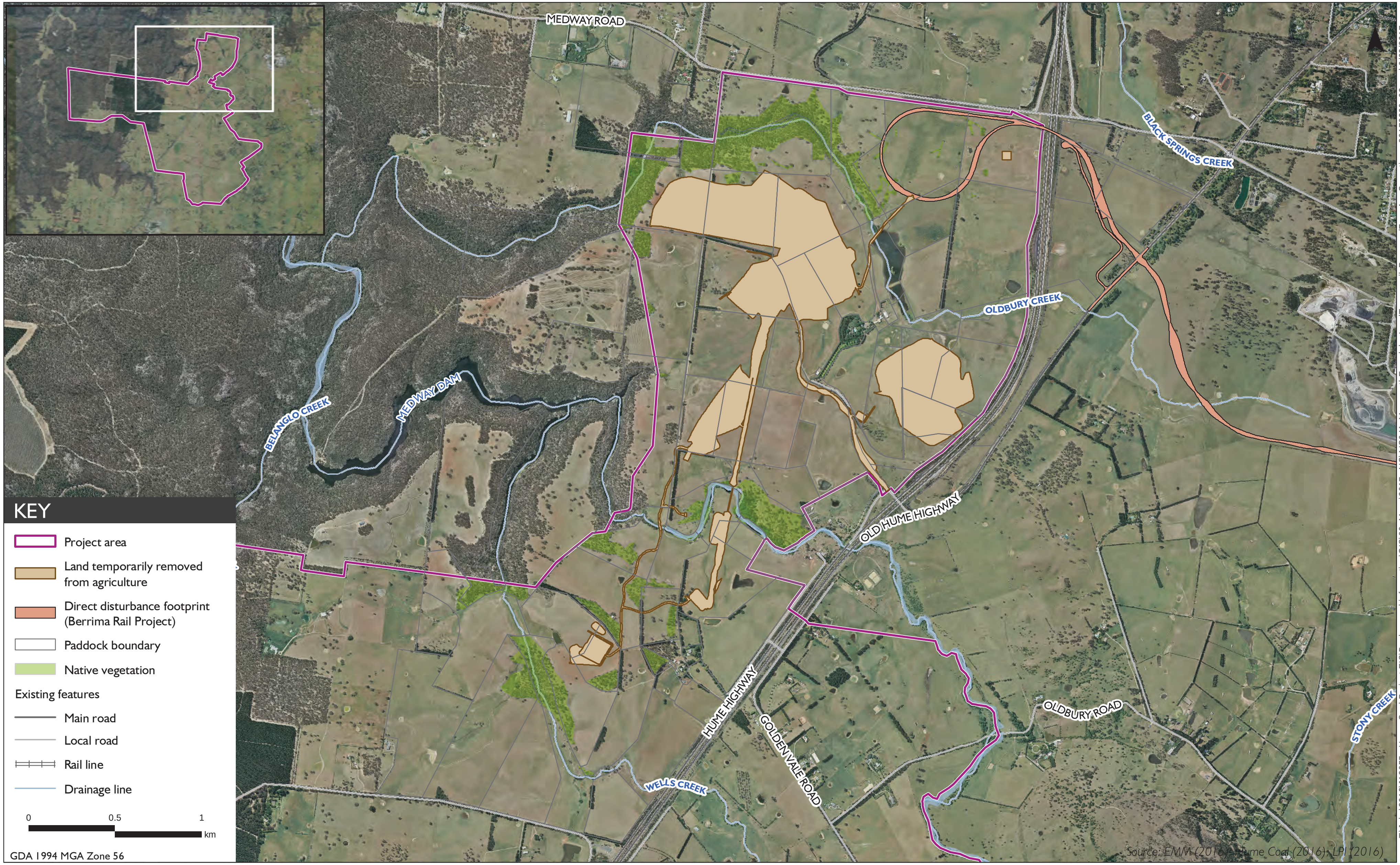

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Land temporarily removed from agriculture - operations

Hume Coal Project

Agricultural Impact Statement

Figure 4.5

4.3 Land to be returned to agriculture

4.3.1 Final landform and land use

The post mining land use will be grazing of livestock on improved pastures. The objective will be to restore the land to its pre-mining land use, and enable the post-mining land use to be carried out in a sustainable way.

Mining will cause negligible subsidence and, accordingly, there will be no need to repair the land's surface in the underground mining area. In the areas used for infrastructure, the land will be rehabilitated to be similar to its pre-mining state, including removing dams that are not required.

All land that was disturbed will be returned to agriculture after mining, but there will be a difference to the land and soil capability (LSC) of some of the land, as described in Section 4.3.4. Some land will be returned to agriculture after the construction phase, with the remainder returned at the end of operations.

4.3.2 Land to be returned to agriculture – post construction

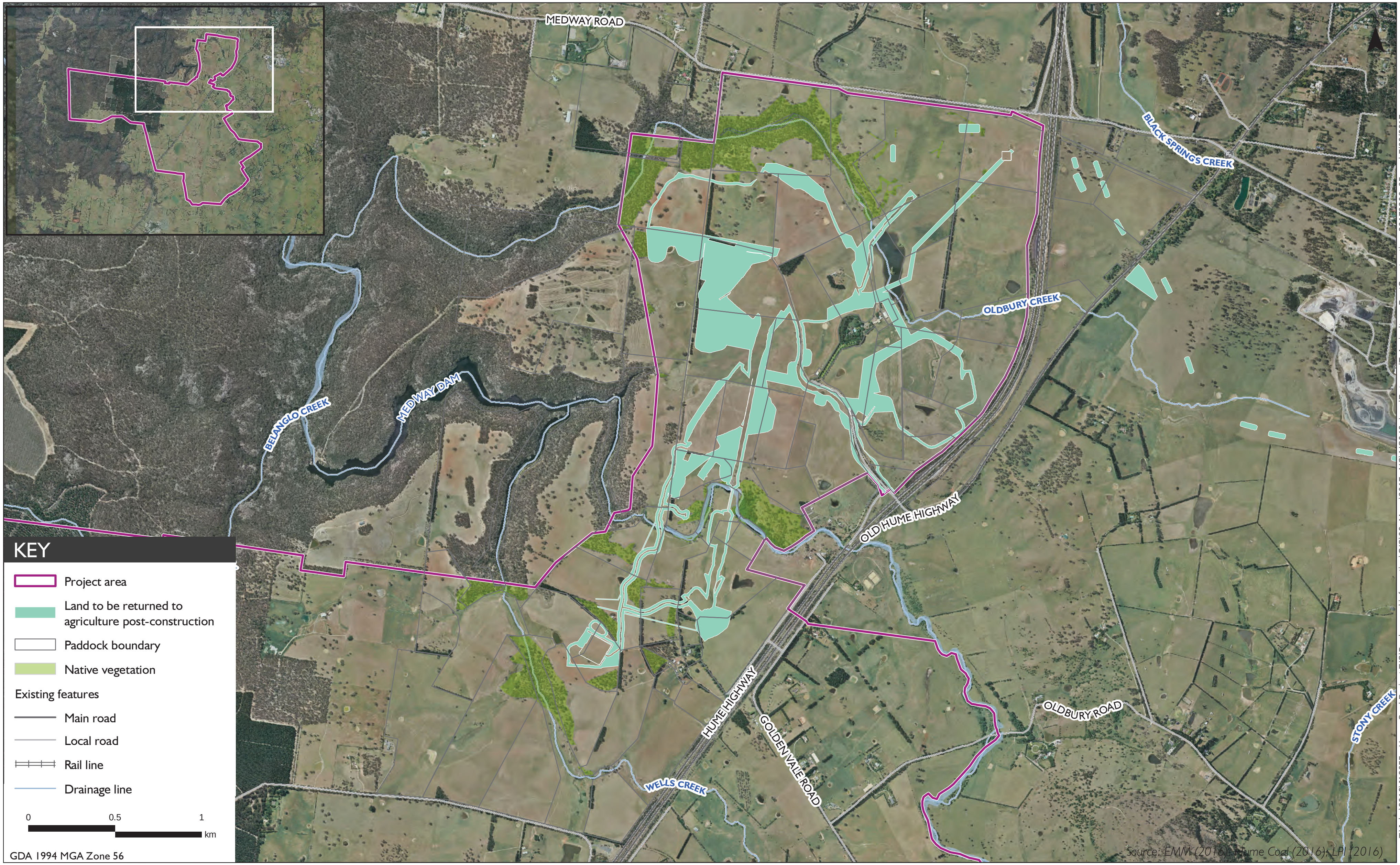
Construction buffer land will be returned to agriculture once it is no longer needed. These areas will not require rehabilitation as topsoil and vegetation will not be disturbed.

