Appendix R – Soil and land resources impact assessment

NEWSTAN MINE EXTENSION PROJECT

SOIL AND LAND RESOURCE ASSESSMENT

Prepared for:

Centennial Coal

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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 Centennial 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
630.12856	March 2020	Murray Fraser	Rod Masters	Rod Masters

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1 Project Overview

Newstan Colliery is an existing underground coal mine located in the Lake Macquarie Local Government Area (LGA), approximately 25 kilometres (km) south-west of Newcastle and 140 km north of Sydney, NSW (**Figure 1**). It is owned and operated by Centennial Newstan Pty Ltd (Centennial Newstan), a wholly owned subsidiary of Centennial Coal Company Limited (Centennial Coal).

Mining operations at Newstan Colliery began in 1887 and upon the introduction of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act) operated pursuant to continuing use rights in accordance with Part 4, Division 10 of the EP&A Act (continuing use rights).

Newstan Colliery has at various times mined the upper coal seams (Great Northern and Fassifern seams) and lower coal seams (West Borehole, Borehole, Young Wallsend and Yard seams) and produced both semi-soft coking coal and thermal coal for the domestic and export markets. In the lower seams, workings to date have been concentrated to the west of the seam split, which is a defining geological feature of the mine. Mining has been undertaken using a combination of bord and pillar and longwall mining.

In August 2014, the underground operations at Newstan Colliery were placed onto care and maintenance due to poor market conditions. In recent years, Centennial Newstan has commenced feasibility investigations into the recommencement of mining at Newstan Colliery. The most recent modification to DA 73-11-98 in January 2019 permits first workings mining within the West Borehole seam in the southern portion of the Newstan Colliery mining lease area. The first workings aim to improve Centennial Newstan's understanding of the geology within the West Borehole seam, including the presence, throw and strike of a major fault zone projected from the historical Newstan workings.

Centennial Newstan is now seeking approval for the continuation of mining within the West Borehole seam. The Newstan Mine Extension Project (the project) proposes to extract up to 25.9 million tonnes (Mt) over a fifteen year period at a maximum production rate of 4 million tonnes per annum (Mtpa) of run of mine (ROM) coal. Bord and pillar mining is proposed using continuous miner methods that will include areas of first workings, partial extraction and total extraction. A mix of metallurgical and thermal coal is proposed to be extracted. ROM coal will be delivered to the Newstan Colliery Surface Site via a series of existing underground conveyors. Once the coal reaches the Newstan Colliery Surface Site it will be handled in accordance with the approved operations for the Northern Coal Logistics Project (SSD-5145), managed by Centennial Coal's Northern Coal Services business unit.

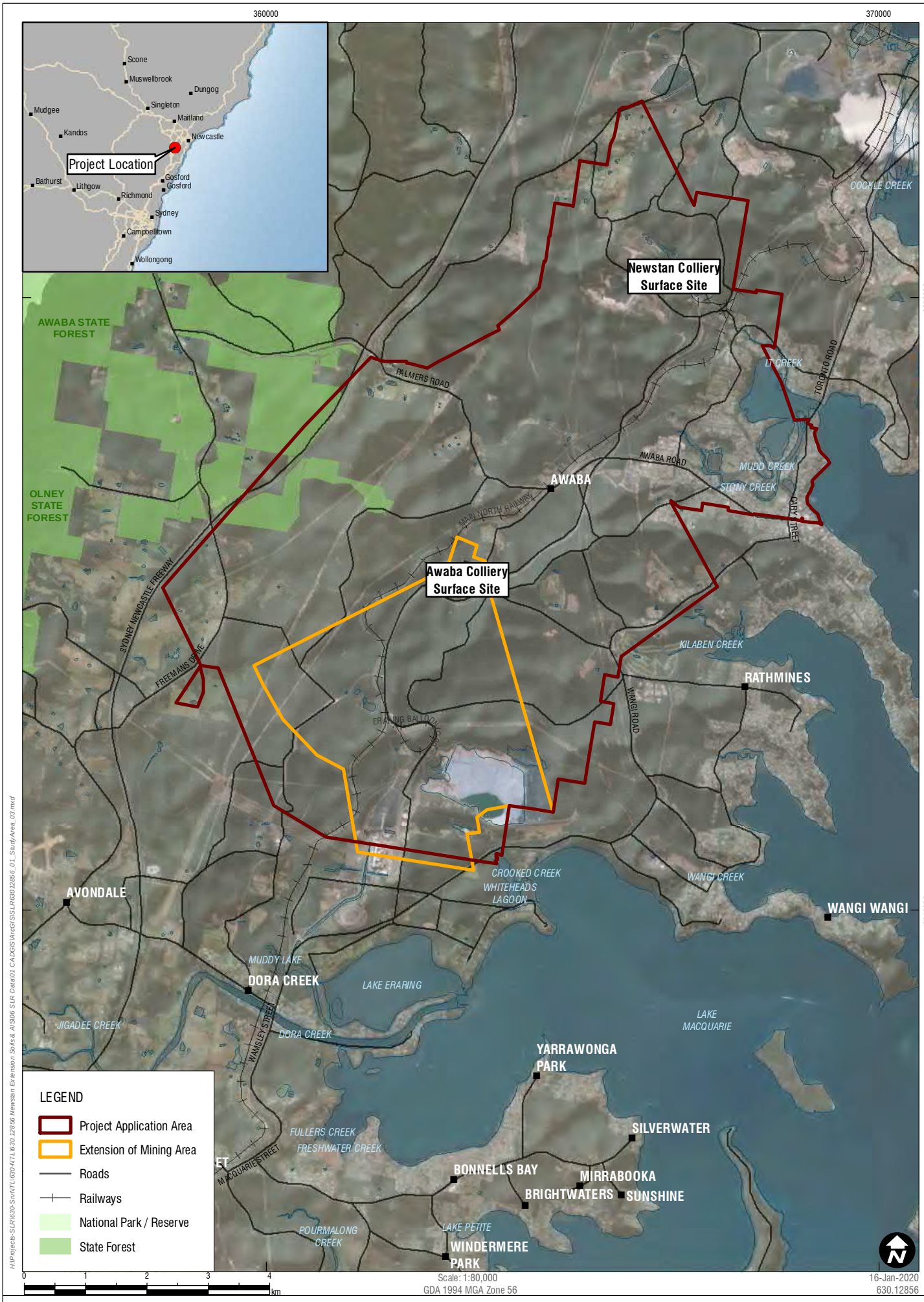
Other key features of the project include:

- Utilisation of the Newstan Colliery Surface Site to provide parking, bathhouse, administration and workshop facilities for the underground workforce. A small number of administrative, maintenance and monitoring personnel will also be located at Awaba Colliery Surface Site.
- Transportation of personnel and materials to and from the underground mining area via the existing men and materials drift at Newstan Colliery Surface Site.
- Continued operation of the two existing ventilation fans at Newstan Colliery Surface Site and the installation and operation of three new ventilation fans at the existing ventilation shaft at Awaba Colliery Surface Site.

- In-seam gas drainage, with gas transferred to a new gas flaring facility to be located within the existing disturbance footprint of Awaba Colliery Surface Site.
- Extraction of underground water via the existing Fassifern Pump Station at Newstan Colliery Surface Site and ongoing groundwater management in accordance with Centennial Coal's Northern Operations Regional Water Management Plan.

The project is aligned with the broader Centennial Coal business strategy in that it facilitates the development of a new semi-soft coking coal product stream and a thermal coal product for both the domestic and export markets. The project will enable supply of export coal products while meeting contractual coal supplies to the domestic markets. Over time, the project can potentially replace the coal product currently supplied to the domestic market by other Centennial Coal operations as these other resources become depleted. This will ensure ongoing security of supply for domestic electricity generation.

If approved, the project will allow for the optimisation of resource recovery from Newstan Colliery while providing ongoing direct and indirect employment opportunities. In addition, the project will provide a number of positive flow-on effects to the local, regional and state economies through additional wages and royalties.



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Locality

FIGURE 1

1.1 Purpose of this Document

The purpose of this document is to address the Secretary's Environmental Assessment Requirements (SEARs) for land resources to inform the preparation of the Environmental Impact Statement (EIS) for the project.

1.2 Study Area

The Study Area subject to this Soil and Land Capability Assessment is the entire Extension of Mining Area of and the predicted maximum extent of subsidence as shown on **Figure 1** and **Figure 2**. The Study Area comprises 1,446 hectares. The Study Area is wholly contained within the Lake Macquarie LGA.

1.3 Secretary's Environmental Assessment Requirements (SEARs)

The NSW Department of Planning, Industry and Environment (DPIE) has issued SEARs for the project. This report has been prepared to address the following elements of the SEARs:

Land Resources:

- An assessment of the likely impacts of the development on the soils and land capability of the site and surrounds (addressed in **Sections 3** and **4**); and
- An assessment of the compatibility of the development with other land uses in the vicinity of the development, in accordance with the requirements of clause 12 of the *State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007*, paying particular attention to the agricultural land use in the region (addressed in **Sections 2**, **4** and **5**).

The Department of Industry (DoI) has provided comments on the SEARs with advice from relevant branches of DoI Lands & Water and the Department of Primary Industry (DPI), specifically those listed below.

Strategic Regional Land Use Policy:

The Strategic Land Use Policy sets out a range of initiatives to better balance growth in the mining and coal seam gas industries with the need to protect important agricultural land and water resources.

Revised SEARs were received by Centennial Newstan on 3rd September 2019 and contained advice from the Department of Industry (DoI) received by DPIE on the 4th June, 2019. This advice stated there was no requirement for an Agricultural Impact Statement (AIS), specifically:

DPI Agriculture

Section 5.2.9 'Soil and Land Resources' of the Scoping Report indicates an intention to undertake an Agricultural Impact Assessment (AIS) in the forthcoming EIS. The proponent should be advised that in this instance an AIS is not necessary as it is unlikely that the proposed underground extension will impact on any existing or future agricultural activity or resources that would not already be addressed in the EIS.

As such there has been no AIS prepared for the project.

2 Existing Environment

2.1 Climate

Meteorological information for the Study Area has been sourced from long-term data collected at the Bureau of Meteorology's (BoM) nearest operational weather stations, along with information provided in the Scoping Report for the project (Centennial Newstan, 2019).

The Study Area is located within a temperate climate zone with no designated wet season. The local climate is characterised by warm to hot summers and cool to mild winters. Continuous daily rainfall data has been obtained from the BoM Cooranbong (Avondale) weather station (station number 061012), with missing data "patched in" using interpolations from nearby stations. The average annual evaporation total was approximately 1,172 millimetres, compared to the annual average rainfall of 1,121 millimetres, giving an annual rainfall deficit of approximately 51 millimetres. The area can be susceptible to occasional heavy showers and thunderstorms due to easterly troughs during warmer months.

2.2 Geology

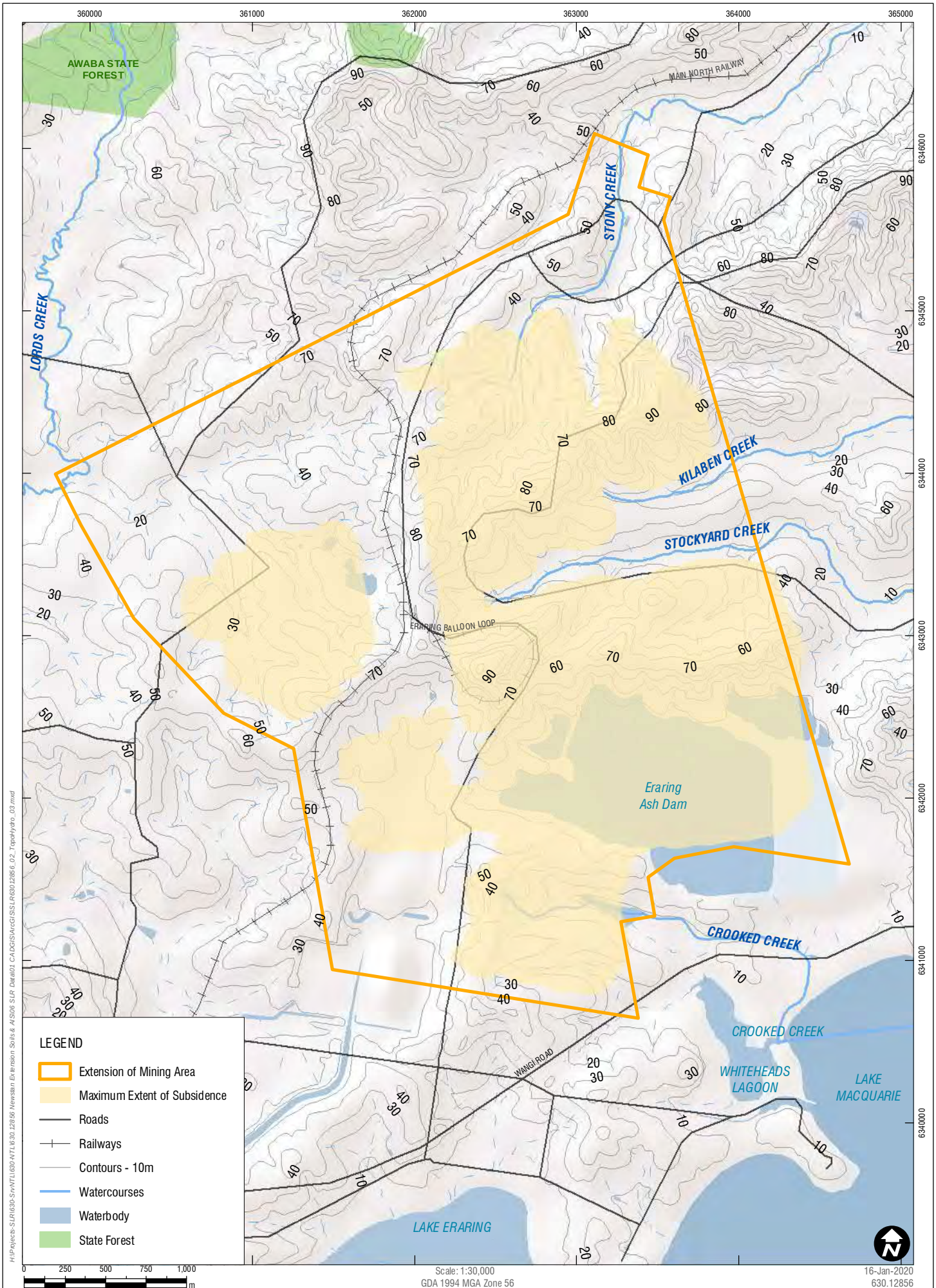
The Study Area is located in the south-western part of the Newcastle Coalfield, which occupies the north-eastern portion of the Sydney Basin. The stratigraphy of the region consists of material from the Triassic and Permian periods. The Newcastle Coal Measures are characterised by complex patterns of splitting and coalescence of the various coal seams. This is generally related to the localised presence of alluvial paleochannels within the sedimentary sequence. The West Borehole seam is contained within the Lambton Formation, the earliest formation of the Newcastle Coal Measures.

The surface lithology in the vicinity of the Extension of Mining Area comprises shallow Quaternary alluvium (associated with the major watercourses) as well as bedrock and surface deposits from the Narrabeen Group and the Moon Island Beach Group of the Newcastle Coal Measures, which dip gently at approximately 1 to 2 degrees to the south-west. The Triassic and Permian rocks that comprise the surface lithology include conglomerate, sandstone, siltstone, claystone, tuff and coal.

The Young Wallsend, Great Northern, Fassifern, Borehole and West Borehole seams have been previously mined at Newstan Colliery. Most recently, mining has been undertaken in the West Borehole seam.

2.3 Topography and Hydrology

The topography of the Study Area generally consists of rolling low hills with short side slopes and numerous closely spaced drainage lines, on predominately coarse-grained sediments of the Narrabeen Group and Newcastle Coal Measures (Centennial Newstan, 2019). Slope gradients are generally 10-25% and local relief is between 10-90 metres Australian Height Datum (AHD). Within the Study Area there are four named watercourses; Kilaben Creek, Stony Creek, Stockyard Creek and Crooked Creek (**Figure 2**).



