3.6 Groundwater resources

3.6.1 Hydrogeology of the project area

The Hawkesbury Sandstone is the main groundwater bearing unit used for water resources in the region, although bores within the overlying shale, basalts and the underlying Illawarra Coal Measures also exist. Groundwater within the Hawkesbury Sandstone is generally fresh with varying bore yields (Parsons Brinckerhoff 2015). The overlying Wianamatta Group Shale has low permeability and acts as a regional barrier (an aquitard) to downward groundwater flow (Ross 2014). Groundwater within the shale is generally brackish to saline with generally very low bore yields (Parsons Brinckerhoff 2015). Reported yields from bores within 5km of A349 have a median value of 2.0 L/s; the majority of these bores are assumed to target the Hawkesbury Sandstone (DPI Water 2013).

The groundwater units within the project area (EMM 2017d) are defined as:

- Localised, perched groundwater systems associated with the Robertson Basalt and Ashfield Shale.
- Porous rock groundwater system associated with the Hawkesbury Sandstone.
- Porous rock aquitard associated with the Illawarra Coal Measures and the Shoalhaven Group.

A detailed description of the groundwater resources of the project is presented Appendix E of the EIS.

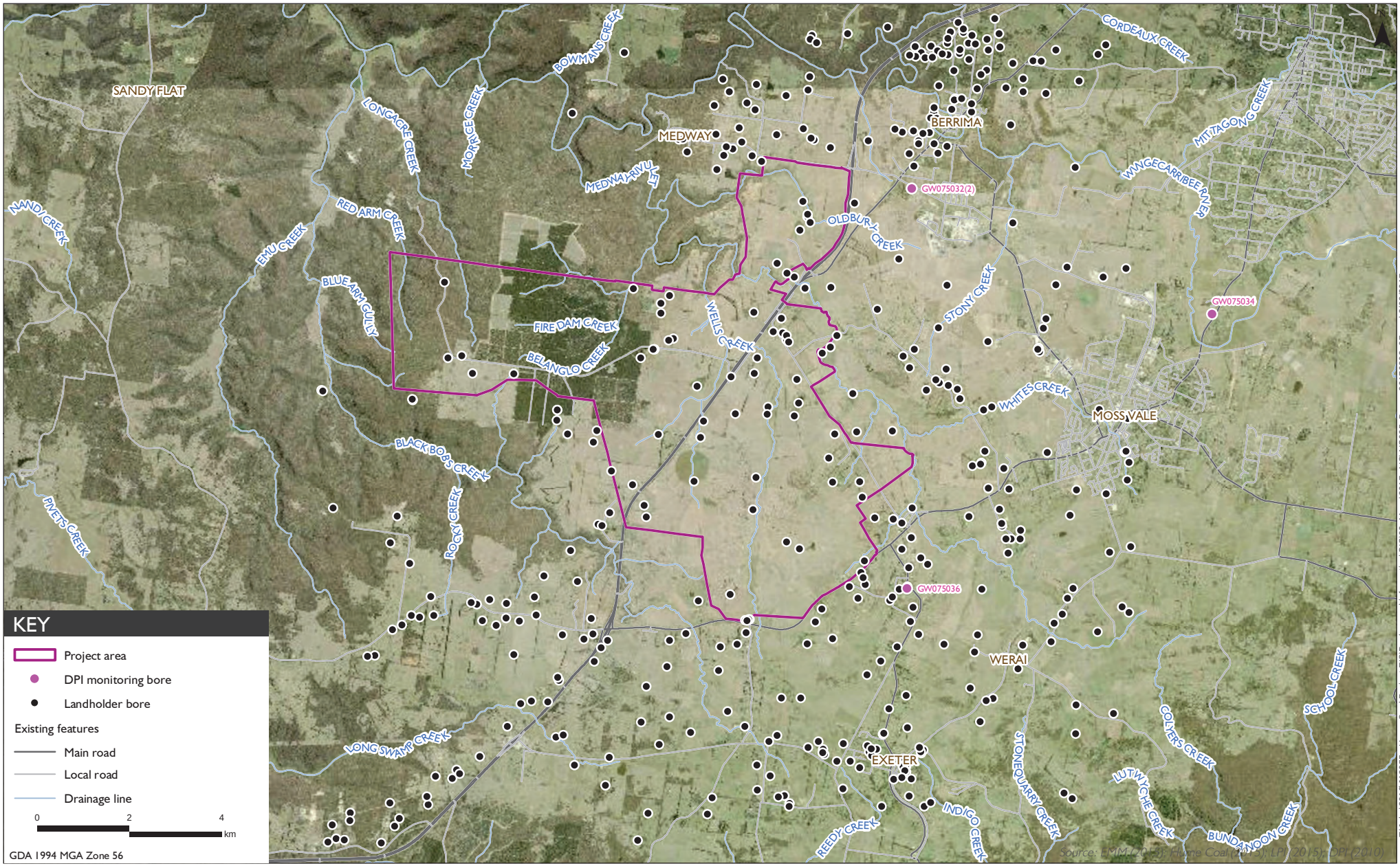
3.6.2 Bores and user extraction points

According to DPI Water's groundwater bore database (DPI Water 2015), there are less than 400 registered landholder bores and three DPI Water monitoring sites within a 9km radius from the middle of the project area. These bores are show in Figure 3.9, with the exception of bores associated with land owned by the proponent.

The median bore depth of the private landholder bores is approximately 85 m, with a majority of bores targeting the Hawkesbury Sandstone. Landholder groundwater extraction from the basalt is concentrated around Exeter. Landholder bores are heavily associated with the farmed areas, with very few bores observed in the Belanglo State Forest. The dominant landholder license purpose is for domestic and stock use (70%), followed by domestic, stock and irrigation (9%).

Coffey (2016a) identified 83 private water bore access licences within the 9 km radius of the project area with a combined level of entitlement of 5300 ML/year. It is possible that a significant number of unregistered bores also exist. No metering of usage is undertaken by regulatory agencies for the area, therefore actual usage from registered bores is not known (EMM 2017a).

A number of basic rights bores (registered for stock and domestic use) also exist; there is no volumetric entitlement associated with these bores. The total usage of basic rights bores within 9 km from the middle of the project area is estimated to be about 950 ML/year (Coffey 2016a).



Groundwater resources of the region

Hume Coal Project

Agricultural Impact Statement

Figure 3.9

3.7 History of agricultural enterprises

3.7.1 Land use of the project area

Approximately three quarters of the project area is within privately owned land. The remaining quarter of the project area is the Belanglo State Forest). The Belanglo State Forest, located in the west of the project area, supports a commercial pine plantation which is processed at a local mill (see Figure 3.10). As the mine is underground and the proposed mining method will result in negligible subsidence, there will be no surface impact on the State Forest or the private properties (excluding impacts discussed in 3.7.2ii) and, therefore, the project is not incompatible with existing land uses.

The property sizes in the project area vary from 0.2 ha (house, garden, paddock of grass) to 560 ha (30 paddocks), with the majority of the landholders (78%) owning blocks less than 100 ha, and 40% of the landholders owning properties less than 20 ha (see Table 3.25).

