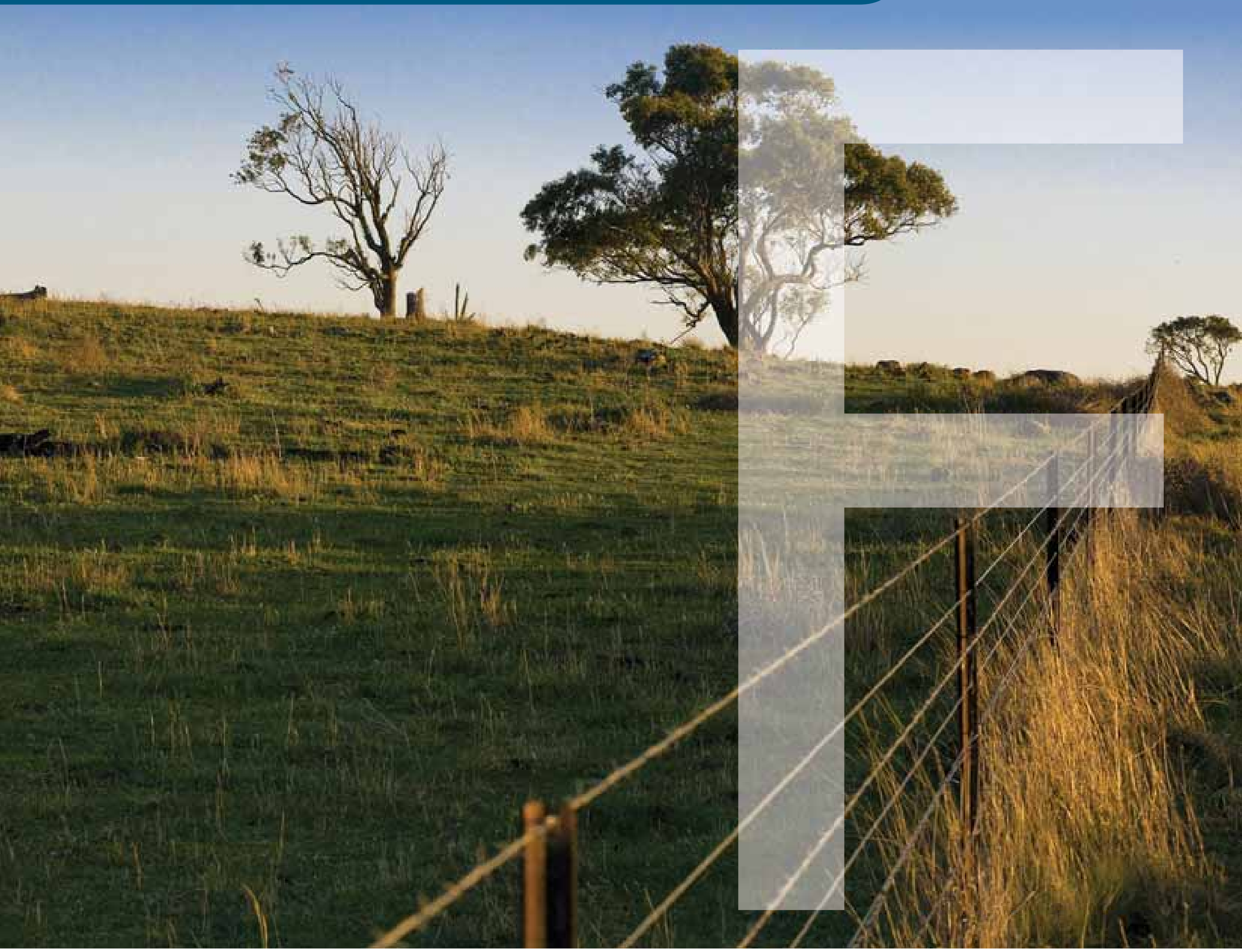
APPENDIX F

Mine rehabilitation strategy



Cobbora Holding Company Pty Limited

EMM EMGA Mitchell McLennan

Cobbora Holding Company Pty Limited

Mine Rehabilitation Strategy: Cobbora Coal Project

September 2012

EMG00-005

GSS ENVIRONMENTAL
Environmental, Land and Project Management Consultants

Prepared on behalf of EMGA Mitchell McLennan for Cobbora Holding Company Pty Limited

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3	13.09.2012	Mine Rehabilitation Strategy – Cobbora Project_Final v2	AC	IT

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LIST OF SHORT FORMS

AEMR	Annual Environmental Monitoring Report
ANZMEC	Australian and New Zealand Minerals and Energy Council
ASC	Australian Soil Classification
CHC	Cobbora Holding Company Pty Limited
CHPP	coal handling and preparation plant
DBH	depth, breadth and height
DGR	Director General's environmental assessment requirements
DTIRIS	Department of Trade & Investment, Regional Infrastructure and Services
DP&I	Department of Planning and Infrastructure
dS/m	deci-Siemen per metre
EC	electrical conductivity
EMM	EMGA Mitchell McLennan Pty Limited
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
ESP	exchange sodium percentage
GSSE	GSS Environmental
ha	hectares
kg/ha	kilogram per hectare
km	kilometre
km^2	kilometre squared
m	metre
MCM	million cubic metres
mm	millimetre
MOP	Mining Operation Plan
Mtpa	million tonnes per annum
n.a.	not applicable
NSW	New South Wales
OEH	Office of Environment and Heritage
OOP	out-of-pit
pH	measure how acidic or basic a substance is.
Project, the	Cobbora Coal Project
ROM	run of mine
t/ha/yr	tonnes per hectare per year

EXECUTIVE SUMMARY

GSS Environmental was commissioned by EMGA Mitchell McLennan Pty Limited on behalf of the proponent, Cobbora Holding Company Pty Limited, to prepare a mine rehabilitation strategy to accompany a major project application under Part 3A of the *Environmental Planning and Assessment Act 1979* (NSW) for the proposed Cobbora Coal Project (the Project).

This document, the *Mine Rehabilitation Strategy*:

- describes the existing environment;
- describes the post-mining landform and conceptual final landform design;
- provides the post-mining landform's Rural Land Capability classification, Agricultural Suitability classification and proposed land use;
- outlines short-term and long-term rehabilitation objectives;
- details actions to manage soil resources for conservation and use in the rehabilitation process;
- details the planned progressive revegetation of the site;
- provides the objectives and preliminary success criteria for mine closure;
- details the monitoring program requirements necessary to assess the performance of rehabilitation;
- outlines the principles of the final void management plan; and
- provides recommendation for regular review of the mine rehabilitation strategy.

The Project Site is 27,386 ha and has a disturbance footprint that covers approximately 4,700 ha. The footprint was divided into five domains: (1) Mining Operations Domain, (2) Mine Infrastructure Domain, (3) Auxiliary Infrastructure Domain, (4) Road Network Domain, and the Raw Water Dam Domain.

The Project Site is covered by two major soil types (Red-Brown Duplex and Yellow Duplex) and three minor soil types (Grey Skeletal, Friable and Alluvial). These soil types range from texture contrast red and yellow clayey soils on the rolling hills to skeletal shallow grey soils on the steeper slopes. The disturbance footprint is covered primarily by the Red-Brown Duplex and Yellow Duplex soil types.

The dominant Rural Land Capability Class across the Project Site is Class IV (approximately 36%). This land is mainly used for cattle and sheep grazing. The Project Site also contains some Class III land (approximately 22%), Class V land (approximately 18%) and Class VI land (approximately 17%). The Class III land is used for the production of crops for feedstock (e.g. wheat and oats) as well as for the production of rotational crops such as canola and wheat. The Class V and Class VI land which is not timbered with native woodland is used for cattle grazing along with some merino wool and prime lamb production. The Project Site also contains a small quantity of Class II land (2%), which is good quality cropping land.

The area to be disturbed by the proposed Project (the disturbance footprint) is primarily covered by Rural Land Capability Class IV (50%). The Project will also disturb some Class III land (17%); no Class II land will be impacted. Non-impacted land on the Project Site will be managed throughout the life of the mine by an on-going land management plan. This plan will ensure the best agricultural use of non-mine lands and provide opportunities for private farmers to use these through long-term leases.

The Project's decommissioning strategy will return most land associated with the mine and auxiliary infrastructure components to their pre-mining state. The exception is the rail spur, which will have only its infrastructure elements removed; the embankments and cuttings will be left in place. The upgraded and realigned roads will remain in place as an active network, whilst the haul roads will be rehabilitated. The raw water dam will also left in place for re-use as a water resource in post-mining agricultural activities. The land within the Mining Operations Domain will be reshaped to form a gently inclined landform with some steeper perimeter slopes and will contain one void area. This reshaped landform will be capable of sustaining rural enterprises similar to the pre-mining landform and, in addition, the overall quantity of Class III land within the Mining Operations Domain will be increased from 660 ha to 1000 ha. Sufficient topsoil resources are available from within the disturbance footprint to facilitate the successful achievement of the proposed post-mining land use.

