TARRAWONGA COAL MINE

MINE SITE REHABILITATION PLAN

Edition	Rev.	Comments	Date
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1 INTRODUCTION

1.1 BACKGROUND

This Tarrawonga Mine Site Rehabilitation Plan (MSRP) has been prepared to facilitate the rehabilitation of the Tarrawonga Coal Mine (TCM) and satisfy the requirements of Conditions 19 to 29 of Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 Approval 2011/5923 and considers Conditions 61 to 65 of Schedule 3 of the State MP 11_0047 (MOD 1). The document details the rehabilitation of disturbed mine landforms to effectively restore potential habitat for the Regent Honey Eater (*Anthochaera phrygia*), the Swift Parrot (*Lathamus discolour*), the Greater Long-eared Bat (*Nyctophilus corbeni*), White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and derived Native Grassland Critically Endangered Ecological Community (referred to herein as the Box-Gum Woodland EEC). The document also details the rehabilitation of Class 3 Agricultural Land as required under Condition 61 of Schedule 3 of PA 11_0047 (MOD 1).

The open cut pit and emplacement areas are active and progressive rehabilitation is currently being undertaken with specific focus on the Northern and Southern Emplacement Areas to produce the Box-Gum Woodland EEC and Agricultural Rehabilitation Areas required under Conditions 23 of EPBC 2011/5923 and Condition 61 of PA 11_0047 (MOD 1), respectively. As a result, this MSRP focuses on activities such as soil stripping, stockpiling, land preparation and infilling the overburden emplacement, temporary stabilisation and progressive rehabilitation.

Subsequent revisions of the MSRP will include more detail on the success of rehabilitation and monitoring of rehabilitation activities as the establishment of these areas progresses. It is also expected that the findings of on-site monitoring programs and rehabilitation research activities will be used to refine rehabilitation practices at the TCM.

This MSRP will be periodically reviewed and updated during the life of the TCM in order to incorporate details of the planned progressive rehabilitation activities, and improvements to soil management measures and rehabilitation practices. Annual reports would be prepared and provided to the Commonwealth Department of the Environment and Energy (DotEE). These reports would describe the management actions undertaken during the reporting period, the outcome of the actions, and the mechanisms to be used to facilitate continuous improvement.

1.2 LOCATION, OWNERSHIP AND OVERVIEW OF TCM ENVIRONMENTAL APPROVALS

The TCM is located on the northwest slopes and plains of New South Wales (NSW), approximately 15 kilometres (km) north-east of Boggabri and 42 km north-northwest of Gunnedah NSW. **Figure 1-1** shows the regional location of the TCM.

The ownership of the TCM currently lies with Tarrawonga Coal Pty. Ltd. (TCPL).

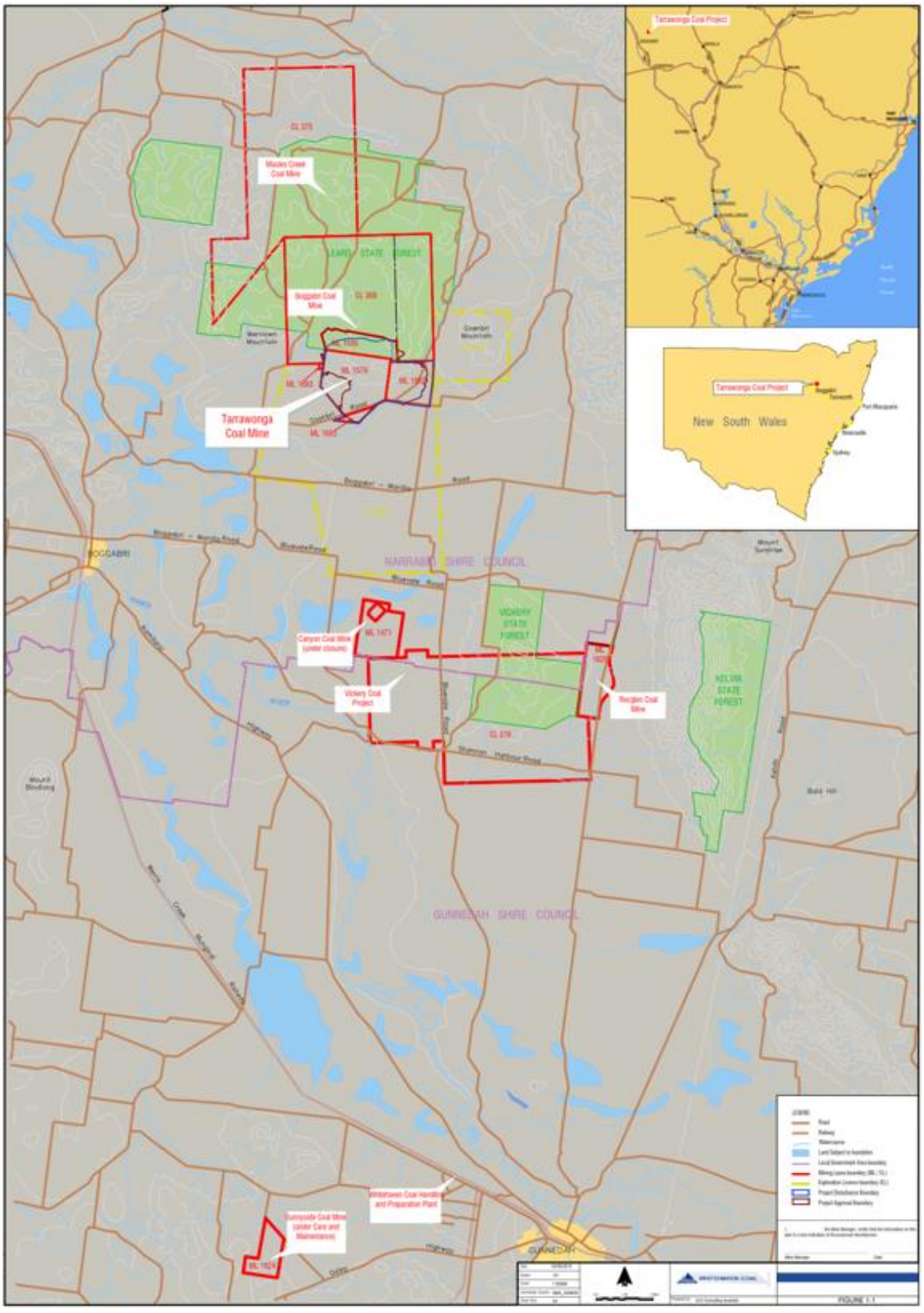

Figure 1-1 Project Location

In 2013, TCPL received PA 11_0047 from the Planning Assessment Commission (as delegate of the Minister for Planning and Infrastructure) under Part 3A of the EP&A Act for the Tarrawonga Coal Project. PA 11_0047 provides for the continuation and extension of the mine.

EPBC 2011/5923 was granted for the Tarrawonga Coal Mine Extension by the former Department of Sustainability, Environment, Water, Population and Communities on the 11th March 2013. EPBC 2011/5923 was subsequently varied on the 15th October 2015, 20th April 2016, 7th February 2018 and 22nd February 2019. This MSRP has been developed to satisfy the requirements of Conditions 19 to 29 of EPBC 2011/5923.

1.3 PROJECT OVERVIEW

The State and Commonwealth environmental approvals for the TCM allow for the construction and operation of an open cut coal mine with a mine life of approximately 17 years. In particular, current operations include the following activities:

- Continued development of mining operations in the Maules Creek Formation to facilitate a Run of Mine (ROM) coal production rate of up to 3 Million tonnes per annum (Mtpa), including open cut extensions;
- Open cut mining fleet including excavator/shovels and fleet of haul trucks, dozers, graders and water carts;
- Ongoing exploration activities;
- Continuation of transport of ROM coal via the approved haulage route to the Whitehaven Coal Handling Preparation Plant (CHPP), or to the Boggabri CHPP via internal haul roads, subject to a suitable commercial agreement between Boggabri and Tarrawonga Mines;
- Use of an existing on-site mobile crusher for coal crushing and screening of up to 150,000 tonnes (t) of domestic specification coal per annum for direct collection by customers at the mine site for transport offsite;
- Use an existing on-site mobile crusher to produce up to approximately 90,000 m^3 of gravel materials per annum for direct collection by customers at the mine site;
- Progressive backfilling of the mine void behind the advancing open cut mining operation with waste rock and minor quantities of reject material from the Gunnedah CHPP;
- Progressive development of new haul roads and internal roads, as mining develops;
- Progressive development of sediment basins and storage dams, pumps, pipelines and other water management equipment and structures;
- Continued development of soil stockpiles, laydown areas and gravel/borrow areas;
- Ongoing and progressive rehabilitation and monitoring; and
- Other associated minor infrastructure, plant, equipment and activities.

The approved open cut extension and surface development area (as defined by PA 11_0047 Disturbance Boundary) for the TCM are shown in **Figure 1-2**.

1.4 RELATIONSHIP BETWEEN THIS DOCUMENT AND OTHER TCM MANAGEMENT PLANS

This document has been specifically prepared to satisfy the requirements of Conditions 19 to 29 of Commonwealth approval EPBC 2011/5923 and considers Conditions 61 to 65 of Schedule 3 of the State approval PA 11_0047 (MOD 1). The focus of this MSRP is the rehabilitation of disturbed areas within the Disturbance Boundary associated with mining (Approximate Extent of Open Cut Extension on **Figure 1-2**). These conditions, and other relevant conditions, are discussed further in **Section 2**.

This MSRP has also been designed to be aligned with the approved Stage 1 TCM Biodiversity Management Plan (BMP) required under Condition 47 of Schedule 3 of PA 11_0047 (MOD 1) and Condition 12 of EPBC 2011/5923. The focus of the BMP/Offset Management Plan is to provide a consolidated plan for the management of flora and fauna within the Tarrawonga Coal Mine Project (including rehabilitation areas) and the conservation management of the TCM biodiversity offset areas. This MSRP also integrates with the *TCM Threatened Fauna Implementation Plan* (Whitehaven, 2015a) (TCMTFIP), *TCM Box-Gum Woodland Endangered Ecological Community Implementation Plan* (Whitehaven, 2015b) and the current TCM Mining Operations Plan (MOP). Relevant sections of these plans are summarised and/or referenced in this MRMP where appropriate.

Figures 1-3 and **1-4** show the early development of the TCM (i.e. 2016 and 2020) as depicted in the MOP. **Figure 1-5** shows the final rehabilitation and post-mining land use at the conclusion of the mine life, as depicted in the MOP.

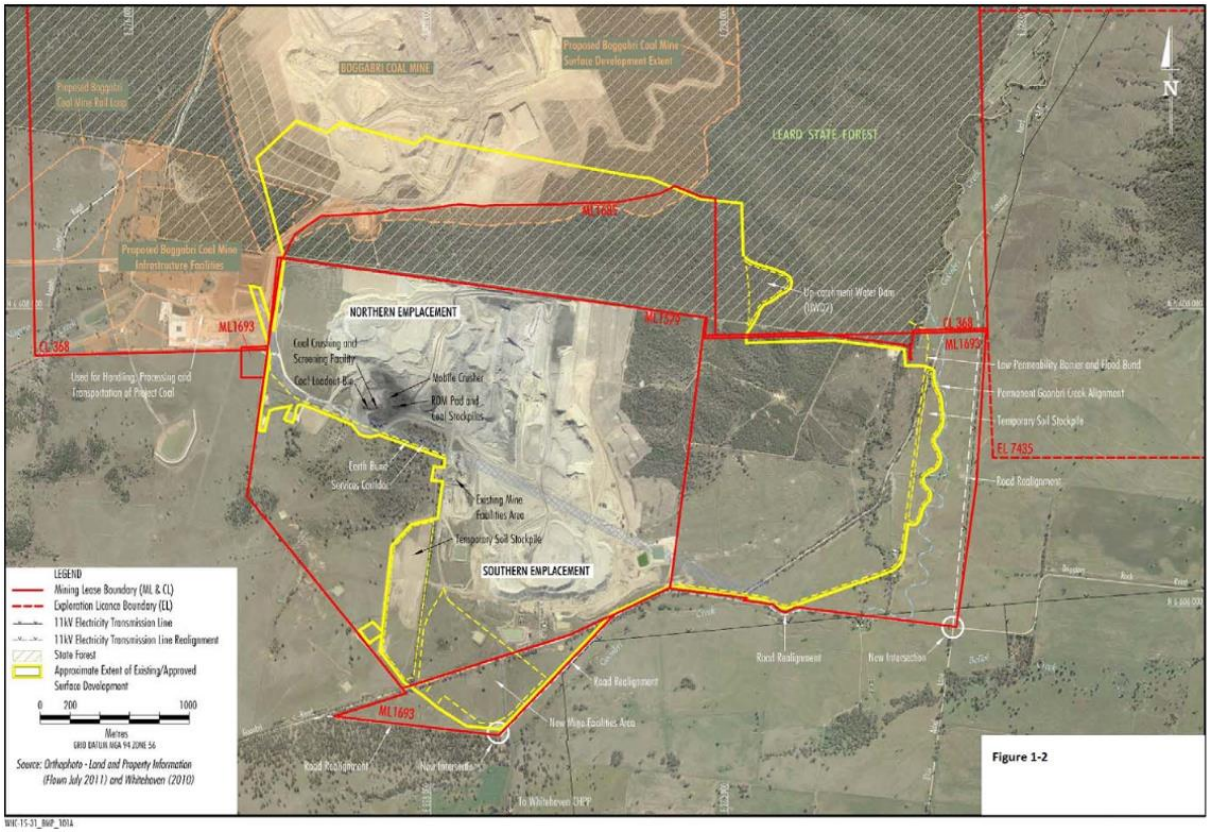

Figure 1-2 **Approved Disturbance Boundary and Surface Development Area**

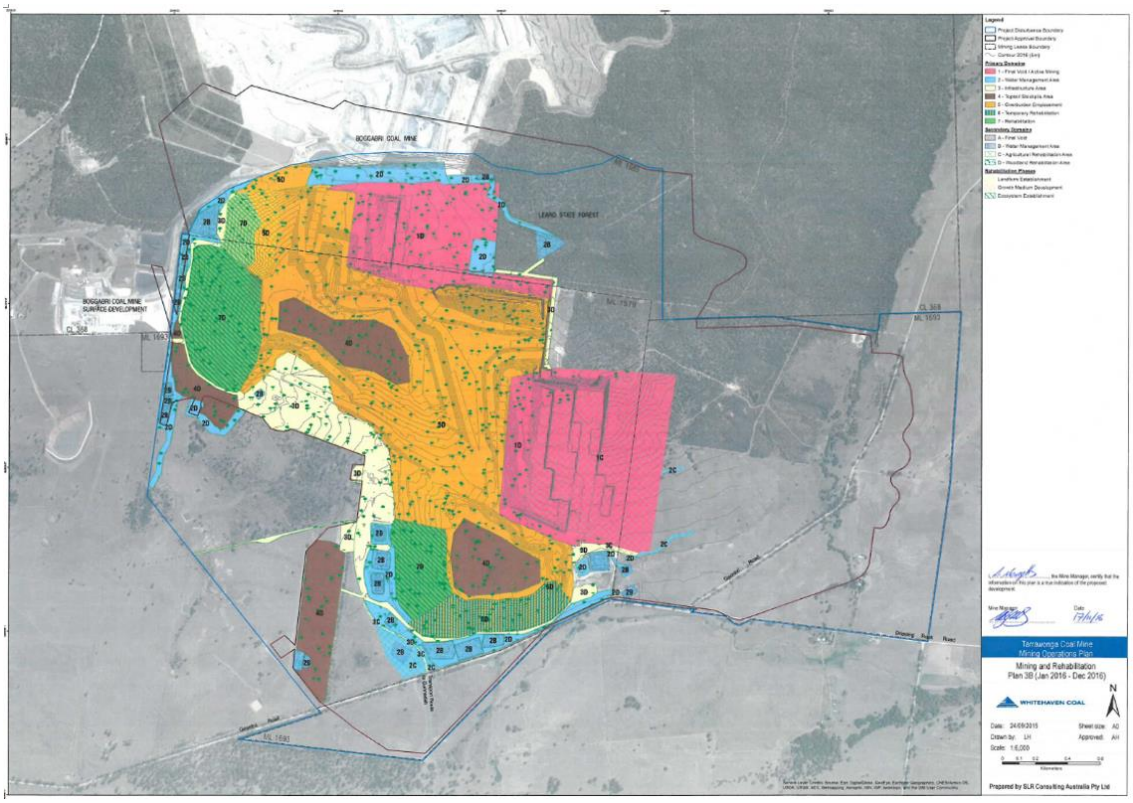

Figure 1-3 TCM Development 2016

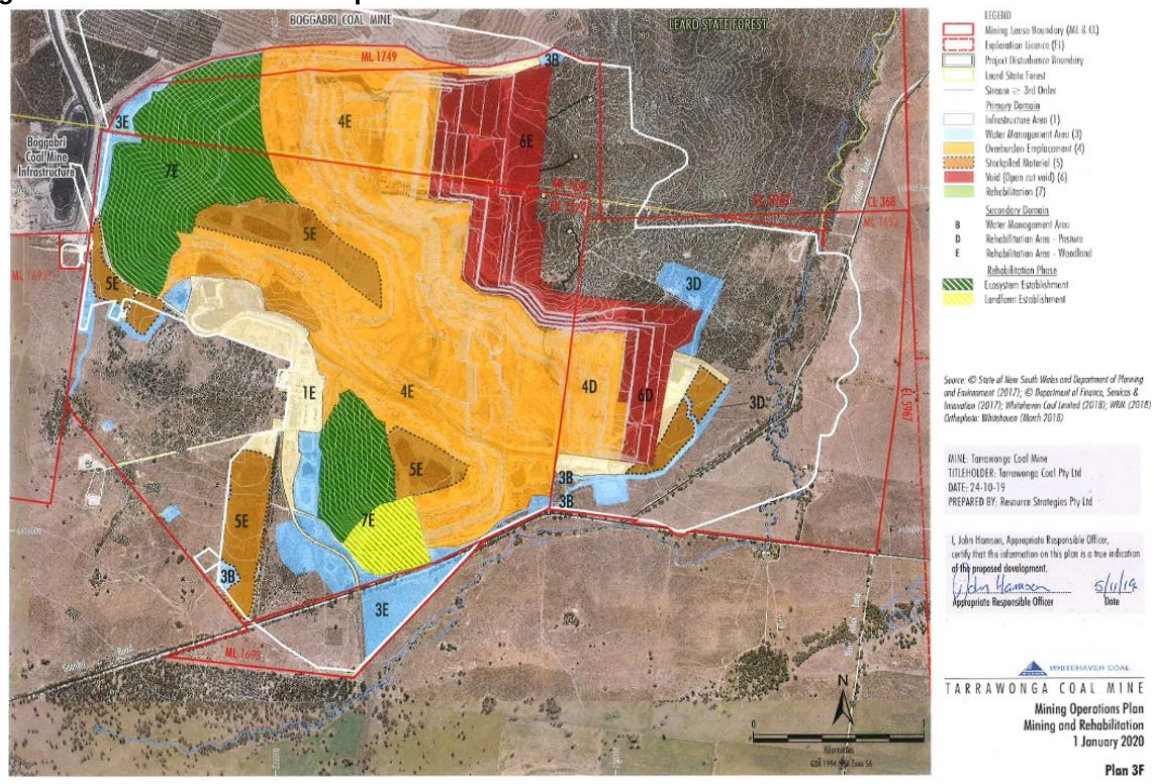

Figure 1-4 TCM Development 2020

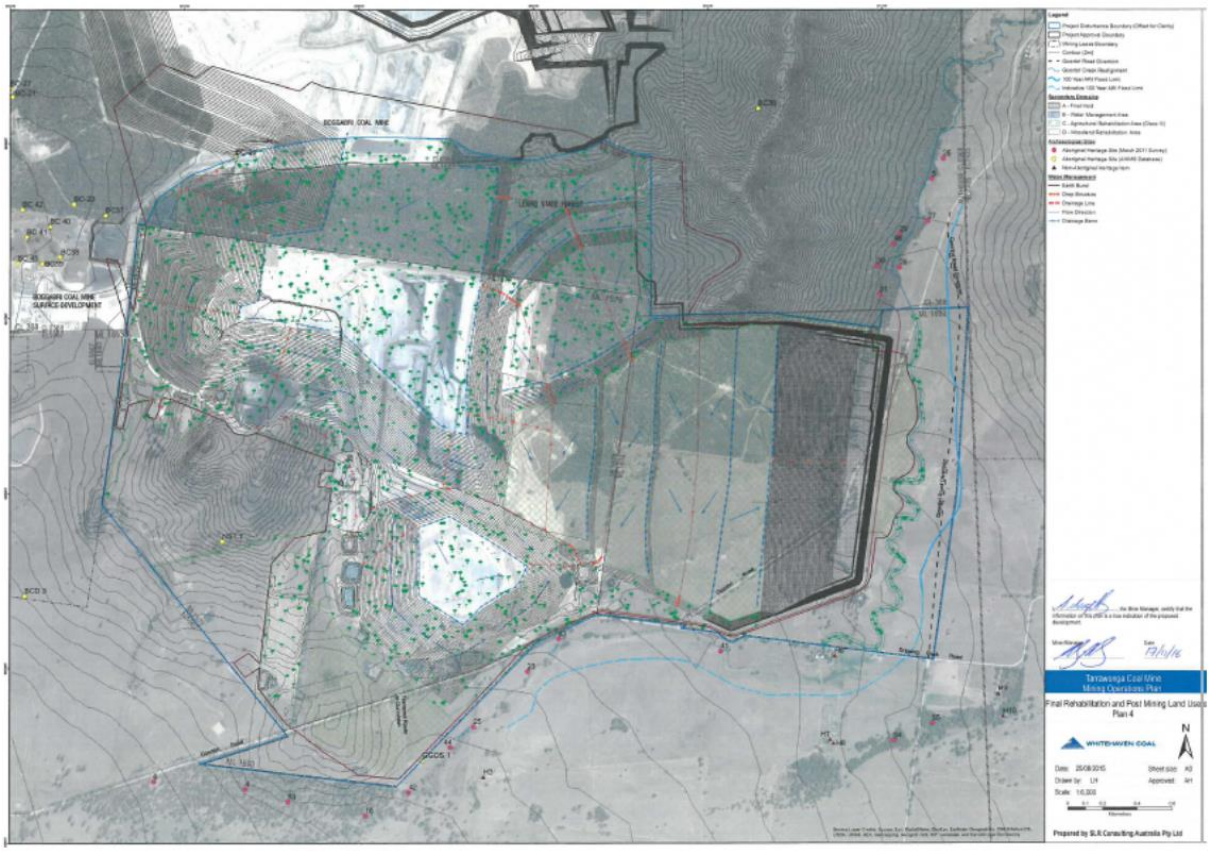

Figure 1-5 Final Rehabilitation and Post Mining Land Use

1.5 INDEPENDENT REVIEW OF THIS DOCUMENT

Condition 26 of Commonwealth approval EPBC 2011/5923 requires the MSRP to be subject to an independent review by a qualified ecologist prior to being submitted to the Commonwealth Minister for the Environment for approval. The independent review of this MSRP has been conducted by Dr David Freudenberger of ANU Enterprise Pty. Ltd. A copy of a letter indicating the findings of the review of this MSRP is contained in **Appendix A** in the final version of this MSRP.

1.6 STRUCTURE OF THIS DOCUMENT

The structure of this plan is as follows:

- Section 1 Provides background information on the TCM including its location and ownership, a project overview, and discusses the relationship between this MSRP and other management plans.
- Section 2 Discusses the particular EPBC and PA Conditions applicable to this MSRP.
- Section 3 Describes the rehabilitation strategy and objectives for the TCM.
- Section 4 Describes the soil management procedures that will be adopted at the TCM during the operation and rehabilitation of the mine site.
- Section 5 Provides details of the vegetation communities to be rehabilitated and the timing of progressive rehabilitation.
- Section 6 Provides an assessment of potential risks to successful management of rehabilitation, including weed invasion, and describes the contingency measures that would be implemented to mitigate these risks.
- Section 7 Describes the rehabilitation monitoring and reporting process that will be adopted to enable adaptive management and continuous improvement.
- Section 8 Describes the process that will be used to review, audit and review the implementation of this MSRP during the life of the TCM.
- Section 9 Provides a list of references contained in this MSRP.

2 APPROVAL CONDITIONS RELEVANT TO REHABILITATION OF THE TCM

2.1 COMMONWEALTH

EPBC 2011/5923 conditions that are relevant to the rehabilitation of the areas disturbed by mining at TCM are presented in **Table 2-1**. Where applicable, cross references are provided to the relevant section of this MSRP (or separate document) where the requirements of the conditions have been addressed.

Table 2-1 EPBC Act Rehabilitation-Related Approval Requirements

Applicable Condition	Requirement	Section Addressed/ Comment
Condition 19	*The person taking the action must provide to the **Minister** for approval, before **commencement of the construction of the permanent Goonbri Creek alignment**, **permanent flood bund and low permeability barrier**, a Goonbri Creek Diversion and Flood Bund Concept Design Plan. No construction activities in relation to the permanent Goonbri Creek alignment, permanent flood bund and/or low permeability barrier can commence until the Goonbri Creek Diversion and Flood Bund Concept Design Plan has been approved by the **Minister**. The approved must be implemented.*	DP&E have accepted that Condition 35b of PA 11_0047 (MOD 1) is yet to be triggered as mining has not to date advanced as far towards Goonbri Creek as was predicted in the Projects Environmental Assessment.
Condition 20	*The Goonbri Creek Diversion and Flood Bund Concept Design Plan must include:* *a. an assessment of the surface water and groundwater quality, ecology, hydrological and geomorphic baseline conditions within the creek;* *b. a description of how restoration of the re-aligned riparian zone will be undertaken to best replicate the habitat of the existing creek, including plant species and fauna habitat features;* *c. water quality, ecology, hydrological and geomorphic performance and completion criteria for the creek diversion and low permeability barrier based on the assessment of the baseline conditions identified in condition 20 (a);* *d. a risk assessment of the environmental consequences of the proposed low permeability barrier and the proposed Goonbri Creek realignment including the potential for impacts on groundwater and surface discharge. The risk assessment must be peer-reviewed; and* *e. details for ongoing monitoring and management of downstream impacts on the adjacent floodplains and Namoi River floodplain.*	
Condition 22	*The person taking the action must implement the regional biodiversity strategy as required under condition 41 of the NSW state government project approval dated 22 January 2013 (application number 11_0047). The required scoping report for the development of the strategy must be submitted to the **Minister** for approval on or before 31 July 2013. The approved strategy must be implemented.*	Refer to the BMP
Condition 23	*To mitigate the impacts to the White Box-Yellow Box –Blakely's Red Gum Grassy Woodland and Derived Native Grassland and the habitat of the regent honeyeater, swift parrot and greater long-eared bat, the person taking the action must, within six months of the date of this variation to conditions of approval, submit to the Minister for approval a mine site rehabilitation plan for the progressive rehabilitation and revegetation of no less than 752 ha of native forest and woodland in the project area including 13 ha using species consistent with a White Box—Yellow Box—Blakely's Red Gum Grassy Woodland and Derived Native Grassland Ecological Community. This approved mine site rehabilitation plan must be implemented.*	Section 3.3
Condition 24	*The person taking the action must rehabilitate the site to be consistent with the proposed rehabilitation strategy as provided in the Environmental Assessment and, as required under the NSW State Government approval dated 22 January 2013 (Application 11_0047).*	Section 1

Condition 25	*The mine site rehabilitation plan must include, at a minimum, the following information:* *a. targets and performance indicators to achieve effective restoration of potential habitat for the regent honeyeater, swift parrot and greater long-eared bat and White Box—Yellow Box—Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community, including weed management;*	Section 3.6
	b. details of the vegetation communities to be rehabilitated and the timing of progressive rehabilitation (commencing as soon as practicable following disturbance);	Section 5.1 Section 5.2.7
	c. detailed soil depth surveys and analysis to inform the effective placement and restoration of soils underlying the proposed rehabilitation sites; including mapping of soils across the disturbance sites and soil sampling at no less than one sample point per 20 ha of each soil type identified. Sampling must identify; type, depth, water holding capacity, structure and physio-chemical properties of each of the soil and subsoil layers;	Section 4.2 Section 4.3 Appendix D Appendix I Agricultural Resources (TCM EA on WHC Website)
	d. processes and methodologies for the removal, storage and re-layering of the top soil and sub soil layers underlying the disturbed sites being prepared for rehabilitation. These processes and methodologies must ensure the replacement of top soil and sub soil layers as provided in the Environment Assessment.	Section 4.1 Section 5
	e. a process to report annually to the department the rehabilitation management actions undertaken and the outcome of those actions, and the mechanisms to be used to identify the need for improved management;	Section 8.2 Section 7.4
	f. a description of the potential risks to successful management and rehabilitation on the project site, including weed invasion, and a description of the contingency measures that would be implemented to mitigate these risks;	Section 6
	g. details of long-term management and protection of the mine site, including details of the commitment of funds to achieve this.	Sections 5 and 5.2.11
Condition 26	*The mine site rehabilitation plan must be subject to an independent review by a qualified ecologist. The findings of the **Independent review** must be published on the website of the person taking the action at the same time as the approved Mine Site Rehabilitation Plan is published.* *Note: for consistency, the person taking the action may develop a single mine rehabilitation plan to align with the requirements, including timing of reporting, of the NSW State Government approval dated 22 January 2013 (Application 11_0047) and this approval. The Offset Management Plan and the Rehabilitation management Plan need to be substantially integrated for achieving biodiversity objectives for the rehabilitated mine-site.*	Section 1.5 and Section 7.
Condition 27	*The person taking the action must submit details of the Conservation and Biodiversity Bond (required under condition 49 of the NSW state government project approval dated 22 January 2013) and the Rehabilitation Security Deposit (required under the NSW mining Act 1992) to the **Minister** within one month of lodgement of the Bond and Deposit with the NSW state government. If the **Minister** is not satisfied that the Bond and Deposit lodged by the person taking the action is adequate to provide for the requirements referred to under conditions 19, 20, 22, 23 and 24, the **Minister** may require the person taking the action establish an additional bond or equivalent financial instrument in trust, under conditions approved in writing by the **Minister**.*	Section 5.2.11.
Condition 28	*The person taking the action must undertake rehabilitation to ensure the final landform provides the optimum opportunity for the successful restoration of native forest and woodland including the critically endangered White Box—Yellow Box—Blakely's Red Gum Grassy Woodland and Derived Native Grassland ecological community.*	This MSRP
Condition 29	*The person taking the action must undertake rehabilitation to ensure the final void and landform minimises the extent of any resulting pit lake, avoids salt scalding and ensures that drained waters do not adversely affect the downstream environment and avoids any impacts on matters of national environmental significance.* *Note: the State approval conditions for project 11_0047 require the preparation and implementation of a Final Void and Mine Closure Plan that considers interactions with the adjoining mines, including interaction between final voids, opportunities for integrated mine planning with adjoining mines to minimise environmental impacts, all reasonable and feasible landform options for the final void (including filling) and predicted hydrochemistry and hydrogeology (including long-term groundwater recovery and void groundwater quality).*	To be submitted prior to end of December 2019 as per Condition 65 of PA 11_0047 (MOD 1).

A description of each Matter of National Environmental Significance referenced in Conditions 23 and 25 of Commonwealth approval EPBC 2011/5923 is provided below. The *TCM Threatened Fauna Implementation Plan* (Whitehaven, 2015a) and *TCM Box-Gum Woodland Endangered Ecological Community Implementation Plan* (Whitehaven, 2015b) have been prepared by Whitehaven in accordance with Conditions 43 and 45 of Schedule 3 to PA 11_0047 (MOD 1) in relation to biodiversity management. These implementation plans were approved by the NSW DP&E and by the Director-General on the 14 January 2015.

Regent Honeyeater

The Regent Honeyeater (*Anthochaera phrygia*) has not been previously recorded in Leard State Forest. The nearest record of the species is approximately 30 km to the north of TCM (Birds Australia, 2014). The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia (OEH, 2011). This species can undertake large-scale nomadic movements in the order of hundreds of kilometres (OEH, 2011). In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands (OEH, 2011).

This species has a preference for ironbark, but it also occurs in forests and woodlands of box, yellow gum, swamp mahogany and river oak (Morcombe, 2004). It has a particular preference for blossoming Eucalypts and Mistletoe (Simpson and Day, 1999). The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of Eucalypts and Mistletoes (OEH, 2011). It also feeds on arthropods, occasionally supplemented with fruit (Franklin et al., 1988). When nectar is scarce lerp and honeydew comprise a large proportion of the diet (OEH, 2011). Insects make up about 15% of the total diet and are important components of the diet of nestlings (OEH, 2011).

Regent Honeyeaters build nests with bark, spider webs and grasses in thick vertical forks of trees. There are three known key breeding areas, two of them in NSW - Capertee Valley and Bundarra-Barraba regions (OEH, 2011).

Swift Parrot

The Swift Parrot *(Lathamus discolor)* has not been previously recorded in Leard State Forest. The nearest record of the species is approximately 40 km to the south (OEH, 2014).

The Swift Parrot breeds in Tasmania during spring and summer, migrating in the autumn and winter months to south-eastern Australia from Victoria and the eastern parts of South Australia to south-east Queensland (OEH, 2011). In NSW it mostly occurs on the coast and south-west slopes (OEH, 2011).

The Swift Parrot is dependent on flowering resources across a wide range of habitat in its wintering grounds in NSW (NSW Scientific Committee, 2011). On the mainland they occur in areas where Eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations (OEH, 2011).

South-eastern Long-eared Bat

The Greater Long-eared Bat (south-eastern form) (*Nyctophilus timoriensis*) is now known as the South-eastern Long-eared Bat (*Nyctophilus corbeni*).

The South-eastern Long-eared Bat is known to occur within Leard State Forest (mainly towards the north). The distribution of the South-eastern Long-eared Bat coincides approximately with the Murray Darling Basin with the Pilliga Scrub region being a distinct stronghold for this species (OEH, 2011). Overall, the distribution of the South-eastern Long-eared Bat spans the western slopes and plains of NSW with the exception of the Darling Riverine Plains Bioregion, the Hay Plains in the Riverina Bioregion and the north-western semi-arid corner of NSW (Turbill and Ellis, 2006).

The South-eastern Long-eared Bat (south-eastern form) inhabits dry woodlands and the River Red Gum communities of major watercourses (Van Dyck and Strahan, 2008). The species is quite flexible in its roost selection, but has a predilection for tree hollows, exfoliating bark or dense foliage (Lunney *et al.,* 1988).

The South-eastern Long-eared Bat forages for large moths and beetles over water or in arid habitats (Hall and Richards, 1979; Richards, 1983). It may use the understorey to hunt non-flying prey (especially caterpillars and beetles) or hunt on the ground (OEH, 2011).

Box-Gum Woodland EEC

The remnants of Box-Gum Woodland EEC at the TCM have been considerably disturbed and degraded by past land use practices including clearing of trees and shrubs, cropping and heavy grazing by domestic animals. Approximately 13 ha of Box-Gum Woodland EEC will be cleared for the TCM which is required to be replaced in the mining rehabilitation area under Condition 23 of EPBC 2011/5923.

The Box-Gum Woodland EEC is represented in the TCM Disturbance Boundary by the following vegetation types (FloraSearch, 2011):

- White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest;
- White Box – White Cypress Pine shrubby woodland;
- White Box – White Cypress Pine grassy woodland;
- White Box - White Cypress Pine Regeneration;
- White Cypress Pine Regeneration; and
- Derived Native Grasslands.

Figure 2-1 shows the location of these, and other non-threatened vegetation communities, in the Disturbance Boundary as mapped during the Project EA flora surveys.

2.2 STATE

New South Wales State approval PA 11_0047 (MOD 1) includes several conditions relevant to the rehabilitation and closure of the TCM, which are repeated below with a reference to where these conditions are addressed in this MSRP (or separate document). As described in **Section 1.4**, the MOP has been prepared to address the requirements of Condition 64 of Schedule 3 of the State Approval PA 11_0047 (MOD 1) (i.e. preparation of a Rehabilitation Management Plan [RMP]). This MSRP has been prepared to support the rehabilitation component of the MOP.