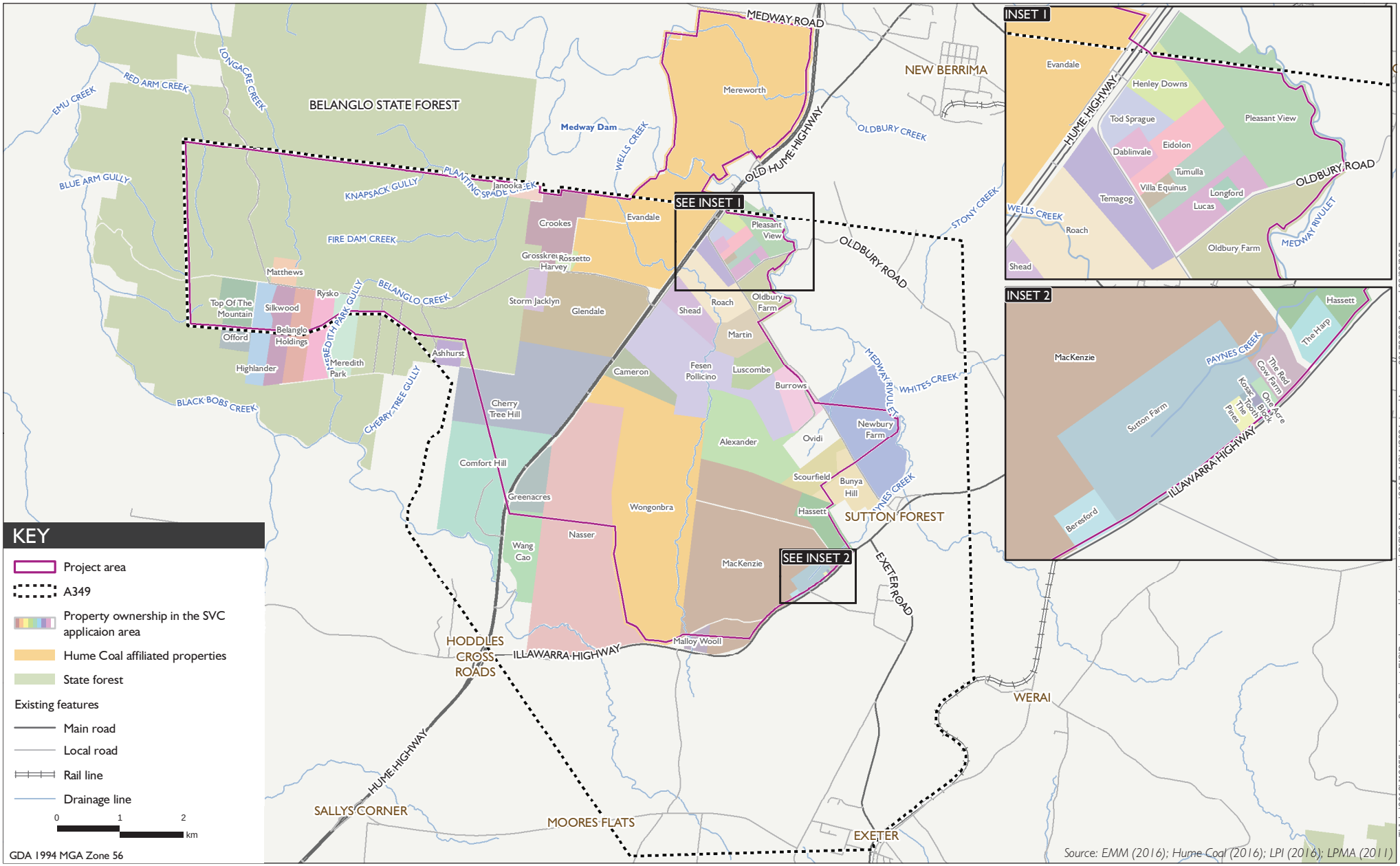
The predominant land use on privately owned land is agriculture. Relative distribution of land use (see Figure 3.11) is broad acre grazing with occasional cultivation (72%), equestrian properties (1.5%), viticulture (0.3%), olives (0.2%), and cropping (pivot irrigation 1%). Native vegetation covers approximately 18% of the privately owned land, within grazing paddocks. Some properties are used for tourism, such as the Red Cow Farm (a landscaped garden), and accommodation.

A number of the landholders in the project area have not allowed Hume Coal access to their land for assessments, and this limits the ability to obtain information regarding the current and historical uses of the properties for agriculture. The land use assessment for the project area has been undertaken using aerial photos over different years to identify grazing or cultivation on parcels of land. Farm improvements such as outbuildings, dams, access tracks, fences, yards and gardens were able to be identified by the use of the aerial photography of these properties. Figure 3.11 shows the assumed general land use of the project area and Tables 3.26 – 3.29 summarise the assumed current land use for each property.

Table 3.25 Distribution of property sizes and landholders

Ownership and property type	% of land area	Number of Landholders	General description
State Forest	25%	-	Pine forest and native forest.
Private properties greater than 400 ha	37%	5	Properties are used for livestock grazing and occasional cultivation. Three of the 5 properties are owned by Hume Coal (See Table 3.26 for more details).
Private properties between 100 and 400 ha	20%	7	Properties are generally used for livestock grazing. One property includes vineyards. One property has pivot irrigated paddocks.
Private properties between 20 and 100 ha	15%	22	Properties have some grazing paddocks. A variety of other land uses on these properties including olive groves, truffle orchards, equestrian cross-country event course, 4 hole golf course.
Private properties less than 20 ha	3%	22	Most properties have paddocks which may be used for grazing. One property is an Equestrian centre. Blocks smaller than 5 ha (11 properties) are mainly residential with 1 or 2 paddocks of pasture grass.

Notes: 1.Land use estimated using Google Earth.

