TAHMOOR EXTRACTION PLAN LW W1-W2

Land and Agricultural Resource Assessment

Prepared for:

Tahmoor Coal
2975 Remembrance Drive
Bargo NSW 2573 Australia

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PREPARED BY

SLR Consulting Australia Pty Ltd
ABN 29 001 584 612
10 Kings Road
New Lambton NSW 2305 Australia
(PO Box 447 New Lambton NSW 2305 Australia)
T: +61 2 4037 3200
E: newcastleau@slrconsulting.com www.slrconsulting.com

BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Tahmoor Coal (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
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1 Introduction

The Tahmoor Coal Mine (**Tahmoor Mine**) is an underground coal mine located approximately 80 kilometres south-west of Sydney between the towns of Tahmoor and Bargo, New South Wales (**NSW**) (refer to **Figure 1**). Tahmoor Mine produces up to three million tonnes of Run of Mine (**ROM**) coal per annum from the Bulli Coal Seam. Tahmoor Mine produces a primary hard coking coal product and a secondary higher ash coking coal product that are used predominantly for coke manufacture for steel production. Product coal is transported via rail to Port Kembla and Newcastle for Australian domestic customers and export customers.

The Tahmoor Mine has been operated by Tahmoor Coal Pty Ltd (**Tahmoor Coal**) since Tahmoor Mine commenced in 1979 using bord and pillar mining methods, and via longwall mining methods since 1987. Tahmoor Coal, trading as Tahmoor Coking Coal Operations (**TCCO**), is a wholly owned subsidiary within the SIMEC Mining Division (**SIMEC**) of the GFG Alliance (**GFG**).

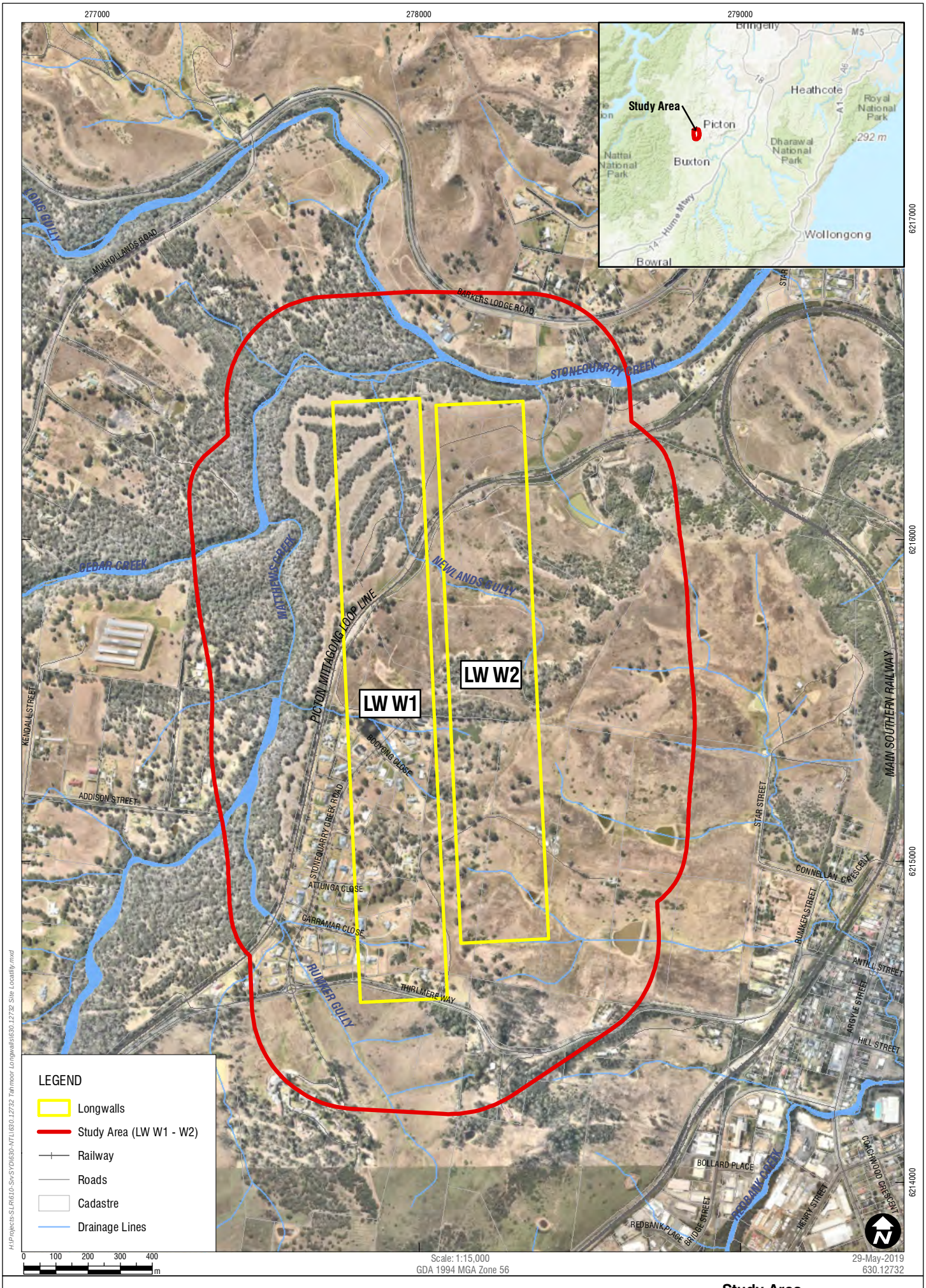
Tahmoor Coal has previously mined 31 longwalls to the north and west of the Tahmoor Mine's current pit top location. Tahmoor Coal is currently mining Longwall 32 in accordance with Development Consents and Subsidence Management Plan Approval.

Tahmoor Coal proposes to extent underground coal mining to the north-west of the Main Southern Railway (referred to as the 'Western Domain') which will include Longwalls West 1 (**LW W1**) to West 4 (**LW W4**) at Picton and Thirlmere. The first two longwalls to be mined are LW W1 and Longwall West 2 (**LW W2**) (collectively referred to as LW W1-W2), which will be the focus of this Extraction Plan.

SLR has been commissioned by Tahmoor Coal Pty Limited (Tahmoor Coal) to complete a Land and Agricultural Resource Assessment for the extraction of Longwalls W1 and W2 (LW W1-W2). The purpose of this assessment is to form part of an Extraction Plan for LW W1 –W2.

1.1 Assessment Objective

The objective of this Land and Agricultural Resource Assessment is to outline the monitoring and management measures to be implemented to manage these potential subsidence related impacts on agricultural resources, specifically from the extraction of LW W1-W2.
This assessment will form part of an Extraction Plan being prepared by Tahmoor Coal for LW W1-W2 for submission to the NSW Department of Planning and Environment.



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Study Area
Tahmoor Extraction Plan
LW W1 - W2

FIGURE 1

2 Agricultural and Water Resources

2.1 Climate

Representative climate data for the Study Area has been obtained from the nearest Bureau of Meteorology (BOM) weather station located at Picton, approximately one kilometre to the north-west of the Study Area (Picton Council Depot, BOM Station 068052, Monthly Climate Statistics).

Picton BOM Station has recorded an average annual rainfall of 801 millimetres, of which approximately 475 millimetres (60%) falls between November and April, with an average of 70.8 rain days in any given year (**Table 1**). Mean monthly maximum temperatures range between 29.3°C and 16.8 C, with January being the warmest month. Mean monthly minimum temperatures range between 15.4 C and 1.7°C, with July being the coldest month.

Table 1 Picton Climate Data

Temperature	Average (Mean)	Annual Range
Minimum temperature	23.4°C	1.7°C – 15.4°C
Maximum temperature	8.8°C	16.8°C – 29.3°C
Rainfall	**Average (Mean)**	**Average Rain Days**
Annual Rainfall	800.9 mm	70.8
Wettest month	February 89.3 mm	6.8
Driest month	September 43.6 mm	5.1

Source: *Bureau of Meteorology (2019)*

The BOM classifies this as a temperate climate zone. The area can be susceptible to occasional heavy showers and thunderstorms due to easterly troughs during warmer months. Summer winds are generally from the south or south-east, with a tendency for afternoon north-easterly winds. During winter, winds are predominantly from the south or south-west.

2.2 Topography

Topography in the region (Wollondilly LGA) is varied, ranging from gently undulating plateaus, ridges and low hills in the upland areas, to a rugged landscape of deeply dissected valleys and gorges within the Hawkesbury Sandstone.

Topography within the Study Area is generally undulating with rises in the south-east falling to lower slopes in the north. High points on rises have surface elevations up to 280 metres Australian Height Datum (AHD) and are generally cleared for small scale rural production, as shown in **Figure 2**, Surface levels on relatively flat land to the north of the Study Area are the location of vegetated creek lines running from the west to the north-east. Surface elevations of the low points are approximately 180 metres AHD. The slope analysis (**Figure 3**) further highlights the undulating rises and creek valleys, shown in red.

2.3 Hydrology

2.3.1 Surface Water

The Study Area is located in the catchment of the Hawkesbury-Nepean River, within the sub-catchment of the Nepean River (**Table 2**). The Nepean River rises in the Great Dividing Range to the west of the Study Area. Flows in the upper reaches of the Nepean River are highly regulated by the Upper Nepean Water Supply Scheme, operated by the Water NSW, incorporating four major water supply dams on the Cataract, Cordeaux, Avon and Nepean Rivers.

The Nepean River has been extensively modified by the construction of a series of in-stream weirs which have created a series of pondages, with the nearest to the Study Area being the Malden Weir.

There are three dominant drainage channels within the Study Area. Matthews Creek flows north draining the south-western section of the Study Area. Matthews Creek discharges into Cedar Creek, which subsequently flows to Stonequarry Creek at the north of the site. Stonequarry Creek flows east through the Study Area then drains south-east to its confluence with the Nepean River. Stonequarry Creek drains the northern section of the site and flow falling east off rises within the Study Area (GeoTerra, 2019).