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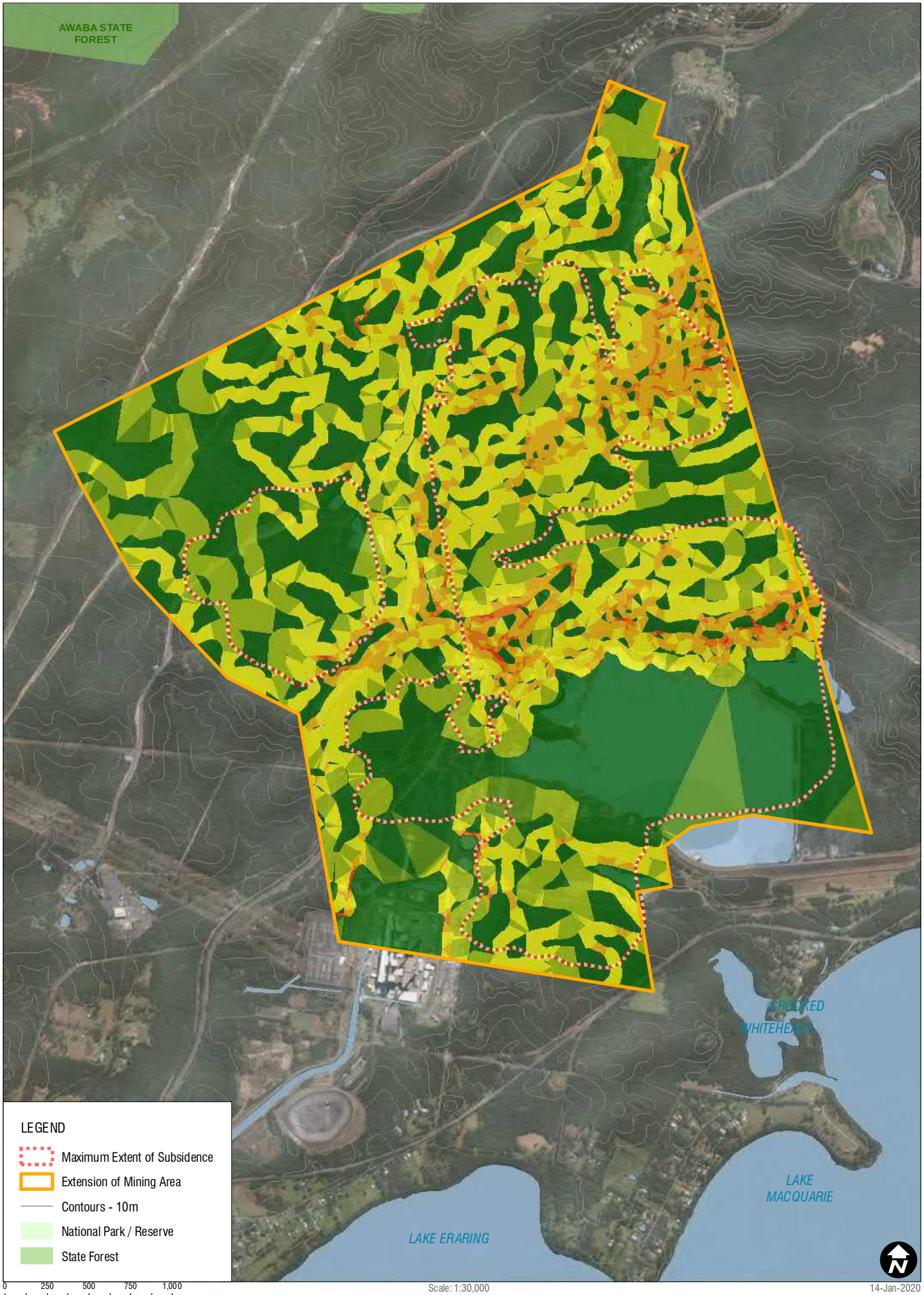
Topography and Hydrology

FIGURE 2



Slope Analysis

FIGURE 3

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2.4 Soil Landscape Units

Soil Landscapes Units are described as "*areas of land that have recognisable and specific topographies and soils that can be presented on maps and described by concise statements*" (Northcote 1978).

The Soil Landscape Units 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 DPI), on the *Soil Landscapes of the Gosford – Lake Macquarie Sheet 1:100,000 Sheet* (Murphy, 1993) shown in **Figure 4**.

Five Soil Landscape Units occur in the Study Area and are summarised in **Table 1** with full descriptions provided below.

Table 1 Soil Landscape Units

Soil Landscape Unit	Map Code	Dominant ASC	Study Area	
			Hectares	%
Awaba	ERaw	Tenosols and Kurosols	528	37
Awaba (Slopes >25%)	ERawa		45	3
Wyong	ALwy	Dermosols, Chromosol, Kurosols	17	1
Doyalson	ERdo	Kandosols, Kurosols, Chromosols	595	41
Disturbed Terrain	DTxx	Anthroposol	261	18
		Total	**1,446**	**100**

2.4.1 Awaba Soil Landscape

The Awaba Soil Landscape Unit consists of rolling low hills on predominately coarse-grained sediments of the Narrabeen Group and Newcastle Measures in the Awaba Hills. Local relief is between 20-80 m and slope gradients are 10-25% with some localised steep slopes up to 60%. A variant of the Awaba soil landscape are soils on slopes greater than 25%. The landscape is characterised by relatively broad crests, short sideslopes, and steeper downslopes with narrow and incised drainage lines. The land is mostly uncleared open-forest. The soils are dominated by shallow Tenosol on steep slopes, shallow to moderately deep Sodosols and Yellow Chromosols/Kurosols on gentler slopes with Sodosols in drainage lines and occasionally Deep Chromosols/Kurosols, Sodosols and Hydrosols on fine-grained substrates.

Limitations include steep slopes (localised), mass movement (localised), very high erosion hazard, shallow soils (localised) with hard setting, stony, occasionally shallow and acidic soils of low fertility.

The Awaba Soil Landscape Unit occurs across 573 hectares (40%) of the Study Area, characterised by a landscape setting shown in **Plate 1**.

Plate 1 – Awaba Soil Landscape Unit

2.4.2 Wyong Soil Landscape

The Wyong Soil Landscape Unit consists of broad, poorly drained deltaic floodplains and alluvial flats of Quaternary sediments on the Central Coast Lowlands. Slope gradients are less than 3%, and local relief is less than 10 m. Meander scrolls, oxbows and swamps are common in the landscape. The land is extensively cleared open-forest. The soils are dominated by deep Yellow and Brown Chromosols and Brown Sodosols, with some Humus Podosols around lake edges.

Limitations include flooding, seasonal waterlogging, foundation hazard, permanent waterlogging (localised), stream bank erosion (localised), acid sulphate potential (localised), strong acidic, poorly drained and impermeable soils of low fertility with saline subsoils. The rural capability is deemed to have generally low limitations for cultivation except for water logged areas which have high to severe limitations. Generally, there are low to moderate limitations for grazing.

The Wyong Soil Landscape Unit occurs across 17 hectares (1%) of the Study Area, characterised by a landscape setting shown in **Plate 2**.

Plate 2 – Wyong Soil Landscape Unit

2.4.3 Doyalson Soil Landscape

The Doyalson Soil Landscape Unit consists of gently undulating rises on Munmorah Conglomerate. Slope gradients are less than 10%, with local relief to 30 m. The landscape is characterised by broad crests and ridges and long gently inclined slopes. The land is partially cleared eucalypt open-forest. The soils are dominated by moderately deep Kandosols, Yellow Chromosols/Kurosols and Sodosols on sandstones and conglomerates. Moderately deep Yellow Chromosols/Kurosols Soils, Sodosols and some Red Chromosols/Kurosols occur on fine grained siltstones and claystone. Moderately deep to deep Yellow Leached Earths, Grey Earths, Sodosols and Hydrosols occur along drainage lines.

Limitations include high erosion hazard, foundation hazard (localised), high run-on (localised), mine subsidence district, seasonal waterlogging (localised), hard setting, stony and strong acidic soils of low fertility.

The Doyalson Soil Landscape Unit occurs across 595 hectares (41%) of the Study Area, which is characterised by a landscape setting shown in **Plate 3**.

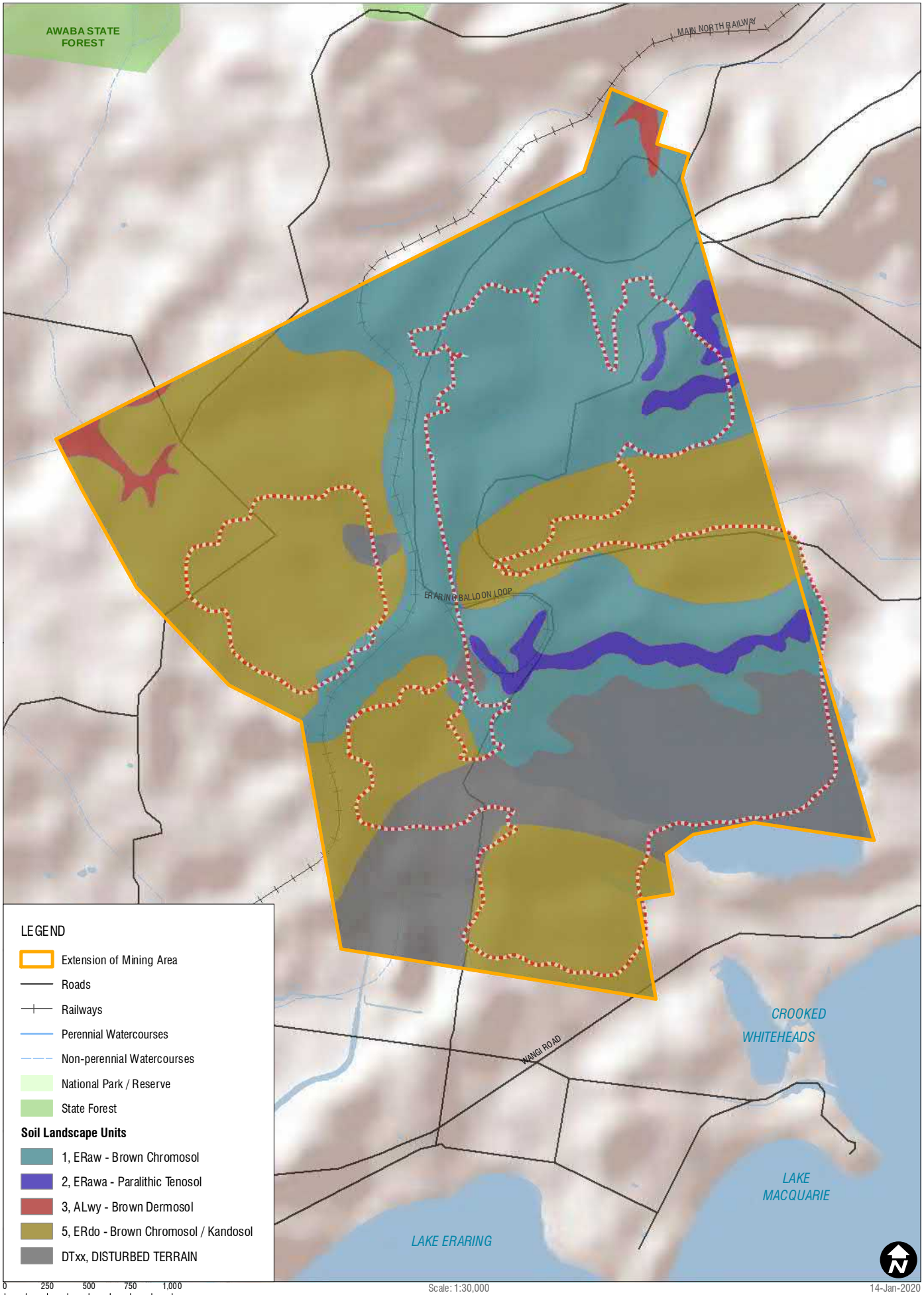
Plate 3 – Doyalson Soil Landscape Unit

2.4.4 Disturbed Terrain

Disturbed Terrain consists of level plain to hummocky terrain, extensively disturbed by human activity, including complete disturbance, removal or burial of soil. Local relief and slopes are highly variable. Due to disturbance very little vegetation remains in this Soil Landscape Unit. The soils are disturbed and highly variable. In these areas most of the original soil has either been removed, buried or greatly disturbed.

Limitations are highly variable depending on the site and mass movement hazard, rock fall hazard, erosion hazard, steep slopes, mine subsidence district (localised) and shallow soils.

Disturbed Terrain occurs throughout 261 hectares (18%) of the Study Area.



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Soil Landscapes

FIGURE 4

2.5 Vegetation & Land Use

The Study Area and surrounds is predominately native forest, with no land being used for agricultural production. The nearest land used for agricultural production is approximately 1 kilometre to the west of any predicted subsidence.

The main land uses within the Study Area include the Eraring Power Station and Ash Dam, The Main Northern Railway, powerline easements and biodiversity conservation areas. A portion of the Study Area has also been used for urban development.

Lake Macquarie City Council Plant Community Types (PCT) map indicates there are nine PCTs identified as potentially occurring within the Extension of Mining Area, of which four have been identified as having a Threatened Ecological Community (TEC) equivalent under the NSW *Biodiversity Conservation Act 2016* (Centennial Newstan, 2019). The identified PCTs include:

- PCT 1636 – Scribbly Gum – Red Bloodwood - Angophora inopina heathy woodland on lowlands of the Central Coast.
- PCT 1619 – Smooth-barked Apple – Red Bloodwood - Brown Stringybark - Hairpin Banksia heathy open forest of coastal lowlands.
- PCT 1588 – Grey Ironbark – Broad-leaved Mahogany - Forest Red Gum shrubby open forest on Coastal Lowlands of the Central Coast.
- PCT 1627 – Smooth-barked Apple – Turpentine - Sydney Peppermint heathy woodland on sandstone ranges of the Central Coast.
- PCT 1718 – Swamp Mahogany – Flax-leaved Paperbark swamp forest on coastal lowlands of the Central Coast, TEC equivalent: Swamp Sclerophyll Forest on Coastal Floodplains listed as an EEC under the BC Act.
- PCT 1649 – Smooth-barked Apple – Red Mahogany - Swamp Mahogany - Melaleuca sieberi heathy swamp woodland of coastal lowlands, TEC equivalent: Swamp Sclerophyll Forest on Coastal Floodplains listed as an EEC under the BC Act.
- PCT 1716 – Prickly-leaved Paperbark forest on coastal lowlands of the Central Coast and Lower North Coast, TEC equivalent: Swamp Sclerophyll Forest on Coastal Floodplains listed as an EEC under the BC Act.
- PCT 1737 – Typha rushland, TEC equivalent: Freshwater Wetlands on Coastal Floodplains listed as an EEC under the BC Act.
- PCT 1638 – Smooth-barked Apple – Red Bloodwood - Scribbly Gum grass - shrub woodland on lowlands of the Central Coast.

2.5.1 Agricultural Resources

The Cooranbong locality was settled in the mid 1850's, with farming and timber cutting being the mainstays of employment. Farming consisted of cattle and sheep grazing with some crop growing. In the late 1800's the timber industry declined, and the poor soil could not sustain farming on a commercial scale. Cooranbong is now regaining popularity as a hobby farming area (LMCC, 2012).

Within the vicinity of the Study Area, most agricultural enterprises have traditionally been small farm enterprises conducted in pockets of cleared native bushland, reliant upon off-farm income to be sustainable. Cattle grazing, pleasure horse agistment and small orchard areas are the main agricultural activities in the area. However, it is assumed, that given the terrain and soils within the area, very little other agricultural activity has occurred in the immediate vicinity of the Study Area.

The key points for agricultural resources in the Lake Macquarie LGA are derived from Australian Bureau of Statistics Census of Population and Housing 2011 (ABS, 2011) census data and are as follows.

- Agriculture is a minor land use within the LGA, accounting for 5.9% of land use.
- Agricultural land is almost exclusively used for grazing, utilising 99.5% of all agricultural land. The primary enterprise is meat cattle farming, which accounts for 70.3% of livestock numbers.
- Cropping enterprises comprise a minor portion of agricultural activities. The primary crops grown are vegetables, fruit and other non-cereal crops. No cereals for grains are grown in the region.
- Agriculture is only minor water user in the Lake Macquarie LGA, with 325 ML used to for irrigation and an additional 179 ML utilised for other agricultural uses, such as poultry and egg production.
- 382 people employed in agricultural related industries within the Lake Macquarie LGA, which represents approximately 0.47% of the workforce.

In a broad context, agriculture is only a minor contributor to the economy of the Lake Macquarie LGA, with a total gross value of approximately $27.3 million per annum (ABS, 2011). Although there is only a small area of land utilised for agriculture in the Lake Macquarie LGA, it averages a relatively high $7,250 per hectare of production per annum, reflecting high intensity agricultural enterprises such as housed poultry and orchards.

