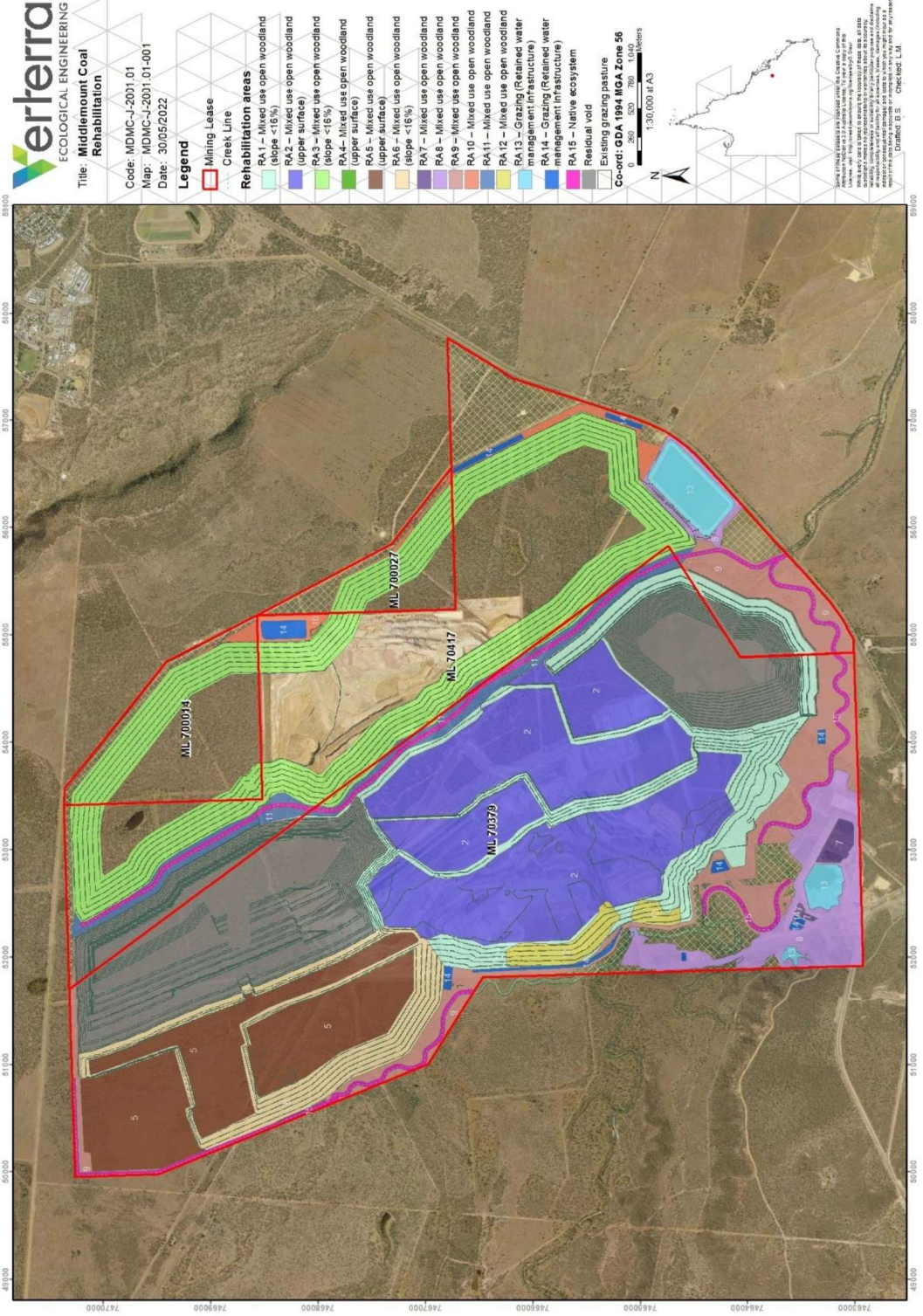


Figure 3: Rehabilitation Areas

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6. Soil Management

6.1 Amelioration approach

In situ waste rock material should be treated prior to placement and spreading of topsoil material to enable incorporation of ameliorants to a greater depth than can be achieved after topsoil application. (Section 5.2).

Treated in situ waste rock material, which underlies placed topsoil, will provide a buffer to erosion and tunnel formation, particularly in the early stages of the rehabilitation sequence, prior to full exchange of gypsum in the growth medium and establishment of vegetation. This process will further improve the capacity of the underlying waste rock material to support vegetation root growth.

Treatment of waste rock material will involve the incorporation of gypsum prior to placement and spreading of topsoil. This approach of waste rock material amelioration aims to create a substantial depth of growth medium that contains waste rock material combined with topsoil and attains reduced dispersive properties.

Amelioration of topsoil material will also be undertaken to minimise chemical and physical properties, which may limit the establishment and growth of vegetation cover. Topsoil amelioration will involve:

- application of fertiliser to remove macro and micro-nutrient deficiencies;
- balancing nutrient ratios to ensure no induced deficiencies or toxicities;
- neutralisation of pH to ensure plant availability of in situ and applied nutrients;
- treatment of dispersive topsoil chemistry to reduce risk of erosion and improve topsoil structure; and
- organic matter to assist priming re-initiation of soil biological processes, including organic matter accumulation, soil particle aggregation, and nutrient mineralisation in order to improve soil water holding capacity, soil permeability, soil structure, resistance to surface crusting, resistance to erosion, and capacity to support healthy plant growth.

6.2 Waste rock material, topsoil chemistry and plant nutrition

6.2.1 Waste rock material and topsoil sampling program

To further inform the amelioration approach (Section 6.1) and input requirements, a soil sampling program (including laboratory analysis) should be undertaken for both the waste rock material and stockpiled topsoil material. Investment in laboratory analyses (Step 3 of the revegetation sequence, Section 5.2) may significantly reduce potential costs and/or reduce risk of future rehabilitation failure.

The nature of mine site rehabilitation, involving stripping and replacement of waste rock material and topsoil materials, may homogenise materials but, equally, often leads to placement of heterogenous materials, with significant changes in chemical and physical characteristics over short distances. Therefore, a comprehensive sampling program is required to identify spatial variability.

Where spatial survey data is available to provide an indication of the variability in waste rock properties (e.g., electromagnetic (EM) surveys, multispectral surveys), point-sampling is recommended given the capacity to correlate lab results with the spatial data, and capacity to use the spatial data to ensure representative sample collection across the range of variability.

When spatial survey data is not available, or not appropriate (as for topsoil stockpiles) composite sampling is recommended to provide a reliable representation of the relevant material on a sample number per unit volume basis.

All samples should be submitted to a National Association of Testing Authorities (NATA) approved laboratory and analysed for an agronomic suite of analytes (Table 5), noting that a different suite of analytes is required for topsoil and waste rock material samples. This suite of analyses and methodology are to inform agronomic requirements and do not address any contaminant assessment requirements.

