Land and Soil Assessment Report

Appendix L

Appendix L — Land and Soil Assessment Report

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Berrima Rail Project

Soil and Land Assessment Report

Prepared for Hume Coal Pty Limited | 2 March 2017

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Berrima Rail Project

Final

Report J12055RP1 | Prepared for Hume Coal Pty Limited | 2 March 2017

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1.1 Overview

Hume Coal Pty Limited (Hume Coal) is seeking approval for the construction and operation of a new rail spur and loop (the Berrima Rail Project) in the Southern Highlands region of New South Wales (NSW). Hume Coal is also seeking approval in a separate State significant development application to develop and operate the Hume Coal Project; an underground coal mine and associated mine infrastructure in the NSW Southern Coalfields. Coal produced by the Hume Coal Project will be transported to port for export or to domestic markets by rail via a new rail spur and loop, constructed as part of the Berrima Rail Project.

Approval for the Berrima Rail Project (the project) is being sought under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). An environmental impact statement (EIS) is a requirement of the approval processes. This soil and land assessment report forms part of the EIS. It documents the methodology and results of the assessment, the measures taken to avoid and minimise impacts and the additional mitigation and management measures proposed.

The location of the project is shown in Figure 1.1, and the local context around the project area is illustrated in Figure 1.2.

1.2 Project description

The Berrima Rail Project will enable the transportation of coal produced by the Hume Coal Project to various customers. The new rail spur and loop will be connected to the western end of the existing Berrima Branch Line; a privately owned line branching off the Main Southern Rail Line at the Berrima Junction approximately 2.5 km north of Moss Vale. The Berrima Branch Line is owned and used by Boral Cement Ltd (Boral) for the transportation of cement, limestone, coal and clinker to and from the Berrima Cement Works. It is also used by Inghams Enterprises Pty Limited (Inghams) for the transportation of grain to its feed mill east of the cement works, and by Omya (Australia) Pty Ltd (Omya) for the transportation of limestone to their Moss Vale plant at the Berrima Junction.

In addition to the construction of the new rail spur and loop, the project also involves upgrades to the Berrima Branch Line and the use of the rail infrastructure by Hume Coal and Boral. The Berrima Rail Project and the Hume Coal Project are the subject of separate development applications as the rail project involves rail infrastructure used by users other than Hume Coal, as noted above.

Hume Coal will transport product coal by rail, primarily to Port Kembla for export, and possibly to the domestic market depending on demand. Hume Coal will transport up to 3.5 Million tonnes per annum (Mtpa) of product coal which will require up to eight train paths per day (four in each direction), with a typical day involving four to six paths (two to three in each direction).

In summary the project involves:

- upgrades to Berrima Junction (at the eastern end of the Berrima Branch Line) to improve the operational functionality of the junction, including extending the number 1 siding, installation of new turnouts and associated signalling;
- construction of a new rail line connected to the western end of the existing Berrima Branch Line approximately 700 m east of the Berrima Cement Works;
- construction of a railway bridge over Berrima Road;

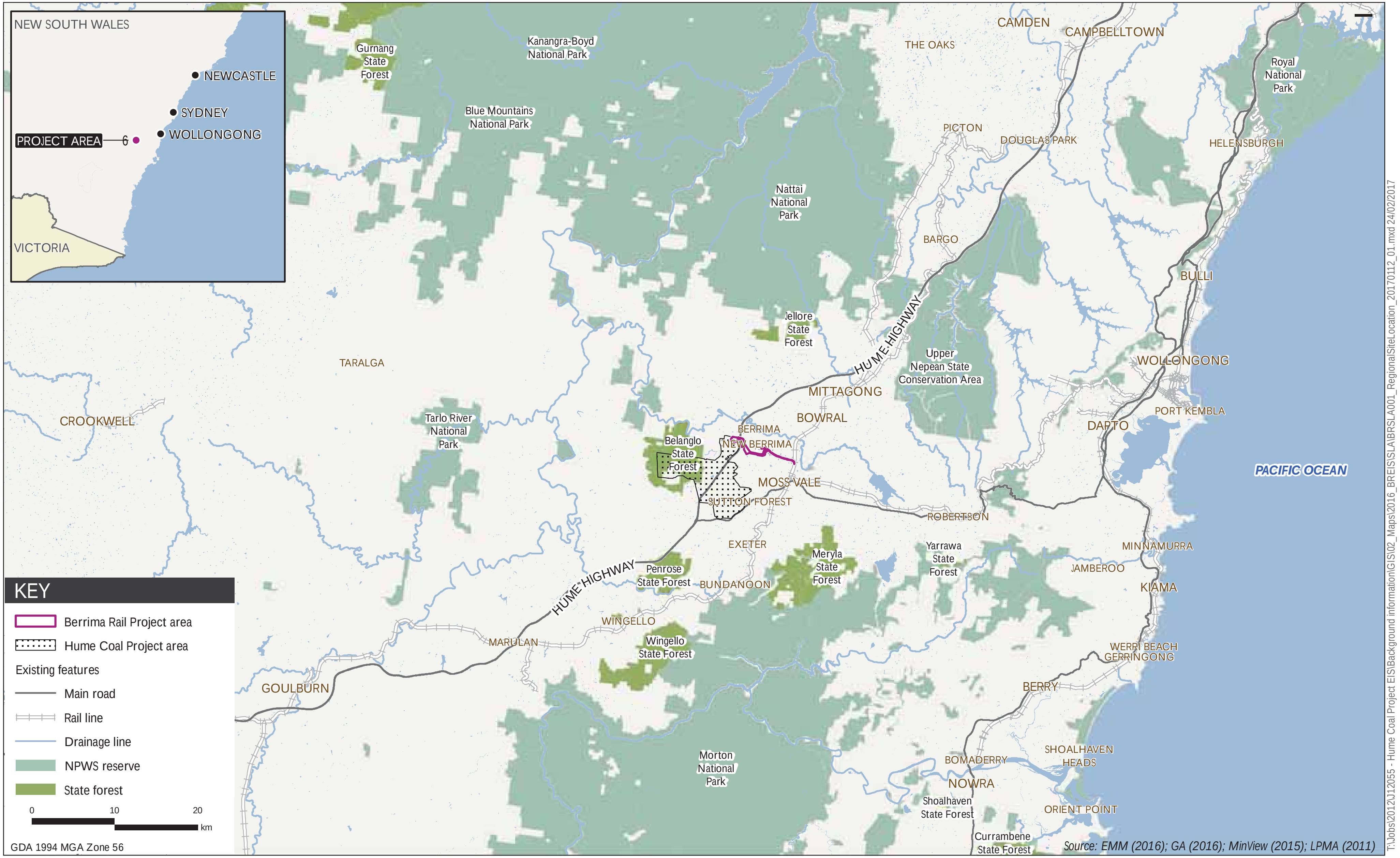
- construction of a new rail connection into the Berrima Cement Works from the railway bridge;
- decommissioning of the existing rail connection into the Berrima Cement Works including the Berrima Road level rail crossing;
- construction of a new rail spur line from the Berrima Branch Line connection to the Hume Coal Project coal loading facility;
- construction of a grade separated crossing (railway bridge) over the Old Hume Highway;
- construction and operation of a maintenance siding and basic provisioning facility on the western side of the Old Hume Highway, including an associated access road, car parking and buildings; and
- construction of the Hume Coal rail loop with the Hume Coal Project Area, adjacent to Medway Road.

The conceptual project layout is illustrated in Figure 1.3. As shown, approval is sought for two alignments of the new rail line where it will cross Berrima Road. The preferred option is the blue rail alignment shown in Figure 1.3, which includes construction of a railway bridge over Berrima Road as described in the points above. This preferred project design has been developed in consultation with Boral as the owner of the Berrima Branch Line.

The alternative option (orange alignment in Figure 1.3) accounts for a proposal by Wingecarribee Shire Council (WSC) to realign approximately 700 m of Berrima Road between Taylor Avenue and Stony Creek to replace the T-intersection at Berrima Road and Taylor Avenue with a roundabout, and to replace the existing rail level crossing into the Berrima Cement Works with a rail overbridge. If WSC relocates Berrima Road to the alignment shown in Figure 1.3, then the following project components would vary:

- the turnout for the new spur line to service the Hume Coal Project would be installed on the existing Berrima Branch Line approximately 1000 m east of the cement works. A short section of the existing Berrima Branch Line would be shifted north, within the rail corridor on Boral-owned land, to accommodate the spur line;
- the construction of a railway bridge over Berrima Road would be replaced by a railway underpass beneath the realigned Berrima Road, constructed through the elevated embankment for the road;
- the construction of a new rail connection into the Berrima Cement Works from the railway bridge would no longer be required, and the cement works access would remain unchanged; and
- the existing rail connection into the Berrima Cement Works and the Berrima Road level rail crossing would not be decommissioned, since the road would be realigned to pass over the existing rail alignment using a bridge.

This soil and land assessment has considered the impacts of both options shown in Figure 1.3.



Locality plan
Berrima Rail Project
Soil and land assessment
Figure 1.1

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Local context

Berrima Rail Project

Soil and land assessment

Figure 1.2

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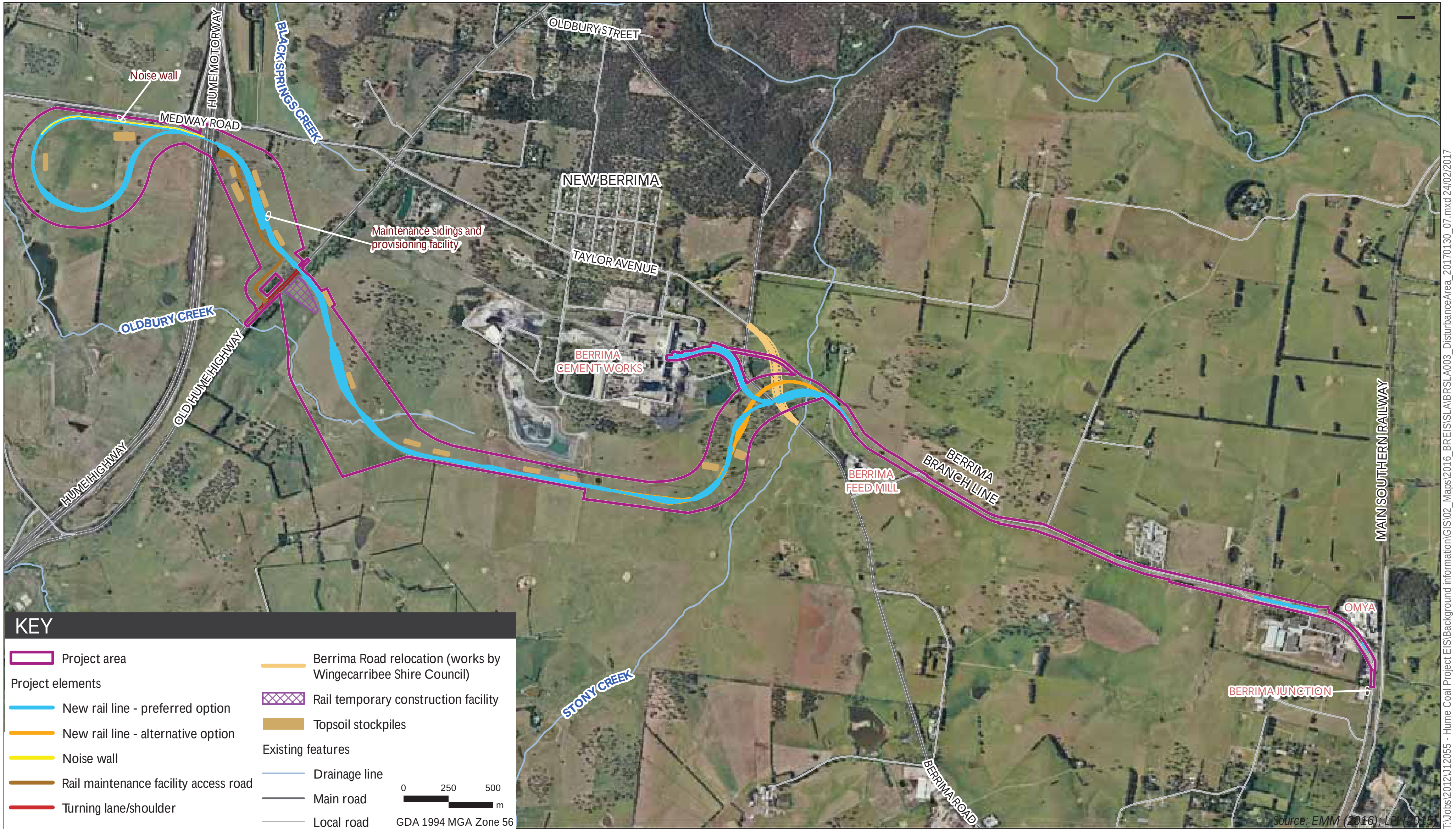


Conceptual project components

Berrima Rail Project

Soil and land assessment

Figure 1.3

1.3 Project area

The project area is located in the Southern Highlands region of NSW in the Wingecarribee local government area, approximately 100 km south-west of Sydney. It occupies a corridor that is around 8 km long, stretching from the Berrima Junction on the outskirts of Moss Vale, heading west in parallel with Douglas Road past the Berrima Feed Mill, around the southern side of the Berrima Cement Works, across the Old Hume Highway and under the Hume Highway through an existing underpass into the Hume Coal Project area, south of Medway Road.

The project area is in a semi-rural setting. It is surrounded by grazing properties, small-scale farm businesses, and scattered rural residences, large and small industries and is traversed by the Hume Highway. The project area contains predominately cleared agricultural land consisting of improved pasture for grazing, and over a third of the area comprises the existing Berrima Branch Line.

The villages of New Berrima, Berrima and Moss Vale are located in the general area. Medway is also located nearby while Bowral and Mittagong are located between 6 and 10 km north-east of the eastern end of the project area, respectively. There are also scattered homesteads, dwellings and other built structures associated with agricultural production surrounding the project area.

1.4 Assessment guidelines and requirements

This soil and land assessment has been prepared in accordance with the relevant governmental assessment requirements, guidelines and policies, and in consultation with the relevant government agencies. In particular, the following guidelines and policies were considered in this assessment:

- *Interim Protocol for Site Verification and Mapping of Biophysical Strategic Land* (NSW Government 2013);
- *Soil and Landscape Issues in Environmental Impact Assessment* (DLWC 1997);
- *The land and soil capability assessment scheme (OEH 2012);* and
- *Agfact AC25: Agricultural Land Classification* (NSW Agriculture, 2002).

The soil and land assessment was prepared in accordance with the requirements of the NSW Department of Planning and Environment (DP&E). These were set out in the Secretary's Environmental Assessment Requirements (SEARs) for the project, issued on 20 August 2015. Table 1.1 lists the individual requirements relevant to this assessment and where they are addressed in this report.

Table 1.1 Soil and land assessment – related SEARs

Requirement	Section addressed
An assessment of the likely impact of the development on the environment, focusing on the specific issues identified below, including:	
- a description of the existing environment likely to be affected by the development, using sufficient baseline data;	Section 3
- an assessment of the likely impacts of all stages of the development, including any cumulative impacts, taking into consideration any relevant legislation, environmental planning instruments, guidelines, policies, plans and industry codes of practice;	Section 7
- a description of the measures that would be implemented to mitigate and/or offset the likely impacts of the development, and an assessment of: ▪ whether these measures are consistent with industry best practice, and represent the full range of reasonable and feasible mitigation measures that could be implemented; ▪ the likely effectiveness of these measures, including performance measures where relevant; and ▪ whether contingency plans would be necessary to manage any residual risks.	Section 8; contingency measures in 8.8
- a description of the measures that would be implemented to monitor and report on the environmental performance of the development if it is approved.	Section 8.7

To inform preparation of the SEARs, DP&E invited other government agencies to recommend matters for address in the EIS. These matters were taken into account by the Secretary for DP&E when preparing the SEARs. Copies of the government agencies' advice to DP&E was attached to the SEARs.

A number of agencies raised matters relevant to the soil and land assessment. The matters raised are listed in Table 1.2.

Table 1.2 Government agency assessment recommendations

Recommendation	Section addressed
Agriculture NSW	
- Consideration of impacts to livestock access and movement from construction of the railway.	Section 8.5
- Consideration of the Infrastructure Proposals on Rural Land Guideline to assess impacts.	Impacts on farming operations and livestock see Section 7.2.7; Weed management will be addressed in CEMP; Rehabilitation see Section 8.6
DPI Water	
Soil Resources	
- An outline of the measures to be put in place to ensure that sufficient resources are available to implement the proposed rehabilitation.	Section 7.2.5
OEH	
- The EIS must map the following features relevant to water and soils including: ▪ a. Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map).	There are no acid sulfate soils – see Section 3.7v

Table 1.2 Government agency assessment recommendations

Recommendation	Section addressed
Water NSW	
Soil Resources	
- Provide concept plans/protocols/procedures for the following: ▪ - Soil and Water Management Plan	Chapter 8 includes the procedures for topsoil management that will be incorporated into the Soil and Water Management Plan

2 Assessment method

2.1 Overview of assessment process

The land and soil assessment comprised the following steps:

- a desktop review of existing information (incorporated into Section 3.6 and 3.7);
- a soil survey to characterise soil types of the project area, including field assessment and laboratory analysis (Section 4);
- an assessment of land and soil capability (LSC) using results from the soil survey (Section 5);
- an assessment of agricultural land use (Section 6); and
- an assessment of potential impacts on soil resources (Section 7) and proposed management and mitigation methods (Section 8).

2.2 Desktop survey

Existing information on soils and soil environments for the project area was sourced from the following regional mapping published by government departments. The relevant information is summarised in Section 3.

- *Soil and land resources of the Hawkesbury-Nepean catchment* (DECC 2008);
- *Australian soil classification (ASC) soil type map of NSW* (OEH 2016a);
- *Great soil group soil type mapping of NSW* (OEH 2016b);
- *Hydrological soil group mapping* (OEH 2016c);
- *Inherent soil fertility mapping* (OEH 2016d);
- *Land and soil capability classes mapping* (OEH 2016e);
- *NSW soil and land information system* (SALIS) (OEH 2016f);
- *Soil profile attribute data environment* (eSPADE) online database (OEH 2016g); and
- *State Environmental Planning Policy* (Mining, Petroleum Production and Extractive Industries) 2007 - Strategic Agricultural Land Map of NSW (NSWG 2013).

2.3 Field Survey

2.3.1 Survey density

A total of 29 observation points were surveyed over an overall area of 355 ha in 2014 and 2015. The mapping scale is therefore 1:25,000 because the sample density is between one sample per 4-20 ha, as described in McKenzie et al (2008). The locations of the sites are shown in Figure 2.1. The survey points covered an area larger than the project area, as the final alignment of the railway line and associated infrastructure had not been finalised at the time of the survey.

2.3.2 Sampling method

Soil was sampled using either a 4WD-mounted push tube machine or a hand auger. A hand auger was used in some locations where landholder access requirements and vehicular access were constraints, as well as to minimise disturbance, with samples up to 750 mm deep. Soil core holes were backfilled as soon as the assessment was finished.

All sites were described in detail using the *NSW soil and land information system* (SALIS) data record sheets, and all data was submitted to the OEH database. Field observations included the GPS location, photographs of the site and the soil core, soil texture, soil type classification, and site observations (eg vegetation, land-use, drainage, site morphology). Soil profiles were assessed in accordance with the *Australian Soil and Land Survey Handbook* (NCST 2009).

The soil assessment of the Hume Coal Project (HCP) was extensive (246 soil survey sites), and included 33 sites which were subjected to soil analysis. Soil pits were excavated for these sites to fully classify the five identified soil types in the project area. The soils sampled in the Berrima Rail Project (BRP) area were identified to be the same soil types described in the Hume Coal Project area, therefore, given the comprehensive assessment of the Hume Coal Project area and that the two projects share the landscape, additional soil pits and laboratory analysis were not deemed necessary.

2.3.3 Survey limitation

The existing linear rail line and wide road corridor that traverse this part of the project area result in 100% pre-existing disturbance due to mixing, grading, cutting and filling. Observations were made of the cut batter locations (see Photograph 2.1) and a preliminary assessment of the soil type was made.

When the rail line is removed during rehabilitation, the soils will be further assessed to determine their usability and compatibility with the future proposed land use for the area.

Photograph 2.1 Rail cutting on Collins Rd, Berrima

Soil sampling sites

Berrima Rail Project

Soil and land assessment

Figure 2.1

3 Biophysical environment

3.1 Climate

The Southern Highlands is in the temperate climatic zone. It has a warm summer and cold winter, with uniform rainfall (BOM 2012). The nearest weather station to the project area is located in the town of Moss Vale (Station 068045), 5 km to the east of the project area. The region experiences four distinct seasons. Temperatures range between 12 and 24 °C in summer and 2 to 12 °C in winter. The area experiences a mean rainfall of 970 mm with more cloudy days than clear throughout the average year. Figure 3.1 shows the mean monthly temperature and rainfall over the last 100 years, sourced from the Moss Vale weather station (Station 068045).

The NSW and ACT Regional Climate Modelling (NARCLiM) Project has released climate prediction maps for 2060-2079 (NARCLiM 2015), which is well beyond the duration of the project. By this time, the project area may expect increased overall temperatures with colder nights, and less rainfall in spring with more rainfall occurring in the autumn months.

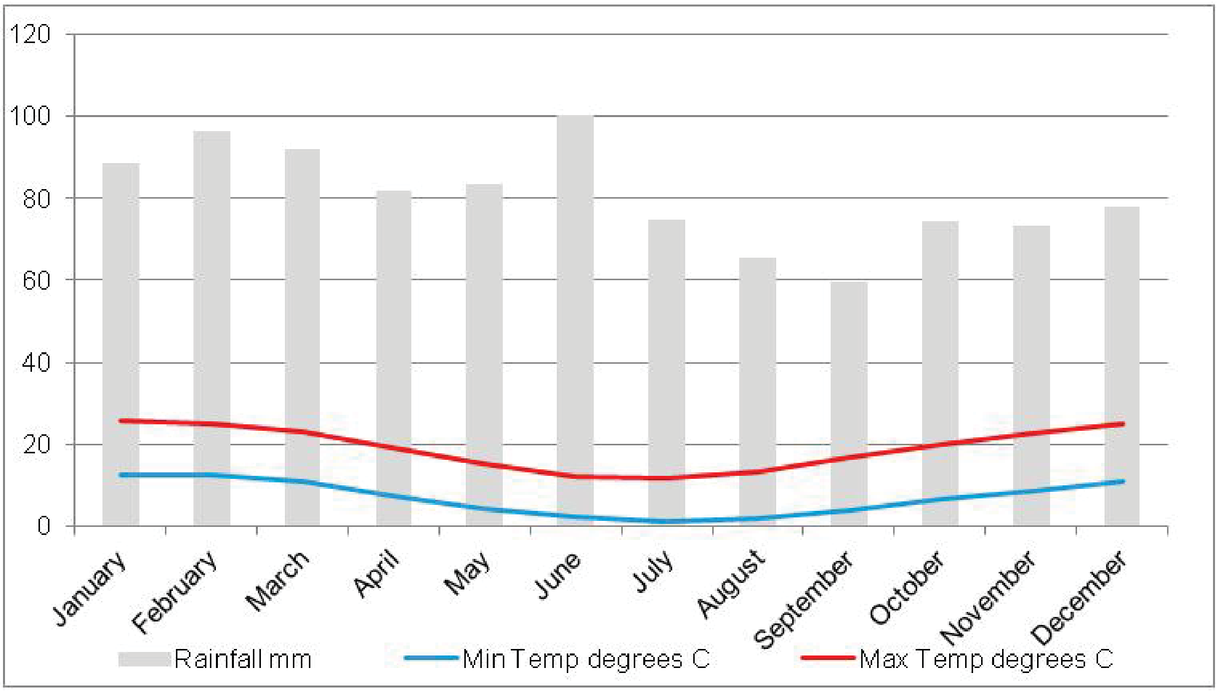
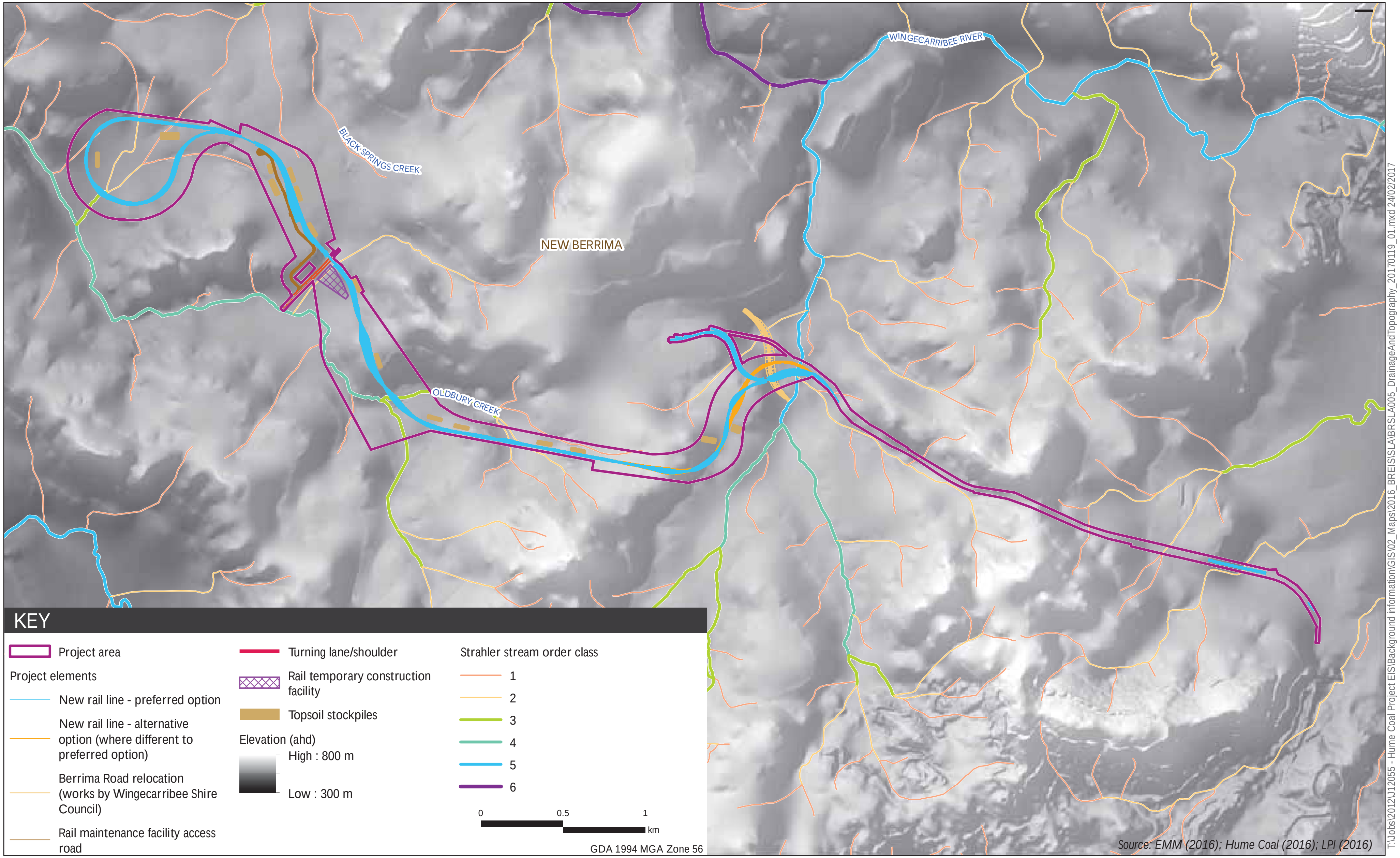


Figure 3.1 Mean rainfall and temperature in Moss Vale (Station 68045) 1914 - 2014

3.2 Topography

The project area is situated on the elevated, relatively flat Woronora-Nattai Plateau of the Southern Highlands. Elevations range from about 650 m to 690 m Australian Height Datum (AHD) (see Figure 3.2). The project area is characterised by low rolling hills, with generally low to very low local relief.