The main purpose-built regional agricultural support infrastructure is a number of large poultry sheds, which are used for raising meat chickens and egg production. There are a number of small retail agricultural suppliers that service the numerous hobby farms in the region. Outside of this, there is little formal infrastructure for the support of agricultural industries in the Lake Macquarie LGA.

Poultry processing is conducted outside the Lake Macquarie LGA. The Inghams Enterprises poultry processing facility (abattoir) is located at Mangrove Mountain in the Central Coast LGA, processing the majority of meat chickens grown there, while other poultry processors are located at in the Newcastle (Baiada Poultry), Cessnock (Valley Feeds) and Blacktown (Red Lea).

Inspection by SLR's Associate Agronomist during the soil survey followed by a desktop review, confirmed there are no agricultural enterprises or support infrastructure within the Study Area or the immediate surrounds.

3 Soil Survey and Assessment

3.1 Soil Survey Methodology

A desktop study and field survey were undertaken for the Study Area. The various components of this process are described in the following sub sections.

3.1.1 Reference Mapping

An initial soil map (reference map) was developed using the following resources and techniques:

- **Aerial photographs and topographic maps –** aerial photo and topographic map interpretation was undertaken allowing detailed analysis of the landscape, and mapping of features expected to be related to the distribution of soils within the Study Area. Aerial and topographical maps were provided by Centennial Newstan.
- **Reference information** – source materials were used to obtain correlations between pattern elements and soil properties that may be observable in the field. These materials included cadastral data, prior and current geological, vegetation, and water resources studies.
- **Previous reports** – previous studies were taken into consideration for soils mapping and land assessment. These include the following:
    - Soil Landscapes of the Gosford – Lake Macquarie 1:100,000 Sheet (Murphy 1993) (refer to **Section 2.2**); and
    - NSW Soil and Land Information System (SALIS) (accessed through eSpade).
- **Stratified observations** – following production of a broad soil map, surface soil exposures, topography and vegetation throughout the potential disturbance areas were visually assessed to verify potential soil types, delineate soil type boundaries and determine preferred locations for targeted subsurface investigations (hereafter referred to as soil pits).

3.1.2 Field Survey

3.1.2.1 Scale

The field survey was undertaken at a moderate intensity scale of 1:150,000. This survey scale enables the production of a detailed map that is suitable for intense land uses such as engineering works (*Guidelines for Surveying Soil and Land Resources* (NCST 2008)). This survey scale was adopted to offer an adequate dataset of soil types within the Study Area and to assess the potential impact on these soils following the works proposed as part of the project.

3.1.2.2 Survey Type

The field survey undertaken was an integrated and qualitative survey. An integrated survey assumes that many land characteristics are interdependent and tend to occur in correlated sets (NCST 2008). Background reference information derived from sources cited in **Section 3.1.1** were used to predict the distribution of soil attributes in the field. The characteristics evaluated to generate the correlated sets include vegetation type, landform and geology.

The specific type of integrated survey undertaken was a 'free survey'. A free survey is a conventional form of integrated survey and its strength lies in its ability to assess soil and land at medium to detailed-scales. Survey points are irregularly located according to the survey teams' judgement to enable the delineation of soil boundaries. Soil boundaries can be abrupt or gradual, and catena and toposequences are used to aid the description of this variation.

3.1.2.3 Survey Observations

Survey observations undertaken comply with the 1:150,000 scale survey criteria prescribed in the *Guidelines for Surveying Soil and Land Resources* (NCST, 2008). The recommended observation density for 1:150,000 scale survey is one observation type every 150 hectares. For the Study Area of 1,446 hectares this equates to approximately 10 observations. A minimum of 10-30% (1 – 3 observations) are to be Detailed Profile Descriptions (also referred to as Class I observations), 5% (1 observations) of these are to be Laboratory Assessed (also referred to as Class II observations), and the remainder are to be made up by Minor Class Observations (also referred to as Class IV observations).

Nine Class I observations and two Class II observations were made within the Study Area. This satisfied the observation requirements for a 1:150,000 survey scale. **Figure 5** illustrates the distribution of the survey observations throughout the Study Area.

3.1.2.4 Detailed Soil Profile Observation

Across the Study Area, 11 exposed soil profiles were assessed (**Figure 5**). A number of factors influenced the distribution of soil profile assessment, including equipment accessibility and land ownership. Detailed soil profiles were assessed for soil type and distribution. Each detailed profile was excavated by a hydraulic soil corer to bedrock, equipment refusal or an approximate depth of 1.2 metres. Pits were backfilled after the profile was assessed and soil samples taken.

Soil profiles within the Study Area were assessed in accordance with the *Australian Soil and Land Survey Field Handbook* (NCST, 2009). Detailed soil profile descriptions recorded the parameters specified in **Table 2**. Soil profile logging was undertaken in the field using soil data sheets.

Global Positioning System (GPS) recordings were taken for all sites where detailed soil descriptions were made. Vegetation type and land use were also recorded. Soil exposures from cores were photographed during field operations with photographs being a useful adjunct to description of land attributes.

Soil layers at each profile site were also assessed according to a procedure devised by Elliot and Veness (1981) for the recognition of suitable topdressing material in the event surface disturbance occurs in the future. This procedure assesses soils based on grading, texture, structure, consistence, mottling and root presence. A more detailed explanation of the Elliot and Veness (1981) procedure is presented in **Section 5** of this report.

Table 2 Field Assessment Parameters

Descriptor	Application
Horizon Depth	Weathering characteristics, soil development
Field Colour	Permeability, susceptibility to dispersion /erosion
Field Texture Grade	Erodibility, hydraulic conductivity, moisture retention, root penetration
Boundary Distinctness and Shape	Erosional / dispositional status, textural grade
Consistence Force	Structural stability, dispersion, ped formation
Structure Pedality Grade	Soil structure, root penetration, permeability, aeration
Unit of Soil Structure (Ped) & Size	Soil structure, root penetration, permeability, aeration
Stones – Amount & Size	Water holding capacity, weathering status, erosional / depositional character
Roots – Amount & Size	Effective rooting depth, vegetative sustainability
Ants, Termites, Worms etc.	Biological mixing depth

3.1.3 Soil Laboratory Assessment

Soil samples from nine of the soil assessment sites were subject to laboratory analysis. Samples were analysed in order to:

- Classify soil taxonomic classes;
- Determine Land and Soil Capability; and
- Determine suitability of soil as topdressing material in future rehabilitation works.

Soil was collected from each major soil horizon (soil layer) and sent to a NATA accredited Environmental Analysis Laboratory (EAL) for analysis. Certificate of Analyses for these results are contained in **Appendix A**. The selected physical and chemical laboratory analysis parameters and their relevant application are listed in **Table 3**.

Table 3 Laboratory Analysis Parameters

Property	Application
Coarse fragments (>2mm)	Soil workability; root development
Particle-size distribution (<2mm)	Determine fraction of Clay (Cl), Silty (Si), Fine Sand (Fs) and Coarse Sand (Cs); Nutrient retention; exchange properties; erodibility; workability; permeability; sealing; drainage; interpretation of most other physical and chemical properties and soil qualities
Soil reaction (pH)	Nutrient availability; nutrient fixation; toxicities (especially aluminium (Al) and manganese (Mn)); liming; sodicity; correlation with other physical, chemical and biological properties
Electrical conductivity (EC)	Appraisal of salinity hazard in soil substrates or groundwater; total soluble salts
Cation Exchange Capacity (CEC) and exchangeable cations	Nutrient status; calculation of exchangeable cations including Sodium (Na), Calcium (Ca), Magnesium (Mg), Potassium (K) and exchangeable sodium percentage (ESP); assessment of other physical and chemical properties, especially dispersivity, shrink – swell, water movement, aeration
Munsell Colour Chart (Munsell)	Drainage, oxidation, fertility, correlation with other physical, chemical and biological properties

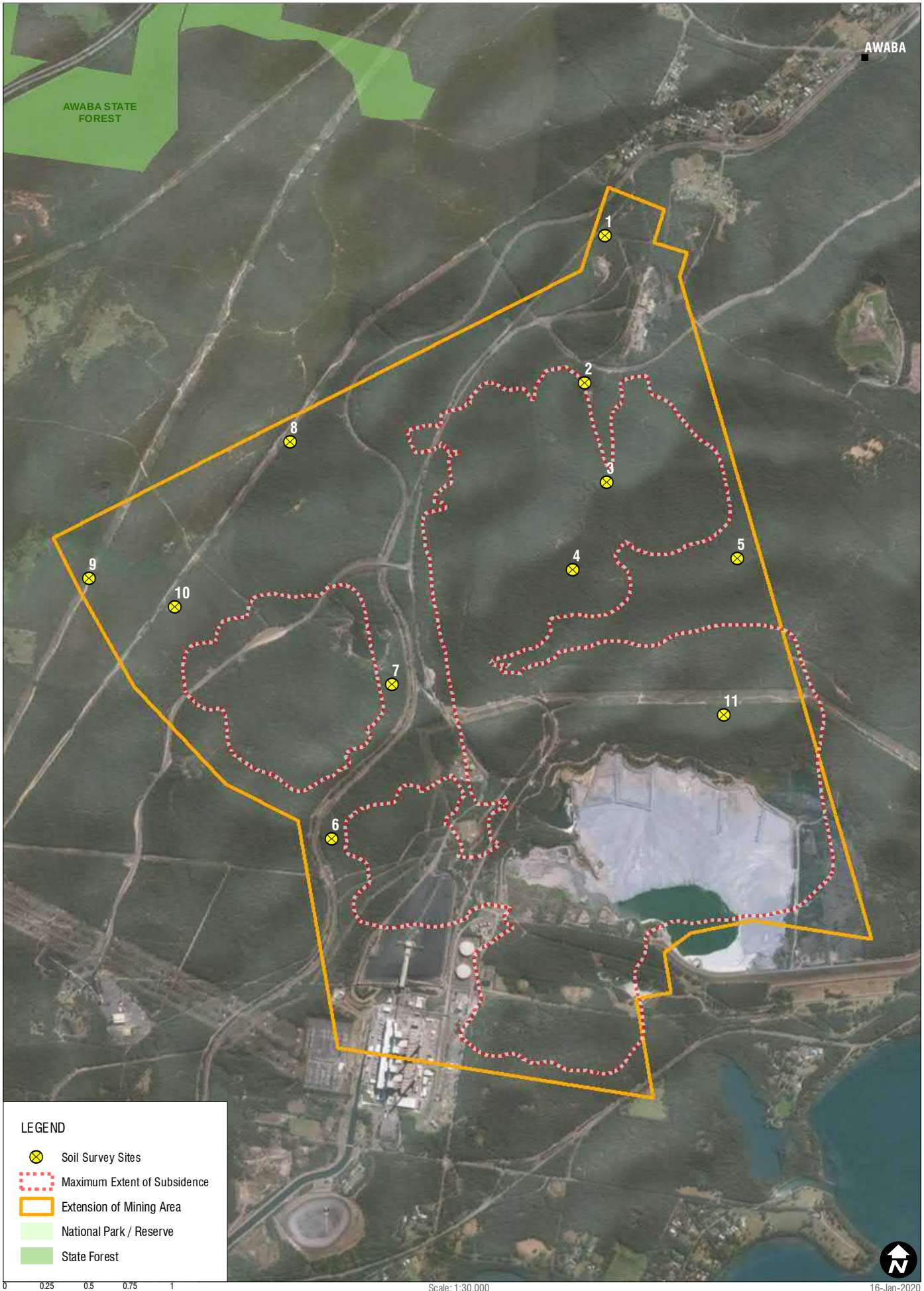
The laboratory methods used by EAL for key physical and chemical parameters are provided below in **Table 4.**

Table 4 Laboratory Test Methods

Parameter	Method
Particle Size Analysis (PSA)	Sieve and hydrometer
pH	1:5 soil/water extract
EC	1:5 soil/water extract
CEC and exchangeable cations	(AgTU)+ extraction

3.1.4 Soil Type Nomenclature

The applicable technical standard adopted by SLR for the project is the ASC system (Isbell, 2002). This is the standard nomenclature routinely used as the soil classification system in Australia.



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Soil Survey Sites

FIGURE 5

3.2 Soil Survey Results

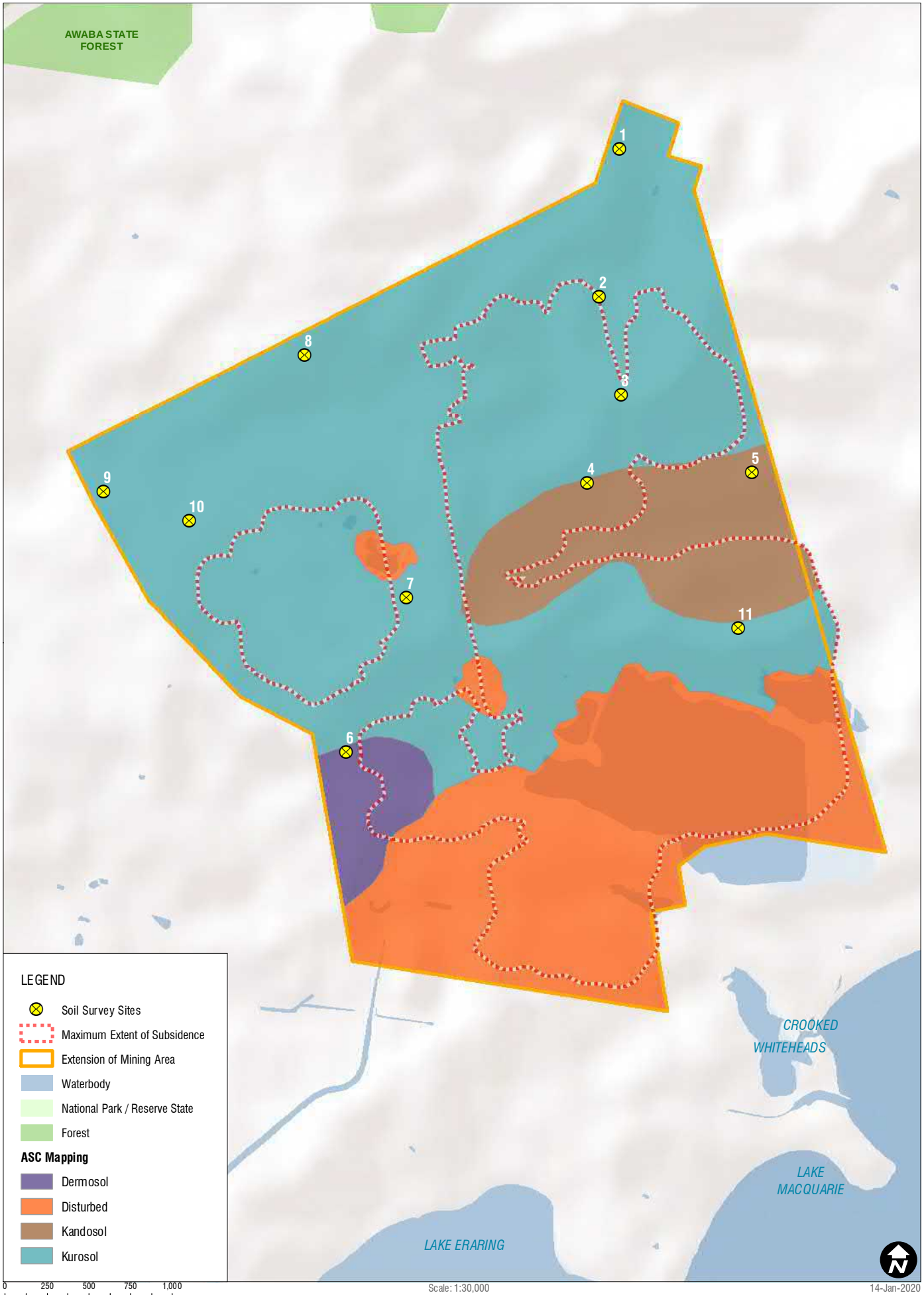
Within the Study Area three dominant Australia Soil Classification (ASC) soil map units were identified, shown on **Figure 6**. Four soil types are present in the Study Area: Kurosols, Kandosols, Dermosols and Disturbed Terrain (Anthroposols). These are summarised in **Table 5** and the major points listed below.