A series of rehabilitation objectives and success criteria have been set for the Project Site; these relate to its target post-mining land use classification. Recommendations on the management of final void areas, and final land use options, are addressed in this report. In year 15 (that is, five years prior to the mine's closure) a detailed closure plan will be prepared.

1.0 INTRODUCTION

GSS Environmental (GSSE) was commissioned by EMGA Mitchell McLennan Pty Limited (EMM) on behalf of the proponent, Cobbora Holding Company Pty Limited (CHC), to prepare a mine rehabilitation strategy to accompany a major project application under Part 3A of the *Environmental Planning and Assessment Act 1979* (New South Wales (NSW)) (the EP&A Act) for the proposed Cobbora Coal Project (the Project).

A major project application under Part 3A of the EP&A Act was submitted to the NSW Department of Planning and Infrastructure (DP&I) on 5 January 2010 (application number MP_10_0001). The Director General's environmental assessment requirements (DGRs) for the Project were issued on 4 March 2010. Following changes to the proposed Project and government assessment requirements, revised DGRs were issued for the Project on 23 December 2011.

In August 2012, the mine plan was revised for Year 16 and Year 20 operations to improve final rehabilitation outcomes. The primary changes were as follows:

Year 16:

- removal of the waste dump extension to the east of Mining Area C; and
- waste rock placement in the northern part of the mined-out area of Mining Area B.

Year 20:

- removal of the waste dump extension to the east of Mining Area C, as per Year 16;
- further waste rock placement in the northern part of the mined-out area of Mining Area B; and
- waste rock placement in the mined-out area of Mining Areas A and C.

The modification reduces the number of final voids from three to one, halves area of the remaining final void and increases the area of rehabilitated landform. This report has been updated to reflect these modifications.

1.1 Project Description Overview

The Project is a new open-cut coalmine that will be developed near Dunedoo in the central west of NSW. The Project Application Area is approximately 274 square kilometres (km^2) (see **Figure 1.1**). The primary purpose of the Project is to provide coal for five major NSW power stations.

The mine will extract around 20 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. From this, a total of approximately 9.5 Mtpa of product coal will be produced for sale to Macquarie Generation, Origin Energy and Delta Electricity under long-term contracts. In addition, approximately 2.5 Mtpa will be produced for export or for sale on the spot domestic market.

The Project's key elements are:

- an open-cut mine;
- a coal handling and preparation plant (CHPP);
- a train loading facility and rail spur;
- a mine infrastructure area; and

- supporting infrastructure, which includes access roads, water supply and storage, and electricity supply.

It is envisaged that construction activities will commence in mid-2013 with coal supplied to customers from the second half of 2015. The mine life will be 21 years.

1.1.1 Open-cut Mine

Multiple open-cut mining pits will be developed within three mining areas:

- Mining Area A, north of the infrastructure area;
- Mining Area B, south of the infrastructure area; and
- Mining Area C, north-east of the infrastructure area.

There will be three out-of-pit waste rock emplacements:

- AC-OOP between mining areas A and C;
- B-OOP E adjacent to Mining Area B on the east side of Laheys Creek; and
- B-OOP W adjacent to Mining Area B on the west side of Laheys Creek.

A conventional load and haul operation is proposed using excavators, front-end loaders and trucks. Initially, trucks will haul waste rock to out-of-pit emplacements. Following this, the majority of the waste rock will be placed in the mined-out voids.

Trucks will haul excavated ROM coal to the CHPP where it will be tipped into hoppers above the primary crushers or onto secondary ROM stockpiles for later rehandling.

1.1.2 Coal Handling and Preparation Plant

The CHPP will treat up to 20 Mtpa of ROM coal to produce a product coal that meets the customers' coal sizing and quality requirements. Subject to the level of impurities (rejects) in the coal and washability characteristics, the ROM will be either crushed and bypassed or treated (washed) in the preparation plant. The rejects will typically include waste rock from above and below the coal seam as well as material dispersed within the coal.

The CHPP processes will be typical of those used in the majority of CHPPs in NSW, with product coal separated from rejects in a series of coal cleaning circuits. The CHPP area will also contain a truck dump station, crushing plants, coal stockpiles, and the infrastructure to move and stockpile the coal. Rejects from the CHPP will be disposed of within the footprint of the mining area.

1.1.3 Train Loading Facility and Rail Spur

Coal will be transported by rail to the Project's customers, Bayswater and Liddell power stations in the Upper Hunter Valley and Eraring, Vales Point and Munmorah power stations on Lake Macquarie on the NSW Central Coast.

Product coal will be loaded onto trains from an overhead train-loading bin located on a rail spur balloon loop. Approximately five trains will be loaded each day. The rail spur will be approximately 28 km long and will join the Dunedoo–Gulgong rail line near Tallawang. A locomotive provisioning facility and a siding for fuel delivery may be located adjacent to the balloon loop.

1.1.4 Mine Infrastructure Area

The Mine Infrastructure Area will be located adjacent to the mining areas. It will include workshops, hardstand and lay-down areas, bulk storage buildings, bulk fuel storage and a fuelling station, office buildings, an operations building and change-house, parking, an explosives magazine, and vehicle wash-down bays.

1.1.5 Supporting Infrastructure

1.1.5.1 Access Roads

The main access to the mine will be from the Golden Highway to the north of the mine, via a road diversion that will replace a section of Spring Ridge Road. There will be limited light vehicle access from the south via the established Spring Ridge Road.

Internal roads will connect the access road to the workshop, administration buildings and to the mine infrastructure area. Internal roads will also connect the various areas of the Project.

1.1.5.2 Water Supply

The Project will require water primarily for the CHPP and for dust suppression. Water will be sourced by intercepting surface water and by pumping groundwater that enters the mine pits in accordance with the relevant permits and licences. Water will also be sourced from the Cudgegong River and pumped approximately 26 km to the primary raw water dam south-east of the mining area. Pre-existing high security water access licences have been purchased for the Project to allow up to 3.3 gigalitres (GL) of water to be extracted from the river.

1.1.5.3 Electricity Supply

The Project will require approximately 25 megavoltamperes (mva) of electrical power. The Project will be connected to the grid at a small switching yard adjacent to the Castlereagh Highway. A power line, generally running parallel to the rail spur, will deliver the electricity to a substation in the Mine Infrastructure Area.

An 11 kV power line will supply the Cudgegong River pump station from an existing grid approximately 2 km south of the pump station site.

1.2 Description of Rehabilitation Domains

The Project's disturbance footprint is approximately 4,700 ha. The Project's disturbance footprint has been divided into five domains for the purposes of rehabilitation planning (**Figure 1.2**). An overview of each domain is provided below.

Domain 1: Mining Operations Domain

Domain 1 is the Mining Operations area (3,950 ha). It includes the open-cut Mining Areas A, B and C, and the out-of-pit waste rock emplacements AC-OOP, B-OOPE and B-OOPW. These Mining Areas and waste rock emplacements occur in three discrete disturbance areas:

- Northern Mining Operations area, which includes the open-cut Mining Areas A and C and out-of-pit waste rock emplacement AC-OOP;
- Southern Mining Operations area, which includes open-cut Mining Area B and out-of-pit waste rock emplacement area B-OOPW; and
- Eastern Operations Mining area, which includes the out-of-pit waste rock emplacement area B-OOPE.

Domain 2: Mine Infrastructure Domain

Domain 2 is the Mine Infrastructure area (130 ha). It includes the administration and workshop buildings, CHPP, coal stockpile area and locomotive provisioning infrastructure.

Domain 3: Auxiliary Infrastructure Domain

Domain 3 is the Auxiliary Infrastructure area (450 ha). It includes the water pipelines, rail lines and electricity infrastructure.

Domain 4: Road Network Domain

Domain 4 is the road network (110 ha). It includes the road upgrades and haul roads outside the mining area.

Domain 5: Raw Water Dam Domain

Domain 5 is the raw water storage dam (60 ha).

Total Disturbance Area

The area of land estimated to be disturbed by the Project has been generated by grouping individual disturbance elements into a single disturbance area. This area includes some land that is located between individual disturbance elements that will in practice not be impacted upon by the Project. For example, the rail spur will have a maximum disturbance footprint 60 m wide; however, this will be within a potential disturbance area that is up to 140 m wide to allow for minor changes to the alignment. The widths of the various disturbance elements are listed in **Table 1.1** and the expected total area to be disturbed is approximately 4,300 ha. For the purpose of this assessment, 4,700 ha is considered to be the potential disturbance footprint.