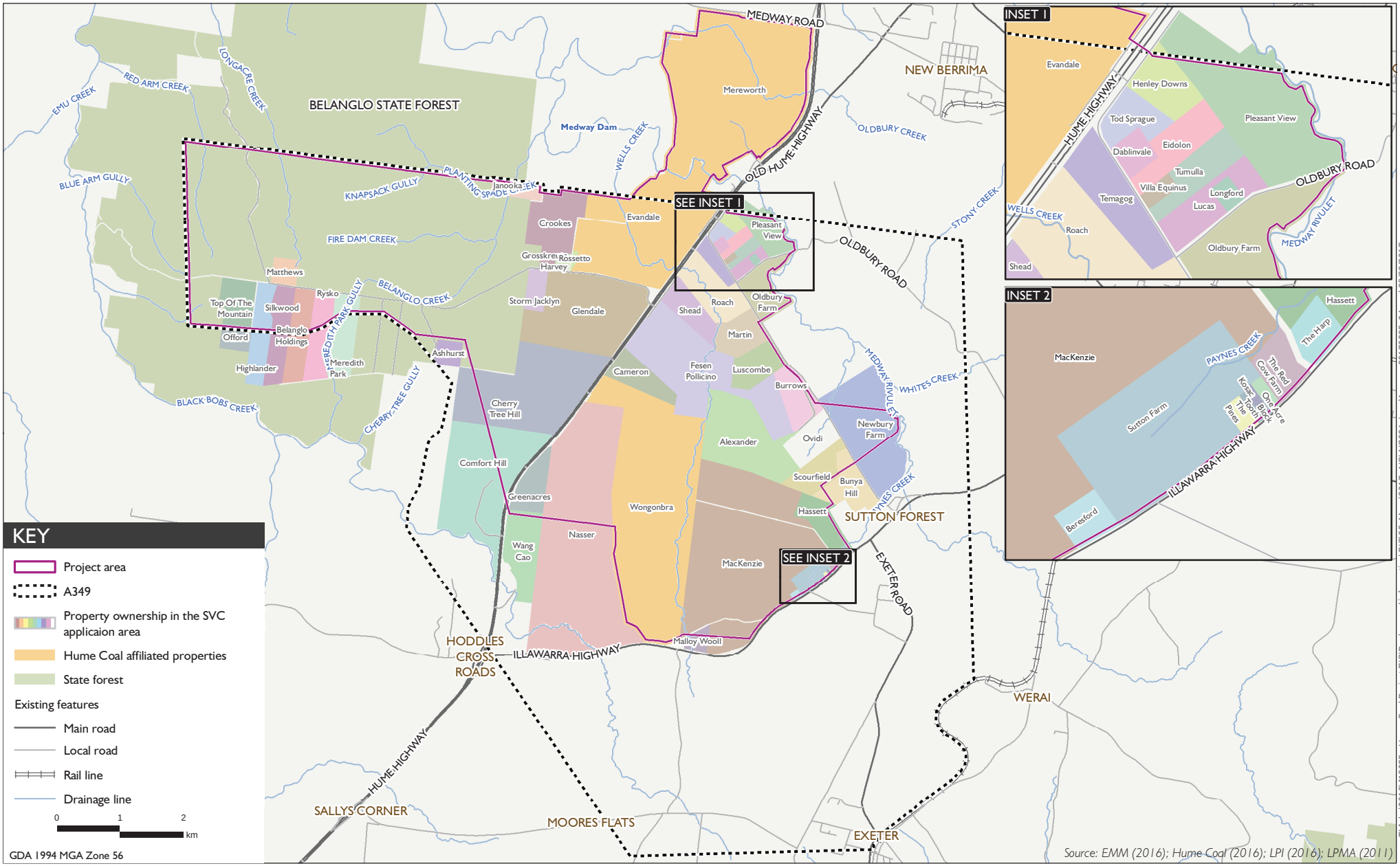


Land tenure in the project area

Hume Coal Project

Agricultural Impact Statement

Figure 3.10



Land tenure in the project area

Hume Coal Project

Agricultural Impact Statement

Figure 3.10

Table 3.26 Land use in the project area – properties larger than 400 ha

Property name	Land area (ha)	Grazing paddocks[1]	Cultivated paddocks[2]	Other land use	Water sources	Windbreaks/ shelter trees	Residence/ buildings	Other
Evandale	560	12 paddocks	16 paddocks		14 dams, creek frontage, 1 bore	10 windbreaks; scattered trees.	Large residence and cultivated garden.	Patches of remnant bushland
Mereworth	503	15 paddocks	20 paddocks		2 creeks, 1 large dam, 13 small dams, 6 bores	10 windbreaks, scattered trees	Large residence and cultivated garden (Heritage listed)	Patches of remnant bushland
Wongonbra	461	20 paddocks	4 paddocks		21 dams, 3 bores	4 windbreaks, scattered trees	Large residence and cultivated garden	Several patches of remnant bushland
Mackenzie	444	20 paddocks	3 paddocks		1 large dam, 22 small dams, 2 bores	9 windbreaks, scattered trees	2 large residences and cultivated garden	-
Rosedale	456	5 paddocks (outside of project area)	17 paddocks (6 in project area)	1 pivot irrigation paddock; (vineyards outside of project area)	1 large dam, 20 small dams (8 dams in project area), 2 bores	2 windbreaks, scattered trees (mostly outside of project area)	1 large residence and cultivated garden (outside of project area)	Some remnant vegetation outside of project area

Notes: 1.Land use estimated using Google Earth.

2. Cultivated paddocks estimated from Google earth and historic aerial photography.

Table 3.27 Land use in the project area - properties larger than 100 and less than 400 ha

Property name	Land area (ha)	Grazing paddocks[1]	Cultivated paddocks[2]	Other land use	Water sources	Windbreaks/ shelter trees	Residence/ buildings	Other
Cherry Tree Hill	229	10 paddocks	4 paddocks	3 planted vineyards	1 large dam, 9 small dams, 3 bores	4 windbreaks, scattered trees	Large residence, cultivated garden, tennis court, swimming pool; 2nd residence with gardens and farm buildings	Winery (cellar door) Large patches of bushland
Comfort Hill	217	20 paddocks (4 in project area)			1 large dam, 12 small dams (4 in project area), 4 bores	26 windbreak, scattered trees	5 residences and highly cultivated garden, tennis courts, swimming pool, numerous farm buildings (not in project area)	Several patches of remnant bushland
Fessen Polcino	205	23 paddocks (horses and cattle)			8 dams, creek, 5 bores	9 windbreaks, a few scattered trees	1 residence and garden	
Glendale	190	20 paddocks			1 very large dam, 12 small dams	3 windbreaks, scattered trees	large residence and cultivated garden (outside of project area)	
Newbury Farm	162	5 large paddocks (4 in project area)	4 paddocks in pivot irrigation (2 in project area)		(4 in project area), 1 bore	8 windbreaks, scattered trees	1 house, farm buildings	
Oldbury	186	7 paddocks			Creek frontage, 1 dam	4 windbreaks, a few scattered trees	1 large residence, cultivated garden.	
Roscoe Park	136	11 paddocks			7 dams, creek, 1 bore	8 windbreaks, scattered trees	Large residence and garden.	Large patch of remnant bushland

Notes: 1. Land use estimated using Google Earth.

2. Cultivated paddocks estimated from Google earth and historic aerial photography.

Table 3.28 Land use in the project area - properties larger than 20 and less than 100 ha

Property ID	Land area (ha)	Grazing paddocks[1]	Cultivated paddocks[2]	Other land use	Water sources	Windbreaks/ shelter trees	Residence/ buildings	Other
"Araluen"	62	13 paddocks		Equestrian eventing course (28 permanent jumps, Olympic standard, used for Berrima Horse trials)	11 dams, 2 bores	8 windbreaks, scattered shelter trees, patch of native vegetation	Residence and outbuildings	
"Bunya Hill"	48	6 large paddocks (2 in project area)		Angus bull stud and horses	(1 dam in project area), 2 bores	Windbreaks on property boundary, scattered trees in paddocks	Large residence with landscaped gardens	
"Candle Bark"	43	7 grazing paddocks	2 hay paddocks	Truffle Orchard (6ha)	Large lake, 1 bore	1 large established windbreak; several newly planted windbreaks; large patch of native vegetation	Extensive gardens (25,000 plants)	Critically endangered Southern Highland shale woodland - intensive regeneration project
"Eliza Grove"	40	6 paddocks	2 paddocks ploughed or used for hay	Sutton Grove Olive Farm (olive grove approx. 8.7ha)	2 dams, 1 bore	7 windbreaks	Large residence; landscaped gardens	
"Lane's End"	41	10 paddocks		tree plantation (species uncertain, 7ha)	1 very large dam/lake; 2 smaller dams1 bore		Large residence; extensive landscaped gardens	
Belanglo Holdings	47	5 paddocks			5 dams, 1 bore			
Cameron	42	2 paddocks			Creek runs through 1 paddock, 3 small dams			Large patches of forested land
Crookes	81	16 paddocks		4 hole golf course	10 dams, 2 bores		Large residence; landscaped gardens, outbuildings	Large patches of forested land
Hassett	41	3 paddocks			1 large dam			
Highlander	47	3 paddocks			1 large dam, 4 small dams, 1 bore			
Luscombe	42	7 paddocks	2 paddocks					