- Kurosols are the major soil type within the Study Area. Kurosols are soils with a strong texture contrast between the A horizon and a strongly acidic B horizon. Kurosols generally have moderately low inherent fertility.
- Kandosols are soils which lack strong texture contrast, have massive or only weakly structured B horizons, and are not calcareous throughout. Kandosols generally have moderately low inherent fertility.
- 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.
- Disturbed Terrain includes areas of infrastructure, dams and Anthroposols. Anthroposols are soils that have resulted from human activities which have led to a profound modification, truncation or burial of the original soil horizons, or creation of new soil parent materials by a variety of mechanical means.

Table 5 Soil Map Units

Soil Map Unit	ASC	Study Area	
		Hectares	%
1	Kurosol	874	61
2	Kandosol	149	10
3	Dermosol	44	3
4	Disturbed Terrain (Anthroposol)	379	26
	Total	**1,446**	**100**

Representative profile descriptions for each of the three soil types follow **Figure 6** with profile descriptions for all detailed sites given in **Appendix B**. Soil stripping criteria as shown in **Appendix c**.



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ASC Mapping

FIGURE 6

3.2.1 Soil Unit 1: Kurosol

Magnesic Red Kurosol

Table 6 Summary: Magnesic Red Kurosol (Site 2)

Overview	
	
Landscape Site 2	
ASC Name	Magnesic Red Kurosol
Representative Site	Site 2
Other Mapped Sites	1, 3, 7, 8, 9, 10, 11
Survey Type	Detailed
Dominant Topography	Cutting
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Spotted gum, turpentine
Inherent Soil Fertility	Moderately Low
Slope (%)	7
Aspect	East

Table 7 Profile: Magnesic Red Kurosol (Site 2)

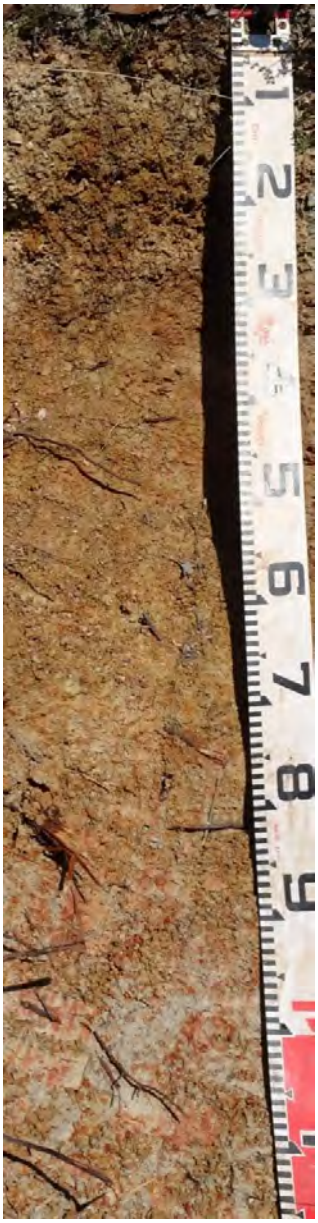
Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Brown (10YR 5/3) silty loam, weak structured 5-10 mm blocky peds with weak consistence and a rough fabric. Nil mottling, 30% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.0 – 0.10
	B21 0.10 – 0.30	Red (2.5YR 5/8) heavy clay, moderately structured 10-20 mm blocky peds with moderate consistence and a rough fabric. 20% distinct red mottles, 5% gravel 10 mm, nil segregations, course roots common. Well drained with a gradual and even boundary. Sampled 0.20 – 0.30
	B22 0.30 – 0.60	Light red (2.5YR 6/8) heavy clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. 30% distinct red mottles, 10% gravel 10 mm, nil segregations, coarse roots common. Poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50
	B23 +0.60	Pink (2.5YR 8/4) silty clay, massive structure. 30% distinct red mottles, 50% gravel 5 mm, nil segregations, coarse roots common. Poorly drained, layer continues beyond sample depth. Sampled 0.65 – 0.75

Table 8 Chemical Parameters: Magnesic Red Kurosol (Site 2)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.0	Very Strongly Acidic	4.3	Non sodic	0.6	Non-saline	0.8	Ca deficient
B21	5.0	Very Strongly Acidic	2.4	Non sodic	0.3	Non-saline	0.1	Ca deficient
B22	4.9	Very Strongly Acidic	2.0	Non sodic	0.2	Non-saline	0.0	Ca deficient
B23	4.8	Very Strongly Acidic	2.2	Non sodic	0.3	Non-saline	0.0	Ca deficient

3.2.2 Soil Unit 2: Kandosol

Magnesic Red Kandosol

Table 9 Summary: Magnesic Red Kandosol (Site 5)

Overview	
	
Landscape Site 5	
ASC Name	Magnesic Red Kandosol
Representative Site	Site 5
Other Mapped Sites	4
Survey Type	Detailed
Dominant Topography	Plateau
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Casuarina, red gum, grass tree
Inherent Soil Fertility	Moderately Low
Slope (%)	7
Aspect	Nil

Table 10 Profile: Magnesic Red Kandosol (Site 5)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Brown (10YR 5/3) loamy sand, apedal structured. Nil mottling, 25% gravel 10-40 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.0 – 0.10
	B2 0.20 – 0.40	Light red (2.5YR7/6) loam, moderately structured 20-40 mm subangular blocky peds with moderate consistence and a rough fabric. 10% faint grey mottles, <5% gravel 10-40 mm, nil segregations, coarse roots common. Poorly drained with a gradual and even boundary. Sampled 0.25 – 0.35
	BC +0.40	Weathered parent material Not sampled

Table 11 Chemical Parameters: Magnesic Red Kandosol (Site 5)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.0	Very Strongly Acidic	3.1	Non sodic	0.6	Non-saline	0.4	Ca deficient
B2	5.5	Strongly Acidic	3.7	Non sodic	0.2	Non-saline	0.0	Ca deficient

3.2.3 Soil Unit 3: Dermosol

Eutrophic Grey Dermosol

Table 12 Summary: Eutrophic Grey Dermosol (Site 6)

Overview	
	
Landscape Site 6	
ASC Name	Eutrophic Grey Dermosol
Representative Site	Site 6
Other Mapped Sites	Nil
Survey Type	Detailed
Dominant Topography	Upper Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Red gum, grass tree, turpentine
Inherent Soil Fertility	Moderately Low
Slope (%)	5
Aspect	South East

Table 13 Profile: Eutrophic Grey Dermosol (Site 6)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Very dark grey (7.5YR 3/1) loamy sand, apedal structure. Nil mottling, 25% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.0 – 0.10
	B21 0.20 – 0.40	Dark grey (10YR 4/1) silty loam, moderately structured 5-10 mm blocky peds with moderate consistence and a rough fabric. Nil mottling, 25% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.20 – 0.30
	B22 0.40 – 0.60	Light yellowish-brown (2.5YR 6/3) silty loam, moderately structured 10-20 mm blocky peds with moderate consistence and a rough fabric. Nil mottling, 10% gravel 10 mm, nil segregations, coarse roots common. Well drained with a gradual and even boundary. Sampled 0.40 – 0.50
	B23 0.60 – 0.90	Pale olive (5Y 6/3) silty loam, moderately structured 5-10 mm blocky peds with moderate consistence and a rough fabric. Nil mottling, 20% gravel 10 mm, nil segregations, coarse roots common. Well drained with a clear and even boundary. Sampled 0.65 – 0.75
	BC +0.90	Weathered parent material Not sampled

Table 14 Chemical Parameters: Eutrophic Grey Dermosol (Site 6)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	4.8	Very Strongly Acidic	3.4	Non sodic	0.8	Non-saline	1.8	Ca low
B21	5.1	Strongly Acidic	1.6	Non sodic	0.1	Non-saline	2.2	Ca low
B22	5.1	Strongly Acidic	2.4	Non sodic	0.1	Non-saline	2.0	Ca low
B23	5.1	Strongly Acidic	5.2	Non sodic	0.2	Non-saline	2.0	Ca low

4 Land and Soil Capability

4.1 Land and Soil Capability Methodology

The 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) (referred to as the LSC Guideline). 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 15** and their definition is 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 15 Land and Soil Capability Classification

Class	Land and Soil Capability
Land capable of a wide variety of land uses (cropping, grazing, horticulture, forestry, nature conservation)	
1	**Extremely high capability land**: Land has no limitations. No special land management practices required. Land capable of all rural land uses and land management practices.
2	**Very high capability land**: Land has slight limitations. These can be managed by readily available, easily implemented management practices. Land is capable of most land uses and land management practices, including intensive cropping with cultivation.
3	**High capability land**: Land has moderate limitations and is capable of sustaining high-impact land uses, such as cropping with cultivation, using more intensive, readily available and widely accepted management practices. However, careful management of limitations is required for cropping and intensive grazing to avoid land and environmental degradation.
Land capable of a variety of land uses (cropping with restricted cultivation, pasture cropping, grazing, some horticulture, forestry, nature conservation)	
4	**Moderate capability land**: Land has moderate to high limitations for high-impact land uses. Will restrict land management options for regular high-impact land uses such as cropping, high-intensity grazing and horticulture. These limitations can only be managed by specialised management practices with a high level of knowledge, expertise, inputs, investment and technology.
5	**Moderate–low capability land**: Land has high limitations for high-impact land uses. Will largely restrict land use to grazing, some horticulture (orchards), forestry and nature conservation. The limitations need to be carefully managed to prevent long-term degradation.
Land capable for a limited set of land uses (grazing, forestry and nature conservation, 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)	

Class	Land and Soil Capability
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.

4.1.1 Assessing LSC Classes

The biophysical features of the land that are associated with various hazards are broadly soil, climate and landform and more specifically: slope, landform position, acidity, salinity, drainage, rockiness; and climate.

The eight hazards associated with these biophysical features that are assessed by the scheme are:

1. Water erosion
2. Wind erosion
3. Soil structure decline
4. Soil acidification
5. Salinity
6. Water logging
7. Shallow soils and rockiness
8. Mass movement

Each hazard is assessed against set criteria tables, as described in the LSC Guideline; each hazard for the land is ranked from 1 through to 8 with the overall ranking of the land determined by its most significant limitation.

Hazard 1: Water Erosion

The Study Area lies within the Eastern and Central NSW Division, and the appropriate criteria for this division were used in the assessment. Assessment of water erosion hazard is almost solely dependent on the slope percentage of the land, based on each Soil Landscape Unit. The only exception is land which falls within the slope range of 10-20%, which may be designated LSC Class 4 or LSC Class 5 depending on the presence of gully erosion and/or sodic/dispersible soils.

Hazard 2: Wind Erosion

There are four factors used to assess wind erosion hazard for each soil type. Three criteria were assessed to be consistent for each soil type:

- Wind erosive power for the Study Area has been mapped as “Moderate” (NSW Department of Trade and Investment);
- Exposure of the land to wind was also determined to be “Moderate” throughout the Study Area; and
- The average rainfall for the region is 1,121 millimetres (BOM, 2015), and therefore the Study Area lies within the “greater than 500 millimetres rainfall” category.

The determining factor with regard to wind erosion hazard was therefore the erodibility of each soil type as determined by soil texture according the LSC Guideline.

Hazard 3: Soil Structure Decline

Soil structure decline is assessed on soil characteristics, including surface soil texture, sodicity (laboratory tested) and degree of self-mulching (field tested). These parameters assess the soil structure, stability and resilience of the soil.

Hazard 4: Soil Acidification

The soil acidification hazard is assessed using three criteria, being soil buffering capacity, pH and mean annual rainfall. In this assessment, soil buffering capacity was based on soil Great Soil Group; surface soil pH and a regional mean annual rainfall range of greater than 900 millimetres.

Hazard 5: Salinity

The salinity hazard is determined through a range of data and criteria. The recharge and discharge potential for the site was determined based on an average annual rainfall of 1,123 millimetres, with annual evaporation of 1,172 millimetres (BoM, 2015), giving a moderate recharge potential and low discharge potential.

The Study Area according to the Salt Store Map of NSW, is located in an area of low salt store. However, due the current available scale of this mapping, laboratory tested salinity (ECe) values were used to determine salt store.

Hazard 6: Water Logging

Water logging was determined by the soils drainage characteristics, specifically field sample evidence of mottling, soil texture attributes as well as slope and climate.

Hazard 7: Shallow Soils and Rockiness

The shallow soils and rockiness hazard is determined by an estimated exposure of rocky outcrops and average soil depth.

Hazard 8: Mass Movement

The mass movement hazard is assessed through a combination of three criteria; mean annual rainfall, presence of mass movement and slope class.

4.2 Land & Soil Capability Assessment

As listed in **Table 16**, the pre-disturbance Study Area has been classified into LSC Class 4, 5 and 6.

Table 16 Land & Soil Capability Classification

Soil Type		Hazard Criteria								
Site	ASC Name	1	2	3	4	5	6	7	8	LSC
Soil Unit 1										
1	Magnesic-Natric Brown Kurosol	3	3	3	6	1	3	1	1	**6**
2	Magnesic Red Kurosol	3	2	3	4	1	3	1	1	**4**
7	Magnesic Grey Kurosol	3	5	3	4	1	3	1	1	**5**
8	Magnesic Grey Kurosol	3	3	3	4	1	3	3	1	**4**
10	Magnesic Yellow Kurosol	3	2	3	4	1	3	1	1	**4**
11	Magnesic Red Kurosol	3	2	3	4	1	3	1	1	**4**
Soil Unit 2										
4	Magnesic Yellow Kandosol	3	3	3	4	1	3	6	1	**6**
5	Magnesic Red Kandosol	3	3	3	4	1	3	6	1	**6**
Soil Unit 3										
6	Eutrophic Grey Dermosol	3	5	3	4	1	2	3	1	**5**

The limitations associated with each LSC Class are discussed below and the land area of each LSC Class is shown in **Table 17** and **Figure 7**.

Table 17 Land & Soil Capability Classes

Land and Soil Capability	Study Area		Agricultural Capability Rating
Class	Hectares	%	
4	682	47	Moderate
5	85	6	Moderately Low
6	300	21	Low
Disturbed Terrain	379	26	Nil
Total	**1,446**	**100**	

LSC Class 4 Land

Class 4 land is characterised by soils on lower slopes and flats associated with Soil Map Unit 1 – Kurosol. This classification indicates that the land is moderately capable for a range of land uses, and specialised practices are necessary to overcome very severe limitations. The primary constraint to this land class is soil acidification.

LSC Class 5 Land

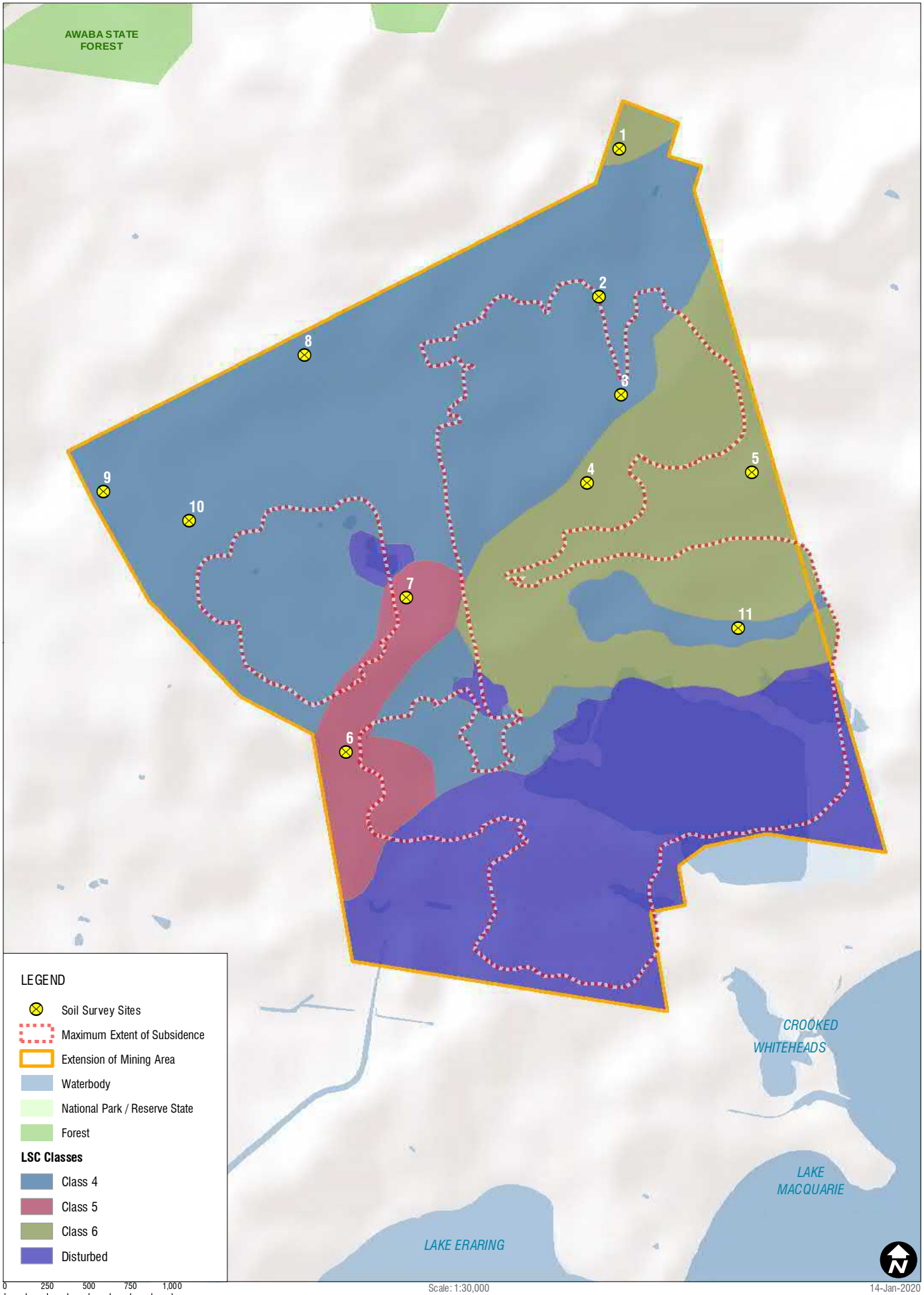
Class 5 land is represented by areas of Soil Map Unit 1 and 3. This classification indicates a moderate to low land capability, with severe limitations to high impact land management uses such as cropping. This land is generally more suitable for grazing with some limitations, or very occasional cultivation for pasture establishment. The primary constraints to this land class are steep slopes (water erosion hazard) and wind erosion.