Table 5: Agronomic nutrients for laboratory analysis

Suite/ Analyte	Parameter	Reference Method ^[1]	Topsoil	Sub-soil (Spoil)
Physico-chemical	pH (H ₂ O) & pH (CaCl ₂)	RL Method 4A1	✓	✓
	Electrical conductivity	RL Method 3A1	✓	✓
	Texture	Field texture (Northcote, 1979)	✓	✓
Cations	Exchangeable Cations (Na, K, Ca, Mg) + CEC	RL Method 15D3 ^[2]	✓	✓
	Exchangeable Al	RL Method 15G1	✓	✓
Anions	Total Carbonate	RL Method 19A1	✓	✓
	Chloride	RL Method 5A2	✓	✓
Nitrogen	Ammonia-N (KCl)	RL Method 7C2a or 7C2b	✓	✗
	Nitrate/Nitrite Nitrogen, NO _x as N	RL Method 7B1	✓	✗
	Total Nitrogen	RL Method 7A5 (Leco)	✓	✗
Phosphorous	Phosphorus (Colwell)	RL Method 9B2	✓	✗
	PBI	RL Method 9I2a or 9I2b	✓	✗
	Total Phosphorous ^[3]	RL Method 9A3a or 17B1	✓	✗
Sulphur	Sulphur (KCl)	RL Method 10D1	✓	✗
Carbon	Organic Carbon	RL Method 6A1 (Walkley-Black)	✓	✗
Trace Elements	Boron (CaCl ₂)	RL Method 12C2	✓	✗
	DTPA extract (Cu, Fe, Mn, Zn)	RL Method 12A1	✓	✗

^[1] "RL Method" reference: Rayment and Lyons, 2011.

^[2] With correction for water soluble cations in the event EC1:5 is greater than 0.3dS/m.

^[3] Optional. Only carry out if included in other analyses.

6.2.1.1 Waste rock material point sampling methodology

Where a spatial survey of waste rock material variation is available (e.g., EM survey, multi or hyperspectral survey), point sampling locations should be selected to sample the full range of survey variation. This will involve sampling at locations corresponding to each extreme of the survey data, and a roughly even distribution of samples corresponding to intermediate survey values. Sampling to achieve a mapping scale of approximately 1:25,000 is recommended (McKenzie et al., 2008), corresponding to a minimum of five samples, or one sampling point per 6.25 ha.

Where possible, point waste rock analysis data should be statistically correlated with spatial survey data, to allow spatial representation of the waste rock analysis results which, in turn, will inform site specific management.

6.2.1.2 Waste rock material composite sampling methodology

Where survey data to inform spatial variation is not available, a composite sampling methodology is proposed to average out variability at each sampling location.

Sampling to achieve a mapping scale of approximately 1:25,000 is recommended (McKenzie et al., 2008), corresponding to a minimum of five samples for analysis, or one sample for analysis per 6.25 ha.

To reduce the risk of bias and improve the likelihood of a representative sample, grid sampling is recommended. To achieve one sample for analysis per 6.25 ha, samples should be on a maximum grid of 250 metres (m) x 250 m.

Each sample for analysis should consist of a composite of five sub-samples. The first sub-sample of each sample for analysis should be at the designated grid location, and four other sub-samples should be collected from the corners of an imaginary square around this point at a distance of approximately 5 m.

When collecting sub-samples to compile a composite sample, an equal measure of soil (e.g., a 250 mm cup) should be collected at each sampling location and placed in a large container or bucket. When all the sub-samples for a bulk have been collected, the combined sample should be thoroughly mixed, and a suitable amount submitted to the laboratory for analysis (minimum 500 grams (g)).

Sample depth should be a minimum of 200 mm below the surface and preferably to 300 mm in the higher risk soils expected to be highly dispersive and requiring higher amelioration rates.

Where sample results indicate abrupt or disparate differences between adjacent samples, additional samples should be collected in the areas of disparity.

6.2.1.3 Stockpiled topsoil

The number of sub-samples required to make up a representative composite sample is informed by the size of the topsoil stockpile. Each topsoil stockpile should be treated separately as their origin is likely to be different. For a 95% confidence level, the New South Wales Environmental Protection Agency's (EPA) recommendations are presented in Table 6. This EPA guideline is informed by Australian Standards AS4481.1 and AS 4481.2 (Standards Australia, 1999, 2005). Section 579B of the EP Act provides for sampling under alternative methods defined in Australian Standards where an appropriate protocol has not been defined, such is the case in Queensland. Samples should be collected from at least 150 mm below the surface of the stockpile (EPA, 2009).

Table 6: Number of laboratory samples per volume of topsoil stockpile

Stockpile size	Number of sub-samples	Number of laboratory samples
< 2,500 m ³	1 sub-sample per 25 m ³ (a minimum of 10)	20–40 sub-samples = 1 lab (minimum 1 lab/stockpile)
> 2,500 m ³	1 sub-sample per 250 m ³	20–40 subsamples = 1 lab sample
Example: 5,685 m³	23	1

6.2.1.4 *In situ* topsoil

If sampling of topsoil material is only possible after it has been placed over waste rock material, the sampling rate should be as per waste rock material sampling procedure (i.e. as per Section 6.2.1.1 where spatial survey data is available, and as per Section 6.2.1.2 where spatial data is unavailable). Samples should be collected to a depth of 100–150 mm below the surface to avoid mixing with underlying waste rock material.

6.2.2 Growth medium nutrient targets

After laboratory analyses are complete and the existing nutrient levels within the growth medium are known, amelioration rates can be calculated. Target ranges for each parameter are presented in Table 7 and are considered to be levels at which vegetation nutrient deficiencies are relieved and vegetation growth will be promoted (Hazelton and Murphy, 2017; Lambert and Turner, 2000; Noble, 1996; Baker and Eldershaw, 1993).

Table 7: Target ranges for growth medium nutrients

Suite/Analyte	Parameter	Units ^[1]	Target range ^[2]
Physico-chemical	pH (H ₂ O)	pH units	6.5–7.5
	pH (CaCl ₂)	pH units	5.5–6.5
	Electrical conductivity	dS/m	<i>see ECe</i>
	EC (saturated extract) ECe	dS/m	< 2.0
	Texture	-	N/A
Exchangeable Cations	Exchangeable Sodium (Na)	cmol/kg	< 0.3 (<1% of cation-exchange capacity [CEC])
	Exchangeable Potassium (K)	cmol/kg	> 0.3 (1-5% of CEC)
	Exchangeable Magnesium (Mg)	cmol/kg	> 1.0 (10-15% of CEC)
	Exchangeable Calcium (Ca)	cmol/kg	> 5.0 (65-80% of CEC)
	Exchangeable Aluminium (Al)	cmol/kg	<i>Significant if pH < 5.5</i>
	Cation exchange capacity (CEC)	cmol/kg	> 12.0
	Exchangeable Sodium Percentage (ESP)	%	< 6.0
Anions	Total Carbonate	mg/kg	N/A
	Chloride	mg/kg	N/A
Nitrogen	Ammonia-N (KCl)	mg/kg	> 3.0
	Nitrate	mg/kg	> 30
	Total Nitrogen	mg/kg	> 1,500
	C:N ratio	-	10–25
Phosphorous	Phosphorus (Colwell)	mg/kg	> 20
	PBI	-	N/A
	Total Phosphorous (<i>optional</i>)	mg/kg	N/A
Sulphur	Sulphur (KCl)	mg/kg	> 117
Carbon	Organic Carbon	%	> 1.0
	Organic Matter	%	> 1.7