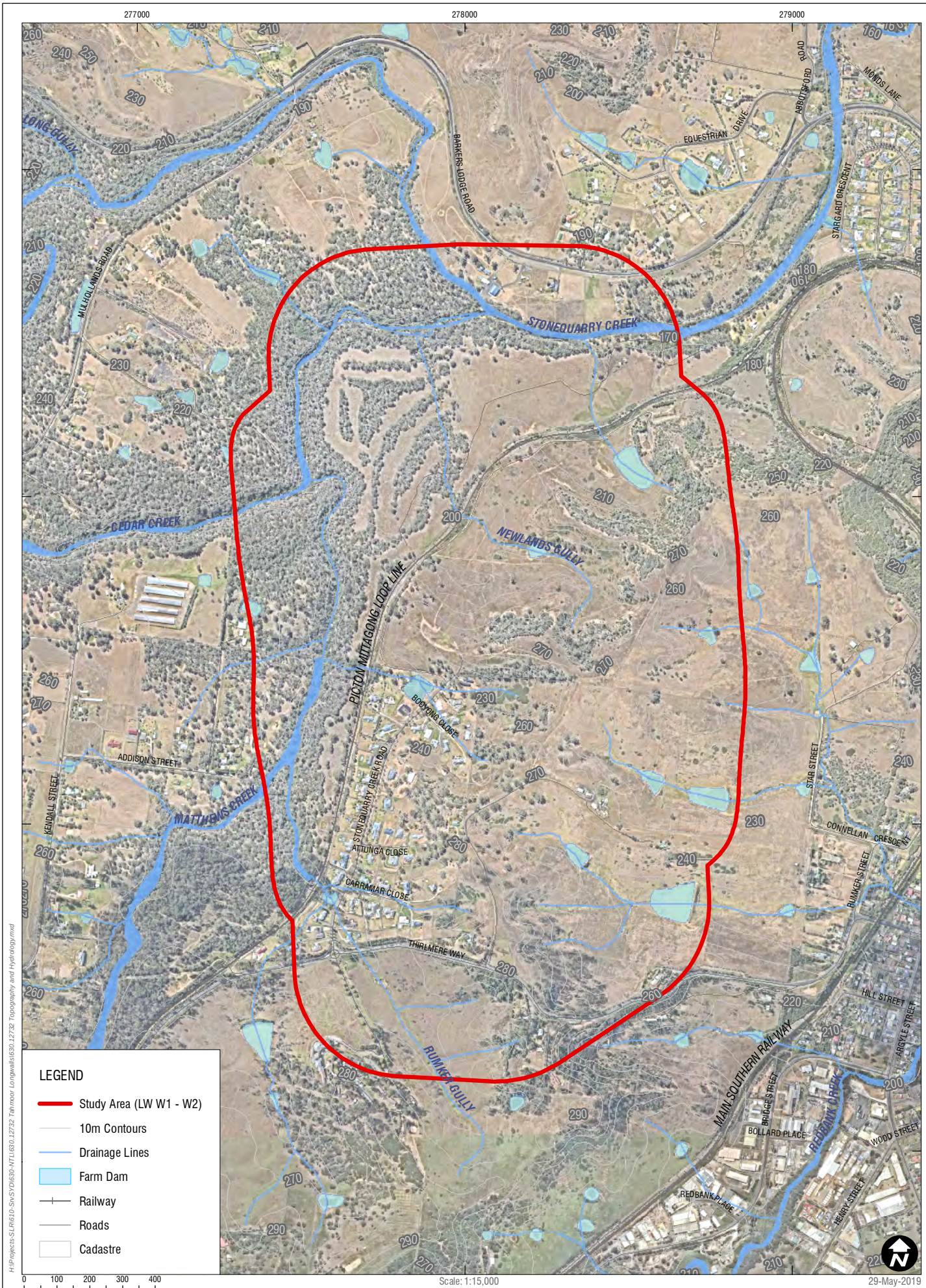
In addition to these drainage channels there are a number of intermitted watercourses and numerous small farm dams. All drainage channels within the Study Area are considered low flow or intermitted channels suggesting that the number of users dependent on flows from these watercourses is limited.

Table 2 Drainage Channels

Catchment	Sub Catchment	Associated Watercourses	Flow Direction
Hawkesbury-Nepean River	Nepean River	Stonequarry Creek	East
		Cedar Creek	North-East
		Matthews Creek	North

2.3.2 Licenced Surface Water Users

A search of the Department of Industry (Water) Register for surface water licenses found no surface water extraction licences within the Study Area.



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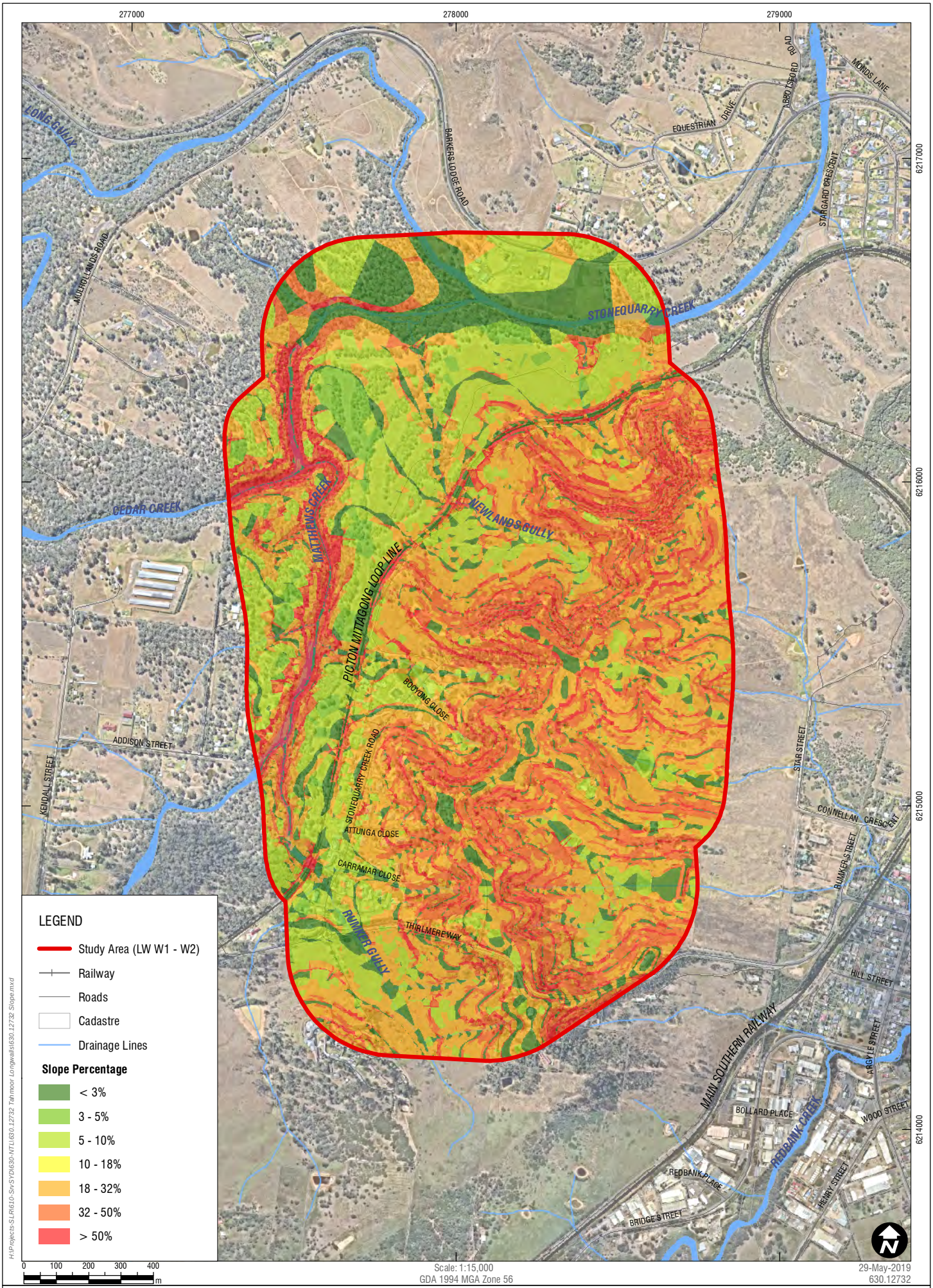
Topography and Hydrology
Tahmoor Extraction Plan
LW W1 - W2

FIGURE 2



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Slope Analysis
Tahmoor Extraction Plan
LW W1 - W2

FIGURE 3

2.3.3 Groundwater

The Study Area is located within the Sydney Basin porous rock groundwater system (Nepean Groundwater Source, Management Zone 2) which is classed as highly productive. The recognised aquifers/water bearing zones within the area are the:

- Alluvium/sediment aquifers;
- Hawkesbury Sandstone aquifers;
- Narrabeen Group sandstone aquifers; and
- Illawarra Coal Measures water bearing seams.

Alluvium/Sediment Aquifers

Alluvial sediments within the plateau gullies and river bed are too shallow to be used as aquifers for groundwater supply (Geoterra, 2013).

Hawkesbury Sandstone

The Hawkesbury Sandstone aquifers are the principal groundwater source used within the region due to their significantly higher yields and quality in comparison to other water bearing strata. Due to the lack of fracturing and fault lines within the Hawkesbury Sandstone, the associated aquifers are generally primary permeability aquifers. As a result, yields and quality are highest in recharge areas south of the Nepean River. Groundwater monitored in the Hawkesbury Sandstone piezometers within the Study Area is considered low to brackish salinity (less than 6,895 µS/cm) with acid to circum-neutral pH (3.52 to 7.72). Recorded bore yields in the Hawkesbury Sandstone in the Study Area ranged from 0.22 litres per second to 4.5 litres per second (Geoterra, 2013).

Narrabeen Group and Associated Aquitards

The Narrabeen Group is the other major aquifer within the region, however, the quality and yield is significantly lower than the Hawkesbury Sandstone. The major aquifers are separated by aquitards associated with the Bald Hill Claystone, Stanwell Park Claystone and the Wombarra Claystone. These aquitards are exhibit low permeability and limit vertical groundwater flow between the aquifers.

Illawarra Coal Measures

The Illawarra Coal Measures exhibit low permeability due to their depth and fine-grained associated rock. Water quality within the water bearing coal seams is considered brackish to moderately saline (Geoterra, 2013).

2.3.4 Licenced Groundwater Users

The Study Area is covered by the Greater Metropolitan Groundwater Sources Water Sharing Plan. Two Department of Industry (Water) registered bores are located within the Study Area (GW104090 and GW064469), with a further six bores located within the vicinity of the Study Area (**Table 3**). The majority of bores are registered for stock and/or domestic use. Groundwater for these bores is sourced from the Hawkesbury Sandstone Aquifer, with low yields ranging from 0.40 to 2.67 litres per second (GeoTerra, 2019).

Table 3 Registered Groundwater Users

Identifier	Depth (m)	Yield (L/s)	Purpose	Currently Used	In Study Area
GW024750	11.9	N/A	Stock & Domestic	No – Bore Collapsed	No
GW035844	45.7	1.01	Irrigation	Unknown	No
GW064469	91.0	0.5	Domestic	Unknown	Yes
GW072402	72.0	0.5	Stock & Domestic	No – Pump Removed	No
GW104090	150.5	1.1	Recreation	Unknown	Yes
GW105228	63.0	1.5	Stock & Domestic	Yes	No
GW105467	12.0	0.4	Stock & Domestic	Yes	No
GW105546	163.0	2.67	Irrigation	Yes	No

2.4 Geology

The Study Area is located within the southern area of the Permo-Triassic Sydney Basin. The main coal bearing sequence is the Illawarra Coal Measures, which contains four workable seams. The upper most seam, located in the north-western part of the Illawarra Coalfield, is the Bulli Seam. Overlying the Bulli Seam is the Hawkesbury Tectonic Stage which is comprised of three stratigraphic units, namely the Narrabeen Group, Hawkesbury Sandstone Group and the Wianamatta Group. The Narrabeen Group overlies the Illawarra Coal Measures and is comprised of interbedded sandstones and claystone units up to 310 metres thick. Overlying the Narrabeen Group is the Hawkesbury Sandstone which is comprised of a series of bedded sandstones up to 185 metres thick. The Wianamatta Group overlies the Hawkesbury Sandstone, and is comprised of shales and siltstones and is relatively thin in comparison.