Table 1.1: Disturbance Footprint by Domain

Domain	Disturbance Element	Disturbance Description	Size (ha)
Mining Operations Domain			
1	Mining areas	Open-cut mining areas and out-of-pit waste rock emplacement areas	3,950
Mine Infrastructure Domain			
2	Mine infrastructure areas	Infrastructure area west of Spring Ridge Road including the administration buildings and explosives magazine	130
		Infrastructure area east of Spring Ridge Road including the CHPP, coal stockpile area, provisioning road, locomotive provisioning infrastructure and electricity substation	
Auxiliary Infrastructure Domain			
3	Water supply pipeline: raw water and supply pipeline	Pipeline construction corridors approximately 10 m wide and approximately 35 km long, including sections between the raw water dam and the CHPP	450*
	Rail spur, rail siding and locomotive provisioning facility	Rail spur and siding: 20 m to 60 m wide and approximately 28 km long; includes the switching station	
	Power easement	The power easement will be predominately within the rail spur footprint, with minor surface disturbance. Where this line deviates from the rail spur the footprint has a width of 40–60 m	
Road Network Domain			

Domain	Disturbance Element	Disturbance Description	Size (ha)
4	Roads	Realignment of Spring Ridge Road: west and north of the Northern Mining Operations area approximately 10 m wide and approximately 10 km long	110*
		Realignment of Dapper Road: approximately 10 m wide and approximately 5 km long	
		Realignment of Brooklyn Road: approximately 10 m wide and approximately 5 km long	
		Haul roads: approximately 40 m wide and approximately 10 km long	
Raw Water Dam Domain			
5	Raw water dam	Dam located to the south-east of B-OOPE	60*
Total			**4,700**

* potential disturbance area including a buffer

1.3 Objectives of the Mine Rehabilitation Strategy

The *Strategic Framework for Mine Closure* (ANZMEC, 2000) rehabilitation contains a series of rehabilitation criteria. These criteria state that rehabilitation outcomes:

- should be consistent with the environmental assessment which formed the basis of approval;
- must be based on mine closure criteria and rehabilitation outcomes developed through stakeholder consultation;
- should integrate rehabilitated native vegetation with undisturbed native vegetation to provide for larger areas and wildlife corridors;
- should be suitable for an agreed subsequent land use that is, as far as possible, compatible with the surrounding land fabric and land use requirements;
- should address limitations on the use of rehabilitated land;
- be sustainable in terms of that land use;
- produce stable and permanent landforms, with soils, hydrology, and ecosystems with maintenance needs no greater than those of surrounding land (may include waste emplacements, voids, pits and water bodies providing that they are part of the accepted final outcome);
- securely and safely contain waste substances that have the potential to affect land use or result in pollution;
- do not present a hazard to persons, stock or native fauna;
- address threatened species issues;
- address heritage issues;
- be clean and tidy, and free of rubbish, metal and derelict equipment/structures, except for heritage and other agreed features; and
- be free from unacceptable air and water pollution, and other environmental effects outside the disturbed area.

The purpose of this *Mine Rehabilitation Strategy* is therefore to establish objectives for the rehabilitation of the disturbed land that will result from the construction and operation of the Cobbora Coal Mine. In order to meet these objectives, the *Mine Rehabilitation Strategy* provides:

- a summary of the Project Site's existing biophysical environment;
- a rehabilitation strategy for the areas that are expected to be affected by surface disturbance;

- short-and long-term objectives for the rehabilitation of the site;
- a revegetation program based on current industry good practice and progressive learning as the site program is implemented;
- objectives and preliminary success criteria for mine closure; and
- a monitoring program to progressively assess performance of the rehabilitated areas.

1.4 Structure of the Mine Rehabilitation Strategy

This strategy comprises the following sections and information.

Section 1.0: Introduction

This section:

- provides a summary of the Project description;
- details the Project's disturbance footprint; and
- outlines the structure of the report.

Section 2.0: Planning and Legislation

This section:

- details the DGRs and other applicable standards; and
- outlines the relevance of key environmental assessment reports.

Section 3.0: Existing Environment

This section provides information on the Project Site's:

- climate, topography and hydrology;
- soil landscapes and soil types; and
- vegetation and land use.

Section 4.0: Post-mining Landform and Land Use

This section:

- details the general decommissioning strategy for each rehabilitation domain;
- provides the conceptual final landform design;
- provides the post-mining landform's Rural Land Capability classification;
- provides the post-mining landform's Agricultural Suitability classification; and
- provides the proposed post-mining land use.

Section 5.0: Rehabilitation Management Strategy

This section:

- provides rehabilitation principles;
- provides short-term and long-term rehabilitation objectives;
- describes the planned progressive revegetation of areas across the mine site;
- describes suitability of soil resources;
- describes management actions for stripped topsoil resources;
- describes a revegetation program; and
- outlines the basic requirements necessary to control erosion.

Section 6.0: Rehabilitation Monitoring and Performance

This section:

- provides objectives and preliminary success criteria for mine closure; and
- details a monitoring program to assess the performance of the rehabilitated areas.

Section 7.0 Final Void Management Plan

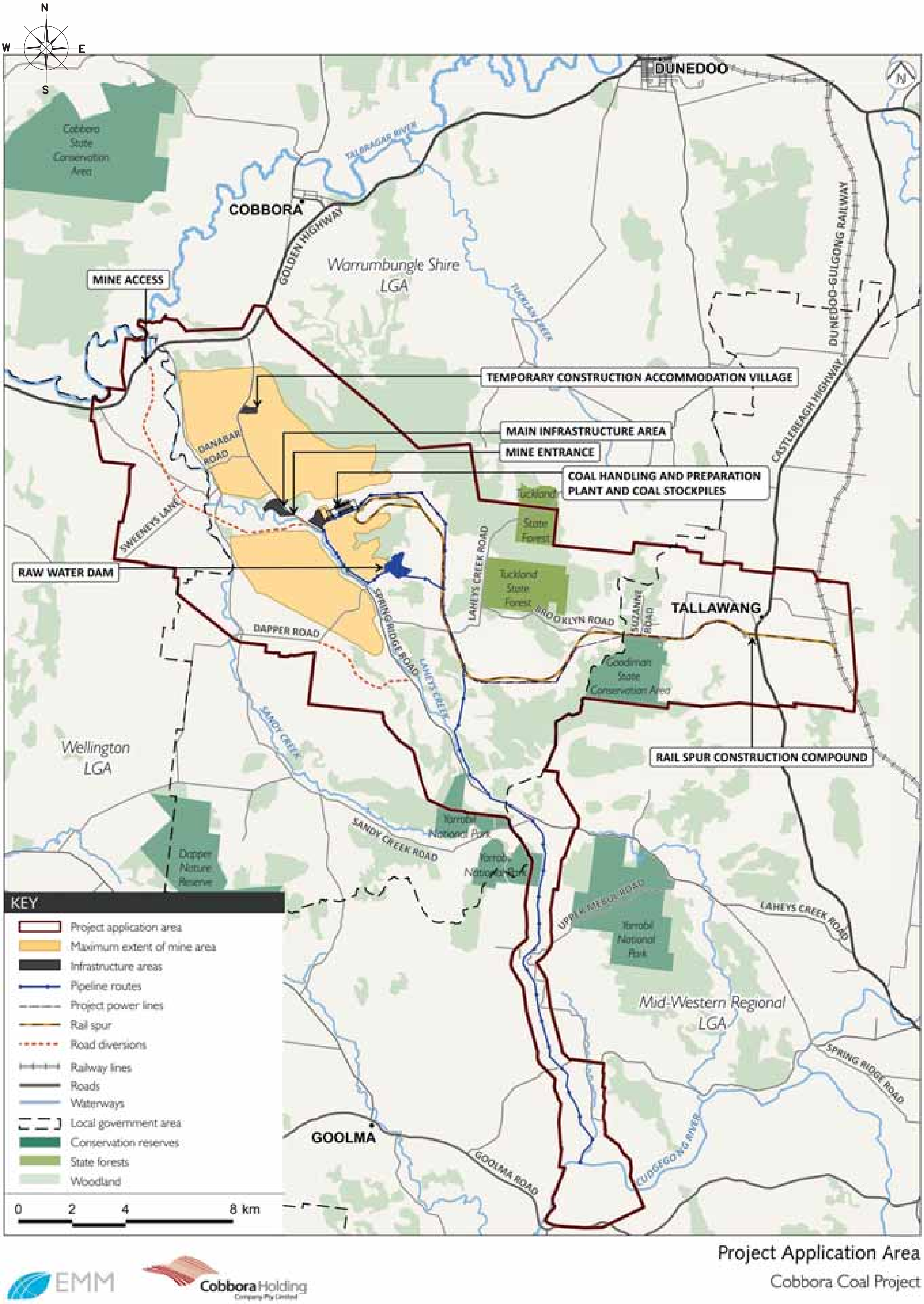
This section:

- describes the final void that will remain following cessation of mining;
- details the final slope stability and rehabilitation of the void; and
- recommends provisions for post-closure safety and final land use options for the void.

Section 8.0: Review of Mine Rehabilitation Strategy

This section:

- provides recommended frequencies for the review and update of this strategy throughout the life of the Project.