Suite/Analyte	Parameter	Units ^[1]	Target range ^[2]
Trace Elements	Boron (CaCl ₂)	mg/kg	1.0–5.0
	DTPA extract Copper (Cu)	mg/kg	> 0.3
	DTPA extract Iron (Fe)	mg/kg	-
	DTPA extract Manganese (Mn)	mg/kg	> 2.0
	DTPA extract Zinc (Zn)	mg/kg	> 0.8 (pH >= 7.0) > 0.5 (pH < 7.0)

^[1] dS = 0.1 Siemens; m = metre; cmol = 0.01 mol; kg = 1 kilogram; mg = 0.001gram

^[2] There are no target ranges for Texture, Total Carbonate, Chloride, PBI, Total Phosphorous, or DTPA extract Iron. They are included in Table 7 for consistency with Table 5.

6.3 Incorporation of ameliorants

6.3.1 Waste rock material amelioration

After sampling and analysis, waste rock material substrate should be ameliorated with the required rate of gypsum to reduce dispersive chemical characteristics. Two distinct layers of amended topsoil and waste rock material (herein referred to as amended subsoil) should be created, with a total depth of 500 mm. Assuming topsoil will be placed to a depth of 200 mm, 300 mm of subsoil should be amended with gypsum in the following sequence:

1. calculate gypsum rate from laboratory analysis and target ESP (Table 7);
2. spread gypsum on the waste rock material surface (prior to topsoil placement); and
3. incorporate to 300 mm:
 - a. ripping with a bulldozer, or similar, with tynes spaced at 500 mm centres;
 - b. ripping on the contour; and
 - c. incorporate soon after spreading to avoid loss by wind or overland flow.

The aim of creating a layer of growth medium comprising of amended subsoil and topsoil in the upper 500 mm of the reconstructed profile is to resist erosion, particularly in the initial stages post rehabilitation when soil is bare, before vegetation is fully established, and while the rehabilitation is most vulnerable.

6.3.2 Topsoil amelioration

If sampling indicates that topsoil material requires the application of ameliorants (Section 6.2), the recommended sequence for topsoil amelioration and spreading is as follows:

1. spread topsoil;
2. apply gypsum and organic matter at rates calculated from topsoil testing/sampling and targets:
 - a. harrow to the full depth (up to 200 mm) with offset disc harrows or similar; and
 - b. harrow on the contour and avoid exposing dispersive subsoil;
3. apply fertiliser and seed together:
 - a. integrate into topsoil with scarifiers or chain harrows (to a maximum of 50 mm depth), or tracking chains, which will assist with seed incorporation; and
4. if required to aid in water retention and erosion protection, spread hay or other weed free mulch across the surface, to a maximum depth of 50mm.

7. Revegetation

7.1 Revegetation requirements

Revegetation to achieve the target PMLU of mixed-use open woodland will be undertaken primarily through direct seeding. Tubestock planting may be used to augment direct seeding in the revegetation of the creek diversions, drainage lines, other areas that require rapid establishment of shrubs and trees to halt erosion, improve habitat and amenity value, or where grasses have established and broadscale seeding may cause more disturbance than targeted planting. If tubestock planting is undertaken, it is recommended that a detailed design plan is developed prior to revegetation as tubestock will require intensive maintenance.

To achieve rapid stabilisation of the growth medium, to assist with progression to mixed use open woodland, a successional seed mix is required. Such a mix should include:

- a fast-establishing cover crop species;
- a deep-rooted legume to bind the soil and contribute nitrogen;
- improved pasture grass species comprising a mix of species with a stoloniferous habit to stabilise the landform and rapidly cover bare areas, as well as species with a tussock habit to provide palatable grass for grazing and increase capacity to accumulation of soil organic matter;
- native tree species; and
- native grass species.

7.1.1 Revegetation timing

For the majority of the MCM revegetation process, dryland seeding is proposed, with no manual watering activities or irrigation planned to promote soil moisture and sustain vegetation growth. Therefore, it is important to time the seeding to coincide with expected optimal rainfall and an established soil moisture profile. Given the scale of areas to be revegetated, and the appropriate reshaping and topsoil spreading during the dry season, it will be necessary to ameliorate and seed immediately prior to the wet season (September to November, Figure 1). Noting that winter dryland seeding should be avoided as average winter rainfall (Figure 1) is insufficient to support revegetation establishment.

As native seed procurement has a long lead time and requires adequate seed storage facilities (i.e., controlled conditions) the timing of supply or re-supply and application of native seed is important to reduce on-site storage requirements. As the MCM currently lacks adequate on-site native seed storage facilities, procurement timing and storage capability should be considered when scheduling rehabilitation works prior to the wet season.

7.1.2 Seed mix

Based on the target PMLU of mixed-use open woodland, the recommended proportion of seed by species lifeform is shown in Table 8 and candidate species for each lifeform are shown in Table 9.

Table 8: Seed mix proportion by stratum/lifeform

Stratum	Treatment Zone 1 (Slope ≤16%)	Treatment Zone 2 (Slope >16%)	Treatment Zone 3 (Riparian)	Treatment Zone 4 (NUMA)
Target application rate	35kg/ha	55kg/ha	20kg/ha	Nil ^[1]
Cover crop	28.5%	33.0%	25.0%	-
Non-native grass	43.0%	45.5%	25.0%	-
Pasture legume	11.5%	-	5.0%	-
Native grass	14.0%	18.0%	20.0%	-
Native tree and shrub	3.0%	3.5%	15.0%	-
Native sedge	-	-	10.0% ^[2]	-

^[1] Where portions of the low wall can be revegetated, but not grazed, revert to Treatment Zone 2 mix.

^[2] Sedge species are important to riparian vegetation establishment but are sensitive to soil moisture content. There may be greater success if supplemented or replaced with tubestock planting.