Another major geological feature is the Bald Hill Claystone which lies at the base of the Hawkesbury Sandstone. The Bald Hill Claystone varies in width to over 25 metres, which tends to act as an aquitard.

2.5 Soil Landscape Units

The Soil Landscapes Units (SLU) within the Study Area have been mapped by the former NSW Department of Land and Water Conservation, incorporating the NSW Soil Conservation Service (now part of NSW Department of Primary Industries (DPI)), on the *Wollongong – Port Hacking 1:100,000 Sheet* (Hazelton & Tille, 1990) as shown in **Figure 4**. Six soil landscapes occur in the Study Area and are summarised in **Table 4.**

Below is a summary of the key agricultural features of each SLU:

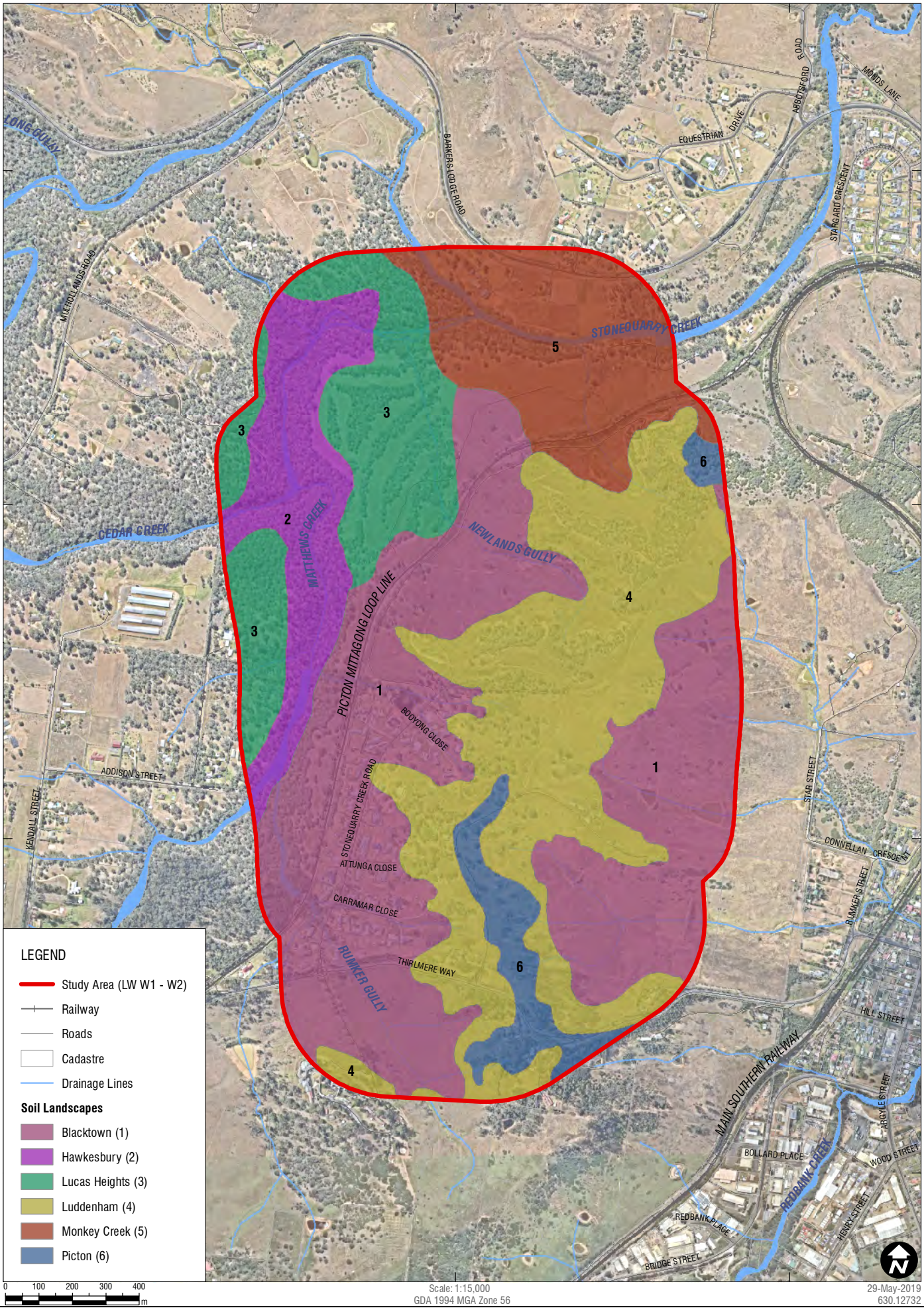
- The majority of the Study Area (75%) is moderately constrained for cultivation;
- The Hawkesbury and Picton SLU are highly to severely constrained for any agricultural enterprises, which covers 13% of the Study Area;
- Agricultural land best suited to grazing enterprises includes the Blacktown SLU, Luddenham SLU, and Monkey Creek SLU which covers 75% of the Study Area; and
- Lucas Heights SLU is moderate limitations for grazing and high limitation for cultivation and covers 12% of the Study Area.

Table 4 Soil Landscape Units

Soil Landscape	Study Area		Agricultural Limitation Rating	
Unit	Hectares	%	Unit	Hectares
Hawkesbury	31	9	High – Severe	High – Severe
Picton	14	4		
Sub Total	**45**	**13**		
Lucas Height	39	12	Moderate	High
Sub Total	**39**	**12**		
Blacktown	125	37	Low	Moderate
Luddenham	88	26		
Monkey Creek	40	12		
Sub Total	**253**	**75**		
Total	**337**	**100**		

Source: *Soil Landscapes of the Wollongong – Port Hacking 1:100,000 Sheet* (Hazelton & Tille, 1990)

Full descriptions of the six Soil Landscape Units within the Study Area are presented in **Appendix A**.



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Soil Landscape Units
Tahmoor Extraction Plan
LW W1 - W2

FIGURE 4

2.6 Dominant Soil Types and Inherent Fertility

The five dominant Australia Soil Classification (ASC) soil types were digitally mapped by the Office of Environment & Heritage and are shown on **Figure 5**. Five soil types are present in the Study Area: Dermosols, Kurosols, Natric Kurosol, Sodosol and Tenosol and Rudosol (**Table 5**). These are summarised in and the major points listed below:

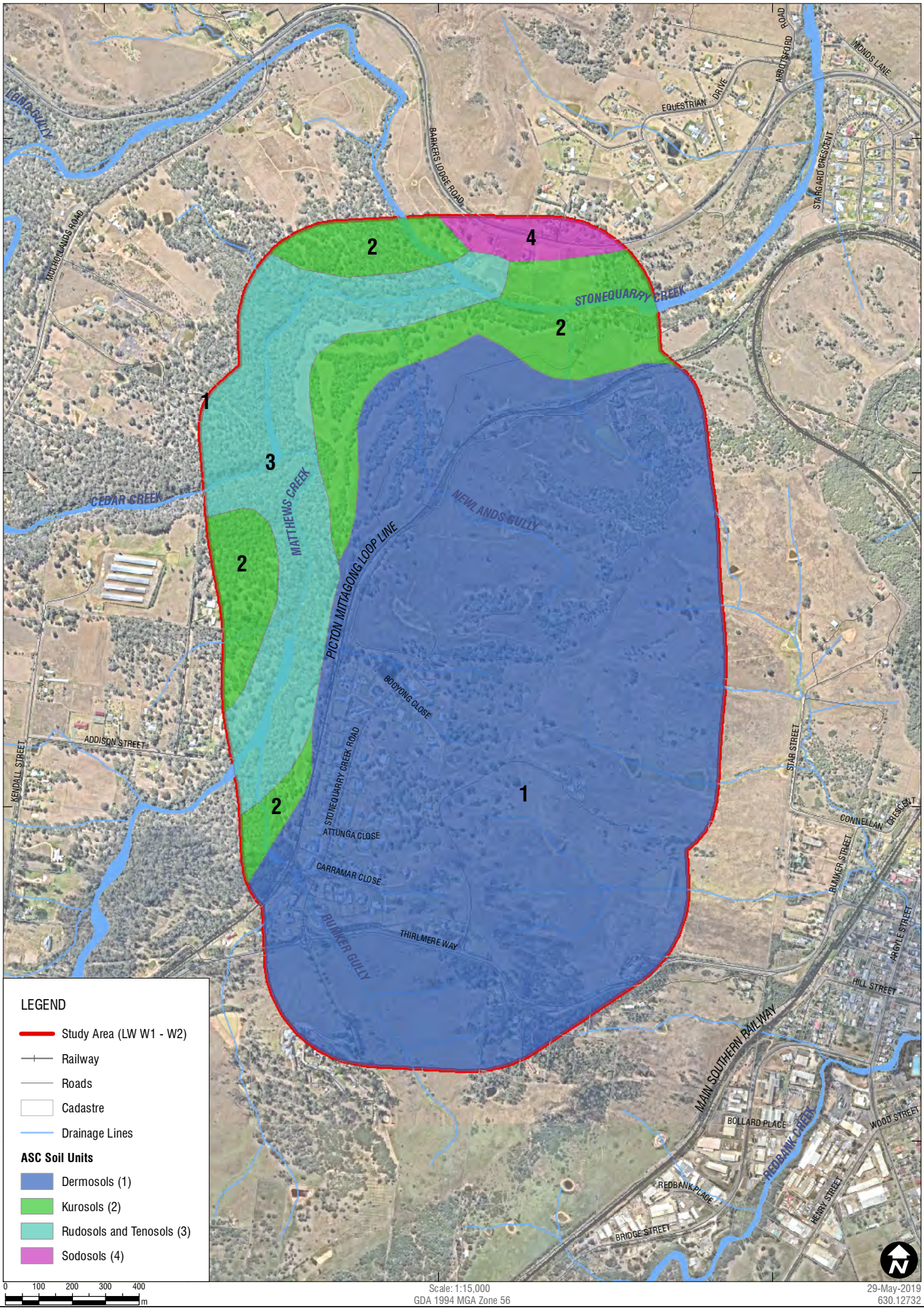
- Dermosols are the major soil type within the Study Area. Dermosols are soils with structured B horizons which lack strong texture contrast between the A and B horizons. Dermosols generally have moderately high inherent fertility. Dermosols comprise 70% of the Study Area;
- Kurosols are soils with a strong texture contrast between the A horizons and a strongly acidic B upper horizon. Kurosols generally have moderate inherent low fertility. Kurosols comprise 15% of the Study Area;
- Sodosols are soils with a strong texture contrast between A horizons and sodic B horizons. Sodosols generally have a moderately low inherent fertility. Sodosols comprise 14% of the Study Area; and
- Rudosols & Tenosols are soils with weak to negligible pedologic organisation. They encompass diverse range of soils generally lacking an advanced structure with a profile characterized by a sandy to sandy loam texture throughout. Tenosols & Rudosols generally have low inherent fertility. Rudosol & Tenosol comprises 1% of the Study Area.

