9 Soils and agriculture

9.1 Assessment objectives

The DGRs that relate specifically to soil resources and agriculture land are:

Land resources – including a detailed assessment of the impacts of the project on:

- National Park estate; and
- agricultural land and productivity, which includes:
  - a detailed assessment and mapping pre- and post-mining (including 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;
  - 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;
  - 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;
  - a detailed assessment of the potential impacts of the project on agricultural resources and/or enterprises of the locality including;
    - impacts as a result of re-allocation of licensed water extraction from irrigation to mining uses;
    - direct impacts on soil, groundwater and surface water resources as a result of mining activity; and
    - change in land use due to requirements for biodiversity offsets;
  - a detailed description of the measures that would be implemented to avoid, reduce or mitigate 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 and associated groundwater resources) are proposed to be affected by the project.

The DGRs that relate to rehabilitation activities are:

- Provide description of the proposed rehabilitation strategy for the project having regard for the key principles in the Strategic Framework for Mine Closure, including:
  - nominated final land use, having regard for any relevant strategic land use planning or resources management plans or policies;
  - rehabilitation objectives, methodology, monitoring programs, performance standards and proposed completion criteria; and
  - the potential for integrating this strategy with any other offset strategies in the region.

9.2 Assessment method

9.2.1 Soils and rehabilitation

A rehabilitation strategy, including a soil resources and land capability assessment, was prepared by GSS Environmental (GSSE) (Appendix F) and the results are summarised in this chapter. The assessment was in accordance with the following regulations, methods and guidance documents as specified in the DGRs:

- *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites* (ANZECC 1992);
- *Rural Land Capability Mapping* (DLWC 2004);
- *Agricultural Land Classification* (DPI 2002);
- *Strategic Framework for Mine Closure* (ANZMEC 2000)*;*
- *Guidelines for Developments Adjoining Land and Water Managed by the Department of Environment, Climate Change and Water* (DECCW 2010b)*;*
- *Mine rehabilitation – Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth of Australia 2006a)*; and*
- *Mine closure and completion – Leading Practice Sustainable Development Program for the Mining Industry* (Commonwealth of Australia 2006b).

9.2.2 Agricultural resources

The Project will affect some agricultural resources in the Project assessment area (PAA) during its construction and operation. Where there is high value agricultural land and increasing activity in the coal and coal seam gas industries the NSW Strategic Regional Land Use Policy applies. The policy will apply to seven regions in NSW and each of these regions will have a strategic regional land use plan (SRLUP) developed. The Project site falls within the Central West region. At the time of publication, an SRLUP had not been released for this region.

In the absence of a finalised SRLUP, an agricultural impact study is required for all new development applications of state significance for mining and coal seam gas projects that could affect agricultural resources or industries. While the Project is not classified as a state significant development, an agricultural impact statement has been developed to meet the Director General's Environmental Requirements for the Project (Section 9.1). The agriculture impact statement was prepared by GSSE (Appendix G) which includes an Agricultural Lands and Water Economic Assessment prepared by Gillespie Economics. The agricultural use of land and water resources in the region and the PAA is summarised in this chapter.

9.2.3 Field survey

A soil map for the PAA was developed using aerial photos, satellite imagery and previous soil survey results. Surface soil exposures in the PAA were assessed to determine soil units, delineate soil unit boundaries and determine preferred locations for field surveys.

GSSE inspected the site and undertook a field survey to classify the soil types in the PAA in October 2009. Backhoe excavation exposed eleven soil profiles 1 m to 1.5 m deep to provide representative soil samples. Soil profiles were assessed in accordance with the A*ustralian Soil and Land Survey Field Handbook Soil Classification Procedures* (NCST 2009). The parameters in Table 9.1 were determined.

Table 9.1 Detailed soil profile description parameters

Description	Application
Horizon depth	Weathering characteristics, soil development
Field colour	Permeability, susceptibility to dispersion/erosion
Field texture grade	Erodibility, hydraulic conductivity, moisture retention, root penetration
Boundary distinctiveness shape	Erosional/dispositional status, textural grade
Consistence force	Structural stability, dispersion, ped formation
Structure pedality grade	Soil structure, root penetration, permeability, aeration
Structure pedality and size	Soil structure, root penetration, permeability, aeration
Stones: amount and size	Water holding capacity, weathering status, erosional/depositional character
Roots: amount and size	Effective rooting depth, vegetative sustainability
Ants, termites, worms, etc	Biological mixing depth

9.2.4 Laboratory testing

Soil samples from the eleven sample locations were sent to the NSW Land and Property Management Authority Soil Conservation Service Laboratory (Scone) and were analysed to:

- help classify soil taxonomic classes;
- help determine land suitability classes; and
- determine the suitability of soils as topdressing media.

Samples were laboratory tested for the physical and chemical parameters presented in Table 9.2.

Table 9.2 Laboratory analysis parameters

Property	Applications
Physical	
Colour	Soil colour based on Munsell Colour Chart
Particle-size analysis (PSA) (<2 mm)	Nutrient retention; exchange properties; erodibility; workability; permeability; sealing; drainage; interpretation of most other physical and chemical properties and soil qualities
Emerson Aggregate Test (EAT)	Stability of soil structural units when immersed in water; measure of soil dispersibility or soils structural stability
Chemical	
Soil reaction (pH) (1:5, soil: water suspension)	Nutrient availability; nutrient fixation; toxicities (especially aluminium and manganese); liming; sodicity; correlation with other physical, chemical and biological properties
Electrical conductivity (EC) (1:5, soil: water suspension	Appraisal of salinity hazard in soil substrates or groundwater; and total soluble salts
Cation exchange capacity (CEC) and exchangeable cations	Nutrient status; calculation of exchangeable sodium percentage (ESP); and assessment of other physical and chemical properties, especially dispersivity, shrink–swell, water movement and aeration

9.2.5 Land classification

Historically the quality of rural land in NSW was mapped according to two different land classification systems. The first is known as the Rural Land Capability System, which identifies eight possible land classes, with rural land capability decreasing progressively from Rural Land Capability Class I to Class VIII (Table 9.3). Rural land capability in the PAA was assessed using the guideline *Systems Used to Classify Rural Lands in New South Wales* (Cunningham et al. 1988).

Table 9.3 Rural Land Capability Classes

Classes	Land use	Management
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 requirements, 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	Management required to ensure groundcover is maintained
VII	Unsuitable for rural production	Green timber required to control erosion
VIII	Unsuitable for rural production	Cannot be cleared, logged or grazed

The second system is known as the agricultural suitability system and ranks lands according to their relative productivity for a range of agricultural activities. Agricultural Suitability Class 1 is the most productive and Class 5 the least productive (Table 9.4). The agricultural suitability system expands on the rural land capability assessment system by incorporating specific factors, such as market proximity, cultural factors and reduced market demand, to determine the appropriate agricultural suitability class. Consequently, the agricultural suitability classification of a site may change over time due to market forces and changes to site-specific infrastructure. In contrast, the rural land capability of a site generally does not change. Agricultural suitability in the PAA was assessed using the guideline *Agricultural Suitability Maps: Uses and Limitations* (NSW Agricultural and Fisheries 1990).