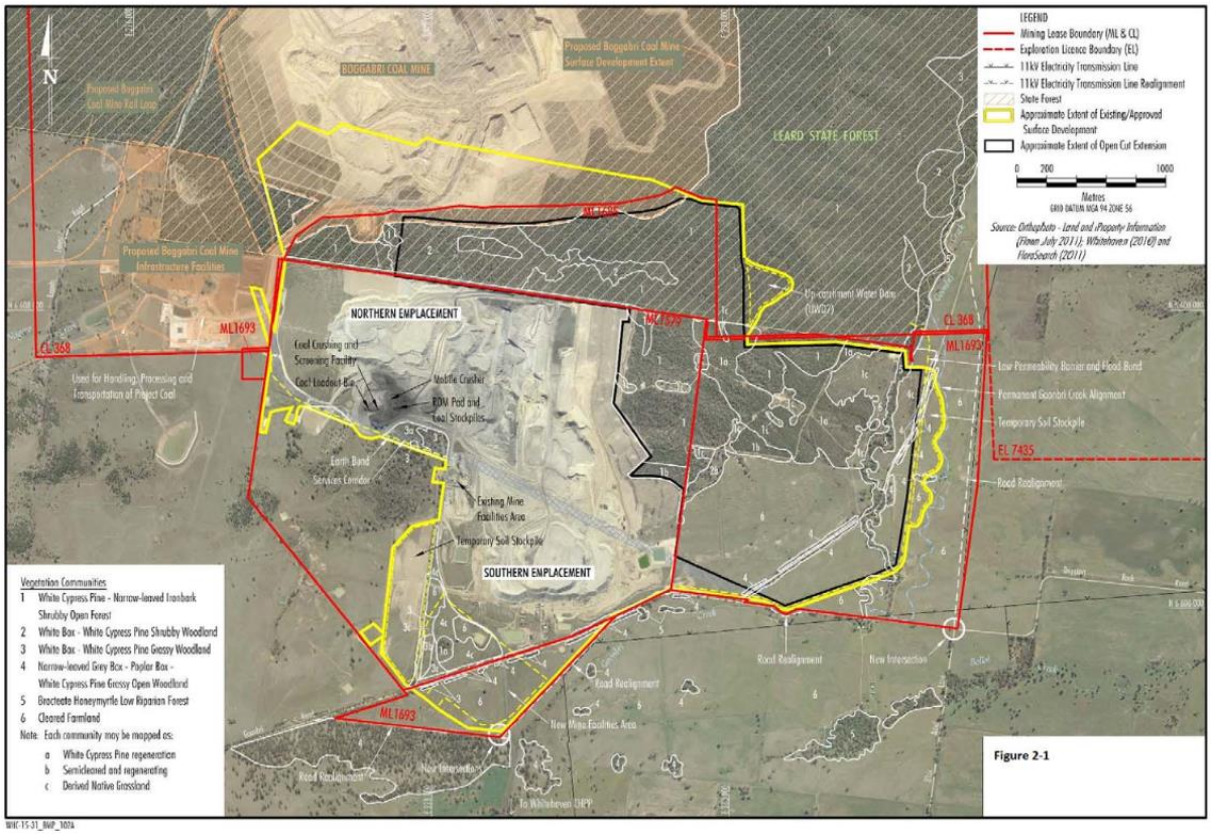

Figure 2-1 Mapped Vegetation Communities within the Disturbance Boundary

Table 2-2 PA 11_0047 (MOD 1) under Part 3A of the EP&A Act Rehabilitation-Related Approval Requirements

Applicable Condition	Requirement		Section Addressed/ Comments
Schedule 3, Condition 34	*The Proponent shall ensure that the project has no greater environmental consequences than predicted in the EA and complies with the performance objectives in Table 13, to the satisfaction of the Director-General* *Table 13: Goonbri Creek and alluvial aquifer performance objectives*		DP&E have accepted that Condition 35b of PA 11_0047 (MOD 1) is yet to be triggered as mining has not to date advanced as far towards Goonbri Creek as was predicted in the Projects Environmental Assessment.
	Feature	*Objective*	
	Goonbri Creek and the Upper Namoi alluvial aquifer	*No more than negligible environmental consequences to the alluvial aquifer, including:* • *negligible change in groundwater levels;* • *negligible leakage through low permeability barrier;* • *negligible change in groundwater quality; and* • *negligible impact to other groundwater users.*	
	Goonbri Creek diversion	*Hydraulically and geomorphologically stable (including the low permeability barrier).* *Negligible change to off-site flooding characteristics (including flood levels, velocities and flood storage capacity).* *Riparian vegetation, habitat, energy management and dissipation, bedload transport, biophysical maintenance and pool holding capacity that is the same or better than existed prior to mining.*	

Applicable Condition	Requirement		Section Addressed/ Comments
		Revegetation of the riparian zone focused on establishment of self-sustaining vegetation characteristic of the Bracteate Honeymyrtle community (as proposed in the EA)	
	Low permeability barrier, including associated flood bund	*Hydraulically and geomorphologically stable.* *The effectiveness of the Low Permeability Barrier shall be at least 10^{-8} metres/second.* *Negligible change to off-site flooding characteristics (including flood levels, velocities and flood storage capacity).* *Provides suitable protection for flood events up to and including the Probable Maximum Flood.*	
Schedule 3, Condition 35	*The Proponent shall prepare and implement a Goonbri Creek Diversion and Flood Bund Concept Design Plan, to the satisfaction of the Director-General. The plan must:* *a. be prepare in consultation with NOW, OEH and the Namoi CMA;* *b. be submitted to the Director-General for approval by December 2016;* *c. set out the vision statement for the creek diversion;* *d. assess the surface water and groundwater quality, ecology, hydrological (including flooding) and geomorphic baseline conditions within the creek;* *e. set out the construction program for the creek diversion and LPB, describing how the work would be staged, and integrated with mining operations;* *f. describe the revegetation program for the creek diversion and the use of a range of suitable native species;* *g. establish the water quality, ecology, hydrological (including flooding) and geomorphic performance and completion criteria for the creek diversion and LPB based on the assessment of baseline conditions; and* *h. be revised in consultation with NOW, OEH and Namoi CMA, and resubmitted for approval by the Director-General in response to the findings of the detailed technical design required in condition 36 and the Monitoring and Management Plan in condition 38.*		DP&E have accepted that Condition 35b of PA 11_0047 (MOD 1) is yet to be triggered as mining has not to date advanced as far towards Goonbri Creek as was predicted in the Projects Environmental Assessment.
Schedule 3, Condition 36	*The Proponent shall design the Goonbri Creek diversion and LPB to the satisfaction of NOW and the Director-General. The detailed designs must:* *a. be designed by a suitably qualitied and experienced expert/s;* *b. be endorsed by NOW and approved by the Director-General prior to the commencement of any work or construction on the Goonbri Creek diversion and LPB;* *c. be generally in accordance with the conceptual design in the EA (and depicted in Appendix 6), and applicable Australian Stands (including AS 3798-2007);* *d. include detailed design, construction and engineering specifications, performance criteria and completion criteria;* *e. demonstrate that the design would achieve the relevant performance objectives and criteria; and* *f. demonstrate the LPB design would remain effective over an appropriate lifespan and would withstand mining operations, geological and weather events, decay and corrosive attack – including biological attack.*		DP&E have accepted that Condition 35b of PA 11_0047 (MOD 1) is yet to be triggered as mining has not to date advanced as far towards Goonbri Creek as was predicted in the Projects Environmental Assessment.
Schedule 3, Condition 37	*The Proponent shall:* *a. construct the Goonbri Creek diversion and LPB prior to undertaking any mining operations within 200 metres of the Goonbri Creek alluvium, and at least 5 years prior to the planned mining in the alluvium; and* *b. within 2 months of the construction of the Goonbri Creek diversion and LPB, submit an as-executed report to the Director-General and NOW, certified by a practising engineer, confirming that the diversion and barrier have been constructed:* • *in accordance with the concept design in the EA, applicable Australian Standards (including AS 3798-2007) and the approved design (see condition 36 above); and*		DP&E have accepted that Condition 35b of PA 11_0047 (MOD 1) is yet to be triggered as mining has not to date advanced as far towards

<table>
<tr><th>Applicable Condition</th><th>Requirement</th><th>Section Addressed/ Comments</th></tr>
<tr><td></td><td>• in a manner that achieves the performance objectives in Table 13.
Notes:
• The Goonbri Creek alluvium, diversion, conceptual low permeability barrier and flood bunds are shown in Appendix 6.
• The diversion and low permeability barrier may be constructed on a staged basis. In this case, the reports required under conditions 36 and 37 shall be submitted for each stage.</td><td>Goonbri Creek as was predicted in the Projects Environmental Assessment.</td></tr>
<tr><td>Schedule 3, Condition 38</td><td>The Proponent shall prepare and implement a Goonbri Creek Diversion and Low Permeability Barrier Monitoring and Management Plan to the satisfaction of the NOW and the Director-General. The plan must:
a. be pared by a suitably qualitied and experienced expert/s;
b. be endorsed by the NOW and approved to the Director-General prior to commencement of any works or construction on the Goonbri Creek diversion and LPB;
c. describe the monitoring and maintenance procedures to be implemented and the scheduling of these procedures;
d. demonstrate the monitoring system would be capable of timely detection of any failure or deficiency in the LPB and any impacts on Goonbri Creek and its associated alluvium;
e. describe the contingency measures that would be implemented in the event of a failure or deficiency in the LPB, or other impact on Goonbri Creek and its associated alluvium; and
f. identify the entity that would take responsibility for the future liabilities and costs associated with the long-term monitoring and maintenance of the LPB, flood bund, void and pit lake, and demonstrate that this entity's security and finances would be assured in the long term.</td><td>DP&E have accepted that Condition 35b of PA 11_0047 (MOD 1) is yet to be triggered as mining has not to date advanced as far towards Goonbri Creek as was predicted in the Projects Environmental Assessment.</td></tr>
<tr><td>Schedule 3, Condition 40</td><td>The Proponent shall implement the biodiversity offset strategy described in the EA, summarised in Table 14 and shown conceptually in Appendix 7, to the satisfaction of the Director-General.
<table>
<tr><th>Area</th><th>Offset Type</th><th>Minimum Size (hectares)</th></tr>
<tr><td>Willeroi Offset Area</td><td>Existing native vegetation to be enhanced, and additional native vegetation to be established with the restoration of at least 193 ha of Box Gun Woodland EEC, as listed under the TSC Act</td><td>1,660</td></tr>
<tr><td>Rehabilitation Area</td><td>Native woodland vegetation communities to be re-established, focused on Box Gum Woodland EEC</td><td>752</td></tr>
<tr><td colspan="3">Note: For the purposes of this approval Box Gum Woodland refers to the EEC listed as White Box Yellow Box Blakely's Red Gum Woodland under the TSC Act, and the EEC listed as White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grasslands under the EPBC Act, or similar EEC as may be updated from time to time.</td></tr>
</table></td><td>Section 3.4.1</td></tr>
<tr><td>Schedule 3, Condition 43</td><td>For the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland Endangered Ecological Community the Proponent shall:
a. ensure that the Biodiversity Offset Strategy and site Rehabilitation Strategy is focused on protection rehabilitation, re-establishment and long-term maintenance of viable stands of this community;
b. investigate in consultation with OEH and the Namoi CMA, all factors likely to enhance or impede the effective long term restoration of degraded remnants of this EEC in offset areas or regeneration of this EEC on disturbed areas (both offset areas and the site);
c. within 24 months of the date of this approval (and if possible in conjunction with Stage 2 of the Leard Forest Mining Precinct Regional Biodiversity Strategy), submit a report of this investigation and provide an implementation plan to maximise the prospects for rehabilitation and regeneration of this EEC on the offset areas and the site, for approval by the Director-General; and
d. incorporate the approved implementation plan into the revised Biodiversity Management Plan, required under condition 48.</td><td>Section 3.4.1</td></tr>
</table>

<table>
<tr><th>Applicable Condition</th><th colspan="2">Requirement</th><th>Section Addressed/ Comments</th></tr>
<tr><td>Schedule 3, Condition 61</td><td colspan="2">The Proponent shall rehabilitate the site to the satisfaction of the Executive Director Mineral Resources. This rehabilitation must be generally consistent with the proposed Rehabilitation Strategy described in the EA (and depicted conceptually in Appendix 8) and comply with the objectives in Table 15.
Table 15: Rehabilitation Objectives
<table>
<tr><th>Feature</th><th>Objective</th></tr>
<tr><td>Mine site (as a whole)</td><td>Safe, stable and non-polluting
Constructed landforms drain to the natural environment
Landforms fully integrated with the final landform for the Boggabri coal mine</td></tr>
<tr><td>Final void</td><td>Minimise the size and depth of the final void as far as is reasonable and feasible
Minimise the drainage catchment of the final void as far as is reasonable and feasible
Negligible highwall instability risk
Minimise risk of flood interaction for all flood events up to and including the Probable Maximum Flood level</td></tr>
<tr><td>Surface infrastructure</td><td>To be decommissioned and removed, unless the Executive Director, Mineral Resources agrees otherwise</td></tr>
<tr><td>Agricultural land</td><td>Establish a minimum of 210 hectares of Class 3 agricultural suitability land, including 160 hectares with cropping capability</td></tr>
<tr><td>All land – excluding the 210 ha of agricultural land and the final void</td><td>Restore ecosystem function, including maintaining or establishing self-sustaining ecosystems comprised of:
• local native plant species (particularly Box Gum Woodland EEC); and
• a landform consistent with the surrounding environment</td></tr>
<tr><td>Goonbri Creek diversion and LPB</td><td>See Table 13
Note: Goonbri Ck diversion and LPB not proposed within this MOP period</td></tr>
<tr><td>Community</td><td>Ensure public safety
Minimise the adverse socio-economic effects associated with mine closure</td></tr>
</table></td><td>Section 3.3</td></tr>
<tr><td>Schedule 3, Condition 62</td><td colspan="2">The Proponent shall in consultation with the Namoi CMA:
a. develop a detailed soil management protocol that identifies procedures for:
○ comprehensive soil surveys prior to soil stripping; assessment of top-soil and sub-soil suitability for mine rehabilitation; and annual soil
○ balances to manage soil handling including direct respreading and stockpiling;
○ annual soil balances to manage soil handling including direct respreading and stockpiling;
b. maximise the salvage of suitable top-soils and sub-soils and biodiversity habitat components such as bush rocks, tree hollows and fallen timber for rehabilitation of disturbed areas within the site and for enhancement of biodiversity offset areas; and
c. ensure that coal reject, or any potentially acid forming interburden materials, are not emplaced at elevations in the pit shell where they may promote acid or sulphate species generation and migration beyond the pit shell.</td><td>Section 4.2

Section 4

Section 3.4.2</td></tr>
<tr><td>Schedule 3, Condition 63</td><td colspan="2">The Proponent shall rehabilitate the site progressively, that is, as soon as reasonably practicable following disturbance. All reasonable and feasible measures must be taken to minimise the total area exposed for dust generation at any time. Interim rehabilitation strategies shall be employed when areas prone to dust generation cannot yet be permanently rehabilitated.</td><td>Section 3.2</td></tr>
</table>

Applicable Condition	Requirement	Section Addressed/ Comments
	Note: It is accepted that the parts of the site that are progressively rehabilitated may be subject to further disturbance in future.	
Schedule 3, Condition 64	*The Proponent shall prepare and implement a Rehabilitation Management Plan to the satisfaction of the Executive Director, Mineral Resources. This plan must:* *a. be prepared in consultation with the Department, Forests NSW, NOW, OEH, Namoi CMA and Council;* *b. be submitted to the Executive Director, Mineral Resources for approval by the end of May 2013;* *c. be prepared in accordance with any relevant DRE guideline;* *d. describe how the rehabilitation of the site would be integrated with:* o *the implementation of the biodiversity offset strategy; and* o *the final landform for the Boggabri coal mine;* *e. include detailed performance and completion criteria for evaluating the performance of the rehabilitation of the site, and triggering remedial action (if necessary);* *f. describe the measures that would be implemented to ensure compliance with the relevant conditions of this approval, and address all aspects of rehabilitation including mine closure, final landform and final land use;* *g. include interim rehabilitation where necessary to minimise the area exposed for dust generation;* *h. include a program to monitor, independently audit and report on the effectiveness of the rehabilitation measures, and progress against the detailed performance and completion criteria; and* *i. build to the maximum extent practicable on the other management plans required under this approval.* *Note: The Biodiversity Management Plan and Rehabilitation Management Plan require substantial integration to achieve biodiversity objectives for the rehabilitated mine site.*	This Document and Mining Operations Plan
Schedule 3, Condition 65	*The Proponent shall prepare and implement an updated Final Void and Mine Closure Plan (as a component of the overall Rehabilitation Management Plan required under condition 64 of schedule 3) to the satisfaction of the Executive Director Mineral Resources, following consultation with the Director-General. A draft plan must be prepared and submitted to the Executive Director Mineral Resources by the end of December 2019, and a final plan must be prepared and submitted to the Executive Director Mineral Resources by the end of December 2024. Each version of the plan must:* *a. be subject to independent review and verification by suitably qualified, experienced and independent person/s (including a groundwater expert) whose appointment has been approved by the Director-General;* *b. identify and consider:* o *options for continued mining beyond current project life;* o *interactions with the final landform of adjoining mines (including any direct or indirect interaction between final voids);* o *opportunities for integrated mine planning with adjoining mines to minimise environmental impacts of the mines' final landforms;* o *all reasonable and feasible landform options for the final void (including filling);* o *predicted stability of the proposed landforms; and* o *predicted hydrochemistry and hydrogeology (including long-term groundwater recovery and void groundwater quality);* *c. include a detailed proposed landform design; and* *d. demonstrate that the proposed final landform:* o *satisfies the relevant objectives in Table 15;* o *minimises the extent of any resulting pit lake;* o *avoids salt scalding;* o *maximises the capacity of emplaced spoil to drain to the natural environment; and* o *ensures that drained waters do not adversely affect the downstream environment.*	To be submitted prior to end of December 2019.

3 REHABILITATION STRATEGY

3.1 OVERVIEW

The Rehabilitation Strategy for the TCM is described in Section 5 of the Project Environmental Assessment (EA) (Resource Strategies, 2012). The State and Commonwealth approvals both specify that the rehabilitation of the TCM must be consistent with the Rehabilitation Strategy (i.e. Condition 24 of EPBC 2011/5923 and Condition 61 of Schedule 3 of PA 11_0047 (MOD 1)). The Rehabilitation Strategy includes a description of the following aspects:

- Rehabilitation goals;
- Rehabilitation techniques;
- Final landform and rehabilitation domains;
- Decommissioning;
- Rehabilitation completion criteria; and
- Management and mitigation.

Figure 1-5 shows the broad final landform and rehabilitation concept for the TCM as depicted in the MOP. The concept is consistent with the one depicted in the Project EA, however it should be noted that it will be refined and more detail will be provided in future revisions of the MOP and this MSRP during the mine life as more detailed information on mine planning, material characteristics and landform/rehabilitation monitoring are available.

Section 3.2 provides a description of the current status of rehabilitation at the TCM.

The Rehabilitation Strategy for the TCM is domain based and has been developed to deliver the objectives outlined in **Section 3.3**. This rehabilitation strategy as presented below has been developed from that described in Section 5.5 of the Project EA and further refined in the BMP and current MOP. **Section 5** provides further detail of the rehabilitation methods to be used at the TCM to meet the rehabilitation strategy.

3.2 CURRENT STATUS OF REHABILITATION

As described in Section 1, the current MOP for the TCM covers the period from November 2015 to December 2020. The NSW Division of Resources and Geoscience's (DRG) *Mining Operations Plan Guidelines* (DRE, 2013) require each MOP to provide details of the status of rehabilitation to date within each domain at the commencement of the MOP (**Table 3-1**). The MOP must also describe and show pictorially the rehabilitation activities proposed to be implemented over the MOP term on a domain by domain basis.

The ongoing development of TCM will involve the sequential clearing of vegetation and removal of soil (land preparation) prior to the removal of overburden and interburden, mining of the identified coal resource and progressive backfilling and rehabilitation of mined-out areas. It is anticipated that approximately 193 ha will be cleared for mining related activities during the current MOP term (2015 – 2020).

During this MOP term (2015-2020), approximately 127,460 m^3 of topsoil will be stripped within the pit extension and out-of-pit emplacement areas, following vegetation clearing. Preferably, stripped soils will be directly placed on rehabilitation areas (subject to the availability of shaped rehabilitation areas). If no suitable rehabilitation areas are available for direct placement, soils will be stockpiled until shaped areas with the appropriate intended final land use for the soil type is available.

Mining operations will use overburden and interburden materials to in-fill the mine void behind the advancing open cut, as well as being placed in the two adjoining out-of-pit mine waste rock emplacements (Northern Emplacement and Southern Emplacement).

Progressive rehabilitation will continue at the overburden emplacement areas in this MOP period (2015 – 2020). Domains and associated rehabilitation phases have been established. Detailed planning to optimise integration of the final rehabilitated landform will be developed during this MOP term and documented in a Boggabri – Tarrawonga Overburden Emplacement Integration Management Plan.

Rehabilitation monitoring will be undertaken after seeding and tube stock planting until it can be demonstrated that rehabilitation areas have met all conditions for relinquishment. Generally ongoing maintenance and land management activities will include: minimising risks to rehabilitation, comparing specific ecosystem characteristics such as soil profile development, floristic composition and structure and faunal diversity and abundance with the characteristics of appropriate analogue sites and undertaking adaptive management and remedial works.

Progressive rehabilitation of parts of the main mine landforms have occurred to date. Additional areas are scheduled to occur during the period covered by the current MOP (i.e. November 2015 to December 2020). Progressive rehabilitation is being undertaken on the Northern and Southern Emplacement Areas. The waste rock emplacements at TCM are being progressively shaped by bulldozers for rehabilitation activities, including final re-contouring, topsoiling and revegetation. Specific attention is directed towards the Agricultural Rehabilitation Areas and the Woodland Rehabilitation Areas. Section 5 of this MSRP includes a description of the rehabilitation schedule for the TCM based on the current mine plan and conceptual mine closure plan.

It is expected that subsequent revisions of the MOP will include more information on the closure domains, criteria and progress at the TCM.

Table 3-1 Current State of Mine Development and Rehabilitation

Domain	Area (ha)	Major Assets
Domain 1 – Infrastructure Area	53	Existing Infrastructure and facilities, including administration areas, workshops, and coal handling and preparation facilities.
Domain 3 – Water Management Area	59	Network of dams, channels and associated water management infrastructure.
Domain 4 – Overburden Emplacement Area	203	Footprint of out of pit (Northern Emplacement and Southern Emplacement and environmental bunds) and in-pit waste rock dump areas.
Domain 5 – Stockpiled Material[1]	66	Areas disturbed to stockpile topsoil and vegetation for reuse in rehabilitation.
Domain 6 – Void (open cut void)	132	Footprint of the open cut mining pits.
Domain 7 - Rehabilitation Area	50	Footprint of existing rehabilitation area

[1] Area of Stockpiled Material included within other Domains.

3.3 REHABILITATION OBJECTIVES

Overall, the key goal of the rehabilitation activities is to create landforms that are safe, stable, and non-polluting. Provide adequate post-mining drainage, and have a shape that is sympathetic with the types of naturally occurring landform features that occur in the region. In addition, ecologically TCM aim to restore native vegetation and fauna habitat on the rehabilitation area through focusing on assisted natural regeneration, targeted vegetation establishment and introduction of fauna habitat features. TCPL will aim to revegetate the completed landform with flora species characteristic of the local area (as per the BMP).

Rehabilitation will be undertaken generally in accordance with the *Strategic Framework for Mine Closure* (ANZMEC & MCA, 2000) and the *Mine Closure and Completion* (DITR, 2009a) and *Mine Rehabilitation* (DITR, 2009b) Handbooks. Rehabilitation planning and execution will also consider the *National Recovery Plan for White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* (SEWPaC, 2010).

The key rehabilitation objective of the TCM is the establishment of native forests and woodlands as a native vegetation final land use. Condition 23 of Commonwealth approval EPBC 2011/5923 requires *'the progressive rehabilitation and revegetation of no less than 752 ha of native forest woodland in the Project Area including 13 ha using species consistent with a White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland Ecological Community.'*

Further key rehabilitation objectives for TCM as prescribed in Schedule 3, Condition 61 of State PA 11_0047 (MOD 1) including the establishment of 210 ha of Class 3 agricultural suitability land, including 160 ha with cropping capability are outlined below (**Table 3-2**).

The 'woodland' vegetation is depicted in the final landform (**Figure 1-5**). The 13 ha area that will be rehabilitated using species consistent with a White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and derived Native Grassland Ecological Community has not yet been specifically identified and is therefore not shown on the figures. It is intended that this detail will be provided in subsequent revisions of this MSRP and the MOP during the mine life.

Condition 61 of Schedule 3 of State Approval PA 11_0047 (MOD 1) includes a table which lists the overall rehabilitation objectives for the TCM. These are integrated with the relevant EPBC Act Objectives and those from the Rehabilitation Strategy presented in the EA are outlined below (**Table 3-2**).

Table 3-2 Rehabilitation Objectives

Domain	Objective
PRIMARY DOMAINS	
Water Management Area	• Clean water will be diverted around operational areas prior to disturbance, where practical. • Mine water and sediment laden (dirty) water runoff from disturbance areas will be captured and diverted to mine water and dirty water dams. • Mine water and dirty water will be preferentially used for operational requirements such as dust suppression and earthworks. • Dirty water will be treated before discharge from site in accordance with regulatory requirements. • No mine water will be discharged from site. • Water management structures will be designed and constructed prior to disturbance, in accordance with Best Practice and "the Blue Book". • Sediment dams and associated water management structures will remain in place until the catchment is rehabilitated and discharge water quality is similar to comparable undisturbed landforms.
Infrastructure Area	• Mining infrastructure will be removed progressively, and the area rehabilitated, when no longer required, • All land contamination will be identified and appropriately remediated.
Stockpiled Material	• Topsoil stockpiles will be stabilised with temporary cover crops to minimise weed infestation and retain soil biological health. • Topsoil stockpiles will be constructed and managed to optimise physical, chemical and biological characteristics. • Topsoil stockpile areas will be rehabilitated progressively when no longer required.
Overburden Emplacement Area	• Final landform will be safe, stable and adequately drained. • Final landforms will be designed to integrate with the surrounding landscape. • The Northern Emplacement will be progressively constructed to a maximum height of 370 m AHD to integrate with the southern extent of the Boggabri waste rock emplacement. • The Southern Emplacement will be progressively constructed to a maximum height of 340 m AHD. • Outer batter slopes for the Northern and Southern Emplacements will be predominantly constructed at 10 degrees or shallower. • Any potentially acid forming (PAF) material will be covered with at least 15 m of non-acid forming material (NAF). • Final outer surfaces of overburden emplacements will be constructed with non-sodic or low sodicity and/or will be treated with gypsum. • Dump sequencing will be optimised to facilitate progressive shaping and rehabilitation.
Final Void / Active Mining **Note:** The Final Void is not required to be addressed in this MSRP as per Schedule 3, Condition 65 of PA11_0047.	• Rehabilitation resources including vegetation, topsoil and habitat resources will be identified for salvage ahead of mining. • Vegetation and topsoil will be progressively stripped ahead of mining to minimise the total area of disturbance and the potential period of soil storage. • Mined areas will be progressively backfilled and rehabilitated where possible.

• Rehabilitation Areas	• Rehabilitation will be managed and maintained to minimise dust and visual impact. • As per objectives for Overburden Emplacements
SECONDARY DOMAINS	
Final Void	• Final void will be safe, stable and non-polluting. • Final void northern and eastern highwalls will be profiled to be geotechnically stable with slopes approximately 60 degrees. • Material from the Southern Emplacement will be used to partially infill the southern and western low walls of the open cut to construct final grades generally between 10 and 15 degrees. • Surface water inflows to the final void will be managed through appropriate landform design (including final void perimeter bunding and the permanent flood bund) to minimise long term drawdown and potential water quality impacts on local aquifers. • Native vegetation will be established above the permanent water level (260 m AHD).
Water Management Area	• The final landform drainage will integrate with the surrounding catchments and will achieve long term geomorphic stability and minimise erosion. • Sediment dams identified for retention in the final landform will be desilted if required and preserved as clean water farm dams or water sources for native fauna.
Rehabilitation Area - Pasture	• At least 210 ha of Class 3 agricultural land (including 160 ha constructed on emplaced overburden) will be reinstated on areas disturbed by mining. • Soil profiles (soil characteristics and soil depths) will be reinstated to produce an Effective Rooting Depth at least 1.5 m, and capable of sustaining cereal and pasture production comparable to pre-mining agricultural areas near Goonbri Creek.
Woodland Rehabilitation Area	• No less than 752 ha of open woodland/forest, with riparian corridors (including Goonbri Creek realignment) will be established on areas disturbed by mining. • Woodland Rehabilitation Areas will be comparable with adjacent undisturbed remnant native vegetation including areas commensurate with Box-Gum Woodland EEC.

Note: Appropriate non-native plants may be used for stabilisation and dust suppression purposes on a temporary basis, if required.

3.4 FINAL LANDFORM AND REHABILITATION DOMAINS

The final landform goal at TCM is to create a physically and chemically stable mine landform that is adequately drained and integrates with the adjoining hilly topography of the Willowtree Range and the southern extent of the Boggabri Coal Mine waste rock emplacement. The rehabilitation of mining disturbed areas into the surrounding landscape will deliver final land uses that achieve biodiversity and agricultural outcomes. The final void will be designed and constructed to have minimal adverse impacts upon post-mining land use outcomes, and surface and groundwater resources.

Rehabilitated landforms will also integrate with the adjoining Leard State Forest to enhance regional biodiversity and conservation outcomes. In areas requiring vegetation clearance within ML 1685 (i.e. the Leard State Forest), clearing activities will be undertaken in accordance with requirements established under agreement with Forestry NSW. This agreement defines requirements for access, clearance procedures and appropriate compensation arrangements.

The current MOP for the TCM, contains a description the final landform concept, including a description of the major rehabilitation 'domains' that would be created over the mine life. Primary and secondary domains have been defined in accordance with the methodology prescribed in ESG3 (DTIRIS 2013). As such the following applies:

- Primary Domains are defined as the set of discrete areas that have a particular operational or functional purpose. Land management units with similar operational function are likely to have similar geophysical features and constraints /opportunities for rehabilitation.

- Secondary Domains are land management units with similar post mining land use objectives, such as woodland communities and native grasslands.

Accordingly, domains have been defined considering the operational function and specific final land use objectives.

Domains at the commencement of the MOP period are listed in **Table 3-3**.

Table 3-3 Primary and Secondary Rehabilitation Domains

Domain	Code	Description
Primary Domains		
Final Void / Active Mining	1	Footprint for the open cut mining pit(s).
Water Management Area	2	Network of dams, channels and associated water management infrastructure (pipelines and pumps etc.). Includes disturbance footprint for works for the permanent Goonbri Creek re-alignment.
Infrastructure Area	3	Existing infrastructure and facilities to be constructed during the MOP period, including administration areas, workshops, and coal handling and preparation facilities.
Topsoil Stockpile Area	4	Areas disturbed to stockpile topsoil and vegetation for reuse in rehabilitation.
Overburden Emplacement Area	5	Footprint of out of pit (Northern Emplacement and Southern Emplacement and environmental bunds) and in-pit waste rock dump areas.
Temporary Rehabilitation	6	Area of overburden emplacement temporarily rehabilitated
Secondary Domains		
Final Void	A	Tarrawonga has approval to retain a single void along the eastern perimeter of the open cut pit. The final void will include flood mitigation and safety infrastructure and will be rehabilitated with woodland vegetation above the permanent water level (approx. 240 to 260 m AHD).
Water Management Area	B	Footprint of water management structures and dams retained in the final landform.
Agricultural Rehabilitation Area	C	Middle and lower terraces of the open cut in-fill areas (280 to 300 m AHD) will be rehabilitated with selected topsoil resources suitable for Class 3 agricultural suitability land, capable of pasture production and occasional cropping. Some infrastructure areas and topsoil stockpile areas constructed on the Goonbri Creek alluvial floodplain will also be rehabilitated to Class 3 agricultural suitability land.
Woodland Rehabilitation Area	D	Slopes and upper terraces (>300m AHD) rehabilitated with woodland species commensurate with adjacent remnant vegetation. This domain will include at least 13 ha commensurate with the White Box Yellow Box Blakeley's Red Gum Grassy Woodland and Derived Native Grassland EEC. Species selection and planting densities will vary to enhance integration with adjacent Leard State Forest and Boggabri waste emplacement area. This domain also includes riparian vegetation corridors adjacent to drainage structures and watercourses including the permanent Goonbri Creek realignment.

Source: TCM MOP – November 2015 to December 2020.

The main domains for the TCM are shown on **Figures 1-3, 1-4** and **1-5**.

A brief description of the domains is provided below.

Primary Domain 1 and Secondary Domain A - Final Void

Tarrawonga has approval to retain a single void along the eastern perimeter of the open cut pit. The final void will include flood mitigation and safety infrastructure and will be rehabilitated with woodland vegetation above the permanent water level (approx. 240 to 260 m AHD). **Figure 1-5** shows the final void conceptual design as depicted in the MOP.

The open cut will be filled with material from the Southern Emplacement along the southern and western lowwalls of the open cut to construct final grades generally between 10 and 15 degrees after mine closure. These areas will be reshaped to their final landform and progressively rehabilitated.

The MOP states that at the conclusion of mining the northern and eastern highwalls will be profiled to be geotechnically stable with slopes of approximately 60 degrees and the partial backfill of the final void will be undertaken to complete the lowwall slopes into the void. Surface water inflows to the final void will be managed through appropriate landform design (including designing the landform to shed water away from the void, final void perimeter bunding and the permanent flood bund) to minimise accumulated water volumes and any potential for water quality impacts on local aquifers.

Condition 65 of Schedule 3 of State Approval PA 11_0047 (MOD 1) (refer to Section 2.2) requires the proponent to prepare and implement a Final Void and Mine Closure Plan, as a component of the overall Rehabilitation Management Plan (required under condition 64 of Schedule 3 of State approval PA 11_0047 (MOD 1)). A draft of the Final Void and Mine Closure Plan is required to be submitted to the Executive Director of DRG by the end of December 2019, and a final plan must be submitted by the end of December 2024.

The Final Void and Mine Closure Plan must identify and consider:

- Options for continued mining beyond the current project life;
- Interactions with the final landform of adjoining mines;
- Opportunities for integrated mine planning with adjoining mines to minimise environmental impacts of the mines' final landforms;
- All reasonable and feasible landform options for the final void (including filling);
- The predicted stability of the proposed landforms; and
- Predicted hydrochemistry and hydrogeology (including long-term groundwater recovery and void groundwater quality).

It must also include a detailed proposed final landform, and demonstrate that it:

- Satisfies the relevant rehabilitation objectives (**Table 3-2**);
- Minimises the extent of any resulting pit lake;

- Avoids salt scalding;
- Maximises the capacity of emplaced spoil to drain to the natural environment; and
- Ensures that drained waters do not adversely affect the downstream environment.

Primary Domain 2 and Secondary Domain B - Water Management Infrastructure.

The Water Management Domain (2) will be scattered through the Project Disturbance Boundary and will include a network of dams, channels and associated water management infrastructure (pipelines and pumps etc.). Sediment dams identified for retention in the final landform will be decontaminated and preserved as clean water farm dams or water sources for native fauna. The primary objective for this domain will be to construct and stabilise the water management structures so that they can used during the mine life and as features in the final landform to meet the water management objectives for the TCM (i.e. segregation and containment/treatment of dirty water, and diversion of clean water around mine disturbance areas). The final landform drainage will integrate with the surrounding catchments and will achieve long term geomorphic stability and minimise erosion. This domain includes the disturbance footprint for works for the permanent Goonbri Creek re-alignment. Details around the Goonbri Creek Diversion and Flood Bund Concept Design Plan are being progressed for submission to the Secretary of DP&E for approval. Once this design plan is approved it will be incorporated into this MSRMP.

Primary Domain 3 and Secondary Domains C and D - Infrastructure Area

The Infrastructure Area Domain (3) is located in an area that, prior to mining, consisted of woodlands and isolated pockets of remnant vegetation and derived grassland. This domain includes the administration areas, offices, workshops, and coal handling and preparation facilities, loading facilities, entrance roads, mine access road. **Figures 1-3** and **1-4** show the locations of these infrastructure components as depicted in the current MOP (2015 to 2020).

Upon mine closure, mine-related infrastructure will be decommissioned, all land contamination will be identified and appropriately remediated and the landscape rehabilitated as woodland (**Figure 1-5**).
A key rehabilitation objective for this domain will be to stabilise the batters and slopes surrounding this infrastructure area to a final landform that minimises potential erosion and sedimentation issues in downstream waterways.

As part of the Woodland Rehabilitation Area this domain adjoins land that contains remnant native vegetation on neighbouring properties and the adjoining Leard State Forest. The rehabilitation strategy for this domain will, where practical, revegetate the decommissioned areas of the mine access road and rail spur corridor to maximise its ecological contribution to Leard State Forest. It is envisaged that this domain will include a significant proportion of the 13 ha area to be rehabilitated with species consistent with a White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and derived Native Grassland Ecological Community (i.e. as required by Condition 23 of Commonwealth approval EPBC 2011/5923).

Primary Domain 4 and Secondary Domains C and D – Topsoil Stockpile Area

The Topsoil Stockpile Area (4) incorporates the TCM soil and vegetation stockpiles waiting to be incorporated into active rehabilitation. Section 4.1 provides details of the soil stripping and stockpiling processes that will be adopted. The BMP provides details of the methods and processes for salvaging, stockpiling and reusing vegetation that is cleared during the land clearing process (i.e. for reuse as

habitat features in rehabilitation areas). Salvaged vegetative material may include hollow trees, woody ground debris, and trees and fallen logs without hollows. Isolated trees requiring removal from predominantly treeless areas may be salvaged for on-farm re-use (such as fence posts and stays) subject to demand, or will be stockpiled for re-use in rehabilitation or mulched for use as a topsoil conditioner. Rocks may also be collected and stockpiled for later reuse.

The soil and vegetation stockpiles will be used progressively during the mine life. They will be located in available land within the Disturbance Boundary, and will be accessed as required to stockpile material and to reclaim it for use in rehabilitation. Once the stockpile areas are no longer required, the disturbance areas will be rehabilitated into native forests and woodlands. While in place, the soil stockpiles will be managed in accordance with the Soil Management Protocol (refer to Section 4) and the vegetation stockpiles will be managed in accordance with the BMP.