LSC Class 6 Land

Class 6 land is represented by Soil Map Unit 2. This classification indicates low capability land with 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, it is considered capable for a limited set of land uses such as grazing, forestry, nature conservation and some horticulture. The primary constraint to this land class is steep slopes, soil depth and soil acidification.

Disturbed Terrain

Disturbed Terrain has no agricultural capability rating.



LSC Classes

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FIGURE 7

4.3 Post Disturbance Land Assessment

4.3.1 Subsidence and Remnant Ponding

As outlined in the *Newstan Mine Extension Project Flood Impact Assessment* (EMM, 2019), the assessment of the predicted subsidence identified an additional 2 hectares of remnant ponding will be experienced under subsidence conditions (**Figure 8**). Changes to remnant ponding were primarily around existing waterbodies with minor areas within native bushland areas. Furthermore, the extent of flood inundation is similar to existing conditions with new areas of flooding and areas that no longer experience flooding, generally evenly distributed. Depth changes of greater than 50 millimetres typically occur in isolated areas or in reaches where the predicted subsidence contours are adjacent to the watercourse.

As a result of predicted subsidence there will be approximately 2 hectares of additional remnant ponding.

4.3.2 Post-Mining Land Use

Post-mining land use will be comparable with pre-mining land uses, with only approximately 2 hectares of additional remnant ponding across the Study Area. The majority of predicted remnant ponding will occur in native bushland areas (**Figure 8**) and all within the maximum extent of subsidence. The project will require an additional 0.32 hectares of vegetation clearing to facilitate the construction of additional infrastructure at the Awaba Colliery Surface Site (**Figure 1**). This area is not used for agricultural production, being native bushland.
There will be negligible change in post-mining land use to the Study Area and surrounds.

4.3.3 Post-Disturbance Land & Soil Capability Assessment

The post-disturbance LSC classes determined for the Study Area are anticipated to be the same as the pre-disturbance classes. Due to the nature of the project, the only surface impacts likely to impact on the classification of land resources are associated with surface water ponding and increases in overbank flood events as a result of subsidence. Surface water ponding can limit agricultural capability of the land, whereas increased flooding can result in waterlogging of soils.

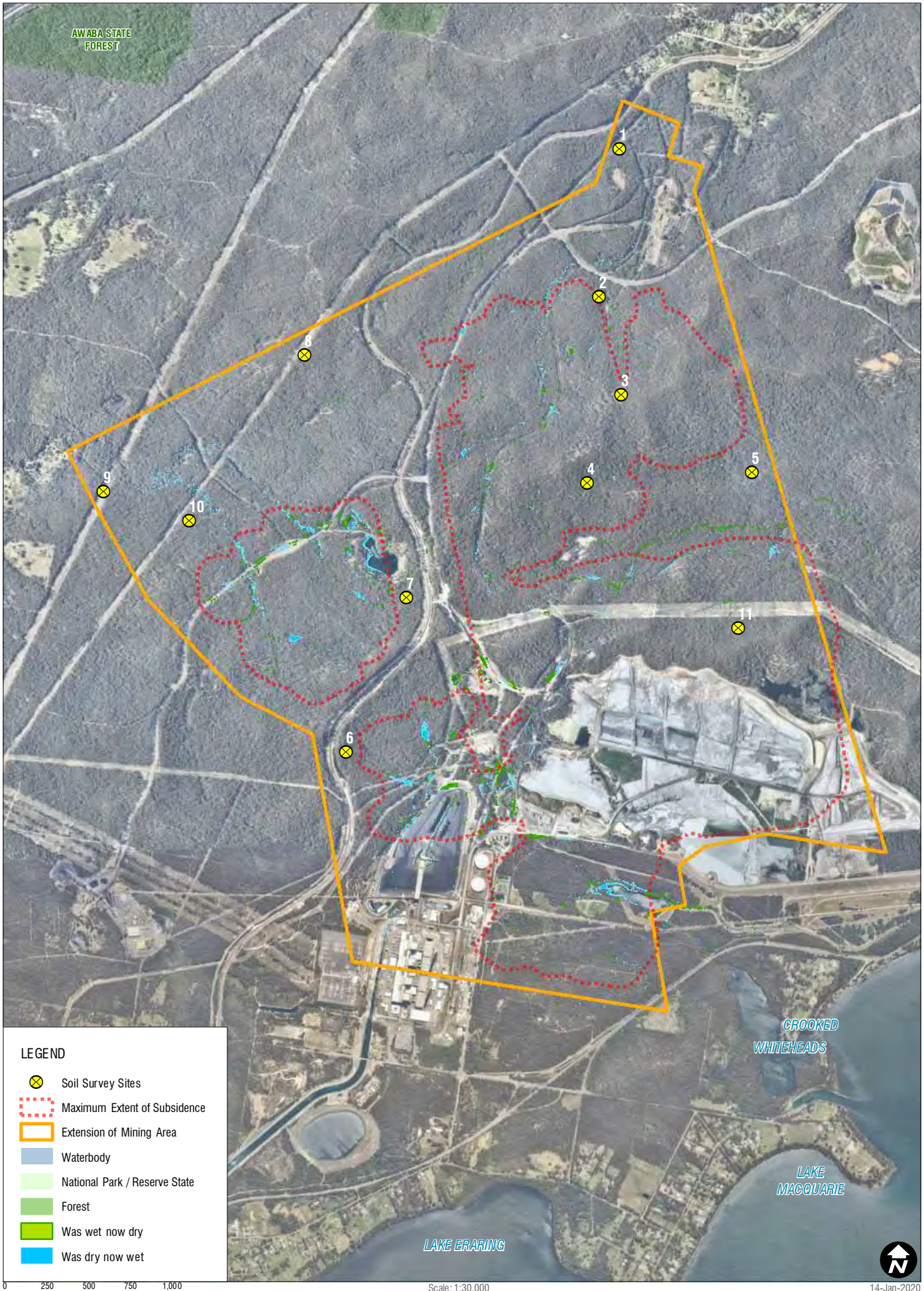
Land impacted by additional remnant ponding (2 hectares) within the Study Area is LSC class 4 and 5 or within areas of disturbed terrain. Areas previously classified as LSC 4 or 5 will now be classified as Class 8 land.

LSC Class 8 Land indicates that the land has serve limitation that make the land incapable of sustaining any land use apart from nature conservation. The primary limitation of LSC Class 8 is waterlogging.

The utilisation of the existing Awaba Colliery Surface Site infrastructure area will result in no changes to the existing LSC classes due to construction and operation of surface facilities associated with the project.

4.3.4 Impact to Agricultural Resources

As the project will have comparable post-mining land use and the minor changes to LSC do not occur on land used for agricultural production there will be negligible impact from the project on agricultural resources or enterprises.



H:\Projects-SLR\630-SYD\TL\630.NTL\630.12856 Newstan Extension Soils & AIS\06 SLR Data\01 CAD\GIS\ArcGIS\SLR630.12856_08 Remnant Ponding_02.mxd

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Remnant Ponding

FIGURE 8

5 Disturbance Management

Impacts of the proposed Newstan Colliery Extension of Mining Project on vegetation and soil resources within the Study Area are expected to be negligible due to the utilisation of the existing Awaba Colliery Surface Site infrastructure area. Therefore, minimal vegetation clearing, or topsoil stripping will result from the Project.

Soils that are subject to surface disturbance for infrastructure or subsidence remediation should be managed in order to minimise impact and ensure appropriate rehabilitation of the disturbed areas can be undertaken. Surface cracking has the potential to cause long term erosion problems, which may be exacerbated by the sodic nature of several of the soil types throughout the Study Area, specifically the Kurosols with sodic B horizons.

It is recommended that a Construction Environmental Management Plan (CEMP) be prepared for the project prior to the commencement of any construction activities. The CEMP should include protocols for topsoil stripping, soil stockpile management and erosion and sediment control.

6 Summary

This Soil and Land Resource Assessment for the project has been based on the findings of a field investigation and a desktop review of reference information. The findings of the study include the following:

- Soils types within the Study Area – soils are varied , being dominated by texture contrast soils (Kurosols) with smaller areas of gradational soils (Dermosols and Kandosols).
- Land Assessment – The Study Area was been assessed for LSC pre and post-mining in accordance with the LSC Guideline.
- LSC classes within the Study Area range from Class 4 (moderately capable land), to Class 5 (moderately low capability land) and Class 6 (low capability land). Approximately 50% of the Study Area is classified as having a moderate agricultural capability.
- Findings from the *Newstan Mine Extension Project Flood Impact Assessment* (EMM, 2019) undertaken for the project indicate that an additional 2 hectares of remnant ponding will impact LSC Class 4 and Class 5 land.
- A CEMP should be prepared for the project prior to the commencement of any construction activities. The CEMP should include protocols for topsoil stripping, soil stockpile management and erosion and sediment control.
- The project will have negligible impact to soil and land resources within and surrounding the Study Area.
- The project will have negligible impact to agricultural resources or enterprises within and surrounding the Study Area.

7 References

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APPENDIX A

Laboratory Certificates of Analysis

Environmental Analysis Laboratory

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AGRICULTURAL SOIL ANALYSIS REPORT

30 samples supplied by SLR Consulting Australia Pty Ltd on 11/10/2019. Lab Job No.I6755
Analysis requested by Murray Fraser. Your Job: SLR 630.12856 Newstan Soils
10 Kings Rd NEW LAMBTON NSW 2305

	Parameter		Method reference	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
		Sample ID:		N1 0-10	N1 20-30	N1 40-50	N1 65-75	N2 0-10
		Crop:		Soil	Soil	Soil	Soil	Soil
		Client:		Newstan	Newstan	Newstan	Newstan	Newstan
				I6755/1	I6755/2	I6755/3	I6755/4	I6755/5
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	4.57	5.36	4.76	4.43	4.95
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.152	0.040	0.148	0.427	0.060
	Exchangeable Calcium	(cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.80	0.06	<0.05	0.50	0.70
		(kg/ha)		360	25	<22	224	316
		(mg/kg)		161	11	<10	100	141
	Exchangeable Magnesium	(cmol$_+$/kg)		1.5	0.87	4.9	6.8	0.83
		(kg/ha)		400	235	1,343	1,846	225
		(mg/kg)		178	105	599	824	100
	Exchangeable Potassium	(cmol$_+$/kg)		0.30	<0.12	0.18	0.25	0.35
		(kg/ha)		263	<112	157	223	307
		(mg/kg)		118	<50	70	100	137
	Exchangeable Sodium	(cmol$_+$/kg)		0.66	0.21	0.96	2.9	0.18
		(kg/ha)		340	109	495	1,472	93
		(mg/kg)		152	49	221	657	41
	Exchangeable Aluminium	(cmol$_+$/kg)	**Inhouse S37 (KCl)	2.1	1.1	7.0	9.8	1.7
		(kg/ha)		419	227	1,409	1,972	338
		(mg/kg)		187	102	629	880	151
	Exchangeable Hydrogen	(cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.24	<0.01	<0.01	<0.01	0.42
		(kg/ha)		5.5	<1	<1	<1	9.5
		(mg/kg)		2.4	<1	<1	<1	4.2
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	5.6	2.4	13	20	4.2
	Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	14	2.4	0.32	2.5	17
	Magnesium (%)			26	36	38	34	20
	Potassium (%)			5.4	4.8	1.4	1.3	8.4
	Sodium - ESP (%)			12	8.9	7.3	14	4.3
	Aluminium (%)			37	47	53	48	40
	Hydrogen (%)			4.4	0.00	0.00	0.00	10
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)	0.55	0.06	0.01	0.07	0.85
	Colour (Munsell Soil Colour Classification) - Hue/Colour		**Inhouse	10yr 5/1	7.5yr 5/1	10YR 5/3	10YR 6/3	10YR 5/3
	Colour (Munsell Soil Colour Classification) - Value/Chroma		**Inhouse	GREY	GREY	BROWN	PALE BROWN	BROWN
	Colour (Munsell Soil Colour Classification) - Mottle Hue, Value/Chroma		**Inhouse	..	..	2.5YR 4/8	2.5YR 4/8	..
	Colour (Munsell Soil Colour Classification)		**Inhouse	..	..	RED	RED	..
	Colour (Munsell Soil Colour Classification), Proportion %		**Inhouse	..	..	10	15	..

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AGRICULTURAL SOIL ANALYSIS REPORT

30 samples supplied by SLR Consulting Australia Pty Ltd on 11/10/2019. Lab Job No.I6755
Analysis requested by Murray Fraser. Your Job: SLR 630.12856 Newstan Soils
10 Kings Rd NEW LAMBTON NSW 2305

		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
	Sample ID:	N1 0-10	N1 20-30	N1 40-50	N1 65-75	N2 0-10
	Crop:	Soil	Soil	Soil	Soil	Soil
	Client:	Newstan	Newstan	Newstan	Newstan	Newstan
Parameter	Method reference	I6755/1	I6755/2	I6755/3	I6755/4	I6755/5

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimate
13. ** NATA accreditation does not cover the performance of this service.
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17. This report was issued on 16/10/2019.