The primary topographic feature is the residual volcanic peak of Mount Gingenbullen around 2 km south of the project area. Mount Gingenbullen is a 70 ha flat-topped mountain with a dolerite intrusion. It is a product of the more erosion resistant characteristics of the Jurassic and Tertiary basalts and dolerites when compared to the surrounding sedimentary sandstones and shales.



Topography and landform

Berrima Rail Project

Soil and land assessment

Figure 3.2

3.3 Geology

The project area is in the Southern Coalfield, on the south-western edge of the Permo-Triassic Sydney Basin. The Sydney Basin primarily consists of sediments deposited in a 'basin' environment, which were deposited between two major 'fold belts'; the Lachlan Fold Belt to the north-east and the New England Fold Belt to the west, both of which constrain this central depositional trough. Initially, sediments were deposited into the basin from the north and interspersed with several sequences of coal seams. The Illawarra Coal Measures contains some 10 recognised coal seams, some of which are of economic importance, in particular the Bulli and Wongawilli Seams.

The marine sedimentary rocks of the Shoalhaven Group form the immediate base of the Illawarra Coal Measures, which is, in turn overlain by the Triassic aged Narrabeen Group, the Hawkesbury Sandstone and the Wianamatta Group, the latter being the uppermost unit in this regional context. Hawkesbury Sandstone dominates the natural topography of the Sydney region and is typically composed of medium to coarse grained quartzose sandstone with a clay matrix. The Hawkesbury Sandstone is up to 200 m thick in certain areas of the Sydney Basin.

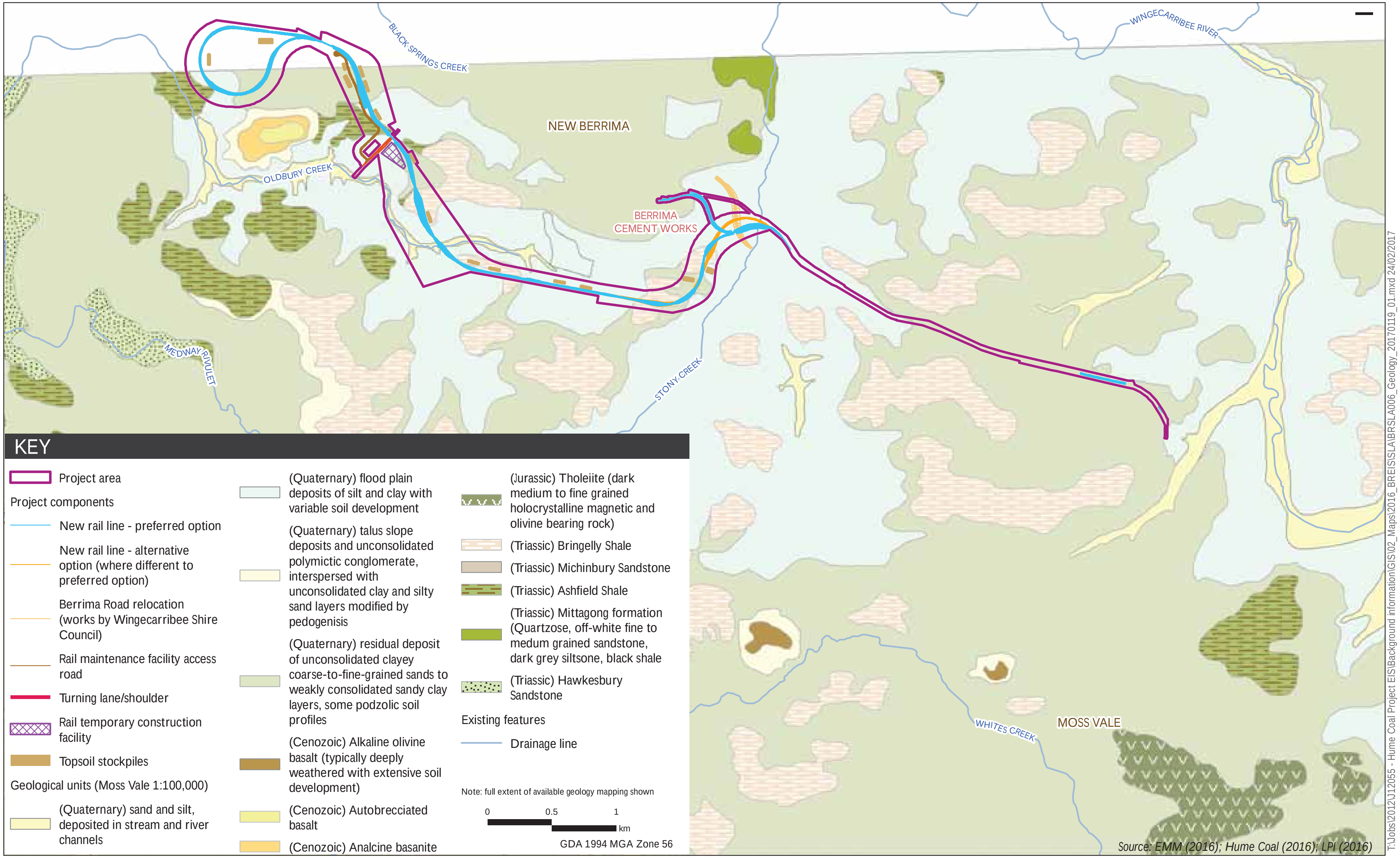
There are numerous igneous intrusive and extrusive rocks in the regional area including Jurassic aged micro-synenite at Mount Gibraltar and silling at Mount Gingenbullen, as well as Tertiary aged basalts at Robertson.

The *Moss Vale 1:100,000 Geological Sheet* (Trigg and Campbell 2009) shows that the majority of the BRP project area is covered by Quaternary deposits, interspersed with Bringelly Shale and Ashfield Shale. Table 3.1 summarises the descriptions of geological units mapped for the BRP project area, which are also illustrated in Figure 3.3. Bringelly Shale is the most recent deposit in the sequence, which was deposited in an alluvial plain and cut by streams flowing from west to east and have formed discontinuous beds of sandstone. It is similar to Ashfield Shale but generally has higher sandstone content. Surficial Bringelly Shale occurs on crests in the eastern parts of the project area.

Table 3.1 Geological Units mapped in BRP project area

Age	Code	Name	Description
Cenozoic Quaternary	Qa	Alluvium	Sand and silt, deposited in stream and river channels
	Qap	Alluvium	Flood plain deposits of silt and clay with variable soil development
	Qr	Residual Deposits	Residual deposits of unconsolidated clayey course- to fine-grained sands to weakly consolidated sandy clay layers; some podzolic soil profiles
Mesozoic Triassic (Wianamatta Group)	Rwb	Bringelly Shale	Bringelly Shale – Light to dark grey, sideritic claystone to siltstone, dark grey carbonaceous claystone, laminite, sandstone to siltstone, quartz-lithic very fine-to medium-grained sandstone, coal. Plant fragments and fossil roots abundant
	Rwa	Ashfield Shale	Ashfield Shale – Dark grey to black, sideritic claystone to siltstone and sandstone/siltstone laminite. Plant fossils rare

Notes: 1.Map Unit Descriptions (Moss Vale 1:100,000 Geological Sheet).



Geology of the project area

Berrima Rail Project
Soil and land assessment

Figure 3.3

3.4 Surface water

The project area is within the broader Wingecarribee River catchment, which is a component of the broader Warragamba Dam and Hawkesbury-Nepean catchments. The Wingecarribee River flows north-west before it reaches its confluence with the Wollondilly River north of Tugalong. The main drainage features in the project area are Oldbury Creek (a 4^{th} order stream in accordance with the Strahler system of stream order) and its tributaries and Stony Creek (5^{th} order) and its tributaries. Oldbury Creek and its tributaries flow through the western and central portions of the project area and Stony Creek flows across a portion of the project area between the Berrima Feed Mill and the Berrima Cement Works. Stony Creek drains directly into the Wingecarribee River to the north of the project area.

3.5 Ecology

The project area has largely been cleared of vegetation and used for agricultural purposes for approximately the last 150 years. It therefore contains predominantly cleared land, with the eastern portion comprising existing rail infrastructure (the Berrima Branch Line). The majority of the disturbance footprint associated with the project is characterised by exotic pasture. Some larger patches of native vegetation occur; however many are small and highly fragmented, comprising only small pockets of isolated trees. These remaining patches are currently in use for grazing and have a highly degraded understorey.

Prior to clearing, the project area would have comprised tall open forest and open woodland communities dominated by Eucalyptus species such as scribbly gum (*E. sclerophylla*), white stringybark (*E. globoidea*) and black ash (*E. sieberi*). These vegetation communities are likely to have been maintained by regular anthropogenic and natural bushfires.

Two native and one exotic vegetation community are present in the project area as follows:

- Broad-leaved Peppermint Narrow-leaved Peppermint grassy woodland;
- Snow Gum Woodland; and
- Cleared land.

The Broad-leaved Peppermint Narrow-leaved Peppermint grassy woodland has some representative species of 'Southern Highlands Shale Woodland in the Sydney Basin Bioregion', which is listed as an endangered ecological community (EEC) under the *Threatened Species Conservation Act 1995* (TSC Act). The Snow Gum Woodland has a representative canopy species of 'Tablelands Snow Gum, Black Sallee, Candlebark and Ribbon Gum Grassy Woodland in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South Western Slopes Bioregions; which is listed as an EEC under the TSC Act.

Of the native plant species recorded in the project area, Paddy's River Box (*Eucalyptus macarthurii*) is listed as an endangered species under the NSW TSC Act and the EPBC Act. Fifteen Paddy's River Box recorded within the project area; however the project design was modified so that impacts are minimised on these species. One individual tree will be removed under the preferred project option, whilst the alternative option will avoid all direct impacts to the species.

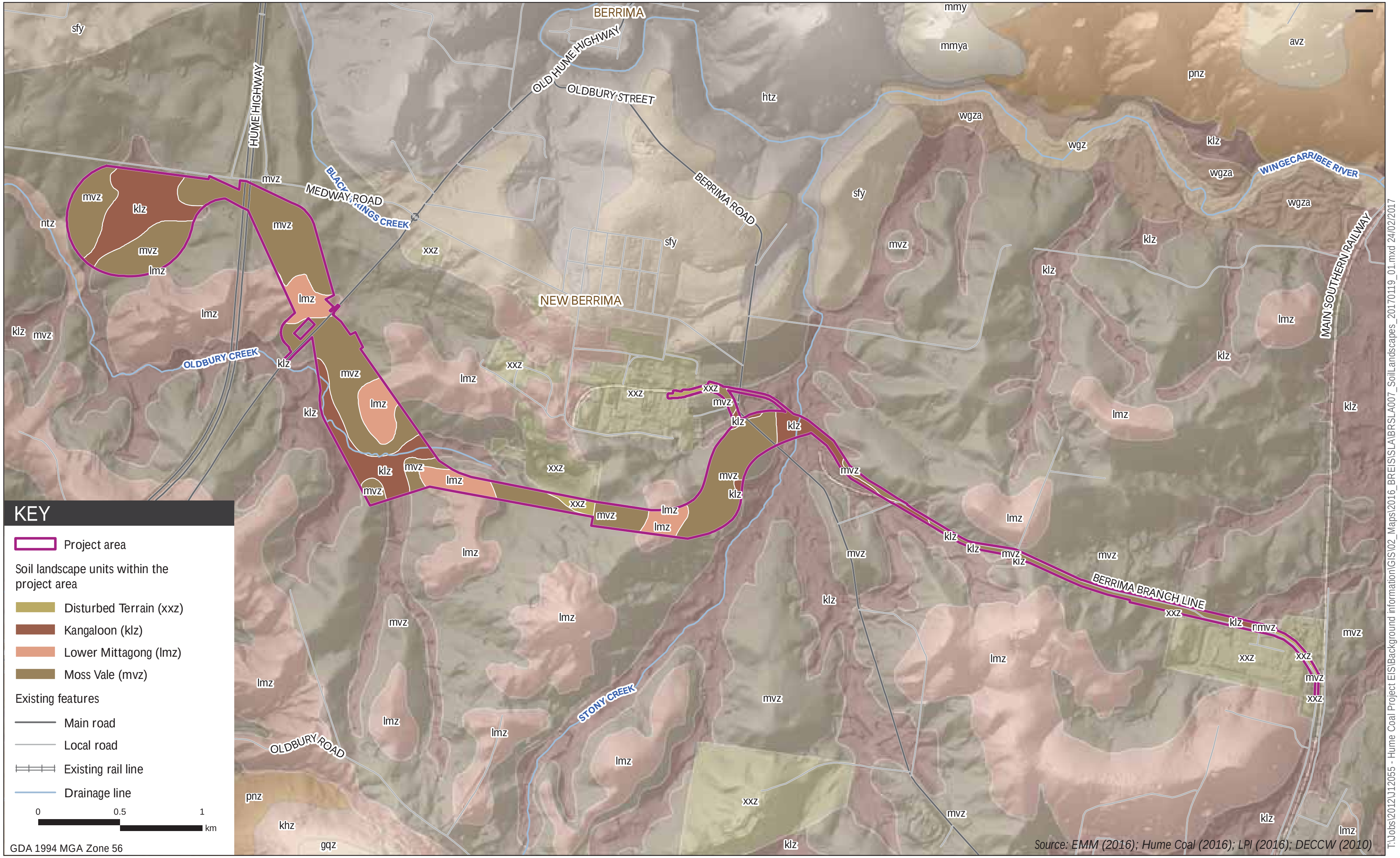
3.6 Regional soil mapping

i Soil and land resources mapping

The *Soil and Land Resources of the Hawkesbury-Nepean Catchment Map* (1:100,000) identifies three soil landscapes within the project area (DECC 2008), with some of the area classified as disturbed terrain. The soil landscapes are: Lower Mittagong, Kangaloon, and Moss Vale, and are described in Table 3.2 and illustrated in Figure 3.4. Instead of soil type, the soil landscapes are mostly based on geological origin and similarity in local relief and slopes. Therefore each landscape may include a range of soil types within it. Similarly, each soil type described in Section 4 occurs across more than one soil landscape.

Table 3.2 Soil landscapes in the project area

Description	General landscape	Land use	Soils and vegetation	Erosion
Kangaloon	Foot slopes within plain on Wianamatta Group Shale. Local relief 0–9m; altitude 531–745m; slopes 1–3%; rock outcrop nil	Grazing	Brown Kurosols and Hydrosols; extensively cleared open grassland	Waterlogging as a result of tree clearing
Lower Mittagong	Rises and low hills on Wianamatta Group Shale (shale). Local relief 5–90 m; altitude 534–820 m; slopes 0–25%; rock outcrop nil	Beef cattle grazing, rural residential development, olive and vineyard development, plus urban development around Mittagong and Moss Vale	Brown Kurosols, Red Kurosols, Brown Dermosols and Red and Brown Kandosols, with Yellow Natric Kurosols in drainage lines; generally Mittagong Sandstone Woodland community	Minor to moderate gully erosion occurs in cleared drainage plains; minor sheet erosion is common
Moss Vale	Rises on Wianamatta Group Shale (shale). Local relief 5–30 m; altitude 544–740 m; slopes 0–5%; rock outcrop nil	Beef cattle grazing and rural residential development	Yellow Kurosol, Red Kurosols, Brown Kurosols and Yellow Kandosols; mostly cleared pasture with isolated paddock trees	Minor to moderate gully erosion occurs in cleared drainage plains



Soil landscapes of project area and surrounds

Berrima Rail Project

Soil and land assessment

Figure 3.4

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ii Australian Soil Classification

The Australian Soil Classification (ASC) scheme (Isbell 2002) is a multi-category scheme with soil classes defined on the basis of diagnostic horizons and their arrangement in vertical sequence, as seen in an exposed soil profile. Table 3.3 provides descriptions of the ASC orders that are mapped on a regional scale within the project area (OEH 2016a) and some indicative information of agricultural values. Figure 3.5 shows the distribution of the soil types. The mapping is based on a small number of historic soil survey observations and is superseded by more detailed mapping that EMM have made for the project area (Section 4). The table also shows the area of each soil order within the project area.

Table 3.3 Regional soil mapping – ASC soil orders distribution in the project area

Order	Description	Agricultural potential[1]	Soil Landscapes	Approximate location	ha
Kurosol	Soils with strong texture contrast between A horizons and strongly acid B horizons	Very low with high acidity (pH<5.5), low chemical fertility, low water-holding capacity and often sodic	Kangaloon	Low lying areas subject to periodic inundation	41.2
Dermosols	Lack a strong texture contrast and have a well-structured B horizon. Soils have a gradual increase in clay content with depth, and a more defined structure then Kandosols.	High with good structure and moderate to high chemical fertility and water-holding capacity with few problems	Lower Mittagong, Moss Vale	Widespread over most of the project area	135.4
Other	Land associated with the Berrima Cement Works, and other industrial works.	Not assessed	Disturbed terrain	Southern end of the Berrima Branch Line, south of the Berrima Cement Works	4.7

Notes: 1.Based on Gray and Murphy (2002).

iii Great soil group

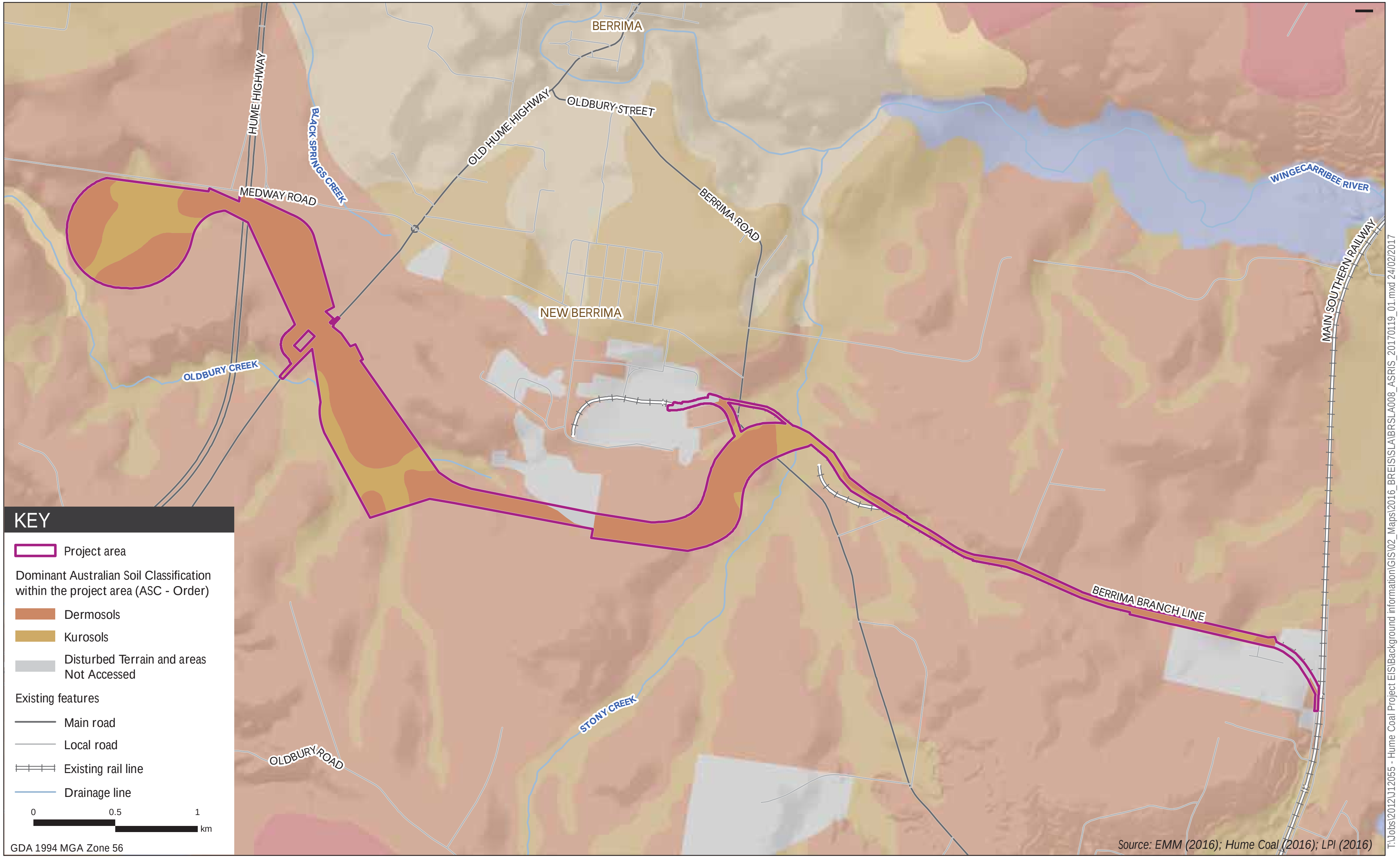
Great soil groups (GSG) is a soil classification system that Stace et al (1968) developed. It is based on the description of soil properties such as colour, texture, structure, drainage, lime, iron, organic matter and salt accumulation, as well as theories of soil formation. Historic soil mapping identified from NSW government mapping data (OEH 2016b) for the project area comprises Yellow podzolic soils – more fertile (YPm), and Yellow podzolic soils – less fertile (YPi).

iv Inherent soil fertility

The inherent fertility based on GSG mapping of the rail project area identifies soils ranging from moderately low (2) soil fertility to moderate (3). The inherent fertility is based on GSG data (Stace et al 1968), from which a fertility value was derived using a lookup table modified from Charman (1978).

The fertility rankings are defined by OEH (2016d) as:

- moderate (3): soils have low to moderate fertilities and usually require fertiliser and/or have some physical restriction for arable use; and
- moderately low (2): includes soils with low fertilities, such that, generally, only plants suited to grazing can be supported. Large inputs of fertiliser are required to make the soils arable.