Table 9.4 Agricultural Suitability Classes

Agricultural Suitability Class	Land use	Management
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	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

9.2.6 Soil suitability for rehabilitation

Soil suitable for conservation and use in rehabilitation was determined based on Elliot and Reynolds (2007) criteria (Table 9.5).

Table 9.5 Suitability for conservation and use in rehabilitation criteria

Parameter	Desirable criteria
Structure grade	30% peds
Coherence	Coherent (wet and dry)
Mottling	Absent
Macrostructure	10 cm
Force to disrupt peds	≤3 force
Texture	Finer than a Fine Sandy Loam
Gravel and sand content	<60%
pH	4.5 to 8.4
Salt content	<1.5 dS/m

9.3 Existing environment

9.3.1 Regional agriculture

The agricultural enterprises in the wider region (ie Dubbo, Mid-Western and Wellington) and in the Warrumbungle LGA (in which the mining area is situated) are described below.

i Land use

Based on the area, agriculture is the dominant land use in the wider region, using 66% of the total area (Table 9.6). The total gross value of agricultural production in the wider region (in 2006) was estimated to be $271 million (Appendix G 'Agricultural impact statement').

Table 9.6 Regional agricultural land use

LGA	Total land area (ha)	Area under agricultural enterprises (ha)	Agricultural land as % of total LGA area
Wellington LGA	411,000	395,000	96%
Warrumbungle LGA	1,238,000	871,000	70%
Dubbo LGA	343,000	210,000	61%
Mid-Western LGA	876,000	422,000	48%
Total	**2,868,000**	**1,898,000**	**66%**

The Warrumbungle LGA covers 1,238,000 ha, of which about 70% (871,000 ha) is agricultural land. Grazing activities are the dominant agricultural land use (92%) in the LGA followed by cropping (Table 9.7). Sheep farming is the dominant form of grazing in the LGA followed by meat cattle farming (Table 9.8). Dryland cropping is the dominant of cropping activity in the LGA (Table 9.9).

Table 9.7 Agricultural land use by rural activity in Warrumbungle LGA

Land use	Area (ha)	Percentage
Land under grazing activities	798,394	92%
Land under cropping activities	72,606	8%
Total	**871,000**	**100%**

Table 9.8 Agricultural grazing activities in Warrumbungle LGA

Grazing activity	Proportion by stock number
Sheep and lambs	75%
Meat cattle	24%
Dairy cattle	<1%
Pigs	<1%

Table 9.9 Cropping activities in Warrumbungle LGA

Cropping activity	Area (ha)
Dryland cropping	71,606
Cropping using irrigation	1,000

ii Agricultural employment

The wider region employs 3,261 people in the agricultural industry (Appendix G 'Agricultural impact statement'). The main employment industries are beef and sheep farming (71% of agricultural employment). A summary of the main enterprises and employment is provided in Table 9.10.

Table 9.10 Regional agricultural employment

Agricultural enterprise	People employed	%
Beef farming (specialised)	726	22
Sheep farming (specialised)	635	19
Grain sheep or grain-beef cattle farming	502	15
Sheep-beef cattle farming	481	15
Other grain growing	204	6
Grape growing	136	4
Other (eg bee keeping, pigs, deer, horses and poultry)	577	18
Total	**3,261**	**100**

iii National park estate

A small portion of Yarrobil National Park is located within the PAA and will not be disturbed by the Project.

9.3.2 Agricultural enterprise in the PAA

Cattle and sheep grazing is the dominant land use in the PAA. On the better Rural Land Capability Class III land some crops (eg wheat and oats) are being produced for feedstock. On land to the south of the PAA, near Goolma Road, rotation crops of canola, wheat, pulses and barley have been produced. Over 65% of the land within the PAA is owned by CHC and generally is being leased and the agricultural enterprises that took place before CHC bought the land are continuing.

9.3.3 Agricultural economic value

i Agricultural productivity

The existing agricultural productivity in the PAA has been estimated using DTIRIS productivity data (Appendix G 'Agricultural impact statement'). The enterprises used to estimate the productivity were selected based on the land capability and represent the best gross margins that can be expected under current economic conditions. The gross margin is the value that remains from sales after the cost of production has been deducted.

Agricultural enterprises in the PAA can generate a gross margin of about $12 million a year. Of this, about $2 million (17%) could be generated on land in the proposed disturbance area. These values are derived from the best potential uses and are likely to be higher than the actual incomes received and are considered a conservative estimate. These enterprises could support the direct employment of about 33 people and about 41 more through indirect employment.

9.3.4 Land classes

i Existing rural land capability

No Rural Land Capability Class I land or Class VIII land is present in the PAA (Table 9.11 and Figure 9.1). The majority of the land in the PAA is Rural Land Capability Class III (5,985 ha), Class IV (9,880 ha), Class V (4,797 ha) or Class VI (4,664 ha) (Table 9.11).