Table 3.28 Land use in the project area - properties larger than 20 and less than 100 ha

Property ID	Land area (ha)	Grazing paddocks[1]	Cultivated paddocks[2]	Other land use	Water sources	Windbreaks/ shelter trees	Residence/ buildings	Other
Meredith Park	55	Miniature Hereford Stud		Horse agistment paddocks; Horse services (breaking, pre-training, yearling preparation)	5 dams, 1 bore			Large patches of forested land
Pleasant View	45	6 large paddocks (4 paddocks in project area)			7 dams (6 in project area)		Residence (outside project area)	
Rysko	43	5 paddocks			2 large dams, 3 small dams			
Silkwood	48	8 paddocks			13 small dams			
Eling Forest Winery	64	14 paddocks (2 in project area		Vineyards	1 large dam, 12 smaller dams (3 in project area)	2 planted windbreaks, many scattered trees	Large residence; landscaped gardens (outside project area)	Winery
Greenacres	39	6 paddocks			4 dams, 2 bores	8 windbreaks	Large residence, landscaped gardens	
Janooka	21	3 heavily vegetated grazing paddocks			2 dams, 1 bore			Large patches of forested land
Scourfield	39	7 paddocks			3 dams, 2 bores			
Shead	39	7 large paddocks			2 dams, 1 bore	10 windbreaks	Large residence, smaller residence, numerous other buildings	
Storm Jacklyn	20	5 paddocks			5 dams, 3 bores		Large residence, gardens, tennis court	
Top of the Mountain	36	3 paddocks			1 large dam, 1 small dam			Large patches of forested land

Notes: *1.Land use estimated using Google Earth.*

2. Cultivated paddocks estimated from Google earth and historic aerial photography.

Table 3.29 Land use in the project area - properties less than 20 ha

Property ID	Land area	Grazing paddocks[1]	Cultivated paddocks[2]	Other land use	Water sources	Windbreaks/ shelter trees	Residence/ buildings	Other
Sutton Farm	19.4	3 large horse paddocks		The Highlands Equestrian Centre (stable complex, Olympic size arena, barns)	2 large dams (along Paynes ck)		Large residence (c1830); small cottage (C1827); Landscaped gardens	
Offord	18.3	1 paddock of mostly vegetated land			2 dams		Residence	Mostly heavily forested land
Temagog	16.8	3 paddocks			1 bore		Residence	Patch of remnant vegetation
Matthews	16.1	7 paddocks			1 large dam, 3 small dams, 1 bore		Residence and outbuildings	Large patches of forested land
Malloy Wooll	11.8	3 paddocks			1 large dam		Residence	
Lucas	10.5	5 paddocks			2 dams		Large residence, landscaped garden	
Eidolon	10.3	5 paddocks			2 dams, 1 bore		Large residence, landscaped garden	
Henley Downs	9.6	Horse agistment paddocks			1 dam		Residence	Patch of remnant vegetation
Tumulla	9.6	5 paddocks			3 dams, 1 bore		Large residence, landscaped garden	
Tod Sprague	7.5	5 paddocks			2 dams, 1 bore		Large residence, landscaped garden	
Grosskreutz Harvey	6	3 paddocks			1 bore		Residence	Large patch of forested land
Dablinvale	4.1	2 paddocks			1 dam, 1 bore		Large residence, landscaped garden	
The Red Cow Farm	2.1			Landscaped garden – tourist attraction	1 bore		Large residence	
Beresford	2	1 paddock of pasture grass					Large residence	

Table 3.29 Land use in the project area - properties less than 20 ha

Property ID	Land area	Grazing paddocks[1]	Cultivated paddocks[2]	Other land use	Water sources	Windbreaks/ shelter trees	Residence/ buildings	Other
Longford	2	1 paddock of pasture grass					Large residence, landscaped garden	
Rosetto	2	1 paddock of pasture grass			1 bore		Residence, garden	
The Harp	2	1 paddock of pasture grass					Large residence, landscaped garden	
Villa Equinas	1.9	1 paddock of pasture grass			1 bore		Large residence, landscaped garden	
The Pines	0.6	1 paddock of pasture grass					Large residence	
One Acre Block	0.4	1 paddock of pasture grass					Large residence	
Kosac	0.3	1 paddock of pasture grass					Large residence	
Tooth	0.2	1 paddock of pasture grass					Large residence	

Notes: *1.Land use estimated using Google Earth.*

2. Cultivated paddocks estimated from Google earth and historic aerial photography.

3.7.2 Land use of the properties that will be temporarily disturbed

All the land that will be subject to surface disturbance (with the exception of a downcast shaft, which will be in Belanglo State Forest) is Hume Coal affiliated land, and comprises of two properties: namely, Mereworth and Evandale. The properties were purchased in November 2014 and July 2014 respectively, and so 10 years of history (as per AIS technical notes) on crops sown, cropping yields, fertilisers used, etc are not known and are limited to the last 2 years. Aerial photography from Google Earth imagery was available for the 10 year period 2006 to 2016, so past land use was able to be determined as described below.

i Historical land use

a. Mereworth property

The Mereworth property, approximately 500 ha in size, was purchased by Hume Coal in November 2014. At the time of the purchase it was partially stocked with breeding cattle and offspring. There was some pasture improvement with the growing of rye, barley and lucerne for fattening stock, but primarily it was a grazing operation. In the past, the property also had a good sheep breeding operation with infrastructure of sheep yards and shearing shed.

The property consists of 36 individual paddocks. The Princess Pastoral Farm Management Plan (PPC 2015) states that in 2014, the property consisted of mainly pasture (30 paddocks) and two paddocks of improved pasture (ryegrass – 100 ha). Irrigation lines are indicated on the farm map to extend to at least five paddocks, which cover 180 ha. One paddock consists of a house only.

The predominantly grazed paddocks have been used for occasional cultivation in years of good rainfall. This can be observed from historical imagery (Google Earth), and supported by rainfall data. For example, Spring 2010 was the wettest on record for NSW. Satellite imagery from 2007 and 2009 suggest predominantly grazing, but 2013 indicates that significant areas of the southern half of the property were cultivated (up to 20 paddocks). It is unclear whether the cultivation may be from sown pasture grasses, or other fodder crops.

b. Evandale property

The Evandale property, approximately 560 ha in size, was purchased by Hume Coal in July 2014. When purchased, it was stocked primarily with breeding sheep with some breeding cattle and offspring. The property was severely run down with little or no pasture improvement and significant weed infestation, consequently it was running at approximately 20% capacity (PPC 2016).

The property consists of 29 individual paddocks. The Princess Pastoral Farm Management Plan (PPC 2015) states that in 2014, the property consisted of mainly pasture (22 paddocks), as well as fallow (six paddocks) and bare paddocks (one). There is a house and outbuildings in one paddock.

Satellite imagery from 2013 indicates that significant areas have some evidence of cultivation. Satellite imagery from 2006 and 2009 demonstrate that the majority of the fallow and bare paddocks were utilised as grazing land in this time thus suggesting a rotation scheme or a recent land use change.

ii Current land use

Princess Pastoral Company leases the Mereworth and Evandale properties from Hume Coal, along with the other Hume Coal affiliated land; namely, Wongonbra (including Carlisle Downs), Stonington and the Eastern Properties (Leets Vale and 325 Berrima Rd), which together cover a total area of 1,700 ha. The aim is to significantly enhance the agricultural productivity of the properties, and to run the properties together as a sole agricultural commercial entity.