Base Plan Data Source: Integrated Design Solutions Pty Ltd

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Mine Rehabilitation Strategy: Cobbora Coal Project
Mine Plan

FIGURE 1.1

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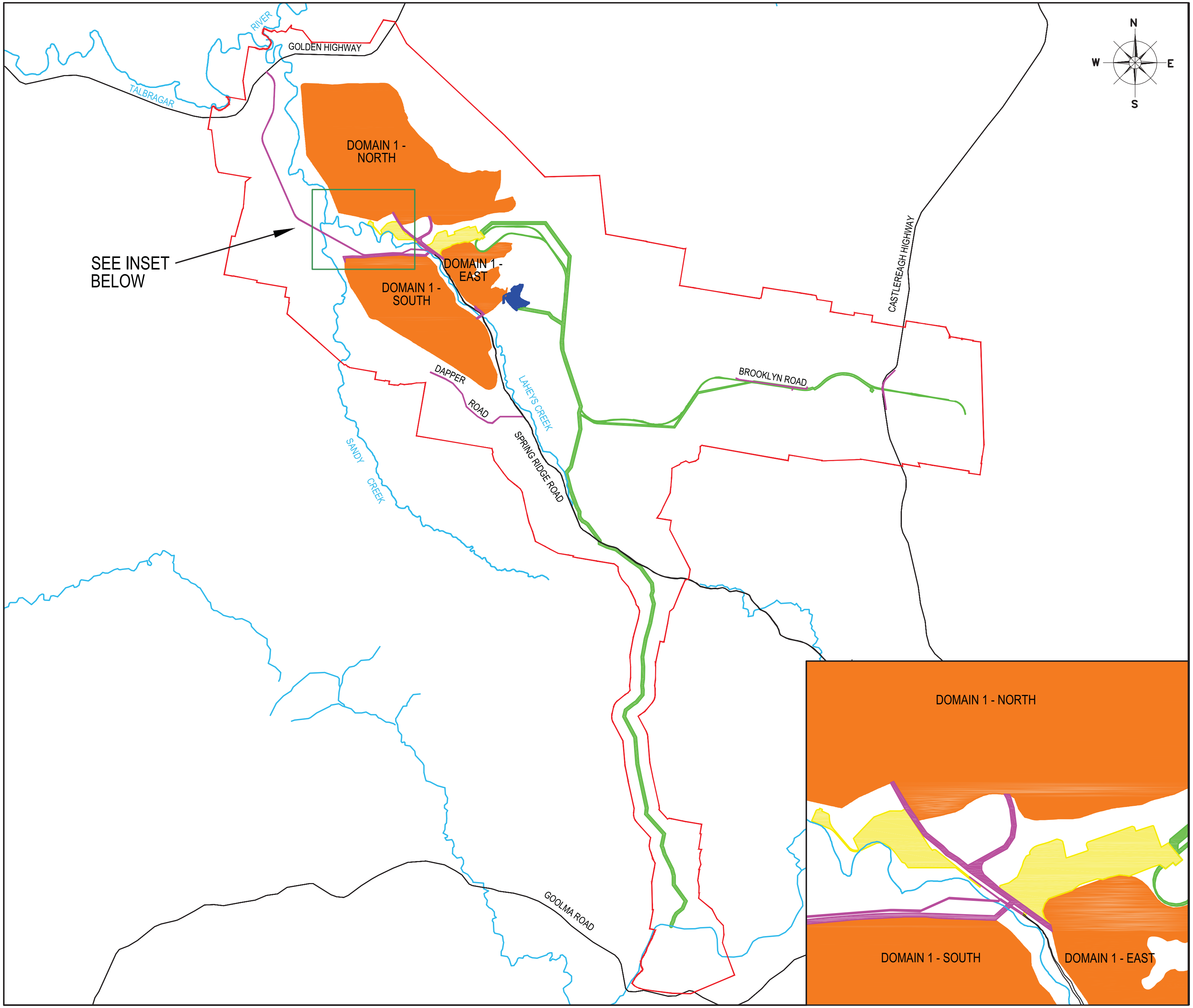

LEGEND

- Project Application Area
- Waterways
- Roads
- Project Components
- Domain 1 - Operations Area North, Operations Area South, Operations Area East
- Domain 2 - Mine Infrastructure
- Domain 3 - Auxillary Infrastructure
- Domain 4 - Road Network
- Domain 5 - Raw Water Dam

0 3.0km 6.0km

Scale 1: 190 000

FIGURE 1.2

Domain Plan

Project: Mine Rehabilitation Strategy: Cobbora Coal Project

Client: EMGA Mitchell McLennan Pty Limited

File: Fg1.2_EMG00-005_DomainPlan_120618

Projection: MGA94 Zone 55

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2.0 PLANNING AND LEGISLATION

2.1 Director General's Environmental Assessment Requirements

The DGRs for the Project were issued on 4 March 2011, and revised DGRs were issued on 23 December 2011. This revision was provided in response to amendments to the proposed Project and government assessment requirements.

This *Mine Rehabilitation Strategy* has been prepared in accordance with the DGRs. **Table 2.1** summarises the DGRs relevant to rehabilitation and indicates where specific issues have been addressed in this document.

Table 2.1: Summary of Director General's Requirements

Specific Issue	Where Addressed in Document
Provide a description of the proposed agricultural land and productivity, including:	
– a detailed assessment and mapping pre- and post-mining (including Rural Land Capability and Agricultural Suitability mapping) of soil characteristics, across all proposed areas of surface disturbance and an assessment of their value and limitations for rehabilitation;	Section 3
– 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;	Section 3
– identification of any regionally or state-significant agricultural resources in the locality, with particular reference to higher productive alluvial soils and associated surface/groundwater systems that may be impacted directly or indirectly by the proposal; and	Section 3
– justification for any significant long-term changes to agricultural resources, particularly if highly productive agricultural resources (e.g. alluvial lands and associated groundwater resources) are proposed to be affected by the Project.	Section 4
Provide a description of the proposed rehabilitation strategy for the Project, having regard for the key principles in the *Strategic Framework for Mine Closure* (ANZMEC, 2000), including:	
– nominated final land use, having regard for any relevant strategic land use planning or resources management plans or policies;	Section 4
– the potential for integrating this strategy with any other offset strategies in the region; and	Section 4
– rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria.	Section 5 and 6

2.2 Policy and Guidelines

This report has generally been prepared in accordance with the requirements of the following relevant strategic land use planning and resource management plans and policies:

- The *Strategic Framework for Mine Closure* (ANZMEC, 2000).
- The draft *Strategic Regional Land Use Policy* (DP&I, 2011).
- For soil taxonomy, the *Australian Soil Classification* (ASC) (Isbell, 1996) system was used to classify the soil.

- For the Rural Land Capability classification assessment, *Systems Used to Classify Rural Lands in New South Wales* (Cunningham et al., 1988) was applied.

- For the Agricultural Suitability Classification assessment, *Agricultural Suitability Maps – uses and limitations* (NSW Agricultural & Fisheries, 1990) was applied.

- For the soil suitability assessment the *Guide for Selection of Topdressing Material for Rehabilitation of Disturbed Areas* (Elliot & Reynolds, 2007) was applied to determine which soils on the site are suitable for conserving and utilising in the mine rehabilitation program.

2.3 Relevant Project Environmental Assessment Reports

This report should be read in conjunction with the *Agricultural Impact Statement: Cobbora Coal Project* (GSSE, 2012), which provides detailed information on the socio-economic value of the Project's agricultural land resources and quantifies the Project's socio-economic impacts from changed land use.

3.0 EXISTING ENVIRONMENT

3.1 Climate

The Project Site is located in the north-western region of NSW, which typically has a cool temperate climate with moderately dry winters and wetter summers. The annual average rainfall is 619 mm with the majority of this rainfall falling in the summer months of December to January (BOM, 2012). Temperatures within the Project region range from an average monthly maximum of 32º C in January to an average monthly minimum of 2º C in July. The average annual evaporation within the Project Site ranges between 1,800 and 2,000 mm (BOM, 2008).

3.2 Hydrology and Topography

The Project Site is situated in the Macquarie-Bogan Catchment and lies within the Sandy Creek Catchment. The Macquarie-Bogan Catchment extends from the central tablelands of Oberon, Bathurst and Rylstone to the western plains of Nyngan and Coonamble, and includes the Castlereagh, Bogan and Macquarie river valleys.

Regional rivers in the wider region include the Talbragar River, Cudgegong River, Castlereagh River and the Macquarie River. The Talbragar and Cudgegong rivers are proximal to the Project Site, situated on its northern edge and traversing the Project Site in the south respectively. The Talbrager River flows in a south-westerly direction, joining the Macquarie River north of Dubbo. It is an ephemeral waterway; that is, it ceases to flow during dry periods. The Cudgegong River rises in the Great Dividing Range above Rylstone and is a major tributary of the Macquarie River.

Within the Project Site, the main watercourses are the ephemeral Laheys Creek and Sandy Creek. Laheys Creek begins in the Project Site's central area and flows north to drain into Talbragar River. Sandy Creek begins in the south-western section of Yarrobil National Park and flows in a northerly direction external to the Project Site until its confluence with Laheys Creek in the Project Site's central north (**Figure 3.1**).