Table 9: Candidate species suitable for inclusion in the revegetation seed mix for each lifeform

Scientific name	Common name	Recommended rate (kg/ha)	Target species number by stratum
Cover crops			
<i>Echinochloa esculenta</i>	Japanese Millet (summer)	5.0–15.0	1–2 species
<i>Panicum miliaceum</i>	White French Millett (summer)	5.0–15.0	
<i>Avena sativa</i>	Wintaroo Oats (winter)	5.0–15.0	
<i>Hordeum vulgare</i>	Barley (winter)	5.0–15.0	
<i>Lolium rigidum</i>	Annual ryegrass (winter-spring)	5.0–15.0	
Non-native grasses			
<i>Bothriochloa insculpta</i>	Creeping bluegrass	2.5–5.0	3–5 species
<i>Bothriochloa pertusa</i>	Indian bluegrass	4.0–6.0	
<i>Cenchrus ciliaris</i>	Buffel grass	2.5–5.0	
<i>Chloris gayana</i> cv Reclaimer	Rhodes grass (Reclaimer)	2.5–5.0	
<i>Cynodon dactylon</i>	Green couch	4.0–6.0	
<i>Digitaria eriantha</i>	Digit grass		
<i>Melinis repens</i>	Red Natal grass	1.0–3.0	
<i>Urochloa mosambicensis</i>	Sabi grass	2.5–5.0	
Legumes			
<i>Clitoria ternatea</i>	Butterfly pea	2.5–10	1–2 species
<i>Desmanthus progardes</i>	Progardes	2.5–10	
<i>Stylosanthes hamata</i>	Verano	2.5–10	
<i>Stylosanthes scabra</i>	Seca Stylo	2.5–10	

Scientific name	Common name	Recommended rate (kg/ha)	Target species number by stratum	
Native grasses (grazing)				
<i>Bothriochloa bladhii</i>	Forest bluegrass	1.0–3.0	3–5 species	
<i>Bothriochloa decipiens</i>	Pitted bluegrass	0.5–2.0		
<i>Bothriochloa ewartiana</i>	Desert bluegrass	0.5–2.0		
<i>Cymbopogon refractus</i>	Barbwire grass	0.5–2.0		
<i>Dichanthium sericeum</i>	Queensland bluegrass	1.0–3.0		
<i>Enteropogon acicularis</i>	Curly windmill grass	1.0–2.0		
<i>Heteropogon contortus</i> ^[1]	Black spear grass	0.5–1.0		
<i>Panicum decompositum</i>	Native millet	0.5–2.0		
<i>Themeda triandra</i>	Kangaroo grass	0.5–2.0		
Native trees/shrubs – Treatment Zones 1 and 2		Recommended rate (g/ha)		
<i>Corymbia erythrophloia</i>	Variable barked bloodwood	75–125	Priority species	3–5 species
<i>Eucalyptus exerta</i>	Queensland peppermint	25–75		
<i>Eucalyptus microcarpa</i>	Grey Box	25–75		
<i>Eucalyptus melanophloia</i>	Silver leaved ironbark	25–75		
<i>Eucalyptus orgadophila</i>	Mountain coolibah	25–75		
<i>Acacia harpophylla</i>	Brigalow	100–150		
<i>Casaurina cristata</i>	Belah	25–75		
<i>Corymbia citriodora</i>	Lemon-scented gum	50–100		
<i>Corymbia clarksoniana</i>	Clarkson’s bloodwood	75–125		
<i>Corymbia dallachiana</i>	Dallachy’s gum	75–125		
<i>Eucalyptus cambageana</i>	Dawson River blackbutt	25–75		
<i>Eucalyptus crebra</i>	Narrow leaved ironbark	25–75		
<i>Eucalyptus populnea</i>	Poplar box	25–75		
<i>Geijera parviflora</i>	Wilga	50–100		

^[1] Important to note that unless threshed and coated, *Heteropogon contortus* is very difficult to mix and can cause problems with spreading machinery.

7.1.2.1 Riparian vegetation

Vegetation located adjacent to creek diversions and drainage lines within the final landform would form riparian vegetation. Revegetation of riparian areas (Treatment Zone 3) requires a detailed design and implementation plan specific to the MCM, due to the variability in soil, adjacent vegetation and channel flow energy characteristics.

Riparian environments have a high level of risk associated with retaining soils in concentrated flow, which require integration of traditional controls, such as rock chutes, as well as advanced revegetation strategies, such as the application of suitable seed mix and/or planting of tubestock that are quick to establish with the aid of irrigation. Germination and sustained growth of the quick to establish vegetative erosion protection blanket is essential to ensure that the revegetation develops suitable root mass to reduce the risk of soil loss before the channel is exposed to erosive forces brought about by wet season rainfall.

Consistent with the above, creek diversions and drainage lines within the MCM final landform (i.e., Treatment Zone 3) would be rehabilitated to achieve the target PMLU of mixed use open woodland. However, as described above, riparian areas would require a quick to establish seed mix more suited to a riparian environment. Seed species required would vary from the toe of the bank to the overbank area and, while utilising some species noted in Table 9, seed mixes would require species such as:

- Native trees:
 - *Casuarina cunninghamiana* (River she-oak);
 - *Eucalyptus camaldulensis* (River red gum);
 - *Eucalyptus tereticornis* (Forest red gum);
 - *Melaleuca viminalis* (Dawson River bottlebrush); and
- Native sedge-rushes:
 - *Lomandra longifolia* (Spiny-head mat-rush);
 - *Cyperus exaltatus* (Tall flatsedge).

7.1.3 Seed quality

Seed should be sourced from reputable suppliers with documented quality control procedures. Germination and purity testing by a certified laboratory are desirable, but visual inspections by a suitably qualified person (e.g., agronomist or reputable seed supplier) would also be acceptable.

7.2 Seeding

7.2.1 Mechanical seeding

A range of tractor drawn, and dozer mounted seeding equipment can be utilised to sow seed. Final landform slope and roughness will determine the requirements for final site preparation and suitable equipment configuration. Beds prepared for seeding that have become crusted must have the surface broken up by scarifiers or coulter discs. Seed sowing delivery options include:

- mounted box seeders with GPS tracking and electronically metered seed delivery eg. Seabrook (preferred);
- direct drill air-seeders;
- drum seeders; and
- surface spreaders (e.g., Marshall spreader).

Each of the above options should also be integrated with scarifiers, harrows, or tracking chains, which will assist with seed incorporation. Seed incorporation to a depth of approximately 50 mm is desirable to ensure adequate soil moisture is attained before germination is initiated, and that seed is not too deep to penetrate the soil surface.

Seeding equipment should be capable of adjustment to:

- place seed at the recommended depth ensuring the seed is covered by topsoil, and
- achieve required application rate (Table 8).

Other forms of seeding, such as manual or hydroseeding, are less desirable due to their lower success rate in dry climates. Application of seed at the surface without incorporation into

topsoil/growth medium may result in germination following light rains, and subsequent failure of germinants, if there is inadequate soil moisture to sustain initial growth.

7.2.2 Irrigation

If practical, the vegetative erosion protection blanket of cover crop, stoloniferous grasses and legumes can be irrigated for at least six to eight weeks before the start of the wet season. This is to maintain soil moisture at field capacity and to significantly increase plant survival. MCM has a tropical climate, which experiences large variation between wet and dry season rainfall, resulting in low vegetation growth in the dry season, and high erosion risk in the wet season. Therefore, in specific high-risk areas, such as creek diversions and drainage channels, irrigation is required in the dry season, to establish vegetation prior to peak rainfall events.

7.3 Habitat creation

Given the high erodibility factors of the chemically problematic waste rock material and soil typical in the Bowen Basin, the primary objective of the revegetation component of the rehabilitation process is to rapidly establish a vegetation cover that will stabilise the post-mining landform, utilising ecological engineering in addition to more traditional rock mulching methodologies.