Regional soil mapping - Australian Soil Classification (eSpade)

Berrima Rail Project

Soil and land assessment

Figure 3.5

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v Hydrological soil group

The hydrologic soil groups present in the project area are largely classed as group C – slow infiltration. This category is defined as follows (OEH 2016c):

- Group C: soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

vi eSPADE soil profiles

The *soil profile attribute data environment* (eSPADE) soil profile database search identifies information on a number of soils profiles previously surveyed in the greater Bowral area. Table 3.4 details the six historic eSPADE soil profiles within the project area. Very few of these sites have a complete soil survey record.

Table 3.4 eSPADE historic soil profiles within the project area

Site ID	Soil type (GSG)	Surface texture	Surface pH	Easting[1]	Northing[1]
Survey name and date					
Sydney Catchment Authority reconnaissance soil survey – Moss Vale (1004229) 13/2/2001					
Profile 28	Red Podzolic	Light medium silty clay loam	6	259382	6175341
Profile 29	Red Podzolic	Light silty clay loam	6.5	256776	6177340
Profile 31	Red Podzolic	Sandy clay loam	6	253594	6178608
Soil Landscapes of the Burragorang 1:100 000 Sheet (1001013) 6/11/1998					
Profile 20	Red Earth	Loam	7	251504	6179690
Profile 22	Yellow Earth	Sandy Loam	7.5	251704	6179590
Bowral/Mittagong Effluent (1000635) 10/09/1994					
Profile 10	-	Clay loam	7	256904	6177400

Notes: 1.MGA Zone 56.

3.7 Regional land use and capability

i Land use

The existing land use in and surrounding the project area comprises a mixture of agricultural, industrial, rural residential and residential land uses. The land use within the project area where the rail loop and new rail line will be constructed is mostly improved pasture for grazing. There is also some land which already has rail and road infrastructure. Further information on land use is presented in Section 6.

ii Land and soil capability classes

The project area is mapped by the *Land and Soil Capability Mapping of NSW* (mapping data sourced from OEH 2015b) as mainly Class 4 – moderate capability land and Class 3 – high capability, as shown in Figure 3.6. Table 3.5 also provides the LSC class definitions according to OEH (2015b). The LSC classes in the project area are matched with the relevant Soil Landscapes in this table. These maps are not intended to be used for detailed rural capability assessment at the property scale, as that would require more intensive field investigation. Land and soil capability has been assessed at a local scale using the field survey results, and is described in detail in Section 5.

Table 3.5 Regional land and soil capability classes in the project area

LSC Class	Soil landscapes	Description	Area
3	Moss Vale	**High capability land:** Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.	113.9
4	Kangaloon, Lower Mittagong	**Moderate capability land:** Moderate to high limitations for high-impact land uses. It will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture; and the limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.	62.7
8	Disturbed Terrain (existing infrastructure)	**Extremely low capability land:** Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation.	4.7

iii Agricultural suitability assessment

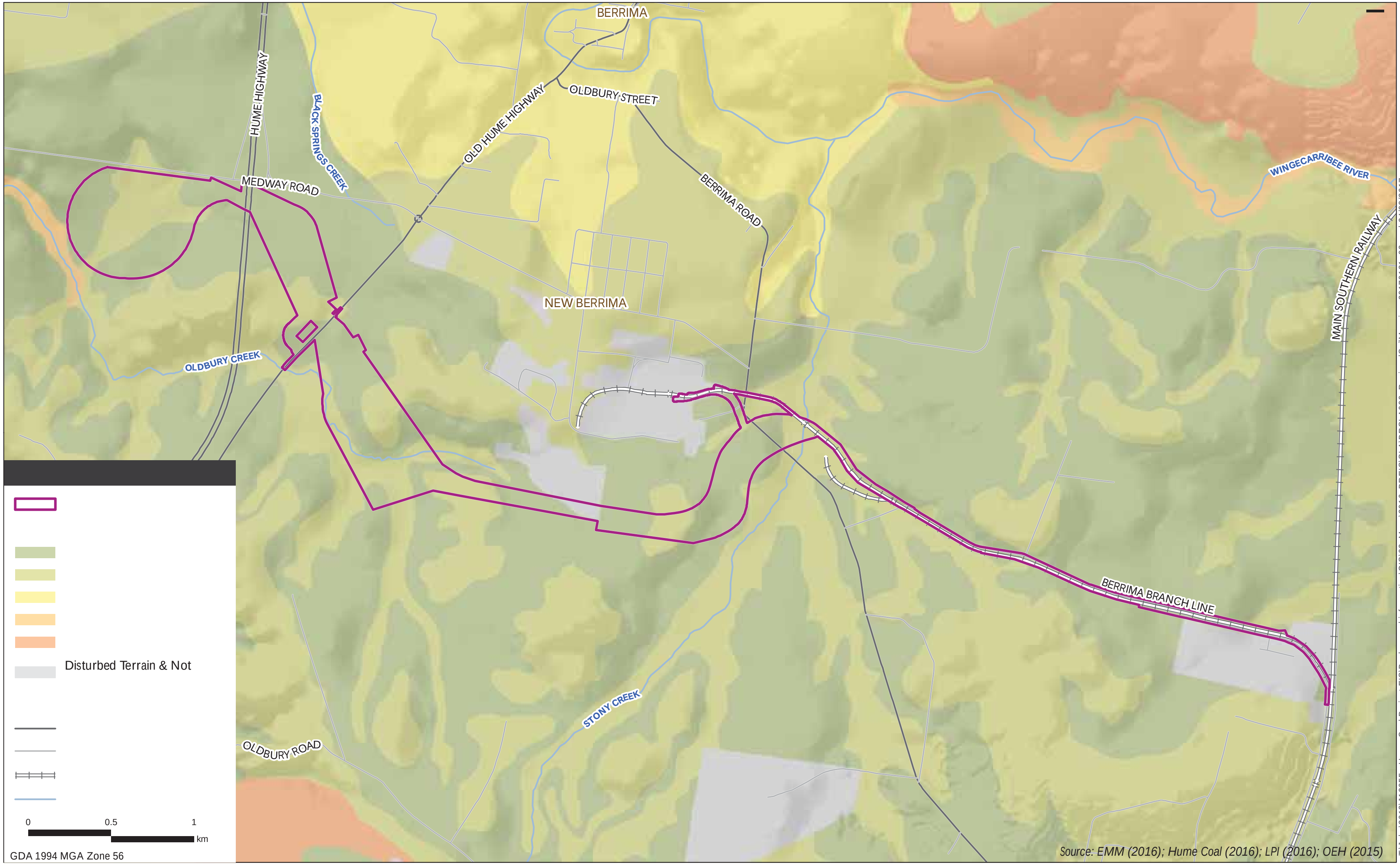
The agricultural suitability assessment is a five class system (developed in 1979), which classifies land in terms of its suitability for general agricultural use (NSW Agriculture 2002). The classification system relies on the evaluation of biophysical, social and economic factors. It is a useful tool for government land use planning purposes, but is not used at a farm scale.

Class definitions for agricultural land classification are:

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

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

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



T:\Jobs\2012\J12055 - Hume Coal Project EIS\Background information\GIS\02_Maps\2016_BREIS\SLA\BRSLA009_RegionalSoilMapping_20170131_02.mxd 24/02/2017

Land and soil capability in the project area (regional soil mapping)

Berrima Rail Project

Soil and land assessment

Figure 3.6

EMM HUMECOAL

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

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

There is no Class 1 or 2 land suitable for cultivation. The project area contains mainly Class 3 agricultural land, and some land which has been developed with infrastructure (Class 5).

iv Biophysical Strategic Agricultural Land

The NSW Government has mapped Biophysical Strategic Agricultural Land (BSAL) across the whole of NSW, based on a desktop study, and the resultant maps accompany the Mining SEPP. BSAL is land with high quality soil and water resources capable of sustaining high levels of productivity. As of October 2015, the *Strategic Agricultural Land Map* prepared by OEH and presented in the *Interim protocol for site verification and mapping of biophysical strategic agricultural land* (NSWG 2013) indicates there is no BSAL in the project area. The closest mapped BSAL area is about 2 km south of the project area, on Mount Gingenbullen. The project is linear infrastructure that is not subject to the Gateway process.

v Acid sulphate soil planning map

There are no acid sulphate soils in the project area, as per the *Guidelines for the Use of Acid Sulfate Soil Risk Maps* (DLWC 1998). Given the elevation of the project area it is evident that the surface strata are not subject to seawater intrusion, which is a prerequisite for ASS formation.

4 Soil descriptions

4.1 Summary of units

The soil survey identified Dystrophic Yellow Kandosol as the major soil type (or soil order) within the project area (Figure 5.1). A red variation and a shallow phase variation of the soil were also observed. Small patches of Kandosolic Redoxic Hydrosol and Eutrophic Grey Dermosol were also identified. The soil types in the project area as identified by the field survey are summarised in Table 4.1 and described further below the table.

Visual assessment of cut batters along the existing rail corridor in the eastern part of the project area identified a possible texture contrast soil, most likely a Kurosol (Photograph 2.1). Access restrictions have not allowed these cut batter locations to be validated. The existing linear rail line and wide road corridor that traverse this part of the project area result in 100% pre-existing disturbance there.

Table 4.1 Soil types in the project area

ASC order (Soil type)	Total area mapped within project area	
	ha	%
Kandosol (Dystrophic Yellow Kandosol)	147.5	81.4
Hydrosol (Kandosolic Redoxic Hydrosol)	13.3	7.3
Dermosol (Eutrophic Grey Dermosol)	2.2	1.2
Unclassified (probably Kurosol)	18.4	10.1

4.1.1 Kandosols

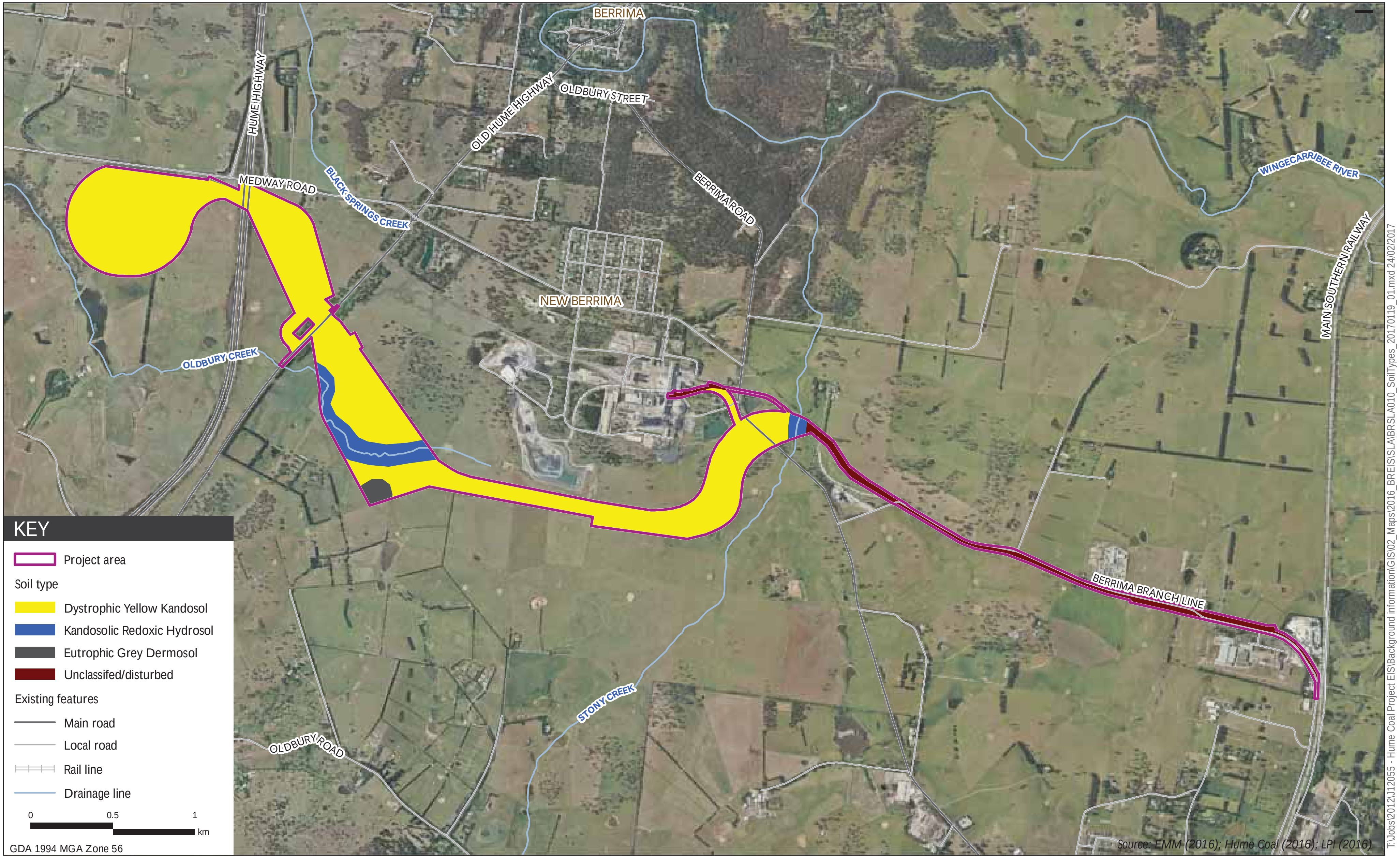
Kandosols are soils that lack strong texture contrast, have massive or only weakly structured B horizons, and are not calcareous throughout. The B2 horizon is generally well developed and has a maximum clay content in some part of the B2 horizon, which exceeds 15%. In the project area, Kandosols are mainly associated with cleared, undulating pasture in the west and existing infrastructure corridors in the east. The Kandosol described in the project area is further classified as Dystrophic Yellow Kandosol and is described in detail in Section 4.2.

4.1.2 Hydrosols

This order includes a range of seasonally or permanently wet soils that experience saturation of the greater part of the profile for prolonged periods (2–3 months). There is a large diversity in this soil group. The soils may or may not experience reducing conditions for all or part of the period of saturation, and thus manifestations of reduction and oxidation, such as 'gley' colours and mottles, may or may not be present. The Hydrosol described in the project area is further classified as Kandosolic Redoxic Hydrosol and is described in detail in Section 4.3.

4.1.3 Dermosols

Dermosols are moderately deep and well-drained soils of wetter areas in eastern Australia. They have B2 horizons with structure more developed than weak throughout the major part of the horizon, and do not have clear or abrupt textural B horizons. These soils can support a wide range of land uses, including cattle and sheep grazing of native pastures, forestry and sugar cane. Cereal crops, especially wheat, are commonly grown on the more fertile Dermosols. The Dermosol described in the project area is further classified as Eutrophic Grey Dermosol and is described in detail in Section 4.4.



Soil type distribution across the project area

Berrima Rail Project

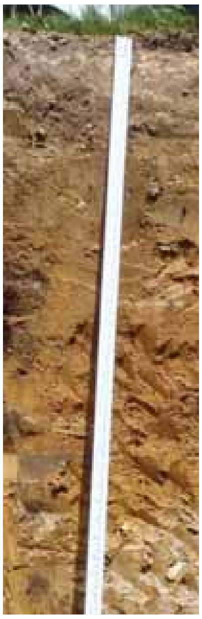
Soil and land assessment

Figure 4.1

4.2 Dystrophic Yellow Kandosol

The Dystrophic Yellow Kandosol soils are lacking strong texture contrast with silty clay loams over light clays, transitioning to medium clays at depth. The soil surface is mostly firm when dry and without surface coarse fragments. Topsoils have few coarse fragments and are without mottling. Subsoils have few coarse fragments, massive structure and are imperfectly drained. Mottling is common to many with colouring typically being orange or red. A soil profile description for a typical Dystrophic Yellow Kandosol is provided in Table 4.2. A typical profile can be provided as Dystrophic Yellow Kandosol soils are virtually the same regardless of their locations.

Table 4.2 Dystrophic Yellow Kandosol typical soil profile summary

ASC:	Horizon name and average depth (m)	Colour, mottles and bleach	Moisture, laboratory pH (median) and drainage	Texture and structure	Coarse fragments, segregations and roots
	A1 0.0–0.19	Dark greyish brown, 10YR4/2 and no mottles or bleaching	Moderately moist, pH 5.2 and well drained	Silty loam and sub-angular blocky or massive	No surface rock, few coarse fragments, no segregations and many roots
	A2 0.19–0.36 (Sometimes A2e)	Pale brown, 10YR6/3 and no mottles or bleaching	Moderately moist; pH 6.1 and well drained	Clay loam sandy and sub-angular blocky or massive	Few coarse fragments, no segregations and common roots
	B21 0.36–0.53	Brownish yellow, 10YR6/8, common orange or red mottles and no bleaching	Moist; pH 4.3 and imperfectly drained	Light clay and massive	Common coarse fragments, no segregations and few roots
	B22 0.53-0.76	Brownish yellow, 10YR6/8, common to many orange or red mottles and no bleaching	Moist to wet, pH 4.3 and imperfectly to poorly drained	Medium clay and massive	Common coarse fragments, no segregations and few to no roots

Notes: 1. Description in accordance with the Australian Soil and Land Survey Field Handbook (NCST 2009).

The Dystrophic Yellow Kandosol soil unit occurs on all slopes and crests of low rolling hills on shale surface geology (see Photograph 4.1). Land within the project area that is characterised by this soil type is extensively cleared primarily for grazing of improved pastures. The Dystrophic Yellow Kandosol is more common across the eastern and central part of the project area where it is associated with shale surface geology of low rolling hills.

Two variations were noted, a shallow phase variation (10% of total occurrences) and a variation with a redder hue in the upper B2 horizon (10%). The shallow phase variation typically exists on steep slopes or hillcrests. Another variation exists on spurs and ridge lines with a redder hue in the upper B2 horizon. Laboratory testing using a citrate-dithionite extractable iron procedure confirmed that the percentage of free iron oxide is less than 5% and so the red variation is not a Ferrosol.

Photograph 4.1 Dystrophic Yellow Kandosol (Site 754)

The Dystrophic Yellow Kandosol can be strongly acidic in the A1 horizon with pH values ranging from 3.8 to 6.2 (see Table 4.3). As described in the HCP EIS (EMM 2017), 73 of the sites which were tested for field pH in the A1 horizon, 68% were below pH 5.5, and 15% were below 4.5. These results were mirrored in the B horizon with 66% below pH5.5. The pH's of the majority of the soils in this soil unit are therefore generally unsuitable for cultivation, and restricted to grazing, forestry and nature conservation (EOH 2012). The soils with the more neutral pH may be suitable for some restricted cultivation and pasture cropping, depending on other factors such as slope.

The macronutrients (nitrogen, phosphorous, and potassium) and the micronutrients (copper, zinc, iron, manganese, and boron) are mostly low which could restrict agriculture, although fertiliser could amend these concentrations. The cation exchange capacity (CEC) is also very low, which also may present some fertility issues.

The soil chemistry constituent values highlighted in the 'soil sufficiency' column in this table are agricultural industry benchmarks (Baker & Eldershaw 1993; Department of the Environment and Resource Management (DERM) 2011; Peverill, Sparrow & Reuter 1999) and have been referenced in interpreting the laboratory results. The outcomes are presented in the comments column, and are in reference to the median values with increasing depth. A summary of the agricultural potential of Dystrophic Yellow Kandosol is given in Table 4.4.

Table 4.3 Dystrophic Yellow Kandosol soil chemistry result medians (and ranges)

Constituents	Unit	Soil sufficiency[1]	A1 0-0.19	A2 0.19-0.36	B21 0.36-0.53	B22 0.53-0.76	Comments on median values (in increasing depth)
pH_{water}	pH units	6.0-7.5	5.2 (3.8–6.2)	6.1 (4.3–6.5)	4.3 (3.8–7.1)	4.3 (4.0–7.2)	Strong (top of A horizon) to extreme acidity (B horizon)
Electrical conductivity – saturated extract (EC_{se})	dS/m	<1.9	0.49 (0.16–4.63)	0.26 (0.23–0.66)	0.19 (0.09–1.17)	0.13 (0.07–1.51)	Very low soil salinity
Chloride (Cl^-)	mg/kg	<800	30 (20–50)	50 (50–50)	20 (10–140)	105 (30–200)	Not restrictive
Plant available water capacity (PAWC)	mm	>80	11.4 (L-ZCL)	13.6 (ZL-ZCL)	17.0 (LC-LMC)	27.6 (LMC-HC)	Small (total of 69.6)
Macronutrients							
Nitrite + Nitrate as N (Sol.)	mg/kg	>15	19.6 (0.1–333)	13.7 (12.9–14.5)	2.8 (0.1–12.2)	2.1 (0.8–6.8)	Moderate (top of A horizon) to very low (with depth).
Total Nitrogen as N	mg/kg	>1500	1485 (520–2680)	520 (390–940)	410 (200–960)	380 (110–530)	Deficient.
Phosphorous (P) (Colwell)	mg/kg	>10	3 (<2–46)	<2 (<2–5)	<2 (<2–24)	<2 (<2–26)	Very low (except in the A1 horizon).
Potassium (K) (Acid Extract)	mg/kg	>117	<100 (<100–300)	<100 (<100–<100)	<100 (<100–<100)	<100 (<100–200)	Insufficient.
K (Total)	mg/kg	>150	275 (200–790)	260 (220–320)	390 (140–610)	420 (170–830)	High (A horizon) to very high (B horizon).
Micronutrients							
Copper (Cu)	mg/kg	>0.3	<1.0 (<1.0–<1.0)	<1.0 (<1.0–<1.0)	<1.0 (<1.0–<1.0)	<1.0 (<1.0–<1.0)	Low (inconclusive).
Zinc (Zn)	mg/kg	>0.5 (pH<7) >0.8 (pH>7)	<1.0 (<1.0–8.1)	<1.0 (<1.0–<0.1)	<1.0 (<1.0–2.9)	<1.0 (<1.0–2.0)	Low (inconclusive).
Manganese (Mn)	mg/kg	>2	47.0 (<1.0–74)	21.0 (<1.0–44)	<1.0 (<1.0–14)	<1.0 (<1.0–9)	Moderate (A horizon) to very low (B horizon).
Boron (B)	mg/kg	>1	0.95 (<0.2–1.6)	0.50 (<0.2–0.7)	0.50 (<0.2–3.3)	0.50 (<0.2–1.7)	Low (A1 horizon) to very low (A2 and B horizons).
Cation Exchange Capacity (CEC)	meq/ 100g	12-25	3.8 (0.6–11.8)	2.1 (1.4–3.5)	0.8 (0.1–3.9)	0.3 (0.04–4.3)	Very low.
Calcium (Ca)	meq/ 100g	>5	2.9 (0.3–8.4)	1.7 (0.7–4.7)	1.1 (<0.1–4.4)	1.0 (0.2–5.5)	Low (A horizon) to very low (B horizon).
Magnesium (Mg)	meq/ 100g	>1	0.8 (0.3–3.5)	0.8 (0.2–3.3)	0.7 (0.4–5.9)	1.6 (0.6–7.7)	Low (A and B1 horizons) to moderate.

Table 4.3 Dystrophic Yellow Kandosol soil chemistry result medians (and ranges)

Constituents	Unit	Soil sufficiency[1]	A1 0-0.19	A2 0.19-0.36	B21 0.36-0.53	B22 0.53-0.76	Comments on median values (in increasing depth)
Sodium (Na)	meq/ 100g	<0.7	<0.1 (<0.1–0.2)	<0.1 (<0.1–0.2)	<0.1 (<0.1–0.3)	<0.1 (<0.1–0.4)	Very low.
K	meq/ 100g	>0.3	0.3 (<0.1–1.2)	<0.1 (<0.1–0.1)	<0.1 (<0.1–0.2)	<0.1 (<0.1–0.4)	Low (A1 horizon) to very low (A2 and B horizons).
Exchangeable sodium percentage (ESP)	%	<6	<2.70* (1.7–16.7)	<3.90* (2.41–11.1)	4.35 (2.8–16.7)	3.60 (2.8–11.1)	Non-sodic
Ca:Mg ratio		>2	3.40 (1.0–6)	2.10 (1.4–3.5)	0.83 (0.1–3.9)	0.30 (0.04–4.3)	Stable A horizon. Unstable B horizon
Organic Carbon	%	>1.2	2.0 (<0.5–4.1)	<0.5 (<0.5–2.2)	<0.5 (<0.5–1.8)	<0.5 (<0.5–1.8)	Moderate (A1 horizon) to very low (A2 and B horizons)

Notes: 1. Plant sufficiency sources: Baker and Eldershaw (1993), DERM (2011) and Peverill, Sparrow and Reuter (1999).