Leading pasture improvement and cropping practices that have been implemented by Princess Pastoral Company have enabled this aim to be achieved (refer to Table 3.30). The methods in use are based on the farming experiences from their Goulburn properties, which have significantly improved productivity and profitability. This includes cropping using the speed-tilling process, which causes minimum impact on soil and it improves the productivity and build-up of organic matter in the soil which improves the long-term stability and fertility of the soil.

Fertiliser and other inputs over the period of July to October 2015 were:

- 1000 tonne (t) of lime;
- 12 cubic metres per ha (m^3/ha)of turkey manure (2% nitrogen, 2% phosphorous, 2% potassium); and
- 200 kilograms per hectare (kg/ha) of 28% nitrogen and 14% phosphorous blend sown with the seed on all paddocks.

On 20 July 2016, Mereworth supported 1,090 cattle (steer and weaner cattle) and 1,600 lambs, and cropping of rye grass and canola on 398 ha (PPC 2016). On 20 July 2016, Evandale supported 295 cattle (steer and heifer weaner cattle) and 1,350 lambs, and cropping of rye grass 441 ha (previously rye, canola and buckwheat) (PPC 2016). The stocking rates that have been achieved with the new management by Princess Pastoral Company are far superior to the average stocking rate of 9 DSE/ha for the Southern Tablelands region as reported by DPI 2016. A comparison of stocking rates is presented in Table 3.30.

The pre-purchase stocking rates are unknown for Mereworth and Evandale, however the Wongonbra property (in the project area, but no surface disturbance) was fully stocked when purchased and the stocking rate was approximately 9-10 DSE/ha (PPC 2016).

The Berrima Rail Project will be constructed on the Stonington and Eastern Properties (Leets Vale and 325 Berrima Rd), as well as portions of Mereworth. The impacts of this are addressed in the Berrima Rail EIS (EMM 2017f) however are shown in Table 3.30 for the purpose of the cumulative impacts presented in Chapter 4.

Table 3.30 Stocking rates – Princess Pastoral Management compared with average for Southern Highlands region

Property	Grazing land (ha)	Hume farm management				Average stocking rate		
		Sheep[1]	Cattle[1]	DSE[2]/ha	Cattle/ha	DSE[3]/ha	Cattle/ha	Cattle
Hume Coal Project								
Mereworth	500	1600	1090	19.5	2.6	9	1.2	600
Evandale	200[4]	1350	295	17.8	2.4	9	1.2	240
Berrima Rail Project							**1.2**	
Stonington	120	-	270	16.8	2.2	9	1.2	144
Eastern Properties[5]	80	-	158	14.8	2	9	1.2	96

Notes: *1. Current stocking rates as per Hume Coal – Pre & Post Operations Overview (PPC 2016).*

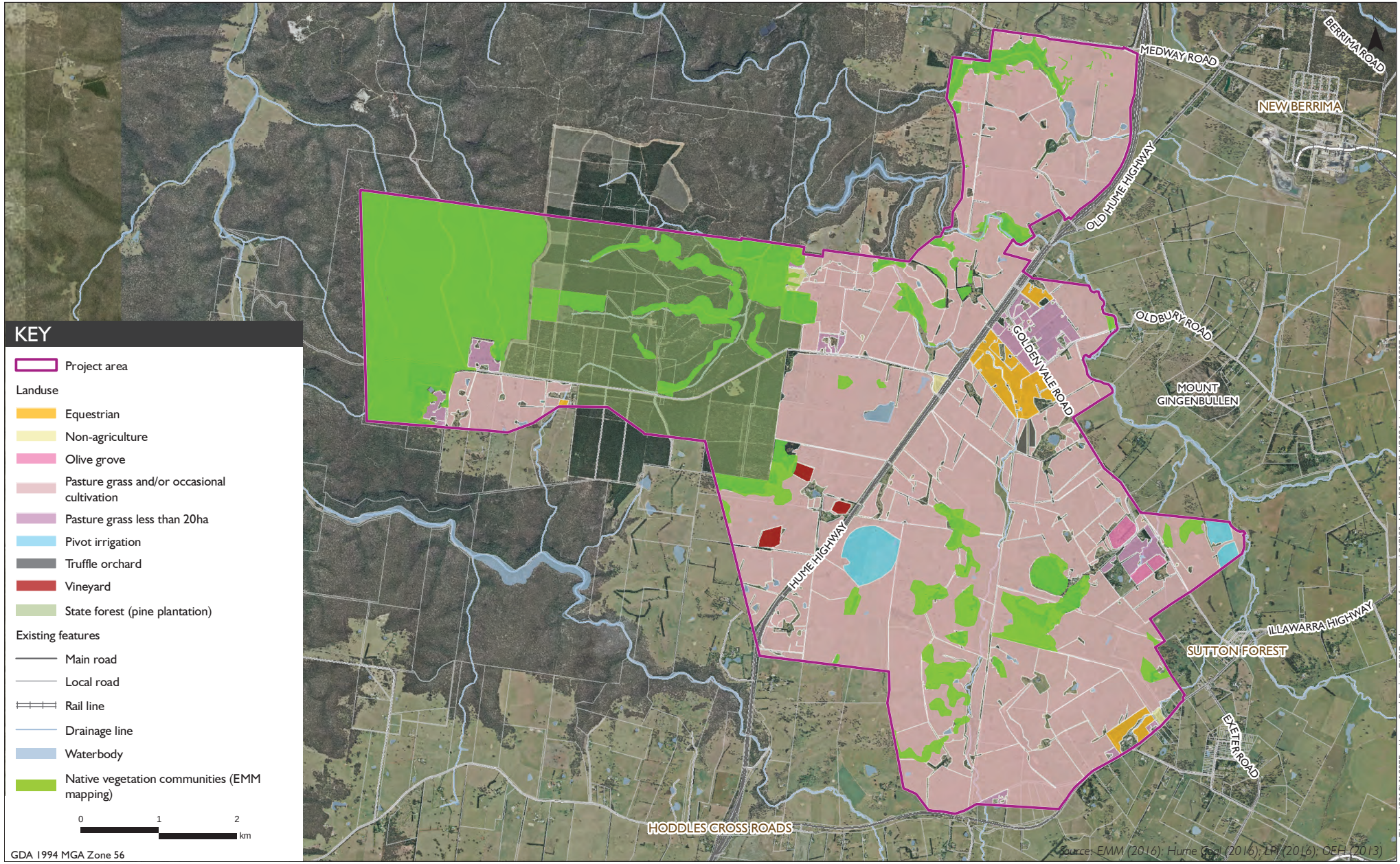
2. Calculated using the assumption that cattle are 7.5 Dry Sheep Equivalents (DSE).

3. Stocking rates as per average for Southern Tablelands (DPI 2016).

4. Livestock currently grazing on 200ha of the property only.

5. Eastern Properties includes Leets Vale and 325 Berrima Rd.

Figure 3.12 shows the current use of the Mereworth and Evandale paddocks within the project area – all are used for grazing and/or cropping, depending on seasonal conditions (PPC pers. com. 2016). In some paddocks there is a significant amount of native vegetation, including protected riparian vegetation (fenced off from livestock use).



Current land use of the Hume Project area

Hume Coal Project
Agricultural Impact Statement
Figure 3.11

4 Location and areas of land to be impacted

The AIS guidelines require identification of the areas of land to be temporarily removed and returned to agriculture post mining and identification of land that will not be returned to agriculture post mining. This chapter addresses these matters.