Once successfully established, the ecological erosion protection blanket of carefully selected cover crop, grasses and legumes will significantly reduce the risk of erosion soon after the first rains of the wet season. This cover crop has similar habitat values to the surrounding grazing land that is common in the Middlemount region and is a key component of the PMLU.

The MCM final landform will have anthropogenic slope and aspect components that have not previously existed at the MCM. These anthropogenic factors are likely to vary the suitability of the revegetated landscape away from the pre-mining upper stratum of vegetation species.

In the region surrounding the MCM, the geomorphology of the mesa landscape of the Peak Range National Park has different parent geology, however, similar slopes to those within the MCM final landform do occur. For this reason, tree species present in the Peak Ranges National Park, such as *Eucalyptus orgadophila* (mountain coolabah), *Eucalyptus exserta* (Queensland peppermint), *Eucalyptus microcarpa* (grey box), and *Eucalyptus melanophloia* (silver-leaved ironbark) have been selected in this Revegetation Management Plan.

Whilst it is not the objective of this revegetation plan, it is hoped that, given the necessary time for habitat connectivity to occur and hollows to form, that the inclusion of the abovementioned tree species in the post mining landscape of the rehabilitated MCM will offer habitat values capable of supporting woodland birds and native mammals known to have existed at the MCM prior to the commencement of mining (Section 2.4.2).

8. Rehabilitation Milestones

Table 10: Indicative revegetation milestones

Milestone Reference	Rehabilitation Milestone	Treatment Zone	Milestone Criteria	Approximate Timeframe
RM1	Infrastructure Decommissioning and Removal	Zone 1	<ul style="list-style-type: none"> a) All services disconnected and decommissioned. b) Contaminated land and water (e.g. affected by hydrocarbons, metals, brine, etc) is treated to ensure consistency with upstream water quality characteristics, or removed off site. c) All wastes removed from site and lawfully disposed. d) All infrastructure water storages demolished and removed, unless agreed in writing by the landholders and relevant agencies. e) All haul roads and access tracks to be ripped and removed to reduce compaction unless agreed in writing by landholders and relevant agencies. f) Risk assessment undertaken to ensure that all infrastructure has been appropriately disconnected and decommissioned. 	3 months
RM2	Remediation of Contaminated Land (Characterisation)	Zone 1 Zone 2	<ul style="list-style-type: none"> a) Detailed site investigation report, as required under the <i>Environmental Protection Act 1994</i>, completed. b) Contaminated and hazardous materials (e.g. PCBs, Mercury, hydrocarbon contaminated soils, Dioxins etc.) have been removed and appropriately disposed of or remediated. c) Hydrocarbon, heavy metal, or other contaminants are within allowable departmental limits, has been certified by an appropriately qualified person. d) A site suitability statement confirms the uses or activities for which the land is suitable and aligns to the approved PMLUS for the site. e) Validation testing confirms that contaminated soils have been removed or remediated. 	3 months
RM3	Remediation of Contaminated Land (Waste Rock Material Treatment)	Zone 1 Zone 2	<ul style="list-style-type: none"> a) Site added to the Environmental Management Register, if required. b) Remediation of contaminated soil materials such as hydrocarbon has been undertaken as required. c) Validation testing confirms that contaminated soils have been removed or remediated. d) No acid rock drainage is occurring or has the potential to occur. 	3 months
RM4	Landform Establishment (Capping, Development and Reshaping/Re-profiling)	Zone 1 Zone 2	<ul style="list-style-type: none"> a) Engineering and design plans for TSF and emplacement areas finalised. b) Tailings have settled before capping. c) Non-acid forming (NAF) waste rock or other identified capping materials such as clay will be compacted with suitable oxygen diffusion control properties to reduce the minimum encapsulation thickness. d) All major earthworks completed. e) Landform recontoured to conform with adjacent landforms. f) Out-of-pit coal emplacement slopes no greater than 10%, or up to 18.5% where rock mulch or other stabilisation controls are used. g) Infrastructure area slope angles do not exceed 5%. h) Slopes of >16% have been treated with rock mulch to assist with maintaining slope stability. i) Installation of contour or graded drains as per construction design which has been certified by an appropriately qualified person. j) Final voids certified by a suitably qualified and experienced person as geotechnically stable. k) Final landform is stable and has been certified by an appropriately qualified person. 	6 months

Milestone Reference	Rehabilitation Milestone	Treatment Zone	Milestone Criteria	Approximate Timeframe
RM5	Growth Medium Application (Surface preparation and application of ameliorants)	Zone 1 Zone 2	<p>a) An assessment of soil health and suitability has been completed by an appropriately qualified person to confirm soil is suitable for target vegetation growth.</p> <p>b) Waste rock material ripped to a maximum of 300 mm depth via grader tynes or equivalent to incorporate gypsum (as required).</p> <p>c) Topsoil placed to a minimum depth of 200 mm, to achieve 500 mm of amended material.</p> <p>d) Topsoil amelioration and fertilisation process completed to minimise chemical and physical limitations of establishment and growth of vigorous vegetation cover. Approach involves the application of gypsum and organic matter prior to applying chemical fertiliser (as required) (target Nitrate as N: >30 milligram [mg] per kg [mg/kg], Phosphate (Collwell P): >20 mg/kg).</p> <p>e) Use of offset disc harrows, or similar, to harrow gypsum and organic matter into full depth (maximum 200 mm) and on the contour. Use of scarifiers or chain harrows (maximum 50 mm depth) to apply fertiliser and seed incorporation. No deep ripping of topsoil.</p> <p>f) Installation of fencing (if required) completed.</p> <p>g) Evidence, certified by an appropriately qualified person, that topsoil/growth medium has been spread to a suitable depth in rehabilitated areas to sustain the post mining land use.</p> <p>h) Amelioration of topsoil undertaken to minimise chemical and physical properties limiting establishment and growth of vegetation cover.</p> <p>i) For areas < 16 % slope, vertical rills and troughs removed, and topsoil applied to a minimum depth of 200 mm.</p> <p>j) Seed applied and harrowed to average depth of approximately 50 mm.</p> <p>k) For areas > 16 % slope, seed over rock mulch applied to a minimum depth of 1 m.</p> <p>l) Soil surface crusting occurs in less than 2% of the rehabilitated domain area.</p>	3 months
RM6	Revegetation (mixed use ¹ – grazing)	Zone 1	<p>a) Direct seeding of cover crop and pasture species completed on relevant rehabilitation areas (seed mix proportions specified in Revegetation Management Plan).</p> <p>b) Use of tractor drawn, or dozer mounted seeding equipment to sow seed.</p> <p>c) Seed incorporated to a depth of approximately 50 mm to ensure adequate soil moisture is stored before germination is initiated and so that the seed is not penetrated too deep in the soil surface. Use of scarifiers, chain harrows or tracking chains to incorporate seed.</p> <p>d) Seed sourced from reputable seed suppliers with documented quality control procedures.</p> <p>e) Stock fencing to protect early stages of revegetation instalment.</p> <p>f) A minimum of 70 % vegetation cover is present, and evidence of generational succession of trees and shrubs is evident.</p> <p>g) Bare surface areas are not to exceed 100 m² in area, and exceed a length of 10 m along slope, based on a five year average period.</p>	12 months
RM7	Revegetation (mixed use open woodland)	Zone 1 Zone 2 Zone 3	<p>a) Direct seeding of cover crop, pasture species and native vegetation completed (seed mix proportions specified in Revegetation Management Plan).</p> <p>b) Use of tractor drawn, or dozer mounted seeding equipment to sow seed.</p> <p>c) Seed incorporated to a depth of approximately 50 mm to ensure adequate soil moisture is stored before germination is initiated and so that the seed is not penetrated too deep in the soil surface. Use of scarifiers, chain harrows or tracking chains to incorporate seed.</p> <p>d) Seed sourced from reputable seed suppliers with documented quality control procedures.</p> <p>e) Germination and purity visual inspections by a certified professional undertaken (e.g., agronomist or reputable seed supplier).</p> <p>f) Stock fencing to protect early stages of revegetation instalment.</p> <p>g) Till along the contour with a tined implement with tyne spacing no greater than 500 mm.</p> <p>h) Non-vegetation cover (stones, rock cover, litter, logs etc) does not cover greater than 30% of the total area.</p> <p>i) A minimum of 70% vegetation cover is present, and evidence of generational succession of trees and shrubs is apparent in rehabilitated areas.</p> <p>j) Pasture grass and woodland species are comparable in cover to designated vegetation reference sites.</p>	12 months