NATA
WORLD RECOGNISED ACCREDITATION
Accreditation No. 14960
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Quality Checked: Kris Saville
Agricultural Co-Ordinator KS

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			Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
		Sample ID:	N2 20-30	N2 40-50	N2 65-75	N4 0-10	N4 25-35
		Crop:	Soil	Soil	Soil	Soil	Soil
		Client:	Newstan	Newstan	Newstan	Newstan	Newstan
	Parameter	Method reference	I6755/6	I6755/7	I6755/8	I6755/9	I6755/10
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	4.99	4.89	4.82	5.07	5.63
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.046	0.037	0.037	0.031	0.030
	Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.52	0.19	0.10	0.09	<0.05
	Exchangeable Calcium (kg/ha)		235	87	45	40	<22
	Exchangeable Calcium (mg/kg)		105	39	20	18	<10
	Exchangeable Magnesium (cmol$_+$/kg)		5.9	4.7	4.0	0.58	2.9
	Exchangeable Magnesium (kg/ha)		1,599	1,290	1,093	158	790
	Exchangeable Magnesium (mg/kg)		714	576	488	70	353
	Exchangeable Potassium (cmol$_+$/kg)		0.42	0.24	0.16	0.17	0.15
	Exchangeable Potassium (kg/ha)		364	206	141	149	132
	Exchangeable Potassium (mg/kg)		162	92	63	67	59
	Exchangeable Sodium (cmol$_+$/kg)		0.33	0.30	0.32	0.11	0.31
	Exchangeable Sodium (kg/ha)		170	156	165	55	161
	Exchangeable Sodium (mg/kg)		76	70	74	25	72
	Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	5.9	8.0	9.0	1.4	1.2
	Exchangeable Aluminium (kg/ha)		1,190	1,618	1,815	286	248
	Exchangeable Aluminium (mg/kg)		531	722	810	128	111
	Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.58	1.2	0.76	0.62	0.57
	Exchangeable Hydrogen (kg/ha)		13	26	17	14	13
	Exchangeable Hydrogen (mg/kg)		5.8	12	7.6	6.2	5.7
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	14	15	14	3.0	5.2
	Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	3.8	1.3	0.69	3.0	0.37
	Magnesium (%)		43	32	28	19	56
	Potassium (%)		3.1	1.6	1.1	5.7	2.9
	Sodium - ESP (%)		2.4	2.1	2.2	3.6	6.0
	Aluminium (%)		43	55	63	48	24
	Hydrogen (%)		4.2	7.9	5.3	21	11
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	0.09	0.04	0.02	0.15	0.01
	Colour (Munsell Soil Colour Classification) - Hue/Colour	**Inhouse	2.5YR 5/8	2.5YR 6/8	2.5YR 8/4	10YR 5/3	10YR 6/4
	Colour (Munsell Soil Colour Classification) - Value/Chroma	**Inhouse	RED	LIGHT RED	RED	BROWN	LIGHT YELLOW BROWN
	Colour (Munsell Soil Colour Classification) - Mottle Hue, Value/Chroma	**Inhouse	..	..	10YR 5/2	..	7YR 5/8
	Colour (Munsell Soil Colour Classification)	**Inhouse	..	..	GREY BROWN	..	Strong Brown
	Colour (Munsell Soil Colour Classification), Proportion %	**Inhouse	..	..	15	..	15

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Analysis requested by Murray Fraser. Your Job: SLR 630.12856 Newstan Soils
10 Kings Rd NEW LAMBTON NSW 2305

			Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
		Sample ID:	N2 20-30	N2 40-50	N2 65-75	N4 0-10	N4 25-35
		Crop:	Soil	Soil	Soil	Soil	Soil
		Client:	Newstan	Newstan	Newstan	Newstan	Newstan
	Parameter	Method reference	I6755/6	I6755/7	I6755/8	I6755/9	I6755/10

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium,
    122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimat
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	Parameter		Method reference	Sample 11 N5 0-10 Soil Newstan I6755/11	Sample 12 N5 25-35 Soil Newstan I6755/12	Sample 13 N6 0-10 Soil Newstan I6755/13	Sample 14 N6 20-30 Soil Newstan I6755/14	Sample 15 N6 40-50 Soil Newstan I6755/15
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	4.95	5.50	4.83	5.06	5.06
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.024	0.022	0.036	0.015	0.013
	Exchangeable Calcium	**(cmol$_+$/kg)**	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.15	<0.05	0.63	0.24	0.10
		(kg/ha)		68	<22	282	107	46
		(mg/kg)		30	<10	126	48	20
	Exchangeable Magnesium	**(cmol$_+$/kg)**		0.38	2.4	0.35	0.11	0.05
		(kg/ha)		104	640	97	29	13
		(mg/kg)		46	286	43	13	5.7
	Exchangeable Potassium	**(cmol$_+$/kg)**		<0.12	<0.12	<0.12	<0.12	<0.12
		(kg/ha)		<112	<112	<112	<112	<112
		(mg/kg)		<50	<50	<50	<50	<50
	Exchangeable Sodium	**(cmol$_+$/kg)**		0.09	0.15	0.11	<0.065	<0.065
		(kg/ha)		45	77	55	<33	<33
		(mg/kg)		20	34	25	<15	<15
	Exchangeable Aluminium	**(cmol$_+$/kg)**	**Inhouse S37 (KCl)	1.6	1.0	1.4	1.1	0.66
		(kg/ha)		327	207	282	213	134
		(mg/kg)		146	92	126	95	60
	Exchangeable Hydrogen	**(cmol$_+$/kg)**	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.62	0.46	0.66	0.35	0.33
		(kg/ha)		14	10	15	7.9	7.5
		(mg/kg)		6.2	4.6	6.6	3.5	3.3
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	2.9	4.1	3.2	1.8	1.2
	Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	5.1	0.63	19	13	8.2
	Magnesium (%)			13	58	11	5.8	3.8
	Potassium (%)			2.7	1.5	2.6	1.3	3.6
	Sodium - ESP (%)			3.0	3.7	3.3	3.2	4.3
	Aluminium (%)			55	25	43	58	53
	Hydrogen (%)			21	11	20	19	27
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)	0.39	0.01	1.8	2.3	2.2
	Colour (Munsell Soil Colour Classification) - Hue/Colour		**Inhouse	10YR 5/3	2.5YR 7/6	7.5YR 3/1	10YR 4/1	2.5Y 6/3
	Colour (Munsell Soil Colour Classification) - Value/Chroma		**Inhouse	BROWN	YELLOW	VERY DARK GREY	DARK GREY	LIGHT YELLOWISH BROWN
	Colour (Munsell Soil Colour Classification) - Mottle Hue, Value/Chroma		**Inhouse	..	..	..	..	..
	Colour (Munsell Soil Colour Classification)		**Inhouse	..	..	..	..	..
	Colour (Munsell Soil Colour Classification), Proportion %		**Inhouse	..	..	..	..	..

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Analysis requested by Murray Fraser. Your Job: SLR 630.12856 Newstan Soils
10 Kings Rd NEW LAMBTON NSW 2305

		Sample 11	Sample 12	Sample 13	Sample 14	Sample 15
	Sample ID:	N5 0-10	N5 25-35	N6 0-10	N6 20-30	N6 40-50
	Crop:	Soil	Soil	Soil	Soil	Soil
	Client:	Newstan	Newstan	Newstan	Newstan	Newstan
	Parameter / Method reference	I6755/11	I6755/12	I6755/13	I6755/14	I6755/15

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
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11. Conversions to kg/ha = mg/kg x 2.24
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	Parameter		Method reference	Sample 16	Sample 17	Sample 18	Sample 19	Sample 20
	Sample ID:			N6 65-75	N7 0-10	N7 30-40	N7 65-75	N8 0-10
	Crop:			Soil	Soil	Soil	Soil	Soil
	Client:			Newstan	Newstan	Newstan	Newstan	Newstan
				I6755/16	I6755/17	I6755/18	I6755/19	I6755/20
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.13	5.14	4.99	4.93	4.89
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.016	0.029	0.037	0.042	0.048
	Exchangeable Calcium	(cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.12	0.19	0.13	<0.05	0.30
		(kg/ha)		55	87	59	<22	137
		(mg/kg)		24	39	26	<10	61
	Exchangeable Magnesium	(cmol$_+$/kg)		0.06	1.3	4.5	4.2	0.88
		(kg/ha)		18	347	1,222	1,138	239
		(mg/kg)		7.9	155	545	508	107
	Exchangeable Potassium	(cmol$_+$/kg)		<0.12	0.32	0.52	0.41	0.20
		(kg/ha)		<112	279	459	361	178
		(mg/kg)		<50	124	205	161	79
	Exchangeable Sodium	(cmol$_+$/kg)		0.08	0.15	0.52	0.73	0.17
		(kg/ha)		39	79	269	376	86
		(mg/kg)		18	35	120	168	38
	Exchangeable Aluminium	(cmol$_+$/kg)	**Inhouse S37 (KCl)	0.81	3.1	13	13	3.4
		(kg/ha)		164	623	2,716	2,582	681
		(mg/kg)		73	278	1,213	1,153	304
	Exchangeable Hydrogen	(cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.41	<0.01	0.46	<0.01	<0.01
		(kg/ha)		9.2	<1	10	<1	<1
		(mg/kg)		4.1	<1	4.6	<1	<1
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	1.5	5.0	20	18	4.9
	Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	7.9	3.8	0.67	0.17	6.2
	Magnesium (%)			4.2	25	23	23	18
	Potassium (%)			3.6	6.3	2.7	2.3	4.1
	Sodium - ESP (%)			4.9	3.0	2.7	4.0	3.4
	Aluminium (%)			53	61	69	71	69
	Hydrogen (%)			27	0.00	2.4	0.00	0.00
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)	1.9	0.15	0.03	0.01	0.35
	Colour (Munsell Soil Colour Classification) - Hue/Colour		**Inhouse	5Y 6/3	7.5YR 3/1	2.5Y 6/3	10YR 6/2	10YR 5/2
	Colour (Munsell Soil Colour Classification) - Value/Chroma		**Inhouse	PALE OLIVE	VERY DARK GREY	LIGHT YELLOWISH BROWN	LIGHT BROWNISH GREY	GREYISH BROWN
	Colour (Munsell Soil Colour Classification) - Mottle Hue, Value/Chroma		**Inhouse	..	..	10YR 6/8	..	..
	Colour (Munsell Soil Colour Classification)		**Inhouse	..	..	Brownish yellow	..	..
	Colour (Munsell Soil Colour Classification), Proportion %		**Inhouse	..	..	40	..	..

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			Sample 16	Sample 17	Sample 18	Sample 19	Sample 20
		Sample ID:	N6 65-75	N7 0-10	N7 30-40	N7 65-75	N8 0-10
		Crop:	Soil	Soil	Soil	Soil	Soil
		Client:	Newstan	Newstan	Newstan	Newstan	Newstan
	Parameter	Method reference	I6755/16	I6755/17	I6755/18	I6755/19	I6755/20

Notes:

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3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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	Parameter		Method reference	Sample 21 N8 20-30 Soil Newstan I6755/21	Sample 22 N8 40-50 Soil Newstan I6755/22	Sample 23 N8 65-75 Soil Newstan I6755/23	Sample 24 N10 0-10 Soil Newstan I6755/24	Sample 25 N10 30-40 Soil Newstan I6755/25
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	5.17	5.14	5.08	5.15	5.44
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.032	0.050	0.075	0.016	0.036
	Exchangeable Calcium	(cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	0.15	<0.05	<0.05	0.12	<0.05
		(kg/ha)		66	<22	<22	56	<22
		(mg/kg)		29	<10	<10	25	<10
	Exchangeable Magnesium	(cmol$_+$/kg)		1.0	3.5	3.7	0.35	6.4
		(kg/ha)		278	961	1,004	95	1,752
		(mg/kg)		124	429	448	42	782
	Exchangeable Potassium	(cmol$_+$/kg)		0.18	0.24	0.27	<0.12	0.28
		(kg/ha)		162	214	233	<112	242
		(mg/kg)		72	95	104	<50	108
	Exchangeable Sodium	(cmol$_+$/kg)		0.13	0.29	0.41	<0.065	0.28
		(kg/ha)		67	152	213	<33	144
		(mg/kg)		30	68	95	<15	64
	Exchangeable Aluminium	(cmol$_+$/kg)	**Inhouse S37 (KCl)	2.2	3.8	3.1	1.5	1.1
		(kg/ha)		452	764	629	298	221
		(mg/kg)		202	341	281	133	99
	Exchangeable Hydrogen	(cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	<0.01	0.13	0.29	0.32	0.35
		(kg/ha)		<1	3.0	6.5	7.1	7.9
		(mg/kg)		<1	1.3	2.9	3.2	3.5
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	3.7	8.0	7.8	2.4	8.5
	Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	3.9	0.33	0.07	5.2	0.26
	Magnesium (%)			27	44	47	14	76
	Potassium (%)			5.0	3.0	3.4	3.5	3.3
	Sodium - ESP (%)			3.5	3.7	5.3	2.2	3.3
	Aluminium (%)			60	47	40	61	13
	Hydrogen (%)			0.00	1.7	3.7	13	4.2
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)	0.14	0.01	0.00	0.36	0.00
	Colour (Munsell Soil Colour Classification) - Hue/Colour		**Inhouse	2.5Y 4/2	5Y 6/3	2.5Y 6/3	2.5Y 5/3	10YR 7/8
	Colour (Munsell Soil Colour Classification) - Value/Chroma		**Inhouse	DARK GREYISH BROWN	PALE OLIVE	LIGHT YELLOW BROWN	LIGHT OLIVE	YELLOW
	Colour (Munsell Soil Colour Classification) - Mottle Hue, Value/Chroma		**Inhouse	..	2.5Y 6/8	10YR 7/8	..	..
	Colour (Munsell Soil Colour Classification)		**Inhouse	..	OLIVE YELLOW	YELLOW	..	..
	Colour (Munsell Soil Colour Classification), Proportion %		**Inhouse	..	30	20	..	..

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Analysis requested by Murray Fraser. Your Job: SLR 630.12856 Newstan Soils
10 Kings Rd NEW LAMBTON NSW 2305

			Sample 21	Sample 22	Sample 23	Sample 24	Sample 25
		Sample ID:	N8 20-30	N8 40-50	N8 65-75	N10 0-10	N10 30-40
		Crop:	Soil	Soil	Soil	Soil	Soil
		Client:	Newstan	Newstan	Newstan	Newstan	Newstan
	Parameter	Method reference	I6755/21	I6755/22	I6755/23	I6755/24	I6755/25

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium,
    122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimat
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Agricultural Co-Ordinator KS

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			Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
		Sample ID:	N10 65-75	N11 0-10	N11 20-30	N11 40-50	N11 65-75
		Crop:	Soil	Soil	Soil	Soil	Soil
		Client:	Newstan	Newstan	Newstan	Newstan	Newstan
	Parameter	Method reference	I6755/26	I6755/27	I6755/28	I6755/29	I6755/30
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	4.92	4.84	5.19	5.02	4.85
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.048	0.031	0.033	0.035	0.049
	Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	<0.05	0.23	0.14	<0.05	<0.05
	Exchangeable Calcium (kg/ha)		<22	101	61	<22	<22
	Exchangeable Calcium (mg/kg)		<10	45	27	<10	<10
	Exchangeable Magnesium (cmol$_+$/kg)		3.9	1.7	3.7	2.8	2.1
	Exchangeable Magnesium (kg/ha)		1,067	457	1,007	774	577
	Exchangeable Magnesium (mg/kg)		476	204	450	346	258
	Exchangeable Potassium (cmol$_+$/kg)		0.13	0.18	0.30	0.28	0.22
	Exchangeable Potassium (kg/ha)		112	156	262	245	190
	Exchangeable Potassium (mg/kg)		50	69	117	109	85
	Exchangeable Sodium (cmol$_+$/kg)		0.31	0.12	0.30	0.32	0.45
	Exchangeable Sodium (kg/ha)		161	64	152	164	231
	Exchangeable Sodium (mg/kg)		72	29	68	73	103
	Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	4.8	3.1	9.7	9.8	9.6
	Exchangeable Aluminium (kg/ha)		975	620	1,952	1,972	1,945
	Exchangeable Aluminium (mg/kg)		435	277	871	880	868
	Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	1.1	0.85	<0.01	<0.01	<0.01
	Exchangeable Hydrogen (kg/ha)		25	19	<1	<1	<1
	Exchangeable Hydrogen (mg/kg)		11	8.5	<1	<1	<1
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	10	6.1	14	13	12
	Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	0.19	3.7	0.96	0.28	0.20
	Magnesium (%)		38	27	26	21	17
	Potassium (%)		1.2	2.9	2.1	2.1	1.7
	Sodium - ESP (%)		3.0	2.0	2.1	2.4	3.6
	Aluminium (%)		47	50	69	74	77
	Hydrogen (%)		11	14	0.00	0.00	0.00
	Calcium/Magnesium Ratio	**Calculation: Calcium / Magnesium (cmol$_+$/kg)	0.00	0.13	0.04	0.01	0.01
	Colour (Munsell Soil Colour Classification) - Hue/Colour	**Inhouse	7.5YR 6/8	7.5YR 5/2	5YR 4/6	7.5YR 6/1	2.5YR 7/1
	Colour (Munsell Soil Colour Classification) - Value/Chroma	**Inhouse	REDDISH YELLOW	BROWN	YELLOWISH RED	GREY	LIGHT REDDISH GREY
	Colour (Munsell Soil Colour Classification) - Mottle Hue, Value/Chroma	**Inhouse	7.5R 3/8	..	2.5YR 4/8	10YR 4/8	5R 3/4
	Colour (Munsell Soil Colour Classification)	**Inhouse	DARK RED	..	RED	RED	DUSKY RED
	Colour (Munsell Soil Colour Classification), Proportion %	**Inhouse	5	..	15	50	30