Table 5 Dominant Soil Types and Inherent Fertility

Australian Soil Classification	Inherent Fertility	Hectares	%
Dermosol	Moderately High	237	70
Kurosol	Moderately Low	48	15
Sodosol		47	14
Rudosol & Tenosol	Low	5	1
	Total	**337**	**100**

2.7 Acid Sulfate Soils

The likelihood of acid sulfate soils occurring within the Study Area is very low due to its position away from the coast and potential acid sulfate landform type. Furthermore, none of the Soil Landscape Units mapped within the Study Area have acid sulfate soil potential.



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Soil Units
Tahmoor Extraction Plan
LW W1 - W2

FIGURE 5

2.8 Vegetation and Land Use

Review of recent aerial images shows that the majority of the Study Area comprises of cleared pastoral land (approximately 53%) that may be suitable for agricultural enterprise, as shown in **Figure 6**. The remainder is comprised of thick native vegetation along riparian zones and small areas used for rural residential land. A site inspection in March 2019 by SLR's Associate Agronomist, in conjunction with a desktop assessment, has shown that small scale cattle and horse grazing of improved native grass species such as Kangaroo Grass (*Themeda australis*), Poa Tussock (*Poa labillardierei*), Red Grass (*Bothriochloa* spp.), Paspalum (*Paspalum dilatatum*) and Kikuyu grass (*Pennisetum clandestinum*) is the dominant agricultural enterprise. A small number of poultry farms, orchards and commercial vegetable gardens also exist within or adjacent to the Study Area. No intensive cropping activities were observed at the time of the inspection and assessment. The various land uses at each inspection site were recorded and are shown on **Figure 6** and described in **Table 6**. Plates for each inspection site are shown in **Appendix B**.

Table 6 Observed Land Uses

Site	Land Use
1	Pleasure horses
2	"Stargard" cattle grazing
3	Cattle grazing
4	Rural residential
5	Rural residential
6	Cattle grazing
7	Pleasure horses
8	Pasture
9	Goats
10	Pleasure horses
11	Orchards
12	No stock, poultry sheds
13	Rural residential, pleasure horses
14	Rural residential

Grazing within the Study Area appears to be commonly used as a grass and vegetation management tool rather than an income generating agricultural enterprise. Overall farm size is considered small and many would be classified as hobby farms with a very low potential to produce significant agricultural income. Approximately 160 hectares of potential grazing land is currently available for agricultural use. As described in correspondence received from the NSW DPI (30 April, 2019) poultry farms are a significant industry in the area, with two located to the west of the Study Area (**Figure 6**). DPI has also identified at least three protected cropping businesses to the south of the Study Area.

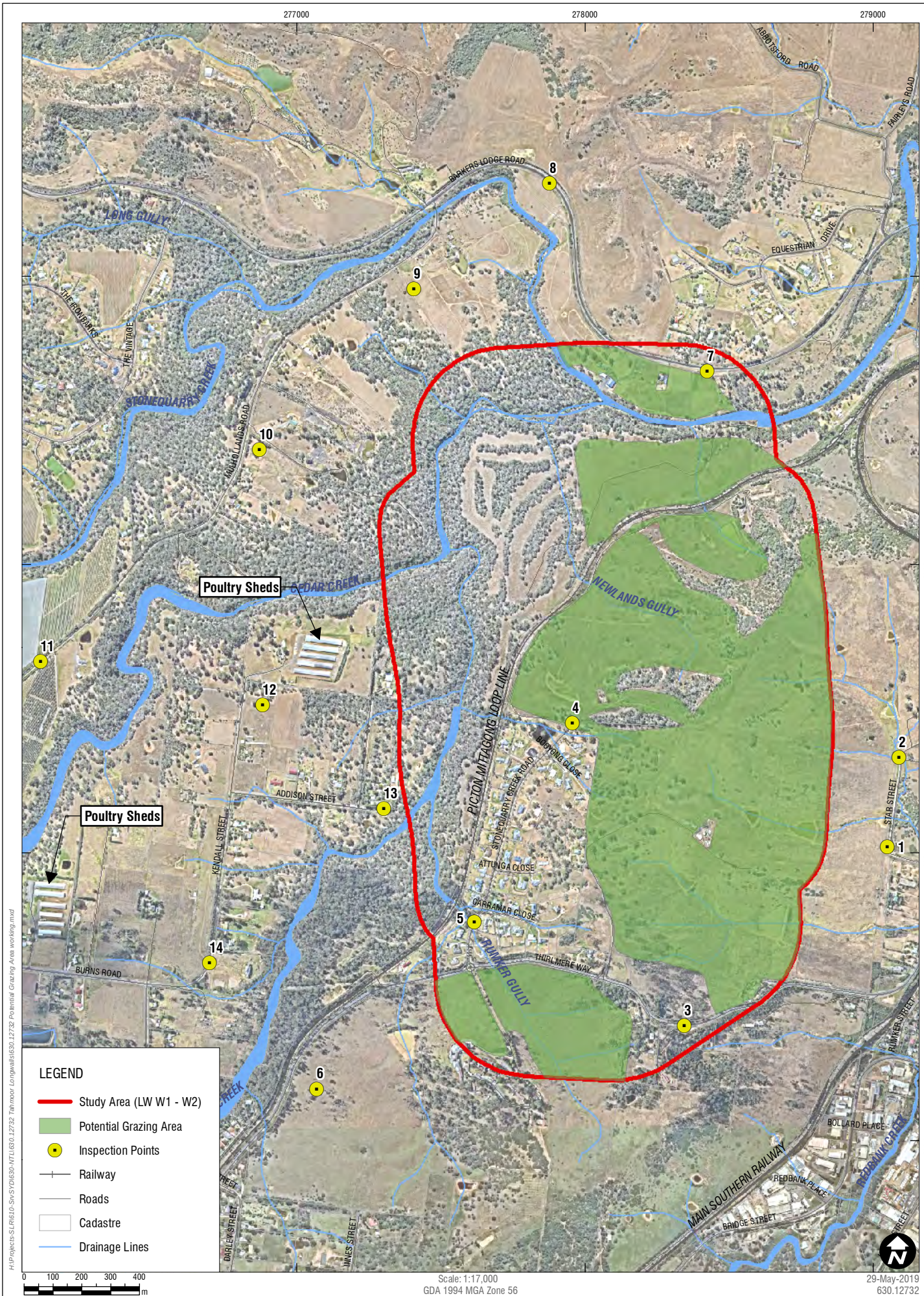
Site inspection revealed no poultry farms or protected cropping businesses in the Study Area.

Native Vegetation, present predominantly in riparian zones within the Study Area, was mapped during the Native Vegetation of Southeast NSW mapping project (Tozer et al., 2006). It includes the Cumberland Shale Sandstone Transition Forest which is listed as an Endangered Ecological community (EEC) under the NSW *Biodiversity Conservation Act 2016* (BC Act) and the Commonwealth *Environment Protection and Biodiversity Conservation Act* (EPBC Act), and a small area of Cumberland River Flat Forest which is listed as an EEC on the BC Act. **Plate 1** to **Plate 3** shows some of the typical vegetation types in the area.

Plate 1 Cattle grazing grass pasture area on cleared hills within the Study Area

Plate 2 Grass Pasture on a cleared flat within the Study Area

Plate 3 Eucalypt wooded area on riparian zone within the Study Area



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Potential Grazing Area
Tahmoor Extraction Plan
LW W1 - W2

FIGURE 6

2.9 Land and Soil Capability Classification

2.9.1 Land and Soil Capability Methodology

The Land and Soil Capability (LSC) classification applied to the Study Area was in accordance with the OEH guideline *The Land and Soil Capability Assessment Scheme; Second Approximation* (OEH 2013). This scheme uses the biophysical features of the land and soil to derive detailed rating tables for a range of land and soil hazards. The scheme consists of eight classes, which classify the land based on the severity of long-term limitations. The LSC classes are described in **Table 7** and their definition has been based on two considerations:

- The biophysical features of the land to derive the LSC classes associated with various hazards; and
- The management of the hazards including the level of inputs, expertise and investment required to manage the land sustainably.

Table 7 Land and Soil Capability Classification

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

2.9.2 Determining LSC Classes

The LSC for the Study Area has been digitally mapped by the OEH and is summarised in **Table 8** and shown in **Figure 7**. Classes 4, 5 and 7 comprised 93 hectares, 21 hectares and 223 hectares of land within the Study Area respectively. The limitations associated with each LSC Class are discussed below.

Table 8 Land and Soil Capability Areas

LSC Class	Agricultural Capability Rating	Hectares	%
4	Moderate	92	28
5	Moderately Low	21	6
7	Very Low	223	66
	Total	**337**	**100**

LSC Class 4 Land

Class 4 land is associated with Dermosols and Kurosols. This classification indicates a moderate land capability, with moderate to serve limitations for some land uses that need to be consciously managed to prevent soil and land degradation. This land is capable of pasture improvement and can be tilled for an occasional crop. LSC Class 4 land comprises 28% of the Study Area.

LSC Class 5 Land

Class 5 land is associated with Kurosols and Sodosols. This classification indicates a moderate to low land capability, with severe limitations to high impact land management uses such as cropping. This land is generally more suitable for grazing with some limitations, or very occasional cultivation for pasture establishment. LSC Class 5 land comprises 6% of the Study Area.