Primary Domain 5 and Secondary Domains C and D - Overburden Emplacement Area

The overburden emplacement area Domain (5) consists of the areas within the Disturbance Boundary used for out of pit overburden emplacement (Northern Emplacement and Southern Emplacement and environmental bunds) and in-pit waste rock dump areas (i.e. the infilled sections of the open cut). The rehabilitation objective for this domain is to develop a free draining, physically and chemically stable and non-polluting final landform designed to integrate with the surrounding catchments by channelling water towards natural drainage lines of Goonbri Creek so that it drains in a stable manner via a series of terraces with drop structures on the intervening batters. **Figure 1-5** shows the conceptual design of the overburden emplacement area as depicted in the MOP.

The domain will be progressively rehabilitated over the life of the mine. This will assist in minimising the mine disturbance area that is open at any one time and will reduce the environmental impacts of the mining operations (i.e. reduced dust emissions, visual impacts, and biodiversity).

The Southern Emplacement will be re-profiled to a final height of 330 m AHD and partially infill the adjoining services corridor so that it integrates with the Northern Emplacement.

The final rehabilitated batters will predominantly have a maximum overall slope of 10 degrees or shallower, which will assist in the long term stability and sustainability of the landform. The final batter slope and top surface configuration of the overburden emplacement area landform will be a key factor in determining which areas will be rehabilitated as woodland versus agricultural areas.

Middle and lower terraces of the open cut in-fill areas (280 to 300 m AHD) will be rehabilitated with selected topsoil resources suitable for Class 3 agricultural suitability land, capable of pasture production and occasional cropping. Some infrastructure areas and topsoil stockpile areas constructed on the Goonbri Creek alluvial floodplain will also be rehabilitated to Class 3 agricultural suitability land. Soil profiles (soil characteristics and soil depths) will be reinstated to establish a soil depth of a minimum of 1.5 m.

Slopes and upper terraces (>300m AHD) rehabilitated with woodland species commensurate with adjacent remnant vegetation. Species selection and planting densities will vary to enhance integration with adjacent Leard State Forest and Boggabri waste emplacement area (**Figure 1-5**). Mine planning has been conducted so that only the flatter areas and shallower parts of the overburden emplacement area will be used for species consistent with a White Box – Yellow Box – Blakely's Red Gum Grassy

Woodland and derived Native Grassland Ecological Community (i.e. the minimum 13 ha required under Condition 23 of Commonwealth approval EPBC 2011/5923).

This domain also includes riparian vegetation corridors adjacent to drainage structures and watercourses including the permanent Goonbri Creek realignment.

Primary Domain 6 – Temporary Rehabilitation

Temporary Rehabilitation is applied to active and to ongoing operational areas of the overburden emplacement area. It provides temporary stabilisation through the application of a cover crop and will be managed and maintained to minimise dust and visual impact.

3.4.1 Habitat Creation for Matters of National Environmental Significance

The rehabilitation of the TCM will include fauna habitat resources to encourage fauna use.

The TCM Box-Gum Woodland Endangered Ecological Community Implementation Plan (Whitehaven, 2015b) was developed to maximise the prospects for rehabilitation and regeneration of the White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland) (listed as a EEC under the EPBC Act and an Endangered Ecological Community [EEC] under the NSW Threatened Species Conservation Act [TSC Act]) on the offset area and the mine site. The implementation plans require a combined list of 51 individual actions relating to the Rehabilitation Strategy (Appendix B).

Regent Honeyeater

The Regent Honeyeater is a generalist forager, which mainly feeds on the nectar from a wide range of Eucalypts and Mistletoes. In consideration of the potential foraging habitat requirements of the Regent Honeyeater, a variety of box, ironbark and gum eucalypt species would be established on the post-mine landforms, including, but not limited to, White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*), Blakely's Red Gum (*E. blakelyi*), Mugga Ironbark (*E. sideroxylon*), Allocasuarina and Casuarina species.

It is considered unlikely that this species will breed in the locality as this species has not been previously recorded in Leard State Forest and the closest breeding location is in the Bundarra-Barraba region (Section 2.1).

Swift Parrot

In consideration of the potential habitat requirements of the Swift Parrot, a variety of winter-flowering box, ironbark and gum eucalypt species would be established on the post-mine rehabilitation landforms, including, but not limited to, White Box (*E. albens*) and Mugga Ironbark (*E. sideroxylon*).

South-eastern Long-eared Bat

The South-eastern Long-eared Bat forages on insects and roosts in tree hollows in the locality surrounding TCM (Section 1.2). In the short to medium term, the proposed revegetation of box, ironbark and gum eucalypt species can provide potential source of habitat for prey.

Trees will be salvaged during vegetation clearance at the mine and will be reinstalled upright as stag (dead) trees augmenting the rehabilitation area with arboreal habitat replicating potential roosting resource for this species.

The success of this stag tree program for the South-eastern Long-eared Bat will be assessed as part of the ongoing rehabilitation monitoring program.

Other Habitat Creation

Timber and bush rocks piles will be relocated to rehabilitation areas before, during and after clearing as per the Land Disturbance Protocol, which is contained in the BMP. Also, vegetative material (cleared at the mine site) will be incorporated into the soil used for rehabilitation or as mulch.

3.4.2 Revegetation Techniques

The BMP states revegetation works will generally be carried out when climatic growth conditions are optimal, and that they will involve direct native seeding and/or supplementary tube stock planting.

It also states that native groundcover vegetation will be established to prevent raindrop and sheet erosion from occurring, and in the event that native grass cover is initially insufficient to stabilise sloped areas due to slow growth rates, seasonal ground covers such as millet may be used to supplement plantings. Natural seed germination from the soil seed bank will be assisted with direct seeding and where applicable, seed will be treated to enhance germination rates. Planting of tube stock will supplement areas of low success rates from the natural regeneration from the seed bank and direct seeding. Where possible the seed used for direct seeding and for growing tube stock will be sourced from healthy, large and accessible populations that are located as near to the TCM as possible. Local endemic species will be preferentially used, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source. In addition and where feasible, climate-adjusted seed provenances (where collected seed incorporates a mix of genotypes from a climate gradient) will be used.

Section 5 provides further detail of the revegetation methods that will be adopted at the TCM to achieve effective restoration of potential habitat for the Regent Honey Eater, Swift Parrot and Greater Long-eared Bat and the Box-Gum Woodland EEC.

3.5 DECOMMISSIONING

Decommissioning and removal of all infrastructure items from the mine site will take place during the mine closure phase. Any infrastructure including dams, levee banks, roads and buildings, which is beneficial for future use by post mine landowners, will be left in place in accordance with the relevant stakeholder or landowner agreements. Decommissioning of the mine infrastructure area will include removal of foundation and hardstand materials, services, equipment and infrastructure, remediation of any land contamination, ripping, topsoiling (if necessary) and seeding.

3.6 REHABILITATION COMPLETION CRITERIA

The Project EA (Resource Strategies, 2012) included a table of preliminary rehabilitation criteria, and indicated that the criteria would be further developed and agreed in consultation with the relevant

government agencies and community. It also stated that these criteria will continue to be revised and developed to demonstrate that the rehabilitation objectives have been achieved, and that the achievement of the completion criteria will be monitored and reported to relevant stakeholders in the Annual Environmental Monitoring Reports and through Independent Third Party Audit Reports as required under PA 11_0047 (MOD 1) and EPBC 2011/5923 (see Section 8).

As part of the preparation of the MOP, the preliminary rehabilitation completion criteria have been reviewed and revised in light of the Commonwealth and State approvals issued for the TCM. **Table 3-4** provides the completion criteria contained within the MOP for the domains identified in **Table 3-3**.

The performance indicators and completion criteria (targets) in **Table 3-4** are also relevant to the re-establishment of potential habitat for the Regent Honeyeater, Swift Parrot and Southern Long-eared Bat and the Box-Gum Woodland EEC. The Regent Honeyeater, Swift Parrot and Southern Long-eared Bats all use woodland and forest habitats that will be established on the post-mine landforms in accordance with Condition 23 of EPBC 2011/5923. Once the completion criteria is achieved rehabilitation is then considered similar to the required benchmark vegetation community and therefore containing the habitat requirements of the Regent Honeyeater, Swift Parrot and Southern Long-eared Bats. Of the 752 ha of woodland and forest habitats that will be established on the post-mine landforms, 13 ha will be revegetated with species consistent with Box-Gum Woodland EEC in accordance with Condition 23 of Commonwealth approval EPBC 2011/5923.

The quality of rehabilitation will be monitored annually using Landscape Function Analysis (LFA) unless improvements are identified and recommended during the rehab criteria revision process.

Further detail of the TCM rehabilitation monitoring program is provided in Section 7.4.

Table 3-4 (Continued) Rehabilitation Completion Criteria

Table 3-4 Rehabilitation Completion Criteria

Domain Objective	Performance Indicator	Completion Criteria	Justification/ Source	Complete (Yes/No)	Link to TARP	Progress at start of MOP
Phase 1– Decommissioning of Infrastructure						
All mine-related infrastructure removed from the site and disposed of at an appropriate facility, relocated to another Whitehaven site, or sold.	Communications, power supply, water supply, and water management services and infrastructure removed.	All infrastructure components dismantled and/or removed from the site unless otherwise agreed with the Administering Authority and landholder.	MOP Section 5.2	No	No	To commence
	Offices, workshops and other buildings removed.		MOP Section 5.2	No	No	To commence
	Fuel, chemical, explosive storage tanks and containers removed.		MOP Section 5.2	No	No	To commence
	Roads and rail infrastructure removed.		MOP Section 5.2	No	No	To commence
All hazardous materials removed and contaminated areas remediated.	Hazardous materials such as hydrocarbons, chemicals and explosives removed from site.	All hazardous materials removed from the site and appropriately disposed of.	Contaminated Land Management Act 1997 POEO Act	No	No	To commence

Table 3-4 (Continued) Rehabilitation Completion Criteria

Domain Objective	Performance Indicator	Completion Criteria	Justification/ Source	Complete (Yes/No)	Link to TARP	Progress at start of MOP
Phase 1 – Decommissioning of Infrastructure (Cont.)						
	Areas where hazardous materials have been stored or transferred have been assessed for contamination and remediated if required.	Land contamination assessments and remediation (if necessary) conducted in accordance with the relevant legislative requirements.	Contaminated Land Management Act 1997 POEO Act	No	No	To commence
Groundwater bores and piezometers decommissioned and sealed if no longer required for monitoring or water supply purposes.	Groundwater bores and piezometers stand pipes removed and sealed.	Bentonite seal installed, standpipe and piezometer 'cap' removed and cement grout installed to the surface.	Minimum Construction Requirements for Water Bores in Australia, 2011	No	No	To commence
Phase 2 – Landform Establishment						
Mine landform integrates and generally blends in with surrounding landscape and is stable.	Minimal active erosion.	Absence of gullies > 200 mm wide or deep, or gullies stable.	MOP Section 4.3	No	Yes	Commenced
	Minimal active erosion.	Absence of tunnel erosion intake or outlets points.	MOP Section 4.3	No	Yes	Commenced
		Landform has an average overall slope of 10 degrees	MOP Section 4.3, 5.2, 5.4.2	No	Yes	Commenced

Table 3-4 (Continued) Rehabilitation Completion Criteria

Domain Objective	Performance Indicator	Completion Criteria	Justification/ Source	Complete (Yes/No)	Link to TARP	Progress at start of MOP
Phase 2– Landform Establishment (Cont.)						
Water quality non-polluting and appropriate for conservation end land use.	Water quality.	Oil/grease ≤ 10 milligrams per litre (mg/L).	MOP Section 3.2.8	No	Yes	Ongoing
		EC < 600 micro Siemens per centimetre (µS/cm).	MOP Section 3.2.8	No	Yes	Ongoing
		pH between 6.5 and 8.5 as per the EPL.	MOP Section 3.2.8	No	Yes	Ongoing
		TSS < 50 mg/L.	MOP Section 3.2.8	No	Yes	Ongoing
Phase 3– Growth Medium Development						
Mixture of native vegetation communities including grassy woodland, shrubby woodland/ open forest.	Soils ameliorated to sustain pasture or native ecosystems.	The depth and layering of respread subsoil and topsoil are in accordance with the EA.	EA	No	Yes	Commenced
		Soil based criteria equal analogue sites (to be determined based on sampling results). Will include: • pH; • Organic matter; and • Phosphorous .	EA	No	No	Commenced

Table 3-4 (Continued) Rehabilitation Completion Criteria

Domain Objective	Performance Indicator	Completion Criteria							Justification/ Source	Complete (Yes/No)	Link to TARP	Progress at start of MOP
Phase 4 – Ecosystem Establishment		**Time since Initial Revegetation**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**				
Woodland rehabilitation revegetation for White Box grassy woodland (BVT 226 and PCT 1383) and Narrow-leaved Ironbark - cypress pine - White Box shrubby open forest (BVT 316 and PCT 592) as consulted with OEH September 2018	BVT 226 and PCT 1383 Native Species Richness	**Mean Target**	1	2	3	4	5	5	Powerpoint Presentation used to consult with OEH in September 2018 titled "WHC-OEH Woodland Revegetation Completion Criteria Meeting 25Sept18. pptx"	No	Yes	Not commenced
		Minimum Target	1	1	2	3	3	4				
	BVT 226 and PCT 1383 Native Overstorey Cover	**Mean Target**	1%	3%	4%	5%	6%	8%		No	Yes	Not commenced
		Minimum Target	0%	0%	0%	0%	0%	0%				
	BVT 226 and PCT 1383 Native Mid-storey Cover	**Mean Target**	0%	1%	1%	1%	1%	2%		No	Yes	Not commenced
		Minimum Target	0%	0%	0%	0%	0%	0%				
	BVT 226 and PCT 1383 Native Groundcover (Grasses)	**Mean Target**	2%	4%	6%	8%	10%	12%		No	Yes	Not commenced
		Minimum Target	2%	3%	5%	6%	8%	9%				
	BVT 316 and PCT 592 Native Species Richness	**Mean Target**	1	2	4	5	6	7		No	Yes	Not commenced
		Minimum Target	1	2	3	4	5	6				
	BVT 316 and PCT 592 Native Overstorey Cover	**Mean Target**	2%	4%	6%	8%	10%	12%		No	Yes	Not commenced
		Minimum Target	0%	0%	0%	0%	0%	0%				
	BVT 316 and PCT 592 Native Mid-storey Cover	**Mean Target**	1%	3%	4%	5%	6%	8%		No	Yes	Not commenced
		Minimum Target	0%	1%	1%	1%	2%	2%				
	BVT 316 and PCT 592 Native Groundcover (Grasses)	**Mean Target**	2%	3%	5%	6%	8%	9%		No	Yes	Not commenced
		Minimum Target	1%	2%	3%	4%	5%	6%				

Table 3-4 (Continued) Rehabilitation Completion Criteria

Domain Objective	Performance Indicator	Completion Criteria					Justification/ Source	Complete (Yes/No)	Link to TARP	Progress at start of MOP
Phase 5 – Ecosystem Sustainability		**Benchmarks**	**RBS* (80%) BVT NA 226**	**BVT NA 226**	**PCT BBS 1383****	**Local Reference**				
Woodland rehabilitation revegetation for White Box grassy woodland (BVT 226 and PCT 1383) and Narrow-leaved Ironbark - cypress pine - White Box shrubby open forest (BVT 316 and PCT 592) as consulted with OEH September 2018	BVT 226 and PCT 1383 Native Species Richness	**Mean Target**	18	23	33	60	Powerpoint Presentation used to consult with OEH in September 2018 titled "WHC-OEH Woodland Revegetation Completion Criteria Meeting 25Sept18. pptx"	No	Yes	Not commenced
		Minimum Target	13	18	28	55				
	BVT 226 and PCT 1383 Native Overstorey Cover	**Mean Target**	Not Applicable	25%	17%	13%		No	Yes	Not commenced
		Minimum Target	Not Applicable	6%	Not Applicable	Not Applicable				
	BVT 226 and PCT 1383 Native Mid-storey Cover	**Mean Target**	Not Applicable	5%	2%	4%		No	Yes	Not commenced
		Minimum Target	Not Applicable	0%	Not Applicable	Not Applicable				
	BVT 226 and PCT 1383 Native Groundcover (Grasses)	**Mean Target**	Not Applicable	40%	45%	38%		No	Yes	Not commenced
		Minimum Target	Not Applicable	30%	Not Applicable	Not Applicable				
	BVT 316 and PCT 592 Native Species Richness	**Mean Target**	24	30	35	Not Applicable	Powerpoint Presentation used to consult with OEH in September 2018 titled "WHC-OEH Woodland Revegetation Completion Criteria Meeting 25Sept18. pptx"	No	Yes	Not commenced
		Minimum Target	19	25	30	Not Applicable				
	BVT 316 and PCT 592 Native Overstorey Cover	**Mean Target**	Not Applicable	40	59	Not Applicable		No	Yes	Not commenced
		Minimum Target	Not Applicable	25	Not Applicable	Not Applicable				
	BVT 316 and PCT 592 Native Mid-storey Cover	**Mean Target**	Not Applicable	25	30	Not Applicable		No	Yes	Not commenced
		Minimum Target	Not Applicable	6	Not Applicable	Not Applicable				
	BVT 316 and PCT 592 Native Groundcover (Grasses)	**Mean Target**	Not Applicable	30	22	Not Applicable		No	Yes	Not commenced
		Minimum Target	Not Applicable	20	Not Applicable	Not Applicable				

Table 3-4 (Continued) Rehabilitation Completion Criteria

Domain Objective	Performance Indicator	Completion Criteria	Justification/ Source	Complete (Yes/No)	Link to TARP	Progress at start of MOP
Phase 6 – Relinquishment						
Unrestricted fauna movement across the rehabilitation.	Presence of a range of fauna assemblages throughout the rehabilitation.	A consistently observed increase in fauna species richness and/or abundance within each rehabilitation domain across at least half of the monitoring sites in that domain.	MCCM BMP Table 6.11	No	Yes	Not commenced

* Leard Forest Regional Biodiversity Strategy Stage 2 (Umwelt, 2017) Table 2.3 Strategic Biodiversity Performance Measures and Preliminary Completion Criteria on Page 31 for Active Revegetation
** Based on OEH (2017) Visual Information Database for Export of Plant Community Types (PCT) Benchmarks for Brigalow Belt South (BBS) 1383 White Box grassy woodland of the Nandewar and Brigalow Belt South Bioregions and 592 Narrow-leaved Ironbark - cypress pine - White Box shrubby open forest in the Brigalow Belt South Bioregion and Nandewar Bioregion.

4 CLEARING AND SOIL MANAGEMENT

4.1 LAND DISTURBANCE PROTOCOL

The TCM Land Disturbance Protocol (LDP) (**Appendix C**) will be applied prior to the clearing of any native vegetation, in particular pre-strip clearing activities in advance of mining. The LDP will be used to manage the clearing process and to document all licensing, safety and management requirements.

The LDP is an environmental checklist that must be completed for each stage of clearing by the person responsible for the clearing activities, the relevant technical expert (e.g. Electrical Engineer to confirm no presence of cables, etc.) and signed off by TCPL's Environmental Officer or a delegate and final authorisation by the Operations Manager.

4.2 SOIL MANAGEMENT PROTOCOL

Soil management procedures have been developed and are documented below. These procedures are being implemented at the TCM to enable soil resources within disturbance areas to be characterised, stripped, stockpiled and re-used appropriately.

The soil management procedures have been developed to meet the requirements of the State and Commonwealth approvals for the TCM. In particular, the requirements of Condition 62 of Schedule 3 of PA 11_0047 (MOD 1) (i.e. preparation of a soil management protocol), and Conditions 25(c) and 25(d) of EPBC 2011/5923 (refer to **Table 2-1**). These soil management procedures are consistent with the TCM Environmental Assessment.

A list of the TCM soil procedures/management measures is provided below.

- **Soil Profile:** Seven soil types/groups were identified within the Disturbance Boundary as part of the baseline soil surveys conducted in the Agricultural Resources Assessment: "Tarrawonga Coal Project", Boggabri NSW) (Agricultural Resources Assessment) (McKenzie Soil Management, 2011) prepared for the Project EA, which is attached as Appendix D (supporting maps and other attachments to the ARA are available at http://www.whitehavencoal.com.au/environment/tarrawonga_mine_environmental_management.cfm). Appendix E of the assessment lists the seven landscape unit types, their key constraints, and the specific management measures to be adopted for each type, including recommended stripping depths.
- **Soil Testing Procedure:** Prior to stripping, soil will be sampled to: identify the soil resource and direct topsoil return opportunities prior to stripping, assist with the preparation of a soil balance/inventory and the allocation of topsoil stockpiling sites if required; and to determine if the soil requires amelioration. The soil sampling will be to minimum sampling frequency of one sample point per 20 ha of each soil type identified, and will include an assessment of soil depth and analysis of soil characteristics. Individual Soil Stripping and Placement Plans will be prepared for each stripping event.
- **Soil Balance:** The Soil Stripping and Placement Plans will document the amount and type of soil stripped from each area. This information will be recorded in a centralised inventory. The soil balance for the TCM will be updated and reviewed regularly as new surveys are conducted, and progressive stripping and rehabilitation is undertaken.

- **Clearing and Grubbing:** Vegetation clearing will be undertaken using the management practices contained in the BMP and outlined below. Prior to clearing, suitable salvage items will be identified, recorded, flagged with marking tape, and marked with a large (>1 m) "S" using spray paint on two sides of a tree. Hollow trees will be considered for salvage based on structural integrity, number and size of hollows. Trees and fallen logs without hollows can be selected at random during clearing and stock-piled to provide additional habitat features in rehabilitated land. Large flat or creviced rocks (>500 mm width) that appear solid enough to survive translocation will be considered for translocation to rehabilitation or offset sites. Records of salvaged vegetation (particularly hollow trunks) and large rocks will be retained, and these materials will be used in rehabilitation areas to provide fauna habitat opportunities.
- **Soil and Spoil Amelioration:** The soil testing results will be used to determine if physical and/or chemical amelioration is required, and the rates and method of application. Where soil ameliorants are used they should be applied to the stockpiles.
- **Soil Stripping:** The surface 0.15 m of *in situ* soil is biologically active and contains almost all of the nutrients, seeds, and beneficial organisms. In many parts of the Disturbance Boundary, the biologically active layer is likely to be shallower than 0.15 m, however, stripping soil in layers thinner than this is generally not possible with available machinery.

  Depth for soil stripping for the disturbance area are as follows (as per the BMP):

  - Cleared creek flats (relatively recent alluvium; Stratic Rudosols), there is potential to collect soil (from an average depth of 3 m) with the high quality soil to be used as topdressing material for agricultural post-mining land use, following treatment with coarse-grade gypsum (approximately 80 ha total);
  - Sub-sections of the vegetated areas in the north of the TCM site have soil conditions that allow a cut of 0.25 m (approximately 30 ha total);
  - Due to major subsoil constraints, a cutting depth of 0.10 m is recommended elsewhere in the remaining TCM disturbance areas (approximately 405 ha). These soils could be used for woodland/forest rehabilitation (McKenzie Soil Management, 2011); and
  - In addition to the high quality soil resources described above, large volumes of other soils could be used in rehabilitation without amelioration to provide conditions suitable for the native woodland/forest. This additional soil could be obtained from the Class 3 Agricultural Suitability areas that are not Stratic Rudosols to a depth of approximately 1 m.

  Earthmoving plant operators will be supervised to ensure that stripping operations are conducted in accordance with the stripping plan and *in situ* soil conditions. The process summarised below for stripping topsoil will be followed:

  - The area to be stripped of soil will be clearly demarcated and surveyed;
  - Soil will not be stripped during excessively wet or dry conditions;
  - Where practical, stripped material will be placed directly onto reshaped overburden and spread immediately (if mining sequences, equipment scheduling and weather conditions permit) to avoid the requirement for stockpiling and costs with double handling;
  - As part of the planning process, sufficient area for stockpiling or placement of soil will have been identified and these areas will be accessible;
  - Different soil types to be stripped separately;

- As part of the planning process, temporary drainage, sediment control and structures to prevent erosion will be developed for each area if required; and
- Grading or pushing soil into shallow windrows with graders or dozers will be undertaken for later collection by open bowl scrapers or loading into rear dump trucks by front-end loaders.

Where practicable, soil stripped from each vegetation community will be used in areas identified for rehabilitation for the corresponding vegetation community. Where soil cannot be used for rehabilitation immediately it will be stockpiled wherever practicable according to vegetation community type.

A summary of the available soil stripping information for mine disturbance areas cleared to date is provided in in **Appendix D**.

- **Soil Stockpiling:** The soil seed bank is an important reserve of native plant seeds and symbiotic soil micro-organisms, which will assist with the preservation of local genetic material and the re-establishment of a similar range and mix of species of the original vegetation in the rehabilitation area. The individual Soil Stripping and Placement Plans for each area will describe the soil stockpiling requirements for each area to be cleared (e.g. stockpile locations, methods, depths and reporting requirements). Where possible, soils will be directly placed onto prepared rehabilitation areas.

  Where stockpiling is unavoidable, the following process for soil stockpiling will be followed to minimise degradation of stored soil:

  - Where possible, stockpiles will be located in areas away from drainage lines and/or drainage will be diverted around stockpiles to prevent erosion;
  - Sediment controls will be installed downstream from stockpiles to prevent contamination of clean water;
  - Stockpiles will be limited to a maximum height of 3 m (BMP);
  - Different soil types will be stockpiled separately;
  - More erodible materials will be placed on flatter areas to minimise the potential for erosion;
  - The surface of soil stockpiles shall promote infiltration and minimise erosion until vegetation is established; and
  - When necessary, stockpiles will be seeded with annual cover crops (if storage times will be less than one year) or native grasses to protect the stockpile from raindrop splash erosion, enhance organic carbon levels and suppress weeds.

- **Characterisation:** Characterisation of subsoil for erosion (primarily dispersion) and agronomic parameters (pH, EC, CEC and metals) will be undertaken. Sampling will determine if the subsoil is suitable for rehabilitation use or if it requires amelioration or selective handling and placement.

  If not able to be ameliorated, unsuitable subsoil and spoil, including PAF material, will be capped with a minimum of 15 m of suitable NAF spoil (MOP 2015). Capping spoil will be ameliorated and contour ripped prior to the placement of the ameliorated topsoil. The individual Soil Stripping and Placement Plans for each stripping area will identify where unsuitable spoil and subsoil has been placed.

- **Soil Respreading:** Prior to the re-spreading of stockpiled soil, an assessment of weed infestation will be undertaken. If unsuitable soil is identified, the stockpiled material will be buried and capped

as described above. For all other stockpiled material, the following re-spreading measures will be adopted where appropriate/relevant.

- When planning soil re-spreading, TCM will consider the information contained in the stockpile inventory (i.e. amount, age, type), climatic conditions, the location and distance of the stockpile from the area to be rehabilitated, the pre-mining vegetation communities (i.e. what communities were growing in the area prior to stripping), and the vegetation communities and final land use proposed for the rehabilitation area;
- Over handling of soil will be minimised to mitigate structural degradation of the soils;
- Material will be spread in even layers at an appropriate thickness (minimum 0.2 m), and will consider the soil depth information obtained through the pre-stripping soil sampling.
- All soils will be lightly ripped prior to seeding. This will be conducted on the contour and will be managed to minimise the potential for unsuitable spoil material being ripped up to the surface; and
- Fertiliser application will be considered prior to seeding (agricultural rehabilitation only) while the surface is being lightly scarified to create an optimal seed bed.

- **Monitoring, Responsibility and Reporting:** Implementation of the various stages of soil stripping, stockpiling and re-use will be monitored and periodically reviewed. Where appropriate, management practices will be revised and updated based on operation experience and where improved performance/outcomes are identified.

  The Tarrawonga Coal Environmental Officer is accountable for providing the necessary advice to ensure that the operational team manages overall soil in accordance with respective management plans and approval conditions. However, all staff and contractors have a responsibility to follow the processes and procedures for managing soils. All staff and contractors must ensure that they have the necessary permits and approvals in place, including a Soil Stripping and Placement Plan, prior to undertaking works which will disturb soils.

  Soil stockpiling and rehabilitation will be assessed and reported annually as part of the TCM Annual Review.

4.3 SUMMARY OF AVAILABLE SOIL SURVEY AND STRIPPING INFORMATION

Soil Survey

Soil survey findings and suggested stripping depths and reinstatement depths for the mine landform areas are documented in the Agricultural Resources Assessment: "Tarrawonga Coal Project", Boggabri NSW) (Agricultural Resources Assessment) prepared for the Project EA. The survey was conducted by McKenzie Soil Management (2011) and the survey report is contained in **Appendix D**. Soil surveys of the remaining areas of the planned TCM mine disturbance footprint will be conducted progressively over the mine life prior to the commencement of topsoil stripping (i.e. as summarised in **Section 4.1**).

The soil survey conducted by McKenzie Soil Management (2011) focused on MLA 1,MLA 2 and MLA 3 areas and included the extent of Project surface development. The soil survey was undertaken with 63 backhoe pits surveyed of each soil type identified. The pits were located in a way that covered the main variations in vegetation type and topography. **Figure 4-1** shows the seven soil landscapes that were identified (i.e. Leard, Blue Vale Slopes, Tally Ho hillcrests, Brentry drainage plains and Hartfell).

Each soil profile class was described, classified and quantified for the purpose of evaluating soil layers as plant growth media for rehabilitation. Soil samples were taken and their physical and chemical properties were analysed. The soil survey report (**Appendix D**) provides detailed descriptions of each soil profile class that was identified, including an analysis of the observation and laboratory data, and a discussion of the key features and potential management issues to be considered when salvaging soils for re-use as plant growth media.

In accordance with Condition 25c of Commonwealth approval EPBC 2011/5923, SLR (2015) prepared a *Soil Type Classification Report* to ensure one sample point per 20 ha of each soil type identified had been undertaken.

Salinity

Material testing undertaken for the Project EA concluded that the overburden and interburden materials are typically alkaline and are expected to be generally non-saline. Salinity in rehabilitation areas is therefore considered a low risk. Management strategies will include:

- Overburden and interburden will be characterised prior to emplacement in waste dumps to ensure the final outer surfaces of the overburden emplacements (and structures such as drainage elements) are constructed with suitable non-saline material where possible;
- Irrigation activities of pasture areas will be undertaken to maximise evapo-transpiration but avoid surface runoff to minimise the risk of impacts on downstream water resources; and
- Water quality monitoring of sites on Goonbri Creek shall continue to be undertaken on an event based frequency.

Dispersive Materials

Sodicity test results indicate that a relatively high proportion of the overburden and interburden from the open cut extension areas is likely to be moderately to highly sodic. If these materials are left exposed on the dump surfaces or final pit walls they may be dispersive and highly erodible. To minimise erosion, the final outer surfaces of the overburden emplacements will be constructed with suitable non-sodic or low sodicity material and/or will be treated with gypsum. Overburden and interburden will be characterised prior to emplacement in waste dumps to ensure the final outer surfaces of the overburden emplacements (and structures such as drainage elements) are constructed with suitable non-sodic or low sodicity material where possible.

Sodic material identified in the final void highwalls and lowwalls will be covered with backfill and/or managed in accordance with the Final Void and Mine Closure Plan (to be developed) or ameliorated with gypsum.

Soil Stripping

Soil stripping and stockpiling activities have been conducted at the TCM since construction and development of the mine commenced in 2006. The main soil striping areas have been located in the initial open cut development area and the overburden emplacement area. As described in **Section 3.2**, progressive rehabilitation is occurring at the main mine landforms and re-use of stockpiled soil has commenced.

Table 4-1 summarises the volume and type of soil that has been stripped and stockpiled from the main mine disturbance areas 2014-2015. **Figure 4-2** shows the vegetation clearing areas and the soil stockpile locations as of July 2015. As illustrated on **Figure 4-2**, some of the areas that have been cleared of vegetation have not yet been stripped of soil.

As per the approved BMP, vegetation clearing at the TCM will be conducted annually in campaigns during the period from 15 February to 30 April each year, except under exceptional circumstances agreed to by the Secretary of the DPI&E. The amount of land cleared each year will be restricted to the practicable minimum required for the safe and efficient operation of the TCM. During clearing trees requiring removal may be mulched for use as a topsoil conditioner. Soil stripping of the cleared areas will occur when required, and following completion of the necessary pre-stripping soil surveys.

Table 4-1 Summary of Soil Types and Areas Stripped and Stockpiled at the TCM

Year	Area (ha)	Soil Type
2014	10.05	Bleached leptic tenosols
2014	41.19	Mosaic of kendosols, tenosolsm chomosols and sodosols
2015	16.14	Bleached leptic tenosols
2015	21.04	Mosaic of kendosols, tenosolsm chomosols and sodosols

Suitable soil resources have been identified to meet the rehabilitation objective of (on average) a soil re-application targeting EA approximate depths of 1.5 m on agricultural rehabilitation areas and 0.2 m in native vegetation rehabilitation areas. Prior to soil stripping activities, additional investigations will be conducted to confirm the appropriate soil stripping and re-application depths for each soil type identified for salvage.

Where possible, soils will be re-spread directly onto re-shaped landforms. Subsoils and topsoils will be characterised prior to re-spreading to determine the type and application rates for any required soil ameliorants (e.g. lime, gypsum, fertiliser and organics). The use of soil ameliorants improves germination and vegetation establishment by minimising surface crusting, increasing moisture retention and organic content, and buffering surface temperatures.

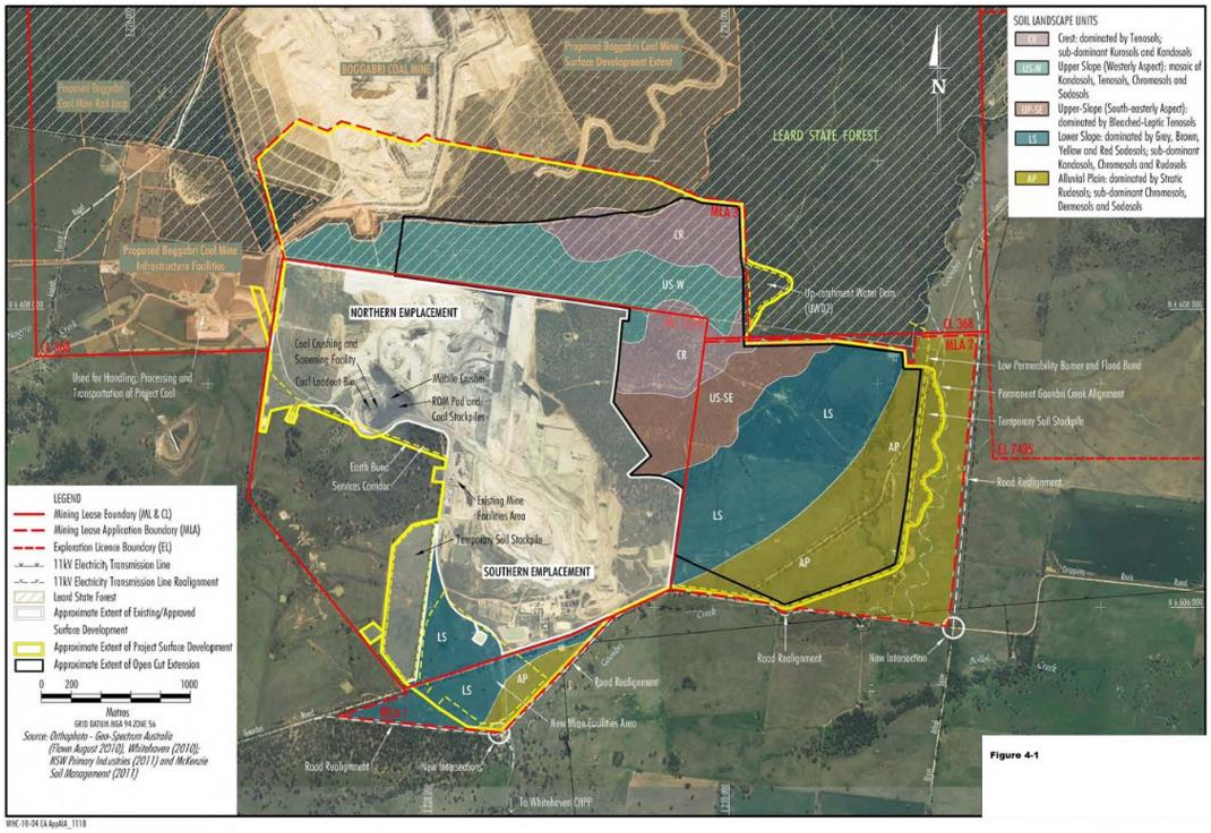

Figure 4-1 Soil Landscapes

Figure 4-2 Soil Stripping and Stockpile Locations (2015)

5 REHABILITATION MANAGEMENT

5.1 REHABILITATION PROGRAM

As described in **Section 1.4**, the current MOP for the TCM covers the period from November 2015 to December 2020. The MOP Guidelines (DRE 2013) requires each MOP to provide details of the status of rehabilitation at each domain as at the commencement of the MOP (i.e. outline activities that have occurred to date), plus it must also describe the rehabilitation activities proposed to be implemented over the MOP term on a domain by domain basis. The rehabilitation information must also be shown pictorially.