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10 Kings Rd NEW LAMBTON NSW 2305

		Sample 26	Sample 27	Sample 28	Sample 29	Sample 30
	Sample ID:	N10 65-75	N11 0-10	N11 20-30	N11 40-50	N11 65-75
	Crop:	Soil	Soil	Soil	Soil	Soil
	Client:	Newstan	Newstan	Newstan	Newstan	Newstan
	Parameter / Method reference	I6755/26	I6755/27	I6755/28	I6755/29	I6755/30

Notes:

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and LaMotte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium,
    122 mg/kg Magnesium, 200 mg/kg Calcium
11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimat
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Agricultural Co-Ordinator KS

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	Parameter		Method reference	Heavy Soil	Medium Soil	Light Soil	Sandy Soil
	Sample ID:						
	Crop:						
	Client:			*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter		**Method reference**	**Indicative guidelines - refer to Notes 6 and 8**			
	pH		Rayment & Lyons 2011 - 4A1 (1:5 Water)	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)		Rayment & Lyons 2011 - 3A1 (1:5 Water)	*0.200*	*0.150*	*0.120*	*0.100*
	Exchangeable Calcium	**(cmol$_+$/kg)**	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	*15.6*	*10.8*	*5.0*	*1.9*
		(kg/ha)		*7000*	*4816*	*2240*	*840*
		(mg/kg)		*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium	**(cmol$_+$/kg)**		*2.4*	*1.7*	*1.2*	*0.60*
		(kg/ha)		*650*	*448*	*325*	*168*
		(mg/kg)		*290*	*200*	*145*	*75*
	Exchangeable Potassium	**(cmol$_+$/kg)**		*0.60*	*0.50*	*0.40*	*0.30*
		(kg/ha)		*526*	*426*	*336*	*224*
		(mg/kg)		*235*	*190*	*150*	*100*
	Exchangeable Sodium	**(cmol$_+$/kg)**		*0.3*	*0.26*	*0.22*	*0.11*
		(kg/ha)		*155*	*134*	*113*	*57*
		(mg/kg)		*69*	*60*	*51*	*25*
	Exchangeable Aluminium	**(cmol$_+$/kg)**	**Inhouse S37 (KCl)	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		*121*	*101*	*73*	*30*
		(mg/kg)		*54*	*45*	*32*	*14*
	Exchangeable Hydrogen	**(cmol$_+$/kg)**	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		*13*	*11*	*8*	*3*
		(mg/kg)		*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)			*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)			*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)			*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)			*6.0*	*7.1*	*10.5*	*12.1*
	Hydrogen (%)						
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)	*6.5*	*6.4*	*4.2*	*3.2*
	Colour (Munsell Soil Colour Classification) - Hue/Colour		**Inhouse	..			
	Colour (Munsell Soil Colour Classification) - Value/Chroma		**Inhouse	..			
	Colour (Munsell Soil Colour Classification) - Mottle Hue, Value/Chroma		**Inhouse	..			
	Colour (Munsell Soil Colour Classification)		**Inhouse	..			
	Colour (Munsell Soil Colour Classification), Proportion %		**Inhouse	..			

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10 Kings Rd NEW LAMBTON NSW 2305

			Heavy Soil	Medium Soil	Light Soil	Sandy Soil
		Sample ID:				
		Crop:				
		Client:	Clay	Clay Loam	Loam	Loamy Sand
	Parameter	Method reference	Indicative guidelines - refer to Notes 6 and 8			
Notes:						

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to < 2 mm.
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods - Australasia.* CSIRO Publishing: Collingwo
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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5. Guidelines for phosphorus have been reduced for Australian soils.
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts.
7. Total Acid Extractable Nutrients indicate a store of nutrients.
8. National Environmental Protection (Assessment of Site Contamination) Measure 2013,
   Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil res
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium,
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11. Conversions to kg/ha = mg/kg x 2.24
12. The chloride calculation of Cl mg/L = EC x 640 is considered an estimate, and most likely an over-estimat
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GRAIN SIZE ANALYSIS (hydrometer techniques)

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SAMPLE ID	Lab Code	EMERSON DISPERSION CLASS (Emerson Aggregate Test)	MOISTURE CONTENT (% Moisture)	GRAVEL > 2 mm (%)	SAND > 50 µm USDA (< 2 mm fraction)	SAND > 20 µm ISSS (< 2 mm fraction)	SILT 2–50 µm USDA (< 2 mm fraction)	SILT 2–20 µm ISSS (< 2 mm fraction)	CLAY < 2 µm (< 2 mm fraction)
N1 0-10	i6755/1	3	7.8%	35.3%	61.0%	70.7%	33.9%	24.2%	5.1%
N1 20-30	i6755/2	3	6.1%	42.1%	55.5%	70.2%	37.1%	22.4%	7.4%
N1 40-50	i6755/3	4	23.9%	0.3%	12.9%	16.1%	19.4%	16.1%	67.7%
N1 65-75	i6755/4	4	22.9%	0.0%	10.6%	13.8%	24.6%	21.4%	64.8%
N2 0-10	i6755/5	3	4.1%	27.1%	52.7%	65.1%	34.1%	21.7%	13.2%
N2 20-30	i6755/6	4	20.3%	5.6%	21.0%	21.0%	12.2%	12.2%	66.8%
N2 40-50	i6755/7	4	24.9%	0.9%	18.5%	23.0%	10.4%	5.9%	71.1%
N2 65-75	i6755/8	4	20.5%	47.3%	10.8%	14.5%	25.0%	21.2%	64.3%
N4 0-10	i6755/9	3	13.4%	0.4%	72.0%	74.6%	22.2%	19.5%	5.9%
N4 25-35	i6755/10	3	16.3%	0.0%	63.8%	67.5%	14.5%	10.7%	21.7%
N5 0-10	i6755/11	3	10.6%	23.5%	80.7%	83.3%	13.7%	11.1%	5.6%
N5 25-35	i6755/12	4	15.8%	1.2%	65.1%	70.3%	17.6%	12.3%	17.4%
N6 0-10	i6755/13	3	13.2%	24.2%	73.6%	80.0%	24.2%	17.8%	2.2%
N6 20-30	i6755/14	3	10.8%	24.1%	72.9%	75.9%	25.1%	22.0%	2.1%
N6 40-50	i6755/15	3	11.9%	10.6%	69.2%	82.7%	28.2%	14.6%	2.7%
N6 65-75	i6755/16	3	10.8%	21.4%	61.9%	66.8%	30.7%	25.8%	7.4%
N7 0-10	i6755/17	3	14.7%	2.5%	65.9%	73.4%	32.3%	24.8%	1.8%
N7 30-40	i6755/18	3	21.1%	0.0%	21.5%	28.2%	34.7%	28.0%	43.8%
N7 65-75	i6755/19	3	18.9%	0.1%	26.0%	38.6%	34.3%	21.7%	39.7%
N8 0-10	i6755/20	3	11.4%	13.1%	62.1%	64.4%	27.1%	24.8%	10.8%
N8 20-30	i6755/21	3	11.4%	2.3%	60.7%	66.7%	27.8%	21.8%	11.4%
N8 40-50	i6755/22	4	20.9%	0.3%	45.0%	44.8%	10.5%	10.7%	44.5%
N8 65-75	i6755/23	4	17.6%	11.7%	38.8%	47.2%	32.2%	23.8%	29.0%
N10 0-10	i6755/24	3	11.2%	32.9%	40.7%	53.8%	43.9%	30.8%	15.4%
N10 30-40	i6755/25	4	20.3%	2.6%	38.9%	44.4%	21.8%	16.4%	39.2%
N10 65-75	i6755/26	4	19.6%	32.1%	25.0%	24.4%	20.9%	21.4%	54.2%
N11 0-10	i6755/27	3	11.6%	0.9%	55.9%	68.4%	28.9%	16.3%	15.2%
N11 20-30	i6755/28	4	20.2%	9.9%	31.3%	31.0%	18.6%	18.9%	50.1%
N11 40-50	i6755/29	4	21.4%	2.8%	43.7%	44.0%	19.9%	19.6%	36.5%
N11 65-75	i6755/30	4	18.2%	8.0%	33.0%	36.5%	17.8%	14.2%	49.3%

Note:

1: The Hydrometer Analysis method was used to determine the percentage sand, silt and clay,
modified from SOP meth004 (California Dept of Pesticide Regulation), using method of Gee & Bauder (1986),
in *Methods of Soil Analysis. Part 1* Agron. Monogr. 9 (2nd Ed). Klute, A., American Soc. of Agronomy Inc., Soil Sci. Soc. America Inc., Madison WI: 383-411.

2: All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions.
These Terms and Conditions are available on the EAL website: scu.edu.au/eal, or on request.

checked: .....
Graham Lancaster (Nata signatory)
Laboratory Manager

APPENDIX B

Detailed Site Descriptions

Soil Unit 1: Kurosol

Magnesic Brown Kurosol

Table 1 Summary: Magnesic Brown Kurosol (Site 1)

Overview	
 Landscape Site 1	
ASC Name	Magnesic Brown Kurosol
Representative Site	Site 1
Other Mapped Sites	2, 3, 7, 8, 9, 10, 11
Survey Type	Detailed
Dominant Topography	Mid Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Spotted gum, turpentine, casuarina
Inherent Soil Fertility	Moderately Low
Slope (%)	5
Aspect	North

Table 2 Profile: Magnesic Brown Kurosol (Site 1)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.15	Grey (10YR 5/1) silty loam, apedal structured. Nil mottling, 35% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.0 – 0.10
	A2 0.15 – 0.30	Grey (7.5YR 5/1) silty loam, moderately structured 5-10 mm blocky peds with moderate consistence and a rough fabric. Nil mottling, 40% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.20 – 0.30
	B21 0.30 – 0.50	Brown (10YR 5/3) heavy clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a smooth fabric. 20% distinct yellow mottles, <5% gravel <5mm, nil segregations, coarse roots common. Poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50
	B22 +0.50	Pale brown (10YR 6/3) heavy clay, massive structure. 20% distinct red mottles, nil stone content, nil segregations, coarse roots common. Poorly drained, layer continues beyond sample depth. Sampled 0.65 – 0.75

Table 3 Chemical Parameters: Magnesic Brown Kurosol (Site 1)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	4.6	Very Strongly Acidic	11.9	Sodic	1.4	Non-Saline	0.5	Ca Deficient
A2	5.4	Strongly Acidic	8.8	Marginally Sodic	0.4	Non-Saline	0.1	Ca Deficient
B21	4.8	Very Strongly Acidic	7.3	Marginally Sodic	0.9	Non-Saline	0.0	Ca Deficient
B22	4.4	Very Strongly Acidic	14.2	Strongly Sodic	2.5	Slightly Saline	0.1	Ca Deficient

Soil Unit 1: Kurosol

Magnesic Red Kurosol

Table 4 Summary: Magnesic Red Kurosol (Site 2)

Overview	
 Landscape Site 2	
ASC Name	Magnesic Red Kurosol
Representative Site	Site 2
Other Mapped Sites	1, 3, 7, 8, 9, 10, 11
Survey Type	Detailed
Dominant Topography	Cutting
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Spotted gum, turpentine
Inherent Soil Fertility	Moderately Low
Slope (%)	7
Aspect	East

Table 5 Profile: Magnesic Red Kurosol (Site 2)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Brown (10YR 5/3) silty loam, weak structured 5-10 mm blocky peds with weak consistence and a rough fabric. Nil mottling, 30% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.0 – 0.10
	B21 0.10 – 0.30	Red (2.5YR 5/8) heavy clay, moderately structured 10-20 mm blocky peds with moderate consistence and a rough fabric. 20% distinct red mottles, 5% gravel 10 mm, nil segregations, course roots common. Well drained with a gradual and even boundary. Sampled 0.20 – 0.30
	B22 0.30 – 0.60	Light red (2.5YR 6/8) heavy clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. 30% distinct red mottles, 10% gravel 10 mm, nil segregations, coarse roots common. Poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50
	B23 +0.60	Pink (2.5YR 8/4) silty clay, massive structure. 30% distinct red mottles, 50% gravel 5 mm, nil segregations, coarse roots common. Poorly drained, layer continues beyond sample depth. Sampled 0.65 – 0.75

Table 6 Chemical Parameters: Magnesic Red Kurosol (Site 2)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.0	Very Strongly Acidic	4.3	Non-Sodic	0.6	Non-Saline	0.8	Ca Deficient
B21	5.0	Very Strongly Acidic	2.4	Non-Sodic	0.3	Non-Saline	0.1	Ca Deficient
B22	4.9	Very Strongly Acidic	2.0	Non-Sodic	0.2	Non-Saline	0.0	Ca Deficient
B23	4.8	Very Strongly Acidic	2.2	Non-Sodic	0.3	Non-Saline	0.0	Ca Deficient

Soil Unit 1: Kurosol

Grey Kurosol

Table 7 Summary: Grey Kurosol (Site 3)

Overview	
 Landscape Site 3	
ASC Name	Grey Kurosol
Representative Site	Site 3
Other Mapped Sites	1, 2, 7, 8, 9, 10, 11
Survey Type	Checked
Dominant Topography	Mid Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Spotted gum, turpentine, casuarina
Inherent Soil Fertility	Moderately Low
Slope (%)	5
Aspect	North

Table 8 Profile: Yellow Kurosol (Site 3)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Brown (7.5YR 3/1) sandy loam, apedal structure. Nil mottling, 40% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.0 – 0.10
	B21 0.20 – 0.50	Grey (10YR 5/1) clay, moderately structured 10-20 mm blocky peds with moderate consistence and a rough fabric. Nil mottling, 20% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.20 – 0.30
	B22 +0.50	Grey (10YR 6/1) clay, strongly structured 20-50 mm blocky peds with moderate consistence and a rough fabric. 20% distinct red mottles, 30% gravel <20 mm, nil segregations, coarse roots common. Poorly drained, layer continues beyond sample depth. Sampled 0.50 – 0.60

Table 9 Chemical Parameters: Grey Kurosol (Site 3)

Layer	Field pH		Field Dispersion	Field Effervescence
	Unit	Rating	Rating	Rating
A1	5.5	Strongly Acidic	Nil	Nil
B21	5.0	Strongly Acidic	Moderate	Nil
B22	5.0	Strongly Acidic	High	Nil

Soil Unit 1: Kurosol

Magnesic Grey Kurosol

Table 10 Summary: Magnesic Grey Kurosol (Site 7)

Overview	
 Landscape Site 7	
ASC Name	Magnesic Grey Kurosol
Representative Site	Site 7
Other Mapped Sites	1, 2, 3, 8, 9, 10, 11
Survey Type	Detailed
Dominant Topography	Upper Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Grass tree, turpentine, spotted gum
Inherent Soil Fertility	Moderately Low
Slope (%)	
Aspect	South West

Table 11 Profile: Magnesic Grey Kurosol (Site 7)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.25	Very dark grey (7.5YR 3/1) silty loam, moderately structured 5-10 mm blocky peds with weak consistence and a rough fabric. Nil mottling, <5% gravel 5 mm, nil segregations, abundant fine roots. Well drained with an abrupt and even boundary. Sampled 0.0 – 0.10
	B21 0.25 – 0.60	Light yellowish-brown (2.5YR 6/3) silty clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. 20% distinct brown mottles, nil stone content, nil segregations, course roots common. Poorly drained with a gradual and even boundary. Sampled 0.30 – 0.40
	B22 +0.60	Light brownish-grey (10YR 6/2) silty clay loam, massive structure. 30% distinct yellow mottles, nil stone content, nil segregations, abundant fine roots. Poorly drained, layer continues beyond sample depth. Sampled 0.65 – 0.75

Table 12 Chemical Parameters: Magnesic Grey Kurosol (Site 7)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.1	Strongly Acidic	3.0	Non-Sodic	0.3	Non-Saline	0.1	Ca Deficient
B21	5.0	Very Strongly Acidic	2.7	Non-Sodic	0.3	Non-Saline	0.0	Ca Deficient
B22	4.9	Very Strongly Acidic	4.0	Non-Sodic	0.4	Non-Saline	0.0	Ca Deficient

Soil Unit 1: Kurosol

Magnesic Grey Kurosol

Table 13 Summary: Magnesic Grey Kurosol (Site 8)

Overview	
 Landscape Site 8	
ASC Name	Magnesic Grey Kurosol
Representative Site	Site 8
Other Mapped Sites	1, 2, 3, 7, 9, 10, 11
Survey Type	Detailed
Dominant Topography	Upper Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Grass tree, turpentine, spotted gum
Inherent Soil Fertility	Moderately Low
Slope (%)	8
Aspect	South West