¹ The proposed PMLU of mixed use open woodland comprises areas grazing surfaces, as well as open woodland, therefore two separate rehabilitation milestones have been implemented to account for the mix uses in revegetation (i.e. grazing pasture and grasses, and open woodland tree and shrub species).

Milestone Reference	Rehabilitation Milestone	Treatment Zone	Milestone Criteria	Approximate Timeframe
RM8	Surface Conditions	Zone 1 Zone 2	<p>a) No evidence of slumping and erosion maintenance requirements are comparable to designated vegetation reference sites, for a period of at least five years post-mining.</p> <p>b) Hydraulic and geomorphic characteristics of rehabilitated portions of Roper Creek (Diversion 1 and 2), and Thirteen Mile Gully (Diversion) reviewed by a suitably certified person and confirmed that it is trending towards the hydraulic and geomorphic characteristics of undisturbed sections of Roper Creek and Thirteen Mile Gully channels.</p> <p>c) Target ranges for chemical and physico-chemical nutrients are considered to be at levels in which plant nutrient deficiencies are relieved and plant growth is encouraged (refer to Revegetation Management Plan).</p> <p>d) Hydrocarbon, heavy metals or other contamination levels are within appropriate DES limits.</p>	5 years
RM9	Achievement of PM10 to Stable Condition (mixed use – grazing)	Zone 1	<p>Safe:</p> <p>a) Certification that slopes are safe and predicted to remain safe.</p> <p>b) Certification that the relevant specified cover thickness has been obtained.</p> <p>c) Evidence that any site contamination has been resolved and relevant measures implemented, resulting in removal of the site from the Environmental Management Register (if required).</p> <p>d) Receiving water system water quality monitoring results comply with EA EPML00716913 or are comparable with upstream values, for an ongoing period of time.</p> <p>e) A Bushfire Management Plan developed in accordance with relevant Queensland Fire and Emergency Services is in place.</p> <p>Stable:</p> <p>f) Active erosion (t/ha/year) is less than 110% of the levels present in designated vegetation reference sites.</p> <p>g) Erosion maintenance requirements are comparable to designated vegetation reference sites, for a period of at least five years post-mining.</p> <p>h) No evidence of severe erosion².</p> <p>i) Persistent groundcover greater than or equal to 70 % established as assessed against comparable reference sites.</p> <p>j) Evidence of effective pest management with pest species abundance being comparable to designated vegetation reference sites.</p> <p>k) Evidence of effective weed management with weed diversity and density being less than 110 % of baseline survey results and abundance being comparable to designated vegetation reference sites.</p> <p>Self-sustaining land use:</p> <p>l) Meets land suitability class 3³ for beef cattle grazing.</p> <p>m) Assessed stocking rates in rehabilitated pasture areas are comparable to designated vegetation reference sites.</p> <p>n) Pasture grass species are comparable in cover and composition to designated vegetation reference sites.</p> <p>o) Pasture grass species show evidence of seed set, germination and emergence.</p> <p>p) Salinity levels of less than 2.0 dS/m in soil root zone or less than 110 % of designated vegetation reference sites.</p> <p>q) Cation exchange capacity levels are greater than 10 to 12 in soil root zone or less than 110 % of designated vegetation reference sites.</p> <p>Non-polluting:</p> <p>r) Hydrocarbon, heavy metal or other contamination levels are within relevant DES limits.</p> <p>s) Receiving water system water quality monitoring results comply with EA EPML00716913 or are comparable with upstream values, for an ongoing period of time.</p> <p>t) Groundwater quality monitoring results comply with EA EPML00716913, for an ongoing period of time.</p>	Up to 20 years

² Severe erosion has any of the following characteristics – Loss of surface horizons, root exposure, etc. (sheet erosion), >30 rills and/or any >0.3 m deep (rill / gully erosion); presence of tunnel erosion; or evidence of mass soil movement.

³ Land suitability class should be measured at a landscape / paddock scale. It is recognised that the wider rehabilitated landform may contain small areas of Class 5 land.

Milestone Reference	Rehabilitation Milestone	Treatment Zone	Milestone Criteria	Approximate Timeframe
RM10	Achievement of PMLU to Stable Condition (mixed use – open woodland)	Zone 1 Zone 2 Zone 3	<p>Safe:</p> <ul style="list-style-type: none"> a) Certification that slopes are safe and predicted to remain safe. b) Certification that the relevant specified cover thickness has been obtained. c) Evidence that any site contamination has been resolved and relevant measures implemented, resulting in removal of the site from the Environmental Management Register (if required). d) A Bushfire Management Plan developed in accordance with relevant Queensland Fire and Emergency Services is in place. <p>Stable:</p> <ul style="list-style-type: none"> e) Rehabilitation area has remained stable when comparing photographs from successive monitoring events, for a period of at least five years post-mining. f) Active erosion (t/ha/year) is less than 110% of the levels present in designated vegetation reference sites. g) Erosion maintenance requirements are comparable to designated vegetation reference sites, for a period of at least five years post-mining. h) Nutrient cycling processes are comparable to designated reference sites which are representative of the PMLU. i) Pest species abundance comparable to designated reference sites. j) Weed diversity and density less than 110% of the levels present in the designated reference sites, for a period of at least two years. k) Vegetative material layer(s) (e.g. leaf litter) is evident and contributing to nutrient cycling and development of microbial mass. l) Hydraulic and geomorphic characteristics of rehabilitated portions of Roper Creek (Diversion 1 and 2), and Thirteen Mile Gully (Diversion) reviewed by a suitably certified person and confirmed that it is trending towards the hydraulic and geomorphic characteristics of undisturbed sections of Roper Creek and Thirteen Mile Gully channels. <p>Self-sustaining land use:</p> <ul style="list-style-type: none"> m) Assessed stocking rates in rehabilitated woodland areas are comparable to designated vegetation reference sites. n) Litter density comparable to vegetation reference sites. o) Declared weed species cover is comparable to designated vegetation reference sites. p) Tree and shrub species are comparable to designated vegetation reference sites. q) Tree and shrub species show evidence of flowering, viable seed setting, germination and emergence. r) Persistent cover greater than or equal to 70% as assessed against comparable reference sites. <p>Non-polluting:</p> <ul style="list-style-type: none"> s) Hydrocarbon, heavy metal or other contamination levels are within relevant DES limits. t) Receiving water system water quality monitoring results comply with EA EPML00716913 or are comparable with upstream values, for a period of at least two years. u) Groundwater quality monitoring results comply with EA EPML00716913, for an ongoing period of time. 	Up to 20 years
RM11	Retained Water Structures ⁴	Zone 1	<p>Stable:</p> <ul style="list-style-type: none"> a) Certification of structural integrity. b) Water quality within the retained water structures is comparable with upstream values. <p>Non-polluting:</p> <ul style="list-style-type: none"> c) Water quality monitoring results comply with EA EPML00716913 for an ongoing period of time. 	2 years