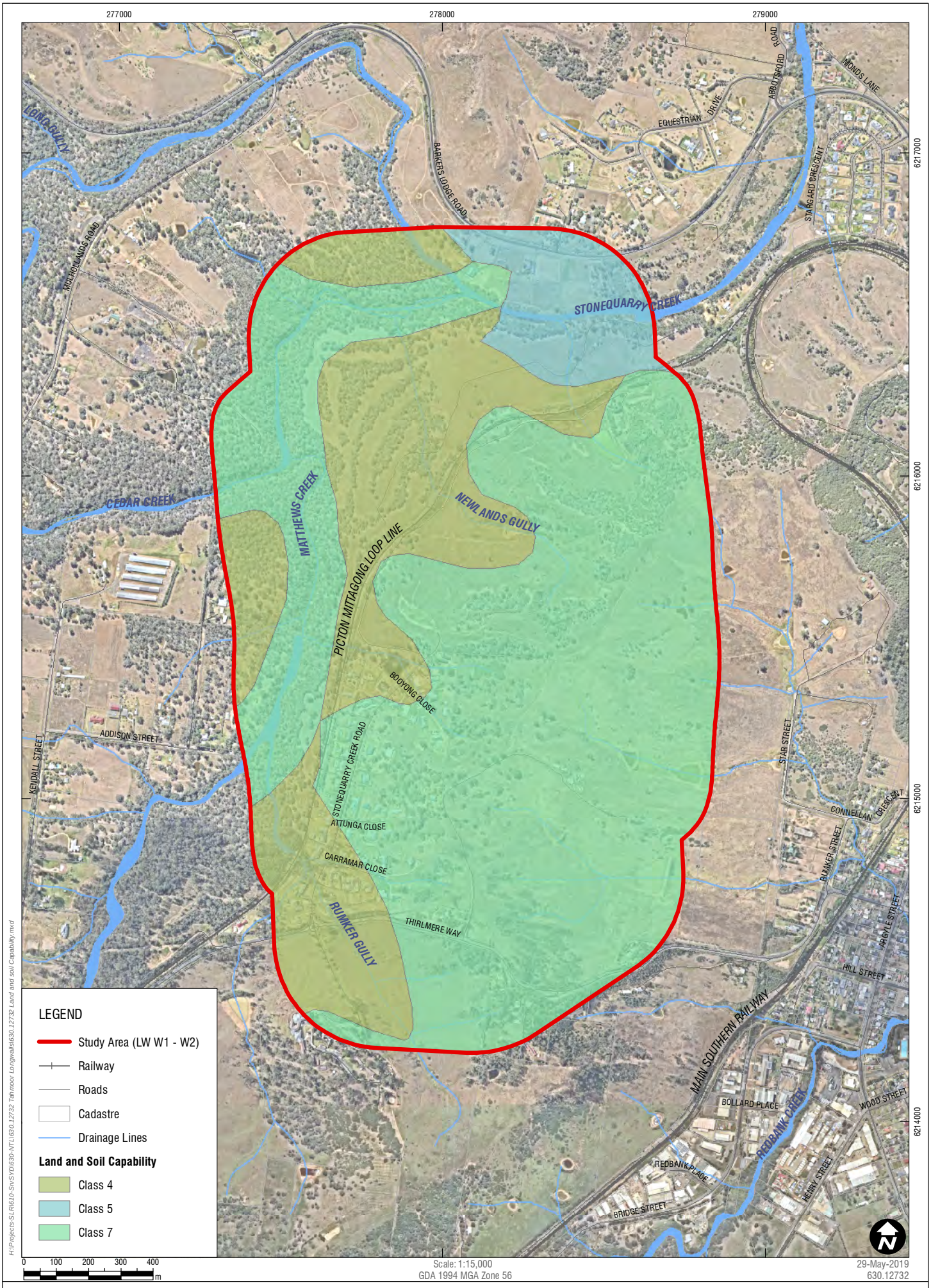
LSC Class 7 Land

Class 7 land is represented by Dermosols, Rudosols and Tenosols. This classification indicates very low capability land, with severe limitations for most land uses. It is generally unsuitable for any type of cropping or grazing due to its limitations. It covers the major portion of the Study Area (66%).

Within the Study Area, 66% of the land area is considered to have very low agricultural capability according to definitions given in *The Land and Soil Capability Assessment Scheme: Second Approximation* (OEH, 2013a), whilst the remainder has moderate to moderately low agricultural capability.

2.10 Biophysical Strategic Agricultural Land

The nearest mapped Biophysical Strategic Agricultural Land (BSAL) according to the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 – Strategic Agricultural Land Map – Sheet STA_41* (DP&I, 2013) is between Douglas Park and Camden, approximately 20 kilometres to the north-east of the Study Area.



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Land and Soil Capability
Tahmoor Extraction Plan
LW W1 - W2

FIGURE 7

3 Local and Regional Agricultural Enterprises

3.1 Regional Agricultural History

Agriculture within the Wollondilly LGA is based on a foundation of market gardens, orchards, dairy and poultry. Early European settlement saw the establishment of small villages including Picton, Menangle, Thirlmere, Tahmoor, Bargo, and Appin.

Picton is one of the earliest European settlements in the area. Agriculture dates back to when a number of cattle went missing in the early days of the colony and were later found in 1795 by a convict near the Nepean River. This area became known as Cowpastures and then Stonequarry until gaining its current name, Picton, in 1841.

In the 1860's the railway system came to Picton and created a building explosion. The area was proclaimed a municipality in 1895, and in 1939 Wollondilly Shire Council and Picton Municipality amalgamated to create today's LGA (Wollondilly Shire Council, 2019).

Poultry farming was established in in the Wollondilly region during the 1930's. Many Estonian families fled political upheaval in their homeland between 1924 and 1939. Australia offered cheap land and a new life, with many of these people settling at Thirlmere and established poultry farms.

In the late 1940's many Estonians who were caught in European Displaced Persons camps after World War II also chose to come to Australia, and were sponsored and supported by the Thirlmere community. They built on their national connections and helped each other to start poultry farming. By the 1960's there were over 60 families from Estonia involved in poultry farming in Thirlmere. Most farms comprised of 2,000 to 4,000 hens.

Estonians pioneered the Cooperative movement in 1912. The Thirlmere Estonians started "KUNGLA", the Thirlmere farmers' Cooperative in 1939 and was continued by the new settlers after the war. This considerably increased the viability and efficiency of the poultry industry until Thirlmere became the largest producer of eggs in Australia by the 1960's (Migration Heritage Centre, 2019).

Today, Wollondilly LGA is predominantly rural area with several national parks, whilst there are urban areas in 15 towns and villages. Two-thirds of the population live in the urban centres, and one-third in the rural areas. There are five large towns, the largest of which is Tahmoor, whilst Picton is the administrative centre. The LGA encompasses a land area of nearly 260,000 hectares, of which approximately 90% is national park, bushland, water catchment or rural land, including gorges, ranges and plains. Most of the rural land is used for agricultural purposes, including market gardens, orchards, dairy farms, poultry farms and grazing (profile.id, 2019).

3.2 Agricultural Enterprises and Associated Industries

3.2.1 Regional Land Use

Agriculture is a minor land use for the regional area (Wollondilly LGA), accounting for 11% of land use. (Australian Bureau of Statistics (ABS), 2011*). The agricultural land use is outlined in **Table 9**. It details the area of land used for agriculture in the region and the specific uses of the land. The major points are summarised below.

- Agricultural land is almost exclusively used for grazing, utilising 98% of all agricultural land. The primary enterprise is meat cattle farming, which accounts for 60% of livestock numbers, followed by milk cattle (25%) and sheep farming (15%);
- Cropping enterprises comprise a minor portion of agricultural activities. The primary crops grown are vegetables for human consumption along with fruit and nuts. No cereals for grain are grown in the region;
- Minor irrigation cropping is carried out, comprising only 7% of the agricultural land in the region. Agriculture accounts for 5,513 megalitres of volume to irrigate approximately 2,000 ha of agricultural area, while 981 megalitres is utilised for other agricultural uses, such as poultry production and hydroponic vegetables; and
- Poultry comprise a large portion of livestock numbers within the Wollondilly LGA, with 2.3 million birds were recorded at the last census of these 2.1 million were being raised for poultry meat production. The region also produced 2.4 million dozen eggs.

Table 9 Wollondilly LGA Agricultural Land Use

Agricultural Land Area	Units	Total
Total land area within LGA	Hectare	255,593
Area of National Parks, nature reserves & other protected lands	Hectare	160,555
Area of agricultural land	Hectare	28,058
Proportion of agricultural land	**%**	**11**
Agricultural Enterprise		
Land under cropping activities	Hectare	598
Land under grazing activities	Hectare	27,460
Proportion of agricultural land used for grazing	**%**	**98**
Grazing Enterprises	**Total**	**%**
Sheep and lambs	2,315	15
Meat cattle	9,553	60
Dairy cattle (excluding house cows)	3,943	25
Pigs	55	<1
Total	**15,866**	**100**
Cropping Enterprises		
Cereals for grain	Hectare	Nil
Vegetables for human consumption	Hectare	461
All fruit and nuts	Hectare	142
Total land cropped	**Hectare**	**603**

Agricultural Land Area	Units	Total
Irrigation		
Area irrigated	Hectare	2,000
Irrigation volume applied	Megalitre	5,513
Other agricultural uses	Megalitre	981
Total water use	**Megalitre**	**6,494**
Proportion of agricultural land irrigated	**%**	**7**

Source: *ABS* (2011*) 2011* is the latest agricultural data available from ABS

3.2.2 Regional Employment

A summary of the total regional employment and the proportion of agriculture related employment is shown in **Table 10.** The regional employment in the agriculture related sectors is shown in **Table 10.** The major points are summarised below:

- Agriculture is not a major employer within the region; the total of 1,911 persons employed in the direct and indirect agricultural sectors is only 10% of the total employed population;
- Agriculture-related wholesaling and retailing is responsible for 48% of agricultural employment, followed by processing and manufacturing (26%), and agricultural production (26%);
- The major agricultural production employers are beef cattle farming, poultry farming and vegetable growing, which account for 13% employment in agriculture. Horse farming, dairying and floriculture and nursery production comprise another 6% of employment in agriculture. All other sectors are minor agricultural employers in the region;
- The main agriculture-related processing and manufacturing is poultry processing, comprising 12% of agricultural related employment; and
- Supermarkets and grocery stores account for the vast majority of agricultural related wholesaling and retailing employment, comprising 27% of the agricultural related employment.

Detailed agricultural employment figures are not available for the Study Area; however the main agricultural activities generating income within and adjacent to the Study Area observed during the site inspection were small scale horse and cattle grazing along with a number of poultry farms and orchards.