When the construction phase is completed, any areas not required for surface infrastructure during the operations phase will be rehabilitated with pasture grass. Once the vegetation has re-established the land will be returned to grazing.

Approximately 83 ha of the land temporarily removed from agriculture will be returned post construction phase. The land that will be returned to agriculture post construction is shown in Figure 4.6.

4.3.3 Land to be returned to agriculture – post operations

All areas of surface disturbance will be rehabilitated by returning topsoil and establishing pasture species. All areas will be returned to agriculture post operations. Approximately 107 ha will be returned to agriculture post operations as shown in Figure 4.7.



Land returned to agriculture post-construction

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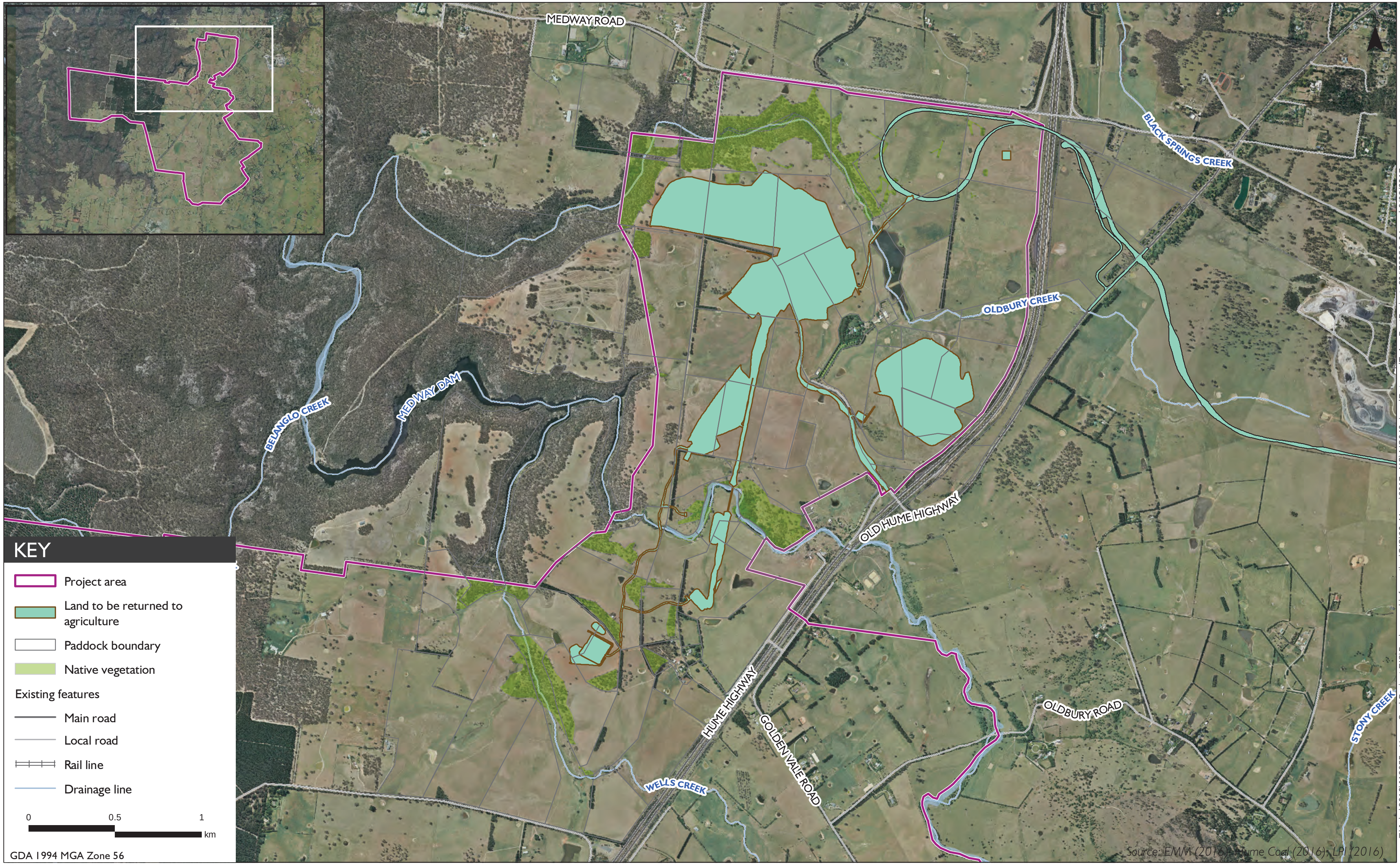
Figure 4.6



Land to be returned to agriculture - post-project

Hume Coal Project

Agricultural Impact Statement

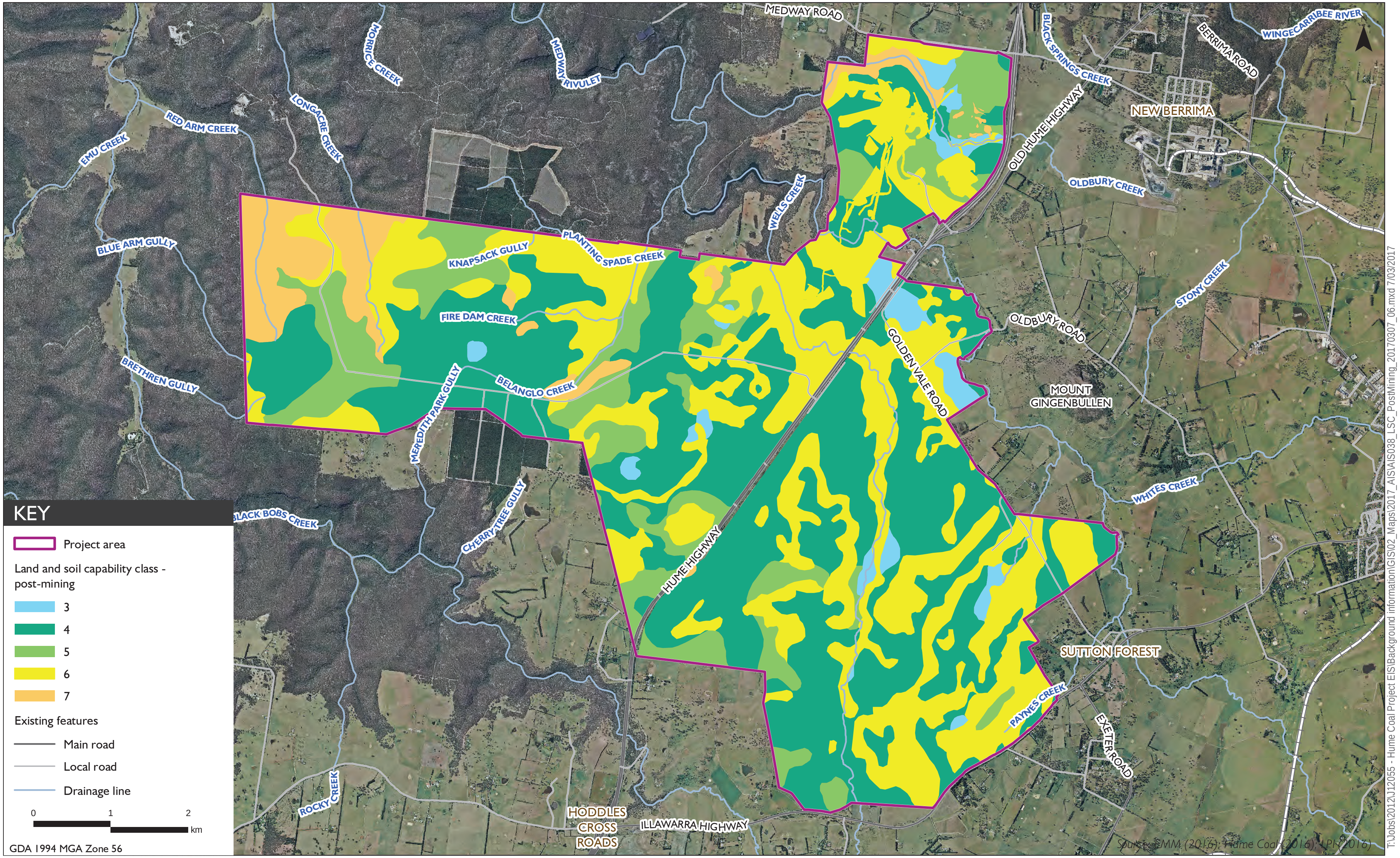
Figure 4.7

4.3.4 Post mine land use and land capability

Table 4.6 compares the LSC classes before and after mining, Figure 4.8 shows the post mining LSC map of the project area. Of the 117 ha to be disturbed by infrastructure, 59 ha will be rehabilitated back to the original land and soil capability, as the soil profile will not be significantly altered. The pre-mining land class of the remaining 58 ha of disturbed land (3 ha of Class 3, 37 ha of Class 4 and 18 ha of Class 5) will change to Class 6. The change in LSC class is due to a reduction in soil depth to 0.3m as the replaced topsoil will overlie re-profiled fill materials. However, Class 6 land will still be suitable for grazing and improved pasture, allowing the continuation of agricultural land-use post-mining, as currently occurs.