⁴ Retained water structures (i.e. water storage and water management areas) will be retained within the final landform and are not proposed to be revegetated, not withstanding, these areas will be rehabilitated to be safe, stable, non-polluting prior to the completion of rehabilitation activities (Section 3.5.7).

9. Rehabilitation Monitoring Program

The MCM Rehabilitation Monitoring Program will be implemented over the life of the MCM and designed to quantify revegetation success, track revegetation progress, identify and inform timely mitigation and/or intervention actions (e.g., supplementary seeding) for areas of revegetation that have not met the rehabilitation completion criteria for the domain.

The rehabilitation objective of the MCM is to establish a self-sustaining vegetation cover suited to mixed use open woodland, which is safe, stable, and non-polluting. To meet compliance requirements, and provide useful data on the sustainability and productivity of the revegetated landscape accurate, consistent, representative, and repeatable assessments of land and vegetation condition will be required.

MCPL currently undertakes rehabilitation monitoring and reports the outcomes in an annual report. The rehabilitation monitoring reports describe the state of the land prior to the reporting period (i.e., baseline state) and evaluates key indicators of long-term land conditions. This baseline state is then used to track rehabilitation progress and continual improvement against previous monitoring reports.

Additionally, MCPL should undertake further assessments of the condition of existing pasture used for grazing adjacent to the MCPL to provide a valuable benchmark to assess MCM rehabilitation progress and success against (Section 9.1). Benchmarks should be developed using similar and adjoining environments where grazing remains the predominant land use (i.e., analogue sites, Section 9.1).

With the emergence of higher resolution satellite-based remote sensing capabilities and Un-manned Aerial Vehicle (UAV) based spectral analyses, alternative approaches may complement existing ground-based surveys and enable non-biased, whole-of-landscape, assessments to be undertaken.

9.1 Analogue sites

It is recommended that the following three initial vegetation analogue sites (i.e., vegetation reference sites) should be established on land owned by MCPL. These sites are consistent with the PMLU of mixed-use open woodland.

The following sites are recommended (coordinates are provided in GDA94, MGA Zone 55):

- Analogue Site 01: 662883E, 7475606N (preclear RE: 11.5.3).
- Analogue Site 02: 664591E, 7468202N (preclear RE: 11.12.2).
- Analogue Site 03: 663833E, 7471263N (preclear RE: 11.3.25).

The above vegetation reference sites, in addition to the initial sites, may be established once additional areas of the MCM have undergone rehabilitation works and monitoring reports can provide data which can be compared to the initial three reference sites.

9.2 Performance indicators

Field surveys should be undertaken annually to measure success against performance indicators, with early intervention and additional remedial works key to the success of the revegetation work.

Relevant performance indicators include:

- vegetation groundcover and canopy cover;
- vegetation density and health;
- vegetation diversity and structure;
- in situ species recruitment (self-sustaining);
- signs of land disturbance, degradation, or erosion; and
- weed density and diversity.

Independent of any monitoring survey outcomes, remedial revegetation (e.g., seed re-sowing) may be required on revegetated areas up to the end of the revegetation maintenance period within any Treatment Zone if the following conditions are present:

- any contiguous bare area greater than 100 m²; and/or
- any contiguous area of 200 m² with less than 65% groundcover.

If the above requirements are not met, it is recommended that these areas undergo remedial revegetation to achieve:

- a minimum ground cover of 65%; and/or
- a minimum vegetation survival rate in line with analogue survey sites.

The above thresholds provide guidance for vegetation management in all Treatment Zones.

9.3 Monitoring methodology and objectives

The establishment of a number of representative monitoring plots including photo points, within each treatment zone of the rehabilitated landform should be undertaken upon completion of revegetation work. Plots should be established at an intensity of one plot per 50 ha, with a minimum of at least three plots per landform/soil type/stratum.

Monitoring methodology should align with the current MCM Rehabilitation Monitoring Program, assessing at a minimum:

- Species richness by stratum (i.e., native tree, shrub, grass species)
- Ground cover distribution (i.e., the percentage of each cover type)
- Introduced/weed species
- Tree height
- Tree cover
- Stocking and survival (derived)

A number of reference sites, reflecting similar surface soil conditions to each zone (Section 9.1), must be included to ensure any external environmental influences outside the rehabilitation area, are reflected in on-site assessments and to provide a comparison for benchmarking rehabilitation success.

Outlined below are the parameters recommended for monitoring in addition to those outlined above:

- Ground level assessment:
 - Native and/or pasture species (ground cover) and growth phase - 3P grasses (i.e., palatable, perennial and productive), native grasses, legumes, low shrubs.
 - Ground cover density (e.g., isolated, sparse, mid-dense, dense) and distribution (even distribution, unevenly distributed).
 - Land surface ground cover, including organic material (litter), soil and rock.
 - Ground cover density (isolated, sparse, mid-dense, dense) and distribution (even distribution, unevenly distributed).
- Mid and upper strata assessment:
 - Understory layer, including species and density of shrubs and juvenile trees (0-3 m).
 - Native tree species, density, height greater than threshold in Monitoring Program).
 - Tree and shrub species diversity.
 - Land surface (sheet erosion, rills, gullies) and density (percentage of site).
 - Weeds (species listed in the Biosecurity Act 2014) and pest animal impacts (species and density).
 - Grazing pressure (species).
 - Other site impacts (e.g., fire, drought, periodic inundation).

9.4 Survival monitoring and supplementary seeding

Initial monitoring of the survival in seeded areas will commence immediately after the wet season to obtain baseline data and then at three, six and twelve-month intervals thereafter.