Table 10 Wollondilly LGA Employment Related to Agriculture

Employment Sector	No. of persons	%
Total Regional Employment	**19,417**	**100**
Direct Regional Agricultural Employment	497	3
Indirect Regional Agricultural Employment	1,414	7
Total Regional Employment Related to Agriculture	**1,911**	**10**

Source: *ABS* (2011*)

Table 11 Wollondilly LGA Agricultural Related Employment by Sector

Agricultural Production	Number of People	%
Beef Cattle Farming (Specialised)	103	5
Poultry Farming	84	4
Horse Farming	41	2
Dairy Cattle Farming	47	2
Other Livestock Farming and Beekeeping	24	1
Vegetable Growing (Outdoors)	80	4
Floriculture and Nursery Production	44	2
Turf Growing	12	1
Other Crop Growing (Grains, fruit and tree nuts, mushrooms etc.)	33	2
Agriculture (Not further defined)	29	2
Subtotal	**497**	**26**
Agriculture Related Processing and Manufacturing	**Number of People**	**%**
Poultry Processing	229	12
Cereal, Pasta and Baking Mix Manufacturing	56	3
Factory Based Manufacturing Bread, Biscuit, Cake, Pastry	50	3
Meat Processing and Manufacturing (Inc. Cured Meat and Smallgoods)	26	1
Log Sawmilling, Timber Re-sawing and Dressing	25	1
Cheese, Ice-cream, Milk and Other Dairy Product Manufacturing	25	1
Fruit and Vegetable Processing	20	1
Bakery Product Manufacturing (Non-factory based)	17	1
Potato, Corn and Other Crisp Manufacturing	11	1
Food Product Manufacturing (Not further defined)	46	2
Subtotal	**505**	**26**
Agricultural Related Wholesaling and Retailing	**Number of People**	**%**
Supermarket and Grocery Stores	509	27
Fresh Meat, Fish, Poultry, Smallgoods Retailing and Wholesaling	76	4
Fruit and Vegetable Retailing and Wholesaling	63	3
Grocery, Liquor and Tobacco Product Retailing and Wholesaling	113	5
Food Retailing (Not further defined)	25	1
Timber Wholesaling	20	1
Flower Retailing	14	1
Other Agricultural Product Wholesaling	89	4
Sub total	**909**	**48**
Total Agricultural Related Employment	**1,911**	**100**

Source: *ABS* (2011*)

3.3 Regional Agricultural Production Value

Agricultural production values for the Wollondilly LGA totals $61.3 M, detailed in **Table 12.** The main agricultural production by value is from poultry production, both for meat and eggs (livestock slaughtering and livestock products), and vegetables for human consumption (crops) accounting for almost 90% of the value of agricultural commodities produced (ABS, 2011*).

Table 12 Regional Agricultural Production

Agricultural Production Gross Value	Value (M)	%
Crops	$21.7	35
Livestock slaughtering	$33.0	54
Livestock products	$6.6	11
Total gross agricultural production	**$61.3**	**100**

Source: *ABS* (2011*)

3.4 Potential Agricultural Production Value of the Study Area

Potential agricultural productivity was determined using DPI agricultural gross margin productivity data for agricultural enterprises suitable for each of the LSC classes (see **Section 2.9**) that are present within the Study Area. This analysis has been undertaken on the potential capability of the land rather than current land use. If potential agricultural production values were to be pursued, significant investment in land management and agricultural infrastructure would be required. However, this information can be used to approximate potential farm incomes.

The *Beef Cattle Gross Margin Budget Inland Store Weaners* (NSW Department of Primary Industries, 2017) has been applied to this assessment to determine potential agricultural income for the Study Area. The *NSW Department of Primary Industries Beef Stocking Rates & Farm Size* (DPI, 2006) was used to determine stocking rates in Dry Sheep Equivalents (DSE) for the three LSC's mapped within the Study Area. Full agricultural gross margin information is contained in **Appendix C.**

Table 13 summarises the potential gross margins for each applicable agricultural enterprise per LSC Class. The major points are listed below:

- Class 4 land has the potential to generate approximately $296 per hectare from beef cattle grazing enterprises (yearling beef production);
- Class 5 land has the potential to generate approximately $222 per hectare from beef cattle grazing enterprises (yearling beef production); and
- Class 7 land has the potential to generate approximately $74 per hectare from beef cattle grazing enterprises (yearling beef production).

Table 13 Gross Margin per LSC Class

LSC	Stocking Rate	Cow & Calf Equivalent	Revenue	Variable Costs	Gross Margin
Class	**DSE**	**Per Hectare**	**Per Hectare**	**Per Hectare**	**Per Hectare**
4	8	0.47	$376	$80	$296
5	6	0.36	$282	$60	$222
7	2	0.12	$94	$20	$74

Based on the nominated gross margins, and assuming the required agricultural capital costs and fixed costs are outlaid (not included in the calculations in **Table 13**), the Study Area has the capacity to generate an estimated gross margin of $48,396 per annum (**Table 14**). It is important to note that these figures are derived from the optimum potential uses and are likely to be higher than the actual incomes being achieved from the area under actual production.

Table 14 Annual Gross Margins per LSC Class

LSC	Gross Margin	Study Area	
Class	**Per Hectare**	**Hectares**	**Gross Margin**
4	$296	92	$27,232
5	$222	21	$4,662
7	$74	223	$16,502
	Total	**337**	**$48,396**

It is expected that income generated from agricultural enterprises within the Study Area would be minimal due to the small area (160 hectares) available for actual agricultural production (**Figure 6**). The majority of this cleared area is LSC Class 7 and using the gross margin information presented in **Table 14**, 160 hectares of LSC Class 7 land has a potential gross margin of $11,840 per annum.

3.5 Regional Agricultural Support Infrastructure

Agricultural support infrastructure within the Wollondilly LGA includes the Hume Highway as the major arterial road, and rail infrastructure providing transport from agricultural areas in the west, south and north of the state.

The main purpose-built agricultural support infrastructure within the Study Area is a number of large farm dams which are used for cattle and horse grazing areas.

There are two abattoirs located nearby in Tahmoor. Poultry processing is carried out at the Inghams processing facility whilst the Wollondilly Co-op abattoir processes pigs. The closest livestock selling centre is located at Moss Vale, approximately 55 kilometres south-west of the Study Area.

There are a number of small retail agricultural suppliers that service the numerous small hobby farms in the region. Other purpose built agricultural infrastructure is generally for intensive agricultural enterprises and includes greenhouses and hothouses for cut flower and vegetable production, poultry laying and growing sheds, farm dams and groundwater extraction bores.

4 Assessment of Potential Impacts

The primary potential impact to agricultural resources is from subsidence. MSEC (2019) predicts maximum vertical subsidence over LW W1-W2 to be 750 millimetres. Maximum predicted tilt is 5.5 millimetres per metre which is very small when compared to the natural surface grades of steep slopes within the Study Area, which are greater than 1 in 3. However, steep slopes are likely affected by curvature and strain that result in tension cracks appearing at the tops and sides of steep slopes with compression ridges forming at the bottom of the steep slopes (MSEC, 2019).

4.1 Land Resources

4.1.1 Land Temporarily Removed from Agriculture

Based on the natural landscape contours and the predicted subsidence contours, there is unlikely to be any remnant ponding in the landscape (HEC, 2019). Therefore, there is no land which will be temporarily removed from agriculture as a result of LW W1 – W2.

4.1.2 Land Permanently Removed From Agriculture

There is no land which will be permanently removed from agriculture as a result of LW W1 – W2.

4.1.3 Acid Sulfate Soils

As outlined in **Section 2.7** there are no Soil Landscape Units associated with the Study Area with acid sulfate potential. LW W1 –W2 will not impact upon Acid Sulfate Soils.

4.1.4 Impact on Biophysical Strategic Agricultural Land

There is no Biophysical Strategic Agricultural Land within the Study Area. LW W1 –W2 will not impact any Biophysical Strategic Agricultural Land.

4.2 Water Resources

4.2.1 Surface Water

The Matthews, Cedar and Stonequarry Creek system is partly located within the Study Area. These ephemeral creeks are located outside but adjacent to LW W1-W2.

Matthews, Cedar and Stonequarry Creeks are predicted to experience maximum values of total vertical subsidence between 60 millimetres and 90 millimetres. Maximum predicted total upsidence is between 90 millimetres and 175 millimetres, with maximum predicted total closure 180 millimetres (MSEC, 2019).

Subsidence impacts are predicted to be relatively greater in the south of the Study Area, with Matthews Creek predicted to experience greater subsidence effects than Stonequarry Creek and Cedar Creek. The maximum closure for these major creeks is predicted to be less than 200 millimetres and hence flow diversion and pool water level impacts are expected to be minimal (HEC, 2019).

As Stonequarry Creek, Matthews Creek and Cedar Creek are outside the proposed longwall alignment, the maximum total closure predicted for these surface water systems is less than 200 millimetres and the maximum total predicted vertical subsidence is less than 100 millimetres, it is unlikely that streambed cracking will occur within these surface water systems or that the predicted change in gradient will result in an observable impact to pool water levels, pool connectivity or stream bed erosion. (HEC, 2019).

Isolated, episodic pulses in salinity, iron, manganese, zinc and nickel may occur in Stonequarry Creek, Matthews Creek and Cedar Creek due to subsidence induced changes in surface water runoff, throughflow and baseflow discharging to these surface water systems. However, as Stonequarry Creek, Matthews Creek and Cedar Creek will not be directly mined beneath; the subsidence related impacts to water quality are likely to be less than that recorded previously in Redbank Creek following mining of LW 25 to LW 32 (HEC, 2019).

Gas emissions from the sandstone strata have been previously observed above and adjacent to mining areas in the Southern Coalfield, and some gas emissions have also been observed in water bores. Analyses of gas compositions indicate that the Bulli Seam is not the direct and major source of the gas and that the most likely source is the Hawkesbury Sandstone (MSEC, 2019).

All recorded examples of gas emissions have occurred in collieries located to the east and to the north-east of Tahmoor Mine. No gas emissions or consequential changes in water quality have been reported over Tahmoor Mine in the Bargo River, Redbank Creek or Myrtle Creek.

4.2.2 Groundwater

Mining induced cracking and vertical subsidence of strata over the longwalls will occur and may potentially extend to approximately 20 metres below surface, with bedding dilation below the tensional zone potentially to around 150 metres below surface. No adverse interconnection of aquifers and aquitards is anticipated within 20 metres of the plateau surface as there are no recorded aquifers in this interval (GeoTerra, 2019).

Previous observations indicated that water quality of subsided bores is not generally adversely affected; however there may be an increased iron hydroxide precipitation and a lowering of pH if the groundwater is exposed to “fresh” surfaces in the strata with dissolution of unweathered iron sulphide (Geoterra, 2019).

The NSW Aquifer Interference (AI) Policy 2012 established a 2 metre threshold as the maximum allowable drawdown for ‘water supply works’ in order to satisfy the considerations for ‘minimal harm’.

The mean and maximum predicted drawdowns for all private bores within the vicinity of LW W1-W2 are shown in **Table 15**. Hydrosimulations (2019) states that the maximum drawdown value represents the greatest drawdown at any period within the model. The cumulative drawdown is also presented and represents the maximum drawdown predicted to occur due to the extraction of LW W1-W2 in addition to the drawdown predicted to occur as a result of historic and approved mining for the Tahmoor Mine.