Table 4.6 Land characteristics comparing pre and post-mining outcomes

LSC Class	Capability	Pre-mining LSC (ha)	Post-mining LSC (ha)	Amount lost or gained (+/- ha)	% change
LSC of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)					
1	Extremely high	-	-		
2	Very high	-	-		
3	High	144	141	-3	-2%
LSC of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)					
4	Moderate	2221	2184	-37	-2%
5	Moderate-low	704	686	-18	-3%
LSC for a limited set of land uses (grazing, forestry and nature conservation)					
6	Low	1641	1699	+58	+4%
LSC generally incapable of agricultural land use (selective forestry and nature conservation)					
7	Very low	300	300		
8	Extremely low	-	-		
None	Waterbodies, Hume Highway, etc	41	41		



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Post mining land use capability

Hume Coal Project

Agricultural Impact Statement

Figure 4.8

Soil depth will be shallower in the rehabilitated post-mining land because not all soil is suitable for use in rehabilitation. Therefore, there will be less soil available resulting in shallower soil depths by comparison to the pre-mining land. Table 4.7 (OEH 2012) is taken from the LSC assessment scheme guideline, and shows how the depth of soil is translated into a LSC.

Table 4.7 Shallow soils and rockiness LSC class assessment table[1]

Rocky outcrop (% coverage)	Soil depth (m)[2]	LSC class
<30 (localised)	>1	2
	0.75 -<1	3
	0.5 - <0.75	4
	0.25 - <0.5	6
	0 - <0.25	7

Notes: 1. only relevant portion of table shown.
2. depths presented in m – modified from original.

From the ASC and SALIS there are three factors that may come into effect regarding the definition of soil depth in the LSC assessment scheme guideline:

- depth to a hardpan in the mining landscape (ie land which has been compacted by heavy machinery, noting that the impact of compaction can be overcome by deep ripping);
- depth to rock (ie vegetation cannot grow in rock because of low plant available water capacity and inherent fertility); and
- most importantly, the presence of a C horizon (ie the layer of soil above bedrock, which is defined as weathered rock or a mixture of weathered rock and newly developed soil in the *Australian Soil Classification)*.

Table 4.8 describes the type of disturbance and rehabilitation required for each of the surface infrastructure types. The table also describes the reason for the change in land class. It should be noted that the fill used in construction will be sourced mostly from the excavation of the underground mine access (ie drift portal) and will therefore be a mixture of soil and rock. In the rehabilitated land, areas that are likely to be underlain by rocky fill are equivalent to having a C horizon of weathered rock, so only the returned topsoil is counted as the overall soil depth.

Some surface infrastructure may be underlain by subsoil however; the depth of soil may also be constrained by chemical inhibition such as high salinity. Salt is highly water soluble and mobile and there is some potential that it may become concentrated overtime creating a chemical inhibition layer. The assessment shown in Table 4.8 conservatively assumes that subsoil has been built up under infrastructure. If it is found after rehabilitation that subsoil is not constrained by chemical inhibition then the overall soil depth may increase from the conservative assumptions given in Table 4.8 resulting in a higher LSC class.

Table 4.8 Reasons for LSC changes in the post mining land

Surface infrastructure	Disturbance and rehabilitation type	Justification for post-mining LSC
Drift portals, ventilation shafts	Portal and shafts excavated into rock deep underground – rehabilitation involves replacing fill materials and overlaying with 0.3m topsoil.	LSC class 6, based on replaced soil depth of 0.3m (fill material is not equivalent to natural soil profile).
Dam walls	Dam walls constructed with fill material – rehabilitation involves re-profiling of fill material to match surrounding contours and overlaying 0.3m topsoil.	LSC class 6, based on replaced soil depth of 0.3m (fill material is not equivalent to natural soil profile).
Excavated sediment dams	Dams constructed by excavating material – rehabilitation involves filling with excavated material or fill removed from dam walls or roadways, and overlaying 0.3m topsoil.	LSC class 6, based on replaced soil depth of 0.3m (fill material is not equivalent to natural soil profile).
Waterbody areas	Dam areas of natural contours which held water for extended periods of time – rehabilitation involves return of topsoil.	LSC class 6, based on the assumption that the subsoil which has been saturated for extended periods has effectively become a Hydrosol soil.
Soil stockpiles	Topsoil stockpiles placed on natural land contours, only topsoil disturbed – rehabilitation involves spreading of topsoil over underlying subsoil.	LSC class the same as the pre-mining LSC, as the soil profile depth is now the same, and all other factors are still the same.
Temporary accommodation and construction facilities	Buildings placed on natural land contours, only topsoil disturbed – rehabilitation involves spreading of topsoil over underlying subsoil.	LSC class the same as the pre-mining LSC, as the soil profile depth is now the same, and all other factors are still the same.
Overland conveyor system	Conveyor footings placed on natural land contours, only topsoil disturbed – rehabilitation involves spreading of topsoil over underlying subsoil.	LSC class the same as the pre-mining LSC, as the soil profile depth is now the same, and all other factors are still the same.
Minor tracks and roads (no cut and fill)	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.	LSC class the same as the pre-mining LSC, as the soil profile depth is now the same, and all other factors are still the same.
Constructed roadways and infrastructure areas	Roads and infrastructure areas created by cut and fill of existing land surface. Rehabilitation involves re-profiling the fill material to match surrounding contours and overlaying 0.3m topsoil.	LSC class 6, based on replaced soil depth of 0.3m.
Underground mine area	No surface disturbance, negligible subsidence – no rehabilitation.	No change to LSC class.

Class 6 land will still be suitable for grazing and improved pasture. The LSC guideline says in relation to Class 6 land:

> "...This land requires careful management to maintain good ground cover (maintaining grass or cover taller than 8 cm is a guide). Grazing pressures need to be lower than those used on Class 4 and 5 land. Rotational grazing systems with adequate recovery time for plant regrowth are essential. It is important to minimise soil disturbance, retain perennial ground cover and maintain high organic matter levels...."

Therefore, grazing will still be an option for land beneath the infrastructure area and water management areas, even with a lower LSC class compared to pre-mining.

4.4 Land permanently removed from agriculture

There is no land that is proposed to be permanently removed from agriculture from the Hume Coal Project. It is noted that there will be 3 ha of land in the Berrima Rail Project that will remain as infrastructure post operations.

4.5 Agricultural enterprises to be undertaken on buffer and/or offset lands

There are no agricultural activities proposed to be undertaken on buffer or offset lands.

5 Assessment of agricultural impacts

The AIS guidelines require identification of impacts from the project on agricultural resources and enterprises, including consequential productivity effects and risks from aspects such as weeds, water and erosion etc. This chapter addresses these matters.

5.1 Risk assessment

A risk assessment was conducted to identify risks on agriculture from the project. It followed the process outlined in the *Guideline for Agricultural Impact Statements at the Exploration Stage* (NSW Government, 2012).

The risk matrix used is reproduced in Table 5.1 with the risk rankings shown in Table 5.2. The consequence descriptors are shown in Table 5.3.

Management and mitigation measures are described in Chapter 6. Table 5.4 presents the unmitigated level of risk and residual level of risk following the implementation of the management and mitigation measures to agriculture from the project.