The Project Site exhibits three prominent topographic landforms: alluvial plains, undulating/rolling low hills and steep hills. The elevation ranges between 280 m above sea level around Sandy Creek to 600 m above sea level in the south of the Project Site (**Figure 3.1**).

3.3 Geology

The majority of the Project Site is underpinned by the Nappery and Dunedoo formations, ancient fractured igneous and sedimentary rocks. Basic geologic structures include undifferentiated Permian sandstones and shale and alluvium. Parent rocks include conglomerate; sandstone; siltstone; shale; quartz sandstone; lithic sandstone; ferruginous sandstone and siltstone; carbonaceous shale and coal (Colquhoun et al., 1999).

3.4 Soil Landscape Units

The Project Site contains six main geomorphic units: (1) Quaternary alluvium; (2) Permian – Triassic sedimentary sandstone and conglomerate; (3) Silurian – Early Devonian marine sandstone; (4) Early Devonian andesite; (5) Tertiary basalt; and (6) Devonian – Carboniferous siliceous granites.

Within these six broad geomorphic units, there are 16 soil landscapes as described by *Soil Landscapes of the Dubbo 1:250,000 Sheet* (Murphy & Lawrie, 1998). These landscapes are listed in **Table 3.1** and are described below.

Table 3.1: Soil Landscapes

Geomorphic Unit		Dominant Parent Rocks	Soil Landscape Unit	Project Site	
				ha	%
1	Quaternary alluvium	Alluvium	Cudgegong (Cd)	127	<1%
			Mitchell Creek (Mi)	507	2
			Talbragar (Tb)	116	<1%
Subtotal				750	3
2	Permian – Triassic sedimentary sandstone/ conglomerate	Permian sandstone and shales	Laheys Creek (Lc)	8,273	30
		Triassic and Jurassic conglomerate, sandstone, shale and coal	Dapper Hill (Dh)	6,834	25
			Spring Ridge (Sr)	1,546	6
		Triassic Sandstone, conglomerate, ferruginous limestone, shale and coal	Ballimore (Bm)	4,696	17
Subtotal				21,349	78
3	Silurian – early Devonian marine sandstone	Quartz-rich greywacke and slates	Mullion Creek (Mu)	648	2
			Mookerawa (Mk)	312	1
		Sediments and metasediments mainly of marine origin	Burrendong (Bd)	291	1
Subtotal				1,251	4
4	Early Devonian andesite	Andesite and tuff	Tucklan (Tk)	2,027	7
			Surface Hill (Su)	184	<1
Subtotal				2,211	8
5	Tertiary basalt	Olivine basalt	Mebul (Me)	452	2
			Bald Hill (Bh)	320	1
Subtotal				772	3
6	Devonian – Carboniferous siliceous granite	Granite	Rouse (Rs)	4	<1%
			Home Rule (Hr)	1,049	4
Subtotal				1,053	4
Total				**27,386**	**100**

Geomorphic unit 1: Quaternary alluvium

The Quaternary alluvium geomorphic unit covers approximately 3% of the Project Site and includes the Mitchell Creek, Talbragar and Cudgegong Soil Landscapes. The Mitchell Creek and Talbragar Soil Landscapes consist predominately of alluvial plains and low terraces of minor streams, levees and basins and are located in the Project Site's north-west where Laheys Creek joins with Sandy Creek. The Cudgegong Soil Landscape is located along the Cudgegong River in the south. The dominant underlying parent rock is Quaternary alluvium (sand, silt, clay), which has been derived from various rock types within the catchment.

Geomorphic unit 2: Permian – Triassic Sedimentary sandstone /conglomerate

The Permian – Triassic sedimentary sandstone/conglomerate geomorphic unit covers approximately 78% of the Project Site and includes the Laheys Creek, Dapper Hill, Ballimore and Spring Ridge Soil Landscapes. These landscapes cover the centre of the Project Site and are characterised by undulating low hills to rolling low hills.

The dominant underlying geology is sedimentary sequences of sandstone and conglomerate. The Laheys Creek Soil Landscape is underlain by Permian sandstone and shales, the Dapper Hill and Spring Ridge Soil Landscapes by Triassic and Jurassic conglomerates and sandstones, and the Ballimore Soil Landscape by Triassic sandstone and conglomerate as well as ferruginous limestone, shale and coal.

Geomorphic unit 3: Silurian – early Devonian marine sandstone

The Silurian – early Devonian marine sandstone geomorphic unit covers approximately 4% of the Project Site and includes the Mullion Creek, Mookerawa and Burrendong Soil Landscapes. The Mullion Creek Soil Landscape is located in the most southern extent of the Project Site and is characterised by undulating low hills. The Mookerawa Soil Landscape occurs along the lower south-east edge of the Project Site and is characterised by undulating to rolling low hills, while the Burrendong Soil Landscape occurs in the central-eastern part and is characterised by rolling to steep hills.

The underlying geology is Silurian to early Devonian greywacke, slate, shale, and acidic/siliceous volcanics. The Burrendong Soil Landscape is also underlain by sediments and metamorphic metasediments, mainly of marine origin, which are composed of schist, phylite and additionally some gneiss and rhyolite.

Geomorphic unit 4: early Devonian andesite

The early Devonian andesite geomorphic unit covers approximately 8% of the Project Site and includes the Tucklan and Surface Hill Soil Landscapes. These landscapes occur in the east of the Project Site and are characterised by low undulating hills and rolling low hills. Slopes are generally level to gently inclined (0–3%), with some minor areas having steeper slopes of 3–18%. The underlying parent rocks within this geomorphic unit are andesite, tuff, arkose and shale.

Geomorphic unit 5: Tertiary basalt

The Tertiary basalt geomorphic unit covers approximately 3% of the Project Site and consists of the Bald Hill and Mebel Soil Landscapes. These landscapes are located in discreet patches in the Project Site's southern parts and are characterised by undulating to rolling hills. Slopes are very gentle to gently inclined (3–10%). The underlying rock is predominately composed of Tertiary olivine basalt and dolerite. Rock outcrops are common in the Bald Hill Soil Landscape.

Geomorphic unit 6: Devonian – Carboniferous siliceous granite

The Devonian – Carboniferous siliceous granite geomorphic unit covers approximately 4% of the Project Site and includes the Home Rule and Rouse Soil Landscapes. These landscapes are located in the most eastern extent of the Project Site and cover undulating low rises. The underlying parent rock consists of siliceous granite. The Rouse Soil Landscape also exhibits granite outcropping as tors.

3.5 Soil Types

The Project Site contains five main soil types: (1) Red-Brown Duplex; (2) Yellow Duplex; (3) Grey Skeletal; (4) Friable; and (5) Alluvial (refer **Appendix 1**). These soil types are listed in **Table 3.2** and described below. **Figure 3.2** shows the spatial distribution of these soil types across the Project Site.

Table 3.2: Soil Types Overview

Soil Type			Project Site		Disturbance Footprint	
#	Common Name	ASC Name	ha	%	ha	%
1	Red-Brown Duplex	Red-Brown Chromosol/Sodosol	11,253	41	2,209	47
2	Yellow Duplex	Yellow Chromosol/Sodosol	12,944	47	2,115	45
3	Grey Skeletal	Grey Tenosol/Rudosol	1,783	7	329	7
4	Friable	Red-Brown Dermosol	656	2	<5	<1
5	Alluvial	Rudosol/Tenosol	750	3	47	1
Total			**27,386**	**100**	**4,700**	**100**

The co-dominant soil types across the site are the Red-Brown Duplex and Yellow Duplex, which comprise 47% and 41% of the Project Site respectively. The Grey Skeletal soil type comprises a minor proportion (7%) and the Alluvial and Friable soil types comprise a very minor proportion of the Project Site (<3% coverage each). The disturbance footprint is covered mainly by the co-dominant soil types.

Soil Type 1: Red-Brown Duplex

The Red-Brown Duplex soil type generally consists of weakly structured brown loams and sandy loams overlying strongly structured brown to strong-brown medium-heavy clay subsoil. These soils range from moderately acidic in the upper layers to moderately alkaline at depth and are non-saline. The topsoil is generally non-sodic; however the subsoil can be sodic.

Plate 3.1: Profile (Pit 8)

Plate 3.2: Landscape (Pit 8)

Soil Type 2: Yellow Duplex

The Yellow Duplex soil type generally consists of weakly structured brown loams and sandy loams overlying strongly structured yellow to yellowish-brown medium-heavy clay subsoil. Red-grey subsoil mottling is present which indicates restricted internal drainage. These soils range from moderately acidic in the upper layers to moderately alkaline at depth and are non-saline. The topsoil is generally non-sodic; however the subsoil can be sodic.

Plate 3.3: Profile (Pit 5)

Plate 3.4: Landscape (Pit 5)

Soil Type 3: Grey Skeletal

The Grey Skeletal soil type is characterised by shallow greyish-brown stony-clayey loams associated with the steeper eroded slopes and ridgelines throughout the Project Site. This soil type is poorly structured, strongly to very strongly acidic and non-saline throughout the profile. The topsoil is generally non-sodic with sodicity increasing with depth.

