Spur Hill Underground Coking Coal Project

Application for a Gateway Certificate

Agricultural Impact Assessment

SPUR HILL
UNDERGROUND COKING COAL

la tierra the earth
NATURAL RESOURCE SCIENTISTS & ENGINEERS

AGRICULTURAL IMPACT ASSESSMENT TO SUPPORT A GATEWAY APPLICATION FOR THE SPUR HILL UNDERGROUND COKING COAL PROJECT

12 December 2013

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EXECUTIVE SUMMARY

Agricultural impact assessment to support a Gateway Application

This agricultural impact assessment report has been prepared to support a Gateway Application for the Spur Hill Underground Coking Coal Project (the Project) near Denman in the Upper Hunter region of New South Wales.

Underground longwall mining

The Project is an underground longwall coal mine that proposes to sequentially extract several coal seams within a Project area of 3,300 hectares (ha).

Potential SAL

There is mapped Strategic Agricultural Land within the Project area, including Biophysical Strategic Agricultural Land (BSAL) and Critical Industry Clusters (CICs) for both equine and viticulture.

86 ha of verified BSAL

Thorough on-ground verification determines the Project area contains:

- *86 ha of verified BSAL;*
- *One viticulture enterprise with 26 ha of vines;*
- *No equine enterprises; and,*
- *Predominantly cattle grazing enterprises.*

Potential mining impacts are subsidence and infrastructure

The foremost agricultural impacts of the Project are the nature, extent and timing of surface subsidence, and the location and lifespan of surface infrastructure.

No major infrastructure shall be sited on verified BSAL within the Project area.

Land & soil capability unaffected

This assessment finds that although some verified BSAL is subject to subsidence of <4 metres (m) causing a change in micro-relief:

- *Land & soil capability is not affected;*
- *There are no impacts on soil fertility, effective rooting depth or soil drainage;*
- *There are no impacts on soil salinity, rock outcrop, surface rockiness or to soil pH;*
- *There are minimal impacts on highly productive aquifers;*
- *There is no permanent fragmentation of agricultural land uses; and,*
- *There is no reduction in the area of BSAL as a consequence of the Project.*

No loss of BSAL

There are no off-site effects on BSAL within the surrounding locality.

Affected vineyard will be fully rehabilitated

With regard to CICs, it is also found that although a portion of a single vineyard is subject to subsidence:

- *The effects of subsidence on the affected vineyard can be fully mitigated;*
- *No equine enterprises are impacted in any significant way;*
- *There is no reduced access to, or impacts on, water resources and agricultural resources;*
- *There is no reduced access to support services and infrastructure;*
- *There is no reduced access to transport routes; and,*
- *There is no loss of scenic amenity or landscape values.*

No effect on Viticulture CIC

No effect on Equine CIC

There are no significant off-site effects on CICs within the surrounding locality or the broader Upper Hunter region.

Aquifer minimum interference criteria met

The Project meets the Level 1 Minimal Impact Considerations of the Aquifer Interference Policy for 'highly productive' groundwater associated with the Hunter River Alluvium.

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1 INTRODUCTION

This agricultural impact assessment report has been prepared to accompany a Gateway Application for the Spur Hill Underground Coking Coal Project (the Project), near Denman in the Upper Hunter region of New South Wales (NSW) (Figure 1-1). The Project is a proposed multi-seam underground longwall mining operation within part of Exploration Licence (EL) 7429 (Figure 1-2).

The Project proponent and Gateway applicant is Spur Hill Management Pty Limited (SHM). SHM manages the Project on behalf of joint venture partners Spur Hill U.T. Pty Ltd & Spur Hill No. 2 Pty Limited.

This report has been prepared by La Tierra Pty Ltd (La Tierra), as independent specialist land resource consultants, for and on behalf of the proponent. In preparing this report, La Tierra has liaised extensively with landholders and other stakeholders. La Tierra has worked with Resource Strategies Pty Limited (Resource Strategies) who is assisting in the preparation of an Environmental Impact Statement (EIS) and Gateway Application for the Project.

This report has been prepared in accordance with the following legislation, plans, guidelines and technical notes.

1. State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (the Mining SEPP by NSW Government, 2013);
2. Upper Hunter Strategic Regional Land Use Plan (the SRLUP by DP&I, 2012a);
3. Strategic Regional Land Use Plan Guideline for Agricultural Impact Statements (the AIS Guideline by DP&I, 2012b);
4. Agricultural Impact Statement Technical Notes (the AIS Technical Notes by DP&I, 2013a); and
5. Strategic Regional Land Use Policy Guideline for Gateway Applicants (the Applicant's Guideline by DP&I, 2013b).

The Project is required to make a Gateway Application because:

- It is a proposed development specified in clause 5 (Mining) of Schedule 1 (State significant development—general) to State Environmental Planning Policy (State and Regional Development) 2011 (State and Regional Development SEPP);
- There is no current Mining Lease in relation to the proposed development; and
- The proposed development is on land shown on the Strategic Agricultural Land (SAL) Map in the Mining SEPP (Sheet STA_04) to be SAL as Biophysical Strategic Agricultural Land (BSAL) and Critical Industry Clusters (CIC) – Equine and Viticulture (refer to Figure 1.2).

This report presents a detailed analysis of the agricultural resources, systems and enterprises on and surrounding the Project. As preparation of the report commenced in early 2013 and prior to the public release of the Technical Notes and the Applicant's Guideline, it is likely that some sections of the report contain significantly more information than required in a Gateway Application supporting document.

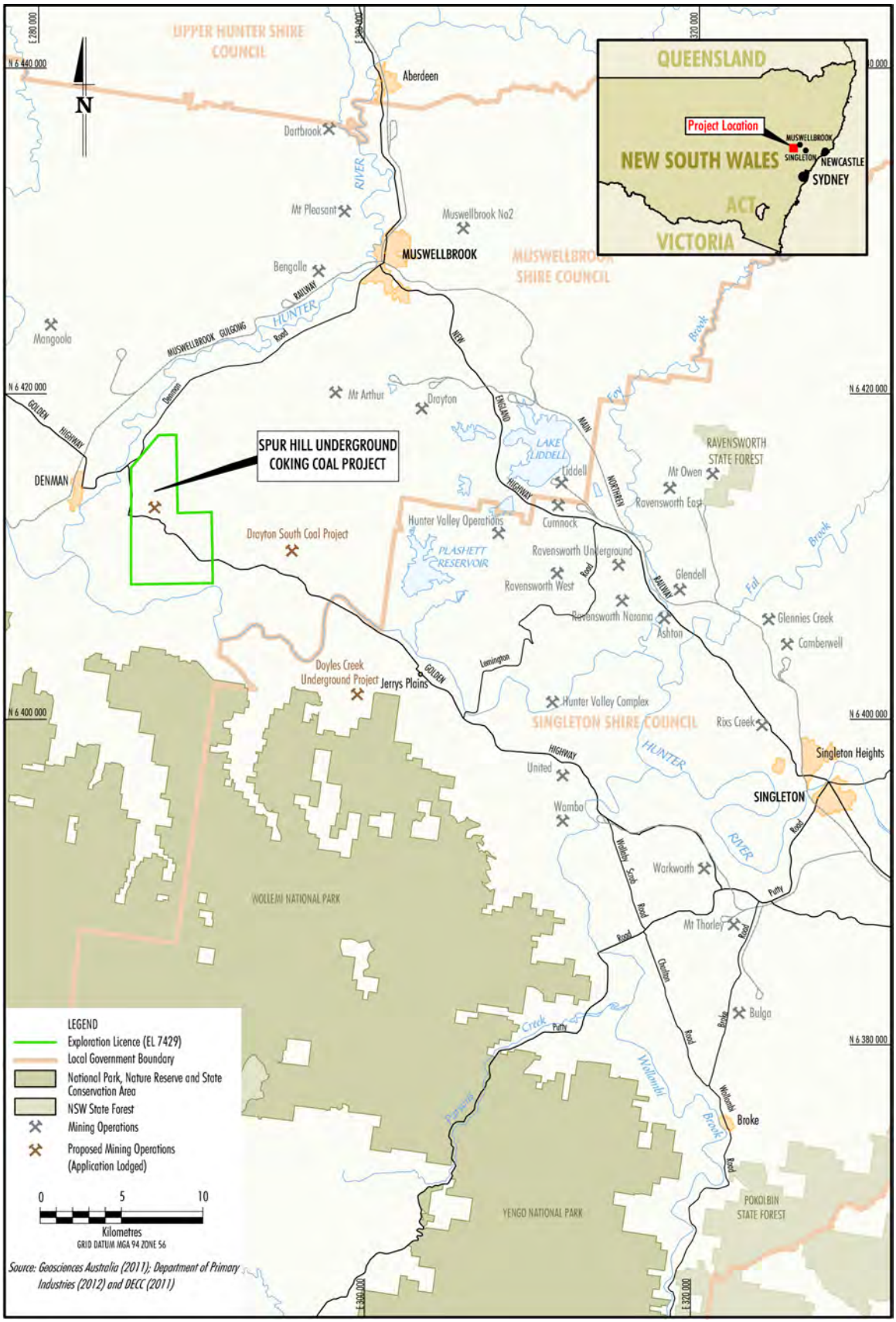

Figure 1-1 Project location

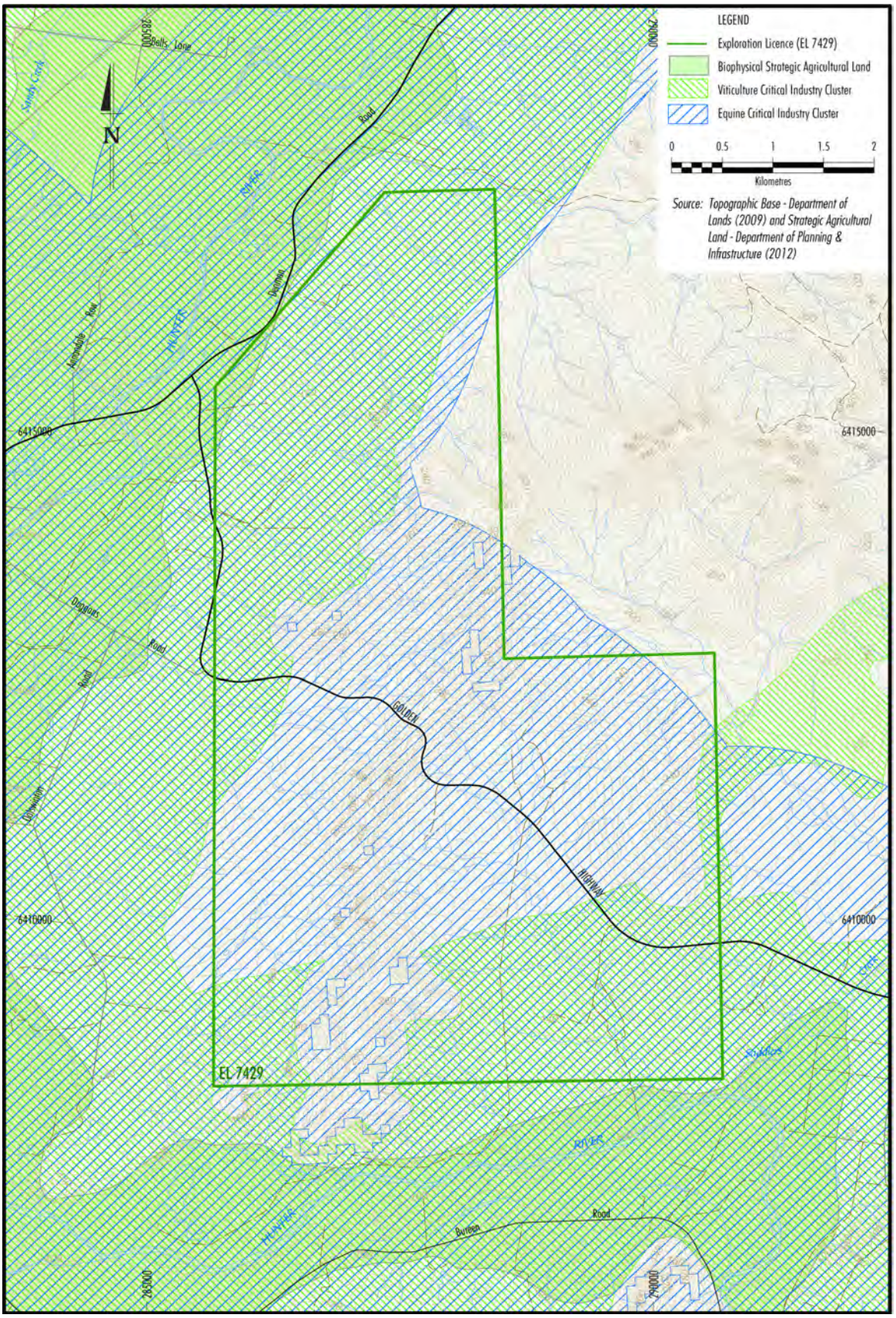

Figure 1-2 Project area in relation to mapped SAL – BSAL (green), CIC viticulture (hash) and CIC equine (blue)

1.1 Project description

The Project is a proposed development of an underground coal mining operation for a mine life of up to 25 years.

The Project underground mining area would be located entirely within Exploration Licence (EL) 7429. The Project would also include development of facilities for handling, processing and transportation of coal.

SHM is seeking approval from the NSW Minister for Planning and Infrastructure for Development Consent under Division 4.1 of Part 4 of the EP&A Act for the Project.

The Project would include the following activities:

- Longwall mining from a number of seams in the Wittingham Coal Measures within the underground mining area of EL 7429 for a mine life of up to 25 years;
- Production of up to approximately 8 million tonnes per annum (Mtpa) run-of-mine coal;
- Development of mine access drifts and mine infrastructure area including administration offices, bathhouse, workshop compound, store buildings, coal stockpile areas, bunded fuel tank, laydown areas, car parking and access road;
- Construction and operation of a coal handling and preparation plant (CHPP);
- Development of coal transportation infrastructure;
- Construction and operation of train load-out facility, rail spur and loop;
- Emplacement of waste rock excavated during the construction of access drifts and shafts and coarse rejects and fines generated during the initial processing of ROM coal;
- Development of ventilation surface infrastructure and gas drainage infrastructure;
- Progressive development of sumps, pumps, and pipelines, water storages and other water management equipment and structures;
- Ongoing exploration activities within EL7429;
- Ongoing surface monitoring, rehabilitation and remediation of subsidence effects;
- Rehabilitation of mine related infrastructure areas at the end of mine life; and,
- Other associated minor infrastructure, plant, equipment and activities.

1.1.1 Project area

The Project area is defined as the extents of EL7429, an area of approximately 33 square kilometres (km^2) or 3,300 hectares (ha). The Project general arrangement is provided, including conceptual surface infrastructure location and the proposed underground mining area (Figure 1-3). Not all properties within the Project area are expected to be directly affected by underground mining or surface infrastructure.

The Project area excludes adjacent infrastructure. La Tierra is advised that the train load-out facility (including rail spur and loop), product coal transportation infrastructure and other linear infrastructure (e.g. power supply infrastructure, water supply pipelines) would not require a mining lease and therefore do not fall within the definition of "mining or petroleum development" under clause 17A of the Mining SEPP. These activities do not require a Gateway Certificate and have been excluded from this Gateway Application. The location of the train load-out facility (including rail spur and loop), product coal transportation infrastructure and other linear infrastructure would be documented and assessed in the EIS.

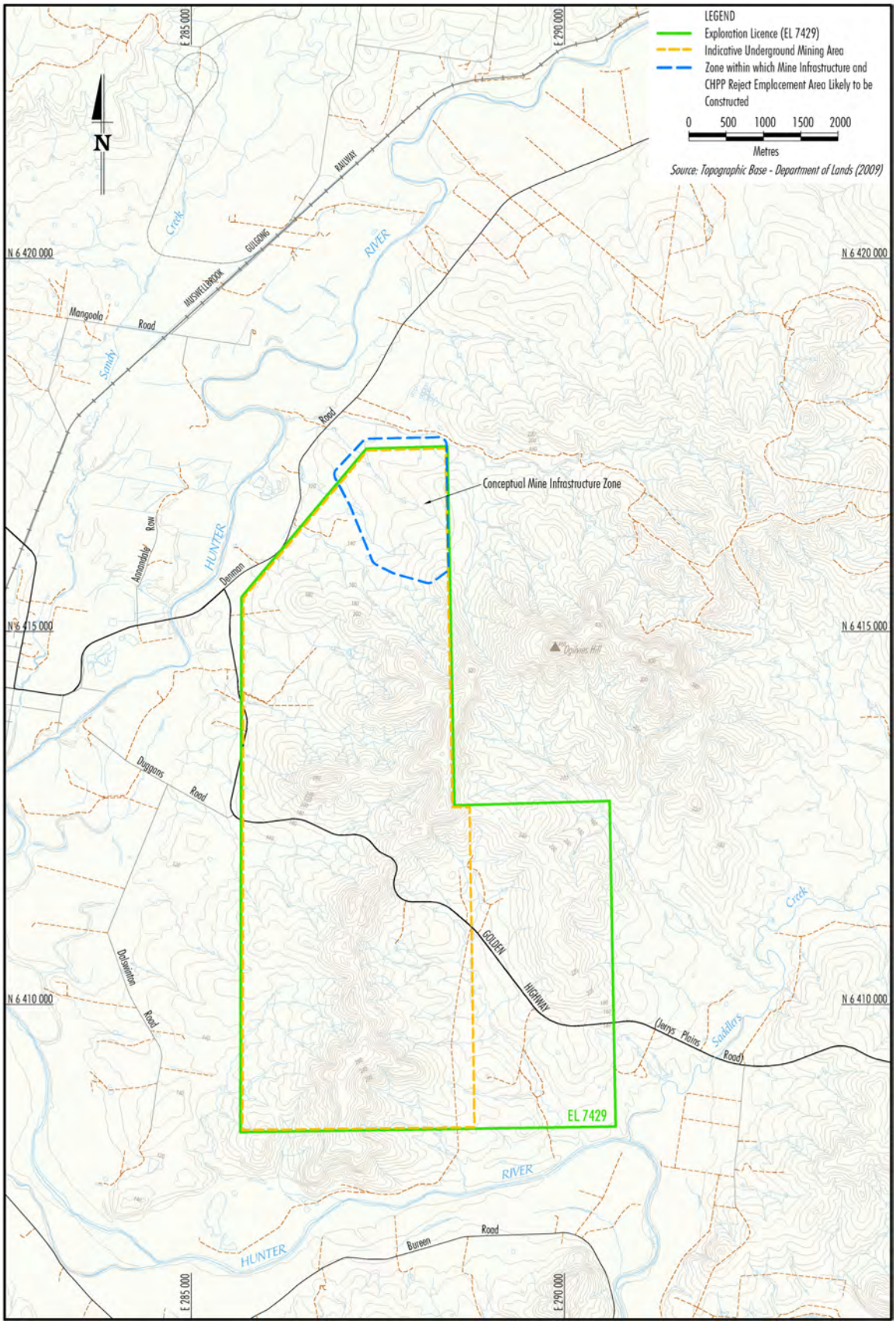

Figure 1-3 Conceptual general arrangement

1.1.2 Surrounding locality

In accordance with the Technical Notes the *surrounding locality* is described as Althorpe and Vaux Parishes, County of Durham in the Muswellbrook Local Government Area (LGA) of the Upper Hunter Region, NSW (Figure 1-4).

1.2 Definition of "agriculture"

In this report, the term "agriculture" has the meaning provided by Australian Bureau of Statistics (ABS, 2006) and reproduced as follows.

"The term 'agriculture' is used broadly to refer to both the growing and cultivation of horticultural and other crops (excluding forestry), and the controlled breeding, raising or farming of animals (excluding aquaculture)." So that there is no doubt, agriculture includes the breeding of thoroughbred horses.

1.3 Upper Hunter Strategic Regional Land Use Plan

1.3.1 Overview

The NSW Government Strategic Regional Land Use Policy (the Policy) (DP&I, 2012c) was released in September 2012. A key element of the Policy is the SRLUP. The SRLUP sets out the process for assessing the impact of large-scale mining and coal seam gas (CSG) developments on areas of land with agricultural and environmental values by mapping SAL and CICs, setting new assessment mechanisms and codes of practice for mining and CSG developments, and setting guidelines on how mining and CSG developments can interfere with groundwater (aquifers), via an Aquifer Interference Policy (DPI, 2012).

The SRLUP identifies and maps SAL and also potential mining and CSG resources. In addition, it provides an analysis of the region in terms of infrastructure, economic development and employment, housing and settlement, community health and amenity, the natural environment, natural hazards and climate change, and cultural heritage. For each of these matters, the SRLUP identifies challenges and provides a policy response.

A key aim of the SRLUP is to balance agriculture and resource development. In this regard, the SRLUP provides for a new Gateway Process, which is an upfront, independent and scientific assessment of the impacts of mining and CSG proposals on SAL. The Gateway Process is to be undertaken prior to the lodgment of a Development Application for a proposed project.

In 2013 the Mining SEPP and other legislation was amended to provide the SRLUP, including the Gateway Process, with a head of power in law.

1.3.2 Gateway process and criteria

The Gateway Process applies to certain types of mining and petroleum development on Strategic Agricultural Land (SAL):

- State significant mining development that requires a new or extended mining lease;
- Extraction of a bulk sample of more than 20,000 tonnes of coal or any mineral ore (ie. State significant mining exploration activity);
- State significant petroleum development that requires a new or extended petroleum production lease; and,
- State significant petroleum exploration activity.

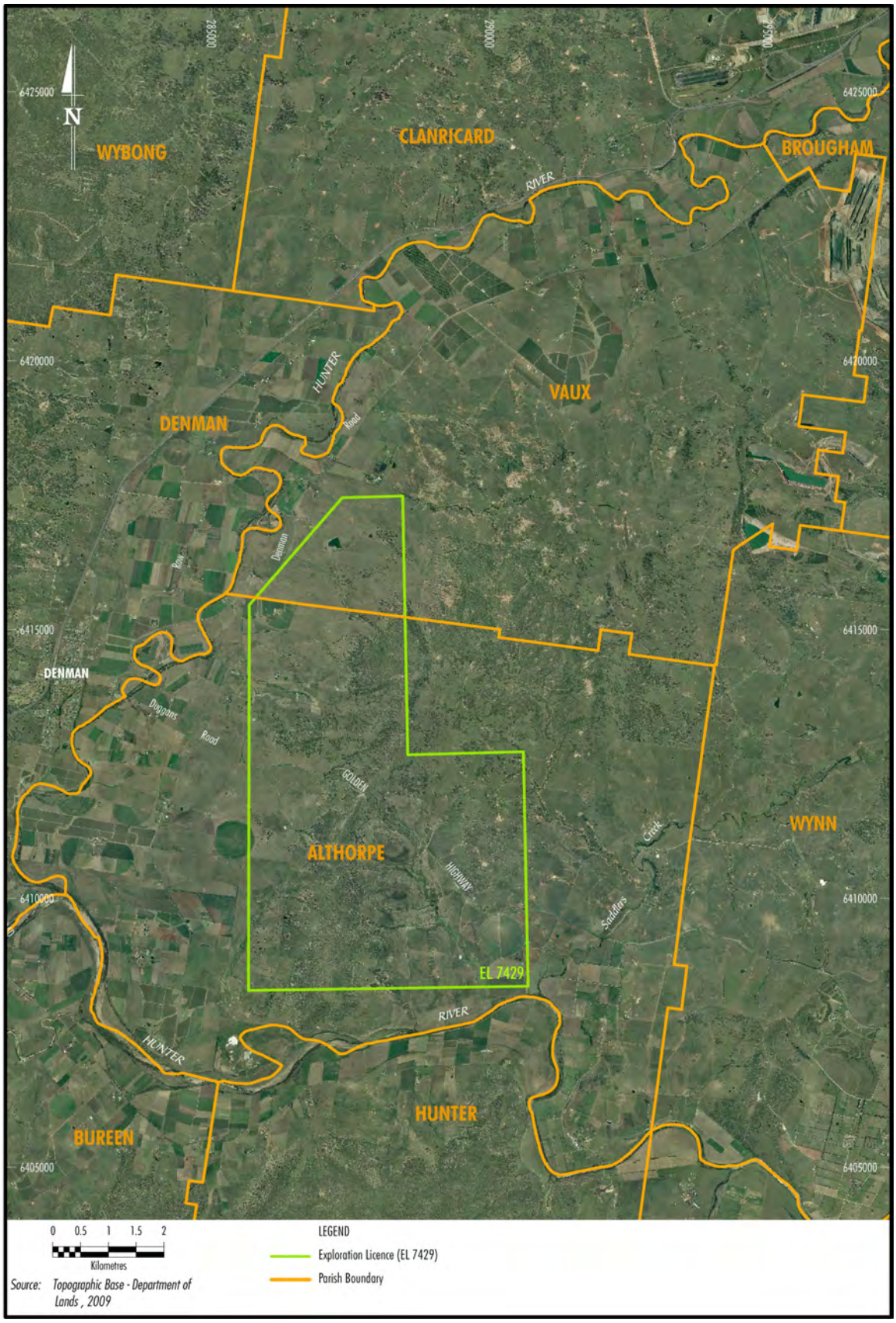

Figure 1-4 The Project area and the surrounding locality

A Gateway Panel (the Panel) of experts in agricultural science, water and mining will assess Gateway applications. The Panel must assess applications against specific criteria.

For BSAL, that the proposed development will not significantly reduce the agricultural productivity of the land based on a consideration of:

a) Impacts on the land through surface area disturbance and subsidence;
b) Impacts on soil fertility, effective rooting depth or soil drainage;
c) Increases in land surface micro-relief, soil salinity, rock outcrop, slope and surface rockiness or significant changes to soil pH;
d) Impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy);
e) Any fragmentation of agricultural land uses; and,
f) Any reduction in the area of BSAL.

For CICs, that the proposed development will not lead to significant impacts on the relevant critical industry cluster based on a consideration of:

a) Surface area disturbance and subsidence;
b) Reduced access to, or impacts on, water resources and agricultural resources;
c) Reduced access to support services and infrastructure;
d) Reduced access to transport routes; and
e) The loss of scenic and landscape values.

In considering the above, the Gateway Panel is to have regard to the duration of potential impacts and any proposed avoidance, mitigation, offset or rehabilitation measures.

Upon completion of its assessment the Gateway Panel will either:

i) Issue an unconditional Gateway Certificate, without recommendations, if the Gateway Panel determines that the proposal meets the criteria relating to agricultural and water impacts; or,
ii) Issue a conditional Gateway Certificate if the Gateway Panel determines that the proposal does not meet the criteria. The recommendations of the gateway certificate must be addressed in the development application for the proposal and must be considered by the relevant consent authority when determining the development application.

The Panel must issue a Gateway Certificate within 90 days of the application, but provisions exist for this timeframe to be lengthened. Once a Gateway Certificate has been issued, the applicant can lodge a State Significant Development (SSD) application with the NSW Department of Planning and Infrastructure, which will be assessed under the *Environmental Planning and Assessment Act 1979* (EP & A Act) and subsequent amendments.

The applicant must address any conditions imposed by the Gateway Certificate in an Environmental Impact Statement (EIS) that it prepares as part of an SSD application. The Planning Assessment Commission (PAC) must consider the extent of compliance with the conditions in determining whether to grant SSD consent for the proposed project.

1.3.3 Aquifer interference policy

The Aquifer Interference Policy (AIP) applies to all of NSW, not just those regions in which an SRLUP is in place. If the Gateway Process applies to a particular project, the AIP is considered in this process. Otherwise, it is considered in the assessment of the Development Application.

The AIP indicates that the level of groundwater assessment required at the Gateway stage will include a simple modeling platform that has been:

a) Developed using the available baseline data that has been collected at an appropriate frequency and scale; and
b) Determined to be fit for purpose to the satisfaction of the Minister for Primary Industries.

The NSW Office of Water will assess the potential level of impact relative to the Level 1 or Level 2 minimal impact considerations provided in the AIP. The assessment includes determining the rigour of impact predictions and the suitability of proposed mitigation, prevention or avoidance strategies.

1.4 Purpose of this report

The purpose of this agricultural impact assessment report is to accompany an Application by the Proponent for a Gateway Certificate. The report contains a detailed analysis of the agricultural values of the land on which the Project is located and the surrounding locality. This is provided to inform the Gateway Panel of the potential agricultural impacts of the proposed Project. For reference by the Gateway Panel, the report complies with the Mining SEPP, the AIS Guideline and Applicant's Guideline (Table 1-1 and Table 1-2).