2. Values in brackets are the ranges measured.

** These values are an approximation based on calculations using the lowest measurable level.*

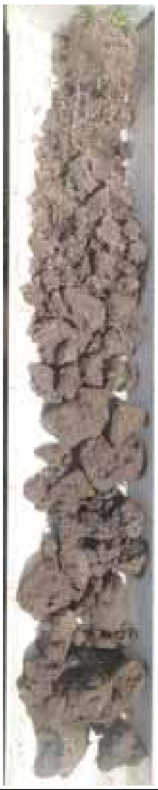
Table 4.4 Dystrophic Yellow Kandosol agricultural use summary

Elements	Comments
pH_{water}	Strongly acidic at the surface, progressing to extremely acidic with depth. Outside of the desirable range for agriculture throughout most of the profile. Would restrict agriculture.
EC	Very low salinity levels that would not restrict agriculture.
Cl	Acceptable chloride levels that would not restrict agriculture.
PAWC	At the upper limit of a low plant available water capacity, this would restrict agriculture.
Fertility	
Macronutrients	Mostly low levels of macronutrients, which present fertility issues. Would restrict agriculture.
Micronutrients	Mostly low to very low levels of micronutrients, which present fertility issues. Would restrict agriculture.
CEC	Very low CEC, which may present some fertility issues.
Fertility ranking	**Relative Fertility of ASC Classes (NSW Government 2013):** Moderately low Kandosols (order), Any (sub-order), Dystrophic (Great Group) **EMM applied Relative Fertility of ASC Classes (lab and field data applied to Murphy et al. 2007):** Moderately low (Group 2) **Explanation (Murphy et al. 2007):** Low fertilities that generally only support plants suited to grazing. Generally deficient in nitrogen, phosphorus and many other elements.
ESP	Low ESP indicating a non-sodic soil, which would not restrict agriculture.
Ca:Mg ratio	A mostly stable Ca:Mg ratio in the topsoil, but decreasing with depth to levels that suggest strong soil instability.
Organic Carbon	Indicative of good structural condition and structural stability in the A1 horizon. Low levels below this horizon.
Major limitations to agriculture	PAWC. Macronutrients (eg nitrate, total nitrogen, phosphorus, potassium extract) Micronutrients (eg boron, calcium, magnesium, sodium, potassium)

4.3 Kandosolic Redoxic Hydrosol

Kandosolic Redoxic Hydrosols are weakly to moderately developed, with variable textures and colour grades depending on the localised site morphology. The A Horizons are silty clay loam to light clay grading with depth towards medium to heavy clay B horizons. Surface condition is cracked and without coarse fragments. They have no coarse fragments throughout the profile. Orange mottles may be present at depth. Subsoils typically have no segregations. A soil profile description for a typical Kandosolic Redoxic Hydrosol is provided in Table 4.5.

Table 4.5 Kandosolic Redoxic Hydrosol typical soil profile summary

ASC:	Horizon name and depth (average) (m)	Colour, mottles and bleach	Moisture, laboratory pH (median value) and drainage	Texture, structure and consistence	Coarse fragments, segregations and roots
	A11 0–0.18	Yellowish brown, no mottles and no bleaching	Moderately moist, pH 4.5 and poorly drained	Light clay, sub-angular blocky and moderately weak force	No surface coarse fragments, no coarse fragments, no segregations and many roots
	A12 0.18–0.33	Yellowish brown, few orange mottles and no bleaching	Moist, pH 5.2 and poorly drained	Light clay, sub-angular blocky and moderately weak force	No coarse fragments, no segregations and few roots
	B21 0.33–0.58	Very dark greyish brown, few orange mottles and no bleaching	Wet, pH 5.0 and poorly drained	Light-medium clay, massive and moderately weak force	No coarse fragments, no segregations and few roots
	B22 0.58–0.80+	Dark greyish brown, common orange mottles and no bleaching	Moist, pH 4.9 and poorly drained	Medium-heavy clay, massive and very firm force	No coarse fragments, no segregations and few roots

Note: 1. Description in accordance with the Australian Soil and Land Survey Field Handbook (NCST 2009).

Kandosolic Redoxic Hydrosol have moderately low fertility, are strongly acidic, slowly permeable, poorly drained, sodic in the B horizon and are moderately saline in the A horizon. The soils in this soil unit are therefore generally unsuitable for cultivation, and restricted to grazing (EOH 2012).

All soil chemistry results are given in Table 4.6. The soil chemistry constituent values highlighted in the 'soil sufficiency' column are agricultural industry benchmarks (Baker and Eldershaw 1993; Department of the Environment and Resource Management (DERM) 2011; Peverill, Sparrow and Reuter 1999) and have been referenced in interpreting the laboratory results. The outcomes are presented in the comments column, and are in reference to the median values with increasing depth. A summary of the agricultural potential of Kandosolic Redoxic Hydrosol is given in Table 4.7.

The Kandosolic Redoxic Hydrosol is limited to drainage depressions and associated floodplains that experience regular inundation. This soil unit is spread throughout the project area and is directly associated with drainage lines and water bodies. Within the project area, land use on this soil type is generally for improved and native pastures (see Photograph 4.2).

Photograph 4.2 Kandosolic Redoxic Hydrosol (site 645)

Table 4.6 Kandosolic Redoxic Hydrosol soil chemistry result medians (and ranges)

Constituents	Unit	Soil sufficiency[1]	A11 0–0.18	A12 0.18–0.33	B21 0.33–0.58	B22 0.58–0.80+	Comments on median values (in increasing depth)
pH_{water}	pH units	6.0–7.5	4.5 (3.7–5.2)	5.2 (3.8–5.2)	5.0 (4.0–5.1)	4.9 (4.3–6.5)	Extreme (A11 horizon) to very strong acidity (A12 horizon and below)
EC_{se}	dS/m	<1.9	1.39 (0.89–4.46)	0.20 (0.19–1.02)	0.32 (0.13–3.27)	0.37 (0.13–5.53)	Moderate to low soil salinity
Cl^-	mg/kg	<800	20 (20–50)	50 (30–110)	150 (50–880)	290 (50–1500)	Not restrictive
PAWC	mm	>80	18.0 (ZL-MC)	15.0 (LC-LMC)	30.0 (LC-HC)	26.4 (LC-HC)	Moderate (total of 89.4)
Macronutrients							
Total Nitrogen as N	mg/kg	>1500	2540 (2320–2900)	1295 (670–1760)	890 (440–2000)	745 (400–1320)	Sufficient (A11 horizon) to deficient (below A12 horizon)
P (Colwell)	mg/kg	>10	11 (9–13)	2 (<2-3)	2 (<2-2)	2 (<2-2)	Moderate (A11 horizon) to very low (A12 horizon and below)
K (Acid Extract)	mg/kg	>117	200 (100–200)	<100 (<100<100)	<100 (<100-<100)	<100 (<100–100)	Moderate (A11 horizon) to low – insufficient (A12 horizon and below)
K (Total)	mg/kg	>150	490 (360–680)	380 (150–520)	450 (180–930)	455 (360–1040)	Very high
Micronutrients							
Cu	mg/kg	>0.3	1.91 (<1–3.1)	1.78 (<1–2.5)	1.05 (<1–1.9)	1.10 (<1–1.8)	Moderate.
Zn	mg/kg	>0.5 (pH<7) >0.8 (pH>7)	2.3 (1.9–2.8)	<1.0 (<1.0–<0.1)	<1.0 (<1.0–1.1)	<1.0 (<1.0–<1.0)	High (A11 horizon) to low (inconclusive) (A12 horizon and below)
Mn	mg/kg	>2	39.5 (31.4–123.0)	93.8 (4.25–138.0)	<1.0 (<1.0–78.8)	<1.0 (<1.0–17.9)	High (A horizon) to very low (B horizon)
B	mg/kg	>1	1.40 (1.4–1.6)	0.75 (0.6–1)	0.80 (0.6–1.8)	0.75 (0.3–1.8)	Moderate (A11 horizon) to low (A12 horizon and below)
CEC	meq/ 100g	12-25	6.50 (4.2–11.2)	7.00 (0.8–7.6)	6.50 (0.7–24.8)	7.95 (1.6–34.9)	Low
Ca	meq/ 100g	>5	3.20 (2.2–5.7)	3.00 (0.2–3.6)	2.75 (0.3–10.7)	2.20 (0.2–12.8)	Low

Table 4.6 Kandosolic Redoxic Hydrosol soil chemistry result medians (and ranges)

Constituents	Unit	Soil sufficiency[1]	A11 0–0.18	A12 0.18–0.33	B21 0.33–0.58	B22 0.58–0.80+	Comments on median values (in increasing depth)
Mg	meq/100g	>1	3.10 (1.7–4.7)	3.25 (0.4–4.0)	3.80 (0.5–12.7)	4.80 (1.0–19.8)	High
Na	meq/100g	<0.7	<0.10 (<0.1–0.5)	0.30 (<0.1–0.5)	0.40 (0.1–1.1)	0.50 (<0.1–2.1)	Low to moderate
K	meq/100g	>0.3	0.3 (0.2–0.3)	0.1 (<0.1–0.1)	0.1 (<0.1–0.3)	0.1 (<0.1–0.2)	Low to very low
ESP	%	<6	2.40 (<1.5*–4.5)	6.81 (1.5–<12.5*)	4.40 (3.1–16.7)	5.90 (<3.3*–16.4)	Non-sodic to sodic
Ca:Mg ratio		>2	1.2 (1.0–1.3)	0.9 (0.5–1.1)	0.6 (0.2–0.8)	0.5 (0.2–0.7)	Unstable to strongly unstable
Organic Carbon	%	>1.2	3.1 (2.4–5.0)	1.4 (0.6–1.9)	1.0 (<0.5–4.5)	0.9 (<0.5–1.1)	Very high to low

Notes: 1. Sources: Baker and Eldershaw (1993), DERM (2011) and Peverill, Sparrow and Reuter (1999).
2. Values in brackets are the ranges measured.
** These values are an approximation based on calculations using the lowest measurable level.*

Table 4.7 Kandosolic Redoxic Hydrosol soil chemistry summary

Elements	Comments
pH_{water}	Varying from extremely to very strongly acidic throughout the profile. Outside of the desirable range for agriculture. Would restrict agriculture.
EC	Moderate to low soil salinity levels that would not restrict agriculture.
Cl	Acceptable chloride levels that would not restrict agriculture.
PAWC	A moderate PAWC, which would not restrict agriculture.
Fertility	
Macronutrients	Very high to very low levels of nitrogen in the A horizons. Moderate to low levels of phosphorus and potassium extract in the A horizons. Mostly low levels of macronutrients in the B horizons. Would restrict agriculture.
Micronutrients	Variable levels of micronutrients in the A horizons, ranging from high to low depending on the parameter, and generally decreasing to moderate to very low levels in the B horizons. Would restrict agriculture.
CEC	Low CEC levels throughout the soil. Would restrict agriculture.
Fertility ranking	**Relative Fertility of ASC Classes (NSW Government 2013):** Moderately low – Hydrosol (order), Redoxic (sub-order), any but some Sulfuric (Great Group) **EMM applied Relative Fertility of ASC Classes (lab and field data applied to Murphy et al. 2007):** Moderately low (Group 2) **Explanation (Murphy et al. 2007):** Low fertilities that generally only support plants suited to grazing. Large inputs of fertiliser are required to make soil usable for arable purposes. Generally deficient in nitrogen, phosphorus and many other elements.

Table 4.7 Kandosolic Redoxic Hydrosol soil chemistry summary

Elements	Comments
ESP	ESP indicating sodic soils. Would restrict agriculture.
Ca:Mg ratio	Unstable Ca:Mg ratio indicating soil instability.
Organic Carbon	Indicative of good structural condition and structural stability in the upper A horizon, but reducing with depth to low levels. Would not restrict agriculture.
Major limitations to agriculture	pH Macronutrients (eg phosphorus, potassium extract) Micronutrients (eg boron, calcium, potassium) Sodicity

4.4 Eutrophic Grey Dermosol

Eutrophic Grey Dermosol soils are moderately to well developed, depending on the landform element with which they are associated. The soil lacks strong texture contrast and has increasing clay content with depth. A horizons are typically greyish brown silty loam over grey medium to heavy clay B horizons. The soil surface is mostly without coarse fragments and of firm to cracked condition. Eutrophic Grey Dermosols generally have few or no coarse fragments in the lower A and upper B horizons with coarse fragments more common in the lower B horizon. Subsoils commonly have red and orange mottling with no segregations. A soil profile description for a typical Eutrophic Grey Dermosols is provided in Table 4.8.

Table 4.8 Eutrophic Grey Dermosol typical soil profile summary

ASC:	Horizon name and depth (m) (average)	Colour, mottles and bleach	Moisture, laboratory pH (median value) and drainage	Texture, structure and consistence	Coarse fragments, segregations and roots
	A1 0–0.18	Dark greyish brown, no mottles and no bleaching	Moist, pH 4.9 and moderately well drained	Silty loam, sub-angular blocky and moderately weak force	No surface coarse fragments, no coarse fragments, no segregations and many roots
	A2 0.18–0.30	Dark greyish brown, few red mottles and no bleaching	Moderately moist, pH 4.8 and imperfectly drained	Silty clay loam, sub-angular blocky and very firm force	No coarse fragments, no segregations and common roots
	B21 0.30–0.50	Greyish brown, common orange mottles and no bleaching	Moderately moist, pH 5.1 and imperfectly drained	Medium heavy clay, sub-angular blocky and very firm force	Few coarse fragments, no segregations and few roots
	B22 0.50–0.67	Grey, many orange mottles and no bleaching	Dry, pH 6.8 and poorly drained	Heavy clay, sub-angular blocky and moderately strong force	Few coarse fragments, no segregations and few roots

Note: 1. Description in accordance with the Australian Soil and Land Survey Field Handbook (NCST 2009).

Eutrophic Grey Dermosols occur on gently to moderately incline rolling low hills to rolling hills on small, randomly distributed, and isolated basalt intrusions. Within the project area, land use on this soil type is for grazing of native and improved pastures (Photograph 4.3). Eutrophic Grey Dermosols appear to be limited to the small, randomly distributed, and isolated basalt intrusions. They were not recorded away from these surface geology expressions.

Photograph 4.3 Eutrophic Grey Dermosol (site 648)

Eutrophic Grey Dermosols are of moderately high fertility, moderately permeable, poorly drained and have moderate to low salinity. They have sodic B horizons and very strongly acidic A horizons.

Soil chemistry results are given in Table 4.9, the soil chemistry constituent values highlighted in the 'soil sufficiency' column are agricultural industry benchmarks (Baker and Eldershaw 1993; Department of the Environment and Resource Management (DERM) 2011; Peverill, Sparrow and Reuter 1999) and have been referenced in interpreting the laboratory results. The outcomes are presented in the comments column, and are in reference to the median values with increasing depth. A summary of the agricultural potential of Eutrophic Grey Dermosols is given in Table 4.10.

Table 4.9 Eutrophic Grey Dermosol soil chemistry result medians (and ranges)

Constituents	Unit	Soil sufficiency[1]	A1 0–0.18	A2 0.18–0.30	B21 0.30–0.50	B22 0.50–0.67	Comments on median values (in increasing depth)
pH_{water}	pH units	6.0–7.5	4.9 (4.5–5.4)	4.8 (4.7–4.9)	5.1 (4.8–7.4)	6.8 (5.2–8.3)	Very strong acidity (A1 to B21 horizons) to neutral (B22 horizon)
EC_{se}	dS/m	<1.9	1.51 (0.26–2.37)	0.56 (0.13–0.98)	0.22 (0.07–1.10)	1.21 (0.05–2.36)	Moderate to low soil salinity
Cl^-	mg/kg	<800	10 (<10–10)	10 (10–10)	20 (10–140)	105 (30–200)	Not restrictive
PAWC	mm	>80	10.8 (ZL-ZCL)	9.6 (ZL-ZCL)	24.0 (MC-HC)	20.4 (MC-HC)	Small (total of 64.8)
Macronutrients							
Nitrite + Nitrate as N (Sol.)	mg/kg	>15	104.70 (14–164)	36.60 (1.2–71.9)	1.60 (1.1–5.8)	0.35 (0.3–0.4)	Very high (A horizon) to very low (B horizon)
Total Nitrogen as N	mg/kg	>1500	3690 (1510–5650)	2645 (1240–4050)	990 (900–1330)	635 (560–710)	Sufficient (A horizon) to deficient (B horizon)
P (Colwell)	mg/kg	>10	12.0 (3.0–25.0)	8.5 (2.0–15.0)	<2.0 (<2.0–<2.0)	<2.0 (<2.0–<2.0)	Moderate (A1 horizon), low (A2 horizon) to very low (B horizon)
K (Acid Extract)	mg/kg	>117	200 (100–400)	200 (<100–300)	<100 (<100–<100)	<100 (<100–100)	Moderate (A horizon) to low – insufficient (B horizon)
K (Total)	mg/kg	>150	595 (370–840)	515 (320-710)	570 (490-740)	570 (490-650)	Very high.
Micronutrients							
Cu	mg/kg	>0.3	1.51 (<1.00–1.71)	<1.00 (<1.00–<1.00)	<1.00 (<1.00–<1.00)	<1.00 (<1.00–<1.00)	Moderate (A1 horizon) to low – inconclusive (A2 horizon and below)
Zn	mg/kg	>0.5 (pH<7) >0.8 (pH>7)	<1.0 (<1.0–8.1)	<1.0 (<1.0–<0.1)	<1.0 (<1.0-<1.0)	<1.0 (<1.0–<1.0)	Low (inconclusive)
Mn	mg/kg	>2	45.10 (37.9–51.8)	31.30 (28.4–34.1)	1.23 (<1.0–1.46)	<1.00 (<1.0–<1.0)	Very high (A horizon) to low (B21 horizon) to very low (B22 horizon)
B	mg/kg	>1	1.65 (0.8–2.4)	1.60 (1.2–2.0)	1.20 (0.7–1.7)	0.45 (0.4–0.5)	Moderate (A1 to B21 horizons) to very low (B22 horizon)
CEC	meq/ 100g	12-25	8.55 (6.9–10.4)	8.25 (6.6–9.9)	17.90 (12.0–21.0)	16.80 (12.6–21.0)	Low (A horizon) to moderate (B horizon)
Ca	meq/ 100g	>5	6.0 (5.0–6.9)	5.7 (4.4–6.9)	6.5 (5.4–7.1)	5.5 (4.7–6.2)	Moderate

Table 4.9 Eutrophic Grey Dermosol soil chemistry result medians (and ranges)

Constituents	Unit	Soil sufficiency[1]	A1 0–0.18	A2 0.18–0.30	B21 0.30–0.50	B22 0.50–0.67	Comments on median values (in increasing depth)
Mg	meq/ 100g	>1	2.1 (1.5–2.8)	2.1 (1.8–2.4)	10.6 (4.9–12.4)	9.9 (5.6–14.1)	Moderate (A horizon) to high (B horizon)
Na	meq/ 100g	<0.7	0.10 (<0.1–0.2)	0.15 (<0.1–0.2)	1.30 (0.4–1.4)	1.25 (0.4–2.1)	Low (A horizon) to moderate (B horizon)
K	meq/ 100g	>0.3	0.4 (0.2–0.6)	0.4 (0.2–0.6)	0.3 (0.2–0.5)	0.2 (0.1–0.3)	Moderate (A horizon) to low (B horizon)
ESP	%	<6	<1.20* (0.96–2.9)	2.00 (1.0–3.0)	6.19 (3.3–7.8)	6.60 (3.2–10.0)	Non-sodic (A horizon) to sodic (B horizon)
Ca:Mg ratio		>2	3.00 (2.5–3.4)	2.70 (2.4–2.9)	0.57 (0.5–1.3)	0.72 (0.3–1.1)	Stable (A horizon) to strongly unstable (B horizon)
Organic Carbon	%	>1.2	3.75 (1.6–4.9)	2.80 (1.3–4.3)	1.00 (0.7–1.1)	<0.50 (<0.5–0.5)	Very high (A horizon) to very low (B horizon)

Notes: 1. Sources: Baker and Eldershaw (1993), DERM (2011) and Peverill, Sparrow and Reuter (1999).

2. Values in brackets are the ranges measured.

** These values are an approximation based on calculations using the lowest measurable level.*

Table 4.10 Eutrophic Grey Dermosol soil chemistry summary

Elements	Comments
pH_{water}	Very strongly acidic at the surface grading to neutral in the subsoil. Outside of the desirable range for agriculture in the upper profile. Would restrict agriculture.
EC	Moderate to low soil salinity levels that would not restrict agriculture.
Cl	Acceptable chloride levels that would not restrict agriculture.
PAWC	A small PAWC, which would restrict agriculture.
Fertility	
Macronutrients	Moderate to high levels of macronutrients in the A horizon. Would not restrict agriculture. Note: there was evidence of recent cultivation at the detailed survey sites on this soil type and demonstrated field and laboratory signs of recent fertiliser application, including non-soil related white substance noted in the field and high nutrient levels in the A horizon.
Micronutrients	Moderate to low levels of micronutrients in the A horizon. Would not restrict agriculture.
CEC	Low CEC levels in the A horizon, which may present some fertility issues.

Table 4.10 Eutrophic Grey Dermosol soil chemistry summary

Elements	Comments
Fertility ranking	**Relative Fertility of ASC Classes (NSW Government 2013):** Moderately high – Dermosol (order), any (sub-order), Eutrophic (Great Group) **EMM applied Relative Fertility of ASC Classes (lab and field data applied to Murphy et al. 2007):** Moderate (Group 3) **Explanation (Murphy et al. 2007):** Soils have moderate fertility and usually require fertiliser and/or have some physical restrictions for arable use. Soils within this group are moderately deficient in nitrogen, phosphorus and some other elements. The grey, red and brown clays have a somewhat better chemical status than the other soils within this group. The high clay content and strongly coherent nature of some subsoils restrict water and root penetration. Note: The laboratory results class the soil as moderately high to high fertility, particularly with the very high nitrogen and total potassium levels recorded in the A horizon. However, the moderate to very low levels of most other macronutrients and micronutrients indicated by the laboratory results, particularly below 30 cm deep, suggest moderate natural fertility. Field and laboratory results suggest recent application of fertiliser.
ESP	ESP indicating sodic subsoil that would restrict agriculture.
Ca:Mg ratio	Stable Ca:Mg ratio in the topsoil, but decreasing with depth to levels that suggest soil instability.
Organic Carbon	Indicative of good structural condition and structural stability in the A horizon, but reducing with depth to low levels. Would not restrict agriculture.
Major limitations to agriculture	Surface pH PAWC Subsoil sodicity

5 Land and soil capability assessment

5.1 Land and soil capability assessment system

The LSC classes of the project area were assessed in accordance with the requirements of the *Land and soil capability assessment scheme* (OEH 2012). The LSC class definitions are presented in Table 5.1. The assessment used the information collected during the field survey supplemented with information gathered during the desktop assessment.

The assessment classifies soils and landscape characteristics against eight decision tables that use landscape, soils and climate data on the various hazards or limitations to allocate land to an LSC class based on each hazard or limitation (OEH 2012). Each hazard is assigned one of eight LSC classes where Class 1 represents the least limitation and Class 8 represents the greatest limitation; each is assessed individually to develop a profile of hazards for the parcel of land being assessed. The final hazard assessment for a parcel of land is based on the highest hazard in that parcel of land (OEH 2012).

Table 5.1 Land and soil capability class definitions (OEH 2012)

LSC Class	Description
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land:** Land has no limitations. No special land management practices required. Capable of all rural land uses and land management practices.
2	**Very high capability land:** Land has slight limitations. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land:** Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land:** Moderate to high limitations for high-impact land uses. It will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture; and the limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate-low capability land:** High limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation)	
6	**Low capability land:** Very high limitations for high-impact land uses, and are generally suitable for limited land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land:** Severe limitations that restrict most land uses and generally cannot be overcome. Generally suitable only for selective forestry and nature conservation.
8	**Extremely low capability land:** Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation.

5.2 Land and soil capability results

Data for the assessment were sourced from field survey observations, desktop analysis and soil laboratory analysis. There was pH data for 15 of the 29 sites in the BRP project area. The sites with no pH data were assigned a pH range which represented the median pH of the sites with pH data (soil acidification classes indicated with an asterisk*). The soil acidification class for the soils with no pH data were classed as 2 or 3 which were based on soil texture, and would be higher if the pH was lower than average. However, all but two of these sites had an overall LSC class that was higher than 3, due to other limiting factors such as waterlogging or soil shallowness. The results for each site that was assessed are summarised in Table 5.2. The full Land and soil capability assessment is attached as Appendix A.