Table 5.1 Agricultural impacts risk ranking matrix

PROBABILITY / **Consequence**	**A** Almost Certain	**B** Likely	**C** Possible	**D** Unlikely	**E** Rare
1. Severe and/or permanent damage. Irreversible impacts	**A1 high**	**B1 high**	**C1 high**	D1 high	E1 medium
2. Significant and /or long term damage. Long term mgt implications. Impacts difficult or impractical to reverse.	**A2 high**	**B2 high**	**C2 high**	D2 medium	E2 medium
3. Moderate damage and/or medium-term impact to agricultural resources or industries. Some ongoing mgt implications which may be expensive to implement. Minor damage or impacts over the long term.	**A3 high**	**B3 high**	**C3 medium**	D3 medium	**E3 medium**
4. Minor damage and/or short-term impact to agricultural resources or industries. Can be managed as part of routine operations	A4 medium	B4 medium	C4 low	D4 low	**E4 low**
5. Very minor damage and minor impact to agricultural resources or industries. Can be effectively managed as part of normal operations	A5 low	B5 low	C5 low	**D5 low**	**E5 low**

where:

- (yellow) = low risk
- (orange) = medium risk
- (red) = high risk

Table 5.2 Agricultural impact risk ranking – probability descriptors[1]

Level	Descriptor	Description
A	Almost certain	Common or repeating occurrence
B	Likely	Known to occur or it has happened
C	Possible	Could occur or I've heard of it happening
D	Unlikely	Could occur in some circumstances but not likely to occur
E	Rare	Practically impossible or I've never heard of it happening

Notes: 1.NSW Government, 2012.

Table 5.3 Agricultural impact risk ranking – consequence descriptors

Level: 1	Severe Consequences	Example of Implications
Description	Severe and/or permanent damage to agricultural resources, or industries Irreversible Severe impact on the community	Long term (eg 20 years) damage to soil or water resources Long term impacts (eg 20 years) on a cluster of agricultural industries or Important agricultural lands
Level: 2	**Major Consequences**	**Example of Implications**
Description	Significant and/or long-term impact to agricultural resources, or industries Long-term management implications Serious detrimental impact on the community	Water and / or soil impacted, possibly in the long term (eg 20 years) Long term (eg 20 years) displacement / serious impacts on agricultural industries
Level:3	**Moderate Consequences**	**Example of Implications**
Description	Moderate and/or medium-term impact to agricultural resources, or industries Some ongoing management implications Minor damage or impacts but over the long term.	Water and/ or soil known to be affected, probably in the short – medium term (eg 1-5 years) Management could include significant change of management needed to agricultural enterprises to continue.
Level: 4	**Minor Consequences**	**Example of Implications**
Description	Minor damage and/or short-term impact to agricultural resources, or industries Can be effectively managed as part of normal operations	Theoretically could affect the agricultural resource or industry in short term, but no impacts demonstrated Minor erosion, compaction or water quality impacts that can be mitigated. For example, dust and noise impacts in a 12 month period on extensive grazing enterprises.
Level: 5	**Negligible Consequences**	**Example of Implications**
Description	Very minor damage or impact to agricultural resources, or industries Can be effectively managed as part of normal operations	No measurable or identifiable impact on the agricultural resource or industry

Table 5.4 Potential risks on agriculture from the Hume Coal Project

Type	Potential impact on agriculture (no controls)	Consequence	Likelihood	Risk	Proposed management and mitigation (see Chapter 7)	Consequence	Likelihood	Risk
Groundwater	The long term groundwater drawdown associated with dewatering activities impacts groundwater users with an agricultural land use.	3	B	High	Groundwater Management Plan; "Make Good" mitigation measures proposed; Monitoring with triggers	5	A	Low
Surface water	Contaminants (from rainfall runoff from the site, or overflowing stormwater dams) pollutes downstream water users who use the water for agricultural purposes.	5	B	Low	Surface Water Management Plan; Drainage diversion around the infrastructure; adequately sized stormwater management dams; Monitoring program with triggers	5	D	Low
Geochemistry	Potential Acid Mine Drainage from coal and coal reject materials may cause contamination of land, impacting the ability of the land to support the post mine land use of grazing.	4	D	Low	Coal Reject Monitoring Plan; Monitoring program with triggers	5	D	Low
	Rainfall runoff from drift spoil materials in stockpiles may cause contamination to land, impacting the ability of land to support the post mine land use of grazing.	5	D	Low	Monitoring program with triggers	5	D	Low
	Potential Acid Mine Drainage in underground workings may cause contamination of groundwater, which could impact bore water users who use the water for agricultural purposes.	3	D	Medium	Monitoring program with triggers	5	C	Low
Subsidence	Subsidence occurs and creates drainage depressions which impacts on the agricultural use of the land (eg may cause waterlogging).	4	D	Low	Subsidence Management Plan	5	D	Low
Topsoil	Insufficient topsoil resource is salvaged, impacting the ability to rehabilitate the land to support the post mining land use of grazing.	3	C	Medium	Topsoil requirements determined prior to stripping; extra topsoil stripped as required; topsoil inventory; Topsoil Management Plan; monitoring with triggers.	5	D	Low
	Soil quality of stockpiled soil is poor and impacts on the success of rehabilitation, causing reduced ability to achieve a sustainable post mining land use of grazing.	3	C	Medium	Appropriate stockpile height; minimisation of compaction during stockpiling and handling; amelioration as required; Rehabilitation Management Plan; monitoring with triggers.	4	C	Low
Erosion and sediment	High rainfall events cause excessive runoff from rehabilitated landforms, releasing sediment to surface water.	4	B	Medium	Establishment of vegetation cover; establishment of drainage structures; Erosion and Sediment Control Plan; Rehabilitation Management Plan.	5	C	Low

Table 5.4 Potential risks on agriculture from the Hume Coal Project

Type	Potential impact on agriculture (no controls)	Consequence	Likelihood	Risk	Proposed management and mitigation (see Chapter 7)	Consequence	Likelihood	Risk
Dust	Dust from operations causes an impact to agricultural operations (eg contamination of crops or livestock).	5	B	Low	Air Quality Management Plans.	5	B	Low
	Community complaints about nuisance dust relating to impacts on agricultural operations.	5	B	Low		5	D	Low
Pests and weeds	Pest and weeds from the project area impact other surrounding agricultural land.	4	C	Low	Pest and Weed Management Plan.	5	C	Low
	Pest and weeds on the rehabilitated land impact on the ability to achieve a sustainable post mining use of grazing.	4	C	Low		5	C	Low
Hydrocarbon, chemical and waste	Hydrocarbon spills or leaks causing soil and surface water contamination which will impact the soil capability of grazing as the post-mine land use.	4	D	Low	Hydrocarbons and hazardous substances managed in accordance with Australian Standards; storage of materials in bunded areas; sewerage treatment plant; Waste Management Plan.	5	D	Low
	Waste products are present on the site after mining has ceased, causing potential contamination of soil.	5	C	Low		5	E	Low
	Poor sewerage management causes soil contamination which will impact the soil capability of grazing as the post-mine land use.	5	D	Low		5	E	Low
Bushfire	Risk of fire due to use of flammable substances in the MIA/CHPP, may cause a bushfire if fire spread from the site, potentially causing damage to agricultural properties.	3	D	Medium	Transport and storage of explosives and hazardous substances in accordance with Australian Standards; buffers between vegetation and surface infrastructure; Bushfire Management Plan.	5	D	Low
Stakeholders	Local people employed in agricultural based industries are negatively impacted by the project (eg loss of jobs, lower income) due to loss from agricultural production and related industries.	5	D	Low	Stakeholder Engagement Plan.	5	E	Low

5.2 Potential impacts on agricultural land resources

Potential impacts on agricultural land resources identified in Table 5.4 are further described in the following sections. A greater level of detail is given on groundwater as it was the higher unmitigated risk identified.

5.2.1 Groundwater

A regional numerical groundwater flow model has been developed as part of the water assessment (Coffey 2016a). This has identified and quantified the potential impacts of the project on the groundwater and surface water resources (Section 5.2.2), and on groundwater users including environmental and landholder users.

Assessment of groundwater drawdown and associated impacts on groundwater users (environmental and landholder) was prepared in accordance with the Aquifer Interference Policy (AIP) 2012.

i Aquifer interference policy

The NSW Government released the AIP in 2012. The policy explains the role and requirements of the Minister for aquifer interference activities when administering the *Water Management Act 2000*. The AIP:

1. clarifies the requirements for licensing of water intercepted during aquifer interference activities (such as mining, quarrying, dewatering for construction); and

2. defines and establishes 'minimal impacts' for water related assets (such as existing bores and groundwater dependent ecosystems).