Table 1-1 AIS Guideline requirements and report compliance

AIS Guideline requirement	Relevant location in this report
Information relating to the site and region	Section 2
Detailed assessment of the agricultural resources and agricultural production of the project area	Section 2.1
Identification of the agricultural resources and current agricultural enterprises within the surrounding locality of the project area	Section 2.2
Assessment of impacts	Section 3
Identification and assessment of the impacts of the project on agricultural resources or industries	Sections 3.1 and 3.2
Account for any physical movement of water away from agriculture	Section 3.3
Assessment of socio-economic impacts	Section 3.4
Mitigation measures	Section 4
Identification of options for minimising adverse impacts on agricultural resources, including agricultural lands, enterprises and infrastructure at the local and regional level	Sections 4.2, 4.3, 4.4 and 4.5
Consultation	Section 5
Document consultation with adjoining land-users and Government Departments	Section 5.1

Table 1-2 Mining SEPP criteria, Applicant's Guideline requirements and report compliance

Criteria listed in Mining SEPP	Guideline requirement	Relevant location in this report
Biophysical SAL	Biophysical SAL	Biophysical SAL
(i) Any impacts on the land through surface area disturbance and subsidence	• Maps and text that identify and describe the areal extent of the surface area disturbance and subsidence; • Description and mapping of the classes of land and soil capability and soil fertility that will be affected; • An estimation of the likelihood of full rehabilitation of this area post mining activity and an overview of the processes used to achieve the rehabilitation.	• Location of verified BSAL (Section 2.1.1.6; Appendix A – McKenzie, 2013; and Appendix B – MESC, 2013) • Extent of BSAL subsidence (Section 3.2.3; Appendix B – MESC, 2013) • Land & soil capability (Section 2.1.1.3) • Rehabilitation of BSAL (Section 4)
(ii) Any impacts on soil fertility, effective rooting depth or soil drainage (iii) Increases in land surface micro-relief, soil salinity, rock outcrop, slope and surface rockiness or significant changes to soil pH	• Refer to the Interim Protocol for Site Verification and Mapping of Biophysical Strategic Agricultural Land which describes relevant criteria and their analysis and identifies key references; • Refer to the Agricultural Impact Statement: Technical Notes which are technical guidelines supporting agricultural impact assessments; • Provide information in tabular form that demonstrates the pre-development and post development land and soil capability and soil fertility classes.	• Reference to Verification Protocol (Appendix A – McKenzie, 2013) • Reference to Technical Notes (Section 1) • Land & soil capability (Section 2.1.1.3)
(iv) Any impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy)	• Estimates of all quantities of water that are likely to be taken from any water source on an annual basis during and following cessation of the activity; • A strategy for obtaining appropriate water licence/s for maximum predicted annual take; • Establishment of baseline groundwater conditions including groundwater depth, quality and flow based on sampling of all existing bores in the area, any existing monitoring bores and any new monitoring bores that may be required under an authorisation issued under the Mining Act 1992 or the Petroleum	• Removal of water from agriculture (Section 3.3) • Groundwater Report (Appendix C - HydroSimulations, 2013)

Criteria listed in Mining SEPP	Guideline requirement	Relevant location in this report
	(Onshore) Act 1991; • A strategy for complying with any water access rules applying to relevant categories of water access licences, as specified in relevant water sharing plans; • Estimates of potential water level, quality or pressure drawdown impacts on nearby water users who are exercising their right to take water under a basic landholder right; • Estimates of potential water level, quality or pressure drawdown impacts on nearby licensed water users in connected groundwater and surface water sources; • Estimates of potential water level, quality or pressure drawdown impacts on groundwater dependent ecosystems; • Estimates of potential for increased saline or contaminated water inflows to aquifers and highly connected river systems; • Estimates of the potential to cause or enhance hydraulic connection between aquifers; • Estimates of the potential for river bank instability, or high wall instability or failure to occur; • Outline of the method for disposing of extracted water (in the case of coal seam gas activities). Assess the project against the criteria specified in 'Table 1 – Minimal Impact Considerations for Aquifer Interference Activities' in the Aquifer Interference Policy.	
(v) Any fragmentation of agricultural land uses	• The decrease in production and efficiency of agriculture in the area; • Reduced access to critical farm and rural infrastructure such as water resources, transport routes and stock reserves; • Changes in land use from agriculture to other land use.	• Production implications (Section 3) • Changes in land use (Section 3.2.3) • Access to support services (Section 3.4.1)

Criteria listed in Mining SEPP	Guideline requirement	Relevant location in this report
(vi) Any reduction in the area of biophysical strategic agricultural land	• Quantify any likely reduction in the pre-development and post development area of Biophysical SAL.	• Any reduction in the area of BSAL (Section 3.2.3)
Critical Industry Clusters	Critical Industry Clusters	Critical Industry Clusters
(i) Any impacts on the land through surface area disturbance and subsidence	• Maps and text that identify and describe the areal extent of the surface area disturbance and subsidence; • The assessment should also describe and map the classes of land and soil capability and soil fertility that will be affected; • An estimation of the likelihood of full rehabilitation of this area post mining activity and an overview of the processes used to achieve the rehabilitation.	• Extent of subsidence (Section 3, Appendix B – MSEC, 2013) • Land & soil capability (Section 2.1.1.3) • Likelihood of full rehabilitation (Section 4)
(ii) Reduced access to, or impacts on, water resources and agricultural resources	• Identify all water and agricultural resources with direct utility to the CIC. The impact of the proposal on these resources should be quantified as well as the significance of any temporary or permanent disruption of access to these resources by the CIC.	• Identification of water resources (Section 2.1.1.4) • Water taken away from agriculture (Section 3.3)
(iii) Reduced access to support services and infrastructure	• Any properties acquired (including both operational land and buffer areas) or directly impacted in another way as a result of the project must be identified; • Consider whether these property acquisitions or other impacts of the proposal are likely to isolate any CIC property from, or lead to the closure of, a CIC support service such as an equine veterinarian or winery; • Impacts of any temporary or permanent disruption of access from CIC properties to support services and infrastructure must also be assessed.	• Property acquisitions and potential impacts on CICs (Sections 2.1.2, 2.2.2 and 4) • Access to support services (Sections 3.4.1 and 4)
(iv) Reduced access to transport routes	• Road and rail traffic volumes and routes and vehicle sizes associated with the project; • Existing CIC-related road and rail traffic movements that occur on the same	• Access routes (Section 2.2.1.3) • Existing traffic movements

Criteria listed in Mining SEPP	Guideline requirement	Relevant location in this report
	routes as proposed in the project; • The potential impacts on CIC-related road and rail transport routes. The impact of any temporary or permanent road or rail closures on CIC-related transport routes must also be assessed.	(Section 2.2.1.3) • Potential impacts on transport routes (Sections 3 and 4)
(v) The loss of scenic and landscape values	Views of the project site from CIC properties or CIC-related tourist routes must be assessed in the application. The application should use visual aids such as photomontages to explain the potential impacts. Any mitigation measures such as visual bunds or plantings should also be shown in images.	• Visual amenity (Section 3.4.2)

2 INFORMATION RELATING TO THE SITE AND REGION

Following is a detailed synthesis of available information relating to agricultural resources, industries, enterprises, and production and support infrastructure within the Project area, surrounding locality and/or region.

2.1 Project area

The Project area has been defined (refer to Section 1.1.1 of this report).

2.1.1 Agricultural resources

2.1.1.1 Soils

Soils within the Project area were mapped and described by the former NSW Department of Land and Water Conservation more than 20 years ago (Kovac and Lawrie, 1991). This early work provided only reconnaissance-scale mapping, i.e. 1:250,000 scale, but high-quality descriptions of the dominant soil landscapes on the land. Mapping indicates five soil landscapes within the Project area (Figure 2-1 and Table 2-1).

Table 2-1 Soil landscapes within the Project area

Soil Landscape	Characteristics
	Alluvial Landscapes
Hunter	• Floodplains of the Hunter River and its tributaries located on Quaternary alluvium. • Level plains and river terraces of the Hunter River with elevations of 20-60 m. • Minor stream bank erosion occurs on present watercourses with minor sheet and gully erosion on adjacent terraces.
	Brown Clay Landscapes
Dartbrook	• Gentle slopes located on the Singleton Coal Measures and Quaternary alluvium. • Smooth undulating rises and low hills with elevation ranges of 100-140 m and 200-260 m. • Minor to moderate sheet erosion on some hill slopes.
	Red Clay Landscapes
Brays Hill	• Rounded undulating low hills, located on the Singleton Coal Measures and Tertiary basalt. • The lower slopes are often elongated and smooth, with linear gilgai that generally run parallel to the slope. • Minor sheet erosion may occur on hill slopes after clearing. Moderate gullying in many of the drainage lines, with minor rilling in gilgai depressions with Red and Grey Clays.
	Shallow Soil Landscapes
Ogilvie Lees Pinch	• Covers steep hills and escarpments with sandstone and conglomerate outcrops forming cliffs on the Narrabeen Group. Occasional benches occur with some ravines along drainage lines. • Minor sheet erosion is common with some mass movement seen in road cuttings.
	Soloths Landscapes
Liddell	• Typically low rolling to undulating hills. • Highly erodible soloths and solodic soils.

Source: Kovac and Lawrie, 1991

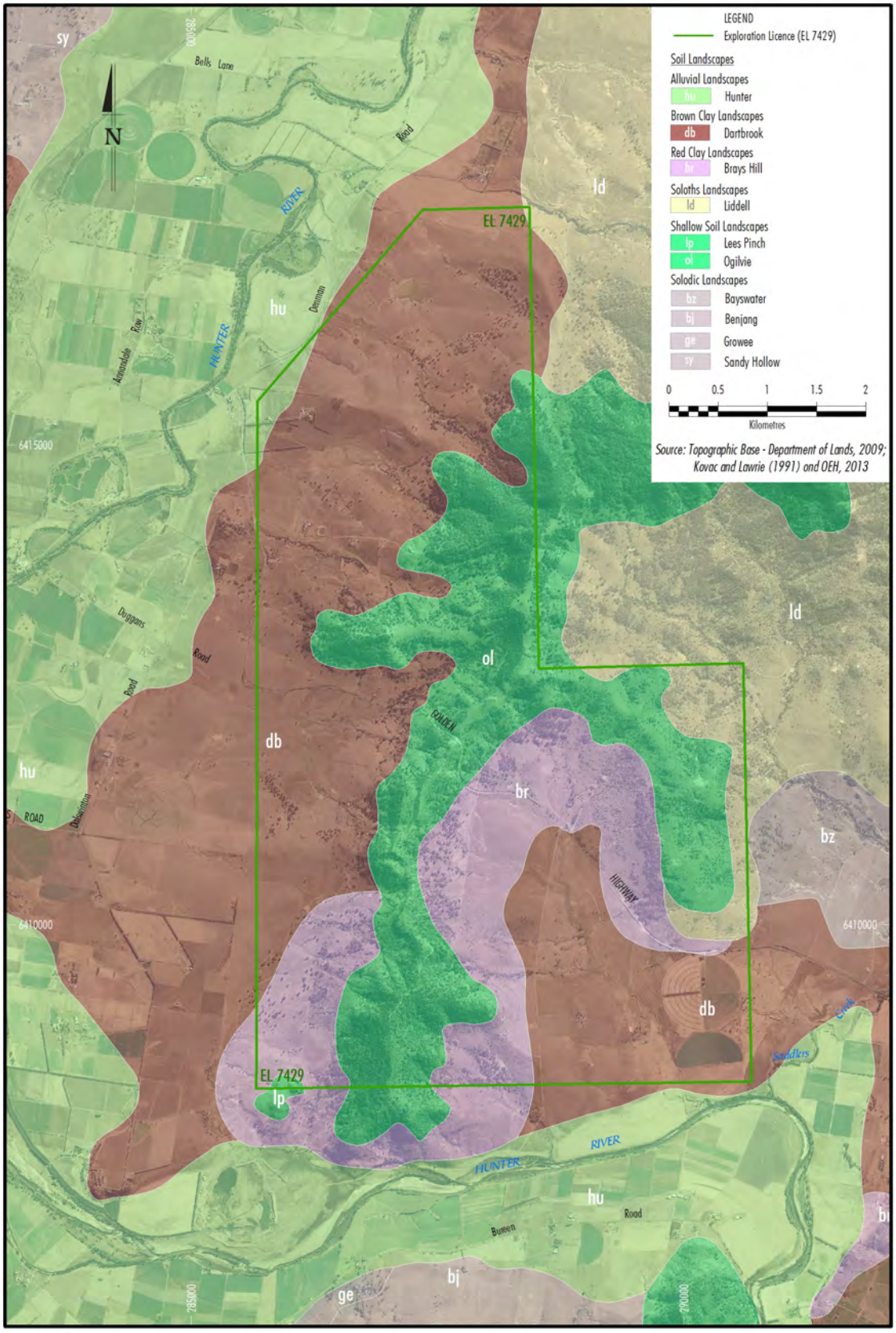

Figure 2-1 Soil landscapes

Of these soil landscapes, and notwithstanding the importance of Vertosols in Australian agriculture, the Hunter Alluvial Soil Landscape is the most agriculturally significant here. Soils within this landscape have few limitations to plant growth, are inherently fertile (moderately to highly fertile according to Charman (1978), have low water holding capacity and are well drained, making them suitable for cropping and irrigation. Formed on alluvium, these soils are typically found on floodplains adjacent the Hunter River and its major tributaries (Charman, 1978).

More recently, the soils and land & soil capability of the Project area have been assessed in greater detail (McKenzie, 2013 – Appendix A). Eight soil types within seven landscape units were identified, described and mapped (Table 2-2, Table 2-3, Figure 2-2). The Upper Slope and/or Shallow landscape, is dominant. This landscape unit is comprised mainly of shallow Tenosol soils (previously known as Lithosols) with Sodosols, Dermosols and Vertosols also present. McKenzie (2013) notes that these shallow soils have a low capacity to store water and this is a significant constraint to their agricultural usefulness.

Table 2-2 Soil types within the Project area

ASC Soil Type	Number of sites	Great Soil Group Equivalent
Sodosols (Brown, Red, Grey, Black, Yellow)	46	Solodic Soils
Vertosols (Brown, Grey, Red, Yellow)	35	Grey, Brown and Red Clays
Black Vertosol	7	Black Earths
Dermosols (Brown, Red, Grey, Yellow, Red)	31	Chocolate Soils, Red Podzolics
Stratic Rudosols	18	Alluvial Soils
Chromosols (Red, Brown)	10	Red-brown Earths, Non-calcic brown soils
Tenosols ((Red/Brown/Grey/Yellow-Orthic)	7	Lithosols
Kandosols (Red, Brown)	5	Calcareous red earths

Source: McKenzie, 2013

According to McKenzie (2013), soils across much of the Project area have limitations to plant growth that include the following.

- Universally low Phosphorus (P) levels (note that P is a macro-nutrient essential for plant growth);
- Subsoil salinity, which will limit plant root development and the ability of plants to extract water from the soil;
- Subsoil pH imbalance with a trend towards alkalinity at depth; and
- Dispersive subsoils.

This assessment is largely consistent with that by DPI (2006), who state the broader Hunter region as having typically shallow soils, erodible subsoils, low P and pH imbalances.

Notwithstanding, a single area of approximately 86 ha, or 2.6 percent (%) of the Project area, was identified as having negligible constraints to plant growth and this is verified BSAL (McKenzie, 2013). Dermosol soils derived from colluvium dominate within this landscape unit (Lower Slope Variant C) with Kandosols and Vertosols sub-dominant.

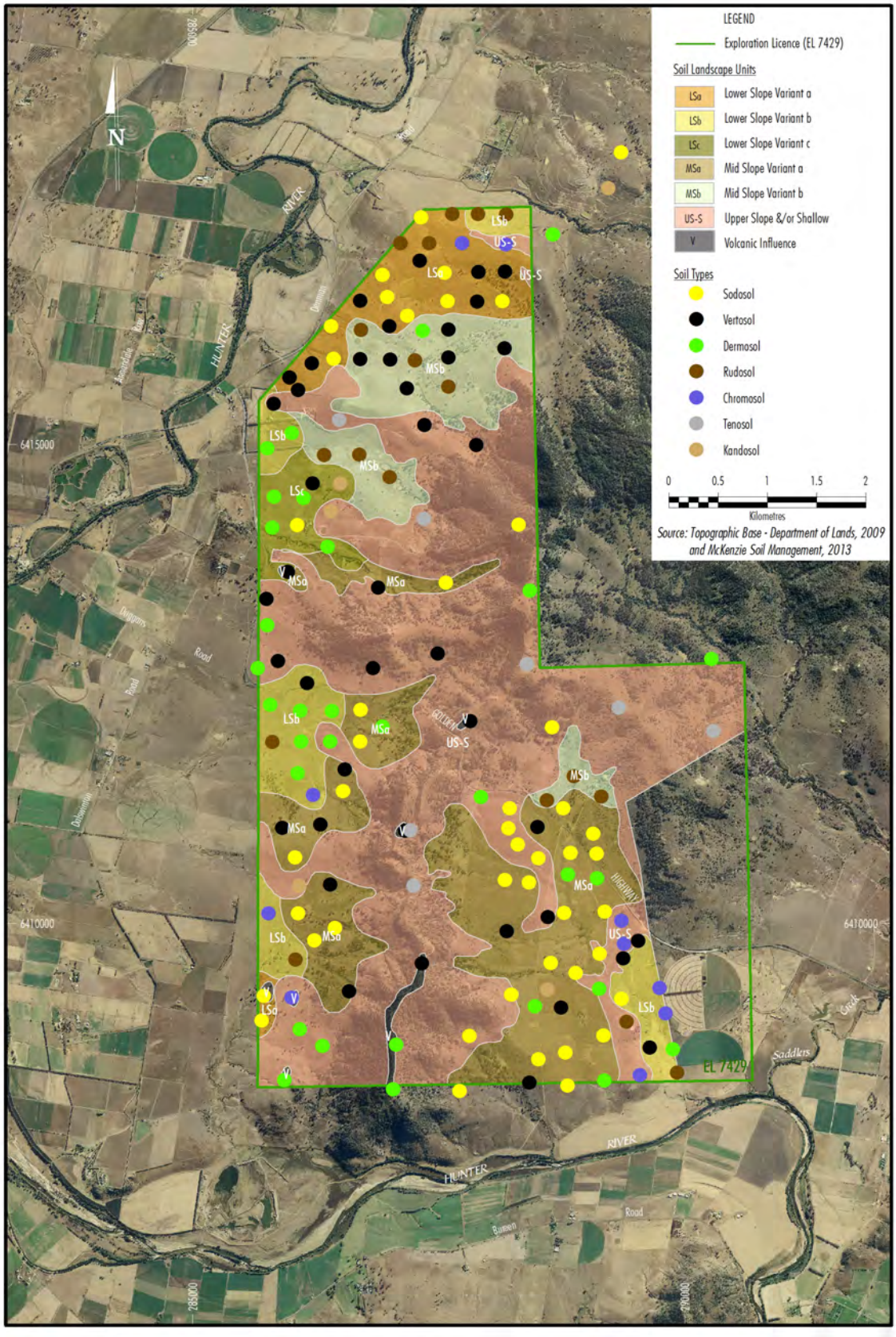

Figure 2-2 Soil types within the Project area

Table 2-3 Soil landscape units within the Project area

Soil Landscape Unit	Map code	Dominant soil types	Sub-dominant soil types
Lower Slope Variant a	LSa	Sodosol, Vertosol	Chromosol
Lower Slope Variant b	LSb	Dermosol, Chromosol	Vertosol, Stratic Rudosol
Lower Slope Variant c	LSc	Dermosol (less saline/alkaline/ sodic than LSb)	Kandosol, Vertosol
Mid Slope Variant a	MSa	Sodosol	Vertosol, Dermosol, Kandosol
Mid Slope Variant b	MSb	Stratic Rudosol, Vertosol	Dermosol
Upper slope &/or shallow	US-S	Tenosol	Sodosol, Vertosol, Dermosol
Volcanic influence	V	Dermosol	Black Vertosol

Source: McKenzie, 2013

2.1.1.2 Slope

The topography of the Project area is dominated by a prominent vegetated ridge that trends southwards from near Ogilvies Hill through to Denman Gap to the south (Figure 2-3). The site ranges in elevation from a maximum of 330 metres (m) in the eastern mid-section of the site, to a minimum of 100m in the south-eastern corner where the site is closest to the Hunter River.

Much of the Project area has slopes in excess of 10% gradient (refer to Figure 2-3) and because of this, as well as other factors that affects its agricultural capability, is suitable only for low-intensity cattle grazing on natural or improved pastures.

2.1.1.3 Land characteristics

The term "land characteristics" is taken to mean the attributes of land that can be explicitly observed for qualitative measurement or measured quantitatively, during land resource evaluation, e.g. land & soil capability assessment. A discussion on land & soil capability within the Project area is provided.

Previous land & soil capability assessment indicates land within the Project area ranges from Class 3 to Class 7 land (DECC, 2009), and is predominantly Class 5 and Class 6 land. Only small areas of Class 3 land, land suitable for cultivation, occur.

A more recent and detailed land & soil capability assessment has been completed for the Project area (McKenzie, 2013 – Appendix A). Whilst generally consistent with the earlier assessment, the current assessment determines Class 4 land to dominate the Project area (Figure 2-4). Class 4 land that has moderate to high limitations for high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialized management practices with a high level of knowledge, expertise, inputs, investment and technology (OEH, 2012). There is no Class 1 land and only minor occurrences of Class 2 and 3 land within the Project area. Pre- and post-mining land & soil capability classes are provided (Table 2-4).

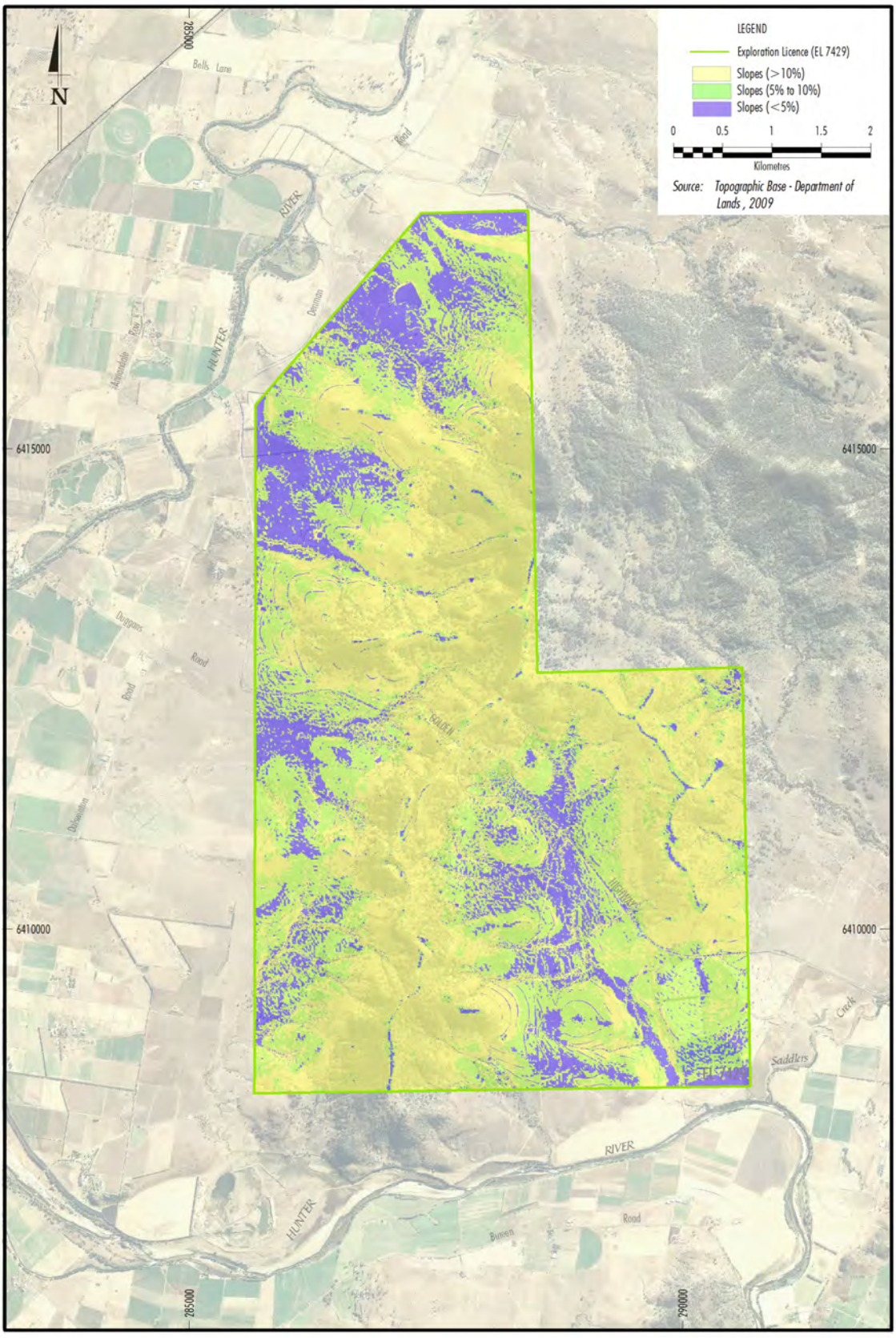

Figure 2-3 Project area slope gradients

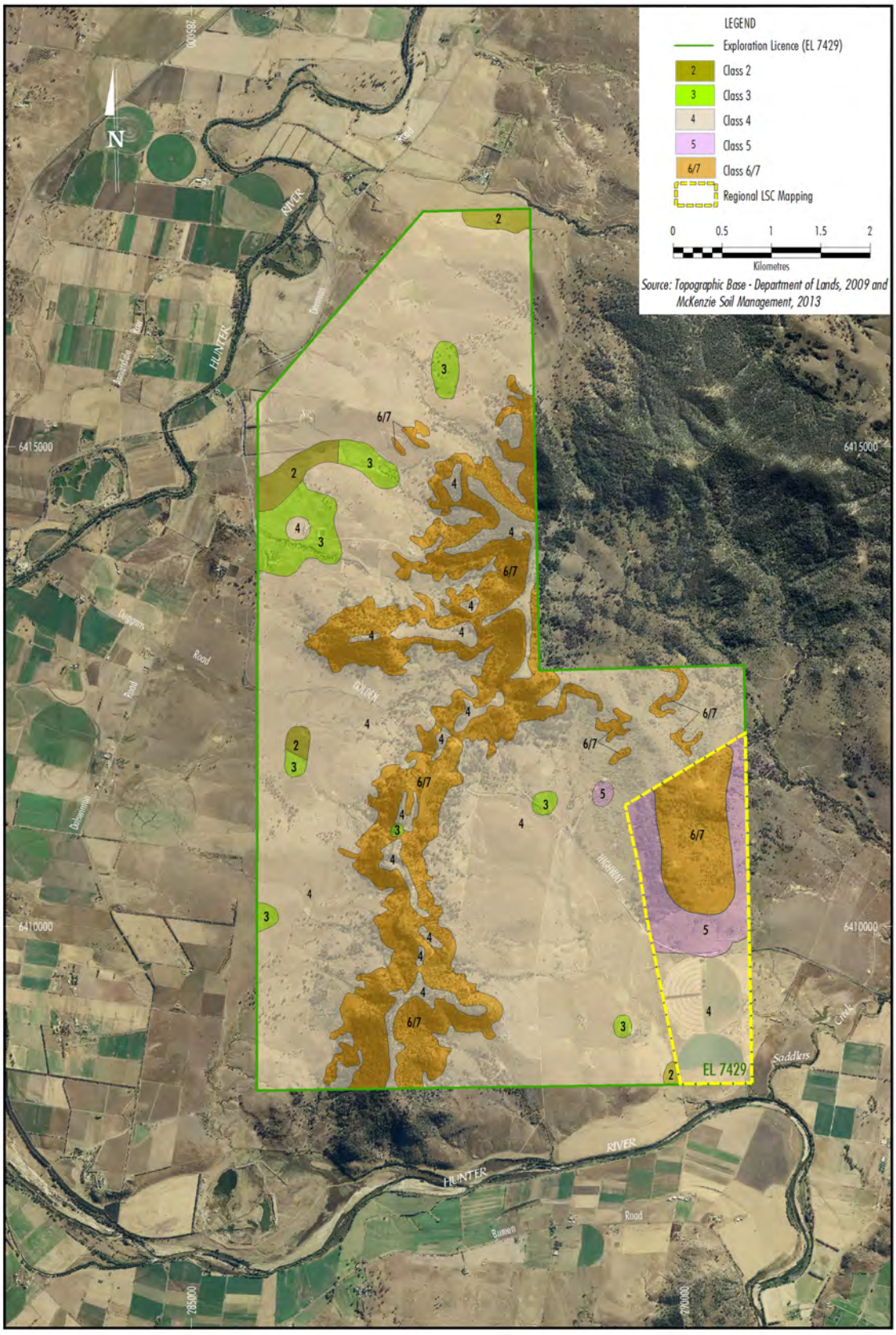

Figure 2-4 Project area land & soil capability classes

Table 2-4 Project area pre- and post-mining land & soil capability classes

Land & Soil Capability Class	Area pre-mining (ha)	Area post-mining (ha)	Change (%)
1	0	0	0
2	49	49	0
3	106	100	-6
4	2389	2395	<1
5	109	109	0
6 & 7	692	692	0
8	0	0	0
TOTAL	**3,346**	**3,346**	

Source: McKenzie, 2013

2.1.1.4 Water characteristics

With respect to agricultural enterprises and agricultural production, there are three important water characteristics of the Project area.

1. Proximity to the Hunter River;
2. The Hunter Alluvial Aquifer; and
3. Overland flow (from rainfall runoff).

The Hunter River flows near to the western and southern boundaries of the Project area, and is the most important source of water for agricultural purposes. All farms affected by the Project area source water from the river. This is mostly by common or property rights for domestic and stock supply under the *Water Management Act 2000* (the WM Act) but several enterprises have significant licensed extraction allocations (refer to Section 2.1.2).

The Project area is located within the boundaries of the Water Sharing Plan for the Hunter Regulated River Water Source, 2003 and the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources, 2009 (DPI, 2009).

Within the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources 2009, the Project area is located within the Jerrys water source. The Jerrys water source has a total surface water entitlement of 10,280 megalitres (ML) per year (23% used for irrigation purposes and 76% used for industrial purposes) (DPI, 2009). A significant number of registered bores are located within the highly productive alluvial aquifers associated with the Hunter River and Saddlers Creek to the east and south of the Project area. Only thirteen registered groundwater bores are located within the Project area itself, and ten of these are within the underground mining area (Figure 2-5).

Previous studies of bores within the Hunter River alluvium in the vicinity of the Project area indicate that bore yields are generally low due to the relatively thin saturated thickness of the alluvium (Mackie Environmental Research, 2000). Groundwater data collected by the nearby Mt Arthur Coal Mine from bores within the Hunter Valley alluvium indicate that the water quality of the alluvial aquifer is quite variable, with electrical conductivity ranging from 1,500 to 9,370 micro-Siemens per centimetre (µS/cm) and pH ranging from 6.7 to 7.6 (Australasian Groundwater and Environment, 2013).

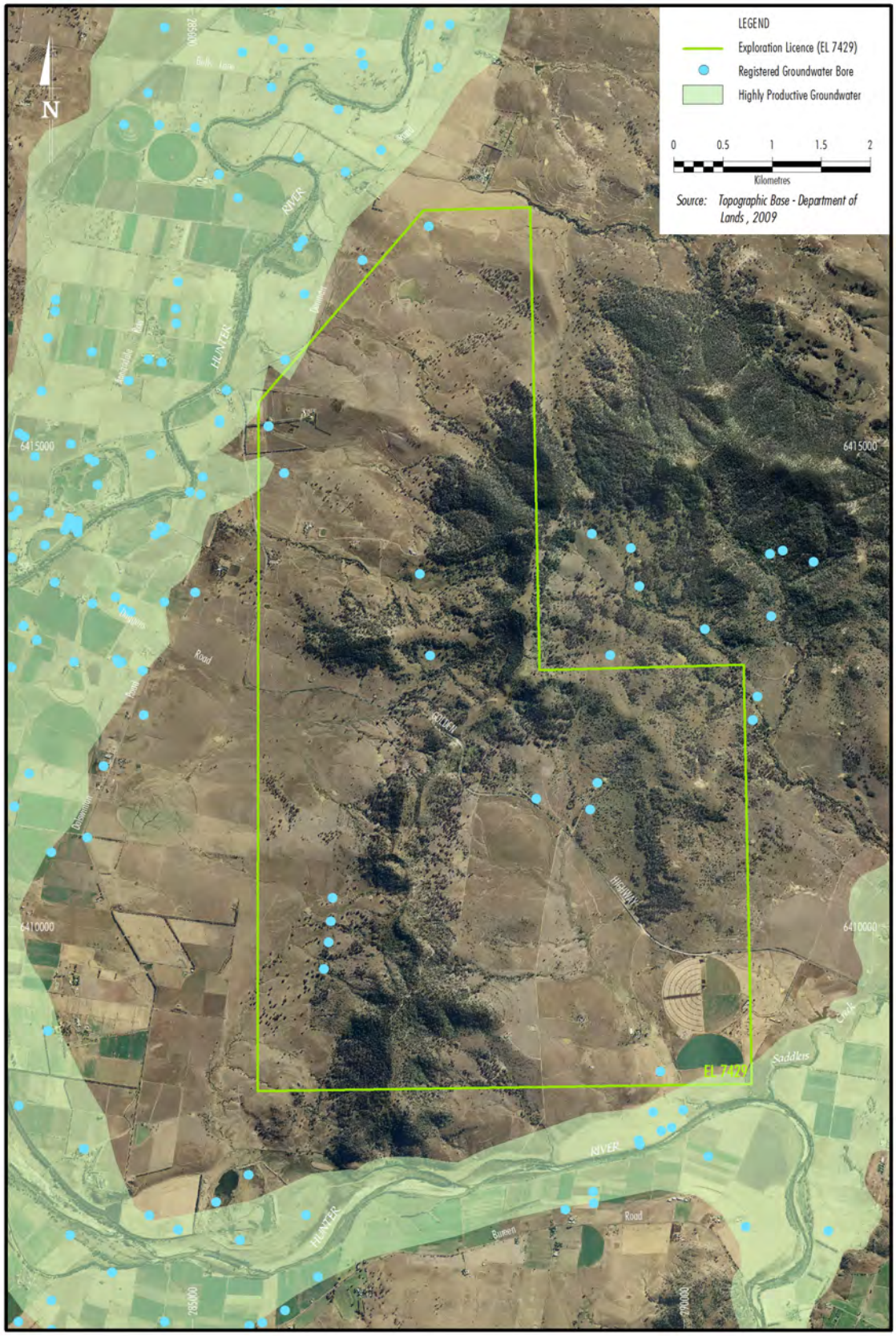

Figure 2-5 Registered groundwater bores in the Project area and surrounds

There are a number of rain-fed farm dams within the Project area for the purpose of stock watering. These dams are often the only permanent water source within fenced paddocks and are, therefore, critical infrastructure for existing agricultural enterprises.