The rehabilitation process can be described as a sequence of conceptual rehabilitation phases to achieve a final land use that is self-sustaining. These phases of rehabilitation are described in **Table 5-1** and include time to complete each stage after completion of the previous stage.

Table 5-1 Rehabilitation Phases

Phase	Description	Timing
Phase 1 Decommissioning	The process of removing plant and equipment from active services and rendering the area safe.	When no longer required
Phase 2 Landform Establishment	The process of shaping unformed rock of other sub-stratum material into a desired land surface profile. This includes earthworks activities such as cut and fill, rock raking, water storage and drainage construction.	Within 12month of Phase 1
Phase 3 Growth Medium Development	The process of establishing and enhancing the physical structure, chemical properties and biological properties of a soil stratum suitable for plant growth. This includes placing and spreading soil and applying ameliorants.	Within 12month of Phase 2
Phase 4 Ecosystem Establishment	The process of seeding, planting and transplanting plant species. Incorporates management actions such as weed and feral pest control to achieve species establishment and growth to juvenile communities, and habitat augmentation.	Within 6 months of Phase 3
Phase 5 Ecosystem Sustainability	The process of applying management techniques to encourage an ecosystem to grow and develop towards a desired and sustainable post mining land use outcome. Incorporates features including species reproduction, nutrient recycling and community structure.	10 to 15year after Phase 4
Phase 6 Land Relinquishment	The completion criteria for rehabilitation are met and the land is determined to be suitable to be relinquished from the mining tenement.	Within 2 years of Phase 5

The open cut pit and emplacement areas are active and progressive rehabilitation is currently being undertaken with specific focus on the Northern Emplacement Area and Southern Emplacement.

The MOP includes information on the progressive rehabilitation of the TCM, as parts of the overburden emplacement area and infilled open cut are finalised and become available. Notwithstanding, the indicative rehabilitation program for the TCM based on the current mine plan and mine closure strategy is presented in **Table 5-2**.

5.2 REHABILITATION METHODOLOGY

5.2.1 Mine Landform Reshaping and Design

The final outer surfaces of the mine landforms will be designed to be safe, stable, and non-polluting. Provide an adequately drained post-mining landform, and have a shape that integrates with the adjoining hilly topography of the Willowtree Range and the southern extent of the Boggabri Coal Mine waste rock emplacement. The final void will be designed and constructed to have minimal adverse impacts upon post-mining land use outcomes, and surface and groundwater resources. Rehabilitated landforms will also integrate with the adjoining Leard State Forest to enhance regional biodiversity and conservation outcomes. A key focus in landform design is to provide a final surface that facilitates revegetation and growth of species that occurred in the native woodland and forest communities that were present prior to the commencement of mining. This is largely achieved by keeping slopes less than 10 degrees and returning topsoil, logs, hollow logs (and standing trees where possible) from woodland areas to the woodland rehabilitation sites.

In some instances, parts of the mine landforms will be constructed in their final configuration from the outset (e.g. some batters of the out-of-pit overburden emplacement and some cut and fill areas associated with the mine-related infrastructure). However for the majority of the out-of-pit overburden emplacement area and the open cut, the working batters and berms will need to be pushed back/down (or in-filled with overburden in the case of the open cut) to form the final mine landform surface. Micro-relief features and permanent water management structures (e.g. drop structures between batters and final bunds) would also be installed as part of this process. As described in the **Section 3.5**, the final rehabilitated batters of the overburden emplacement will predominantly have a maximum overall slope of 15 degrees, and the walls of the final void will be a slope of approximately 60 degrees, or less.

The designs of final landforms will be refined as part of the overall mine planning process, in a manner that is consistent with the overall rehabilitation and mine closure concept for the TCM (**Section 3**). The MOP will provide detailed descriptions and plans of the landform reshaping activities and final designs for the period covered by each MOP.

5.2.2 Surface Preparation

Rehabilitation of the TCM will involve replacement of topsoil in areas such as the active mining area, overburden emplacement area and infrastructure area where it has been stripped.

Where topsoil is to be respread over subsoil or overburden, the subsoil or overburden surface will be deep ripped to a depth of approximately 1 m using a dozer to address compaction and to incorporate ameliorants such as gypsum. Subsoil and/or topsoil will then be spread over the ripped area using a grader or dozer. The depth and layering of respread soil will be based on the results of the pre-disturbance soil testing program (refer to **Section 4.1** for a summary of this program).

Where practicable, soil stripped from each vegetation community will be used in areas identified for rehabilitation for the corresponding vegetation community.

For Secondary Domain C (Agricultural Rehabilitation Area) the re-establishment of a soil profile consistent with Class 3 agricultural suitability land will be achieved by selectively emplacing, rock raking, ripping, and ameliorating the surface 300 mm of spoil, emplacing approximately 1 m of select subsoil, and 0.5 m of topsoil.

Vehicle and general personnel access will be predominantly restricted to designated tracks on mine landforms that have been revegetated to minimise ground disturbance (e.g. compaction) except as required for maintenance and monitoring/inspection activities.

5.2.3 Amelioration of Growing Media

Some soils may have physical and chemical characteristics that would otherwise limit plant establishment and have a high potential for erosion. The pre-disturbance soil testing program (**Section 4.2**) will be used to determine whether these materials can be ameliorated (and the required application rates), or whether they should be left *in situ* or buried within the overburden emplacement areas.

Where necessary soil will typically be but not be limited to one or more of the following ameliorants:

- Mulching to increase organic carbon, and improve the soils water holding capacity and soil biota levels;
- Fertiliser (i.e. to increase nutrient levels) (restricted to agricultural soil rehabilitation areas, where possible, or as a slow release formula applied directly beneath hand planted tree seedlings); and/or
- Gypsum (i.e. to treat dispersion, calcium to magnesium ratio, and improve structure and water holding capacity).

Some soils may also contain soil microbes, such as *Rhizobia* sp., Bacteria and mycorrhiza fungi, which assist leguminous species such as *Acacia* and peas to grow and eventually contribute to increasing the nitrogen content of the system, which is often the most growth limiting nutrient in spoil (UoN, 2012). Direct respreading of topsoil and the appropriate construction and management of topsoil stockpiles will be undertaken wherever possible to facilitate the transfer and survival of soil microorganisms.

Where topsoil is unavailable or of insufficient quality, subsoil or mine spoil may be able to be ameliorated to form a suitable growing media. The pre-disturbance soil testing program and the rehabilitation monitoring and research activities will be used to determine whether subsoil amelioration is practicable.

5.2.4 Erosion Control

Erosion and sediment control (ESC) measures will be used at the TCM rehabilitation areas in order to manage dispersive topsoils and spoils, provide soil surface cover, and to minimise the creation of concentrated surface water flow conditions. Erosion control works will include, but are not necessarily limited to the measures listed below.

- Amelioration of dispersive spoil to minimise the risk of rill, gully and tunnel erosion and to allow the infiltration of surface water (reduce the amount and velocity of surface water). This will be determined during the soil testing program;
- Contour scarification of compacted surfaces to encourage infiltration and surface roughness;
- Use of cover crops, native grasses and native legumes to minimise raindrop and sheet erosion of reshaped areas;
- Use of inert rock mulches of appropriate stone sizes and cover where effective and appropriate;

- Engineered temporary channel banks, slope drains and energy dissipaters in areas where concentrated surface flow may occur to reduce erosion if necessary. However, it should be noted that one of the aims of the landform design process will be to minimises the reliance on structural erosion control measures. Drainage and sediment control structures will be designed in accordance with Table 6.1 of *Managing Urban Stormwater: Soils and Construction* Volume 2E – Mines and Quarries (DECC, 2008);
- Structural erosion controls may be used on overburden emplacement areas if necessary until vegetation cover is sufficient to provide adequate erosion protection.

The management of ESC for all mining and associated disturbances is detailed further in the TCM Water Management Plan, and for initial clearing activities via the Land Disturbance Protocol, which is Appendix C of the BMP.

5.2.5 Timing of Revegetation Works

Rehabilitation will commence as soon as practicable following disturbance in accordance with Condition 25b of Commonwealth approval EPBC 2011/5923 to minimise the potential for erosion and weeds.

Where possible, each campaign of rehabilitation works will be completed in early Autumn each year to allow sufficient time for appropriate levels of vegetation cover to establish through spring before the period of potential high erosion hazard rainfall from October to February.

5.2.6 Revegetation of Domains

Section 3.5 summarises the major rehabilitation domains for the TCM based on the Rehabilitation Strategy for the primary domains and the current MOP as follows:

- Domain 1 - Final Void / Active Mining;
- Domain 2 - Water Management Area;
- Domain 3 - Infrastructure Area with a post mining land use of rehabilitated woodland/forest;
- Domain 4 - Topsoil Stockpile Area with a post mining land use of rehabilitated woodland/forest;
- Domain 5 - Overburden Emplacement Area with a post mining land use of rehabilitated woodland/forest and agricultural rehabilitation; and
- Domain 6 - Temporary Rehabilitation used for stabilisation.

Domains 3, 4 and 5 will be revegetated to woodland/forest or agricultural lands (**Figure 1-5**). Domain 1 (the final void) would not be revegetated, whereas Domain 2 (water management areas) will be left unseeded if drop structures or dams or seeded with a cover crop (**Table 5.4**) and pasture species to ensure the short term stabilisation of drains. These water management structures will be left in place until rehabilitation has stabilised and mine closure is imminent or complete.

A detailed methodology to treat the final void will be developed in a Final Void and Mine Closure Plan that will be developed closer to mine closure when more certainty about the final void conditions will be known.

5.2.7 Vegetation to be Established

All of the remnant native vegetation types that were mapped in the Disturbance Boundary prior to mining (**Figure 2-1**) provide potential habitat resources for the Regent Honeyeater, Swift Parrot and Southern Long-eared Bat as these species all use woodland and forest habitats. Condition 23 of Commonwealth approval EPBC 2011/5923 requires no less than 752 ha of woodland and forest to be established on the post-mine landforms. Woodlands and forests to be established will target , the following vegetation types that occur in the Project area:

- White Box - Narrow-leaved Ironbark - White Cypress Pine grassy open forest;
- White Box – White Cypress Pine shrubby woodland;
- White Box – White Cypress Pine grassy woodland;
- Pilliga Box - Poplar Box - White Cypress Pine Grassy Open Woodland;
- Bracteata Honey Myrtle Low Riparian Forest; and
- Derived Native Grasslands.

No less than 13 ha of the post-mine landforms will be revegetated with species consistent with Box-Gum Woodland EEC in accordance with Condition 23 of Commonwealth approval EPBC 2011/5923. The placement of these vegetation types will depend on final slopes, drainage and subsoil and topsoil characteristics. Box-Gum Woodland will be targeted for areas least disturbed e.g infrastructure areas with an un-mined regolith.

It is noted that topsoils from under native woodlands and forests are likely self-generate a dense cover of native vegetation.

5.2.8 Plant Species Selection for Revegetation

It is anticipated that natural seed germination from the soil seed bank will need to be assisted with direct seeding. Planting of tube stock will also be used to supplement areas of natural regeneration and direct seeding as required. In particularly tube stock may be necessary to ensure the appropriate composition and density of long-lived woody vegetation needed for threatened fauna. A combination of all three techniques is likely to be used in order to achieve the rehabilitation objectives in certain areas.

Seed and tube stock used in revegetation will include a variety of grasses, low shrubs, mid-sized shrubs and tall trees to create structurally diverse habitat.

Local endemic species will be preferentially used, however consideration would be given to the use of a high quality seed sourced further from the site over a low quality more local seed source.

Where feasible, genetic provenances from drier regions (following the climate-adjusted seed provenances strategy of Prober et al. (2015)) should be used.

Revegetation species will include the main strata species of each vegetation community (**Table 5-3**) and species to assist in the initial development of the ecosystem including short lived *Acacia* species to contribute nitrogen to the developing system but not at excessive densities (UoN, 2012). *Acacia* species to be included in the seed mix from vegetation communities that include *Acacia decora* and *A. cheelii.*

Species mixes will be matched to pre-mining soil-landscapes and guided by local reference sites. For example, *Eucalpytus populnea* will be planted on low slopes and will be targeted for areas of likely seepage and temporary inundation (e.g. bottoms of slopes and drains). *E. crebra, E. dealbata* and *E. melanophloia* will be planted on high steep slopes.

Direct seeding trials will be undertaken to determine the optimum method for vegetation establishment.

Consideration should also be given to sowing of Kangaroo Grass (as this species has been known to out-compete annual grass weeds and provide inter tussock spaces for a diversity of ground cover species [e.g. wildflowers]).

Temporary Cover

Temporary or interim rehabilitation (Domain 6) will be used where required to provide cover to minimise erosion and dust impacts. This will involve the application of a temporary cover crop for short term uses, and native grasses for longer term requirements. The species that are used will be selected so as to not be likely to impede the final revegetation of native vegetation.

The recommended seed mix for temporary cover crops is Millet (Shirohie/Japanese) or rye corn as an alternative, with a recommenced application rate of 15 kg per ha.

Table 5-3 Provisional Woodland Revegetation Species List

Common Name	Scientific Name	Common Name	Scientific Name
Dry Open Forest (Upper Slopes)		**Other****	
Overstorey		**Overstorey**	
White Box	*Eucalyptus albens*	Pilliga Grey Box	*Eucalyptus pilligaensis*
Narrow-leaved Ironbark	*Eucalyptus crebra*	Western Rosewood	*Alecttyon oleifolius*
Tumbledown Red Gum	*Eucalyptus dealbata*	**Midstorey**	
Silver-leaved Ironbark	*Eucalyptus melanophloia*	Black Tea-tree	*Melaleuca bracteata*
Midstorey		Amulla	*Eremophila debilis*
-	*Allocasuarina spp*	Emubush	*Eremophila longofolia*
Woodland (Lower Slopes)		Sandlewood	*Santalum lanceolatum*
Overstorey		Eastern Cottonbush	*Marireana microphylla*
*White Box	*Eucalyptus albens*	Native Jasmine	*Jasminium lineare*
*Yellow Box	*Eucalyptus melliodora*	Gangaloo	*Parsonsia eucalyptophylla*
*Blakely's Red Gum	*Eucalyptus blakelyi*	Yellow Berry Bush	*Maytenus cunninghamii*
Midstorey		Wild Lemon	*Canthium oleifolum*
*Sticky Hop-Bush	*Dodonaea viscosa ssp. angustifolia*	Wild Orange	*Capparis mitchelli*
*Wilga	*Geijera parviflora*	Native Olive	*Notelaea macrocarpa*
Western Silver Wattle	*Acacia decora*	Butterbush	*Pittosporum angustifolium*
Hickory Wattle	*Acacia implexa*	Cough Bush	*Cassinia laevis*
Understorey		**Understorey**	
*Smooth Darling Pea	*Swainsona galegifolia*	Blue Trumpet	*Brunoniella australis*
*Barb-wire Grass	*Cymbopogon refractus*	Three-awn Speargrass	*Aristida vagans*
*Silky Blue-grass	*Dichanthium sericeum*	Yellow Burr-daisy	*Calotis lappulacea*
*Daises	*Brachyscome spp.*	-	*Chloris spp.*
*Wallaby Grass	*Austrodanthonia induta*	Two Coloured Panic	*Panicum simile*
*Kangaroo Grass	*Themeda triandra*	Bothriochloa	*Bothriochloa spp.*
*Winter Apple	*Eremophila debilis*	Native Forbs	
-	*Austrodanthonia spp.*		
Riparian Open Forest (Drainage Lines and Creeks)			
Overstorey			
Bimble Box	*Eucalyptus populnea*		
Belah	*Casuarina cristata*		
Midstorey			
River Oak	*Casuarina cunninghamiana*		

*** Specifically associated with the Box-Gum Woodland EEC.**

**** Other species to be incorporated into the vegetation communities.**

5.2.9 Seed Collection, Application and Storage

Native seed collection will be undertaken in the areas to be cleared where practicable, and from the remainder of the TCM mining tenements. TCM will seek written authority the Forest Corporation NSW (FCNSW) prior to the collection of seed outside of the boundary of ML1685 and within Leard State Forest. Seed will also be collected from offset properties in accordance with Florabank guidelines (Florabank, 1999). TCM will arrange for the collection of seed at the site at appropriate times after flowering. The seed collection times and methods will be recorded and a database established to enable regular review and revision of the program. The monitoring of plant flowering and seeding cycles by the seed collectors will allow for the establishment of a comprehensive database and detailed strategy. Seed processing and storage will be managed by the seed collection contractor prior to use for revegetation. Seed viability testing will be sought, on a cost efficiency basis.

5.2.10 Rehabilitation Maintenance and Contingency Measures

Active management in response to monitoring and research activities in the rehabilitation areas will be completed as required to address any issues of concern identified during monitoring. TCPL undertakes annual rehabilitation monitoring using LFA based methods to provide quantitative and qualitative data to assess rehabilitation progress against completion criteria and/or triggers for re-work and adaptive management and assist in refining rehabilitation methods.

Maintenance activities will be developed in response to rehabilitation which is not performing on a case by case basis to ensure that these activities are focussed towards the achievement of rehabilitation objectives and targets. Maintenance works may include the following activities:

- Supplementary seeding or planting of vegetated areas;
- Application of soil ameliorants;
- Weed and pest control;
- De-silting or repair of drainage structures and sedimentation dams;
- Infilling, regrading and revegetation of eroded areas;
- Potential clearing or rehabilitation for ecological thinning, maintenance or ecological monitoring; and
- Assess vegetation density and undertake ecological thinning (e.g. through selective clearance or fire) if necessary.

Supplementary Seeding

Supplementary seed broadcasting will be undertaken in areas where revegetation success is considered to be sub-optimal. The sufficiency of vegetation establishment will be determined based on inspection or monitoring results and the comparison against the appropriate rehabilitation objective and/or completion criteria and their analogue sites. Seed for broadcasting will be treated where necessary prior to broadcasting to maximise germination rates.

Weed and Pest Control

Weed management will include the following actions:

- Rehabilitated areas, tracks, temporary creek lines and disturbed areas will be inspected regularly (at least monthly (BMP)) for the presence and spread of noxious and environmental weeds;
- Relevant personnel will be asked to report incidental sightings in their work area;
- Treatment of entire infestations where possible through mechanical removal and/or the application of approved herbicides (in accordance with the Pesticides Act 1999). The method of herbicide application will be determined on a case by case basis;
- Re-treatment of recurring infestations at regular intervals;
- Mapping of key weed infestations following monitoring to track progress and focus control activities where necessary;
- Prompt rehabilitation of land post disturbance;
- Cleaning of mobile equipment and vehicles prior to them entering and leaving the site;
- Inspection of vegetated areas prior to clearing to ensure that the appropriate controls are implemented to prevent the spread of weeds; and
- Annual reporting of rehabilitated areas for environmental weeds that suppress rehabilitation.

Feral animal management will focus on the main feral animals recorded from the Project area (including feral pigs, rabbits and foxes) and native herbivore pest species (e.g. wallaroos and kangaroos) based on monitoring. However, if new feral animals are found during monitoring those new feral animals will also be managed in accordance with the BMP. The control of feral animals is intended to be adaptive and will be informed/reviewed based on the findings from the Feral Animal Monitoring Program.

Control measures will be implemented by mine staff or by an appropriate Pest Control Contractor(s) as required. All personnel involved in feral animal control will be required to hold valid licences/permits, including any relevant chemical licences for pesticide use or a firearms licence for shooting. The DPI's model code of practice of humane pest animal control will be followed.

A variety of techniques are available, including shooting, baiting or trapping and additional techniques may be undertaken depending on the feral animal species which is in an abundance that requires control (as determined through monitoring) and the success of these control techniques.

Pest control actions will be undertaken with reference to the appropriate model Code of Practice and Standard Operating Procedures (these documents are available on the DotEE website).

De-silting or Repairing Drainage Structures, Infill and Regrading

Additional surface stabilisation works will be undertaken as required and may include reshaping, installation of surface stabilisation structures, amelioration of soil, revegetation, fencing and de-silting and repair of drainage structures.

Stabilisation works will be inspected annually and some of the works will be formally monitored as part of the rehabilitation monitoring program (**Section 7**).

Irrigation

Irrigation of the rehabilitation areas may be used to assist the germination of the plants *in situ* and to assist the supplementary tube stock planted. Supplementary watering of tube stock at the time of planting can be particularly useful. Irrigation (if required and where practically possible) will be undertaken in consideration of the prevailing weather conditions, soil moisture and plant health. Water availability following seeding has been found to be a major influence on a number of experimental sites (UoN, 2012).

Bushfire Management

All fire breaks and access trails will be inspected at least once a year for maintenance requirements prior to the fire season. However, maintenance issues may also be noted during other routine management and monitoring activities undertaken in the offset area. Maintenance of fire breaks and access trails will be scheduled as and when required.

Monitoring fuel levels will take place as part of the annual inspection. Where fuel loads are considered to pose a threat and fuel loads are required to be reduced, the method to reduce fuel loads will involve consultation with the NSW Rural Fire Services.

No controlled burns will be undertaken on the mine rehabilitation whilst vegetation is establishing.

Livestock Management

Livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding) and all those area with a Land Capability Class unsuitable for grazing (i.e. Classes VI and VII).

5.2.11 Rehabilitation and Mine Closure Financial Provisioning

DRG has a mine site rehabilitation cost estimate (RCE) provisioning process which is used to estimate the liabilities associated with rehabilitating each of its operations in accordance with the operating approvals, mining lease conditions, applicable mine closure plan and relevant guidelines. The cost estimate includes consideration of mobilisation costs, project management costs, monitoring costs and a contingency. It also includes indexation for inflation where appropriate. The degree of existing disturbance and the status of rehabilitation at the site has been factored in to the consideration of rehabilitation and mine closure liability.

TCPL will regularly review and revise its rehabilitation and mine closure provisioning for the TCM during the life of the project, and will provide the necessary security deposits as required by the operating approvals for the mine.

In addition a Conservation and Biodiversity Bond has been determined for the Project in accordance with Condition 27 of EPBC 2011/5923 and Condition 49 of PA 11_0047.

6 RISK ASSESSMENT OF REHABILITATION-RELATED ASPECTS

Condition 25(f) of Commonwealth approval EPBC 2011/5923 requires the MSRP to provide a description of the potential risks to successful management and rehabilitation on the project site, including weed invasion, and a description of the contingency measures that would be implemented to mitigate these risks. In order to address this aspect, a qualitative risk-based approach has been adopted. The assessment focused on evaluating the likelihood and consequence of environmental impacts associated with rehabilitation occurring and identifying the management measures that would reduce the potential impact.

This approach allowed for the potential interactions between TCM aspects (or hazards) and environmental factors (or receptors) to be considered on the basis of potential risk, therefore enabling the prioritisation of management measures to achieve an overall acceptable level of environmental risk.

The rehabilitation and closure risk assessment includes:

- Establishment of a risk assessment framework (definition of consequences and likelihood and establishment and validation of risk matrix);
- Systematic identification of environmental factors, related hazardous events, their causes and environmental aspects;
- Initial characterisation of environmental risks based on standard management practices (inherent risk);
- Identification of additional management options to reduce risks to acceptable levels; and
- Analysis of residual risk following implementation of the additional management options.

The overall environmental risk assessment process used to support this MSRP is shown in **Figure 6-1**.

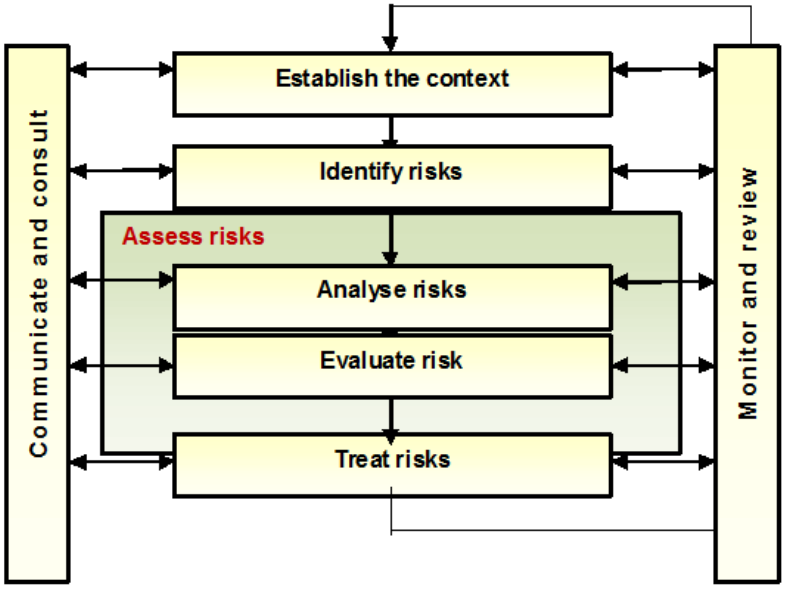

Figure 6-1 Risk-based Environmental Impact Assessment Process

The aspects and hazards associated with rehabilitation of the TCM were identified through a review of the conceptual closure design, relevant approval conditions for the TCM, the baseline studies and environmental impact assessment conducted for the Project EA (Resource Strategies, 2012) and rehabilitation methods and performance in the Industry and at Whitehaven's other mines.

The aspects and hazards were classified in accordance with the following qualitative definitions:

High Significance

- Require high level of mitigation and/or management for potential impact to comply with guidelines and standards; and/or
- Direct/permanent loss of environmental attributes of conservation significance and/or social attributes of significance; and/or
- High risk rating.

Medium Significance

- Potential impacts require moderate management measures to comply with guidelines and standards; and/or
- Potential impacts will be localised and medium term, with moderate loss to environmental attributes of conservation significance and/or social attributes of significance; and/or
- Medium risk rating.

Low Significance

- Potential impacts will be minor requiring minimal management measures to comply with guidelines and standards; and/or
- Potential impacts will be localised and short-term, with minimal loss to environmental attributes of conservation significance and/or social attributes of significance; and/or;
- Low risk rating.

The environmental factors and rehabilitation-related aspects considered for the risk assessment undertaken for this MSRP are outlined in **Table 6-1**.

Table 6-1 Environmental Factors and Hazards

Environmental Factor (Receptors)	Rehabilitation-related Hazard (Stressor)
• Landforms and Closure • Surface Water • Groundwater • Flora and Vegetation • Fauna • Soil Resources	• Clearing and rehabilitation earthworks • Discharge of water outside Environmental Protection Licence Limits • Physical Presence • Physical Interaction • Fire • Erosion • AMD • Spontaneous combustion propensity • Leaks and Spills • Soil type, suitability and availability • Weeds and pest animals • Bushfire

The risk assessment process involved the identification of the following for each environmental factor:

- Hazard (stressor);
- Source of hazard;
- Event;
- Potential impacts;
- Inherent risk;
- Proposed controls; and
- Residual risk.

A risk assessment framework (including factor-specific definitions of consequences and likelihood and establishment and validation of risk matrix) was used to assess rehabilitation-related risks of the TCM. The risk assessment framework defines the type and duration of potential impacts based on five categories of consequence (minor, moderate, serious, major and critical). Similarly, there are five categories of likelihood of an event causing a particular impact. Risk is categorised as high, medium or low based on the scoring of likelihood and consequences.

Tables 6-2 and **6-3** were used to assign a consequence factor/ranking[1] and likelihood factor/ranking[2] to each potential impact. The inherent risk ranking was calculated by multiplying the consequence factor and the likelihood factor (**Table 6-4**).

[1] Consequence is defined as a measure of the expected degree of gain, harm, injury or loss (impact) from the most severe event associated with a risk issue.

[2] Likelihood is defined as a measure of the chance of an impact at that selected level of severity actually being incurred.

Table 6-2 Consequence Factor

Relevant Consequence Criteria	Negligible 1	Minor 2	Moderate 3	Significant 4	Serious 5
Soils and rehabilitated landforms	• Local contamination that can be readily remediated • Negligible impact on soil characteristics • Local and minor changes in recharge patterns within sub-catchments • Disturbance of well-represented landform habitats	• Local contamination requiring a long-term remediation effort • Local, short-term change in soil characteristics • Local and major change in recharge patterns within sub-catchments • Widespread and minor changes in recharge patterns • Local loss of well-represented landform habitat	• Local contamination that cannot be readily remediated • Local, long-term or widespread, short-term change in soil characteristics • Major widespread changes in sub-catchment recharge patterns • Widespread loss of well-represented landform habitats • Local loss of a unique landform habitat	• Widespread contamination requiring a significant long-term remediation effort • Widespread, long-term change in soil characteristics • Minor changes in regional recharge patterns • Widespread loss of a unique landform habitat	• Widespread contamination that cannot be readily remediated • Major changes in regional recharge patterns • Regional loss of a unique landform habitat
Flora and Vegetation	• Local and temporary decrease in abundance of flora or impact on community structure • Sub-lethal physiological impacts	• Widespread, short-term or local, long-term decrease in abundance of flora or impact on community structure	• Widespread, short-term or local, long-term decrease in abundance of flora or impact on community structure	• Widespread and long-term decrease in abundance of flora or impact on community structure	• Widespread and long-term decrease in abundance of flora or impact on community structure
Fauna	• Widespread, temporary or local, long-term behavioural impact • Local, long-term or widespread, temporary decrease in abundance	• Widespread and long-term behavioural impact • Local, long-term or widespread, short-term decrease in abundance	• Local, long-term or widespread, short-term impact on population	• Widespread, long-term impact on population	• Extinction in the immediate region
Surface and Groundwater quality and quantity	• Local, temporary or minor reduction in quality and quantity	• Minor reduction in water quality which is widespread, short-term or local, long-term • Large reduction in water quality which is local, short-term	• Widespread, long-term reduction in water quality	• Regional, short-term reduction in water quality	• Regional, long-term reduction in water quality

Table 6-3 Likelihood Factor/Ranking

Likelihood Category	Likelihood Factor	Description
Almost Certain	5	Very likely to occur on an annual basis or during construction
Likely	4	Likely to occur more than once during the life of the proposed development
Possible/Occasional	3	May occur during the life of the proposed development
Unlikely	2	Not likely to occur within the life of the proposed development
Rare/Improbable	1	Highly unlikely, but theoretically possible

Table 6-4 Risk Rating Classification

		Consequence Category				
		Negligible	Minor	Moderate	Significant	Serious
Likelihood Factor	Almost Certain	Low	Medium	High	High	High
	Likely	Low	Medium	High	High	High
	Possible/Occasionally	Low	Medium	Medium	High	High
	Unlikely	Low	Low	Medium	Medium	Medium
	Rare/Improbable	Low	Low	Low	Medium	Medium

The inherent level of risk posed by rehabilitation-related aspects to the relevant environmental factors was assessed assuming no controls in place.

The key environmental factors (those representing a medium or high inherent risk level) were subjected to further assessment in order to determine the extent and significance of environmental impacts.

To ensure the risks for each of the key factors was reduced to 'As Low as Reasonably Practicable' (ALARP), best practicable environmental management was applied to all key environmental factors to determine appropriate refinements of the TCM design and controls to reduce the risks as far as practicable.

Appendix E presents the rehabilitation-related risk assessment conducted for this MSRP.

7 MONITORING AND REPORTING

7.1 OVERVIEW

The TCM rehabilitation monitoring program will involve the gathering of information and data, systematic record keeping of all management inputs, regular review and analysis of the data against compliance requirements, assessment of progress toward mine closure criteria, rehabilitation objectives, and rehabilitation TARPs to drive progressive rehabilitation and continuous improvement. The monitoring program will:

- Compare results against rehabilitation objectives and targets (i.e. Closure Criteria);
- Identify possible trends and continuous improvement;
- Link to records of rehabilitation activities and inputs to determine causes and explain results;
- Assess effectiveness of environmental controls;
- Where required, identify modifications required for the monitoring program, rehabilitation practices or areas requiring research;
- Compare flora species present against original seed mix and/or analogue sites;
- Assess vegetation health;
- Assess landscape function (soil surface stability, nutrient cycling and water infiltration);
- Assess vegetation structure (e.g. density and cover of upper, mid and lower storey); and
- Where applicable, assess native fauna species diversity and the effectiveness of habitat creation for target fauna species.

The TCM rehabilitation monitoring program involves regular record keeping and analysis of the following key rehabilitation inputs:

- Mining operations;
- Rehabilitation methods; and
- Revegetation practices.

A summary of each aspect and the monitoring methods that are, or will be, applied is provided in **Sections 7.2** to **7.4**. **Sections 7.5** and **7.6** describe the rehabilitation reporting mechanisms and adaptive management approach that would be adopted at the TCM.

7.2 MONITORING OF MINING OPERATIONS

TCPL will maintain detailed records of the mining operations at the TCM in order to provide a record of the various activities and processes that occur at the site over the life of the mine relevant to rehabilitation. These records will allow TCPL to identify areas and/or activities that may impact/influence the success of future rehabilitation, decommissioning and mine closure activities and to report on these internally and externally. The records will include, but are not necessarily limited to:

- As-built plans for mine-related infrastructure and detailed plans for the open cut mine, void and overburden emplacement areas as they are developed over the mine life (e.g. location, type, timing and volume of overburden materials placed in the out-of-pit and in-pit emplacement areas [including any identified PAF materials]);
- A register of the type, location, amount and characteristics of hazardous materials used at the mine site (e.g. details of the areas where explosives and hydrocarbons are stored);
- A register of all areas where land or water contamination occurs during the mine life and details of the source of contamination, its extent and how and when it was remediated;
- Records of production wastes and other waste streams, including details of where they are located and/or have been stored on site;
- General environmental monitoring records, including surface water, groundwater, noise and air quality as required by the State and Commonwealth approvals;
- Environmental incident records; and
- Soil survey, stripping and stockpiling records (i.e. mapped pre-disturbance soil types and depths, stripping areas and depths, and volumes, types, locations of stockpiled soil materials, and maintenance works undertaken (e.g. weed control, planting with cover crops etc.).

7.3 MONITORING OF REHABILITATION METHODS

The inspection and monitoring of rehabilitation will be undertaken by TCM personnel through regular inspections as well as through engaging suitably qualified specialists (as required).

Aspects of rehabilitation to be inspected will include:

- Evidence of any erosion or sedimentation from areas with establishing vegetation cover;
- Success of initial grass cover establishment;
- Success of tree and shrub plantings;
- Adequacy of drainage controls;
- Presence/absence of weeds; and
- General stability of the rehabilitation site.

The aim of the vegetation monitoring program at TCM is to evaluate the success of revegetation of the Rehabilitation towards achieving the performance and completion criteria. The Rehabilitation monitoring program will be consistent with the monitoring program implemented for the Biodiversity Offsets in the BMP (2018 in draft). The experimental design for TCM's Rehabilitation monitoring program will involve three types of vegetation monitoring sites (including replicate plots to increase statistic robustness) aiming to sample revegetation management (treatment = action sites) compared to no management (untreated/unmanaged = control sites) and the development of revegetation towards the desired woodland final land use (remnant woodland vegetation = analogue/reference sites).

TCM will engage qualified ecologists to undertake vegetation monitoring on an annual basis in spring. Fixed vegetation monitoring plots measuring 20 x 50 m will be established at each monitoring site and permanently marked with a star picket and within each plot a 20 x 20 m quadrat will also be established based on the BioBanking Assessment Methodology (BBAM) (OEH, 2014). The BBAM vegetation monitoring methodology includes monitoring vegetation structural parameters and flora species diversity consistent with the performance and completion criteria.

The Tarrawonga rehabilitation monitoring program will be reviewed as part of a broad Whitehaven Ecological Monitoring Methodology review program and standardisation across all rehabilitation and offset areas. This review will commence in 2018 with an anticipated duration of 12 months.

No time limit has been placed on post-mining rehabilitation monitoring and maintenance in terms of lease relinquishment. Maintenance will continue until such time as the performance and completion criteria are met.

There are no specific rehabilitation trials or research proposed for TCM. Rehabilitation monitoring and rehabilitation methodology records are, however, shared among Whitehaven operations to inform decision making regarding future rehabilitation campaigns. Specifically the nearby Maules Creek mine has a requirement to undertake a $1M research program into rehabilitation of Box Gum Grassy Woodland upon mine rehabilitation, the findings from which will be considered by TCM and integrated into future MOP amendments as appropriate.

7.3.1 Independent Biodiversity Audit

In addition to the scheduled monitoring events, Tarrawonga will be independently audited every three years to assess compliance with the requirements of PA 11_0047 (MOD 1) MOD 1, EPL 12365 and ML 1579, along with any assessment, management plan, strategy or program required under those approvals. The next audit is scheduled for 2020.

All rehabilitation areas will be audited in the Independent Biodiversity Audit to verify rehabilitation progress documented in the MOP and Annual Review.

7.4 REHABILITATION REPORTING

An Annual Review will be submitted by the end of June each year as per Condition 4 of Schedule 5 of State approval PA 11_0047. It will describe the environmental performance of the TCM over the preceding 12 month period. The Annual Review will discuss rehabilitation performance and any non-compliance issues. This will include monitoring results, statutory requirements, and a description of rehabilitation activities and measures that will be implemented over the following year. An analysis of rehabilitation performance against the key objectives and completion criteria will be included in the Annual Review. All stakeholders will have access to this document via Whitehaven's website.