The AIP defines water sources as being either 'highly productive' or 'less productive' based on levels of salinity and average yields from bores. The AIP then defines water sources by their lithological character, being either: alluvium, coastal sand, porous rock or fractured rock. The project area is considered to be within a 'less productive' porous rock source.

The AIP then discusses the impact of an activity as either being 'level 1 minimal impact' or 'exceeding minimal impact'. The definition of 'minimal impact' is outlined in a series of tables which outline the how the criteria is applied for different types of water sources and for different sensitive receptors (ie other users and ecosystems).

If the impact of an activity is assessed as being 'minimal impact' or the impacts are no more than the accuracy thresholds of the model, then it is defined to be a 'minimal impact'.

Where impacts are predicted to be 'greater than minimal impact', then additional studies are required to fully understand the predicted impact. If this assessment shows that the predicted impacts, although greater than 'minimal', do not prevent the long-term viability of the relevant water-dependent asset,, then the impacts will be considered to be ‘acceptable’.

Where impacts are predicted to be 'greater than minimal impact' and the long-term viability of the water-dependent asset is compromised, then the impact is subject to 'make good' provisions. Neither the AIP nor the *Water Management Act 2000* define what the ‘make good provisions’ are required to be. These would be determined on a case by case basis involving consultation with the landholder.

The defined impacts are outlined in Table 5.5.

Table 5.5 Minimal impact criteria for 'less productive' porous rock

Water table	Water pressure	Water quality
1. Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site listed in the schedule of the relevant water sharing plan. A maximum of a 2m decline cumulatively at any water supply work. 2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any: (a) high priority groundwater dependent ecosystem; or (b) high priority culturally significant site; listed in the schedule of the relevant water sharing plan if appropriate studies demonstrate to the Minister's satisfaction that the variation will not prevent the long-term viability of the dependent ecosystem or significant site. If more than a 2m decline cumulatively at any water supply work then make good provisions should apply.	1. A cumulative pressure head decline of not more than a 2m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1 above, then appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.	1. Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity. 2. If condition 1 is not met then appropriate studies will need to demonstrate to the Minister's satisfaction that the change in groundwater quality will not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.

Note: *All cumulative impacts are to be based on the combined impacts of all 'post-water sharing plan' activities within the water source.*

ii Groundwater modelling

A complex, regional numerical groundwater flow model has been developed for the project in accordance with the AIP requirement to inform predicted groundwater impacts. An analysis of a substantial database of Hume Coal data and data from published sources was undertaken to build the numerical model, and subsequently calibrate and refine the model. The numerical model estimates mine inflows and water table drawdown and/or pressure head reductions associated with mine dewatering. This model has been used to simulate impacts on the groundwater system and sensitive receptors (ie landholders and environmental users) during and after the operation of the project.

A detailed description of the groundwater modelling of the project is presented in Chapter 8, Section 3 of Appendix E of the EIS.

iii Water level drawdown effects on users

a. Landholder bores

The AIP minimal impact criterion is predicted to be exceeded in 93 landholder bores as a result of the project. The location of highest impact migrates depending on active mining areas. The median duration of drawdown on the 93 affected bores is 36 years, with the maximum duration being 65 years; however, most of the recovery occurs much faster. Typically, a bore will recover by 75% within 23 years of first being impacted.

Figure 5.1 shows the distribution of modelled maximum project induced total drawdown at landholder bores, and the time taken to reach this maximum impact.

The majority of the impacted landholder bores are within the Hawkesbury Sandstone. Approximately one thirdwill require a replacement water source during and or subsequent to mining, with the remainder requiring repositioning of submersible pump intake depths for certain periods of time.. Hume Coal is committed to implementing the necessary 'make good' arrangements in accordance with the AIP to effectively manage the potential for adverse impacts on agricultural resources from bore drawdown.

b. Surface water users of watercourses or drainage lines that receive baseflow

The model predicts baseflow reduction is expected to occur in the majority of drainage lines within the vicinity of the project. The rate of reduction is not constant over time. For example, the rate of baseflow reduction at the Medway Rivulet water source only exceeds 0.9 ML/day for less than a year (at 11 years since the start of mining). The maximum rate of reduction is expected to be a minor proportion of the total baseflow. As such, the impact of reduction in baseflow is expected to be minimal on surface water users during a range of climate conditions.

Decreased streamflow associated with reduced catchment size and reduction of baseflow due to underground mining has the potential to reduce access to surface water for downstream water users. Downstream of the surface infrastructure area, Medway Dam is the only licensed user in the Medway Rivulet; although the associated treatment plant was operated for town water supply it is not currently being used. Landholders with basic water rights are located downstream and upstream of the surface infrastructure area. There is potential for a reduction in streamflow in the Medway Rivulet.

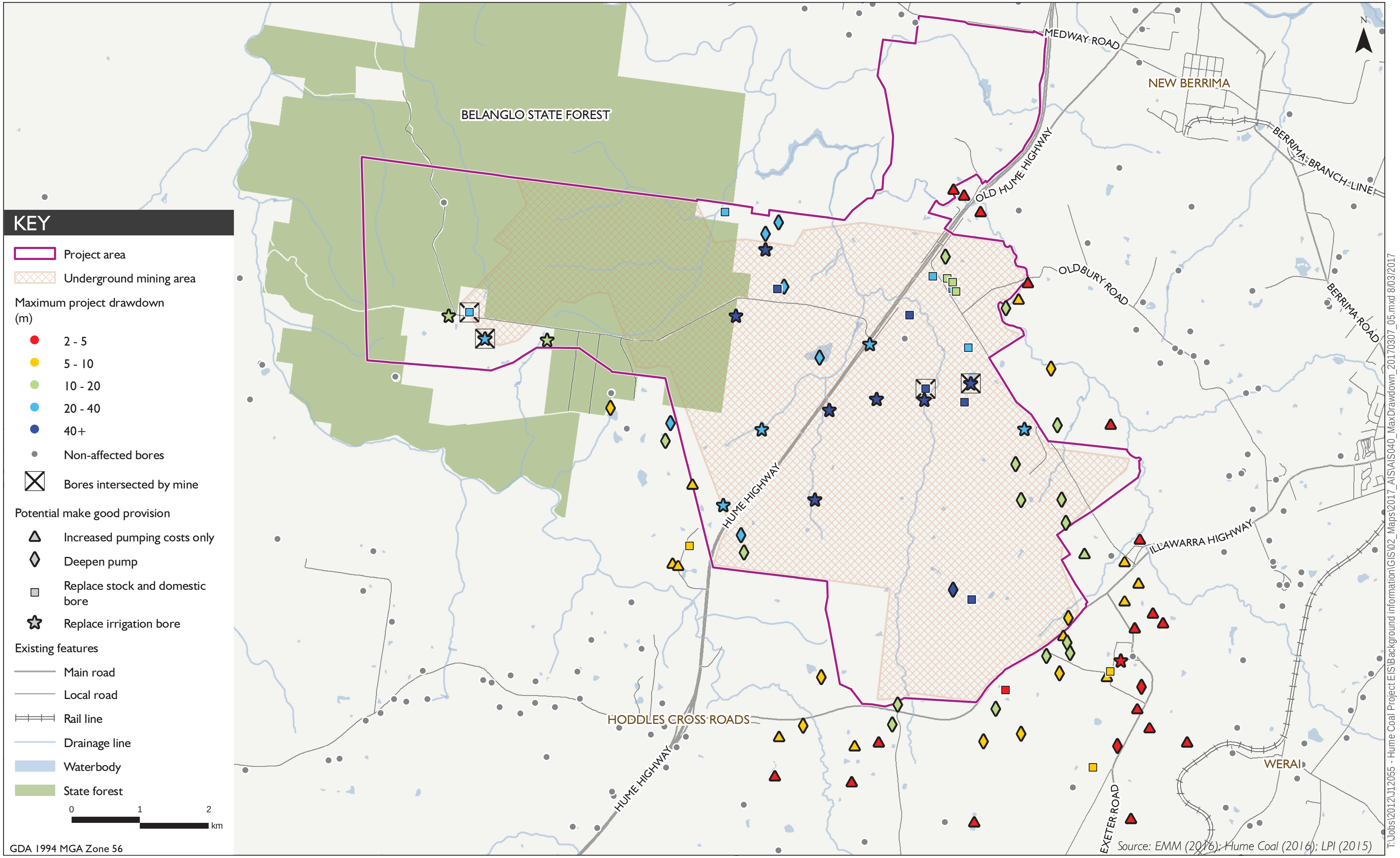
The potential for reduced flow is mainly attributable to the interception of baseflow associated with underground mining depressurising groundwater systems. The interception of baseflow in the Medway Rivulet catchment will decrease to less than 0.1 ML/day 17 years after mining begins and will decrease to 0 ML/day 38 years after mining begins as groundwater levels recover (Coffey 2016b).