2.1.1.5 History of agricultural enterprises

Parcels of agricultural land in the surrounding locality were first surveyed for allocation to early settlers in 1824 (MSC, 2013a). Muswellbrook was declared a township in 1833 and by 1841 had a flourmill, indicating the prominence of wheat cropping in early agriculture. Wool, wheat and cattle were the main agricultural enterprises in the early years and the centrepiece of the local economy (MSC, 2013a). The railway was constructed in 1869.

The first European settlement near Denman was Merton station in 1825. Merton was an 809ha land grant, located east of the present Denman Township and on the opposite side of the river. At this time, Merton was a remote settlement, by necessity self-sufficient, with a population of more than 100 people. Agricultural enterprises at Merton comprised beef cattle and sheep grazing, dairying and viticulture. The site of the current Denman Township was not gazetted until 1853, and shortly thereafter most people relocated from Merton to Denman to be closer to the Hunter River (Turner, 1995). By 1860, the new township became an important cattle-trading centre, as it was located on a significant stock route from the Upper Goulburn region. In 1915, the railway connected Denman to Muswellbrook and Sydney (Turner, 1995).

The original landholdings in the Denman area, indeed the whole of the Upper Hunter region, were deliberately 'large'. Land grants were made on the basis of *"640 acres (250ha) for each 500 pounds sterling they possessed in cash or goods"* or by leasehold *"so that, by means of grant, purchase and lease, some settlers were able to build up very large estates"* (Turner, 1995). Smallholdings were rare in the 1800s.

An 1825 census indicates that of the 191 large estates, i.e. estates greater than 1,000 acres (404 ha) size, occupying the Hunter Valley, two-thirds were cattle enterprises and only one-third sheep. By the 1890s, dairying had established as an important industry in the area. In 1893 there was a creamery built at Kayuga, in 1903 one at Overton, and in 1907 the Denman Cooperative Dairy Company was founded. In 1919, the Muswellbrook Dairy Cooperative Factory was built (Turner, 1995).

After both World Wars, larger landholdings were split into smaller lots and returned soldiers were encouraged to the area. Following the First World War until about 1980, dairy farming dominated agriculture in the Upper Hunter region. However, drought in the 1980s and market deregulation in the 1990s saw the dairy industry shrink significantly. The Denman milk factory is long closed, so too is the dairy factory in Muswellbrook, and beef cattle enterprises again dominate the region by number of enterprises and land area, just as they did more than 150 years ago. In the past ten years, little has changed in terms of agricultural enterprises within the Project area or the surrounding locality. A detailed account of current and immediately prior land use is provided for each property affected by the proposed Project (refer to Section 2.1.2).

Historical aerial photographs are provided for years including 1958, 1967, 1989 and 1998 (Figures 2-6, 2-7, 2-8 and 2-9). Evident in the aerial photographs is a visible trend of increasing cultivation on the alluvial soils to the west of the Project area. The Project area has remained largely undeveloped, due most probably to slope limitations of the land.

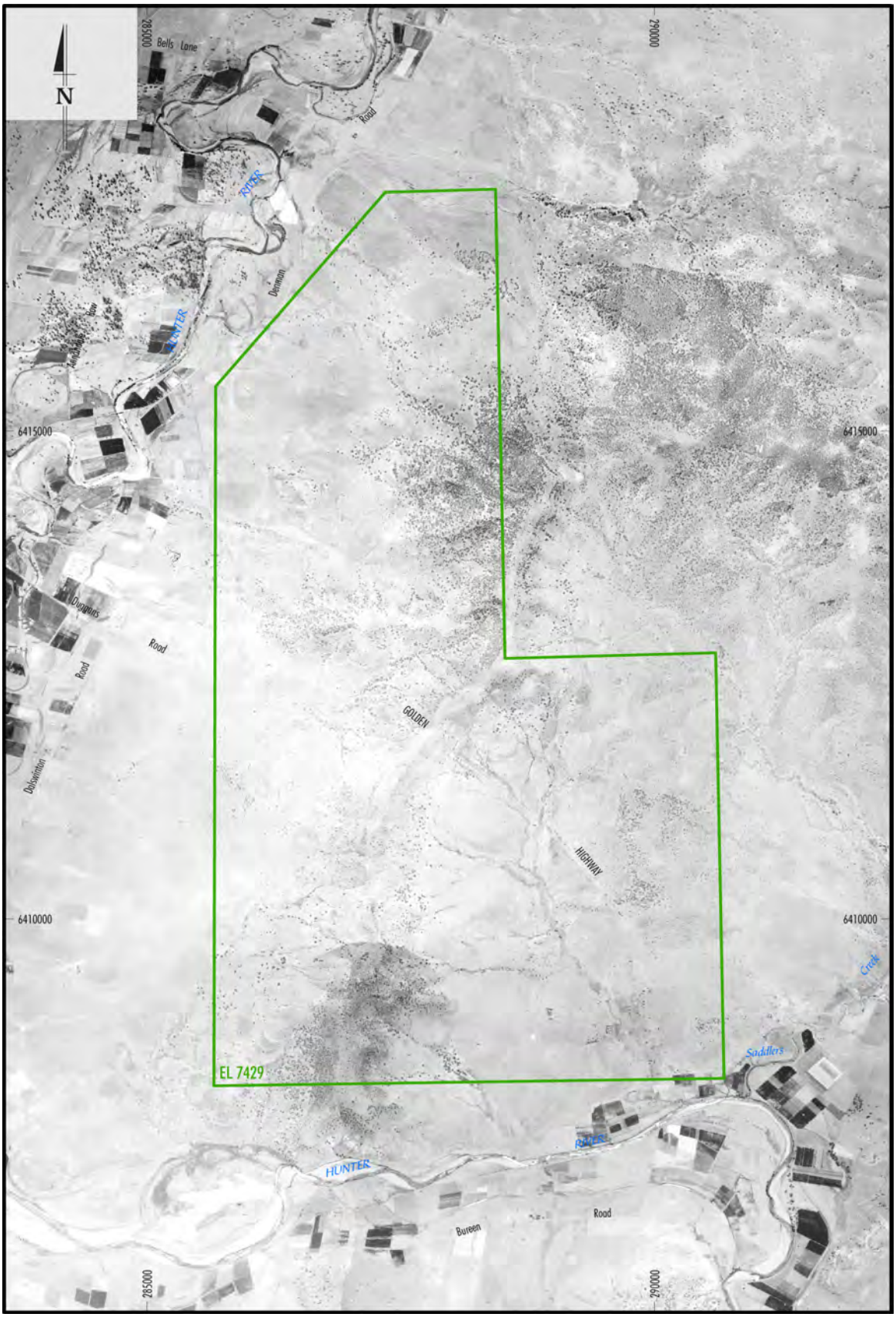

Figure 2-6 Aerial image of Project area in 1958

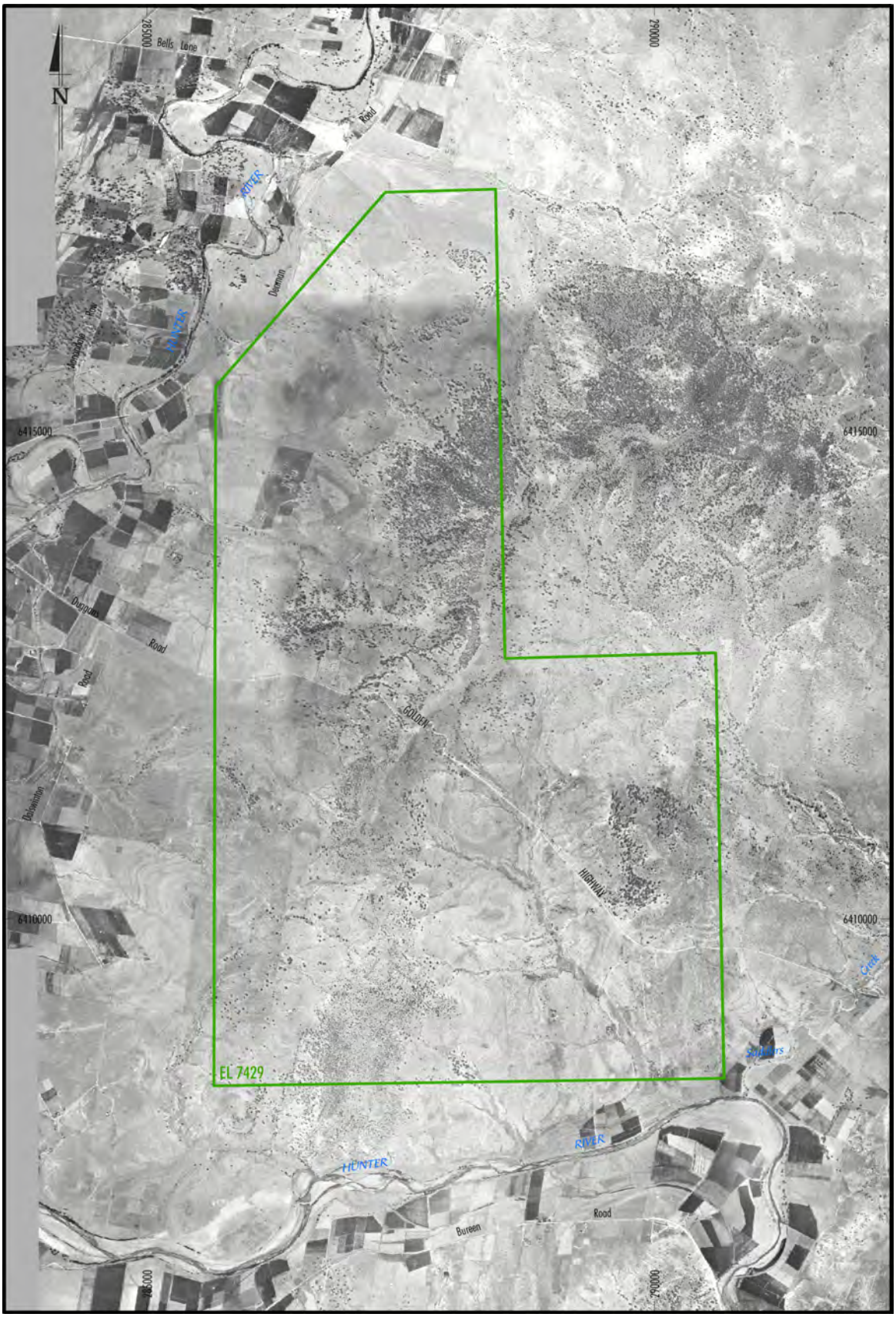

Figure 2-7 Aerial image of the Project area in 1967

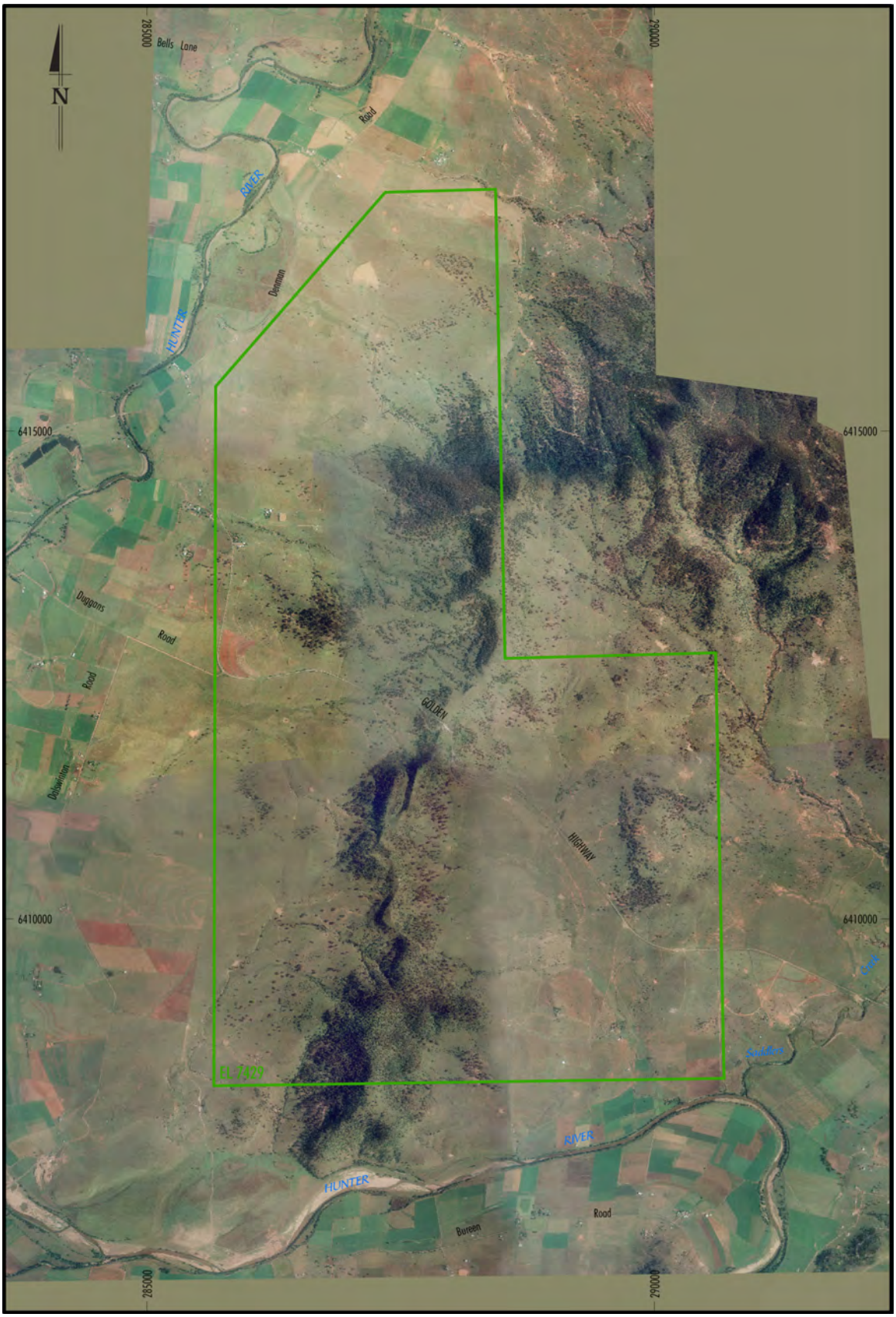

Figure 2-8 Aerial image of Project area in 1989

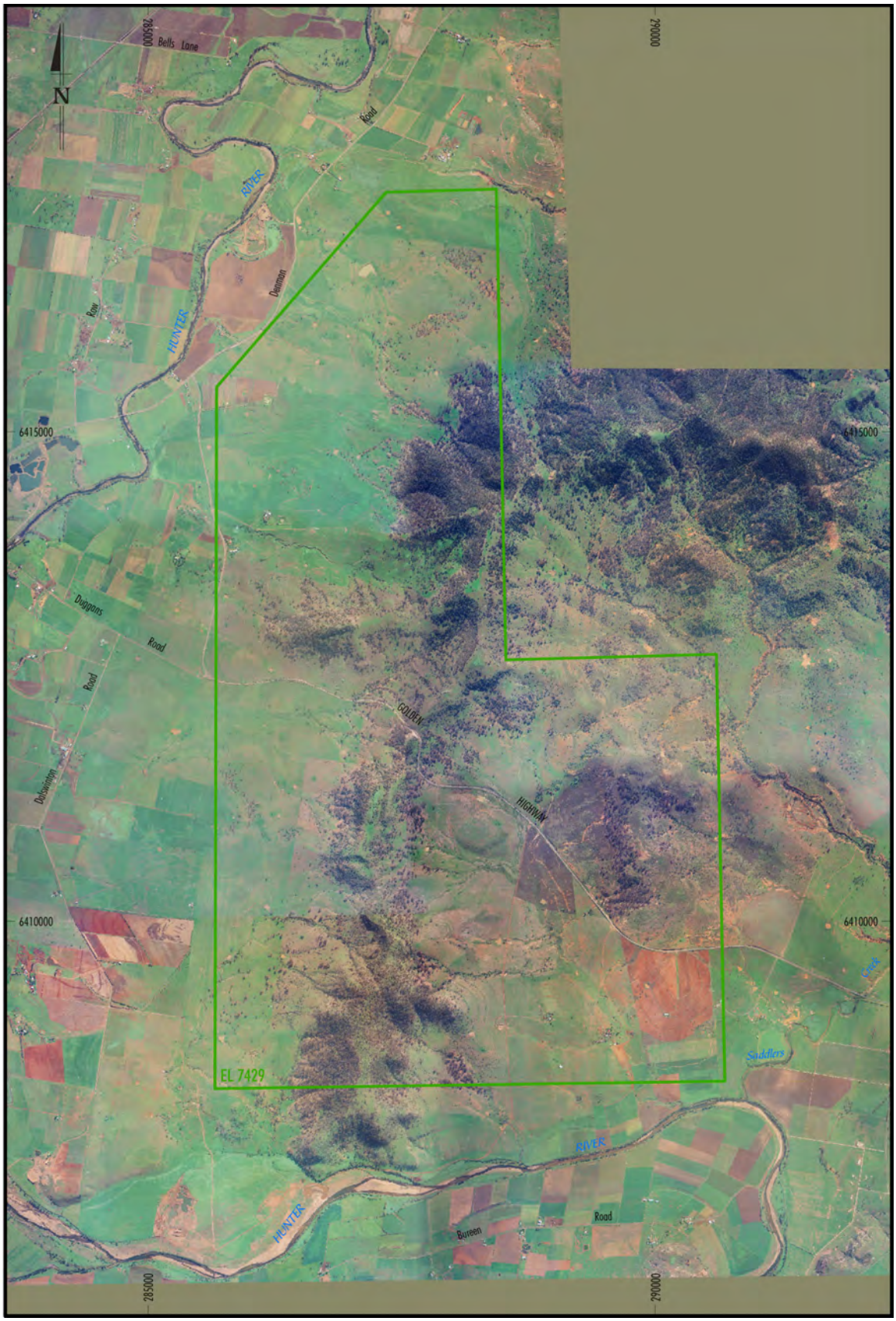

Figure 2-9 Aerial image of the Project area in 1998

Thoroughbred horse breeding commenced in the Upper Hunter in about 1860. For example, the Woodlands stud, to the southeast of the Project area, was first surveyed by Henry Dangar

in 1822. The first thoroughbreds arrived on the property around 1911. After that the stud changed hands regularly up until Jack and Bob Ingham purchased it and adjoining properties in 1986. The Ingham brothers stood many leading stallions, including Octagonal. In 2008 the Ingham family sold the stud on a walk-in, walk-off basis, which included all bloodstock and other properties, to His Highness Sheikh Mohammed bin Rashid Al Maktoum, Prime Minister of the United Arab Emirates, for $500M. Woodlands is operated in conjunction with Kelvinside stud near Scone, and remains a key component of His Highness' global Darley thoroughbred enterprise.

2.1.1.6 Strategic Agricultural Land (SAL)

There is mapped potential SAL within the Project area and surrounding locality (refer to Figure 1.2). This mapping indicates a small area of BSAL in the northwest of the Project area plus viticulture and equine CIC areas.

Recent on-ground assessment using the BSAL verification protocol (DP&I, 2013c) confirms approximately 86 ha of BSAL within the Project area (McKenzie, 2013) (Figure 2-10). These soils are not currently cropped and there is no on-ground evidence of previous cropping. The land is currently used for pasture production, predominantly native pastures, to feed beef cattle (McKenzie, 2013). The context of BSAL areas within the Project area and surrounding locality and region is provided (Table 2-5).

Table 2-5 Areas of BSAL within the Project area and surrounding locality

Location	Extent of BSAL (ha)	Percentage of BSAL within Upper Hunter region
Upper Hunter region	211,060[1]	100.00
Muswellbrook LGA	18,300[2]	8.67
Althorpe Parish	1,850[2]	0.88
Vaux Parish	1,580[2]	0.75
Project area	86[3]	0.04

Sources: [1]DP&I, 2012a; [2]Calculation by Resources Strategies Pty Ltd; [3]McKenzie, 2013

Much of the Project area is mapped as viticulture (about 40%) and equine (almost 100%) CIC areas (refer to Figure 1.2). The geographical criteria for Equine and Viticulture CICs, as relevant to the Project area, are provided (Table 2-6 and Figure 2-11).

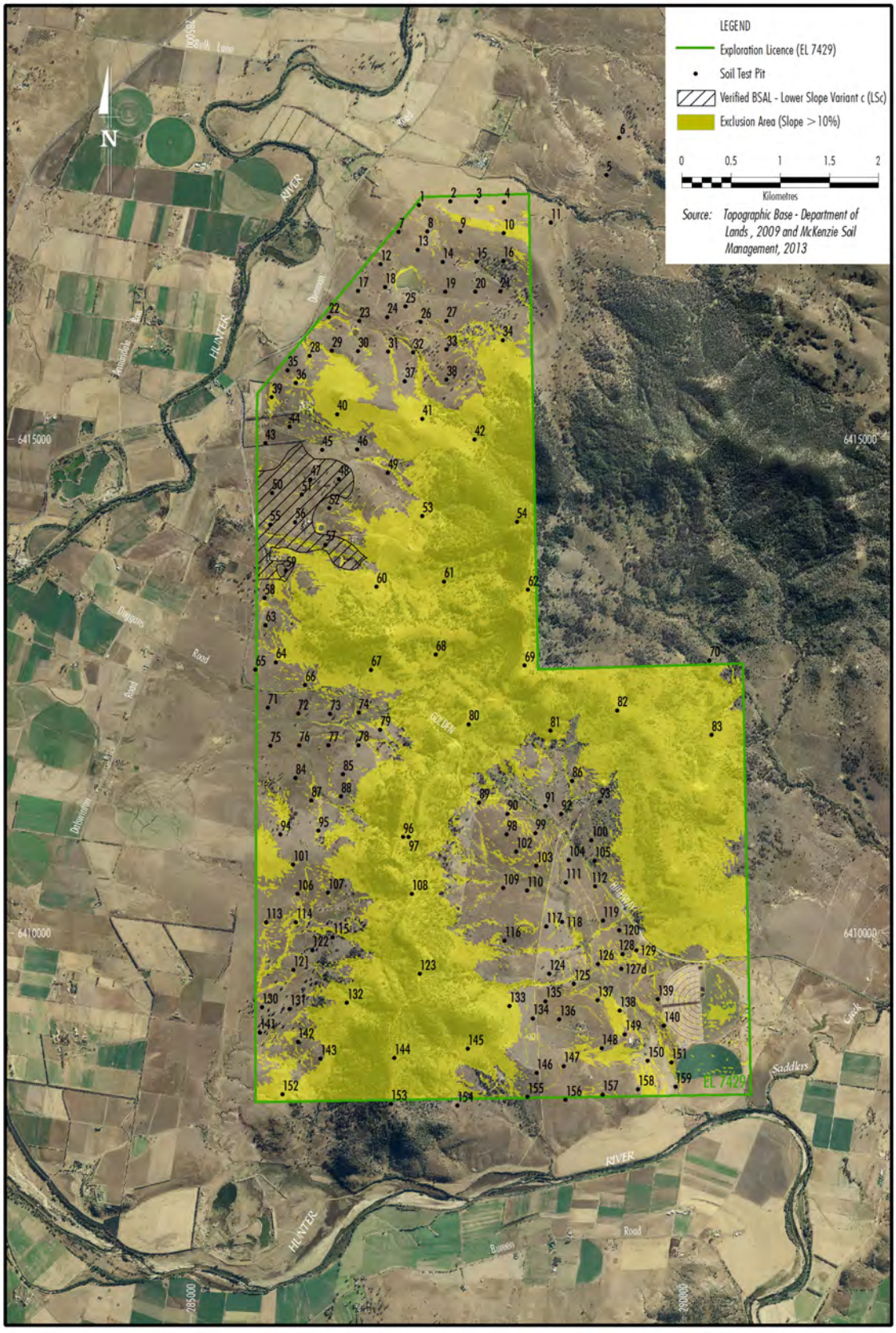

Figure 2-10 Verified BSAL in the Project area

Table 2-6 Equine and Viticulture CIC geographical criteria applied to the Project area

Component	Criteria	Project Area
		Equine CIC criteria
Equine CIC Criteria: *A project site forms part of the Equine CIC if it is:*	Wholly or partially within the area mapped as Equine CIC in the map accompanying the Mining SEPP.	Yes (partially)
	Located on or within 2km of a property that is also within the area mapped as Equine CIC and which is primarily used for horse breeding, horse husbandry, horse sales, or forage sales directly to registered horse breeders.	Yes (5 properties) Woodlands (about <500m) Redman Park (about 500m) Amarina Farm (about 700m) Wexford Farm (about 1km) Monarch Stud (about 1km)
		Viticulture CIC criteria
Viticulture CIC Criteria: *A project site forms part of the Viticulture CIC if it is:*	Wholly or partially within the area mapped as Viticulture CIC in the map accompanying the Mining SEPP.	Yes (partially)
	Located on or within 2km of a property that is also within the area mapped as Viticulture CIC and which is primarily used for a vineyard, a cellar door, a winery, grape sales directly to a registered commercial wine producer, or wine industry-related tourism.	Yes (2 properties) Callatoota Estate (within the Project area) Winbirra Estate (1km)

In addition to the SRLUP, Muswellbrook Shire Council has released a Land Use Development Strategy (LUDS) (MSC, 2013a), which includes an Equine Industry Land Use Strategy and a Viticulture Industry Land Use Strategy. The LUDS was developed to actively manage strategic agricultural land and land use conflicts within the Muswellbrook Local Government Area (LGA). The mapping of *Important Equine Land – Muswellbrook LGA* and *Important Viticultural Land – Muswellbrook LGA* has been released in draft form (MSC, 2013b).

2.1.1.7 Land removed from agriculture

The Project will not permanently remove any land from agriculture. For the 25-year life-of-mine, the Project will require an area of about 200 ha to be temporarily removed from agriculture. This area (refer to Figure 1-3), located in the northeast part of the Project area, shall be required to accommodate pit top and mine surface infrastructure necessary for operation the mine, e.g. offices, warehouse (refer to Section 1.1).

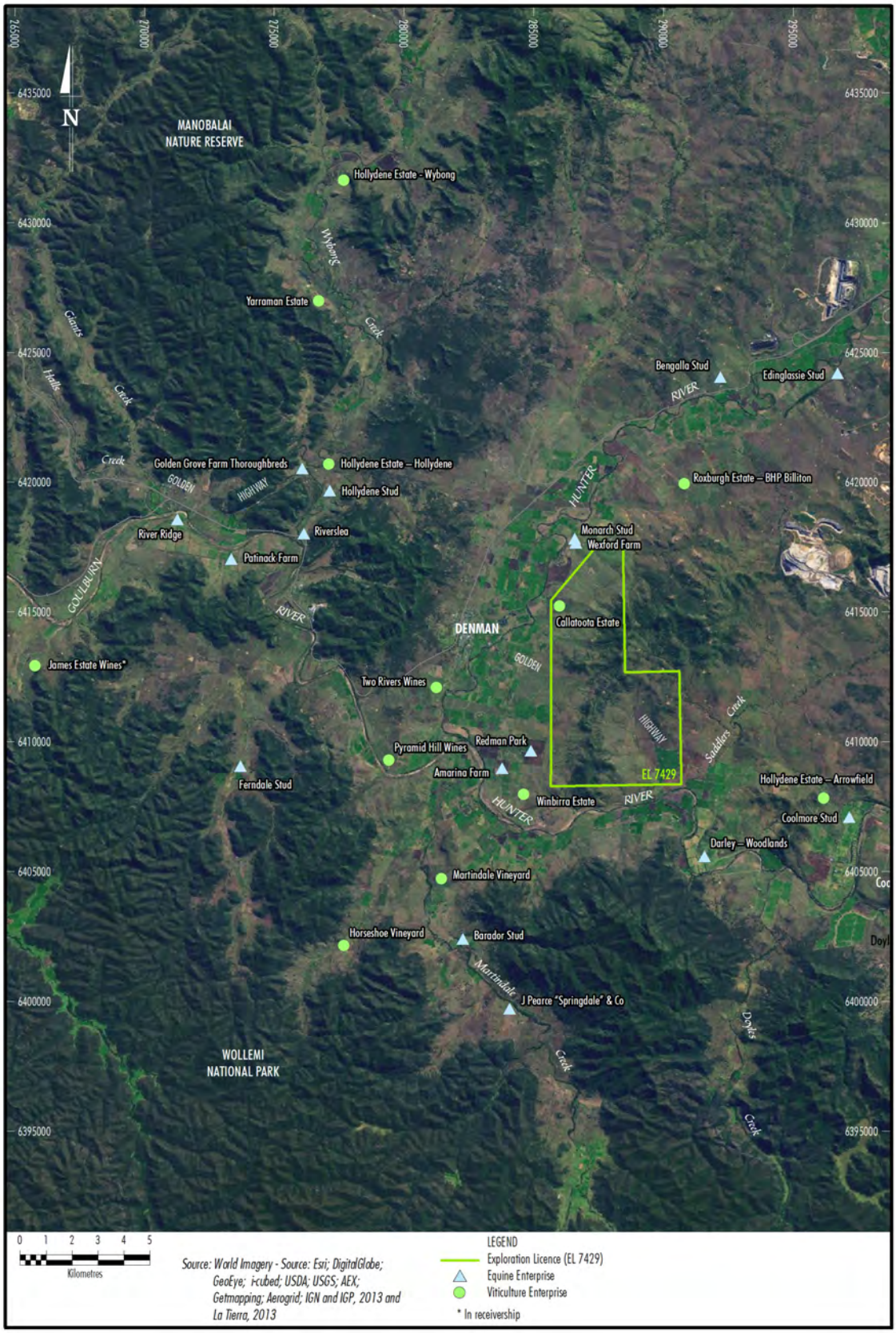

Figure 2-11 Equine and viticulture enterprises in vicinity to the Project area

The land needed for surface infrastructure is Classes 2, 3 and 4 agricultural capability land that is currently utilised for the grazing of beef cattle for weaner production. The approximate limit of lost agricultural production during this period of temporary land use change can be readily calculated. DPI (2006) provides a process for calculating stocking rates. As different grazing animals have different feed intake requirements, and these also vary with growth phase, these calculations are standardised to a Dry Sheep Equivalent (DSE). A DSE is a mature, non-lactating, non-breeding, 50 kilogram (kg) wether. Common DSE ratings for various cattle are listed and the average for a 450 kg cow and weaner calf (cow/weaner unit) is 13.5 DSE, i.e. one cow and calf has a comparable feed intake requirement to 13.5 sheep.

DPI (2006) also refers to pasture carrying capacities in terms of DSE on a hectare basis. In the Upper Hunter region, native unimproved pastures that have not had seed or fertiliser added but which have moderate fertility, have an average rating of 2.8 DSE/ha. On this basis, a cow/weaner unit would require 4.82 ha to maintain adequate feed intake.

The temporary removal of 200 ha from weaner production on the affected land will mean a reduction of 41 cow/weaner units each year for the duration of the Project. This temporary reduction in agricultural productivity is considered small, and immaterial to agricultural production at the Project area or surrounding locality level.

2.1.2 Agricultural enterprises and production on affected land

An assessment of agricultural enterprises and agricultural production on affected land is provided. The assessment has been undertaken through a process of detailed desktop analysis and research, direct interviews with landholders affected by the Project area, and interpretation of aerial imagery. An estimated annual gross value of production has been calculated for each enterprise, based on production information and review of variable regional agricultural commodity prices at the time of this report. This market price review has included reference to Meat and Livestock Australia (MLA, 2013b) and the Australian Livestock Markets Association (ALMA, 2013). No gross margin analysis or other indication of enterprise profitability is made, as this is not considered to be either appropriate or necessary.