Table 9.11 Existing rural land capability classes – PAA

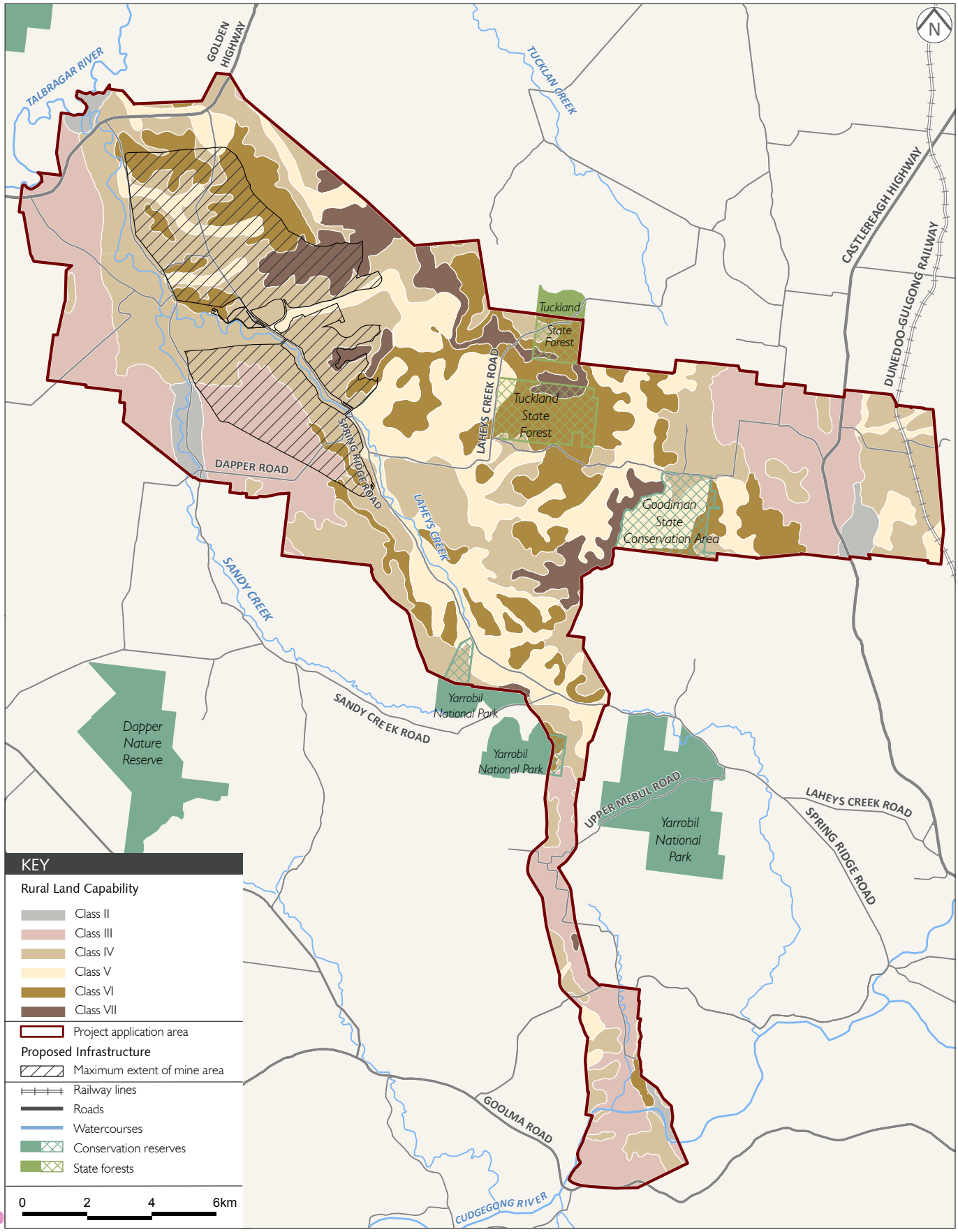
Land capability class	Area (ha)	%
I	0	0
II	568	2
III	5,985	22
IV	9,880	36
V	4,797	18
VI	4,664	17
VII	1,492	5
VIII	0	0
Total	**27,386**	**100**

ii Existing agricultural suitability

The pre-mining agricultural suitability classification for the PAA ranges from Class 1 through to Class 5 (Figure 9.2). This indicates that land in the PAA is suitable for both cropping (Class 2 and Class 3) and grazing (Class 3 and Class 4) enterprises. The dominant agricultural suitability class in the PAA is Class 3 (54%), followed by Class 2 (22%) and Class 4 (17%) land (Table 9.12).

Table 9.12 Existing agricultural suitability classes – PAA

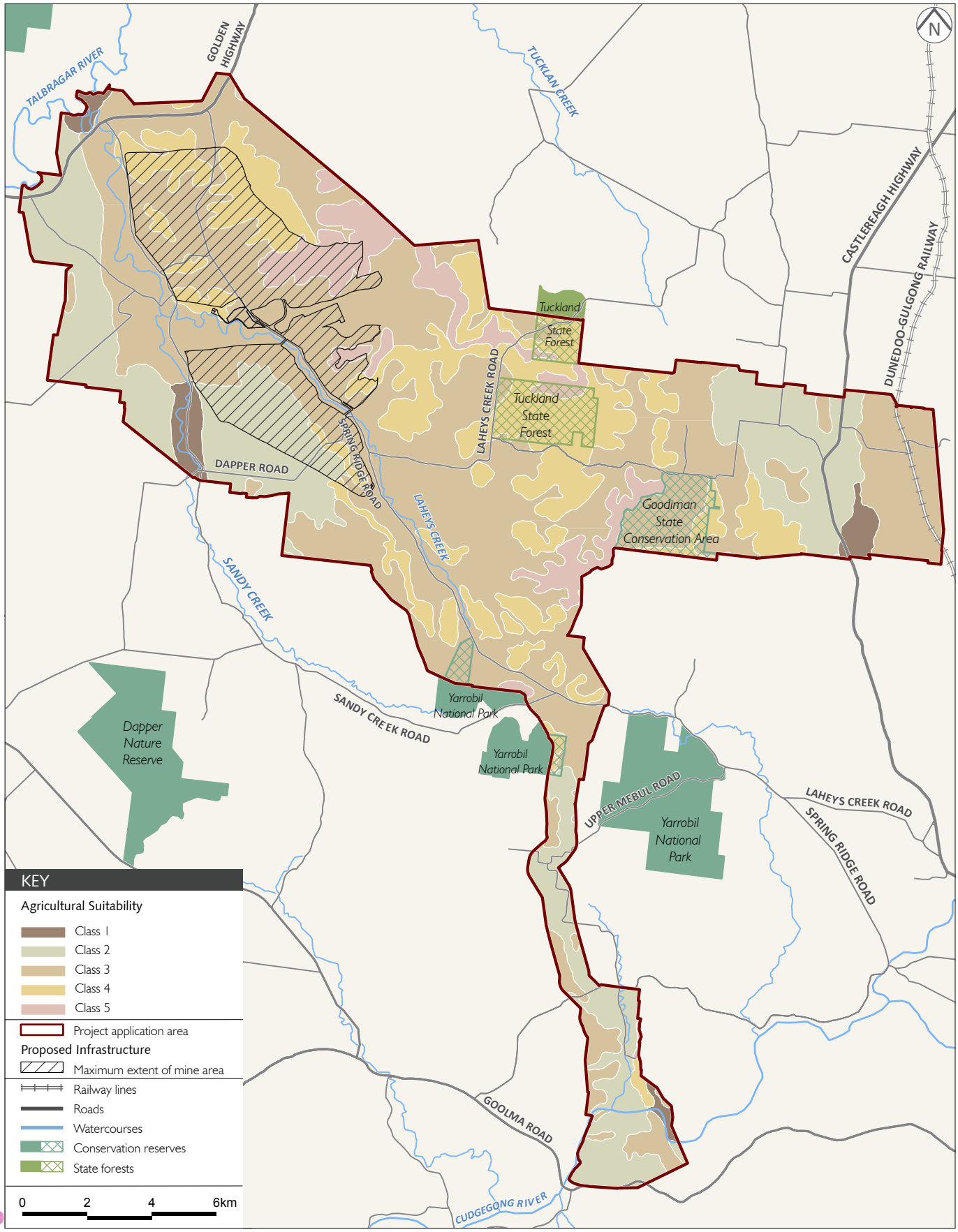
Agricultural suitability class	Area (ha)	Percentage
1	568	2%
2	5,985	22%
3	14,677	54%
4	4,664	17%
5	1,492	5%
Total	**27,386**	**100%**



Pre-mining Rural Land Capability

Cobbora Coal Project - Environmental Assessment

Figure 9.1



EMM

Cobbora Holding Company Pty Limited

Pre-mining Agricultural Suitability

Cobbora Coal Project - Environmental Assessment

Figure 9.2

9.3.5 Water resources

Water resources in the PAA are described in Chapter 7 ('Groundwater') and in Chapter 8 ('Surface water).