Table 5.2 Summary of LSC classes across the project area

Site ID	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class[1]	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	Overall LSC class
Kandosols									
615	3	3	3	3*	1	2	6	1	**6**
616	3	3	3	3*	1	2	3	1	**3**
617	3	3	3	2*	1	5	3	1	**5**
618	2	4	3	3*	1	4	4	1	**4**
636	3	2	3	3*	1	3	4	1	**4**
637	3	3	3	3*	1	4	4	1	**4**
638	2	4	3	3*	1	5	4	1	**5**
639	2	3	3	3	1	5	3	1	**5**
642	4	3	3	3*	1	3	4	1	**4**
643	3	4	3	3*	1	3	3	1	**4**
644	2	2	3	5	1	5	3	1	**5**
646	3	3	3	3*	1	4	3	1	**4**
647	3	3	3	3*	1	4	3	1	**4**
649	3	2	3	3*	1	3	3	1	**3**
650	3	4	3	5	1	3	3	1	**5**
675	3	4	3	5	1	5	6	1	**6**
676	2	2	3	3	1	5	3	1	**5**
677	2	3	3	3*	1	5	3	1	**5**
678	2	4	3	3	1	5	4	1	**5**
679	3	3	3	3	1	5	4	1	**5**
680	3	2	3	4	1	5	4	1	**5**
753	3	3	3	4	1	3	3	1	**4**
754	3	4	3	5	1	4	3	1	**5**
755	2	4	3	5	1	3	3	1	**5**
756	2	3	3	3	1	4	3	1	**4**

Table 5.2 Summary of LSC classes across the project area

Site ID	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class[1]	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	Overall LSC class
Dermosol									
648	2	3	3	2*	1	4	3	1	**4**
Hydrosol									
640	2	2	3	3*	1	6	3	1	**6**
645	2	2	3	3	1	6	3	1	**6**
709	3	2	3	5	1	6	3	1	**6**

*Notes: 1. Incomplete classification - lack of pH data indicated with *.*

5.3 Land and soil capability conclusions

Initially the region and project area were classed as Class 3 and Class 4 in terms of land and soil capability classes (Section 3.7) (OEH mapping). The survey (ie field testing) undertaken for this EIS concludes that the project area mainly consists of Class 4 and Class 5 capability land and, therefore, its agricultural productivity ranges from moderate to moderate-low capability.

The project area has been mapped as mainly Class 5 (44% of land area) and Class 4 (25% of land area) capability land. These soils are most suited for grazing. Occasional cultivation may be possible on the Class 4 and 5 lands with the implementation of suitable soil conservation measures. Almost half of the sites were poorly drained or waterlogged (13 of the 29 sites). This is consistent with the geological mapping (see Figure 3.3), which maps most of the project area as floodplain deposits of silt and clay.

The Kandosol soils are spread across a range of classes (3, 4, 5 and 6), but are generally Class 4 or 5, which is consistent with the land use of grazing. The sites which were Class 5 were either poorly drained or slightly acidic. Two sites were Class 6 due to shallow soils.

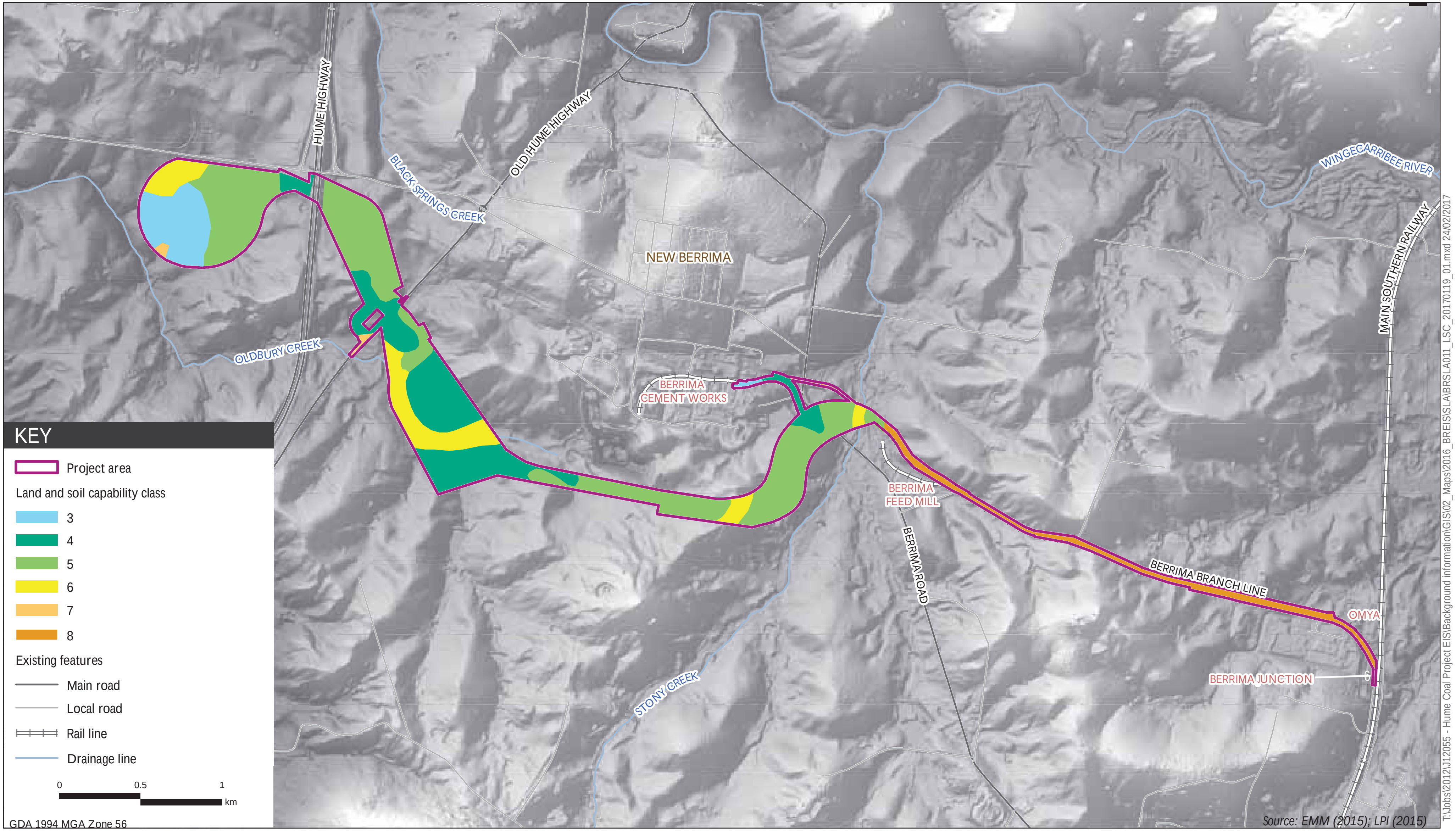
Two of the Kandosol soil sites were Class 3, however incomplete data for surface pH means these sites are conservatively classified (without soil pH) and may be Class 4 or 5. It should be noted that only 17.5 ha of land was classified as Class 3. OEH state that 20 hectares is the minimum area required for commercial food production and therefore, use this as a requirement for defining BSAL in the interim protocol (DP&E 2015).

The Hydrosols have also been classified as Class 6, based on being waterlogged for several months of the year. The disturbed terrain (existing Berrima Branch Line) is classed as Class 8 as it is not available for agricultural use.

The map in Figure 5.1 was developed using the distribution of the land class data from the assessment, and mapped using topography to determine spatial extent. Table 5.3 shows the soil types associated with each land class, and the mapped number of hectares of each land class.

Table 5.3 Land and soil capability classes in the project area

Class	Capability	Land in the project area	Hectares (ha)	%
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)				
1	Extremely high	None	0	
2	Very high	None	0	
3	High	Kandosols (limited dataset – surface pH unknown)	17.5	9.7
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)				
4	Moderate	Kandosols	44.5	24.5
5	Moderate–low	Kandosols (slightly acidic or poorly drained soils)	79.0	43.6
Land capable for a limited set of land uses (grazing, forestry and nature conservation)				
6	Low	Hydrosols Kandosols (shallow soil depth)	21.5	11.9
Land generally incapable of agricultural land use (selective forestry and nature conservation)				
7	Very low		1.2	10.4
8	Extremely low	Disturbed terrain (existing railway line)	17.7	



Land and soil capability of the project area

Berrima Rail Project

Soil and land assessment

Figure 5.1

6 Agricultural land use - project area

The majority of the project area is currently used for grazing cattle or railway operations.

6.1 Hume coal owned properties

The following Hume Coal owned properties are shown on Figure 6.1.

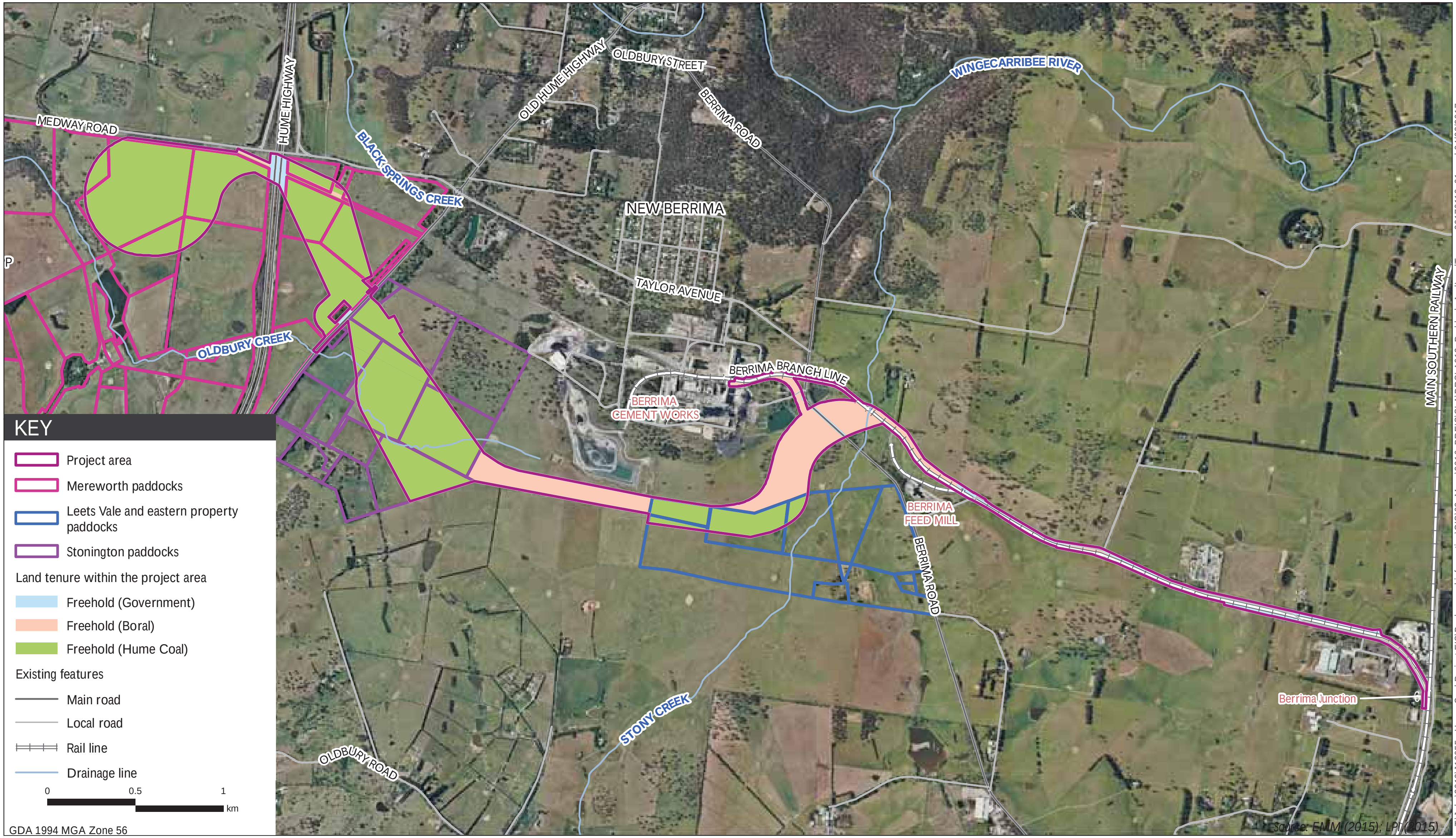
Mereworth: The Mereworth property comprises approximately 500 ha and is split by the Hume Highway. The majority of the property lies on the western side of the Hume Highway and is the location of the proposed Hume Coal Project surface infrastructure area. Mereworth consists of 36 individual paddocks. Six of the paddocks are located on the eastern side of the Hume Highway. The property currently consists of mainly pasture for cattle, with some paddocks cultivated for fodder crops.

Stonington: The Stonington property is approximately 122 ha and consists of 12 individual paddocks. The entire property is currently utilised as permanent pasture except for the Remembrance Driveway plantings which are excluded from grazing. All grazing paddocks will be converted to improved pasture (ryegrass) in the coming year.

Eastern properties: The Eastern properties are an amalgamation of properties, namely Leets Vale and 325 Berrima Road. It is approximately 80 ha and consists of eight individual paddocks. The entire property is currently utilised as permanent improved pasture.

6.2 Other properties

There is some freehold land comprising paddocks of pasture grass surrounding the Berrima Cement Works. Cattle grazing is currently undertaken in some areas (predominantly to the east of the cement works) by agistment.



Hume Coal affiliated properties and land tenure in the project area
Berrima Rail Project
Soil and land assessment
Figure 6.1

EMM HUMECOAL

7 Impact assessment

7.1 Potential risks to soil resources

7.1.1 Soil degradation

The soil resources in the project area could be degraded by a number of processes and such degradation could reduce the agricultural potential of the affected land.

Nutrient decline: A decline in nutrient content could occur while the soil is stored in stockpiles. This would decrease fertility, and may mean that the rehabilitated land using the returned soil would support less plant growth and reduce the agricultural potential of the land. This could be amended by adding fertilisers to the returned soil (Keipert 2005).

Structural decline: Structural decline of the soil refers to the breakdown of the aggregates (or peds), resulting in soil particles becoming more randomly and closely packed together with little pore space compared to the original structure (DLWC 2000). Structural decline is caused by compaction by heavy vehicles and machinery during the removal, stockpiling and re-spreading process. Soil permeability, water-holding capacity, aeration and microfauna presence decreases and the affected soils are less favourable for plant growth.

Acidification: A gradual increase in acidity of the soil could lead to a decline in pasture growth. It can occur on agricultural land as a result of long-term application of nitrogenous fertilisers, and the increased leaching processes following the loss of deep-rooted vegetation (DLWC 2000). The land in the majority of the project area has been extensively cleared of deep-rooted vegetation, and used for pasture for many decades. The pH of the surface soil in some parts of the project area is currently slightly acidic and may need soil amendments to increase the pH to support plant growth.

7.1.2 Loss of soil resource

The soil will be stripped from the direct disturbance footprint of the project, and stored in stockpiles for later use in rehabilitation. There is a risk that not enough soil will be stripped for effective rehabilitation. Some soil is generally lost during handling (ie stripping, stockpiling and spreading), and poor site selection for stockpiles may further decrease the available soil, particularly if the stockpile has to be relocated.

7.1.3 Soil erosion and sediment transport

Erosion results the in loss of soil from the landscape leading to deterioration of the land’s productive capacity and its capacity to perform ecosystem functions. The potential for soils to erode determines which management measures should be used and whether the soils are appropriate to use for rehabilitation.

7.1.4 Soil contamination

Small areas of soil contamination could occur from hydrocarbon spills during soil stripping and construction activities; although the likelihood of occurrence is considered to be low in consideration of measures that will be implemented in accordance with the project CEMP.

7.2 Impact assessment

7.2.1 Potential impacts

The project's potential impacts on soil resources are associated with the temporary loss of land due to construction and operation of rail infrastructure; and during rehabilitation and closure. The assessment focuses on the disturbance footprint within the project area.

There will be cut and fill which will create a flatter profile in areas along the railway alignment. Most of the railway will be elevated above the existing ground level; however, there will be exposed wall cuttings in areas of existing elevated topography. Earthworks will include construction of a 6 m wide and 1.5 m deep capping layer, with an overlying ballast layer comprising rock aggregate. The tracks will be placed on top of the ballast layer. During decommissioning it is anticipated that the ballast will be removed, although the capping layer will remain. The area will be deep-ripped and covered by stockpiled soil materials.

Disturbance of soil could increase erosion, depending on slope, and mix lower class soils and subsoils with better quality soils. Machinery used in the construction phase could also degrade soil quality as a result of compaction when creating topsoil stockpiles, and on areas used for temporary construction (eg. access tracks, laydown areas).

During decommissioning works, soils may be disturbed temporarily while infrastructure is demolished, and access roads and other supporting infrastructure removed to decommission the railway line. All disturbed land will be rehabilitated with stockpiled soil.

Mitigation measures for the potential impacts to soil resources are described in Section 8.

7.2.2 Disturbance footprint

The preferred option will have a direct disturbance footprint of approximately 28.11 ha, and the alternative option has a direct disturbance footprint of approximately 25.92 ha. A construction buffer zone which does not comprise soil stripping or earthworks covers an area of 89.34 ha for the preferred option, and an area of 87.09 ha for the alternative option.

7.2.3 Soil types disturbed

The majority of the proposed surface infrastructure is positioned over one soil type; Dystrophic Yellow Kandosol soils as shown in Figure 4.1. These soils are associated with gently undulating landscapes that have been mainly cleared and replaced with pasture grasses. Kandosolic Redoxic Hydrosol soils are around Oldbury Creek and Stony Creek areas where the project area crosses the creeks. The area of soil to be disturbed, by soil type, is summarised in Table 7.1 for the preferred and alternative options.

Table 7.1 Area and type of soils disturbed

Soil type	Preferred option		Alternative option	
	Operational footprint (Ha)	Construction footprint (Ha)	Operational footprint (Ha)	Construction footprint (Ha)
Dystrophic Yellow Kandosol	25.45	84.17	24.38	82.18
Kandosolic Redoxic Hydrosol	0.94	3.22	0.68	3.22
Unclassified (assumed Kurosol)	1.72	1.95	0.86	1.69
TOTAL	**28.11**	**89.34**	**25.92**	**87.09**

7.2.4 Topsoil volume requirements

To successfully rehabilitate the BRP project area, soil will be replaced generally at about 0.3 m deep over the disturbed land.

The area of disturbance for the preferred option is 28.11 ha; therefore, approximately 84,330 m^3 of soil will need to be stripped. Because stripping the topsoil only, that is without the subsoil, would result in not enough soil, subsoil will need to be stripped as well.

The area of disturbance for the alternative option is 25.92 ha, and therefore approximately 77,760 m^3 of soil will need to be stripped.

7.2.5 Soil stripping depth

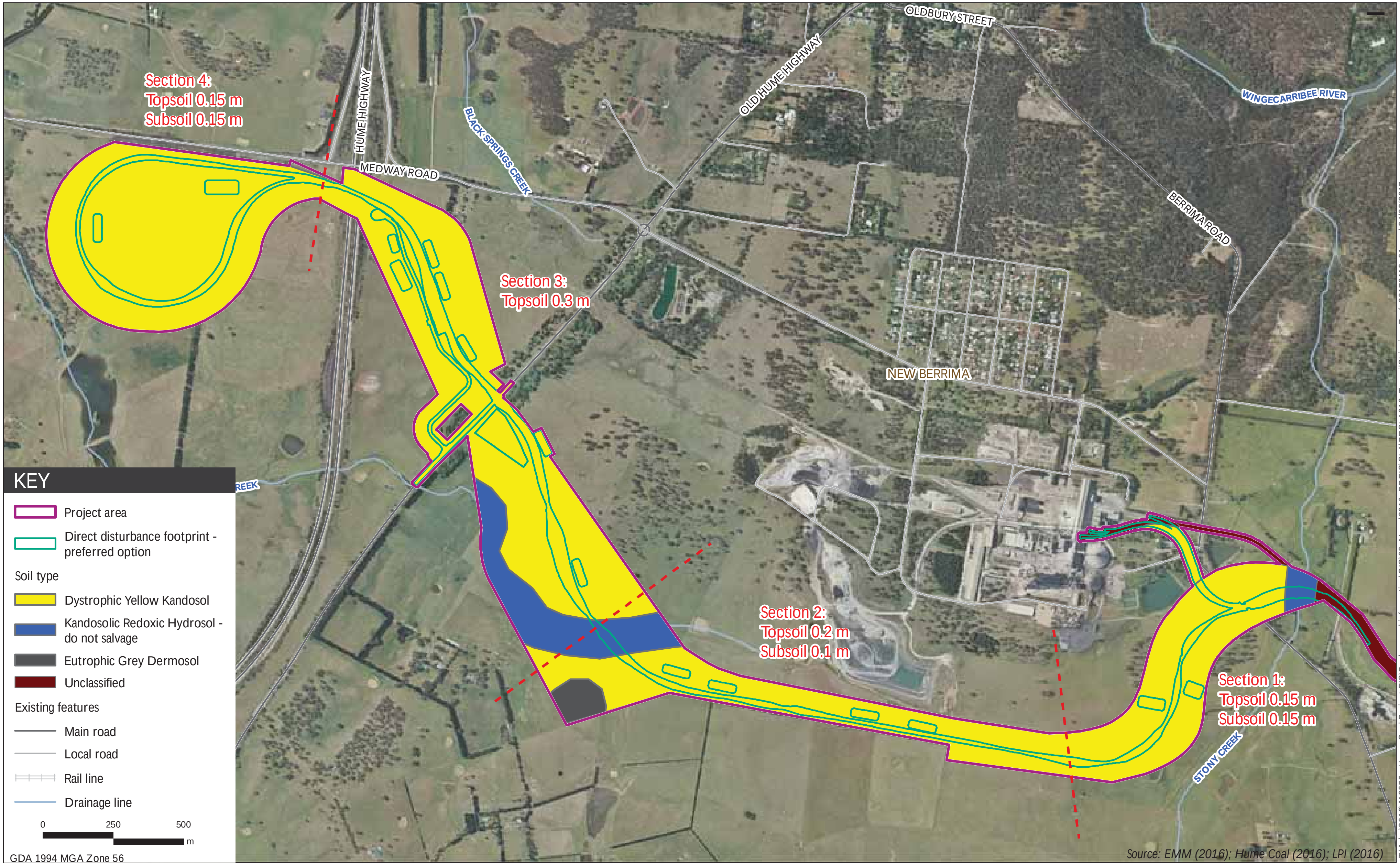
The recommended stripping depths for both options are based on results from the soil survey, which measured soil depths found across the project area. Soil will need to be stripped to about 0.3 m deep (including topsoil and subsoil). Table 7.2 lists the measured depths of topsoil and subsoil for different zones of the railway line, based on the soil assessment. The recommended topsoil stripping depths are illustrated in Figure 7.1.

The depths of topsoil and subsoil vary along the railway line. In most sections of the railway line it is recommended to strip and stockpile the topsoil and subsoil separately, because returning subsoil and topsoil separately to the rehabilitation areas will improve rehabilitation outcomes. An advantage of stockpiling topsoil and subsoil separately is that the subsoil can be stockpiled higher than 3 m. However, subject to operational constraints, they could be stripped and stockpiled together, and soil amendments such as fertilisers and gypsum could be applied, if required, at the time of rehabilitation. In the section of railway line on the eastern portion of the Mereworth property between the Hume Highway and the Old Hume Highway the topsoil is deeper, and could be stripped to 0.3 m without stripping the subsoil.

In some sections of railway line, subsoils are recorded as moderately moist at 0.27-0.35 m depth. Other areas have recorded dry soils at depth with mottling, which indicates it may be waterlogged sometimes. Most of the soils could be stripped to 0.3 m deep, but it may be preferable to reduce the stripping depth to 0.25 m if the soils are moist at depth. There are a few sections near creeks where Kandosolic Redoxic Hydrosols may be encountered. They are typically wet, which would lead to them compacting and breaking down during stripping operations. These soils are not recommended to be stockpiled for later rehabilitation use.