Based on the information above, licensed and basic rights flow changes are predicted to be minor or negligible.

iv Groundwater quality

The AIP requires that water quality impacts are considered minimal, if the beneficial use class is not compromised. The project is within an upland recharge environment, and therefore the groundwater quality is fresh. It would be considered to have a beneficial use of irrigation and potable supply. Extraction of water for the project is highly unlikely to cause changes in the beneficial use class and, therefore will not adversely impact agricultural resources.

A detailed description of the groundwater quality of the project is presented in Chapter 8, Section 4 of Appendix E of the EIS.



Project drawdown and potential make good provisions
Hume Coal Project
Agricultural Impact Statement
Figure 5.1

EMM HUMECOAL PROJECT

5.2.2 Surface water

There is a risk that rainfall runoff on an industrial site, or on land that has had soil disturbance, could carry contaminants (from rainfall runoff from the site, or overflowing stormwater dams) which could pollute downstream water users who use the water for agricultural purposes. Also, modification to the landscape can change the surface water flow and reduced water yield to dams, or flooding could occur.

A surface water impact assessment was prepared that included:

- numerical modelling of surface water quality impacts;
- numerical modelling of flood impacts; and
- assessment of changes to surface water flow and yield.

An overview of surface water assessment outcomes with potential implications on agriculture is given below.

- The project will have a neutral or beneficial effect on surface water quality in the receiving environments.
  - The project will have negligible impacts on flood levels in the Medway Rivulet catchment for during operation and rehabilitation up to the 100 year annual recurring interval (ARI) event.
  - The impacts of the project on flood levels in the Oldbury Creek catchment will be within proposed acceptable limits for public roads and private land during operation, apart from a localised impact on Oldbury Creek downstream of the instream storage on Hume Coal affiliated land.
  - The project will have negligible impacts on flood levels in the Oldbury Creek catchment during rehabilitation, apart from a localised impact downstream of the instream storage on Hume Coal affiliated land.
- The flow regimes in Medway Rivulet and Oldbury Creek during operation of the project will be similar to pre-mining conditions. Very minor changes to the low flow regime are predicted for both waterways. In both cases the impact on yield in the downstream catchments will be minor.

As such, the potential for adverse impacts on agricultural users of surface water is effectively managed.

Further detail is presented in Chapter 10 of Appendix E of the EIS.

5.2.3 Geochemistry

The geochemistry of the coal, coal reject and drift materials have been tested and assessed to determine if they represent any risk to agriculture.

i Coal reject

The potential for changes to groundwater quality arising from the process of using coal reject to backfill the mine workings has been assessed through consideration of the kinetic leach column (KLC) testing reported by RGS (2016), using representative samples of reject material and groundwater for leaching.

The results of the limestone-amended KLC test indicate that the expected leachate quality arising from groundwater interaction with the reject material presents a negligible risk to groundwater quality.

ii Drift spoil

There may still be a stockpile of drift spoil at the time of closure, although some may have been used during the operational phase (eg road construction). This material could be used in the rehabilitation and closure phase for capping and filling in excavations, if required..

RGS Environmental (2016) tested drift spoil materials and determined that they have excess acid buffering capacity and a high factor of safety with respect to potential for acid generation. The concentrations of metals/metalloids in excavated drift spoil materials will be low, within relevant background criteria for soils, and therefore unlikely to present any environmental issues associated with revegetation and rehabilitation activities. Surface runoff and seepage from drift spoil materials is likely to be pH neutral. Salinity will be low due to a low level of dissolved solids. Drift spoil materials are expected to have a low level of sodicity and therefore have a relatively low risk of being susceptible to significant dispersion and erosion.

Static and kinetic leach tests indicate that trace metals/metalloids and major ions will be sparingly soluble in surface runoff and seepage from drift spoil material. Dissolved concentrations released into contact water are therefore expected to be low and unlikely to present any significant environmental risks for on-site or downstream water quality. Dilution effects from rainfall and natural attenuation are also likely to occur in the field and further reduce the concentrations of soluble metals and metalloids in surface runoff and seepage.

5.2.4 Subsidence

The subsidence study by Mine Advice (2016) has assessed the predicted maximum subsidence across the project area will be less than 20 mm, and the surface impacts will be “negligible” or “imperceptible”.

5.2.5 Topsoil

i Loss of soil resource

To manage any potential adverse impacts to the establishment of the post mining land use of agriculture, the soil will be stripped from land to be disturbed, and stored in stockpiles for later use in rehabilitation. There is a risk that insufficient soil resource will be stripped and salvaged to enable effective rehabilitation. There is always a loss of some soil during handling (ie stripping, stockpiling and spreading), and poor selection of areas for stockpiles may further decrease the available topsoil, particularly if the stockpile has to be re-located.

While the soil is stockpiled, there are risks that some losses will occur because of wind and water erosion. To minimise soil loss, a vegetative cover should be established. In addition, stockpile locations should not be exposed to overland or flood flow.

ii Soil degradation

The quality of the soil resources in the stockpiles could be degraded by a number of processes at different stages of the project and such degradation would reduce the agricultural potential of the rehabilitated land.

A decline in nutrient content is likely to occur whilst the soil is stored in the soil stockpiles. This will result in a decrease in fertility which may mean that the rehabilitated land using the returned soil will be less able to support plant growth which will reduce the agricultural potential of the land. This would be able to be amended by adding fertilisers to the returned soil (Keipert 2005).

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, waterholding capacity, aeration and microfauna presence decreases and the affected soils are less favourable for plant growth.

A gradual increase in acidity of the soil will 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 project area has been extensively cleared of deep-rooted vegetation, and has been used for pasture for many decades. The pH of the surface soil is currently slightly acidic. Consequently, soil amendments may be needed to increase the pH to assist plant growth during revegetation establishment.

5.2.6 Erosion and sedimentation

Erosion results in loss of soil from the landscape and a subsequent deterioration in the productive capacity of the land and in the capacity of the land to perform ecosystem functions. High rainfall events can also cause excessive runoff from rehabilitated landforms, releasing sediment to surface water. The potential for soils to erode determines the applicability of management measures and whether the soils are appropriate for use in rehabilitation activities. Erosion of soil may take place after the topsoil has been spread on the rehabilitated areas. The design of the re-contoured landforms will need to take into account soil erosion and sediment control to prevent off-site impacts to waterways, as well as impacts to the rehabilitation itself.

5.2.7 Dust

The Air Quality Assessment Report (Ramboll Environ 2016) identified the potential sources of dust, and outlined mitigation methods. Particulate matter (PM), diesel combustion and odour emissions inventories have been developed for peak construction and operational phases of the Hume Coal Project.

The results of the modelling show that for both construction and operational phases, the predicted particulate matter (TSP, PM_{10}, $PM_{2.5}$) and gaseous pollutant (NO_2 and VOCs) concentrations and dust deposition levels associated with project emissions are well below applicable impact assessment criterion at neighbouring sensitive receptors and represent negligible risk to agriculture.

5.2.8 Pests and weeds

The presence of weed species has the potential to have a major impact on revegetation outcomes of the post mining land use of agriculture. Additionally, any significant weed species within the surrounding land has the potential to impact on the success of the rehabilitated areas. Weed management will be an important component of rehabilitation activities. Weeds are prevalent in the project area, and significant infestations of weeds were present on the Hume Coal affiliated properties when purchased. An ongoing weed management program is in place. The project will not result in an increased risk of weeds.

Introduced species including the European Rabbit and Red Fox were observed throughout the agricultural parts of the project area, and within the surface infrastructure area. These pest species can spread into new areas and compete with native species with the creation of new roads. As the surface infrastructure area is already heavily cleared, and existing access tracks will be used, these species are not expected to spread to other parts of the project area or study area as a result of the project.

5.2.9 Hydrocarbons, chemicals and wastes

In the infrastructure areas there is a risk that land will have been contaminated during the operations phase from hydrocarbon spills, storage of fuel and chemicals, refuelling activities, sewerage, etc. With appropriate management, the potential risks are extremely low. If Hydrocarbon spills or leaks occurred (eg. a hydraulic hose bursting during soil replacement activities) it could result in soil and surface water contamination which could impact the soil capability of grazing as the post-mine land use. The impact of such a spill would be isolated and spill-clean-up procedures would mitigate the impacts.