9.3.6 Significant agricultural resources

There are no alluvial soils that will be disturbed directly or indirectly by the proposal. There are no agricultural resources of regional or state significance in the PAA.

9.3.7 Soil resources

The PAA contains five main soil types: Red-Brown Duplex, Yellow Duplex, Grey Shallow, Friable and Alluvial (Table 9.13). Red-Brown Duplex and Yellow Duplex are the dominant soil types across the PAA and occur in 41% and 47% of the PAA respectively.

Table 9.13 Existing soil resources – PAA

Soil type (common name)	Australian soil classification	Area (ha)	Percentage
Red-Brown Duplex soil	Red/Brown Chromosols/Sodosols	11,253	41%
Yellow Duplex soil	Yellow/Yellow-brown Chromosols/Sodosols	12,944	47%
Grey Shallow soil	Grey Tenosol/Rudosol	1,783	7%
Friable soil	Dermosols	656	2%
Alluvial soil	Rudosols/Tenosols	750	3%
Total		**27,386**	**100%**

9.3.8 Soil suitability for rehabilitation

Much of the topsoil in the PAA has physical characteristics, such as sodic properties or weak structure, that will need to be treated before it is used in rehabilitation.

Sodic soils are not ideal for rehabilitation works because clay particles tend to disperse and swell, which produces poor physical soil conditions. These conditions include water logging and hard setting crusts, which, in turn, reduce infiltration rates, plant available water capacity, seedling emergence and root development. These physical limitations will be overcome through the application of soil ameliorants that decrease soil dispersibility and increase soil aggregate stability.

Weak soil structure will be improved through adding carbon in the form of mulch, which increases soil aggregate stability and improves soil structure. All subsoils are unsuitable for rehabilitation due to severe physical and/or chemical limitations. The maximum recommended stripping depths for each soil type and their limitations are summarised in Table 9.14.

Table 9.14 Soil stripping depths and limitations

Soil type	Stripping depth (m)		Limitations	
Name	**Topsoil**	**Subsoil**	**Topsoil**	**Subsoil**
Yellow Duplex	0.35	0	Weak structure – improvement required	Clayey and sodic subsoil
Red-Brown Duplex	0.40	0	Weak structure – improvement required	Clayey and sodic subsoil
Grey Skeletal Soil	0	0	Weak structure, acidic profile and high stone content	-
Friable	0.55	0	Moderately fine texture	Very fine soil texture
Alluvial	0.40	0	No limitations	Coarse texture

9.4 Environmental management

The long-term mine rehabilitation objective is to leave a landform that is safe, low maintenance, geotechnically stable and blends in with the surrounding topography. Final land use will be consistent with pre-mining land use and will provide a mixture of grazing, cropping and rehabilitated woodland areas. Progressive rehabilitation will be integrated into the mining process and will occur as soon as practicable. Temporary rehabilitation may be used to provide short-term stabilisation and to minimise dust generation in areas that will be temporarily inactive.

The mine rehabilitation management strategy (Appendix F) details measures for the long-term mine rehabilitation. This will be supported by a topsoil management plan that will detail measures to minimise topsoil losses during stripping and to ensure that topsoil resources are preserved.

9.4.1 Rehabilitation

i Rehabilitation objectives

The primary mitigation measure to avoid, reduce or mitigate the Project's impacts on long-term agricultural resources and enterprises will be to rehabilitate the disturbed areas as described in the mine rehabilitation strategy (Appendix F).

The general principles of the rehabilitation strategy are described in Chapter 3 ('Project Description'). Detailed management measures to ensure the success of the rehabilitation program are described below.

ii Soil stripping and handling

Mitigation measures to prevent excessive soil deterioration during operations will include the following:

- soil will be stripped to predetermined depths as indicated in Table 9.14 and subject to ongoing inspections;
- each mining and emplacement area will be progressively rehabilitated as soon as practicable;
- soil will be maintained in a slightly moist condition during stripping — soil will not be stripped in either an excessively dry or wet condition;

- stripped soil will be placed directly onto reshaped overburden and spread immediately where mining sequences, equipment scheduling and weather conditions permit;
- soil stripping will use methods that minimise soil compression;
- the surface of soil stockpiles will be coarsely textured to promote infiltration, minimise erosion and prevent anaerobic zones forming before vegetation is established;
- the maximum topsoil stockpile height will be 3 m; clayey soils will be stored in lower stockpiles for shorter periods compared to sandier soils;
- stockpiles will be seeded and fertilised as soon as possible; and
- an inventory of available soil will be maintained so that enough topsoil continues to be available for rehabilitation.

iii Soil respreading and seedbed preparation

Mitigation and management measures to use topsoil effectively during rehabilitation will include the following:

- topsoil will be spread to the depths as specified in the mine rehabilitation strategy (Appendix F);
- topsoil will be spread, treated with fertiliser and seeded in one consecutive operation to reduce the potential for topsoil loss from wind and water erosion;
- the seedbed will be prepared thoroughly to ensure optimum establishment and growth of vegetation;
- all topsoiled areas will be lightly contour ripped (after topsoil spreading) to create a 'key' between the soil and the underlying material;
- soil ameliorants that decrease soil dispersibility and increase soil aggregate stability will be applied to soils that exhibit sodic properties;
- soil carbon that increases soil aggregate stability and improve soil structure will be applied to any soils that exhibit weak soil structure;
- revegetation will be take place as soon as possible to avoid erosion;
- a progressive soil testing program will be undertaken; and
- fertiliser will be applied if necessary to ensure successful rehabilitation.

iv Weed management

Weed management and mitigation measures to ensure rehabilitation and surrounding agricultural enterprises are successful will include:

- areas of known weed infestation will be marked as 'weed risk' areas using signs or other clearly recognisable markers to minimise the potential for inadvertent access and spread of weeds;
- access to weed risk areas with known infestations will be restricted to authorised personnel;