Ground cover will be used as a surrogate for survival. Using a 1 m² quadrat, evaluate the successful germination (ground cover) at five evenly spaced locations along a 100m transect. The transect is to be established, initially, at random within a newly rehabilitated area and then revisited at every assessment.

In alignment with Section 9.2, if ground cover averages less than 65% in the five transects after 12 months of growth, supplementary seeding may be required.

Survival monitoring need not be undertaken by an ecologist.

9.5 Monitoring schedule and reporting

Monitoring and associated reporting of revegetation areas should be carried out annually post wet season consistent with the current MCM Rehabilitation Monitoring Program.

The annual monitoring report should include the methodology used to collect the monitoring parameters recommended in Section 9.3, outline monitoring results including any identification of pest/weed species and describe the rehabilitation works undertaken since the last monitoring report. The monitoring report should be supported by maps, georeferenced photographs, remote sensing and/or data analyses, any unintended site disturbances, and any appropriate management or intervention recommendations.

10. Maintenance

10.1 Weed management

To maintain and preserve the quality of the revegetated pasture (once established) and as a general environmental duty of care, weed management is undertaken at the MCM. Through both the monitoring program (Section 9) and incidental monitoring, weed occurrence is noted, particularly when weeds of environmental significance are observed/recorded. Management activities include:

- vehicle and machinery wash down before entering the rehabilitation works;
- monitoring and treatment of any significant infestations;
- revegetation occurring as soon as practicable in rehabilitation areas to minimise the emergence of undesirable weed species; and
- recording and mapping infestations/treatments.

10.2 Feral animal control

To maintain and preserve the quality of the revegetated pasture (once established), MCM has developed a feral animal management plan to monitor, and where necessary control, feral animals. Left unchecked, feral animals can mix with livestock and act as a vector for disease, destroy large areas of vegetation, cause soil erosion, and contaminate feed and water causing disease (Farm Biosecurity, ND). The following actions are included in the feral animal management plan:

- Protect feed and water sources.
- Regularly check and mend broken fences.
- Ensure any buildings are in good repair.
- Dispose of any carcasses properly and promptly.
- Work with neighbours and other producers in the area to implement a coordinated approach to feral animal control.
- Keep records as part of your control program.
- Refer to any Regional, State or National action plans.

10.3 Livestock management

Livestock should be excluded from areas undergoing active revegetation. If native trees are included with the pasture seed mix, these may require several years before they can tolerate cattle presence and browsing stress on the trees should be considered before allowing cattle access to the area. Livestock should be excluded from areas of unsuitable areas of revegetation through the use of fencing.

Once rehabilitation has been established there is benefit in allowing low density beef cattle grazing to occur in established areas, including nutrient recycling, stimulation of active growing phases and fire risk reduction. The following management options should be considered for keeping land in good condition with a high proportion and density of preferred groundcover species:

- manage total grazing pressure;
- use appropriate utilisation/stocking rates;
- implement appropriately timed spelling and herd management strategies;
- monitor pasture composition;
- use of hay, supplements, fodder trees and shrubs in a strategic manner;
- manage the tree/grass balance to avoid woodland thickening;
- implement forage budgeting strategies;
- use climate and seasonal forecasting resources;
- use appropriate fire management practices;
- fence according to land types; and
- manage the distance stock must travel to water.

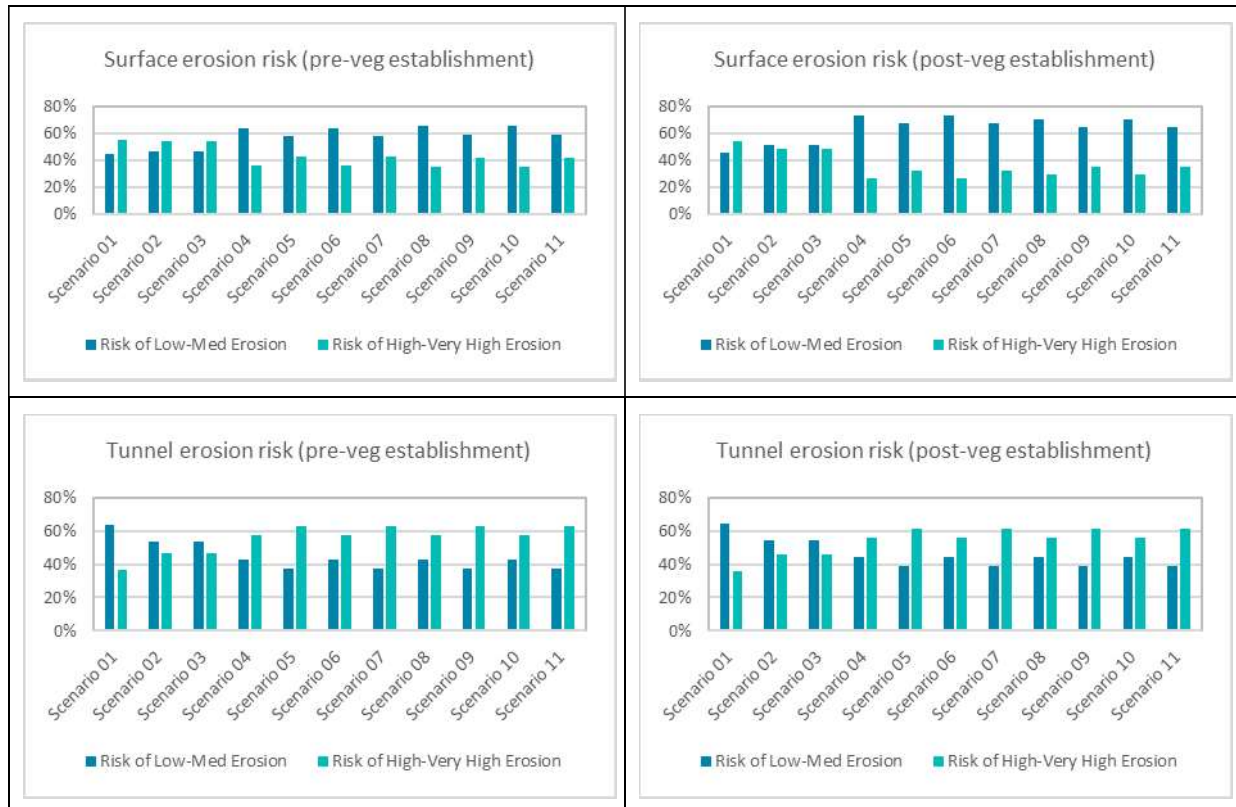
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Appendix 1: Risk modelling results

Erosion risk modelling of a subset of soils located in the 2021 rehabilitation areas in the east of the MCM indicated that the risk of high/very high surface erosion is decreased with vegetation establishment (Verterra, 2021). It was also found that the risk of high/very high surface erosion was reduced in scenarios where the full depth of waste rock material was treated with ameliorants. Relative erosion risk by scenario is presented in Table 3 (Section 4.1) and absolute risk by scenario below.



MDMC-2002 Revegetation Management Plan_v3

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