7.5 REHABILIATION RESEARCH AND ADAPTIVE MANAGEMENT AT THE TCM

Rehabilitation research activities will be conducted as necessary during the life of the mine. These will be developed and implemented as required in order to investigate relevant components of the rehabilitation process. Where practicable and appropriate they will be conducted in collaboration with

other nearby mining operations, landholders, Government agencies, interest groups or research/academic organisations. Research activities may cover a broad range of rehabilitation-related activities. The scope of the research activities will be summarised in the MOP and a summary of the findings will be provided in the Annual Review.

Continuous Improvement

TCM adopts a continuous improvement approach to rehabilitation. Results from rehabilitation monitoring surveys and opportunistic monitoring observations are used to refine rehabilitation methodologies on an on-going basis.

Direct Seeding Trials

TCPL will trial during direct seeding techniques between 2015 and 2020 in small areas to determine the effectiveness of direct seeding to establish native vegetation. TCPL will engage contractors to undertake direct seeding works. Rehabilitation progress will be monitored to identify potential benefits to supplementing tubestock planting with direct seeding. Trial results will be reported in the Annual Review and if successful, direct seeding methodologies will be formalised in this MSRMP.

7.6 INTERVENTION AND ADAPTIVE MANAGEMENT

Where rehabilitation monitoring indicates that rehabilitation outcomes are not trending toward the nominated completion criteria TCPL will instigate early intervention and adaptive management to minimise the potential for rehabilitation failure. Aspects that may be considered as part of the investigation may include, but are not necessarily limited to the following:

- Nutrient availability;
- pH, salinity and metal toxicity;
- Shallow root depth;
- Other soil limitations;
- Insect attack;
- Lack of nitrogen fixing legumes;
- Insufficient density and diversity of long lived plants (e.g. overstorey trees);
- Lack of organisms involved in litter breakdown (e.g. fungal fruiting bodies) and nutrient cycling (e.g. puff balls);
- Predation;
- Evidence of drought effects or storm damage;
- In appropriate plant species density and diversity;
- Poor soil and/or landscape preparation; and
- Weed competition.

7.6.1 Threats to Rehabilitation

Unpredictable events such as bushfires, droughts and floods may present risks to rehabilitation both during the life of mine and post closure. These events generally have significant consequences for rehabilitation quality and are likely to require adaptive management in order to mitigate risks and achieve relinquishment of affected rehabilitation areas within a satisfactory timeframe.

Although these events may have a high degree of unpredictability, monitoring the status of contributing factors enables an assessment of the likelihood of a major impact to rehabilitation occurring. For example, measuring fuel loads in and adjacent to woodland rehabilitation areas informs a periodic assessment of the likelihood of a bushfire event.

Other major risks to rehabilitation may not present as sudden events, but as an increasing impact over an extended period of time. For example evolution of regulator or community expectations regarding post mining land-uses may present a risk to achieving relinquishment, or increasing feral pest numbers may increase pressure on native fauna and vegetation communities.

Key threats to rehabilitation were identified in the Risk Assessment (**Appendix E**) and as stated in the MOP (2019) are listed in **Table 7-1**.

Table 7-1 Key Threats to Rehabilitation

Threat	Caused by
Erosion and Sediment Control	Rainfall events Lack of appropriate vegetation cover Failure of water management structures
Acid Mine Drainage	Poor knowledge of material that may result in AMD. Poor management of the materials that have a propensity to AMD
Spontaneous Combustion	Poor management of materials with propensity for spontaneous combustion
Geotechnical	Geotechnical failure
Soil Type(s) and Suitability	Inadequate topsoil available Poor topsoil quality Weed infested topsoil Poor recovery of topsoil from currently rehabilitated areas
Flora and Fauna	Failure to manage weeds Pest species / grazing pressures (kangaroos, rabbits etc.)
Bushfire	Proximity to state forest
Contaminated Land	Long term use of the site Spills, leaks etc.

7.6.2 Trigger Action Response Plan

The following TARP (**Table 7-2**) for rehabilitation has been developed to identify required management actions in the event of impacts to rehabilitation, or where rehabilitation outcomes are not achieved in an acceptable timeframe. Where necessary, rehabilitation procedures will be amended accordingly with the aim of continually improving rehabilitation standards. TCPL will notify the DRG and other relevant stakeholders of any incident resulting in major impacts to rehabilitation.

The responses specified within the TARP have been based upon the rehabilitation completion criteria developed during the preparation of the MOP and the current rehabilitation monitoring program. Monitoring of the TARP will be undertaken as outlined in **Section 7.4**. The rehabilitation monitoring program will trigger response actions, as specified in the TARP to ensure that threats to rehabilitation do not become unmanageable.

The TARP is provided as **Table 7-2**, and will be reviewed and may be revised as conditions at TCPL change or new threats to rehabilitation are identified.

First Tier Triggers

First tier triggers are intended to detect early indications that rehabilitation is not trending toward desired completion criteria.

Second Tier Triggers

Quantitative or quantitative trigger values for key indicators will be developed and documented for both the Project Area. Trigger values will be developed based on monitoring program outcomes, including rehabilitation areas, and selected analogue sites.

Table 7-2 Trigger Action Response Plan for Rehabilitation at the TCM

Aspect/ Category	Key Element	Element Number	Trigger Response	1st Level Trigger	2nd Level Trigger
Landform stability	Slope gradient	1	Trigger	<70% of the rehabilitation area has slopes within the limits stipulated in the MOP.	<55% of the rehabilitation area has slopes within the limits stipulated in the MOP.
			Response	Undertake re-grading and revegetation of the area.	Undertake a review of the landform design, including survey if required. Undertake re-grading and revegetation of the area.
	Erosion control	2	Trigger	Minor gully or tunnel erosion present and/or minor rilling (rilling up to 200 mm in depth or width).	Slumping and/or significant gully or tunnel erosion present and/or significant rilling, which is compromising landform.
			Response	An inspection of the site will be undertaken by a suitably trained person. Investigate opportunities to install water management infrastructure to address erosion. Remediate as appropriate.	Engage suitably qualified person(s) to assist with the management of erosion and sedimentation at the site and provide recommendations to appropriately remediate the erosion. Remediate as soon as practicable.
	Water management Structures	3	Trigger	Water management structures (sediment dams, channels, contour banks) minor erosion and/or scouring as determined by monitoring.	Water management structures fail or display significant scouring / erosion as determined by monitoring.
			Response	An inspection of the site will be undertaken by a suitably trained person. Identify remedial actions such as amelioration, re-vegetation or alternative scour protection	Engage a suitably qualified person to develop a site specific remediation plan and review water management structure design criteria. Provide for physical works on the basis of design review.
Soil/spoil Quality	Salinity	4	Trigger	Increasing trend in soil/water salinity levels	Presence of salt scalds

Aspect/ Category	Key Element	Element Number	Trigger Response	1st Level Trigger	2nd Level Trigger
			Response	Undertake soil/spoil testing to verify EC and recommend further soil / spoil amelioration	Engage a specialist consultant suitably qualified person to develop a site specific management report to be implemented to remediate salinity scalds. Undertake works as required.
	Spoil surface layers chemical characteristics	5	Trigger	Increasing trend in soil dispersivity (EAT)	Soil are moderately to highly dispersive
			Response	Undertake testing to determine required amelioration and undertake amelioration as required.	Review material handling practices to confirm that non-dispersive spoil is selectively dumped at final RL where possible and /or dispersive spoils emplaced at surface are appropriately ameliorated. Ameliorate dispersive spoils (for example with coarse gypsum) to a depth of 300 mm. Re-vegetate if required.
	Soil biophysical and chemical characteristics	6	Trigger	Soil nitrogen, potassium and phosphorous levels are not in the range of analogue sites by Year 5	Soil physical, chemical and biological characteristics are not able to sustain the desired final land use.
			Response	Engage a consultant to recommend appropriate soil/spoil amelioration. Undertake amelioration and re-vegetation in accordance with the consultant recommendations.	Engage a consultant to recommend appropriate soil/spoil amelioration. Undertake amelioration and re-vegetation in accordance with the consultant recommendations.

Aspect/ Category	Key Element	Element Number	Trigger Response	1st Level Trigger	2nd Level Trigger
	Topsoil Depth	7	Trigger	Topsoil is not reinstated to, at least, the minimum depth specified for the proposed final land use.	Sufficient suitable topsoil cannot be identified for reinstatement at the minimum specified depth for the proposed final land use ie 1.5m (agriculture areas), 0.2m (other disturbance areas).
			Response	Top dress with additional suitable topsoil resource. If additional suitable material is not immediately available stabilise the area with cover crop until additional suitable topsoil is sourced and re-emplaced.	Undertake a review of the topsoil balance to confirm sufficient material to meet minimum depth requirements. Investigate suitable topsoil resource substitutes and introduce if required.
Biodiversity (native vegetation areas)	Native Species Richness	8	Trigger	Less than 50% of species sown recorded.	Less than 25% of species sown recorded.
			Response	Undertake a field survey to identify which species not present in revegetation areas. Re-seed or maintenance planting of revegetation areas with unsatisfactory species richness.	Engage a suitably qualified person to investigate causes for revegetation failure and recommend remedial actions. Implement appropriate management actions including revising rehabilitation procedures if required.
	Native Groundcover	9	Trigger	Less than 50% of groundcover species sown recorded.	Less than 25% of groundcover species sown recorded.
			Response	Undertake a field survey to identify likely causes of unsatisfactory germination rates. Re-seed areas with unsatisfactory cover. Review seeding procedures incl. seasonal mixes, timing and seed rate per hectare.	Engage a suitably qualified person to investigate causes for germination failure and recommend remedial actions. Implement appropriate management actions including revising rehabilitation procedures if required.

Aspect/ Category	Key Element	Element Number	Trigger Response	1st Level Trigger	2nd Level Trigger
	Exotic Plant Cover (Weeds)	10	Trigger	Increasing number and cover of exotic species and/or occurrence of newly identified exotic species.	More than 10% of domain area and/or significant weed invasions.
			Response	Engage weed management contractor to remove / spray introduced weed species.	Engage weed management contractor to remove introduced weed species. Investigate management measures to improve native plant establishment and weed suppression including additional soil amelioration, establishment and retention of cover crops until weed presence is at acceptable levels. Implement recommendations as appropriate.
Water Quality	Water quality	11	Trigger	Water quality exceeds baseline values	Long term trend outside ANZECC quality guideline limits values
			Response	Review and investigation of water quality monitoring and management where appropriate. Implement relevant remedial measures where required.	Hydrologist (or similar specialist) to review sampling and climate data and review likely cause(s). If mine related, undertake assessment to identify sources of water quality degradation and recommend remedial actions Implement specialist recommendations
	Discharge water quality at licence discharge points	12	Trigger	Sediment basin discharge exceeds EPL criteria for pH, TSS and/or oil/grease	Long term trend outside ANZECC quality guideline limits
			Response	Re-sampling will be undertaken during the next discharge event to confirm results exceed limits, and investigate potential causes.	Review sediment basin maintenance and discharge procedures, and sediment basin capacity requirements. Undertake required corrective actions.

Aspect/ Category	Key Element	Element Number	Trigger Response	1st Level Trigger	2nd Level Trigger
Soil	Topsoil Depth	13	Trigger	Topsoil is not reinstated to, at least, the minimum depth specified for the proposed final land use.	Sufficient suitable topsoil cannot be identified for reinstatement at the minimum specified depth for the proposed final land use ie 1.5m (agriculture areas), 0.2m (other disturbance areas).
			Response	Top dress with additional suitable topsoil resource. If additional suitable material is not immediately available stabilise the area with cover crop until additional suitable topsoil is sourced and re-emplaced.	Undertake a review of the topsoil balance to confirm sufficient material to meet minimum depth requirements. Investigate suitable topsoil resource substitutes and introduce if required.
REA - Landform Stability	Reshaping of coarse rejects stockpile with dozers	14	Trigger	Material becomes wet/soft resulting in possible loss of traction or bogging	N/A
			Response	Based on investigation, remediate area if possible or determine alternate course of action in consultation with MEM.	N/A
			Trigger	Surveyor/OCE identifies non-compliance with design surface.	N/A
			Response	OCE/MEM/Surveyor to investigate reason for non-compliance and make any necessary adjustments to implementation process.	N/A
			Trigger	Hot zone exposed by dozer.	N/A
			Response	Determine possible extent of hot zone and remediation plan. A JHA must be performed in conjunction with remediation plan.	N/A
		15	Trigger	Cracks appear on live tip head	N/A

Aspect/ Category	Key Element	Element Number	Trigger Response	1st Level Trigger	2nd Level Trigger
	Dumping of inert Overburden Material over reshaped rejects		Response	Determine if cracking likely to deteriorate and extend to the 5m offset rear dump windrow. If so, cut this section of dump down with dozer and re-establish tip-head. If not, continue to monitor by dozer operator.	N/A
			Trigger	Rejects stockpile toe slumps.	N/A
			Response	Establish survey monitoring of slumped area and monitor for movement. MEM to contact a geotechnical expert to undertake investigation and determination of remedial actions.	N/A
REA – Monitoring of Landform	Monitoring of initial landform (prior to life of mine landform establishment)	16	Trigger	Movement of overburden capping is detected through monthly survey monitoring.	N/A
			Response	Based on survey monitoring results, MEM to determine course of action which may involve advice from geotechnical expert.	N/A
			Trigger	Cracking is detected on surface of overburden capping	N/A
			Response	Based on monitoring results, MEM to determine course of action which may involve advice from geotechnical expert.	N/A
			Trigger	Presence of spontaneous combustion evident in encapsulation area (smoke/odour)	N/A

Aspect/ Category	Key Element	Element Number	Trigger Response	1st Level Trigger	2nd Level Trigger
			Response	Based on investigation, MEM to determine remedial actions to arrest and control spontaneous combustion source.	N/A
	Monitoring of final landform (mine still active)	17	Trigger	Slumping/Cracking occurs exposing coarse rejects stockpile to oxygen source	N/A
			Response	MEM to investigate severity of cracking and remediation works required	N/A
			Trigger	Presence of spontaneous combustion evident in encapsulation area (smoke/odour)	N/A
			Response	MEM to investigate severity of spontaneous combustion and remediation works required	N/A
	Monitoring of final landform (after mine closure)	18	Trigger	Slumping/Cracking occurs exposing coarse rejects stockpile to oxygen source	N/A
			Response	Group Manager – Environment to investigate and determine remediation works required. (MEM to be included in process if mine still under his/her statutory control)	N/A
			Trigger	Failure of rehabilitation ie vegetative cover less than 70%	N/A
			Response	Group Manager – Environment to investigate and determine remediation works required. (MEM to be included in process if mine still under his/her statutory control)	N/A

Aspect/ Category	Key Element	Element Number	Trigger Response	1st Level Trigger	2nd Level Trigger
			Trigger	Presence of spontaneous combustion evident in encapsulation area (smoke/odour)	N/A
			Response	Group Manager – Environment to investigate and determine remediation works required. (MEM to be included in process if mine still under his/her statutory control)	N/A

8 REVISION, AUDITING AND REPORTING OF IMPLEMENTATION OF THE MSRP

The MSRP will be subject to reporting procedures and regularly audited in order to demonstrate compliancy with approval conditions, review the progress of management actions implemented, and to review the adequacy of the document. Recommendations made available through the auditing and reporting procedure will be used to update rehabilitation, decommissioning and mine closure practices at the TCM. This section summarises the reporting that will be completed for the MSRP and the revisions and audits that will or may be prepared.

8.1 REVISION OF THE MSRP

The MSRP may be reviewed and revised from time to time. In accordance with Condition 34 of the Commonwealth approval EPBC 2011/5923, if TCPL wishes to carry out any activity otherwise than in accordance with the MSRP (as it pertains to Commonwealth approval EPBC 2011/5923), TCPL will submit a revised MSRP to DotE for the Minister's written approval.

8.1.1 Revision of the MSRP to be consistent with the MOP/Rehabilitation Management Plan

In accordance with Condition 64 of Schedule 3 of State approval PA 11_0047 (MOD 1), a Rehabilitation Management Plan will be prepared and implemented. This MSRP has been prepared to be consistent with the rehabilitation component of the MOP, developed to meet Condition 64 of Schedule 3, which covers the period from November 2015 to December 2020.

TCPL will review and revise this MSRP as necessary during the life of the TCM to ensure that it is consistent with the MOP. Each revision of the MSRP will be submitted to the DotE for the Minister's written approval.

8.1.2 Other Triggers for Revisions to the MSRP

In accordance with Condition 35 of Commonwealth approval EPBC 2011/5923, if the Minister believes that it is necessary or convenient for the better protection of listed threatened species and communities or listed migratory species to do so, the Minister may request TCPL to make specified revisions to the MSRP and submit the revised plan for the Minister's written approval.

8.2 REPORTING AND AUDITING

In accordance with Condition 38 of Commonwealth approval EPBC 2011/5923, the MSRP will be published on Whitehaven's website. Any revisions to the MSRP will be published on the website within one month of being approved.

In accordance with Condition 26 of Commonwealth approval EPBC 2011/5923, the findings of the independent review of this MSRP (**Section 1.5**) will be published on the website.

The TCM Annual Review (**Section 7.4**) will be the process by which to report annually to DoEE the progress of rehabilitation management actions undertaken and the outcome of those actions, and the mechanisms to be used to identify the need for improved management in accordance with Condition 25 e of the Approval Decision EPBC 2011/5923.

8.2.1 Commonwealth Approval Compliance Reports

A report pertaining to the annual compliance with Commonwealth approval EPBC 2011/5923 will be published on Whitehaven's website by the 12th June each year after the commencement of the TCM in accordance with Condition 32 of the Commonwealth approval EPBC 2011/5923. Non-compliance with any of the conditions will be reported to DotEE at the same time as the compliance report is published.

8.2.2 Recording Survey Data and Other Information

In accordance with Condition 30 of the Commonwealth approval EPBC 2011/5923, survey data will be recorded so as to conform to data standards notified from time to time by DotEE. When requested by the DotEE, TCPL will provide all species and ecological survey data and related survey information from ecological surveys undertaken for MNES. This survey data will be provided within 30 business days of request, or in a timeframe agreed to by DotEE in writing.

In accordance with Condition 37 of the Approval Decision EPBC 2011/5923, TCPL will maintain accurate records substantiating all activities and outcomes associated with or relevant to Commonwealth approval EPBC 2011/5923, including measures taken to implement this MSRP, and make them available upon request to the DotEE.

8.3 INDEPENDENT AUDITS

In accordance with Condition 33 of the Commonwealth approval EPBC 2011/5923, upon the direction of the Minister, TCPL will ensure that an independent audit of compliance with the conditions of the Commonwealth approval is conducted and a report submitted to the Minister. The independent auditor will be approved by the Minister prior to the commencement of the audit. Audit criteria will be agreed to by the Minister and the audit report will address the criteria to the satisfaction of the Minister.

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APPENDIX A

INDEPENDENT ECOLOGIST REVIEW REPORT

ANU enterprise

Independent Review of the

TARRAWONGA MINE SITE REHABILITATION PLAN

Conducted by Dr David Freudenberger for
ANU ENTERPRISE PTY LIMITED
Canberra, ACT
30 May 2016

Review Scope

Whitehaven Coal Ltd has developed the *Tarrawonga Coal Mine Mine Site Rehabilitation Plan* (30 May 2016) as specified in approval 2011/5923; Conditions 19 to 29 of the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999. The *Plan* details the rehabilitation of disturbed mine landforms to effectively restore potential habitat for the Regent Honey Eater (*Anthochaera phrygia*), the Swift Parrot (*Lathamus discolour*), the Greater Long-eared Bat (*Nyctophilus corbeni*), and White Box – Yellow Box – Blakely's Red Gum Grassy Woodland and derived Native Grassland Critically Endangered Ecological Community. The *Plan* also details the rehabilitation of Class 3 Agricultural Land as required under Condition 61 of Schedule 3 of MP 11_0047 (MOD 1).

The Commonwealth Approval includes the requirement that "*The mine site rehabilitation plan must be subject to an independent review by a qualified ecologist prior to being submitted to the Minister for Approval. The findings of the independent review must be published on the proponent's website* (Condition 28). ANU Enterprises was engaged by Whitehaven Coal to undertake this review that was performed by Dr David Freudenberger, a senior ecologist and Board Member of the Society of Ecological Restoration Australasia.

Review Framework

The review was conducted using the over-arching ecological framework of Noss (1991) which recognises that ecosystems have *functional, structural and compositional* attributes (characteristics) at multiple scales. The Tongway and Ludwig (2011) framework of how landscapes function and their "Principles for Restoring Landscape Functionality" were also used to guide this review. *The National Standards for the Practice of Ecological Restoration in Australia* (SERA 2016) were used to assess the quality of planning. The practical restoration guides by Munro and Lindenmayer (2011) and Rawlings et al. (2010) were used to help assess the adequacy of specific rehabilitation methodologies described in the Rehabilitation Plan.

The first phase of the review examined the draft *Plan* and made numerous suggestions for clarification or correction. These are shown in Appendix A of the final *Plan*. The revisions in the final *Plan* (30 May 2016) were then reviewed for acceptability.

Review Findings

The *Tarrawonga Coal Mine Mine site Rehabilitation Plan* provides a broad and ecologically sound framework for informing and guiding more detailed annual Mine Operational Plans. This *Rehabilitation Plan* also provides a sound framework for regular assessments of progress in rehabilitating the final landforms of the mine site.

Rehabilitation objectives (Table 3-2) are rather broad as they refer to overarching domains (e.g. infrastructure areas, final void and woodland rehabilitation areas). However there is high degree of specificity stated in the Rehabilitation Completion Criteria (Table 3-4). It is particularly significant that these Completion Criteria include quantitative comparisons with benchmark values from "analogue sites" (reference sites).

The *Plan* provides suitable guidance for targeting plants for restoring to final landforms. The *Plan* acknowledges that different woodland and open forest communities should be targeted to appropriate slopes and drainages (e.g. Table 5-3). The Plan also acknowledges recent research that genetic plant provenances from drier regions should be included in rehabilitation seed mixes which has been termed a "climate-adjusted seed provenances strategy" (Prober et al. 2015). Addressing climate change is particularly important for selecting seed for eucalypts which can live to over 200 years.

There are a great many operational and environmental threats and uncertainties when rehabilitating mined surfaces. These are identified in a comprehensive Risk Assessment (Appendix E). The *Trigger Action Response Plan* (Table 7-2) provides a comprehensive risk management strategy across a wide range of rehabilitation elements.

The *Plan* provides a monitoring and assessment strategy that includes the importance of monitoring both rehabilitation and analogue (reference) sites on an annual basis. The *Plan* properly recognises that rehabilitation is a long term process that should aim for continuous improvement and adaptive management.

Review Recommendations

This review recommends to the relevant Authority that the *Tarrawonga Coal Mine Mine Site Rehabilitation Plan* (30 May 2016) is ecologically sound and provides clear guidance for the short, medium and long-term rehabilitation of this mining lease.

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APPENDIX B

IMPLEMENTATION ACTION PLAN

Action	Section
1. The RMP will define the objectives for the Box-Gum Woodland EEC.	3.3
2. The RMP will discuss an adaptive management framework and monitoring programme for the management of the Box-Gum Woodland EEC.	7.6
3. The RMP will include monitoring of landscape function.	7.4
4. The RMP will describe roles for suitability qualified personnel (e.g. restoration ecologist to provide direction about the rehabilitation and restoration of the Box-Gum Woodland EEC).	5
5. The RMP will describe how the batter slopes have been designed to minimise instability of the final landform.	5.2.1
6. The RMP will provide for soil surveys and inventories to be undertaken prior to soil stripping (consistent with Condition 25[c] of the Approval Decision EPBC 2011/5923).	4.3
7. The RMP will provide for selective identification and placement (burial) of potentially acid forming interburden materials.	5.2.1
8. The RMP will provide for selective identification and placement (burial) of soils unsuitable for use as a growth media.	5.2.1
9. The RMP will provide soil handling processes for removal, storage and re-layering of topsoil and subsoil (consistent with Condition 25[d] of the Approval Decision EPBC 2011/5923). This will specifically detail the stripping of topsoil likely to contain seeds.	4.1
10. The RMP will provide for annual soil balances to be undertaken to facilitate management of soil handling.	4.3
11. The RMP will provide options for minimising the risk of erosion including treatment of dispersive soils and spoils, as well as use of use of structural erosion controls (e.g. channel banks, slope drains and energy dissipaters).	5.2.4
12. The RMP will describe minimum topsoil and subsoil depths for revegetation (consistent with Condition 25[c] of the Approval Decision EPBC 2011/5923).	4.3
13. The RMP will describe the incorporation of vegetative material (cleared at the mine site) into the soil used for rehabilitation or as mulch.	3.4.1
14. The RMP will provide parameters for the physical and chemical characteristics of topsoils and overburden based on likely suitable characteristics for establishment of Box-Gum Woodland.	5.2.2
15. The RMP will provide for soil testing to be undertaken on topsoil and overburden to identify issues with physical and chemical characteristics as well as determine amelioration requirements and rates.	5.2.3
16. The RMP will describe options for ameliorating soils to improve the suitability of the soils as a growth media (e.g. amelioration with agricultural gypsum, compost [i.e. mulch saved during clearing activities] or native plant fertilisers depending on the nutrient deficiency).	5.2.3
17. The RMP will describe site preparation (e.g. ripping or use of spiked rollers) to reduce soil compaction impacting the success of the revegetation.	5.2.2
18. The RMP will consider the use of benign (hard rock) mulch to stabilise batter surfaces that has been sourced onsite (i.e. salvaged from clearing areas or from waste material).	5.2.4
19. The RMP will describe research that will aim to identify effective methodologies for achieving rehabilitation and revegetation of Box-Gum Woodland on the mine rehabilitation.	7.5
20. The RMP will provide for soil seed bank germination testing to be undertaken on topsoil stockpiles, possibly by monitoring in-field what species germinate and at what densities from the surface of soil stockpiles.	4.2
21. The RMP will provide for rehabilitation trials (focusing on rehabilitation and revegetation of Box-Gum Woodland) to be undertaken on different rehabilitation substrates.	7.5

Action	Section
22. The RMP will describe procedures for strategic and long term seed collection, management (including pre-treatment) and storage following the relevant Florabank guidelines. The RMP will describe procedures for sowing seed (e.g. appropriate sowing depths).	5.2.10
23. The RMP will describe a seed and tube stock supply strategy including calculation of the amount and species of seed and tube stock required each year and how the seed and tube stock will be sourced and managed to meet the demand.	5.2.9
24. The RMP will provide for the preferential use of local endemic (adapted) species, however consideration would be given to the use of a high quality seed source further from the site over a low quality more local seed source.	5.2.9
25. The RMP will provide for establishing vegetation cover as soon as practicable following disturbance to minimise the potential for erosion and weeds. This will involve the application of a temporary cover crop (or native grasses) using species that are not likely to impede revegetation of the Box-Gum Woodland.	5.2.5
26. The RMP will provide options for remediating erosion including adjust seed and planning densities to maximise ground cover.	5.2.4
27. The RMP will describe that vehicle access will be predominantly restricted to designated tracks on mine landforms that have been revegetated to minimise ground disturbance (e.g. compaction).	5.2.2
28. The RMP will provide for selective use of slow-release native plant fertiliser to promote plant growth (if required).	4
29. The RMP will provide for the use of fresh topsoil where possible and practical.	5.2.2
30. The RMP will describe a contingency for supplementary seeding/tube stock planting if the regeneration from the soil seed bank is not sufficient.	5.2.10
31. The RMP will provide application rates for seeds as well as planting densities for tube stock to avoid excessive shading.	5.2.9
32. The RMP will provide measures to improve understorey diversity (e.g. replanting, causing disturbance through fire or grazing).	5.2.10
33. The RMP will describe that revegetation at the mine would not be cleared (unless for ecological thinning, maintenance or ecological monitoring).	5.2.10
34. The RMP will include provision to assess vegetation density and undertake ecological thinning (e.g. through selective clearance or fire) if necessary.	5.2.10
35. The RMP include sowing of Kangaroo Grass (as this species has been known to out-compete annual grass weeds and provide inter tussock spaces for a diversity of ground cover species [eg. wildflowers]).	5.2.8
36. The RMP will describe that seed and tube stock used in revegetation will include a variety of grasses (including tussock grass species), low shrubs, midsized shrubs, native herbs, native forbs and tall trees to create structurally diverse habitat.	5.2.8
37. The RMP will include the planting of Acacia species, including both tree and shrub varieties.	5.2.8
38. The RMP will include the planting (in appropriate soil landscapes) of a variety of box, ironbark and gum eucalypt species, these may include: - White Box (*Eucalyptus albens*); - Yellow Box (*E. melliodora*); and - Blakely's Red Gum (*E. blakelyi*).	5.2.8
39. The RMP will provide an option for using tree guards to protect young seedlings from browsing or grazing native animals.	Table 3.4
40. The RMP will describe how livestock will be excluded from areas undergoing active revegetation (i.e. planting or seeding).	5.2.10

Action	Section
41. The RMP will describe how the growth and survival of the vegetation sown or planted will be monitored.	5.2.8
42. The RMP will aim to include a wide diversity of species in the seed mix.	5.2.8
43. The RMP will include hygiene protocols to minimise the risk of plant diseases (i.e. restricting site access).	5.2.10
44. The RMP will include provision to review the need for kangaroo control measures.	7.6.1
45. The RMP will describe procedures to reuse bush rocks salvaged during vegetation clearance.	3.4.1
46. The RMP will describe procedures to reuse timber/hollow logs salvaged during vegetation clearance, including: - placement of hollow limbs or artificial hollows in some select trees without hollows; and - use of artificial stag trees on the mine rehabilitation.	5.2.1
47. The RMP will describe procedures to prevent, monitor and control feral animals (including feral pigs, goats, rabbits and foxes).	7.6.1
48. The RMP will provide methods for the safe use of pesticides.	5.2.10
49. The RMP will describe procedures to prevent, monitor and control weeds. The RMP will also describe relevant targets and performance indicators for weed management (consistent with Condition 25[a] of the Approval Decision EPBC 2011/5923)	7.6.1
50. The RMP will provide methods for the use of herbicides (minimised through spot-spraying, basal spraying, stem injection or cut and paint application methods).	5.2.10
51. The RMP will describe measures to prevent fires, such as maintaining fire breaks and access (i.e. no controlled burns would be undertaken on the mine rehabilitation whilst vegetation is establishing).	7.6.1
52. A comprehensive seed supply strategy will be developed and incorporated into the revised MOP.	5.2.8

APPENDIX C

LAND DISTURBANCE PROTOCOL (most recent version)

TARRAWONGA COAL MINE

LAND DISTURBANCE PROTOCOL FORM

LDP Number: (Env. Department only)	

FOR COMPLETION & STAGED SIGN-OFF PRIOR TO UNDERTAKING ANY DISTURBANCE, THEN FINAL SIGNOFF AT COMPLETION OF WORKS

Note: The below form is to be completed by the Environmental Department or contractor and signed by the TCM Environmental Officer and Site Manager prior to the commencement of all proposed land disturbance works.

Name of Operator /Contractor	
Position/s	
Name/s of Person Responsible	
Company	

Description of Work to be Undertaken	
Describe any access constraints that require consideration	
Date Scheduled to Commence	
Scheduled Date of Completion	
Duration of Works	

ATTACHMENTS

To be reviewed by: Construction Supervisor/Site Manager(s) responsible for all disturbance and clearing activity

Please check the following has been attached as required:

Design Plans
Sediment and Erosion Control Plans
Excavation Permit
Dial Before you Dig

Map(s) clearly indicating:

- LDP boundary;
- Disturbance footprint;
- Proposed access tracks
- Sensitive flora and fauna habitat boundaries;
- Adjacent water ways;
- Above and underground utility services;
- Identified Aboriginal sites (including scar trees identified by pre-clearance surveys); and
- Location of habitat trees, boulders and other habitat resources which will be salvaged for use in rehabilitation/restoration activities.

Please list any other supporting documentation or attachments in the order provided

Name	
Position	
Signature	
Date	

1.0 PROPOSED DISTURBANCE ACTIVITY LOCATION

To be reviewed by: Construction Supervisor/Site Manager(s) responsible for all disturbance and clearing activity

GPS Coordinates		Disturbance Area (Ha)	
Landholder Name		Lot / Plan/Tenement	
Property Name		Local Council	
Tenure			

Is the area to be disturbed clearly demarcated for site inspections to be undertaken?

Name	
Position	
Signature	
Date	

2.0 EXCAVATIONS AND SERVICES

To be reviewed by: Construction Supervisor/Site Manager(s) responsible for all disturbance and clearing activity

Is an excavation or penetration to a depth of 150 mm or greater below ground level required for any of the associated works (ERSED control work, pits, footings, cuttings etc.)?

If YES an excavation permit and associated Dial Before You Dig/Utility Clearance Survey is required

Has an excavation permit and dial before you dig been completed?

Are you satisfied that the proposed works will not interfere with any existing power, water or telecommunication lines?

Has a subsurface utility clearance survey of the area been undertaken to locate and mark identified utilities?

If no, please provide details on items that may be impacted by the proposed disturbance activities and attach a map showing services:

List any mitigation measures to be implemented to avoid risks involved with nearby power, water, gas or telecommunication lines:

Name	
Position	
Signature	
Date	

3.0 PLANNING APPROVALS / ENVIRONMENTAL

To be reviewed by: Environmental Officer

3.1 Introduction

Are access arrangements in place with the Landholder?

If no, then works cannot commence until arrangements are in place. Advise person responsible for activity. What action(s) need to be taken?

Do the proposed works adhere to the conditions of the Occupation Agreement (Forests NSW)?

If no, then works cannot commence until works meet conditions of Occupation Agreement. Advise person responsible for activity. What action(s) need to be taken to meet Occupation Agreement conditions?

Are the proposed works in accordance with the Project Approval?

If no, then works cannot commence until works meet conditions of Project Approval. Advise person responsible for activity. What action(s) need to be taken to meet Project Approval conditions?

Are the proposed works in accordance with the approved Environmental Management Plans?

If no, then works cannot commence until works meet requirements of approved Environmental Management Plans. Advise person responsible for activity. What action(s) need to be taken to meet requirements of Environmental Management Plans?

Are the proposed works in compliance with the MOP?

If no, then works cannot commence until works meet requirements of MOP. Advise person responsible for activity. What action(s) need to be taken to meet requirements of MOP?

Are there any outstanding complaints in regards to this disturbance activity?

If yes, then works cannot commence until complaints have been responded to. Advise person responsible for activity. What action(s) need to be taken?

Name	
Position	
Signature	
Date	

3.2 Fauna and Flora

To be reviewed by: Environmental Officer

Ensure key vegetation clearance criteria are met:-

- *Vegetation removal only to be undertaken between 15th February and 30th April,*
- *Clearing to cease when temperatures exceed 35°C.*

Ensure the proposed disturbance area has had a Fauna and Flora survey undertaken no greater than 4 weeks prior to commencement of disturbance.

Has a pre-clearance survey (including consideration of seasonality) been completed?

Date and type of survey

Fauna identified

Flora to be removed

Trees:

Key Native Species

Area to be cleared (approx.)

How many habitat trees were identified?

Have habitat trees been clearly marked throughout the area to be cleared?

Shrubs:

Key Native Species

Description

Cover

Groundcover:

Key Native Species

Description

Cover

Boulders/Other Features:

Number in area to be cleared (approx.)

How many boulders/other features with habitat potential were identified?

Have items of potential habitat value been clearly marked throughout the area to be cleared?

Describe how identified fauna should be managed

Describe how the felled timber should be managed:

Describe how habitat features marked for rehabilitation are to be managed/stored:

Identify any Management strategies or plans which detail mitigation techniques and methods to minimise harm.

Stage 1 Signoff: Environmental Officer to complete an inspection of the site to be disturbed and storage area to confirm that the above identified fauna habitat features have been labelled? *If yes, Stage 1 clearing activities can proceed (i.e. clearing of vegetation around labelled fauna habitat features), otherwise advise person responsible of remaining actions prior to signoff*:

Name	
Position	
Signature	
Date	

Stage 2 Signoff: On the day following Stage 1 clearing activities, identified habitat features are to be cleared using the procedure(s) described within the Biodiversity Management Plan.

Environmental Officer to record the details of the recovered habitat features and where they are stored to track reuse within rehabilitation/restoration activities. Has this been undertaken?

Name	
Position	
Signature	
Date	

3.3 Water, Sediment and Erosion Control

To be reviewed by: Environmental Officer

Confirm plan has been developed according to the requirements of the Water Management Plan?

Are there any potential issues associated with sediment and erosion prior to clearance?

Describe these issues:

a) Analysis of the drainage of the site to be cleared:

b) Potential for soil dispersivity/ erosivity:

c) Identify potential impacts to nearby creeks or drainage lines that may be impacted:

d) Other

Has the site Erosion and Sediment Control Plan been attached

Have clean water diversion drains been included in the Erosion and Sediment Control Plans for catchments upslope of proposed disturbance?

Are these diversion banks/structures considered adequate for the works being undertaken?

Have preliminary ERSED works (vegetation barriers, silt fencing etc.) been proposed and designed for installation prior to the construction of ERSED works requiring excavation?

Have all mitigation measures been completed and in working order prior to disturbance activity e.g. sediment dams, silt fencing, culverts

Preliminary Signoff: Environmental Officer to complete an inspection of the site and confirm erosion and sediment control mitigation and management measures have been completed to a satisfactory standard prior to any clearing commencing? *If yes, clearing activities can proceed, otherwise advise person responsible of remaining actions that need to be completed prior to signing off*:

Name	
Position	
Signature	
Date	

3.4 Soil Management

To be reviewed by: Environmental Officer

Soil Type(s)

Please describe any existing land degradation issues:

Has the top soil clarification assessment been undertaken?