- the Project site induction program will promote awareness of weed management measures and specific training in weed identification and eradication measures will be provided to relevant site personnel and contractors;
- mobile machinery and equipment will be inspected, and cleaned where necessary, before it is brought onto the site;
- vegetation and topsoil stripped from the weed risk areas with known weed infestations will be stripped and stockpiled separately;
- the stockpiles will be marked, recorded and in accordance with the site's environmental management system and be subject to follow-up inspections;
- the stockpiles will be assessed for weeds to determine if individual stockpiles require herbicide application and/or 'scalping' of weed species before spreading the topsoil;
- topsoil stripped from weed risk areas with known infestations will either be buried if treatment is not practicable or it will be treated (several times if necessary); and
- soils from weed risk areas that are used in the rehabilitation program will be monitored after rehabilitation and any residual weeds that germinate will be treated appropriately.

v Erosion and sediment control actions

The primary design aspect of the Project is the prevention of clean runoff entering the active disturbance footprint. This will be achieved through the use of diversionary structures, eg drains, berms and banks, as well as the containment of overburden water in sediment control structures within the active areas of the PAA to eliminate uncontrolled runoff.

Mitigation measures to prevent excessive erosion during soil stripping and rehabilitation will include:

- a detailed erosion and sediment control plan will be developed;
- the retention time of surface runoff from disturbed catchments will be maximised to ensure discharge from disturbed areas meet the relevant water quality limits;
- surface flows upstream of the PAA will be managed so that rehabilitation activities are not affected by flooding;
- after rehabilitation sustainable long-term surface water management features will be established;
- structures, including contour banks and drains, will be built to encourage water transfer at non-erosive velocities;
- rock-lined drop structures will be built on the slopes of emplacements and will be allowed to revegetate naturally;
- trees and other vegetation will be planted around water management structures to enhance the filtration ability of these structures and surrounding areas and to minimise erosion;
- if unacceptable levels of erosion are observed, specific fast-growing species and specialised treatments, such as bitumen/jute meshing or rock lining, will be used; and
- the final landform will allow free drainage of surface runoff while minimising erosion (this will include designing an appropriate drainage system that minimises or mitigates excessive erosion).

vi Rehabilitation of tailings emplacements

The principal rehabilitation measures will be as follows:

- the water content of tailings will be minimised to promote drying and early rehabilitation, this will be achieved by diverting runoff around the emplacements and using flocculants to hasen settling of suspended tailings particles in water from the CHPP;
- tailings will be allowed to dry to form a stable surface that can support capping and covering layers. This is expected to take about five years;
- tailings beaches will be managed to maximise the removal of surface water to decant ponds;
- decommissioned tailings emplacements will be covered with:
  - a cap of at least 1 m low permeability material (eg coarse reject);
  - a 'capillary break' (with wide interstitial spacing) at least 1.2 m thick preventing water moving upwards to the soil layer; and
  - topsoil or suitable top dressing at least 0.3 m thick;
- the final cover design will be developed in consultation with DTIRIS; and
- the covered emplacements will be re-vegetated and monitored in the same way as the waste rock emplacements.

vii Ongoing agricultural enterprises

A land management plan will describe measures to enable the best agricultural use of land owned by CHC outside the disturbance footprint. It will provide opportunities for private farmers to use these areas through long-term leases. Management measures for ongoing agricultural enterprises will include:

- ongoing communication with landholders to minimise disruptions from Project operations;
- access to farm properties for the private farmers will be maintained; and
- water over and above the Project's requirements will be supplied to selected properties along the Project's water supply pipeline.

9.5 Impacts

Impacts to soils and agricultural resources following the implementation of the management measures described in Section 9.4 are described below.

9.5.1 Operations

The area available for agriculture will gradually decline as the mining areas expand. However, some rehabilitated agricultural land may also become available for agricultural enterprise before the end of the mine life.

CHC is committed to ensuring the best agricultural use of the non-mine lands it owns and will continue to provide opportunities for private farmers to use these through long-term leases.

9.5.2 Post-mining rural land capability

Areas of Rural Land Capability Class III to VII land will be disturbed by the Project (Table 9.15). No Rural Land Capability Class I or Class II land will be disturbed.

The post-mining landform will be capable of cropping (Class III) and grazing (Class IV) enterprises and will contain some land that will be revegetated with trees and shrubs for erosion control (Class VI). It will contain some land that is not suitable for any agricultural enterprise (Class VIII), including the final voids and land associated with the raw water dam and upgraded and realigned roads. The area of land in each rural land capability class in the disturbance footprint and in the PAA after mining is shown in Table 9.15 and Table 9.16 respectively and in Figure 9.3.

When rehabilitation is finished, the area of the best agricultural land in the disturbance footprint (Class III) will increase by 323 ha (from 17% to 24% of the total post-mining disturbance footprint area). There will be less Class IV and Class V land.

Table 9.15 Post-mining rural land capability – disturbance footprint

Land capability	Pre-mining area		Post-mining area		Difference	
Class	**ha**	**%**	**ha**	**%**	**ha**	**%**
I	0	0	0	0	0	0
II	0	0	0	0	0	0
III	782	17	1,105	24	323	7
IV	2,380	50	1,743	37	-637	-13
V	435	9	156	3	-279	-6
VI	790	17	1,406	30	616	7
VII	313	7	5	0	-308	-7
VIII	0	0	285	6	285	12
Total	**4,766**	**100**	**4,766**	**100**	**-**	**-**

Table 9.16 Post-mining rural land capability – PAA

Land capability	Pre-mining area		Post-mining area		Difference	
Class	**ha**	**%**	**ha**	**%**	**ha**	**%**
I	0	0	0	0	0	0
II	568	2	568	2	0	0
III	5,985	22	6,308	23	323	1
IV	9,880	36	9,243	34	-637	-2
V	4,797	18	4,518	17	-279	-1
VI	4,664	17	5,280	19	616	2
VII	1,492	5	1,184	4	-308	-1
VIII	0	0	285	1	285	1
Total	**27,386**	**100**	**27,386**	**100**	**-**	**-**