Table 7.2 Indicative depths of topsoil in each section of the project area

Surface disturbance	Topsoil (m)	Subsoil (m)
Section 1 - Railway line (Eastern properties)	0.15	0.15
Section 2 - Railway line (Stonington)	0.2	0.1
Section 3 - Railway line (btw Hume Hwy and Old Hume Hwy)	0.3	0.0
Section 4 - Rail loop area	0.15	0.15



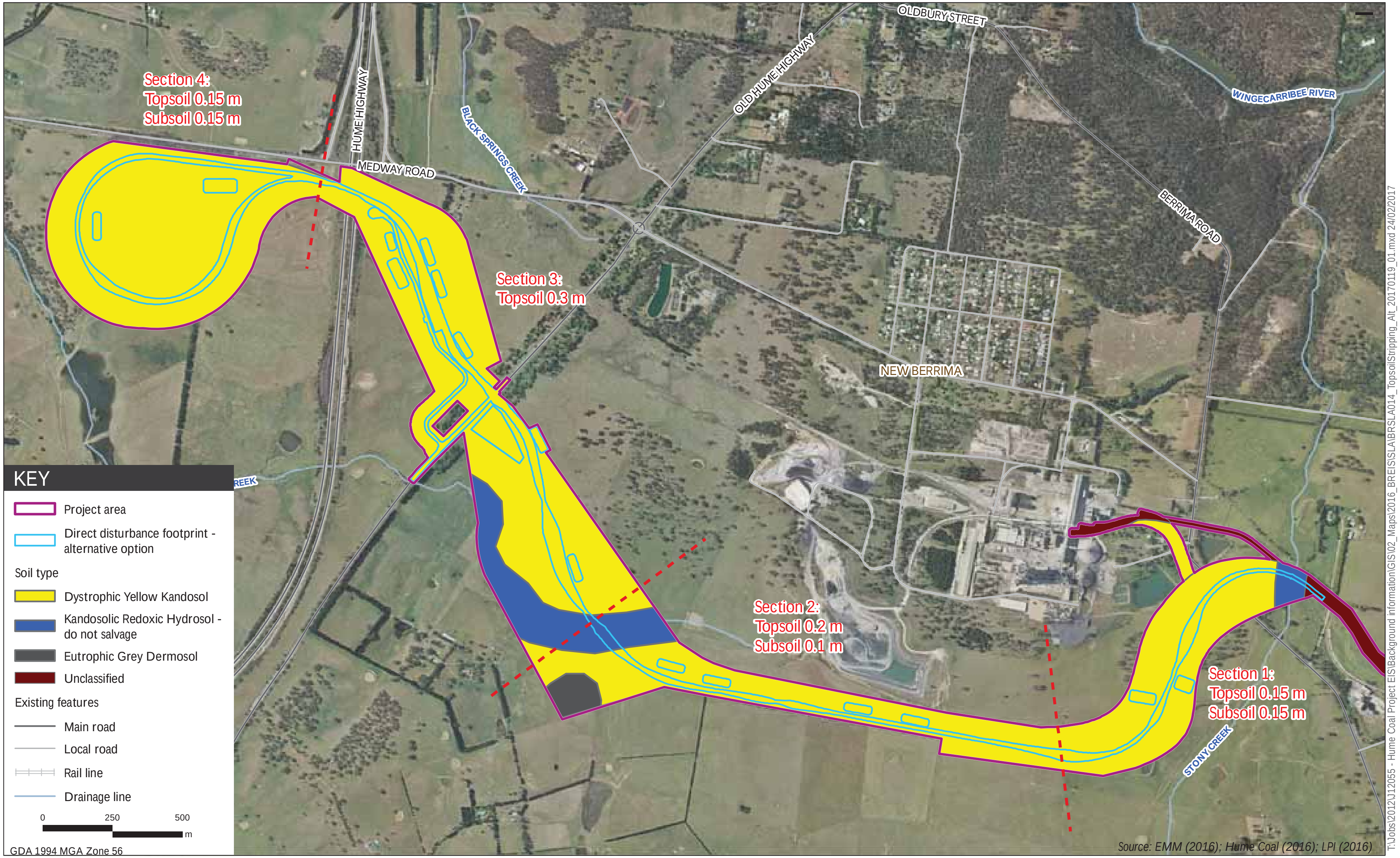
Topsoil stripping depths - preferred option

Berrima Rail Project

Soil and land assessment

Figure 7.1

EMM HUMECOAL



Topsoil stripping depths - alternative option

Berrima Rail Project

Soil and land assessment

Figure 7.2

7.2.6 Post disturbance land use and land capability

Upon completion of the project, the Hume Coal rail infrastructure will be dismantled and removed. The portion of track owned by Boral, including the rail siding to the cement works, will remain indefinitely.

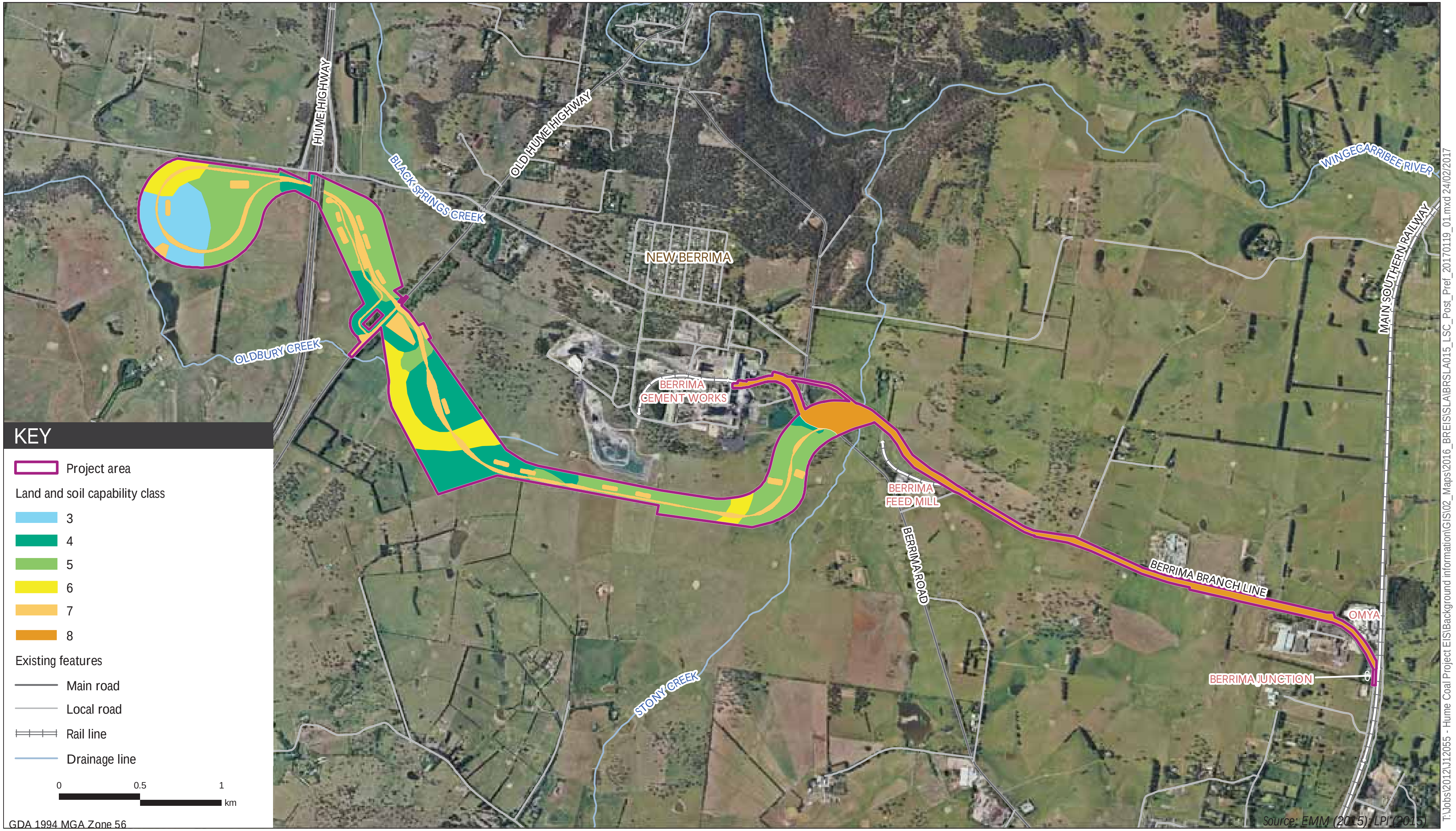
For the Hume Coal rail infrastructure, the overriding goal for the project's rehabilitation will be to return disturbed land to a condition that is stable, and supports the proposed post-disturbance land use, which is to return the site to grazing with improved pasture. The area to be disturbed is currently mainly Class 4 and 5 capability land. These soils are most suited for grazing. Although most of the land will be returned to grazing, the post disturbance LSC (once rehabilitation has been completed) will be reduced across 14% of the project area (a reduction of 1% of Class 3, 4% of Class 4, 8% of Class 5, 1% of Class 6). This will result in an increase of land classified as Class 7 (14%).

The post-disturbance land capability of the areas of land disturbed around the vicinity of the railway line (ie maintenance roads, construction areas, topsoil stockpile areas) should be able to be returned to their original land capability with careful management and improvement of the soil structure and fertility. The area of the railway line itself will be returned to a Class 7, based on the projected depth of re-spread topsoil being no deeper than 25 cm. The underlying material is expected to be made up of the capping material used in building up the railway corridor, or could include re-graded fill material. Neither of these materials is considered to be soil, therefore the soil available for plant root growth will be shallow and therefore a lower capability LSC class. Exposed wall cuttings will be Class 8, but are too small to be seen on a map. Berrima Branch Line will remain in use, and has been calculated as Class 8. Table 7.3 shows the pre-and post-disturbance areas of each LSC class for the preferred and alternative options, as illustrated in Figure 7.3 and Figure 7.4.

Table 7.3 Land and soil capability classes – post disturbance

Class	Capability	Current area (ha)	Post disturbance (ha)	
			Preferred option	Alternative option
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)				
1	Extremely high	0	0	0
2	Very high	0	0	0
3	High	17.5	15.3	15.3
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)				
4	Moderate	44.5	34.4	34.4
5	Moderate–low	79.0	59.9	59.6
Land capable for a limited set of land uses (grazing, forestry and nature conservation)				
6	Low	21.5	19.0	19.0
Land generally incapable of agricultural land use (selective forestry and nature conservation)				
7	Very low	1.2	25.2	25.4
8	Extremely low	17.7	27.6*	27.7*

Note: **the railway will be on this land and it will not be available for agricultural use.*



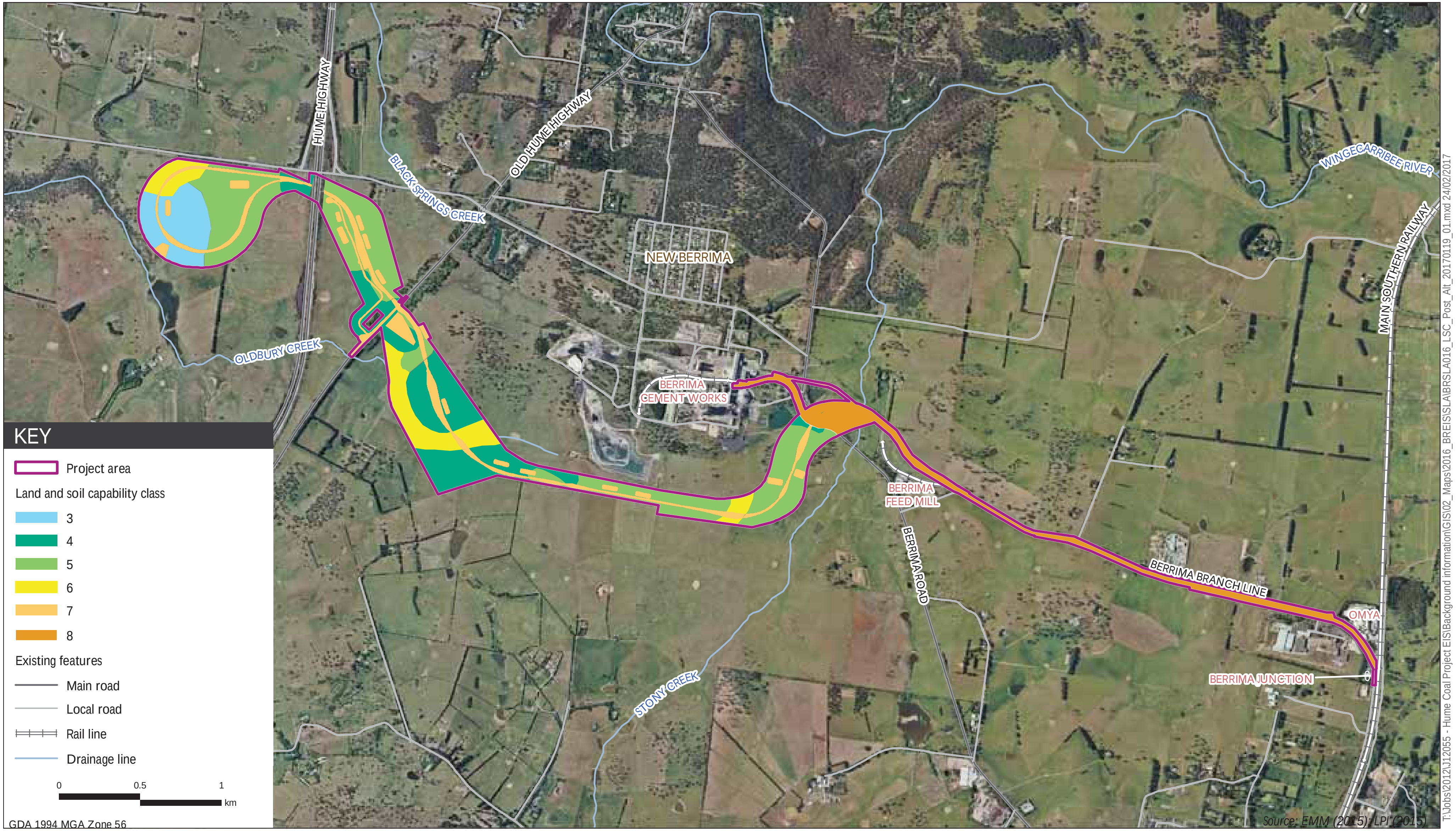
Post-disturbance land and soil capability (preferred option)

Berrima Rail Project

Soil and land assessment

Figure 7.3

EMM HUMECOAL



Post-disturbance land and soil capability (alternative option)

Berrima Rail Project

Soil and land assessment

Figure 7.4

EMM HUMECOAL

7.2.7 Impacts to agricultural land use

The impact to agricultural land use of the proposed railway corridor is limited to the proposed construction footprint. Cattle will be able to cross the railway line at specified access locations. After construction, the area of land impacted will only comprise area of the infrastructure itself (the operational disturbance footprint). The railway corridor does bisect some paddocks; however, the paddocks will still be able to support the current grazing land use. The reduction in paddock size and stocking capacity during construction will be 9-10% for each property, which reduces to 5% or less during operations. Table 7.4 and Table 7.5 summarise the area of land impacted and the calculated reduced stocking capacity based on the stocking rates indicated in the managing pastoral company's Farm Management Plan, for the preferred and alternative options, respectively. After the site is rehabilitated most of the site will revert to grazing land.

Table 7.4 Agricultural impact of proposed works (preferred option)

Property Name	Property Size (ha)	Stocking rate/ha	Operational disturbance footprint (ha)	Impact (No. Stock)	Construction footprint (ha)	Impact (No. Stock)
Mereworth	500	3	10.9	33	43	129
Stonington	122	3.3	6.1	20	12.8	42
Leets Vale	40	3.1	1.1	3	3.9	12
325 Berrima Rd	40	3.1	0.4	1	3.5	11
Other freehold		1	9.6	10	26.1	26
TOTAL			**28.1**	**67**	**89.3**	**220**

Table 7.5 Agricultural impact of proposed works (alternative option)

Property Name	Property Size (ha)	Stocking rate/ha	Operational disturbance footprint (ha)	Impact (No. Stock)	Construction footprint (ha)	Impact (No. Stock)
Mereworth	500	3	10.9	33	43	129
Stonington	122	3.3	6	20	12.8	42
Leets Vale	40	3.1	1	3	3.9	12
325 Berrima Rd	40	3.1	0.5	2	3.5	11
Other freehold		1	7.5	7	24.2	24
TOTAL			**25.9**	**65**	**87.4**	**218**

7.3 Difference between the impacts of the two options

There is very little difference between the two options in the impacts to soil resources. The alternative option will result in approximately 2.2 ha less of overall soil disturbance. This equates to 2.2 ha of less land available to agriculture during operations and also during construction for the preferred option, which is a calculated stock number reduction of 1 stock during operation; and about 2 less stock during construction.

8 Management and mitigation measures

8.1 Measures to prevent loss of soil resource

To mitigate the risk of not enough soil being available for rehabilitation, soil requirements must be accurately determined before construction works begin. The volume of soil required for rehabilitation can be calculated using the area estimated for rehabilitation multiplied by the depth of soil required. These calculations have been made using current design plans (see Table 7.2). If any alterations to the plans are made, or if site conditions are different than expected (eg shallow soil in places) the required volume of soil for rehabilitation should be re-calculated. An inventory of soil stripped should be prepared, so that if any significant deficit is identified, additional material can be sourced prior to rehabilitation.

8.2 Measures to manage soil erosion and sediment transport

The Kandosolic Redoxic Hydrosol soils are sodic and will be highly erosive, and are therefore not recommended to be used in rehabilitation. These soils are restricted to the drainage channels, and are likely to be boggy and waterlogged. The Dystrophic Yellow Kandosol soils are slightly sodic and have the potential to be subject to erosion, particularly on a slope. Therefore soil erosion management will be implemented during construction activities. Generally, the railway alignment will be relatively flat along its length, but in places the embankments will be steep and will need erosion control to be put in place during construction. Drainage structures have been designed for the railway line and associated infrastructure to manage water runoff for the life of the operations (see Chapter 13 in the EIS). Sediment control measures, including but not limited to silt fences, will also be used during construction (also described in Chapter 13 in the EIS).

To minimise the risk of loss from wind and water erosion to stockpiled topsoil, a vegetative cover will be established. Stockpiles will also be located where they are not exposed to overland or flood flow.

Soil may erode after the topsoil has been spread on the rehabilitated areas. Soil erosion and sediment control will be considered where there could potentially be off-site impacts to waterways, as well as impacts to the rehabilitation itself.

8.3 Measures to prevent soil contamination

Hydrocarbon management practices will be implemented to prevent hydrocarbon spills during construction activities (eg. re-fuelling, maintenance, hydrocarbon storage) and spill containment materials will be available to clean-up any spills if they occurred. If any hydrocarbon spills were to occur during soil stripping, the impact will be isolated and clean-up procedures will mitigate any impacts from the spill.

Construction materials, such as ballast aggregate materials and sub-ballast capping material will generally be sourced off-site. Any material brought onto site will need to be clean and contaminant-free.

8.4 Measures to minimise soil degradation

To minimise structural decline of soil, the amount of compaction of soils during stripping and stockpiling will be minimised. This can be achieved by using suitable machinery and stockpile development techniques. Nutrient decline will occur during stockpiling of soils, but can be minimised by managing stockpile methods and heights. Any nutrient decline can be amended at the time of rehabilitation by utilising fertilisers and amendment techniques (eg gypsum application). The recommendations made in the topsoil stripping procedure and the stockpiling procedure addresses all of these risks to soil degradation. These will be included in the Soil and Water Management component of the CEMP which will be developed for the site prior to the commencement of construction works.

8.4.1 Topsoil stripping procedure

The topsoil stripping procedure will be designed to maximise the salvage of suitable topsoils and subsoils. These measures will be consistent with leading practice and incorporate the full range of reasonable and feasible mitigation methods for soil stripping.

The procedure for topsoil stripping will include the following soil handling measures that will minimise soil degradation (in terms of nutrients and micro-organisms present) and compaction, thus retaining its value for plant growth.

- The area to be stripped will be clearly defined on the ground, avoiding any waterlogged or similarly constrained areas. The target depths of topsoil and subsoil to be stripped for each location will be clearly communicated to machinery operators and supervisors.
- A combination of suitable earthworks equipment will be used for stripping and placing soils in stockpiles. Machinery haulage circuits will be located to minimise the compaction of the stockpiled soil.
- Soil stockpile locations will be identified during planning and will be stripped of topsoil before they are stockpiled.
- Topsoil and subsoil will be stripped to the required depths as nominated in this assessment and then stockpiled. Subsoil will be stripped and stockpiled separately where identified as suitable. Depending on compaction and recovery rates, deep ripping may be required to maximise topsoil recovery. Where soils are shallower, topsoil and subsoils will be stripped and stockpiled together.
- Handling and rehandling of stripped topsoil will be minimised as far as practicable by progressively stripping vegetation and soil only as needed for development activities.
- Soil stripping in very wet conditions will be avoided if practicable, because of the risk of compaction, nutrient deterioration and less volume of suitable materials being available. However, when possible, soils will be stripped when they are slightly moisture conditioned, which would help in their removal and retain their structure.
- To avoid dust hazards, stripping of soil during particularly dry conditions will be avoided where possible.

8.4.2 Topsoil stockpile management

Soil stockpile management procedures will be designed to minimise the degradation of soil characteristics that are favourable for plant growth. These measures are consistent with leading practices and incorporate all reasonable and feasible mitigation methods.

The following management practices will generally be adopted:

- Stockpiles will be located at an appropriate distance from water courses and dams.
- Where practical, topsoil and subsoil will be stockpiled separately. Where this is not possible, combined topsoil and subsoil stockpiles will still be built to the specifications for topsoil stockpiles.
- Topsoil stockpiles will be designed and constructed to a height no greater than 3 m to limit anaerobic conditions being generated within the stockpile and to minimise the deterioration of nutrients, soil biota and seed banks.
- Subsoil stockpiles can be designed to be over 3 m high; however, will have an embankment slope grade suitable to limit erosion potential.
- The surface of the soil stockpiles should be left in a 'rough' condition to help promote water infiltration and minimise erosion via runoff. If required, sediment controls will be installed downstream of stockpile areas to collect any runoff.
- Overland water flow onto or across stockpile sites will be kept to a practical minimum and will not be concentrated to the extent that it causes visible soil erosion.
- Stockpiles will be seeded with an appropriate grass mixture to stabilise the surface, restrict dust generation, minimise erosion and weed growth.
- After the stockpiles are established, machinery and vehicles will be excluded for general access (stockpile maintenance works excepted). The location will be marked on site maps to protect the stockpiles from future disturbance.
- The stockpile locations will be surveyed and data recorded about the soil types and volumes present.
- The establishment of weeds on the stockpiles will be monitored and control programs implemented as required.

8.4.3 Topsoil application procedure

The topsoil application procedure will essentially be the reverse of the stripping procedure. It will be designed to minimise any degradation of soil characteristics, consistent with industry leading practice.

Generally, all soils will be applied 0.2–0.3 m thick so they are deep enough for ripping and plant growth.

The rehabilitation strategy will include the following measures:

1. A soil balance plan will be prepared before the topsoil is spread, which shows the depths and volume of soils to be reapplied in particular areas. The plan will take account of the relative erodibility of the soils, with more erodible material being placed on flatter areas to minimise the potential for erosion.

2. When the area to be rehabilitated has been re-profiled and/or deep ripped, the subsoil will be spread onto the site, followed by the topsoil (or all at once if not stripped and stored separately).

3. Soil will be respread in even layers at a thickness appropriate for the land capability of the area to be rehabilitated.

4. Soils will be contour ripped to encourage rainfall infiltration and minimise run-off.

5. As soon as practicable after respreading, pasture grasses will be seeded.

6. Erosion and sediment controls will be implemented where deemed necessary prior to vegetation establishment.

8.5 Measures to mitigate impacts to agricultural land use

The alignment of the rail infrastructure has considered the impacts of segmenting paddocks and excluding access to land parcels. Where possible, the chosen alignment has minimised the potential impact of reducing the viability of agricultural production in those areas. Livestock access areas will be created to cross the line.

8.6 Rehabilitation

The rail infrastructure will remain for the duration of the HCP, and will be rehabilitated when it is no longer required. There is little opportunity for progressive rehabilitation, other than for rehabilitation of areas disturbed during construction which are not required during operation of the railway. During rehabilitation the rail infrastructure will be dismantled and removed. Some re-profiling of steep slopes formed by embankments along the railway line may be required, and the surface material will be deep ripped and covered with topsoil material and seeded with pasture species and returned to grazing pasture. See Chapter 2, Section 2.6 of the EIS (EMM 2017) for additional rehabilitation management details, including completion criteria.

8.7 Operational monitoring and maintenance

During the life of the project the following parameters will be monitored, and will be included in the CEMP:

- erosion and sediment control;
- vegetation cover on topsoil piles; and
- weed species alongside the railway lines.

8.8 Contingency measures

If the topsoil stripping procedure is carried out as currently proposed, no contingency measures should be needed. However, if there is not enough topsoil available at the time of rehabilitation, or if the topsoil material has been degraded, the following contingency measures will be implemented:

- Topsoil will be spread at a shallower thickness and/or only on selected parts of the site.
- Fertilisers and other soil additives will be added to the topsoil and subsoil to improve fertility and structure.

9 Conclusions

The impacts to land and soil resources in the railway corridor and loop are restricted to the footprint of the proposed railway infrastructure. The main soil type which was identified in the soil survey is Kandosol (Dystrophic Yellow Kandosol), which generally occurs on slopes and crests of low rolling hills on sandstone and shale surface geology. This land is typical of the region, and is extensively cleared and used mainly for grazing on improved pastures. Two other soil types (Eutrophic Grey Dermosol and Kandosolic Redoxic Hydrosol) were identified in the project area. The Dermosol soil type will not be disturbed. The Hydrosol is found in the drainage depression and is waterlogged for much of the year, and is not suitable for rehabilitation.