The Project area of 3,300 ha encompasses 12 existing agricultural enterprises (Table 2-7 and Figure 2-12). Current agricultural production systems within the Project area include a relatively small area of viticulture (26ha) and also irrigated cropping (100ha), with low-intensity beef cattle grazing for weaner and vealer production being the predominant land use (>3,000ha).

In development of the Project, SHM has acquired properties with land references 9 and 22 (refer to Table 2.7). Property 9 is a vineyard and winery.

Table 2-7 List of agricultural enterprises within the Project area (3,300 ha)

Enterprise count	Land reference	Agricultural production system/s
1	9	Viticulture for winemaking
2	13	Irrigated cropping, beef cattle grazing
3	8	Beef cattle grazing
4	34,35,36	Beef cattle grazing
5	27,32,38	Beef cattle grazing
6	29,30	Beef cattle grazing
7	31	Beef cattle grazing
8	23, 129	Dairy farming
9	22	Beef cattle grazing
10	19	Beef cattle grazing
11	17	Beef cattle grazing
12	15	Beef cattle grazing

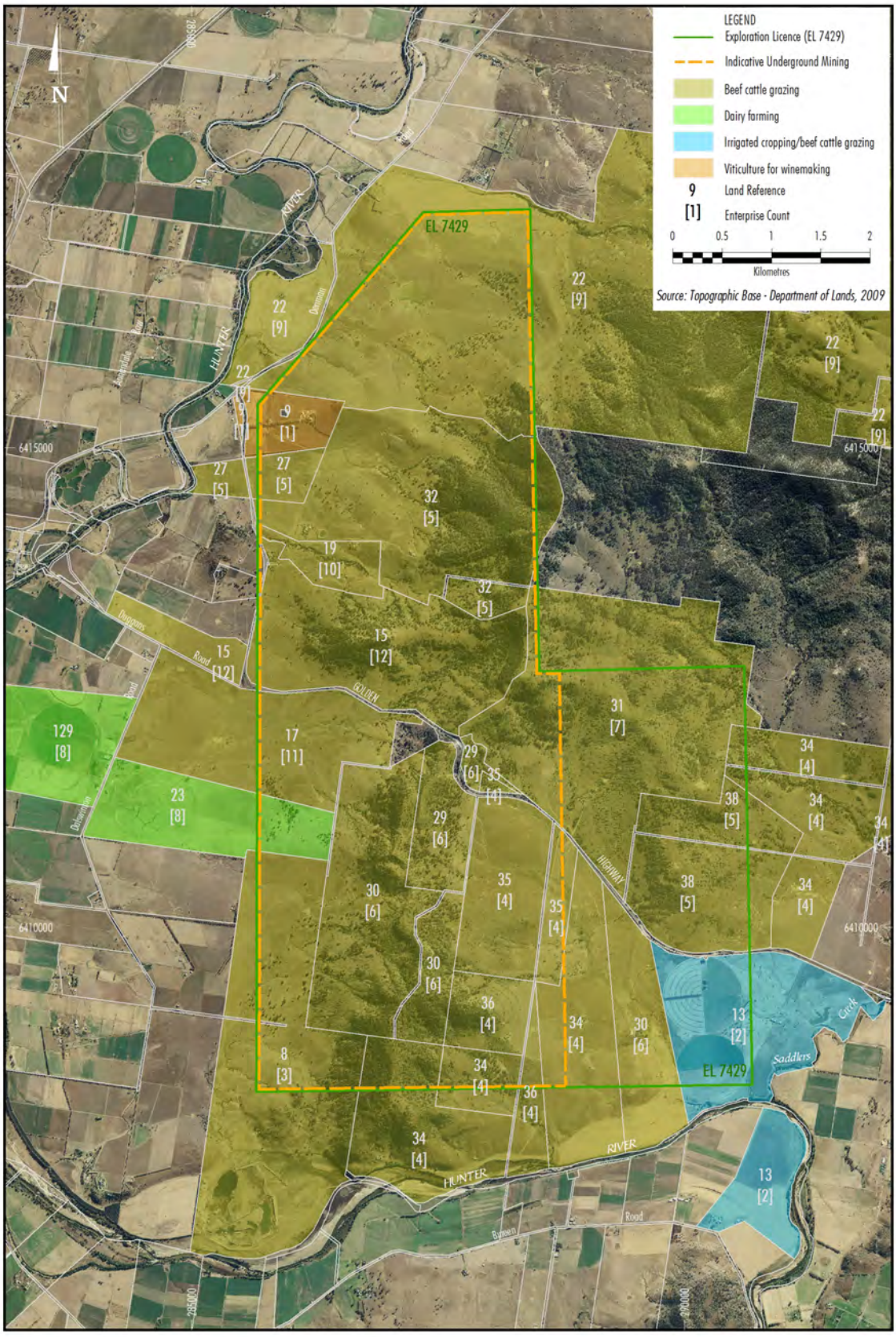

Figure 2-12 Location and types of affected agricultural enterprises in the Project area

2.1.2.1 Enterprise 1

This agricultural enterprise (land reference #9) is the Callatoota Estate, a vineyard and winery primarily concerned with the production and sale of wine by cellar door and direct order. The key agribusiness indicators for this enterprise have been determined (Table 2-8).

Table 2-8 Enterprise 1 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	9 (refer to Figure 2-12)	
Manager	Mr. John Cruickshank at the time of interview, now Spur Hill Agricultural	
Area of production (ha)	TOTAL	Within Project area
	58	45 (78%)
Water	Hunter River allocations totaling 98ML	
System	Vineyard of 26 ha in total: Shiraz (7.14ha), Cabernet (8.45ha), Cabernet Franc (1.01ha), Verdelho (6.77ha) and Chardonnay (2.86ha) and Winery	
Product (unit)	Wine (litre)	
Scale	56,158 vines on 26 ha	
Yield	50 tonnes (t) fruit for 35,000 litres (L) (2012 harvest data from Mr Cruickshank)	
Market	Largely cellar door and online sales, some small retailers within the broader Hunter region carry some product lines	

This 58ha farm features 56,158 grapevines planted on 26ha of the land. Grape varieties include Shiraz, Cabernet, Cabernet Franc, Verdelho and Chardonnay (Figure 2-13, Figure 2-14 and Figure 2-15). The balance of the land area is either utilised for farm infrastructure or is not directly utilised for agricultural production.

The land is highly improved, at least in part, with trellises and drip irrigation for all vines. Irrigation water is via a 98ML allocation from the Hunter River. Other improvements include two residential dwellings, a winery, a tasting room and office, and miscellaneous farm sheds. Soils are generally degraded and requiring amelioration to ensure sustained and viable fruit production for wine making (Landmark, 2008). The land encompasses another small parcel, Lot 18 on 752441 (#40), which is a historic cemetery with gravesites dating from the mid-1800s (Figure 2-16). The cemetery is in a deteriorated condition and is infested with rabbits.

Figure 2-13 Callatoota Estate - vineyard, residential dwellings and winery (township of Denman in background)

Figure 2-14 Callatoota Estate - vineyard

Figure 2-15 Callatoota Estate - winery

Figure 2-16 Historical cemetery - deteriorated condition and infested with rabbits

2.1.2.2 Enterprise 2

This agricultural enterprise (land reference #13) is a highly productive mixed-system agribusiness featuring irrigated cropping and beef cattle production. The key agribusiness indicators for this enterprise have been determined (Table 2-9).

Table 2-9 Enterprise 2 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	13 (refer to Figure 2-12)	
Manager	Mr. Murray Richards	
Area in production (ha)	TOTAL	Within Project area
	333	117 (35%)
Water	Hunter River allocations totaling 763 ML, plus 5 dams	
System	Cropping under center-pivot irrigation	Beef cattle finishing on improved pastures
Product (unit)	Hemp (industrial fiber) Lucerne (hay) Wheat (feed grain and hay) Oats (feed grain and hay)	Grown Steers (400kg LW)
Scale	100 ha under two center-pivot irrigators	300 steers
Yield	Hemp – 300t Lucerne – 180t Wheat – 100t Oats – 50t	300 grown steers units/year
Market	Hemp – contract to EcoFibre Industries Operations at Jerry's Plains Lucerne – local Wheat – local Oats - local	Scone Municipal Saleyards

Mr. Murray Richards manages a medium- to high-intensity cropping and cattle finishing agribusiness on this land (#13). The property totals an area of 333ha and is highly improved. Cropping is conducted under two centre-pivot irrigators covering 60 ha and 40 ha, respectively. The balance of the land is improved for pasture production and is used to grow-out steers to finishing weights.

Bordered by the Golden Highway to the north, the land has about 4 km of frontage to the Hunter River from which irrigation water is sourced. Total water allocations from the river are 763 ML. The current cropping system is a rotation of industrial hemp (Figure 2-17 and Figure 2-18), lucerne, wheat and oats (Figure 2-19).

Major property improvements include two centre-pivot irrigators and associated water pumping and piping infrastructure. There are two residential dwellings, numerous farm sheds, and 5 rain-fed dams. Fencing and internal roadways are in good order.

Most improvements on the land can be attributed to Mr. Richards' 11-year management of the property. In addition to fixed capital improvements, most of the soils within the land have

been ameliorated with significant quantities of Bio-solids (composted human waste) to support sustained cropping and grazing. For example, Mr. Richards applied 70 t/ha Bio-solids prior to sowing the current hemp crop. Bio-solids add chemical and physical nutrition to soils.

Figure 2-17 Mr. Murray Richards' land - industrial hemp (*Cannibus sativa*) crop (right), lucerne crop (left) and centre-pivot irrigator

Figure 2-18 Mr. Murray Richards' land - industrial hemp (*Cannibus sativa*) crop (30ha)

Figure 2-19 Mr. Murray Richards' land - irrigated lucerne crop (30ha)

2.1.2.3 Enterprise 3

This agricultural enterprise (land reference #8, the Cole Family Estate land) is a beef cattle agribusiness producing Vealer calves to local markets. The key agribusiness indicators for this enterprise have been determined (Table 2-10).

Table 2-10 Enterprise 3 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	8 (refer to Figure 2-12)	
Manager	Mrs. Enid Clarke	
Area in production (ha)	TOTAL	Within Project area
	482	179 (37%)
Water	Hunter River stock and domestic supply, 5 rain-fed dams	
System	Mixed breed beef production on native pastures	
Product (unit)	Vealer (330-350kg LW) at 7-9 months of age	
Scale	150 cows with calves	
Yield	95 Vealer units/year	
Market	Singleton Municipal Saleyards	

Mrs. Enid Clarke (nee Cole) manages this mixed breed cattle grazing agribusiness for and on behalf of herself and her siblings (Figure 2-20). This is a low management-intensity agricultural production system. Cattle are yarded periodically and only to remove unweaned and unmarked calves for sale.

The land is comprised of two cadastral parcels totalling approximately 486 ha and is fenced into three equal sized paddocks. The property is accessed via the Rosebrook Dalswinton Quarry Access Road, off the Golden Highway. The property has about 4 km frontage to the Hunter River. There are no major property improvements or infrastructure, other than five rain-fed dams for stock watering (Figure 2-21) and a modest set of cattle yards (Figure 2-22). Fencing is in good order. There are no dwellings on the land.

The Dalswinton Quarry, owned by Rosebrook Sand and Gravel, is a licenced sand and gravel extractive industry operation that exists adjacent to the Hunter River on 100 ha of the land. This quarry is outside of the Project area. The quarry has operated for 50 years (Figure 2-23).

Figure 2-20 Cole Family Estate - mixed breed Vealer beef production

Figure 2-21 Cole Family Estate – rain-fed dam for stock watering

Figure 2-22 Cole Family Estate - cattle yards with covered crush

Figure 2-23 Cole Family Estate - quarry void filled with water (foreground) and active quarry operations (background)

2.1.2.4 Enterprise 4

This agricultural enterprise is a beef cattle agribusiness owned and operated by Mr. Robin and Mrs. Sandra Wolfgang and family (land references 34, 35 and 36). Key agribusiness indicators for this enterprise have been determined (Table 2-11).

Table 2-11 Enterprise 4 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	34, 35 and 36 (refer to Figure 2-12)	
Manager	Mr. Robin and Mrs. Sandra Wolfgang	
Area in production (ha)	TOTAL	Within Project area
	608 (#34) + 190 (#35) + 158 (#36) = 956 (total)	183 (#34) + 190 (#35) + 111 (#36) = 484 (51%)
Water	Hunter River stock and domestic supply, 11 dams, 1 bore	
System	Hereford x Angus beef production on native and improved pastures	
Product (unit)	Vealer (<350kg LW) and Grown Steers (500-600kg LW)	
Scale	220 cows with calves (about 450 head total)	
Yield	80 Vealer units/year, plus 85 Grown Steer units/year	
Market	Singleton or Scone Municipal Saleyards	

The Wolfgang family has held this land since 1911. Current ownership is Mr. and Mrs. Robin Wolfgang (#34 and #35) and their son Mr. Timothy Wolfgang (#36). The aggregation is managed as a single agribusiness and is a low management intensity beef cattle production system producing Vealers and Grown Steers. Terminal progeny is sold through local agents at municipal saleyards in either Singleton or Scone, depending on market conditions.

The land is comprised of three cadastral parcels totalling approximately 956 ha and is fenced into four main paddocks. Access to the property is via Rosebrook Dalswinton Quarry Access Road off the Golden Highway. The property has about 5km frontage to the Hunter River and about 4km frontage to the Golden Highway. There are two residential dwellings (Figure 2-24 and Figure 2-25) and proximate farming infrastructure, including four sheds. Major improvements include 27km of contour bank construction, soil and pasture improvement, cattle yards and 11 rain-fed dams for stock watering (Figure 2-26 and Figure 2-27). Fencing and access roads are in good order. Whilst some of the land has been cultivated previously, none is currently. Parts of the land have been improved with fertiliser (superphosphate) addition and sown to improved pasture species.

Figure 2-24 Mr. Robin Wolfgang's land - access road to residential dwelling with farming infrastructure

Figure 2-25 Mr. Robin Wolfgang's land - second residential dwelling

Figure 2-26 Mr. Robin Wolfgang's land - stock watering dam, improved pasture and contour banking

Figure 2-27 Mr. Robin Wolfgang's land - Hereford x Angus beef production

2.1.2.5 Enterprise 5

This agricultural enterprise is a beef cattle agribusiness owned and operated by Mr. Marcus and Mrs. Robyn Wolfgang (land references 27, 32 and 38). The key agribusiness indicators for this enterprise have been determined (Table 2-12).

Table 2-12 Enterprise 5 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	27, 32 and 38 (refer to Figure 2-12)	
Manager	Mr. Marcus and Mrs. Robyn Wolfgang, and Mr. Peter Wolfgang	
Area in production (ha)	TOTAL	Within Project area
	52 (#27) + 425 (#32) + 232 (#38) = 709 (total)	29 (#27) + 404 (#32) + 181 (#38) = 614 (total)
Water	Hunter River allocations is 170ML (#27), and about 30 dams and 9 bores throughout the land area	
System	Limousin x Charolais beef production on native pastures	
Product (unit)	Grown Steer - Jap Ox (500-600kg LW) > 30 months	
Scale	370 head total	
Yield	150 unit/year (estimate)	
Market	Scone Municipal Saleyards	

Mr. and Mrs. Marcus Wolfgang and Mr. Peter Wolfgang operate a low management intensity agribusiness producing grown steers for local markets. The land is comprised of three cadastral parcels totalling approximately 709 ha and is fenced into a large number paddocks.

There are two residential dwellings on the land (Figure 2-28). There are no other major improvements, save a modest set of cattle yards and 30 rain-fed dams and around 9 bores for stock watering. Fencing is in good order.

Figure 2-28 Mr. Marcus Wolfgang's land - residential dwellings and native pasture

2.1.2.6 Enterprise 6

This agricultural enterprise is a beef cattle agribusiness owned and operated by Mr. Jeffrey Wolfgang (land references 29 and 30). The key agribusiness indicators for this enterprise have been determined (Table 2-13).

Table 2-13 Enterprise 6 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	29 and 30 (refer to Figure 2-12)	
Manager	Mr. Jeffrey Wolfgang	
Area in production (ha)	TOTAL	Within Project area
	90 (#29)+ 450 (#30)= 540 (total)	90 (#29) + 413 (#30) = 503 (total)
Water	Hunter River allocations totaling 374ML, and 6 dams	
System	Black Angus x Herefords (Black Baldy) beef production on native pastures	
Product (unit)	Vealers (300kg LW) at 6 to 10 months	
Scale	210 cows with calves	
Yield	120 Vealer units/year	
Market	Scone and/or Singleton Municipal Saleyards	

Mr. Jeffrey Wolfgang's father acquired this land between 1906 and 1908. At that time, his predecessors commenced dairy farming, which the family continued until 2004. The Friesian dairy herd was retained and put to Hereford and later Angus bulls to produce Black Baldy beef cattle. Today, Mr. Wolfgang operates a low-intensity agribusiness producing Vealer cattle for the local market. Cattle are only handled to remove unmarked and unweaned progeny for sale at either Singleton or Scone municipal saleyards.

There is a single residential dwelling on the farm but no other major improvements or infrastructure (Figure 2-29), save a modest set of cattle yards and a number of farming sheds. Several sheds are used to house and display Mr. Wolfgang's remarkable collection of local historical farming equipment (Figure 2-30). Fencing is in good order.

Figure 2-29 Mr. Jeffrey Wolfgang's land - view of the "Ogilvie" property (#29) from the Wolfgang Family Estate (#31)

Figure 2-30 Mr. Jeffrey Wolfgang's land - native pastures and residential dwelling on "Mayland" (#30)

2.1.2.7 Enterprise 7

This enterprise is a beef cattle agribusiness producing Vealer calves to local markets (land reference 31). Known as the Wolfgang Estate Land, this farm is operated by Mr. Nigel and Mrs. Kate Wolfgang. The key agribusiness indicators for this enterprise have been determined (Table 2-14).

Table 2-14 Enterprise 7 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	31 (refer to Figure 2-12)	
Manager	Mr. Nigel and Mrs. Kate Wolfgang	
Area in production (ha)	TOTAL	Within Project area
	543	396 (73%)
Water	Hunter River (via 29), 7 dams, 3 bores	
System	Hereford x Black Angus beef production on native pastures	
Product (unit)	Vealers (300kg LW) at 6-10 months	
Scale	320 cows with calves	
Yield	160 units/year (estimate)	
Market	Scone and/or Singleton Municipal Saleyards	

Mr. Nigel Wolfgang and Mrs. Kate Wolfgang operate a low-intensity agribusiness producing Vealer cattle on this land known as the Wolfgang Estate land. Cattle are yarded periodically only to remove unweaned, unmarked calves for sale. Approximately 40% of the property is undulating and timbered by native bushland (Figure 2-31).

The land is comprised of one cadastral parcel totalling approximately 543 ha and is fenced into a number of paddocks. Access to the property is via the Golden Highway. Seven rain-fed dams and three bores provide stockwater across the property. There are no major improvements, save a modest set of cattle yards and a number of farming sheds around the residential dwelling. Fencing is in good order.

Figure 2-31 Wolfgang Estate land (foreground) and Rosebrook Dalswinton Quarry Access Road (background)

2.1.2.8 Enterprise 8

This property is known as "Rossett Park" (land references 23 and 129) and is owned by Nejeka Pty Limited, which is thought to be a private superannuation entity. The property is leased to another party and operated as a dairy. In preparing this report, it was not possible to discuss this agribusiness with the landowner or the lessee dairy farmer or to inspect this land directly. Notwithstanding, there is considerable information relating to this land that is accessible via the Internet. Within these limitations the key agribusiness indicators for this property have been determined (Table 2-15).

Table 2-15 Enterprise 8 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	23 (refer to Figure 2-12)	
Owner	Nejeka Pty Ltd (Mr. David Mansfield)	
Area in production (ha)	TOTAL	Within Project area
	167	40 (24%)
Water	2 dams (#129)	
System	Dairy farming	Cropping under centre-pivot irrigation (assumed for self-supply to dairy operation). Potentially a combination of maize, oats, barley, lucerne for feed.
Product (unit)	Milk (litre)	n/a
Scale	n/a	n/a
Yield	n/a	
Market	n/a	

In 2012, "Rossett Park" (#23) in combination with adjoining lots (#129), was offered for sale but has since been withdrawn from the market (Homehound, 2013). This sale advertisement reveals the following property information.

- *"Leased as Dairy - secure income from January 2010, 3 years;*
- *4 Centre Pivots - 50 shares Hunter River water, 376 shares from wells;*
- *230 Ha irrigation including alluviums; and,*
- *24 aside Dairy, covered feed shed, 5 houses" (Homehound, 2013).*

In 2013 the dairy herd, thought to have comprised nearly 600 head of Jersey and Jersey x Holstein cows, was subject to two separate dispersal sales (Dairy Livestock Services, 2013a and 2013b). Confirmation of the results of these sales was not obtainable. From visual assessment however, the enterprise is still an operating dairy farm. Confirmation of any production levels or details of the cropping system was not obtainable. Anecdotally, some or all of the Hunter River water allocation has also been sold.

The property is highly developed for intensive agriculture and from available imagery appears to be in good order (Figure 2-32, Figure 2-33 and Figure 2-34).

Figure 2-32 “Rossett Park” centre pivot irrigators

Figure 2-33 "Rossett Park" 24 aside herringbone dairy

Figure 2-34 "Rossett Park" covered feed shed

2.1.2.9 Enterprise 9

This agricultural enterprise is a beef cattle agribusiness on land now owned by Spur Hill Agricultural P/L (SHA), a company operated by the Spur Hill Joint Venture (land reference 22). SHA have licensed the land back to some of its former owners who run a beef cattle agribusiness on the property. SHA retains the services of Mr. Richard Webb, who provides advice to SHA on the management of properties owned by the company. The key agribusiness indicators for this enterprise have been determined (Table 2-16).

Table 2-16 Enterprise 9 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	22 (refer to Figure 2-12)	
Owner	SHA	
Area in production (ha)	TOTAL	Within Project area
	1844 (#22)	410 (#22)
Water	Hunter River allocations totaling 968ML plus 5 dams	
System	Mixed breed (majority Black Angus) beef production on native pastures	
Product (unit)	Weaner calf	
Scale	400 total herd (estimate)	
Yield	170 weaner calves	
Market	Nundle (taken as Weaner to integrated property of leasee)	

This land was owned by Rosebrook P/L, a company controlled by the Blake family, prior to its purchase by SHA in 2012. The land was subsequently licenced back to the Blake family and SHA retains the services of Mr. Richard Webb, to oversee the licensee's activities.

The land is comprised of multiple cadastral parcels totalling approximately 1,844 ha. The property is divided into three blocks known as "Mayfield", "Willowdell" and "Fairfield". The operation is a low-management-intensity production system, grazing mixed-breed beef cattle on native pastures (Figure 2-35). The cattle are yarded periodically only to process Weaner calves for transport to another of the licensee's properties near Nundle, NSW. There is around 80ha of alluvial soils with irrigation infrastructure adjacent the Hunter River. This infrastructure is thought to be in an unserviceable condition.

There is one residential dwelling on the land. There are no other major improvements, save four sets of cattle yards (e.g. Figure 2-36) and 4 to 5 rain-fed dams for stock watering (Figure 2-37 and Figure 2-38). Fencing is in fair order, though some sections adjacent the highway require attention.

Figure 2-35 SHA "Mayfield" land - mixed breed grown steers (Angus, Charolais and Brahman genetics)

Figure 2-36 SHA "Mayfield" land - cattle yards

Figure 2-37 SHA "Mayfield" land - mixed breed cows and calves, and rain-fed dam for stock watering

Figure 2-38 SHA "Mayfield" land - native pasture and rain-fed dam

2.1.2.10 Enterprise 10

This agricultural enterprise is a beef cattle agribusiness on land owned and managed by Mr. Philip Nichols (land reference 19). Although 'non-operational' at present, the land having been destocked due to wildfire damage to fencing and pastures. The key agribusiness indicators for this enterprise have been determined on the basis that the property will be restocked in the near future (Table 2-17).

Table 2-17 Enterprise 10 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	19 (refer to Figure 2-12)	
Manager	Mr. Philip Nichols	
Area in production (ha)	TOTAL	Within Project area
	48 (#19)	48 (#19)
Water	Hunter River stock and domestic supply, 1 dam, 1 bore	
System	Beef production on native pastures	
Product (unit)	Grown Steer	
Scale	40 Grown Steer units	
Yield	40 Grown Steer units	
Market	Scone and/or Singleton Municipal Saleyards	

Mr. Philip Nichols' land consists of one cadastral parcel and is divided into several paddocks. There is currently no active agribusiness on this land. The property has been previously used for beef production and is likely to be restocked in approximately 12 months. The expected re-stocking will be around 40 head total. There is one residential dwelling on the land. The land is watered via access to the Hunter River, one bore and one dam.

There are no other major improvements or infrastructure, save a solid set of new cattle yards and a number of farming sheds around the residential dwelling (Figure 2-39). Fencing across the property has been damaged by recent bush fires and is currently being replaced. A feature of this property is the completed restoration of a previously unstable and badly eroded gully (Figure 2-40).

Figure 2-39 Mr. Nichols' land - native pastures and residential dwelling

Figure 2-40 Mr. Nichols' land - gully restoration including tree planting for erosion control

2.1.2.11 Enterprise 11

This agricultural enterprise is a beef cattle agribusiness owned and managed by Mr. John Moore (land reference 17). The key agribusiness indicators for this enterprise have been determined (Table 2-18). The interview for this enterprise was undertaken remotely. As such, no photographs of the property were taken.

Table 2-18 Enterprise 11 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	17 (refer to Figure 2-12)	
Manager	Mr. John and Mrs. Julie Moore	
Area in production (ha)	TOTAL	Within Project area
	283 (#17)	140 (#17)
Water	8 dams, 1 bore	
System	Cattle finishing on improved pastures	
Product (unit)	Grown Steers (700-800kg LW)	
Scale	200 cows with 170 calves	
Yield	120 Grown Steer units/year	
Market	Singleton Municipal Saleyards or directly to Throsby Abattoirs in Singleton	

Mr. and Mrs. Moore have owned the property since 1989 and operate it in conjunction with two other properties near Singleton. Cattle are bred at the Singleton properties and finished to market weights on improved pastures at the Denman property. The Golden Highway and Dalswinton Road border the land on two sides. The land is divided into four paddocks. There are no residential dwellings.

Major improvements to the property include pasture improvement, cattle yards and 8 rain-fed dams for stock watering. Fencing and the access road are in good order. Parts of the land have been improved with the application of fertiliser (superphosphate) to improve pasture.

2.1.2.12 Enterprise 12

This agricultural enterprise is a mixed breed beef cattle agribusiness owned by Mr. Guiseppe Mediati (land reference 15). The key agribusiness indicators for this enterprise have been determined (Table 2-19). The interview for this enterprise was undertaken remotely. As such, no photographs of the property were taken.

Table 2-19 Enterprise 12 - key agribusiness indicators

Key Agribusiness Indicators	Description	
Land reference #	15 (refer to Figure 2-12)	
Manager	Mr. Guiseppe Mediati	
Area in production (ha)	TOTAL	Within Project area
	363 (#15)	363 (#15)
Water	11 dams, 1 well and Hunter River domestic and stock licence	
System	Cattle finishing on improved pastures	
Product (unit)	Grown Steers (450-600kg LW)	
Yield	200 Grown Steer units/year	
Market	Denman, Singleton and, Scone Saleyards and Primo Abattoirs in Scone	

Mr. Guiseppe Mediati has owned this property "Browlea Park" since 2003 but resides in Sydney and visits the property as required. Mr. Mediati finishes mixed breed beef cattle, including Angus, Murray Grey and Hereford. A part-time employee from the Denman area manages the property. There is one residence on the property. In addition to the residence, the property has five farm sheds, three cattle yards, eleven rain-fed dams for stock watering and two centre-pivot irrigators.

The Golden Highway, with 4 km of property frontage, borders the land on two sides. An estimated 20% of the property is covered in remnant dry sclerophyll woodland, described by the Muswellbrook Local Environmental Plan (LEP) as part E3 (Environmental Management) Zone (MSC, 2009).

Weaners and vealers are purchased locally at Denman, Muswellbrook and Singleton for finishing on the property. Cattle are purchased at an approximate weight of 200 kg and sold

at between 450 to 600 kg. The primary sale markets are the local Denman Saleyards, Singleton and Scone as well as the Primo Abattoirs in Scone.

Major improvements to the property include pasture improvement by fertiliser (superphosphate), fencing, extension of the water supply line to the rear of the property, the construction of two new centre pivot irrigators, and cattle yard upgrades.

2.2 Surrounding locality

The surrounding locality is defined specifically as the Parishes of Althorpe and Vaux (County of Durham) in the Muswellbrook LGA of the Upper Hunter Region, NSW (refer to Figure 1-4). For regional context, these are two of 45 Parishes in the Muswellbrook LGA. The Muswellbrook LGA of 340,500ha, plus the Upper Hunter, Singleton, Dungog and Gloucester LGAs, form the Upper Hunter region covering more than 2.18 million ha (DP&I, 2012a).

Following is an assessment of the agricultural resources and enterprises within the surrounding locality. While skewed to the Parishes of Althorpe and Vaux specifically, certain aspects are discussed at a broader, both LGA-level and regional-level, due to the nature and limitations of available data, e.g. Australian Bureau of Statistics (ABS) data.

2.2.1 Agricultural resources

The agricultural resources of the surrounding locality are described.

2.2.1.1 Soils

Kovac and Lawrie (1990) describe and map the following soil landscapes within the surrounding locality.

- Alluvial soils - Hunter and Wollombi soil landscapes;
- Shallow soils – Lees Pinch and Ogilvie soil landscapes;
- Red clays – Brays Hill soil landscape;
- Brown clays – Dartbrook soil landscape;
- Soloths – Liddell and Jerry's Plains soil landscapes;
- Brown podzolic soils – Three Ways soil landscape;
- Yellow podzolic soils – Roxburgh soil landscape; and
- Solodic soils – Bayswater, Benjang, Growee and Sandy Hollow soil landscapes.

The Hunter Alluvial soil landscape grouping underlies the floodplains of the Hunter River and its tributaries. This grouping is characterised by brown clays and black earths along watercourses and drainage lines typically adjacent to the Dartbrook and Brays Hill soil landscapes groupings. Red podzolic soils and lateritic soils are known to occur on terraces, with the presence of non-calcic brown soils and yellow solodic soils in some drainage lines.

The Dartbrook soil landscape grouping typically underlies low rolling to undulating hills. This grouping is characterised by prairie soils on the alluvial flats with brown earth intergrades and non-calcic brown soils on the mid to lower slopes. Brown clays with some black and brown earth intergrades are known to occur on mid slopes while red-brown earths are present on upper slopes.

The Liddell soil landscape grouping typically underlies low rolling to undulating hills. This grouping is characterised by yellow soloths and some yellow solodic soils on slopes with earthy and silaceaous sands on mid to lower slopes. Red soloths, solodic soils and podzolic soils are known to occur within the landscape.

Of these soils landscapes, the Hunter Alluvial soil is considered the most agriculturally significant. These soils are typically deep brown/black clays, with moderate to high inherent fertility. With a low water holding capacity and excellent drainage, these soils are well suited to cropping and irrigation. The extent of Hunter Alluvial is restricted to the floodplains of the Hunter River and its tributaries.

2.2.1.2 Slope/topography

At a broad regional level and generally, the Upper Hunter has four regional landform units.