4.1 Land areas temporarily disturbed

4.1.1 Disturbed land

The project's potential impacts on soil resources are limited to temporary loss of land due to construction and operation of mine infrastructure (eg surface facilities) prior to rehabilitation and closure activities.

Surface infrastructure is proposed to be developed on predominately cleared land owned by Hume Coal (with the exception of a downcast shaft, which will be in Belanglo State Forest), and where the land is relatively free from environmental and other constraints. The project design integrates with the existing topography and landform and is set back from sensitive receptors where possible, to minimise the potential for visual, noise, dust and amenity impacts.

Due to the underground nature and limited coal extraction method to be employed, impacts on soil resources are not expected to be significant during the operational phases and because only very localised land clearing will occur and subsidence will be negligible.

4.1.2 Surface infrastructure area

Land disturbance will be mainly associated with the development and use of surface infrastructure (ie coal handling infrastructure, mining infrastructure, roads, dams and stockpiles), and will have a direct disturbance footprint of approximately 117 ha of land (details given in Table 4.1). The location of the surface disturbance is shown in Figure 4.1.

Table 4.1 Surface Infrastructure disturbance area

	Description	Area (ha)
Infrastructure area	• Mining infrastructure o drifts o upcast ventilation shaft o downcast ventilation shafts o service supply holes (power, water, gravel supply) • Coal handling infrastructure o coal preparation plant o coal loading facility o coal product stockpiles o temporary coal reject stockpile o ROM stockpile • General infrastructure o offices, bathhouse, carpark, workshop o temporary accommodation facility o temporary construction facilities o utilities (power line, water pipeline)	58
Water management area	• Primary water dam; • Stormwater basins • Sediment control dams	44
Roads, tracks, conveyor	• ROM overland conveyor system • Product overland conveyor system • Access roads • Tracks	6
Stockpiled material	• Drift spoil stockpile • Soil stockpiles (topsoil and subsoil)	9
TOTAL		117

Surface disturbance

Hume Coal Project
Agricultural Impact Statement

Figure 4.1

4.1.3 Land characteristics of area to be disturbed by the project

The land characteristics of the area to be disturbed by the project are described in the following section (ie the soil type, and the soil and land capability). The depths of soil in the area is also described and the depths for soil stripping are recommended.

i Soil types and LSC classes to be disturbed by the project

The majority of the proposed disturbance area is positioned over one soil type, Dystrophic Yellow Kandosol soils (see Figure 4.2 and Table 4.2). The Dystrophic Yellow Kandosol soils are associated with gently undulating landscapes which have been predominantly cleared and replaced with pasture grasses.

Small patches of Kandosolic Redoxic Hydrosol have been mapped in the disturbance area. The conveyor corridor crosses Oldbury Creek where it is expected to encounter Kandosolic Redoxic Hydrosol, or very wet soils.

The Dystrophic Yellow Kandosol soil type will be the most useful for rehabilitation purposes due to its structure and depth. The Paralithic Leptic Tenosol soils are generally shallow and not expected to provide a significant volume of useable material. Kandosolic Redoxic Hydrosols are not considered suitable for use in rehabilitation. These soils are typically wet which would lead to them compacting and breaking down during stripping operations.

The LSC classes to be disturbed are shown in Figure 4.3.

Table 4.2 Soil types to be disturbed

Soil type	Area	
	Ha	%
Dystrophic Yellow Kandosol	110.3	94.3
Eutrophic Grey Dermosol	1.1	0.9
Kandosolic Redoxic Hydrosol	3.6	3.1
Paralithic Leptic Tenosol	1.6	1.4
Lithic Leptic Rudosol	0.4	0.3
TOTAL	**117**	**100%**

Notes: 1. Based on EMM (2016) assessment (refer to Section 3.3).

ii Soil stripping depth

The topsoil depth in the area of disturbance ranges between 0.15 and 0.3 m. The subsoil depth in the area of disturbance ranges between 0.3 and 0.9 m. The majority of the soils to be disturbed are Dystrophic Yellow Kandosol, but the depth is not uniform across the disturbance area. Topsoils on the upper slopes tend to be about 0.15 m in depth, whilst topsoils in the lower parts of the landscape are up to 0.4 m in depth.

The topsoil stockpile areas only require a shallow depth of topsoil to be stripped (mainly just to remove the vegetation before creating the stockpile), as only topsoil is to be stockpiled on this land. Other areas with minimal surface disturbance such as the construction accommodation village (assuming temporary construction dongas are used and are elevated off the ground) can also be stripped with a minimal depth of topsoil. If the areas are not also subjected to significant compaction and long term use, a return of the shallow topsoil will be sufficient for rehabilitation to be successful. This approach will limit the disturbance of the overall soil profile.

All other areas of surface disturbance need to be stripped to at least 0.3 m depth, to allow for sufficient soil to be replaced for rehabilitation at a depth of 0.3 m. As this topsoil will be placed over land that is comprised of fill material (meaning that the original soil profile has been substantially disturbed) a depth of 0.3 m is considered adequate to re-establish pasture for grazing.

In the areas where topsoil is less than 0.3 m in depth, subsoil will need to be stripped down to the overall soil depth of 0.3 m. If the depth to bedrock is less than 0.3 m in depth, additional soil from an area with deeper soils should be obtained to make up the shortfall.

Soil mapping suggests that up to 3.6 ha of soils to be disturbed could be Hydrosols. There may be less area than this, but there will be some Hydrosols encountered. These soils are found in drainage depressions and near drainage lines and will be easily identified as they will be waterlogged. This soil is unsuitable for rehabilitation purposes and it is not recommended to stockpile these soils for later use. This will result in a shortfall of topsoil resource for later rehabilitation if all areas are to be spread with topsoil to 0.3m depth.