Identify the soil resources to be separately stripped and stockpiled for reuse in rehabilitation.

Topsoil Depth (m)

Subsoil Depth (m)

For larger areas with varying soil profiles please attach a map identifying soil type and stripping procedures/depth.

Can topsoil be utilised directly on rehabilitation areas?

If no, provide details for topsoil stockpiling and any resources to be transported in accordance with the soil stripping and stockpiling strategy detailed in the Rehabilitation Management Plan.

Please detail any proposed mitigation measures to manage the possible impacts:

Name	
Position	
Signature	
Date	

3.5 Air Quality Management

To be reviewed by: Environmental Officer

Is a water cart readily available during disturbance activities?

Where will the water be sourced from?

Identify any potential impacts on air quality that may result because of land clearance and disturbance:

List mitigation measures to manage possible impacts:

Name	
Position	
Signature	
Date	

3.6 Acoustics Management

To be reviewed by: Environmental Officer

Are all works scheduled within approved work hours?

Has all the plant machinery and tools to be used onsite been serviced (or tagged) and fitted with the necessary attenuation equipment (e.g. exhaust silencers)?

Identify any potential environmental impacts on acoustics that may result because of land disturbance:

List mitigation measures to manage the possible impacts:

Name	
Position	
Signature	
Date	

3.7 Traffic Management

To be reviewed by: Environmental Officer

Will the proposed works impact upon the capacity of the public traffic network? (if **NO** please skip to next section)

If **YES**, has a Traffic Control Plan been prepared to the satisfaction of the relevant roads authority (Narrabri Shire Council and / or Roads and Maritime Services)?

Please detail any mitigation measures that have been put in place to minimise impacts to other workers:

Identify any other potential impacts as a result of increased traffic to sites of disturbance:

List mitigation measures to manage the possible impacts:

Name	
Position	
Signature	
Date	

3.8 Aboriginal and Cultural Heritage

To be reviewed by: Environmental Officer

Are the works to be undertaken within the vicinity of Significant Heritage Areas or culturally sensitive heritage areas (refer to Aboriginal Cultural Heritage Management Plan)?

If yes please notify the Environmental Officer and arrange a site inspection

If there are listed artefacts in the disturbance area, has the required salvage program been undertaken?

If yes, Environmental Officer to attach the completed Archaeological Clearance Works Sign Off Form. Clearing activities can then proceed.

Have all listed artefacts or culturally significant areas either been collected (as above) or adequately fenced off and is signage provided to limit disturbance?

If a relic was found has this been reported to the Heritage Council compliant with *Section 146* of the *Heritage Act?*

Identify any potential environmental impacts on Aboriginal and Cultural Heritage that may result because of land clearance and excavation:

List mitigation measures to manage the possible impacts

Preliminary Signoff: Attending Archaeologist (only where items identified)

Name	
Position	
Signature	
Date	

Preliminary Signoff: Environmental Officer

Name	
Position	
Signature	
Date	

3.9 Rehabilitation

To be reviewed by: Environmental Officer

Describe rehabilitation tasks that are required to be carried out in order to restore the land to previous conditions:

Preliminary Signoff: Environmental Officer to complete an inspection of the site to confirm that rehabilitation tasks have been completed to a satisfactory standard? *If yes, the LDP can be closed out in Section 5.0, otherwise advise person responsible of remaining actions that need to be completed prior to signing off*:

Name	
Position	
Signature	
Date	

4.0 AUTHORISATION SIGNOFF TO COMMENCE ACTIVITY

To be completed by: Environmental Officer and Site Manager:

The Environmental Officer and Site Manager to complete an inspection of the site and review the contents of this LDP (including preliminary signoff sections in green that must be completed) to confirm that activities within this LDP can commence.

Recommendations/Outcomes from the LDP that need to be addressed during conduct of activities

Can the proposed works proceed according to the Information and Plans presented in this LDP?

If no, Environmental Manager to refuse application, with a new LDP to be completed for the activity with the required information.

Environmental Officer:	
Signature:	
Date:	
Site Manager:	
Signature:	
Date:	

5.0 WORKS COMPLETED

To be completed by: Environmental Officer

Outcomes from activity:

Environmental Officer:	
Signature:	
Date:	
Site Manager:	
Signature:	
Date:	

APPENDIX D
SOIL SURVEY AND GROWTH MEDIA INVENTORY FOR REHABILITATION AREA 1

ATTACHMENT B

AGRICULTURAL RESOURCE ASSESSMENT: "TARRAWONGA COAL PROJECT', BOGGABRI, NSW (MCKENZIE SOIL MANAGEMENT, 2011)

October 2011

Agricultural Resource Assessment: "Tarrawonga Coal Project", Boggabri NSW

Prepared for Whitehaven Coal Mining Pty Ltd.

Dr. David McKenzie
McKenzie Soil Management Pty. Ltd.
Orange NSW

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1 INTRODUCTION

1.1 Background

The Tarrawonga Coal Mine is an open cut mining operation located approximately 15 kilometres (km) north-east of Boggabri and 42 km north-northwest of Gunnedah in New South Wales (NSW) (Figure 1). Tarrawonga Coal Pty Ltd (TCPL) is the owner and operator of the Tarrawonga Coal Mine, which is a joint venture between Whitehaven Coal Mining Pty Ltd (Whitehaven) (70% interest) and Boggabri Coal Pty Ltd (a wholly owned subsidiary of Idemitsu Australia Resources Pty Ltd) (30% interest). The Tarrawonga Coal Mine commenced operations in 2006 and currently produces up to approximately 2 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal.

The Tarrawonga Coal Project (the Project) would involve the continuation and extension of open cut mining operations at the Tarrawonga Coal Mine and would facilitate a ROM coal production rate of up to 3 Mtpa. The proposed life of the Project is 17 years, commencing 1 January 2013. This would extend the life of the currently approved operations at the Tarrawonga Coal Mine by approximately 12 years (i.e. until 2029).

The approximate extent of the existing and approved surface development (including open cut, mine waste rock emplacement, soil stockpiles and infrastructure areas) at the Tarrawonga Coal Mine are shown on Figure 2.

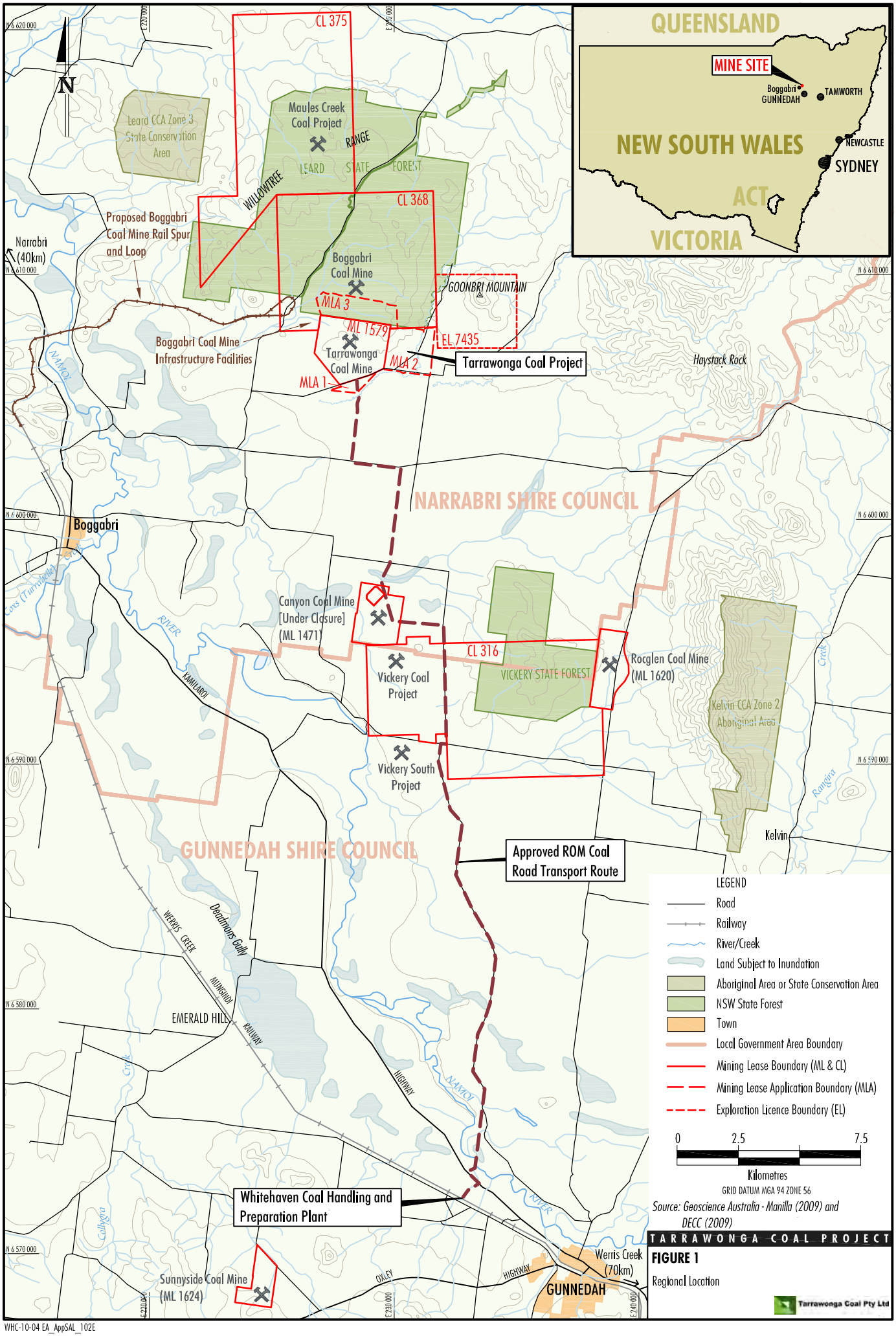
A detailed description of the Project is provided in Section 2 of the Main Report of the Environmental Assessment (EA).

1.2 Scope and Objectives

This assessment has been prepared to assist with addressing of the following components of the Director General's Environmental Assessment Requirements for the Project:

> ***Agricultural Productivity*** *– including:*
>
> - *a description of the agricultural resources (especially soils and water resources used or capable of being used for agriculture) and agricultural enterprises of the locality;*
> - *a detailed assessment of the potential impacts of the project on agricultural resources and/or enterprises of the locality;*
> - *a detailed description of the measures that would be implemented to avoid and/or minimise the potential impacts of the project on agricultural resources and/or enterprises of the locality, and*
> - *justification for any significant long term changes to agricultural resources, particularly if highly productive agricultural resources (eg alluvial lands) are proposed to be affected by the project;*

Additional detail on the water resources used or capable of being used for agriculture is provided in the Groundwater Assessment (Heritage Computing 2011) (Appendix A of the EA), Surface Water Assessment (Gilbert & Associates 2011) (Appendix B of the EA) and the Agricultural Resources and Productivity Assessment (Resource Strategies 2011) (Appendix I of EA).



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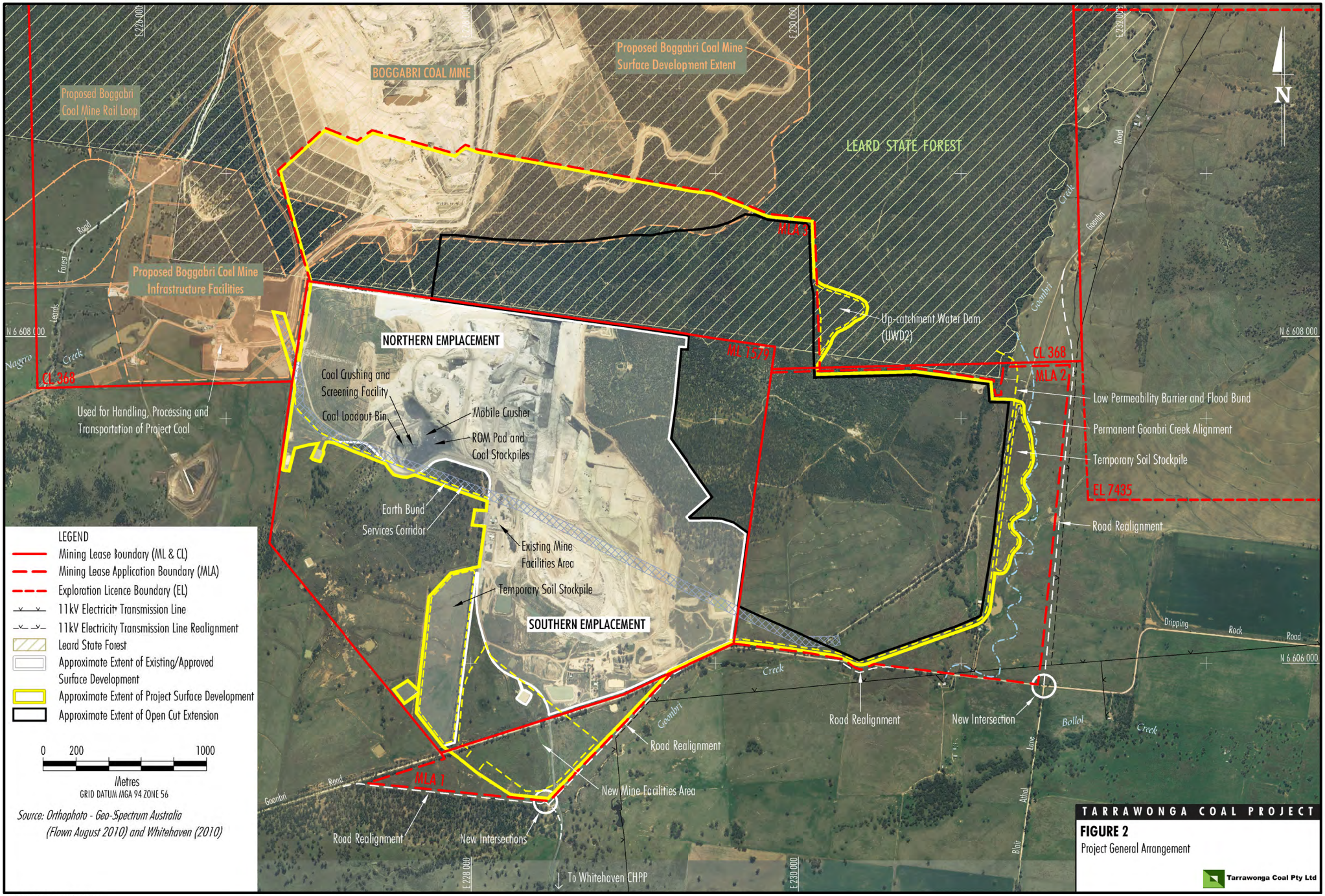

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The objectives of this study were to provide the following:

- Describe the agriculture resources and enterprises of the lands associated with the Project site.
- Estimate the post mining agriculture resources of the lands associated with the Project site.
- Recommend management measures for agriculture resources.

2 PROJECT OVERVIEW

The main activities associated with the development of the Project would include (Figure 2):

- continued development of mining operations in the Maules Creek Formation to facilitate a Project ROM coal production rate of up to 3 Mtpa, including open cut extensions:
  - to the east within Mining Lease (ML) 1579 and Mining Lease Application (MLA) 2; and
  - to the north within CL 368 (MLA 3) which adjoins ML 1579;
- ongoing exploration activities;
- construction and use of a services corridor (including haul road link) directly from the Project open cut mining operation to the upgraded Boggabri Coal Mine Infrastructure Facilities[1];
- use of upgraded Boggabri Coal Mine Infrastructure Facilities for the handling and processing of Project coal and the loading of Project product coal to trains for transport on the Boggabri Coal Mine private rail spur to the Werris Creek Mungindi Railway[1];
- construction and use of a new mine facilities area including relocation of existing mine facilities infrastructure and service facilities;
- use of an existing on-site mobile crusher for coal crushing and screening of up to 150,000 tonnes of domestic specification coal per annum for direct collection by customers at the mine site;
- use an existing on-site mobile crusher to produce up to approximately 90,000 cubic metres (m^3) of gravel materials per annum for direct collection by customers at the mine site;
- progressive backfilling of the mine void behind the advancing open cut mining operation with waste rock and minor quantities of coarse reject material;
- continued and expanded placement of waste rock in the Northern Emplacement (including integration with the Boggabri Coal Mine emplacement) and Southern Emplacement, as mining develops;
- progressive development of new haul roads and internal roads, as mining develops;
- realignment of sections of Goonbri Road and construction of new intersections;
- construction of an engineered low permeability barrier to the east and south-east of the open cut to reduce the potential for local drainage of alluvial groundwater into the open cut;
- removal of a section of Goonbri Creek within the Project open cut and the establishment of a permanent Goonbri Creek alignment and associated flood bund to the east and south-east of the open cut;

[1] Subject to approvals and upgrades being in place for the transfer of Project ROM coal to the Boggabri Coal Mine Infrastructure Facilities.

- progressive development of sediment basins and storage dams, pumps, pipelines and other water management equipment and structures;
- continued development of soil stockpiles, laydown areas and gravel/borrow areas;
- ongoing monitoring and rehabilitation; and
- other associated minor infrastructure, plant, equipment and activities.

The use of the Boggabri Coal Mine Infrastructure Facilities for the handling, processing and transportation of coal from the Tarrawonga Coal Mine would be authorised by an appropriately modified approval for the Boggabri Coal Mine.

The proposed life of the Project is 17 years, commencing 1 January 2013. This would extend the life of the currently approved operations at the Tarrawonga Coal Mine by approximately 12 years.

3 PROJECT SITE DESCRIPTION

The Project would be located within existing mining tenements ML 1579 and would extend into new MLA areas (MLA 1, MLA 2 and MLA 3) (Figure 2). MLA 3 would be located within the existing Coal Lease 368. The existing/approved Tarrawonga Coal Mine is located wholly within ML 1579 (Figure 2).

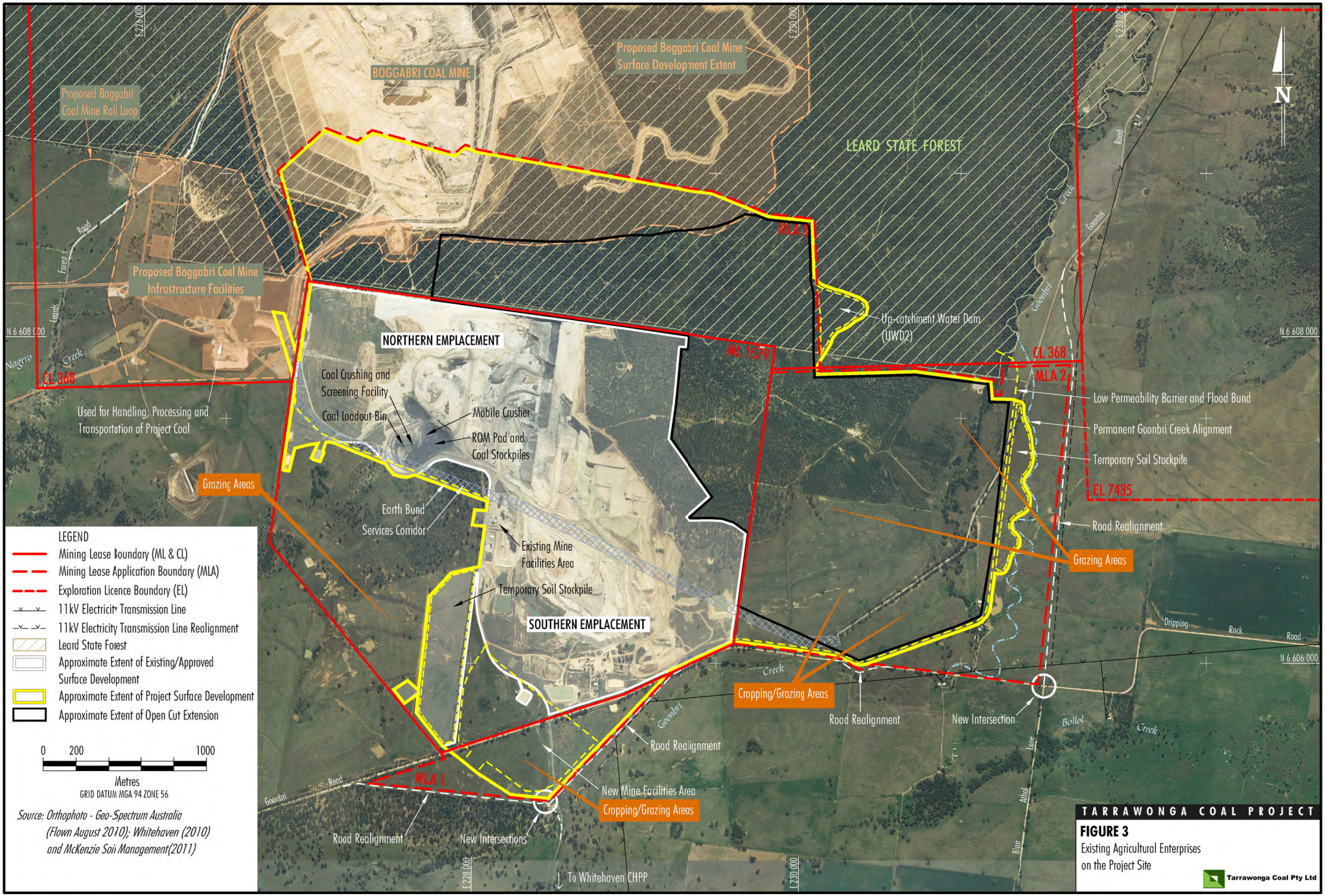
The topography of the Project site comprises rolling hills in the north up to approximately 370 metres (m) Australian Height Datum (AHD) in elevation gradually decreasing to approximately 260 m AHD in the floodplains of Goonbri Creek in the south. This floodplain is part of the Central Mixed Soil Floodplain as defined in *Namoi Catchment Water Study Independent Expert Phase 2 Report* (Schlumberger Water Services 2011). Slope of the land ranges from approximately 0.5% in the alluvial areas to about 20% on the steepest hillsides.

Agricultural areas are located in MLA 1 and the southern areas of ML 1579 and MLA 2 (Figure 2). No agricultural areas are currently located in MLA 3. Other areas of the Project site consist of the existing/approved Tarrawonga Coal Mine, the Boggabri Coal Mine, the Leard State Forest and vegetated areas (Figure 2).

Agricultural enterprises known to have been conducted on the Project site include areas where a combination of pasture production for grazing and some rainfed crop production are undertaken and areas where pasture production for grazing only is undertaken. Figure 3 shows the areas of the Project site that are known to have been used for agricultural enterprises.

There has been rotation of crops (usually wheat) with lucerne-based pasture, all of which is non-irrigated. The main areas where rainfed crop production has occurred/could occur are located on the flatter areas of the Project site near Goonbri Creek. Remaining more elevated agricultural land has typically been used for grazing.

An aerial image of the Project site is shown on Figure 2. Elevation data supplied by TCPL are shown on **Map 1**.



TARRAWONGA COAL PROJECT

FIGURE 3

Existing Agricultural Enterprises on the Project Site

Tarrawonga Coal Pty Ltd

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4 SOIL RESOURCES

4.1 Existing Information

The following existing information relevant to the Project site was available for this assessment:

- *Soil Landscapes of the Boggabri 1:100 000 Sheet (Boggabri, Gunnedah, Maules Creek, Carroll*) (Banks and King in press);
- *Proposed East Boggabri Coal Mine: Soils and Land Capability Study of Proposed Mine Site* (Cunningham 2005a);
- *Proposed East Boggabri Coal Mine: Soils and Land Capability Study of the Proposed Transport Route* (Cunningham 2005b); and
- *Continuation of Boggabri Coal Mine Project Environmental Assessment: Soil Survey and Land Resource Assessment* (GSS Environmental 2010).

A brief summary of relevant information from the reports above is provided below.

Soil Landscapes of the Boggabri 1:100 000 Sheet

Banks and King conducted a Soil Landscapes study across the region in 2004. The report remains unpublished ('in press'), but was made available by Robert Banks (pers. comm.). The soil profile data used in their study are available from the NSW Government Soil Profile Attribute Data Environment (SPADE) Website (part of the NSW Natural Resource Atlas).

Three soil profiles descriptions (Appendix 1) in the Project site are available from this study. Their locations are shown on Figure 4. A sub-set of the Soil Landscapes map prepared by Banks and King (in press) is shown on Figure 5. Features of the Soil Landscape units are described in Table 1.

Proposed East Boggabri Coal Mine: Soils and Land Capability Studies

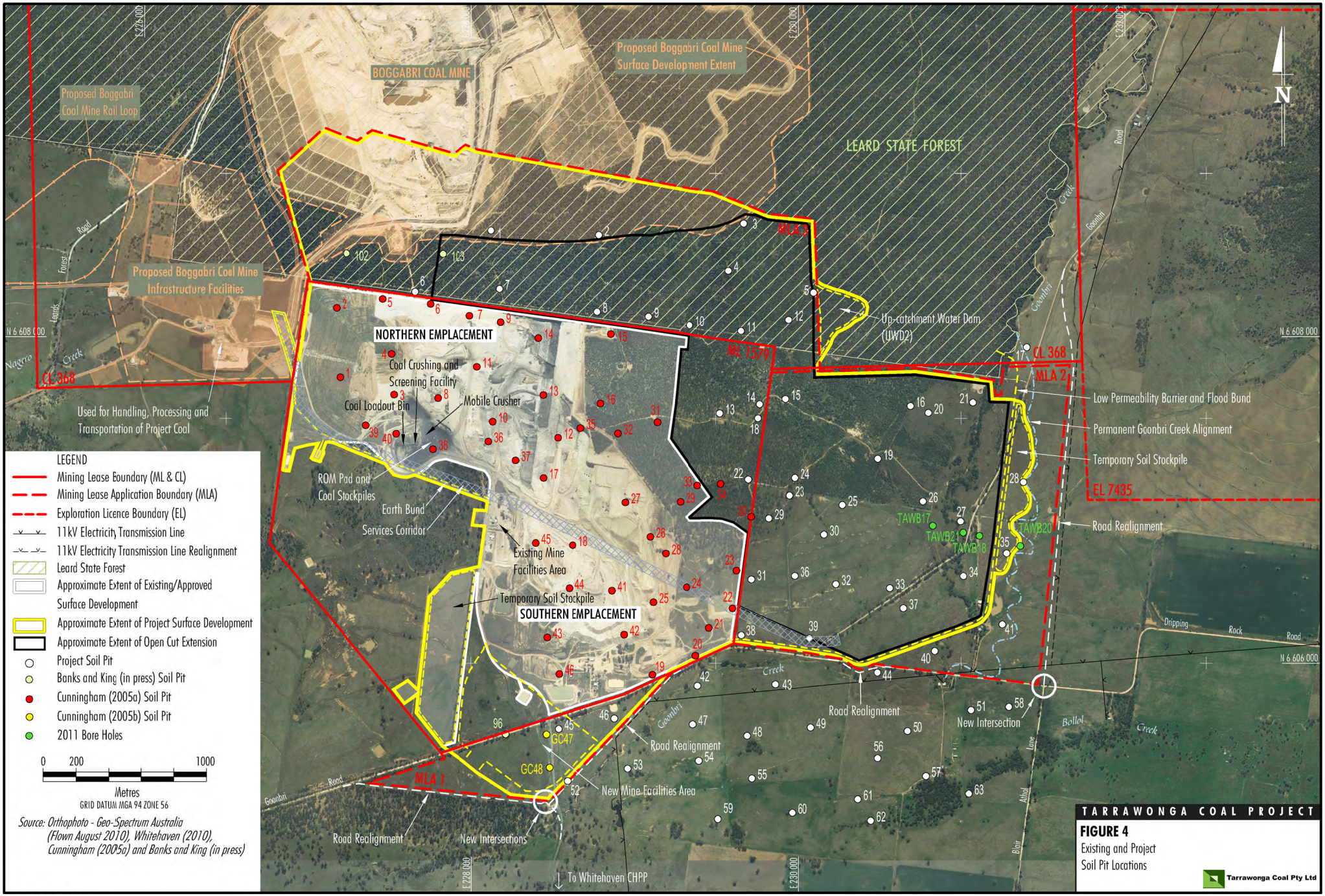
Soil at the site of the existing Tarrawonga Coal Mine (i.e. ML 1579) was assessed by Cunningham (2005a); 46 soil pits (Figure 4) were assessed over an area of 395 hectares (ha). Pits 47 and 48 (Figure 4) in the investigation by Cunningham (2005b) are located in MLA 2 and therefore are particularly relevant to this assessment. Descriptions for these pits are shown in Appendix 1. In addition, the report provided a valuable preview of soil conditions and variability that were likely to be experienced in the hilly sections of MLA 2.

There are two main sources of parent material at the study site (Wiram 1982, cited by Cunningham 2005a):

- the residuum of weathered sandy conglomerates; and
- alluvium and/or colluvium derived from weathering of former soil profiles and bedrock of surrounding volcanic and sedimentary outcrops.

The conglomerate is part of the coal-bearing 'Maules Creek Formation'[2].

[2] http://www.dpi.nsw.gov.au/minerals/geological/overview/regional/sedimentary-basins/gunnedah



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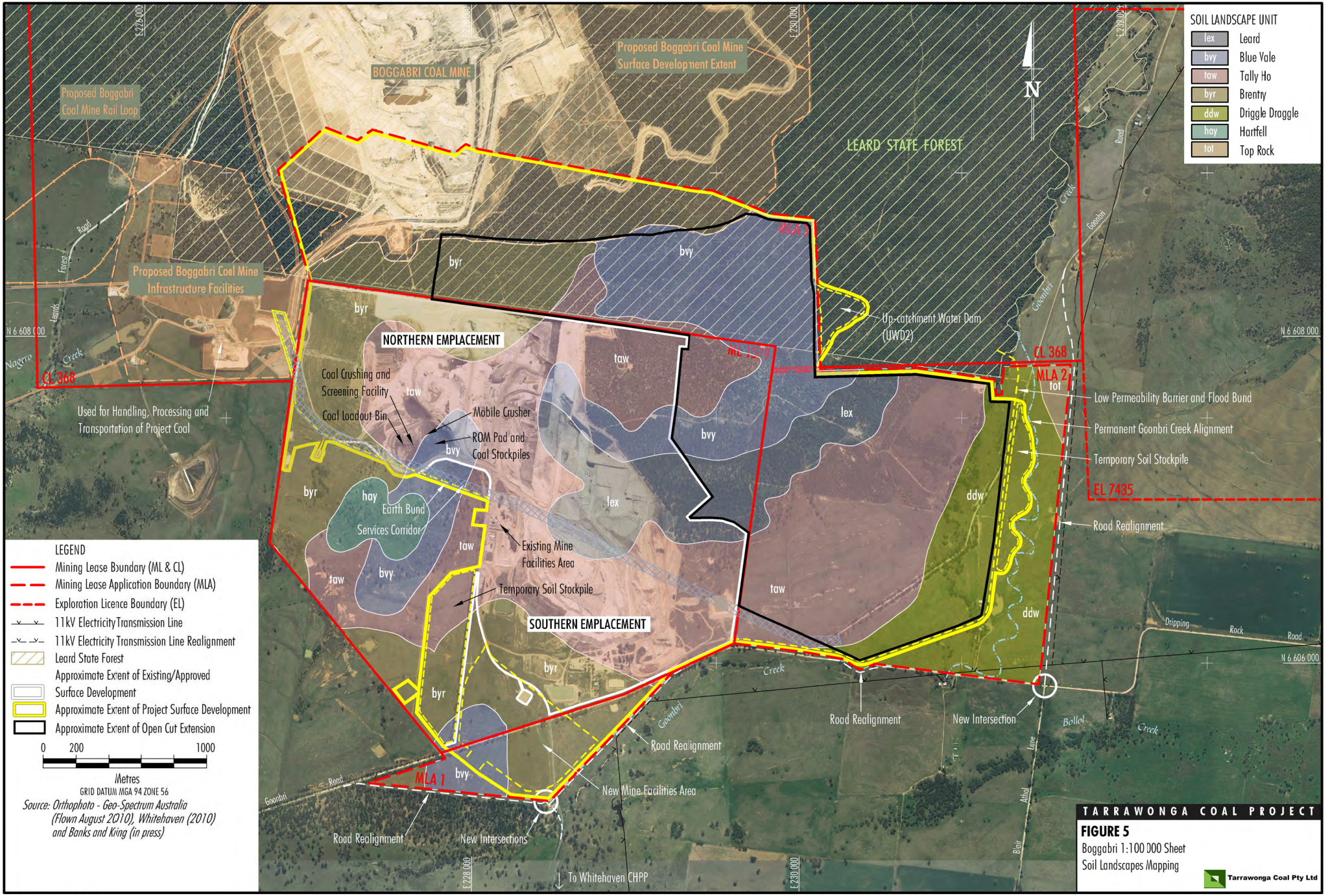

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Table 1. Soil landscape units for the Project site (Banks and King, in press)

Soil Landscape Unit	Position in Landscape	Soil Types (Australian Soil Classification)
Leard (lex)	Rolling to steep and low hills on Permian sandstones and conglomerates (Erosional).	Hillcrests and benches are dominated by well drained Rudosols and Tenosols, with Brown Kurosols and minor Red and Brown Chromosols on acidic shale/mudstone.
Blue Vale (bvy)	Undulating low hills and hills on Permian sandstones and conglomerates (Residual).	Brown Chromosols and Brown Sodosols are dominant.
Tally Ho (taw)	Undulating broad hillcrests, and plateaux, on Jurassic basalts and dolerites (Residual).	Very deep Red Ferrosols and Dermosols are dominant. Shallow Leptic Rudosols occur on some of the rocky crests. Red, Brown and Black Vertosols are occasionally present on broad crests and plateaux.
Brentry (byr)	Drainage plains and fans formed on Quaternary alluvium from Permian quartz sandstones and conglomerates (Transferral).	Footslopes are dominated by Grey Chromosols or by Brown Sodosols. Plain elements of the landscape are dominated by Brown Vertosols and Brown Sodosols.
Driggle Draggle (ddw)	Extensive plains created by ancient alluvial processes which are no longer evident (Stagnant Alluvial).	Soil distribution is complex. Soil types include Grey Chromosols, Brown Sodosols, Grey and Brown Vertosols and Brown Dermosols.
Hartfell (hay)	Rolling to undulating low hills on Permian-Carboniferous rhyolites, rhyolite tuffs and andesites of the Gunnedah and Boggabri Volcanics (Erosional).	Hillcrests dominated by very shallow Tenosols, with hillslopes on rhyolite dominated by Chernic Tenosols. Hillslopes on dacite and andesite tend to have heavier soils such as Grey or Black Vertosols.
Top Rock (tot)	Broad, long (1000-1500m) gently inclined footslopes on colluvium derived from Permian sandstones and conglomerates of the Curlewis Hills (Transferral).	Upper slopes are generally dominated by very deep Red Sodosols and some Bleached Red Chromosols; mid to lower footslopes are dominated by imperfectly to poorly drained deep to very deep Brown Sodosols.

Continuation of Boggabri Coal Mine: Soil Survey and Land Resource Assessment

A soil survey for a proposed expansion of the Boggabri Coal Mine was conducted in the Leard State Forest, immediately to the north of the Project, by GSS Environmental (2010). Fourteen soil inspection sites were examined over an area of 2,924 ha. Data from this study are of limited value for this study because of the following problems:

- Soil horizon designations were not given as per the 'Australian Soil and Land Survey Field Handbook' (McDonald *et al*. 1990).
- The soil has not been classified according to the Australian Soil Classification (Isbell 2002).
- The methodology indicates that cation exchange capacity and exchangeable sodium (both important factors) are to be analysed, but the results are not provided in the report. This means that dispersibility and gypsum requirement cannot be determined with sufficient accuracy.
- The soil pit to area ratio is considered too low to obtain a reliable dataset.

The review of previous studies indicated that very little information about soil condition was available for MLA 1, MLA 2 and MLA 3 areas. Further assessment of these areas was therefore required – particularly in the proposed extent of Project surface development (Figure 4). The soil survey component of this assessment therefore focuses on MLA 1, MLA 2 and MLA 3 areas of the Project site (Figure 4).

4.2 Methodology

A soil survey was conducted to characterise and assess the soils in the survey area (Figure 4). This section provides a description of the soil survey methodology and outcomes.

The following soil information is regarded by Ward (1998) as being important for soil and overburden assessment associated with mine site reclamation.

- Classification (structure, texture etc); allows existing data and experience on managing similar soils elsewhere to be applied.
- Dispersion index and particle size analysis; indicates soil structural stability and erodibility.
- pH; need to identify extreme ranges for treatment of lime or selection of suitable plant species.
- Electrical conductivity; indicates soluble salt status.
- Macro- and micro-nutrients.

More specifically, Elliott and Reynolds (2007) suggest that the following soil factors need to be considered when assessing suitability of topdressing materials for mine site reclamation:

- Structure grade, which affects the ability of water and oxygen to enter soil.
- The ability of a soil to maintain structure grade following mechanical work associated with the extraction, transportation and spreading of topdressing material.
- The ability of soil peds to resist deflocculation when moist.
- Macrostructure; where soil peds are larger than 100 millimetres (mm) in the subsoil, they are likely to slake or be hardsetting and prone to surface sealing.
- Mottling; its presence may indicate reducing conditions and poor soil aeration.
- Texture; soil with textures equal to or coarser than sandy loam are considered unsuitable as topdressing materials because they are extremely erodible and have low water holding capacities.
- Material with a gravel and sand content greater than 60% is unsuitable.
- Saline material is unsuitable.