- Liverpool and Mount Royal Ranges [including Barrington Tops];
- Merriwa Plateau and Goulburn Valley;
- North Eastern Foothills; and
- Central Lowlands.

The Liverpool Ranges, Mount Royal Ranges and Barrington Tops in the north and northeast of the valley form the headwaters of the Hunter River and Wollombi Brook.

The Merriwa Plateau is derived from weathered basalt. The Goulburn Valley to the south has softer sandstones forming broad open valleys. A sandstone escarpment and plateau forming the Wollemi National Park defines the southwestern part of the Upper Hunter.

The northeastern part of the Upper Hunter is a hilly and low mountainous area derived from hard sedimentary rocks and lava. It extends from Mount Royal and Barrington Tops to the central part of the valley.

The Central Lowlands extend from Murrurundi to Branxton and were formed from relatively weak Permian sediments.

Surface contours of the surrounding locality are provided (Figure 2-41).

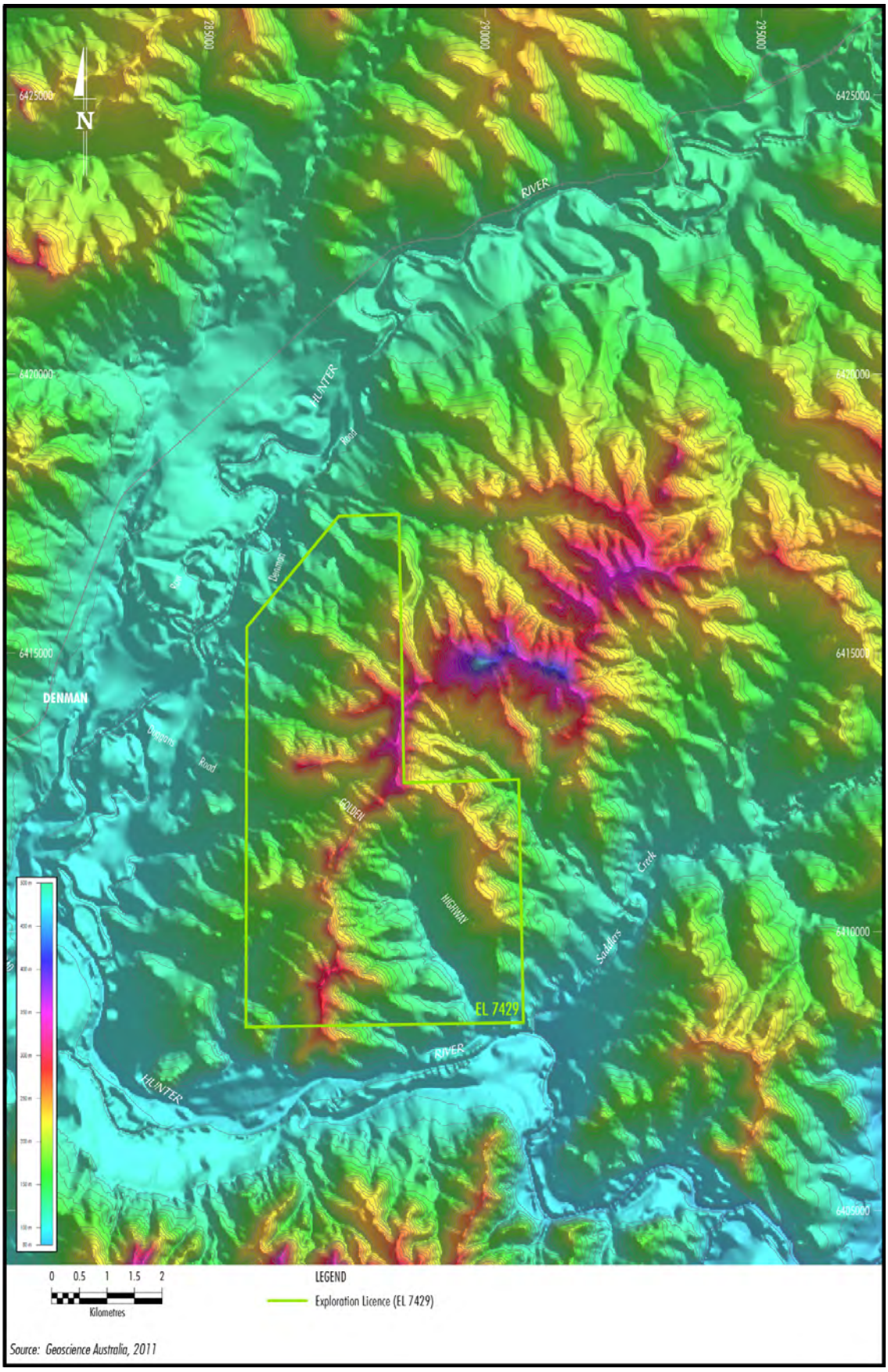

Figure 2-41 Surface contours of the surrounding locality

2.2.1.3 Key Support infrastructure

There is well-developed and well functioning agricultural support infrastructure in the surrounding locality and broader LGA.

Transport infrastructure

The Golden Highway (Figure 2-42), State Route 84, bisects the Project area and is the most important road in the surrounding locality. It runs from the New England Highway between Branxton and Singleton to the Newell Highway at Dubbo, passing through Denman, Merriwa and Dunedoo. It is a major access route to the Upper Hunter Valley vineyards, which are centred on the area between Putty Road and Merriwa, as well as carrying an increasing volume of agricultural produce destined for the port at Newcastle. Rural traffic volumes peak at about 8,000 vehicles per day (vpd) near Broke Rd at Mt Thorley and they are at their lowest west of Cassilis (just over 1,000 vpd) (OzRoads, 2013).

Figure 2-42 Golden Highway within the Project area - looking west towards Denman Gap

At a high-level, industry specific support services and infrastructure are as follows.

Cattle industry

- Selling centres at Scone (Scone and Upper Hunter Regional Saleyards), Singleton (Singleton Livestock Markets) and Denman saleyards (Figure 2-43);
- Agents in Scone, Aberdeen, Singleton and Denman;
- Numerous livestock carriers; and
- Meatworks at Scone (Primo).

Figure 2-43 Denman cattle saleyards

Upper Hunter equine CIC

Components of the equine CIC have been identified (Table 2-20). The core business of the cluster is horse breeding to produce a primary product of foals for customers. The core businesses, also termed *central actors*, have been identified. These include thoroughbred studs and, importantly, other horse breed studs including Australian Stock Horses and Quarter Horses. DPI (2013) notes the presence of other breeds in the CIC. Whilst other breeds are important contributors within the region, the highest value is found within the thoroughbred sector.

Central actors are supported by a significant and interdependent array of support businesses, and soft and hard infrastructure. Recognising the importance of geographical proximity, particularly with respect to communication as described in Kleinhardt-FGI (2002), example cluster components are limited to those within a one-hour journey by road. Whilst other businesses beyond this distance may contribute to the cluster, these may be thought of as satellite actors and not direct components of the CIC.

Table 2-20 Upper Hunter Equine CIC components and examples

Primary Customers	International racing industry Australian racing industry Equine sport and recreational riding sectors
↑	
Primary Products	Thoroughbred Yearlings Other breed progeny
↑	

(table continued overleaf)

Cluster Components	Type	Example
Core business (central actors)	Thoroughbred Stallion Studs[1, 2]	Arrowfield, Coolmore, Bengalla, Byerley, Emerites Park, Kelvinside (Darley), Kitchwin Hills, Patinack Farm, Toolooganvale Farm, Turangga Farm, Vinery, Widen, Yarraman Park
	Thoroughbred Broodmare Studs[1, 2]	Amarina Farm, Ashleigh, Attunga, Barador, Baramul, Bellerive, Chatsworth Park, Cressfield, Crowningstone, Edinglassie, Flame Tree, Glastonbury Farms, Golden Grove, Goodwood Farm, Holbrook, Kia Ora, Middlebrook Valley Lodge, Middlebrook Station, Monarch, Murrulla, Redman Park, Riversdale Farm, Riverslea Farm, Segenhoe, Sledmere, Timor Creek, Willowpark, Woodlands (Darley), Wexford Farm
	Other breed Studs[3]	Australian Stock Horses: JR Poole, TJ Blake, BW Brooker, DF and JF Mcintyre, Glew Family Partnership, Barsham, Haydon, PA and JM Cutler, SM Fitzpatrick, NJ and L Holz Australian Quarter Horses: Our Range Arabian Horses: Alabama Stud
Support business (support actors)	Equine health	Scone Equine Hospital, Scone Brooks Veterinary Services, Scone Stenhouse Equine Dentistry, Scone Equine Podiatry and Lameness Centre, Muswellbrook Jerry's Plains Veterinary Clinic Centre for Equine Reproductive Medicine
	Equine R&D	Hunter Valley Equine Research Centre, Scone
	Equine legal	Equilaw, Muswellbrook
	Bloodstock agents	Scone Blookstock Service, Scone William Inglis & Son Bloodstock Agents, Scone
	Farriers	A & B Jones, Scone; Brian Atfield Farrier Service, Jerry's Plains; Shannon Smith, Glendonbrook; Ben Anderson Farrier, Denman
	Feed suppliers	Various feed supply merchants in Scone and Muswellbrook
	Feed producers	Numerous including lucerne farmers along the Hunter River
	Horse transport	RB Horse Transport, Scone; Signature Equine Transport, Scone
	Landscape architecture	Ladd-Hudson Architects, Sydney; Timothy Court & Company, Sydney.

Cluster Components	Type	Example
	Trades/technical	Carpenters, plumbers, electricians, painters, horticulturalists, greenkeepers
Soft support infrastructure	Education	Tocal Agricultural College, Tocal Scone TAFE, Scone
	Tourism	Hunter Valley Thoroughbred Tours
	Government policy	State level, e.g. NSW Strategic Regional Land Use Plan; Local, e.g. Muswellbrook Shire Council Community Strategic Plan
Hard support infrastructure	Racing facilities	Scone Race Club, Scone Muswellbrook Race Club Merriwa Race Club
	Transport infrastructure	Roads, rail, air (private)

Sources: [1] HTBA (2013)
[2] MSC (2012a)
[3] Australian Stock Horse Society (2013)

Upper Hunter Viticulture CIC

Components of the viticulture CIC have been identified (Table 2-21). The core business of the cluster is viniculture to produce a primary product of wine for customers. The core businesses, also termed *central actors*, have been identified. Again, consistent with established clustering theories, this analysis is limited to business operating within a one-hour journey by road.

Table 2-21 Upper Hunter Viticulture CIC components and examples

Primary Customers	Export wine industry Australian wine industry
↑	
Primary Products	Wine
↑	

Cluster Components	Type	Example
Core business (central actors)	Vineyards and wineries	Adina, Allandale, Audrey Wilkinson, Arrowfield, Ballabourneen, Batchelors Terracevale, Bimbideen, Bimbadgen, Blackwattle, Briar Ridge, Brokenwood, Broke Fordwitch, Brokes Promise, Casuarina, Catherine Vale, Colvin, Constable, David Hook, De Bortoli, De Iuliis, DenMar, Divinity, Drayton's Family, Elsemores, Caprera Grove, Elysium, Foate's Ridge, Gartelmann, Hunter Valley Wines, Ghostriders, Hollydene, Ironbark Hill, James Estate, Kelman, Keith Tulloch, Kevin Sobels, Krinklewood, Kurrajong, Lakes

Cluster Components	Type	Example
		Folly, McGuigan, Margan Family, Marsh, McLeish, McWilliams, Mt Pleasant, Milbrooke, Millers Hillside, Misty Glen, Molly Morgan, Mont Valley, Mt Broke, Nightingale, Oakvale, Olio Mio, Outram, Peterson, Pepper Tree, Polin and Polin, Pooles Rock, Pyramid Hill, Racecourse Lane, Robyn Drayton, Roche, Rosebrook, Rothvale, Saddler's Creek, Scarborough, Tamburlane, Tatler, Terrace Vale, Tinklers, Tintilla, The Little Wine Company, Thomas, Tower, Tulloch, Tuscany, Two Rivers, Tyrells, Vercoe's, Vinden, Wandin Valley, Warraroong, Whispering Brooke, Windsor's Edge, Wombat Crossing, Wirral Grange, Wyndham, Yarraman (HVWIA, 2013)
Support business (support actors)	Agronomy	Landmark, Ace Ohlsson, Bright Vine Services, Vitibit
	Equipment & supplies	Agricultural traders, e.g. Elders, CRT
	Hospitality	Local restaurants, hotels, resorts
	Trades/technical	Carpenters, plumbers, electricians, painters, horticulturalists, greenkeepers
Soft support infrastructure	Education	Tocal Agricultural College, Tocal Scone TAFE, Scone
	Tourism	Tourism operators
	Government policy	State level, e.g. NSW Strategic Regional Land Use Plan; Local, e.g. Muswellbrook Shire Council Community Strategic Plan
Hard support infrastructure	Transport infrastructure	Roads, rail

2.2.1.4 Water resources

Surface water

The surrounding locality (specifically, the Muswellbrook LGA) is within the Upper Hunter region of the Hunter Valley, the catchment of the Hunter River and its tributaries. The Hunter Valley is a unique area of environmental, industrial, agricultural and economic value and the river underpins these values (DoP, 2005). The Hunter River rises in the Mount Royal Range north east of Scone and travels approximately 450km to the sea at Newcastle. The river is regulated from Glenbawn Dam to Maitland, a distance of about 250km.

Being a "regulated river" means that the flow regime has been altered and is controlled to deliver water for industry, agricultural and town water supplies. In the surrounding locality, river flow is controlled by releases of water from Glenbawn Dam, near Scone. This dam, along with Glennies Creek Dam and Lostock Dam, both downstream of the surrounding

locality, ensure water for irrigation along the river. Importantly, while these dams are used to manage water delivery to water users, they only interfere with 8% of the Hunter River catchment (DoP, 2005). Notwithstanding, the volume and pattern of flows in the Hunter River system have been significantly altered by the construction and operation of Glenbawn and Glennies Creek Dams and significant volumes of water are also taken and stored for power station use in Lake Liddell (DIPNR, 2004).

Water extraction is regulated via the Water Sharing Plan, under Section 50 of the WM Act. The provisions in the Water Sharing Plan provide water to support the ecological processes and environmental needs of the river, and direct how the water available for extraction is to be shared. The Water Sharing Plan also sets rules that affect the management of water access licences, water allocation accounts, the trading of or dealings in licences and water allocations, the extraction of water, the operation of dams and the management of water flows.

Under the Water Sharing Plan, all water extraction, other than basic landholder rights extractions, must be authorised by an access licence. Basic landholder rights provide for stock and domestic, and also native title, extraction without the need for an access licence. Annual licenced water use is limited under the Plan (Table 2-22).

Table 2-22 Hunter regulated river water use allocation

Access licence category	Share component	Explanatory note
Basic landholder right, stock and domestic	5,515 ML/y	No access licence required
Basic landholder right, native title	Nil currently	No access licence required
Major utility	36,000 ML/y	Guaranteed 100% allocation except in exceptional drought conditions. Major utilities are Hunter Water Corporation, Macquarie Generation. Local utilities are Shire Councils.
Local utility	10,832 ML/y	
Domestic and stock	1,738 ML/y	
High security	22,159 unit shares	At least 0.75ML/unit share except in exceptional drought. 1.0 ML/unit share when general security is allocated >0.5ML/unit share.
General security	128,163 unit shares	<1ML/unit share, flow dependant.
Supplementary	49,000 unit shares	Extraction allowed only during periods of high flow, e.g. dam spill events.

Source: adapted from DIPNR (2004)

In addition to stock and domestic extraction, under basic landholder rights or access licence, irrigation water is typically high or general security water. An embargo on new access licences creates a 'value' on existing licences, which are tradeable. In 2009/10, the median price for general security water in the Hunter regulated river was $3,000/ML, the most expensive general security water of any regulated river in NSW (National Water Commission, 2011). In 2012/13, this price was $2,500/ML (NSW Office of Water, 2013).

Alluvial Aquifers

The WM Act describes an aquifer as *"a geological structure or formation, or a landfill, that is permeated with water or is capable of being permeated with water."* Alluvial aquifers generally overlie deeper hard rock aquifers. In NSW, these vertically layered aquifers may be managed as separate water sources. All alluvial aquifers have a major hydrologic connection with a surface water feature. The alluvial aquifers of the surrounding locality consist of the unconsolidated sediments, being gravels, sands, silts and clays, associated with the Hunter River and its tributaries. This aquifer is known as the Hunter Valley Alluvium aquifer and it is an important Groundwater Management Unit (GMU) for agriculture, due to its capacity to store groundwater, capacity for groundwater flow and water quality (ANRA, 2013; DPI, 2005).

The aquifer extends in a continuous and thin strip from the tidal limit of the Hunter River midway between Newcastle and Maitland to above Scone, a distance of more than 250km. The aquifer also includes alluvial deposits continuous with those of the Hunter River in Wollombi Brook, Pages River, Goulburn River and Paterson River. Some minor discontinuous alluvials are also included.

The GMU is a significant source of water for agriculture due to its proximity to better farming soils, potential yield and suitable water quality (Table 2-23). It has been used for irrigation for many years, often as a supplement to surface water supplies due to the proximity to the river of most of the better alluvial soils, particularly the Hunter Alluvial soil landscape (Section 2.1.1.1). Most of the groundwater used for irrigation is used for pasture irrigation, for the dairying industry, but a significant amount is also used for irrigation of grapes. There are thought to be many unlicensed bores within the GMU (ANRA, 2013).

Table 2-23 Characteristics of the Hunter Valley Alluvium aquifer GMU

Statistical characteristic	Hunter Valley Alluvium
Area (km^2)	908
Total water allocated (ML)	Not known
Total water consumed (ML)	68,982
Average salinity (mg/L)	900
Sustainable yield (ML)	57,000
Depth to top of aquifer (m)	5

Source: ANRA (2013)

Significant localised variability exists in aquifer characteristics. Studies have shown that aquifer recharge is closely related to river flow events (DoP, 2005). During periods of lower rainfall and reduced river flow, the alluvial groundwater quantity and quality may decline. During a low rainfall period between 2000 and 2003, the quality of alluvial groundwater in the vicinity of Scone, upstream of the surrounding locality, declined to the extent that it was not suitable for irrigation of salt sensitive crops (Table 2-24).

Another study assessed the characteristics of the alluvial aquifer immediately upstream of the surrounding locality. Groundwater data collected by the nearby Mt Arthur Coal Mine from bores within the Hunter Valley alluvium indicate that the water quality of the alluvial aquifer is quite variable, with electrical conductivity (EC) ranging from 1,500 to 9,370 µS/cm

and pH ranging from 6.7 to 7.6 Australasian Groundwater and Environmental Consultants (AGE, 2013).

More recently and specific to the Project area, HydroSimulations (2013) shows an average Hunter Valley alluvium EC of 1187 uS/cm on the floodplain (based on 11 samples), and 4570 uS/cm on the colluvial slopes (i.e. more distal to the river; based on 3 samples).

Table 2-24 Salinity of Hunter Valley Alluvium aquifer - near Scone, 2000 to 2003

Bore	Salinity 2000 (µS/cm)	Salinity 2003 (µS/cm)
1	n/a	1710
2	587	794
3	1780	2740
4	1730	2640
5	695	961
6	549	769
7	930	1099
MEAN	1045	1500

Source: DoP (2005)

The Water Sharing Plan regulates water extraction from the Hunter Alluvial aquifer for the Hunter Unregulated and Alluvial Water Sources 2009 (the Plan), under Section 50 of the WM Act. The objectives of the Plan include providing environmental and user certainty, and facilitating the trading of water. The Plan requires that all water extraction, other than extraction in accordance with basic landholder rights, be licenced.

Hardrock Aquifers

Much of the surrounding locality and broader Upper Hunter region is underlain with Basalt flows that can yield productive groundwater flows for agricultural use (DPI, 2005). Whilst useful for stock watering and domestic supply, such aquifers are typically not capable of supplying sufficient flow for irrigation purposes.

Deeper Permian Age formations, Upper and Lower Coal Measures and intervening Marine Sequence, contain saline groundwater in coal seams with recorded salinity of 4000 to >26,000 µS/cm (DPI, 2005). This groundwater is too saline to have any beneficial agricultural use. Hardrock aquifers are of relatively lower importance than alluvial aquifers with respect to agriculture in the surrounding locality.

2.2.1.5 Location and type of agricultural industries

The types of agricultural industries within the surrounding locality include beef cattle, dairy cattle, horse breeding and viticulture. At a regional level, these industries together account for an estimated $400M in annual production and employ more than 5,000 people or 13% of the regional workforce (Table 2-25).

Whilst widespread and diverse in size, type and management, some clustering of specific agricultural industries is evident. Beef cattle production dominates the agricultural

enterprises in the region by production area, stock numbers and output value. The equine industry is concentrated around Scone, Aberdeen, Muswellbrook and Denman within the Upper Hunter and Muswellbrook LGAs. Dairying is confined to the alluvial flats with irrigation potential, mostly adjacent the Hunter River. Cereal cropping is most prevalent in the western parts of the Upper Hunter LGA and the Merriwa Plateau (Buchan Consulting, 2011).

Table 2-25 Major Upper Hunter agriculture value by sector

Upper Hunter Agriculture Sector	Value Unit	Output Value ($) (2009 estimates)	Employment (2009 estimates)
Beef and dairy, including cropping	Farm gate value of production	248M	3753 (direct and support)
Thoroughbred horse breeding	Industry revenue	100M	886 (direct)
Viticulture	Revenue	50M	400 (direct)

Source: Buchan Consulting (2011)

According to the Australian and New Zealand Standard Industrial Classification (ABS and SNZ, 2006), the types of agricultural industries within the LGA are classified as follows.

Division A – Agriculture, Forestry and Fishing

Subdivision – 01 Agriculture

Group – 013 Fruit tree and nut growing

Class – 0131 Grape growing

- Primary activity is wine grape growing

Group – 014 Sheep, beef cattle and grain farming

Class – 0142 Beef cattle farming (specialised)

- Primary activity is beef cattle farming

Class – 0145 Grain-sheep or grain-beef cattle farming

- Primary activity is beef cattle farming and grain growing

Class – 0149 Other grain growing

- Primary activity is growing cereals, e.g. wheat

Group – 016 Dairy cattle farming

Class – 0160 Dairy cattle farming

- Primary activity is dairy cattle farming

Group – 019 Other livestock farming

Class – 0191 Horse farming

- Primary activities are horse breeding and stud farm operation

The ABS provides data for most of these classes at a LGA level of detail (Table 2-26). This data shows that Class 0142 Beef cattle farming (specialized) is the dominant type of agricultural system in the Muswellbrook LGA.

Table 2-26 ANZSIC Classes, Muswellbrook LGA

ANZSIC Class	Statistic
0131 Grape growing	4,416 ha
0142 Beef cattle farming (specialised)	35,745 head
0145 Grain-beef cattle farming	n/a
0149 Other grain growing	345 ha
0160 Dairy cattle farming	10,421 head
0191 Horse farming	n/a

Source: ABS (2013c)

2.2.1.6 Vegetation

Vegetation within the Project area and surrounding locality is highly affected by anthropic development for agriculture and, to a lesser extent, mining. Existing vegetation is characterised by remnant dry sclerophyll woodland on a ridge that trends though the centre of the Project area, surrounded by pasturelands.

As an agricultural resource, the vegetation is used predominantly as livestock grazing, livestock shade, and slope and riparian land stability. Much of the area has been extensively cleared for the purpose of livestock grazing, dairy farming and other agricultural production. Large areas of pasturelands have been subject to *improvement*, by fertilisation and introduction of exotic pasture species (Section 2.1.2). Endangered ecological communities (EECs) and endangered populations potentially occur.

According to the Muswellbrook Local Environmental Plan (LEP) (MSC, 2009) the Project area is partly zoned RU1 (primary production) and partly E3 (environmental management). The E3 zone basically captures remnant woodlands to form an Environmental Protection Zone – Environmentally Sensitive Land (remnant vegetation of significance). This accounts for about 50% of the Project area. The balance of the land has been cleared.

The Vegetation Information System (VIS) database, administered by the Office of Environment and Heritage (OEH) was accessed to complete a preliminary desktop assessment of the status of vegetation within the Project area. The database provided results for the vegetation communities, potentially endangered populations and flora species. There were 286 plant species listed as potentially occurring, both native and exotic species (OEH, 2013). The database indicates that Endangered Ecological Communities (EEC) under the *Threatened Species Conservation Act 1995* (TSC Act) may be present (Table 2-27).

Table 2-27 Project area - Endangered Ecological Communities that may be present

Community	Descriptions
Central Hunter Grey Box-Ironbark Woodland in the New South Wales North Coast and Sydney Basin	The community generally occurs on Permian geology characteristics of the Hunter Valley where if forms woodland to open forest on slopes and undulating hills (NSW Scientific Committee). The community occurs

Community	Descriptions
Bioregions under the TSC Act. E3 Status	between Singleton and Muswellbrook. Floristic composition can vary depending on location and disturbance history; however a number of flora species have been identified as typical of the community assemblage (NSW Scientific Committee, 2010a). These include Narrow-leaved Ironbark, Kurrajong and Grey Box as dominant canopy species. Its known to contain the vulnerable species *Diuris tricolor* and an endangered population of Cymbidium canaliculatum (NSW Scientific Committee, 2010a).
Hunter Floodplain Red Gum Woodland in the NSW North Coast and Sydney Basin Bioregions. E3 Status	Hunter Floodplain Red Gum Woodland is listed as a floodplain woodland that occurs on deeper soils at the base of foothills and along creeklines (Peake, 2006; NSW Scientific Committee, 2010b). It has a sparse distribution in the Hunter region and is strongly associated with alluvial soils on floodplain rises along major rivers and creeks. It is generally found in location where inundation occurs during river overflow and flood events. *Eucalyptus camaldulensis* (River Red Gum) can often occur as the sole canopy species; however in some areas, it is common to find co-dominants of *Eucalyptus tereticornius* (Forest Red Gum), *Eucalyptus melliodora* (Yellow Box), *Angophora floribunda* (Rough-barked Apple) and *Casuarina cunninghamiana* (River Oak).

Source: OEH (2013)

Endangered populations that are listed as potentially occurring in the Project area are also provided (Table 2-28).

Table 2-28 Project area - Endangered Populations that may be present

Population	Descriptions
Acacia pendula (Weeping Myall) Population in the Hunter Catchment. E2 Status	Restricted to six known locations (1000 individuals) within the Muswellbrook and Singleton LGAs. The species occurs on heavy soils on margins of small floodplains but also in more undulating locations (SEWPaC, 2011).
Eucalyptus camaldulensis (River Red Gum) Population in the Hunter Catchment. E3 Status	The only known coast catchment and occurs on the major floodplains of the Hunter and Goulburn rivers. Population currently restricted to 19 known stands in small remnants occupying a total of 100 ha and 600-1000 individuals (NSW Scientific Committee, 2005).
Cymbidium canaliculatum (Tiger Orchid) Population in the Hunter Catchment.	Population in the Hunter Catchment is at the south-eastern limit of the species' geographic range and, as significant as it is, one of the few ephiphytic orchids occurring at temperate latitudes. Grown in tree hollows, particularly White Box, in dry sclerophyll

Population	Descriptions
E2, P, 2 Status	forests and woodlands (NSW Scientific Committee, 2011).
Diuris tricolor Fitzg. (Pine Donkey Orchid) In the Muswellbrook Local Government Area (LGA). E2, V, P, 2	In the Muswellbrook LGA comprises a number of occurrences, ranging from a few scattered individuals to a few thousand individuals. The area of occupancy is less than 50km^2 in the Muswellbrook LGA. The population is found in sclerophyll vegetation on flats or small rises, on a range of substrates including sandy or loamy soils derived from granite, porphyryr, laterite or alluvium (NSW Scientific Committee, 2006).

Source: OEH (2013)

DPI (2006) identifies native grasses with the highest grazing value as those that retain green leaf for most of the year such as Wallaby grass (*Danthonia spp.*) (also known as white-top) or weeping grass (*Microleanna stipoides*). Other native grasses provide useful feed during their narrow growing season. Summer growing perennial grasses such as kangaroo grass (*Themeda australis*) produces reasonable spring and early summer feed.

2.2.1.7 Climate conditions

The following description of climatic conditions relies upon data from the Bureau of Meteorology (BoM) weather station nearest to the Project area. The nearest weather station is *Jerrys Plains Post Office (061086)* (BoM, 2013a), located about 25 km to the east. Records at this weather station commenced in 1884.

The weather station elevation is 90m compared to the Project area that ranges to 300m (100m to 300m AHD). This will likely cause minor discrepancy between recorded weather statistics at Jerrys Plains and actual conditions at the Project area, particularly for temperature. As the maximum elevation delta is about 200m, and the average atmospheric lapse rate is 6.4^{0}C/1000m elevation, this discrepancy is likely between zero and -1.3^{0}C.

Notwithstanding, data from this weather station is considered suitable for use here because:

- The weather station location is proximate to the Project area and surrounding locality;
- The data set exceeds 100 years of continuous records for most climate statistics;
- Recorded statistics include those of concern to agricultural production (Table 2-29); and,
- Understanding local climatic conditions is essential when assessing the potential of a property for sustainable agricultural production.

The surrounding locality has a subtropical climate with warm, wet summers and cool, dry winters. The highest mean monthly temperature is 31.7 degrees Celsius (^{0}C) in January and the lowest is 3.8^{0}C in July. Average temperatures exceed 35^{0}C on 24 days each year. Frosts can occur on 27 days each year between April and October but are most frequent in June, July and August (minimum temperatures equal to or less than 2^{0}C). On average, 10 days each year have a minimum temperature of 0^{0}C or lower (BoM, 2013). Due to the elevation of the Project area, and particularly the aspect of west facing slopes, localised frost occurrences may occur on more days per year.

Mean and median (P_{50}) annual rainfall is 644mm and 650mm, respectively. On average, one year in each ten has less than 428mm (P_{10}) or greater than 826mm (P_{90}) of rainfall. Rainfall

Variability Index [P_{90}-P_{10})/P_{50}] is 0.6 which BoM classify as low to moderate variability; indicating rainfall is reliable year on year. Rainfall is summer-dominated with an average 217mm received between December and February. Winter is the driest period each year with only 128mm of rainfall received in this three-month period (BoM, 2013a).

Records indicate the 1980s was a particularly dry decade. Lowest ever recorded monthly rainfalls occurred four-times between 1980 and 1988. BOM (2013a) shows the area to have been in severe drought in 1979-80 and again in 1982-83. Most recent drought conditions were recorded in 2005/06 (DPI, 2005). Conversely, intense wet periods often associated with La Nina events (positive Southern Oscillation Index) have occurred causing serious flooding, e.g. in 1955. Drought and flood are features of the climate.

Pan evaporation is high, 1642.5mm/y, and exceeds median rainfall by about 1000mm. This indicates that evapotranspiration moisture losses will be similarly high, creating moisture demand for crops and livestock. Evapotranspiration contributes to humidity, which is also affected by temperature and wind. Relative humidity is typically higher in the morning due to temperature effects. The area is not considered to be particularly windy.