The land and soil capability (LSC) assessment mapped 44% of the land area as Class 5 (Moderate – Low capability) and 25% as Class 4 (Moderate capability). These soils are most suited for grazing, but could be occasionally cultivated with the implementation of suitable soil conservation measures. Approximately 10% of the land was conservatively classified as Class 3 (High capability), however insufficient data for surface pH means that it is not fully classified, and may in fact be Class 4 or 5. It should be noted that there is only 17.5 ha of this higher capability land, of which just 1.5 ha will be disturbed. The remainder of the land in the project area is either Low or Very Low capability land.

Potential impacts to land and soil resources from the proposed rail corridor will be managed through appropriate mitigation techniques aimed at returning the site to a land use similar to the pre-existing land uses of infrastructure and agriculture. The topsoils of the area to be disturbed will be stripped (up to 0.3 m deep) prior to construction and stockpiled for use in later rehabilitation. Although most of the land will be returned to grazing, the post disturbance LSC (once rehabilitation has been completed) will be reduced across 14% of the project area (a reduction of 1% of Class 3, 4% of Class 4, 8% of Class 5, 1% of Class 6). This will result in an increase of land classified as Class 7 (14%).

The reduction in paddock size and stocking capacity as a result of the project will be minimal; during construction it will be reduced by 9-10% for each property, which reduces to 5% or less during operations. The impacts of segmenting paddocks and excluding access to land parcels will be minimised by creating access areas to move from one side of the track to the other in areas where livestock cannot roam freely (steep cuttings or embankments).

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Appendix A

Land and soil capability assessment

Land and Soil Capability Assessment Report

Decision Tables

Berrima Rail Project

Prepared for Hume Coal | 2 March 2017

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Land and Soil Capability Assessment Report

Final

Report J12055RP1 | Prepared for Hume Coal | 2 March 2017

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Date	2 March 2017	Date	2 March 2017

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Figures

1 Introduction

This report is focused on meeting the requirements of *The land and soil capability assessment scheme* (OEH 2012). The land and soil capability assessment scheme (OEH 2012) outlines the process to assess the limitations of land-use based on the biophysical characteristics of the land. It should be noted that the tables enclosed within this report are either directly replicated or adapted from OEH 2012.

The land and soil capability (LSC) classes present on a property are determined at the farm scale for each soil management unit (SMU). This is done using the information collected during the field survey and supplemented with information gathered during the desktop assessment. Table 1.1 outlines the information required to make an assessment of land and soil capability classes and their definitions (OEH 2012). Table 1.2 provides definitions of the land and soil capability classes.

Table 1.1 Data requirements for determining LSC classes (OEH 2012)

	Water erosion	Wind erosion	Soil structure decline	Soil acidification	Salinity	Water-logging	Shallow soils and rock	Mass movement
NSW Division	✓							
Sand dune or mobile sand body	✓							
Slope %	✓							✓
Scree or talus slope								✓
Footslope or drainage plain receiving high run-on	✓							
Gully erosion or sodic dispersible subsoils	✓							
Annual rainfall		✓		✓				✓
Wind erosive power		✓						
Exposure to wind		✓						
Surface soil texture		✓	✓	✓				
Surface soil texture modifier			✓					
Great Soil Group				✓				
pH of surface soil				✓				
Surface soil modifier				✓				
Parent material				✓				
Recharge potential of landscape					✓			
Discharge potential of landscape					✓			
Salt store of landscape					✓			
Waterlogging duration						✓		
Return period of waterlogging						✓		
Rocky outcrop							✓	
Soil depth							✓	
Presence of existing mass movement								✓

Table 1.2 Land and soil capability classes - general definitions (EOH 2012)

LSC class	General definition
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land**: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land**: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation	
6	**Low capability land**: Land has very high limitations for high-impact land uses. Land use restricted to low-impact land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.
Land generally incapable of agricultural land use (selective forestry and nature conservation)	
7	**Very low capability land**: Land has severe limitations that restrict most land uses and generally cannot be overcome. On-site and off-site impacts of land management practices can be extremely severe if limitations not managed. There should be minimal disturbance of native vegetation.
8	**Extremely low capability land**: Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation. There should be no disturbance of native vegetation.

2 New South Wales land divisions

The land and soil capability assessment scheme (OEH 2012) applies different criteria to properties depending on their location in New South Wales (NSW). Under The Crown Lands Act of 1884 NSW was divided into the three land division zones of Western, Central and Eastern. The first step in the assessment process is to determine which zone the property exists in. This can be determined by locating the property on the map in Figure 2.1.

Figure 2.1 Map of NSW land divisions

This can accurately be achieved through examination of the 1907 Map of New South Wales. Table 2.1 provides the result of looking up the project on the 1907 map.

Table 2.1 NSW Land Division of the project

	Division
Hume Coal Project	Eastern Division

Source: http://www.nla.gov.au/apps/cdview/?pi=nla.map-rm2795-sd

3 Assessment of water erosion LSC classes

Table 3.1 outlines the assessment table for determining water erosion LSC classes. Assessment has been based on the criteria applicable to the Eastern Land Division. Table 3.2 outlines the results table for water erosion LSC classes for each of the detailed sites.

Table 3.1 Water erosion LSC class assessment table (OEH 2012)

NSW division	Slope class (%) for each LSC class							
	Class 1	Class 2	Class 3	Class 4[1]	Class 5[2]	Class 6	Class 7	Class 8
Eastern and Central divisions	<1	1 to <3	3 to <10 or 1 to <3 with slopes >500m length	10 to <20	10 to <20	20 to <33	33 to <50	>50
Western division[3]	<1	1 to <3 or <1 for hardsetting red soils	1 to 3	3 to 5	3 to 5	5 to 33	33 to 50	>50

Notes: 1.No gully erosion or sodic/dispersible soils are present.
2. Gully erosion and/or sodic/dispersible soils are present.
3. Western CMA provided advice on slope classes.

Table 3.2 Water erosion LSC classes for the SMUs within the project area

Site ID	Slope (%)[1]	Slope class (%)[1]	Water Erosion LSC class
Kandosols			
615	4.	3 to <10%	3
616	5.	3 to <10%	3
617	3.	3 to <10%	3
618	1.	1 to<3%	2
636	5.	3 to <10%	3
637	3.	3 to <10%	3
638	2.	1 to<3%	2
639	2.	1 to<3%	2
642	10.	10 to <20%	4
643	4.	3 to <10%	3
644	2.	1 to<3%	2
646	7.	3 to <10%	3
647	4.	3 to <10%	3
649	4.	3 to <10%	3
650	8.	3 to <10%	3
675	7.	3 to <10%	3
676	2.	1 to<3%	2
677	2.	1 to<3%	2
678	2.	1 to<3%	2
679	6.	3 to <10%	3
680	4.	3 to <10%	3
753	4	4 to <10%	3

Table 3.2 Water erosion LSC classes for the SMUs within the project area

Site ID	Slope (%)[1]	Slope class (%)[1]	Water Erosion LSC class
754	5	5 to <10%	3
755	2	1 to<3%	2
756	2	1 to<3%	2
615	4.	3 to <10%	3
Dermosol			
648	2.	1 to<3%	2
Hydrosol			
640	1.	1 to<3%	2
645	1.	1 to<3%	2
709	6.	3 to <10%	3

4 Assessment of wind erosion LSC classes

The wind erosion LSC class requires the assessment of four hazards:

1. wind erodibility class of surface soil;
2. wind erosion power;
3. exposure to wind; and
4. average yearly rainfall.

4.1 Wind erodibility hazard

Table 4.1 outlines the assessment figure for determining wind erodibility hazard.

Table 4.1 Wind erodibility hazard of surface soils (OEH 2012)

Wind erodibility class of surface soil	Surface soil texture
Low	Loams, clay loams or clays (all with >13% clay)
Moderate	Fine sandy loams or sandy loams (all with 6–13% clay); also includes organic peats
High	Loamy sands or loose sands (all with <6% clay).

4.2 Exposure to Wind

Table 4.2 outlines the assessment figure for determining exposure to wind.

Table 4.2 Exposure to wind (OEH 2012)

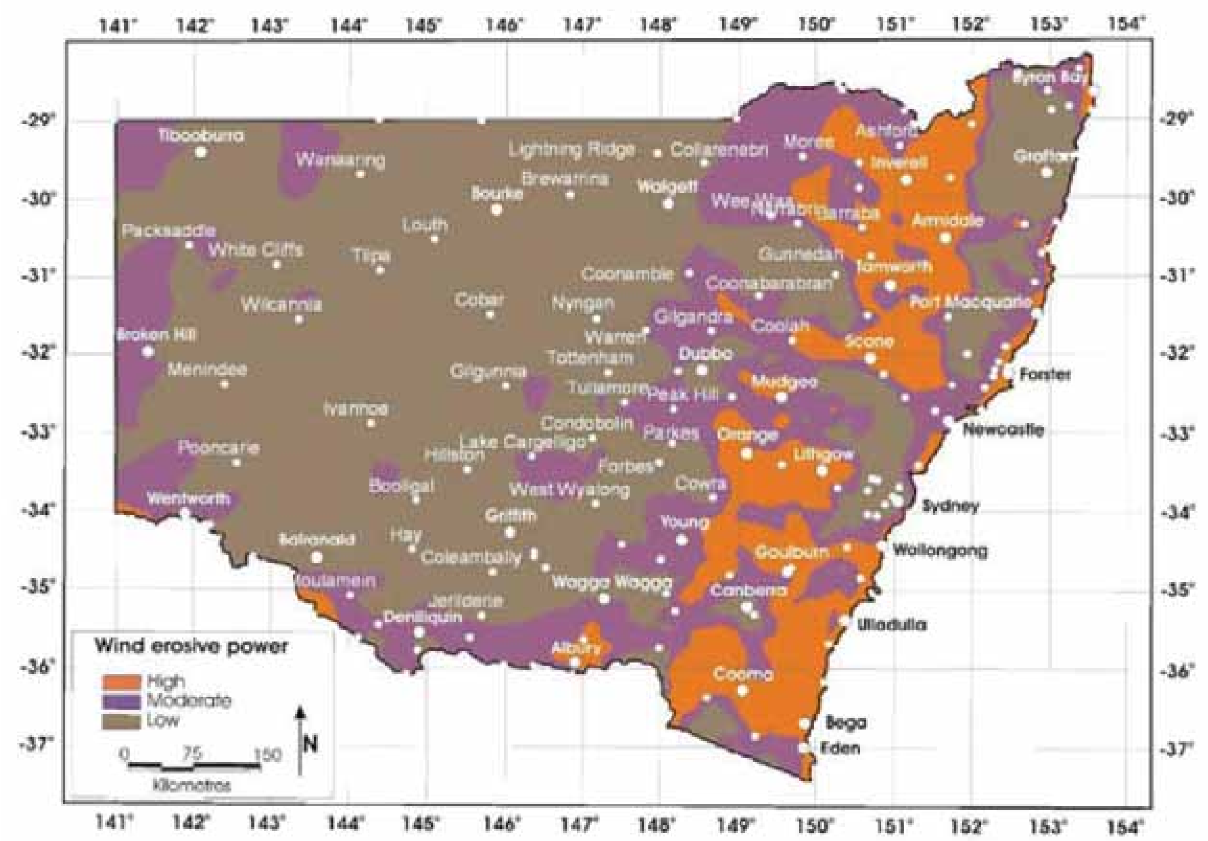
Exposure to wind class of surface soil	Site exposure to prevailing winds
Low	Sheltered locations in valleys or in the lee of hills
Moderate	Intermediate situations – not low or high exposure locations
High	Hilltops, cols or saddles, open plains or exposed coastal locations

4.3 Average yearly Rainfall

Average yearly rainfall for the project area is 970mm. http://www.bom.gov.au/climate/data/ (June 2015).

4.4 Wind erosion power

Figure 4.1 outlines the assessment figure for determining wind erosion power.



Source: NSW Department of Trade and Investment (undated).

Figure 4.1 Wind erosive power (NSW Department of Trade and Investment in OEH 2012)

4.5 Wind erosion LSC classes

Table 4.3 outlines the assessment table for determining wind erosion LSC classes. The Berrima Rail Project location falls in the High scale for wind erosive power (from Figure 4.1) and the annual average rainfall is 961mm. The following Table 4.3 has been shaded for the sections that do not apply to the site based on wind erosive power and average annual rainfall. Table 4.4 outlines the results table for water erosion LSC classes.

Table 4.3 Wind erosion LSC class assessment table (OEH 2012)

Wind erodibility class of surface soil	Wind erosive power	Exposure to wind	Average annual rainfall (mm)			
			>500	300–500	200 to <300	<200
Low	Low	Low	1	2	3	6
		Moderate	1	2	3	6
		High	2	3	4	7
	Moderate	Low	1	2	3	6
		Moderate	2	3	4	6
		High	3	4	5	7
	High	Low	2	3	4	6
		Moderate	3	4	5	7
		High	4	5	6	7
Moderate	Low	Low	2	3	4	7
		Moderate	3	4	5	7
		High	4	5	6	8
	Moderate	Low	2	3	4	6
		Moderate	3	4	5	7
		High	4	5	6	8
	High	Low	3	4	5	7
		Moderate	4	5	6	8
		High	5	6	7	8
High	Low	Low	3	4	5	7
		Moderate	4	5	6	8
		High	5	6	7	8
	Moderate	Low	4	5	6	8
		Moderate	5	6	7	8
		High	6	7	8	8
	High	Low	5	6	7	8
		Moderate	6	7	8	8
		High	7 (8*)	8	8	8

*Note: * Mobile sand bodies such as coastal beaches, foredunes and blowouts are Class 8.*

Table 4.4 Wind erosion LSC classes for the SMUs within the project area

Site ID	Surface soil texture	Wind erodibility class	Landform element	Site morphology	Local relief	Exposure to wind	Wind Erosion LSC class
Kandosols							
615	sandy clay loam	Low	hillslope	upper slope	low (30-90 m)	Moderate	3
616	silty loam	Moderate	hillslope	upper slope	very low (9-30 m)	Low	4
617	clay	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
618	silty clay loam	Low	hillcrest	upper slope		High	4
636	silty clay loam	Low	hillslope	lower slope	low (30-90 m)	Low	2
637	silty clay loam	Low		mid-slope	very low (9-30 m)	Moderate	3
638	silty clay loam	Low	hillslope	upper slope		High	4
639	clay	Low	hillslope	mid-slope	very low (9-30 m)	Moderate	3
642	clay loam sandy	Low	hillslope	upper slope	very low (9-30 m)	Moderate	3
643	silty loam	Moderate	hillslope	upper slope	low (30-90 m)	Moderate	4
644	clay	Low	hillslope	lower slope	very low (9-30 m)	Low	2
646	silty clay loam	Low	hillslope	mid-slope	low (30-90 m)	Moderate	3
647	silty loam	Moderate	hillslope	lower slope	very low (9-30 m)	Low	3
649	silty clay loam	Low	hillslope	lower slope	very low (9-30 m)	Low	2
650	silty loam	Moderate	hillslope	upper slope	very low (9-30 m)	Moderate	4
675	sandy loam	Moderate	hillslope	hillock		Moderate	4
676	sandy clay loam	Low	drainage depression	open depression		Low	2
677	sandy clay loam	Low	hillslope	mid-slope		Moderate	3
678	silty loam	Moderate	hillslope	upper slope		Moderate	4
679	sandy clay loam	Low	hillslope	hillock		Moderate	3
680	sandy clay loam	Low	hillslope	lower slope		Low	2
753	clay loam	Low	hillslope	mid-slope		Moderate	3
754	sandy loam	Moderate	hillslope	upper slope		Moderate	4
755	sandy loam	Moderate	hillcrest	crest		Moderate	4
756	sandy clay loam	Low				Moderate	3
Dermosol							
648	clay	Low	hillcrest	upper slope	very low (9-30 m)	Moderate	3
Hydrosol							
640	silty clay loam	Low	drainage depression	open depression	extremely low (< 9m)	Low	2
645	clay	Low	valley flat	open depression	extremely low (< 9m)	Low	2
709	sandy clay loam	Low	drainage depression	lower slope	very low (9-30 m)	Low	2

Note: *1. Climate data from nearest the site, Moss Vale (Hoskins Street) Bureau of Meteorology weather station, site number 068045.*

5 Assessment of soil structural decline LSC classes

Table 5.1 outlines the assessment table for determining soil structural decline LSC classes. Table 5.2 provides further information on the surface soil properties of clays to be used in collaboration with Table 5.3 outlines the results table for soil structural decline LSC classes.

Table 5.1 Soil structural decline LSC class assessment table (OEH 2012)

Field texture (surface soils)	Modifier	Outcome – surface soil type	LCS class
Loose sand	Nil	Loose sand	1
Sandy loam	Nil	Fragile light textured surface soil	3
Fine sandy loam	Normal	Fragile light textured soil	3
	High levels of silt and very fine sand (>60%)	Fragile light textured soil – very hardsetting	4
Loam	Normal	Fragile medium textured soil	3
	Friable/ferric[1]	Friable medium textured soils – includes dark, friable loam soils	1
	High levels of silt and very fine sand	Fragile medium textured soil – very hardsetting	4
	Mildly sodic	Mildly sodic loam surface soil	4
	Moderately sodic	Moderately sodic loam surface soil	6
Clay loam	Normal	Fragile medium textured soil	3
	Friable/ferric[1]	Friable clay loam surface soil – includes dark, friable clay loam soils	1
	High levels of silt and very fine sand (>60%)	Fragile medium textured soil – very hardsetting	4
	Mildly sodic	Mildly sodic clay loam surface soil	4
	Moderately sodic	Moderately sodic clay loam surface soil	6
Clay	Friable/ferric[1]	Friable clay surface soil	2
	Strongly self-mulching	Strongly self-mulching surface soil	1
	Weakly self-mulching	Weakly self-mulching surface soil	3
	Mildly sodic	Mildly sodic/coarsely structured clay surface soil	4
	Moderately sodic	Moderately sodic/coarsely structured clay surface soil	6
	Strongly sodic	Strongly sodic surface soil	7
Highly organic soils	Mineral soils with high organic matter[2]	Mineral soils with high organic matter	-[2]
	Organosol/peat soils[3]	Organic/peat soils	7

Note: *1. The occurrence of friable or ferric surface soils is associated with (a) basaltic or basic parent materials and soils of the Ferrosols groups in the Australian Soil Classification or the Krasnozems and Euchrozem Great Soil Groups, and (b) the dark loam surface soils of the Chernozems and Prairie Soils on alluvial flats.*
2. Loosely defined here as soils with over 8% organic carbon. These soils revert to the LSC class determined by the mineral component of the soils.
3. Organosols have organic material layers over 0.4 m thick with minimum organic carbon of 12% if sands or 18% if clays (Isbell 2002).

Table 5.2 Guidelines for evaluating some surface soil properties of clays

Sodicity/size of soil structural units	Character of surface soil
Very low exchangeable sodium (<3%), high exchangeable calcium, strongly swelling clays (smectitic) as in Vertosols (GSG Black Earths) Peds/aggregates 2–5 mm in an air dry condition	Strongly self-mulching surface soil
Low exchangeable sodium (3–5%), moderate exchangeable calcium, moderately swelling clays (illitic, interstratified, kaolinitic) as in many Dermosols and fertile Chromosols (GSG, Krasnozems, Euchrozems and others) Peds/aggregates 5–10 mm in an air dry condition	Weakly self-mulching surface soil
Moderate levels of exchangeable sodium (5–8%), often moderately low exchangeable calcium relative to exchangeable magnesium (ratio <2:1) Peds/aggregates 10–20 mm in an air dry condition	Mildly sodic surface soils
High levels of exchangeable sodium (8–15%), often low exchangeable calcium relative to exchangeable magnesium (ratio <1:1) Peds/aggregates 20–50 mm in an air dry condition	Moderately sodic surface soils
Very high levels of exchangeable sodium (>15%), often very low exchangeable calcium relative to exchangeable magnesium (ratio <0.5:1) Peds/aggregates >50 mm in an air dry condition	Strongly sodic surface soils

Table 5.3 Soil structural decline LSC classes for the SMU's within the project area

Site ID	Field texture (surface soils)	Modifier	Outcome - surface soil type	Soil structural decline LSC class
Kandosols				
615	sandy clay loam	Normal	Fragile medium textured soil	3
616	silty loam	Normal	Fragile medium textured soil	3
617	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
618	silty clay loam	Normal	Fragile medium textured soil	3
636	silty clay loam	Normal	Fragile medium textured soil	3
637	silty clay loam	Normal	Fragile medium textured soil	3
638	silty clay loam	Normal	Fragile medium textured soil	3
639	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
642	clay loam sandy	Normal	Fragile medium textured soil	3
643	silty loam	Normal	Fragile medium textured soil	3
644	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
646	silty clay loam	Normal	Fragile medium textured soil	3
647	silty loam	Normal	Fragile medium textured soil	3
649	silty clay loam	Normal	Fragile medium textured soil	3
650	silty loam	Normal	Fragile medium textured soil	3
675	sandy loam	Nil	Fragile light textured surface soil	3
676	sandy clay loam	Normal	Fragile medium textured soil	3
677	sandy clay loam	Normal	Fragile medium textured soil	3
678	silty loam	Normal	Fragile medium textured soil	3
679	sandy clay loam	Normal	Fragile medium textured soil	3

Table 5.3 Soil structural decline LSC classes for the SMU's within the project area

Site ID	Field texture (surface soils)	Modifier	Outcome - surface soil type	Soil structural decline LSC class
680	sandy clay loam	Normal	Fragile medium textured soil	3
753	clay loam	Normal	Fragile medium textured soil	3
754	sandy loam	Normal	Fragile medium textured soil	3
755	sandy loam	Normal	Fragile medium textured soil	3
756	sandy clay loam	Normal	Fragile medium textured soil	3
Dermosol				
648	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
Hydrosol				
640	silty clay loam	Normal	Fragile medium textured soil	3
645	clay	Weakly self-mulching	Weakly self-mulching surface soil	3
709	sandy clay loam	Normal	Fragile medium textured soil	3

6 Assessment of soil acidification LSC classes

Soil acidification is determined through a combination of buffering capacity of the soil surface, mean annual rainfall and pH of the natural soil surface. Buffering capacity of the soil surface can be determined through three different processes: the Great Soil Group, the surface soil texture or the geology of the area. For the Berrima Rail Project the surface soil texture was used (Table 6.1). Table 6.2 is the assessment table that uses the buffering capacity information to determine the LSC class. The mean annual rainfall is 961mm, so the sections of the table that are not relevant to the site rainfall have been shaded in grey. Table 6.3 outlines the results table for soil acidification LSC classes.

Table 6.1 Estimating buffering capacity of the soil surface by surface soil texture (OEH 2012)

Surface soil texture	Buffering capacity of surface soil
Sands and sandy loams – no calcium carbonate	VL
Sands and sandy loams – with calcium carbonate	M
Fine sandy loams – no calcium carbonate	L
Fine sandy loams – with calcium carbonate	M
Loams and clay loams – no calcium carbonate	M
Loams and clay loams – with calcium carbonate	H
Dark loams and clay loams (eg topsoils in Chernozems and Prairie Soils)	H
Clays – no calcium carbonate	H
Clays – with calcium carbonate	VH
Clays – with high shrink–swell	VH

The following textures described in the field survey were not specifically listed in Table 6.1, so the buffering capacity was assumed by using the equivalent clay percentages (as per the standard soil texture triangle).

Buffering capacity – Moderate:

- Silty clay loam.
- Sandy clay loam.
- Silty loam.

Some of the sites did not have pH data, so a land class has been assigned using the surface soil texture and a pH of 5.5-6.7 (water) which represents the most neutral pH range measured for the site. Therefore these land classes are likely to be a lower class, but would not be a higher class. These classes have been indicated with an *.