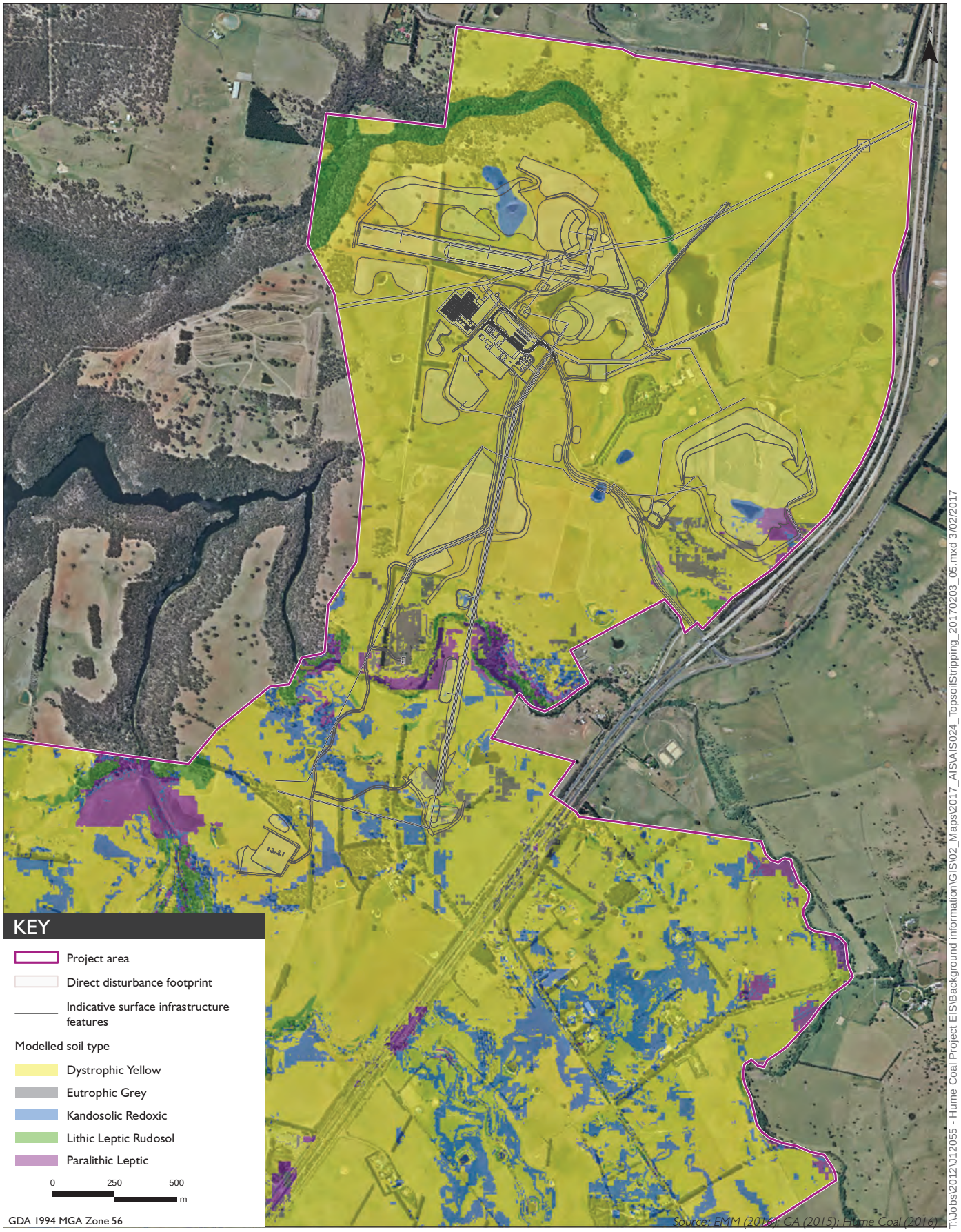
Table 4.3 presents the recommended topsoil stripping depths for each part of the project area to be subject to surface disturbance. It also shows the overall depth of soil (topsoil plus subsoil) which indicates areas that may be suitable for salvaging extra soil material. For example, the soil in the area of some the water dams may be salvageable down to 0.5 m depth.

Table 4.3 Depths of topsoil and subsoil available for stripping[1]

Surface infrastructure	Depth to strip		Total soil depth (m)
	Topsoil (m)	Subsoil (m)	
Offices, bath house, carpark, workshop	0.15	0.15	0.3
Coal processing plant (CPP),	0.15	0.15	0.9[2]
Primary water dam, stormwater dams and sediment control dams	0.3	0.2	0.5[2]
Temporary accommodation facility	0.1	-	0.3
Soil stockpiles	0.1	-	0.3
Overland conveyor, constructed roadway (ie access road)	0.2	0.1	0.4[2]
Upcast ventilation shaft and associated infrastructure	0.2	0.1	0.3

Notes: *1. Estimated using soil depths recorded in EMM soil survey.*

2. Excess soil available for stripping to make up any soil volume shortfall.



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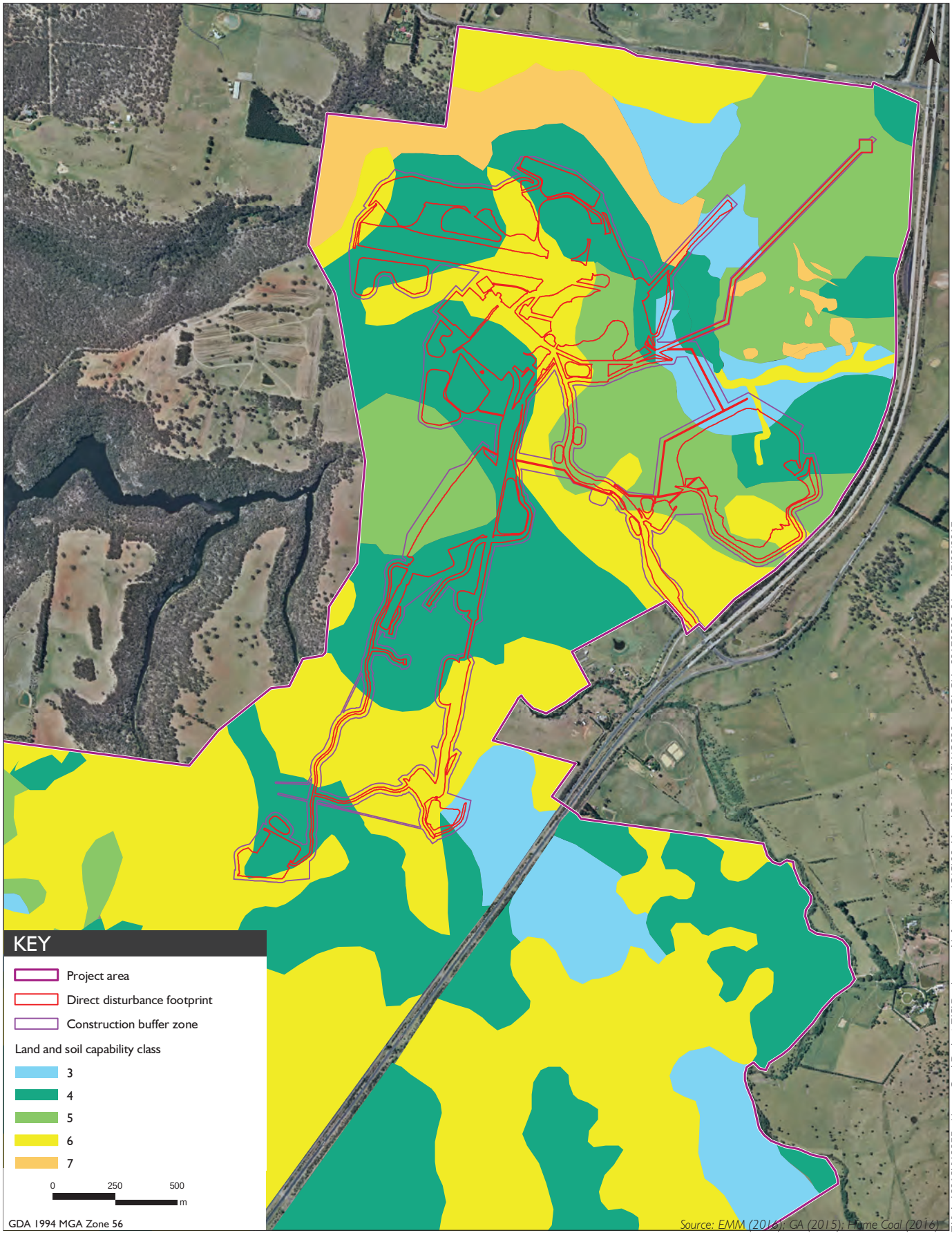
Soil types disturbed

Hume Coal Project
Agricultural Impact Statement
Figure 4.2



Impacts to land and soil capability

Hume Coal Project
Agricultural Impact Statement
Figure 4.3

4.2 Land temporarily removed from agriculture

The disturbance of agricultural land occurs exclusively on Hume Coal affiliated properties; namely, Mereworth and Evandale. The land temporarily removed from agriculture has been calculated as 190 ha during the construction phase. This area includes the actual surface area disturbance of 117 ha (Table 4.1) and the construction buffer, as well as a small area of a paddock that has been isolated by infrastructure (Table 4.4). Re-alignment of fences will take place to incorporate other fragmented paddocks into existing ones and, accordingly, the useability of this land will not be impacted.