Table 2-29 Summary climate statistics important to agricultural production

Climate Statistic	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Mean maximum temperature (^{0}C)	31.7	30.9	28.9	25.3	21.3	18	17.4	19.4	22.9	26.2	29.1	31.2	25.2
Mean minimum temperature (^{0}C)	17.2	17.1	15	11	7.4	5.3	3.8	4.4	7	10.3	13.2	15.7	10.6
Mean number of days <= 2 (^{0}C)	0	0	0	0.2	1.7	5.7	9.8	8.4	1.6	0.1	0	0	27.5
Mean daily solar exposure (MJ/(m*m))	24.1	20.9	18.1	14.7	10.9	9.3	10.3	13.9	17.9	21.1	23.3	25.1	17.5
Decile 1 monthly rainfall (mm)	24.1	9.4	10.6	5	5.9	9.7	8.1	7	9.1	10.1	13	15.8	428.3
Decile 5 (median) monthly rainfall (mm)	64.3	49.6	47	32.3	29.9	31.2	35.4	30.6	34	49.2	50.1	57	650.8
Decile 9 monthly rainfall (mm)	159.6	166.3	115	95.9	84	100.8	90.8	68.1	81.8	95.4	122.2	136.3	826.6
Mean 9am relative humidity (%)	67	72	72	72	77	80	78	71	65	59	60	61	69.5
Mean 3pm relative humidity (%)	47	50	49	49	52	54	51	45	43	42	42	42	47
Mean 9am wind speed (km/h)	9.6	9	8.8	8.6	9	9.4	10.6	11	11.7	10.9	10.5	9.9	9.9
Mean 3pm wind speed (km/h)	13.2	13	12.4	11.3	11	11.5	13	14.3	14.7	14.1	14.2	14.2	13.1

Source: BOM (2013)

2.2.2 Agricultural enterprises and production

Agricultural enterprises and production in the surrounding locality is dominated by beef cattle grazing. Notwithstanding, Equine and Viticulture CICs are important industries in the surrounding locality.

2.2.2.1 Cattle – beef

Beef production is the dominant and major agricultural sector across the region. Beef production in the Upper Hunter is characterised by a number of different production systems due to the region's diverse topography, soils, rainfall and management. Production systems range from large-scale breeding operations for the production of store cattle, through to smaller properties focussed on finished cattle production, based on irrigated alluvial river and creek flats. The sector is serviced by a number of farm support businesses in the region. The majority of producers average 200 head of cattle and there is evident trending towards larger herds of 600-700 head (Buchan Consulting, 2011). There are more than 400,000 head of beef cattle in the region (ABS, 2013a).

The major concentrations of beef properties are around Scone, Muswellbrook, Singleton, Dungog and Gloucester. The beef cattle sector is serviced by critical selling and processing infrastructure including saleyards at Denman, Scone, Singleton and Gloucester, and abattoirs at Scone and Kurri. The larger export licensed abattoirs of Tamworth and Ipswich (Queensland) will also source cattle from Upper Hunter saleyards (Buchan Consulting, 2011).

Cattle grazing enterprises in the region include breeding enterprises producing weaners or domestic vealers, growing out steers to finishing weights, and backgrounding steers for feedlot market. These enterprises use a combination of native and naturalized pasture, improved tropical perennial-based pastures and fodder crops, which may or may not also be harvested for grain or conserved for forage.

2.2.2.2 Cattle - dairy

The region also has a long history of dairy farming. There are currently about 45,000 dairy cows in the region (ABS, 2013a), or about 13% of the NSW herd (ABS, 2013b). The average size of a holding in the region is 316 cows on an average 140 ha farm (Buchan Consulting, 2011). Deregulation during the 1990's has resulted in decline in the number of operators and consolidation into much larger holdings and herd sizes. There are some limitations on further consolidation due to constraints on land availability (due to mining leases and lifestyle blocks/hobby farms). There is a squeeze on margins due to the combination of milk prices and rising input costs (Buchan Consulting, 2011). More broadly, the number of dairy farms in the state has declined from 3,600 in 1980 to 778 in 2012 (Dairy Australia, 2012).

2.2.2.3 Cropping

The surrounding locality produces a typical variety of cereals, including wheat, barley, sorghum, oats and maize, and non-cereals including hemp and lucerne. Cropping is generally confined to the alluvial soils adjacent to the Hunter River and suitable lands in the northwest of the Upper Hunter LGA and Merriwa Plateau. In a 2005 study of the region, cropping was determined the third most valuable agricultural industry (DPI, 2005).

2.2.2.4 Equine

The thoroughbred horse breeding industry is centred on Scone in the Upper Hunter LGA and extends into the Muswellbrook LGA. The region produces over 70% of thoroughbred foals

born in Australia (McManus *et al*, 2011). The Australian breeding season commences on 1 September each year, and it is illegal to join a Registered Thoroughbred prior to this date. The breeding season continues until January the following year. In the off-season, most mares return to their respective studs to complete gestation and foal-down, while many stallions are flown to the northern hemisphere to continue breeding. The northern hemisphere breeding season is reciprocal to Australia's allowing stallions to stand at stud for most of the year (McManus *et al*, 2011). The Upper Hunter thoroughbred sector provides over $100 million in yearling sales annually (RDA Hunter, 2013).

There are 26 horse studs within Muswellbrook LGA and the Denman Equine CIC (MSC, 2011). Of these horse studs, there are five stallion farms and six broodmare and agistment farms registered as members of the Hunter Thoroughbred Breeders Association (HTBA). The remaining 16 studs are comprised of stallion farms, broodmare agistment, and yearling preparation to varying production scales (MSC, 2011).

Within the Denman Equine CIC, there are 15 horse studs within a 20km radius of the Project area. These studs include (including distance to Project area) Redman Park (500m) (land reference 25), Amarina Farm (700m) (land reference 147), Wexford Farm (1km) (land reference 11), Monarch Stud (1km) (land reference 6), Darley – Woodlands (<0.5km) (land reference 10), J Pearce "Springdale" & Co (5.5km), Coolmore Stud (6.5km), Golden Grove Thoroughbreds (9km), Edinglassie Stud (11km), Riverslea (12km), Hollydeen Stud (12km), Ferndale Stud (12km), Barador Stud (13km), Patinack Farm (15km), and River Ridge (17km) (MSC, 2011).

A profile for the studs within a 10km radius of the Project area is provided. A profile for Redman Park, Wexford Farm, Monarch Stud and Golden Grove Thoroughbreds is not provided, as no detailed publicly information is available.

2.2.2.4.1 Amarina Farm

Amarina Farm is a thoroughbred broodmare farm located 10 km from Denman. The farm is 170 ha and was established in 2006, specialising in thoroughbred agistment, professional breeding services and sales preparation (Table 2-30). Mr. Craig and Ms. Sue Anderson manage the property, in partnership with Mr. Gavin Murphy and Ms. Catherine Donovan.

Table 2-30 Amarina Farm - equine enterprise

Key Equine CIC Indicators	Description
Land reference #	47 (refer to Figure 2-12)
Owner	Mr. Craig and Ms. Sue Anderson Mr. Gavin Murphy and Ms. Catherine Donovan*
Size (hectares)	170*
Enterprise	Broodmare and agistment
Activities	Agistment, foaling, weaning, walking out, sales preparation, quarantine facility*
Facilities	2 horse walkers, yearling barns, 2 covered yards, 3 crushes, dedicated foaling area, 9 day yards, yearling runs, pasture paddocks, quarantine area*.

Key Equine CIC Indicators	Description	
Sales	Sold to Australia, Hong Kong, Singapore, New Zealand, South Africa and Great Britain markets*	
	2013 sales prepared at Amarina:*	*Estimate:*
	Scone Yearling Sale	Not provided
	Inglis Easter Yearling Sale	>$835,000
	Inglis Easter Broodmare Sale	>$15,000
	Magic Millions Gold Coast Yearling Sale	>$1,135,000
	Inglis Summer Classic Yearling Sale	>$258,500
Performers	*Group 1 mares prepared at Amarina include***:	
	Gallica (Prizes: $1,010,495, Trainer: Mick Price)	
	The Heckler (Prizes: $724,000, Trainer: MH Brooks)	
	Aqua D'Amore (Prizes: $1,927,750, Raced by: Coolmoore, Trainer: Gai Waterhouse)	
	*Group 1 geldings prepared at Amarina include**:*	
	Super Cool (Prizes: $1,205, 350, Trainer: Mark Kavanagh)	
Foals	92 foals (2012)*	
Gross value per annum	Not provided.	

Source: *Amarina (2013); **RaceNet (2013)

Amarina provides services of agistment, foaling, weaning, walking out, sales preparation (Figure 2-44) and has an Australian Quarantine Inspection Service (AQIS) approved Quarantine facility for imported mares in foal (Figure 2-45). Most paddocks are irrigated from the Hunter River (Amarina, 2013).

Figure 2-44 Amarina Farm stables and horse walker

Figure 2-45 Amarina Farm broodmare and foal

2.2.2.4.2 Darley - Woodlands

Woodlands Stud and associated other assets was purchased by His Highness Sheikh Mohammed bin Rashid Al Maktoum from Inghams Enterprises on 13 May 2008 for $500 million for his private racing interests (Thomson, 2013). Darley - Woodlands is now part of the Darley private global breeding operations, currently standing stallions in seven countries around the world (Darley, 2013). The purchase of the property included 1000 horses, two studs, a pre-training farm and racing stables in Sydney and Melbourne (Young, 2008). The property is one of two owned by Darley in the Upper Hunter, the second being the larger Kelvinside Stud, a stallion stud 4 km north east of Aberdeen (Table 2-31). Darley employs around 230 people in Australia (Darley, 2013).

The 2,630 ha property is located on Woodlands Road off the Golden Highway, between Denman and Jerry's Plains. The stud is used solely for the private breeding and foaling for the Darley group (ABC Upper Hunter, 1 May 2012) (Figure 2-46, Figure 2-47, and Figure 2-48). The Darley stallions stand at Kelvinside (Aberdeen) and Northwood Park (Victoria) (Darley, 2013). The foals are kept at Darley – Woodlands for up to 18 months and are then transported for racetrack preparation (Doyle and Brown, 2012).

Woodlands Stud is recognized as one of the greatest in Australian racing history. It has produced more than 35 Group One winners (Presnell, 2013). The property is 'state significant' due to its long history of thoroughbred horse breeding and the historic 1830's homestead (MSC, 1996).

Table 2-31 Darley - Woodlands equine enterprise

Key Equine CIC Indicators	Description
Land reference #	10 (refer to Figure 2-12)
Owner	His Highness Sheikh Mohammed bin Rashid Al Maktoum Vice President of the United Arab Emirates, Prime Minister and Ruler of Dubai^
Size (hectares)	2630*
Enterprise	Broodmare and foaling (private)*
Activities	Agistment, foaling, weaning, walking out and quarantine
Facilities	Estimated as yearling barns, covered yards, crushes, dedicated foaling areas, yearling runs, pasture paddocks, quarantine area, standing area, staff residences and office buildings
Foals	160 (2012)*
Gross value per annum	Darley Australia Pty Limited Bloodstock (estimated as relevant to Woodlands)**: Broodmares (owned, not sold annually) $68,750,000 Foals $15,992,500 Yearlings $1,221,165

Sources: ^Darley (2013); * Doyle and Brown (2012); **ASIC (2011)

Figure 2-46 Darley - Woodlands stables and round yard

Figure 2-47 Darley - Woodlands paddocks, stables and office buildings

Figure 2-48 Darley - Woodlands broodmares and foals

2.2.2.4.3 J Pearce "Springdale" & Co

"Springdale" is an established horse agistment property located on Martindale Road, Martindale, approximately 17km south west of Denman (MSC, 2011). The 242 ha property is owned and managed by Mr. John Pearce, who has provided the agistment service on the property for over 40 years (Figure 2-49 and Figure 2-50). The property currently holds 100 horses. Horses are run in small groups of up to 12 per paddock – based on similar feed and management requirements (J Pearce, 2013).

Most paddocks are pasture improved with some watered through a travelling irrigator as required. Electric fencing is utilised in most areas. At 1 January 2010, the agistment rates are between $3.25 and $4.00 per horse, per day (J Pearce, 2013).

Figure 2-49 J Pearce "Springdale" agistment property

Figure 2-50 J Pearce "Springdale" horses on agistment property

2.2.2.4.4 Coolmore

Coolmore Australia Pty is a thoroughbred stallion stud located 22 km from Denman and 8 km from Jerry's Plains on the Golden Highway. The stud is the Australian venture of the Irish Coolmore Stud, headquartered in Fethard, County Tipperary. Coolmore Stud is a global operation, owned by John Magnier, and was founded in 1975. The Coolmore Stud operates

Coolmore Ireland and it's two branches – Ashford Stud, which operates as Coolmore America, based in Kentucky and Coolmore Australia (Race Horse Owner, 2011). In 2008, the estimated value of the global operation was $5 billion (Reynolds and Webb, 2008).

The property is 3,340 ha and is located on the banks of the Hunter River (Figure 2-51). The primary activity at the property is breeding (Table 2-32). The business operates on a 12-month cycle so the stallions are transported to the northern then southern hemispheres for the respective breeding seasons (Cooper, 2011). Coolmore Australia stands 13 Group One stallions (Figure 2-52). The stallions cover around three mares per day (UK News, 2003) at up to $275,000 standing fee (Coolmore, 2013) for a period from September to January each year (Australian Racing Board, 2013).

Coolmore houses an estimated 1000 horses and produces around 300 foals annually (Farr, 2011).

Table 2-32 Coolmore Australia - equine enterprise

Key Equine CIC Indicators	Description	
Land reference #	NA – outside reference area	
Owner	John Magnier*	
Manager	Tom Magnier*	
Size (hectares)	3,340^	
Enterprise	Stallions, broodmares, foals and agistment	
Activities	Stallion standing, agistment, foaling, weaning, walking out, sales preparation, quarantine facility	
Facilities	Estimated as stallion stables, stables, covering rooms, yearling barns, covered yards, holding yards, crushes, dedicated foaling area, yearling runs, pasture paddocks, quarantine area, staff residences, manager residence and office building	
Stallions	Coolmore has 13 world-class Group one stallions standing in the southern breeding season. The stallions are transported to Ireland and Kentucky for the northern breeding season^:	
	Coolmore Australia Roster 2013, examples:*	*Standing Fee:*
	Choisir	$27,500
	Duke of Marmalade	$16,500
	Encosta De Lago	$55,000
	Excelebration	$27,500
	Haradasun	$275,000
	Pierro	$77,000
	So You Think	$66,000
Horses	1000 (stallions, broodmares, foals, yearlings, agistment) ^	
Foals	300 (2012) ^	

Key Equine CIC Indicators	Description
Gross value per annum	Coolmore Stud (global) has an estimate value of EU 4 billion (A$5 billon)**

Sources: *Coolmore (2013); ** Reynolds & Webb (2008); ^ Farr (2011)

Figure 2-51 Coolmore property, paddocks

Figure 2-52 Coolmore property, stallion stables

Figure 2-53 Coolmore stallion "Fastnet Rock"

2.2.2.5 Viticulture

The region is renowned for its wine production with more than 4,000 ha of vineyards. The Hunter Valley Research Foundation has identified that viticulture and wine-tourism in the region generates $1.1 billion per year (DPI, 2005). The wine industry is of significant importance to the Upper Hunter region, both in terms of its economic contribution as an industry and its role in the region's tourism industry (MSC, 2012a).

In the Upper Hunter, viticulture enterprises are mainly located in the Singleton and Muswellbrook LGAs. Many of the larger labels have been based in the Hunter Region: including Tyrrell's, McWilliams, Lindemans, McGuigan, Draytons, Brokenwood, Wyndham Estate and Rothbury Estate. There has also been a clustering of smaller wineries include: the Broke - Fordwich Wine Region vineyards group; and in the Upper Hunter, a cluster centred on the Denman - the Upper Hunter sub- region. There are also some wineries located in other areas, including Gloucester, Great Lakes and Dungog (Buchan Consulting, 2011).

The capital value of investment associated with Hunter Valley wine and grape production in 2010 was $450 million. The 90 growers in the Upper Hunter cover an area of 108 hectares per grower, compared to the 125 grape growers located in the Lower Hunter covering an area of 12 hectares per grower. The viticulture industry in the Hunter Valley produced 25 million litres of wine in 2010 valued at over $210 million, including cellar door sales of circa $75 million (MSC, 2012a).

Wine tourism is of major importance to the wine sector in the region. This is evidenced by the extent of cellar door sales, with the overall business viability of many vineyards and wineries being based on these visitors (Buchan Consulting, 2011). The Hunter Valley viticulture and tourism industries combined contributed $1.8 billion annually to the NSW economy (MSC, 2012b). The industry employs over 7,000 people with an additional 10,000 indirectly employed (MSC, 2012b).

From the Muswellbrook Shire *Council Draft Land Use Development Strategy (Coal mine land use component)* (2011), there were 21 viticulture enterprises within the Muswellbrook LGA and the Denman Viticulture CIC in 2011. The viticulture enterprises listed in the strategy are located within a 31.5 km radius of Denman. Further desktop verification of the vineyards confirms that an estimated 3 to 4 vineyards and wineries have either closed, amalgamated or have been renamed since the strategy development. For example, the prominent Rosemount Estate sale was settled in 2011 (WineBiz, 2010). The Rosemount Estate, previously owned by Fosters, covers 260 hectares and includes the winery buildings and 59ha of Chardonnay, Traminer and Verdelho (WineBiz, 2010).

Of the enterprises listed, there are 14 prominent and operational vineyards / wineries in the surrounding locality. These viticulture enterprises include (including distance to Project area) Callatoota Estate (within the Project area, land reference 9), Winbirra Estate (land reference 28) (1km), Two Rivers Wines (5km), Pyramid Hill Wines (5km), Rombo Ridge – Martindale Vineyard, part of Penmana Wines (Penmara Wines, 2013) (5km), Hollydene Estate – Arrowfield (5.5km), Roxburgh Estate – BHP Billiton, grapes contracted to The Little Wine Company (Lewis, 2012) (5.5km), Hope Estate – Rothbury (5.5km) (Hope Estate, 2013), Horseshoe Vineyard (10km), Hollydene Estate - Hollydene (12.5km), James Estate Wines (20km), Yarraman Estate (28km), and Hollydene Estate – Wybong (33km) (MSC, 2011).

Of the vineyards / wineries in the surrounding locality, there are six registered as members of the Hunter Valley Wine Industry Association – Hunter Valley Vineyard Association (HVWIA, 2013).

In February 2013, a major tourist development at the Hollydene Estate - Arrowfield was approved. Hollydene Estate – Arrowfield will be investing $10 million in 12 months to upgrade the vineyard / winery to construct 22 high-quality cabins, housing wedding function facilities, as well as corporate clients, namely from the region's mining and equine industries (Muswellbrook Chronicle, 2013). The estate already has a restaurant, cellar door, helipad and conference and meeting room facilities. The project is expected to create 18 full-time jobs (Muswellbrook Chronicle, 2013a).

A profile for the vineyards and wineries within 20 km of the Project area is provided. A profile for Winbarra Estate, Horseshoe Vineyard, Rombo Road – Martindale Vineyard, (specific to the Denman Vineyard), Hope Estate – Rothbury (specific to the Denman vineyard), and Roxburgh Estate – BHP Billiton (specific to the Denman vineyard) is not provided as no publicly available information is available. The owner of Horseshoe Vineyard, Mr John Horden, operates Hunter Wine Services, a successful contract winemaker enterprise in Muswellbrook (Halliday, 2013a). A profile for Callatoota Estate is provided as a Project area enterprise (Section 2.1.2.1).

2.2.2.5.1 Hollydene Estate - Arrowfield

Hollydene Estate – Arrowfield is owned by Ms Karen Williams who markets wine under two brands including Juul and Hollydene across the Hollydene Estate. Viticulture details for the entire Hollydene Estate are provided (Table 2-33). Hollydene Estate itself has three vineyards, Wybong Estate (established in 1965), Hollydene (established in 1969, also producing wheat and beef cattle) and the 2012 purchase of Arrowfield Estate (Halliday, 2013b) (Figure 2-54). Hollydene is located directly between Darley – Woodlands and Coolmore Studs (Hollydene, 2013). The vineyard / winery is adjacent to the Drayton South Coal Project. The Anglo American Metallurgical Coal Drayton open cut mine may extend to the southern boundary of the mine's lease area, with the Golden Highway as a common

boundary between the mine and vineyard (Muswellbrook Chronicle, 2013a).

Table 2-33 Hollydene Estate - viticulture enterprise

Key Viticulture CIC Indicators	Description
Distance to Project area	5.5 km
Winemaker	Matt Burton, Burton International Wines, owned by Karen Williams
Established	1965
Size (hectares)	80 ha
Cases	2,000
Varietals	Rose, Semillon, Shiraz Cabernet, Chardonnay, Sauvignon Blanc, Semillon Sauvignon, Cabernet Merlot, Riesling, Semillon Sauvignon Blanc, Cabernet Sauvignon, Verdelho, Shiraz Viognier, Un-wooded Chardonnay
Facilities	Vineyard, winery, cellar door Conference and wedding facilities Helipad
Exports	Indonesia and China

Source: Halliday (2013b)

Figure 2-54 Hollydene Estate (Arrowfield) - vineyard, winery and cellar door

2.2.2.5.2 Two Rivers Wines

Two Rivers Wines is located across the Hunter River from the Project area. The vineyard and winery is managed by Mr. Brett and Mrs. Linda Keeping (Two Rivers, 2013) (Table 2-34). Two Rivers Wines is considered to be a significant part of the viticulture industry in the Upper Hunter Valley, with over 75 ha of vineyards (Figure 2-55), involving a total investment of

around $7 million. Part of the fruit is sold under long-term contracts, and part is made for the expanding winemaking and marketing operations of Two Rivers, the chief brand of Inglewood Vineyards (Halliday, 2013c) (Figure 2-56).

The emphasis of the enterprise is on Chardonnay and Semillon, and these wines have been medal winners at the Hunter Valley Wine Show. It is also a partner in the Tulloch business, together with the Tulloch and Angove families, and supplies much of the grapes for the Tulloch label. The enterprise has a contemporary cellar door (Figure 2-57), which attracts wine tourists in the Upper Hunter Valley (Halliday, 2013c).

Table 2-34 Two Rivers Wines - viticulture enterprise

Key Viticulture CIC Indicators	Description*
Distance to Project area	5 km
Winemaker	Liz Jackson (First Creek)
Viticulturist	Brett Keeping with wife Linda
Established	1988
Size (hectares)	75 ha
Cases	10,000
Varietals	Semillon**, Verdelho, Sauvignon Blanc, Chardonnay, Verdelho, Un-wooded Chardonnay, Shiraz, Cabernet Sauvignon, Merlot, Cabernet Merlot, Fortified, Block Viognier
Facilities	Vineyard, winery Cellar door Guest house
Exports	China

Source: *Halliday (2013c); **Two Rivers (2013)

Figure 2-55 Two Rivers Wines - vineyard

Figure 2-56 Two Rivers Wines - grape harvesting

Figure 2-57 Two Rivers Wines - cellar door

2.2.2.5.3 Pyramid Hill Wines

Pyramid Hill Wines vineyard and winery is set on the eastern bank of the Goulburn River, approximately 6km south west of Denman. The vineyards cover 72 ha (Figure 2-58 and Figure 2-59). The property has a 2.5 km of Goulburn River frontage. It is backed by the Wollemi National Park (Pyramid Hill Wines, 2013).

Pyramid Hill Wines (Table 2-35) is a partnership between the Alder and Hilder families. Richard Hilder is a veteran viticulturist who has overseen the establishment of many Rosemount vineyards. The vineyard has a computer-controlled irrigation system connected to a network of radio-linked weather and soil moisture sensors that constantly relay data detailing the amount of available moisture at different soil depths to a central computer, thus avoiding excess irrigation and preventing stress. Most of the grapes are sold, but part has been vinified with expansion planned (Halliday, 2013d).

Table 2-35 Pyramid Hill Vineyard - viticulture enterprise

Key Viticulture CIC Indicators	Description
Distance to Project area	5 km
Personnel	Owned by Nicholas Adler and Caroline Sherwood with Richard Hilder
Established	2002
Size (hectares)	72 ha
Cases	5000
Varietals	Shiraz, Verdelho, Merlot, Semillon,

Key Viticulture CIC Indicators	Description
	Chardonnay, Un-wooded Chardonnay, Rose Saignee
Facilities	Vineyard, winery Two residences
Exports	UK, Canada, Japan and Singapore

Source: Halliday (2013d)

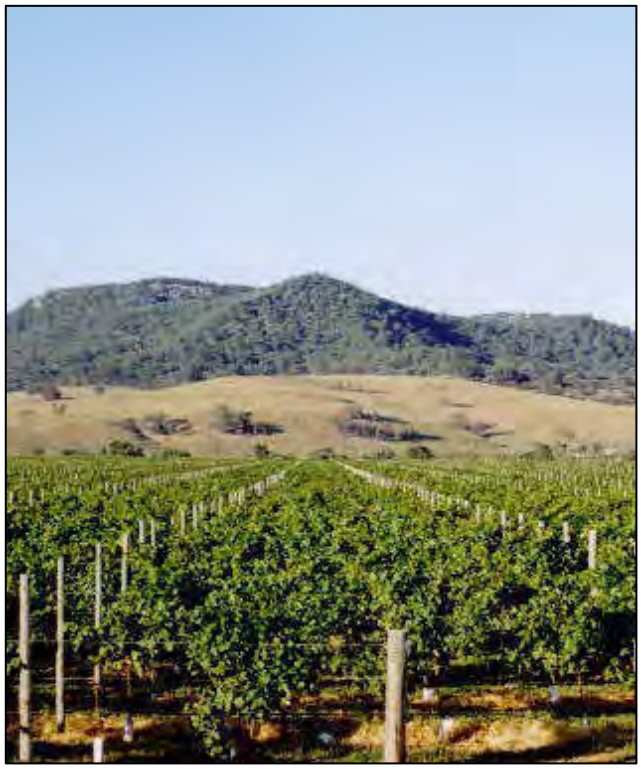

Figure 2-58 Pyramid Hill Wines - grapevines and trellises

Figure 2-59 Pyramid Hill Wines - grapevines and trellises

2.2.2.5.4 Hollydene Estate - Hollydene

Hollydene Estate – Hollydene is located on the Golden Highway, approximately 12 km west of the Project area, at the village of Hollydeen. The Hollydene vineyard is also owned by Ms Karen Williams (see Hollydene Estate – Arrowfield, Section 2.2.2.5.1) who markets wine under two brands including Juul and Hollydene. Hollydene Estate – Wybong is located further north on Yarraman Road, Wybong (Hollydene, 2013). The property was established in 1969 and also runs beef cattle and crops wheat (Hollydene, 2013). Viticulture details for the entire Hollydene Estate are provided in Section 2.2.2.5.1.

2.2.2.5.5 James Estate Wines

James Estate Wines has a vineyard, winery (Table 2-36) and cellar door on Bylong Road, Baerami, some 18 km from Denman, and an additional cellar door at Polokbin (Figure 2-60). The vineyard is also a venue in the Shimano Mountain Bike Grand Prix Series (HMBA, 2013) (Figure 2-61), which also functions as a significant tourist attraction for the local area. Mr Graeme Scott has recently been appointed the senior winemaker (Halliday, 2013e). The Estate is a large wine producer in the Muswellbrook Shire LGA, putting out 15,000 cases in 2012 (Halliday, 2013e).

Table 2-36 James Estate - viticulture enterprise

Key Viticulture CIC Indicators	Description*
Distance to Project area	20 km
Winemaker	Graeme Scott
Established	1997

Key Viticulture CIC Indicators	Description*
Size (hectares)	86 ha
Cases	15,000
Varietals	Semillon, Verdelho, Chardonnay, Pinot Noir, Merlot, Cabernet Sauvignon, Petit Verdot, Shiraz
Facilities	Vineyard, winery Cellar doors (Baerami and Pokolbin) Mountain Bike Racing (Shimano MTB GT Series)
Exports	China

Source: *Halliday (2013e)

Figure 2-60 James Estate Wines - vineyard and winery

Figure 2-61 James Estate Wines - Shimano MTB Grand Prix

2.3 Summary of agricultural production and gross value in the Project area

La Tierra has identified the agricultural enterprises represented in the Project area and the broader surrounding locality. The gross value of agricultural production from these agribusinesses has been calculated (Table 2-37). This data is combined with Australian Bureau of Statistics (ABS) data for agricultural production and gross value within the Muswellbrook LGA, Upper Hunter region and NSW, to allow quantitative comparison.

Table 2-37 Type and gross value of agricultural production in the Project area, surrounding locality, Upper Hunter region and NSW

Agribusiness sector	Units	NSW[1]	Upper Hunter region[2]	Muswellbrook LGA[3]	Project area[4]
Cattle, beef	Head	5,861,972	382,439	35,745	1,520
Cattle, milk	Head	349,214	43,900	10,421	0
Sheep and lambs	Head	32,145,630	261,201	2,517	0
Pigs	Head	655,117	3,357	1,211	0
Cereals	Ha	5,715,963	10,047	346	50
Vegetables	Ha	19,675	137	14	0
Orchards (including nuts)	Ha	48,830	743	369	0
Fruit (excluding grapes)	Ha	51,515	746	369	0
Non-cereals (broad-acre)	Ha	726,379	895	32	50
Gross value crops	A$M	5,068	28.6	9.6	0.15
Gross value livestock slaughtering	A$M	2,762	118.4	11.3	0
Gross value livestock products	A$M	1,211	61.3	13.1	1.1
Gross value agricultural production (total)	A$M	9,041	208.3	34.0	1.25

Source: [1] Data from ABS (2013b);
[2] Upper Hunter region is comprised of the Dungog, Singleton, Gloucester, Upper Hunter and Muswellbrook LGAs. Data from ABS (2013a) and ABS (2012);
[3] Data from ABS (2013a) which reports 2006 census data; and,
[4] Data calculated by La Tierra in 2013

The calculated value of agricultural production from the Project area is "gross value" and not a discounted value or gross margin. This allows direct comparison with ABS data. The gross value of agricultural production from within the Project area is $1.25M, which represents just 3.7% of production within the Muswellbrook LGA, 0.6% of production within the Upper Hunter region, and just 0.01% of NSW production.

The gross value of thoroughbred horse breeding and viticulture in the Project area, surrounding locality, Upper Hunter region and NSW is also provided (Table 2-38 and Table 2-39).

Table 2-38 Count, production and gross value of thoroughbred production in the Project area, surrounding locality, Upper Hunter region and NSW

Agribusiness sector	Units	NSW	Upper Hunter region	Muswellbrook LGA	Surrounding locality	Project area
Horse studs	Count	138[1]	80[2]	26[3]	5 (within 2km)	0
Production	Foals	6,665[4]	3,900[5]	1,300[6]	560	0
Gross value agricultural production	A$M	1,466[7]	850[8]	276[8]	123[9]	0

Source: [1] Thoroughbred Breeders Australia (2013)
[2] HTBA (2013);
[3] MSC (2013b);
[4] Racing Information Services Australia (2012), La Tierra notes that not all foals sired in NSW will be born and registered in NSW;
[5] Calculation based on proportion of studs in region relative to NSW and total NSW foal production;
[6] Calculation based on proportion of studs in LGA relative to NSW and total NSW foal production;
[7] Calculation based on a price of $220,000 for yearlings: Source, Thoroughbred Breeders NSW (2013);
[8] Calculation based on proportion of studs and total value of production in NSW;
[9] Calculation based on foal production and note 7 (above).

Table 2-39 Count, production and gross value of viticulture production in the Project area, surrounding locality, Upper Hunter region and NSW

Agribusiness sector	Units	NSW	Upper Hunter region	Muswellbrook LGA	Surrounding locality	Project area
Viticulture	Ha	38,313[1]	2,682[1]	--	--	26
Viticulture	Tonnes crushed	460,802[1]	10,554[1]	--	--	50
Gross value agricultural production (total)	A$M	5,200[2]	120.2[2]	--	--	0.745

[1] ABS (2012); and,
[2] Calculated by La Tierra assuming 760 L/t and $15/L using summer 2013 harvest result.

3 ASSESSMENT OF IMPACTS

Following is a risk-based identification and description of potential impacts, including cumulative impacts, of the Project on agricultural enterprises, resources and production within the Project area and surrounding locality.