Table 14 Profile: Magnesic Grey Kurosol (Site 8)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.15	Greyish brown (7.5YR 5/2) silty loam, weakly structured 5-10 mm blocky peds with weak consistence and a rough fabric. Nil mottling, 15% gravel 5 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.0 – 0.10
	A2 0.15 – 0.30	Dark greyish brown (2.5YR 4/2) silty loam, weakly structured 5-20 mm blocky peds with weak consistence and a rough fabric. Nil mottling, <5% gravel <5 mm, nil segregations, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.20 – 0.30
	B21 0.30 – 0.60	Pale olive (5Y 6/3) light-medium clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. 30% distinct yellow mottles, nil stone content, nil segregations, course roots common. Poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50
	B22 0.60 – 0.90	Light yellowish-brown (2.5YR 6/3) silty clay loam, moderately structured 10-40 mm subangular blocky peds with strong consistence and a rough fabric. 20% distinct yellow mottles, 10% gravel 5 mm, nil segregations, course roots common. Poorly drained. Sampled 0.65 – 0.75

Table 15 Chemical Parameters: Magnesic Grey Kurosol (Site 8)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	4.9	Very Strongly Acidic	3.4	Non-Sodic	0.5	Non-Saline	0.3	Ca Deficient
A2	5.2	Strongly Acidic	3.5	Non-Sodic	0.3	Non-Saline	0.1	Ca Deficient
B21	5.1	Strongly Acidic	3.6	Non-Sodic	0.4	Non-Saline	0.0	Ca Deficient
B22	5.1	Strongly Acidic	5.3	Non-Sodic	0.6	Non-Saline	0.0	Ca Deficient

Soil Unit 1: Kurosol

Yellow Kurosol

Table 16 Summary: Yellow Kurosol (Site 9)

Overview	
 Landscape Site 9	
ASC Name	Yellow Kurosol
Representative Site	Site 9
Other Mapped Sites	1, 2, 3, 7, 8, 10, 11
Survey Type	Checked
Dominant Topography	Mid Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Grass tree, turpentine, spotted gum
Inherent Soil Fertility	Moderately Low
Slope (%)	
Aspect	North East

Table 17 Profile: Yellow Kurosol (Site 9)

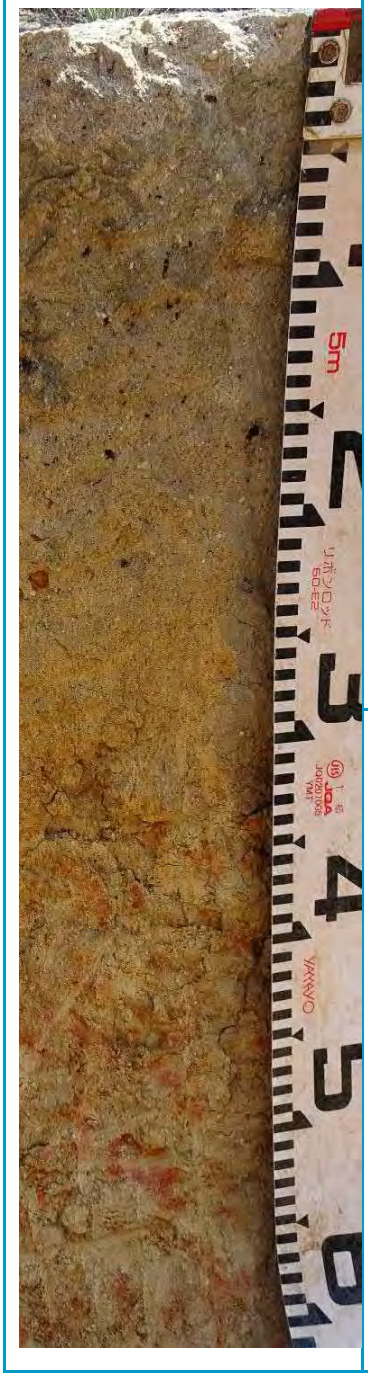
Profile	Horizon / Depth (m)	Description
	A2 0.0 – 0.30	A1 horizon has been eroded away and is not present. Light brown (7.5YR 6/4) bleached sandy loam, weakly structured 5-10 mm blocky peds with weak consistence and a rough fabric. Nil mottling, 30% gravel <5 mm, nil segregations, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.0 – 0.10
	B2 +0.30	Brownish yellow (7.5YR 6/6) clay, strongly structured 10-40 mm subangular blocky peds with strong consistence and a rough fabric. 30% distinct orange mottles, nil stone content, nil segregations, course roots common Poorly drained, layer continues beyond sample depth. Sampled 0.30 – 0.40

Table 18 Chemical Parameters: Yellow Kurosol (Site 9)

Layer	Field pH		Field Dispersion	Field Effervescence
	Unit	Rating	Rating	Rating
A2	5.0	Strongly Acidic	Slight	Nil
B2	5.0	Strongly Acidic	High	Nil

Soil Unit 1: Kurosol

Magnesic Yellow Kurosol

Table 19 Summary: Magnesic Yellow Kurosol (Site 10)

Overview	
 Landscape Site 10	
ASC Name	Magnesic Yellow Kurosol
Representative Site	Site 10
Other Mapped Sites	1, 2, 3, 7, 8, 9, 11
Survey Type	Detailed
Dominant Topography	Mid Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Grass tree, turpentine, red gum, casuarina
Inherent Soil Fertility	Moderately Low
Slope (%)	6
Aspect	North

Table 20 Profile: Magnesic Yellow Kurosol (Site 10)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Light olive brown (2.5YR 5/3) silty loam, weakly structured 5-10 mm blocky peds with weak consistence and a rough fabric. Nil mottling, 30% gravel <5 mm, nil segregations, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.0 – 0.10
	B21 0.20 – 0.60	Yellow (10YR 7/8) light clay, strongly structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. 30% distinct red mottles, <5% gravel <5 mm, nil segregations, course roots common. Poorly drained with a gradual and even boundary. Sampled 0.30 – 0.40
	B22 +0.60	Reddish-yellow (7.5YR 6/8) heavy clay, moderately structured 10-40 mm subangular blocky peds with strong consistence and a rough fabric. 20% distinct red mottles, 30% gravel <5 mm, nil segregations, course roots common. Poorly drained, layer continues beyond sample depth. Sampled 0.65 – 0.75

Table 21 Chemical Parameters: Magnesic Yellow Kurosol (Site 10)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.2	Strongly Acidic	1.3	Non-Sodic	0.2	Non-Saline	0.3	Ca Deficient
B21	5.4	Strongly Acidic	3.3	Non-Sodic	0.3	Non-Saline	0.0	Ca Deficient
B22	4.9	Very Strongly Acidic	3.0	Non-Sodic	0.3	Non-Saline	0.0	Ca Deficient

Soil Unit 1: Kurosol

Magnesic Red Kurosol

Table 22 Summary: Magnesic Red Kurosol (Site 11)

Overview	
 Landscape Site 11	
ASC Name	Magnesic Red Kurosol
Representative Site	Site 11
Other Mapped Sites	1, 2, 3, 7, 8, 9, 10
Survey Type	Detailed
Dominant Topography	Mid Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Turpentine, casuarina, red gum
Inherent Soil Fertility	Moderately Low
Slope (%)	5
Aspect	South

Table 23 Profile: Magnesic Red Kurosol (Site 11)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.10	Brown (7.5YR 5/2) silty loam, weakly structured 5-10 mm blocky peds with weak consistence and a rough fabric. Nil mottling, <5% gravel <5 mm, nil segregations, abundant fine roots. Well drained with a clear and even boundary. Sampled 0.0 – 0.10
	B21 0.10 – 0.40	Yellowish-red (5YR 4/6) heavy clay, weakly structured 5-20 mm blocky peds with weak consistence and a rough fabric. 20% distinct red mottles, 10% gravel <5 mm, nil segregations, course roots common. Poorly drained with a gradual and even boundary. Sampled 0.20 – 0.30
	B22 0.40 – 0.60	Grey (7.5YR 6/1) clay loam, strongly structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. 20% distinct yellow mottles, <5% gravel 5 mm, nil segregations, course roots common. Poorly drained with a gradual and even boundary. Sampled 0.40 – 0.50
	B23 +0.60	Light reddish-grey (2.5YR 7/1) medium clay, moderately structured 10-40 mm subangular blocky peds with strong consistence and a rough fabric. 30% distinct red mottles, 10% gravel 5 mm, nil segregations, course roots common. Poorly drained, layer continues beyond sample depth. Sampled 0.65 – 0.75

Table 24 Chemical Parameters: Magnesic Red Kurosol (Site 11)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	4.8	Very Strongly Acidic	2.0	Non-Sodic	0.3	Non-Saline	0.1	Ca Deficient
B21	5.2	Strongly Acidic	2.1	Non-Sodic	0.2	Non-Saline	0.0	Ca Deficient
B22	5.0	Very Strongly Acidic	2.4	Non-Sodic	0.3	Non-Saline	0.0	Ca Deficient
B23	4.9	Very Strongly Acidic	3.6	Non-Sodic	0.4	Non-Saline	0.0	Ca Deficient

Soil Unit 2: Kandosol

Magnesic Yellow Kandosol

Table 25 Summary: Magnesic Yellow Kandosol (Site 4)

Overview	
 Landscape Site 4	
ASC Name	Magnesic Yellow Kandosol
Representative Site	Site 4
Other Mapped Sites	5
Survey Type	Detailed
Dominant Topography	Upper Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Red gum, casuarina
Inherent Soil Fertility	Moderately Low
Slope (%)	8
Aspect	East

Table 26 Profile: Magnesic Yellow Kandosol (Site 4)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.15	Brown (10YR 5/3) loamy sand, apedal structured. Nil mottling, <5% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.0 – 0.10
	B2 0.15 – 0.40	Light yellowish-brown (10YR 6/4) loam, moderately structured 20-40 mm subangular blocky peds with strong consistence and a rough fabric. 20% distinct orange mottles, nil stone content, nil segregations, course roots common. Poorly drained with a gradual and even boundary. Sampled 0.25 – 0.35
	BC +0.40	Weathered parent material Not sampled

Table 27 Chemical Parameters: Yellow Kandosol (Site 4)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.1	Strongly Acidic	3.7	Non-Sodic	0.7	Non-Saline	0.2	Ca Deficient
B2	5.6	Moderately Acidic	6.0	Non-Sodic	0.3	Non-Saline	0.0	Ca Deficient

Soil Unit 2: Kandosol

Magnesic Red Kandosol

Table 28 Summary: Magnesic Red Kandosol (Site 5)

Overview	
 Landscape Site 5	
ASC Name	Magnesic Red Kandosol
Representative Site	Site 5
Other Mapped Sites	4
Survey Type	Detailed
Dominant Topography	Plateau
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Casuarina, red gum, grass tree
Inherent Soil Fertility	Moderately Low
Slope (%)	7
Aspect	Nil

Table 29 Profile: Magnesic Red Kandosol (Site 5)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Brown (10YR 5/3) loamy sand, apedal structured. Nil mottling, 25% gravel 10-40 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.0 – 0.10
	B2 0.20 – 0.40	Light red (2.5YR7/6) loam, moderately structured 20-40 mm subangular blocky peds with moderate consistence and a rough fabric. 10% faint grey mottles, <5% gravel 10-40 mm, nil segregations, coarse roots common. Poorly drained. Sampled 0.25 – 0.35

Table 30 Chemical Parameters: Magnesic Red Kandosol (Site 5)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	5.0	Very Strongly Acidic	3.1	Non-Sodic	0.6	Non-Saline	0.4	Ca Deficient
B2	5.5	Strongly Acidic	3.7	Non-Sodic	0.2	Non-Saline	0.0	Ca Deficient

Soil Unit 3: Dermosol

Eutrophic Grey Dermosol

Table 31 Summary: Eutrophic Grey Dermosol (Site 6)

Overview	
 Landscape Site 6	
ASC Name	Eutrophic Grey Dermosol
Representative Site	Site 6
Other Mapped Sites	Nil
Survey Type	Detailed
Dominant Topography	Upper Slope
Microrelief	Nil
Dominant Land Use	Native Vegetation
Vegetation	Red gum, grass tree, turpentine
Inherent Soil Fertility	Moderately Low
Slope (%)	5
Aspect	South East

Table 32 Profile: Eutrophic Grey Dermosol (Site 6)

Profile	Horizon / Depth (m)	Description
	A1 0.0 – 0.20	Very dark grey (7.5YR 3/1) loamy sand, apedal structure. Nil mottling, 25% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.0 – 0.10
	B21 0.20 – 0.40	Dark grey (10YR 4/1) silty loam, moderately structured 5-10 mm blocky peds with moderate consistence and a rough fabric. Nil mottling, 25% gravel 10 mm, nil segregations, abundant fine roots. Well drained with a gradual and even boundary. Sampled 0.20 – 0.30
	B22 0.40 – 0.60	Light yellowish-brown (2.5YR 6/3) silty loam, moderately structured 10-20 mm blocky peds with moderate consistence and a rough fabric. Nil mottling, 10% gravel 10 mm, nil segregations, coarse roots common. Well drained with a gradual and even boundary. Sampled 0.40 – 0.50
	B23 0.60 – 0.90	Pale olive (5Y 6/3) silty loam, moderately structured 5-10 mm blocky peds with moderate consistence and a rough fabric. Nil mottling, 20% gravel 10 mm, nil segregations, coarse roots common. Well drained with a clear and even boundary. Sampled 0.65 – 0.75
	BC +0.90	Weathered parent material Not sampled

Table 33 Chemical Parameters: Eutrophic Grey Dermosol (Site 6)

Layer	pH (1:5 water)		ESP		ECe		Ca:Mg	
	Unit	Rating	%	Rating	dS/m	Rating	Ratio	Rating
A1	4.8	Very Strongly Acidic	3.4	Non-Sodic	0.8	Non-Saline	1.8	Ca Low
B21	5.1	Strongly Acidic	1.6	Non-Sodic	0.1	Non-Saline	2.2	Ca Low
B22	5.1	Strongly Acidic	2.4	Non-Sodic	0.1	Non-Saline	2.0	Ca Low
B23	5.1	Strongly Acidic	5.2	Non-Sodic	0.2	Non-Saline	2.0	Ca Low

APPENDIX C

Soil Stripping Criteria Assessment

Table 1 Topsoil Stripping Criteria Assessment

Site	Structure	Coherence	Mottling	Macro-Structure	Force to Disrupt Peds	Texture	Gravel & Sand Content	pH (water)	Salt Content
	>30% Peds	Coherent (wet and dry)	Absence	>10 cm	<3 force	Finer than Fine SL	<60%	4.5 to 8.4	<1.5 dS/m
1	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✗	✓	✓	✓	✓
3	✗	✗	✓	✓	✗	✗	✓	✓	✓
4	✗	✗	✓	✓	✗	✗	✓	✓	✓
5	✗	✗	✓	✓	✗	✗	✓	✓	✓
6	✗	✗	✓	✓	✗	✗	✓	✓	✓
7	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	✓	✓	✓	✓	✓	✗	✓	✓	✓
10	✓	✓	✓	✓	✓	✓	✓	✓	✓
11	✓	✓	✓	✓	✓	✓	✓	✓	✓

Table 2 Subsoil Stripping Criteria Assessment

Site	Structure	Coherence	Mottling	Macro-Structure	Force to Disrupt Peds	Texture	Gravel & Sand Content	pH (water)	Salt Content
	>30% Peds	Coherent (wet and dry)	Absence	>10 cm	<3 force	Finer than Fine SL	<60%	4.5 to 8.4	<1.5 dS/m
1	✓	✓	✗	✓	✓	✓	✓	✓	✗
2	✓	✓	✗	✓	✓	✓	✓	✓	✓
3	✓	✓	✗	✓	✓	✓	✓	✓	✓
4	✓	✓	✗	✓	✓	✓	✓	✓	✓
5	✓	✓	✗	✓	✓	✓	✓	✓	✓
6	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	✓	✓	✗	✓	✓	✓	✓	✓	✓
8	✓	✓	✗	✓	✓	✓	✓	✓	✓
9	✓	✓	✗	✓	✓	✓	✓	✓	✓
10	✓	✓	✗	✓	✓	✓	✓	✓	✓
11	✓	✓	✗	✓	✓	✓	✓	✓	✓

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