Plate 3.5: Profile (Pit 15)

Plate 3.6: Landscape (Pit 15)

Soil Type 4: Friable

The Friable soil type is characterised by well-structured gradational friable, self-mulching, reddish brown, stony-clayey loams and light clays. This soil type is associated with basaltic parent material scattered throughout the Project Site. The soil is slightly acidic in the upper layers and alkaline at depth, non-saline and non-sodic.

Plate 3.7: Profile (Pit 3)

Soil Type 5: Alluvial

The Alluvial soil type is characterised by a variety of alluvial deposits with sands and loams associated with the lower younger terraces throughout the Project Site and along the Cudgegong River. These alluvial soils range from moderately acidic in the upper layers to slightly alkaline at depth and non-saline throughout the profile. The topsoil is generally non-sodic; however the subsoil can be sodic.

3.6 Vegetation and Land Use

The Project Site has been highly modified by agricultural practices. More than half the site has been cleared and is covered by pasture grasses. The remaining areas are in various stages of natural regeneration post-grazing (<10% of the site) or contain mature remnant woodland communities (EMM, 2012). Remnant vegetation occurs in large patches across the Project Site and includes parts of Tuckland State Forest, Goodiman State Conservation Area and a small section of the Yarrobil National Park, with smaller discrete patches along the watercourses, road reserves and on hill tops.

Remnant vegetation typically consists of five broad vegetation communities. These are Box Gum Woodlands, Ironbark/Stringybark Woodlands, Red Gum Woodlands, Cypress Woodlands and regrowth communities. Box Gum Woodlands occur on the lower-lying parts of the Project Site, usually in association with the floodplain. Ironbark/Stringybark Woodlands occur on gentle midslopes to steep upper slopes. Stringybark Woodlands usually contain large rocky sandstone or granite outcrops, while those dominated by Ironbark contain sandstone or lateritic outcropping. Red Gum Woodlands occur on flat topography at the foot of gentle and steep slopes, whereas Cypress Woodlands occur on gentle midslopes to steep upper slopes and crests. Regrowth communities occur between the floodplain and the lower slopes of the Project Site and have been cleared previously for pastoral purposes.

3.7 Agricultural Land Classification

The quality of rural land in NSW has been historically mapped according to two different land classification systems. The first of these is known as the Rural Land Capability system. The system identifies eight possible land classes, with Rural Land Capability decreasing progressively from Class I to Class VIII. Class I is the most productive and Class VIII the least productive. The second system is known as the Agricultural Suitability system and provides a ranking of lands according to their relative productivity for a range of agricultural activities. Class 1 is the most productive and Class 5 the least productive.

The aim of the Rural Land Capability classification system is to delineate the various classes of rural lands on the basis of their capability to remain stable under particular land uses. This system classifies the land in terms of its inherent physical characteristics or physical constraints and denotes measures needed to protect the land from soil erosion and other forms of land degradation. It therefore considers the optimum use of land rather than the maximum use. The Rural Land Capability classification system does not imply any aspect of agricultural suitability, which can involve connection to markets, availability of water and other facilities. The Agricultural Suitability classification system aims to satisfy these agricultural suitability aspects.

The Agricultural Suitability system uses the Rural Land Capability assessment as a basis and then incorporates other specific factors such as closeness to markets, cultural factors, land location and adverse market demand to determine the appropriate Agricultural Suitability class. Consequently, a site's Agricultural Suitability classification may change over time due to market forces and changes to site-specific infrastructure. In contrast, the Rural Land Capability of a site generally will not change; however, some change may occur in conjunction with improvements in agricultural farming methodology that reduce erosion risk.

3.7.1 Rural Land Capability Classification

The relevant guideline used to classify the agricultural capability of land in NSW is the S*ystems Used to Classify Rural Lands in New South Wales* (Cunningham et al., 1988). This system classifies the land on its potential for sustainable agricultural use if developed, rather than its current land use, and includes land:

- suitable for cultivation;
- suitable for grazing; and
- not suitable for rural production.

The Rural Land Capacity classes classify the land based on the severity of long-term limitations. Limitations are the result of the interaction between physical resources and a specific land use. A range of factors are used to assess this interaction. These factors include climate, soils, geology, geomorphology, soil erosion, topography and the effects of past land uses. The principal limitation recognised by the classifications is the stability of the soil mantle. The classes are ranked on their increasing soil erosion hazard and decreasing versatility of use. A description of each of these classes is provided in **Table 3.3**.

Table 3.3: Rural Land Capability Classification

Class	Land Use	Management Options
I	Regular cultivation	No erosion control requirements
II	Regular cultivation	Simple requirements, such as crop rotation and minor strategic works
III	Regular cultivation	Intensive soil conservation measures required, such as contour banks and waterways
IV	Grazing, occasional cultivation	Simple practices, such as stock control and fertiliser application
V	Grazing, occasional cultivation	Intensive soil conservation measures required, such as contour ripping and banks
VI	Grazing only	Managed to ensure groundcover is maintained
VII	Unsuitable for rural production	Green timber maintained to control erosion
VIII	Unsuitable for rural production	Should not be cleared, logged or grazed

Source: Cunningham et al., 1988

The pre-mining Rural Land Capability Class for the Project Site ranges from Class II through to Class VII. This indicates that the site is capable of both cropping (Class II and III) and grazing (Classes IV to VI) enterprises as well containing some land that is best vegetated with trees and shrubs for erosion control (Class VII). The dominant class in the Project Site is Class IV (36%), followed by similar proportions of Class III (22%), Class V (18%) and Class VI (17%). The Project's proposed disturbance footprint will disturb predominantly Class IV land (50%) as well as some Class III land (17%) and VI land (17%) (**Table 3.4**; **Figure 3.3**).

Table 3.4: Pre-mining Rural Land Capability Classes

Rural Land Capability	Project Site		Disturbance Footprint	
Class	ha	%	ha	%
II	568	2	Nil	Nil
III	5,985	22	782	17
IV	9,880	36	2,380	50
V	4,797	18	435	9
VI	4,664	17	790	17
VII	1,492	5	313	7
VIII	Nil	Nil	Nil	Nil
Total	**27,386**	**100**	**4,700**	**100**

3.7.2 Agricultural Suitability Classification

The relevant guideline used to classify the agricultural suitability of land in NSW is the *Agricultural Suitability Maps: Uses and Limitations* (NSW Agricultural & Fisheries, 1990). Class 1 ranks the land as most suitable for agricultural activities and Class 5 as the least suitable. Classes 1 to 3 are generally considered suitable for a wide variety of agricultural production whereas Classes 4 and 5 are unsuitable for cropping; however, they are suitable for some grazing activities. A description of each of the Agricultural Suitability classes is provided in **Table 3.5**.