These soil factors have been taken into account when planning the soil assessment procedures for the Project.

Field Survey

The field work was carried out over nine days between 2 and 7 February 2011 and 15 to 17 February 2011. Sixty-three backhoe pits (approx. 1.4 m deep; shallower where hard rock was encountered) were assessed and the locations are shown on Figure 4. The pits were located in a way that covered the main variations in vegetation type (FloraSearch 2011) and topography. It should be noted that the MLA 1 and MLA 2 boundaries were modified after the completion of the field survey conducted in February 2011 and therefore some pits are located outside of the Project area (Figure 4).

A 'Magellan Explorist 210' GPS instrument with an accuracy of about ±4 m was used to record the pit coordinates (Appendix 2).

The soil was examined using pits approximately 1.4 m deep that were dug with a backhoe. They were trimmed with a geological pick to allow photography and description of the undisturbed structure and root growth.

Thirty-six of the pits were sampled for laboratory analysis. At most of these sites, extra pits were dug more deeply (and immediately refilled) to allow collection of deeper soil samples, where possible, to a depth of 3 m.

The field description methods were as described in the 'Australian Soil and Land Survey Field Handbook' (McDonald *et al*. 1990) and the 'Guidelines for Surveying Soil and Land Resources, Chapter 29' (McKenzie *et al*. 2008). The soil profiles have been classified (Appendix 2) according to the Australian Soil Classification (Isbell 2002).

Field Soil Observations/Testing

The following characteristics were assessed for the layers identified in each of the soil profiles:

- thickness of each layer (horizon);
- soil moisture status at the time of sampling;
- pH (using Raupach test kit);
- colour of moistened soil (using Munsell reference colours);
- pedality of the soil aggregates;
- amount and type of coarse fragments (gravel, rock, manganese oxide nodules);
- texture (proportions of sand, silt and clay), estimated by hand;
- presence/absence of free lime and gypsum;
- root frequency; and
- dispersibility and the degree of slaking in deionised water (after 10 minutes).

Field observations for each pit are presented in Appendices 2 and 3.

The soil structure information (Appendix 4) has been summarised to give SOILpak 'compaction severity' scores (McKenzie 2001). This allows deep tillage recommendations to be made from the structure observations. The score is on a scale of 0.0 to 2.0, with a score of 0.0 indicating very poor structure for crop root growth and water entry/storage. Ideally, the SOILpak score of the root zone should be in the range 1.5–2.0.

Hand texturing provides an approximation of the clay content of a soil (Table 2). In conjunction with the estimation of coarse fragment (gravel) content, it provides a low-cost alternative to particle size analysis (PSA).

Table 2. Relationship between hand texture descriptions and the clay content of a soil (McDonald *et al.* 1990)

Texture Description	Approximate Clay Content (%)
Sand	commonly <5%
Loamy sand	about 5%
Clayey sand	5-10%
Sandy loam	10-20%
Loam	about 25%
Silty loam	about 25%
Sandy clay loam	20-30%
Clay loam	30-35%
Silty clay loam	30-35%
Light clay	35-40%
Light medium clay	40-45%
Medium clay	45-55%
Medium heavy clay	50% or more
Heavy clay	50% or more

Laboratory Soil Testing

A total of 197 × 1 kilogram (kg) soil samples were collected from 36 pits:

- 0-15 centimetres (cm): 36 samples;
- 15-30 cm: 36 samples;
- 30-60 cm: 36 samples;
- 60-90 cm: 30 samples (some of the hill sites had hard rock below 60 cm);
- 90-120 cm: 11 samples (only collected where a contrasting/important layer of soil was observed below 90 cm);
- 2 m: 25 samples (mainly alluvial sites); and
- 3 m: 23 samples (mainly alluvial sites).

Where a distinct A2 horizon was present, for example between 10-25 cm, the sampling depths were adjusted to keep the contrasting layers separate; in this case, 0-15 cm = 0-10 cm, 15-30 cm = 15-25 cm.

The soil was analysed by Incitec-Pivot Laboratory, Werribee Victoria for exchangeable cations, pH, electrical conductivity, chlorides, nutrient status (nitrate-nitrogen, phosphorus, sulfur, zinc, copper, boron) and organic matter content. An ammonium acetate method was used for the extraction of exchangeable cations. The cation exchange capacity (CEC) values are the sum of exchangeable sodium, potassium, calcium, and magnesium. Phosphorus was determined using the Colwell method, sulphur by the CPC method, boron by a calcium chloride ($CaCl_2$) extraction and zinc/copper by a DTPA extraction (see Rayment and Lyons [2011] for further details).

Soil dispersibility, as measured by the Aggregate Stability in Water (ASWAT) test (Field *et al.* 1997), was assessed by McKenzie Soil Management in Orange. The results are presented in Appendix 5. The ASWAT test has been related to the well known Emerson aggregate stability test by Hazelton and Murphy (2007) – see Table 3. An advantage of the ASWAT test is that the results can be linked with management issues such as the need for gypsum application and avoidance of wet working (Figure 6).

Table 3. The relationship between the Emerson aggregate stability test and the ASWAT test that assess the severity of dispersion when soil aggregates are added to water

Dispersibility	Emerson Aggregate Classes	Probable Score for the ASWAT Test (Field *et al.* 1997)
Very high	1 and 2(3)	12-16
High	2(2)	10-12
High to moderate	2(1)	9-10
Moderate	3(4) and 3(3)	5-8
Slight	3(2), 3(1) and 5	0-4
Negligible/aggregated	4, 6, 7, 8	0

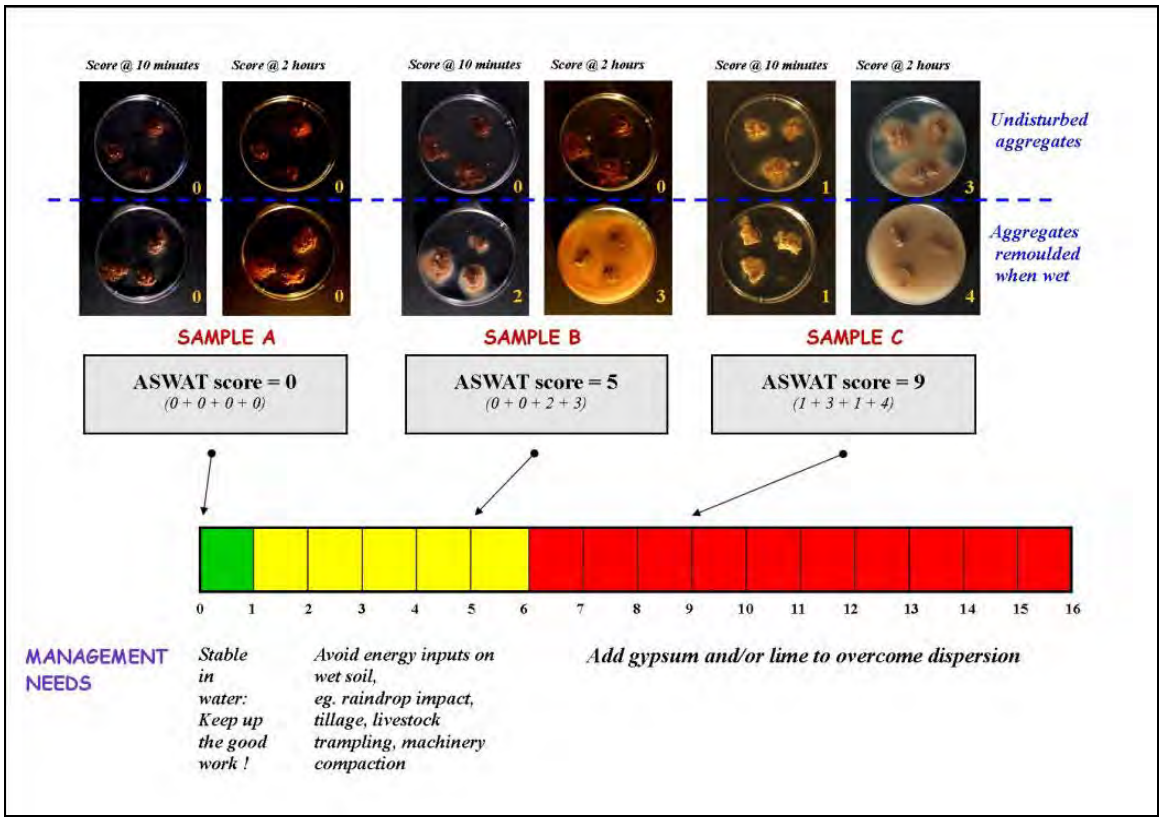


Figure 6 The Link between Aggregate Stability in Water (ASWAT) Results and Soil Management Options (Central West Catchment Management Authority 2007)

The conversion factors of Slavich and Petterson (1993) allowed the electrical conductivity of saturated paste extracts (EC_e) to be calculated from the electrical conductivity of 1:5 soil: water suspensions ($EC_{1:5}$) and texture.

Seven calibration samples (2 kg samples from Pit 13 (0-15 cm, 15-30 cm, 30-60 cm) and Pit 27 (0-15 cm, 15-30 cm, 30-60 cm, 60-90 cm)[3] were analysed by NSW Soil Conservation Service (SCS) Laboratory for the following analyses, which are part of the 'Erosion and sediment control' package (Appendix 6):

- Dispersion percentage.
- Emerson aggregate test.
- Organic carbon.
- Particle size analysis.
- Particle size analysis – mechanical dispersion.
- Soil erodibility factor (K factor).

The following important key soil factors are attached in the form of colour coded maps (prepared by Paul Hatton, HRP Design, Orange):

Map 2. Soil types; Australian Soil Classification.
Map 3. Depth to rock.
Map 4. Depth to gravel/sand layers in alluvium/colluvium.
Map 5. Dispersion; ASWAT scores.
Map 6. Dispersion; ESP values.
Map 7. Compaction severity SOILpak score.
Map 8. Cation exchange capacity (meq/100g).
Map 9. Salinity; electrical conductivity (ECe, dS/m).
Map 10. pH ($CaCl_2$).
Map 11. Phosphorus (Colwell P, mg/kg).
Map 12. Organic carbon (%).

4.3 Soil Types and Mapping

General Description of Soil Types

The Australian Soil Classification (Isbell 2002) has been used to determine soil types at each of the 63 pits (**Map 2**). A summary of the soil types observed during the survey is shown in Table 4.

[3] Pit 13 is referred to as Pit T17 and Pit 27 is referred to as Pit T18 is in Appendix 6.

Table 4. Soil types, according to the Australian Soil Classification

SOIL GROUPINGS	Australian Soil Classification Orders	Australian Soil Classification Suborders	Number of Soil Profiles in Each Category
Deep Recent Alluvium (28)	Rudosol (28)	Stratic	28
Shallow Stony Soil (11)	Tenosol (11)	Leptic	4
		Brown-Orthic	2
		Yellow-Orthic	2
		Bleached Leptic	3
Duplex Soil – loam topsoil, clay-rich subsoil (17)	Chromosol (5)	Red	2
		Brown	2
		Grey	1
	Sodosol (10)	Red	5
		Brown	3
		Grey	1
		Yellow	1
	Kurosol (2)	Red	2
Non-Duplex Loams (7)	Kandosol (5)	Grey	3
		Yellow	2
	Dermosol (2)	Brown	2

The main soil types were Stratic Rudosols (all Stratic) (44%) and Tenosols (17%). Sodosols (16%), Chromosols (8%), Kandosols (8%), Kurosols (3%) and Dermosols (3%) were also observed[4].

- Stratic Rudosols are characterised by a number of alluvial depositional layers that have been little altered by pedogenic processes except at or near the surface. The uppermost depositional layers may be as young as recent floods (McKenzie *et al*. 2004).
- Tenosols are shallow stony soils with only weak pedological development.
- Chromosols are duplex, ie. a strong contrast in texture between topsoil and subsoil. They have subsoil (B horizon) which is not strongly acidic and not sodic.
- Sodosols have a strong texture contrast between topsoil and sodic (ESP of 6 or greater) subsoil which is not strongly acidic.
- Kurosols are duplex soils with strongly acidic subsoil. Many of them have unusual subsoil chemical features (eg. high aluminium and sodium).
- Kandosols lack strong texture contrast and have poorly structured massive subsoils.
- Dermosols also lack strong texture contrast, but have structured B horizons.

[4] Due to rounding, the percentages do not equal 100%.

Approximate correlations between the Australian Soil Classification (Isbell 2002) and the superseded Great Soil Group (Stace et al. 1968) terminology are shown in Table 5.

Table 5. Association between Australian Soil Classification and Great Soil Groups for Soil

Australian Soil Classification	Great Soil Group
Stratic Rudosol	Alluvial soils
Tenosols	Lithosols, silicious and earthy sands
Chromosols	Non-calcic brown soils, some red-brown earths and a range of podzolic soils
Sodosols	Solodized solonetz and solodic soils, some soloths and red-brown earths
Kurosols	Many podzolic soils and soloths
Kandosols	Red, yellow and grey earths, calcareous red earths
Dermosols	Prairie soils, chocolate soils, some red and yellow podzolic soils

Photos of representative soil profiles identified during the survey are presented in Figure 7.

In the forested areas, soil under the 'white box – cypress pine' communities tended to be deeper and less acidic than under adjacent 'ironbark – cypress pine' vegetation. At Pit 1, there was unusually moist soil around tree roots at a depth of 80-100 cm beneath the box trees. Most soil profiles in the area at that time were very dry following several weeks of extremely hot weather. It appears that the box tree roots were able to extract water from very deep layers and exude it into layers nearer the surface where nutrient availability may have been more favourable, ie. hydraulic lift (Caldwell *et al.* 1998).

The soil landscapes associated with these soil types identified during the survey include:

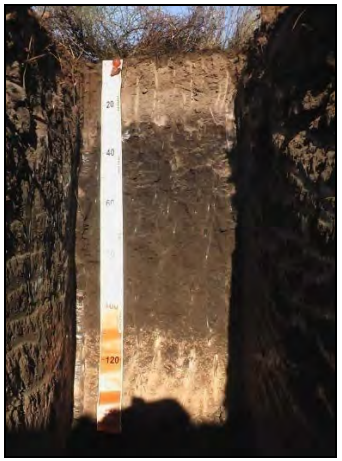
- Crest (CR) is dominated by Tenosols; sub-dominant Kurosols and Kandosols.
- Upper Slope (westerly aspect) (US-W) is a mosaic of Kandosols, Tenosols, Chromosols and Sodosols.
- Upper Slope (south-easterly aspect) (US-SE) is dominated by Bleached-Leptic Tenosols.
- Lower Slope (LS) is dominated by Grey, Brown, Yellow and Red Sodosols; sub-dominant Kandosols, Chromosols, and Stratic Rudosols.
- Alluvial Plain (AP) is dominated by Stratic Rudosols; sub-dominant Chromosols, Dermosols and Sodosols.

As noted in Section 3, the alluvial plain associated with Goonbri Creek is part of the Central Mixed Soil Floodplain as defined in *Namoi Catchment Water Study Independent Expert Phase 2 Report* (Schlumberger Water Services 2011). The distribution of the soil landscapes is shown on Figure 8.


Stratic Rudosol – Pit 41


Stratic Rudosol – Pit 43


Stratic Rudosol – Pit 57


Stratic Rudosol – Pit 59


Tenosol – Pit 14


Chromosol – Pit 23


Sodosol – Pit 17


Kurosol – Pit 2


Kandosol – Pit 12


Dermosol – Pit 7

Figure 7. Examples of the Soil Types Identified during the Survey

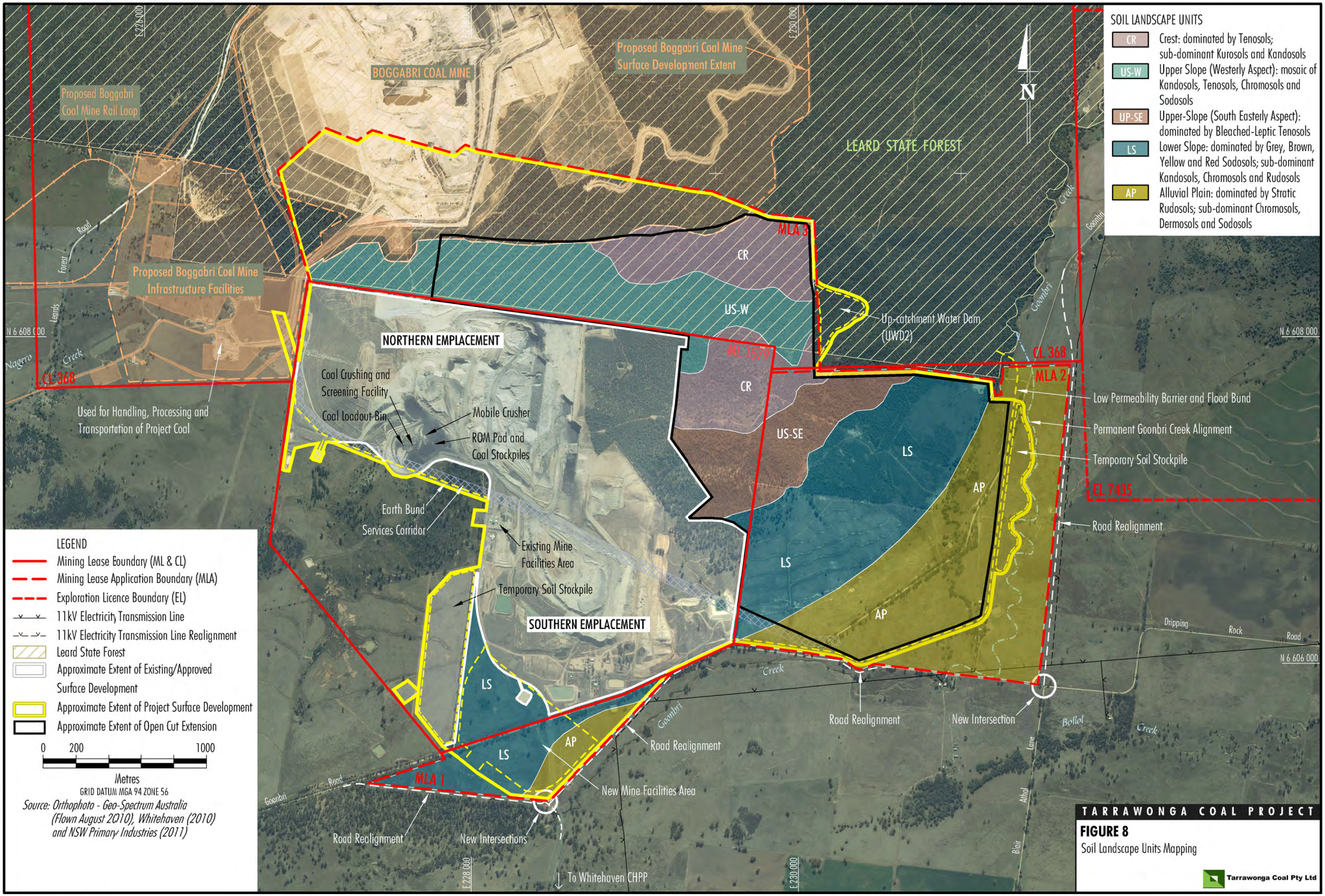


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FIGURE 8

Soil Landscape Units Mapping

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WHC-10-04 EA_AppSAL_113G

Accuracy of Soil Landscapes information for the Boggabri 1:100 000 Sheet

The Soil Landscapes map shown in Figure 5 was prepared using a negligible amount of soil profile descriptions and analyses on the Project site, and several errors are evident:

- There was no evidence of Red Ferrosols and Dermosols on Jurassic basalts and dolerites ('Tally Ho' unit).
- The 'Driggle Draggle' unit is supposed to be dominated by soil with strong pedological development on alluvial plains that are no longer active, but the Stratic Rudosols with excellent subsoil conditions for root growth observed in this study did not fit the description.

4.4 Soil Conditions

Soil Depth, Texture and Water Holding Capacity

As soil becomes shallower, stonier and/or sandier, its ability to store water declines (White 2006).

Map 3 shows the decrease in soil depth moving up the hill from the alluvial plain at the survey site. The shallow areas are associated with slopes of about 20%; erosion losses under the native vegetation on this steep infertile land would have prevented the development of deep soil profiles. With the surface texture being sandy loam and lighter at some of the hilly sites, wind erosion is likely to have occurred, in addition to erosion by water.

Some of the soil on the alluvial plains is underlaid by coarse sand and/or water-worn gravel (**Map 4**) (Figure 7, e.g. Pit 43). Recent drilling in alluvium near Goonbri Creek in the vicinity of Pits 27 and 35 (Table 6) indicated that the unconsolidated gravel extended to depths ranging from 24 m (beneath 3 m of 'soil') to 41 m (beneath 4 m of 'soil' and 'clay'), and was underlaid by siltstone and conglomerate.

Plants are more likely to suffer drought stress where soil has a poor water storage capacity, particularly in hot weather with extended dry periods between rainfall events. At the Project site, the lack of waterholding capacity in shallow soils on the slopes (bedrock close to the surface) – and on alluvial soils with coarse gravel close to the surface – is a major constraint to agricultural productivity.

Waterlogging Hazard

When soil is waterlogged, several adverse processes take place (Batey 1988):

- The lack of oxygen reduces the ability of plant roots to function properly.
- Anaerobic conditions can cause large losses of soil nitrogen to the atmosphere.
- Near-surface waterlogging is associated with inefficient storage of water due to excessive evaporation losses.

Table 6. Bore logs; drilling carried out by Mannion Drilling for Whitehaven Coal (10 to 13 May 2011)

Site	Easting (m)	Northing (m)	Bore Log
TAWB17	230825	6606842	Soil 0-3 m Unconsolidated gravel 3-24 m Siltstone >24 m
TAWB18	231110	6606780	Soil 0-2.5 m Unconsolidated gravel 2.5-30 m Conglomerate >30 m
TAWB20	231360	6606718	Soil and 'clay' 0-4 m Unconsolidated gravel 4-41 m Siltstone >41 m
TAWB21	231011	6606800	Soil and 'clay' 0-2 m Unconsolidated gravel 2-27 m Clay 27-30 m Conglomerate >30 m

The main causes of waterlogging in the Gunnedah-Boggabri area under rainfed conditions (e.g. at the Project site) are likely to be soil instability in water (slaking, dispersion), and compaction by farm machinery (and, to a lesser extent, by large grazing animals) (McKenzie and McGarry 2000). These issues are explored in the following two sections.

Soil Stability in Water – Dispersion and Slaking

Dispersion is the separation of soil micro-aggregates into sand, silt and clay particles, which tend to block soil pores and create problems with poor aeration (Levy 2000). It is a process with the potential to reduce root growth and adversely affect profitability of most crop and pasture enterprises.

Dispersion may be associated with slaking, which is the collapse of soil aggregates to form micro-aggregates under moist conditions (So and Aylmore 1995). Slaking is associated with a lack of organic matter, which is important for the binding of soil micro-aggregates.

Soil prone to slaking, and particularly dispersion, is much more likely to be lost by water erosion than stable soil. This is because the soil tends to seal over under moist conditions and lose water as runoff, rather than taking in the water for storage in the subsoil (So and Aylmore 1995).

Two maps relating to soil stability in water are presented. The ASWAT score (**Map 5**) shows how prone the soil is to dispersion under conditions that existed when the soil was sampled (Field *et al.* 1997). The 'working when wet' procedure that is part of the ASWAT test is a simulation of processes such as raindrop impact on wet soil and the cutting/stockpiling of moist soil. Much of the topsoil and subsoil in the survey area is prone to dispersion, particularly after being worked when wet.

Exchangeable sodium percentage (ESP) values (**Map 6**) are mostly lower than expected for such dispersive soil (as indicated by the ASWAT scores). The Electrochemical Stability Index (ESI) values (Appendix 5) however are very low, indicating that most of the soil in the survey area has aggravation of dispersion because of very low electrolyte concentrations. A notable feature on **Map 6** is the great depth (up to 3 m) to which the low-sodicity subsoil extends.

The main chemical factors influencing the behaviour of clay particles in sodic soils are exchangeable sodium and electrolyte concentration, but elevated exchangeable magnesium concentrations also can make clay particles in soil less stable in water (Levy 2000). On the non-alluvial areas, there are some very low 'exchangeable calcium' –'exchangeable magnesium' ratios that would contribute to dispersion problems.

Laboratory analysis results for soil erosion hazard are shown in Appendix 6 for two of the pits (Pit 17 and Pit 18).

Compaction Status

Compaction can strongly restrict plant growth because of poor water entry, poor efficiency of water storage, waterlogging when moist, and poor access to nutrients by plant roots (McKenzie 1998). The forested sites were relatively free of serious compaction problems, unlike the areas that had been farmed (**Map 7**).

Structure Self-repair Ability

The ability of a soil to overcome compaction through shrinking and swelling induced by wet-dry cycles (soil structural resilience) can be estimated via CEC values (**Map 8**) (McKenzie 1998).

Much of the topsoil has a poor shrink-swell capacity, so the rate of recovery from compaction damage would be slow. However, the clay-rich subsoils in the Stratic Rudosols (south-east section of the survey area) have favourable self-repair capacity via shrink-swell processes.

Salt Concentrations and Watertable Status

Most of the topsoil and subsoil in the area surveyed is non-saline (**Map 9**).

Groundwater in sand/gravel layers was observed between depths of 2.3 m and 3.0 m at Pits 31, 34, 35, 42 and 47.

pH Imbalance

Topsoil acidity was widespread across the area surveyed (**Map 10**) and was associated with the presence of exchangeable aluminium (Appendix 5). However, the acidity only extended deeply into the subsoil under native vegetation in the hilly areas. The limitation was most extreme under the 'ironbark-pine' communities.

Nutrients

Much of the soil was deficient (from an agricultural perspective) in phosphorus in the survey area (**Map 11**). Sulfur and nitrogen deficiencies (Appendix 5) were also widespread across the survey area. There was evidence of zinc deficiency below a depth of 15 cm for most sampling sites, and copper deficiency was evident in the non-alluvial soil.

As the sum of exchangeable cations (an approximation of CEC) increases, the ability of soil to hold cation nutrients such as calcium, magnesium and potassium becomes greater (White 2006). CEC values (**Map 8**) show CEC trends across the area surveyed. Nutrient holding capacity was much more favourable in the alluvial soil than soil on the slopes; the only exception was a 'white box / pine' site in the Leard State Forest (Pit 1) with higher CEC values than nearby 'ironbark/pine' sites.

Soil Carbon and Soil Biological Health

At the time of sampling, organic matter content of the soil was poor, particularly below a depth of 15 cm (**Map 12**).

5 RURAL LAND CAPABILITY ASSESSMENT

5.1 Background

The rural land capability classification in NSW was developed by the NSW SCS (Emery 1986). It was derived from the scheme of Klingebiel and Montgomery (1961).

Land is allocated to one of eight classes, with emphasis on the erosion hazards in the use of the land. The rural land capability classes are as follows (Emery 1986; Sonter and Lawrie 2007):

Land Suitable for Regular Cultivation / Cropping

Class I: No special soil conservation works or practices necessary.

Class II: Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotations are necessary.

Class III: Soil conservation practices such as graded banks and waterways are necessary, together with all the soil conservation practices as in Class II.

Land Suitable Mainly for Grazing

Class IV: Soil conservation practices such as pasture improvement, stock control, application of fertiliser, minimal cultivation for the establishment or re-establishment of permanent pasture and maintenance of good ground cover.

Class V: Soil conservation works such as diversion banks and contour ripping, in addition to the practices in Class IV.

Land Suitable for Grazing

Class VI: Not capable of cultivation. Soil conservation practices include limitation of stock, broadcasting of seed and fertiliser, promotion of native pasture regeneration, prevention of fire, destruction of vermin, maintenance of good ground cover and possibly some structural works.

Land Suitable for Tree Cover

Class VII: Land best protected by trees.

Land Unsuitable for Agriculture

Class VIII: Cliffs, lakes or swamps where it is impractical to grow crops or graze pasture.

A New Approach: 'Land and Soil Capability'

The existing rural land capability system (Emery 1986) has an emphasis on the construction of earthworks, which are no longer a frontline erosion control mechanism for cropping lands (B. Murphy, pers. comm.).

Staff from the NSW Office of Environment and Heritage are in the process of developing a 'Land and Soil Capability' (LSC) scheme that builds on the rural land capability system by including land degradation issues such as salinity, sodicity and acidity. As the LSC approach is still being developed and requires further testing, the existing Emery (1986) rural land capability system has been used in this assessment.

5.2 Existing Information

The following existing information relevant to the Project site was available for this assessment:

- Rural land capability mapping prepared by NSW government departments using data collected prior to the Banks and King (In Press) study.
- Rural land capability mapping in the south-western section of ML 1579 prepared by Cunningham (2005a) (Figure 9).

5.3 Rural Land Capability Classification

Rural land capability mapping was prepared for the MLA 1, MLA 2, MLA 3 and the north-eastern section of ML 1579 based on the results of the soil survey (Section 4).

Land slope is a primary determinant of land capability because erosion hazard increases with slope steepness and because slope steepness imposes physical limits on many types of land usage (Sonter and Lawrie 2007). The slope categories in Table 1 of Murphy and Taylor (2008) assisted in determining the class allocation.

Estimates of rural land capability across the Project site are shown on Figure 9. Values ranged from Class II to Class VI. The major factor influencing the classification was land slope. The slope of the land ranged from approximately 0.5% in the Class II areas to about 20% on the steepest hillsides with a Class VI classification.

The presence – across the site – of soil with a strong potential to disperse, topsoil acidity and major nutrient deficiencies prevented the allotment of rural land capability categories that were more favourable. All of these factors reduce a landholder's ability to create and maintain organic material to protect soil surfaces from water and wind erosion.

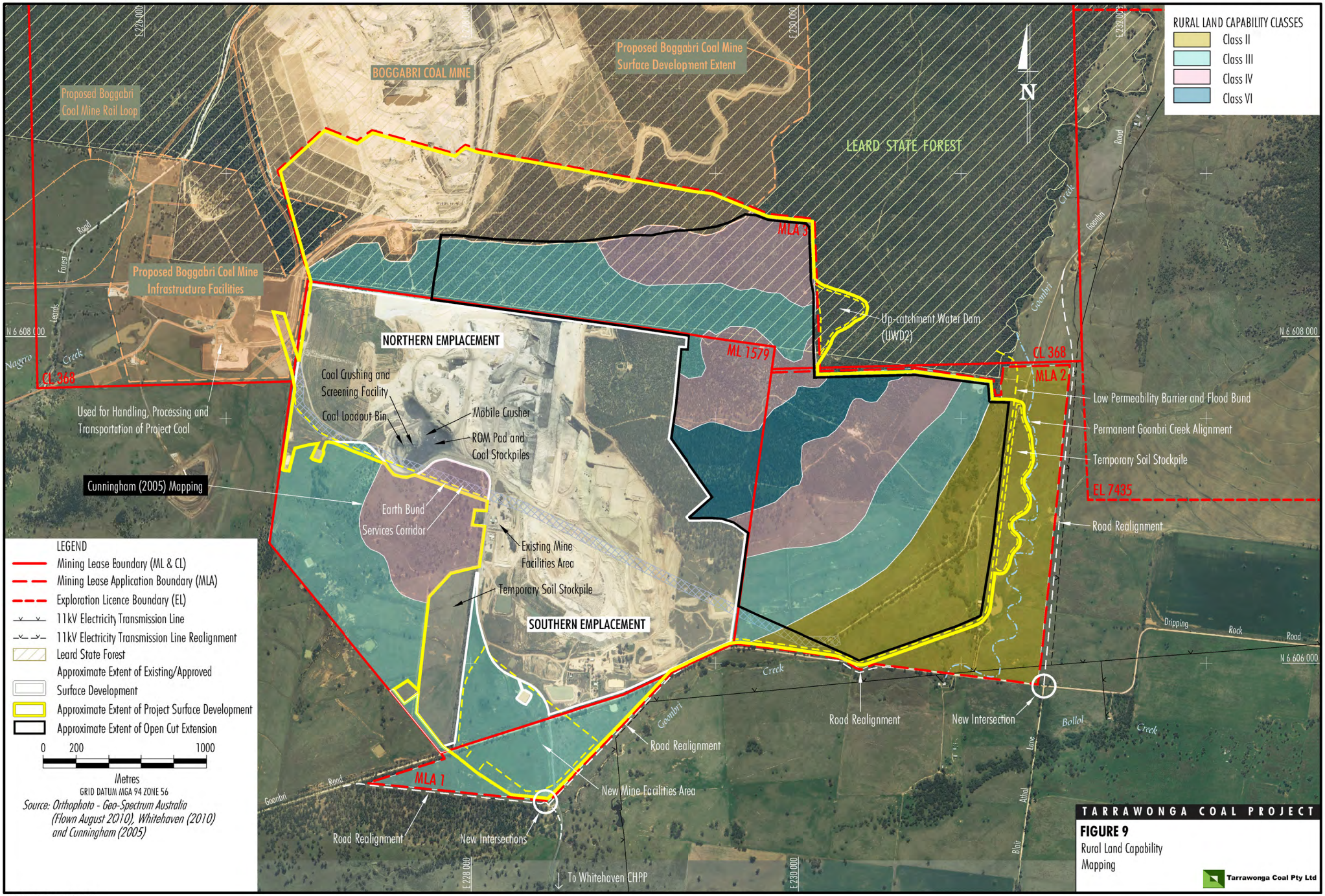

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FIGURE 9

Rural Land Capability Mapping

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6 AGRICULTURAL SUITABILITY

6.1 Background

This five class system used by NSW Agriculture classifies land in terms of its suitability for general agricultural use (Hulme *et al*. 2002). It was developed specifically to meet the objectives of the NSW *Environmental Planning and Assessment Act, 1979*.

Agricultural land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture. In general terms, the fewer the constraints on the land, the greater its value for agriculture (Hulme *et al*. 2002). Higher quality lands (Classes 1 and 2) have fewer constraints and a greater versatility for agriculture than poorer quality lands.

The essential characteristics of the five classes are as follows (Hulme *et al*. 2002):

Class 1: Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent.

Class 2: Arable land suitable for regular cultivation for crops, but not suited to continuous cultivation. It has a moderate to high suitability for agriculture but soil factors or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.

Class 3: Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with sown pasture. The overall production level is moderate because of soil or environmental constraints. Erosion hazard, soil structural breakdown or other factors, including climate, may limit the capacity for cultivation and soil conservation or drainage works may be required.

Class 4: Land suitable for grazing but not for cultivation. Agriculture is based on native pastures and improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints.

Class 5: Land unsuitable for agriculture, or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors which prevent land improvement.

Hulme *et al.* (2002) recognised that agriculture suitability classification maps have a limited life because of changes in social and economic factors. They also note that agricultural land classification maps produced at small scales (1:50,000 to 1:100,000) are inappropriate for making decisions about individual development applications because of a lack of detail.

6.2 Existing Information

The following existing information relevant to the Project site was available for this assessment:

- Agriculture suitability mapping prepared by NSW government departments using data collected prior to the Banks and King (In Press) study.
- Agriculture suitability mapping in the south-western section of ML 1579 prepared by Cunningham (2005a) (Figure 10).

6.3 Agricultural Suitability Classification

Agricultural suitability mapping was prepared for the MLA 1, MLA 2, the south-eastern corner of MLA 3 and the north-eastern section of ML 1579 based on the results of the soil survey (Section 4).

To help assess the agricultural suitability of the Project site, 10 soil related factors at 6 locations across the Project site were assessed; they are shown in Appendix 7.

In addition to the soil related factors reviewed in Appendix 7, land slope had a major bearing on the agricultural suitability of the Project site. Terracing is used to overcome slope and soil shallowness limitations in other parts of the world, but usually is not economically viable under Australian conditions. In contrast, topsoil limitations such as dispersion, compaction, acidity and nutrient deficiency can be overcome in a cost-effective manner through improved soil management.

Estimates of agricultural land suitability across the study site are shown on Figure 10. It is noted that the Leard State Forest is an exclusion zone (i.e. should not be mapped) as per the guidelines of Hulme *et al.* (2002):

> ***i. Lands that need not be evaluated***
> *Before mapping begins, all lands that can be clearly excluded from agriculture are identified and marked on the map to reduce the area to be assessed. Such lands include:*
> …
> - *state forests and timber reserves, although sometimes these areas may be suitable and available for grazing*
>
> …

The agricultural suitability mapping described here therefore did not extend north of the southern and eastern boundaries of the Leard State Forest (Figure 10).

Agricultural suitability classes identified across the site ranged from Class 3 to Class 5. The alluvial soil in the southeast of the study area has serious limitations for plant growth in the topsoil, although there are some excellent characteristics for root growth in the deep subsoil where gravel beds are not present.