Figure 4.4 shows the areas that will be temporarily removed from agriculture during the construction phase.

The rail loop (Berrima Rail Project) has been indicated in Figure 4.4 and Table 4.4 as it is considered to be a cumulative impact within the project area. The Berrima Rail Project will be constructed on the Stonington and Eastern Properties (Leets Vale and 325 Berrima Rd), as well as portions of Mereworth. The impacts of this are addressed in the Berrima Rail EIS (EMM 2017f).

Table 4.4 Land temporarily removed from agriculture

Property name	Construction phase[1]	Operation phase[2]
	ha	ha
Hume Coal Project		
Mereworth	145	89
Evandale	45	18
TOTAL	**190**	**107**
Berrima Rail Project		
Mereworth	43	11
Stonington	13	6
Eastern Properties[3]	7	2
Other freehold	26	9
TOTAL	**89**	**28**

Notes: 1. Construction phase includes an extra 1 year for rehabilitation post-construction – 3 years.

2. Operation phase assumes rehabilitation has returned land to agriculture, post construction rehabilitation period – 21 years.

3. Eastern Properties include Leets Vale and 325 Berrima Rd.

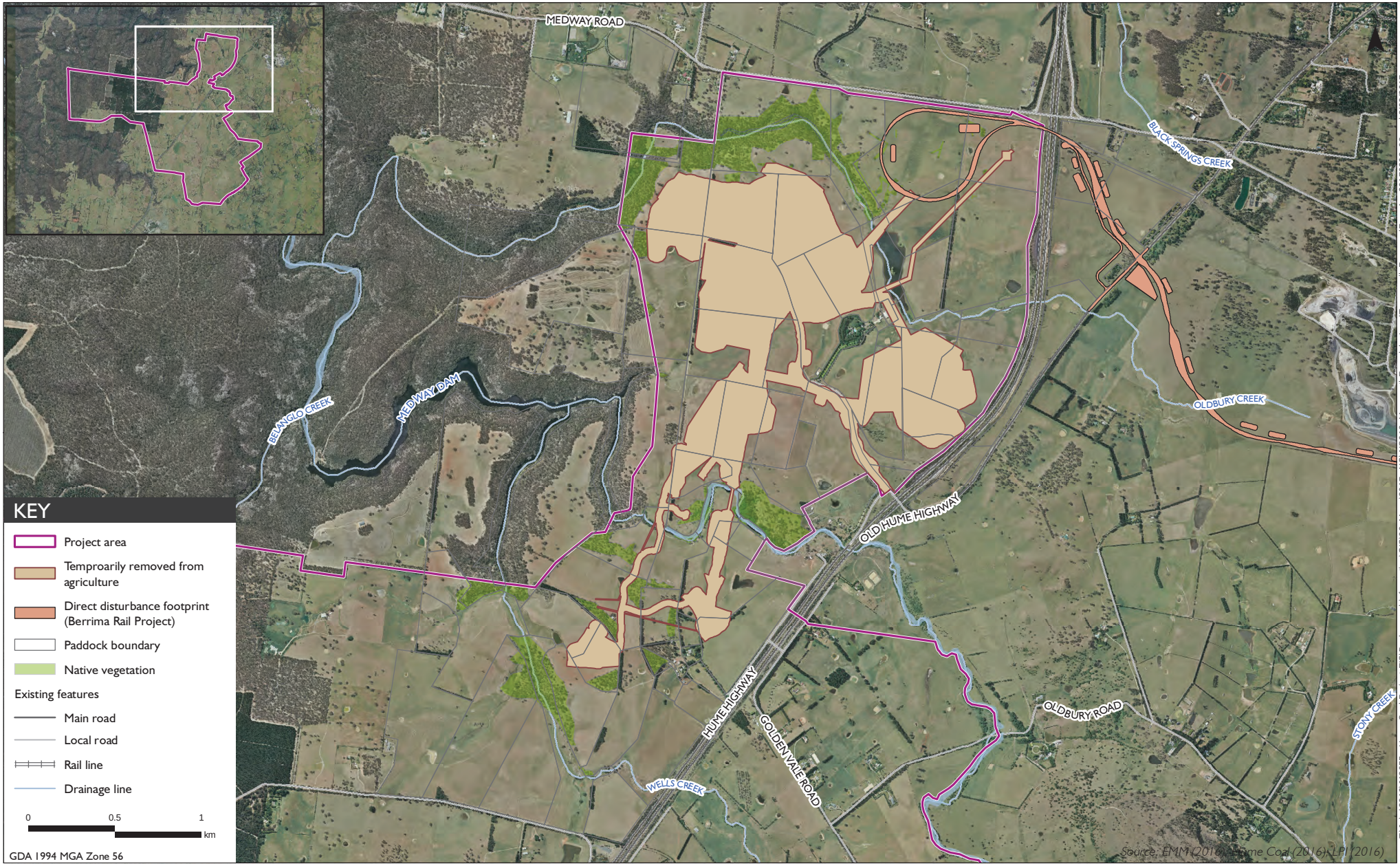
The construction phase has been assumed to be three years, which comprises the construction period and time for rehabilitation of temporary disturbance areas (ie accommodation village, buried services, topsoil stockpiles). These areas will be returned to agriculture at the end of the construction phase.

The operations phase is assumed to be 23 years, and the area which will be temporarily removed from agriculture has been calculated at only 107 ha. The area includes all surface disturbance that has not been rehabilitated during the construction phase. Figure 4.5 shows the areas that will be temporarily removed from agriculture during the operations phase.

The extent and type of disturbance for the area of direct disturbance is presented in Table 4.5. These areas will be rehabilitated at the end of the mine life. Land temporarily removed from agriculture, due to the construction buffer and fragmentation, will not have any surface disturbance and, therefore, will not require rehabilitation.

Table 4.5 Surface infrastructure disturbance areas and description of impact

Surface infrastructure	Area (ha)	Current land use	Duration of impact	Description of impact
Temporary accommodation facility	3	Grazing and/or occasional cultivation	Removed after construction completed (3 years)	No cut and fill. Placed on natural land contours, only topsoil disturbed – rehabilitation involves spreading of topsoil over underlying subsoil.
Soil stockpiles	9	Grazing and/or occasional cultivation	Removed at decommissioning (20 years)	No cut and fill. Placed on natural land contours, only topsoil disturbed – rehabilitation involves spreading of topsoil over underlying subsoil.
Overland conveyor, constructed roadways, minor tracks and roads	6	Grazing and/or occasional cultivation	Removed at decommissioning (20 years)	Roads or tracks built on existing land surface, topsoil removed, road base materials placed over the top. Rehabilitation involves the removal of road base and return of topsoil.
Coal processing plant (CPP), offices, bath house, carpark, workshop, primary water dam, stormwater dams and sediment control dams	99	Grazing and/or occasional cultivation	Removed at decommissioning (20 years)	Constructed by excavating material and/or using fill– rehabilitation involves re-profiling to match surrounding contours, and overlaying 0.3m topsoil.
TOTAL	**117**			



Land temporarily removed from agriculture - construction

Hume Coal Project

Agricultural Impact Statement

Figure 4.4