Table 3.5: Agricultural Suitability Classification

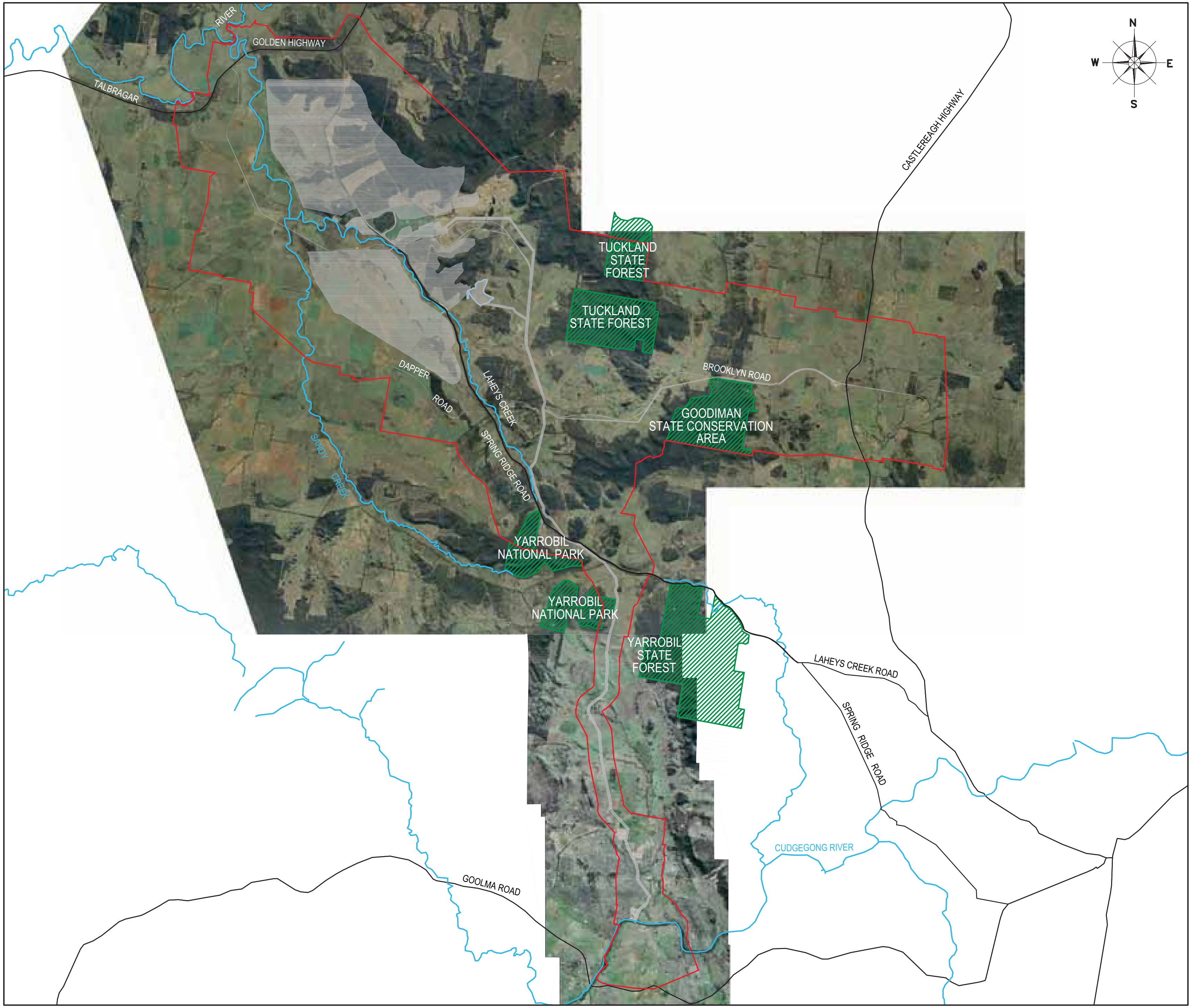
Class	Land Use	Management Options
1	Highly productive land suited to both row and field crops	Arable land suitable for intensive cultivation where constraints to sustained high levels of agricultural production are minor or absent
2	Highly productive land suited to both row and field crops	Arable land suitable for regular cultivation for crops but not suited to continuous cultivation
3	Moderately productive lands suited to improved pasture and to cropping within a pasture rotation	Grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture
4	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing	Land suitable for grazing but not for cultivation. Agriculture is based on native or improved pastures established using minimum tillage
5	Marginal lands not suitable for cultivation and with a low to very low productivity for grazing	Land unsuitable for agriculture or at best suited only to light grazing

Source: NSW Agriculture & Fisheries (1990).

The pre-mining Agricultural Suitability classification for the Project Site ranges from Class 1 through to Class 5) (**Figure 3.4**). This indicates that the site is suitable for both cropping (Classes 2 and 3) and grazing (Class 3 and 4) enterprises as well containing some land that is best used only for light grazing (Class 5). The dominant Class in the Project Site is Class 3 (54%), followed by smaller proportions of Class 2 (22%) and Class 4 (17%). The Project's proposed disturbance footprint will disturb predominantly Class 3 land (59%) as well as some Class 2 land (17%) and Class 4 land (17%) (**Table 3.6**).

Table 3.6: Pre-mining Agricultural Suitability Classes

Agricultural Suitability	Project Site		Disturbance Footprint	
Class	ha	%	ha	%
1	568	2	Nil	Nil
2	5,985	22	782	17
3	14,677	54	2,815	59
4	4,664	17	790	17
5	1,492	5	313	7
Total	**27,386**	**100**	**4,700**	**100**



LEGEND

- Project Application Area
- Disturbance Footprint
- Waterways
- Roads
- State Forest

0 3.0km 6.0km

Scale 1: 190 000

FIGURE 3.1

Biophysical Environment

Project: Mine Rehabilitation Strategy: Cobbora Coal Project

Client: EMGA Mitchell McLennan Pty Limited

File: Fg3.1_EMG00-005_BiophysicalEnvironment_120619

Projection: MGA94 Zone 55

Version:	Date:	Author:	Checked:	Approved:
1	30/03/12	KC	AC	AC
2	25/05/12	ZJ	AC	AC
3	19/06/12	ZJ/LF	AC	AC

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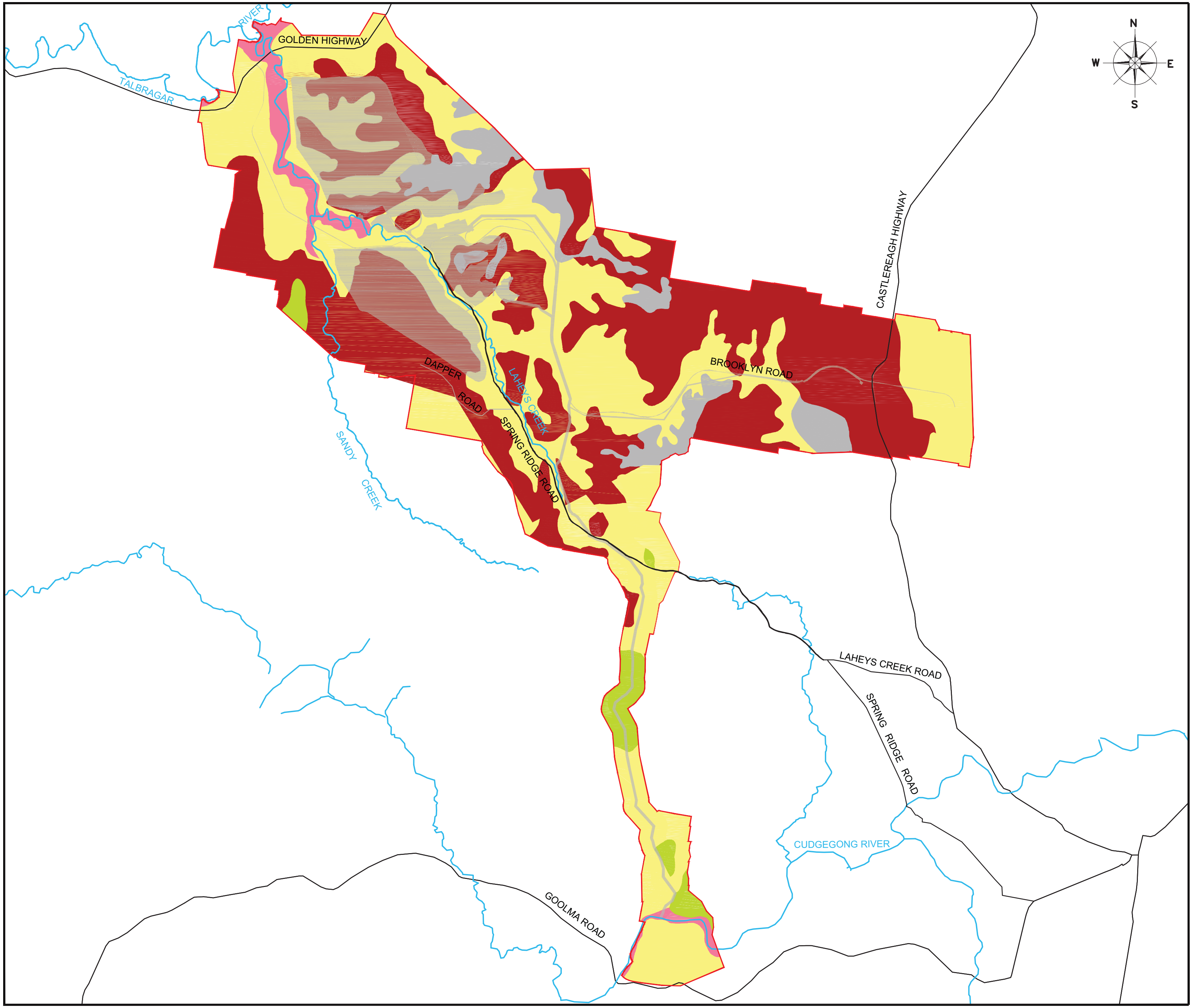