3.1 Nature of mining impacts

The Project proposes underground longwall coal mining methods in a number of coal seams within the Wittingham Coal Measures. Undoubtedly, for the mining of any coal resource, the underground longwall mining method has lower-order potential impacts on agriculture than does open-cut mining. The foremost agricultural impacts of underground longwall mining are the nature, extent and timing of surface subsidence, and the location and lifespan of surface infrastructure.

3.1.1 Subsidence

Surface subsidence refers to the vertical and horizontal movement of the land surface and is the inevitable consequence of underground longwall coal mining. The extent and nature of subsidence is defined by several key parameters, i.e. vertical movement, tilt (change in slope), curvature (rate of change of tilt), and strain (relative differential horizontal movement). Engineering calculation and modelling can reliably predict each of these parameters.

MSEC (2013) (refer to Appendix B) provides a thorough description of predicted subsidence parameters and surface impacts for the Project. The maximum predicted subsidence parameters are as follows:

- Vertical subsidence of up to 5,300 mm;
- Tilt of 40 mm/m (i.e. 4% or 1 mV in 25 mH);
- Hogging and sagging curvatures of 1.0 km^{-1} (i.e. 1 km radius of curvature); and
- Strains typically between 10 mm/m and 20 mm/m, with isolated strains greater than 20 mm/m.

Further, MSEC (2013) describes the potential impacts of subsidence on the land, and agricultural enterprises, resources and production within the Project area, as follows.

3.1.1.1 Surface cracking and land deformation

Subsidence will produce cracks on the land surface, potentially in any location above the longwalls blocks due to multi-seam extraction. Although typically between 25 mm and 50 mm in width, with some isolated cracking around 100 mm or greater. Larger cracks are expected along the steep slopes on the sides of the central ridgeline. These larger cracks are expected to be typically in the order of 50 mm to 100 mm, with isolated cracking around 200 mm or greater.

3.1.1.2 Changes in surface water drainage

Subsidence will cause ground depressions that increase surface water ponding. The largest of these depressions are predicted to occur in the northern part of the Project area. These depressions will be up to 2.5 m depth, but actual water ponding depths will be less, perhaps <1000 mm, due to other factors, e.g. rainfall, catchment size, surface water runoff, infiltration and evaporation.

3.1.1.3 Changes to surface water resources

Subsidence will have no measurable effect on the Hunter River (<5 mm vertical subsidence), which is outside of the Project area. However, within the Project area, increased ponding and flooding, and increased scouring may affect drainage lines that flow to the river. Increased ponding may be up to 2.5 m deep and 200 m long within drainage lines. Increased scouring (erosion) within drainage lines is also possible where tilt (slope) increases and water flow velocities exceed 1 m/s. Surface cracking is also likely to form within drainage lines.

3.1.1.4 Changes to groundwater resources

It is likely that groundwater bores will be affected by subsidence, particularly those directly above the underground mining area. Impacts would include lowering of standing water levels, blockages, and changes to water quality due to aquifer mixing within the affected strata.

The mapped limit of the Hunter Alluvial Aquifer is immediately adjacent to the northwest part of the underground mining area. Here, this alluvial aquifer is expected to experience about <100 mm of vertical subsidence but no significant tilts, curvature or strains. As this aquifer is shallow, contained within unconsolidated alluvium and hydrologically connected to the Hunter River, water quality and quantity within the aquifer will not be adversely affected.

3.1.1.5 Effects on built features

Built features affected by subsidence include houses and sheds, farm dams, and fencing, as well as the Golden Highway and minor roads, electrical transmission lines and buried telecommunications cables. Each of these built features within the underground mining area may incur some form of damage from subsidence.

3.1.1.6 Changes to agricultural land use

Subsidence will cause surface cracking and land deformation, changes to water drainage, changes to surface water resources, changes to groundwater resources and impacts to built features. Land use within the Project area is predominantly grazing, with smaller areas of viticulture and irrigated cropping. Subsidence will not affect the area of irrigated cropping as this is well outside the underground mining area but subsidence will affect the other land uses. The successful mitigation of these effects is discussed in a subsequent section of this report (Section 4).

3.1.2 Surface infrastructure

Surface infrastructure is required to support underground longwall coal mining and includes the following.

- Buildings – offices, bathhouse, warehouse, underground control room, fuel storage;
- Electrical infrastructure - overhead transmission lines, switchyard;
- Ventilation infrastructure – exhausting fan assemblies;
- Coal Handling and Preparation Plant (CHPP) – coal stockpiles, coal-washing plant;
- Fine and coarse reject emplacement – dump and/or dam;
- Gas management infrastructure – flares; and
- Roads – internal and external access routes.

This area that will be temporarily removed from agricultural land use for the life-of-mine duration has a footprint of 200 ha (refer to Section 2.1.1.7). Whilst the shape of this area and

the conceptual general arrangement of surface infrastructure may vary in engineering feasibility and design prior to construction, no surface infrastructure shall be located on verified BSAL.

3.2 Identification and assessment of impacts

A risk tool (DP&I, 2012c and DP&I, 2013c) has been used to identify and semi-quantitatively assess potential hazards associated with planned Project activities on existing agricultural resources, enterprises, SAL, water and socio-economic aspects. The tool comprised a risk ranking matrix (Table 3-1), plus probability and consequence descriptor tables (Table 3-2 and Table 3-3, respectively).

Hazards were considered in each of three Project phases, viz. construction, operation and decommissioning/closure. Risk scores were calculated for each hazard with proposed mitigation measures considered. This allowed residual risk scores to be determined for each hazard. The outcomes of the risk assessment are provided and discussed further herein.

Table 3-1 Agricultural impact risk ranking matrix

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

[1] yellow – low risk, orange – medium risk, red – high risk

Table 3-2 Agricultural impact risk ranking - probability descriptors

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

Table 3-3 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 (e.g. 20 years) damage to soil or water resources • Long-term impacts (e.g. 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 or soil impacted, possibly in the long-term (e.g. 20 years) • Long-term (e.g. 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 or soil known to be affected, probably in the short to medium-term (e.g. 1-5 years) • Management could include significant change of management needed for 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 the 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 operation	• No measurable or identifiable impact on the agricultural resource or industry

3.2.1 Impacts on agricultural resources

Following is a risk-based assessment of potential physical impacts on agricultural resources due to proposed Project construction, operation and closure activities (Table 3-4). In this assessment, agricultural resources are considered to include soils, surface waters, groundwaters, and critical agricultural infrastructure such as roads. Practical, proven mitigation strategies are proposed to reduce potential impacts and achieve risk levels as low as reasonably possible.

Table 3-4 Risks to agricultural resources

Project Phase & Activity	Hazard	Mitigation	L	C	Score
CONSTRUCTION PHASE (2 years)					
Traffic to and from Project area	Noise and vibration affects grazing livestock.	Vibration caused by traffic is a null issue. Traffic noise shall be managed by limiting construction hours and adherence to Australian Standards, e.g. ISO4872:1978.	E	4	Low
	Dust from traffic falls onto pasture reducing palatability for grazing livestock.	Dust suppression with water sprays. Limiting vehicle travel speeds on unsealed roadways.	C	4	Low
	Vehicle & domestic stock interactions lead to stock injury or death.	Site access thoroughfares and the construction site itself will be fenced to prevent stock incursion and eliminate the potential for vehicle-stock interactions.	E	5	Low
	Biosecurity (weeds, pests, diseases) affects pasture composition and grazing animal health.	Vehicle wash-down facilities and procedures will be in place and used. Similar procedures are currently in place with respect to exploration activities. No domestic animals shall be brought onto the construction site.	D	4	Low
Surface construction activities	Noise affects grazing livestock.	Noise shall be managed by limiting construction hours and adherence to	C	4	Low

Project Phase & Activity	Hazard	Mitigation	L	C	Score
		Australian Standards, e.g. ISO4872:1978			
	Loss of vegetation used for grazing (pasture) and shade (trees).	Minimal land shall be removed from agricultural production for site infrastructure (refer to Sections 2.1.1.7 and 3.1.2). Site rehabilitation at mine closure will include re-establishing pasture and tree species.	E	5	Low
	Erosion of land disturbed by construction activities leading to soil loss and sediment contamination of waterways.	No construction activities will occur on BSAL. Sediment controls including silt fencing and settling dams, will be constructed and maintained as necessary.	C	4	Low
	Soil contamination by hydrocarbons and chemicals used in construction.	Fuels and chemicals shall be managed in accordance with Australian Standards, e.g. AS1940 for storage and handling of flammable and combustible liquids.	D	4	Low
	Loss of agricultural land.	With reference to Section 2.1.1.7 and 3.1.2, the Project will temporarily remove only 200 ha of agricultural land from production for the life of the mine. None of this land is BSAL.	A	4	Med
	Biosecurity (weeds, pests, diseases) affects pasture composition and grazing animal health.	Vehicle wash-down facilities and procedures will be in place and used. Similar procedures are currently in place with respect to exploration activities.	D	4	Low
	Ground and surface water contamination by hydrocarbons and chemicals used in construction,	Fuels and chemicals shall be managed in accordance with Australian Standards, e.g.	C	4	Low

Project Phase & Activity	Hazard	Mitigation	L	C	Score
	and sedimentation from erosion run-off, reduces usefulness of water resources available to agriculture.	AS1940 for storage and handling of flammable and combustible liquids. Sediment controls including silt fencing and settling dams, will be constructed and maintained as necessary.			
Shaft and drift construction Construction blasting	Noise and vibration affects grazing livestock.	Construction noise shall be managed by limiting construction hours and adherence to Australian Standards, e.g. ISO4872:1978. Industry standard shaft and drift construction methods shall be used. Noise and vibration monitoring shall be undertaken continuously.	C	4	Low
	Dust from construction activities falls onto pasture reducing palatability for grazing livestock. Dust from construction activities falls onto vineyards, reducing plant vigour, and fruit yield and quality.	Dust suppression with water sprays. Limiting vehicle travel speeds on unsealed roadways. Dust monitoring shall be undertaken continuously.	C	4	Low
	Water contamination reduces usefulness of water resources available to agriculture.	Fuels and chemicals shall be managed in accordance with Australian Standards, e.g. AS1940 for storage and handling of flammable and combustible liquids. Sediment controls including silt fencing and settling dams, will be constructed and maintained as necessary.	C	4	Low
	Loss of agricultural land due to the formation of surface waste emplacement.	The surface waste emplacement is included in the area for mine infrastructure that will temporarily be removed from agricultural	A	4	Med

Project Phase & Activity	Hazard	Mitigation	L	C	Score
		production.			
OPERATIONAL PHASE (25 years)					
Subsidence of land	Damage to fencing.	A Property Subsidence Management Plan (PSMP) shall be prepared for each agricultural enterprise affected by subsidence. Please refer to Section 3.2.2.2 for detail about these Plans.	B	4	Med
	Damage to farm access tracks/roads.				
	Damage to farm dams.				
	Damage to farm bores.				
	Damage to farm buildings.				
	Changed surface drainage conditions leading to erosion and/or water logging.				
	Human and stock injuries due to surface cracking.				
Subsidence of Golden Highway	Loss/interruption of a critical transport route.	The Project proponent, the road authority, the Mine Subsidence Board and the Muswellbrook Shire Council, plus other stakeholders, shall work together to develop risk management strategies to manage mine subsidence impacts to the Golden Highway. Such strategies have been successfully implemented elsewhere in NSW (Kay *et al.*, 2011). For example, ongoing subsidence of the Hume Highway by BHP Billiton's Appin Colliery and subsidence of Charlton Road near Singleton by Xstrata Coal's Beltana underground operation. Whilst access along the highway may be interrupted due to road surface repair works, the highway will remain "open" at all times.	B	4	Med

Project Phase & Activity	Hazard	Mitigation	L	C	Score
Mine water ingress	Draw down of Hunter Alluvial Aquifer removes the availability of this water for use by agriculture.	Refer to Section 3.1.1.4. The Project will not adversely affect this important aquifer.	D	4	Low
Mine water use Draw-down in Permian aquifers	Mine water drawn from the Hunter River removes the availability of this water for use by agriculture.	The mine will draw operational water from the Hunter River under licence/s. This will not affect the existing licences held by agricultural enterprises that extract water from the river.	D	5	Low
Access	Biosecurity (weeds, pests, diseases) affects pasture composition and grazing animal health.	Vehicle wash-down facilities and procedures will be in place and used. Similar procedures are currently in place with respect to exploration activities. No domestic animals shall be brought onto the construction site.	D	4	Low
	Noise and vibration affects grazing livestock.	Vibration caused by traffic is a null issue. Noise caused by traffic during operational phase is a null issue.	E	5	Low
	Dust from traffic falls onto pasture reducing palatability for grazing livestock.	Thoroughfares used for site access during operational phase shall be sealed.	E	5	Low
	Vehicle & domestic stock interactions leads to stock injury or death.	During operational phase, thoroughfares used for site access will be fenced to prevent stock incursion and eliminate the potential for vehicle-stock interactions.	E	5	Low
CLOSURE PHASE (1 year)					
Removal of infrastructure	Site of former mine infrastructure is not returned to agricultural land use leading to the permanent loss of agricultural land.	All mine surface infrastructure shall be removed at the cessation of mining. These disturbed area will be rehabilitated to achieve the land capability classes indicated	E	5	Low

Project Phase & Activity	Hazard	Mitigation	L	C	Score
		post-mining (refer to Section 2.1.1.3).			
Sealing of shafts	Unsealed shafts cause injury and death to livestock that enter them.	All entrances to underground mine workings shall be permanently sealed and made safe, in accordance with NSW Government requirements.	E	5	Low
Remediation of contaminated land	Hydrocarbons and chemicals contaminate land, preventing reinstatement of its former land use, e.g. grazing.	Conduct a Contaminated Land Assessment as a component of the mine closure program. Any contaminated land shall be remediated on site or removed for disposal at an appropriately licenced facility. Post-mining land capabilities will be demonstrated (refer to Section 2.1.1.3) and pre-mining agricultural land use/s shall be re-established, e.g. grazing of cattle.	E	5	Low

3.2.2 Impacts on agricultural enterprises

Following is a risk-based assessment of potential impacts on agricultural enterprises, specifically productivity, land value, communities and the surrounding environment, due to proposed Project construction, operation and closure activities.

3.2.2.1 Farm productivity

Project induced hazards that can potentially affect farm productivity have been identified and assessed (Table 3-5). Mitigation strategies are proposed to reduce impacts and achieve risk levels as low as reasonably possible.

Table 3-5 Risks to farm productivity

Activity	Hazard	Mitigation	L	C	Score
Subsidence of land	Subsidence causes reduced land & soil capability.	Subsidence will not affect land & soil capability within the Project area (Mckenzie, 2013).	E	5	Low
	Temporary removal of land from agricultural production during active subsidence.	Grazing livestock may be removed from land during active subsidence only. A Property Subsidence Management Plan (PSMP) will be developed for each agricultural enterprise (refer to Section 3.2.2.2 below).	D	4	Low

The Project, and specifically subsidence, will have no permanent or material effect on farm productivity.

3.2.2.2 Property subsidence management plans

A Property Subsidence Management Plan (PSMP) shall be prepared for each individual agricultural enterprise affected by subsidence. PSMPs should be in place prior to the commencement of subsidence impacts and, as a minimum, include detail about the following.

- Property and mine workings mapping;
- The extent, nature and timing of predicted subsidence;
- Anticipated effects on agricultural infrastructure including fencing, access tracks and water supplies;
- Monitoring methods and frequencies to be used to determine actual subsidence effects;
- Temporary mitigation measures during subsidence, such as fencing for stock security and stock water supply;
- Long term mitigation measures such as replacement fencing, permanent water supply, ground rehabilitation, e.g. repair of cracking; and,
- Landholder and mining company communication processes.

3.2.2.3 Land values

The prediction of future land values is a difficult task. Evidence of property valuations affected by resource development is scant, and there is currently no peer-reviewed article on this subject.

Certainly, there is anecdotal evidence that proximity to resource development in the Hunter region will decrease agricultural land value (Kelly, 2012). In this article of December last year, the Director of national property valuation agency Herron Todd White, is quoted to have said *"I've done valuations up in the valley and they are 20 to 30% under what you would expect."* Other articles, e.g. (Sharpe, 2012) and (Real Estate Institute NSW, 2013), seemingly counter this claim but likely report the residential real estate market and not agricultural land valuations.

NSW Department of Finance Services publishes representative land values for grazing properties in the Upper Hunter region (Table 3-6). This table is said to provide representative market valuations and trends (DFSLPI, 2013). Although some price corrections occurred at the time of the Global Financial Crisis (GFC), particularly for land near Singleton, grazing land values in the Upper Hunter have increased significantly since 1996 and held steady since 2010.

Throughout this period the number of coal mines and coal production in the Upper Hunter region has increased and resource exploration activities have expanded considerably. This suggests that grazing land values are not affected by exploration activities or coal mining, at least not at a district (Parish) or regional (LGA) level.

Table 3-6 Property market trends for grazing land in the Upper Hunter region, 1996 to 2012

Location	Area (ha)	1996	2007	2008	2009	2010	2011	2012
Denman	74	253,000	653,000	653,000	780,000	780,000	780,000	780,000
Singleton	764	513,000	1,410,000	1,750,000	1,620,000	1,164,000	1,160,000	1,160,000
Scone	476	356,000	1,130,000	1,130,000	1,040,000	1,040,000	1,040,000	1,010,000

Source: DFSLPI, 2013

Project induced hazards that can potentially affect land valuations have been identified and assessed (Table 3-7). Mitigation strategies are proposed to reduce impacts and achieve risk levels as low as reasonably possible.

Table 3-7 Risks to land values

Activity	Hazard	Mitigation	L	C	Score
Operation of an underground coal mine beneath grazing properties	Subsidence impacts may reduce land values.	Develop individual Property Subsidence Management Plans to mitigate effects of subsidence (refer to Section 3.2.2.2)	D	4	Low
Mining tenure (mining lease)	Existence of mining tenure over land may reduce land values.	With reference to Table 3-6 (above) there is no evidence to support reduced land values due to presence of resource tenure.	E	5	Low

3.2.2.4 Communities of the surrounding locality

Typically, mining induced hazards can potentially affect communities in the surrounding locality. These have been identified and assessed for the Project (Table 3-8). Mitigation

strategies are proposed to reduce impacts and achieve risk levels as low as reasonably possible.

Table 3-8 Risks to communities of the surrounding locality

Activity	Hazard	Mitigation	L	C	Score
Operation of an underground coal mine in the surrounding locality	Adverse impact on agricultural support services in the communities within the surrounding locality.	The Project will have a negligible effect on agricultural resources or productivities within the Project area and no adverse impacts within the surrounding locality.	E	5	Low
Cumulative impacts of multiple coal mines operating in the surrounding locality	Adverse impact on agricultural support services in the communities within the surrounding locality.	With reference to the above, the Project will not add to cumulative adverse impacts on agricultural in the surrounding locality.	E	5	Low

3.2.2.5 Environment of the surrounding locality

Project induced hazards that can potentially affect the environment in the surrounding locality, along with mitigation strategies, shall be subject to further and more detailed assessment in the Project EIS process.

3.2.3 Impacts on strategic agricultural land

Potential impacts on SAL have been assessed in accordance with the Gateway criteria (DP&I, 2013a)) for BSAL, Equine CIC and Viticulture CIC (Table 3-9, Table 3-10 and Table 3-11, respectively).

Table 3-9 BSAL Gateway criteria assessment

Criteria[1]	Project Assessment
In relation to BSAL – the proposed development will not significantly reduce the agricultural productivity of the land based on a consideration of:	
(i) Impacts on the land through surface area disturbance and subsidence	The project will cause negligible disturbance to BSAL, except for subsidence (see Section 3.1.1). The Project will cause the 86 ha area of verified BSAL to be subsided by <4 m maximum (MSEC, 2013). This area is currently pastured and utilised for the grazing of beef cattle, and will be rehabilitated as above. Subsidence will not affect the agricultural land & soil capability within the Project area, i.e. capability classes and the relative proportions of these (Section 2.1.1.1 and McKenzie, 2013). Subsidence will not cause adverse impacts to verified BSAL.
(ii) Impacts on soil fertility, effective rooting depth or soil drainage	The project will cause negligible disturbance to BSAL, except for subsidence (see Section 3.1.1). Subsidence will not affect the agricultural land &

Criteria[1]	Project Assessment
	soil capability within the Project area, i.e. land capability classes and the relative proportions of these (Section 2.1.1.1 and McKenzie, 2013). The Project will not cause the soil fertility, rooting depth or soil drainage of verified BSAL to be changed.
(iii) Increases in land surface micro-relief, soil salinity, rock outcrop, slope and surface rockiness or significant changes to soil pH	Subsidence will increase the micro-relief of BSAL in the Project area. However, this will not affect the agricultural land & soil capability class of this BSAL (Section 2.1.1.1 and McKenzie, 2013). Apart from subsidence, the Project may cause minimal (<1 ha) disturbance to BSAL for ventilation and gas drainage infrastructure, services boreholes, exploration and remediation. This temporary disturbance will not affect soil salinity, rockiness or pH on that land. The Project will not reduce the agricultural productivity of verified BSAL.
(iv) Impacts on highly productive groundwater (within the meaning of the Aquifer Interference Policy)	The Project meets the minimal impact provisions of the Aquifer Interference Policy for highly productive groundwater (Section 3.3.1).
(v) Any fragmentation of agricultural land uses	The Project will not fragment any agricultural land uses.
(vi) Any reduction in the area of biophysical strategic agricultural land	The Project will not cause any reduction in the area of BSAL.

Source: [1] DP&I, 2012a

Table 3-10 Equine CIC Gateway criteria assessment

Criteria	Project Assessment
In relation to CICs - the proposed development will not lead to significant impacts on the relevant critical industry cluster based on a consideration of:	
(i) Surface area disturbance and subsidence	There are no equine enterprises within the Project area. There are 5 equine enterprises within 2 km of the Project area boundary (Section 2.2.2.4). Surface area disturbance and subsidence by the Project will have no effect on existing equine enterprises.
(ii) Reduced access to, or impacts on, water resources and agricultural resources	There are no equine enterprises within the Project area. There are 5 equine enterprises within 2 km of the Project area boundary (Section 2.2.2.4). The Project will not cause reduced access to, or impacts on, water resources or agricultural

Criteria	Project Assessment
	resources of any equine enterprises.
(iii) Reduced access to support services and infrastructure	The Project will not cause reduced access to support services or infrastructure of any equine enterprises.
(iv) Reduced access to transport routes	The Project will not cause reduced access to transport routes of any equine enterprises.
(v) Loss of scenic and landscape values	The Project will not cause loss of scenic or landscape values of any equine enterprises.

The Project will not cause any change to land use with respect to equine or viticulture CICs. The Project will cause the loss of any verified BSAL.

Table 3-11 Viticulture CIC Gateway criteria assessment

Criteria	Project Assessment
In relation to CICs - the proposed development will not lead to significant impacts on the relevant critical industry cluster based on a consideration of:	
(i) Surface area disturbance and subsidence	The Project will cause subsidence to one vineyard within the Project area. There are two additional vineyards within 2 km of the Project area (Section 2.2.2.5). Subsidence will not affect the agricultural land & soil capability of the affected vineyard, i.e. capability classes and the relative proportions of these (Section 2.1.1.1 and McKenzie, 2013). Appropriate mitigation measures (refer to Section 4.4) will ensure that surface subsidence has no adverse impact on this viticulture enterprise.
(ii) Reduced access to, or impacts on, water resources and agricultural resources	The Project will not cause reduced access to, or impacts on, water resources or agricultural resources of any viticulture enterprise.
(iii) Reduced access to support services and infrastructure	The Project will not cause reduced access to support services or infrastructure of any viticulture enterprises.
(iv) Reduced access to transport routes	The Project will not cause reduced access to transport routes of any viticulture enterprises.
(v) Loss of scenic and landscape values	The Project will not cause loss of scenic or landscape values of any viticulture enterprises.

3.3 Physical removal of water away from agriculture

The Project is anticipated to require about 1,200 ML of per year (gross) of raw water for operational purposes. This water will be drawn from underground dewatering, surface

runoff and the Hunter River under an access licence in accordance with the Water Sharing Plan for the Hunter Regulated River Water Source 2003, under Section 50 of the WM Act.

Under the Water Sharing Plan for the Hunter Regulated River Water Sources 2003, a component of the water available within the Water Source is allocated for domestic and stock access licences. Regulated river access licences for use by irrigators and industry have a separate share component. SHM currently holds regulated river (general security) licences under the Water Sharing Plan with an entitlement of 832 unit shares that were obtained through property acquisitions. SHM would acquire any additional licences required prior to the commencement of operations.

3.3.1 Aquifer interference policy

According to HydroSimulations (2013) (refer to Appendix C), the potential impacts of the Project satisfy the "minimum interference" provisions of the AIP (Table 3-12).

Table 3-12 Summary of AI Policy assessment for Hunter Alluvium (from: HydroSimulations, 2013)

Summary	AI Policy Assessment – Hunter Alluvium
Minimum impact considerations for aquifer interference activities	
Aquifer	Alluvial aquifer (Hunter unregulated and alluvial water sources)
Category	Highly productive
Level 1 Impact Consideration	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 m 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. OR A maximum of a 2 m water table decline cumulatively at any water supply work.	At the time of writing there were no Culturally Significant Sites or high priority Groundwater Dependent Ecosystems (GDEs) known in the study area or listed in Water Sharing Plans for the area, i.e. 'Hunter Unregulated and Alluvial Water Sources' (version current for 8 March 2013). Hence there are no known risks of mine development to such sites. No drawdown in excess of the water supply work drawdown criterion (2 m) within the Hunter Alluvium. **Level 1 minimal impact consideration classification.**
Water pressure A cumulative pressure head decline of not more than 40% of the "post-water sharing plan" pressure head above the base of the water source to a maximum of a 2m decline, at any water supply work. **OR**, for the Lower Murrumbidgee Deep Groundwater Source: A cumulative pressure head decline of not more than 40% of the "post-water sharing	N/A (only unconfined conditions in alluvial aquifer).

Summary	AI Policy Assessment – Hunter Alluvium
plan" pressure head above the top of the relevant aquifer to a maximum of a 3m decline, at any water supply work.	
Water quality	
Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.	Mining is predicted to induce leakage of surface water into the Hunter Alluvium. This will, if anything, have a beneficial impact on EC of the alluvial aquifer. There are therefore no simulated risks of reduced beneficial uses of the Hunter Alluvium as a result of the Project. Nor is there any predicted increase in the salinity of the Hunter River.
No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity.	
No mining activity to be below the natural ground surface within 200m laterally from the top of high bank or 100m vertically beneath (or the three dimensional extent of the alluvial water source - whichever is the lesser distance) of a highly connected surface water source that is defined as a "reliable water supply".	No proposed mining activity within these specified proximities to the Hunter Alluvium.
Not more than 10% cumulatively of the three dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200m laterally from the top of high bank and 100m vertically beneath a highly connected surface water source that is defined as a "reliable water supply".	No proposed excavation of alluvial material proposed. **Level 1 minimal impact consideration classification.**

3.4 Assessment of socio-economic impacts

An assessment of socio-economic impacts of the proposed Project has been completed and follows.

3.4.1 Agricultural support services, processing and value-adding industries

Agricultural support services, processing and value-adding industries (collectively, "support services") for the enterprises identified in the Project area have been assessed. Agricultural production in the Project area is dominated by livestock grazing. Livestock grazing is a widespread and dominant agricultural industry across the entire Upper Hunter region (Section 2.2.1.5).

A description and quantification of the major support services to the livestock grazing industry in the surrounding locality of the Project (including Singleton, Muswellbrook and Scone) is provided (Table 3-13). There are two major selling centres, one each located in Scone and Singleton, a selling centre in Denman, and a large number of agents and livestock carriers around Scone, Muswellbrook and Singleton.

As detailed previously (refer to Section 3.2) no agricultural enterprise within the Project area will be materially and/or permanently impacted by the Project. The Project will have no

adverse impact on the agricultural industry in the surrounding locality or broader Upper Hunter region. Key support infrastructure for the livestock industry, including rail and road networks will be unaffected by the Project.

Table 3-13 Support services for cattle grazing enterprises in the surrounding locality

Livestock grazing support services	Details (and distance to Project area)
Selling centres	Denman Saleyards (7 km)* • Fat sales; • Store sales; and, • Clearance sales. Scone & Upper Hunter Regional Saleyards (50 km)** • EU accredited; • Pre sale live weight facilities; • Truckwash, loading ramps, crushes and drafting; • Fat sales; • Store sales; • Annual breed sales; and • Fats weekly sales, stores monthly sales. Singleton Regional Livestock Markets (70 km)** • NQSA accredited; • EU accredited; • Truckwash, loading ramps crushes and drafting; • Fat sales; and • Store sales.
Agents	Edward Higgens, Parkinson & Co, Muswellbrook (25 km) and Denman (5km)** Boyle Estate Agents, Muswellbrook (25 km)** MacCallum Inglis, Scone (50 km)** Davidson Cameron Clydsdale & Co, Scone (50 km)** Landmark Townsand, Scone (50 km)** Iain Mackintosh Property and Livestock, Scone (50 km)** Ray White Taylor, Scone (50 km) ** Gordon Fuller Pty Ltd, Singleton (65 km)** Max Bailey Pty Ltd, Singleton (65 km)**
Livestock carriers	J C Thomas Livestock Transport, Muswellbrook (25 km)** Martin's Stock Haulage, Scone (50 km)** Davis & Sons Livestock Transport, Blandford (88 km)** Richardson Livestock Transport, Rutherford (87 km)** Clarrie Lawlor, Scone (50 km)** A & S Watts Carriers, Scone (50 km)** Stockmaster Livestock Transport, Tamworth (184 km)** A & H Yates, Gloucester (188 km)** A & W Hardes, Scone (50 km)** J Clydsdale, Rouchel (54 km)**
Meatworks	E C Throsby Pty Limited, Whittingham (65 km)^ • Wholly Australian owned private beef processing; • Processes cows and bulls for export and domestic; • Exports 98% to USA, South East Asia and the Middle East; • Halal accreditation, AQIS accreditation, Aus-Meat; and

Livestock grazing support services	Details (and distance to Project area)
	• Onsite waste water treatment. Primo Australia, Scone (50 km) ^^ • Meat division of Primo Smallgoods; • Supplies major retail outlets; • Halal accreditation; and • Exports beef to Asian and South African markets.

Source: *Upper Hunter Country (2013); **ALMA (2013); ^E C Throsby (2013); ^^Primo (2013)

Recent observed changes to support services for the livestock grazing industry in the surrounding locality, include potential impacts by open cut coal mining through land acquisition as well as industrial and commercial factors.

1. A large open cut mining operation on Wybong Road, Wybong, is thought to have directly impacted Denman saleyards. The mining company purchased cattle grazing properties for mine development, farming families vacated the land, and, only in part, were replaced by a company-owned cattle operation. The company-enterprise is integrated with properties throughout NSW, QLD and the Northern Territory, and has alternative support services to the surrounding locality, including cattle markets. It is estimated that that this resulted in the removal of 40 buyers and 40 sellers from the Denman Saleyards (Pritchard, 2010); and,
2. Aberdeen Meatworks closed in 1999. The meatworks had operated for 109 years. A total of 400 employees were dismissed under difficult industrial circumstances. There is no correlation drawn between abattoir closure and the mining industry (Souris et al, 1999).

In the last decade, the Australian red meat industry, including support services, has been significantly impacted by droughts, the discovery of bovine spongiform encephalopathy (BSE) in Japan in 2001 and North America in 2003, the global financial crisis in 2009, the significant decline in live exports as a result of the Indonesian live export ban in 2010 and the persistent high value of the Australian dollar. Australia-wide, the livestock grazing industry has been impacted (MLA, 2013a). Like other regional areas and agribusiness sectors, there are issues in relation to recruiting farm labour (Buchan Consulting, 2011).