If waste products were to remain on the site after mining has ceased, they could cause potential contamination of soil. The waste management practices for the site should mean that the risk of this happening is extremely low.

Poor sewerage management could potentially cause soil contamination which will impact the soil capability of grazing as the post-mine land use. This could have a positive impact if there were no contaminants in the sewage. There will be a sewerage treatment plant on site which will remove this risk.

5.2.10 Bushfire

The potential for project-related activities to ignite a bushfire has been considered. A bushfire management plan will be prepared that will contain measures to minimise the risk of bushfire damaging the project or the project initiating a bushfire.

Surface activities at the mine could initiate a bushfire. The risk of this occurring will be reduced by implementation of the following measures:

- fire extinguishers will be provided in buildings, vehicles and refuelling areas;
- there will be no smoking in, or adjacent to, vegetated parts of the project area;
- firefighting water will be reticulated around the surface infrastructure facilities;
- a permit system will be used to control activities such as welding and oxyacetylene use; and
- spill response kits will be available should there be a spill of flammable substances.

In addition, the severity of fires will be reduced by implementing the following:

- a bushfire management plan will be prepared and implemented as part of the mine's operating procedures;
- risk reduction, such as slashing, will be undertaken where appropriate, such as along fence-lines; and
- the RFS will be contacted if there is a fire.

Management measures will be used to: prevent a fire or explosion in the surface infrastructure areas initiating a bushfire; reduce the severity of an existing bushfire through fire breaks; and by fighting fires with mine resources. Therefore, the project is unlikely to be damaged by, initiate or contribute to the severity of a bushfire.

5.2.11 Stakeholders

There is risk that local people employed in agricultural based industries will be negatively impacted by the project (eg loss of jobs, lower income) due to loss from agricultural production and related industries. The potential loss of jobs is calculated in Section 5.4.1iii. There would be some limited local impacts on agricultural employment which would equate to no more than 0.4 full time equivalent workers.

5.3 Potential impacts on agricultural support infrastructure

5.3.1 Transport routes

The major transport routes used by agricultural producers to access supporting services and to move their products include the Hume Highway and the Illawarra Highway and some major local roads, such Golden Vale Road and Berrima Road, as well as the Main north-south rail line to Sydney and Goulburn and the Moss Vale to Unanderra rail line to Wollongong. The Hume Highway has three grade separated interchanges which provide major road access into and around the project area.

The *Traffic and Transport Assessment Report* (EMM 2017b) comprehensively assessed impacts on transport, including agricultural traffic. The following is a summary of the impact assessment, as it relates to agricultural support infrastructure.

In the transport investigations undertaken for early project planning, a number of vehicular access constraints and options for the project were identified. It was determined that nearly all project traffic would use access routes which do not require right turn access at any intersections on the Hume Highway south of the Mereworth Road (Old Hume Highway) interchange.

The two northern interchanges at Mereworth Road (Old Hume Highway) and Medway Road are both located outside the mine lease area boundary. The southern interchange, at the Illawarra Highway and Canyonleigh Road, is located on the south-western boundary of the project area.

Between the Mereworth Road (Old Hume Highway) and Illawarra Highway interchanges, the Hume Highway is dual carriageway with a wide central median, but it not classified as a motorway. It has a number of local access intersections with private properties and local roads including Belanglo Road and Golden Vale Road.

The project's construction and operations traffic would generally use either the Medway or Mereworth Road interchanges (which are located approximately 3 km apart) to provide the northbound and southbound access onto the Hume Highway, respectively. Mereworth road will be widened and upgraded to provide access to the mine administration area.

The proposed Hume Highway accesses will provide reasonably direct routes for regionally based mine traffic either approaching or departing from the area. Other locally based project traffic which will be travelling to and from nearby locations such as Moss Vale, Mittagong and Berrima will generally use other routes, such as the Old Hume Highway, which connects via Taylor Avenue and Berrima Road to Moss Vale and the Illawarra Highway.

The project traffic impacts assessment for the project construction and operations stage traffic movements has investigated the existing (2015) and future baseline (2020) traffic volumes at a large number of locations and intersections on the road network in the locality of the project area and on the Berrima Road route between Berrima and Moss Vale.

No significant adverse traffic impacts have been identified for future traffic movements generated by the project in these areas for either:

- the road network traffic capacity;
- intersection traffic operations;
- the road network condition; or
- road safety and the efficiency of the operation of the road network.

5.3.2 Agricultural industries

There will be no changes to the ability of agricultural industries to be carried out in the region. Apart from the temporary loss of land to the Mereworth and Evandale properties, no surface impacts are predicted. Therefore, there will be no overall impact on agricultural industries able to be carried out in the region.

5.4 Consequential productivity effects on agricultural enterprises

5.4.1 Forgone agricultural production values

All land currently supporting agriculture and to be disturbed will be rehabilitated back to land supporting agriculture. No land will be permanently removed from agriculture. The overriding goal for the project's rehabilitation plan is to return the disturbed land to a condition that is stable, and supports the proposed post mining land use which is grazing with improved pasture. There will be some limited but permanent changes to land capability class, which have been assessed as not altering the stocking rate of the land for grazing.

Minor agricultural productivity losses will occur due to the temporary loss of land to agriculture during the construction and operation phases of the mine. The foregone agricultural values for these estimated productivity losses have been calculated in the Cost Benefit Analysis (CBA), prepared by BAEconomics for the Hume Coal Project EIS (BAEconomics, 2017). These foregone values are also costs from a NSW perspective as they offset the direct and flow on benefits of the mine on NSW gross state product (GSP) and impact on the local economy. Estimated losses are based on average farm stocking rates.

Prior to Hume Coal becoming the owners of the Mereworth and Evandale properties, a lower than average stocking rate was achieved (see Section 3.7.2ii). As described in Section 3.7.2ii, implementation of leading practice under the ownership of Hume Coal has enabled above average stocking to be achieved. As a result, the foregone agricultural value is higher. For the purposes of this assessment, the average stocking rate for the Southern Highlands (as per DPI 2016) has been used as a comparison. The values for both the average and Hume farm management are presented in the following sections.

i Gross margins per hectare

To estimate the value of the agricultural production from these properties (BAEconomics, 2017), gross margins per hectare for typical livestock enterprises were taken from budgets compiled by the NSW Department of Primary Industry (DPI, 2016). The enterprises were selected to be conservative in the context of the CBA (BAEconomics, 2017) and are amongst the highest returning per dry sheep equivalents (DSE). The fattening of weaner calves at $48 per DSE; and merino ewes 20 micron at $36 per DSE.

The gross margin or value per hectare per annum for each property (Table 5.6) were calculated using the gross margins/ha and the DSE/ha (from Table 3.30 in Section 3.7.2ii). Gross margins on Hume Coal managed properties are significantly higher than would be the case for typical properties in the region (based on DPI 2016).

Table 5.6 Agricultural gross margins per hectare – average values for standard management

Property	Average farm management			Hume farm management		
	DSE/ha	$/DSE[1]	$/ha/yr	DSE/ha	$/DSE	$/ha/yr
Mereworth	9	46	414	19.6	46	900
Evandale	9	43	391	17.8	43	774
Stonington	9	48	432	16.9	48	810
Eastern properties[2]	9	48	432	14.8	48	711
Other freehold	9	48	432	9	48	432

Notes: 1. $/DSE influenced by percentage of sheep and cattle on the property.
2. Eastern Properties include Leets Vale and 325 Berrima Rd.

ii Foregone agricultural values per property

The net present value (NPV) calculations with a discount rate of 7% for the construction and operational phases of the mine (BAEconomics, 2017), have been carried out for the construction and operational phase of the mine. The losses in perpetuity have not been calculated, as no land will be permanently removed from agriculture.

The net present value (NPV) of gross margins is an approximate value of the land removed from agriculture over a period of time. However, it excludes capital costs of farming and is therefore an over estimate. The degree of over estimation increases with the length of the time period, so the estimates are conservative in the context of the overall CBA, and for the period of construction and operations. This overestimation may, to some degree, be offset as the time required to rehabilitate the disturbed land has not been directly taken into account. However, this would not have a large impact as the majority of the rehabilitation takes place at the end of the mine life, which at a discount rate of 7%, is heavily discounted.