LEGEND

- Project Application Area
- Disturbance Footprint
- Roads
- Waterways

SOIL TYPE CLASSIFICATION

- Red-Brown Duplex
- Yellow Duplex
- Grey Skeletal
- Friable
- Alluvial

0 3.0km 6.0km

Scale 1: 190 000

FIGURE 3.2

Soil Types

Project: Mine Rehabilitation Strategy: Cobbora Coal Project

Client: EMGA Mitchell McLennan Pty Limited

File: Fg3.2_EMG00-005_SoilTypes_120619

Projection: MGA94 Zone 55

Version:	Date:	Author:	Checked:	Approved:
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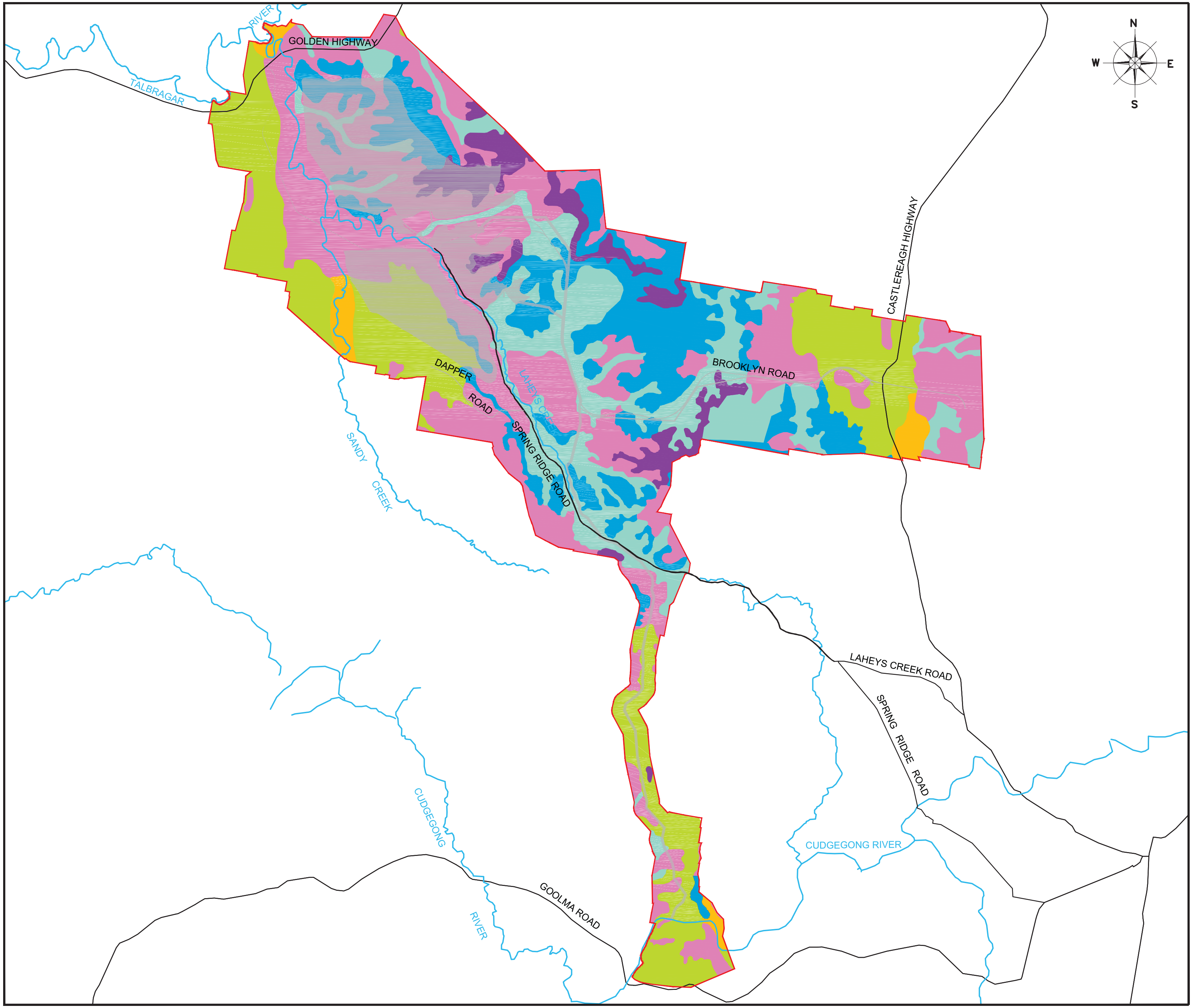

LEGEND

- Project Application Area
- Disturbance Footprint
- Roads
- Waterways

LAND CAPABILITY

- II Class II
- III Class III
- IV Class IV
- V Class V
- VI Class VI
- VII Class VII

0 3.0km 6.0km

Scale 1: 190 000

FIGURE 3.3

Pre-mining Rural Land Capability

Project: Mine Rehabilitation Strategy: Cobbora Coal Project

Client: EMGA Mitchell McLennan Pty Limited

File: Fg3.3_EMG00-005_RuralLandCap_120619

Projection: MGA94 Zone 55

Version:	Date:	Author:	Checked:	Approved:
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3	01/02/12	KC	AC	AC
4	20/02/12	LF	AC	AC
5	30/03/12	KC	AC	AC
6	25/05/12	ZJ	AC	AC
7	19/06/12	ZJ/LF	AC	AC

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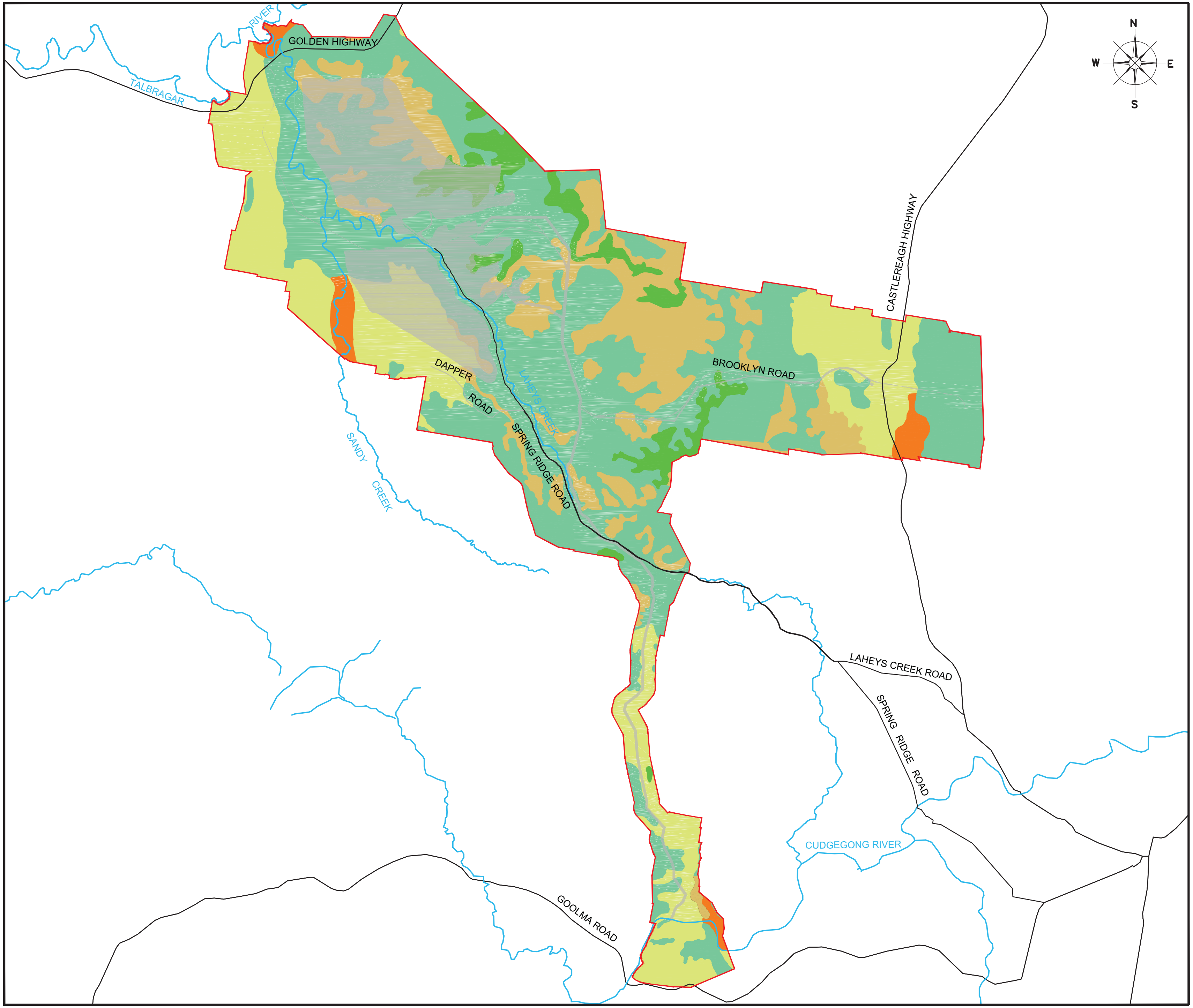

LEGEND

- Project Application Area
- Disturbance Footprint
- Roads
- Waterways

AGRICULTURAL SUITABILITY

- Class 1
- Class 2
- Class 3
- Class 4
- Class 5

0 3.0km 6.0km
Scale 1: 190 000

FIGURE 3.4

Pre-mining Agricultural Suitability

Project: Mine Rehabilitation Strategy: Cobbora Coal Project

Client: EMGA Mitchell McLennan Pty Limited

File: Fg3.4_EMG00-005_PreMineAgSuit_120619

Projection: MGA94 Zone 55

Version:	Date:	Author:	Checked:	Approved:
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2	29/11/11	ZJ/LH	AC	AC
3	01/02/12	KC	AC	AC
4	20/02/12	LF	AC	AC
5	30/03/12	KC	AC	AC
6	25/05/12	ZJ	AC	AC
7	19/06/12	ZJ/LF	AC	AC

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