Small-scale beef producers, including those identified in the Project area, face higher unit cost of inputs (including fertiliser, drenches, farm equipment); higher costs per head for pasture improvement; and have limited capacity to negotiate prices or to access more profitable cattle markets. Recent analysis for the industry shows that while there has been an increase in income, this has tended to be squeezed by rising input costs from support services, particularly for small producers (Buchan Consulting, 2011).

3.4.2 Visual amenity, landscape values and tourism infrastructure

The Upper Hunter region retains substantial natural heritage with nearly 60% of the area covered by native bushland. About 43% or 1,455 km^2 of land within the Muswellbrook LGA is national park. Lake Liddell delineates the Muswellbrook Shire boundary to the east, Wollemi National Park to the west, Aberdeen to the north and Coricudgy State Forest to the south. The area has significant natural heritage landscape value and high visual amenity. This amenity, the local wine industry and the region's proximity to Sydney, Australia's largest city, encourages tourism and the development of tourism infrastructure.

With respect to agricultural tourism, vineyard-tourism is the most important contributor to the economic base of the surrounding locality and the broader Muswellbrook LGA. According to MSC (2013b), the value of the Hunter Valley viticulture industry extends to tourism contributing revenue $256 million in 2010. Hunter Valley viticulture and tourism industries combined contribute $1.8 billion dollars annually into the NSW economy and the industry employs over 7,000 people with an additional 10,000 indirectly employed (MSC, 2013b). The overall commercial viability of many vineyards is thought to rely on tourism, specifically cellar door wine sales (Buchan Consulting, 2011). Vineyard tourism of the surrounding locality has been determined (Table 3-14).

A detailed Visual Impact Assessment, including photomontages, will be provided as part of the EIS. However, at an anecdotal level, the proposed Project area surface infrastructure will be visible by tourists travelling along Denman Road between Denman and Muswellbrook. In this regard, it is expected that the Project will have some adverse but immaterial impact on visual amenity in the surrounding locality.

Table 3-14 Vineyard-tourism infrastructure of the Project area and surrounding locality

Tourism infrastructure	Details (and distance to Project area)
Wineries and vineyards	A full description of these vineyards – wineries, including their tourism functionality, is provided in Section 2.2.2.5, summarised as follows. Callatoota Estate (within Project area) – Cellar Door Winbirra Estate (1km) Two Rivers Wines (5km) – Cellar Door Pyramid Hill Wines (5km) – Cellar Door Rombo Ridge – Martindale Vineyard, part of Penmana Wines (5km) Hollydene Estate – Arrowfield (5.5km) – Cellar Door Roxburgh Estate – BHP Billiton, grapes contracted to The Little Wine Company (5.5km) Hope Estate – Rothbury (5.5km) Horseshoe Vineyard (10km) Hollydene Estate - Hollydene (12.5km) James Estate Wines (20km) – Cellar Door Yarraman Estate (28km) – Cellar Door Hollydene Estate – Wybong (33km)

Source: Refer to Section 2.2.2.5

The physical landscape, comprised of soils, water, topography and land use, is important to the thoroughbred breeding industry in the Upper Hunter and elsewhere. Fertile soils, good pasture, rolling topography and clean water are prerequisites to successful horse breeding. However, landscape value extends far beyond the physical.

McManus and Connor (2013) identifies four landscape values that are important to the Upper Hunter Equine CIC. Understanding how the CIC values landscape provides insight to its serious concerns about competing land uses that alter the physical landscape and risk these landscape values. Each of the landscape values is engineered at considerable cost. Whilst this cost burden is not evenly apportioned across the industry, i.e. studs like Coolmore and Woodlands have invested heavily, the outcomes create a positive externality enjoyed by the whole cluster. Each landscape value is intrinsically linked to stud and cluster economics. These landscape values are *rural idyll, landscapes of conspicuous consumption, brandscapes* and *landscapes of work*.

The *rural idyll* is an image of well-maintained properties with green pasture, painted-wooden fences, and not a thing out of place. According to McManus and Connor (2013), it is *"intended to convey the message that the stud is organized and caring, and that the care shown in the landscaping is transferred into care for the horses. Landscape is therefore symbolic of caring for animals and for an owner's investment."*

Landscapes of conspicuous consumption project an image of status, of wealth, to attract similarly wealthy customers. Thoroughbred breeding studs like Coolmore and Woodlands are landscaped to attract investment. These studs are customer focussed and this makes them different from most other agricultural land uses. As McManus (2013) explains, even the electronic gates are a symbol that most people are excluded and those who are invited inside are special, part of the *"experience economy."*

In an experience economy, customers become associated with the cluster and individual stud brands. Here, the desirability of the experience is paramount. The engineered landscape is entwined with the name, prestige and reputation of the stud and contributes to the positive experience. This is now *brandscape*. It is important at cluster-level but critical at an enterprise-level, particularly for the most significant central actors in the cluster, e.g. Coolmore and Woodlands.

Lastly, *landscapes of work* recognises that these built landscapes of rural idyll, where conspicuous consumption and brandscaping attract the wealthy, are places of work. Whilst made to look perfect and complete for customers, the work of maintaining the thoroughbred landscape never ceases and is an enduring business expense.

The importance of landscape values to both the equine and viticulture CIC within the Upper Hunter region cannot be overstated. As the proposed Project is for an underground mine, as opposed to an open-cut coal mine, it is not anticipated that landscape values important to the CICs will be adversely impacted. Further assessment of visual impacts, including photomontages, will be a component of the EIS.

3.4.3 Local and regional employment impacts

The Project is expected to have no adverse or material impact on local or regional employment. The majority of the 5,500 mining jobs in the Upper Hunter region are already located in the Singleton (70%) and Muswellbrook (28%) LGAs (Buchan Consulting, 2011). The majority of these employees are residents of Singleton and Muswellbrook (Buchan Consulting, 2011).

The Project employee demands will account for less than 5% of total mining sector employees in the Upper Hunter region. In construction phase, the Project will employ 400 personnel. In operational phase, the Project will employ up to 300 personnel. The construction period would be approximately two years.

Relying on current economic analyses, it is possible that personnel for the Project would be primarily sourced from a pool of existing residents in the Muswellbrook, Scone, Singleton, Upper Hunter and Newcastle LGAs (Buchan Consulting, 2011). The exact labour pool sources for the Project will be identified through a detailed assessment undertaken as part of the subsequent EIS. Whether the operational labour pool for the Project will require additional permanent accommodation in Denman, Muswellbrook, Scone and Jerry's Plains and the broader Upper Hunter region, is a factor that will be identified through further analysis.

Comparatively, there is an estimated 1,265 employees in the livestock grazing industry sector in the Upper Hunter region (Buchan Consulting, 2011), the majority of whom would be expected to live on or adjacent to the property on which they work. As indicated in Section 2.2.1.5, the livestock grazing industry is a major component of the region's economy.

Nonetheless, there is a labour shortage in agriculture across Australia. For example, there are currently an estimated 100,000 jobs available in agriculture (NFF, 2012). NFF (2008) cite an up to 12 factors contributing to this labour shortage, including the following.

- Permanent departure from the industry by thousands of workers as a direct result of the 2002-03 drought;
- The depletion of regional populations stifling regional development, and the consequent reduction of the talent and labour pool, in tandem with the lack of sufficient infrastructure, resources and lifestyle in regional areas to attract town and city workers to relocate;
- Incorrect perceptions of the nature of employment in agriculture; and
- Wage rates and perceptions about wage rates – the nearest competing industry is the mining sector, which, despite its remuneration packages, is still experiencing major labour supply issues (NFF, 2008).

The Project will not have any adverse or material impact on the surrounding locality's employment rate in the agricultural sector, including the livestock grazing industry.

3.4.4 Critical mass thresholds

An assessment of the significance of agricultural enterprises in the Project area, surrounding locality and Upper Hunter region is provided (Section 2.2.1.5). The dominant agricultural enterprise within the Project area, beef cattle grazing, is widely represented throughout the Upper Hunter region. There is significant infrastructure, support services and transport networks that service this dominant industry.

The Project will have no adverse or material impact on the livestock enterprises within the Project area, the surrounding locality or the broader Upper Hunter region. The Project will not remove any agricultural enterprise from the Upper Hunter agricultural industry.

Cumulative impacts, including any potential impact on the accommodation thresholds of Denman, Muswellbrook, Singleton and Scone, as a result of the Project together with other proposed mining operations, will be considered in the EIS.

3.5 Sustainable agriculture and rural development

FAO (1995) defines sustainable agriculture and rural development (SARD) as a process that meets that following criteria:

- *"Ensures that the basic nutritional requirements of present and future generations, qualitatively and quantitatively, are met while providing a number of other agricultural products.*
- *Provides durable employment, sufficient income, and decent living and working conditions for all those engaged in agricultural production.*
- *Maintains and, where possible, enhances the productive capacity of the natural resource base as a whole, and the regenerative capacity of renewable resources, without disrupting the functioning of basic ecological cycles and natural balances, destroying the socio-cultural attributes of rural communities, or causing contamination of the environment.*

- *Reduces the vulnerability of the agricultural sector to adverse natural and socio-economic factors and other risks, and strengthens self-reliance."*

SARD is undoubtedly a complex matter. Its measure would surely include biological, physical, social and economic matters, the interrelationship of these, and the integration of management, natural resources and externalities. Many of these issues have been considered in this AIS. The potential impacts of the Project will not negatively affect SARD within the Project area or surrounding locality.

4 MITIGATION MEASURES

Following is a detailed discussion of mitigation measures to reduce potential impacts of the Project on agricultural resources, enterprises and systems, and SAL.

4.1 Project alternatives

The proposed Project is for an underground longwall coal mine. It is beyond the scope of an agricultural assessment to provide feasibility-analysis of mining options, i.e. analysis of alternate coal mining methodologies. An overview of potential Project alternatives was included in the *Project Description and Preliminary Environmental Assessment* (Resource Strategies, 2012) and is amended as follows.

1. ***Project location***

   The location of the Project is determined by the presence of coal seams and ability to transport product coal to market.

2. ***Mining method***

   The Project is solely an underground mining operation which mitigates local issues, notably dust, visual amenity and impacts to agricultural resources. The Project does not include any open cut mining. Due to the coal seam thickness and strike, longwall mining methods are the preferred mining method over bord and pillar.

3. ***Scale***

   The indicated and inferred resources within the Whynot, Bowfield and Warkworth Seams is estimated at approximately 252 Mt (as at November 2013). Resource definition and exploration drilling conducted by SHM indicates that these seams are the most optimal seams for an underground mining operation.

The Project has also considered alternative locations for surface infrastructure, i.e. offices, workshop, etc. This infrastructure shall not be located on any verified BSAL.

4.2 Monitoring programmes

Subsidence of agricultural land is the assessed highest-risk impact of the Project (refer to Section 3.2.1). Prior to causing any subsidence, the Project will be required to prepare and submit a *Subsidence Management Plan* (SMP) for approval by NSW Trade & Investment, Division of Resources & Energy (DRE). This is a standard approval required by condition of mining lease for an underground coal mine in NSW (under the Mining Act 1992).

In general, DMR (2003) requires that SMPs must describe the following.

1. Area that may be affected;
2. Process of subsidence prediction employed;
3. Prediction and assessment of subsidence impacts on the area affected;
4. Consultation process undertaken with government agencies and the community;
5. Results of that consultation; and
6. Proposals to prevent, mitigate or rehabilitate subsidence impacts.

By requirement, SMPs contain considerable detail including the monitoring and assessment of actual subsidence impacts on affected land. Without pre-empting this detail, a monitoring schedule and methodologies is proposed here (Table 4-1). Application of such monitoring

will allow comparison of actual versus predicted subsidence impacts, and inform trigger action response plans (TARPs) (discussed subsequently in this report).

Table 4-1 Subsidence monitoring methodologies and schedule during active subsidence

Affected item	Parameter	Methodology	Units	Schedule
All land	Ground deformation	Traverse survey (centre-line and x-sections)	mm (x,y,z)	Monthly
		Aerial survey (LIDAR)	mm (x,y,z)	Annual
	Ground cracking	Visual inspection with GPS locations	Inspection	Monthly
		Length and width measurement	mm	Monthly
		Photography	Count	Monthly
Stock fencing	Fence condition	Visual inspection with GPS locations	Inspection	Weekly
		Photography	Count	Monthly
Stock water dams	Dam condition, cracking	Visual inspection with GPS locations	Inspection	Weekly
		Photography	Count	Monthly
Farm tracks	Track condition, cracking, deformation	Visual inspection with GPS locations	Inspection	Weekly
		Length and width measurement (cracks)	mm	Monthly
		Photography	Count	Monthly
Drainage lines	General condition, cracking, erosion	Visual inspection	Inspection	Monthly
		Photography	Count	Monthly
Vineyard	Trellis condition	Visual inspection with GPS locations	Inspection	Fortnightly
	Irrigation condition	Visual inspection with GPS locations	Inspection	Weekly
	Vine condition	Visual inspection with GPS locations	Inspection	Weekly
	Fruit yield	Sample harvesting across vineyard	kg/vine or kg/length trellis	Annual
BSAL	General condition	Visual inspection	Inspection	Monthly
		Photography	Count	Monthly

Prior to causing subsidence to the Golden Highway, the Project proponent together with NSW Transport – Roads and Maritime Services, the Mine Subsidence Board, the Muswellbrook Shire Council, and other stakeholders and technical experts, shall develop a detailed road subsidence management plan. This specific management plan will contain monitoring methodologies and schedules. It is beyond the scope of this report to specify this further.

4.3 Trigger action response plans (TARPs)

Monitoring methodologies and schedules detailed above shall inform TARPs in relation to mine subsidence. Draft TARPs are provided (Table 4-2).

4.3.1 Remedial actions

Remedial actions derived from assessment of impacts (Section 3), monitoring programmes (Section 4.2) and TARPs (Section 4.3) will minimise impacts on agriculture. Temporary remedial actions to negate the potential adverse effects of subsidence have been listed (Table 4.2) and these include the following.

- Erection of temporary electric fencing to maintain paddock-level stock security during subsidence;
- Construction of temporary stock watering systems to maintain paddock-level grazing viability during subsidence, e.g. tanks and troughs;
- Regrading of farm access tracks during and post subsidence;
- Erosion control measures in surface drainage lines;
- Repair of vineyard infrastructure, i.e. trellises and irrigation systems; and,
- Drainage works to prevent the semi-permanent submersion of BSAL.

Notwithstanding subsidence changing the topography of the affected land, all potential impacts on agriculture caused by subsidence are reversible, i.e. none are permanent, in this instance. The temporary remedial actions proposed, and also the permanent rehabilitation actions proposed, are based on proven industry practices.

4.4 Demonstrated capacity for the rehabilitation of disturbed lands

The principal type of land disturbance posed by the Project is subsidence. Laterally extensive, subsidence will affect about 2,500 ha of the Project area (3,300 ha). The subsided land is predominantly permanently pastured, including 86 ha of verified BSAL, and also includes 26 ha of grape vines and a 3.5 km section of the Golden Highway. However, by using industry-proven rehabilitation methods, there will be no permanent loss of agricultural land and no loss of agricultural productivity on any affected land.

The rehabilitation of grazing land affected by subsidence shall focus on the removal of any surface cracking and earthworks to limit or prevent water ponding in subsidence induced depressions. This will be achieved using conventional earthmoving equipment to:

- In-fill minor surface cracks by cultivation of the ground surface; or,
- In-fill larger surface cracks with suitable soil or other material; and
- Localised reshaping to limit the potential for water ponding; and
- Stabilisation of disturbed areas with temporary erosion controls, e.g. silt fences, and long-term measures, e.g. vegetation planting.

This rehabilitation methodology is standard industry practice throughout Australia and a common inclusion in SMP approvals in NSW, e.g. recent approvals for subsidence at Wambo mine near to Warkworth (Peabody, 2012).

Table 4-2 Subsidence TARP

Affected item	Trigger / response	Pre-subsidence	During subsidence			Post-Subsidence
			Level 1	Level 2	Level 3	
All land (generally)	Trigger	No subsidence deformation or cracking.	Deformation and cracking within 10% of prediction.	Deformation and cracking exceeds prediction by >20%.	Deformation and cracking exceeds prediction by >30%.	Monitoring indicates subsidence is completed.
	Remedial action	Develop baseline digital terrain model. Complete predictive subsidence modelling. Develop and submit SMP for approval.	Continue routine monitoring.	Increase frequency of monitoring to weekly. Re-do predictive subsidence modelling. Inform Principal Subsidence Engineer (DRE).	Seek direction from Principal Subsidence Engineer (DRE).	Progressively in-fill or deep rip to remove surface cracks.
Stock fencing	Trigger	Subsidence to commence within 2 weeks.	Subsidence commenced.	Minor fence movement, stock security not compromised.	Temporary electric fencing failed due to subsidence effects. Stock not secure.	Fence subsidence complete.
	Remedial action	Erect temporary electric fencing alongside existing fence.	Commence routine monitoring.	Continue routine monitoring.	Repair electric fencing to ensure it is stock proof. Notify landholder and assist to account for stock. Increase frequency of monitoring to daily.	Remove temporary electric fencing. Repair or replace original stock fencing.
Stock water dams	Trigger	Subsidence to commence within 2 weeks.	Subsidence commenced.	Minor land deformation, but temporary stock water system not compromised.	Land deformation and/or cracking causes temporary stock water system to fail.	Subsidence of farm dam complete.
	Response	Establish temporary stock water sources, e.g. tank and trough.	Commence routine monitoring.	Continue routine monitoring.	Repair temporary stock watering system immediately. Notify landholder. Increase monitoring frequency to daily.	Remove temporary stock water supply systems. Repair or replace original stock water dams.

Affected item	Trigger / response	Pre-subsidence	During subsidence			Post-Subsidence
			Level 1	Level 2	Level 3	
Farm tracks	Trigger	Subsidence to commence within 2 weeks.	Subsidence commenced.	Some deformation and/or cracking >100 mm width.	Significant deformation and/or cracking >200 mm width.	Subsidence of tracks completed.
	Response	Take baseline photographs of track condition.	Commence routine monitoring.	Implement remedial earthworks, i.e. grade track to remove cracks. Increase frequency of monitoring.	Establish alternate access track. Implement remedial earthworks following subsidence. "No Road" tracks if considered necessary for safety reasons. Notify landholder.	Implement earthworks to permanently repair tracks.
Drainage lines	Trigger	Normal flow conditions.	Subsidence commenced.	Deformation and/or cracking causes minor erosion and flow interruption.	Deformation and/or cracking causes significant erosion and flow interruption.	Subsidence of drainage lines completed.
	Response	Implement monitoring to develop baseline data on surface flow hydrology.	Commence routine monitoring.	Install erosion control measures, e.g. silt fencing. Increase monitoring frequency to weekly.	Notify Principal Subsidence Engineer (DRE) and other Government departments, as necessary. Engage expert hydrological advisor to develop a management plan. Increase monitoring frequency based on rainfall events.	In-fill or deep rip to remove surface cracks. Design and implement earthworks to correct flow paths, if necessary. Plant grass and woody species to rehabilitated scoured bank and bed sections.
Vineyard	Trigger	Pre-subsidence.	Subsidence commenced.	Deformation and/or cracking causes damage to trellis and irrigation infrastructure, and affects vine health.	Vine death or yield impact >25% reduction.	Subsidence of vineyard complete.

Affected item	Trigger / response	Pre-subsidence	During subsidence			Post-Subsidence
			Level 1	Level 2	Level 3	
	Response	Yield map the vineyard for as many vintages as possible.	Commence routine monitoring.	Repair trellis and irrigation infrastructure. Engage specialist horticultural advisor to make recommendations on vine health. Continue routine monitoring.	Engage specialist horticultural advisor to make recommendations on vineyard management. Continue routine monitoring.	In-fill or deep rip to remove surface cracks. Complete necessary repairs to trellis and irrigation infrastructure. Continue vineyard yield mapping for next three vintages.
BSAL	Trigger	Pre-subsidence.	Subsidence commenced.	Land deformation and/or cracking <100 mm width.	Land deformation leads to ponding.	Subsidence of BSAL completed.
	Response	Develop baseline soils and land information.	Commence routine monitoring.	Continue routine monitoring.	Implement temporary pond drainage measures to prevent BSAL submersion. Continue routine monitoring.	In-fill or deep rip to remove surface cracks. Design and implement permanent drainage solutions to prevent BSAL submersion. Seed and fertilise, as appropriate, to rehabilitate BSAL surface disturbance.

The Project will cause the area of verified BSAL to be subsided by <4 m maximum (MSEC, 2013). This area is currently pastured and utilised for the grazing of beef cattle, and will be rehabilitated as above.

MSEC (2013) shows that subsidence will occur to the vineyard within the Project area (property 9). Here, two coal seams will be progressively extracted and maximum subsidence is expected to be 2.0 to 3.5 m. Potential impacts include surface cracking typically 25 to 50 mm with isolated cracking >100 mm width, potential water ponding, and damage to vineyard trellis and irrigation infrastructure. Surface cracking and ponding shall be rehabilitated as per grazing lands, using conventional earthmoving equipment. Studies have shown that other subsidence affects on trellis and irrigation infrastructure, and on vines themselves, can be successfully mitigated (see CASE STUDY 1).

CASE STUDY 1 – Rehabilitation of vineyards at Broke following longwall subsidence

The effects of longwall mine subsidence on wine grape yields and vineyard infrastructure in the Upper Hunter region has been extensively studied since about 1998 (for example, Thompson *et al.*, 2007; Thompson *et al.*, 2010; and, NSWMIN, 2012).

The Beltana longwall mine, near Broke, has caused subsidence to about 90 ha of vineyards since 2005. Results of various studies to date show impacts are minimal and manageable (NSWMIN, 2012) with:

- Minor surface cracking;
- Minor damage to trellis and irrigation infrastructure;
- No impacts on vine health; and,
- No long-term impacts.

Thompson *et al.* (2010), using both on-ground and remote-sensing techniques, determined that subsidence of these vineyards had no effect on grape yield throughout a five-year study period.

Stakeholders assessing the impacts of subsidence on a vineyard near Broke

NSWMIN (2012) conclude that impacts were minor and short-term, able to be remediated or compensated, and no long-term impacts were observed. The Beltana operation will eventually undermine, subside and rehabilitate about 119 ha of existing vineyards (Thompson, et al., 2007).

The Project will cause subsidence to about 3.5 km of the Golden Highway (State Route 84), which transects the underground mining area. There are many examples of roads in NSW having been subsided by underground coal mining and successfully rehabilitated, viz.

- Charlton, Fordwich and Broke Roads at Broke, NSW, by Beltana mine in 2012 (Xstrata Coal, 2012);

- Hume Highway at Douglas Park, NSW, by Appin Colliery in 2011 (Kay *et al.*, 2011);
- F6 Southern Freeway, NSW, by Metropolitan Colliery in 2010;
- Link Road F3 Freeway at Doyalson, NSW, by Munmorah Colliery in 1995 (MSB, 1997); and
- Pacific Highway at Catherine Hill Bay, NSW, by Wallarah Colliery in 1984 – 88 (MSB, 1997).

The NSW industry has a demonstrated capacity to safely undermine and repair road infrastructure (see CASE STUDY 2).

CASE STUDY 2 – Rehabilitation of the Hume Highway following longwall subsidence

Although most road-users would be unaware, BHP Billiton has been subsiding and rehabilitating the Hume Highway southwest of Sydney since 2011. The Hume is arguably the most important road corridor in the country, linking Sydney with Canberra and Melbourne. This dual two-lane carriageway currently carries in excess of 20 million tonnes of road freight annually and traffic volumes exceed 39,000 vehicles per day (Kay *et al.*, 2011). This highway is undoubtedly of critical importance to Australian agriculture.

Following a lengthy planning period, the road authority, the mining company and a Technical Committee that included specialists in the fields of pavement engineering, geotechnical engineering and subsidence, successfully managed the risks to the highway. Not least of these risks was maintaining road safety and highway functionality during active subsidence and rehabilitation.

Innovative, world-first, monitoring systems were used. The highway was undermined, subsided more than 1000 mm in places, and subsequently rehabilitated. This work received the NSW Premiers Award for Infrastructure Innovation in 2011.

This section of the Hume Highway has been subsided and successfully rehabilitated

4.5 Demonstrated planning for progressive rehabilitation

Subsidence occurs progressively and should be rehabilitated progressively, on a paddock-scale basis. Requirements for progressive rehabilitation are typical development consent conditions, and mining lease conditions will require that this process is detailed within SMPs.

5 CONSULTATION AND ENGAGEMENT STRATEGY

The following details the Project's stakeholder consultation and engagement history and strategy. Specific stakeholder engagement with respect to this report is also discussed.

5.1 Consultation to date

SHM has implemented a stakeholder engagement program for the Project. Key objectives of the program are to:

- Inform government and public stakeholders about the progress and nature of the Project;
- Recognise and respond to local interests or concerns regarding the Project; and,
- Continue the ongoing dialogue between local landholders and SHM.

Consultation undertaken to date in relation to the Project has included:

- Ongoing consultation with local landholders regarding the Project and access for exploration and environmental baseline studies;
- Meetings with Darley (Woodlands) on 11 August 2008 and 09 August 2011;
- Ongoing consultation with representatives of the DRE since 2010 regarding exploration activities in EL 7429;
- Ongoing consultation with the DP&I regarding the status of environmental baseline studies and the application process for the Gateway Certificate;
- Conceptual Project Development Plan meeting with representatives of the DRE on 21 August 2012;
- Consultation with the Department of Primary Industries (Office of Agricultural Sustainability and Food Security) about exploration activities in EL 7429 in March 2013; and
- Involvement in the Strategic Biodiversity Assessment for Coal Mines in the Upper Hunter Valley with the NSW Office of Environment and Heritage (OEH), DP&I, NSW Trade & Investment and the Commonwealth Department of Sustainability, Environment, Water, Population and Communities.

In addition to the above, SHM is committed to contributing to the local community with sponsorship of the Upper Hunter Education Fund, Upper Hunter Wine and Food Affair, Denman Public Primary School, St Joseph's Primary School, Denman Aged Care, Dalswinton Rural Fire Service, Denman Children's Centre, Denman and Sandy Hollow Junior Rugby League Football Club, Denman Rugby League Football Club, Denman Men's Shed and Denman Pony Club Showjumping Championships. SHM has a long-term community contributions plan which expands as the Spur Hill Underground Coking Coal Project transitions through its development phases.

5.1.1 Consultation with impacted landholders

Specifically to assist the preparation of this report, La Tierra engaged with and consulted the landholders affected by the Project area (Table 5-1). This was mostly by on-property meetings and inspections, however, due to circumstances, some landholders were engaged via telephone and property inspections were not possible.

Table 5-1 List of landholders affected by the Project area and consulted during preparation of this report

Enterprise count	Land Reference	Manager/representative	Consultation method	Date
1	9	Mr John Cruickshank	On-property interview and inspection	February 2013
2	13	Mr Murray Richards	On-property interview and inspection	February 2013
3	8	Mrs Enid Clarke	On-property interview and inspection	February 2013
4	34,35,36	Mr Robin and Mrs Sandra Wolfgang	On-property interview and inspection	February 2013
5	27,32,38	Mr Marcus and Mrs Robyn Wolfgang	On-property interview and inspection	February 2013
6	29,30	Mr Jeffrey Wolfgang	On-property interview and inspection	February 2013
7	31	Mr Nigel and Mrs Kate Wolfgang	On-property interview and inspection	February 2013
8	23 and 129	Mr David Mansfield	Telephone discussion	April 2013
9	22	Mr Richard Webb	On-property interview and inspection	February 2013
10	19	Mr Philip Nichols	On-property interview and inspection	February 2013
11	17	Mr John and Mrs Julie Moore	Telephone and email discussions	April 2013
12	15	Mr Giuseppe Mediati	Telephone and email discussions	April 2013

5.1.2 Issues identified and corrective measures

Stakeholder consultation (Table 5.1) identified several issues or matters of concern to affected landholders. These issues and corrective measures are detailed (Table 5-2).

Table 5-2 Issues identified and proposed corrective measures

Issue	Description	Proposed corrective measure
Land access agreement	Various matters regarding land access agreements with SHM.	These matters concerned commercial aspects of land access agreements and are not considered relevant to this report.
Subsidence	Nature and extent of subsidence.	Nature and extent of subsidence (Section 3.1.1), risk assessment (Section 3.2.1 and 3.2.2), monitoring (Section 4.2),

Issue	Description	Proposed corrective measure
		TARP and remedial actions (Section 4.3).
Water	Cumulative impacts of mining on Hunter River water quality.	Movement of water away from agriculture (Section 3.3). Cumulative impacts on the Hunter River are to be addressed fully in the Project EIS.
Water	Subsidence impacts on existing farm dams.	Nature and extent of subsidence (Section 3.1.1), risk assessment (Section 3.2.1 and 3.2.2), monitoring (Section 4.2), TARP and remedial actions (Section 4.3).
Fencing	Subsidence impacts on farm fencing	Nature and extent of subsidence (Section 3.1.1), Risk Assessment (Section 3.2.1 and 3.2.2), Monitoring (Section 4.2), TARP and remedial actions (Section 4.3).
Visual amenity	Visual impacts on visual amenity due to proposed mine surface infrastructure	Visual amenity impacts (Section 3.4.2)
Land use	Ability to use the land whilst the mining operation occurs.	Land use (Section 3.1.1.6 and Section 4)
Weeds	Weed proliferation due to seed spread and ground disturbance by exploration and mining activities.	Risk assessment (Section 3.2.1)
Air quality	Cumulative impacts of mining on air quality in the Upper Hunter region.	To be addressed fully in the Project EIS.
Support services and infrastructure	Loss of agricultural support services and infrastructure due to cumulative effects of mining, particularly on the township of Denman.	Impacts on agricultural support services (Section 3.4.1)

5.2 Further and continuing consultation

Stakeholder consultation, including engagement with landholders affected by the Project area, will continue throughout each phase of the Project.

Following grant of a Gateway Certificate, the Project will lodge development applications triggering, amongst other things, an environmental impact assessment and preparation of an Environmental Impact Statement (EIS). The EIS process will necessarily include a comprehensive stakeholder engagement programme. The issues raised and outcomes of the stakeholder engagement programme will be reported in the EIS.

The programme would include the use of a variety of consultation mechanisms, which in summary include current and future actions such as:

- Public exhibition of key documents (e.g. the EIS);
- Provision of Project information on the SHM website;
- Ongoing consultation with the local community and landowners, including formation of a Project Reference Group in 2014 in consideration of the *Guidelines for*

Establishing and Operating Community Consultative Committees for Mining Projects (Department of Planning, 2007);
- Meetings with the general community including Aboriginal groups and directly affected landowners;
- Meetings with relevant government agencies; and
- Community information brochures and community information sessions.

The consultation would include, but not necessarily be limited to, the following government agencies and authorities:

- DP&I;
- OEH (including the Heritage Branch);
- NSW Environment Protection Authority;
- NSW Trade & Investment (including the DRE);
- Department of Primary Industries (including the NSW Office of Water and Office of Agricultural Sustainability and Food Security);
- NSW Roads and Maritime Service;
- NSW Treasury;
- Mine Subsidence Board;
- Muswellbrook Shire Council; and
- Commonwealth Department of Sustainability, Environment, Water, Population and Communities.

Consultation with the Australian Rail Track Corporation (ARTC) and coal chain operators would be undertaken to discuss potential rail movements. Consultation would also be conducted with Port Waratah Coal Services and Newcastle Coal Infrastructure Group.

Consultation with the Aboriginal community would be conducted in consideration of the requirements of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW, 2010).

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