Table 15 Predicted Impacts to Private Bores

Identifier	Purpose	Maximum Incremental Drawdown (m)	Mean Incremental Drawdown (m)	Maximum Cumulative Drawdown (m)
GW024750	Stock & Domestic	**7.0**	1.2	**14.4**
GW035844	Irrigation	2.0	0.2	**3.4**
GW064469	Domestic	1.8	0.2	**2.8**
GW072402	Stock & Domestic	1.4	0.2	**3.5**
GW104090	Recreation	**2.9**	0.5	**7.6**
GW105228	Stock & Domestic	1.7	0.3	**3.6**
GW105467	Stock & Domestic	**2.3**	0.3	**5.3**
GW105546	Irrigation	1.5	0.1	**5.3**

Two stock and domestic bores (and one recreation bore) will have a maximum incremental drawdown of greater than the Level 1 minimal impact considerations for the NSW AI Policy, of greater than two metres (highlighted in red). Bore GW024750 is currently not in operation as the bore casing has collapsed. Bore GW105467 is the only bore with a current agricultural use which is predicted to have maximum incremental drawdown of greater than two metres (Hydrosimulations, 2019).

4.2.3 Water Reallocation

Tahmoor Mine currently holds three groundwater extraction licences for a total of 1,642 megalitres, utilised for mine dewatering. However, this water would not be considered as being taken from potential agricultural use as Licence Condition 16 of all three groundwater extraction licences states '*this is a special purpose (mine de-watering) licence; as such, the licence is including the volumetric groundwater allocation not transferrable, and the licence will be lapsed at the conclusion of mining operations*'.

Therefore, whilst Tahmoor Coal currently holds groundwater extraction licences for 1,642 megalitres, this water would not be considered as being taken from potential agricultural production as the licences are restricted to mine de-watering only.

There will be no impact on agricultural users through water reallocation.

4.2.4 Water Resource Impacts on Agricultural Productivity

Given the very limited impacts described previously, longwall subsidence will result in negligible impacts on water resources relied upon by agricultural enterprises and will not result in any impact on agricultural productivity.

4.3 Impact on Agricultural Resources from Biodiversity Offsets

The extraction of LW W1 –W2 is not expected to result in the establishment of any biodiversity offsets; therefore there will be no impact to agricultural resources resulting from biodiversity offsets.

4.4 Other Impacts

4.4.1 Visual Amenity and Landscape Values

Site inspection by SLR's Associate Agronomist did not identify any agricultural enterprises which were reliant upon visual amenity or landscape values as component of their operations. On this basis, the extraction of LW W1-W2 is considered to have negligible impact on visual amenity and landscape value relied upon by local and regional agricultural enterprises.

4.4.2 Tourism

The assessment has not identified any tourism infrastructure in the local area upon which agricultural enterprises are reliant. Therefore LW W1 –W2 is not anticipated to impact on agriculture-related tourism.

4.4.3 Weed Management and Biosecurity

There is no risk from weed infestation during the extraction of LW W1-W2 through vehicle movements on and off site. Weeds are currently managed within the frameworks of the Tahmoor Environmental Management System.

Biosecurity is defined in the *NSW Biosecurity Strategy 2013 – 2021* (NSW DPI, 2013) as 'protecting the economy, environment and community from the negative impacts of pests, diseases and weeds'. It includes measures to prevent new pests, diseases and weeds from entering our country and becoming established. On a regional level, appropriate weed management will reduce biosecurity risks.

The vast majority of equipment used at Tahmoor Mine is site-dedicated and poses no biosecurity risk. Any import of equipment or machinery from interstate or overseas will follow the standard procurement safeguards and quarantine procedures as per NSW and Australian requirements.

Given the processes above, it is considered the extraction of LW W1 –W2 has negligible risk to the biosecurity of agricultural resources and enterprises within the region.

4.4.4 Air Quality

The extraction of LW W1-W2 involves the extraction of two underground longwall panels and as such there will be no impact to air quality resulting from LW W1 –W2.

4.4.5 Noise

The extraction of LW W1-W2 involves the extraction of two underground longwall panels and as such there will be no impacts to agricultural production from noise generated during the extraction of LW W1 –W2.

4.4.6 Blasting

The extraction of LW W1-W2 does not involve any blasting on the surface and as such there will be no impact to agricultural resources from blasting.

4.4.7 Traffic

The extraction of LW W1-W2 involves the extraction of two underground longwall panels with no increased surface traffic movements, and as such the impact to agricultural resources as a result of increased traffic movements is considered negligible.

4.4.8 Rural Structures

The majority of rural structures within the Study Area are of lightweight construction and are expected to tolerate mining induced tilt. It has been found from past longwall mining experience that tilts of the magnitudes predicted for LW W1-W2 generally have limited adverse impacts on rural structures. Some minor serviceability impacts could occur at the higher levels of tilt, including door swing and issues with roof and pavement drainage. These serviceability impacts can generally be remediated using normal building maintenance techniques (MSEC, 2019).

4.4.9 Tanks

There are water, gas and fuel storage tanks on some of the properties within the Study Area.

The tanks themselves are typically constructed above ground level, and therefore are unlikely to experience the full ground movements resulting from the proposed mining. It is possible, that any buried water pipelines associated with the tanks within the Study Area could be impacted by the ground strains, if they are anchored by the tanks, or by other structures in the ground. Any impacts are expected to be of minor nature and easily repaired (MSEC, 2019).

4.4.10 Farm Fencing

Farm fences are generally flexible in construction and can usually tolerate mine subsidence movements. Impacts to fences may include tension loss and changes to post alignment. The most vulnerable section of farm fences are gates particularly long gates or those with latches as they are less tolerant to differential horizontal movements and tilts between the gate posts and the ground (MSEC, 2019).

4.4.11 Farm Dams

There are 19 farm dams that have been identified within the Study Area that may be subsided by up to 750 millimetres. The predicted tilt for the farm dams is 5.0 millimetres per metre causing changes in freeboard by a maximum of 140 millimetres. This small change in freeboard is unlikely to have adverse impacts on the storage capacity of the farm dams (MSEC, 2019).

There are four farm dams located directly above LW W1-W2 which could experience cracking in their bases of walls due to mining. However, extensive experience of mining directly beneath farm dams in the Southern Coalfield indicates that the incidence that the incidence of impacts is very low. Farm dams are constructed with cohesive materials in the bases and walls which can absorb the conventional subsidence movements typically experienced in the Southern Coalfields without the development of substantial cracking. Non-conventional

cracking movements can result in localised cracking and deformations at the surface and, where coincident with farm dams, could result in adverse impacts (MSEC, 2019).

4.4.12 Surface Water Extraction

As there is no registered surface water extraction within the Study Area, any predicted impacts to surface water will be negligible.

4.4.13 Groundwater Wells and Bores

Temporary lowering of the regional piezometric surface over the subsidence area due to extraction of LW W1-W2 may occur, with impacts more notable directly over extracted panels. Groundwater levels may reduce up to 15 metres at GW104090, which is located directly over LW W2. All other private bores are not anticipated to experience adverse impacts to bore yield or serviceability (Geoterra, 2019)

It is anticipated that groundwater levels will recover over a few months to two to three years. However it must be noted the rate of groundwater level recovery is significantly affected by climatic conditions at the time. There is no predicted permanent post mining reduction in the Hawkesbury Sandstone Aquifer groundwater levels (GeoTerra, 2019).

4.4.14 Impact on State Forest

There are no State forests or conservation areas present within the Study Area. The extraction of LW W1-W2 is not expected to impact the State Forest.

4.5 Agricultural Regional Community Impacts

No other impacts which may affect the regional agricultural community, resource or enterprises have been identified in this assessment.

5 Mitigation Measures and Management Strategies

This section describes the proposed mitigation measures and management strategies recommended to minimise potential agricultural impacts. Whilst the majority of impacts on agricultural enterprises and resources have been assessed as negligible, as a matter of best practice, Tahmoor Coal has adopted a number of mitigation measures to further minimise these impacts. A summary of key measures specifically in relation to potential agricultural impact is provided below.

5.1 Soil Resources

Whilst there are no earthworks proposed during the extraction of LW W1-W2, in the unlikely event they would be required, gypsum will be applied for any remediation earthworks where sodic subsoils (exchangeable sodium is greater than 5%) are exposed. The application of gypsum will minimise the potential for tunnel erosion to occur on disturbed subsoil. The recommended application rates are shown in **Table 16** .

Table 16 Gypsum Application Rates

Exchangeable Sodium (ESP)	Gypsum Rate per Hectare	Gypsum Rate per Square Metre
5 to 10%	2 to 5 tonnes	0.2 to 0.5 kilograms
Greater than 10%	5 tonnes	0.5 kilograms

It is noted that there are no soil stripping or stockpiling activities anticipated within the Study Area associated with the extraction of LW W1-W2.

5.2 Groundwater Resources

One currently operating private bore (GW105467) is predicted to be impacted by a maximum incremental drawdown of greater than two metres (2.3 metres). Tahmoor Coal have committed to “make good” provisions for any groundwater users shown to be adversely affected by mine operations and associated impacts.

5.3 Tanks

Only minor impacts to tanks are expected, if impacts occur the structure will be repaired in accordance with the *Coal Mine Subsidence Compensation Act 2017*.

5.4 Farm Fencing

In the unlikely event of damage to fence tensioning or farm gate levels, Tahmoor Coal will remediate the damage in consultation with relevant stakeholders.

5.5 Farm Dams

Any substantial cracking in the dam bases or walls within the Study Area could be repaired by reinstating with cohesive materials. If any farm dams were to lose water as a result of mining, the mine would provide an alternative water source until the completion of repairs in accordance with the *Coal Mine Subsidence Compensation Act 2017.*

6 Key Findings

This Land and Agricultural Resource Assessment has been prepared to be included in Tahmoor Coal's Extraction Plan LW W1-W2. The purpose of this Land and Agricultural Resource Assessment is to assess and report on the potential impacts agricultural resources within and the Study Area and recommend mitigation measures to alleviate any identified impacts. The key findings are listed below:

- The majority of agricultural land use within the Study Area is for small scale cattle and horse grazing areas, which are not major contributors to agricultural income generation. This small scale grazing is mostly carried out as a land and vegetation management tool. Land available for agricultural land use comprises 53% of the Study Area;
- Post-mining agricultural economic potential in the Study Area is expected to be very similar to pre-mining potential;
- The longwall mining will have minor impacts on surface and groundwater resources relied upon by agriculture, comprising one stock and domestic bore. Any groundwater impacts will be "made good" by Tahmoor Coal;
- Any impacts resulting from longwall mining are expected to be minor and temporary, and can be managed through application of appropriate mitigation measures and management strategies; and
- Continuation of longwall mining by Tahmoor Coal will provide considerable positive economic benefits to the local and broader communities. These benefits are far greater than any potential income lost by existing or potential agricultural enterprises.

In summary, the extraction of LW W1-W2 will provide considerable economic benefits to the region whilst having negligible impact on agricultural resources, enterprises or related industries.