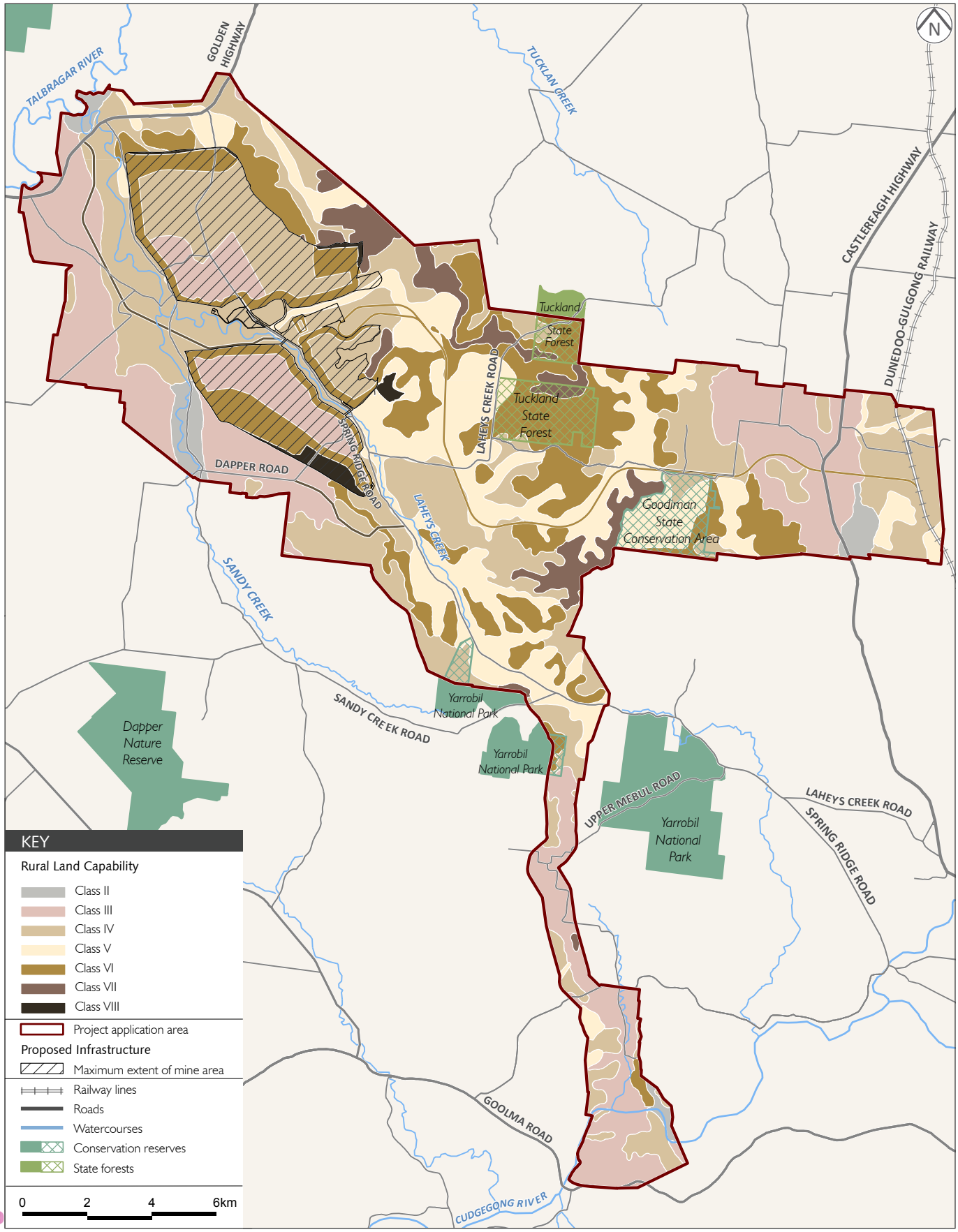
9.5.3 Post-mining agricultural suitability

No Agricultural Suitability Class 1 land will be disturbed by the Project (Table 9.17 and Table 9.18). Areas of Agricultural Suitability Class 2 to 5 will be disturbed (Figure 9.4). Following the completion of rehabilitation, the area of Agricultural Suitability Class 2 land will increase by 323 ha (an increase of 7% of the total area in the disturbance footprint). There will be 915 ha less Class 3 land (a 19% reduction within the disturbance footprint).

Table 9.17 Post-mining agricultural suitability – disturbance footprint

Agricultural suitability class	Pre-mining area		Post-mining area		Difference	
	ha	**%**	**ha**	**%**	**ha**	**%**
1	0	0	0	0	0	0
2	782	17	1,105	24	323	7
3	2,815	59	1,899	40	-916	-19
4	790	17	1,406	30	616	13
5	313	7	290	6	-23	-1
Total	**4,700**	**100**	**4,700**	**100**	**-**	**-**

Overall, the available agricultural land resources available in the PAA will be similar pre- and post-mining. The area of land in each rural land capability class will change by less than 2% (Table 9.6) and in each agricultural suitability class will change by no more than 3% (Table 9.18).



EMM

Cobbora Holding Company Pty Limited

Post-mining Rural Land Capability

Cobbora Coal Project - Environmental Assessment

Figure 9.3

Table 9.18 Post-mining agricultural suitability – PAA

Agricultural suitability class	Pre-mining area		Post-mining area		Change	
	ha	%	ha	%	ha	%
1	568	2	568	2	0	0
2	5,985	22	6,308	23	323	1
3	14,677	54	13,761	51	-916	-3
4	4,664	17	5,280	19	616	2
5	1,492	5	1,469	5	-23	<1
Total	**27,386**	**100**	**27,386**	**100**	**-**	**-**