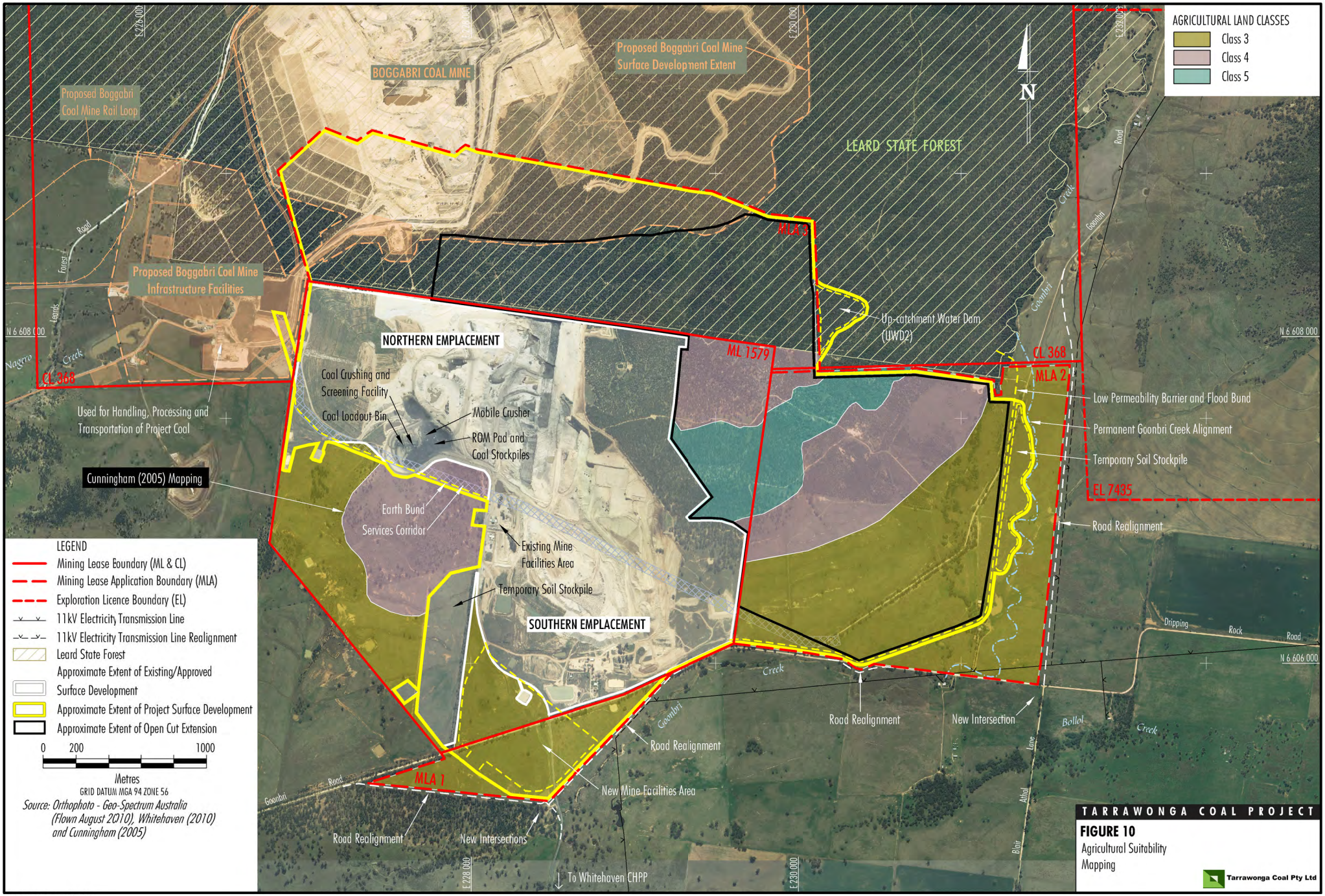

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FIGURE 10
Agricultural Suitability Mapping

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Soil compaction is considered to be serious enough in the alluvial topsoil to create a Class 4 characterisation. The introduction of 'best practice' soil management techniques such as soil decompaction with agrowplowing and lime application almost certainly would improve its agricultural suitability class. However, the current degraded state of the land suggests that its full potential is unlikely to be achieved by existing land management practices implemented in the vicinity of the Project. Therefore, Class 3 is the most realistic agricultural suitability category for the alluvial soil in the Project area.

In the areas mapped as Classes 4 and 5, soil limitations include various combinations of the following factors: erosion hazard associated with steep slopes, shallowness, dispersion, acidity, nutrient deficiencies and compaction.

7 REHABILITATION AND SOIL MANAGEMENT

7.1 Proposed Rehabilitation Strategy

The Project straddles the boundary of the Leard State Forest to the north and undulating predominantly cleared agricultural land used for livestock and occasional cropping to the south and east. The Project would be progressively rehabilitated in a manner that provides a sustainable balance between these existing land uses. The Project final landform and land uses at the end of the Project life are presented on Figure 11.

Woodland/forest regeneration areas would be incorporated into the rehabilitation program (Figure 11) and would be designed to link with remnant native vegetation and contribute to local and regional habitat corridors. Agricultural land would also be incorporated into the rehabilitation program and would consist of areas that are suitable for cropping/grazing (Figure 11).

The details of the proposed rehabilitation strategy for the Project are presented in Section 5 of the Main Text of the EA.

7.2 Soil Resource Estimate

The available soil resource for rehabilitation at the Project has been estimated. The stripping depth has been selected such that only soils suitable for use as plant growth media for at least one of the following post-mine land uses at the Project would be stripped:

- Agriculture – cropping/grazing (improved pasture).
- Woodland/forest.

The suitability of the soils for each of these post-mine land uses has been determined based on a comparison of the results of the soil survey observations and laboratory analytical results against the criteria outlined in Table 7. It has also been assumed that appropriate management practices (Section 7.4) are implemented during soil handling and relevant amelioration measures (Section 7.3) are applied where necessary[5].

[5] Soil materials for mine site rehabilitation can be ameliorated for physical and chemical attributes that might otherwise preclude their general use (Elliot and Reynolds 2007)

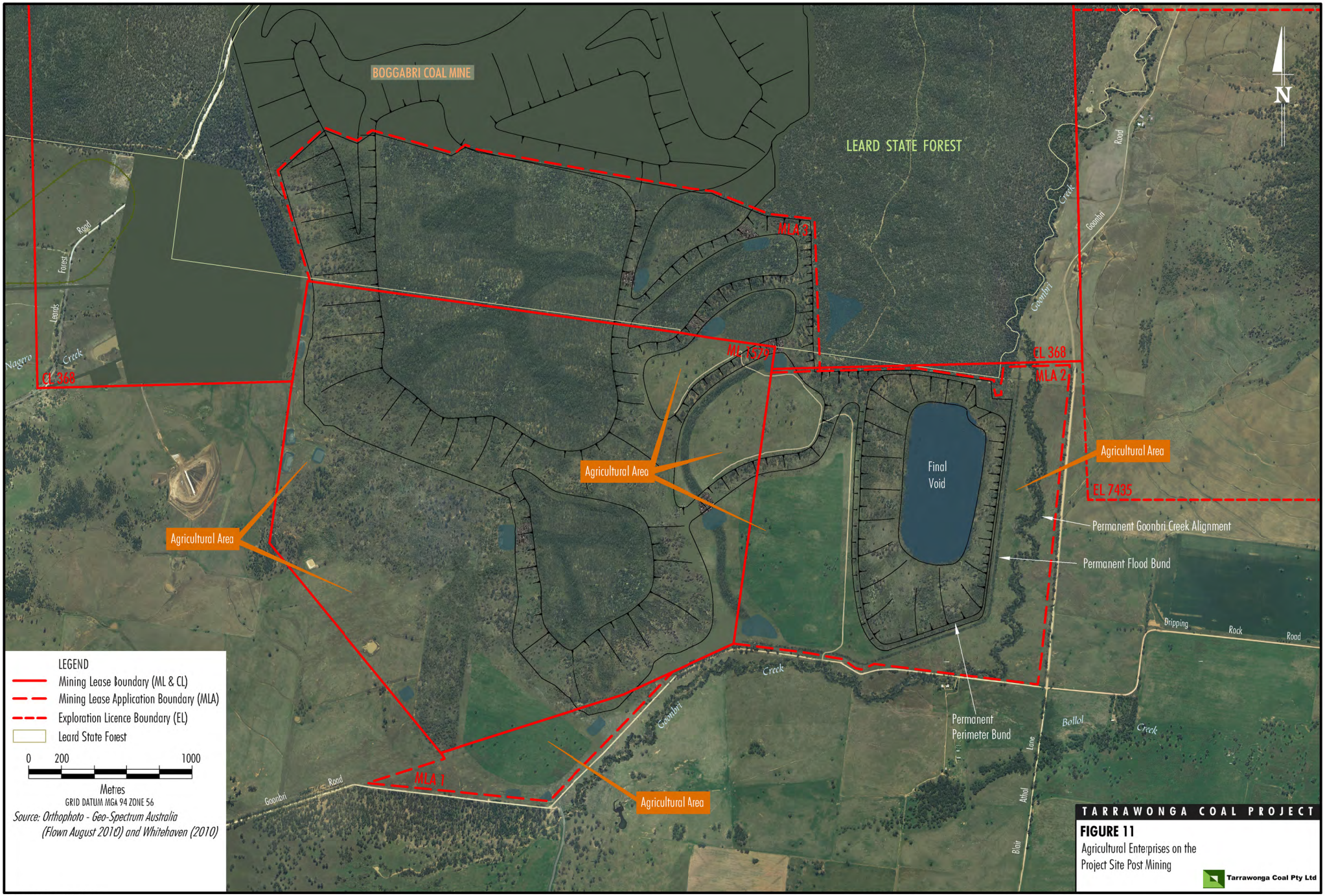

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Table 7. Soil suitability criteria

Parameter	Cropping/Grazing targets
Compaction severity (SOILpak score)	Topsoil: >1.5 Subsoil >1.0
Exchangeable Sodium Percentage	Topsoil: <2 Subsoil <6
Acidity (pH $CaCl_2$)	>5.5, <8.0
Salinity (ECe, dS/m)	<1.5
Cation Exchange Capacity (meq/100 g)	>15
Phosphorus (Colwell; mg/kg	>30
Depth	150 cm root zone

The suggested depth for soil stripping for the additional disturbance area at the Project is presented on Figure 12.

On the cleared creek flats (relatively recent alluvium; Stratic Rudosols), there is potential to collect soil – from an average depth of 3 m (Figure 12) – with the high quality soil to be used as topdressing material for agricultural post-mining land use, following treatment with coarse-grade gypsum (Section 7.3).

Sub-sections of the vegetated areas in the north of the Project site (white box trees rather than ironbark) have soil conditions that allow a cut of 25 cm (Figure 12). Because of major subsoil constraints, a cutting depth of 10 cm is recommended in the remaining Project disturbance areas (Figure 12). These soils could be used for woodland/forest rehabilitation.

Some of the pits surveyed showed that coarse gravel and sand exists near the surface (**Map 4**); it is much less suitable as a rehabilitation material than the nearby clay-rich soil. These pits, however, are located outside of the Project disturbance area.

It should be noted that confidence in the recommended stripping depths in the south-western and western areas of the Project site is lower than the other areas as there are fewer pits in these areas. However, soil would only be stripped in the new mine facilities area where cut and fill earthworks are required (i.e. the majority of the area would not be stripped).

In addition to high quality soil resource described above, large volumes of other soils could also be used in rehabilitation. This soil could also be used without amelioration to provide conditions suitable for the native woodland/forest. This additional soil could be obtained from the Class 3 Agricultural Suitability areas (Figure 10) that are not Stratic Rudosols to a depth of approximately 1 m.

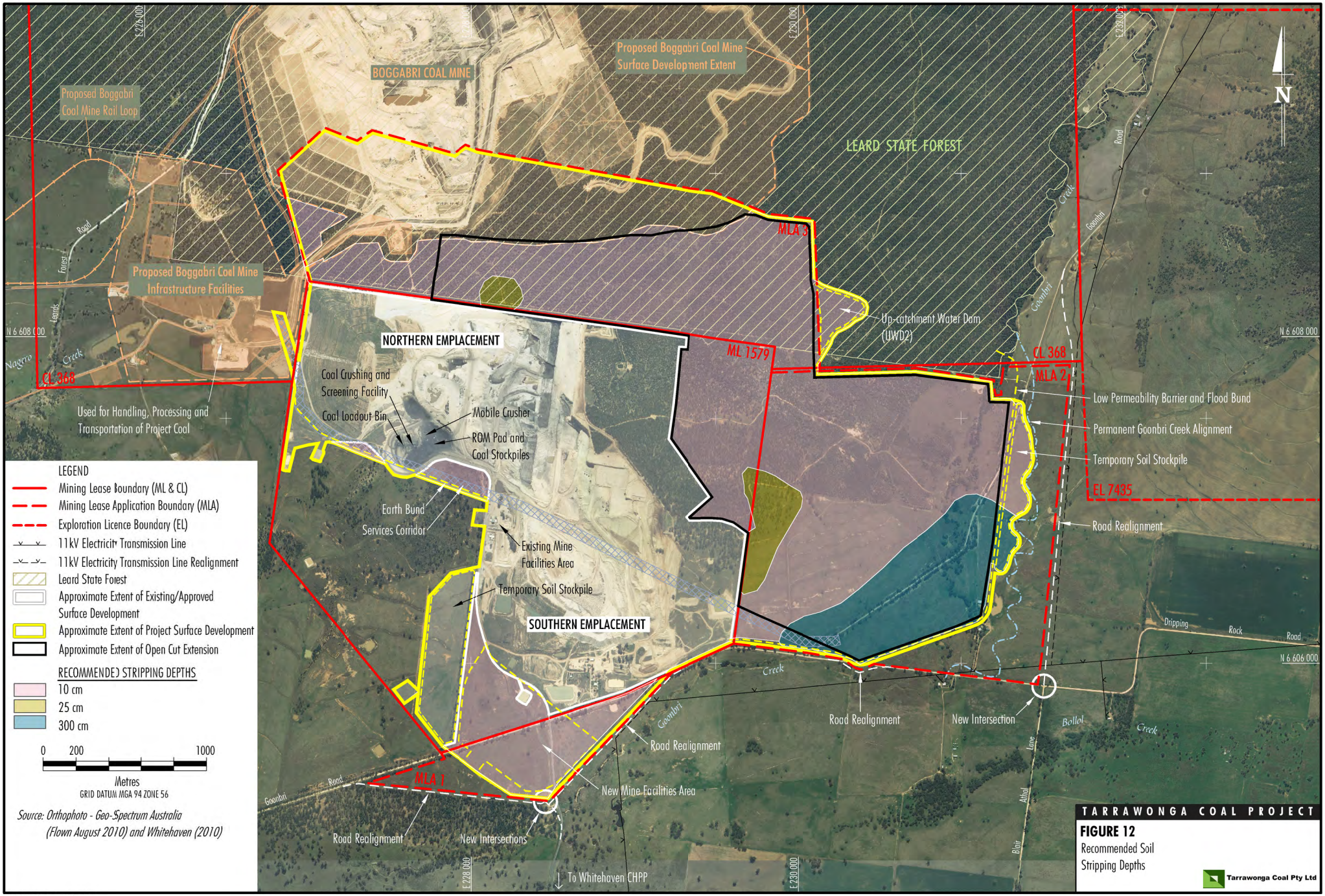

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FIGURE 12
Recommended Soil Stripping Depths

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The approximate volume of soil that would be available for rehabilitation purposes based on the mapping included on Figure 12 is provided in Table 8.

Table 8. Soil resource availability

Recommended Stripping Depth (cm) (refer Figure 12)	Approximate Stripping Area (ha)	Approximate Volume (m^3)
0 – 10	405	405,000
0 – 25	30	75,000
0 – 300	80	2,400,000
Currently Stockpiled	**-**	**1,293,400**
Total	**515**	**4,173,400**

Preliminary material balance calculations based on the recommended soil stripping depths outlined in Table 8 indicate an approximate topsoil/subsoil volume of 2,880,000 m^3 would be available from the Project disturbance area for use during future rehabilitation[6]. In addition, 1,293,400 m^3 of soil is currently stockpiled at the Tarrawonga Coal Mine (TCPL 2011). The total available soil resource is approximately 4,173,400 m^3.

The available soil resource outlined in Table 8, is sufficient to allow for soil re-application to a depth of 1.5 m on 160 ha of rehabilitated agricultural areas (Section 8.2) and for up to approximately 20 cm to be used on other Project mine landforms.

7.3 Soil Constraints and Ameliorants

In the areas cleared for agriculture, a broad range of soil physical and chemical constraints have been identified (Section 4.4).

Much of the cleared land had evidence of structural degradation in the topsoil. Compaction is the main issue. Causes are likely to be excessive cultivation, uncontrolled farm trafficking and trampling by livestock.

Topsoil and sub-surface acidity was observed across the survey area. This appears to be an inherent problem, but it would have likely been aggravated by decades of export of agricultural produce without a counter-balance via lime application.

A decline in organic matter content because of soil disturbance, and cultivation at moisture contents that were either too wet or too dry, appears to have made the soil more prone to instability in water. In the alluvial areas, however, many of the subsoils were excellent for root growth to a depth of 3 m.

[6] The soil stripping volumes in Table 8 do not include the area associated with the new mine facilities area.

Notwithstanding the above, cost-effective methods are available to improve the soil for optimal production. Extension products such as the NSW Department of Primary Industries SOILpak manuals (eg. McKenzie 1998) are available to systematically assist farmers and graziers with the identification and treatment of problems such as soil structural decline and acidification.

A summary of the soil constraints and measures which could be implemented to ameliorate the constraints is provided in Table 9. The estimated application rates and associated costs are also provided in Table 9.

Table 9. Summary of soil constraints and ameliorants

Soil Constraint	Ameliorants	Application Details	Estimated Cost
Dispersion	Application of coarse-grade (20 mm-50 mm) recycled gypsum on the Sodosols. Gypsum has a two-fold effect – it reduces sodicity through the displacement of exchangeable sodium and magnesium by calcium, and provides a mildly saline soil solution that creates a beneficial electrolyte effect.	Rate = 2.5 t/ha; So and McKenzie (1984)[1]	$225 per ha Cost includes purchase price (delivered to Gunnedah) and spreading; McKenzie *et al.* (1995) data[2]
Compaction	Mechanical loosening with an implement such as an agrowplow across all of the farming and grazing land. Procedures to minimise the risk of re-compaction, eg. GPS guidance of farm machinery, and avoidance – where possible – of grazing under moist conditions, would have to be implemented.	Shatter compacted layers to a depth of approx. 25 cm with a once-only agrowplowing (carried out, if possible, with soil water content at or just below the 'plastic limit')	$55 per ha This estimate is only approximate; the cost of mechanical loosening is strongly influenced by soil water content, stubble cover and machinery availability
Acidity	Application of finely-ground Attunga limestone ('lime'); incorporated via agrowplowing. Most of the cleared areas would benefit from 1 t/ha lime; areas represented by Pits 29, 41, 45 and 55 require double this rate.	Rate = 1 t/ha; Fenton (2003) calculations	$82-164 per ha Cost includes purchase price (delivered to Gunnedah), and spreading; McKenzie *et al.* (1995) data[2]

Table 9. Summary of soil constraints and ameliorants (cont)

Soil Constraint	Ameliorants	Application Details	Estimated Cost
Organic Carbon	Application of organic amendments is effective, but unlikely to be economically viable under dryland cropping/farming in the Boggabri area. Instead, maximise soil organic matter via conservation of organic residues produced by cash crops and pasture	n/a	n/a
Water Holding Capacity	There are no cost effective management measures to ameliorate the presence of bedrock and/or coarse gravel close to the surface.	n/a	n/a

[1] Follow-up applications may be needed if very wet weather rapidly leaches the dissolved gypsum

[2] Estimated supply and delivery costs verified with Landmark, Gunnedah in August 2011.

7.4 Soil Resource Management Measures

General soil resource management practices, where surface development is proposed within the Project area, should involve the stripping and stockpiling of soil resources prior to any mine-related disturbance, other than clearing vegetation. The general strategy should be for those disturbance areas to be rehabilitated progressively, or at the completion of mining activities.

The objectives of soil resource management for the Project are to:

- Identify and quantify potential soil resources for rehabilitation.
- Optimise the recovery of useable topsoil and subsoil during stripping operations.
- Manage topsoil and subsoil reserves so as not to degrade the resource when stockpiled.
- Establish effective soil amelioration procedures to maximise the availability of soil reserves for future rehabilitation works.
- Take into account both the natural soil requirements of the local native vegetation, and the need to provide soil conditions that minimise the risk of soil loss via wind and water erosion during and after rehabilitation.

Stripping

The following management measures should be implemented during the stripping of soils at the Project (TCPL 2010):

- Areas of disturbance are to be stripped progressively, as required, to reduce potential erosion and sediment generation, and to minimise the extent of topsoil stockpiles and the period of soil storage.
- Areas of disturbance requiring soil stripping are to be clearly defined following vegetation clearing.
- Topsoil and subsoil stripping during periods of high soil moisture content (i.e. following heavy rain) is to be avoided to reduce the likelihood of damage to soil structure.

The degree of success of a stripping and stockpiling program is strongly influenced by soil water content. Attempts to strip soil under moist conditions with inappropriate machinery settings can aggravate structural degradation problems. Excessive compaction and/or remoulding of the soil by heavy machinery under wet conditions also can be a major problem.

Where soil dispersion problems are aggravated by stripping during periods of high moisture content, gypsum should be applied to encourage re-stabilisation of the stripped soil.

Stockpile Management

The following management measures should be implemented during the stockpiling/storage of soils at the Project:

- Topsoil and subsoil stockpiles should be retained at a height of 3 m, with slopes no greater than 1:2 (vertical to horizontal [V:H]) and a slightly roughened surface to minimise erosion.
- Construct topsoil stockpiles in a way that minimises erosion, encourages drainage, and promotes revegetation.
- Where amendments such as lime, gypsum and fertiliser are needed to improve the condition of cut soil, they should be applied to the stockpiles in-between the application of separate layers from the scrapers.
- Wherever practicable, soil should not be trafficked, deep ripped or removed in wet conditions to avoid breakdown in soil structure.
- All topsoil and subsoil stockpiles should be seeded with a non-persistent cover crop to reduce erosion potential as soon as practicable after completion of stockpiling. Where seasonal conditions preclude adequate development of a cover crop, stockpiles should be treated with a straw/vegetative mulch to improve stability.

- Grow deep-rooting vegetation to encourage organic matter accumulation and maintain microbial activity. Stockpile height can be excessive because of limited space at mine sites, but try to keep it as low as possible. This maximises the chances of plenty of plant roots reaching the base of the stockpile as it awaits redistribution.
- There should be no vehicle access on soil stockpiles.
- Soil stockpiles should be located in positions to avoid surface water flows. Silt stop fencing would be placed immediately down-slope of stockpiles until stable vegetation cover is established.
- In the event that unacceptable weed generation is observed on soil stockpiles, a weed eradication program should be implemented.
- An inventory of soil resources (available and stripped) on the Project site should be maintained and regularly reconciled with rehabilitation requirements.
- In preference to stockpiling, wherever practicable, stripped topsoil and subsoil should be directly replaced on completed sections of the final landform.

Application of Soil on Rehabilitated Landforms

The following management measures should be implemented during the application of soils on rehabilitated landforms at the Project:

- Topsoil and subsoil placement shall only proceed once the final landform and major drainage works (i.e. graded banks, drainage channels and rock waterways if required) have been completed.
- Topsoil and subsoil placement is to be undertaken from the top of slopes or top of sub drainage catchment to minimise erosion damage created by storm run-off from bare upslope areas.
- Topsoil and subsoil placement is to be conducted along the general run of the contour to minimise the incidence of erosion.
- Topsoil and subsoil is not to be placed in the invert of drainage lines or drainage works.
- Spread topsoil/subsoil profile thickness and quality is to be evaluated prior to sowing.

Rehabilitation Management Plan

It is recommended that a Rehabilitation Management Plan for the Project be prepared by a suitability qualified expert to detail the soil resource management measures outlined in the sections above. The Rehabilitation Management Plan should be progressively updated to cater for the site-specific management requirements of soils as the Project progresses from west to east.

7.5 Rehabilitation – Agricultural Land Uses

Chemical and physical assessment of the soil properties of the area surveyed indicate that the soil resources quantified in Table 8 would be suitable for rehabilitation purposes provided appropriate management practices (Section 7.4) are implemented during handling and relevant amelioration measures (Section 7.3) are applied where necessary. This section focuses on the rehabilitation of lands proposed for agricultural land uses post-mining.

The Stratic Rudosols located along the south-eastern section of the Project surface disturbance area have the potential to be stripped to a depth of at least 3 m (Figure 12) for use in rehabilitation (Section 7.2). It is considered that this soil could be used as a rehabilitation medium for agricultural uses (including cropping/grazing areas) post-mining, following treatment with coarse-grade gypsum (Section 7.3). This soil is considered suitable for this post-mining land use for the following reasons:

- pH values are favourable;
- ESP values are low enough to be treated easily with coarse-grade gypsum;
- Most of the soil is non-saline; and
- CEC is high enough to allow natural decompaction through shrink-swell processes.

These chemical properties of the Stratic Rudosols would not be modified greatly during the stripping, stockpiling and spreading of the soils.

It is recommended that the Stratic Rudosols associated with the cleared creek flats be used to rehabilitate areas where a cropping/grazing post-mine land use is proposed. These areas should be prepared with a total soil profile depth of 150 cm. The waste rock that would underlie this layer is expected to have high porosity/permeability and is therefore expected to allow for beneficial deep drainage and deep root growth beyond a depth of 1.5 m. These areas should also be sloped to allow suitable drainage so that waterlogging can be avoided.

Soil profile reconstruction following major earthworks has been conducted in the Boggabri district previously. Cutting and filling operations (including soil profile reconstruction) associated with the landforming of nearby alluvial soil for irrigated cotton production has been very successful, despite some early challenges with soil structural degradation (McKenzie 1998). Soil structural problems induced by landforming for irrigated cotton have been addressed via a range of site-specific approaches that include deep ripping, gypsum spreading, nutrient application, and *in-situ* production of organic mulches.

The soil profile described above would provide rootzone chemical and physical conditions that are at least as favourable for cereal and pasture production as the existing agricultural areas. Based on the soil quantities detailed in Table 8 and a soil profile of 1.5 m, up to approximately 160 ha of agricultural land capable of cropping could be re-established post-mining.

8. PROJECT SITE AGRICULTURAL ACTIVITIES

8.1. Existing

Agricultural Enterprises and Productivity

Agricultural enterprises known to have been conducted on the Project site include areas where a combination of pasture production for grazing and some rainfed crop production are undertaken and areas where pasture production for grazing only is undertaken. Figure 3 shows the areas of the Project site that are known to have been used for agricultural enterprises (i.e. pasture production for grazing or rainfed crop production).

Approximately 335 ha of agricultural land on the Project site would be disturbed (Table 10). About 210 ha of this has been/could be potentially used for rotational rainfed crop production (based on the area of Agricultural Suitability Class 3 lands – Figure 10) (Table 10). There has been rotation of crops (usually wheat) with lucerne-based pasture, all of which is non-irrigated. The main areas where rainfed crop production has occurred/could occur are located on the flatter areas of the Project site near Goonbri Creek. Remaining agricultural land that would be disturbed (125 ha) by the Project has typically been used for grazing (based on the area of Agricultural Suitability Class 4 lands – Figure 10). The Agricultural Suitability Class 5 lands (Figure 10) are not considered suitable for agriculture – mainly because of site steepness and shallowness of the soil profiles – and are therefore not included in Table 10. Table 10 provides an overview of the main agricultural enterprises conducted on the Project site that would be disturbed.

Table 10. Summary of agricultural enterprises conducted on the Project site

Enterprise	Approximate Area to be Disturbed (ha)
Rainfed crop production in rotation with improved pasture; ▪ Wheat ▪ Lucerne pasture; grazed by beef cattle	210
Grazing on pasture dominated by native species ▪ Beef cattle	125
Total	335

Agricultural Infrastructure

Agricultural infrastructure located on the Project site includes:

- Fences.
- Small farm dams.

Agricultural Productivity

A range of agricultural enterprises have been conducted at the Project site (Table 10). The productivities of the different agricultural enterprises in average rainfall years have been estimated for each of the agricultural areas on the Project site (Table 11). The productivities and rotation sequences have been estimated based on local farmer descriptions (collated by Whitehaven), Department of Primary Industries Farm Budget website[7], and the 'Soils, land use systems and land management practices' Tables for the 'Brigalow Belt South Bioregion' (McKenzie and Mactaggart 2002).

Table 11. Approximate productivity of the agricultural enterprises on the Project site

Enterprise	Yield (t/ha)	Gross Margin ($/ha/year)
Rainfed crop production in rotation with improved pasture;		
▪ Wheat	1.7 grain	285 (70% of time)
▪ Lucerne	4.0 DM	203 (30% of time)
Grazing (native pasture)		
▪ Beef cattle	2.0 DM	95

Note: DM = Dry Matter.

The following assumptions were used to estimate the information in Table 11:

- Dryland wheat produced with a 'No Till, Short Fallow' production system (Class 3 agricultural land).
- Improved (Lucerne) pasture used to grow out Steers 240-460 kg in 12 months (Class 3 agricultural land).
- Native pasture (Non-Lucerne) used to produce Inland Weaners (Class 4 agricultural land).
- It is important to note that crop and pasture productivity in the Boggabri district is influenced very strongly by year-to-year variations in rainfall, but the approximate yields and gross margins that have been presented are based on a year with an average rainfall.
- In some years, it is anticipated that stormwater from the up-slope Class 4 land will run onto the down-slope Class 3 areas and boost productivity through enhanced soil moisture availability.

[7] http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/176071/West-All-2011.pdf;
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/175526/Grow-out-steers-240-420kg.pdf
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/175534/Inland-weaners-stores.pdf
http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/175533/Summary.pdf

8.2. Post-Mining

Agricultural Enterprises

As described in Section 7.1, areas of the rehabilitated Project site would be established for agricultural purposes (Figure 11). Approximately 210 ha of agricultural land would be established on Project disturbance areas post-mining. This area would consist of 160 ha of re-established agricultural land (Section 7.5) and approximately 50 ha of Class 3 agricultural land (i.e. the mine facilities area and the temporary soil stockpile) that would be returned to agricultural use post mining. A breakdown of this agricultural land is provided in Table 12.

Table 12. Summary of agricultural enterprises conducted on the Project site post-mining

Enterprise	Area (ha)
Rainfed crop production in rotation with improved pasture; ▪ Wheat ▪ Lucerne pasture	210
Grazing ▪ Cattle	0
Total	210

Agricultural Productivity

The productivity of the agricultural enterprises that would be re-established post-mining are expected to be similar to the existing productivities (Section 7.5) provided in Table 11.

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APPENDIX E

REHABILITATION RISK ASSESSMENT

Risk Assessment of Rehabilitation-Related Aspects

Environmental Factor	Hazard (Stressor)	Source of Hazard	Event	Potential Impacts	Likelihood	Consequence	Inherent Risk	Proposed controls	Likelihood	Consequence	Residual Risk
Landforms and Closure	Clearing and earthworks Physical presence	• Open cut and OEA	• Landform instability • Landform incompatibility • Alteration of natural landform function	Design failure results in landform instability	5	4	High	• Controls outlined in the MSRP and the MOP, specifically: – progressive mine planning; – regular review and revision of mine plans and rehabilitation performance; and – progressive rehabilitation.	2	4	Medium
				Significantly impacts on visual amenity	2	4	Medium	• Controls outlined in the MSRP and the MOP, specifically: – progressive rehabilitation; and – low impact colour infrastructure.	2	1	Low
				Significant change in surface water flow	5	4	High	• Controls outlined in the MSRP, MOP and Water Management Plan, specifically: – Stockpiled materials would be selected and drainage designed to minimise erosion. • Appropriately engineered surface water diversions.	2	4	Medium

Environmental Factor	Hazard (Stressor)	Source of Hazard	Event	Potential Impacts	Likelihood	Consequence	Inherent Risk	Proposed controls	Likelihood	Consequence	Residual Risk
Surface Water	Clearing and rehabilitation earthworks Liquid and solid waste disposal Hazardous substances	Overburden emplacement area Open cut Mine infrastructure area	• Misdirection of surface water flows • Erosion • Sedimentation • Contamination of surface water flows	Sedimentation of watercourses	4	2	Medium	• The open cut would be bunded to separate clean and dirty run-off. • Sediment control measures would be designed and implemented as required. • Containment bunds. • Controls outlined in the MOP. • Controls outlined in the Water Management Plan.	4	2	Medium
				Significant reduction in water quality	3	2	Medium	• Spill procedures/kits. • Water quality monitoring and maintenance of hydraulic control structures. • Controls outlined in the Water Management Plan, specifically: – Controlled wastes would be properly handled. – On-site solid waste disposal would be minimised and properly managed. – Hazardous substances would be stored in properly bunded facilities. – Manage drainage and water flows so as to protect water quality and direction of water flow including drainage diversions.	3	2	Medium

Environmental Factor	Hazard (Stressor)	Source of Hazard	Event	Potential Impacts	Likelihood	Consequence	Inherent Risk	Proposed controls	Likelihood	Consequence	Residual Risk
Groundwater	Clearing and earthworks Liquid and solid waste disposal Hazardous substances	Open cut dewatering Overburden emplacement area	• Localised dewatering of aquifer • Contamination of aquifer during operations • Contamination of aquifer post-closure	Significant impact on existing supply bores	2	2	Low	• Monitoring to verify predicted groundwater model drawdown. • Monitor abstraction of groundwater volume and levels and quality of groundwater bores. • Identification of at-risk bores and implementation of mitigation measures (if required).	2	2	Low
				Significant impact on surface water (incl. Back Creek, Namoi River)	2	2	Low	• Monitoring to verify predicted low risk of impact.	2	2	Low
				Significant reduction in groundwater quality	3	2	Medium	• Promote awareness of management procedures for contaminants used on-site. • Store contaminants in appropriately bunded facilities, ensure spills are thoroughly cleaned up. • Appropriate disposal. • Spill procedures/kits. • Monitoring and maintenance strategy.	2	2	Low
				Long-term significant groundwater contamination (salinity) arising from pit lake	3	2	Medium	• Monitoring to verify predicted groundwater behaviour. • Implementation of mitigation measures (e.g. backfill if required).	2	2	Low

Environmental Factor	Hazard (Stressor)	Source of Hazard	Event	Potential Impacts	Likelihood	Consequence	Inherent Risk	Proposed controls	Likelihood	Consequence	Residual Risk
Flora and Vegetation	Climatic conditions Fire Dust Weed Invasion Inappropriate soil substrate	Overburden storage area Backfilled sections of the open cut	• Failure of revegetation through poor climatic conditions, pests, inappropriate selection of plant species • Accumulation of dust in rehabilitation areas (from nearby operational areas) • Weed invasion/spread into rehabilitation areas • Failure of vegetation due to poor soil conditions	Vegetation communities that develop in rehabilitation areas are inconsistent with surrounding areas and the pre-mining vegetation.	4	4	High	• Soil Management Protocol. • Implement the MOP and MSRP. • Conduct progressive rehabilitation. • Implement the rehabilitation monitoring program. • Implement the BMP. • Educate employees about preventing bushfires and implement the TCM Bushfire Management Plan. • Educate employees about dust control and implement the TCM Air Quality Management Plan.	2	4	Medium
Fauna	Clearing and rehabilitation earthworks Lighting Noise Physical presence Physical interaction	Overburden storage area Backfilled sections of the open cut	• Failure of fauna habitat in rehabilitation areas due to climatic conditions, pests, inappropriate selection of plant species • Artificial lighting • Noise associated with mining activities adjacent to rehabilitation areas • Increase in feral animal habitat	Fauna habitat in rehabilitation areas is not suitable or insufficiently developed. Feral animals become established in rehabilitation areas.	4	2	Medium	• Implement the MOP and MSRP. • Conduct progressive rehabilitation. • Implement the rehabilitation monitoring program. • Implement the BMP. • Educate employees about the identification and management of feral animals.	2	2	Low

Environmental Factor	Hazard (Stressor)	Source of Hazard	Event	Potential Impacts	Likelihood	Consequence	Inherent Risk	Proposed controls	Likelihood	Consequence	Residual Risk
Environmental Factor	Hazard (Stressor)	Source of Hazard	Event	Potential Impacts	Likelihood	Consequence	Inherent Risk	Proposed controls	Likelihood	Consequence	Residual Risk
Soil Resources	Clearing and earthworks Hazardous substances	Rehabilitation areas Project wide	• Inadequate salvage of topsoil • Compaction of soil • Inadequate management of PAF material • Lack of stockpile coordination • Soil mixed up with waste dumps or buried under waste dumps	Loss of soil resources that significantly impacts rehabilitation	3	2	Medium	• MSRP and MOP • Soil Management Protocol and Land Disturbance Protocol. • Mine planning measures to identify PAF material and avoid or appropriately manage.	2	2	Low
				Significant contamination of soil resources	2	2	Low	• Bunded fuel/chemical storage. • Appropriate disposal. • Spill procedures/kits.	2	2	Low
				Reduction in viability of seeds, nutrients, organic matter and micro-organisms	2	2	Medium	• Stockpile management as per measures outlined in Soil Management Protocol.	2	2	Low
				Changes to the natural soil evolution/forming process caused by stripping and reusing soil from disturbed areas in rehabilitation	2	2	Low	• Stockpile management as per measures outlined in Soil Management Protocol.	2	2	Low