7 References

Australian Bureau of Statistics website accessed April, 2019 www.abs.gov.au

Bureau of Meteorology website accessed April, 2019 www.bom.gov.au

Geoterra (2013), *Tahmoor South Project Shallow Groundwater Baseline Monitoring*

Geoterra (2019), *Tahmoor Coal Pty Ltd Longwalls West 1 & West 2 Baseline Private Bore Assessment*

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Appendix A

Soil Landscape Unit Descriptions

Blacktown Soil Landscape

The Blacktown Soil Landscape Unit consists of gently undulating rises, broad rounded crests and ridges, with slopes less than 5%, but occasionally up to 10% and local relief is up to 30 metres. It occurs on the Wianamatta Group geological unit, which is predominately comprised of shale. Vegetation is almost completely cleared eucalypt woodland, open-forest and tall open-forest. Soils are dominated by shallow to moderately deep Chromosols on crests, upper slopes and well drained areas; deep Dermosols occur on lower slopes and in drainage depressions.

Limitations of this unit include moderately reactive soil, low fertility and seasonal waterlogging. The Soil Landscape unit is suitable for cropping (requiring intensive management practices) and grazing. Much of the Blacktown Soil Landscape Unit has been urbanised or under rural residential development.

This soil landscape occurs throughout 125 hectares (37%) of the Study Area.

Hawkesbury Soil Landscape Unit

The Hawkesbury Soil Landscape Unit covers rugged, rolling to very steep hills, with slopes greater than 25% and local relief of 100-200 meters. It occurs on the Hawkesbury Sandstone geological unit consisting of sandstone and some shale and laminate. Vegetation consists of mostly cleared eucalypt woodland, open-forest and tall open-forest. Soils are dominated by shallow Tenosols and Rudosols associated with rock outcrops; Tenosols and Kandosols and locally deep sands occur on the inside of benches and along joints and factures. Kurosols are present on shale lenses with Tenosols on valley flats.

Limitations of this soil landscape unit include extreme erosion hazard, mass movement hazard, steep slopes, rock outcrops and shallow soils with low fertility. The Hawkesbury unit is not suitable for any agricultural enterprise.

This soil landscape occurs throughout 31 hectares (9%) of the Study Area.

Lucas Heights

The Lucas Heights Soil Landscape Unit consists of gently undulating crests, ridges and plateau surfaces, with slopes less than 10% and local relief is 10-50 metres. It occurs on the Mittagong Formation geological unit consisting of shale, laminite and quartz sandstone. Vegetation is extensively to completely cleared dry sclerophyll low open-forest and low woodland. Soils are dominated by moderately deep hard setting Kurosols on ridges and plateaus with Kurosols on crests, Kandosols on shoulders of plateaus and ridges and Tensosols on valley flats.

Limitations of this unit include stoniness, low fertility and land surface movement potential. The soil landscape is predominantly suited to grazing enterprises.

This soil landscape occurs throughout 39 hectares (12%) of the Study Area.

Luddenham Soil Landscape Unit

The Luddenham Soil Landscape Unit consists of undulating to rolling low hills, with slopes 5-20% and local relief is 50-80 metres. It occurs on the Wianamatta Group shales and often associated with Minchinbury Sandstone. Vegetation has been extensively cleared, consisting of open-forest. Soils are dominated by shallow Dermosols on crests; moderately deep Dermosols on upper and lower slopes and near drainage lines.

Limitations of this unit include erosion hazard, mass movement potential and moderate surface swelling potential. This soil landscape unit is suited to grazing enterprises.

This soil landscape occurs throughout 88 hectares (26%) of the Study Area.

Picton Soil Landscape Unit

The Picton Soil Landscape Unit consists of steep to very steep sideslopes, with slopes greater than 20% and local relief of 90-300 meters. It occurs on Wianamatta group shales and derived colluvial materials. Vegetation consists of extensively cleared tall open-forest of blue gum and blackbutt. Dominant soils are shallow to deep Dermosols on upper slopes and Kurosols on lower slopes and benches.

Limitations of this soil landscape unit include steep slopes, mass movement hazards, seasonal waterlogging and water erosion hazards. This soil landscape is not suitable for any agricultural enterprise.

This soil landscape occurs throughout 14 hectares (4%) of the Study Area.

Monkey Creek Soil Landscape Unit

The Monkey Creek Soil Landscape Unit consists of floodplains, valley flats and drainage depressions of the creeks draining the Cumberland Plain. Slopes are generally 1-2% but can locally range to up to 10%, local relief is less than 5 meters. Vegetation has been extensively cleared with isolated stands of river oaks. Dominant soils include Sodosols and Kurosols on floodplains and valley floors, with alluvial soils and Hydrosols and Rudosols on poorly drained depressions and close to recent flow lines.

Limitations of this soil landscape include flood hazards, permanently high watertable and seasonal waterlogging. This soil landscape is capable of both grazing and regular cultivation.

This soil landscape occurs throughout 40 hectares (12%) of the Study Area.

Appendix B

Site Inspection Plates

Site 1 – Pleasure Horses

Site 2 – "Stargard" Cattle Grazing

Site 3 – Cattle Grazing

Site 4 – Rural Residential

Site 5 – Rural Residential

Site 6 – Cattle Grazing

Site 7 – Pleasure Horses

Site 8 – Pasture

Site 9 – Goats

Site 10 – Pleasure Horses

Site 11 – Orchards

Site 12 – No Stock, Poultry Sheds

Site 13 – Rural Residential, Pleasure Horses

Site 14 – Rural Residential

Appendix C

Agricultural Productivity Gross Margin Data

BEEF CATTLE GROSS MARGIN BUDGET

Farm enterprise Budget Series: February 2017

Enterprise: **Inland store weaners**

Enterprise Unit: **100 cows**

Pasture: **Native pasture**

INCOME:			**Standard Budget**	**Your Budget**
42	steer weaners @	$1,079 /hd	$45,318	
21	heifer weaners @	$828 /hd	$17,388	
1	CFA Bull @	$1,554 /hd	$1,554	
6	CFA cows @	$1,116 /hd	$6,696	
0	Dry cows @	$1,116 /hd	$0	
13	Other culls @	$1,116 /hd	$14,508	
83				
	A. Total Income:		**$85,464**	
VARIABLE COSTS:				
Replacements	1 Bull @	$6,000 /hd	$6,000	
Livestock and vet costs: see section titled beef health costs for details.			$1,061	
Hay & Grain or silage. Low level supplementary feeding for 3 months			$2,250	
Drought feeding costs.			$0	
Pasture maintenence (372 Ha of native pasture)			$0	
Livestock selling cost (see assumptions on next page)			$5,792	
	B. Total Variable Costs:		**$15,103**	
	GROSS MARGIN (A-B)		**$70,361**	
	GROSS MARGIN/COW		**$703.61**	
	GROSS MARGIN/DSE*		**$47.29**	
	GROSS MARGIN/HA		**$189.14**	

Change in gross margin ($/cow) for change in price &/or the weight of sale stock

(Note: Table assumes that the price and weight of other stock changes in the same proportion as steers. As an example if steer sale price falls to 405c/kg and steer weight to 240 kg, gross margin would fall to $621 per cow. This assumes that price and weight of all other sale stock falls by the same percentage.

Liveweight (kg's) of Stock sold		**Steer sale price cents/kg live**				
		395	**405**	**415**	**425**	**435**
Steer wt.						
-40 kgs	**220**	542	559	576	593	610
-20 kgs	**240**	603	621	640	658	677
0	**260**	664	684	704	724	744
+20 kgs	**280**	724	746	767	789	810
+40 kgs	**300**	785	808	831	854	877

GM $ per Cow

An increase of 5% in weaning percentage increases gross margin per cow by $44.32

Assumptions **Inland store weaners**

Enterprise unit is 100 cows weighing on average 480 kg
Weaning rate: 84% - conception rate 90%

Sales

Steers sold at 9 months	260 kg	@415c/kg	live weight
Heifers sold at 9 months	230 kg	@360c/kg	live weight
21 heifers retained for replacement.			
Cull cows cast for age at 10 years	240 kg	@465c/kg	dressed weight
100% of preg tested empty cows culled	"	"	"
4% cows culled for other reasons	"	"	"
Bulls run at 3% & sold after 4 years use	420 kg	@370c/kg	dressed weight

Selling costs include: Commission 4%; yard dues $8.00/hd; MLA levy $5/hd; average freight cost to saleyards $12/hd; NLIS tags $3.60

Cows: age at first calf : 24 months

Mortality rate of adult stock: 2%

The average feed requirement of a cow + followers is rated at 2.21 LSU or 15.25 dse's. This is an average figure and will vary during the year.
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Age structure

Age	Number
2	21
3	18
4	15
5	13
6	11
7	9
8	7
9	6
Total Joined	**100**
10	6

6 sold cfa

Marketing Information:

Mainly sold to grass back-grounders for growing out.
Steers likely to end up in feedlots after further weight gain on grass.
Following sale, heifers either grown out to become breeders or fattened for the local trade market.

Production Information:

Mixed sex weaners sold from March to June from lighter country or at heavier stocking rates than for vealers. Common on unimproved areas with some supplementary feed in normal years.
This enterprise is the most drought susceptible.

ASIA PACIFIC OFFICES

BRISBANE
Level 2, 15 Astor Terrace
Spring Hill QLD 4000
Australia
T: +61 7 3858 4800
F: +61 7 3858 4801

CANBERRA
GPO 410
Canberra ACT 2600
Australia
T: +61 2 6287 0800
F: +61 2 9427 8200

DARWIN
5 Foelsche Street
Darwin NT 0800
Australia
T: +61 8 8998 0100
F: +61 2 9427 8200

GOLD COAST
Ground Floor, 194 Varsity Parade
Varsity Lakes QLD 4227
Australia
M: +61 438 763 516

MACKAY
21 River Street
Mackay QLD 4740
Australia
T: +61 7 3181 3300

MELBOURNE
Suite 2, 2 Domville Avenue
Hawthorn VIC 3122
Australia
T: +61 3 9249 9400
F: +61 3 9249 9499

NEWCASTLE
10 Kings Road
New Lambton NSW 2305
Australia
T: +61 2 4037 3200
F: +61 2 4037 3201

PERTH
Ground Floor, 503 Murray Street
Perth WA 6000
Australia
T: +61 8 9422 5900
F: +61 8 9422 5901

SYDNEY
2 Lincoln Street
Lane Cove NSW 2066
Australia
T: +61 2 9427 8100
F: +61 2 9427 8200

TOWNSVILLE
Level 1, 514 Sturt Street
Townsville QLD 4810
Australia
T: +61 7 4722 8000
F: +61 7 4722 8001

AUCKLAND
68 Beach Road
Auckland 1010
New Zealand
T: +64 27 441 7849

NELSON
6/A Cambridge Street
Richmond, Nelson 7020
New Zealand
T: +64 274 898 628