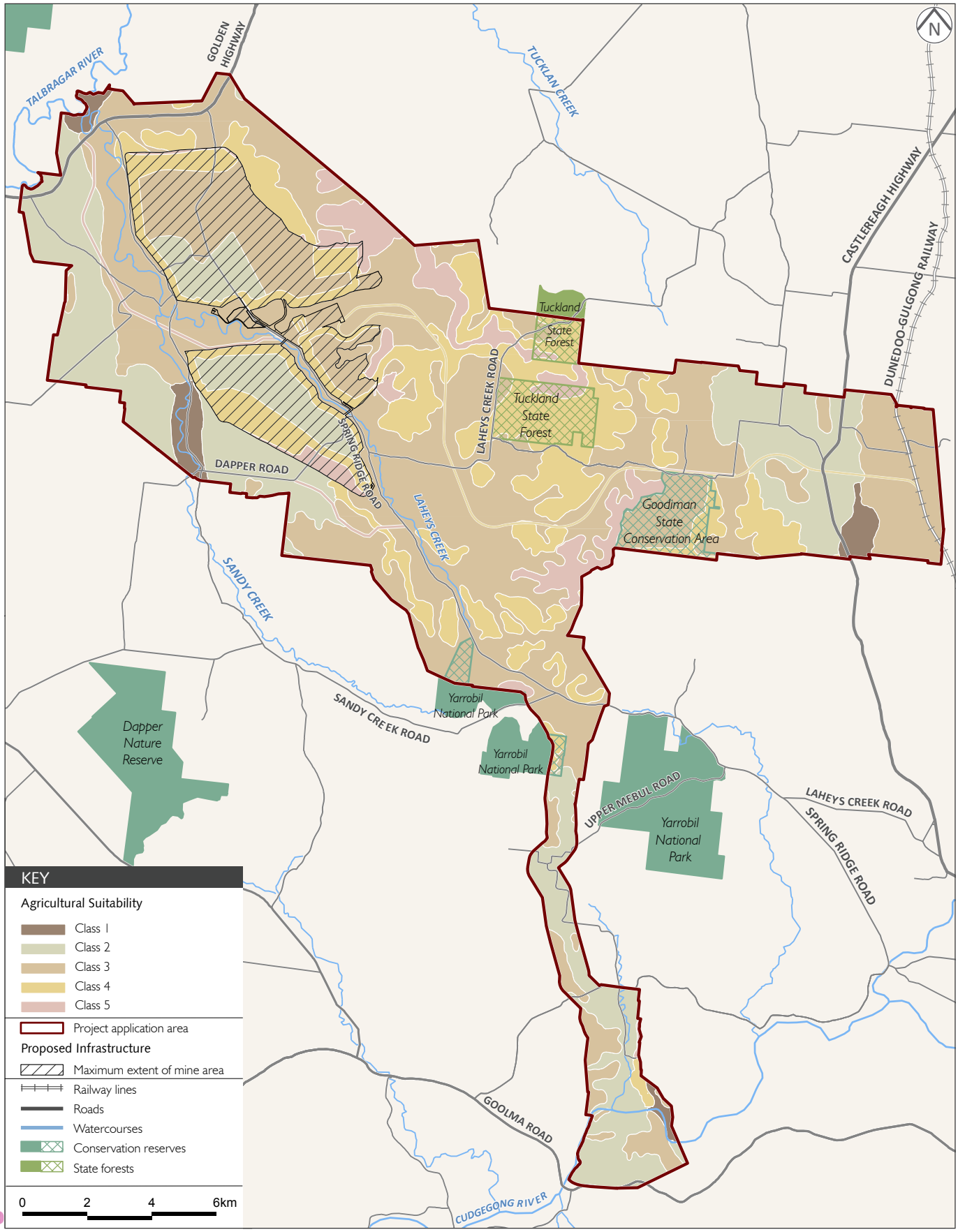
9.5.4 Rehabilitation soil resources

Some 14.4 million m^3 of soil will be removed during soil stripping in the disturbance footprint. It will be removed so that losses are minimised during handling and storage (where required). Conservatively allowing for a 5% handling loss, 13.7 million m^3 of soil will be available for rehabilitation when measures to improve the quality of the existing soil are applied (see Section 9.3.8).

As the total volume of soil required for rehabilitation is 13.2 million m^3 (Table 9.19), there is sufficient soil within the disturbance areas to allow successful rehabilitation.

Table 9.19 Soil required for rehabilitation

Land use	Rural land capability	Area (ha)	Nominal soil depth (m)			Soil volume required (million m^3)
			Topsoil	Subsoil	Total	
Cropping	III	1,000	0.3	0.2	0.5	5.0
Grazing	III	105	0.3	0.2	0.5	0.5
Grazing	IV	835	0.15	0.15	0.3	2.6
Grazing	V	145	0.15	0.15	0.3	0.4
Grazing	VI	125	0.1	0.1	0.2	0.3
Woodland	IV and VI	2,200	0.1	0.1	0.2	4.4
Woodland	VII	5	0.1	0.1	0.2	<0.1
Total	**-**	**4,415**	**-**	**-**	**-**	**13.2**



Integrated Design Solutions | 030518 Cobora Coal Project - EA F9-4 Rev A - 19 September 2012

Post-mining Agricultural Suitability

Cobbora Coal Project - Environmental Assessment

Figure 9.4

9.5.5 Economic agricultural impacts

The Project's economic value is described in detail in Chapter 20 ('Economic'). The agricultural production that will not be realised in the disturbance footprint is described in Section 9.3.2. The impacts of the Project on agriculture as a result of using water licences for agriculture instead of for the Project and the use of agricultural land in the biodiversity offset package are described below.

i Water resources for agricultural use

As described in Chapter 8 ('Surface water'), 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. CHC has purchased 3,310 ML water access licences from willing sellers from within the area covered by the Macquarie and Cudgegong Rivers Water Sharing Plan. The licences are high security and will provide 1,000 ML from the Cudgegong River (Mid-Western Regional LGA) and 2,311 ML transferred from the Macquarie River (848 ML from the Warren LGA and 1,463 ML from the Narrabri LGA).

Before the WALs were transferred, NOW undertook detailed impact assessments, including hydrologic modelling over 18 months. The assessments indicated there would be no significant third party or environmental impacts. Accordingly, NOW granted approval for the change in extraction zone for the WALs in June 2011 under section 71S of the *Water Management Act 2000* (NSW).

The groundwater modelling indicates that the peak mine inflow rate from groundwater sources will be 1,775 ML per annum in 2031. This will be about 280 ML per year from the Talbragar River and about 1,495 ML per year from the Gunnedah-Oxley Basin groundwater source. Licences from each individual water source will be obtained by CHC.

The total peak annual water allocation for the Project will be about 5,100 ML (3,310 ML from the Cudgegong River, 280 ML from the Talbragar River and 1,495 ML from the Gunnedah-Oxley Basin groundwater source). The gross margin for the production of high yielding spray irrigated lucerne using this water allocation has been calculated to estimate the maximum agricultural return from this water. It requires about 8 ML/ha annually to produce spray irrigated lucerne and the total gross margin for this enterprise would be $1,405/ha (five cuts each producing 2.5 t). Therefore, the gross margin is $176/ML of water. In total, 636 ha of lucerne could be produced with 5,100 ML of water, so it is estimated the water licences the Project holds could generate $1.5 million annually if used to produce a high yielding crop.

CHC will investigate the sale of any unused water from the water access licences to agricultural enterprises. After mining operations end and the site has been rehabilitated, the water licences will be sold on the open market so that the water will be available for agricultural or other beneficial use.

ii Biodiversity offsets

The EA biodiversity offset strategy will compensate for unavoidable impacts on threatened flora species, threatened fauna habitat, threatened ecological communities (TECs) and other native vegetation (see Section 10.7). The specific land parcels to be part of the offset package are not finalised but will consist mainly of land that already contains native vegetation. A smaller area of land that is currently used for agriculture will also be used as this land will be important to allow wildlife corridors to be improved. Rural Land Capability Class I, II or III land will not be used for offsets unless this leads to substantial ecological benefits.

Based on a number of broad assumptions:

- there will be some 4,450 ha conserved in offset areas (there will be additional TECs conserved that are not in areas used for agriculture);
- up to 40% of offsets will be on agricultural land; and
- all of this agricultural land will be Class IV land (although it is likely that offsets will be on a combination of Class IV, V and VI land).