The areas of land used to calculate the foregone agricultural values are based on the areas identified as being temporarily lost to agriculture (Table 4.4 in Section 4.2). The calculations include the land directly disturbed by construction and infrastructure as well as the additional land that has been fragmented which may not be economically viable to farm.

The foregone value of agriculture production for each property impacted, as measured by gross enterprise margins, is shown in Table 5.7.

Table 5.7 Foregone agricultural values per property

Property	Average farm management			Farm management on Hume Coal affiliated land		
	Ha	Cattle	Foregone value	Ha	Cattle	Foregone value
Mereworth				Ha		
Construction phase	145	174	$138,000	-	377	$299,000
Operations phase	89	107	$381,000	45	231	$827,000
Evandale						
Construction phase	45	54	$40,000	145	108	$80,000
Operations phase	18	22	$73,000	18	43	$144,000

iii Foregone agricultural values and flow-on effects

The foregone value of agriculture production for the project, as measured by gross enterprise margins, is shown in Table 5.8. The total cost of foregone agriculture is:

- $0.63 million with average stocking rates; and
- $1.35 million with the leading farm management practices implemented on Hume Coal affiliated land.

There would be flow-on impacts of the foregone value of agricultural output. Using a Type 1A value-add multiplier for NSW agriculture of 0.41 these costs would be of the order of:

- $0.26 million with average stocking rates; and
- $0.55 million with the leading farm management practices implemented on Hume Coal affiliated land.

There would also be some limited local impacts on employment. To calculate income and employment impacts requires the gross value of agricultural output. The Australian 2013-14 input output direct requirements tables show that the value add from cropping and livestock industries is 45 per cent of the total value of agricultural output. Wages and salaries comprise seven per cent of the gross value of output. The implied direct impacts on NSW income and, assuming that labour is supplied locally the Wingecarribee region, is:

- an NPV of $0.1 million ($8,000 per annum) with average stocking rates; and
- an NPV of $0.2 million (16,000 per annum) with the leading farm management practices implemented on Hume Coal affiliated land.

In terms of employment this would represent less than one half a full-time equivalents (FTE) per annum. At a salary of $45,000 per annum this would be:

- 0.2 FTE with average stocking rates; and
- 0.4 FTE with the leading farm management practices implemented on Hume Coal affiliated land.

There would also be minor flow on impacts, the Type 1A employment multiplier for Wingecarribee is 1.39 which would equate to 0.14 FTE with average stocking rates, and 0.28 FTE with the leading farm management practices implemented on Hume Coal affiliated land.

Table 5.8 Foregone agricultural values and flow-on impacts – Hume Coal Project

Project phase	Ha	Average farm management			Farm management on Hume Coal affiliated land		
		Stock	Foregone value	Flow-on effects	Stock	Foregone value	Flow-on effects
Construction phase	190	228	$178,000	$72,980	485	$379,000	$155,390
Operational phase	107	129	$454,000	$186,140	274	$971,000	$398,110
Total			**$632,000**	**$259,120**		**$1,350,000**	**$553,500**

The foregone agricultural production values will be temporary. However, there will be an increase in productivity achieved on the rest of Hume Coal affiliated properties by the implementation of leading practice management techniques when compared to pre-Hume Coal affiliated management regimes. This is discussed further in Section 5.4.3.

5.4.2 Cumulative effects – Berrima Rail Project

The cumulative impact on agricultural land from the Berrima Rail Project, associated with the project, have been calculated and presented in Table 5.9.

The total cost of foregone agriculture is:

- $0.22 million with average stocking rates; and
- $0.37 million with the leading farm management practices implemented on Hume Coal affiliated land.

There would be flow-on impacts of the foregone value of agricultural output. Using a Type 1A value-add multiplier for NSW agriculture of 0.41 these costs would be of the order of:

- $0.09 million with average stocking rates; and
- $0.15 million with the leading farm management practices implemented on Hume Coal affiliated land.

Again, there would also be some extremely limited local impacts on employment. The implied direct impacts on NSW income and, assuming that labour is supplied locally the Wingecarribee region, is:

- an NPV of $0.03 million ($2500 per annum); and
- an NPV of $0.06 million (5,000 per annum) with the leading farm management practices implemented on Hume Coal affiliated land.

In terms of employment this would represent less than one tenth of an FTE per annum at a salary of $45,000 per annum and the local flow on effects would be of a similar low order of magnitude. The estimated foregone values and flow on impacts are shown in Table 5.9.

Table 5.9 Foregone agricultural values for the rail spur and loop

Project phase	Ha	Average farm management			Farm management on Hume Coal affiliated land		
		Stock	Foregone value	Flow-on effects	Stock	Foregone value	Flow-on effects
Construction phase	89	228	$86,000	$35,260	186	$150,000	$61,500
Operational phase	28	129	$123,000	$50,430	54	$207,000	$84,870
Perpetuity post operation	3	3	$15,000	$6,150		$15,000	$6,150
Total			**$224,000**	**$91,840**		**$372,000**	**$152,520**

5.4.3 Increased productivity on Hume Coal affiliated properties

The productivity and stocking rates of the Hume Coal affiliated properties would have been lower than the average stocking rates for the Southern Tablelands region (DPI, 2016) prior to purchase, with many paddocks heavily infested with weeds. A lack of data, however, means that the values cannot be accurately estimated. The weed management and soil improvements made to the land since the purchase of the properties have improved the productivity of each property.

During construction and operations, the Hume Coal affiliated properties will continue to be managed using the more productive farming methods described in Section 3.7.2ii. This will produce a net benefit when compared to the value which would have been realised using standard farm management with average stocking rates (see Table 3.30).

To enable quantification of benefits, the area available for agriculture for each property has been conservatively calculated. This excludes the areas temporarily removed from agriculture during construction and operations, or unavailable due to native vegetation or Aboriginal Heritage protection (Table 5.10). Using the gross margins from Table 5.6, the NPV has been calculated for the areas available for agriculture for all of the Hume Coal affiliated land using both the leading farm management practices implemented on Hume Coal affiliated land and average stocking rates (DPI 2016). The increase in productivity ($4.46M) is calculated by using the difference between average stocking rates and productivity achieved under Hume Coal’s ownership. This increase in productivity from the areas not impacted by the Hume Coal Project will be greater than the loss of productivity from the areas temporarily removed from agriculture ($1.7M for the Hume Coal Project plus the Berrima Rail Project).

Table 5.10 Improved agricultural values for the Hume Coal properties –project duration

Property	Ha available for agriculture[1]		Farm management		Increased value
	Construction	Operations	Hume Coal affiliated land	Average	Difference
Mereworth	152	232	$2,470,000	$1,137,000	$1,333,000
Evandale	300	325	$3,130,000	$1,582,000	$1,549,000
Stonington	87	94	$948,000	$505,000	$442,000
Eastern Properties[2]	63	68	$602,000	$366,000	$236,000
Wongonbra	418	418	$3,181,000	$2,279,000	$902,000
Total	**1020**	**1137**	**$10,331,000**	**$5,869,000**	**$4,462,000**

Notes: 1.Excludes areas temporarily removed from agriculture associated with Hume Coal Project and Berrima Rail Project, and other unavailable land (native vegetation, AHIP, etc).

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

5.5 Physical movement of water away from agriculture

The groundwater modelling has determined the potential drawdown on individual boreholes over the life of the project. Further assessment at individual bores will be required to determine what 'make good' provisions might be required. As Hume Coal will be required to provide 'make good' provisions for landholders that incur impact above the AIP minimal impact threshold, there will be no overall economic loss to agriculture (refer to Section 5.2.1).

Based on the numerical groundwater model and the water balance model results, the maximum volume required for licensing for each individual surface or groundwater source is:

- Nepean Management Zone 1 Sydney Basin Nepean Groundwater Source 2,235 ML/yr in year 15;
- Nepean Management Zone 2 Sydney Basin Nepean Groundwater Source 1 ML/yr from year 5 through to year 18;
- Sydney Basin South Groundwater Source 18 ML/yr for years 14 through to 16; and
- Medway Rivulet Management Zone of the Upper Nepean and Upstream Warragamba Unregulated River Water Source 36.5 ML/yr for all years of mining and rehabilitation.

Hume Coal has already secured about 60% of the total peak licence requirement for the project, and has a clear pathway for how the remaining 40% will be secured before the project's early operational life. Refer to Section 12 of EMM 2017 *Hume Coal Project: Environmental Impact Statement – Appendix E – Water Assessment* for further information on water licensing.