Table 6.2 Soil acidification LSC class assessment table (OEH 2012)

Texture/ buffering capacity	pH of the natural surface soil				
	<4.0 (CaCl2) <4.7 (water)	4.0–4.7 (CaCl2) 4.7–5.5 (water)	4.7–6.0 (CaCl2) 5.5–6.7 (water)	6.0–7.5 (CaCl2) 6.7–8.0 (water)	>7.5 (CaCl2) >8.0 (water)
Mean annual rainfall <550 mm					
Very low	6*	5	4	3	n/a
Low	5	5	3	3	n/a
Moderate	5	4	3	2	1
High	4	3	2	1	1
Very high	n/a	n/a	1	1	1
Mean annual rainfall 550–700 mm					
Very low	6*	5	5	4	n/a
Low	5	5	4	3	n/a
Moderate	5	4	3	3	1
High	n/a	n/a	2	2	1
Very high	n/a	n/a	1	1	1
Mean annual rainfall 700–900 mm					
Very low	6*	5	5	4	n/a
Low	6*	5	4	4	n/a
Moderate	5	4	3	3	2
High	n/a	n/a	2	2	1
Very high	n/a	n/a	2	1	1
Mean annual rainfall >900 mm or irrigation					
Very low	6*	5	5*	4	n/a
Low	6*	4	4	3*	n/a
Moderate	5	4	3	3	2
High	5	3	2	2	1
Very high	5	3	2	1	1

Notes: *Based on natural pH status, buffering capacity and climate.*

** These lands usually have very low fertility.*

Table 6.3 Soil acidification LSC class for the SMU's within the project area

Site ID	Surface soil texture	Buffering capacity of surface soil	pH of the natural surface soil	Soil acidification LSC class[1]
Kandosols				
615	sandy clay loam	Moderate		3*
616	silty loam	Moderate		3*
617	clay	High		2*
618	silty clay loam	Moderate		3*
636	silty clay loam	Moderate		3*
637	silty clay loam	Moderate		3*
638	silty clay loam	Moderate		3*
639	clay	High	4.9	3
642	clay loam sandy	Moderate		3*
643	silty loam	Moderate		3*
644	clay	High	4.1	5
646	silty clay loam	Moderate		3*
647	silty loam	Moderate		3*
649	silty clay loam	Moderate		3*
650	silty loam	Moderate	4.6	5
675	sandy loam	Very Low	6.1	5
676	sandy clay loam	Moderate	6	3
677	sandy clay loam	Moderate		3*
678	silty loam	Moderate	6	3
679	sandy clay loam	Moderate	6.1	3
680	sandy clay loam	Moderate	5.1	4
753	clay loam	Moderate	5.2	4
754	sandy loam	Very Low	5.1	5
755	sandy loam	Very Low	6.5	5
756	sandy clay loam	Moderate	6.3	3
Dermosol				
648	clay	High		2*
Hydrosol				
640	silty clay loam	Moderate		3*
645	clay	High	4.7	3
709	sandy clay loam	Moderate	4.6	5

Note: 1. Where no pH data exists, the highest possible land class is estimated for the surface soil texture and is indicated by.*

7 Assessment of salinity LSC classes

Salinity hazard is determined as a result of recharge potential, discharge potential and salt store. Table 7.1 and Figure 7.1 summarises the supporting information for decision making, while Table 7.2 is the assessment table for salinity LSC classes. Table 7.3 outlines the results table for salinity LSC classes.

Table 7.1 A summary of salinity LSC notes from OEH 2012

Factor	Notes	Example	Information Source
Recharge potential	Recharge potential is the potential for water from rainfall, irrigation or streams to infiltrate past the plant root zone into the underlying groundwater system. This can occur over a whole landscape, or a component of the landscape, where water readily infiltrates soil, sediment or rock. Typically recharge areas have permeable, shallow and/or stony soils and fractured and/or weathered rock.	Recharge potential is highest where there is high rainfall relative to evaporation, low leaf area and plant water use, low water-holding capacity, and high permeability of the soils, regolith and rocks. Under natural conditions it relates to the climate, land use and hydrological characteristics of the catchment. It is exacerbated by land-use practices that disturb the vegetation cover or soil surface.	The value assigned for recharge potential is a qualitative assessment based on aerial photography, field observation and/or available literature, in particular soil landscape maps and reports.
Discharge potential	Discharge potential is the potential for groundwater to flow from the saturated zone to the land surface. It is a function of position in the landscape, depth to water table, groundwater pressure, soil type, substrate permeability and evapotranspiration. Discharge may occur as leakage to streams, evaporation from shallow water tables, or as springs and wet areas where water tables intersect the land surface or where narrow breaks occur in low permeability layers above confined aquifers.	Discharge potential is highest when recharge rates are greater than the amount of water that leaves the groundwater system through base flow and evapotranspiration. Typical discharge areas are low in the landscape and have high water tables, or higher in the landscape if sub-surface barriers impede groundwater flow.	The value assigned for discharge potential is a qualitative assessment based on aerial photography, field observation and/or available literature, in particular soil landscape maps and reports.
Salt store	**Salt stores** are high for many soils, regolith materials and rock types. This will depend on weathering characteristics, geological structures, rock and soil type, depth of the various materials and salt flux.	It is possible to have areas of low salt store and still have a salinity hazard due to evaporative concentration of salts at the soil surface. Conversely, areas of high salt store can have a lower hazard due to low rainfall. For example, in areas of low rainfall and low slope, salinity hazard can be low.	Figure 7.1 provides a broad indication of salt stores throughout NSW. This map is generalised and local information should be used where available.

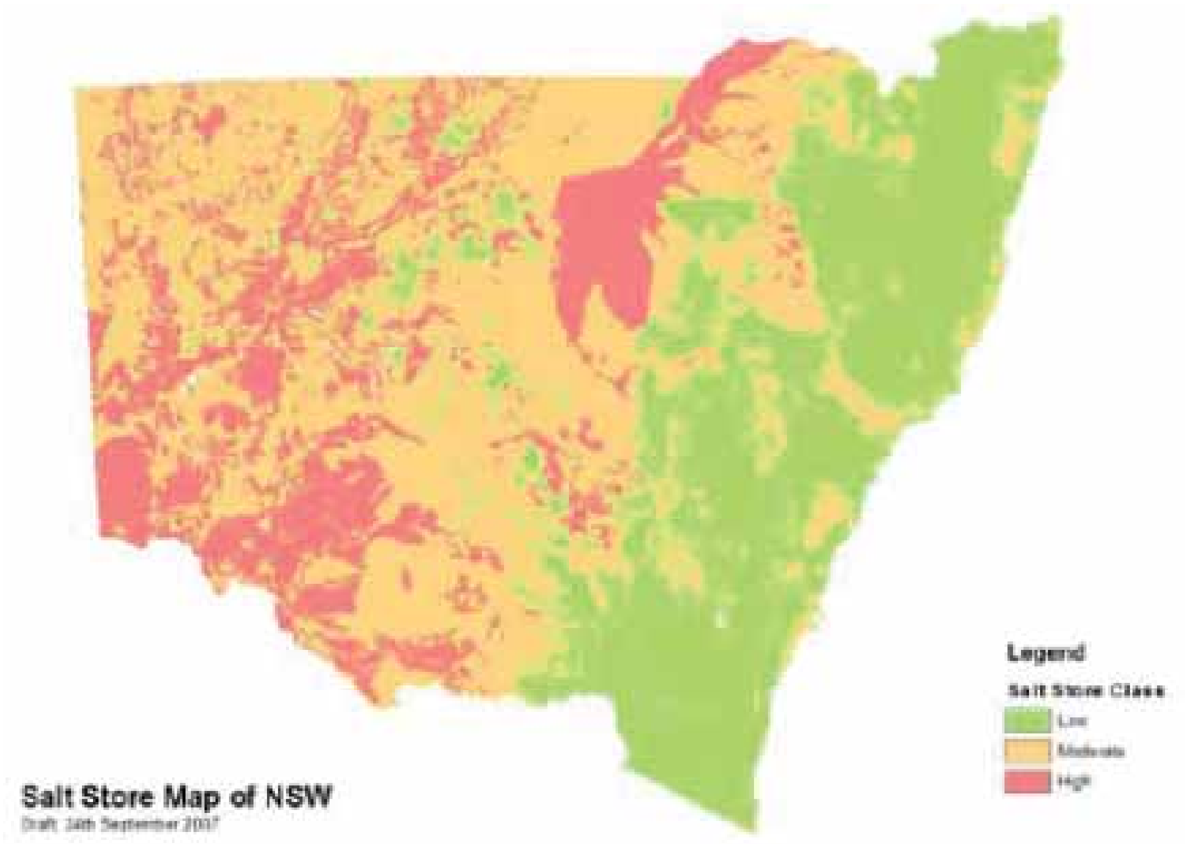


Figure 7.1 Salt store map of NSW (OEH 2012)

Table 7.2 Salinity LSC class assessment table (OEH 2012)

Recharge potential	Discharge potential	Salt store	LSC class
Low	Low	Low	1
		Moderate	3
		High	4
	Moderate	Low	1
		Moderate	4
		High	4
	High	Low	1
		Moderate	4
		High	5
Moderate	Low	Low	1
		Moderate	3
		High	4
	Moderate	Low	2
		Moderate	5
		High	6
	High	Low	1 (3) *
		Moderate	6
		High	6
High	Low	Low	1
		Moderate	4
		High	5
	Moderate	Low	3 (2) *
		Moderate	4
		High	7
	High	Low	2 (3) *
		Moderate	6
		High	7

*Note: * The values in brackets are more accurate and should be used in preference to the original.*

Table 7.3 Salinity LSC classes for the SMUs within the project area

Site ID	Recharge Potential	Discharge Potential	Salt store	Information sources	Salinity LSC class
Kandosols					
615	Moderate	Low	Low	Salis data cards, lab data, BOM	1
616	Moderate	Low	Low	Salis data cards, lab data, BOM	1
617	Low	Low	Low	Salis data cards, lab data, BOM	1
618	Low	Low	Low	Salis data cards, lab data, BOM	1
636	Low	Low	Low	Salis data cards, lab data, BOM	1
637	Low	Low	Low	Salis data cards, lab data, BOM	1
638	Low	Low	Low	Salis data cards, lab data, BOM	1
639	Low	Low	Low	Salis data cards, lab data, BOM	1
642	Low	Low	Low	Salis data cards, lab data, BOM	1
643	Low	Low	Low	Salis data cards, lab data, BOM	1
644	Low	Low	Low	Salis data cards, lab data, BOM	1
646	Low	Low	Low	Salis data cards, lab data, BOM	1
647	Low	Low	Low	Salis data cards, lab data, BOM	1
649	Low	Low	Low	Salis data cards, lab data, BOM	1
650	Low	Low	Low	Salis data cards, lab data, BOM	1
675	Low	Low	Low	Salis data cards, lab data, BOM	1
676	Low	Low	Low	Salis data cards, lab data, BOM	1
677	Low	Low	Low	Salis data cards, lab data, BOM	1
678	Low	Low	Low	Salis data cards, lab data, BOM	1
679	Low	Low	Low	Salis data cards, lab data, BOM	1
680	Low	Low	Low	Salis data cards, lab data, BOM	1
753	Low	Low	Low	Salis data cards, lab data, BOM	1
754	Low	Low	Low	Salis data cards, lab data, BOM	1
755	Low	Low	Low	Salis data cards, lab data, BOM	1
756	Low	Low	Low	Salis data cards, lab data, BOM	1
Dermosol					
648	Low	Low	Low	Salis data cards, lab data, BOM	1
Hydrosol					
640	Low	Low	Low	Salis data cards, lab data, BOM	1
645	Low	Low	Low	Salis data cards, lab data, BOM	1
709	Low	Moderate	Low	Salis data cards, lab data, BOM	1

8 Assessment of waterlogging LSC classes

Table 8.1 outlines the assessment table for determining waterlogging LSC classes. Table 8.2 provides the results.

The typical waterlogging duration was not known, but the presence of mottling was used to distinguish the degree of waterlogging. Soil profiles which were logged as "imperfectly drained" with 20-50% mottles in the B horizon were classed as 4 (i.e. waterlogged every 2-3 years for 2-3 months duration). Soils which were logged as Hydrosols were assumed to be LSC class 6, but soils that were logged as poorly drained but were not classified as Hydrosol was assumed to be LSC class 5.

Table 8.1 Waterlogging LSC class assessment table (OEH 2012)

Typical waterlogging duration (months)	Return period	Typical soil drainage*	LSC class**
0	every year	rapidly drained and well drained	1
0–0.25	every year	moderately well drained	2
0.25–2	every year	imperfectly drained	3
2–3	every 2 to 3 years	imperfectly drained	4
2–3	every year	imperfectly drained	5
>3	every year	poorly drained	6
Almost permanently	every year	very poorly drained	8

Notes: * NCST (2009, p.202–4)

** Based on slope position, climate and length of time soils are wet.

Table 8.2 Waterlogging LSC classes for the SMUs within the project area

Site ID	Typical soil drainage	Waterlogging LSC class
Kandosols		
615	moderately well drained	2
616	moderately well drained	2
617	Poorly drained	5
618	Imperfectly drained (20-50% mottles)	4
636	imperfectly drained	3
637	Imperfectly drained (20-50% mottles)	4
638	Poorly drained	5
639	poorly drained	5
642	imperfectly drained	3
643	imperfectly drained	3
644	Poorly drained	5
646	Imperfectly drained (20-50% mottles)	4
647	Imperfectly drained (20-50% mottles)	4
649	imperfectly drained	3
650	imperfectly drained	3
675	Poorly drained	5
676	Poorly drained	5

Table 8.2 Waterlogging LSC classes for the SMUs within the project area

Site ID	Typical soil drainage	Waterlogging LSC class
677	Poorly drained	5
678	Poorly drained	5
679	Poorly drained	5
680	Poorly drained	5
753	imperfectly drained	3
754	Imperfectly drained (20-50% mottles)	4
755	imperfectly drained	3
756	Imperfectly drained (20-50% mottles)	4
Dermosol		
648	Imperfectly drained (20-50% mottles)	4
Hydrosol		
640	Poorly drained (Hydrosol)	6
645	Poorly drained (Hydrosol)	6
709	Poorly drained (Hydrosol)	6

9 Assessment of shallow soils and rockiness LSC classes

Table 9.1 outlines the assessment table for determining shallow soils and rockiness LSC classes and Table 9.2 provides the results.

Table 9.1 Shallow soils and rockiness LSC class assessment table (OEH 2012)

Rocky outcrop (% coverage)*	Soil depth (cm)	LSC class**
Nil	>100	1
<30 (localised*)	>100	2
	75– <100	3
	50– <75	4
	25– <50	6
	0– <25	7
30–50 (widespread*)	>100	4
	75–100	5
	25–75	6
	<25	7
50–70 (widespread*)	>100	6
	50–100	6
	25– <50	7
	<25	7
>70	n/a	8

Notes: * *Rock outcrop limitation from soil landscape report.*

** *Based on rocky outcrop and soil depth.*

Table 9.2 Shallow soils and rockiness LSC classes for each soil type

Site ID	Rocky outcrop (% coverage)	Soil depth (cm)	Soil depth category (cm)	Shallow soils and rockiness LSC class
Kandosols				
615	Nil	0.4	25-<50cm	6
616	Nil	0.8	75-<100cm	3
617	Nil	0.84	75-<100cm	3
618	Nil	0.57	50-<75cm	4
636	Nil	0.74	50-<75cm	4
637	Nil	0.74	50-<75cm	4
638	Nil	0.74	50-<75cm	4
639	Nil	0.8	75-<100cm	3
642	Nil	0.69	50-<75cm	4
643	Nil	0.78	75-<100cm	3
644	Nil	0.77	75-<100cm	3
646	Nil	0.8	75-<100cm	3
647	Nil	0.8	75-<100cm	3
649	Nil	0.8	75-<100cm	3
650	Nil	0.8	75-<100cm	3
675	>20 - 30%	0.43	25-<50cm	6
676		0.9	75-<100cm	3
677	Nil	0.75	75-<100cm	3
678	Nil	0.58	50-<75cm	4
679		0.69	50-<75cm	4
680	Nil	0.66	50-<75cm	4
753		0.8	75-<100cm	3
754		0.7	75-<100cm	3
755		0.8	75-<100cm	3
756		0.8	75-<100cm	3
Dermosol				
648	Nil	0.8	75-<100cm	3
Hydrosol				
640	Nil	0.8	75-<100cm	3
645	Nil	0.8	75-<100cm	3
709	Nil	0.82	75-<100cm	3

10 Assessment of mass movement LSC classes

Table 10.1 outlines the assessment table for determining mass movement LSC classes and Table 10.2 provides the results.

Table 10.1 Mass movement LSC class assessment table (OEH 2012)

Mean annual rainfall (mm)	Mass movement present	Slope class (%)	LSC class
<500	No	n/a	1
	Yes	n/a	8
>500	No	n/a	1
	Yes	<20	6
		>20–50	7
		50 or any scree or talus slope	8

Note: That scree or talus slopes go automatically into Class 8.

Table 10.2 Mass movement LSC classes for the SMUs within the project area

Site ID	Mean annual rainfall (mm)	Mass movement present	Slope class (%)	Mass movement LSC class
Kandosols				
615	961.0	No	n/a	1
616	961.0	No	n/a	1
617	961.0	No	n/a	1
618	961.0	No	n/a	1
636	961.0	No	n/a	1
637	961.0	No	n/a	1
638	961.0	No	n/a	1
639	961.0	No	n/a	1
642	961.0	No	n/a	1
643	961.0	No	n/a	1
644	961.0	No	n/a	1
646	961.0	No	n/a	1
647	961.0	No	n/a	1
649	961.0	No	n/a	1
650	961.0	No	n/a	1
675	961.0	No	n/a	1
676	961.0	No	n/a	1
677	961.0	No	n/a	1
678	961.0	No	n/a	1
679	961.0	No	n/a	1
680	961.0	No	n/a	1
753	961.0	No	n/a	1
754	961.0	No	n/a	1
755	961.0	No	n/a	1
756	961.0	No	n/a	1

Table 10.2 Mass movement LSC classes for the SMUs within the project area

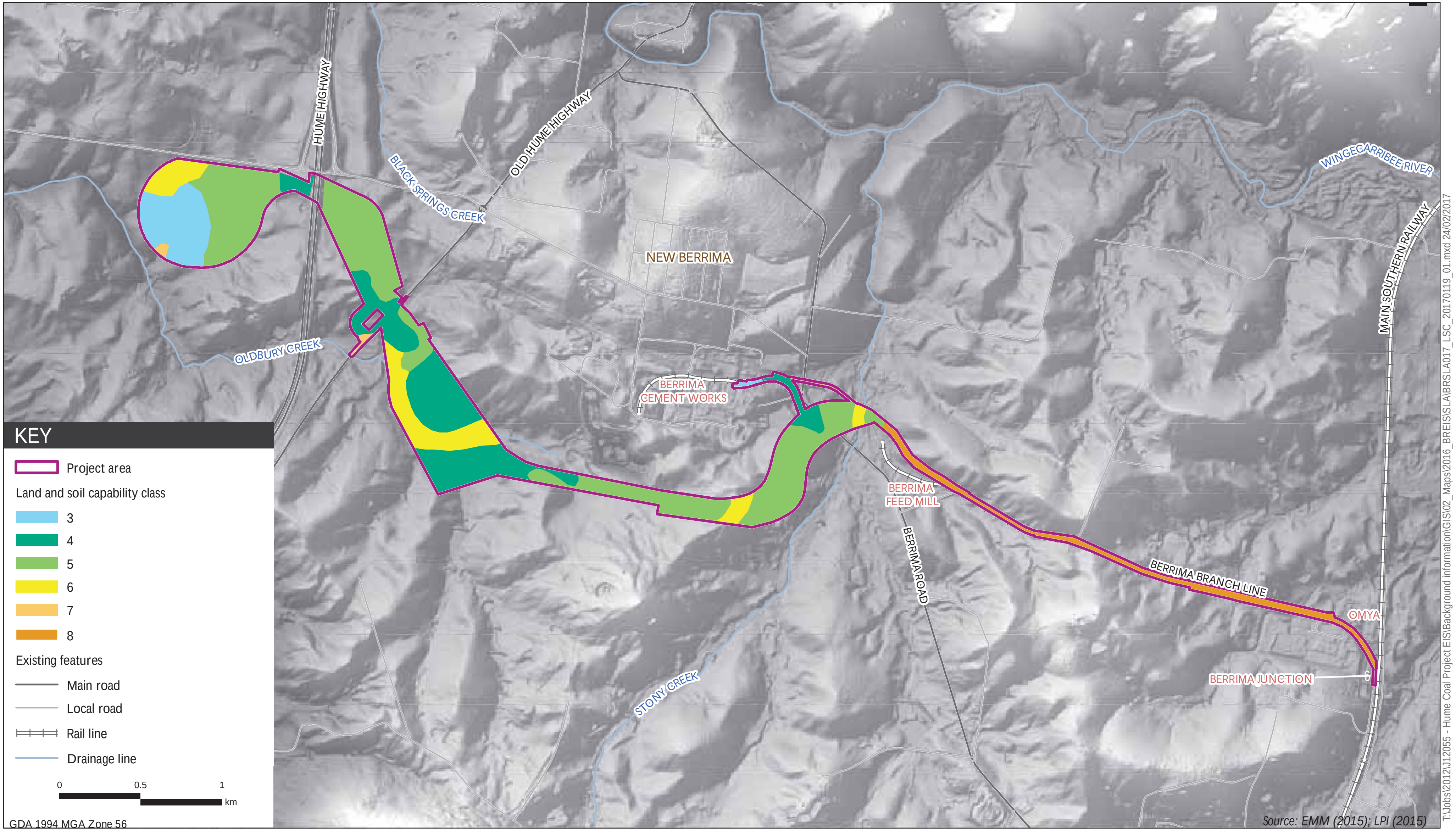
Site ID	Mean annual rainfall (mm)	Mass movement present	Slope class (%)	Mass movement LSC class
Dermosol				
648	961.0	No	n/a	1
Hydrosol				
640	961.0	No	n/a	1
645	961.0	No	n/a	1
709	961.0	No	n/a	1

11 Assessment of LSC classes for soil management units

Table 11.1 below is a summary table of soil management units (SMU), LSC classes of each element and the overall LSC classes for each SMU. The Kandosol soil units mostly fall into a LSC class of 4 or 5, even though a few sites were classified as 3 and 6. The Hydrosol soil units have a classification of 6. Figure 11.1 shows the distribution of LSC classes across the project area which have been mapped using the LSC class of each site and the surrounding topographic features.

Table 11.1 Summary of LSC classes across the project area

Site ID	Water Erosion LSC class	Wind Erosion LSC class	Soil structural decline LSC class	Soil acidification LSC class	Salinity LSC class	Waterlogging LSC class	Shallow soils and rockiness LSC class	Mass movement LSC class	SMULSC class
Kandosols									
615	3	3	3	3*	1	2	6	1	6
616	3	3	3	3*	1	2	3	1	3
617	3	3	3	2*	1	5	3	1	5
618	2	4	3	3*	1	4	4	1	4
636	3	2	3	3*	1	3	4	1	4
637	3	3	3	3*	1	4	4	1	4
638	2	4	3	3*	1	5	4	1	5
639	2	3	3	3	1	5	3	1	5
642	4	3	3	3*	1	3	4	1	4
643	3	4	3	3*	1	3	3	1	4
644	2	2	3	5	1	5	3	1	5
646	3	3	3	3*	1	4	3	1	4
647	3	3	3	3*	1	4	3	1	4
649	3	2	3	3*	1	3	3	1	3
650	3	4	3	5	1	3	3	1	5
675	3	4	3	5	1	5	6	1	6
676	2	2	3	3	1	5	3	1	5
677	2	3	3	3*	1	5	3	1	5
678	2	4	3	3	1	5	4	1	5
679	3	3	3	3	1	5	4	1	5
680	3	2	3	4	1	5	4	1	5
753	3	3	3	4	1	3	3	1	4
754	3	4	3	5	1	4	3	1	5
755	2	4	3	5	1	3	3	1	5
756	2	3	3	3	1	4	3	1	4
Dermosol									
648	2	3	3	2*	1	4	3	1	4
Hydrosol									
640	2	2	3	3*	1	6	3	1	6
645	2	2	3	3	1	6	3	1	6
709	3	2	3	5	1	6	3	1	6



Land and soil capability of the project area

Berrima Rail Project

Soil and land capability assessment

Figure 11.1

EMM HUMECOAL

12 Conclusion

The assessment of the land and soil capability classes for the project and each soil management unit was conducted in accordance with the requirements of the *Land and soil capability assessment scheme* (OEH 2012). The assessment found that the project area is identified as mostly Class 4 and 5 capability land, associated with the large area of Kandosols and the Dermosols. These soils are most suited for grazing and occasional cultivation with suitable soil conservation measures implemented. Some of the Kandosols were classified as Class 3, but only in small zones. The Hydrosols have been classified as Class 6, based on being waterlogged for several months of the year.

Table 12.1 Land and soil capability classes in the project area

Class	Capability	General definition[1]	Land in the project area
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)			
1	Extremely high	Land has no limitations. No special land management practices required. Capable of all rural land uses and land management practices.	0
2	Very high	Land has slight limitations. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.	0
3	High	Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.	17.5
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)			
4	Moderate	Moderate to high limitations for high-impact land uses. It will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture; and the limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology	44.5
5	Moderate-low	High limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.	79
Land capable for a limited set of land uses (grazing, forestry and nature conservation)			
6	Low	Very high limitations for high-impact land uses and is generally suitable for limited land uses such as grazing, forestry and nature conservation. Careful management of limitations is required to prevent severe land and environmental degradation.	21.5
Land generally incapable of agricultural land use (selective forestry and nature conservation)			
7	Very low	Severe limitations that restrict most land uses and generally cannot be overcome. Generally suitable only for selective forestry and nature conservation.	1.2
8	Extremely low	Limitations are so severe that the land is incapable of sustaining any land use apart from nature conservation.	17.7

Notes: 1.modified description from OEH 2012.

References

Australian Bureau of Meteorology http://www.bom.gov.au/climate/data/ (visited 02 June 2015)

Department of Environment and Heritage (2012) *Land and soil capability assessment scheme.* NSW government.

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