The estimated regional economic impact from the displacement of agriculture as a result of the biodiversity offset package will be:

- $1.8 million (m) in annual direct and indirect output or regional business turnover;
- $0.8 m in annual direct and indirect regional value-added;
- $0.4 m in annual direct and indirect income; and
- 16 direct and indirect jobs.

This represents about 0.4% of the 2006 annual regional output value of agriculture production, with these impacts occurring in perpetuity.

9.5.6 Combined impacts to agricultural economics

The direct and indirect regional impacts on annual agricultural production in the disturbance footprint (assuming area is currently used for grain and sheep production), biodiversity offsets (assuming offset sites areas are currently used for sheep production) and from the purchase of 5,100 ML of water (assuming water is currently used for irrigated lucerne production and is replaced by dryland cropping) is shown in Table 9.20. The table shows the total agricultural impacts and the estimated annual direct and indirect regional economic impact of the Project.

Table 9.20 Regional economic impacts of the Project and displaced agriculture

	Agriculture based on irrigation	Agriculture in the disturbance footprint	Agriculture in the biodiversity offsets	Total agricultural impact	Project
Peak ground and surface water use (ML)	5,100	-	-	5,100	5,100
Area (ha)	636	4,700	1,780	7,116	4,700
Direct output ($ million)	1.0	3.4	1.2	5.6	535
Direct value added ($million)	0.4	1.6	0.6	2.6	100
Direct income ($ million)	0.2	0.7	0.2	1.2	50
Direct employment (no.)	6	31	13	51	482
Direct and indirect output ($ million)	1.5	5.0	1.8	8.3	714
Direct and indirect value added ($ million)	0.6	2.3	0.8	3.7	184
Direct and indirect income ($ million)	0.4	1.2	0.4	2.0	102
Direct and indirect employment (no.)	9	39	16	63	1,170

Source: Appendix G. Some inconsistencies are due to rounding.

The direct annual output of the Project is estimated to be $535 m. This is greater than the annual value of all agriculture production in region in 2006 and 96 times the agricultural revenue from the land and water entitlements used by the Project. Direct employment provided by the Project will be about nine times that provided by continued agricultural use of the land and water.

After mining, the rehabilitated landform will be capable of supporting a similar level of agricultural activity as it does at present and surface water licenses will be sold and potentially used for agricultural production.

The economic activity generated by the Project will be much greater than the regional economic impacts of using the impacted agricultural land and water resources for agriculture and the majority of impacts on agriculture will be temporary.

9.5.7 Soils and agriculture outcomes

There will be a reduction in the quantity of agricultural land available for agricultural enterprise during the life of the mine. However, progressive and final rehabilitation will deliver a final landform capable of supporting a similar level of agricultural activity as it does now.

Areas of Rural Land Capability Class III to VII land will be disturbed by the Project. No Rural Land Capability Class I or Class II land will be disturbed. The area available for agriculture in the disturbance footprint will gradually decline as the mining areas expand. However, some rehabilitated agricultural land may also become available for agricultural enterprise before the end of the mine life. CHC is committed to ensuring the best agricultural use of the non-mine lands it owns and will continue to provide opportunities for private farmers to use these through long-term leases.

The post-mining landform will be capable of cropping (Class III) and grazing (Class IV) enterprises and will contain some land that will be revegetated with trees and shrubs for erosion control (Class VI). It will contain some land that is not suitable for any agricultural enterprise (Class VIII), including the final voids and land associated with the raw water dam and upgraded and realigned roads. When rehabilitation is finished, the area of the best agricultural land in the disturbance footprint (Class III) will increase by 323 ha (from 17% to 24% of the total post-mining disturbance footprint area). There will be less Class IV and Class V land.

Some 14.4 million m^3 of soil will be removed during soil stripping in the disturbance footprint. It will be removed so that losses are minimised during handling and storage (where required) so there will be sufficient soil to allow successful rehabilitation.

Overall, the available agricultural land resources available in the PAA will be similar pre- and post-mining. The area of land in each rural land capability class will change by less than 2% and in each agricultural suitability class will change by no more than 3%.

The economic activity generated by the Project will be much greater than the regional economic impacts of using the impacted agricultural land and water resources for agriculture and the majority of impacts on agriculture will be temporary.

9.6 Monitoring

9.6.1 Rehabilitation

Rehabilitated areas will be monitored regularly during and after vegetation establishment to determine whether the rehabilitation strategy objectives are being achieved.

i Success criteria

Detailed criteria to determine success in achieving these objectives have been taken from the *Strategic Framework for Mine Closure (*ANZMEC 2000) and are presented in Appendix F ('Mine rehabilitation strategy').

Success criteria for Class III land is based on the following elements:

- landform stability (slope gradient, erosion control and surface water drainage);
- soil (soil depth, soil structure, salinity, pH, sodicity and nutrient cycling);
- vegetation (land use); and
- soil fauna (species composition).

Detailed success criteria for Class IV–VIII lands have been developed based on the following elements:

- landform stability (slope gradient, erosion control and surface water drainage);
- water quality;
- soil (soil depth, soil structure, salinity, pH, sodicity and nutrient cycling);
- vegetation (land use, surface cover, species composition, resilience to disturbance and sustainability);
- fauna: woodland (vertebrate species, invertebrate species, habitat structure);
- visual amenity; and
- physical safety.

ii Monitoring activities

Monitoring activities will include the following:

- replicated monitoring sites will be established in rehabilitation areas representative of different ages — one monitoring site for 20–40 ha for each major age class of the rehabilitation areas will be established; and
- sites will be monitored 12 months after vegetation establishment and then every two years.

a. Native vegetation rehabilitation monitoring

A standard monitoring plot design for areas rehabilitated with trees will use:

- 2 m x 2 m quadrants — these will provide some estimate of statistical variance so that, if required, statistical analyses can be used to objectively compare different rehabilitation treatments and changes over time;
- a 20 m x 10 m plot overlying the 2 m quadrants and located 5 m either side of the centreline, for ease of monitoring; and
- a 50 m erosion monitoring transect on contour, running through the centre of the plot.

b. Agricultural land rehabilitation monitoring

For the areas rehabilitated as pasture, a 100 m transect will be established across a typical section of rehabilitation at the site and monitored for:

- grass cover in 2 m x 2 m plots every 20 m;
- pasture species present;
- weed species present and percentage of area covered;
- percentage of bare ground;
- extent and type of erosion;
- along the 100 m transect, general comments (such as rocks present, presence/absence of topsoil and other factors likely to influence rehabilitation development) will be noted; and
- site-specific rehabilitation methods will be improved as additional knowledge develops from monitoring data collected through these programs.